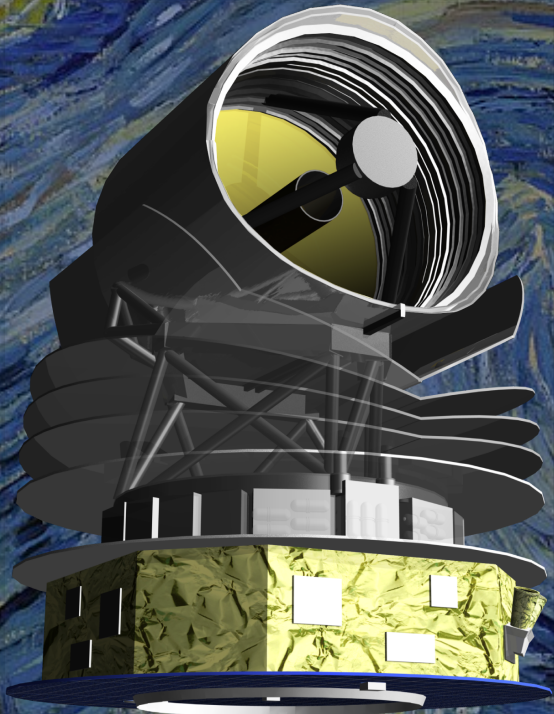
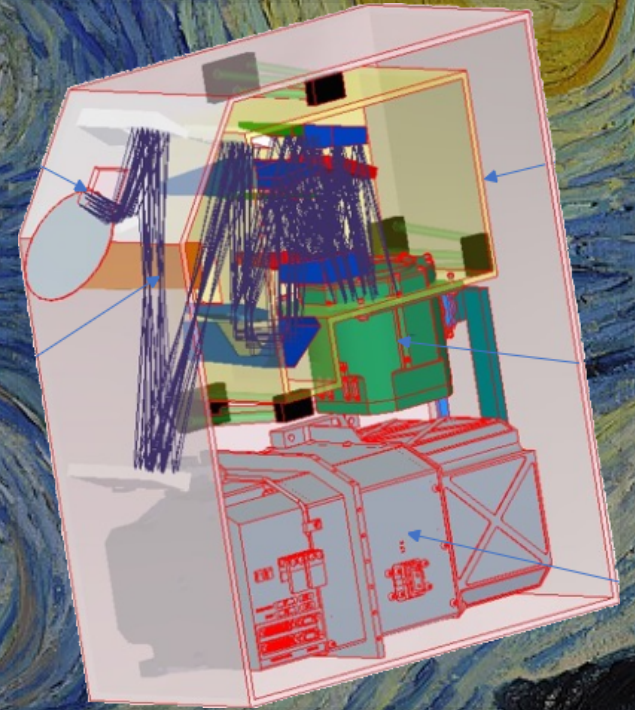
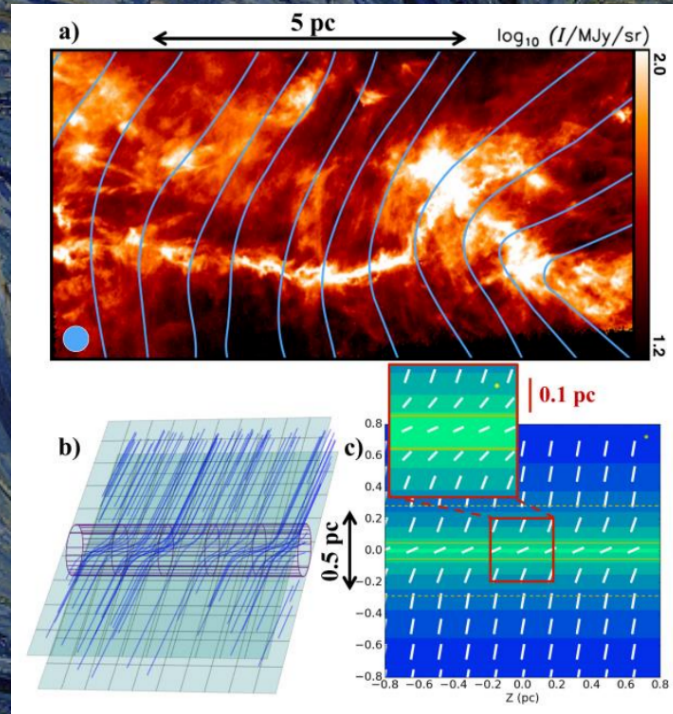


SPICA FIR imaging polarimeter



JAXA / SPICA Team



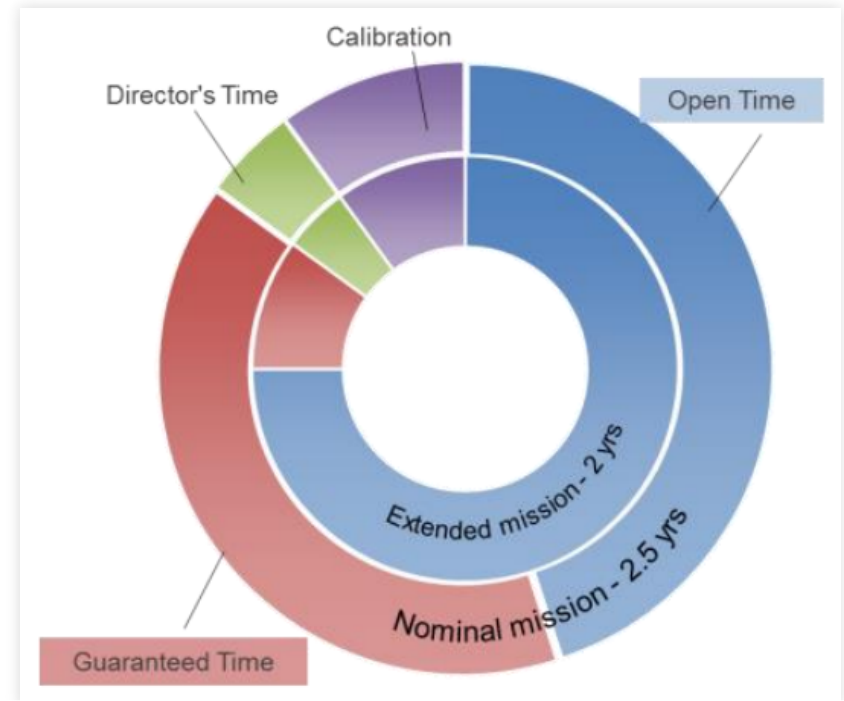
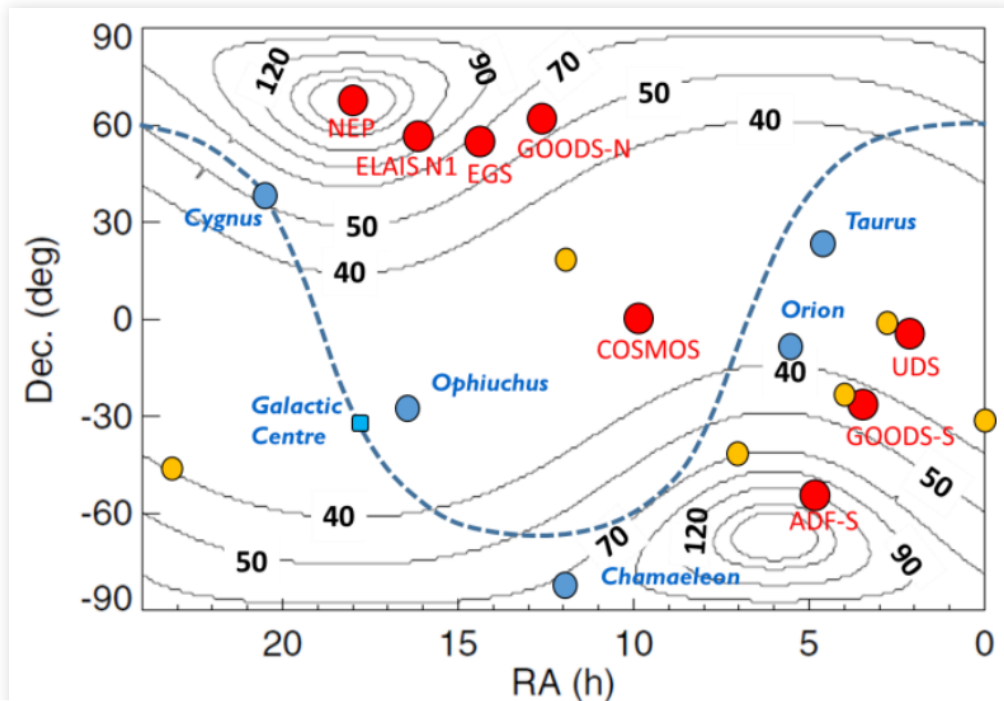
2017/11/22 @ SPICA science workshop Y.Do

SPICA status

- ESA cosmic vision M5 candidate
 - 1st selection in this December
- ISAS strategic large-class mission in the late 2020's
 - one of the “hightest-priority large projects” by the Science Council of Japan
 - one of the top rank “Large-Facilities and Projects Roadmap” by MEXT

Observation by SPICA

- ϕ 2.5m, cooled telescope ($< 8\text{K}$)
- Mission life: 2.5yrs nominal, +2yrs extension foreseen
- Target visibility: once / 6 months
- Key programme + General programme
- Guaranteed time & Open time



SPICA Instruments

1. SMI

- 17 – 36 μm background limited spectroscopy,
 $R \sim 100 - 2000$
- 10' \times 12' survey camera and $R \sim 100$ spectrometer
- 12 – 18 μm spectroscopy at $R \sim 28000$

2. SAFARI-SPEC

- 34 – 230 μm background limited spectroscopy,
 $R \sim 300 - 11000$

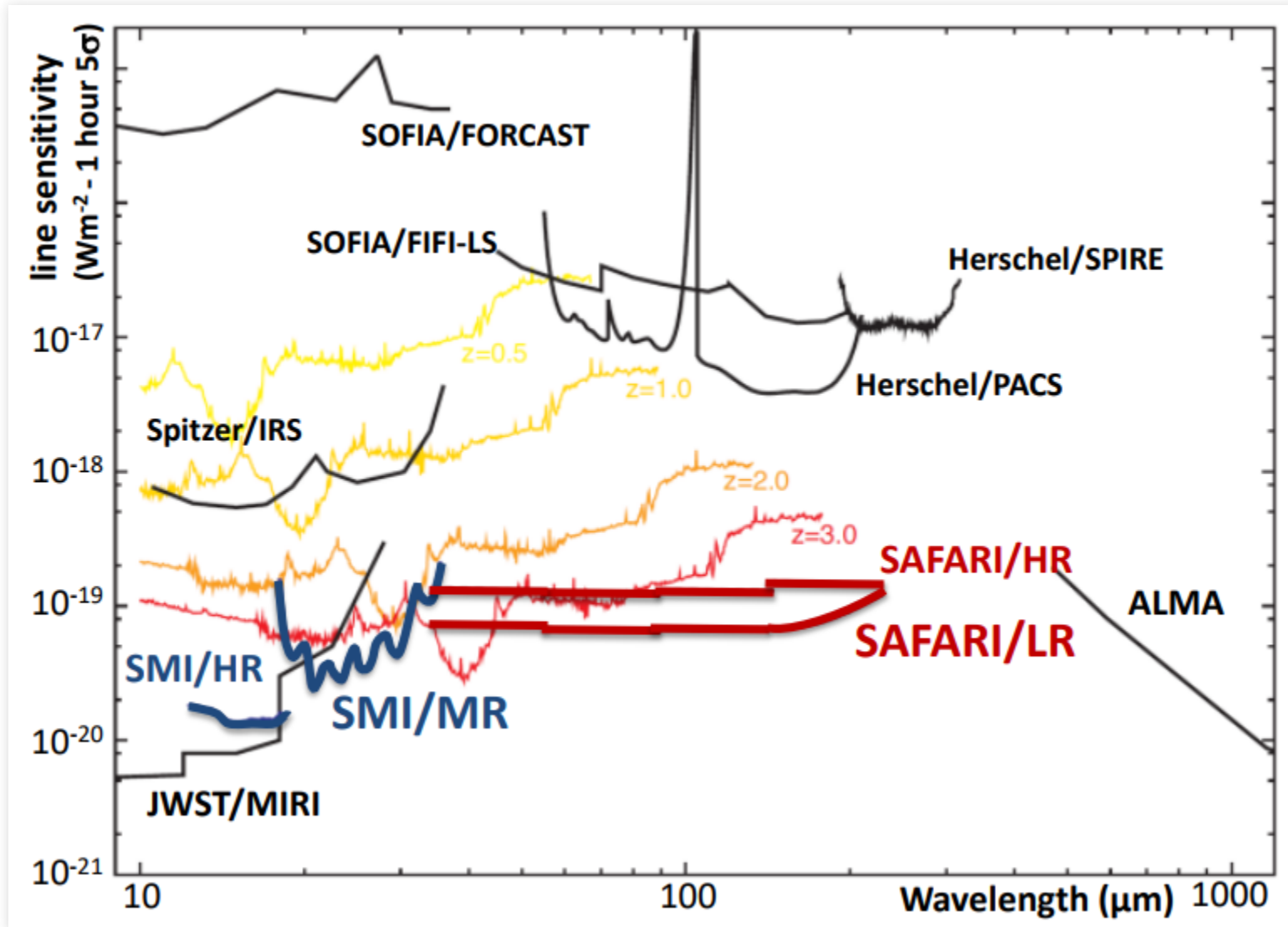
3. SAFARI-POL

- 100, 200, 350 μm imaging polarimeter

Diffraction-limited Spatial Resolution

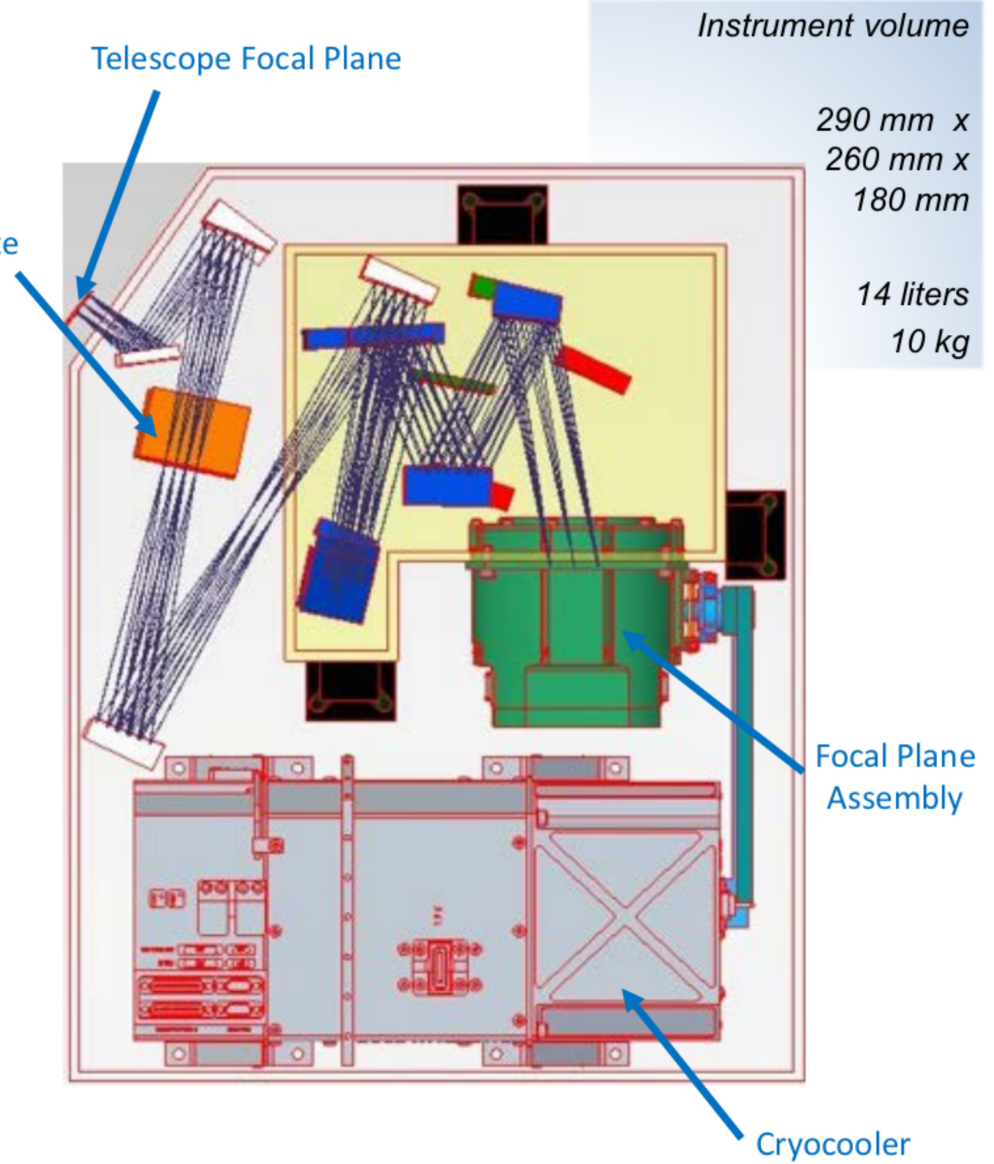
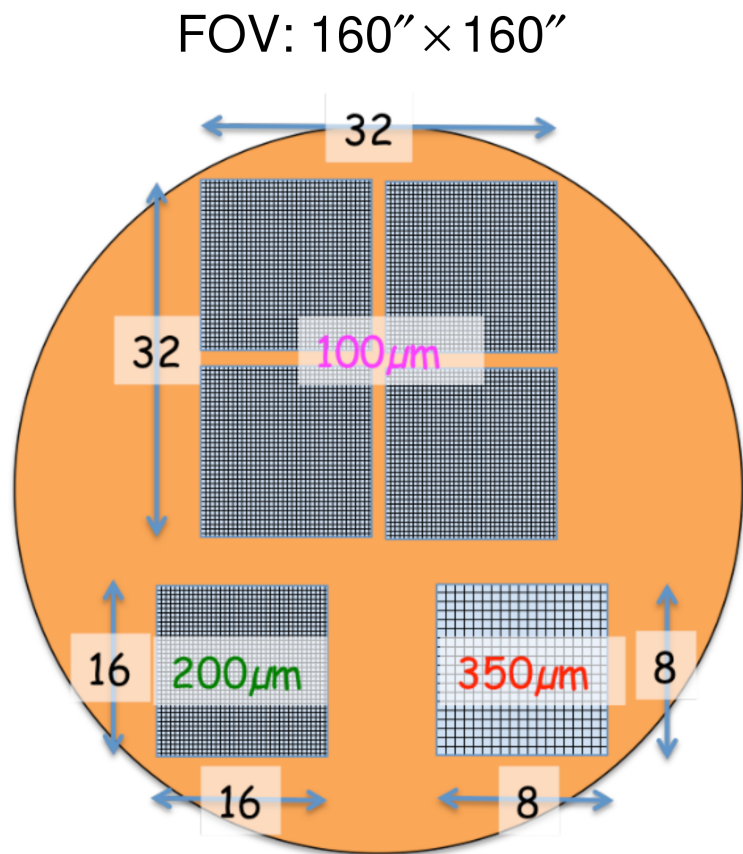
wavelength [μm]	12.0	18.0	36.0	100.0	200.0	230.0	350.0
resolution [arcsec]	1.2	1.8	3.6	10.1	20.1	23.2	35.2

SPICA sensitivity

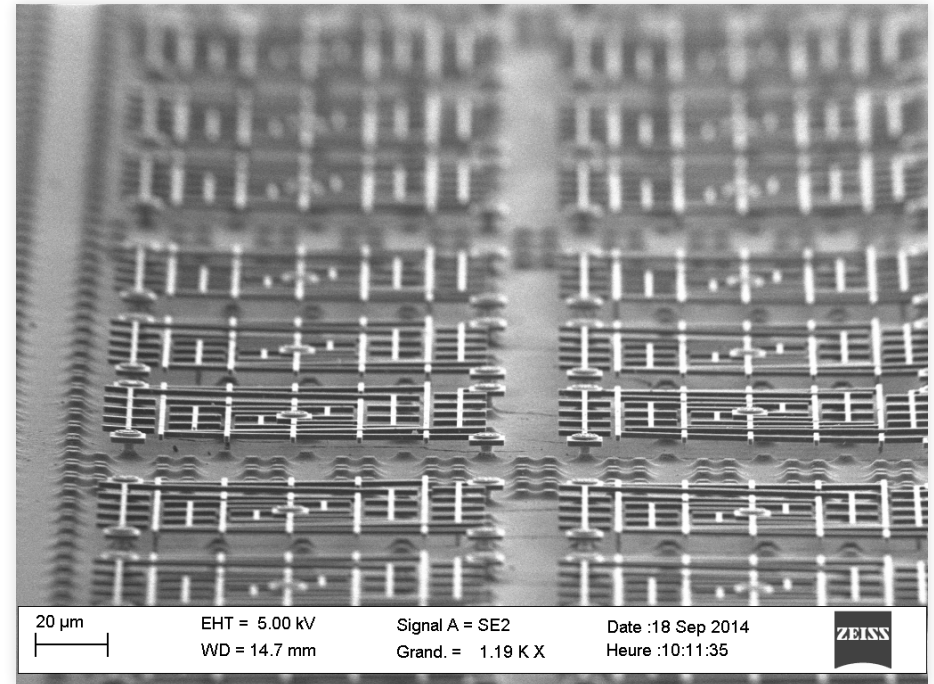
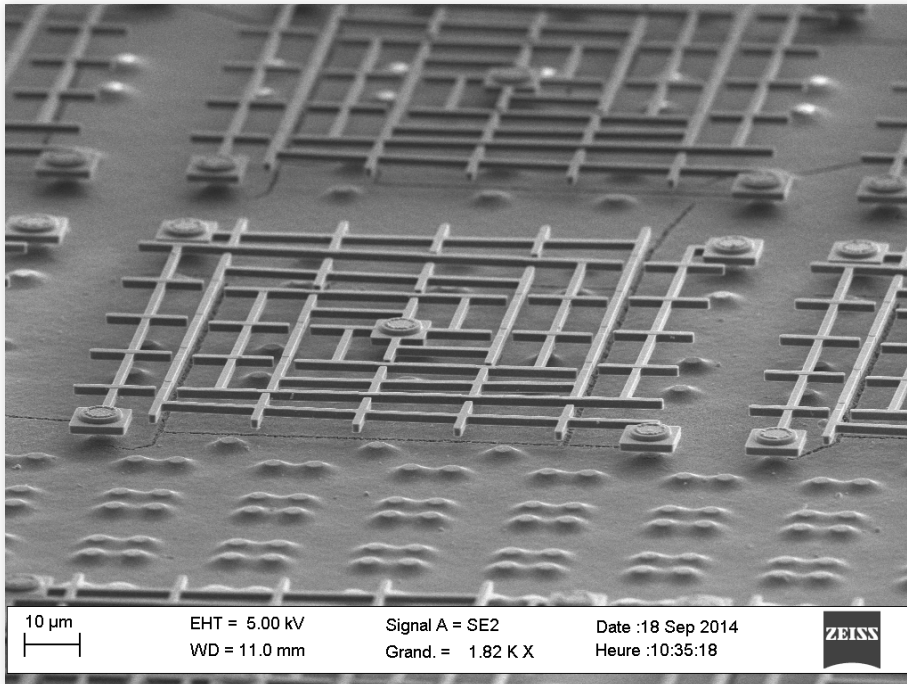


SPICA FIR imaging polarimeter

100 μm	200 μm	350 μm
75–125	150–250	280–420

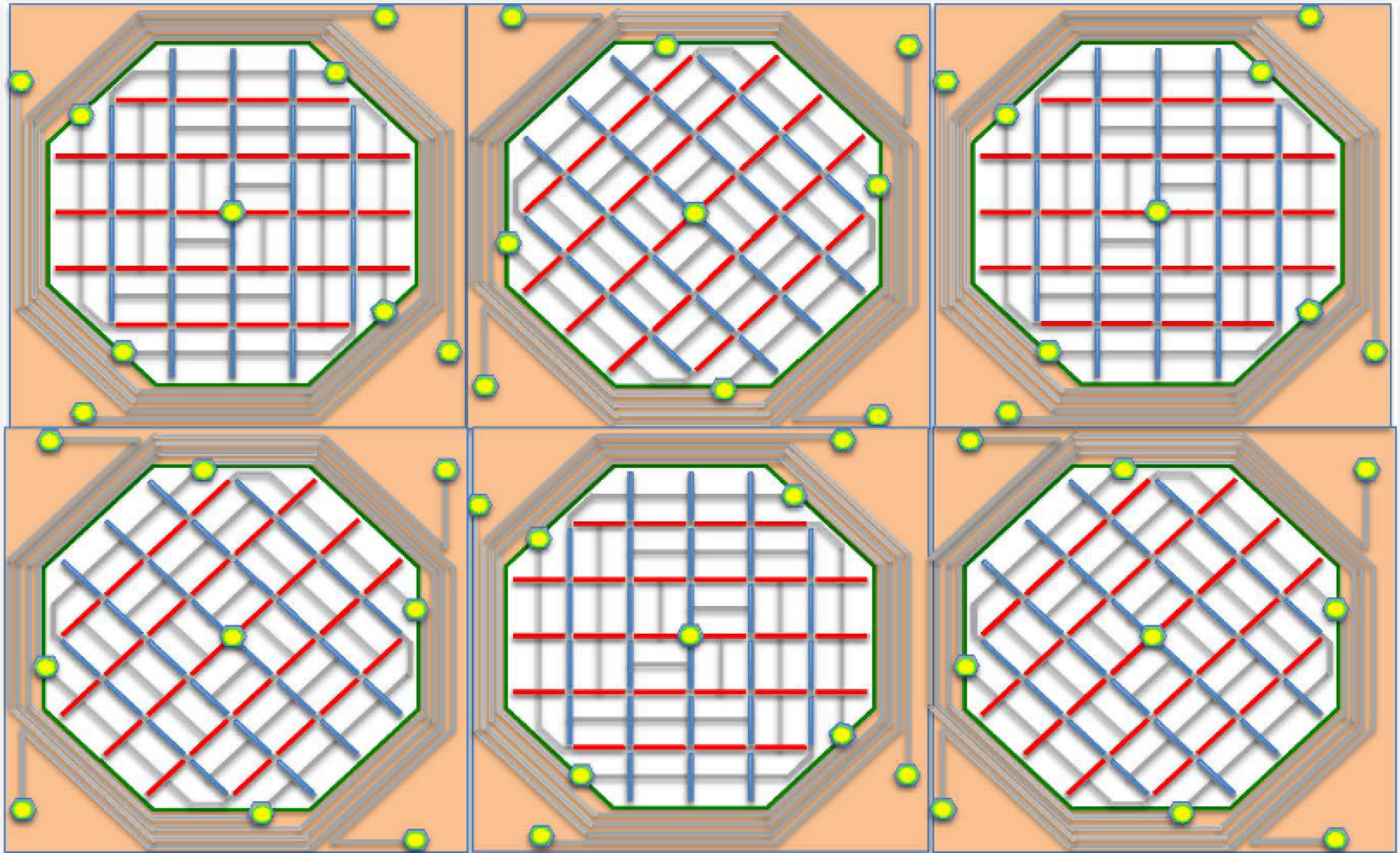


Polarisation-sensitive bolometer array



credit : CEA Saclay

A possible array configuration: Stokes array

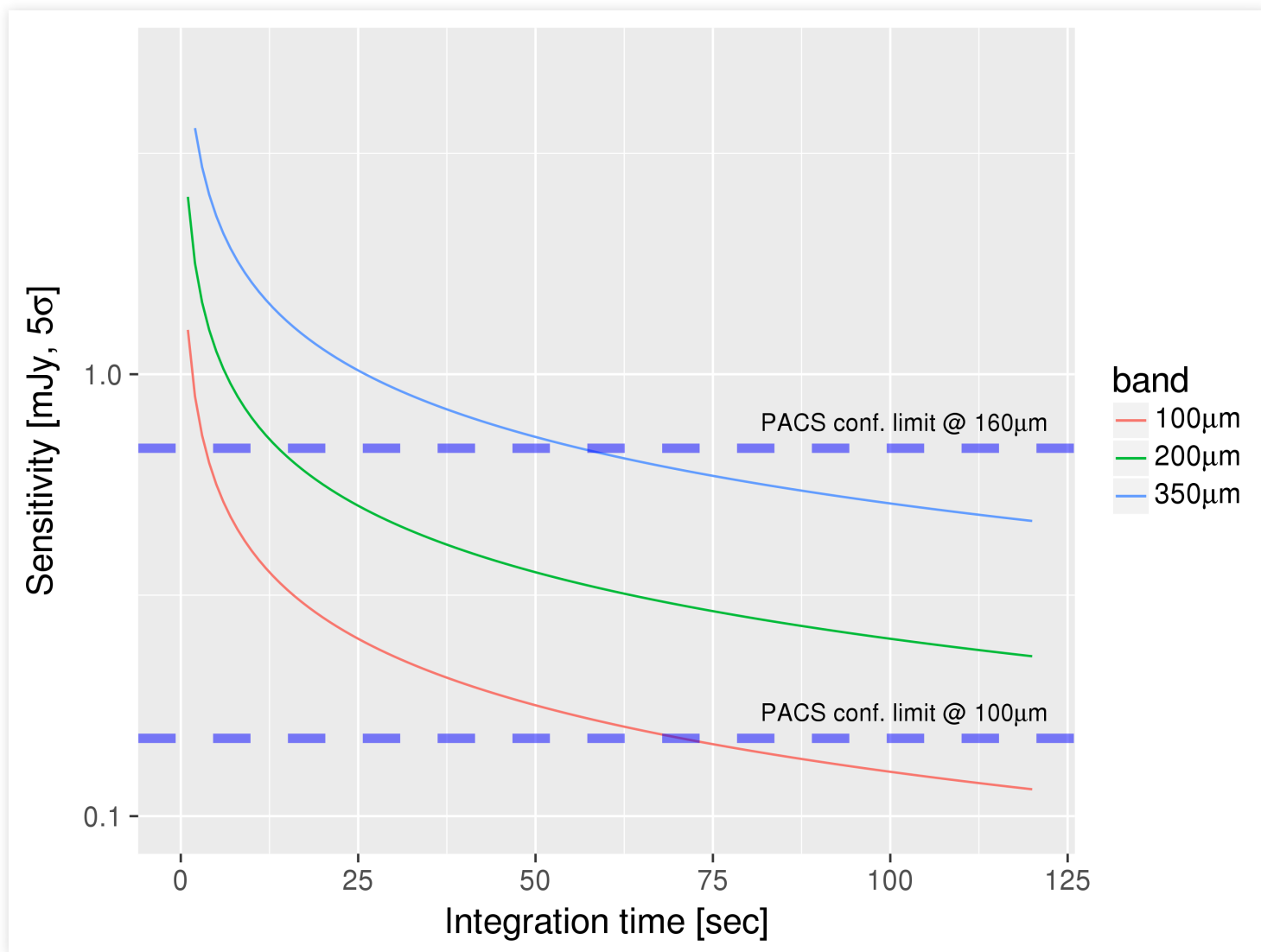


Detector performance in practical observations

How faint can we observe?

- confusion limit (unpolarised):
0.15 mJy (PACS-100 μm), 0.68 mJy (PACS-160 μm ;
Magnelli et al. 2013, A&A 553 A132 @ the GOODS-S field)
 - pointed observations can achieve confusion limited sensitivity instantaneously
- polarisation sensitivity: $\sqrt{2}/P$ times of the photometric (unpolarised) sensitivity
 - confusion limit for polarised intensity. . .??

Sensitivity vs. Confusion limit (tentative)



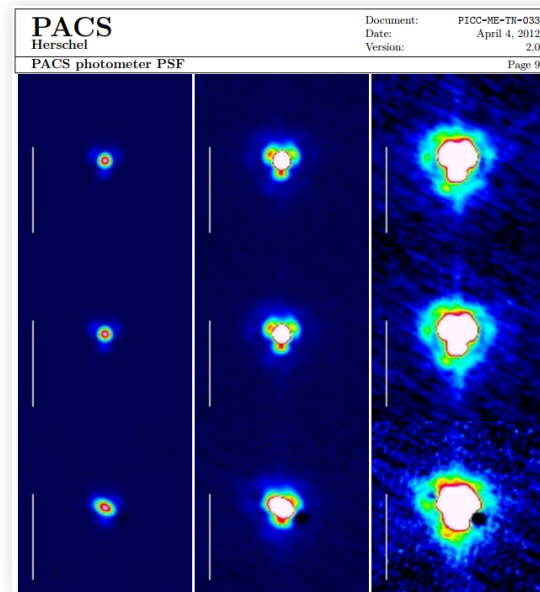
Detector performance in practical observations

How bright can we observe?

- detector/array dynamic range : > 8000
- several sensitivity modes are expected for different ranges of sky brightness
 - lower bias current \leftrightarrow better sensitivity for faint sources
 - higher bias current \leftrightarrow higher saturation limit
 - *cf.* sources brighter than ~ 1 Jy can be observed by HAWC+

Mapping speed – How wide can we map?

- $1^\circ \times 1^\circ$ mapping in a few ~ 10 hours can achieve the confusion limited sensitivity.

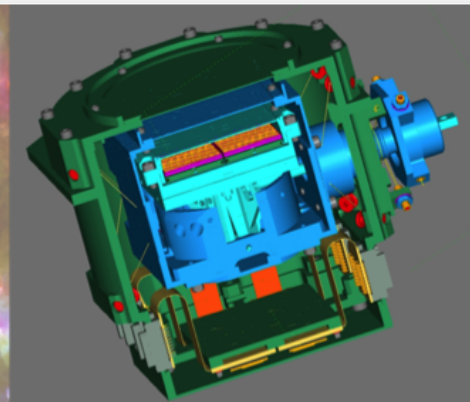


PACS green channel PSF for $10''/\text{sec}$, $20''/\text{sec}$, and $60''/\text{sec}$.

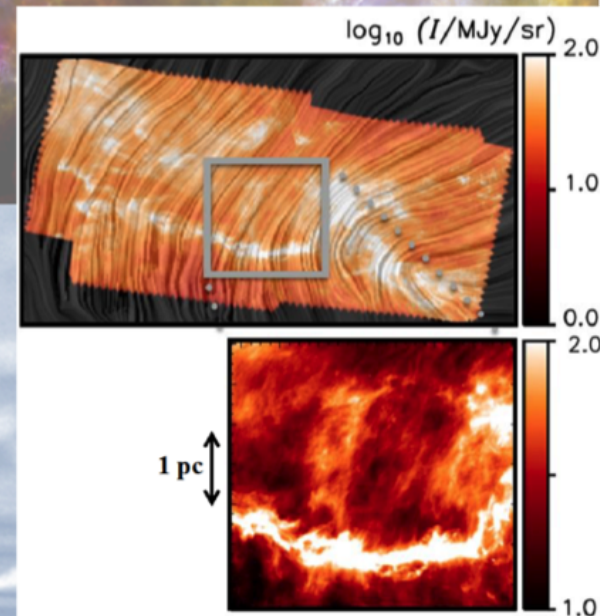
- scan speed $\gg 20''/\text{sec}$ or $\gg 1[\text{deg}^2/\text{hour}]$ is not realistic according to PACS experiences

SPICA / SAFARI_Pol Fact Sheet

A polarimetric camera with
3 simultaneous bands 100, 200 & 350 μm
on the same FOV : 2,6' x 2,6' @ 0,6 f# λ sampling



	100 μm	200 μm	350 μm
Band edges	75—125 μm	150—250 μm	280—420 μm
# of pixels	32 x 32 (x 2)	16 x 16 (x 2)	8 x 8 (x 2)
Pixel size	5" x 5"	10" x 10"	20" x 20"
Band centre beam FWHM	9"	18"	32"
PS sensitivity 5σ/1h/FOV (unpolarised)	21 μJy	42 μJy	85 μJy
PS sensitivity in Stokes (Q,U) 5σ/1h/FOV (polarised)	30 μJy	60 μJy	120 μJy
PS sensitivity 5σ/10h/1deg² (unpolarised)	0.16 mJy	0.32 mJy	0.65 mJy
PS sensitivity in Stokes (Q,U) 5σ/10h/1deg² (polarised)	0.23 mJy	0.46 mJy	0.92 mJy
Surface brightness sensitivity 5σ/10h/1deg² (unpolarised)	0.09 MJy/sr	0.045 MJy/sr	0.025 MJy/sr
Sensitivity to map Stokes parameters (Q,U) at 5% level 5σ/10h/1deg²	2.5 MJy/sr	1.25 MJy/sr	0.7 MJy/sr





SPICA/SAFARI Fact Sheet

SAFARI Overview

- Four band *grating spectrometer*
- Continuous spectroscopic capability from 34-230 μm

Parameter	Waveband				
	SW	MW	LW	LLW	
Band centre / μm	45	72	115	185	
Wavelength range / μm	34-56	54-89	87-143	140-230	
Band centre beam FWHM	4.5"	7.2"	12"	19"	
Point source spectroscopy (5σ-1hr)					
R \sim 300	Limiting flux / $\times 10^{-20} \text{ W m}^{-2}$	7.2	6.6	6.6	8.2
	Limiting flux density / mJy	0.31	0.45	0.72	1.44
High R	Limiting flux / $\times 10^{-20} \text{ W m}^{-2}$	13	13	13	15
	Limiting flux density / mJy	18	17	17	19
Mapping spectroscopy* (5σ-1hr)					
R \sim 300	Limiting flux / $\times 10^{-20} \text{ W m}^{-2}$	84	49	30	23
	Limiting flux density / mJy	3.6	3.3	3.3	4.1
High R	Limiting flux / $\times 10^{-20} \text{ W m}^{-2}$	189	113	73	51
	Limiting flux density / mJy	253	151	97	67
Photometric mapping* (5σ-1hr)					
Limiting flux density / μJy	209	192	194	239	
Confusion limit (5 σ)	15 μJy	200 μJy	2 mJy	10 mJy	

CRON

Sensitivities based on detector NEP $2 \times 10^{-19} \text{ W}/\sqrt{\text{Hz}}$
 * Mapping performance is for a reference area of 1 arcmin²



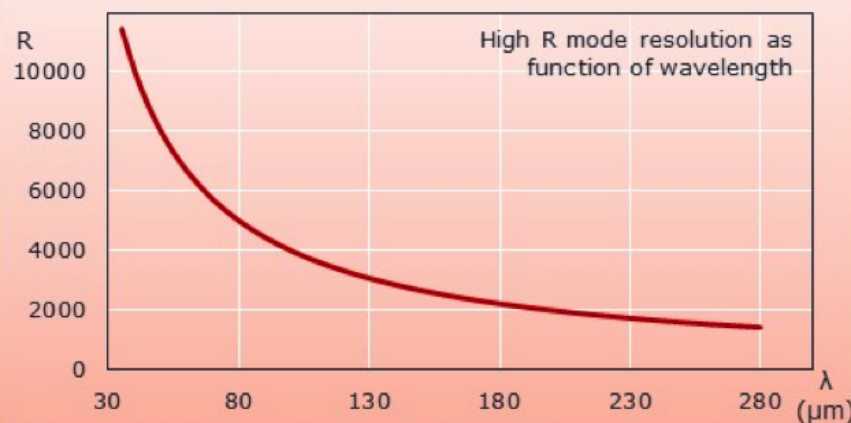
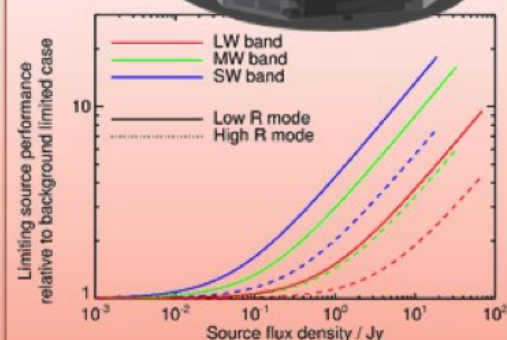
SPICA Mission

- ESA/JAXA collaboration
- Telescope effective area 4.6 m²
- Primary mirror temperature 8K
- Goal mission lifetime – 5 years



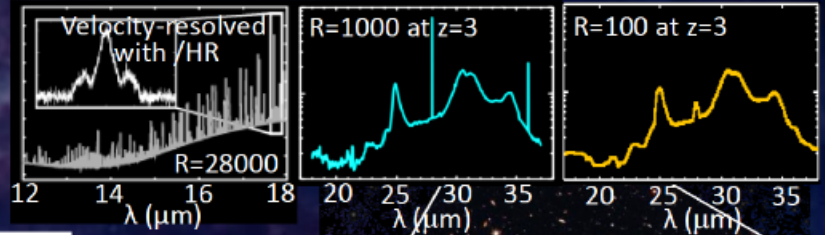
System performance v.s. target flux density, relative to the background limited case

- The sensitivity decrease is due to the increased photon noise from the target source
- Data given up to the instrument saturation limits for each band (31, 51 and 87 Jy for the SW, MW and LW bands respectively).

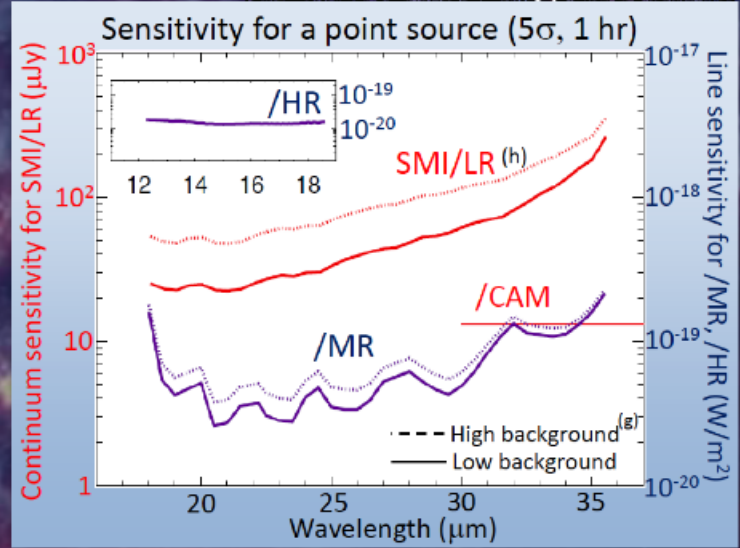
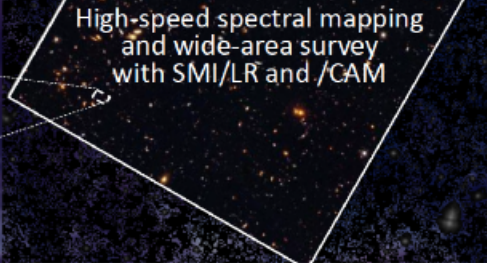
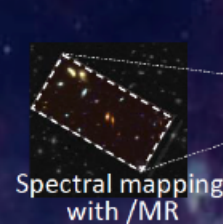


SPICA / SMI Fact Sheet

SPICA Mid-infrared Instrument (SMI) covers the wavelength range of 12–36 μm with four channels: spectroscopy (SMI/LR, /MR, /HR) and imaging (/CAM).



Parameter	SMI /LR	/CAM Slit viewer for SMI /LR	/MR	/HR
Band centre - μm	27	34	27	15
Wavelength - μm	17 – 36	34	18 – 36	12 – 18 (a)
Spectral resolution R (diffuse source)	50 – 120 (b) (20 – 110)	5	1300 – 2300 (b) (1100 – 1400)	28000 (c)
Field of view	600" x 3.7"	600" x 720"	60" x 3.7"	4" x 1.7"
	4 slits		1 slit	1 slit
Band centre FWHM	2.7"	3.5"	2.7"	2"
Pixel scale	0.7" x 0.7"	0.7" x 0.7"	0.7"	0.5"
Detector 1K x 1K	Si:Sb	Si:Sb	Si:Sb	Si:As
Point source sensitivity (5 σ /1 hr)				
Continuum - μJy	50	13	400	1500
Line - 10^{-20} W/m ² (d)	8		4	1.5
Survey speed - arcmin ² /hr (e)	~16	~5900	~1.5	
Diffuse source sensitivity (5 σ /1 hr) ^(f)				
Continuum - MJy/sr	0.05	0.05		
Line - 10^{-10} W/m ² /sr			1	1.5
Saturation limit - Jy	~20	~1	~1000	~20000



- (a) continuous coverage up to 17.3 μm + partial coverage for H₂O 17.77, 18.66 μm .
- (b) $\lambda/\delta\lambda = 120$ (SMI/LR) and 1300 (/MR) at $\lambda = 36$ μm .
- (c) designed for $\lambda/20$ μm diffraction limited PSF.
- (d) sensitivity for an unresolved line.
- (e) survey speed for the 5 σ detection of a point source with the continuum flux of 100 μJy for SMI/LR at $\lambda = 30$ μm (/CAM at 34 μm) and the line flux of 3×10^{-19} W/m² for /MR at $\lambda = 28$ μm , both in the low background case (see the right-hand figure).

- (f) sensitivity for a diffuse source in a 4" x 4" (SMI/LR, /MR) or 2" x 2" area (/HR).
- (g) background levels are assumed to be 80 MJy/sr (High) and 15 MJy/sr (Low) at 25 μm .
- (h) continuum sensitivity rescaled with $R = 50$.

SMI Factsheet v10 – 4 Jan 2016