INAF inside the ASTRI/CTA ICT

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This work was conducted in the context of the CTA ASTRI Project

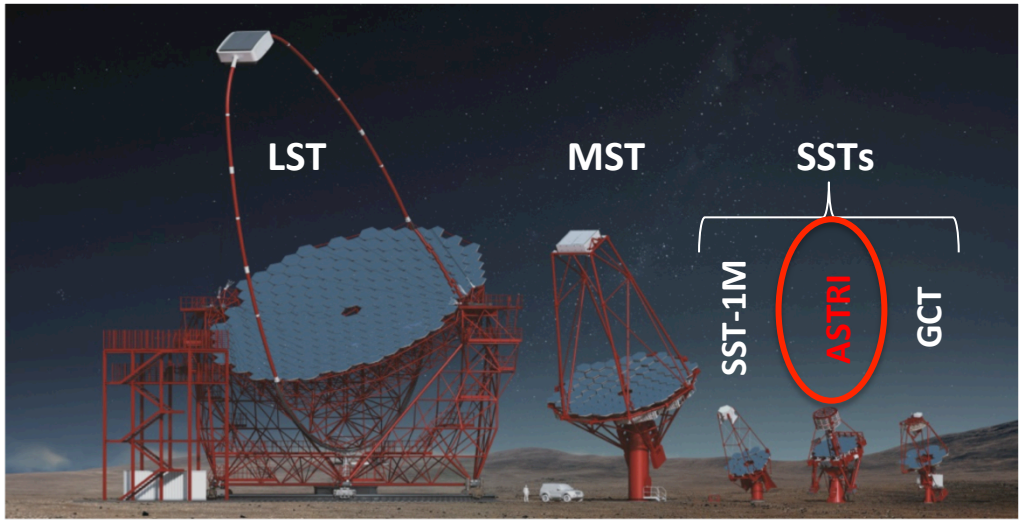
OUTLINE:

- CTA Introduction
- ASTRI End-To-End Prototype
- ASTRI SW
  - UPC-UA Interface
  - Telescope Control Software
  - Camera Control Software
  - Camera Server DAQ Software
  - ASTRI ASciSoft Software and data Archiving
- ASTRI On-Site ICT Infrastructure
- ASTRI/CTA Monitoring System
- ASTRI Off-Site ICT
- ASTRI Mini-Array ICT Infrastructure Design

CTA, the Cherenkov Telescope Array

The CTA Observatory:

- **two arrays**, one in **N**orthern one in **S**outhern hemisphere, (**N**, La Palma, Spain; **S**, Paranal, Chile) to provide all-sky coverage;



- **three classes of IACT telescopes**, Large, Medium and Small Size to cover the very-high-energy gamma-ray range from 20 GeV up to 300 TeV.

	Large Size, LST	Medium Size, MST	Small Size, SST
# of telescopes	N(4), S(4)	N(15), S(25)	N(--), S(70)
Energy range [TeV]	0.02 - 1	0.1 - 10	3 - 300
Field of View [deg]	4.5	8	> 9
Dish diameter [m]	23	12	4

ASTRI

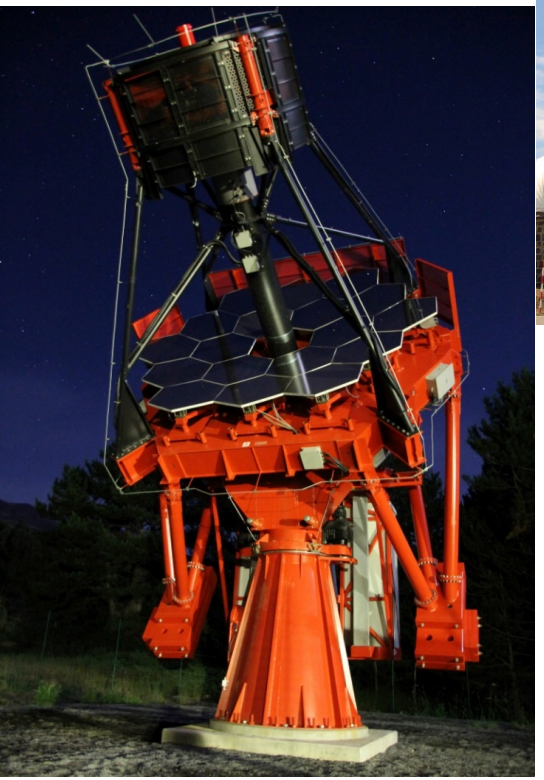
ASTRI SST-2M telescope prototype

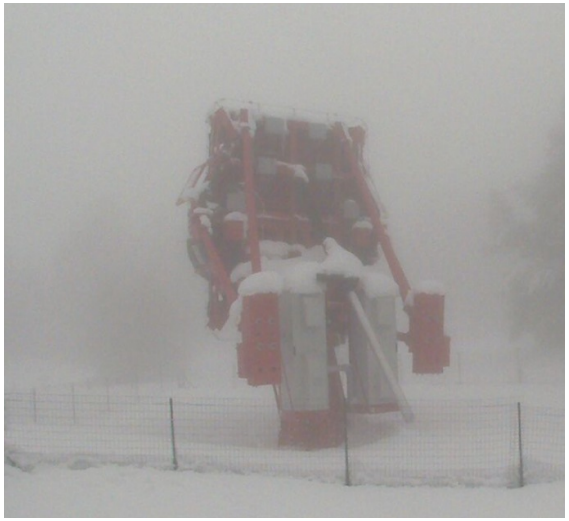
ASTRI SST-2M, designed to comply with all CTA-SST requirements, is an 'end-to-end' telescope prototype: it comprises all of the work that should be done to achieve the final scientific products

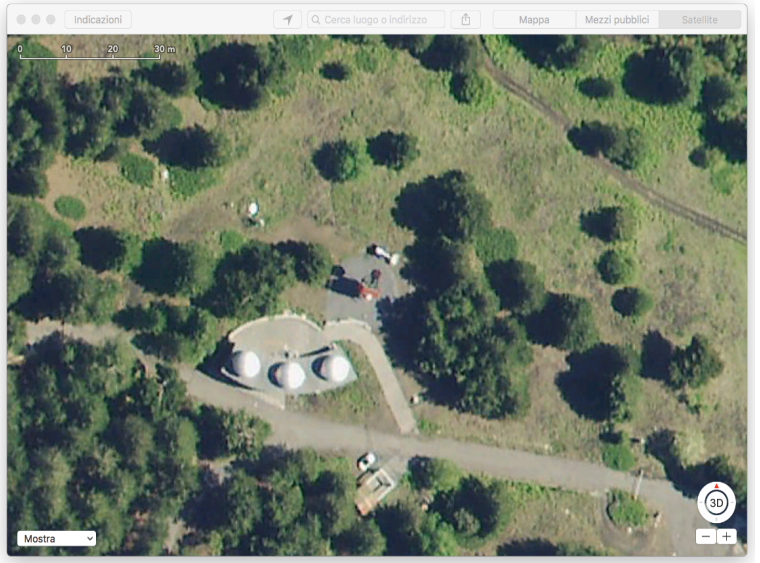
- Telescope
  - Structure
  - Mirrors geometry and coating
- Camera
  - Photosensors and electronics
  - Thermal system
  - Ancillary devices
  - Camera Control
  - Data acquisition
- Calibration
  - Camera calibration
  - External equipment for pointing and calibration
- Control system
  - Tracking and pointing
  - Monitoring and alarm
- Data reduction and analysis
  - Pipelines
  - Data archiving
- ICT Infrastructure
  - Complete and stand alone Computing Center

ASTRI Prototype: The telescope @ Serra La Nave

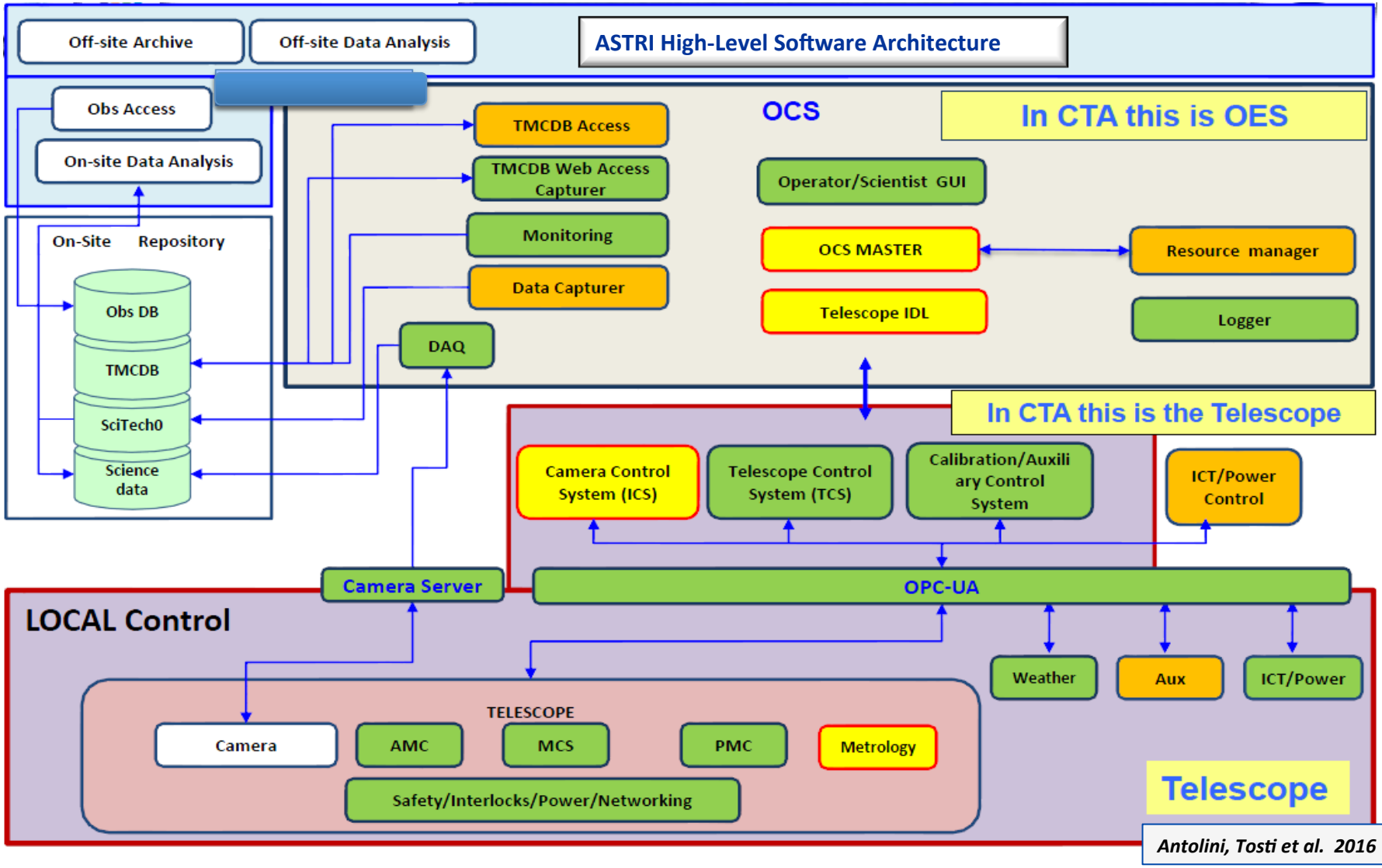
The prototype is placed at 1735 meters on the Etna volcano @ INAF-OACT Catania mountain station in Serra La Nave







ASTRI SST-2M SW architecture

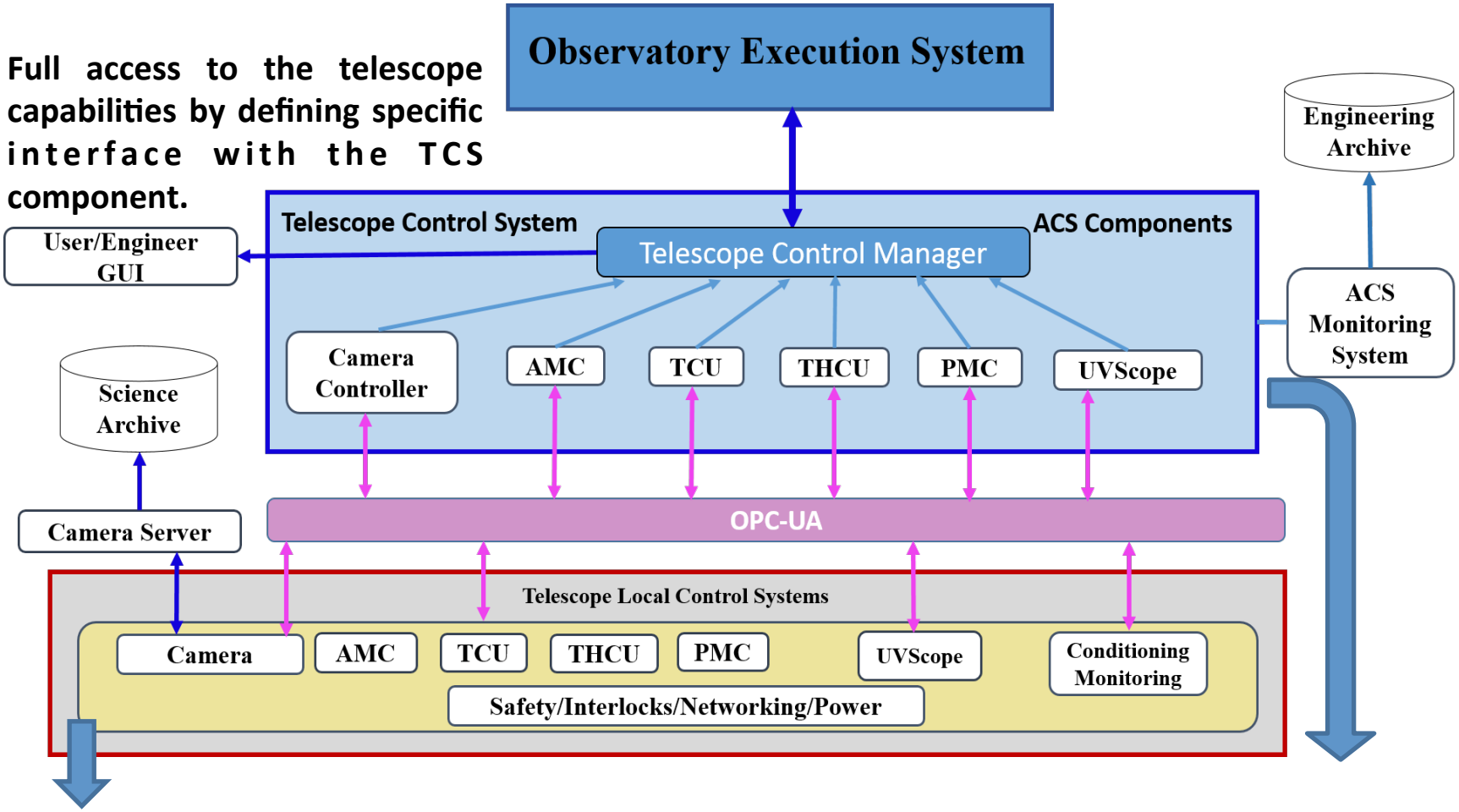


Antolini, Tosti et al. 2016

All components have been developed in view of the ASTRI telescopes for the CTA array configuration in which they will be easy to be integrated .

Telescope Control General Architecture

Full access to the telescope capabilities by defining specific interface with the TCS component.

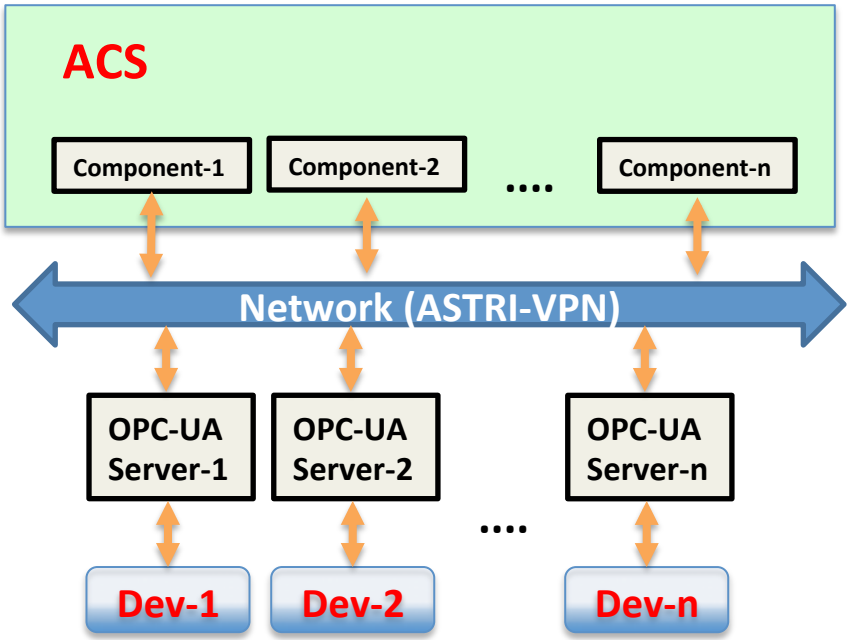


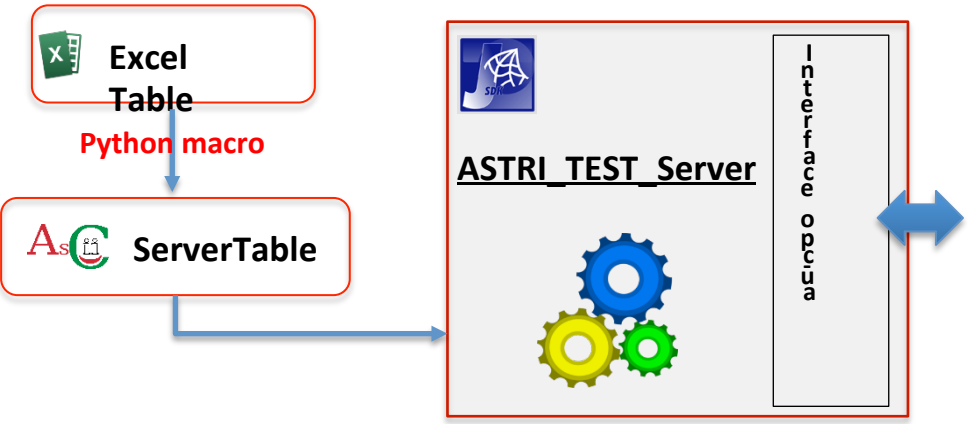
- Telescope Hardware and auxiliaries controllers.
- Auto consistent real-time functions development.

- Monitoring, coordination and execution of the hardware functionalities.
- No direct hardware control
- No responsibility for time-critical operations.

E.Antolini, Talk in this WS

ASTRI SST-2M OPC-UA Control Software





Run: Java –jar ASTRI_TEST_Server –c ServerTable.txt

In accord with the ASTRI standard, for each instrument has been realized a SW interface between low level systems and ACS, based on OPC-UA technology .

For each auxiliary device, as well as for any other ASTRI subsystem, was product an Interface Control Document (ICD).

From each ICD has been extracted an Excel spreadsheet that summarizes all commands and configuration of the server OPC-UA.

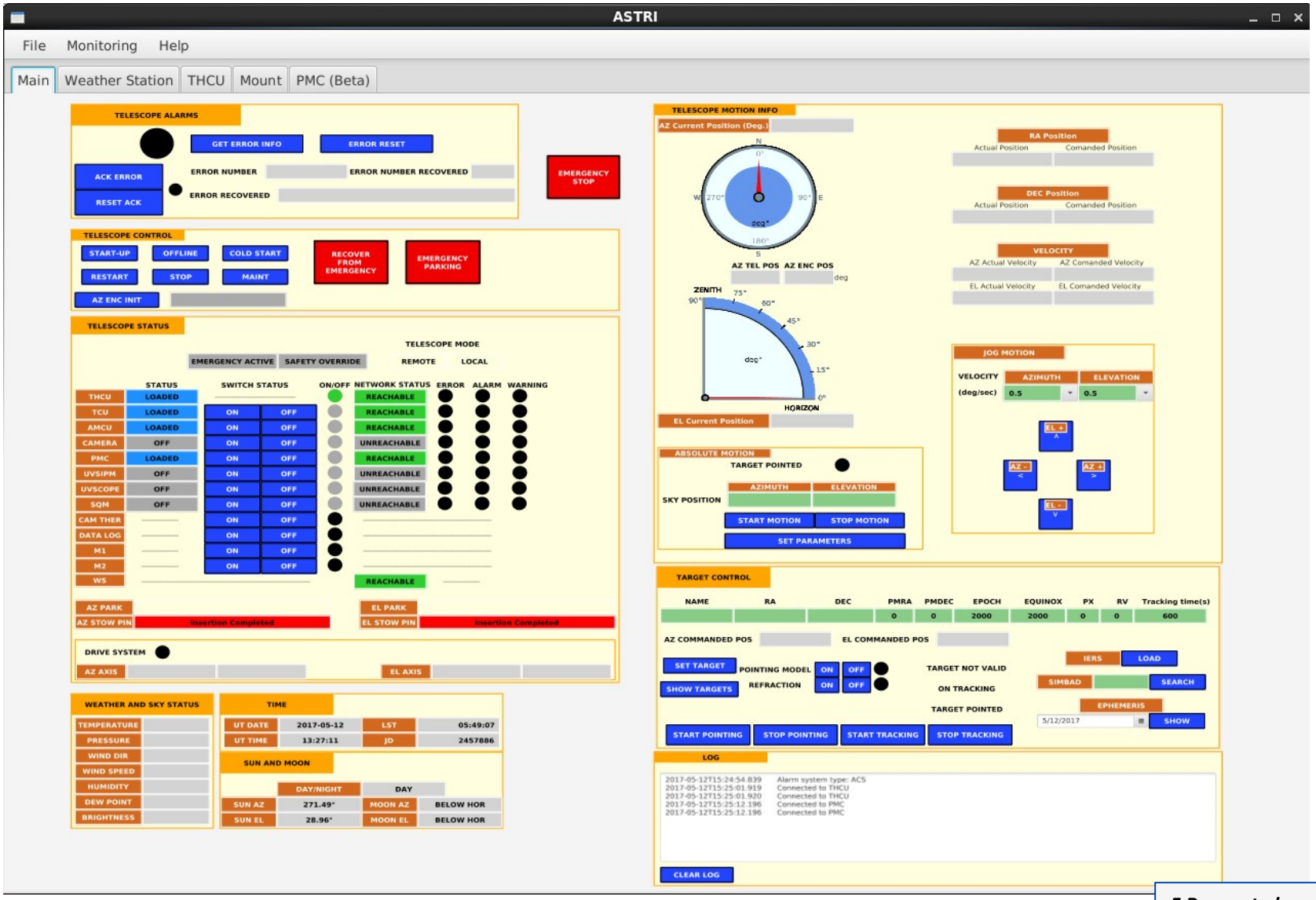
Has also been realized a server opc-ua, named "ASTRI_TEST_Server", for testing and simulation.

This server accepts as line argument an ASCII "ServerTable", extracted from the Excel spreadsheet by a python macro , to generate a standard interface OPC-UA.

In this way, you may obtain an OPC-UA server simulator for each device.

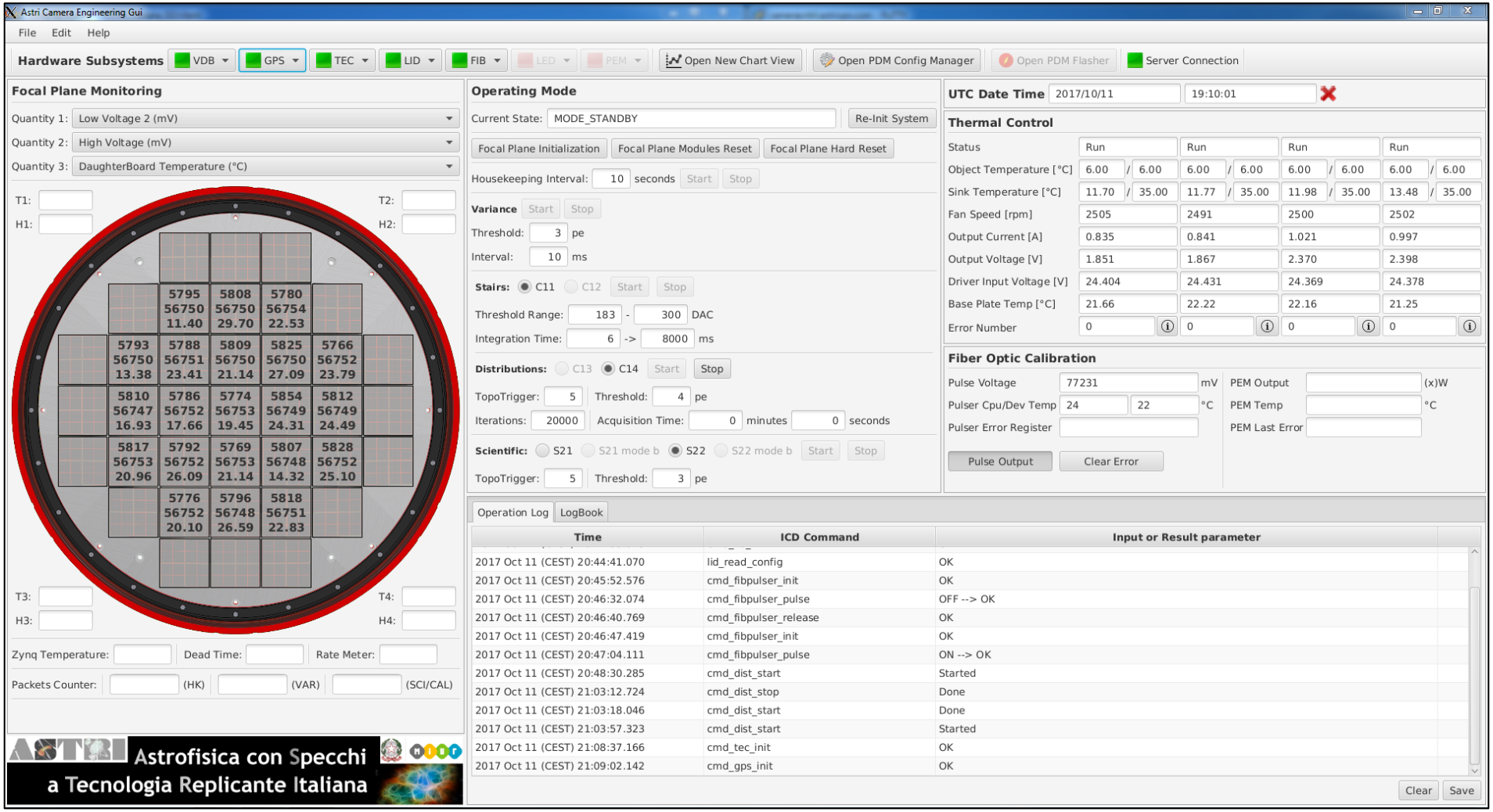
P.Bruno et al. 2016

Observatory Control System GUI



F.Russo et al.

ASTRI SST-2M Camera Controller



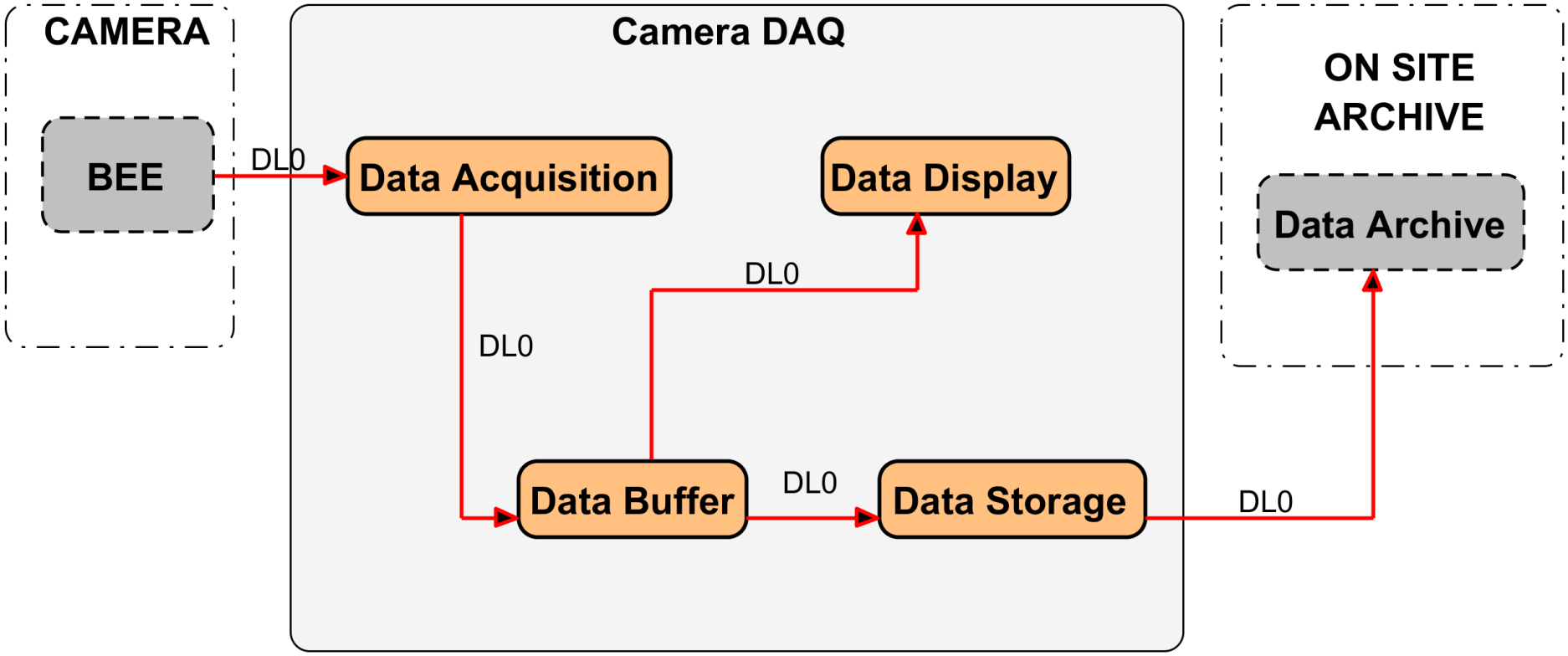
Every ICD commands must be accessible from the Engineering GUI

Lots of controls and information for expert users, but must be user friendly

One single Main GUI with information and commands frequently useful

P. Sangiorgi et al. 2017

The Camera DAQ Software



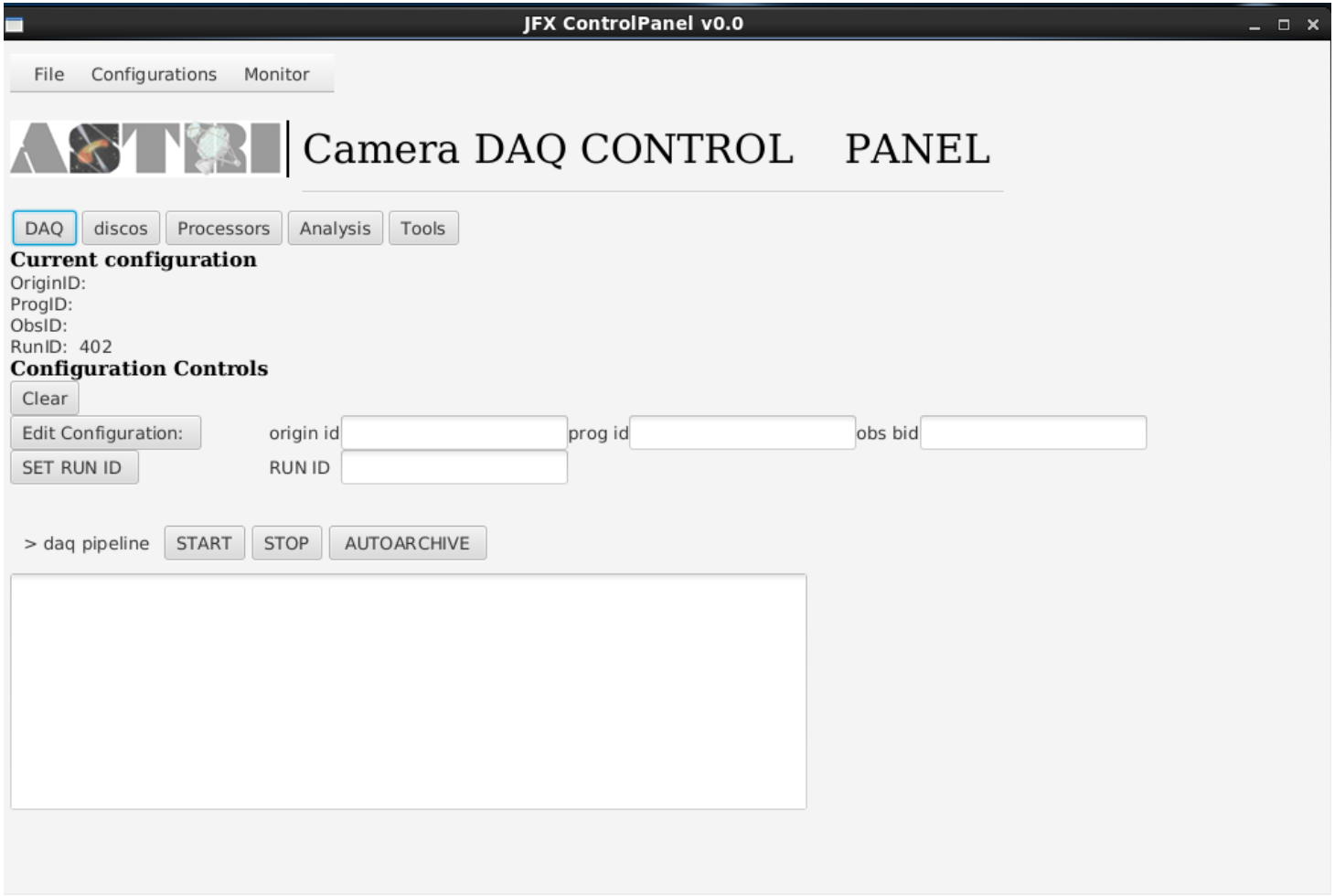
The logic model

V.Conforti, F.Gianotti et al. 2017

Camera DAQ Capabilities

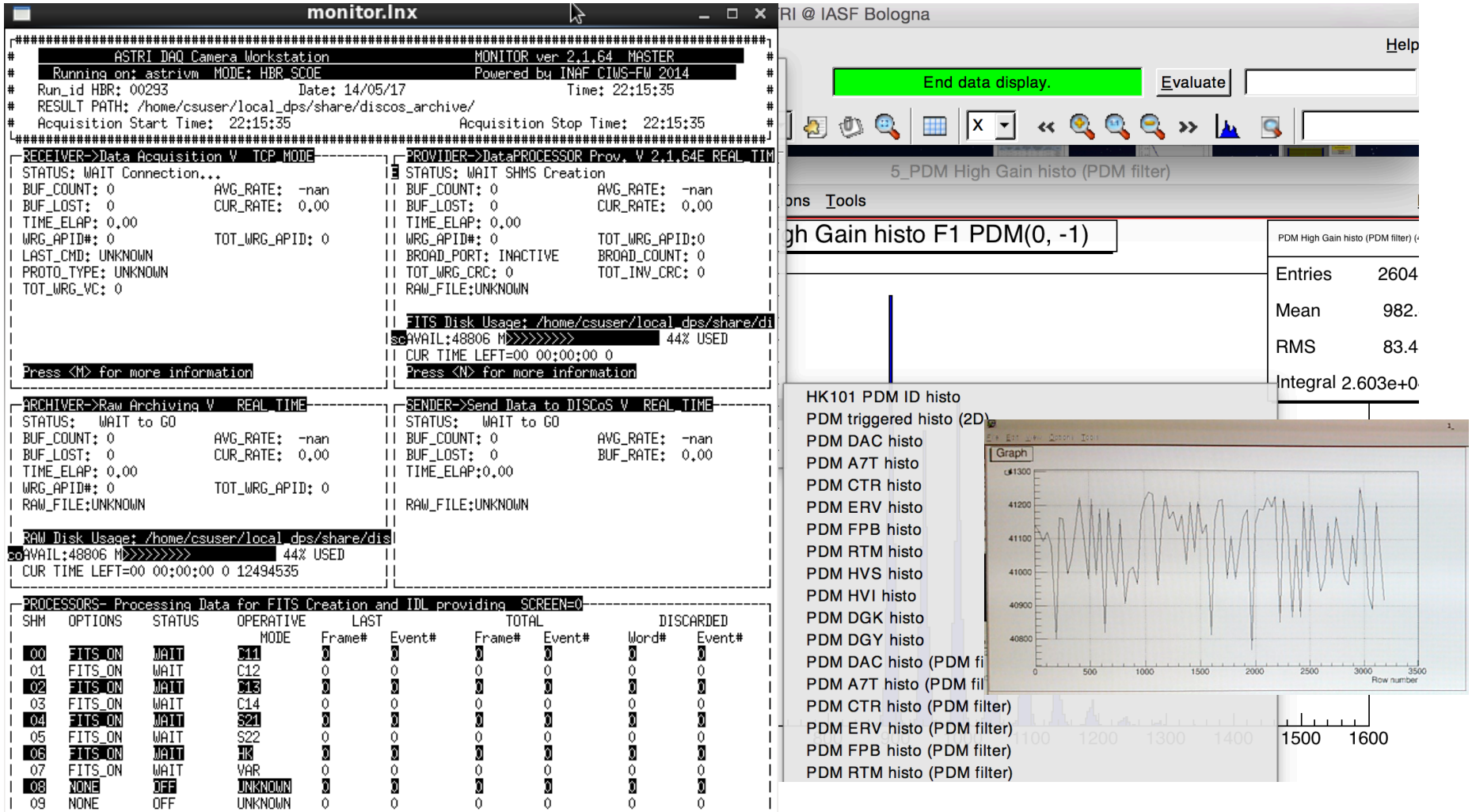
- Bulk data acquisition from BEE (~10MB/s)
- Real time L0 FITS Creation
- Level 0 data storage in RAW and FITS files
- Send Data to Archiving System
- Quick Look
- Monitor and Control
  - Local GUIs
  - ACS components

The Software



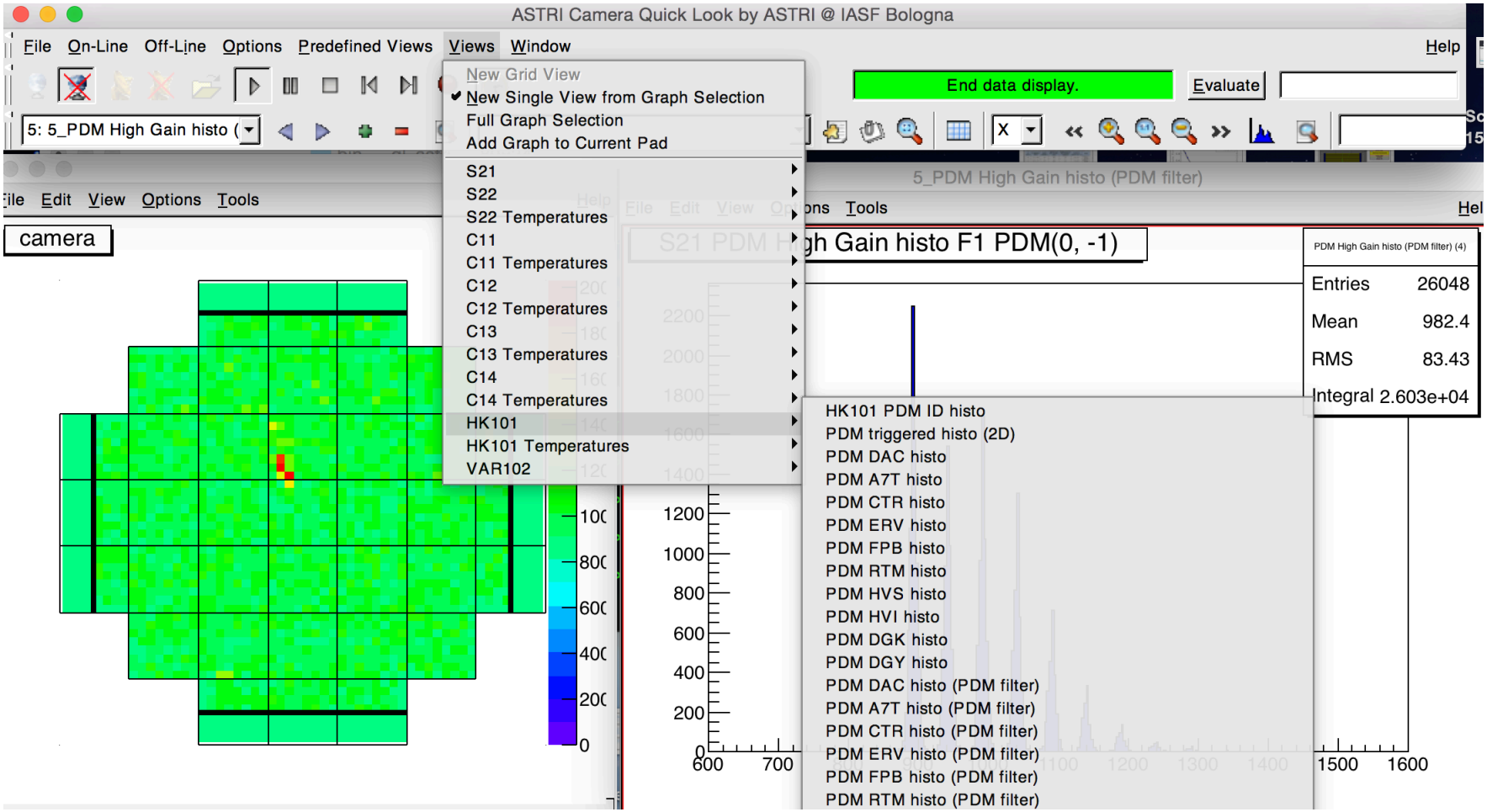
The ASTRI DAQ Local GUIs – Control Panel

The Software



The ASTRI DAQ Local GUIs – Monitor & Quick Look

The Software



The ASTRI DAQ Local GUIs – Quick Look

ASTRI SST-2M: data management

Data Acquisition

On-site Archive

On-line/On-site Analysis

Off-line/On-site Analysis

Observatory (Serra La Nave)

Data Centre (Rome)

Data Access

Off-site Archive

Off-line/Off-site Analysis

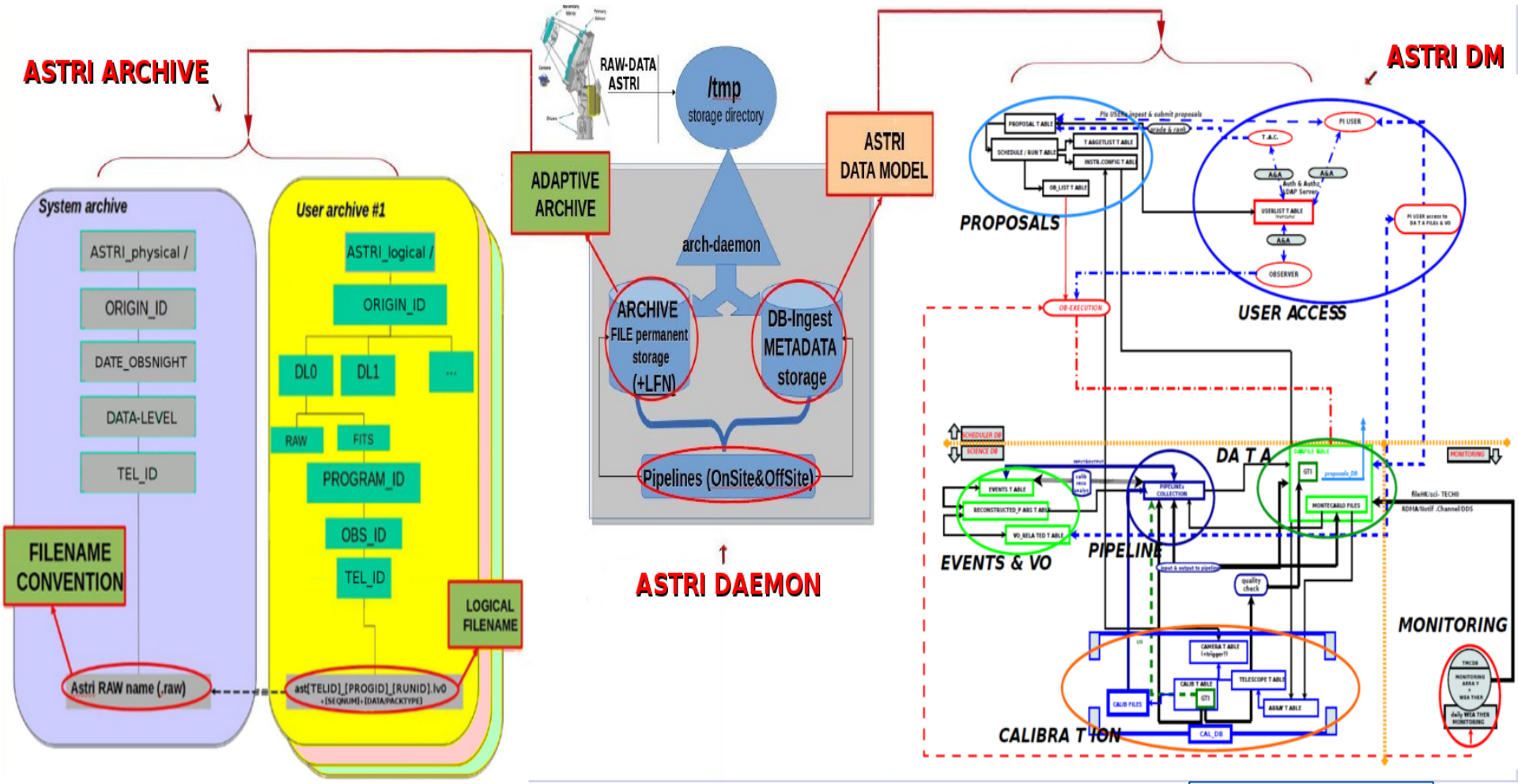
A.Antonelli et al. 2017

ASTRI Archive and Data Base: *take care of the full data chain produced by the different ASTRI components at different analysis steps*

A-SciSoft: *the ASTRI scientific data analysis system applied with different levels of detail and organized in four distinct functional breakdown stages: calibration, reconstruction, analysis, science.*

ASTRI Archive and Data Base:

take care of the full data chain produced by the different scientific devices at different analysis steps

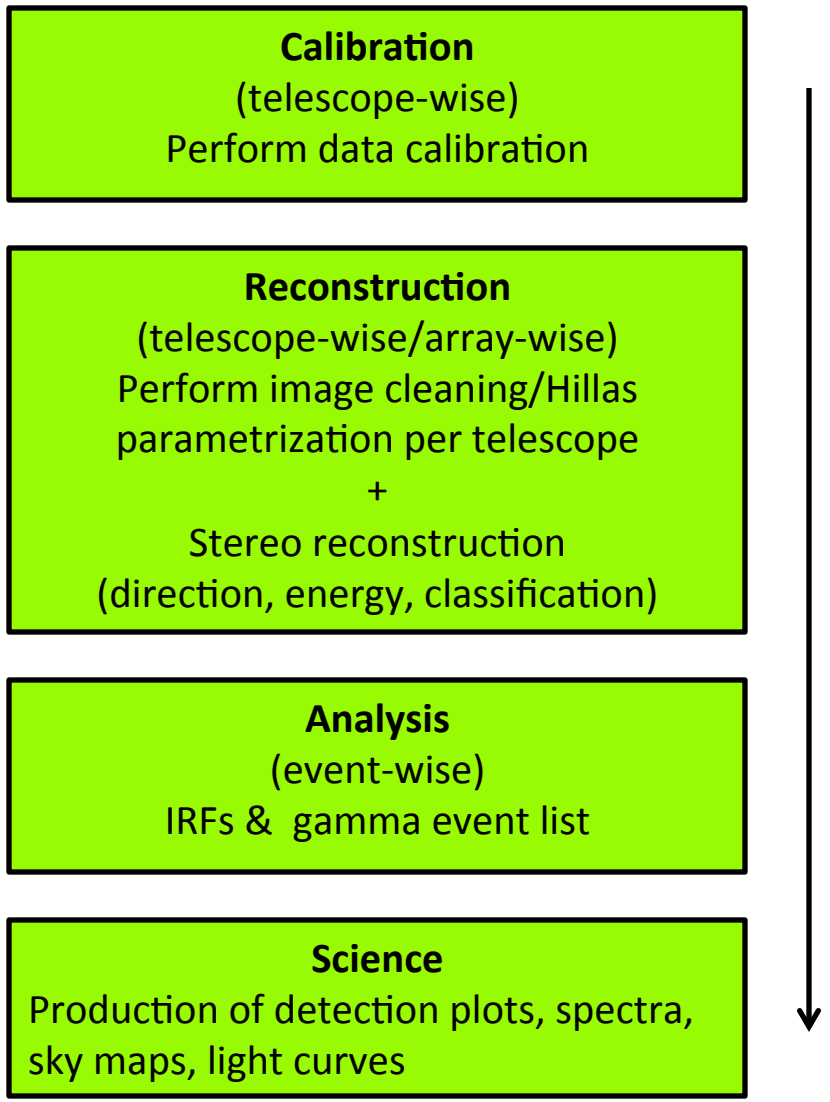


A.Antonelli.et al. 2016

A-SciSoft Functional layout

ASTRI Scientific Analysis Software is organized in four distinct functional breakdown stages:

- **Calibration (DL0 -> DL1a)**
- **Reconstruction (DL1a -> DL2b)**
- **Analysis (DL2b -> DL3)**
- **Science (DL3 -> DL4)**



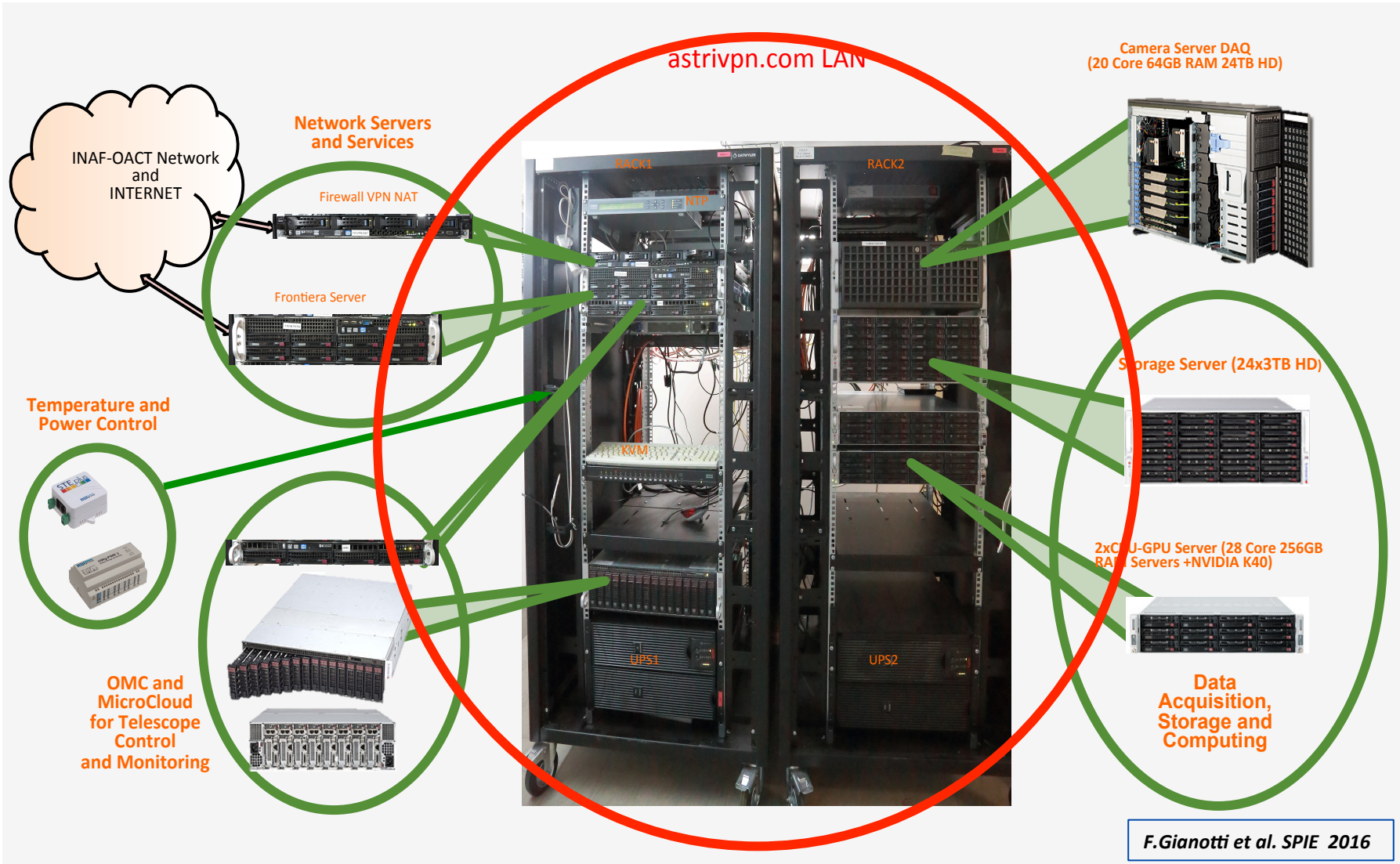
Lombardi, Antonelli, Bastieri, Madonna, Mastropietro et al., SPIE 2016

To support the software architecture as outlined above, an adequate On-Site ICT infrastructure is needed

- Stand-Alone infrastructure that implements all major network services
- Supports different software modules in defined and possibly distinct hardware
- Connect all the hardware components between them and the Internet
- Allow the connection and remote control
- Be sufficiently reliable and redundant
- Provided with an efficient and complete monitoring system
- It's possible to scale it up to handle multiple telescope systems

ASTRI Prototype: ICT Infrastructure

ASTRI-SST-2M ITC overall schema. This figure represents the current and almost definitive status of the ICT infrastructure of the ASTRI-SST-2M Telescope. It identifies the main elements that compose it



Network Servers and Services

The *Firewall VPN NAT Server* provides all the network services required for Internet access (Firewall, VPN, NAT, DNS, DHCP). The *Frontiera Server* is in charge of other services required for user access and data retrieval from Internet (SSH, HTTP, FTP, LDAP, SW repository).

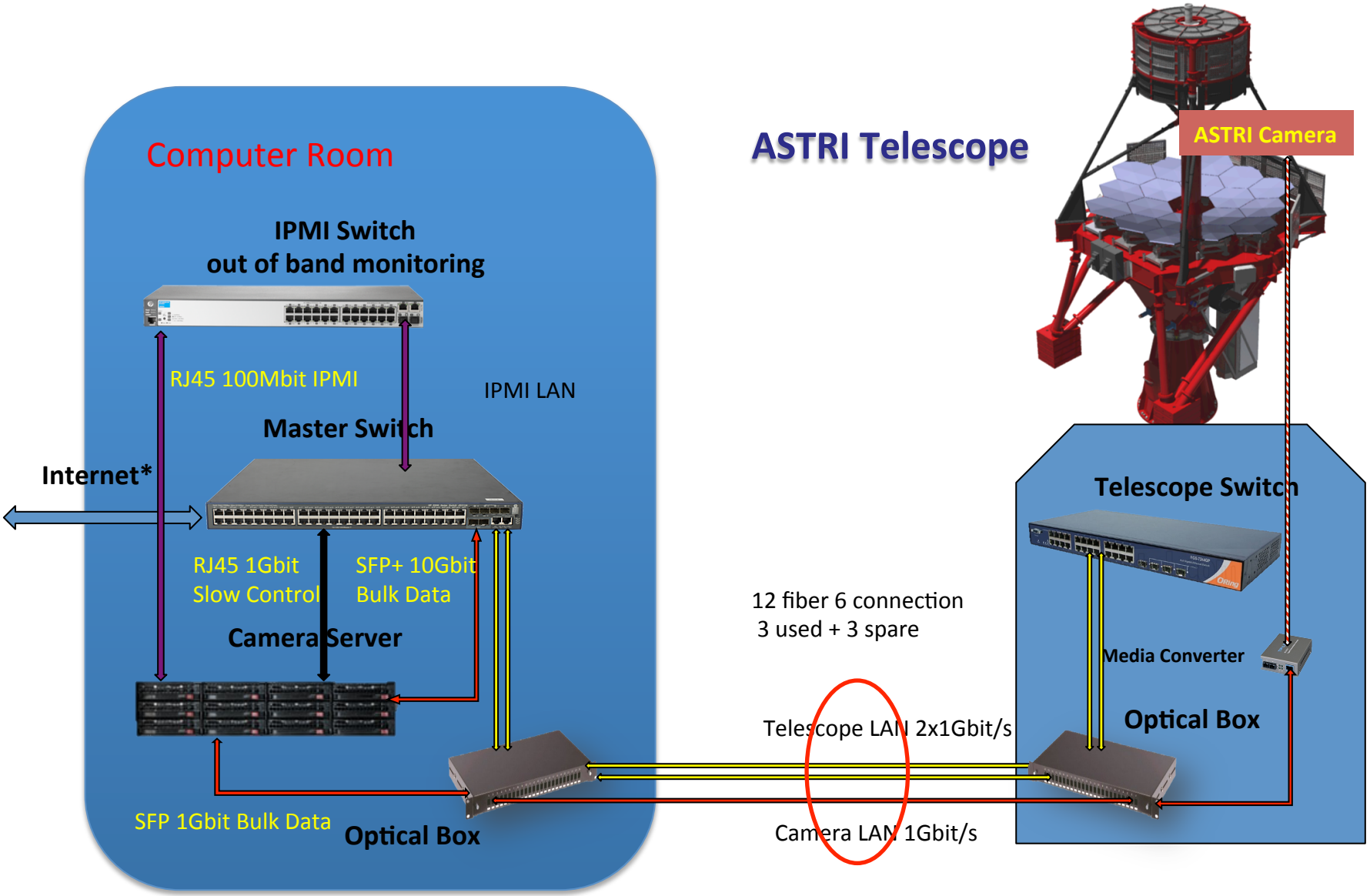
Telescope Control and Monitoring

The OMC Server and the MicroCloud (8 blade servers) host the ASTRI/CTA Mini-Array Software System (MASS) built on top the Alma Common Software (ACS) framework. The former is devoted to the Operation Control and Monitor. The MicroCloud provides the Telescope Monitor and Configuration DB (TMCDB) server, the Alma Common Software (ACS) File Server, the ACS Service Server, the Telescope Control Server (TCS), the Camera Instrument Control System (ICS) server, two servers which handle the devices required to monitor the environment and to calibrate the Cherenkov Camera. An additional server is envisaged for the monitoring of the ICT devices.

Data Acquisition, Archiving and Analysis

The *Camera Server* is devoted to the acquisition of the bulk data generated by the Cherenkov Camera. The *Storage Server* is for the on-site data archive. A multi-CPU multi-core Server and a server equipped with two GPU accelerators are envisaged for the on-site data processing and analysis.

Main Network Component and Structure



* Internet: Radio link 100Mbit to OACT-Catania

Main Network Structure and Components

The *astrivpn.com* is a private LAN composed by 3 switches. The *Master Switch* is the hearth of the system which connects all the computers servers and network devices. The *Telescope Switch* is located on the Telescope cabinet and connects all the Telescope devices to the Computer Room. Two optical fibers are connecting the two switches at 1 Gbit . A third fiber provides a point-to-point connection at 1 Gbit among the Telescope Cherenkov Camera and the Camera Server devoted to the Camera data acquisition. The *IPMI Switch* manages the out of band monitoring of the servers (e.g. Intelligent Platform Management Interface)

The ASTRI/CTA ONSITE ICT monitoring will mainly consist of two independent monitoring systems running in parallel:

- *a traditional monitoring system for Computer Centre, based on SNMP+ICMP*
- *a monitoring system required to provide monitoring data directly to the control system based on ACS, by converting SNMP+ICMP to OPC-UA*

In addition:

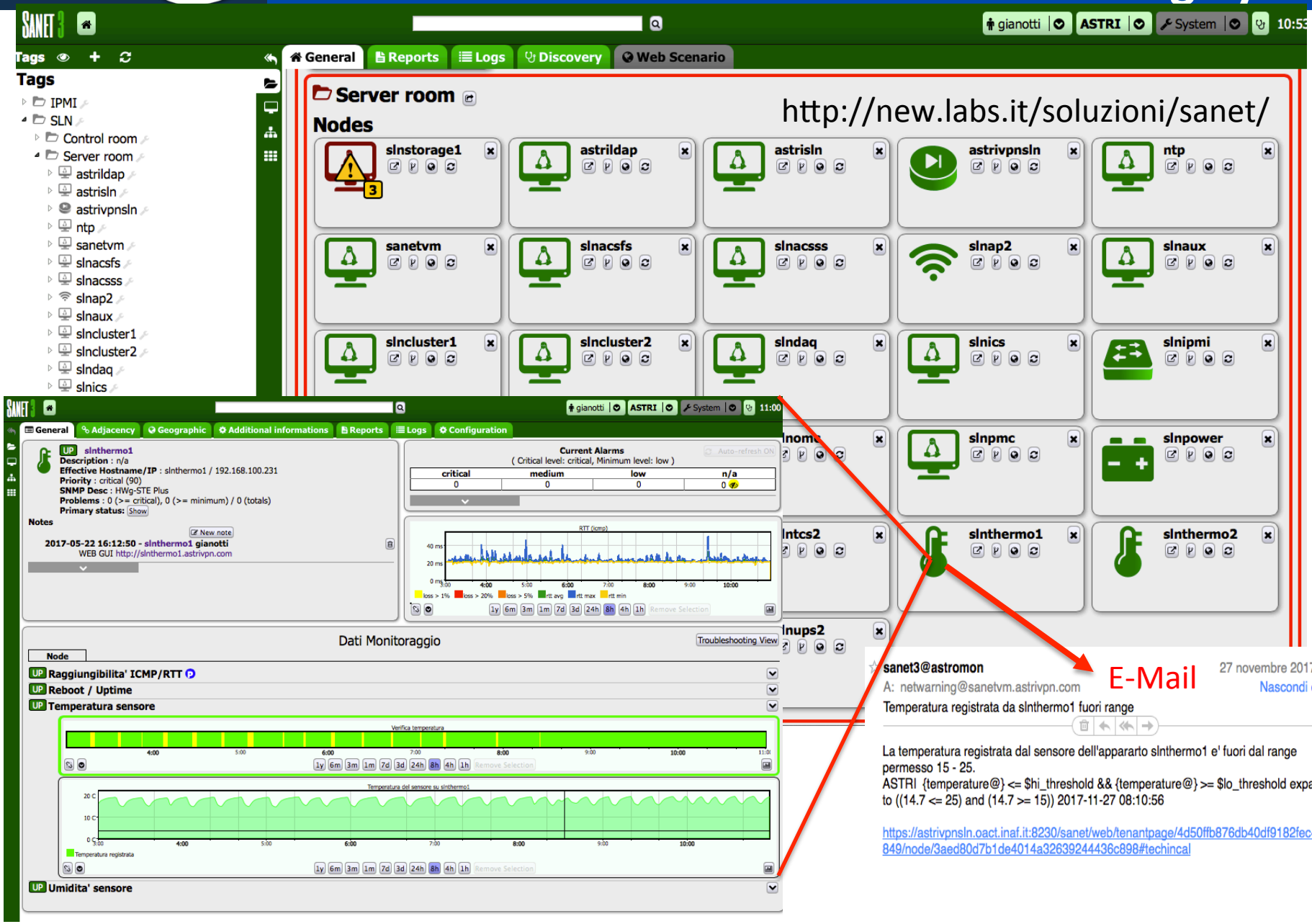
- Specific monitor tools embedded in the equipment, using IPMI, Web based tools, command line tools

ICMP Protocol (ping) will be used only to monitoring the UP/DOWN status of the equipment.

The Traditional Monitoring System Concepts

- It will be based on SNMP/ICMP Protocol
- Simple interface (WEB based)
- Very easy to use
- Fast of implementing
- Data collection non-invasive
- It monitors all required parameters
- Customizable alarms with error thresholds (Mail &SMS);
- Reporting;
- Possibility to export data for further processing

Traditional SANET Monitoring System



➢ ACS ICT Monitoring System:

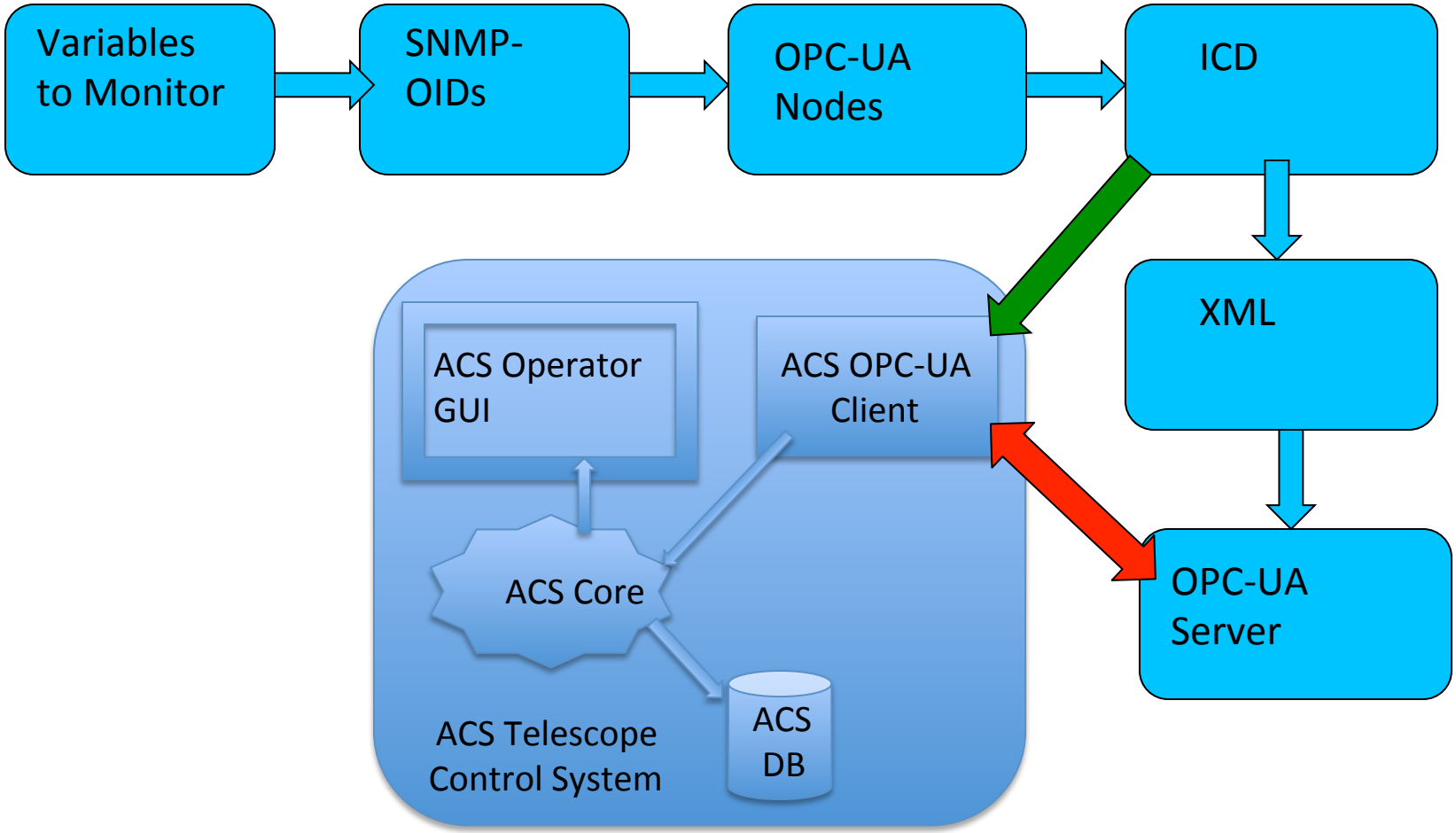
1. a set of OPC-UA servers that:

   a. manage the subset of the monitoring values to be monitored by ACS.

   b. converts their SNMP data and presents them as OPC-UA nodes

2. a set of the corresponding ACS component which implements an OPC-UA client by means of an ACS DEV/IO

ACS Monitoring System design concept



F.Gianotti, P. Bruno et al. SPIE 2016

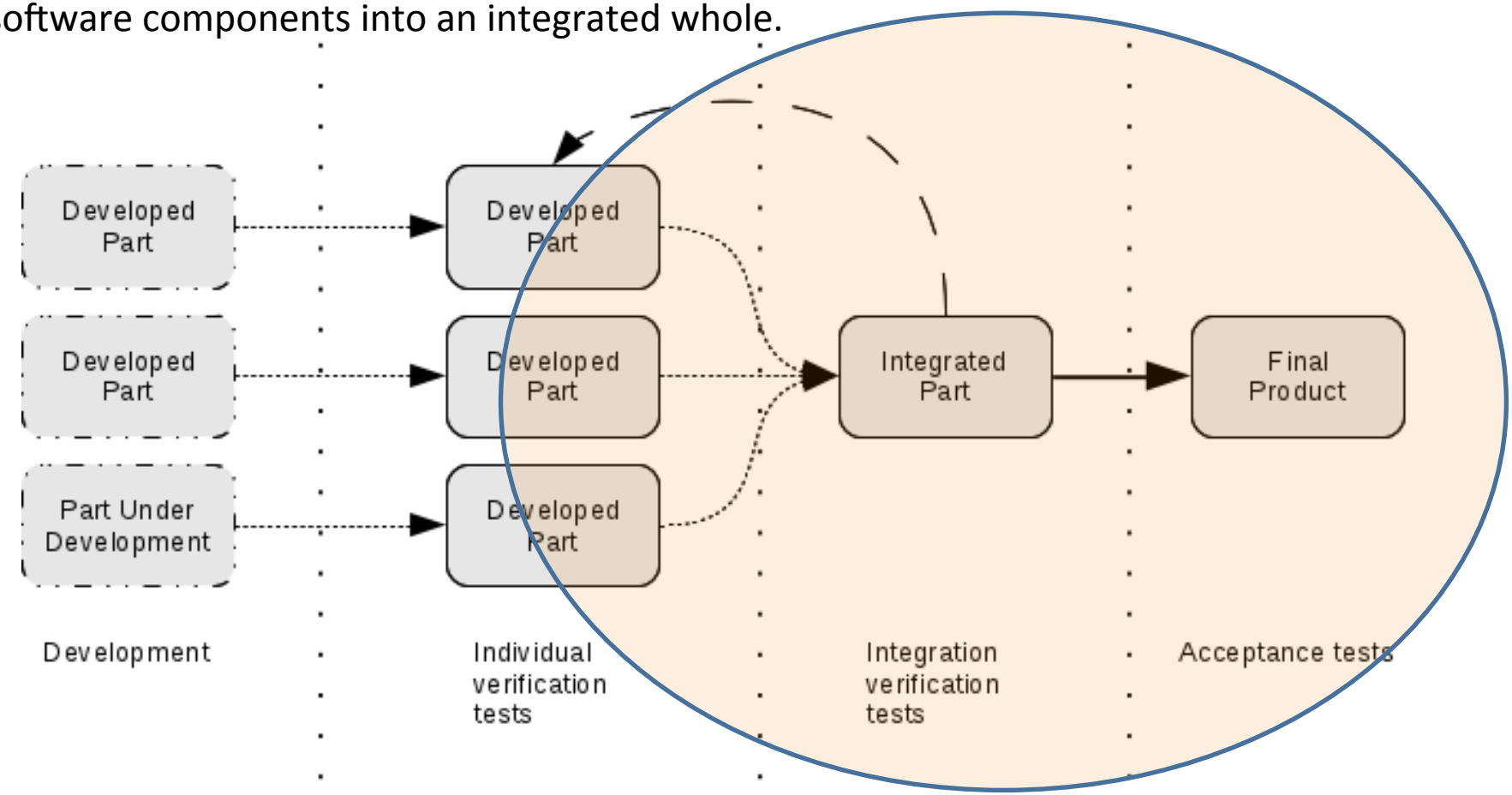
INAF-IASF BO Data center

- Version Control Software: GIT Repository
- Collaboration Tools : REDMINE
- ASTRI Virtual Test Bed for:
  - Software developing
  - Software Integration
  - Automatic Software Integration: Jenkins

Software integration within the verification process

What is Software Integration

Software system integration refers to the practice of combining individually tested software components into an integrated whole.



Guidelines:

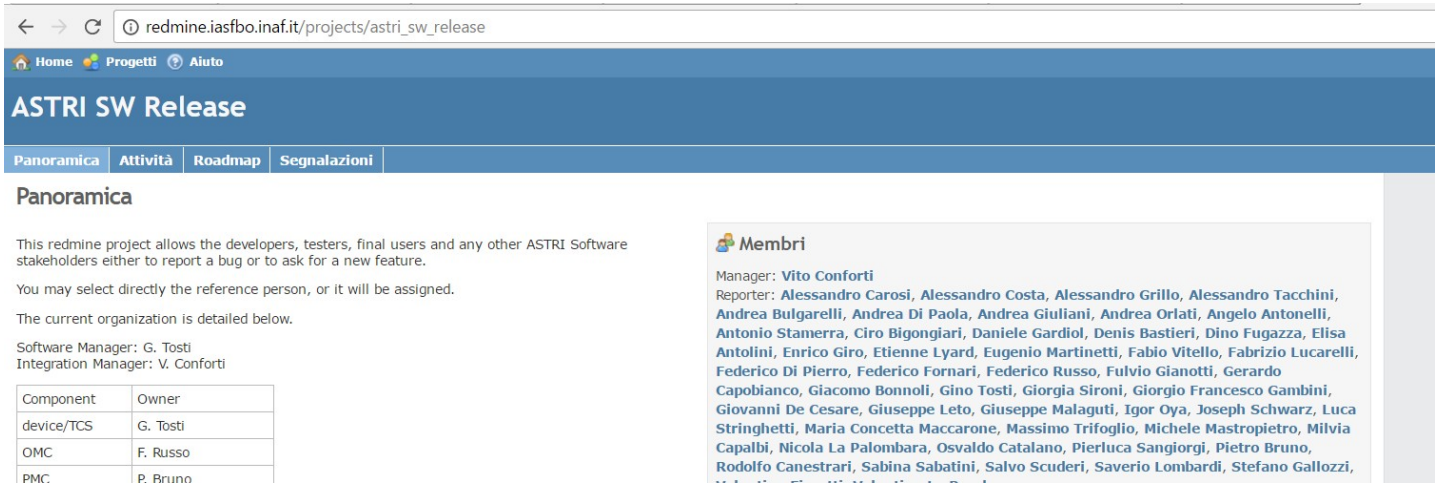
- Document «ASTRI Software Development integration and building»
- Integration test workflow

Tools:

- Test Bed
- Git Repository
- Jenkins
- Hardware simulator
- Code Generator
- Tool for automated test (from ALMA)
- Software Installer/controller
- Templates for Test Report and Software Release Document

Software release system

- The software release document provide details of module versions and describe the capabilities;
- We have a redmine project for the management of new features and bug fixing:
  http://redmine.iasfbo.inaf.it/projects/astri_sw_release



ASTRI Test Bed reproduces the SLN environment

- Network Services: Firewall, NAT, VPN, DNS, LDAP, Frontier Server (**astrisln**), ISCSI/NFS Storage
- Telescope Servers: slntmcdb, slnics, slntcs, slnomc, slndaq, slnaux, slnpipe, slnstorage
- We use a template to create the VM

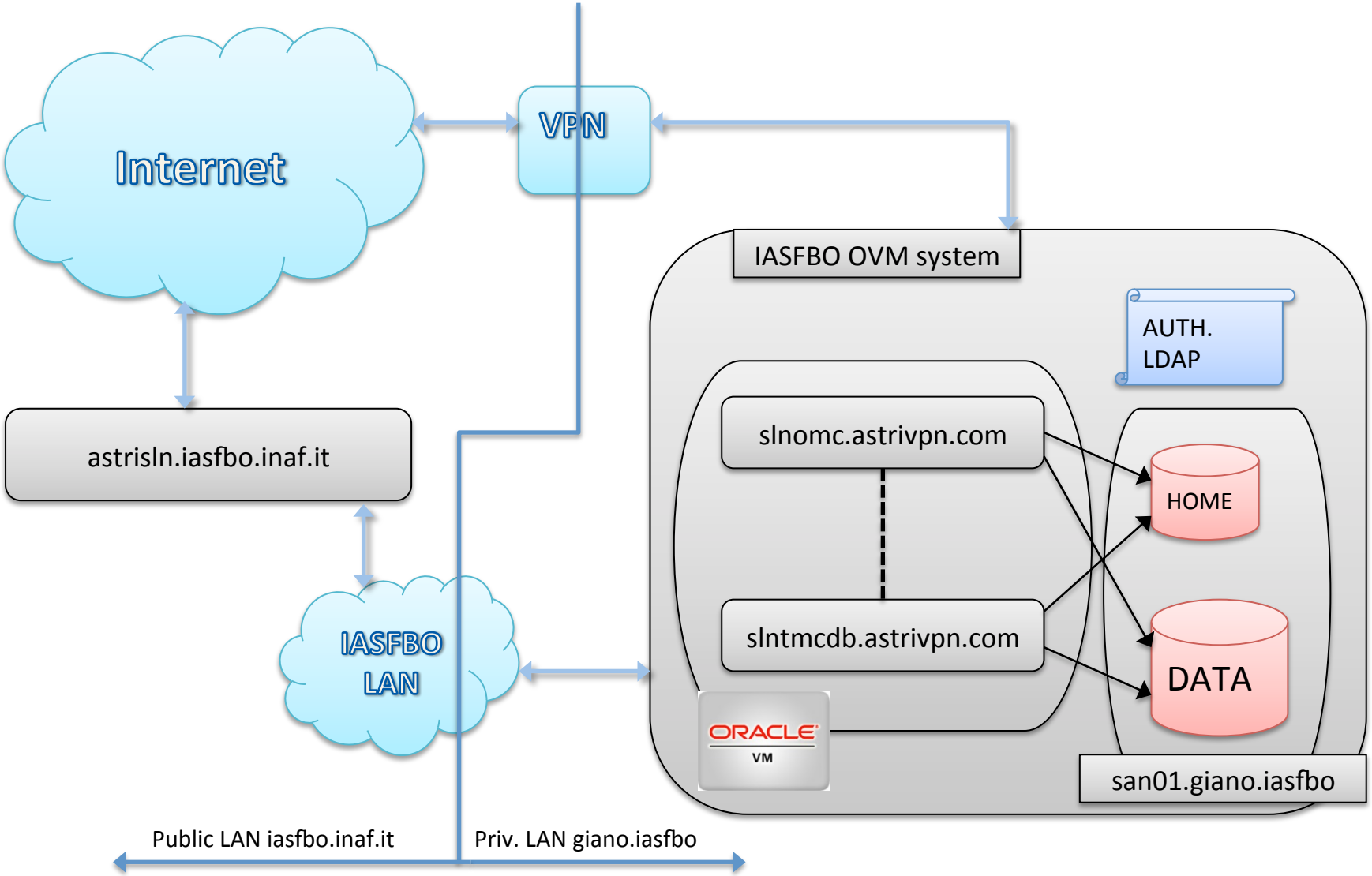
Why ASTRI Test bed

- software integration test
- Continuous integration with Jenkins
- Distributed ACS system configuration test

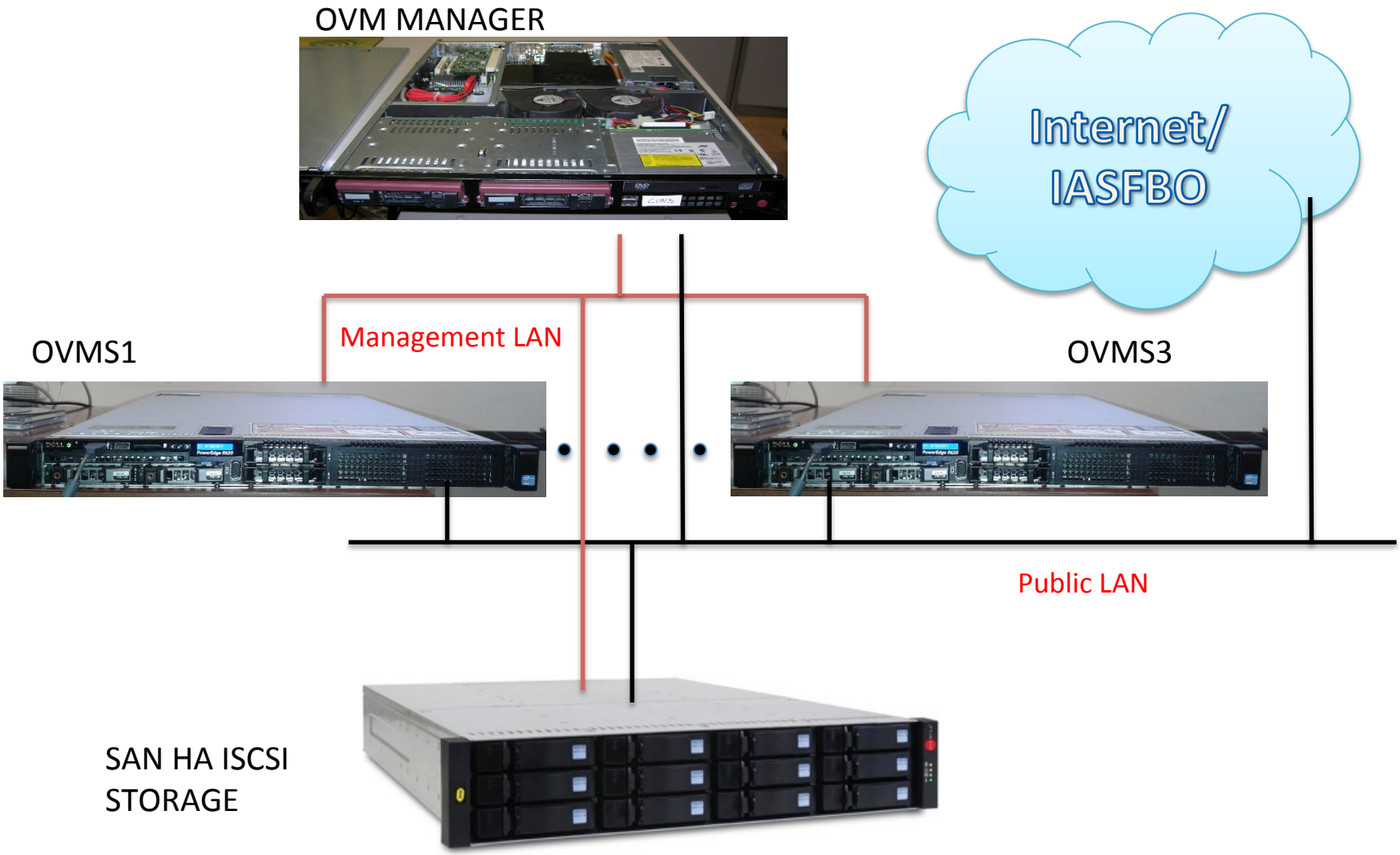
Test Bed as virtual environment

- Test Bed is based on Oracle VM
- The virtual Machines are easily replicable
- A copy of VM has been distributed to the developers
- Oracle VM system is fast and reliable and free for small installations
- The OVM system can ensure high availability
- The Virtualization System is less expensive than "real" system in term of Cost, Time and Power
- It can run more than 20 VMs in 3 physical servers
- Oracle VM allows to have a single control console to easily manage multiple servers OVMS and dozens of Virtual Machines.

ASTRI Off-Site ICT Infrastructures



ASTRI Off-Site ICT Infrastructures



ASTRI Off-Site ICT Infrastructures

- 1 Oracle VM Manager
  Server SuperMicro X7DLV-E-B 2 Case 1U CPU Xeon 5140 64bit 2.33GHz 4MB 1333Mhz BUS dual core 8GB RAM 667MHz 4x2GB dual ch. HW RAID 2 HDD SATA II 300 GB RAID1 2x LAN 1Gbit. IPMI
- 3 Virtualizzation Servers
  DELL PowerEdge R620 Case 1U , Processors 2x6 core:Intel Xeon E5-2620v2 2.1GHz, 15M Cache, 7.2GT/s RAM 128GB. 4x1Gbit LAN. IDRAC7
- Storage Area Network System (SAN)
  DotHill 2U 12Bay 8 x iSCSI-1Gb to SAS 2GB Dual Controller System. 6 x HDD 2TB SAS 7.200 RPM in RAID 6 configuration. Redundant Control System.

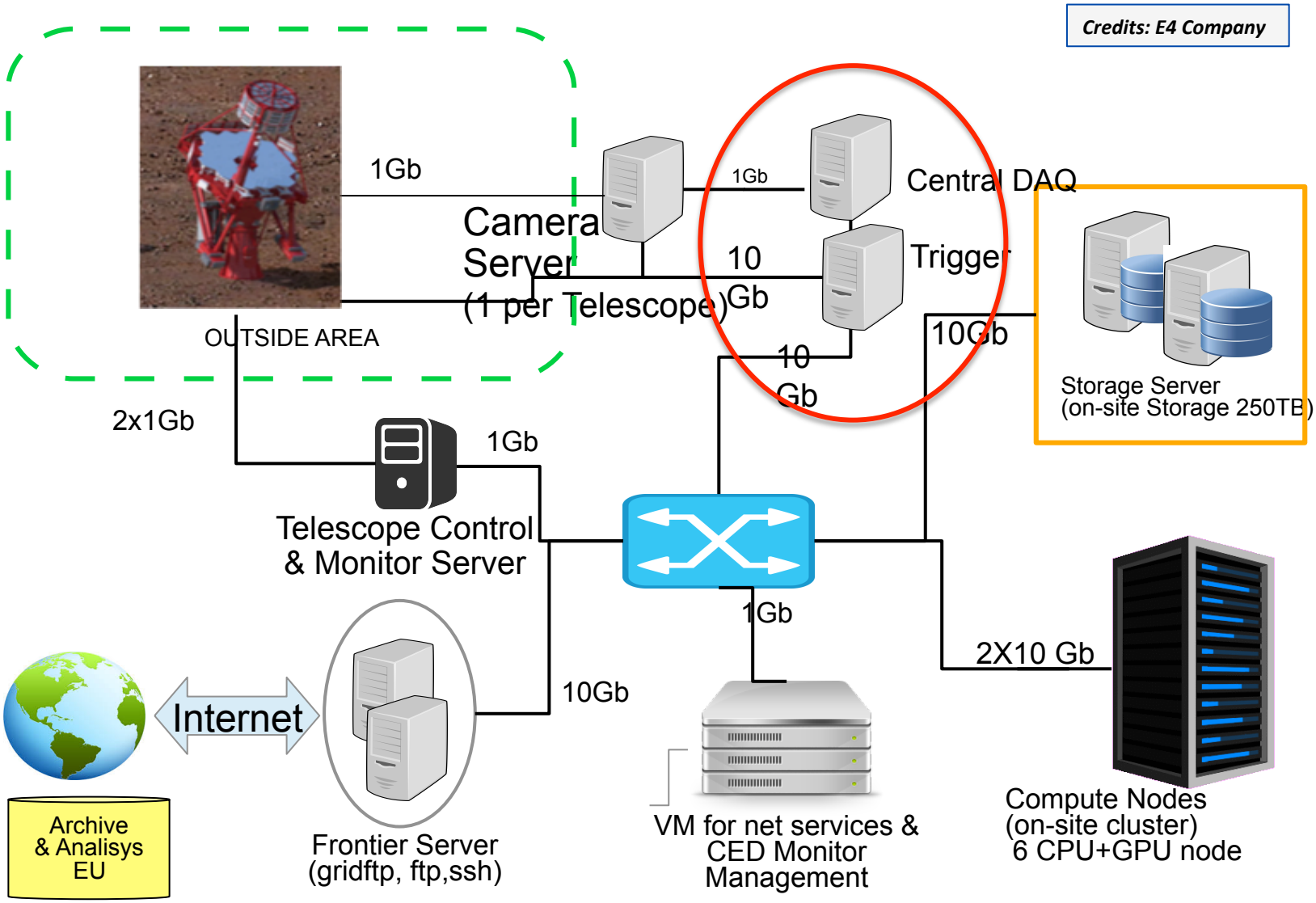
First step, the ASTRI mini-array:

- **At least 9 ASTRI telescopes proposed to be implemented as part of the early implementation of the CTA Southern Site**

Final aim:

- **At least 35 ASTRI telescopes on 70 SSTs foreseen for the CTA Southern Site.**

ASTRI Mini Array Computing Schema



Server categories

1. Camera Server
2. Central DAQ
3. Trigger (Timing)
4. Observatory, Telescope and Camera Control and monitoring
5. On-Site Analysis
6. On-Site Storage
7. Service Servers

For each of these categories we will have to determine the number of required servers and their characteristics

Server main caracteristics

- CPU, CPU Core
- RAM
- HD and HD Capacity
- RAID and RAID Level
- Network type and Number of Interface

After this:

- Choosing the server model respecting the desired performance the necessary reliability
- Trying to standardize as much as possible servers in a few different models

Network main caracteristics

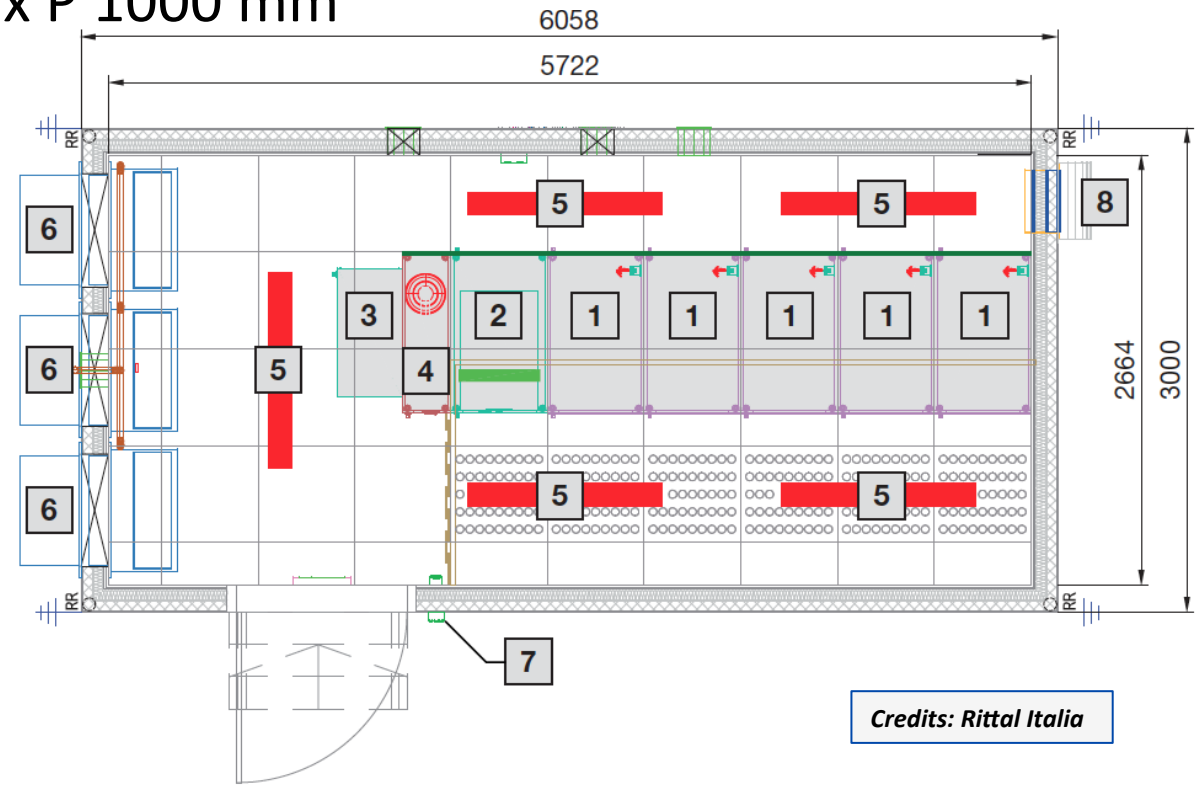
- LAN
  - Realized by 1-10Gbit/s Ethernet switch
  - Dimensioned according to the number of expected servers
- Telescope to Server Room connection
  - Fiber Optics LAN connection -> we will refer to the documents produced by CTA
- Internet we should have:
  - 2-4 public IPv4 addresses with global connection speeds of 100Mbit / s. For VPN, NAT and frontiera Servers
  - 1-2 public IPv4 addresses with global connection speeds of 1Gbit / s for data transfer.
- Timing LAN: low-latency network for the time and the trigger distribution
  - 1Gbit/s Dedicated switch (white rabbit)

Data Center in a BOX

Assembled at home, just connect the data network and the power and turn on

Container -> L 6050-8000 x A 3250 x P 3000

1. Rack L 600 x A 2000 x P 1000 mm
2. UPS Rack
3. Electrical board
4. Fire system
5. Lighting
6. Cooling System
7. Access control
8. Air Pressure Control



Credits: Rittal Italia

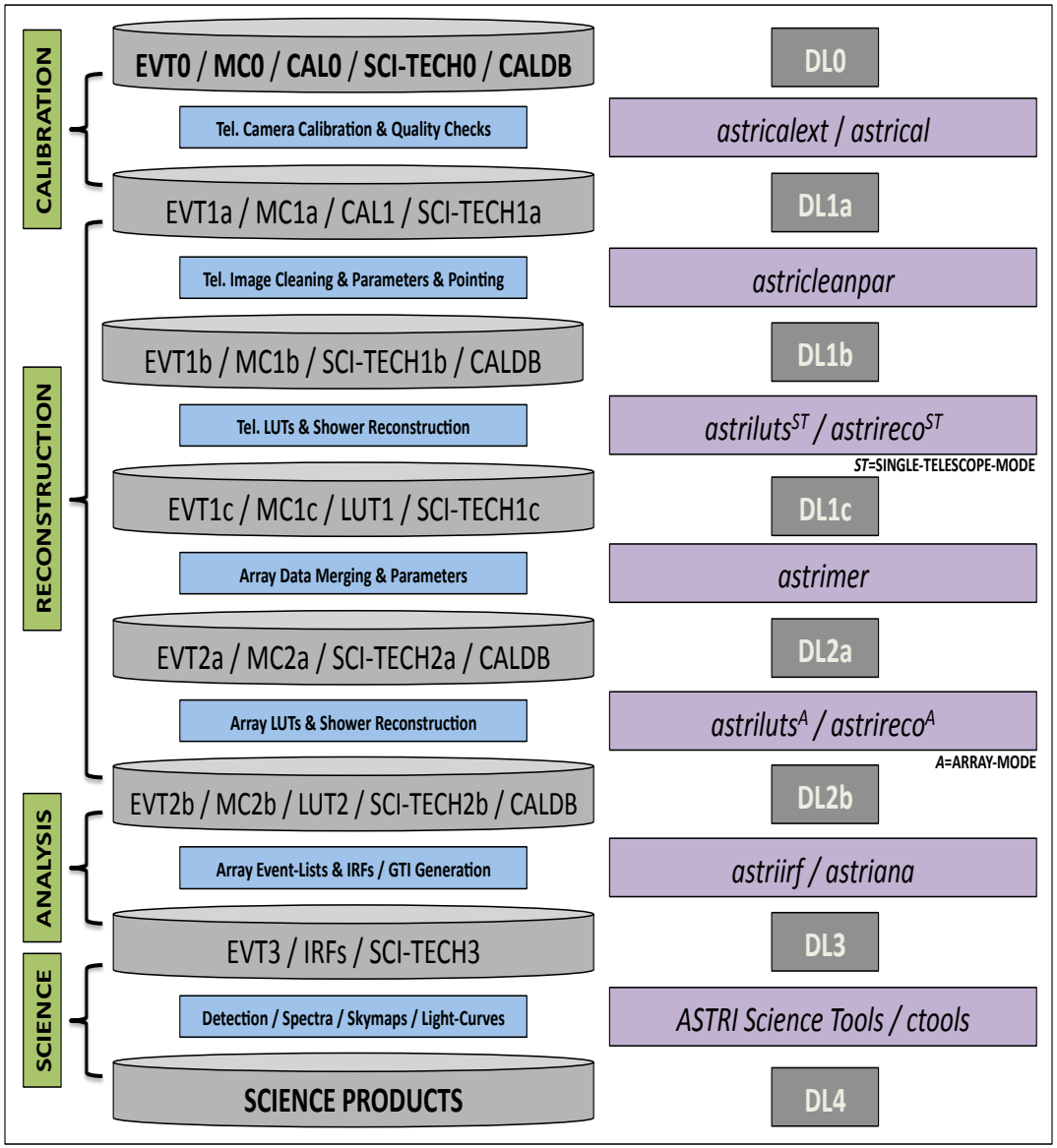
CONCLUSIONS:

- ICT is an integral and fundamental part of the ASTRI prototype that contributed to its realization and development.
- ASTRI ICT has been fully developed by INAF, taking into account the requirements for CTA both HW and SW
- The experience with the ICT prototype will allow us to make a fundamental contribution to the realization of CTA and in particular of the ASTRI Mini-Array.

We gratefully acknowledge financial support from the agencies and organizations listed here:

http://www.cta-observatory.org/consortium_acknowledgments/

Back Up Slides



Breakdown stages; Basic components; Executable modules; I/O Data level.

From raw data to science products

Organized in independent executable modules allowing an easier development and maintenance

Modules can be run in that order in cascade by an *astri-pipe* super module (wrapper)

Rely on IRAF parameters

The Software

ASTRI CAMERA SERVER LOCAL ARCHIVE

Acquired Files - Measure Plan - IW - Pipelines - Swcomponents - Data types

Actions

Please insert the dates in the format: yyyy-mm-dd HH:MM:SS
If you filter on the date please insert the lower and upper limits.
If you filter on the measure please insert Origin program and Observations IDs.

Starting date between

and :

Origin ID:

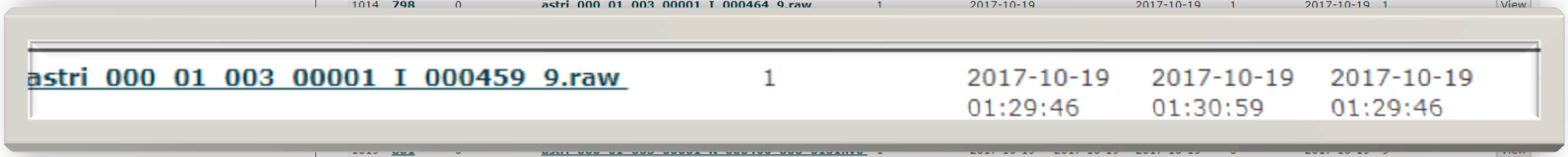
Program ID:

Observation ID:

Apply filter

Myfiles

Id	Measure	Sequence Number	Filename	Status	Error	Startdate	Enddate	Creationdate	Openclose	Last Update Time	Swcomponentid	Actions
1004	788	0	astri_000_01_003_00001_I_000459_9.raw	1		2017-10-19 01:29:46	2017-10-19 01:30:59	2017-10-19 01:29:46	0	2017-10-19 01:30:59	1	View
1005	789	0	astri_000_01_003_00001_R_000459_9.raw	2		2017-10-19 01:31:00	2017-10-19 02:01:22	2017-10-19 01:31:00	0	2017-10-19 02:01:22	1	View
1006	790	0	astri_000_01_003_00001_I_000460_9.raw	1		2017-10-19 02:01:23	2017-10-19 02:02:18	2017-10-19 02:01:23	0	2017-10-19 02:02:18	1	View
1007	791	0	astri_000_01_003_00001_R_000460_9.raw	2		2017-10-19 02:02:19	2017-10-19 03:02:07	2017-10-19 02:02:19	0	2017-10-19 03:02:07	1	View
1008	792	0	astri_000_01_003_00001_I_000461_9.raw	1		2017-10-19 03:02:08	2017-10-19 03:03:26	2017-10-19 03:02:08	0	2017-10-19 03:03:26	1	View
1009	793	0	astri_000_01_003_00001_R_000461_9.raw	2		2017-10-19 03:03:27	2017-10-19 03:13:58	2017-10-19 03:03:27	0	2017-10-19 03:13:58	1	View
1010	794	0	astri_000_01_003_00001_I_000462_9.raw	1		2017-10-19 03:13:59	2017-10-19 03:14:54	2017-10-19 03:13:59	0	2017-10-19 03:14:54	1	View
1011	795	0	astri_000_01_003_00001_R_000462_9.raw	2		2017-10-19 03:14:55	2017-10-19 03:27:42	2017-10-19 03:14:55	0	2017-10-19 03:27:42	1	View
1012	796	0	astri_000_01_003_00001_I_000463_9.raw	1		2017-10-19 03:27:43	2017-10-19 03:28:26	2017-10-19 03:27:43	0	2017-10-19 03:28:26	1	View
1013	797	0	astri_000_01_003_00001_R_000463_9.raw	2		2017-10-19 03:28:27	2017-10-19 04:47:41	2017-10-19 03:28:27	0	2017-10-19 04:47:41	1	View
1014	798	0	astri_000_01_003_00001_I_000464_9.raw	1		2017-10-19		2017-10-19	1	2017-10-19	1	View
1020	802	0	astri_000_01_003_00001_I_000467_9.raw	1		2017-10-19 20:03:36	2017-10-19 21:02:51	2017-10-19 20:03:36	0	2017-10-19 21:02:51	1	View
1021	802	0	astri_000_01_003_00001_I_000467_000_1001.lv0	1		2017-10-19 18:24:47	2017-10-19 19:00:39	2017-10-19 20:24:47	0	2017-10-19 21:02:58	14	View
1022	803	0	astri_000_01_003_00001_R_000467_9.raw	2		2017-10-19	2017-10-19	2017-10-19	0	2017-10-19	1	View



The ASTRI DAQ Local GUIs – persistence display

CAMERA Server SLN:

- Case 4U Supermicro SuperChassis Rack Montable 2000W Redundant power, 8 bay for SAS/SATA HD. GPU XEON PHI Compliant
- MB SuperMicro Dual Xeon
- CPU -> 2 x Xeon 10-Cores 20 Threads 2,3Ghz 25MB 9,6GT/s QPI
- 64 GB RAM -> 4 x DDR3-2133 Reg. ECC 16 GB module
- Storage RAID- > 1 x Adaptec 6805 Raid SAS/SATA 8Port PCI-EX
- 2HD 1TB SATA III RAID1 for SO
- 6HD 4TB SAS II RAID10 for DATA (16TB Gross)
- Video Board 1 x PNY Quadro K2200 PCI EX 4GB DDR5
- IPMI2 KVM dedicated LAN
- 2x LAN 1Gbit Intel i350 (INTEL PRO 1000)
- 2x 10Gbit SFP+ ports

Camera Workstation (in lab) and Camera Server (SLN)

Benefits:

- very powerful, reliable and expandable WS
- Dual Xeon 12-20 core 24-40 Thread
- RAM 32-64GB
- SL 6.x and CentOS 7.x Certified
- Large capacity and storage performance RAID10
- Separate RAID1 HD for OS
- Hot-Swap HD
- Option to install GPU or XEON PHI Accelerators
- Good graphics power 2D/3D OpenGL
- 5 years of on-site support
- WS:VERY SILENT ! Like a last generation PC!
- Server: Redundant Power + IPMI

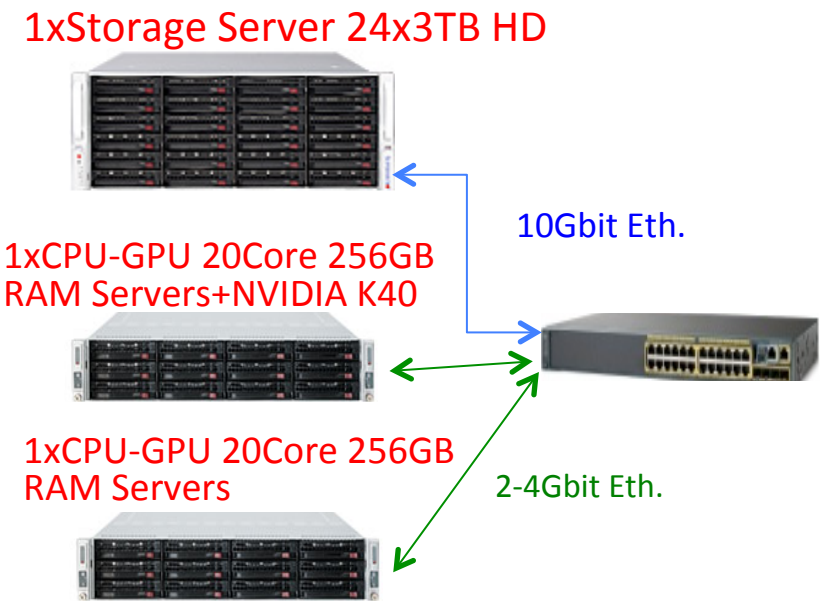
Disadvantage:

- Large size and weight

ASTRI On-Site ICT Infrastructures

- It takes only 3 servers to handle the On-Site analysis of ASTRI in Serra la Nave
  - 1x Storage Server 24x4TB HD (40TB RAID10 Space + 2Spare)
  - 2x CPU+ GPU Server 2xNVIDIA K40 (28 CPU Core => 56 Thread + 2880 CUDA Cores)
- To reduce costs will not be expected server or spare parts only a few disks
- The server must have a minimum warranty of 5 years NBD
- The reliability depend on a good Monitoring and Remote Control:
  - LABS Monitoring System plus IPMI, HD & RAID Monitor
  - Generate an E-mail and/or a SMS every significant event
- Solutions with hot or cold redundancy will be provided only at the level of mini-array/CTA

- Storage Requires
  - 0.8TB/night compressed
  - Data transfer to permanent archive every 7-14 Day
  - About 15 day of data in the storage
  - 5TB of Montecarlo Data
  - => 17TB of RAID10 Storage with 2 hot spare => 14x4TB HD
  - The storage server will also be used as a backup server and data transfer
  - Data to be transferred 0.2TBx15= 3TB 4x3TB HD
  - Server Configuration Backup 4x3TB HD
  - Total about 22 34TB HD
- Computing Requires
  - We must provide 2 CPU-GPU server with 20 Core 40 Thread 256GB RAM and 1xNVDIA K40 GPU
  - The computing servers have been designed taking as an example those already purchased in Rome for the analysis SW development and testing.



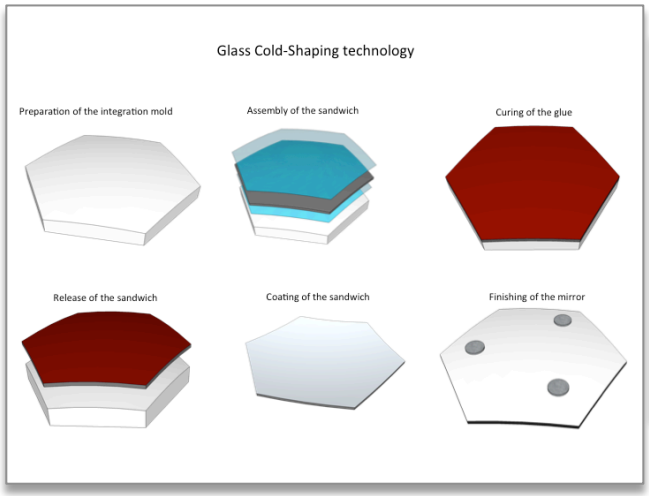
10 ASTRI Telescope Case

- 10xCamera Server
- 3xCentral DAQ
- 2xTrigger (Timing)
- 8xObservatory, Telescope and Camera Control and monitoring
- 6xOn-Site Analysis
- 4x On-Site Storage (250TB avaiable)
- 3x Service Servers + 1 SAN (20TB)
- 4x10Gbit + 4x1Gbit network switch
- 4 x 42 Unit computer rack
- 8x 10KW/h UPS
- Electrical power 35KW (TBV) excluding Cooling
- Everything can fit in a Data Center Container (see slide 5)
- Cost -> less than 700KE tax included excluding container

ASTRI, the acronyms and the project

ASTRI, the acronym …

''Astrofisica con Specchi a Tecnologia Replicante Italiana''
(Astrophysics with Mirrors via Italian Replication Technology)



… but ASTRI is more than this …

The main goals of the INAF-led **ASTRI project** are the design, development and deployment of:

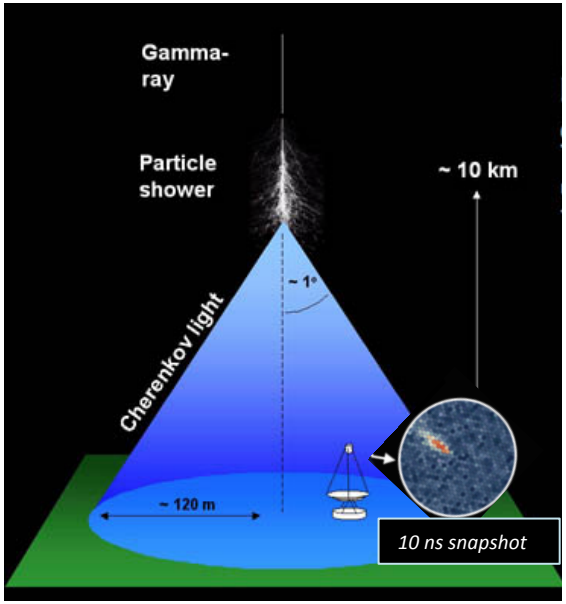
- an **end-to-end ASTRI telescope prototype** of the **CTA small-sized telescopes** in a dual-mirror Schwarschild-Couder configuration (the prototype is installed in Italy),
- a set of at least nine **ASTRI telescopes** proposed to be installed at the CTA Southern site as part of the initial partial CTA array …

… aiming at the construction of at least 35 out of the 70 small-sized telescopes envisaged for the CTA Southern site

Pareschi et al. 2013

ASTRI SST-2M, the telescope prototype

The **ASTRI SST-2M telescope prototype** is installed in Italy at the INAF observing station 'M.C. Fracastoro' located in Serra La Nave (Mt. Etna, Sicily), 1740 m a.s.l. (inauguration on 24 September 2014).



IACT, *Image Atmospheric Cherenkov Technique/Telescope*

The ASTRI SST-2M telescope works like every IACT telescope by imaging the very short flash of Cherenkov radiation generated by the cascade of relativistic charged particles produced when a very-high-energy gamma-ray strikes the atmosphere. The collecting mirror system reflects the Cherenkov light to a high-speed camera that digitizes and records the image of the shower.

What are its technological solutions?

ASTRI telescopes towards the CTA construction

All components of the ASTRI SST-2M telescope prototype have been developed in view of the ASTRI telescopes array configuration proposed for the CTA southern site.

Furthermore, thanks to the experience acquired with the prototype, technological improvements in the ASTRI telescopes for CTA will be applied:

- **Telescope structure: lightened**
- **Active Mirror Control: simplified**
- **Coating of the mirrors: optimized even in function of the protection window material**
- **SiPM sensors: upgraded at their last useful version**
- **CITIROC: upgraded version for time-tag**

ASTRI Timetable:

- **Scheduled production of the first telescope structure → End 2017**
- **Camera for the first telescope → Autumn 2018**
- **First telescope implemented at the CTA Southern site → 2019**

- The ASTRI SST-2M end-to-end telescope prototype installed in Italy has already successfully confirmed the expectations related to its technological solutions.
- The science verification phase will start early Autumn 2017.

- The development of the ASTRI telescopes for the CTA southern site is already ongoing aiming to install the first telescope in 2019.
- Final aim of the ASTRI project is the construction of at least 35 out of the 70 small-sized telescopes envisaged for the CTA Southern site.

Work is in progress

ASTRI SST-2M: data analysis and archive

Calibration (telescope-wise)
Apply data calibration algorithms and perform data quality checks

↓

Reconstruction (telescope-wise)
Image cleaning and parameterization + single-telescope event reconstruction
(array-wise)
Stereo parameters and reconstruction (event direction, energy, classification)

↓

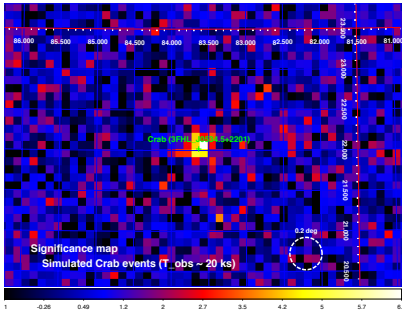
Analysis (event-wise)
Production of gamma event list, IRFs and good time intervals (GTI)

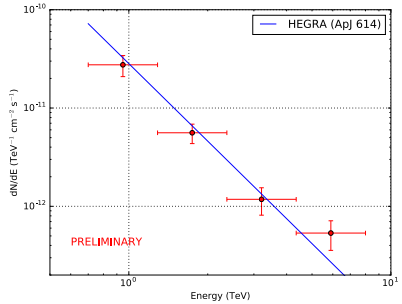
↓

Science
Production of detection plots, spectra, sky maps, light curves

The ASTRI Scientific Software:

- can handle real and MC data for both prototype and mini-array
- follows the general CTA design and data model scheme defined in CTA Data Management
- is developed for on-line/on-site/ off-site data reduction pipelines
- manages FITS data from DL0 to DL4 (`cfitsio`/`CCfits` libraries) (for mini-array, DL0 in RAW format)
- is written in C++/Python/CUDA
- can run on x86 / ARM CPUs & NVIDIA GPUs
- is developed in independent software modules linked by pipelines written in Python
- makes use of ad hoc and ad… CTA Science Tools



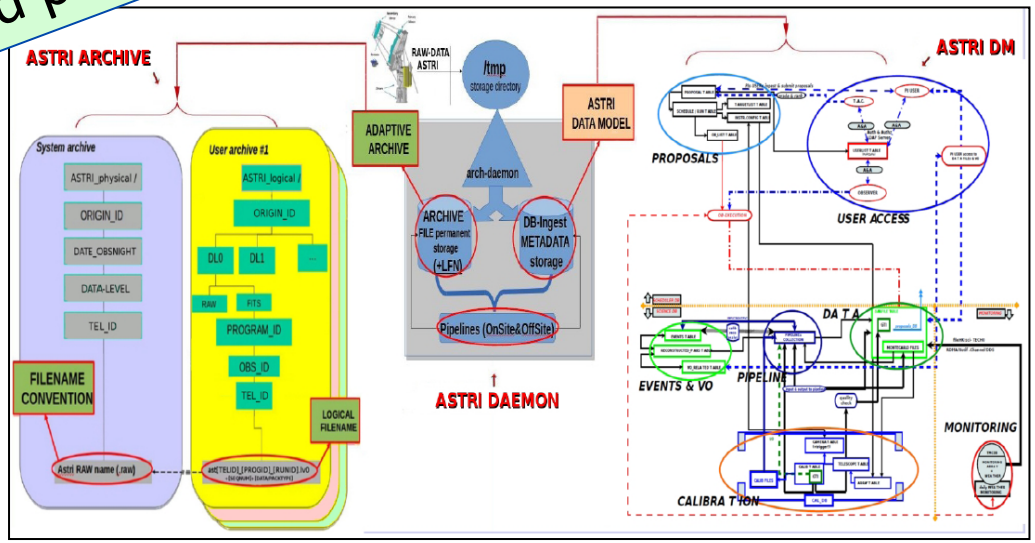


Left: Significance map of the ON… (5.8 hours) sky region obtained with th… ools task. Right: Differential spec… ebula obtained with the cssp… ue line reprints the best-fit …erization of the Crab Nebula … the HEGRA Coll.

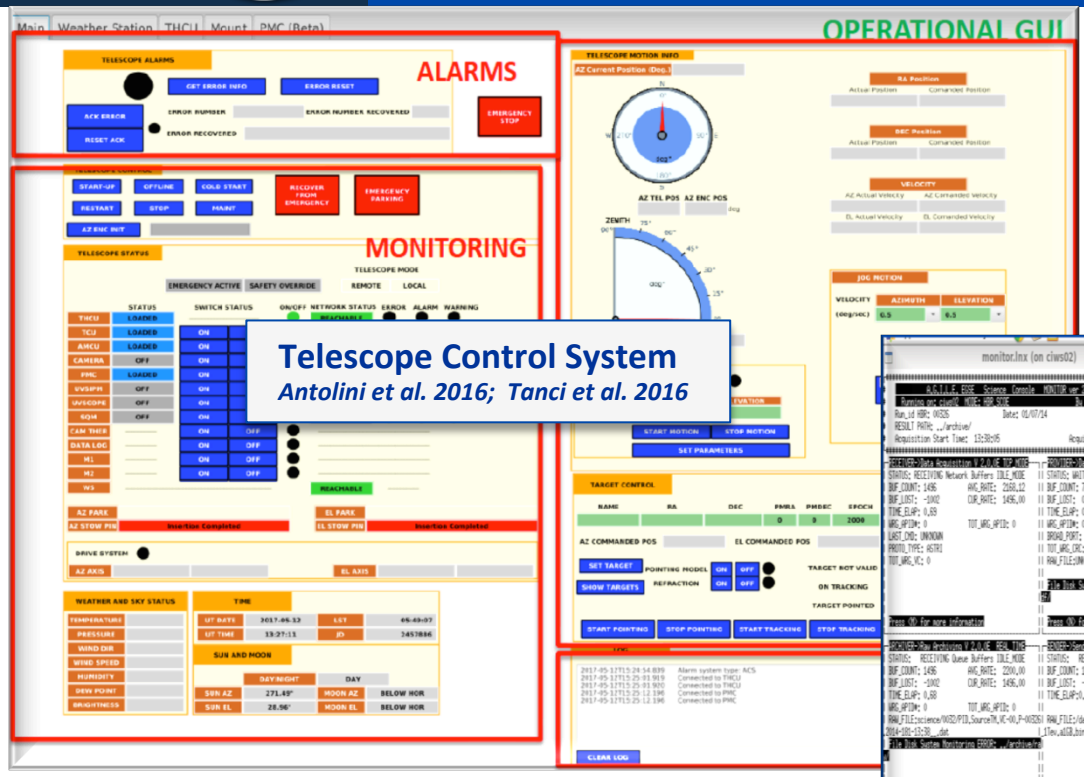
see dedicated poster by S. Lombardi et al.

A-SciSoft: *the ASTRI data reconstruction and analysis system organized in four distinct functional breakdown stages*

ASTRI Archive and Data Base: *take care of the full data chain produced by the different scientific devices at different analysis steps*

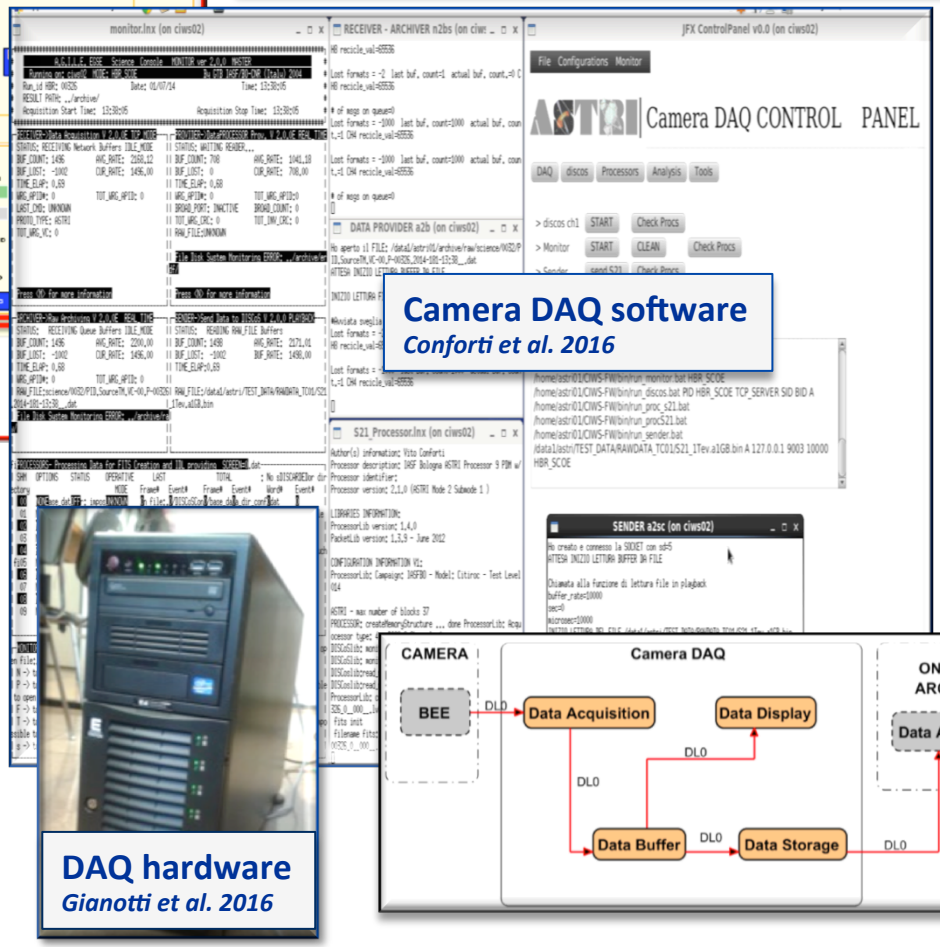


ASTRI SST-2M: control software



Telescope Control System
Antolini et al. 2016; Tanci et al. 2016

AMC, Active Mirror Control
Russo et al. 2016



Camera DAQ software
Conforti et al. 2016

Camera Engineering GUI
Sangiorgi et al. 2016

DAQ hardware
Gianotti et al. 2016