

# Proposte di tesi per l'esperimento CTA (Cherenkov Telescope Array) Osservatorio per fotoni gamma di altissima energia

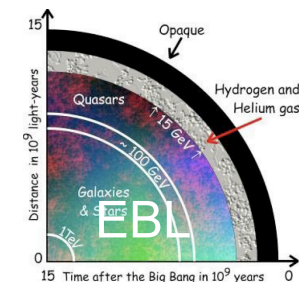
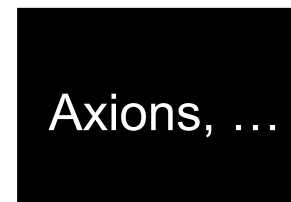
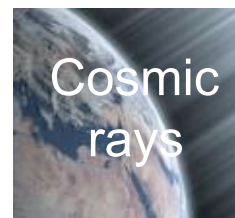
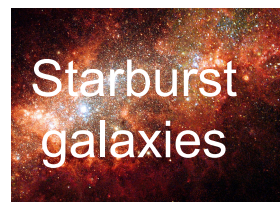
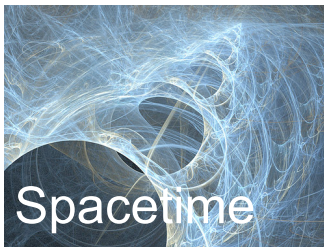
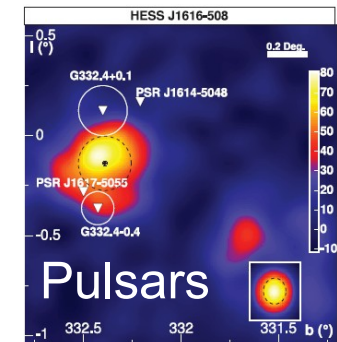
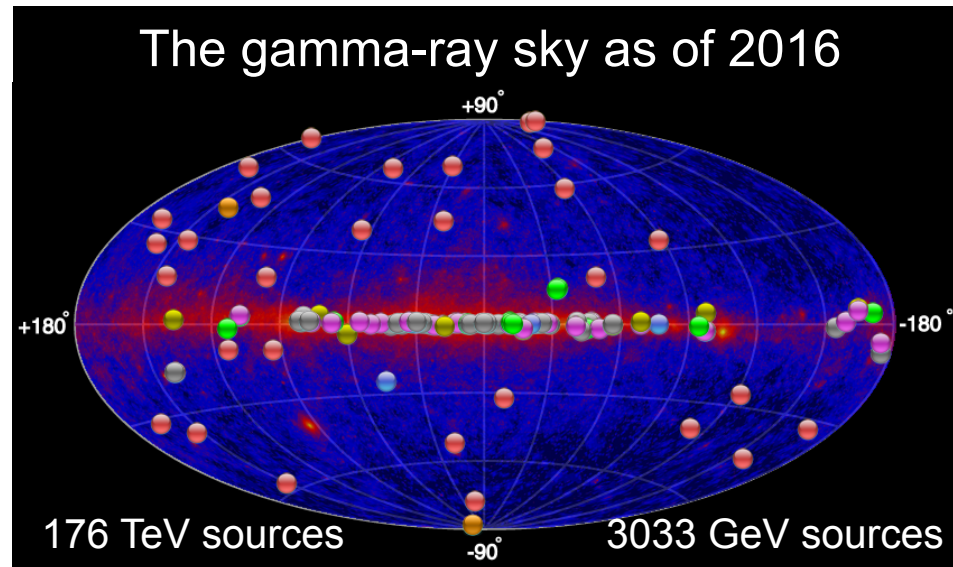
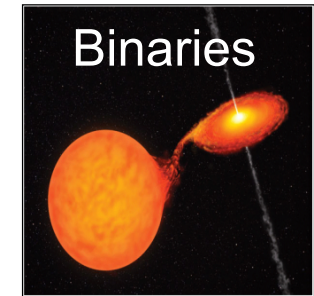
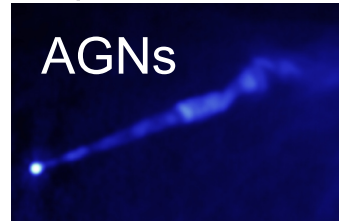
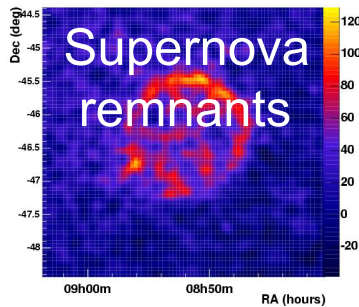
E. Fiandrini, Università&INFN Perugia





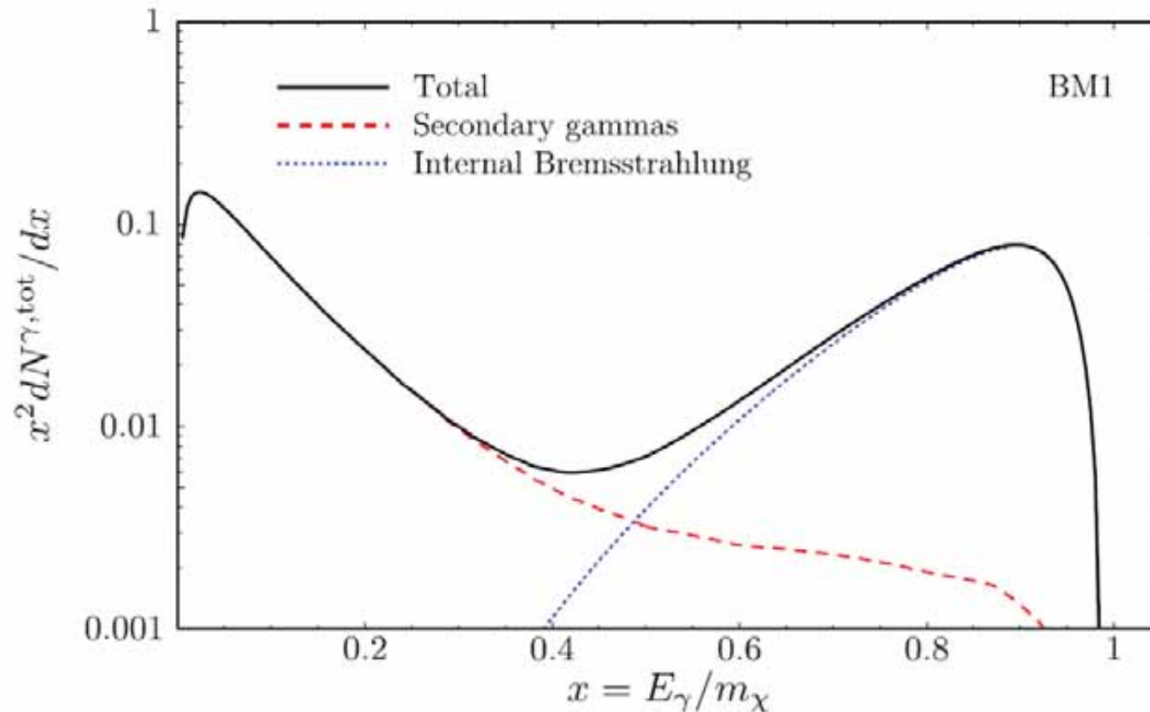
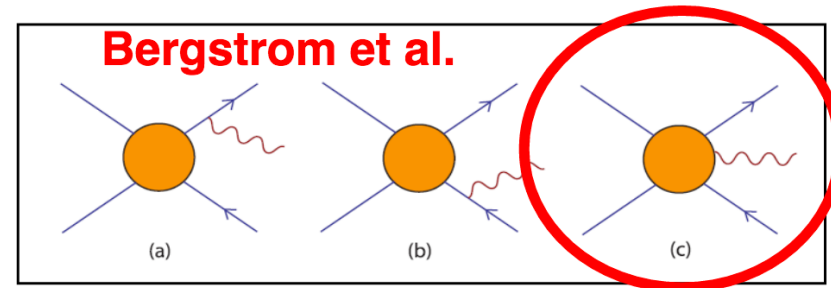
# Fisica dei telescopi $\gamma$

La maggior parte dell'informazione sul nostro universo viene da particelle che emettono fotoni



# Esempio: materia oscura

T. Bringmann, L. Bergstrom, J. Edsjo  
arXiv:0710.3169

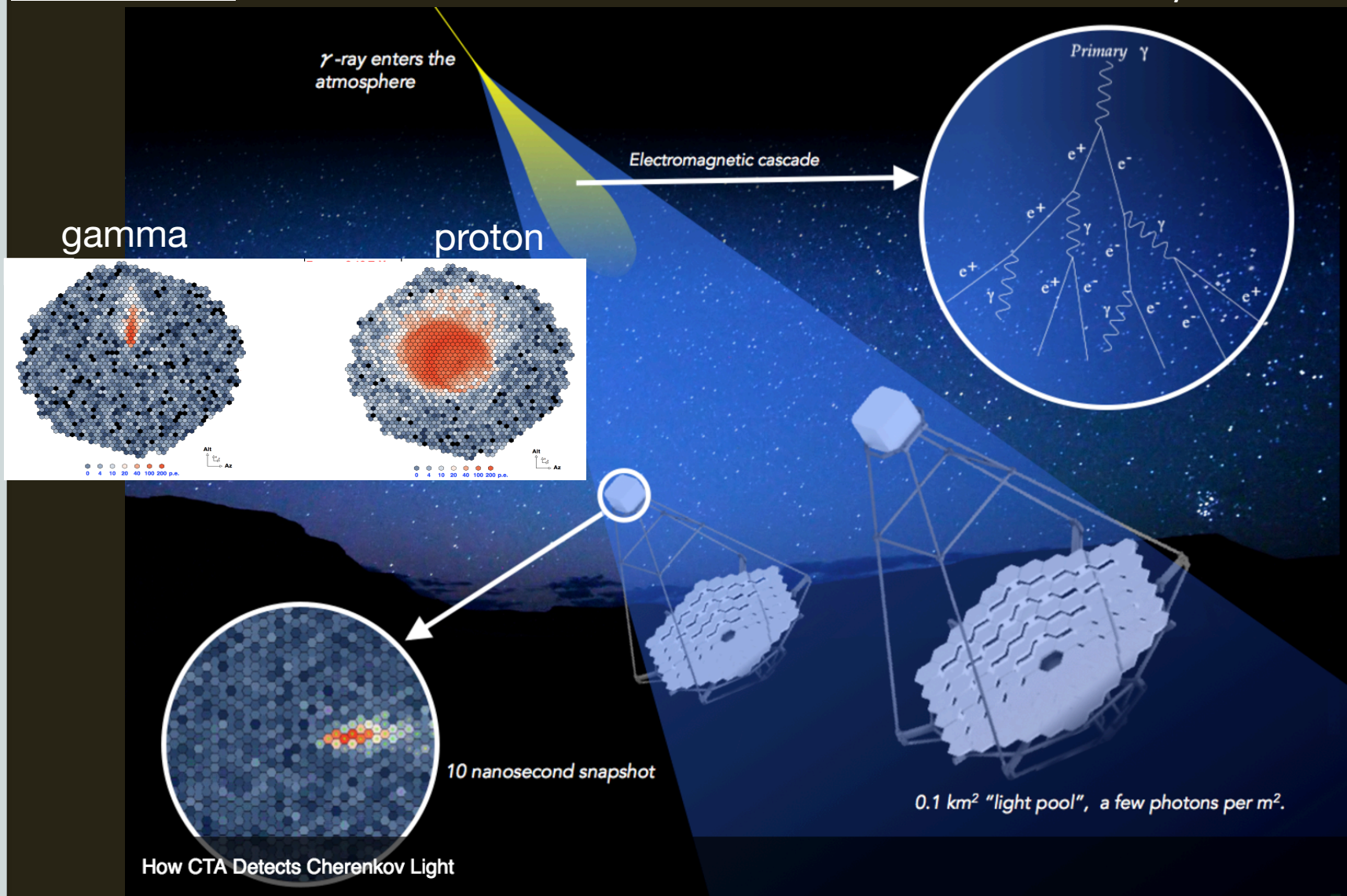


DM annihilation  
“lines” are back!

Perfect match for  
10-15% energy  
resolution of CTA

# Imaging Air Cherenkov Telescopes

## Gamma Ray





# Cherencov Telescope Array (CTA)

L'attuale generazione di matrici cherenkov sono formate al piu' da 5 telescopi CTA sarà dotato di oltre 100 telescopi su un'area molto estesa in due siti situato nell'emisfero sud e nord (La Palma e nel deserto di Atachama)

## Low energies

Energy threshold 20-30 GeV  
23 m diameter  
4 large telescopes

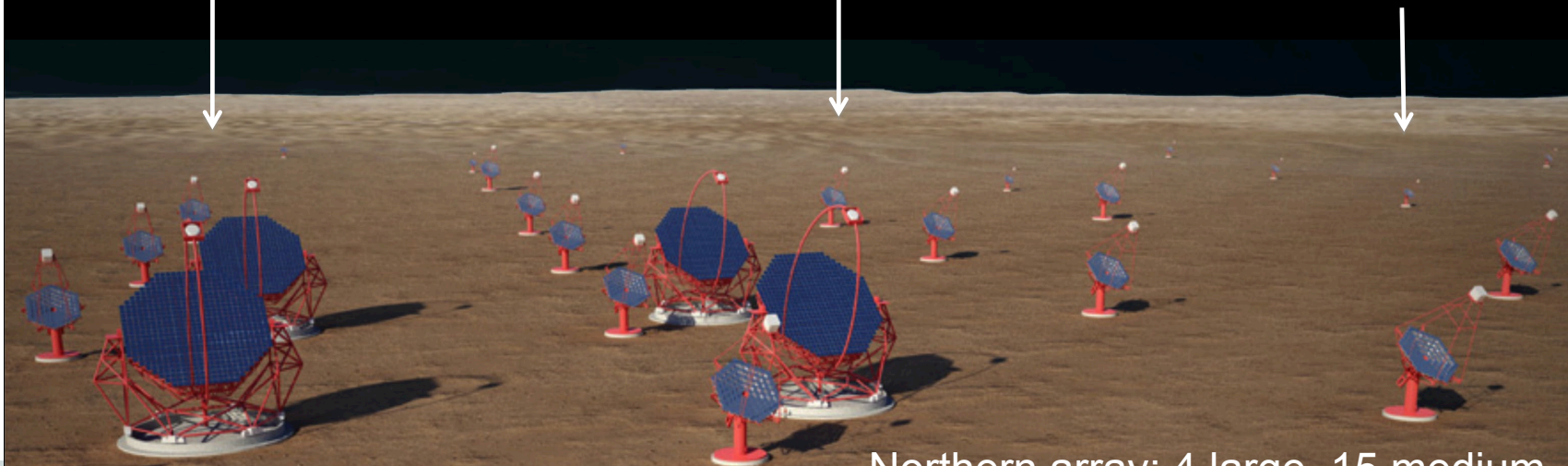
Entrerà in funzione nel 2024

## Medium energies

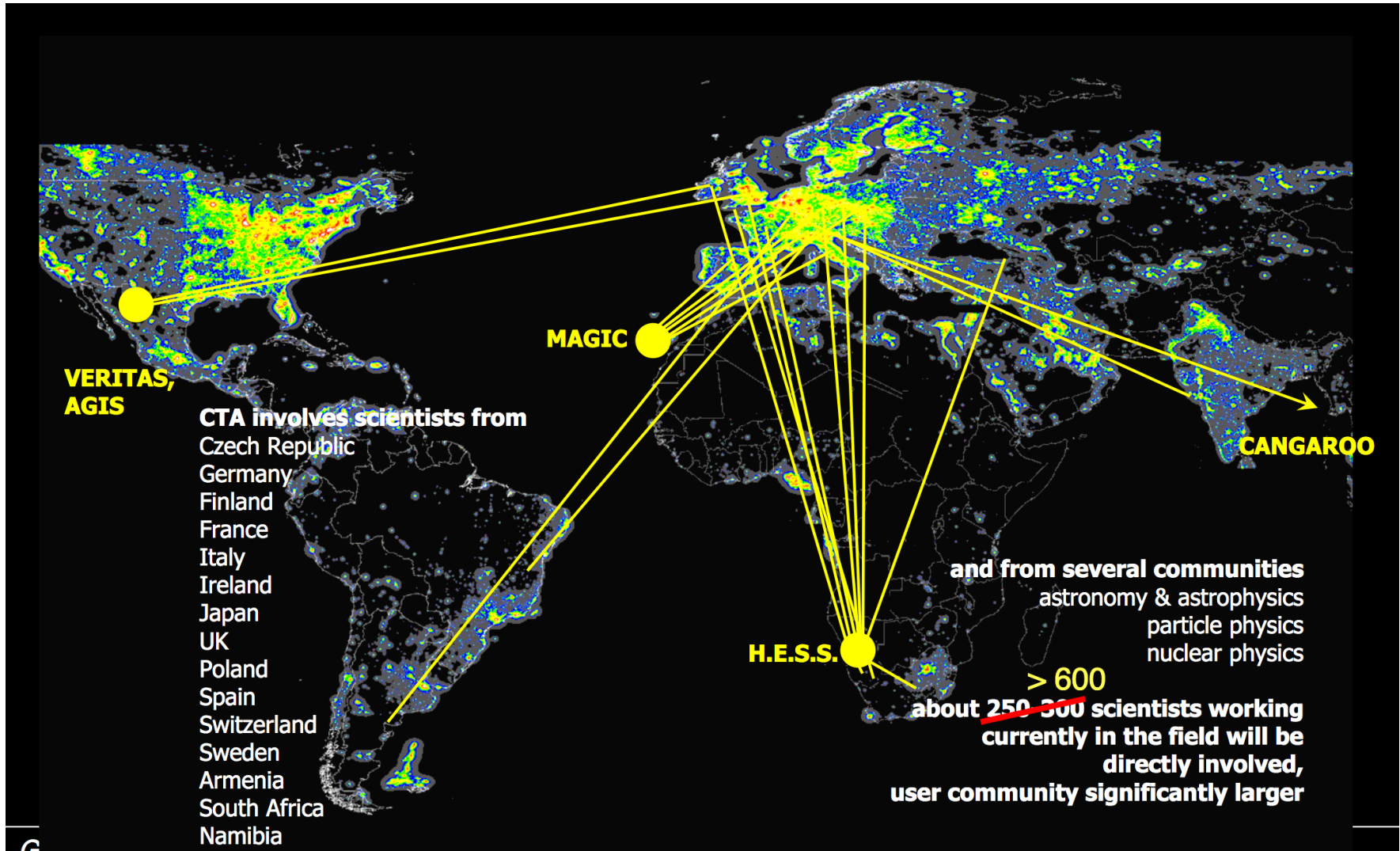
100 GeV – 10 TeV  
9.5 to 12 m diameter  
25 medium telescopes

## High energies

Few TeV – 300 TeV  
10 km<sup>2</sup> at few TeV  
3 to 4 m diameter  
70 small telescopes



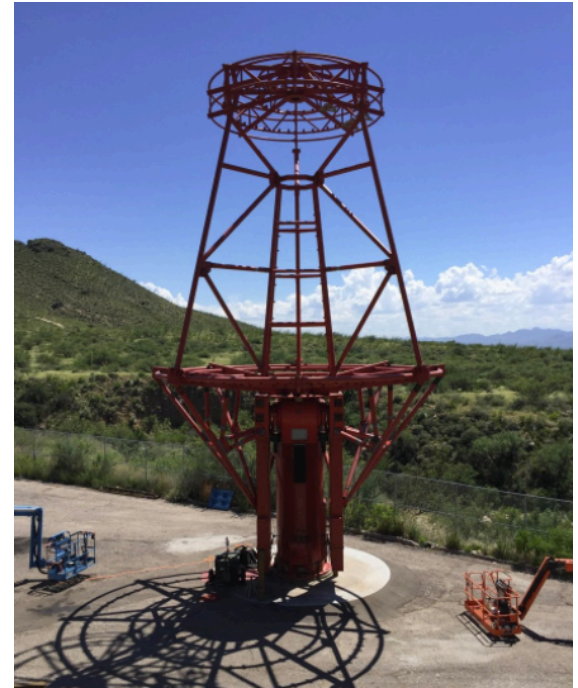
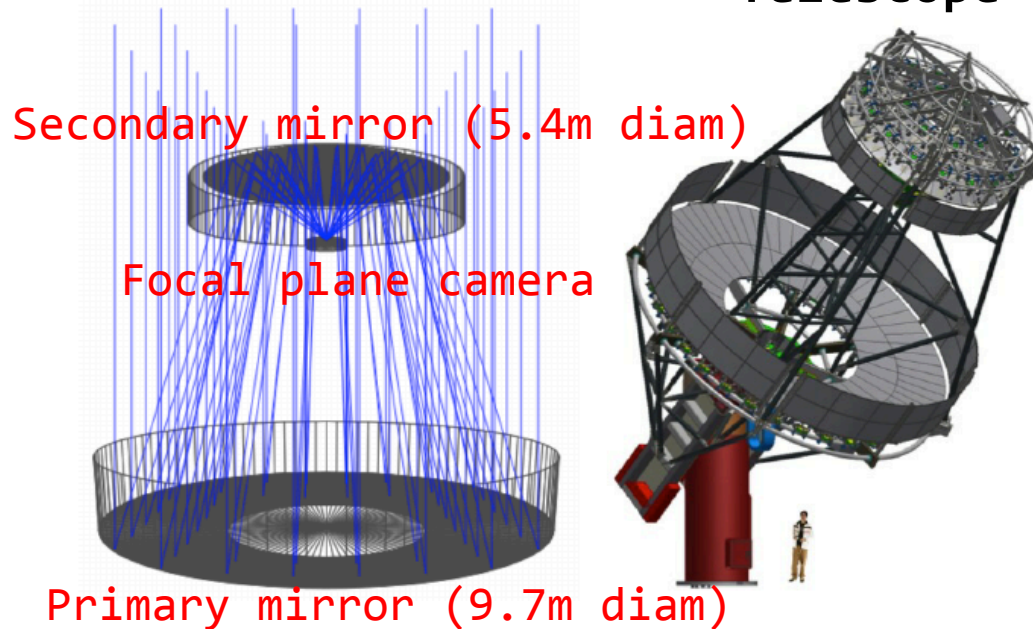
Northern array: 4 large, 15 medium





# SCT Telescope

Schwarzschild-Couder dual mirror optics Medium Size Telescope



Dual mirror optics designed to cancel aberration and de-magnify images, to be compatible with compact high-resolution SiPM camera and resulting in a smaller point spread function (PSF) and improved angular resolution than the classical single mirror Cherenkov Telescope.

Perugia activity consists of:

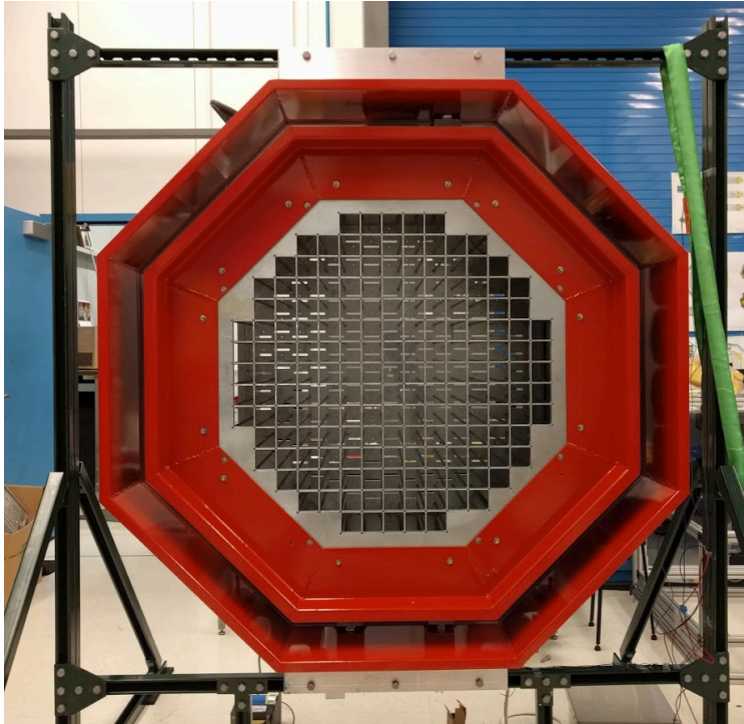
- Design, assembly, tests, installation and data analysis of more than 100 modules
- Development of advanced software tools for physics analysis in the framework of the CTA collaboration, mainly MonteCarlo programs for high level analysis and study of the performance of the prototypes



- INFN (PG, PD, TO, PI, NA, BA) is in charge of the construction of the focal plane of a prototype of the Medium Size Telescopes in a Schwarzschild-Couder configuration
- Perugia is involved in:
  - R&D for new generations of silicon light detectors (Si PhotoMultipliers), optimized for the cherenkov near UV light spectrum, low noise, high dynamic range and fast signals
  - The assembling, electro-optical characterization, installation of the modules in the camera focal plane in USA
  - data analysis of the camera modules, equipped with SiPM, for the **SCT prototype**

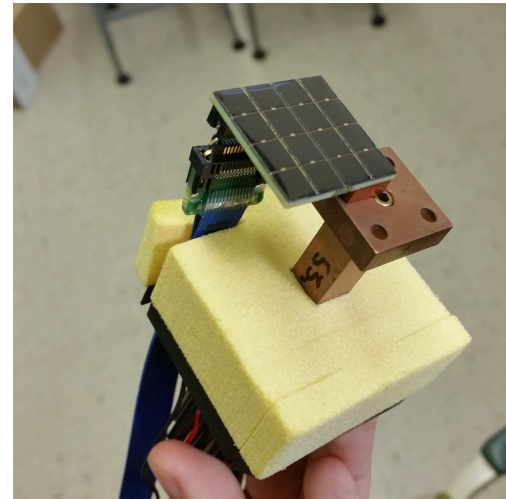
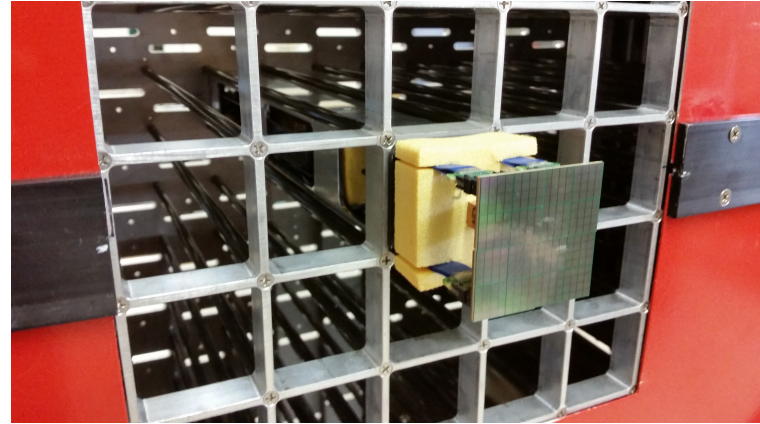
# pSCT Telescope

pSCT camera mechanics in  
Madison (Wisconsin, USA)



The first FBK  $6 \times 6 \text{ mm}^2$  SiPM have been just installed and will equip an upgrade of the pSCT camera

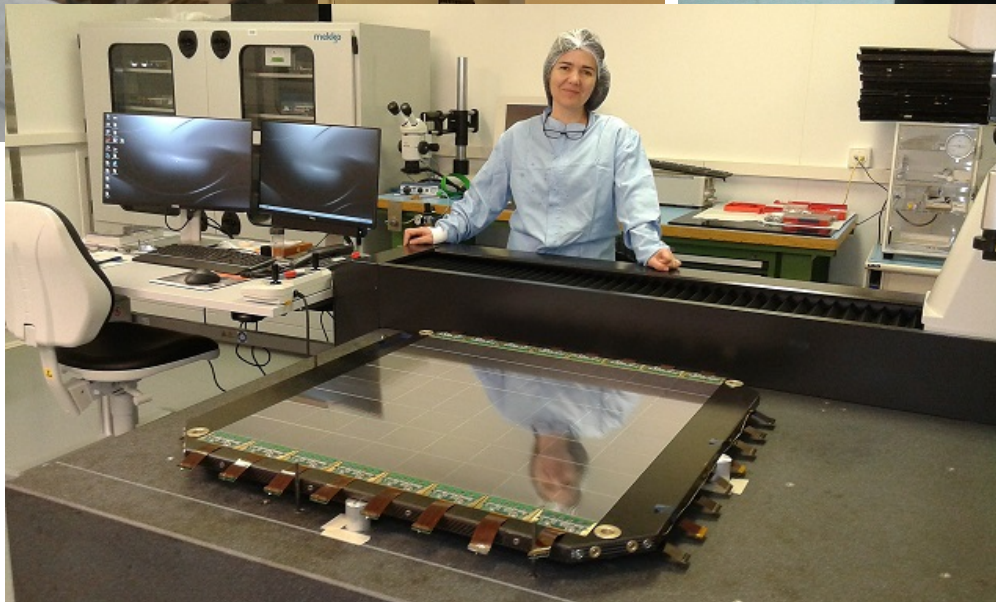
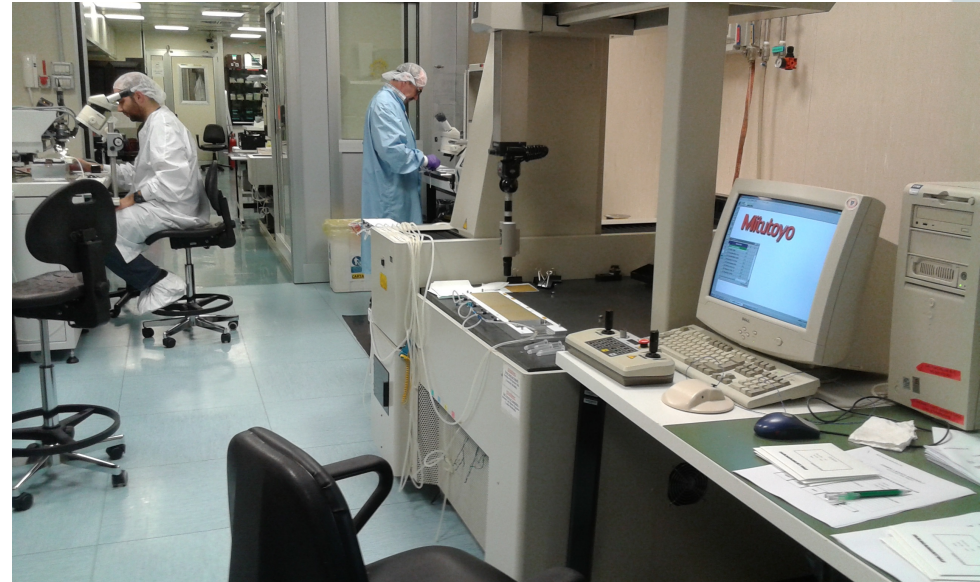
pSCT camera currently equipped with  
Hamamatsu MPPC S12642-0404PA-50(X)

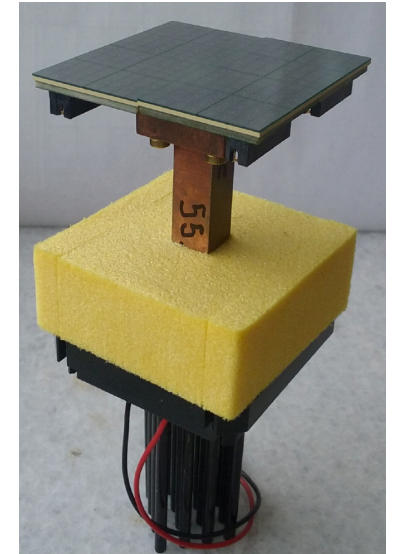
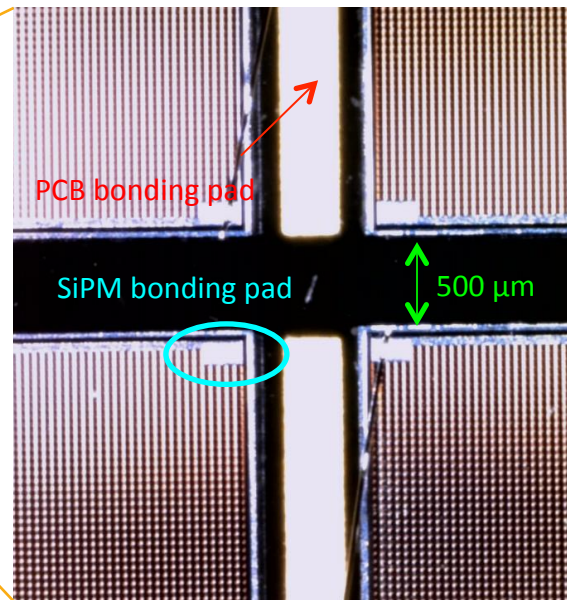
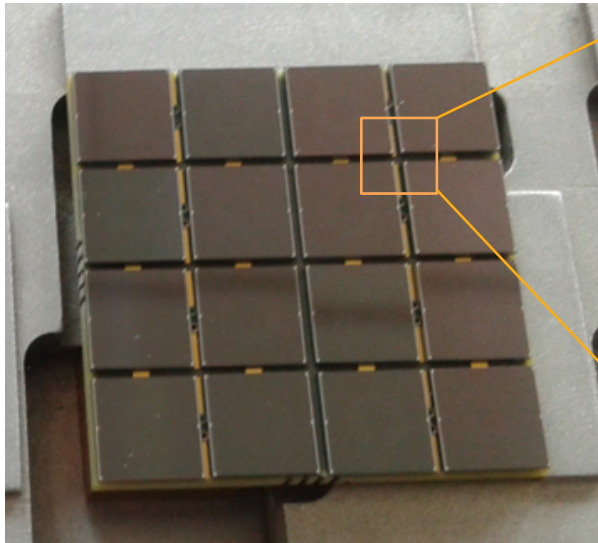


**INFN prototype**

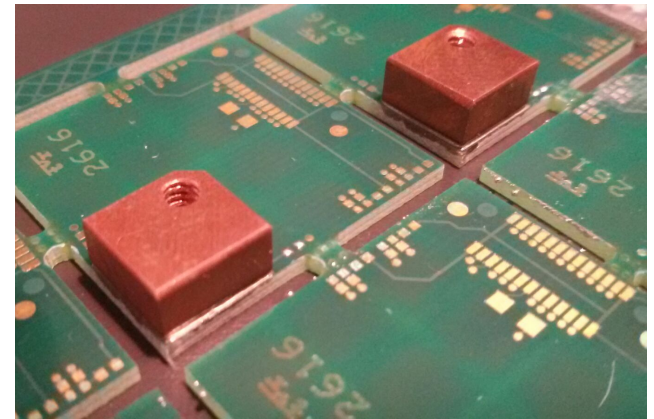


# Work made in Clean Room





- The blocks have been placed on the PCBs with a precision of  $<100$  micron in XY plane,  $<0.1^\circ$  degrees in Z coord
- The requirements for alignment precision are of  $\sim 300 \mu\text{m}$  in XY plane and  $< 2^\circ$  in z (vertical) axis
- Custom mechanical holders have been produced with holes and position pins to achieve a high accuracy for the alignment ( $\sim 10 \mu\text{m}$ ) in the xy plane and z direction ( $<0.1^\circ$ ).

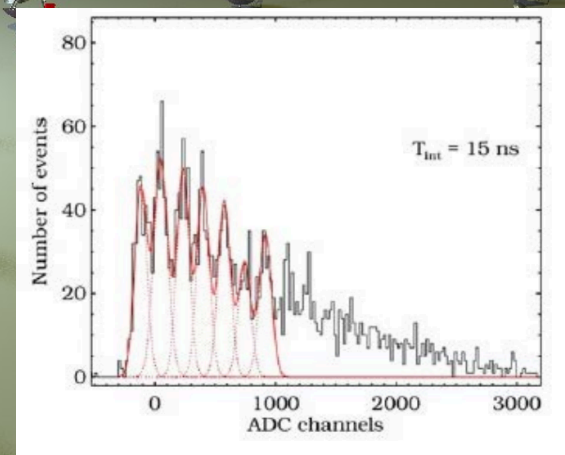
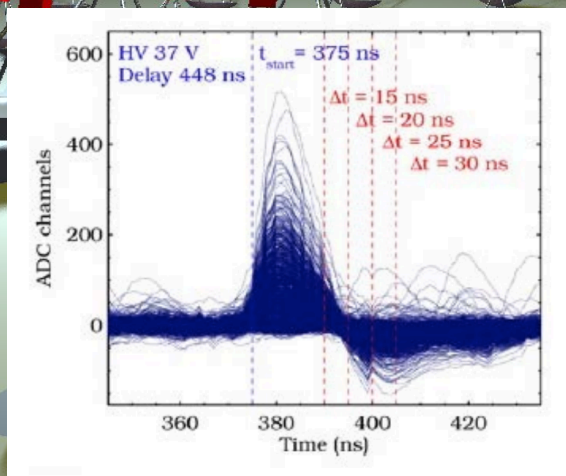
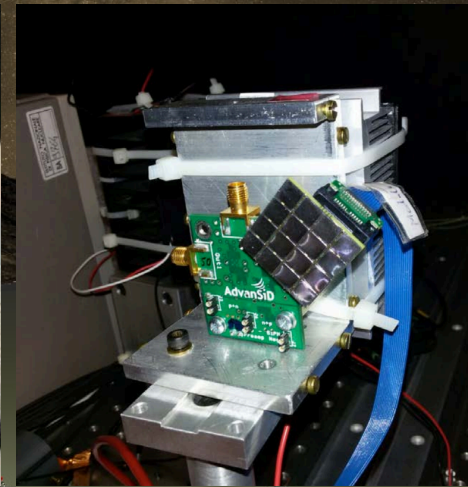
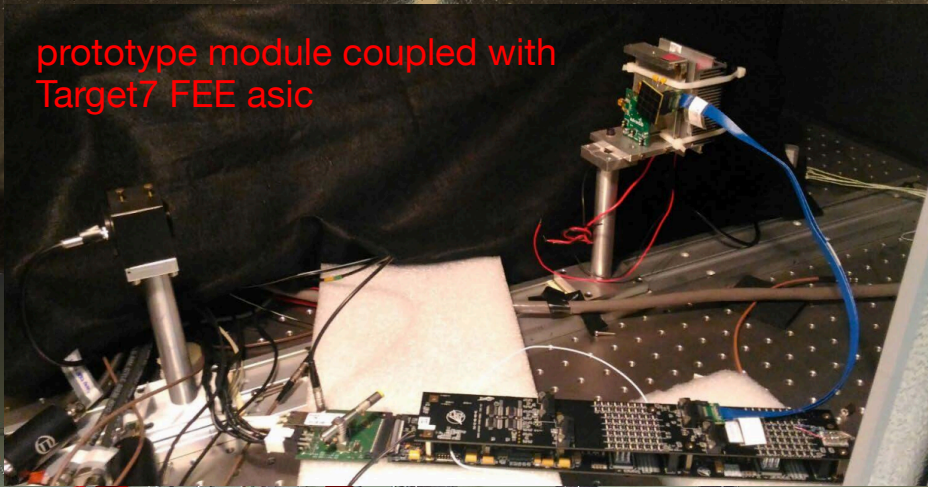




# SiPM module assembly tests

After the protection of the sensor surface with deposition of epoxy, modules are shipped to other INFN laboratories for further performance tests

prototype module coupled with  
Target7 FEE asic



- The Master Degree Thesis proposed are:
  - Study of the performances of the INFN modules installed in the focal plane of pSCT telescope (6-8 months with some weeks in USA and Na, Ba and Pi test facilities)
  - High precision module assembly, optical and electrical characterization in the clean room: not merely “assembly”, but a challenge to find new smart, fast ways to build the modules with very high precision (duration 6-8 months with some weeks in Na, Ba, Pi test facilities)
  - Installation of the modules on the SCT telescope prototype (Madison, Wisconsin, USA and Whipple Observatory, Arizona), Data taking and analysis (-8 months with travel and stay in Arizona at the VERITAS site and Wisconsin University test facilities)

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