



Observatorios de Canarias Present and Future

Alex Oscoz





Instituto de Astrofísica de Canarias (IAC)

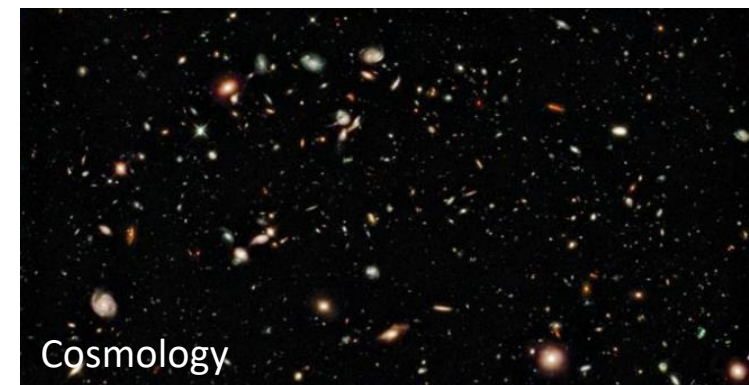
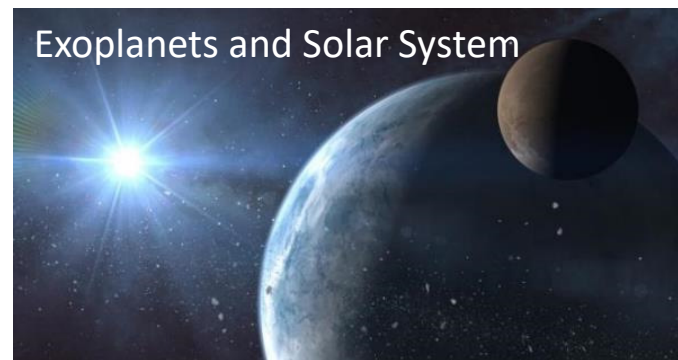
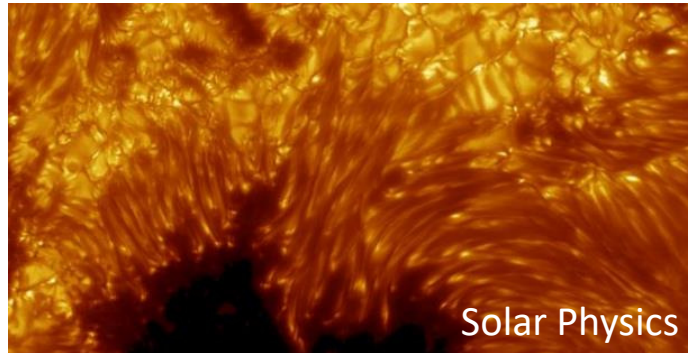
Public research consortium ~500 people



International cooperation – more than 60 collaborative agreements



Research





Instrumentation Division

- Optical system design and testing
- Optical manufacturing
- Mechanical and opto-mechanical system design and development
- Cryogenic and vacuum system design and development
- Precision mechanics
- Adaptive optics
- Fibre optics
- Control systems
- Sensor characterisation
- Project management
- Systems engineering
- Electronic systems
- Software design and Laser communications









Telescopes installed in the Canary Island Observatories

DIAMETER	TELESCOPE	INSTITUTION
	CILBO	ESA
	AMOS-CI	Univ. Bratislava
	AStMon	IAC
11	TIZON	IAC
20	Automatic Seeing Monitor (DIMMA)	IAC
40	GroundBIRD	GroundBIRD collaboration
43	COAST	Open University
50	MONS	IAC
61	PIRATE	Open University
70	Vacuum Tower Telescope	Inst. Kiepenheuer
50, 43, 8	Optical Telescope Array	Telescope Society
80	IZN-1	ESA
80x2	TTT	Light Bridges
82	IAC-80	IAC
90	THEMIS	CNRS
100	SONG	Univ. Aarhus, IAC
100	OGS	ESA
100	Artemis	Univ. Liega, MIT, IAC
100x2, 40x2	LCOGT	LCOGT Network
120x2	STELLA	Inst. Postdam
150	GREGOR	Inst. Kiepenheuer, MPS, Inst. Postdam
152	Telescopio Carlos Sánchez	IAC
225x2	QUIJOTE I – II	IAC, Univ. Cambridge, Univ. Manchester, IFCA, Univ. Cantabria
400	ASTRI	Inst. N. de Astrofísica
	Laboratorio Solar: Mark-I, GONG	IAC, Univ. Birmingham, NSO

DIAMETER	TELESCOPE	INSTITUTION
	CILBO	ESA
	AMOS-CI	Univ. Bratislava
12x4	SuperWASP	Univ. Warwick
20	Automatic Seeing Monitor (DIMMA)	IAC, Univ. Niza
30	Automatic Seeing Monitor (DIMMA)	STFC, ING
36x16	CLASP	Univ. Warwick
40x16	GOTO	Univ. Warwick
97	Swedish Solar Tower	Univ. Estocolmo
100	Jacobus Kapteyn Telescope	IAC, SARA
100	Super-WASP Alsubai Follow-up Telescope	Univ. Warwick
120	Mercator Telescope	Inst. Sterrenkund, Univ. Leuven
200	Liverpool Telescope	Univ. John Moores Liverpool
250	Isaac Newton Telescope	IAC, ING
256	Nordic Optical Telescope	NOTSA
300	First G-APD Cherenkov Telescope	FACT Collaboration
350	Telescopio Nazionale Galileo	INAF
420	William Herschel Telescope	IAC, ING
1040	Gran Telescopio Canarias	GRANTECAN, Univ. Florida, INAOUE-UNAM
1700x2	MAGIC I y II	MAGIC Collaboration
2300	LST-1	LST Collaboration



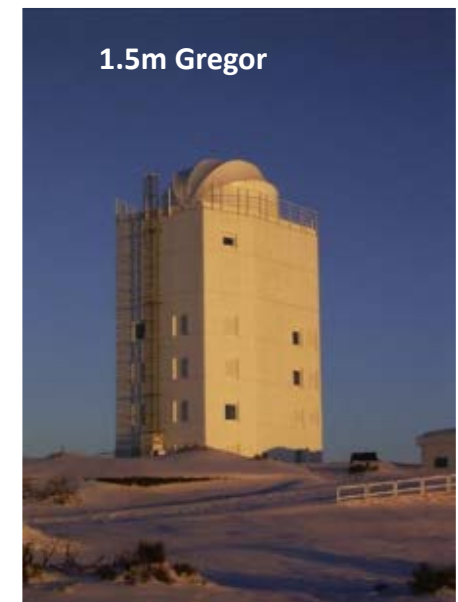
Capabilites of some Telescopes installed at the OCAN

	Optical			Near IR			Med IR		Special							
	Img	MRS	HRS	Img	MRS	HRS	Img	MRS	AO	Opt WFI	IR WFI	WF Spec	Polar Img	Polar Spec	Fast Phot	Coro
GTC	X	X	X	X	X	X	X	X	X				X	X	X	X
WHT				X	X		X	X					X			
TNG	X	X	X	X	X	X									X	
NOT	X	X	X	X	X								X	X		
INT	X	X								X						
LT	X	X											X			
Mercator	X	X	X													
TCS	X														X	
Stella	X		X							X						
SONG			X												X	
OGS	X															
JKT	X															
LCOGT										X						
IAC80	X															

Img: image, MRS: med-res. spec., HRS: high-res. spec., AO: adapt. Opt., WFI: wide field image, Polar: polar., Phot: photom., Coro: coronagraphy



Solar Telescopes

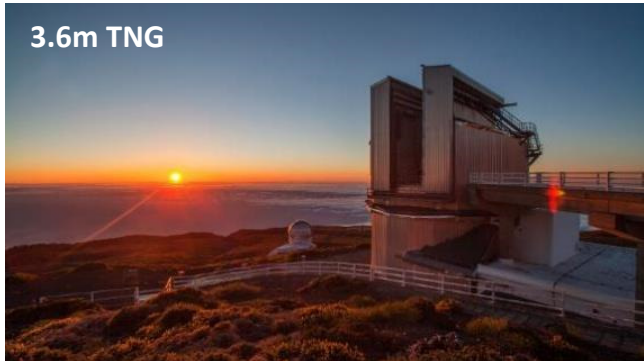




4.2m WHT

Night-Time Telescopes

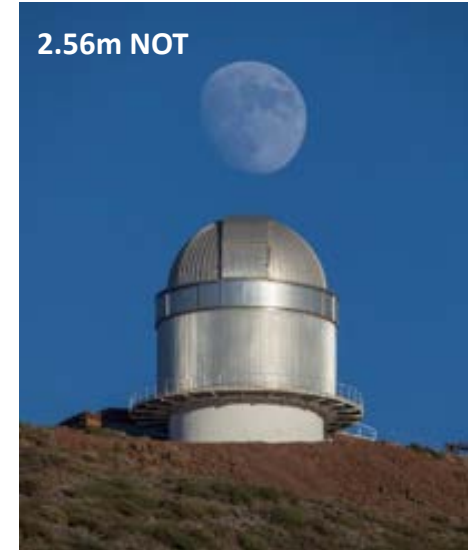
3.6m TNG



1m SONG



2.56m NOT



2.5m INT



1.56m TCS



0.82m IAC80



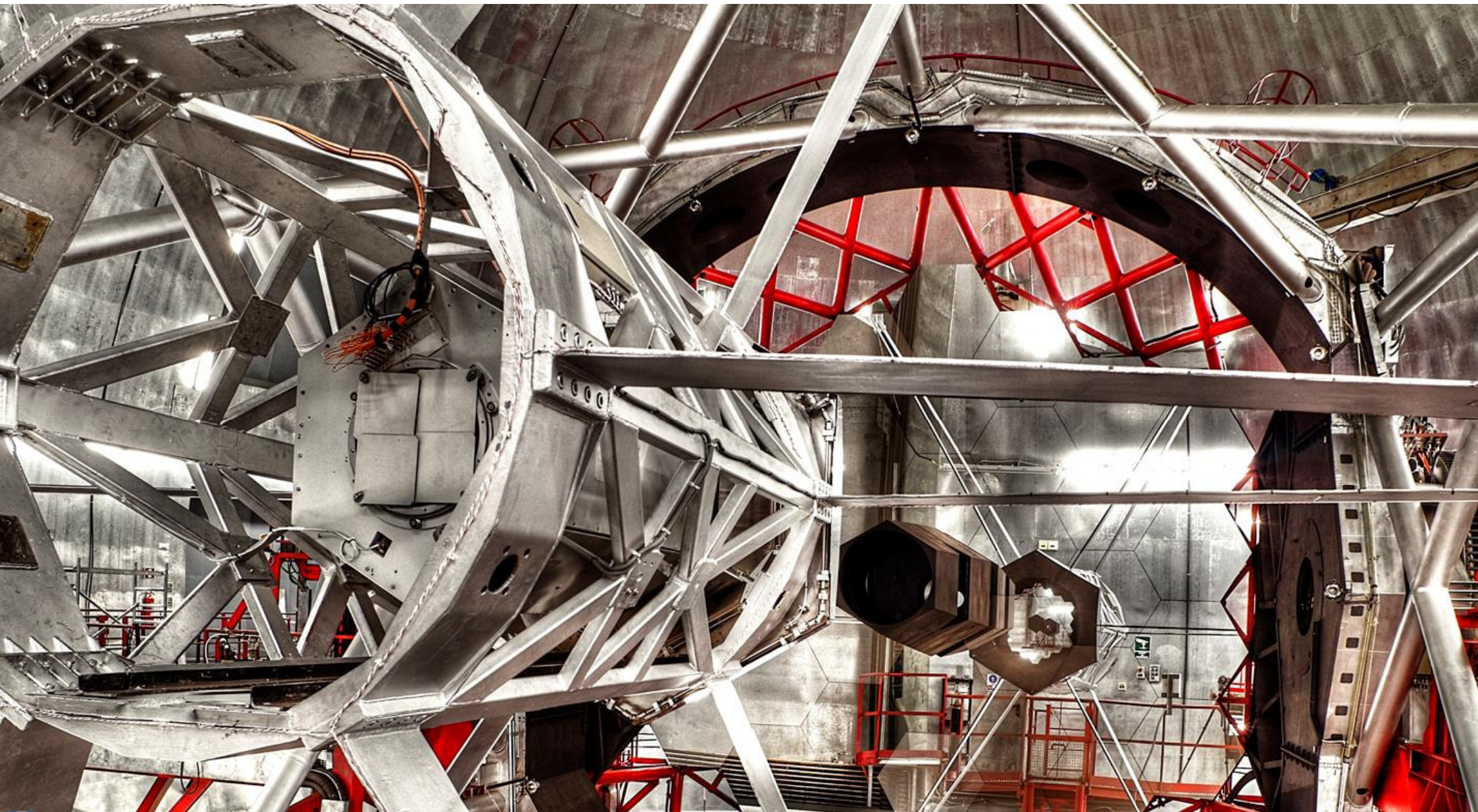
1.2m Mercator



GTC

Gran Telescopio Canarias
10.4m





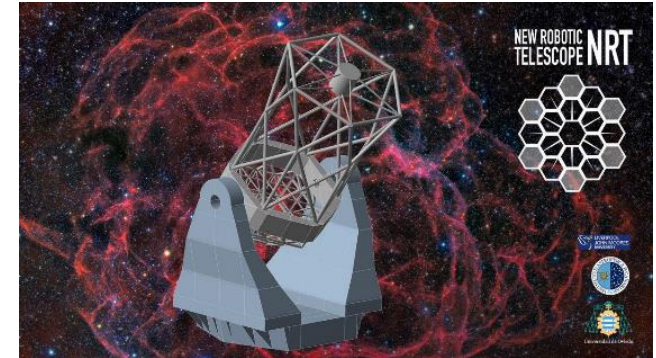


SMALL & MEDIUM-SIZED NIGHT TELESCOPES



New Robotic Telescope (NRT)

Contact – Carlos Gutierrez (cgc@iac.es)



- International collaboration → largest ($\varnothing$ 4 m) robotic telescope in the world
- Based on the success of the LT and GTC
- Standard for future telescopes
- Quick response (on target in 30 s)
- FoV $\sim 5'$ - $30'$ diameter
- Sited at ORM in La Palma
- Optical and NIR ranges
- Focal stations at direct and folded Cassegrain
- Optimal image quality dominated by seeing (ORM median $\sim 0.7''$)

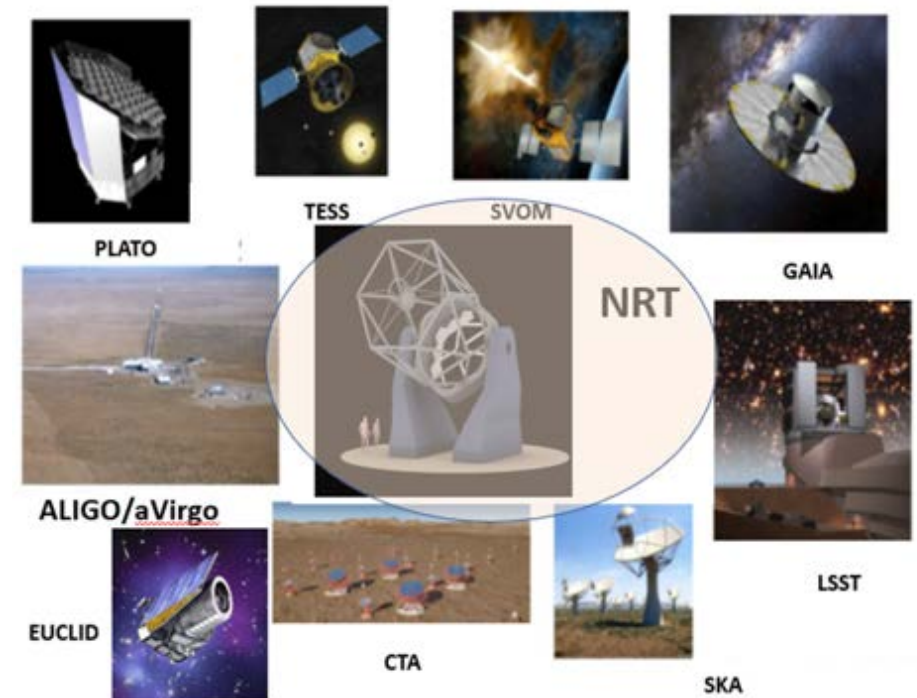
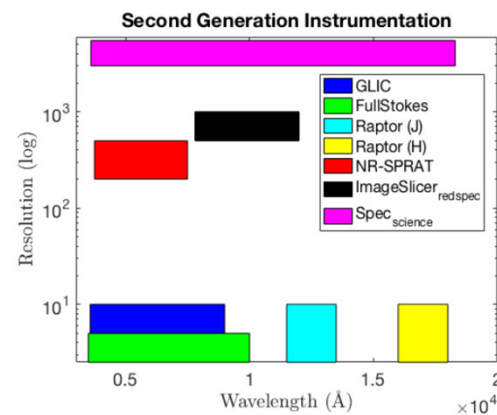
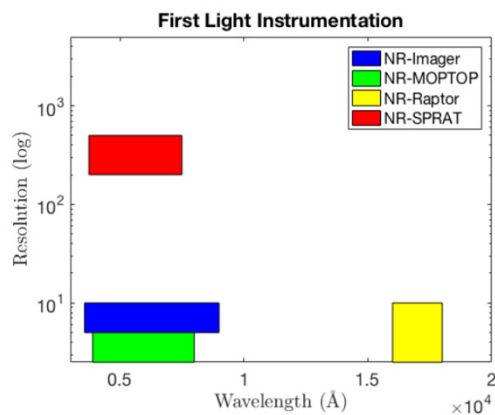




Science Cases

Detection, classification and characterization of:

- Gravitational waves
- Gamma Ray Bursts
- Supernovae
- Exoplanets
- Tidal Disruptions Events



Scheduling

- 2022 -2024 detailed design
- 2025-2026 construction
- 2027 first light
- 2029 full operation

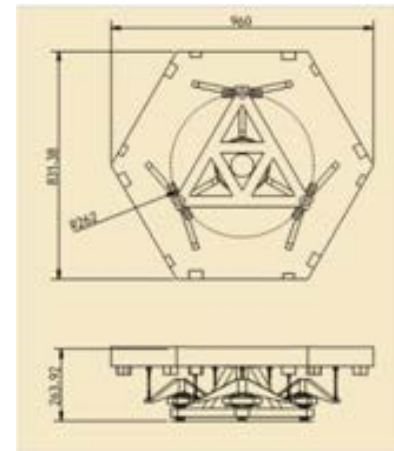


HEX-18 possibility to produce them at IAC – CSOA
Optomechanics similar to GTC

	Distance (mm)	Radius (mm) (edge)	RoC (mm)	Conic
M1	-6657.69	2090	-16770	-1.020449
M2	6657.69	455.3 (465.3)	-4257.7	-2.331897
BFD	1650	264.7		
Fold mirror	850	190 (200)		
Focal plane		194.6		



- Richey-Chretien – $f/10.635$, $220 \mu\text{m}/\text{arcsec}$
- $\varnothing 4.18\text{m}$, 18 segments primary mirror – Tip, tilt, piston
- Instruments at Cassegrain focal station:
 - 1 x Straight Through Instrument
 - 6 x Folded Port Instruments
- FOV: 30 arcmin straight through port, 14 arcmin folded ports



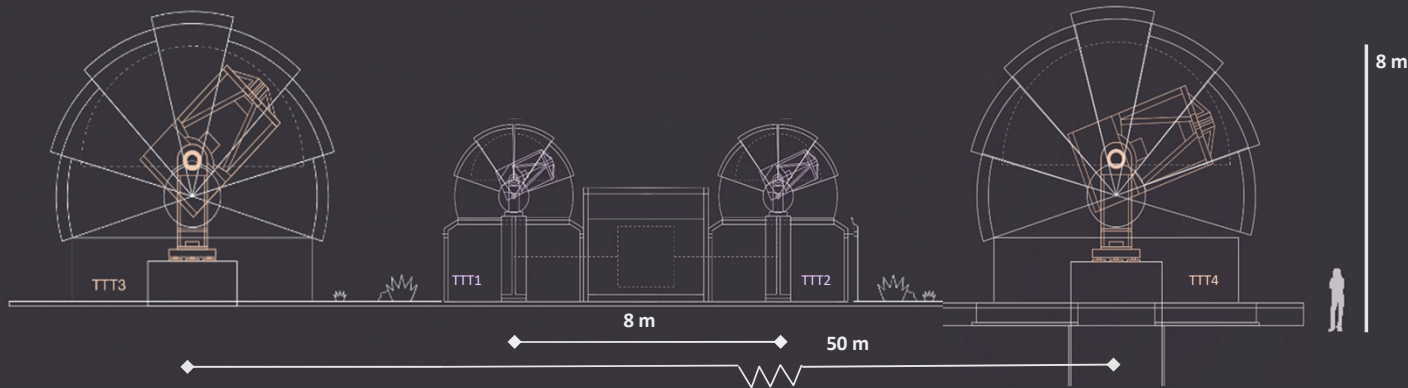
Segments:

- 9 points axial Whiffle Tree
- 3 tripods
- 120 kg/segment



Two meter Twin Telescope (TTT)

Contact – Antonio Maudes (antonio@lightbridges.es)



TTT1 & TTT2 – 2x80 cm telescopes, producing science

TTT3 & TTT4 – 2x2 m telescopes, scheduled for Dec 2024

TST – 1 m telescope, scheduled for fall 2024





TTT-80 – TTT1 & TTT2

ASA ALT-AZ 800 mm RC – f/6.85, f/4.4 focal reducer



FOV Ikon L936: 17.34' x 17.34' (2K*2Kpix)

Plate scale: 0.51 ''/px

Filters: SDSS u', g', r', i', zs, Ha, Lum

FOV QHY990Pro: 4.64' x 3.5' (1.3K*1Kpix)

Plate scale: 0.2 ''/px

Filters: SDSS r', i', zs / Y,J,H

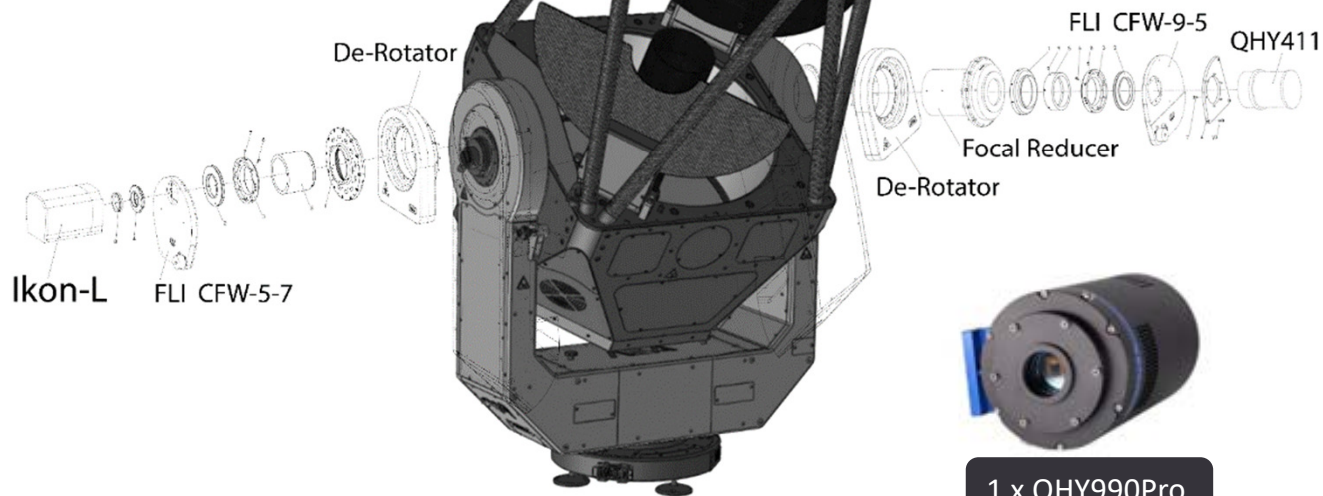
FOV QHY411: 52.72' x 39.61' (15Kx10Kpix)

Plate scale: 0.22 ''/px

Filters: Lum, SDSS g', r', i', Dark/Ha



1 x Ikon-L 936



1 x QHY990Pro



2 x QHY411M



TTT-200 – TTT3 & TTT4

ASA ALT-AZ 2000 mm RC – f/6

Expected Dec 2024

- Min. observable elevation 15° – Max. speed 10 deg/s
- Tracking $< 0.1''$ RMS/min – Pointing $< 8''$ RMS
- Instruments:
 - 1 sCMOS
 - Nasmyth for budgeting in sci projects

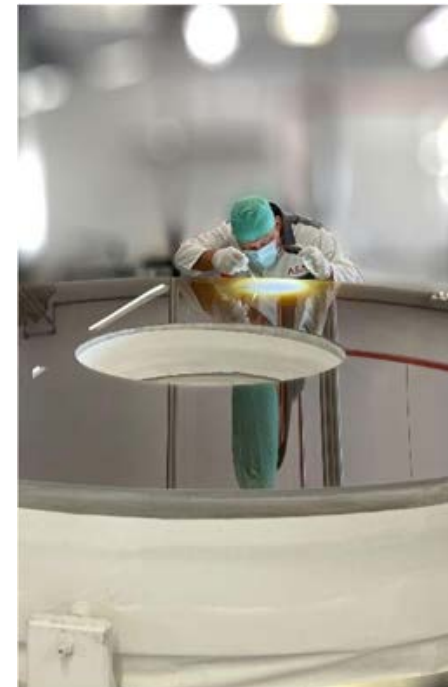


TST – TRANSIENT SURVEY TELESCOPE

ASA ALT-AZ 1000 mm RC – f/1.3

Expected fall 2024

- Instrumentation – Primary focus
- sCMOS QHY411M
- FoV $2.4^\circ \times 1.8^\circ$ – $0.6''$ /px

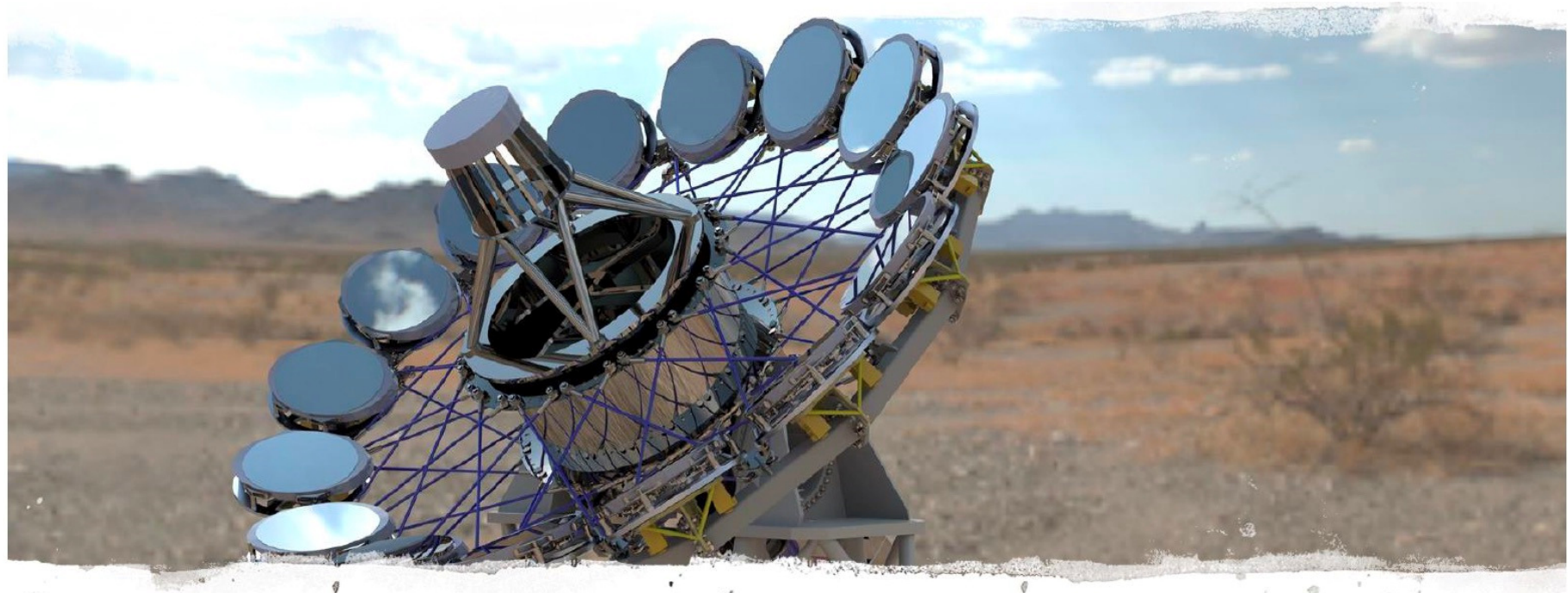




The ExoLife Finder (ELF)

A new machine to detect biomarkers in the atmosphere of exoplanets

Contact – Nicolas Lodieu (nlodieu@iac.es)



Funded by
the European Union



Plan de
Recuperación,
Transformación
y Resiliencia

Financiado por
la Unión Europea
NextGenerationEU

LIOM LABORATORY
FOR INNOVATION
IN OPTOMECHANIC

**PLANETS
FOUNDATION**



MorphOptic



INSA INSTITUT NATIONAL
DES SCIENCES
APPLIQUÉES
LYON

DiSL

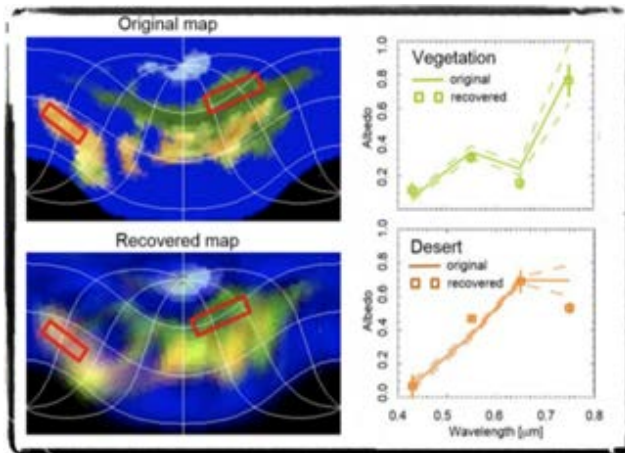
QVS

buble



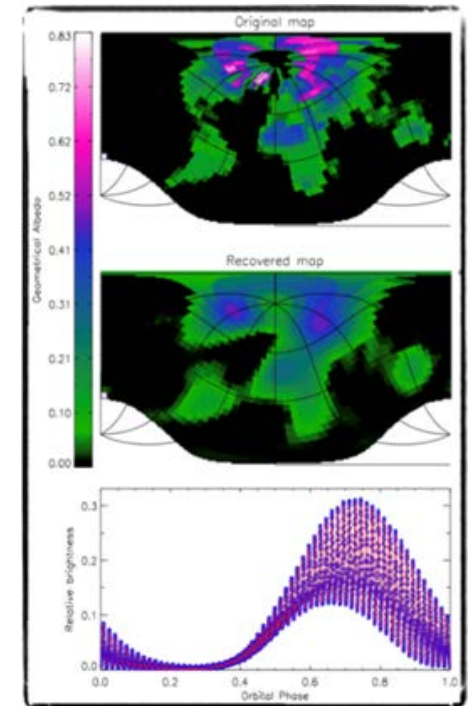
Key aspects to image exoplanets

- High spatial resolution = angular separation
- High dynamic range = contrast photometry
- High sensitivity = depth
- Never mind the field-of-view → build a dedicated large coronagraphic telescope
- Observe in the infrared
- Off-axis telescope segments
- Scalable distributed pupils



Follow orbital motion and rotation of the planet with time
Reconstruct surface image of the atmospheres of
exoplanets

Inversion technique: ExoPlanet Surface Imaging (EPSI)





New technologies:

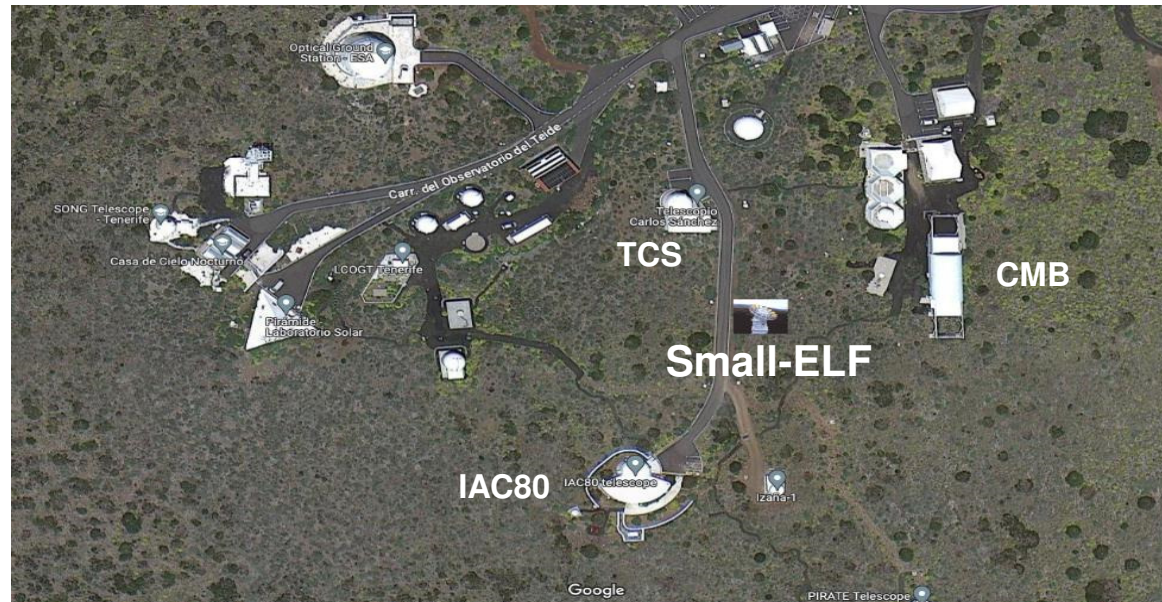
- Fizeau optics
- Tensegrity optomechanics
- Thin mirrors
- Advanced WFS

→ A telescope with a diameter of 40-50m at least 10 times cheaper



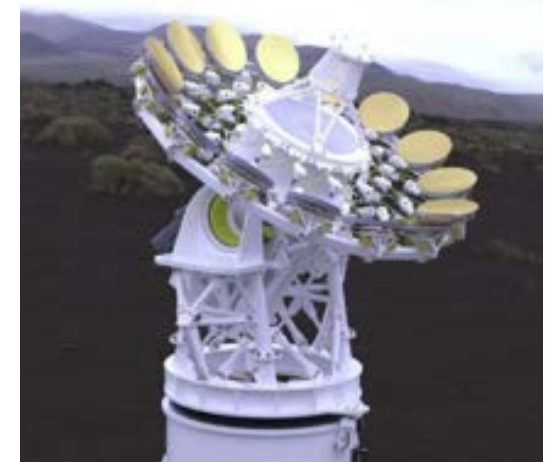
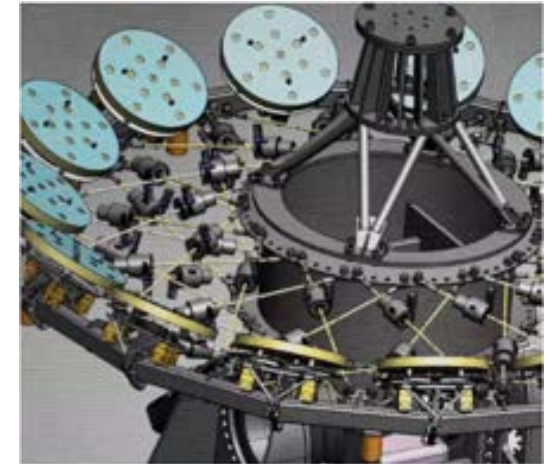


SMALL-ELF at OT



3.5-m prototype – 15 x 0.5m mirrors in a bicycle wheel

- Detection through direct imaging of exoplanets (e.g. ϵ Eridani b)
- Rotation and variability of planetary-mass companions
- Orbital determination of masses of systems with planetary-mass companions
- Search for substellar companions to the brightest and nearest stars and around members of nearby ($d \leq 150$ pc) young moving groups





TCS

Contact – Alex Oscoz (aoscoz@iac.es)

New control system – Standard for future IAC telescopes

MuSCAT2

Multi-instrument platform with:

- AO module
- Lucky imaging instrument
- NIR instrument
- Spectrograph
- Coronagraph





The Atlas Project

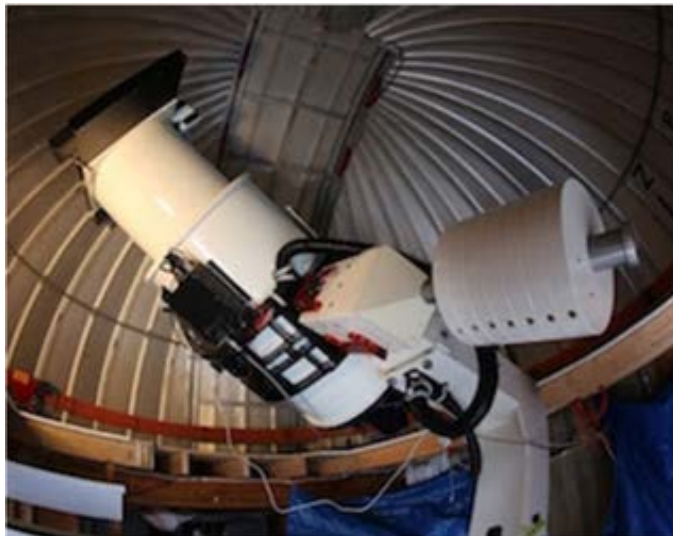
Early warning impact alert system

Contact – Javier Licandro (jlicandr@iac.es)

4x50cm f/D = 2.0 Wright Schmidt telescopes (Hawaii, Chile, South Africa)

Each ATLAS: ¼ of the sky/night, each field 4 times/hr – $T_{exp}=30s$, $V\sim 19.5$

Moving objects – Cometary activity – Time-domain astronomy



ATLAS Discovery Totals	
Near-Earth Asteroids	895
Potentially Hazardous Asteroids	87
Comets	82
Supernovae	15090





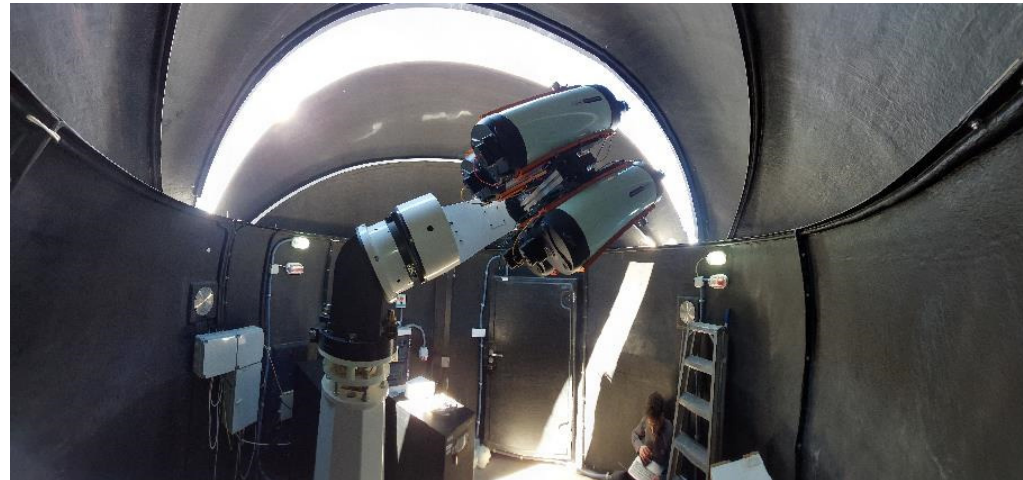
ATLAS-TEIDE: ATLAS NEXT GENERATION PROJECT

IAC & Univ. of Hawaii → ATLAS-Teide

Access to the ATLAS dataset granted to the Spanish Astronomical Community

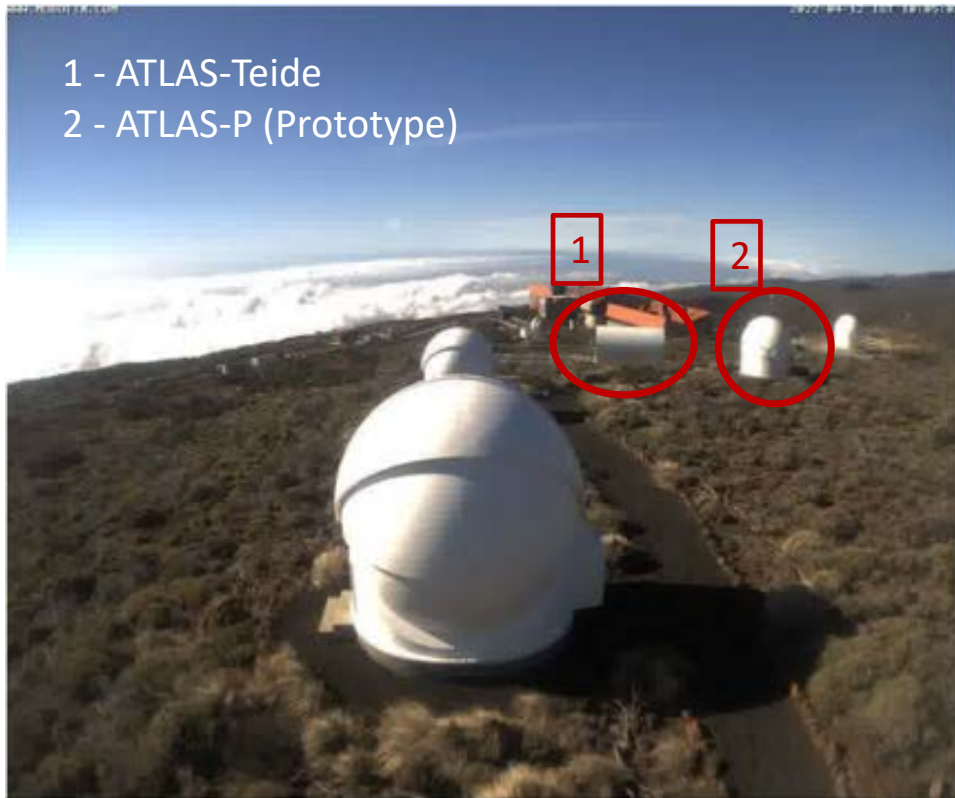
Characteristics

- Optics: 4 x RASA11 OTAs
- Cameras: QHY600PRO BI sCMOS
- Mounts: improved Planewave L-500 (L-550 version)
- Effective aperture = 56cm – FoV $\sim 7.35 \text{ deg}^2$ – Detection limit $V > 19.5$
- 4 ATLAS modules – same FoV than ATLAS





- 1 - ATLAS-Teide
2 - ATLAS-P (Prototype)

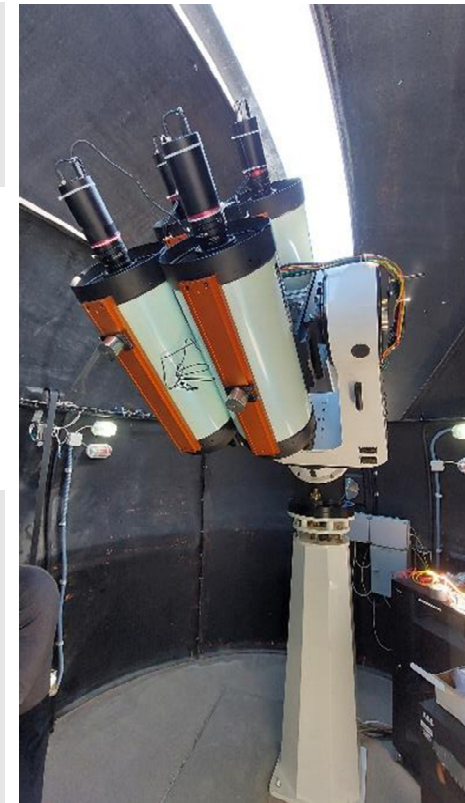


Phase 1:

- 1st ATLAS module (ATLAS-P) to test hardware and develop software
- First Light: Nov 2022
- Regular operation: May 2023

Phase 2 :

- Site adapted in 2023-2024
- Building of the 4 modules of ATLAS-Teide
- Installation - end 2024





FSOC – Free Space Optical Communications

(Quantum & Classic)

Contact – Luis Fernando Rodriguez-Ramos (lrr@iac.es)

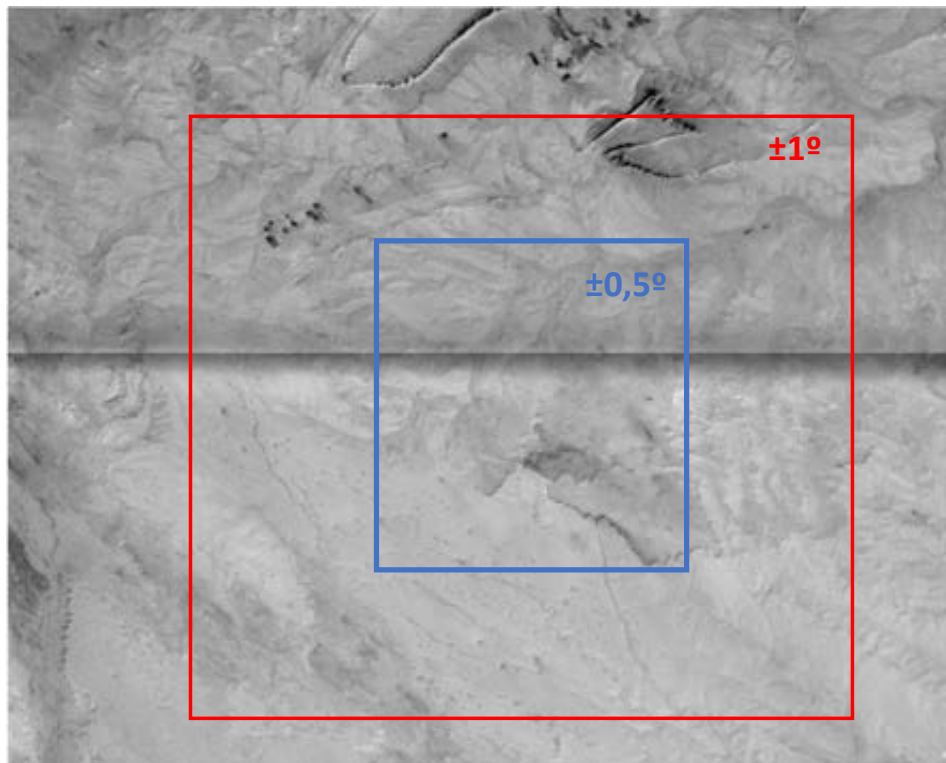
Missions

- ALISIO-1
- IACLink
- Role in quantum communications – QKD
- FYLA (Ultrashort Lasers):
 - Adaptive optics AND integrated photonics
- SPANISH QKD from LEO
 - Downlink quantum channel
- Software for modelling of laser propagation in atmosphere

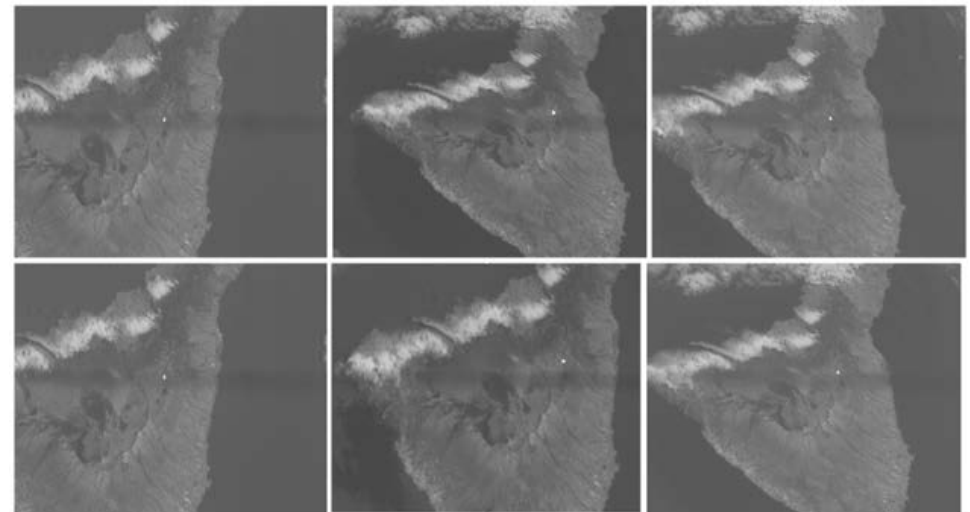




ALISIO-1 OPTICAL COMMUNICATIONS



Pointing and stability tests



10/09/2024 | IZN-1 | ALISIO1



First optical link → IZN-1-ALISIO-1



IACLINK

JKT

- Remote controlled window
- Nearby control room
- Building refurbishment, to include meeting rooms
- Small laboratories, workshops and tools

TOTLINK

- Telescope ~100 cm
- Coudé focus + 2 optical benches with windows openings to La Palma
- Capable of tracking LEO satellites & pointing to La Palma
- Remote controlled window
- Nearby control room

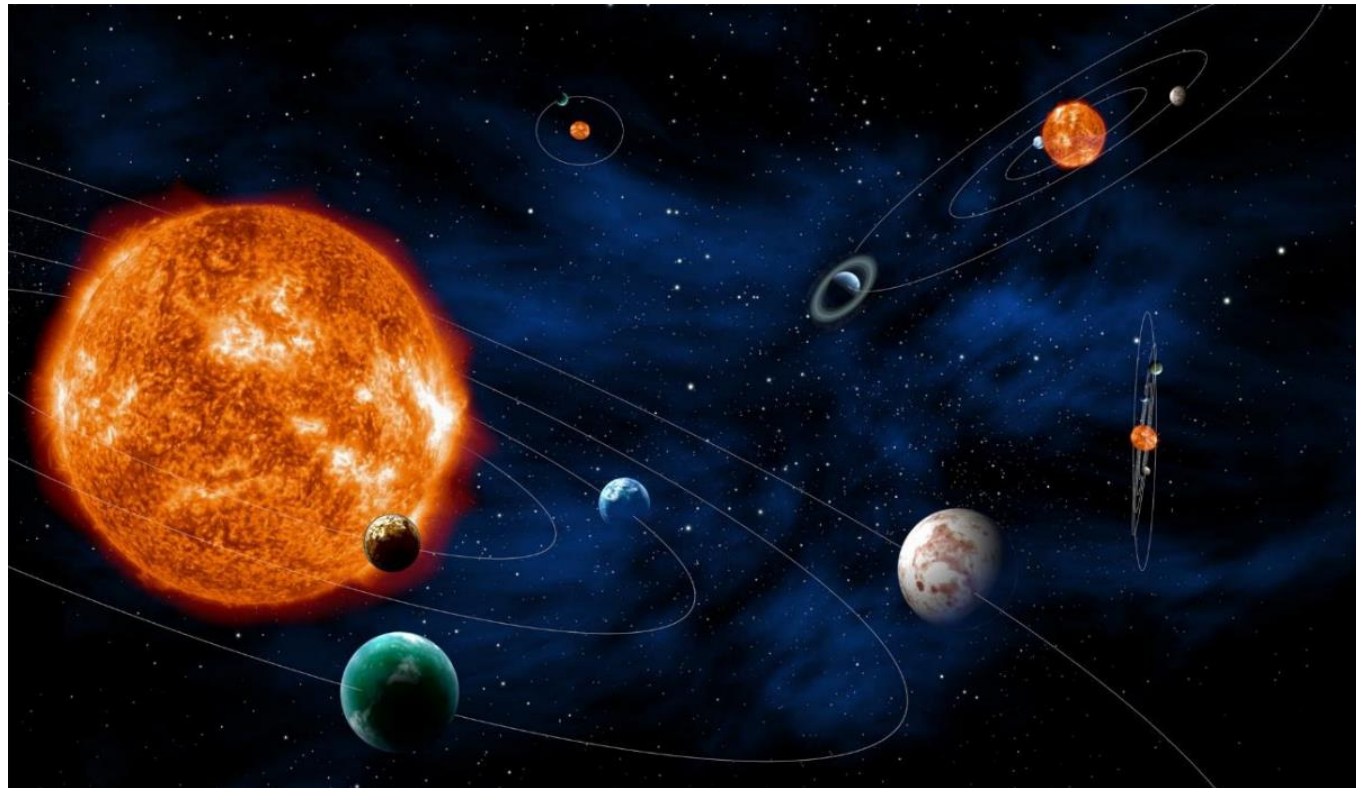




Mercator Array for Radial Velocities (MARVEL)

Unravelling the nature of exoplanets

Contact – Saskia Prins (saskia.prins@kuleuven.be)



MACQUARIE
University
SYDNEY-AUSTRALIA



universität
wien



Stockholm
University



CSIC

fwo



Science & Technology Facilities Council
UK Astronomy Technology Centre



UCL

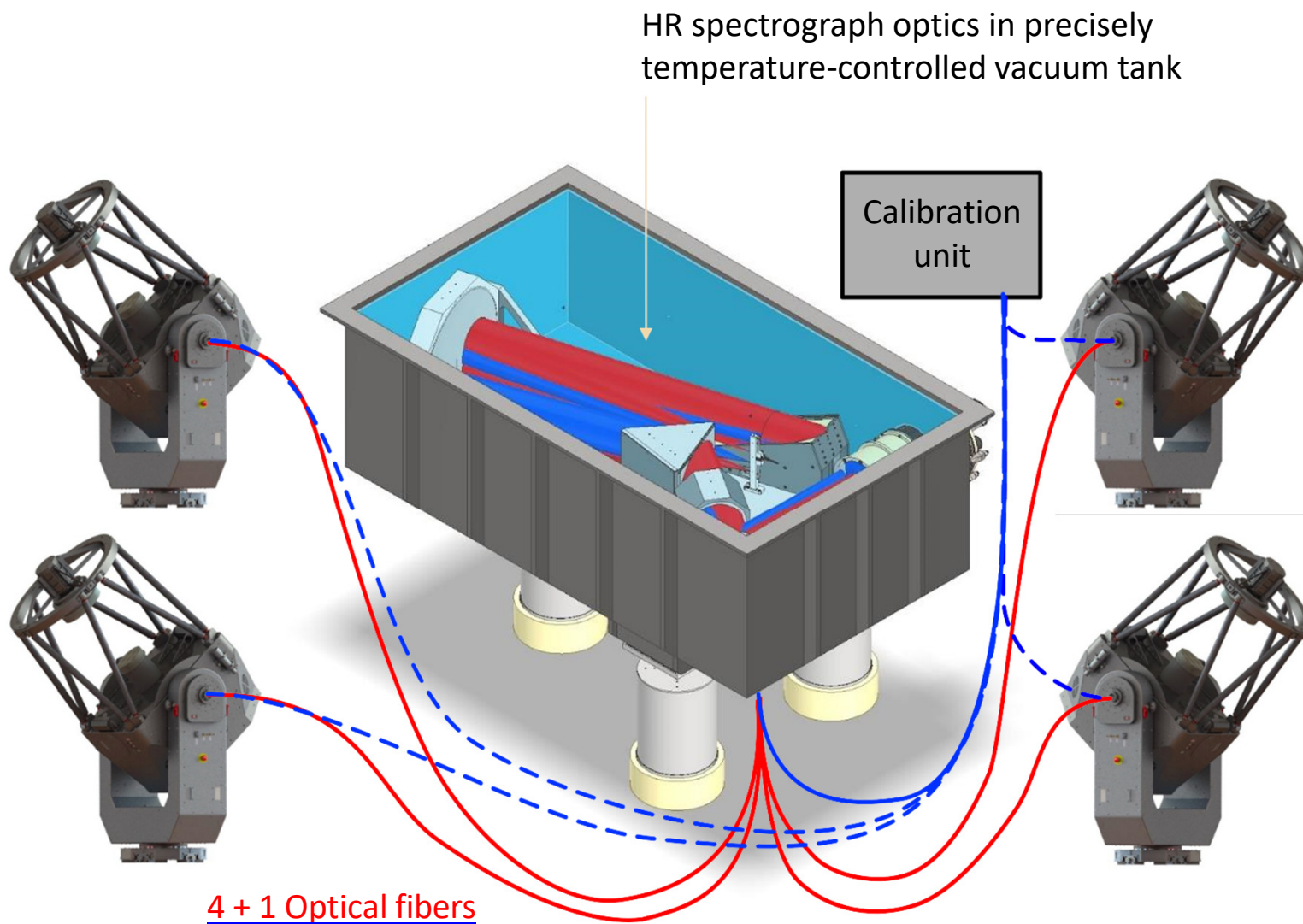
WARWICK

ZA

KU LEUVEN

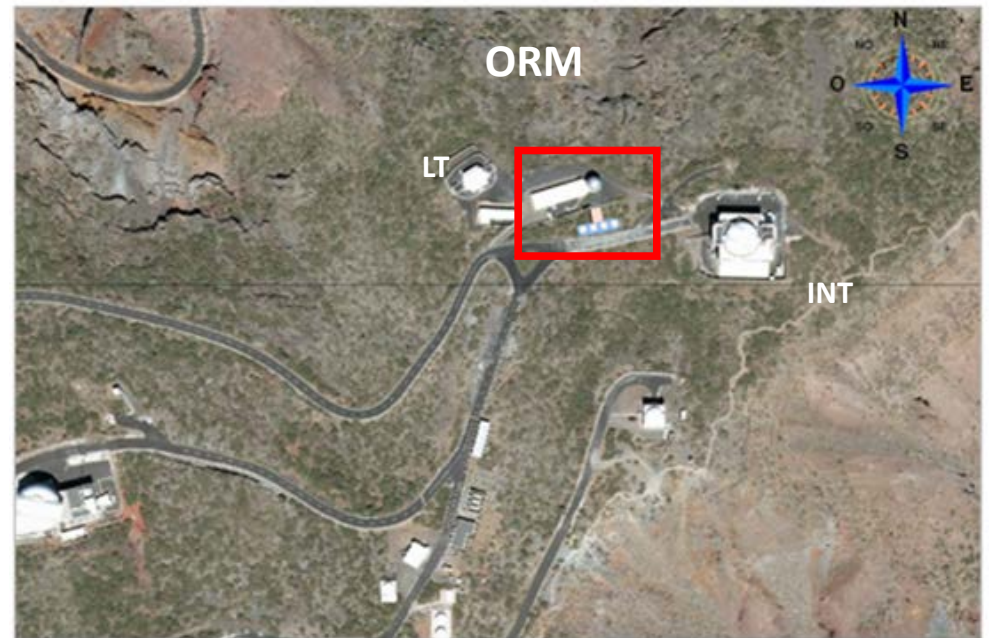
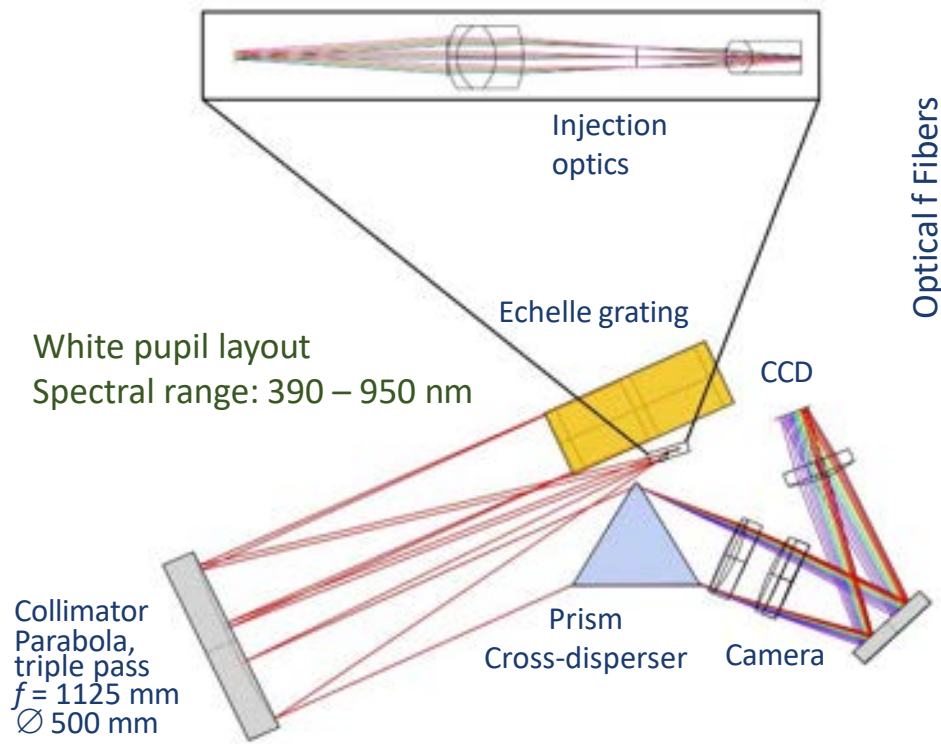


Four 80-cm COTS
Telescopes:
4 x AZ800 (f/10)
ASA (Austria)





Spectrograph optical design



- 4 Individual domes on concrete platform
- Gambato 4m domes
- Double-isolated spectrograph building





Canarian Observatories eXtinction Monitor (COXMo)

Contact – Julio Castro (jcastro@iac.es)



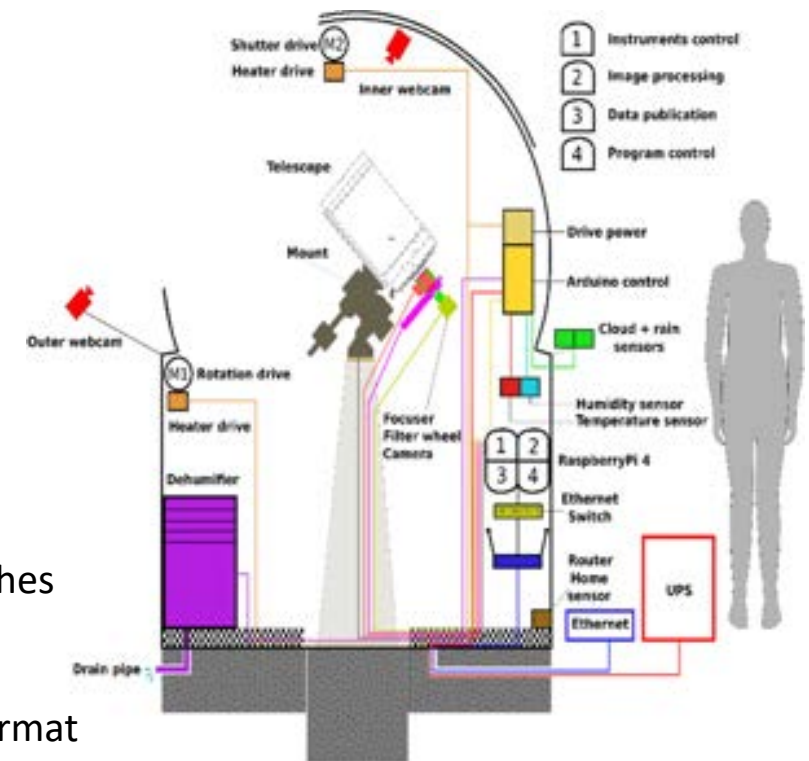
- Two (OT and ORM) night-time fully automatic extinction monitors based on calibrated stellar photometry
- Budget: €200000
- Simple and robust design
- Open source development
- Public access to measurements
- Real time data

Dome - 2.2 m

Optical tube - Schmidt-Cassegrain 11 inches

Mount - Equatorial GoTo-Mount

Camera - Back-illuminated sensor, 4/3 format



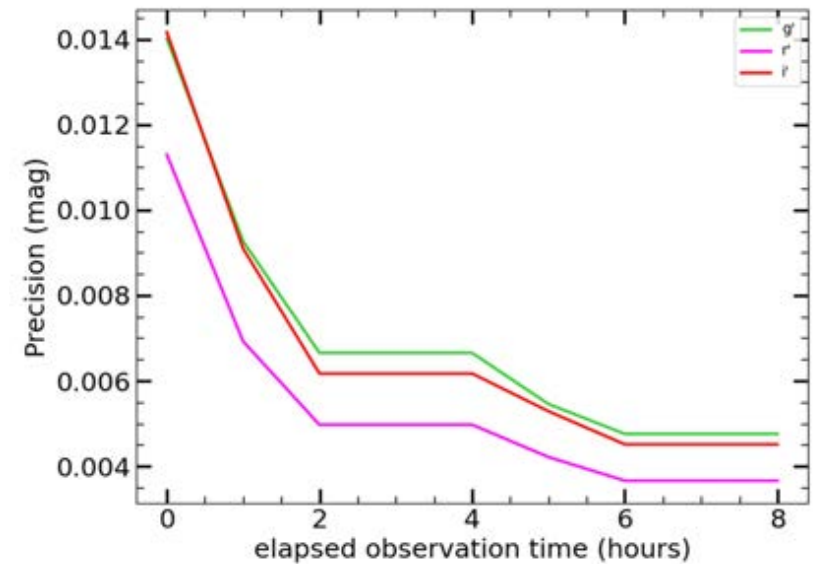


Two extinction values (E/W) at BVRI and $g' r' i'$ every 30 minutes
An average value at the end of the night
Comparison instrumental/calibrated mags as a function of air mass
Calibration equations – Color terms + zero points
Extinction and sky brightness
Precision: better than 0.005 mag
Photometric data useful for calibration
Controlled by Python open source software

Operative Summer 2025

+

OT & ORM official and calibrated WS



COXMo		Filter				
Extinction uncertainties (m mag·airmass ⁻¹)		J-C/SDSS				
		B	V/g'	R/r'	I/i'	z'
Moon	dark	5	5	5	5	15
	grey	7	7	7	7	20
	bright	9	9	9	9	20

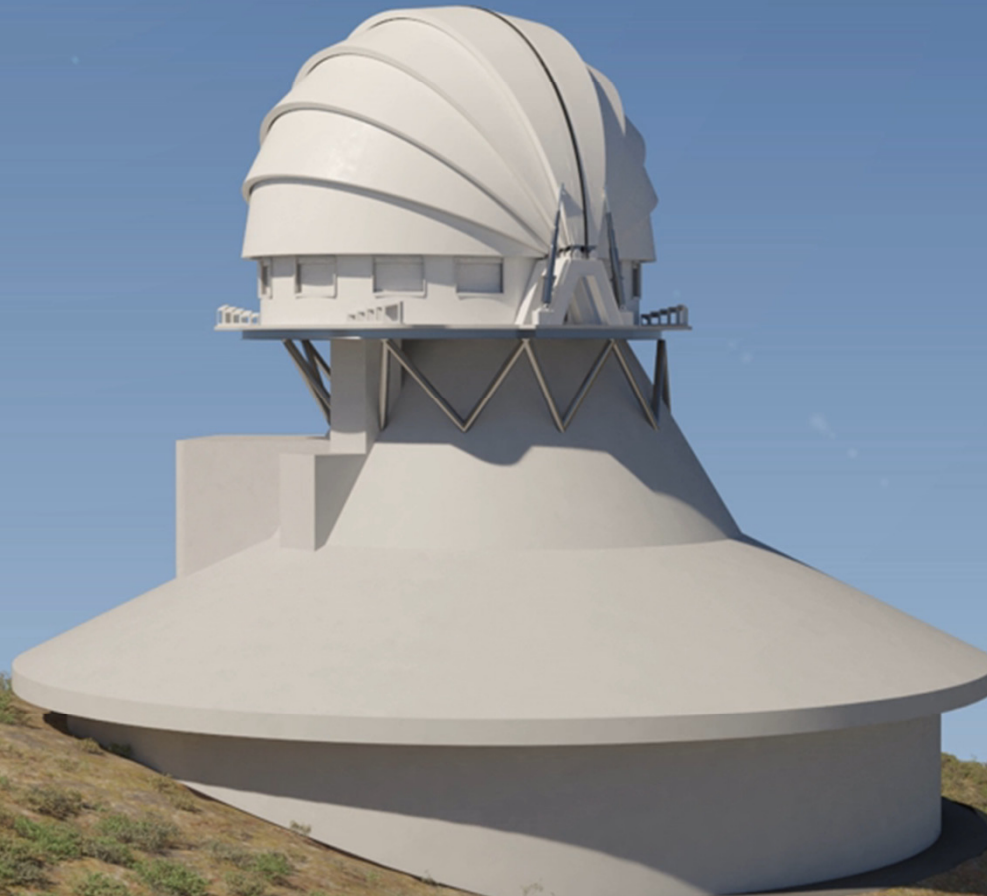


SOLAR TELESCOPES



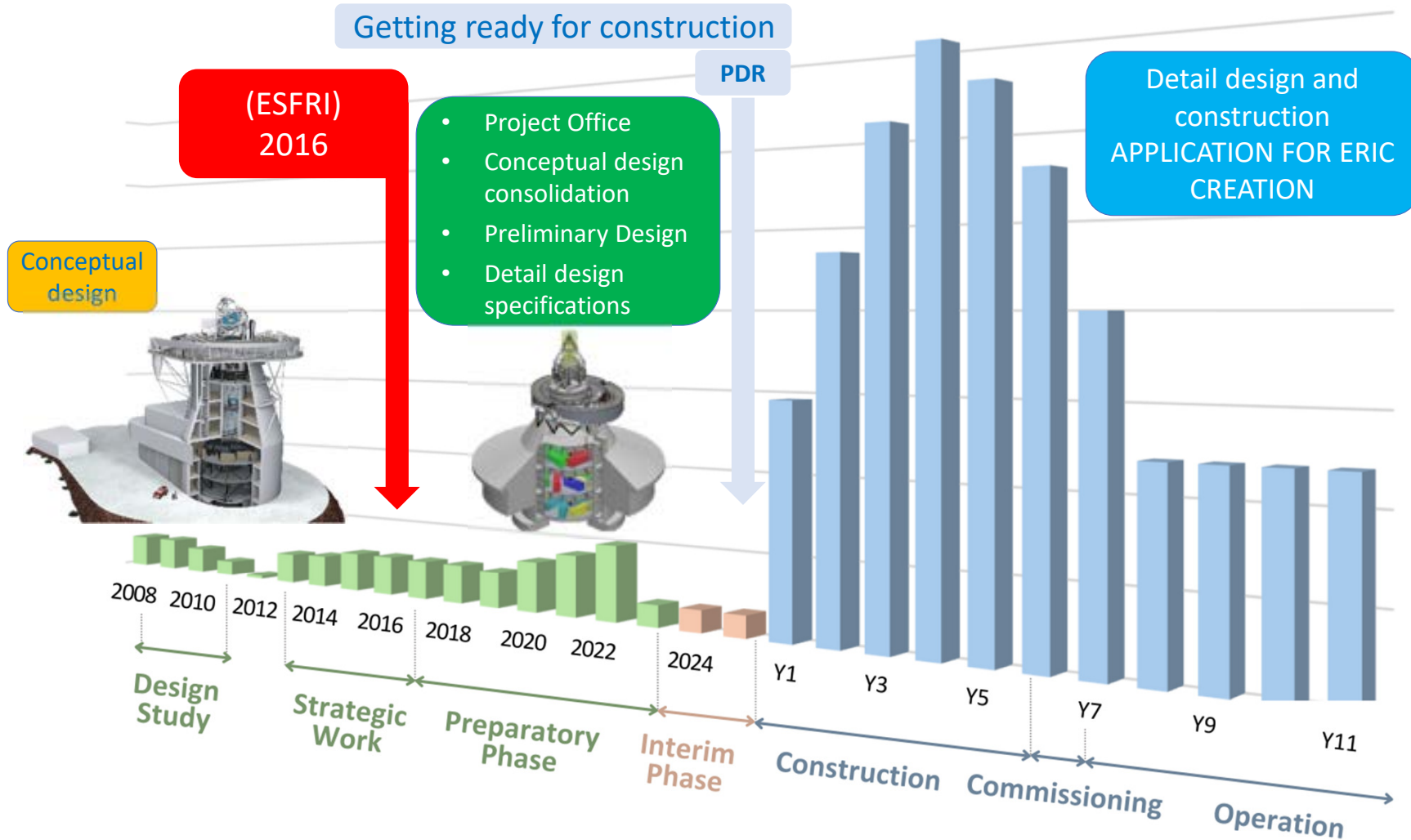
European Solar Telescope (EST)

Contact – Manolo Collados (mcv@iac.es)



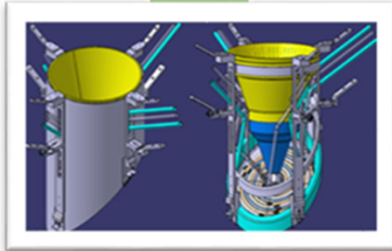
www.est-east.eu



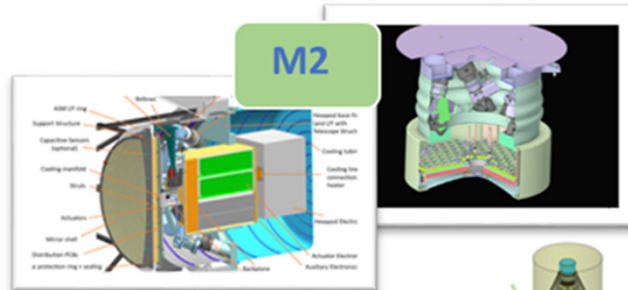




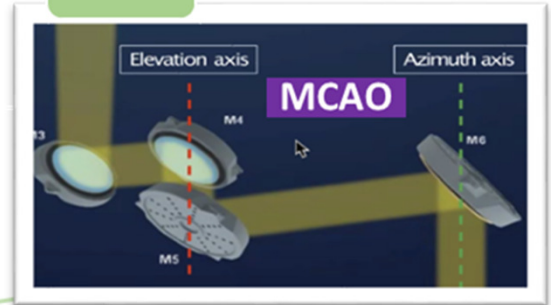
HR



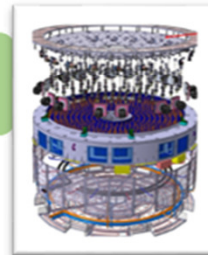
M2



TOCA

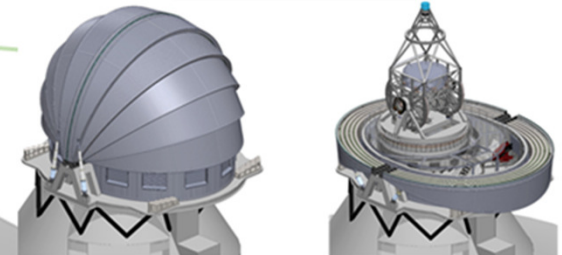


M1

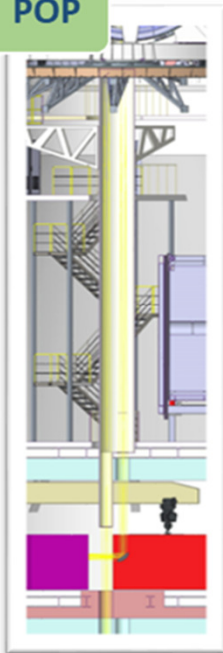


Telescope Structure

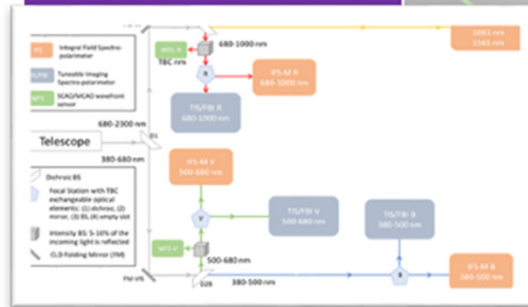
Enclosure



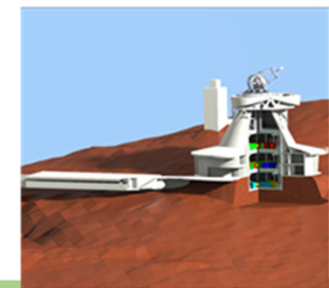
POP



Coudé Light Distribution
INSTRUMENTS



Building and Facilities





EST Fundación Canaria Legal Figure for the Interim Phase

Contact – Hector Socas (hector.socas@iac.es)

July 25, 2023

9 institutions from 7 European countries signed the **deed of the Foundation**

1. Astronomický Ústav AV ČR, V. V. I. (**Czech Republic**)
2. Astronomický ústav Slovenskej Akadémie vied (**Slovakia**)
3. Agencia Estatal Consejo Superior de Investigaciones Científicas - Instituto de Astrofísica de Andalucía (**Spain**)
4. Instituto de Astrofísica de Canarias (**Spain**)
5. Leibniz Institute für Sonnenphysik KIS (**Germany**)
6. Max Planck Institute for Solar System Research (**Germany**)
7. Stockholms Universitet (**Sweden**)
8. Università della Svizzera italiana - Istituto Ricerche Solari Aldo e Cele Daccò (**Switzerland**)
9. University of Sheffield (**UK**), representing the United Kingdom Universities Consortium (Aberystwyth, Durham, Exeter, Glasgow, Sheffield and Queen's University Belfast)

December 21, 2023

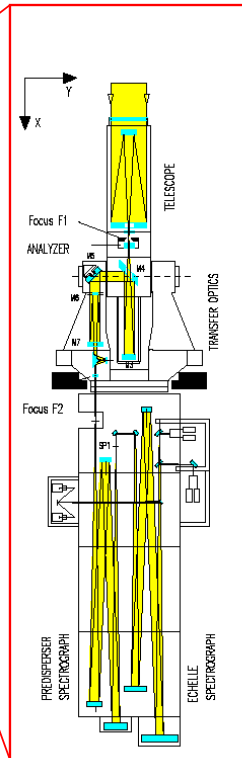
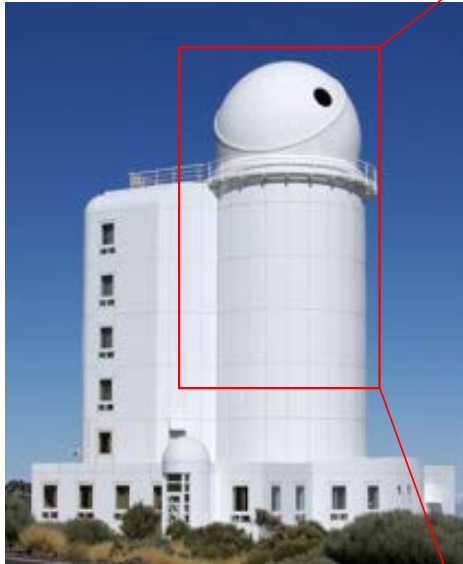
10. University of Graz (**Austria**)



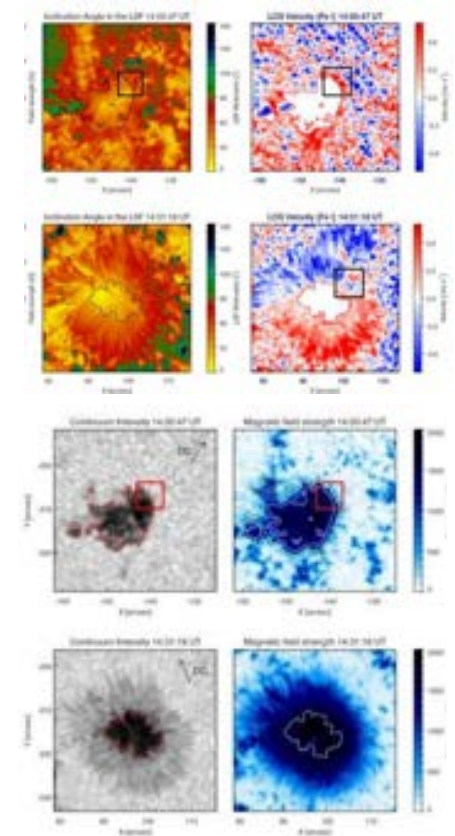


THEMIS

Contact – Bernard Gelly (bgelly@themis.iac.es)

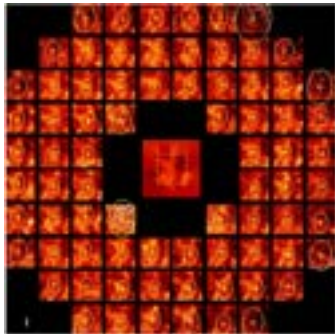


- $\varnothing$ 92 cm solar optical telescope (5 in aper.)
 - 400–1100 nm useful range
 - Multiline long slit spectropolarimetric
- Very deep refurbishing – 1M€
- New redesigned optics except M1 and spectrograph
 - Telescope and spectrograph Mueller matrixes under control
 - New polarization modulation and analysis
 - **TAO (THEMIS Adaptive Optics)**
 - IBIS 2.0@THEMIS (coming soon)
- Interferometric Bidimensional Spectrometer

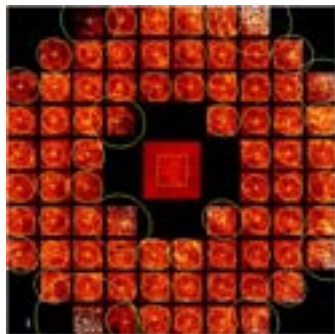


Alternative to 1–1.5 m class telescopes (GREGOR, SST, New BBSO)

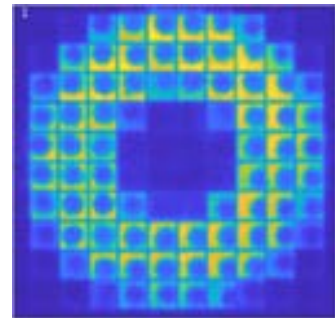
Ground support to space missions: Hinode-SOT / SDO-HMI / IRIS / Solar Orbiter-PHI / Mercury Messenger / Bepi-Colombo and possibly PSP



Quiet sun
good seeing

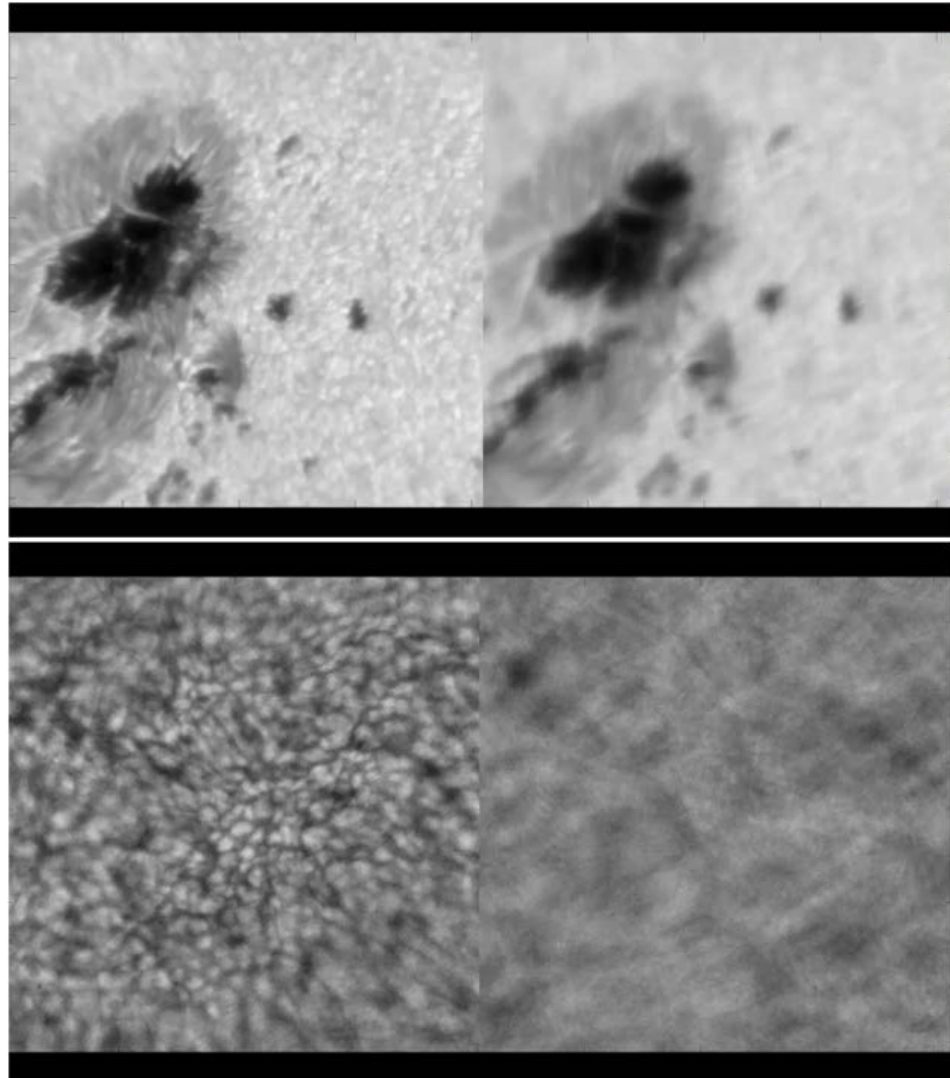


Quiet sun
bad seeing



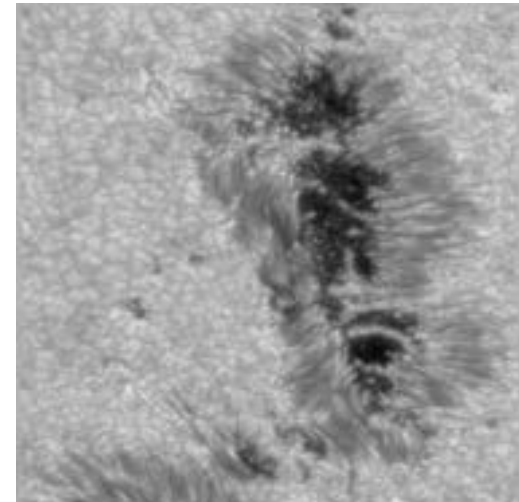
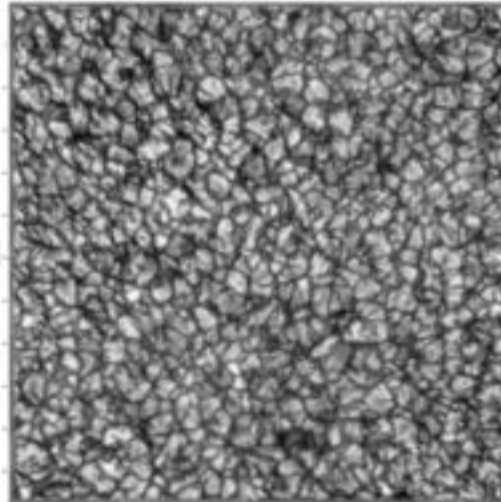
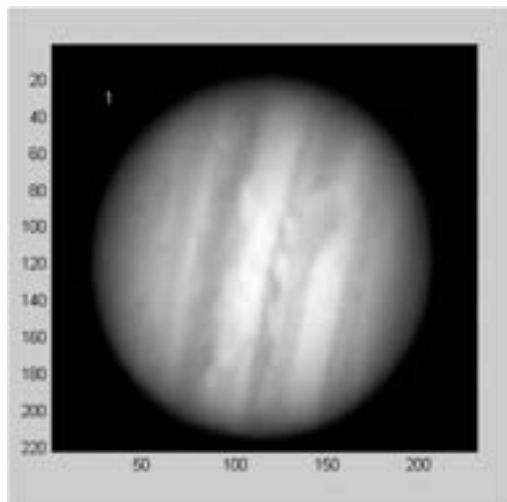
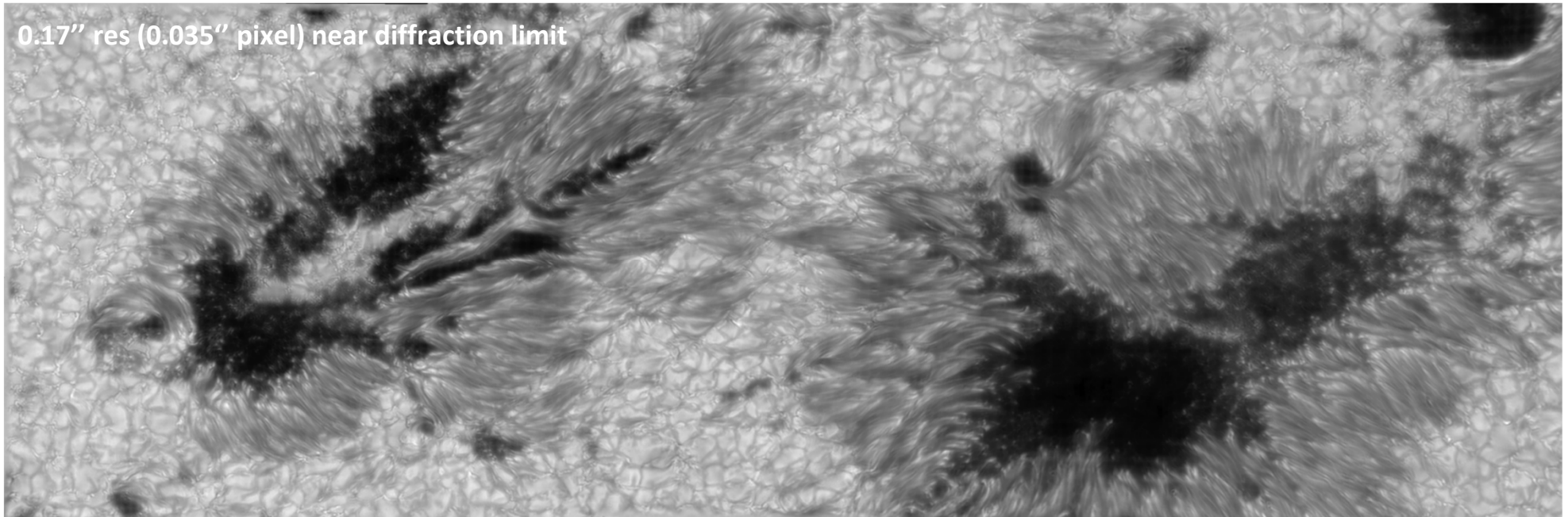
Mercury
(transit version)

TAO





0.17" res (0.035" pixel) near diffraction limit





GREGOR

Contact – Rolf Schlichenmaier (schliche@leibniz-kis.de)

H α alpha Adaptive Optics to lock on solar prominences off-limb

Conventional solar AO: used almost every day

- correlating FoV: 12.6'' sampled by 36x36 pixels at 430nm

H α (prominence) solar AO, from April 2024

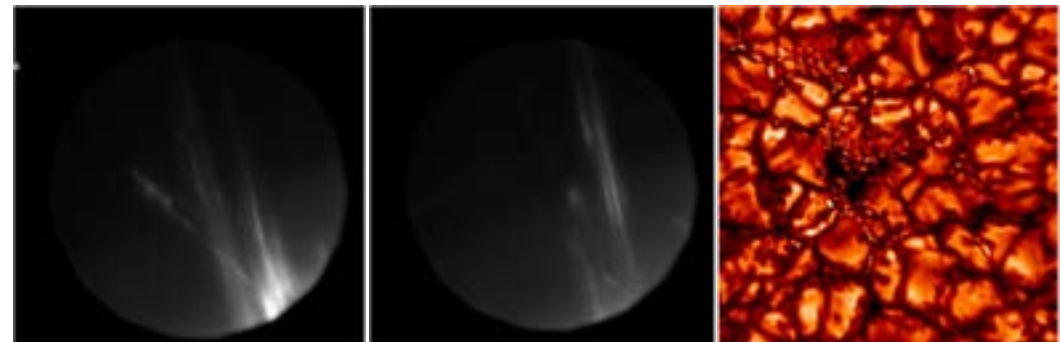
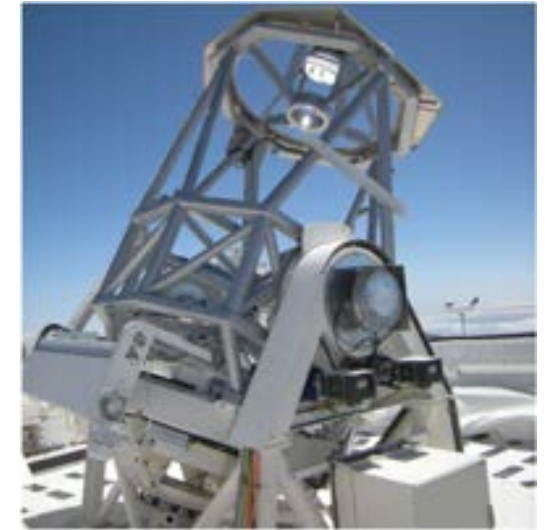
- for locking on H α -structures on disk close to the limb, on the limb or on prominences
- correlating FoV: 18'' (will change to 14.4'' in Q3 2024), sampled by 24x24 pixels

Solar MCAO tests 2023+2024 as an EST precursor within the SOLARNET framework

- 5-DM MCAO (DMs at 0,2,4,8,20km)
- successful closed loop on artificial target using all DMs
- corrected FoV = 45''

Night-time AO, to be reinstalled in 2025

- profits from excellent night-time seeing (very often <0.5'')
- correlating FoV: up to 20'' (solar system planet research)



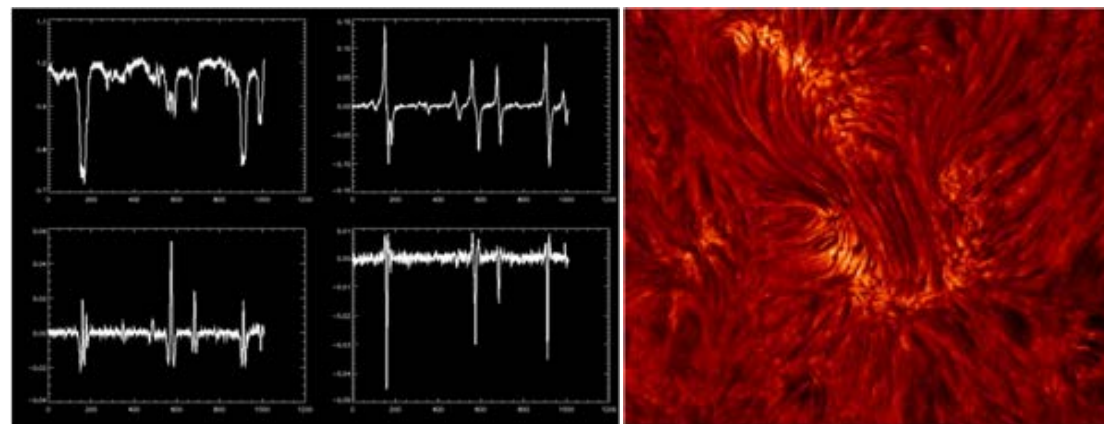
Left, center: prominences observed with an 1A H α interference filter, FoV = 20'', raw data
right: quiet sun at 524nm, FoV = 16'', speckle-reconstructed



The GREGOR Infrared Spectrograph (GRIS) in commissioning phase

Extended capabilities adding a second arm

- Grating spectrograph – Czerny-Turner configuration
- Wavelength [1.0 - 1.3, 1.5 - 1.8, 2.0 - 2.3] μm – Polarimetry [1.0 - 1.3, 1.5 - 1.8] μm
- Spatial resol. 0.25'', spectral resol. 100000, scan range 60''
- Polarimetric sensitivity = a few 10^{-4}
- IFU mode, spatial sampling: 0.136'' x 0.187''
- 2024: a second channel allows simultaneous observations of 854nm Ca and 1083nm He, also in IFU mode
- 2025: a third channel allows simultaneous observations of 656nm H α , 854nm Ca and 1083nm He, also in IFU mode
- 2024/2025 upgrade of the IFU in order to improve the spatial resolution



GRIS spectral profiles @1.56 μm (left) and H α -slitjaw image (right)



OTHER WAVELENGTHS AND PROJECTS

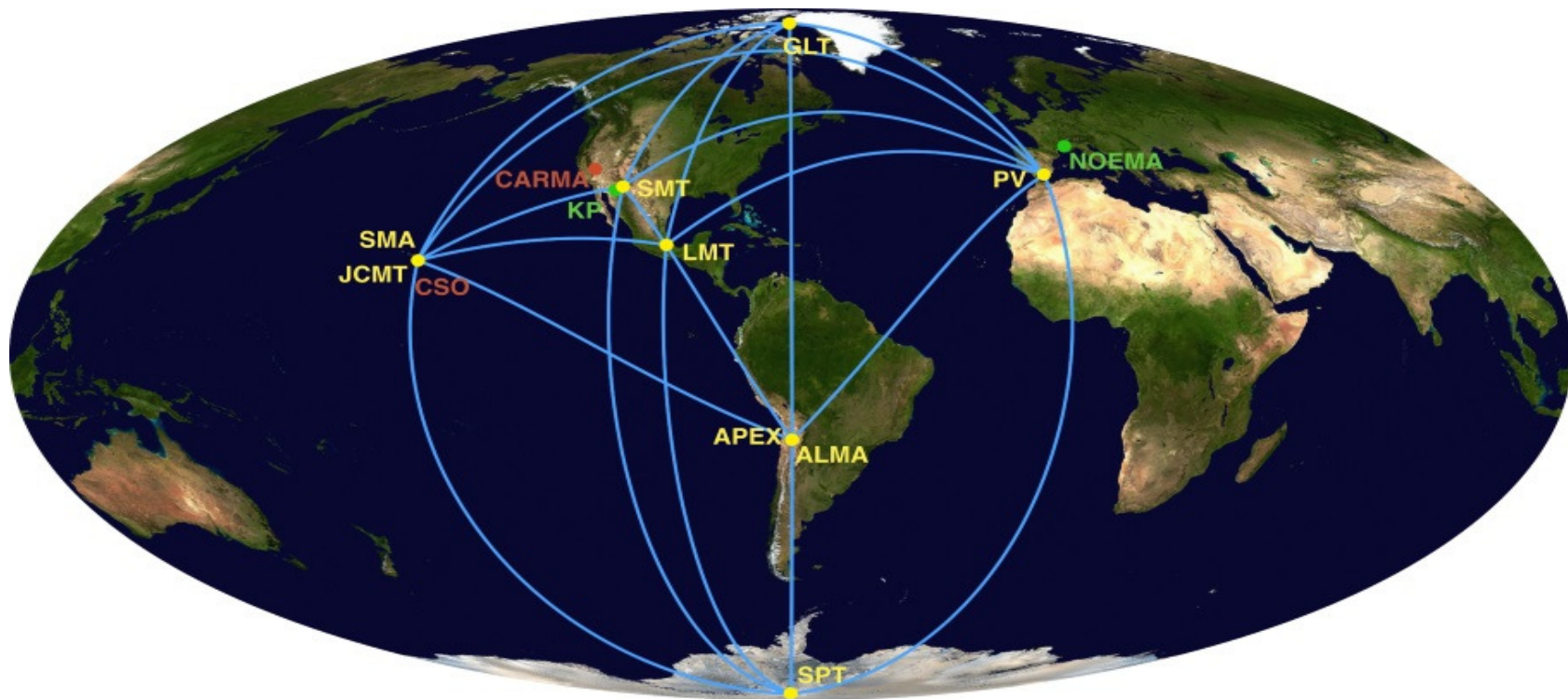




NEXT GENERATION EVENT HORIZON TELESCOPE



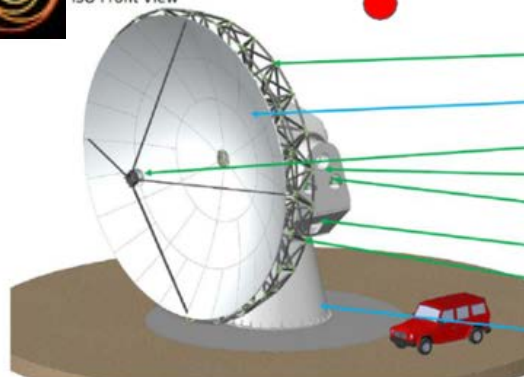
Contact – Jose Alberto Rubiño (jalberto@iac.es)





13m Telescope Design / First Look

ISO Front View

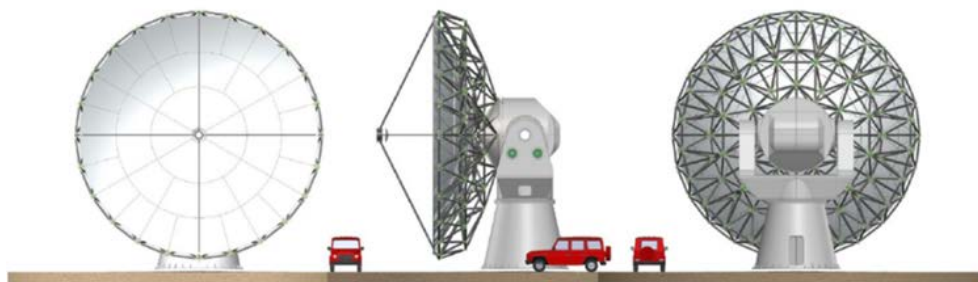


- CFRP BUS
- 3 Panel Rings
- 750mm Subreflector
- Spherical Roller Bearings
- 4 Elevation Drives
- Easy Maintenance
- 3m Az Bearing
- Pedestal Steel Cone



13m Telescope Design / First Look

Front / Side / Rear





CTA-N / LST

Cherenkov observations

Contact – Ramon Garcia (rgl@iac.es)

LST1

LST1 in commissioning phase

Producing first science

Detection of AGN OP313 in VHE





LST2 – LST3 – LST4

LST2 – LST3 – LST4 under construction (end 2025)

2026 – Commissioning of the array

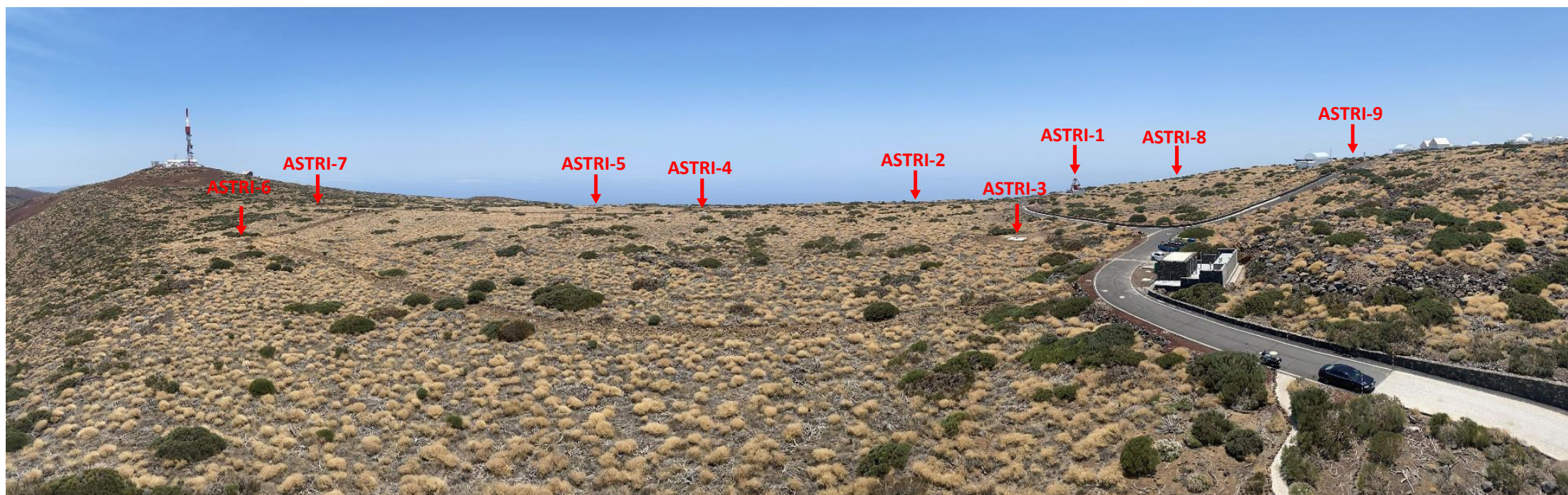
2027 – Normal operation

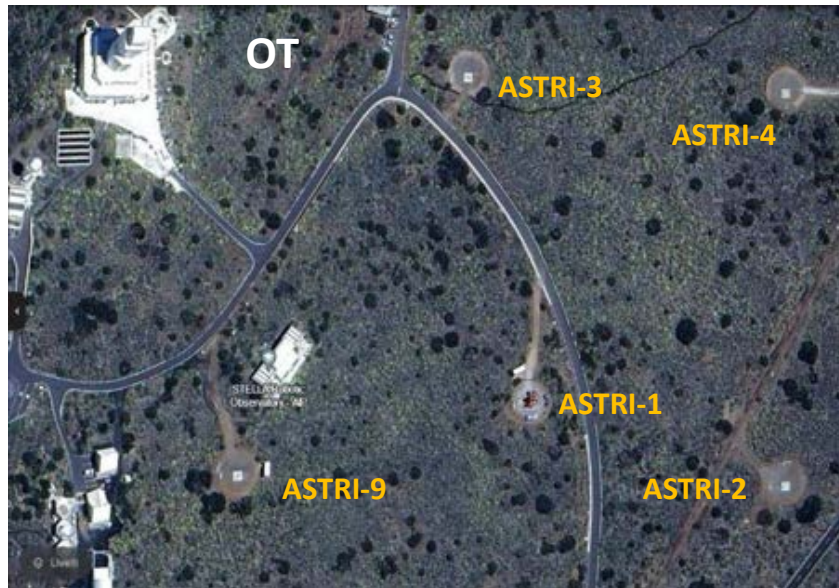




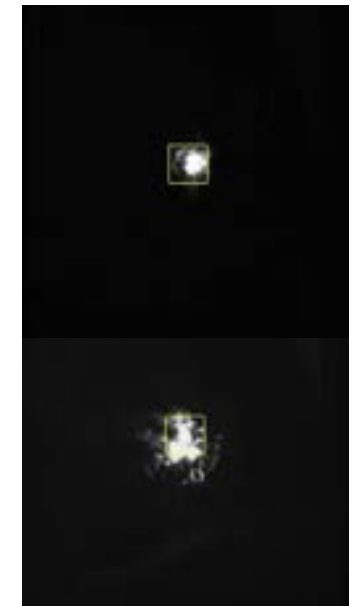
THE ASTRI MINI-ARRAY

Contact – Giovanni Pareschi (giovanni.pareschi@inaf.it)





- ASTRI-1 accepted by INAF in October 2023
- Characterization of the telescope (pointing model)
- Optimization of the mirror alignment procedure
- Current activities:
 - Integration of 6 service cabinets
 - Grounding issue on ASTRI-1, 8 and 9





CURRENT MASTER SCHEDULE

General timeline

- Teide infrastructure completed
- ASTRI-1 telescope accepted October 2023
- ASTRI-3 delivered September 2024
- ASTRI-8 & ASTRI-9 telescopes delivered December 2024
- First camera (engineering camera) on ASTRI-1 July 2024
- Two more cameras completed by end of 2024 (Goal)
- ASTRI Mini-Array ready for commissioning late summer 2025
- Early observations will start already with three telescopes
- Scientific observations start end 2025





OT - CMLAB

Contact – Jose Alberto Rubiño (jalberto@iac.es)





OT - CMLAB

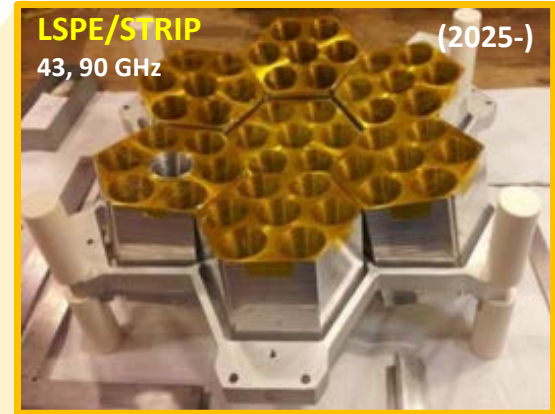
TMS
10-20 GHz

(2025-)



LSPE/STRIP
43, 90 GHz

(2025-)



Groundbird
145, 220 GHz

(2019-)



QUIJOTE

11,13,17,19,30,40 GHz

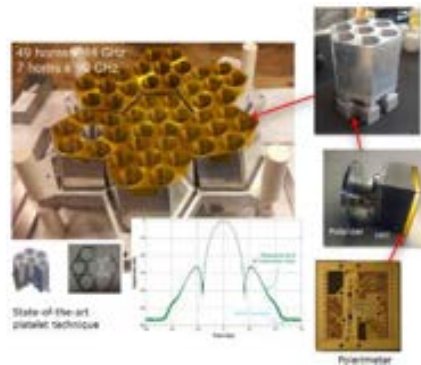
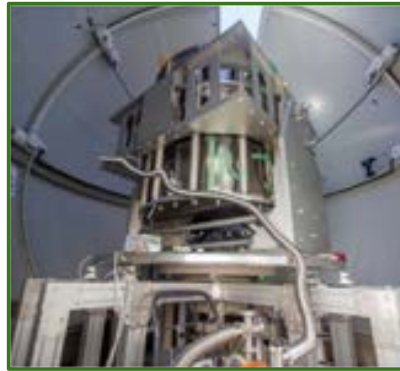
(2012-)





GroundBIRD

- Installation completed in 2019
- New set of detectors installed in 2023
- **Operation plan:** 3 years from now
- **145 GHz** (660 KIDs) and **220 GHz** (224 KIDs)



LSPE/STRIP

- Deployment at Teide Observatory: Fall 2025
- Direct measurement of Q & U, low systematics
- High efficiency 2-stage 18-20K cooler
- Intermediate 80-100K shield

Tenerife Microwave Spectrometer (TMS)

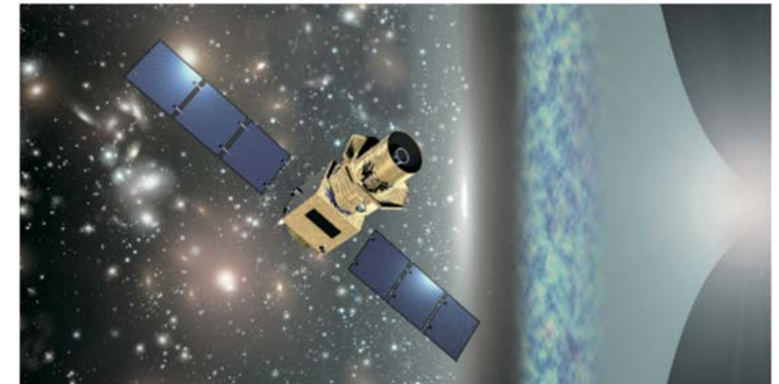
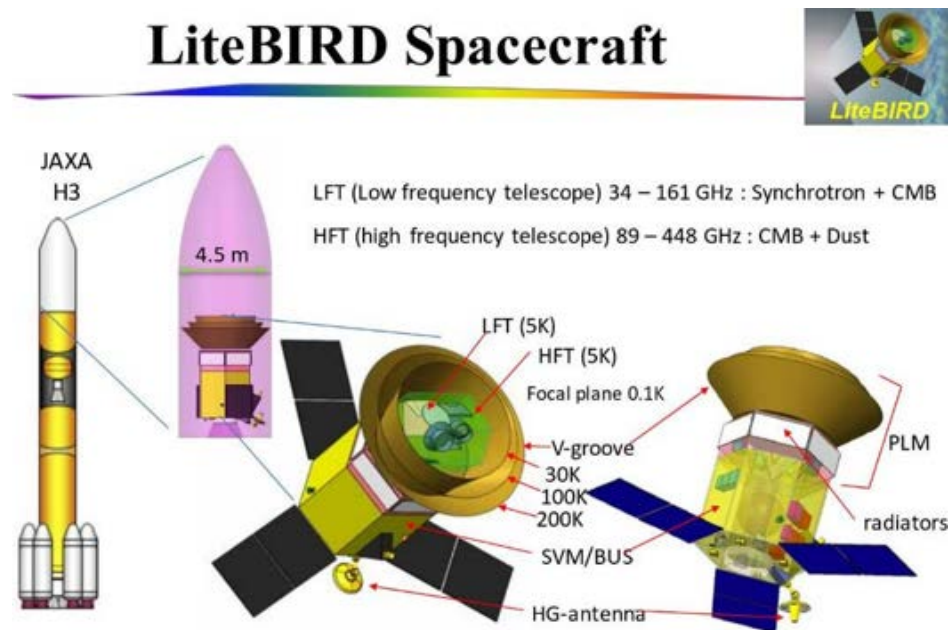
- Ground-based low resolution spectroscopy observations
- Mirrors designed
- Shielding and support structure to be designed
- Optomechanics in final fabrication phase
- Commissioning in late 2025





LiteBIRD

- International proposal, led by JAXA (12 countries).
- Launch **2032**. Duration: 3 years, observing from L2
- 15 frequency bands (34-448GHz)
- **Objective:** error in $r < 10^{-3}$



- European participation – <http://www.litebird-europe.eu/>



OTHER ASSETS OF THE IAC



Centro de Sistemas Ópticos Avanzados (CSOA)

Contact – Jose Luis Rasilla (jlr@iac.es)

CSOA 0.5 for optics up to $\varnothing = 0.5\text{m}$



IAC Headquarters

CSOA 1.5 for optics up to $\varnothing = 1.5\text{m}$



IACTEC Building





Projects, developments and equipment

Mirror segments for telescopes

Optical elements for astronomical instrumentation

Optical elements for satellite payloads

Filters, beam splitters, dichroics

Research in manufacturing techniques:

- Lightweighting of mirrors
- Manufacturing of freeform elements
- Metallic mirrors
- Additive manufacturing

CSOA 0.5

Cutting	Optotech OTS-400-NC
Grinding	Optotech MGC 250 CNC
Polishing	Zeeko IRP600
Ultrapolishing	Buhler IBF450
Coating	Electrorava Sputtering and E-Beam

CSOA 1.5

Polishing	Optotech MCP1501 CNC
Coating	AGC



CSOA 0.5



Cutting Machine
Semi-automatic sawing
process with NC



Grinding Machine
Aspherical, spherical,
prisms, cylinders, 3D optics



Polish Machine
Up to 600 mm in diameter



Ion Beam Figuring
Surface errors $< \lambda/200$ – Dry polishing



Thin film coatings:

- Electron beam evaporation
- Sputtering



CSOA 1.5



Polishing Machine

Up to 1.6 m – 6 different techniques



Coating Machine

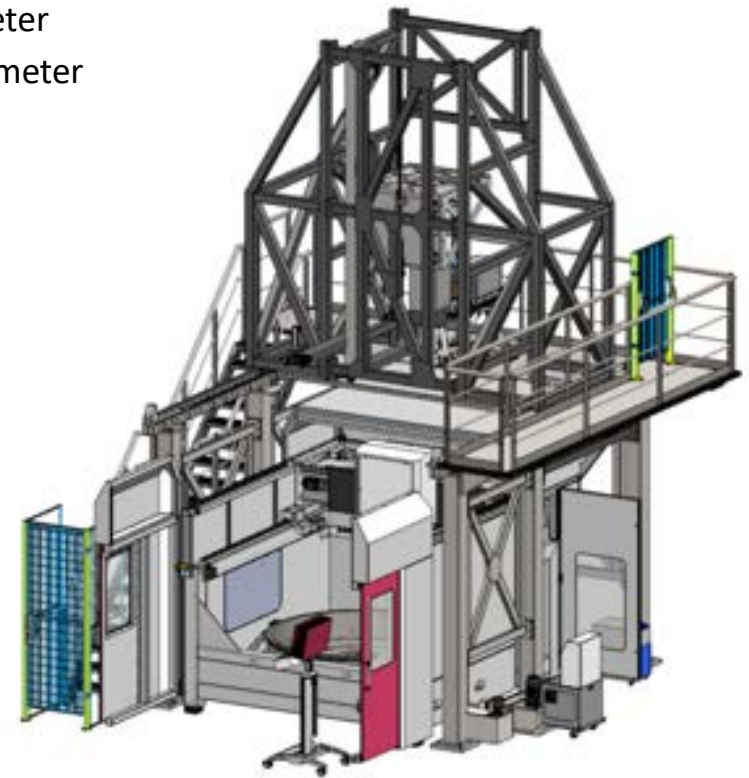
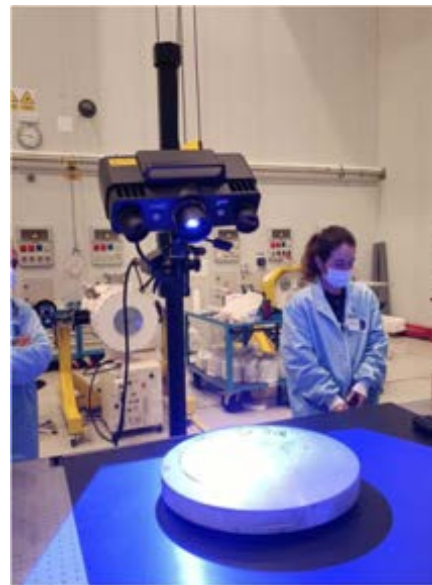
4 sputtering targets – Substrates up to 2m with central hole
Delivery September 2024



CSOA Metrology



Nanocam. 4D Tech. Profiler
Zygo Verifire HD Fizeau Interferometer
Phasecam Twyman – Green Interferometer
GOM ATOS 5. 3D Scanner
Spherometer
Cary 7000 Spectrophotometer
Talysurf. Taylor Hobson Profiler





CSOA Schedule

CSOA 0.5		
	INSTALLATION	PRODUCTION
Coating systems	May 2022	January 2023
Cutting machine	November 2024	April 2025
Grinding machine	November 2024	April 2025
Polishing machine	October 2024	April 2025
Ion beam figuring	October 2024	April 2025

CSOA 1.5		
	INSTALLATION	PRODUCTION
Polishing	November 2024	May 2025
Coating	December 2024	June 2025
Metrologic Test Tower	May 2025	October 2025



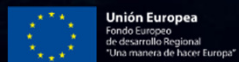
SPACE



IACTEC-SPACE

Small satellites from the Canary Islands

Contact – Alex Oscoz (aoscoz@iac.es)



Unión Europea
Fondo Europeo
de desarrollo Regional
"Una manera de hacer Europa"



@CDTIoficial



GOBIERNO
DE ESPAÑA
MINISTERIO
DE ECONOMÍA, INDUSTRIA
Y TURISMO



Plan de Recuperación,
Transformación y Resiliencia



tenerife
innova



Canarias
avanza
con Europa

ECAN





DRAGO

Demonstrator for Remote Analysis of Ground Observations

DRAGO-1



DRAGO-2



6 times better resolution

A compact, SWaP, **uncooled** space SWIR (1.1 & 1.6 μm)
camera for small satellites



DRAGO-1 Launched in January 2021

INSTRUMENT SPECIFICATIONS (@ 500Km orbit)

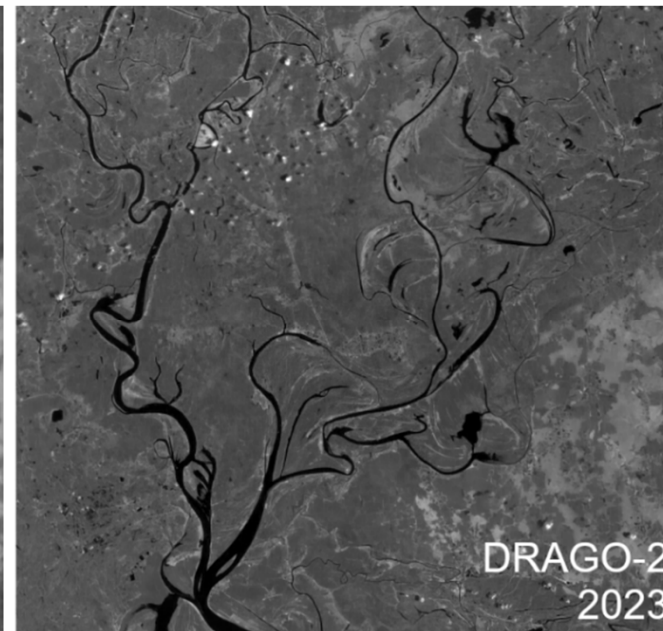
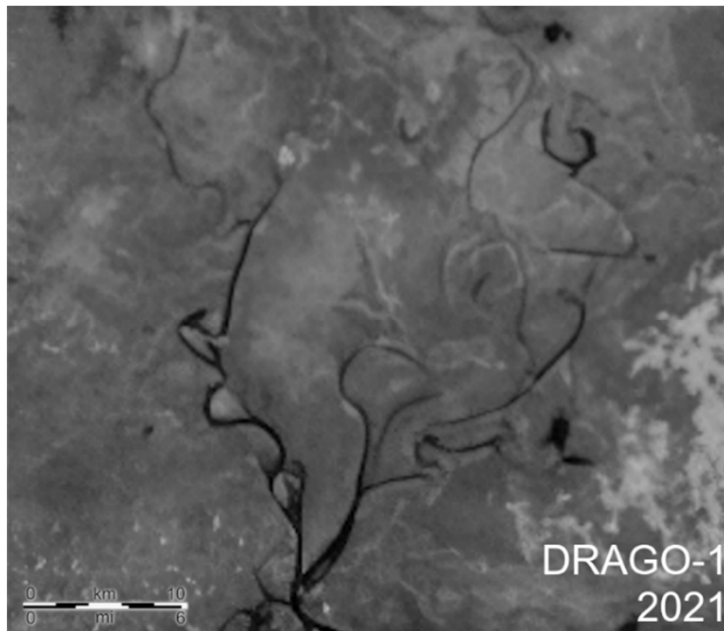
Spectral range (simult. multiband)	1.1 μm (NIR) 1.6 μm (SWIR)
Resolution	300m/pixel
Swath	190 Km
SNR	> 100
Power	< 5.5 W
Size	8.9 x 9.2 x 13.7 cm
Weight	1.04 Kg





DRAGO-2 Launched in January 2023

INSTRUMENT SPECIFICATIONS (@ 500Km orbit)	
Spectral range (simultaneous multiband)	1.1 μm (NIR) 1.6 μm (SWIR)
Resolution	50 m/pixel
Swath	32 Km
SNR	> 100
Power	< 5.5 W
Size	9.6 x 9.6 x 10.7 cm
Weight	1.16 Kg





• DRAGO

15/04/2021

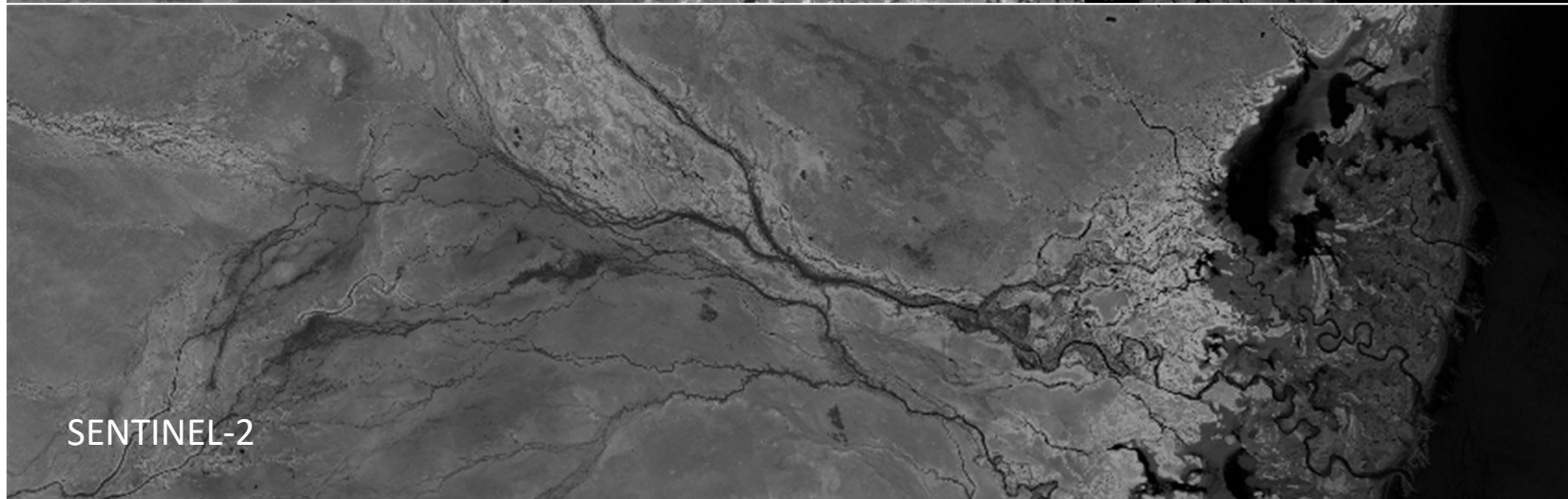
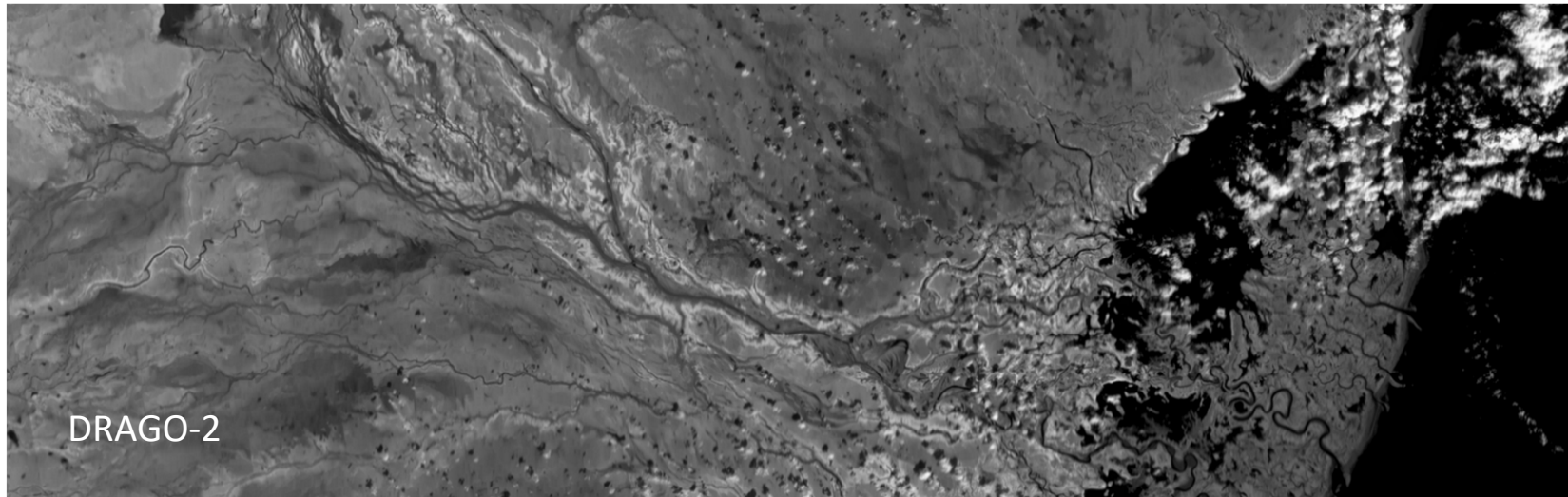
03:43:14 UTC

534 km

Image Landsat / Copernicus

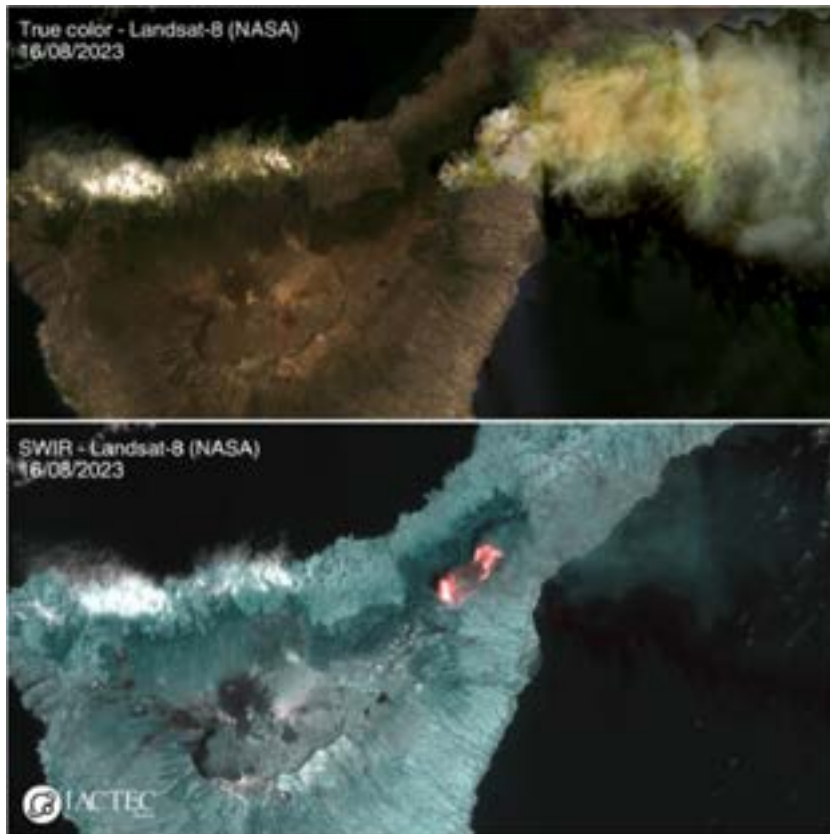
Google Earth



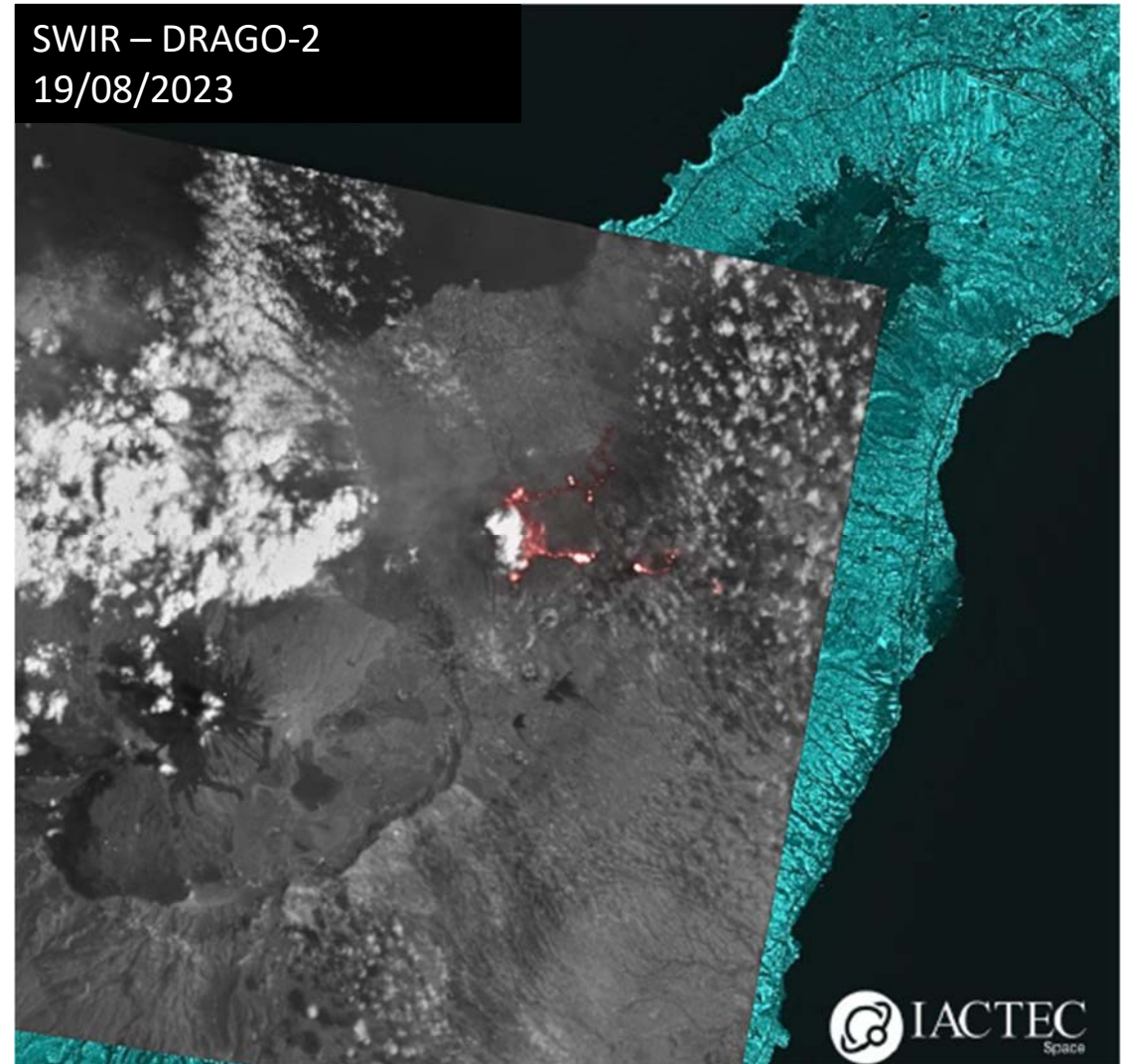




Wildfire Tenerife 2023



SWIR – DRAGO-2
19/08/2023





ALISIO-1

The first satellite of the Canary Islands

Launched in December 2023



DRAGO-2



CubeLCT





Chihuahua - Mexico

NDMI Index: Normalized Difference Moisture Index



$$\text{NDMI} = \frac{(\text{NIR} - \text{SWIR})}{(\text{NIR} + \text{SWIR})}$$

Sentinel-2 RGB
(29/12/23)

Sentinel-2 NDMI
(29/12/23)

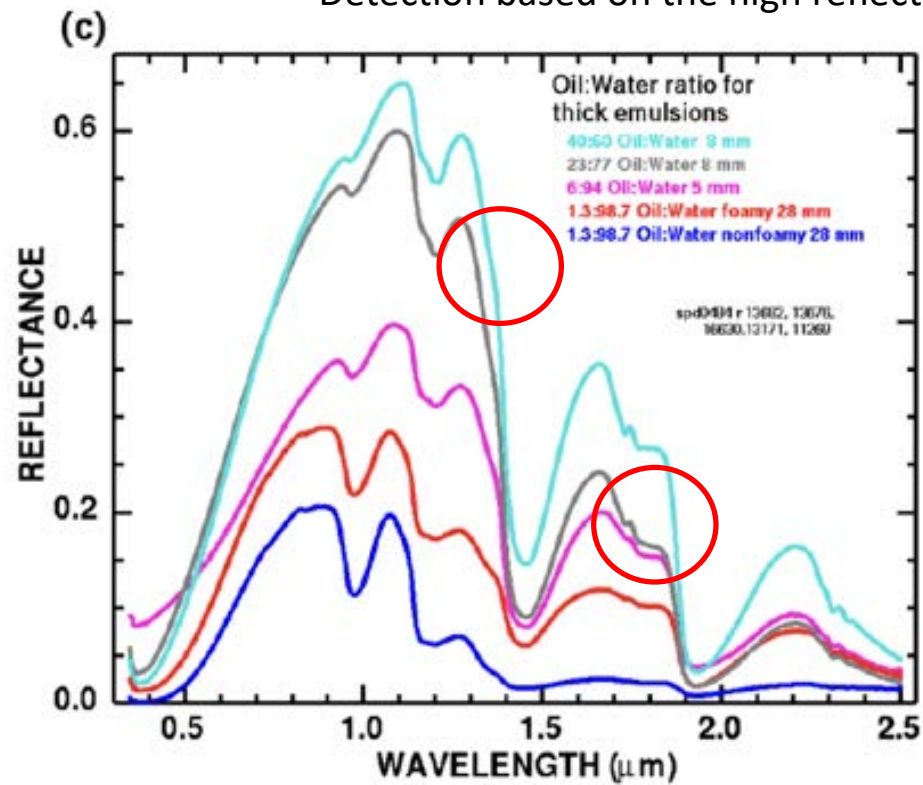
ALISIO-1 NDMI*
(09/01/24)

*ALISIO-1 NDMI uses 1100 nm band instead of NIR band

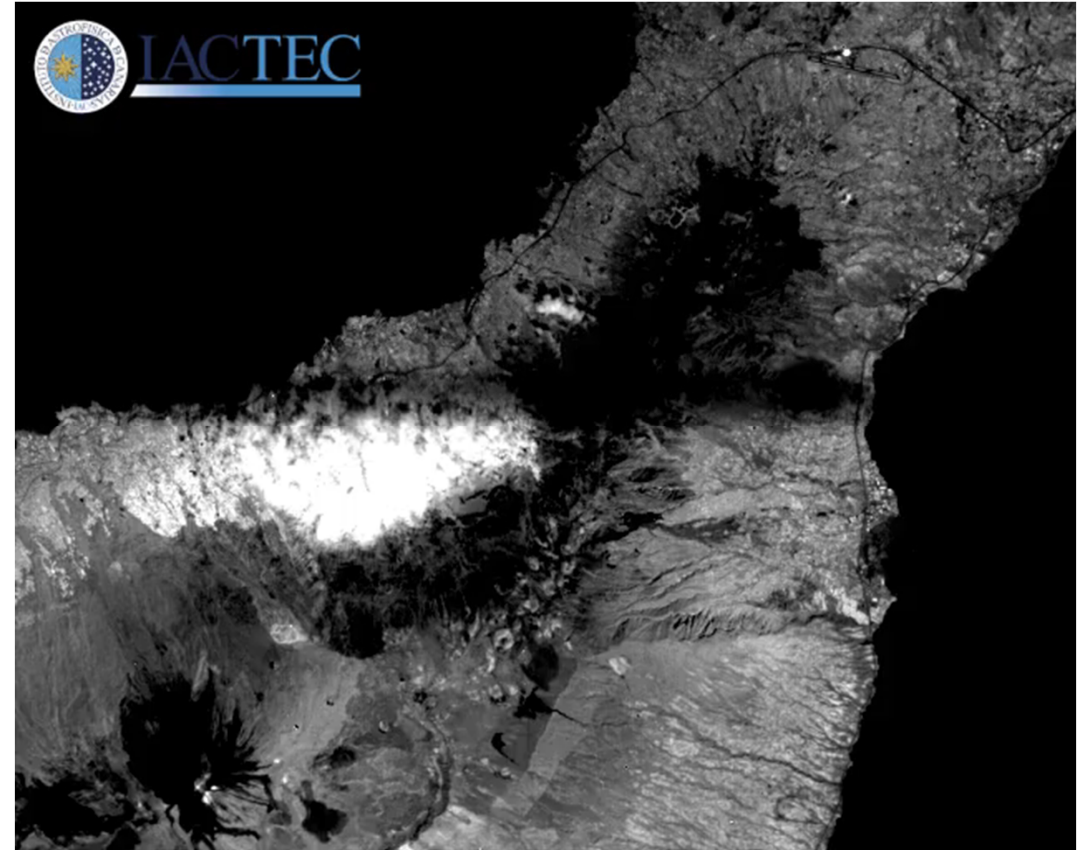
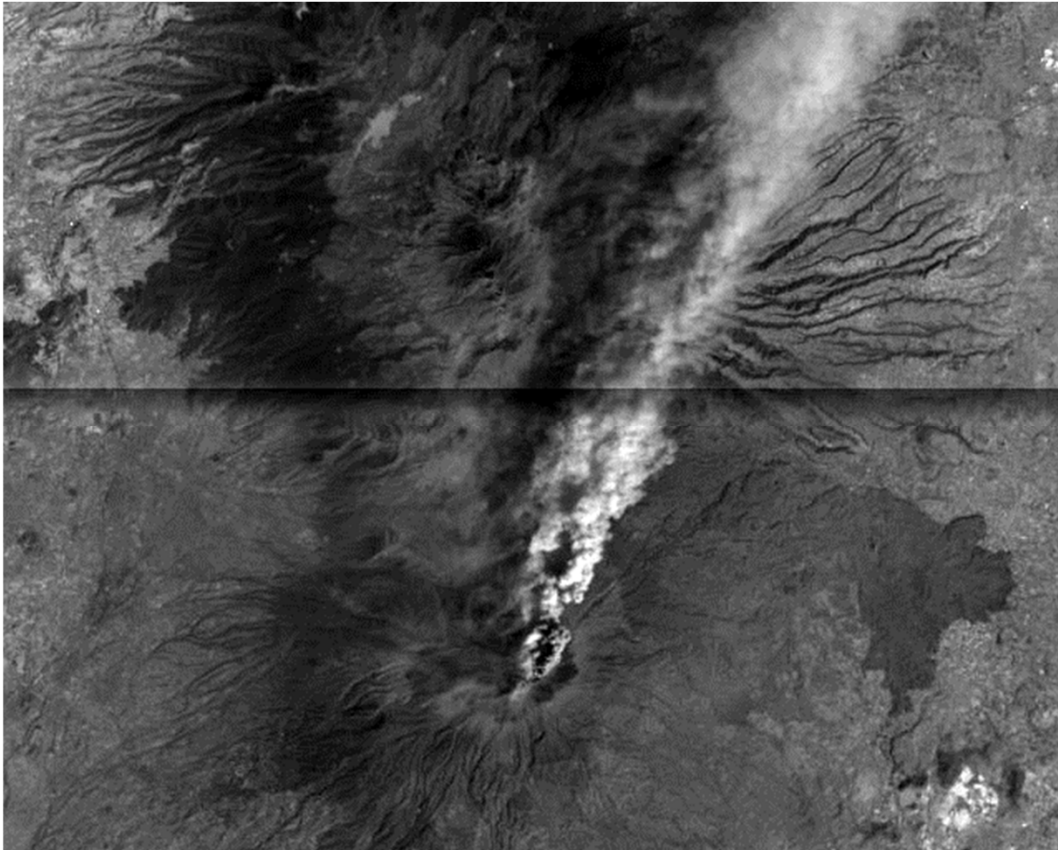


Oil spill detection

Detection based on the high reflectance of oil in SWIR bands specially at 1100 nm

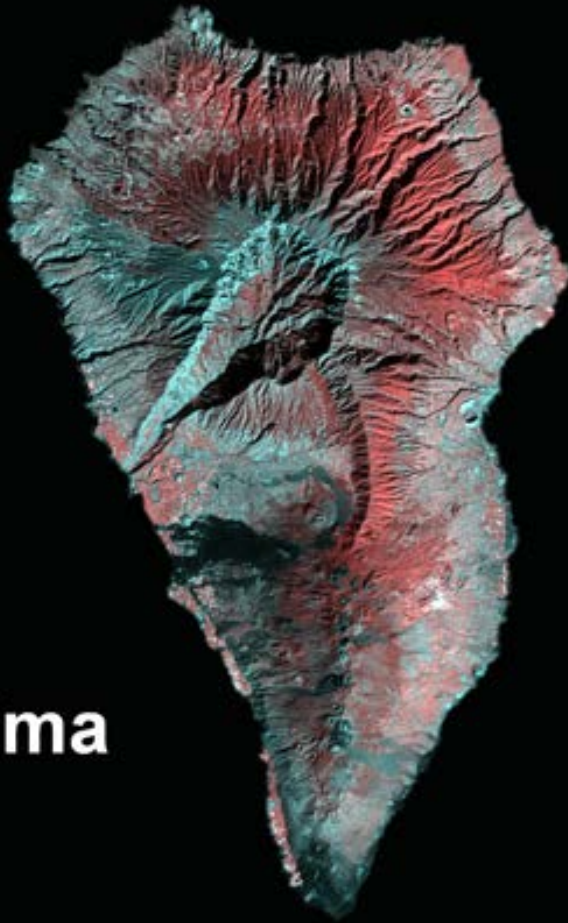


Credit: Clark et al (2010)

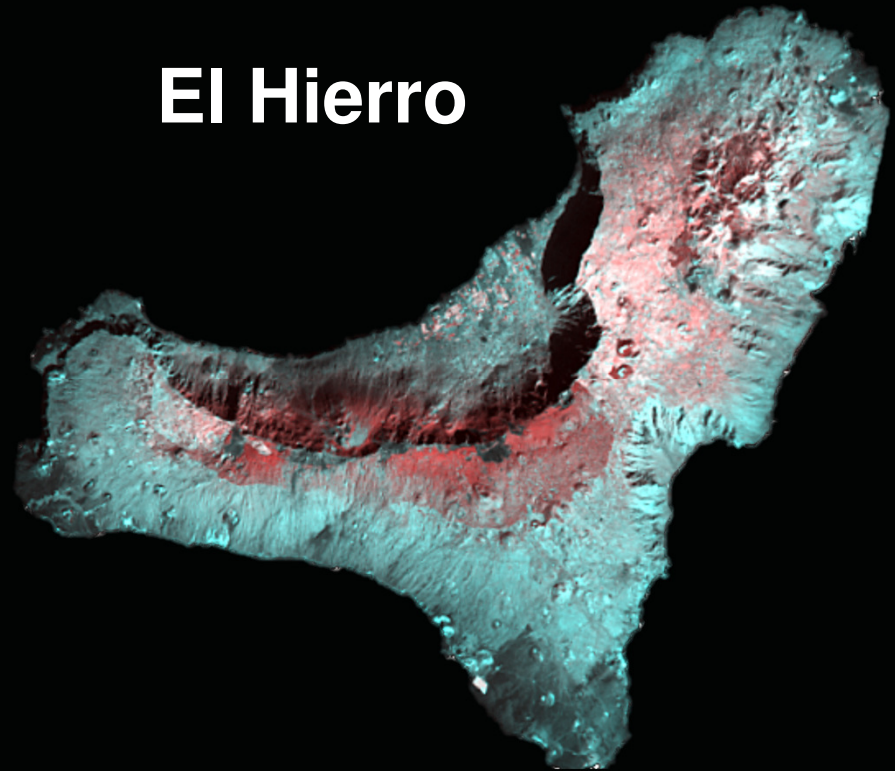




La Palma



El Hierro





VINIS

Applications

- Support on **fire fighting** tasks
- Detection of **oil spills** at sea
- Monitoring **hydric stress** on crops
- **Flood impact** assessment
- Detection for **rescue on the high seas**
- **Light pollution** monitoring
- Analysis of **construction evolution**
- **Geological** studies

Band	Central wavelength [nm]	Bandwidth [nm]	Transmission performance	Blocking performance
B	480	100	>90%	OD3 or better
G	545	100	>90%	OD3 or better
R	660	100	>90%	OD3 or better
NIR	833	80	>90%	OD3 or better
SWIR	1614	80	>90%	OD3 or better



INSTRUMENT SPECIFICATIONS (@ 500Km orbit)

Spectral range (simultaneous multiband)	1 – 1.7 μm (SWIR) 0.4 – 0.9 (VIS-NIR)
Resolution	< 5m
Swath	~ 5 Km
SNR	> 100
Power	35 W
Size	50 x 40 x 40 cm
Weight	< 20 Kg (payload)





IACSAT ASTRO-1

The third IAC observatory

Scientific small satellite for astronomical observation

- Dawn-Dusk Sun-Sync (@600-800 km) – 5 years life
- 100-180 kg
- ESPA ring
- Absolute pointing error (8 hours) < 30 arcsec/axis (sigma)
- Pointing stability error (8 hours) < 8 arcsec/axis (sigma)
- Payload developed by IAC
- 500-1700 nm (VIS NIR SWIR): precision photometry
- Size telescope + instrument: 65 x 60 x 45 cm

PHASE-1 ITT:

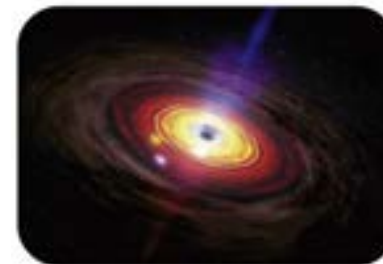
- Scope: PD of the platform and AOCS demonstrator



Exoplanets



Primitive
asteroids



Blazars

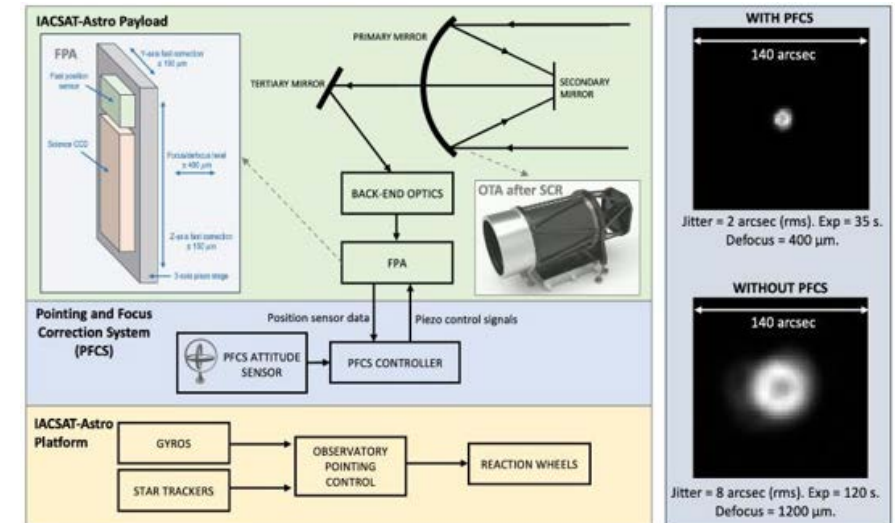


Stellar activity



Instrument:

- Athermal Cassegrain telescope
- f/5 – 24 cm primary
- Focal Plane Assembly (FPA) – 1024x1024 px InGaAs of 12 μm
- 2.2 "/px $\rightarrow$ FoV $\approx$ 37'.5x37'.5



Pointing and Focus Correction System (PFCS) $\rightarrow$ reduction of pointing error from 8" to 2" (up to 8 h)

Subsystem to control the level of defocus in the FPA to optimize the size of the PSF

a. Actuator

Piezoelectric-based 3-axis actuator – fast corrections in the FPA to compensate for satellite jitter

b. Sensing

- Fast-accurate measurements of satellite jitter to close the feedback loop of the control system
- Miniaturized 3-axis gyroscopes to measure angular motion
- Fast position sensors in the same plane as the CCD
- Image processing techniques



SATELLITE CONTROL STATION

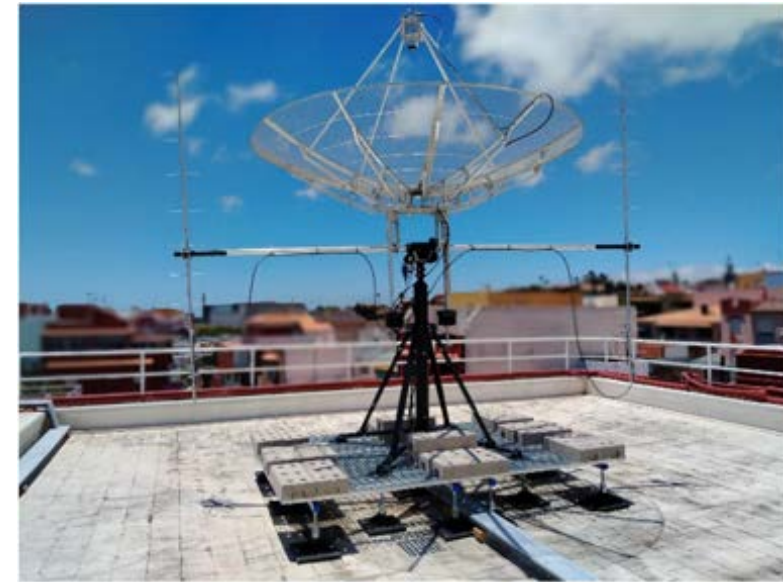
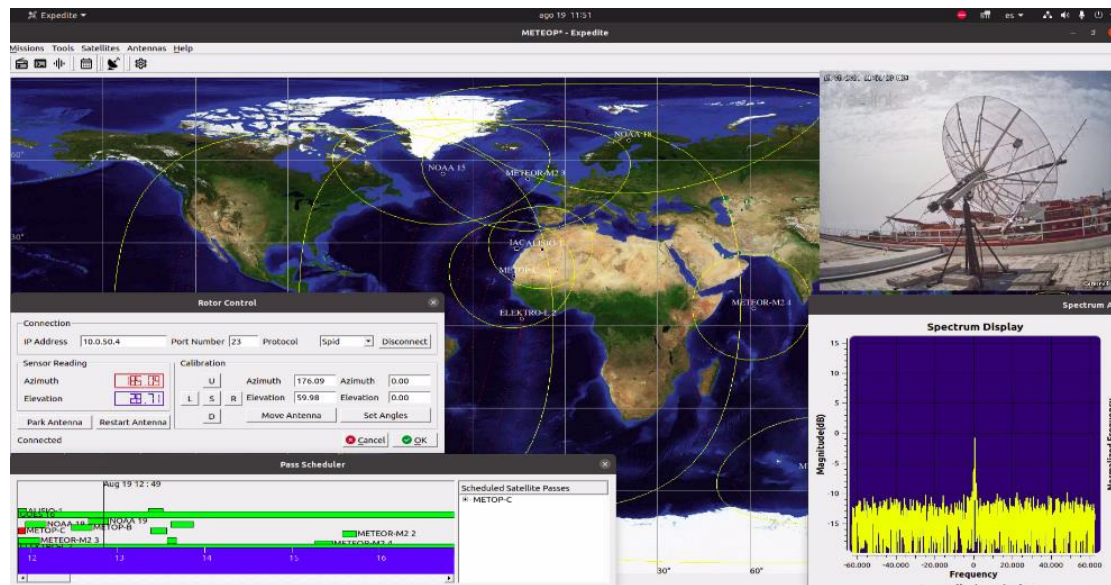


Technical feasibility study: radioelectric and structural

Study of aeronautical easements

Uplink (TX) and downlink (RX) capacity in the S-band for tracking satellites in LEO orbit

Operational summer 2024





Telescopes installed in the Canary Island Observatories

DIAMETER	TELESCOPE	INSTITUTION
	CILBO	ESA
	AMOS-CI	Univ. Bratislava
	AStMon	IAC
11	TIZON	IAC
20	Automatic Seeing Monitor (DIMMA)	IAC
40	GroundBIRD	GroundBIRD collaboration
43	COAST	Open University
50	MONS	IAC
61	PIRATE	Open University
70	Vacuum Tower Telescope	Inst. Kiepenheuer
50, 43, 8	Optical Telescope Array	Telescope Society
80	IZN-1	ESA
80x2	TTT	Light Bridges
82	IAC-80	IAC
90	THEMIS	CNRS
100	SONG	Univ. Aarhus, IAC
100	OGS	ESA
100	Artemis	Univ. Liega, MIT, IAC
100x2, 40x2	LCOGT	LCOGT Network
120x2	STELLA	Inst. Postdam
150	GREGOR	Inst. Kiepenheuer, MPS, Inst. Postdam
152	Telescopio Carlos Sánchez	IAC
225x2	QUIJOTE I – II	IAC, Univ. Cambridge, Univ. Manchester, IFCA, Univ. Cantabria
400	ASTRI	Inst. N. de Astrofísica
	Laboratorio Solar: Mark-I, GONG	IAC, Univ. Birmingham, NSO

DIAMETER	TELESCOPE	INSTITUTION
	CILBO	ESA
	AMOS-CI	Univ. Bratislava
12x4	SuperWASP	Univ. Warwick
20	Automatic Seeing Monitor (DIMMA)	IAC, Univ. Niza
30	Automatic Seeing Monitor (DIMMA)	STFC, ING
36x16	CLASP	Univ. Warwick
40x16	GOTO	Univ. Warwick
97	Swedish Solar Tower	Univ. Estocolmo
100	Jacobus Kapteyn Telescope	IAC, SARA
100	Super-WASP Alsubai Follow-up Telescope	Univ. Warwick
120	Mercator Telescope	Inst. Sterrenkund, Univ. Leuven
200	Liverpool Telescope	Univ. John Moores Liverpool
250	Isaac Newton Telescope	IAC, ING
256	Nordic Optical Telescope	NOTSA
300	First G-APD Cherenkov Telescope	FACT Collaboration
350	Telescopio Nazionale Galileo	INAF
420	William Herschel Telescope	IAC, ING
1040	Gran Telescopio Canarias	GRANTECAN, Univ. Florida, INAOUE-UNAM
1700x2	MAGIC I y II	MAGIC Collaboration
2300	LST-1	LST Collaboration



THANK YOU





Título 1

Texto bajo título

Título 2

