GUAIX

UCM Group of Extragalactic Astrophysics and Astronomical Instrumentation

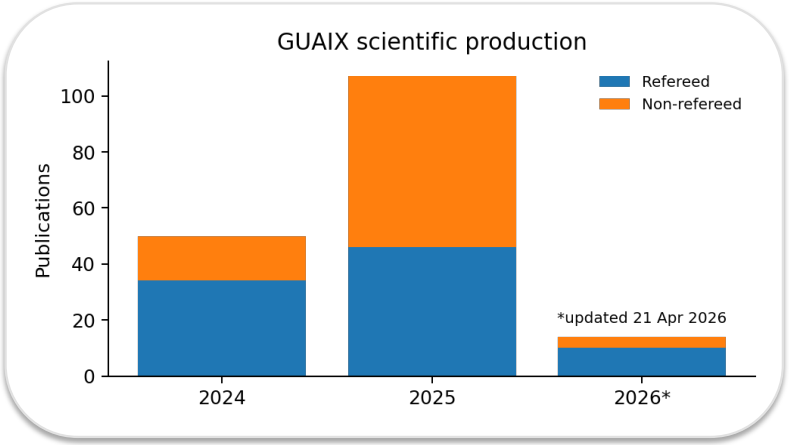
Instrumentation developments in Astrophysics — Universidad Complutense de Madrid

IPARCOS Scientific Advisory Board: Bi-Annual Review — 2026

GUAIX at a glance

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

34	90	>4.7 M€	3+4	7+12
members	refereed papers since Jan 2024	active funding	full + associate professors	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.

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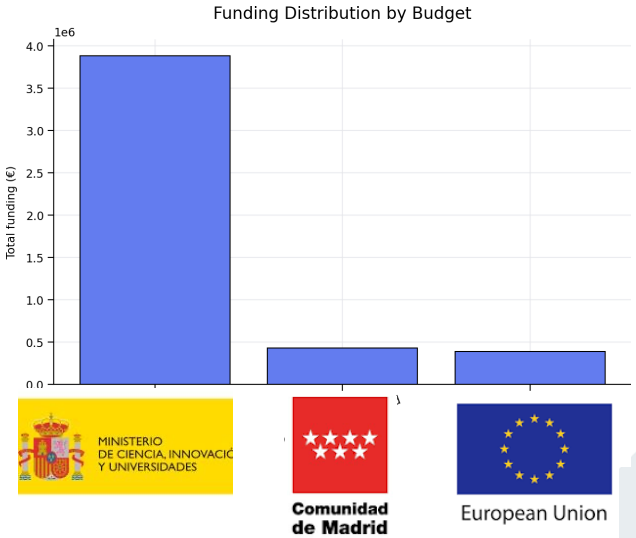
Key performance indicators

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)
TARSIS (~€731k)
ARRAKIHS (~€460k)
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).

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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

ESFRI
European Strategy Forum on Research Infrastructures

European Southern Observatory

www.eso.org

Group's Overview

Top 2-3 Scientific Highlights

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

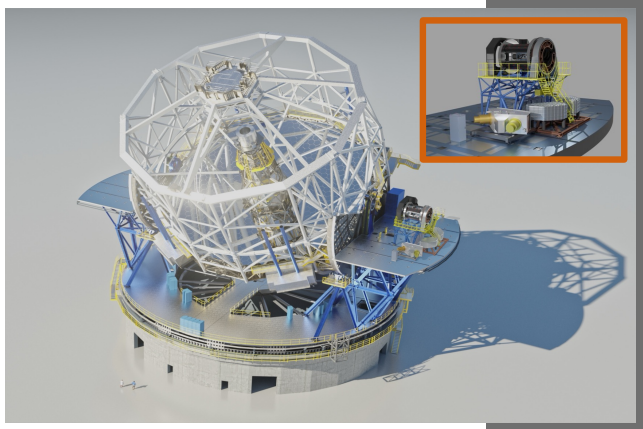
Leadership, Internationalization & Impact

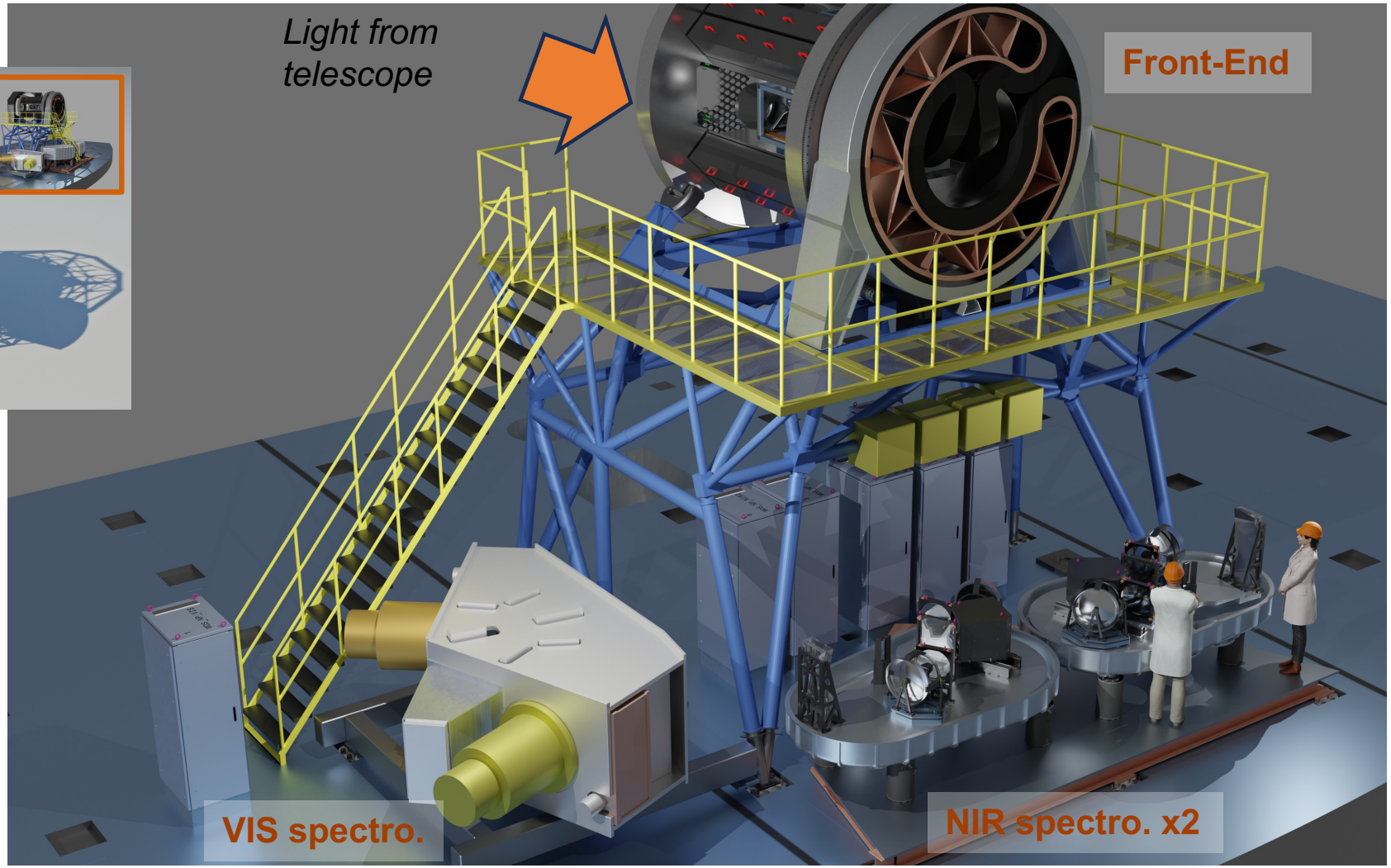
- **Major Roles:**
  J. Gallego: National representative and co-chair of the Board. Members of Science Working Groups
  A. Gil de Paz: Calibration Scientist
  CALEMOS: Calibration unit: Á. Castillo+
  near-IR channel; near-IR spectrographs: F. Montenegro+ 10-15 % MOSAIC total (One channel, 3 WPs)
- **Recognitions:**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



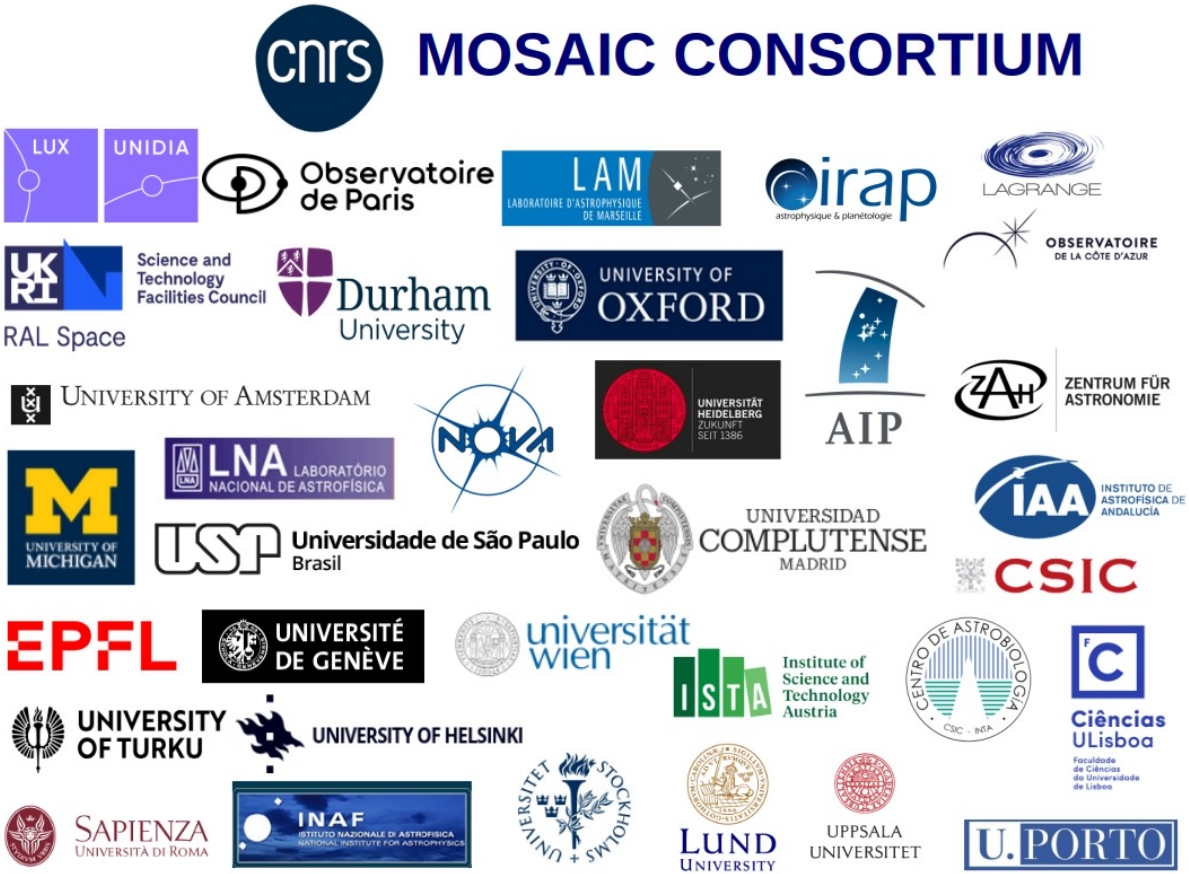


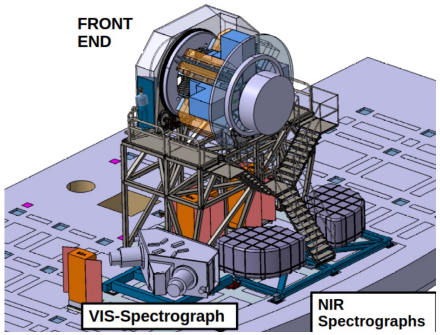
MOSAIC Consortium

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





MOSAIC Organisation

Organisation by channels:

- Front End (including GLAO)
- Visible
- NIR

+ Instrument Level

Work Packages

Instrument Level

16	EICS
PM: M. Larrieu - IRAP SE: M. Dupieux - IRAP	
17	SSO
PM: C. Surace - LAM SE: C. Hottier - GEPI	
19	Detectors
PM: D. Ives (TBC) SE: E. Georges	
18	AIT
PM: K. El Hadi - LAM SE: K. Dolhen - LAM	

Front End

21	Front End
PM: K. El Hadi - LAM SE: D. Chapuis - EPLF	
9	Focal Plane
PM: G. Dalton - UoO SE: I. Lewis - UoO	
10	ICOS
PM: D. Ferreira - LNA SE: B. Castilho - LNA	
11	Optical Relays
PM: N. Cvetojevic - Lagrange SE: J. Dejonghe - Lagrange	
20	Positioners
PM: M. Rombach - EPFL SE: M. Thurneysen - EPFL	
12	CALEMOS
PM: M. Garcia - UCM SE: A. Perez - UCM	
15	GLAO
PM: J. King - UoD SE: A. Bharmal/ R. Artan - AK ATC	

Vis Channel

22	VIS Channel
PM: J. Lynn - NOVA SE: M. Mohamed - NOVA	
4	Visible Spectrograph
PM: J. Lynn - NOVA SE: W. Seyfert - LWS	
6	Vis Fiber Link
PM: A. Kelz - AIP SE: A. Kelz - AIP	

NIR Channel

23	NIR Channel
PM: M. Garcia Vargas - UCM SE: A. Perez - UCM	
8	m-IFU Fiber Link
PM: P. Laporte - GEPI SE: I. Guinouard - GEPI	
7	NIR Fiber Link
PM: Y. Ivanisenko - UoG SE: A. Lanotte - UoG	
5	NIR Spectrograph
PM: M. Garcia - UCM SE: A. Perez - UCM	

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

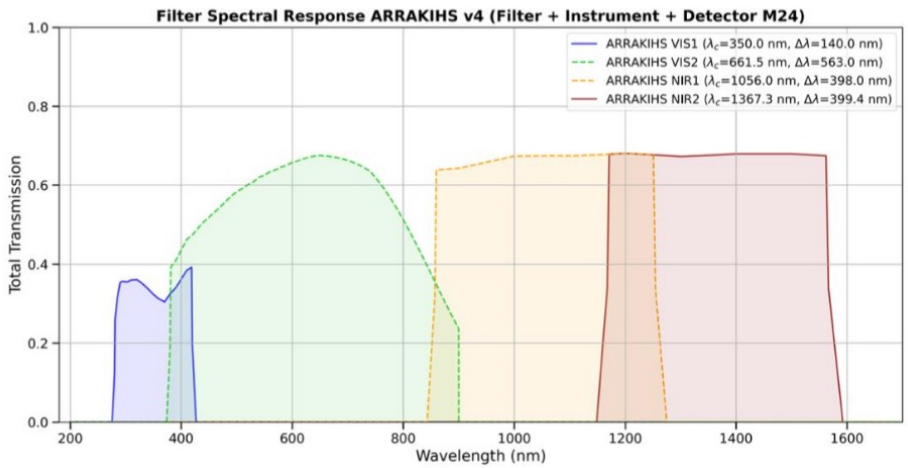
UCM-IPARCOS contribution

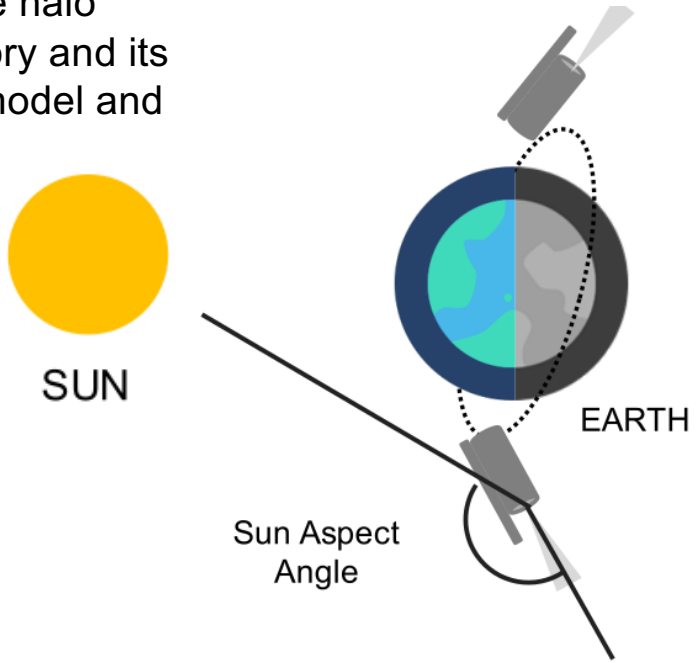
ARRAKIHS Mission

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**

Visibillity:

- **90^O < Solar Angle < 130^O**
- **100km above Earth's surface – ZA < 60^O**
- **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

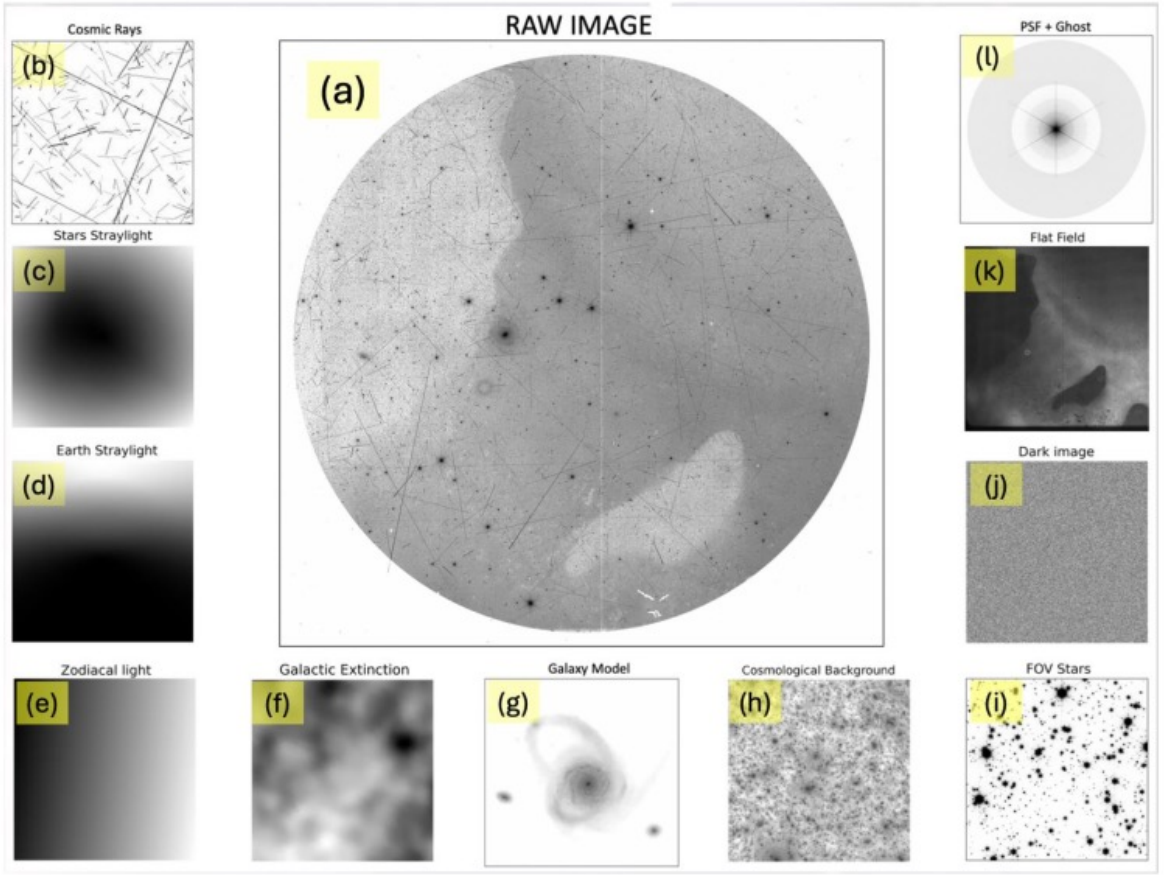
- **Major Roles:** Member of the ESA Science Study Team of the ARRAKIHS mission. Coordination of the Survey Strategy Working Group of ARRAKIHS and participation in other seven WGs of the mission. Coordination of the Spanish Team of the ARRAKIHS mission.
- **Recognitions:** Invited conference at a conference organized by the Royal Astronomical Society. Science organization committee of an EAS2024 symposium.
- **Tech Transfer / Out)reach (Optional but encouraged):** 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

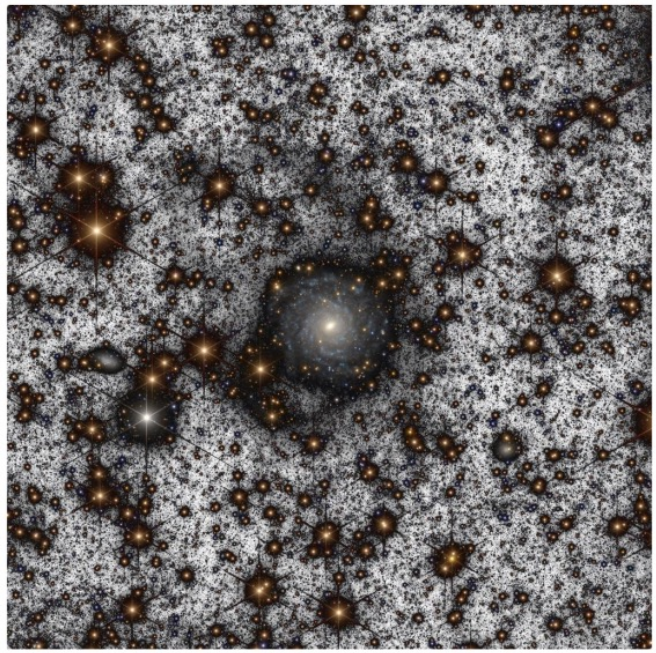
- **Next Big Milestone:** Adoption of ARRAKIHS as the first F-class mission of science led by Spain Mid-2026

ARRAKIHS Mission

ATREIDS (ARRAKIHS Telescope Realistic Exploration and Imaging Detection Simulations)



Mock image generator



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

UCM-IPARCOS contribution

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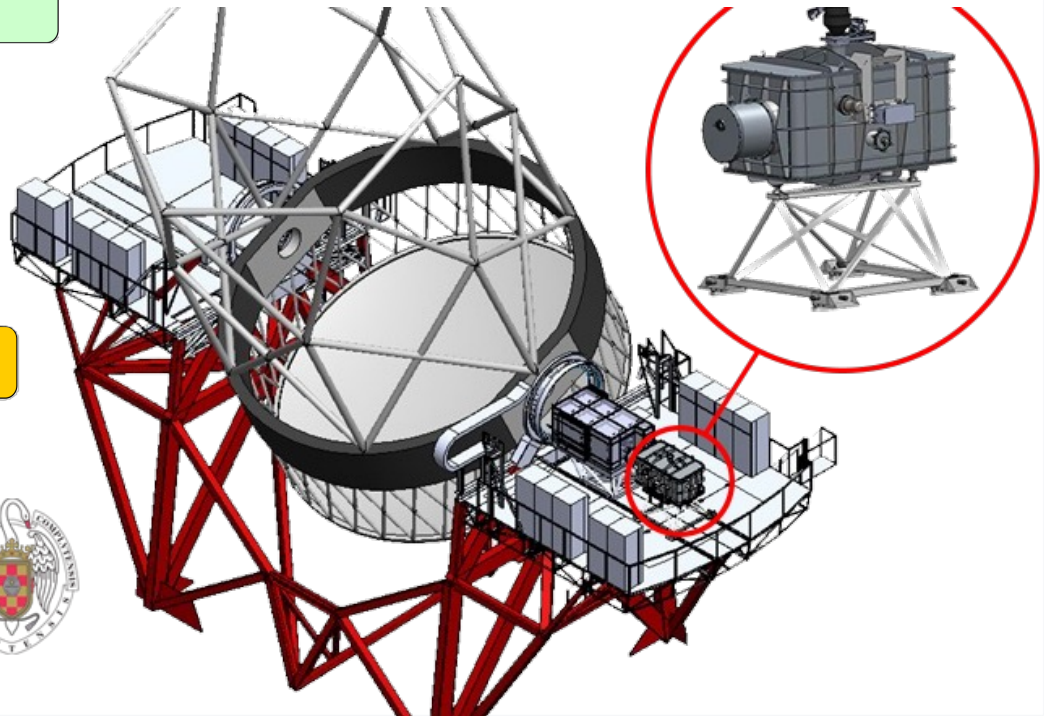
FRIDA

FRIDA (in**FR**ared **I**mager and **D**issector for **A**daptive 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.



Principal Investigator
UNAM
A. Watson

Project Manager
UNAM
B. Sánchez

Core Science Group
A. Watson
J.A. López
A. Prieto
S. Eikenberry
F. Garzón
P. Hammersley
N. Cardiel
J.A. Acosta

Optics
UNAM
S. Cuevas

Mechanics
CIDESI
B. Rodríguez

Control
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AIV
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C. Keiman

Optics
UNAM
S. Cuevas

IFU and FM
UF
S. Eikenberry

Control
UNAM
R. Flores

Detector
IAC
E. Joven

H. L. Software
IAC
E. Matilla

DRP
UCM
N. Cardiel

UF | Astronomy

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:** Convert prototypes of DRP recipes into validated science-grade data-production code. In this sense, we are currently pending the acquisition of calibration images required to characterize the distortions across all observing modes and configurations of the FRIDA instrument.

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

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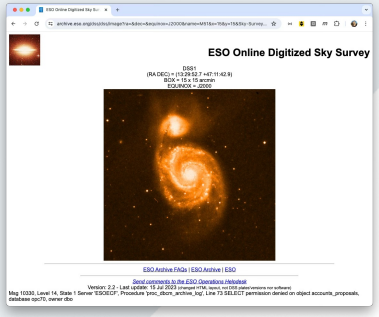
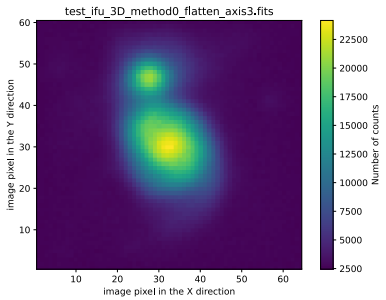
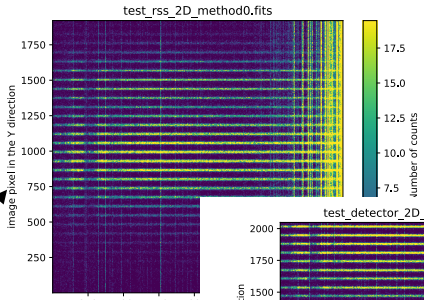
Simulator of **FRIDA** IFU data cubes

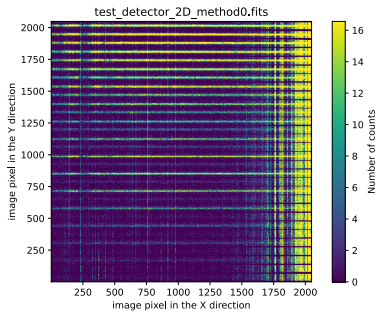
The IFU image simulator has been essential for initiating the development of the instrument's DRP prototypes.



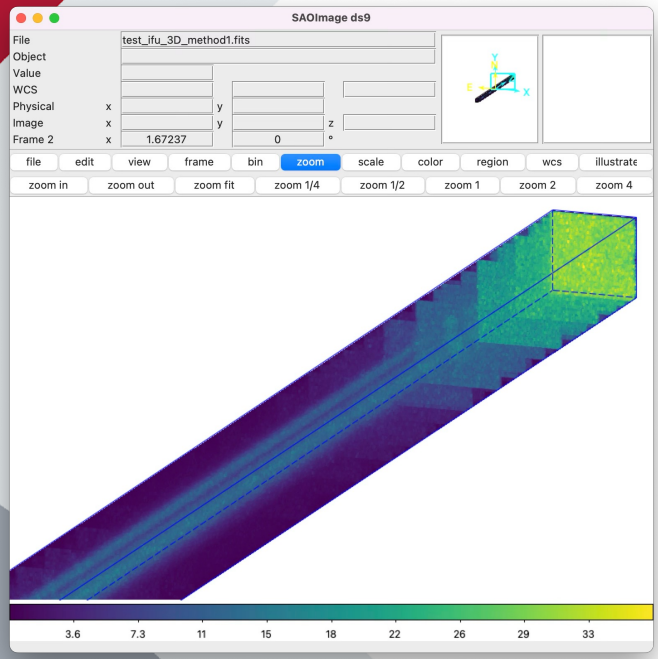


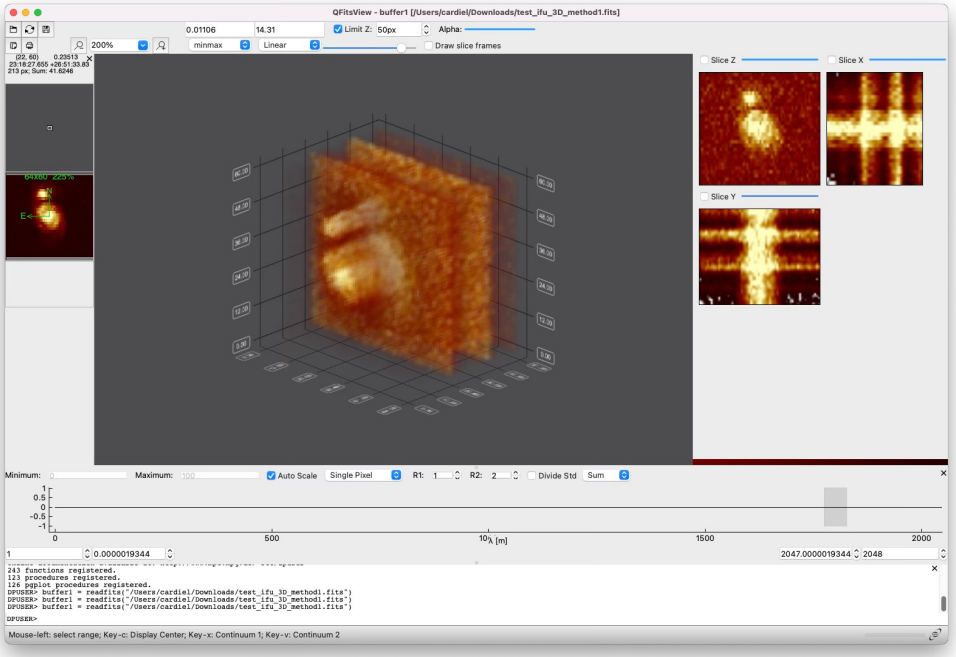


Raw Stacked Spectra



Detector Image (Hawaii 2)





FRIDA

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AtLAST UCM-IPARCOS node

The Atacama Large Aperture Submm Telescope (AtLAST)

- ✓ First **high-res** (< 2" at v > 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

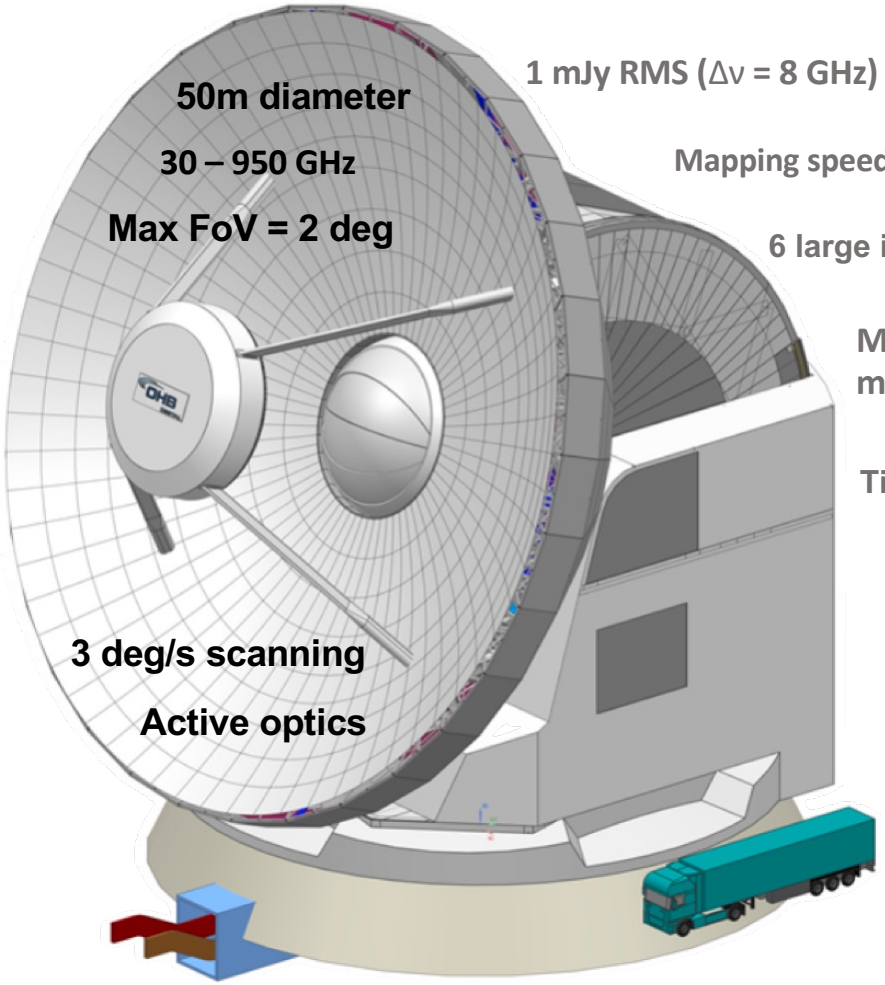
- Link sub-pc protostellar cores & disks with their large-scale environment in our Galaxy
- Resolve the cosmic infrared background
- SDSS-like submm surveys of the local Universe
- Map elusive gas flows and cosmic web filaments

CROSS-FIELDS

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

SOLAR SYSTEM

- Track solar activity driving space weather
- Survey HDO & D_2O 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

Mroczkowski et al. (2025), A&A, 694, A142

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Find out more : www.atlast-telescope.org

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:** (e.g., "Preparing for Run 4 data taking," or "Shifting focus to multi-messenger modeling.")

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

IPARCOS

	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

IPARCOS

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, archving 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

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

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.

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