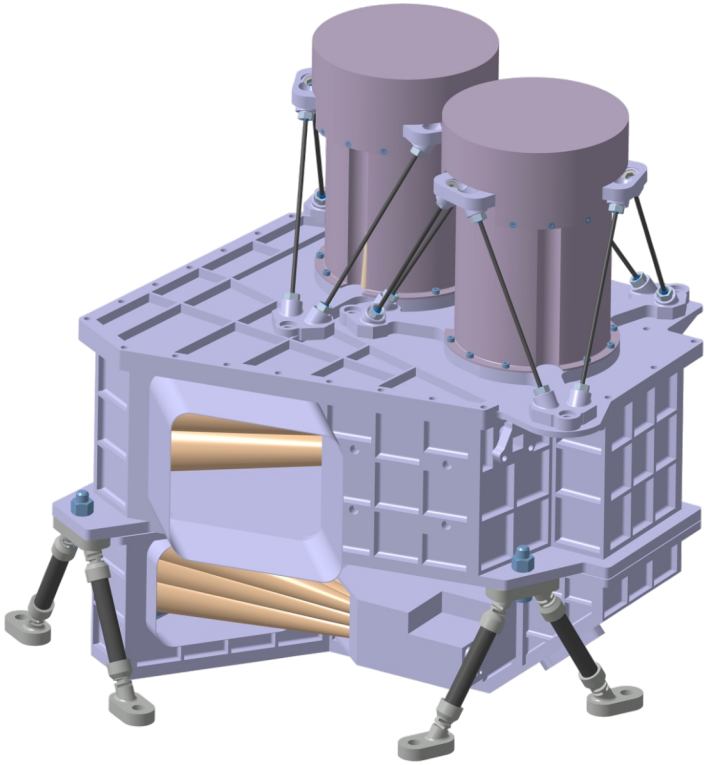
PRIMA *The PRobe far-Infrared Mission for Astrophysics*

PRIMAger

PRIMA: PRIMAger, a far-infrared hyperspectral and polarimetric instrument



Laure Ciesla

Denis Burgarella, Marc Sauvage, Charles D. Dowell, and the PRIMAger team

cnes

LAM LABORATOIRE D'ASTROPHYSIQUE DE MARSEILLE

cea

SRON Netherlands Institute for Space Research

CARDIFF UNIVERSITY PRIFYSGOL CAERDYDD

JPL Jet Propulsion Laboratory California Institute of Technology

NASA Goddard SPACE FLIGHT CENTER

PRIMAger in a nutshell

PRIMAger Hyperspectral Imager (PHI)

24—84 microns

R=10

Total intensity

FWHM: 4”, 7”

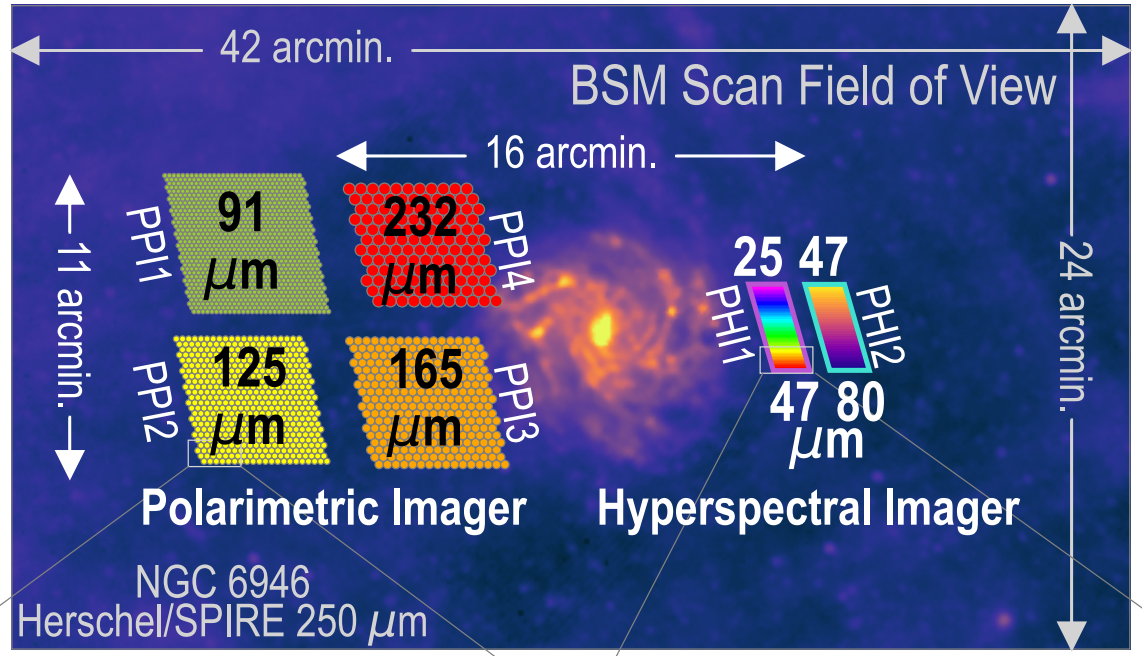
PRIMAger Polarimetric Imager (PPI)

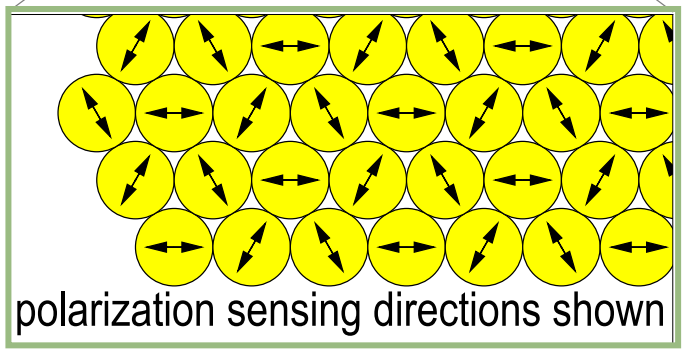
91, 125, 165, 232 microns

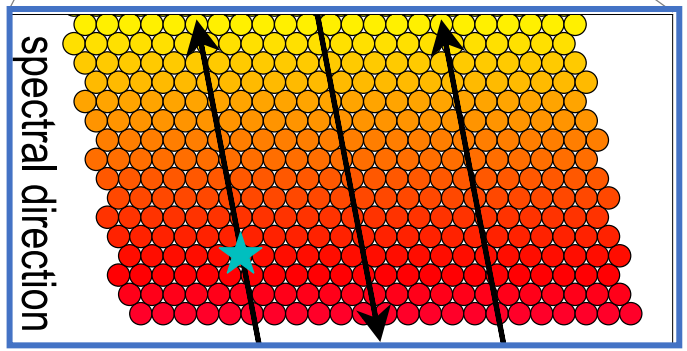
R=4

Total intensity, polarization

FWHM: 9”—24”







Both focal planes observe simultaneously

Efficient mapping instrument!

GO Science book (Moullet+23):

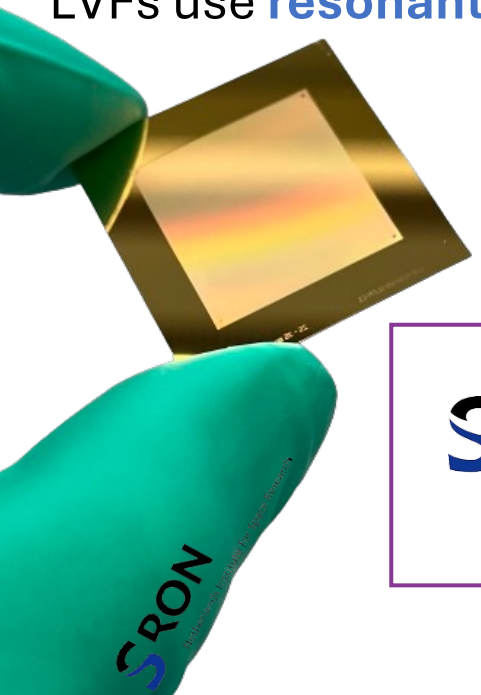
35% for PRIMAger and 33% for PRIMAger+FIRESS

Hyperspectral imager

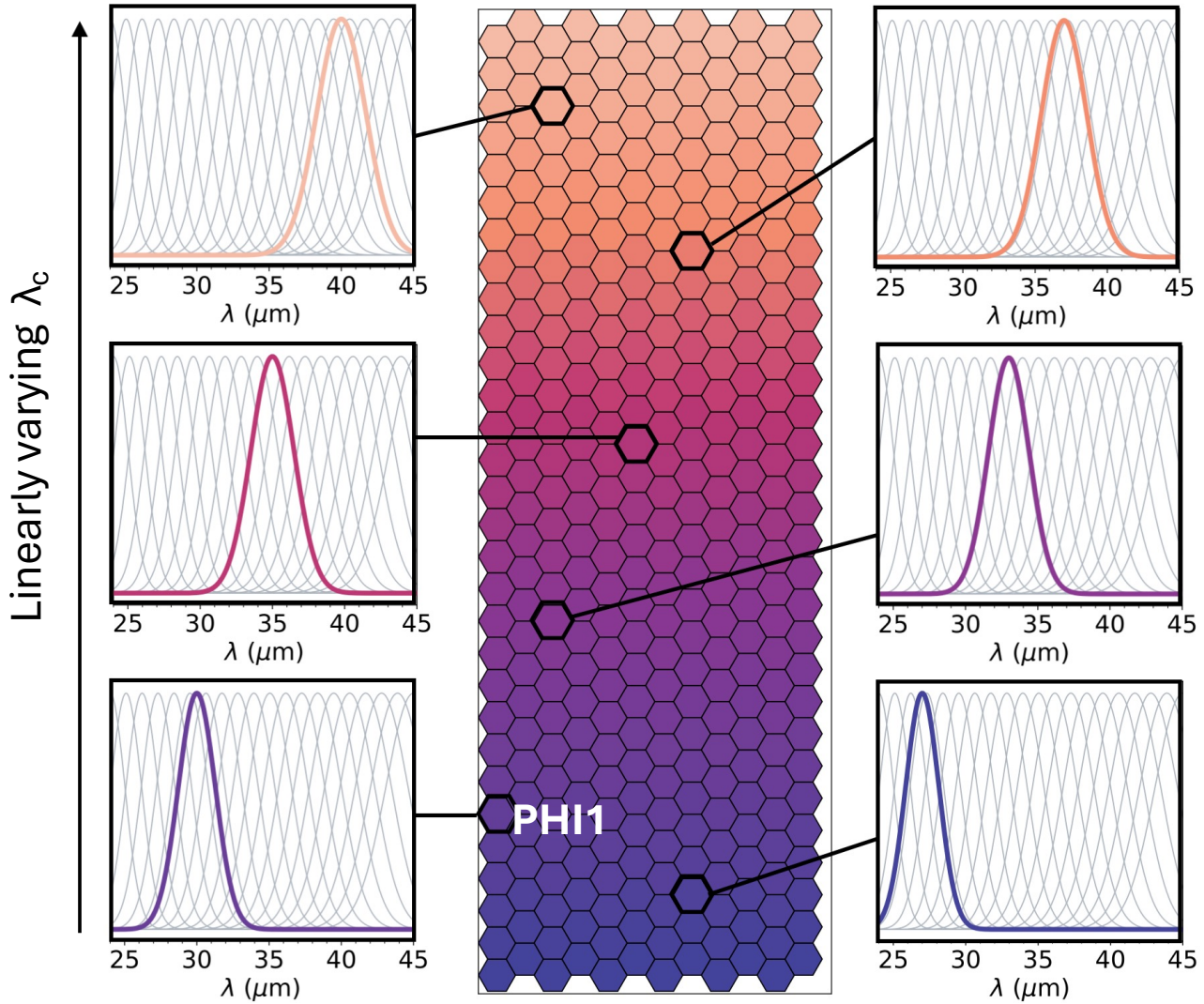
PHI has two arrays (PHI1 & PHI2) of **absorber-coupled KIDs** (**24-84** microns).

R=10 using **Linear Variable Filter** (LVF): spectral response varies linearly along one axis.

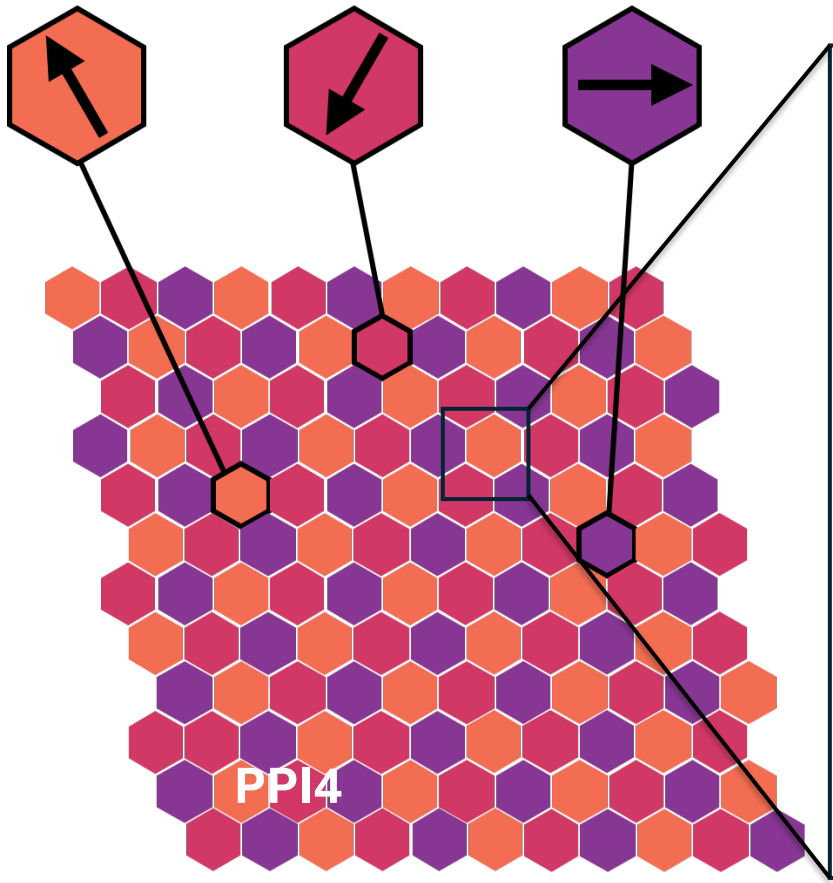
LVFs use **resonant metal-mesh structures**.



SRON Netherlands Institute for Space Research and CARDIFF UNIVERSITY / PRIFYSGOL CAERDYDD are building prototypes.

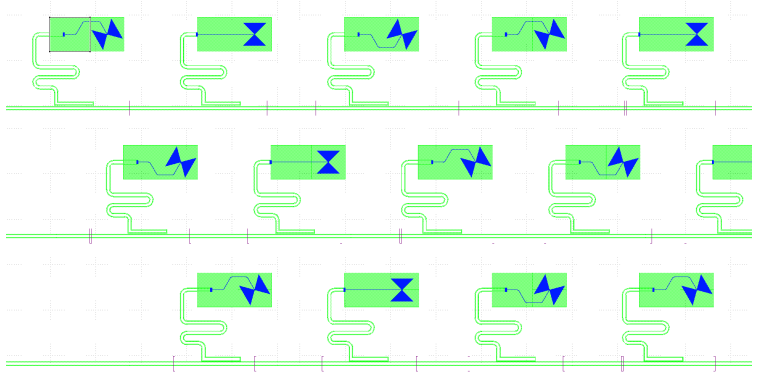


Polarimetric imager



3 type of pixels, each sensitive to 1 angle of polarization

Polarization selectivity achieved by **orientation of MKID antenna**. Pixel type distribution in focal plane can further be adjusted.



4 monochromatic broad-band filters (**R=4**) at **91**, **126**, **172**, and **232** microns.

~2000 pixels and beam sizes near diffraction limit.

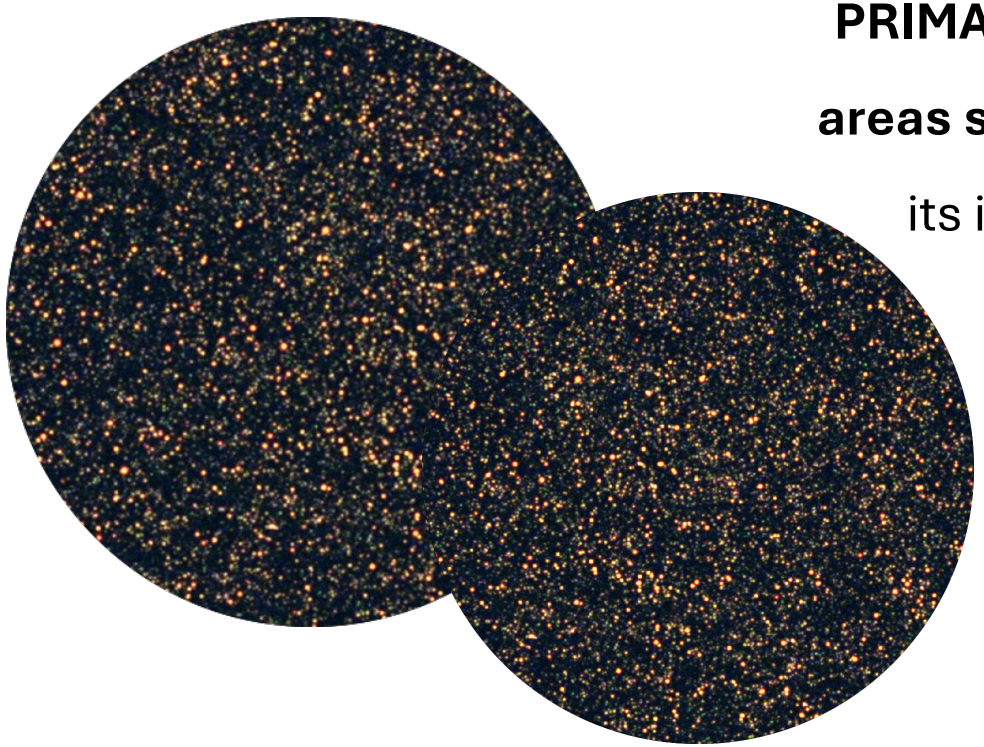
Common **f/9** optical path

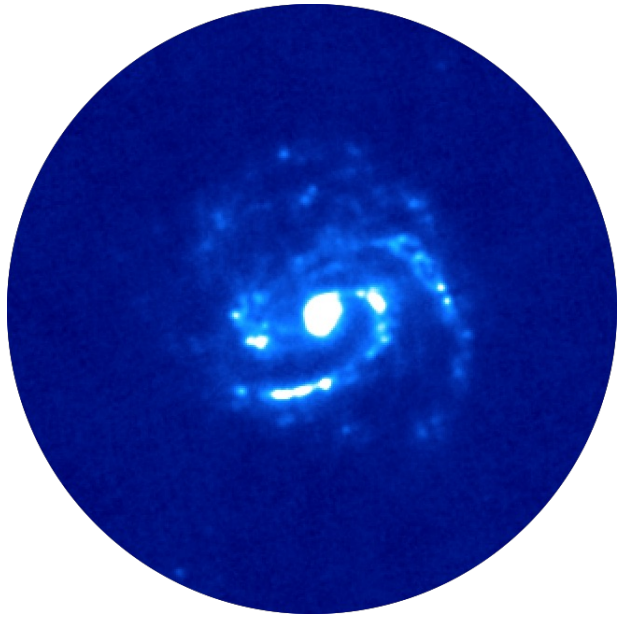
Dowell+24: recovering the Stokes parameters with PRIMAger
https://arxiv.org/pdf/2404.17050

Mapping strategy

No « snap shot » mode

PRIMAger is designed to map **areas significantly larger** than its intrinsic FoV (~4'x4')





Fields **< 42'x24'** : **Beam steering mirror** (agile and allows any kind of **2D** trajectories : **Lissajous, pong-like**)

Fields from **tens of arcmins** to **few degrees** wide:

Scanning with the **spacecraft** (*Herschel* approach with 2 perpendicular "boustrophedon"-like scans)

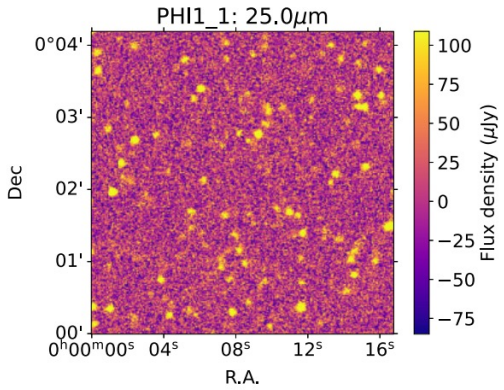
For **large fields**:

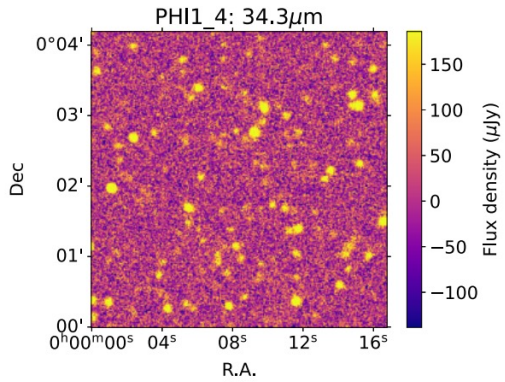
optimized spacecraft + beam steering mirror mapping

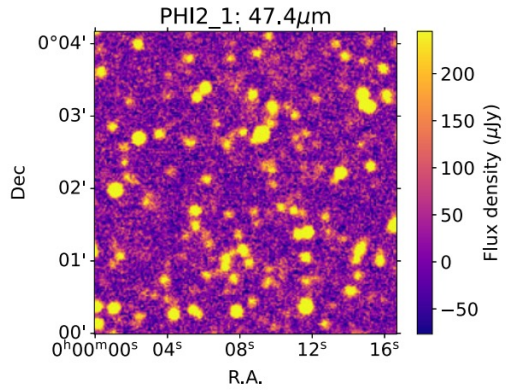
cea M. Sauvage JPL Jet Propulsion Laboratory California Institute of Technology C. D. Dowell

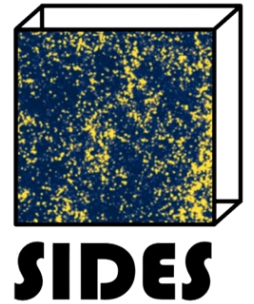
Confusion

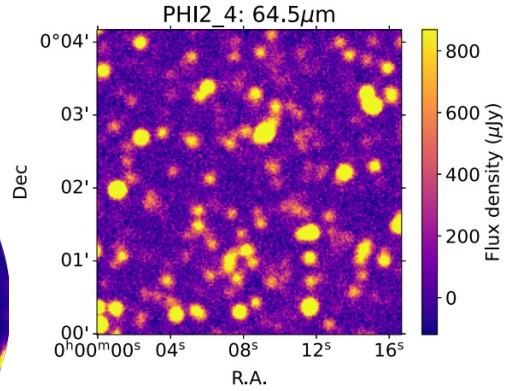
Béthermin+2024
Donnellan+2024

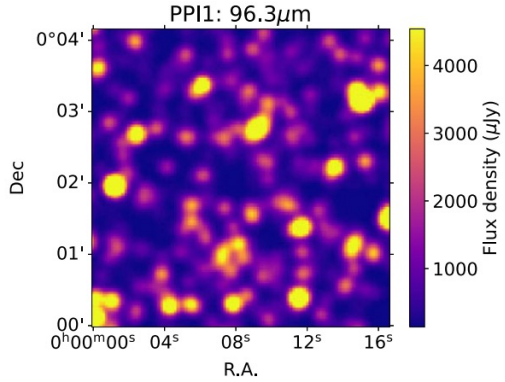


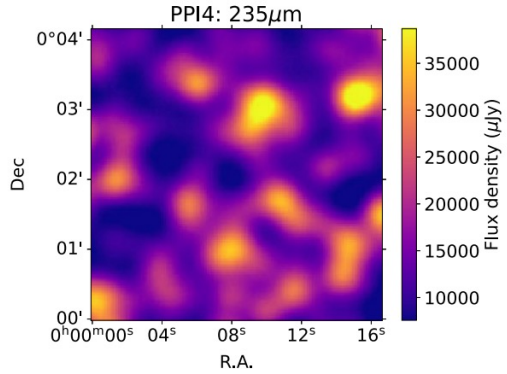




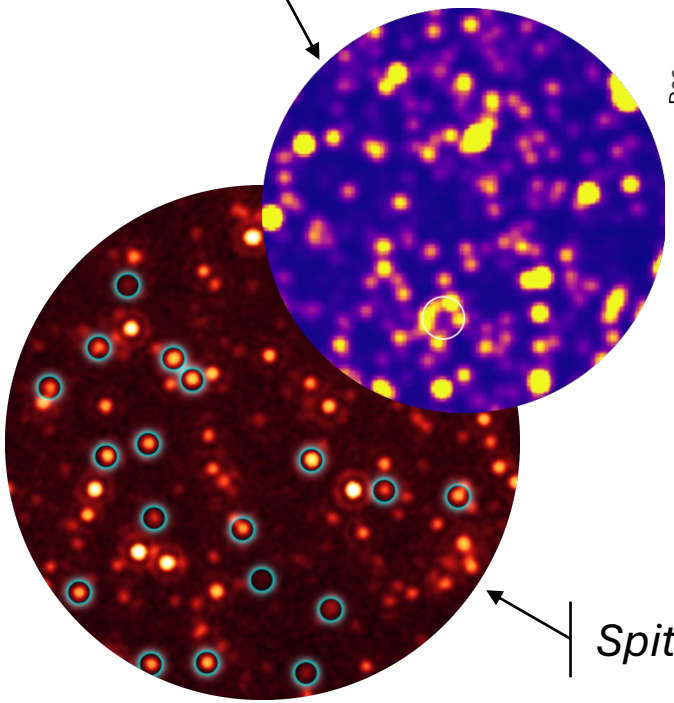








PRIMAger 65 microns



Spitzer 24 microns

PRIMAger will be **able to detect** and measure source **fluxes** well **below** the classical **confusion limit**.

Characteristics and Sensitivities

Table 1 Characteristics of the two PRIMAger focal planes, PHI and PPI.

Parameter	PRIMA Hyperspectral Imager		PRIMA Polarimetry Imager			
	PHI1	PHI2	PPI1	PPI2	PPI3	PPI4
Wavelength coverage (μm)	24-45	45-84	96	126	172	235
Spectral resolving power	10	10	4	4	4	4
Polarimetry	-	-	Yes	Yes	Yes	Yes
Band centre FWHM (”)	4	7	10	13	18	24
Pixel size (”)	4	6	9	13	17	24
Pixel count	63×23	35×14	36×31	24×21	18×16	12×11
Field of view	3.8’×3’	3.8’×3’	5’×4.5’	5’×4.5’	5’×4.5’	5’×4.5’
Focal ratio	F/20	F/20	F/9	F/9	F/9	F/9

Characteristics and Sensitivities

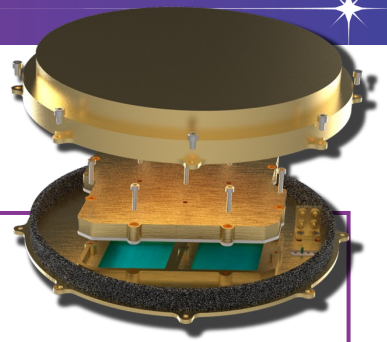
To be used in the JATIS papers

Required sensitivities of PRIMAger in large map mode.

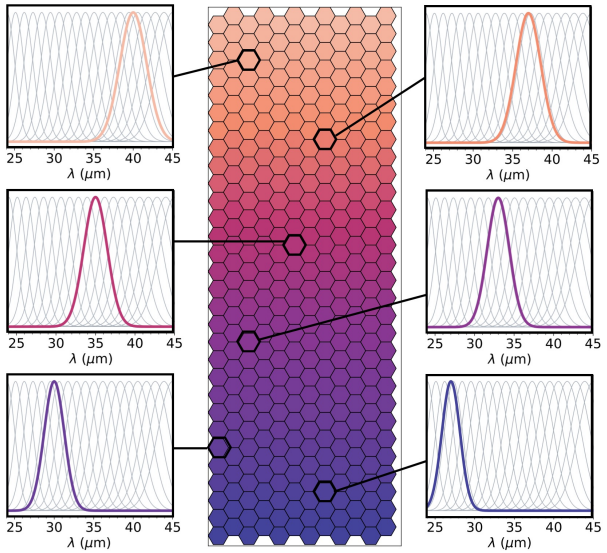
Source type	PRIMA Hyperspectral Imager		PRIMA Polarimetry Imager			
	PHI1 24 – 45	PHI2 45 – 84	PPI1 96	PPI2 126	PPI3 172	PPI4 235
Point Src. (total power, I; mJy)	0.92 –1.56	1.72 – 2.92	1.10	1.44	1.97	2.29
Point Src. (polarized intensity, P; mJy)	–	–	1.55	2.04	2.78	3.80
Surf. bright. (total power, I; MJy/sr)	4.5	2.5	1.58	1.20	0.88	0.65
Surf. bright. (polarized intensity, P; MJy/sr)	–	–	2.23	1.70	1.25	0.91

The numbers correspond to the 5σ background-subtracted flux limit in a 1 square degree map observed for a total duration of 10 h (overheads included). For PHI the sensitivity is estimated for an R=10 filter position at the center of each bands. Polarized intensity P is $\sqrt{Q^2 + U^2}$.

Summary — Thank you!



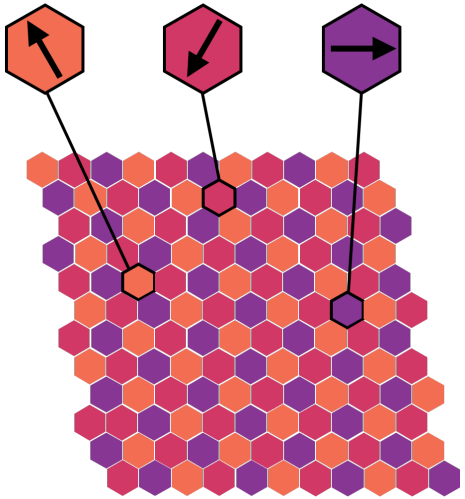
PRIMAger Hyperspectral Imager (PHI)



24-84 microns; 91-232 microns
R=10; R=4

Efficient mapping instrument!

PRIMAger Polarimetric Imager (PPI)



More information:

Polarimetry: Dowell+24 https://arxiv.org/pdf/2404.17050
Surveys with PHI: Bisigello+24 https://arxiv.org/abs/2404.17634
Overcoming confusion: Béthermin+24 https://arxiv.org/pdf/2404.04320
Donnellan+24 https://arxiv.org/pdf/2404.06935