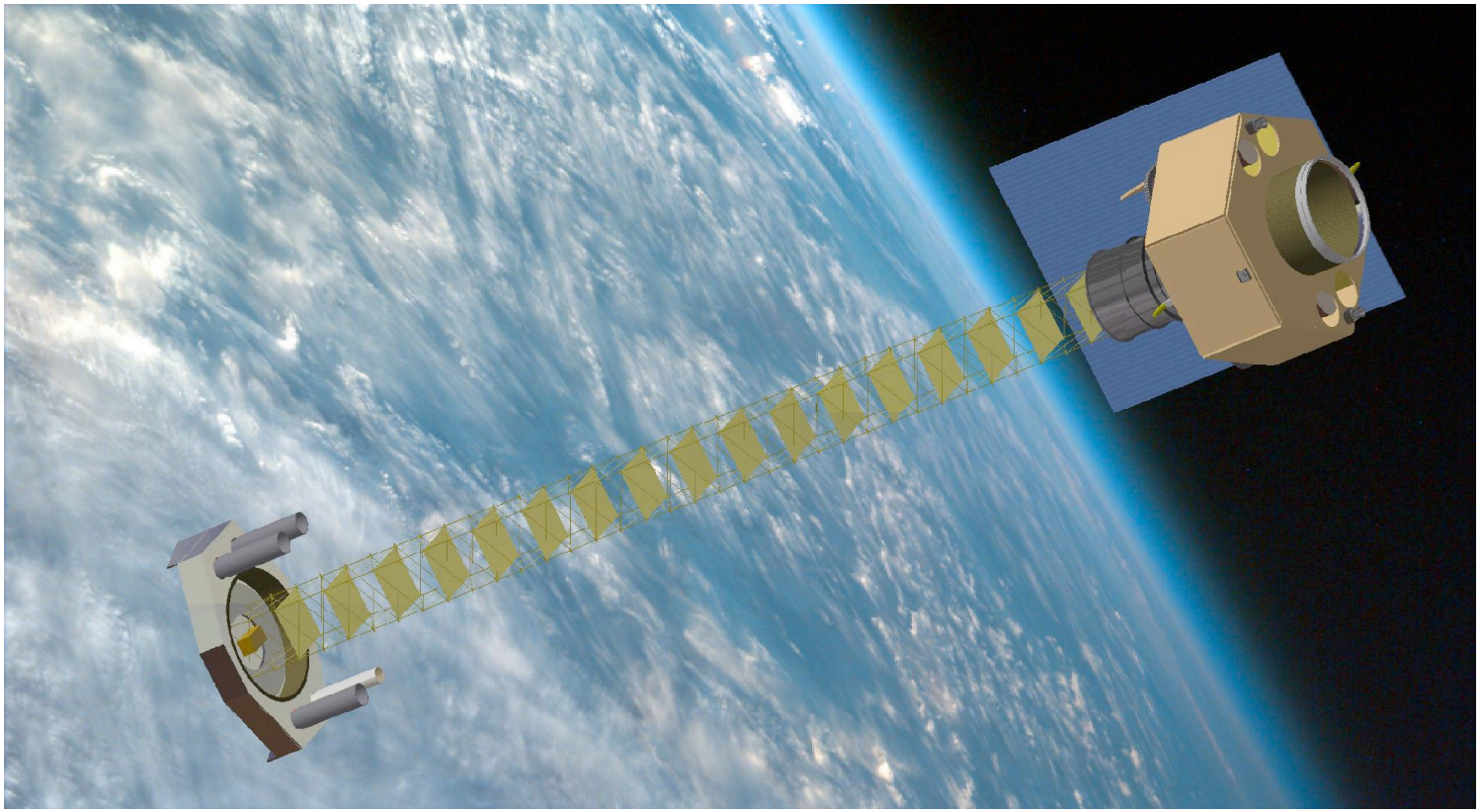
NHXM: a New Hard X-ray Imaging and Polarimetric Mission

Sergio Campana & Gianpiero Tagliaferri

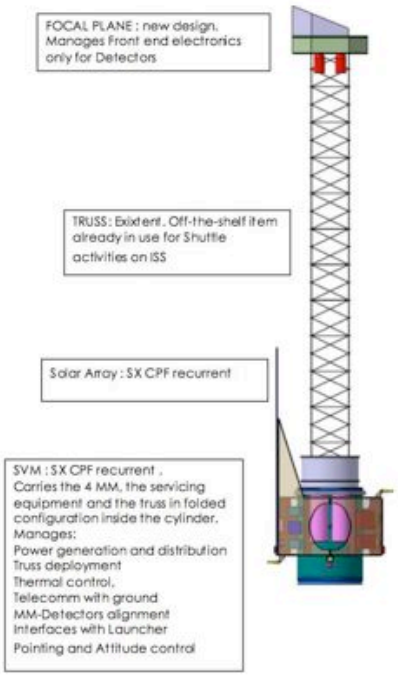
INAF - Osservatorio Astronomico di Brera

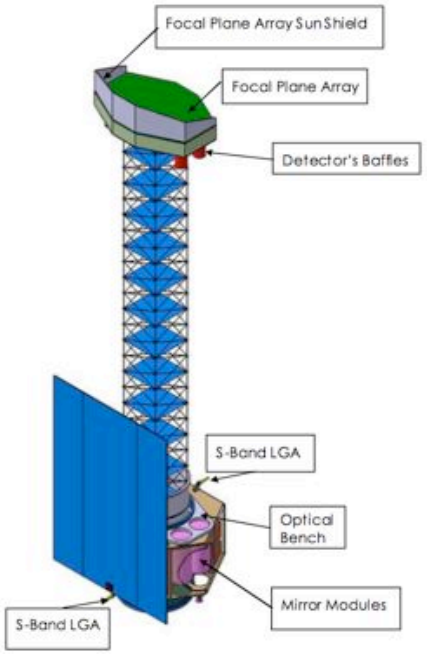


New Hard X-ray Mission main features

- Single satellite with extendable bench (NO Formation Flight!)
  - **Four high quality (XMM-like) mirrors with multilayer coatings (0.2-80 keV)**
  - **Three Telescope Modules dedicated to broad band imaging & spectroscopy**
  - **One telescope Module dedicated to imaging polarimetry (2-35 keV)**
    ➔ extendable up to 80 keV with a scattering polarimeter
  - **LEO (equatorial) ➔ low internal background**

Mission Configuration





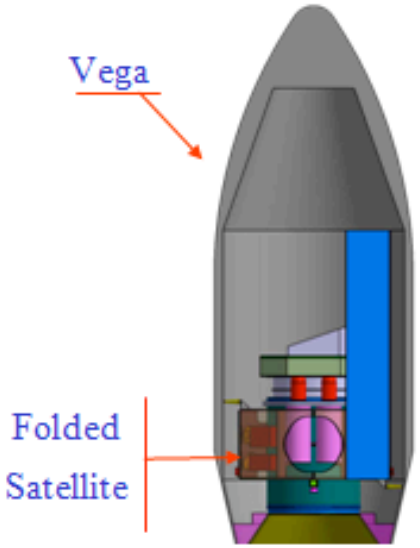
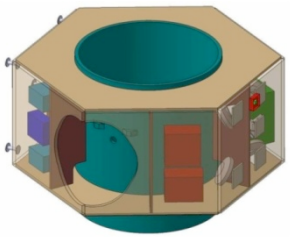
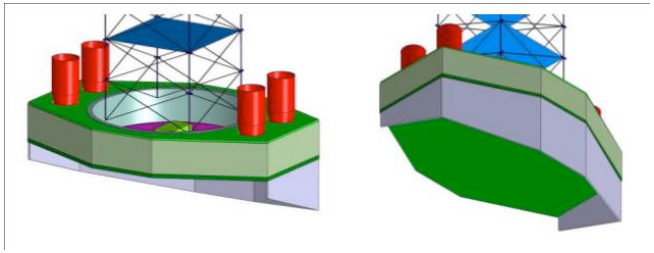


Figure 28: The folded satellite inside the VEGA fairing



Service module (PRIMA Science platform)



Focal plane module

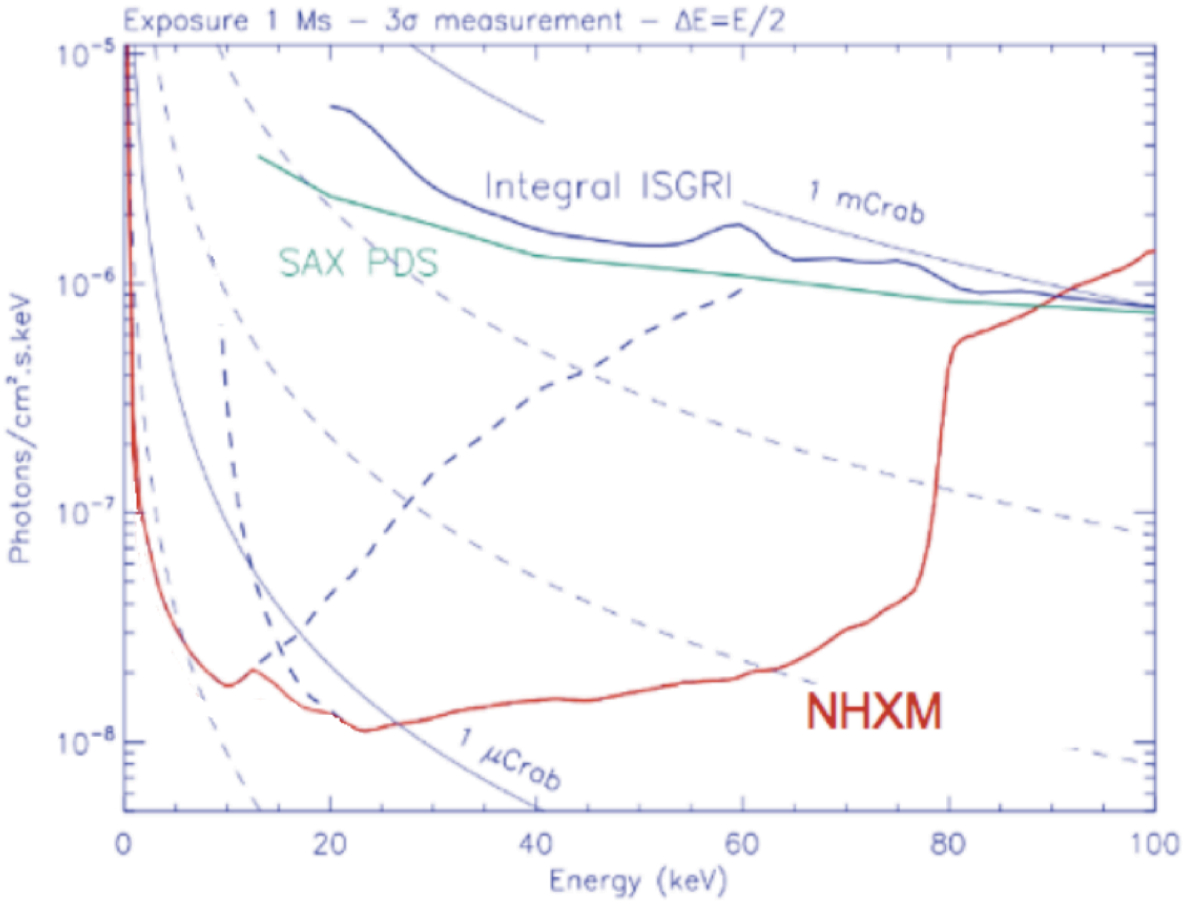
Key parameters of future hard X-ray missions

		NHXM	NuSTAR	Astro-H
# of Telescopes		3+1	2	2+2
Energy band (keV)		0.2 ÷ 80	7 ÷ 80	0.5 ÷ 80
Effective area (cm^2)	at 30 keV	350	300	320
	at 5 keV	>1000	0	500
Orbit, inclination		Low Equatorial <5°	Low Equatorial ~6°	Low Equatorial ~30°
Focal Length (meters)		10	10.14	12
Field of View diameter (arcmin)		12	12	9
Half Power Diameter (arcsec at 30 keV)		20	45-60	>100
10-40 keV flux sensitivity at confusion limit (erg cm^{-2} s^{-1})		3×10^{-15}	2×10^{-14}	4×10^{-14}
Sources per field		40	6	1

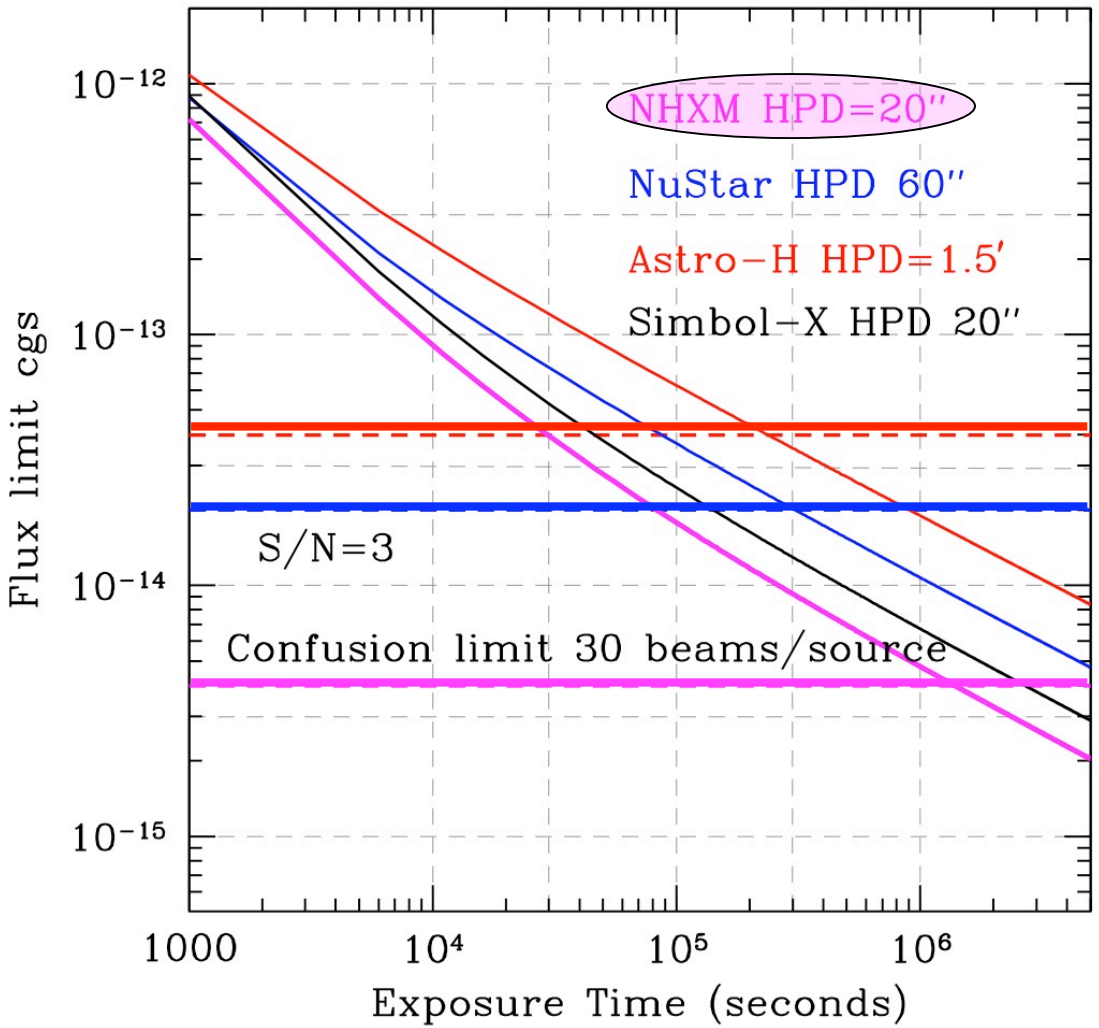
Key parameters of future polarimteric missions

	NHXM	GEMS
# of Telescopes	1	3
Energy band (keV)	2 ÷ 35 (2-10 + 6-35)	2 ÷ 10 (+0.5 keV)
Field of View diameter (arcmin)	12	12
Half Power Diameter (arcsec at 30 keV)	20	Non imaging
MDP (1 mCrab, 100 ks 2-10 keV band)	10%	5%
Rotation	Not needed	Yes (0.1 rpm)
MDP (systematics)	<< 1%	Unknown
Background	0.13 μCrab (2-10 keV) 0.4 μCrab (6-35 keV)	0.2 mCrab

Flux Sensitivity (I)

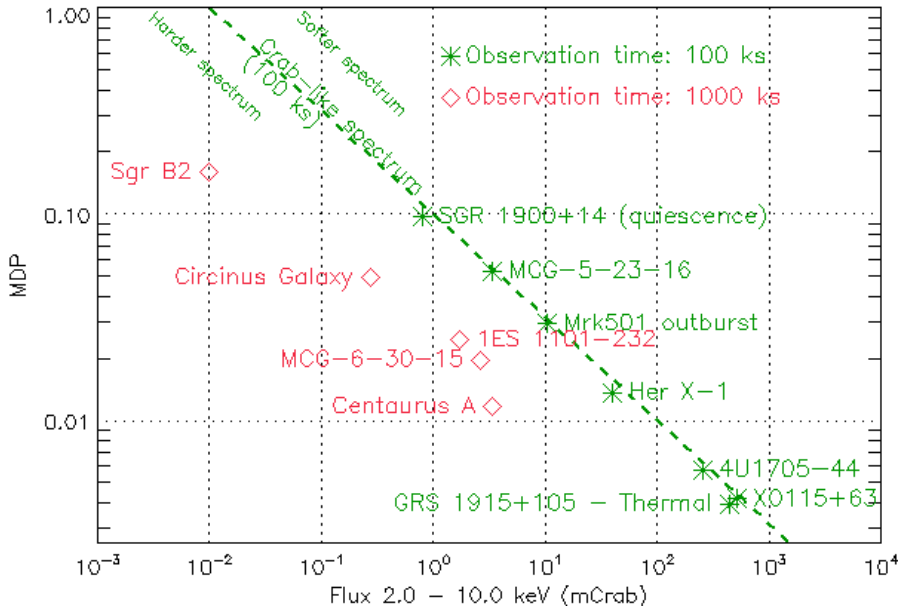


Flux sensitivity



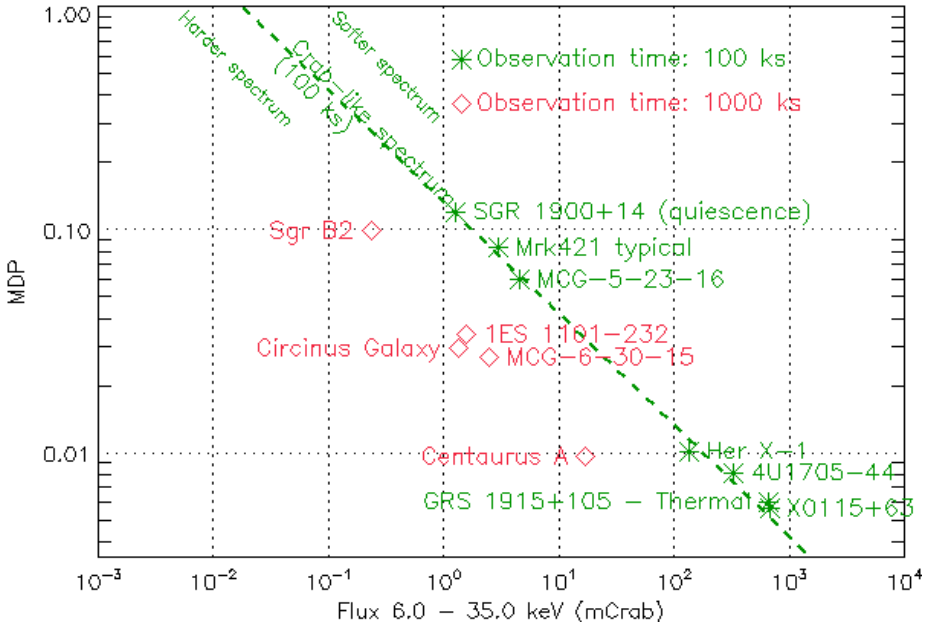
Polarimetric sensitivity

Soft X-ray channel



Two polarimetric channels (2 – 10 keV and 10 – 35 keV) for an effective diagnostic of the emission mechanisms

Hard X-ray channel



Cross correlation with the spectroscopy data between 2 and 36 keV!

NHXM: Core scientific objectives

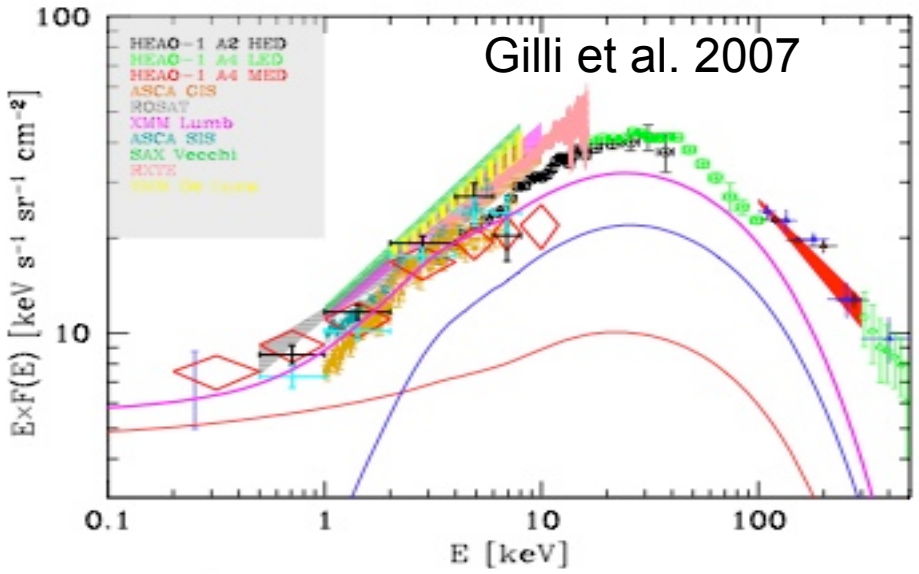
- **Black hole physics and census**

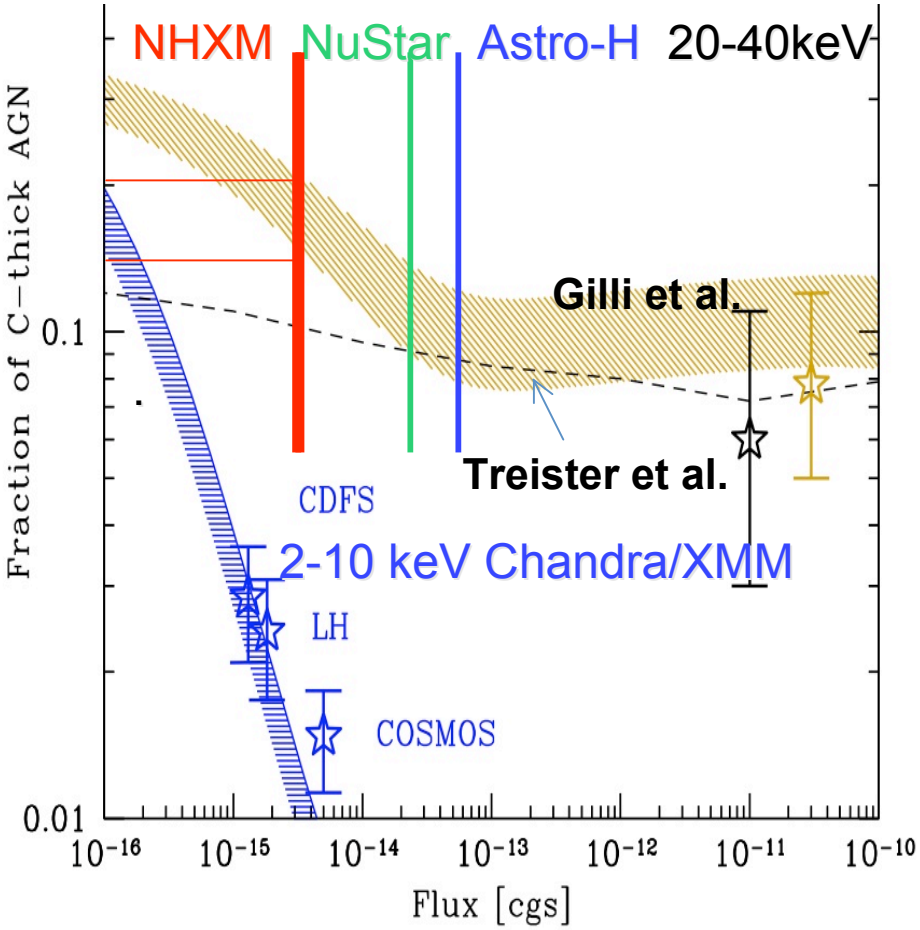
- resolve at least 50-60% of the CXB in the energy range where it peaks (20-30 keV)
- solve the puzzle on the origin of the hard X–ray emission from the Galactic centre
- constrain the physics of the accretion flow onto both SMBH and solar mass BH

- **Particle acceleration mechanisms**

- constrain acceleration processes in relativistic jets of blazars and GRB
- measure the maximum energy of electron acceleration in supernova remnants shocks
- probe acceleration mechanisms in the strong EM and gravitational fields of pulsars

CXB fraction & Compton Thick AGN



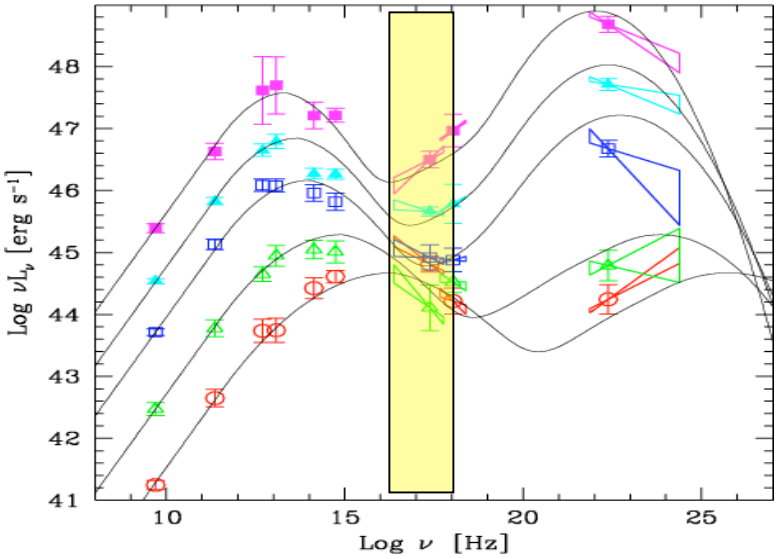


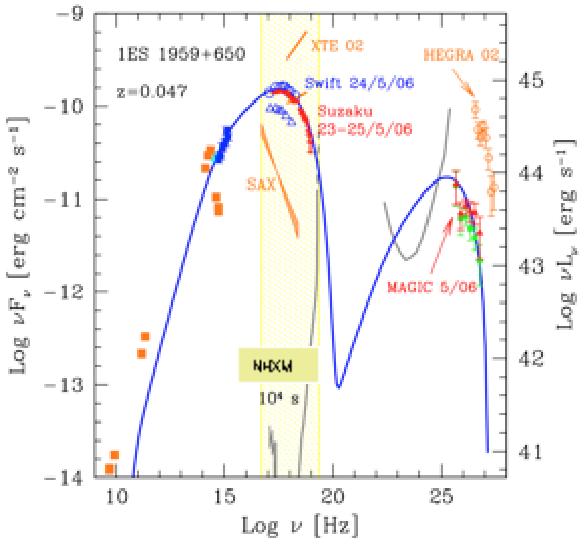
- Strong evidences for missing SMBH
- Complete SMBH census needed, including Compton Thick AGN
- Obscured AGN: probe of early galaxy evolution phases, when feedback must be in action

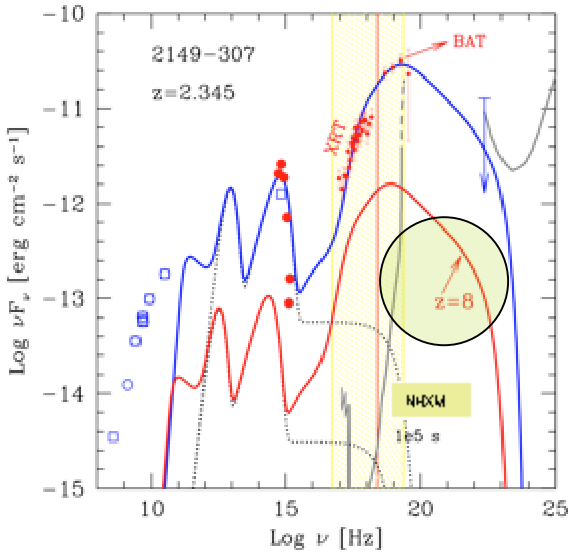
Acceleration mechanisms

- Jet emission is due to both synchrotron and Inverse Compton, both components are strongly polarized.

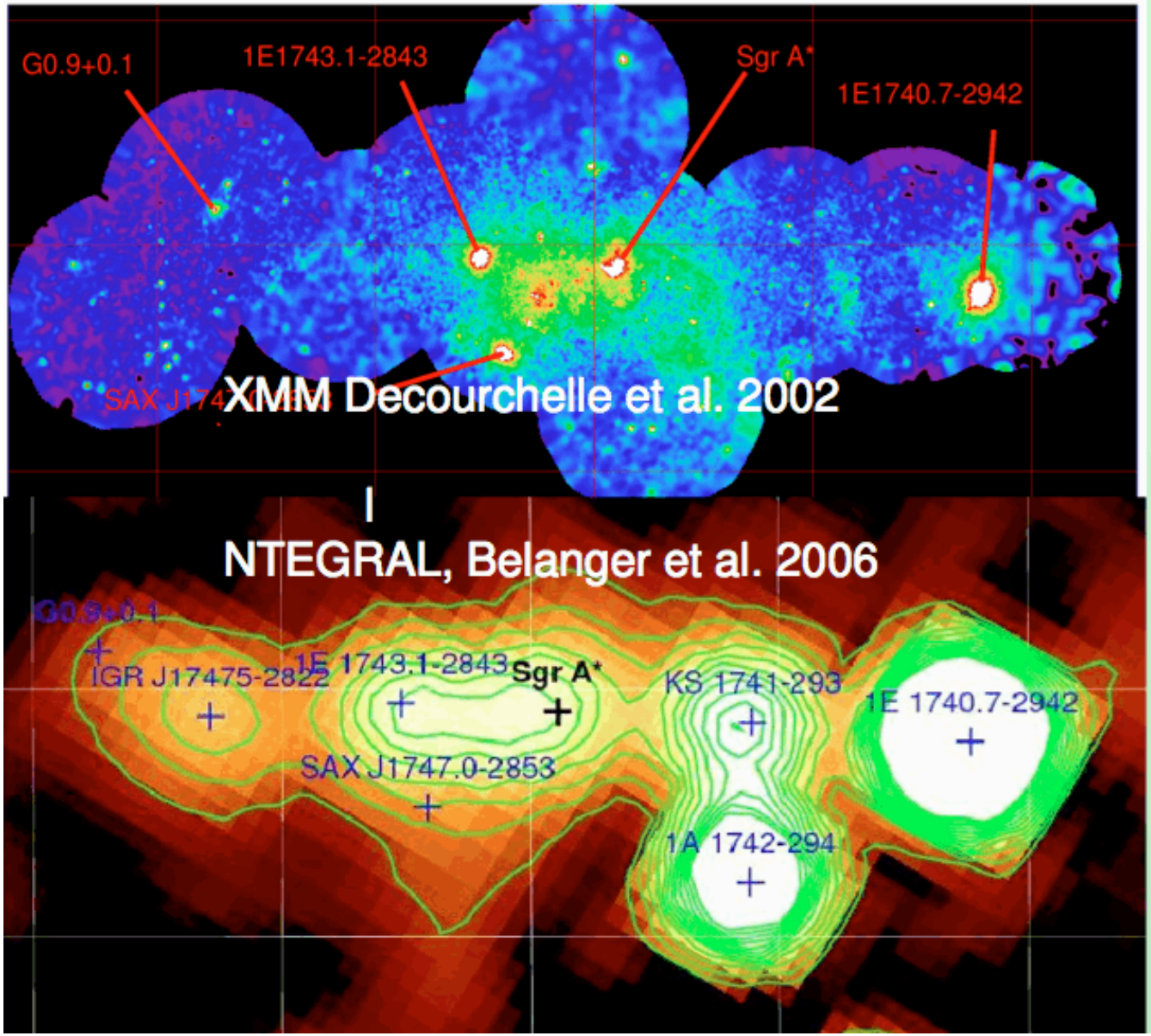
- Therefore, multi-band (IR, Opt., X-ray) spectroscopy and polarimetry can probe
  - jet structure
  - nature of jet seed photons
  - jet power





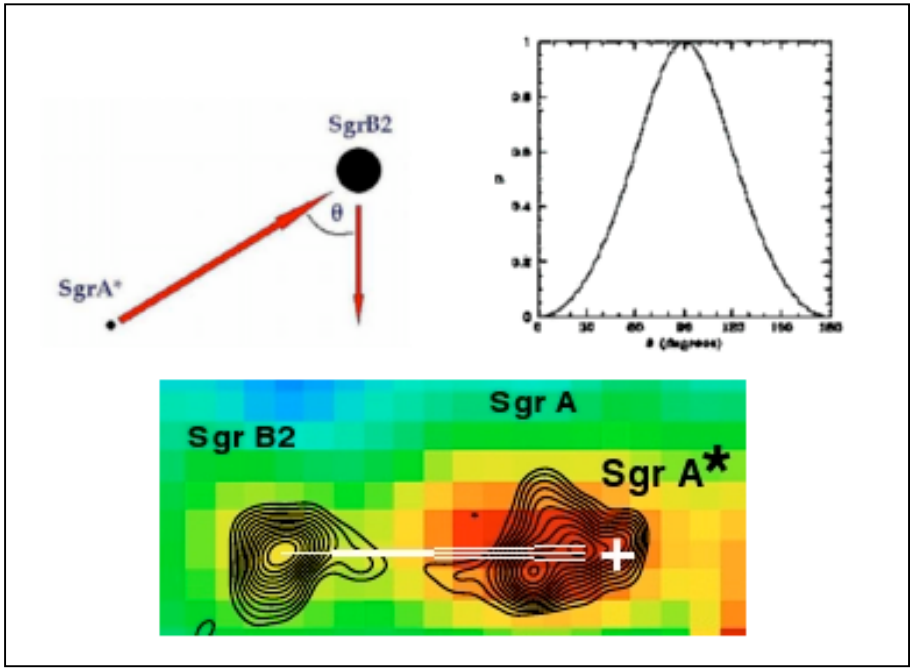


The Galactic Centre



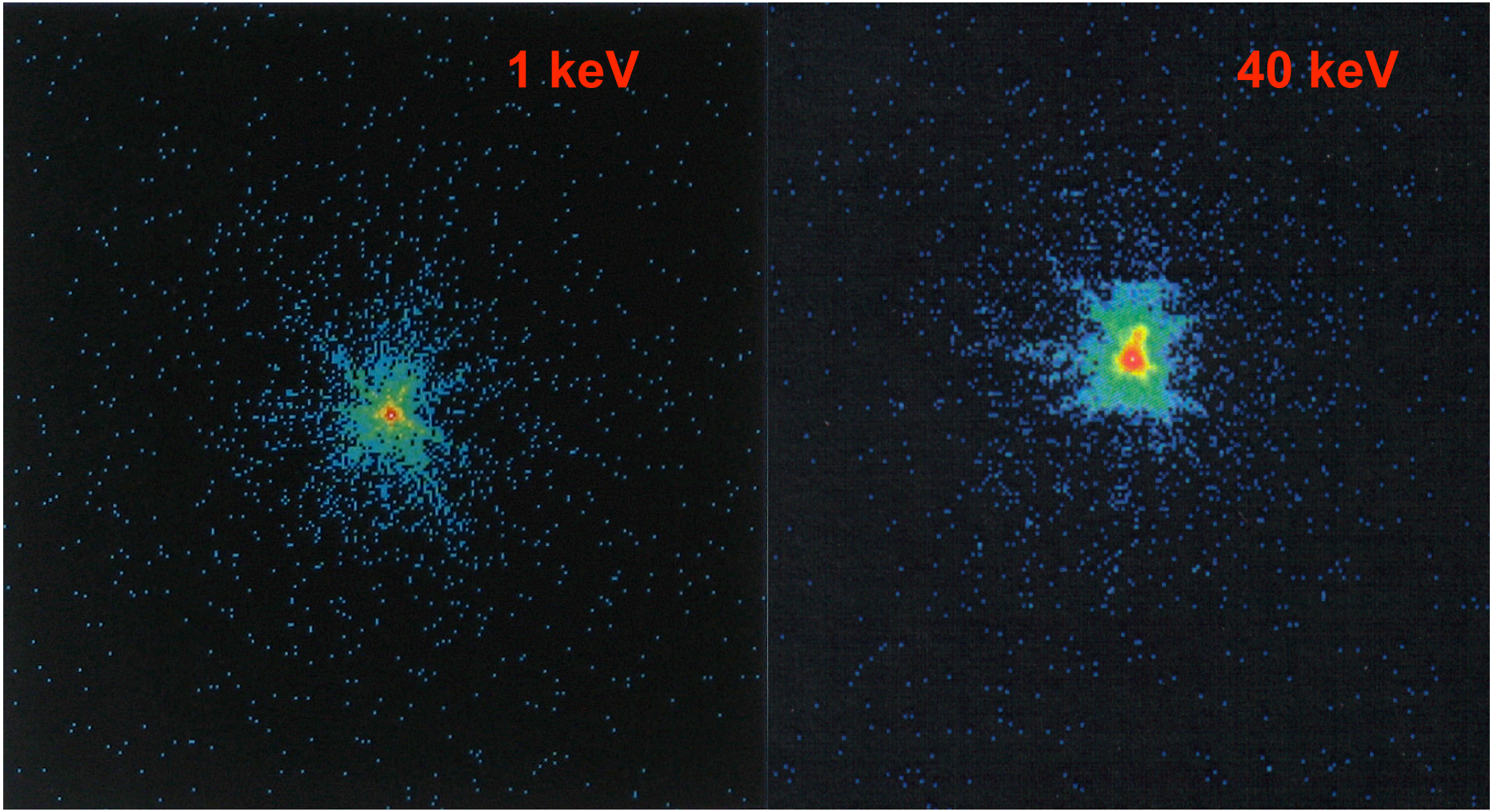
- Accretion physics and GR test in the closest SMBH: spectrum and variability of Sgr A* flares in hard X-rays
- Particle acceleration from SMBH: identify and reveal the nature of the central INTEGRAL and HESS source
- The nature of the hot diffuse X-ray emission

X-ray Polarimetry with imaging capabilities

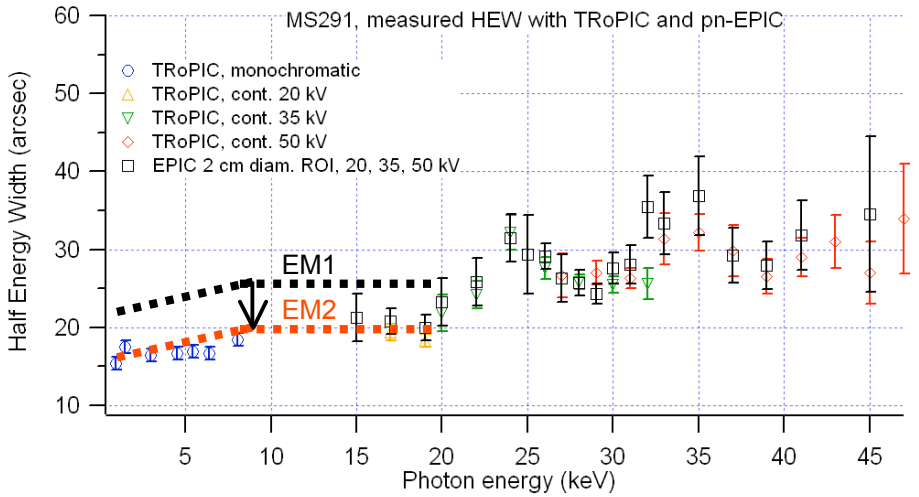


The possibility to associate to the polarimetric sensitivity also an imaging capability is of paramount importance in the case of extended sources investigation, like e.g. the SN remnants and the Galactic Centre region.

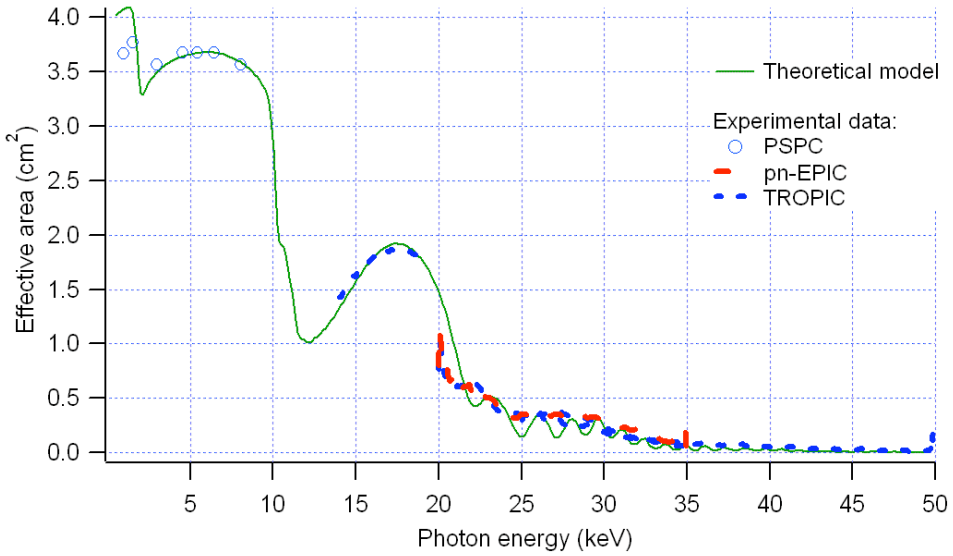
EM3: optics calibration @ Panter/MPE



Panter measurements of EM1, EM2 & EM3



HEW



Effective Area

Summary

- The discovery space of the NHXM mission is extremely wide; also thanks to the addition of simultaneous **imaging polarimetry**.

- This is achievable by the small/medium-size NHXM project, exploiting already available technology in mirror and detector manufacturing, well within the next decade. The mission could be ready for a launch in 2016-17.

- All technologies have old and strong roots, building up on the BeppoSAX, INTEGRAL & XMM-Newton heritage and on the recent technological advance made for the mirrors, polarimeter, detectors and truss.

- Strong interest has been expressed also by other International Institutes.

- NHXM is a big step forward following on the hard X-ray focusing missions NUSTAR and ASTRO-H and on the polarimetric GEMS mission. NHXM will also be a good precursor for IXO, testing various technologies that are foreseen on a much larger scale for IXO.

- Initial stages of the mission (phase B) are now supported by an ASI constract. We plan to submit a NHXM proposal to the ESA call soon to be issued.