EUROPEAN SPACE AGENCY
DIRECTORATE OF TECHNICAL AND OPERATIONAL SUPPORT
MISSION OPERATIONS DEPARTMENT

INFRARED SPACE OBSERVATORY (ISO)

Launch and Early Orbit Phase & Satellite Commissioning Phase Report

D/TOS-ISO-LEOP/SCP/JF

ISSUE: 1

REV: 0

31 October, 1997

DOCUMENT APPROVAL

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LIST OF ABBREVIATIONS AND ACRONYMS

A

ACC	Attitude Control Computer
AGC	Automatic Frequency Control
AM	Acquisition Mode
AMA	Absolute Measurement Accuracy
AND	Alphanumeric Display
ANO	Anomaly Report
AOCS	Attitude and Orbit Control Subsystem
AOP	Attitude Operations Plan
AOS	Acquisition Of Signal
AP	Applications Programme
APD	Absolute Pointing Drift
APE	Absolute Pointing Error
APH	Attitude [Apertures] Pointing History
ARIANE-44P	Ariane-4 Launcher with 4 solid Propellant boosters attached
AR-4	Ariane-4
ARM	Arming
ARS	Adjoint Reseau Sol
AS	Aerospatiale [Cannes, France]
ASW	Address and Synchronisation Word
ASW	Application Software
AUTO	Automatic

B

BAT	Battery
BCR	Battery Charge Regulator
BCT	Break Contact
BDR	Battery Discharge Regulator
BMC	Battery Management Circuit
BOL	Beginning Of Life
BOTM	Battery Overcharge Monitoring [OBDH-ASW]
BPS	Bits Per Second
BSW	Basic Software
BUVM	Battery Under Voltage Monitoring [OBDH-ASW]

C

CA	Constant Area [STR-RAM]
CA	California, USA
CAL	Calibration
CAM	Infrared Array Camera
CATBED	Catalyst Bed
CCD	Charge Coupled Device
CCS	Central Command Schedule
CE	Cryo Electronics
CEU	Command Execution Unit
CEV	Command Execution Verification
CHCON	Charge Control [OBDH-ASW]
CIDT	CAM Instrument Dedicated Team
CM	Calibration Mode

CMD	Command
CPDU	Command Processing and Distribution Unit
CPU	Central Processing Unit
CRP	Contingency Recovery Procedure
CRYO	Cryogenic
CTU	Central Terminal Unit
CTV	Command Transmission Verification

D

DCR	Dedicated Control Room
DEC	Declination
DELTA-V	Velocity Increment [orbit correction manoeuvre]
DFT	Data Flow Test
D/ESTEC	Director of ESTEC [old, now see: D/TOS]
DLC	Dry Loop Command
DLCM	Direct Liquid Content Measurement
DMU	Distribution and Monitoring Unit [AOCS/RCS Power]
DOC	Document
DOD	Depth Of Discharge
D/OPS	Director of Operations [ESOC, now: D/TOS]
DP	Derived Parameter
DPD	Data Processing Division [ESOC]
DRAM	Default RAM [ACC database]
DROM	Default ROM [ACC database]
D/SCI	Director of the Science [ESA/HQ]
DSN	Deep Space Network [NASA/JPL]
DSS-27	Deep Space Station-27 [Goldstone]
D/TOS	Director of Technical and Operational Support

E

EGSE	Electrical Ground Support Equipment
ELS	Earth Limb Sensor
ELS-E	Earth Limb Sensor Electronics
ELS-S	Earth Limb Sensor Head
EOC	End Of Charge
EOL	End Of Life
ERD	Event Related Data [AOCS]
ESA	European Space Agency
ESOC	European Space Operations Centre [Darmstadt, Germany]
ESTEC	European Space Research and Technology Centre [Noordwijk, Holland]

F

FCP	Flight Control Procedure
FCT	Flight Control Team
FD	Flight Dynamics
FDS	Flight Dynamics System
FEC	Front End Controller
FM	Flight Model
FOD	Flight Operations Director
FOP	Flight Operations Plan

FOV	Field Of View
FP	Fabry-Perot
FPG	Focal Plane Geometry
FPM	Fine Pointing Mode
FPO	First Power On
FPU	Focal Plane Unit
FSS	Fokker Space and Systems
FSS	Fine Sun Sensor
FSS-E	Fine Sun Sensor Electronics
FSS-S	Fine Sun Sensor Head

G

GDS	Goldstone Station [Barstow, CA., USA]
GHE	Gaseous Helium
GRD	Graphics Display
GSC	Guyana Space Centre [Kourou, Fr. Guyana]
GYP	Gyro Package
GYR	Gyroscope
GYR-E	Gyro Electronics
GYR-S	Gyro Sensor

H

HE-I	Normal Fluid Helium
HE-II	Superfluid Helium
HK	House Keeping Mode [OBDH]
HSS	Helium Subsystem
HW	Hardware
H/W	Hardware

I

ICD	Interface Control Document
ICS	Instrument Command Sequence
ID	Identification
IDCS	ISO Dedicated Control System
IDT	Instrument Dedicated Team
IFOP	Scientific Instruments Flight Operations Plan
I/F	Interface
INFO	Information
INSCON	Instrument Controller
INTEL W/S	Intel Workstation [PSR]
I/O	Input/Output
IPF	Immediate Parameter File [TC]
IR	Infrared
IS	Instrument Station [SOC]
ISO	Infrared Space Observatory
ISODV	ISO Development [Computer - IDCS]
ISORT	ISO Real-Time [Computer - IDCS]
IUM	ISO User Manual

J

JPL	Jet Propulsion Laboratory, Pasadena, CA.

K

KAL	Keep Alive Line
KBPS	Kilo Bit Per Second
KOUROU	ESA LEOP Station [French Guyana]
KRU	Kourou

L

LA	Launch Mode [OBDH]
LEOP	Launch and Early Orbit Phase
LEOPCS	LEOP Computer System
LEOPDV	LEOP Development [Computer - IDCS]
LEOPRT	LEOP Real-Time [Computer - IDCS]
LIDT	LWS Instrument Dedicated Team
LOS	Loss Of Signal
LSB	Least Significant Bit
LV	Latched Valve
LVSS	Launch Vehicle Separation Strap
LWS	Long Wavelength Spectrometer Experiment

M

M	Manual
MACS	Modular Attitude Control System [AOCS]
MAX	Maximum
MCR	Main Control Room [ESOC]
MEA	Main Error Amplifier
MF	Master Function
MIN	Minutes
MJD	Modified Julian Day
ML	Memory Load
MRU	Main Regulator Unit
M&O	Maintenance and Operations
MP	Mission Planner
MPP1	Mission Planning Phase-1 [SOC]
MPP2	Mission Planning Phase-2 [SCC]
MPTS	Multiple Purpose Tracking System
MRT	Mission Readiness Test
MSB	Most Significant Bit
M/S	Metre per Second
MWC	Multiple Word Command

N

N	Nominal
N/A	Not Applicable
NASA	National Aeronautics and Space Agency [USA]
NCA	Non Contaminating Actuator
NCR	Non Conformance Report
NDIU	Network Data Interface Unit
NMS	Newton -Metre- Second [Angular Momentum]

NOD	Network Operations Division [ESOC]

O

OAD	Orbit and Attitude Division [ESOC]
OBDH	On Board Data Handling Subsystem
OBS	On Board Software
OBSF	On Board data Storage Facility [OBDH-ASW]
OBSW	On Board Software
OBT	On Board Time
OCC	Operations Control Centre [ESOC]
ODS	Operational Data Server
OOL	Out Of Limits
OS	Operating System
OSS	Optical Support Structure
OTF	On Target Flag

P

PCS	Power Conditioning Subsystem
PCS	Permanent [Instrument] Command Sequence
PDU	Power Distribution Unit
PERTH	ESA LEOP Station [Western Australia]
PER	Perth
PHT	Photo-Polarimeter Instrument
PI	Principal Investigator
PIDT	PHT Instrument Dedicated Team
PLM	Payload Module
PM	Protected Memory
POF	Planned Observation File [MPP1]
PPL	Programmed Pointing List
PPM	Programmable Pointing Mode
PPS	Passive Phase Separator
PRAM	Programmable Random Access Memory
PROM	Programmable Read Only Memory
PSF	Planning Skeleton File [MPP2]
PSOF	Planned Spacecraft Operations File [MPP2]
PSS	Portable Software Simulator
PT	Pressure Transducer
PTV	Pre Transmission Validation
PV	Performance Verification Phase

Q

QSS	Quadrant Star Sensor
QSS-E	Quadrant Star Sensor Electronics
QDS-S	Quadrant Star Sensor Head

R

R	Redundant
RA	Right Ascension
RAC	Real-time Attitude Command
RAM	Random Access Memory

RCS	Reaction Control Subsystem
RD	Reference Document
REL	Relay
REV	Revolution [Orbit]
RFCON	Radio Frequency Control [OBDH-ASW]
RFS	Radio Frequency Subsystem
RMC	Real-time Multiple Word Command
ROM	Read Only Memory
RP	Routine Phase
RPE	Relative Pointing Error
RPM	Raster Pointing Mode
RT	Real Time
R/T	Real Time
RTU	Remote Terminal Unit [OBDH]
RWL	Reaction Wheel
RWS	Reaction Wheel System
RX	Receiver

S

SAA	Solar Aspect Angle
SAM	Star Acquisition Mode
SAR	Satellite Acceptance Review
SAS	Sun Acquisition Sensor
SBM	Stand-By Mode
S/C	Spacecraft
SC	Science
SCC	Spacecraft Control Centre [dedicated :see VILSPA]
SCOM	Science Operations Manager
SCP	Satellite Commissioning Phase
SCP	Satellite Commissioning Plan
SDB	Satellite Data Base
SEC	Second
SEPAR	Separation [OBDH-ASW]
SEU	Single Event Upset
SIDT	SWS Instrument Dedicated Team
SM	Survival Mode
SOC	Science Operations Centre [dedicated: see VILSPA]
SOE	Spacecraft Operations Engineer
SOM	Spacecraft Operations Manager
SPR	Software Problem Report
SPACON	Spacecraft Controller
S/S	Subsystem
SSH	Sun Shade Heater
SSO	Solar System Objects
STDM	Satellite Trajectory Data Messages
STR	Star Tracker
STR-E	Star Tracker Electronics
STR-S	Star Tracker Sensor
S/TR	Search & Tracking Mode [STR]
SVM	Service Module
SW	Short Wavelength
S/W	Software
SWS	Short Wavelength Spectrometer Experiment

T

TB	Thermal Balance [Test]
TC	Telecommand
TCCON	Telecommand I/F Control [OBDH-ASW]
TCE	Telecommand Encoder
TEMP	Temperature
THC	Thermal Control Subsystem
THS	Thermal System [OBDH-ASW]
TM	Telemetry
TMCON	Telemetry I/F Control [OBDH-ASW]
TMP	Telemetry Processor
TO	Transfer Orbit
TR	Transition
TT	Time Tagged
TV	Thermal Vacuum [Test]
TX	Transmitter
T4	Transition-4 [OBDH; LA ->HK]

U

USA	United States of America
USD	User Selectable Data
UTC	Universal Time Coordinated

V

VILSPA	ESA Villafranca del Castillo Satellite Tracking Station, Madrid/Spain
VIL	Vilspa

W

WD	Watch Dog
WDE	Wheel Drive Electronics
W/O	Without
WRT	With Respect To
WS	Workstation
W/S	Workstation

X

X-AXIS	X-Axis (Roll) in the S/C Control Frame

Y

Y-AXIS	Y-Axis (Pitch) in the S/C Control Frame

Z

Z-AXIS	Z-Axis (Yaw) in the S/C Control Frame

CONTENTS

1 INTRODUCTION

1.1 Purpose

ISO was launched at 01:20 UTC on 17 November, 1995.

This report provides a record of the ISO mission during the Launch and Early Orbit Phase [LEOP] conducted from the ESOC/OCC, the handover of the Satellite to the Villafranca dedicated Spacecraft Control Centre [SCC] and Science Operations Centre [SOC] facilities, and the subsequent Satellite Commissioning Phase [SCP] operations conducted from Villafranca. Reporting about SCP activities are restricted to major events, such as the initial switch on of the scientific instruments, the orbit correction manoeuvre, the cryostat cover ejection, and the closure of the high flow venting valves etc.

1.2 Scope

The report covers the period starting with OCC pre-launch activities at 17:30 on 951116, i.e. at -7.5 hours prior to lift off, which took place at 01:20 on 951117, and terminating with revolution 21 of the Satellite Commissioning Phase [SCP]at 02:57 on 951209. However, the SCP part only covers major spacecraft operations related events under responsibility of D/OPS. Spacecraft and ground segment performance are covered.

The report also provides an assessment of the functional performances of the spacecraft subsystems during operations.

Note: All times quoted in the report are given in Universal Time Coordinated [UTC], unless otherwise indicated.

Details on platform and payload subsystems performances can be found in the following documents:

ISO SATELLITE COMMISSIONING PHASE REPORT

document reference ISO.AS.1400.TN.1404. This report is provided by the ISO Prime Contractor Aerospatiale/Cannes and covers LEOP and SCP.

ISO SCIENTIFIC INSTRUMENTS IN-ORBIT COMMISSIONING REPORT

document reference ISO-RP-Z-12573. This report is provided by the ISO-PROJECT/ESTEC and covers the scientific instruments check-out and commissioning during SCP.

2 PRE-LAUNCH ACTIVITIES

The original launch was scheduled for 01:42 on the 11 th of November, 1995. The pre-launch briefing was held in ESOC on Friday, the 10 th of November in preparation, and everything was committed and ready to support the launch. Around 14:00 Arianespace post-poned the launch of Ariane Flight V-80 because of an anomaly detected in the launcher's flight computer destined for a later Ariane flight, pending further investigation to determine the cause of the anomaly.

The launch was subsequently re-scheduled for the 17 th of November.

2.1 Key Events

S/C telemetry data monitoring

Flight Control Team-B [FCT-B] was on console in the OCC/ MCR at T0-7:25 which corresponds to 17:55:00 on 951116. An IDCS checkout was performed by DPD/Software Support and the Maintained Images of the S/C on-board memories were initialised on both computers LEOP/RT and LEOP/DV.

At T0-7:00 the Adjoint Reseau SOL [ARS] reported from the launch range that the spacecraft was switched on. Real - time telemetry was received and processed on LEOP/ RT and LEOP/DV in the OCC.

The following parameters were seen unexpected as being Out Of Limits:

B136 GYRO-2 motor current equals 9.0 mA while GYRO-2 was OFF. This was explained by the fact that the calibration curve of the GYRO-2 motor current was updated in the IDCS [bias of 9.0 mA], but not the limit check while the motor was OFF.

Parameters Q187, Q178, Q165, Q116, Q122 and Q107; the Battery TEMP's were above 15° C due to environmental conditions on the launch pad and the on-going charging process of the batteries.

In the period from T0-6:05 to T0-2:30 the following activities were carried out:

- Dump of the S/C on board memories [OBDH, ACC];
- Data Flow Tests with all LEOP ground stations [KRU, PER, VIL];
- Ranging Calibrations with all three LEOP ground stations.

At T0-2:15 Handover from FCT-B to FCT-A took place.

At T0-1:42 Flight Dynamics reported that the expected on-board antenna should be +Y for initial AOS at Perth, while the spacecraft TM indicated the -Y antenna selected.

At T0-1:30 the draining of the He-I tank began. The latter was required to empty the tank before lift-off and upon completion, to close the exit valves. The He-I was required to keep the He-II in superfluid conditions during the 3 days launch autonomy, while the He-II tank remained ceiled after the last He-II top-up was performed at the launch pad. 331 kg He-II were loaded at launch. To ensure as complete an evacuation as possible

from the He-I tank it was heated using a 650 Watt heater to a temperature of about 30 K. The operation was successfully completed one hour and five minutes later.

At T0-1:17 the OCC requested a change and the-Y antenna was selected.

At T0-0:59 the four instrument compensation heaters [SWS/LWS/PHT/CAM] were switched on.

At T0-0:50 parameter K035 went out of limits > 2.267 K and was reported to Project/Kourou.

At T0-0:29 -Y antenna was re-selected, since when separation is detected by the OBDH, the application software "SEPAR" will select by default the -Y antenna again.

Launch Configuration

At T0-0:25 the rapid depletion of the Helium-I in the auxiliary tank was completed. The heaters H701, H702 and H501 were switched off and Valves V501 and V503 were closed, i.e. launch configuration was established.

Countdown

The countdown proceeded smoothly.

At T0-0:13 Project reported the spacecraft ready for launch.
At T0-0:10 OCC and LEOP Network Stations were reported ready for launch.
At T0-0:06 the automatic launch sequence started.

The spacecraft was switched to internal power on batteries at T0-6 minutes. Since both transmitters were off, telemetry reception at the OCC ceased with the umbilical removal at lift-off.

3 LAUNCH AND EARLY ORBIT PHASE SUMMARY

3.1 Launch

ISO was launched by an ARIANE 44P [with 4 solid strap on boosters] on Flight V-80 from Kourou at 01:20 on 17 November, 1995. The official lift off time was on day 321 at 01:20:04.477. Table 3.1 shows the nominal ISO Launch Phase Events.

Table 3.1 - ISO Launch Phase Events

T +TIME Mn:Sc:ss	EVENT	ACTION
H0 -09:00:00		Inertial platform separation.
00:00:00	H0	Launcher ignition.
00:04:20		Solid boosters ignition and lift-off.
00:11:00		End vertical rise. Beginning of roll & pitch motion.
01:10:00		Solid boosters jettison.
03:26:60	H1	First stage burnout.
03:31:60		First stage separation.
03:34:40		Second stage main thrust start.
04:24:60		Fairing jettison.
05:36:90	H2	Second stage burnout.
05:41:90		Second stage separation. Third stage ignition.
05:46:95		Third stage main thrust start.
18:39:30	H3	Third stage burnout.
18:41:30	H4	Satellite injection.
20:31:30	H4.1	ISO separation.

" Dry loop" commands were issued by the AR-4 electronics at H0 + 307,6 sec to arm Cryo-Valves V501/V503 [External Venting Valves] and to open the Valves at H0 + 317.6 sec, respectively.

The Cryo-Valves V103/V106 [Open He-II tank] were armed at H0 + 876.9 sec and opened at H0 + 886.9 sec, respectively. The latter started the Passive Phase Separator [PPS].The "dry loop" commands were confirmed in the AR-4 telemetry and by ARIANESPACE.

The trajectory was nominal and, after successful re-orientation of the composite Ariane 3rd stage/ISO, separation was reported by Arianespace at 01:40:50.

First orbit determination from Flight Dynamics revealed that the initial transfer orbit [TO] was very accurate and the dispersion on all elements much less than standard deviation.

The Apogee height was 71.577 Km, about 43 Km lower than the expected Apogee of 71.620 Km. The Perigee height of 500 Km and the Inclination of 5.25 ° were as expected. The orbital period was 1 min. 15 sec. higher than expected.

3.2 ISO separation and initial autonomous events

Separation was reported by Arianespace at 01:40:50. Shortly after the Libreville tracking station reported the acquisition of the ISO downlink carrier. At 01:47 the ESA Malindi station reported ISO telemetry lock with a signal strength of -44.8 dbm. Note, the Malindi station was not part of the ISO LEOP Network and was providing ad hoc support.

After Ariane 3rd stage/ISO separation was detected by the OBDH, Mode Transition T4 was triggered with a 32 seconds delay, which configured the OBDH from Launch Mode [LA] to Housekeeping Mode [HK]. T4 executed successfully. At Mode Transition T4 the following events occur:

- Send LM 5 command to AOCS to inform it that separation has occurred [in case either of the AOCS separation straps fail to indicate separation];
- Select -Y Antenna;
- Command on Transmitter-1;
- Command open Cryo Valves V501, V503, V504 and V505;
- Command Battery Discharge Regulators [BDR's] and Battery Charge Regulator [BCR] on;
- Command Automatic Battery and Charge Rate Selection;
- Enable Thermal control;
- Authorise Transition to OBDH Science Mode.

The above sequence of events took place approximately 22 minutes before initial acquisition [AOS] at Perth. Since separation took place during eclipse, the AOCS autonomous operations in **Acquisition Mode [AM]** were limited to S/C rate reductions and only after exit from eclipse at 01:45:13, AOCS Sun acquisition was started, based on input signals of the Sun Acquisition Sensors [SAS's], Gyros and Thrusters, which re-oriented the spacecraft to a Sun aspect angle of 90 °.

AOS Perth was announced at 02:01:27.

First ISO telemetry data [TM] were received and processed at 02:01:40 on both [IDCS] control computers, LEOP/RT and LEOP/DV in the OCC. The S/C status was immediately assessed and stable pointing in **Acquisition Mode [AM]** confirmed. The S/C rates were well within limits, the Solar Aspect Angle [SAA] ~ 90 °, and RCS thruster actuation was nominal. With the exception of the cryo valves V103, V106 and the RCS Latch Valve-2, which indicated status CLOSED, the spacecraft configuration was nominal. The uplink carrier was swept and both on board receivers were in lock at 02:04:09.

The ISO dedicated Spacecraft Control Centre [SCC], located at ESA's Villafranca del Castillo Satellite Tracking Station premises, as well reported proper receipt of telemetry data from the PERTH station, while configured in the so called " Listen-In " mode [TM reception only].

3.3 Events during the LEOP

3.3.1 Revolution-0 Summary

Following a nominal countdown and lift-off at 01:20 on 951117, all marked events of the powered flight were reported on schedule. Separation had been confirmed by Arianespace and initial Acquisition of Signal [AOS] at the Perth station occurred at 02:01:27. The OCC processed for the fist time in-flight telemetry data.

The uplink carrier was swept and both on-board RX's were in lock at 02:04. The first telecommand was uplinked at 02:12. However, intermittent telecommanding problems were experienced, when the FCT attempted to validate the TC capability.

Meantime, the spacecraft status was assessed and the behaviour was nominal. The AOCS was in Acquisition Mode [AM] while the OBDH was in Housekeeping Mode [HK]. However, the following discrepancies were noted:

1. The statuses of Cryogenic Valves V103 and V106 were found "CLOSED" in TM, although the opening of the valves had been confirmed during the powered flight. Indeed, the proper functioning of the cryogenic was confirmed based on pressure and temperatures TM data after AOS Perth.

2. The status of RCS Latch Valve-2 was found "CLOSED", but was expected to be "OPEN".

Problem [1] was corrected by uplinking the commands to open valves V103 and V106 at 02:24, i.e. make the TM compatible with the actual status of the valves [see section: 3.3.1.1].

The intermittent TC problem was rectified [ground station configuration problem] at 02:45 [see section 7.5.1].

Problem [2] was resolved after the RCS was re-configured at 02:54 [see section: 3.3.1.1].

Subsystems check-out continued per Flight Operations Plan [FOP], with the following major events:

- Ranging operations to determine initial orbit;
- Transition from Acquisition Mode to Survival Mode [SM] at 04:01;
- OBDH Quality System and ASW programmes activations at 04:54;
- Initial Star Tracker-A [STR-A] switch on at 07:02.

Soon after STR-A was switched on, an anomalous behaviour of the CCD temperature was noted. Instead of stabilizing at -40 ° C, the temperature settled at - 22 ° C. The anomaly was discussed between Project/Industry and FCT. Since the functionality of STR-A was nominal and no risk of damaging the unit was involved, activities continued with a delay of 1.5 hours.

BAT-1 did not reach End of Charge [EOC] automatically. EOC was terminated manually at 07:19 by selecting C/200 [Trickle Charge] per FCP: PCS-100.

normal, except that the control team was not made aware of it [refer to section 6.4; ISO-ANO-0001]. LV-2 was commanded to "OPEN" at 02:53:15, by application of the relevant Flight Control Procedures, in order to re- configure the RCS subsystem to it's expected status.

Activities then continued as per the Flight Operations Plan [FOP].

Sun Shade Heater-1 ON was commanded at 03:21:14.

ERD Buffer dump was commanded at 03:30:51. The evaluation of the AOCS Event Related Data [ERD] revealed the following:

01:40:50 Separation detected
01:40:51 Gyro-1 reported UNHEALTHY for one cycle [separation effect]
01:45:13 End of Eclipse.

Transition from Acquisition Mode [AM] to Survival Mode [SM] was executed at 04:04:59 and Mode transition to SM was confirmed. The reaction wheels 1 to 3 were used for the first time. The performance in Survival Mode was nominal, with the three wheels stabilizing with rates less than 7 radians/sec.

OBDH/CTU Memory Dumps and PRAM Comparison to refresh IDCS Images were commanded starting at 04:28, following the dumps a comparison of the dumped PRAM Image with the Ground Image was carried out, no discrepancies were found.

The **ACC RAM** was enabled at 04:51:24. **Activation of the OBDH Quality Checking System** began at 04:53, the activation proceeded nominally and the CTU Watchdog was re-enabled at 05:03.

AOS Vilspa-2 at 06:20.

OBDH Applications Programmes Activation started at 06:21, scheduling the following programmes:

06:21	RFCON [Transmitter Output Power Monitoring]
06:25	TMCON / TCCON [PDU TM / TC Interface Monitoring]
06:57	ULCON [BMC Battery Charger Switching Frequency Monitoring]
07:09	BOTM [Battery Over-temperature Monitoring]
09:54	BUVM [Battery Under-voltage Monitoring]
10:22	OBSF [On-board Data Storage Facility]
13:31	CHCON [Monitoring of BDRs and BCRs currents]

The Activation of all Applications Programmes proceeded nominally.

Star Tracker-A [STR-A] was switched on for the first time at 07:04:34. The CCD temperature of the STR-A stabilised around - 22 °C, rather than the expected - 40 °C. Following detailed discussions it was agreed to continue with the planned operations as per FOP Timeline, since the functionality of the STR-A was not effected. An Anomaly Report was raised [see Section 6., ISO-ANO-0004].

Ground Station handover PERTH -> VILSPA-2 at 07:31.

STR-A Mapping Mode was commanded at 09:20:00 using the direct MACS TC 16833, resulting in 18 stars being acquired.

STR-A Search & Tracking Mode [S/TR] was commended at 09:36:18 using the direct MACS TC 16832, resulting in one star being found and tracked.

AOS Kourou at 09:49.

First on-board Attitude Update was commanded at 10:18:12, based on the stars being found during the previously performed Mapping Mode and the subsequently performed pattern matching by OAD.

Transition to Star Acquisition Mode [SAM] was executed at 10:38:00, resulting in 20 stars being acquired. This was the first time the AOCS was transferred in a RAM controlled mode. The inertial attitude was estimated by OAD and an attitude update was made at 11:21:49.

Authorization and Enabling of OBDH Autonomy Entry Conditions was completed at 11:58. At this time ISO was protected against AOCS fallback to ROM Mode, RF Link Loss and Battery Under-voltage.

First Programmed Pointings List [PPL] was loaded and validated between 11:46:00 and 11:50:09.

Transition to Fine Pointing Mode [FPM] was executed at 11:53:46 and inertial attitude confirmed by acquiring the anticipated **Guide Star** with STR-A and AOCS submode " **POINT** ".

The Inertialisation Function was enabled at 12:02:52.

Reaction Wheel Biasing was performed successfully at 13:20:59. The achieved angular momentum was well within specifications, i.e. < 1 Nms difference.

Gyro Drift Accumulation was commanded at 14:02:22 for a period of 15 minutes between 14:00:00 and 14:25:00. The estimated drift was below 1 arcsec.

Ground Station handover VILSPA-2 -> KOUROU at 15:13.

First Slew in FPM was executed at 15:25:43 and successfully completed by acquiring the anticipated Guide Star at the end of the slew. The slew magnitude was 9.6 degrees. Following this, another slew in SAM, with a magnitude of 128.7 degrees, was executed to reach the PPL attitude and to enable OAD to better estimate the gyro scale factor error. The attitude reconstruction afterwards lead to a mismatch of 4.9 arcmin and a subsequent scale factor error of approximately 0.1%

Gyro Scale Factor Calibration was performed between 17:53:31 and 19:22:29. OAD processing resulted in an error of 0.1 % for all gyros. The gyro misalignment was determined in parallel to be 10 arcmin.

LOS Vilspa-2 at 18:32.

Transition to Programmable Pointing Mode [PPM] was executed at 22:14:53.The slew to PPL attitude P1 was monitored and the PPL re-uploaded.

STR-A was switched off at 22:35 for the complete perigee passage as per Project Support Team recommendation to investigate further the CCD cooling problem.

LOS Kourou at 23:55.

GOLDSTONE telemetry data were processed at the OCC between 00:11 and 01:03, although Goldstone was not a LEOP station.

AOS Kourou at 01:03 [short perigee pass].

Eclipse Entry at 01:32. Functioning of all subsystems was confirmed during the beginning of the eclipse until 01:43, when **LOS Kourou** occurred.

Eclipse Exit took place at 01:54, during a period without ground station coverage.

End of Revolution-0 [951118]

Transition to FPM was executed at 11:12:56. AOCS/RCS re-configuration activities for the delta-v continued as planned. The **Attitude Operations Plan [AOP]** was loaded and accepted containing the following entries:

- transition to AGM at 13:24:52;
- delta-v duration = 300 seconds;
- delta-v execution at 13:44:52.

The slew to the delta-v attitude in FPM was executed at 12:26:49. At the end of the 135 deg. slew the Guide Star was found without problems.

Heater STR-A [N] was switched off at 12:46:44 to investigate further the anomalous STR-A CCD temperature being at this time - 25.9 ° C.

AOP Enable command [SWC 664] was uplinked at 13:02:21 and the above indicated entries [events] were monitored and confirmed in TM.

DELTA-V Rehearsal was executed at 13:44:52. The burn was terminated autonomously at 13:49:52.

AOCS/RCS were reconfigured by 14:16. Following this, a slew away from the delta-v attitude was performed at 14:17:47.

Heater STR-A [N] was switched on again at 15:37:47 to investigate further the anomalous STR-A CCD temperature.

New PPL loaded at 16:22:03 reflecting the orbit changes of the test delta-v.

Ground station handover VILSPA-2 -> KOUROU at 17:26.

Heater STR-A [N] was switched off at 17:43:38 for further investigation of the anomalous STR-A CCD temperature.

Reaction Wheel Biasing to 0.0 Nms for the forthcoming perigee passage.

STR-A switched off at 19:33:56 for the complete perigee passage.

Flight Dynamics reports an RCS over-performance of 18-19 % of the test delta-v [see 3.5 for further details].

LOS Kourou at 00:00.

AOS Kourou at 01:00 [short perigee pass].

Project Support advised FCT that the Battery-1 temperatures may reach the lower limits. This would cause an autonomous heater reconfiguration. Procedure FCP OSW-1084, step-8 [Disable Control of Thermal Process-4] was executed at 01:25.

Eclipse Entry at 01:42. Functioning of all subsystems was confirmed during the beginning of the eclipse until LOS Kourou occurred at 01:50.

Eclipse exit took place at 02:04, but without ground station coverage.

Autonomous Unloading of RWL's occurred between 01:50 and 01:52:25.The latter time was retrieved from the ERD dump performed after AOS Perth.

End of Revolution-1 [951119]

3.3.3 Revolution-2 Summary

The perigee passage and eclipse passed uneventfully.

During REV-2 [951119] operations continued per FOP Timeline. In addition, extra activities wrt STR-A operations were necessary in order to continue CCD cooling problem investigations. Heater STR-A [N] was switched on/off, as required.

The **major event** of this revolution was the preparation and execution of the **Main Delta-V [Perigee Raising] Manoeuvre**. Beside this, the following events took place:

- S/C re-configuration after perigee exit;
- Ranging operations;
- STR-A switch on at 05:38;
- Transition from PPM to FPM following perigee;
- Slew to Delta-V attitude in FPM;
- Attitude Operations Plan [AOP] upload;
- AOCS/RCS preparation and execution of Main Delta-V [Perigee Raising from 500 to 1000 Km] Manoeuvre [111 min 24.5 sec] at 13:10:03;
- AOCS/RCS re-configuration;
- Satellite Inertial Matrix [Post Delta-V] updated;
- Transition to PPM at 20:15;
- "GO" for part of the FCT to depart for Madrid at 22:00;
- S/C re-configuration for perigee passage and eclipse;

All operations planned for completion by this stage of the mission had been completed. Deviations from the thermal behaviour of the batteries [cold biased], required modifications to the battery heater configuration and thermal processes. STR-A was left "ON' during perigee.

3.3.3.1 Details

AOS Perth at 02:23.

A problem on the IDCS software was noted after the OBDH TT-Command for PPM entry [MF 654 TR - PPM] was uplinked at 04:39:25. The IDCS Image display task of the TT buffer indicated DOY 320/19:36:55, while the requested time was DOY 323/20:26. Software Support investigated the problem and stated that indeed a conversion problem exists in the Image Display Task as follows:

If a TT command is uplinked at the end of the 72.3 hours TT buffer time limit, the s/w subtracts - 72.3 hours. A fix [SPR] on the Image Display Task is required.

However, FCT confirmed that the uplinked execution time resident in the TT buffer is correct.

STR-A switched on at 05:38:18.

Transition to FPM executed at 05:43:27. Guide Star acquired successfully after being 11.5 hours in PPM.

AOS Vilspa-2 at 06:21.

Ground station handover PERTH -> VILSPA-2 at 07:35.

LOS Perth at 09:18.

AOS Kourou at 09:49.

Preparation for the Perigee Raising Manoeuvre began at 10:10.

The execution time of the perigee raising manoeuvre [Main Delta-V] was programmed for 13:10:03, with a burn duration of 111 MIN 24.5 SEC.

Attitude Operations Plan [AOP] for Delta-V uplinked/accepted at 10:20:32.

RCS re-configuration [Branch-1 and 2; Catbed Heater-2 ON] at 11:18:20.

Slew to Delta-V Attitude [FPM-slew] at 11:34:16. Slew magnitude was 137 °, with a slew error of 1.7 arcmin upon termination.

AOP Enable TT command uplinked at 12:15:33, with AOP execution time of 12:48:00.

Reset OBDH TT-Que at 12:26:24 in an attempt to clear the problem reported with the IDCS Image Display Task [see above].

Re-transmission of TT commands TR - PPM and AOP Enable at 12:27:06 and 12:27:40, respectively. The problem with TR - PPM did not clear.

AOP executing at 12:48:00.

1st AOP Entry at 12:50:03 - Transition to AGM executed.
2nd AOP Entry at 13:08:03 - Delta-V Programming executed.
3rd AOP Entry at 13:10:03 - **Delta-V Execution** started.
4th AOP Entry at 15:01:27 - **Delta-V Termination** executed.

AOP aborted at 15:06:01.

Slew to new target [FPM-slew] at 15:10:09. Guide Star acquired w/o problems at the end of the slew.

RCS reconfiguration [Branch-2 OFF] at 11:18:20.

Battery-1 Heater Reconfiguration at 15:34:32. In order to increase the low Battery-1 temperature as being reported above, it was decided to switch on the Redundant Battery-1 Heater [permanently], while the Normal Battery-1 Heater will regulate the temperature. A new CRP PCS-5075 [Control Batt-1 Temperature, using both Heaters] was provided for by the responsible S/S Engineer.

Battery-2 Thermal Control Disabled at 15:44:04. This was required to prevent an on-board heater reconfiguration due to low Battery-2 temperature [Thermal Process 17 of OBDH ASW THS].

Orbit Time and PPL uplinked between 15:57 and 16:04, based on post Delta-V orbit predictions.

Following confirmation that ISO indeed was put in its anticipated orbit, the **"GO" to commence the transfer of the FCT to depart for Madrid [Vilspa]** on the next morning, was given at ~ 22:00.

Ground station handover VILSPA-2 -> Kourou at 17:06.

Heater STR-A [N] was switched OFF at 17:39:23 to investigate further the anomalous STR-A CCD temperature.

Goldstone [DSS-27] Telecommand Test was conducted between 18:00 and 18:10, respectively. Five DUMMY TC's [MF2999 EGSE I/F OFF] were successfully uplinked and confirmed.

LOS Vilspa-2 at 18:15.

Satellite Inertial Matrix [Post-Delta-V] uplinked at 18:20.

An under-performance of 1.8 % of the Perigee Raising Manoeuvre was reported by Flight Dynamics at 18:23 and hence, no top-up manoeuvre was required [see 3.5 for further information].

Heater STR-A [N] was switched ON again at 18:40:08 to investigate further the anomalous STR-A CCD temperature.

Battery-1 reached -5 deg. C [warming up] at 20:03. Thermal process-4 re-enabled.

Flight Dynamics reported at 21:25 that no new orbit parameters and PPL is needed. Consequently, FOP Timeline steps 93 - 99 were skipped.

STR-A RAM Dump started at 22:45 on request from Project/Galileo to further investigate STR-CCD temperature problem.

LOS Kourou at 23:30.

AOS Kourou at 01:40 [short perigee pass]. Between 01:45 and 01:52, the station lost autotrack and telemetry [FEC problem].

Eclipse entry at 01:55 was monitored until **LOS Kourou** occurred at 02:08.

Eclipse exit took place at 02:18, during a period without ground station coverage.

End of Revolution-2 [951120]

3.3.4 Revolution-3 Summary

The perigee passage and eclipse passed uneventfully.

During REV-3 [951120] operations continued per FOP Timeline. The spacecraft was maintained in PPM mode [safe configuration] throughout this revolution in order to allow part of the FCT to depart for Madrid [VILSPA]. This was in preparation for the Handover of operations from the OCC/ESOC to the dedicated SCC/VILSPA in REV-4.In addition, extra activities wrt STR-A operations were necessary in order to continue CCD cooling problem investigations. Heater STR-A [N] was switched on/off, as required.

The following events took place:

- Anomalous behaviour of Parameter K010;
- S/C re-configuration after perigee;
- Ranging operations;
- Sun Shade Heater-1 switch off;
- Inhibition of ELS-A/B autonomous calibration;
- ELS-A/B sensors switch on;
- ELS data acquisition;
- Departure of part of the FCT for Madrid;
- Handover preparations of the SCC/VILSPA;
- S/C re-configuration for perigee passage and eclipse;

All operations planned for completion by this stage of the mission had been completed.

3.3.4.1 Details

AOS Perth at 02:48.

Parameter K010 [Sun Shade Base-Z Temperature] Out Of Limit [OOL-High] at 03:05:22. A sudden jump from 171 K to 84.8 K was observed. Project Support stated that such a change is physically impossible and that most likely Thermistor T354 is malfunctioning. An Anomaly Report was raised [see Section 6., ISO-ANO-0003].

Parameter V01002 [ACC DROM/DRAM DBASE] uplinked at 04:10:38 with new value of 16383.5 [sec] as per FCP AOCS-2599 to cover a Lunar Eclipse in REV-5.

Sun Shade Heater-1 switched off at 05:55:44.

AOS Vilspa-2 at 06:10.

Earth Limb Sensor [ELS] Health Check disabled at 06:03:40.

ELS-A/B Sensors switched on at 06:24:35. **Parameters B113/B114** [ELS-A/ELS-B Temperatures] below lower limits [84.5 K]. Project reported that the ELS temperatures are not reliable, since they were expected to be considerably higher [for details refer to Section 6.1.1.5; ELS].

Ground station handover Perth -> Vilspa-2 at 07:23.

The **first members of the FCT departed for Madrid** at 08:45.

LOS Perth at 09:02.

AOS Kourou at 09:44.

The **second part of the FCT departed for Madrid** at 11:55.

On Vilspa/SCC-FCT request a set of USD selections was uplinked from the OCC, starting at 15:21, in order to clean up the Out Of Limits [OOL] display on ISORT [VILSPA/SCC].

Ground station handover Vilspa-2 -> Kourou at 16:24.

ACC Full Database dump executed at 17:27 on request of Vilspa/SCC.

LOS Vilspa-2 at 18:10.

Full ACC ROM&RAM dump executed at 21:53 on request of Vilspa/SCC.

Parameter K010 [Sun Shade Base-Z Temperature] back within limits at 22:49:43.

LOS Kourou at 23:20.

Goldstone Telemetry data processed on LEOPRT/DV during no coverage period of Kourou, i.e. between 23:20 and 02:07, respectively.

AOS Kourou at 02:08 [short perigee pass].

Eclipse entry at 02:22 was monitored until **LOS Kourou** occurred at 02:36.

Eclipse exit took place at 02:40, during a period without ground station coverage.

End of Revolution-3 [951121]

3.3.5 Revolution-4 Summary

The perigee passage and eclipse passed uneventfully.

During REV-4 [951121] operations continued per FOP Timeline. **The major event of the first part of this revolution was the successful Handover of**

operations from the OCC/ESOC to the dedicated SCC/VILSPA at 09:15.

Beside this, the following events took place before handover:

- S/C re-configuration after perigee;
- Ranging operations;
- ELS data acquisition;
- Handover of Operations preparation;

All operations planned for completion by this stage of the mission had been completed.

3.3.5.1 Details

AOS Vilspa-2 at 02:41 [short low elevation pass].

LOS Vilspa-2 at 02:55.

AOS Perth at 03:11.

First members of the FCT in position at VILSPA/SCC at 05:30.

AOS Vilspa-2 at 05:59.

Ground station handover Perth -> Vilspa-2 at 06:16.

Handover of Operations from ESOC/OCC to VILSPA/SCC commenced at 06:20.

TC Control handed over to VILSPA/SCC at 08:30.

32 Kbps Science Format commanded for the first time - with PHT instrument selected "Prime" in TM - at 08:57. Up to this moment 8 Kbps HK TM had been used explicitly during LEOP.

Handover of Operations to VILSPA/SCC terminated at 09:15 [see also section 3.6].

The remainder of Revolution-4 is reported in section 4.1, Satellite Commissioning Phase [SCP]- Key Events.

3.4 Eclipse Operations

Eclipse operations started when the satellite was switched to internal power at 01:15, 6 minutes prior to launch on 951117. Spacecraft separation at 01:40:50 took place in eclipse, which terminated at 01:45 in REV-0. Subsequently, the spacecraft was in eclipse during each perigee passage for some 22 minutes [LEOP only].

Detailed information is given in section 6.1.4, Power Conditioning Subsystem [PCS] performance.

3.5 Summary of Perigee Raising Manoeuvre

Delta-V Rehearsal in REV-1:

In view of the long burn duration of the RCS Thrusters required to raise the perigee from 500 Km to 1000 Km, the decision was made long before launch to perform a 5 minutes Delta-V Rehearsal [Test] at apogee of REV-1 in order to calibrate the AOCS/RCS Thrusters for the Main Delta-V, and to monitor the proper functioning of the autonomous execution of the Attitude Operations Plan [AOP]. The configuration of the AOCS/RCS was chosen for maximum possible thrust, i.e. use of all 8 thrusters in + X axis direction [Telescope boresight], whereby RCS Branch-1 was selected as Control branch [4 Thrusters] and RCS Branch-2 as Delta-V branch [4 Thrusters]. The Delta-V attitude was chosen to align the + X-axis [Telescope boresight] with the orbital plane.

The Delta-V Rehearsal was successfully executed through the AOP at 13:44:52. The predicted velocity increment [Delta-V] was 1.55 m/s. The burn terminated autonomously at 13:49:52.

Post manoeuvre data from Flight Dynamics revealed a Delta-V over - performance of 17.2 %, resulting from the observed thruster performance of 1.0093 % and an Off Modulation of 93.8 % vice 66 %, used to compute the manoeuvre. The actual velocity increment was 1.82 m/s, which raised the perigee by 29.8 Km to 529.6 Km. In a meeting held shortly after, it was agreed to compensate the Delta-v manoeuvre computation by - 17.2 %.

Perigee Raising Manoeuvre [Main Delta-V] in REV-2:

The preparation began at 10:10 with the input data provided by Flight Dynamics as follows:

A velocity increment [Delta-V] of 31.67 m/s, resulting in a burn duration of 111 Minutes and 24.5 Seconds. The manoeuvre execution time was set for 13:10:03. The manoeuvre input data were compensated with the results obtained from the Delta-V Rehearsal. Spacecraft configuration and manoeuvre strategy were identical on both days.

The manoeuvre was executed through the AOP at 13:10:03. Throughout the burn the STR, although not in the control loop in All Gyro Mode [AGM], tracked the Guide Star and only one single glitch was observed. The manoeuvre terminated at 15:01:27.

Flight Dynamics announced a 1.8 % under-performance of the Perigee Raising Manoeuvre, resulting in a 9 to 10 Km lower perigee [target perigee height was 1040 Km]. This represented an excellent AOCS/RCS performance and hence, no top-up manoeuvre was required.

3.6 Handover of Spacecraft Operations Summary

Handover of Spacecraft Operations from ESOC/OCC to VILSPA/SCC commenced on 951121 at 06:20, according to the established procedures in the FOP Timeline.

Confirmation was given by the SOM/OCC to the SOM/SCC that all activities had been executed as per FOP Timeline. Procedural changes to be applied with respect to Battery ½ and STR-A CCD temperature monitoring and control was received. These were recommended by the Project Support Team still at ESOC. The status at handover was as follows:

Bat-1 Heater [N] controlled by thermal process-4 being enabled, while Heater [R] was switched ON permanently. Bat-2 Heater [N] was ON, but thermal process-17 disabled. Bat-1 temperatures had stabilized, while Bat-2 temperatures were still slowly decreasing. If two of the three Bat-2 temperatures [P244/P245/P246] should reach - 8 ° C, the Heater [R] of Bat-2 was to be switched ON. The STR-A baseplate and CCD temperatures had stabilized at 23 ° C. and - 17 ° C., respectively. The new strategy to be followed was to leave STR-A "ON". In case the baseplate should rise to 25 ° C., lower the HETLIM by 1 deg.C in the OBDH Protected Memory [PM] for STR-A Heater [N].

The satellite was in Programmable Pointing Mode [PPM] with 0003_06.PPL [REV-3] executing, while 0004_01.PPL [REV-4] was loaded OK in the PPL buffer.

The Out of Limits [OOL] display was compared and no deviations were observed. The ELS-A and B temperatures [B113/B114] being OOL was explained. The MSB was not processed and required a database change.

A set of dedicated Alpha Numerical Display [AND] hard copies were taken at the OCC and were submitted by FAX to the SCC. These hard copies represented the current satellite status of all subsystems at indicated times, and contained digital and analogue telemetry data. At the SCC telemetry retrievals were made according to the time stamps of the OCC provided AND hard copies and a one to one comparison was made successfully as per step 21 and 23 of Transfer of Operations ESOC to Villafranca/Part-1.

At 08:34 the SCC established the TC link [VIL21] to the VILSPA-2 station. The uplink was swept successfully and the first TC [MF2999] transmitted from the SCC and verified at 08:35. MF2999 was repeated as a Block Command and verified at 08:36. Following this, a 10 minutes RANGING operations was performed between 08:43 and 08:53, before the transition from 8 K HK TM-Format to 32 K SCIENCE TM-Format was successfully commanded at 08:57 for the first time.

Consequently, the transfer of operations was formally agreed as of 951121 at 09:15. Subsequently, the VILSPA/SCC was in full control of the mission and no further support was required from ESOC/OCC. The PERTH station was released at the same time, thus maintaining the VILSPA-2 and GOLDSTONE ground stations for ISO support, while the KOUROU station was maintained up to the end of REV-15, to cover the perigee passages.

4 SATELLITE COMMISSIONING PHASE SUMMARY

The Satellite Commissioning Phase [SCP] started in REV-4 [951121], soon after ISO Operations were handed over from ESOC/OCC to Vilspa/SCC, and terminated at the end of REV-21 [951209]. The SCP was carried out according to the operations defined in document:

Satellite Commissioning Plan [ISO-PL-Z-12449],
Issue 1, dated 2 October 1995.

The first goal of the SCP was to continue with spacecraft check-out and subsystems [AOCS/STR/RCS] performance verification, as initiated during LEOP, to achieve the mission orbit, and to eject the cryostat cover.

The second goal of the SCP was to complete the overall check-out of the ISO payload, i.e. the scientific instruments. To validate the instrument activation and deactivation sequences, and to calibrate the in-flight performances of each instrument, so as to ready the space segment for the Performance Verification [PV] Phase and the Routine Phase [RP] executed immediately hereafter. In the process of executing the SCP, the overall integrated Ground Segment [SCC, SOC, Ground Stations, and communications network] was also validated.

From above, the objectives of the SCP were the following:

- continue with satellite control and monitoring activities;
- determine the status of the complete satellite after LEOP;
- verify compliance with system specifications for parameters impossible to measure on ground [pointing performance];
- assess the effects of the in-orbit environment and determine possible deviations with predictions [radiation effects on the instrument detectors].

All activities defined in the SCP were carried out successfully, although many changes had to be adopted on short notice to achieve the goals of the SCP, in particular with respect to scientific instrument operations. It is worse to mention, that the nature of the SCP activities required manual commanding activities interleaved with scheduled driven [CCS] command activities during several revolutions. Table 4, indicates the major activities performed during SCP.

Table-4: Overview of SCP Activities per revolution

REV #	Command Method and Source [M = manual] [CCS=automatic]	PLM/SVM Sub-system [s]	ACTIVITY
4	M Procedure M FOP/Timeline	PLM/PHT SVM/ALL	Wheel Commissioning Housekeeping Operations ELS Data Acquisition
5	M SCP/IFOP M FOP/Timeline	PLM/PHT SVM/ALL	Checkout & [TDATA] Housekeeping Operations STR Dark Current Acquisition ELS Data Acquisition
6	M Procedure M FOP/Timeline	PLM/PHT SVM/ALL SVM/AOCS SVM/RCS	Detector Curing-1 Housekeeping Operations ELS Data Acquisition Apogee Lowering Manoeuvre
7	M SCP/IFOP M Procedure M FOP/Timeline	PLM/CAM PLM/PHT SVM/ALL SVM/AOCS	Checkout & [TDATA] Detector Curing-2 Housekeeping Operations Gyro Scale Factor Calibration
8	M SCP/IFOP M Procedure M FOP/Timeline	PLM/LWS PLM/PHT SVM/ALL SVM/AOCS	Checkout & [TDATA] Detector Curing-3 Housekeeping Operations ELS Data Acquisition SAM Star Acquisition[STR-FOV]
9	M SCP/IFOP M Procedure M FOP/Timeline	PLM/SWS PLM/PHT SVM/ALL SVM/AOCS	Checkout & [TDATA] Detector Curing #4 Housekeeping Operations ELS Data Acquisition ELS-A/B Activation High Precision RPM Test
10	M FOP/Timeline	PLM/CRYO SVM/AOCS	Cryostat Cover Ejection QSS Switch On, Calibration Mode [CM] entry, QSS/STR Misalignment Calibration, FSS Misalignment Calibration [X/Y/Z].
11	CCS[2 AUTO-DEACTIV] M SCP/IFOP M Procedure M FOP/Timeline	CAM/LWS/SWS PLM/LWS PLM/LWS PLM/CAM PLM/SWS PLM/CRYO SVM/AOCS	1st CCS [Manual Activation] Detector Curing Checkout & [TDATA] Activation/Deactivation FP Parallelisation Cryo valves V504/V505 closure Gyro Scale Factor Calibration FSS-Z re-calibration

12	CCS [4 IS's-AUTO] M IFOP M FOP/Timeline	PLM/LWS PLM/CAM PLM/SWS PLM/PHT SVM/AOCS	Dark Current Measurement Parallel Mode Verification FPG trial, using SWS and PHT. FPG Star Acquisition Ops. FSS-Y re-calibration
13	CCS [4 IS's-AUTO] M FOP/Timeline	PLM/PHT PLM/LWS PLM/CAM PLM/SWS SVM/ALL	Init and curing+Jitter check Init and curing+Jitter check Activation+Jitter check Init and curing+Jitter check Housekeeping Operations
14	CCS [3 IS's-AUTO] M FOP/Timeline	PLM/LWS PLM/CAM PLM/SWS SVM/ALL	Init and curing + FPG Activation, calibration, FPG Init and curing Housekeeping Operations
15	CCS [1 IS-AUTO] M FOP/Timeline	PLM/CAM SVM/ALL	Solar System Objects verif. Housekeeping Operations
16	CCS [1 IS-AUTO] M FOP/Timeline	PLM/CAM SVM/ALL SVM/AOCS	Imaging, FPM and RPM, FPG Housekeeping Operations APD Calibration
17	CCS [SWS] IFOP [PHT-M-ACTIV] CCS [2 IS-DEACTIV] M FOP/Timeline	PLM/SWS PLM/PHT PLM/CAM PLM/LWS SVM/AOCS	FPG-1 FPG-1 No Activities No Activities FPG-1 Star Acquisition Ops.
18	CCS [SWS] IFOP [PHT M-ACTIV] IFOP [CAM M-ACTIV] CCS [3 IS-DEACTIV] M FOP/Timeline	PLM/SWS PLM/PHT PLM/CAM PLM/LWS SVM/AOCS	FPG-2 FPG-2 Parallel Mode Verification No Activities FPG-2 Star Acquisition Ops.
19	CCS [SWS] IFOP [PHT M-ACTIV] IFOP [CAM M-ACTIV] CCS [3 IS-DEACTIV] M FOP/Timeline	PLM/SWS PLM/PHT PLM/CAM PLM/LWS SVM/AOCS	FPG-3 FPG-3 Parallel Mode Verification No Activities FPG-3 Star Acquisition Ops.
20	CCS [SWS] IFOP [PHT M-ACTIV] IFOP [CAM M-ACTIV] CCS [3 IS-DEACTIV] M FOP/Timeline	PLM/SWS PLM/PHT PLM/CAM PLM/LWS SVM/AOCS	FPG-4 FPG-4 Parallel Mode Verification No Activities FPG-4 Star Acquisition Ops.
21	CCS [4 IS's-AUTO] M Procedure	PLM/PHT PLM/LWS PLM/CAM PLM/SWS SVM/RF	Validation of new Instrument Activation/Deactivation Sequences. Validation of revised IS's aperture offset. Uplink Mod-Index Optimisation

4.1 Key Events during the SCP

With the successfully performed **Handover of Operations from ESOC/OCC to VILSPA/SCC** on 951121 at 09:15, LEOP terminated and the Satellite Commissioning Phase [SCP] started as planned in REV-4. The SCP terminated on 951209 at 02:57, i.e. at the end of REV-21. Only major spacecraft operational events are reported below.

4.1.1 Revolution-4 Summary [contd.]

The major event of the first part of this revolution was the successful Handover of operations from the OCC/ESOC to the dedicated SCC/VILSPA. The latter was formally agreed at 09:15.

Beside this, the following activities were carried out in REV-4 [951121]:

- Change TM from 8 Kbps HK to 32 Kbps SC [first time since launch];
- PHT Instrument switch on [first time in orbit];
- PHT wheel commissioning;
- S/C re-configuration for perigee passage and eclipse;

All operations planned for completion by this stage of the mission had been completed.

4.1.1.1 Details

Initial PHT Instrument switch-on commanded at 09:56:16

Transition PPM to SAM at 10:16.

Transition SAM to FPM at 11:03. The Guide Star was acquired without problems after the S/C was maintained in PPM during the past 36 hours to permit transferring the control team from ESOC/OCC to VILSPA/SCC.

Dumping of all on-board memories [ACC/OBDH] terminated at 11:23.

PHT instrument switched off at 14:25 on request of Project Support due to the fact that an invalid [old] RAM patch [PF06_2.MPS] was transferred to the SCC and hence, resident on ISORT [IDCS] and uplinked.

PHT instrument switched on at 14:31.

AOS Goldstone [DSS-27] at 15:17.

PHT instrument switched off at 16:04.

Ground station handover Vilspa-2 -> Goldstone at 16:10.

No Guide Star acquired at end of FPM at 17:38.

Guide Star acquired at end of FPM at 17:58. The STR magnitude threshold was increased from 6.75 to 7.0, i.e. the Guide was acquired with a magnitude mv=6.85, slightly dimmer than expected.

LOS Vilspa at 18:01.

STR-A Constant Area [CA] parameter CD11 [Cooler Control Temperature Threshold] changed from -38.5 ° C to -10.0 ° C. The STR-A CCD temperature settled at - 34 ° C with the baseplate temperature at 10 ° C. STR-A Heater [N] was switched off/on several times, cycle ~ 80 minutes, to maintain the baseplate TMP between 10 ° C and 23 ° C, respectively.

Goldstone DSS-17 testing took place between 20:19 and 20:57 [ad hoc request from JPL/NASA].

PPM entry via OBDH TT-Command at 23:16.

STR-A RAM Dump executed at 23:45.

PPL re-upload performed at 23:48.

RWL Biasing executed at 00:03.

OBDH Re-configuration performed at 00:33 [perigee entry].

LOS Goldstone [DSS-27] at 02:47.

AOS Kourou at 02:50 [short perigee pass].

LOS Kourou at 03:03.

End of Revolution-4 [951122]

4.1.2 Revolution-5 Summary

The following activities were carried out in REV-5 [951122]:

- S/C re-configuration after perigee exit;
- PHT Instrument switch on;
- PHT check-out;
- ELS data acquisition;
- STR dark current calibration;
- S/C re-configuration for perigee passage and eclipse;

All operations planned in this revolution were completed.

4.1.2.1 Details

AOS Vilspa at 03:10 [low elevation pass].

LOS Vilspa at 03:36.

AOS Vilspa at 05:05.

Heater STR-A [N] switched on at 05:36.

OBDH Re-configuration performed at 05:44 [perigee exit].

Heater STR-A [N] switched off at 07:46.

PHT switched on at 07:40 to continue check-out and commissioning.

ISO has been allocated the International Satellite ID-Number: 950621

Transition PPM to FPM at 09:38. Guide Star successfully acquired.

Heater STR-A [N] switched on at 10:05.

ELS data acquisition at 10:12.

STR-A Dark Current Calibration conducted between 11:24 and 15:30 [see section: 6.1.1.7 for STR details].

Heater STR-A [N] switched off at 11:57.

ELS data acquisition at 12:16.

Heater STR-A [N] switched on at 14:05.

AOS Goldstone [DSS-27] at 14:52.

PHT switched off at 15:56.

Ground station handover Vilspa-2 -> Goldstone at 16:22.

Heater STR-A [N] switched off at 16:26.

Two High Precision Raster Pointing Mode [RPM] Tests executed at 17:10 and 18:05, respectively. For further details refer to section 4.3.

LOS Vilspa at 17:52.

Well before the start of the **Lunar Eclipse** at 20:45, the S/C was slewed to an SAA of 110 ° in order to improve the thermal environment [S/C warm case]. This was in view of the following Earth eclipse around perigee. The Lunar eclipse terminated at 23:12. The behaviour was nominal.

PPM entry via OBDH TT-Command at 23:59.

OBDH Re-configuration performed at 00:25 [perigee entry].

AOS Kourou at 03:09 [short perigee pass].

LOS Goldstone [DSS-27] at 03:11.

LOS Kourou at 03:30.

End of Revolution-5 [951123]

4.1.3 Revolution-6 Summary

The main event was the preparation and execution of the Apogee Lowering Manoeuvre [Delta-V] at the end of this revolution.

Beside this, the following activities were carried out in REV-6 [951123]:

- S/C re-configuration after perigee exit;
- PHT Instrument switch on;
- PHT Detector Curing, Part-1;
- ELS data acquisition;
- STR CCD temperature reached -40 ° C;
- S/C re-configuration for perigee passage and eclipse;

All operations planned in this revolution were completed.

4.1.3.1 Details

AOS Vilspa at 03:30.

OBDH Re-configuration performed at 04:05 [perigee exit].

PHT switched on at 06:40 for curing detectors P1, P2, P3, S1, S2, C100 and C200.

Heater STR-A [N] switched on at 04:20.

PHT switched off at 08:55. This completed all instrument activities in this revolution.

8 Kbps HK telemetry was selected at 09:00 in preparation for the Apogee lowering manoeuvre [Delta-V].

Heater STR-A [N] switched off at 11:33.

Heater STR-A [N] switched on at 12:56.

Heater STR-A [N] switched off at 16:23. As a response, the STR CCD temperature steadily decreased from - 27 ° C and reached - 40 ° C at 19:00. The STR-A baseplate also decreased. A new lower limit of -18 ° C was set, at which the STR-A [N] Heater should be switched ON again.

Ground station handover Vilspa-2 -> Goldstone [DSS-16] at 16:29. The DSS-16 Station was provided by JPL/NASA to support the Delta-V operations, since it is equipped with auto-track capability. The latter is not available on DSS-27, and there was some preoccupation that it could loose track, since the forthcoming Delta-V was going to be executed close to perigee.

Preparation for Apogee Lowering Manoeuvre [Delta-V] began at 22:00.

The execution time of the apogee lowering manoeuvre was computed for 02:50:04, the duration of the burn being 39 MIN 20.5 SEC, representing a velocity increment of 8.85 m/s.

Transition FPM to PPM at 22:19.

PPL re-uplinked at 22:56. The PPL was based on post Delta-V orbit predictions.

AOP [Delta-V] uplinked/accepted at 23:21.

RCS re-configuration [Branch-1 and 2; Catbed Heater-2 ON] at 00:41.

Slew in PPM to Delta-V Attitude started at 01:14, and terminated at 01:20.

All Gyro Mode [AGM] entry at 01:30.

AOP Enable TT command uplinked at 01:50:29, with an AOP execution time of 02:28:00.

RCS Re-configuration TT commands uplinked at 01:51.

AOP executing at 02:28:00.

1st AOP Entry at 02:30:04 - Transition to AGM executed.
2nd AOP Entry at 02:48:04 - Delta-V Programming executed.
3rd AOP Entry at 02:50:04 - **Delta-V Execution** started.

4th AOP Entry at 03:29:24 - **Delta-V Termination** executed.

AOP end and transition to PPM at 03:31:24.

Eclipse entry at 03:33.

LOS Goldstone [DSS-16] at 03:35:56.

AOS Kourou at 03:36:10 [short perigee pass].

LOS Kourou at 03:56:32.

End of Revolution-6 [951124]

4.1.4 Revolution-7 Summary

The following activities were carried out in REV-7 [951124]:

- S/C re-configuration after Delta-V and perigee exit;
- PHT Instrument switch on;
- PHT Detector Curing, Part-2;
- Initial CAM Instrument switch on [first time in orbit];
- Gyro Scale Factor Calibration;
- S/C re-configuration for perigee passage and eclipse;

All operations planned in this revolution were completed.

4.1.4.1 Details

AOS Vilspa at 03:58.

First report on the Delta-V performance [end of REV-6] was provided by OAD/ESOC at 04:15, indicating that based on KOUROU ranging data, a small over - performance can be expected. This was rectified shortly after, when the first two VILSPA-2 rangings were available as well, indicating a very nominal manoeuvre performance.

Telemetry Processor [TMP] Tests with Goldstone and ISODV were conducted successfully at 04:20. The original TMP configuration was restored, i.e. TMP2/1 was reconnected to port GL11, while the spare TMP was disconnected. The spare TMP worked fine after the ESOC/NOD representative corrected the YEAR number in the Unix table during a troubleshooting exercise at 19:30, last night. The YEAR was found in error [1994 vice 1995] by DPD Software Support [Vilspa], which prevented TM processing on the IDCS.

32 Kbps SCIENCE telemetry was selected at 05:53.

PHT switched on at 06:07.

Battery-1/2 End Of Charge [EOC] optimisation commenced at 06:24. For detailed information refer to section 6.1.4 [PCS].

PHT switched off at 08:28.

Initial CAM Instrument switch-on for the first time in orbit was commanded at 08:41:28.

Shortly after the CAM instrument was switched ON, **Project reported column 24 of the Long Wavelength detector is missing.** This problem existed already before launch and was detected during TV/TB testing of ISO. For details refer to **anomaly report: ISO-ANO-0005**, section 6.4.

Another CAM anomaly occurred, when the **CAM Spare Task did not execute** during testing. This is reflected in **anomaly report: ISO-ANO-0006.**

Transition PPM to SAM commanded at 09:02 for S/C attitude determination after Delta-V.

Heater STR-A [N] switched on at 09:25.

Battery-1/2 EOC optimisation terminated at 10:12.

Transition SAM to FPM at 10:40, Guide Star acquired w/o problems.

Heater STR-A [N] switched off at 11:24.

Ground station handover Vilspa-2 -> Goldstone [DSS-27] at 15:35.

Gyro Scale Factor Calibration-1 commenced at 16:39. This operation involved 4 successive slews in FPM as follows:

1. FPM slew to the extreme Solar Aspect Angle [SAA] of 60 ° or 120 °.
2. FPM slew of 60 ° about the Sun direction [S/C Z-axis].
3. FPM slew of 60 ° about the S/C Y-axis to the other extreme SAA.
4. FPM slew of 60 ° about the Sun direction [S/C Z-axis].

New Gyro Scale Factors and Transformation Matrices [as determined by Flight Dynamics] uplinked at 20:39 [ACC database load].

Heater STR-A [N] switched on at 17:22.

LOS Vilspa at 17:44.

Heater STR-A [N] switched off at 19:59.

CAM RAM patch problem identified at 20:05. Project requests to import a new version onto ISORT.

Gyro Scale Factor Calibration-2 started at 21:36. This operation involved 4 successive slews in FPM, but in reversed order than part-1, above. For further details refer to section 6.1.1.3.

New Gyro Scale Factors and Transformation Matrices [as determined by Flight Dynamics] uplinked at 23:00 [ACC database load].

CAM switched off at 23:52.

Heater STR-B [R] switched on at 00:05 on request of Project. The aim was to stop the slow decreasing trend of the STR-A baseplate temperature, now at - 16.8 ° and try to stabilize at approximately - 10 °.

PPM entry via OBDH TT-Command at 00:27.

OBDH Re-configuration performed at 01:22 [perigee entry].

LOS Goldstone at 03:33.

AOS Kourou at 03:34 [short perigee pass].

LOS Kourou at 03:54.

End of Revolution-7 [951125]

4.1.5 Revolution-8 Summary

The following activities were carried out in REV-8 [951125]:

- S/C re-configuration after perigee exit;
- PHT Instrument switch on;
- PHT Detector Curing, Part-3;
- Initial LWS Instrument switch on [first time in orbit];
- SAM Star Acquisition;
- CAM put in safe configuration for cover ejection;
- ELS forced in Earth warning region;
- S/C re-configuration for perigee passage and eclipse;

All operations planned in this revolution were completed.

4.1.5.1 Details

AOS Vilspa at 03:56.

OBDH Re-configuration performed at 04:33 [perigee exit].

PHT switched on at 06:08.

Both Batteries reached End Of Charge [EOC] at 07:05, after EOC level adjustments were performed on both batteries during REV-7.

Transition PPM to FPM at 07:15, Guide Star acquisition w/o problems.

PHT switched off at 08:15.

Initial LWS Instrument switch-on for the first time in orbit was commanded at 08:42:15.

AOS Goldstone at 14:53.

Ground station handover Vilspa-2 -> Goldstone [DSS-27] at 15:39.

CAM switched on at 20:31 on request of Project in order to deactivate the instrument and put it in a safe configuration for the planned cryo cover ejection in REV-10.

CAM switched off at 20:41.

New version of PHT Permanent Command Sequence File [PHT_009.PCS] imported onto ISORT at 21:01 on request of SOC. The new version was required in support of PHT instrument checkout in REV-9.

On Project request: PPL_0008_02 uplinked and validated at 21:33. This PPL was modified by Flight Dynamics in such a way as to force the satellite to enter the Earth Warning region by 10 ° during the forthcoming perigee passage in PPM, and to monitor/check the response of the Earth Limb Sensor [ELS] outputs in telemetry.

PPM entry via OBDH TT-Command at 00:25.

PPL_0008_02 re-uplinked at 00:49.

On Project and LWS-PI request, the LWS instrument was left in observing mode till perigee crossing - 2 hours, in order to check the Radiation Belt impact down to an altitude of 23.500 KM. Nominally, instrument observations are terminated at perigee crossing - 3 hours, which corresponds to an altitude of 37.250 Km.

LWS switched off at 01:34.

Eclipse entry at 03:28.

LOS Goldstone at 03:31.

AOS Kourou at 03:32 [short perigee pass].

Eclipse exit at 03:51.

LOS Kourou at 03:52.

End of Revolution-8 [951126]

4.1.6 Revolution-9 Summary

The following activities were carried out in REV-9 [951126]:

- S/C re-configuration after perigee exit;
- PHT Instrument switch on;
- PHT Detector Curing, Part-4;
- Initial SWS Instrument switch on [first time in orbit];
- High Precision RPM Test;
- Normal RPM Test;
- ELS-A/B Sensor enabled for perigee passage;
- S/C re-configuration for perigee passage and eclipse;

All operations planned in this revolution were completed.

4.1.6.1 Details

AOS Vilspa at 03:50.

PPL_0009_01 uplinked at 05:26.

OBDH Re-configuration performed at 05:30 [perigee exit].

PHT switched on at 05:45.

Transition PPM to FPM at 07:17, Guide Star acquired w/o problems.

PHT switched off at 07:43.

Initial SWS Instrument switch-on for the first time in orbit was commanded at 08:08:28.

High Precision Raster Pointing Mode [RPM] Test, part-1 was conducted between 09:28 and 11:20.

On Project request, a new SWS RAM patch [SWS_1.RAM] was imported onto ISORT at 13:33 and the checksum verified by DPD Software Support.

High Precision Raster Pointing Mode Test, part-2 was conducted between 13:55 and 16:01. Good results were obtained from both tests. For details refer to section 4.3.

Ground station handover Vilspa-2 -> Goldstone [DSS-27] at 15:40.

Normal Raster Pointing Mode Tests were conducted between 16:21 and 18:42.

LOS Vilspa at 17:31.

The ELS-A/B sensors were enabled at 19:50.

SWS switched off at 19:54.

PPM entry via OBDH TT-Command at 00:21.

Eclipse start at 03:26.

LOS Goldstone at 03:27.

AOS Kourou at 03:28 [short perigee pass].

LOS Kourou at 03:49.

End of Revolution-9 [951127]

4.1.7 Revolution-10 Summary

REV-10 [951127] had been long anticipated, as **the cryo cover ejection, one of the major milestones of the mission**, was planned to take place.

The four instruments had been commanded in a safe configuration during the past revolutions in order to protect them against a possible "solar flash".This was feared to be happen shortly after cover release, when sunlight reflections from the white painted back side of the free flying cover could enter into the then open telescope and hence, affect the instruments.

The major activities carried out in this revolution were as follows:

- S/C re-configuration after perigee exit;
- Cryo cover ejection preparation;
- Arming NCA's for cover release;
- Cover ejection at 10:27:43;
- S/C re-configuration;
- QSS initial switch on and calibration;
- Calibration Mode [CM] entry [first time];
- QSS/STR calibration;
- FSS/STR calibration;
- S/C re-configuration for perigee passage and eclipse;

All planned activities had been executed according to the FOP although, the original approach for the cover ejection had been modified the day before, since there was some doubt expressed by the PLM manufacturer, that cover release could not be detected by the gyros. No instrument operations had been planned in REV-10.

4.1.7.1 Details

AOS Vilspa at 03:47.

OBDH Re-configuration performed at 04:25 [perigee exit].

Transition PPM to FPM at 07:18, Guide Star acquired w/o problems.

Preparation for Cryostat Cover Ejection commenced at 08:15.

FPM slew to the Cryo Cover Release Attitude [SAA=65 °] at 09:22. The original procedure was slightly changed and the slew was made in FPM versus AGM to improve the visibility of the ejection. The time for the anticipated cover ejection [10:27:43] was optimised to achieve maximum orbital separation of the satellite with respect to the cover.

ELS-A/ELS-B sensor processing disabled at 09:40.

AGM critical command uploaded at 10:17.

RWL Biasing at 10:19. This was ad hoc introduced to prevent an undesired autonomous wheel unloading at transition from FPM to AGM, immediately after cover ejection.

Arming commands for cover ejection [NCA ARM1 ON[N] and NCA ARM2 ON[N]] linked at 10:23 and 10:25, respectively.

Go for Cover Ejection [NCA FIRE REL ON[N]] executed at 10:27:43.

-> 3 sec. and 7 sec. after the "FIRE" command was uplinked, Clamp Band Release and Cover Ejection was observed in Gyro 1-4 O/P rates [see section 4.4, Figure 4.4].

Go from Project for AGM critical command "RMC ENABLED" at 10:27:58, which initiated a fast slew in AGM [using the RCS thrusters] to SAA=85 °.

Absolute confirmation of Cover Ejection was observed in the change of the Telescope Baffle temperatures from 6 K to 3.1 K in approximately 15 minutes.

Transition AGM to FPM at 10:47, Guide Star acquired w/o problems.

Spacecraft Re-configuration [AOCS/RCS, ELS and Inertial Matrix Update] took place between 10:49 and 11:38, respectively.

Initial Quadrant Star Sensor [QSS] switch on was commanded at 11:44.

FPM slew to Calibration Star executed at 11:48 in preparation for the initial transition to Calibration Mode [CM] with the calibration star aligned to the centre of the FOV of the Star Tracker.

QSS Bias Reversal commanded at 12:52 - No star in the FOV of the QSS, but spikes observed in the QSS O/P cells did indicate that the Star is very near to the 3.8 * 3.8 arcmin FOV. Since in FPM the Star was not detected, the contingency called for RPM to be used [CRP: AOCS-4032].

Transition FPM to RPM at 13:04. During execution of the raster, the star was seen in positions m=4/n=5 and m=5/n=5, respectively.

Transition RPM to FPM at 14:28, with the objective to bring the Star in the FOV of the QSS.

Transition FPM to CM executed at 14:35, the Calibration Star is within the FOV of the QSS.

QSS Bias and Scale Factor Calibration commenced with the transition from CM to RPM at 15:04.

Ground station handover Vilspa-2 -> Goldstone [DSS-27] at 16:13.

QSS Gain and Dark Current parameters with modified QST = 40.0 uplinked at 17:38 [ACC database load].

Fine Sun Sensor [FSS] X-axis calibration started at 20:54.

PPM entry via OBDH TT-Command at 01:04:53.

LOS Goldstone at 03:23.

AOS Kourou at 03:27 [short perigee pass].

LOS Kourou at 03:46.

End of Revolution-10 [951128]

4.1.8 Revolution-11 Summary

REV-11 was the first opportunity for the instruments to be activated after cryo cover ejection, i.e. the telescope and hence, the instruments are receiving celestial radiation.

It was as well the first time that the Central Command Schedule [CCS] was used. For this reason, further reporting will be restricted to a summary per revolution, covering only the manual operations interleaved with the relevant CCS.

As of REV-11 S/C re-configuration after perigee exit and before perigee entry has been done in the automated way, i.e. per CCS.

For safety reasons [cover ejected], instrument activation of CAM, LWS and SWS was manually performed. With the exception of LWS, the automated de-activation was performed per CCS. PHT was not used in this revolution.

The following activities were carried out in REV-11 [951128]:

- **First image taken with the CAM instrument [M51 Galaxy]**;
- First use of the Central Command Schedule [CCS];
- LWS detector curing and checkout;
- CAM de-activation tests;
- SWS Checkout and Fabry-Perot Parallelisation [SW];
- Closure of cryo vent valves V504, V505 at 14:35;
- FSS-Z re-calibration;
- Gyro scale factor misalignment calibration;

AOCS calibration activities were manually interleaved within the executing CCS.

A new PHT_010.PCS library and a new PHT_1.RAM patch were imported onto ISORT at 00:57. These files contained optimised detector settings based on previous revolutions checkout and detector curing results. Also a new SWS_1.RAM patch was imported resulting from the 4 successfully conducted iterations of the Parallelisation procedure of the short-wavelength SWS Fabry-Perot. The checksums of the RAM patches were verified off-line by Software Support.

All operations planned in this revolution were completed.

For detailed information refer to the relevant sections in chapter 6.

End of Revolution-11 [951129]

4.1.9 Revolution-12 Summary

A revolution loaded with may manual operations for the SWS and PHT Focal Plane Geometry [FPG] trial, during which a number of difficulties were encountered and had to be overcome before activities could be completed. Nevertheless, at the end of the activities it was agreed to repeat the FPG trial in REV-14 [refer to chapter 4.3 for details].

The following activities were carried out in REV-12 [951129]:

- **SWS and PHT FPG trial**;
- **First light obtained with PHT [Gamma Draconis]**;
- LWS dark current measurement;
- CAM parallel mode verification;
- SWS Fabry-Perot Parallelisation [LW];
- FSS-Y re-calibration;

4 instruments automatic activation and de-activation per CCS had been scheduled for the first time.

During PHT activation, the PIDT requested to switch off the instrument at

06:15 due to problems encountered when uploading the PHT_1.RAM patch. It was thought that an incorrect RAM patch was used. At 07:32 PHT was switched on again and manually activated using a different patch version, i.e. PHT_2.RAM.. This worked flawless.

Investigation revealed that there was nothing wrong with the RAM patch rather then a timing conflict when switching TM formats from PHT 'Prime' to CAM 'Prime'. PHT requires not to be 'Prime' instrument when the upload of the RAM patch will be executed. The 10 sec. were deemed to be insufficient and have been extended to 20 sec. in the next version of the activation sequences.

At 14:57 PHT was switched off and switched on again at 14:58 in an attempt to re-load the PHT-1.RAM patch. CAM Prime was selected in TM at 15:04. Four attempts to start the manual uploading of the PHT_1.RAM patch failed PTV. This was correct, because for PHT safety reasons an interlock had been implemented in the IDCS [derived parameter algorithm 'PHTPTV'] that would prevent a second upload in the same revolution [SOC request]. The PTV criteria was disabled on the IDCS 'TCSPACON' task and the PHT_1.RAM patch uploaded correctly at 15:20. The PHT RAM was dumped and successfully compared with the ground image. PTV was re-enabled at 15:21.

A new SWS_1.RAM patch was imported at 20:06 which resulted from 2 successfully conducted iterations of the Parallelisation procedure of the short-and long wavelength SWS Fabry-Perot. The checksum of the RAM patch was verified off-line by Software Support.

AOCS calibration and FPG activities were manually interleaved within the executing CCS.

Several TC problems were experienced with Goldstone. During one occasion at 16:06 only part of a Block Command [BC] was received onboard the S/C [MF9020].

Some TM drops occurred which caused the schedule to enter several times in HOLD mode and recovery was required. One of these incidents at 00:46 hit the de-activation of the CAM instrument and consequently, CAM had to be manually de-activated and switched off at 00:50.

The Flight Dynamics datafile was corrected for SWS [aperture S2] at 01:00, since during the repeat of the FPG trial between 20:50 and 23:20 the source was not detected. An offset of 1.5 arcmin. in the location of aperture S2 was found.

End of Revolution-12 [951130]

4.1.10 Revolution-13 Summary

This revolution was allocated to perform the so called **"Telecommand Jitter Test"** in order to validate the overhead associated with the TC link to Goldstone, particularly re-transmissions times in the event of packet errors.

The **Telecommand Jitter Test** performed during this revolution revealed that all four instruments showed excellent performance **using a 1 second command buffer versus 6 seconds** originally planned between successive commands. All Instrument Teams [x-IDT] gave the go ahead for the future planning of observations to be based on a 1 second buffer. This will significantly increase the overall observation time available for the mission.

The following activities were carried out in REV-13 [951130]:

- CAM, LWS and SWS automatic activation;
- PHT electrically switched on per CCS;
- PHT RAM patch manual uplink;
- PHT manual activation;
- **First light obtained with LWS [S106] at 12:29;**
- CAM, LWS, SWS and PHT automatic de-activation.

The PHT RAM patch was executed manually during PHT activation by SOC [INSCON] at 05:57. This was done in order to prevent a possible repetition of the problems experienced in REV-12. The instrument was manually activated during the calibration window.

The planned observing sequence contained a total of 114 fine pointing and raster pointing requests, thus it was a rather loaded schedule. No special spacecraft operations were planned.

The Confirmation Star procedure failed at 07:02. It was realized that by allocating only 2 minutes for this manual operation, the time is insufficient for any recovery. One Guide Star acquisition failed at 09:15. Investigation by Flight Dynamics revealed that this star was not usable as a Guide Star [catalogue problem]. As the same star was also planned to be used on another 14 pointing requests, Flight Dynamics was requested to deliver IPF's, selecting different Guide Stars.

The SWS aperture S2 offset correction applied in REV-12 did not work. No light was seen with SWS.

End of Revolution-13 [951201]

4.1.11 Revolution-14 Summary

The revolution was re-planned on short notice. In addition to the planned Focal Plane Geometry [FPG] for CAM and LWS, it was decided to add the SWS FPG operation which had failed in REV-12. Furthermore, LWS requested to observe Saturn towards the end of this revolution.

The following activities were carried out in REV-14 [951201]:

- CAM, LWS and SWS automatic activation;
- CAM and LWS Focal Plane Geometry [FPG] Calibration;
- SWS FPG re-trial at 10:18;
- **First light obtained with SWS [Gamma Draconis] at 11:05;**
- LWS and SWS automatic de-activation;
- CAM manual de-activation.

FPG calibration offsets were calculated for CAM and LWS and provided to Flight Dynamics after the first offsets indicated sign errors. Two extra raster pointing IPF's were delivered by Flight Dynamics with corrected offsets. The new CAM aperture offsets were: Y= -7.65 arcsec and Z= -12.45 arcsec. The CAM FPG raster pointing was executed at 22:05.

The new LWS aperture offsets were: Y= -4.5 arcsec and Z= -13.5 arcsec. The LWS FPG raster pointing was executed at 22:45. Further FPG details are provided in chapter 4.5.

An extra manual fine pointing per IPF was executed at 23:14 to enable LWS to observe the centre of Saturn.

Several TM drops occurred during the Goldstone support period. One of them affected the schedule driven de-activation of CAM, because the CCS went on HOLD. Therefore, the instrument was manually de-activated by SOC [INSCON] at 23:48.

End of Revolution-14 [951202]

4.1.12 Revolution-15 Summary

The entire revolution [951202] was devoted to **verify the ability of ISO to track Solar System Objects** [SSO's]. Only the CAM instrument was used for this test. The CAM aperture offsets determined in REV-14 [FPG-Tests] were not applied, since there was some doubt on their correctness.

During instrument activation several TC's failed Command Transmission Verification [CTV] causing the CCS to enter on HOLD. The CTV failures were caused by TC interference to the TM downlink due to the fact that the ranging transponder was left erroneously "ON' [human problem]. This necessitated to perform a manual activation of CAM.

During the SSO tracking campaign, the following asteroids were tracked using one-dimensional rasters:

ATEN - fast and faint source on 13 rasters over 1 hour;

NUWA - slow, on 1 raster, over ½ hour;

MASSALIA - medium, on 1 raster [10 points], over ½ hour;
- medium, on 1 raster [24 points], over 1 hour;
- medium, on 1 raster, over 1 hour;

HESTIA - medium, on 1 raster, over 1 hour;

HISPANIA - slows, on 1 raster [10 points], over 1 hour.

The SSO tracking test was completely successful. A maximum drift of ~1.5 arcsec was determined relevant to a moving target rate of 120 arcsec/hour.

At the end of a fine pointing request at 18:07 the Guide Star failed to be acquired. The STR magnitude threshold was manually increased in several steps up to 8.00 without being able to find the star. A direct STR mapping was performed at 18:38 which detected 17 stars, including the failed one. However, the position differed about 2 arcmin wrt to the STR set points derived from the catalogue. In addition, the instrumental magnitude was measured with mv = 7.20 vice mv = 6.93 derived from the star catalogue [class K0 star]. At 18:48 an IPF with a different Guide Star was uplinked and the star successfully acquired. Further investigation revealed however, that the origin of the problem was caused in a version mishap between AOPF_03 and APF_02. Both files used in the composition of the CCS must have an identical version. An SPR was raised to check this in an automated way.

The final KOUROU perigee ranging pass took place between 03:13 and 03:34.

End of Revolution-15 [951203]

4.1.13 Revolution-16 Summary

This revolution was originally planned to be dedicated to further evaluation of the AOCS performance, in particular, **measurement of the Absolute Pointing Drift** [APD]. It was however decided to supplement this with additional CAM operations: 1. Detector transient tests; 2.Spare Task re-test and: 3. Re-check of the FPG offsets determined in REV-14.

Only the CAM instrument was scheduled and hence, the following activities were carried out in REV-16 [951203]:

- CAM Spare Task re-test;
- CAM manual activation at 06:06;
- CAM detector transients evaluation;
- First APD measurement at SAA of 90 Deg.[07:00 - 13:00];
- Second APD measurement at SAA of 61 Deg.[15:00 - 21:00];
- CAM validation of FPG offsets;
- CAM automatic de-activation.

Commanding to CAM was disabled from the schedule at 05:14 in order to proceed only with the electrical switch on at 05:24. The CAM Spare Task re-test started at 05:32 to investigate the anomaly detected in REV-7 [see: ISO-ANO-0006, chapter 6.4]. The test was partially successful, but the dumped memory did not correspond to the RAM patch uplinked. At 06:02 CAM was switched off to clear the suspect RAM patch. At 06:06 CAM was switched on again and manually initialized in order to re-join at 06:20 the remaining part of the activation sequence, i.e. the CAM-SW detector curing part.

For the CAM FPG validation the following offsets were delivered to Flight Dynamics: Y= + 7.65 arcsec and Z= + 12.45 arcsec (see REV-14). The validation was not successful due to a misunderstanding on the implementation of the offsets.

The APD drift measured during this revolution showed no marked differences in the results. For details refer to section 6.1.1.13 - [AOCS] Pointing Performance.

End of Revolution-16 [951204]

4.1.14 Revolution-17 Summary

This revolution was the first **[FPG-1]** of four successive revolutions devoted to **PHT and SWS Focal Plane Geometry Calibration** activities, all of them concerned with the precise determination of the apertures of the instruments on the focal plane assembly of the telescope.

Because of the problem experienced in REV-12, the PHT instrument will be always manually activated up to REV-20. In REV-21, a new set of instrument activation sequences will be installed, which should resolve the problem.

The following activities were carried out in REV-17 [951204]:

- AOS Vilspa at 03:28;
- S/C post-perigee re-configuration per CCS;
- SWS automatic activation [05:20 - 05:38];
- PHT manual activation [05:39 - 06:42];
- Transition PPM -> FPM Guide Star OK at 06:45;
- STR restricted search/tracking mode [5 stars] at 07:29;
- SWS FPG-1 started at 08:20;
- PHT FPG-1 started at 10:38;

- SWS Fabry-Perot Parallelisation [13:56 - 18:04];
- SWS FPG-1 terminated at 22:19;
- PHT FPG-1 terminated at 23:26;
- PPM entry by OBDH TT CMD at 23:32;
- SWS and PHT automatic de-activation [00:35 - 00:43];
- LOS Goldstone at 03:06.

Very detailed FPG information is given in section 4.5. CAM Parallel Mode verification was skipped from this revolution. LWS was not used at all.

New Permanent [instrument] Command Sequence [PCS] files for CAM and LWS [CAM_006.PCS and LWS_009.PCS] were imported onto ISORT at 09:14 on request of SOC.

A new SWS_1.RAM patch was imported onto ISORT at 18:55, resulting from the Fabry-Perot Parallelisation procedure.

End of Revolution-17 [951205]

4.1.15 Revolution-18 Summary

This revolution was the second **[FPG-2]** of four successive revolutions devoted to **PHT and SWS Focal Plane Geometry Calibration** activities.

The following activities were carried out in REV-18 [951205]:

- AOS Vilspa at 03:27;
- S/C post-perigee re-configuration per CCS;
- SWS automatic activation [05:17 - 05:36];
- PHT manual activation [06:09 - 06:42};
- Transition PPM -> FPM Guide Star OK at 06:43;
- CAM manual activation [07:31 - 07:53];
- CAM Parallel Mode verification;
- STR restricted search/tracking mode [5 stars] at 08:13;
- SWS FPG-2 started at 08:17;
- PHT FPG-2 started at 10:34;
- STR restricted search/tracking mode [5 stars] at 11:20;
- STR restricted search/tracking mode [5 stars] at 17:02;
- SWS FPG-2 terminated at 21:13;
- PHT FPG-2 terminated at 23:23;
- PPM entry by OBDH TT CMD at 23:29;
- CAM, SWS and PHT automatic de-activation [23:36 - 00:41];
- LOS Goldstone at 03:04;

End of Revolution-18 [951206]

4.1.16 Revolution-19 Summary

This revolution was the third **[FPG-3]** of the four successive revolutions devoted to **PHT and SWS Focal Plane Geometry Calibration** activities.

The following activities were carried out in REV-19 [951206]:

- AOS Vilspa at 03:12;
- S/C post-perigee re-configuration per CCS;
- SWS automatic activation [05:14 - 05:33];
- PHT manual activation [06:08 - 06:35};
- Transition PPM -> FPM Guide Star OK at 06:40;
- CAM manual activation [07:28 - 07:47];
- CAM Parallel Mode verification;
- STR restricted search/tracking mode [5 stars] at 07:24;
- SWS FPG-3 started at 08:13;
- PHT FPG-3 started at 11:37;
- SWS Band-3/4 detector behaviour investigation [13:41];
- STR restricted search/tracking mode [5 stars] at 13:40;
- SWS Band-3/4 detector behaviour investigation [18:30];
- SWS FPG-3 terminated at 22:11;
- PHT FPG-3 terminated at 23:19;
- PPM entry by OBDH TT CMD at 23:27;
- CAM, SWS and PHT automatic de-activation [23:33-00:38];
- LOS Goldstone at 03:01;

End of Revolution-19 [951207]

4.1.17 Revolution-20 Summary

This revolution was the fourth **[FPG-4]** and as well last of the four successive revolutions devoted to **PHT and SWS Focal Plane Geometry Calibration** activities.

The following activities were carried out in REV-20 [951207]:

- AOS Vilspa at 03:24;
- S/C post-perigee re-configuration per CCS;
- SWS automatic activation [05:12 - 05:30];
- PHT manual activation [06:05 - 06:28};
- Transition PPM -> FPM Guide Star OK at 06:38;
- CAM manual activation [07:28 - 07:46];
- CAM Parallel Mode verification;
- STR restricted search/tracking mode [5 stars] at 07:46;
- SWS FPG-4 started at 08:11;
- PHT FPG-4 started at 11:36;
- SWS Band-3/4 detector behaviour investigation [13:38];
- STR restricted search/tracking mode [5 stars] at 13:55;
- SWS FPG-4 terminated at 16:15;
- PHT FPG-3 terminated at 18:23;
- FSS/STR re-calibration [21:53 - 00:57];
- CAM, SWS and PHT automatic de-activation [23:31-00:36];
- LOS Goldstone at 02:58;

End of Revolution-20 [951208]

4.1.18 Revolution-21 Summary

This revolution had been originally planned as the "SCP Contingency Day" in case the planned activities could not be completed by REV-20. Since all SCP activities were indeed completed, REV-21 was used **to validate the new automatic 4-Instrument Activation Sequences, to determine an optimized TC uplink modulation index, to validate the revised instrument aperture pointing offsets and to perform further investigations on instrument detector curing and responsivity. Some filler observations had been added to complete the available time.**

The following activities were carried out in REV-21 [951208]:

- AOS Vilspa at 03:18;
- S/C post-perigee re-configuration per CCS;
- Mod-Index investigation and testing, part-1 [03:50 - 04:51];
- Automatic 4-Instruments activation [05:09 - 06:34];
- Transition PPM -> FPM Guide Star OK at 06:35;
- PHT detector responsivity checks [07:52, 11:17, 15:17, 22:11];
- SWS FPG calibration offsets verification [08:17 - 09:10];
- PHT FPG calibration offsets verification [09:18 - 10:10];
- SWS Band-3/4 detector investigations [10:10; 18:10];
- CAM FPG calibration offsets verification [14:44; 22:11];
- Mod-Index investigation and testing, part-2 [15:19 - 15:32];
- CAM observations of NGC 7252 [PV-Phase-visibility problem]
- LWS FPG calibration offsets verification [22:38 - 23:19];
- PPM entry by OBDH TT CMD at 23:21;
- Automatic 4-Instruments de-activation [23:28-00:33];
- LOS Goldstone at 02:57;

The TC uplink modulation index tests indicated that for all values below the nominal value of 0.8 radians, no TM drops occurred when the ranging transponder was switched on and no tones were uplinked. With a value of 0.5 radians, perfect commanding around apogee was maintained [for more information refer to section 7.3].

The new automatic 4-Instruments activation sequences, version IN4_04.ADF [02/12/95] performed flawless. The earlier reported problem with the PHT RAM patch uplink was resolved by increasing the time between "CAM // Mode prime in TM" and the start of the PHT RAM patch from 10 to 20 seconds.

For LWS, PHT and SWS the measurements confirmed the FPG calibration offsets determined in the previous revolutions. For CAM however some inconsistency was found between the offsets applicable to the LW and SW detectors, and a compromise solution was worked out. This last change required a REPLAN of REV-22 on short notice, since CAM was the first instrument to be used in the Performance Verification Phase [PV].

The operations carried out during REV-21 concluded successfully the activities of the Satellite Commissioning Phase.

End of Revolution-21 [951209]

4.2 Summary of Apogee Lowering Manoeuvre

The preparation of the **Apogee Lowering Manoeuvre [Delta-V] at the end of REV-6** began at 22:00 with the manoeuvre input data provided by Flight Dynamics as follows:

A velocity increment [Delta-V] of 8.85 m/s, resulting in a burn duration of 39 Minutes and 20.5 Seconds. The manoeuvre execution time was set for 02:50:04. The manoeuvre input data were compensated with the results obtained from the Delta-V Rehearsal. The Spacecraft configuration was identical with respect to the two previously executed manoeuvres [refer to section 3.5, above]. However, since the manoeuvre was executed close to perigee, a different manoeuvre strategy had to used as follows:

The transition from FPM to PPM was executed at 22:19. The AOP was uplinked at 23:21 UT. The Delta-V attitude was incorporated in the PPL of REV-06 [PPL_0006_05] and hence, the attitude was acquired in PPM at 01:20. All Gyro Mode [AGM] entry was executed at 01:30, resulting in a static transition from PPM to AGM at this time. The STR-A was in standby, since it cannot be used around perigee +/- 3 hours.

The AOP enable command was uplinked as OBDH TT-Command at 01:50, with an AOP execution time set to 02:08:00.

The manoeuvre was executed through the AOP at 02:50:04. The manoeuvre terminated autonomously at 03:29:24.

ESOC/OAD reported a very accurate performance of the apogee lowering Manoeuvre as follows:

The expected Delta-V should have reduced the apogee by - 1007.4 Km, while the actual reduction of the apogee was -1008.4 Km, i.e. a small 0.1 % over - performance.

Future Manoeuvre:

The orbital period will steadily decrease from 23 hours 57.3 minutes to 23 hours 56.6 minutes, i.e. the perigee longitude will reach the maximum westerly point of 66 ° west about 21 March 96. The longitude will return to 50 ° west on 11 August 96 and hence, no further orbit correction manoeuvre would be required before this date.

4.3 Raster Pointing Mode Tests

The aim of this activity was to provide a comparison between the two RPM control lows present in the AOCS SW, i.e. the "Normal RPM" and the "High Precision RPM" and subsequently to determine which mode would have to be used during ISO routine operations in order to maximize the S/C pointing performance. The high precision RPM was especially designed to compensate for excessive bias on the STR CCD [due to "Charge Pocket Effect"], nevertheless the replacement of the STR CCD with an improved model [CCD 7863D] could have invalidated the performance of the new "high precision" mode or at least made its utilization unnecessary: this had to be proved, based on direct in flight experience.

The whole test activity was split into two macro-steps:

- calibration of the "high precision" Raster Pointing Mode, to fine tune the relevant on board SW parameters in order to guarantee maximum performance: this was performed in Revolution 5 [day 326];

- direct comparison between "high precision" and "Normal" Raster Pointing Modes and between "high precision" pointing mode [actually a raster 1x1] and Fine Pointing Mode: this was carried out in Revolution 9 [day 330].

High Precision RPM calibration

The High Precision Raster Pointing Mode calibration consisted in executing in sequence two identical rasters, rotated by 90 deg. to each other, and in acquiring during their execution the STR bias information [via USD telemetry] to be processed off-line by a Flight Dynamics dedicated tool.
The activity started on day 326 [Revolution 5] at 16:46, with the update of the ACC Data-base parameter 1108 [i.e. the "RMP update factor" was forced to zero while its default value is = 0.1].
After acquisition [in Fine Pointing Mode] of the guide star in the centre of a CCD pixel at 16:52, the first High Precision Raster [IPF 005_01.RPM], was commanded at 17:16:18.
The characteristics of the raster are summarized here below:

size = 2 legs X 10 points
distance between two consecutive raster points = 10 arcsec
duration of each raster point = 2 minutes
total duration of the raster = 40 minutes

Note: the second raster [see below] was rotated by 90 deg. with respect to the first one; all the other raster parameters remained unchanged.

A guide star of visual magnitude 4.55 was used, located relatively close to the STR FOV centre [mean coordinated: y=-4000, z=-5000]. At the end of the raster execution a transition back to Fine Pointing Mode was commanded at 18:03. The second raster [IPF 005_02.RPM] started at 18:06:19 and it was completed by 18:47; again a transition to Fine Pointing Mode was commanded at the end [18:55]; subsequently the default value of data-base parameter 1108 ["RPM update factor"] was restored on board [at 19:02].

The data acquired during the tests were processed off-line by Flight

Dynamics and the relevant results were provided on day 330; a summary is given here below:

- mean STR Y bias for first raster = -0.54 arcsec [sigma =0.35]
- mean STR Z bias for first raster = +0.14 arcsec [sigma =0.31]
- estimated "new" update factor [raster-1] = 1.792

- mean STR Y bias for second raster = +0.43 arcsec [sigma =0.25]
- mean STR Z bias for second raster = -0.27 arcsec [sigma =0.22]
- estimated "new" update factor [raster-2] = 0.845

Due to the inconsistency between the two values of the RPM update factor evaluated for the two rasters [see above], no update of the ACC on board data-base parameter 1108 ["RPM update factor"] was required and the default value [= 0.1] was retained to guarantee maximum pointing performance [an update is required, as a consequence of the calibration, only if the "new" update factors estimated for raster-1 and raster-2 respectively, agree within 5 %].

Comparison between High Precision & Normal Raster Pointing Modes

This activity consisted in executing in sequence the following steps:

a] acquisition of 5 stars in the STR field of view [with the STR in Restricted Searching/Tracking mode];
b] execution of two identical "High Precision" rasters, with different USD sets [15 and 61 respectively] to acquire all the necessary information for the relevant off-line data processing;
c] execution of two "High Precision" Pointing procedures [Rasters 1 X 1];
d] selection on board of the Normal Raster Pointing Mode, via modification of ACC Data-Base parameter [DB load command];
e] repetition of the same raster [as per step b] above] in "Normal" RPM;
f] execution of two normal pointing procedures in Fine Pointing Mode, equivalent to step c] above;
g] off line data processing and evaluation/comparison of the High Precision RPM / Normal RPM performances.

The activity for the acquisition of the 5 stars started at 09:22 [DOY 330]: the acquisition of the first star in RPM with the STR in Normal Search-Tracking mode was successfully completed at 09:22:14, nevertheless the transition to RPM with the STR in Restricted Search-Tracking mode [same guide star] that was executed at 09:28:38 failed: no guide star was detected. The command was repeated at 09:33, 09:48, 09:51 with slightly different magnitude thresholds: i.e. 3.5, 4.0, 3.75 respectively, instead of the original 4.25 value; all the attempts were still unsuccessful. A new guide star [of magnitude 7.25] was therefore selected by Flight Dynamics and the whole procedure was repeated, starting at 10:39. The transition to RPM with the STR in Restricted Search-Tracking mode was this time successful and the acquisition of the 5 stars in the STR FOV was completed by 11:04; the execution of the first High Precision Raster with 5 stars simultaneously tracked, started at 11:29 and was completed by 13:51. The characteristics of the raster are summarized here below:

size = 11 legs X 11 points
distance between two consecutive raster points = 31 arcsec
duration of each raster point = 70 seconds
total duration of the raster = 2 h, 22 m

The repetition of the same Raster [with USD set 61 selected] started at 13:55; because of time constraints due to previous difficulties in acquiring the 5 stars, the second raster was truncated after 99 points [out of 121] at 15:46; it has to be noticed that the repetition of this raster was aimed to collect supplementary information via different USD Telemetry [i.e. nice to have], but not strictly mandatory for the successful execution of the overall test.

The execution of the two High Precision Pointing procedures [Raster 1X1 with 5 stars simultaneously tracked] started at 15:52 and was completed by 16:12.

The selection on board of the "Nominal" Raster Pointing Mode [ACC database parameter 1107 set to "NO"] took place at 16:13. After that the same raster was repeated in Normal RPM [with 5 stars simultaneously tracked] from 16:21 to 18:43.

The test activity was completed by the execution of two pointings in "nominal" FPM, at the same attitude of the previous "high precision" pointings: the first FPM [with 5 stars simultaneously tracked] was commanded at 19:21, the second at 19:39, respectively. The whole test activity was completed by 19:55.

The data collected during the test were analysed off-line by Flight-Dynamics/Project with the following outcomes/results:

1] the spacial variation in STR bias was measured to be very small: < 1 arcsec wrt. a specification value of 2 arcsec.

2] since the High Precision RPM was especially designed to expect substantial changes in the STR bias and additional error sources are added in case the STR bias is in fact absent, the performance of the High Precision RPM was found to be lower than the Nominal RPM.

3] Normal Raster was measured to be about 3 times more accurate than the High Precision Pointing. For example for the STR Y-axis the following results were evaluated:

	High Precision RPM	Normal RPM
maximum error [arcsec]	4.0	2.74
minimum error [arcsec]	-2.63	0.85
bias [arcsec]	0.822	1.82
stnd. deviat. [arcsec]	1.33	0.39

Similar results were obtained for the z-axis.
The presence of a considerably high bias [especially for the HP RPM] was indicating that some fine-tuning had still to be implemented [e.g. at AOCS sensor calibration level] to improve the pointing performance, nevertheless the error dispersion in the two cases was a clear indication that the Normal RPM was providing a much better performance.

A visualisation of the above results is provided in fig 4.3-1 & 4.3-2.

4] Normal RPM was therefore selected as base-line Raster Pointing Mode during all the ISO scientific observations.

Fig 4.3-1 : High Precision Raster Pointing Mode [error-Y]

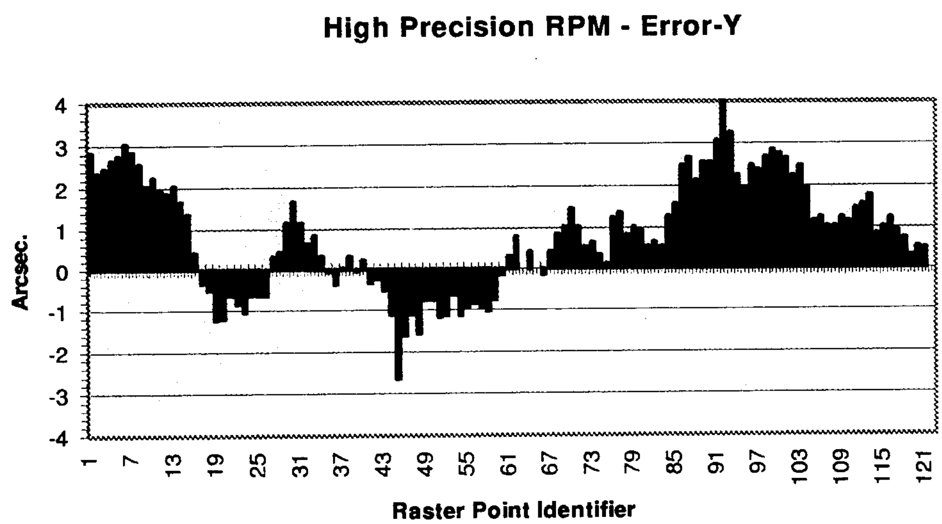
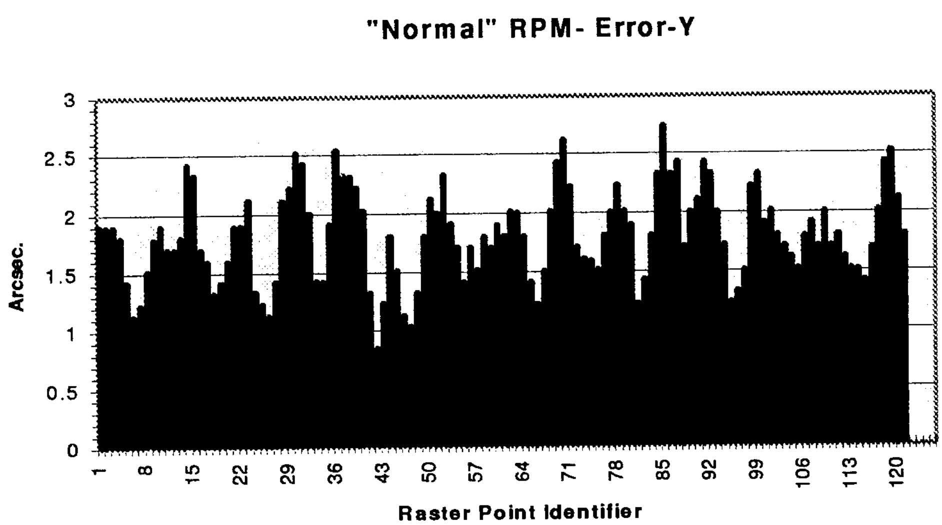


Fig 4.3-2 : "Normal" Raster Pointing Mode [error-Y]



4.4 Summary of Cryostat Cover Ejection

A new strategy was discussed and approved a day before cover ejection was scheduled. There was much discussion and worry if positive verification could be observed from the gyro outputs by the PLM prime contractor. The new and agreed strategy was as follows:

1. FPM slew to cover ejection attitude [SAA=65°] vice AGM in Timeline;
2. Bias Reaction Wheels;
3. Stay in FPM with USD-008 selected;
4. Load critical All Gyro Mode [AGM] IPF;
5. Execute AGM [slew to SAA=85 °] no earlier than 10 seconds after positive confirmation is seen in the gyro outputs. The 10 seconds delay were required to prevent a possible collision of the cover with the telescope sunshade;
6. No slew to SAA=85 °, if nothing seen on the gyro outputs.

The preparation for the cryo cover ejection activities in REV-10 started on 951127 at 08:50. The slew to the cover ejection attitude in FPM [SAA=65 °]was executed at 09:22. The ELS-A/B disabled at 09:40. The ACC-A Database parameters Vfall1, Vfall2 and Vfall3 updated for AGM. Some disturbance was created in the IDCS telemetry receiver [crashed twice] by a malfunctioning INTEL workstation [W/S-7] in the Project Support Room at 09:31 and 10:09, respectively. Software support was instructed to leave W/S-7 disconnected. RWL Biasing to 3.6 Nms was done at 10:09. The NCA ARM-1 [MF 3003] and NCA ARM-2 [MF 3005]commands were uplinked at 10:25, while the NCA FIRE [MF3001] command was executed at 10:27:43.

CLAMP BAND RELEASE and COVER EJECTION was immediately confirmed in telemetry by the gyro outputs.

The transition to AGM was executed at 10:27:58, which initiated a fast slew under RCS Thruster Control to SAA=85 ° in order to prevent reflecting Sunlight [flash effect] from the free-flying Cryo-cover entering the Telescope.

Although the impact on the spacecraft was immediately observed on the gyro outputs [see Figure 4.4], the absolute confirmation that the cover was gone was the drop of the upper baffle temperature from 6 K to 3.1 K, within 15 minutes.

The evolution of SAA before during and after the Cryo-cover release can be seen in Figure 6.2.1-5 of section 6.2.1.

The spacecraft was re-configured by enabling ELS-A/B at 11:13 and the S/C Inertial Matrix was updated at 11:38.

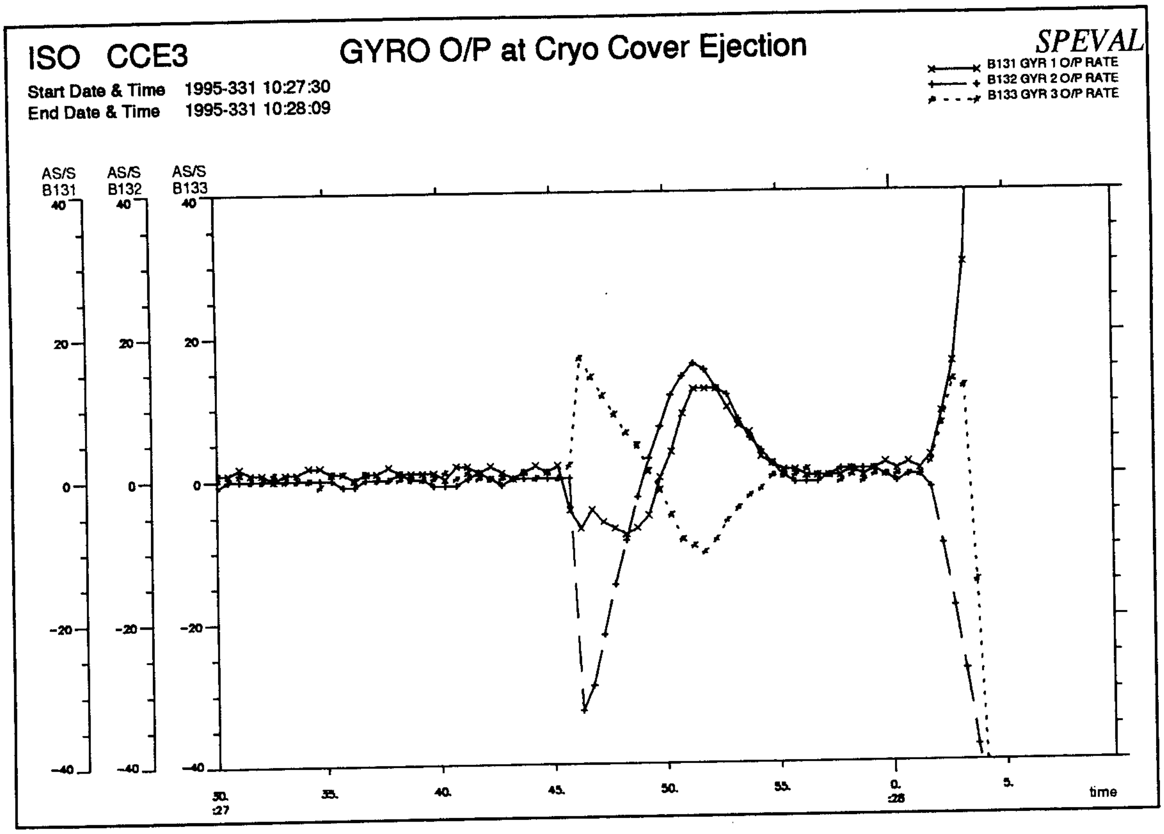


Figure 4.4: **Gyro 1-3 outputs at Cryo Cover Ejection**

Remarks:

The first excursion of Gyro 1-3 outputs represents the Clamp Band release; the second excursion represents the Cover Release and the third one shows the thruster controlled fast slew from SAA 65 ° to 85 °.

4.5 Summary of Focal Plane Geometry Calibration

The Focal Plane Geometry [FPG] Calibration of the four scientific instruments occupied a large part of the Satellite Commissioning Phase [7 revolutions], because the procedures used to acquire up to 5 stars for the PHT and the SWS experiments using the Star Tracker Restricted Search and Tracking mode, had to be manually interleaved with the executing Central Command Schedules [CCS], whereby all teams [SOC/SCC/Instrument Dedicated Teams [IDT]/PROJECT and FLIGHT DYNAMICS] were required to work very closely together. A difficult issue was the implementation of the FPG offsets values in the FDS, since the application of the offset sign determined by the relevant IDT's caused some confusion. An overview of the FPG activities is given here below:

REV-12: SWS/PHT FPG trial

The aim of this activity was to test the general approach used for the focal plane geometry calibration of the SWS/PHT instruments, involving complicated interfaces between all groups [Control team, Flight dynamics team, Instrument dedicated teams]. The activity started on day 333 at about 08:00; great difficulties were experienced during the acquisition of the 5 stars in RPM-Restricted_Searching/Tracking mode: the transition from RPM-Normal_ Search/ Track mode to RPM-Restricted_ Search/Track mode failed systematically during several attempts where different STR magnitude thresholds and different guide stars were tried. The activity was suspended at 08:50 to allow the execution of an on board attitude reconstruction which showed a residual error on the Y-axis of about 200 arcsec.: this pointed to a potential problem with the last FSS calibration about the Y-axis executed in REV-11 [i.e the on board parameter FSSY9 was suspected to be inaccurate]. Due to time limitations it was nevertheless decided to continue the FPG activity, by implementing a modification to the relevant AOCS procedure: i.e. acquisition of 3 stars only in RPM-Normal_ Search/Track mode. This back-up strategy allowed eventually a partial execution of the 11 X 11 Raster for SWS FPG calibration purposes [at 09:30] and the complete execution of the 7 X 7 Raster for PHT [at 10:50].
The whole activity was completed by 11:44, but since the SWS raster was truncated after 6 legs out of 11, due to synchronization constraints imposed by the CCS automatic execution, it was agreed to repeat the SWS raster later in the revolution. In the meantime the control team decided to repeat the FSS-Y calibration: the activity was carried out from 12:40 to 13:30.
A new value for FSSY9 was uplinked at 13:45 [value = 1.7 E-04] and some tests were executed afterwards [at 13:50 and 18:10] to check the capability of switching between RPM-Normal_Search/Track mode to RPM-Restricted_Search/ Track mode: the transition was this time successful. The repetition of the FPG trial procedure started at 20:50: the SWS 11X11 raster was successfully executed with 5 stars simultaneously tracked, in the period from 21:20 to 23:20. Despite the fact the raster execution was nominal, the SWS instrument did not see the source; later on it was discovered that, due to a misreading of a drawing, the SWS S2 slit was given a wrong offset in the Flight Dynamics database. It was agreed by all parties to repeat the SWS part of the FPG trial during a time slot of 2.5 h in revolution 14.

REV-14:

In this revolution three major FPG calibration activities were executed:

a] **CAM FPG**: the calibration was based on the execution of a 3X3 raster [step size of 24 arcsec and total duration of 45 minutes] in "normal" conditions [only one star tracked & automatic execution via CCS]. The activity started at about 08:00 and successfully completed by 08:45. A second measurement was taken at about 19:00, to confirm the results of the first calibration.

b] LWS FPG: the calibration was based on the execution of a 11X11 raster [step size of 9 arcsec and a total duration of 1 h & 30 minutes] in "normal" conditions [only one star tracked & automatic execution via CCS]. The activity started at about 08:45 successfully completed by 10:15.
A second measurement was taken at about 19:45 [11X11 raster on Saturn, with a step size of 45 arcsec]: this second measurement indicated that the first corrections had been applied with the wrong sign.

c] repetition of the SWS part of the SWS/PHT FPG trial: the preparation activity started at 10:20; the 5 star acquisition was successfully completed by 10:31. The raster execution started at 11:00 completed by 13:05.
This time the test source was properly detected the first rough offsets could be determined.

REV-17: SWS/PHT FPG calibration part-1

The sequence of activities is provided in table 4.5-1 here below.
A description of the Rasters that were executed during the day is given in table 4.5-2. The whole activity was carried out in two time windows, from 07:40 to 13:45, from 20:00 to 23:30 respectively: manual operations [AOCS commanding] were interleaved with CCS operations [Instrument commanding]; no problems were experienced during the execution of the procedure.

macro step	Activity description	S/S involved
1	QSS/STR misalignment calibration [QDS evaluation]	AOCS/SYS
2	acquisition of 5 stars in the STR FOV [in STR Restricted Search/Track mode]	AOCS/SYS
[illegible]	execution of raster R1	SWS
[illegible]	execution of raster R3	PHT
[illegible]	execution of raster R2	SWS
[illegible]	[illegible] processing evaluation of the instrument offsets to be [illegible] for the next iteration	OAD/SOC
[illegible]	[illegible] misalignment calibration [QDS evaluation]	AOCS/SYS
[illegible]	[illegible] of 5 stars in the STR FOV [in STR Restricted [illegible] mode]	AOCS/SYS
[illegible]	[illegible] raster R1	SWS
[illegible]	[illegible] raster R3	PHT
[illegible]	[illegible] evaluation of the instrument offsets to be [illegible] iteration	OAD/SOC

Table 4.5-1: FPG activities in REV-17

Raster ID	Instrument	size	step_size [arcsec]	total duration [minutes]
R1	SWS	11 X 11	6	121
R2	SWS	11 X 11	10	121
R3	PHT	7 X 7	10	49

Table 4.5-2: Description of Rasters used for FPG activity in REV-17

REV-18: SWS/PHT FPG calibration part-2

The sequence of activities is provided in table 4.5-3 here below. A description of the Rasters that were executed is given in table 4.5-4. The whole activity was carried out in two time windows, from 07:35 to 16:05, and from 18:00 to 23:25 respectively: manual operations [AOCS commanding] were interleaved with CCS operations [Instrument commanding]; no problems were experienced during the execution of the procedure.

macro step	Activity description	S/S involved
1	QSS/STR misalignment calibration [QDS evaluation]	AOCS/SYS
2	acquisition of 5 stars in the STR FOV [in STR Restricted Search/Track mode]	AOCS/SYS
3	execution of raster R4	SWS
4	execution of rasters R6	PHT
5	execution of slew to different test source	AOCS/SYS
6	acquisition of 5 stars in the STR FOV [in STR Restricted Search/Track mode]	AOCS/SYS
7	execution of rasters R5	SWS
8	execution of rasters R5	SWS
9	execution of rasters R5	SWS
10	execution of rasters R6	PHT
11	data processing and evaluation of the instrument offsets to be used for the next iteration	OAD/SOC
12	QSS/STR misalignment calibration [QDS evaluation]	AOCS/SYS

13	acquisition of 5 stars in the STR FOV [in STR Restricted Search/Track mode]	AOCS/SYS
14	execution of rasters R5	SWS
15	execution of rasters R5	SWS
16	execution of rasters R5	SWS
17	execution of rasters R7	PHT
18	execution of rasters R8	PHT
19	data processing and evaluation of the instrument offsets to be used for the next iteration	OAD/SOC

Table 4.5-3: FPG activities in REV-18

Raster ID	Instrument	size	step_size [arcsec]	raster type/shape	total duration [minutes]
R4	SWS	11 X 11	4	single	121
R5	SWS	twice 12 X 2	2	cross	2x24 = 48
R6	PHT	twice 9 X 2	5	cross	2x18 = 36
R7	PHT	twice 11 X 2	2	cross	2x22 = 44
R8	PHT	twice 13 X 2	3	cross	2x26 = 52

Table 4.5-4: Rasters used for FPG activity in REV-18 / 19 /20

REV-19: SWS/PHT FPG calibration part-3

The sequence of activities is provided in table 4.5-5 here below. A description of the Rasters that were executed during the day is given in table 4.5-4. The whole activity was carried out from 08:00 to 23:15: manual operations [AOCS commanding] were interleaved with CCS operations [Instrument commanding; no problems were experienced during the execution of the procedure.

macro step	Activity description	S/S involved
1	QSS/STR misalignment calibration [QDS evaluation]	AOCS/SYS
2	acquisition of 5 stars in the STR FOV [in STR Restricted Search/Track mode]	AOCS/SYS
3	execution of raster R5	SWS
4	execution of raster R5	SWS
5	execution of raster R5	SWS
6	execution of raster R7	PHT
7	execution of raster R8	PHT
8	execution of slew to different test source	AOCS/SYS
9	acquisition of 5 stars in the STR FOV [in STR Restricted Search/Track mode]	AOCS/SYS
10	execution of raster R5	SWS
11	execution of raster R5	SWS
12	execution of raster R7	PHT
13	execution of raster R8	PHT
14	execution of slew to different test source	AOCS/SYS
15	acquisition of 5 stars in the STR FOV [in STR Restricted Search/Track mode]	AOCS/SYS
16	execution of raster R5	SWS
17	execution of raster R5	SWS
18	execution of raster R7	PHT
19	execution of raster R8	PHT
20	data processing and evaluation of the instrument offsets to be used for the next iteration	OAD/SOC

Table 4.5-5: FPG activities in REV-19

REV-20: SWS/PHT FPG calibration part-4

The sequence of activities is provided in table 4.5-6 here below. A description of the Rasters that were executed during the day is given in table 4.5-4. The whole activity was carried out from 07:40 to 18:20:

manual operations [AOCS commanding] were interleaved with CCS operations [Instrument commanding; no problems were experienced during the execution of the procedure.

macro step	Activity description	S/S involved
1	QSS/STR misalignment calibration [QDS evaluation]	AOCS/SYS
2	acquisition of 5 stars in the STR FOV [in STR Restricted Search/Track mode]	AOCS/SYS
3	execution of raster R5	SWS
4	execution of raster R5	SWS
5	execution of raster R5	SWS
6	execution of raster R7	PHT
7	execution of raster R8	PHT
8	execution of slew to different test source	AOCS/SYS
9	acquisition of 5 stars in the STR FOV [in STR Restricted Search/Track mode]	AOCS/SYS
10	execution of raster R5	SWS
11	execution of raster R5	SWS
12	execution of raster R7	PHT
13	execution of raster R8	PHT
14	data processing and evaluation of the instrument offsets to be used for the next iteration	OAD/SOC

Table 4.5-6: FPG activities in REV-20

REV-21: verification/confirmation of FPG results

The "contingency" revolution [i.e. REV-21] was allocated to the final verification of the implemented offsets for all the scientific instruments.

For SWS, PHT, LWS the measurements confirmed the results acquired in the previous revolutions. For CAM some inconsistency was found between the offsets applicable to different detectors, and a compromise solution was worked out.

Table-4.5 shows the final offsets determined for each of the instruments and their relevant apertures wrt to the telescope boresight [QSS].

Table-4.5: **ISO Focal Plane Geometry Calibration Offsets**

INSTRUMENT	UNITS	Y-AXIS	Z-AXIS
CAM	arcsec	2.65	7.45
LWS	"	13.5	4.5
PHT-1	"	-9.5	-3.9
PHT-2	"	-9.5	-3.9
PHT-3	"	-6.8	-5.1
SWS-1	"	1.5	-19.6
SWS-2	"	4.7	-22.2
SWS-3	"	9.3	-24.5

5 ORBITAL ELEMENTS

5.1 Initial Orbital Elements

The orbit determination results at Ho+ 07:30 hours [17 November] were based on 10 measurements from PERTH and 3 measurements from VILSPA-2.

Epoch November 17th at 01:40:52.5:

Height of perigee	499.8	Km
Height of apogee	71577.1	Km
Semi-major axis	42635.7	Km
Eccentricity	0.838672	
Inclination	5.248	Deg.
Ascending node	308.514	Deg.
Argument of perigee	114.854	Deg.
True anomaly	22.999	Deg.

The orbit determination results on 18 November, at 23:50, include the effect of the 5 minutes test Delta-V manoeuvre rehearsal, executed at 13:44:52 around Apogee 1.

Epoch November 18th at 13:49:51: [apogee 1]:

Height of perigee	518.07	Km	[perigee 2]
Height of apogee	71583.5	Km	
Semi-major axis	42423.4	Km	
Eccentricity	0.837312		
Inclination	5.2429	Deg.	
Ascending node	308.437	Deg.	
Argument of perigee	115.111	Deg.	
True anomaly	179.999	Deg.	

5.2 Post Perigee Raising Orbital Elements

The orbit determination results on 20 November, at 08:57, include the effect of the 111 min. and 24.5 sec. main Delta-V manoeuvre, executed at 13:10:03 around apogee 2.

Epoch November 20th at 02:11:16: [perigee 3]

Height of perigee	1030.4	Km	
Height of apogee	71606.8	Km	[apogee crossing time]
Semi-major axis	42886.7	Km	
Eccentricity	0.827253		
Inclination	5.2409	Deg.	
Ascending node	308.212	Deg.	
Argument of perigee	115.547	Deg.	
True anomaly	359.962	Deg.	

5.3 Post Apogee Lowering Orbital Elements

The orbit determination results on 24 November, include the effect of the 39 min. and 20.5 sec. Delta-V manoeuvre, executed at 02:50:04 prior to perigee 7.

Epoch November 24th at 03:45:29: [perigee 7]

Height of perigee	1004.0	Km
Height of apogee	70611.1	Km
Semi-major axis	42374.6	Km
Eccentricity	0.825788	
Inclination	5.1975	Deg.
Ascending node	308.7	Deg.
Argument of perigee	115.78	Deg.
True anomaly	359.98	Deg.

5.4 Mission Orbital Elements

The orbit determination results on 28 November, include the effect of the Cryo Cover Release in revolution 10, executed at 10:27:43, 6 hours and 50 minutes after perigee crossing.

Epoch November 28th at 03:34:57: [perigee 11]

Height of perigee	1035.7	Km
Height of apogee	70578.8	Km
Semi-major axis	42376.05	Km
Eccentricity	0.825046	
Inclination	5.1536	Deg.
Ascending node	309.02	Deg.
Argument of perigee	116.01	Deg.
True anomaly	359.93	Deg.

The orbit determination results on 7 December represent the mission orbital elements one day before the end of the **Satellite Commissioning Phase [SCP]**.

Epoch December 7th at 15:09:43: [apogee rev. 20]

Height of perigee	1007.1	Km
Height of apogee	70607.6	Km
Semi-major axis	42188.75	Km
Eccentricity	0.824794	
Inclination	5.109	Deg.
Ascending node	308.81	Deg.
Argument of perigee	117.51	Deg.
True anomaly	180.00	Deg.

6 SPACECRAFT PERFORMANCE

This section provides an analysis of the performance of the spacecraft subsystems [SVM and PLM] during LEOP and SCP as far as operations are concerned, and where applicable, have been affected.

The spacecraft performance was excellent throughout LEOP and SCP. The satellite status at the end of the SCP was nominal. All planned operations have been executed according to the FOP Timeline [LEOP and SCP, where applicable] and the Satellite Commissioning Plan [SCP only].

The six Anomalies recorded during these phases had no impact on nominal operations.

At the end of the SCP the satellite was declared ready to enter the Observatory Performance Verification [PV] Phase, which started in REV-22 on 971209.

6.1 Service Module [SVM] Subsystems

All nominal modes of the SVM Subsystems have been successfully verified.

6.1.1 AOCS/RCS

During the LEOP and Commissioning phases the AOCS units & functions were extensively exercised and tested to prove correct functionality and to assess the relevant performances. A summary of dedicated AOCS activities carried out during the first days of the ISO mission is provided in table 6.1.1-1.

6.1.1.1 General Overview of AOCS/RCS Performances

The performance of the AOCS/RCS was nominal throughout LEOP and SCP with the exception of the STR-A CCD temperature. All operations were conducted according to the FOP Timeline. All nominal modes and relevant software functions have been successfully exercised.

The Pointing performance was found much better than specifications with indications that margin of improvement were still available.

The Slew performance was nominal and within expectations. After a couple of large slew manoeuvres were successfully executed, i.e. the relevant Guide Stars were acquired at the end of each slew, the residual slew error was determined to be 0.02 %, relevant for slew magnitudes in the order of 135 °.

The STR-A performance was nominal despite the initial CCD temperature problem. Sensitivity down to magnitude [mv] = 8 verified. CCD temperature nominal at - 40 ° C as of REV-12. The Bias error estimate is < 1 arcsec [spec. = 2 arcsec]. The Noise Equivalent Angle [NEA] estimate is about 1 arcsec [spec. = 1.5 arcsec].

The Gyro's indicated excellent performance. Drift and Scale Factors have been measured and are well within specifications [Factor ~10 better].

The RCS Thrusters performance was confirmed by the good precision of the Delta-V manoeuvre results.

The following sections will give a more detailed excursus of the AOCS performances, by analysing each individual function or unit separately.

6.1.1.2 AOCS Operating Modes

All the AOCS operating mode were successfully exercised during the first 11 revolutions of the ISO mission: an overview is given in table 6.1.1-2.

a] Acquisition Mode [AM]

Acquisition Mode was automatically entered at separation: the S/C was separated at a Sun Aspect Angle = 115 Deg and Roll Angle = -10 Deg. The slew performance during the initial Sun acquisition was nominal: at the end of the eclipse [at 01:45:13] the S/C successfully started a Sun acquisition manoeuvre which oriented the S/C z-axis towards the Sun: SAA = 90 Deg, Roll angle = 0 Deg. The attitude control in acquisition mode was nominal: the attitude error on all axes was maintained in a bandwidth of +/- 1 Deg and with rates within +/- 50 As/sec [refer to fig 6.1.1-1]. A visualisation of the attitude errors versus thruster actuations in given in fig 6.1.1-2: the efficiency of the controller is proved by the fact that thruster pulses of minimum duration [100 ms] are applied [exceptionally 200 ms on the Z-axis only].

b] Survival Mode [SM]

Pointing performance was nominal: slews in SM were not exercised.
A visualisation of the attitude error and S/C rates during the point sub-state in given in fig 6.1.1-3: the attitude error on all axis was maintained within +/- 4 Arcsec and with rates within +/- 2 As/sec; RWL torque requests remain below 0.01 Nm [refer to figure 6.1.1-4].

c] Programmable Pointing Mode [PPM]

Slew & pointing performance were nominal. The attitude error introduced on board by the Sun_Locking effect during the autonomy period could be accurately predicted & the ground strategy to compensate for such an error at the end of the PPM phase proved to be successful. This avoided systematic repetition of the on board attitude reconstruction after perigee passage, allowing a direct transition from PPM to FPM [the residual error is well within the STR Searching window size].

d] Star Acquisition Mode [SAM]

Slew and pointing performance were nominal. In few occasions an overlap condition between tracking & searching windows was detected during the execution of the STR mapping [this occurs when the guide star is detected on the border of an elementary search window]; this situation that was anticipated [and which consequence is that part of the STR FOV is not scanned] did not impact the performance of the ground attitude determination task.

e] Fine Pointing Mode [FPM]

Slew and pointing performance were nominal. The pointing stability [to which contributed excellent STR & Gyro performances] is such that the attitude control errors on each S/C axis are maintained within +/- 0.5 arcsec with rates within +/- 1 arcsec/sec: a visualization is provided in fig 6.1.1-5.
An example of the variation of the guide star coordinates during a stable pointing is shown in fig. 6.1.1-6: typical deviations from the set-points are +/- 2 CCD units. The order of magnitude of the limit cycle period is around 5-6 seconds. The behaviour of the S/C during a dual slew [on Y and Z axes simultaneously] in FPM is provided in fig 6.1.1-7; the relevant RWL torques are shown in fig 6.1.1-8.

f] All Gyro Mode [AGM]

Slew and pointing performance of AGM ON-Modulation sub-state were nominal: fig 6.1.1-9 shows the evolution of the attitude errors on each axis and relevant thruster actuations: the error is controlled within a bandwidth of +/- 12 arcmin with thruster firing of minimum duration [100 ms].
In addition, the AGM OFF-modulation sub-mode was extensively exercised during the execution of the Delta-V manoeuvres. Fig 6.1.1-10 shows a typical off-modulation pattern [the graph refers to the Main Perigee Raising manoeuvre in REV-2]: very intensive off modulation activity is visible on the Y/Z axes, due to thruster misalignments; the efficiency of the controller is proved by the fact that the errors were permanently maintained at the edge of the bandwidth [no bang-bang effect], which resulted in a high pointing stability during the Delta-V execution. Integration of the off-modulation activity over the duration of the Delta-V [in particular during the Delta-V rehearsal in REV-1] provided a good prediction of the loss of efficiency that was used to optimize all the subsequent manoeuvres.

g] Raster Pointing Mode [RPM]

Both "Normal" and "High Precision" Raster modes were exercised and tested; a full description of the activity and relevant results are provided in paragraph 4.3. Visualization of a raster pattern [guide star position in the STR field of view] is shown in fig 6.1.1-11.

h] Calibration Mode [CM]

The performance was nominal; fig 6.1.1-12 shows an example of attitude control in CM; a discontinuity in the attitude control errors is visible at mode entry, when the control is transferred to the QSS. The mean coordinates of the guide star in the STR FOV [i.e. -795 for Y and -268 for Z] after convergence is achieved in CM, measure the STR/QSS misalignment [205 arcsec in module].

Table 6.1.1-1: AOCS functional/performance verification activities during LEOP-SCP

Activity	REV	Unit exercised / verified / tested
Acquisition Mode function/perf. verification	REV-0	ACC ASW / System
Survival Mode function./perf. verification	REV-0	ACC ASW / System
ACC Memory check	REV-0	ACC memory [ROM + RAM]
Gyro unit health check	REV-0	GYRO's
FSS unit [A+B] health check	REV-0	FSS
RWL unit health check	REV-0	RWL
SAS unit health check	REV-0	SAS
DMU health check	REV-0	DMU
STR Memory check	REV-0	STR memory
STR CCD check	REV-0	STR
STR Mapping mode verification	REV-0	STR ASW
STR Searching/Tracking mode verification	REV-0	STR ASW
Star Acquisition Mode function./perf. verification	REV-0	ACC ASW / System
Fine Pointing Mode function./perf. verification	REV-0	ACC ASW / System
Relative Pointing Error estimate	REV-0	System
Gyro Beating effect test/assessment	REV-0	GYRO's
Gyro drift calibration [first time]	REV-0	GYRO's
Gyro scale factor calibration [first time]	REV-0	GYRO's
Fine Pointing Mode slew verification	REV-0	ACC ASW / System
PPM functional/performance verification	REV-0	ACC ASW / System
FSS calibration about x-axis [first time]	REV-1	FSS
FSS calibration about y-axis [first time]	REV-1	FSS
STR calibration about x-axis [first time]	REV-1	STR
All Gyro Mode [AGM] function./perf. verification	REV-1	ACC ASW / System
Delta-V manoeuvre test [RCS functional check]	REV-1	ACC ASW / RCS / System
RCS Off-Modulation estimate & thruster [global]	REV-1	RCS
STR Dark current measurement [all magn. range] & noise equivalent angle [NEA] estimate	REV-5	STR
High Precision RPM testing & calibration	REV-5	ACC ASW / STR / System

Activity	REV	Unit exercised / verified / tested
STR Restricted Searching/Tracking mode verification.	REV-5	STR ASW
FSS LIT status response wrt solar intensity measurement	REV-5	FSS
SAS LIT status response wrt solar intensity measurement	REV-5	SAS
Gyro scale factor calibration with reversed slews	REV-7	GYRO's
STR optical distortion check & Bias/NEA estimate	REV-8	STR
STR instrumental magnitude calibration	REV-8	STR
ELS dark signal verification wrt temperature	REV-3 to 9	ELS
ELS response factor calibration	REV-3 to 9	ELS
ELS response to Earth signal verification	REV-8	ELS
HP RPM / Normal RPM test/comparison	REV-9	ACC ASW / STR / System
Quadrant Star Sensor [QSS] function./perf. verification	REV-10	QSS
Calibration Mode [CM] function./perf. verification	REV-10	ACC ASW / QSS / System
QSS bias/scale factor/KQ parameter calibration	REV-10	QSS
QSS/STR misalignment measurement [first time]	REV-10	QSS
FSS misalignment calib. about z-axis [first time]	REV-11	FSS
Absolute Pointing Drift estimate	REV-16	System

Table 6.1.1-2: AOCS Operating modes execution / verification

Mode	Entered the first time in REV:	Entered the first time at:	Performance
AM	REV-0 [separation]	321 01:40:50	Nominal
SM [no slew]	REV-0	321 04:04:59	Nominal
SAM [static trans.]	REV-0	321 09:20:00	Nominal
FPM [static trans.]	REV-0	321 11:53:46	Nominal
FPM [long slew]	REV-0	321 15:25:43	Nominal
SAM [long slew]	REV-0	321 15:41:52	Nominal
PPM	REV-0	321 22:14:53	Nominal
AGM [on mod/static]	REV-1	322 10:20:23	Nominal
AGM [on mod/slew]	REV-10	331 10:27:58	Nominal
AGM [off mod-DV]	REV-1	322 13:44:52	Nominal
Normal RPM	REV-9	330 16:21:07	Nominal
High Prec. RPM	REV-5	326 17:16:18	Nominal
CM	REV-10	331 14:35:12	Nominal

Fig 6.1.1-1 : Attitude control in Acquisition Mode

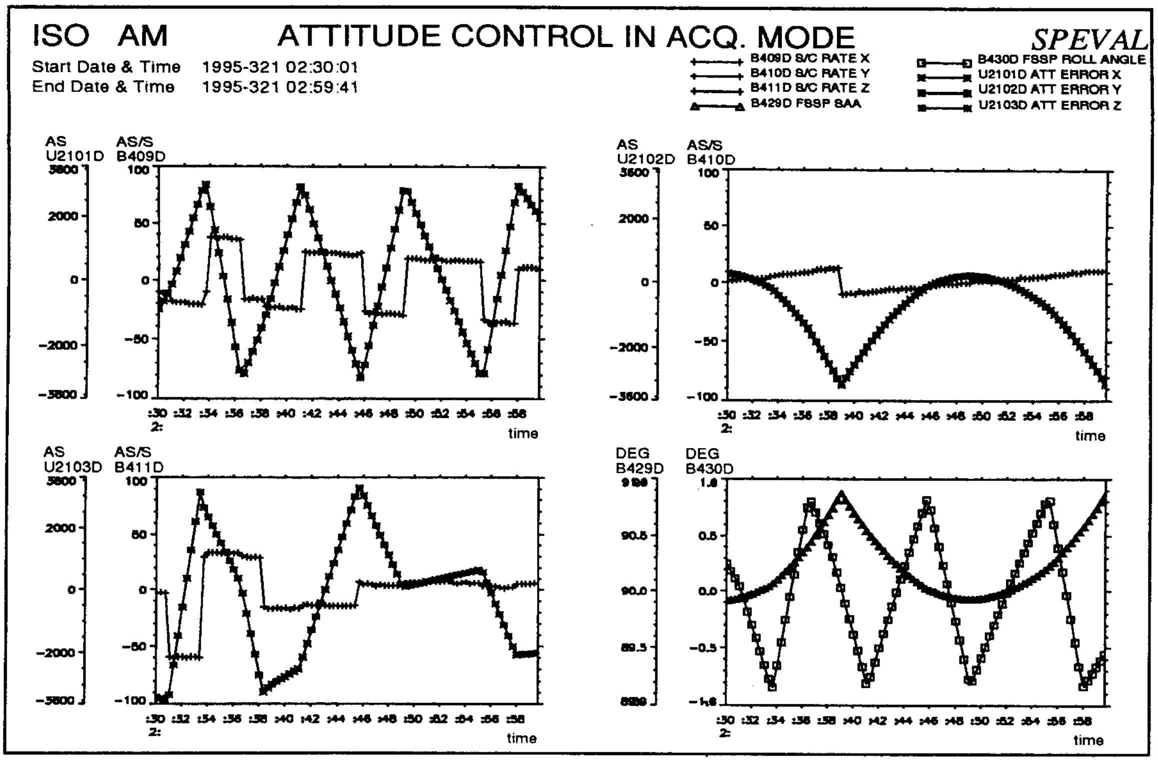


Fig 6.1.1-2 : Thruster actuations in Acquisition Mode

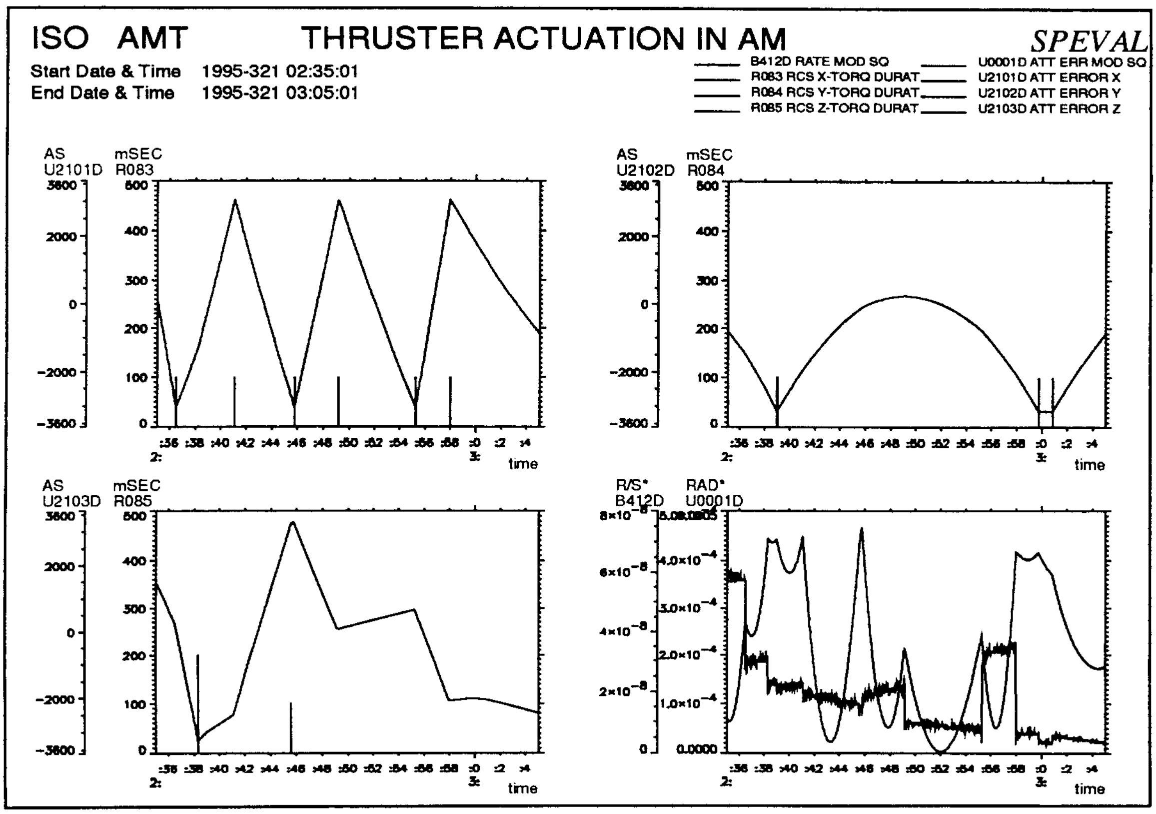


Fig 6.1.1-3: Attitude control in Survival Mode

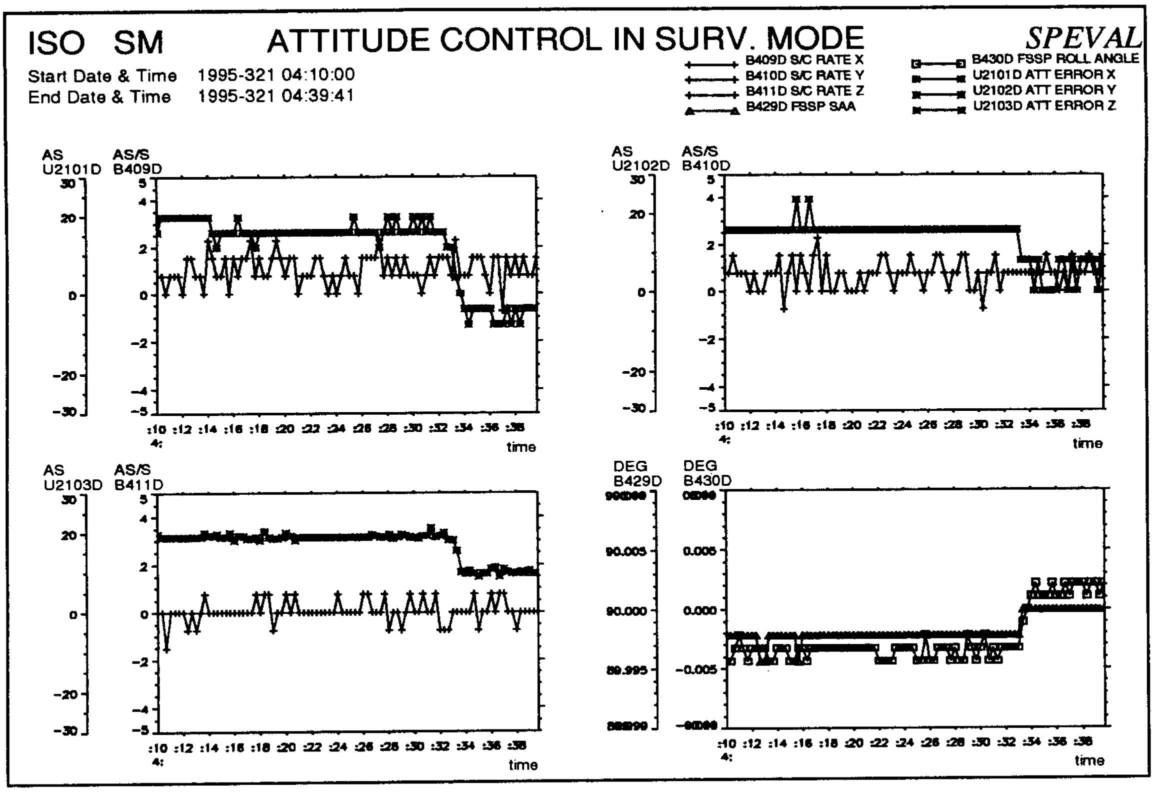


Fig 6.1.1-4: RWL torque requests in SM sub-state POINT

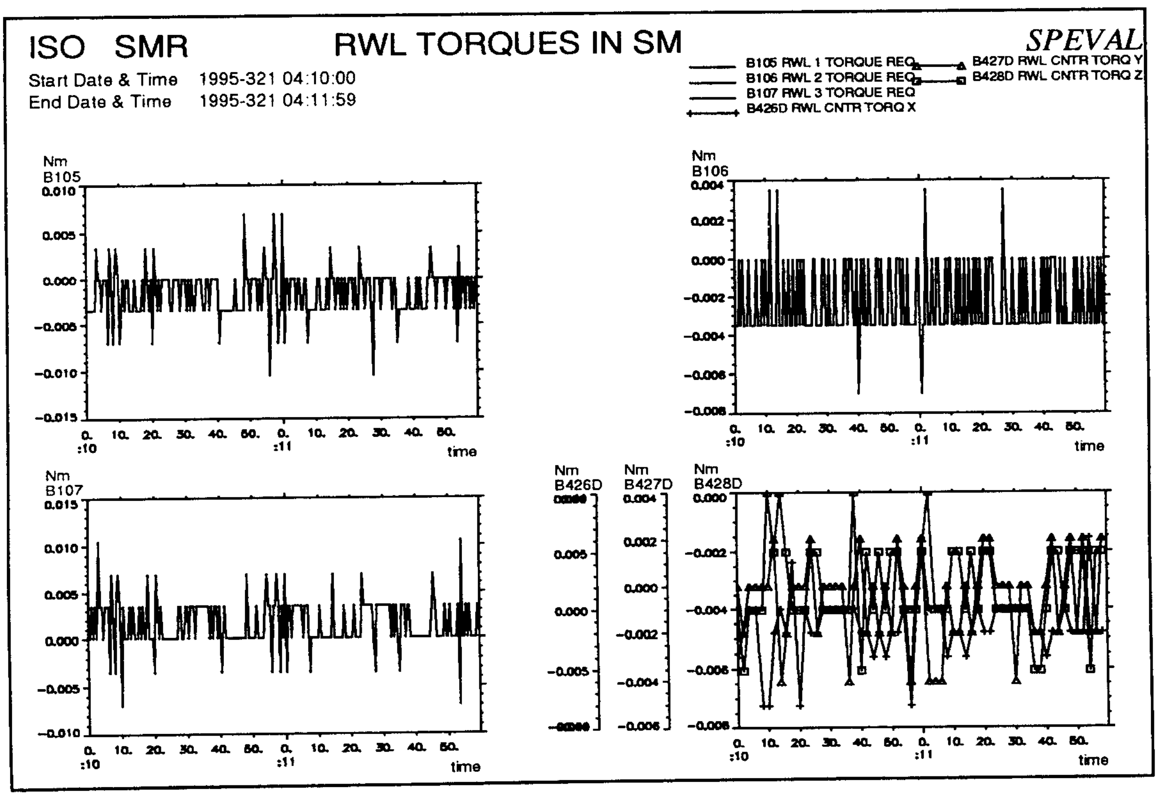


Fig 6.1.1-5: Attitude control in Fine Pointing Mode, sub-state POINT

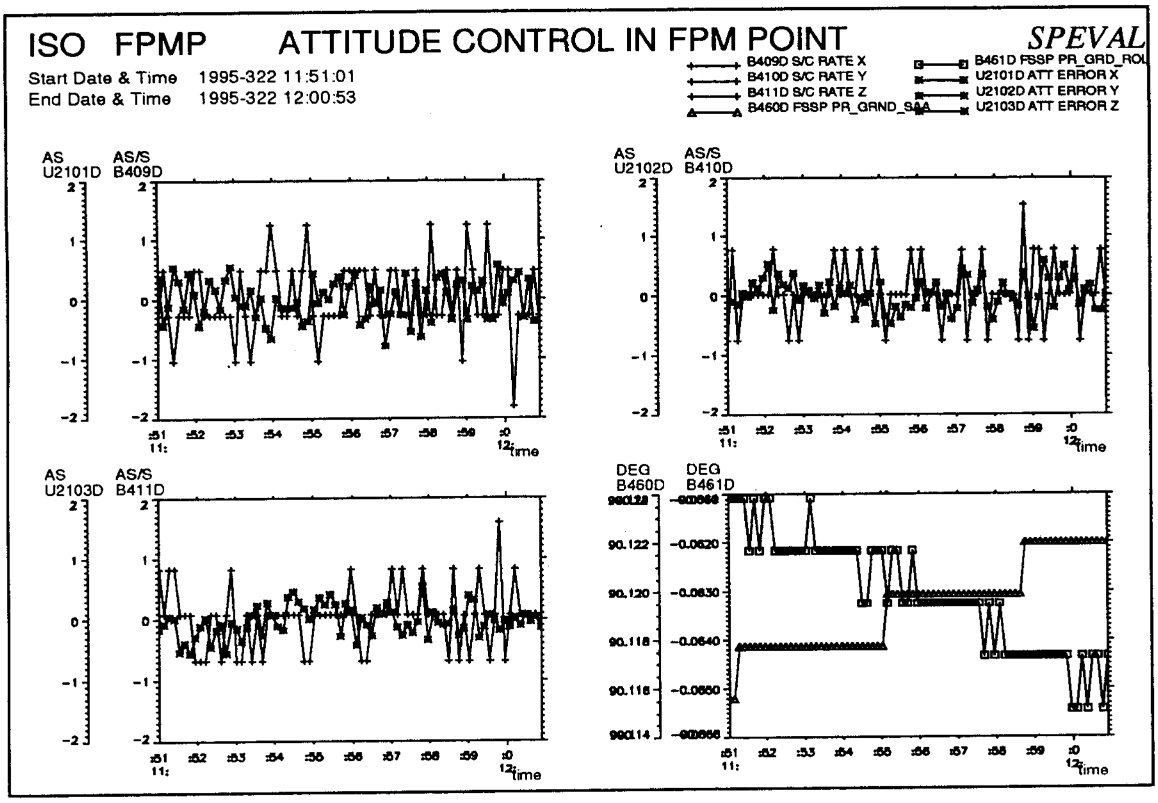


Fig 6.1.1-6: Example of Fine Pointing Mode limit cycle

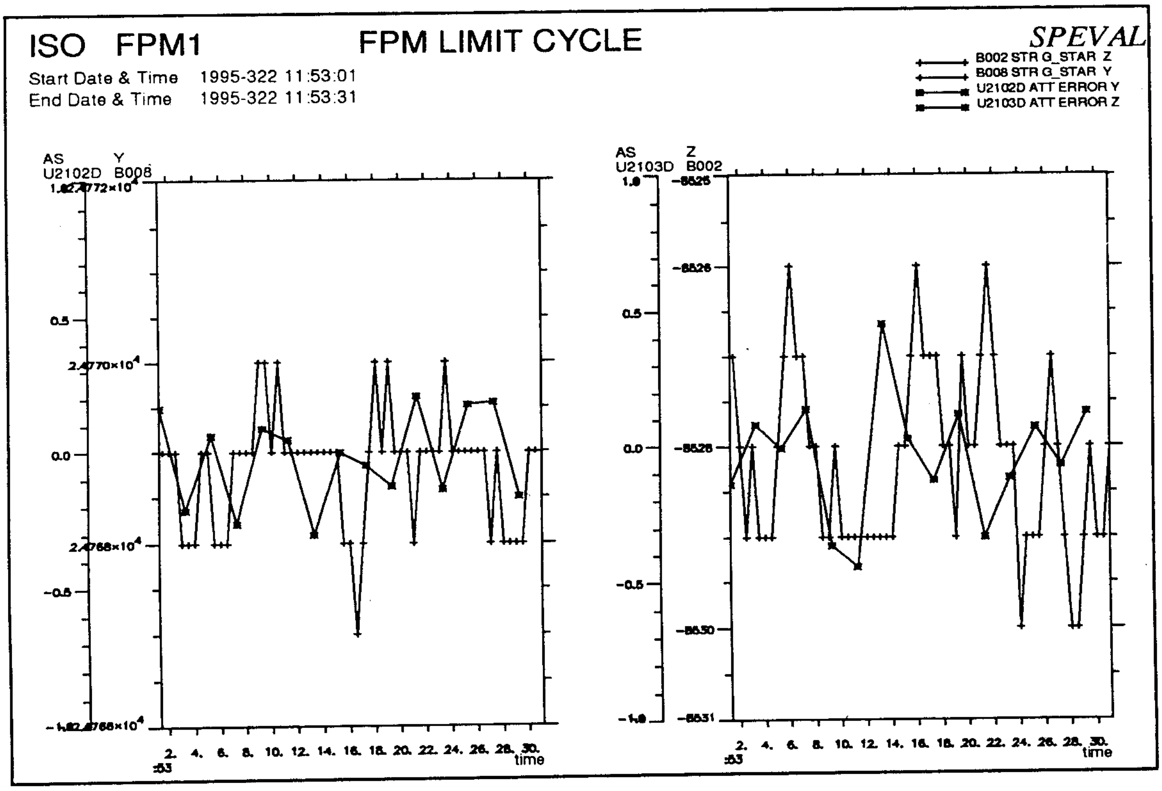


Fig 6.1.1-7: Attitude control in Fine Pointing Mode, sub-state SLEW

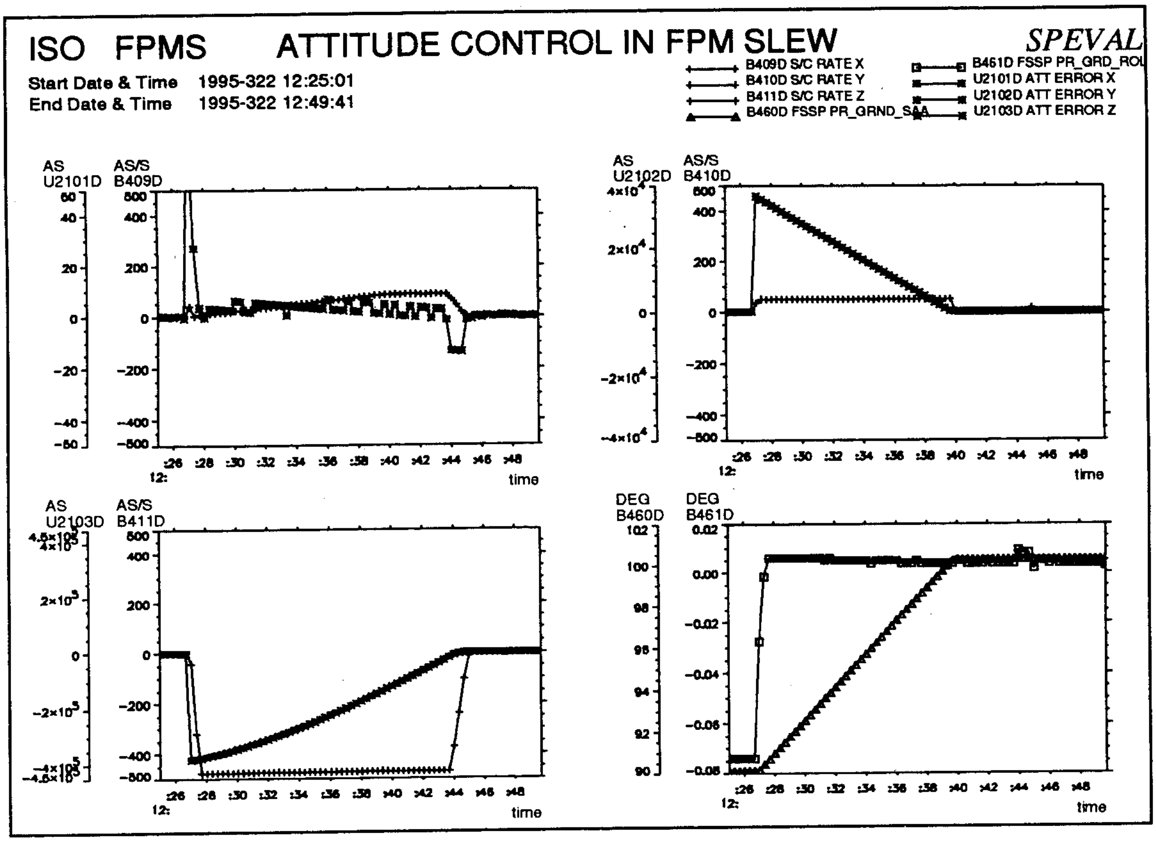


Fig 6.1.1-8: example of RWL torque requests during a slew in FPM

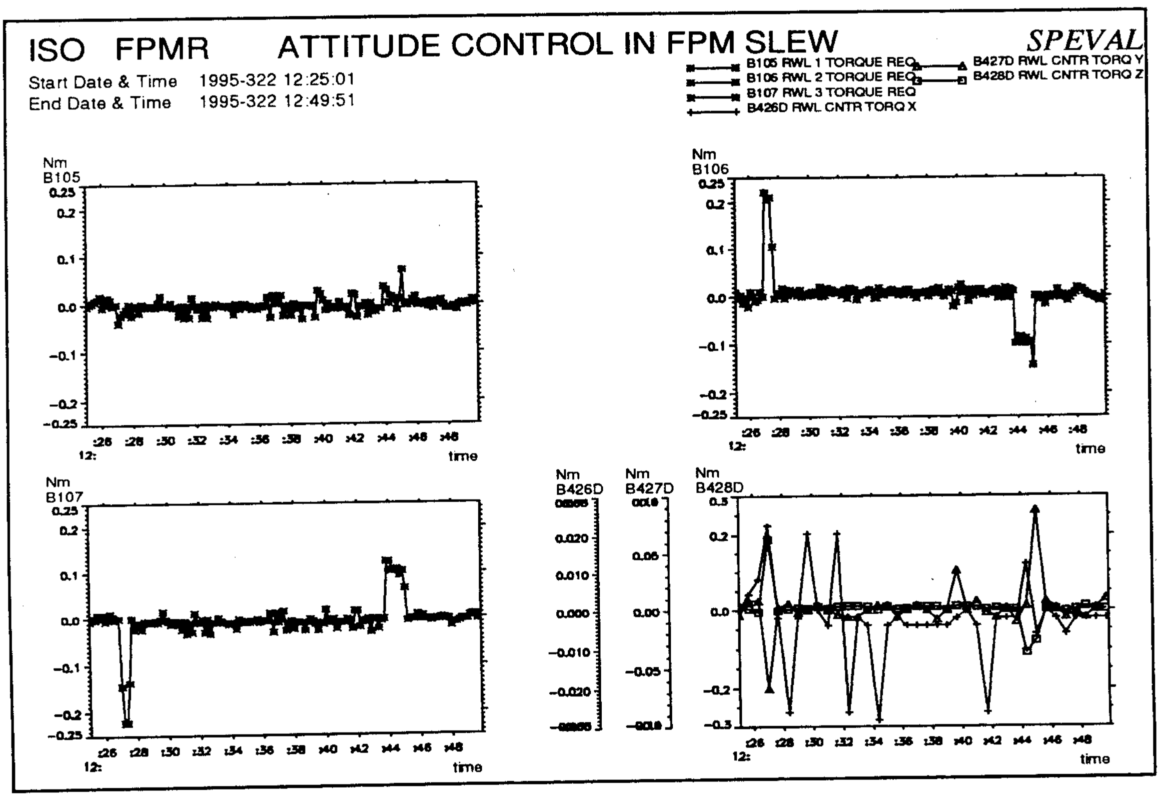


Fig 6.1.1-9: Attitude control in All Gyro Mode, sub-state "on modulation" [no Delta-V]

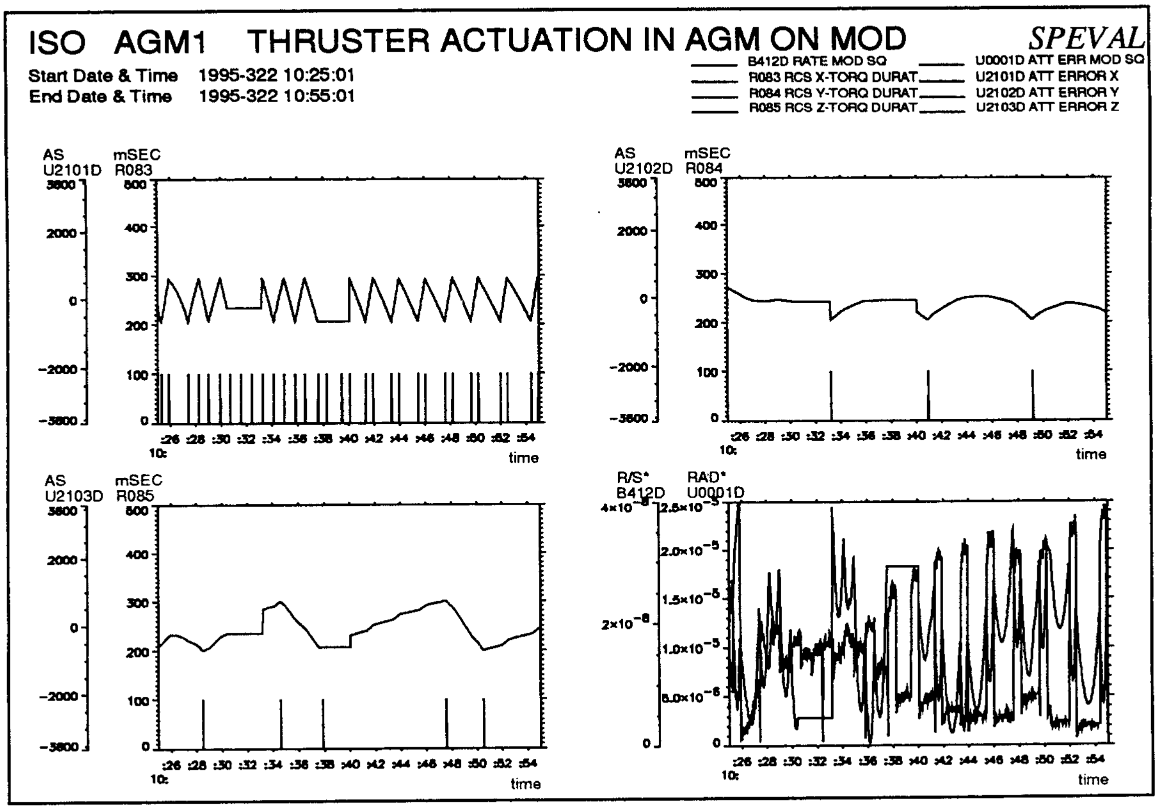


Fig 6.1.1-10: Attitude control in AGM, sub-state Off-Modulation [Main Delta-V execution]

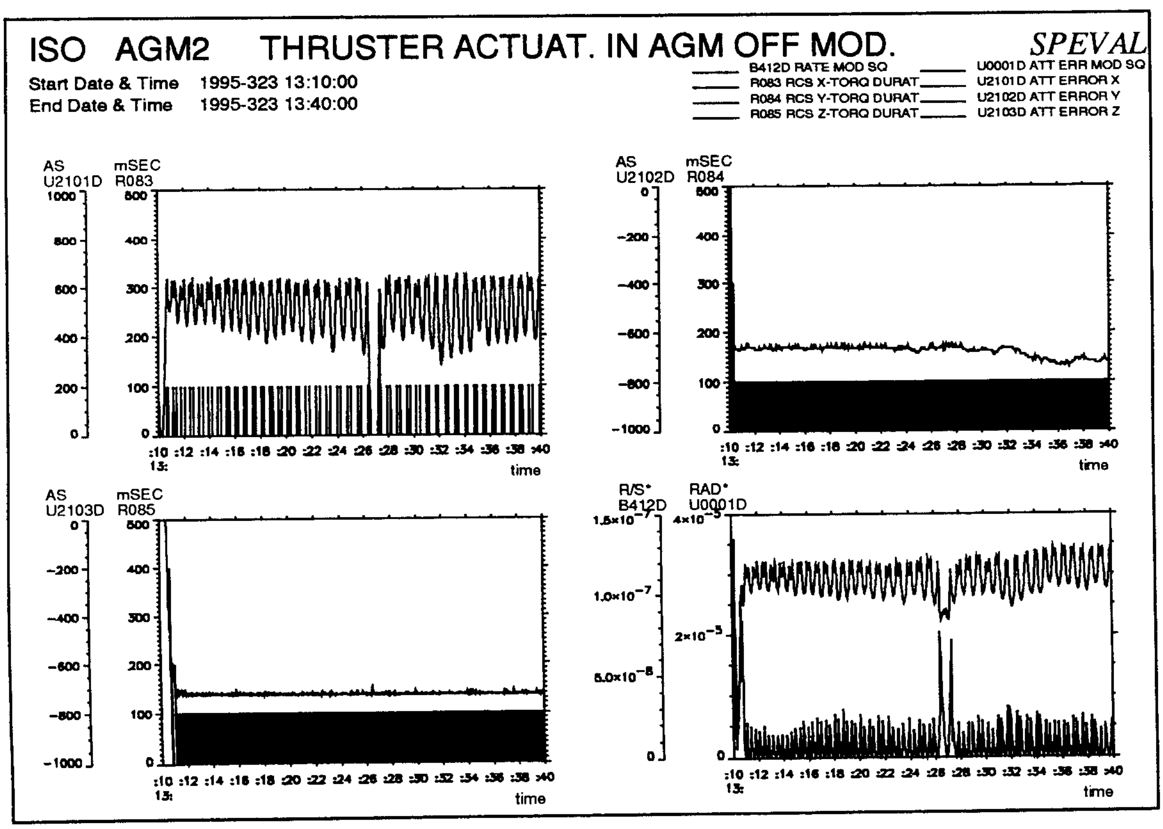


Fig 6.1.1-11. Raster Pointing Mode: example of Raster execution / guide star position

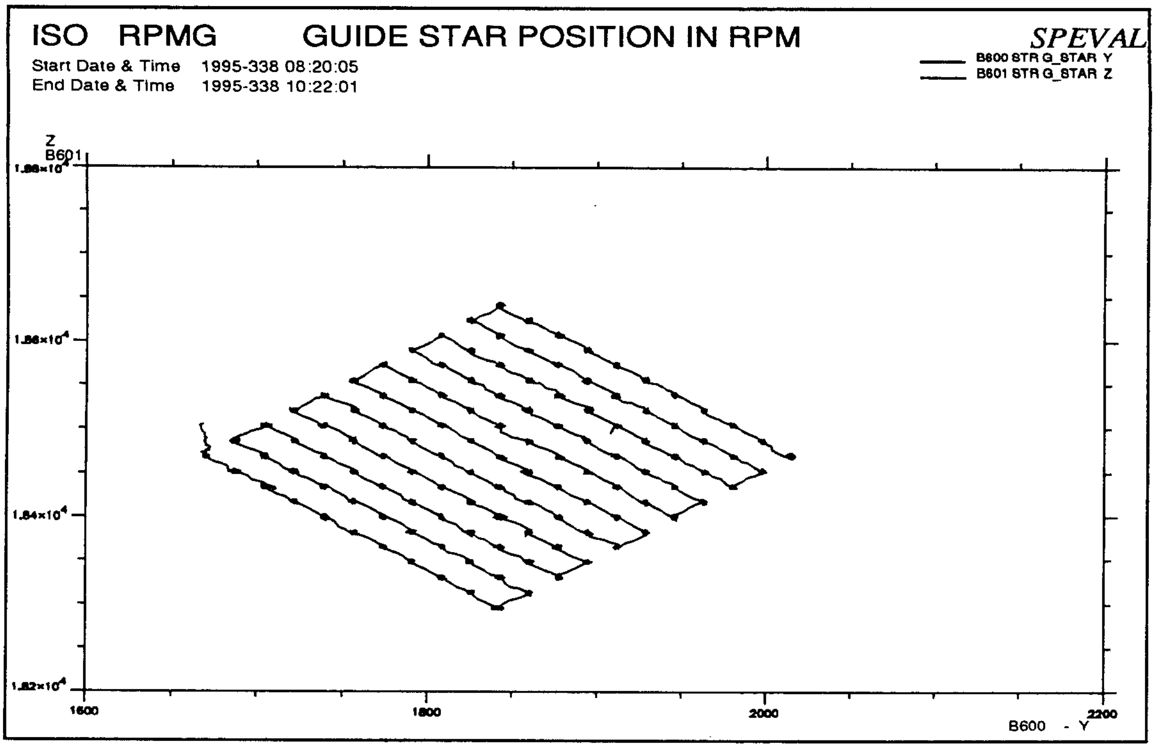
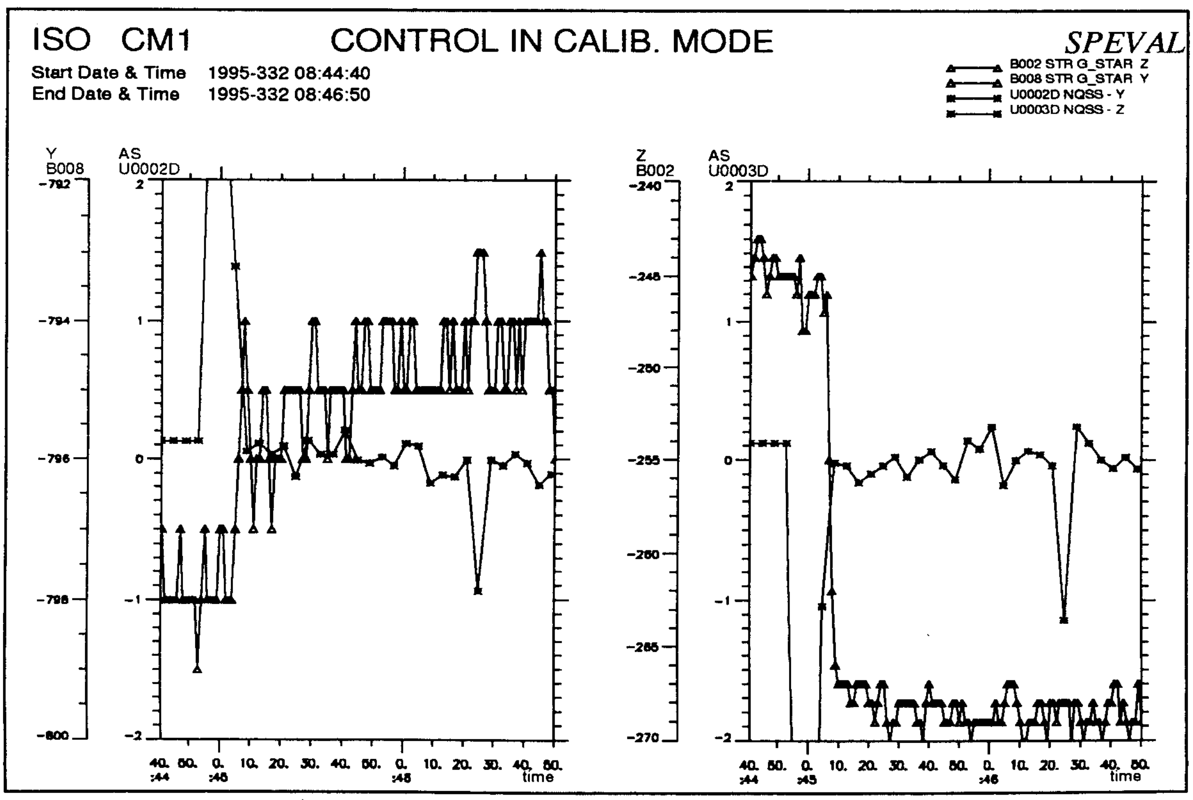


Fig 6.1.1-12: Attitude control in Calibration Mode



6.1.1.3 GYROS

Anomalies/Out_Of_Limits

GYRO TEMPERATURES: the GYR thermal behaviour was nominal with the exception of GYR-2, which temperature was observed to toggle between 74.7 and 75.5 C, violating the high soft limit [set at 74 C]: refer to fig 6.1.1-13. Anomaly report ISO-ANO-02 was issued: for details refer to section 6.4 of this document. As indicated in the relevant section the anomaly was mainly due to overcompensation of the raw TM data: to give an idea, the raw GYR-2 temperature output corresponding to 75.7 C was 233 counts, while for the other three gyros the same value is converted into a calibrated value of about 72 C.

The GYR heater duty cycle was nominal for all gyros: a value < 0.3 was measured for GYR-1/3/4 and a value ranging between 0.4 and 0.55 was measured for GYR-2 [as expected, according to ground setting/testing]: refer to fig 6.1.1-13 for a visualisation. The higher value for GYR-2 is fully justified and it is due to the mounting configuration which results in a lower thermal resistance between GYR-2 and the base of the GYRO unit frame than the other three gyros.

GYRO MOTOR CURRENTS: During the very first hours following initial AOS the GYR-1 motor current was observed to be significantly higher than for the other three gyros, with peaks up to 74 mA: refer to fig 6.1.1-14. The same behaviour was already noticed during the ISO Dress-Rehearsal activity: the observed feature was considered nominal by Fokker/Ferranti and it was explained to be caused by thermal instability in the measuring circuit: the higher the environmental temperature, the higher the motor current value reported [even if the actual current remains stable]. As visible from fig 6.1.1-14 the GYR-1 motor current stabilized at the nominal expected value [< 70 mA] when thermal equilibrium was reached approximately 2.5 hours after S/C separation.

GYRO AUTONOMOUS HEALTH CHECK TRIGGERING: the analysis of the ERD buffer dump executed just after initial AOS showed that the autonomous GYR Continuity check triggered for GYR-1 at 01:40:50 [S/C separation time]: the spike in the gyro output was detected for one cycle only and therefore it was not sufficient to trigger a Gyro re-configuration. It is likely to have been caused by the shock experienced by the gyro at separation [though the lack of TM data did not allow further analysis]. The occurrence did not have any impact on operations.

In flight calibrations

GYRO DRIFTS: A complete history of the GYRO drift calibration activity for the first 21 revolutions is reported in table 6.1.1-3; a summary of the data analysis is given in table 6.1.1-5.

The GYR drift was measured to be within specification for all gyros:

- the absolute drift values were within specification [see table 6.1.1-4]
- the ground/orbit drift change was within specification [see table 6.1.1-4 & 6.1.1-5]
- the calibrations executed during LEOP and SCP showed good stability: refer to fig 6.1.1-15 to 6.1.1-18 for a visualization; for GYR-1 only a trend is visible, nonetheless the "extrapolated" variation over one month is well within specification [see table 6.1.1-4 & 6.1.1-5].
- dedicated checks executed during LEOP showed that the accuracy of the ground gyro drift calibration is better than 0.5 %.

Fig 6.1.1-13: GYR temperatures & heater duty cycles evolution [complete revolution]

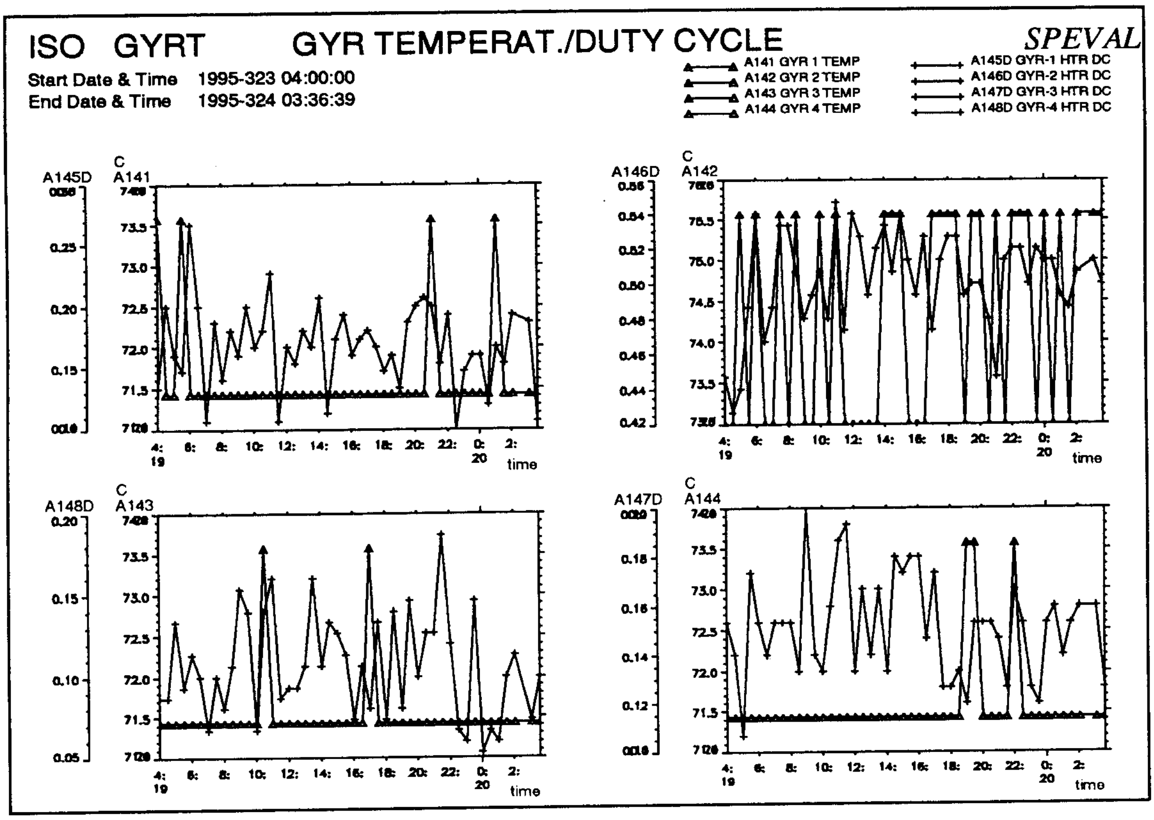
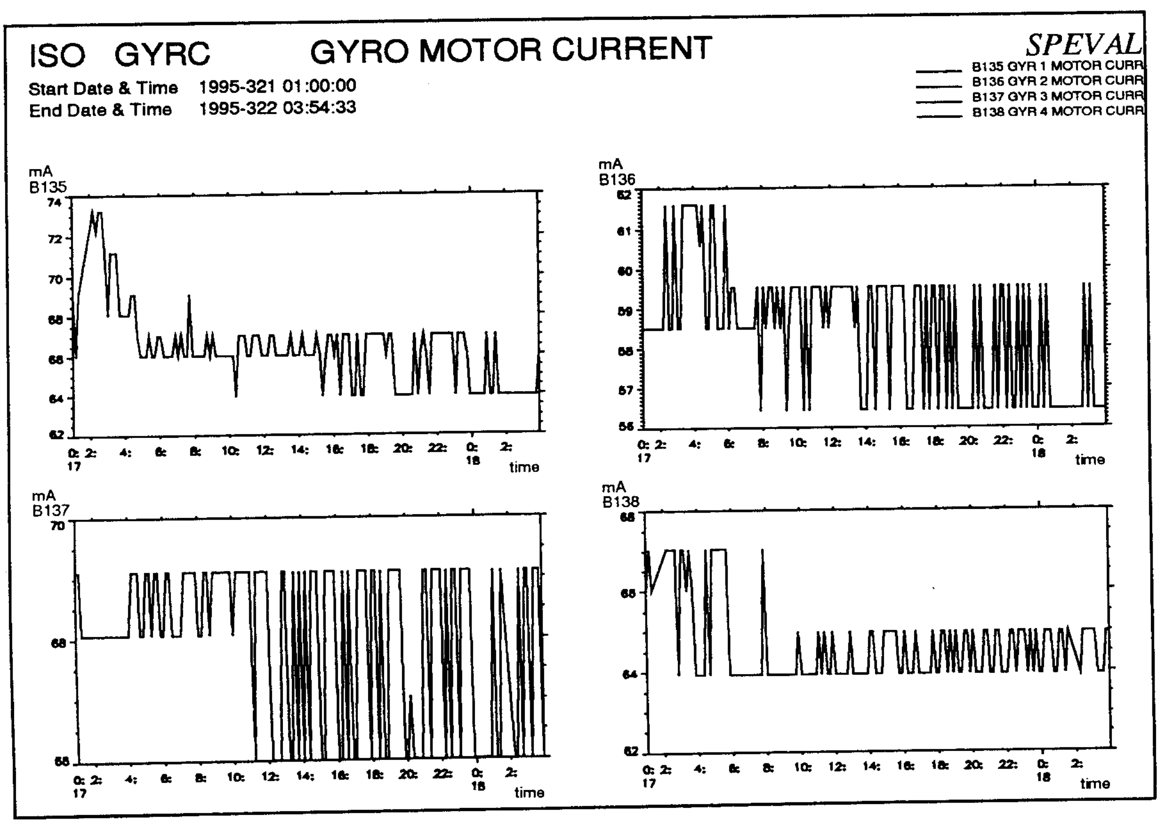


Fig 6.1.1-14: GYR Motor current evolution during REV-0



REV	GYR-1	GYR-2	GYR-3	GYR-4	REV	GYR-1	GYR-2	GYR-3	GYR-4
0	0.9883	-0.1270	0.2065	-0.2681	9	0.9805	-0.1255	0.2080	-0.2666
0	0.9885	-0.1328	0.2148	-0.2686	10	0.9829	-0.1255	0.2056	-0.2681
1	0.9924	-0.1262	0.2078	-0.2698	11	0.9824	-0.1262	0.2050	-0.2664
1	0.9903	-0.1270	0.2085	-0.2695	12	0.9848	-0.1263	0.2036	-0.2641
2	0.9903	-0.1257	0.2082	-0.2688	13	0.9827	-0.1262	0.2068	-0.2657
4	0.9880	-0.1261	0.2073	-0.2672	14	0.9812	-0.1274	0.2084	-0.2652
5	0.9880	-0.1230	0.2061	-0.2678	15	0.9793	-0.1307	0.2127	-0.2672
6	0.9852	-0.1239	0.2062	-0.2672	16	0.9817	-0.1289	0.2087	-0.2688
6	0.9868	-0.1268	0.2073	-0.2661	17	0.9796	-0.1260	0.2064	-0.2656
7	0.9873	-0.1270	0.2072	-0.2659	18	0.9791	-0.1263	0.2067	-0.2656
8	0.9853	-0.1260	0.2075	-0.2681	19	0.9789	-0.1264	0.2066	-0.2657
8	0.9851	-0.1261	0.2058	-0.2676	20	0.9782	-0.1303	0.2113	-0.2680

Table 6.1.1-3: GYR drift calibration history [units = Deg/hour]

characteristics	Specification value
bias drift at launch	< 2 Deg/hour
drift ground/flight change	< 0.3 Deg/hour [absolute]
bias drift change in flight	< 0.0166 Deg/hour/ month

Table 6.1.1-4: GYR drift specification

<table>
<tr><th>GYR</th><th>Average drift [first 21 rev]</th><th>Standard Deviation</th><th>Acceptance test [Jul '94]</th><th>First calibrat. REV-0</th><th>ground/ flight variation</th><th>variation after 21 REV's.</th><th>Extrapol. variation in 1 month</th></tr>
<tr><td>1</td><td>0.984</td><td>0.00427</td><td>0.993</td><td>0.988</td><td>-0.005</td><td>- 0.01</td><td>|0.0143|</td></tr>
<tr><td>2</td><td>-0.127</td><td>0.00207</td><td>-0.152</td><td>-0.127</td><td>0.025</td><td>- 0.0033</td><td>|0.00471|</td></tr>
<tr><td>3</td><td>0.207</td><td>0.00247</td><td>0.233</td><td>0.207</td><td>-0.026</td><td>+ 0.0048</td><td>|0.00686|</td></tr>
<tr><td>4</td><td>-0.267</td><td>0.00147</td><td>-0.282</td><td>-0.268</td><td>0.014</td><td>+ 0.0001</td><td>|0.000143|</td></tr>
</table>

Table 6.1.1-5: GYR Drift calibration [all the above values are in Deg/hour]

FIG 6.1.1-15: GYR-1 drift evolution

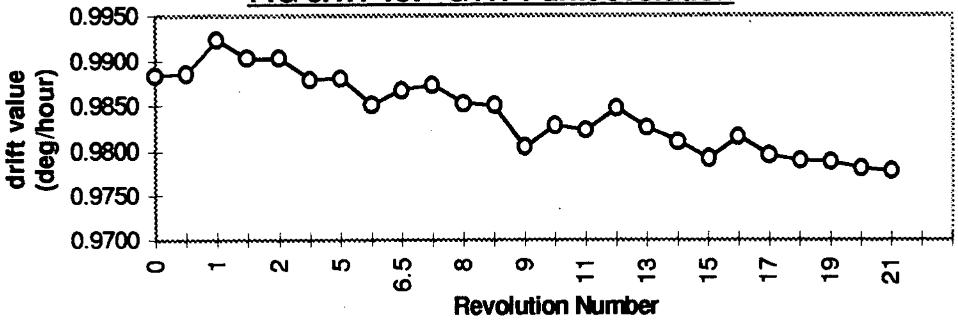


FIG 6.1.1-16: GYR-2 drift evolution

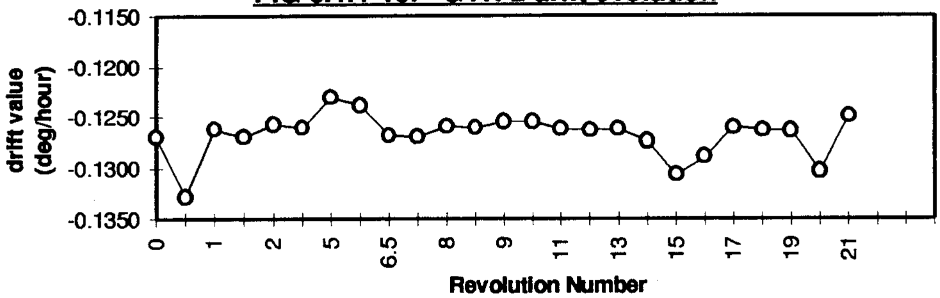


FIG 6.1.1-17: GYR-3 drift evolution

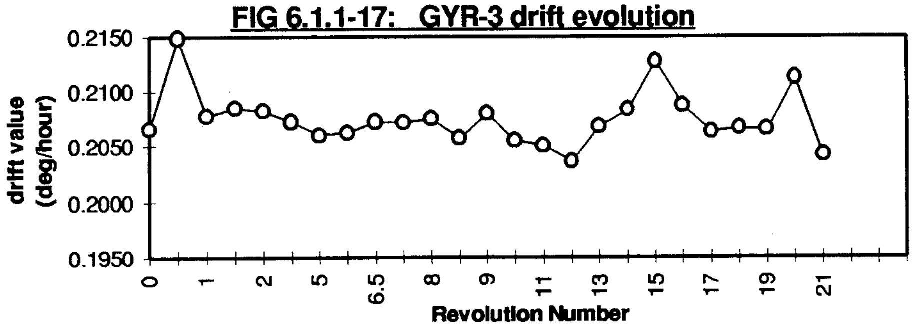
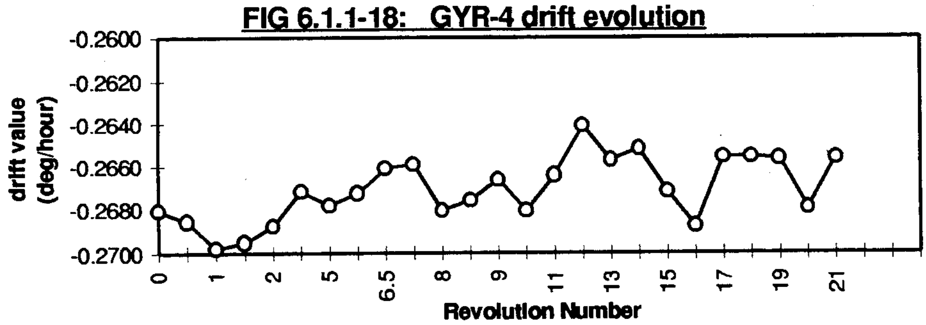


FIG 6.1.1-18: GYR-4 drift evolution



GYRO SCALE FACTORS / MISALIGNMENTS: A complete history of the GYRO scale factor calibration during LEOP/SCP is provided in table 6.1.1-6 [the calibrations in revolution 0 & 11 were based on "single slew" method, while the calibration in REV-7 was based on "reversed slew" method: the relevant results do not differ significantly]. A summary of the data analysis is given in table 6.1.1-8. Misalignments up to 10 arcminutes were measured.

The GYR scale factors were measured to be within specification for all gyros:

- the absolute scale factor errors were within spec. [see table 6.1.1-7]
- the ground/orbit scale factor change was within specification [see tables 6.1.1-7 & 6.1.1-8]
- scale factor stability: for GYR-4 only a significant variation after 12 days is visible [refer to fig 6.1.1-19 to 6.1.1-22 for a visualization], nonetheless a fourth calibration executed during the ISO Routine Phase showed that the variation over more than 2 months was only 0.022 % and well within specification [see table 6.1.1-7].
- dedicated checks executed during LEOP/SCP showed that the accuracy of the ground gyro scale factor calibration is better than 0.02 %.

REV	s.f. GYR-1	s.f. GYR-2	s.f. GYR-3	s.f. GYR-4
0	1.000001	0.999909	0.999206	1.00044
7	1.000262	1.000638	1.000217	1.00046
11	1.000109	0.999909	0.999327	0.999845

Table 6.1.1-6: Gyro Scale Factor Calibration history

feature	Spec. Value
scale factor maximum error	< 1.1 %
s.f. ground/orbit change	< 0.5 %
s.f. long term change	< 0.04 % in one month
s.f. change during mission	< 0.1 % in 18 months
s.f. short term change	< 0.02 % in one hour

Table 6.1.1-7: GYR scale factor specification

	GYR-1	GYR-2	GYR-3	GYR-4
average	1.000124	1.0001519	0.99958317	1.0002482
error %	0.012%	0.016%	-0.040%	0.025%
var. 12 d	0.011%	0.000%	0.012%	0.060%
accept '94	1.000850	1.000190	0.999720	1.000530
ground/orbit change	-0.073 %	-0.0038 %	-0.0137 %	-0.028 %

Table 6.1.1-8: GYR scale factor analysis (first 12 revol.)

GYRO SCALE FACTORS / MISALIGNMENTS: A complete history of the GYRO scale factor calibration during LEOP/SCP is provided in table 6.1.1-6 [the calibrations in revolution 0 & 11 were based on "single slew" method, while the calibration in REV-7 was based on "reversed slew" method: the relevant results do not differ significantly]. A summary of the data analysis is given in table 6.1.1-8. Misalignments up to 10 arcminutes were measured.

The GYR scale factors were measured to be within specification for all gyros:

- the absolute scale factor errors were within spec. [see table 6.1.1-7]

- the ground/orbit scale factor change was within specification [see tables 6.1.1-7 & 6.1.1-8]

- scale factor stability: for GYR-4 only a significant variation after 12 days is visible [refer to fig 6.1.1-19 to 6.1.1-22 for a visualization], nonetheless a fourth calibration executed during the ISO Routine Phase showed that the variation over more than 2 months was only 0.022 % and well within specification [see table 6.1.1-7].

- dedicated checks executed during LEOP/SCP showed that the accuracy of the ground gyro scale factor calibration is better than 0.02 %.

REV	s.f. GYR-1	s.f. GYR-2	s.f. GYR-3	s.f. GYR-4
0	1.000001	0.999909	0.999206	1.00044
7	1.000262	1.000638	1.000217	1.00046
11	1.000109	0.999909	0.999327	0.999845

Table 6.1.1-6: Gyro Scale Factor Calibration history

FIG 6.1.1-19 GYRO-1 Scale factor measurements

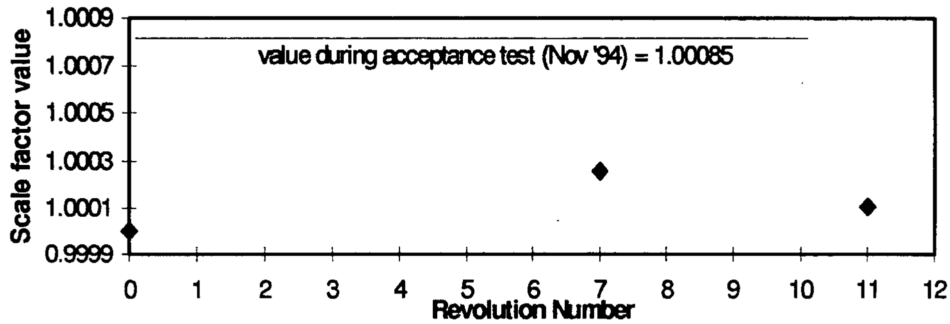


FIG 6.1.1-20 GYRO-2 Scale factor measurements

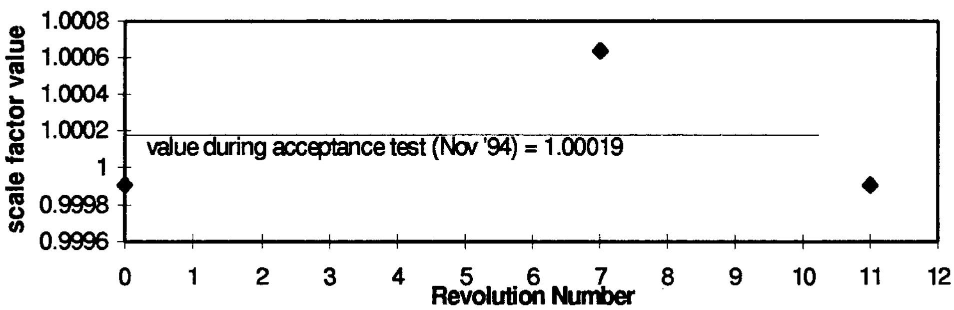


FIG 6.1.1-21 GYRO-3 Scale factor measurements

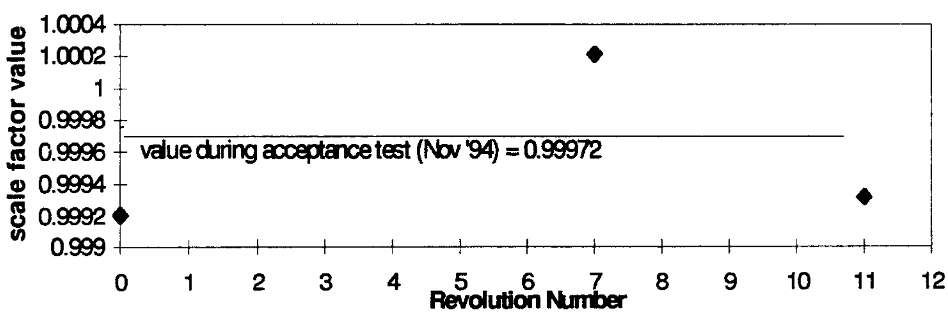
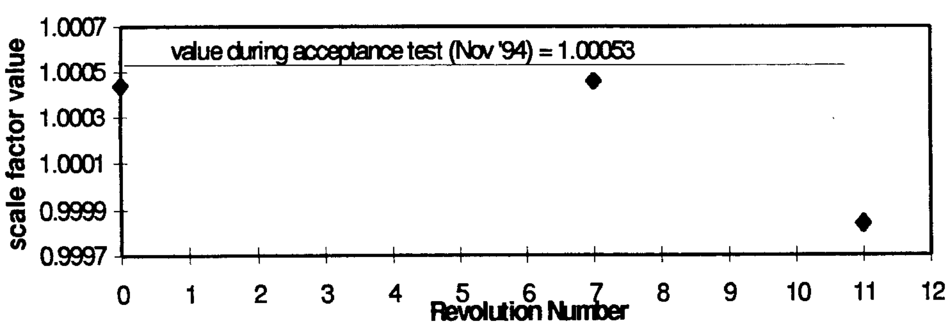


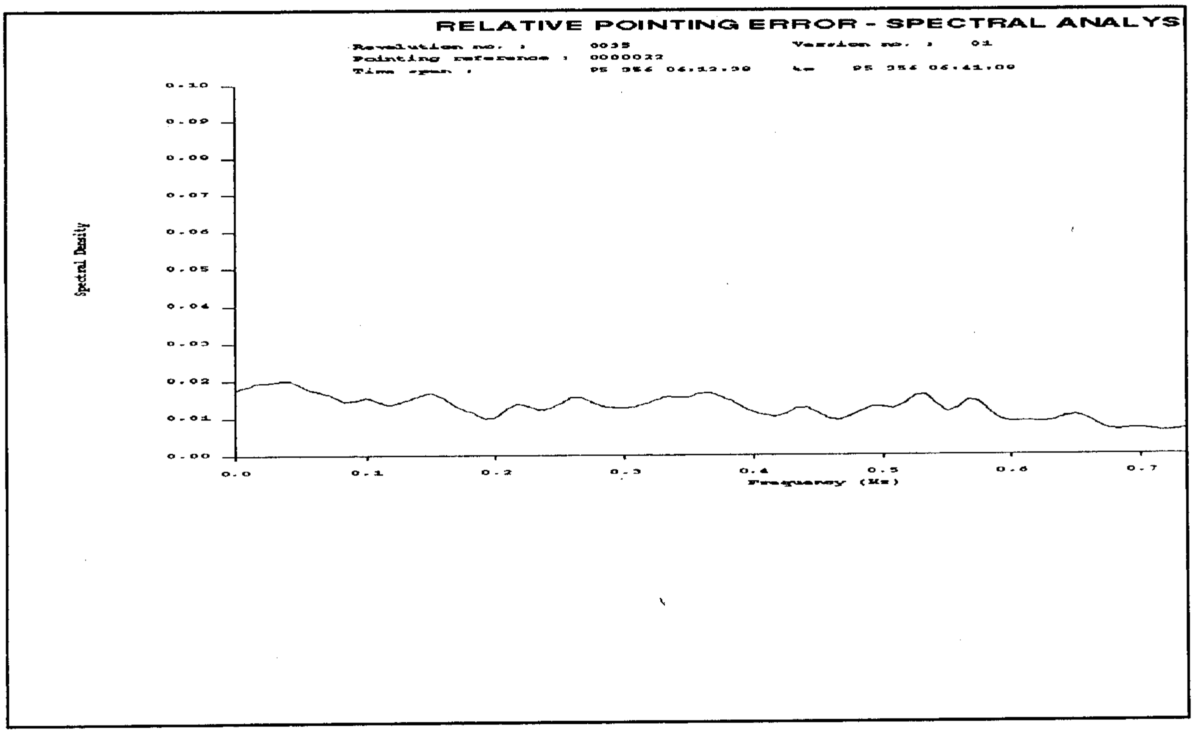
FIG 6.1.1-22 GYRO-4 Scale factor measurements



GYRO BEATING EFFECT

If the operational gyros are not all synchronized to the same clock, a beating effect, caused by interference between different channels can be observed; the effect can be monitored and identified [if any] by inspecting the Relative Pointing Error spectral analysis. This check was executed in REV-0 after the first stable pointing in FPM: the absence of spectral components at very low frequency [normally between 0 and 0.01 Hz] was the indication that no beating effect was present, consequently no reconfiguration of the gyro clock was carried out [clock-1 was selected as master clock by the Project team as part of the pre-launch activities]. The same check was repeated periodically during the subsequent revolutions: a typical example of spectral analysis pattern is provided in fig 6.1.1-23.

Fig 6.1.1-23: RPE spectral analysis



6.1.1.4 FSS

***Anomalies/Out_Of_Limits*:** None

In flight Calibrations

FSS Misalignment about X-axis

A summary is provided in table 6.1.1-9.

FSS Misalignment about Y-axis

A summary is provided in table 6.1.1-10.
The values marked with [*], i.e.for Rev. 10 & 12 were erroneously evaluated with respect to the QSS boresight [taken as definition of the S/C X-axis]

instead of STR boresight [as it should have been]. This discrepancy had some impacts in the execution of the Focal Plane Geometry Trial activity [refer to section 4.5].

FSS Misalignment about Z-axis

A summary is provided in table 6.1.1-11.

Miscellaneous

a] a comparison of the FSS-A & FSS-B outputs was executed in REV-0 during the FSS health check activity, with the following results:
the zero output of FSS-A [i.e. FSS-X output = 0 / FSS-Y output =0] corresponds to the following FSS-B outputs: 78 LSB's [i.e. 300 arcsec] for FSS-X, and 25 LSB's [i.e. 196 arcsec] for FSS-Y, respectively.

b] The transition from FSS LIT to FSS DARK occurs at 0.56 and 0.54 solar constant for FSS-A and FSS-B respectively; the transition from FSS DARK to FSS LIT occurs at 0.57 and 0.6 solar constant for FSS-A and FSS-B respectively.

c] As it can be seen from point b] above, FSS-A is fortunately slightly less sensitive than FSS-B: this fact prevents the occurrence of an FSS reconfiguration at each eclipse entry [the OBS logic is such that in case of illumination status discrepancy the dark FSS is always believed].

REV	parameter	DB: fssx9	misal. angle	previous value [default]
1	tan_fssx9	7.5439E-04	155.6 arcsec	59.76 arcsec
10	tan_fssx9	7.3519E-04	151.6 arcsec	-
20	tan_fssx9	7.6154E-04	157.1 arcsec	-

Table 6.1.1-9: FSS misalignment calibration about X-axis

REV	parameter	DB: fssy9	misal. angle	previous value [default]
1	tan_fssy9	-1.4100E-04	- 29.1 arcsec	- 79.92 arcsec
10	tan_fssy9	-8.2005E-04	- 169.1 arcsec *	-
12	tan_fssy9	-7.8670E-04	- 162.3 arcsec *	-
20	tan_fssy9	-4.8741E-05	- 10.1 arcsec	-

Table 6.1.1-10: FSS-A misalignment calibration about Y-axis

REV	parameter	DB: fssx10	misal. angle	previous value [default]
11	x10	-7.2802E-05	- 15.0 arcsec	0.0
20	x10	-5.6308E-04	- 116.1 arcsec	-

Table 6.1.1-11: FSS-A misalignment calibration about Z-axis

6.1.1.5 ELS

The ELS was switched on in REV-3 at 06:24 [all the detectors were declared unhealthy beforehand]; during the cool-down phase from REV-3 to REV-9 the ELS A/B outputs and temperatures were periodically collected for the execution of the off-line ELS response factor calibration. The first ELS Temperature TM reading, just after sensor switch-on, generated some confusion: the reading was erroneously giving 84 K, while the Sun-Shade temperature [which is expected to be very close] was around 175 K. The inconsistency was caused by an incorrect masking of the 12 bit data word, limiting the raw value to 11 bits only corresponding to the ELS temperature operational range between 77 and 131 K [so the additional 2048 raw counts were disregarded in the evaluation of the calibrated output]. The Data-base was modified accordingly.
The evolution of the ELS A/B dark signals during the cool-down phase is shown in fig 6.1.1-25 & 6.1.1-26 as a function of the ELS temperature [the output of the ELS "forbidden" region detector looks significantly higher than the "warning" detectors since a different scale factor [ratio = 1.57] is used].
The output of the ELS response factor calibration was such that no modification to the on board parameters was required and the default response factor coefficients [1 for warning detectors and 1.57 for the forbidden one] were retained.

Before enabling the ELS, a test was executed during the perigee pass in REV-8 to check the ELS response to Earth limb signal: an ad hoc pointing was inserted in the PPL list, with an attitude violating on purpose the ELS warning region constraint [note that since the detectors were all declared unhealthy no escape manoeuvre could be triggered autonomously by the OBS].
The results of the test are shown in fig. 6.1.1-24; the Earth signal detected by the sensor was found to be in agreement with the Earth direction and the Earth limb protrusion.
The ELS was enabled [and it became operational] in REV-9 at 19:50.

Fig 6.1.1-24: ELS response to Earth limb signal [test executed in REV-8]

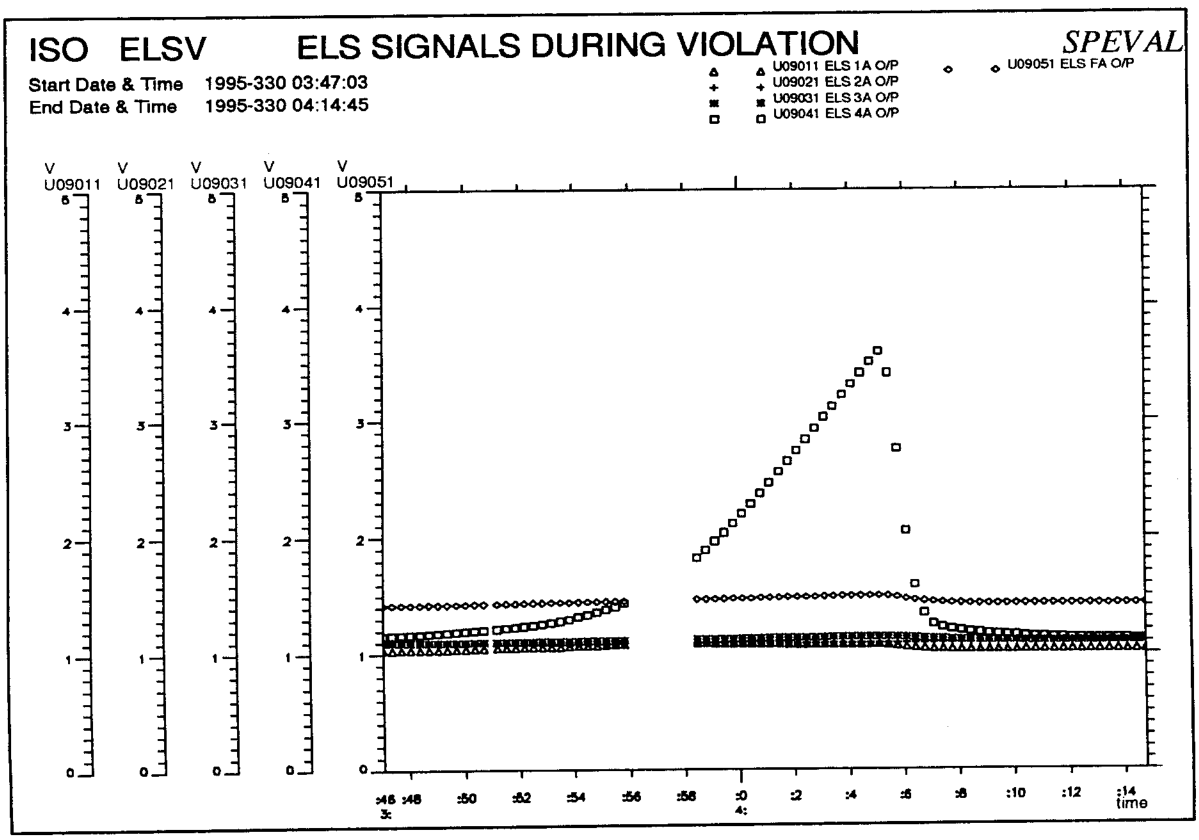


Fig 6.1.1-25: ELS-A dark signal evolution during the cool-down phase

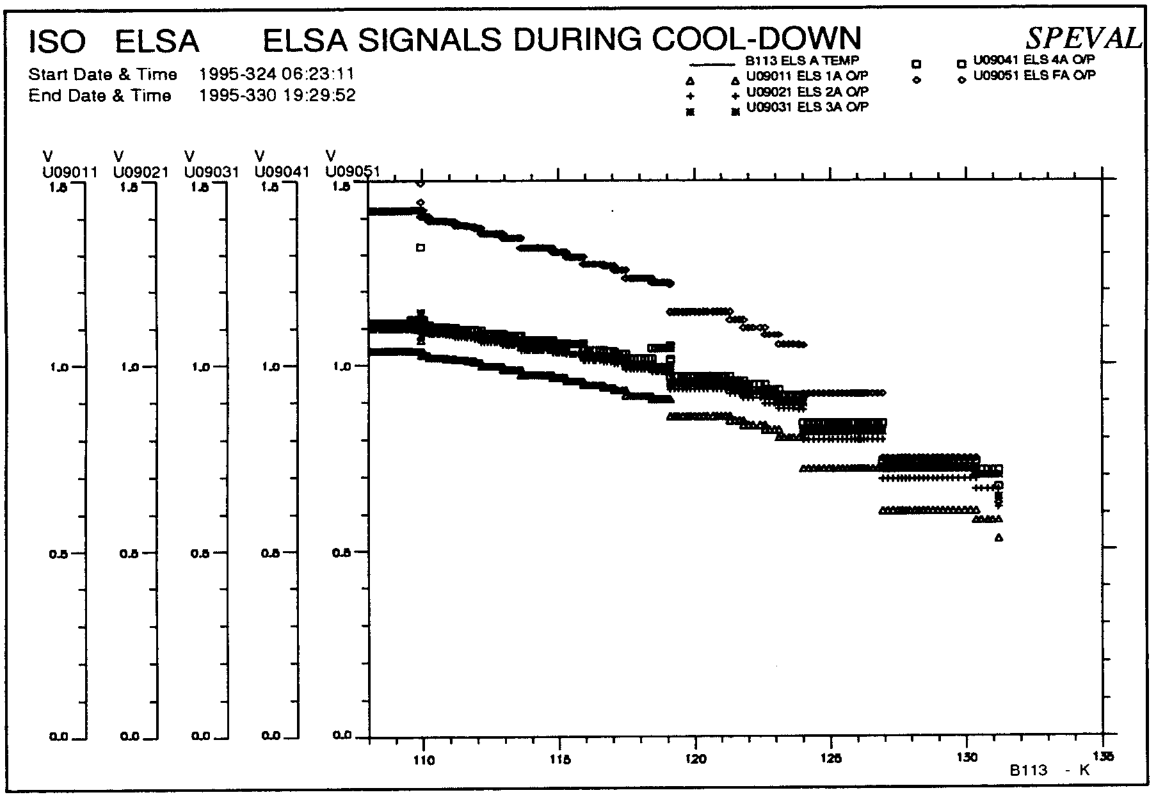
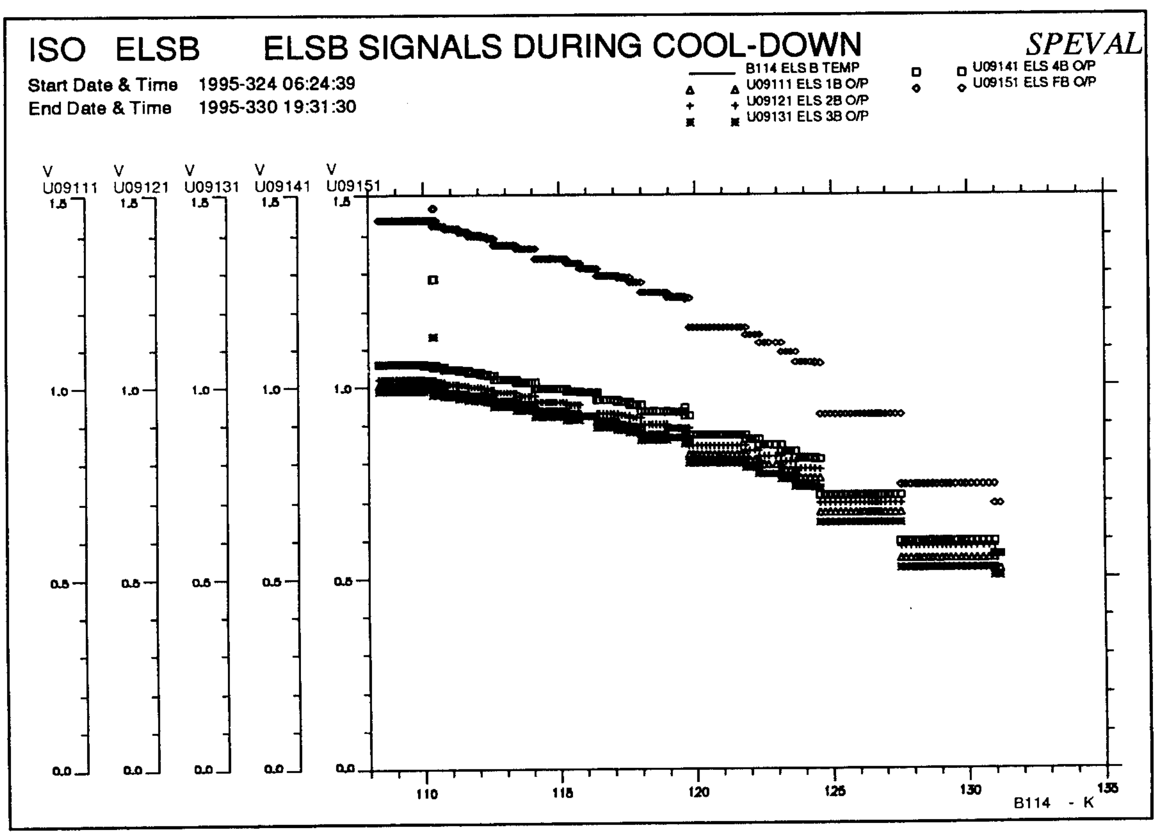


Fig 6.1.1-26: ELS-B dark signal evolution during the cool-down phase



6.1.1.6 SAS

Anomalies/Out_Of_Limits : none

The SAS performance was nominal [only + Z SAS has been exercised]; the blind spot around the sensor boresight is according to specification: the appropriate sensor detector gets lit only for Sun Aspect Angles significantly different from 90 deg.
The transition from LIT to DARK and vice-versa during eclipse occurs at about 0.6 solar constants.

6.1.1.7 STR

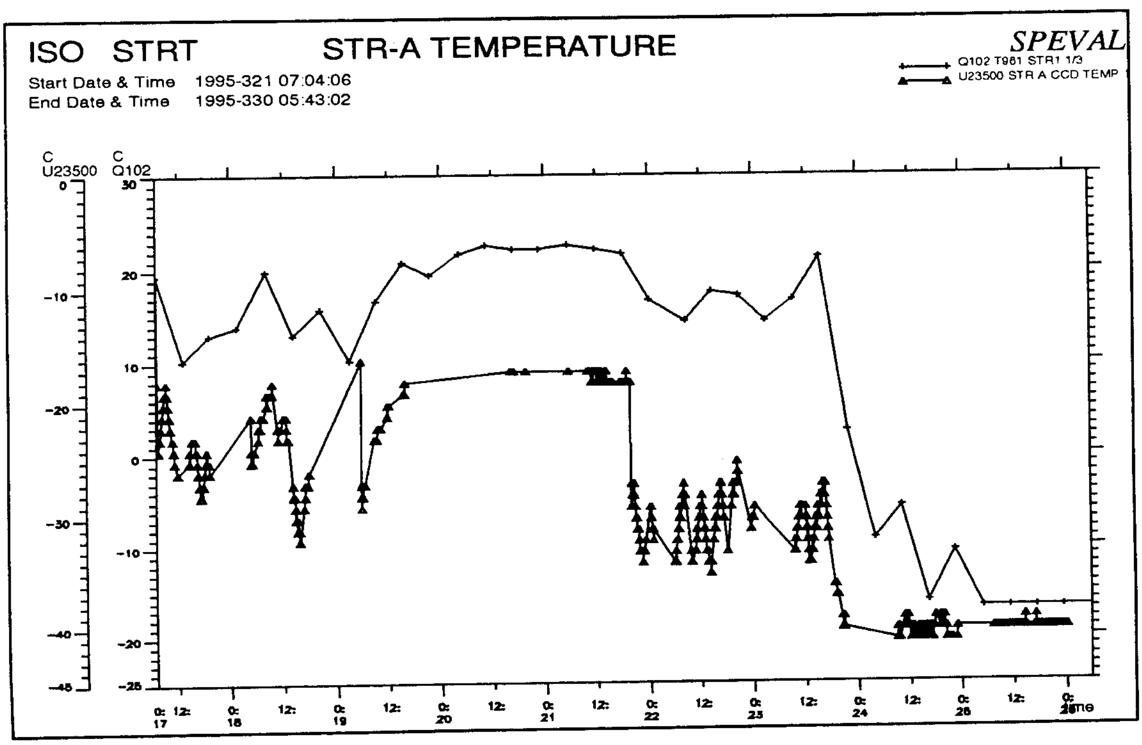
Anomalies

STR CCD TEMPERATURE: After STR switch-on at 07:04 in REV-0, the CCD temperature was expected to reach -40 C within 15 minutes maximum, but it reached instead a minimum temperature of - 24 C only, oscillating in the next hours/days between -30 and - 20 C. Anomaly report ISO-ANO-004 was issued: refer to section 6.4 for details.
Fig 6.1.1-26B here below, shows the evolution of the STR CCD and base-plate temperatures during the first 9 days of mission: it is evident that there was a tight coupling between the CCD temperature and the STR base plate temperature: for the first 5 revolutions an almost fixed delta of 39/40 C is maintained [against a nominal value of about 60 C] between the two temperatures [e.g for a base-plate temperature of about 22 C a minimum CCD temperature of -18 C could be observed].

The actions taken to resolve the anomaly [refer also to sections 6.4 and 6.1.5] were:

a] try to force maximum CCD Peltier cooler power by forcing the cooler active phase at higher temperatures than in nominal conditions; nominally the Peltier cooler active phase, where maximum cooler current can be delivered, starts at -38.5 C: this is regulated by an on board STR data-base parameter [CD-11]. On 21 Nov. '95 [REV-4] it was agreed between

Fig. 6.1.1-26B: **Evolution of the STR CCD / base-plate temperatures from REV-0 to REV-8**



Project/STR Manufacturer/Control team to set the CD-11 parameter to a value of -10 C [default = -38.5].

The activity took place at about 19:00 in REV-4:in fig 6.1.1-26B a discontinuity in the CCD temperature can be observed at the time the modification took place; the CCD temperature dropped by several degrees within a few minutes, stabilizing at about -30 C for an STR base-plate temperature between 15 and 20 C.

b] modification/re-design of the STR thermal control to reduce the STR-A base-plate temperature to about -10 C [instead of the nominal 20 C]: refer to section 6.1.5 for details.

Combination of the two actions had as final result that the nominal CCD temperature of -40 C was eventually reached at the end of REV-6/beginning of REV-7 [see fig 6.1.1-26B].

In flight tests/calibrations/**measurements**

STR Operating Modes

All the STR operating modes were successfully exercised during LEOP and SCP: refer to table 6.1.1-1 for an overview. Despite the anomaly on the STR CCD temperature the functionality and performances of Mapping and Searching/ Tracking modes were nominal.

STR Misalignment Calibration about S/C X-axis

A summary is provided in table 6.1.1-13.

STR Dark current measurement& on board "threshold" table calibration

The activity was executed in REV-5; the procedure consisted in acquiring the CCD back-ground level while tracking in sequence 7 different stars in the magnitude range between 3 and 8. The STR CCD temperature during the test was around - 30 C. The results are summarized in table 6.1.1-14. Since the back-ground level depends on the gain in use, different results were obtained for different magnitude classes. The most accurate back-ground value is the one obtained using gain G3 [due to better gain resolution and gain value accuracy]. The value of STR background can therefore be assumed to be at BOL 0.58 Volts, corresponding to 238 ADU's [assuming a value for the internal offset voltage of 0.567 V the actual dark signal is 13 mV]. The measured value was as expected by OG analysis and in line with the measurements executed during the STR acceptance campaign: the value measured during unit tests in OG was 232 ADU's, obtained with a CCD temperature of -40 C [the slight difference between the two measurements can be attributed to the difference in CCD temperature]. The result of the calibration was such that no update of the on board "threshold for true signal detection" table was required [default values were kept].

Further measurements carried out during SCP [always with star of magnitude around 5.5 to force usage of the G3 gain] were very consistent confirming a value of approximately 0.58 Volts.

STR Instrumental Magnitude calibration

During the first days of mission, several cases were experienced where the instrumental star magnitude was different from the expected one. In most of the cases the star was fortunately brighter than predicted by up to 0.35

magnitudes [the worst case was seen for stars of spectral class "K-5"]; in a few occasions the star was reported fainter than predicted by up to 0.3 magnitudes, leading in this case to guide star acquisition failures.
The accuracy requirement for STR magnitude is $e_m = \pm 0.1 + \Delta m$, where Δm is the additional contribution due to inaccuracies in the visual to instrumental magnitude correction formula. Since the correction formula [to convert visual magnitude into STR instrumental magnitude] provided by the manufacturer before launch, was obtained by analysis [and checked for A and M spectral classes only], it was decided to execute in REV-8 a series of STR mappings [5 in total] in a dense sky region to acquire sufficient data for a re-calibration of the Visual to Instrumental magnitude conversion table. About 140 stars were detected and about 100 of them were used for the relevant data analysis: for a given spectral class the number of available samples ranged between 1 and 8, for some spectral classes no sample was available and the relevant correction was evaluated by interpolation.
A new conversion table was produced by OG, able to guarantee an instrumental magnitude prediction with an accuracy better than 0.2 magnitudes. The new correction function is provided in table 6.1.1-15. After the implementation of the new table the magnitude accuracy improved significantly. Table 6.1.1-16 reports the results of a statistical analysis executed later on during the mission by Flight Dynamics on the STR magnitude measurement accuracy; as it can be observed, the difference between the predicted and the measured magnitude is normally much smaller than 0.15 magnitudes [with very few exceptions].

False Events on the STR CCD due to SEU's

False events on the STR CCD are caused by impacts of energetic cosmic radiation [SEU]. For the ISO STR the detection of a false event is based on two independent checks: a test on the star position in two consecutive cycles and a test on the stability of the tracked star magnitude; the probability of SEU occurrence is a function of the star magnitude [increases for fainter stars] and of the energy of the impacting particles.
The frequency of false events during the first 24 revolutions [extracted from the ACC Event Related Data analysis] is provided in fig. 6.1.1-27; a summary is given here below:

max value	min value	aver./rev.	aver./hour
12	0	4.4	0.3

A value of 1 FE/hour would still be in agreement with the analysis.

The above statistics includes also the very few cases where the detection of a false event repeated over two consecutive AOCS cycles caused a transition to AOCS sub-mode slew followed by guide star re-acquisition. It is interesting to note that these occurrences were only experienced in RPM and in case the SEU occurred during the execution of a micro-slew between two raster points.All the "single" false events have no impact on the AOCS since they are ignored by the ASW, and star information from the previous cycle are used.A slight impact [normally a loss of one raster point] is associated to a "double" false event [the probability of occurrence is any way very small].

During REV-11 a check was performed to test the capability of the STR of tracking stars of relatively faint magnitude while crossing the radiation belts. A star of magnitude 7 was selected, and the STR was kept in Searching/ Tracking mode down to Perigee time minus about 2 hours [according to current base-line, tracking of stars is suspended in a window of ± 3 hours around Perigee]. For the whole duration of the test no false event was detected.

This showed that margins in the usage of the STR around Perigee are still available for a potential extension of the Pointing modes operations.

STR Bias measurement

A direct measurement of the STR bias was obtained during the RPM test activity: refer to section 4.3 for an overview of the relevant results.The measured mean STR bias was in all cases < 1 arcsecond [against a specification value of 2.1 arcsec].

STR Noise Equivalent Angle [NEA] measurement

A verification of STR NEA was performed in REV-5 for stars of different magnitudes; in all cases the measured NEA was lower than the requirement [specification value < 1.5 arcsec.] and in agreement with the OG analysis.

A second verification of the STR pointing accuracy was executed in REV-8, by measuring the relative distances for a fixed pattern of 5 stars [the same 5 star constellation was moved in sequence in 5 different locations of the STR FOV, i.e. centre, upper & lover right corner, upper & lower left corner]. For each new location a mapping was executed and the relative distances among all stars evaluated. The average distance for each couple of stars was used as reference for the evaluation of the deviations. Since the star positions were acquired in Mapping mode [single sample] the error is cumulative of Bias and NEA. The error on the distance between two stars includes the sum of the errors on the single star position measurements.

A summary of the results is provided in tables 6.1.1-12A & 6.1.1-12B here below:

Error [on distance]	CCD units	Arcsec.
min error on Y axis	- 9	- 2.2
max error on Y axis	12	2.9
min error on Z axis	- 9	-2.2
max error on Z axis	8	2.0

Table 6.1.1-12A: summary of errors on star distances

Error [on single measurement]	CCD units	Arcsec.
min error on Y axis	- 6	- 1.6
max error on Y axis	9	2.1
min error on Z axis	- 6	- 1.6
max error on Z axis	6	1.4

Table 6.1.1-12B: summary of errors on single measurement

It can be seen that the error on the position of a star in the STR CCD is within [-1.6,2.1] arcsec for both axes [inclusive of Bias and NEA errors].

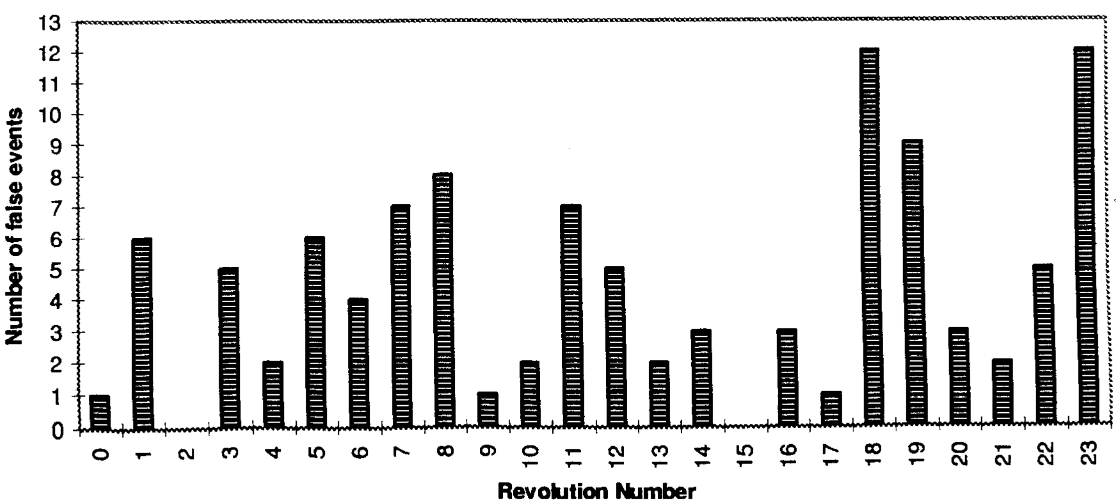
REV	parameter	str-A roll angle	misal. angle	SM1 parameter	SM2 parameter
1	roll[rad]	-44.89414 deg	6.35 arcmin	0.708412	- 0.705799
10	roll[rad]	-44.88121 deg	7.13 arcmin	0.708571	- 0.705639
20	roll[rad]	-44.88955 deg	6.63 arcmin	0.708468	- 0.705742

Table 6.1.1-13: STR misalignment calibration about X-axis

Test case	star class	visual Magn.	Instr. Magn measured	STR Gain	Back-Ground Voltage [V]
1	A3	3.1	3.05	G1	0.34
2	A3	4.3	4.30	G2	0.55
3	K3	4.9	4.30	G2	0.55
4	F0	5.5	5.55	G3	0.58
5	F5	6.7	6.60	G4	0.60
6	K2	6.6	7.20	G4	0.60
7	K2	7.6	7.35	G4	0.60

Table 6.1.1-14: STR dark current measurements

Fig 6.1.1-27: STR False Events occurrences during the first 24 Revolutions



Star class	Correction	Star class	Correction	Star class	Correction	Star class	Correction
M9	+0.85	K3	+0.30	F7	+0.10	A1	-0.10
M8	+0.85	K2	+0.25	F6	+0.05	A0	-0.10
M7	+0.85	K1	+0.25	F5	+0.05	B9	-0.10
M6	+0.80	K0	+0.25	F4	+0.05	B8	-0.10
M5	+0.80	G9	+0.25	F3	+0.05	B7	-0.10
M4	+0.70	G8	+0.25	F2	+0.05	B6	-0.15
M3	+0.60	G7	+0.20	F1	+0.05	B5	-0.15
M2	+0.55	G6	+0.20	F0	0.0	B4	-0.10
M1	+0.50	G5	+0.20	A9	0.0	B3	-0.10
M0	+0.50	G4	+0.15	A8	0.0	B2	-0.10
K9	+0.45	G3	+0.15	A7	0.0	B1	-0.10
K8	+0.40	G2	+0.15	A6	0.0	B0	-0.05
K7	+0.40	G1	+0.10	A5	0.0	O9	0.0
K6	+0.35	G0	+0.10	A4	0.0	O8	0.0
K5	+0.35	F9	+0.10	A3	-0.05	O7	+0.05
K4	+0.30	F8	+0.10	A2	-0.10	O6	+0.05

Table 6.1.1-15: Visual Magnitude/Instrumental Magnitude conversion table [as function of star class]

Star class	Magn. Error	Star class	Magn Error	Star class	Magn Error	Star class	Magn Error
A0	-0.02	B2	0.0	F6	-0.08	K3	-0.14
A1	-0.09	B3	-0.01	F7	-0.04	K4	-0.22
A2	-0.05	B4	-0.04	F8	-0.06	K5	-0.17
A3	-0.02	B5	-0.10	G0	-0.07	K7	-0.14
A4	-0.03	B6	-0.08	G2	-0.04	M0	-0.04
A5	-0.02	B7	-0.16	G3	-0.07	M1	-0.11
A6	-0.00	B8	-0.05	G5	-0.04	M2	-0.09
A7	-0.02	B9	-0.03	G6	-0.04	M3	-0.07
A8	-0.02	F0	-0.05	G8	-0.03	M4	+0.05
A9	-0.02	F2	-0.03	K0	-0.05	M5	+0.12
B0	-0.02	F3	-0.02	K1	-0.06	O7	+0.05
B1	-0.10	F5	-0.06	K2	-0.15	O9	-0.03

Table 6.1.1-16: Instrumental Magnitude accuracy [after implementation of the new conversion table]

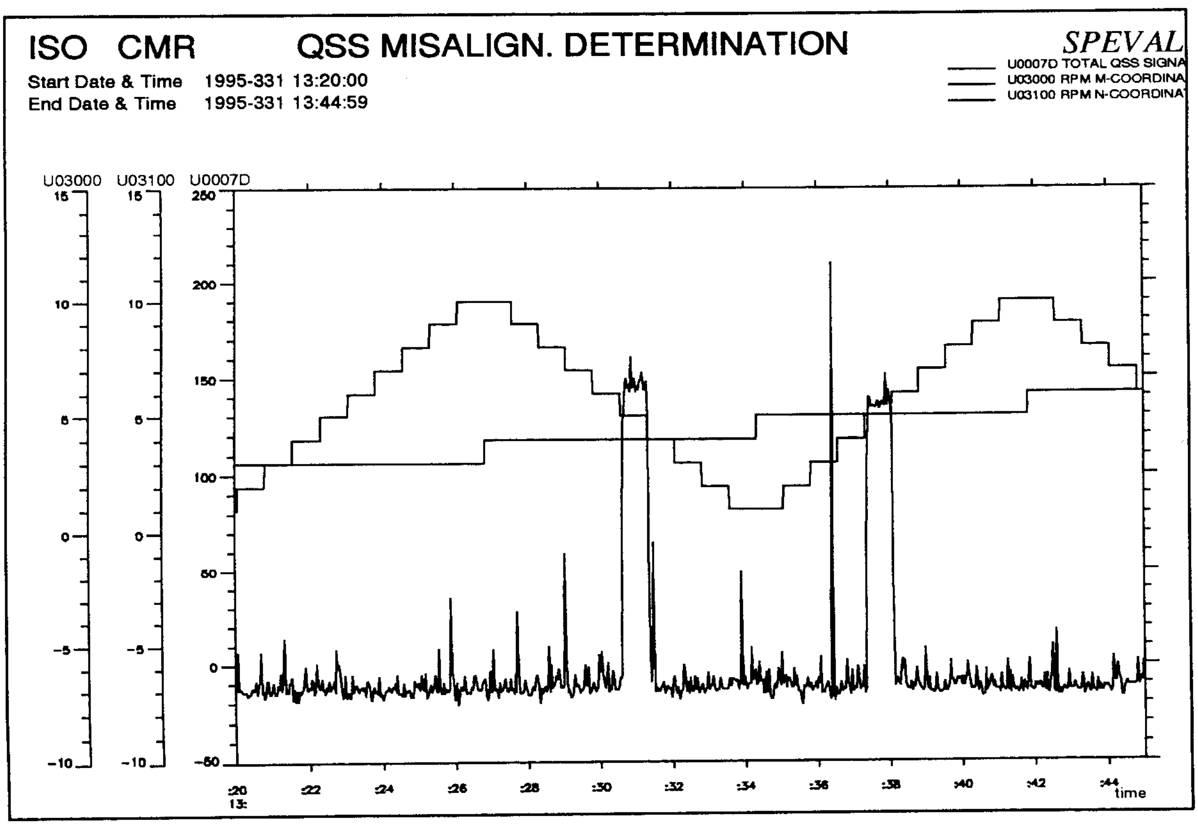
6.1.1.8 QSS

Anomalies/Out_Of_Limits : none

In flight calibrations

<u>QSS/STR MISALIGNMENT</u>: The QSS was switched on for the first time in REV-10 at 11:44, while the STR was tracking a star in the centre of the STR FOV; since the QSS FOV is 1.85 arcmin half-angle, while the QSS/STR misalignment was 3.4 arcmin [as identified later on], the star was not seen by the QSS: this implied the execution of a contingency procedure which consisted in performing a 10X10 raster of a total size of +/- 15 arcmin around the STR centre. The star signal was eventually detected by the QSS in leg-4/point-5 and leg-5/point-5 of the raster [refer to fig. 6.1.1-28] corresponding to a first roughly estimated misalignment of - 190 arcsec on Y-axis and -90 arcsec on Z-axis. Accurate calibrations were executed afterwards and repeated every day in the CCS ACAL window: a complete history of the QSS-STR misalignment calibrations from REV-10 to REV-40 is provided in table 6.1.1-17. Fig. 6.1.1-29/30/31 show the evolution of the misalignment angle: the global angle and the misalignments about the y-axis and z-axis respectively are depicted.
A significant trend is visible: the misalignment is increasing in average by about 0.2 arcsec per day; this behaviour was initially not clearly understood, especially taking into account that the measurements were always executed at almost the same time with respect to Perigee and therefore in very similar environmental conditions; a relationship between the QSS/STR misalignment and the STR base-plate temperature became very evident in REV-52, when a runaway of the STR base-plate temperature by about 10 C, had as counterpart a jump of about 5 arcsec on the QSS/STR misalignment global angle; further analyses confirmed a dependency from the base-plate temperature with a linear coefficient of approximately 0.5 arcsec/C. A stable QSS/STR misalignment was achieved from REV-54 onwards, when the STR

Fig 6.1.1-28: QSS FOV relative position [with respect to STR centre] determination



day	REV	y-misal	z-misal	total angle	day	REV	y-misal	z-misal	total angle
331	10	-181.2	-95.9	205.1	348	27	-190.2	-87.6	209.4
332	11	-184.3	-91.9	206.0	349	28	-190.4	-87.6	209.6
333	12	-183.3	-93.2	205.7	350	29	-190.1	-87.8	209.4
334	13	-187.9	-89.4	208.1	351	30	-190.1	-87.1	209.1
335	14	-187.9	-88.8	207.9	352	31	-190.3	-87.2	209.3
336	15	-188.4	-88.4	208.1	353	32	-191.2	-86.7	209.9
337	16	-189.0	-87.8	208.4	354	33	-191.7	-87.1	210.6
339	18	-189.6	-88.5	209.1	355	34	-191.4	-86.7	210.1
340	19	-189.4	-88.7	209	356	35	-191.5	-86.8	210.3
341	20	-189.5	-88.5	209.1	357	36	-191.4	-86.1	209.9
342	21	-189.6	-88.3	209.8	358	37	-191.8	-87	210.7
344	23	-189.5	-88.2	209.4	359	38	-192.3	-86.3	210.8
345	24	-189.7	-87.9	209.6	360	39	-192.9	-86.5	211.4
346	25	-190.3	-88.4	209.4	361	40	-192.05	-85.7	210.3

Table 6.1.1-17: QSS/STR misalignment calibration history [units = arcsec]

item	calibr. REV-10	default value	TV test measur.
Cell-1 offset	31.311	34.45	30
Cell-2 offset	33.483	38.55	33.5
Cell-3 offset	35.014	37.71	28
Cell-4 offset	39.995	42.99	33
Cell-1 sc. fact	1	1	
Cell-2 sc. fact.	0.9471	0.98	
Cell-3 sc. fact.	0.9917	1.01	
Cell-4 sc. fact.	1.0059	1.02	
KQ parameter	3.90E-04	3.50E-04	
QST parameter	40	20	

Table 6.1.1-18: QSS calibration & comparison with default database values

base-plate temperature stabilized at about - 9 C +/- 0.7 C: day bay day variations are normally < 0.5 arcsec and no trend can be appreciated.

QSS BIAS/SCALE-FACTORS CALIBRATION: The calibration was executed in REV-10; the results are reported in table 6.1.1-18 [just as reference, the last column gives the results obtained during the ISO Thermal-Vacuum test campaign]. The scale factors are all relative to cell-1 [which scale factor is assumed by definition = 1]. The column under "default value" refers to the value stored on board in the ASW data-base at launch [as results of on ground calibrations/ testing]. The KQ parameter [which is an indirect measurement of the QSS focal length] was calibrated in the same occasion. The whole activity was disturbed by a high level of noise present in the QSS output caused by cosmic radiation [an example of this is visible in fig 6.1.1-28 where the spike at 13:36:30 which amounts to > 200 counts is even higher than the actual star signal]: as a consequence of this, the calibration of the QST parameter [true signal detection threshold] was strongly affected and it gave meaningless results [1733 counts !]; the value of 40 counts eventually loaded on board was agreed between Project/Control Team as being a reasonable compromise solution; experience proved that it worked satisfactorily.

FIG-6.1.1-29: Total QSS/STR misalignment angle

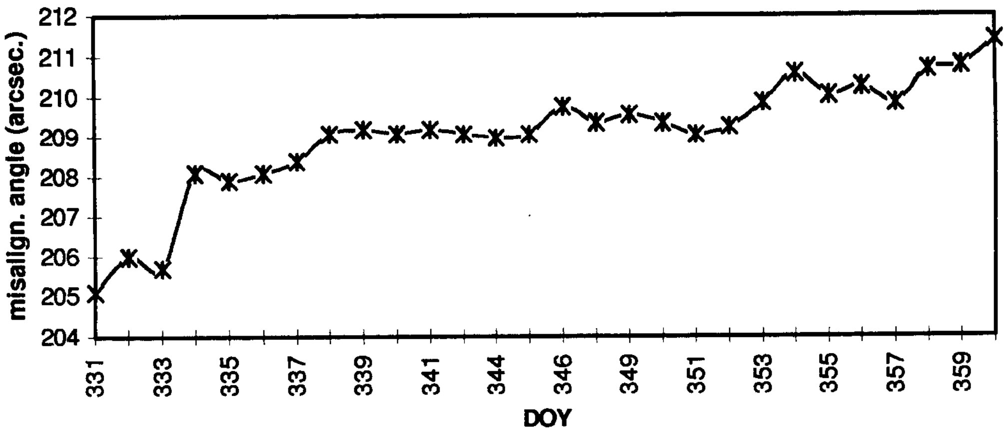


FIG-6.1.1-30: QSS/STR misalignment about Y-axis

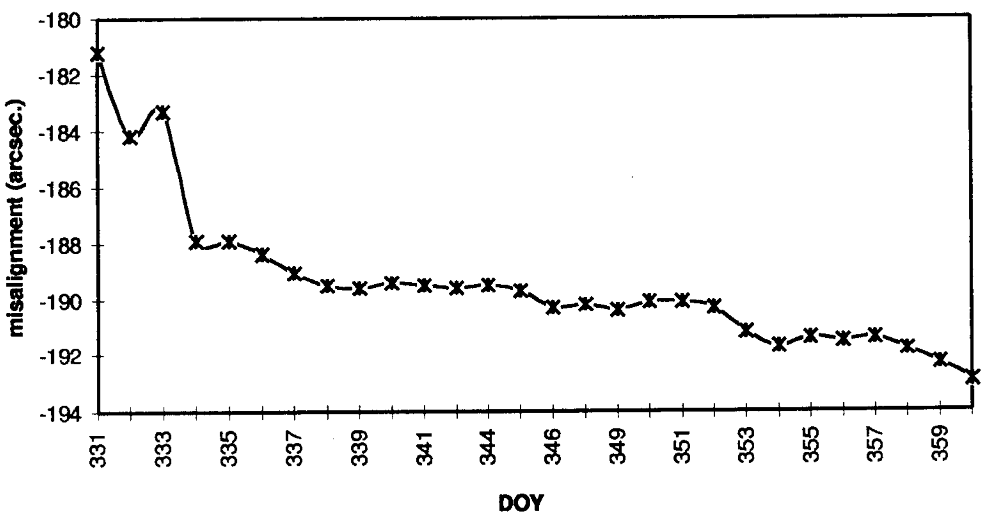
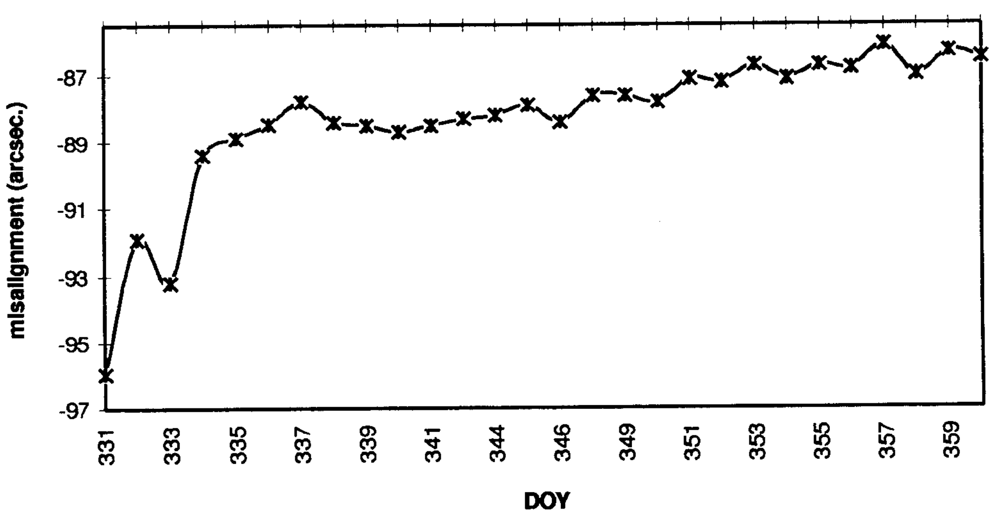


FIG 6.1.1-31: QSS/STR misalignment about Z-axis



6.1.1.9 RCS

Anomalies

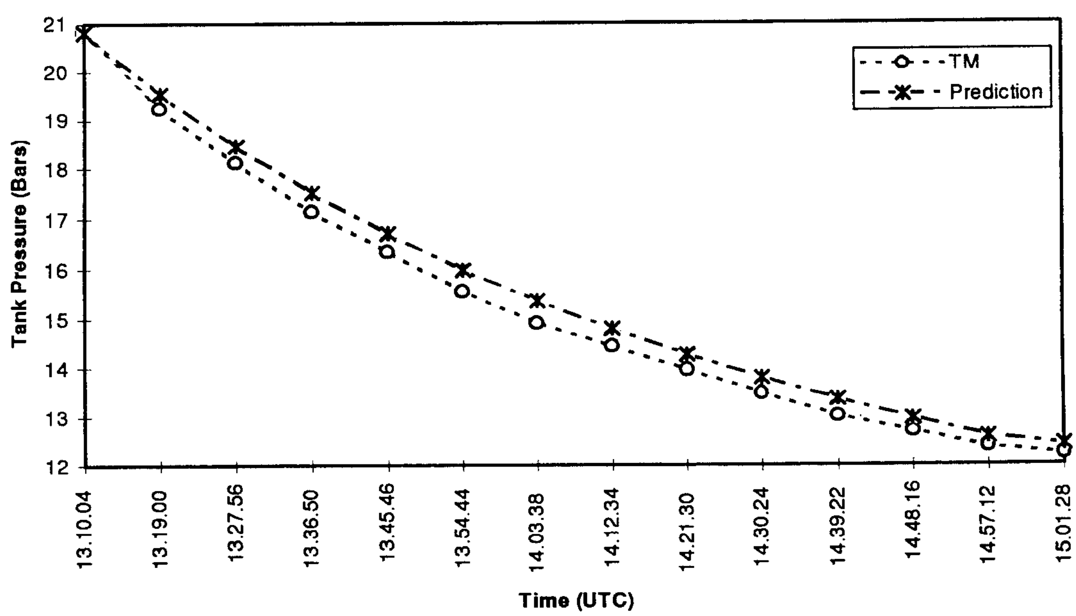
LV-2 UNEXPECTED STATUS AT FIRST AOS: the Latch Valve-2 was found in CLOSED status at initial AOS after S/C separation, while the "OPEN" status was expected. Anomaly report ISO-ANO-001 was issued: for details refer to section 6.4 of this document.

Performance analysis: The performance of the RCS was nominal in all relevant operations: attitude control in Acquisition Mode and in AGM [refer to relevant sections here above], Delta-V manoeuvre execution, RWL autonomous unloading & RWL Biasing.
A summary of the Hydrazine mass budget during LEOP and SCP is provided in table 6.3.2 [section 6.3.2]. Evolution of the Tank pressure before and after the major LEOP/SCP events is given in table 6.1.1-19 [to be noticed that after a delta-V manoeuvre a relaxation time of about 5-6 hours was observed where a very slight increase of the pressure took place]; a typical tank pressure blow down pattern during a Delta-V manoeuvre is shown in fig. 6.1.1-32 [as reference, also the prediction curve has been depicted].
No dedicated calibration of the thruster performances was foreseen for ISO; only a "global efficiency" coefficient could be derived after each Delta-V manoeuvre [which is comprehensive of the performances of all the thrusters involved in the Delta-V], by taking into account the efficiency of the manoeuvre, the thruster performance coefficient and the off-modulation coefficient used to program the manoeuvre and the off-modulation coefficient actually measured during the manoeuvre. The results are reported in table 6.1.1-20 [note that the thruster performance coefficient is relative to the expected performances as measured and provided by the manufacturer].

At Launch	At first AOS	before DV rehearsal	after DV rehearsal	before Main DV	after Main DV	before Perigee DV	after Perigee DV
22.28	22.12	21.80	20.67	20.83	12.22	12.53	12.37

Table 6.1.1-19: Pressure TM reading during LEOP/SCP [all the figures are in BARS]

Fig 6.1.1-32: Tank Pressure evolution during Main Delta-V



Delta-V manoeuvre	Off Modul. Coeff used [%]	Off Modul. measured [%]	Thruster efficiency used [%]	Thruster efficiency calculated [%]	Delta-V required [m/sec]	Efficiency of Manoeuvre [%]
Rehearsal	33 %	9.37 %	100 %	102.05 %	1.54	+ 17.2 %
Main Delta-V	9.38 %	9.18 %	101 %	100.43 %	31.67	- 1.8 %
Perigee	9.19 %	9.28 %	101 %	101 %	10.00	+ 0.2 %

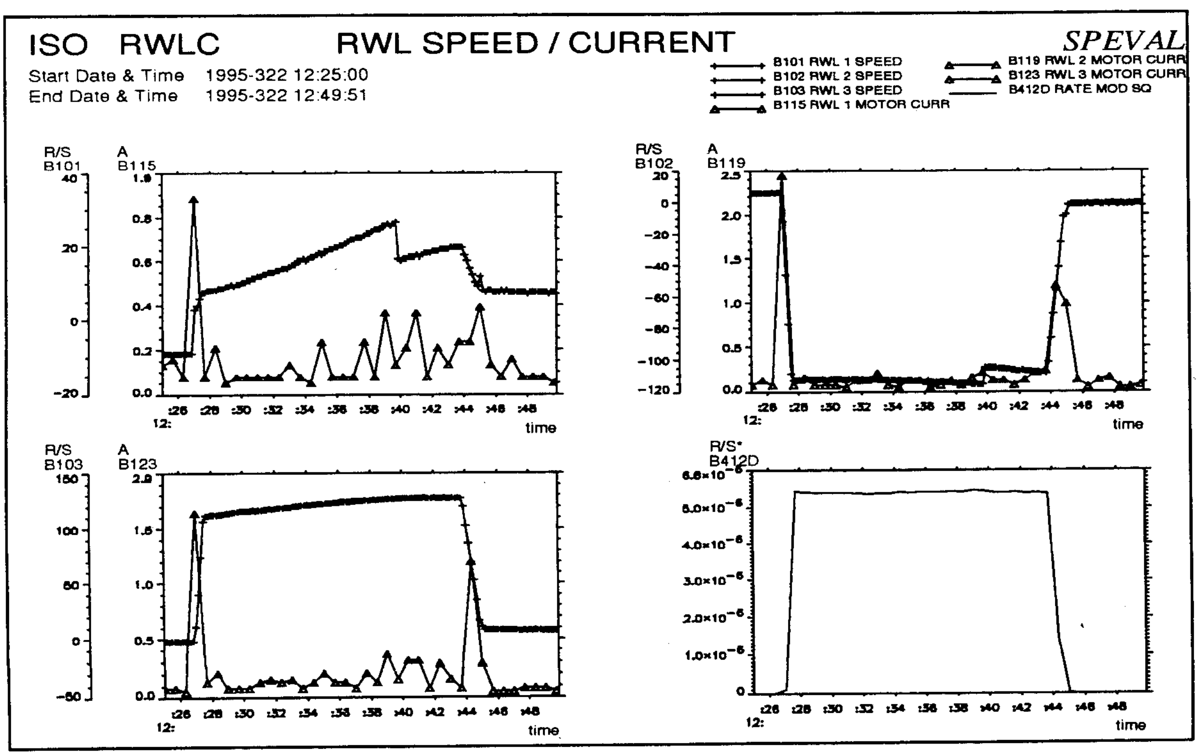
Table 6.1.1-20: Delta-V Manoeuvres performance

6.1.1.10 RWL

The RWL performance was nominal: currents and temperatures remained well within specification during prologued actuation. The provided acceleration is nominal and the slew coasting phase [if any] is reached about 40 seconds after the start of the manoeuvre. A typical example of RWL currents & speeds during a dual slew [about Y & Z axes] is shown in fig 6.1.1-33.

In several occasions the "POWER LIMITER" alarms triggered during the execution of long slews [especially for RWL-1 & RWL-2]; according to the RWL design this is the case when an acceleration is required such that the RWL power consumption is more than 48 W: the current is therefore lowered and the resulting actual torque is less than requested; the activation of the power limiter depends on the RWL speed and on the requested torque: for a maximum torque request the power limiter triggers when the RWL speed is around 100 Rad/sec with a limiting current of 2.4 A: in all the cases observed the RWL power limiter behaved according to design.

Fig 6.1.1-33: RWL currents / speeds during a slew



In one occasion, on day 323 at 21:02 RWL-3 was declared "Unhealthy", during one AOCS cycle but no RWL re-configuration took place; this can occur when the RWL is at standstill [zero-crossing condition]: in that situation, unjustified tachometer outputs can result [not reflecting the actual wheel speed], which consequently can trigger the RWL Continuity health check. In these circumstances the ASW has protections against an unjustified RWL re-configuration and the wheel is only flagged as suspect.
This behaviour was expected [already observed during the SVT test campaign] and has no consequences on the AOCS.

6.1.1.11 ACC

The ACC performance was nominal: no anomaly [SW reset or computer switch] nor OOL's were experienced. The ACC On Board Software performance was nominal as well [for both Operating System and Application SW components].

6.1.1.12 DMU

The DMU performance was nominal.
All the relay switching operations were nominal. The AOCS voltages and currents were as per specification. Internal processing of ELS/SAS outputs was as expected. The performance of the DMU watch-dog was nominal as well: no real [nor false] autonomous watch-dog triggering was experienced.

6.1.1.13 Pointing Performance

The Pointing performance was found much better than specifications with indications that margins of improvement were still available; a summary is provided in table 6.1.1-21.

RELATIVE POINTING ERROR [RPE]

A typical RPE pattern over a complete pointing is shown in fig 6.1.1-34. The RMS values measured so far are < 0.7 arcsec. It is important to note that the RPE figure is calculated using the TM quaternion which is an unfiltered output [$q_{tm} = q_{target} * q_{error}$]: the error quaternion reflects in fact all the instantaneous spikes on the STR guide star position measurements that are below the threshold for false event detection [this is why errors up to several arcseconds can be observed in the RPE pattern: refer for example to fig. 6.1.1-34]. The above spikes do not necessarily entail an actual S/C pointing jitter [the attitude control is based on the error vector, resulting from a Kalman filter, and not from the error quaternion used for the calculation of the TM attitude quaternion]. The above figure is therefore overestimated and it represents a worst case only.

Error	UNITS	IN-ORBIT	SPEC.
Relative Pointing Error [RPE]	arcsec	< 0.7	< 2.7
Absolute Pointing Drift [APD]	arcsec/h	< 0.1	< 2.8
Absolute Pointing Error [APE]	arcsec	< 4.0	< 11.7

Table-6.1.1-21: ISO Pointing Performance

Fig 6.1.1-34: RPE evaluation during an FPM pointing

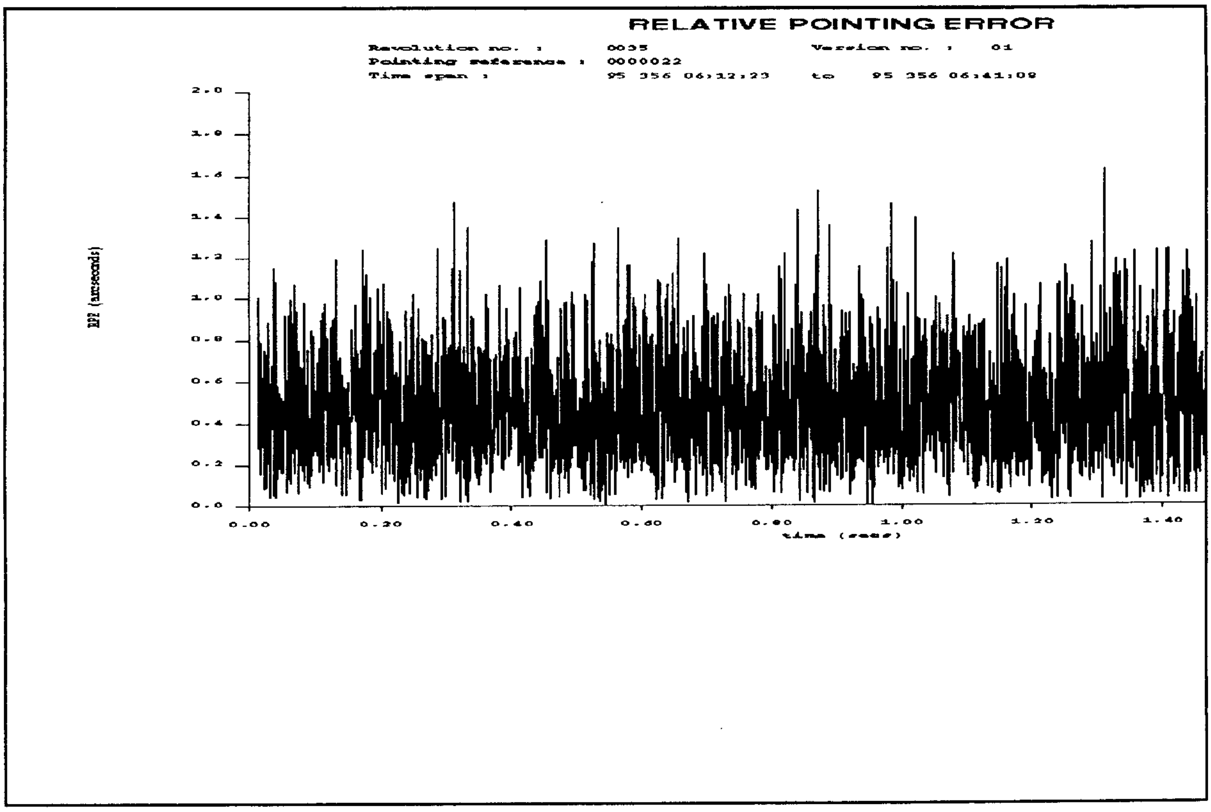
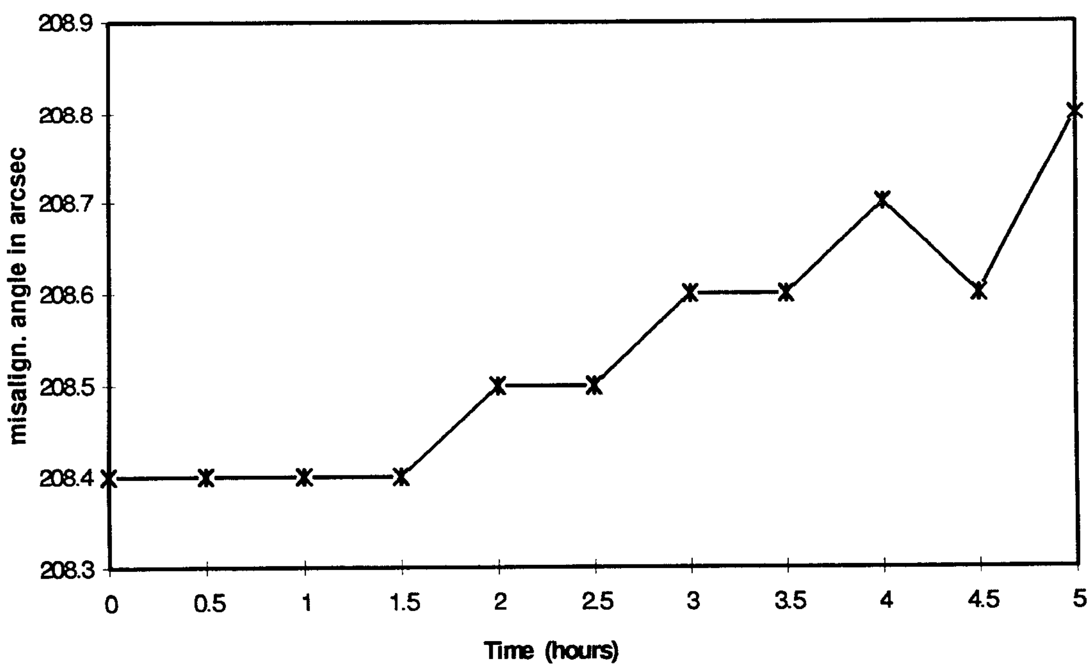


FIG 6.1.1-35: Evolution of the QSS/STR misagn. during APD calibration



In order to provide a more representative estimate of the actual S/C attitude [filtered] a new algorithm was implemented during the first months of mission in the SOC OLP system, making use of the filtered attitude error vector.
The on ground processed attitude quaternion represents more closely the actual S/C jitter and the relevant attitude noise [RPE] appears to be significantly lower.

ABSOLUTE POINTING ERROR [APE]

No dedicated measurement was executed during LEOP and SCP [ad hoc tests were carried out later on during the ISO Routine phase]. The figure reported in table 6.1.1-21 is derived from the outcomes of other tests [as RPM test, FPG activity, where an indication of the actual absolute pointing error could be deduced from the on ground reconstructed attitude, based on the 5 tracked stars method] and from indications from the IDT's, based on instrument data analysis. Measurements executed later on during the mission confirmed such a performance for the first period of the ISO mission; during the ISO routine phase an intensive re-calibration/fine-tuning activity was able to reduce the figure by at least a factor 2.

ABSOLUTE POINTING DRIFT [APD]

A dedicated measurement was carried out in REV-16: the test consisted in remaining for several hours in Calibration Mode at two different attitudes [SVM cold/warm cases] while the STR was simultaneously tracking 5 stars [to allow direct attitude determination], i.e.:

- First Pointing: SAA = 88 Deg, duration 6.5 hours
- Second Pointing: SAA = 63 Deg, duration 6.0 hours

During the whole duration of the test the QSS/STR misalignment was periodically evaluated to detect any potential drift caused by thermal distortion effects: the evolution of the misalignment angle during the first pointing [at 88 Deg SAA] is shown in fig. 6.1.1-35, where within 5 hours a change of 0.4 arcsec only can be appreciated.
More generally, the difference in QSS/STR misalignment between the first measurement at 88 Deg SAA and the last measurement at 63 Deg. SAA was a rotation of 0.6 arcsec [mainly about the Y-axis].

The comparison of 5-star attitude determination at 88 Deg SAA showed a drift of approximately 0.0 arcsec about z and 0.2 arcsec about y, during 6.5 hours. The same measurement at 63 Deg SAA showed a drift of approximately 0.2 arcsec about z and 1.1 arcsec about y, during 6 hours.

As it can be seen from the above figures, the Attitude Pointing Drift [for the Y and Z axes] was too small to allow a significant estimate: it can be assessed that it is certainly less than 0.1 arcsec/h, as reported in table 6.1.1-21.

6.1.1.14 ISO Guide Star Catalogue experience

The ISO star catalogue has been compiled by the Centre de Donnees Stellaires in Strasbourg on the basis of requirements provided by the ISO Project [Ref: Call for Proposal for the ISO Guide and Calibration Star Catalogue, ISO-AO-Z-6048, Issue 2, Jan' 1992]. This catalogue is complete down to visual magnitude 9. Stars suitable for attitude referencing during fine pointings and calibration exercises are flagged as such in the catalogue.

The operational delivery took place in July 1995 for an ISO launch in November 1995.

The main problems experienced during LEOP/SCP with the ISO Guide Star Catalogue are summarized here below:

- Inaccurate photometric data

Cases where the star was fainter than predicted by 0.3 magnitudes led to acquisition failures [guide star not found]. This problem was amplified by the simultaneous pour accuracy of the visual to STR instrumental magnitude transfer function especially for a certain number of star spectral classes]: refer to the "STR" section in paragraph 6.1.1. Nonetheless, even after a complete re-calibration of the STR instrumental magnitude conversion table several guide star acquisition anomalies were still experienced, purely due to star catalogue magnitude inaccuracies. The real time corrective action was to change the detection threshold but this implied also the uplink of the complete attitude change request. Very often the observation was so short [a couple of minutes only] that no time was left for the execution of the recovery procedure.

- Variable stars

In two cases the acquisition failed because the guide stars was also flagged as suspected variable. The guide star selection process was then modified to discard guide stars with variable or suspected variable magnitude.

- Exotic spectral class or absence of spectral class

The STR manufacturer provided a table of corrections of magnitude as function of the spectral class. This table was used to derive the instrumental magnitude from the visual magnitude and the spectral class. In case the spectral class was not given in the star catalogue or it could not be associated with an entry in the table the instrumental magnitude was set equal to the visual magnitude.
There was one case where the guide star being missed had no spectral type recorded. It turned out that star was in fact a planetary nebula. The guide star selection process was then modified to discard guide stars with exotic or unknown spectral type.

- Missing stars in the catalogue

During star mapping procedures it was noted that some stars detected by the star sensor could not be associated with stars in the ISO catalogue. Further investigations showed that they were however registered in other catalogue [INCA, GSC]. Although missing stars in the catalogue have in principle no impact on operations, there was at least one occasion where a bright star not recorded in the catalogue was detected within the search window and tracked in place of the selected star. As the pointing accuracy of ISO after a manoeuvre was higher than predicted the search window of the STR could be reduced accordingly thus decreasing the chances of acquiring the wrong star.

All the anomalies detected with the first version of the ISO Guide Star Catalogue were flagged and reported to CDS to be incorporated in a second version [though this is not subject of the present report, it is worthwhile to notice that the delivery of that version was delayed until June 1996 in order to take benefit of the photometric measurements made by Hipparcos/Tycho which were then made available].

6.1.2 OBDH

The On-Board Data Handling [OBDH] Subsystem performance was nominal throughout LEOP and SCP. All operations were conducted according to the FOP Timeline. All nominal modes and relevant software functions have been successfully exercised. TM/TC interfaces with the instruments [prime configurations] have been nominal.

The following OBDH operations were carried:

1. Mode Transition Launch to Housekeeping
2. CTU Memory Dumps and PRAM comparison.
3. Activation of OBDH Quality Checking System.
4. Applications Programmes Activation.
5. Authorise and Enable Autonomy Entry Conditions.
6. Time-tag Buffer functionality Test

Mode Transition T4, Launch to Housekeeping.

This Transition was triggered by the separation from Ariane 4 after a 32 second delay, the Transition executed successfully. At Mode Transition T4 the following events occur

Send LM5 Command to AOCS to inform it that Separation has occurred [in case either of the AOCS Separation straps fail to indicate separation].
Select +Y Antenna.
Command on Transmitter 1.
Command Open Cryo. Valves V501, V503, V504, V505.
Command BDRs and BCR on.
Command Automatic Battery and Charge Rate Selection.
Enable Thermal control.
Authorise Transition to OBDH Science Mode.

CTU Memory Dumps and PRAM Comparison.

CTU memory Dumps to refresh IDCS Images were commanded starting at DOY 321 04:28, following the dumps a comparison of the dumped PRAM Image with the Ground Image was carried out, no discrepancies were found.

Activation of OBDH Quality Checking System.

Activation of the OBDH Quality Checking System began at DOY 321 04:53, the activation proceeded nominally and the CTU Watchdog was re-enabled at 05:03.

Applications Programmes Activation.

During the course of Revolution 0 the following OBDH Applications Programmes were activated.

06:21	RFCON [Transmitter Output Power Monitoring].
06:25	TMCON / TCCON [PDU TM / TC Interface Monitoring].
06:57	ULCON [BMC Battery Charger Switching Frequency Monitoring]
07:09	BOTM [Battery Over-temperature Monitoring]
09:54	BUVM [Battery Under-voltage Monitoring]
10:22	OBSF [On-board Data Storage Facility]
13:31	CHCON [Monitoring of BDRs and BCRs currents]

The Activation of all Applications Programmes proceeded nominally.

Authorise and Enable Autonomy Entry Conditions.

Authorization and Enabling of Autonomy Entry Conditions was completed on DOY 321 at 11:58. At this time ISO was protected against AOCS fallback to ROM Mode, RF Link Loss and Battery Under-voltage.

Time-tag Buffer functionality Test.

The time-tag Buffer functionality Test was carried out in Revolution 1 on DOY 322 at 04:02, all Time-tag Buffer functionality was confirmed as being nominal - although a minor IDCS problem was discovered in the Time-tag Buffer imaging task, which occurred when Bit 16 [The MSB of TTAG time] of OBDH OBT was set to 1.

6.1.3 RF

RF Subsystem performance was nominal throughout LEOP and SCP indicating a large link margin for both, the TC-Uplink and the TM-Downlink [TX-1 used only]. The Ranging function [TX-1] was nominal.

Withe the exception of the commanding problem shortly after initial AOS Perth [see section 3.2.1; REV-0], the LEOP/SCP TC-Uplink and TM-Downlink configuration was as follows:

- Command Decoder-1 selected [ASW-1];
- Command Receiver-1 and 2 [hot back-up] addressed;
- Antenna-Y/+Y selected, as required;
- Ranging ON/OFF, when required [TX-1];
- Transmitter-1 ON [OFF during on-board antenna switches];
- 8 KB HK Telemetry [OBDH] selected till end of LEOP;
- 32 KB SC Telemetry [OBDH] selected as of beginning of REV-4 [SCP].

The following operations were carried out on the RF Subsystem during the LEOP phase.

1. Autonomous Transmitter-1 switch-on at Mode Transition Launch to Housekeeping.
2. Antenna Switching Operations when necessary.
3. Ranging.

Autonomous Transmitter-1 Switch-on at Mode Transition Launch to Housekeeping.

Thirty-two seconds after separation from Ariane 4 the T4 Mode Transition was triggered. At this stage the on-board software autonomously commanded Transmitter-1 on. Initial Confirmation of Transmitter status and functionality came at DOY 321/01.47 when the Malindi Ground Station reported carrier acquisition. At Perth First AOS the Transmitter status was confirmed Transmitter Output power was a nominal 3.55 Watts.

Antenna Switching Operations.

The First Antenna Switch from Configuration 1 [Transponder 1 to -Y Antenna, Transponder 1 to +Y Antenna] was executed nominally at DOY 321/ 03.32. The First Antenna Switch from Configuration 2 [Transponder 1 to +Y Antenna, Transponder 2 to -Y Antenna] was executed nominally at DOY 321/ 22.43. there after Antenna switchings were executed as defined in the IPFs received from OAD.

Ranging

The first ranging was executed nominally at DOY 321/02.47, thereafter Rangings were carried out at regular intervals.

At the end of the SCP [REV-21], an optimized uplink modulation index was determined. With the implementation of the optimised mod-index [0.5 rad] in the VIL-2 station, the disturbing TM drops in the downlink were eliminated, when RANGING was switched on [refer to section 7.3.2].

6.1.4 PCS

The Power Conditioning Subsystem performance was nominal throughout LEOP and SCP. The Solar Array [Sunshield] output power was 755 W [SAA = 90 °] and provided about 200 Watts of margin at BOL. The two batteries were operating nominally. Adjustment of the End Of Charge [EOC] criteria has been performed, which improved the charge efficiency. The main bus voltage is properly regulated at + 28 Volts +/- 1%.

The following operations were carried out on the PCS during the LEOP and SCP Phase.

1. Battery Recharge following Eclipse.

2. Battery end of Charge Optimisation.

3. Battery temperature control.

Battery Recharge Following Eclipse.

Prior to Launch at 01:15 ISO was switched to internal power, supplied by the Batteries, separation from Ariane 4 took place in Eclipse, the Eclipse ended at 01:45, i.e. ISO was powered by the Batteries for a period of 30 minutes. First AOS was at 02:01 at which time both Batteries were charging nominally. At this time Battery temperatures were between 25 and 30 degrees, the nominal Battery operating temperature is close to 0 degrees. At 05:10 Battery 2 reached End of Charge, unfortunately Battery 1 did not reach End of Charge, probably due to the high Battery Temperature, at 07:19 Battery 1 Charge was terminated manually, by selecting charge rate C/200 [Trickle Charge]. Battery 1 was left to cool for as long as possible before re-selecting Automatic Charge Rate selection, this was done at 20:50 and Battery 1 reached End of Charge nominally at 21:23. The evolution of Battery Temperatures during Revolution 0 can be seen in Figure 6.1.4-1.

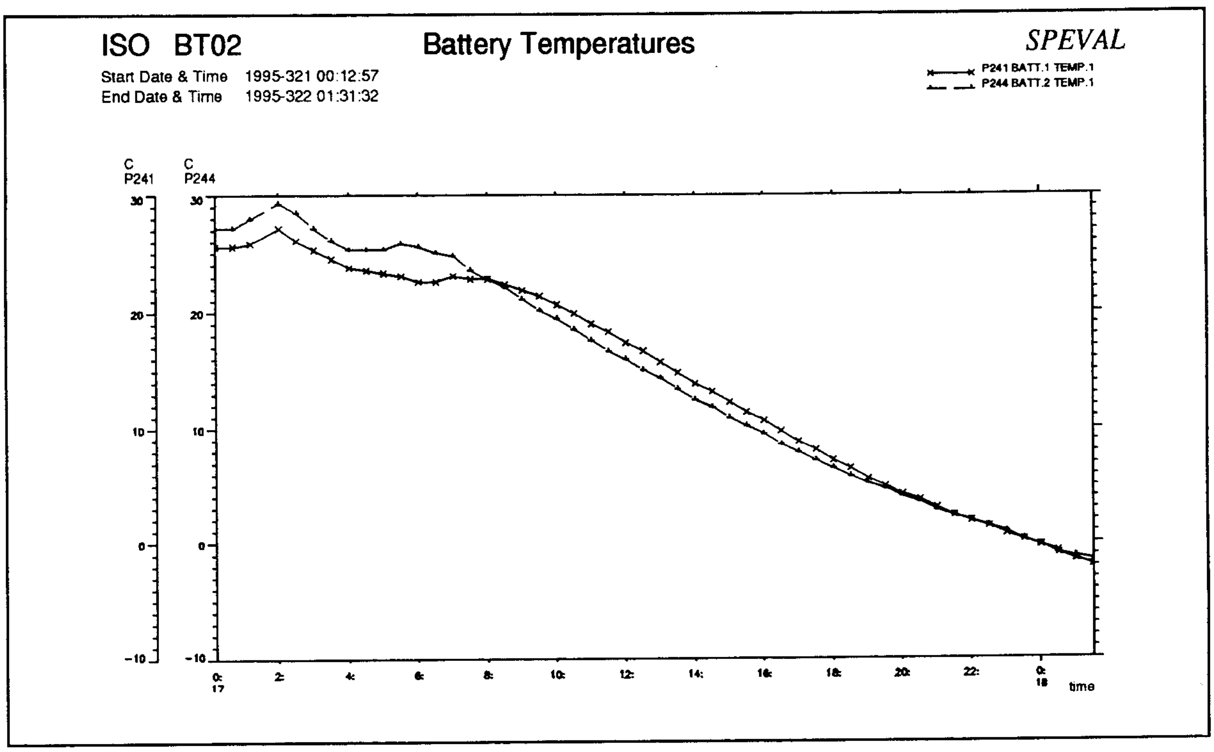


Figure 6.1.4-1: Batteries Temperatures during Revolution 0.

Eclipse Entry on DOY 322 [Beginning of Revolution 1] took place at 01:32, Eclipse exit was at 01:54, following Eclipse both Batteries reached End of Charge nominally, Battery 1 at 04:15 and Battery 2 at 04:19. Throughout Revolution 1 Battery temperature continued to fall, see Figure 6.1.4-2.

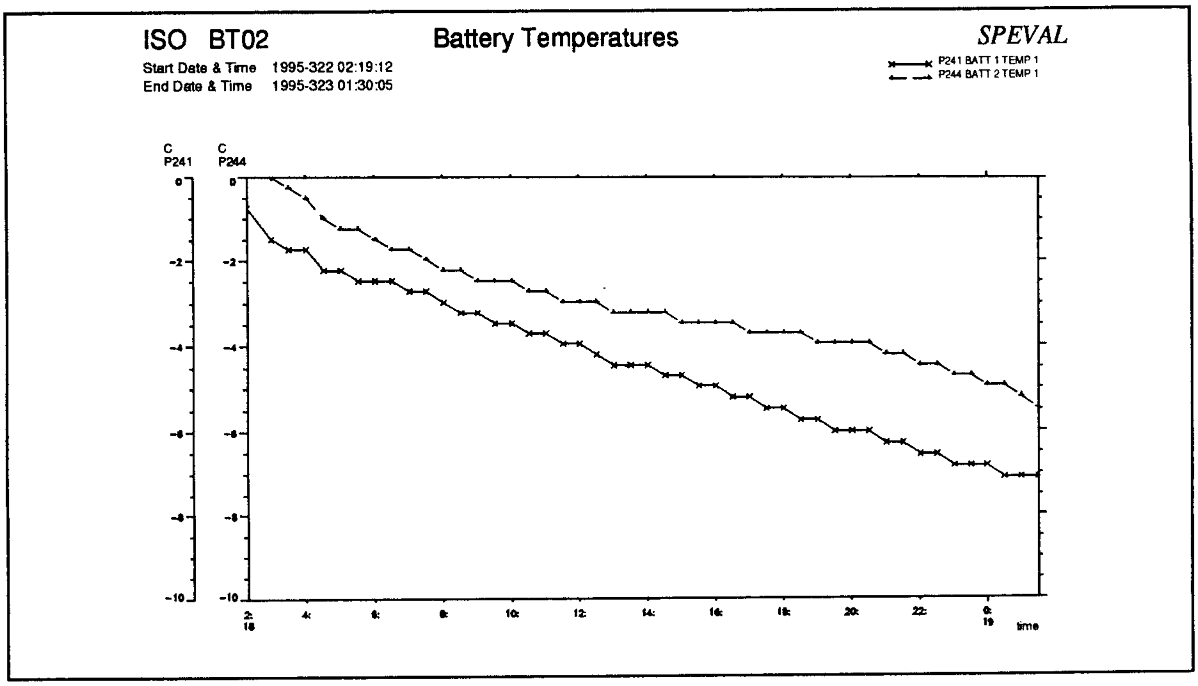


Figure 6.1.4-2: Batteries Temperatures during Revolution 1.

Similarly on Revolution 2, Eclipse entry was at 01:42, Eclipse exit was at 02:04, both Batteries reached End of charge nominally, Battery 1 at 04:08, Battery 2 at 04:06. Once again Battery Temperatures continued to fall during Revolution 2 until at 15:29 the Redundant Battery 1 Heater was switched on [for more details re. Battery thermal control in LEOP see THC section]. Battery 1 Redundant Heater remained on from this time for the entire LEOP / PV-phase, Battery temperature evolution in Revolution 2 can be seen in Figure 6.1.4-3.

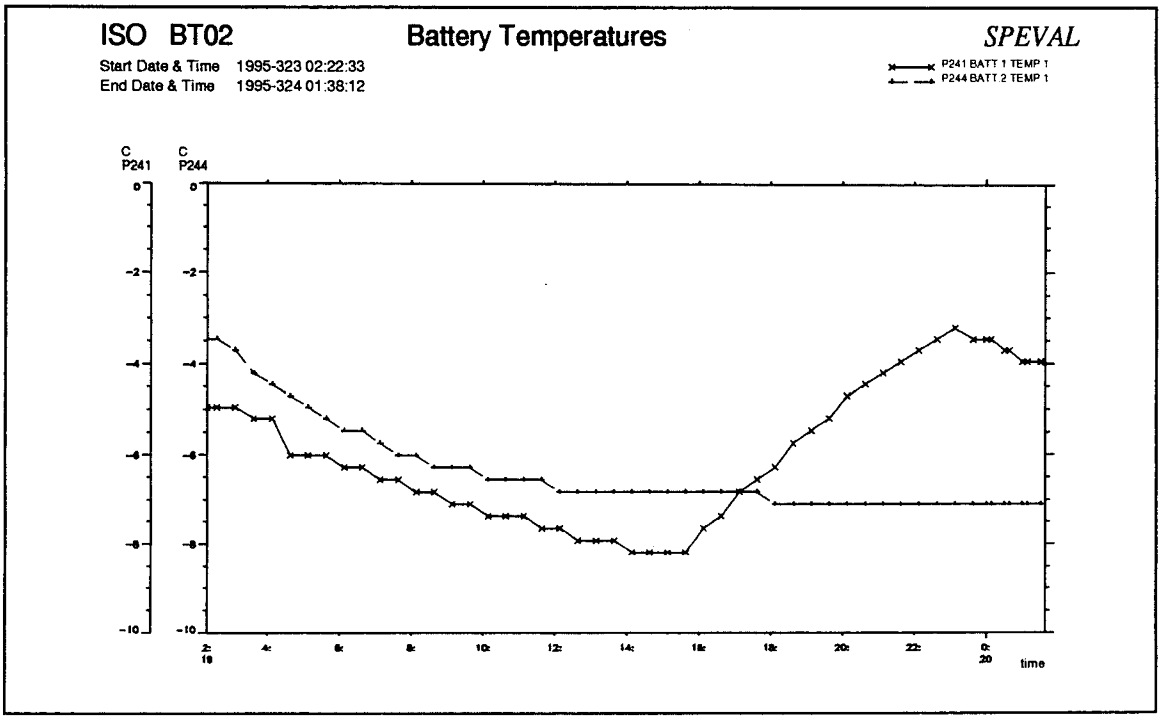


Figure 6.1.4-3: Batteries Temperatures during Revolution 2.

Battery end of Charge Optimisation

The Battery end of Charge Optimisation consists of increasing the EOC reference value from its launch value of 36 step by step until the Battery fails to reach EOC [Temperature increases] or the Battery maximum charge duration [Function of Eclipse duration, defined by manufacturers] is exceeded at this point the EOC Reference should be reduced by 1 point to the value at which the battery last reached EOC successfully.

The Battery end of Charge Optimisation procedure was commenced on DOY 328 at 06:24 for both Batteries in parallel. The procedure was terminated when the maximum charge time for both batteries was exceeded, this occurred with Battery 1 Vref = 47 and Battery 2 Vref = 48, following this the Batteries End of Charge settings were reduced to Vref = 46 and 47 respectively, Battery 1 then reached End of Charge successfully, due to the over-charge Battery 2 temperature had however increased to -1°C by this time and was unable to reach End of Charge a second time with Vref = 47, to prevent further temperature increase and to allow it to cool Battery trickle Charge [C/200] Mode was selected at 10:21. At 18:29 Automatic Battery charge Rate selection was re-selected, at this time Battery 2 Temperature was 0.5°C - still some way above its nominal Temperature, once again Battery 2 was unable to reach EOC, at 20.21 at a Battery 2 Temperature of 5°C Trickle Charge was selected again and the Battery 2 EOC reference reduced, eventually at 00:10 UT on DOY 329 Battery 2 End of Charge was reached with a Vref value of 37. Shortly after this the Battery 2 temperature peaked at 13°C, Battery temperature evolution on DOY 328 and 329 can be seen in Figure 6.1.4-4.

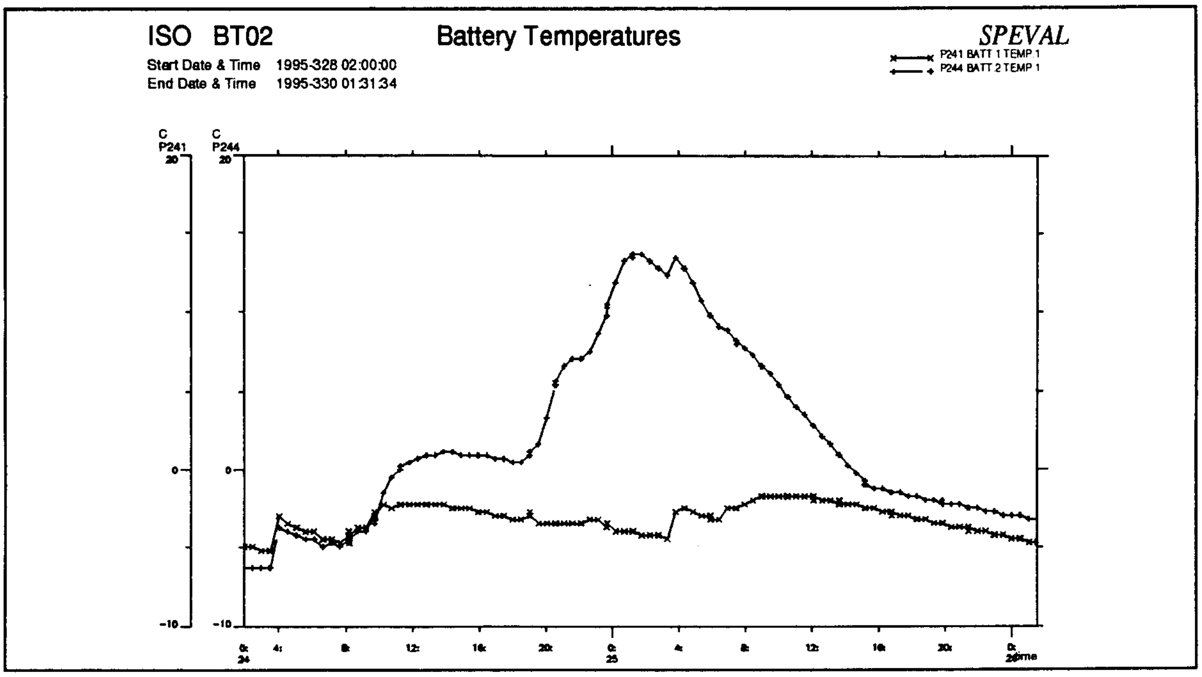


Figure 6.1.4-4: Battery Temperatures During and After Battery End of Charge Optimisation.

Following this the Battery EOC reference value was left at 37 for the next 2 Battery Discharge / Charge cycles, on DOY 330 at 16:23 it was increased to 46 [1 point below its 'optimised' value of 47]. Following the Eclipses on DOY 331 and 332 Battery 2 reached End of Charge normally, charge time for Battery 2 was within 7 minutes of that for Battery 1.

Following the Eclipse on DOY 333 it once again became apparent that Battery 2 was not going to reach End of Charge again and its temperature was starting to increase, at 07:21 [37 minutes after Battery 1 End of Charge] Trickle Charge was again selected and the Battery End of Charge reference was reduced one more step to 45, following this Battery end of Charge was reached nominally.

From the above it can be seen that the Battery End of Charge optimisation Procedure caused a significant Thermal disruption to the Batteries and in fact did not optimise the Battery end of Charge settings, during the first three months of the mission, as the Eclipse duration increased both Batteries suffered a number of Thermal runaway incidents similar to the above and both Batteries End of Charge Vref values were reduced until we were left with Vref Battery 1 = 41 and Vref Battery 2 = 42 selected on DOY 080 of 1996.

6.1.5 THC

The Thermal Control Subsystem performance was nominal with the following exceptions:

- The global SVM thermal environment was found to be within expected range but slightly cold biased.
- The revised STR-A thermal control strategy enabled the STR-A CCD temperature to finally reach -40 ° C and stabilize [REV-12]. This had been achieved by lowering the STR-A baseplate temperature from ~ 20 ° C down to ~ - 6.5 ° C, but the baseplate temperature was still not stable at the end of the SCP, i.e. with a slow increasing trend. No STR-A performance degradation could be noticed.
- The cold state of the batteries observed early in LEOP required a change in the heater configuration. This has no adverse effect on batteries performances and operations.

The following operations were carried out on the THC subsystem during the LEOP phase.

1. Active Thermal Control.
2. STR-A Thermal Control.
3. Battery Thermal Control re-configurations due to low Battery internal temperatures.

Active Thermal control.

Thermal control was enabled prior to launch and functioned nominally throughout LEOP and SCP.

STR-A Thermal Control.

Configuration of STR-A thermal control as per LEOP time line commenced on DOY 321 at 05:44. The STR-A Thermal control philosophy was the following: maintain STR-A Baseplate temperature at approximately 18°C by keeping STR-A Heater on permanently and exercising active Thermal control of STR-B between 2.5°C and 4.5°C to provide a temperature Gradient between the 2 STR-s, any fine tuning necessary would be carried out by adjusting STR-B thermal control Thresholds.

Unfortunately STR-A temperature increased rapidly well beyond the expected 18°C until at 09:02 STR-A temperatures reached 28°C, at this time STR-A Heater N was switched off manually, by 13:23 UT STR-A temperature had fallen to 12°C and STR-A Heater N was switched back on, this STR-A Heater N switch-off switch-on Sequence was executed 3 more times on Revolution 0, with Heater switch off being executed at a STR baseplate temperature of 22°C, and switch-on at 12°C. STR-A Temperature evolution in Revolution 0 can be seen in Figure 6.1.5-1.

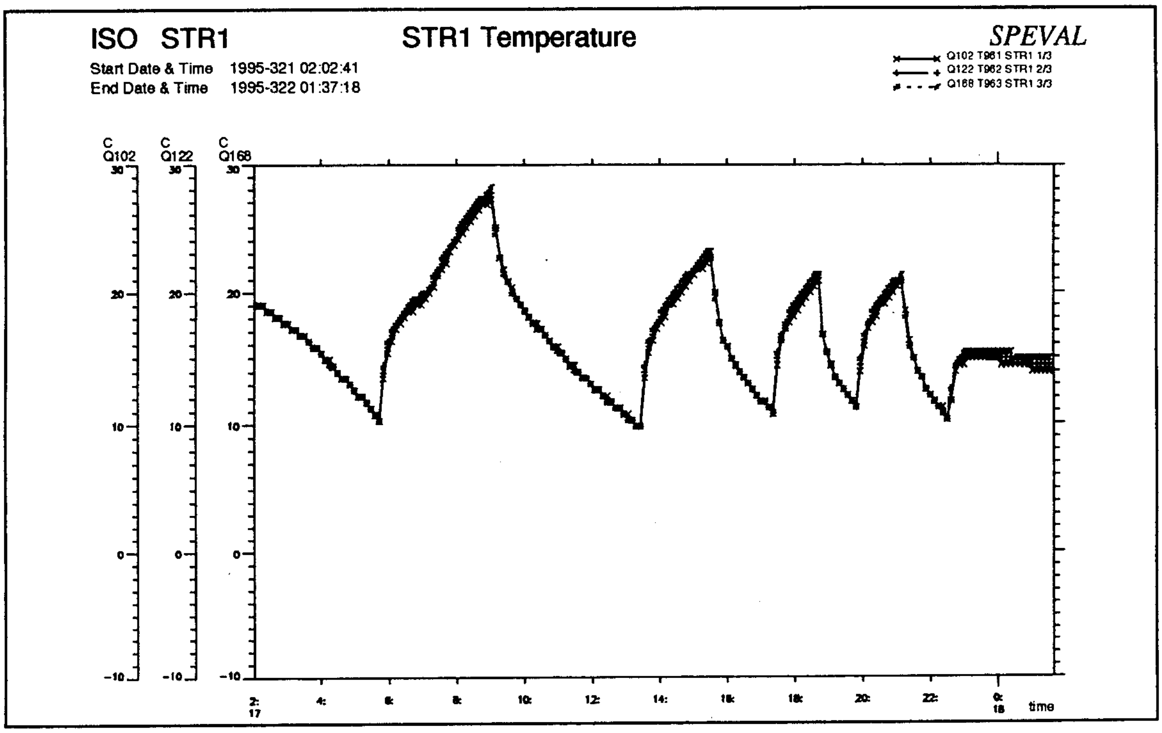


Figure 6.1.5-1: STR-A Baseplate Temperature During Revolution 0.

On Revolution 1 at 10.43 the STR-B thermal control range was reduced to between 0°C and 2.5°C in an attempt to prevent the rapid heating of STR-A, unfortunately this had little effect and the STR-A Heater N switch-off switch-on Sequence was executed 2 more times on Revolution 1, with Heater switch off being executed at a STR baseplate temperature of 22°C, and switch-on at 12°C. STR-A Temperature evolution in Revolution 1 can be seen in Figure 6.1.5-2.

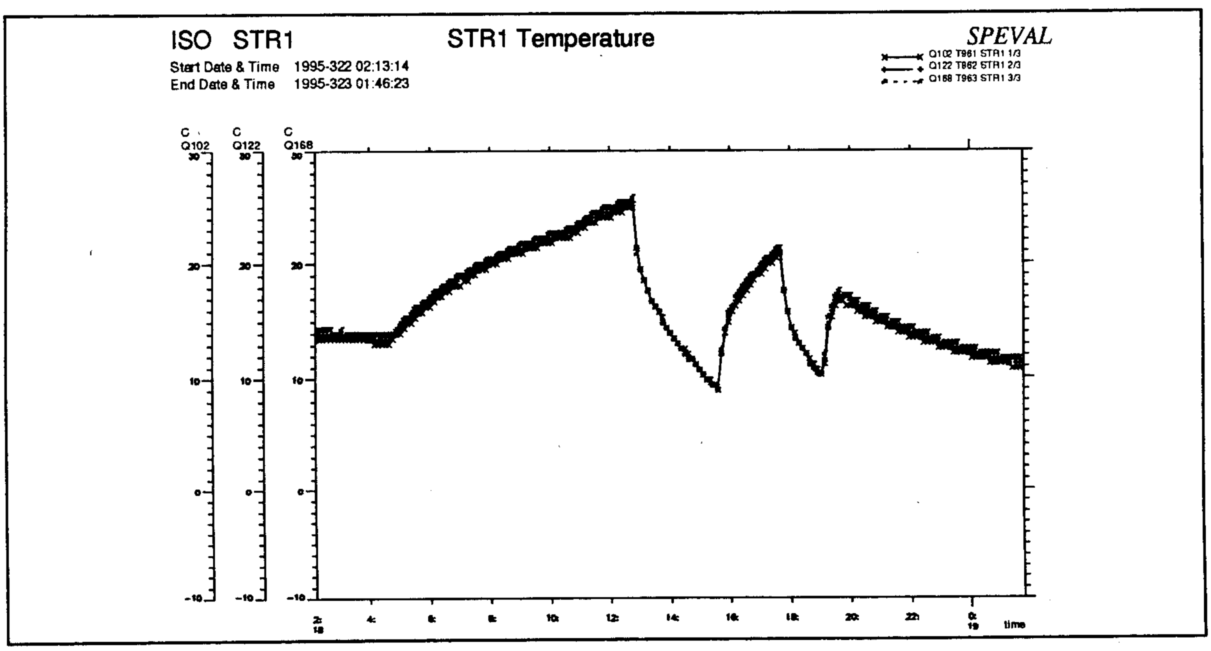


Figure 6.1.5-2: STR-A Baseplate Temperature During Revolution 1.

On Revolution 2 STR-A Temperatures started to stabilise after one STR-A Heater N switch-off switch-on Sequence was executed. Towards the end of Revolution 2 Temperatures stabilised at approximately 23°C, they remained stable throughout Revolution 3. STR-A Temperature evolution in Revolutions 2 and 3 can be seen in Figure 6.1.5-3.

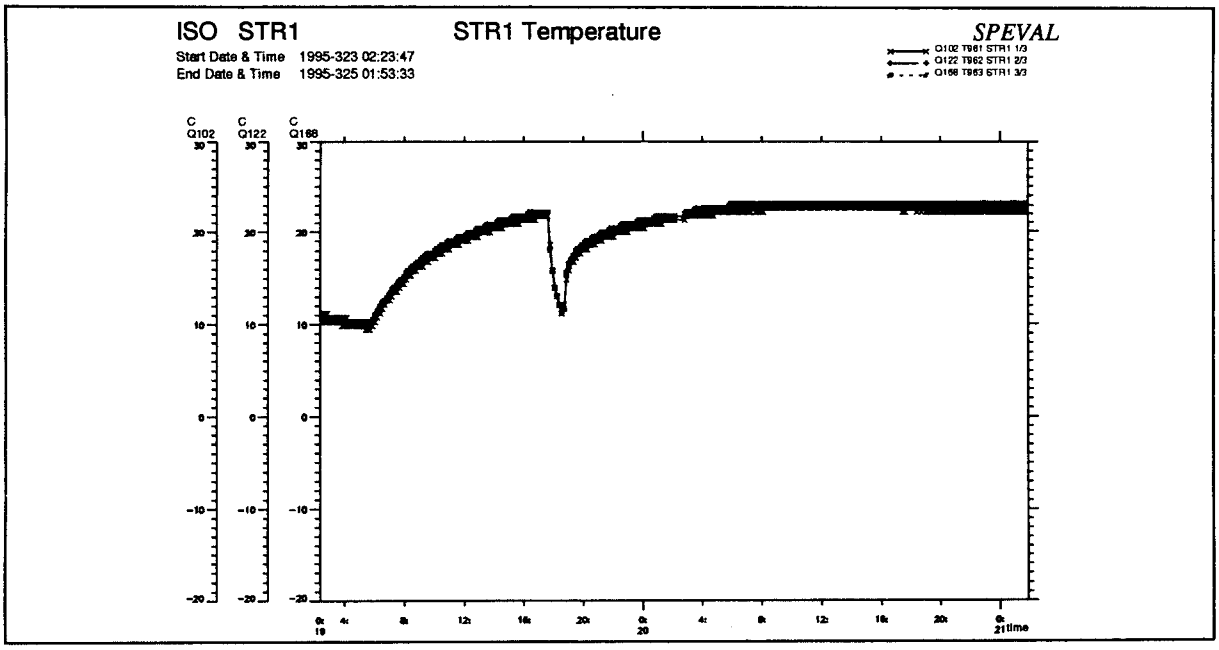


Figure 6.1.5-3: STR-A Baseplate Temperature During Revolutions 2 and 3.

The strategy used for control of STR-A temperature at this point was to leave STR-A heater N on, unless STR-A Baseplate Temperatures rose to 25°C. In the second part of Revolution 4 STR-A Baseplate temperature started to increase, at 20.10 STR-A Heater N was switched off, from this time on the STR-A Heater N switch-off switch-on Sequence had to be repeated every 5 hours approximately. On DOY 326 at 17.40 the STR-B Thermal Control range was reduced to between -9°C and -7°C, in an attempt to provide a greater cooling effect on STR-A Baseplate Temperatures, unfortunately this once again had little effect. Also it was becoming apparent that with such a high Baseplate Temperature the STR-A CCD temperature could not be reduced to its operating temperature of -40°. STR-A Temperature evolution in Revolution 4 can be seen in Figure 6.1.5-4.

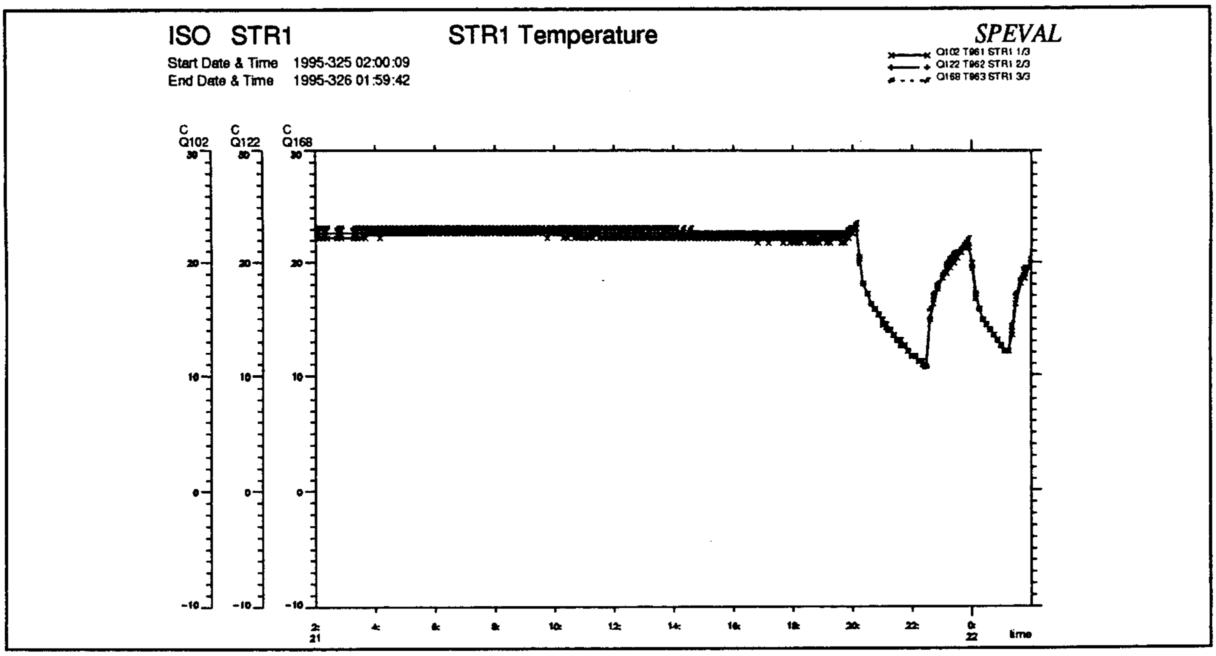


Figure 6.1.5-4: STR-A Baseplate Temperature During Revolution 4.

On DOY 327 [Revolution 6] at 02.00 the STR-B Thermal control Range was further reduced to between -15°C and -13°C, once again this had no noticeable effect on STR-A Baseplate Temperature. On DOY 327 it was decided to implement a different Thermal control strategy for STR-A Baseplate; STR-A Heater N would be left OFF and STR-B thermal control limits would be increased to 18°C to 20°C to provide a warming influence on STR-A baseplate, i.e. the Temperature Gradient would be reversed. This should lead to a stable STR-A baseplate Temperature of approximately -8°C to -10°C. The new Thermal Control was implemented at 17.50, STR-A Baseplate Temperatures quickly fell to -17°C at which point STR-A Heater was switched back on and then off again at a STR-A Baseplate Temperature of 0°C. This STR-A Heater N switch-off switch-on Sequence had to be repeated one more time before STR-A Baseplate Temperature stabilised at -17°C. STR-A Temperature evolution in Revolutions 6, 7 and 8 can be seen in Figure 6.1.5-5.

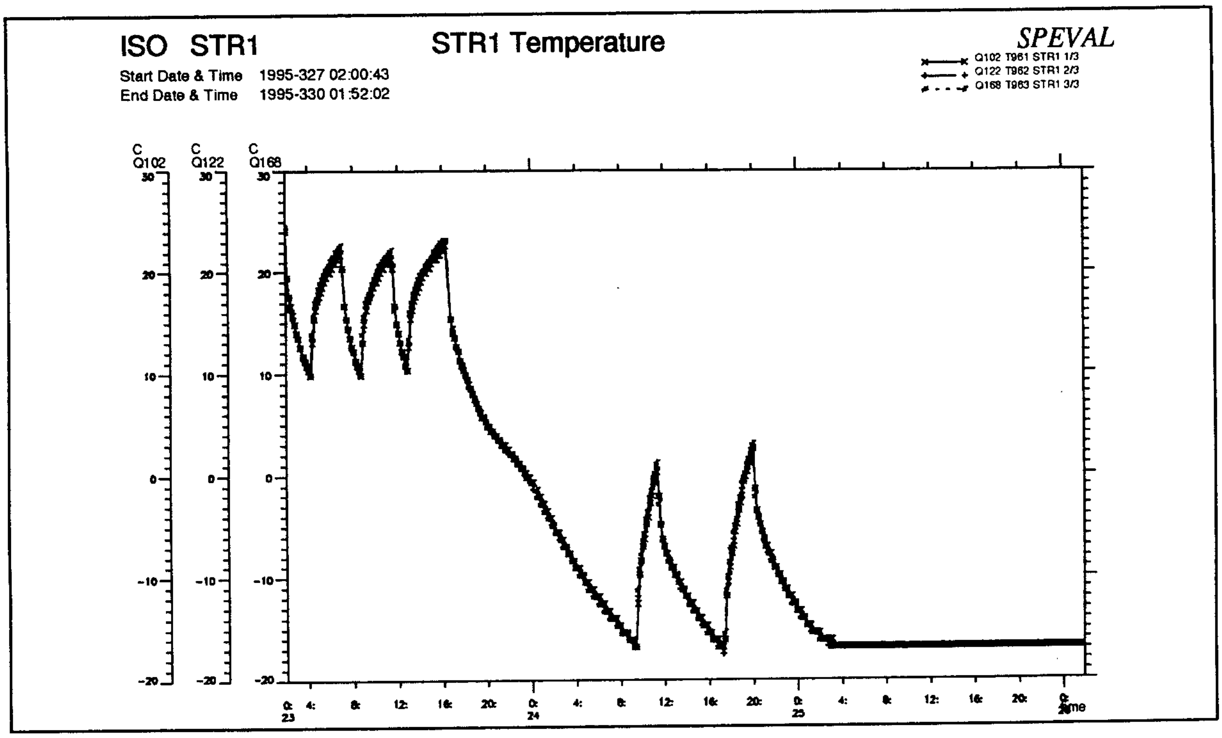


Figure 6.1.5-5: STR-A Baseplate Temperature During Revolutions 6, 7 and 8.

On DOY 331[Revolution 10] at 16.26 STR-B Thermal control limits were increased to between 23°C and 27°C, following this the STR-A Baseplate temperature rose over the next 2 Revolutions eventually stabilising at -9°C, at which value it has remained since. STR-A Temperature evolution in Revolutions 10 and 11 can be seen in Figure 6.1.5-6.

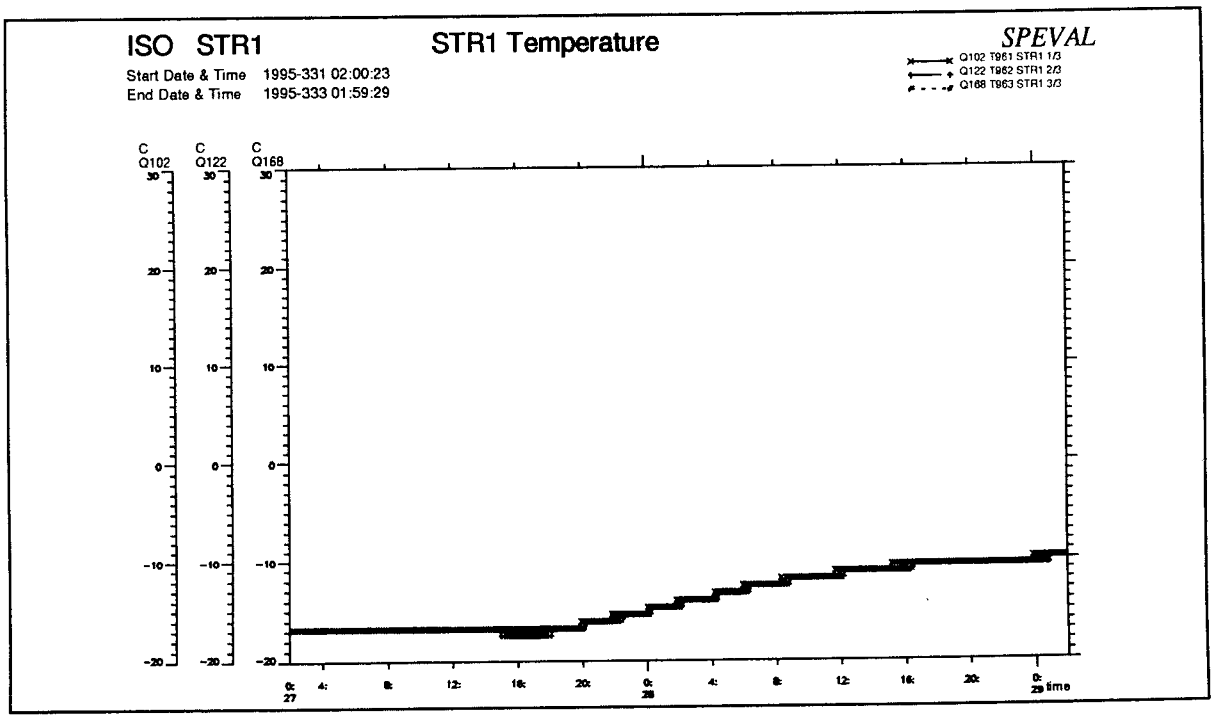


Figure 6.1.5-6: STR-A Baseplate Temperature During Revolutions 10 and 11

An overview of the STR-A Temperature evolution during the first 12 Revolutions can be seen in Figure 6.1.5-7.

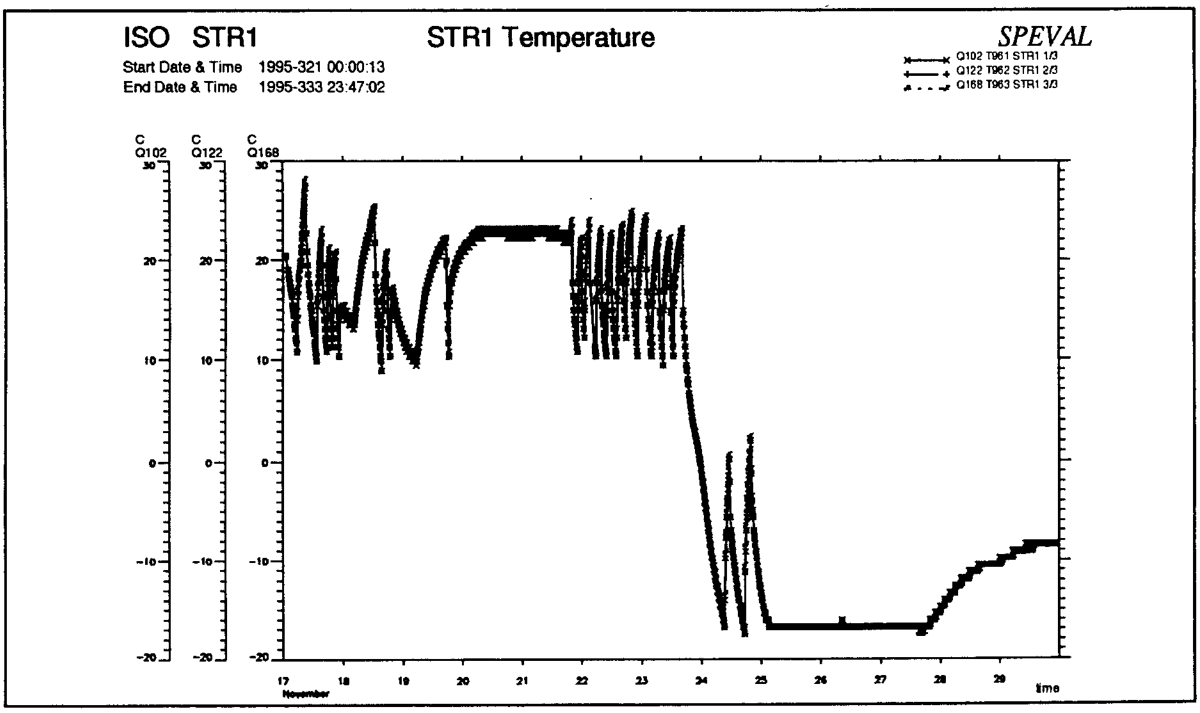


Figure 6.1.5-7: STR-A Baseplate Temperature During Revolutions 0 to 11.

Battery Thermal Control.

At launch Battery external and internal temperatures were between 25 and 30°C, well above their nominal operating level of 0°C. During Revolution 0 Battery temperature fell to approximately -5°C. additionally due to its initially very high temperature Battery 1 was unable to reach End of Charge on Revolution 0 - see PCS section 6.1.4.

During Revolution 1 the Batteries cooled further reaching a low of -6°C [Internally -8°C]. At 01.26 UT on DOY 323 shortly before the end of Revolution 1 Thermal Process 4 [Battery 1] was disabled to prevent a possible THS Re-configuration as Battery 1 external temperatures were approaching their Critical Limit of -8°C [Temperature at which OBDH Software assumes a Heater Failure].

During Revolution 2 Battery 1 Temperature remained close to its critical limit until at 15.29 on DOY 323 the Redundant Battery 1 Heater was switched on in parallel to the Nominal Battery 1 Heater [under on-board Thermal control]. following this Battery 1 temperature increased by about 4°C until at 20.03 Process 4 could be re-enabled. Meanwhile however Battery 2 temperature continued to fall slowly and at 15.42 THC process 17 [Battery 2] was disabled as a precautionary measure, to prevent any Re-configuration.

On DOY 328 at 21.17 Thermal Process 17 [Battery 2] was re-enabled, once it became clear that Battery 2 temperatures would remain safely above the Heater process critical limit during normal operations. A summary of Battery 1 and 2 External Temperatures during the first three Revolutions can be seen in Figure 6.1.5-8.

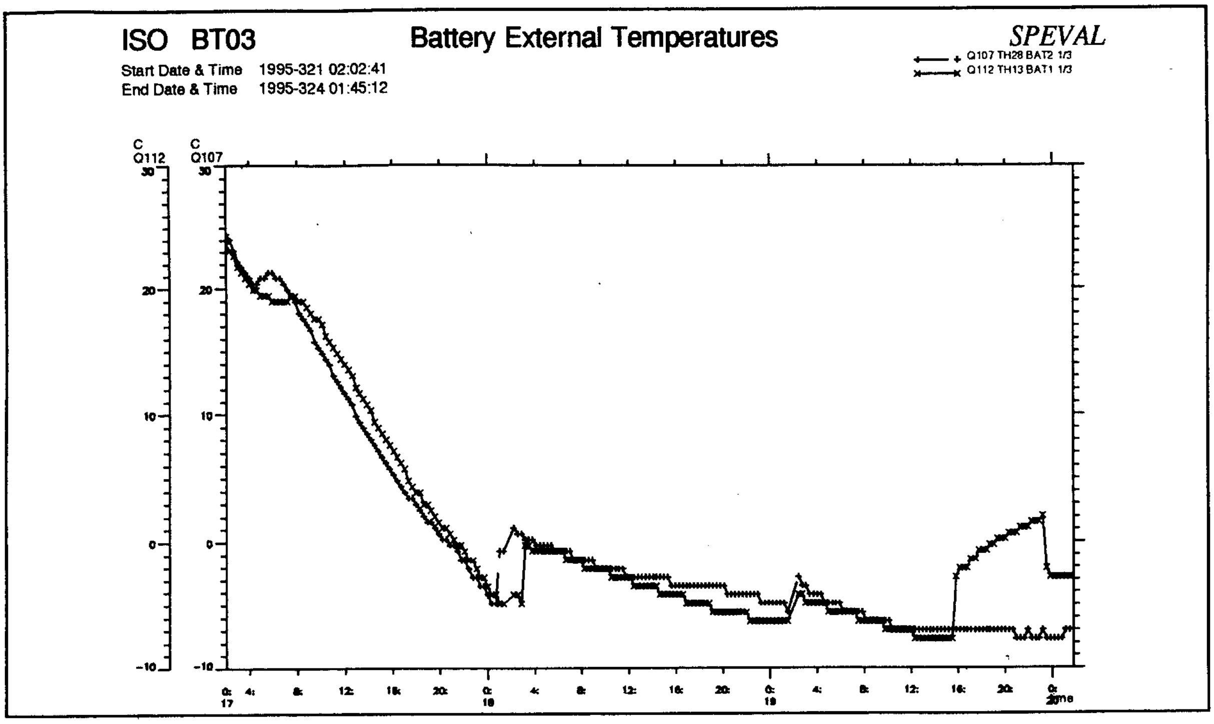


Figure 6.1.5-8: Battery 1 and 2 External Temperatures, REV's 0, 1 and 2.

6.2 Payload Module [PLM] Subsystems

Similar to the SVM subsystems, all nominal modes of the PLM have been successfully verified.

There is no indication that the Telescope is defocussed or suffers from aberrations.

The performance of the four scientific instruments was nominal wrt functionality of the hardware and software.

6.2.1 CRYO

The cooldown phase was determined well in line with the Thermal Model [adjusted to actual launch conditions]. The estimated Helium-II flow rate is well within limits leading to an anticipated lifetime of 24 +/- 2 months, compared with the baseline of 18 months. Direct Liquid Content Measurements [DLCM] are required to determine the remaining He-II mass and to determine the actual mass flow rate and hence, the lifetime. Table 6.2.1 shows the Cryo performance data.

The fluctuations of Phase Separator temperature gradient which was observed during LEOP have disappeared.

The Helium-II bath equilibrium is predicted to take place between 30 to 40 days after on-orbit operations, i.e. well within performance predictions.

Table 6.2.1 **Cryo Performance Data at end of SCP**

	UNITS	IN-ORBIT	SPEC.
He-II Bath	Deg. K	1.724	1.7 to 1.9
He-II Mass Flow Rate	mg/sec	~ 5	< 6
Optical Support Structure	Deg. K	2.8	2.4 to 3.4
Cryostat Vacuum Vessel	Deg. K	115	120

Cryo Operations.

Four crucial operations were carried out on the Cryo-Subsystem during the LEOP and SCP phases:

1. Valve Openings during Launch, commanded by Ariane 4 and at separation.
2. Sun-shade Heating.
3. Cryo-cover Ejection.
4. Closure of HeII Venting Valves.

Autonomous Valve Opening Operations during Launch / Separation.

On Ground the ISO payload was cooled using the Auxiliary He-I Tank, the He-II tank remained sealed, prior to launch it was necessary to drain the He-I Tank and close the exit Valves. One hour and 30 minutes before launch the draining of the He-I tank began, the operation was successfully completed one hour and five minutes later. To ensure as complete an evacuation as possible from the He-I Tank it was heated using a 650 W Heater to a Temperature of about 30 K.

During the Ariane 4 Flight at Fairing Jettisoning commands were issued by Ariane 4 to open valves V501, V503 - the low flow rate venting Valves, at Separation from Ariane the OBDH transition from Launch to Housekeeping Mode issued commands to open Valves V103, V106 to start the flow of HeII from the Tank - as well as commands to confirm the status of V501, V503.

The success or otherwise of the autonomous valve switchings commands issued prior to First AOS can best be determined by monitoring the Temperature drop across the Passive phase Separator [PPS], prior to launch there was no Temperature drop as the HeII Flow Rate was zero, at first AOS a significant change in Temperatures could be observed, indicating that the commands had been correctly issued and had executed successfully.

The change in Cryo Temperatures Downstream of the PPS between Launch and First AOS can be seen in Figure 6.2.1-1.

Shortly after First AOS the valve opening Commands were resent from Ground to confirm the valves open statuses.

Some time after AOS it became apparent that the behaviour of the PPS was not completely stable, in fact there appeared to be 2 modes of operation which switched suddenly from one to the other. The first Mode observed after first AOS in which the Temperature drop across the PPS was of the order of 80 mK, the Second Mode was first observed at approximately 03:40 when the Temperature drop across the PPS suddenly dropped to between 15 and 25 mK, indicating a slow-down in the HeII flow rate through the PPS -see Figure 6.2.1-1.

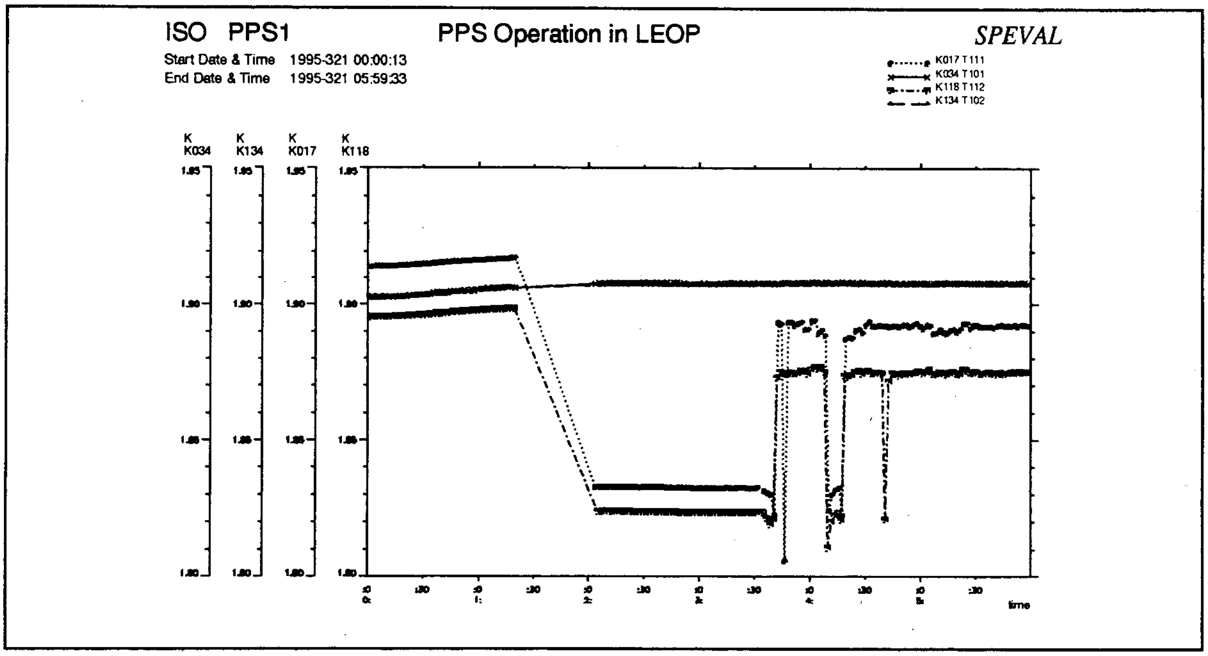


Figure 6.2.1-1: PPS Temperatures prior to Launch and post First AOS.

After some investigation it was discovered that most of these events - except the first two - could be correlated to Spacecraft Manoeuvres, in effect the He-II tank was acting as a giant Accelerometer!, these events continued to occur throughout the LEOP although their frequency diminished after the first Revolution - see Figure 6.2.1-2, the first two of these events were possibly caused by small Bubbles in the He-II.

The PPS behaved nominally throughout the He-II venting Phase, as can be seen in Figure 6.2.1-1. The switches in operating Mode were too infrequent and of too short a duration to have any significant effect on the Cryogenic Subsystem Temperatures.

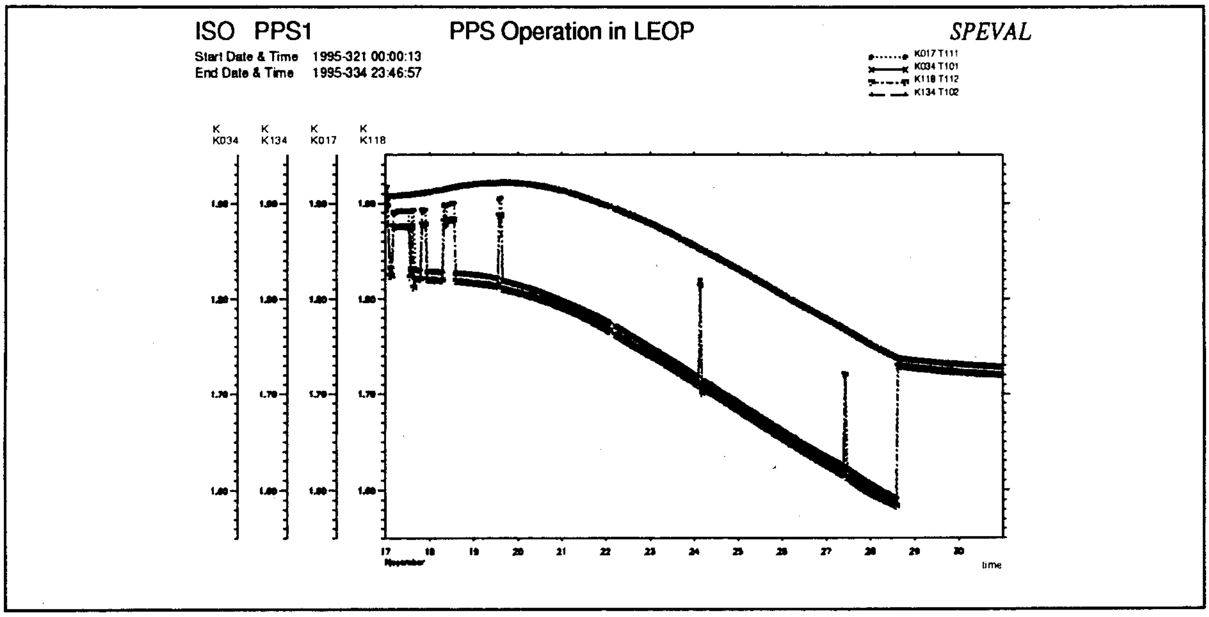


Figure 6.2.1-2: PPS behaviour throughout LEOP.

Sun-shade Heating.

The Sun-shade is equipped with a 20 W Heater which was used post Separation to slow down the rate of cooling of the Sun-shade, the purpose of this is to 'clean' the Sunshade of any contaminants which could enter the Telescope post Cryo-cover ejection.

The Sun-shade Heater was switched on one hour thirty four minutes after first AOS [DOY 321 03:21]. At Sun-shade Heater switch-on an increase in the Cryo Electronics power consumption of approximately 0.7 A was expected, in fact the observed increase was slightly less than 0.6 A [see Figure 6.2.1-3], after a short consultation with Project it was decided that the Heater power was sufficient and no reconfiguration should be made.

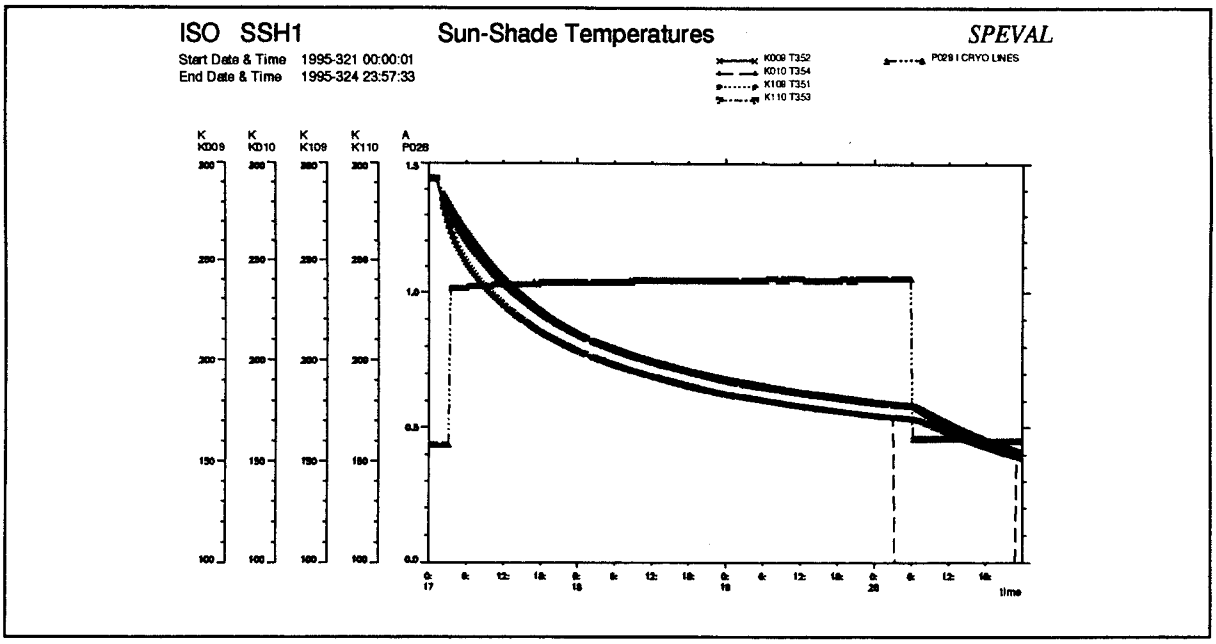


Figure 6.2.1-3: Sun-shade Heating.

Sun-shade Heating was terminated nominally on day 324 at 05:55, the evolution of the Sun-shade Temperatures towards a steady state can be seen in Figure 6.2.1-4.

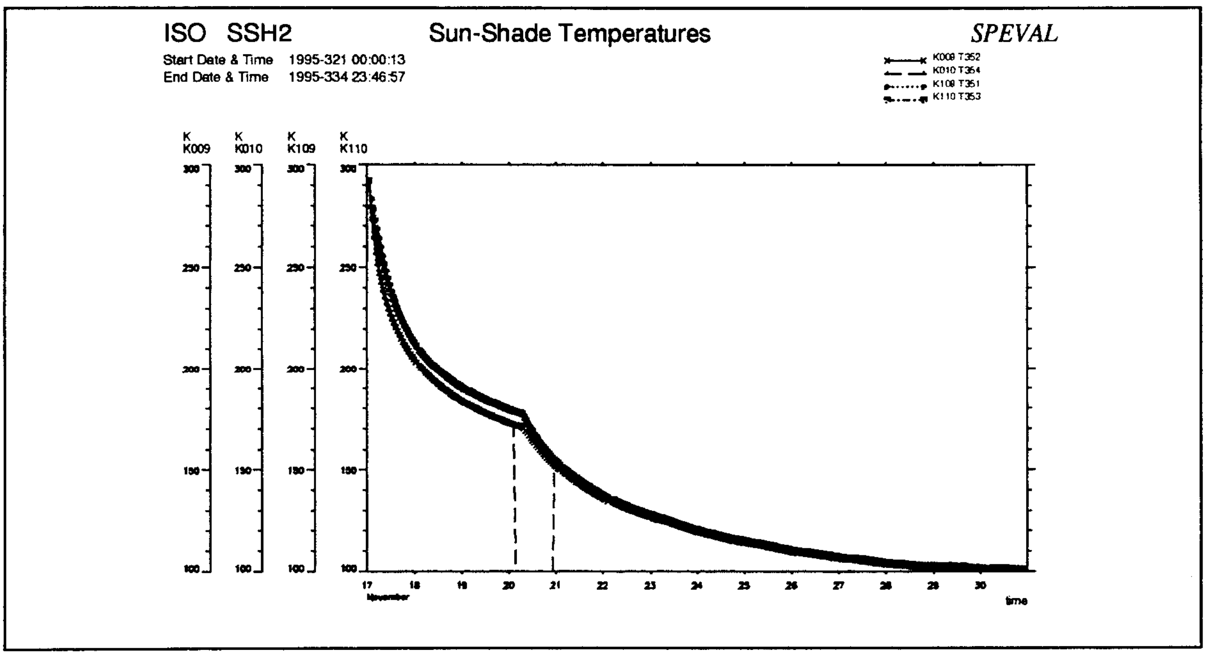


Figure 6.2.1-4: Evolution of Sun-shade Temperatures during LEOP.

Cryo-cover Ejection.

The Cryo-cover Ejection took place on DOY 331 at 10:27, immediately following the Cryo-cover Ejection a slew from a SAA=65° to SAA=95° was commanded to reduce the chance of reflected Sunlight from the free-flying Cryo-cover entering the Telescope. Since no direct Telemetry Confirmation of the Cryo-cover eject status was available, secondary means had to be used: i.e. Change in Gyro rates and change in Telescope Baffle Temperatures [Note that due to the danger of reflected Sunlight from the Cryo-cover post ejection it would not have been possible to use one of the scientific instruments for this purpose]. Immediately following uplink of the Cryo-cover Ejection Command the Gyro rates were monitored [the spring which ensures a clean release and separation of the Cryo-cover was powerful enough to provide a significant disturbance torque], once a significant change in the Gyro rates occurred the Slew command was uplinked. The evolution of the SAA before during and after the Cryo-cover release can be seen in Figure 6.2.1-5.

Secondary confirmation of Cryo-cover release came within 5 minutes from significant changes in Telescope Upper and lower Baffle Temperatures, these can be seen in Figures 6.2.1-5 and 6.2.1-6, respectively.

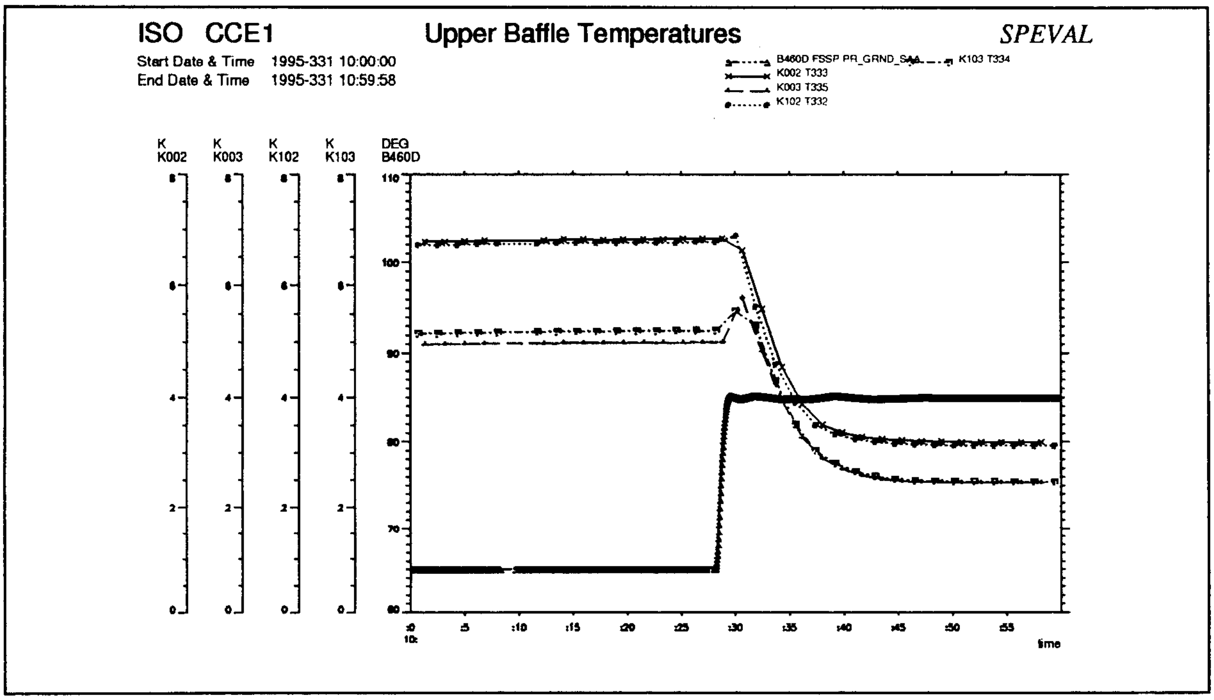


Figure 6.2.1-5: Solar Aspect Angle and Upper Telescope Baffle Temperatures during Cryo-cover release.

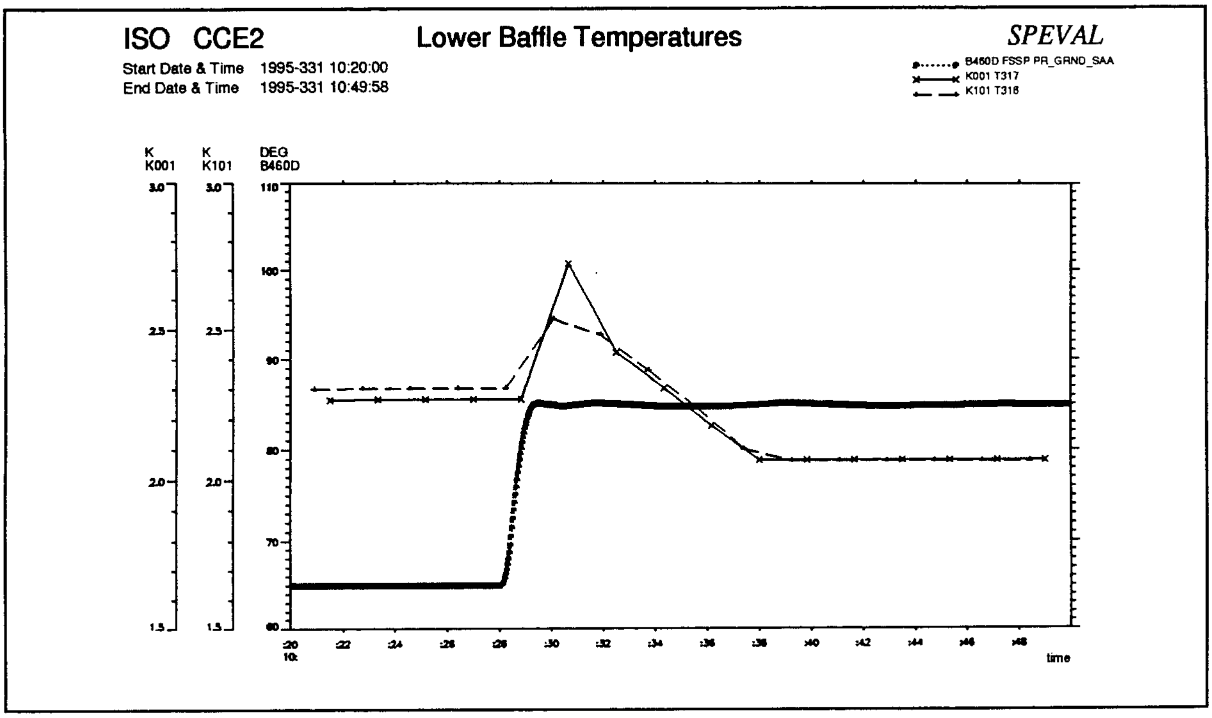


Figure 6.2.1-6: Solar Aspect Angle and Lower Telescope Baffle Temperatures during Cryo-cover release.

Closure of He-II Venting Valves.

Following the initial cool down of the Cryo, and Cryo-cover release, the HeII Flow rate was reduced by closing the venting Valves V504 and V505, this tookplace on DOY 332 at 14:30. Once again no direct confirmation of valve statuses was available in telemetry and the control team had to rely on secondary means to confirm valves closed statuses. At venting Valves closure the Temperature drop across the PPS reduced sharply due to the decreased Flow rate see Figure 6.2.1-7.

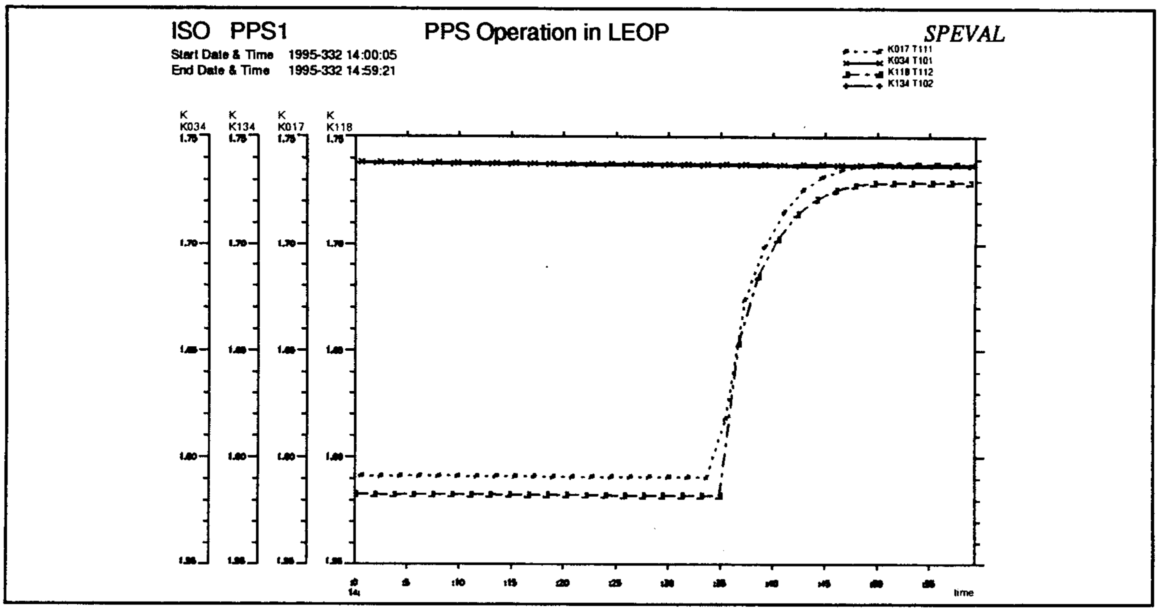


Figure 6.2.1-7: PPS Behaviour at Venting Valves closure.

Similarly a sharp increase in the internal pressure of the He-II System was noted as well as a more gradual increase in the He-II Vent Temperature, see Figure 6.2.1-8.

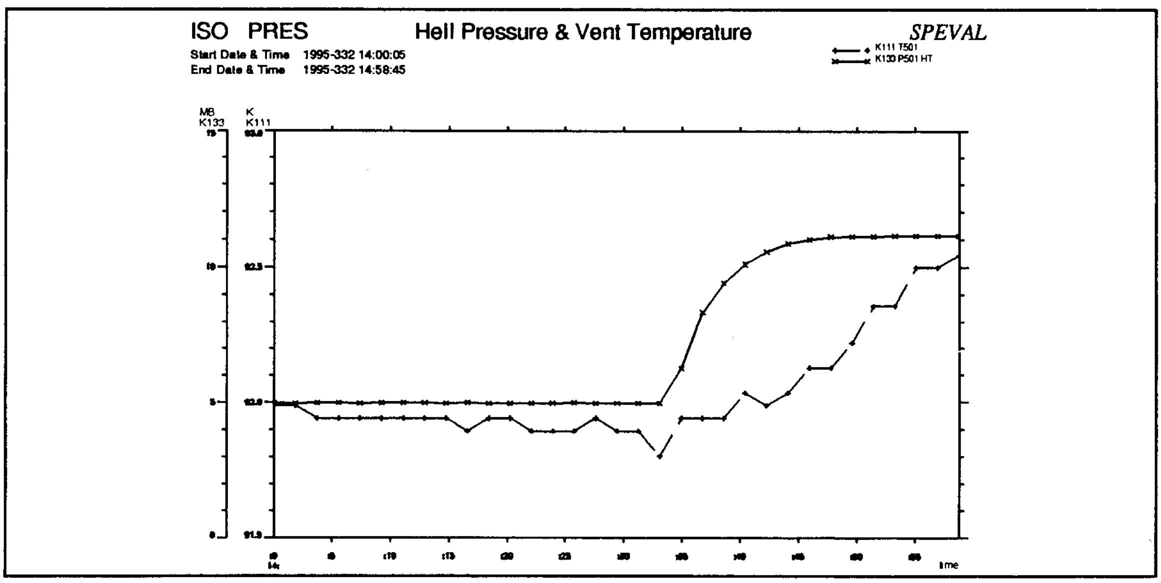


Figure 6.2.1-8: He-II system Internal pressure and Nozzle Temperature at Venting Valves closure.

6.2.2 PHT Instrument

PHT was the first of ISO's four scientific instruments to be switched on. **The initial switch on of PHT** took place on 951121 [REV-4] at 09:56:16 [+ 28 Volt[N] ON], soon after the Transfer of ISO operations from ESOC/OCC to VILSPA/SCC had been completed. Due to the fact that the Optical Support Structure [OSS] temperature was still too low at 2.014 K vice 2.4 K to 3.2 K under nominal conditions, some instrument temperatures were out of limits, i.e. FCS1_TMP , FCS2_TMP, P1_TMP, P2_TMP, S1_TMP and S2_TMP. This was not considered a problem. As part of the manual instrument activation procedure, the PHT RAM patch was uplinked at 10:04. Upon completion of the activation, the Wheel Commissioning Procedures commenced as planned and were completed for wheel#1 and wheel#2 successfully.

Another RAM patch [PF_02.MPS] uplinked at 12:57 was found to be out of date. To clear the RAM, the relevant Instrument Flight Operations Plan [IFOP] Contingency Procedure requires an instrument OFF/ON to be executed. The relevant commands were uplinked at 14:25 [PHT=OFF] and at 14:31 [PHT = ON], respectively. A new look-up table was provided and installed as RAM patch. The corrected RAM patch was uplinked at 14:20. The latter was verified and found to be correct. The incorrect RAM patch [out of date] was removed from the SOC library and the anomaly closed [SOC responsibility].

PHT Wheel Commissioning was successfully completed in REV-4.

Before the PHT activities begun in REV-5, two RAM patches [PHT_02.RAM and PHT_03.RAM] were imported onto ISORT at 04:55. The check-sums were verified by Software Support at 05:04. At 08:15 another PHT RAM patch [PHT_03.RAM] was imported and the check-sum verified.

PHT Check-Out was conducted successfully in REV-5, indicating nominal instrument behaviour. A slightly higher S/N ratio was observed on detectors C100 and C200, respectively. As in REV-4, the OSS temperature was still low and subsequently, the above quoted temperature parameters were again out of limits.

PHT Detector Curing was performed in REV's 6, 7, 8, and 9. The results of the detector curing were built into a new version of the automatic instrument activation sequence and delivered from SOC to SCC for subsequent installation and use in Mission Planning Phase-2 [MPP2]. At the end of detector curing in REV-9, PHT was put in a safe configuration to prevent possible Sun reflections [flash] from the cover during ejection.

PHT Curing Verification took place in REV's 12, 13, 18, 19 and 20.

The **OSS Temperature** was within limits as of REV-12.

PHT Focal Plane Geometry [FPG] Calibration was conducted in REV's 12, 17, 18, 19, 20 and 21. The PHT FPG offsets were determined and delivered to Flight Dynamics for installation in the data files [for details refer to section 4.5].

PHT was used as **PRIME** instrument in REV's 4 to 9, 12, 13, and 17 to 21.

6.2.3 CAM Instrument

CAM was the second of ISO's four scientific instrument to be switched on. **The initial switch-on of CAM** took place on 951124 [REV-7] at 08:41:28 [+28 Volt [N] ON]. At switch on the OSS temperature was still 0.6 K below its lower limit of 2.4 K, but this was not considered to be a problem. Soon after switch-on, and while **CAM Check-Out** was in progress, **column 24 was reported missing** in the Long Wavelength [LW] detector array. This **anomaly** was anticipated and confirmed the results during Thermal Vacuum [TV]/ Thermal Balance [TB] testing on ground [for details refer to section 6.4, ISO-ANO-0005]. A further anomaly occurred when the **CAM Spare Task failed to execute** during check-out. This was traced to an incorrect MPS to RAM patch conversion with respect to memory address locations. Details of this anomaly are recorded in ISO-ANO-0006 [see section 6.4]. Besides of the two anomalies, **CAM Check-out** was successfully completed in REV-7, showing an excellent instrument behaviour. The implications of the missing column 24 for the mission are to be evaluated.

CAM was put in a safe configuration in REV-8 [between 20:28 and 20:43] on request of the CIDT, in order to prevent possible Sun reflections [flash] from the cover during ejection.

CAM Calibration De-activation was conducted along REV-11, the first revolution without presence of the cryo cover. The objective was to validate the strategy of dark current measurements and flat field calibrations, as being implemented in the automatic de-activation sequences of the Central Command Schedule [CCS]. A series of six dark current measurements and flat field exposures were taken at various points along the revolution. Only small variations were observed, i.e. the de-activation strategy was confirmed.

A major highlight in REV-11 [~15:00] was the first image taken with CAM. Images of the **Whirlpool Galaxy [M51]** were acquired at two wavelengths, and the quick look images available in near real-time were viewed with great excitement by all involved in the mission.

CAM Solar System Objects [SSO] Tracking was successfully demonstrated in REV-15 for fast moving objects [~100 arcsec/hour] and slow moving objects [~30 arcsec/hour]. The tracking accuracy was determined to be ~2 arcsec.

CAM Detector Transients Measurements were conducted in REV-16.

CAM Focal Plane Geometry [FPG] Calibration was executed entirely per CCS in REV's 14, 16 and 21, i.e. without manual intervention by MOD/AOCS engineers, as it was required for the PHT and SWS instruments. The CAM FPG calibration offsets were delivered to Flight Dynamics and the relevant parameters updated in the data files [for details refer to section 4.5].

CAM was used as **PRIME** instrument in REV's 7, 8, 11, 13 to 16 and 21, and in **CAM Parallel Mode** in REV's 12 to 14 and 18 to 20.

6.2.4 LWS Instrument

LWS was the third of ISO's four scientific instrument to be switched on. **The initial switch-on of LWS** took place on 951125 [REV-8] at 08:42:15 [+28 Volt [N] ON]. At switch on the OSS temperature was still 0.6 K below its lower limit of 2.4 K, but this was not considered a problem. **LWS Check-out [Part-1]** was successfully terminated. On special request of LIDT, the instrument was put in stand-by mode from 20:18 to 01:35, in order to monitor the instrument performance wrt "glitches" [particle radiation] beyond the established end of measurement altitude of 43.215 Kms [perigee crossing -3.75 hours]. Increase of "glitches" was observed around 00:35, corresponding to an altitude of 30.000 Kms. At this stage LWS was still generating good data. The instrument was deactivated at 01:35 [altitude of 23.000 Kms].

Part-2 of LWS check-out was successfully completed in REV-11, i.e. to complete the activities, check-out was spread over two revolutions.

LWS Detector Curing was performed in REV-8 and REV-11 using part of the check-out procedure. An additional curing was performed in REV-12, using the Calibration Observation Interface File [COIF] of the SOC. Curing was successfully from the functional point of view. Detector memory effects from glitches [cosmic rays] require optimisation of bias voltages.

LWS Focal Plane Geometry [FPG] Calibration was executed entirely per CCS in REV's 14 and 21, i.e. without manual intervention by MOD/AOCS engineers, as it was required for the PHT and SWS instruments. The LWS FPG calibration offsets were delivered to Flight Dynamics and the relevant parameters updated in the data files [for details refer to section 4.5].

LWS was used as **PRIME** instrument in REV's 8, 11 to 14 and 21.

6.2.5 SWS Instrument

SWS was the last of ISO's four scientific instrument to be switched on. **The initial switch-on of SWS** took place on 951126 [REV-9] at 08:08:28 [+28 Volt [N] ON]. At switch on the OSS temperature was still 0.7 K below its lower limit of 2.4 K, but this was not considered to be a problem.

SWS Check-out was successfully completed in REV-9 as per check-out procedure provided by Project. At the end of the check-out, SWS was put in a safe configuration to prevent possible Sun reflections [flash] from cryo cover during ejection.

SWS Detectors Performance Evaluation was performed in REV's 9, 13, 14 and 17 to 21. All detectors worked nominal from the functional point of view. Some of the detectors are affected by "glitches" from particle radiation.

SWS Detector Curing was performed in REV-12 and REV-14, respectively.

SWS Fabry-Perot Parallelisation [FP//] of the Long Wavelength [LW] Interferometer and of the Short Wavelength [SW] Interferometer was successfully performed in REV's 9, 11, 12 and 17. The SOC provided IFOP procedure was used for the FP// activities.

SWS Focal Plane Geometry [FPG] Calibration was executed in a semi-automatic mode, i.e. partially driven by the CCS, but interleaved with manual command activities [acquisition of 5 stars in the STR restricted Search and Tracking mode] by MOD's AOCS engineer. FPG calibrations were conducted in REV's 12, 14 and 17 to 20. The SWS FPG calibration offsets were delivered to Flight Dynamics and the relevant parameters updated in the data files [for details refer to section 4.5].

SWS was used as **PRIME** instrument in REV's 9, 11 to 14 and 17 to 21.

6.3 Budget of Consumables

6.3.1 Helium-II

During the last He-II top-up operation before launch, the Cryostat tank was filled up to 99% level, corresponding to 331 Kg of Helium-II. Since no Direct Liquid Content Measurement [DLCM] was performed during LEOP and SCP, nothing specific can be said about He-II consumption, beside observations made in telemetry on the evolution of temperature and pressure data, that confirmed proper cryostat behaviour on-orbit.

6.3.2 Hydrazine

At launch, 100 Kg of Hydrazine [N2H4] were loaded in the tank. The evolution of the hydrazine consumption from launch up to the end of the Satellite Commissioning Phase [REV-21 - 951208/09] can be depicted in Table 6.3.2, below.

The mass of fuel before a manoeuvre is estimated from hydrazine tank pressure and temperature. This estimation is accurate to within +/- 0.8 kg, due to the fluctuations in the measurements of temperature and pressure.

The mass of fuel being used is based on predictions for mass flow rate, duration of the manoeuvre, blow down effects, thruster characteristics and regime, etc... These predictions are much more accurate.

The difference in mass between the end of a manoeuvre and the start of the next one corresponds to the de-saturation/momentum biasing of the reaction wheels, which occurred two to three times per revolution.

TABLE 6.3.2 Hydrazine Mass Budget

DATE	EVENT	Fuel Mass before Event	Fuel Mass used	Fuel mass remaining
95.321.01.20	Launch	100.000	n/a	100.000
95.321.01.45	Init. Sun Acquisition	100.000	0.200	99.800
95.322.13.44	Delta-V Rehearsal	99.800	2.005	97.795
95.323.13.10	Main Delta-V [Perigee raising]	97.795	34.905	62.890
95.328.02.50	Delta-V [Apogee lowering]	62.890	9.928	52.962
95.343.03.06	RWL Wheel Biasing	52.962	0.250	52.712

Note: All mass figures are given in Kg.

6.4 Summary of Satellite Anomaly Reports

Table 6.4 shows the satellite anomalies that did occur during LEOP and SCP. A brief discussion about each individual anomaly is given below.

Table 6.4 - ISO ANOMALY SUMMARY

No.	TITLE	DATE/TIME	STATUS
ANO-0001	RCS LV-2 Unexpected Status	951117-02:01:28	Closed
ANO-0002	Gyro-2 Temperature OOL-High	951117-02:07:46	Closed
ANO-0003	Thermistor T354 malfunction	951120-03:05:22	Closed
ANO-0004	STR CCD Temperature OOL-High	951117-07:03:00	Closed
ANO-0005	CAM Column 24 missing [LW-Det.]	951124-08:32:00	Closed
ANO-0006	CAM Spare Task not executing	951124-08:32:00	Closed

Anomaly-1 [Latch Valve-2 = CLOSED] was observed at initial AOS Perth and is explained as follows: The condition was in fact nominal. The reason was that the FCT was not aware as to whether a special patch in the OBDH was implemented which would safeguard against RCS open failures at separation. As it turned out, the prime contractor had decided not to implement this patch. Thus, the default RCS redundancy management was activated at separation. This function checks the expected status and if it is not in accordance with the expectation, the application software [ASW] of the AOCS/ACC will autonomously restore the expected status, i.e. command LV-2 = CLOSED.

Anomaly-2 [Gyro-2 Temperature Out of limits - HIGH] was observed shortly after initial AOS, when the " SOFT "operating limit of 74.00 deg.C was intermittently exceeded, and toggling between 74.71 and 75.57 deg. C. The manufacturer explained this as being partially due to a temperature overshoot after de-pressurisation and due to overcompensation of the raw telemetry data. It was recommended to increase the upper limit of parameter A142 [Gyro-2 TMP] to 78.0 deg.C [soft] and 79.0 deg. C [hard], respectively. The change became effective on 951212, when an updated satellite database was put on-line on the IDCS [ISORT].

Anomaly-3 [Thermistor T354 malfunction] was observed during REV-3 [951120], when a sudden temperature decrease from 171 K to 84.8 K took place at 03:05:22. The relevant TM parameter is K010 [Sun Shade Base -Z Temperature]. The other three thermistors monitored through parameters K009, K109 and K110, respectively, indicated the expected temperature of 171 K. After the Sun Shade Heater-1 was switched off at 05:55:44 on 951120, thermistor T354 recovered at 22:49:33.

Anomaly-4 [STR-A CCD Temperature OOL-HIGH] was observed shortly after the initial switch on was commanded at 07:04:34, on 951117. The CCD temperature was expected to reach - 40 °C within ~ 15 minutes, but instead reached only - 25 °C initially, and stabilizing several hours after at - 20 °C. The STR-A baseplate temperature was around 20 °C, at which the STR had been calibrated on ground [ambient temperature]. Following detailed discussions between the Project Support Team and the Flight Control Team, it was agreed to continue present. Indeed, the pointing performance of STR-A was absolutely nominal in all modes of operations. In the course of LEOP and SCP several heater re-configuration changes had been made and the power of the Peltier cooler was increased to its maximum [+ 1.5 Watt]. With the baseplate temperature around 20 °C, the Peltier cooler was not able to decrease the CCD temperature down to - 40 °C. Then the decision was to reverse the dissipation configuration, by switching off the heater of the operating sensor [STR-A], and controlling near 20 °C the non-operating sensor [STR-B]. This was done in several steps, keeping the thermal control process 21 between + 19 and + 21 °C of STR-B. The result was, that the baseplate temperature of STR-A decreased and stabilized at -16.8 °C, close to the critical limit of -18 °C. of process 21, while the CCD temperature of STR-A reached - 40 °C. The temperature threshold of process 21 was then adjusted between + 23 and + 27 °C in an attempt to decrease and stabilize the baseplate of STR-A at approximately - 10 °C. However, a very slow increase towards 0 °C was observed throughout the month of December. To conclude the discussion about this anomaly, further changes have been made in January and a last change on 2 February 96, adjusting the thresholds of process 21 between +21 and +25 °C. Since then the baseplate temperature of STR-A is stable between -9.1 and - 9.8 °C. Although the anomaly is not fully understood, it is believed that:

1. The gas [N2] has not been removed properly from the STR-A casing prior to launch.

2. The thermal control system, which had been adjusted during the last ISO FM Thermal Vacuum [TV] test, does not seem to be able to stabilize the sensor.

Nevertheless, the anomaly had been closed out when the CCD temperature was brought down and stabilized at -40 °C [951127 - REV#10].

Anomaly-5 [CAM column-24 missing] was detected after initial electrical switch on of the instrument on 951125. The problem, i.e. column 24 missing in the Long Wavelength [LW] detector array [32x32 lines/columns] of the CAM instrument was already detected during Thermal Vacuum [TV]/ Thermal Balance [TB] testing [See NCR 1671]. There was much discussion before launch, since the problem is believed to be a bad or broken soldering [steel to brass wire] within the cryo harness, which connects the Focal Plane "Cold Unit" inside the cryostat, with the CAM warm electronics, located in the SVM. In order to fix the problem, a major launch delay would have been resulted. The final decision of the Satellite Acceptance Review [SAR] Board was to launch " as is" and hence, the anomaly was opened/closed at on-orbit detection for record keeping purposes.

Anomaly-6 [CAM Spare Task not executing] was detected after initial switch on of the instrument on 951124 [REV-6], while performing the electrical check out. Step 34 of procedure PR.WE 12439 [CAM SCP] failed to execute both, the RAM patch CAM_2.RAM and the PCS CF 9015. A re-test was scheduled on 951204 [REV-16] which revealed, that the CAM_2.RAM patch did not patch the memory as expected. Subsequent investigations revealed that the origin of the problem was an incorrect translation from MPS to IRAM. An SPR was raised on the above and the anomaly closed.

7 GROUND SEGMENT PERFORMANCE

This section summarizes the performance of the ground segment. In general, the overall performance of the Ground Segment was nominal, although some problems were experienced in the LEOP Stations [PERTH, KOUROU and VIL-2], which caused some minor delays in the execution of the Flight Operations Plan [FOP] Timeline activities. For further details refer to document: **ISO PRE-LAUNCH AND LEOP OM REPORT** [NOD 6.33/951211/OC], dated 11 December 1995.

7.1 Operations Control Centre [OCC]

The OCC was the focal point for the execution of all Spacecraft, Ground Facilities and Flight Dynamics activities under real-time control. During all phases of LEOP the back-up system [LEOPDV] was run in hot standby, processing real-time telemetry data.

Several minor problems were detected with the **SUN workstations** in either the Main Control Room [MCR] or in the Project Support Room [PSR]. All of these were recovered by SCOS-B software support. Most of the problems were subject of existing Software Problem Reports [SPR's] raised during SVT's, Simulations and MRT's. One workstation [121] in the PSR suffered from a hardware fault and was taken off line. A spare workstation [124] was brought into use instead.

One anomaly occurred on the **IDCS Image Display Task**. The ground image did not display the time-tag of an onboard command correctly. This was found to be due to the 72 hours wrap-around of this parameter, which was not interpreted incorrectly for display purposes. However, the command uplinked to the onboard time-tagged buffer did contain the proper time-tag and was correctly uplinked and executed hence, only the display was in error. An SPR was raised.

Apart from above reported problems the IDCS [LEOPRT and LEOPDV] showed an excellent and stable performance throughout LEOP.

The OCC and the PERTH station were officially released from LEOP on 971121 at 09:15, on completion of handover of operations to the Vilspa/SCC.

7.2 LEOP Mission Control

The Flight Operations Plan [FOP] was the committing document for the conduct of all operations. All parts of the FOP, i.e. Mission Timeline, Nominal Flight Control Procedures [FCP's] and Contingency Recovery Procedures [CRP's], were found to be complete and accurate. With the exception of the STR-A CCD Temperature anomaly investigation and discussion, that caused a delay of some 1.5 hours in the FOP Timeline of REV-0. However, the time was recovered afterwards and all Timeline events were executed as planned.

The Flight Dynamics Teams provided all Orbit and Attitude information required to support the mission.

7.3 Dedicated Spacecraft Control Centre [SCC]

Upon transfer of operations from ESOC/OCC to VILSPA/SCC at the beginning of REV-4 [951121], the SCC took over full responsibility and was the focal point during the SCP for the execution of all Spacecraft, Payload, Ground Facilities and Flight Dynamics activities under real-time control. During all phases of the SCP the back-up system [ISODV] was run in cold standby. With the exception of the problems identified below, the SCC performance was nominal.

Two malfunctioning **INTEL workstations** [W/S-6 and W/S-7] of the Project Support Room [PSR] caused the IDCS TM receiver on ISORT to stop on 951121 at 22:55 [REV-4], and twice at 09:31 and 10:09, respectively on 951127 [REV-10], due to IDCS TM buffer manager overflow. The IDCS TM receiver was re-started by Software Support.

Two **SUN workstations** became frozen in the Dedicated Control Room [SCC/DCR] on 951206 at 11:48, and in the SOC/DCR at 21:44. The SCC w/s [120] was recovered after the Computer Operator re-booted the w/s. The SOC w/s [124] problem caused the IDCS TM receiver to stop [see above].

During the first ground station handover from Vilspa to Goldstone [REV-4] it was realized that when 32 Kbps Science telemetry is selected, it is impossible to have one TM stream connected to the **IDCS** [ISORT] in TM **PROC**[essing] and a second TM stream in **INPUT**. The latter performs some checks on TM quality and timing. Within a few seconds the time correlation between TM packet arrival time and IDCS time increased to more than 10 seconds and caused the link in PROC to drop to INPUT. The link between IDCS and OPSLAN is hardware wise rated at 64 Kbps [at IDCS-level], which is an insufficient bandwidth to permit one link in PROC and a second link in INPUT to be used. A work around solution [procedure] was implemented.
The **ODS-1** experienced initialisation problems with the optical disk on 951125 at 05:40 [REV-8]. Several attempts failed to archive Telemetry Distribution Formats [TDF's], till the problem was cleared at 06:00.

Problems with brief **TM drops** were encountered when scheduled driven [CCS] operations commenced on 951128 [REV-11] and MPTS ranging operations were conducted in parallel from the VIL-2 station. This was attributed to the new MPTS replacing the old standard tone ranging system for which the ISO transponder was designed. As a first measure ranging operations were discontinued during the critical instrument activation phases comprising an excessive high command rate over a period of 80 minutes. The next measure was to carry out **Uplink Modulation Index Tests.** A series of tests were jointly conducted on 951208 [REV-21] between the SCC and the VIL-2 station. The tests revealed that for all values below the nominal value of 0.8 rad, there were **no TM drops** when the Ranging Transponder was switched on. With a value of 0.5 rad, perfect commanding around apogee was maintained. This value was implemented at VIL-2 station level, i.e. M&O staff burned new EPROMs and fitted them in the two Telecommand Encoders [TCEs].

Apart from above reported problems the IDCS [ISORT and ISODV] showed an excellent and stable performance throughout SCP.

7.4 SCP Mission Control

The Flight Operations Plan [FOP] was the committing document for the conduct of all spacecraft operations. All parts of the FOP, i.e. Mission Timeline, Nominal Flight Control Procedures [FCP's] and Contingency Recovery Procedures [CRP's], were found to be complete and accurate. The scientific instrument checkout was conducted under Project/SOC responsibility, using a set of Instrument checkout command sequences converted to Permanent Command equences [PCS's] and down loaded onto the IDCS before launch. As far as instrument operations were concerned, the ISO Satellite Commissioning Plan was the committing document, supplemented by the Instrument Flight Operations Plan [IFOP]. All Timeline events were executed as planned, although ~30 change requests for instrument operations were forwarded and approved by the Spacecraft Operations Manager [SOM], before implementation.

The Flight Dynamics Teams provided all Orbit and Attitude information required to support the mission.

The Flight Control Team provided full service till mid of REV-11. This was the first revolution in which the common product of Mission Planning Phase-1 [MPP1/SOC] and MPP2 [SCC], the **Central Command Schedule [CCS]** was used successfully for the first time since launch. During the remainder of the SCP, 24 hours/day MOD engineering support [one SOE] was provided on a per shift basis.

7.5 Ground Stations / Communications Network

The data and voice communications between the OCC and the LEOP stations [PERTH, KOUROU, VIL-2] were based on PTT leased 64 Kbps digital lines. TT&C data transfer within the communications network [OPSNET] used X-25 recommendations. The communications between the SCC and the NASA/JPL Goldstone station is as well based on 64 Kbps digital lines. The second circuit between Vilspa and Goldstone [GDS-2] had not reached the desired performance. This circuit suffered from many short interruptions in service, as being reported by ESOC/COM.

The SCC was connected in Listen-In [LIT] mode, i.e. TM data reception was enabled from the SCC to the LEOP stations in parallel to the OCC. Voice communications was available between SCC and OCC for coordination purposes.

7.5.1 LEOP Stations / Network

The support provided by the LEOP stations and the Communications Network was nominal in all phases of the mission, with the following exceptions:

After initial AOS, the PERTH station suffered from a failure in the TC system, which prevented the OCC to command the spacecraft during some 27 minutes. The problem was found in the wiring from the uplink modems, whose output cables were swapped preventing the commands from the selected Telecommand Encoder [TCE] to reach the amplifiers. The problem was corrected and activities were resumed nominally.

A few Front End Controller [FEC] MK III and Multiple Purpose Tracking System [MPTS] malfunctions were observed in the KOUROU and VIL-2 stations. In all cases the relevant M&O Teams reacted very efficient and hence, reduced the operational impact.

A few communications trunk outages were noted by ESOC/COM. These were properly handled by the Integrated Switching System [ISS] of OPSNET, that initiated automatic re-routings to the relevant redundant trunks. Thus, it was not noticed by the Flight Control Team.

The NASA/JPL Goldstone station [DSS-27] tracked ISO throughout LEOP for training purposes. Also DSS-17 was exercised during LEOP in view of its anticipated support in REV-6. Although not LEOP station, Goldstone was exercised [ad hoc OCC decisions] as follows:

TM data [8 Kbps/HK] were processed on LEOPRT/DV at the OCC between 00:22 and 01:03 on DOY 322 [end of REV-0], and again prior to perigee in REV-1.

A successful TC test with DSS-27 was conducted between 18:00 and 18:10 on DOY 323 [REV-2], when the OCC uplinked/verified 5 test commands [MF2999] to either onboard Command Decoder-1 [ASW-1] and Command Decoder-2 [ASW-2] of the spacecraft.

TM was processed at the OCC during the non-coverage period of Kourou, i.e. between 23:20 and 02:07, respectively on DOY 323 [end of REV-3].

7.5.2 SCP Stations / Network

The support provided by the SCP stations [VIL-2, GOLDSTONE, supplemented by KOUROU for the short perigee passes up to REV-15] and the Communications Network was nominal in all phases of the mission, with the following exceptions:

VIL-2/KOUROU

Both stations suffered from a few Front End Controller [FEC] MK III malfunctions. Some of those could be traced back to the automatic transfer of antenna tracking angle predictions [STDM] from OAD/ESOC to the ground stations when they were tracking the spacecraft. Consequently, the automatic transfer of STDM's was adjusted and done during non-visibility periods of ISO.

Problems with the Multiple Purpose Tracking System [MPTS] were observed in both stations, most of them were related in resolving the ambiguity only during the second attempt. During one occasion, the MPTS connection between the SCC and the VIL-2 station failed. After the MPTS was re-booted, the problem was solved.

The Telecommand Encoder-1 [TCE-1] of the VIL-2 station hung-up on 951127 at 04:12 [REV-10]. TCE-2 was selected at 04:14 and the failed unit re-booted.

GOLDSTONE

The Goldstone **DSS-27** antenna lost the downlink at 01:37 [REV-4] because of Antenna Pointing Control [APC] computer problems. The signal was recovered between 01:59 and 02:10, but then lost again. At 02:24 DSS-12 [12 m dish] was made available till LOS at 02:47.

For the apogee lowering manoeuvre [Delta-V] **DSS-16** [with auto-track capability] was used in REV-6, since it was feared that DSS-27 [program track only] would not be able to properly track the spacecraft close to perigee, while the burn was ongoing. Before the manoeuvre started, TM/TC was lost at 00:16, but was quickly recovered at 00:18. The problem was caused by a circuit breaker shutdown, which stopped the antenna servo system. After recovery , two attempts to sweep the uplink failed. The uplink was finally recovered by a manual sweep.

Telecommand problems were experienced on several occasions during the Goldstone support on 951129 [REV-12].Several Block Command's [BC's] were incorrectly received at OBDH/CTU level and correctly discarded. As a precautionary measure, TCE-1 was taken off-line and TCE-2 used. The problem could not be explained.

In all cases the relevant M&O Teams reacted very efficient and hence, reduced the operational impact.

Also quite a number [~ 20] of **unexplained telemetry drops** occurred during the Goldstone support periods. These were still under investigation at the end of the SCP.

The ESA/ESOC provided NDIU performed well, although one problem occurred when **TMP2/1** was reported unserviceable in REV-6. This was in conjunction with the commissioning the **Spare TMP2**. The latter arrived only two days before launch and there was no time to perform site acceptance before. Initially, the unit did not function, because it was delivered with a wrong site code. After the proper site code was entered in the Unix table, the unit was tested from the SCC and the spare TMP2 declared operational. The TMP2/1 problem was eventually spotted by DPD/Software support [Vilspa], which identified an incorrect YEAR number [94 vice 95] in the SCOS Header. This must have been introduced when the unit was powered up and re-booted. Once the correct YEAR was entered, the SCC did receive good telemetry through TMP2/1. Many hours were devoted troubleshooting problems in TMP2/1 and as well the spare TMP2.

7.6 Ranging Operations

Ranging operations during LEOP were performed as per FOP Timeline, using Perth, Kourou and the Villafranca ground stations.

Ranging operations during SCP were performed as per FOP Timeline, using the Villafranca ground station, while the KOUROU station supported ranging operations up to REV-15 only, covering the short [~ 20 min.] perigee passages, i.e. one ranging per revolution.

8 CONCLUSIONS AND RECOMMENDATIONS

It can be stated that ISO LEOP and SCP was a flawless sequence of events with respect to S/C operations and satellite performance, with the exception of the STR-A CCD temperature anomaly.

Contributed to the said success have been:

- An excellent functioning satellite, with performance better than expectations;
- The smoothly conducted operations per a very well defined Flight Operations Plan [FOP];
- The well organized Handover of Operations from the OCC/ESOC to the SCC/VILSPA;
- The smoothly conducted Satellite Commissioning Phase;
- The good performance of the ISO Ground Segment.

Due to the excellent and professional support that had been provided by all participating parties, i.e. ESOC, VILSPA, ESTEC, Industry, PI's and the Ground Stations, all planned activities had been achieved. Although, a considerable number of changes wrt scientific instruments operations were required to achieve to goal, i.e. to ready ISO to enter the Performance Verification Phase [PV]. Nevertheless, taking the complexity of the scientific instruments and SCP objectives into account, all milestones of the SCP have been met well in time, leaving the SCP contingency revolution [REV-21] unused, i.e. it was re-planned to confirm the modified automatic 4 instrument activation sequences, and to confirm the Focal Plane Geometry [FPG] calibration offsets for all 4 instruments and their relevant apertures. This proved to be a valuable exercise, because at the end of REV-21 new FPG offsets for the CAM instrument were derived and delivered for implementation in the Flight Dynamics data files. The final FPG offsets can be depicted in section 4.5 [Table 4.5].

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The Authors apologise for the late delivery and distribution of this report. This was and still is mainly due to an extremely and constantly high workload imposed on the FCT and in particular to the TOS-OFC engineering team that never entered in "Routine Phase", due to a very demanding space segment [mission extension from 18 to~ 28 months] and ground segment, and the challenge imposed by the user community to tune ISO down to the absolute limits wrt absolute attitude pointing accuracy:~ 1 arcsec is confirmed! Since highest priority has been given to make ISO a real success [for the sake of the science], low priority and hence, little time was left in writing this document.

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APPENDIX A - LEOP TIMELINE

Rev# DOY & Event#	Time	MF/Seq Identifier	TC Description	Notes
Rev# 0 Day 321				
Event# 1	02:01:40			**AOS Perth**
Event# 2	02:12:19	2999	EGSE TC (Dummy)	**Verification of TC capability**
	02:14:57	2999	EGSE TC (Dummy)	
	02:18:04	2999	EGSE TC (Dummy)	
	02:19:28	2999	EGSE TC (Dummy)	Via ASW-2
	02:21:40	2999	EGSE TC (Dummy)	Via ASW-2
	02:22:36	2030	EGSE I/F OFF	Via ASW-1
Event# 3				**Battery Charge Verification**
Event# 4	02:24:24	152	ENA CMD VERIF	**Enable CVD**
Event# 5	02:24:52	151	USD STORAGE DIS	**Stop USD Storage**
	02:24:02	1003	VALVE V103 OPEN	**Cryo Valve Configuration**
	02:25:06	1042	VALVE V106 OPEN	
	02:27:21	1038	V103 ARMING OFF	
	02:27:39	1039	V106 ARMING OFF	
Event# 7	02:31:29	5105	RNG-1 ON	**Ranging**
	02:32:28	5105	RNG-1 ON	
	02:33:21	2999	EGSE TC (Dummy)	
	02:35:14	2999	EGSE TC (Dummy)	
	02:45:14	2999	EGSE TC (Dummy)	
	02:45:43	5105	RNG-1 ON	**Ranging**
	02:55:50	5107	RNG-1 OFF	
Event# 13	02:51:58	156	RC AUTSWCK INH A	**Recover Latch Valve-2 Status**
	02:52:21	184	RC AUTSWCK INH E	

	02:42:42	92	BR-2 SW-22 ON	
	02:53:14	73	LV BRCH2 OPEN	
	02:53:42	91	BR-2 SW-22 OFF	
	02:54:03	157	RC AUTSWCK ENA	
Event# 6	03:02:01	16302	DUMP USD BUFFER	**Dump USD buffer**
Event# 8	03:03:21	16317	DUMP DROM	**Dump DROM area**
Event# 9	03:05:44	80002	USD. SEL P002	**Initial Attitude check**
	03:10:25	80003	USD. SEL P003	
	03:28:40	80031	USD. SEL P031	
	03:06:39	5105	RNG-1 ON	**Ranging**
	03:14:07	5107	RNG-1 OFF	
Event# 14	03:21:11	1011	SSH1 ON 11 NOM	**Sun Shade Heater switch on**
Event# 10	03:39:43	16301	DUMP ERD BUFFER	**Dump ERD buffer**
	03:32:10	RFSW1	ANTENNA SWITCH	**Antenna Switch to +Y**
Event# 16	03:34:51	5105	RNG-1 ON	**Ranging**
	03:41:43	5107	RNG-1 OFF	
	03:54:03	5105	RNG-1 ON	
	04:05:27	5107	RNG-1 OFF	
Event# 11	03:45:23	149	RES ERD CNT	**ERD Counter Reset**
Event# 12				**Verify ERD Buffer contents**
Event# 17	04:01:17	80250	USD. SEL P250	**Transition AM-SM**
	04:01:59	70351	DB_LOAD V00351	
	04:04:22	80003	USD. SEL P003	
	04:04:59	16006	DB ENABLE RMC	
	04:08:08	16317	DUMP DROM	
	04:10:11	80212	USD. SEL P212	
	04:12:38	80092	USD. SEL P092	
	04:13:36	80002	USD. SEL P002	

	04:16:12	80003	USD. SEL P003	
Event# 19	04:17:37	16301	DUMP ERD BUFFER	**ERD Buffer dump and Reset**
Event# 20	04:19:50	149	RES ERD CNT	**Reset ERD Counter**
Event# 23	04:20:55	80250	USD. SEL P250	**Restore USD storage sampling frequency**
	04:23:22	70600	DB LOAD V00600	
	04:24:17	16006	DB ENABLE RMC	
	04:25:01	80003	USD. SEL P003	
Event# 24	04:26:38	16321	DUMP FULL ROM	**Dump ACC full ROM**
Event# 25	04:28:31	92500	DUMP ALL PM	**OBDH memory Dumps Part 1**
	04:28:54	92370	LD ALL PRAM	
	04:29:23	92384	SD ALL BROM	
Event# 26	04:33:36	16320	DUMP FULL RAM	**Dump ACC full RAM**
Event# 27	04:32:51	92382	SD ALL TRAM	**OBDH memory dumps Part 2 and PRAM comparison**
	04:38:11	92381	SD ALL WRAM	
	04:50:26	102	LM3 SOLDET ENA	**Enable SOL Detection**
Event# 30	04:42:02	5105	RNG-1 ON	**Ranging**
	04:52:49	5107	RNG-1 OFF	
Event# 33	04:50:57	80231	SEL. USD P231	**Enable ACC RAM**
	04:51:24	901	RAM ENA CMD	
Event# 34	04:51:57	80090	SEL. USD P090	**GYRO Health Check**
Event# 35	04:53:44	92503	DUMP PM BL 2,3	**OBDH Quality System Activation**
	04:54:21	2009	CTU W-DOG DIS	
	04:54:45	90108	SCHED BROMQ	
	04:55:10	90109	SCHED PRAMQ	
	04:56:26	90110	SCHED RAMQ	
	04:56:45	90111	SCHED RTUQ	
	04:57:03	90112	SCHED PMQ	

	05:03:33	2008	CTU W-DOG ENA	
	05:04:49	92500	DUMP ALL PM	
Event# 37	05:06:01	5105	RNG-1 ON	**Ranging**
	05:17:16	5107	RNG-1 OFF	
Event# 39	05:08:43	92501	DUMP PM BL 0,1	**Authorise and Enable Autonomy Entry Conditions C7.2**
	05:09:43	92312	EN C7.2 IN ECOND	
	05:11:50	92052	AUTHORISE C7.2	
	05:12:15	92314	EN C7.3 IN ECOND	
	05:12:39	92500	DUMP ALL PM	
Event# 41	05:04:27	80036	USD. SEL P036	**FSS Health Check**
	05:17:25	80236	USD. SEL P236	
	05:21:55	80013	USD. SEL P013	
	05:22:35	80092	USD. SEL P092	
Event# 42	05:28:52	80212	USD. SEL P212	RWL Health Check
	05:32:03	80012	USD. SEL P012	
	05:33:52	80092	USD. SEL P092	
Event# 43	05:34:57	16317	DUMP DROM	Verify RWL Health Checks/Autonomous Functions Enabled
	05:37:21	80003	USD. SEL P003	
	05:38:06	5105	RNG-1 ON	**Ranging**
	05:49:38	5107	RNG-1 OFF	
Event# 44	05:44:14	92509	DUMP PM BL 8,9	**STR Thermal Control - STR - A**
	05:44:43	92202	DIS THERMAL CNTL	
	05:45:17	3536	HT STR 1N ON(N)	
	05:46:10	92001	"OR" PM 0-255	
	05:46:50	92535	DUMP PM BL 66,67	
	05:47:34	92248	UPS HETLIM PR 21	
	05:48:13	92545	DUMP PM BL 76,77	
	05:50:08	92519	DUMP PM BL 18,19	

	06:11:44	92010	LOAD PM 256-511	
	06:!2:01	92010	LOAD PM 256-511	
	06:!2:11	92010	LOAD PM 256-511	
	06:14:33	92513	DUMP PM BL 12,13	
	06:15:01	91960	HETEN H21 ENA	
	06:15:36	92509	DUMP PM BL 8,9	
	06:15:59	92203	ENA THERMAL CNTL	
	06:16:24	92565	PM DUMP VARIABLE	
	06:20:00			**AOS Vilspa**
Event# 45	06:21:59	92558	DUMP PM BL 88-91	**Activate RFCON**
	06:23:29	90128	SCHED RFCON	
Event# 48	06:08:03	5105	RNG-1 ON	**Ranging**
	06:21:59	5107	RNG-1 OFF	
Event# 46	06:23:39	90128	SCHED RFCON	**Enable RFCON**
Event# 47	06:25:17	92508	DUMP PM BL 8,13	**Activate TMCON/TCCON Part 1**
	06:25:45	92202	DIS THERMAL CNTL	
	06:26:22	92551	DUMP PM BL 82,83	
	06:27:01	92511	DUMP PM BL 10,11	
	06:29:53	92509	DUMP PM BL 8,9	
	06:30:34	92203	ENA THERMAL CNTL	
	06:30:57	92551	DUMP PM BL 82,83	
	06:31:26	92207	ENA TC-I/F RECON	
Event# 50	06:27:56	80083	USD. SEL P083	**SAS Health Checks - Preparation**
Event# 53	06:29:34	80231	USD. SEL P231	**DMU Health Check Part 1**
Event# 54	06:34:43	80096	USD. SEL P096	**DMU Health Check Part 2**
	06:32:16	5105	RNG-1 ON	**Ranging**
	06:44:04	5107	RNG-1 OFF	
Event# 52	06:45:38	92201	ENA TM-I/F RECON	**Activate TMCON/TCCON Part 2**

	06:51:30	92500	DUMP ALL PM	
Event# 56	06:55:46	92555	DUMP PM BL 86,87	**Activate ULCON**
	06:56:31	92551	DUMP PM BL 82,83	
	06:57:14	90133	SCHED ULCON	
	07:00:21	5105	RNG-1 ON	**Ranging**
	07:11:14	5107	RNG-1 OFF	
Event# 59	07:02:41	16318	DUMP DRAM	**STR Switch-on**
	07:04:34	16852	MACS PDUA STRAON	
	07:05:08	80324	USD. SEL P234	
Event# 60	07:09:20	92550	DUMP PM BL 80,87	**BOTM Activation**
	07:10:45	90131	SCHED BOTM	
Event# 61	07:11:12	80034	USD. SEL P034	**STR Memory Check**
	07:13:52	16837	MACS STR HCMEM	
Event# 63	07:16:45	80085	USD. SEL P085	**Dump STR RAM area**
	07:17:26	16830	STR DMP AREA SEL	
Recovery Procedure	07:19:27	3146	C/200 N	**PCS-100 due to non EOC BATT-1**
	07:28:29	80034	USD. SEL P034	**Monitor CCD TEMPS**

Event# 62	07:31:00		Ground Station Handover	**G/STN H/O Perth - Vilspa**
	07:31:49	2999	EGSE TC (DUMMY)	
	07:34:36	5105	RNG-1 ON	**RANGING VILSPA**
	07:47:27	5107	RNG-1 OFF	
Event# 58	07:37:54	92558	DUMP PM BL 88-89	**Enable RFCON reconfiguration**
	07:38:33	92254	ENA RF RECONFIG	
	07:39:04	92500	DUMP ALL PM	
Recovery Procedure	07:58:08	80085	USD. SEL P085	**CRP-7080 Dump A/D Converter outputs**
	07:58:53	16828	STRA DMP AREASEL	
	08:01:55	80034	USD. SEL P034	
	08:07:08	5105	RNG-1 ON	**Ranging**

	08:19:13	5107	RNG-1 OFF	
	08:25:22	5105	RNG-1 ON	
	08:38:20	5105	RNG-1 ON	
Recovery Procedure	09:04:08	92509	DUMP PM BL 8,9	**OSW-1087 Switch off STR-1 HTR**
	09:04:41	92202	DIS THERMAL CNTL	
	09:05:37	3537	HT STR 1N OFF (N)	
	09:07:34	92002	"AND" PM 0-255	
	09:08:20	92203	ENA THERMAL CNTL	
	09:09:11	92500	DUMP ALL PM	
Event# 68	09:11:17	16834	MACS STR HCCCD	**STR CCD Check**
Event# 71	09:18:16	80004	USD. SEL P004	**STR to Mapping Mode**
	09:20:00	16833	STR MAPPING	
	09:19:29	92550	DUMP PM BL 80-87	**Enable BOTM Control**
	09:19:54	92109	ENA BAT1 BOTM	
	09:25:49	92112	ENA BAT2 BOTM	
Event# 65	09:31:20	92550	DUMP PM BL 84,85	**Load OBTCHARGE**
	09:32:27	92092	EN_TMAX CRIT	
	09:33:26	92550	DUMP PM BL 80-87	
	09:35:38	92557	DUMP PM BL 88,89	
	09:36:32	92130	OBTCHARGE VALUE	
	09:37:10	92500	DUMP ALL PM	
Event# 74	09:36:18	16832	STR S/T	**STR to Search/Track Mode 1**
Event# 78	0956:25	16832	STR S/T	**STR to Search/Track Mode 2**
Event# 80	09:59:17	16832	STR S/T	**STR to Search/Track Mode 3**
	09:49:00			**AOS Kourou**
Event 76	*09:41:03*	*5105*	*RNG-1 ON*	***Ranging***

	09:53:21	5107	RNG-1 OFF	
	09:41:50	80034	USD. SEL P034	
Event# 70	09:53:21	92550	DUMP PM BL 80-87	**BUVM Activation**
	09:54:27	90132	SCHED BUVM	
	09:56:18	92117	ENA BAT1 UV MON	
	10:02:29	92122	ENA BAT2 UV MON	
	10:08:20	92103	ENA BAT REC	
Event# 77	10:16:32	92501	DUMP PM BL 0,1	**Authorise and Enable Autonomy Entry Condition c7.4**
	10:17:31	92316	EN C7.4 IN ECOND	
	10:18:10	92056	AUTHORISE C7.4	
	10:18:49	92500	DUMP ALL PM	
Event# 83	10:17:41	80013	USD. SEL P013	**Inertial Attitude Preliminary Update**
	10:18:12	59100	ATTITUDE UPDATE	
	10:19:31	5105	RNG-1 ON	**Ranging**
	10:26:25	5107	RNG-1 OFF	
Event# 82	10:22:07	92506	DUMP PM BL 4-9	**OBSF First Activation for testing**
	10:23:02	92365	SH DMP OBSF TABS	
	10:24:41	90140	SCHED OBSF	
	10:25:35	92500	DUMP ALL PM	
	10:26:25	92381	SD ALL WRAM	
Event# 86	10:34:36	80231	USD. SEL P231	**Transition SM to SAM**
	10:37:40	80004	USD. SEL P004	
	10:38:00	60100	STAR ACQ MODE	
	11:00:00			**Shift Handover A - B**
Event# 88	10:54:31	5105	RNG-1 ON	**Ranging**
	11:14:04	5107	RNG-1 OFF	

Event# 89	11:21:10	80013	USD. SEL P013	**Inertial Attitude "Nominal" Update**
	11:21:49	59100	ATTITUDE UPDATE	
Event# 91	11:22:58	80031	USD. SEL P031	**Update Orbital Period/Perigee Time**
	11:23:40	ORBTI	ORBIT TIME	
	11:36:11	5105	RNG-1 ON	**Ranging**
	11:47:37	5107	RNG-1 OFF	
Event# 93	11:45:42	80231	USD. SEL P231	**PPL Load**
	11:46:00	59200	PPL TARGET QUAT	
	11:46:28	59200	PPL TARGET QUAT	
	11:47:10	59200	PPL TARGET QUAT	
	11:47:37	59203	PPL TGT Q+STRSBY	
	11:47:57	59200	PPL TARGET QUAT	
	11:48:33	59410	PPL ECL WARNING	
	11:48:53	59200	PPL TARGET QUAT	
	11:49:35	16314	DUMP PPL BUFF	
	11:50:09	401	PPL IS VALID CMD	
Event# 96	11:51:40	80008	USD. SEL P008	**Fine Pointing Mode**
	11:53:46	60200	FINE POINT MODE	
Event# 101	11:58:56	92501	DUMP PM BL 0,1	**Authorise/enable C7.1**
	11:58:56	92050	AUTHORISE C7.1	
	11:59:35	92310	EN C7.1 IN ECOND	
	12:00:02	92500	DUMP ALL PM	
Event# 102	12:01:27	80013	USD. SEL P013	**Enable Inertialisation Function**
	12:02:52	16002	SWC ENA INERT	
Event# 100	12:06:00	5105	RNG-1 ON	**Ranging**
	12:17:17	5107	RNG-1 OFF	
	13:12:03	5105	RNG-1 ON	
	13:24:28	5107	RNG-1 OFF	

	12:10:45	16301	DUMP ERD BUFFER	**ERD Buffer Dump**
Event# 107	13:13:49	80212	USD. SEL P212	**RWL Biasing**
	13:20:59	59500	RWL_WHEEL BIAS	
Recovery Procedure	13:25:52	92202	DIS THERMAL CNTL	**Switch On STR-1 HTR**
	13:25:52	3536	HT STR 1N ON(N)	
	13:27:25	92001	"OR" PM 0-255	
	13:28:00	92203	ENA THERMAL CNTL	
	13:28:22	92500	DUMP ALL PM	
Event# 110	13:31:04	92550	DUMP PM BL 80-87	**Activate BCR/BDR Control**
	13:31:22	92129	ENA BCR SUN CNTL	
	13:32:23	92133	ENA BDR SUN CNTL	
	13:32:57	92137	ENA BDR ECL CNTL	
	13:33:38	90134	SCHED CHCON	
	13:34:55	92142	ENA BDR RECONFIG	
	13:35:23	92115	ENA BAT MAN REC	
	13:35:51	92500	DUMP ALL PM	
	13:36:31	90801	RES BSW WARNING	
Event# 111	13:37:32	92365	SH DMP OBSF TABS	**Deactivate OBSF, Dump XMIN and XMAX Tabs**
	13:38:16	91705	CLEAR OBSF TABS	
	13:38:39	92381	SD ALL WRAM	
	13:48:26	5105	RNG-1 ON	**Ranging**
	14:00:38	5107	RNG-1 OFF	
Event# 113	14:01:15	80011	USD. SEL P011	**Gyro Drift Calibration**
	14:02:22	40200	GYRO ACCUMUL	
	14:27:03	80008	USD. SEL P008	
Event# 114	14:29:55	5105	RNG-1 ON	**Ranging**
	14:42:48	5107	RNG-1 OFF	
Event# 116	14:43:08	80031	USD. SEL P031	**Upload new GYRO drift values**

	14:43:26	GYRDR	GYRO DRIFT UPD	
Annex to T.L. Rev 0	14:50:00	80252	USD. SEL P252	**Modify MaSO, MaF1 MaDO**
	14:50:52	70700	DB_LOAD V00700	
	14:51:55	813	ACC DB ENA CMD	
	14:52:53	70701	DB_LOAD V00701	
	14:53:28	813	ACC DB ENA CMD	
	14:55:16	70703	DB_LOAD V00703	
	14:56:06	813	ACC DB ENA CMD	
	14:56:55	70704	DB_LOAD V00704	
	14:57:33	813	ACC DB ENA CMD	
	14:58:11	16317	DUMP DROM	
Event# 132	15:05:00			**Station Handover Vilspa - Kourou**
	15:11:43	2999	EGSE TC (DUMMY)	
Event# 118	15:03:24	80008	USD. SEL P008	**Fine Pointing Mode**
	15:25:43	60200	FINE POINT MODE	
Event# 120	15:31:17	5105	RNG-1 ON	**Ranging**
	15:45:07	5107	RNG-1 OFF	
Recovery Procedure	15:33:23	92509	DUMP PM BL 8,9	**STR-1 HTR switch off**
	15:33:47	92202	DIS THERMAL CNTL	
	15:34:19	3537	HT STR 1N OFF (N)	
	15:35:21	92002	"AND" PM 0-255	
	15:35:47	92203	ENA THERMAL CNTL	
	15:36:20	92500	DUMP ALL PM	
Event# 122	15:41:52	80004	USD. SEL P004	**Acquisition of PPL Attitude in SAM**
	15:43:57	60100	STAR ACQ MODE	
Event# 125	16:09:14	5105	RNG-1 ON	**Ranging**
	16:21:18	5107	RNG-1 OFF	
	16:42:19	5105	RNG-1 ON	
	16:54:13	5107	RNG-1 OFF	

Event# 124	16:48:36	80013	USD. SEL P013	**Inertial Attitude Update**
	16:51:00	59100	ATTITUDE UPDATE	
Event# 127	16:57:49	80008	USD. SEL P008	**Static Transition to FPM**
	16:58:41	60200	FINE POINT MODE	
	17:04:33	16301	DUMP ERD BUFFER	**ERD buffer dump & reset**
	17:15:30	149	RES ERD CNT	
Event# 136	17:17:54	60200	FINE POINT MODE	**GYRO Scale Factor Calibration get Start Attitude Part 1**
Event# 137	17:26:40	60200	FINE POINT MODE	**GYRO Scale Factor Calibration get Start Attitude Part 2**
Recovery Procedure	17:21:27	92509	DUMP PM BL 8, 9	**STR-1 HTR Switch on**
	17:21:45	92202	DIS THERMAL CNTL	
	17:22:06	3536	HT STR 1N ON (N)	
	17:22:50	92001	"OR" PM 0-255	
	17:23:23	92203	ENA THERMAL CNTL	
	17:23:40	92500	DUMP ALL PM	
Event# 130	17:37:54	80011	USD. SEL P011	**Restart GYRO Accumulation**
	17:38:47	40200	GYRO ACCUMUL	
Event# 141	17:51:15	5105	RNG-1 ON	**Ranging**
	18:06:50	5107	RNG-1 OFF	
Event# 142	17:53:06	80008	USD. SEL P008	**Gyro Scale Factor Calibration 15 Deg. About Sun Vector**
	17:53:31	60200	FINE POINT MODE	
Event# 143	17:58:19	60200	FINE POINT MODE	**2nd Slew, 15 Deg. About Sun Vector**
Event# 144	18:02:51	60200	FINE POINT MODE	**3rd Slew, 15 Deg, about Sun Vector**

Event# 145	18:07:51	60200	FINE POINT MODE	4th Slew, 15 Deg, about Sun Vector
Event# 139	18:12:43	80011	USD. SEL P011	Gyro Accumulation

Event# 147	18:16:22	5105	RNG-1 ON	Ranging
	18:34:10	5107	RNG-1 OFF	
Event# 148	18:22:05	80008	USD. SEL P008	GYRO Scale Factor Calibration 15 Deg. About S/C Y-axis
	18:22:33	60200	FINE POINT MODE	
Event# 149	18:28:07	60200	FINE POINT MODE	2nd Slew, 15 Deg. About S/C Y-axis
Event# 150	18:34:11	60200	FINE POINT MODE	3rd Slew. 15 Deg. About S/C Y-axis
Event# 151	18:38:49	60200	FINE POINT MODE	4th Slew, 15 Deg. About S/C Y-axis
	18:43:27	80011	USD. SEL P011	
Recovery Procedure	18:40:19	92509	DUMP PM BL 8, 9	Switch Off STR-1 HTR
	18:40:41	92202	DIS THERMAL CNTL	
	18:42:18	3537	HT STR 1N OFF (N)	
	18:43:30	92002	"AND" PM 0-255	
	18:43:51	92203	ENA THERMAL CNTL	
	18:44:10	92500	DUMP ALL PM	
Event# 153	18:48:16	5105	RNG-1 ON	Ranging
	19:00:52	5107	RNG-1 OFF	
Event# 154	18:57:18	80008	USD. SEL P008	GYRO Scale Factor Calibration 15 Deg. About Sun Vector
	18:59:07	60200	FINE POINT MODE	
Event# 155	19:04:19	60200	FINE POINT MODE	2nd Slew, 15 Deg. About Sun Vector
Event# 156	19:15:15	60200	FINE POINT MODE	3rd Slew, 15 Deg. About Sun Vector
Event# 157	19:22:29	60200	FINE POINT MODE	4th Slew, 15 Deg, About Sun Vector

	19:27:48	80011	USD. SEL P011	
	19:38:32	16400	STOP USD TM	
	19:14:06	16301	DUMP ERD BUFFER	**ERD Dump & Reset**
	19:14:45	149	RES ERD CNT	
Event# 158	19:34:21	5105	RNG-1 ON	**Ranging**
	19:53:13	5107	RNG-1 OFF	
Recovery Procedure	19:48:55	92509	DUMP PM BL 8, 9	**Switch on STR-1 HTR**
	19:50:01	92202	DIS THERMAL CNTL	
	19:50:28	3536	HT STR 1N (N)	
	19:52:01	92001	"OR" PM 0-255	
	19:52:29	92203	ENA THERMAL CNTL	
	19:52:54	92500	DUMP ALL PM	
	19:59:03	5105	RNG-1 ON	**Ranging**
	20:10:57	5107	RNG-1 OFF	
Event# 159	20:23:09	80250	USD. SEL P250	**Adjust USD sampling frequency**
	20:24:09	70600	DB LOAD V0060	
	20:25:08	813	ACC DB ENA CMD	
	20:25:43	16317	DUMP DROM	
Event# 162	20:29:25	92509	DUMP PM BL 8, 9	**Prepare OBDH for Perigee**
	20:29:46	92202	DIS THERMAL CNTL	
	20:30:06	92551	DUMP PM BL 82, 83	
	20:30:34	92072	AUTH PCSTMIF REC	
	20:31:09	92070	AUTH PCSTCIF REC	
	20:31:46	92511	DUMP PM BL 10, 11	
	20:32:14	92068	AUTH G5 REC	
	20:32:46	92509	DUMP PM BL 8, 9	
	20:33:18	92203	ENA THERMAL CNTL	
	20:34:47	92565	PM DUMP VARIABLE	
	20:35:10	92128	*DIS BCR SUN CNTL*	

	20:36:24	92074	AUTHPCSMGTBAT_R	
	20:36 48	92129	ENA BCR SUN CNTL	
	20:37:40	92116	DIS BAT1 UV MON	
	20:38:13	92121	DIS BAT2 UV MON	
	20:38:37	92076	AUTH BATREC	
	20:38:57	92117	ENA BAT1 UV MON	
	20:39:21	92122	ENA BAT1 UV MON	
	20:39:43	92316	DIS BDR ECL CNTL	
	20:40:12	92132	DIS BDR SUN CNTL	
	20:40:49	92080	AUTH BDRREC	
	20:41:14	92137	ENA BDR ECL CNTL	
	20:41:42	92133	ENA BDR SUN CNTL	
	20:43:32	92559	DUMP PM BL 90, 91	
	20:43:51	92250	DIS RF CONTROL	
	20:44:17	92084	AUTH RFREC	
	20:44:38	92251	ENA RF CONTROL	
	20:45:22	92557	DUMP PM BL 88, 89	
	20:46:47	92506	DUMP PM BL 4 - 9	
	20:47:05	92365	SH DMP OBSF TABS	
	20:47:28	91705	CLEAR OBSF TABS	
	20:47:57	90140	SCHED OBSF	
	20:48:23	92500	DUMP ALL PM	
	20:48:49	92381	SD ALL WRAM	
	20:50:59	3142	AUT CHG SEL N	**Switch BATT to auto-charge**
Event# 163	20:58:34	5105	RNG-1 ON	**Ranging**
	21:16:04	5107	RNG-1 OFF	
Recovery Procedure	21:11:07	92509	DUMP PM BL 8, 9	**Switch off STR-1 HTR**
	21:11:44	92202	DIS THERMAL CNTL	
	21:12:38	3537	HT STR 1N OFF (N)	
	21:14:03	92002	"AND" PM 0-255	

	21:14:49	92203	ENA THERMAL CNTL	
	21:15:14	92500	DUMP ALL PM	
	21:16:05	80011	USD. SEL P011	
	21:17:56	40200	GYRO ACCUMUL	**GYRO Drift Accumulation**
	21:40:53	5105	RNG-1 ON	**Ranging**
	21:53:12	5107	RNG-1 OFF	
Event# 164	21:53:18	80031	USD. SEL P031	**GYRO Scale Factor Misalignment update**
	21:53:47	GYRSF	GYRO MIS UPD	
Event# 165	22:08:50	80231	USD. SEL P231	**AOCS Units Health Check**
Event# 166	22:12:47	80005	USD. SEL P005	**PPM entry**
	22:14:53	654	TR - PPM	
	22:09:42	5105	RNG-1 ON	**Ranging**
	22:21:42	5107	RNG-1 OFF	
	22:22:29	16851	MACSPDUA_STRAOF	**STR-A off**
Event# 168	22:58:57	59200	PPL TARGET QUAT	**Re-upload PPL**
	22:29:21	59200	PPL TARGET QUAT	
	22:29:43	59200	PPL TARGET QUAT	
	22:30:06	59203	PPL TGT Q+STRSBY	
	22:30:27	59200	PPL TARGET QUAT	
	22:30:50	59410	PPL ECL WARNING	
	22:31:18	59200	PPL TARGET QUAT	
	22:33:26	16314	DUMP PPL BUFF	
	22:34:58	401	PPL IS VALID CMD	
Recovery Procedure	22:33:00	92509	DUMP PM BL 8, 9	**STR-1 HTR Switch ON**
	22:33:27	92202	DIS THERMAL CNTL	
	22:33:49	3536	HT STR 1N ON (N)	
	22:34:44	92001	"OR" PM 0-255	
	22:36:50	92203	ENA THERMAL CNTL	

	22:37:21	92500	DUMP ALL PM	
Event# 170	22:36:43	94	OTF I/F A OFF	**Check OTF status**
Event# 171	22:38:02	16301	DUMP ERD BUFFER	**ERD buffer dump**
Event# 172	22:39:47	149	RES ERD CNT	**Reset ERD Counter**
Event# 173	22:41:06	80050	USD. SEL P050	**USD select to observe RWL unload during perigee**
	22:42:36	RFSW3	ANTENNA SWITCH	**Antenna switch to -Y**
Event# 175	22:48:47	150	USD STORAGE ENA	**Start USD Storage**
Event# 174	22:44:46	5105	RNG-1 ON	**Ranging**
	22:59:43	5107	RNG-1 OFF	
	23:07:21	5105	RNG-1 ON	
	23:20:00	5107	RNG-1 OFF	
	23:36:31	5105	RNG-1 ON	
	23:38:46	5107	RNG-1 OFF	
Day 322				
	00:05:02			**LOS TC Kourou**
	01:02:40			**AOS TC Kourou**
Event# 182	01:13:22	151	USD STORAGE DIS	**Stop USD Storage**
Event# 183	01:15:32	16302	DUMP USD BUFFER	**Dump USD Buffer**
Event# 184	01:20:31	150	USD STORAGE ENA	**Start USD Storage**
Event# 181	01:05:23	5105	RNG-1 ON	**Ranging**
	01:30:58	5107	RNG-1 OFF	
Event# 186	01:42:26			**LOS TM/TC Kourou**

Rev# DOY & Event#	Time	MF/Seq Identifier	TC Description	Notes
Rev # 1 Day 322				
Event# 1	02:12:00			**AOS Perth**
	02:17:59	90801	RES BSW WARNING	**Reset Basic S/W Warning**
	02:20:30	5105	RNG-1 ON	

	02:36:20	5107	RNG-1 OFF	
Event# 4	02:37:01	152	ENA CMD VERIF	**Terminate USD Storage**
	02:38:00	151	USD STORAGE DIS	
Event# 5	02:40:36	16302	DUMP USD BUFFER	**Dump USD Buffer**
Event# 6	02:45:01	16301	DUMP ERD BUFFER	**ERD Buffer dump**
Event# 7	02:49:23	149	RES ERD CNT	**ERD Counter Reset**
Event# 8	02:43:44	90240	DESCHED OBSF	**Re-configure OBDH after Perigee**
	02:44:18	92365	SH DMP OBSF TABS	
	02:44:44	92509	DUMP PM BL 8, 9	
	02:45:05	92202	DIS THERMAL CNTL	
	02:46:26	92551	DUMP PM BL 82, 83	
	02:46:46	92071	INH PCSTCIF REC	
	02:47:27	92511	DUMP PM BL 10, 11	
	02:47:51	92069	INHIB G5 REC	
	02:48:26	92509	DUMP PM BL 8, 9	
	02:48:53	92203	ENA THERMAL CNTL	
	02:49:33	92565	PM DUMP VARIABLE	
	02:50:52	92128	DIS BCR SUN CNTL	
	02:51:18	92075	INH PCSMGTBAT R	
	02:51:37	92129	ENA BCR SUN_CNTL	
	02:52:09	92116	DIS BAT1 UV MON	
	02:52:35	92121	DIS BAT2 UV MON	
	02:52:58	92077	INH BATREC	
	02:53:21	92117	ENA BAT1 UV MON	
	02:53:52	92122	ENA BAT2 UV MON	
	02:54:17	92136	DIS BDR ECL CNTL	
	02:54:42	92132	DIS BDR SUN CNTL	
	02:55:02	92081	INH BDRREC	
	02:55:31	92137	ENA BDR ECL CNTL	
	02:56:01	92133	ENA BDR SUN CNTL	

	02:56:38	92079	INH TMAXCRIT@T7	
	02:57:06	92559	DUMP PM BL 90, 91	
	02:57:28	92250	DIS RF CONTROL	
	02:57:49	92085	INHIB RFREC	
	02:59:11	92251	ENA RF CONTROL	
	02:58:32	92381	SD ALL WRAM	
	02:58:46	92500	DUMP ALL PM	
Event# 9	03:29:28	5105	RNG-1 ON	**Ranging**
	03:43:48	5107	RNG-1 OFF	
	03:54:36	5105	RNG-1 ON	
	04:05:43	5107	RNG-1 OFF	
Event# 11	03:58:15	80231	USD. SEL P231	**AOCS health checks**
	03:59:29	80092	USD. SEL P092	
	04:00:00			**Shift Handover B-A**
Event# 12	04:02:28	92383	SHORT DUMP TBUF	**verify TIME-TAG buffer**
	04:05:01	2999	EGSE TC (DUMMY)	
	04:12:12	2999	EGSE TC (DUMMY)	
	04:16:24	91710	RESET TC IN TBUF	
	04:17:00	91715	CHANGE TBSIZE	
	04:17:32	90804	RES TTAG TC QUE	
	04:18:53	92381	SD ALL WRAM	
Event# 14	04:07:57	80005	USD. SEL P005	**PPL Upload**
	04:10:16	59200	PPL TARGET QUAT	
	04:12:45	59200	PPL TARGET QUAT	
	04:13:19	59200	PPL TARGET QUAT	
	04:13:52	59203	PPL TGT Q+STRSBY	
	04:14:47	59200	PPL TARGET QUAT	
	04:15:16	59410	PPL ECL WARNING	
	04:16:35	59200	PPL TARGET QUAT	
	04:17:22	16314	DUMP PPL BUFF	

	04:19:04	401	PPL IS VALID CMD	
Event# 17	04:19:55	16318	DUMP DRAM	**Update orbital period**
	04:21:56	80031	USD. SEL P031	
	04:22:28	ORBTI	DB LOAD & ENABLE	
Event# 18	04:28:32	654	TR - PPM	**TTAG for PPM entry**
	04:29:40	92383	SHORT DUMP TBUF	
	04:31:37	92381	SD ALL WRAM	
Event# 15	04:31:37	5105	RNG-1 ON	**Ranging**
	04:43:22	5107	RNG-1 OFF	
	04:36:35	16852	MACSPDUASTRAON	**STR-A switch on**
	04:37:27	80234	USD. SEL P234	
Event# 27	04:56:57	5105	RNG-1 ON	**Ranging**
	05:07:30	5107	RNG-1 OFF	
Event# 23	05:06:21	80013	USD. SEL P013	**Update Inertial Sun Vector**
	05:07:54	59100	ATTITUDE UPDATE	
Event# 24	05:14:32	80008	USD. SEL P008	**FPM entry**
	05:15:25	60200	FINE POINT MODE	
Event# 25	05:18:06	16002	SWC ENA INERT	**Enable Inertialisation function**
	05:21:23	5105	RNG-1 ON	**Ranging**
	05:35:10	5107	RNG-1 OFF	
Event# 29	05:30:39	80011	USD. SEL P011	**Gyro drift calibration**
	05:33:14	40200	GYRO ACCUMUL	
Event# 31	05:44:12	5105	RNG-1 ON	**Ranging**
	05:56:09	5107	RNG-1 OFF	
	06:07:41	RFSW1	ANTENNA SWITCH	**Antenna switch +Y**
	06:19:42	5105	RNG-1 ON	**Ranging**
	06:30:58	5107	RNG-1 OFF	
Event# 30	*06:20:01*	*80008*	*USD. SEL P008*	***Reset FPM USD selection***

	07:05:38	5105	RNG-1 ON	**Ranging**
	07:16:45	5107	RNG-1 OFF	
Event# 34	07:18:07	80031	USD. SEL P031	**Upload new GYRO drift values**
	07:19:08	GYRDR	DBLOAD & ENABLE	
Event# 38	07:25:42	80008	USD. SEL P008	**FSS misalignment calibration X-axis**
	07:26:58	60200	FINE POINT MODE	
	07:34:31	80236	USD. SEL P236	
	07:44:34	5105	RNG-1 ON	**Ranging**
	07:56:11	5107	RNG-1 OFF	
	08:04:35	16318	DUMP DRAM	
Event# 39	08:05:14	80252	USD. SEL P252	**FSS X9 Parameter upload**
	08:05:44	71039	DB_LOAD V01039	
	08:06:57	813	ACC DB ENA CMD	
	08:07:12	16319	DUMP FULL DB	
Event# 42	08:07:54	80008	USD. SEL P008	**FSS misalignment calibration Y-axis**
	08:08:26	16003	SWC DIS INERT	
	08:09:27	60200	FINE POINT MODE	
Event# 44	08:19:00	2999	EGSE TC (DUMMY)	**Handover Perth - Vilspa**
	08:21:50	5105	RNG-1 ON	**Ranging**
	08:35:36	5107	RNG-1 OFF	
Event# 45	08:36:04	80252	USD. SEL P252	**FSS Y9 Parameter upload**
	08:36:37	71040	DB_LOAD V01040	
	08:49:21	813	ACC DB ENA CMD	
	08:40:51	16319	DUMP FULL DB	
Event# 46	08:41:24	16002	SWC ENA INERT	**Re-enable Inertialisation function**
Event# 47	08:44:39	80013	USD. SEL P013	**STR misalignment** calibration about X-axis

	08:59:56	59100	ATTITUDE UPDATE	
	09:03:11	80004	USD. SEL P004	
	09:04:20	60100	STAR ACQ MODE	
Event# 48	09:33:38	5105	RNG-1 ON	**Ranging**
	09:47:49	5107	RNG-1 OFF	
Event# 49	09:34:18	80031	USD. SEL P031	**STR Projection matrix parameters upload**
	09:35:00	STRSM	DB LOAD & ENA	
	10:09:16	92500	DUMP ALL PM	
Event# 54	10:15:10	16317	DUMP DROM	**AGM entry**
	10:16:54	80007	USD. SEL P007	
	10:20:23	60402	AGM_NON AOP	
Recovery Procedure	10:30:22	80085	USD. SEL P085	**Dump STR-A, A/D outputs as per CRP AOCS#7080**
	10:31:14	16828	STRA DMP AREASEL	
	10:33:07	80007	USD. SEL P007	
	10:37:27	80034	USD. SEL P034	**STR-A Reset**
	10:37:48	16836	MACS_STR_RESET	
	10:39:58	80008	USD. SEL P008	
	10:43:49	92513	DUMP PM BL 12, 13	**Update STR-B Thermal control limits OSW-1086 step 17 onward**
	10:44:38	91961	HETEN H21 DIS	
	10:45:39	92535	DUMP PM BL 66, 67	
	10:48:25	92248	UPD HETLIM PR 21	
	10:49:50	92513	DUMP PM BL 12, 13	
	10:50:23	91960	HETEN H21 ENA	
	10:50:50	92500	DUMP ALL PM	
Event# 58	10:33:26	5105	RNG-1 ON	**Ranging**
	10:45:19	5107	RNG-1 OFF	
Event# 60	11:12:56	60200	*FINE POINT MODE*	***Transition to FPM***

Event# 65	11:22:56	80231	USD. SEL P231	**RCS/ Delta-V Branch Preparation**
	11:23:16	156	RC AUTSWCK INH A	
	11:23:36	184	RC AUTSWCK INH E	
	11:24:05	88	BR-2 SW-21 ON	
	11:24:26	92	BR-2 SW-22 ON	
	11:24:59	69	BR-2 CB-HTR ON	
	11:25:20	71	LV BR-1 OPEN	
	11:25:47	73	LV BRCH2 OPEN	
Event# 61	11:48:01	80250	USD. SEL P250	**Update AOP Margin**
	11:48:50	16318	DUMP DRAM	
	11:49:47	71554	DB_LOAD V01554	
	11:50:10	813	ACC DB ENA CMD	
	11:50:33	16318	DUMP DRAM	
	11:50:58	80008	USD. SEL P008	
	12:00:56	80231	USD. SEL P231	**Delta-V Rehearsal**
Event# 64	12:02:16	60400	AOP AGM (NLE)	**AOP Load**
	12:02:42	40300	AOP DEL-V (NLE)	
	12:03:18	60403	AOP ST D-V (NLE)	
	12:03:51	66100	AOP LAST ENTRY	
	12:05:45	16313	DUMP AOP BUFF	
	12:19:48	5105	RNG-1 ON	**Ranging**
	12:32:47	5107	RNG-1 OFF	
Event# 68	12:25:50	80008	USD. SEL P008	**Transition to FPM to Delta-V attitude**
	12:26:49	60200	FINE POINT MODE	
Recovery Procedure	12:37:36	16836	MACS_STR_RESET	**STR-A Reset O.G. Request**
	12:43:17	92551	DUMP PM BL 82, 83	**OSW-1086 Adjust STR-2 Temp control limits (PS Request)**
	12:44:05	92073	INH PCSTMIF REC	

	12:44:46	92509	DUMP PM BL 8, 9	
	12:46:00	92202	DIS THERMAL CNTL	
	12:46:34	3537	HT STR 1N OFF (N)	
	12:48:14	92002	"AND" PM 0-255	
	12:50:39	92509	DUMP PM BL 8, 9	
	12:50:57	92203	ENA THERMAL CNTL	
	12:52:01	92500	DUMP ALL PM	
	12:58:30	92551	DUMP PM BL 82, 83	
	12:59:06	92072	AUTH PCSTMIF REC	
	12:59:50	92500	DUMP ALL PM	
Event# 70	12:57:11	80007	USD. SEL P007	**AOP Enable Delta-V Rehearsal**
	12:02:21	664	AOP ENABLE	
	13:02:45	80008	USD. SEL P008	
	13:08:28	RFSW3	ANTENNA SWITCH	**Antenna Switch -Y**
	13:09:32	80007	USD. SEL P007	
Event# 71	13:52:19	5105	RNG-1 ON	**Ranging**
	14:06:41	5107	RNG-1 OFF	
Recovery Procedure	13:53:37	16835	MACS_STR_SBM	**STR to Standby mode due to toggling of parameters OOL**
Event# 73	14:07:15	80231	USD. SEL P321	**Abort AOP**
	14:07:43	16799	GYR1MACSINITCRIT	
	14:08:05	2	RMC DISABLE	
	14:12:22	80008	USD. SEL P008	
Event# 79	14:13:09	156	RC AUTSWCK INH A	**Close Delta-V Branch Down**
	14:13:25	184	RC AUTSWCK INH E	
	14:13:49	71	LV BR-1 OPEN	
	14:14:03	73	LV BRCH2 OPEN	
	14:14:25	70	BR-2 CB-HTR OFF	
	14:14:53	87	BR-2 SW-21 OFF	

	14:15:23	91	BR-2 SW-22 OFF	
	14:16:00	157	RC AUTSWCK ENA	
Event# 77	14:17:47	60200	FINE POINT MODE	**Fine Pointing Mode**
Event# 79	14:28:40	80231	USD. SEL P231	**Reconfigure RCS again**
	14:28:56	156	RC AUTSWCK INH A	
	14:29:09	184	RC AUTSWCK INH E	
	14:29:25	71	LV BR-1 OPEN	
	14:29:46	73	LV BRCH2 OPEN	
	14:30:02	70	BR-2 CB-HTR OFF	
	14:30:19	87	BR-2 SW-21 OFF	
	14:30:34	91	BR-2 SW-22 OFF	
	14:30:44	157	RC AUTSWCK ENA	
	14:32:00	80008	USD. SEL P008	
	14:35:44	5105	RNG-1 ON	**Ranging**
	14:55:20	5107	RNG-1 OFF	
	15:36:48	5105	RNG-1 ON	
	15:55:50	5107	RNG-1 OFF	
Recovery Procedure	15:37:05	92509	DUMP PM BL 8,9	**Switch on STR-A HTR**
	15:37:27	92202	DIS THERMAL CNTL	
	15:37:47	3536	HT STR 1N ON (N)	
	15:38:53	92001	"OR" PM 0-255	
	15:39:17	92203	ENA THERMAL CNTL	
	15:39:46	92500	DUMP ALL PM	
Event# 82	15:49:32	16318	DUMP DRAM	**Update Orbital period**
	15:52:32	80031	USD. SEL P031	
	15:53:11	ORBTI	DB_LOAD & ENA	
Event# 83	16:16:05	80005	USD. SEL P005	**New PPL uplink**
	16:16:59	59200	PPL TARGET QUAT	
	16:17:26	*59200*	*PPL TARGET QUAT*	

	16:17:59	59200	PPL TARGET QUAT	
	16:18:18	59203	PPL TGT Q+STRSBY	
	16:18:38	59200	PPL TARGET QUAT	
	16:19:02	59410	PPL ECL WARNING	
	16:19:27	59200	PPL TARGET QUAT	
	16:20:44	16314	DUMP PPL BUFF	
	16:22:03	401	PPL IS VALID CMD	
Event# 84	16:26:12	5105	RNG-1 ON	**Ranging**
	16:38:46	5107	RNG-1 OFF	
Event# 87	16:26:59	80011	USD. SEL P011	**GYRO drift calibration**
	16:28:40	40200	GYRO ACCUMUL	
Event# 89	16:40:02	80008	USD. SEL P008	
Event# 88	17:01:24	5105	RNG-1 ON	**Ranging**
	17:14:03	5107	RNG-1 OFF	
Event# 93	17:26:02	2999	EGSE TC (DUMMY)	**STN H/O Vilspa - Kourou**
Event# 90	17:30:47	80011	USD. SEL P011	**USD selection**
Event# 91	17:36:05	80008	USD. SEL P008	
Recovery Procedure	17:42:54	92509	DUMP PM BL 8, 9	**Switch off STR-A HTR**
	17:43:13	92202	DIS THERMAL CNTL	
	17:43:38	3537	HT STR 1N OFF (N)	
	17:45:19	3537	"AND" PM 0 - 255	
	17:46:08	92002	ENA THERMAL CNTL	
	17:46:30	92500	DUMP ALL PM	
Event# 94	17:47:21	5105	RNG-1 ON	**Ranging**
	18:00:07	5107	RNG-1 OFF	
Event# 96	17:55:06	80031	USD. SEL P031	**Upload new GYRO drift values**
	17:55:41	GYRDR	DB_LOAD & ENA	
Event# 97	18:00:17	92383	SHORT DUMP TBUF	**PPM Entry check**
	18:02:08	92381	SD ALL WRAM	

	18:02:41	80231	USD. SEL P231	
Event# 98	18:05:41	80005	USD. SEL P005	**TTAG Verification**
	18:23:06	5105	RNG-1 ON	**Ranging**
	18:46:50	5107	RNG-1 OFF	
Event# 99	18:32:08	94	OTF I/F OFF	**Switch Off OTF**
Event# 101	18:33:49	59200	PPL TARGET QUAT	**PPL Re-Upload**
	18:34:21	59200	PPL TARGET QUAT	
	18:34:46	59200	PPL TARGET QUAT	
	18:35:09	59203	PPL TGT Q+STRSBY	
	18:35:33	59200	PPL TARGET QUAT	
	18:35:56	59410	PPL ECL WARNING	
	18:36:22	59200	PPL TARGET QUAT	
	18:38:27	16314	DUMP PPL BUFF	
	18:41:29	401	PPL IS VALID CMD	
Event# 102	18:52:23	5105	RNG-1 ON	**Ranging**
	18:21:18	5107	RNG-1 OFF	
Recovery Procedure	19:05:38	92509	DUMP PM 8, 9	**Switch On STR-A HTR**
	19:06:38	92202	DIS THERMAL CNTL	
	19:06:36	3536	HT STR 1N ON (N)	
	19:07:19	92001	"OR" PM 0-255	
	19:07:40	92203	ENA THERMAL CNTL	
	19:08:00	92500	DUMP ALL PM	
	19:24:32	5105	RNG-1 ON	**Ranging**
	19:36:13	5107	RNG-1 OFF	
Event# 104	19:28:42	80212	USD. SEL P212	**RWL Bias**
	19:31:30	59500	RWS_WHEEL BIAS	
	19:33:56	16851	MACS_PDUASTRAOF	**STR-1 Switch Off**
Event# 105	20:16:43	5105	RNG-1 ON	**Ranging**
	20:29:33	5107	RNG-1 OFF	
Event# 106	20:20:40	16301	DUMP ERD BUFFER	**ERD Buffer Dump**

Event# 107	20:23:01	149	RES ERD CNT	**Reset ERD Counter**
Event# 109	20:35:50	80250	USD. SEL P250	**Adjust USD sampling frequency**
	20:37:09	70600	DB_LOAD V00600	
	20:38:28	813	ACC DB ENA CMD	
	20:39:20	16317	DUMP DROM	
Event# 110	20:40:01	80050	USD. SEL P050	**USD Selection**
Event# 112	20:54:08	92509	DUMP PM BL 8, 9	**Prepare OBDH for Perigee**
	20:54:30	92202	DIS THERMAL CNTL	
	20:54:52	92551	DUMP PM BL 82, 83	
	20:55:12	92070	AUTH PCSTCIF REC	
	20:55:36	92511	DUMP PM BL 10, 11	
	20:56:13	92068	AUTH G5 REC	
	20:56:40	92509	DUMP PM BL 8, 9	
	20:57:01	92203	ENA THERMAL CNTL	
	20:57:58	92565	PM DUMP VARIABLE	
	20:58:16	92128	DIS BCR SUN CNTL	
	20:58:39	92074	AUTHPCSMGTBAT_R	
	20:59:06	92129	ENA BCR SUN CNTL	
	20:59:42	92116	DIS BAT1 UV MON	
	21:00:06	92121	DIS BAT2 UV MON	
	21:00:24	92076	AUTH BATREC	
	21:00:52	92117	ENA BAT1 UV MON	
	21:01:14	92122	ENA BAT2 UV MON	
	21:01:45	92316	DIS BDR ECL CNTL	
	21:02:09	92132	DIS BDR SUN CNTL	
	21:02:28	92080	AUTH BDRREC	
	21:03:00	92137	ENA BDR ECL CNTL	
	21:03:31	92133	ENA BDR SUN CNTL	
	21:04:10	92094	AUTH TMAX_CRIT	
	21:04:36	92559	DUMP PM BL 90, 91	

	21:04:57	92250	DIS RF CONTROL	
	21:05:30	92084	AUTH RFREC	
	21:05:59	92251	ENA RF CONTROL	
	21:06:18	92506	DUMP PM BL 4 - 9	
	21:06:38	92365	SH DMP OBSF TABS	
	21:07:04	91705	CLEAR OBSF TABS	
	21:07:28	90140	SCHED OBSF	
	21:07:44	92500	DUMP ALL PM	
	21:08:00	92381	SD ALL WRAM	
Event# 113	21:28:12	150	USD STORAGE ENA	**Enable USD storage**
Event# 115	21:20:47	5105	RNG-1 ON	**Ranging**
	22:04:46	5107	RNG-1 OFF	
	22:24:59	5105	RNG-1 ON	
	22:36:44	5107	RNG-1 OFF	
	23:03:15	5105	RNG-1 ON	
	23:15:05	5107	RNG-1 OFF	
DAY 323				
Event# 117	00:01:00			**LOS Kourou**
Event# 119	01:00:00			**AOS TM Kourou**
Event# 120	01:22:47			**AOS TC Kourou**
CRP	01:25:58	92509	DUMP PM BL 8, 9	**STR Thermal Control**
	01:26:46	92202	DIS THERMAL CNTL	
	01:27:08	92512	DUMP PM BL 10 -13	
		91927	HETEN 4 DIS	
	01:27:55	92509	DUMP PM BL 8, 9	
	01:28:09	92203	ENA THERMAL CNTL	
	01:28:27	92500	DUMP ALL PM	
Event# 121	01:28:03	151	USD STORAGE DIS	**Stop USD storage**
Event# 120	01:29:03	5105	RNG-1 ON	**Ranging**
	01:40:48	5107	RNG-1 OFF	

Event# 122	01:29:41	16302	DUMP USD BUFFER	**USD Buffer Dump**
Event# 123	01:32:49	150	USD STORAGE ENA	
Event# 125				**LOS TC/TM Kourou**

Rev# DOY & Event#	Time	MF/Seq Identifi er	TC Description	Notes
Rev # 2 Day 323				
Event# 1				**AOS Perth**
	02:28:00	5105	RNG-1 ON	**Ranging**
	02:39:43	5107	RNG-1 OFF	
	02:36:46	90801	RES BSW WARNING	**Reset BSW Warning Flag**
Event# 4	02:48:53	152	ENA CMD VERIF	**Terminate USD Storage**
	02:50:31	151	USD STORAGE ENA	
Event# 5	02:53:13	16302	DUMP USD BUFFER	**Dump USD Buffer**
Event# 6	02:56:45	16301	DUMP ERD BUFFER	**Dump ERD Buffer**
Event# 7	03:00:00	149	RES ERD CNT	**Reset ERD Counter**
	03:02:15	5105	RNG-1 ON	**Ranging**
	03:16:09	5107	RNG-1 OFF	
Event# 8	03:04:14	90240	DESCHED OBSF	**Reconfigure OBDH after Perigee**
	03:04:38	92365	SH DMP OBSF TABS	

	03:05:16	92509	DUMP PM BL 8, 9	
	03:05:35	92202	DIS THERMAL CNTL	
	03:05:52	92551	DUMP PM BL 82, 83	
	03:06:14	92071	INH PCSTCIF REC	
	03:06:40	92511	DUMP PM BL 10, 11	
	03:07:15	92069	INHIB G5 REC	
	03:07:26	92509	DUMP PM BL 8, 9	
	03:07:48	92203	ENA THERMAL CNTL	
	03:08:18	92565	PM DUMP VARIABLE	
	03:08:39	92128	DIS BCR SUN CNTL	
	03:08:59	92075	INH PCSMGTBAT R	
	03:09:30	92129	ENA BCR SUN_CNTL	
	03:09:48	92116	DIS BAT1 UV MON	
	03:10:11	92121	DIS BAT2 UV MON	
	03:10:32	92077	INH BATREC	
	03:10:51	92117	ENA BAT1 UV MON	
	03:11:09	92122	ENA BAT2 UV MON	
	03:11:31	92136	DIS BDR ECL CNTL	
	03:11:56	92132	DIS BDR SUN CNTL	
	03:12:18	92081	INH BDRREC	
	03:12:47	92137	ENA BDR ECL CNTL	
	03:13:40	92133	ENA BDR SUN CNTL	
	03:13:54	92079	INH TMAXCRIT@T7	
	03:14:27	92559	DUMP PM BL 90, 91	
	03:14:45	92250	DIS RF CONTROL	
	03:15:25	92085	INHIB RFREC	
	03:15:51	92251	ENA RF CONTROL	
	03:18:39	92381	SD ALL WRAM	
	03:18:57	92500	DUMP ALL PM	
Event# 9	03:31:04	5105	RNG-1 ON	**Ranging**
	03:43:01	5107	RNG-1 OFF	

	03:54:54	5105	RNG-1 ON	
	04:06:04	5107	RNG-1 OFF	
Event# 11	03:56:50	80231	USD. SEL P231	**AOCS Health Checks**
	03:58:19	80092	USD. SEL P092	
	04:18:29	5105	RNG-1 ON	**Ranging**
	04:29:32	5107	RNG-1 OFF	
Event# 13	04:21:39	80005	USD. SEL P005	**New PPL Upload**
	04:22:27	59200	PPL TARGET QUAT	
	04:22:53	59200	PPL TARGET QUAT	
	04:23:23	59200	PPL TARGET QUAT	
	04:23:55	59203	PPL TGT Q+STRSBY	
	04:24:31	59200	PPL TARGET QUAT	
	04:24:52	59410	PPL ECL WARNING	
	04:25:20	59200	PPL TARGET QUAT	
	04:25:44	16314	DUMP PPL BUFF	
	04:26:14	401	PPL IS VALID CMD	
	04:26:40	16319	DUMP DRAM	
Event# 16	04:27:42	80031	USD. SEL P031	**Update Orbital Period/Perigee**
	04:28:10	ORBTI	DB_LOAD & ENA	
Event# 17	04:30:10	654	TR - PPM	**TTAG PPM Entry CMD**
	04:40:13	92383	SHORT DUMP TBUF	
Event# 18	04:53:34	5105	RNG-1 ON	**Ranging**
	05:04:54	5107	RNG-1 OFF	
	05:25:19	5105	RNG-1 ON	
	05:37:17	5107	RNG-1 OFF	
Recovery	05:38:18	16852	MACSPDUASTRAON	**STR-A Switch On**
	05:38:46	80234	USD. SEL P234	
Event# 23	05:40:58	80013	USD. SEL P013	**Attitude Update**
	05:41:29	59100	ATTITUDE UPDATE	
Event# 24	05:42:23	80008	USD. SEL P008	**FPM Entry**

	05:43:27	60200	FINE POINT MODE	
Event# 25	05:45:48	16002	SWC ENA INERT	**Enable Inertialisation Function**
	05:53:10	149	RES ERD CNT	**ERD Counter Reset**
	05:57:28	90804	RES TTAG TC QUE	**Reset TTAG Que due Problem with On-Ground Image.**
	05:59:16	654	TR - PPM	**Re-Uplink TTAG for PPM Entry**
	06:01:27	92381	SD ALL WRAM	
Event# 27	06:06:35	5105	RNG-1 ON	**Ranging**
	06:18:07	5107	RNG-1 OFF	
	06:20:34	RFSW1	ANTENNA SWITCH	**Antenna Switch +Y**
Event# 29	06:23:44	80011	USD. SEL P011	**GYRO Drift Calibration**
	06:24:00	40200	GYRO ACCUMUL	
Event# 30	06:26:02	80008	USD. SEL P008	**Select USD-08**
Event# 32	06:41:13	80011	USD. SEL P011	**Select USD-11**
Event# 31	06:49:37	5105	RNG-1 ON	**Ranging**
	07:07:35	5107	RNG-1 OFF	
	07:18:58	5105	RNG-1 ON	
	07:30:05	5107	RNG-1 OFF	
Event# 35	07:34:24	2999	EGSE TC (DUMMY)	**STN H/O PER To VILSPA**
	07:36:12	5105	RNG-1 ON	**Ranging**
	07:48:27	5107	RNG-1 OFF	
	08:07:53	5105	RNG-1 ON	
	08:21:00	5107	RNG-1 OFF	
Event# 34	08:17:39	80087	USD. SEL P087	**USD Selection**
Event# 37	08:24:39	80031	USD. SEL P031	**GYRO Drift Update**
	08:25:27	GYRDR	DB_LOAD & ENA	
Event# 38	08:31:19	5105	RNG-1 ON	**Ranging**
	08:41:53	*80008*	*USD. SEL P008*	***USD Selection***

	08:43:39	5107	RNG-1 OFF	
Event# 40	09:50:54	5105	RNG-1 ON	**Ranging**
	10:02:32	5107	RNG-1 OFF	
Event# 44	10:17:17	80231	USD. SEL P231	**AOP Up-Link Main DELTA-V**
	10:18:16	60400	AOP AGM (NLE)	
	10:19:02	40300	AOP DEL-V (NLE)	
	10:19:44	60403	AOP ST D-V (NLE)	
	10:20:32	66100	AOP LAST ENTRY	
	10:22:39	16313	DUMP AOP BUFF	
Event# 43	10:21:12	5105	RNG-1 ON	**Ranging**
	10:32:46	5107	RNG-1 OFF	
	10:59:50	5105	RNG-1 ON	
	11:12:31	5107	RNG-1 OFF	
Event# 46	11:16:59	156	RC AUTSWCK INH A	**Delta-V Branch Preparation**
	11:17:16	184	RC AUTSWCK INH E	
	11:17:39	88	BR-2 SW-21 ON	
	11:17:57	92	BR-2 SW-22 ON	
	11:18:20	69	BR-2 CB-HTR ON	
	11:18:59	157	RC AUTSWCK ENA	
Even# 49	11:32:41	80008	USD. SEL P008	**Transition to FPM - Verify Start Conditions**
Event# 50	11:34:16	60200	FINE POINT MODE	**Transition to FPM**
Event# 52	12:14:00	80007	USD. SEL P007	**TTAG to Start Delta-V**
	12:15:33	664	AOP ENABLE	
Event# 53	12:26:09	5105	RNG-1 ON	**Ranging**
	12:37:38	5107	RNG-1 OFF	
Recovery Procedure	12:26:12	92383	SHORT DUMP TBUF	**Reset TTAG QUE - due to problem earlier 04:39 z**
	12:26:24	*90804*	*RES TTAG TC QUE*	

	12:27:06	654	TR - PPM	
	12:27:40	664	AOP ENABLE	
	12:38:04	RFSW3	ANTENNA SWITCH	**Switch to -Y Antenna**
	12:48			**AOP Executing**
Event# 54	13:10:03			**Delta-V Execution**
	15:01:27			**Delta-V Termination**
Event# 56	15:03:14	5105	RNG-1 ON	**Ranging**
	15:14:30	5107	RNG-1 OFF	
Event# 55	15:04:58	80231	USD. SEL P231	**Abort AOP**
	15:05:42	16799	GYR1MACSINITCRIT	
	15:06:01	2	RMC DISABLE	
Event# 58	15:10:09	60200	FINE POINT MODE	**Fine Pointing Mode**
Event# 60	15:15:05	156	RC AUTSWCK INH A	**Close Delta-V Branch**
	15:15:23	184	RC AUTSWCK INH E	
	15:16:12	71	LV BR-1 OPEN	
	15:16:31	73	LV BRCH2 OPEN	
	15:16:48	70	BR-2 CB-HTR OFF	
	15:17:10	87	BR-2 SW-21 OFF	
	15:17:22	91	BR-2 SW-22 OFF	
	15:17:42	157	RC AUTSWCK ENA	
	15:21:37	5105	RNG-1 ON	**Ranging**
	15:28:46	5107	RNG-1 OFF	
	15:24:06	80008	USD. SEL P008	
Recovery Procedure	15:29:27	92551	DUMP PM BL 82, 83	**PCS-5075 Control BAT-1 Temp. using both HTRS**
	15:30:05	92073	INH PCSTMIF REC	
	15:31:32	92510	DUMP PM BL 8 - 11	
	15:33:36	92202	DIS THERMAL CNTL	
	15:34:32	3630	HT LINE1 R ON (N)	

	15:35:30	92218	GRP1 R ON RELEXP	
	15:36:22	3640	BAT1 R HT ON (N)	
	15:43:24	92512	DUMP PM BL 10 - 13	
	15:44:04	91953	HETEN H17 DIS	
	15:45:23	92510	DUMP PM BL 8 -11	
	15:48:07	92203	ENA THERMAL CNTL	
	15:55:21	92551	DUMP PM BL 82, 83	
	15:56:15	92072	AUTH PCSTMIF REC	
	15:56:50	92500	DUMP ALL PM	
	15:39:17	5105	RNG-1 ON	**Ranging**
	15:47:52	5107	RNG-1 OFF	
Event# 63	15:55:27	16318	DUMP DRAM	**Update ORBITAL Period**
	15:56:42	80031	USD. SEL P031	
	15:57:10	ORBTI	DB_LOAD & ENA	
Event# 64	16:00:53	80005	USD. SEL P005	**New PPL Upload**
	16:01:45	59200	PPL TARGET QUAT	
	16:02:16	59200	PPL TARGET QUAT	
	16:02:36	59200	PPL TARGET QUAT	
	16:03:18	59203	PPL TGT Q+STRSBY	
	16:03:38	59200	PPL TARGET QUAT	
	16:04:04	59410	PPL ECL WARNING	
	16:04:37	59200	PPL TARGET QUAT	
	16:04:56	16314	DUMP PPL BUFF	
	16:07:16	401	PPL IS VALID CMD	
	16:06:08	5105	RNG-1 ON	**Ranging**
	16:12:06	5107	RNG-1 OFF	
	16:46:57	5105	RNG-1 ON	
	17:00:30	5107	RNG-1 OFF	
Event# 65	17:06:43	2999	EGSE TC (DUMMY)	**STN H/O VILSPA - KOUROU**

	17:14:22	RFSW1	ANTENNA SWITCH	**Switch to +Y Antenna**
	17:17:17	5105	RNG-1 ON	**Ranging**
	17:29:18	5107	RNG-1 OFF	
	17:38:20	92509	DUMP PM BL 8, 9	**Switch Off STR-A HTR**
	17:38:59	92202	DIS THERMAL CNTL	
	17:39:23	3537	HT STR 1N OFF (N)	
	17:41:04	92002	"AND" PM 0 - 255	
	17:42:20	92203	ENA THERMAL CNTL	
	17:42:40	92500	DUMP ALL PM	
	17:43:31	5105	RNG-1 ON	**Ranging**
	17:50:53	5107	RNG-1 OFF	
	18:01:47	2999	EGSE TC (DUMMY)	**TC Testing with GOLDSTONE**
	18:03:57	2999	EGSE TC (DUMMY)	
	18:06:02	2999	EGSE TC (DUMMY)	
	18:06:32	2999	EGSE TC (DUMMY)	
	18:09:15	2999	EGSE TC (DUMMY)	
	18:09:30	5105	RNG-1 ON	**Ranging**
	18:24:44	5107	RNG-1 OFF	
Event# 68	18:20:20	80031	USD. SEL P031	**Update Inertial Matrix**
	18:20:57	INERT	DB_LOAD & ENA	
Recovery Procedure	18:39:32	92509	DUMP PM BL 8, 9	**Switch On STR_A HTR**
	18:39:51	92202	DIS THERMAL CNTL	
	18:40:08	3536	HT STR 1N ON (N)	
	18:40:52	92001	"OR" PM 0 -255	
	18:41:11	92203	ENA THERMAL CNTL	
	18:41:29	92500	DUMP ALL PM	
Event# 70	18:42:10	5105	RNG-1 ON	**Ranging**
	18:49:10	5107	RNG-1 OFF	

Event# 74	18:57:42	80250	USD. SEL P250	**Adjust USD Frequency**
	18:59:09	70600	DB_LOAD V00600	
	19:00:03	813	ACC DB ENA CMD	
	19:00:42	16317	DUMP DROM	
Event# 75	19:03:13	5105	RNG-1 ON	**Ranging**
	19:14:47	5107	RNG-1 OFF	
	19:30:54	5105	RNG-1 ON	
	19:58:31	5107	RNG-1 OFF	
Event# 76	19:32:45	92509	DUMP PM BL 8, 9	**Prepare OBDH for Perigee**
	19:33:14	92202	DIS THERMAL CNTL	
	19:33:49	92551	DUMP PM BL 82, 83	
	19:34:40	92070	AUTH PCSTCIF REC	
	19:35:47	92511	DUMP PM BL 10, 11	
	19:36:36	92068	AUTH G5 REC	
	19:37:13	92509	DUMP PM BL 8, 9	
	10:37:40	92203	ENA THERMAL CNTL	
	19:39:07	92565	PM DUMP VARIABLE	
	19:40:39	92128	DIS BCR SUN CNTL	
	19:41:24	92074	AUTHPCSMGTBAT_R	
	19:42:02	92129	ENA BCR SUN CNTL	
	19:43:00	92116	DIS BAT1 UV MON	
	19:43:28	92121	DIS BAT2 UV MON	
	19:44:08	92076	AUTH BATREC	
	19:44:43	92117	ENA BAT1 UV MON	
	19:45:06	92122	ENA BAT2 UV MON	
	19:45:44	92316	DIS BDR ECL CNTL	
	19:46:22	92132	DIS BDR SUN CNTL	
	19:46:56	92080	AUTH BDRREC	
	19:47:25	92137	ENA BDR ECL CNTL	
	19:47:55	92133	ENA BDR SUN CNTL	

	19:48:36	92094	AUTH TMAX_CRIT	
	19:49:24	92559	DUMP PM BL 90, 91	
	19:49:49	92250	DIS RF CONTROL	
	19:50:19	92084	AUTH RFREC	
	19:50:41	92251	ENA RF CONTROL	
	19:51:39	92506	DUMP PM BL 4 - 9	
	19:52:50	92365	SH DMP OBSF TABS	
	19:55:27	91705	CLEAR OBSF TABS	
	19:56:00	90140	SCHED OBSF	
	19:56:25	92500	DUMP ALL PM	
	19:57:20	92381	SD ALL WRAM	
	19:59:19	5105	RNG-1 ON	**Ranging**
	20:06:35	5107	RNG-1 OFF	
	20:03:00	92510	DUMP PM BL 8 - 11	**Enable Process 4 Bat-1**
	20:03:19	91926	HETEN H 4 ENA	
	20:03:43	92500	DUMP ALL PM	
Event# 78	20:09:35	92383	SHORT DUMP TBUF	**AOCS Health Checks**
	20:12:34	92381	SD ALL WRAM	
	20:12:44	80231	USD. SEL P231	
Event# 80	20:15:31	80005	USD. SEL P005	**PPM Entry via TTAG**
Event# 81	20:35:47	94	OTF I/F A OFF	**OTF OFF**
Event# 82	20:44:20	59200	PPL TARGET QUAT	**Re-Upload PPL**
	20:44:46	59200	PPL TARGET QUAT	
	20:45:06	59200	PPL TARGET QUAT	
	20:45:29	59203	PPL TGT Q+STRSBY	
	20:45:47	59200	PPL TARGET QUAT	
	20:46:10	59410	PPL ECL WARNING	
	20:46:32	59200	PPL TARGET QUAT	
	20:47:59	16314	DUMP PPL BUFF	
	20:49:39	401	PPL IS VALID CMD	

	20:49:59	5105	RNG-1 ON	**Ranging**
	20:56:42	5107	RNG-1 OFF	
	20:57:36	RFSW3	ANTENNA SWITCH	**Switch to -Y Antenna**
Event# 84	20:59:23	80212	USD. SEL P212	**RWL Bias**
	21:01:16	59500	RWS WHEEL BIAS	
Event# 86	21:06:34	16301	DUMP ERD BUFFER	**ERD Buffer Dump**
Event# 87	21:20:37	149	RES ERD CNT	**Reset ERD Counter**
	21:21:15	5105	RNG-1 ON	**Ranging**
	21:30:24	5107	RNG-1 OFF	
Event# 88	21:23:06	80050	USD. SEL P050	**USD Selection**
Event# 89	21:24:21	150	USD STORAGE ENA	**Enable USD Storage**
Event# 90	21:57:49	5105	RNG-1 ON	**Ranging**
	22:04:02	5107	RNG-1 OFF	
	22:17:45	5105	RNG-1 ON	
	22:23:43	5107	RNG-1 OFF	
	22:37:20	5105	RNG-1 ON	
	22:43:31	5107	RNG-1 OFF	
	22:42:57	80231	USD. SEL P231	**STR Dump AOCS-900**
	22:44:40	80085	USD. SEL P085	
	22:45:21	16830	STR DMP AREA SEL	
	22:46:50	16835	MACS STR SBM	
	22:47:51	80050	USD. SEL P050	**Re-Select USD 050**
	22:58:45	5105	RNG-1 ON	**Ranging**
	23:04:26	5107	RNG-1 OFF	
Event# 100	23:12:52			**LOS Kourou TC**
Event# 101	23:30:00			**LOS Kourou TM**
DOY 324				
Event# 99	01:43:00	5105	RNG-1 ON	**Ranging**
	01:53:44	5107	RNG-1 OFF	
Event# 102	01:27:00			**AOS Kourou TM**

Event# 103	01:40:00			AOS Kourou TC
Event# 105	01:45:47	151	USD STORAGE DIS	Stop USD Storage
Event# 106	01:46:52	16302	DUMP USD BUFFER	Dump USD Buffer
Event# 107	01:52:30	150	USD STORAGE ENA	Re-enable USD Storage
	01:59:27	5105	RNG-1 ON	Ranging
	02:06:49	5107	RNG-1 OFF	
	02:13:00			LOS Kourou TM&TC

Rev# DOY & Event#	Time	MF/Seq Identifier	TC Description	Notes
Rev # 3 Day 324				
Event# 1	02:48:00			AOS PERTH
	02:50:05	5105	RNG-1 ON	Ranging
	02:57:35	5107	RNG-1 OFF	
	03:01:16	90801	RES BSW WARNING	Reset BSW Warning Flag
Event# 4	03:16:18	152	ENA CMD VERIF	Terminate USD Storage
	03:17:38	151	USD STORAGE ENA	
Event# 5	03:20:48	16302	DUMP USD BUFFER	USD Buffer Dump
Event# 6	03:23:13	16301	DUMP ERD BUFFER	ERD Buffer Dumped
Event# 7	03:26:13	149	RES ERD CNT	Reset ERD Counter
	03:27:30	5105	RNG-1 ON	Ranging
	03:34:06	5107	RNG-1 OFF	
Event# 8	03:32:34	90240	DESCHED OBSF	Reconfigure OBDH after Perigee
	03:32:58	92365	SH DMP OBSF TABS	
	03:33:22	92509	DUMP PM BL 8, 9	

	03:34:31	92202	DIS THERMAL CNTL	
	03:35:11	92551	DUMP PM BL 82, 83	
	03:35:36	92071	INH PCSTCIF REC	
	03:36:38	92511	DUMP PM BL 10, 11	
	03:37:09	92069	INHIB G5 REC	
	03:37:43	92509	DUMP PM BL 8, 9	
	03:38:12	92203	ENA THERMAL CNTL	
	03:39:05	92565	PM DUMP VARIABLE	
	03:39:26	92128	DIS BCR SUN CNTL	
	03:39:50	92075	INH PCSMGTBAT R	
	03:40:20	92129	ENA BCR SUN_CNTL	
	03:41:18	92116	DIS BAT1 UV MON	
	03:41:51	92121	DIS BAT2 UV MON	
	03:42:28	92077	INH BATREC	
	03:43:02	92117	ENA BAT1 UV MON	
	03:43:27	92122	ENA BAT2 UV MON	
	03:44:01	92136	DIS BDR ECL CNTL	
	03:44:27	92132	DIS BDR SUN CNTL	
	03:45:00	92081	INH BDRREC	
	03:45:24	92137	ENA BDR ECL CNTL	
	03:45:44	92133	ENA BDR SUN CNTL	
	03:46:29	92079	INH TMAXCRIT@T7	
	03:47:13	92559	DUMP PM BL 90, 91	
	03:47:43	92250	DIS RF CONTROL	
	03:48:10	92085	INHIB RFREC	
	03:48:39	92251	ENA RF CONTROL	
	03:49:08	92381	SD ALL WRAM	
	03:51:00	92500	DUMP ALL PM	
Event# 9	03:53:01	5105	RNG-1 ON	**Ranging**
	03:59:16	5107	RNG-1 OFF	
Event# 11	03:59:52	80231	USD. SEL P231	**AOCS Health Checks**

	04:01:52	80092	USD. SEL P092	
	04:08:49	80250	USD. SEL P250	**Extend Eclipse Duration AOCS-2599**
	04:10:38	71002	DB_LOAD V01002	
	04:11:08	813	ACC DB ENA CMD	
Event# 13	04:22:00	80005	USD. SEL P005	**New PPL Upload**
	04:22:45	59200	PPL TARGET QUAT	
	04:23:04	59200	PPL TARGET QUAT	
	04:23:29	59200	PPL TARGET QUAT	
	04:23:48	59203	PPL TGT Q+STRSBY	
	04:24:06	59200	PPL TARGET QUAT	
	04:24:23	59410	PPL ECL WARNING	
	04:24:44	59200	PPL TARGET QUAT	
	04:26:26	16314	DUMP PPL BUFF	
	04:28:41	401	PPL IS VALID CMD	
Event# 15	04:27:09	5105	RNG-1 ON	**Ranging**
	04:34:03	5107	RNG-1 OFF	
Event# 16	04:31:38	16318	DUMP DRAM	**Update Orbital Period**
	04:33:#3	80031	USD. SEL P031	
	04:34:25	ORBTI	DB_LOAD & ENA	
Event# 17	04:44:41	80005	USD. SEL P005	**Re-Enter PPM with New PPL**
	04:58:47	654	TR - PPM	
Event# 19	05:06:23	59200	PPL TARGET QUAT	**PPL Re-Upload**
	05:06:47	59200	PPL TARGET QUAT	
	05:07:05	59200	PPL TARGET QUAT	
	05:07:26	59203	PPL TGT Q+STRSBY	
	05:07:53	59200	PPL TARGET QUAT	
	05:08:15	59410	PPL ECL WARNING	
	05:08:33	59200	PPL TARGET QUAT	
	05:09:57	16314	DUMP PPL BUFF	

	05:11:33	401	PPL IS VALID CMD	
Event# 21	05:04:29	5105	RNG-1 ON	**Ranging**
	05:11:33	5107	RNG-1 OFF	
	05:31:49	5105	RNG-1 ON	
	05:45:24	5107	RNG-1 OFF	
Event# 22	05:55:44	1012	SSH1 OFF 11 NOM	**Sun Shade HTR Switch-Off**
Event# 23	05:59:51	173	ELSA VCAL INH A	**Inhibit ELS-A Autonomous Calibration**
	06:01:46	186	ELSA VCAL INH E	
Event# 24	06:03:17	174	ELSB VCAL INH A	**Inhibit ELS-B Autonomous Calibration**
	06:03:40	187	ELSB VCAL INH E	
Event# 28	06:03:50	5105	RNG-1 ON	**Ranging**
	06:10:39	5107	RNG-1 OFF	
Event# 25	06:23:07	83	ELS A ON	**ELS Switch-On**
	06:24:35	84	ELS B ON	
Event# 26	06:35:26	80033	USD. SEL P033	**ELS Data Acquisition**
	06:41:42	80093	USD. SEL P093	
Event# 27	06:48:45	80031	USD. SEL P031	**USD Selection**
	06:55:45	RANGING	RANGE	**Ranging Campaign**
Event# 29	07:20:23	2999	EGSE TC (DUMMY)	**Station H/O PERTH To VILSPA**
	07:23:18	2999	EGSE TC (DUMMY)	
	07:37:59	RFSW1	ANTENNA SWITCH	**Switch to +Y**
Event# 31	08:14:06	80033	USD. SEL P033	**ELS Data Acquisition**
	08:21:41	80093	USD. SEL P093	
Event# 32	08:24:25	80031	USD. SEL P031	**USD Selection**
Event# 30	08:58:20	RANGING	RANGE	**Ranging Campaign**
Event# 35	10:27:00	80031	USD. SEL P031	**ELS Data Acquisition**

	10:27:57	80033	USD. SEL P033	
	10:37:30	80093	USD. SEL P093	
Event# 36	10:40:23	80031	USD. SEL P031	**USD Selection**
Event# 37	10:40:34	RANGING	RANGE	**Ranging Campaign**
Event# 39	12:46:13	80033	USD. SEL P033	**ELS Data Acquisition**
	12:52:18	80093	USD. SEL P093	
Event# 40	12:54:58	80031	USD. SEL P031	**USD Selection**
Event# 41	13:06:00	RANGING	RANGE	**Ranging Campaign**
Event# 43	14:23:21	80033	USD. SEL P033	**ELS Data Acquisition**
	14:31:45	80093	USD. SEL P093	
Event# 44	14:43:23	80031	USD. SEL P031	**USD Selection**
Event# 45	14:37:05	RANGING	RANGE	**Ranging Campaign**
	15:21:37	80231	USD. SEL P231	**USD Selection to Rectify OOL Screen in VILSPA**
	15:40:21	80083	USD. SEL P083	
	15:43:56	80038	USD. SEL P038	
	15:52:02	80041	USD. SEL P041	
	16:08:07	80090	USD. SEL P090	
	16:10:53	80092	USD. SEL P092	
Event# 49	16:23:24	2999	EGSE TC (DUMMY)	**Station H/O VILSPA to KOUROU**
Event# 48	16:27:10	80033	USD. SEL P033	**ELS Data Acquisition**
	16:34:53	80093	USD. SEL P093	
Event# 50	16:37:19	80031	USD. SEL P031	**USD Selection**
	16:44:20	80008	USD. SEL P008	
	16:51:38	80031	USD. SEL P031	
	17:27:01	16319	DUMP FULL DB	**DB Dumps requested by VILSPA**

	18:27:53	16321	DUMP FULL ROM	
Event# 53	18:15:10	80033	USD. SEL P033	**ELS Data Acquisition**
	18:21:50	80093	USD. SEL P093	
Event# 54	18:23:28	80031	USD. SEL P031	**USD Selection**
	19:28:04	80041	USD. SEL P041	**STR CCD Temp Information**
Event# 57	19:41:04	80250	USD. SEL P250	**Adjust USD sampling frequency**
	19:42:05	70600	DB_LOAD V00600	
	19:42:59	813	ACC DB ENA CMD	
	19:43:39	16317	DUMP DROM	
Event# 60	20:04:13	80212	USD. SEL P212	**RWS Wheel Biasing**
	20:05:12	5107	RWS_WHEEL BIAS	
Event# 61	20:24:48	80033	USD. SEL P033	**ELS Data Acquisition**
	20:37:21	80093	USD. SEL P093	
Event# 62	20:41:17	80031	USD. SEL P031	**USD Selection**
Event# 64	20:43:39	16301	DUMP ERD BUFFER	**ERD Buffer Dump**
Event# 65	20:44:41	149	RES ERD CNT	**Reset ERD Counter**
Event# 66	20:46:10	80050	USD. SEL P050	**Select USD P050**
Event# 67	21:12:17	92509	DUMP PM BL 8, 9	**Prepare OBDH for Perigee**
	21:12:39	92202	DIS THERMAL CNTL	
	21:13:03	92551	DUMP PM BL 82, 83	
	21:14:08	92070	AUTH PCSTCIF REC	
	21:15:48	92511	DUMP PM BL 10, 11	
	21:16:17	92068	AUTH G5 REC	
	21:16:41	92509	DUMP PM BL 8, 9	
	21:17:15	92203	ENA THERMAL CNTL	
	21:18:05	92565	PM DUMP VARIABLE	

	21:18:30	92128	DIS BCR SUN CNTL	
	21:19:03	92074	AUTHPCSMGTBAT_R	
	21:19:35	92129	ENA BCR SUN CNTL	
	21:20:20	92116	DIS BAT1 UV MON	
	21:20:45	92121	DIS BAT2 UV MON	
	21:21:09	92076	AUTH BATREC	
	21:21:29	92117	ENA BAT1 UV MON	
	21:21:50	92122	ENA BAT2 UV MON	
	21:22:14	92316	DIS BDR ECL CNTL	
	21:22:34	92132	DIS BDR SUN CNTL	
	21:23:10	92080	AUTH BDRREC	
	21:23:37	92137	ENA BDR ECL CNTL	
	21:23:56	92133	ENA BDR SUN CNTL	
	21:24:26	92094	AUTH TMAX_CRIT	
	21:25:17	92559	DUMP PM BL 90, 91	
	21:25:44	92250	DIS RF CONTROL	
	21:26:08	92084	AUTH RFREC	
	21:26:27	92251	ENA RF CONTROL	
	21:27:35	92506	DUMP PM BL 4 - 9	
	21:28:01	92365	SH DMP OBSF TABS	
	21:29:23	91705	CLEAR OBSF TABS	
	21:29:50	90140	SCHED OBSF	
	21:30:13	92500	DUMP ALL PM	
	21:30:36	92381	SD ALL WRAM	
	21:49:37	16321	DUMP FULL ROM	**ROM and RAM Dumps required by VILSPA**
	21:53:11	16320	DUMP FULL RAM	
Event# 69	22:02:11	150	USD STORAGE ENA	**Enable USD Storage**
	22:22:51	16301	DUMP ERD BUFFER	
Event# 71	23:11:00			**LOS Kourou TC**

Event# 72	23:20:00			**LOS Kourou TM**
Day 325				
Event# 74	02:08:00			**AOS Kourou TM**
Event# 75	02:10:30			**AOS Kourou TC**
Event# 76	02:19:57	151	USD STORAGE DIS	**Disable USD storage**
Event# 77	02:21:41	16302	DUMP USD BUFFER	**USD Buffer dump**
Event# 78	02:24:00	150	USD STORAGE ENA	**Enable USD Storage**
Event# 80	02:32:35			**LOS Kourou TC**
Event# 80	02:36:00			**LOS Kourou TM**

Transfer of Operations from ESOC/OCC to VILSPA/SCC

Rev# DOY & Event#	**Time**	**MF/Seq Identifier**	**TC Description**	**Notes**
Rev# 4 Day 325				
Event# 1	03:11:00			**AOS Perth**
	03:19:51	90801	RES BSW WARNING	**Reset BSW FLAG**
	03:29:15	RFSW3	ANTENNA SWITCH	**Switch to -Y Antenna**
Event# 4	03:35:19	152	ENA CMD VERIF	**Terminate USD Storage**
	03:35:38	151	USD STORAGE ENA	
Event# 5	03:37:25	16302	DUMP USD BUFFER	**Dump USD Buffer**
Event# 6	03:38:17	16301	DUMP ERD BUFFER	**Dump ERD Buffer**
Event# 7	03:39:02	149	RES ERD CNT	**Reset ERD Counter**
Event# 8	03:41:19	92500	DUMP ALL PM	**Reconfigure OBDH after Perigee**
	03:44:40	90240	DESCHED OBSF	

	03:45:00	92365	SH DMP OBSF TABS	
	03:45:36	92509	DUMP PM BL 8, 9	
	03:45:59	92202	DIS THERMAL CNTL	
	03:47:51	92551	DUMP PM BL 82, 83	
	03:48:13	92071	INH PCSTCIF REC	
	03:49:15	92511	DUMP PM BL 10, 11	
	03:49:50	92069	INHIB G5 REC	
	03:50:20	92509	DUMP PM BL 8, 9	
	03:50:44	92203	ENA THERMAL CNTL	
	03:51:27	92565	PM DUMP VARIABLE	
	03:51:53	92128	DIS BCR SUN CNTL	
	03:52:42	92075	INH PCSMGTBAT R	
	03:59:04	92129	ENA BCR SUN_CNTL	
	04:01:27	92116	DIS BAT1 UV MON	
	04:03:08	92121	DIS BAT2 UV MON	
	04:03:40	92077	INH BATREC	
	04:04:13	92117	ENA BAT1 UV MON	
	04:04:37	92122	ENA BAT2 UV MON	
	04:05:13	92136	DIS BDR ECL CNTL	
	04:05:36	92132	DIS BDR SUN CNTL	
	04:06:06	92081	INH BDRREC	
	04:06:38	92137	ENA BDR ECL CNTL	
	04:07:53	92133	ENA BDR SUN CNTL	
	04:08:28	92079	INH TMAXCRIT@T7	
	04:09:06	92559	DUMP PM BL 90, 91	
	04:09:27	92250	DIS RF CONTROL	
	04:09:49	92085	INHIB RFREC	
	04:10:10	92251	ENA RF CONTROL	
	04:10:44	92381	SD ALL WRAM	

	04:11:10	92500	DUMP ALL PM	
Event# 11	04:17:17	80231	USD. SEL P231	**AOCS Health Checks**
	04:20:32	80092	USD. SEL P092	
Event# 13	04:47:51	80005	USD. SEL P005	**New PPL Upload**
	04:49:00	59200	PPL TARGET QUAT	
	04:9:50	59200	PPL TARGET QUAT	
	04:50:06	59200	PPL TARGET QUAT	
	04:50:22	59203	PPL TGT Q+STRSBY	
	04:50:39	59200	PPL TARGET QUAT	
	04:50:56	59410	PPL ECL WARNING	
	04:51:18	59200	PPL TARGET QUAT	
	04:51:38	16314	DUMP PPL BUFF	
	04:53:06	401	PPL IS VALID CMD	
Event# 16	05:00:31	16318	DUMP DRAM	**Update Orbital Period/Perigee**
	05:01:55	80031	USD. SEL P031	
	05:02:26	ORBTI	DB_LOAD & ENA	
Event# 17	05:14:45	654	TR - PPM	**TTAG for PPM Entry**
	05:16:30	92383	SHORT DUMP TBUF	
	05:18:50	92381	SD ALL WRAM	
	05:20:35	80041	USD. SEL P041	**USD Selections**
Event# 18	05:37:58	80033	USD. SEL P033	**ELS Data Acquisition**
	05:45:43	80093	USD. SEL P093	
	05:47:24	80031	USD. SEL P031	
Event# 20	06:15:51	2999	EGSE TC (DUMMY)	**Ground Station Handover Perth to Vilspa**
	08:05:03	RFSW1	ANTENNA SWITCH	**Switch to +Y Antenna**
Event# 21	06:20:00		AOCS TM Comparison	**Transfer of Operations ESOC to Vilspa Part 1**

Event# 21	06:18:00	5105	RNG-1 ON	**Ranging**
	06:28:00	5107	RNG-1 OFF	
Event# 23	06:30:00		RF, THC, PCS, OBDH, and CRYO Comparison	**Transfer of Operations ESOC to Vilspa Part 2**
Event# 24	08:30:00		TC Disconnected ESOC TC Connected Vilspa	**Transfer of Operations ESOC to Vilspa Part 3**
	09:15:00		OCC to SCC Handover	**Control in VILSPA. ESOC/OCC released.**

APPENDIX B - SCP TIMELINE [EXTRACT]

Rev# DOY & Event#	Time	MF/Seq Identifier	TC Description	Notes
Rev # 4 Day 325				
Event# 1	03:11:00			Perth AOS
Event# 20	06:14:00		STATION HANDOVER	Perth - Vilspa
Event# 26	08:53:50	92501	DUMP PM BL 0,1	OBDH HK - SC Mode Transition PHT Prime
	08:57:20	92472	HK-SC P(N)/INT	
	08:57:20	2028	TM/CC/SPL/NBR	
	09:13:21	92500	DUMP ALL PM	
Event# 24	09:15:00		ESOC TO VILSPA	Vilspa have ISO Control
Event# 74	09:49:36	92510	DUMP PM BL 8-11	PHT Activation
	09:50:12	92202	DIS THERMAL CNTL	
	09:51:21	3585	C/HT PHT N OF (N)	
	09:51:54	92211	PHTCOMP=0 RELEXP	
	09:52:52	92203	ENA THERMAL CNTL	
	09:53:17	92500	DUMP ALL PM	
	09:55:20	3605	LI P(N) S (R) ON (N)	
	09:56:16	3507	PHT+28V N ON (N)	INITIAL PHT SWITCH ON
	10:04:07	8210	PHT ML CMD 1 NOM	PHT RAM Patch
	12:57:00	8210	PHT ML CMD 1 NOM	PHT RAM Patch Out of Date
	14:20:00	8210	PHT ML CMD 1 NOM	Uplink Corrected PHT RAM Patch
Event# 85	16:04:28	3508	PHT+28V N OFF (N)	PHT De-Activation
	16:04:28	92510	DUMP PM BL 8-11	
	16:04:28	92202	DIS THERMAL CNTL	

	16:04:28	3584	C/HT PHT N ON (N)	
	16:05:02	92211	PHTCOMP=0 RELEXP	
	16:05:04	92203	ENA THERMAL CNTL	
	16:05:14	92500	DUMP ALL PM	
	16:05:14	3605	LI P(N) S (R) ON (N)	
Event# 73	16:10:00		STATION HANDOVER	Vilspa to Goldstone
Event# 104	02:47			LOS Goldstone
Event# 106	02:50			AOS TM Kourou
Event# 112	03:03			LOS Kourou

Rev# DOY & Event#	Time	MF/Seq Identifier	TC Description	Notes
Rev # 5 Day 326				
Event# 1	05:05:00			Vilspa AOS
Event# 10	07:34:24	92510	DUMP PM BL 8-11	PHT Activation
	07:35:19	92202	DIS THERMAL CNTL	
	07:36:31	3585	C/HT PHT N OF (N)	
	07:36:59	92211	PHTCOMP=0 RELEXP	
	07:37:19	92203	ENA THERMAL CNTL	
	07:37:45	92500	DUMP ALL PM	
	07:40:17	3605	LI P(N) S (R) ON (N)	
	07:40:51	3507	PHT+28V N ON (N)	
	07:46:17	8210	PHT ML CMD 1 NOM	PHT RAM Patch
Event# 81	16:22:00		STATION HANDOVER	Vilspa to Goldstone Handover
Event# 92	15:56:20	3508	PHT+28V N OFF (N)	PHT De-Activation
	15:56:20	92510	DUMP PM BL 8-11	
	15:56:20	92202	DIS THERMAL CNTL	

	15:56:54	3584	C/HT PHT N ON (N)	
	15:56:54	92211	PHTCOMP=0 RELEXP	
	15:56:56	92203	ENA THERMAL CNTL	
	15:57:06	92500	DUMP ALL PM	
	15:57:06	3605	LI P(N) S (R) ON (N)	
	17:11:58	80061	USD. SEL P061	High Precision RPM
	17:16:18	60300	RASTER POINT MODE	test
	18:05:53	80061	USD. SEL P061	High Precision RPM
	18:06:19	60300	RASTER POINT MODE	
	20:45:00			Lunar Eclipse
	23:12:00			Lunar Eclipse End
Event# 113	03:11:00			LOS Goldstone
Event# 115	03:10:00			AOS Kourou
Event# 121	03:30:00			LOS Kourou

Rev# DOY & Event#	Time	MF/Seq Identifier	TC Description	Notes
Rev # 6 Day 327				
Event# 1	03:30:00			Vilspa AOS
Event# 10	06:41:18	92510	DUMP PM BL 8-11	PHT Activation
	06:41:39	92202	DIS THERMAL CNTL	
	06:42:20	3585	C/HT PHT N OF (N)	
	06:43:11	92211	PHTCOMP=0 RELEXP	
	06:43:47	92203	ENA THERMAL CNTL	
	06:44:13	92500	DUMP ALL PM	
	06:47:23	3605	LI P(N) S (R) ON (N)	
	06:47:58	3507	PHT+28V N ON (N)	
	06:51:51	8210	PHT ML CMD 1 NOM	PHT RAM Patch
Event# 52	16:29:00		STATION HANDOVER	Vilspa to Goldstone Handover
Event# 23	08:53:16	3508	PHT+28V N OFF (N)	PHT De-Activation
	08:54:45	92510	DUMP PM BL 8-11	
	08:55:05	92202	DIS THERMAL CNTL	
	08:55:43	3584	C/HT PHT N ON (N)	
	08:56:02	92211	PHTCOMP=0 RELEXP	
	08:56:34	92203	ENA THERMAL CNTL	
	08:57:47	92501	DUMP PM BL 0,1	
	09:00:35	92402	TRANS SC TO HK	Mode Trans to HK
	09:00:35	2025	TM/CC/PSK/NBR	
	09:03:25	92500	DUMP ALL PM	
Event# 66	20:25:19	92383	SHORT DUMP TBUF	Delete PPM Entry Command from TTAG Buffer
	20:26:17	90804	RES TTAG TC QUE	

Event# 67	20:49:09	PLPOI	PPL TARGET QUAT	PPL Containing Delta-V Attitude
Event# 73	22:56:31	PLPOI	PPL TARGET QUAT	New PPL Based on Delta-V perform. predictions
Event# 75	23:17:24	80231	USD. SEL P231	Delta-V AOP Upload
	23:19:09	60400	AOP AGM (NLE)	
	23:19:32	40300	AOP DEL-V (NLE)	
	23:19:55	60403	AOP ST D-V (NLE)	
	23:20:21	66100	AOP LAST ENTRY	
	23:21:12	16313	DUMP AOP BUFF	
Day 328 Event# 78	00:37:43	156	RC AUTSWCK INH A	RCS Delta-V Branch - Preparation
	00:37:58	184	RC AUTSWCK INH E	
	00:39:51	88	BR-2 SW-21 ON	
	00:40:08	92	BR-2 SW-22 ON	
	00:40:28	69	BR-2 CB HTR ON	
	00:41:05	157	RC AUTSWCK ON	
Event# 82	01:26:42	80006	USD. SEL P006	AGM Entry
	01:30:33	60402	AGM_NON AOP	
Event# 85	01:40:30	ORBTI	DB LOAD AND ENA	Update Orbital Period (based on delta-v prediction)
Event# 86	01:50:29	664	AOP ENABLE	TTAG to enable AOP at 328.02.28.00
Event# 87	01:50:50	156	RC AUTSWCK INH A	TTAG to Open LV-2 328.02.31.00
	01:51:10	184	RC AUTSWCK INH E	TTAG 328.02.32.00
	01:51:38	73	LV BRCH2 OPEN	TTAG 328.02.33.00
	01:52:03	157	RC AUTSWCK ENA	TTAG 328.02.34.00
Event# 91	03:35:56			LOS Goldstone
Event#A1-2	03:36:10			AOS Kourou
Event#A1-8	03:56:32			LOS Kourou

Rev# DOY & Event#	Time	MF/Seq Identifier	TC Description	Notes
Rev # 7 Day 328				
Event# 1	03:58:22			AOS Vilspa
Event# 11	05:53:21	92501	DUMP PM BL 0,1	OBDH Transition T9 HK-SC
	05:54:08	92472	HK-SC P (N) /INT	
	05:54:08	2028	TM/CC/SPL/NBR	
Event# 12	06:06:18	92510	DUMP PM BL 8-11	PHT Activation
	06:06:18	92202	DIS THERMAL CNTL	
	06:06:18	3585	C/HT PHT N OF (N)	
	06:06:52	92211	PHTCOMP=0 RELEXP	
	06:06:52	92203	ENA THERMAL CNTL	
	06:07:02	92500	DUMP ALL PM	
	06:07:02	3605	LI P(N) S (R) ON (N)	
	06:07:04	3507	PHT+28V N ON (N)	
	06:09:13	8210	PHT ML CMD 1 NOM	PHT RAM Patch
Event# 22	08:21:17	3508	PHT+28V N OFF (N)	PHT De-Activation
	08:21:17	92510	DUMP PM BL 8-11	
	08:21:17	92202	DIS THERMAL CNTL	
	08:21:51	3584	C/HT PHT N ON (N)	
	08:21:51	92211	PHTCOMP=0 RELEXP	
	08:21:53	92203	ENA THERMAL CNTL	
	08:22:03	92500	DUMP ALL PM	
	08:22:03	3606	LI P (N) S (R) OF (N)	
Event# 23	08:36:43	92433	SC-SC CAM PRIME	OBDH Transition T9 SC-SC CAM Prime
Event# 24	08:40:54	92510	DUMP PM BL 8-11	CAM Activation

	08:40:54	92202	DIS THERMAL CNTL	
	08:41:28	3583	C/HT CAM N OF (N)	
	08:41:28	92202	CAMCOMP=0RELEXP	
	08:41:28	92203	ENA THERMAL CNTL	
	08:41:28	92500	DUMP ALL PM	
	08:41:28	3601	LI C (N) L (R) ON (N)	
	08:41:28	3501	CAM+28V N ON (N)	
	08:44:40	6020	CAM ML CMD NOM	CAM RAM PATCH
Event# 59	15:35:00		STATION HANDOVER	Vilspa - Goldstone
Event# 87	23:52:31	3502	CAM+28V N OFF (N)	CAM De-activation
	23:53:54	3602	LI C(N) L (R) OF (N)	
	23:54:40	92510	DUMP PM BL 8-11	
	23:55:09	92202	DIS THERMAL CNTL	
	23:55:58	3582	C/HT CAM N ON (N)	
	23:56:45	92208	CAMCOMP=1RELEXP	
Day 329	00:06:29	92203	ENA THERMAL CNTL	
Event# 105	03:33:00			LOS Goldstone
Event# 107	03:33:46			AOS Kourou
Event# 113	03:54:00			LOS Kourou

Rev# DOY & Event#	Time	MF/Seq Identifier	TC Description	Notes
Rev # 8 Day 329				
Event# 1	03:58:00			AOS Vilspa
Event# 19	06:06:57	92510	DUMP PM BL 8-11	PHT Activation
	06:06:57	92202	DIS THERMAL CNTL	
	06:07:31	3585	C/HT PHT N OF (N)	
	06:07:31	92211	PHTCOMP=0 RELEXP	
	06:07:31	92203	ENA THERMAL CNTL	
	06:07:41	92500	DUMP ALL PM	
	06:07:41	3605	LI P(N) S (R) ON (N)	
	06:07:43	3507	PHT+28V N ON (N)	
	06:08:56	8210	PHT ML CMD 1 NOM	PHT RAM Patch
Event# 35	08:14:50	3508	PHT+28V N OFF (N)	PHT De-activation
	08:15:26	3606	LI P (N) S (R) OF (N)	
	08:16:45	92510	DUMP PM BL 8-11	
	08:17:13	92202	DIS THERMAL CNTL	
	08:18:47	3584	C/HT PHT N ON (N)	
	08:19:18	92211	PHTCOMP=0 RELEXP	
	08:19:43	92203	ENA THERMAL CNTL	
	08:20:56	92500	DUMP ALL PM	
Event# 36	08:34:34	91501	DUMP PM BL 0,1	OBDH Transition T9 SC-SC LWS Prime
	08:35:51	92435	SC-SC LWS PRIME	
	08:38:27	92500	DUMP ALL PM	
Event# 37	08:41:41	3603	LI L (N) P (R) ON (N)	LWS Activation
	08:42:15	3503	LWS+28V N ON (N)	
	08:43:50			LWS RAM Patch

Event# 80	15:44:00		STATION HANDOVER	Vilspa - Goldstone
				LWS Hold Mode
	20:28:24	92433	SC-SC CAM PRIME	OBDH Transition T9 CAM Prime
	20:30:29	92510	DUMP PM BL 8-11	CAM Activation
	20:30:29	92202	DIS THERMAL CNTL	
	20:31:03	3583	C/HT CAM N OF (N)	
	20:31:03	92202	CAMCOMP=0RELEXP	
	20:31:03	92203	ENA THERMAL CNTL	
	20:31:03	92500	DUMP ALL PM	
	20:31:13	3601	LI C (N) L (R) ON (N)	
	20:31:15	3501	CAM+28V N ON (N)	
	20:41:53	3502	CAM+28V N OFF (N)	CAM De-activation
	20:41:53	92510	DUMP PM BL 8-11	
	20:41:53	92202	DIS THERMAL CNTL	
	20:42:27	3582	C/HT CAM N ON (N)	
	20:42:27	92208	CAMCOMP=1RELEXP	
	20:42:29	92203	ENA THERMAL CNTL	
	20:42:39	92500	DUMP ALL PM	
	20:42:39	3602	LI C(N) L (R) OF (N)	
	20:44:27	92420	SC-SC L N/CPD N	LWS Prime
Day 330 Event# 94	01:33:16	3504	LWS+28V N OFF (N)	LWS De-activation
	01:34:08	3604	LI L (N) P (R) OF (N)	
Event# 112	03:31:00			LOS Goldstone
Event# 114	03:32:00			AOS Kourou
Event# 120	03:51:49			LOS Kourou

Rev# DOY & Event#	Time	MF/Seq Identifier	TC Description	Notes
Rev # 9 Day 330				
Event# 1	03:50:02			AOS Vilspa
Event# 19	05:44:20	92510	DUMP PM BL 8-11	PHT Activation
	05:44:20	92202	DIS THERMAL CNTL	
	05:44:54	3585	C/HT PHT N OF (N)	
	05:44:54	92211	PHTCOMP=0 RELEXP	
	05:45:04	92203	ENA THERMAL CNTL	
	05:45:04	92500	DUMP ALL PM	
	05:45:04	3605	LI P(N) S (R) ON (N)	
	05:45:06	3507	PHT+28V N ON (N)	
	05:46:32	8210	PHT ML CMD 1 NOM	PHT RAM Patch
Event# 35	07:43:50	3508	PHT+28V N OFF (N)	PHT De-activation
	07:44:39	3606	LI P (N) S (R) OF (N)	
	07:45:28	92510	DUMP PM BL 8-11	
	07:46:03	92202	DIS THERMAL CNTL	
	07:47:42	3584	C/HT PHT N ON (N)	
	07:48:33	92211	PHTCOMP=0 RELEXP	
	07:49:04	92203	ENA THERMAL CNTL	
	07:49:34	92500	DUMP ALL PM	
Event# 36	08:00:00	92439	SC-SC SWS PRIME	OBDH Transition T9 SC-SC SWS Prime
Event#37	08:03:58	92510	DUMP PM BL 8-11	SWS Activation
	08:04:28	92202	DIS THERMAL CNTL	
	08:05:23	3589	C/HT SWS T N OF (N)	
	08:06:07	92215	SWSCOMP=0RELEXP	
	08:06:24	92203	ENA THERMAL CNTL	

	08:06:45	92500	DUMP ALL PM	
	08:07:51	3607	LI S(N) C (R) ON (N)	
	08:08:28	3505	SWS+28V N ON (N)	
	08:11:57	9020	SWS ML CMD 1 NOM	SWS RAM Patch
Event# 68	15:40:00		STATION HANDOVER	Vilspa - Goldstone
Event# 141	19:54:11	3506	SWS+28V N OFF (N)	SWS De-activation
	19:54:11	92510	DUMP PM BL 8-11	
	19:54:11	92202	DIS THERMAL CNTL	
	19:54:45	3588	C/HT SWS N ON (N)	
	19:54:45	92214	SWSCOMP=1RELEXP	
	19:54:47	92203	ENA THERMAL CNTL	
	19:54:57	92500	DUMP ALL PM	
	19:54:57	3608	LI S (N) C (R) OF (N)	
Day 331 Event# 159	03:27:00			LOS Goldstone
Event# 162	03:28:00			AOS Kourou
Event# 167	03:49:00			LOS Kourou

Rev# DOY & Event#	Time	MF/Seq Identifi er	TC Description	Notes
Rev # 10 Day 331				
Event# 1	03:47:00			AOS Vilspa
Event# 36	09:10:06	80231	USD. SEL P231	Cryo Cover Ejection Preparation
	09:18:38	80008	USD. SEL P008	
Event# 37	09:22:13	60200	FINE POINT MODE	Slew to Cover Ejection Attitude
Event# 38	09:40:05	16500	DMUAREGLO	Inhibit ELS-A Process
Event# 39	09:40:22	16600	DMUBREGLO	Inhibit ELS-b Process
Event# 40	09:41:06	80031	USD. SEL P031	Update Speed Limits ACC DB
	09:43:25	70362	DB_LOAD V00362	
	09:43:40	16006	DB ENABLE RMC	
	09:43:55	70363	DB_LOAD V00363	
	09:44:10	16006	DB ENABLE RMC	
	09:44:25	16319	DUMP FULL DB	
Project Request	10:06:00	80252	USD. SEL P252	Update VFALLB (DB 360) (1.0+E6)
	10:06:35	79998	DB LOAD FP/LI	
	10:07:03	813	ACC DB ENA CMD	
	10:07:23	16319	DUMP FULL DB	
Event# 43	10:15:17	80008	USD. SEL P008	Upload Critical RAC for slew to SAA of 85 Degrees
	10:17:07	60405	AGM_NON AOP CRIT	
Event# 44	10:23:00	3003	NCA: ARM REL 1ON N	Cryo Cover Ejection and Slew from SAA of 65 °
	10:23:00	3003	NCA: ARM REL 1ON N	
	10:25:00	3005	NCA: ARM REL 2ON N	

	10:27:43	3001	NCA: FIR REL ON N	Cover Release
	10:27:58	1	RMC ENABLE	Slew SAA 85° exec.
	10:33:50	3007	NCA: ARM1+2 OF (N)	
	10:40:37	1001	V501 ARMING ON	Restore CRYO Valve
	10:40:47	1040	V503 ARMING ON	Status in OBDH TM
	10:40:58	1007	V504 ARMING ON	
	10:41:09	1046	V506 ARMING ON	
	10:43:13	1005	VALVE V501 OPEN	
	10:43:23	1044	VALVE V503 OPEN	
	10:43:33	1009	VALVE V504 OPEN	
	10:43:43	1048	VALVE V506 OPEN	
	10:47:46	1002	V501 ARMING OFF	
	10:47:58	1041	V503 ARMING OFF	
	10:48:11	1008	V504 ARMING OFF	
	10:48:35	1947	V506 ARMING OFF	
Event# 45	10:46:59	80008	USD. SEL P008	FPM After Cover Ejection
	10:47:35	60200	FINE POINT MODE	
Event# 46	10:48:35	80231	USD. SEL P231	Restore RCS Configuration
	10:49:03	156	RC AUTSWCK INH A	
	10:49:18	184	RC AUTSWCK INH E	
	10:49:37	71	LV BR-1 OPEN	
	10:49:52	92	BR-2 SW-22 ON	
	10:50:04	73	LV BR-2 OPEN	
	10:50:42	91	BR-2 SW-22 OFF	
	10:51:33	157	RC AUTSWCK ENA	
Event# 47	11:06:25	80031	USD. SEL P031	Restore Default Values for Speed Limit Check ACC DB
	11:06:50	70362	DB_LOAD V00362	
	11:07:05	16006	DB ENABLE RMC	

	11:07:20	70363	DB_LOAD V00363	
	11:07:35	16006	DB ENABLE RMC	
	11:07:50	16319	DUMP FULL DB	
	11:10:18	70360	DB_LOAD V00360	
	11:10:38	16319	ACC DB ENA CMD	
	11:10:58	16319	DUMP FULL DB	
Event# 49	11:12:48	16500	DMUAREGLO	Re-enable ELS-A Processing
Event# 50	11:13:22	16600	DMUBREGLO	Re-enable ELS-B Processing
Event# 64	16:13:00		STATION HANDOVER	Vilspa - Goldstone
Day 332 Event# 113	03:23:00			LOS Goldstone
Event# 115	03:27:00			AOS Kourou
Event#121	03:40:00			LOS Kourou

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