Update on ASTRI/CTA

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The Cherenkov Telescope Array concept

Low energy

4.5° FoV

2000 pixels
~ 0.1°

Medium energy

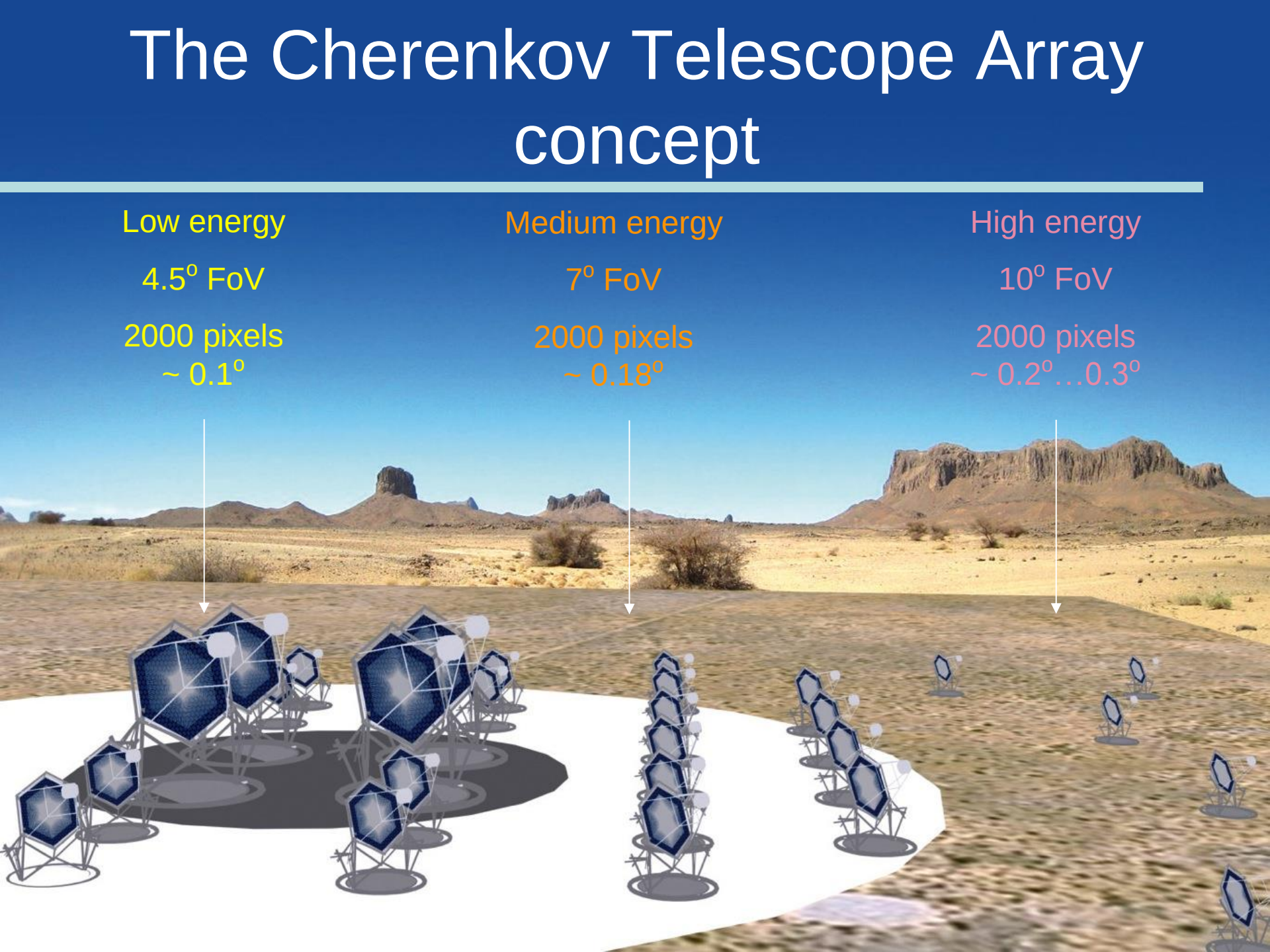
7° FoV

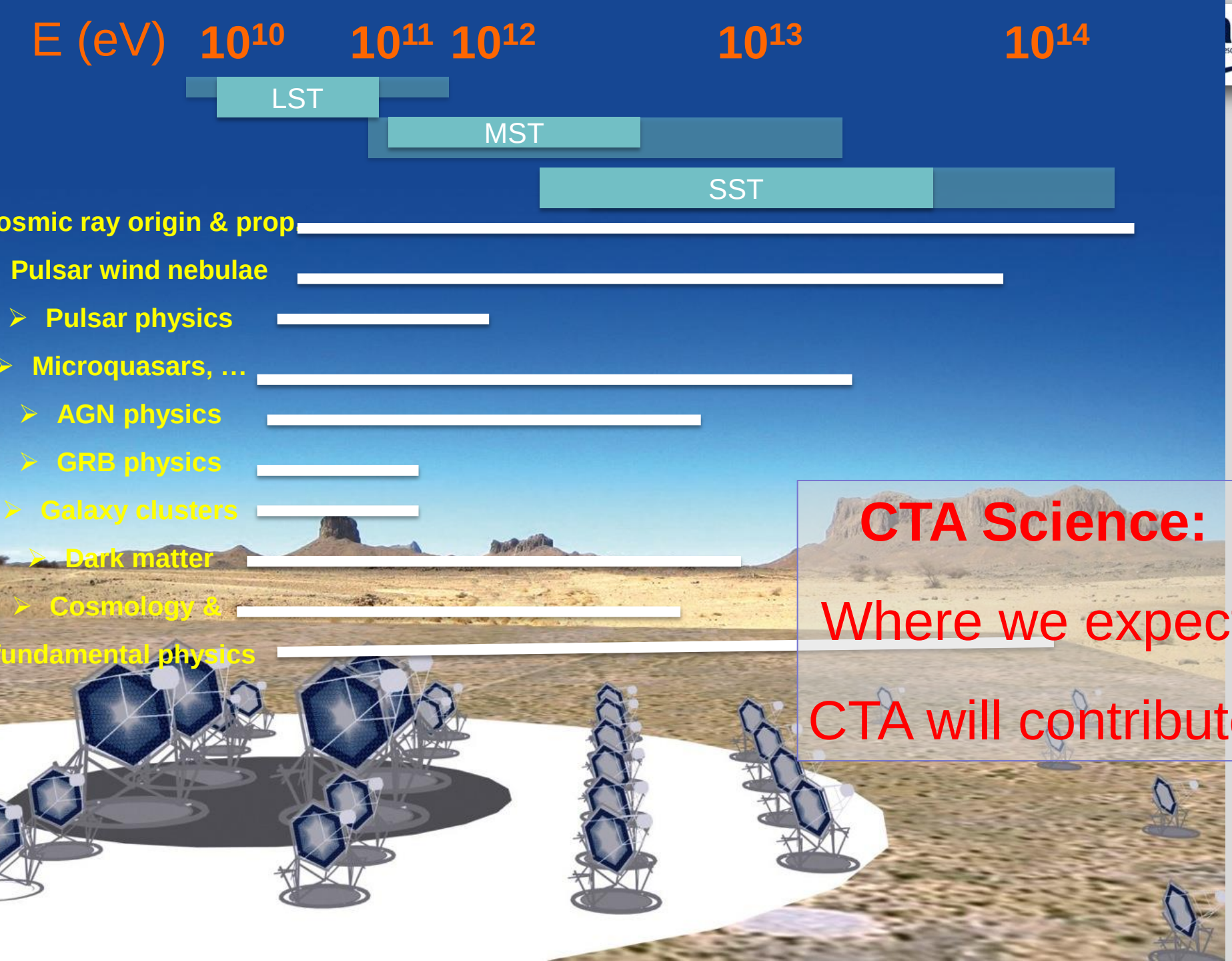
2000 pixels
~ 0.18°

High energy

10° FoV

2000 pixels
~ 0.2°…0.3°




E (eV)
10^{10}
10^{11}
10^{12}
10^{13}
10^{14}
LST
MST
SST
osmic ray origin & prop
Pulsar wind nebulae
Pulsar physics
Microquasars, …
AGN physics
GRB physics
Galaxy clusters
Dark matter
Cosmology &
undamental physics
CTA Science:
Where we expect
CTA will contribute

CTA SST array and Dual-Mirror (DM) configuration

- SST array ~70 telescopes (South only ➔ high energy emission mainly expected from galactic sources)

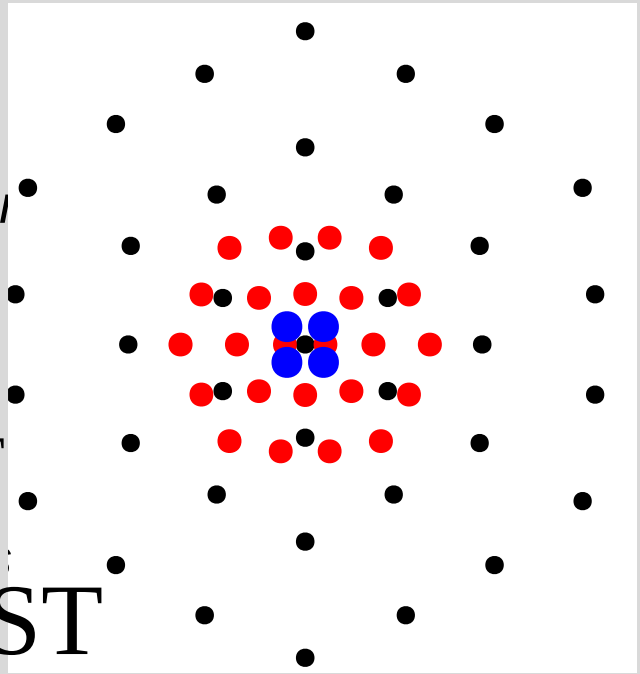
- Possible implementon for the Northern site?

- *Must cover >4 km^2 area*
- *~ 4 m telescope with compact / low cost camer*
  (spacing ~ $\sqrt{(A_{req}/N_{teles})}$ ~ 200-300 m

- *FOV: > 8 deg x 8 deg*

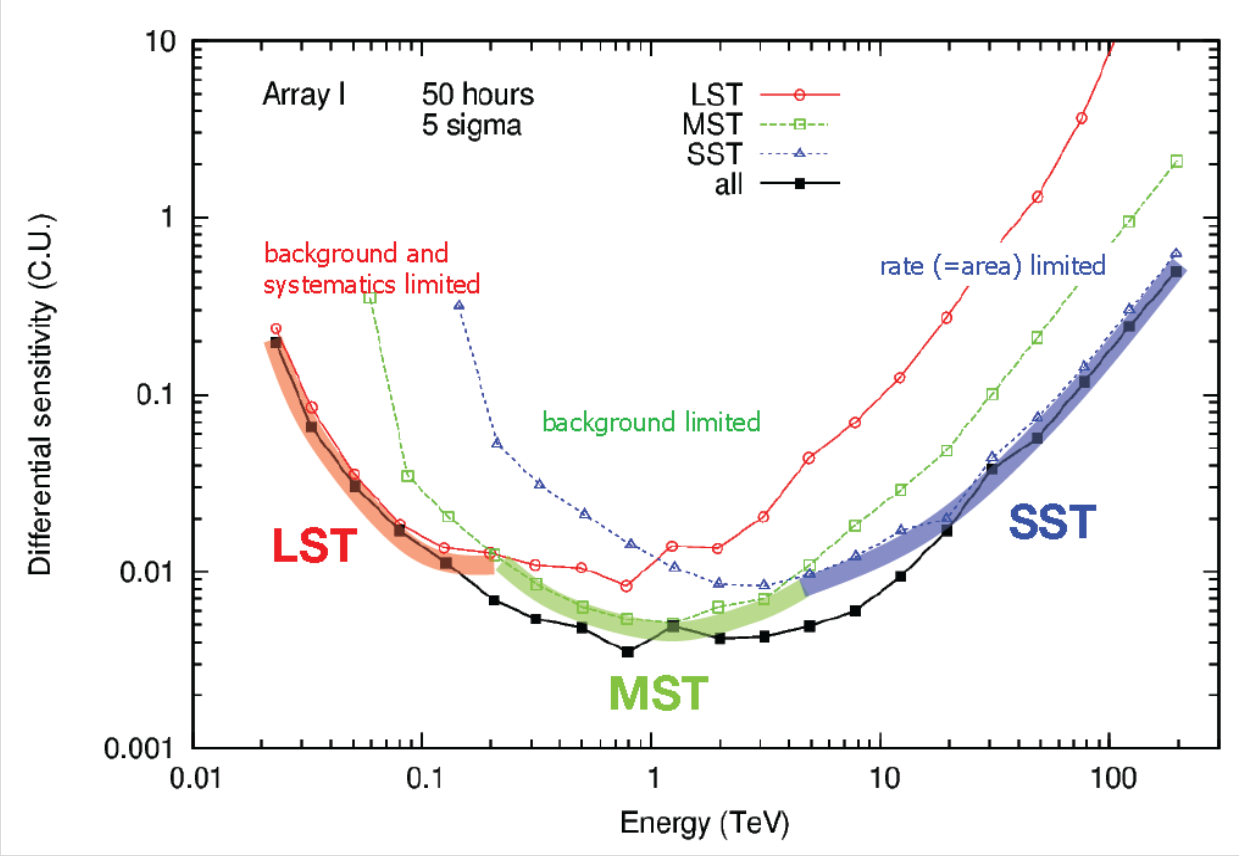
- *Angular resolution < 0.2 deg*

- *LOW COST!*
- *➔Target price ≈ 0.5 Meuro/Telescope*

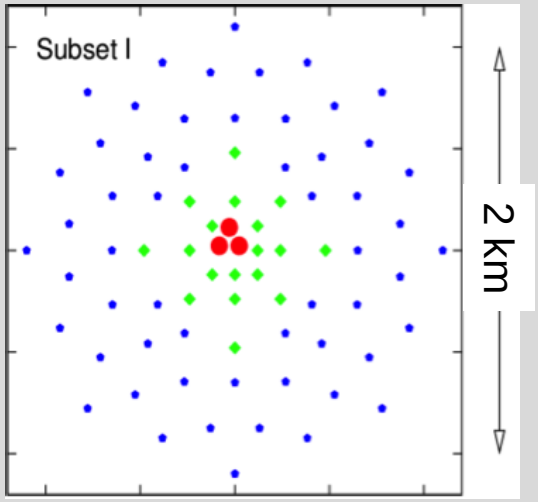


Sensitivity & SST array

- SSTs responsible for high energy sensitivity of CTA.



- Results for Array I



- Must cover area greater than ~ 4 km^2 (sensitivity).

- Must have diameter greater than ~ 3.5 m (trigger threshold).

Small size telescope: two possible designs

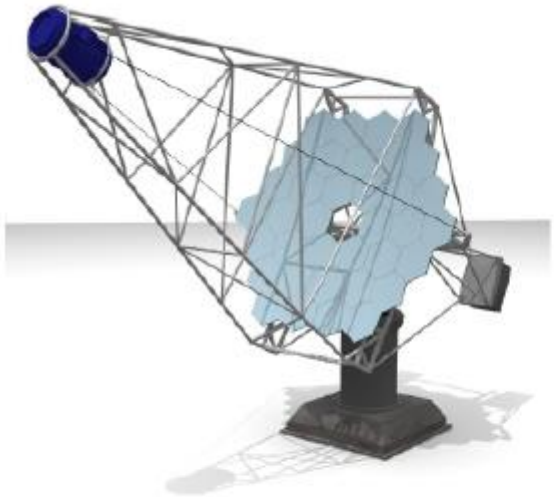


Fig. 5 The Davies-Cotton design.

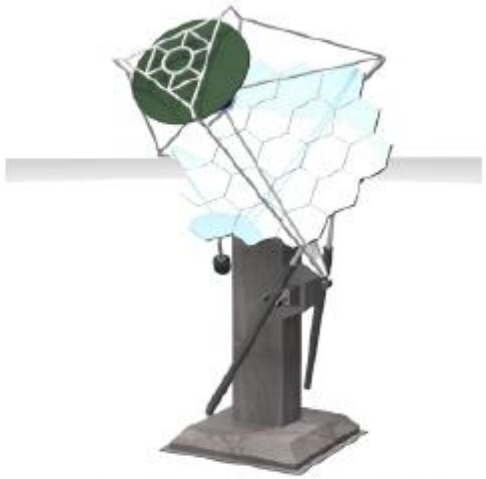
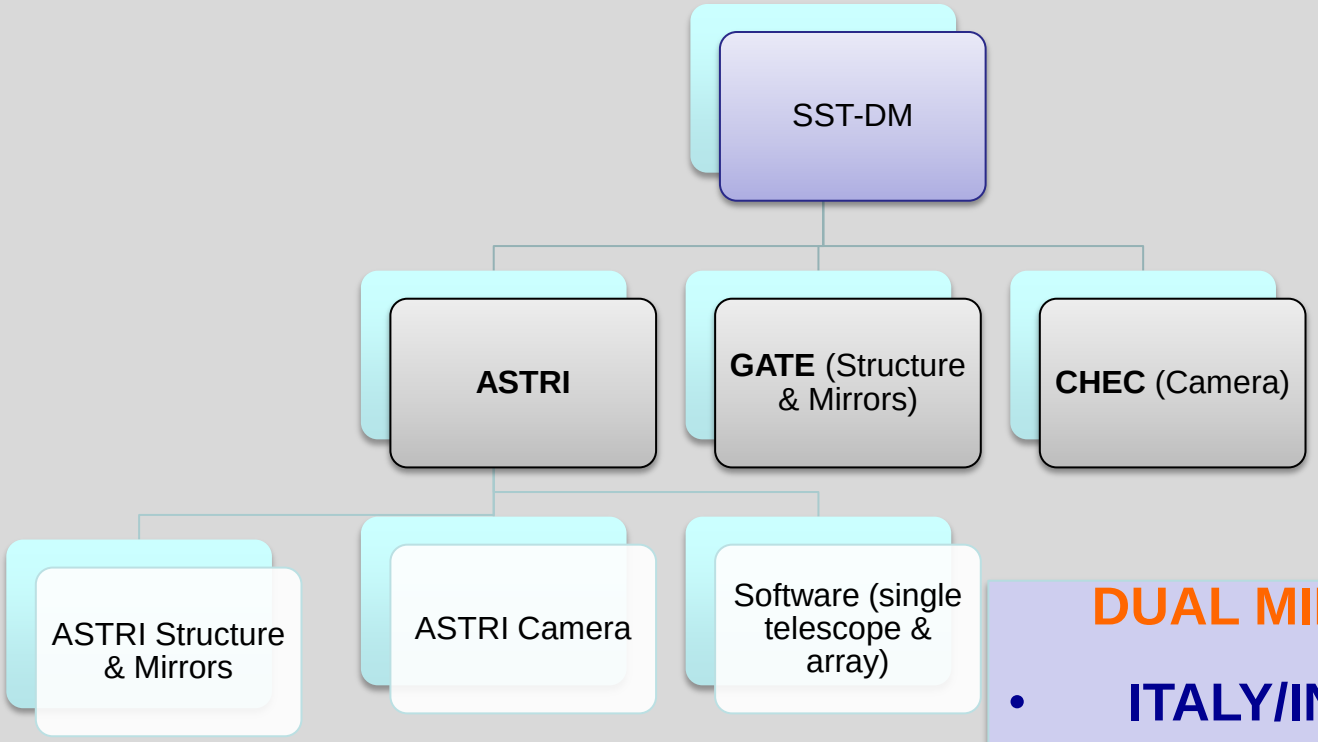


Fig. 6 The Schwarzschild-Couder design.

- Single mirror DC is the optical model of the present Cherenkov telescopes

- Single mirror DC is the baseline for LST and MST of CTA.

SST: roups at work and their organization



DUAL MIRROR MINI-ARRAY

- **ITALY/INAF**
- **South Africa, Brazil (Sao Paulo)**
- France➔ possible agrrement
- Possible contributions by CHEC

The ASTRI Project

- ASTRI is the Flagship Project of INAF devoted to the development of Cherenkov small-size dual-mirror telescopes in the CTA framework

- ASTRI consists of two sub-projects:
  - Prototype Schwarz-Couder **SST-2M** and **SiPM camera** to be installed from fall 2014 at Serra La Nave (INAF Observatory, Mt Etna – Catania)
  - Mini-array of 7 SST-2M installed at CTA south site

The ASTRI Collaboration

Principal Investigator G. Pareschi

Co-PIs O. Catalano & S. Vercellone

Program Manager M. Fiorini

System Engineer L. Stringhetti

INAF/CTA Responsible P. Caraveo

INAF Institutions

IASF Milano

IASF Bologna

IASF Palermo

INAF HQ Roma

OA Brera

OA Torino

OA Padova

OA Bologna

OA Arcetri

OA Roma / ASDC

OA Capodimonte

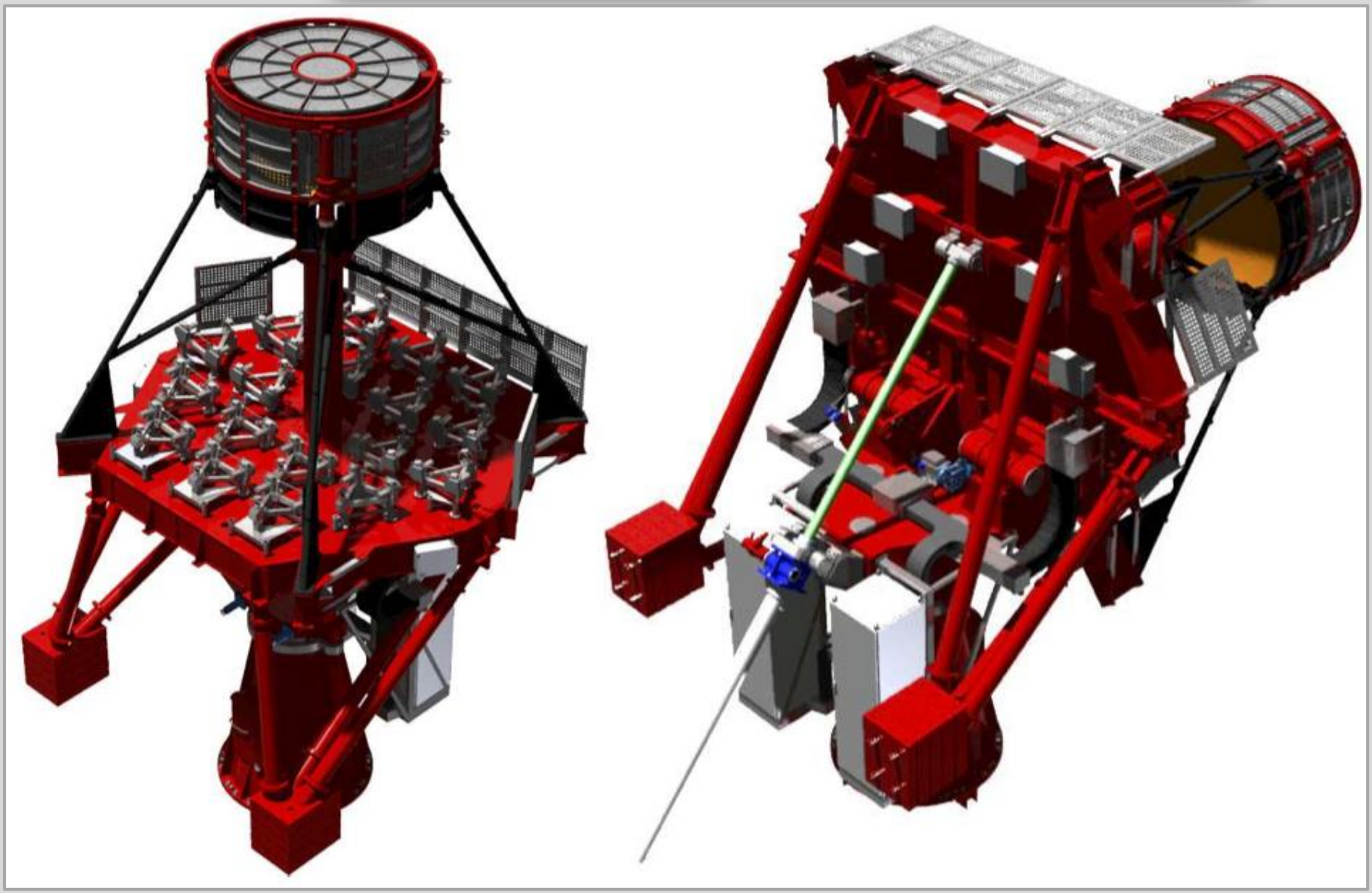
OA Catania

University Partners

Univ. of Padova

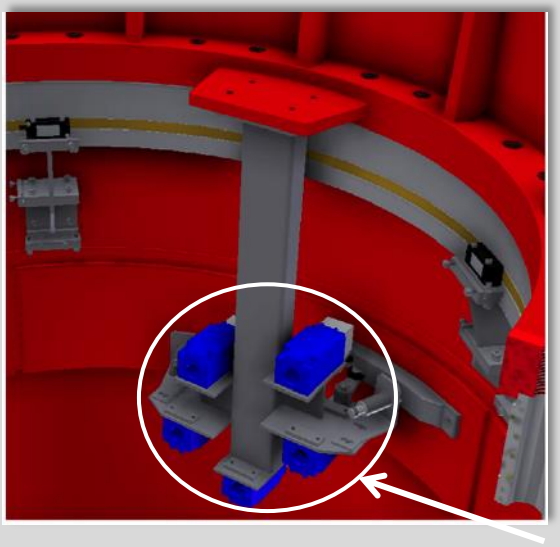
Univ.. of Perugia

ASTRI Structural design



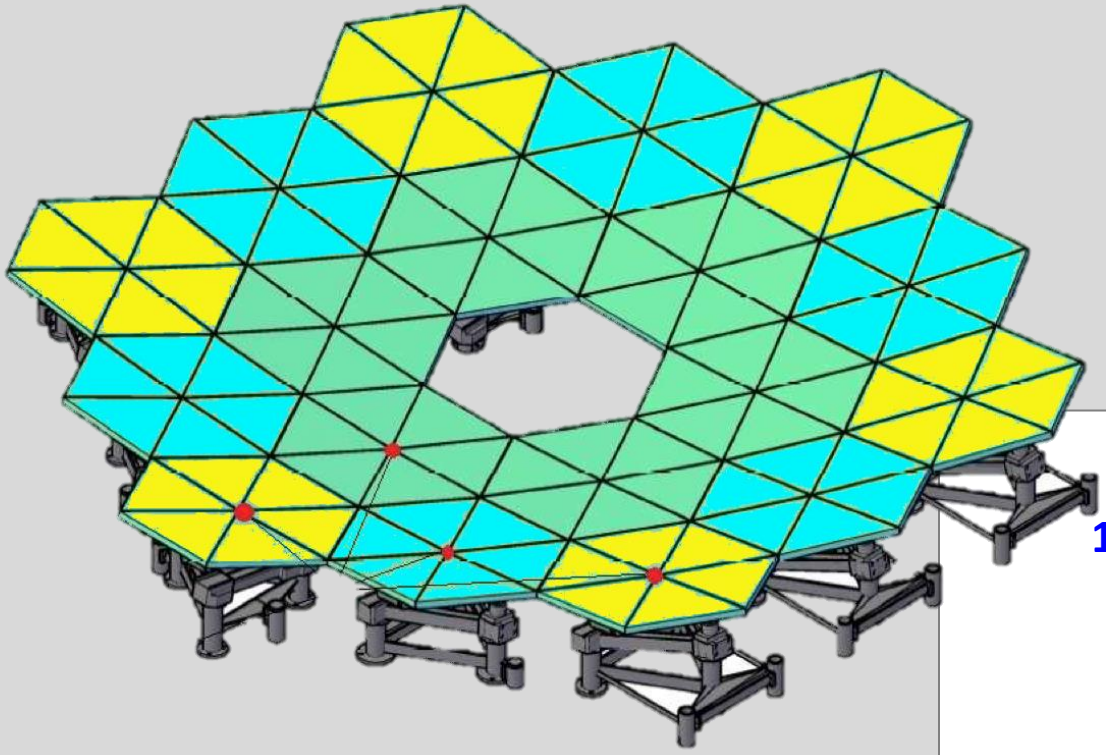
ASTRI Structural design

Heidenhain strip encoder with 4 scanning heads

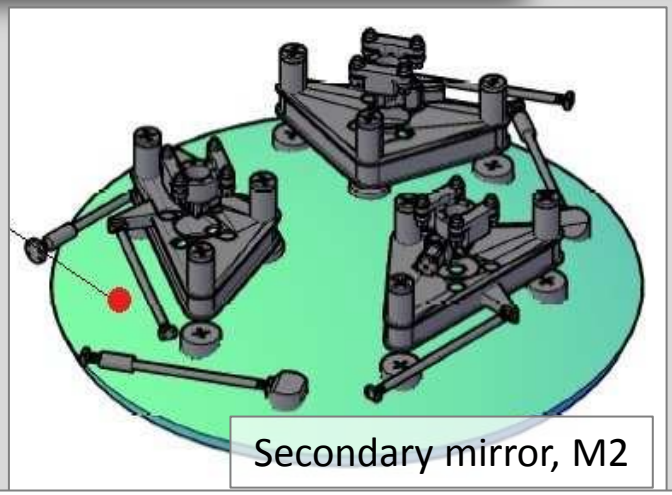


7-switch bracket: 2 inductive +
4 electromechanical + 1 joke

Optical Surfaces: M1 and M2



Primary mirror, M1



Secondary mirror, M2

Primary mirror (M1)

18 hexagonal shaped mirrors (11.2 m^2)

850 mm face-to-face, 1 m diagonal

3 types of segments

2 actuators + 1 fixed point + 1 tangential constraint

Secondary mirror (M2)

1 monolithic mirror, 1.8 m diameter (2.5 m^2)

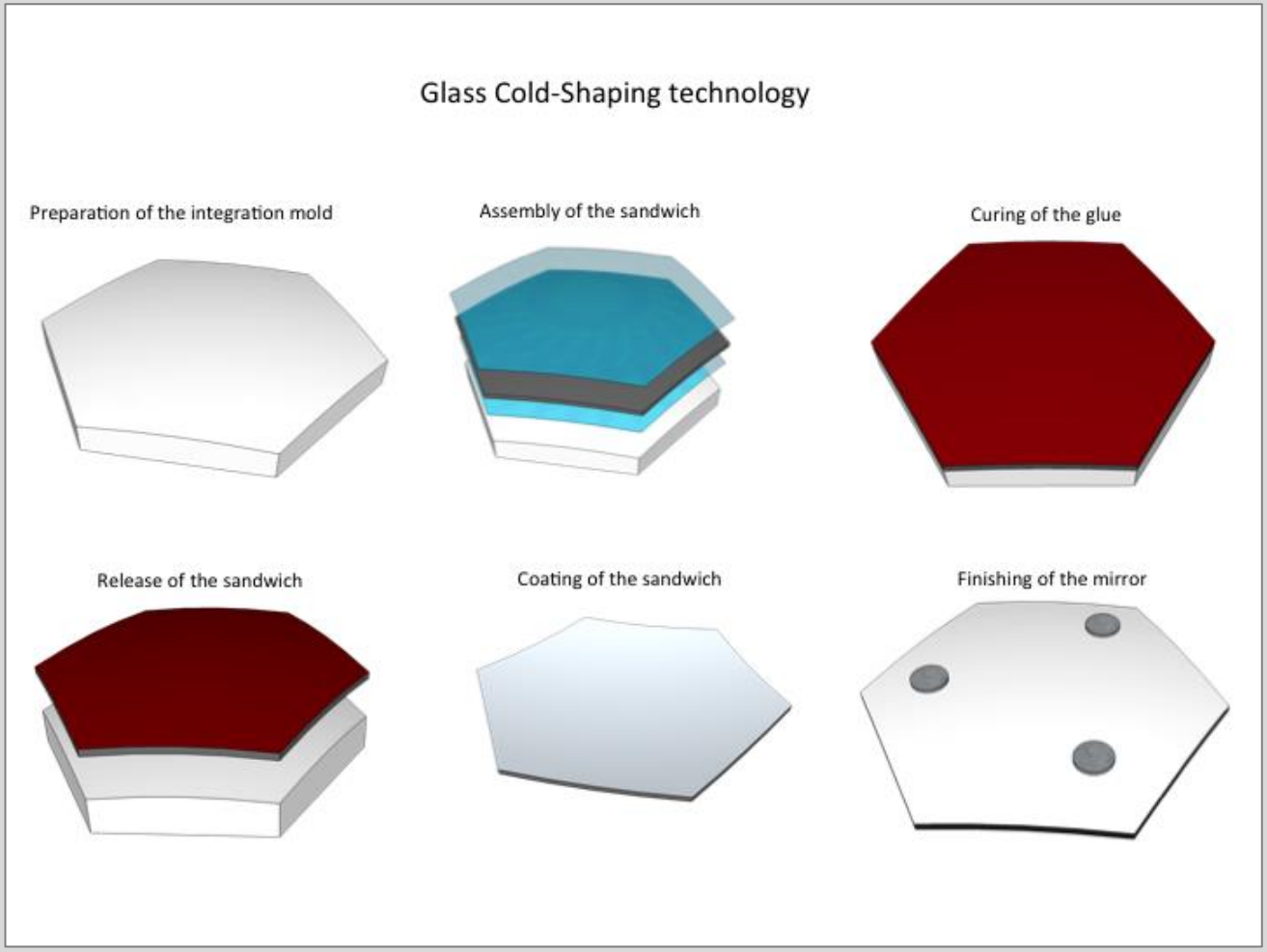
3 actuators + 3 lateral constraints

Coatings

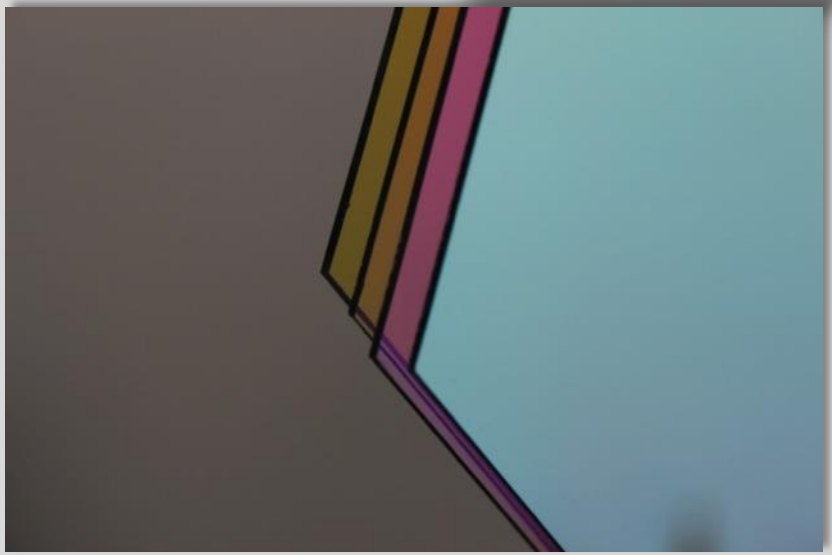
ASTRI Primary Mirror: M1

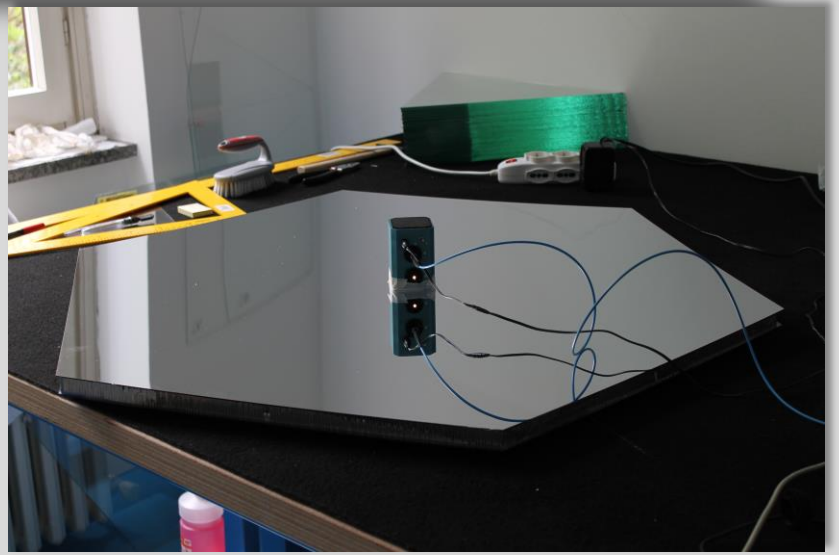
Manufacturing process: Glass cold-shaping

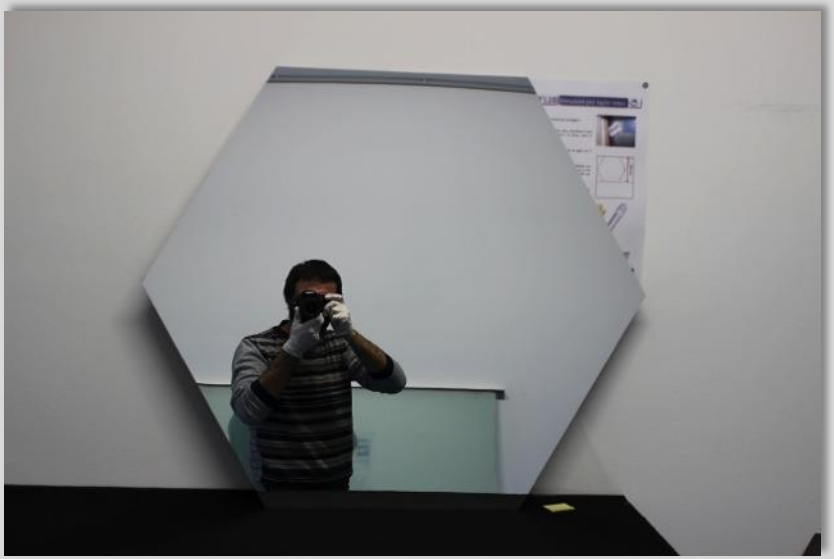
Structural implementation: sandwich panel with thin glass skins



ASTRI Primary Mirror: M1: coatings





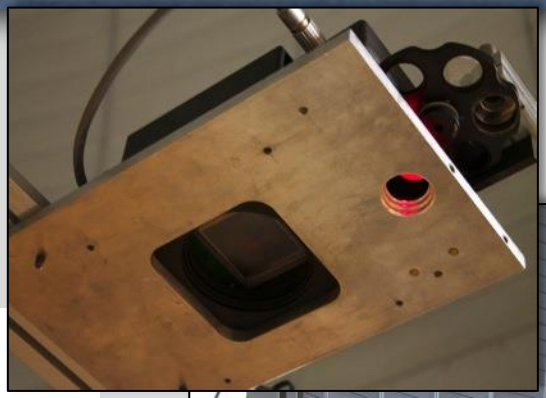


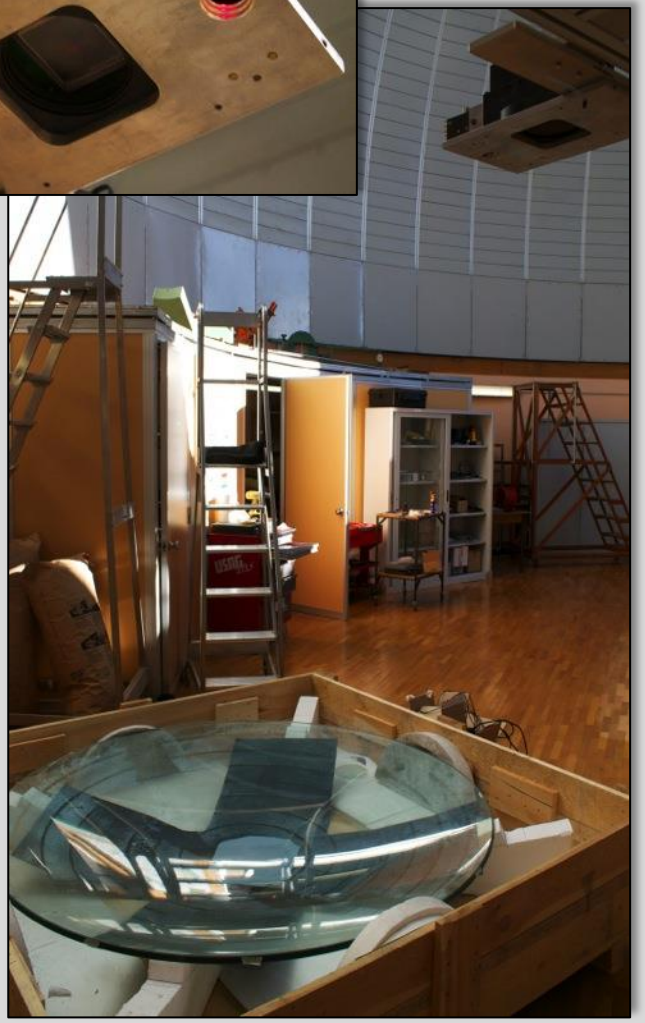
ASTRI Primary Mirror: storage of the tiles

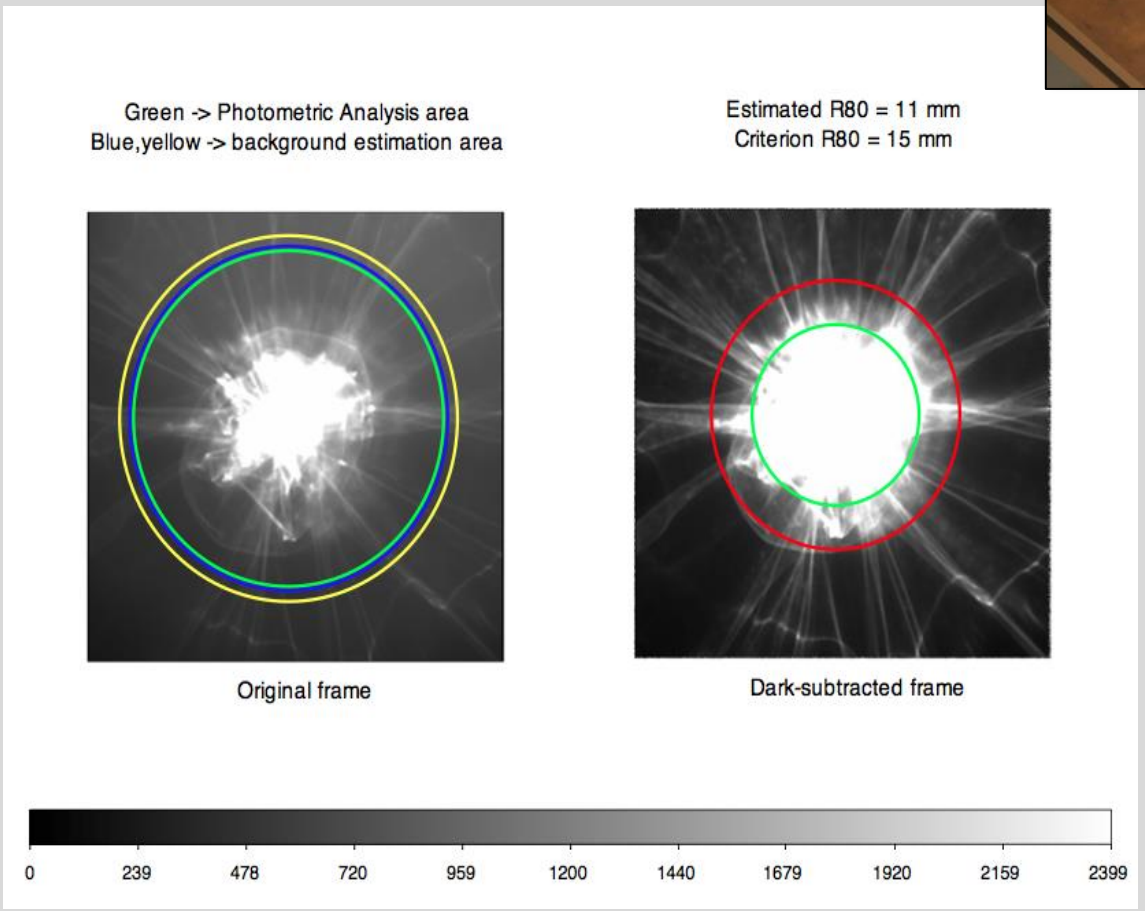
Mirrors are stored, packaged and shipped back and forth for the coating

ASTRI monolithic secondary mirror

Focal length and PSF assessment with laser-meter and large-format CCD camera



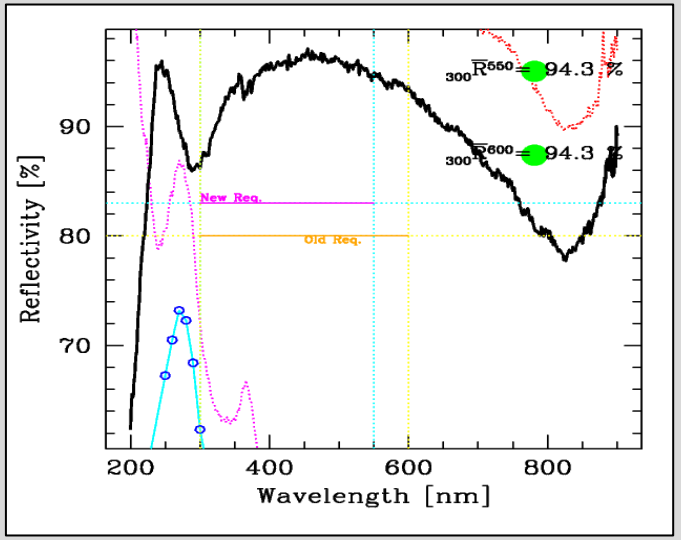




ASTRI Secondary Mirror: M2

An ad-hoc vacuum chamber facility (2 m large) has been designed and developed by ZAOT (Italy) for the deposition of the Aluminum coating and the SiO_2 protective layer.

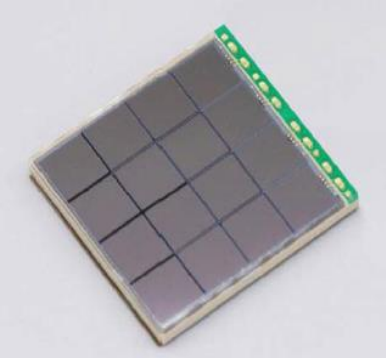
Coating is scheduled from the 22nd – 30th of April.

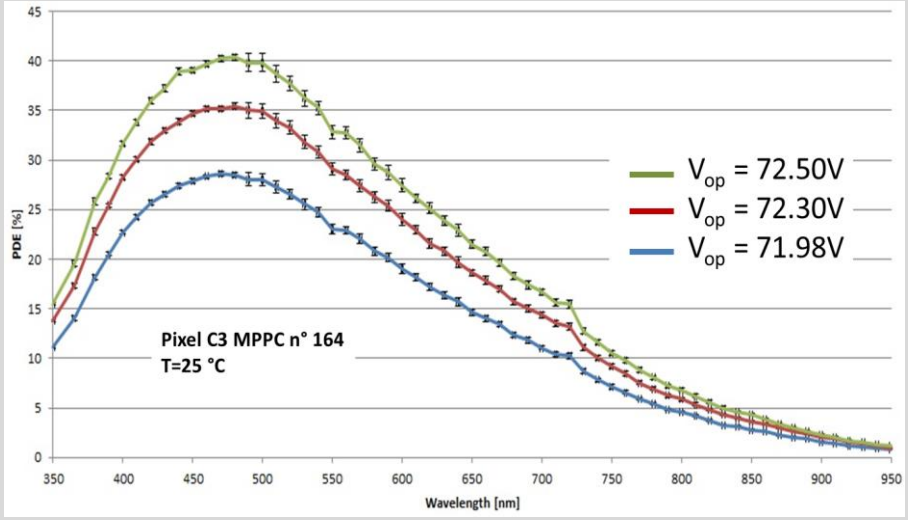


The coating of M2 is composed by Al+SiO_2. Three mirrors will be coated.

ASTRI camera

- EASIROC/CI based electronics
- Hamamatsu SiPM:





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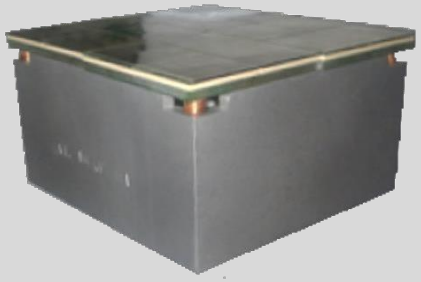
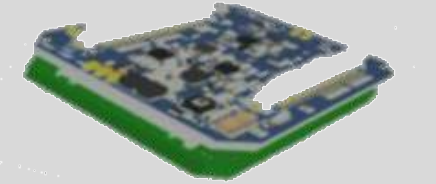
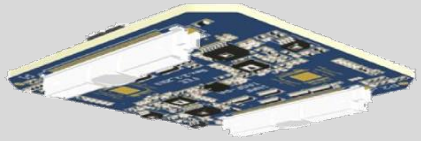
- Mechanical structure:

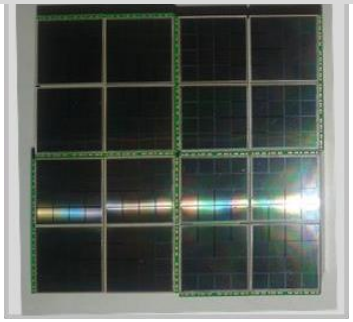
ASTRI Camera

ASSEMBLING

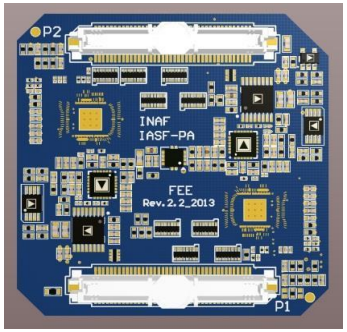








SiPM board
(9 +1 temperature sensors embedded)

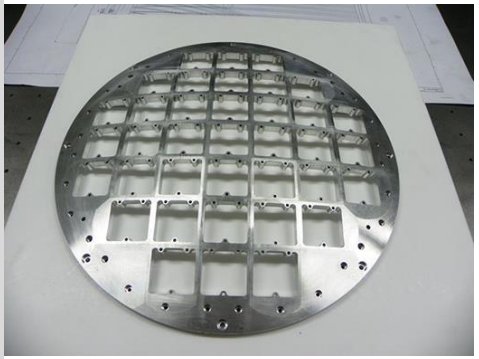
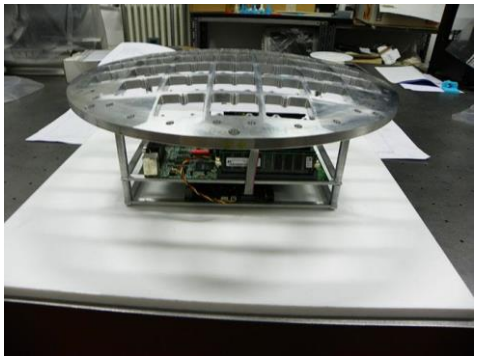
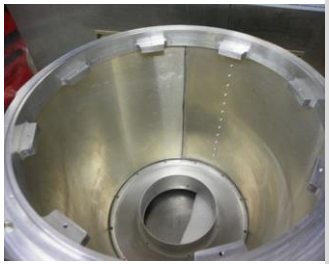
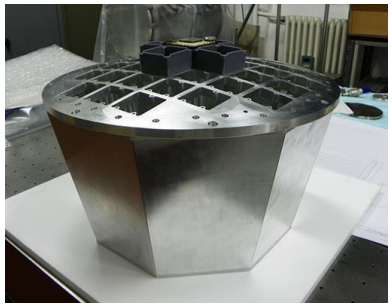


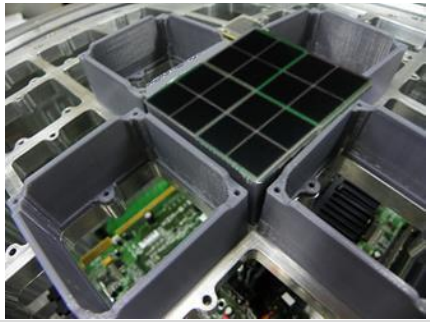
Front-End board
(2 CITIROC ASIC)

PDM FPGA Board
(XILINX ARTIX 7)

ASTRI Camera Mechanical Structure

Second mechanical mock-up snapshots



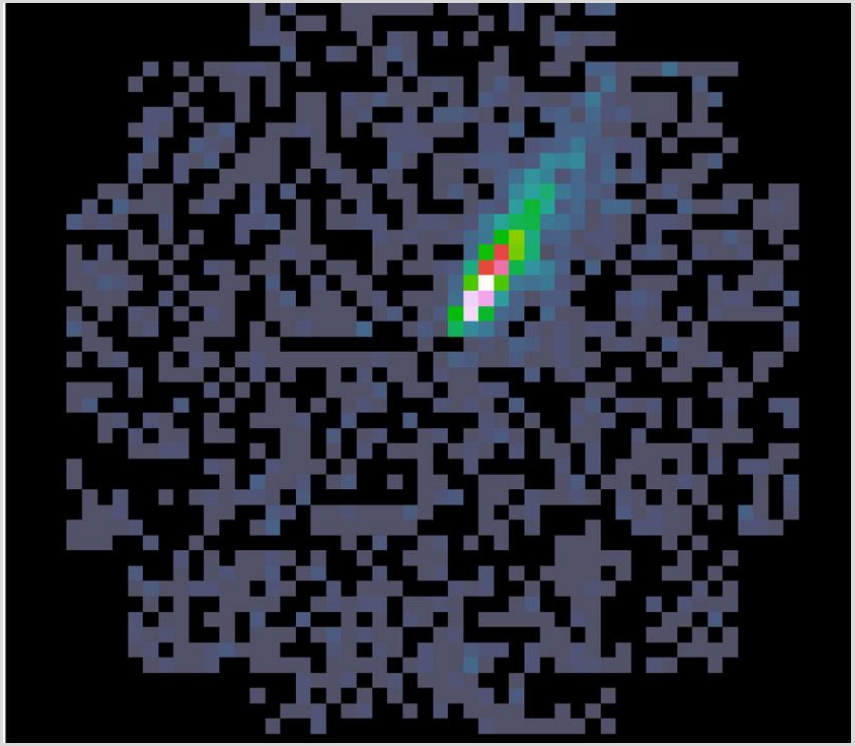
Detection simulation

Image from the ASTRI SST-2M camera of an on-axis simulated gamma-ray event.

The primary gamma-ray signal had an energy of 10 TeV and a core distance of 142.77m.

The night sky background is at a level of 1.9 x 10^{12} phm^{-2} s^{-1} sr^{-1} (about three photoelectrons per pixel).

Color-bar shows number of photoelectrons per pixel.



The ASTRI SST-2M Prototype Site

INAF - Catania Astrophysical Observatory

Etna)

y operative INAF Observatory

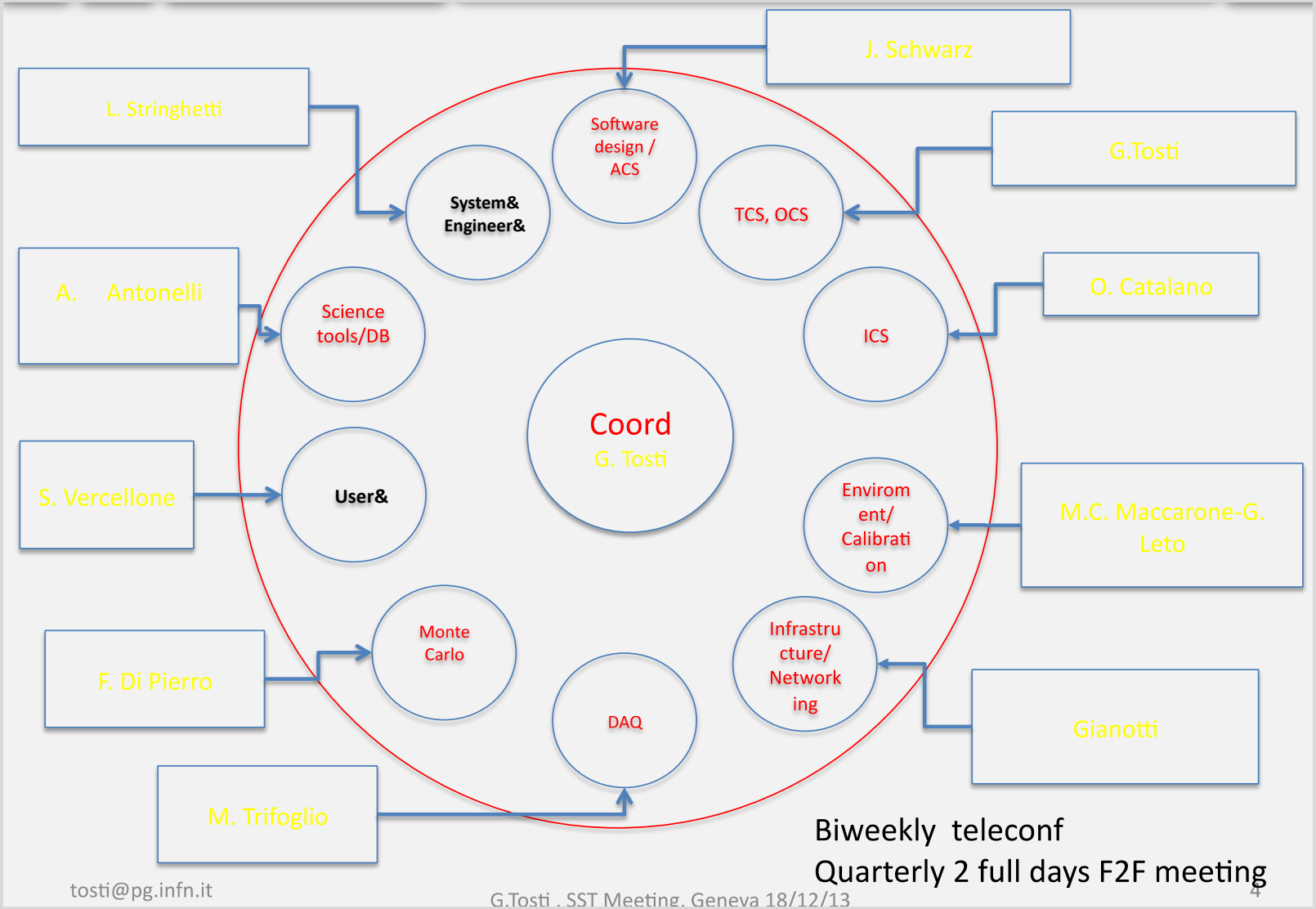
n-speed internet connection

hanical & Electronics Labs

nce

An importan outreach program will be carried out by INAF in collaboration with the Etna Park

SW ASTRI development organization



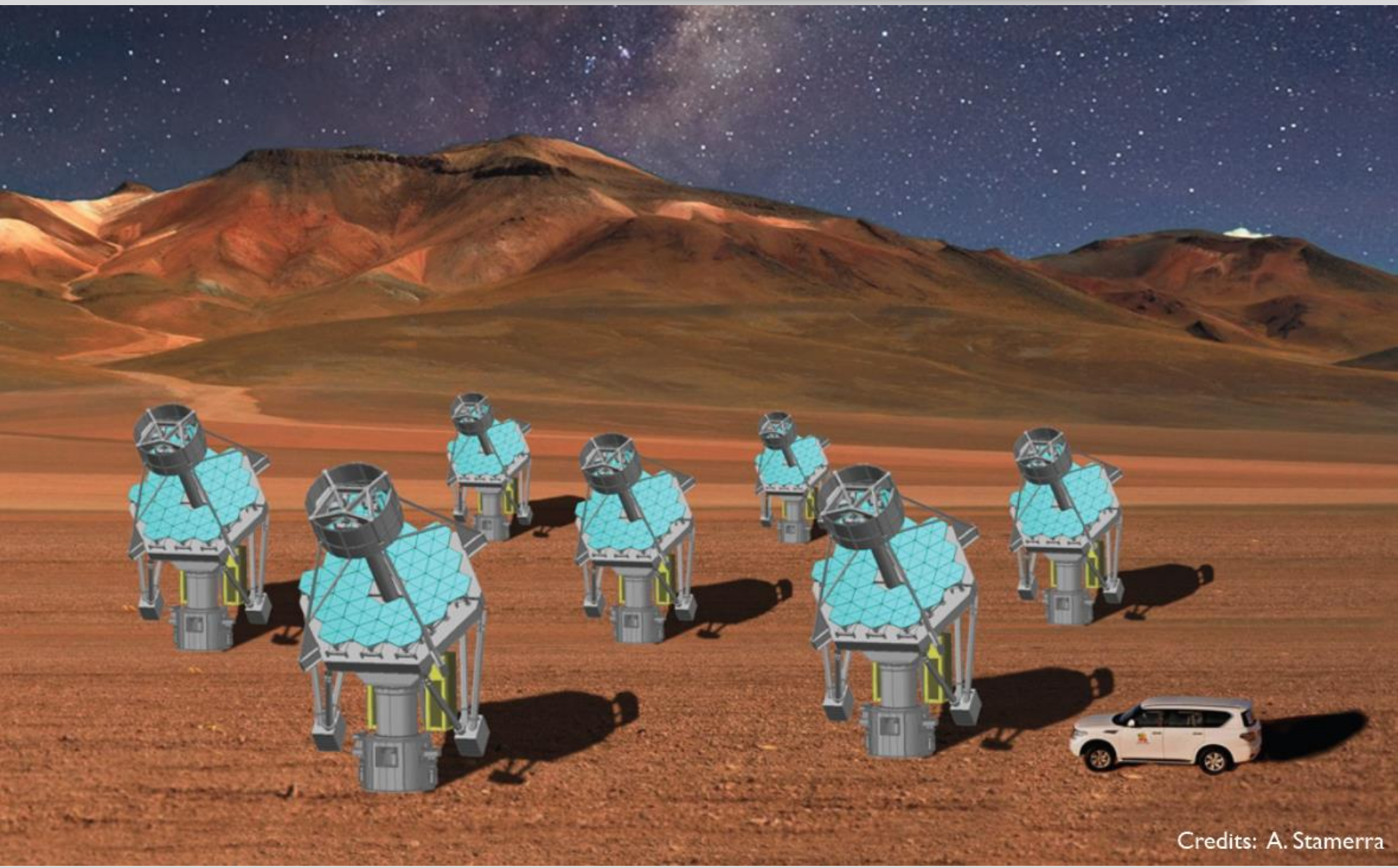
Biweekly teleconf

Quarterly 2 full days F2F meeting

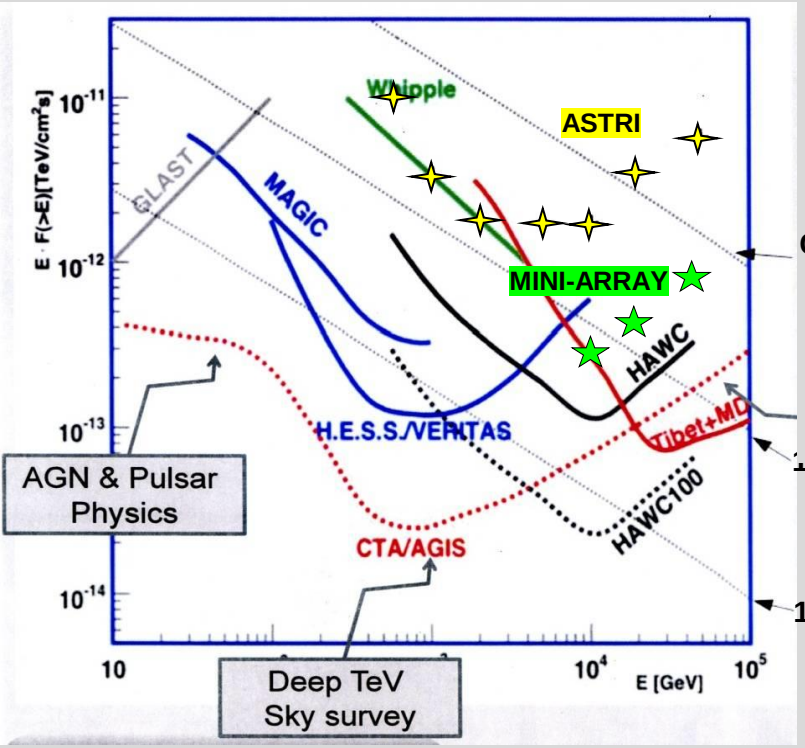
ASTRI inauguration

On schedule for the telescope inauguration at the next Consortium meeting in Catania, September 2014 ☺

THE MINI-ARRAY



ASTRI miniarry expected performance



Energy resolution: ~ 10 % @10 TeV (vs. 20 % di HAWC)

Angular Resolution: 0.06-0.07 deg @10 TeV (improving with the energy) vs. 0.2 deg of HAWC

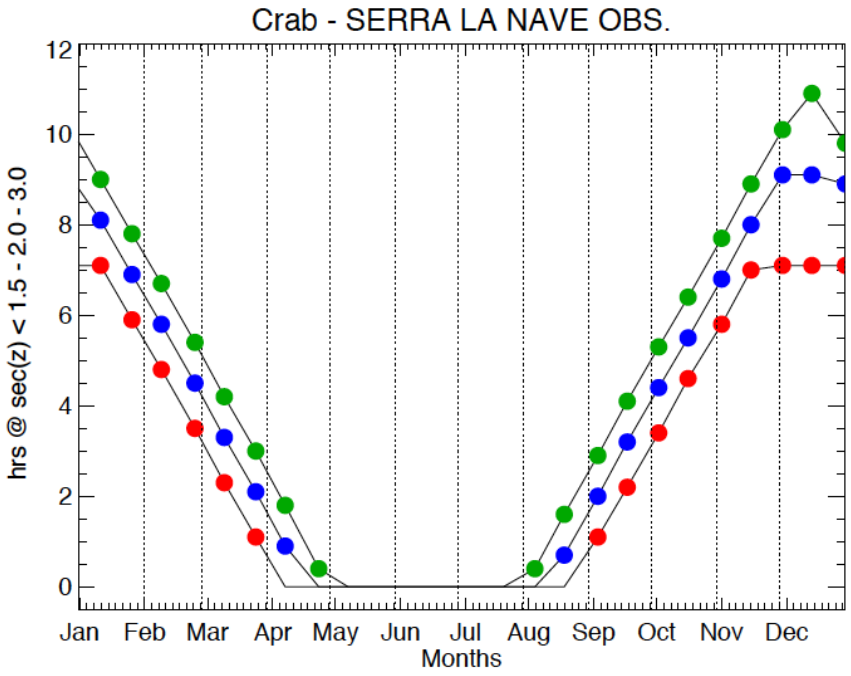
Possibility of very long integrations on a sample of selected source

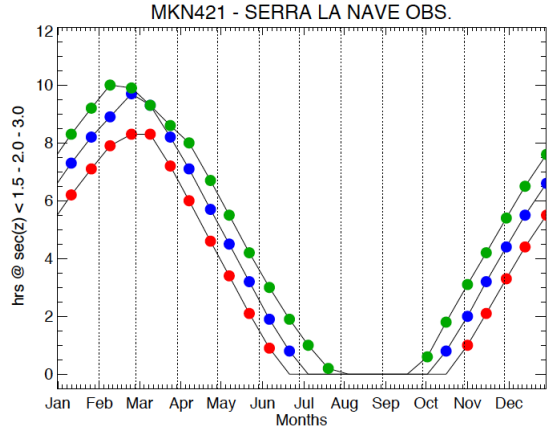
Great improvement at low energies if also two or more MST are implemented!

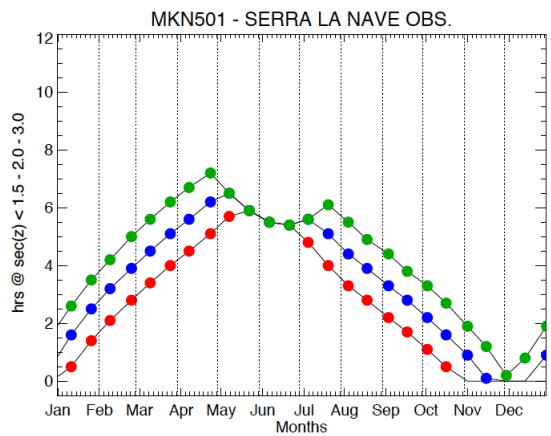
Not only a technology pathfin
possible when FERMI and

ASTRI SST-2M: Scientific observ.

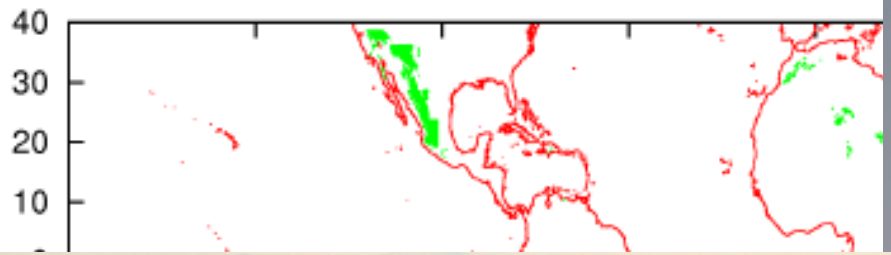
Science Verification Phase starting in Spring 2015







CTA Southern site

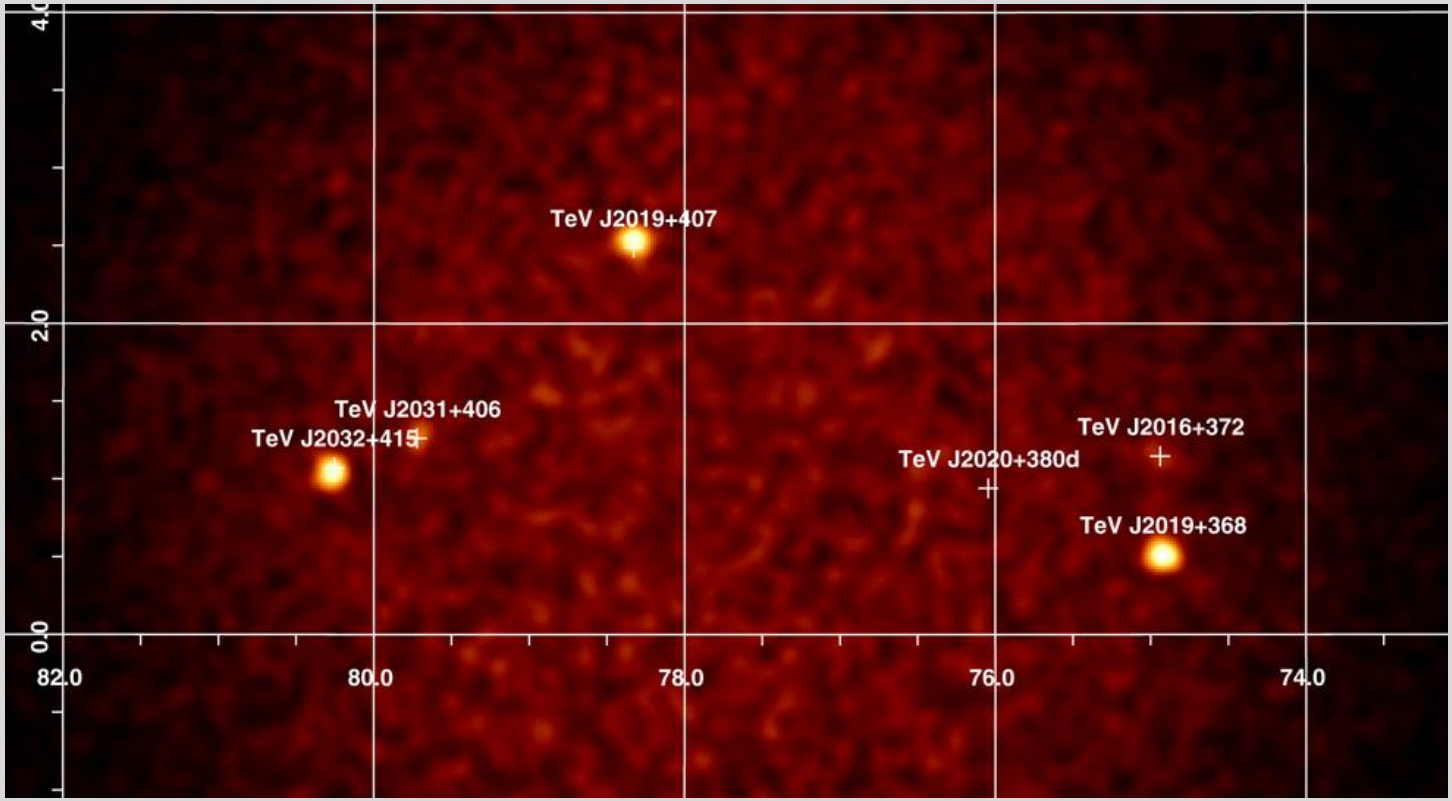


Namibia – Aar

Chile – Cerro Armazones (Antofagasta)

25 km los

Simulation: the Cygnus region



Preliminary ASTRI SST-2M mini-array simulation of the Cygnus region. The simulation is centered on galactic coordinates of 77.7◦ (longitude) and 1.0◦ (latitude) and was conducted for a net observing time of 150 hours and for energies greater than 3TeV. TeV source parameters (position, flux, spectral index) were derived from an online catalogue of the Italian Space Agency