JPCam

The 1.2 Gpix camera for J-PAS

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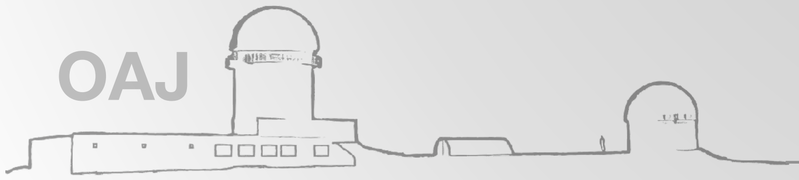

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Plan de Recuperación, Transformación y Resiliencia
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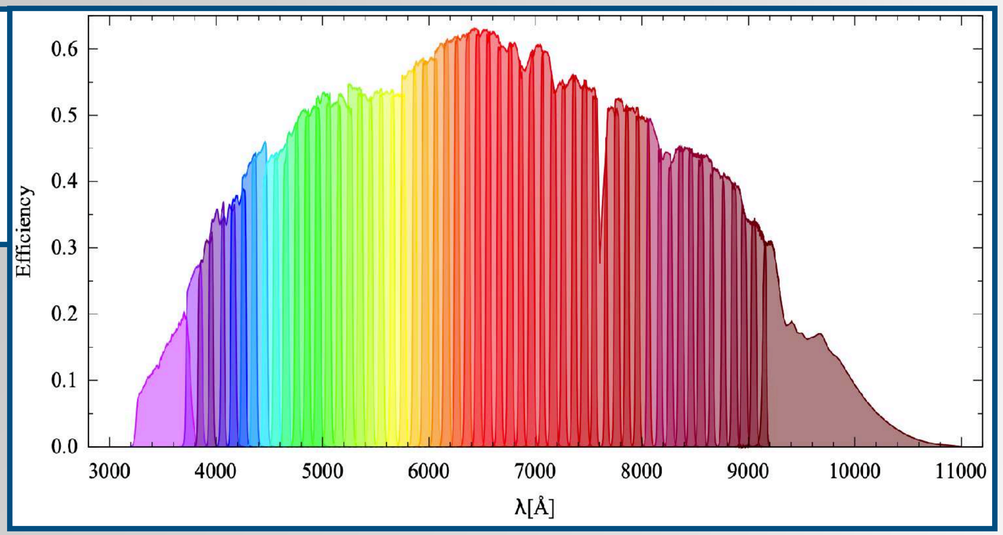
J-PAS

- J-PAS (http://www.j-pas.org) is a narrow-band, very wide field survey designed to produce photometric redshifts with a precision of 0.3% for over 14 million luminous red galaxies in the redshift interval $0.1 < z < 1.2$.
- It will image thousands of deg^2 of Northern Sky with 54 contiguous, narrow-band filters plus 3 medium- and broad-band filters.
- m_{AB} (5σ in 3") = 21.3-22.4 (with the narrow-bands).

Legacy data set:
J-PAS will provide low resolution spectroscopy ($R \sim 50$) for every observed pixel over thousands of deg^2 of the sky.



- *BAOs*
- *2D stellar populations*
- *2D star formation rate*
- *Environment*
- *High redshift galaxies.*
- *Morphological studies.*
- *Mergers and interacting galaxies.*
- *AGN and QSO at low and high redshift.*
- *Galaxies in clusters and groups.*
- *PN2 and MW halo stars.*
- *Minor bodies as moving objects.*
- *...*

To carry out the J-PAS survey, it is required:

- Large *etendue* (2.5m diameter telescope + large field of view)
- Good image quality (good site and seeing limited telescope and instrument)
- Large number of optical filters (the J-PAS filter system)

Observatorio Astrofísico de Javalambre

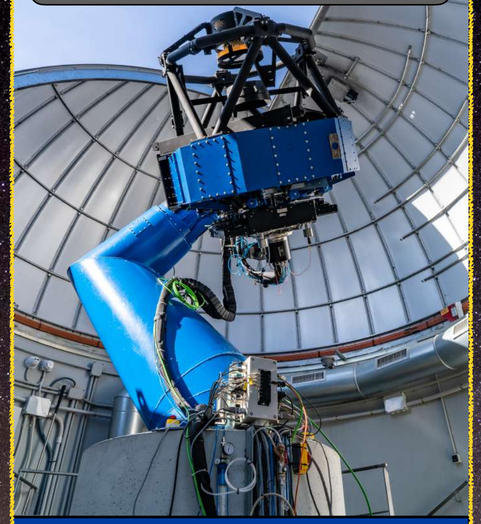
The OAJ is conceived to carry out large astronomical surveys, starting with the **J-PAS** and **J-PLUS**. To this purpose, the OAJ has two unique telescopes and instrumentation of unusually large FoV and a data center.

Located in Javalambre mountain (Teruel, Spain). 1957 m above sea level.

J-PLUS

J-VAR

+ open time (LS)

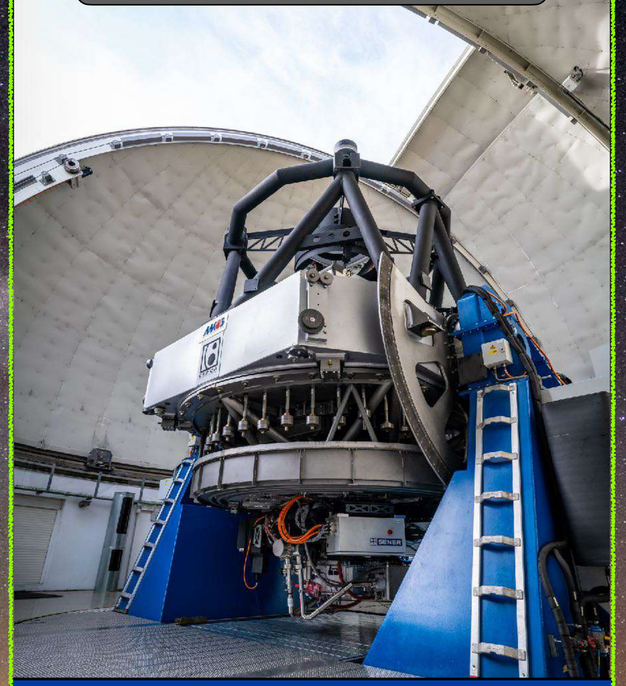


JAST80

Ritchey-Chrétien plus Field Corrector
Diameter = 83 cm
FoV = 2 deg ø
F/4,5
M2 hexapod

J-PAS
Javalambre Physics of the Accelerating Universe Astrophysical Survey

+ open time (2025)

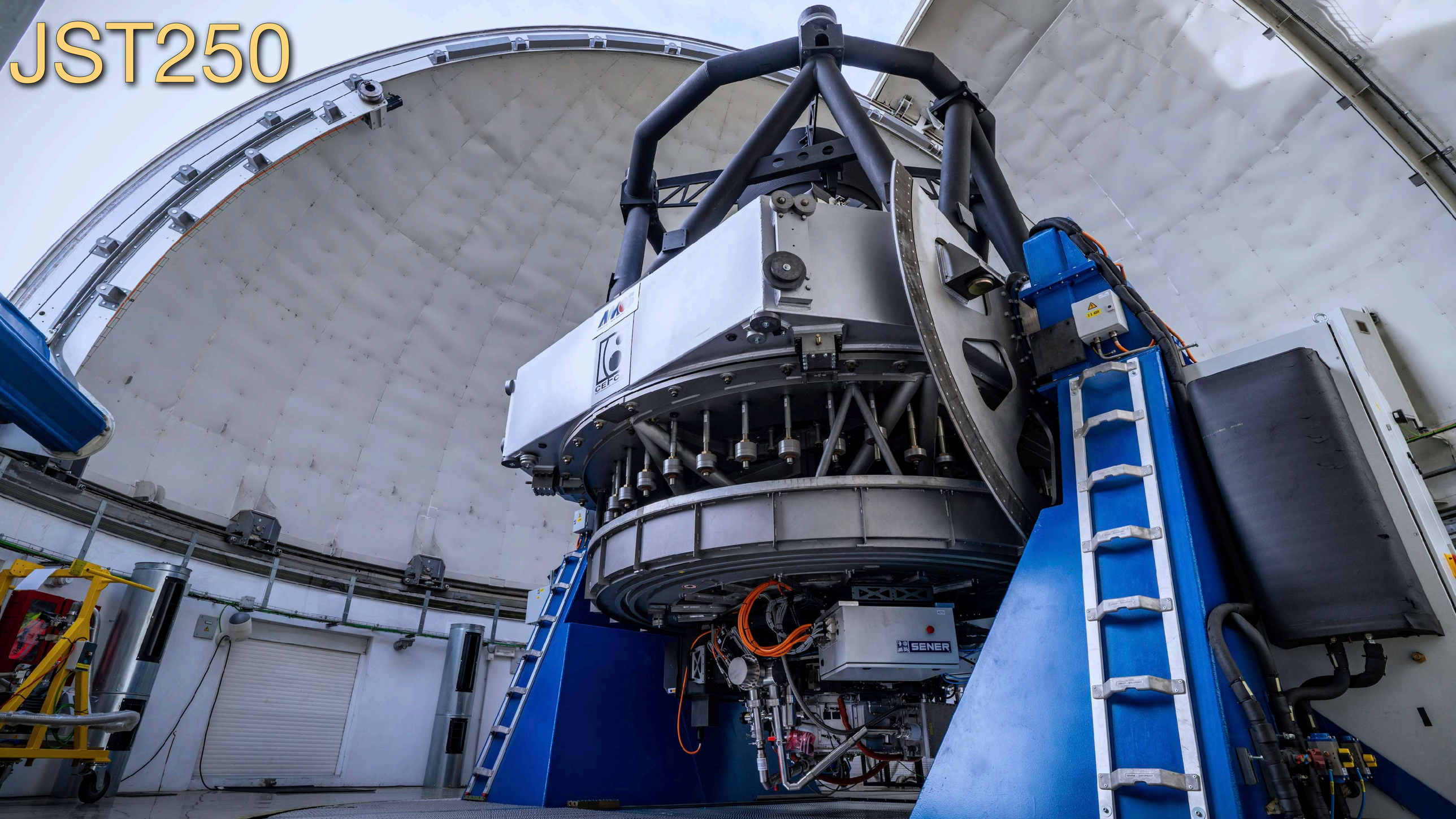


JST250

Ritchey-Chrétien plus Field Corrector
Diameter = 2,55 m
FoV = 3 deg ø
F/3,5
M2 hexapod

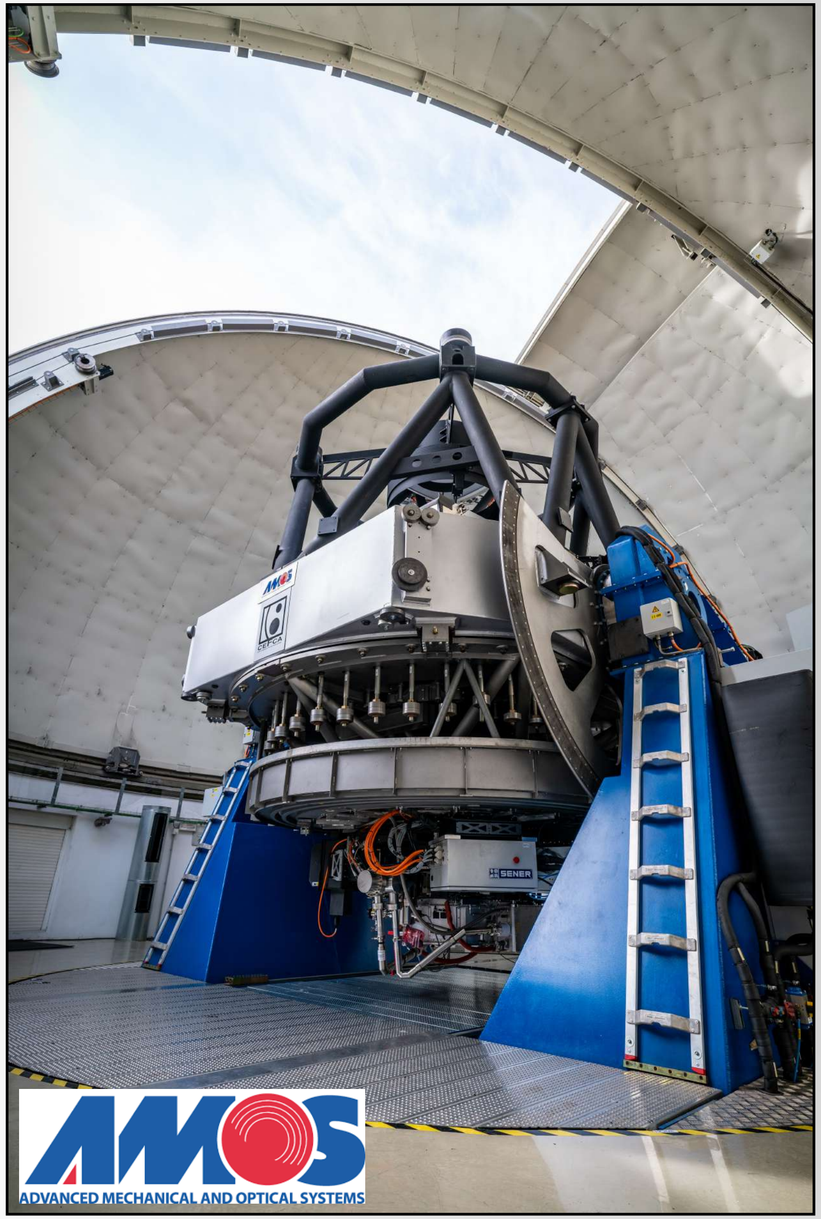
UPAD

- Main **storage**: 1.1 PB of disk storage + 4 PB in a robotic tape library
- Data **processing**: 21 nodes with more that 450 cores
- External **Data Access** System: Redundant web-servers (> 30 TB of storage)


JST250
CEFCA
SENER

Javalambre Survey Telescope — **JST250**

Outstanding Facility (OAJ-OF-1)



J-PAS

Javalambre Physics of the Accelerating Universe Astrophysical Survey

+ MOUs with:

- eROSITA-DE
- JWST-PEARLS (Prime Extragalactic Areas for Reionization and Lensing Science)
- WEAVE-QSO
- EUCLID

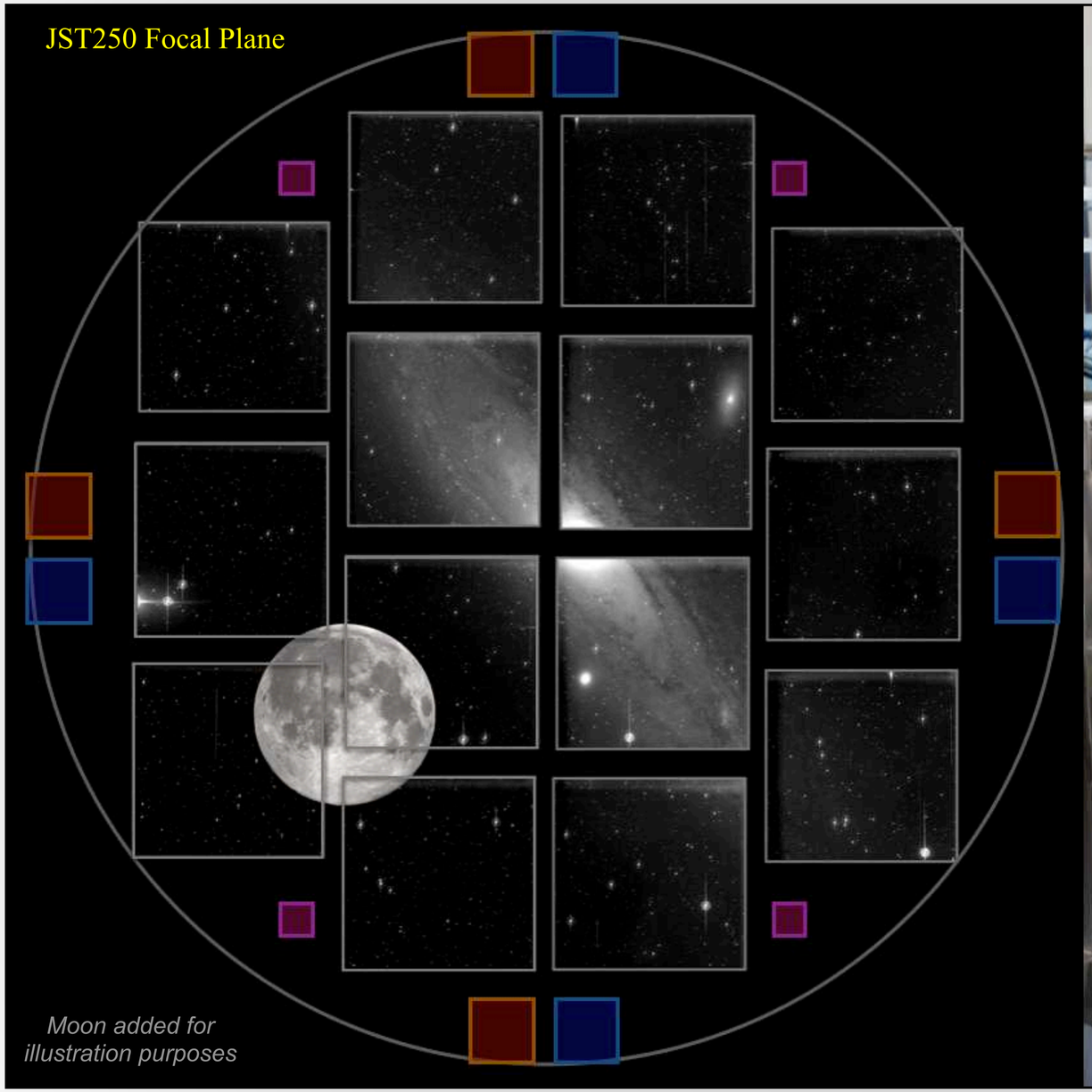
+ open time

2025: Shared-Risk Programs + DDTs

2026: Legacy Surveys

JST250	
Optical configuratio	Ritchey Chrétien like, equipped with a field corrector
M1 diameter	2.55 m
M2 diameter	1.18 m, with an hexapod system
Field Corrector	3 aspherical lenses
FoV diameter	3 deg (476 mm physical size)
Effective collecting	3.75 m^2
Etendue	26.5 $m^2 deg^2$
EE50 (radius)	<4.75 microns (polychromatic) over the whole FoV
Focal length	9098 mm
Plate scale	22.67 arcsec/mm
Mount	Altazimuthal
Focus	Cassegrain

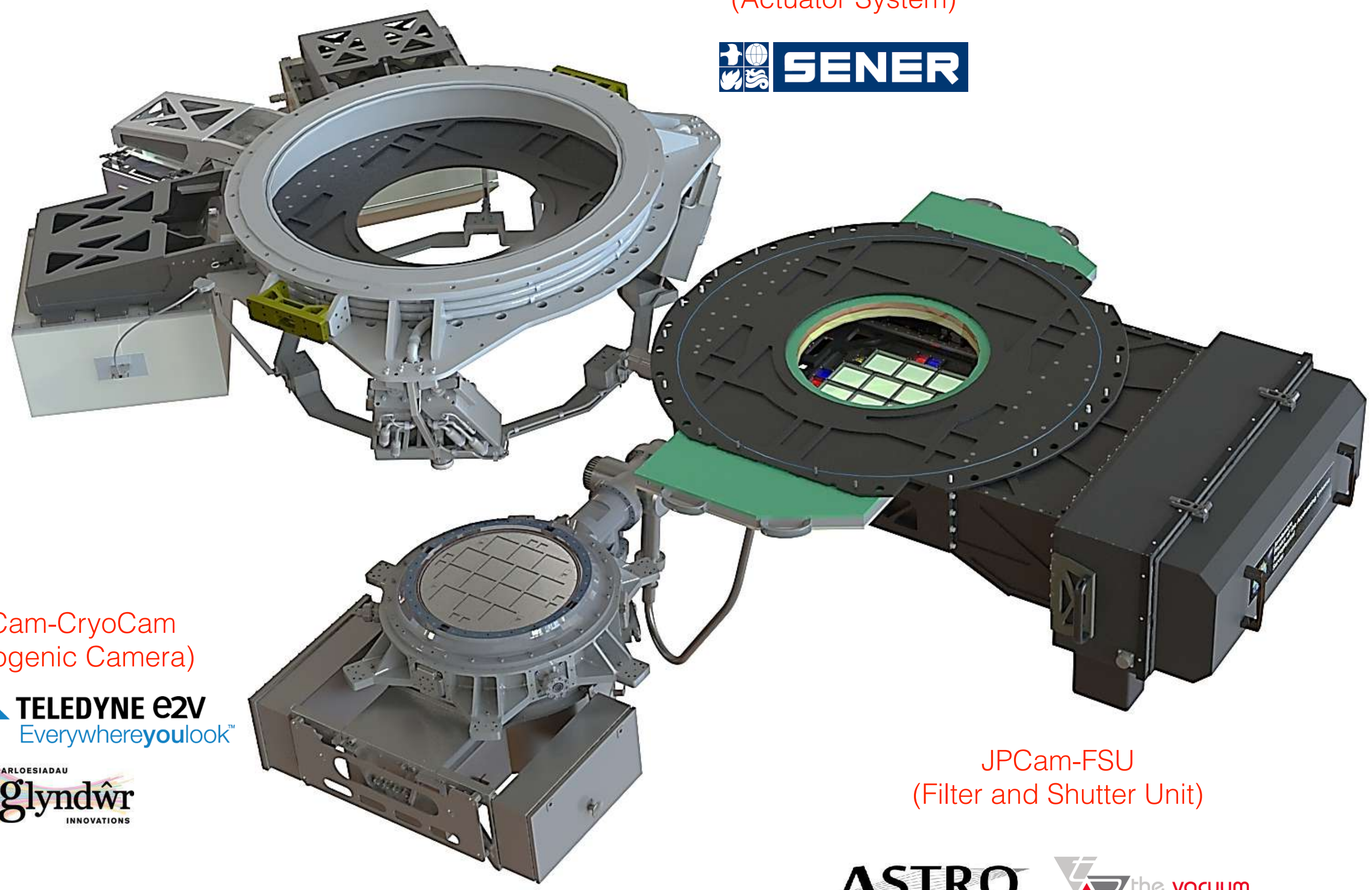
Javalambre Panoramic Camera — **JPCam**



Javalambre Panoramic Camera — **JPCam**

JPCam-AS
(Actuator System)

SENER



JPCam-CryoCam
(Cryogenic Camera)

TELEDYNE e2v
Everywhereyoulook™

ARLOESIADAU glyndŵr INNOVATIONS

JPCam-FSU
(Filter and Shutter Unit)

ASTRO Electro-Mechanical Engineering, LLC

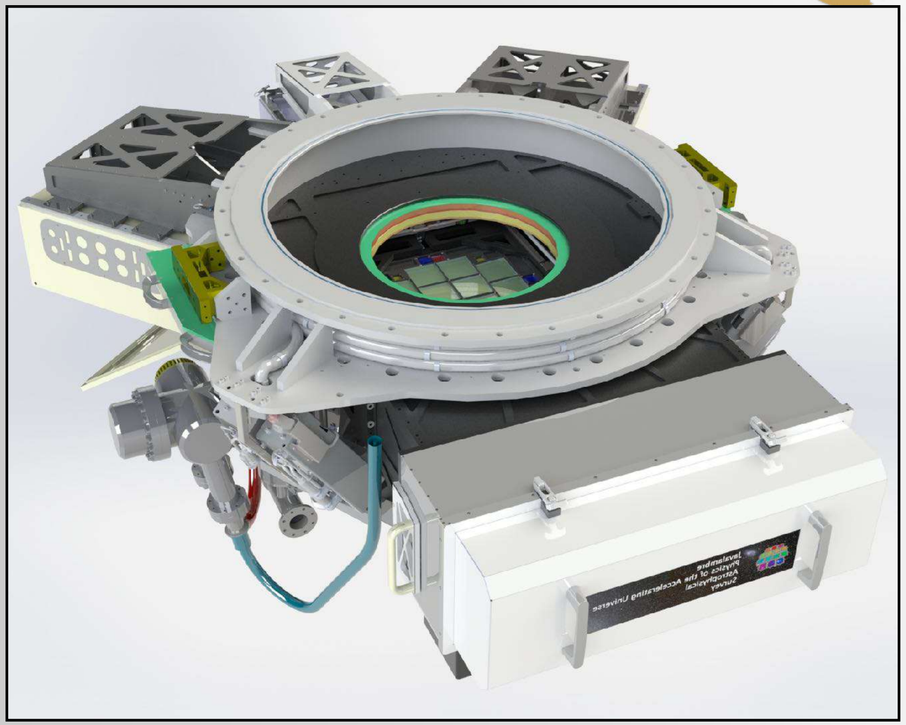
the vacuum projects

B Bonn S Shutter

JAGUAR PRECISION MACHINE

eTe Tecnologias Industriais

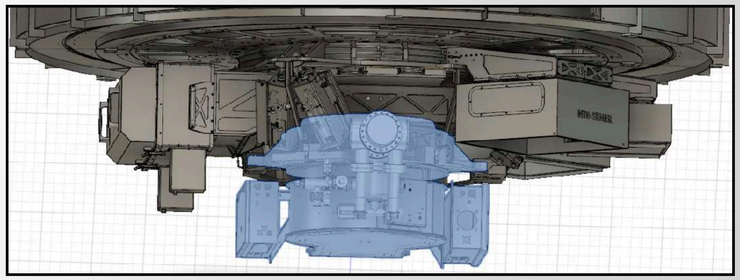
SCHOTT



CCD format	$14 \times 9216 \times 9232$ pix, $10\,\mu$m pix^{-1} 1.2 Gpix camera
Pixel scale	$0.2265''$ pix^{-1}
Unvignetted FoV	3.4deg^2 – (14×) 0.48deg × 0.51deg
Read out time (633kHz)	10.9 s (full frame) – 6.1 s (2x2 binning)
Read out noise (633kHz)	5.5 e$^-$ (RMS)
Read out time (400kHz)	16.4 s (full frame) – 8.9 s (2x2 binning)
Read out noise (400kHz)	4.3 e$^-$ (RMS)
Gain	2.274 $e^- ADU^{-1}$
Minimum exposure time	0.1 s
Exposure homogeneity	1 ms
Full well	> 125 000 e$^-$
Dark current	0.001 e$^-$ pix^{-1} s^{-1}

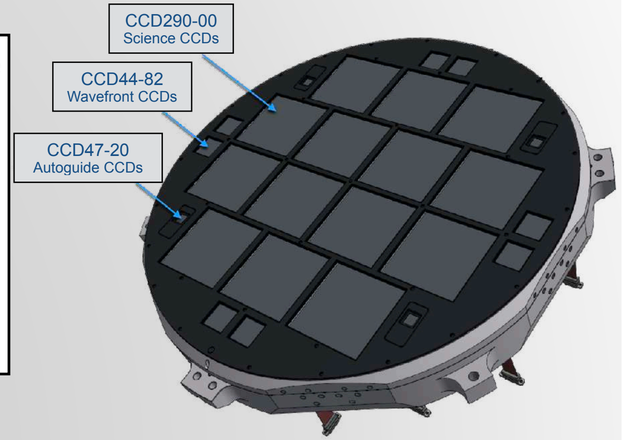
Javalambre Panoramic Camera — **JPCam**

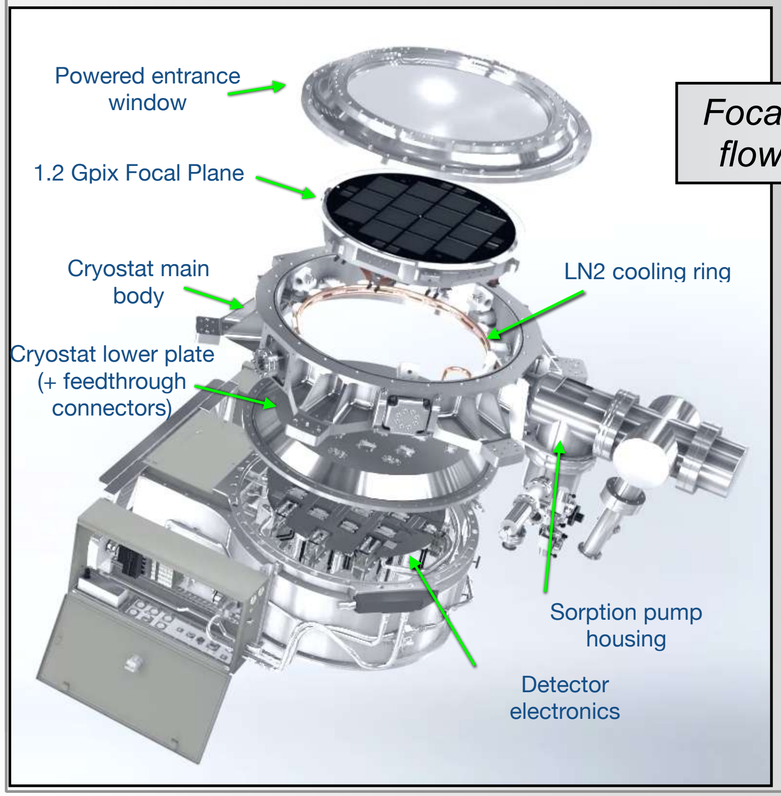
JPCam Cryogenic Camera subsystem



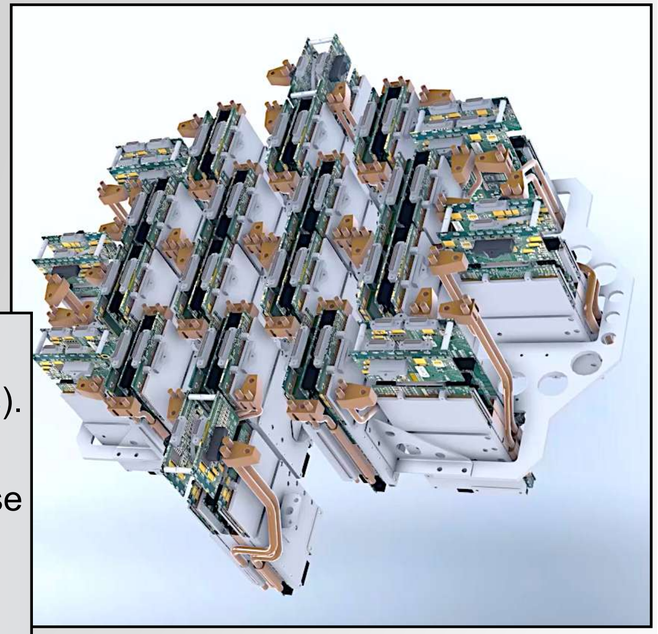
1.2 Gpix focal plane mosaic composed by a total of 26 CCDs of three different types:

- **14 × CCD290–99** (Science CCDs). 9.216 x 9.232, 10μm pixel, non-inverted, full frame, deep depletion, astro multi-2 CCDs.
- **8 × CCD44–82** (Wavefront Sensors). 2048 X 2048 Frame-transfer.
- **4 × CCD47–20** (Autoguide CCDs). 1024 X 1024 Frame-transfer.





Focal Plane Array inside a continuous flow cryostat. LN2 cooled at -110ºC.

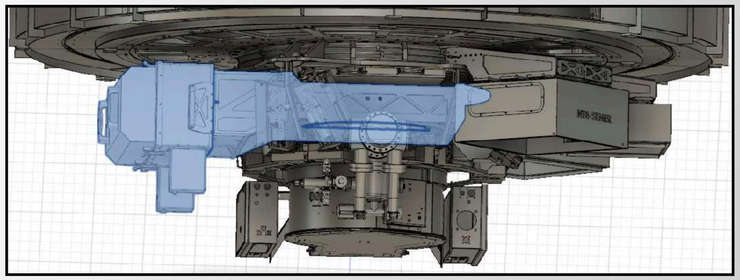


Includes **detector electronics** to control all CCDs:

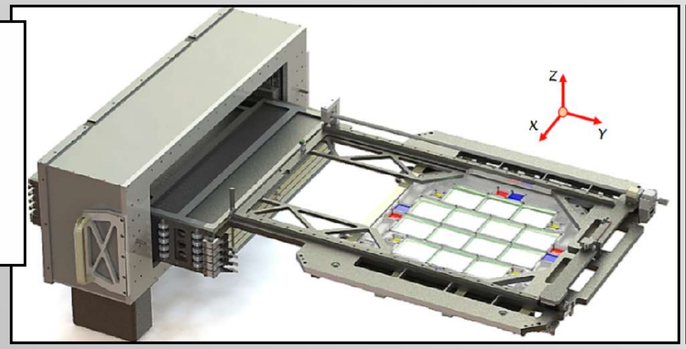
- 22 CCD drive modules + interface module (more than 70 PCBs). Glycol water cooling system.
- Power and data handling electronics (224-channel low noise electronics)
- Over 50 FPGAs to handle the 2.4 GBytes of data per frame
- Digital CDS (Correlated Double Sampling) readout

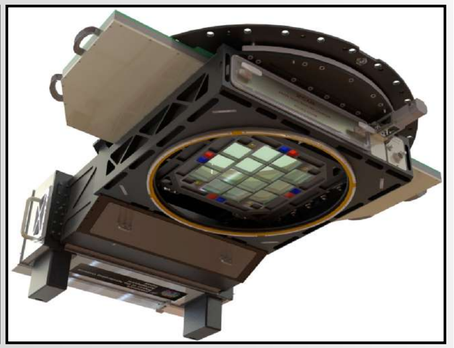
Javalambre Panoramic Camera — **JPCam**

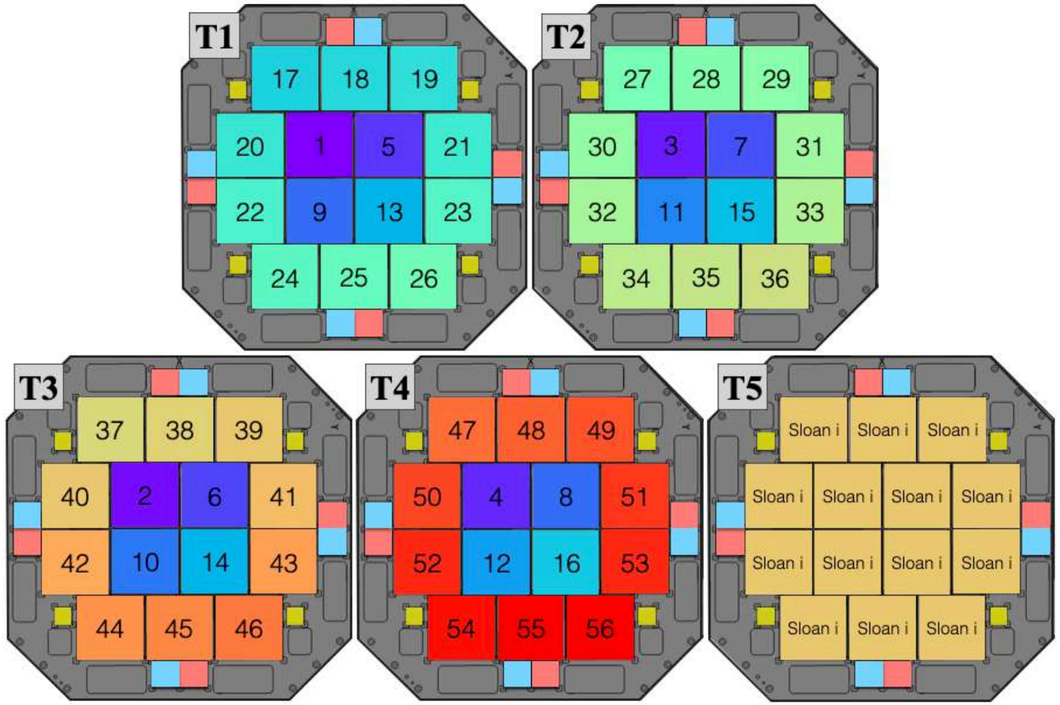
Filter and Shutter Unit



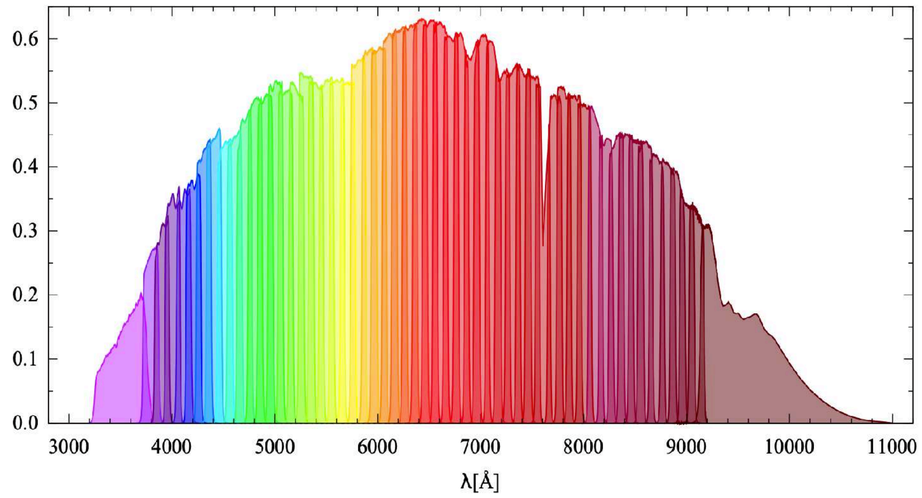
- *Sealed to maintain a GN2 atm.*
- *“Two-curtain” 515mm shutter*
- *Admit 5 filter tray assemblies*
- *Filter tray change in <40s.*







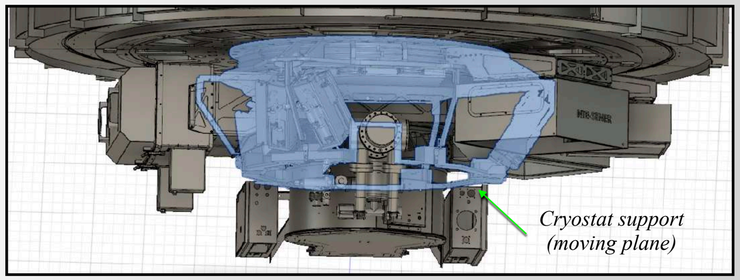
# Filter	CW (nm)	FWHM (nm)
1	348,5	49.5
2	378,5	15.5
3	390,0	14.5
4	400,0	14.5
5	410,0	14.5
...	...	...
54	900,0	14.5
55	910,0	14.5
56	1007,5	188.8



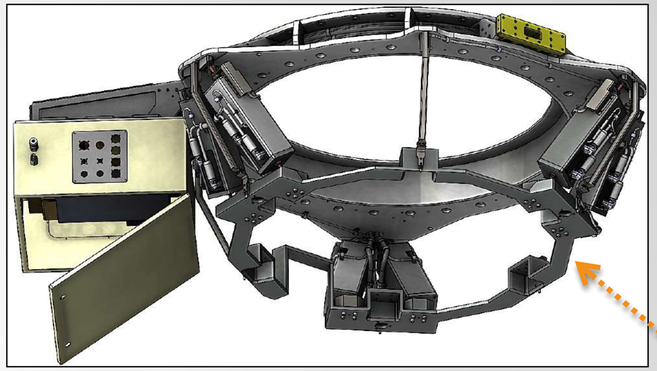
J-PAS
Javalambre Physics of the Accelerating Universe Astrophysical Survey

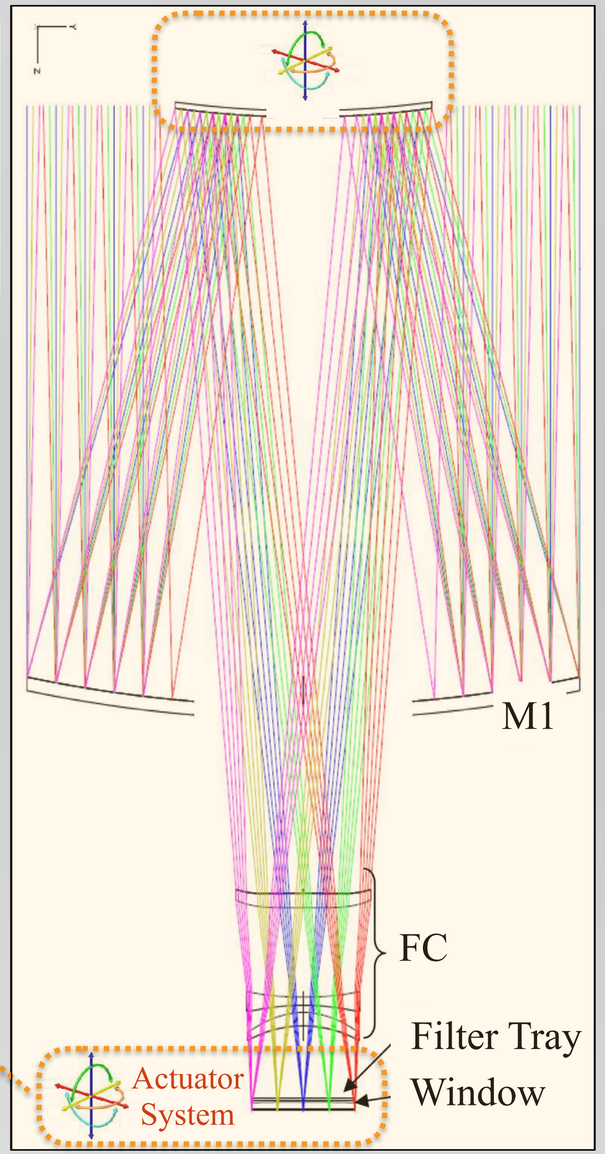
Javalambre Panoramic Camera — **JPCam**

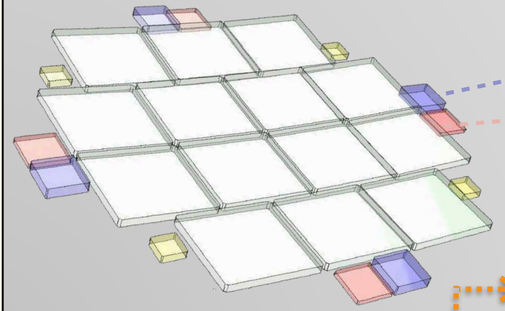
Actuator system and IQ control system

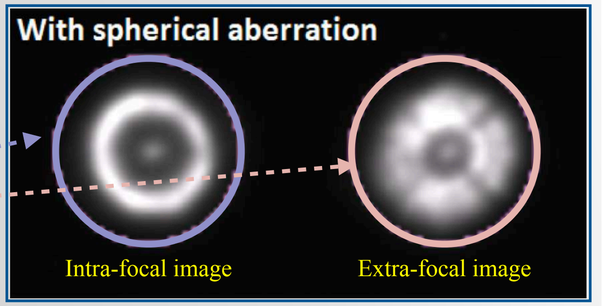


CryoCam weight	580 kg
Relative focus accuracy	±4 µm
Relative tilt accuracy	±1 arcsec
Response time	<3 s



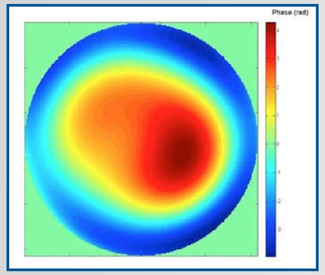






2 Compute Zernike polynoms

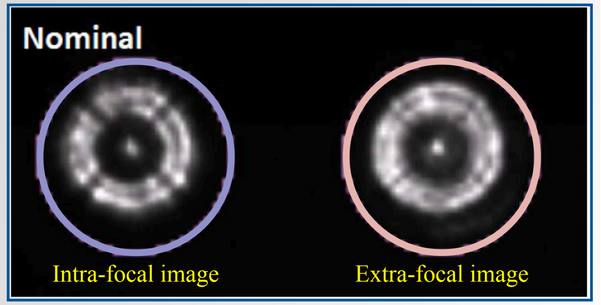
3



WF reconstruction

4 Apply M2 hexapod + Actuator System motions

5



Javalambre Panoramic Camera — **JPCam**

GOAL LA2.A1: The aim is to boost the completion of the JPCam, the 1.2Gpix panoramic camera integrated on the JST250 telescope at the ICTS Observatorio Astrofísico de Javalambre (OAJ) and start scientific operation ➔ The J-PAS Survey.

H2.1.1 – Completion of JPCam commissioning ➔ Milestone achieved in Nov. 2023 ✓

H2.1.2 – Specialized technological assistance contract ✓

To optimize JPCam performances: 2 year specialized technological assistance with the cryogenic camera manufacturer.

Contract's signature: 01/04/2023 — End of service: ~~31/3/2025~~ 31/9/2025

H2.1.3 – Acquisition of a set of auxiliary systems and equipment for JPCam and JST250 ✓

To maximize efficiency and availability during scientific operation: acquisition of a set of auxiliary systems and equipment for the operation of JPCam

Contract's signature: 28/12/2022 — End of supply: 30/8/2024

+ electronics engineer

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Plan de Recuperación, Transformación y Resiliencia
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LIQUID NITROGEN

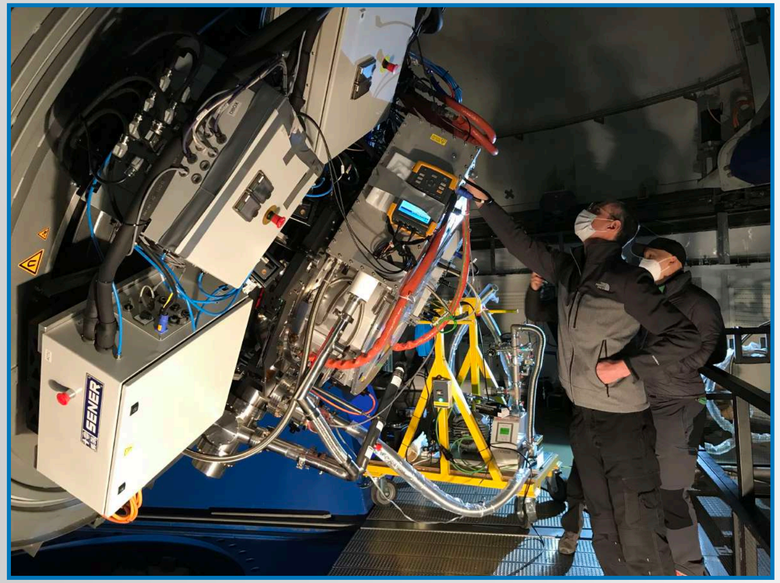
JPCam commissioning results

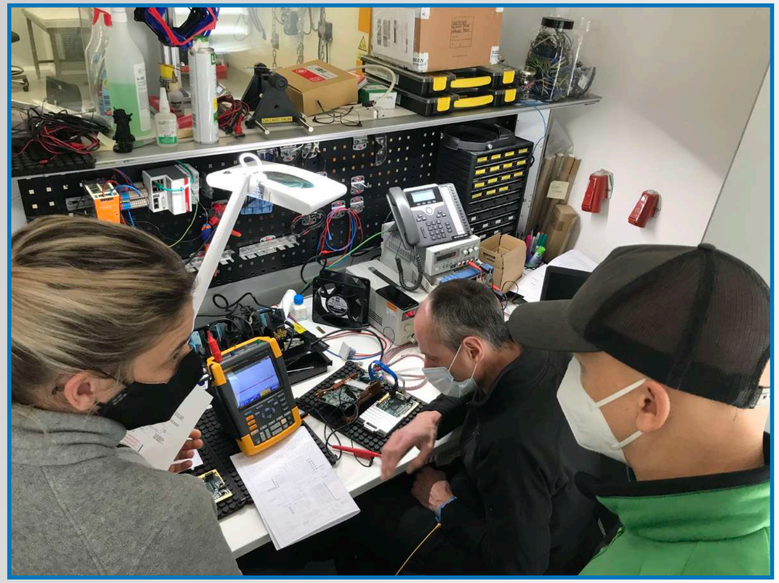
Complex JPCam electronics has represented the **most important commissioning challenge**.

Four Science Drive Modules and the Interface Module have developed faults during first operation.

The root cause of these failures has been identified and a modification to the electronics has been implemented to prevent further failures.

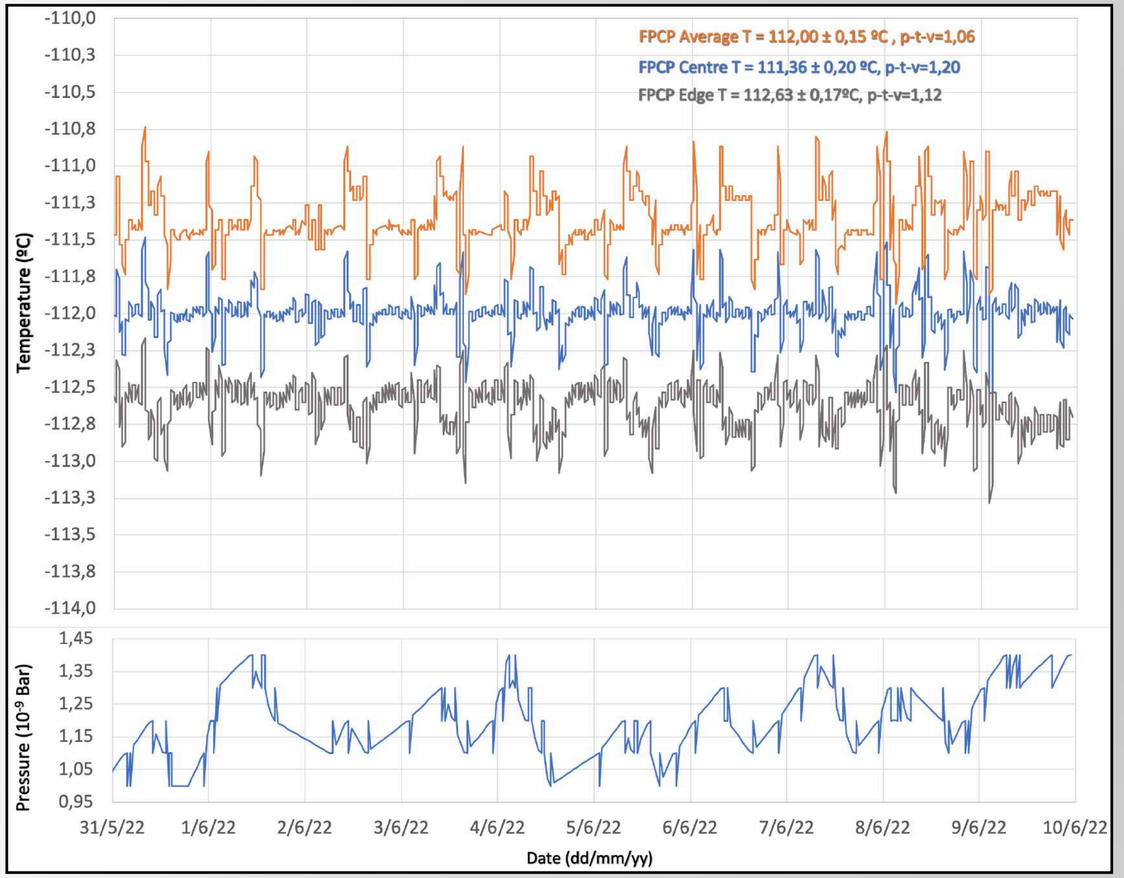
Part of the commissioning performed with a reduced number of CCDs





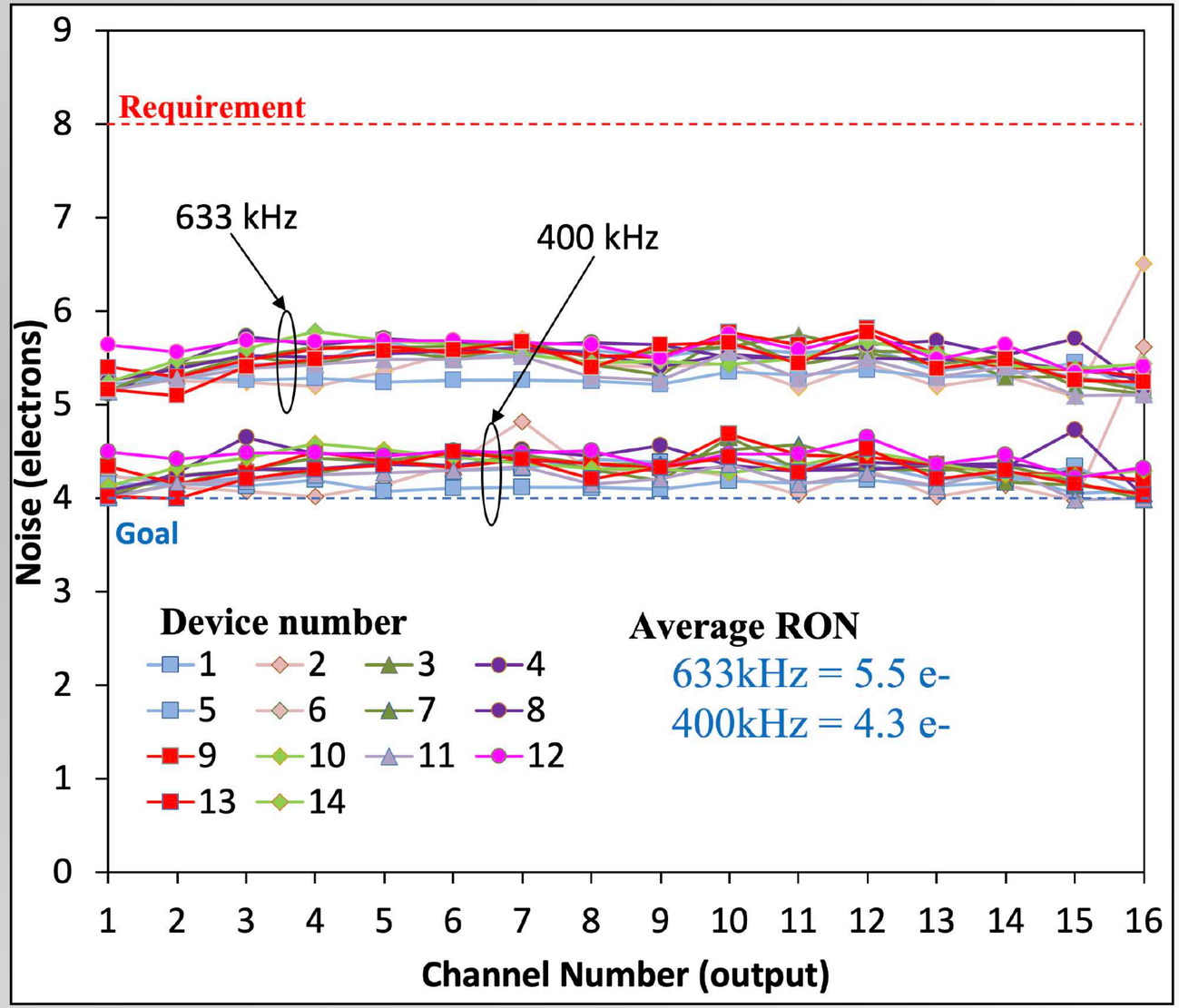
JPCam commissioning results

Cryogenic stability



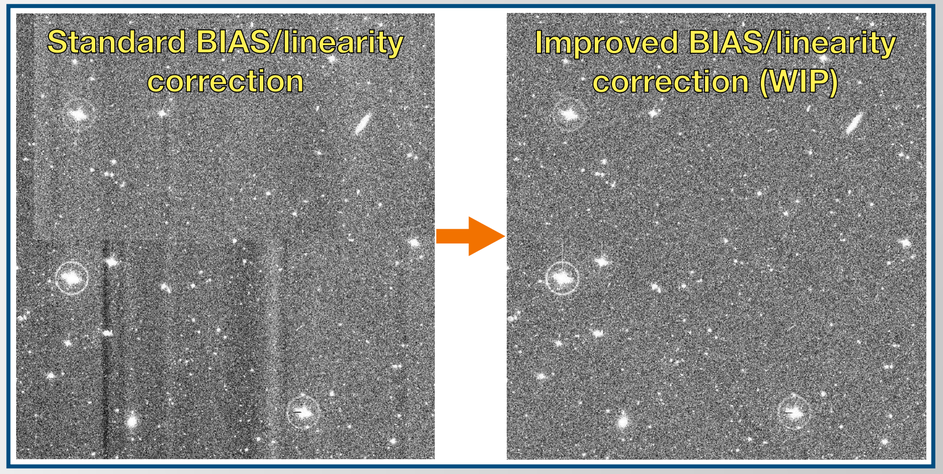
- Temperature set value: -112.00ºC
- Center-to-border variation: 1.27ºC
- T stability over long periods of time: 1.06ºC p-t-v.
- Chamber pressure is maintained at (1.20±0.10)*10^{-9} Bar

Read-out noise

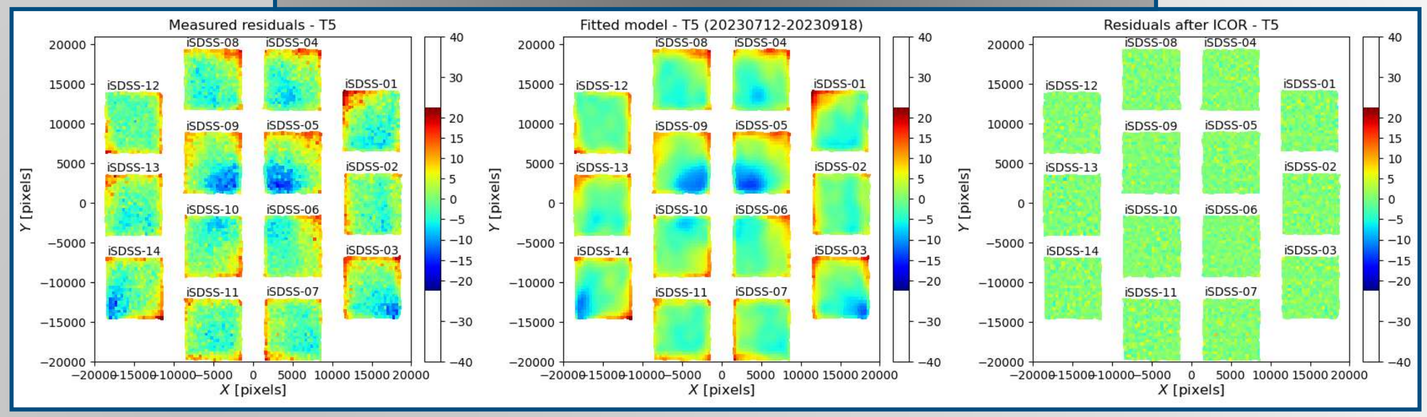


JPCam commissioning results

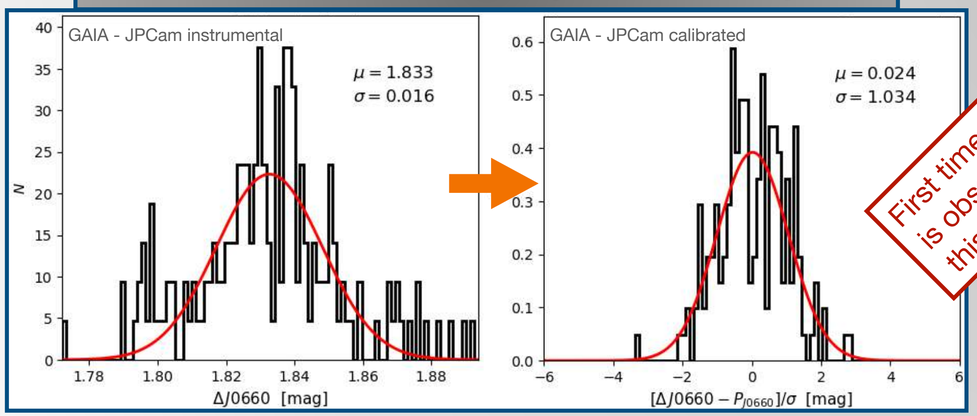
UPAD is developing special routines to optimize the pipeline to JPCam systematics, maximizing the scientific quality of delivered data.



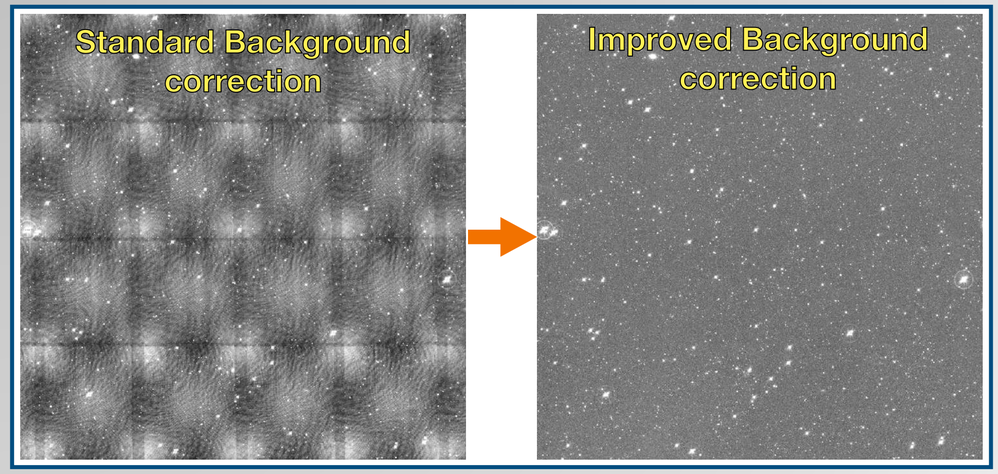
Illumination correction



Photometric calibration (based on GAIA)



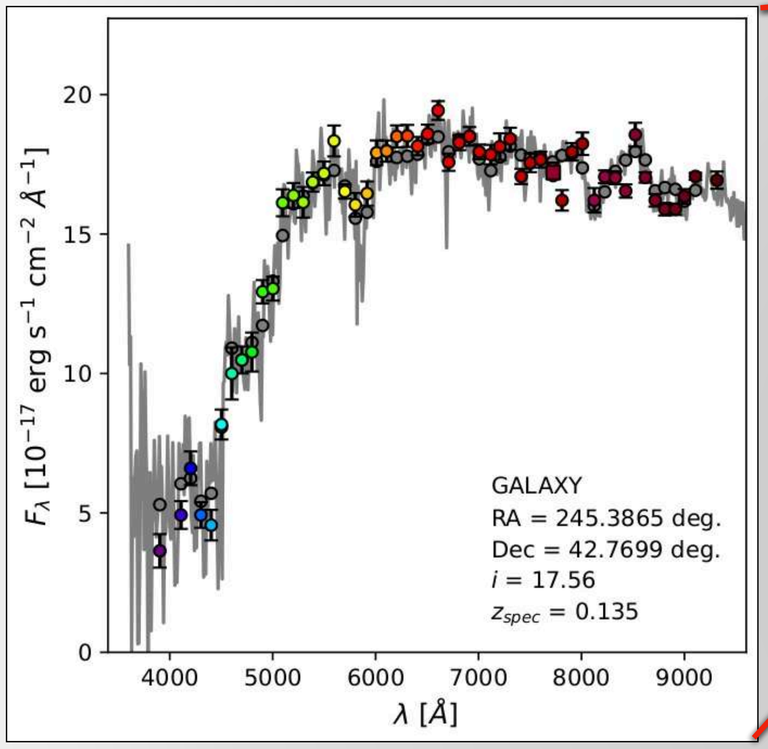
First time the sky is observed with this set of filters

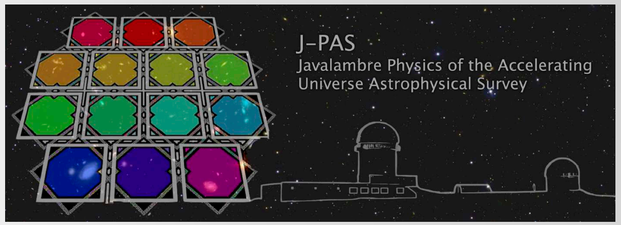


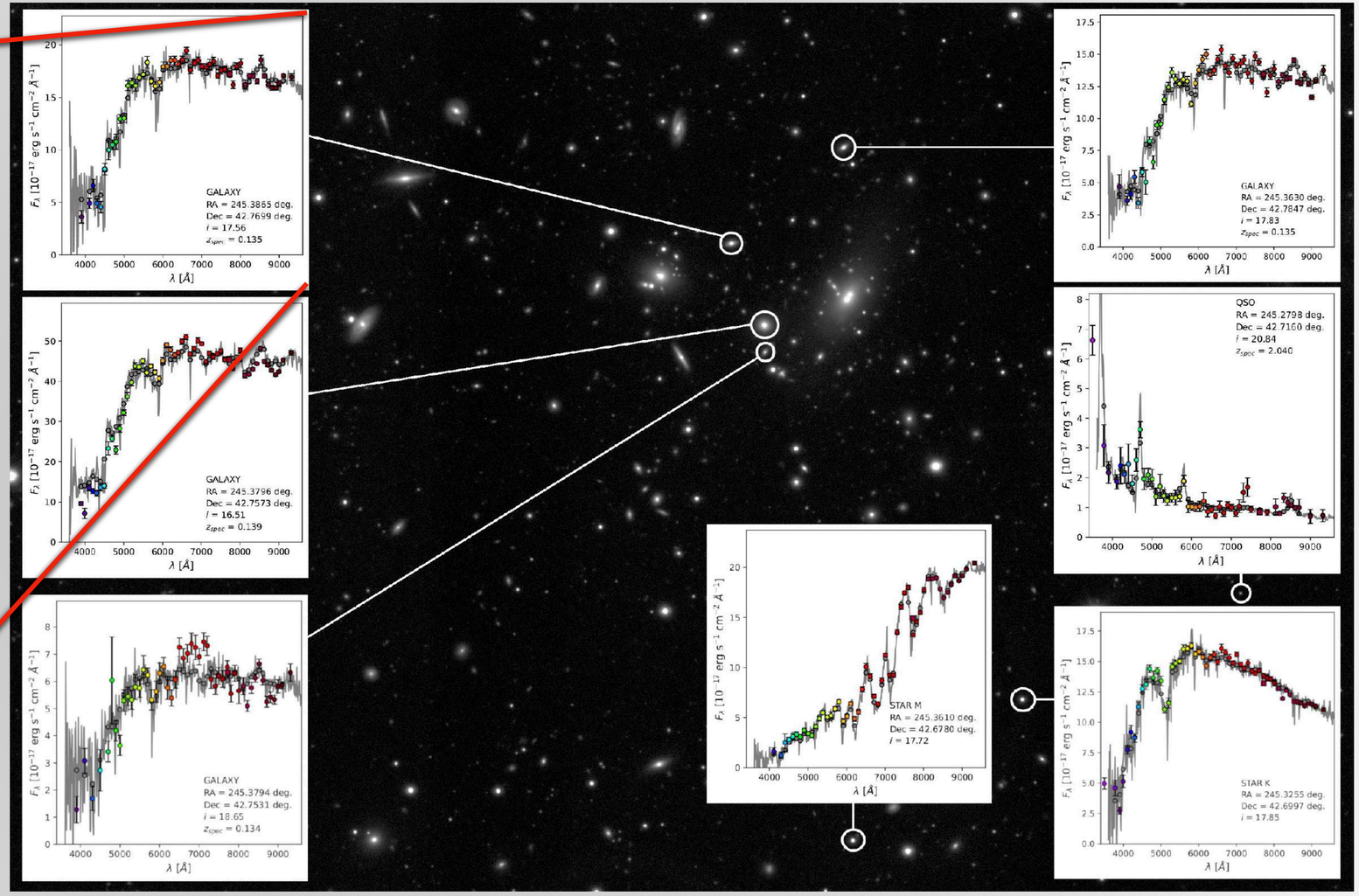
Photometric error: *2 mmag precision at λ > 400 nm, 4 mmag for bluer passbands*

Photo-z precision: *σ = 0.003 after a quality cut in the probability distribution function of the redshift. This selected 39% of the galaxies (LRGs).*

JPCam commissioning completed in 2023 ⇒ J-PAS started!







Data releases:

Previous DRs - Pathfinder instrument:

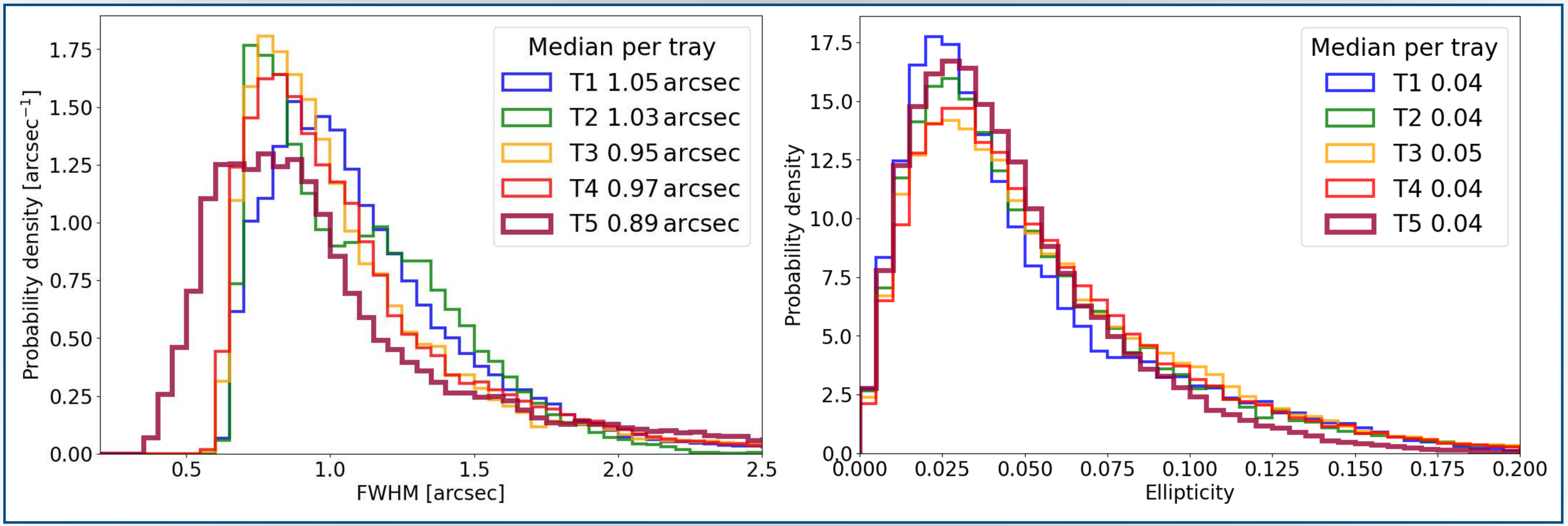
- miniJ-PAS (**public**) — Dec'19
- J-NEP (internal)— Jul'21
- J-NEP (**public**) — Jul'24

J-PAS DRs - JPCam

- JPSV (internal) — Oct'23
- IDR1 (internal) — Jun'24
- EDR1 (**public**) — Nov'24.

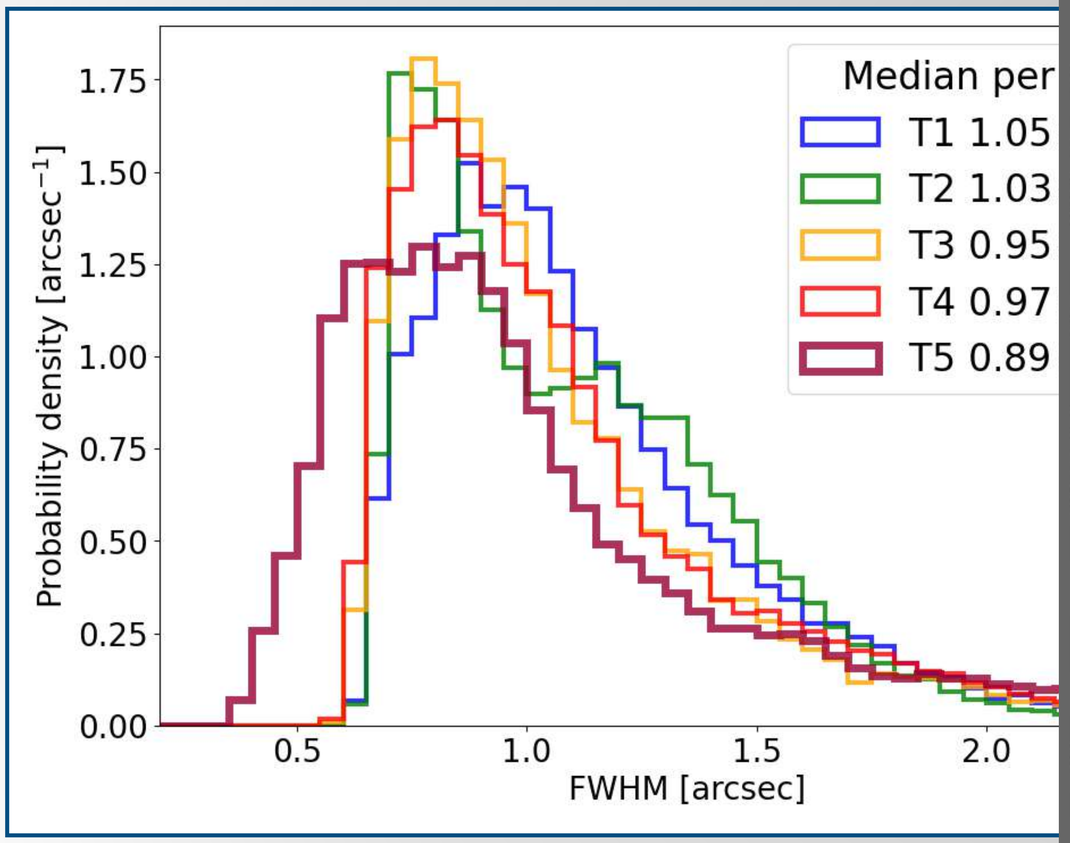
JPCam commissioning completed in 2023 ⇒ J-PAS started!

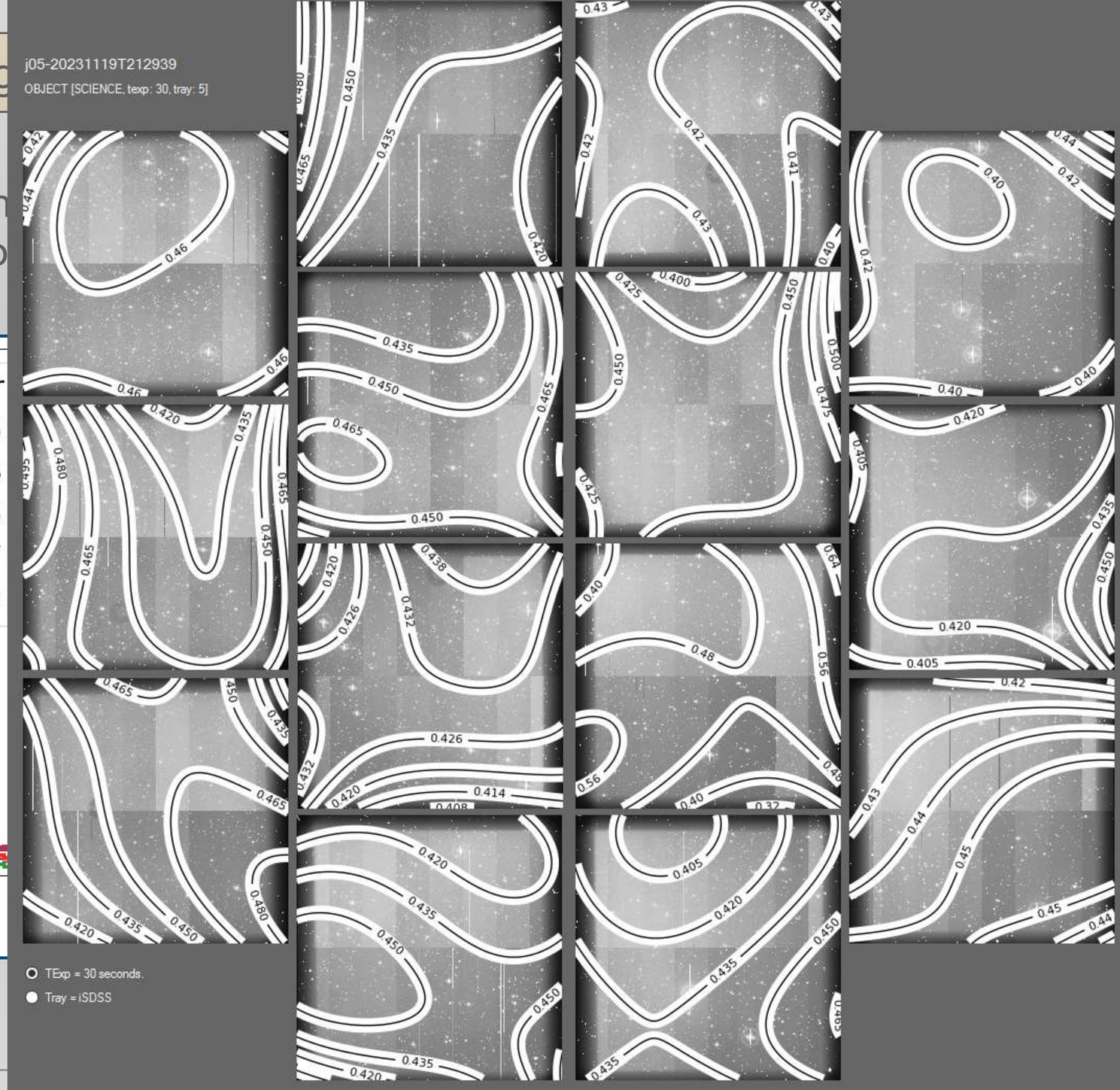
JPCam image quality. Statistics of the measured FWHM and ellipticity of the PSF for each of the five J-PAS filter trays. Observations gathered after ~1 year of scientific operation.



JPCam commissioning

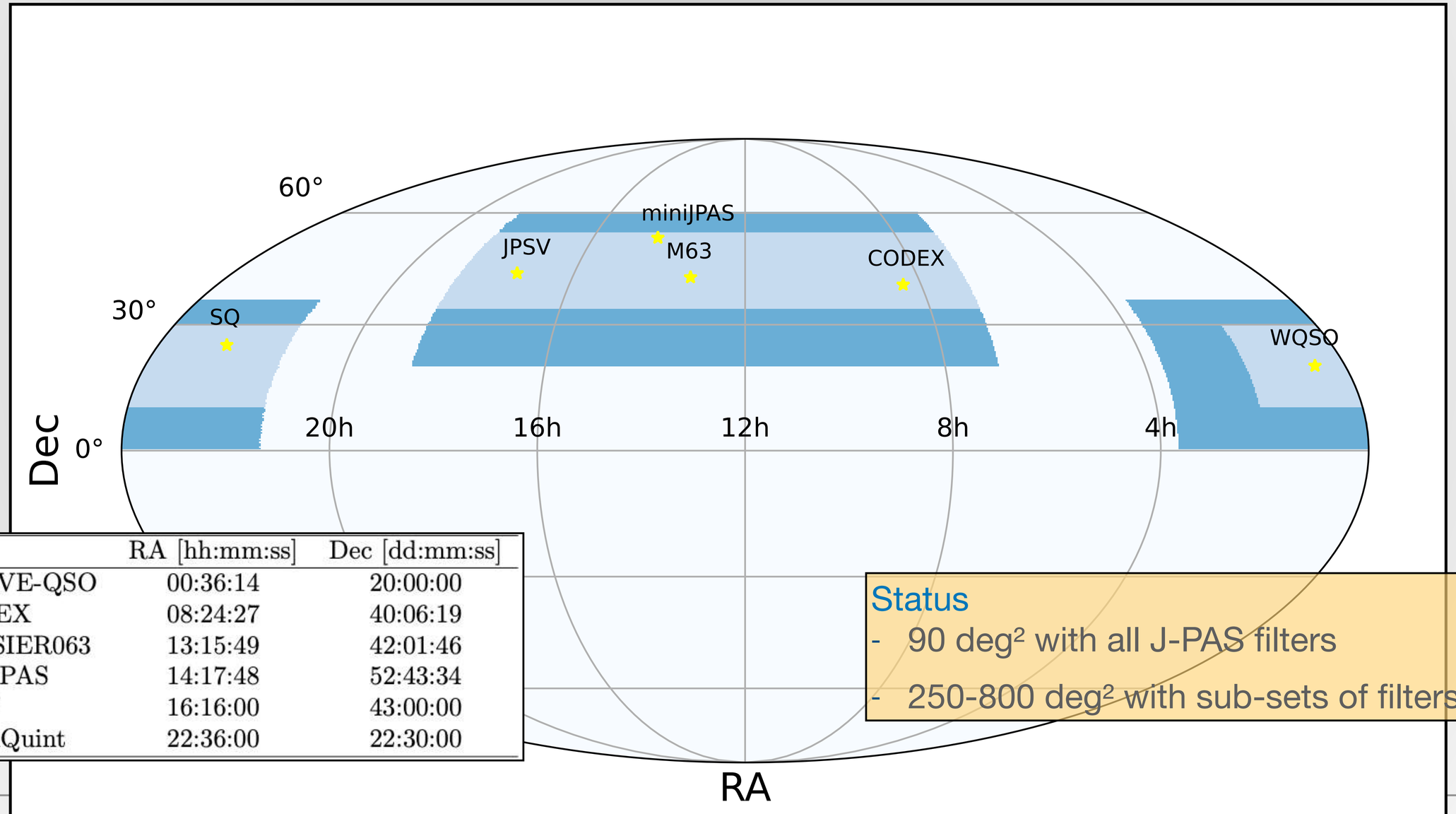
JPCam image quality. Statistics of th
the five J-PAS filter trays. Observatio





JPCam commissioning completed in 2023 ⇒ J-PAS started!

J-PAS Observations started centered in 6 “seeds” chosen based on specific scientific interests and visibility.

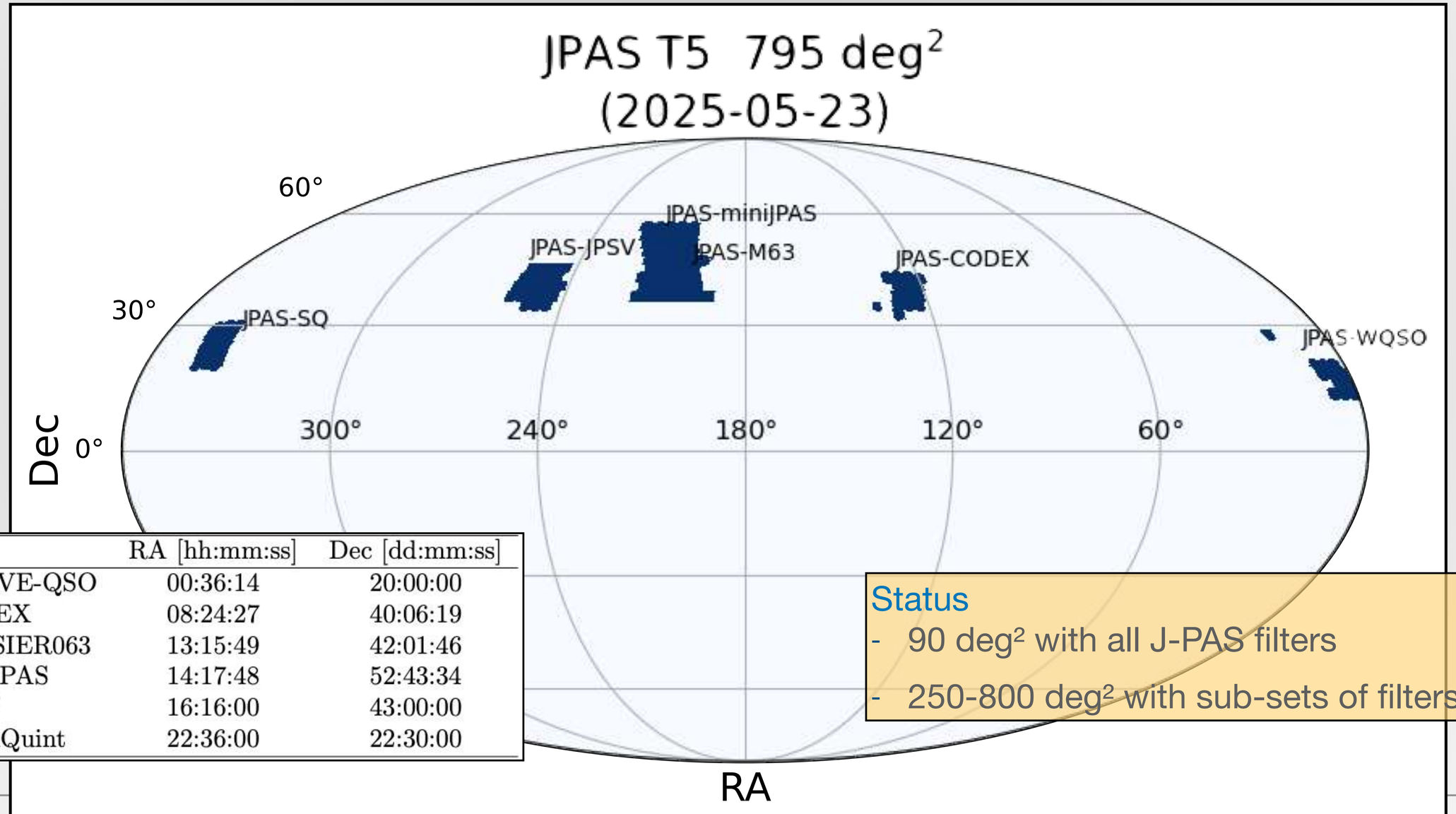


Seed	RA [hh:mm:ss]	Dec [dd:mm:ss]
WEAVE-QSO	00:36:14	20:00:00
CODEX	08:24:27	40:06:19
MESSIER063	13:15:49	42:01:46
miniJPAS	14:17:48	52:43:34
JPSV	16:16:00	43:00:00
StephQuint	22:36:00	22:30:00

Status
- 90 deg² with all J-PAS filters
- 250-800 deg² with sub-sets of filters

JPCam commissioning completed in 2023 ⇒ J-PAS started!

J-PAS Observations started centered in 6 “seeds” chosen based on specific scientific interests and visibility.



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Status
- 90 deg² with all J-PAS filters
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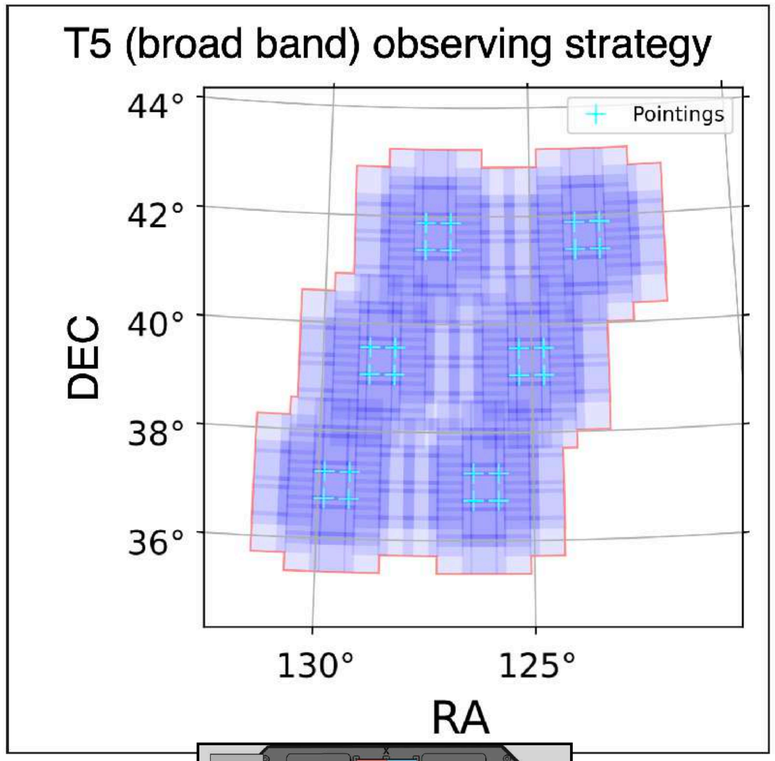
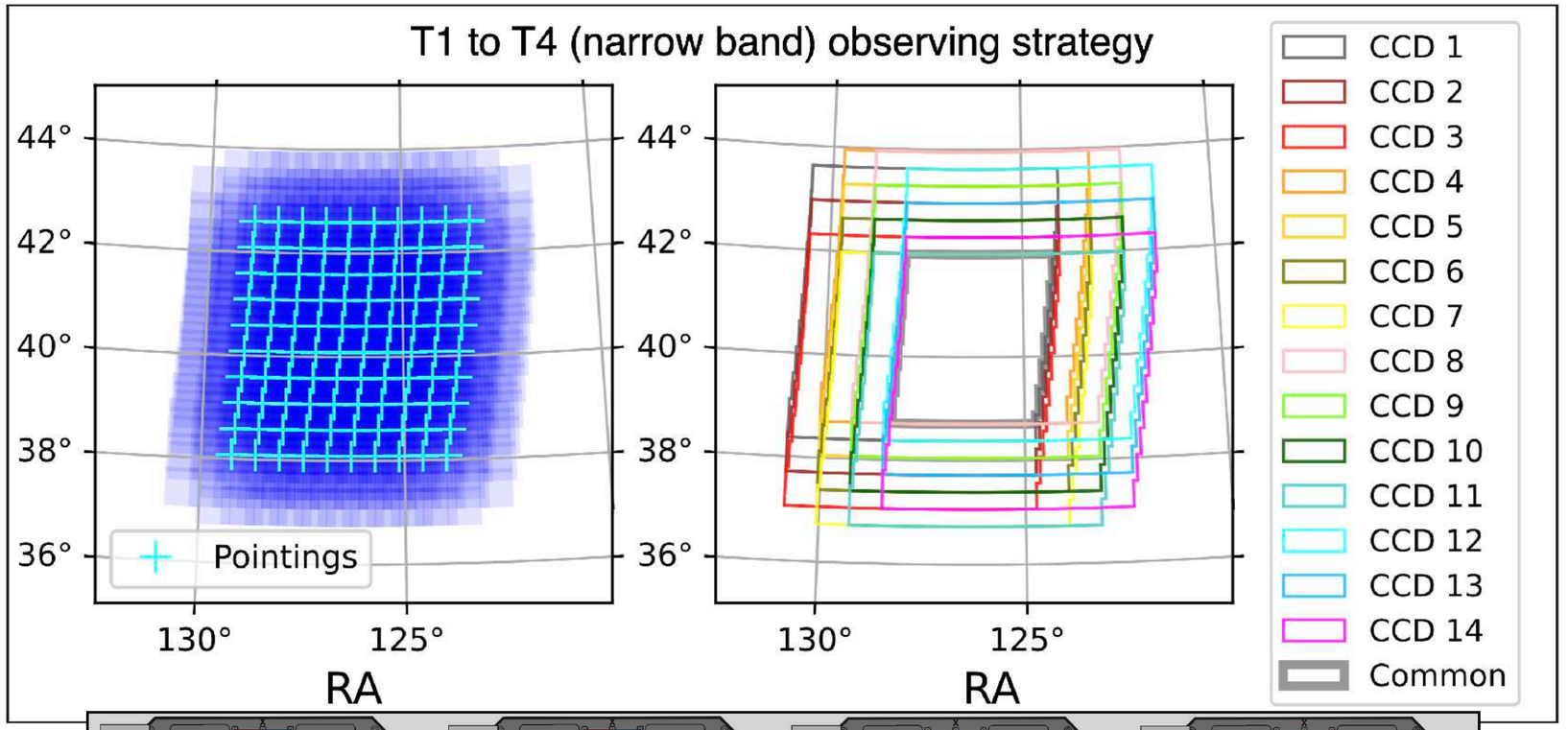
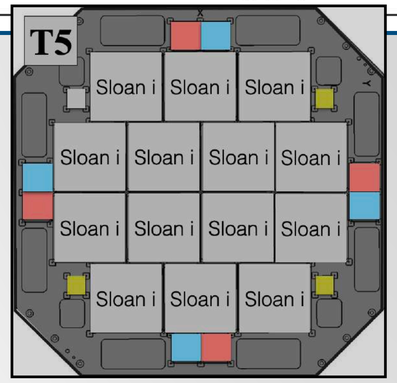
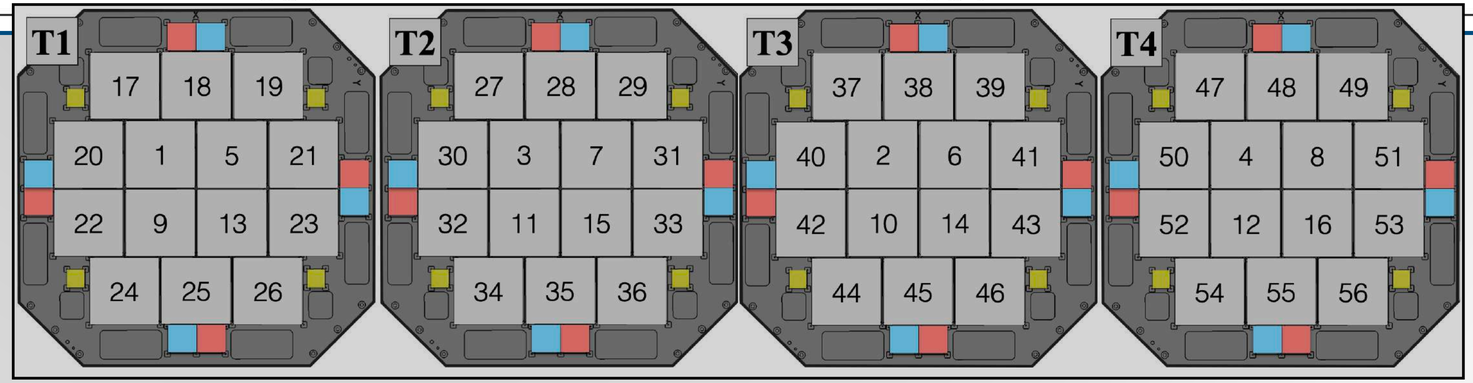
JPCam commissioning completed in 2023 ⇒ J-PAS started!

J-PAS Observational strategy is optimized for the different filter trays.



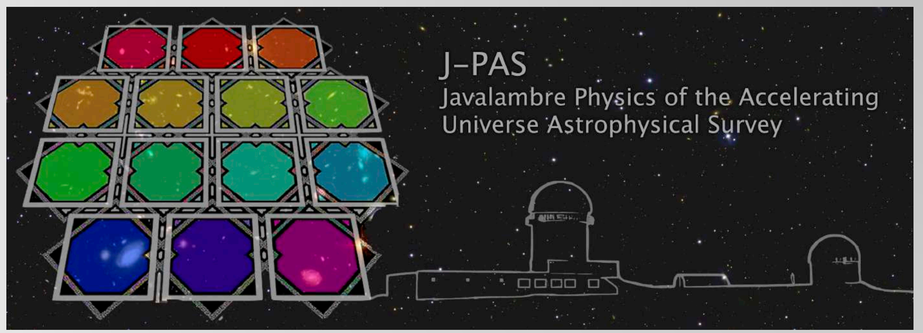






Summary

- The **commissioning of JPCam**, the 1.2Gpix, large FoV J-PAS Camera, has been successfully completed at the JST250 telescope.
- During its first on-sky operation a number of improvements have been implemented both at instrument level (opto-mechanics and light baffling, control system, electronics, IQ monitoring and control...) and data reduction level.
- Main **J-PAS scientific requirements have been achieved** and the main survey has started.
- In November'24 a **J-PAS first data release** became public, making J-PAS data available to the whole scientific community.
- In 2025, the tandem JST250-JPCam has been offered to the scientific community through a competitive, **open call for proposals**.



CCD format	$14 \times 9216 \times 9232$ pix, $10\,\mu$m pix^{-1} 1.2 Gpix camera
Pixel scale	$0.2265''$ pix^{-1}
Unvignetted FoV	3.4deg^2 – $(14\times)$ 0.48deg $\times$ 0.51deg
Read out time (633kHz)	10.9 s (full frame) – 6.1 s (2x2 binning)
Read out noise (633kHz)	5.5 e$^-$ (RMS)
Read out time (400kHz)	16.4 s (full frame) – 8.9 s (2x2 binning)
Read out noise (400kHz)	4.3 e$^-$ (RMS)
Gain	$2.274\,e^-\,ADU^{-1}$
Minimum exposure time	0.1 s
Exposure homogeneity	1 ms
Full well	$> 125\,000$ e$^-$
Dark current	0.001 e$^-$ pix^{-1} s^{-1}

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