



# GTC Instrument Suite

*Antonio Cabrera-Lavers*  
*GRANTECAN*



GTC-CTA Synergies IPARCOS meeting December 17th 2019, UCM, Madrid

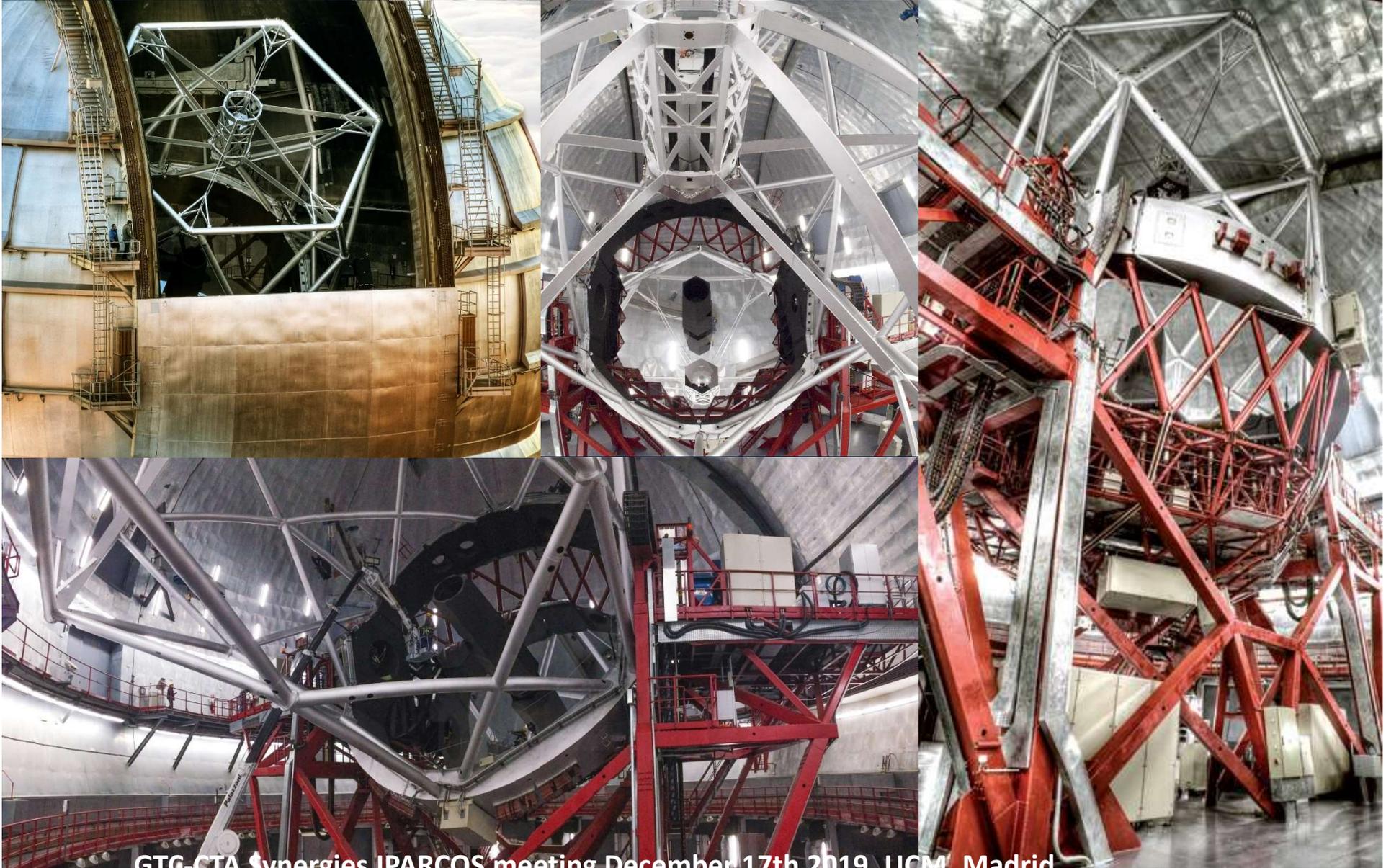


## *The organization*

- **GTC** telescope is an initiative of the Instituto de Astrofísica de Canarias (IAC)
- Funded by Spain (90%), México (5%), and the University of Florida (2.5-5%)
- Belongs to the set of Spanish *Unique Scientific & Technical Infrastructures*
- **GRANTECAN** is the company that built, operates, maintains and upgrades GTC
- The GRANTECAN team consists of 74 support astronomers, engineers, technicians and administrative staff: 56 are based on La Palma, and 18 in Tenerife at the IAC headquarters



# GTC telescope



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## *GTC telescope. The focal stations*





# GTC Current Instrumentation Status





## *The instruments*

Goal is a good balance between general-purpose instruments covering a wide spectral range (e.g. OSIRIS + EMIR + CanariCam) and instruments designed to provide specific capabilities which raise the scientific competitiveness of the GTC. Versatility provided by the number of available foci.

Distinguished features (2022+) are:

- **Tunable filters** (OSIRIS)
- **Fast Imaging** (HiPERCAM)
- **MOS** (OSIRIS, EMIR, MEGARA, MIRADAS)
- **IFU** (MEGARA, MIRADAS, FRIDA)
- at low to **intermediate spectral resolution** (MEGARA, MIRADAS, FRIDA)
- **High spectral resolution** spectroscopy (GTC-HRS)

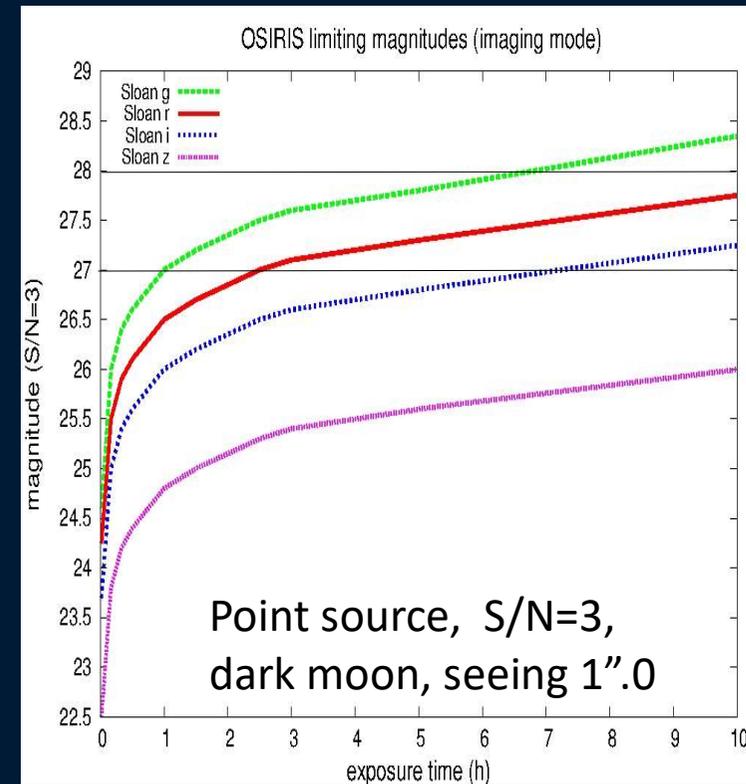
The combination of these features and the large collecting area make them unique instruments, and with higher sensitivity than other similar instruments.



## OSIRIS imager and multi-object spectrograph

Common-user instrument since 2009 (Nasmyth B). Cass in late 2020/early 2021.

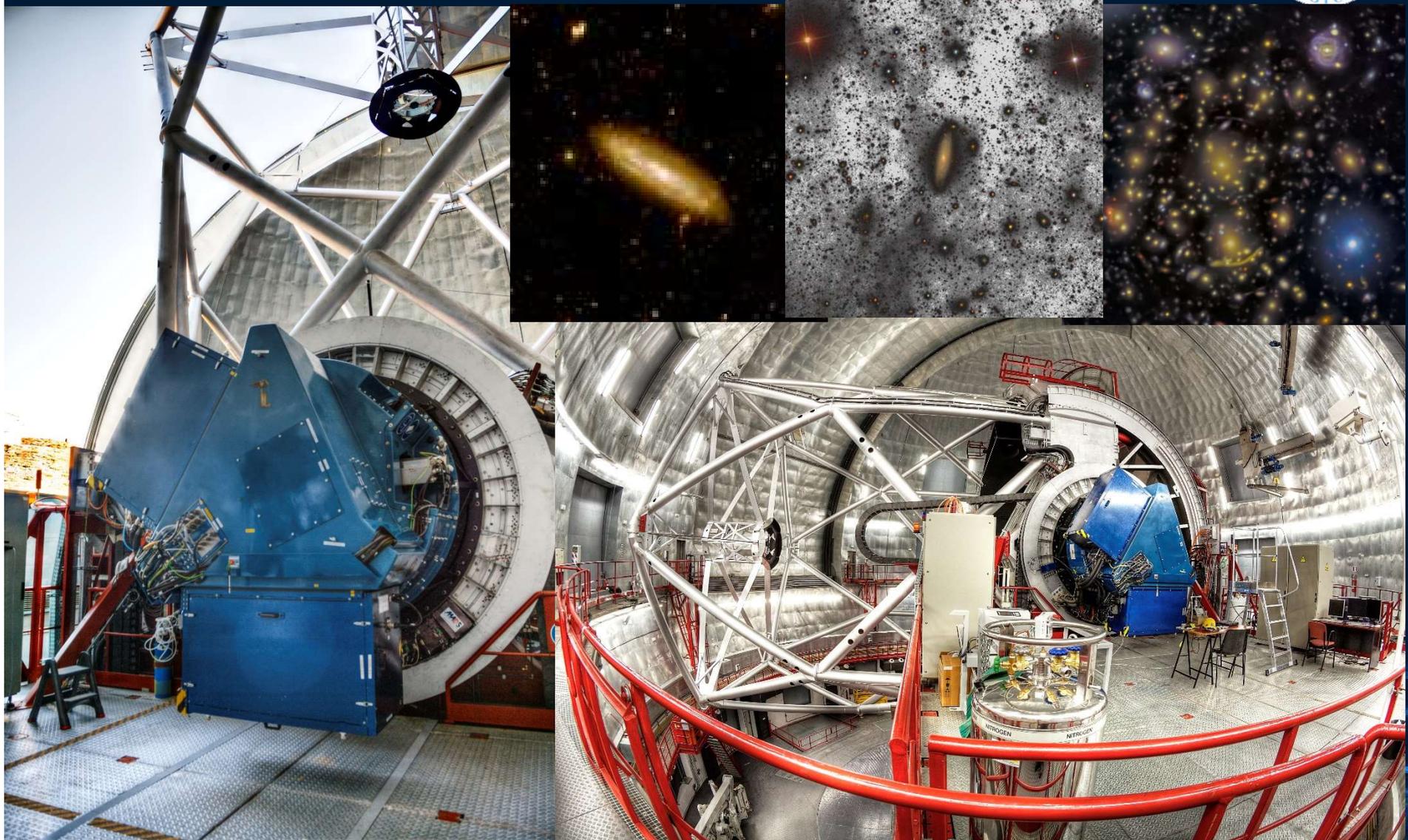
<i>Spectral Range</i>	0.36-1.00 $\mu\text{m}$
<i>Detector</i>	2 x Marconi 2k x 4k
<i>Plate Scale</i>	0.125 arcsec $\text{pix}^{-1}$
<i>Field of view</i>	7.8 x 7.8 arcmin <sup>2</sup>
<i>Imaging modes</i>	broad/medium band, TFs, fast photometry
<i>Spectroscopic modes</i>	long-slit, mask MOS
<i>Spectral resolution</i>	300 to 2500



New monolithic 4kx4k detector will be received by late 2020.

Visitor IFU-module in OSIRIS (MAAT) for transients observations still under discussion.

# *OSIRIS optical imager and spectrograph*

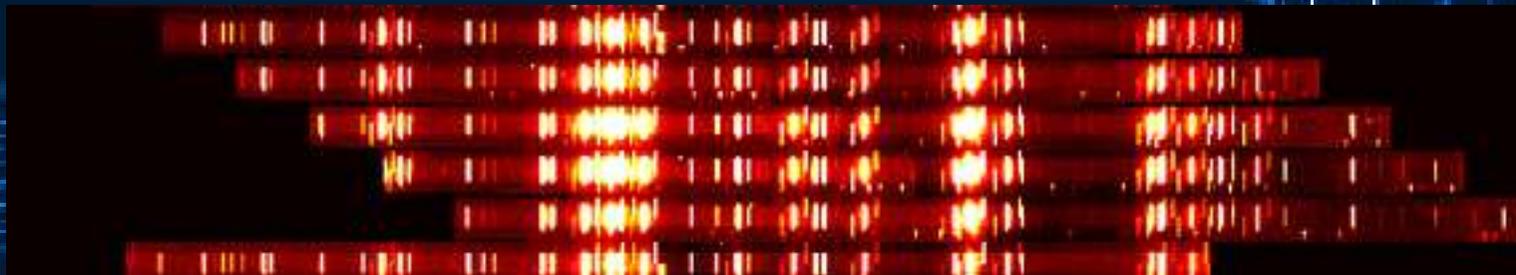




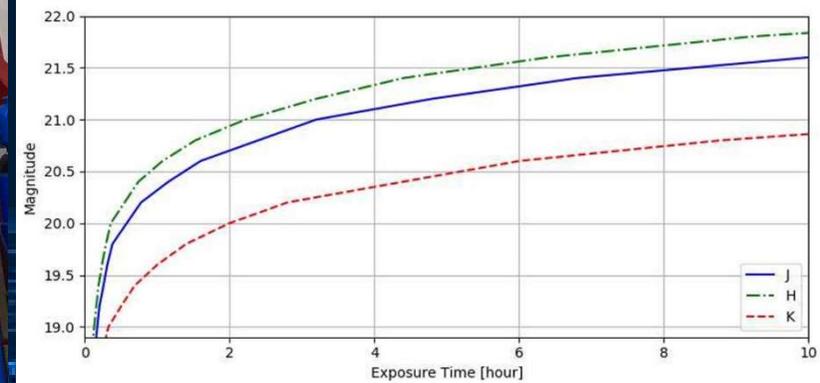
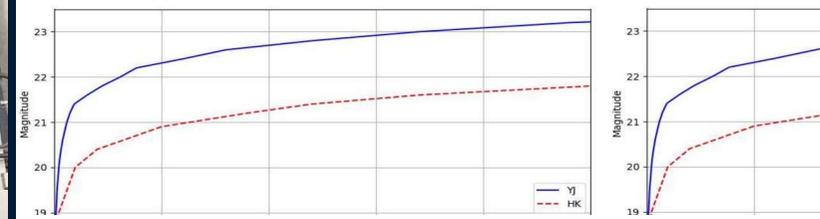
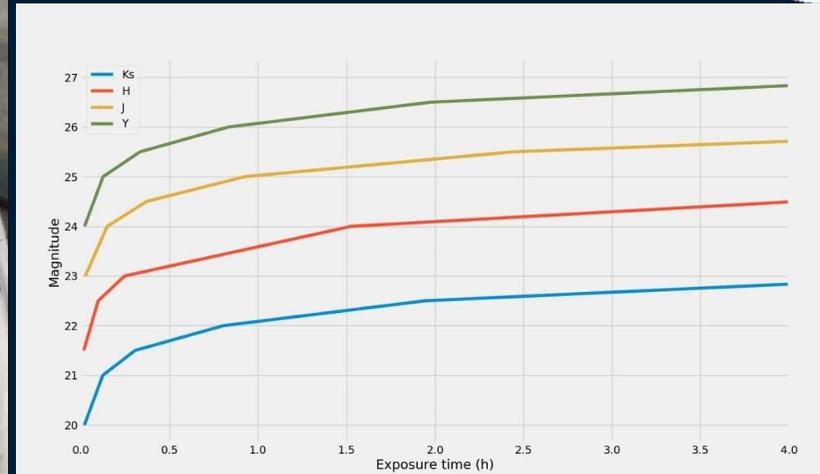
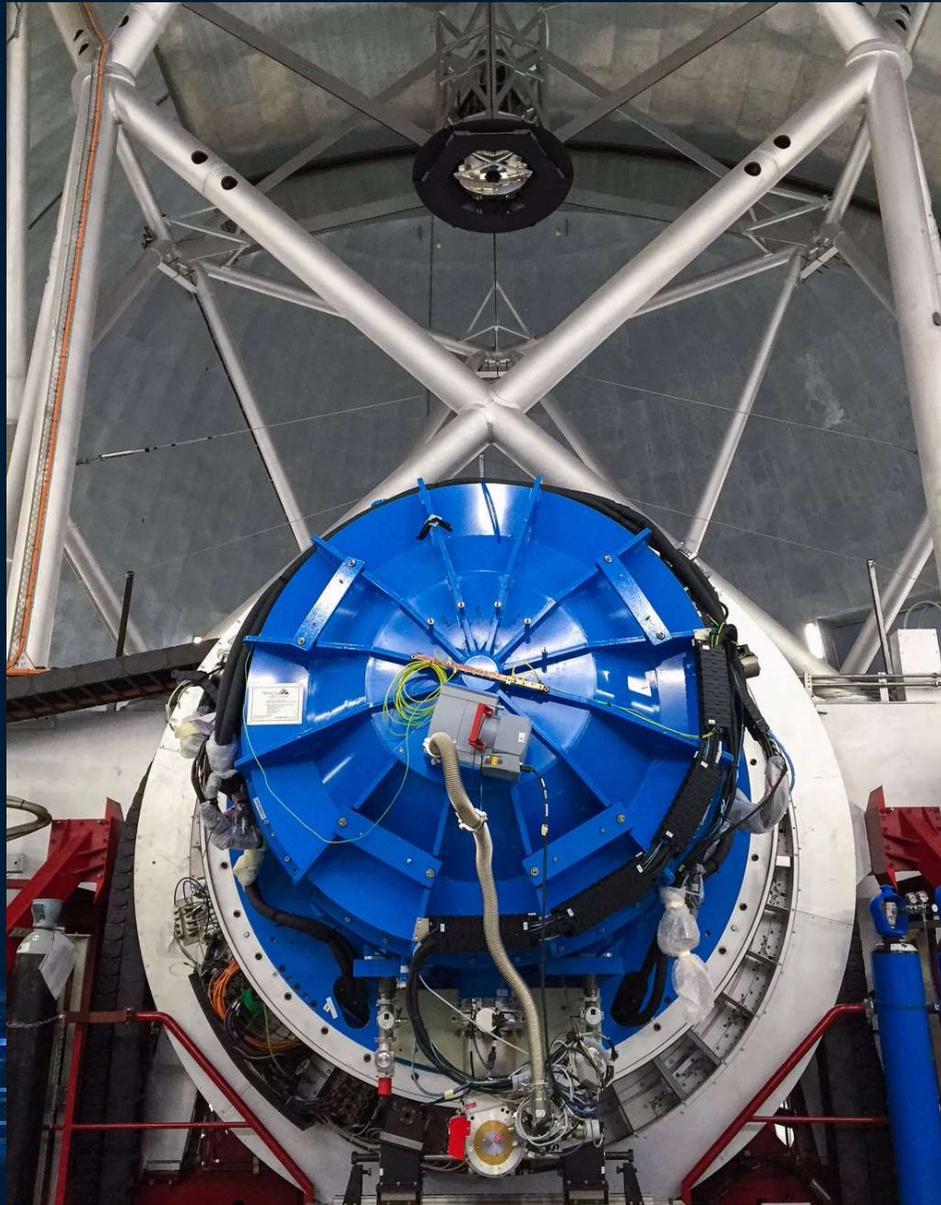
## EMIR NIR imager and multi-object spectrograph

Common-user instrument since 2017 (Nasmyth A).

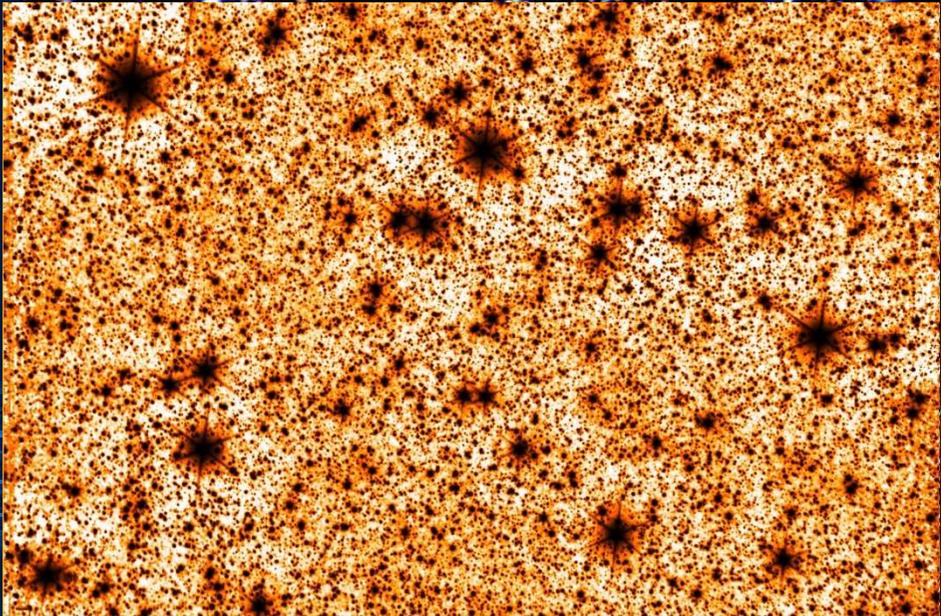
<i>Spectral Range</i>	0.9-2.5 $\mu\text{m}$ [1.1-2.5 $\mu\text{m}$ ]	<i>MOS mode</i>	
<i>Detector</i>	HAWAII2 2048 <sup>2</sup>	<i>F.O.V.</i>	6.7 x 4 arcmin <sup>2</sup> (55 slitlets)
<i>Spectral resolution</i>	1000 (YJ, HK) 5000,4250,4000 (JHK)	<i>Sensitivity</i>	<u>K~20.1 in 2h @ S/N=5 (continuum)</u>
<i>Spectral coverage</i>	1 single window/exp.		1.4x10 <sup>-18</sup> erg/s/cm <sup>2</sup> /Å @ S/N=6 (line)
<i>Imaging modes</i>	Broad/narrow band	<i>Imaging mode</i>	
<i>Plate Scale</i>	0.2 arcsec pix <sup>-1</sup>	<i>F.O.V.</i>	6.7 x 6.7 arcmin <sup>2</sup>
<i>Image quality</i>	$\theta_{80} < 0.3$ arcsec	<i>Sensitivity</i>	<u>K~22.0 in 1h, for S/N=3 &amp; 0.6 arcsec aperture</u>



# EMIR NIR imager and multi-object spectrograph



# *EMIR NIR imager and multi-object spectrograph*

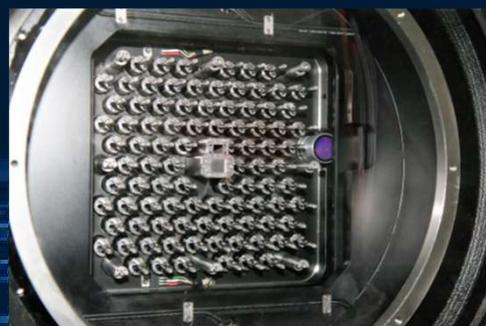
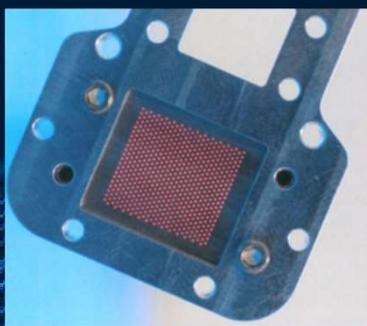
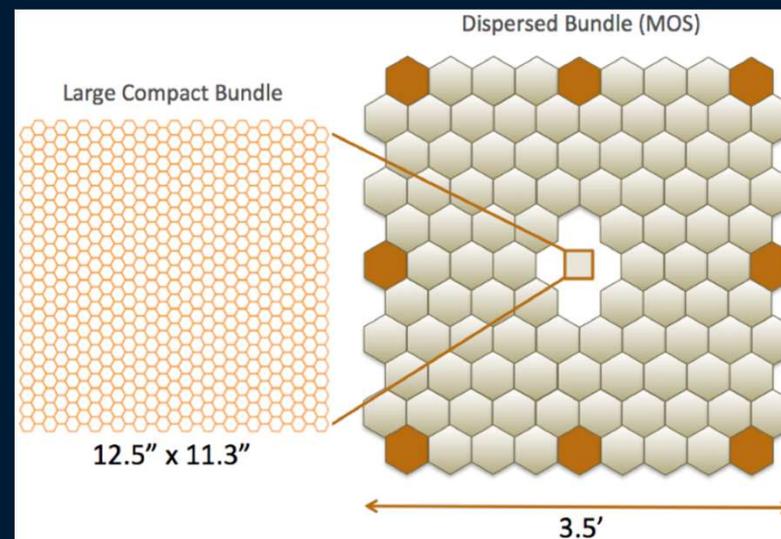




# MEGARA optical medium-res multi-object spectrograph

Common-user instrument since 2018 (FCass-F).

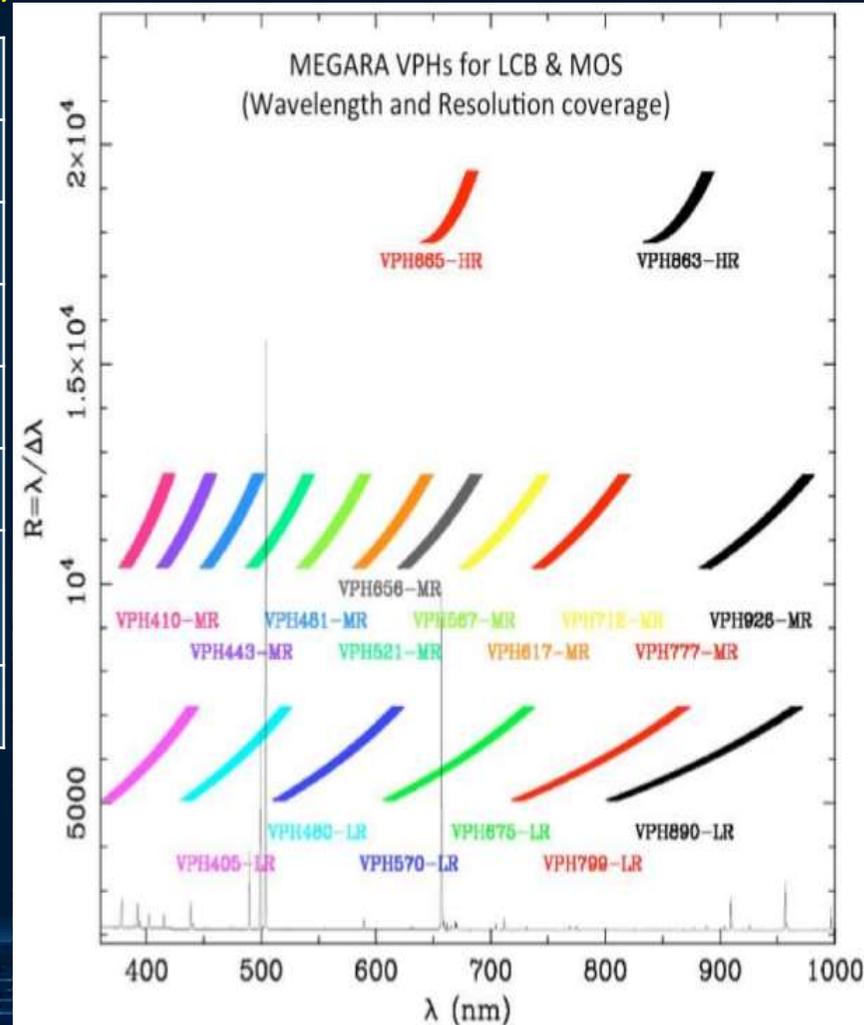
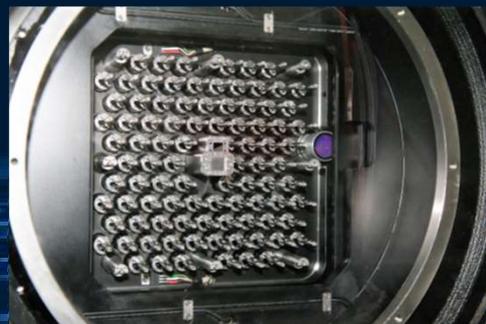
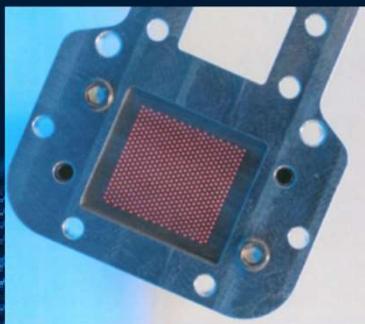
<i>Spectral range</i>	0.365-1.000 $\mu\text{m}$
<i>Detector</i>	E2V CCD231-84-1-E74
<i>IFU field of view</i>	12.5 x 11.3 arcsec <sup>2</sup>
<i>IFU spaxel size</i>	0.62 arcsec
<i>MOS</i>	92 x 7-fiber mini-IFUs
<i>MOS field of view</i>	3.5 x 3.5 arcmin <sup>2</sup>
<i>Spectral resolution</i>	6000 to 20000
<i># of spectra</i>	650



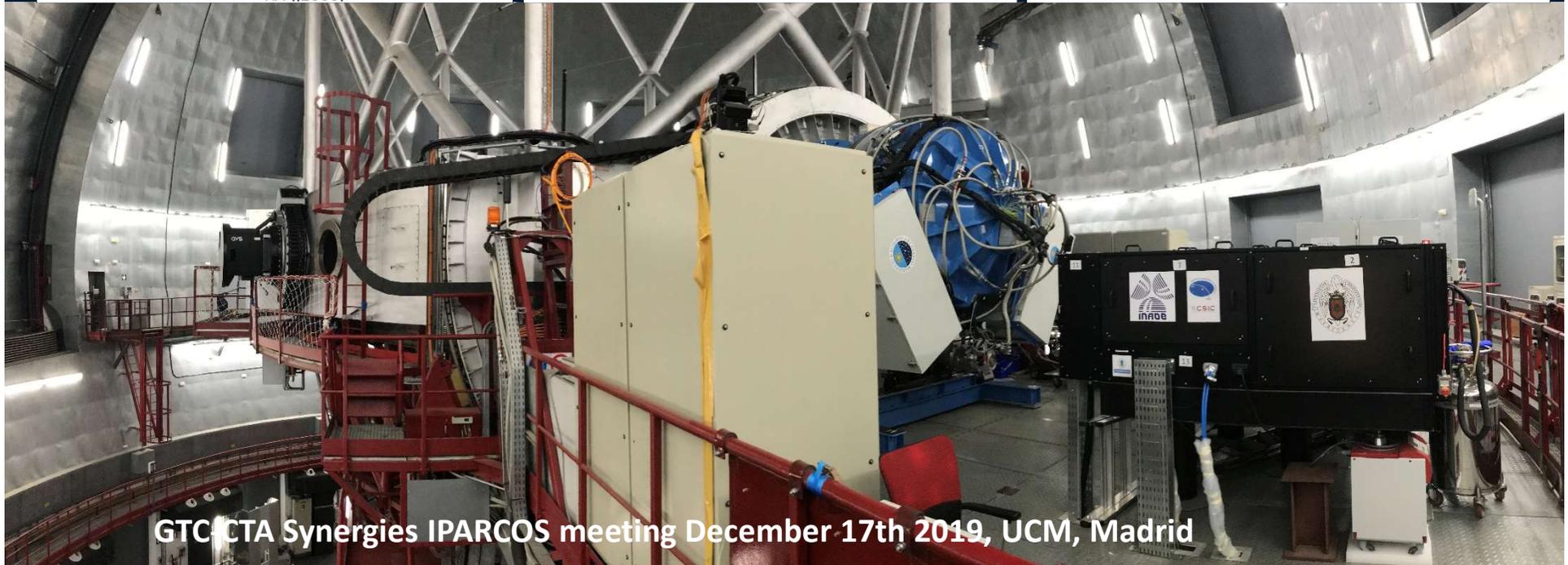
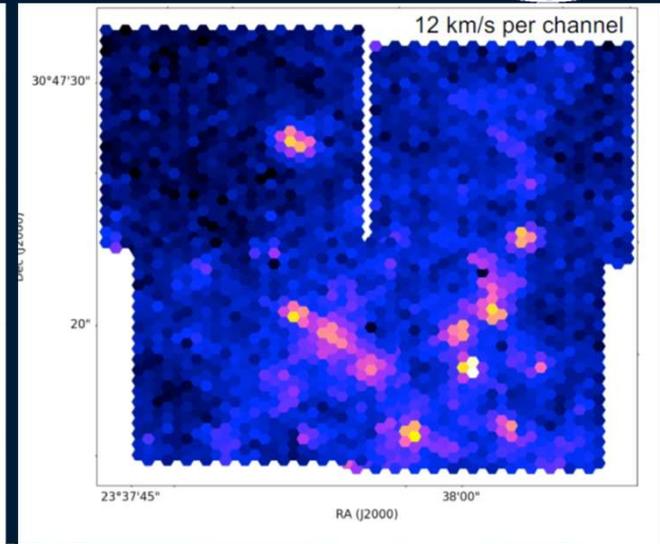
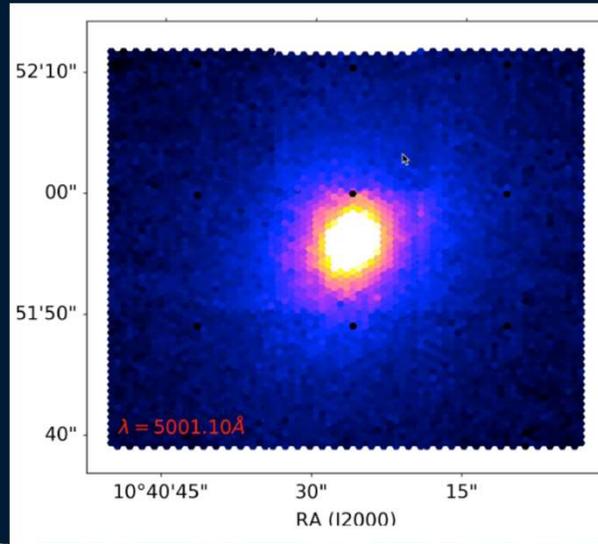
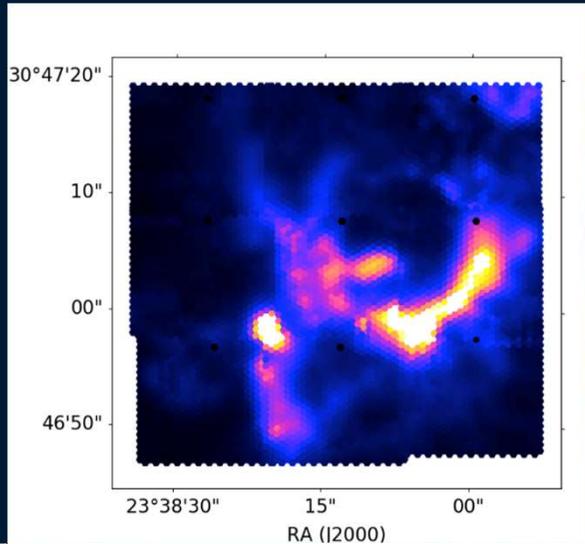
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# MEGARA optical medium-res multi-object spectrograph



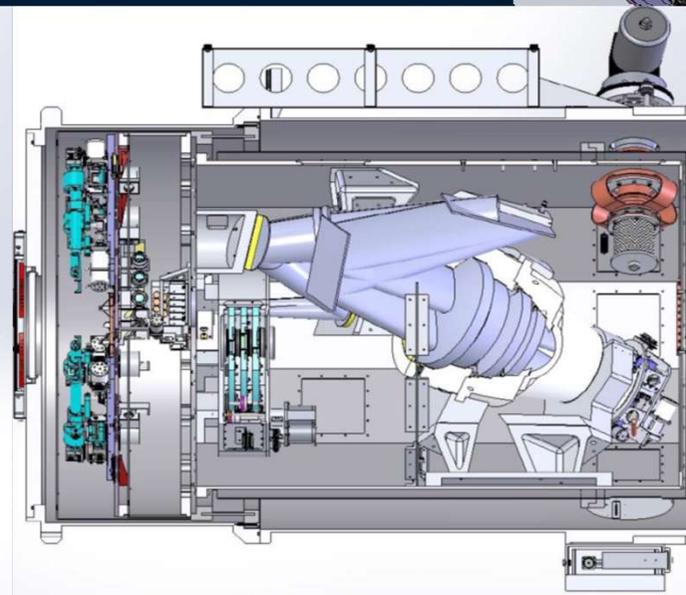
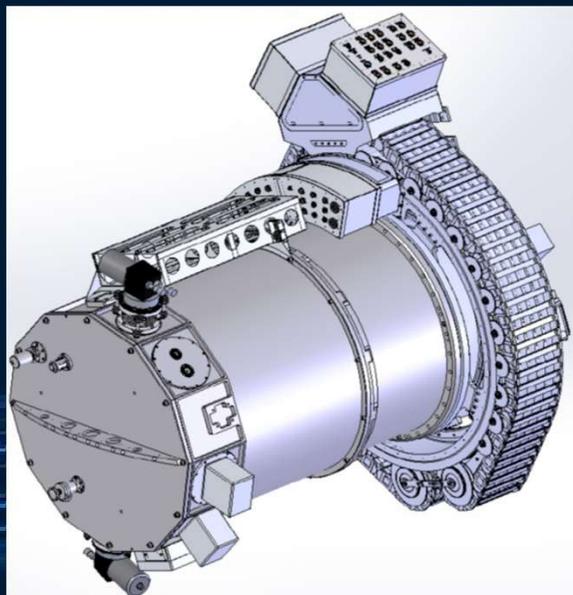
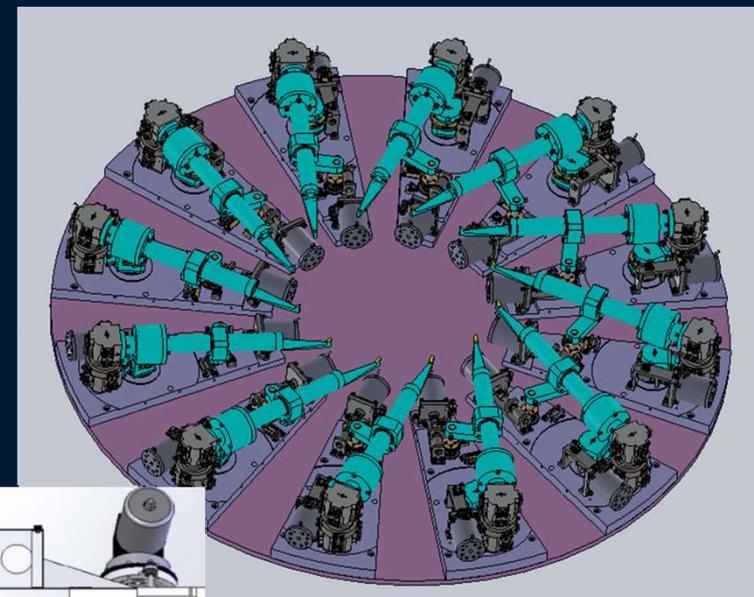
GTC-CTA Synergies IPARCOS meeting December 17th 2019, UCM, Madrid



# MIRADAS NIR medium-resolution multi-object spectrograph

Common user instrument (FCass-E). On the GTC in early 2020.

<i>Spectral Range</i>	1-2.5 $\mu\text{m}$
<i>Field of view</i>	5' x 5'
<i>Spectroscopic mode</i>	MOS up to 12 probe arms
<i>Spectral resolution</i>	20000

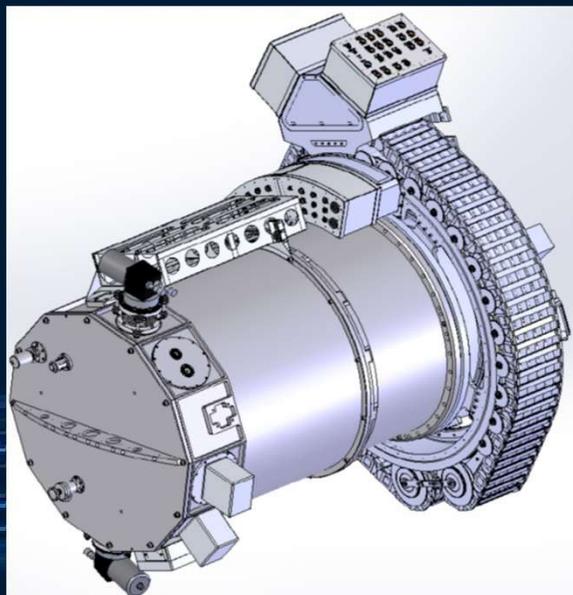




## MIRADAS NIR medium-resolution multi-object spectrograph

Common user instrument (FCass-E). On the GTC in early 2020.

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<i>Spectral resolution</i>	20000





## GTC-AO + FRIDA NIR imager and IFU spectrograph

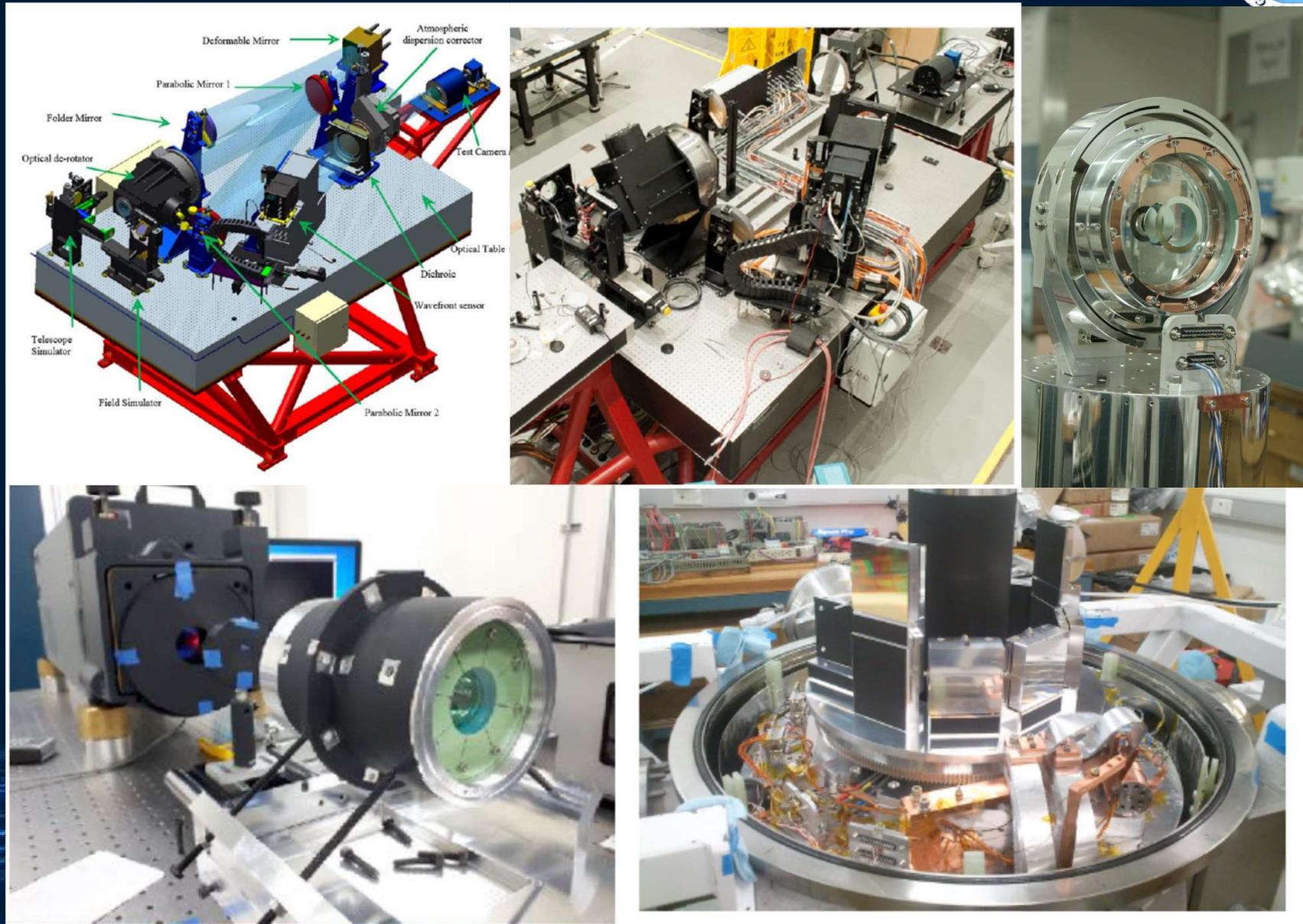
Natural guide-star Adaptive Optics is being developed at the IAC in collaboration with GTC. In a second stage, a laser guide star will be added.

GTC-AO will feed FRIDA at **Nasmyth-B**. FRIDA is developed at UNAM (Mexico).

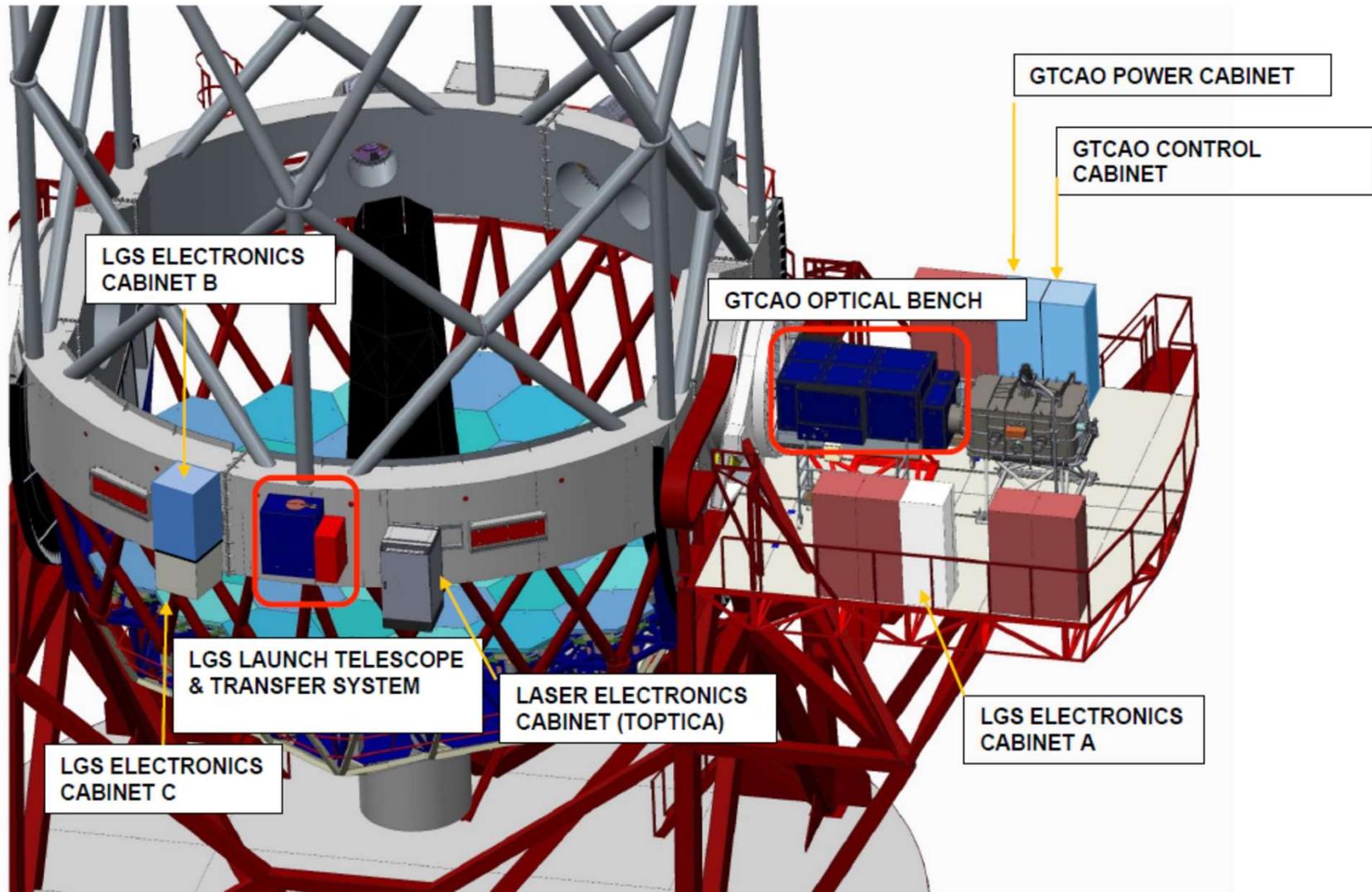
### Both expected in 2020-2021

GTC-AO		FRIDA	
Spectral range	0.9-2.5 $\mu\text{m}$	Spectral range	0.9-2.5 $\mu\text{m}$
Correction	Shack-Hartmann wfs in visible light	Detector	HAWAII2 2048 <sup>2</sup>
Corrected fov	1.5 arcmin	Imaging	mode
On-axis SR	>0.65 at 2.2 $\mu\text{m}$		f.o.v + plate scale
			20''x20'' (0.01 arcsec pix <sup>-1</sup> ) 40''x40'' (0.02 & 0.04 arcsec pix <sup>-1</sup> )
		Spectroscopic mode	IFU 0.6x0.6, 1.2x1.2 & 2.4x2.4 arcsec <sup>2</sup>
		Spectral resolution	1000 (Z, H, K), 4000 (Z, J, H, K), 30000 (H, K)

# GTC-AO + FRIDA NIR imager and IFU spectrograph



# GTC-AO + FRIDA NIR imager and IFU spectrograph

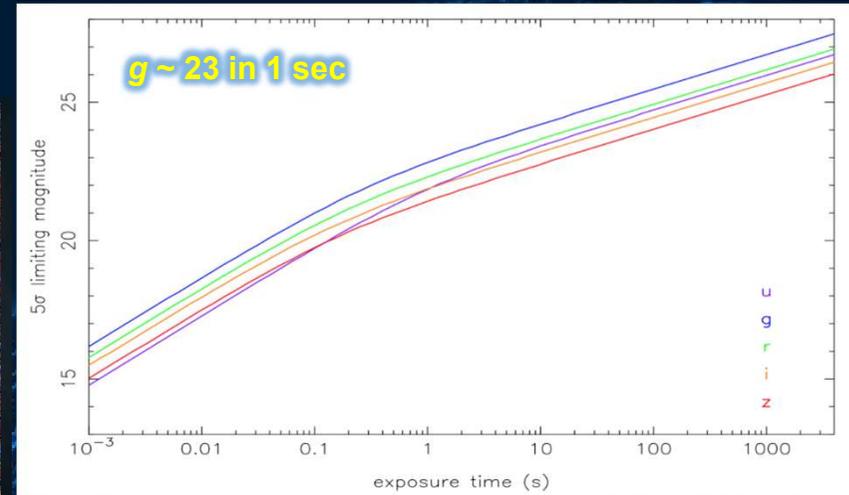
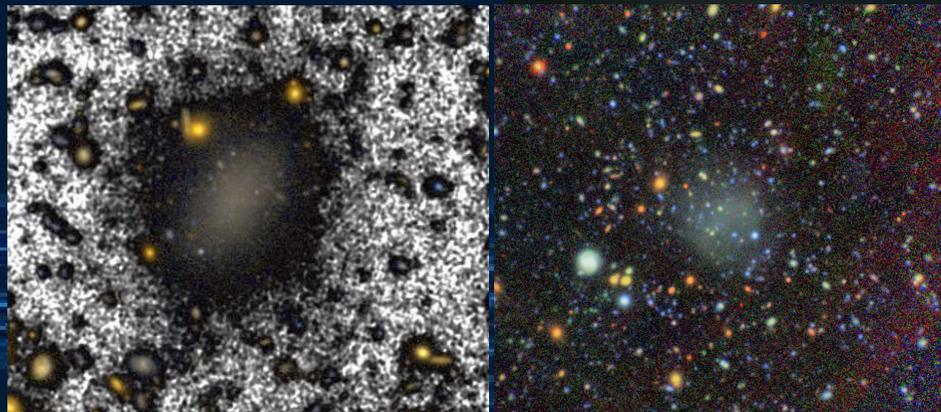
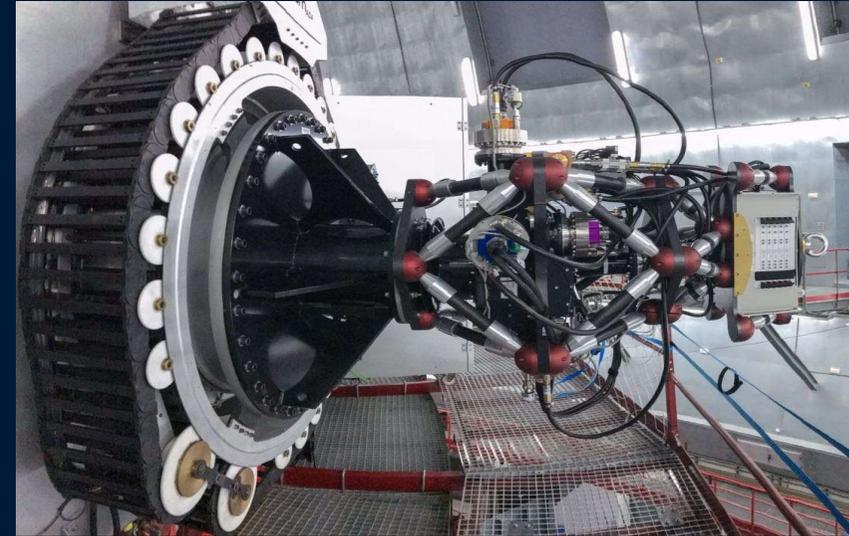




# HIPERCAM: High Speed, Multiband Imager on the GTC

Visitor instrument (Fcass-E). In operation between 2018-2019.

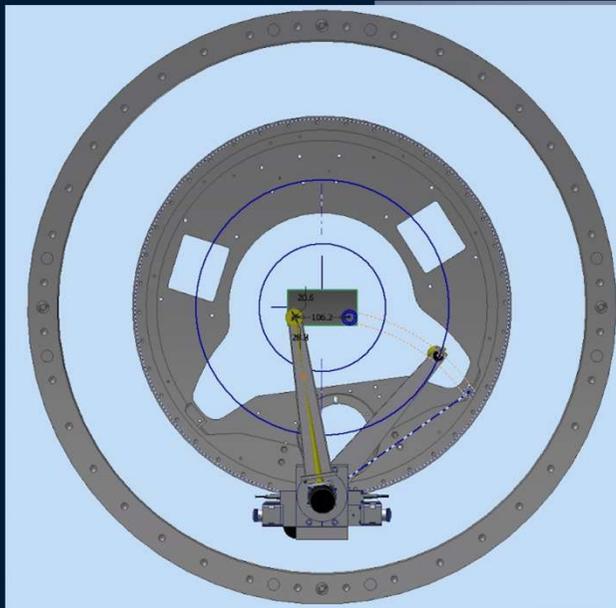
<i>Spectral Range</i>	0.36-1.00 $\mu\text{m}$
<i>Detector</i>	5 x E2V 47-20 frame-transfer devices
<i>Plate Scale</i>	0.081 arcsec $\text{pix}^{-1}$
<i>Field of view</i>	2.8 x 1.4 arcmin <sup>2</sup>
<i>Imaging modes</i>	Fast photometry with broad band filters u'g'r'l'z' (simultaneous)





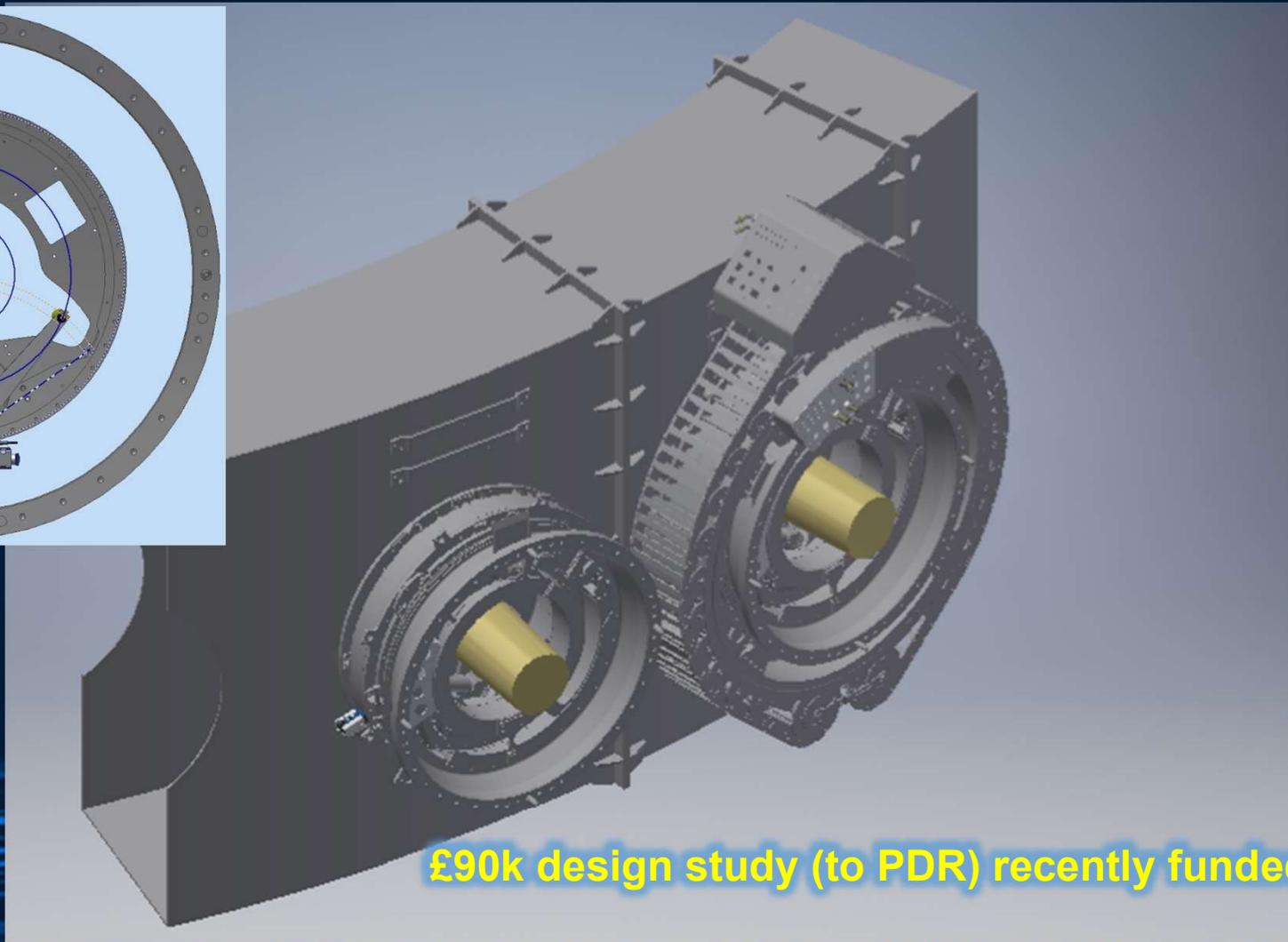
## HIPERCAM: High Speed, Multiband Imager on the GTC

Hipercam permanent mount at new FCass focus (2021+).



Future  
enhancements:  
**COMPO**

*(more details  
V. Dhillon's talk)*



**£90k design study (to PDR) recently funded**



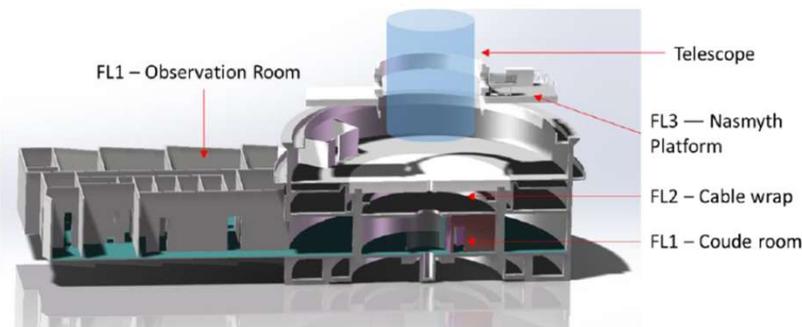
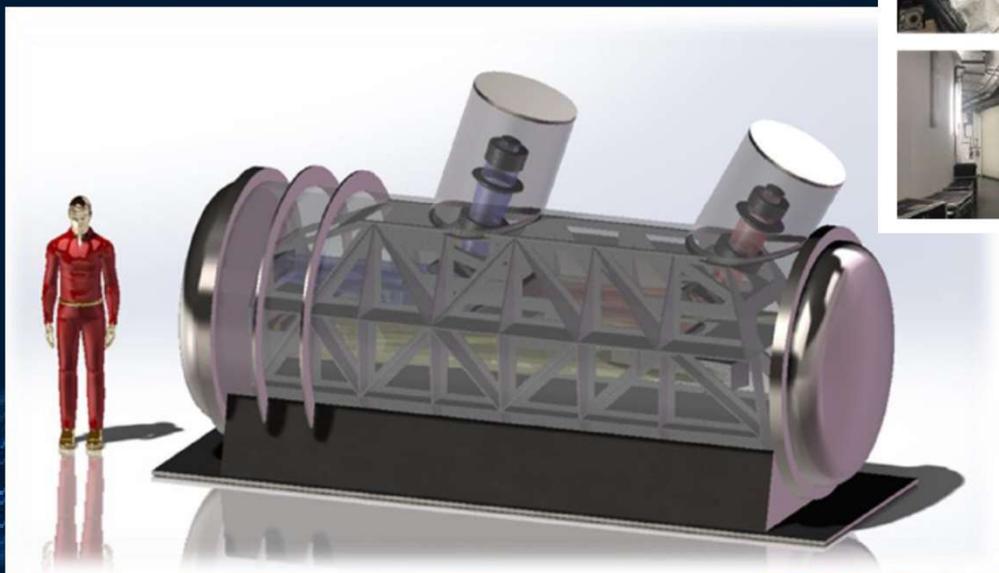
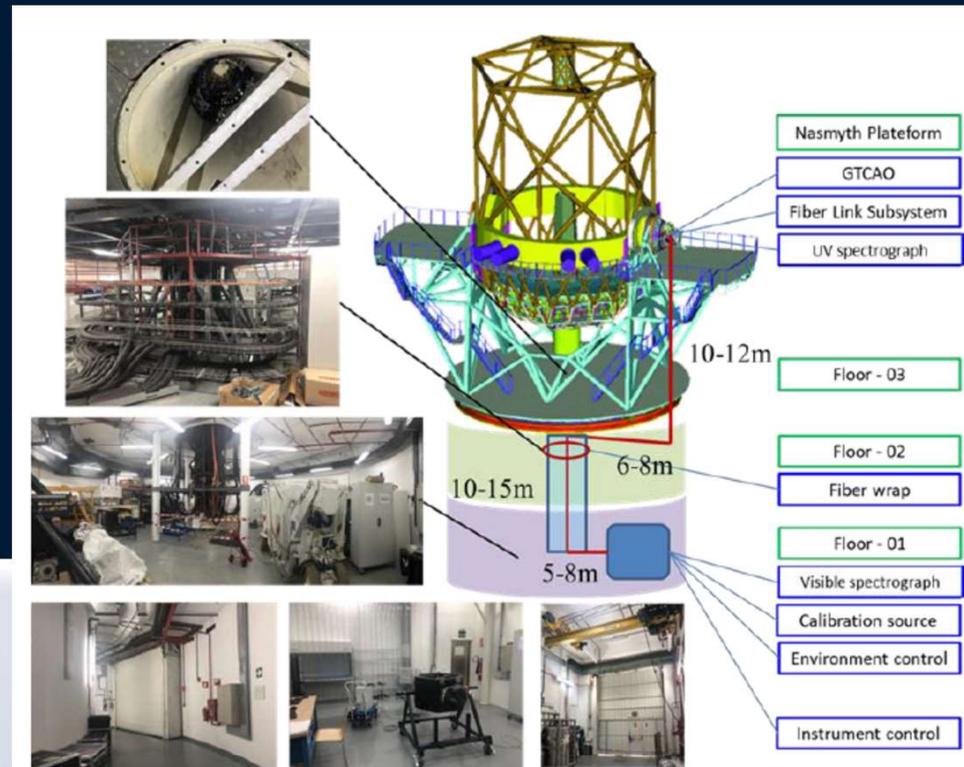
# GTC-HRS: High-resolution Ultra-stable Spectrograph for GTC

Two separated bands:

**UV @ 310 – 420nm ( $R > 25000$ )**  
**Visible @ 420 – 780nm ( $R > 100000$ )**

Successful Conceptual design review on  
June 25-26<sup>th</sup> 2019

Declared design/construction schedule  
6 years (**2025+**)





## GTC next generation instruments (2025+)

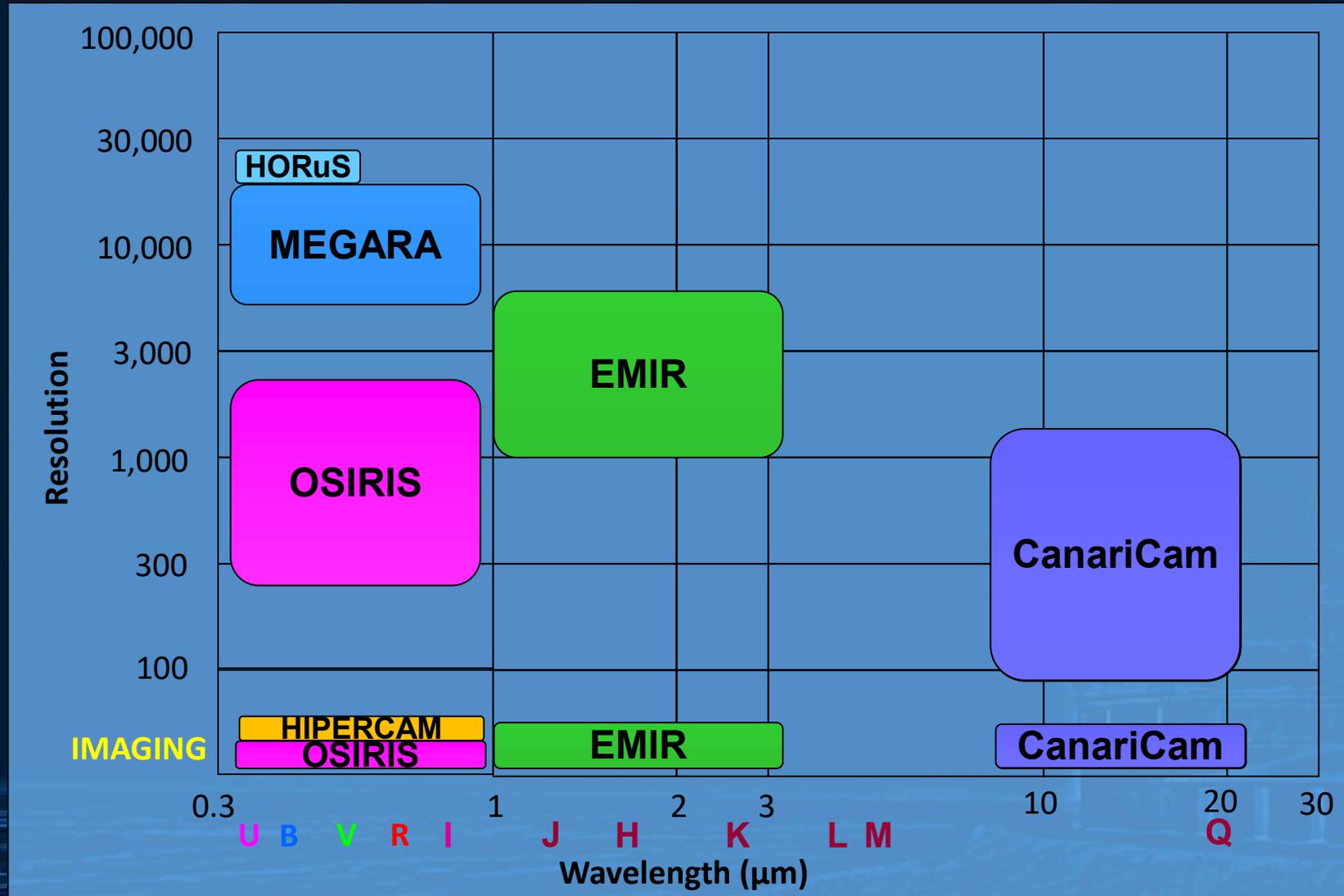
Open call for ideas on April 2018. 5 proposals received:

Instrument	GTC AO?	Wavelength range	Observing modes	FOV	Spectral Resolution	Budget
BATMAN	No	0.36 - 1.0 $\mu\text{m}$	Imaging Multi-Object Spectroscopy	2.3 x 1.2 arcmin (DMD-based) 6.0 x 6.0 arcmin (MIRA-based)	500 - 4000 (for 1-0.2 arcsec slits)	10 MEUR
GATOS	No/Yes	0.37 - 2.35 $\mu\text{m}$ (simultaneous)	Imaging Long Slit Spectroscopy High time- resolution IFU Spectropolarimetry	3 x 3 arcmin or 4.2 arcmin (diameter) 3 arcmin long slit 9.7 x 6.8 arcsec IFU 2.5 x 3.6 arcsec IFU (with AO)	4000	9.7 MEUR
<i>(more details A. de Ugarte's talk)</i>						
GTCMCAO	Yes (MCAO)	0.9 - 2.4 $\mu\text{m}$	Adaptive Optics Facility	40 x 40 arcsec	-	4.1 MEUR
MAGAM	Yes (MCAO)	0.9 - 2.4 $\mu\text{m}$	Diffraction limited Imaging	85 x 85 arcsec	-	43 MEUR
NEREA	No/Yes	0.8 - 1.7 $\mu\text{m}$	Fiber-fed Spectroscopy	-	R > 70000 (req.) R = 110,000 (goal)	4 - 5 MEUR

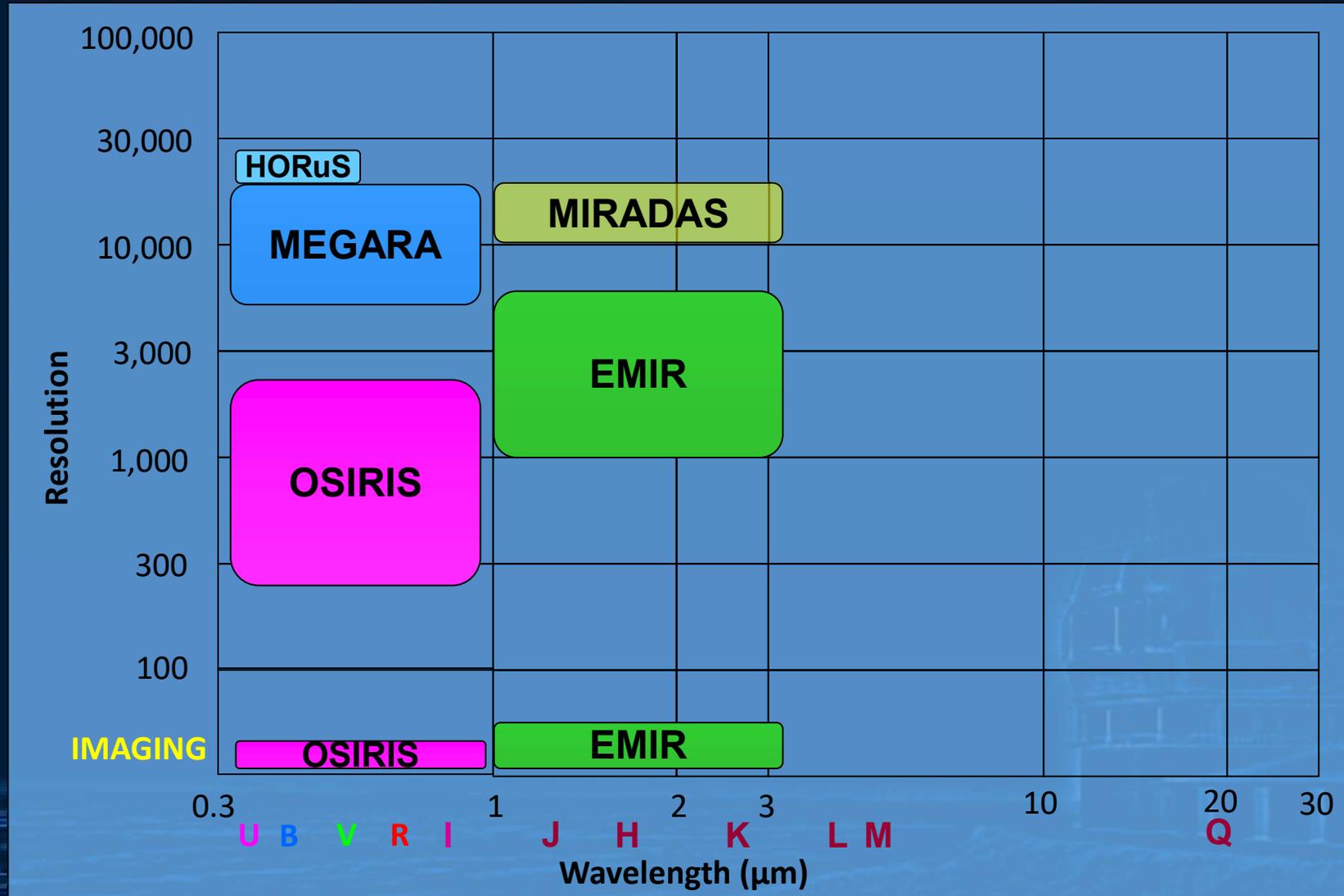
<http://www.gtc.iac.es/instruments/nextgeneration.php>

Waiting for funds from Canarian Government. Still open to new proposals.

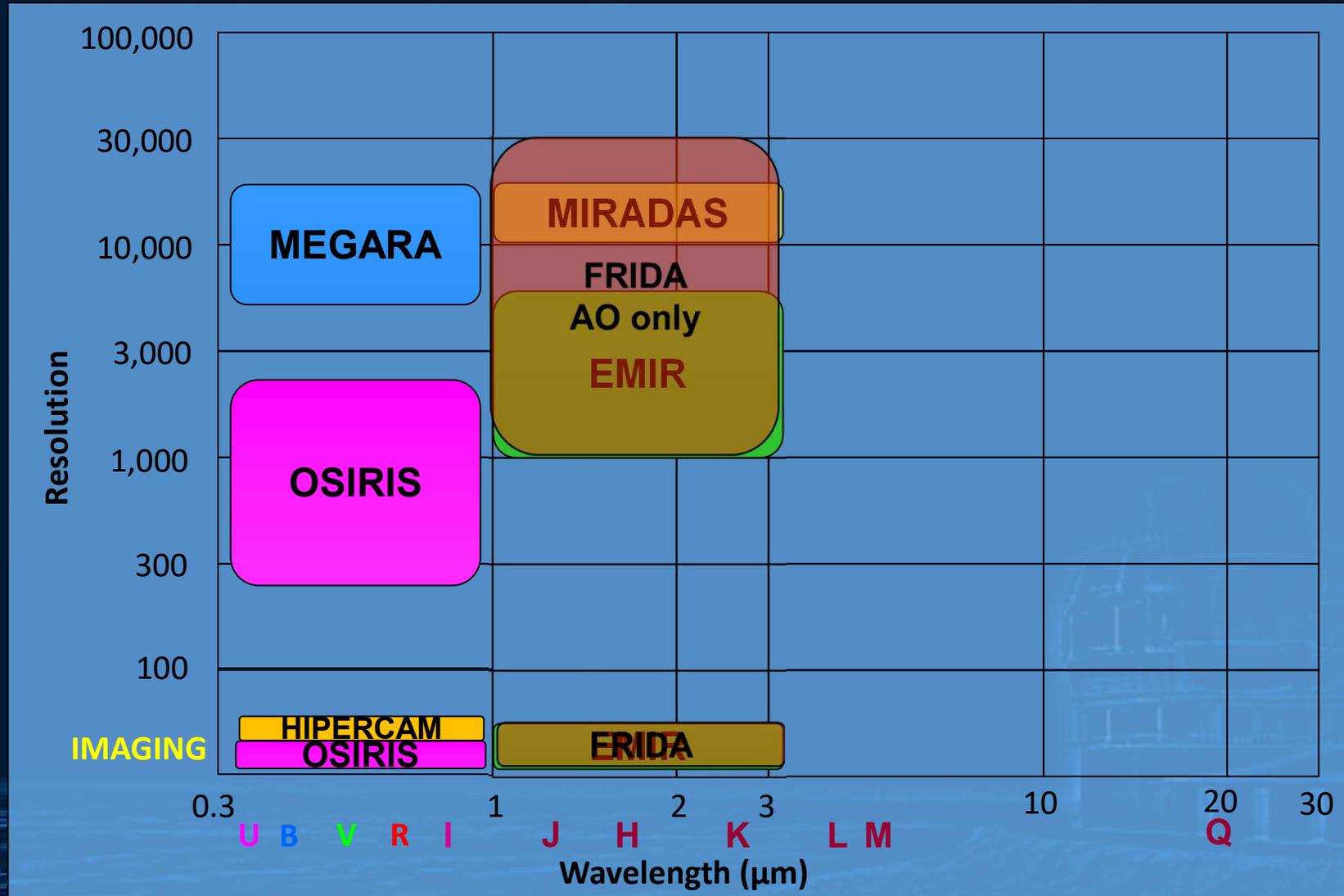
# GTC instrumentation for 2019-2020



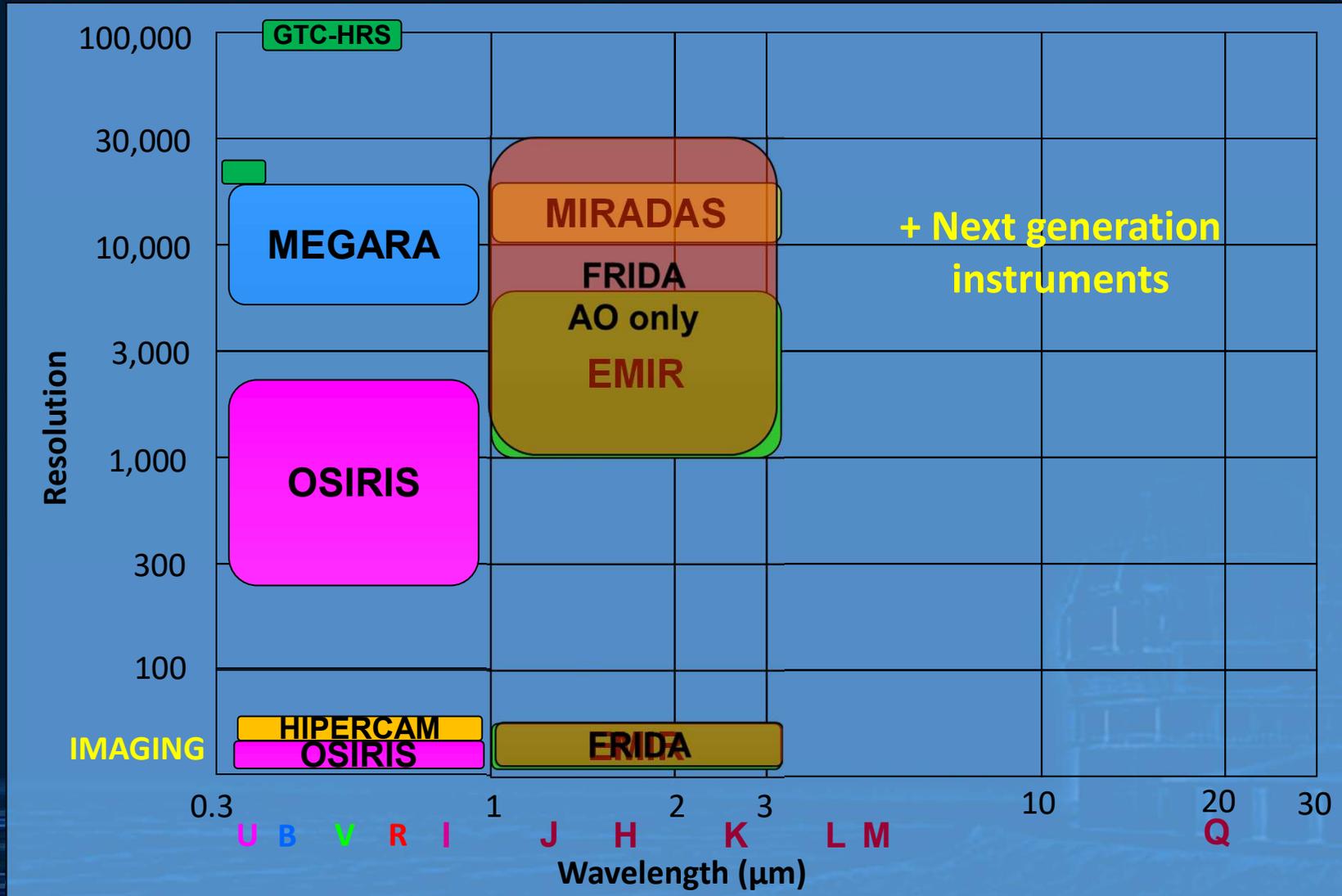
# GTC instrumentation for 2019-2020



# GTC instrumentation for 2021-2025



# GTC instrumentation for 2025+



<http://www.gtc.iac.es/GTChome.php>



**THANKS!!!!**

[antonio.cabrera@gtc.iac.es](mailto:antonio.cabrera@gtc.iac.es)