

GUAIX

**UCM Group of Extragalactic Astrophysics and
Astronomical Instrumentation**

Instrumentation developments in Astrophysics —
Universidad Complutense de Madrid

IPARCOS Scientific Advisory Board: Bi-Annual Review — 2026



IPARCOS



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GUAIX at a glance

Last two years (~2024–2026): critical mass, high output and broad scientific reach

34

members

90

refereed papers
since Jan 2024

>4.7 M€

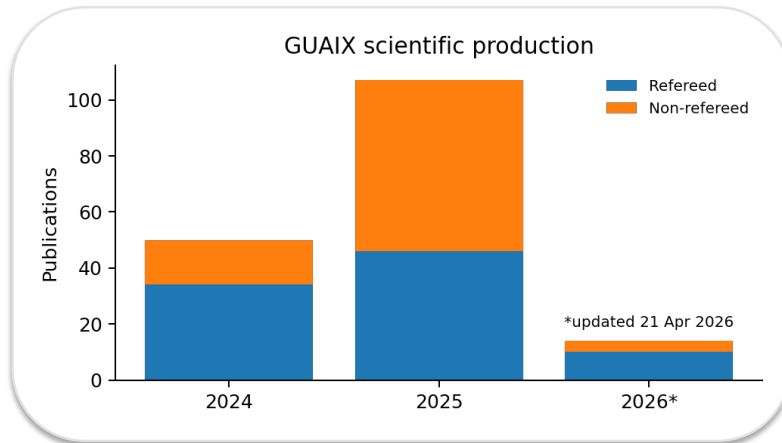
active funding

3+4

full + associate
professors

7+12

postdocs + PhD
students



GUAIX – UCM Group of Extragalactic Astrophysics and Astronomical Instrumentation

Human resources

- 3 Full Professors, 4 Associate Professors, 1 permanent lecturer
- 1 Ramón y Cajal + 1 senior Talent researcher
- 7 postdocs, 12 PhD students, technical + management support

Signature strength

Instrumentation builders + science users: GTC EMIR/MEGARA/FRIDA heritage feeding MOSAIC/ELT ARAKIHS ATLAS2 science.

Publication counts from the GUAIX publication page; group size and active funding from the Historial Científico.



Key performance indicators

High-Impact Publications: 165 peer-reviewed papers. 165 in Q1 journals (SCImago SJR).

Funding Secured: The total funding across ongoing projects reaches €4.7 million.

Main sources:

Spanish National Plan (PID projects)

Horizon Europe programmes

Regional Government of Madrid

Major projects include:

MOSAIC-ELT (€893k + €518k)

ARRAKIHS (~€460k)

TARSIS (~€731k)

Horizon Europe projects (AtLAST2, PLAN-B, AC3)

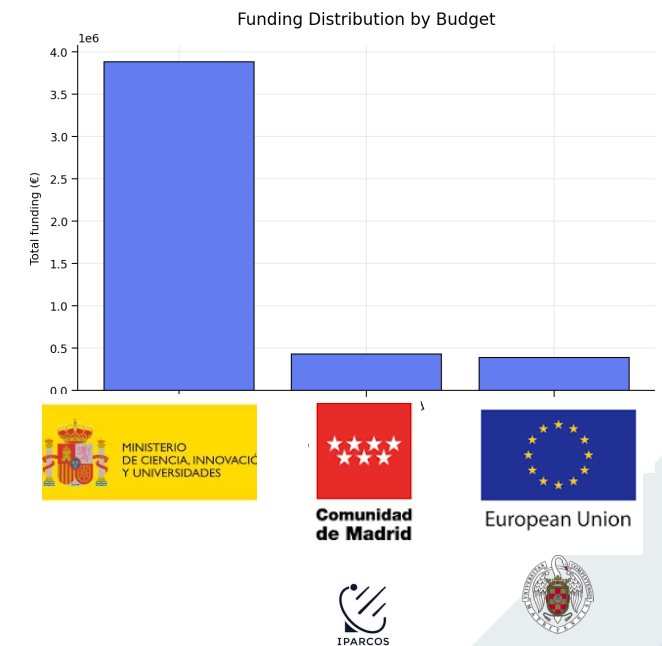
GTC instrumentation: EMIR – FRIDA

Training:

24 PhD theses defended (total). 4 PhD theses defended in 2023–2024.

13 PhD theses currently in progress

(Two of them are about to be defended within the next two months).



Science map and current drivers

A broad extragalactic programme with instrumentation as an enabling layer

Nearby galaxies + stellar populations + Galaxy evolution + AGN feedback + high-energy/magnetism

connected through IFU spectroscopy, surveys, simulations and multi-wavelength facilities

Main active projects and collaborations

- MOSAIC / ELT: Spanish contribution to PDR + LLI-FDR
- TARSIS: 4m-class instrument + science prep
- ARRAKIHS: ESA F-class mission phase at UCM
- AtLAST2 + Mad4Space + SKA-prep / cosmic magnetism
- GTC instrumentation: EMIR – MEGARA - FRIDA

- PLAN-B / light and noise pollution impacts
- AC3: cloud-edge continuum management
- Athena/X-IFU space mission

What the group delivers

- Training pipeline for instrumentation + data-intensive astronomy
- MEGARA / EMIR science exploitation
- Survey science: MEGADES, PHANGS, TIMER, CAVITY, GATOS, POSSUM, OTELO
- Galaxy evolution across environments and cosmic time
- New constraints on feedback and outflows

Representative papers (2024–2026)

- Mroczkowski+25 — AtLAST conceptual design
- van Kampen+24 — AtLAST science: surveying the distant Universe
- Ceballos+24 — optimizing Athena/X-IFU-like TES detectors
- Peille+25 — X-ray Integral Field Unit after Athena reformulation
- Pello+24 MOSAIC instrument
- Pello+25 MOSAIC instrument
- Gallego+26 MOSAIC instrument

- Chamorro-Cazorla+26 — MEGADES science enabled by MEGARA
- Martínez-Delgado+24 — MEGARA follow-up of stellar streams
- García-Vargas+24 — MEGARA IFU on a low-metallicity dwarf
- Hermosa Muñoz+24 — MEGARA outflows in LINERs
- Gallego+26 Dwarfs4MOSAIC La Palma International Program





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MOSAIC mIFU+MOS Spectrograph for ELT

UCM-IPARCOS node

ELT: Extremely Large 39m Telescope

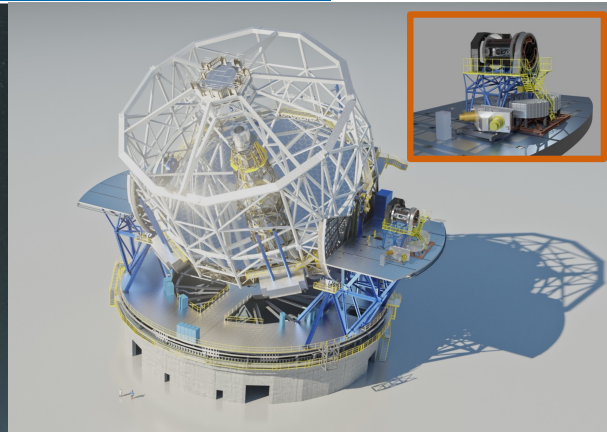


European
Southern
Observatory

www.eso.org

ESFRI

European Strategy Forum
on Research Infrastructures



*Cerro Armazones, December 2025
Planned first light: March 2029*



Group's Overview

Top 2-3 Scientific Highlights

- **Highlight 1:** Massive surveys for Galaxy evolution: first galaxies; inventory of matter; mass assembly
- **Highlight 2:** Extragalactic stellar populations; time-domain astrophysics

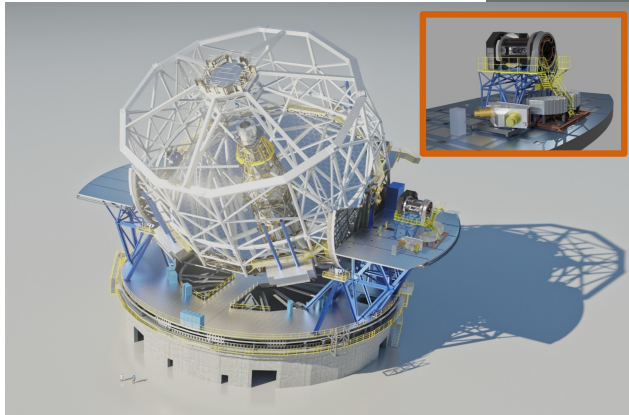
Leadership, Internationalization & Impact

- **Major Roles:**
 - J. Gallego: National representative and co-chair of the Board. Members of Science Working Groups
 - A. Gil de Paz: Calibration Scientist
 - CALEMOS: Calibration unit: Á. Castillo+
near-IR channel; near-IR spectrographs: F. Montenegro+ 10-15 % MOSAIC total (One channel, 3 WPs)
- **Recognitions:** Fully embedded in the MOSAIC technological and science team
- **Tech Transfer / Outreach:**
Work with several private companies: FRACTAL; GMV

The Horizon

- **Next Big Milestone:** Preliminary Design Review (PDR) with ESO in February 2028
- MOSAIC Science Red book

MOSAIC on Nasmyth platform



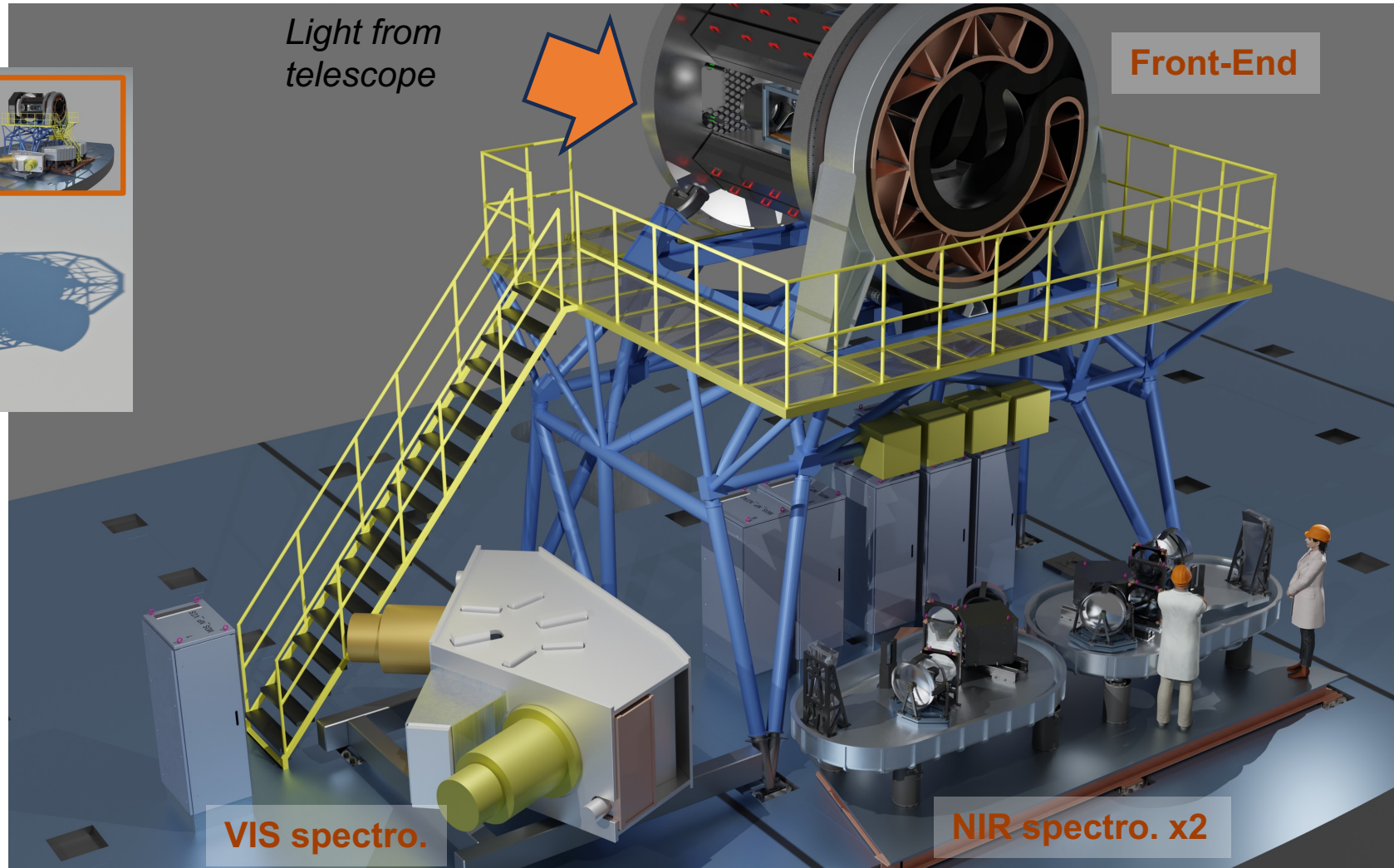
Light from
telescope



Front-End

VIS spectro.

NIR spectro. x2



MOSAIC Consortium

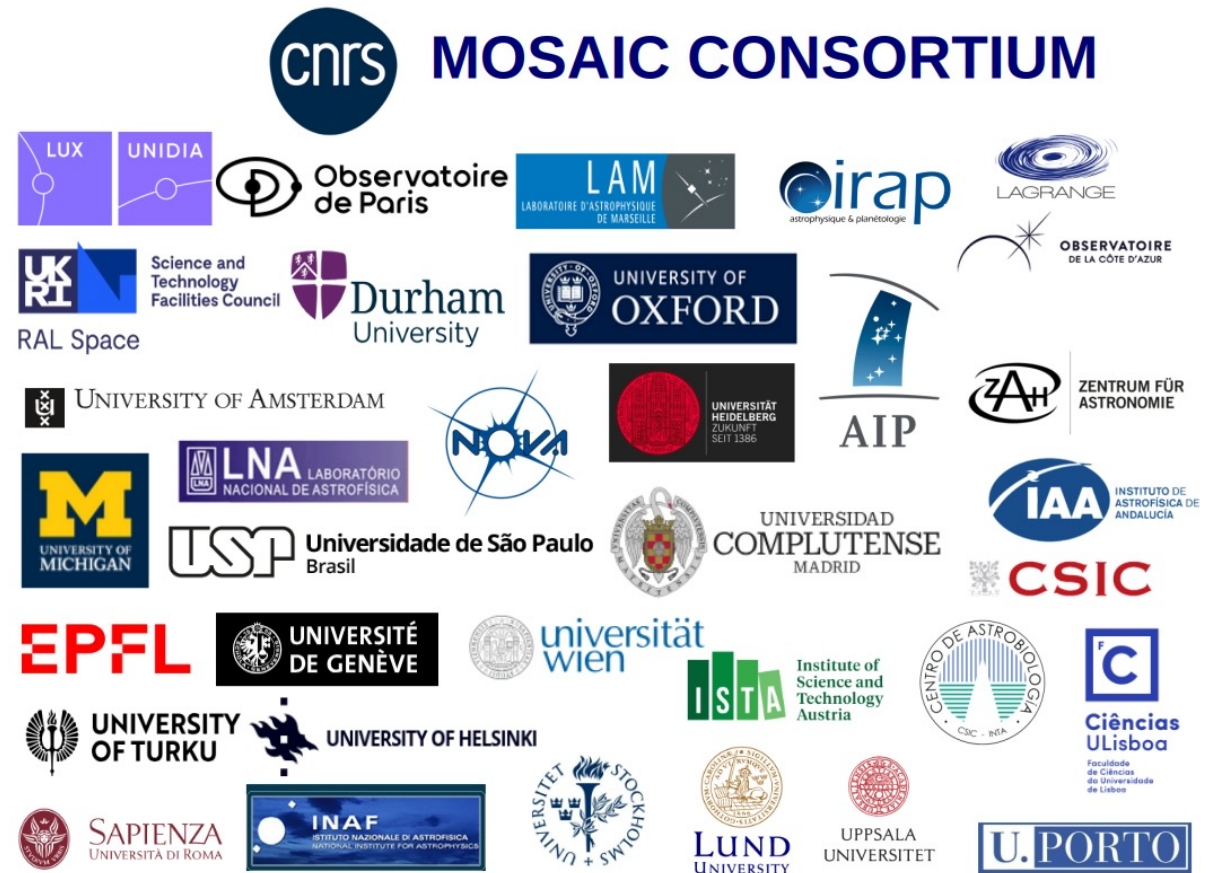
MOSAIC Consortium

- 25 Institutional Partners
- 33 Laboratories
- 14 countries
- ~350 members

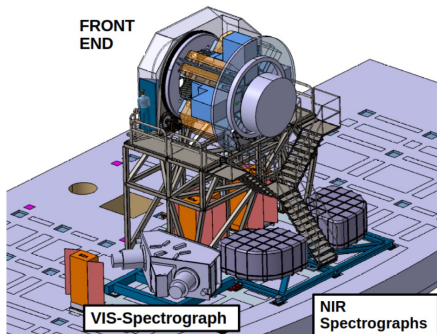
The consortium is responsible for raising the complete construction and commissioning funding of the instrument, including contingencies and functioning costs

IPARCOS-UCM coordinates the contribution of Four Spanish institutions:

- UCM
- Centro Astrobiología (INTA-CSIC)
- Instituto Astrofísica Andalucía (CSIC)
- Universidad Politécnica de Madrid



MOSAIC Organisation

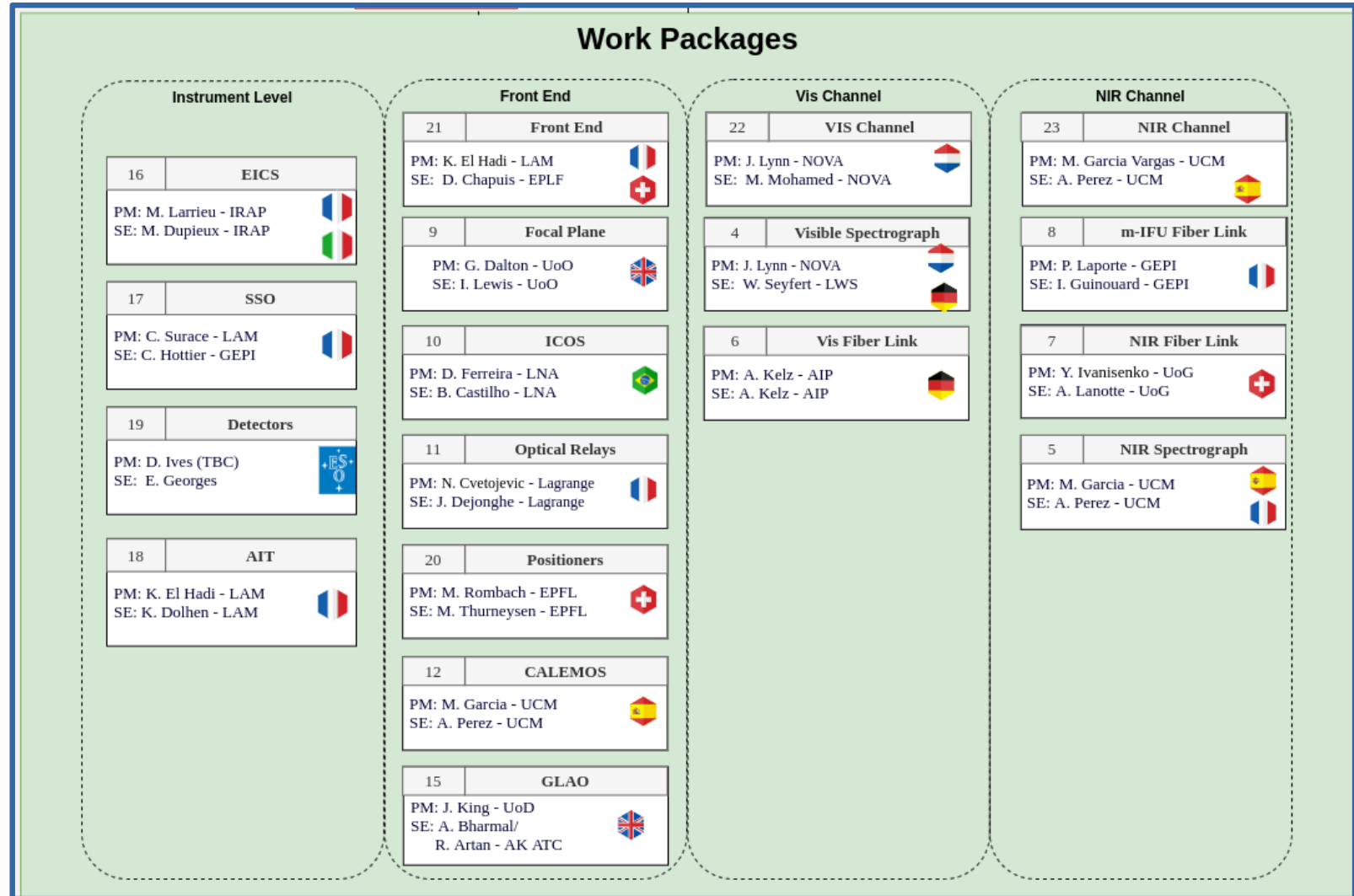


Organisation by channels:

- Front End (including GLAO)
- Visible
- NIR



+ Instrument Level



Project Status

International/ESO context

- Approved by the Council in December 2021
- Phase B1 Kick-Off Meeting 14-15/03/23 in Paris
- Signature of ESO/CNRS B1 Phase Agreement (8/08/23)
- **JUN24**: System Requirements Review (SRR), at UCM
- **APR25**: Specifications and Architecture Review (SAR)
ESO headquarters, Garching
=> **End of the Phase B1**
- **16-18/09/2025**: Phase B2 KOM & Progress Meeting at LAM (Marseille).
=> **Starting the phase B2 (until the PDR)**
- **27-29/10/2025**: Consortium Science Meeting in Amsterdam
KOM for the Red Book

Project Status

- **01/12/2025: MOSAIC signing ceremony** at ESO
Starting the phase B2 (until the PDR)





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ARRAKIHS ESA mission

UCM-IPARCOS contribution

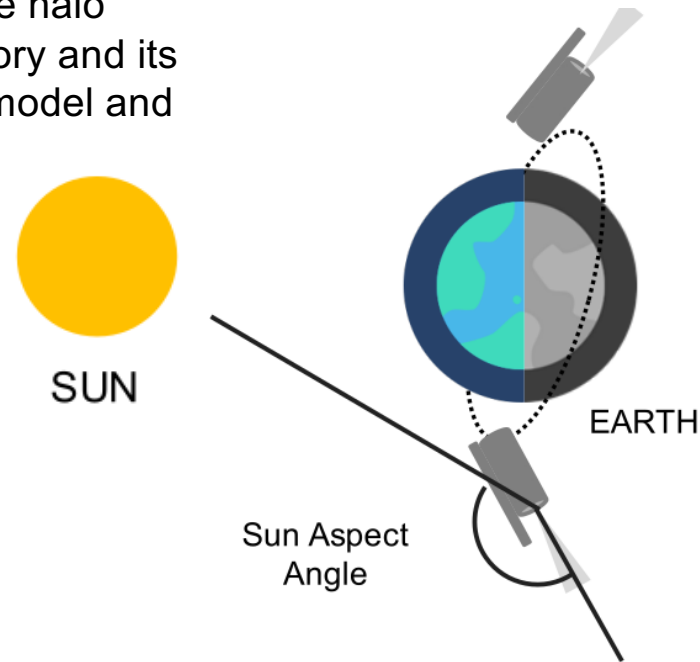
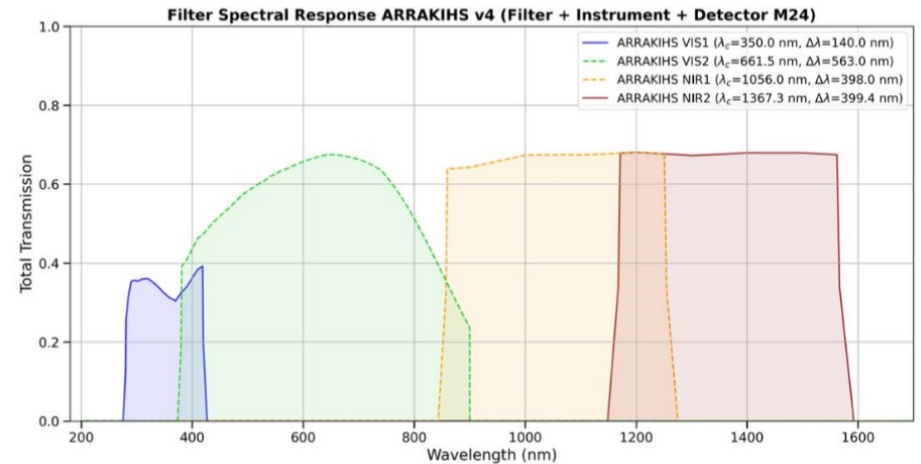
ARRAKIHS Mission

Overview

ARRAKIHS survey ~ 80 MW-like galaxies in four wavelength bands (2 VIS and 2 NIR)

SB limit ~ 31.5 mag/arcsec² in VIS and 30.5 mag/arcsec² in NIR

Detection of LSB features (e.g. stellar streams), satellite galaxies and the diffuse halo
Characterize the accretion history and its relation with the cosmological model and baryonic physics



Height: 650 - 800 Km

Orbit: Sun-Synchronous, 6am-6pm

Visibility:

- $90^\circ < \text{Solar Angle} < 130^\circ$
- 100km above Earth's surface – $\text{ZA} < 60^\circ$
- Zodiacal Light > 22.4 mag arcsec⁻²
- Avoid $E(B-V) > 0.1$ (galactic cirrus)

Group's Overview

Top 2-3 Scientific Highlights

- **Highlight 1:** Definition Study Report of the ARRAKIHS space mission, which includes a description of the science, feasibility, performance, ... of the mission
- **Highlight 2:** HARKONENS cosmological simulations, which are a new generation of high-resolution cosmological simulations, and the product of the 250Mhours of computation time obtained as part of an EuroHPC Joint Undertaking project

Leadership, Internationalization & Impact

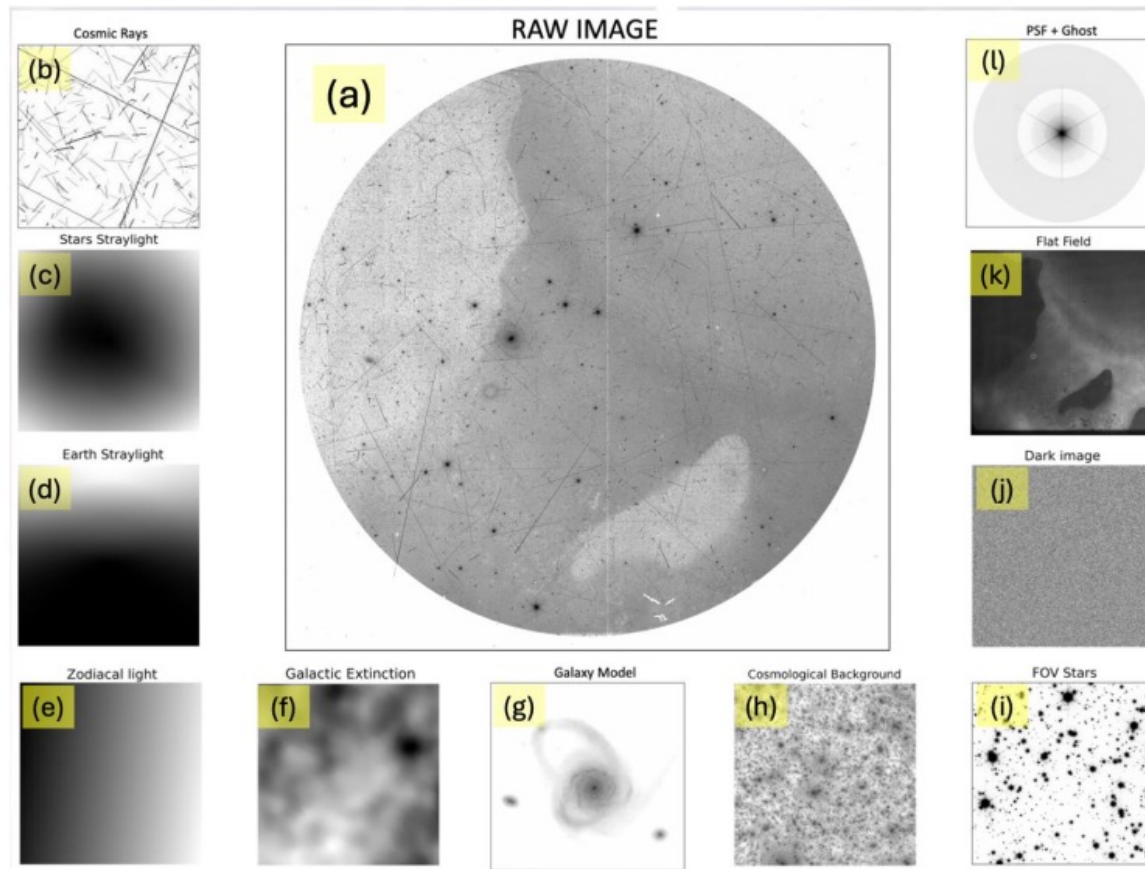
- **Major Roles:** Member of the ESA Science Study Team of the ARRAKIHS mission. Coordination of the Survey Strategy Working Group of ARRAKIHS and participation in other seven WGs of the mission. Coordination of the Spanish Team of the ARRAKIHS mission.
- **Recognitions:** Invited conference at a conference organized by the Royal Astronomical Society. Science organization committee of an EAS2024 symposium.
- **Tech Transfer / Out)reach:** Development of the ATREIDS tool, which generates realistic mock images including a complete set of instrumental and observational effects. Organization of an outreach conference (“El impacto de la astrofotografía en la investigación y divulgación astronómica”), and a summer course as part of the UCM summer school program (“El Universo a nuestro alcance: El auge de las Ciencias del Espacio en España”)

The Horizon

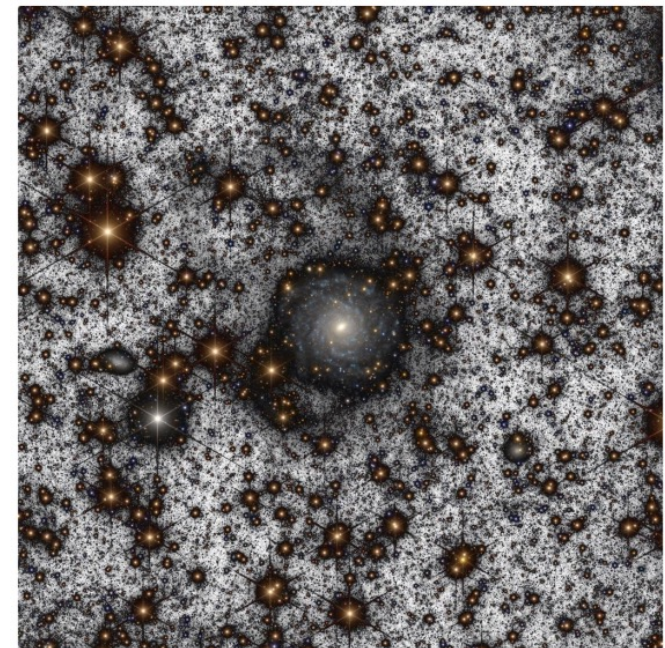
- **Next Big Milestone:** Adoption of ARRAKIHS as the first F-class mission of science led by Spain Mid-2026

ARRAKIHS Mission

ATREIDS tool (ARRAKIHS Telescope Realistic Exploration and Imaging Detection Simulations)



Mock image generator





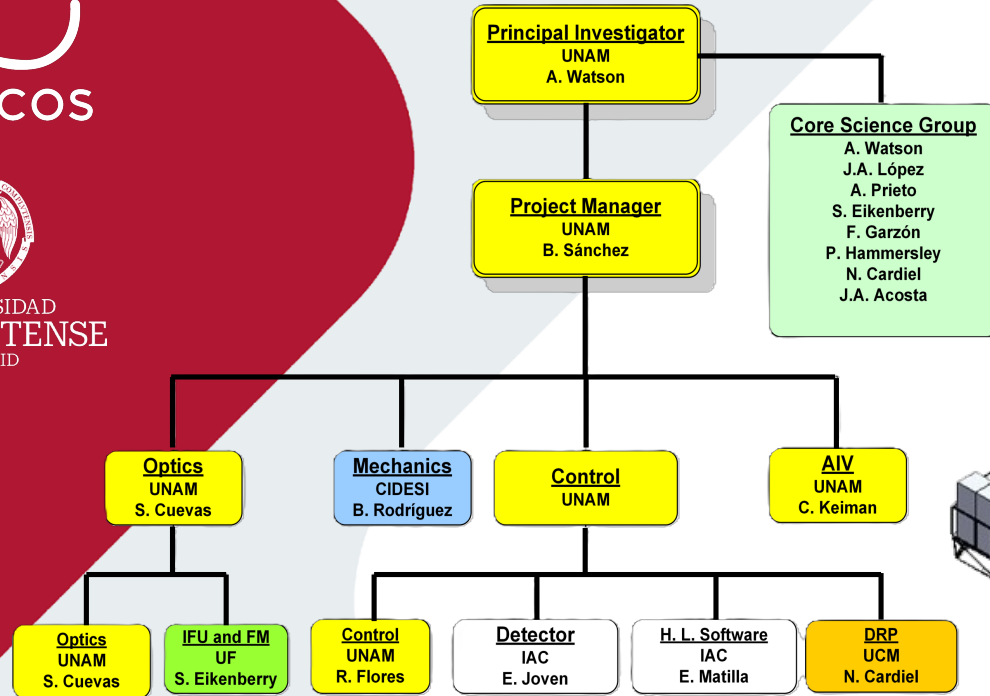
IPARCOS



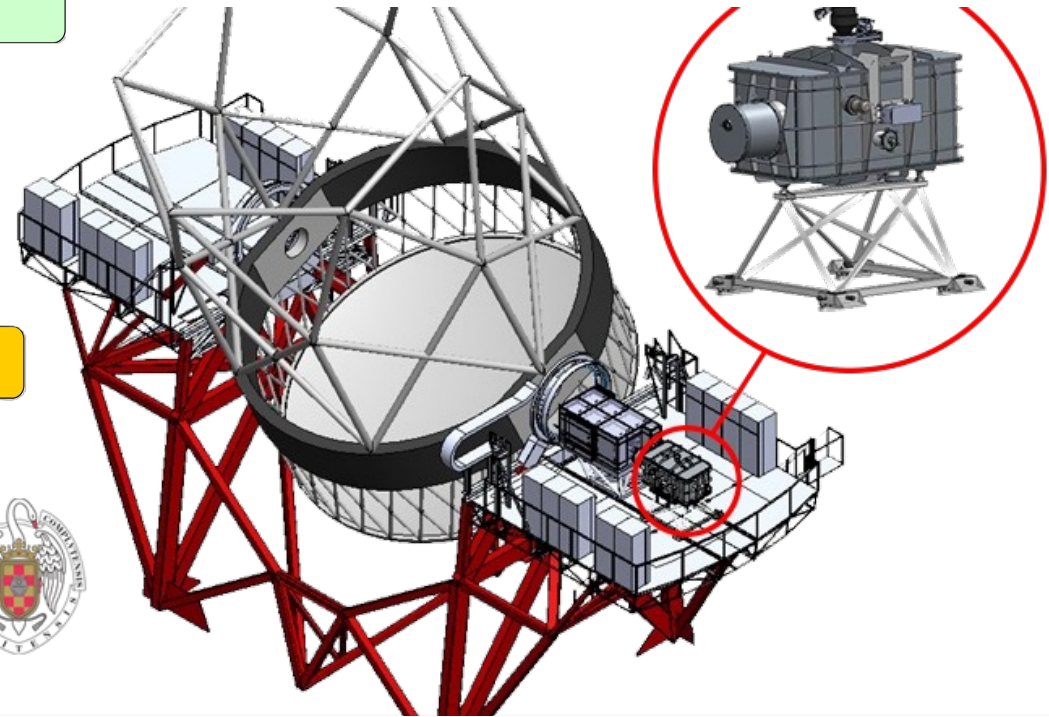
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**FRIDA AO-nIR imager
and spectrograph
for GTC 10.4m telescope**

UCM-IPARCOS contribution



FRIDA (inFRared Imager and **D**issector for **A**aptive optics) is an Integral Field Spectrograph working in the near-infrared wavelength ranges with imaging capability. It will make use of the GTC Adaptive Optics system (GTCAO) at the Nasmyth-B focal station.



Group's Overview

Top 2-3 Scientific Highlights

- **Highlight 1:** Simulator of FRIDA IFU data cubes
- **Highlight 2:** First prototypes of FRIDA Data Reduction Pipeline recipes following GTC standards

Leadership, Internationalization & Impact

- **Major Roles:** Members of FRIDA Core Science Group, and developers of FRIDA Data Reduction Pipeline
- **Tech Transfer / Outreach (Optional but encouraged):** Software released to the community through GitHub

The Horizon

- **Next Big Milestone:** Validated science-grade data-production code.
Delivery of the instrument to the telescope 2027 ?

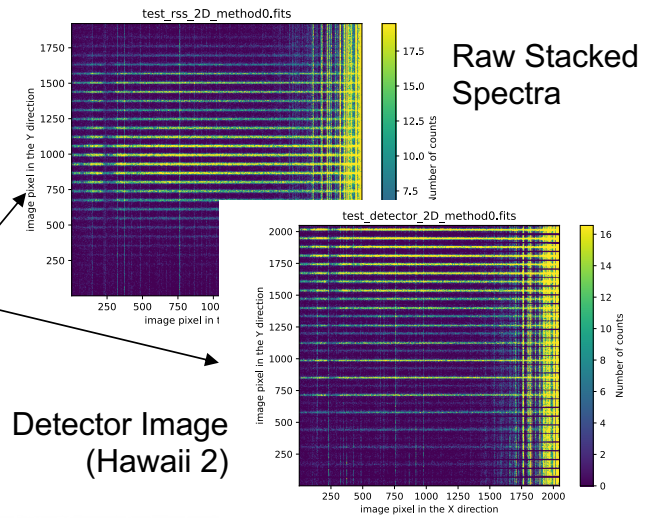
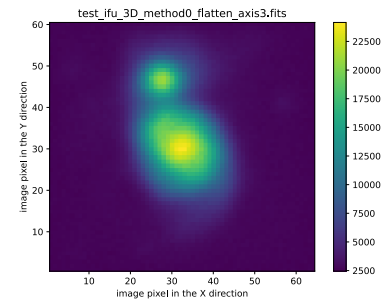
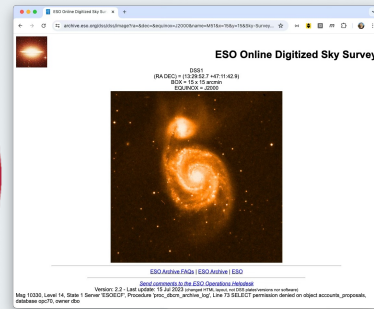
NOTE: (Last two years only, ~from 2024 on)



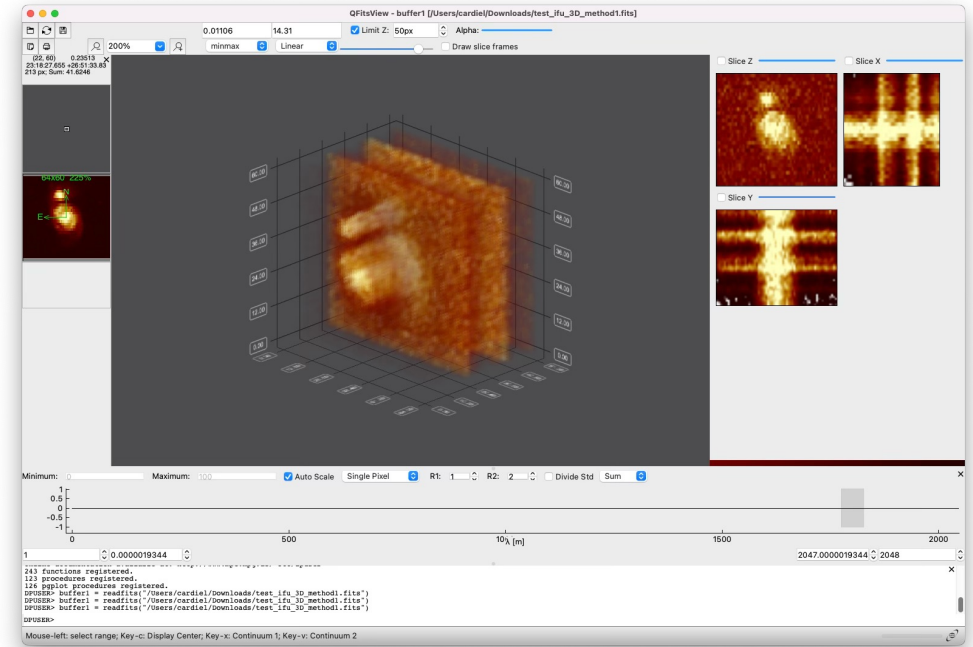
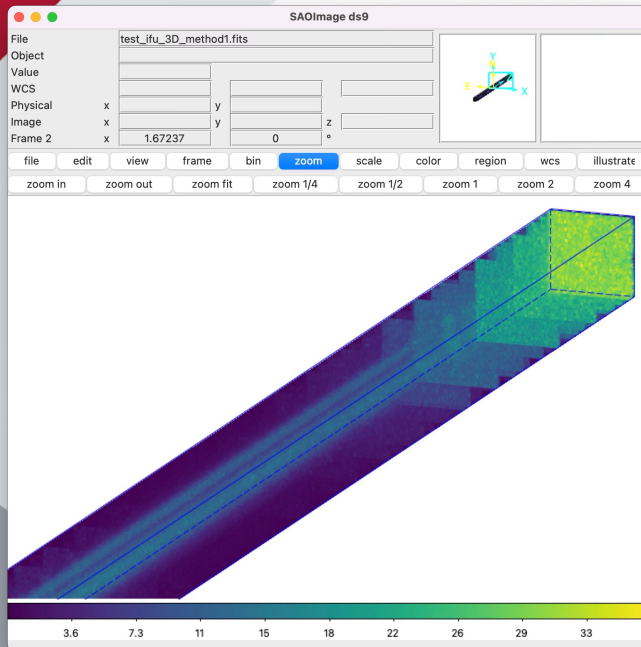


Simulator of FRIDA IFU data cubes

The IFU image simulator has been essential for initiating the development of the instrument's DRP prototypes.



Detector Image (Hawaii 2)





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AtLAST UCM-IPARCOS node

The Atacama Large Aperture Submm Telescope (AtLAST)

- ✓ First **high-res** ($< 2''$ at $\nu > 650$ GHz) and **wide-field** (> 1 deg) single-dish submm observatory
- ✓ Pioneering **sustainable astronomy**: tailored off-grid renewable energy system
- ✓ **Global effort** building upon European and Japanese submm expertise
- ✓ A facility for >30 yr, committed to **open science**

MILKY WAY, GALAXIES, AND COSMOLOGY

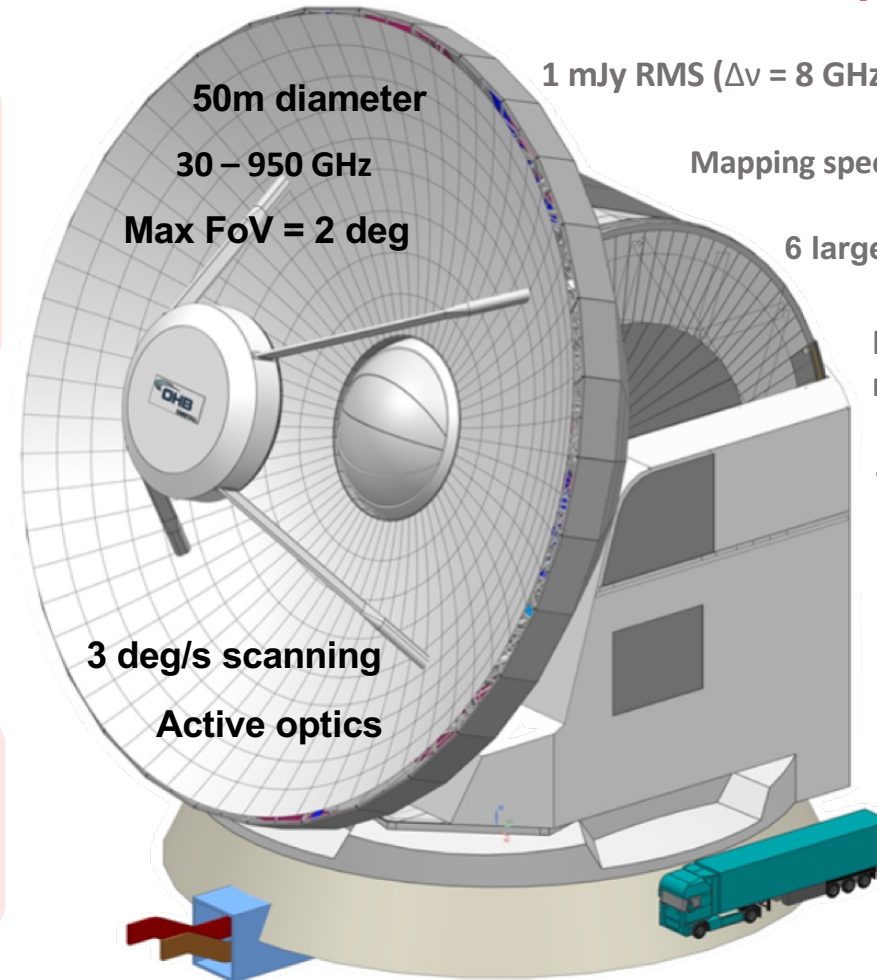
- Link sub-pc protostellar cores & disks with their large-scale environment in our Galaxy
- Resolve the cosmic infrared background
- SDSS-like submm surveys of the local Universe
- Map elusive gas flows and cosmic web filaments

CROSS-FIELDS

- Discover transient & time-varying submm sky
- Solve missing flux issue of interferometers

SOLAR SYSTEM

- Track solar activity driving space weather
- Survey HDO & D₂O in comets



1 mJy RMS ($\Delta\nu = 8$ GHz) @ 350 GHz in < 8 s

Mapping speed $10^3 - 10^5$ x ALMA

6 large instrument cabins

Multi ($>10^5$)- beam & multi-band receivers

Time domain science

Solar observations

Continuum & line polarization



Find out more : www.atlast-telescope.org

Mroczkowski et al. (2025), [A&A, 694, A142](https://doi.org/10.1051/00046361/2025001)



Funded by
the European Union

Group's Overview

Top 2-3 Scientific Highlights

- **Highlight 1:** (e.g., "First measurement of X using Y telescope/accelerator data.")
- **Highlight 2:** (e.g., "Developed new theoretical model for Z, resolving long-standing discrepancy.")

Leadership, Internationalization & Impact

- **Major Roles:** Leadership positions in international collaborations (e.g., working group convener at CERN, board member for a major telescope/mission).
- **Recognitions:** Major awards, honors, or keynote plenary talks at top-tier international conferences.
- **Tech Transfer / Outreach (Optional but encouraged):** Patents, software released to the community, or high-impact public engagement.

The Horizon

- **Next Big Milestone:** contender for ESO's expanding horizons 2040 program

NOTE: (Last two years only, ~from 2024 on)



	Project	Timeline	Partners	EU Funds	Funds UCM
AtLAST-1	Horizon 2020: "Towards an Atacama Large Aperture Submillimeter Telescope" (Grant agreement: 951815)	Mar 21 – Aug 24	5	3.5 M€	In-kind
AtLAST-2	Horizon Europe "Consolidating plans for the Atacama Large Aperture Submillimeter Telescope" (GA: 101188037)	Jan 25 – Jul 28	21	4 M€	187 k€

AtLAST-2 High-level goals

- Consolidate the AtLAST concept
- Prototype and test technology solutions
- Perform a full lifecycle assessment of the facility
- Expand our user community
- Increase TRL of crucial components
- Be ready for the implementation phase



Contender for:
ESO's Expanding Horizons
Transforming Astronomy in the 2040s

27 submitted White papers

- Montenegro-Montes et al. (2025) [arxiv:2512.14238](#)
- IPARCOS participation in 3 additional white papers





AtLAST-2 UCM-IPARCOS node

- **PI:** Armando Gil de Paz
- **Scientific Coordinator:** F. M. Montenegro-Montes
- 12 IPARCOS members involved



Responsibilities and Main Activities

- Co-lead **Operations and User Experience (WP4)**
- Modern operations concepts: Remote and distributed operations
- Data infrastructure, archiving and user access
- User support models
- Engagement of Spanish community
- Contribute to Science Reference Plan

- E. Hatziminaoglou, F.M. Montenegro-Montes (2024) [Deliverable 4.1. "AtLAST Operations plan"](#)
- F. M. Montenegro-Montes, E. Hatziminaoglou, C. De Breuck (2024) [Deliverable 4.2 "On the Use of existing infrastructures"](#)

Outreach:

- IPARCOS colloquium
- Semana de la ciencia 2024 / 2025






IBERIAN AtLAST DAYS 2026




UNIVERSIDAD COMPLUTENSE DE MADRID, 4-5 JUNE 2026





Event funded by:



COLOQUIO IPARCOS

Los ingredientes para explorar el cielo sub-milimétrico



Francisco M. Montenegro-Montes
IPARCOS-UCM

Jueves, 30 de enero de 2025, 13:30
Aula M1, Facultad de Física, UCM



[Unidad](#)[Servicios](#)[Publicaciones](#)[Inicio](#) / [Laboratorio de instrumentación científica avanzada \(LICA\)](#) /

Laboratorio de instrumentación científica avanzada (LICA)

The Advanced Scientific Instrumentation Laboratory (LICA) has equipment for the analysis of detectors and optical and mechanical instrumentation components and has specialized in the development, assembly and calibration of scientific instruments at the system level. It has been in the Department of Earth Physics and Astrophysics of the Faculty of Physical Sciences since its creation in 2010 and has been equipped with equipment with funds from the Moncloa Campus of International Excellence (Action E11, Global Change and New Energies cluster of the CEI-Moncloa), the MINECO and the Community of Madrid. Prof. A. Gil de Paz is the coordinator of this laboratory.



Contacto

CAI Técnicas Físicas

Laboratorio de instrumentación científica avanzada (LICA)

Facultad de Ciencias Físicas

Plaza de las Ciencias 1

28040 Madrid (Madrid)



ISO 9001–certified laboratory

Coordinator

A. Gil de Paz



Horizon: opportunities and challenges

Positioning GUAIX for ELT/SKA/JWST-era science while sustaining people and data capacity

Next big scientific opportunities

- MOSAIC/ELT and TARSIS: turn instrumentation leadership into flagship science
- MEGADES / MEGARA legacy: consolidated IFU diagnostics and public data products
- SKA/POSSUM/LOFAR: cosmic magnetism and radio transients
- JWST + ALMA + NOEMA + GTC: multi-phase feedback constraints
- Simulations + surveys: connect resolved physics to population evolution

Main challenges for the group

- Funding continuity across instrumentation + exploitation cycles
- Retaining postdocs and technical expertise after project peaks
- Scaling reduction, analysis and archive tools for IFU/multiwavelength data
- Maintaining visibility in large collaborations while protecting GUAIX-led science
- Balancing dedicated instrument effort with broad astrophysics output

Take-home message: GUAIX is a compact but highly productive group whose distinctive value is the coupling of astronomical instrumentation, IFU expertise and multiwavelength extragalactic science.

