

The site of the ASTRI SST-2M Telescope Prototype: atmospheric monitoring and auxiliary instrumentation.

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on behalf of the ASTRI Collaboration





ASTRI, “Astrofisica con Specchi a Tecnologia Replicante Italiana”

The ASTRI Program is an **Italian “Progetto Bandiera”** funded by the Ministry of Education, University and Research and led by INAF, the Italian National Institute of Astrophysics.

Main goals: design, development and production, **within the Cherenkov Telescope Array, CTA, framework and following its requirements**, of

- ✚ an **end-to-end prototype** of a Small Size Telescope, SST, devoted to the highest gamma-ray energy region (1-100 TeV) investigated by CTA, to be tested under field conditions in **2014**,
- ✚ a **SST mini-array** to be placed at the final CTA Southern Site during **2016**, which would constitute the first *seed* of the CTA Observatory,
- ✚ the **mirrors** for the prototype of the CTA Medium Size Telescopes, MST.

Principal Investigator: G. Pareschi
Co-PI (Instrument): O. Catalano
Co-PI (Science): S. Vercellone
Program Manager: M. Fiorini
System Engineer: L. Stringhetti
INAF/CTA Responsible: P. Caraveo

INAF Institutions

- IASF Milano
- IASF Bologna
- IASF Palermo
- OA Brera
- OA Bologna
- OA Capodimonte
- OA Catania
- OA Roma
- OA Padova
- OA Torino
- OA Arcetri
- *and* INAF HQ Roma

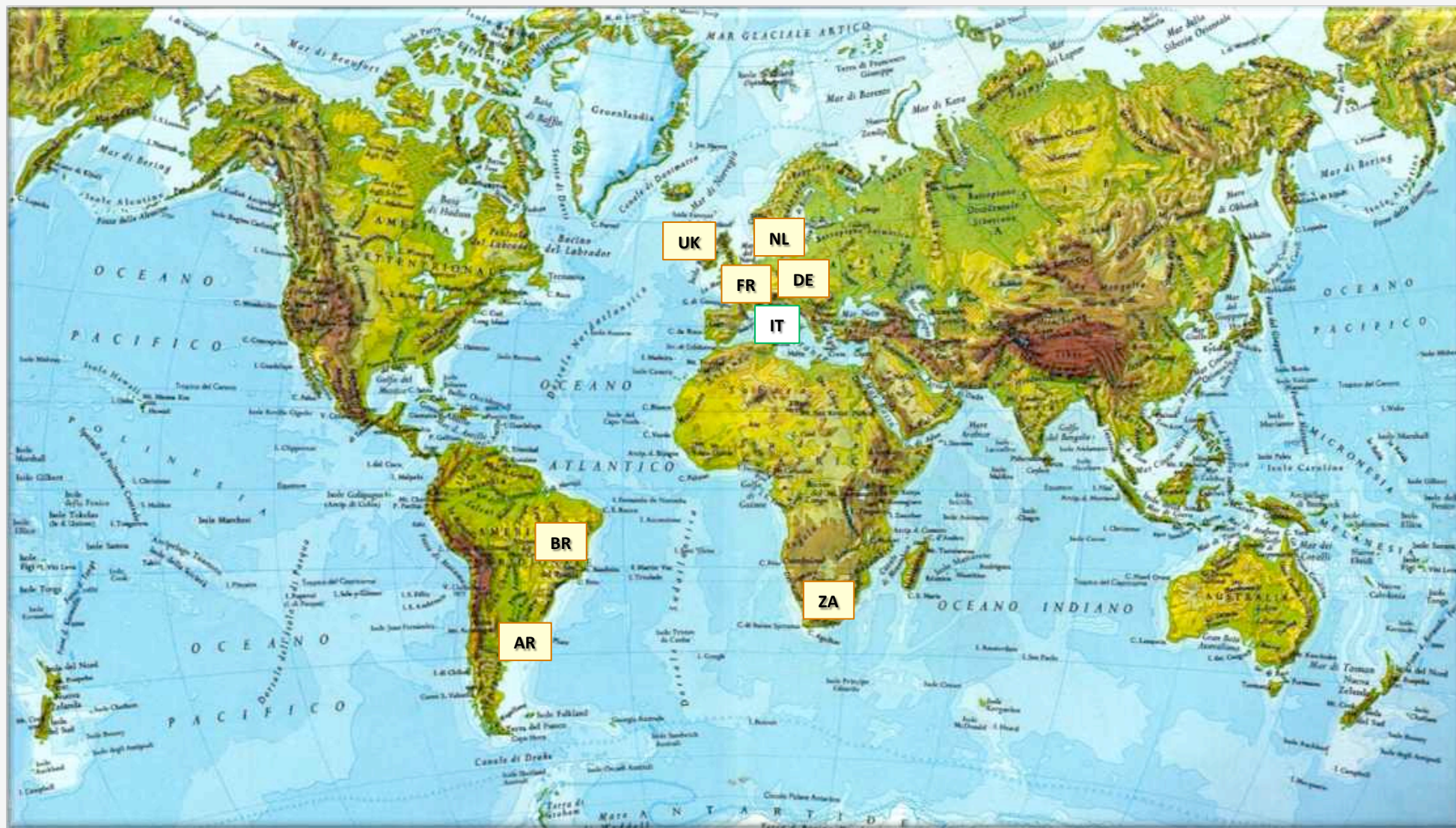
University Partners

- University of Padova
- University of Perugia

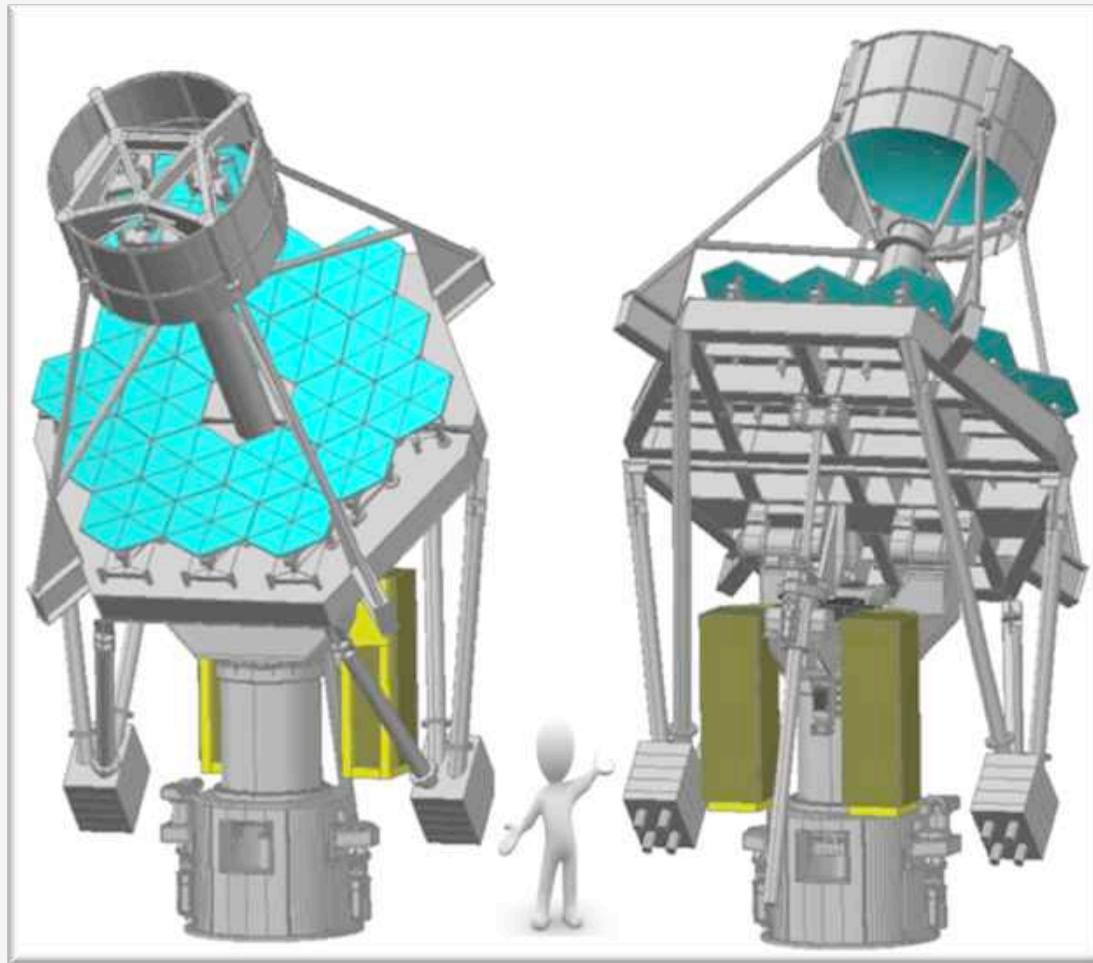
The ASTRI Collaboration ...



... and synergies with other CTA groups



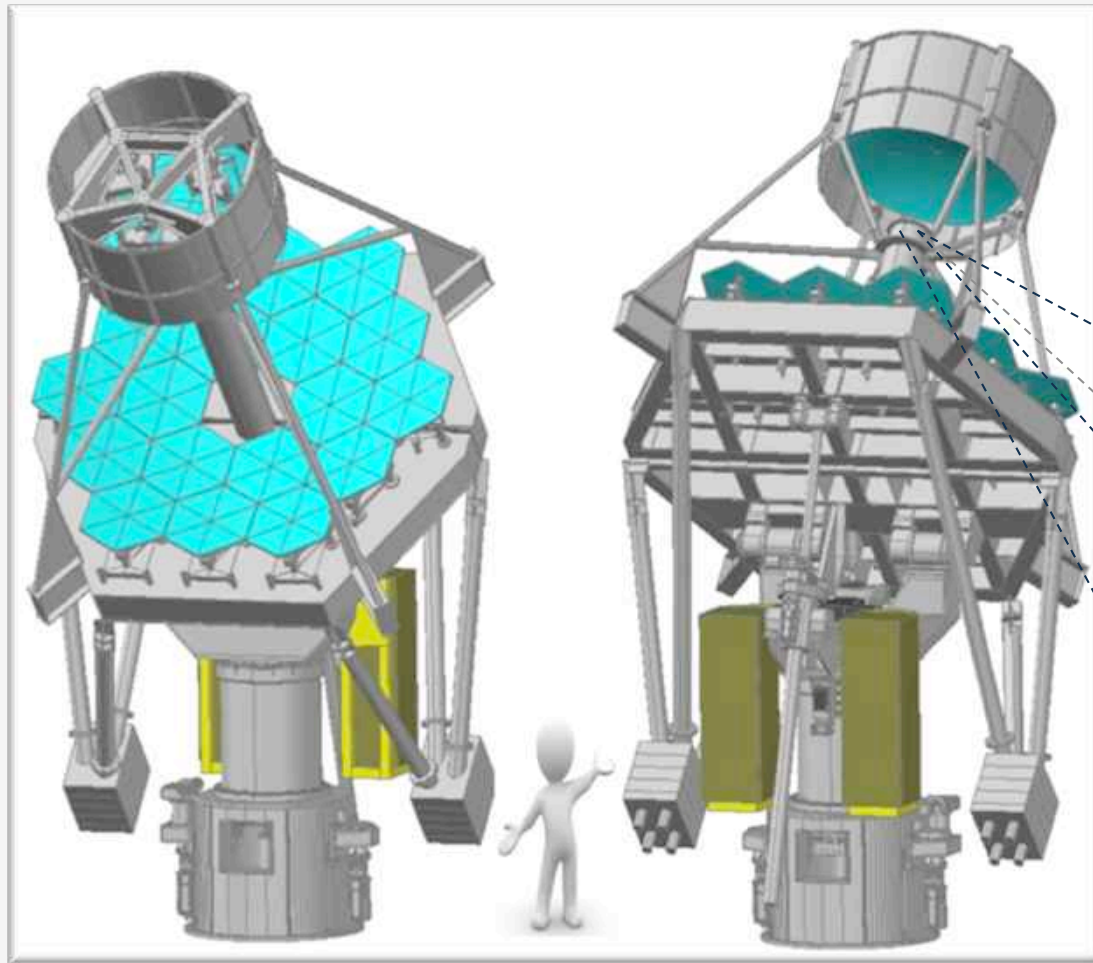
The prototype



... devoted to investigate the VHE region, 1-100 TeV, in a wide field of view, 9.6° full FoV, making use of two innovative technological solutions :

- ✚ a dual-mirror optics Schwarzschild-Couder configuration,
- ✚ a compact focal plane camera ($50 \times 50 \times 50 \text{ cm}^3$) based on Si-PMs sensors.

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Serra La Nave (SLN)

The ASTRI SST-2M telescope is an end-to-end prototype that will be tested on field.

The **ASTRI SST-2M prototype** will be placed, at the INAF "M.G. Fracastoro" observing station located in **Serra La Nave** on the Etna Mountain near Catania.

Latitude: $37^{\circ} 41' 05'' N$

Longitude: $14^{\circ} 58' 04'' E$

Altitude: $1735 m \text{ a.s.l.}$

After the verification tests, devoted to probe the technological solutions adopted, the ASTRI SST-2M prototype will perform scientific observations on the Crab Nebula and on some of the brightest TeV sources ...



Serra La Nave (SLN)

... a few 'numbers'

Light pollution	Medium level extending in SSW, below 30°
Atmosphere quality	Medium level of humidity
	Volcanic ash, rarely present: altitude wind from West to East
Fraction of useful nights	> 53 %
Clear horizon	Above 20° on average
Seismic activity	Low risk of strong earthquakes. Volcanic tremors are modest
Average wind speed	1.9 m/s (7 km/h)
Maximum temperature	28 °C
Minimum temperature	-10 °C
Cloud coverage	50 %
Average summer humidity	67 %
Average winter humidity	79 %

Serra La Nave (SLN) and auxiliary systems

... what weather, atmosphere and sky monitoring systems will be used for ASTRI SST-2M at SLN?

Main Auxiliary Systems:

- Weather Station
- All Sky Camera
- Sky Quality Meter
- UVscope-UVSiPM

... and ...

- LIDAR
- Dust Monitor
- Lightning Detector
- ...



Their outcomes will be used for various purposes:

- **Level Guard (Alerts)**
- **Data Calibration (Analysis)**
- **Statistics and Forecast**

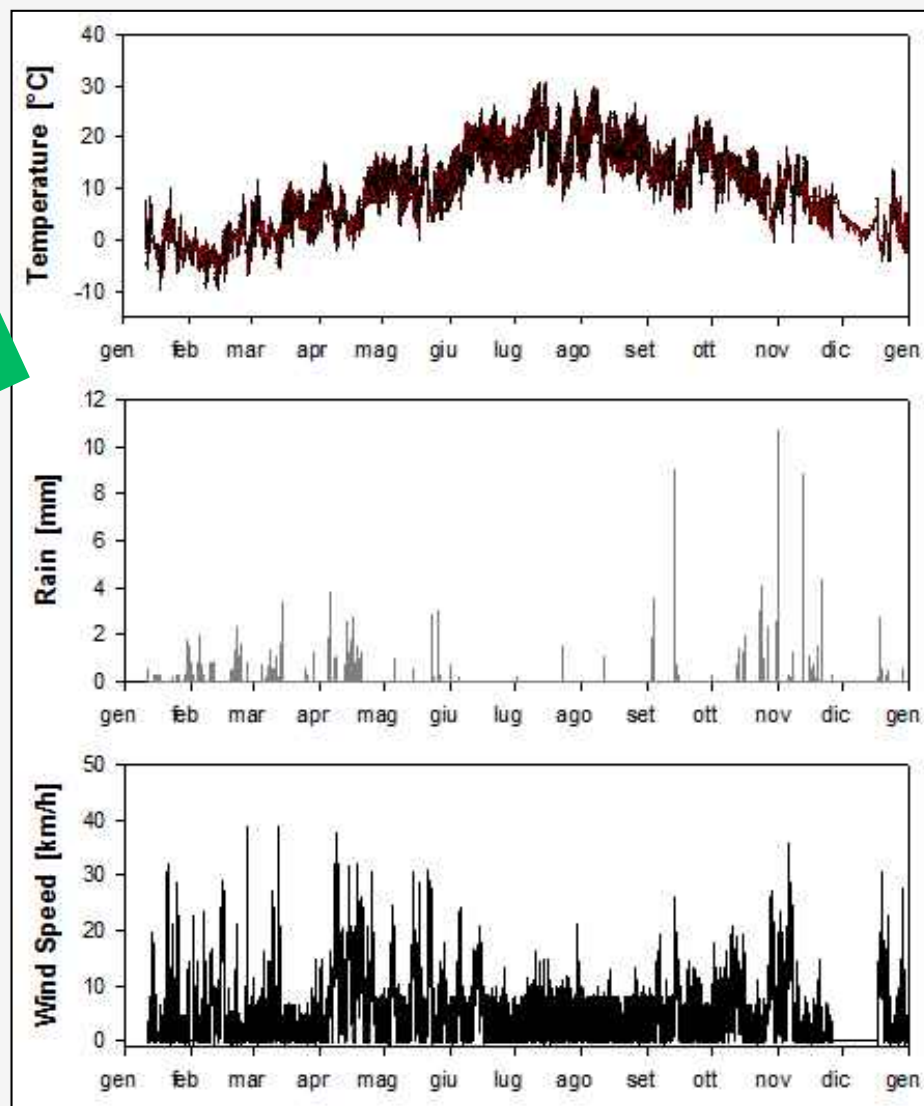
WS Davis Vantage Pro 2
with data logger for alerts
(2 s sample rate)



**fully
functional**



The Weather Station



Weather data at SLN, year 2012

WS Davis Vantage Pro 2
with **data logger for alerts**
(2 s sample rate)

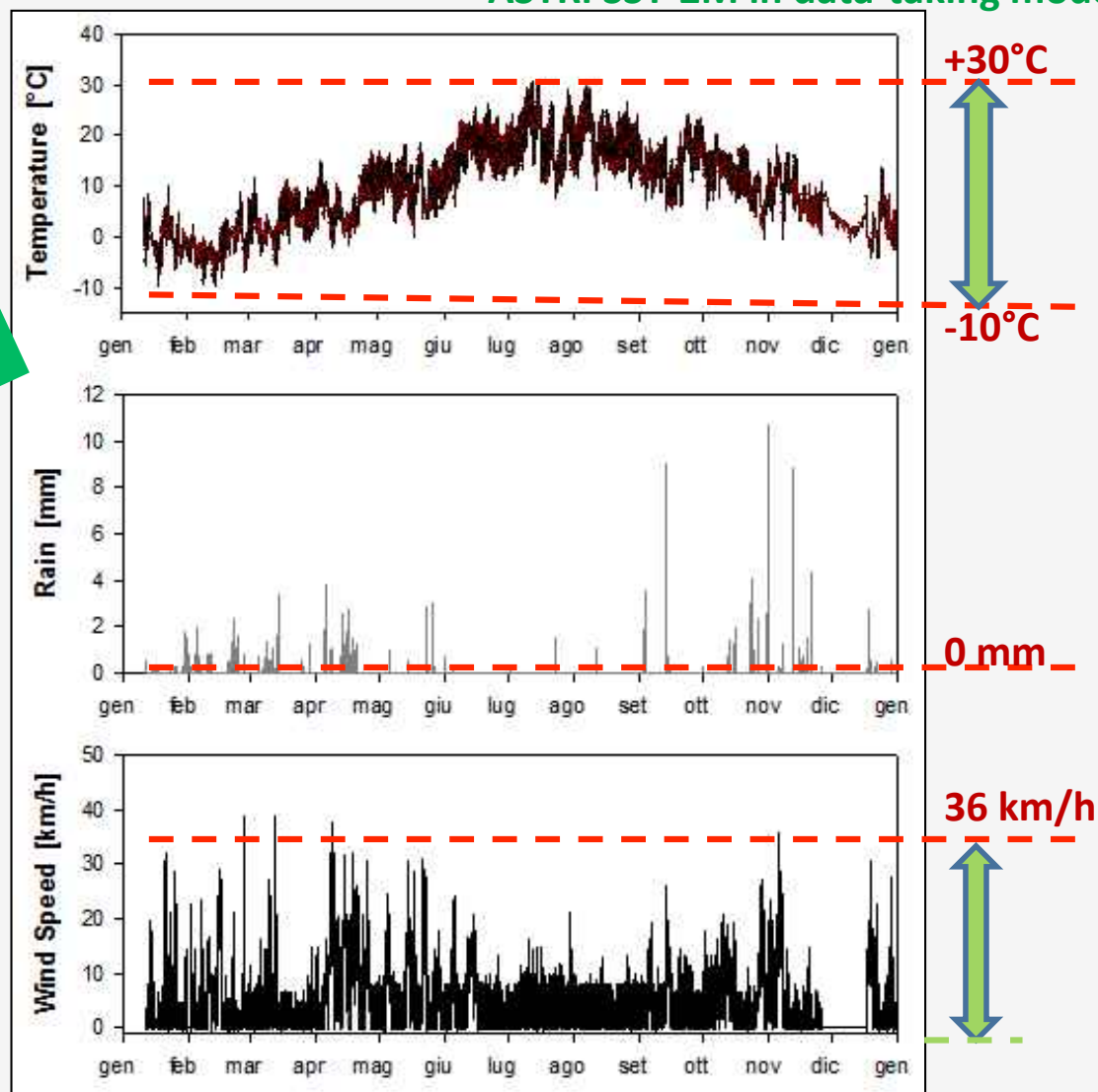


fully functional



The Weather Station

ASTRI SST-2M in data-taking mode

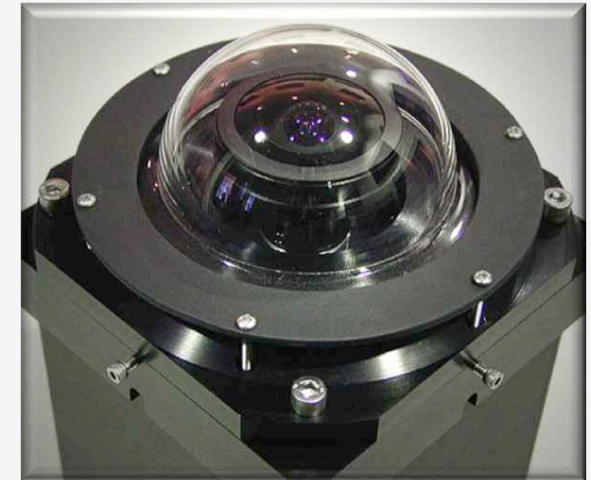


Weather data at SLN, year 2012

SBIG AllSky-340C

Color Fish-Eye

- ✚ Shielded by a water proof housing
- ✚ Kodak KAI-340 CCD (640×480 pixels, 7.4 microns square)
- ✚ Fisheye lens Fujinon FE185C046HA-1 , 1.4mm focal length
- ✚ Integration time range from 50μs for daylight acquisitions
- ✚ Temperature range between -20°C and 50°C
- ✚ Equipped with both RS-232 and USB interfaces
- ✚ Can take an image while transmitting



Images can be saved at different time interval;
(one image per minute → 72Mb/day).

From stored image a log of the
cloudiness of the sky will be created.

***... operating
from July 2013***

The software has the ability to capture .AVI files
and display them afterwards.

Sky Quality Evaluation

SQM-LE

The "Sky Quality Meter" measures the night sky brightness in mag/arcsec² in the visible light spectrum:

- ✚ Precision 10 % (± 0.1 mag/arcsec²).
- ✚ NIST-traceable light meter
- ✚ zero point error within 10% (± 0.1 mag/arcsec²)
- ✚ Ethernet interface
- ✚ 1 Reading/sec
- ✚ Remote controlled
- ✚ HWHM angular sensitivity 10°



The system returns **integral information** about night background light intensity **in the visible light spectrum** and **inside the entire SQM FoV** (about 20°) ...

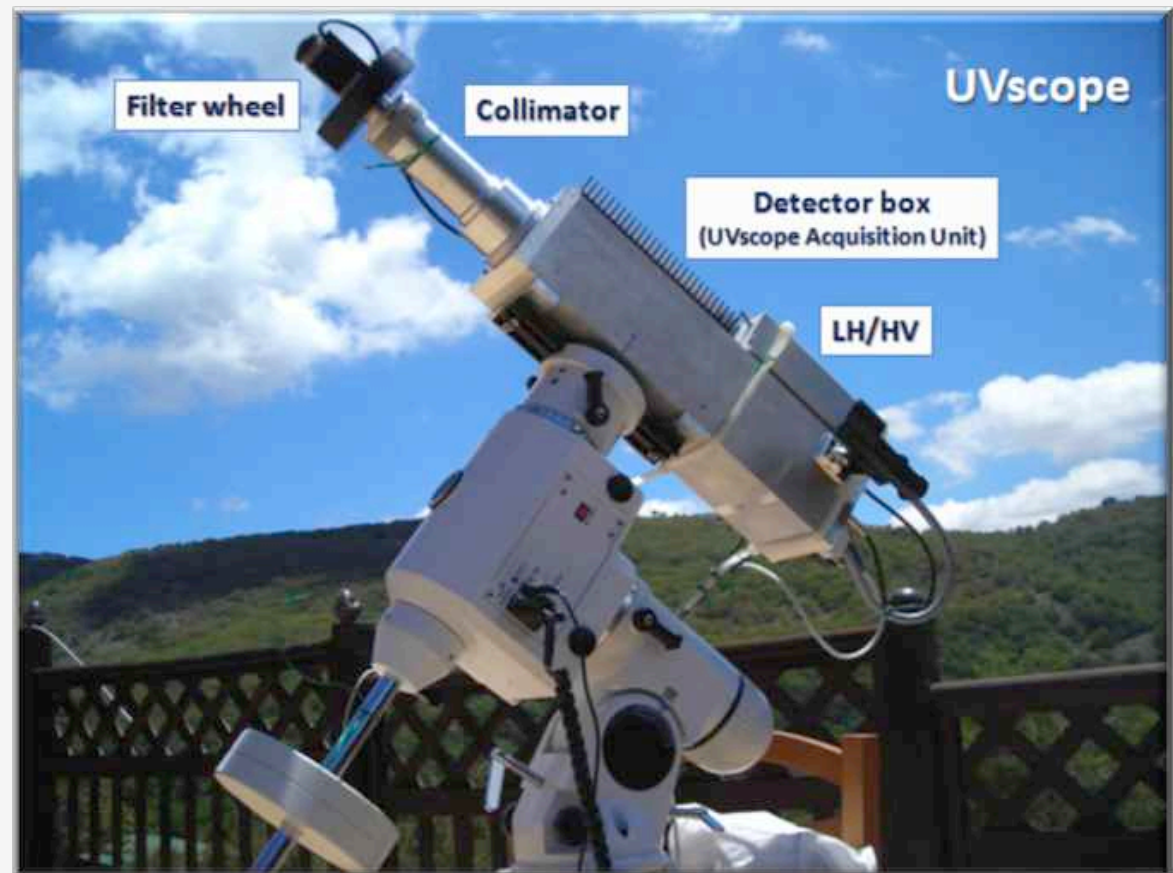


Night Sky Background and more

UVscope

- It's a photon detector (UV extended response) developed at IASF-Palermo, suitable for Night Sky Background (NSB) diffuse light and Atmospheric Extinction measurements

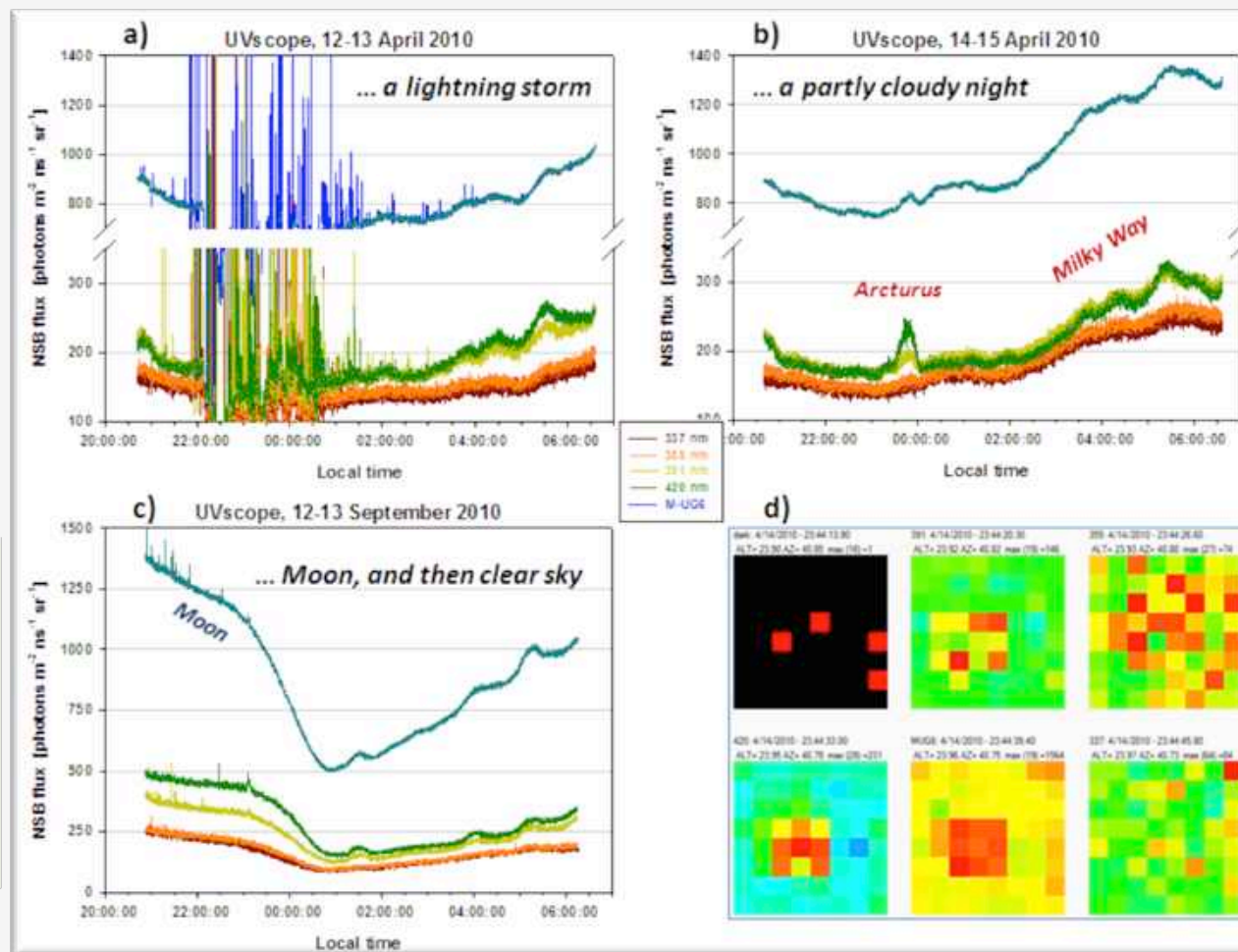
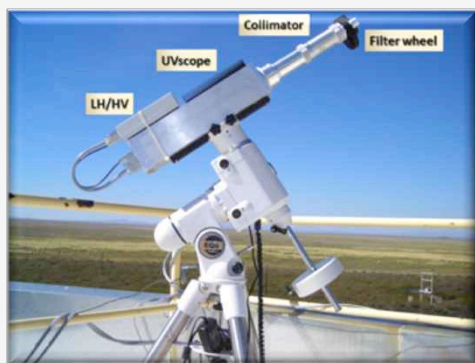
- it works in single photon counting mode
- it's a light, portable instrument that can be easily mounted on a motorized tripod
- its head is a 8×8 multi-anode photomultiplier tube MAPMT Hamamatsu R7600-03-M64.



Ref. Maccarone et al., NIM-A, 659, 569–578 (2011)

UVscope at Los Leones

Night Sky Background and more



Time profiles of the NSB light as observed by UVscope under different weather and sky conditions (a–c). The measurements are performed pointing towards a fixed region of the sky through narrow-band (337, 355, 391 and 420 nm) and wide-band (M-UG6) filters. The remaining slot in the filter wheel is maintained “closed” so to monitor the dark current noise. For each filter in use, panel (d) shows an instantaneous view of the UVscope data acquired at the passage of the Arcturus star near the center of the UVscope FoV (Full FoV=6.56°).

NIM-A, 659, 569–578 (2011)

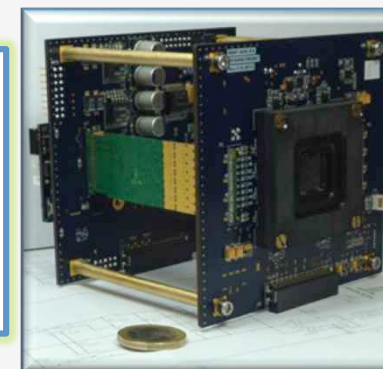
Night Sky Background and more

UVscope & UVSiPM at SLN

- Single Photon Counting mode
- 157.95 mm Collimator Length
- 17.68 mm² Pupil Area
- about 6° Full Field-of-View
- John-B-25 Calibrated Filter

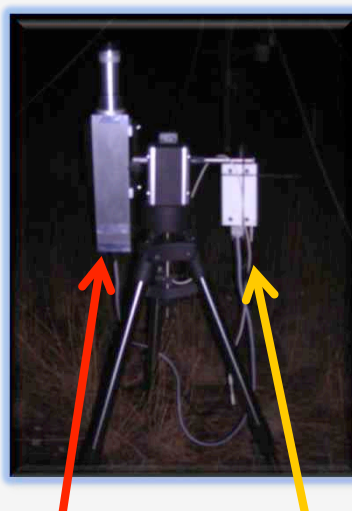
UV-SiPM:

- ❖ SiPM as detection unit,
4x4 pixels module
- ❖ **3 mm Pixel Size**

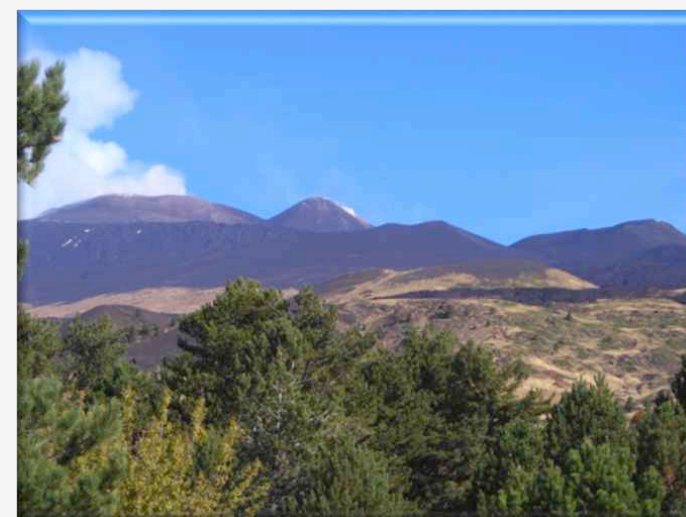


UVscope:

- ❖ MAPMT as detection unit,
8x8 pixels module
- ❖ **2.3 mm Pixel Size**



UVscope on its mount (second arm ready to support the future UV-SiPM)



**... operating from
August 2013**

Serra La Nave (SLN) and further monitoring systems

Their outcomes address various purposes:

Further Monitoring Instruments	Level Guards (Alerts)	Data Calibration (Analysis)	Forecast and Statistics
LIDAR	No	Yes	No
Dust Monitor	Yes	Yes	statistics
Lightning Detector	Yes	Yes	Yes

LIDAR AMPLE

LIDAR at Serra La Nave

The Light Detection And Ranging technology allows to study the atmospheric composition, structure, clouds and aerosol through the measurement of the atmospheric extinction profile.

work in progress at SLN

- Source: Nd-YAG diode pumped
- 355 nm, 0.6 W, 2ns pulse width, Depol+RAMAN, time res. 100 ns
- Alt/Az scan available



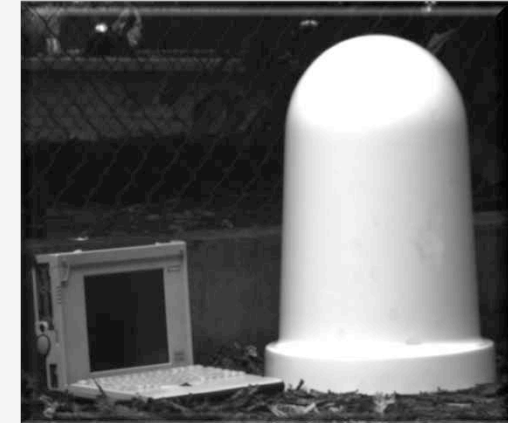
Collaboration INAF-OACT with INGV-CT and University of Naples

Monitoring ash particles and more

PLUDIX

The **Pluviodisdrometer** consists in a small **radar** that

- ✚ exploits the **Doppler effect** of the **ash particles** in motion
- ✚ detects the **amount** and the **particle size** and
- ✚ provides an estimate of the **quantity falls** to the ground.



under test at SLN



- ✚ Detector of the presence of precipitation
- ✚ Identifier of the type of precipitation (rain, snow, hail)
- ✚ Measuring the size distribution of hydrometeors (drops, snowflakes, hailstones) forming the precipitation (disdrometer)
- ✚ Measuring the intensity of the instantaneous precipitation (rain gauge)
- ✚ Totalizer amount of water fall
- ✚ Reveals ash fall

Lightning and thunderstorms

Lightning Detector

Measuring the atmospheric electric field with an **EFM** - Electric Field Meter



- EFM has been developed by INAF-IRA, Institute of Radio Astronomy, as auxiliary instrumentation for SKA, the Square Kilometer Array
- Hardware + Software ready

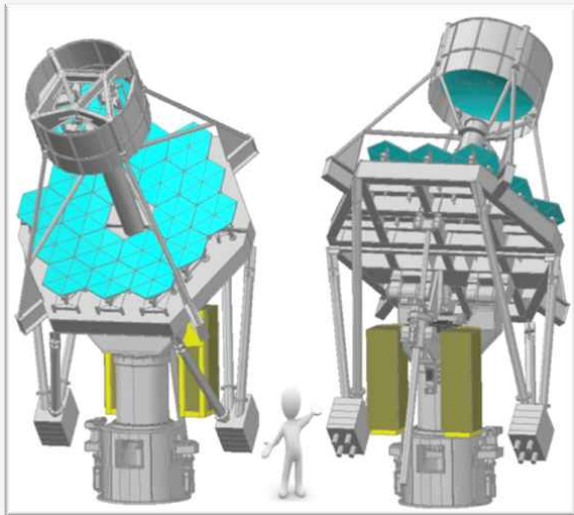
Characteristics:

- ✚ High sensitivity
- ✚ GPS
- ✚ Grid install provide direction/distance
- ✚ Provide alerts

under test at SLN soon



ASTRI SST-2M at Serra La Nave



- Weather Station
- All Sky Camera
- Sky Quality Meter
- UVscope-UVSiPM

- LIDAR
- Dust Monitor
- EFM lightning detector
-





ASTRI Astrofisica con Specchi a Tecnologia Replicante Italiana

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Welcome to ASTRI project Home Page

ASTRI (Astrofisica con Specchi a Tecnologia Replicante Italiana) is a flagship project of the Italian Ministry of Education, University and Research related to the next generation IACT (Imaging Atmospheric Cherenkov Telescope), within the framework of the [CTA](#) (Cherenkov Telescope Array) International Observatory. In this context, INAF (Italian National Institute of Astrophysics) is currently developing a scientific and technological breakthrough to allow the study of the uppermost end of the VHE domain (a few TeV - hundreds of TeV). The ASTRI project timeframe is of about 3 years, and foresees the full development, installation and calibration of a Small Size class Telescope prototype compliant with the requirements of the High Energy array of CTA. The ASTRI prototype will adopt an aplanatic, wide field, double reflection optical layout in a Schwarzschild-Couder configuration. Moreover, the focal plane instrument will explore small pixelated detector sensors such as multi-anode PMTs or Silicon PM.

Among the number of technological challenges, this telescope will be the very first instrument implementing both the Schwarzschild-Couder optical configuration and the double reflection for air Cherenkov imaging.

For other information about INAF Institutes involved in the ASTRI Project click on [Team](#) in the menu above.

News

March 12, 2013

The Final Design Review (FDR) of the telescope structure and electro-mechanical components has been successfully completed in February 2013. The ASTRI project can now move into the manufacturing phase of the telescope. Its on-site erection is foreseen to happen in Spring 2014.

Logos: INAF, ASPPE, IASf, OA Torino, INAF-OAR, CTA, Observatoire de l'Université de Bordeaux



<http://www.brera.inaf.it/astri/>