eROSITA

Prof. Dr. Manami Sasaki

Dr Karl Remeis Observatory Bamberg, Erlangen Centre for Astroparticle Physics, Friedrich-Alexander University Erlangen-Nürnberg

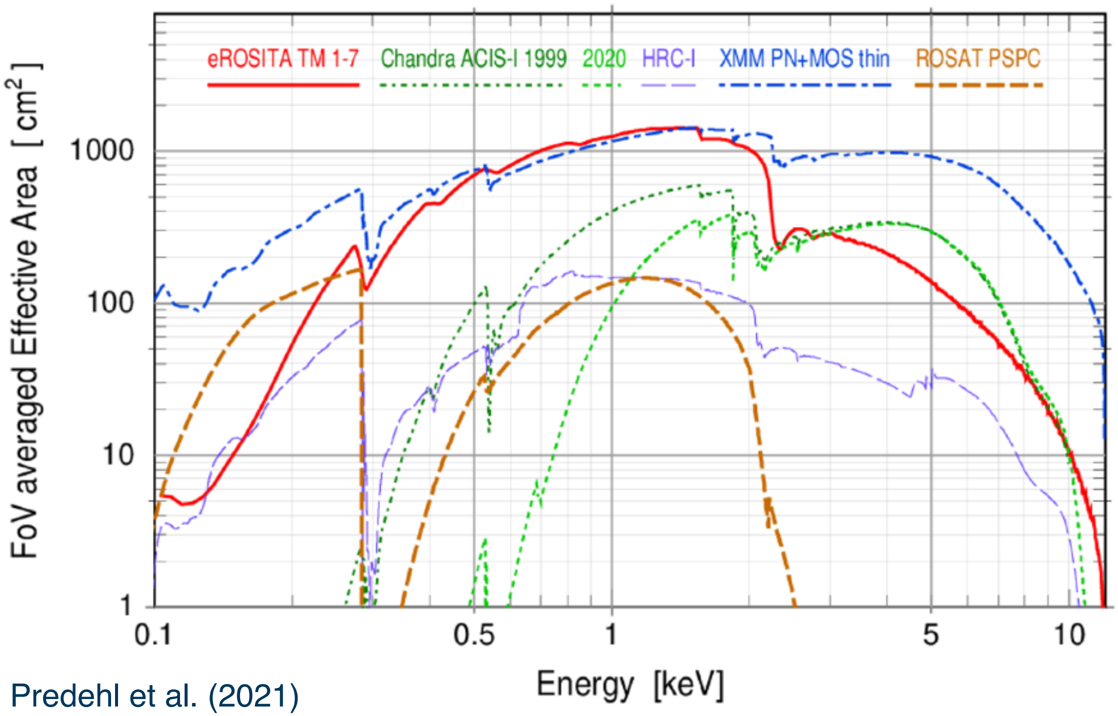
eROSITA

"extended ROentgen Survey with an Imaging Telescope Array"

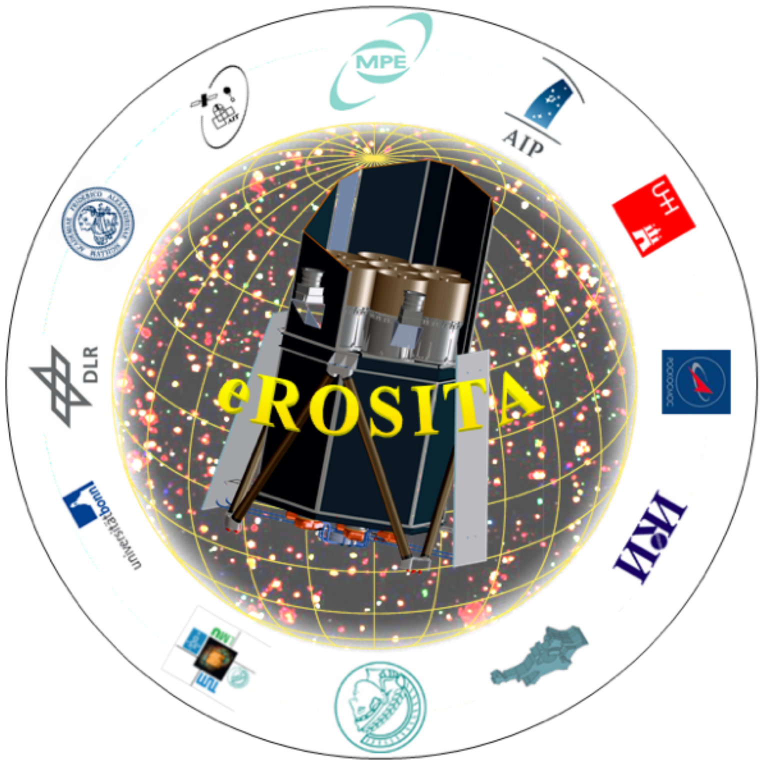
Collaboration between Germany and Russia.

German X-ray telescope on board the Russian "Spectrum-Roentgen-Gamma" (SRG) satellite.

First all-sky survey in the soft to medium X-ray band from 0.2 to 10 keV with a spatial resolution of 26" and spectral resolution of 80 eV at 1.5 keV.



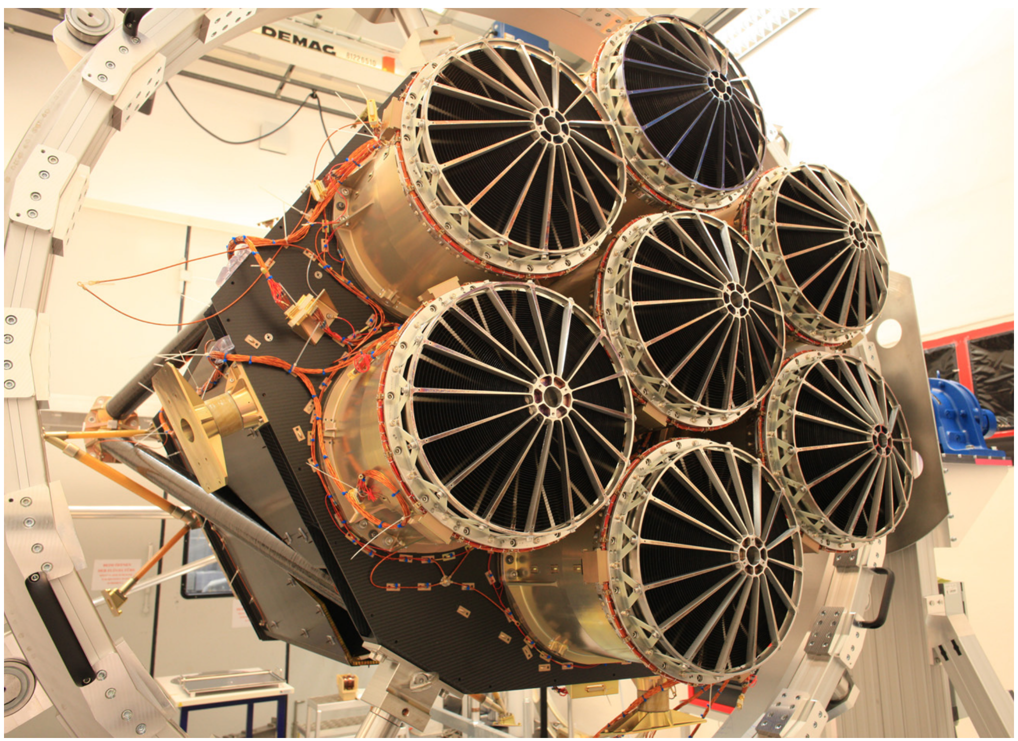
Predehl et al. (2021)



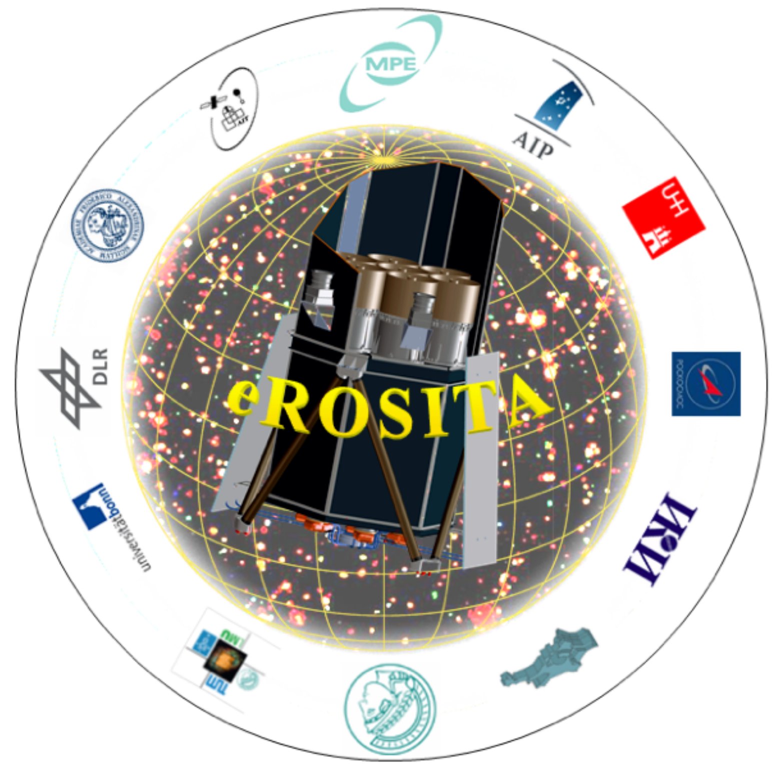
eROSITA

The main goals are:

- to detect the **hot intergalactic medium** of ~100,000 galaxy clusters to study the cosmic structure evolution,
- to detect systematically all obscured accreting **supermassive black holes** in nearby galaxies and many (up to 3 Million) new, distant AGNs, and
- to study in detail the **physics of galactic X-ray source populations**, like pre-main sequence stars, supernova remnants and X-ray binaries.

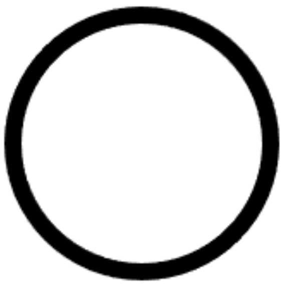


Credit: MPE



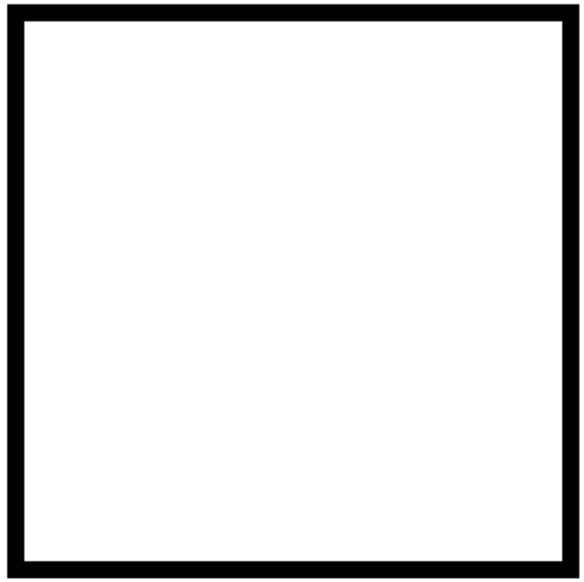
Moon diameter
30 arcmin

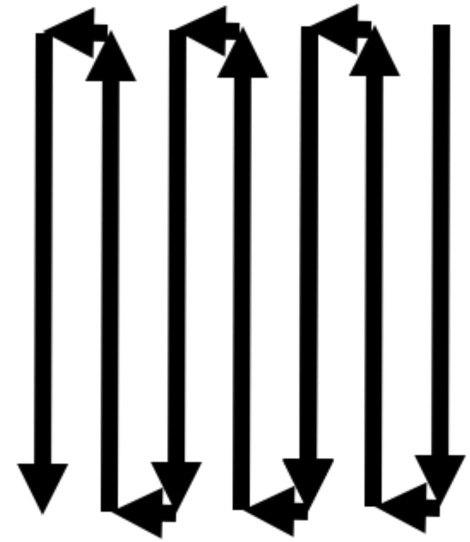
XMM-Newton
Field of view ~ 30 arcmin



Chandra
Field of view ~ 17 arcmin

eROSITA
Field of view ~ 62 arcmin





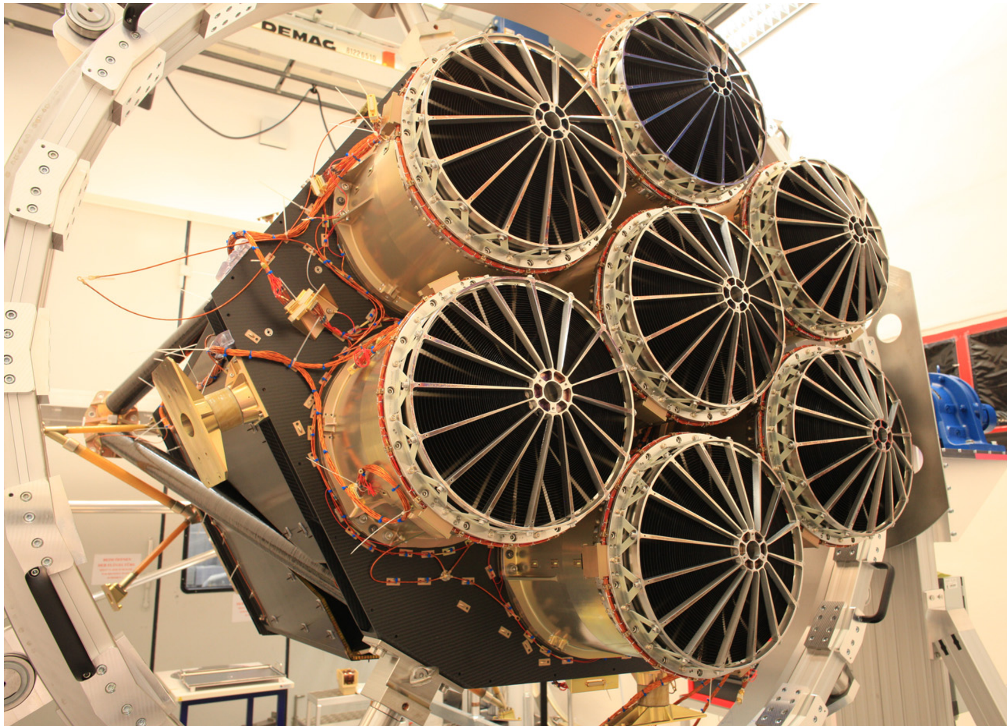
Scanning feature

3 Observing modes:
continuous scan (survey), field scan, pointing

Credit: A. Merloni (MPE)

eRO-STEP
FOR2990

eROSITA



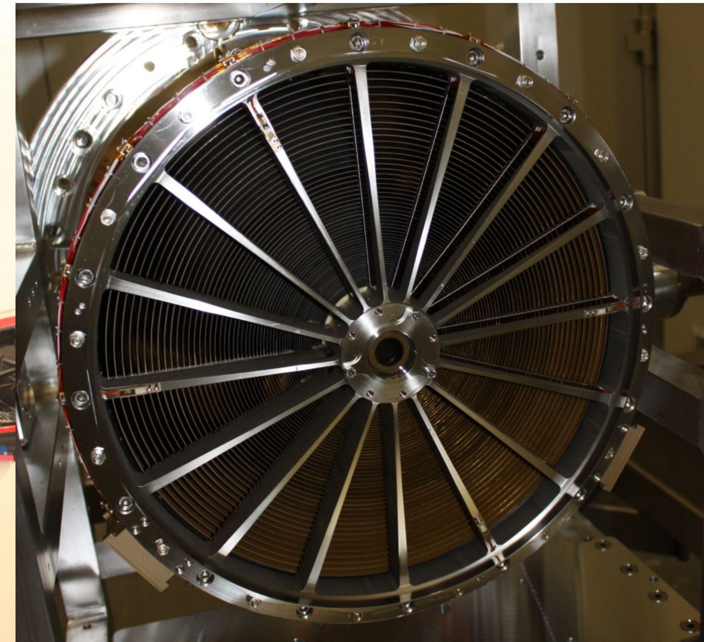
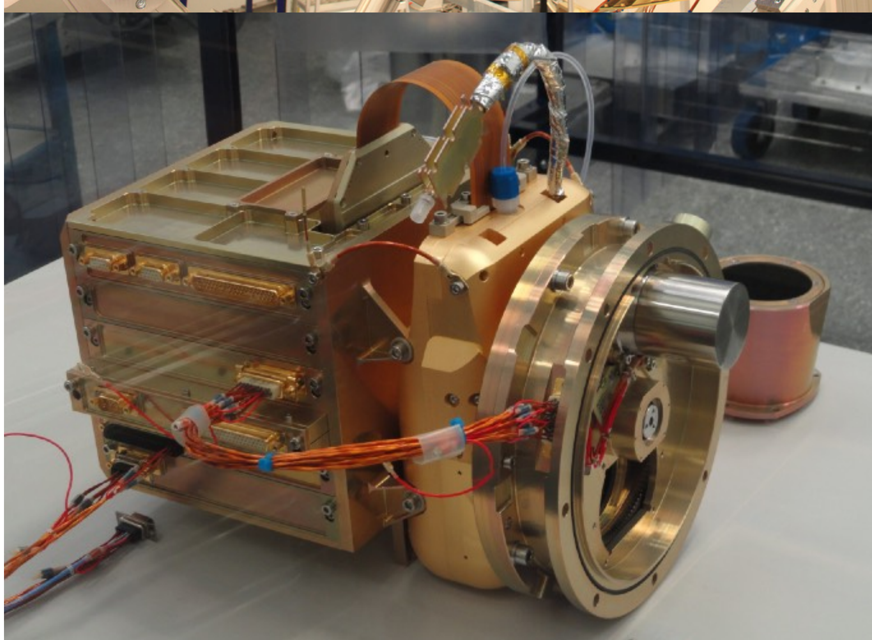
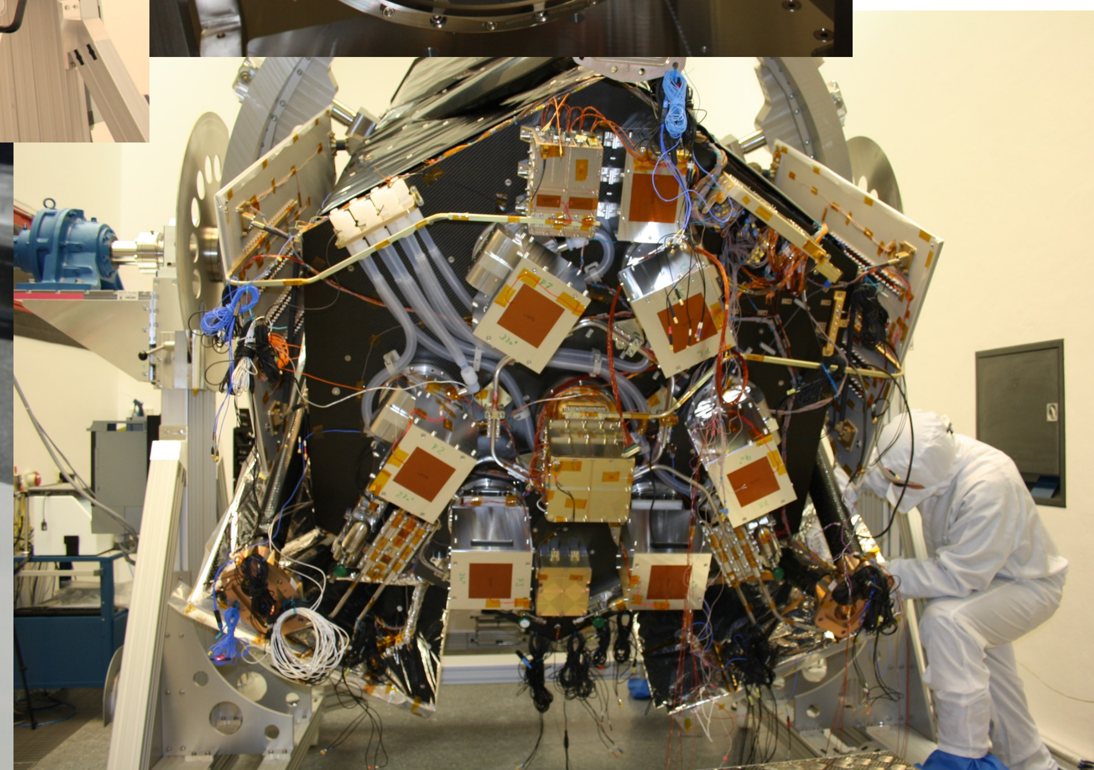


Image credit: MPE



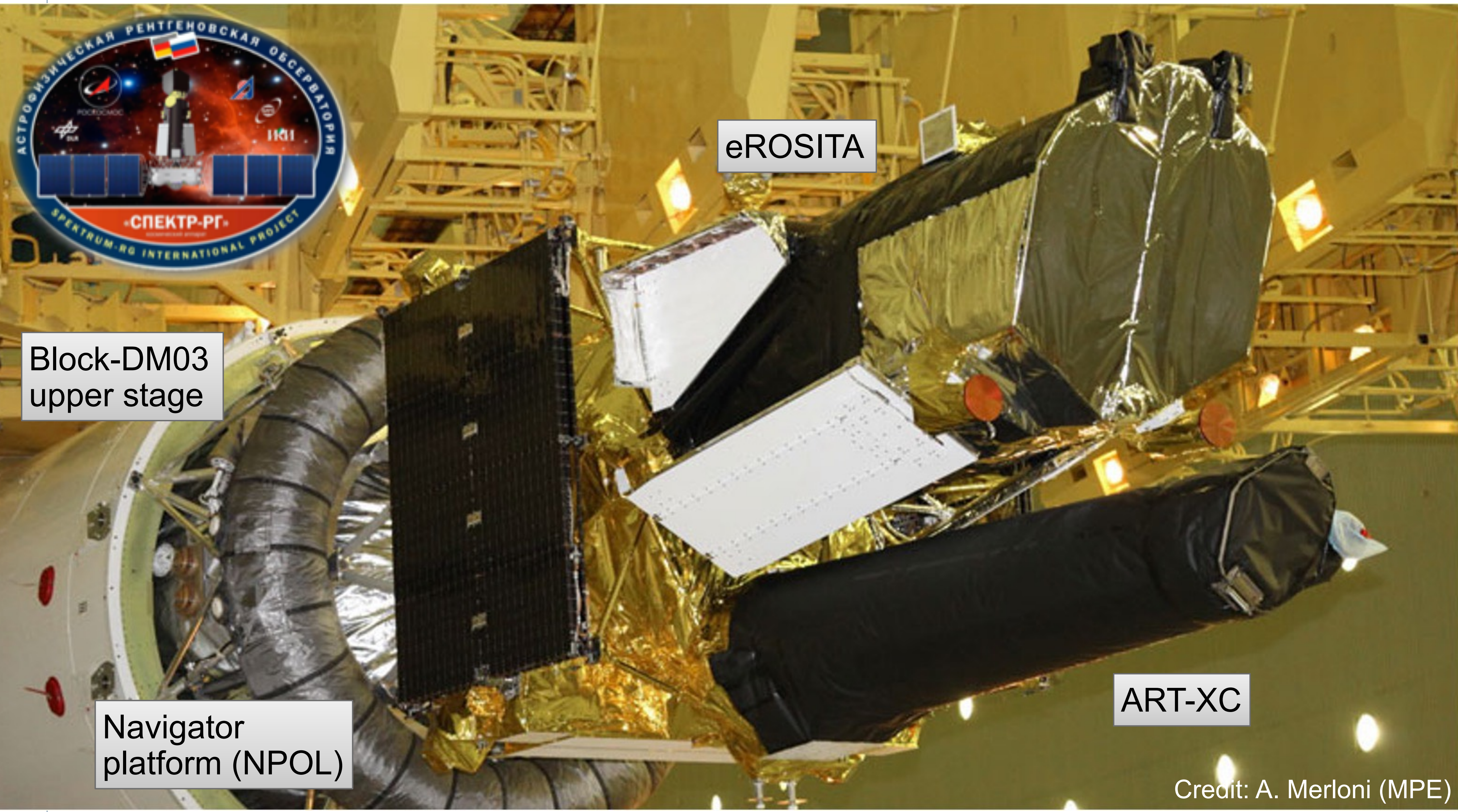


Spektr-Roentgen Gamma

eROSITA and ART-XC on Spektr-RG


Lavochkin

Spektr-Roentgen Gamma



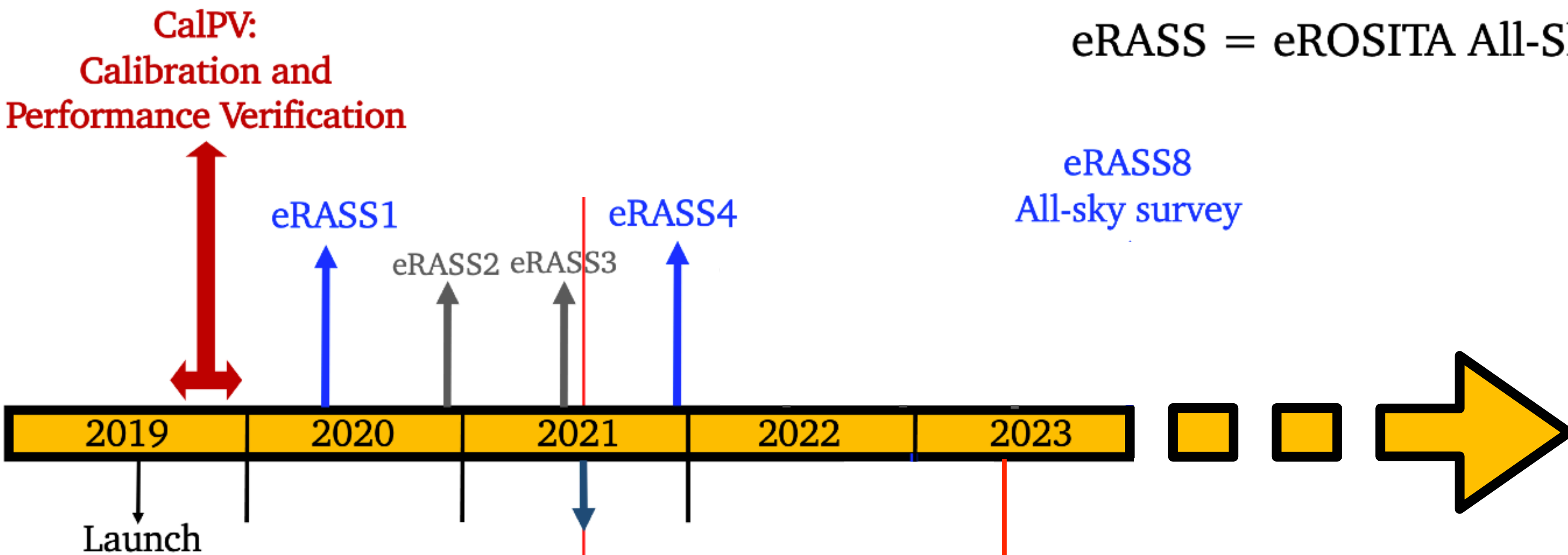
Spektr-Roentgen Gamma

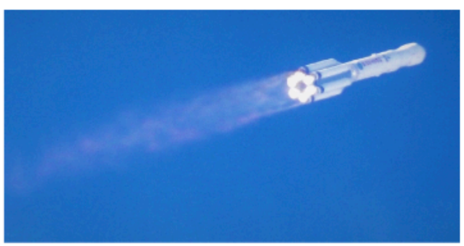
Launch: July 13, 2019, 14:31 CEST

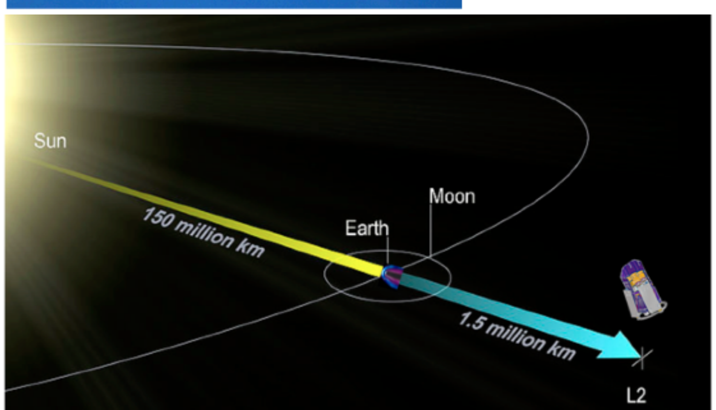
Anatoly Zak, russianspaceweb.com

Timeline

eRASS = eROSITA All-Sky Survey





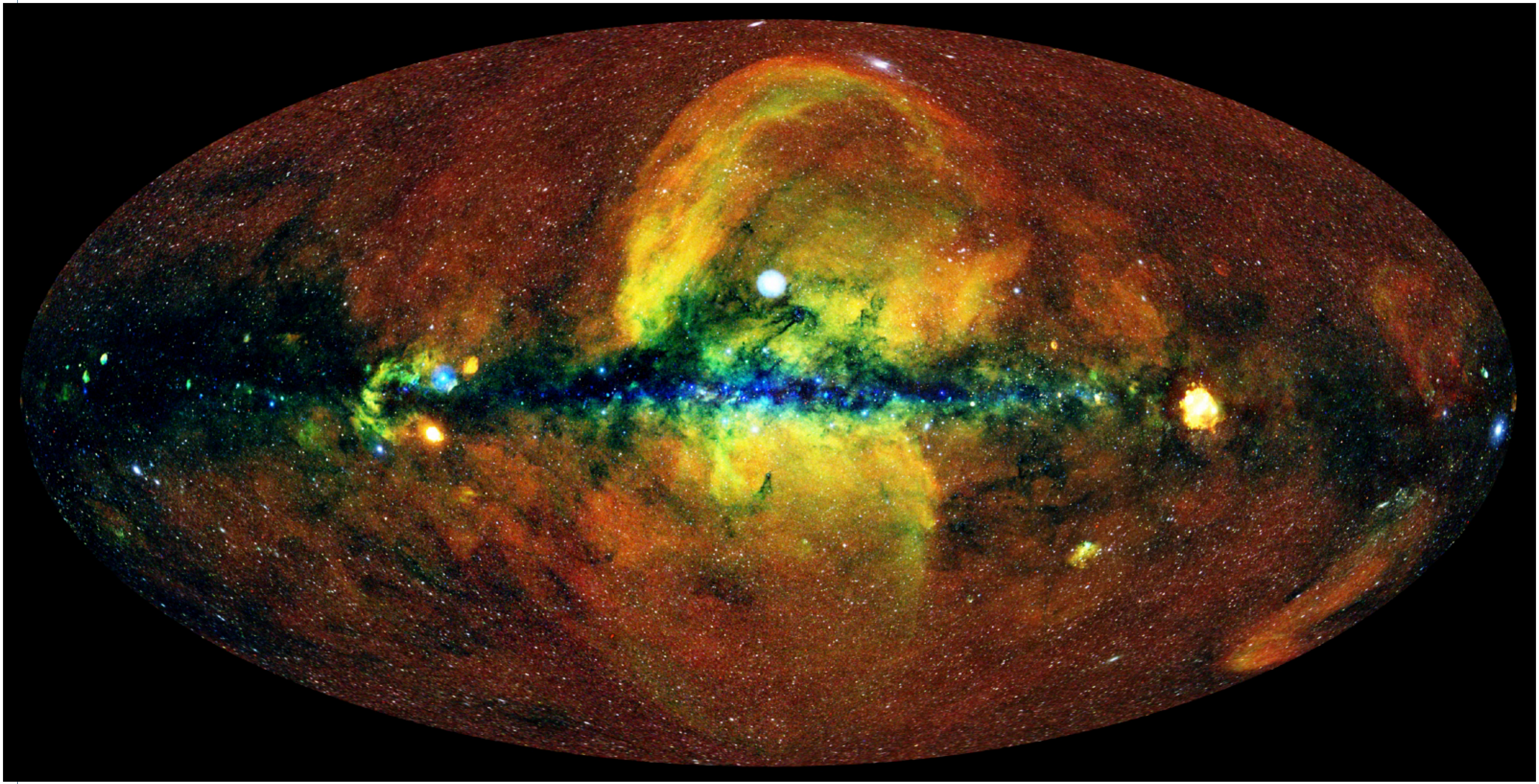


Credit: A. Merloni (MPE)

eROSITA All-Sky Survey

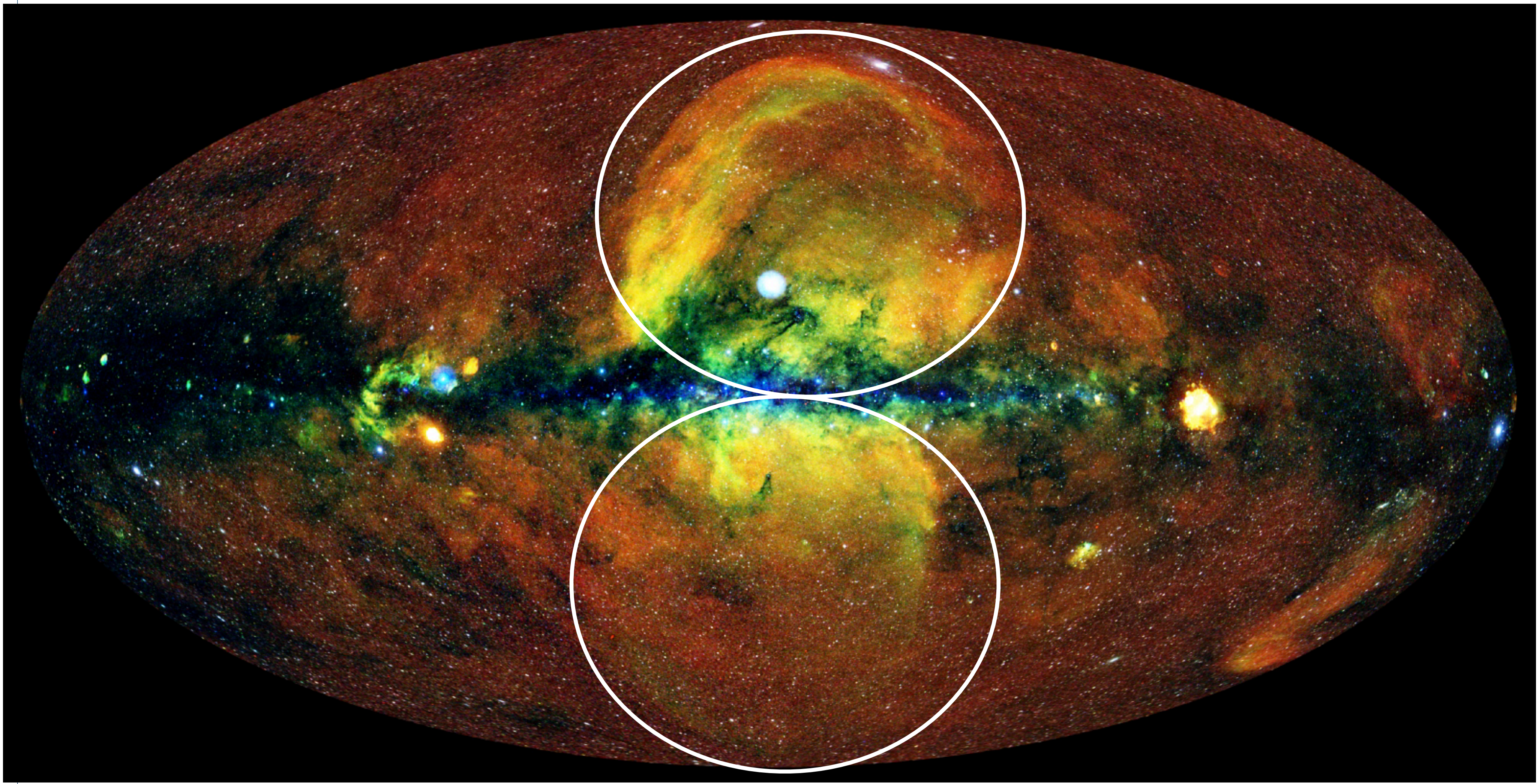
8 surveys, half year for each

eROSITA map from all-sky survey 1 in the energy band of 0.3 - 2.3 keV



J. Sanders, H. Brunner (MPE), E. Churazov, M. Gilfanov (IKI), and eSASS team

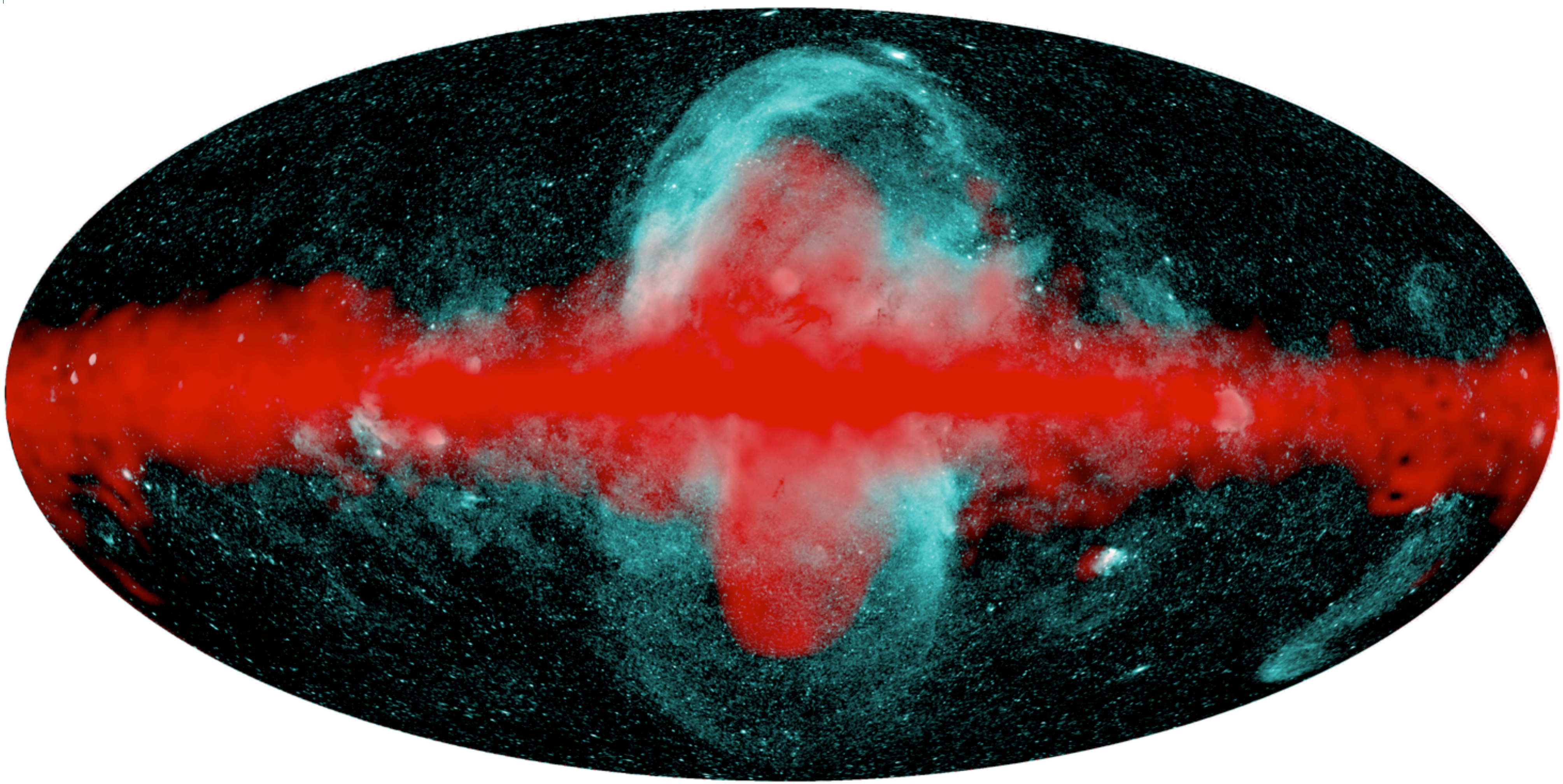
eROSITA bubbles



J. Sanders, H. Brunner (MPE), E. Churazov, M. Gilfanov (IKI), and eSASS team

eROSITA bubbles

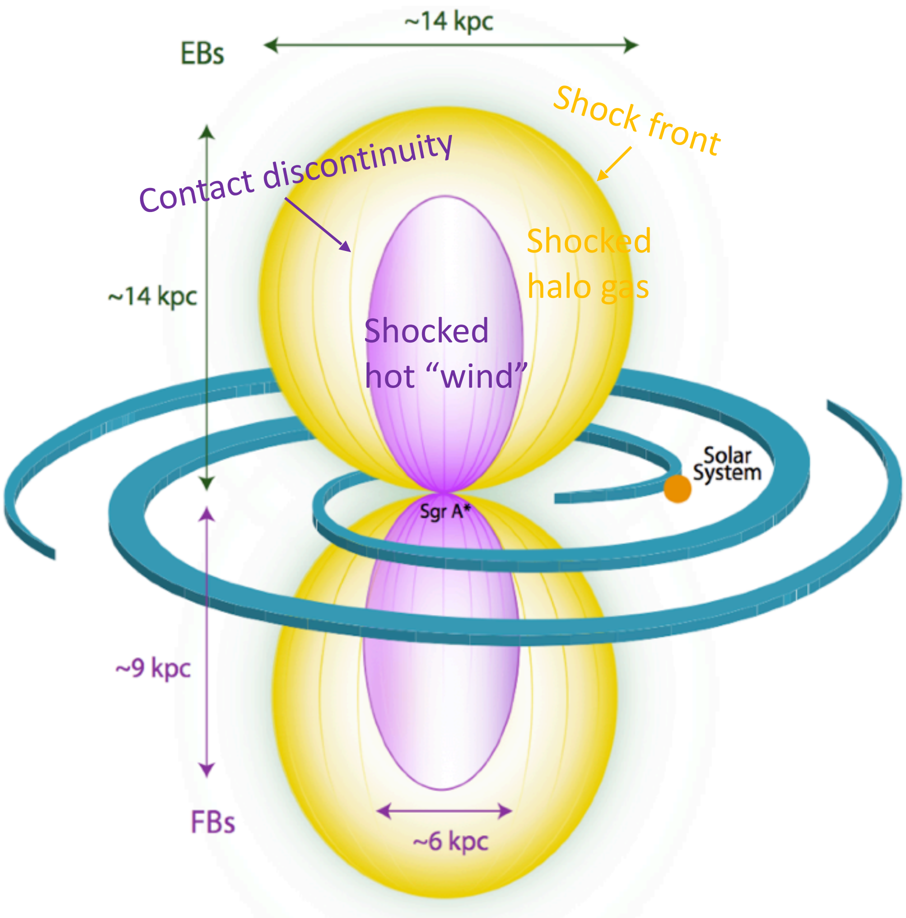
Fermi bubbles vs. eROSITA bubbles



Predehl et al. (2020)

Fermi and eROSITA bubbles

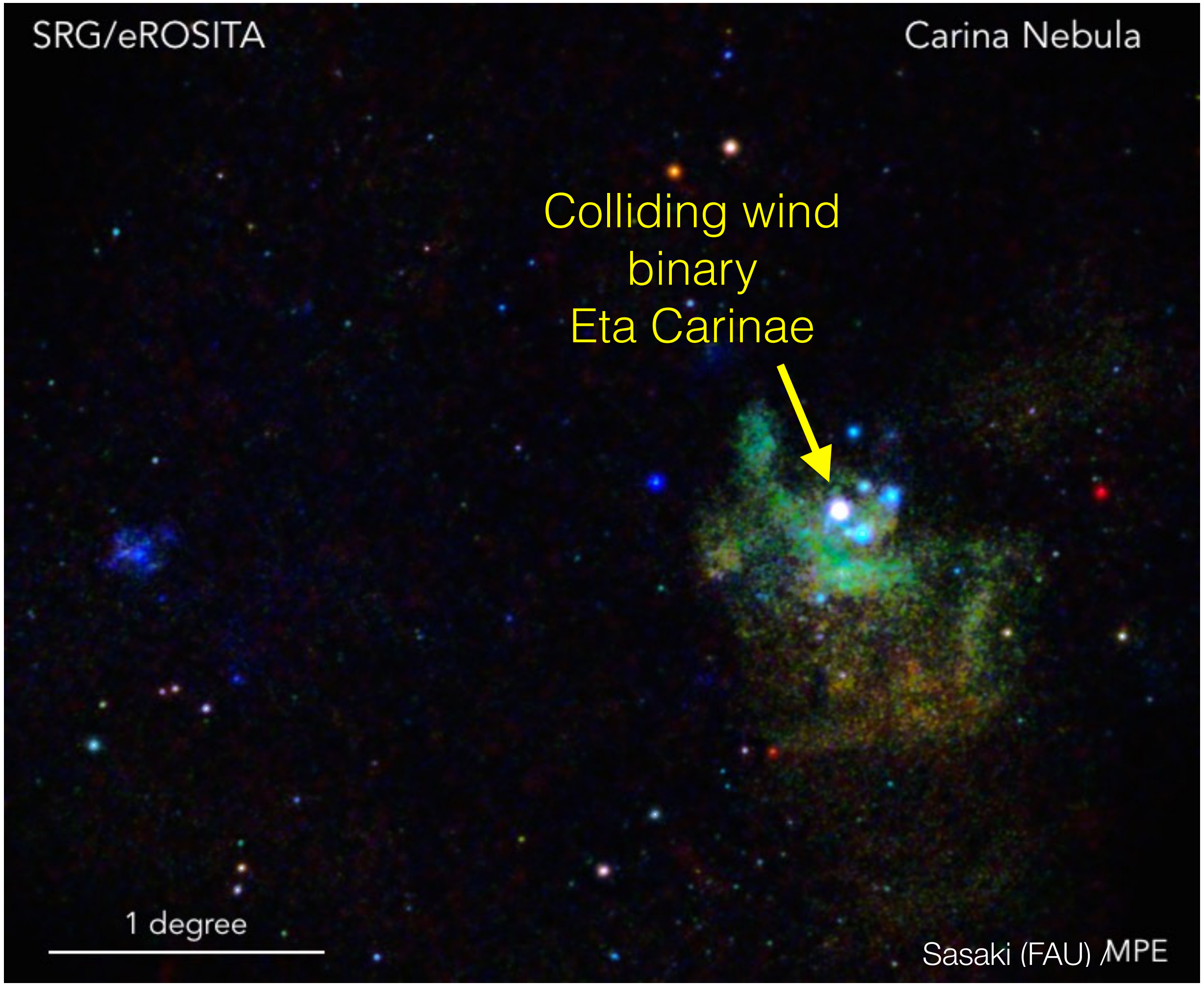
- Mean surface brightness of eROSITA bubbles = (2 - 4) × 10^{-15} erg cm^{-2} s^{-1} $arcmin^{-2}$.
- Thermal plasma with kT = 0.3 keV for 0.2 x solar abundances.
- $L_{X,tot}$ ~ 10^{39} erg/s at a distance of 10.6 kpc.
- Age ~ 20 Myr.
- Shock velocity v_s ~340 km/s.
- Gas cooling time t_{cool} ~ 2 x 10^8 years (>> age of bubbles).
- Sofue & Kataoka (2021):
  - At the outer shock front: v_s = 1000 km/s. t_{cool} = 1.5 Gyr.
  - 3 kpc crater in the disk at the base of the bubbles (HI, CO).



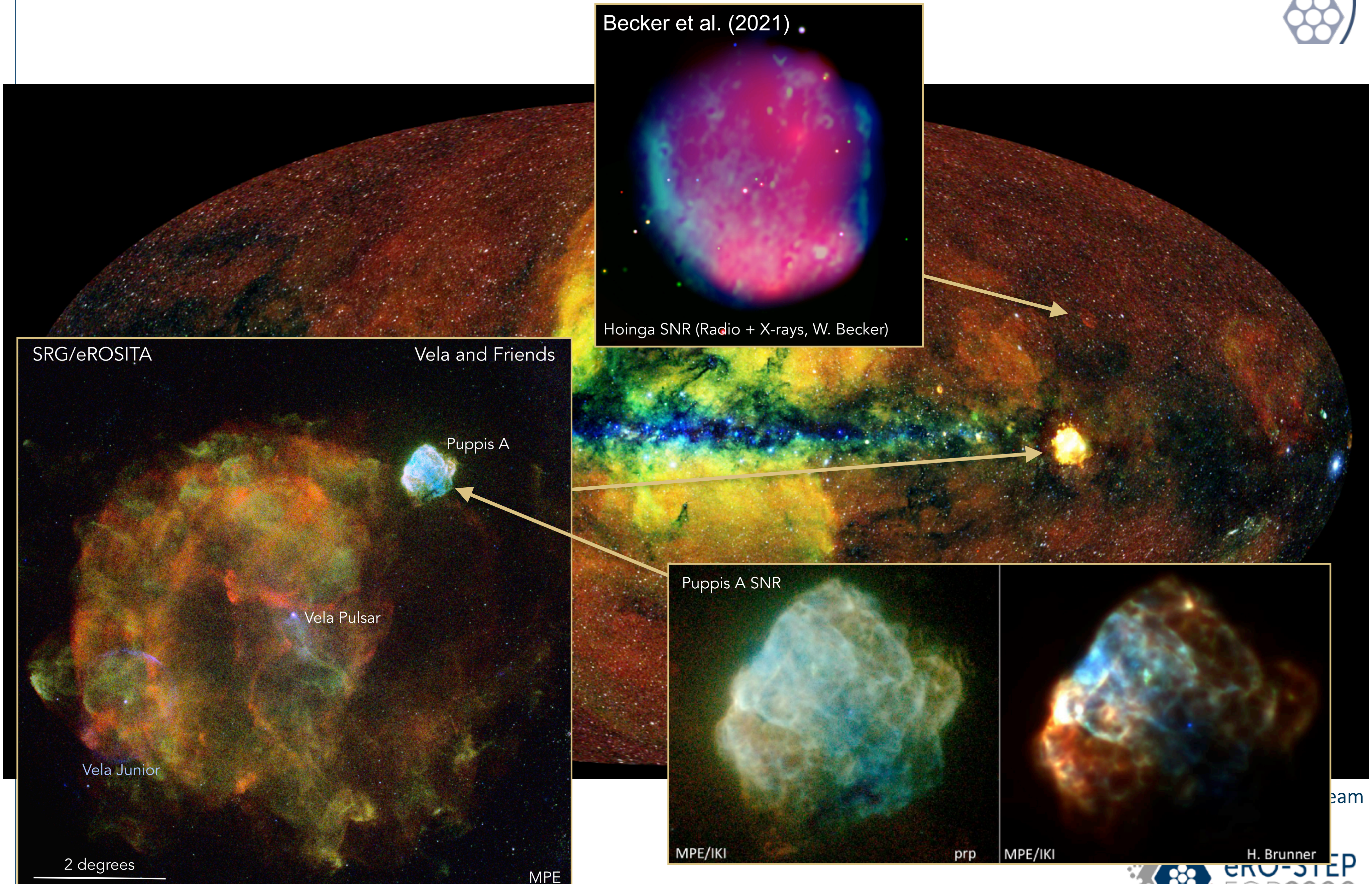
Predehl et al. (2020)

Carina Nebula

- Soft (< 2 keV) X-rays from hot ISM
- Shocks of stellar winds of massive stars
- Colliding wind binary Eta Carinae
- Search for shock-accelerated non-thermal particles



Galactic SNRs

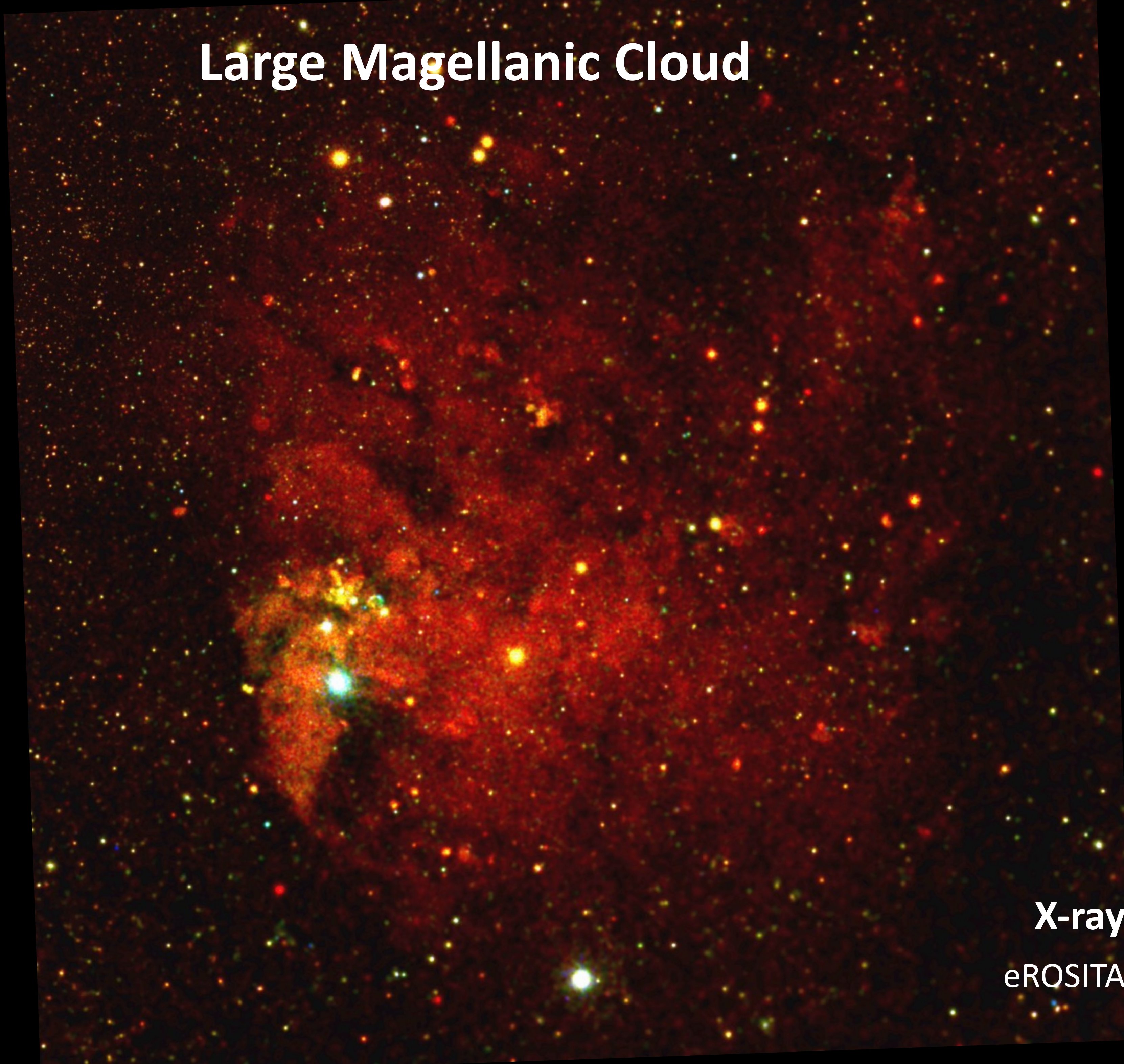


Large Magellanic Cloud

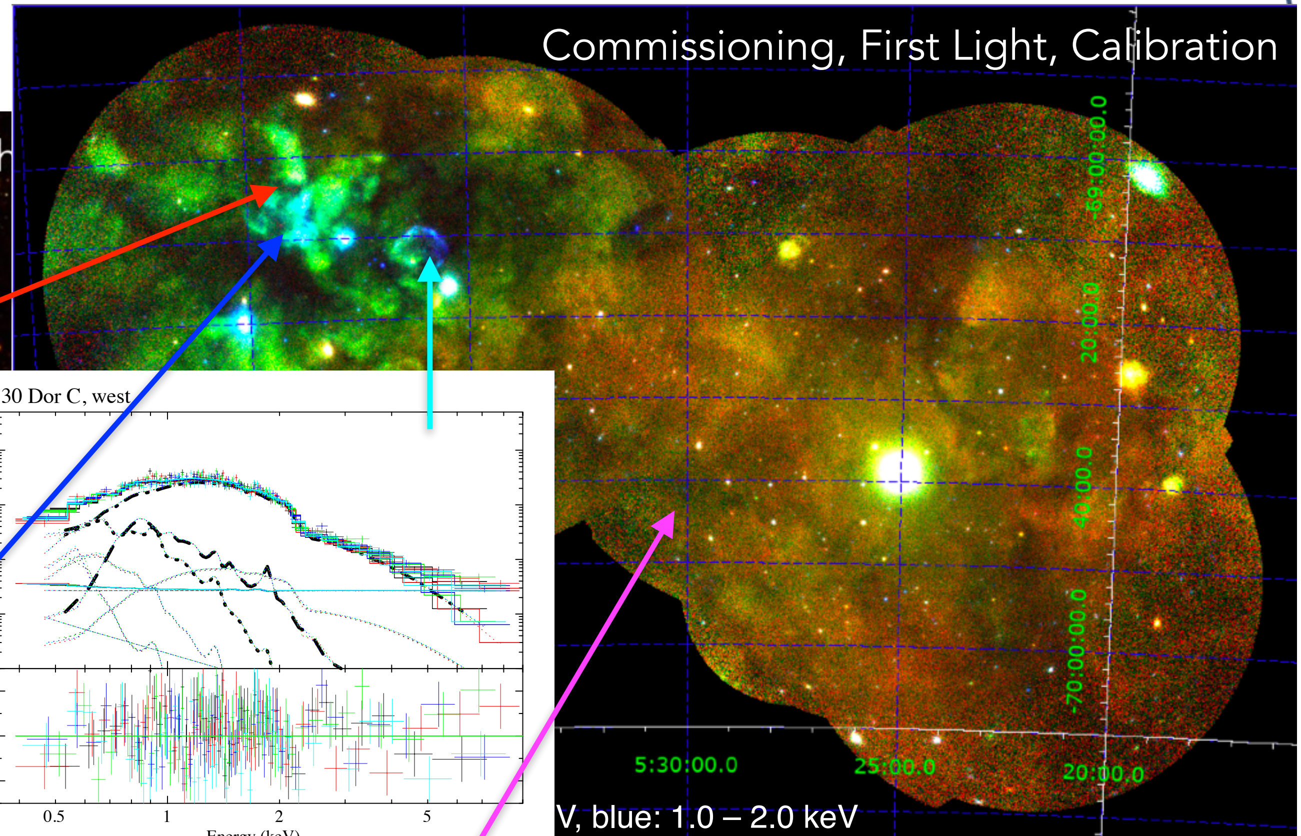
Optical

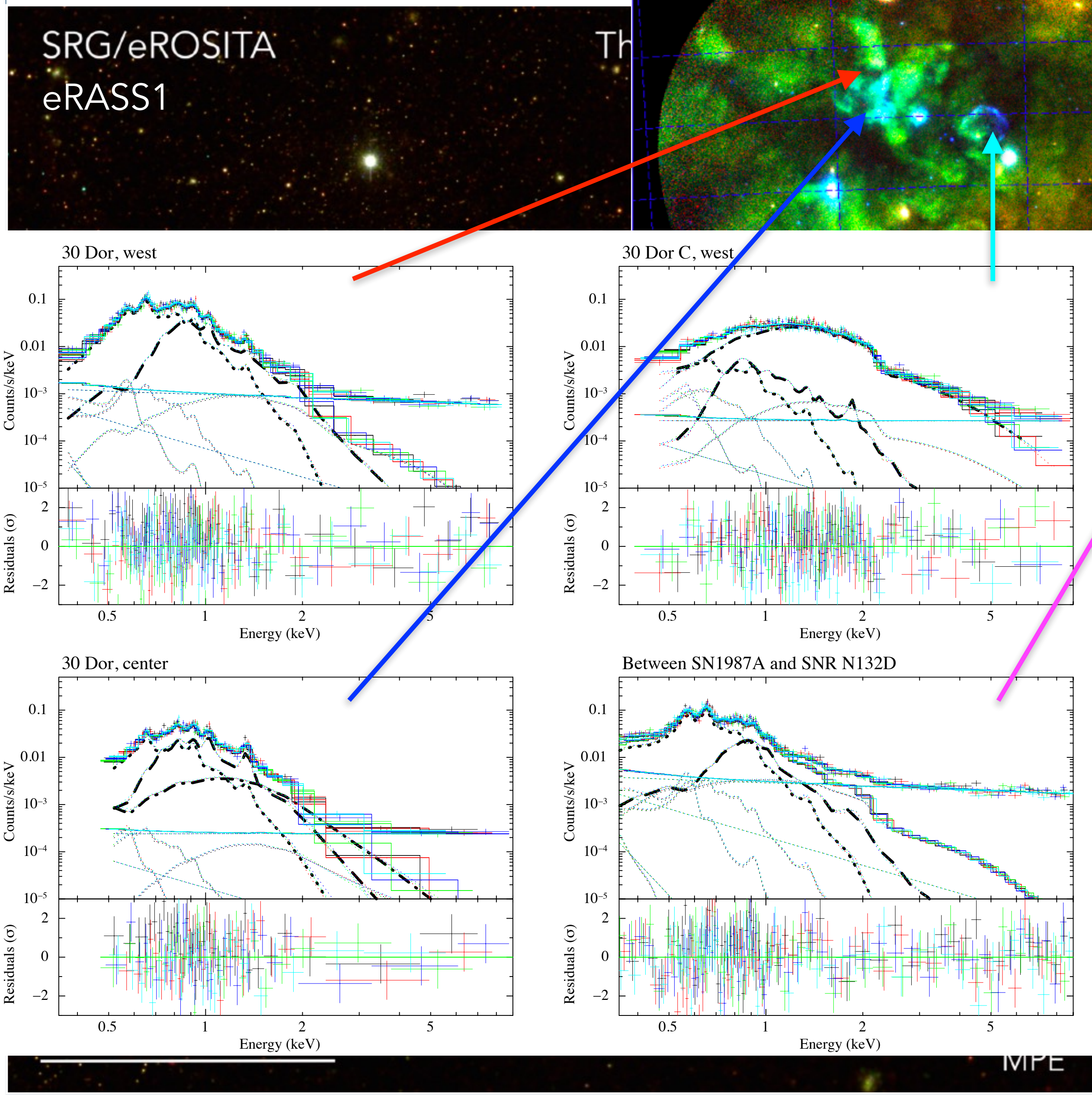
ESO/VMC Survey

Large Magellanic Cloud



X-ray emission in the LMC





Sasaki et al. (2021)

2 thermal plasma components with ~0.2 keV and ~0.7 keV

+ powerlaw in Tarantula Nebula and 30 Dor C

LMC supernova remnants

Green: known SNRs

(Maggi et al., 2016, Maitra et al., 2019)

Red: SNR candidates

(Yew et al., 2020, optical, Bozzetto et al., 2017, radio)

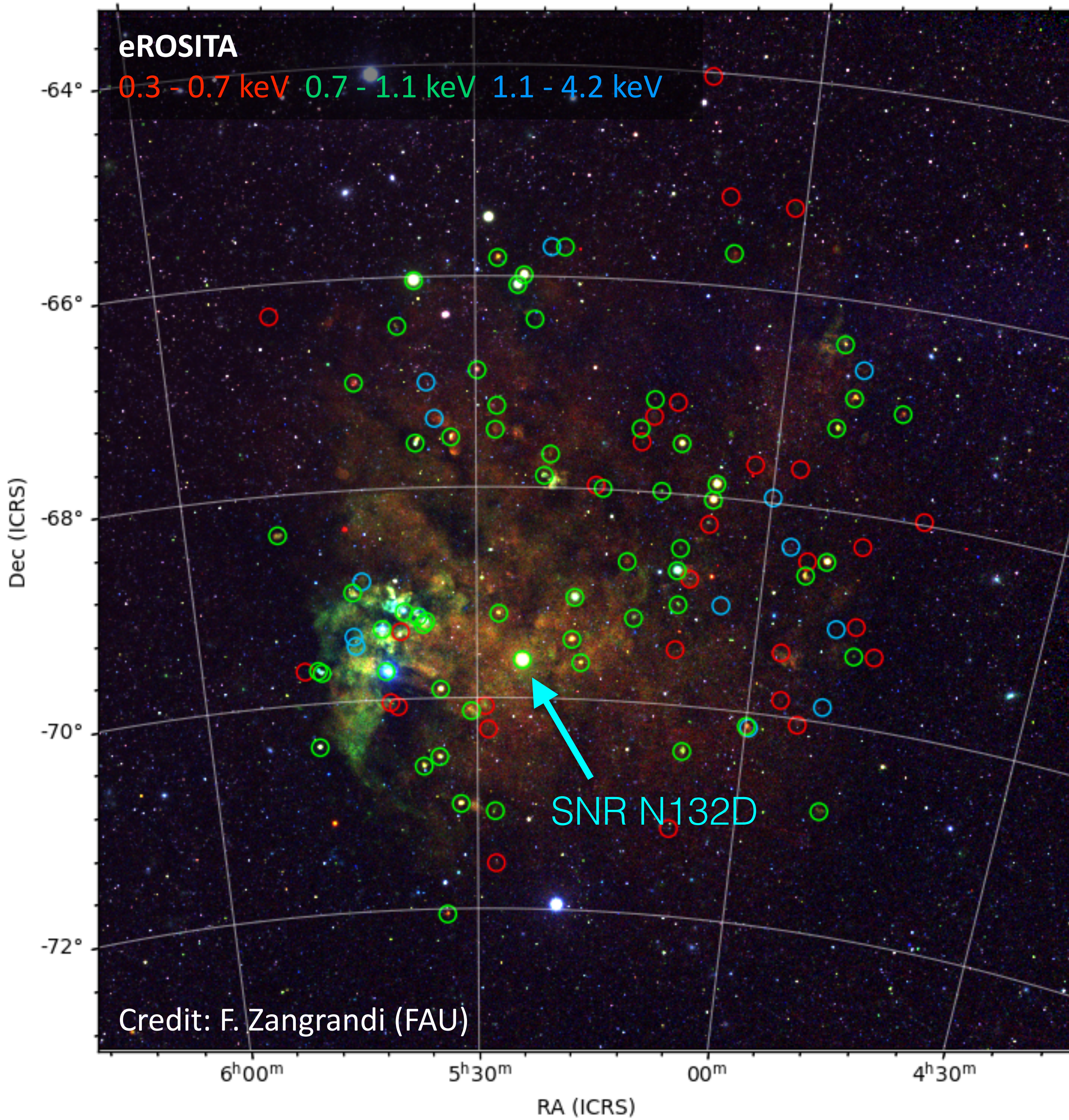
Blue: new SNR candidates

(ASKAP, Bozzeto et al., 2022)

Image and spectral analysis of brighter SNRs

Flux and hardness ratio studies of fainter SNRs

Upper limits for undetected SNRs



TeV sources

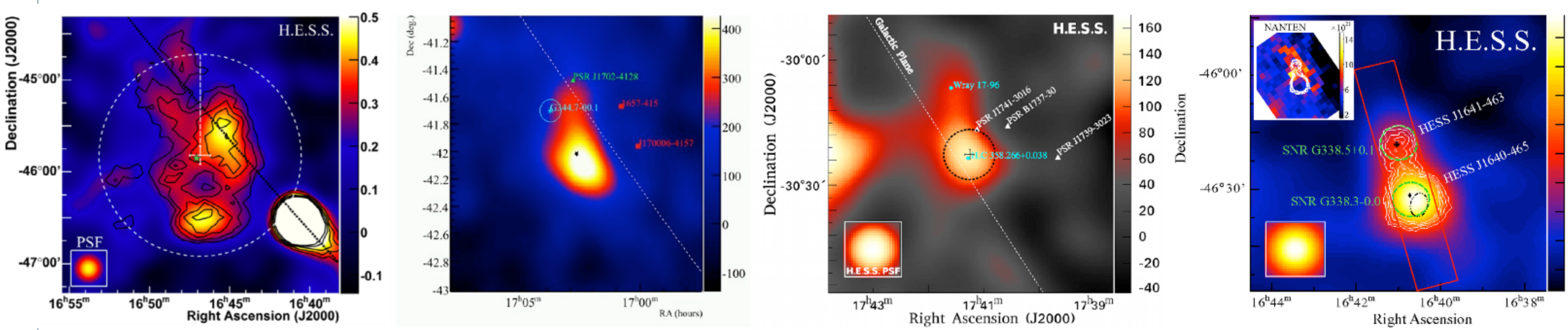
X-rays from eROSITA will allow us to constrain electrons and magnetic field properties of the accelerator via synchrotron emission.

PeVatron candidates: HESS J1646-458, HESS J1741- 302, HESS J1702-420 and HESS J1641-463.

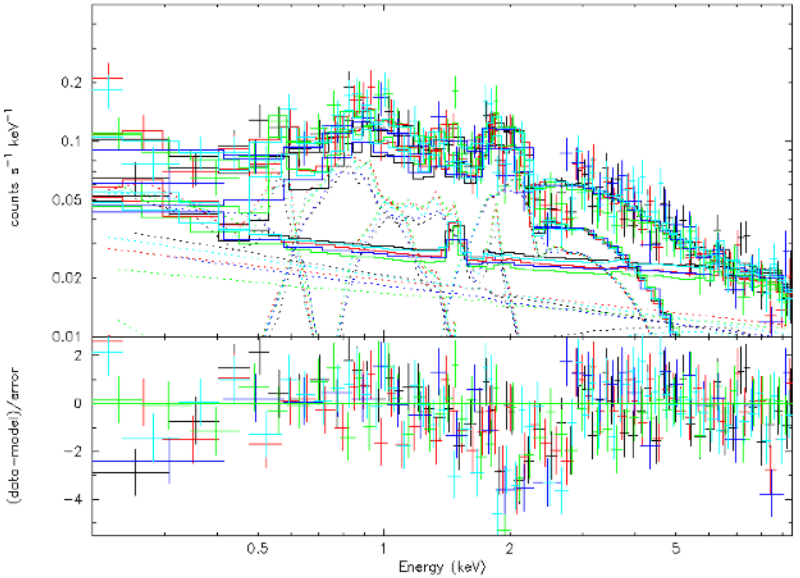
Hard TeV spectrum with no signs for a cut-off.

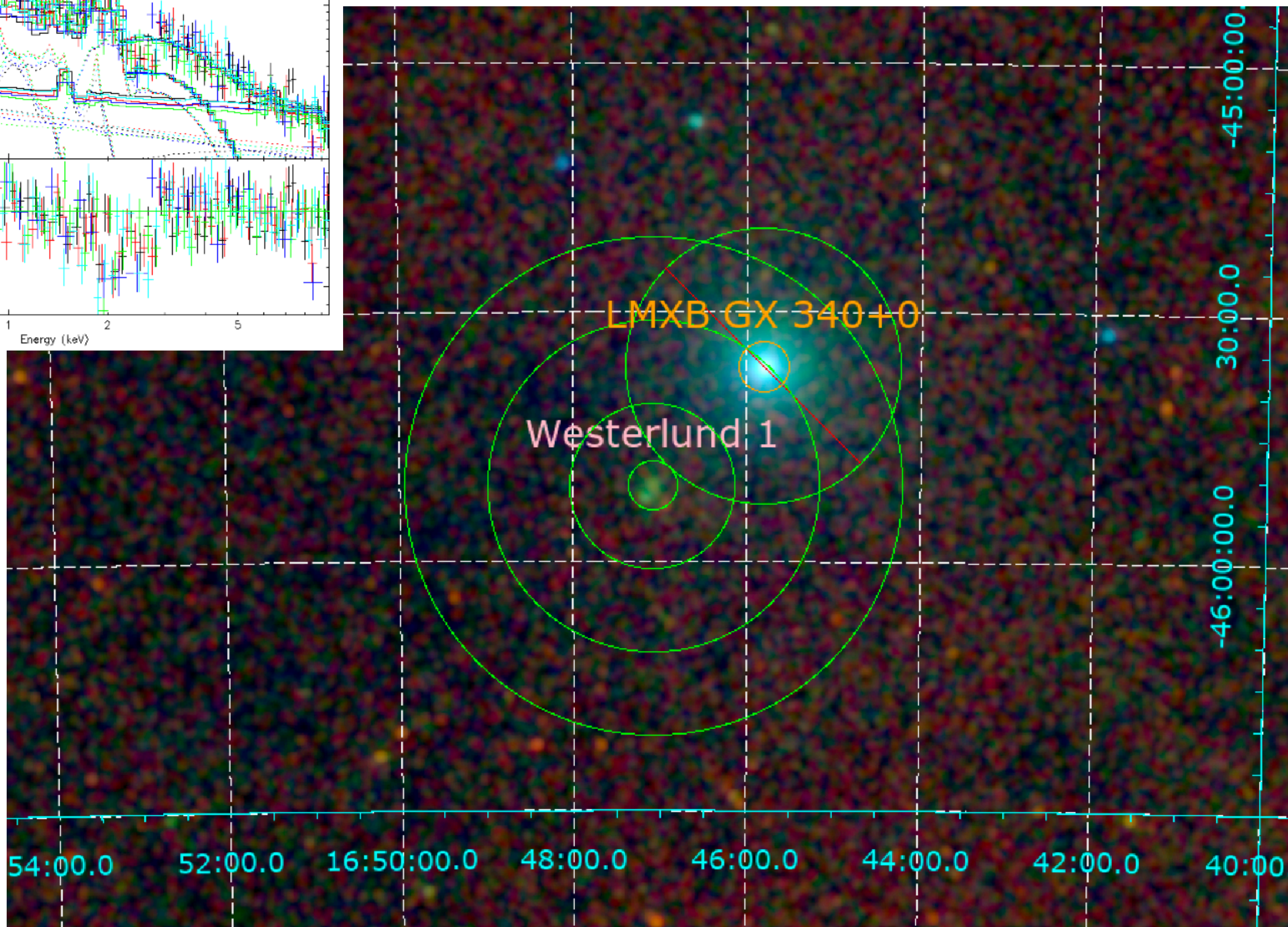
Sample:

- HESS J1646-458: massive star cluster Westerlund1, spectral index of α ≈ 2.19
- HESS J1702-420: unidentified TeV source, spectral index of α ≈ 2.07
- HESS J1741-302: unidentified TeV source, α ≈ 2.3
- HESS J1641-463: SNR G338.5+0.1 α ≈ 2.07



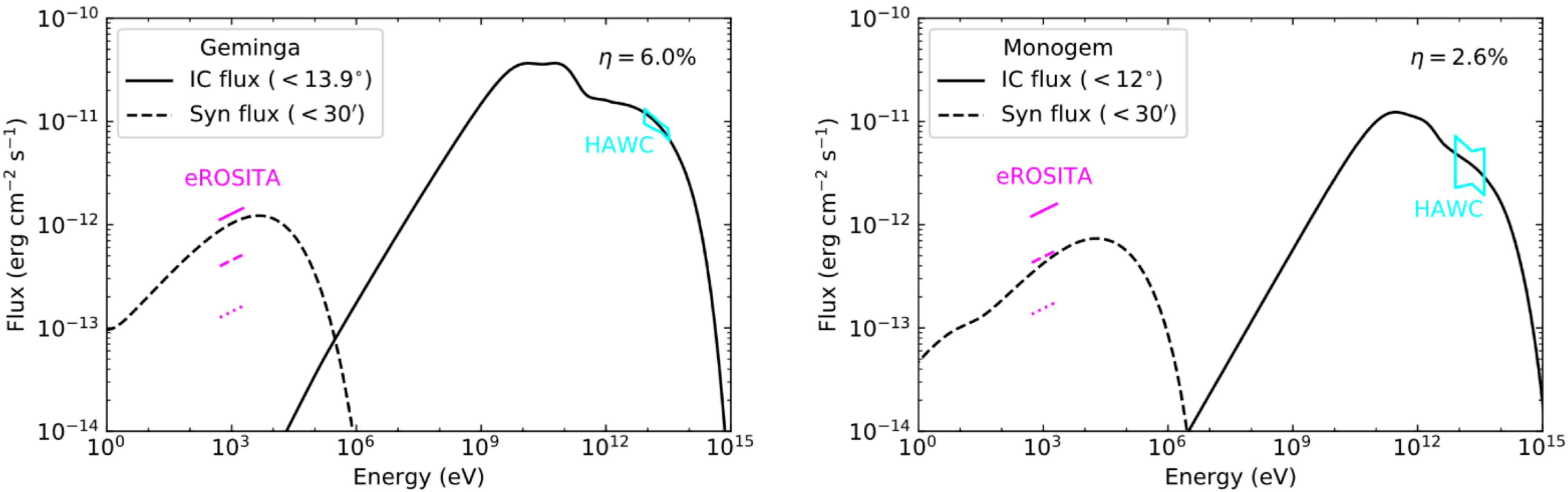
Westerlund 1 with eROSITA





Pulsars as PeVatrons

- MoU with LHAASO
- Crab, Geminga (PSR J0633+1746), Monogem (B0656+14), B0540+23, J0633+0632
- To compare with predictions by Li et al. 2022 “Prospect of detecting X-ray haloes around middle-aged pulsars with eROSITA”



PeVatron search with eROSITA

Particle accelerators in the Milky Way and the Magellanic Clouds

- Massive star clusters (Westerlund 1, R136 in 30 Doradus, …)
- Colliding wind binaries
- Supernova remnants
- Pulars and pulsar wind nebulae
- Search for and characterisation of non-thermal X-ray emission