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MINISTERIO DE CIENCIA, INNOVACIÓN Y UNIVERSIDADES
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AGENCIA ESTATAL DE INVESTIGACIÓN

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UNIVERSIDAD COMPLUTENSE MADRID

Towards a data platform providing a holistic support to AtLAST operations

Francisco Montenegro

Universidad Complutense de Madrid (Spain)

IPARCOS

GUAIX UCM RESEARCH GROUP

Archives and Data Management Systems in the Big Data Era. CNR Bologna, 2025 Feb 26-28

AtLAST in poche parole

Future next-generation 50-m class single-dish sub-mm astronomical observatory, run as a facility telescope by an international partnership and powered by renewable energy.

- Transformational science
  - Sensitivity to study the typical populations of astronomical sources
  - Mapping the barion cycle on multiple spatial scales
  - Open the window to the time-varying (sub-)mm sky
- Innovative design, powerful capabilities, excellent site
  - Unprecedent field-of-view (1-2 degrees)
  - Several large multi-beam instruments
  - Accesible to sub-mm wavelengths (up to 350 micron)
- Sustainability, community engagement
  - Reduced carbon footprint in the long run
  - Dialogue with local communities
  - Sustainable operations for 30+ years

https://www.atlast-telescope.org

Funded by the European Union

AtLAST project (2021-2024)

Towards an Atacama Large Aperture Submillimeter Telescope

EU Grant agreement ID: 951815

Coordination. PI. Claudia Cicone

Main deliverables:

- Solid science case (community)
- Telescope design
- Site selection study
- Operations plan
- Energy studies

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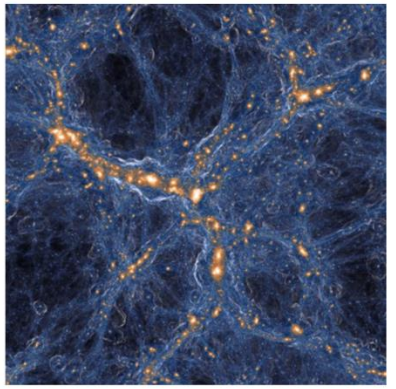

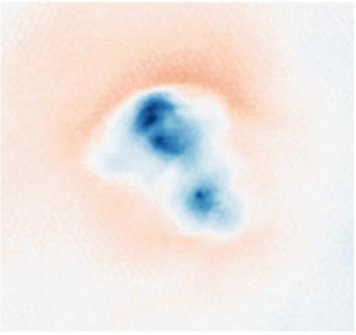

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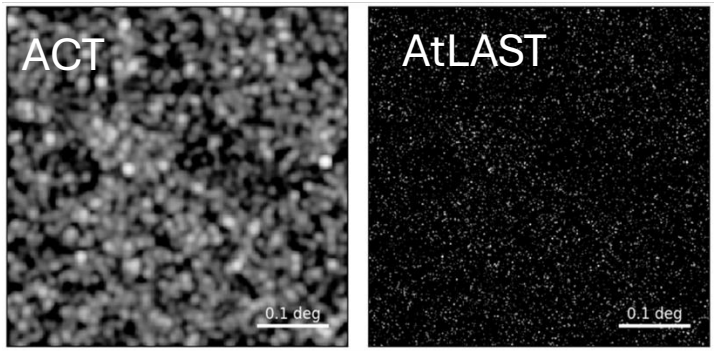

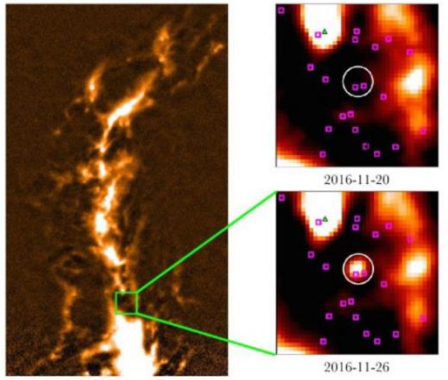

- *AtLAST Science cases collection (8 papers). Open Research Europe.*
- M. Booth, P. Klaasen, C. Cicone, et al. (2024) *AtLAST Science Overview Report* Deliverable 6.7 and on arXiv:2407.01413
- A. Schimek et al. (2024a). *High resolution modelling of [CII], [CI], [OIII] and CO line emission from the ISM and CGM of a star forming galaxy at z ~ 6.5.* A&A, 682, A98
- A. Schimek et al. (2024b). *Constraining the physical properties of gas in high-z galaxies with far-infrared and submillimetre line ratios.* *A&A, 687, L10*

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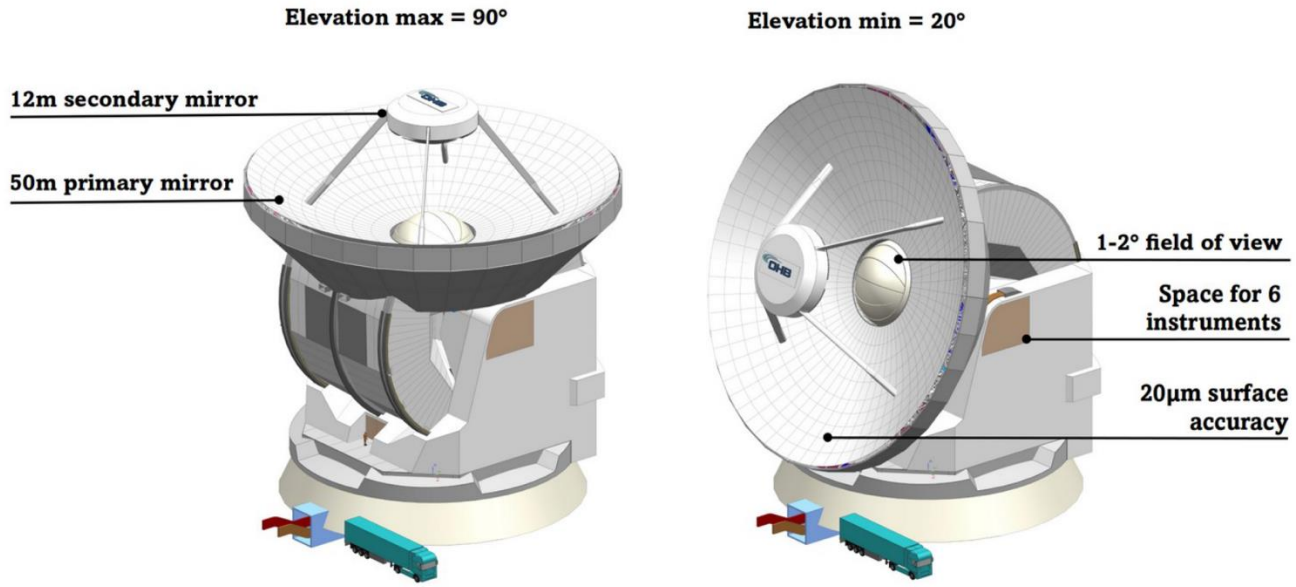

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- P. A. Gallardo+, 2024, Proc of SPIE, Vol 13094, id. 1309428 11 pp. On arXiv:2406.11502
- R. Puddu+, 2024, Proc. of SPIE, id 13094, id. 130944S 22 pp. On arXiv:2406.16602

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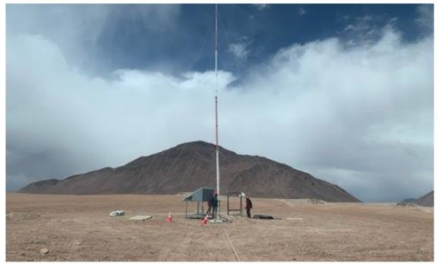

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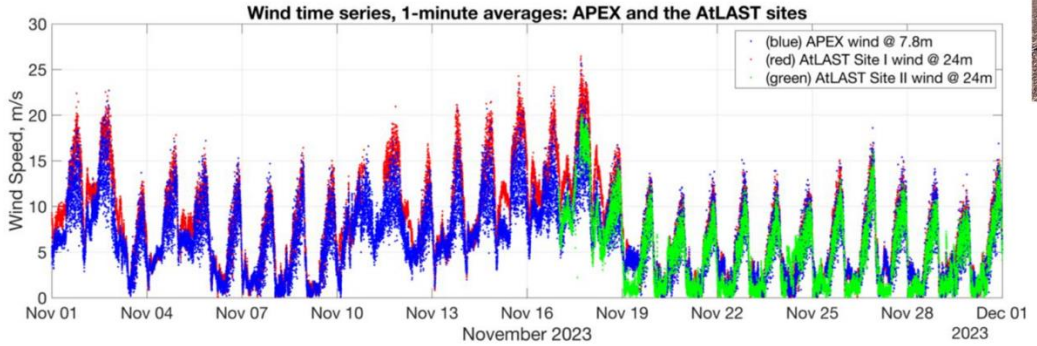

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- C. De Breuck, A. Otárola, J.P. Pérez-Beaupuits, et al. (2024) Deliverable 3.2. "Site selection report"

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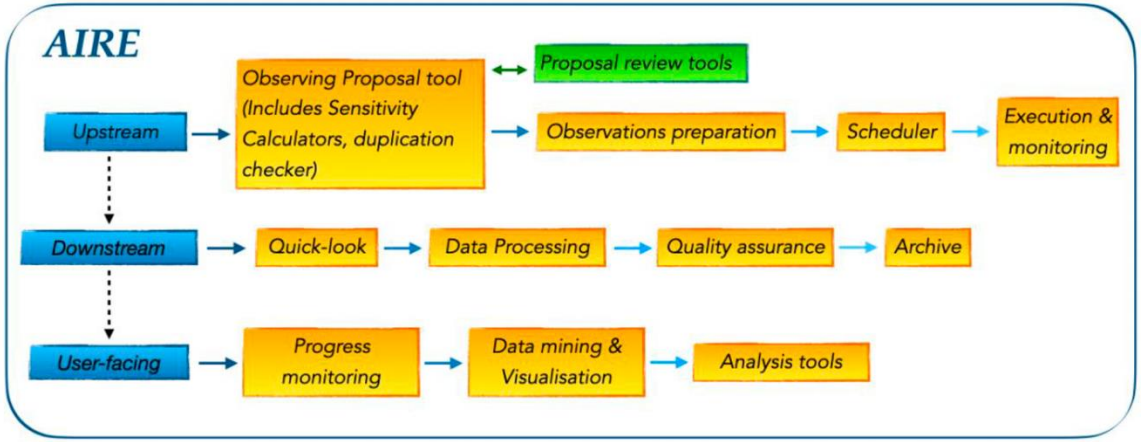
Lessons learned from APEX, ALMA



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- F. M. Montenegro-Montes, E. Hatziminaoglou, C. De Breuck (2024) Deliverable 4.2 "On the Use of existing infrastructures"

Findable
Accessible
Interoperable
Reusable

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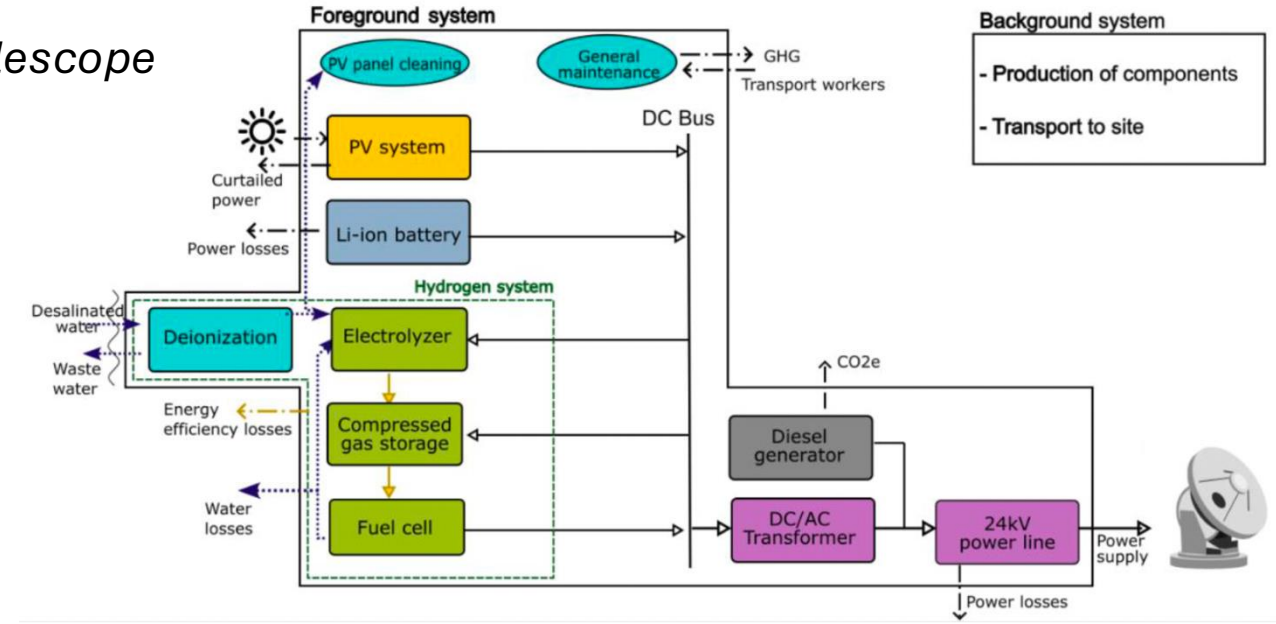

- I. Viole+ 2024a, "Sustainable astronomy: A comparative life cycle assessment of off-grid hybrid energy systems to supply large telescopes." Int. J. Life Cycle Assess, 29, 1706-1726
- I. Viole+ 2024b, "Integrated life cycle in off-grid energy system design – uncovering low hanging fruit for climate mitigation" Applied Energy Vol. 367, 123334
- I. Viole+ 2023 "A renewable power system for an off-grid sustainable telescope fuelled by solar power, batteries and green hydrogen. Elsevier Energy, 2023, 128570.
- G. Valenzuela-Venegas+, 2024, "A renewable and socially accepted energy system for astronomical telescopes". Nature Sustainability (2024), doi:10.1038/s41893-024-01442-3

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AtLAST-2 (2025-2028)

Consolidating plans for the Atacama Large Aperture Submillimeter Telescope

Coordination. PI. Claudia Cicone

UNIVERSITY OF OSLO

Project

- Grant agreement ID: 101188037
- Funded with 4 M€

Objectives

- 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

14 participants

+ 5 partners

Key operations concepts

- **24h observing** (service mode) interrupted by maintenance periods
- Combination of survey projects and PI science
- **Remote operation (world-wide)** supported by local operation
- Dynamic AI-assisted scheduling
- Adequate monitoring of telescope systems and environment
- High-quality data to enable the best science
- **Data (raw and reduced)** to be **archived** and become **publicly available** after a 1-year propietary period
- Effective **Interaction channels** between PIs and observatory
- Adequate data **accessibility** and **long-term preservation** (legacy value)
- Sharing of and synergies with **existing infrastructures** (transfer, HPC, storage, preservation)

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AtLAST data

Scientific data

Level 0 (raw)
Level 1 (calibrated)
Level 2 (science-ready)
Level 3 (special products)

Simulated science data

Weather data

Local weather station
WV Radiometer
Atmospheric model
Forecasts

Data categories

Software and tools

Planning tools
Operational
Data analysis

Engineering/technical data

Antenna and instruments
Power, cooling, computing
Processes, timing

Aspects to consider

- Data model and documentation (metadata)
- Enormous data rates and volumes
- Data location (remote operation)
- Data sharing, interoperability
- Reproducibility
- Long term preservation
- Re-use of existing data and infrastructures

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AtLAST data will be Findable Accessible Interoperable Reusable

Findable

Datasets Uniquely identified. Described with accurate and rich metadata. Follow IVOA standards

Accessible

AtLAST portal + astronomical data portals. Open Access after limited proprietary period.

Interoperable

Interactive and programmatic access. Alert system for transient sources.

Reusable

Clear data provenance. Calibration files and pipelines accessible and version controlled

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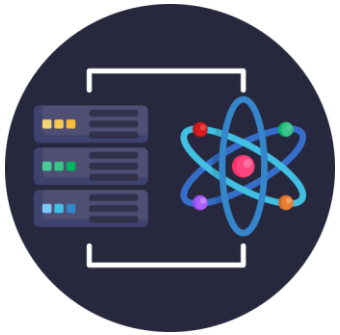
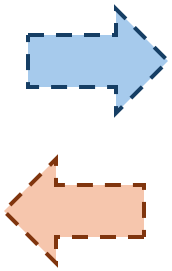
AtLAST Interface for Remote Exploration (AIRE)

- Technical and scientific documentation
- Proposal preparation tools
- Proposal review tools
- Phase 2 preparation



- Scientists
- Proposal reviewers
- Archive users
- General public



- Observations follow up
- Interaction channel during observing run
- Access to Archive
- Simulation, reduction and analysis tools, notebooks
- Support centre

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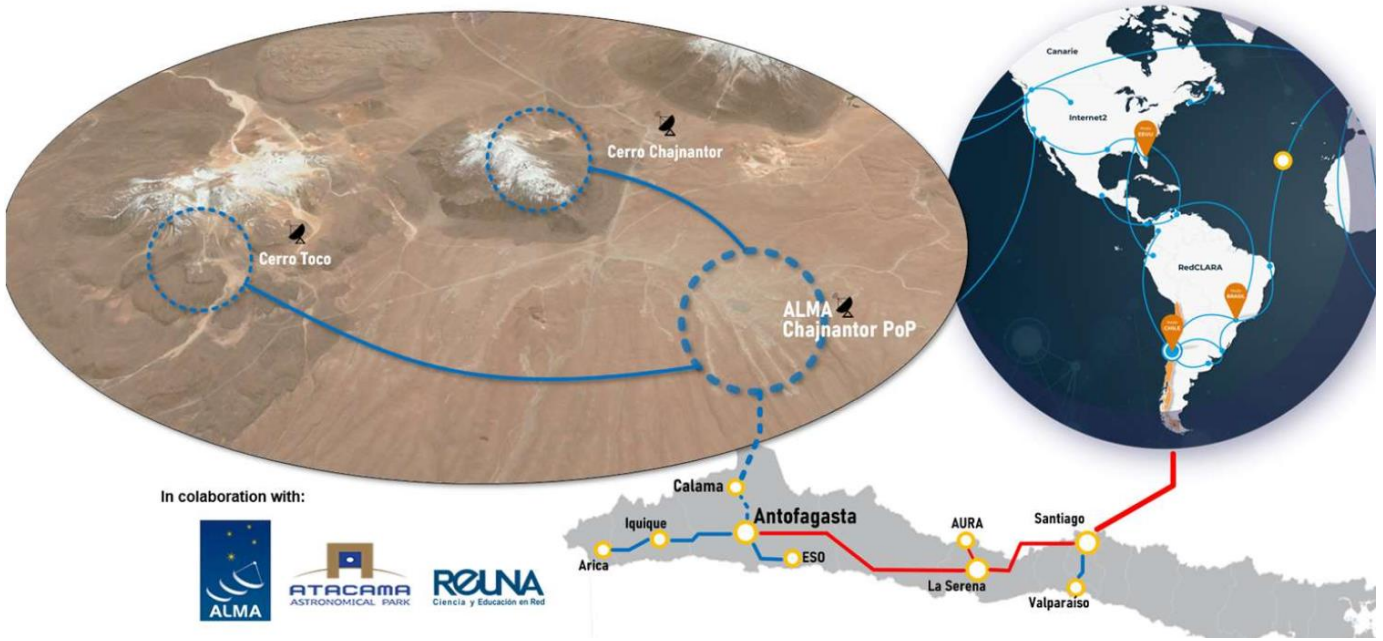
Existing infrastructures

Improved infrastructure is being developed rapidly on the Chajnantor plaeau. AtLAST will need rapid and efficient data transfer capabilities, which is essential for the kind of operations model we are considering.

- **REUNA** (National research and education network in Chile) coordinated with ESO and ALMA to improve connectivity to Chajnantor plateau
  - Individual observatories to be responsible for the last part of the connection to the main system.
  - Connection to Cerro Toco / SO complete
- Current target for overall **100 Gbps** capacity



- Very large data volumes are a common features of most new facilities; new solutions need to be developed for long term storage, access, availability.
- On-site data reduction strategies?
- Synergies advantageous for joint science analysis

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Inspiring existing efforts

V. Navarro, S. Del Río, M. A. Diego, et al. (2024),
ESA Datalabs: Digital Innovation in Space Science.
https://doi.org/10.1007/978-981-97-0041-7_1

AC³
AGILE AND COGNITIVE CLOUD EDGE CONTINUUM MANAGEMENT

Agile and Cognitive Cloud-edge Continuum management

Ongoing EU project. Grant Agreement 101093129

One use case is to demonstrate an efficient distributed processing of astronomical data cubes (100s of TB)

- Use of microservices
- Encapsulation of tools within containers
- Container orchestration platforms
- Compression, binning techniques for memory management
- Software optimization
- Scalability of software

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More sources of inspiration

Atacama Pathfinder EXperiment

APEX

AC³

AGILE AND COGNITIVE CLOUD EDGE CONTINUUM MANAGEMENT

IVOA

esa

ESA DATALABS

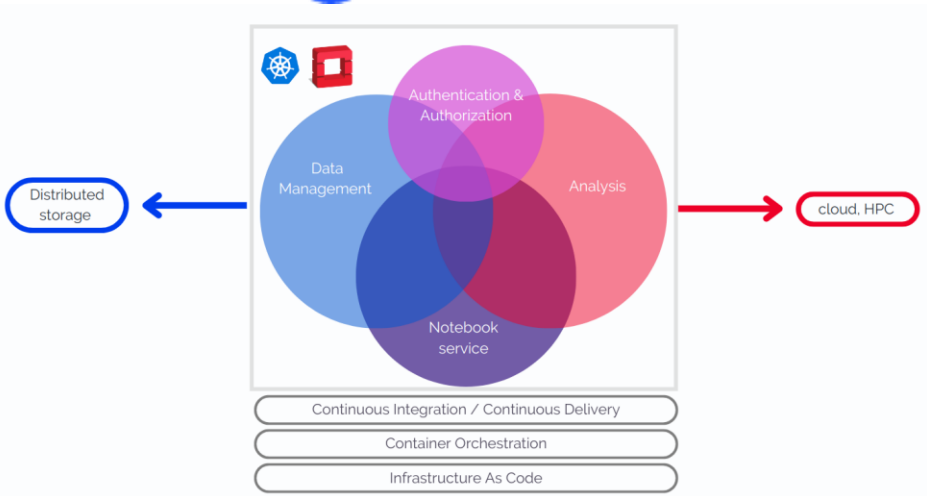
ESO

RUCIO

ALMA

This workshop!

VRE at CERN



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