The ISOPHOT Serendipitous Survey
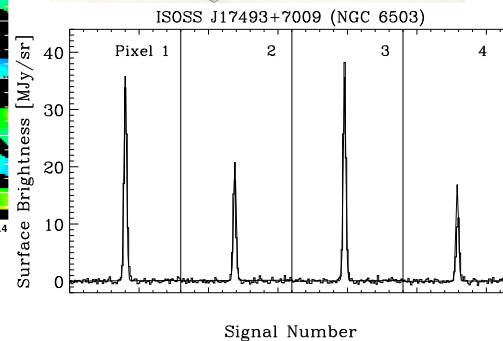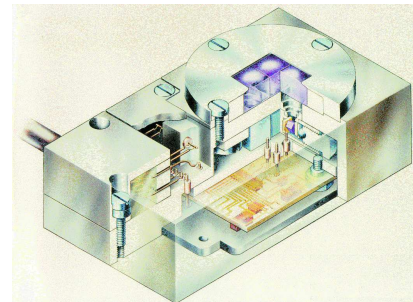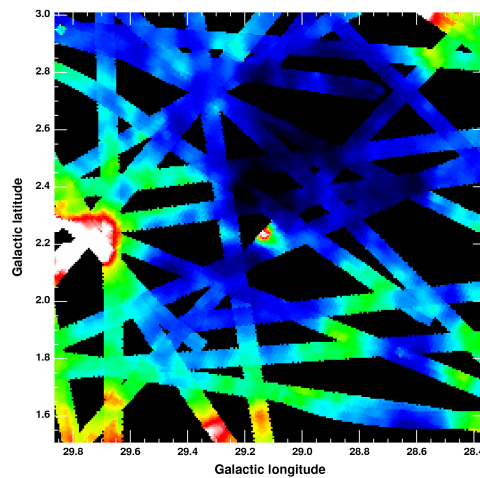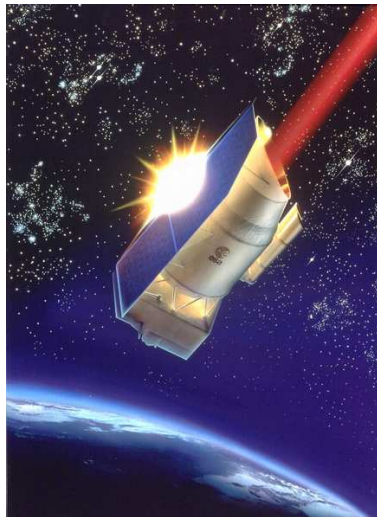# ISO's View of the 15 K Cold Sky

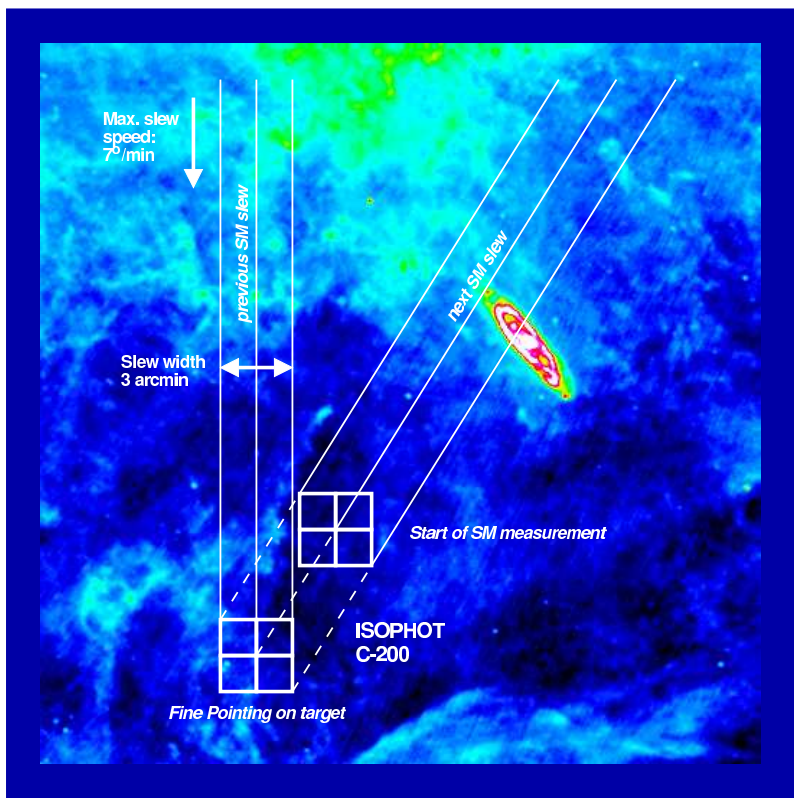## Ulrich Klaas, Manfred Stickel, Oliver Krause, Dietrich Lemke

ISOPHOT Data Centre @ Max-Planck-Institut für Astronomie, Heidelberg

ISO Legacy Colloquium
December 13, 2006, ISO Data Centre, ESAC, Villafranca, Madrid, Spain
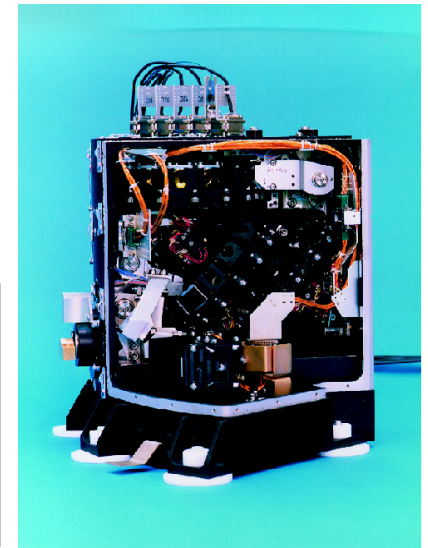
The idea:

One of the hurdles before implementation: Edit Planned Observation File in PV Phase

```
95354115506 START_TDT              Y              /* Starting a TDT
95354115506 MOUT                   Starting TDT : 033017
95354115516 PREQ                   132037.40      /* RA is HHMMSS.SS
                                    +340806.2      /* DEC is +/-DDMMSS.S
                                    10             /* OTF Threshold
                                    P2             /* Instrument/Aperture
                                    0              /* CFPU#
95354120107 ED(PHTTLM)                             /* Telemetry Reconfiguration
95354120117 TDATA_TDT_N            033017
95354120117 TDATA_AOT             P99
95354120117 TDATA_TDT_C           CAL
95354120117 TDATA_APERTURE        P2
95354120117 TDATA_OBS_DESCR       SBOGUN  571031E101005Cslew start: PSC 006
95354120117 TDATA_AOT_VAR         0101000199535310212302.84
95354120117 TDATA_MESSAGE_2       start 160   micron slew measurement with FCS
95354120117 ICSNAME               PC0051017001 /* Turn Wheel 2 absolute
95354120125 ICSNAME               PC1201017002 /* P_MEAS_SER
--> xxx[95354120136 TDATA_EVERYTHING]xxx
95354120136 END_TDT
95354120136 START_TDT              Y              /* Starting a TDT
95354120136 MOUT                   Starting TDT : 033018
95354120146 PREQ                   131136.50      /* RA is HHMMSS.SS
                                    +225453.9      /* DEC is +/-DDMMSS.S
                                    10             /* OTF Threshold
                                    P2             /* Instrument/Aperture
                                    0              /* CFPU#
95354120432 ED(PHTTLM)                             /* Telemetry Reconfiguration
--> xxx[95354120432 TDATA_TDT_N            033018]xxx
--> xxx[95354120432 TDATA_AOT             P99]xxx
--> xxx[95354120432 TDATA_TDT_C           CAL]xxx
--> xxx[95354120432 TDATA_APERTURE        P2]xxx
--> xxx[95354120432 TDATA_OBS_DESCR       SBOGUN  571031E102    Cslew end: PSC 13091+2310]xxx
--> xxx[95354120432 TDATA_AOT_VAR         0101000529534110201302.84]xxx
95354120445 ED(PHTC05)                             /* Stop Exposure
95354120448 ICSNAME               PC0000018001 /* CONFIGURE TO RESET MODE
95354120534 TDATA_MESSAGE_2       end of 160   micron slew measurement with FCS
95354120534 TDATA_EVERYTHING
95354120534 END_TDT
```
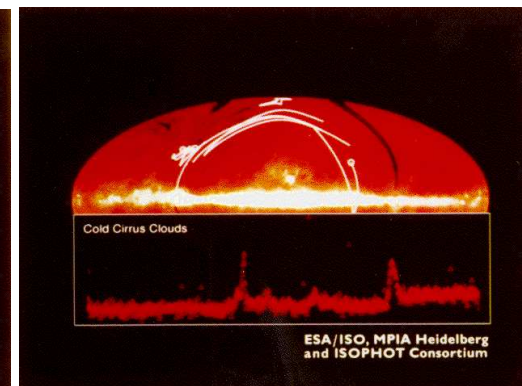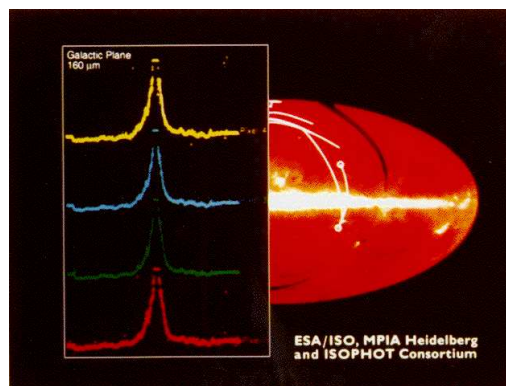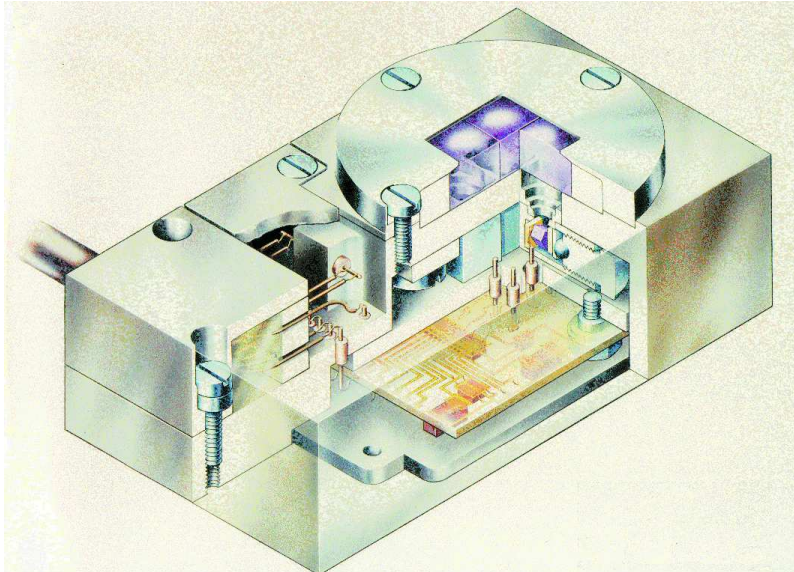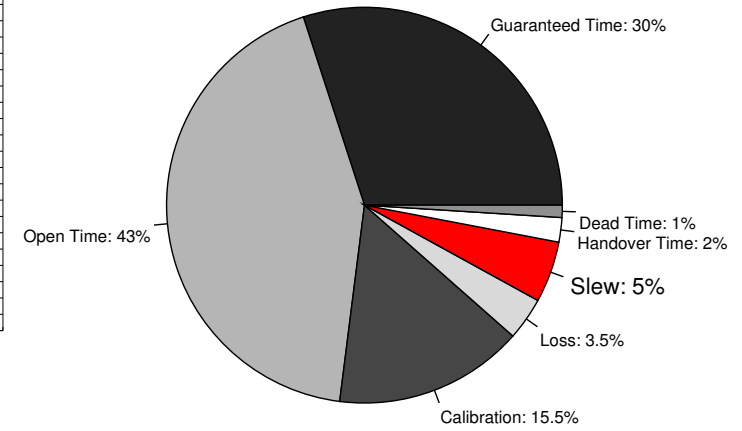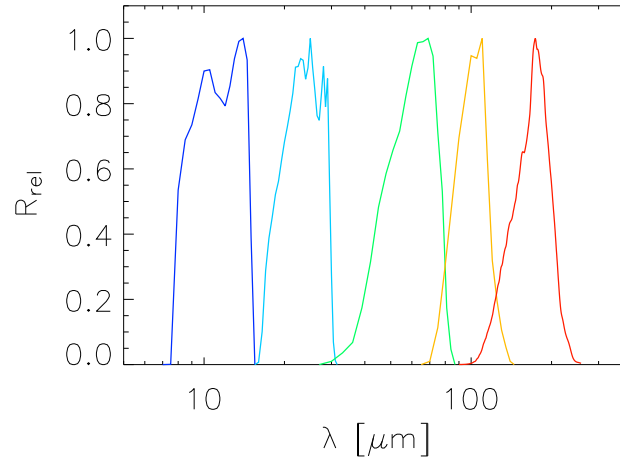
The aim:
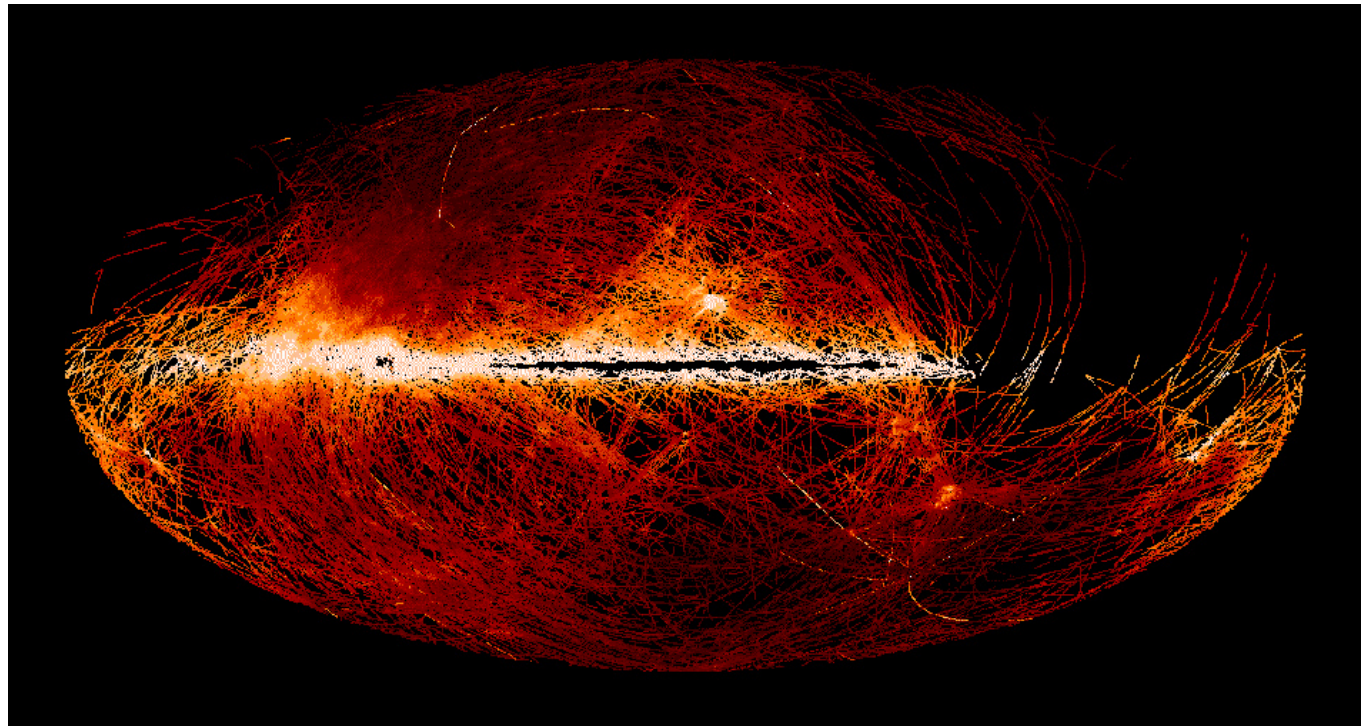
- Picture of the sky in new λ–band at $170\,\mu$m.

- Complementary to IRAS sky survey.

- Maximise mission efficiency.

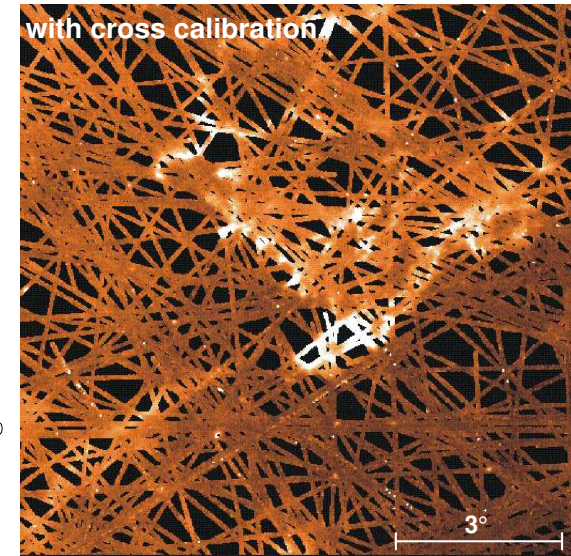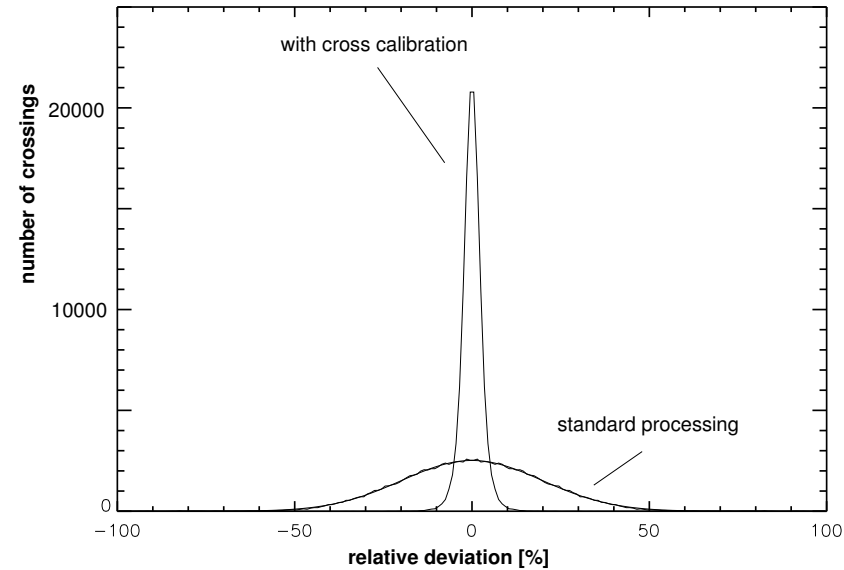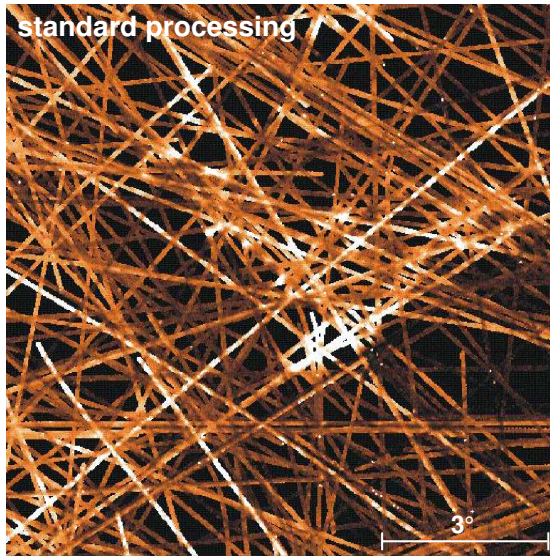The result:

- Serendipity Survey Slews from 792 revolutions.

- $150\,000\,°$ strip scans with $3\,'$ width.

- 15% sky coverage.

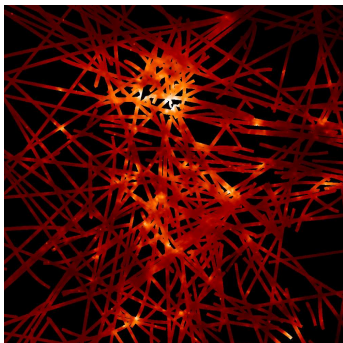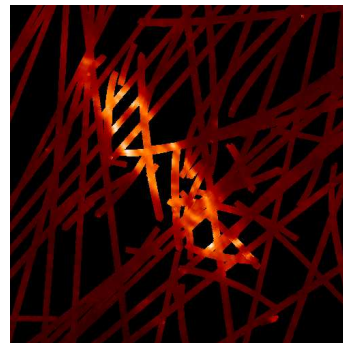# Production of Sky Atlas Maps

standard processing

3°

with cross calibration

with cross calibration

standard processing

number of crossings

relative deviation [%]

minimization:

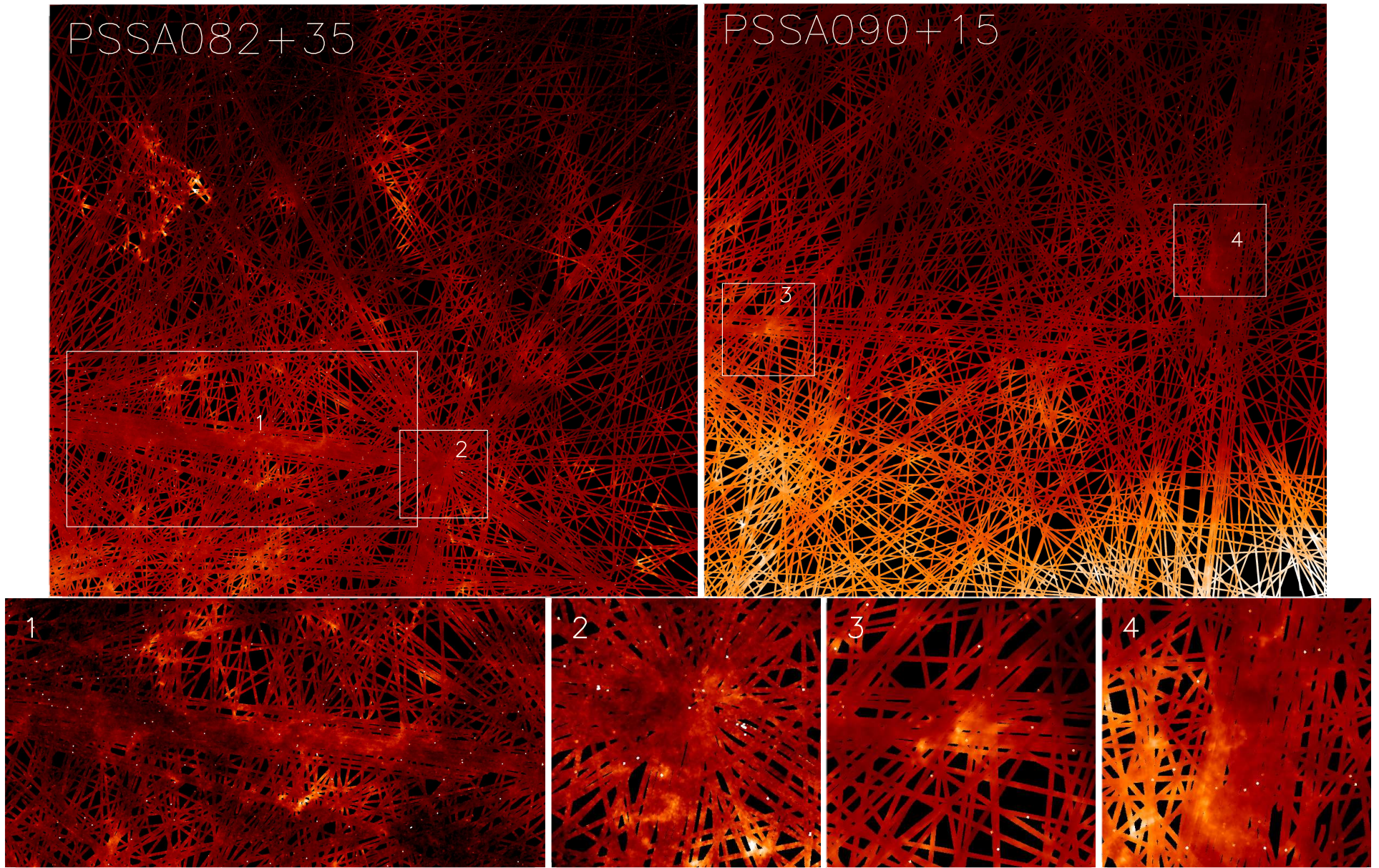$$\chi^2 = \sum_{k>j} \left[\frac{c_j * I_j^\star - Z_j - c_k * I_k^\star - Z_k}{\sigma_{jk}} \right]^2$$

LMC

M31

124 maps with $\approx 20^o \times \approx 20^o$ in gnomonic projection of galactic coordinates

Description of maps & exemplary scientific results:

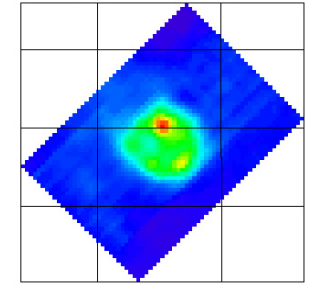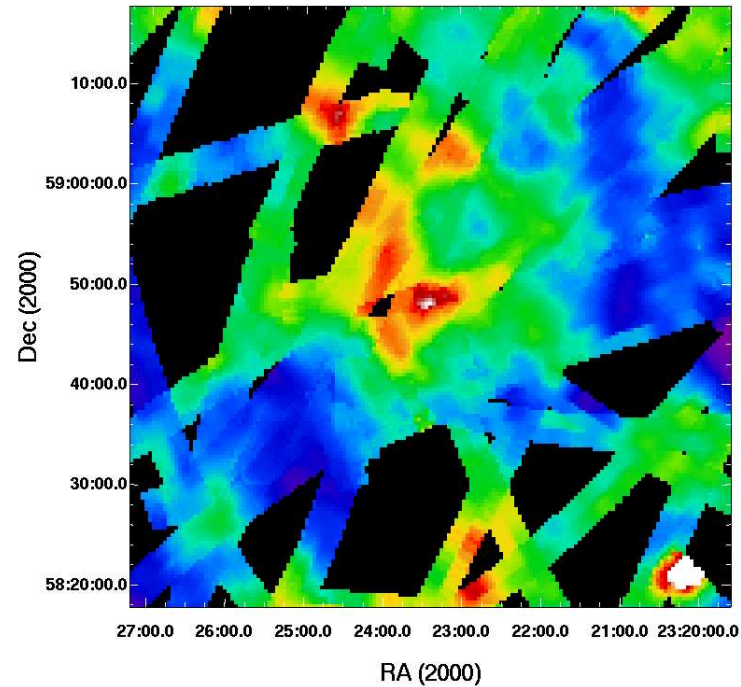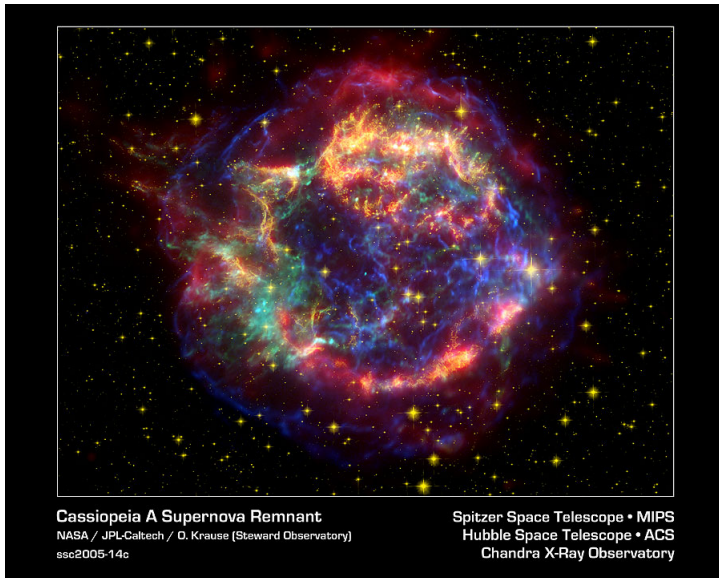Stickel M., Krause O., Klaas U., & Lemke D., 2007, A & A in press

ISOPHOT Serendipity Survey Sky Atlas Maps

PSSA082+35

PSSA090+15

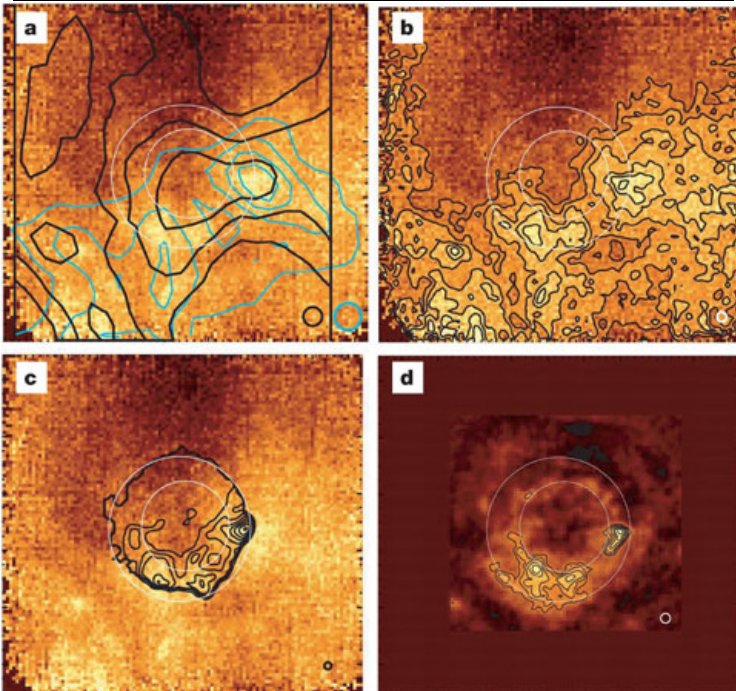Stickel M., Krause O., Klaas U., & Lemke D., 2007, A & A in press

Clarification of the large-scale environment morphology of galactic sources
The debate about the amount of dust production in SNR type II

Cassiopeia A Supernova Remnant
NASA / JPL-Caltech / O. Krause (Steward Observatory)
ssc2005-14c

Spitzer Space Telescope • MIPS
Hubble Space Telescope • ACS
Chandra X-Ray Observatory

ISOPHOT 60 μm

Follow-up: Detection of
fast moving filaments
$\Rightarrow$ infrared echoes

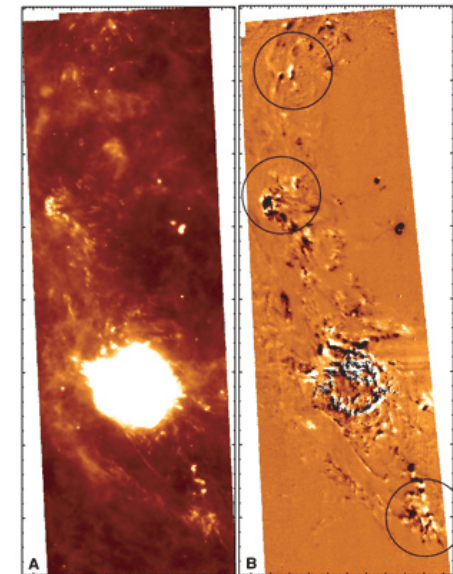Claim: $3\,\mathrm{M_\odot}$ of cold dust produced
in CasA SNR (Dunne et al., 2003)

Serendipity Sky Atlas Maps reveal
presence of dust emission on much
larger scale

OH absorption measurements prove
origin of dust emission in foreground
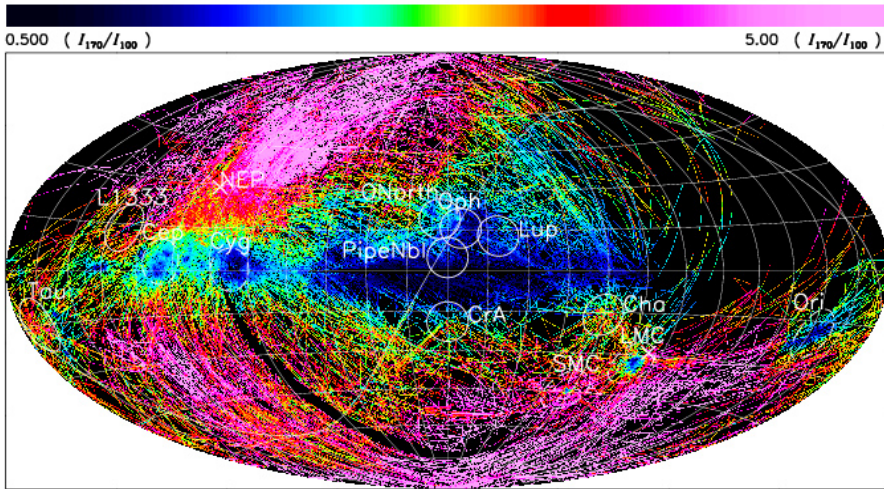molecular material in the line-of-sight
(Perseus arm)

Cold dust in CasA: $<0.2\,\mathrm{M_\odot}$

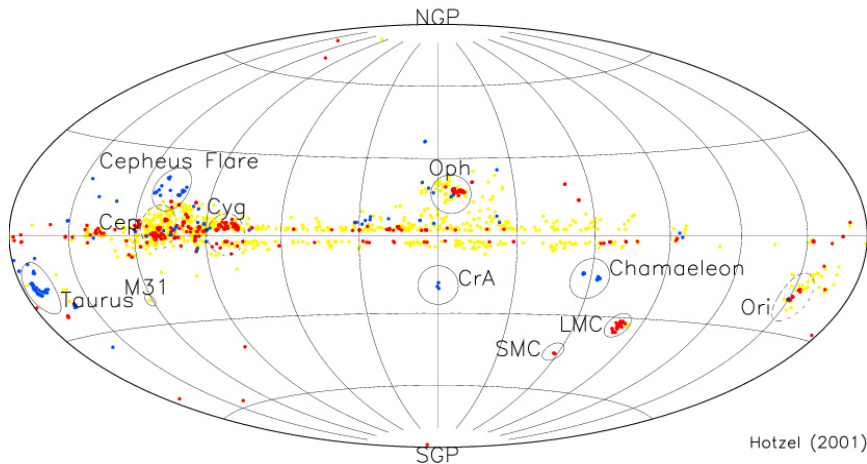Krause et al., 2004, Nature 432, 596

Krause et al., 2005,
Science 308, 1604

Search for the coldest spots in the Milky Way
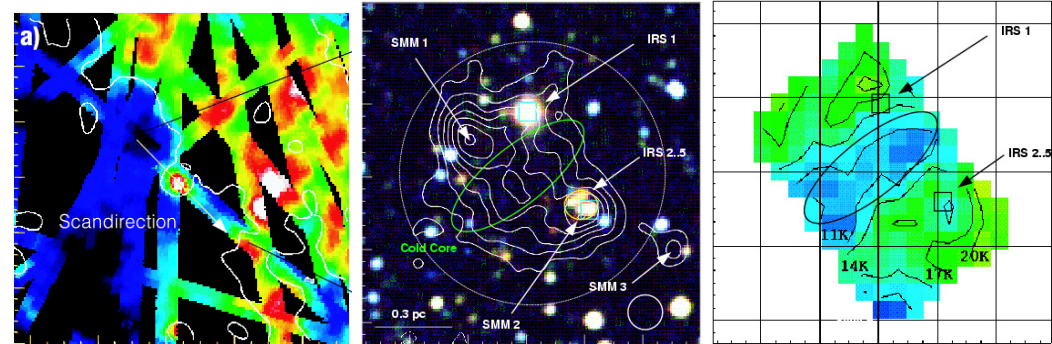## Tracing the very early stages of massive star formation

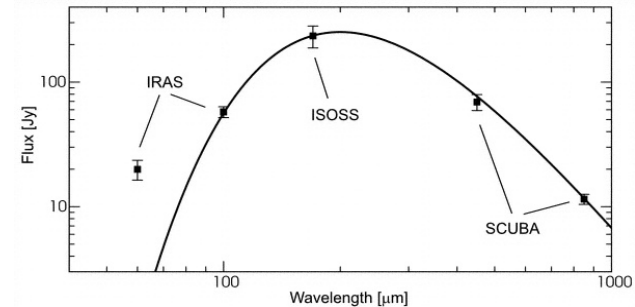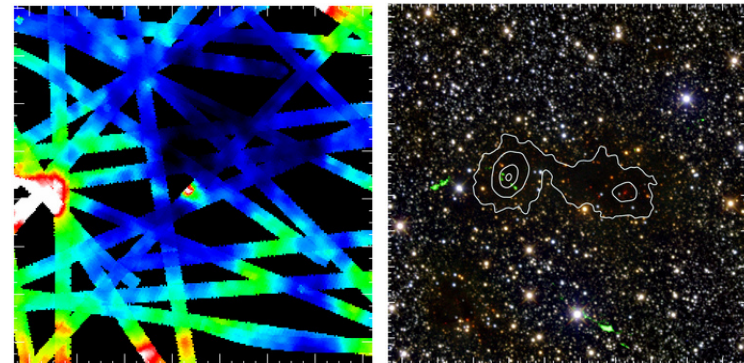Dusty clouds in the Serendipity Survey

ISOPHOT Serendipity Survey Sky Atlas 170 μm / IRAS 100 μm color temperature

Tóth L.V., Hotzel S. et al., 2000, A&A 364, 769
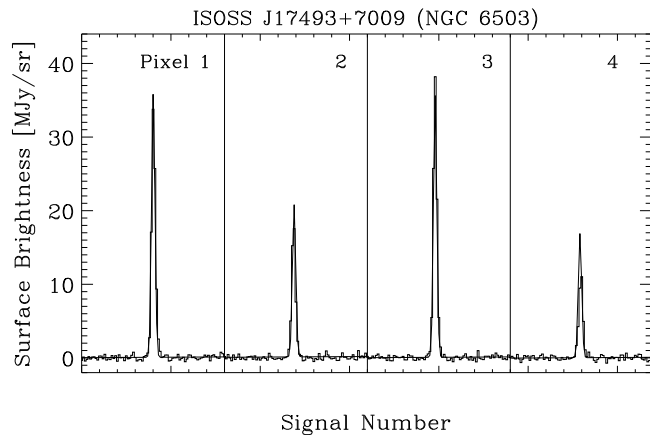

ISOSS J 20298+3559
Krause, O. et al., 2003, A&A 398, 1007

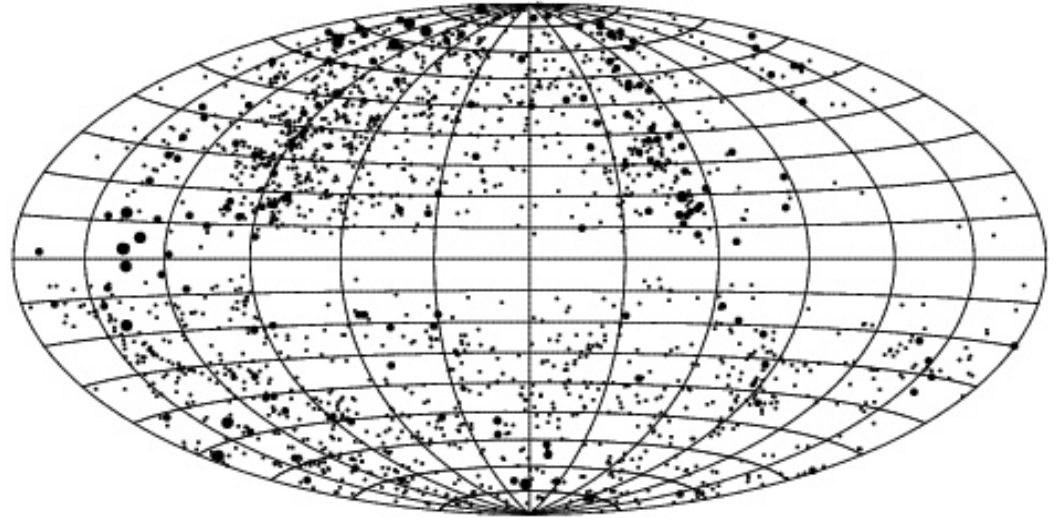**ISOSS J 18364-0221**
Birkmann, S. et al., 2006, ApJ 637, 380
ESA ISO press release 20-Apr-2006.

ISOPHOT Serendipity Sky Survey Galaxy Catalog

ISOSS J17493+7009 (NGC 6503)

Pixel 1   2   3   4

Surface Brightness [MJy/sr]

Signal Number

Galactic Latitude

Galactic Longitude

Catalog of 2000 galaxies (Stickel, M. et al., 2004, A&A 422, 39), complete to ≈ 2 Jy.

$F_{170\mu m}$ [Jy]

Fraction R $(> F_{170\mu m})$ [%]

$F_{170\mu m}$ [Jy]

$N \, (> F_{170\mu m})$ [sr^{-1}]
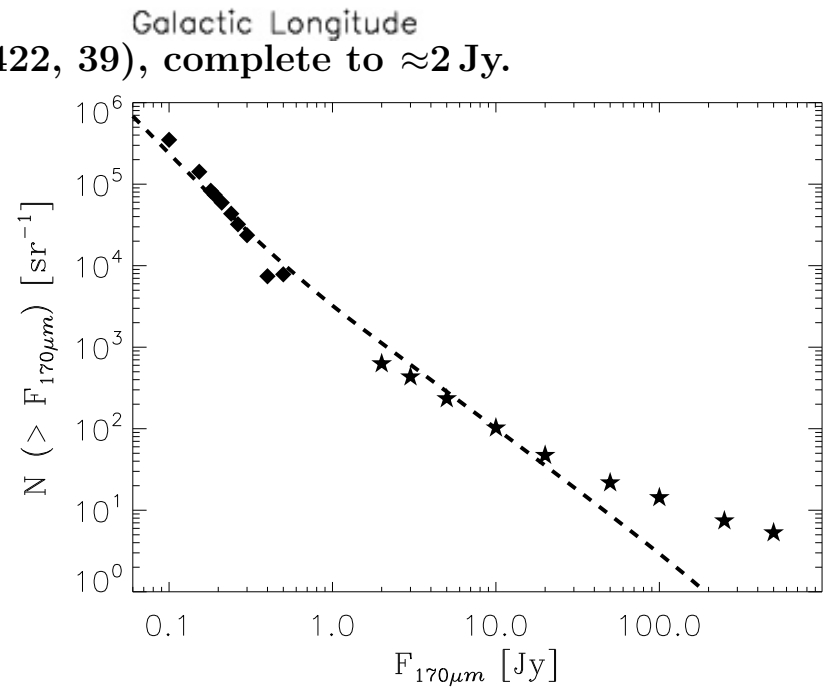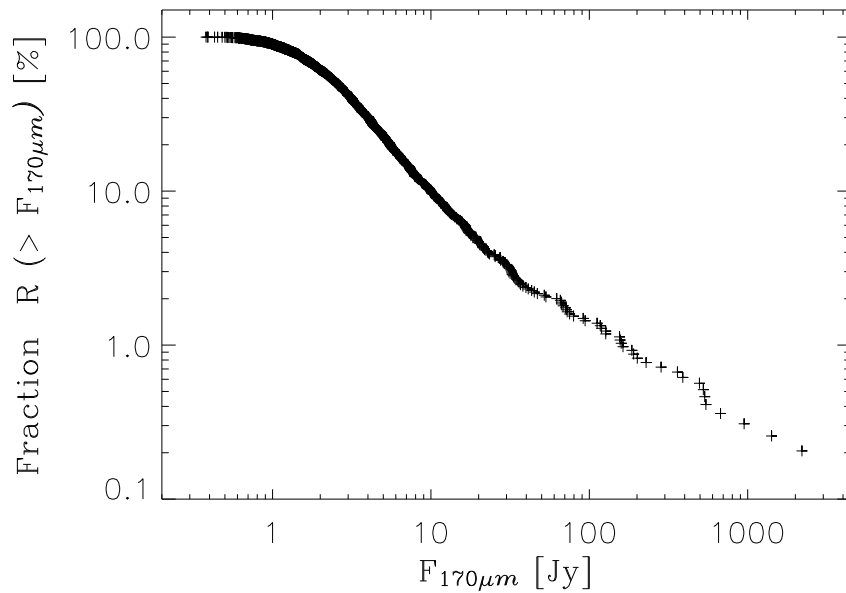
continuous steepening of source counts

Largest catalog of 170 μm fluxes for study of FIR properties with morphological type

peak of
dust color temperature at ≈20 K

$L_{1-1000} \approx 10^{10.5 \pm 1} \, L_\odot$

wide range from HI-to-dust
ratios, no fiducial value

$M_{Dust} \approx 10^{7.5 \pm 0.5} \, M_\odot$
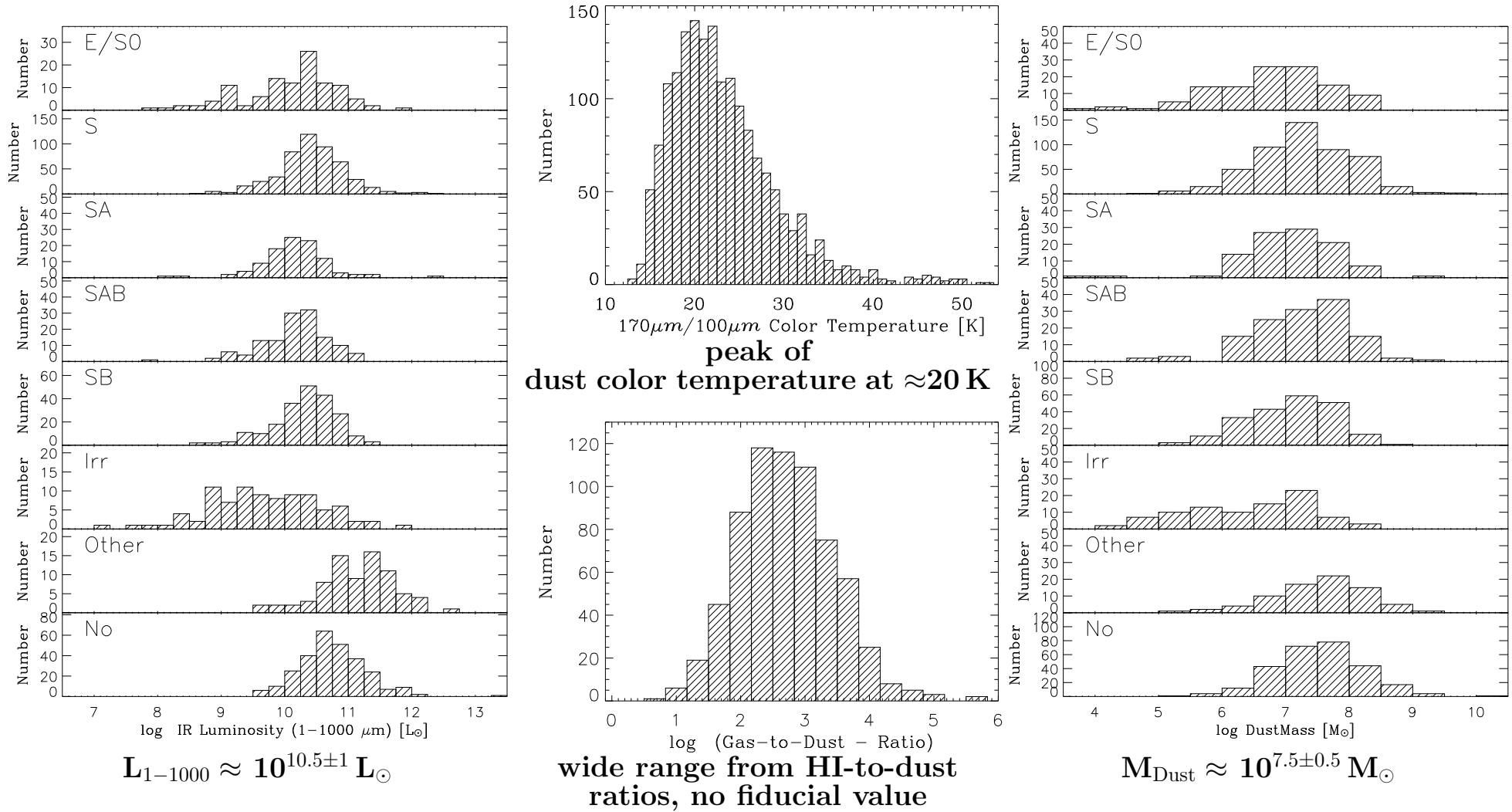
Stickel M., Klaas U. & Lemke D., 2007, A&A in press

ISOSS J 15079+7247, an unusual ultraluminous IR galaxy

Main galaxy shows pure
absorption spectrum, z=0.2136 ⇒
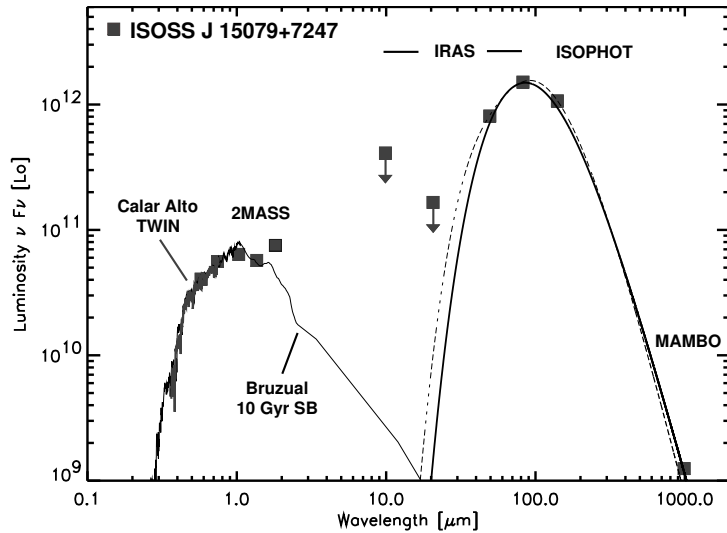
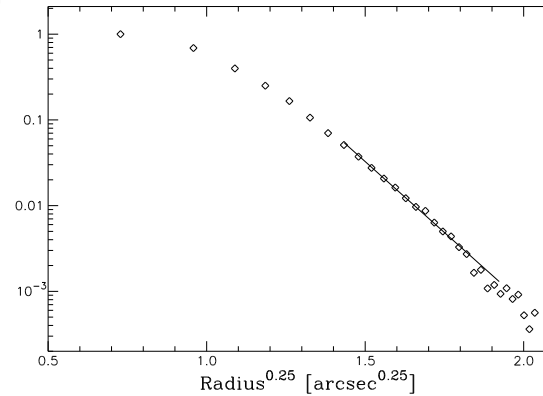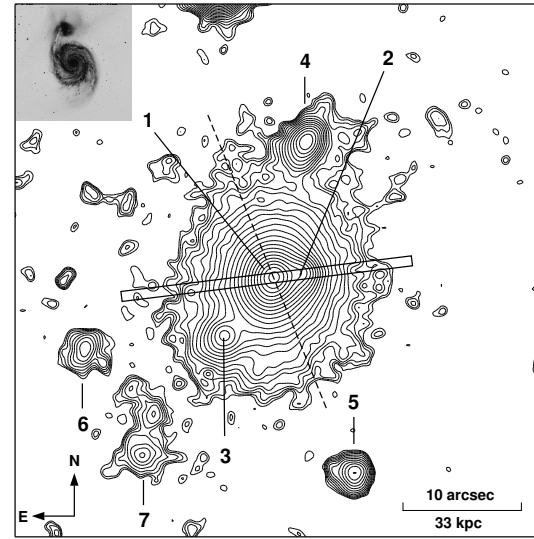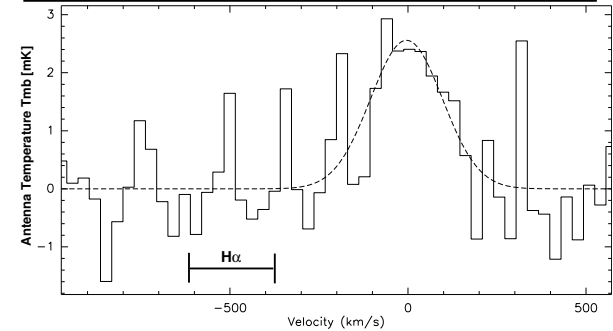1.2 mm continuum source
counterpart of ISOSS source

$$L_{40-1000\,\mu m} = 1.9 \times 10^{12}\,L_\odot$$

Deep R-band imaging reveals
profile of elliptical galaxy
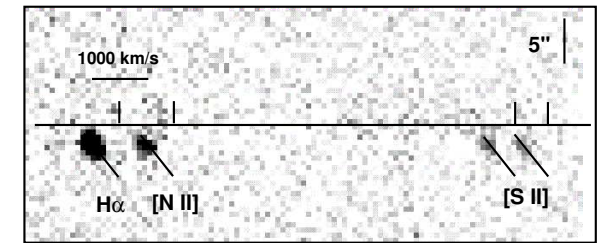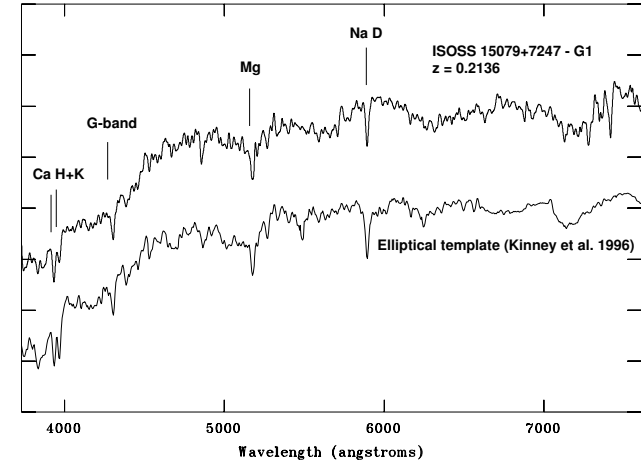
Main galaxy is CO emitter ⇒
$2.9 \times 10^{10}\,M_\odot$ of molecular gas

Implications for identification of "high-z" submm galaxies; ellipticals excluded so far
Alternative explanation for brightest submm source in Hubble Deep Field, HDF 850.1

Krause O. et al., 2003, A&A 402, L1;   Krause O., 2003, PhD thesis, University of Heidelberg

SUMMARY & CONCLUSIONS

- ISOPHOT Serendipity Survey slews from **792** revolutions give a coverage of **15%** of the whole sky at $170\,\mu$m. Locally the coverage can reach $70 - 100\%$.

- Cross-calibration of **10,000** slews at **270,000** crossings results in homogeneous surface brightness calibration.

- **124** Sky Atlas Maps in gnomonic projection of galactic coordinates will be provided by the ISO Data Archive.

- The large-scale galactic dust structure, as traced by the Sky Atlas Maps, can help to clarify the origin of the dust around special objects.

- Color maps derived from $170\,\mu$m Sky Atlas and $100\,\mu$m IRAS images reveal the coldest spots in the Milky Way.

- The cold spot data base provides also a good candidate list for very young sites of massive star formation.

- **2000** optically identified galaxies were detected as compact sources in the new $170\,\mu$m band and compiled in a catalog allowing a statistical investigation of dust properties with Hubble type.

- The large galaxy data base provides the potential to find rare unusual "local" objects, which might be quite common at high-z.

- Combination with Arkari All Sky Maps and Catalogs will allow to search for variable objects.