Progetti di alta energia

Realtà e prospettive per OAB

Non ci sono certezze, solo ragionevoli probabilità.
-- **Edgar Watson Howe**

High-energy Astronomy's Golden Age

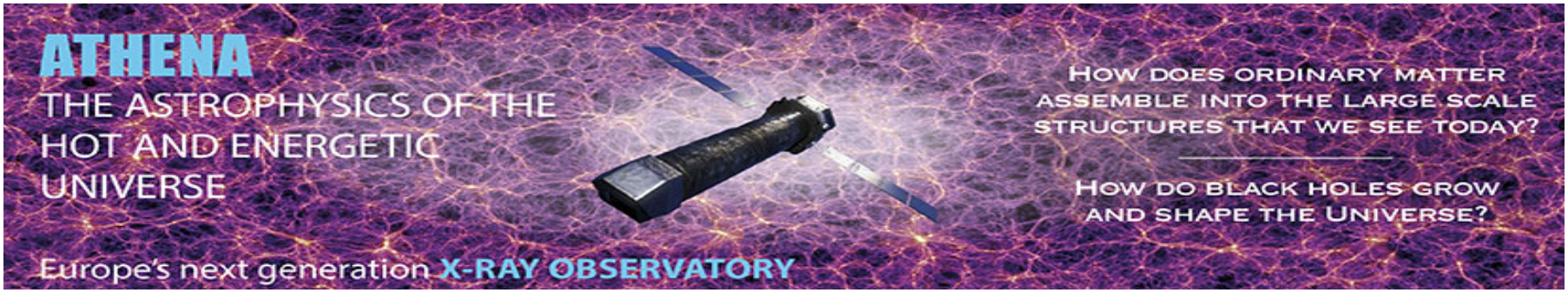
Situazione dell'Astronomia Alte Energie e Relativistica (I)

- Possiamo contare ancora sui dati delle missioni in volo (SWIFT, XMM, Chandra, Integral, Agile, FERMI) lanciate prima del 2010 ➔ alcune sono in via di spegnimento

- Importante partecipazione INAF (e OAB) a Nustar, missione hard X (3 keV – 80 keV) con telescopi focalizzanti
  - Alcuni importanti risultati e finanziamenti ottenuti da ricercatori OAB

- Partecipazione diretta a MAGIC (e dati indiretti per alcuni ricercatori OAB, nell'ambito della collaborazione "at large"), a HESS e VERITAS

- Prossima missione X large: ATHENA (ma solo dopo il 2028!)



Parameter	Requirements	Enabling technology/comments
Effective Area	2 m^2 @ 1 keV (goal 2.5 m^2) 0.25 m^2 @ 6 keV (goal 0.3 m^2)	Silicon Pore Optics developed by ESA. Single telescope: 3 m outer diameter, 12 m fixed focal length.
Angular Resolution	5" (goal 3") on-axis 10" at 25' radius	*Detailed analysis of error budget confirms that a performance of 5" HEW is feasible.*
Energy Range	0.3-12 keV	Grazing incidence optics & detectors.
Instrument Field of View	*Wide-Field Imager:* (WFI): 40' (goal 50')	Large area DEPFET Active Pixel Sensors.
	X-ray Integral Field Unit: (X-IFU): 5' (goal 7')	Large array of multiplexed Transition Edge Sensors (TES) with 250 micron pixels.
Spectral Resolution	WFI: <150 eV @ 6 keV	Large area DEPFET Active Pixel Sensors.
	X-IFU: 2.5 eV @ 6 keV (goal 1.5 eV @ 1 keV)	*Inner array (10"x10") optimized for goal resolution at low energy (50 micron pixels).*
Count Rate Capability	> 1 Crab[3] (WFI)	*Central chip for high count rates without pile-up and with micro-second time resolution.*
	10 mCrab, point source (X-IFU) 1 Crab (30% throughput)	*Filters and beam diffuser enable higher count rate capability with reduced spectral resolution.*
TOO Response	4 hours (goal 2 hours) for 50% of time	*Slew times <2 hours feasible; total response time dependent on ground system issues.*

ATHENA will be large! (2 m^2 A_{eff} @ 1 keV)

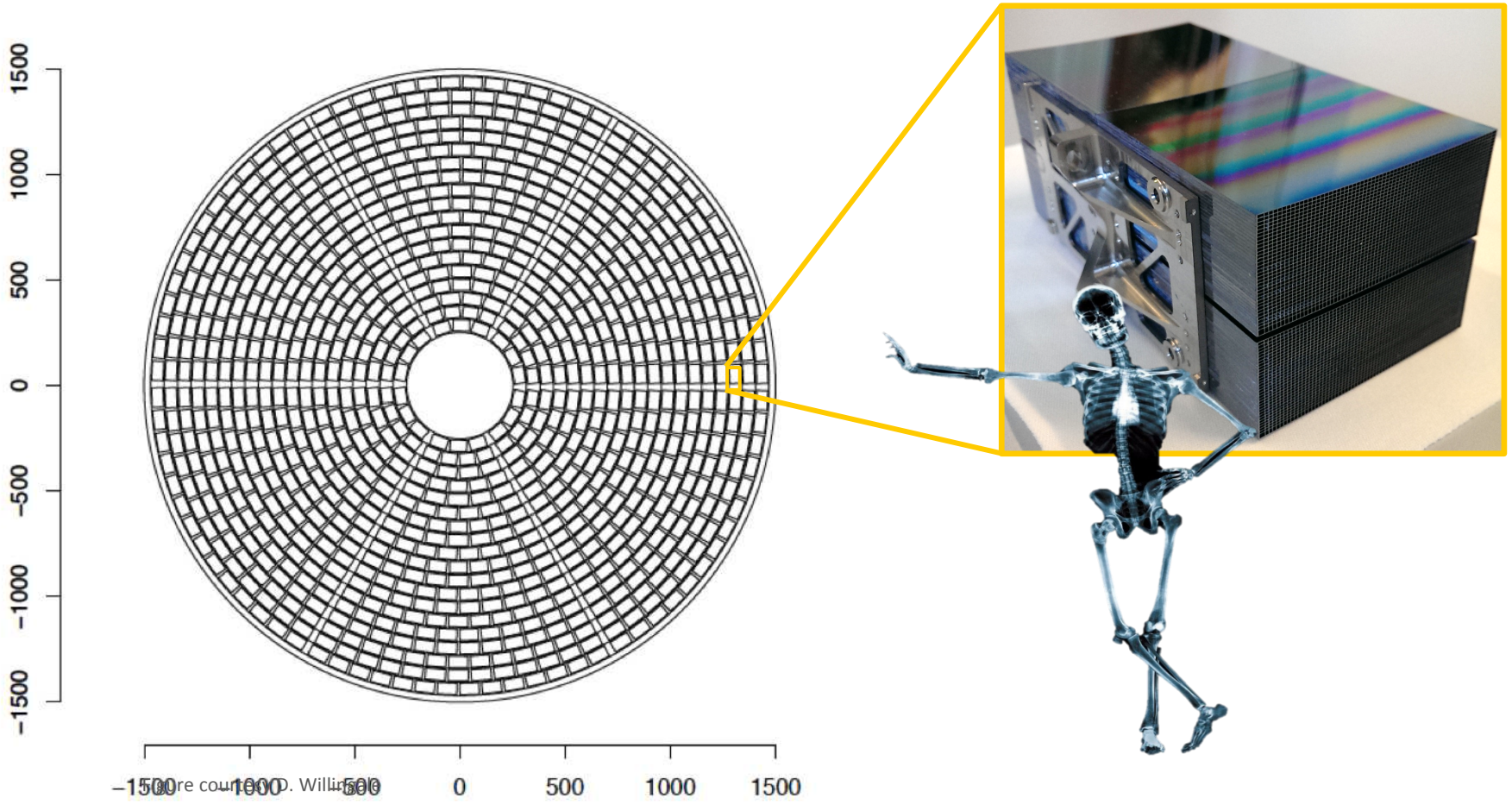
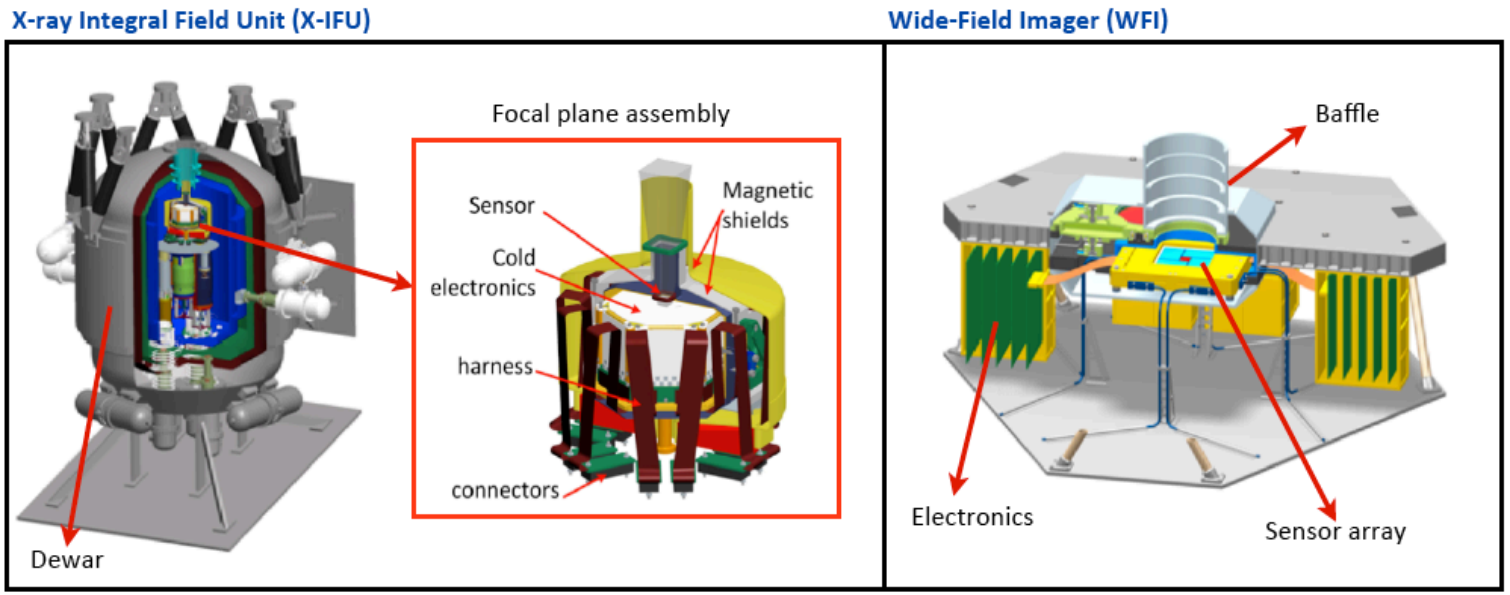


Figure courtesy D. Willingale

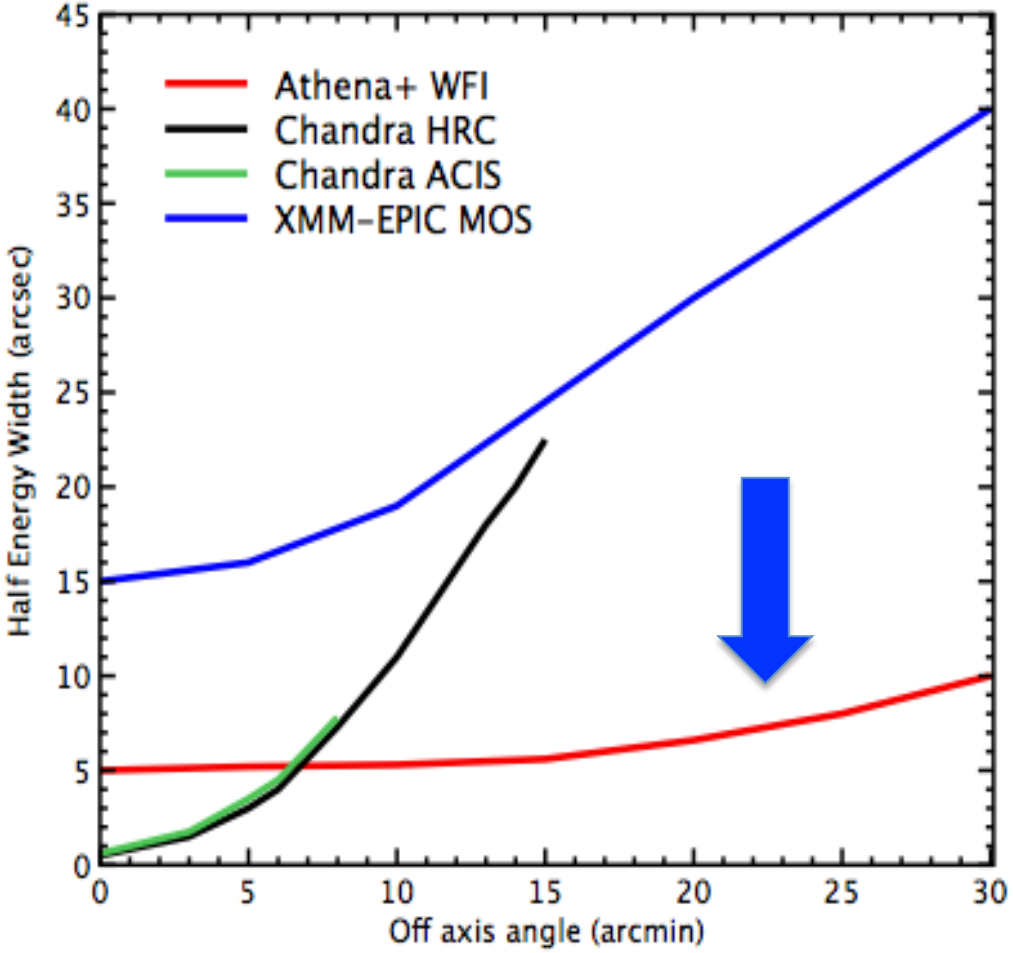
ATHENA Instruments



High Energy Resolution
Spectroscopy with imaging

Wide Field imaging

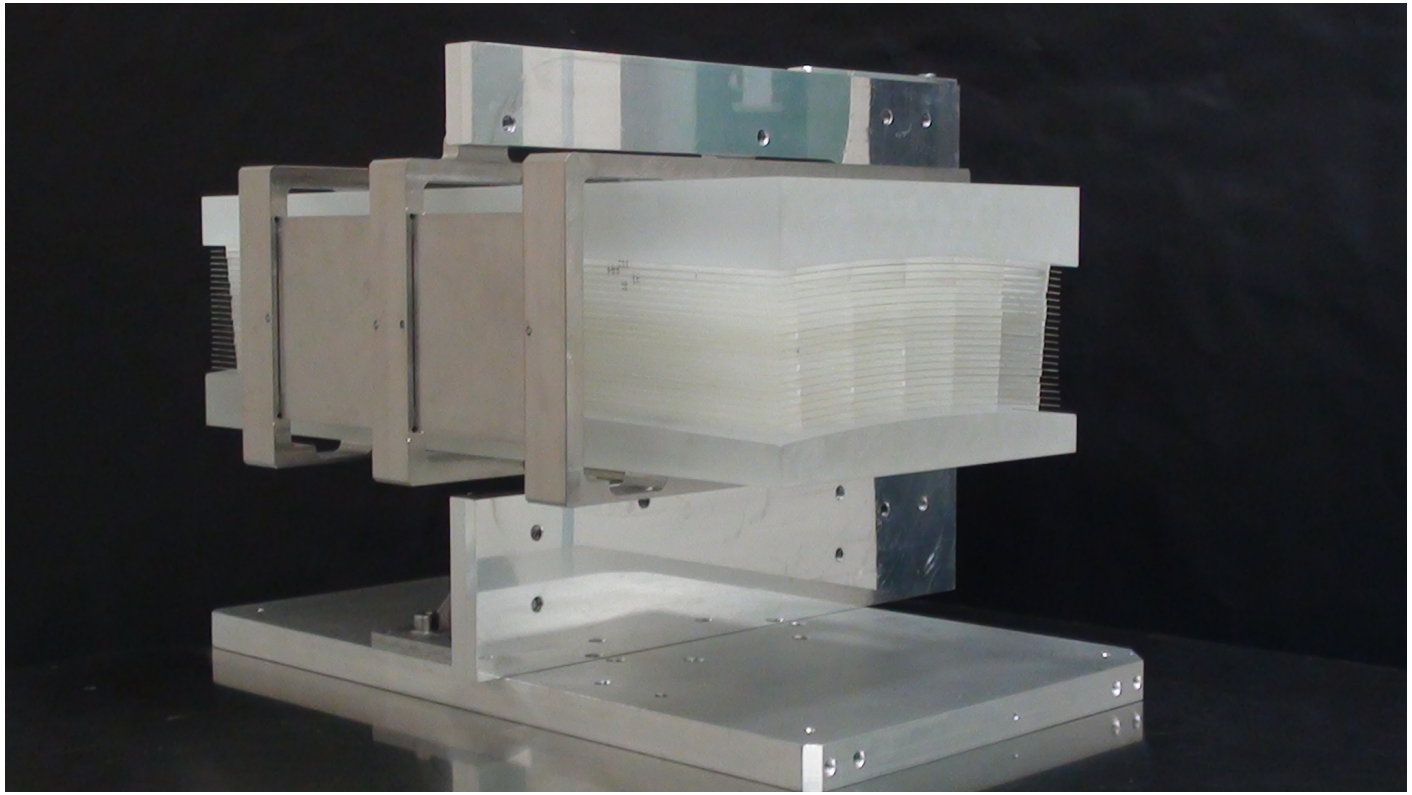
Angular resolution Vs. FOV for AHENA (and past missions)



OAB current involvement in ATHENA

- Important involvement in the optics technology
  - risk of a reduced pay-off, like for XMM
  - However important for the grat consideration by ESA
  - Moreover strategic collaboration with MPE and NASA/GSFC for the alternative technology based on foils
- Calibrations of optics & instrument ➔ possible high scientific pay-off
- Reduced involvement in the development of the two instrument (Moretti & Spiga)
- Participation in scientific WP (but without a leadership role)

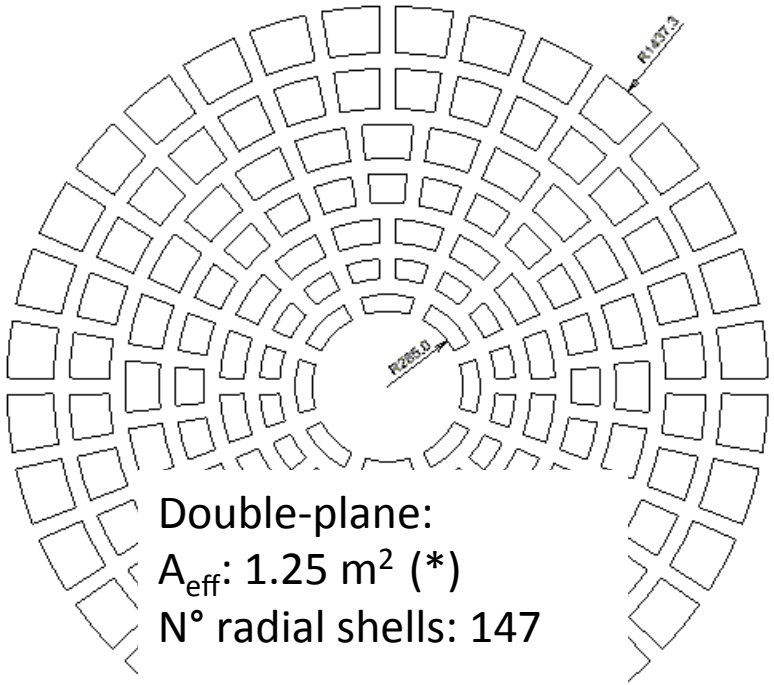
Slumping glass now also in Europe!



ATHENA: alternative design based on glass foil optics (OAB + MPE)

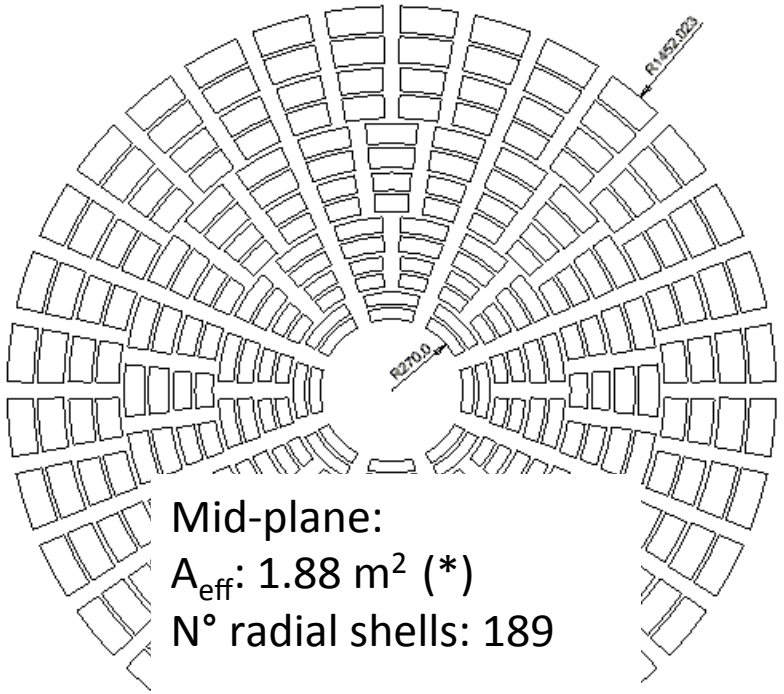
- **The double-plane obscures more area due to the presence of two stiffening plates instead of one.**
- **More shells can be allocated for each module, keeping fixed the external size**

DOUBLE-PLANES



Double-plane:
A_{eff}: 1.25 m^2 (*)
N° radial shells: 147

MID-PLANE



Mid-plane:
A_{eff}: 1.88 m^2 (*)
N° radial shells: 189

(*) @ 1keV with 30' off-axis angle for shell spacing and without ribs (oscuring 5 %)

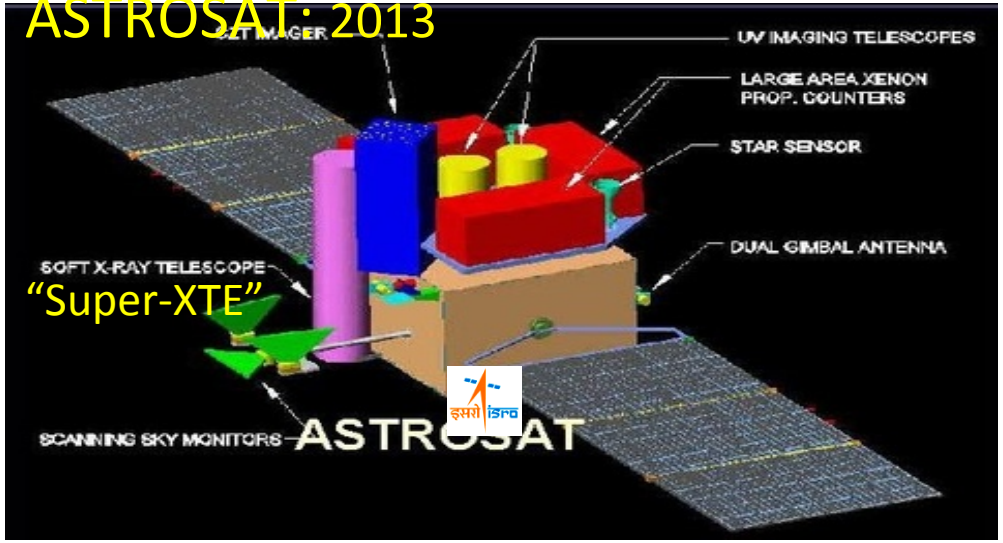
Situazione dell'Astronomia Alte Energie e Relativistica (II)

Altre prospettive di partecipazione in missioni X:

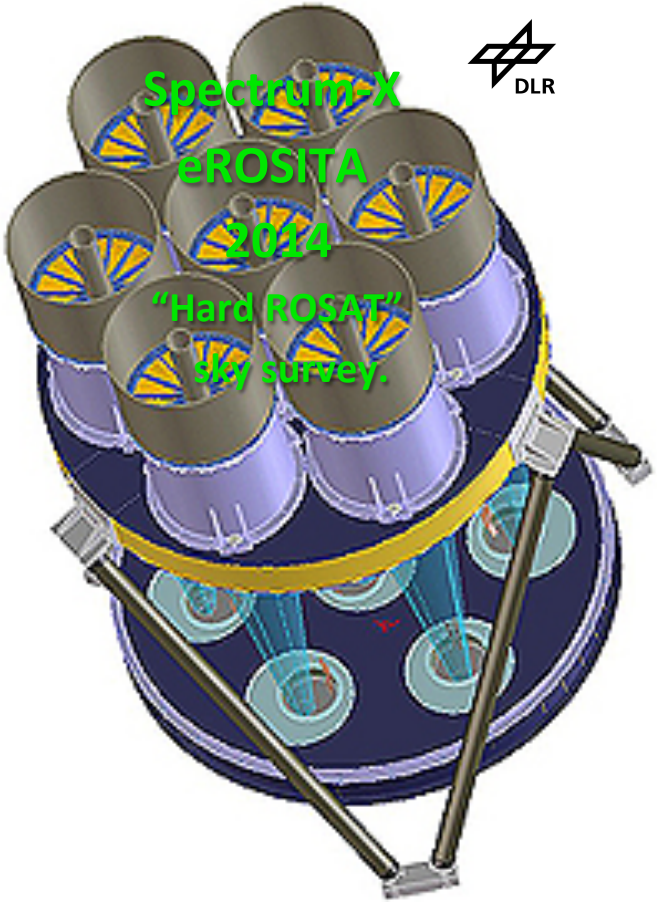
- partecipazione diretta per studi "di nicchia" a e-Rosita e allo sfruttamento della survey quando sarà resa pubblica
- partecipazione a ASTROSAT (India)
- partecipazione indiretta a ASTRO-H,
- Partecipazione diretta a XTP (X-ray Timing e Polarimetric telescope) con Cina e MPE

Other opportunities in near future

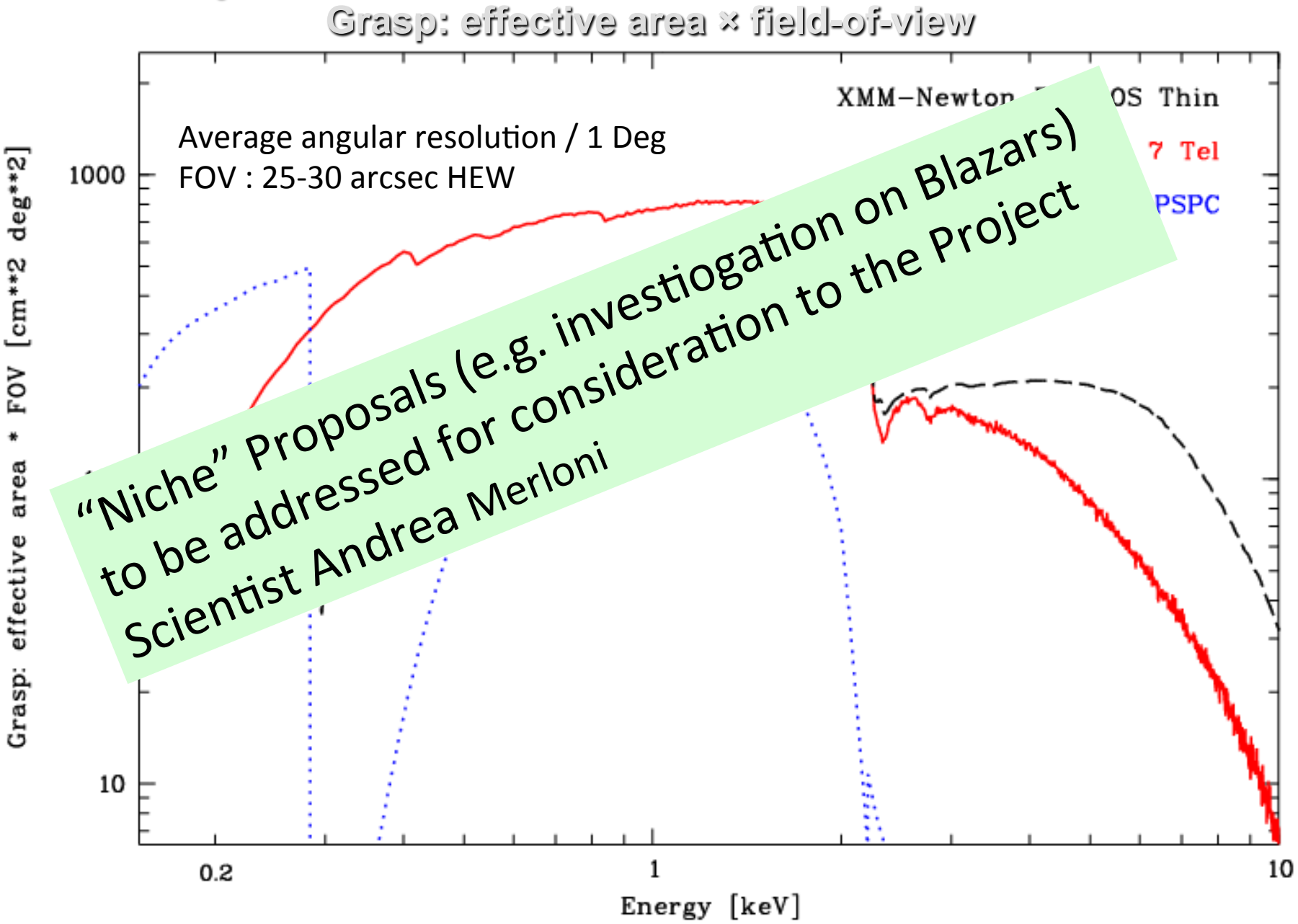
ASTROSAT: 2013



"Super-XTE"



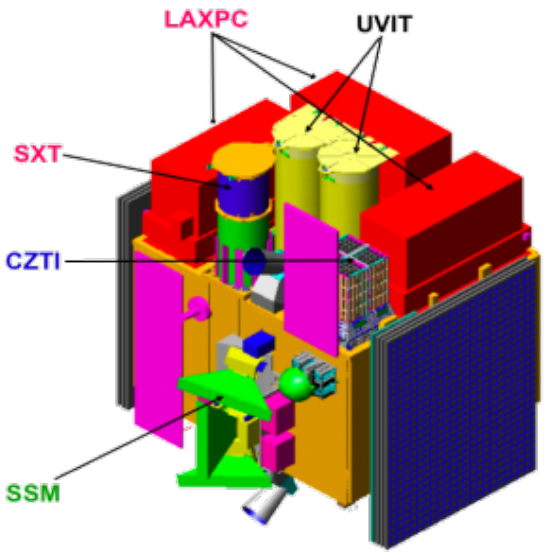
Comparison with XMM and ROSAT



ASTROSAT

(Indian Space Agency and Institutes with UK participation)

ASTROSAT will be a multi-wavelength astronomy mission on an IRS-class satellite in a 650-km, near-equatorial orbit. It is currently scheduled to be launched by the Indian launch vehicle PSLV from the Sriharikota launch centre in May 2015. The expected operating life time of the satellite will be five years.



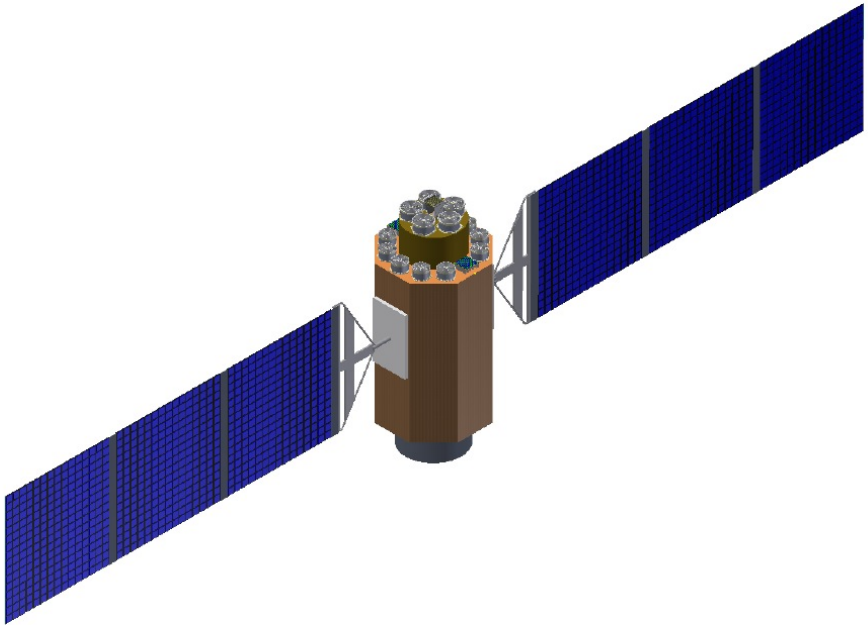
ASTROSAT will carry five astronomy payloads for simultaneous multi-band observations:

- Twin 40-cm Ultraviolet Imaging Telescopes (UVIT) covering Far-UV to optical bands.
- Three units of Large Area Xenon Proportional Counters (LAXPC) covering medium energy X-rays from 3 to 80 keV with an effective area of 6000 sq.cm. at 10 keV.
- A Soft X-ray Telescope (SXT) with conical foil mirrors and X-ray CCD detector, covering the energy range 0.3-8 keV. The effective area will be about 120 sq.cm. at 1 keV.
- A Cadmium-Zinc-Telluride coded-mask imager (CZTI), covering hard X-rays from 10 to 150 keV, with about 10 deg field of view and 500 sq.cm. effective area.
- A Scanning Sky Monitor (SSM) consisting of three one-dimensional position-sensitive proportional counters with coded masks. The assembly will be placed on a rotating platform to scan the available sky once every six hours in order to locate transient X-ray sources.

Implementation: imminent (?)

Possible high level participation in fields not yet covered by the Indian (and UK) community

XTP (X-ray Timing e Polarimetric telescope)



Optics (and polarimeter) for science

ASI to be involved

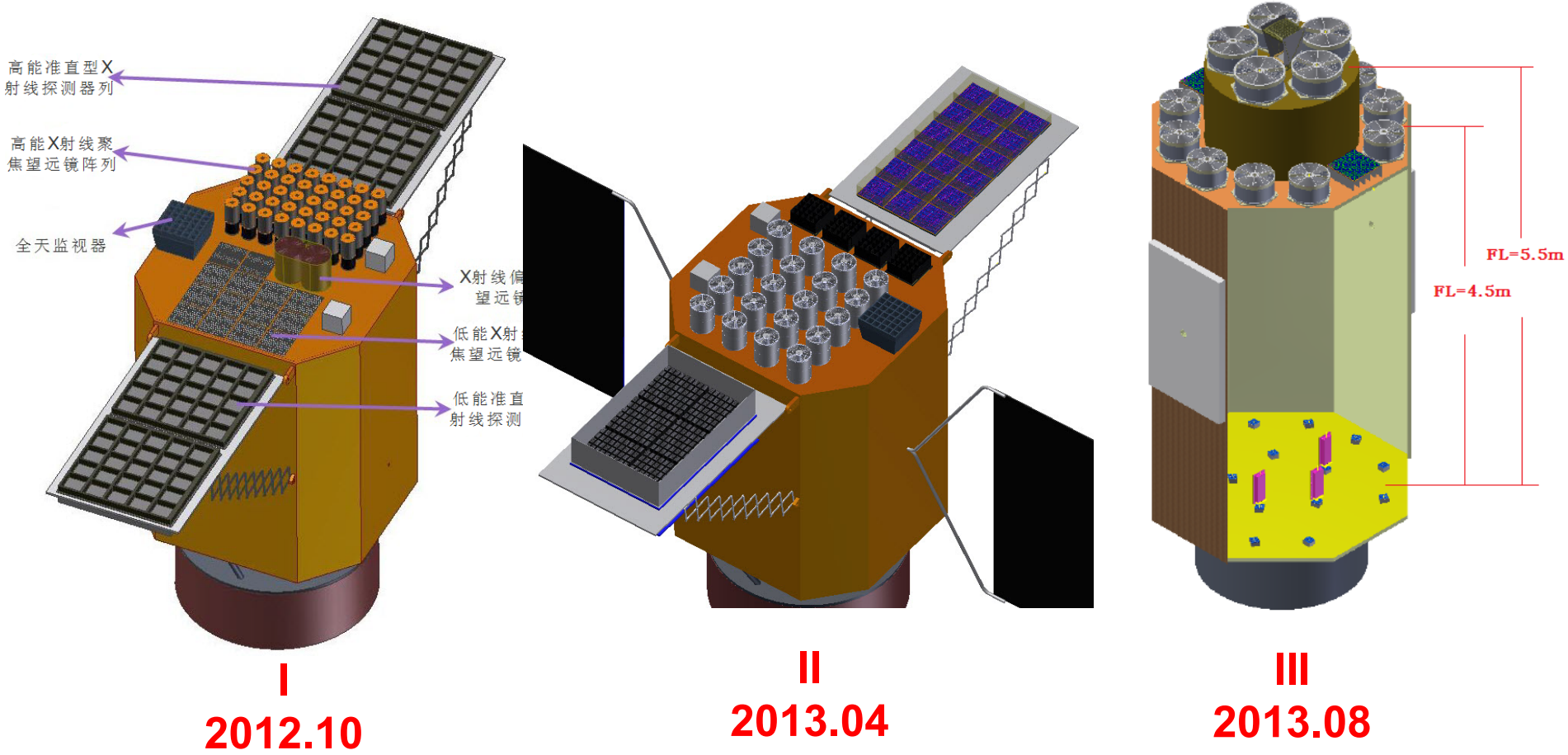
Collaboration started with Institute of High Energy Physics (represented by the Director, Shuang-Nan Zhang
And MPE represented by Kirpal Nandra)
Meeting in Merate, 20 Nov 2014

Summary of XTP main facts

	HFA	LFA
Optics	Quasi-Wolter I, Multi-layer	Quasi-Wolter I
Focal Length	5.5m	4.5m
Field of View	+/-8’	+/-8’
Energy range	1~30 keV	0.5~10 keV
Effective area	4000cm^2@2~6keV 300cm^2@30keV	5000cm^2@2~6keV
Optics units	5 (3+2)	10
Focal plane detector	3 GEM-TPC+ CZT 2 SDD/SPD	CCD/SDD
FWHM	CZT: 600 eV@5.9 keV SDD:150eV@5.9keV	CCD:150eV@5.9keV

Scientific requirements on payload

Scientific driver	Requirement	Value
EOS, BH spins, GR effect	Effective area	~1 m2
broadband spectrum multi-wavelength variability	Energy range	1-100 keV
broad Iron line measurement	Energy resolution	150 eV@6keV
sub-millisecond variability	Timing resolution	<100 μs
B, emission mechanism; emission geometry	Polarization	3% @ 0.1 mCrab
	Effective area for polarimetry (focus)	>1000 cm2



I
2012.10

II
2013.04

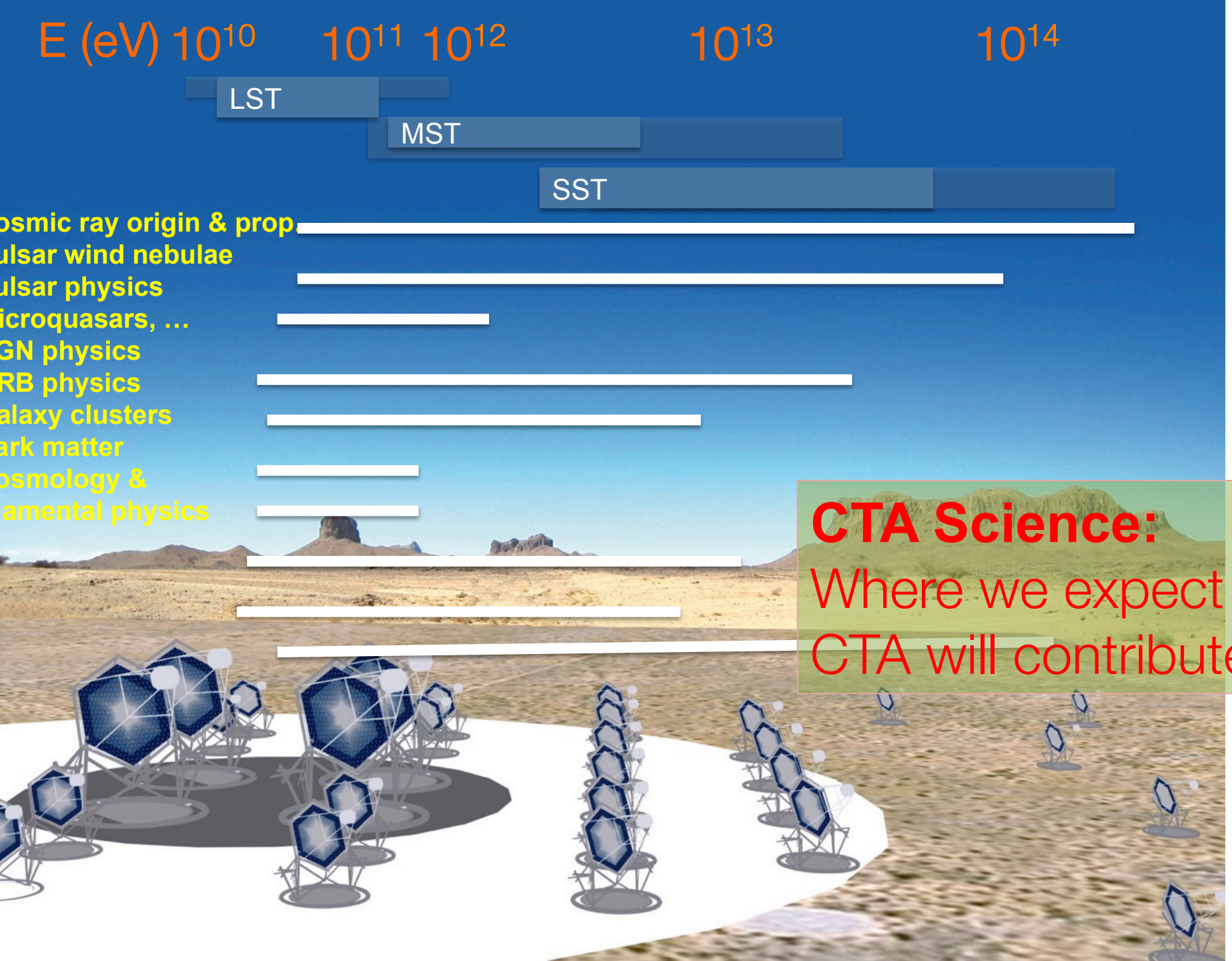
III
2013.08

Situazione dell'Astronomia Alte Energie e Relativistica (II)

- Prospettive nei raggi Gamma:
  - ASTRI/CTA (vicino),
  - HAWC (vicino!)
  - Gamma 400 → piuttosto lontane futuribile

- Partecipazione a SKA e ai suoi precursori (MERKAT e ASKAP)

- Controparti EM di onde gravitazionali


E (eV) 10^10 10^11 10^12 10^13 10^14
LST
MST
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osmic ray origin & prop
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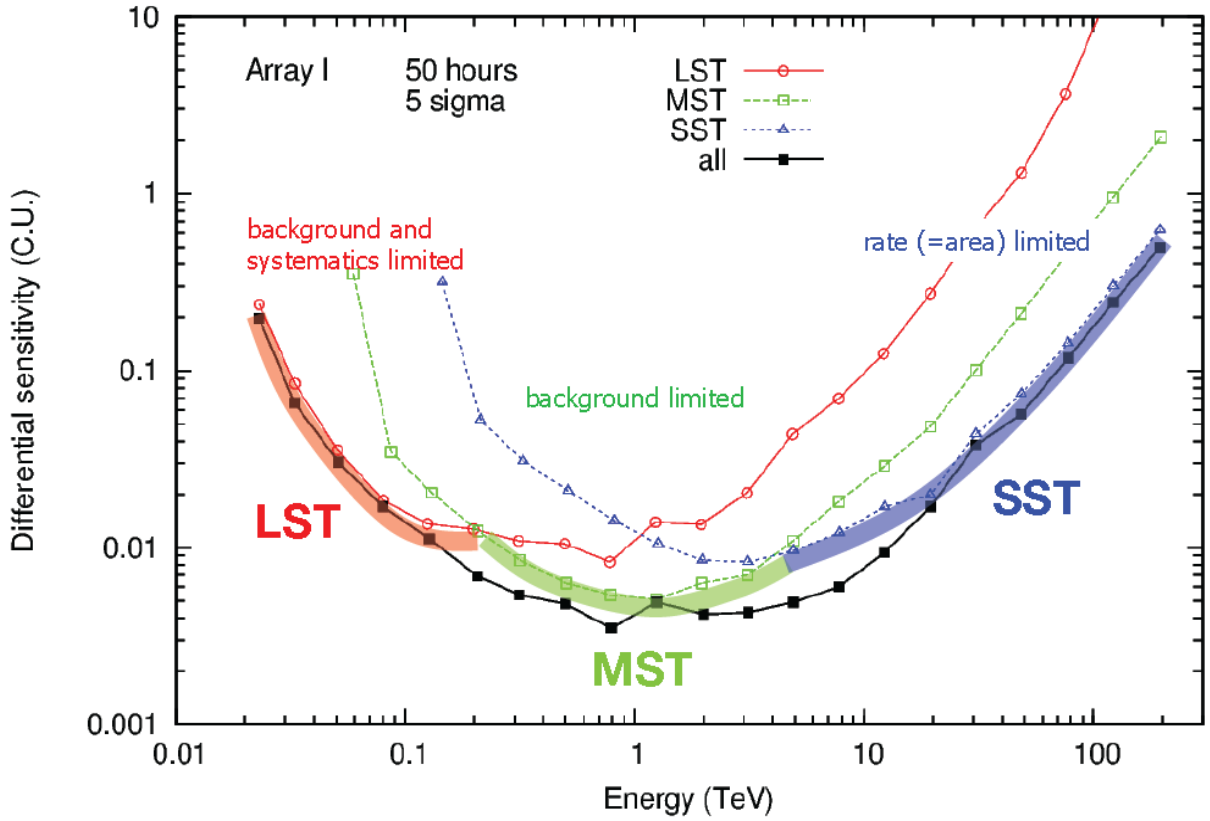
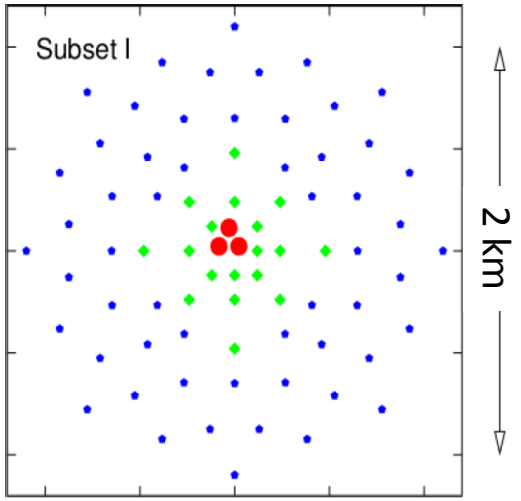
CTA Science:
Where we expect
CTA will contribute

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).

http://vimeo.com/107224505

ASTRI/CTA IN A NUTSHELL

- INAF project funded by the Italian MIUR (> 40 FTE), with the participation of Institutes from South Africa and Brazil

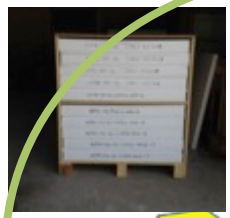
- E2E implementation of an SST-2M prototype in Sicily (Mount Etna, astronomical site of Serra La Nave)
- ➔ Validation e commissioning of the telescope via Cherenkov astronomical observation

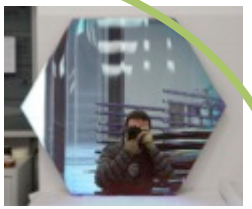
- E2E implementation of a mini-array (# ≥ 7) of SST-2M (pre-production) at the CTA site
- ➔ Validation e commissioning of the array (including trigger and sw) via Cherenkov astronomical observations, first CTA scientific data

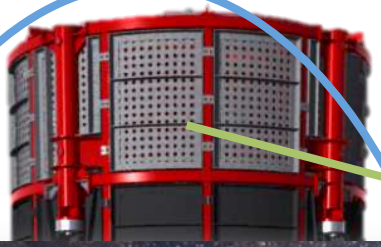
- **Aiming at the realization of 35 out of the 70 SST telescopes of the CTA southern array**

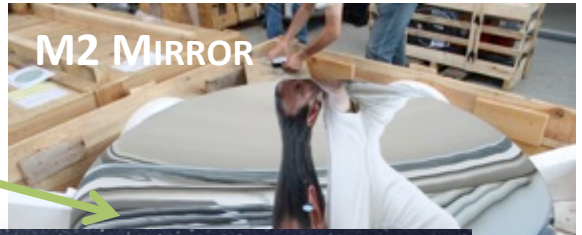
E2E APPROACH

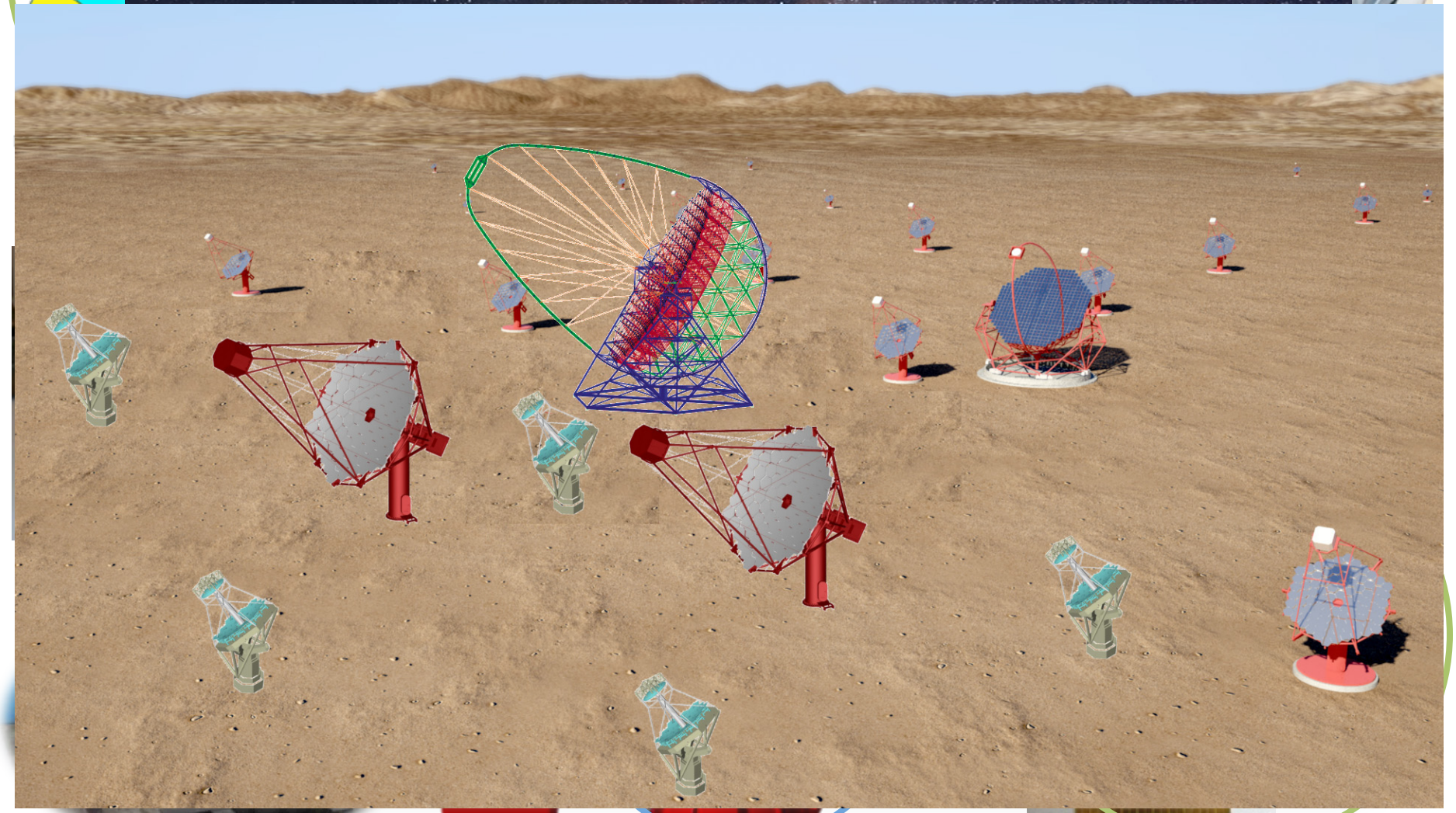
- Optical design and primary segmentation: ➔ PSF (D_{80} = 0.17 deg) constant across the entire large FoV (9.6 deg)
- Design to entirely fulfill the requirements
- Structure, mirrors, camera, software for single telescope and array developed in parallel for the E2E implementation
- SW: control, monitoring, archive, data analysis within the same shell and fulfilling the architecture of ACTL and DATA
- Auxiliary systems for monitoring, calibration and pointing







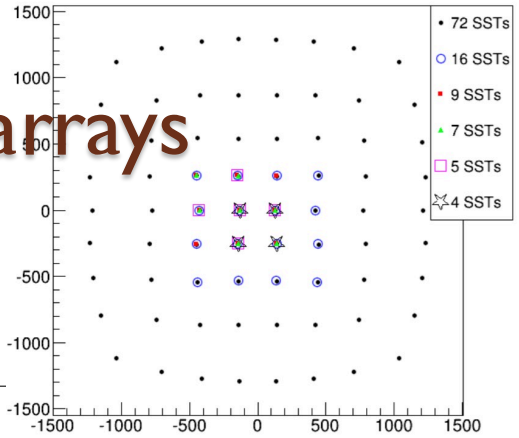

M2 Mirror

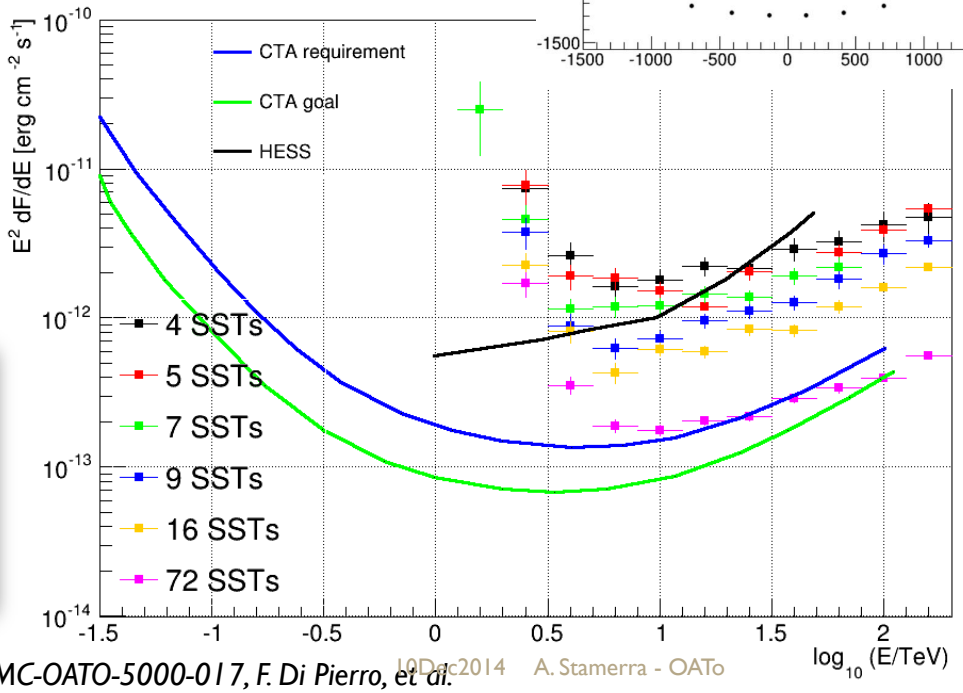


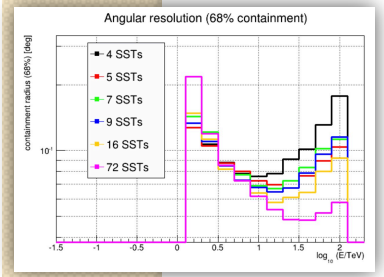
Mini-array sensitivity

Performance: mini-arrays

- Mini-arrays, extracted from PROD-2







internal ASTRI note: ASTRI-MC-OATO-5000-017, F. Di Pierro, et al.

Situation for OAB

- Leadership of the project, important scientific and technical participation, strong collaboration with IASF/Mi and Pa

- Money: well funded project for both technical/ scientific (including people) and industrial aspects

- Recent support by Regione Lombardia and Cariplo for suppoting the preparation to s tarting ERC proposals: a graet oppotunity!

The HAWC Gamma-Ray Observatory

The High-Altitude Water Cherenkov Observatory, or HAWC, is a facility designed to observe TeV gamma rays and cosmic rays with an instantaneous aperture that covers more than 15% of the sky. With this large field of view, the detector will be exposed to two-thirds of the sky during a 24-hour period.

Missioni proposte per ESA/M5

- XIPE
- THESEUS
- ASTROGAM (e GAMMA 400…)

Il significato della parola:"Compromesso".

In altre parole, per le Alte Energie… dobbiamo fare per un po' di tempo…. di necessità virtù!

Facciamolo al meglio e diamoci da fare!