# JPCam & T80Cam:

## First light survey instruments for the Javalambre Astrophysical Observatory

Keith Taylor (IAG.ON), Jordi Cepa (IAC), A. Marín-Franch (CEFCA)
& J-PAS collaboration

# Team

Keith Taylor (IAG/ON) - PI
Jordi Cepa (IAC)
Antonio Marín-Franch (CEFCA)

## T80Cam:

**Filter/Shutter Unit (INPE):**
Rene Laporte (optics, mechanics)
José Angelo Neri (electronics, control)
Mario Celso (systems engineering)

**Camera Unit (Spectral Instruments):**
Kevin Toerne (Project Manager)
Hans Meyer (electronics)
Jim Cook (mechanics)
Roger Cover (control)

## JPCam:

**Filter/Shutter Unit (INPE+):**
Rene Laporte (INPE - optics)
Mario Celso (INPE - systems/control)
Fernando Santoro (MRO - mechanics)
Lucas Marrara (TopCooler - mechanics)

**Camera Unit (e2v):**
Ian Palmer (project manager)
Paul Jorden (project over-sight)
Graham Fenemore-Jones (mechanics)
Mike Dryer (control)
Matthew Clapp (electronics)

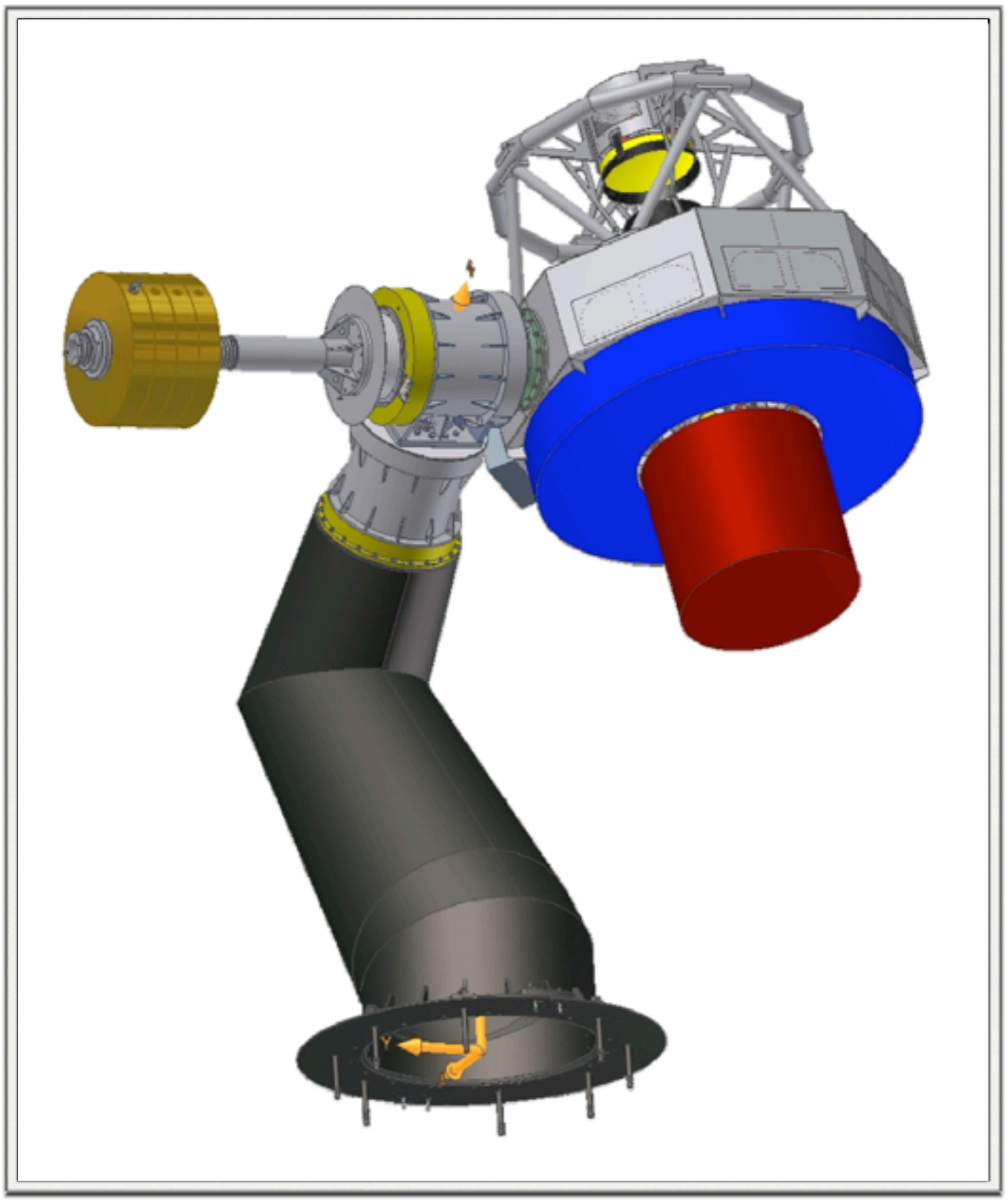
**Actuator Unit (NTE-SENER):**
Joan Manel Casalta
Albert Tomás
Albert Catalan
Francesc Gallart

**Interface management (AMOS)**
Grégory Lousberg (interface control)
Olivier Pirnay (project manager)

# Outline

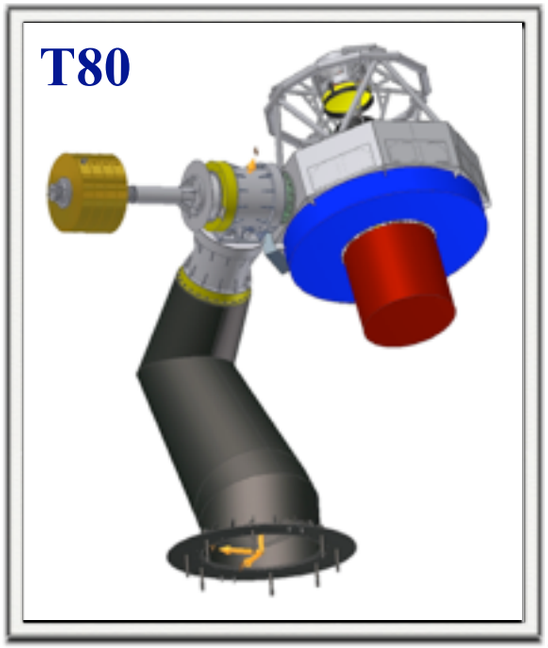
- **T80Cam@T80** ➠ J-PLUS Survey (Cenarro's Talk)
  - Filter/Shutter Unit
  - Camera Unit
- **JPCam@T250** ➠ J-PAS Survey (Benítez's Talk)
  - Filter/Shutter Unit
  - Camera Unit
  - Actuator Unit
- Summary and schedule

# T80Cam@T80



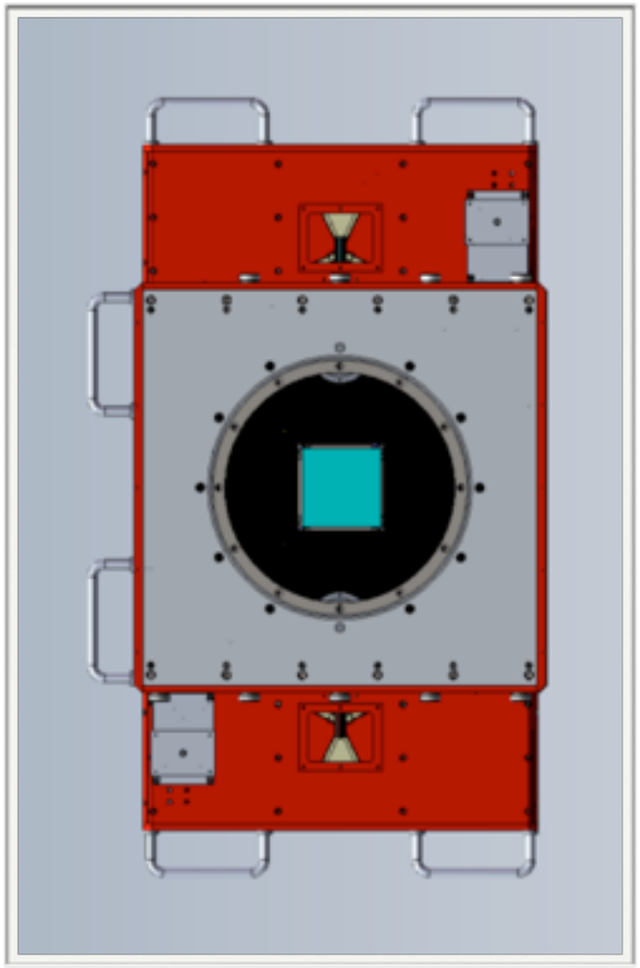
| | T80 |
|---|---|
| Mount | German-equatorial |
| Configuration | Ritchey-Chrétien |
| Focus | One axial Cassegrain |
| Aperture (M1 diameter) | 0.826 m |
| Effective collecting area (corrected for M2 obscuration) | 0.44 $m^2$ |
| Plate scale | 55.56 arcsec/mm |
| Focal length | 3712 mm |
| Field of view (diameter) | 2.0 deg (130 mm) |
| Etendue | $\sim 1.5\,m^2\,deg^2$ |
| Bandwidth | 330 – 1100 nm |
| Image Quality Performance (full error budget included) | EE50 $\leq 9\,\mu$m / 0.49 arcsec |
| | EE80 $\leq 18\,\mu$m / 1.00 arcsec |
| Distortion | 0.6% |
| Working Environment | Temperature −15C to 25C |
| | Humidity < 95% |
| | Wind < 16 m/s |

# T80Cam breakdown




Filter and shutter unit (FSU)

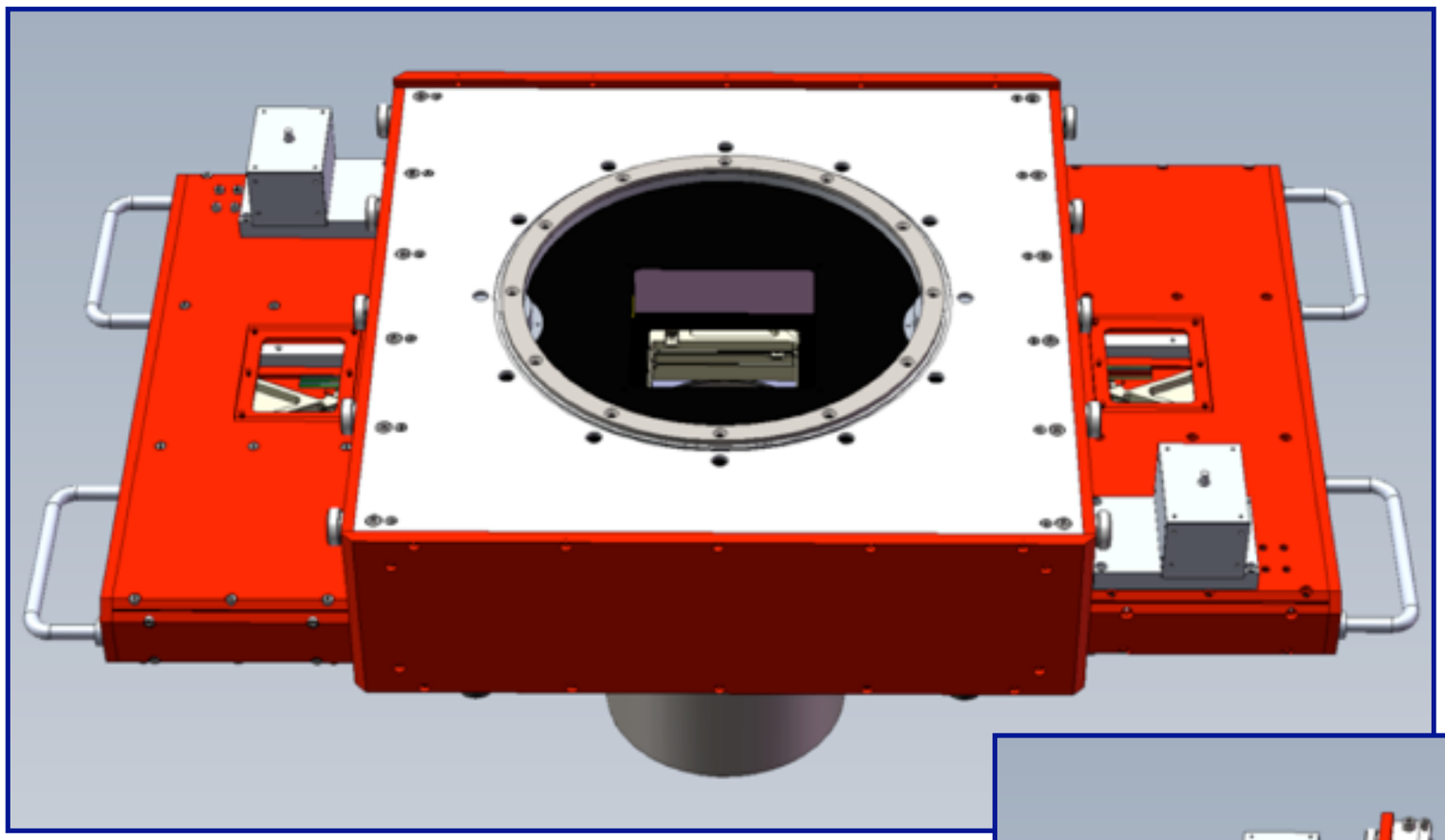
Camera



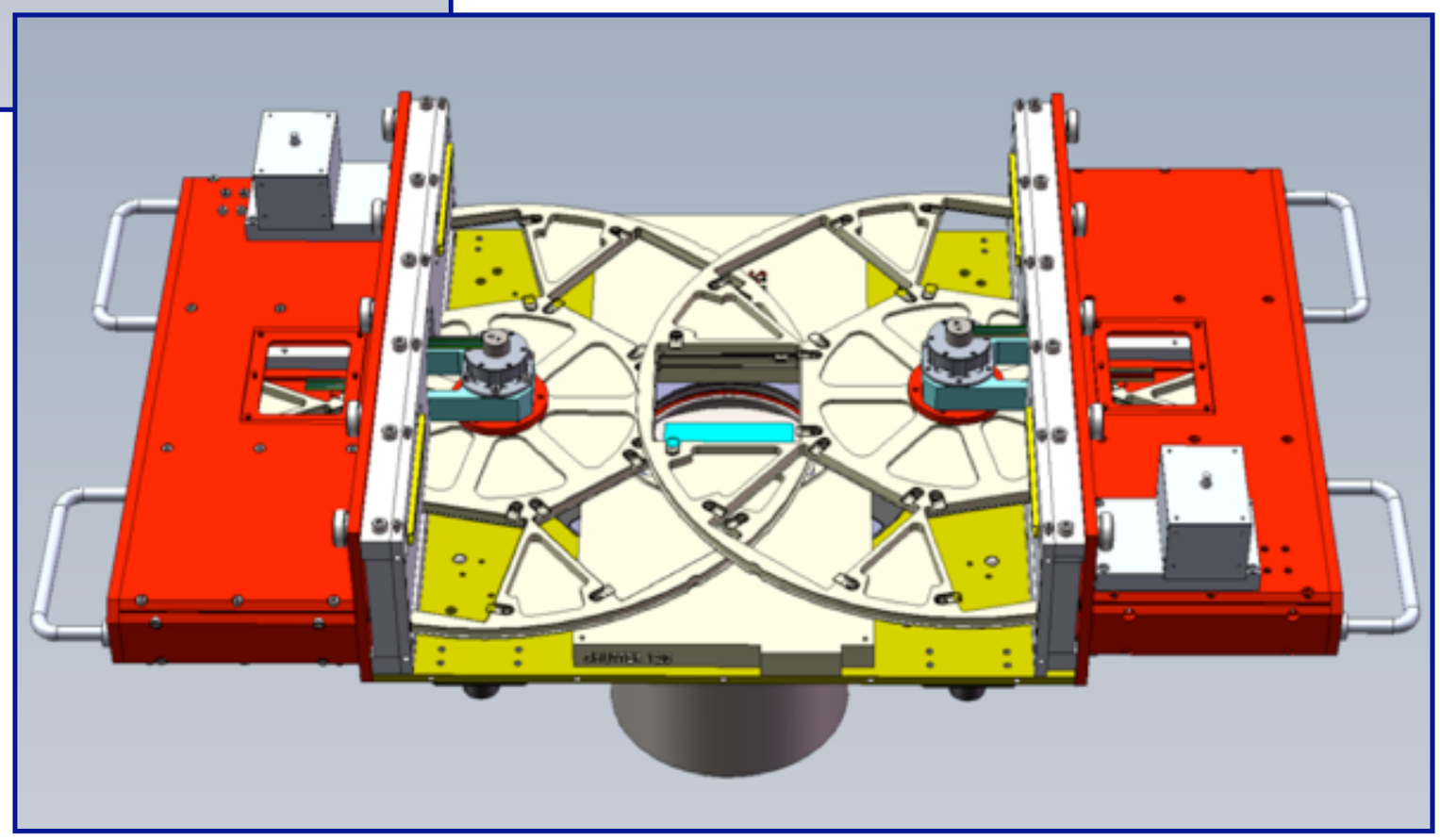
- Designed by CEFCA & Brazil
- Manufactured in Brazil
- Financed by Brazil

- Manufactured by *Spectral Instruments* (USA).
- Financed by CEFCA

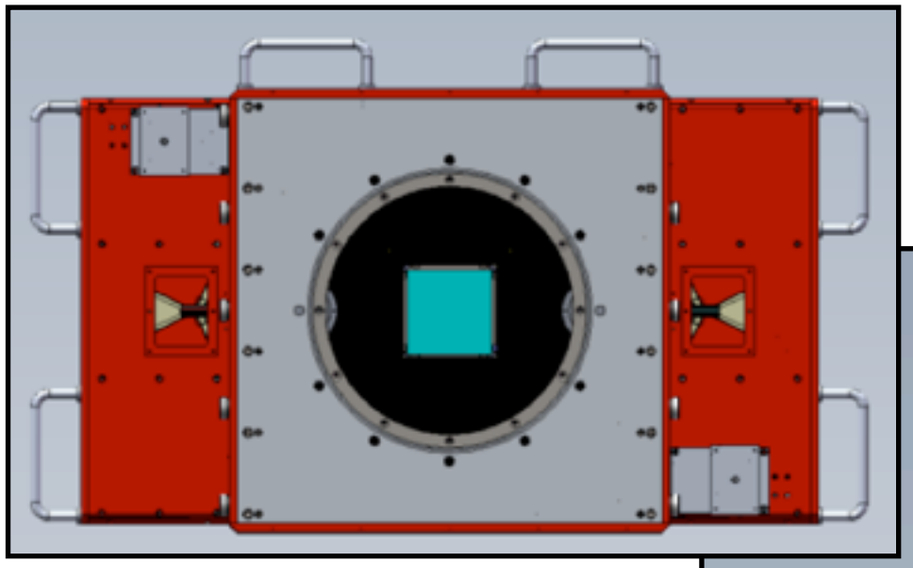
# T80Cam filter and shutter unit (FSU)

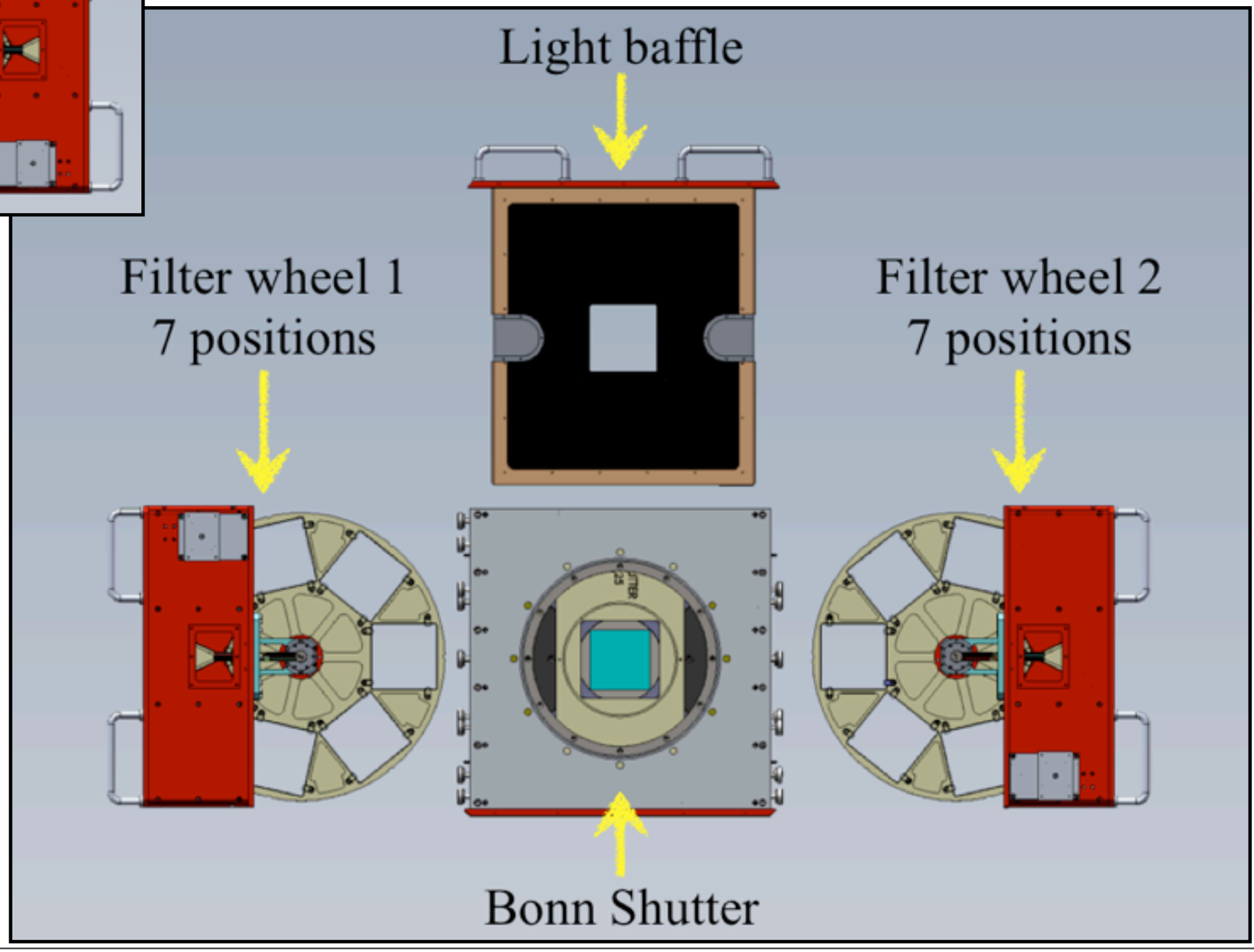


Succeed PDR early this week
(March 27-28, 2012)

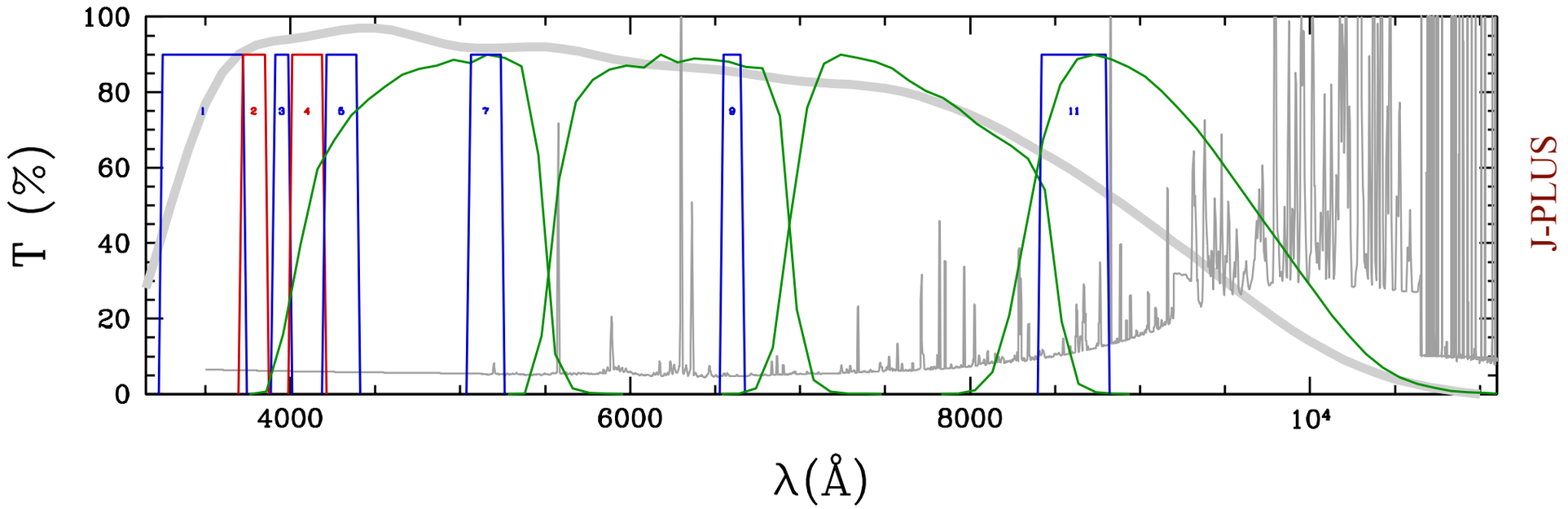


# T80Cam filter and shutter unit (FSU)





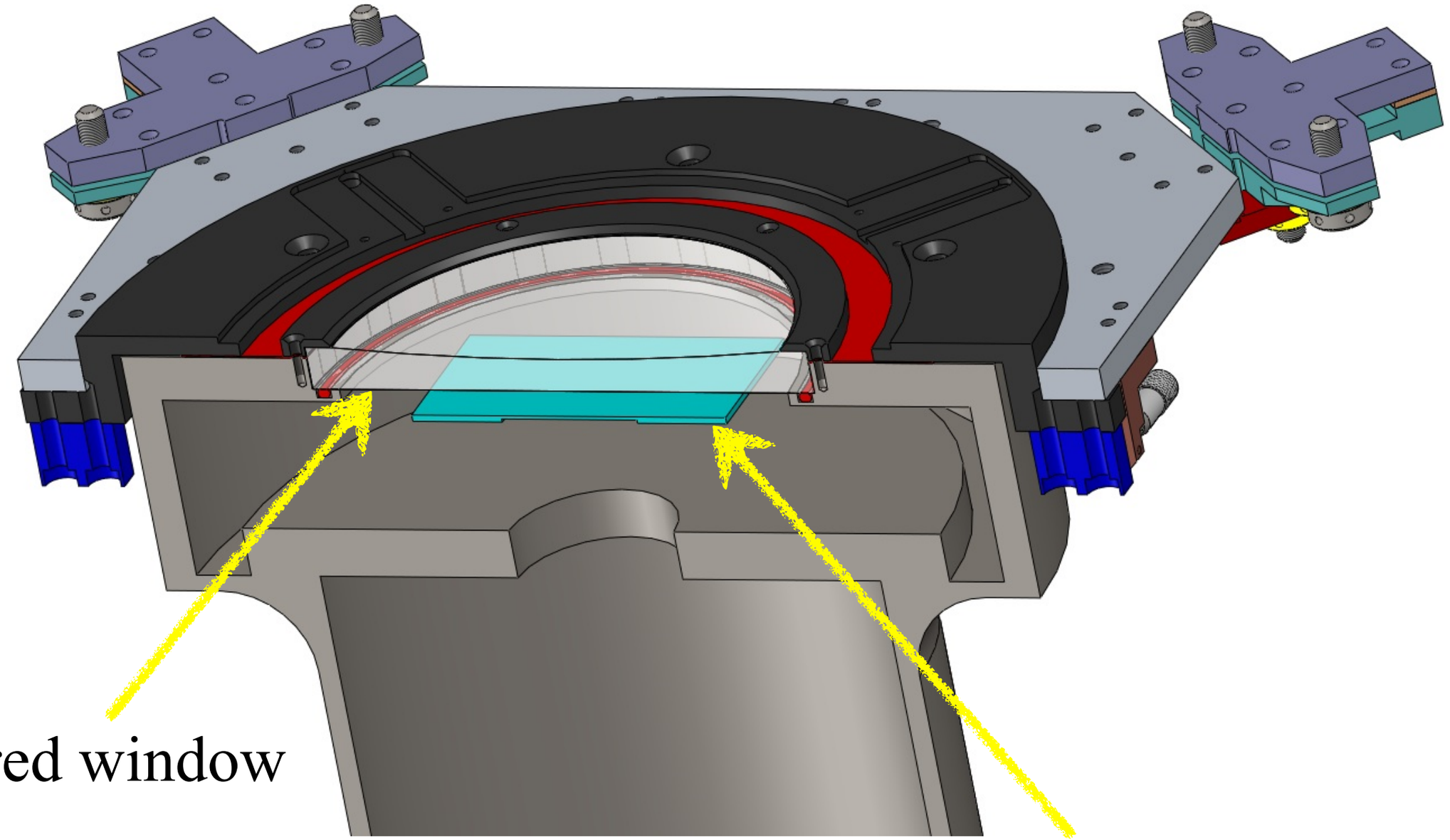
# T80Cam@T80: J-PLUS filters




| Filter | CW (nm) | FWHM (nm) | W1 (nm) | W2 (nm) | Thickness (mm) |
|---|---|---|---|---|---|
| F348 [a] | 348.5 | 49.5 | 47.0 | 52.0 | 8.0 |
| OII [a] | 378.5 | 15.5 | 13.0 | 18.0 | 8.0 |
| F395 | 395.0 | 10.0 | 7.5 | 12.5 | 8.0 |
| F410 | 410.0 | 20.0 | 17.5 | 22.5 | 8.0 |
| F430 | 430.0 | 20.0 | 17.5 | 22.5 | 8.0 |
| $g_{sdss}$ [b] | 480.3 | 140.9 | | | 8.0 |
| F515 | 515.0 | 20.0 | 17.5 | 22.5 | 8.0 |
| $r_{sdss}$ [b] | 625.4 | 138.8 | | | 8.0 |
| Hα [a] | 660 | 12.5 | 10.0 | 15.0 | 8.0 |
| $i_{sdss}$ [b] | 766.8 | 153.5 | | | 8.0 |
| F861 | 861.0 | 40.0 | 37.5 | 42.5 | 8.0 |
| $z_{sdss}$ [b] | 911.4 | 140.9 | | | 8.0 |

*Table 1: JPLUS set of filters.*

# T80Cam camera unit

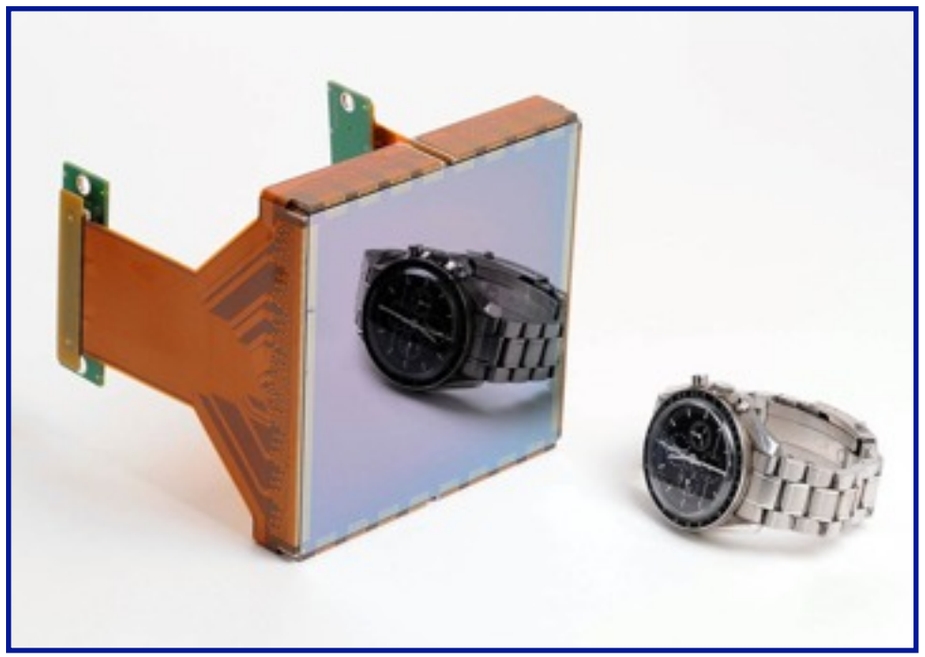


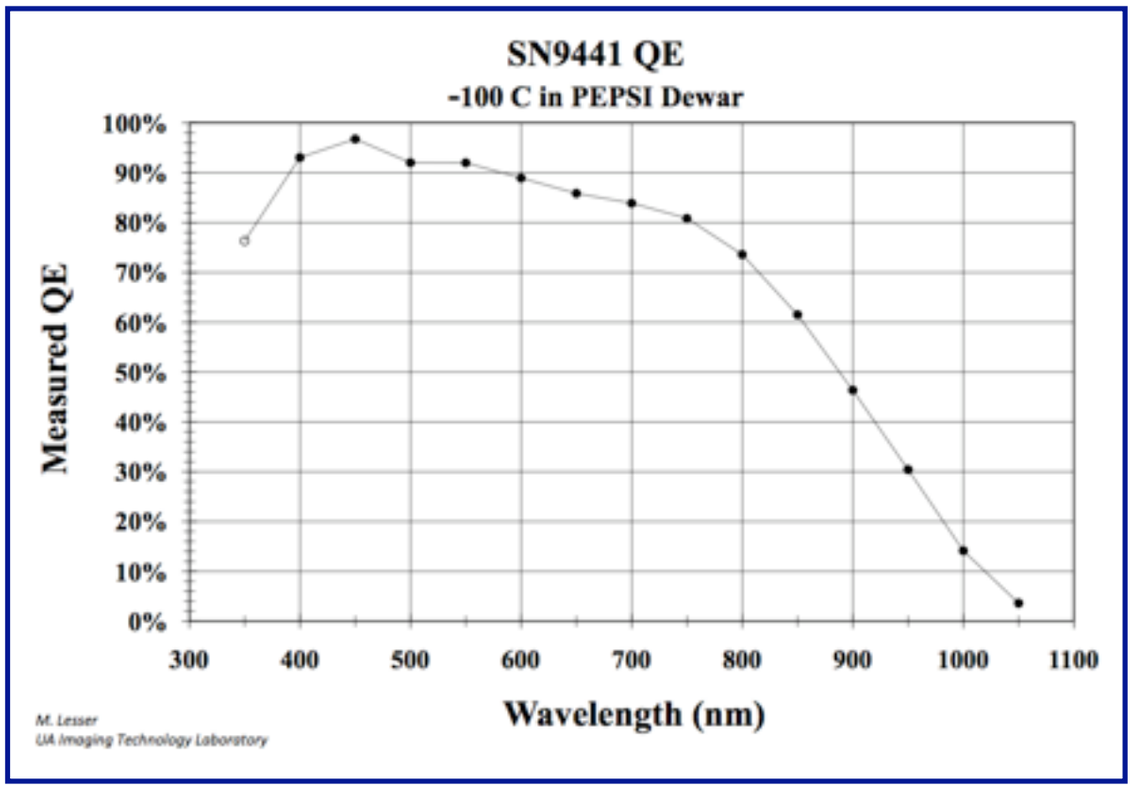
Powered window

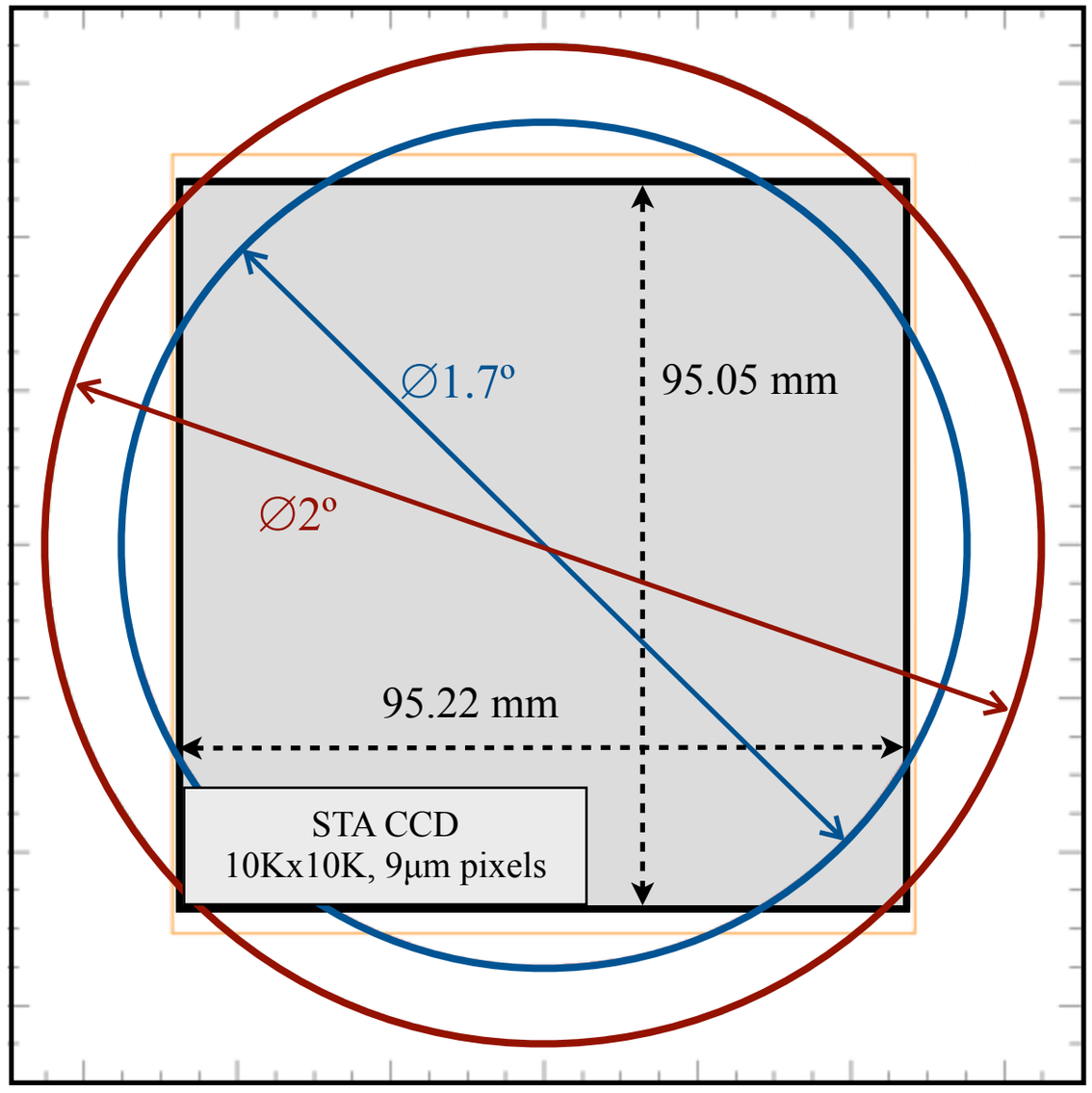
STA detector

# T80Cam camera unit

Grade one STA 1600 backside illuminated, 16 ports

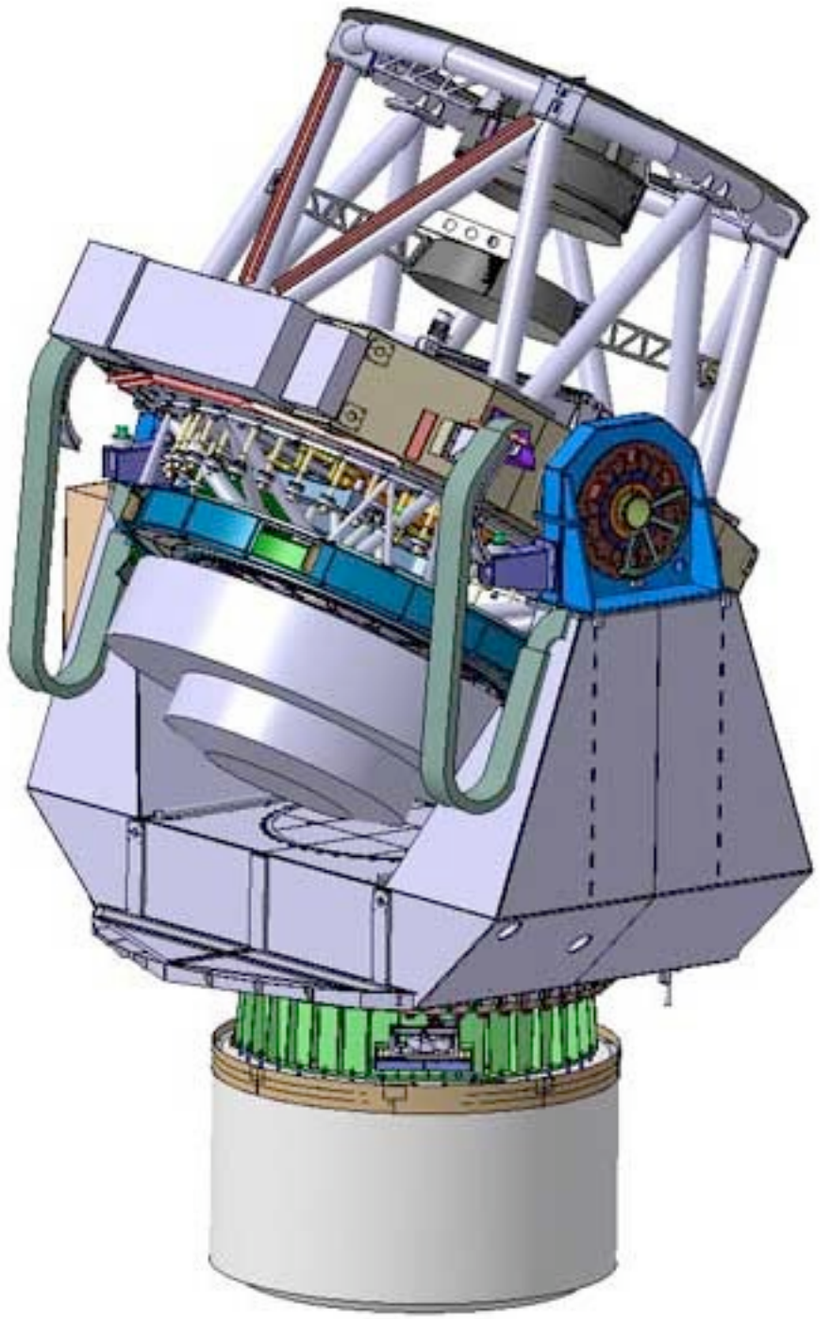




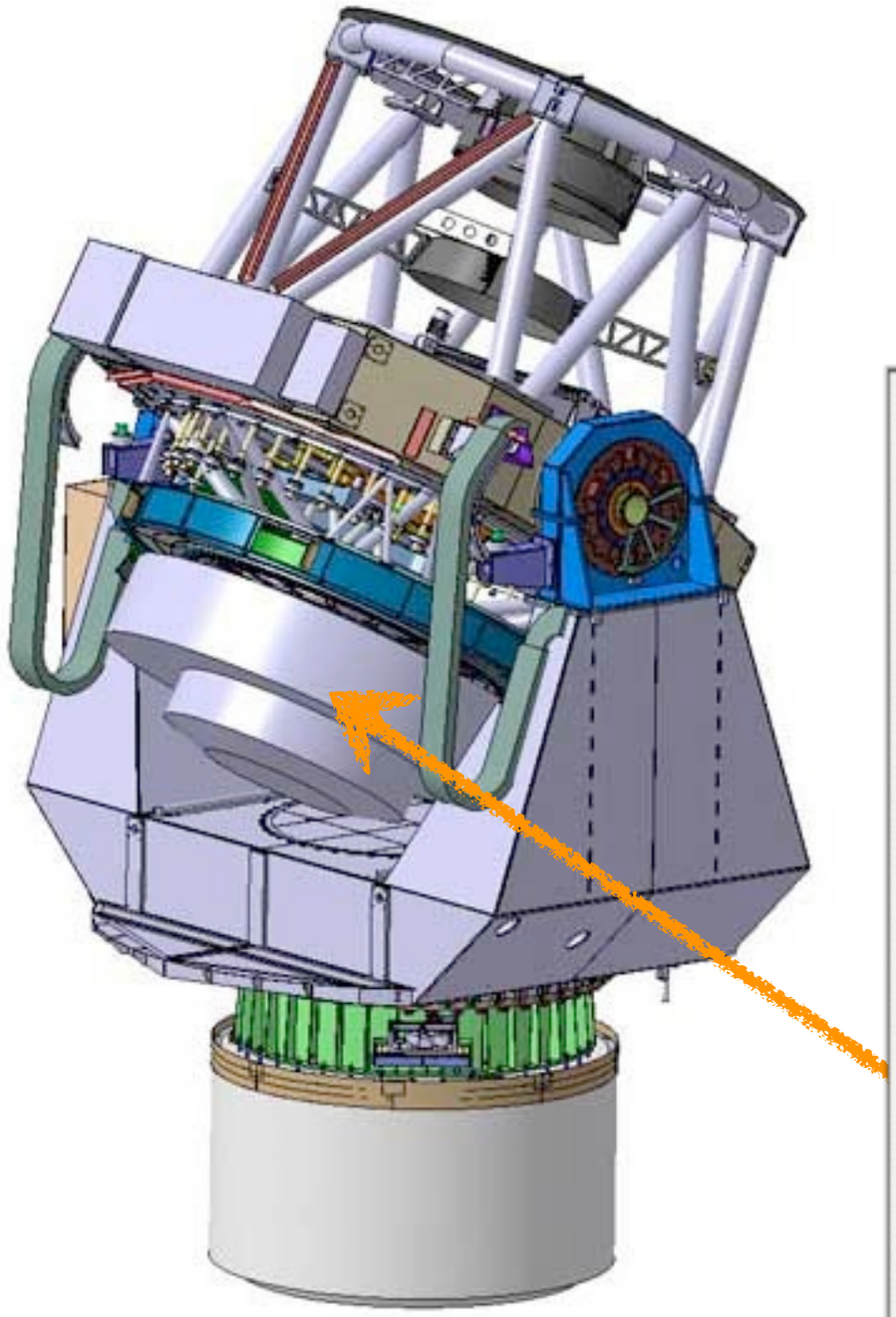

| FoV | Ø=1.7º (full performance)<br>Ø = 2.0º (reduced performance) |
|---|---|
| CCD format | 10580 x 10580 pix, 9 µm/pix |
| Pixel scale | 0.5 “/pix |
| Read out time | <20s |
| Read out noise | <6 $e^-$/pixel |

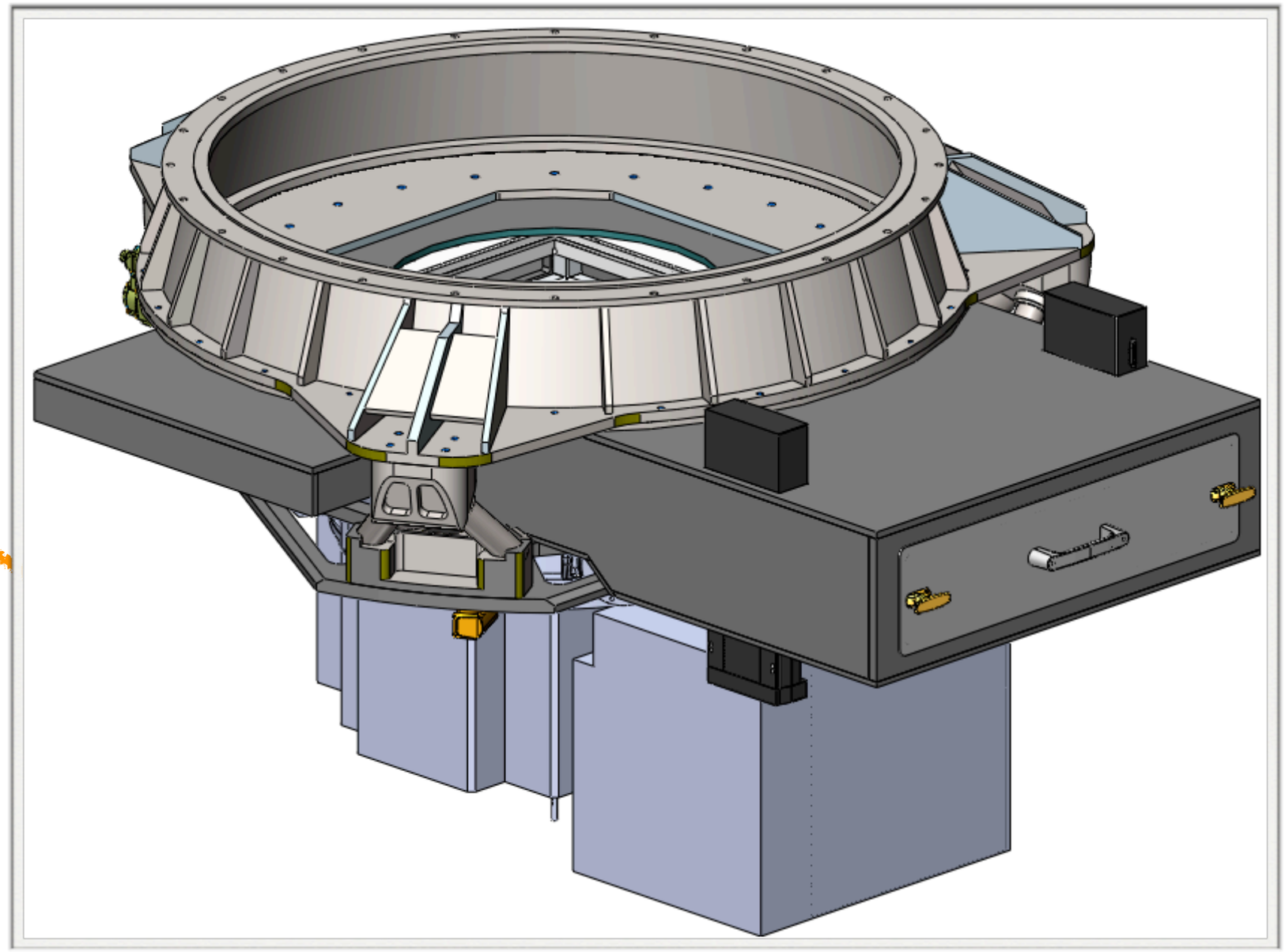
# JPCam@T250



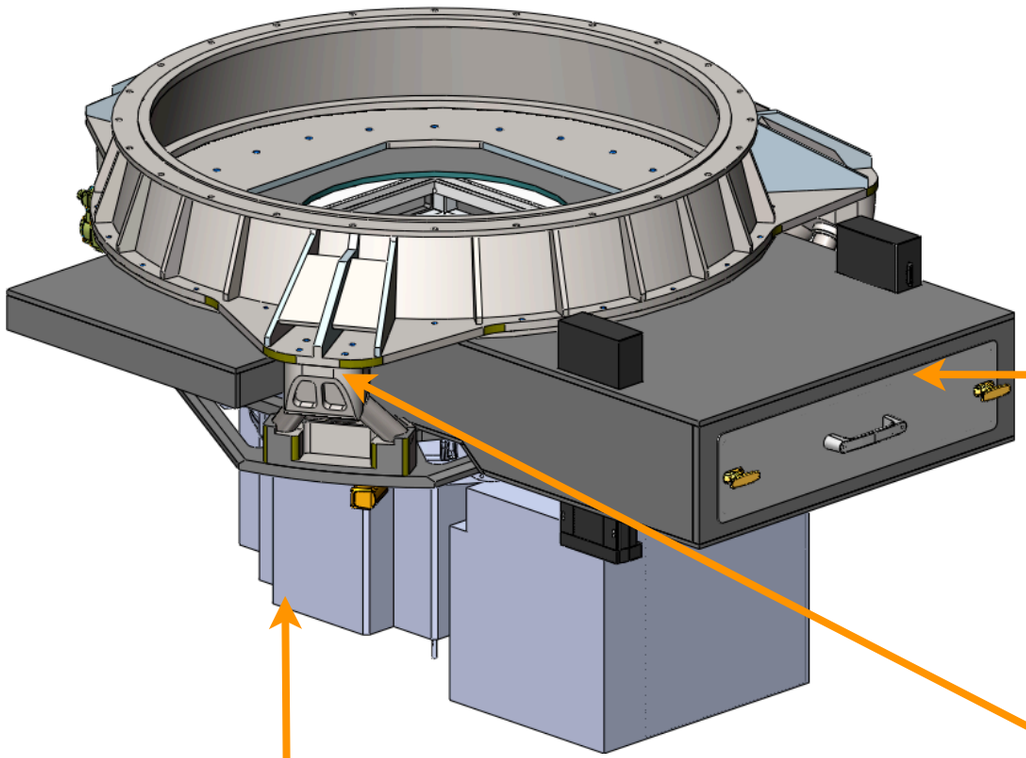
| | T250 |
|---|---|
| Mount | Altazimuthal |
| Configuration | Ritchey-Chrétien-like, equipped with a Field corrector and De-rotator |
| Focus | One axial Cassegrain |
| Aperture (M1 diameter) | 2.55 m |
| Effective collecting area (corrected for M2 obscuration) | $3.75\,m^2$ |
| Plate scale | 22.67 arcsec/mm |
| Focal length | 9098 mm |
| Field of view (diameter) | 3.0 deg (476 mm) |
| Etendue | $26.5\,m^2\,deg^2$ |
| Bandwidth | $330 - 1100$ nm |
| Image Quality Performance (full error budget included) | EE50 $\leq 10\,\mu$m / 0.23 arcsec |
| | EE80 $\leq 20\,\mu$m / 0.45 arcsec |
| Distortion | 0.3% |
| Working Environment | Temperature $-15$C to 25C |
| | Humidity $< 95\%$ |
| | Wind $< 18$ m/s |

# JPCam@T250



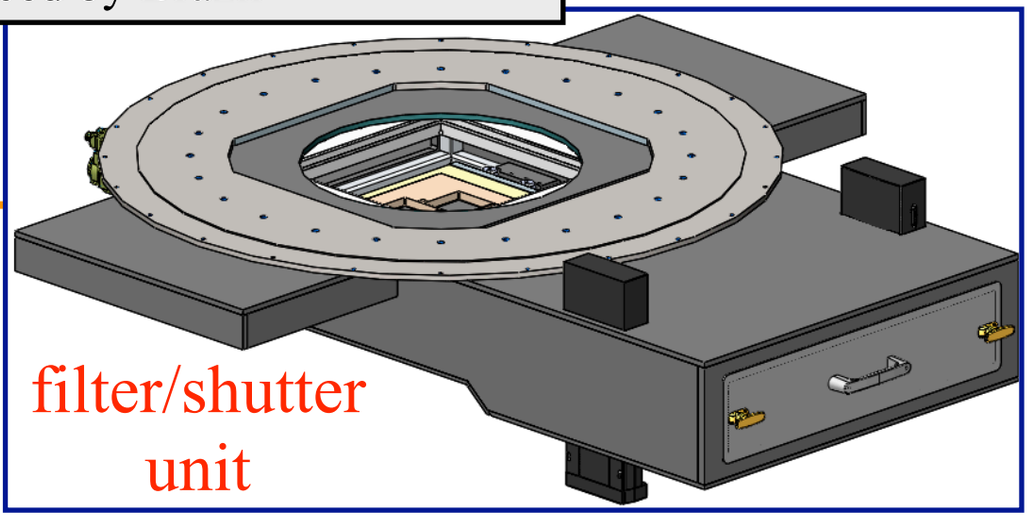


# JPCam breakdown

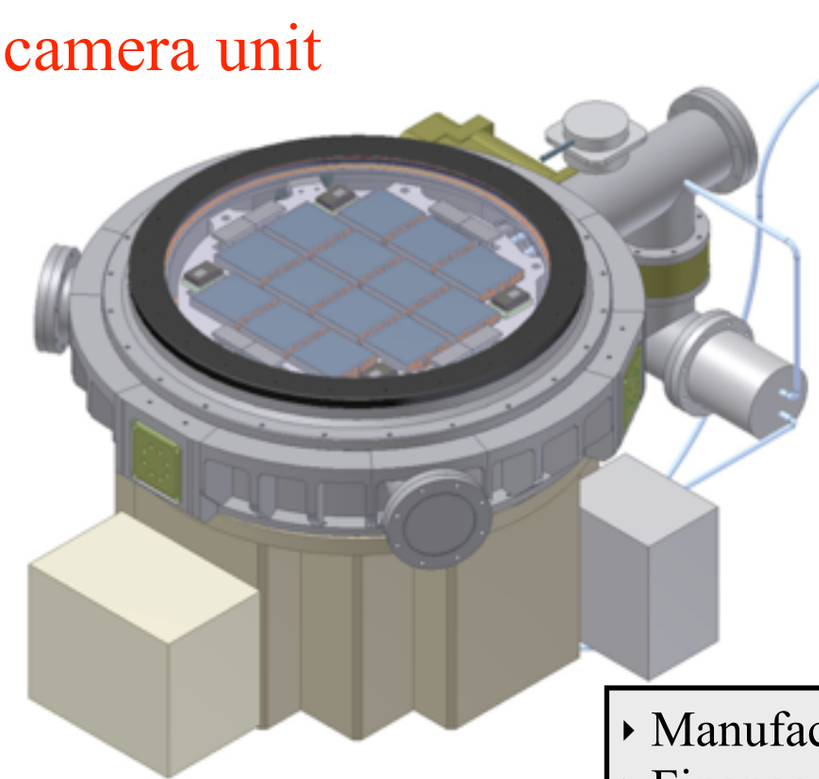


- Designed by CEFCA & Brazil
- Manufactured in Brazil
- Financed by Brazil

filter/shutter unit



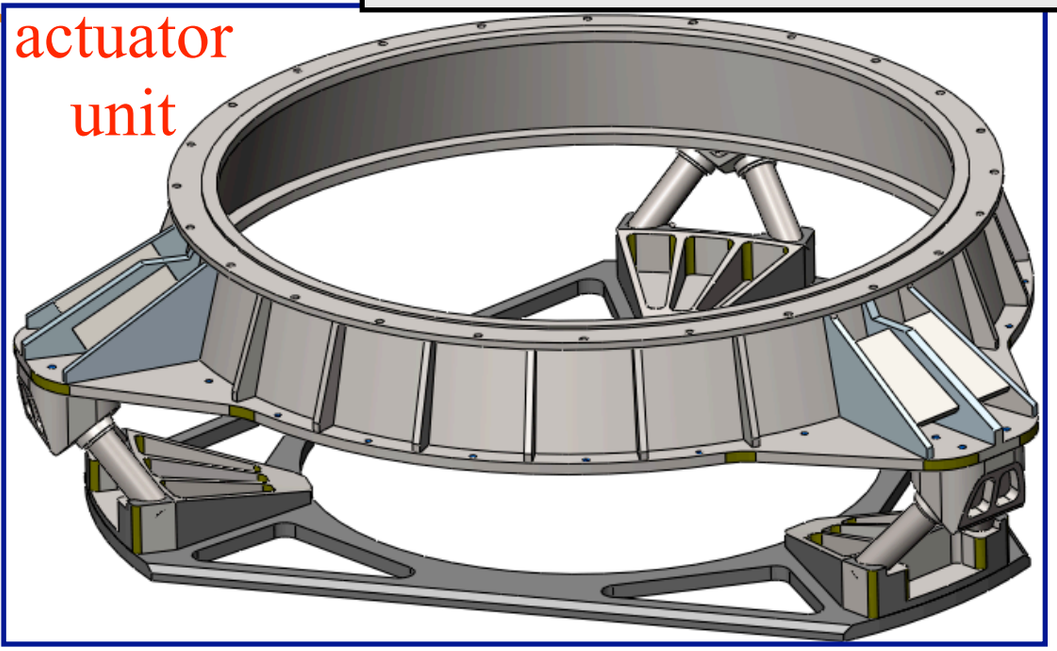
camera unit



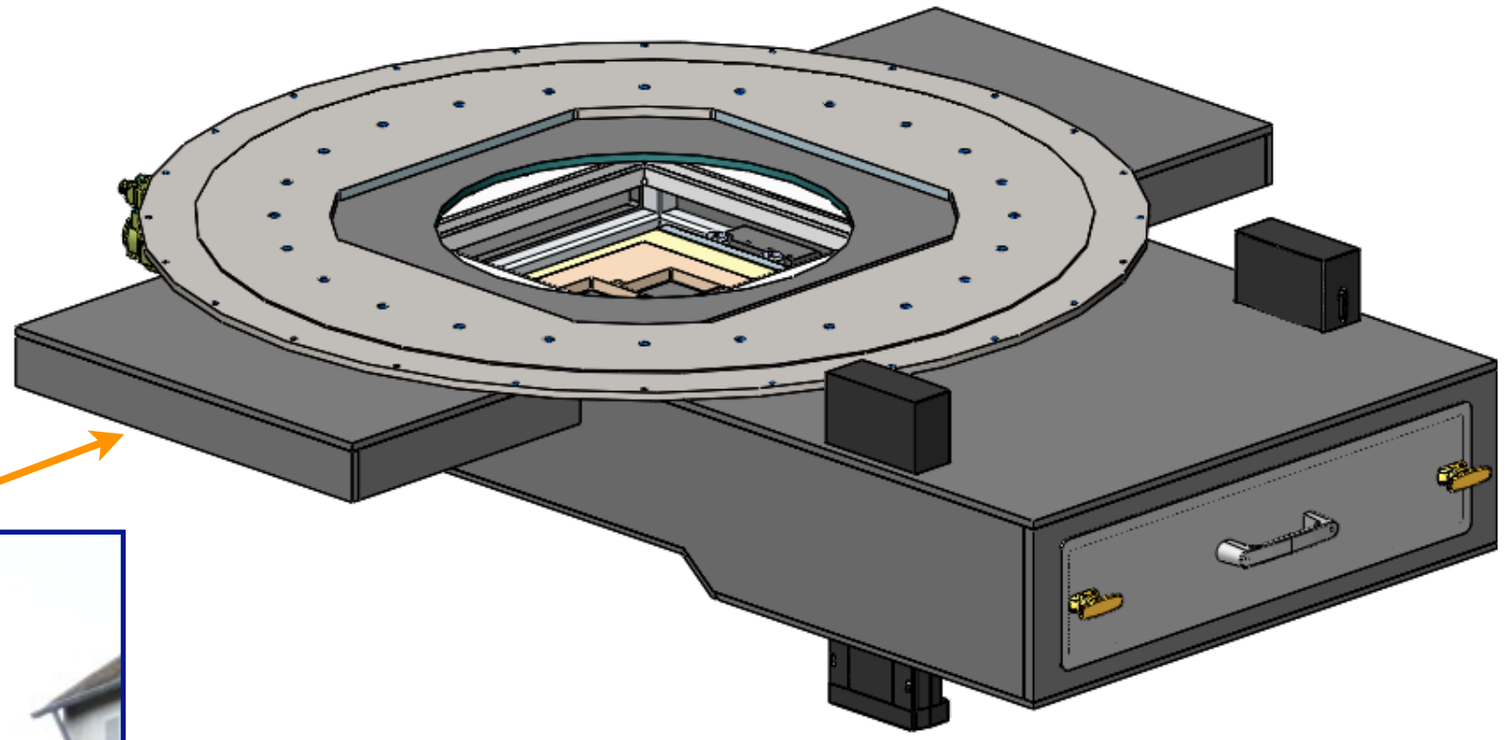
- Manufactured by *e2v* (UK).
- Financed by Brazil

- Manufactured by *NTE-SENER*.
- Financed by Brazil

actuator unit

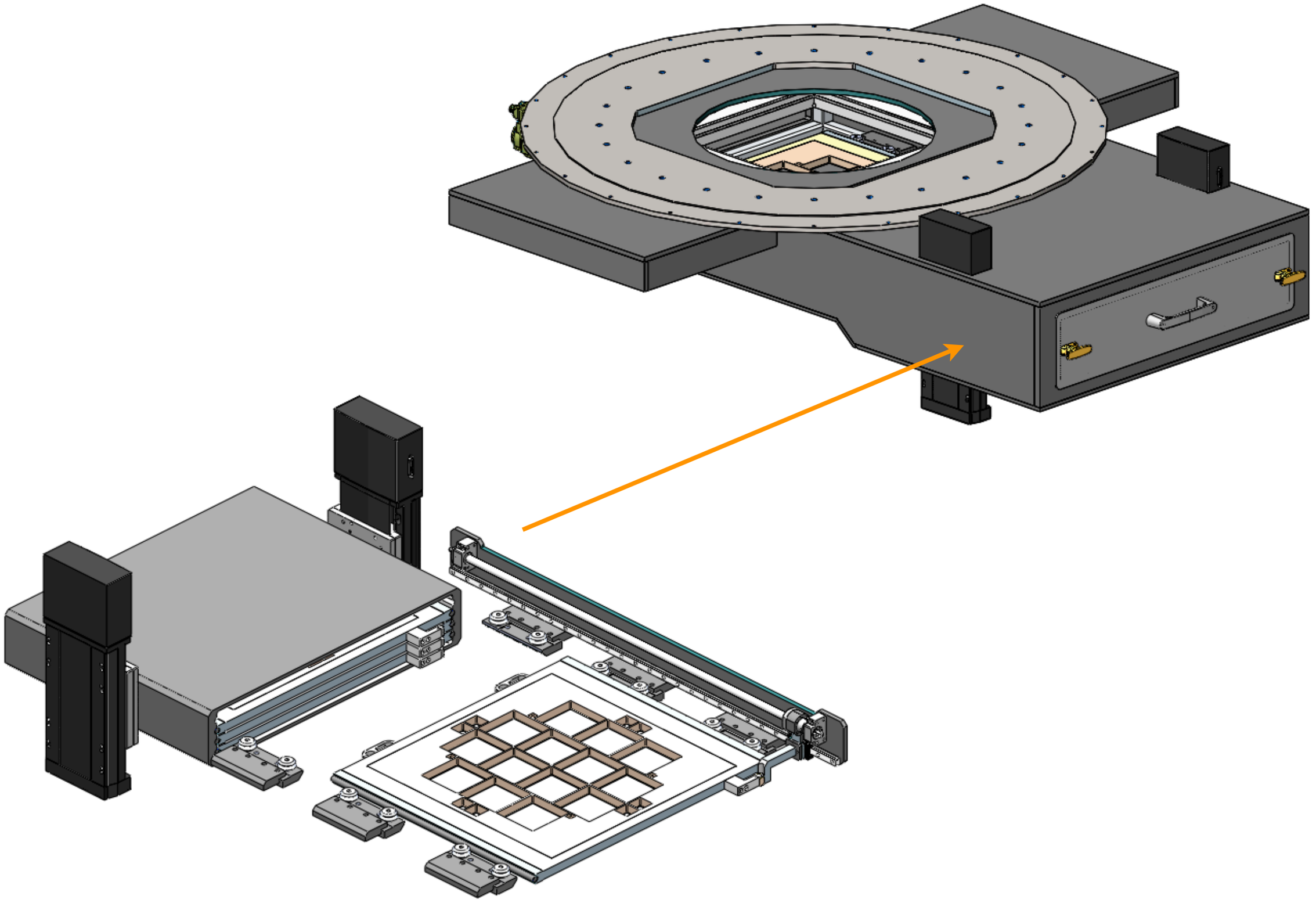


# JPCam filter and shutter unit (FSU)

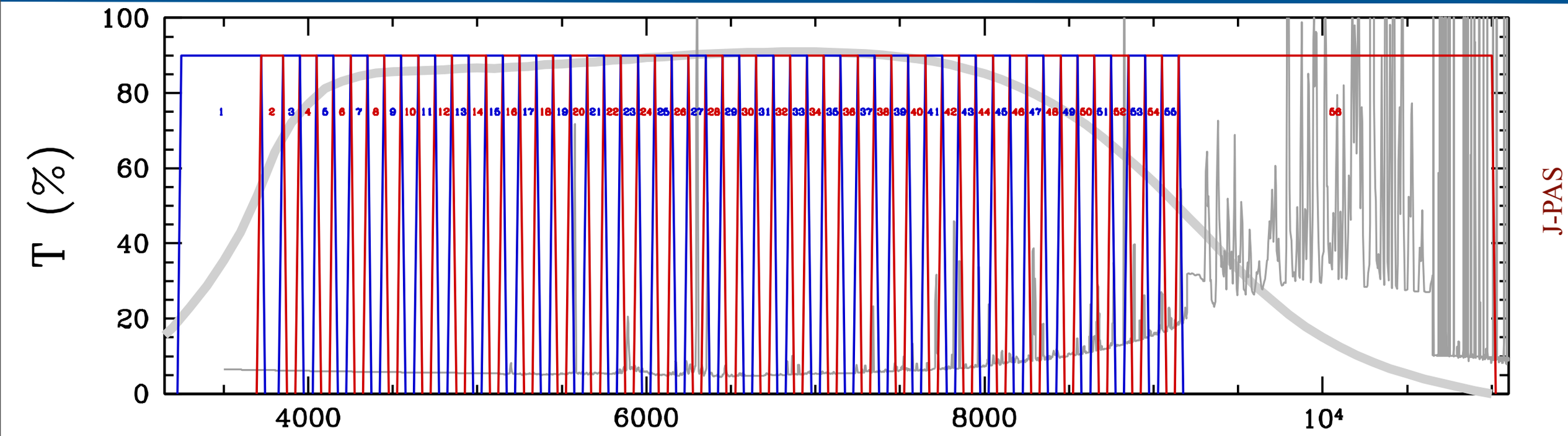


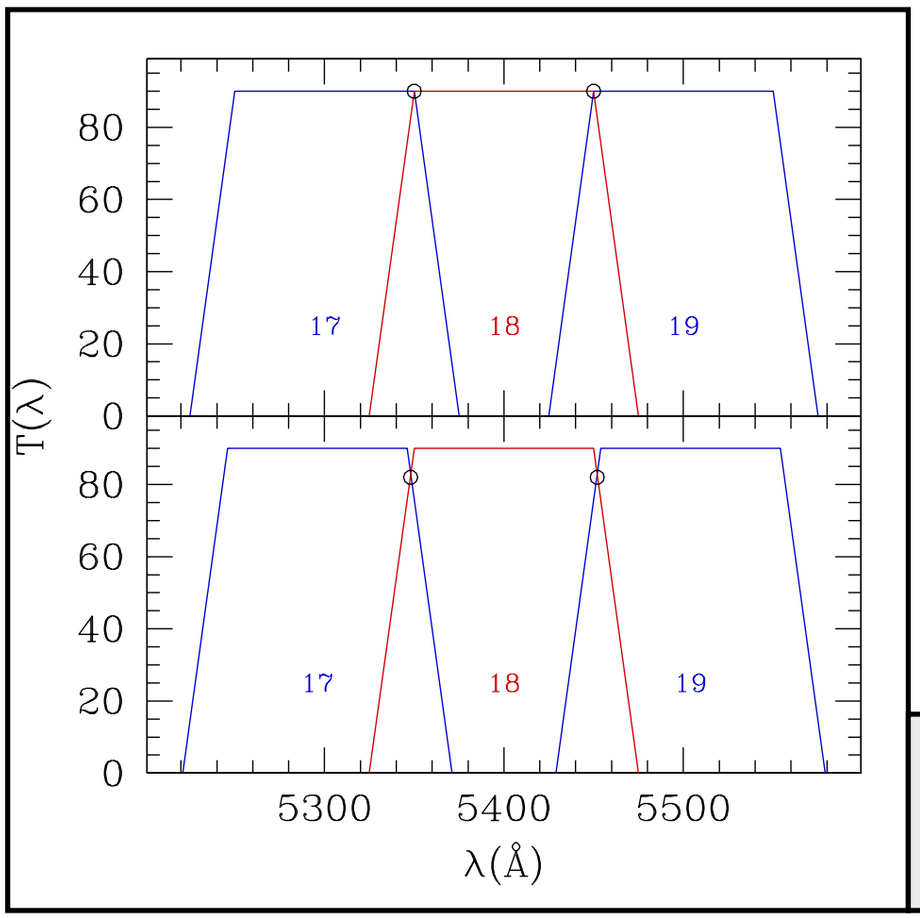
Shortest exposure time = 2ms
Exposure accuracy = 1ms

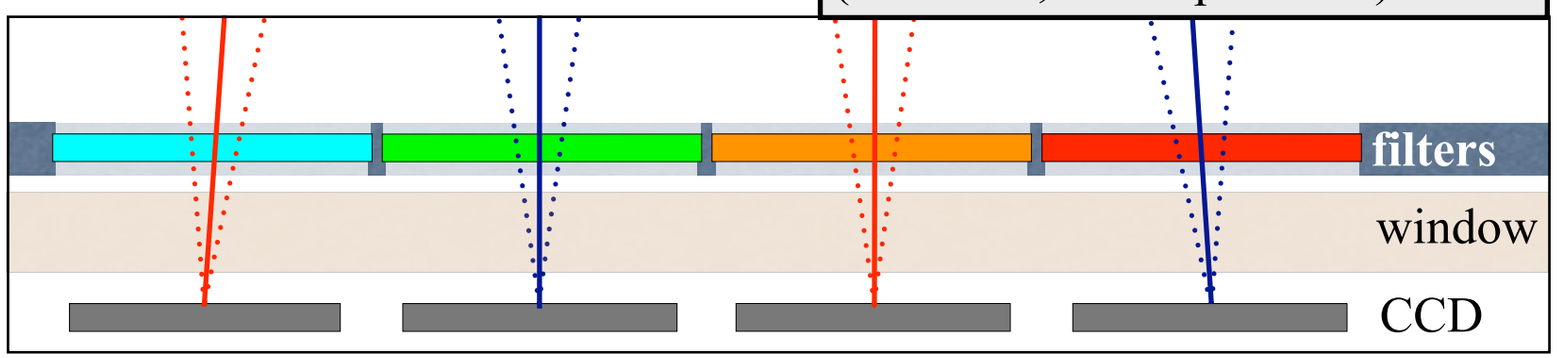
# JPCam filter and shutter unit (FSU)



# JPCam@T250: J-PAS filters



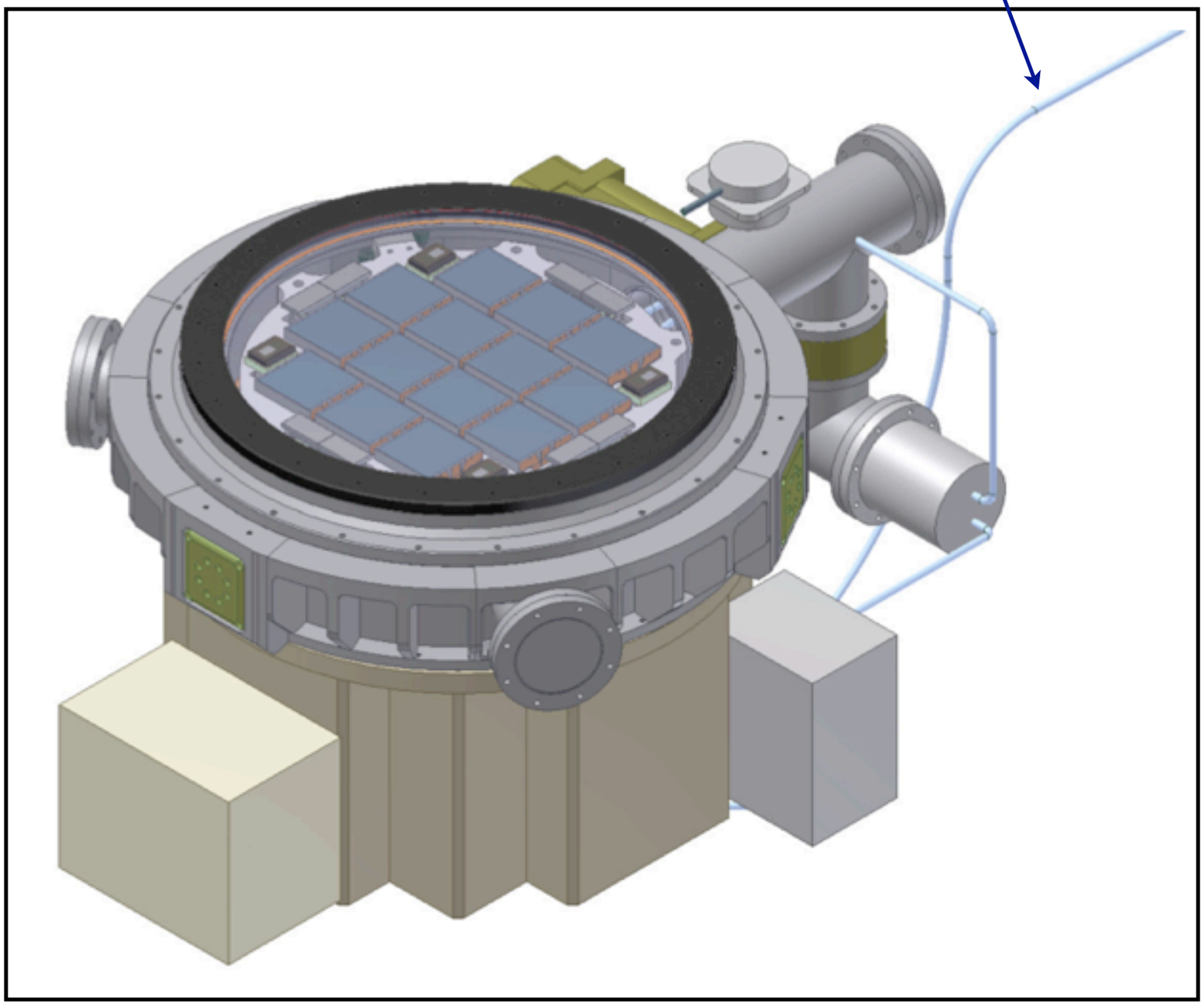



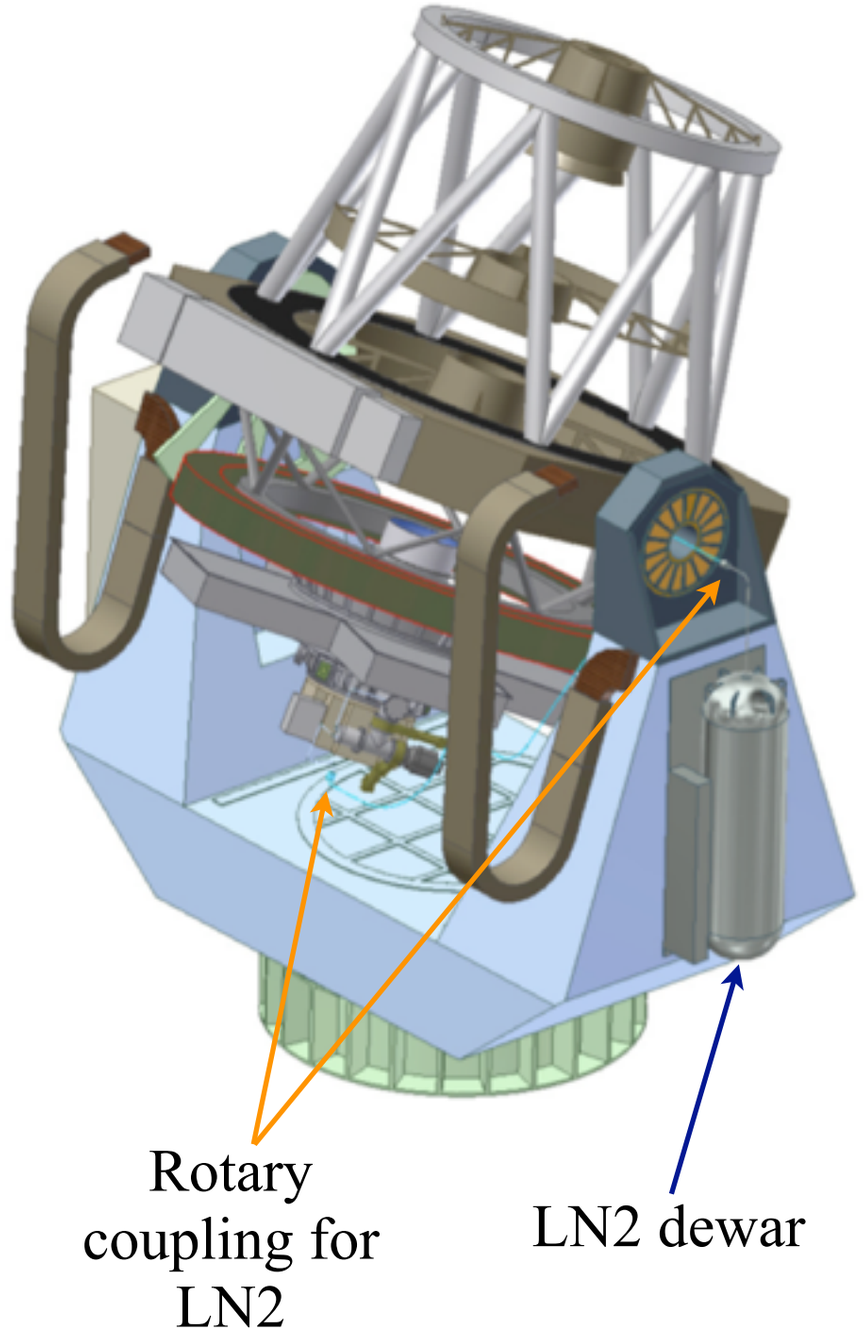




Challenging physical requirements (thickness, clear aperture...)

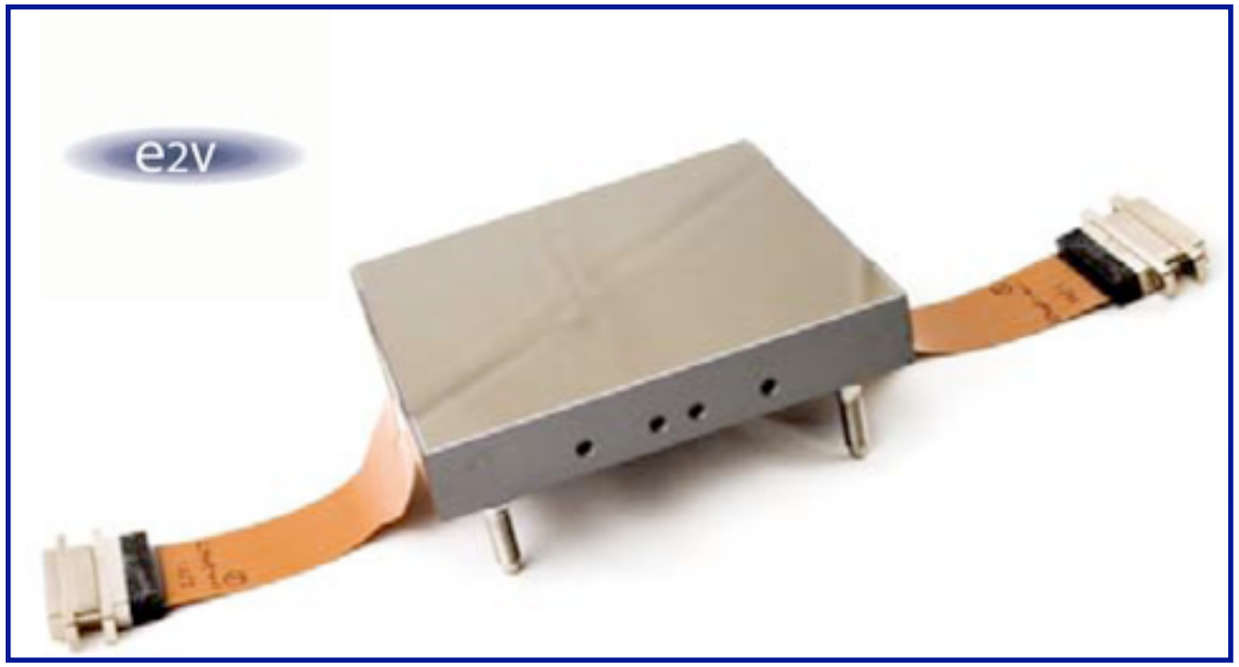
Challenging functional requirements (homogeneity, slope, out of band blocking, continuity...)

# JPCam camera unit

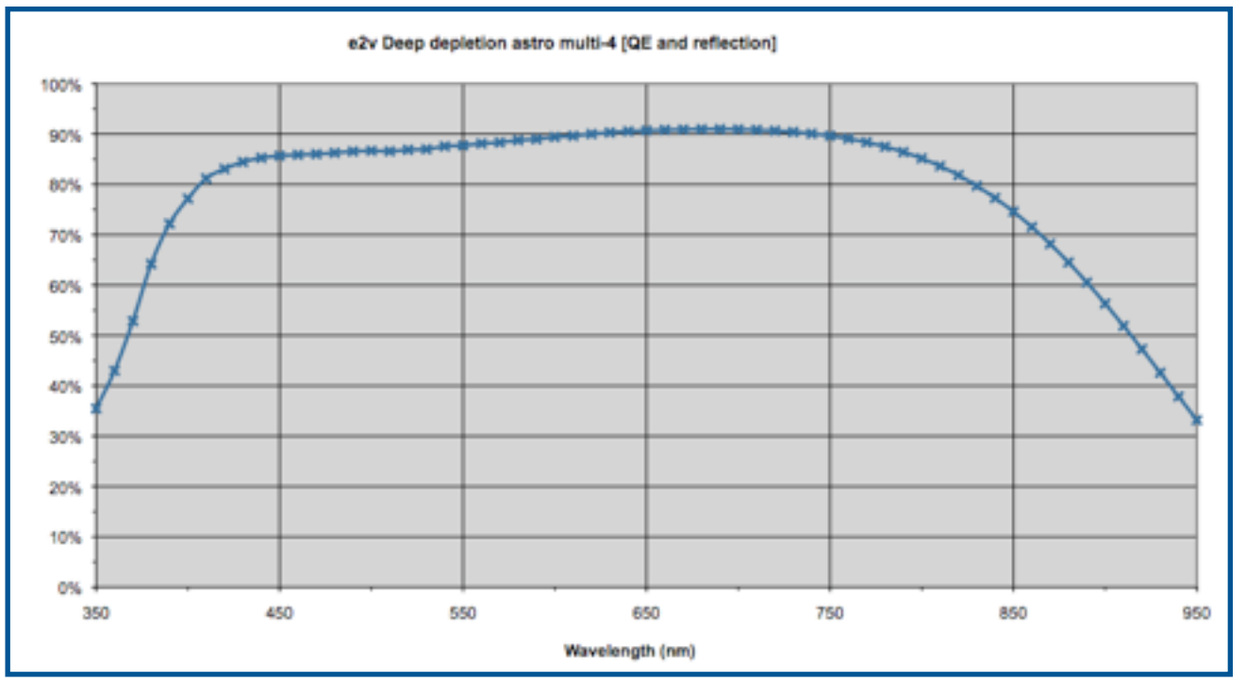


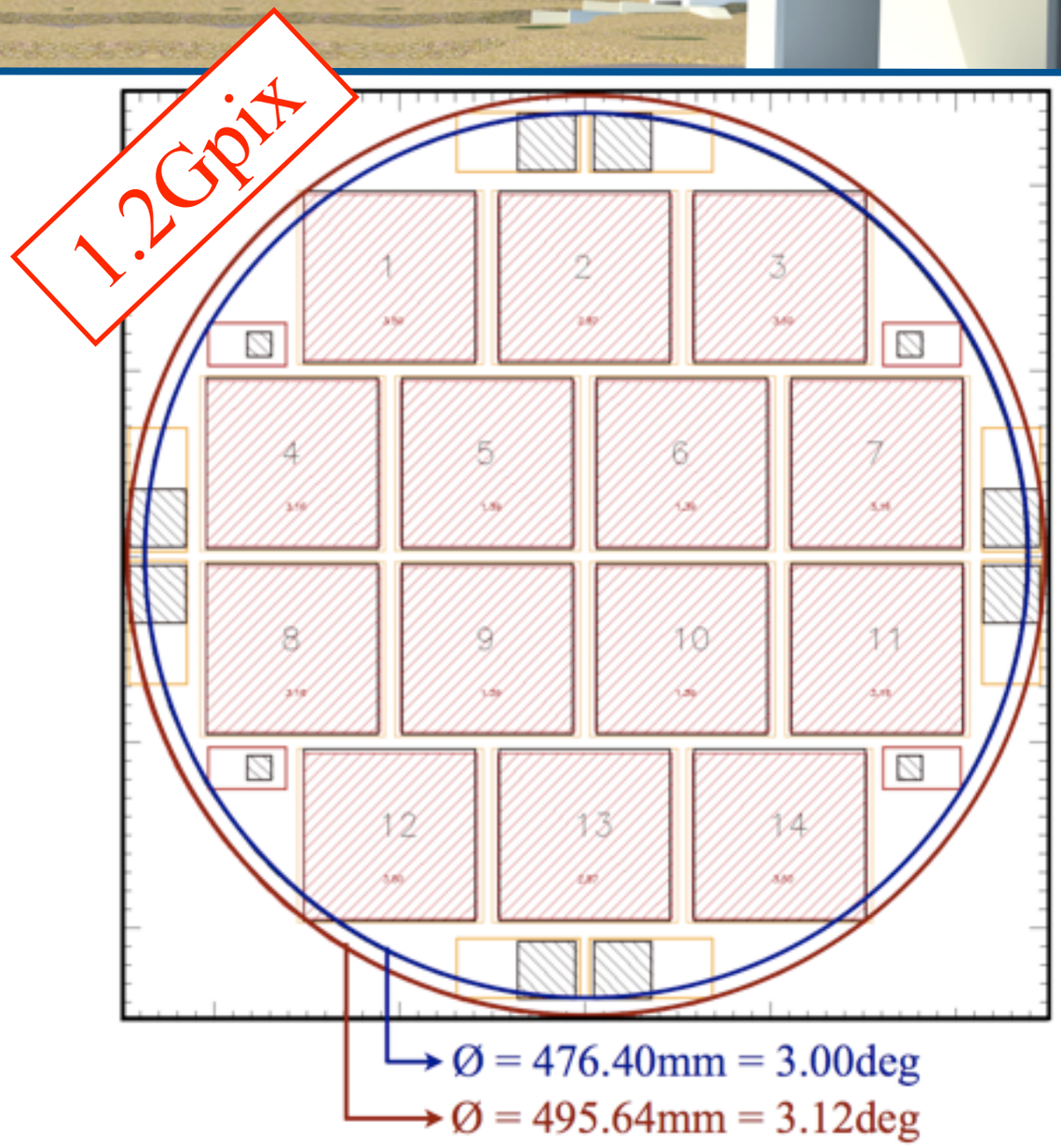



# JPCam camera unit




e2v CCD290-99 backside illuminated, 16 ports
High QE
Low noise



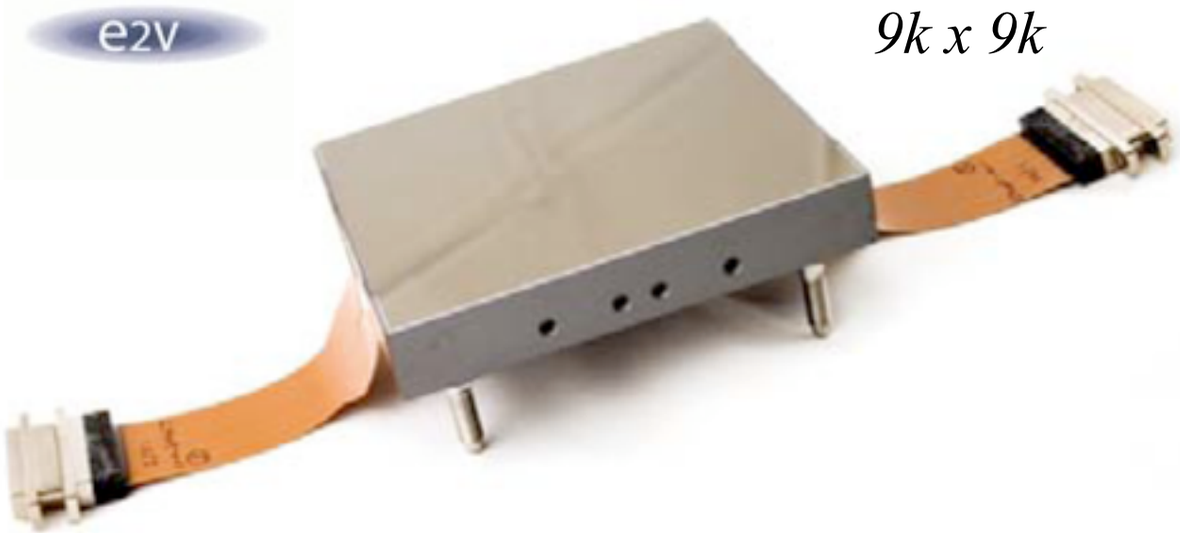

| | |
|---|---|
| FoV | Ø=3.0º (full performance)<br>Ø = 3.1º (reduced performance) |
| CCD format | 9216 x 9240 pix, 10 µm/pix |
| Pixel scale | 0.22 “/pix |
| Read out time | 12s |
| Read out noise | 6 $e^-$/pixel |

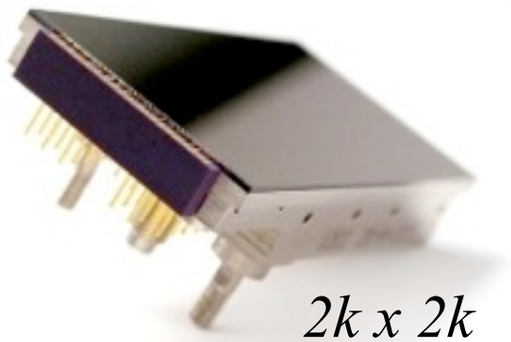
# JPCam camera unit

# JPCam camera unit

Science CCDs

*9k x 9k*



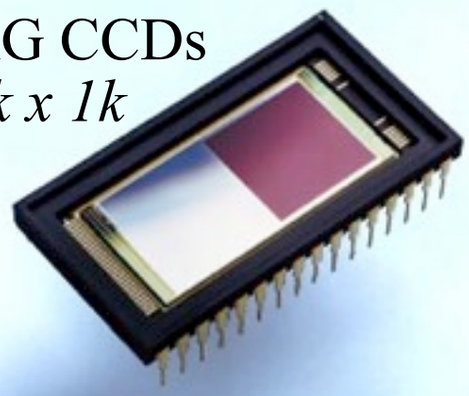


*2k x 2k*

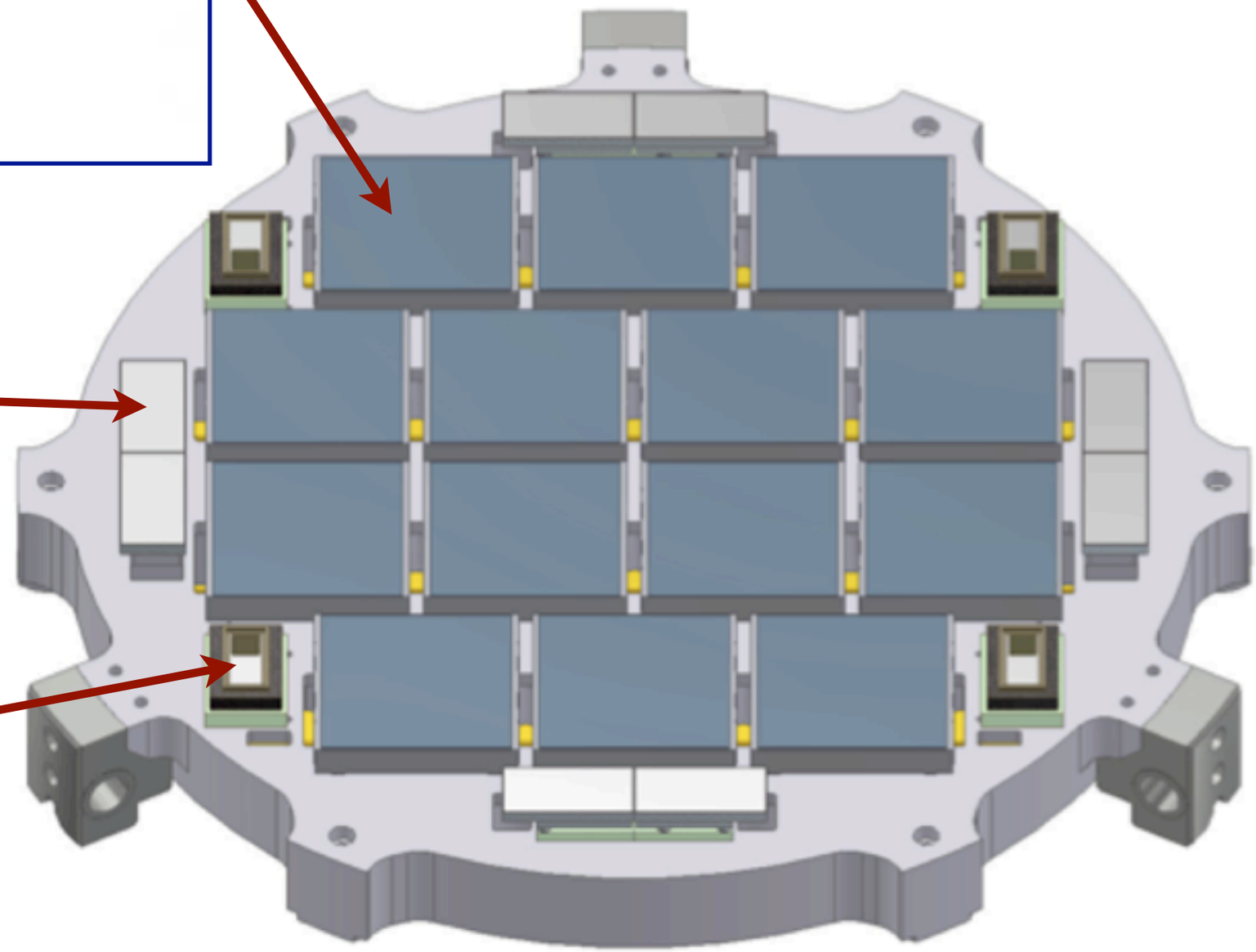
WFS CCDs

AG CCDs

*1k x 1k*



Flatness requirement: 40µm p-t-v surface flatness over the whole focal plane



# JPCam camera unit

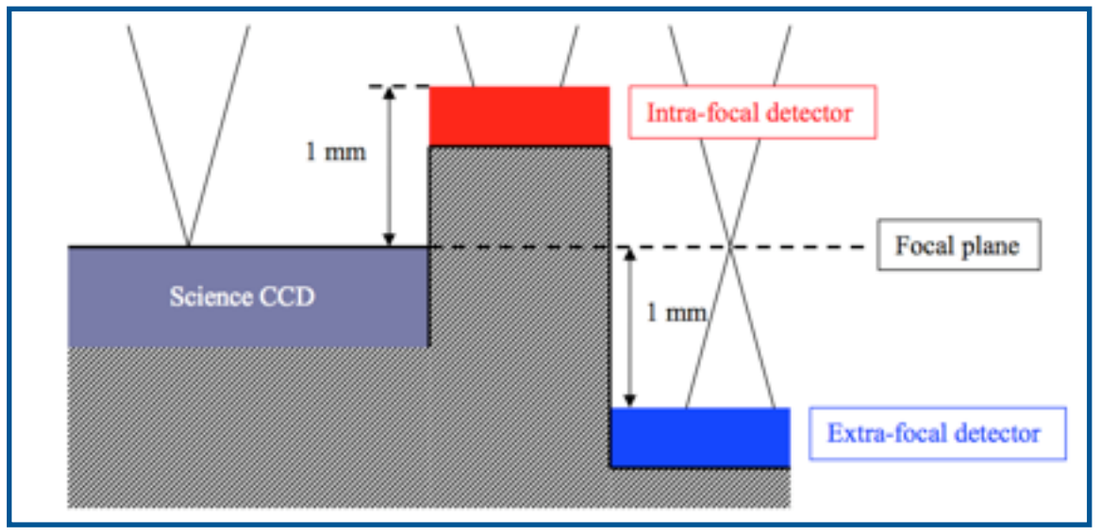
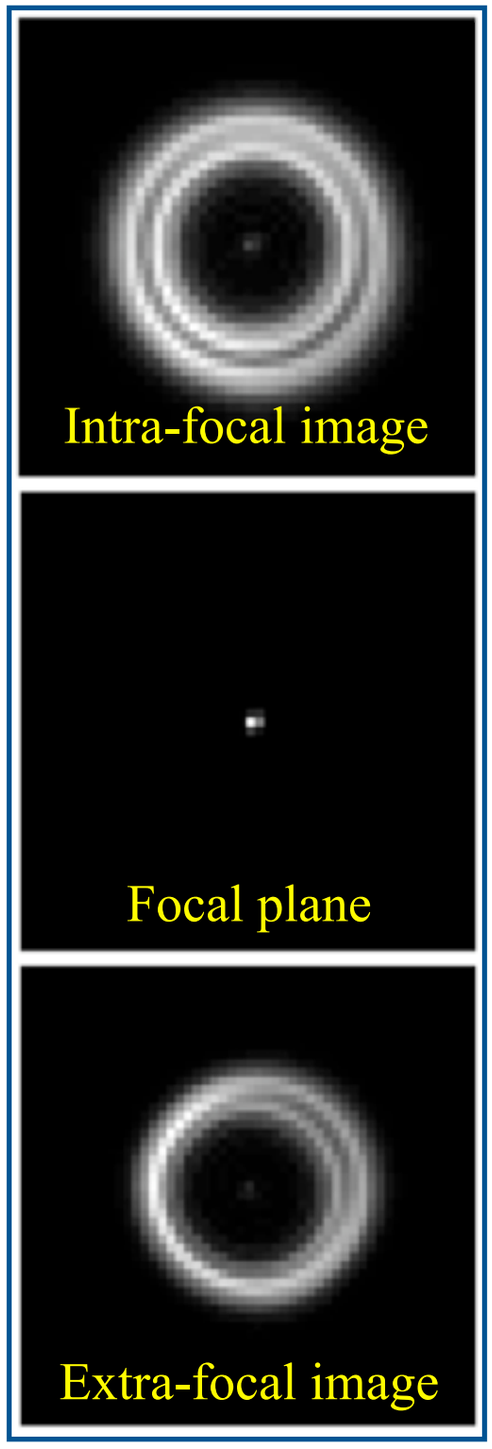
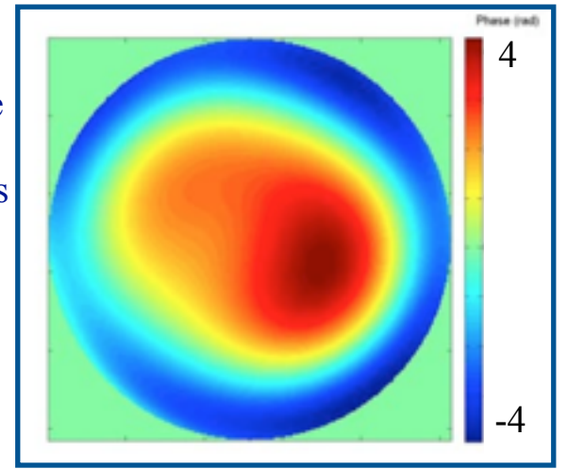



Image quality control closed loop



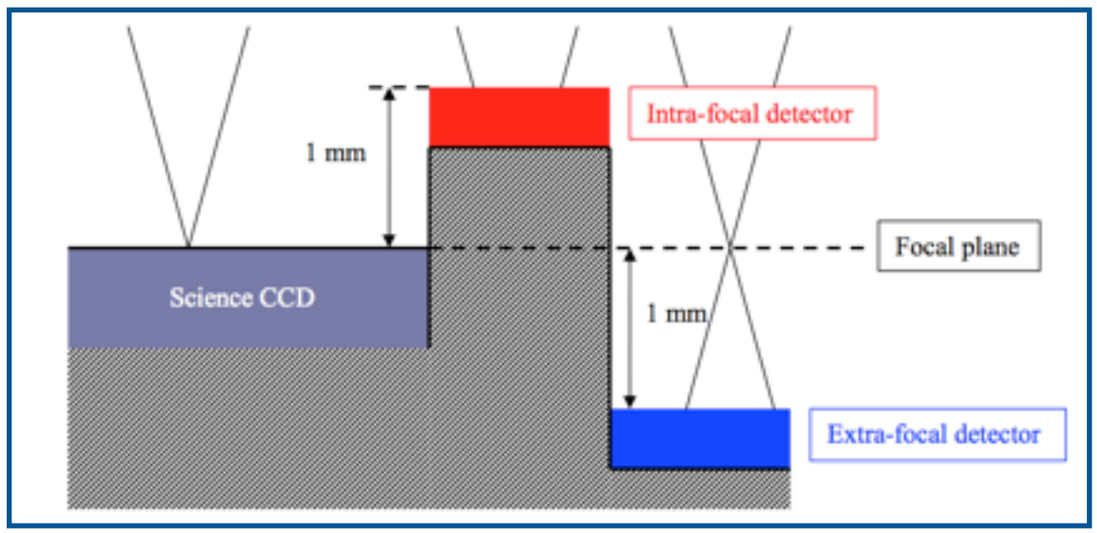

Compute Zernike polynoms →

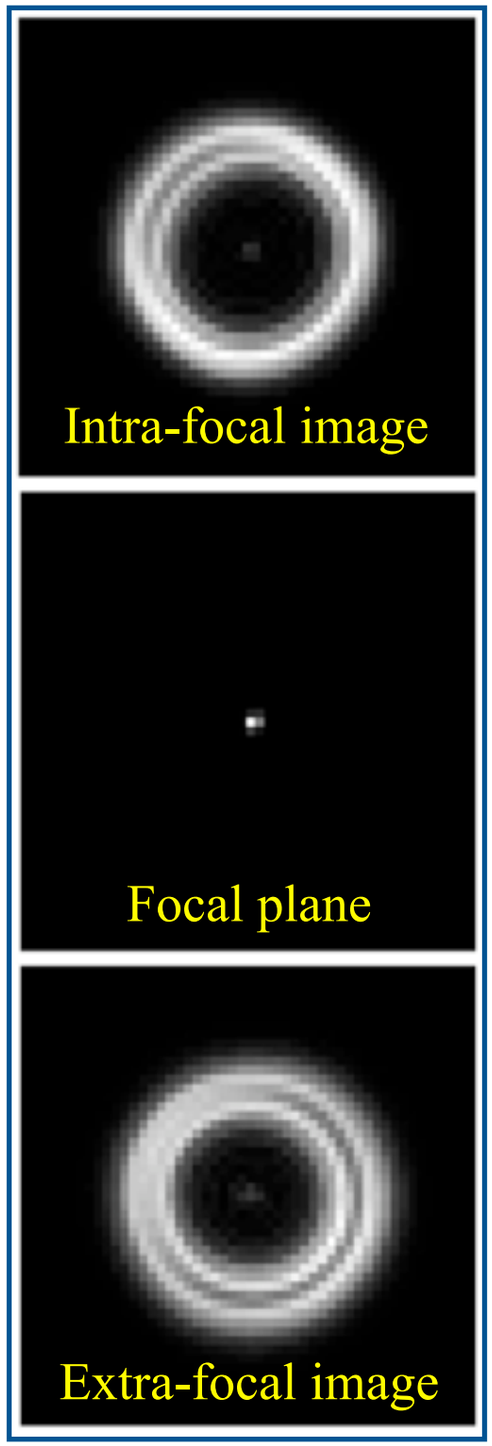
WF reconstruction




Compute and apply:
M2 hexapod motions
+
Focal plane actuators motions

# JPCam camera unit




WF reconstruction

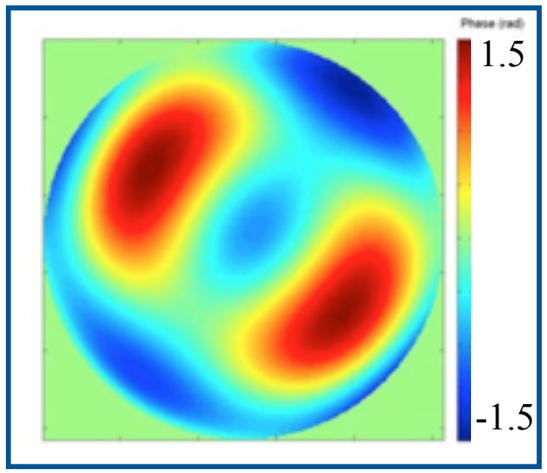
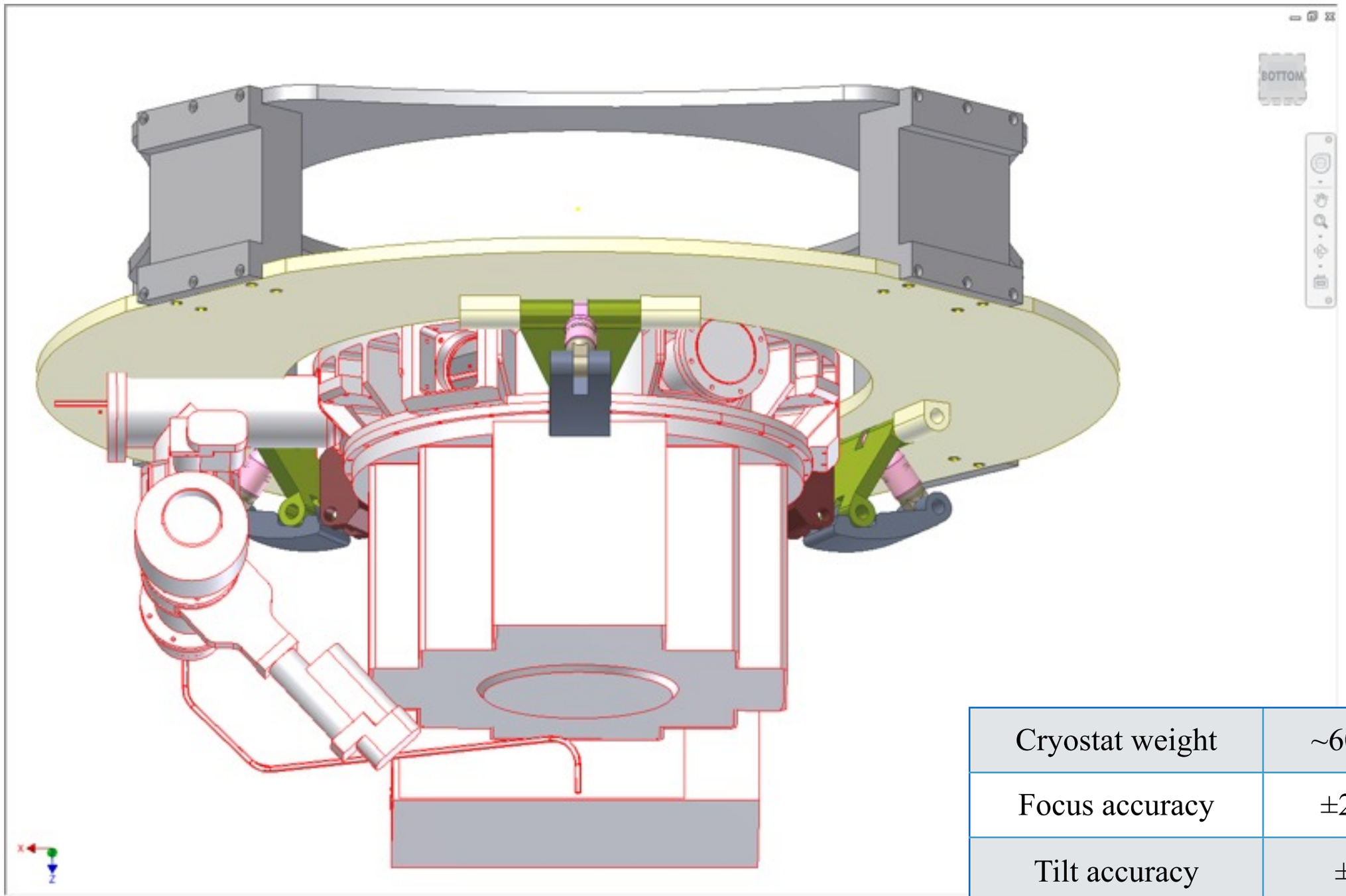



Image quality control closed loop

# JPCam actuator unit




| | |
|---|---|
| Cryostat weight | ~600Kg |
| Focus accuracy | ±2 µm |
| Tilt accuracy | ± 3” |
| Response time | <2s |

# Outline

- T80Cam@T80
  - Filter/Shutter Unit
  - Camera Unit
- JPCam@T250
  - Filter/Shutter Unit
  - Camera Unit
  - Actuator Unit
- Summary and schedule

# Summary and schedule

| T80Cam | |
|---|---|
| FoV | Ø=1.7º (full performance)<br>Ø = 2.0º (reduced performance) |
| Ø EE50 | 0.49” / 9 µm / 1 pix |
| Ø EE80 | 1.00 ” / 18 µm / 2 pix |
| CCD format | 10580 x 10580 pix<br>9 µm/pix |
| Pixel scale | 0.5 “/pix |
| FoV coverage | ~2□$^0$ |
| Read out time | <20s |
| Read out noise | 6 $e^-$/pixel |
| # of filters | 6 intermediate/broad- + 6 narrow-band |

| JPCam | |
|---|---|
| FoV | Ø=3.0º (full performance)<br>Ø = 3.1º (reduced performance) |
| Ø EE50 | 0.23” / 10 µm / 1 pix |
| Ø EE80 | 0.45” / 20 µm / 2 pix |
| CCD format | (14 x) 9216 x 9240 pix<br>10 µm/pix |
| Pixel scale | 0.23“/pix |
| FoV coverage | ~5□$^0$ |
| Read out time | 12s |
| Read out noise | 6 $e^-$/pixel |
| # of filters | 2 intermediate/broad- + 54 narrow-band |

| **Instrument** | **Expected day 1** |
|---|---|
| T80Cam | Beginning 2013 |
| JPCam | Late 2014 |

# JPCam & T80Cam:

## First light survey instruments for the Javalambre Astrophysical Observatory

Keith Taylor (IAG.ON), Jordi Cepa (IAC), A. Marín-Franch (CEFCA)
& J-PAS collaboration