# SWS Photometric Calibrations at EOM. I.

References to IOCD (ISO 94-023)

References to Routine Calibration Programme (ISO 95-032)

Summary of Routine Phase Observations & Spectral Energy Distributions

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# Contents

# 1 *Purpose*

General references to the calibration databases and procedural documentation relevant to the photometric calibration of the SWS grating sections and F-P etalons over the full Routine Phase are given in this document. Part II contains the analysis details.

Referencing documentation such as the IOCD is done by giving brief indications about where the photometric calibration plan and procedures have evolved since launch, specifically over the Routine Phase. The requirements themselves are not rewritten here, and analysis plus results as they stand at EOM are contained in Part II. The referencing here includes the final "Level II" schedule of photometric-related calibration observations (`CO`[1]), along with the database of non-SWS reference fluxes, the sources of data for CAP application. The following pages, in other words, are the reference of the uplink/downlink interface for the photometric calibration of SWS.

Contents herein chiefly concern the 6.2.4 requirements of **grating and F-P flux calibration**. Clearly there has been a strong dependence of flux scale verification and uncertainty assessment on the existing grating RSRFs, which have seen several minor adjustments in various AOT bands, and two major upgrades in all AOT bands but 4. **Items of RSRF studies and distribution of `CO`s** — falling within the scope of work to derive and validate the grating flux scales — are necessarily mentioned. Detailed descriptions are given in the EOM documentation on the RSRFs, and *must* be consulted for a thorough overview on the calfile (CAL25, CAL13) inputs used in the pipeline to convert all scan data from $\mu$V/s to Jy. Instrument Beam Profile calibration activity details are also found in separate EOM documentation, with some items covered in Part II as passing application of data acquired for flux calibration. Other applications of the photometric `CO`s (e.g., **checks of linearity as a function of signal**, **signal-induced noise**, **detector array flatfielding**), either within the fluxcal CAP environment or tangential to it, are also referenced here and detailed in Part II.

Effort has been given to refer to documents for items which are not specifically covered by the present activities, but are still relevant to the photometric error budget. This is guaranteed to be incomplete, on realizing that there are few if any levels of detector calibrations, software, AOT logic changes, S/C systems and the space environment which do not affect the photometric performance of SWS.

# 2 References to IOCD

Fundamental procedures and justifications for types of `CO`s and measurements fulfilling most calibration requirements are found in the IOCD (ISO 94-023, last update Sep 1995). More details on the range, sources and optimal frequency of internal and celestial observations were projected in the Routine Calibration Programme document (ISO 95-032). This plan

[1] In this font, `CO` is distinguished from the CO molecule.

was modified according to experience of PV, and subsequently over the course of the Routine Phase.

In this section, items from the IOCD related to the photometric calibrations are recalled, specifically for calling attention to certain aspects or changes in implementation. The focus is mainly on the 6.2.4 items, but it must be acknowledged that there are few (if any) levels of calibration and pipeline software which are not a part of the photometric conversion chain (further emphasized in Part II).

## 2.1 Flux Calibration 6.2.4.1 (Grating), 6.2.4.5 (F-P)

The scaling constants between signal ($\mu$V/s) at the end of the detector calibration chain, and flux density (Jy) by detector and AOT band were planned to be deducible chiefly from the output signal obtained from S06 `CO`s of various ACSs over passbands $\Delta\lambda_{\rm key}$ centered at key wavelength $\lambda_{\rm key}$. Originally, 18 key wavelengths were defined for 11 grating and 5 F-P AOT bands, including auxiliary key wavelengths in band 4 and band 6. The number of grating $\lambda_{\rm key}$ is increased to 13 since last writing of the IOCD with (1) the introduction of AOT band 3E to alleviate optical leakage of high signal from the 14.0-14.8$\mu$m region into the 29$\mu$m region (SCREW 102), and (2) the introduction of auxiliary key wavelength $\lambda_{\rm key}(2C')$ at 11.0$\mu$m. This key was defined in recognition of potential difficulty at $\lambda_{\rm key}(2C) = 7.7\mu$m where primary stellar calibrators of spectral types late G through M may be strong in SiO fundamental bandhead absorption.

Table 1 updates IOCD table 6.2.4.1-a to include bands 2C$'$ and 3E.

The S06 key wavelength strategy was used throughout the mission, but heavier emphasis than projected in the IOCD and Routine Calibration Programme document was placed on obtaining S01 scans at all four speeds over the mission (cf. Section 3) for verification of the flux scale, RSRF, and Beam Profile analyses, particularly for the grating sections.

For the F-P, sources considered to be continuum in their emission at the 5A-6$'$ key wavelengths were observed for the derivation of CAL13 values, requiring signal only at each $\lambda_{\rm key}$ itself. But due to limited visibility of suitably bright ACSs and the difficulty of confirming the pure continuum expectation prior to observation planning (at least to the detection threshold, which would evolve over the mission with the reduction software), it was decided to obtain signal across each $\Delta\lambda_{\rm key}$in *all* F-P fluxcal observations. This implies the need for a detailed knowledge of the grating instrumental profile as seen by the F-P (6.3.2.6) and current wavelength calibration accuracies to assess the impact on the flux scales by F-P order leakage where it occurs. See EOM report on the instrumental profile. Prior to the uplink change involving pseudo-aperture 4 (SCREW 187) in rev237, most of these observations were obtained in CUS mode to save time by lower sampling per F-P resolution element. The observations were done with S07 subsequent to this when it was realized that the extra 10-20 min, depending on source brightness, could be accommodated in allocated calibration time.

The final distribution of observations among AOTs and sources is covered below.

Among the inputs expected to be needed for 6.2.4.1 and 6.2.4.5 analyses are:

Table 1: Key wavelengths and passbands for flux calibration

| Sequence | AOT band | $\lambda_{\mathrm{key}}$ [$\mu$m] | $\lambda_{\mathrm{nonlinearity}}$ [$\mu$m] | $\Delta\lambda_{\mathrm{key}}$ [$\mu$m] |
|---|---|---|---|---|
| GR | 1A | 2.480 | * | 0.05 |
| GR | 1B | 2.870 | * | 0.07 |
| GR | 1D | 3.080 | * | 0.07 |
| GR | 1E | 3.800 | 3.800 | 0.10 |
| GR | 2A | 4.500 | * | 0.10 |
| GR | 2B | 5.900 | * | 0.20 |
| GR | 2C | 7.700 | 7.700 | 0.20 |
| **GR** | **2C′** | **11.000** | * | **0.20** |
| GR | 3A | 14.000 | * | 0.30 |
| GR | 3C | 17.000 | * | 0.30 |
| GR | 3D | 24.000 | 24.000 | 0.60 |
| **GR** | **3E** | **28.500** | * | **0.60** |
| GR | 4 | 32.000 | 32.000 | 0.60 |
| GR | 4′ | 40.000 | * | 0.60 |
| FP | 5A | 11.800 | * | 0–0.02 |
| FP | 5B | 14.000 | * | 0–0.03 |
| FP | 5C | 17.000 | * | 0–0.03 |
| FP | 5D | 24.000 | 24.000 | 0–0.06 |
| FP | 6 | 27.000 | 27.000 | 0–0.06 |
| FP | 6′ | 38.000 | * | 0–0.06 |

- Representative signal from internal sources (6.2.4.2) for determining $S^d_{ACS}$ and monitoring drift is met by measurements of the internal illuminator with each detector, except for band 1 (SCREW 110). See CAP summary, and further discussion in Part II on the measurement and use of the photochecks.

- Linearity as a function of flux (6.2.4.3) is covered in trend analyses (Part II), but no non-linear terms have been arrived at for inclusion in CAP or pipeline software to improve flux accuracies.

- The IOCD also calls for the RSRFs (6.2.4.4 and 6.2.4.7) for *comparison* purposes, but in practice these have been applied to the external signals following dark current subtraction, effectively dividing out $\lambda$-dependent response variations prior to CAP application and flux scale verifications.

- ILT TPF72 reductions contain initial detector responses for comparison.

- Non-SWS ACS measurements (photometry and spectrophotometry) are needed to establish the flux scale of the grating sections. Ideally this applies also to the brighter ACSs observed for F-P calibration, but independent fluxes over SWS wavelengths have been limited, and are judged to be inferior to using SEDs obtained with the grating sections. See CAP6245 summary. Independent measurements of bright F-P flux calibrators are used instead for comparison.

The basic steps of the CAPs are outlined in the IOCD, adding to this the following summary of implementation. It is not necessary rewrite the online documentation, which is sufficient in its description on definitions and calculation details.

### 2.1.1 CAP6241

The CAP6241 has been used interactively to derive all grating flux scale parameters needed to convert $\mu$V/s$\longrightarrow$ Jy near the end of the pipeline. The calculation of F-P flux scale parameters is done in CAP6245. Both CAPs operate on individual SPDs created with OLP6.0 and later (otherwise derived in IA from ERD), and processed through stages of ANTIMEM, DARK, RESPCAL, and VELCOR. The processed internal and external signals and reference SEDs provide the basic inputs (a database of CAL13 structures) for the optimization process which takes place outside the CAP environment, leading to a master CAL13 called on by FLUXCON. Only the master CAL13(s) are delivered to OLP and inserted in IA (see Part II). The grating parameters stored in the CAL13 structures have been used to evaluate linearity as a function of flux (6.2.4.3). Signal and noise characteristics are separately written to a structure to estimate photon induced noise $N_S$ characteristics at different signals (6.2.2.8) with a call to the CAP6228 within CAP6241.

Several subroutines are called from the CAP6241, performing the following operations on a detector basis:

1. Location and measurement of the internal illuminator signal (C241_PHOT). In bands 2-4,

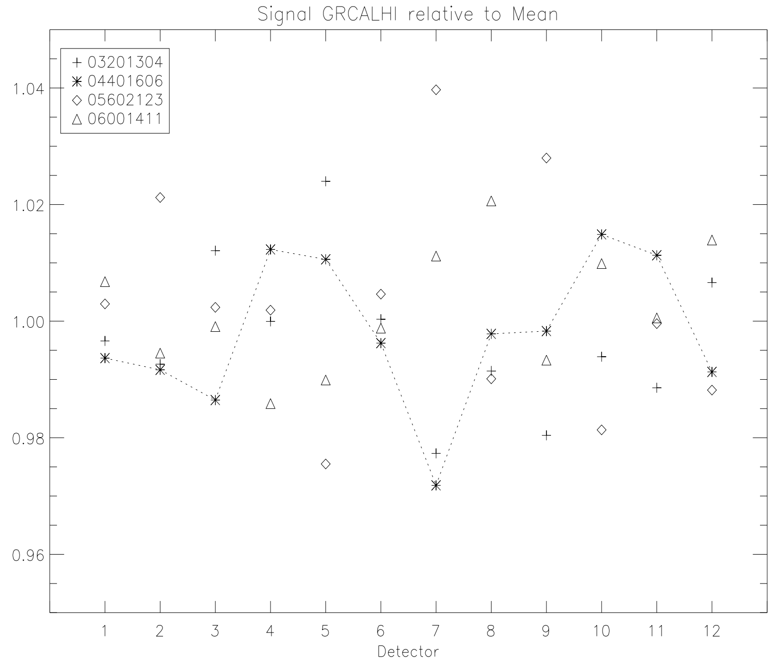


Figure 1: Stability of the internal calibrator high signal as seen by the band 1 detectors during PV. By detector for a given observation, the GRCALHI signal is measured first as the median of valid points (excluding first and last), and then normalized to detector mean. The connected points correspond to the default GRCALHI dataset used in CAP6241.

- the first grating calibrator signal at low power setting is located;
- data are trimmed to those reliably unaffected by systematic timing errors (removing first and last signal points);
- and the median of the remaining data is taken following 3-point median-filtering.

Each step is consistent with the pipeline processing (FLUXCON) of science observations. In band 1, the first grating calibrator signal at high power setting (GRCALHI) is located, and measured as above. Following uplink of SCREW 110 (rev064), this photometric check was eliminated from the AOT logic due to significant memory of it in bands 2 and 4. **If a GRCALHI photocheck is not located, then a default set is taken from a previous `CO`. The default set is the dark-subtracted band 1 GRCALHI photometric check from 04401606 (HR6705).**[2] Using OLP6.0, the grcalhi band 1 photocheck in PV observations is stable to within 3% aside from a glitched outlier in detector 7 of 05602123; see Fig. 1.

2. Flexible selection of data from input SPD by detector / AOTband (C241_SELECT).

   Two simple but significant modifications were made to the default application of C241_SELECT (SPR_S0234):

   (a) Signal discrimation, exploiting glitch recognition techniques in place by OLP 6.0 and later (see Glitch Recognition Report and OLP reports by EkW). Zero weight

[2]This reference structure is not yet stored in the IA CAL database.

is assigned to all signal points whose corresponding slopes were measured from ramps containing *three* or more invalid samples, regardless of reset interval. These points correspond to some of the worst outliers, and invariably affect the median signal level over $\Delta\lambda_{\mathrm{key}}$, particularly in band 4. Representative cases are shown in Fig 2.

Note that the method of discriminating away some fraction of all signal points (10-15% in band 4) is arrived at by current glitch recognition techniques, and is not expected to be harmful to flux scale parameter determination with future deglitching developments.

(b) Default inclusion of both scan directions in S06 calibration measurements, excepting band 2 in some cases. Originally, only the second scan (SDIR = $-1$) was selected to marginalize possible discrepancies due to memory effects between scan data, dark currents, and the internal photometric checks. This is found to be unimportant except in band 2 above some threshold, roughly 100 Jy at any of the four key wavelengths. It is irrelevant in band 4 where ACS signal in this stream of calibrations has been below the memory regime of these detectors. Linearity is covered in Part II.

3. Calculation of parameters (C241_PARAMS) from selected data to fill a calfile structure (C241_MKCAL), either a CAL13 or structure with signal and noise columns (defined in C228_STRUCT). An open SPR_S233 currently exists on the C241_PARAMS subroutine of CAP6241 for proper error calculation.

Finally, note that the CAP6241 has options for combining several individual and equally-weighted CAL13 structures into a single CAL13. Perhaps useful for experiments with calfiles obtained from a limited number of homogeneous observations (such as revolution-basis stability checks; Part II), this option has been generally bypassed in favor of manual operations to handle statistical weighting.

#### 2.1.2 CAP6245

The CAP6245 is the F-P counterpart to CAP6241. For simplicity, and in recognition of the formal distinction between grating and F-P calibration requirements in the IOCD, the software procedures for calculating the F-P flux scale parameters were removed from the CAP6241 environment near the beginning the the Routine Phase to a self-contained environment. Since then, only one slight procedural change (median instead of mean measurement of photometric checks) has been made. Aside from skipping first and last data points in the photocheck, no other filtering of detector output is done.

Concerning CAP6245 output:

- As the F-P fields are calculated separately from the those of the grating, care must be taken to avoid transcription errors when merging into a single CAL13.
- It was noted above that use of scan data obtained with the grating sections serves as reference levels for F-P flux calibration. The amount of independent (non-SWS)

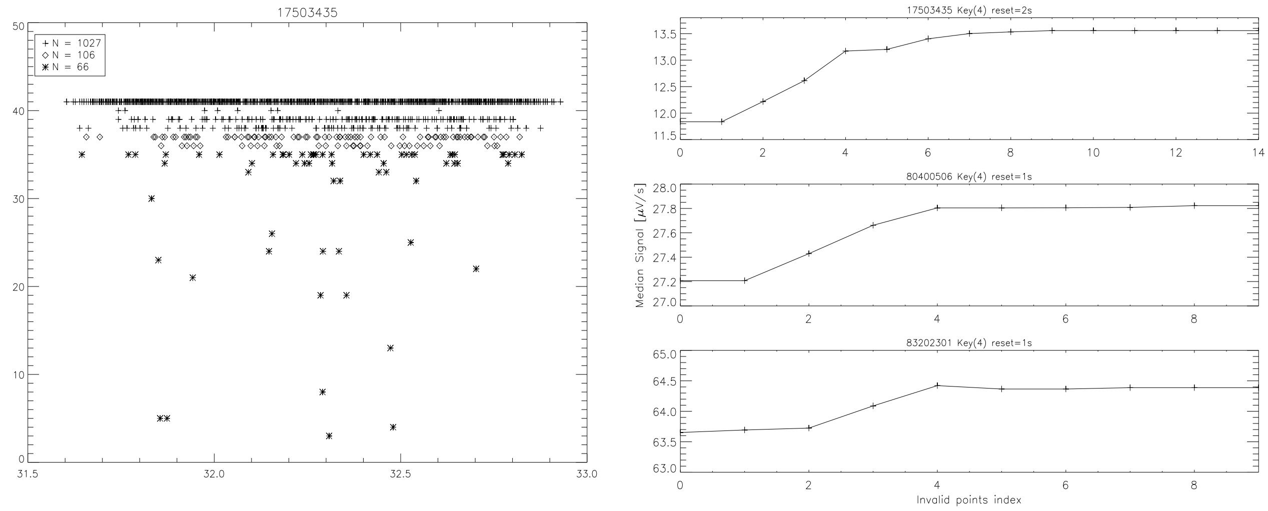


Figure 2: Left: Example of wavelength versus number of valid points per signal ramp in $\lambda_{\rm key}(4)$. Each point corresponds to one signal ramp. The abscissa values are taken from spd.data.det.offset for scan data over $\Delta\lambda_{\rm key}(4)$ in detectors 37-48, where "offset" equal to $t_{\rm reset}*24-{\rm cutout}-N_{\rm invalid}$ is the number of bit values finally used to derived the corresponding value in $\mu$V/s. Right: The effect of excluding glitched points on median signals over $\Delta\lambda_{\rm key}(4)$. The zero-index corresponds to using only "clean" ramps (as far as OLP6.0 glitch detection is concerned). It is clear in all three cases that the median signal is significantly affected once data points with more than 3 bad bits values along the corresponding ramps are no longer excluded.

photometry or spectrophotometry has been limited for suitably bright sources over the accessible wavelength range of the F-P etalons, and methods of applying these data (entailing filter irradiance corrections, beam size corrections, and spline or black-body interpolation) were judged to result in generally larger photometric uncertainties compared to those of the LW grating section. The calibration strategy for the F-Ps has been to rely on grating scans of the brightest sources in the sky (see Sec. 3), subject to their restricted visibilities and neglecting the loss of light due to aperture effects. To account for the latter requires a model with detailed grating beam profile information, and an approximation for the spatial brightness distributions in the 11-45$\mu$m range. The independent data are used to check flux calibration consistency. Error analysis for the grating and F-P sections is in Part II.

### 2.1.3 CAP6228

The photon-induced noise term, $N_S$, of the overall noise per reset interval [Eq. (5.1) of the SWS Observer's Manual] was measured prior to launch (FM_ILT5) and stored and CAL07. It was intended (6.2.2.8) to check these values during PV using data acquired for flux calibration, by forcing a straight line through a comparison of noise vs. $\sqrt{S(\mu V/s)}$ for $S \geq 100\mu V/s$. No change with respect to the ILT measurements was reported (cf. SWS PV report).

$N_S$ has been verified (Part II) with a call to CAP6228 from within CAP6241. An output structure (cf. C228_STRUCT) follows each application, where noise, signal, reset interval, detector, and aotband are stored. The computation of signal and noise is straightforward, and no effort has been put into improving the efficiency of the CAP6228 due its limited scope.

### 2.2 Detector linearity 6.2.4.3 (Grating), 6.2.4.6 (F-P)

It was expected from ILT tests (TPF87) that all detectors are photometrically linear in their response, up to some 50000 Jy. The linearity at one key wavelength per detector block (see Table 1) is checked inflight by a simple comparison of the Relative Flux (dimensionless) to the expected fluxes (Jy). If response is linear at all signal levels, then the ratio of Relative Flux / Expected Flux is a constant. Sources at extremely high flux ($10^5$ Jy range) tend to lack reliable reference SEDs, however. <u>This comparison has been performed only for the grating detector materials</u>.

### 2.3 Relative Spectral Response Function 6.2.4.4 (Grating)

It was intended to verify the fine structure of the grating ILT RSRFs (cf. TPF72) early in the mission (once in PV, once or so during the Routine Phase) with highest-sampled grating scans of relatively featureless sources such as Ceres or Pallas. S/C tracking of SSO objects immediately imposed substantial losses of continuum flux within each tracking step that, together with the resulting fringe pattern shifts, hinder fine-structure verification.

Early flux calibration was more seriously limited by apparent broad-band errors in the RSRFs, tracible partly to the need to correct for point-source diffraction losses (see notes by D. Beintema). **An emphasis was therefore placed on obtaining S01 scans of a range of celestial calibrators**, revealing the need for correction terms beyond first order in bands 1-3. The S01s listed in Table 2 have been exploited for a range of flux calibration and AOT comparison/reproducibility investigations. CUS observations of some SSO objects (Ceres, Callisto), corrected for tracking-related flux losses with latest techniques, together with new modeling should improve the broad-band accuracy of the band 4 RSRF. Fine-structure and narrow-band improvements are currently focused on a detailed comparison of S01 and S06 observations (primarily from SWS_CAL and the STARMOD and ZZSTARMOD programmes) to model stellar atmospheres of Vega, Sirius, and the cool giants (see EOM RSRF report, and Decin et al., 1997, ISO Spectroscopy Workshop proceedings).

## 3 References to Routine Calibration Programme

Table 2 summarizes the completed schedule of `CO`s related to the photometric calibration. The column under which a source is listed indicates the *main* intended calibration activity, as given in SWS_schedule_revNNN.lis. For some revolutions, a source may be listed in more than one column, indicating in some cases different TDT/OSN numbers. See Tables in Section 4 for comparison. Table 2 updates Table 1 of the SWS Routine Calibration Programme document (ISO 95-032), and refers only to OBSID SWS_CAL.

Table 2: Final SWS PV and RP photometric calibration schedule.

| REV | GR-FLUXCAL 6.2.4.1.S06 | FP-FLUXCAL 6.2.4.5.C0 6.2.4.5.S07 | GR-FLUXCAL 6.2.4.1.S01 | GR-RSRF 6.2.4.4.S06 6.2.4.4.C0 | GR-FLUXCAL VERIF. or AOT TEST 6.2.4.1.S01/S06 or none |
|---|---|---|---|---|---|
| 24 | | | | | NGC6543 |
| | | | | | NGC7027 |
| | | | | | HR6705 |
| 28 | | | | | GL2591 NIRS01 |
| | | | | | NGC6543 |
| 32 | HR6705 | | | | P Cyg |
| | | | | | NGC6543 |
| 36 | | | | | Cyg OB2 12 |
| 40 | | | | | HR4049 |
| | | | | | AG Car |
| | | | | | V778 Cyg |
| | | | HR4534 | | |
| 44 | HR5340 | | | | |
| | HR5981 | | | | |
| | HR7504 | | | | |
| | HR6705 | | | | |
| | HR7310 | | | | |
| 48 | HR8775 | NML Cyg | | | WR147 |
| 52 | PALLAS | PALLAS | NML Cyg | PALLAS | |
| | HR7310 | NML Cyg | | | |
| 56 | HR6705 | | HR5340 | | IRAS21282+5050 |
| | HR5563 | | | | HR8775 |
| | | | | | HR8316 |
| 60 | HR6688 | | HR7341 | | AFGL4106 |
| | HR7341 | | | | |
| | HR7310 | | | | |
| 64 | HR5755 | S140 IRS | | | S140 IRS |
| 68 | | CERES | | | |
| 71 | HR5563 | S140 IRS | HR5340 | | eta Car |
| 72 | HR7310 | | HR7310 | | HR4621 |
| | HR6705 | | | | IRN-CHA1 |
| | | | | | HD100546 |
| 86 | HR5340 | | | HR7001 | |
| | HR7001 | | | | |
| 93 | HR6705 | | | HR7001 | |
| | HR7310 | | | | |
| 100 | CERES | CERES | | CERES | |
| 105 | HR6705 | | | HR7001 | |
| 112 | HR5563 | | | | |
| 119 | HR6705 | CERES | | | |
| | HR7001 | | | | |
| 126 | HR7310 | | | | |
| 133 | HR6705 | | | | |
| 140 | HR6688 | | | | |
| 147 | HR6705 | | | | |

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|---|---|---|---|---|---|
| 154 | | IRC+10420 | | NML Cyg | |
| 161 | HR6705 | | | NML Cyg | |
| 168 | | NML Cyg | | NML Cyg | |
| 175 | HR6705 | W51-IRS2 | | | |
| 182 | HR7001 | NML Cyg | HR5563 | | |
| 189 | HR6705 | | HR4534 | | |
| 196 | HR8775 | | HR8775 | | |
| | | | HR7310 | | |
| 201 | HR6705 | | | | |
| 203 | HR6705 | NML Cyg | | | |
| 206 | HR8775 | | HR8775 | | |
| | | | HR7310 | | |
| 217 | HR5340 | eta Car | | | |
| 223 | HR4763 | S140IRS | | | |
| 224 | | | | | AG Car |
| 230 | | | | | NGC7027 |
| 237 | HR6705 | | | | eta Car |
| 244 | | | HR5340 | | eta Car |
| 251 | HR5340 | | | | |
| 258 | HR5340 | | HR4763 | | W Hya |
| | HR6705 | | | | |
| 265 | HR7001 | | | HR7001 | W Hya |
| 272 | HR5340 | | | | NGC3603 |
| 279 | HR6705 | S140IRS | | | |
| | HR8316 | | | | |
| 286 | HR5563 | | | | |
| 293 | HR6705 | | | | |
| 300 | HR6705 | | | | NGC40 |
| 307 | HR7001 | | | | |
| 312 | CERES | | | CERES | |
| 314 | HR7310 | IRC+10420 | NGC6688 | | |
| 321 | HR6705 | | | | |
| | URANUS | | | | |
| 328 | NEPTUNE | | | HR7001 | P Cyg |
| 335 | HR6705 | | | | |
| | URANUS | | | | |
| 342 | NML Cyg | NML Cyg | NML Cyg | | |
| 349 | HR6705 | | | | |
| 356 | HR7001 | | | | |
| 363 | HR5563 | | | | |
| 370 | HR6705 | | | | |
| 377 | HR8775 | | HR6705 | | |
| 384 | HR6705 | | | | K3-50 |
| 391 | HR6688 | | | | |
| 398 | HR6705 | | HR8316 | | |
| 406 | HR5563 | | | | |
| | HYGIEA | | | HYGIEA | |
| 412 | HR6705 | | HR5340 | | |
| | HYGIEA | | | HYGIEA | |
| 419 | HR5340 | | | | ST Her |
| | JUNO | | | JUNO | |
| 426 | HR6705 | | | | PZ Cas |
| 432 | | | | | HYGIEA |
| 433 | HR5340 | | | | |
| 440 | HR5340 | | HR0337 | | W Hya |
| 448 | HR7310 | | | | |

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|---|---|---|---|---|---|
| 453 | HR6705 | | | | |
| 461 | JUNO | | | ZODIACAL | |
| 468 | HR6705 | | | | |
| 475 | HR7001 | | | | |
| 481 | | | | | NGC7023 |
| 482 | HR6705 | | | | |
| 489 | HR5755 | | | | R Aql |
| 496 | NEPTUNE | K3-50 | HR6705 | | |
| 501 | HR6705 | | | | |
| 503 | HR5755 | | | HR5755 | |
| | HR6705 | | | | |
| 510 | HR6688 | NML Cyg | | | |
| | NML Cyg | | | | |
| 517 | HR6705 | | | | G79.29 |
| | NEPTUNE | | | | |
| 524 | HR5563 | | | | |
| 531 | HR6705 | | | | R Aql |
| 538 | HR6705 | | | HR6705 | HR8636 |
| 544 | HR6705 | | | | |
| 552 | HR8775 | | | | |
| | PALLAS | | | PALLAS | |
| 559 | HR6705 | | | HR6705 | |
| 566 | HR6688 | | | | |
| 573 | HR6705 | | | | |
| 579 | HR5563 | | | | |
| | VESTA | | | | |
| 587 | HR6705 | | | NML Cyg | |
| 594 | HR4763 | | | HR4763 | |
| | HR5340 | | | | |
| 601 | HR6705 | | | | |
| | HR5340 | | | | |
| 608 | HR4763 | | | HR4763 | |
| | HR5340 | | | | |
| 615 | HR6705 | | | | |
| 622 | HR4763 | | | | |
| 629 | HR6705 | | | | DO 24107 |
| 636 | HR5340 | | HR1457 | | |
| 643 | HR4763 | | | | |
| 650 | HR7001 | | | | |
| | HR1457 | | | | |
| 657 | HR6705 | S140IRS | | | |
| 664 | HR1457 | | | | |
| 671 | HR6705 | | | | |
| | PALLAS | | | PALLAS | |
| 678 | HR7001 | | | HR7001 | |
| | | | | | R Aql |
| 681 | HR1457 | | | HR1457 | |
| 685 | HR6705 | IRC+10420 | | | |
| 689 | | | HR2491 | | |
| 692 | | | | | G79.29 |
| 698 | | | | | CALLISTO |
| 699 | HR6705 | | | | |
| 706 | | | | NML Cyg | GANYMEDE |
| 707 | HR2491 | | | | |
| 713 | HR6705 | | | | |
| | URANUS | | | | |

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|---|---|---|---|---|---|
| 714 | | | | | EUROPA |
| 720 | HR2491 | | | | G79.29 |
| 721 | | | | | GANYMEDE |
| 727 | HR6705 | | | | |
| | beta Lyr | | | | |
| 728 | | | | | EUROPA |
| 736 | beta Lyr | | | | |
| 741 | HR6705 | | NML Cyg | | |
| 742 | | | | | GANYMEDE |
| 748 | CERES | | | NGC104 | |
| 755 | HR6705 | | | | |
| 762 | HR8775 | | | | |
| | CERES | | | | |
| 769 | HR6705 | | | ZODIACAL | |
| 776 | VESTA | | | M 13 | |
| 783 | HR6705 | | | | |
| 784 | SATURN | | | SATURN | |
| 790 | SATURN | | | | VESTA |
| 797 | HR6705 | | | | HR0911 |
| 804 | HR0337 | | | | VESTA |
| 811 | HR6705 | | HR6705 | | NGC40 |
| 818 | HR7001 | | | HR1457 | |
| | HR7310 | | | | |
| 825 | | | | | VESTA |
| 827 | HR6705 | | | | |
| 832 | HR1457 | | | | |
| | HYGIEA | | | | |
| 839 | HR6705 | S140IRS | | | Cep B |
| 846 | HR7001 | | | | |
| | beta Lyr | | | | |
| 853 | HR6705 | | | | |
| 860 | HR1457 | | | HR1457 | |
| 867 | HR6705 | | | | |
| 874 | HR2491 | | | HR2491 | |
| 878 | HR2491 | | | | |

# 4 6.2.4 Observations Summary

6.2.4.1 S06

| TDTOSN | RA<br>hh mm ss.ss | DEC<br>d ' '' | I time<br>h m s | UTC start | target | coverage<br>& remarks |
|---|---|---|---|---|---|---|
| 03201304 | 17 56 36.41 | +51 29 20.3 | 0 36 22 | 19 Dec 1995 20 17 05 | HR6705 | k |
| 04401092 | 14 15 40.01 | +19 11 04.7 | 0 36 22 | 31 Dec 1995 10 00 55 | HR5340 | k |
| 04401112 | 16 02 05.60 | +52 54 57.5 | 0 58 06 | 31 Dec 1995 10 43 59 | HR5981 | k |
| 04401317 | 19 41 51.94 | +50 31 03.9 | 0 35 56 | 31 Dec 1995 12 46 59 | HR7504 | k |
| 04401606 | 17 56 36.41 | +51 29 20.3 | 0 36 20 | 31 Dec 1995 14 42 01 | HR6705 | k |
| 04401711 | 19 12 33.09 | +67 39 41.2 | 0 36 56 | 31 Dec 1995 15 22 21 | HR7310 | k |
| 04800954 | 20 36 43.60 | +40 21 08.0 | 2 34 45 | 04 Jan 1996 14 38 18 | WR147 | bands1-3 |
| 04801596 | 23 03 46.55 | +28 04 57.6 | 0 36 22 | 04 Jan 1996 20 23 47 | HR8775 | k |

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05200401 14 04 45.12|-03 16 33.9|0 09 38|08 Jan 1996 10 32 13|PALLAS   ap1
05200502 14 04 46.16|-03 16 29.6|0 16 54|08 Jan 1996 10 47 35|PALLAS   ap2
05200603 14 04 47.14|-03 16 25.5|0 12 44|08 Jan 1996 11 10 11|PALLAS   ap3
05201211 19 12 33.09|+67 39 41.2|0 42 04|08 Jan 1996 21 02 53|HR7310   k
05601894 14 50 42.33|+74 09 19.8|0 36 34|12 Jan 1996 16 02 51|HR5563   k
05602123 17 56 36.41|+51 29 20.3|0 36 22|12 Jan 1996 17 14 53|HR6705   k
06000889 17 53 31.67|+56 52 21.3|0 41 04|16 Jan 1996 15 55 03|HR6688   k
06001120 19 18 37.79|+49 34 09.6|1 08 58|16 Jan 1996 17 34 34|HR7341   k
06001411 19 12 33.09|+67 39 41.2|0 39 30|16 Jan 1996 20 16 54|HR7310   k
06400505 15 27 51.49|+60 40 13.0|1 01 16|20 Jan 1996 10 48 10|HR5755   k sw+3A,4
07100694 14 50 42.33|+74 09 19.8|0 34 04|27 Jan 1996 12 08 13|HR5563   k
07200535 19 12 33.09|+67 39 41.2|1 01 48|28 Jan 1996 11 31 15|HR7310   k
07201013 17 56 36.41|+51 29 20.3|0 33 32|28 Jan 1996 17 26 55|HR6705   k
07801644 14 15 40.00|+19 11 04.5|0 31 08|03 Feb 1996 10 26 15|HR5340   k
08603301 14 15 40.00|+19 11 04.5|0 21 04|11 Feb 1996 14 04 10|HR5340   k FAILED
08604502 18 36 56.19|+38 47 00.1|0 18 30|11 Feb 1996 17 12 26|HR7001   k
09304603 17 56 36.41|+51 29 20.3|0 33 32|18 Feb 1996 16 43 44|HR6705   k
09304904 19 12 33.09|+67 39 41.2|1 11 20|18 Feb 1996 19 08 16|HR7310   k
10001105 16 37 20.37|-16 04 20.5|0 07 52|25 Feb 1996 09 02 28|CERES    k ap1
10001206 16 37 21.02|-16 04 22.2|0 14 20|25 Feb 1996 09 16 02|CERES    k ap2
10001307 16 37 21.63|-16 04 23.8|0 10 34|25 Feb 1996 09 36 06|CERES    k ap3
10501608 17 56 36.41|+51 29 20.3|0 32 18|01 Mar 1996 11 47 53|HR6705   k
11200109 14 50 42.32|+74 09 19.8|0 33 58|08 Mar 1996 02 35 45|HR5563   k
11900810 17 56 36.41|+51 29 20.3|0 32 18|15 Mar 1996 04 22 09|HR6705   k
11905302 18 36 56.19|+38 47 00.1|0 27 06|15 Mar 1996 15 17 37|HR7001   k SW only
12606712 19 12 33.10|+67 39 41.2|1 00 24|22 Mar 1996 16 05 07|HR7310   k
13305414 17 56 36.41|+51 29 20.3|0 32 18|29 Mar 1996 13 27 25|HR6705   k
14001622 17 53 31.68|+56 52 21.3|1 02 10|05 Apr 1996 05 07 50|HR6688   k
14701524 17 56 36.40|+51 29 20.3|0 33 58|12 Apr 1996 06 01 24|HR6705   k
16104729 17 56 36.40|+51 29 20.3|0 32 18|26 Apr 1996 10 32 20|HR6705   k
17503435 17 56 36.40|+51 29 20.3|0 33 58|10 May 1996 05 19 48|HR6705   k
18200445 18 36 56.24|+38 47 00.2|0 27 06|17 May 1996 00 23 04|HR7001   k SW only
18902043 17 56 36.40|+51 29 20.3|0 33 26|24 May 1996 06 33 30|HR6705   k 1B,1E,2C-C',3A-E,4
18902642 20 46 25.50|+40 06 59.4|0 30 10|24 May 1996 09 55 32|NML-CYG  k
19605947 23 03 46.45|+28 04 57.6|0 34 10|31 May 1996 13 48 41|HR8775   k SUSPENDED Earth contingency
20101843 17 56 36.40|+51 29 20.3|0 33 26|05 Jun 1996 10 35 54|HR6705   k
20302248 17 56 36.40|+51 29 20.3|0 35 38|07 Jun 1996 03 18 26|HR6705   k
20601447 23 03 46.45|+28 04 57.6|0 34 10|10 Jun 1996 08 55 54|HR8775   k
21700851 14 15 39.97|+19 11 03.8|1 20 40|20 Jun 1996 22 54 12|HR5340   k
22300252 12 31 09.89|-57 06 46.6|0 48 20|26 Jun 1996 20 27 30|HR4763   k
23000955 17 56 36.40|+51 29 20.3|0 35 38|03 Jul 1996 21 50 14|HR6705   k
23701260 17 56 36.40|+51 29 20.3|0 35 38|10 Jul 1996 21 14 50|HR6705   k
25100373 14 15 39.97|+19 11 03.6|1 20 40|24 Jul 1996 18 59 00|HR5340   k
25800579 14 15 39.96|+19 11 03.5|0 30 10|31 Jul 1996 18 58 50|HR5340   k
25800676 17 56 36.40|+51 29 20.3|0 35 38|31 Jul 1996 19 37 28|HR6705   k
25806080 13 49 02.11|-28 22 03.0|0 14 16|01 Aug 1996 08 09 38|W-HYA    full 2B,3D
26505784 13 49 02.11|-28 22 03.0|0 41 22|08 Aug 1996 08 43 54|W-HYA    full 2C,4
26505981 18 36 56.24|+38 47 00.2|0 27 06|08 Aug 1996 09 42 24|HR7001   k
27202185 14 15 39.96|+19 11 03.4|0 30 10|15 Aug 1996 02 35 14|HR5340   k
27903588 17 56 36.40|+51 29 20.3|0 35 38|22 Aug 1996 04 57 25|HR6705   k
27903889 21 43 30.40|+58 46 48.1|0 33 58|22 Aug 1996 07 25 19|HR8136   k HR8316
28604592 14 50 42.33|+74 09 19.8|0 33 58|29 Aug 1996 02 33 39|HR5563   k
29301695 17 56 36.40|+51 29 20.3|0 35 38|04 Sep 1996 20 04 42|HR6705   k
30000201 17 56 36.40|+51 29 20.3|0 35 38|11 Sep 1996 15 17 24|HR6705   k
30003904 17 56 36.40|+51 29 20.3|0 35 38|12 Sep 1996 06 51 39|HR6705   k
30703206 18 36 56.24|+38 47 00.3|0 27 06|19 Sep 1996 01 56 50|HR7001   k
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31200315 16 45 09.52|-24 26 23.9|0 07 32|23 Sep 1996 15 08 19|CERES    k ap1
31200416 16 45 10.31|-24 26 26.7|0 13 40|23 Sep 1996 15 21 35|CERES    k ap2
31200517 16 45 11.17|-24 26 29.7|0 10 36|23 Sep 1996 15 40 57|CERES    k ap3
31401509 19 12 33.25|+67 39 41.3|1 00 24|25 Sep 1996 16 24 29|HR7310   k
32100611 17 56 36.40|+51 29 20.3|0 35 38|02 Oct 1996 18 30 51|HR6705   k
32103812 20 12 12.48|-20 35 01.3|0 43 42|03 Oct 1996 03 47 56|URANUS   k 2C-C',full 3E-4
32803918 19 47 30.97|-20 40 41.1|1 23 02|10 Oct 1996 02 38 01|NEPTUNE  ap3
33501319 17 56 36.40|+51 29 20.3|0 44 10|16 Oct 1996 18 32 49|HR6705   k
33503721 20 12 12.84|-20 34 39.5|0 28 06|17 Oct 1996 01 23 23|URANUS   k 1A+13.35-14.05 (not key)
34201022 20 46 25.50|+40 06 59.4|0 33 14|23 Oct 1996 18 06 59|NML-CYG  k + F-P passbands
34905026 17 56 36.40|+51 29 20.3|0 35 38|31 Oct 1996 04 37 33|HR6705   k
35602031 18 36 56.25|+38 47 00.3|0 27 06|07 Nov 1996 00 53 21|HR7001   k
36000155 20 13 52.73|-20 28 49.2|2 39 20|10 Nov 1996 12 16 19|URANUS   ap3 MGRIFFIN
36301132 14 50 42.32|+74 09 19.8|0 33 58|13 Nov 1996 16 01 47|HR5563   k
37002335 17 56 36.40|+51 29 20.3|0 35 38|20 Nov 1996 18 20 57|HR6705   k
37701436 23 03 46.46|+28 04 57.7|0 34 10|27 Nov 1996 16 14 51|HR8775   k
38403165 17 56 36.40|+51 29 20.3|0 35 38|04 Dec 1996 19 53 47|HR6705   k
39101675 17 53 31.67|+56 52 21.4|0 38 46|11 Dec 1996 15 43 43|HR6688   k
39802101 17 56 36.40|+51 29 20.3|0 20 04|18 Dec 1996 17 30 37|HR6705   k FAILED
40600203 14 50 42.32|+74 09 19.8|0 33 58|26 Dec 1996 10 14 08|HR5563   k
40602104 00 41 00.47|+08 46 34.2|0 41 22|26 Dec 1996 16 34 50|HYGIEA   10.4-11.6, full 3E-4
41200902 17 56 36.40|+51 29 20.3|0 35 38|01 Jan 1997 12 33 22|HR6705   k
41204403 00 44 05.87|+08 57 37.3|0 35 32|01 Jan 1997 20 25 13|HYGIEA   1D,5.4-7.0,3C,19.5-27.5
41204504 00 44 06.56|+08 57 40.3|0 23 54|01 Jan 1997 21 06 29|HYGIEA   1B,3A
41901201 14 15 39.93|+19 11 02.7|0 30 10|08 Jan 1997 10 33 18|HR5340   k FAILED STR
41906902 01 24 18.37|-04 42 11.2|0 41 12|08 Jan 1997 21 10 45|JUNO     ap3
42601001 17 56 36.40|+51 29 20.3|0 35 38|15 Jan 1997 12 52 50|HR6705   k
43201003 00 57 28.20|+09 56 40.3|0 42 16|21 Jan 1997 13 26 41|HYGIEA   2C key,10.4-11.5,28.7-40 obs_open
43201804 00 57 35.82|+09 57 17.6|0 42 18|21 Jan 1997 17 19 49|HYGIEA   2C key,10.4-11.5,28.7-40 perigee
43204305 00 57 49.56|+09 58 28.7|0 42 18|22 Jan 1997 00 41 09|HYGIEA   2C key,10.4-11.5,28.7-40 obs_close
43300701 14 15 43.73|+19 12 42.6|0 27 06|22 Jan 1997 10 35 08|HR5340   k FAILED STR
44000102 14 15 39.93|+19 11 02.5|0 30 10|29 Jan 1997 08 06 11|HR5340   k SCCTEST
44000804 13 49 02.11|-28 22 03.0|0 23 36|29 Jan 1997 10 16 41|W-HYA    full 1B,3A
44003801 17 56 36.40|+51 29 20.3|0 35 38|29 Jan 1997 18 13 00|HR6705   k
44804301 19 12 33.25|+67 39 41.3|1 00 24|06 Feb 1997 20 41 31|HR7310   k
45303101 17 56 36.40|+51 29 20.3|0 35 38|11 Feb 1997 17 04 50|HR6705   k
46103901 02 33 44.06|+02 59 57.1|0 08 36|19 Feb 1997 18 19 19|JUNO     k 1B,3A only
46104002 02 33 44.95|+03 00 02.6|0 13 08|19 Feb 1997 18 28 37|JUNO     k 2A-B,3C-D only
46104103 02 33 46.27|+03 00 10.8|0 20 12|19 Feb 1997 18 42 29|JUNO     k ap3
46802501 17 56 36.40|+51 29 20.3|0 35 38|26 Feb 1997 17 46 28|HR6705   k
47502101 18 36 56.25|+38 47 00.4|0 33 50|05 Mar 1997 15 35 14|HR7001   k
48201701 17 56 36.40|+51 29 20.3|0 35 38|12 Mar 1997 09 04 28|HR6705   k
48900301 15 27 51.51|+60 40 13.0|0 58 42|19 Mar 1997 09 26 30|HR5755   k
48903803 19 06 22.20|+08 13 48.2|1 52 08|19 Mar 1997 19 26 14|R-AQL    full 1D-4 2C FAILED refscan
49602502 20 06 50.86|-19 49 00.3|1 23 02|26 Mar 1997 14 04 56|NEPTUNE  ap3
49602801 19 35 16.37|+10 48 59.3|0 10 36|26 Mar 1997 16 15 00|PALLAS   k ap3
50100902 17 56 36.40|+51 29 20.3|1 16 08|31 Mar 1997 19 05 06|HR6705   2A-C CWAELKEN 2C FAILED refscan
50301602 19 50 46.90|+08 52 04.9|2 00 20|02 Apr 1997 09 42 44|HR7557   k + full 1A-2C
50303801 17 56 36.40|+51 29 20.3|0 35 38|02 Apr 1997 17 39 22|HR6705   k
51001303 17 53 31.67|+56 52 21.4|0 38 46|09 Apr 1997 07 55 22|HR6688   k
51003601 20 46 25.50|+40 06 59.4|0 33 14|09 Apr 1997 15 57 31|NML-CYG  k + F-P passbands
51702601 17 56 36.40|+51 29 20.2|0 35 38|16 Apr 1997 10 16 41|HR6705   k
51703502 20 08 03.64|-19 45 15.8|0 19 24|16 Apr 1997 13 43 51|NEPTUNE  k ap3
51703603 20 08 03.67|-19 45 15.7|0 26 26|16 Apr 1997 14 03 57|NEPTUNE  k 3A + 14.7-15.2
51705105 20 31 42.00|+40 21 50.0|1 22 46|16 Apr 1997 17 47 09|G79.29   ap3
52401901 14 50 42.32|+74 09 19.8|0 18 38|23 Apr 1997 07 39 45|HR5563   k
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| | | | | | |
|---|---|---|---|---|---|
| 53102101 17 56 36.40 | +51 29 20.2 | 0 35 38 | 30 Apr 1997 09 52 29 | HR6705 | k |
| 53103006 19 06 22.20 | +08 13 48.2 | 0 47 28 | 30 Apr 1997 14 28 49 | R-AQL | full 1A-B,3A |
| 53803603 17 56 36.40 | +51 29 20.2 | 0 31 02 | 07 May 1997 17 07 29 | HR6705 | full |
| 53804401 18 36 56.25 | +38 47 00.4 | 0 33 50 | 07 May 1997 18 28 03 | HR7001 | k |
| 54400206 17 56 36.40 | +51 29 20.2 | 0 10 52 | 13 May 1997 02 08 37 | HR6705 | k 1D,2A-B,3C-D |
| 54401408 17 56 36.40 | +51 29 20.2 | 0 10 52 | 13 May 1997 04 47 23 | HR6705 | k 1D,2A-B,3C-D |
| 54402701 17 56 36.40 | +51 29 20.2 | 0 35 38 | 13 May 1997 11 02 18 | HR6705 | k |
| 54403807 17 56 36.40 | +51 29 20.2 | 0 10 52 | 13 May 1997 14 47 30 | HR6705 | k 1D,2A-B,3C-D |
| 54404309 17 56 36.40 | +51 29 20.2 | 0 10 52 | 13 May 1997 18 27 56 | HR6705 | k 1D,2A-B,3C-D |
| 55205005 19 58 07.47 | +18 35 03.7 | 0 45 50 | 21 May 1997 07 43 35 | 2PALLAS | ap3 |
| 55205701 23 03 46.46 | +28 04 57.7 | 0 34 10 | 21 May 1997 12 11 17 | HR8775 | k |
| 55900301 17 56 36.40 | +51 29 20.2 | 1 34 36 | 28 May 1997 02 21 00 | HR6705 | k + full 2A-C |
| 56602002 17 53 31.67 | +56 52 21.4 | 0 38 46 | 04 Jun 1997 12 56 17 | HR6688 | k |
| 57301101 17 56 36.40 | +51 29 20.2 | 0 35 38 | 11 Jun 1997 03 24 40 | HR6705 | k |
| 57900503 01 09 48.12 | +00 39 06.7 | 0 31 36 | 17 Jun 1997 01 57 21 | VESTA | ap1 |
| 57900604 01 09 50.79 | +00 39 17.9 | 0 57 12 | 17 Jun 1997 02 29 39 | VESTA | ap2 |
| 57900705 01 09 53.89 | +00 39 31.0 | 0 46 38 | 17 Jun 1997 03 27 33 | VESTA | ap3 |
| 57901001 14 50 42.32 | +74 09 19.8 | 0 33 58 | 17 Jun 1997 05 06 25 | HR5563 | k |
| 58301601 14 15 39.90 | +19 11 01.8 | 1 05 04 | 21 Jun 1997 05 12 18 | HR5340 | 1A,4.2-4.7,7.0-7.5,band 3 CWAELKEN |
| 58700801 17 56 36.40 | +51 29 20.2 | 0 35 38 | 25 Jun 1997 02 31 04 | HR6705 | k |
| 59401401 14 15 39.89 | +19 11 01.7 | 0 31 50 | 02 Jul 1997 02 05 41 | HR5340 | k |
| 59401502 12 31 09.89 | -57 06 46.8 | 1 00 52 | 02 Jul 1997 02 49 37 | HR4763 | k + full 2C,4 |
| 60100503 14 15 39.89 | +19 11 01.7 | 1 18 40 | 09 Jul 1997 00 52 29 | HR5340 | k + full band 3 |
| 60101301 17 56 36.40 | +51 29 20.2 | 0 35 38 | 09 Jul 1997 06 12 07 | HR6705 | k |
| 60800502 12 31 09.89 | -57 06 46.9 | 1 16 20 | 15 Jul 1997 23 56 23 | HR4763 | k + full 3A-D |
| 60800801 14 15 39.89 | +19 11 01.6 | 1 15 10 | 16 Jul 1997 02 14 01 | HR5340 | k |
| 61503301 17 56 36.40 | +51 29 20.2 | 0 35 38 | 23 Jul 1997 11 14 38 | HR6705 | k |
| 62200601 12 31 09.89 | -57 06 46.9 | 0 45 04 | 30 Jul 1997 00 13 33 | HR4763 | k |
| 62901901 17 56 36.40 | +51 29 20.2 | 0 35 38 | 06 Aug 1997 07 22 04 | HR6705 | k |
| 63600801 14 15 39.88 | +19 11 01.5 | 0 31 50 | 13 Aug 1997 03 34 52 | HR5340 | k |
| 64300503 12 31 09.89 | -57 06 46.9 | 1 33 50 | 19 Aug 1997 22 43 31 | HR4763 | k |
| 64300602 17 56 36.40 | +51 29 20.2 | 0 35 38 | 20 Aug 1997 00 35 07 | HR6705 | k |
| 65000902 18 36 56.26 | +38 47 00.5 | 1 34 02 | 27 Aug 1997 00 34 57 | HR7001 | k SW only + full 2C |
| 65002801 04 35 55.19 | +16 30 33.8 | 0 30 10 | 27 Aug 1997 09 44 49 | HR1457 | k |
| 65700502 17 56 36.40 | +51 29 20.2 | 0 35 38 | 02 Sep 1997 23 29 29 | HR6705 | k |
| 66402301 04 35 55.19 | +16 30 33.8 | 0 30 10 | 10 Sep 1997 04 02 59 | HR1457 | k |
| 67100703 19 01 12.41 | +09 37 36.6 | 1 36 18 | 16 Sep 1997 21 59 19 | PALLAS | full ap2 (no 1D) |
| 67101102 17 56 36.40 | +51 29 20.2 | 0 35 38 | 17 Sep 1997 03 50 29 | HR6705 | k |
| 67801301 18 36 56.26 | +38 47 00.6 | 1 12 34 | 23 Sep 1997 23 58 47 | HR7001 | full 1A,2A + 12-13.5,16.5-18 |
| 67801402 19 06 22.20 | +08 13 48.2 | 0 30 00 | 24 Sep 1997 01 17 03 | R-AQL | full 1A-B,3A |
| 68100401 04 35 55.19 | +16 30 33.8 | 0 30 10 | 26 Sep 1997 20 26 50 | HR1457 | k |
| 68100603 04 35 55.19 | +16 30 33.8 | 1 01 40 | 27 Sep 1997 00 53 28 | HR1457 | 1A,4.2-4.7,7.0-7.5,band3 CWAELKEN |
| 68500902 17 56 36.40 | +51 29 20.2 | 0 35 38 | 30 Sep 1997 23 00 39 | HR6705 | k |
| 69200901 20 31 42.10 | +40 21 59.0 | 1 12 50 | 08 Oct 1997 00 11 15 | G79.29 | band1,4.1-5.2,12.2-13.2,15.3-16.3,3C |
| 69800203 20 59 07.52 | -18 06 59.4 | 0 36 10 | 13 Oct 1997 17 01 50 | CALLISTO | ap1 |
| 69800504 20 59 08.08 | -18 06 56.6 | 0 56 30 | 13 Oct 1997 18 20 50 | CALLISTO | ap2 |
| 69800605 20 59 08.41 | -18 06 54.9 | 0 43 32 | 13 Oct 1997 19 18 02 | CALLISTO | ap3 |
| 69900602 17 56 36.40 | +51 29 20.2 | 0 35 38 | 14 Oct 1997 21 19 09 | HR6705 | k |
| 70603501 21 00 25.72 | -18 00 33.7 | 0 43 32 | 22 Oct 1997 07 11 40 | GANYMEDE | ap3 |
| 70603602 21 00 26.08 | -18 00 31.6 | 0 36 10 | 22 Oct 1997 07 55 56 | GANYMEDE | ap2 |
| 70705203 06 45 08.88 | -16 42 55.4 | 0 39 02 | 23 Oct 1997 04 23 11 | HR2491 | k |
| 71300402 17 56 36.40 | +51 29 20.2 | 1 11 28 | 28 Oct 1997 17 31 43 | HR6705 | full 1D, full 2A-C,3E |
| 71301904 20 29 27.71 | -19 39 18.4 | 0 35 28 | 29 Oct 1997 03 32 51 | URANUS | k ap3 |
| 71400903 21 02 46.69 | -17 49 41.6 | 0 43 36 | 29 Oct 1997 22 49 02 | EUROPA | ap3 |
| 72001202 20 31 42.10 | +40 21 59.0 | 1 19 52 | 04 Nov 1997 20 42 47 | G79.29 | 4.5-4.95,2B,14.5-16.0,19.5-25.0 |
| 72002801 06 45 08.88 | -16 42 55.4 | 0 41 06 | 05 Nov 1997 05 04 27 | HR2491 | k |

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72100604 21 04 26.76|-17 42 14.1|0 47 32|05 Nov 1997 18 15 52|GANYMEDE full 3A AHERAS
72700402 17 56 36.40|+51 29 20.2|0 35 38|11 Nov 1997 16 35 11|HR6705   k
72700705 18 50 04.70|+33 21 45.8|0 56 58|11 Nov 1997 18 59 51|BETA LYR ap2
72801604 21 07 57.53|-17 26 03.2|0 56 30|13 Nov 1997 03 50 08|EUROPA   ap1
72801703 21 07 58.36|-17 25 59.1|0 36 10|13 Nov 1997 04 47 20|EUROPA   ap2
73600101 18 50 04.70|+33 21 45.8|0 56 58|20 Nov 1997 14 26 21|BETA LYR ap2
74101902 19 42 04.10|+55 27 47.0|0 35 38|25 Nov 1997 21 09 45|HR6705   k
74200906 19 42 04.10|+55 27 47.0|0 56 30|27 Nov 1997 01 02 27|GANYMEDE ap2
74803502 22 44 08.30|-19 40 40.3|0 10 36|03 Dec 1997 05 12 34|CERES    k ap3
75500502 17 56 36.40|+51 29 20.2|0 35 38|09 Dec 1997 14 59 33|HR6705   k
76202701 22 55 54.95|-17 44 41.2|0 10 36|17 Dec 1997 00 21 22|CERES    k ap3
76203002 23 03 46.47|+28 04 57.8|0 34 10|17 Dec 1997 02 12 06|HR8775   k
76902502 17 56 36.40|+51 29 20.2|0 35 38|23 Dec 1997 20 47 36|HR6705   k
76903003 23 29 59.99|-03 14 26.0|0 38 48|24 Dec 1997 00 20 04|ZODIACAL 9-1.5,31.0-37.0
77604303 01 22 17.09|+00 43 47.4|0 30 20|31 Dec 1997 01 44 56|VESTA    ap1
77604404 01 22 17.98|+00 44 01.1|0 57 00|31 Dec 1997 02 16 00|VESTA    ap2
77604505 01 22 18.99|+00 44 16.8|0 43 36|31 Dec 1997 03 13 42|VESTA    ap3
78300802 17 56 36.40|+51 29 20.2|0 35 37|06 Jan 1998 14 08 27|HR6705   k
78400803 00 55 28.83|+03 14 45.8|0 39 00|07 Jan 1998 21 14 33|SATURN   full 2C,4
79000201 01 31 44.30|+02 30 01.7|0 24 20|13 Jan 1998 11 36 41|VESTA    9.0-11.9,31.0-45.0 t0
79002302 01 32 08.39|+02 34 15.2|0 24 20|13 Jan 1998 23 39 10|VESTA    9.0-11.9,31.0-45.0 t0+N*P/0.25
79002503 01 32 11.00|+02 34 44.3|0 24 20|14 Jan 1998 01 03 00|VESTA    9.0-11.9,31.0-45.0 t0+N*P/0.50
79002704 01 32 13.33|+02 35 10.5|0 24 20|14 Jan 1998 02 18 38|VESTA    9.0-11.9,31.0-45.0 t0+N*P/0.75
79002805 00 56 29.36|+03 22 51.5|0 39 00|14 Jan 1998 02 45 42|SATURN   full 2C,4
79701102 17 56 36.40|+51 29 20.2|0 35 38|20 Jan 1998 14 55 00|HR6705   k
80400301 01 44 44.42|+04 31 10.2|0 20 12|27 Jan 1998 11 10 43|VESTA    4.06-5.3,3D t0
80400506 01 09 43.87|+35 37 14.2|0 30 10|27 Jan 1998 13 21 59|HR0337   k
80402002 01 45 14.95|+04 35 42.8|0 20 12|27 Jan 1998 23 17 36|VESTA    4.06-5.3,3D t0+N*P/0.25
80402903 01 45 17.97|+04 36 10.8|0 20 12|28 Jan 1998 00 33 10|VESTA    4.06-5.3,3D t0+N*P/0.50
80403104 01 45 20.55|+04 36 34.8|0 20 12|28 Jan 1998 01 38 24|VESTA    4.06-5.3,3D t0+N*P/0.75
81100201 17 56 36.40|+51 29 20.2|0 35 38|03 Feb 1998 10 32 19|HR6705   k
81101203 00 13 01.10|+72 31 19.1|1 00 09|03 Feb 1998 15 15 17|NGC40    8-12,full 4
81800301 18 36 56.27|+38 47 00.7|0 33 50|10 Feb 1998 10 28 35|HR7001   k SW only + 40.0-45.2
81802202 19 12 33.27|+67 39 41.4|1 00 24|10 Feb 1998 17 12 33|HR7310   k
82500203 02 08 59.10|+07 42 02.5|0 16 44|17 Feb 1998 10 01 53|VESTA    2B,3C t0
82501804 02 09 36.80|+07 46 42.0|0 16 44|17 Feb 1998 22 04 09|VESTA    2B,3C t0+N*P/0.25
82502205 02 09 40.76|+07 47 12.0|0 16 44|17 Feb 1998 23 23 13|VESTA    2B,3C t0+N*P/0.50
82502706 02 09 44.84|+07 47 42.9|0 16 44|18 Feb 1998 00 45 07|VESTA    2B,3C t0+N*P/0.75
82700902 17 56 36.40|+51 29 20.2|0 35 38|19 Feb 1998 15 29 03|HR6705   k
83201902 04 46 35.78|+23 22 44.3|0 45 42|24 Feb 1998 22 51 33|HYGIEA   k ap2 (no 2A)
83202301 04 35 55.19|+16 30 33.8|0 33 34|25 Feb 1998 00 43 17|HR1457   k
83900502 17 56 36.40|+51 29 20.2|0 35 38|03 Mar 1998 11 38 48|HR6705   k
84602801 18 36 56.27|+38 47 00.7|0 33 50|10 Mar 1998 16 19 08|HR7001   k SW only + 40.0-45.2
84602902 18 50 04.70|+33 21 45.8|1 13 06|10 Mar 1998 17 33 16|BETA LYR ap1
85300502 17 56 36.40|+51 29 20.2|0 35 38|17 Mar 1998 11 54 36|HR6705   k
86002301 04 35 55.19|+16 30 33.7|1 04 26|24 Mar 1998 17 28 13|HR1457   k + full 2C,39.7-40.3
86703902 17 56 36.40|+51 29 20.2|0 35 38|31 Mar 1998 11 06 43|HR6705   k
87406801 06 45 08.87|-16 42 55.9|1 50 54|07 Apr 1998 20 54 41|HR2491   full 2A,2C,3D,4
87406902 06 45 08.87|-16 42 55.9|0 41 06|07 Apr 1998 22 47 47|HR2491   k
87803203 06 45 08.86|-16 42 55.9|1 43 26|11 Apr 1998 21 33 57|HR2491   k He boil. CCS on hold
--------------------------------------------------------------------------------------------
```

k: key wavelengths.

Aperture remarks denote full coverage unless preceded by "k".

PROPID for all observations is SWS_CAL unless otherwise noted.

FAILED observations are due to lost telemetry of critical formats, unless otherwise denoted by "STR" (real time guide star error) or "refscan" (signal highly corrupted by memory of reference scan).

Vesta in revs 790, 804, 825: t0+N*P/(m*0.25), N = 1 or 2, m = 1,2,3 denotes observations scheduled at intervals of 1/4 the rotational period P or 2P after the start of the first observation at t0.

### 6.2.4.1 S01

The S01 observations tabulated here include a few selected from science programmes on the basis of the role of the intended target as one of the primary ACSs. This does not reflect the full use made of other science observations from the ISO archive.

| TDTOSN | RA<br>hh mm ss.ss | DEC<br>d ' '' | sp | UTC start | target | remarks |
|---|---|---|---|---|---|---|
| 02400714 | 17 58 33.40 | +66 37 59.5 | 4 | 11 Dec 1995 12 56 36 | NGC6543 | |
| 02400807 | 17 58 33.40 | +66 37 59.5 | 3 | 11 Dec 1995 15 22 56 | NGC6543 | |
| 02400910 | 17 58 33.40 | +66 37 59.5 | 1 | 11 Dec 1995 16 21 42 | NGC6543 | |
| 02401183 | 21 07 01.71 | +42 14 09.1 | 4 | 11 Dec 1995 17 09 16 | NGC7027 | |
| 02401579 | 17 56 36.41 | +51 29 20.3 | 2 | 11 Dec 1995 20 01 12 | HR6705 | |
| 02402105 | 17 56 36.40 | +51 29 20.3 | 1 | 11 Dec 1995 22 37 25 | HR6705 | |
| 02800433 | 20 29 24.66 | +40 11 18.9 | 1 | 15 Dec 1995 08 14 22 | GL2591 NIRS 01 | |
| 02800908 | 17 58 33.40 | +66 37 59.5 | 1 | 15 Dec 1995 12 03 54 | NGC6543 | |
| 03201129 | 20 17 47.20 | +38 01 58.3 | 2 | 19 Dec 1995 19 05 35 | P-CYG | |
| 03201202 | 17 58 33.40 | +66 37 59.5 | 2 | 19 Dec 1995 19 42 33 | NGC6543 | |
| 03602226 | 20 32 41.00 | +41 14 29.3 | 1 | 23 Dec 1995 18 59 31 | CYG-OB2-12 | |
| 04000458 | 10 18 07.60 | -28 59 31.3 | 1 | 27 Dec 1995 07 51 01 | HR4049 | |
| 04000652 | 10 56 11.60 | -60 27 13.4 | 1 | 27 Dec 1995 08 34 57 | AG-CAR | |
| 04001456 | 20 36 10.60 | +60 05 20.0 | 1 | 27 Dec 1995 11 55 31 | V778-CYG | |
| 04001710 | 11 49 03.28 | +14 34 19.9 | 1 | 27 Dec 1995 13 36 45 | HR4534 | |
| 04002405 | 17 56 36.41 | +51 29 20.3 | 4 | 27 Dec 1995 17 14 33 | HR6705 | |
| 05200726 | 20 46 25.50 | +40 06 59.4 | 4 | 08 Jan 1996 11 38 29 | NML-CYG | |
| 05601291 | 14 15 40.01 | +19 11 04.6 | 1 | 12 Jan 1996 11 33 31 | HR5340 | |
| 05602477 | 21 29 58.42 | +51 03 59.8 | 2 | 12 Jan 1996 19 34 05 | IRAS21282+5050 | |
| 05602595 | 23 03 46.55 | +28 04 57.6 | 1 | 12 Jan 1996 20 10 37 | HR8775 | |
| 05602852 | 21 43 30.40 | +58 46 48.1 | 1 | 12 Jan 1996 21 20 47 | HR8316 | |
| 06000280 | 10 23 19.65 | -59 32 05.8 | 1 | 16 Jan 1996 05 53 59 | AFGL4106 | |
| 06001362 | 19 18 37.79 | +49 34 09.6 | 1 | 16 Jan 1996 19 54 12 | HR7341 | |
| 06401081 | 22 19 18.30 | +63 18 47.1 | 1 | 20 Jan 1996 14 31 30 | S140IRS | |
| 06800697 | 17 53 31.67 | +56 52 21.3 | 1 | 24 Jan 1996 13 39 08 | HR6688 | |
| 07100250 | 10 45 03.60 | -59 41 04.3 | 4 | 27 Jan 1996 05 33 49 | ETA-CAR | |
| 07100434 | 14 15 40.00 | +19 11 04.5 | 4 | 27 Jan 1996 09 48 21 | HR5340 | |
| 07100579 | 17 44 55.50 | +50 02 39.8 | 1 | 27 Jan 1996 11 45 19 | HD161796 | |
| 07200272 | 12 08 21.51 | -50 43 20.7 | 4 | 28 Jan 1996 08 26 30 | HR4621 | |
| 07200351 | 12 08 21.51 | -50 43 20.7 | 1 | 28 Jan 1996 10 16 02 | HR4621 | |
| 07200459 | 11 08 37.50 | -77 43 53.6 | 2 | 28 Jan 1996 10 38 32 | IRN-CHA1 | |
| 07200660 | 11 33 25.52 | -70 11 41.8 | 1 | 28 Jan 1996 13 35 29 | HD100546 | |
| 07201132 | 19 12 33.09 | +67 39 41.2 | 4 | 28 Jan 1996 18 04 27 | HR7310 | |
| 07901307 | 12 31 09.89 | -57 06 47.0 | 2 | 04 Feb 1996 10 34 54 | HR4763 | AHESKE |

```
07903403|14 50 42.23|+74 09 20.0|2|04 Feb 1996 20 32 11|HR5563          AHESKE
08001274|21 43 30.36|+58 46 48.8|1|05 Feb 1996 14 20 34|HR8316          TDEJONG
12601117|17 56 37.01|+51 29 20.3|1|22 Mar 1996 05 32 19|HR6705 6-0
12601216|17 56 36.71|+51 29 20.3|1|22 Mar 1996 05 50 45|HR6705 3-0
12601315|17 56 36.41|+51 29 20.3|1|22 Mar 1996 06 09 09|HR6705 0-0
12601418|17 56 36.11|+51 29 20.3|1|22 Mar 1996 06 27 35|HR6705 -3-0
12601519|17 56 35.81|+51 29 20.3|1|22 Mar 1996 06 45 59|HR6705 -6-0
12601620|17 56 36.41|+51 29 23.3|1|22 Mar 1996 07 04 25|HR6705 0-3
12601721|17 56 36.41|+51 29 17.3|1|22 Mar 1996 07 22 49|HR6705 0--3
12801311|19 26 47.99|+11 21 16.8|3|24 Mar 1996 15 35 11|IRC+10420       RWATERS
14601350|20 01 45.54|+33 32 43.6|2|11 Apr 1996 16 19 40|IRAS 19598+3324 PCOX
17800501|18 36 56.24|+38 47 00.2|3|13 May 1996 01 21 53|HR7001          CWAELKEN
18205639|14 50 42.33|+74 09 19.8|4|17 May 1996 12 55 57|HR5563
18900244|11 49 03.72|+14 34 19.8|3|23 May 1996 22 36 00|HR4534
19604632|19 12 33.24|+67 39 41.3|4|31 May 1996 08 07 24|HR7310
19605846|23 03 46.45|+28 04 57.6|3|31 May 1996 12 50 24|HR8775
20601232|19 12 33.24|+67 39 41.3|4|10 Jun 1996 05 59 12|HR7310
20601346|23 03 46.45|+28 04 57.6|3|10 Jun 1996 07 57 36|HR8775
20601613|23 03 46.45|+28 04 57.6|1|10 Jun 1996 10 13 38|HR8775          TTSUJI
22400153|10 56 11.61|-60 27 13.3|4|27 Jun 1996 20 02 31|AG-CAR
23001256|21 07 01.70|+42 14 09.1|1|04 Jul 1996 00 53 46|NGC7027
23001357|21 07 01.70|+42 14 09.1|1|04 Jul 1996 01 13 28|NGC7027
23001458|21 07 01.70|+42 14 09.1|3|04 Jul 1996 01 46 04|NGC7027
23701861|10 45 03.60|-59 41 04.3|1|11 Jul 1996 00 31 16|ETA-CAR
24402462|14 15 40.47|+19 11 00.6|1|17 Jul 1996 23 25 08|HR5340_+0_-8
24402563|14 15 40.37|+19 11 01.4|1|17 Jul 1996 23 44 52|HR5340_+0_-6
24402664|14 15 40.27|+19 11 02.1|1|18 Jul 1996 00 04 34|HR5340_+0_-4
24402765|14 15 40.07|+19 11 02.9|1|18 Jul 1996 00 24 18|HR5340_+0_-2
24402866|14 15 39.97|+19 11 03.6|1|18 Jul 1996 00 44 00|HR5340
24402967|14 15 39.87|+19 11 04.4|1|18 Jul 1996 01 03 44|HR5340_+0_+2
24403068|14 15 39.66|+19 11 05.1|1|18 Jul 1996 01 23 26|HR5340_+0_+4
24403169|14 15 39.57|+19 11 05.8|1|18 Jul 1996 01 43 10|HR5340_+0_+6
24403270|14 15 39.47|+19 11 06.6|1|18 Jul 1996 02 02 52|HR5340_+0_+8
24403371|14 15 40.17|+19 11 11.0|1|18 Jul 1996 02 22 36|HR5340_+8_+0
24403472|14 15 39.77|+19 10 56.2|1|18 Jul 1996 02 42 18|HR5340_-8_+0
25806177|12 31 09.89|-57 06 46.6|2|01 Aug 1996 08 29 32|HR4763
27200587|11 15 07.12|-61 15 33.0|3|14 Aug 1996 19 16 35|NGC3603
27200786|19 44 48.20|+50 31 30.0|4|14 Aug 1996 20 51 19|NGC6826
27503811|14 15 39.96|+19 11 03.4|1|17 Aug 1996 22 50 44|HR5340          TTSUJI
30003803|00 13 01.10|+72 31 19.1|3|12 Sep 1996 05 46 59|NGC40
31404910|17 53 31.66|+56 52 21.3|3|26 Sep 1996 00 00 22|HR6688
33504020|20 17 47.20|+38 01 58.2|4|17 Oct 1996 02 39 11|P CYG
34201224|20 46 25.50|+40 06 59.4|1|23 Oct 1996 19 45 07|NML-CYG
37704637|17 56 36.40|+51 29 20.3|4|28 Nov 1996 02 06 47|HR6705
38402466|20 01 45.70|+33 32 43.3|4|04 Dec 1996 16 06 05|K3-50
39802402|21 43 30.40|+58 46 48.0|4|18 Dec 1996 19 10 33|HR8316
41200801|14 15 39.93|+19 11 02.7|4|01 Jan 1997 10 35 50|HR5340          FAILED STR
41901305|15 50 46.60|+48 28 58.7|3|08 Jan 1997 11 09 32|ST-HER
42301404|01 09 43.86|+35 37 14.3|2|12 Jan 1997 18 29 03|HR0337
42604702|23 44 03.30|+61 47 22.3|3|15 Jan 1997 23 50 17|PZ CAS
44004605|01 09 43.86|+35 37 14.3|3|29 Jan 1997 21 11 06|HR0337
45200101|14 15 39.92|+19 11 02.5|4|10 Feb 1997 07 27 07|HR5340          SCCTEST
48101804|21 01 30.40|+68 10 22.1|2|11 Mar 1997 22 05 29|NGC7023
49603004|17 56 36.40|+51 29 20.3|1|26 Mar 1997 17 40 04|HR6705
53802302|22 42 40.06|-46 53 04.7|3|07 May 1997 11 26 23|HR8636
55100705|23 03 46.46|+28 04 57.7|4|20 May 1997 03 41 17|HR8775          CWAELKEN
```

```
60702006|14 39 37.90|-60 50 04.0|4|15 Jul 1997 10 59 38|HR5459          CWAELKEN
60900804|12 31 09.89|-57 06 46.9|4|17 Jul 1997 03 32 40|HR4763          CWAELKEN
62902503|01 11 03.50|+53 43 40.3|1|06 Aug 1997 11 20 16|DO 24107
63602102|04 35 55.19|+16 30 33.9|4|13 Aug 1997 10 44 24|HR1457
64100101|14 15 39.58|+19 11 07.0|1|17 Aug 1997 20 29 53|HR5340
64100102|14 15 40.58|+19 11 05.6|1|17 Aug 1997 20 49 35|HR5340
64100103|14 15 40.18|+19 11 16.2|1|17 Aug 1997 21 09 19|HR5340
64100104|14 15 39.98|+19 10 56.4|1|17 Aug 1997 21 29 01|HR5340
68901202|06 45 08.99|-16 42 55.3|4|05 Oct 1997 07 32 38|HR2491
74103105|19 42 04.10|+55 27 47.0|1|26 Nov 1997 02 37 06|NML-CYG
74803701|00 24 05.10|-72 04 50.5|2|03 Dec 1997 05 42 00|NGC104
77602302|16 41 41.40|+36 27 36.9|2|30 Dec 1997 17 20 32|M 13
79702803|03 02 16.80|+04 05 23.2|4|21 Jan 1998 00 33 54|HR0911
81100302|17 56 36.40|+51 29 20.2|2|03 Feb 1998 11 08 41|HR6705
83901103|22 57 07.20|+62 37 33.1|3|03 Mar 1998 17 57 21|CEP-B
--------------------------------------------------------------------------------------
```

PROPID for all observations is SWS_CAL unless otherwise noted.

FAILED observations due to lost telemetry of critical formats, unless otherwise denoted by "STR" (real time guide star error) or "refscan" (signal highly corrupted by memory of reference scan).

Discrepant CO references:

12601117-12601721, 24402462-24403472, and 64100101-64100104 are beam profile raster experiments and scheduled and documented under 6.2.4.1, but should refer to requirements of
6.4.1.1 and 6.3.1.1.

27200786 observed for AOT1 grating resolution check, should refer to grating IP 6.3.2.1 or 6.3.2.2 requirements.

6.2.4.5 S07 or CUS

```
------------------------------------------------------------------------------------
TDTOSN       RA         DEC        UTC start           target    remarks
S07/CUS  hh mm ss.ss  d  '  ''
--------|-----------|--------------------------------|------------------------------

                               Aperture 3
------------------------------------------------------------------------------------
04801001|20 46 25.50|+40 06 59.4|04 Jan 1996 17 14 51|NML-CYG     CUS
05200301|14 04 40.81|-03 16 51.8|08 Jan 1996 09 10 30|PALLAS      CUS
05200901|20 46 25.50|+40 06 59.4|08 Jan 1996 14 06 45|NML-CYG     CUS
05600301|10 45 03.60|-59 41 04.3|12 Jan 1996 06 31 05|ETA-CAR     CUS
05600601|13 49 02.09|-28 22 03.0|12 Jan 1996 08 01 25|W-HYA       CUS
05601001|14 15 40.01|+19 11 04.6|12 Jan 1996 10 06 29|HR5340      CUS
05602201|21 43 30.40|+58 46 48.1|12 Jan 1996 17 57 01|HR8316      CUS
06401248|22 19 18.30|+63 18 47.1|20 Jan 1996 15 03 36|S140IRS     S07
06800501|15 59 08.12|-14 19 10.5|24 Jan 1996 11 35 08|CERES       CUS
07101201|22 19 37.70|+63 18 47.1|27 Jan 1996 17 45 02|S140IRS     CUS
10001001|16 37 16.69|-16 04 10.7|25 Feb 1996 07 27 41|CERES       CUS
```

```
11905701|16 53 00.71|-16 41 40.5|15 Mar 1996 17 05 33|CERES       CUS
15401001|19 26 48.00|+11 21 16.8|19 Apr 1996 04 34 12|IRC+10420   CUS
16803301|20 46 25.50|+40 06 59.4|03 May 1996 11 11 58|NML-CYG     CUS
17504501|19 23 40.00|+14 31 06.0|10 May 1996 10 45 32|W51-IRS2    CUS
18200301|20 46 25.50|+40 06 59.4|16 May 1996 23 31 50|NML-CYG     CUS
20307001|20 46 25.50|+40 06 59.4|07 Jun 1996 12 29 56|NML-CYG     CUS "ap4"
21700201|10 45 03.60|-59 41 04.3|20 Jun 1996 20 51 20|ETA-CAR     CUS "ap4"
22302001|22 19 37.70|+63 18 47.1|27 Jun 1996 06 36 09|S140IRS     CUS "ap4"

                           Pseudo-aperture 4
------------------------------------------------------------------------------------
27903991|22 19 18.30|+63 18 47.1|22 Aug 1996 08 01 37|S140IRS     S07 no 5C
31405708|19 26 48.00|+11 21 16.9|26 Sep 1996 05 53 56|IRC+10420   S07
34201123|20 46 25.50|+40 06 59.4|23 Oct 1996 18 40 57|NML-CYG     S07
49602903|20 01 45.70|+33 32 43.3|26 Mar 1997 16 30 28|K3-50       S07 5C,D,6,6' only
51003702|20 46 25.50|+40 06 59.4|09 Apr 1997 16 31 27|NML-CYG     S07
65700403|22 19 18.30|+63 18 47.1|02 Sep 1997 21 49 09|S140IRS     S07
68500503|19 26 48.00|+11 21 16.9|30 Sep 1997 20 08 17|IRC+10420   S07
83901004|22 19 18.30|+63 18 47.1|03 Mar 1998 16 02 05|S140IRS     S07
------------------------------------------------------------------------------------

Fluxcal observations 20307001, 21700201, & 22302001 were obtained through
  pseudo-aperture 4 in the FP2 section (see SCREW 187 and documents referenced
  therein) prior to uplink change in revolution 237.  Observation 23002001
  not listed above (FP resolution and IP verification) also employs
  aperture 4.
```

6.2.4.4 S06 or CUS

```
-------- -----------|-----------|-------|--------------------|------------------------------
TDTOSN       RA         DEC      I time     UTC start           target    coverage
         hh mm ss.ss  d  '  ''   h  m  s                                  & remarks
-------- -----------|-----------|-------|--------------------|------------------------------
04800201|11 49 03.29|+14 34 19.8|0 58 04|04 Jan 1996 06 28 18|HR4534   ap1 CUS
04800301|11 49 03.29|+14 34 19.8|1 50 42|04 Jan 1996 07 27 06|HR4534   ap2 CUS
04800401|11 49 03.29|+14 34 19.8|1 43 24|04 Jan 1996 09 18 32|HR4534   ap3 CUS
06400201|14 20 03.25|-01 57 53.9|1 10 46|20 Jan 1996 05 49 01|PALLAS   ap1 CUS
06400301|14 20 07.24|-01 57 25.2|1 46 19|20 Jan 1996 07 05 29|PALLAS   ap2 CUS
06400401|14 20 12.42|-01 56 48.3|1 40 50|20 Jan 1996 08 57 32|PALLAS   ap3 CUS
06800201|15 58 51.85|-14 18 15.6|1 10 46|24 Jan 1996 06 40 04|CERES    ap1 CUS
06800301|15 58 56.41|-14 18 31.2|1 46 20|24 Jan 1996 07 56 32|CERES    ap2 CUS
06800401|15 59 02.54|-14 18 51.9|1 40 52|24 Jan 1996 09 48 34|CERES    ap3 CUS
08604601|18 36 56.19|+38 47 00.1|1 46 20|11 Feb 1996 17 41 34|HR7001   ap2 CUS
09304701|18 36 56.19|+38 47 00.1|1 10 44|18 Feb 1996 17 20 46|HR7001   ap1 CUS
10501401|18 36 56.19|+38 47 00.1|1 39 50|01 Mar 1996 09 01 35|HR7001   ap3 CUS
15401901|20 46 25.50|+40 06 59.4|1 39 56|19 Apr 1996 09 23 35|NML-CYG ap3 CUS
16100301|20 46 25.50|+40 06 59.4|1 09 46|26 Apr 1996 00 25 26|NML-CYG ap1 CUS
16803201|20 46 25.50|+40 06 59.4|1 45 20|03 May 1996 09 25 56|NML-CYG ap2 CUS
26502901|18 36 56.24|+38 47 00.2|1 40 58|08 Aug 1996 00 15 20|HR7001   ap3 CUS
31200601|16 45 13.41|-24 26 37.3|1 10 52|23 Sep 1996 15 57 17|CERES    ap1 CUS
31200701|16 45 16.64|-24 26 48.2|1 46 26|23 Sep 1996 17 13 53|CERES    ap2 CUS
31200801|16 45 21.99|-24 27 05.5|1 40 58|23 Sep 1996 19 06 03|CERES    ap3 CUS
32804001|18 36 56.24|+38 47 00.3|0 45 12|10 Oct 1996 04 10 32|HR7001   2A CUS
32804101|18 36 56.24|+38 47 00.3|1 21 02|10 Oct 1996 04 56 28|HR7001   2C CUS
46101507|17 47 57.90|+69 32 28.4|0 41 54|19 Feb 1997 10 03 15|ZODIACAL 2C RSRF check S06
46101606|15 51 16.50|-20 39 01.3|0 41 54|19 Feb 1997 10 58 31|ZODIACAL 2C RSRF check S06
```

```
58703101|20 46 25.50|+40 06 59.4|1 22 36|25 Jun 1997 09 59 54|NML-CYG Fringe modeling CUS
70601401|20 46 25.50|+40 06 59.4|0 58 24|21 Oct 1997 23 18 03|NML-CYG Fringe modeling CUS
81803201|04 35 55.19|+16 30 33.8|0 37 44|10 Feb 1998 22 44 14|HR1457  ap1 CUS
```

# 5 Spectrophotometric References Summary

## 5.1 Inventory

The following tables are an inventory of non-SWS observations and model SEDs available for flux calibration.

Not all of the models listed (specifically the MARCS2 models by L. Decin and the rev712 thermophysical model of Ceres by T. Müeller) are accessible from the IA SED database due to their transitory status, or at the request of the author. These models are used mainly in qualitative comparisons to spectral features or broad-band shapes.

Standard Thermal Models of the asteroids by T. Müeller have always been regarded as adequate only for uplink purposes (instrument gain settings) rather than calibration analyses. Broad-band RSRF work is more suited to the thermophysical model of Ceres in rev712, and possibly to similar models not yet available for the Hygeia and Juno `COs` listed in Tables 2-4).

Not all photometry used to test or validate the flux calibration is listed below. Such data are generally used during spot checks, and are taken from the literature (starting with Gezari et al. 1993 NASA Catalog of Infrared Observations). The general procedure is described in Part II.

Table 3: Non-SSO reference database

| SWSNAME | ALIAS | SP TYPE | PHOT | | IRAS | SPECTROPHOT[3] | MODEL[4] | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | NIR[1] | MIR[1] | PSC[2] | | KURUCZ | MARCS1 | MARCS2 | other |
| HR1457 | $\alpha$ Tau | K5III | | | vdH | C | | | | |
| HR2341 | $\alpha$ CMa | A1V | | | | | C | | | |
| HR4210 | $\eta$ Car | LBV | $\circ$ | $\circ$ | vdH | | | | | |
| HR4534 | $\beta$ Leo | A3Vv | $\circ$ | | x | | M | | | BB |
| HR4763 | $\gamma$ Cru | M4III | | | vdH | C | | | | |
| HR5340 | $\alpha$ Boo | K1.5IIIp | $\bullet$,$\circ$ | | x | C, LRS | H | vdB | LD | BB |
| HR5459 | $\alpha$ Cen A | G2V(+K) | | | | | C | | | |
| HR5563 | $\beta$ UMi | K4IIIv | $\circ$ | | x | LRS | | | LD | BB |
| HR5755 | HD138265 | K5III | $\bullet$,$\circ$ | | x | | | vdB | | BB |
| HR5981 | HD144204 | K5III | $\bullet$ | | x | | | vdB | | |
| HR6688 | $\xi$ Dra | K2III | $\bullet$,$\circ$ | | x | LRS | | vdB | | BB |
| HR6705 | $\gamma$ Dra | K5III | $\bullet$,$\circ$ | | x | C, LRS | C,H | vdB | LD | BB |
| HR7001 | $\alpha$ Lyr | A0V | $\bullet$,$\circ$ | | x | LRS | C,H | vdB | | |
| HR7310 | $\delta$ Dra | G9III | $\bullet$,$\circ$ | | x | LRS | H | vdB | LD | |
| HR7341 | HD181597 | K1III | $\bullet$,$\circ$ | | x | | H | vdB | | |
| HR7504 | 16 Cyg-B | G5V | $\bullet$,$\circ$ | | x | | | | | |
| HR8316 | $\mu$ Cep | M2Iae | $\bullet$,$\circ$ | $\circ$ | x | LRS | | | | |
| HR8636 | $\beta$ Gru | M5III | $\bullet$,$\circ$ | | x | LRS | | | | |
| HR8775 | $\beta$ Peg | M2.5IIIv | $\bullet$,$\circ$ | | x | C, LRS | | | LD | BB |
| IRC+10216 | CW Leo | C/PN? | $\circ$ | $\circ$ | x | LRS | | | | |
| K3-50 | | HII reg | $\circ$ | $\circ$ | x | LRS | | | | |
| NML Cyg | | M6IIIe | $\circ$ | | x | C, LRS | | | | |
| S140 IRS | GL2884 | PDR | $\bullet$ | $\bullet$ | vdH | | | | | |
| ST Her | HD142143 | M6.5IIIas | $\circ$ | | x | LRS | | | | |
| W Hya | HD120285 | M7e | | $\circ$ | vdH | | | | | |
| W51 IRS2 | | HII reg | $\circ$ | $\circ$ | x | LRS | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

1. Near-IR (NIR) and mid-IR (MIR) literature data from telescope and filter system of $\bullet$ = known origin, or $\circ$ = unknown origin.

2. x = in IA SED database
vdH = reference to ACS MASTER LIST document of K. van der Hucht (with calmanager pages).

3. C = M. Cohen composite spectrum (cf. Cohen literature references in Schaiedt et al. 1995, ISO A&A issue)
LRS = IRAS LRS, processed through Gipsy Irscal by H. Spoon et al.

4. C = provided by M. Cohen
H = provided by P. Hammersley
M = provided by P. Morris
vdB = provided by N. van der Bliek (cf. van der Bliek et al., Bell & Gustafsson, and Gustafsson et al. references in Schaiedt et al. 1995, ISO A&A issue)
LD = provided by L. Decin by priv. comm. (not in IA SED database)
BB = uplink blackbody curve by P. Morris

Table 4: SSO reference database

| Name | Object | Type | Model* | Usable |
|---|---|---|---|---|
| 1 Ceres | asteroid | G | TM (priv comm) | rev714 |
| | | | TM (STM) | rev312 |
| 2 Pallas | asteroid | B | TM (STM) | rev50 |
| Saturn | planet | | TE | 15″ disk |
| | | | TE | 16″ disk |
| | | | TE | 17″ disk |
| Uranus | planet | | EL, MG | |
| Neptune | planet | | EL | |
| | | | | |

* TM = T. Müeller thermophysical model (priv. comm.) or uplink standard thermal model (STM)
TE = T. Encrenaz
EL = E. Lellouch
MG = M. Griffin

## 5.2 dc1 Files for SED modules

The following module identifiers are present (with 95% completeness) for SEDs stored as AARs in IA. Online documentation gives literature references and further details.

```
Module naming convention normally follows the order of
FIELD1_FIELD2_FIELD3_...

where FIELD1 is always OBJECT, FIELD2 is TELESCOPE or "M" for MODEL, FIELD3 is INSTRUMENT
or PASSBANDS, and the last FIELD is OBSERVER.  Maximum number of characters is 21.

123456789012345678901
HR0000_T_JHK_B         Observed JHK broadband fluxes acquired at TCS
HR0000_T_JKL_N         Observed JKL narrowband fluxes acquired at TCS
HR0000_E_JHKLM_B       Observed JHKLM broadband fluxes acquired at ESO
HR0000_E_HKLBRCO_N     Observed HKLBrgammaCO narrowband fluxes acquired at ESO
HR0000_U_LM_GILLET     Observed LM fluxes acquired by Gillett
HR0000_U_JKLN_COMP     Observed JKLN composite fluxes acquired at unknown telescope
HR0000_U_KLM_HACK      Observed KLM fluxes acquired by Hackwell at unknown telescope
HR0000_U_KLM_ENGEL     Observed KLM fluxes acquired by Engelke at unknown telescope
HR0000_U_KLM_THOMAS    Observed KLM fluxes acquired by Thomas at unknown telescope
HR0000_U_MIR_HAGEN     Observed mid-IR fluxes acquired by Hagen at unknown telescope
HR0000_U_MIR_U         Observed mid-IR fluxes acquired  at unknown telescope
HR0000_U_FIR_U         Observed far-IR fluxes acquired  at unknown telescope
HR0000_U_FIR_COMP      Observed far-IR composite fluxes acquired at unknown telescope
HR0000_U_FIR_THRON     Observed far-IR fluxes acquired by Thronson at unknown telescope
HR0000_IRAS_PSC        Observed IRAS Point Source Catalogue fluxes
HR0000_IRAS_LRS        Observed IRAS LRS spectrum
HR0000_U_JM            Observed optical fluxes obtained in Johnson & Mitchell filter system
HR0000_U_GEN           Observed optical fluxes obtained in Geneva filter system
HR0000_U_OPT_COMP      Observed composite optical fluxes acquired at unknown telescope
HR0000_KAO_SPEC_NIR    Observed NIR spectrum acquired with KAO
HR0000_KAO_FIR_SCHW    Observed FIR spectrum acquired by Schwartz with KAO
HR0000_KPNO_JHK_AP62   Observed JHK fluxes acquired at KPNO with 62" aperture
HR0000_KPNO_JHK_AP9    Observed JHK fluxes acquired at KPNO with 9" aperture
HR0000_U_SPEC_UV       Observed UV spectrum acquired with unknown telescope
HR0000_M_AP34_15       Model usable for apertures 3-4, 15" disk
```

```
HR0000_M_LELL_9611      Model by Lellouch (Nov 96)
HR0000_M_COHEN          Composite spectrum OR Kurucz model by M. Cohen
HR0000_M_BB_LEBOF       Model blackbody by Lebofsky
HR0000_M_BB_MORRS       Model blackbody by Morris
HR0000_M_BB_MUELL       Model blackbody by Mueller
HR0000_M_STM_MUELL      Model Standard Thermal Model by Mueller
HR0000_M_HAM            Model Kurucz by Hammersly
HR0000_M_MRCS1          Model MARCS (version 1)
```

It should be noted that the naming convention established in early PV did not always result in a fool-proof identification of SEDs. In particular,

- The "infrared flux method" (IRFM) should refer to the composite spectrophotometry provided by M. Cohen, and not the MARCS model atmospheres which are not calibrated on absolute levels as in the IRFM.
- Most data of M. Cohen in the IA SED database are observed spectral fragments, merged according to the IRFM. These are not accurately referred to as models (e.g. HR8775_M_COHEN, in the same way as a calibrated Kurucz model template (e.g., HR7001_M_COHEN). Online documentation identifies the file contents.

## 5.3 General Atlas

Reference spectrophotometry and photometry available in the IA SED database for flux calibration of the grating and F-P sections are plotted across the wavelength baseline of each grating detector block. The MARCS1 Uppsala SSG spectra, the composites and templates by M. Cohen, other Kurucz model atmospheres, and various non-ISO observations are separately plotted.

Note the following:

1. Uppsula SSG spectra based on MARCS model atmospheres are proprietary, and were provided by priv. comm. from N. van der Bliek et al. during PV. Synthesis of cool star atmospheres using the Uppsula SSG code for photometric calibration in the infrared is disussed in van der Bliek 1997, Ph. D. thesis, U. of Leiden; van der Bliek et al. 1998, in IAU Symposium 189 on Fundamental Stellar Properties: The Interaction between Observation and Theory (eds. Bedding, Booth & Davis), Kluwer, Dordrecht, 89; and van der Bliek, Gustafsson, & Eriksson 1996, A&A, 309, 849.
2. A second generation of MARCS models to include absorption by the SiO fundamental, using linelists of R. Bell, were provided for HR6705 and HR5340 in January 1997. Significant differences in absolute continuum fluxes and strengths of the CO absorption bandheads in the first overtone are unexplained in these data. The models are not in the IA SED database.
3. Further work with the MARCS models, in iteration with SWS observations of $\alpha$ Boo, $\beta$ Peg, and $\gamma$ Dra were provided by priv. comm. for RSRF studies. These are described by Decin et al. 1997, in *ISO to the Peaks* (for $\alpha$ Boo and $\beta$ Peg), and are not in IA.

4. The synthetic spectrum of HR7001 is not a MARCS model (incorrectly named in IA as HR7001_M_MRCS1), but is an Uppsula SSG spectrum based on the model of Dreiling & Bell 1980, ApJ, 241, 736.

5. SED application is described in Part II.

6. All SEDs which have been used in the photometric calibrations, but which are not in IA, may be requested from the author.

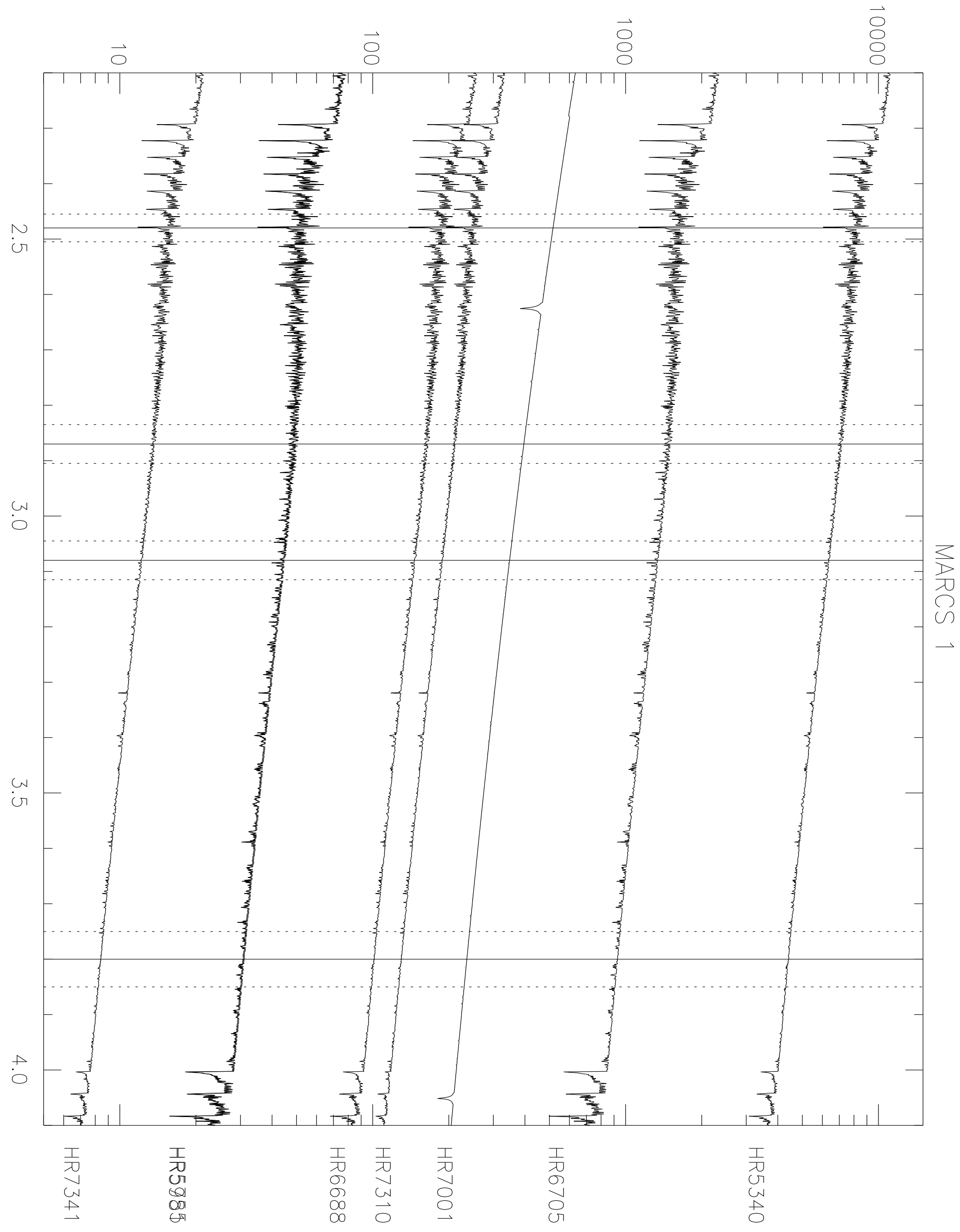


Figure 3: Uppsula SSG synthetic spectra based on MARCS model atmospheres, provided by priv. comm. HR5981 and HR5755 are nearly overlaid due to identical input effective temperature, gravity, and metalicity, and only 0.01 mag difference in narrow band K magnitudes. Vertical lines indicate key wavelengths and passbands.

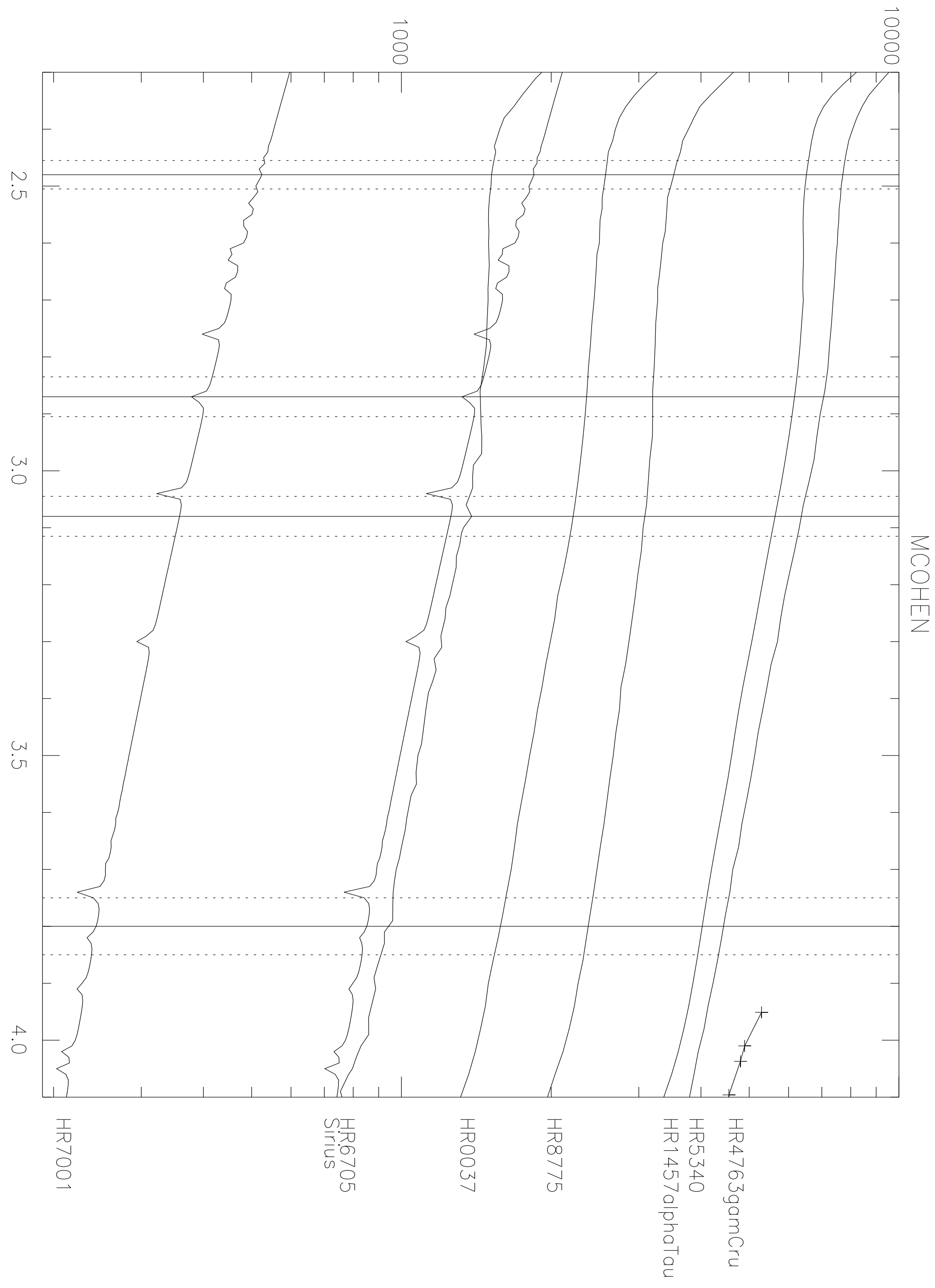


Figure 4: Spectra energy distributions provided by M. Cohen to the ISO project. SEDs for Sirius and Vega (HR7001) are calibrated Kurucz model atmospheres. Others are composite observations. Vertical lines indicate key wavelengths and passbands.

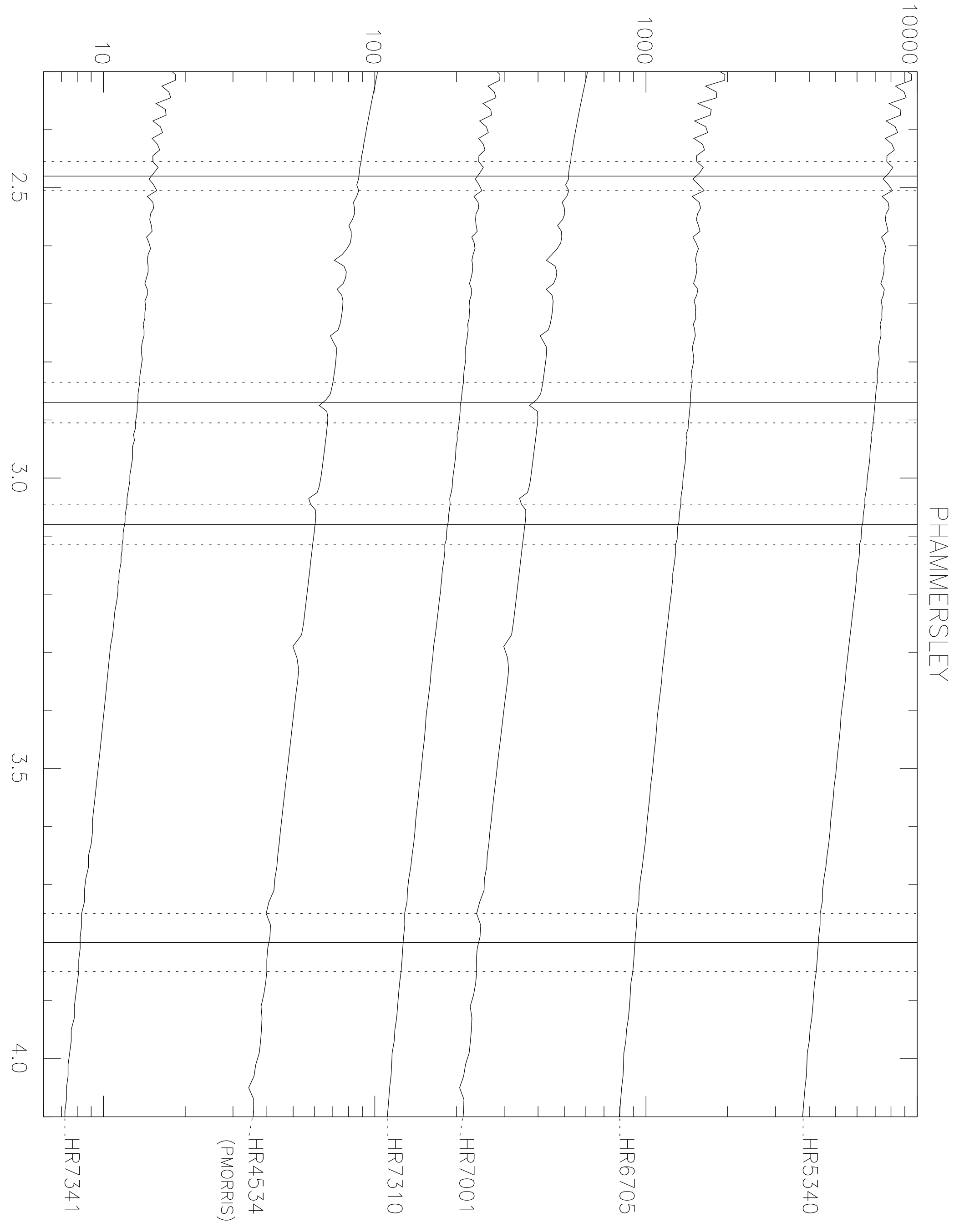


Figure 5: Photometrically calibrated Kurucz model atmospheres, provided by P. Hammersly to the ISO project, except for HR4534 by P. Morris. Vertical lines indicate key wavelengths and passbands.

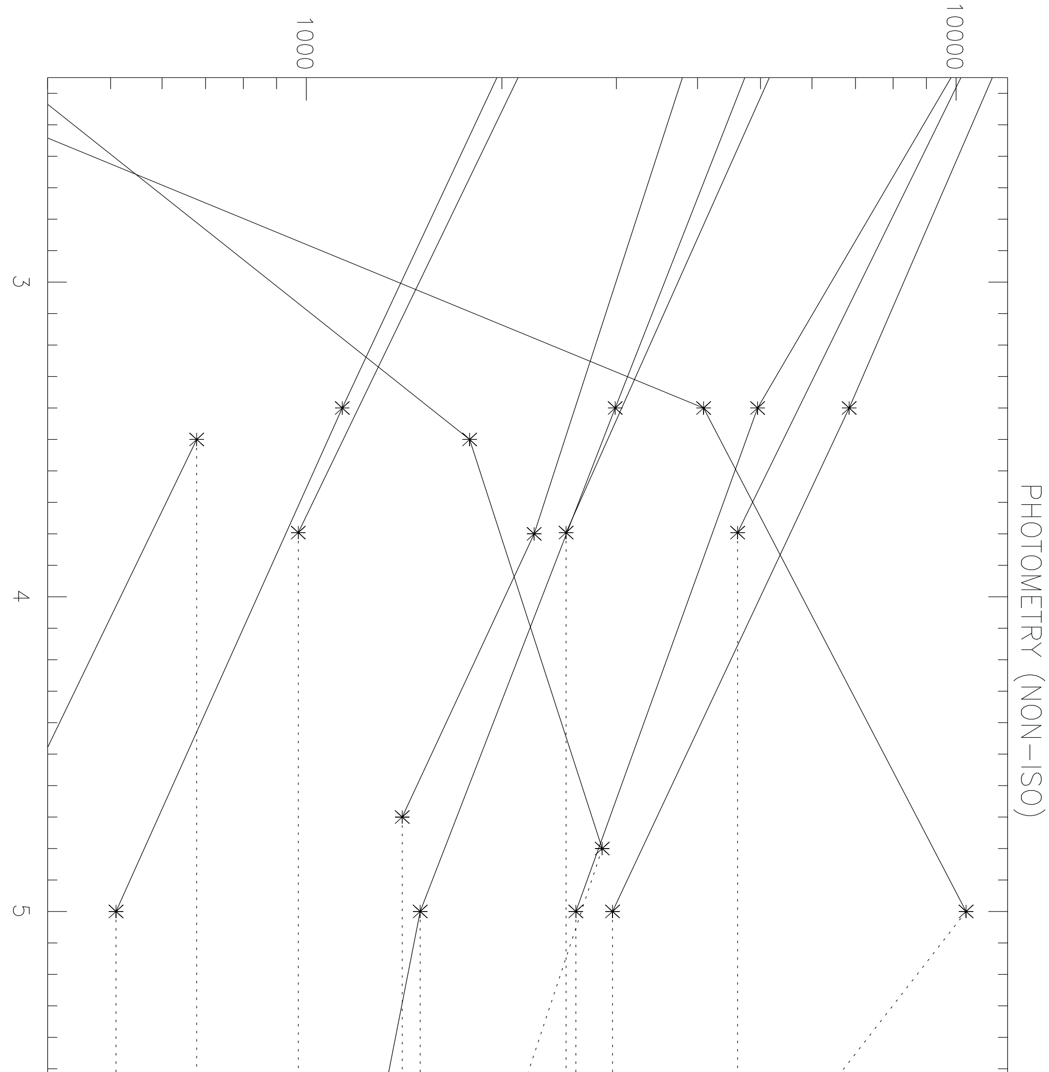


Figure 6: Non-ISO photometry at high flux, collected mainly prior to launch.

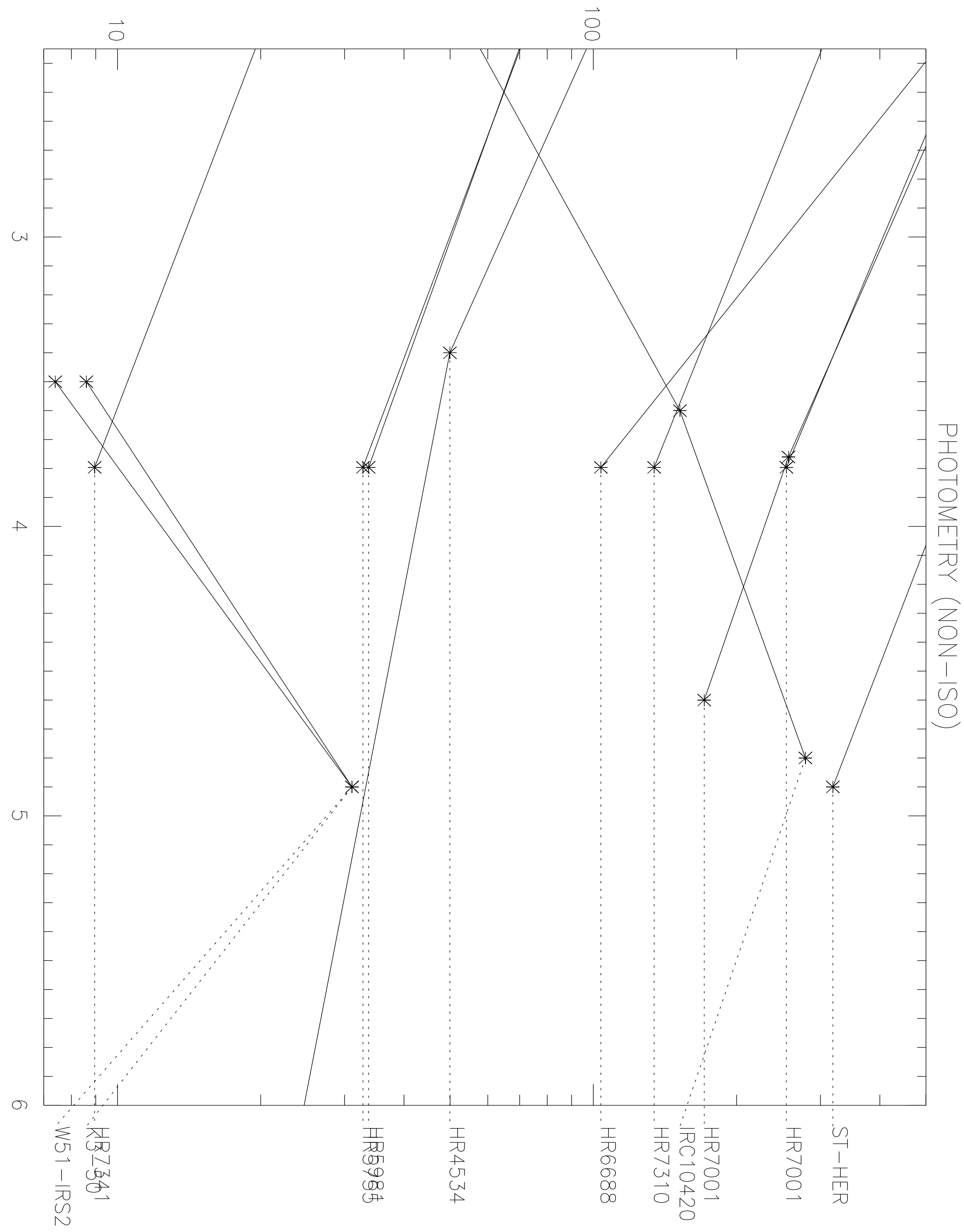


Figure 7: Non-ISO photometry at low flux, collected mainly prior to launch.

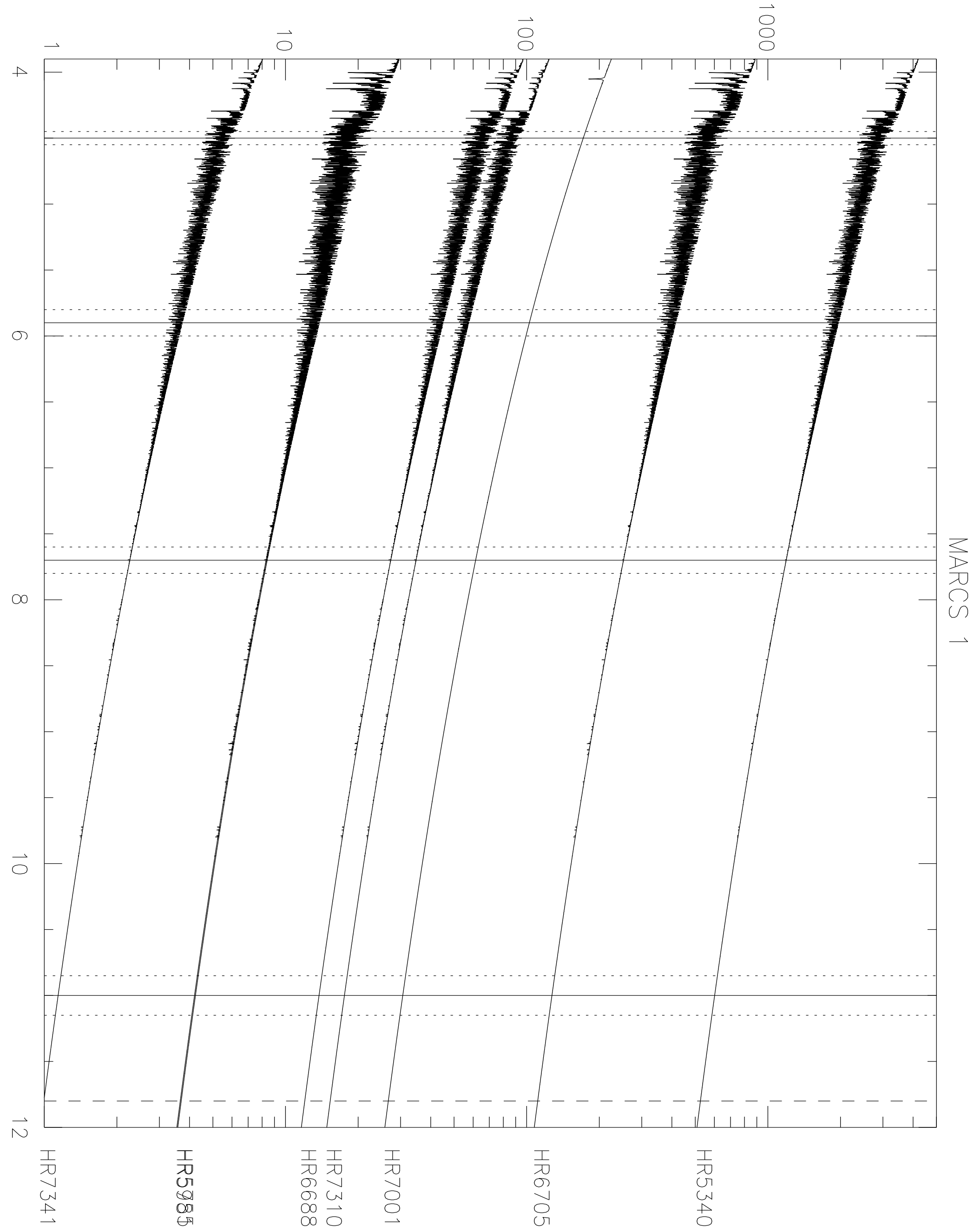


Figure 8: Uppsula SSG synthetic spectra based on MARCS model atmospheres, provided by priv. comm. HR5981 and HR5755 are nearly overlaid.

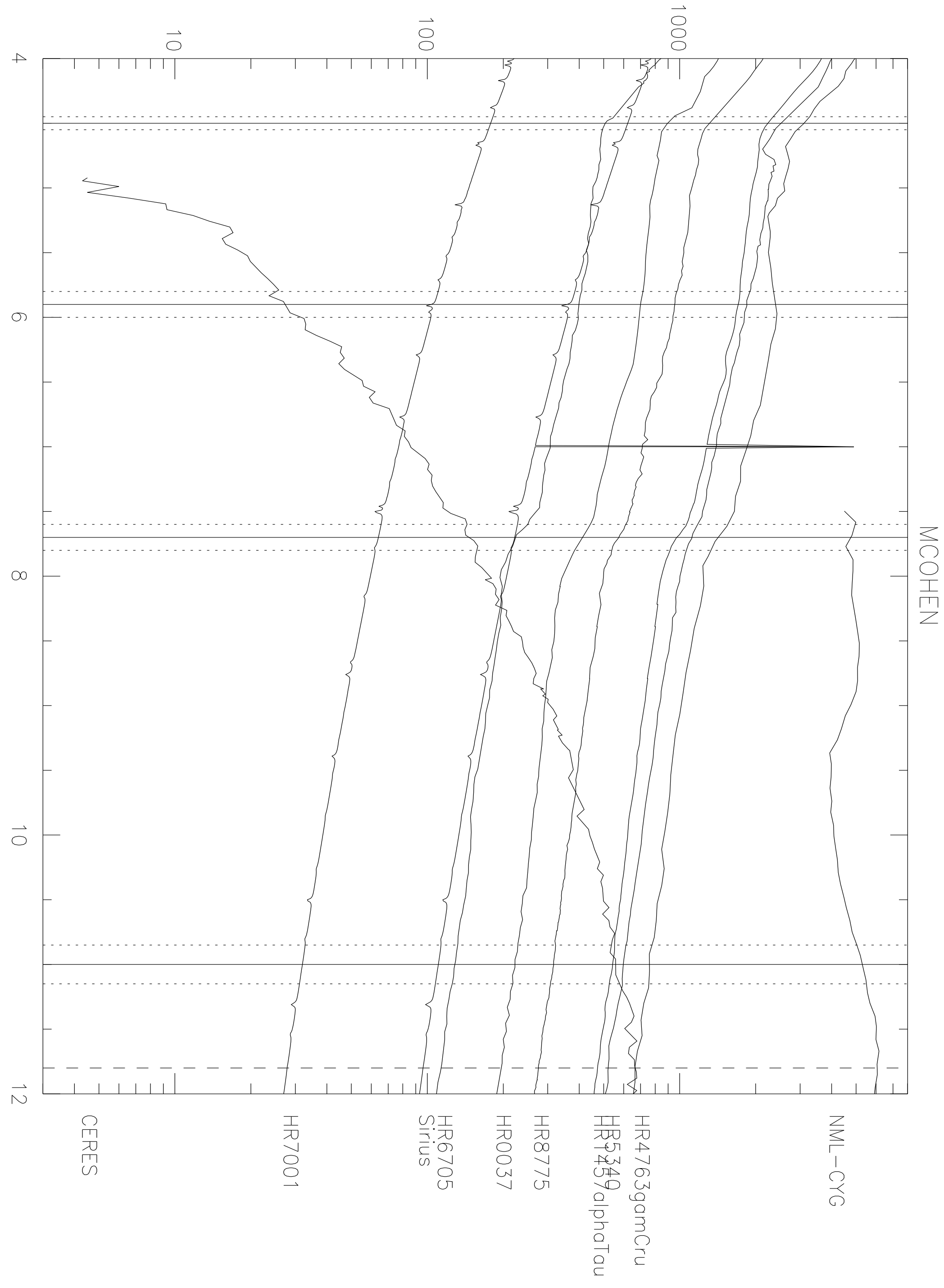


Figure 9: Spectral energy distributions from M. Cohen to the ISO project. SEDs for Sirius and Vega (HR7001) are calibrated Kurucz model atmospheres. Others are composite observations. The energy distribution steeply increasing with wavelength corresponds to that of Ceres.

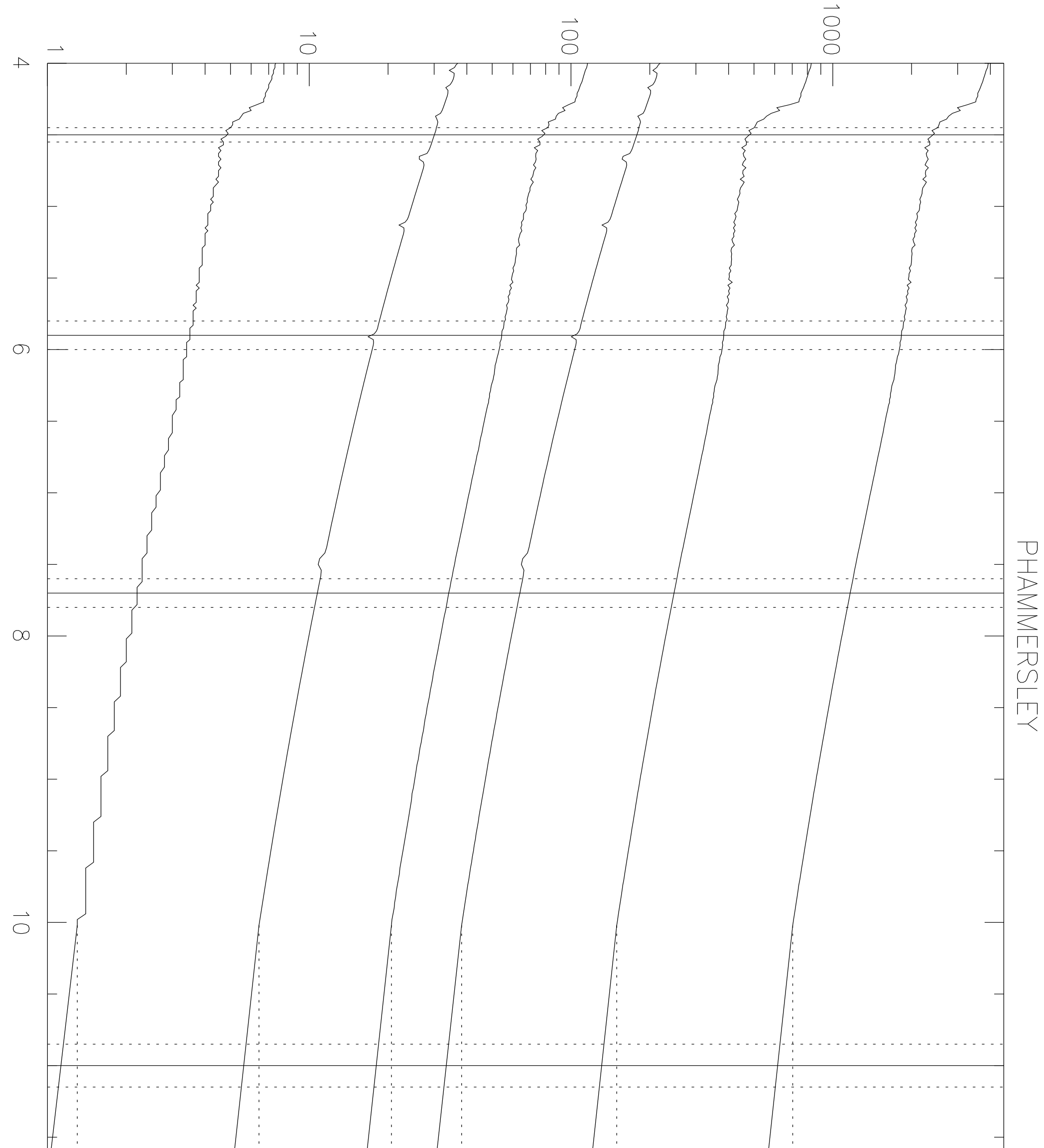


Figure 10: Photometrically calibrated Kurucz model atmospheres, provided by P. Hammersly to the ISO project, except for HR4534 by P. Morris.

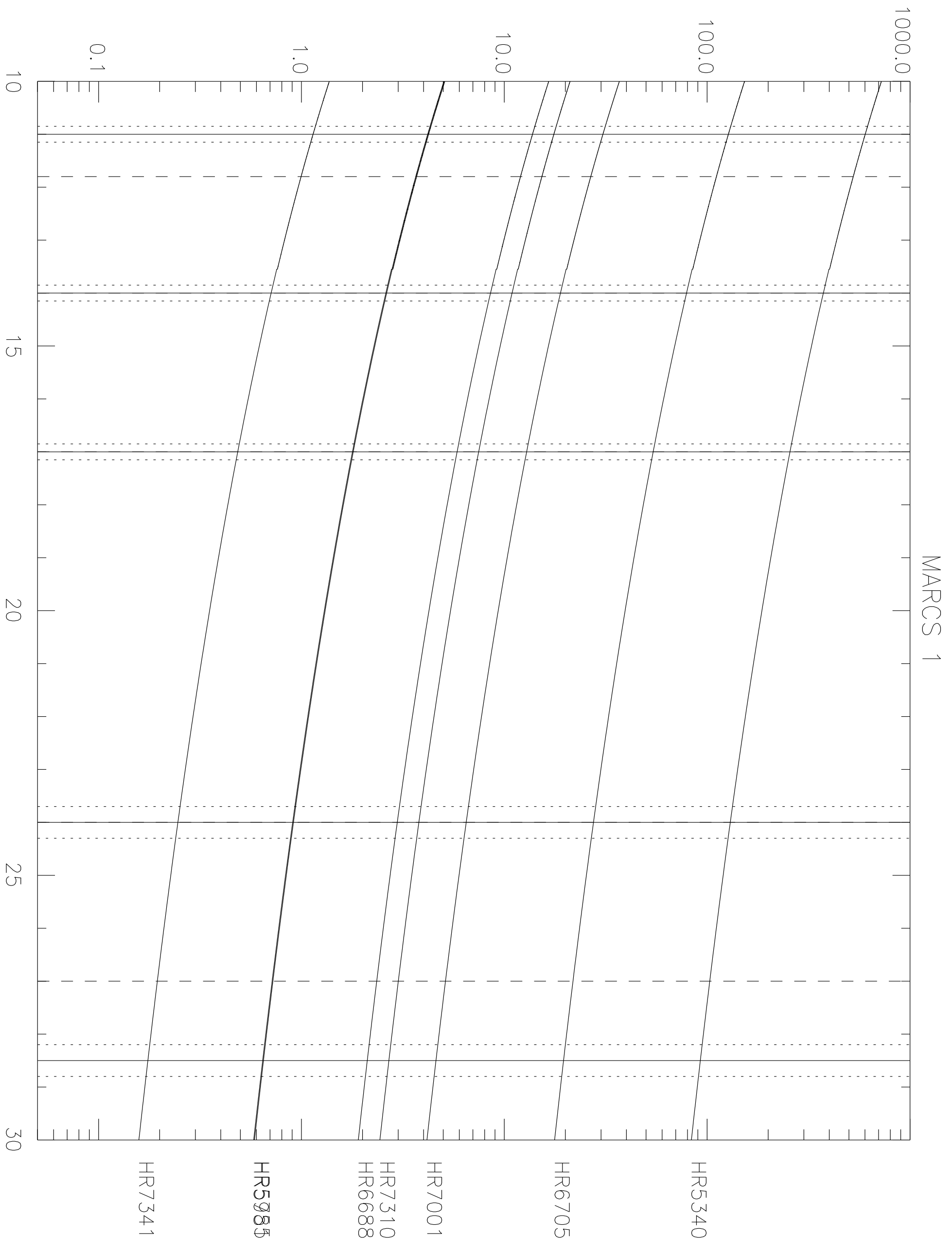


Figure 11: Uppsula SSG synthetic spectra based on MARCS model atmospheres, provided by priv. comm. HR5981 and HR5755 are nearly overlaid.

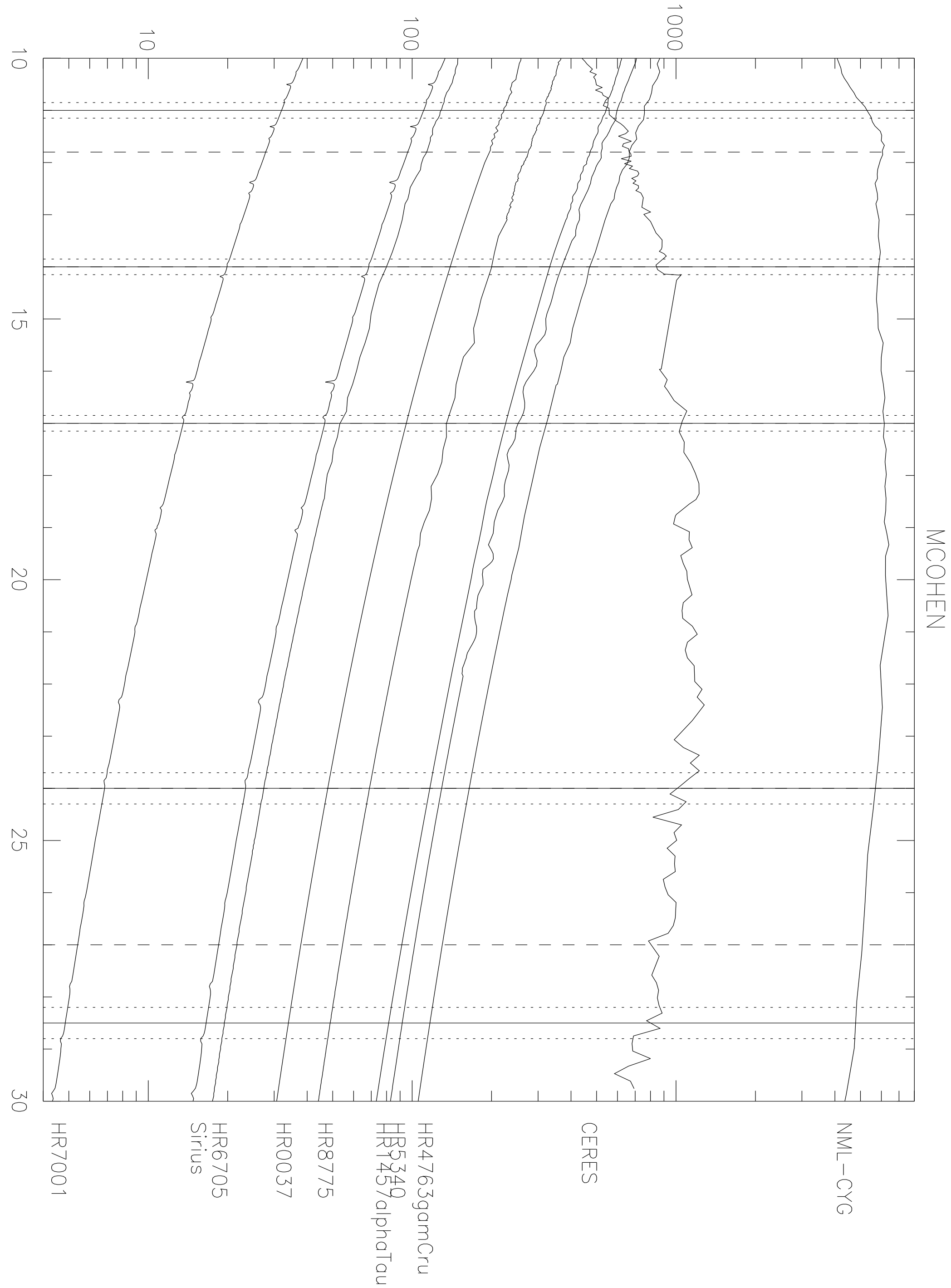


Figure 12: Spectral energy distributions from M. Cohen to the ISO project. SEDs for Sirius and Vega (HR7001) are calibrated Kurucz model atmospheres. Others are composite observations.

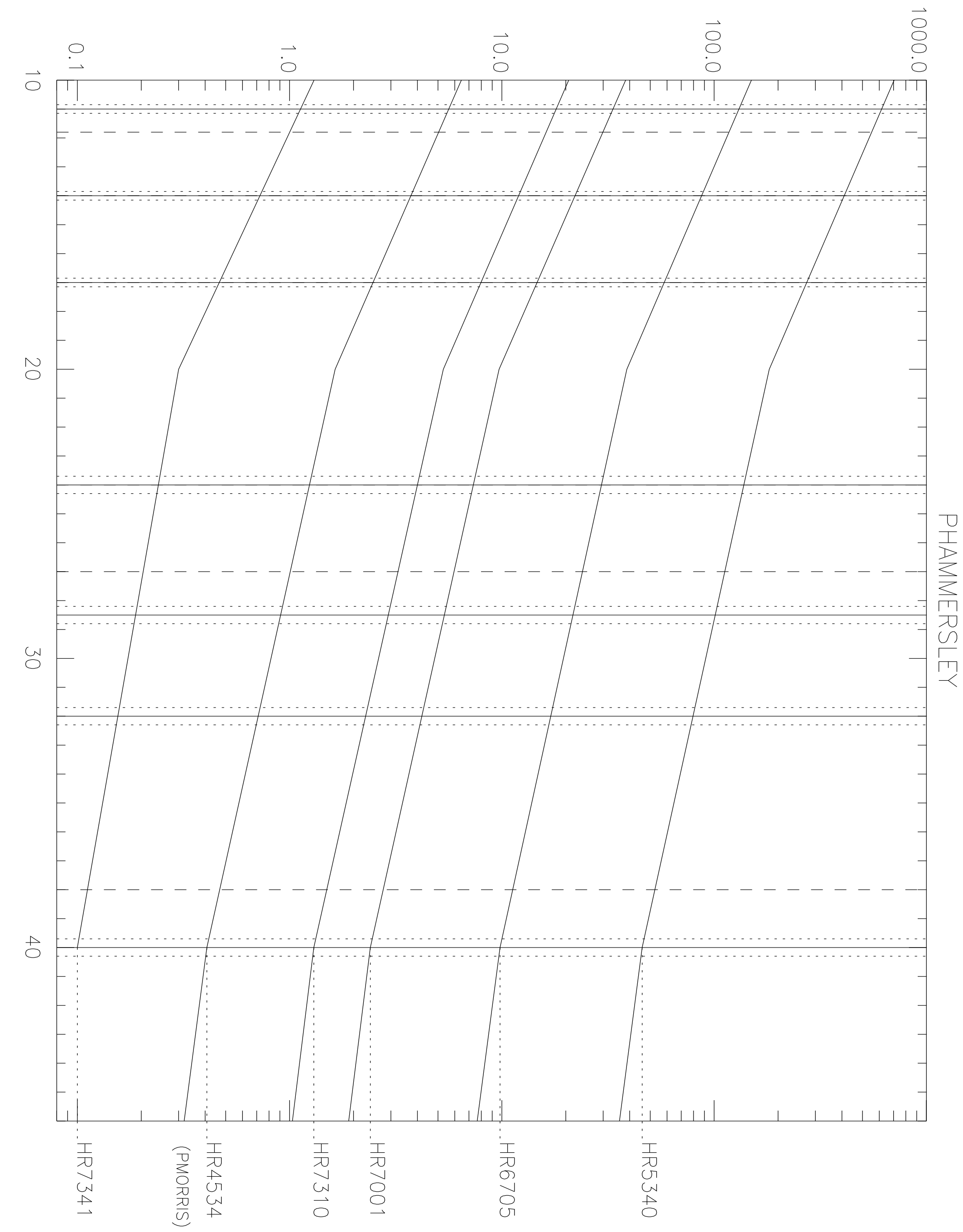


Figure 13: Photometrically calibrated Kurucz model atmospheres, provided by P. Hammersly to the ISO project, except for HR4534 by P. Morris.

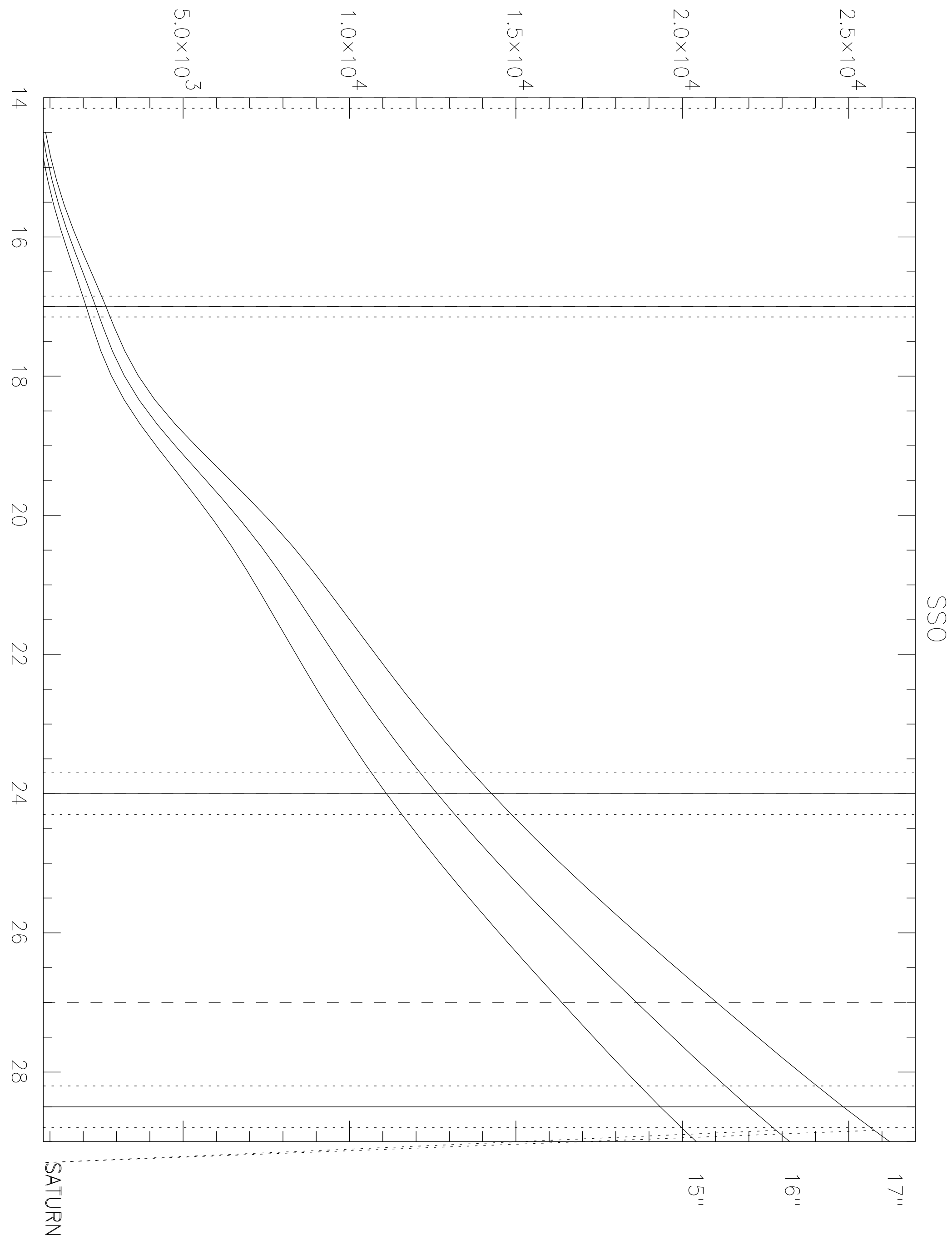


Figure 14: Saturn at different disk sizes, provided by priv. comm. by E. Lellouch.

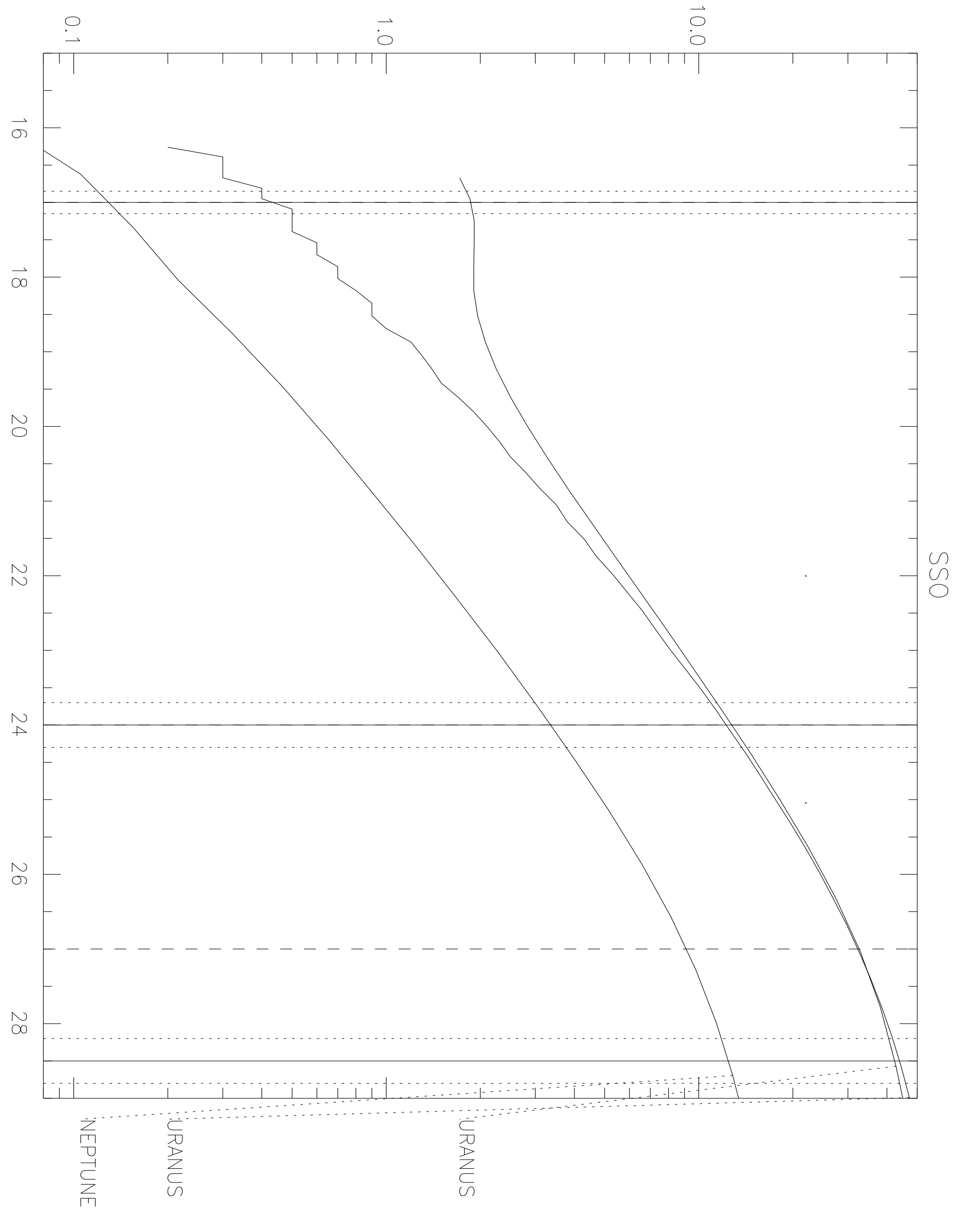


Figure 15: Uranus and Neptune model SEDs, provided by priv. comm. by E. Lellouch and to the ISO project by M. Griffin.

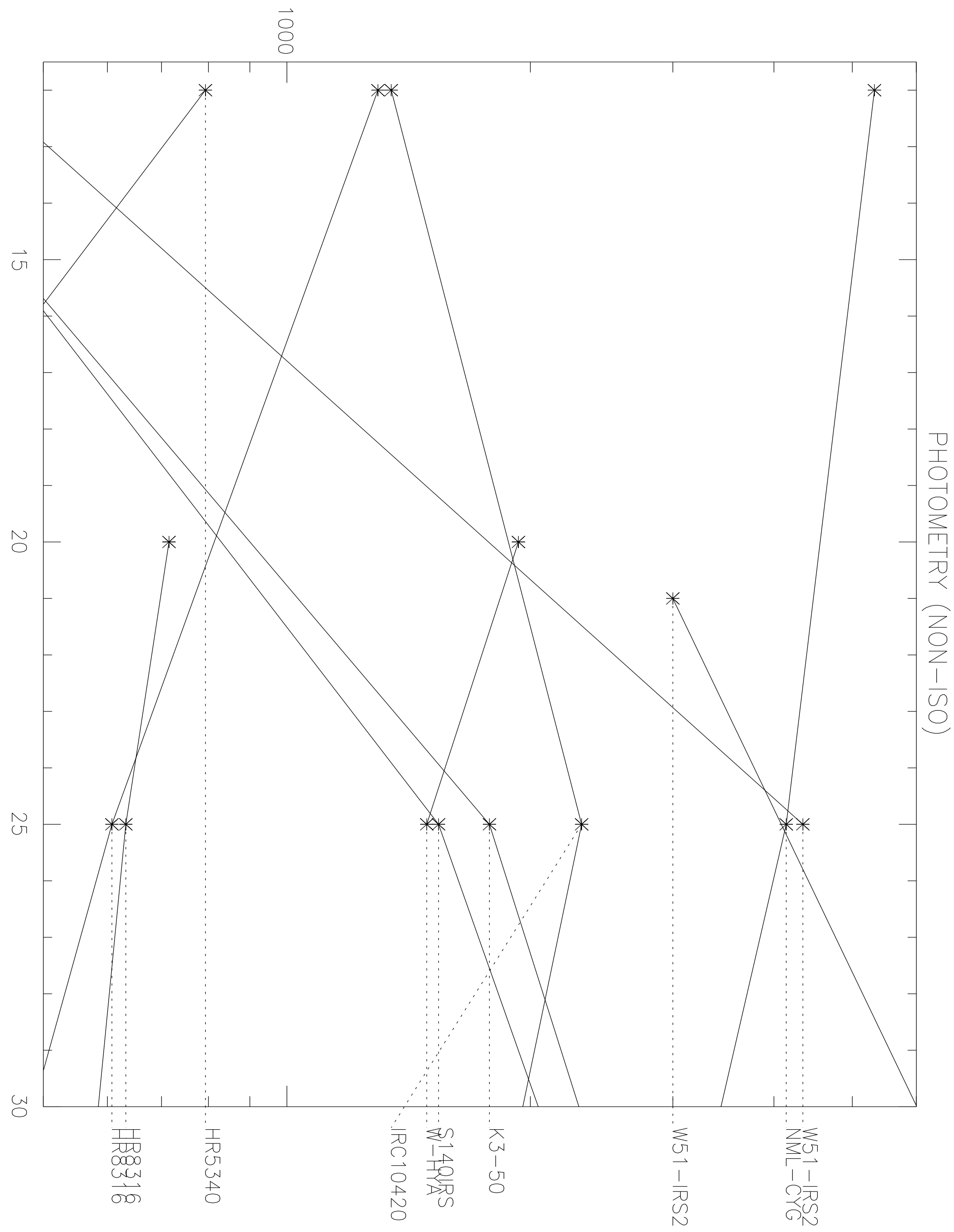


Figure 16: Non-ISO photometry at high signals, collected mainly prior to launch.

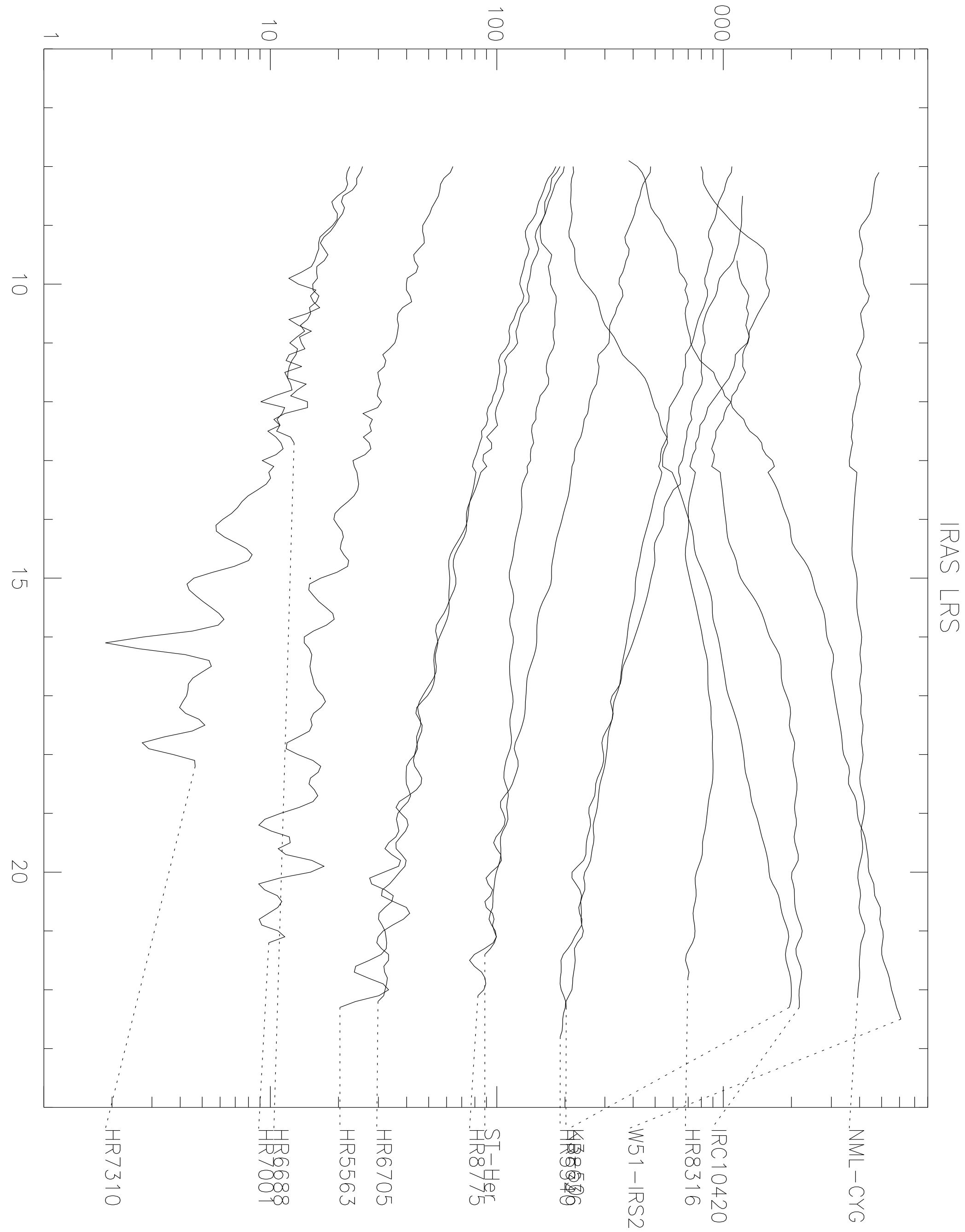


Figure 17: IRAS-LRS.

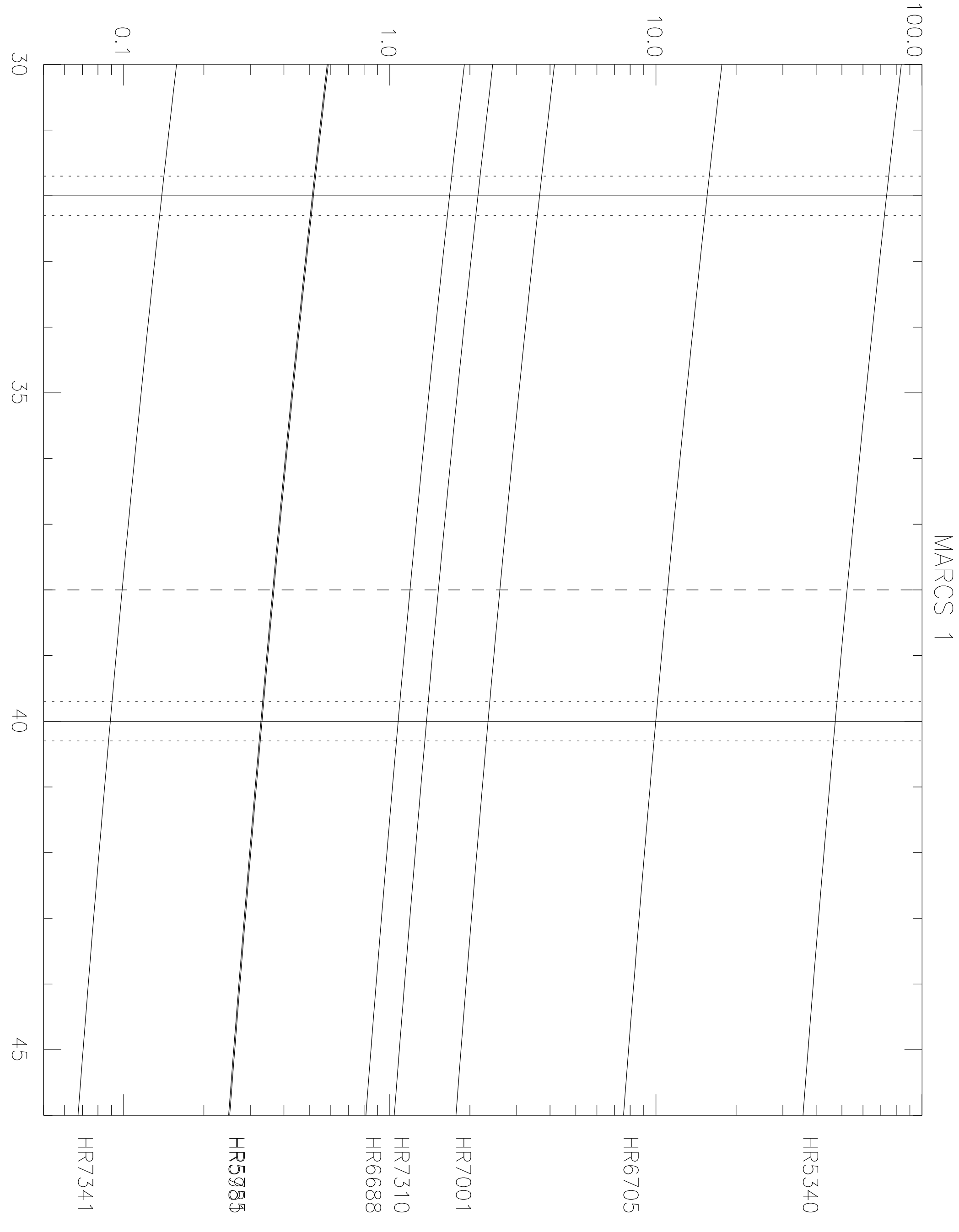


Figure 18: Uppsula SSG synthetic spectra based on MARCS model atmospheres, provided by priv. comm. HR5981 and HR5755 are nearly overlaid.

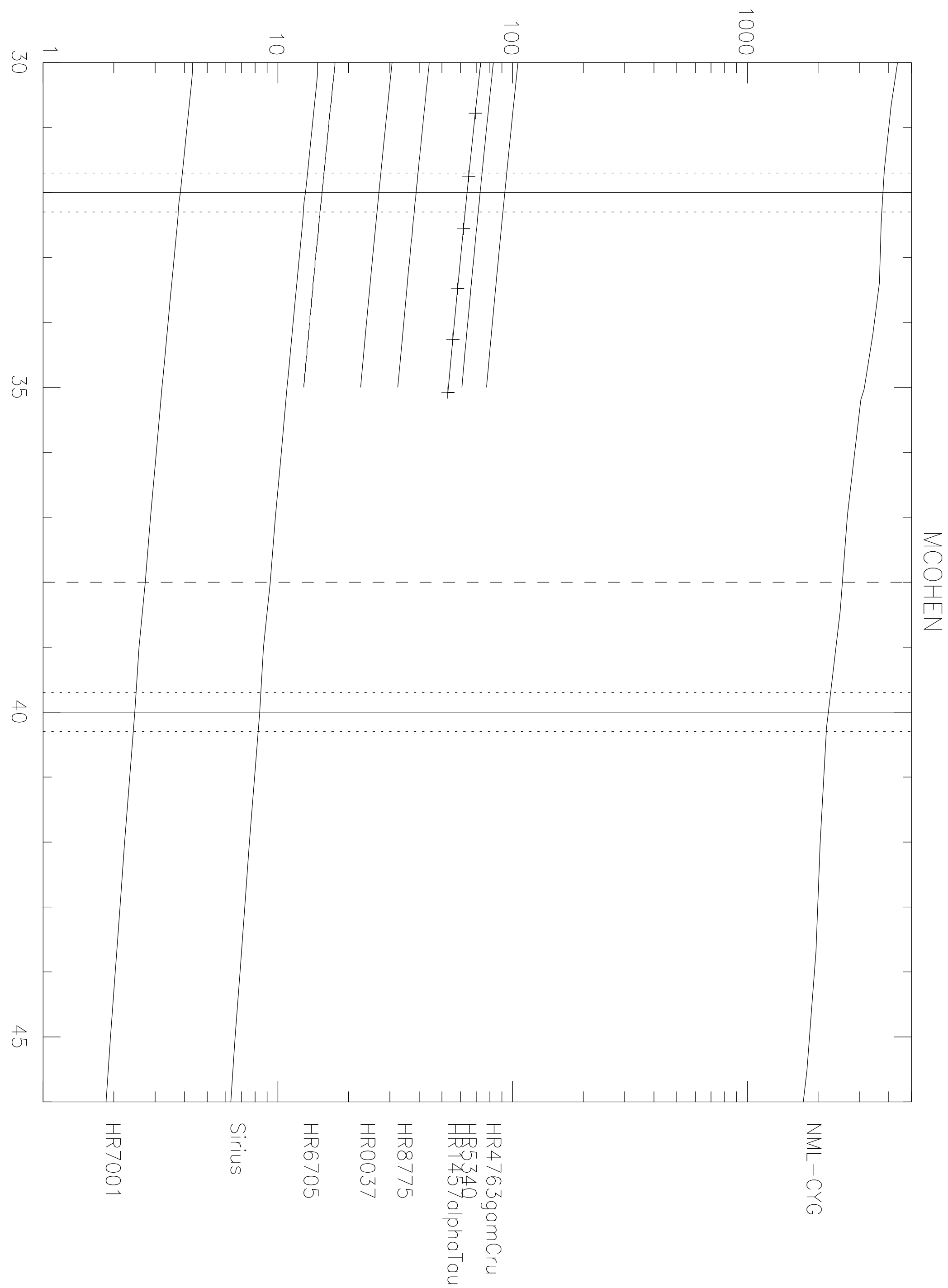


Figure 19: Spectral energy distributions from M. Cohen to the ISO project. SEDs for Sirius and Vega (HR7001) are calibrated Kurucz model atmospheres. Others are composite observations.

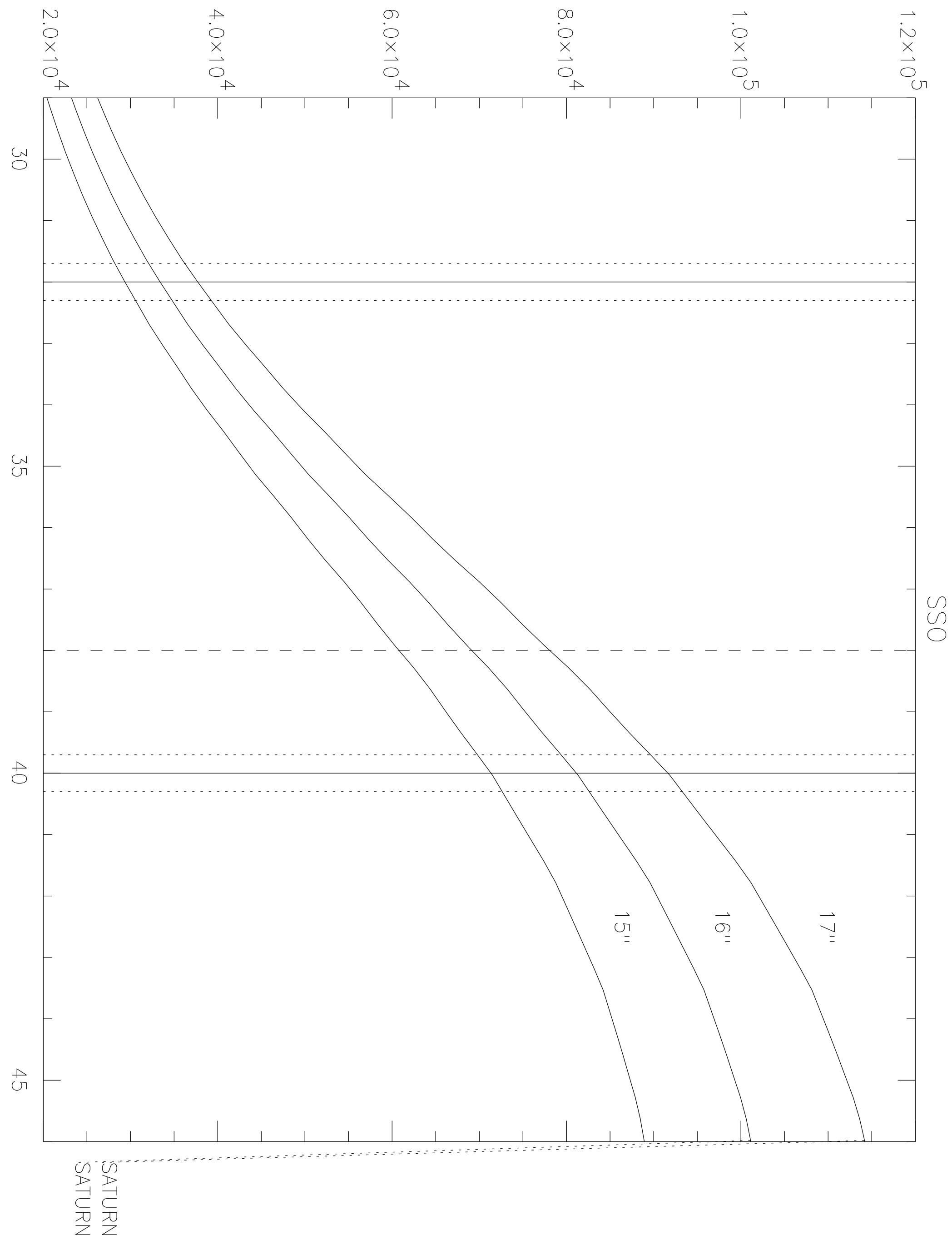


Figure 20: Saturn at different disk sizes, provided by priv. comm. by E. Lellouch.

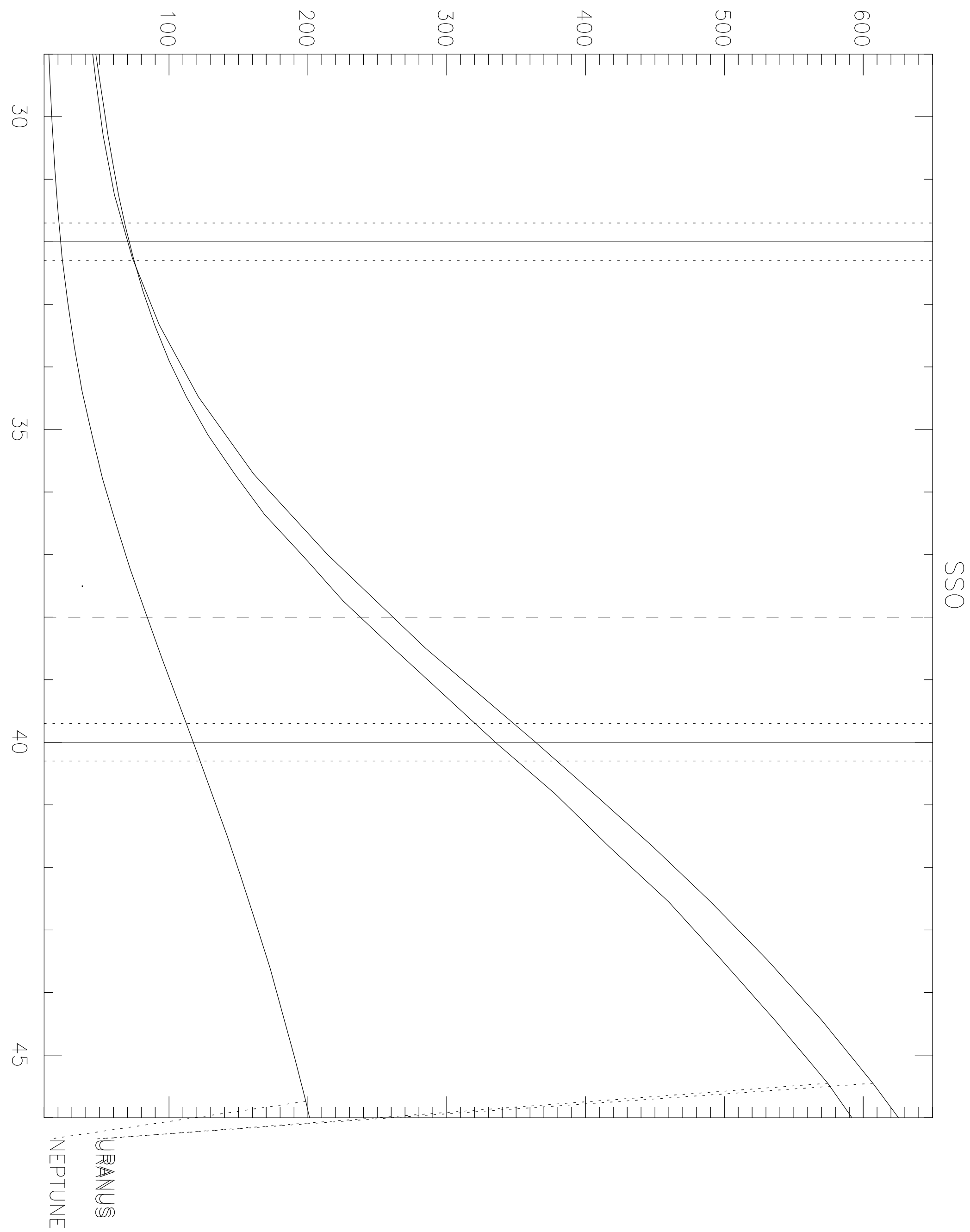


Figure 21: Uranus and Neptune model SEDs, provided by priv. comm. by E. Lellouch and to the ISO project by M. Griffin.

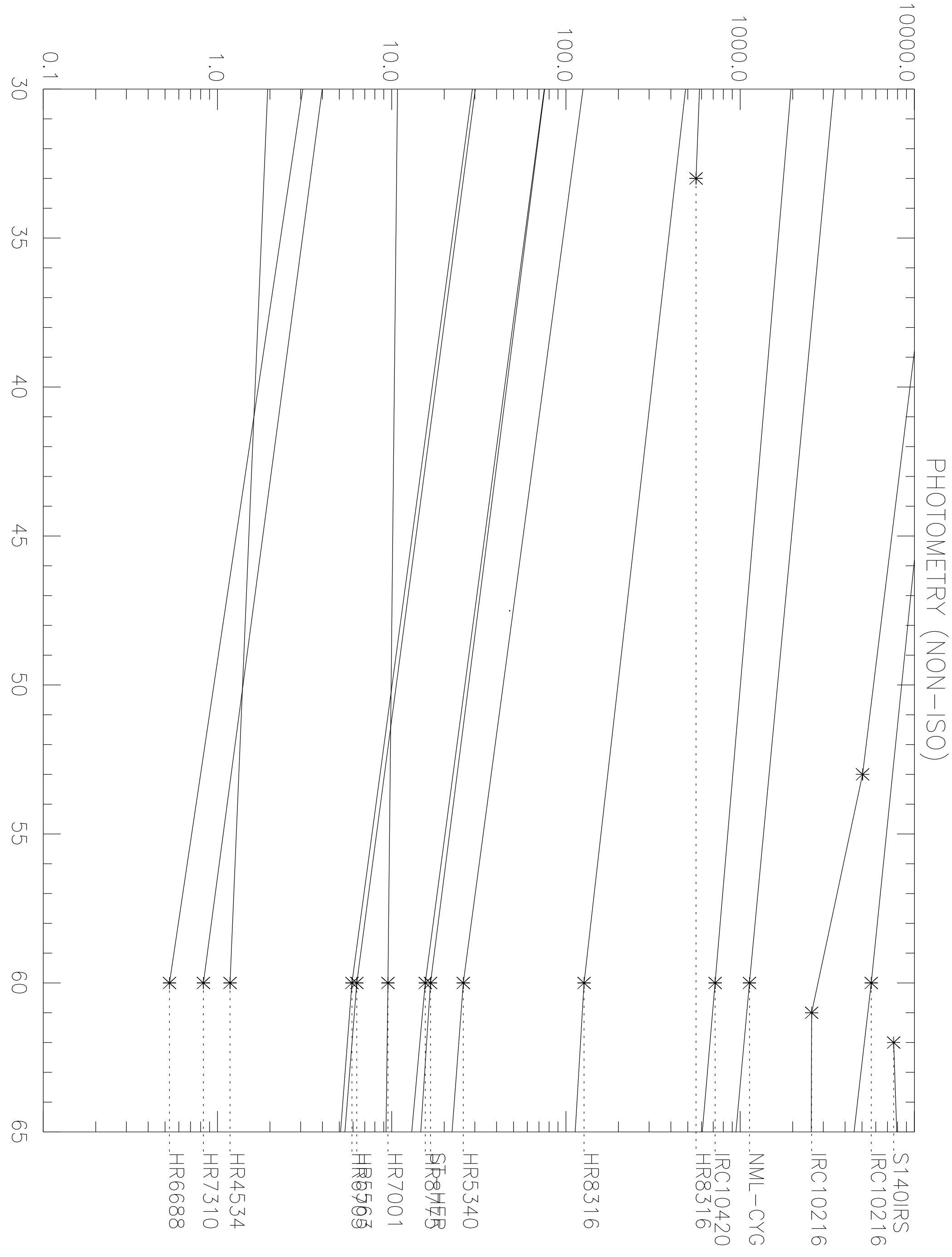


Figure 22: Non-ISO photometry, collected mainly prior to launch.