



ASTRO-F and Korean Collaboration

Presented by

Hyung Mok Lee (Seoul National University, Korea)

for

the ASTRO-F/FIS Data Reduction Team

(Institute for Space and Astronautical Science, Japan)

1. Outline of ASTRO-F

❁ Purpose of the Mission

- To carry out all-sky survey at Far-Infrared
- Near and Mid Infrared Obs. of selected sky

❁ Launch

- Early 2004
- by M-V Rocket

❁ Orbit

- Sun-Synchronous
- Altitude 700-900 km





Mission Structure

- ✿ Science mission of ISAS, Japan

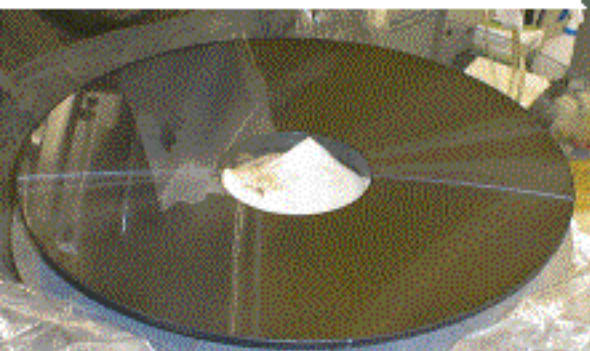
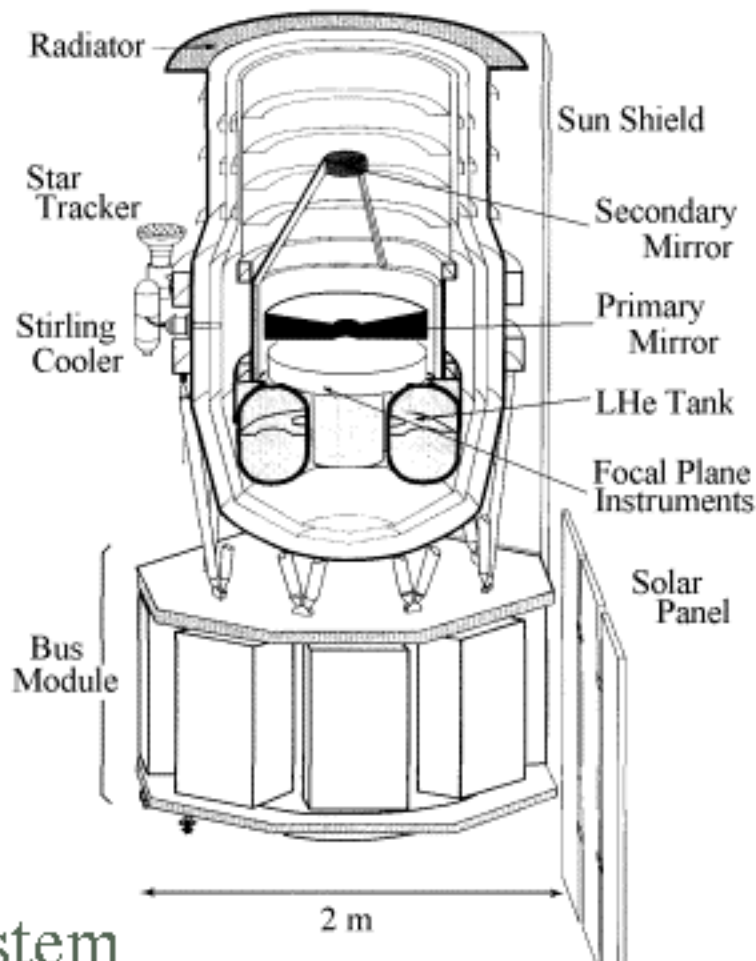
- ✿ Partners

- Seoul National University (Simulation and FIS Data reduction)
 - European Consortium led by M. Rowan-Robinson (FIS Source detection/ confirmation)
 - ESA (pointing reconstruction/telemetry)
- 

Telescope

Mirror

- 70 ($\rightarrow$ 68) cm, F/6
- SiC
- 1" Quality

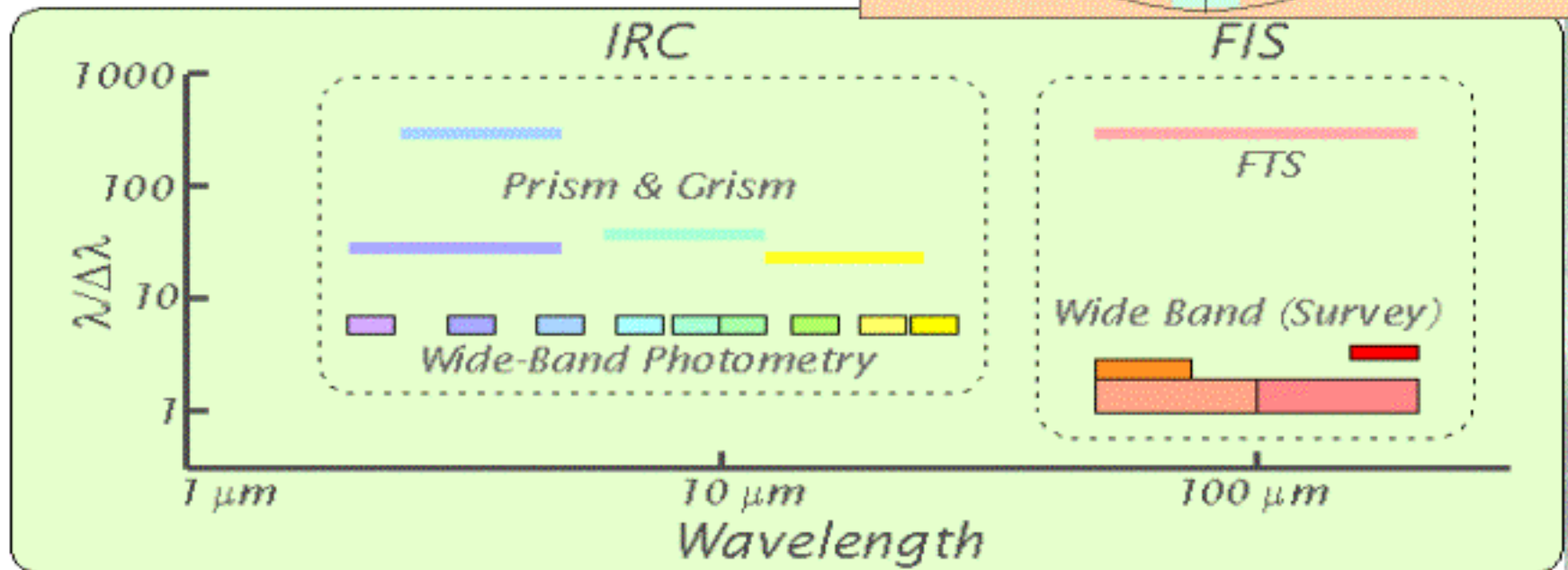
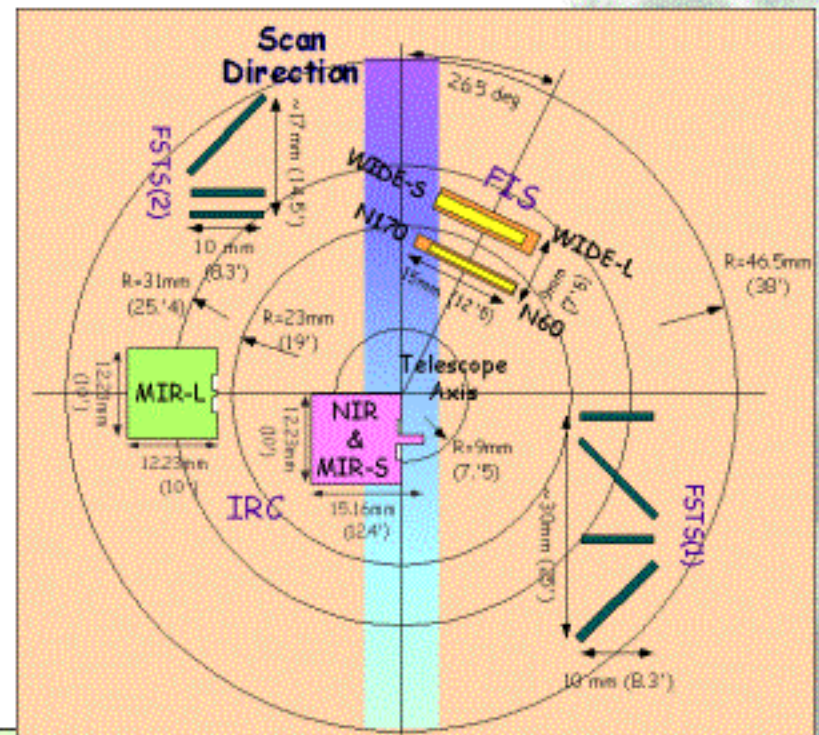


Cryogenic System

- 170 liter LHe + Stirling Cooler
- Life = 550 Days
- $T(\text{tel}) = 5.8 \text{ K}$,
 $T(\text{detector}) = 1.8 \text{ K (st. Ge:Ga)}, 15 \text{ K (InSb)}$

Focal Plane Instruments

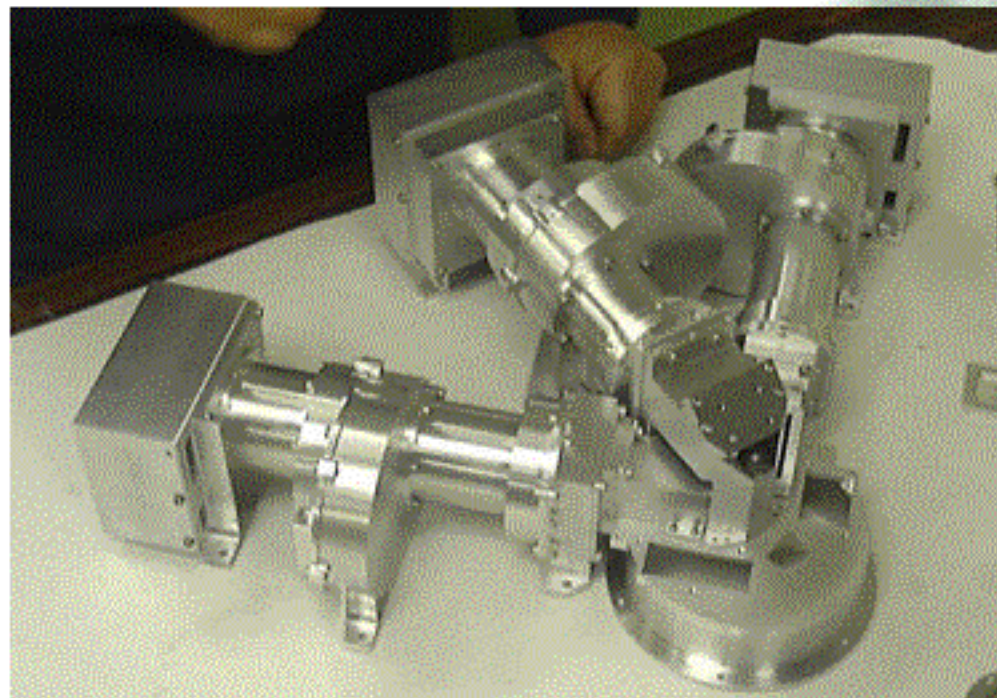
- IRC: Near- and Mid-IR Camera
- FIS: Far-IR Surveyor



IRC: Near- and Mid-IR Camera

band	FOV (Pixel)	detector
NIR 2 - 5 μm	10' $\times$ 10' (1.46")	512 $\times$ 412 InSb
MIR-S 5 - 12 μm	10' $\times$ 10' (2.34")	256 $\times$ 256 Si:As
MIR-L 12 - 26 μm	10' $\times$ 10' (2.34")	256 $\times$ 256 Si:As

- 6 filters / band
- Observations in pointing mode
- All sky scanning survey is now under consideration



FIS: Far-IR Surveyor

band

FOV (Pixel)

detector

N60 50 - 75 μm

WIDE-S 50 - 110 μm

N170 150 - 200 μm

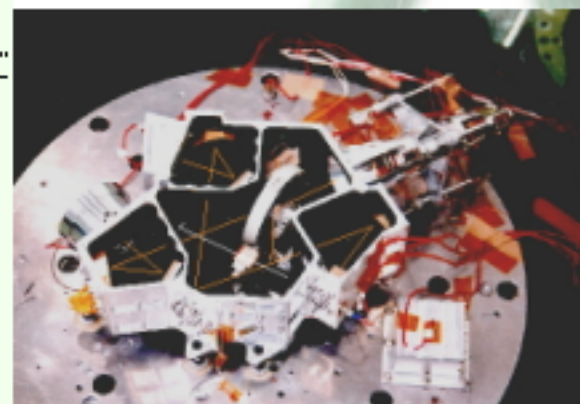
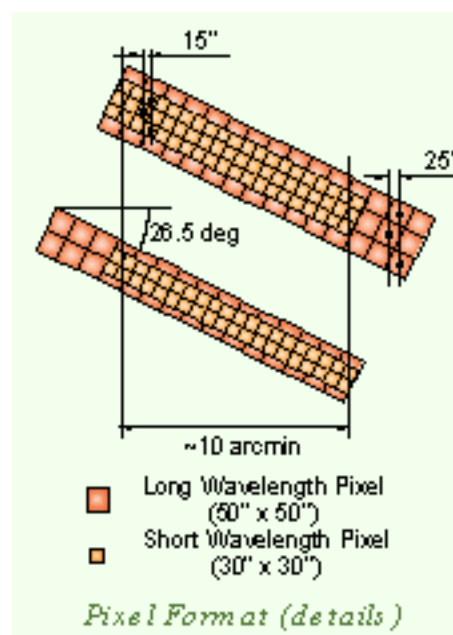
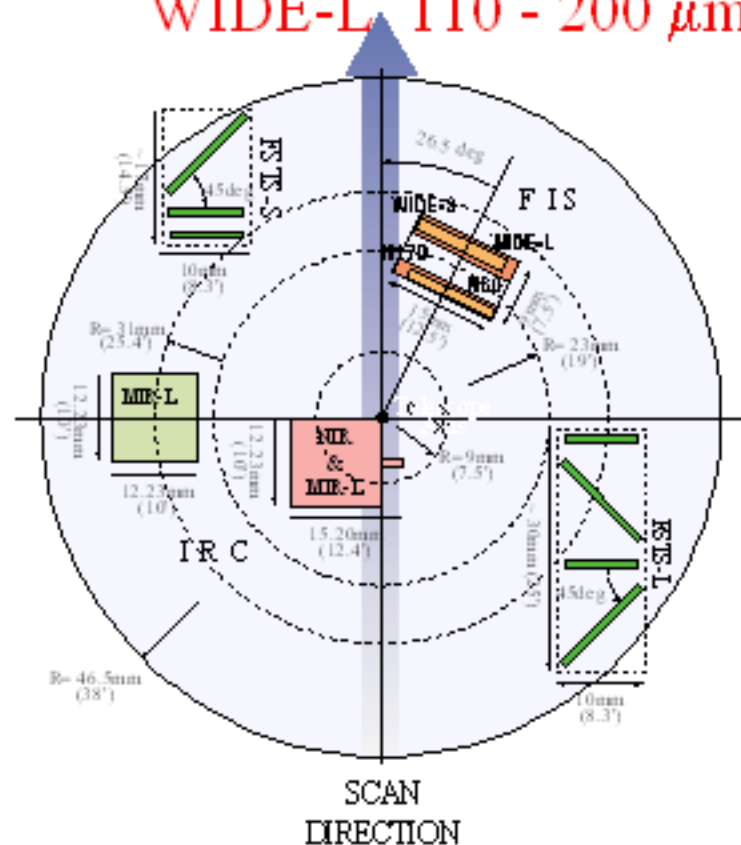
WIDE-L 110 - 200 μm

(30") 20 × 2 hybrid Ge:Ga

(30") 20 × 3 hybrid Ge:Ga

(50") 15 × 2 stressed Ge:Ga

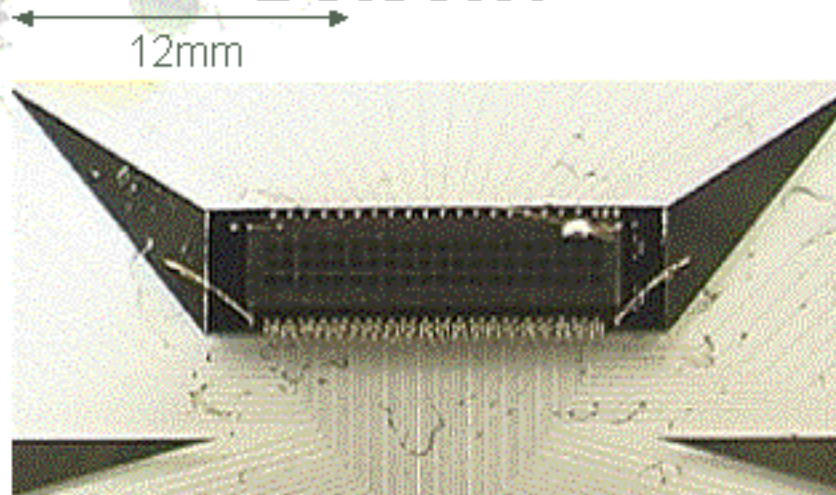
(50") 15 × 3 stressed Ge:Ga



FIS-PM on Vibration Test Bench

FIS: Detectors

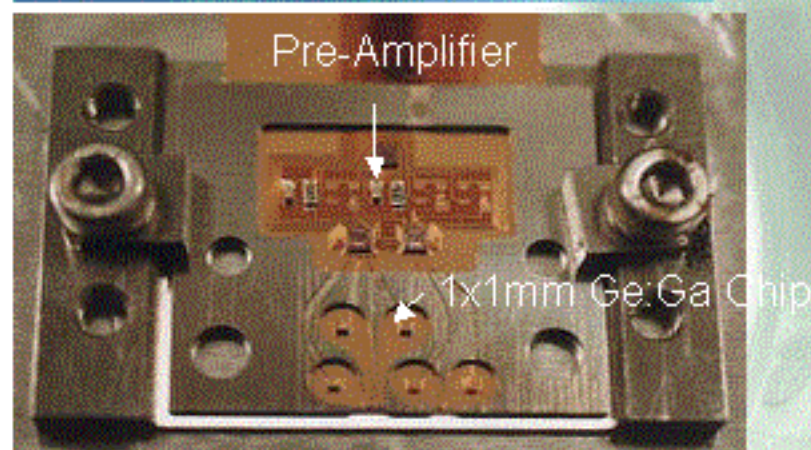
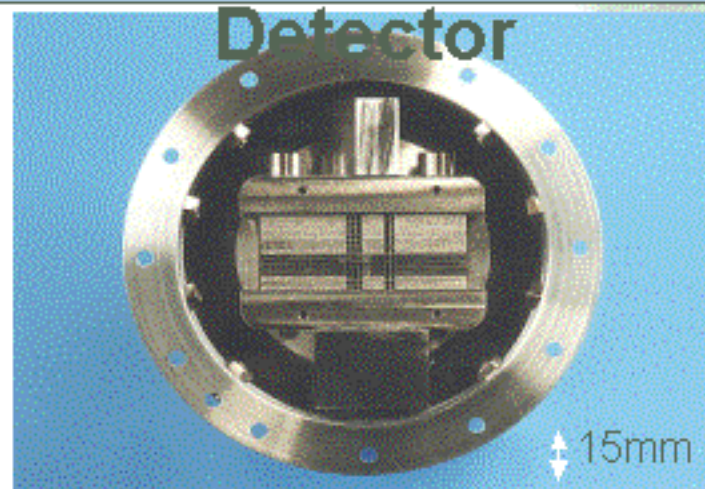
Short Wavelength Detector



by Communication Research Laboratory

Responsivity : 16.2 A/W
NEP : $2.6 \times 10^{-17} \text{ W Hz}^{-1/2}$
 (T = 2.1K; Bias Field = 1.2 V/cm)

Long Wavelength Detector

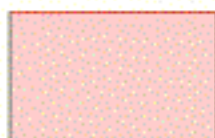
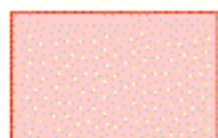


Stress : ~600 N
Responsivity : 47 A/W
NEP : $< 10^{-17} \text{ W Hz}^{-1/2}$

Comparison of Array Sizes

IRAS

IRAS
100 micron



ISO

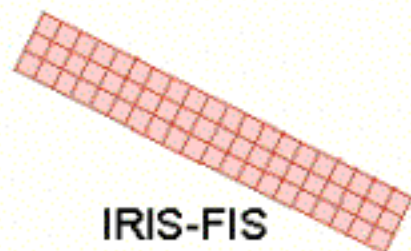
ISOPHOT
90 micron



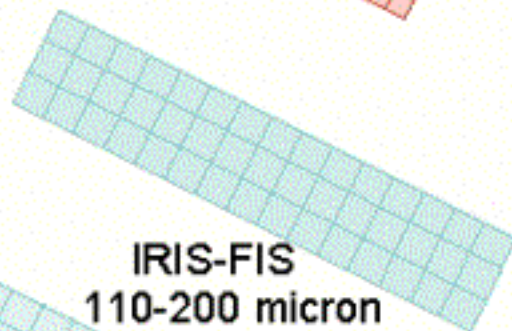
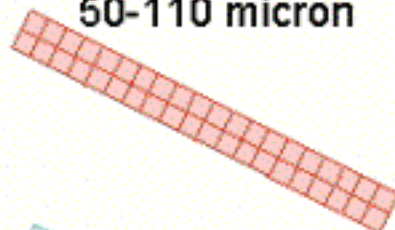
ISOPHOT
160 micron



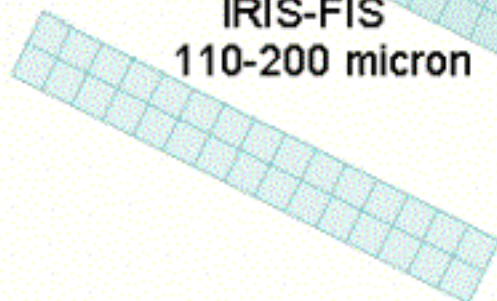
IRIS



IRIS-FIS
50-110 micron

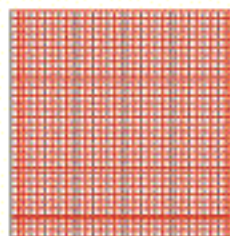


IRIS-FIS
110-200 micron



SIRTF

SIRTF-MIPS
70 micron

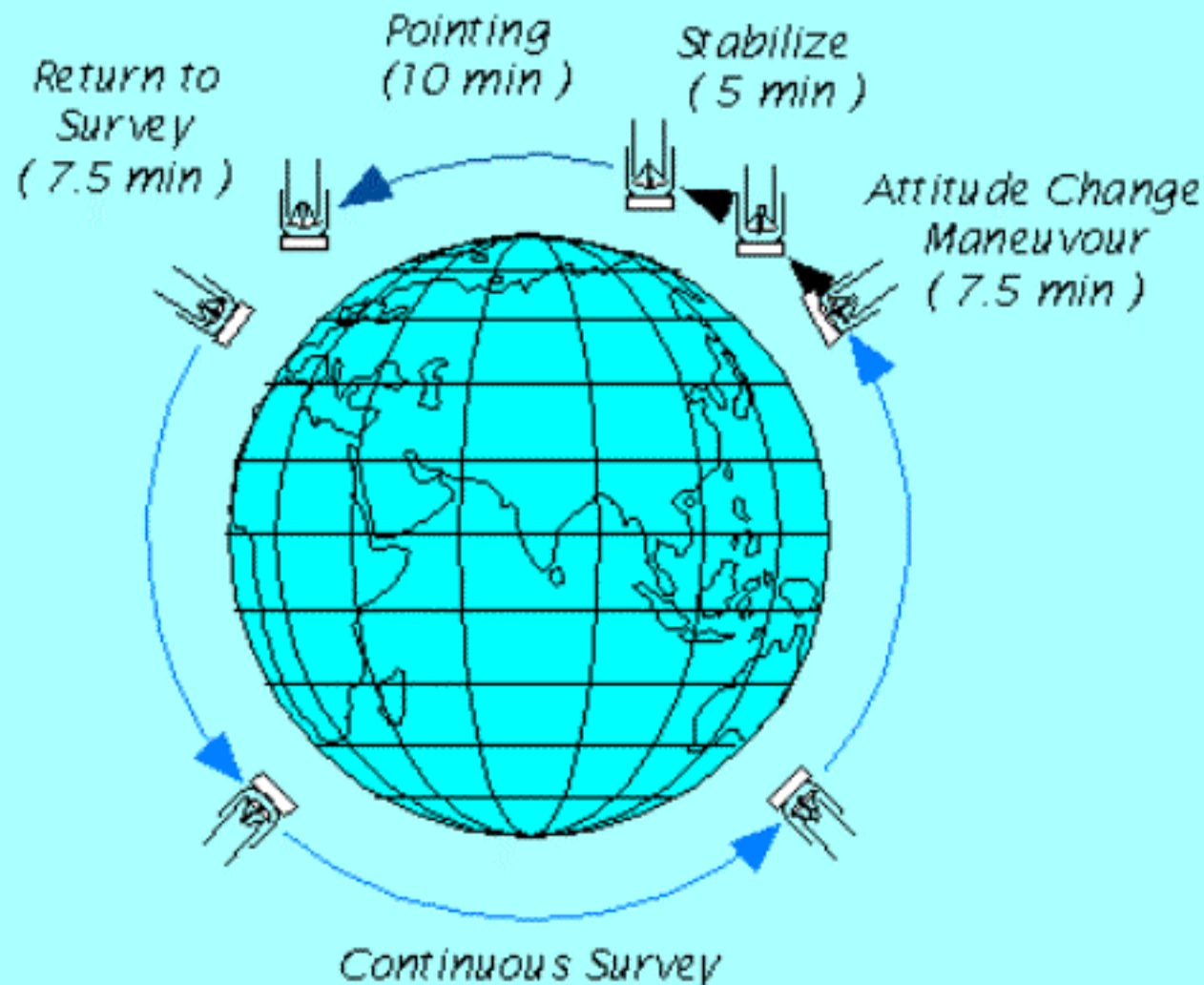


SIRTF-MIPS
160 micron



—
1 arcmin

Observation Mode



- Max Pointings **3 / revol.**

- Pointing observation time **< 10 min per orbit**

Observing Schedule

Checkout

(~20days)

Phase 1

(180 days)

Phase 2

(~300 days)

Phase 3

(>365 days)

FIS all-sky survey

No. of IRC pointings :

8.4/day (mainly for Ecliptic Pole regions)

→ total 1500 pointings

Mainly **Pointing obs.** + **Suppl. FIS survey**

No. of IRC pointings :

19.7 /day → total 5900 pointings

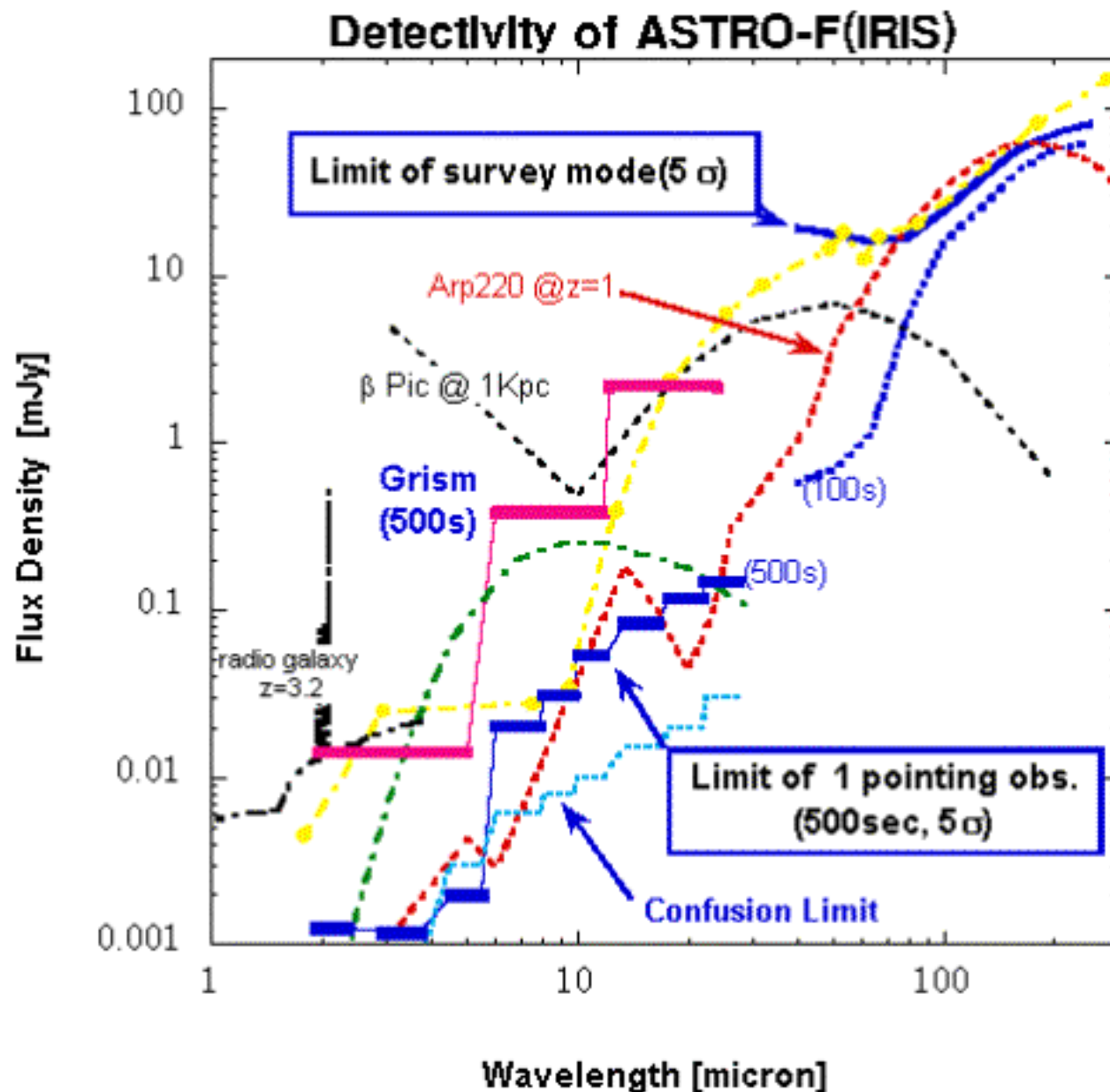
(L He boil-off)

NIR observations

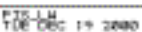
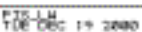
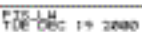
No. of IRC pointings :

28.8 /day → >10500

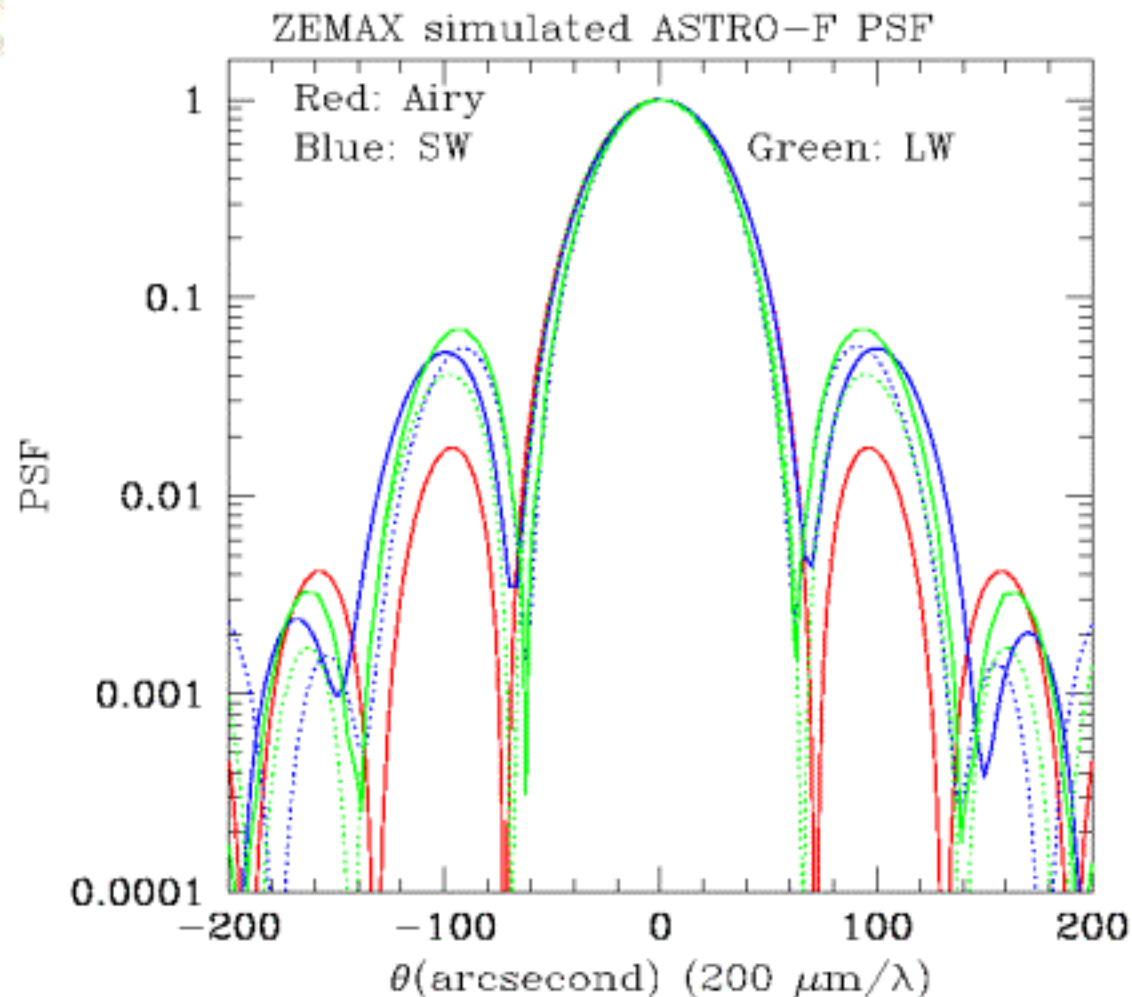
Sensitivity of ASTRO-F



PT5-LM
TUE DEC 19 2000



Point Spread Function

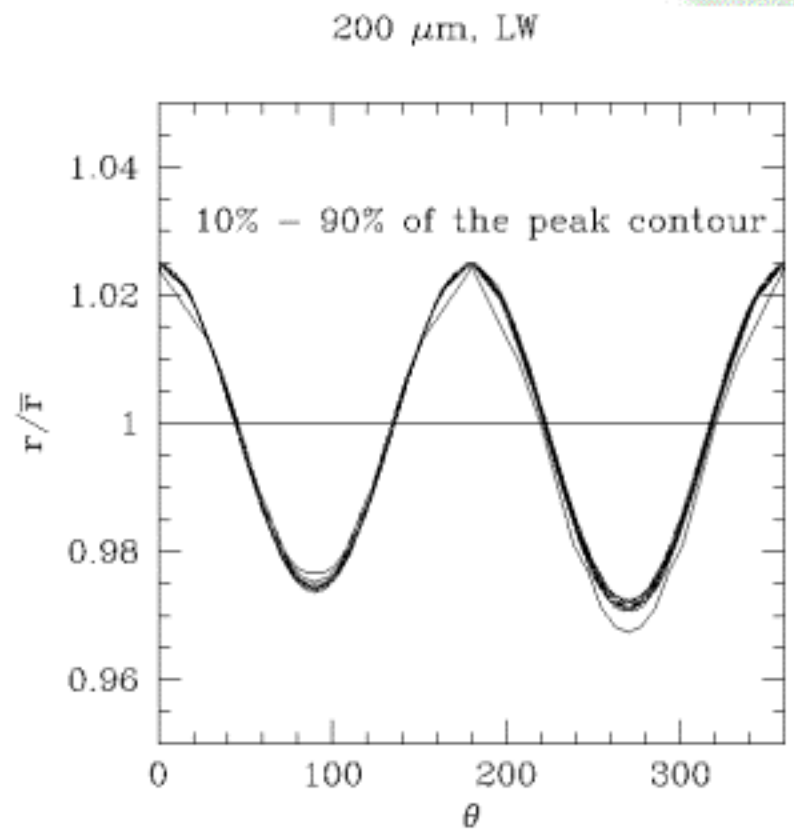
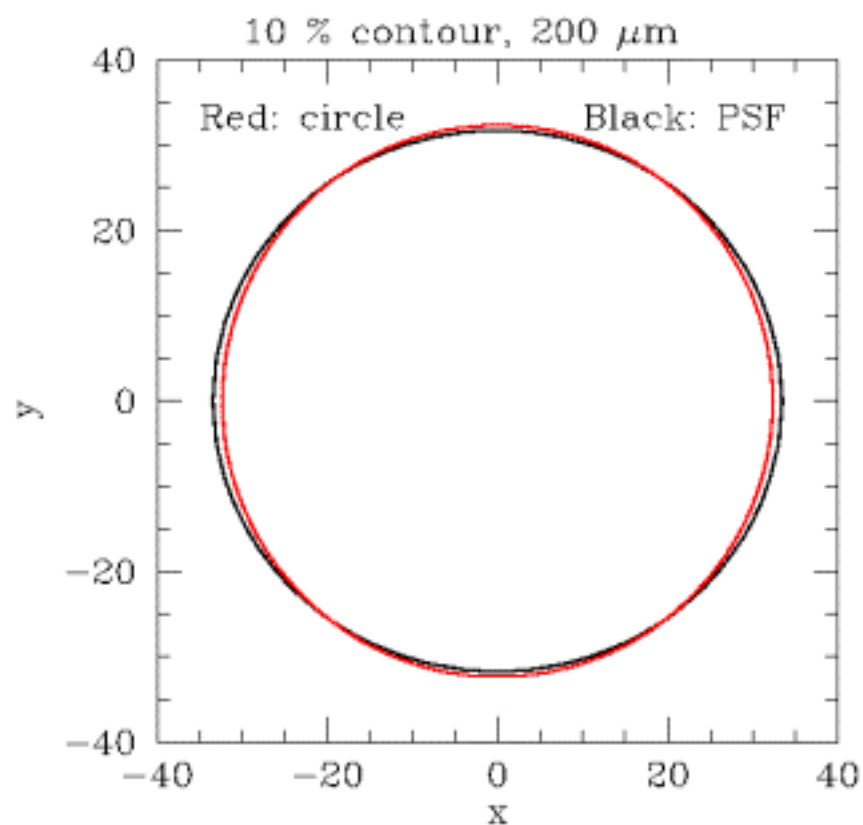


→ Red ; Airy

→ Blue (SW)
Solid ; 60 μm
Dotted ; 90 μm

→ Green (LW)
Solid ; 150 μm
Dotted ; 200 μm

PSF Symmetry



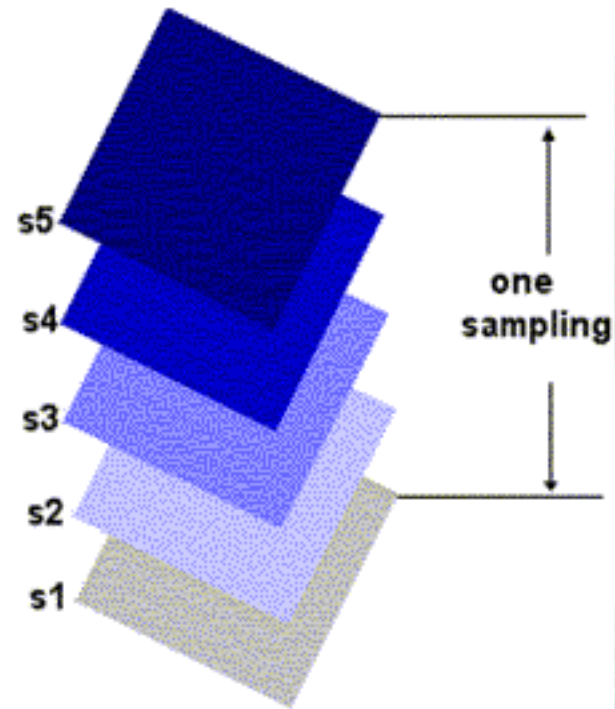
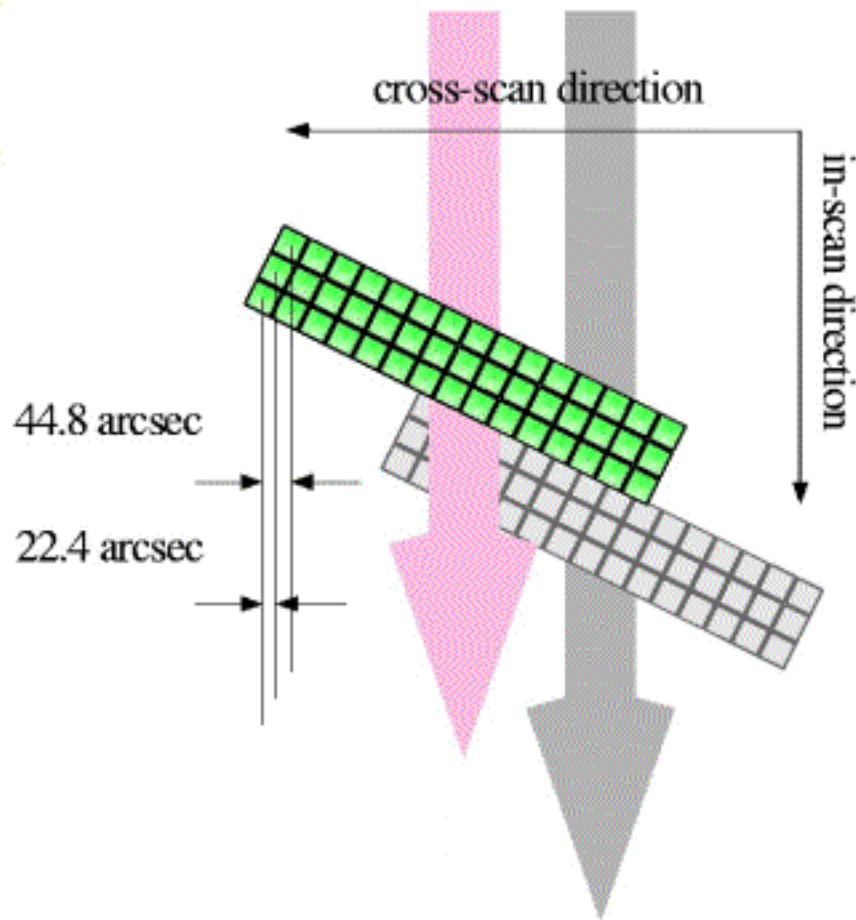
Ellipticity ~ 0.05

3. Observing Simulations for FIS: *FISVI*

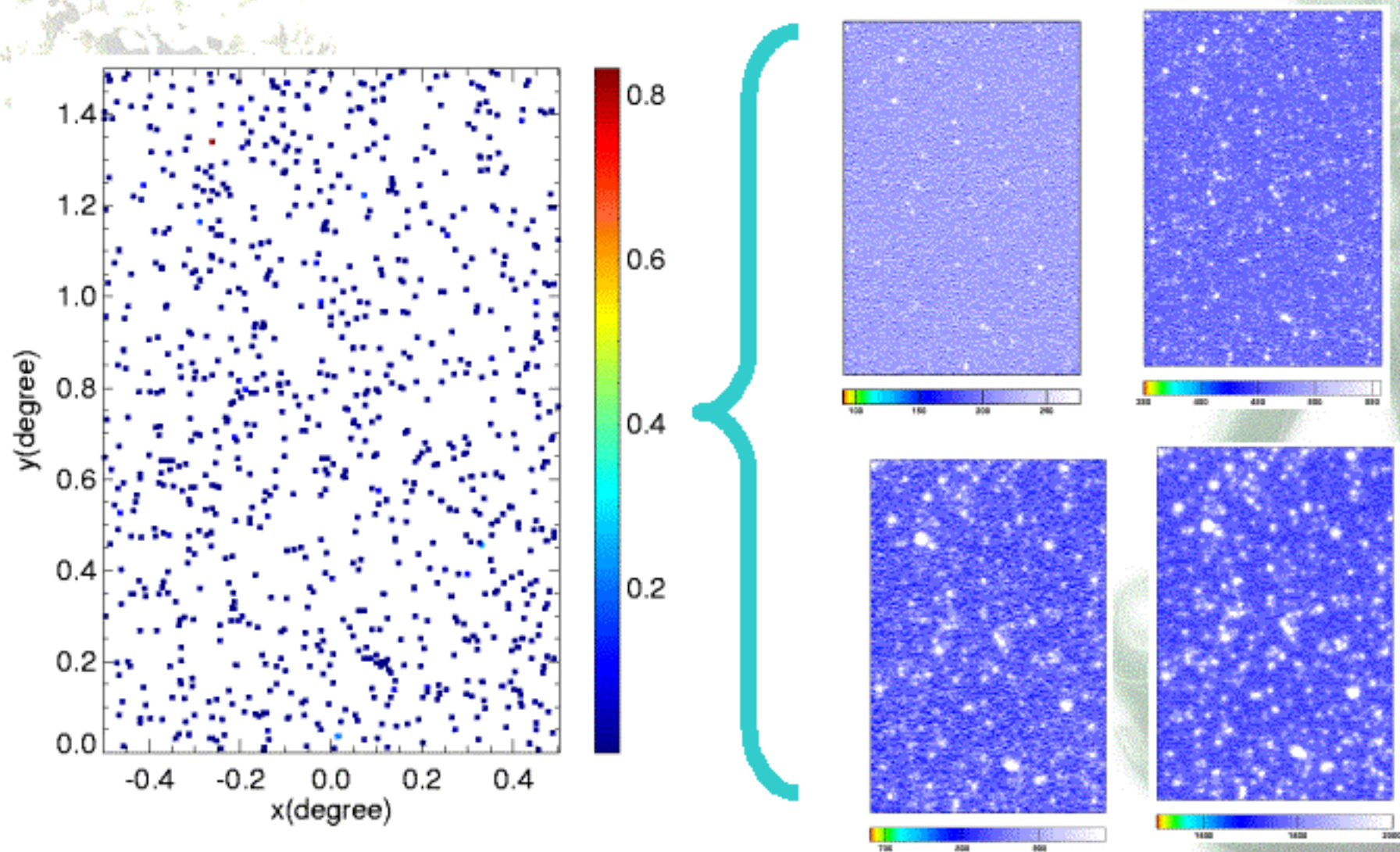
Purposes of FIS Simulation

- ◆ **To check the hardware specifications and configuration.**
- ◆ **To find optimum observing modes while the satellite is in orbit.**
- ◆ **To provide input data for reduction software**

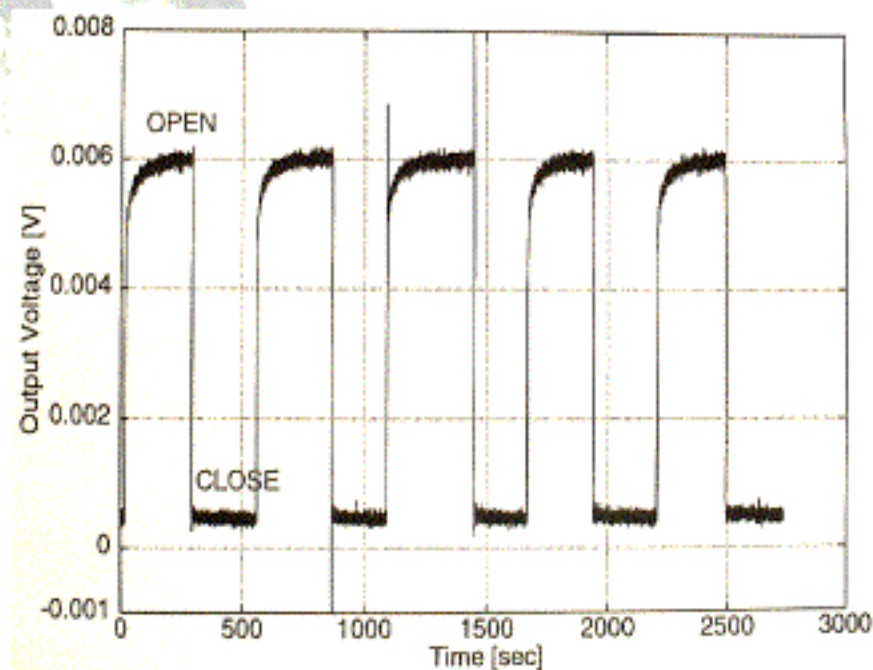
Scanning and Sampling: Methods



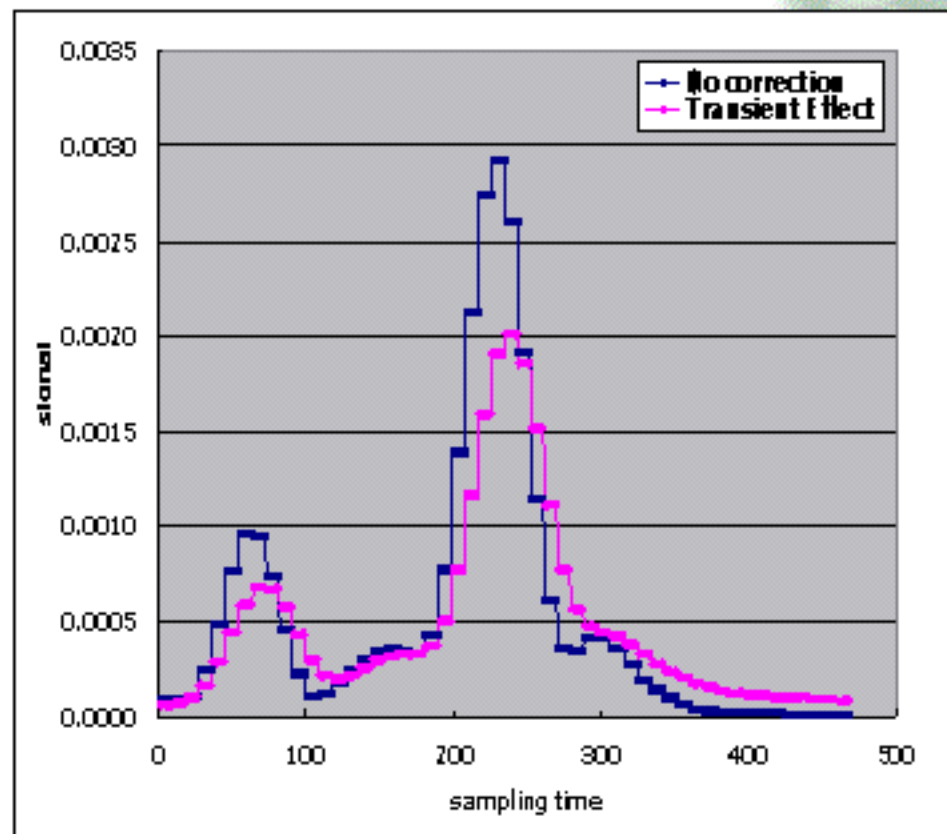
Simulation of Point Sources



Detector Transient Effect



$$r(t) = [1 - \sum_i B_i] \delta(t) + \sum_i \left[\frac{B_i}{\tau_i} \exp\left(-\frac{t}{\tau_i}\right) \right]$$



New Estimates of Detection Limits

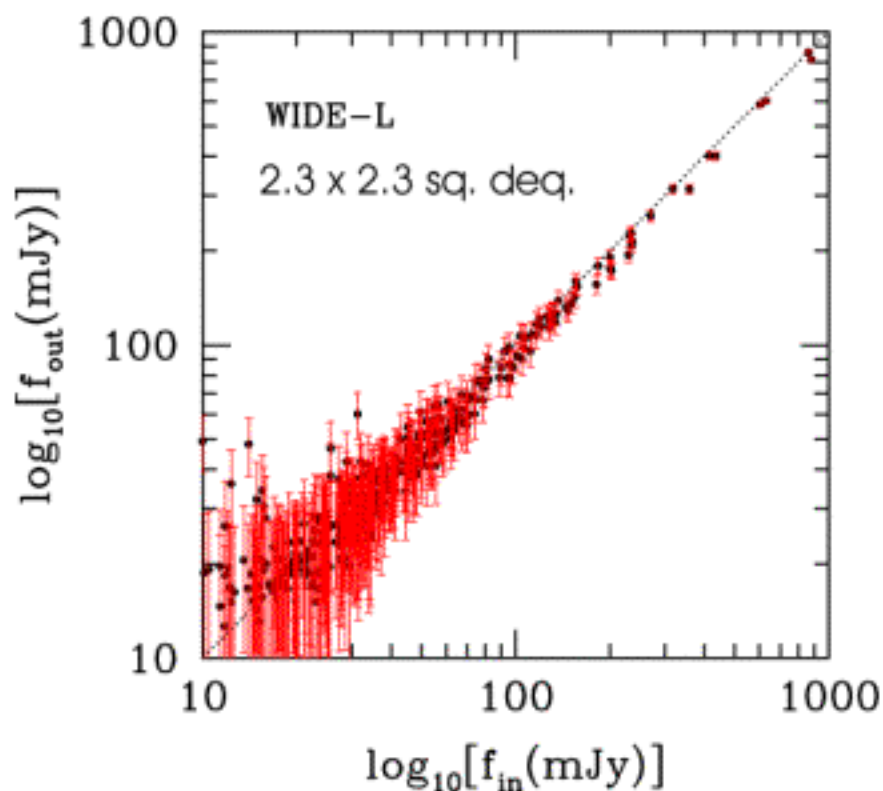
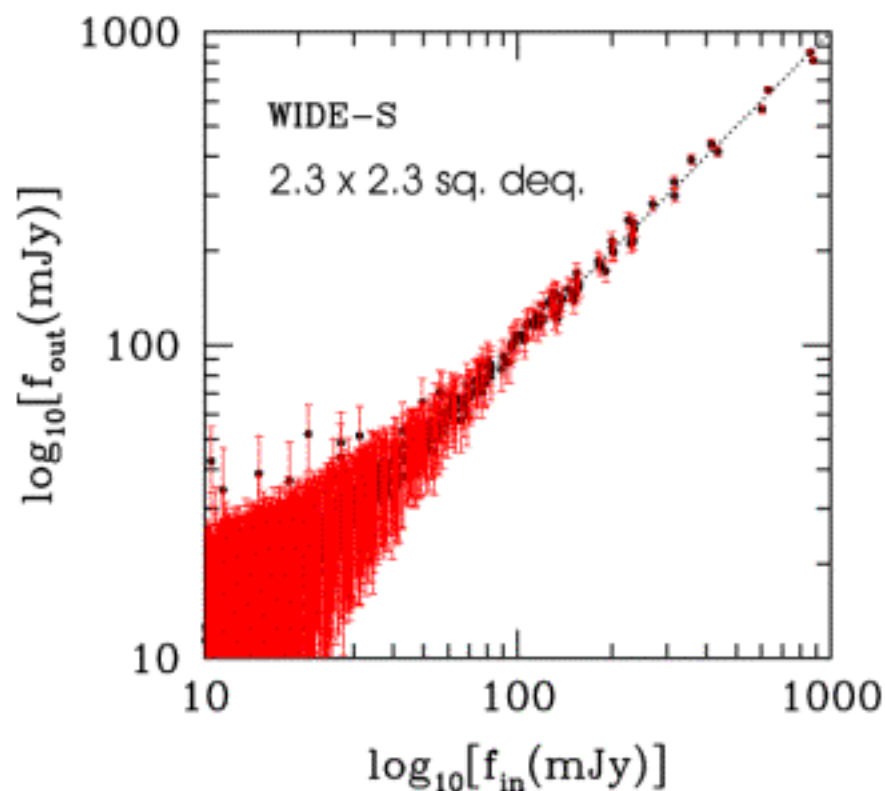
Band	λ_{eff} (μm)	NEF (mJy)		5σ detection limit (mJy)	
		Present	previous	Present	previous
N60	60	6.5	5.5	46	39
WIDE-S	70	2.7	2.3	19	16
WIDE-L	150	3.5	1.3	25	9
N170	170	6.6	3.3	47	23

Point Source Photometry

- SourceExtractor Aperture Photometry
- Cross-correlation between **input** and **output**

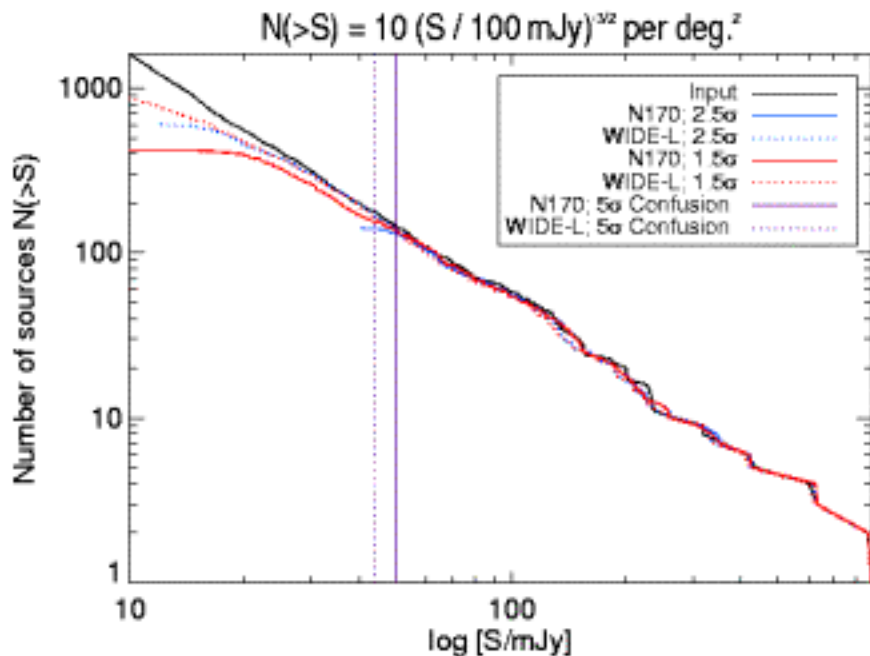
$$N(>S) = 10 (S/100 \text{ mJy})^{-3/2} \text{ per deg.}^2$$

$$N(>S) = 10 (S/100 \text{ mJy})^{-3/2} \text{ per deg.}^2$$

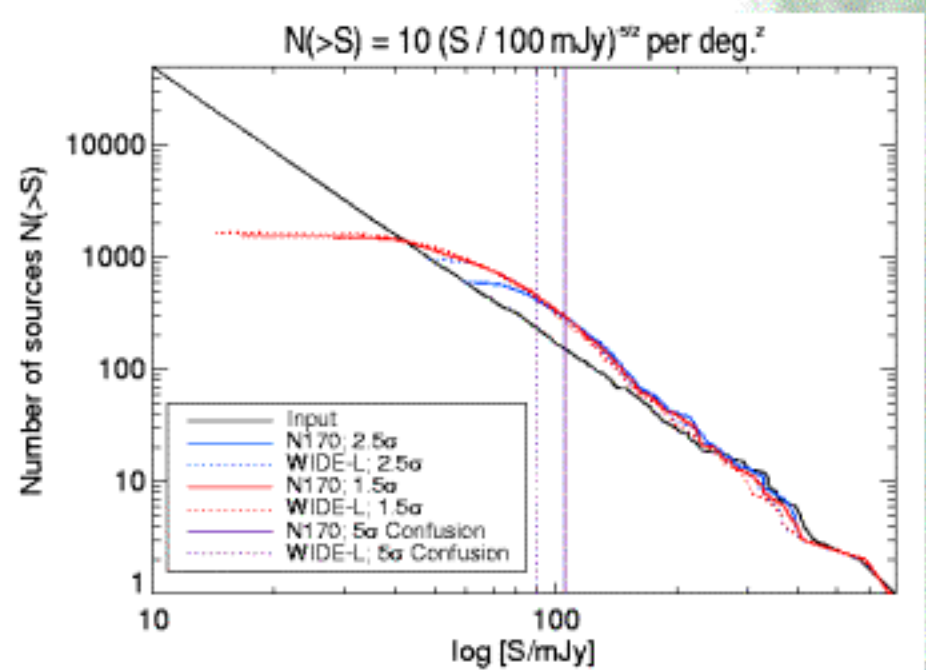


Galaxy Counts

Flat universe, no evolution

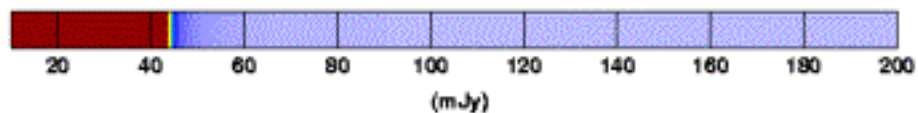
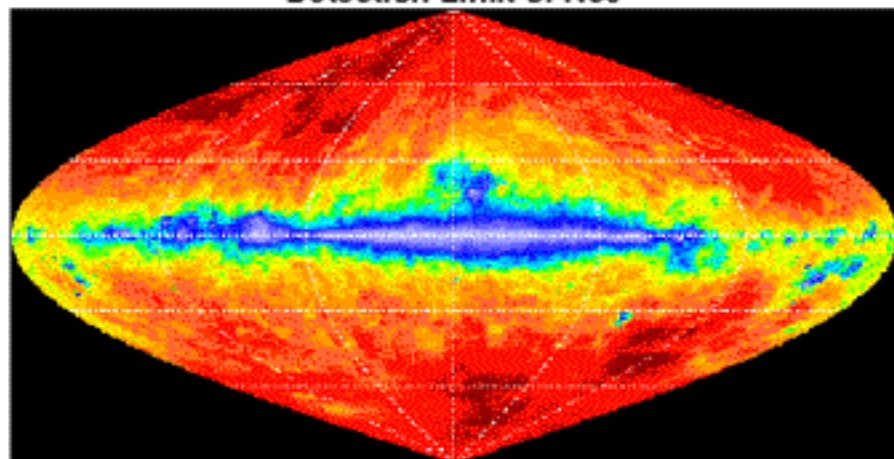


Flat universe, source evolution

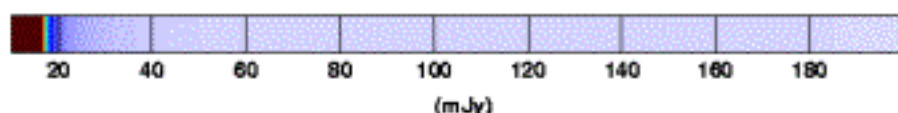
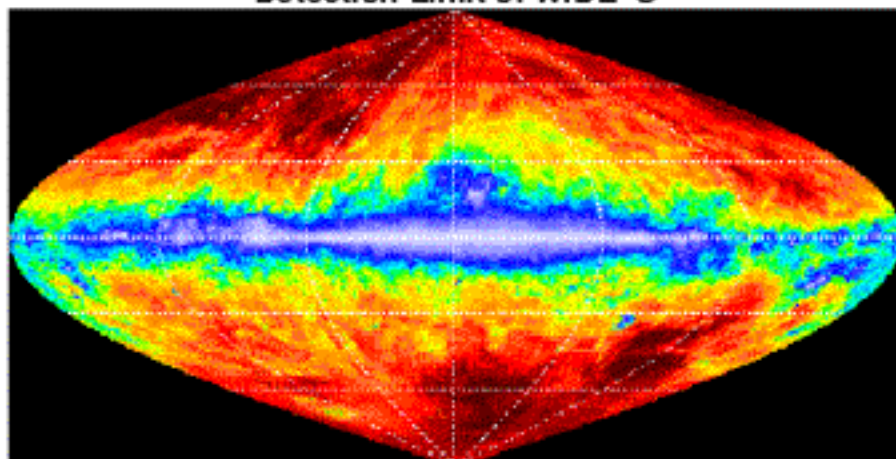


Source confusion could make it difficult to study source evolution

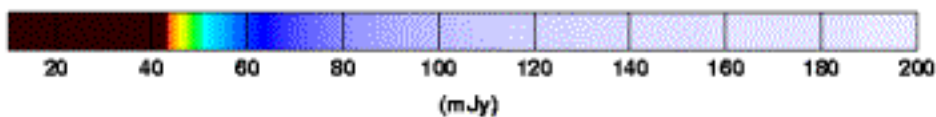
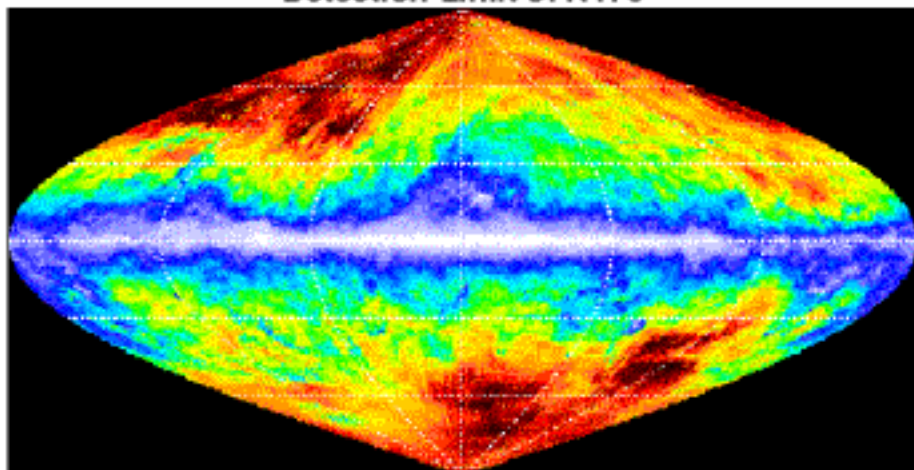
Detection Limit of N60



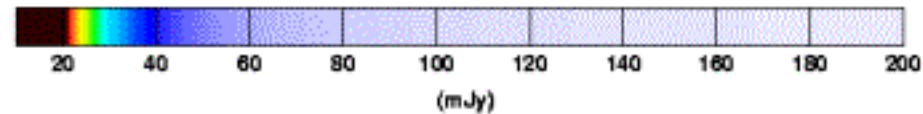
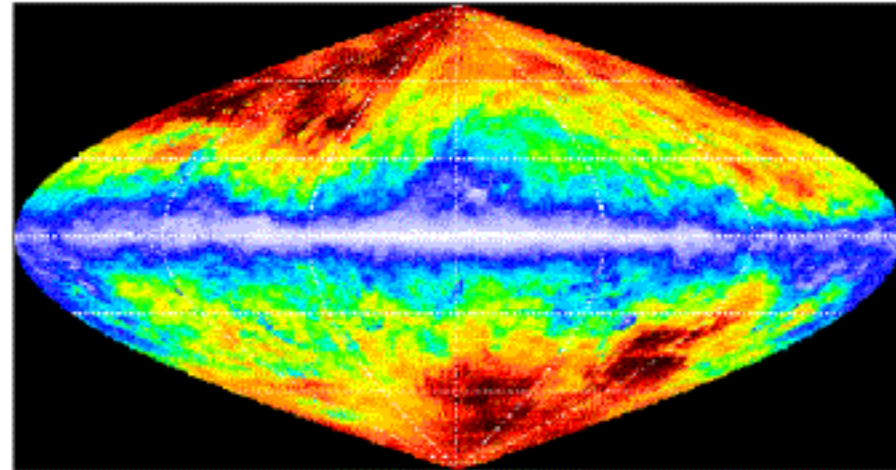
Detection Limit of WIDE-S



Detection Limit of N170



Detection Limit of WIDE-L



Science Programs (Tentative)

- ✿ All sky survey at Far-Infrared (plus IRC)
 1. Point source catalogue
 2. All sky map
- ✿ Propriety period: 1 year after the mission
- ✿ Mission Program: open to science members
To be fixed by the end of 2002
- ✿ European Time: 10% of the pointing observations
- ✿ Open time: open to Japanese (Korean) and European scientists



Future of Space Infrared Astronomy

- ✿ Herschel (3.5m): 2007
- ✿ NGST(8m):2008
- ✿ SPICA(3.5m): 2010

