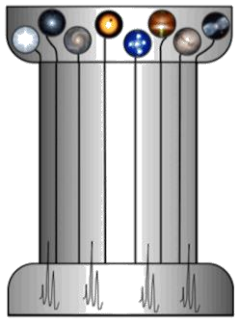
MEGARA, the new generation optical MOS & IFU for GTC

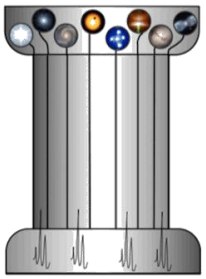
Armando Gil de Paz (Principal Investigator, UCM)
on behalf of the
MEGARA Consortium, Instrument team & Science team



Multi
Espectrógrafo en
GTC de
Alta
Resolución para
Astronomía

"Multi-Object Spectroscopy in the next decade"

La Palma (Spain), 2-6th March 2015



Multi
Espectrógrafo en
GTC de
Alta
Resolución para
Astronomía

MEGARA

Multi-Object Spectroscopy plans for GTC …

The GTC Instrumentation Plan

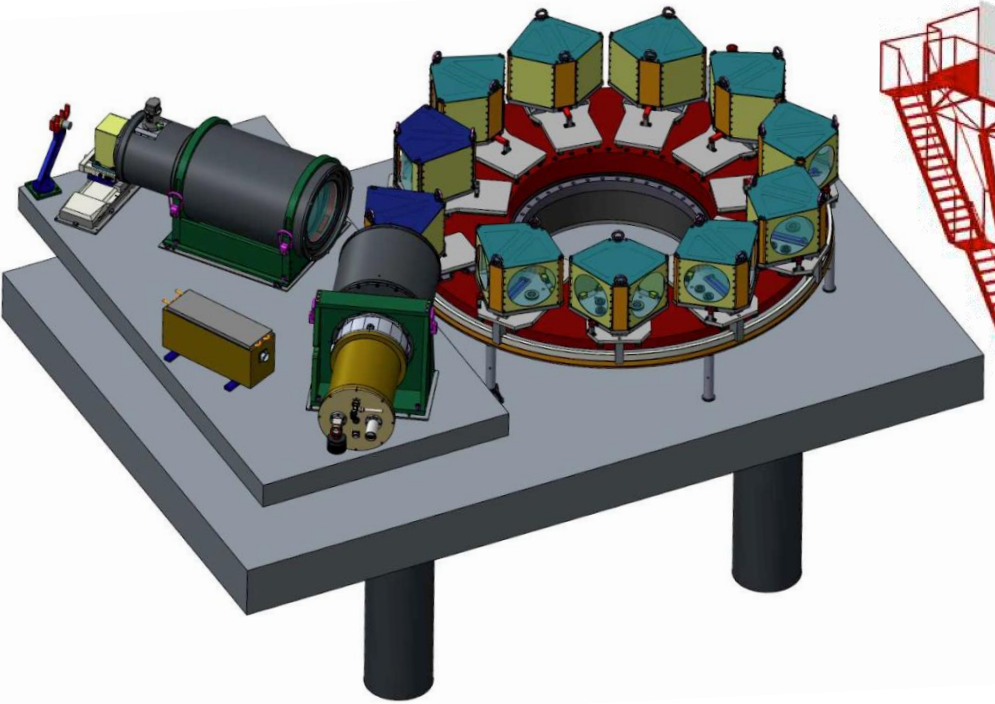
- **A realistic time line:**
  - ✓ To try to install CIRCE by mid-2014 getting some NearIR capabilities before EMIR.
  - ✓ To focus on EMIR to be installed by mid-2015.
  - ✓ To focus on MEGARA to be installed by end-2016.
  - ✓ To work on GTCAO (plus its LGS extension) and FRIDA to go to the telescope by 2017/2018. OSIRIS to the Cass.
  - ✓ To work on MIRADAS to go to the telescope by 2018/2019.

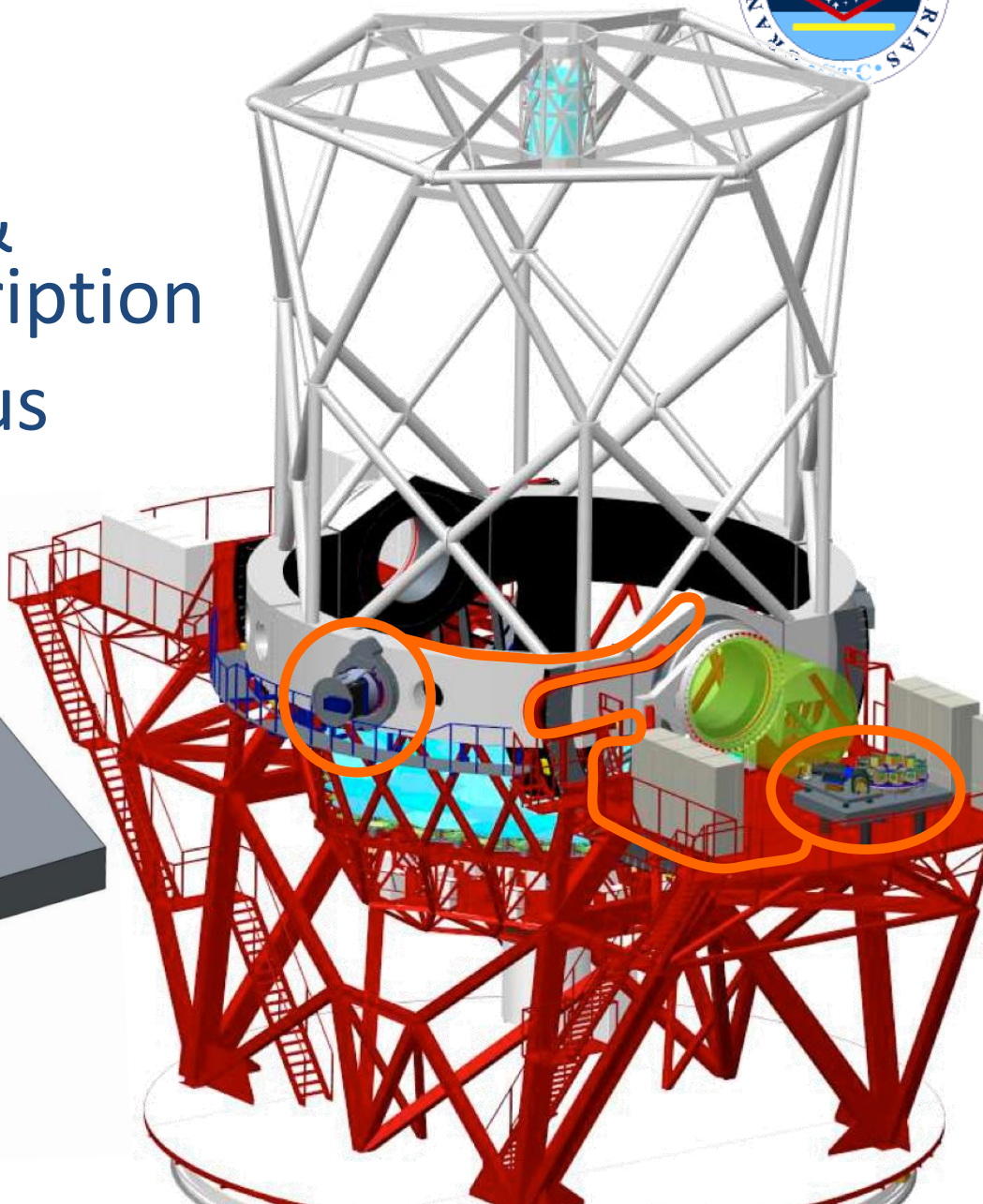
Multi
Espectrógrafo en
GTC de
Alta
Resolución para
Astronomía

MEGARA @ GTC

Outline:

- Scientific drivers & brief project description
- Construction Status





Multi Espectrógrafo en GTC de Alta Resolución para Astronomía

MEGARA Consortium

UCM

PI: Armando Gil de Paz

UCM	INAOE	IAA	UPM
GUAIX & ISCAR Groups	Optics manufac.	Control System-2	Control System-3
Management	Cryostats		
Optical Bundles			
Spectrograph & CCD			
Control System-1			
Representative:	**Representative:**	**Representative:**	**Representative:**
J. Gallego	**E. Carrasco**	**J. Iglesias-Páramo**	**Fco. M. Sánchez Moreno**

Participating companies & associate partners:

avs added value solutions

Fractal S.L.

SEDI·ATI fibres optiques

Wasatch Photonics Ultimate Diffraction Gratings

[ams]

CENTRO DE INVESTIGACIONES EN OPTICA, A.C.

Multi
Espectrógrafo en
GTC de
Alta
Resolución para
Astronomía

MEGARA Instrument Team

Instrument Team Meeting

Madrid, Feb 25th-27th 2015

Missed the photo: Manuel Maldonado, Ismael Martínez Delgado.

MEGARA Science Team

Armando Gil de Paz	UCM
Esperanza Carrasco	INAOE
Artemio Herrero Davó	IAC
Nuria Huélamo	CAB
África Castillo Morales	UCM
Carmen Sánchez Contreras	CAB
Casiana Muñoz Tuñón	IAC
David Barrado	CAB
Ignacio Trujillo	IAC
Javier Cenarro	CEFCA
Jesús Gallego	UCM
Jorge Iglesias	IAA
José Vílchez	IAA
María Luisa García Vargas	FRACTAL
Mercedes Mollá	CIEMAT
Manuel Peimbert	UNAM
Silvia Torres-Peimbert	UNAM
Guillermo Tenorio-Tagle	INAOE
Sergiy Silich	INAOE
Lino Rodríguez Merino	INAOE
Fco. M. Sánchez Moreno	UPM
Raquel Cedazo	UPM
Esteban González	UPM
Fernando Serena	UPM
Alfonso López Aguerri	IAC
Carmen Eliche	UCM
Daniel Rosa González	INAOE
Divakara Mayya	INAOE
Emanuele Bertone	INAOE
Jairo Méndez Abreu	IAC
José Miguel Rguez. Espinosa	IAC
Miguel Chavez	INAOE
Miriam García	CAB
Mónica Rodríguez	INAOE
Nicolás Cardiel	UCM
Olga Vega	INAOE
Pablo G. Pérez González	UCM
Patricia Sánchez Blázquez	UAM
Sebastián Sánchez	UNAM
Sergio Pascual	UCM
Sergio Simón	IAC
Yiannis Tsamis	UCL
Ata Sarajedini	UFL
Enrique Pérez Montero	IAA
Rafael Guzmán	UF
Victor Villar	UCM
Antonio Cava	UCM
Jaime Zamorano	UCM
Jorge Sánchez-Almeida	IAC
Jorge Jiménez-Vicente	UGR
José Guichard	INAOE
David Hughes	INAOE
Roberto Terlevich	INAOE
Elena Terlevich	INAOE
Pepa Masegosa	IAA
Isabel Márquez	IAA
Carolina Kehrig	IAA

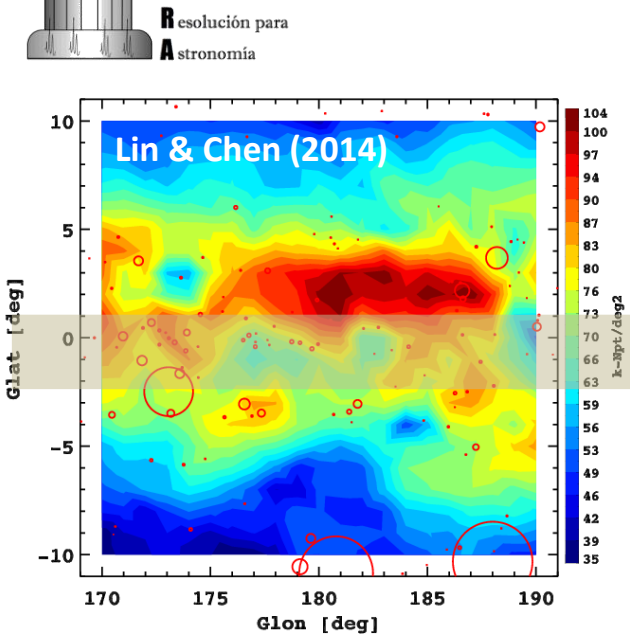
Multi Espectrógrafo en GTC de Alta Resolución para Astronomía

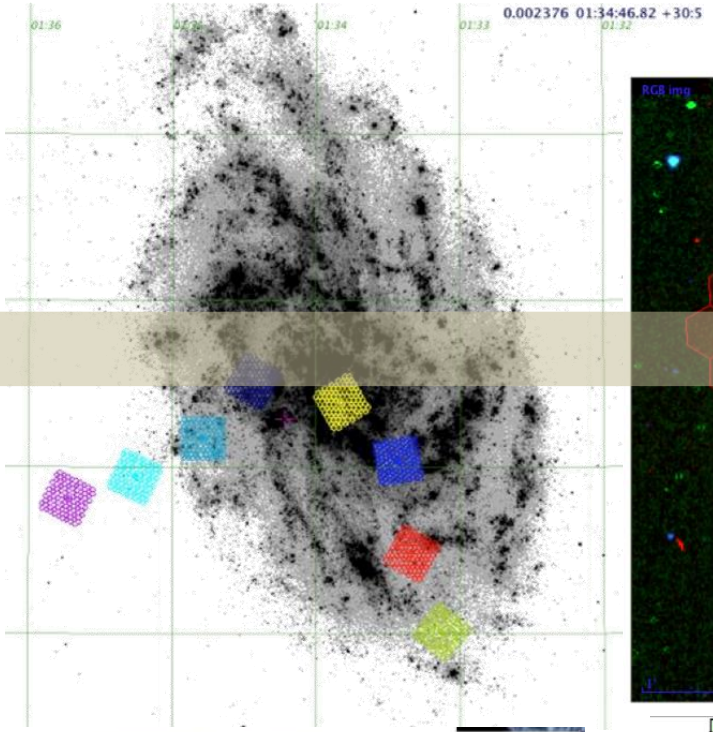
MEGARA Scientific Requirements

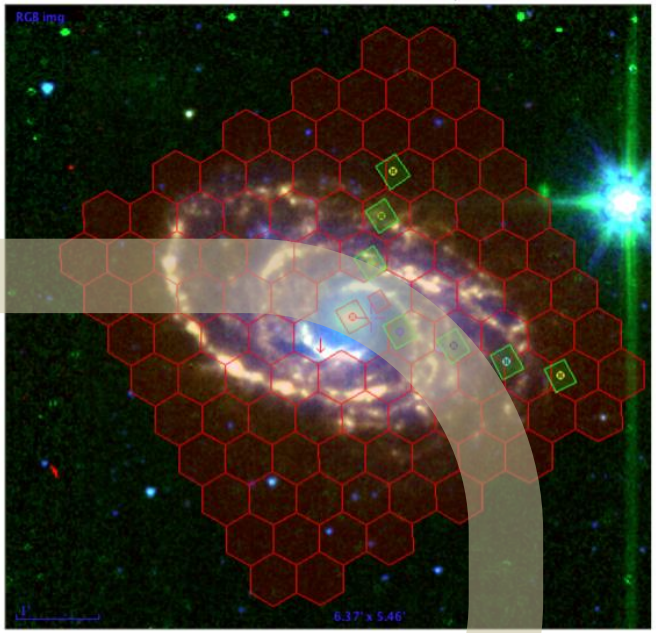
- **Wide-FoV IFU w. good-spatial-resolution to study ...**
  - PNe, MW HII regions, nearby galaxies, Cosmic Web
  - **High-multiplexing, high-density MOS to study ...**
  - MW clusters, LG stars, LV HII regions, high-z dwarfs & clusters and deep cosmological fields

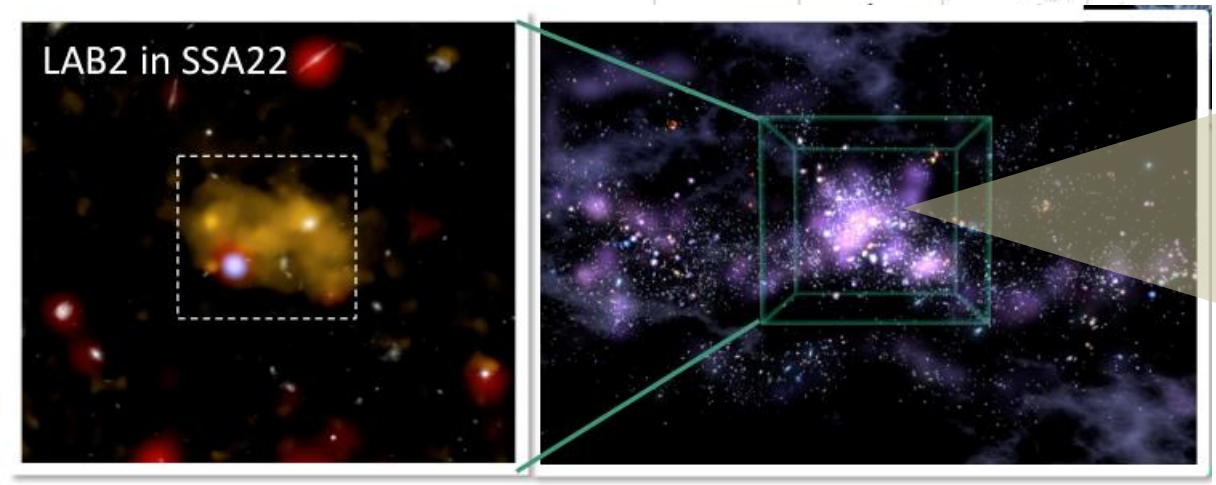
- **High spectral resolution** (R≥10000) for chemical tagging of stellar and gas kinematics of (p)PN and nearby galaxies, stellar kinematics of MW clusters and face-on galaxy disks.
- **Intermediate spectral resolution** (R≈5000) with broad wave-length-coverage for spectral classification, ionized-gas diagnostics in PN and HII regions, stellar-population studies in nearby and distant galaxies (including field-galaxy redshift determination and cluster membership and dynamics).

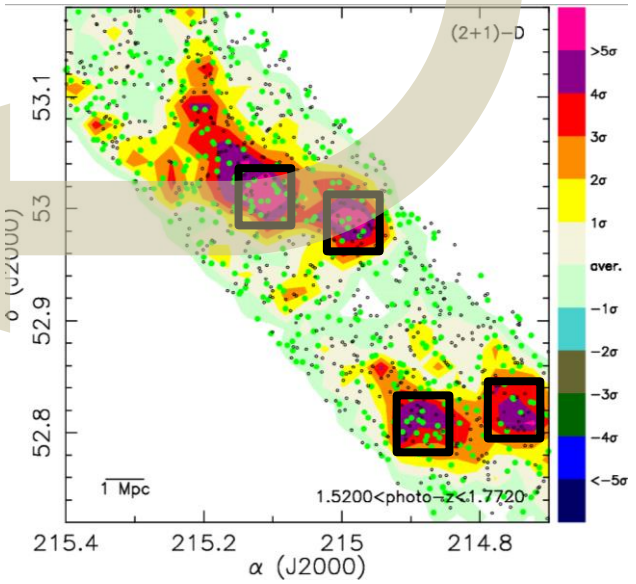
MEGARA Science Exploitation examples







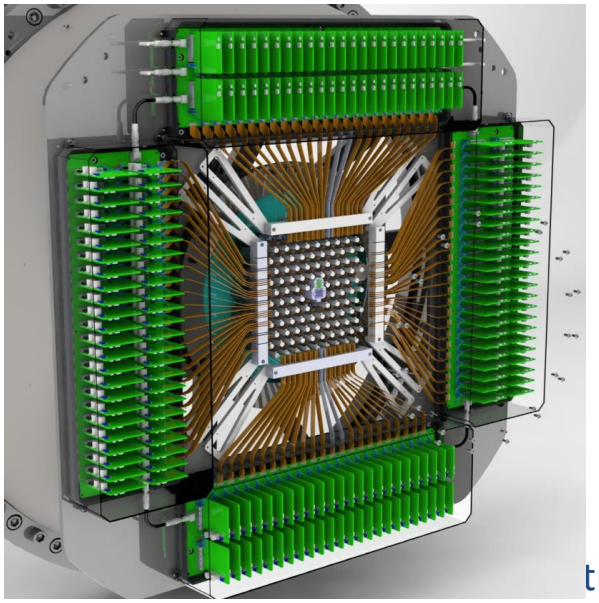


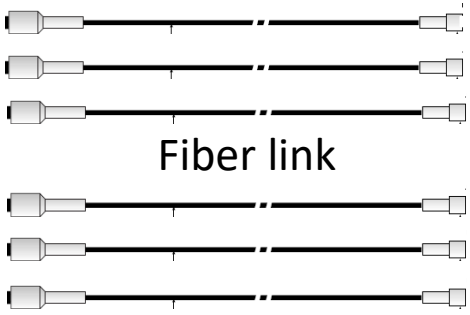


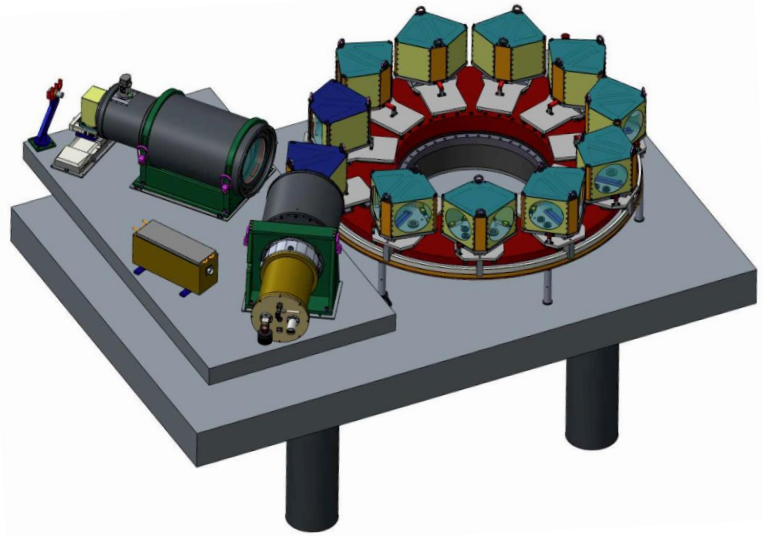
Multi Espectrógrafo en GTC de Alta Resolución para Astronomía

MEGARA factsheet

IFU bundle (LCB)	12.5x11.3 arcsec^2
MOS	92 × 7-fiber mini-IFUs in 3.5x3.5 arcmin^2
Spaxel (fiber) size	0.62 arcsec (1.6 arcsec diameter mini-IFUs)
Wavelength range	3650-10000 ÅÅ
Spectral resolution	R=6000-18700
# of spectra	650 simultaneous fiber spectra (MOS / LCB)
GTC station	Folded-Cass F [spectrograph @ Nasmyth-A]

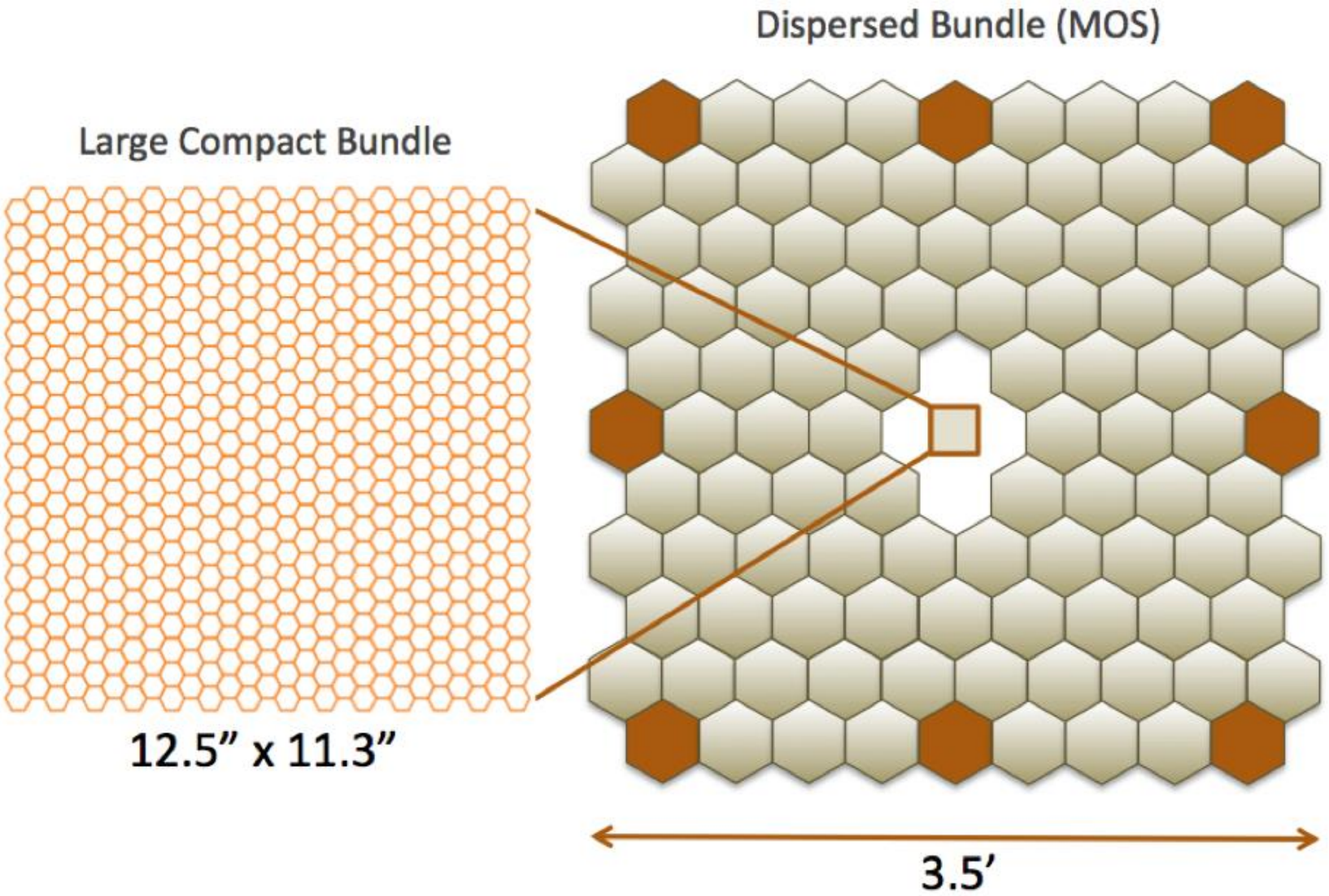




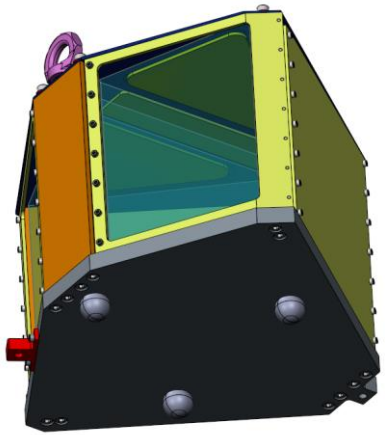


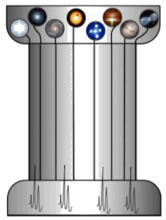
Multi Espectrógrafo en GTC de Alta Resolución para Astronomía

MEGARA IFU & MOS
Focal-plane layout



Spectral setups





Multi
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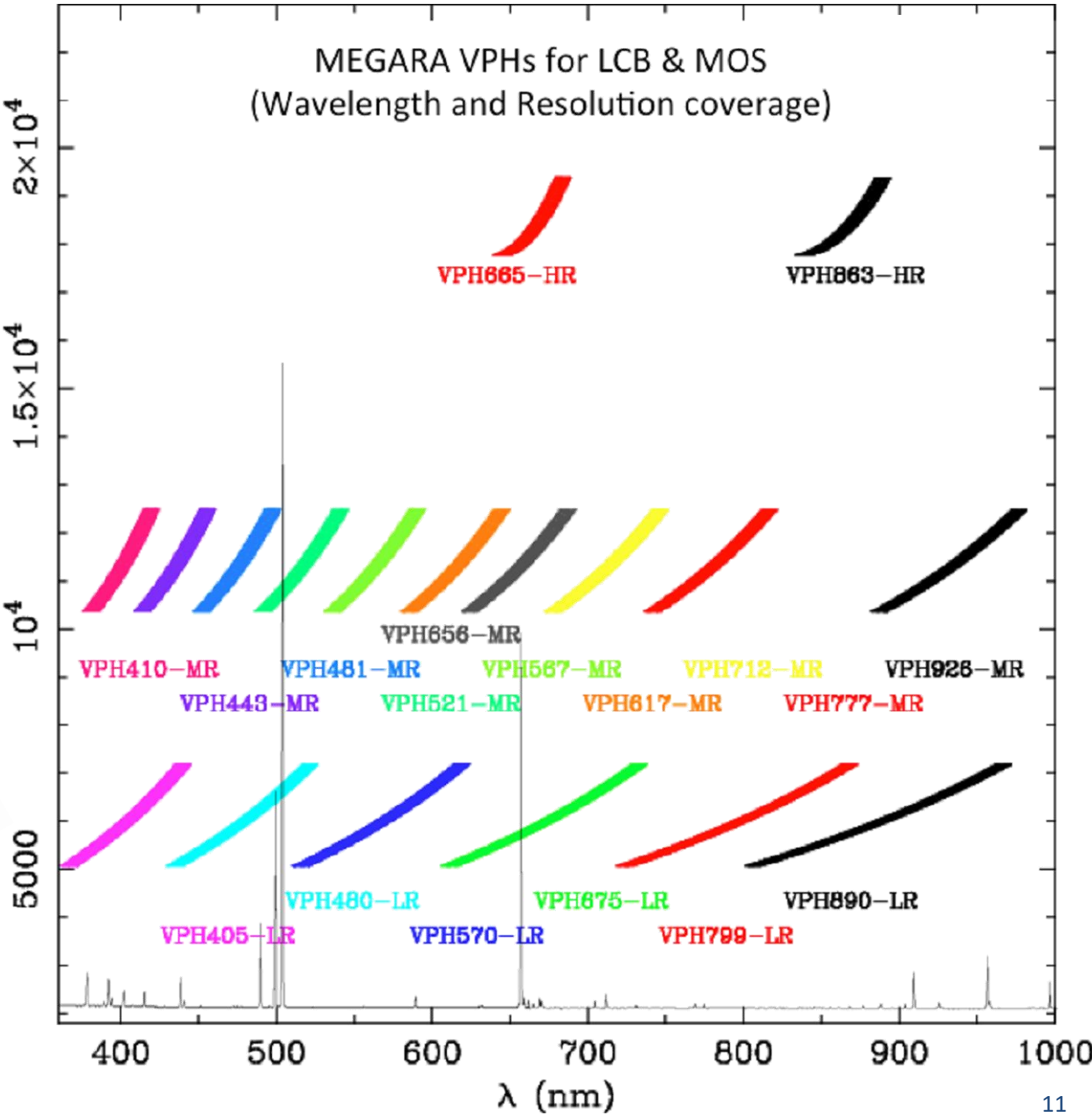
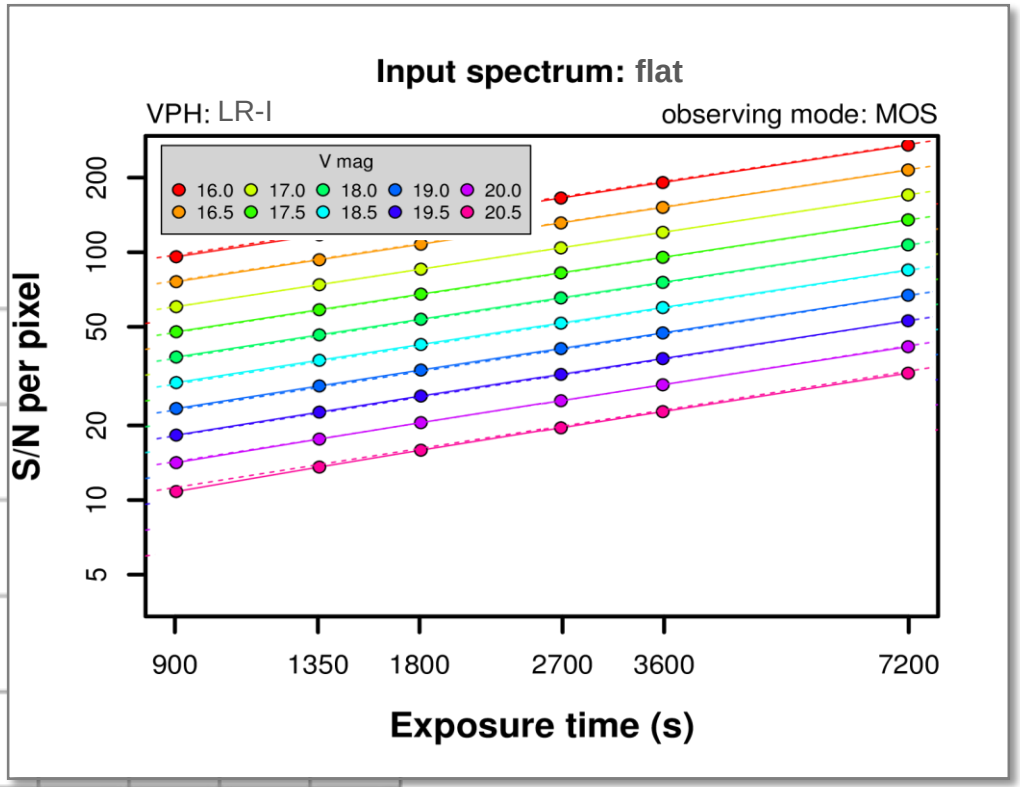
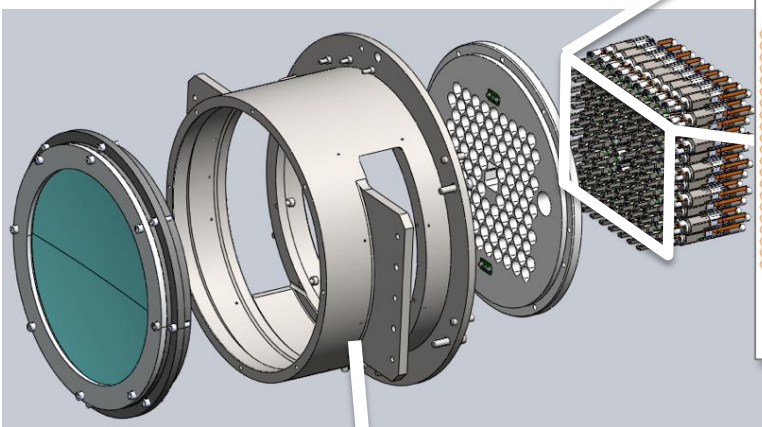


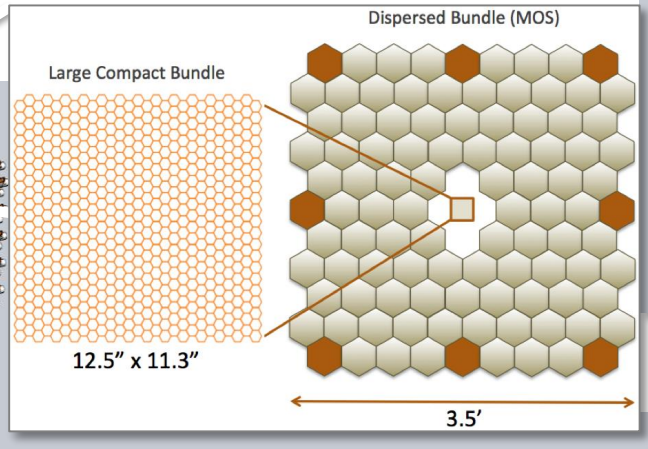
Spectral setups

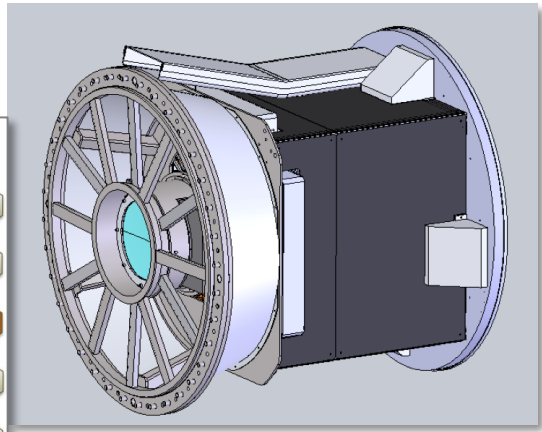


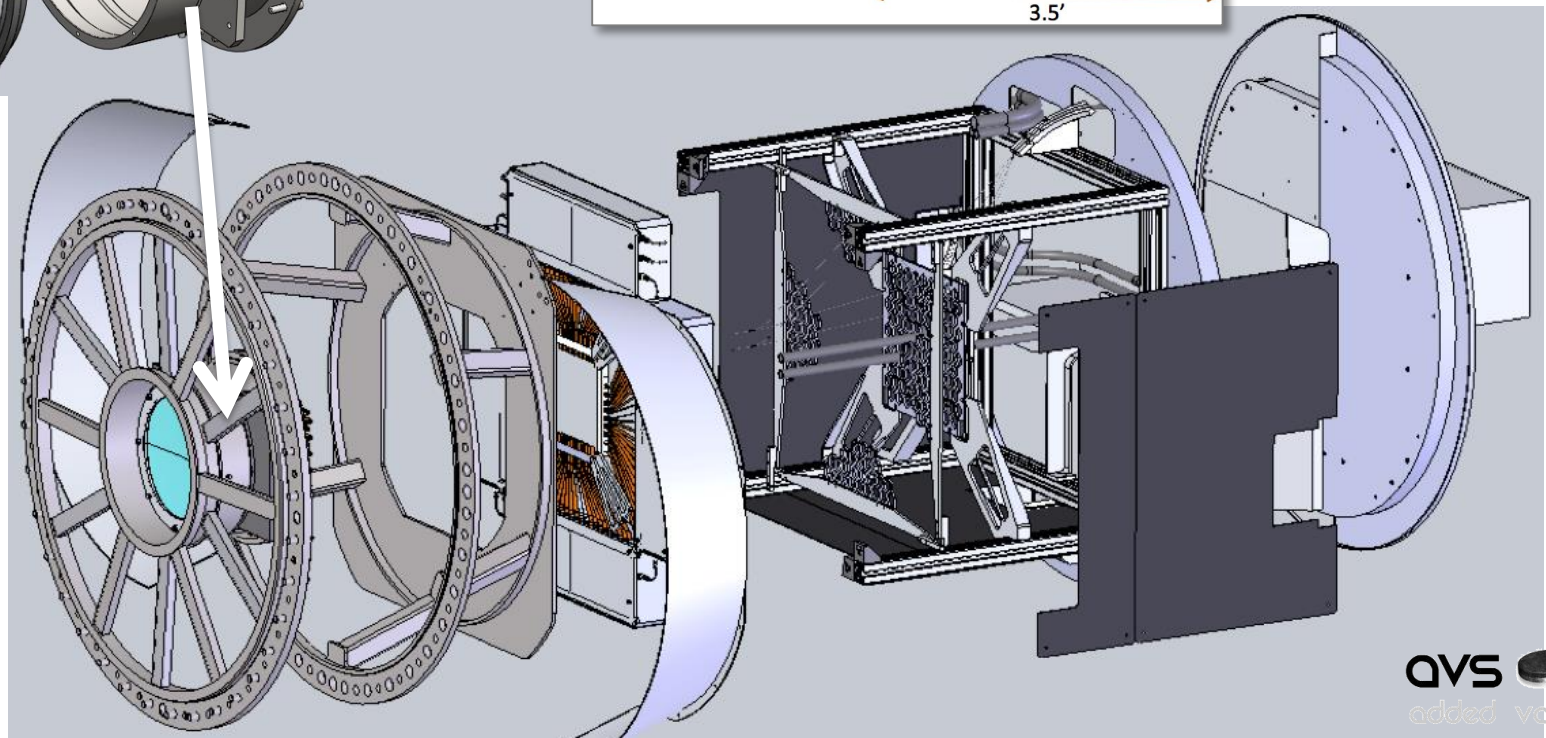
MEGARA Folded-Cass

Detailed Design & Constr. status



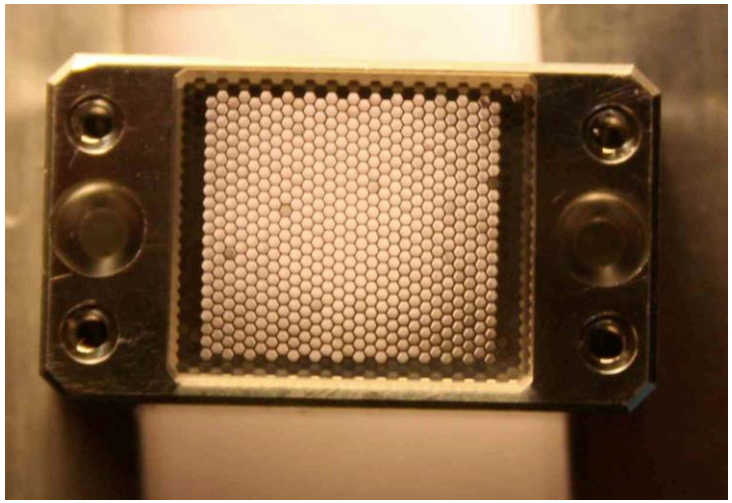


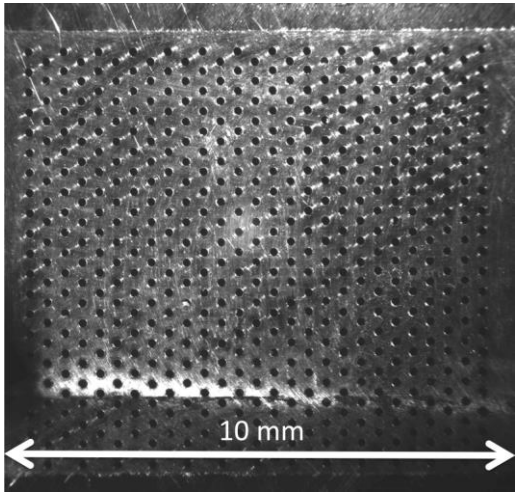


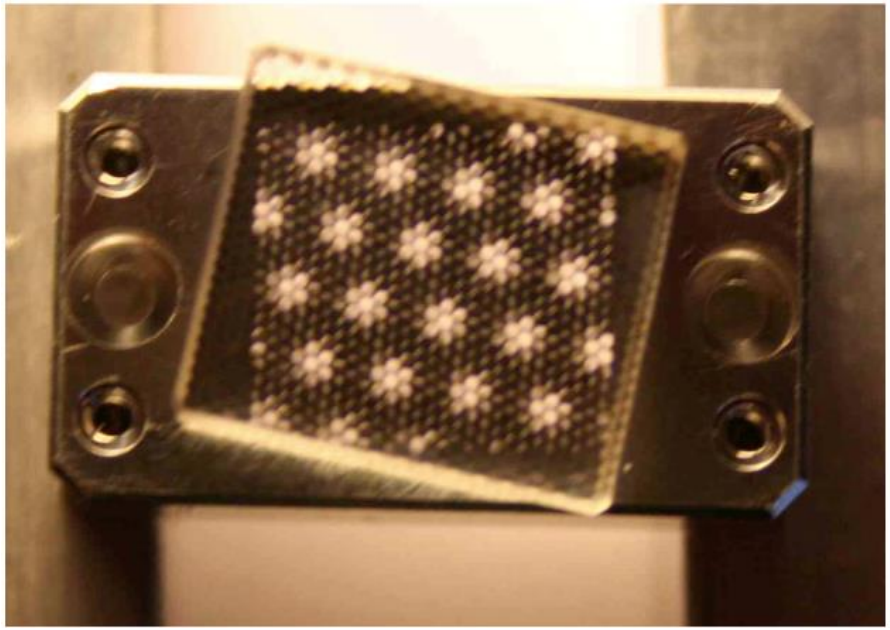


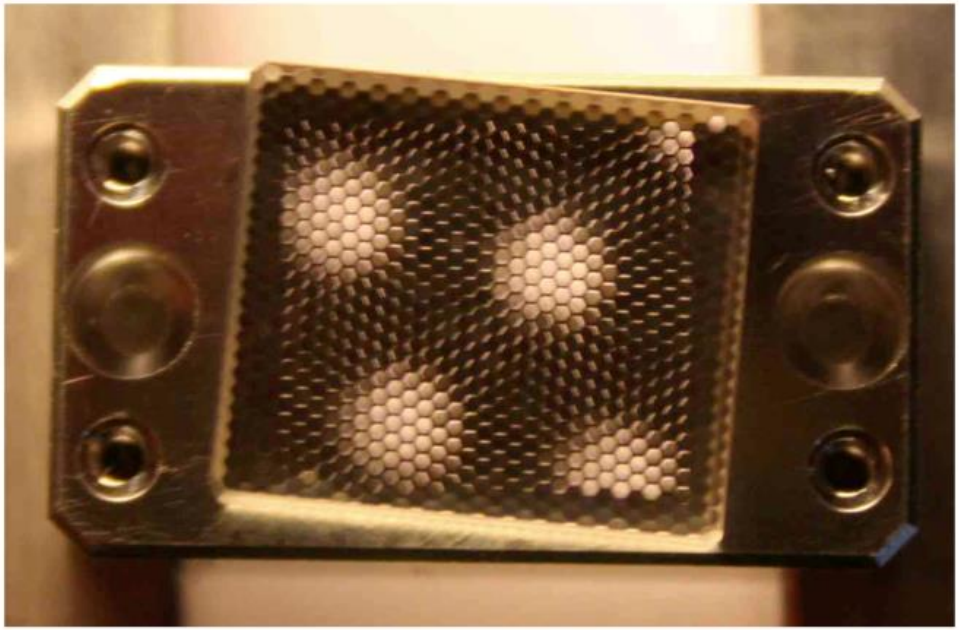
MEGARA Folded-Cass

LCB focal frame & microlenses

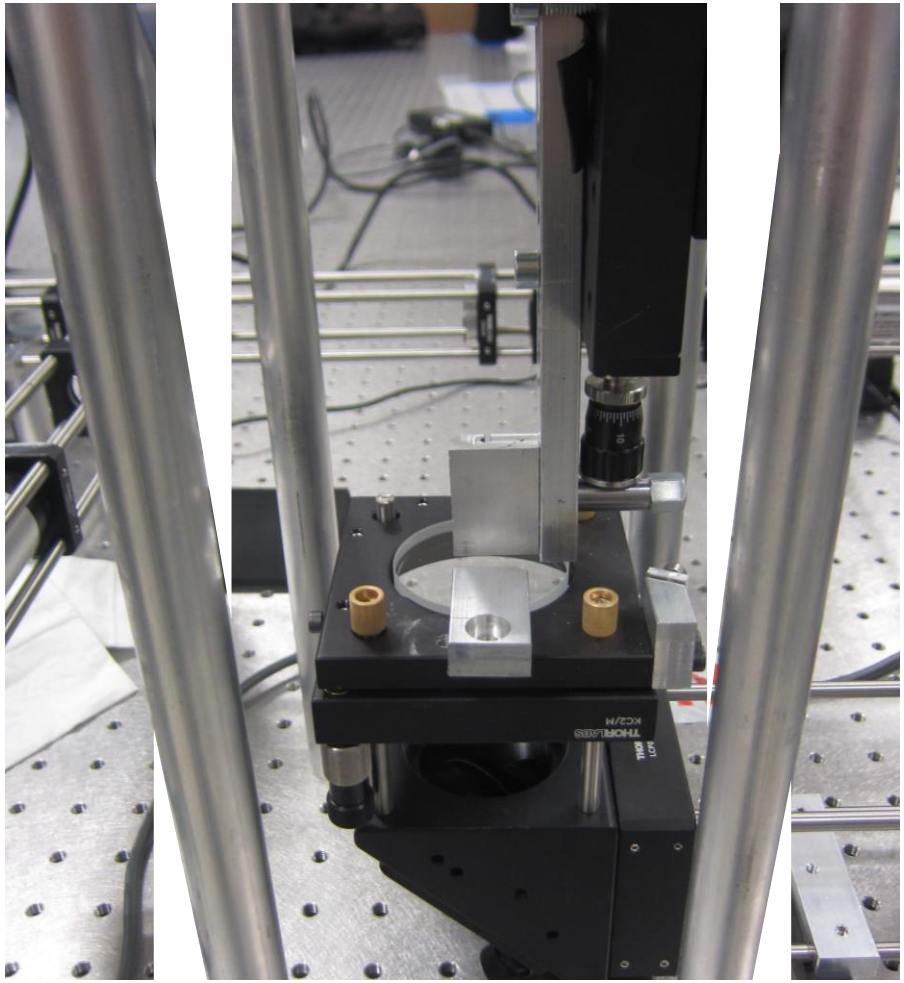


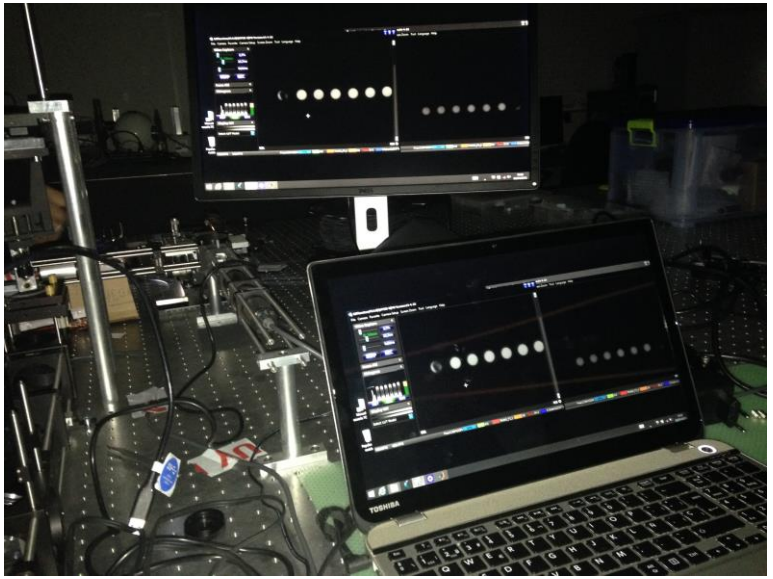






MEGARA Folded-Cass:
Fiber-microlens gluing station

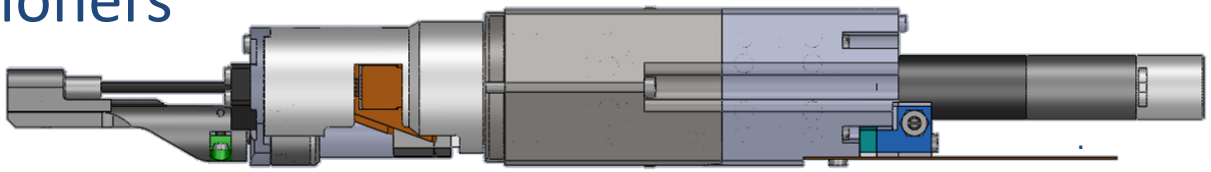


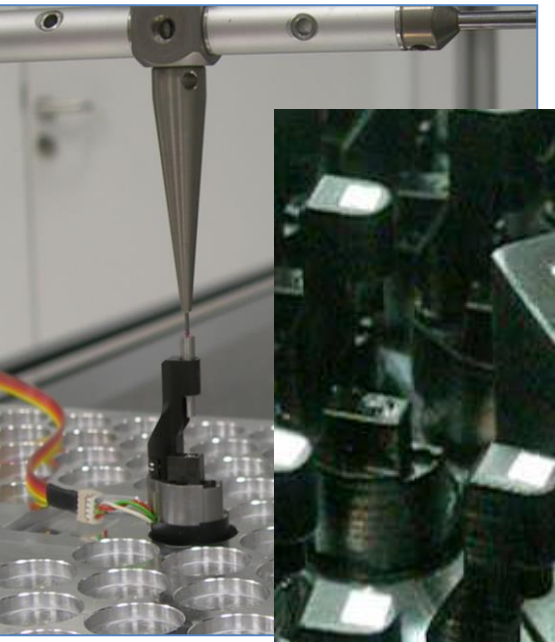


Multi Espectrógrafo en GTC de Alta Resolución para Astronomía

MEGARA Folded-Cass:

Robotic Positioners





- Distance between actuators: 20.1mm
- Hexagonal distribution
- Cover AREA: 23.21mm
- 2 Rotation interpolation, closed loop
- Rotation 1: 365º
- Rotation 2: 180º
- Positioning accuracy: ±25 microns
- MAX Torque: 10mNm
- Reconfiguration time: 15s
- Weight: 85g aprox.
- Voltage: 3.3V
- Consumption: 200mA/h

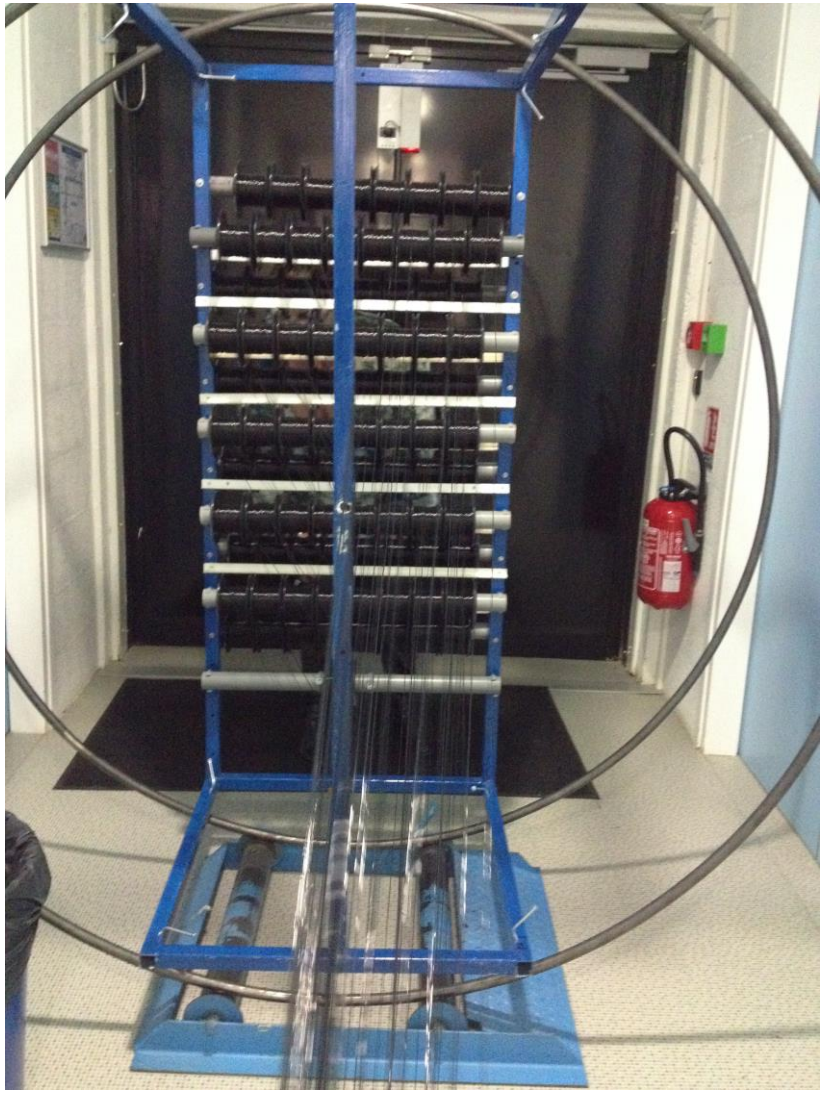
Multi Espectrógrafo en GTC de Alta Resolución para Astronomía

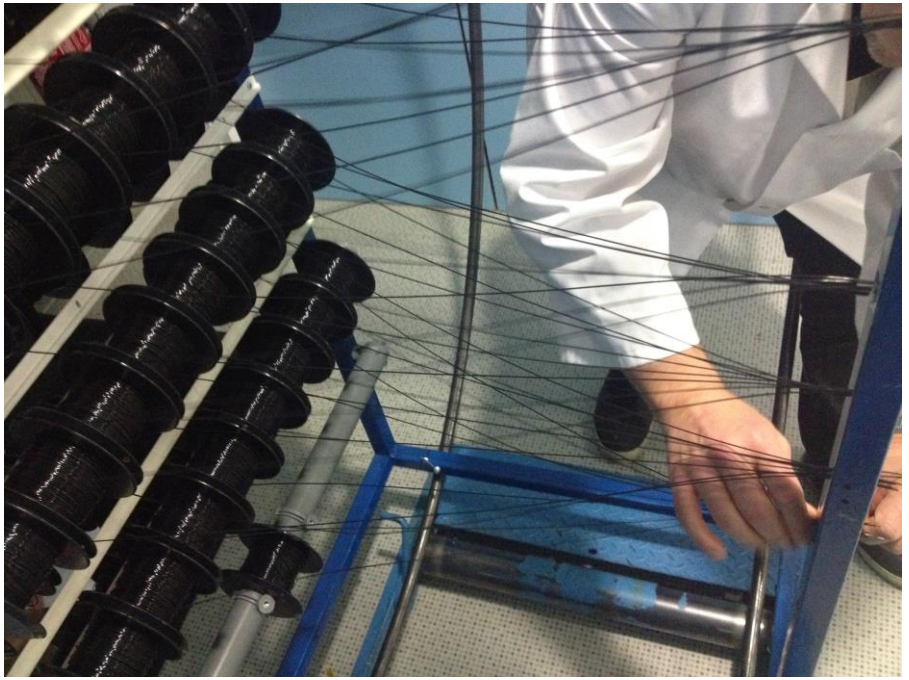
Fiber link: Optical fibers

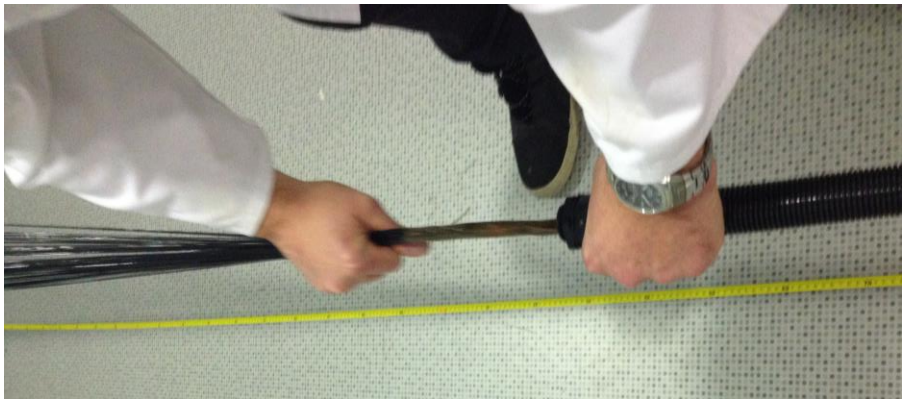
60 km of Polymicro fibers at SEDI

Fiber link: Optical fibers

Preparing the fiber bundles …

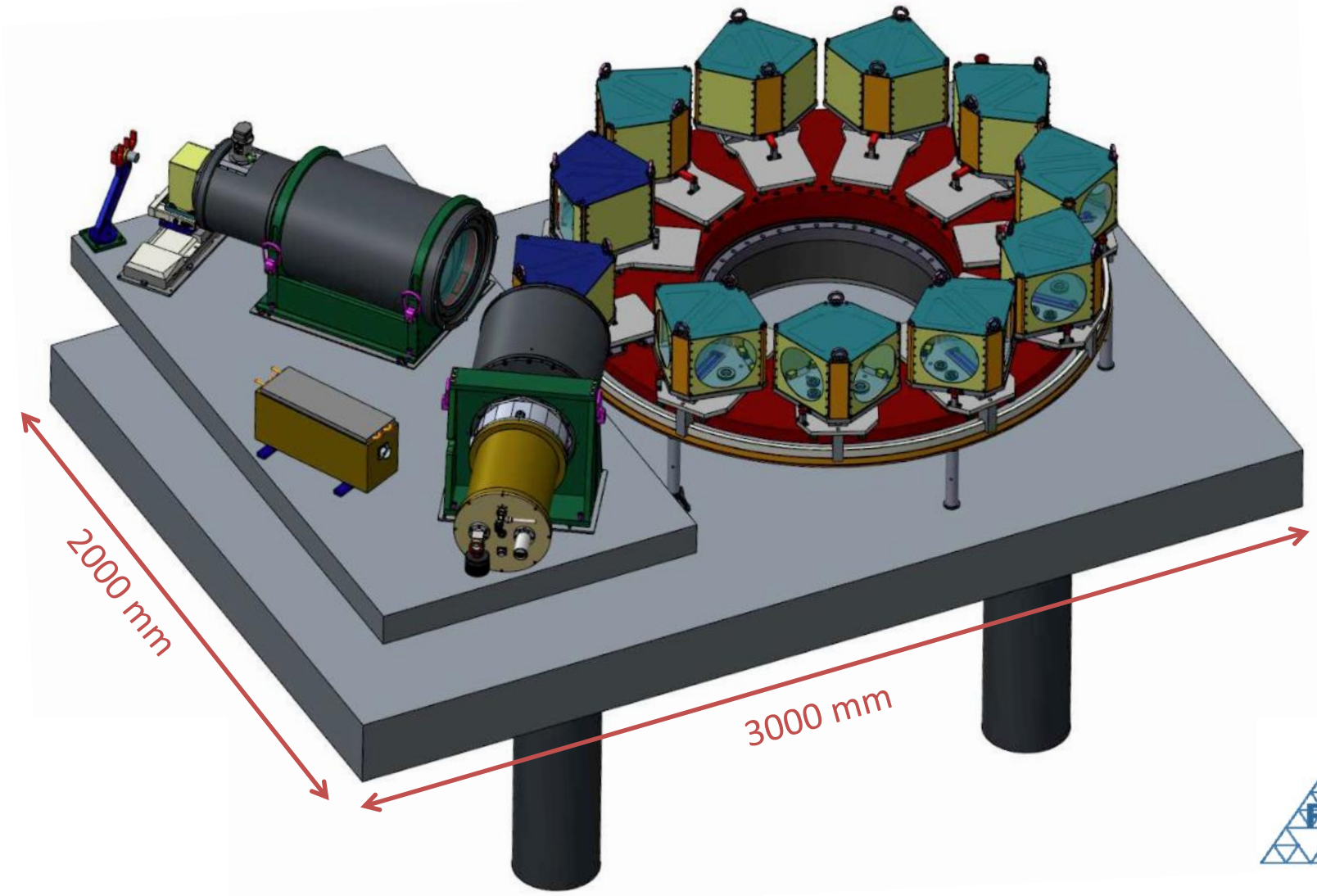






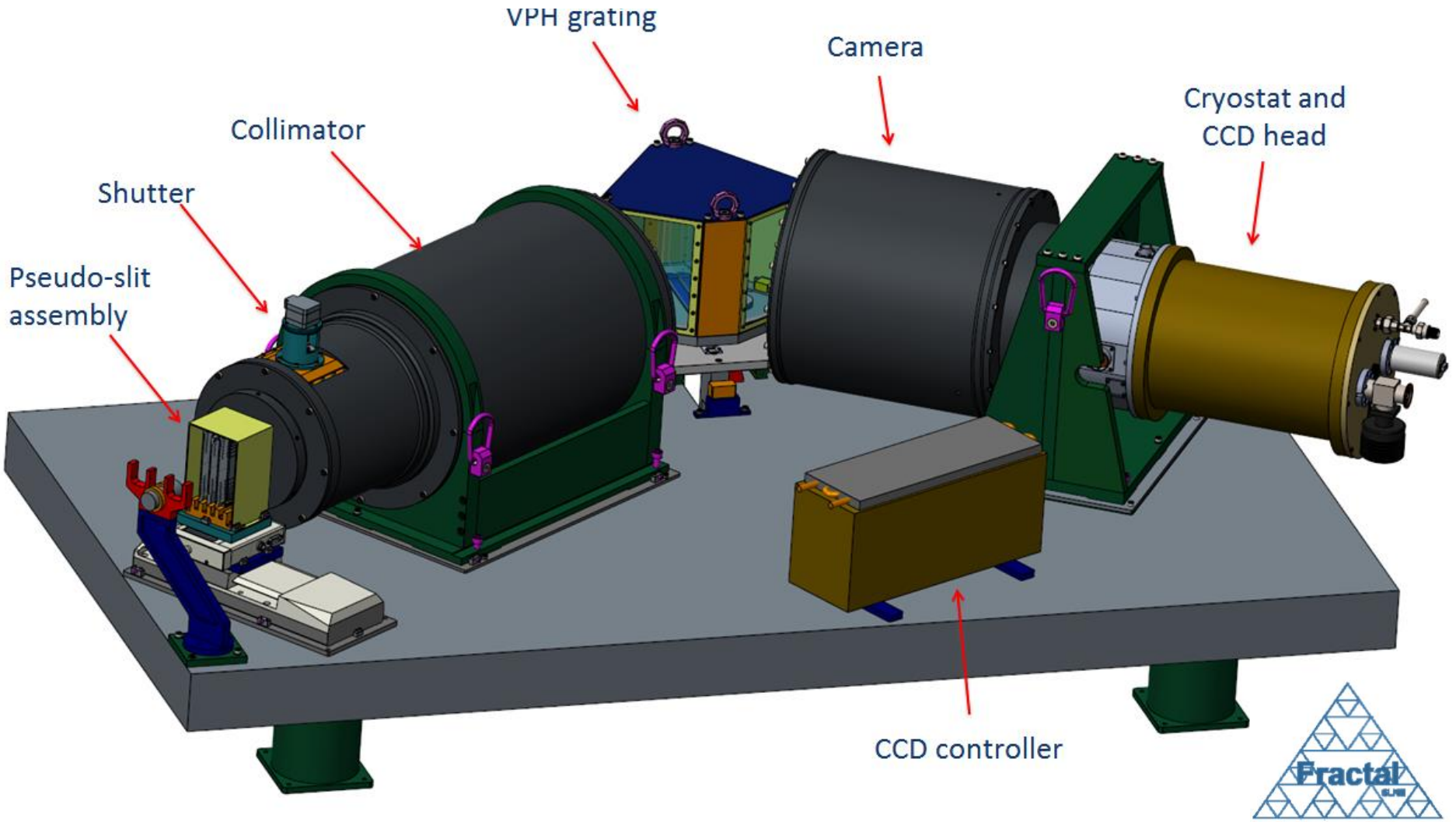
MEGARA Spectrograph

Detailed Design & Construction status



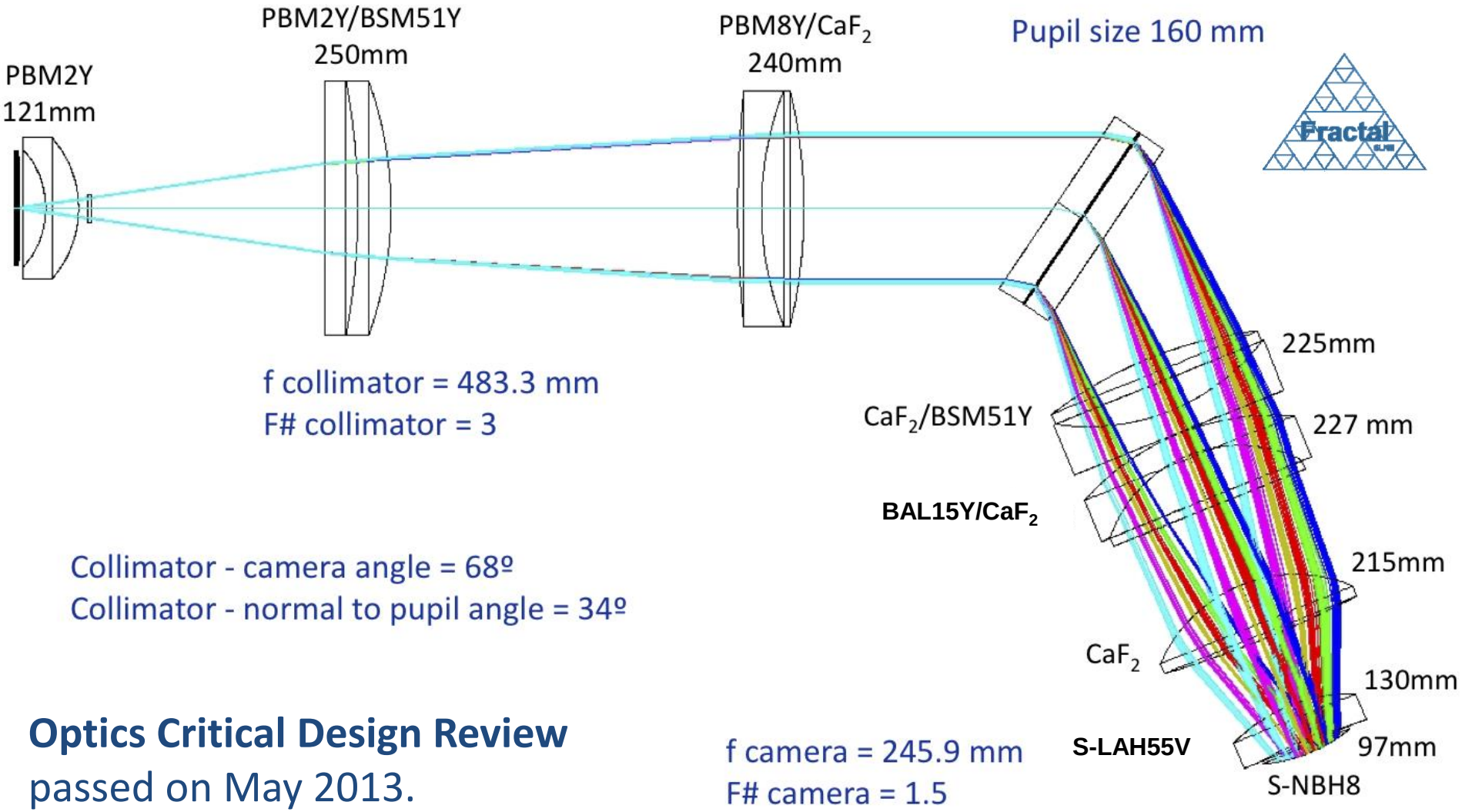
MEGARA Spectrograph

Detailed Design & Construction status



Spectrograph Optics

Detailed Design & Construction status

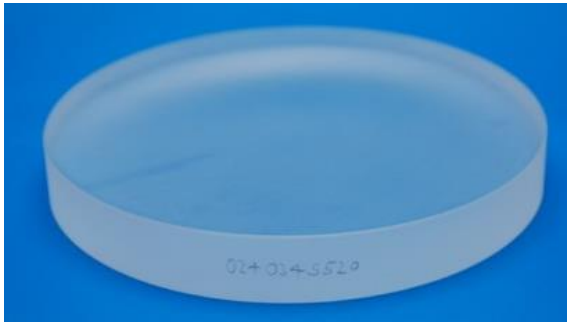


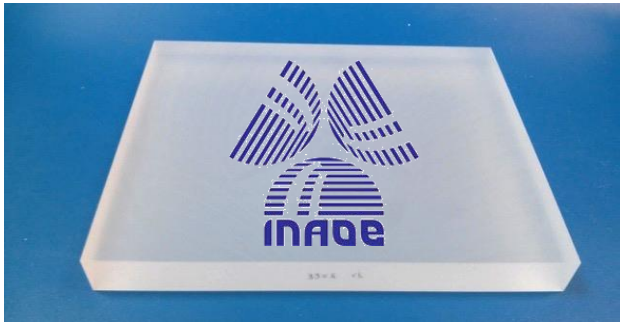
f collimator = 483.3 mm
F# collimator = 3

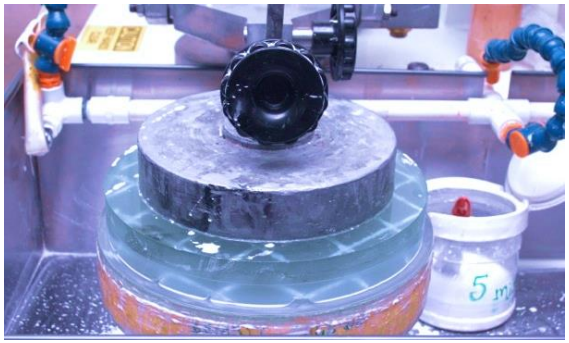
Collimator - camera angle = 68º
Collimator - normal to pupil angle = 34º

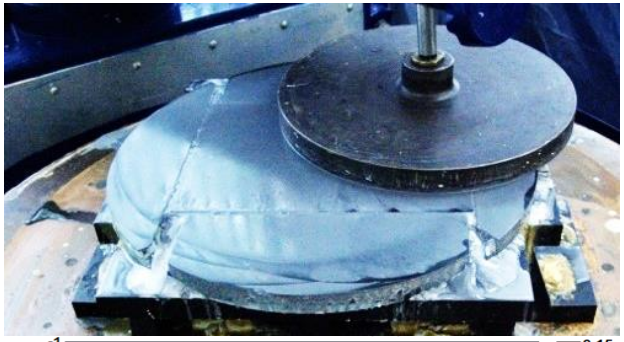
f camera = 245.9 mm
F# camera = 1.5

Optics Critical Design Review passed on May 2013.

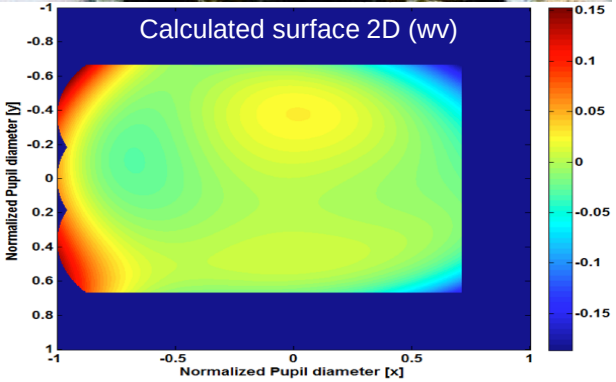




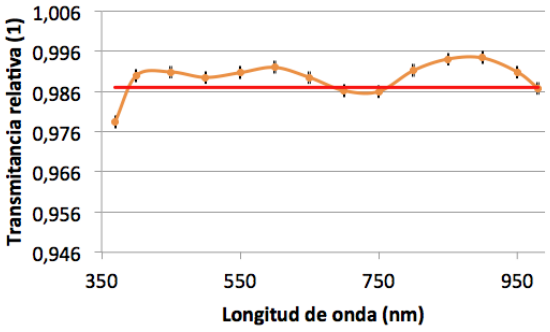


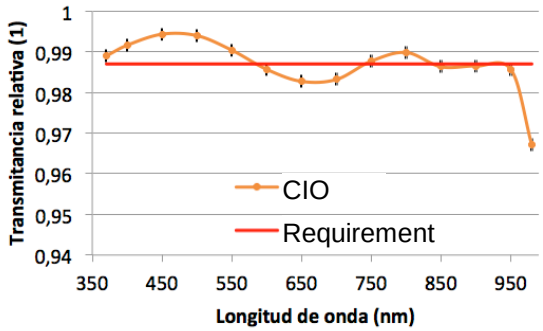


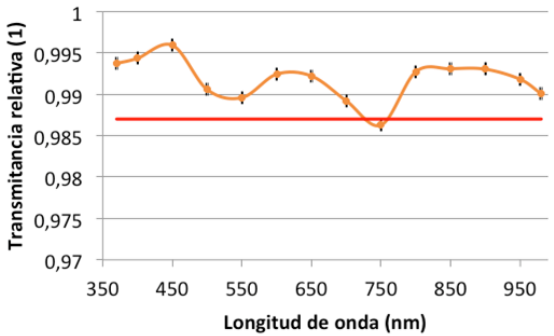
Fused silica



BAL15Y





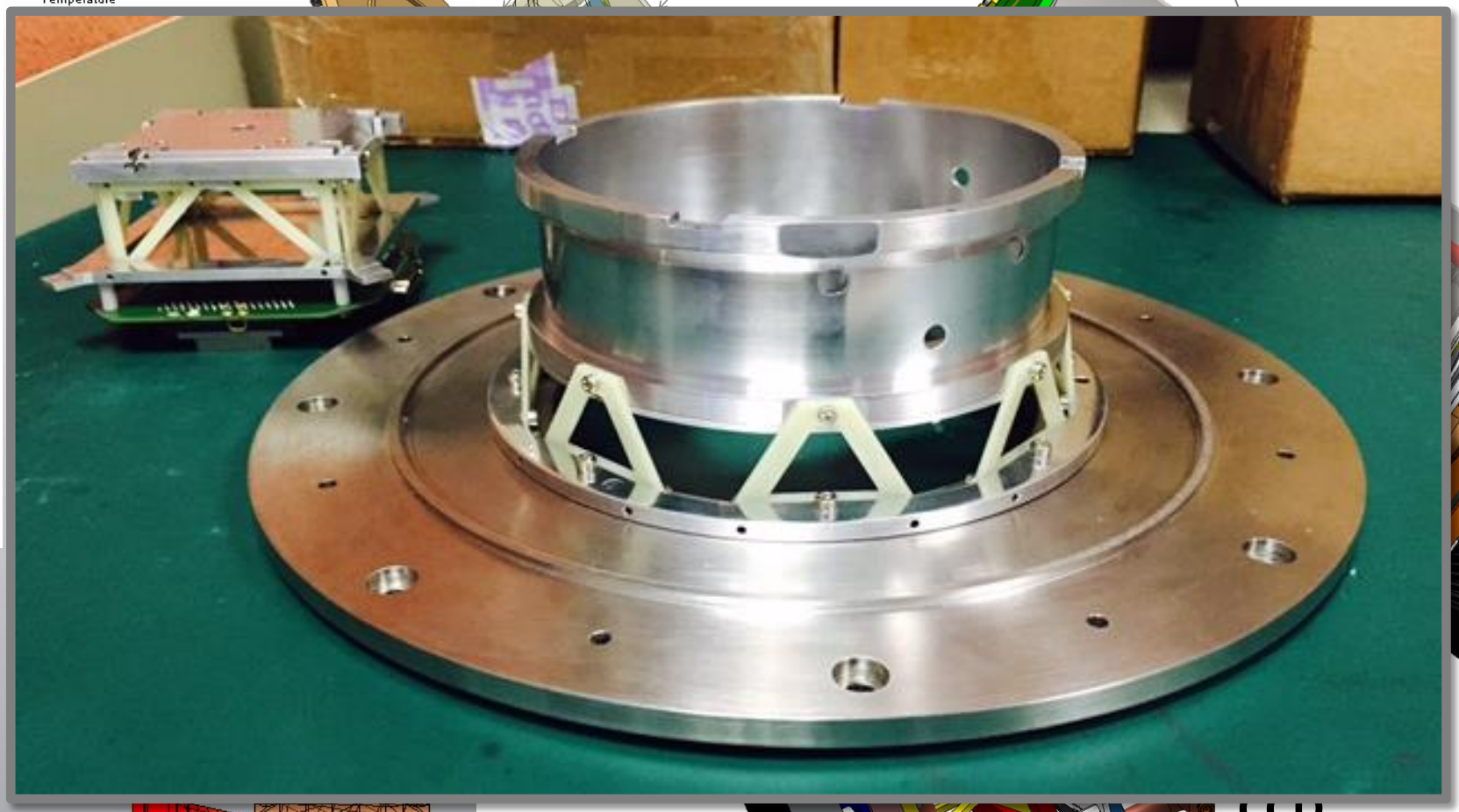


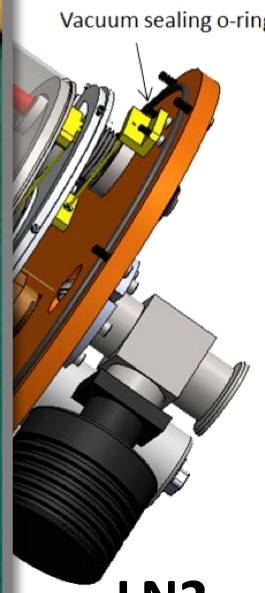
Spectrograph Opto-Mechanics

Detailed Design & Construction status

Cryostat Detailed Design

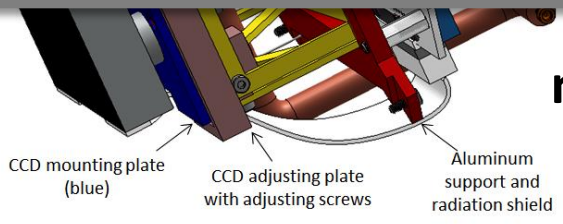
Multi Espectrógrafo en GTC de Alta Resolución para Astronomía





LN2 tank

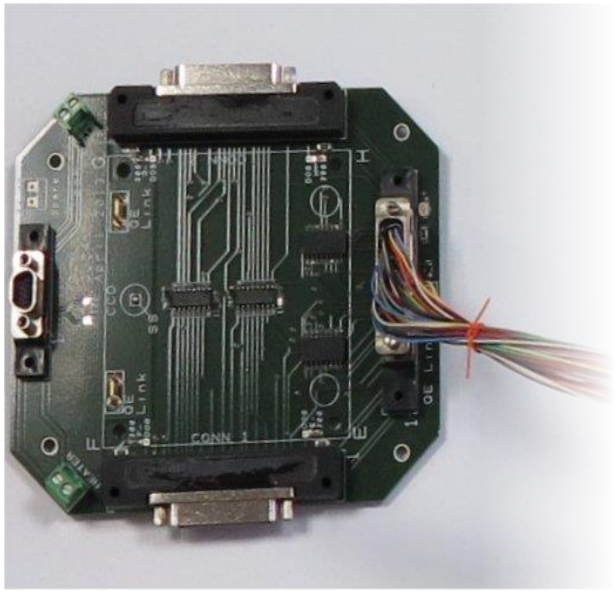
FEA Thermal

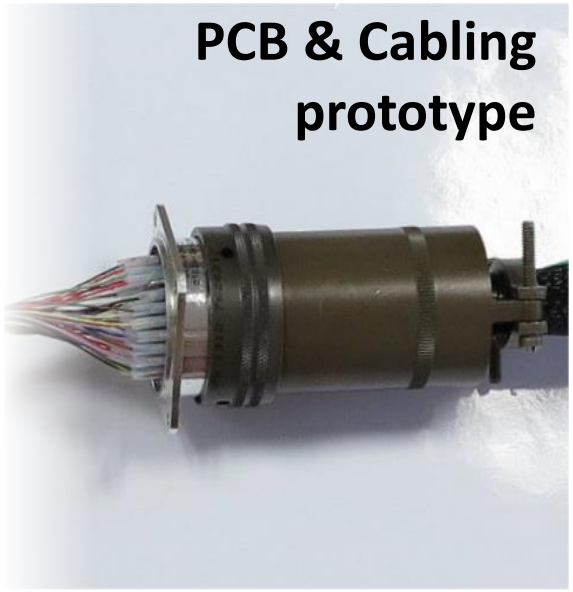


CCD mount

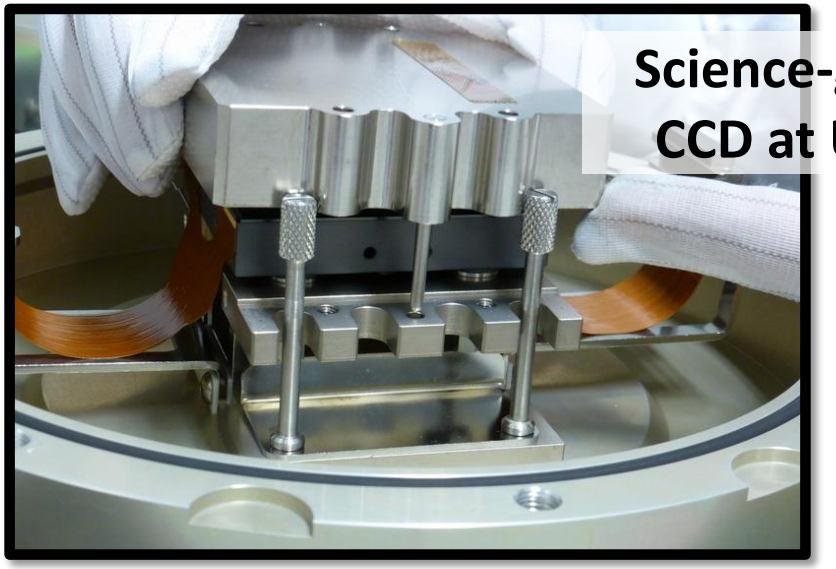
Multi Espectrógrafo en GTC de Alta Resolución para Astronomía

Detector: PCB, cabling & CCD



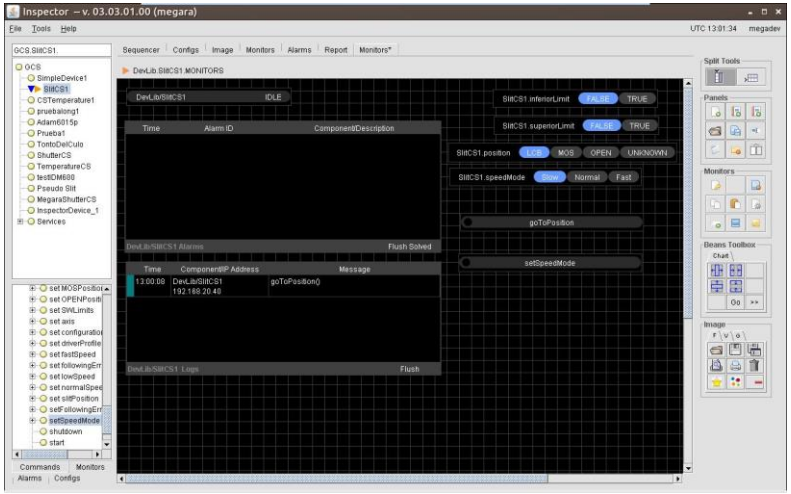


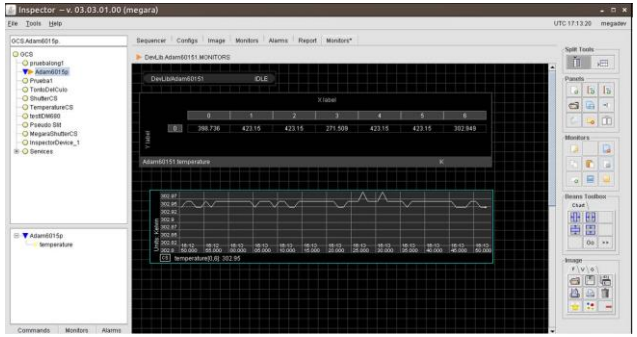
4k x 4k x 15µm – **Deep Depleted E2V CCD231**



MEGARA Control System
Mechanisms & Devices

- Data Acquisition System (DAS)
- Mechanisms and devices:
  - Focus, VPH wheel, pseudo-slit, focal-plane cover & shutter mech.
  - Fiber MOS robotic positioners
  - Interlocks system
  - Temperature sensors





Multi
Espectrógrafo en
GTC de
Alta
Resolución para
Astronomía

MEGARA Control System

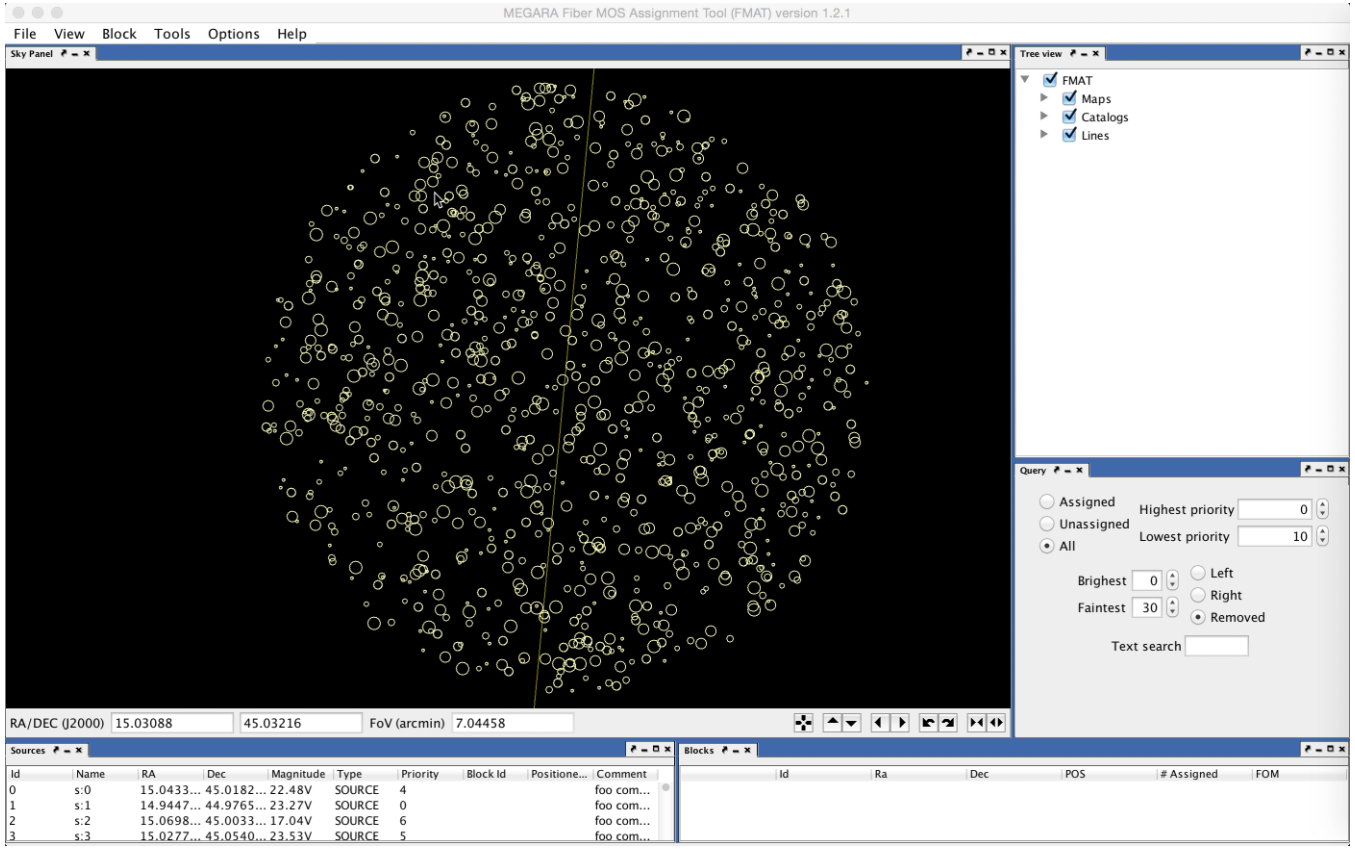
Tools for the Astronomer

MEGARA Observing Preparation Software Suite:

- ETC, End-to-end Simulator
- Fiber MOS Assignment & Positioning Tools

Plus also:

- Data Reduction Pipeline



MOPSS Science Test Case

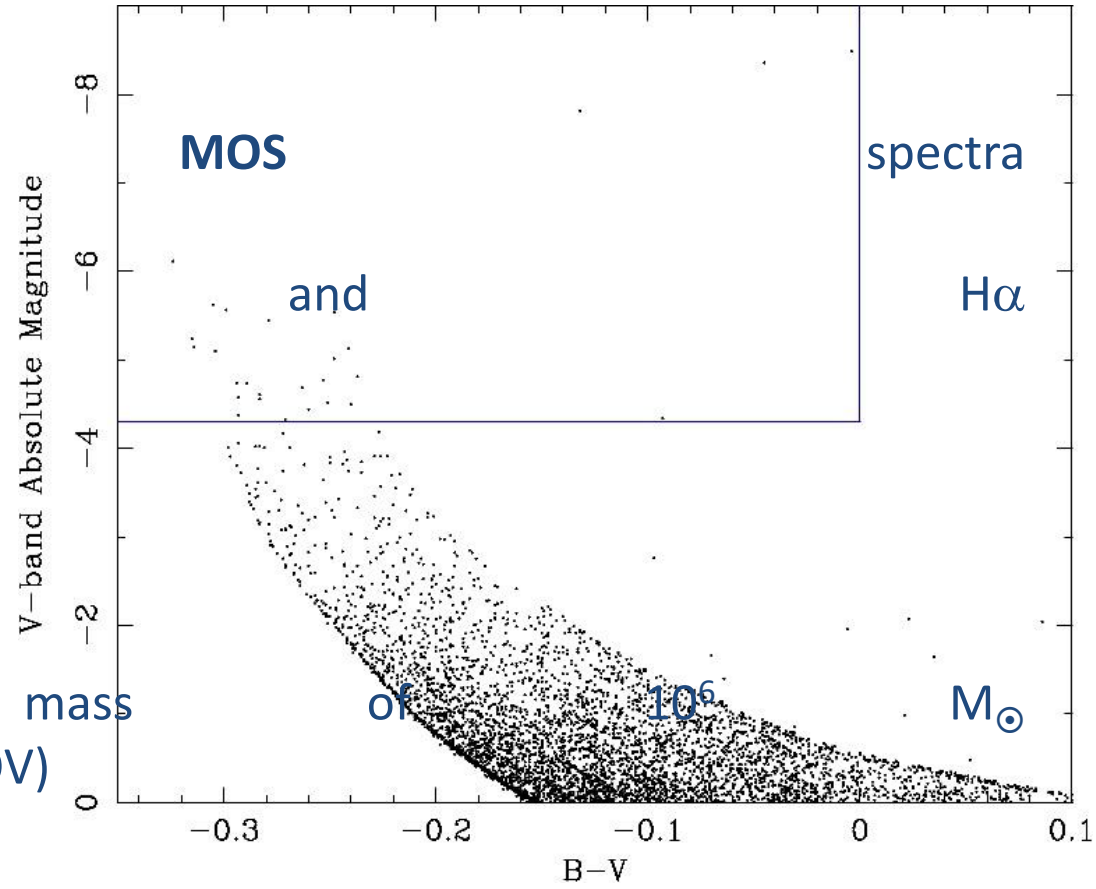
Objective: to determine the properties (chemical composition, effective temperature, mass loss, radial velocity) of a **sample of massive blue stars in the disk of the Local Group galaxy M33.**

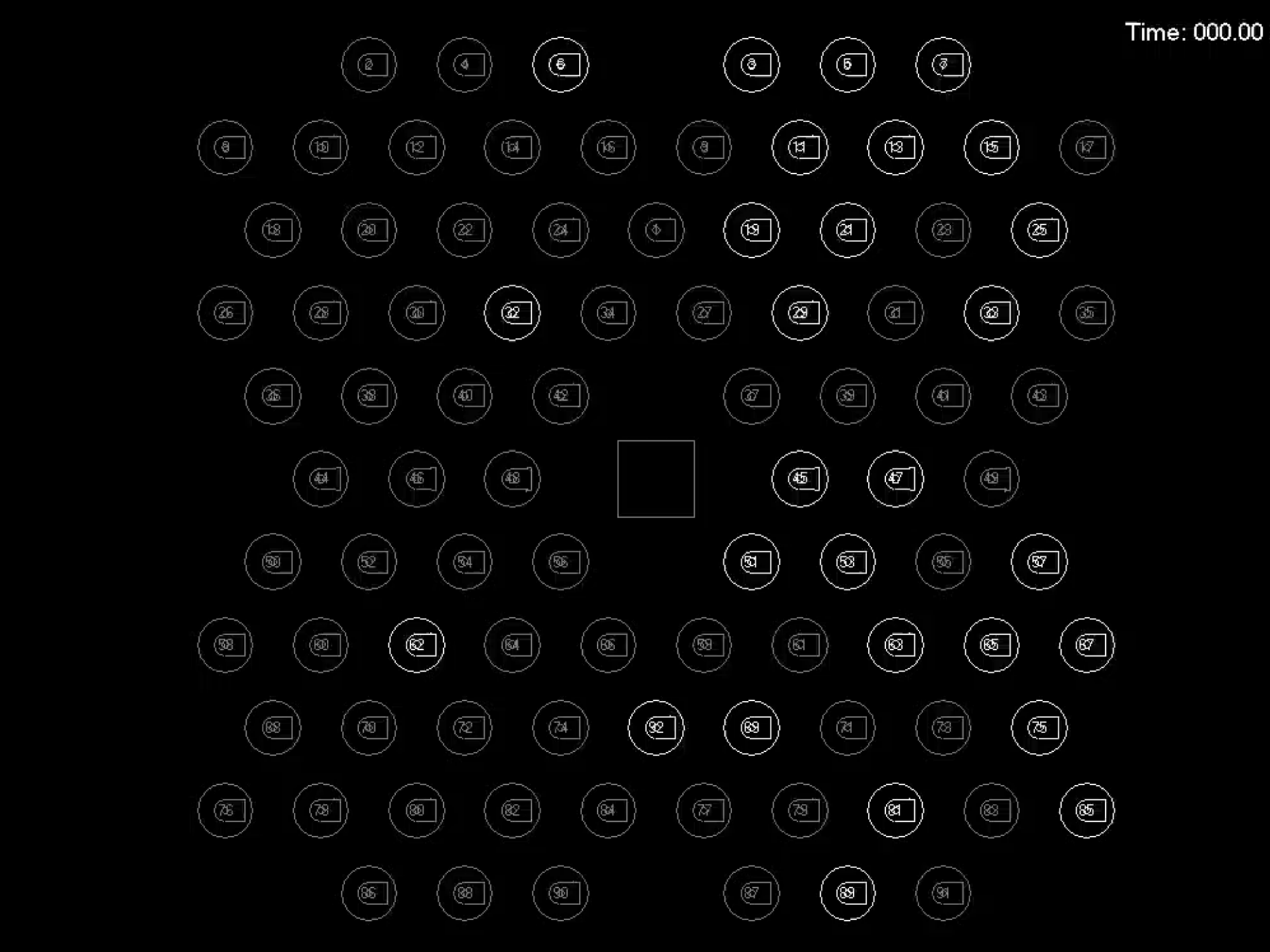
This science case ***requires***:

- MEGARA of M33-disk OB stars
- 3600-4400ÅÅ coverage (**LR-U** & HR-R)
- S/N ≈ 20

We ***make use*** of:

- IAC-star for the SFH
- Total stellar mass of 10^6 $M_\odot$ ($1M_\odot/pc^2$ in $1kpc^2$=MEGARA FOV)
- UVES POP spectra of OB types

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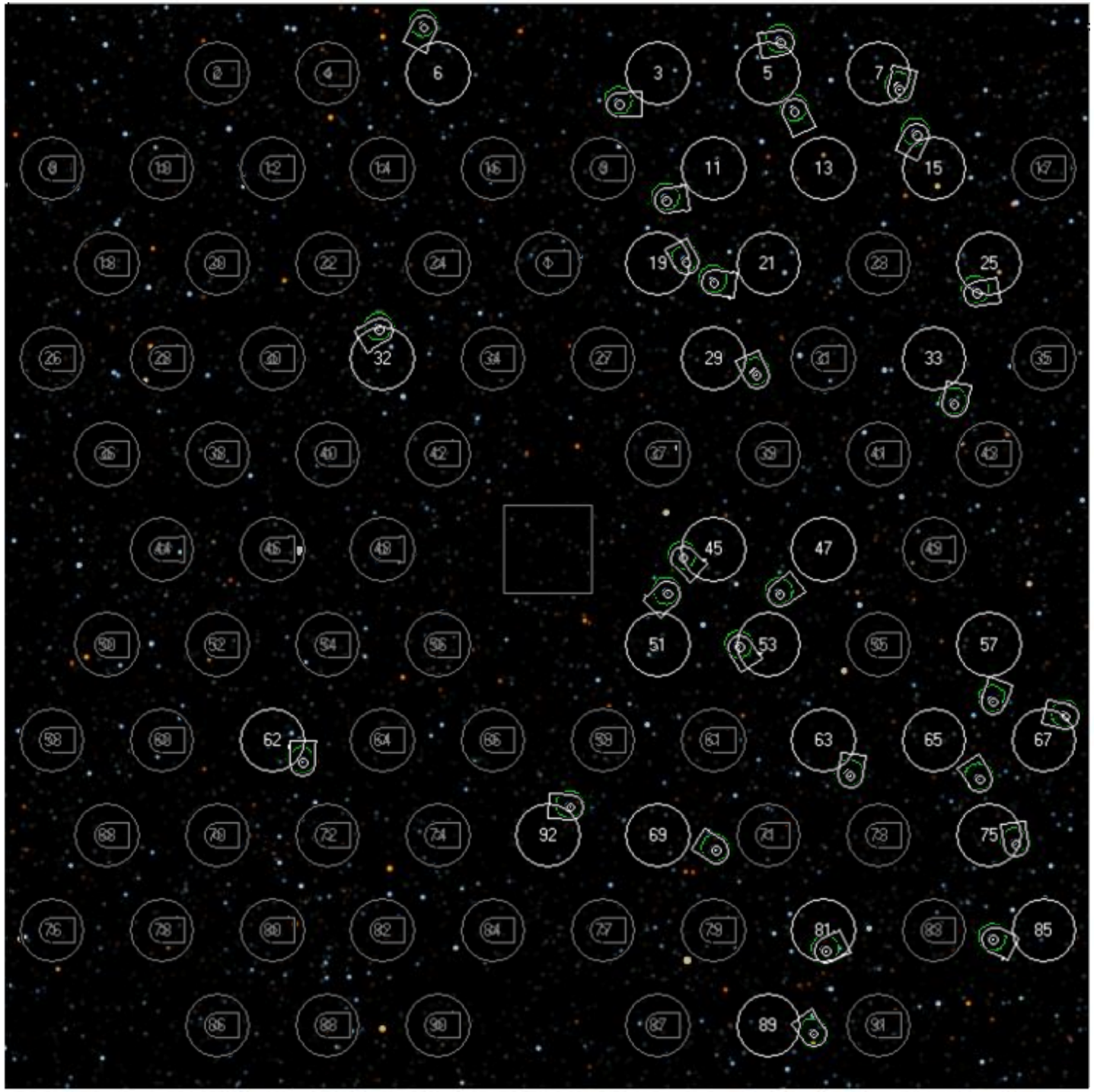
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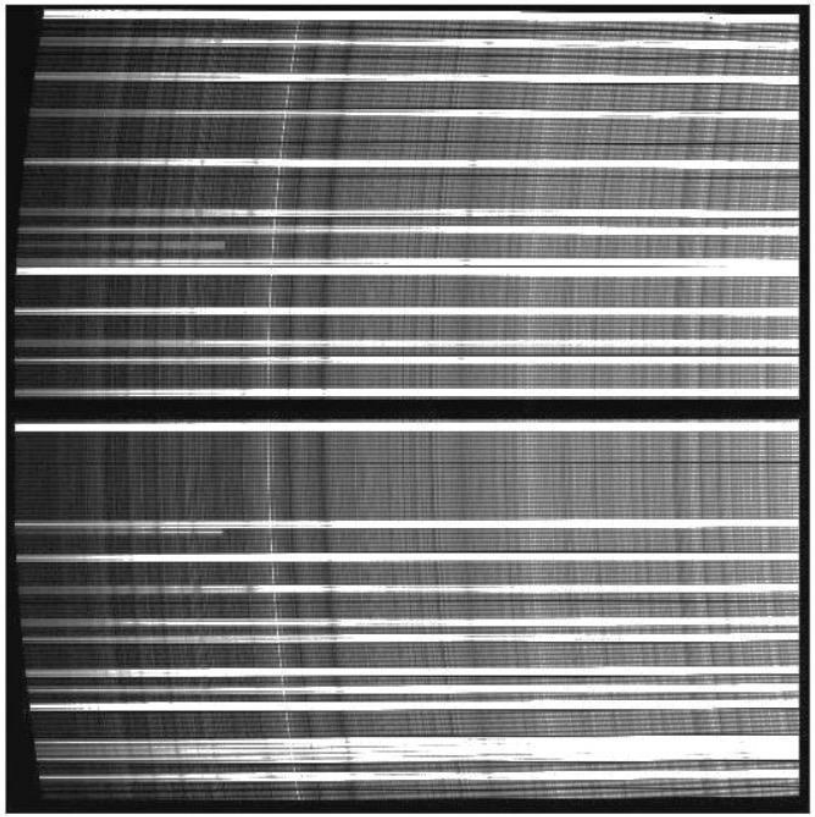
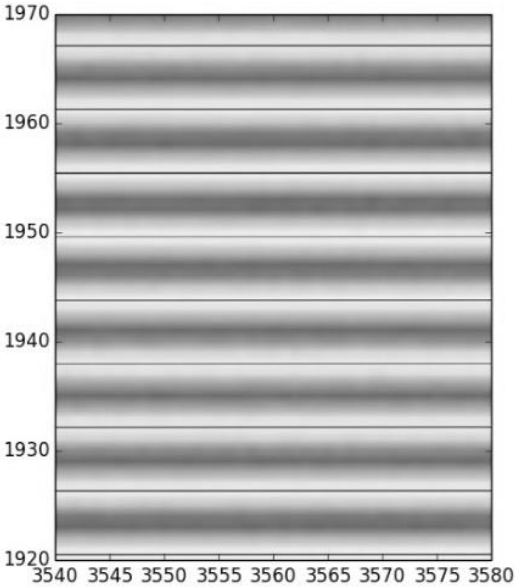
Acquiring and processing the simulated observing program …

MEGARA Simulator
(raw 2D frame)

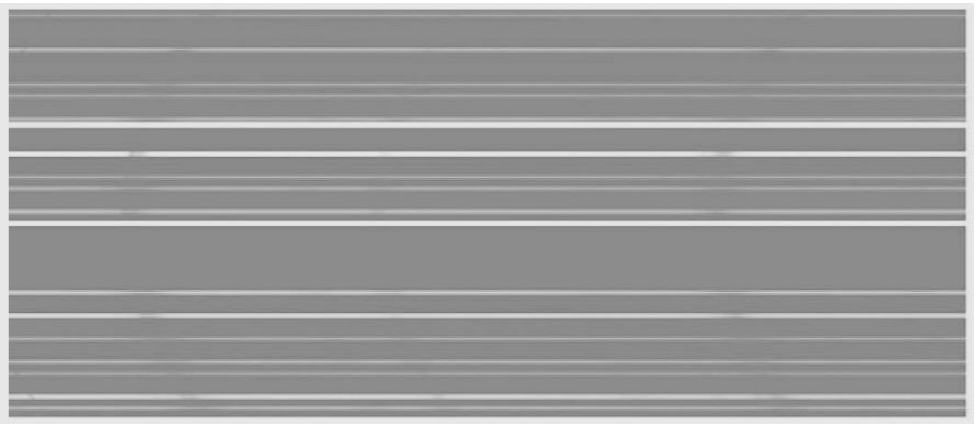


→

MEGARA Data Reduction Pipeline
(tracing & extraction)



(RSS reduced spectra)



Multi Espectrógrafo en GTC de Alta Resolución para Astronomía

MEGARA calendar

2013 May	Optics CDR passed
2013 July-Sept.	Spectrograph blanks purchased (GRANTECAN & Consortium)
2013 September	"Revised GTC Instrumentation Plan" endorses MEGARA
2014 May	CDR + Construction + Commissioning contract is signed
2014 June	System CDR
2014 December 19th	System CDR passed
2015 February	Intermediate "pre-Laboratory acceptance" milestone
2016 May	Laboratory acceptance
2016 Second half	MEGARA is delivered to GTC

MEGARA installation and commissioning dates:

2016 December	MEGARA is installed at GTC
2017 April	MEGARA is commissioned

MEGARA@GTC

The "Chemo-Dynamical" machine will be soon ready to work!

— as the Centennial of the 1st extragalactic redshift —