

Galactic Plane Surveys

Mike Fich
University of Waterloo

Outline

- Science Goals
- **Other far-IR/submm surveys**
- CCAT Survey

Science Goals

- Measure the star formation rate and history Galaxy-wide
- Determine the upper mass end of the Initial Mass Function, measure star formation rates, efficiency, triggers, evolution/time scale of early states of massive stars
- Obtain the complete inventory of cold dust in the Galactic Plane
- Establishing the existence and nature of star formation thresholds as a function of ISM properties across a full range of galactocentric radii metallicity and environmental conditions
- Determining the relative importance of global vs local mechanisms that give rise to star formation
- Provide templates, recipes and prescriptions for Xgal science

Other Surveys

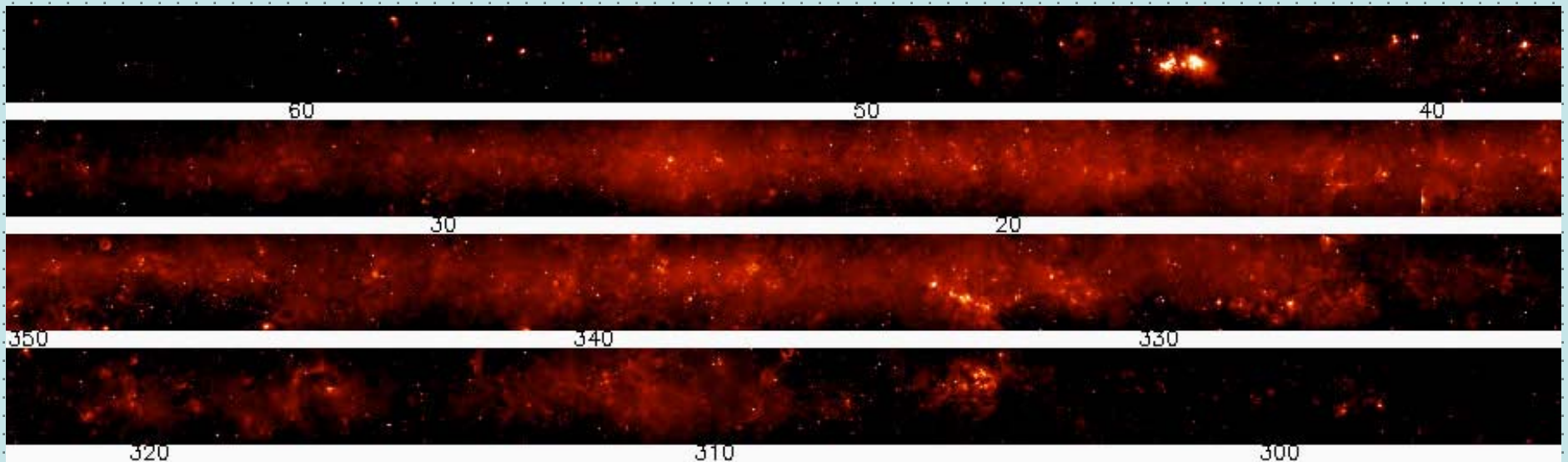
- **IRAS:** 12, 25, 60, 100 μm (1 to 4 arcmin)
- **ISOGAL:** 7 and 15 mm
- **MSX:** 8 to 24 mm
- **GLIMPSE:** Spitzer at 3.6, 4.5, 5.8, 8 mm
- **MIPSGAL:** Spitzer at 24 and 70 μm
- **AKARI/FIS:** 50 to 180 μm
- **BGPS:** BOLOCAM 1100 μm (some 350) see John Bally
- **JCMT SCUBA/SCUBA-2 GPS:** 450 and 850 μm
- **ATLASGAL:** APEX/LABOCA at 870 μm
- **Hi-Gal:** The **H**erschel **i**nfrared **G**alactic Plane Survey 70 - 500 μm (not yet approved)

ISOGAL

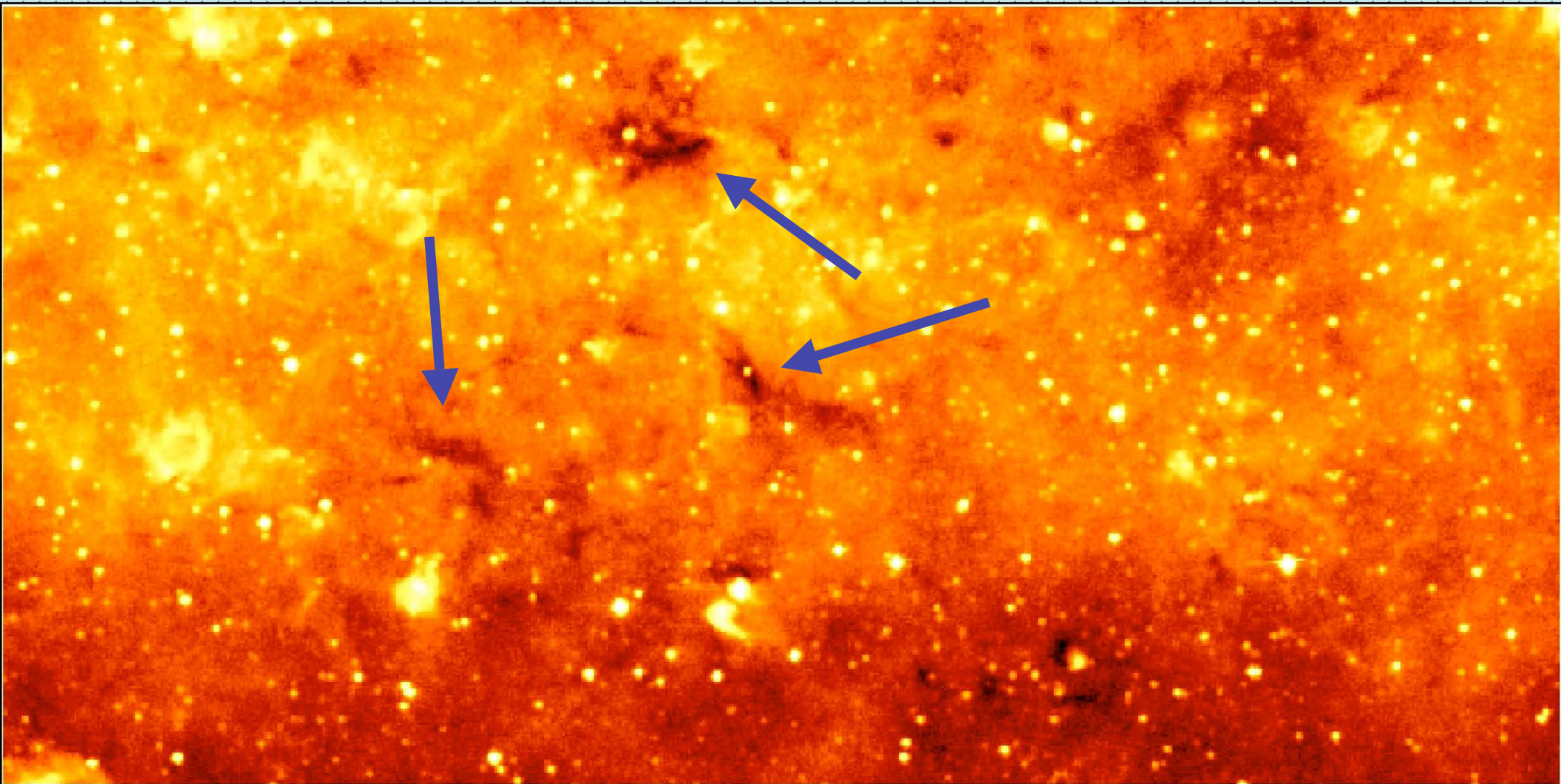
- Infrared Satellite Observatory Galaxy survey
- not complete - many small areas sampled throughout the Galactic Plane - total of 16 sq degrees, selected from IRAS catalogs
- 7 and 15 μm , 10 mJy limit

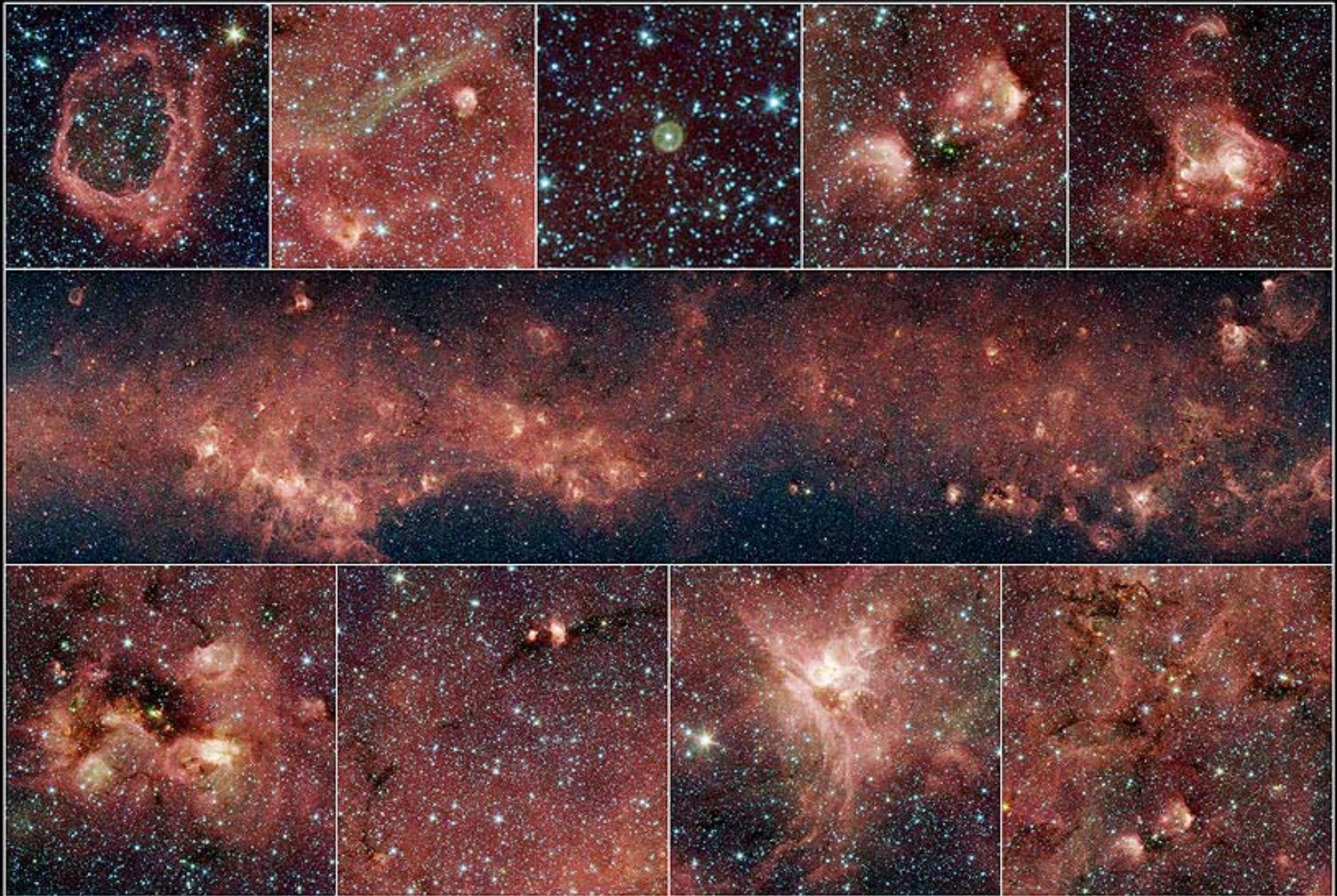
MSX

- MSX = Midcourse Space eXperiment
- 33 cm telescope
- six bands from 4 to 25 μm , 18" resolution
- sensitivity at 8.3 μm \sim 100 mJy



MSX (8 μm continuum)





A GLIMPSE of the Milky Way

NASA / JPL-Caltech / E. Churchwell (University of Wisconsin)

Spitzer Space Telescope • IRAC

sig05-025

Spitzer GLIMPSE

Galactic Legacy Infrared Mid-Plane Survey Extraordinaire

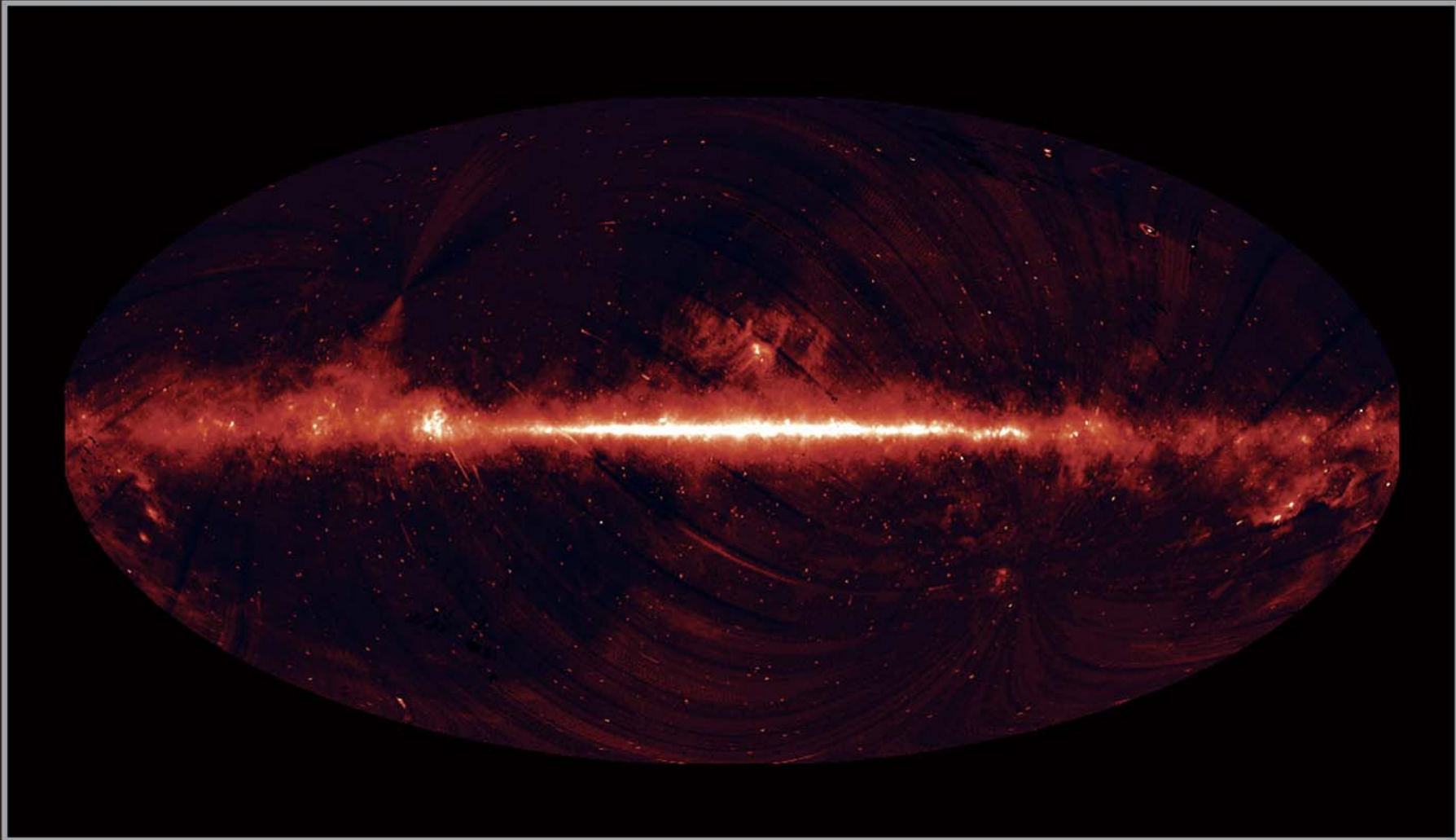
- $10 \leq l \leq 65$ and $-10 \geq l \geq -65$, $-1 \leq b \leq +1$
- Spitzer IRAC (3.6, 4.5, 5.8, 8.0 μm) at 2" resolution and 0.2 and 0.4 mJy sensitivity
- GLIMPSE II: Galactic Centre area
- GLIMPSE 3D: vertical structure using strips up to 4.2 deg. in b at $l=3.5, 11, 15, 18.5, 25$ and 30°

Spitzer MIPS GAL

- Survey of GLIMPSE fields at 24 and 70 μm , 5 and 15 arcsec resolution
- 417 hours allocated
- first data to appear this summer
- sensitivities not given (?anywhere)



The Entire Sky as seen at Mid-Infrared wavelengths



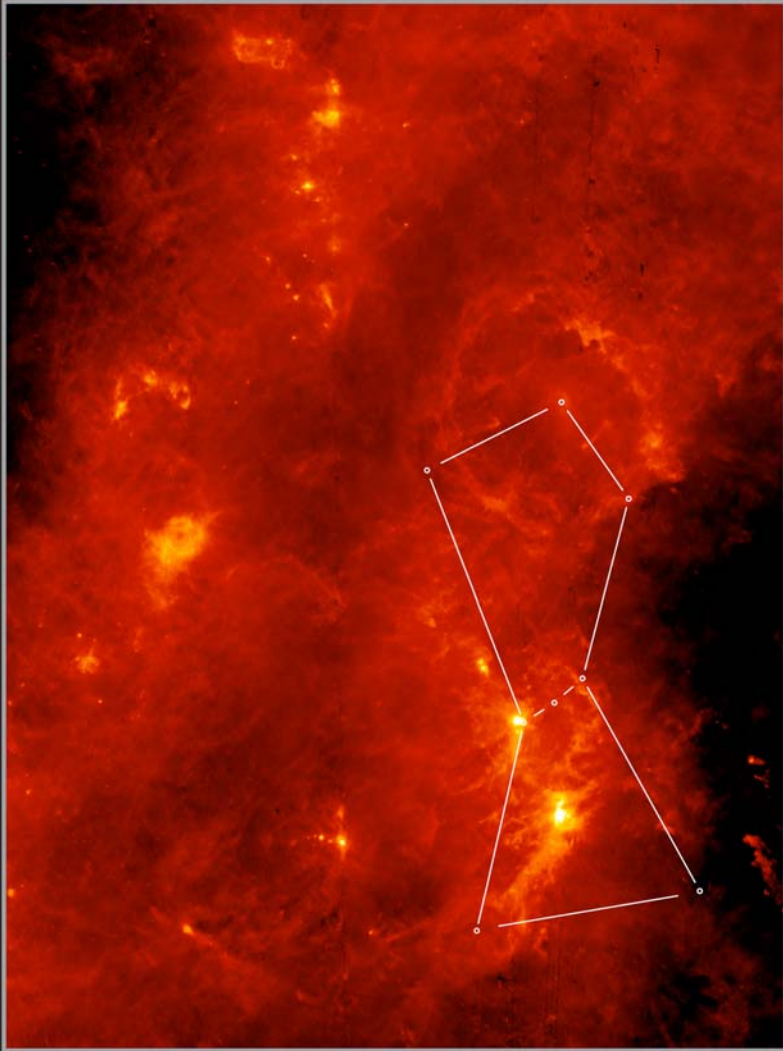
AKARI/Infrared Camera (wavelength: 9 μ m)



11th July, 2007



Far-Infrared Image of the Orion Region and the Milky Way



AKARI/Far-Infrared Surveyor (wavelength: $140 \mu\text{m}$)



11th July, 2007



Far-Infrared Image of the Cygnus-X region



AKARI/Far-Infrared Surveyor
(false-color composite from $90 \mu\text{m}$ and $140 \mu\text{m}$ images)

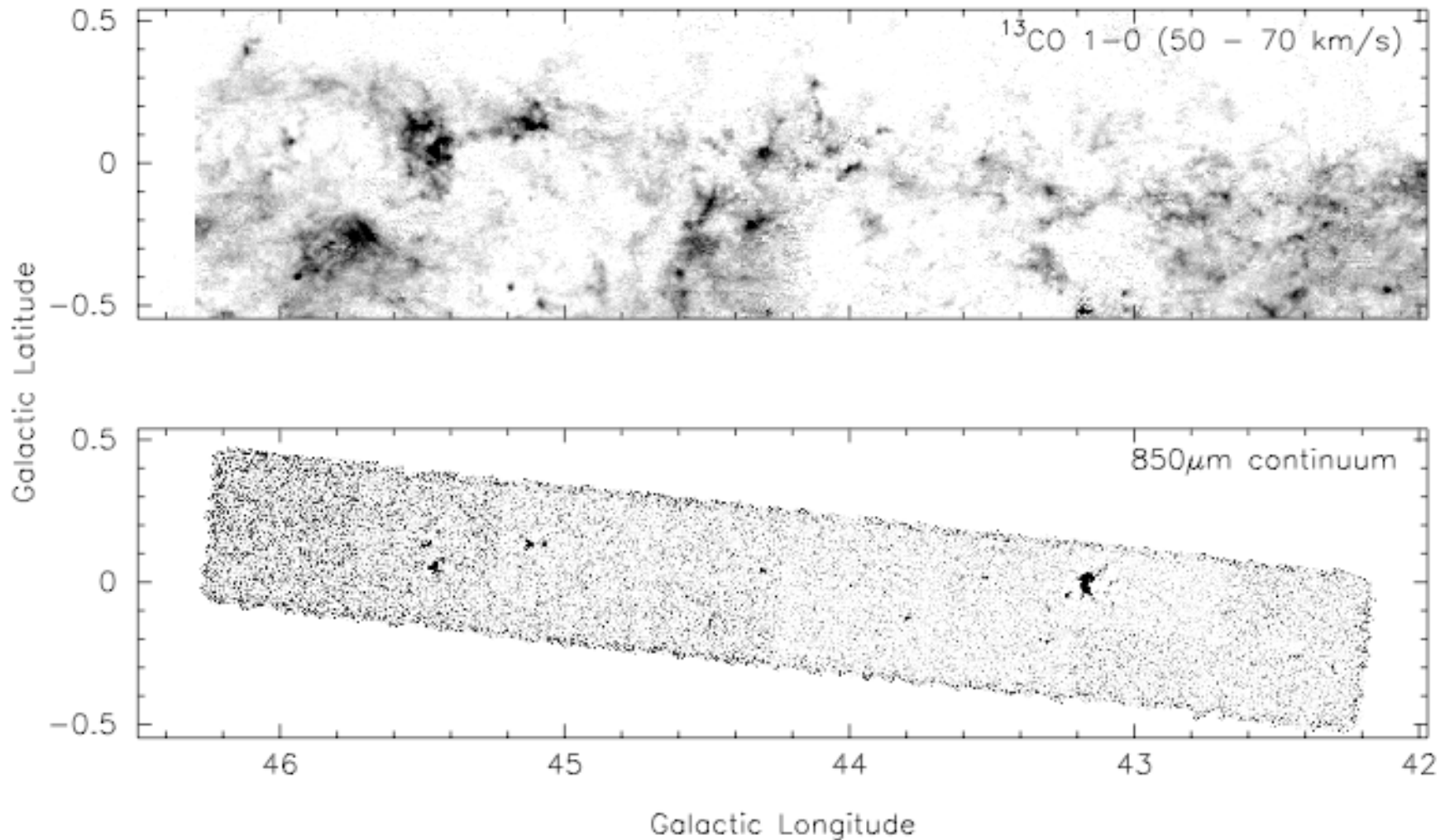


11th July, 2007

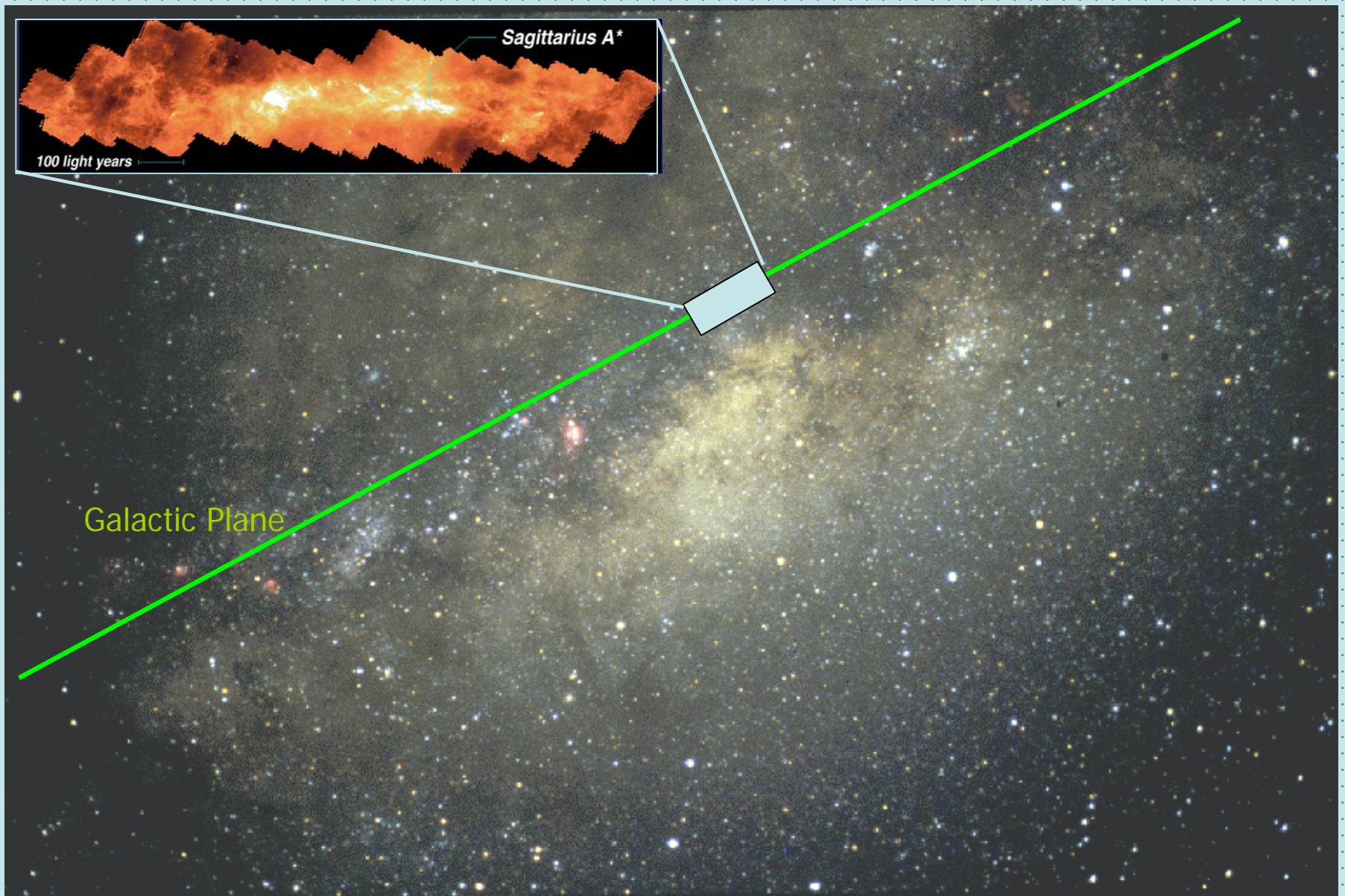
AKARI/FIS

- Japanese satellite launched Feb. 2006
 - 68.5 cm telescope, $\lambda=1.7$ to 180 μm
 - Making an all-sky survey
 - FIS is the Far-Infrared Surveyor instrument
 - 50-180 μm in four bands with 30-60 detectors each with pixel size 27 or 44 arcsec
- Detectors saturate at 100 MJy/sr at 100 μm
 - problem for extended emission, probably prohibits “inner” Galaxy observations at $\lambda \geq 100 \mu\text{m}$

JCMT/SCUBA Galactic Plane Survey



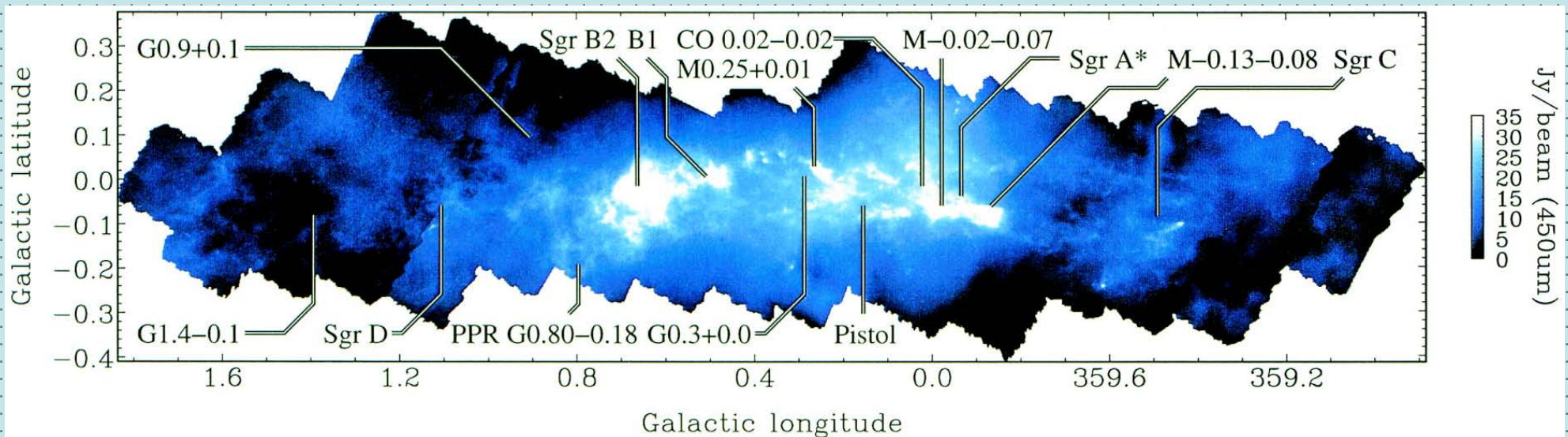
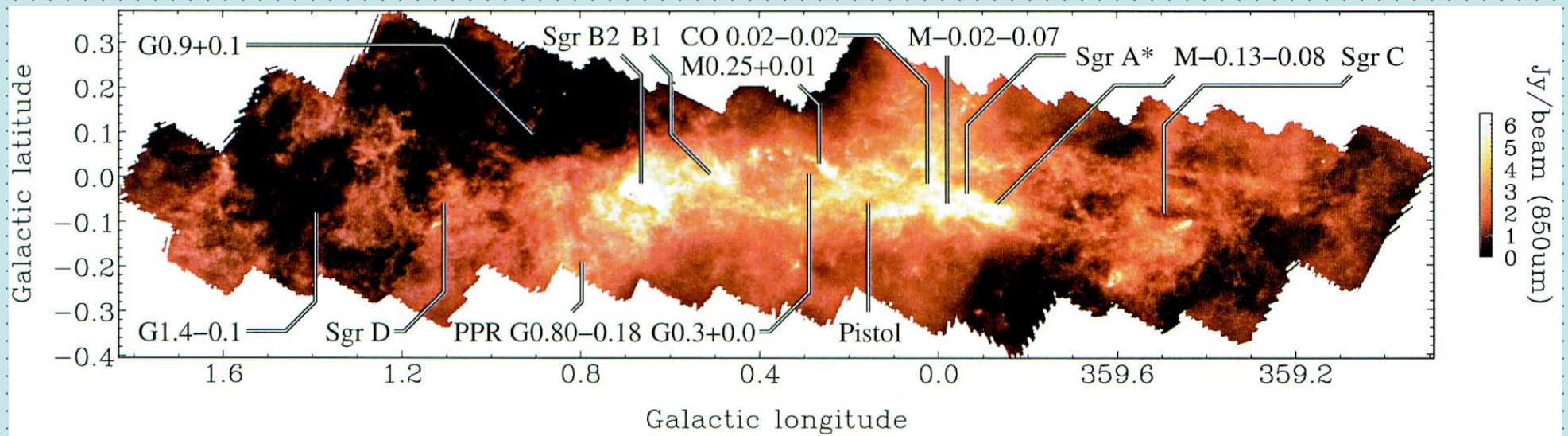
20 hours, poor weather, noise at 100-300 mJy/beam



SCUBA Galactic Center Survey: 120 hours of telescope time

7/18/07

CCAT Status Review



1 σ sensitivity of 30 and 300 mJy/beam at 850 and 450 μ m

JCMT GALACTIC PLANE LEGACY SURVEY

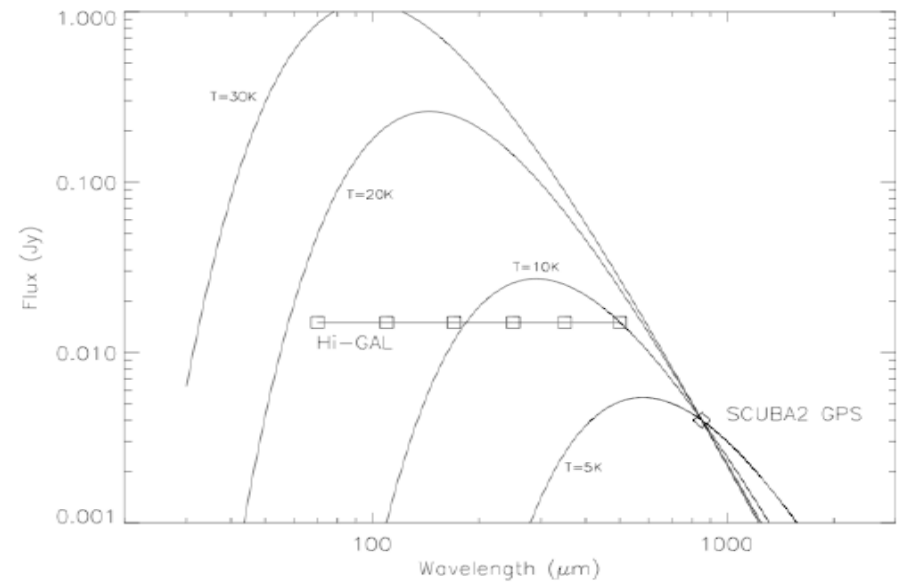
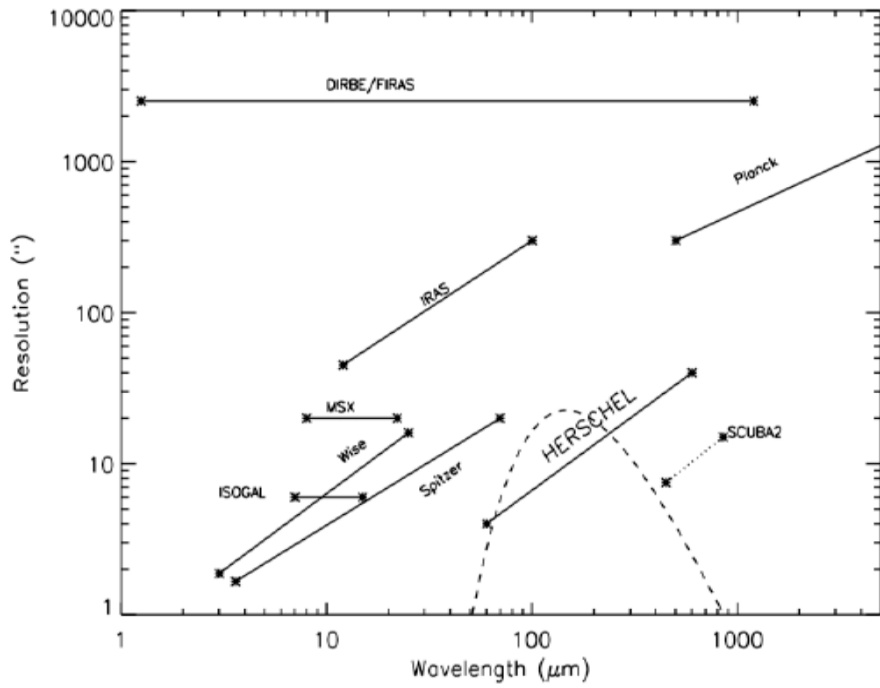
- Sensitivity = 20 mJy/beam (5σ) at 850 μm with 15 arcsec beam ($40 M_{\odot}$ at 20 kpc)
- Two year survey (220 sq. deg., 334 hours)
 - Two regions
 - $10 \leq l \leq 65$, $-1 \leq b \leq +1$ (GLIMPSE area)
 - $102.5 \leq l \leq 141.5$, $-1 \leq b \leq +1$, plus a few higher b pieces
- Five year survey (512 sq. degrees)
 - $10 \leq l \leq 250$, $-1 \leq b \leq +1$ plus high b pieces

ATLASGAL

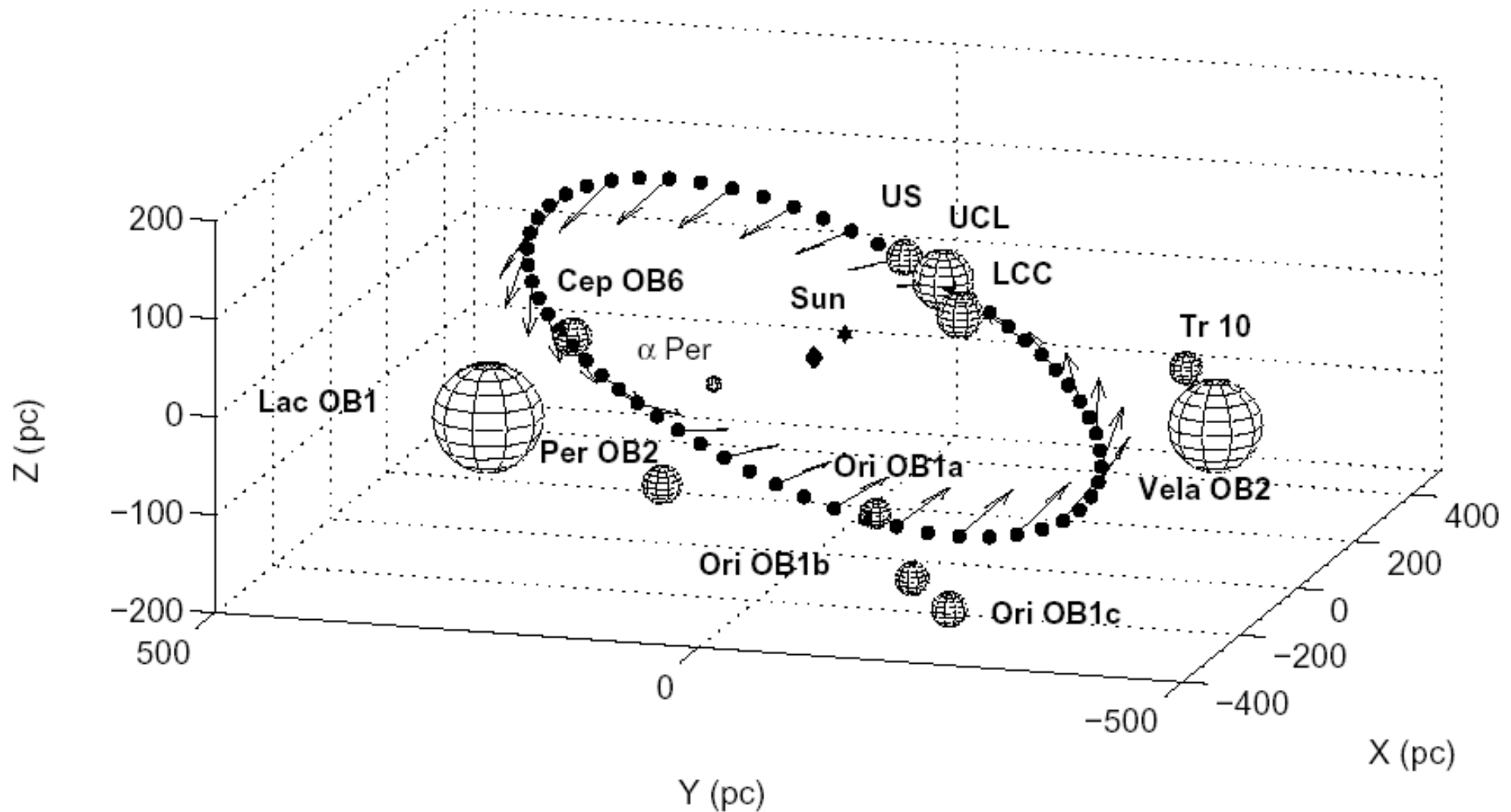
- APEX telescope
- LABOCA: 870 μm , 295 pixels, 18" resolution
- Shallow survey
 - $|l| < 80^\circ$; $|b| < 2.5^\circ$ to $5\sigma = 250 \text{ mJy}$
- Deep survey
 - $|l| < 80^\circ$; $|b| < 1^\circ$ to $5\sigma = 50 \text{ mJy}$
- Deeper survey
 - in limited parts of nearby regions
(e.g. $5\sigma = 10 \text{ mJy}$ in Rosette Nebula)

Hi-Gal

- Herschel PACS and SPIRE instruments
- 60 - 600 μm in five bands
- 5σ sensitivity = 100 mJy
- $-120 \leq l \leq 120, -1 \leq b \leq +1$
- begin in 2009
- Requires 700 hours
- Open Time Key Project - not yet submitted



Several Gould's Belt surveys proposed or underway



Far-IR/submm Galactic Plane Surveys

Survey	λ (μm)	Resolution (arcsec)	Sensitivity (5σ in mJy)
MIPSGAL	70 (24)	15	?50
SCUBA2 GPS	850 (450)	15	20
ATLASGAL	870	18	50
Hi-Gal	250 (60-600)	17	100

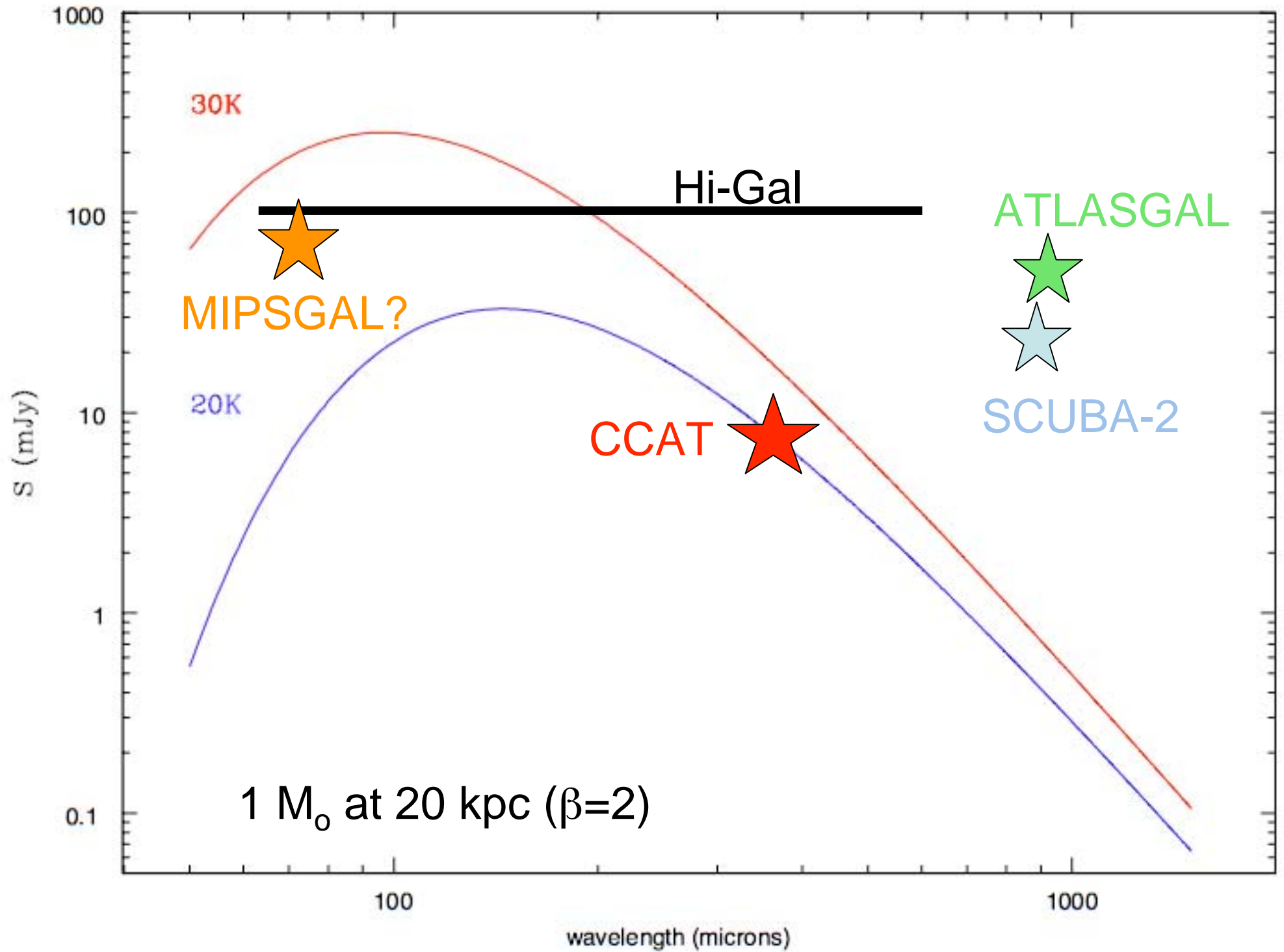
CCAT Galactic Plane Survey

Assumptions:

- SW Cam (32,000 pixels, Nyquist sampled at 350 μm , $5\sigma=1$ mJy in 1 hour [10 mJy at 200 μm])
- dust emissivity $\kappa=0.02$ $\text{cm}^2/\text{gm}(\text{H}_2)$ $(\lambda/850 \mu\text{m})^{-2}$

Time estimates:

- unresolved sources, to edge of Galaxy
1 M_{\odot} at 20K, 20 kpc, $S_{\nu}(350 \mu\text{m}) = 8.4$ mJy
integration time = 51 sec (8.5 min at 200 μm)
- mapping to this level: 1.13 hour/sq.deg.
(36 hours/sq.deg at 200 μm)



CCAT Galactic Plane Survey

In ~200 hours CCAT will be able to survey the “inner” Galactic Plane to a level that will find all of the star forming regions (ie. cool dust), not just the massive star regions (i.e. warm or hot dust)...