The ASTRI Mini-Array

G. Tosti, P. Bruno
for the ASTRI Project

2nd TETIS WORKSHOP, 02-03 Feb 2023

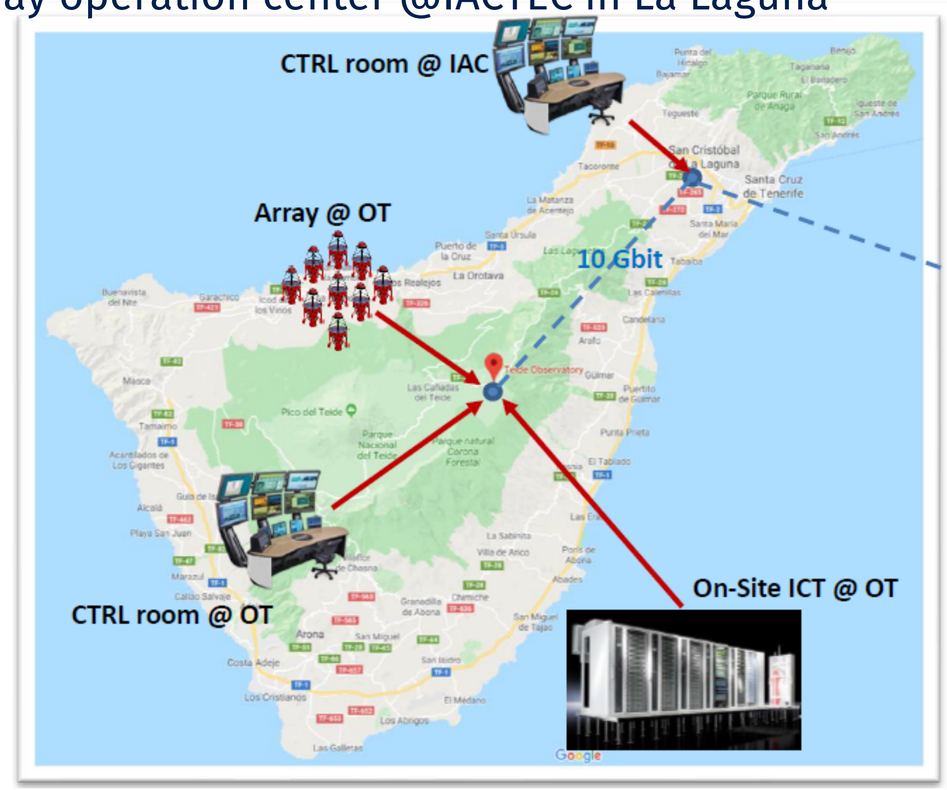
The ASTRI Mini-Array

The ASTRI Mini-Array in Tenerife

- Telescope Array & auxiliaries (Observatorio del Teide - OT)
- Local Control Room @ THEMIS building (OT)
- On site Data Centre @ IAC Teide Residencia (OT)
- Array operation center @IACTEC in La Laguna

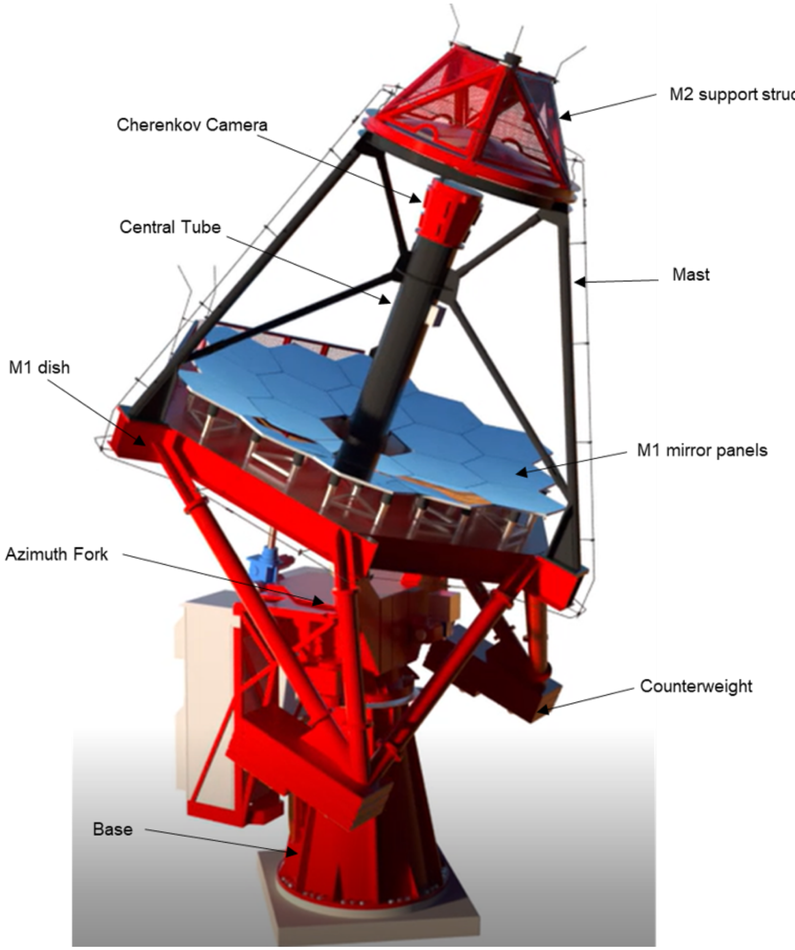
The ASTRI Mini-Array in Italy

- Data Centre in Rome
- Remote Array operation centers

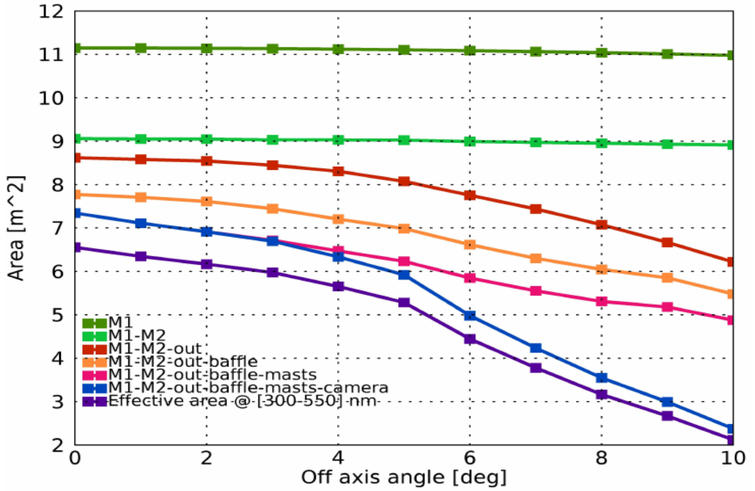


10 Gbit

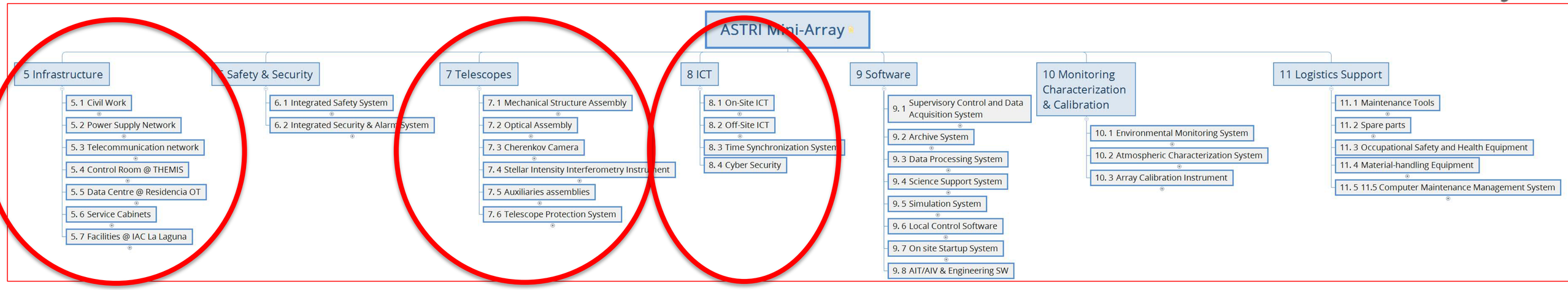
ASTRI Mini-Array telescopes in a nutshell



- **Opto-mechanics (EIE, MLT, Flabeg, ZAOT)**
  - Alt-azimuthal mount
  - Modified Schwarzschild-Couder configuration
  - Primary Mirror: 4.3 m (18 segments)
  - Secondary Mirror: 1.8 m (monolithic)
  - F-number: 0.5
  - Average effective area > 5.0 m^2
  - Optical PSF $\leq$ 0.19 deg
  - Post calibration pointing precision $\leq$ 7 arcsec
- **Cherenkov Camera (CAEN, EIE, NI, Hamamatsu, Weeroc)**
  - Front-end electronics based on CITIROC-1A ASIC
  - SiPM sensors: 7x7 mm (series LV3 – 75 μm pixel size)
  - 2368 pixels (37 matrices of 8x8 pixels)
  - Filter Window with dielectric coating
  - Angular pixel size: 0.19 deg
  - Field of View: 10.5 deg

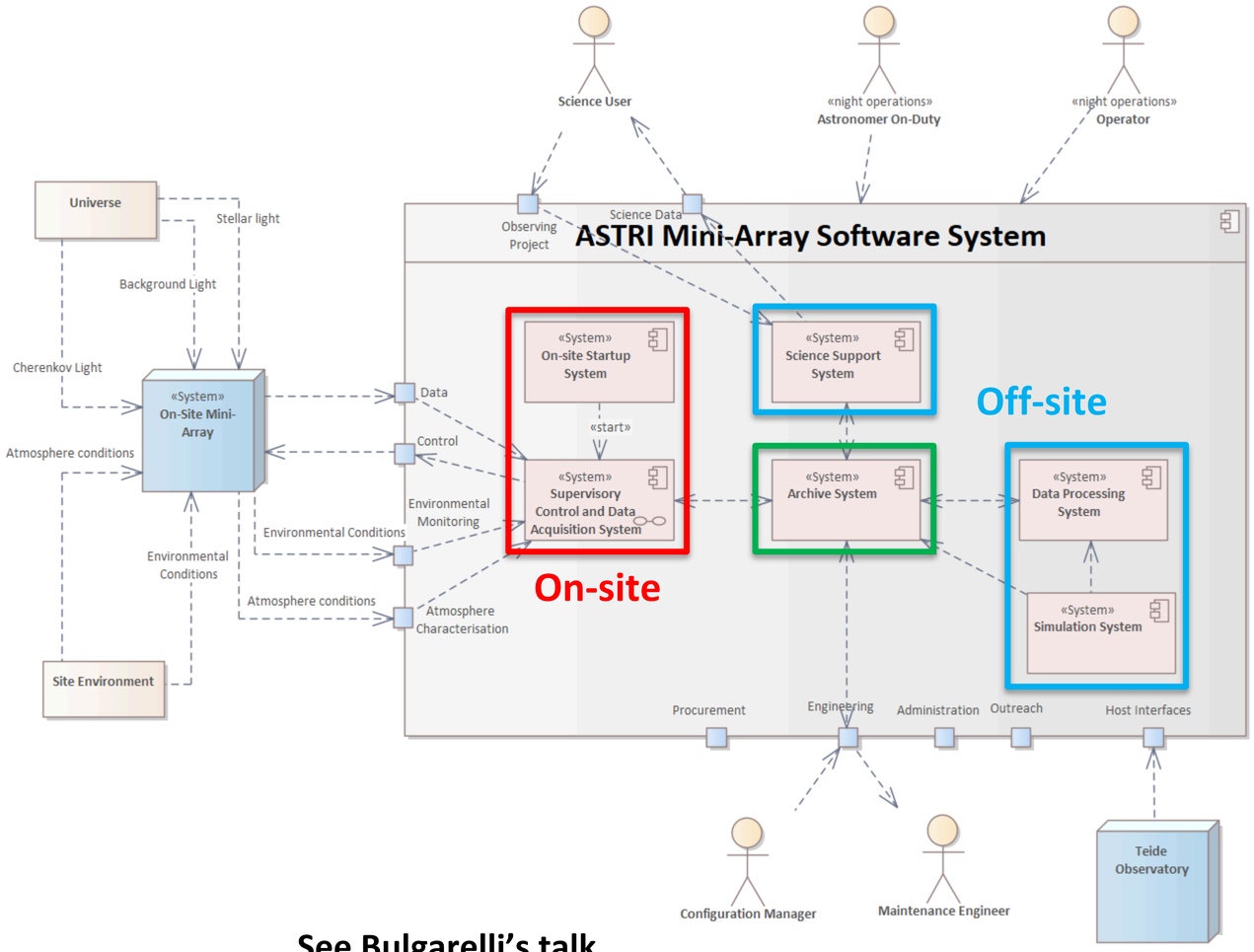


The ASTRI Mini-Array architecture: Product Tree



Infrastructure: composed by all those parts needed to make the observational site suitable to host the telescopes of the ASTRI Mini-Array.
Safety & Security: an independent system for the protection of people and site assets
Telescopes: include mainly the hardware used to collect and image Cherenkov light from air showers and the auxiliary assemblies needed to support this function.
ICT: includes all computing/storage hardware, the overall networking infrastructure (including cabling and switches) and all system services (operating system, networking services, name services, etc.) necessary on site and off site to control and monitor the array and to archive and analyse the scientific and engineering data.
Software: The Mini-Array software will provide to the user a set of tools from the preparation of an observing proposal to the execution of the observations, the analysis of the acquired data online and the retrieval of all the data products from the archive.
Monitoring, Characterization and Calibration: the set of devices that allows the environmental monitoring the atmospheric characterization and the array calibration.
Logistics Support: includes all the hardware & software necessary for the preventive and corrective maintenance of the ASTRI Mini-Array.

Software architecture: context diagram

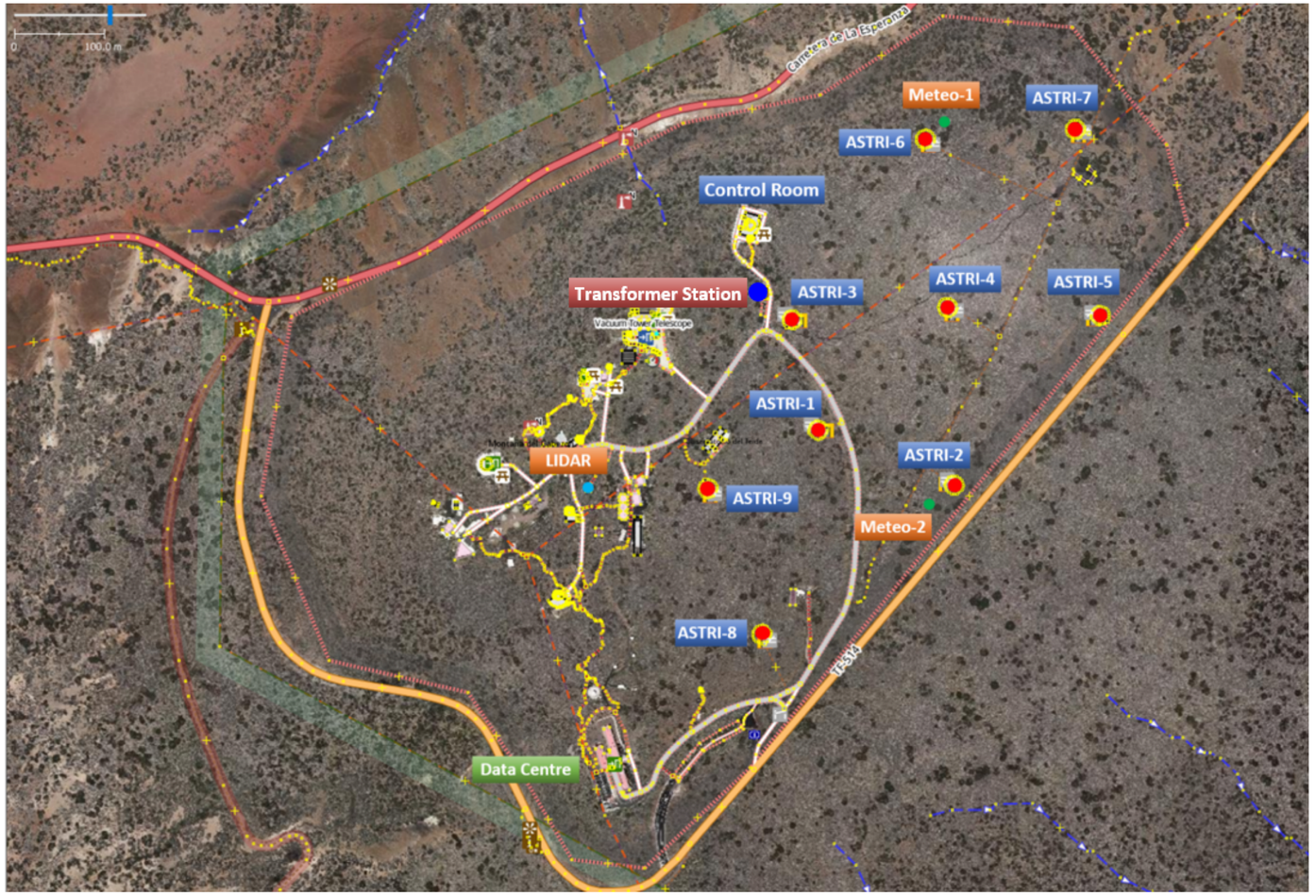


See Bulgarelli's talk

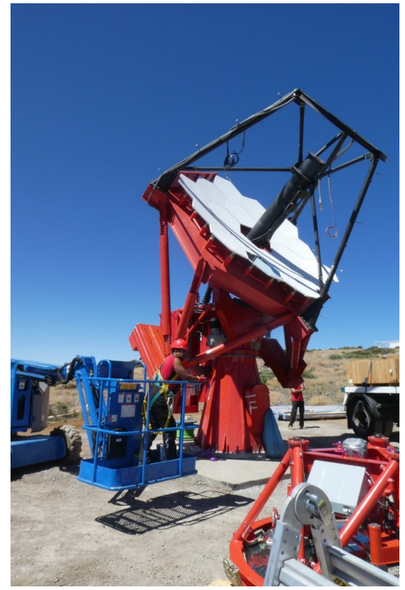
- ***Startup System.*** The software to manage the sequence of the startup and shutdown of the critical on-site systems that have to be available before the start of the Mini-Array.
- ***Supervisory Control And Data Acquisition (SCADA) System.*** The software system devoted to control all the operations carried out at the Mini-Array site, including the startup of the Mini-Array system. SCADA is a central control system which interfaces and communicate with all equipment and dedicated software installed On-Site.
- ***Archive System.*** The software service that provides storage and organization for all data, data products, and metadata generated for and by the Mini-Array, and defined by the Mini-Array Data Models.
- ***Data Processing System.*** The software system used to calibrate and reduce the data acquired. This software is also used to check the quality of the final data products.
- ***Science Support System.*** The software system which provides the main point of access for the exchange of science-related data and information with the ASTRI Science Users, and which supports the whole science-related workflow, from the Observing Project submission to the access to the archived high-level Mini-Array science data products and the corresponding Science Tools to support data analysis.
- ***Simulations System.*** The software system that runs Monte Carlo simulations to provide simulated data for the development of reconstruction algorithms and for the characterization of real observations.

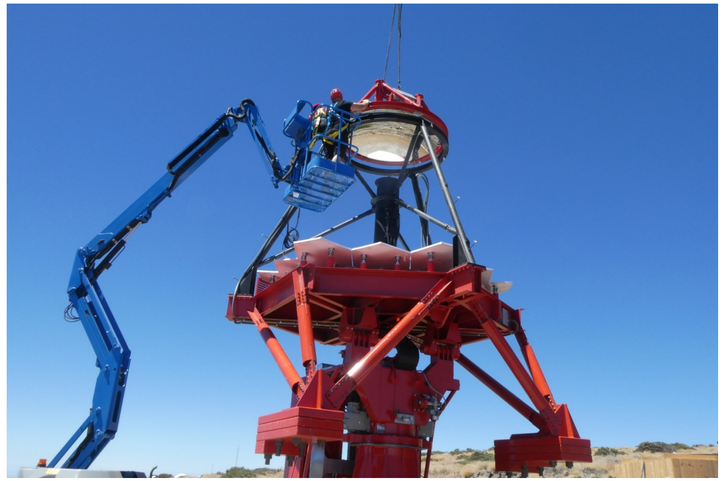
The Teide Infrastructure

- Civil Work (including foundations for telescope and auxiliaries, roads, trenches)
- Power supply network (including transformer station, UPS and emergency power generator)
- Telecommunication network
- Control room @ Themis observatory
- Onsite Data Centre @ Teide Residencia
- Service cabinets



ASTRI-1 on site integration

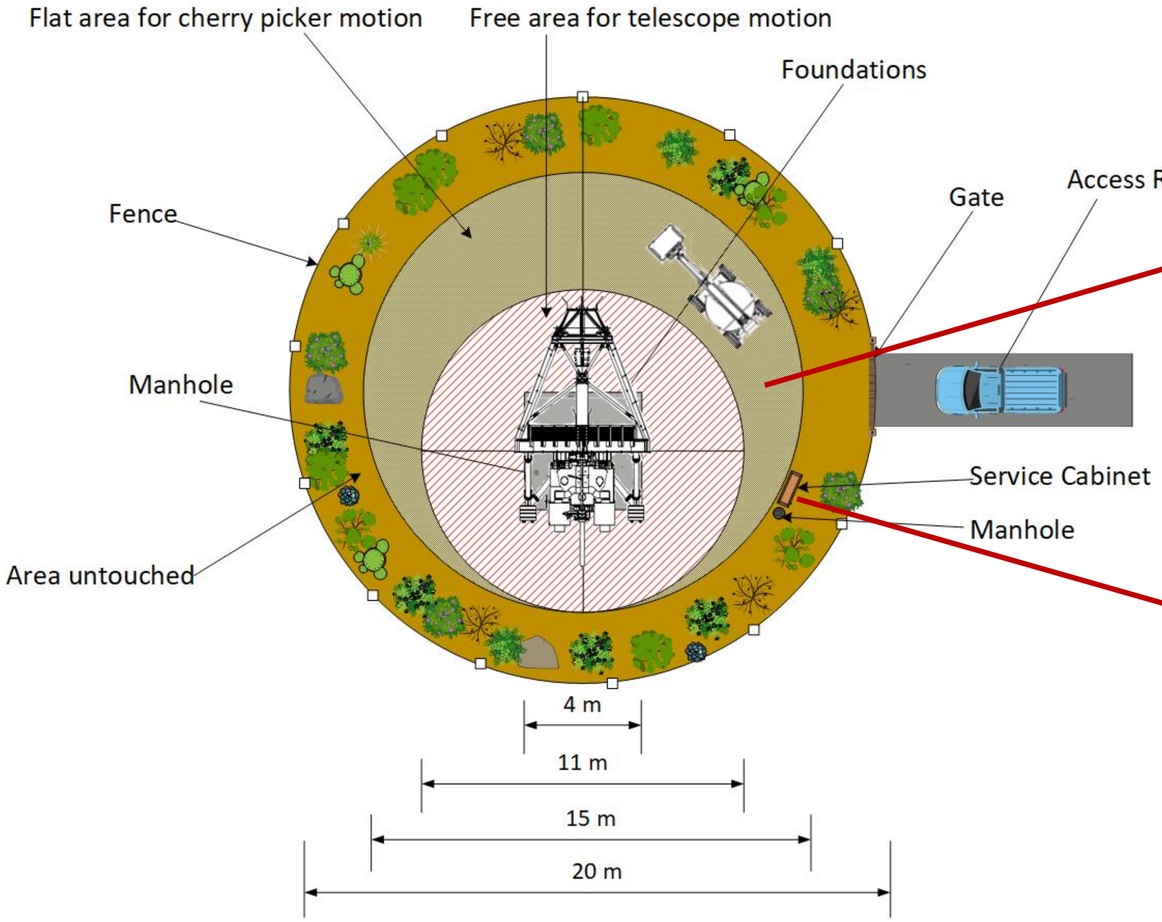




Telescope integration takes 2-3 weeks (working days) including:

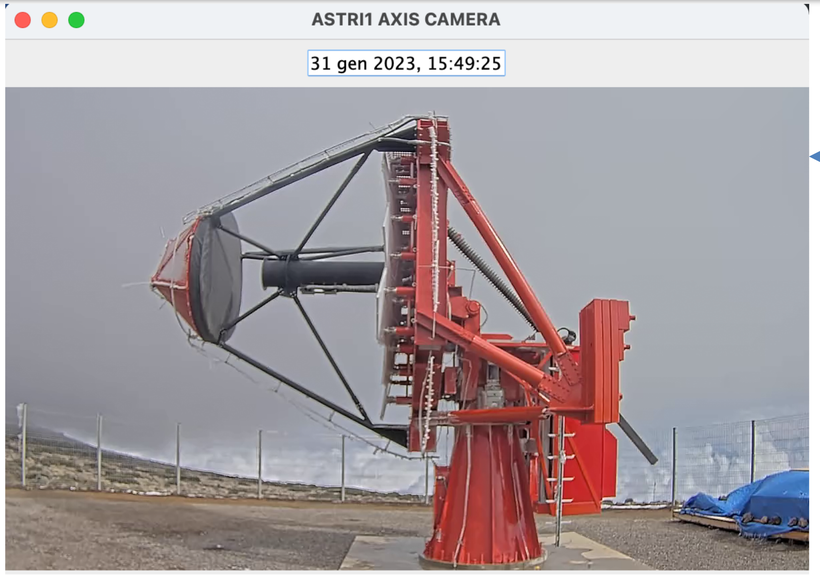
- Base grouting 2-3 days
- M1 panels integration 2 days
- M2 mirror integration 2 days

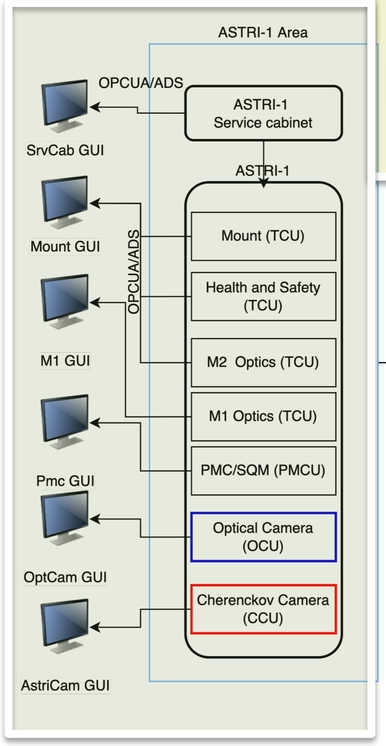
Infrastructure: Telescope's area



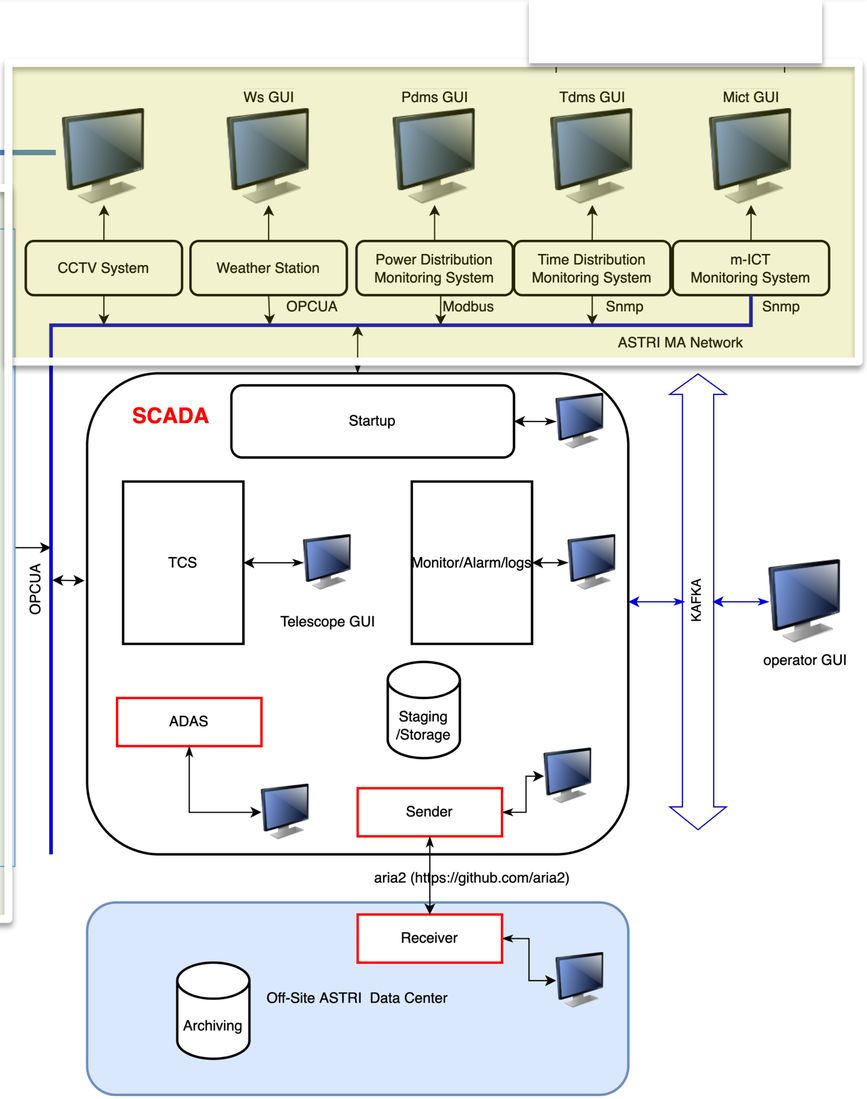
Service cabinet

The MA AIV and Starter SW

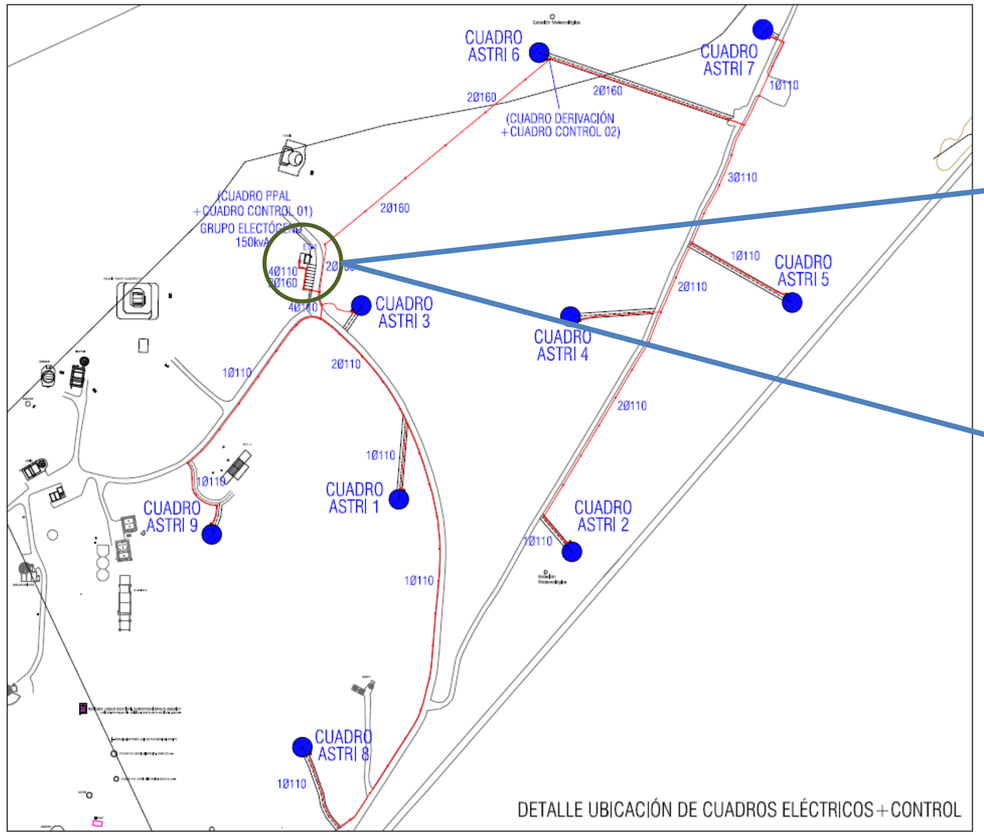


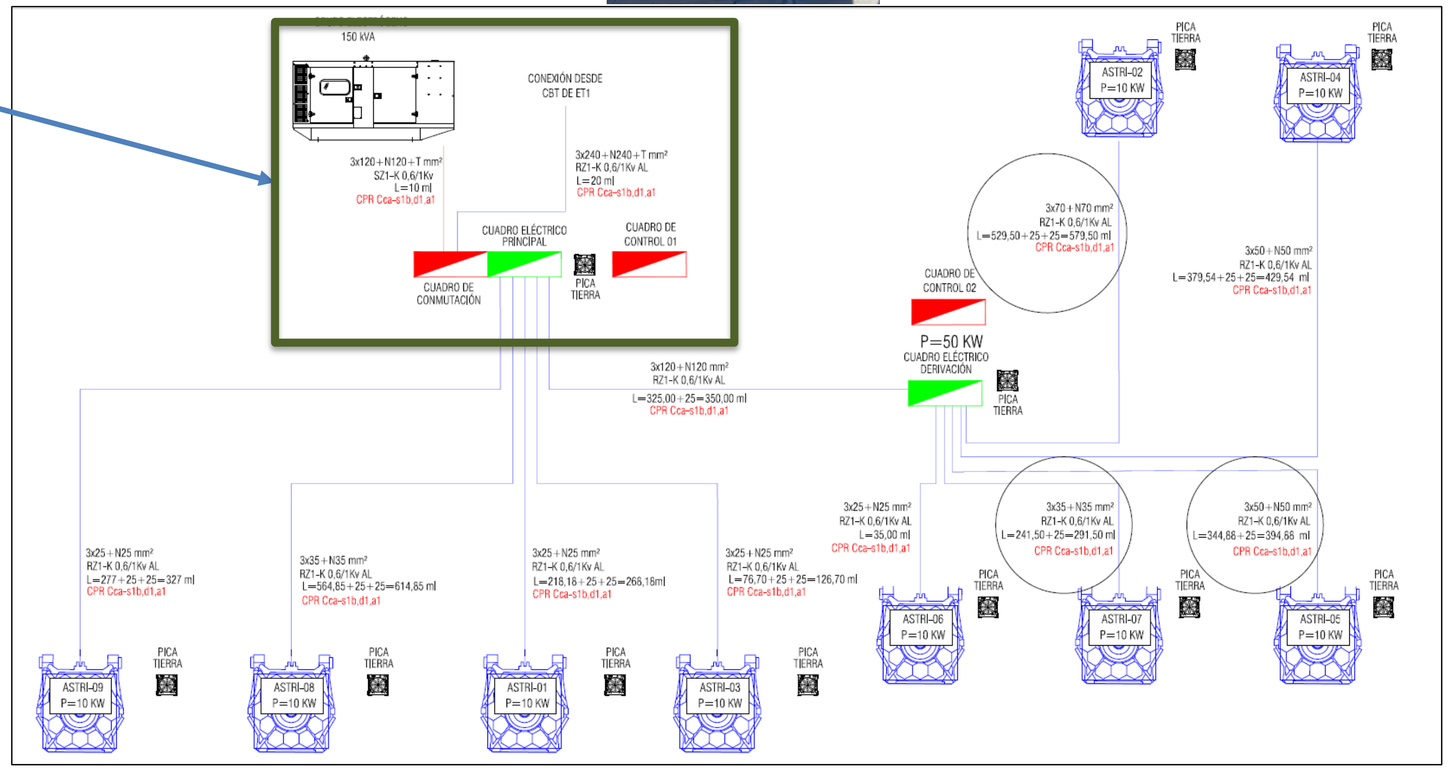


AIV Sw

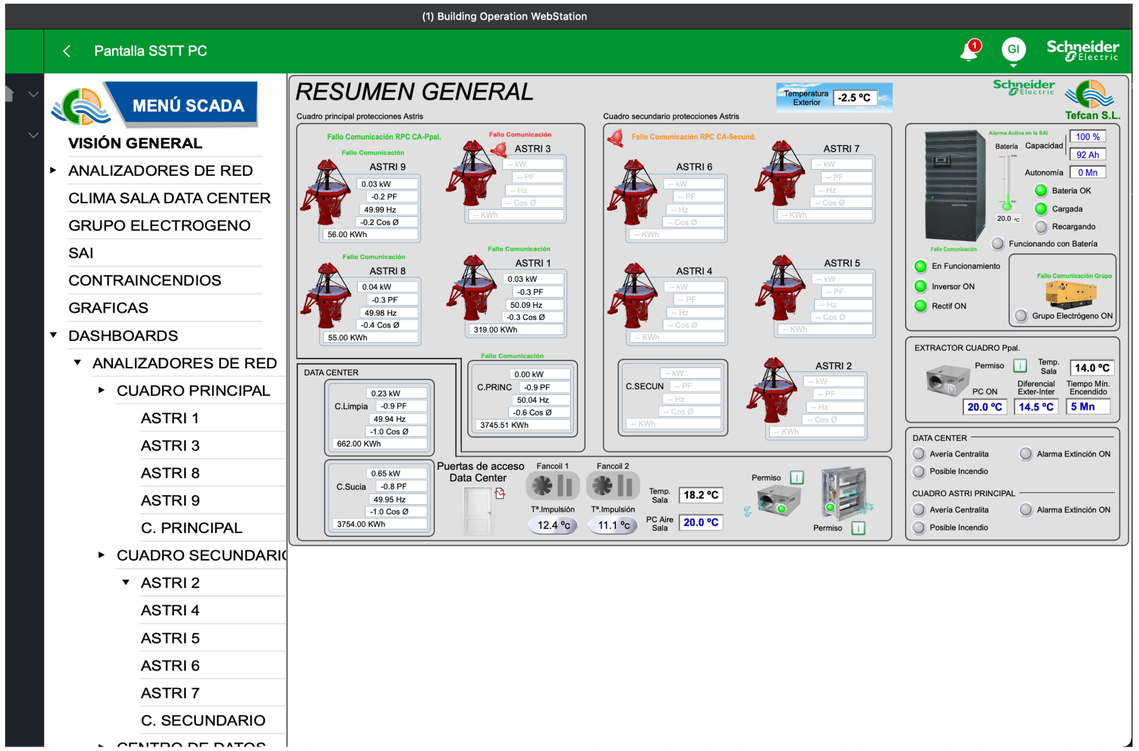


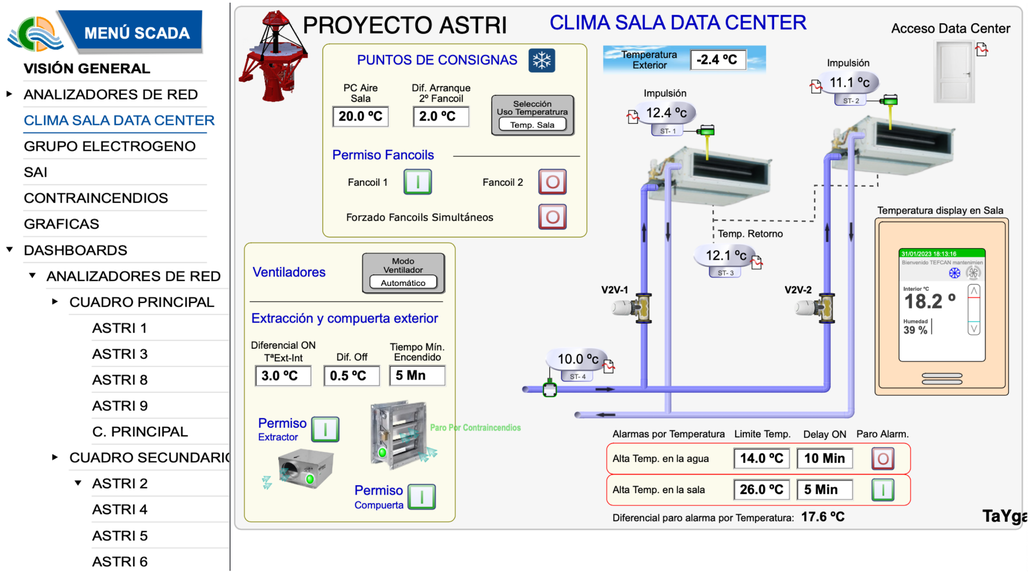
Infrastructure: Power network





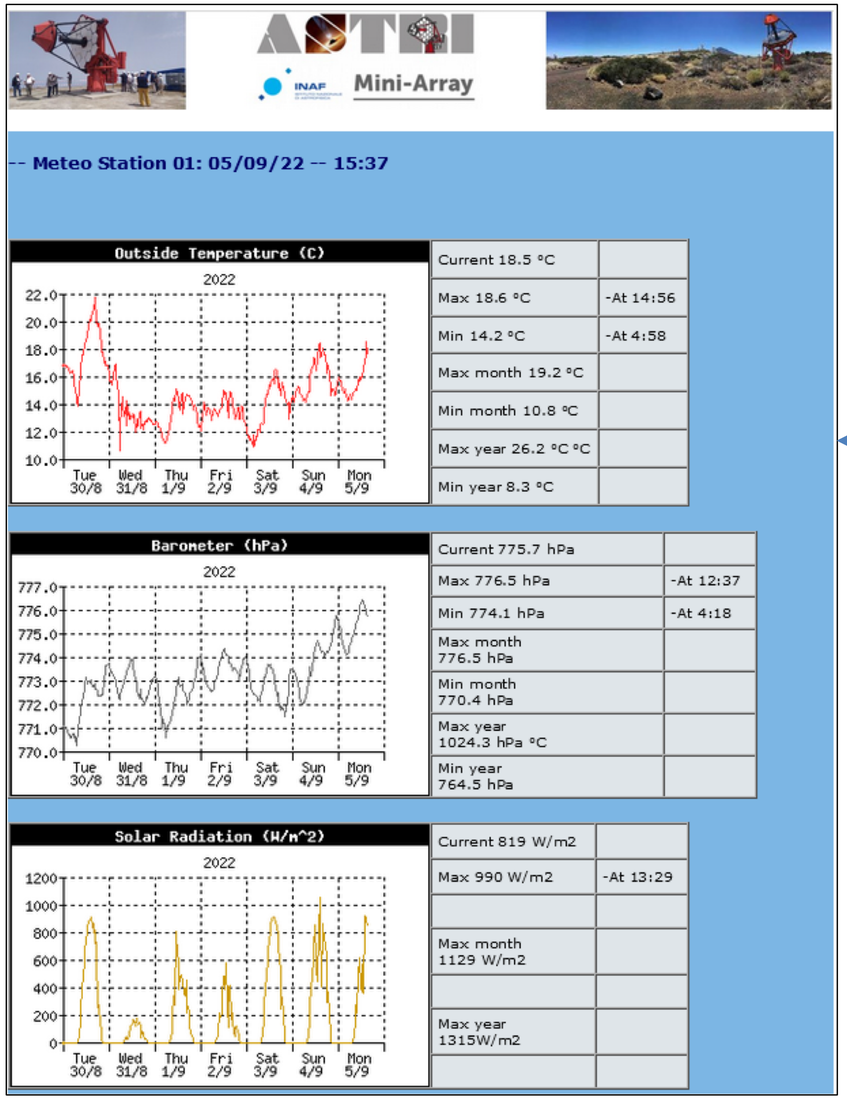
Power Monitoring





A commercial product by Schneider Electric was used

Weather Station

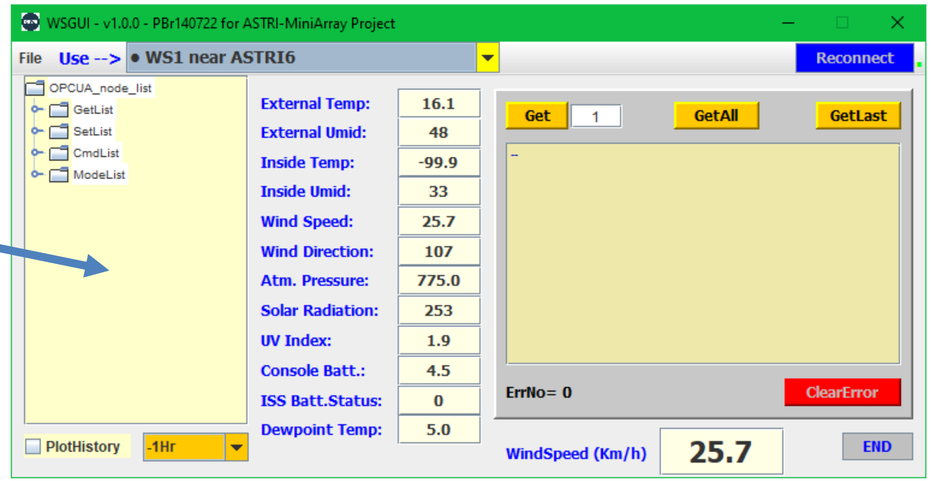


Weather Station 1 installed in July close to ASTRI-6

Weather Station 2 installed last week close to ASTRI-2

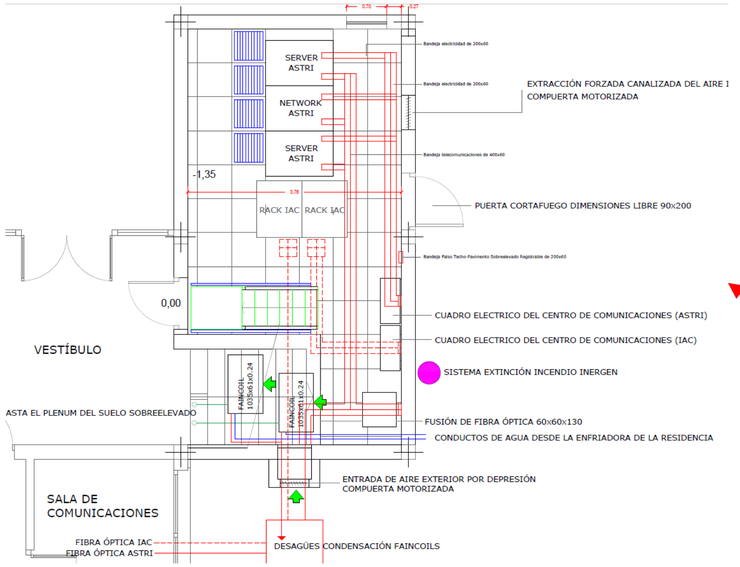
Example of WEB based GUI

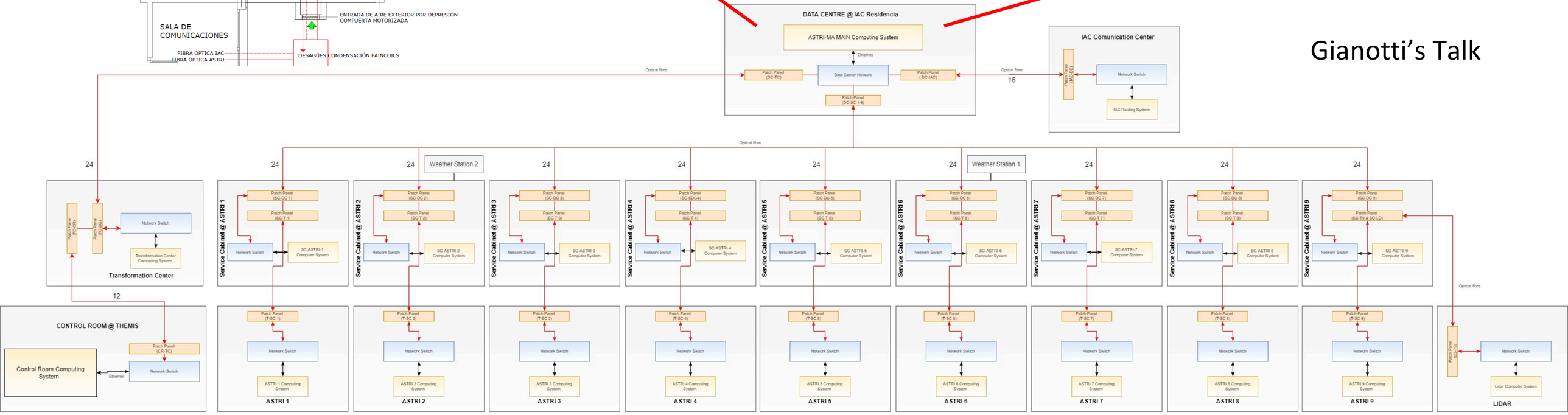
Engineering GUI



Infrastructure: Telecommunication network

Mini-Array



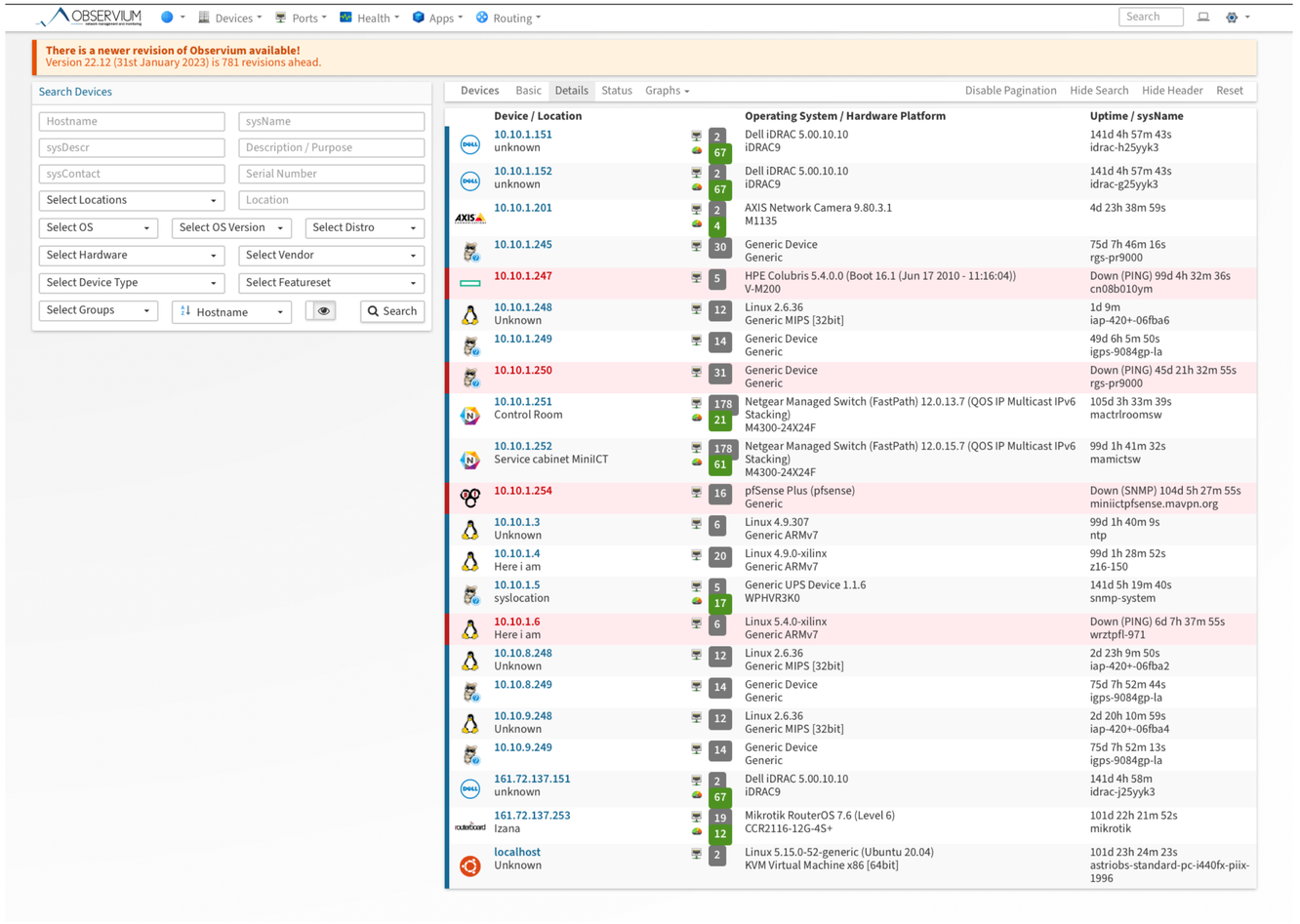


Gianotti's Talk

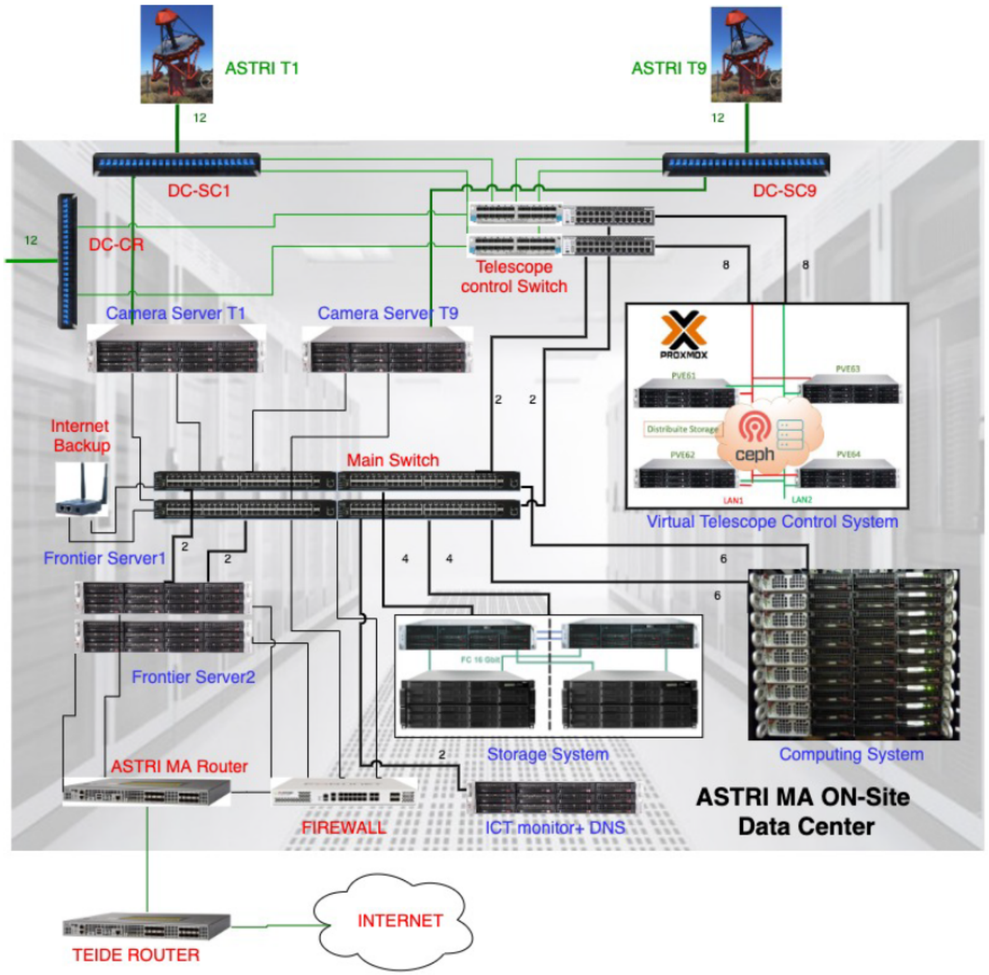
ICT Monitoring

Mini-Array

An open source software is used: Observium



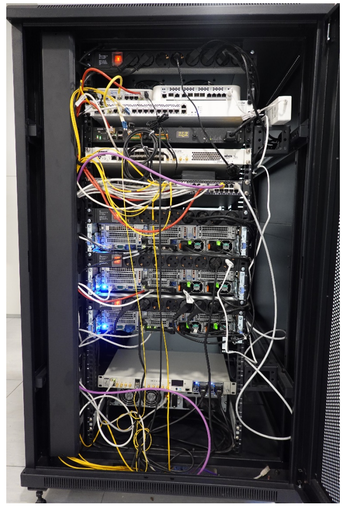
ICT – On site Data centre

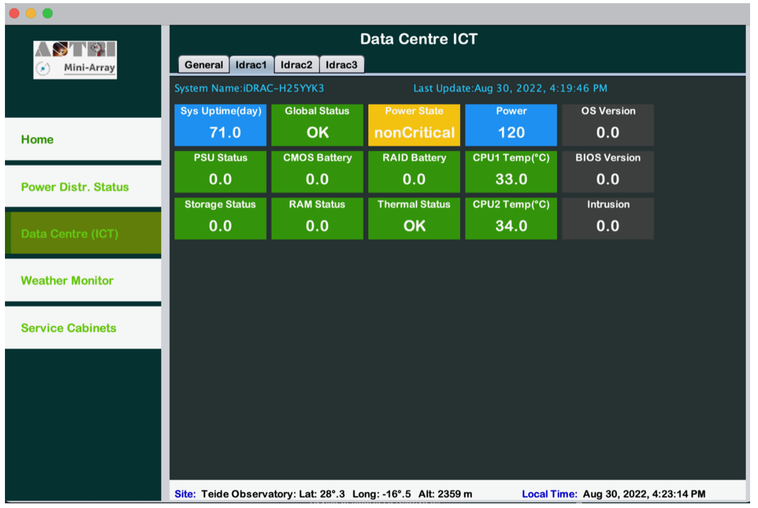


- ***Virtual Telescope Control System***: the system hosting the virtual machines that will be used for the telescopes control.
- ***Camera Servers***: are the physical servers, one for each telescope, for the Cherenkov camera and stellar intensity interferometry data acquisition.
- ***Computing System***: is the set of physical servers dedicated to the on-line analysis of scientific data for quality check and of monitoring data for the alarm management.
- ***Storage System***: is the collection point of the raw scientific data, of the monitoring and of the alarm data. It also the location from where all these data are accessible for remote transfer and for all on-site uses.
- ***Network System***: is the set of devices responsible for internal and external network connections.

m-ICT

Reduced version of the onsite ICT to run single telescopes installed in the data centre in July



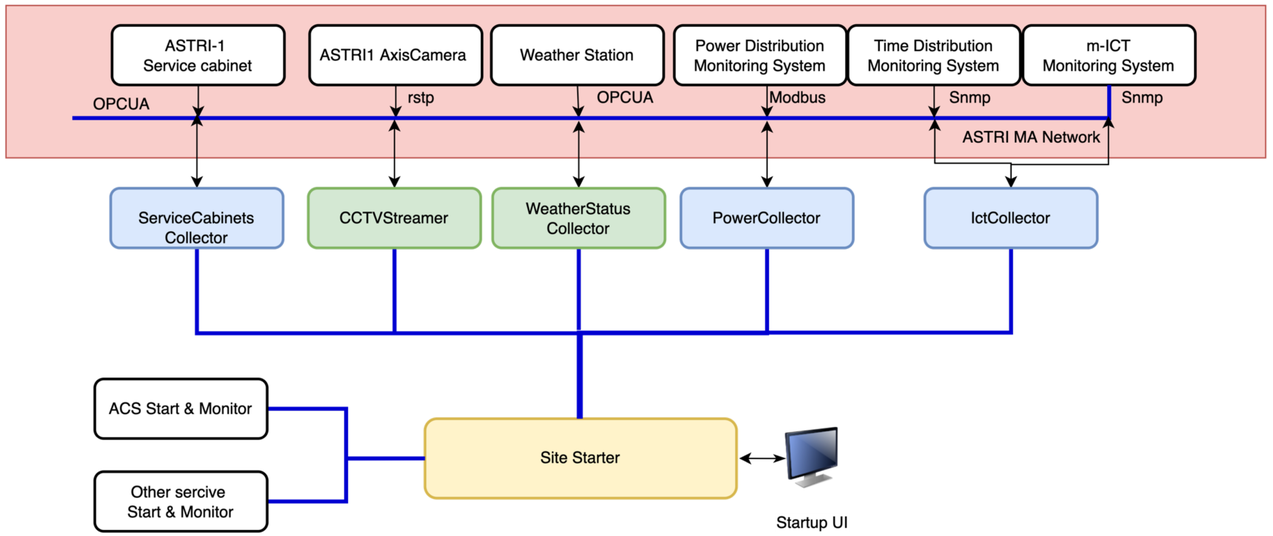


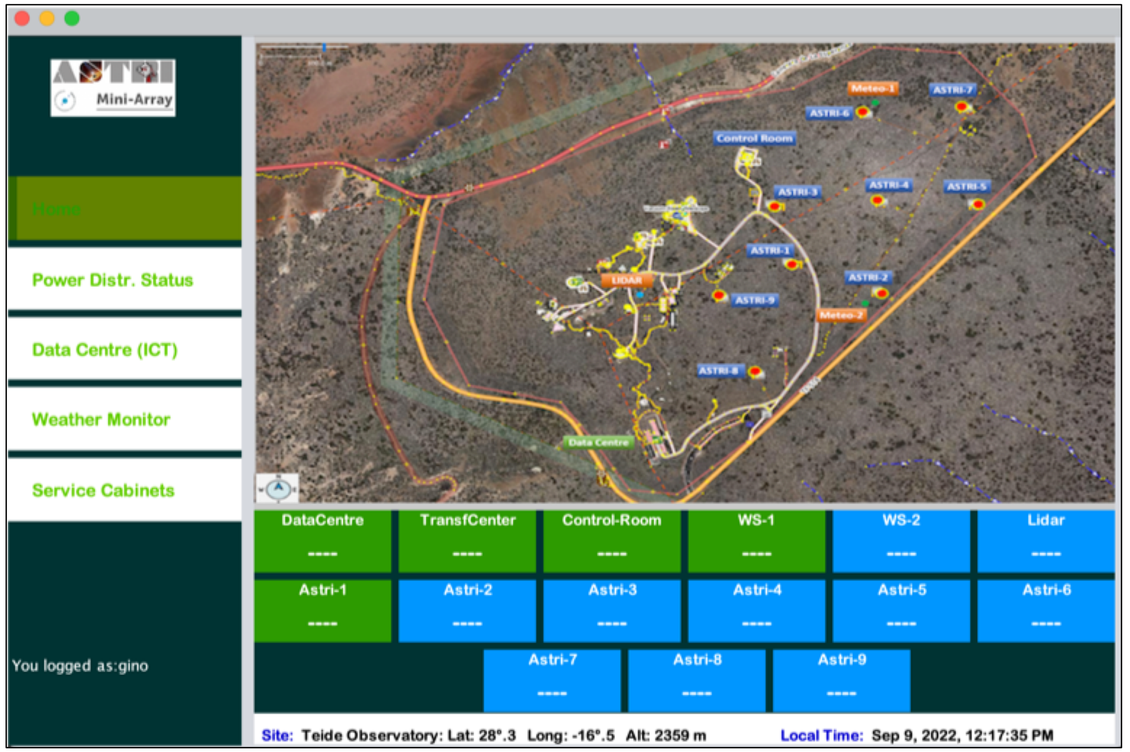
Gianotti's Talk

Startup Software

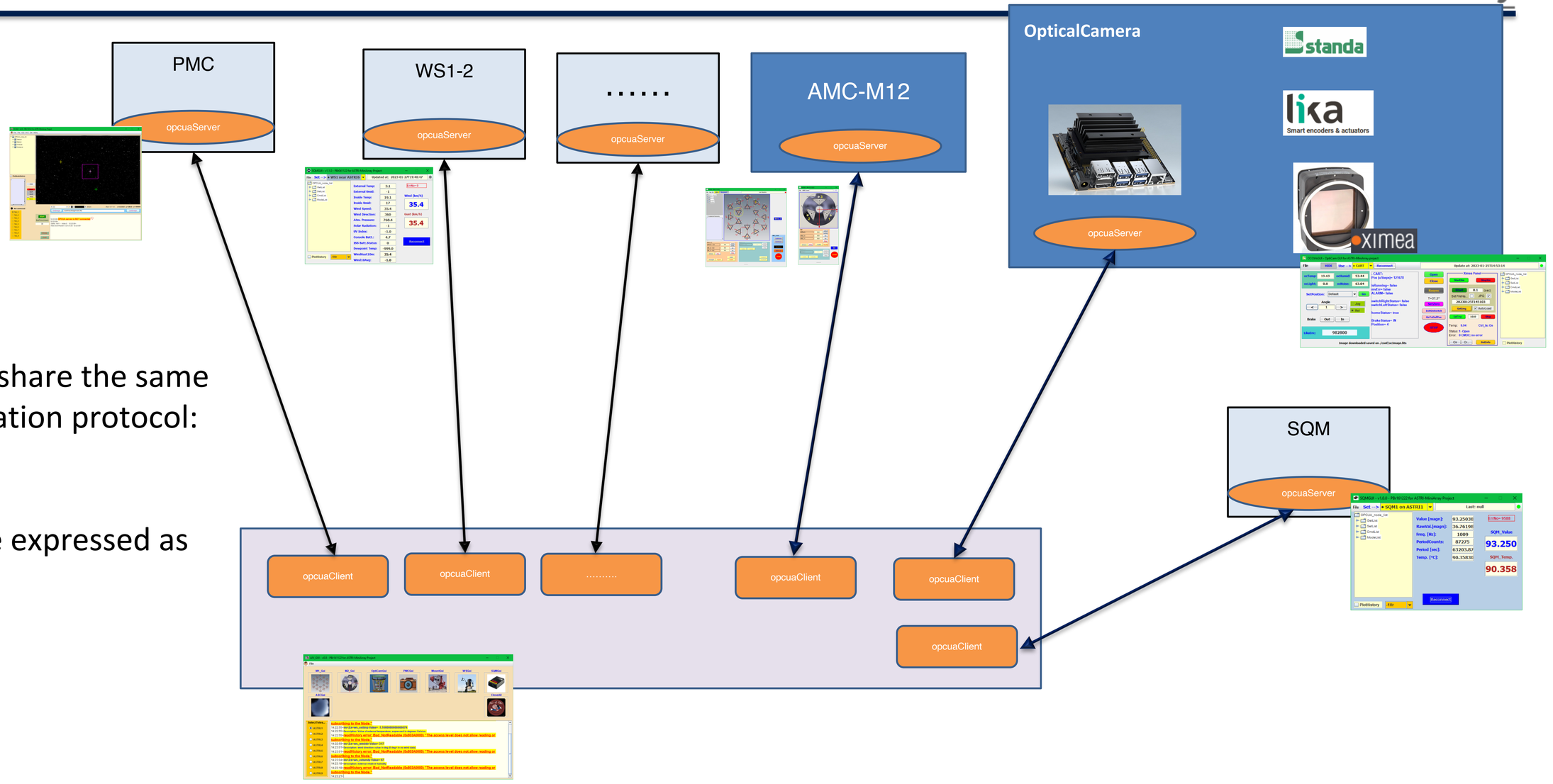
Software development mainly by INAF

Startup system





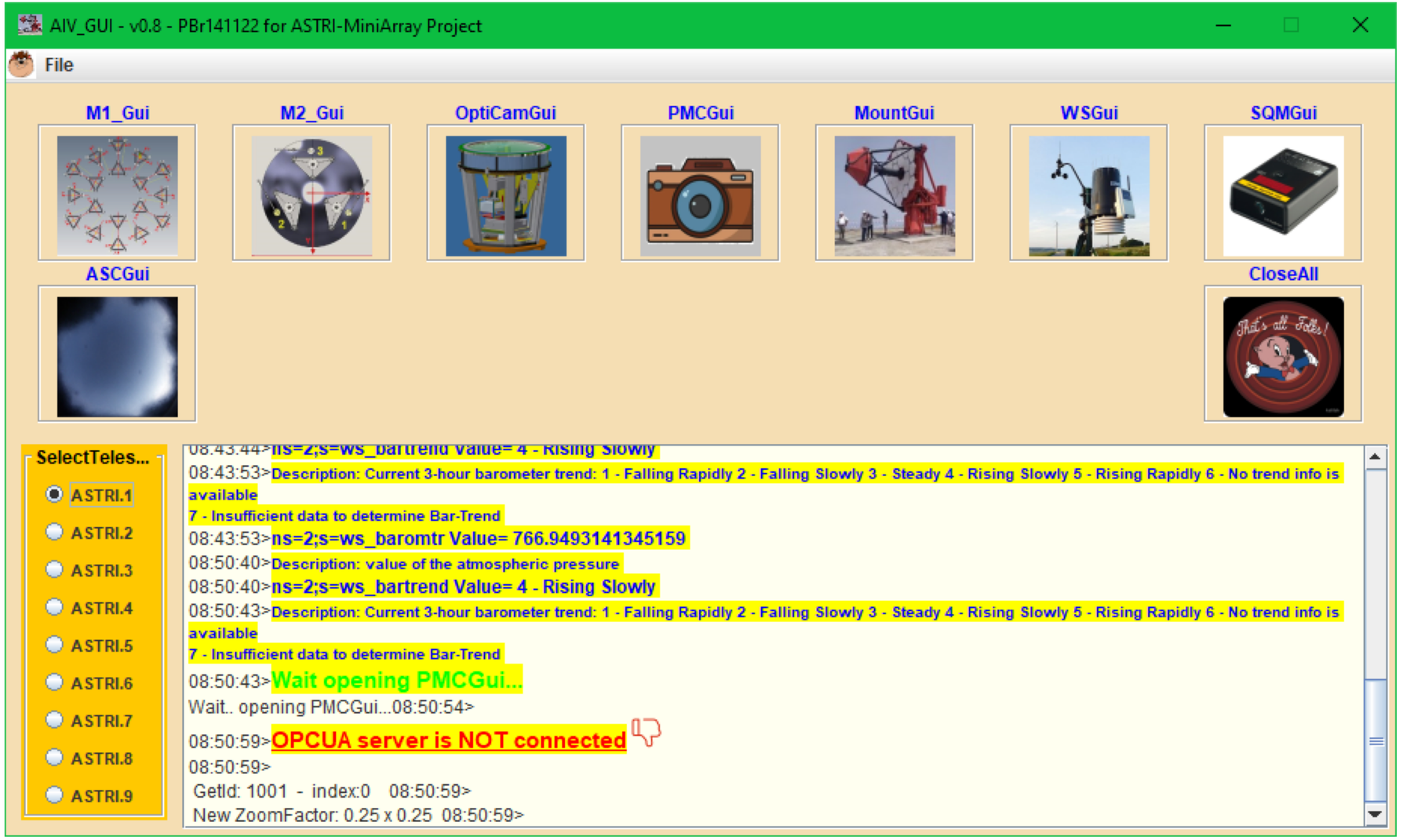
The Telescope AIV SW for Auxiliary devices



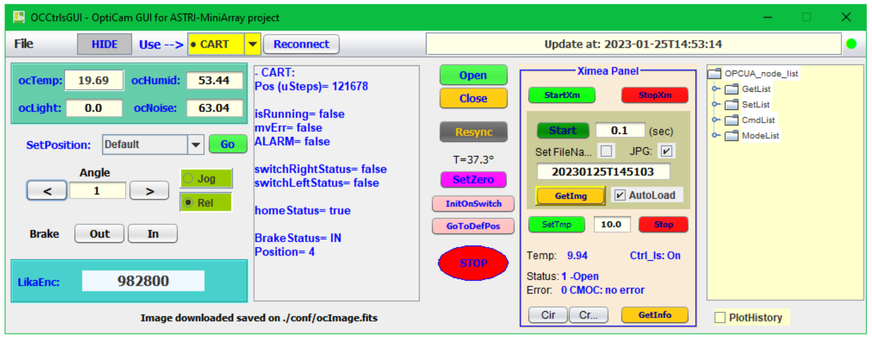
All devices share the same Communication protocol: OPC-UA

The ICD are expressed as Excel files.

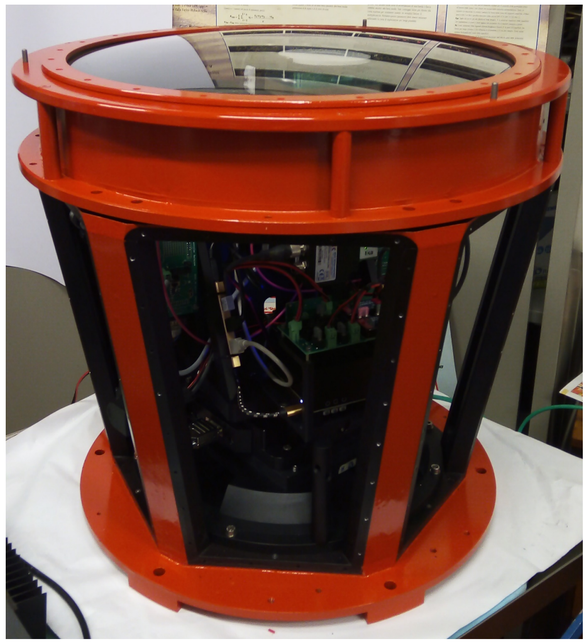
AIV SW for Mirrors Alignment and T-Point

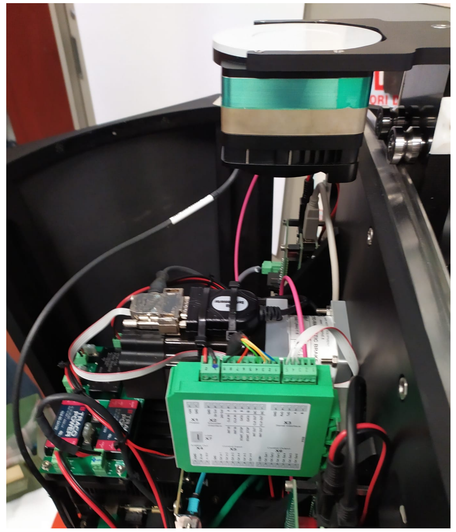


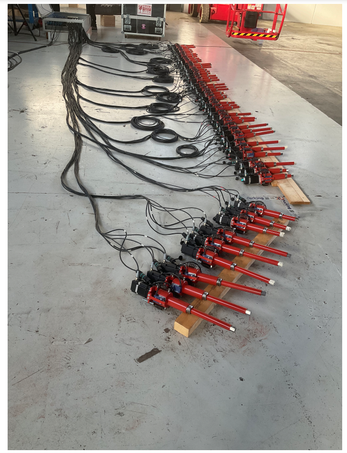
Some specific panels



Optical Camera (IASF-MI, OAPD, OACT, OA Brera)
CCD camera (Ximea sCMOS, 37.7 Mpx) placed on the telescope focal plane to align the panels of M1.

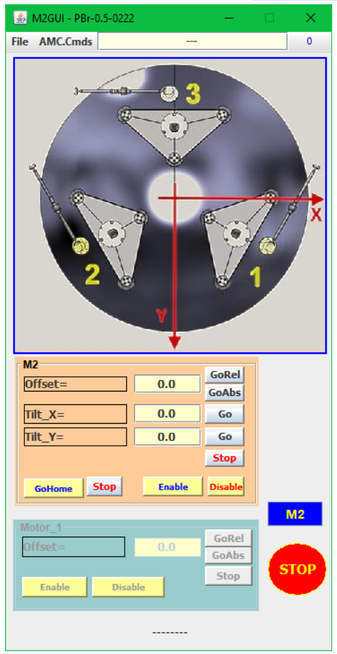


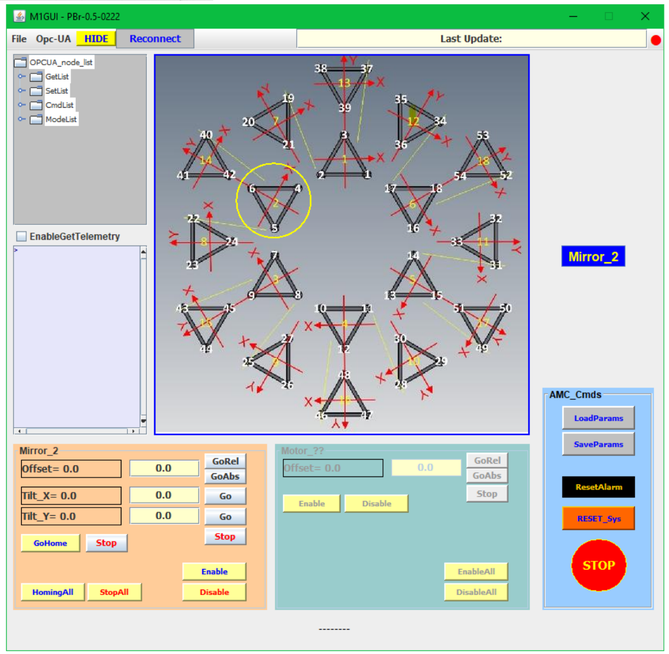




M1 (54 actuators, 3 for each of the 18 M1 mirror sgments)

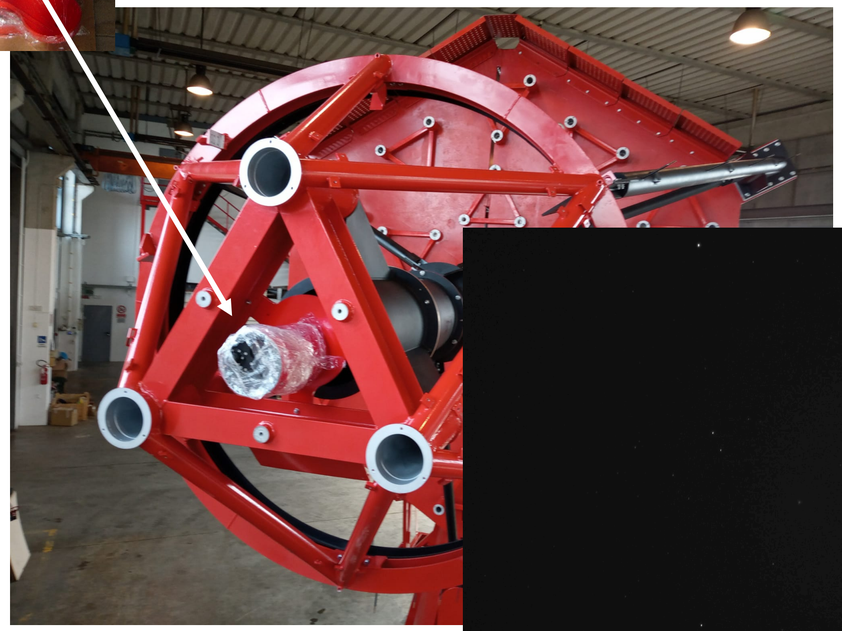
M2 (3 actuators)

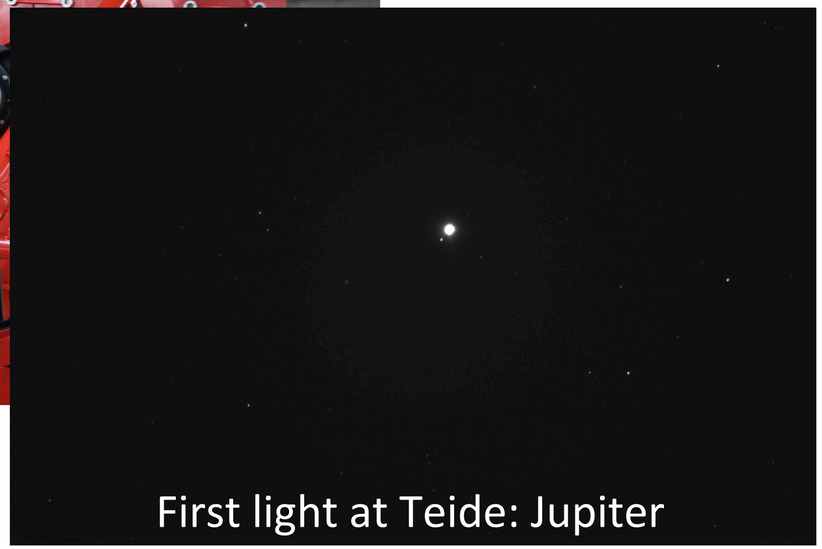


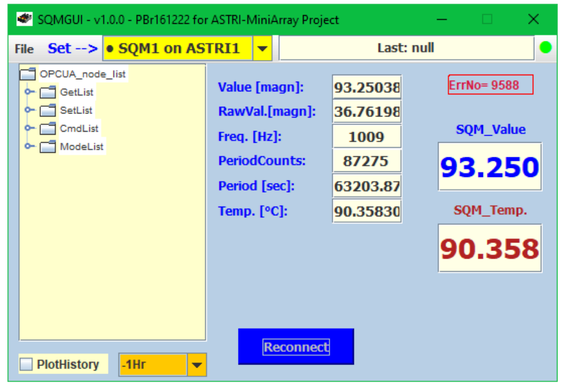


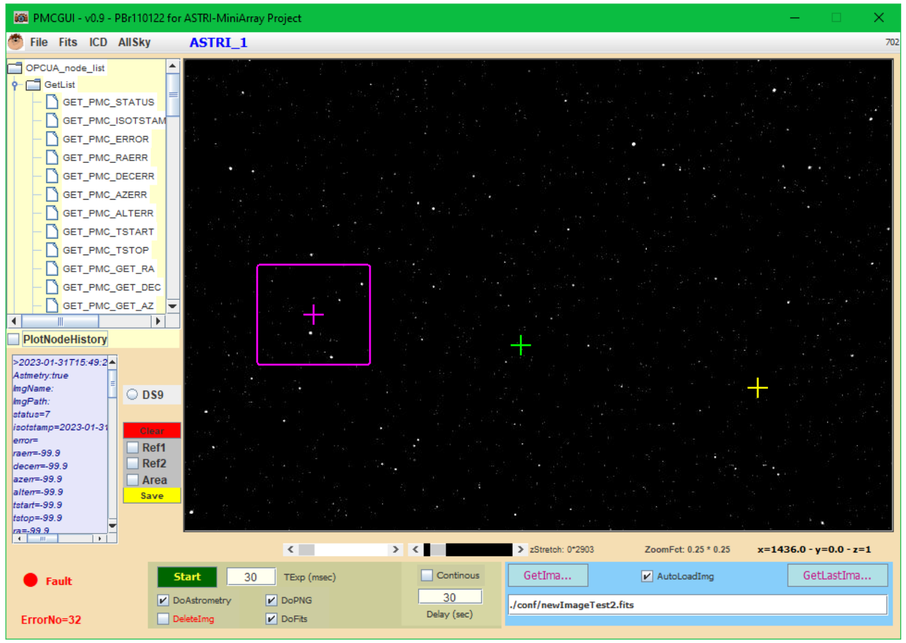
Some specific panels

Pointing Monitoring Cameras (Uni-PG)
CCD camera placed on the M2 support structure used to monitor pointing and tracking performances of the telescope

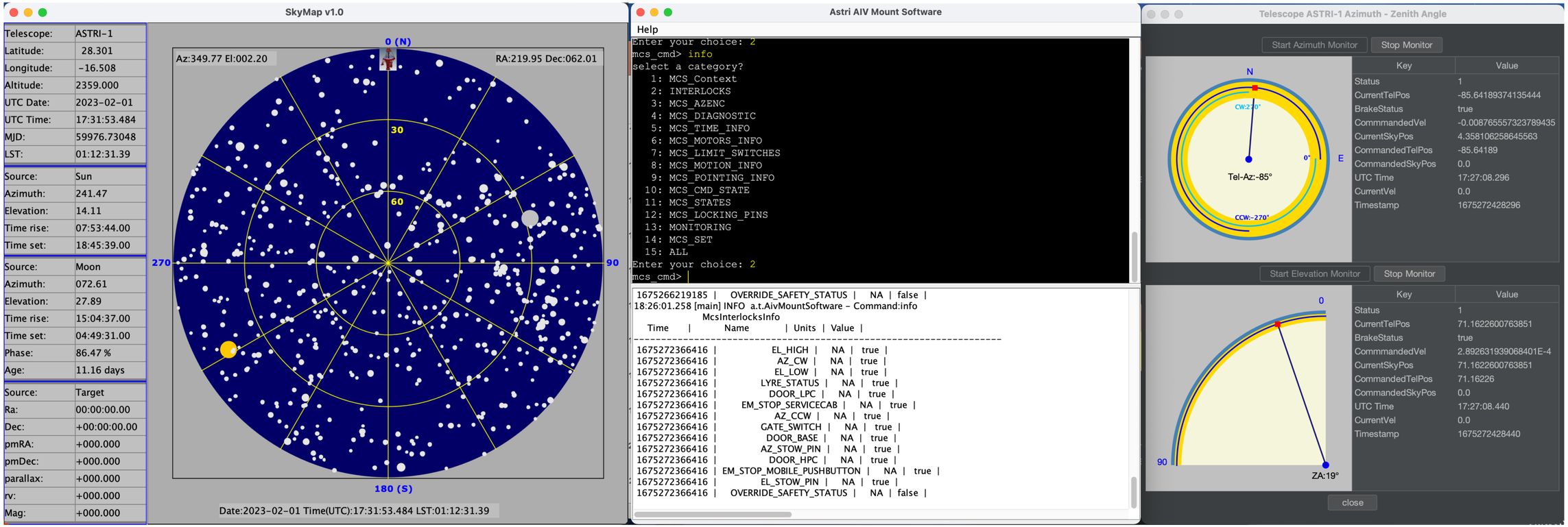






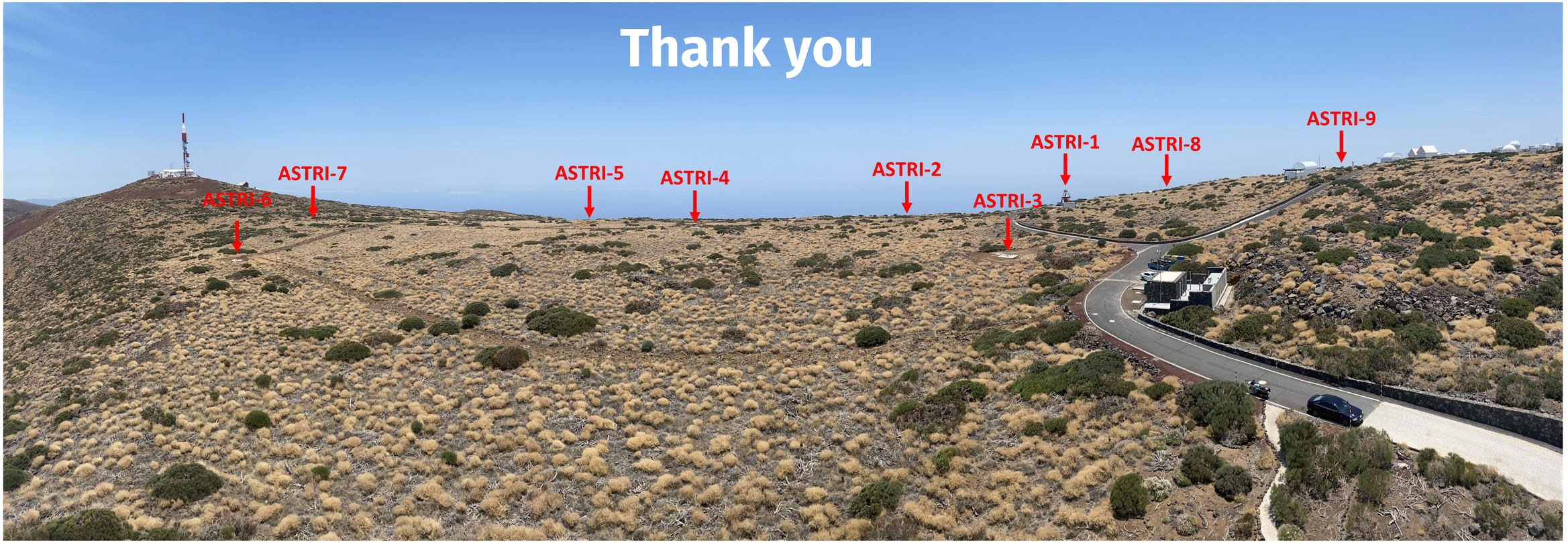


Mount Control System AIV SW



Some Panels of the Mount AIV Software

ASTRI Mini-Array



View from Themis Telescope