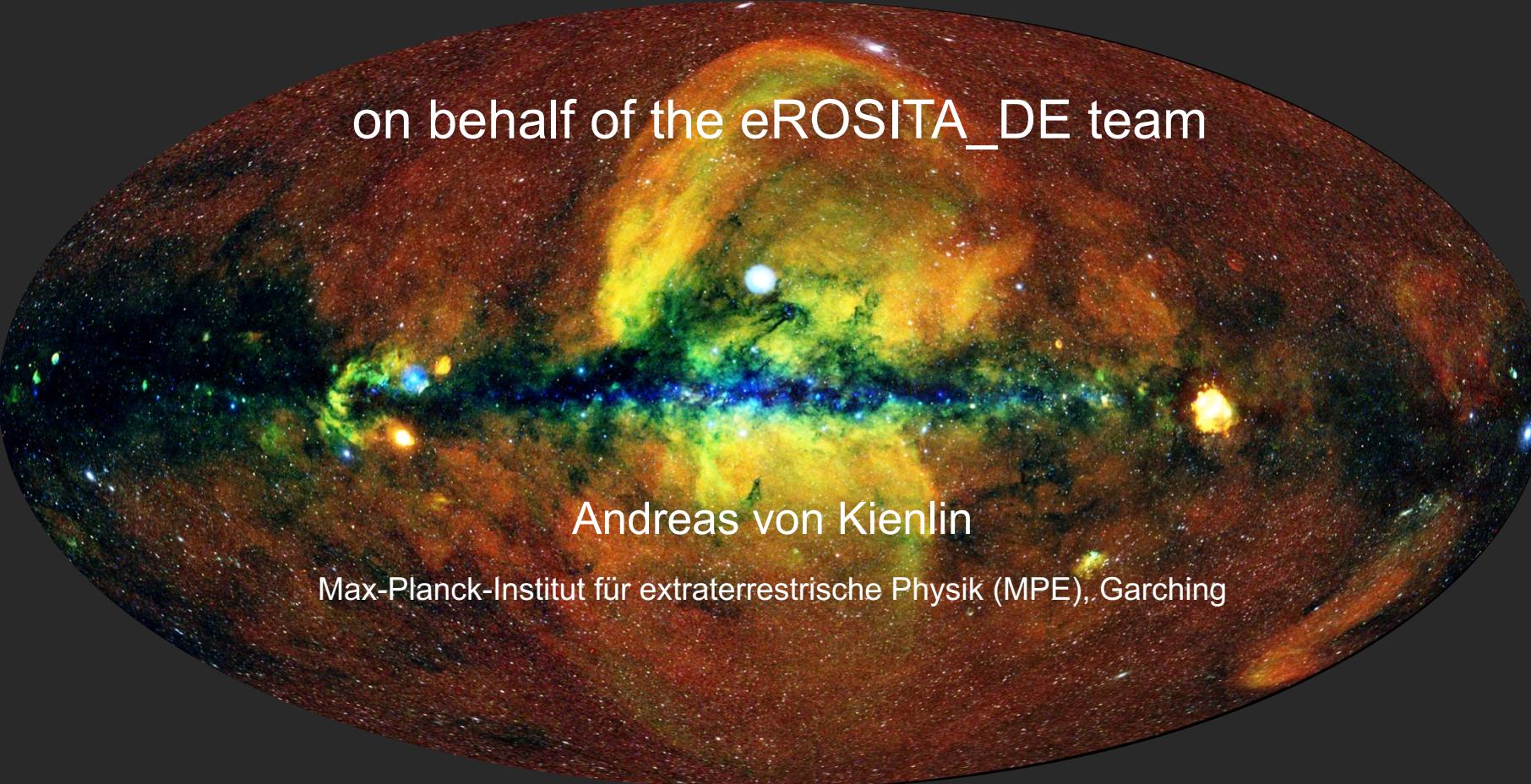


eROSITA on SRG

Mapping the Hot Universe

on behalf of the eROSITA_DE team



Andreas von Kienlin

Max-Planck-Institut für extraterrestrische Physik (MPE), Garching

eROSITA on SRG

➤ Mapping the Hot Universe



13.07.2019, 17:31

Cosmodrom Baikonur/Kazakhstan

Proton-M / BLOK-DM03

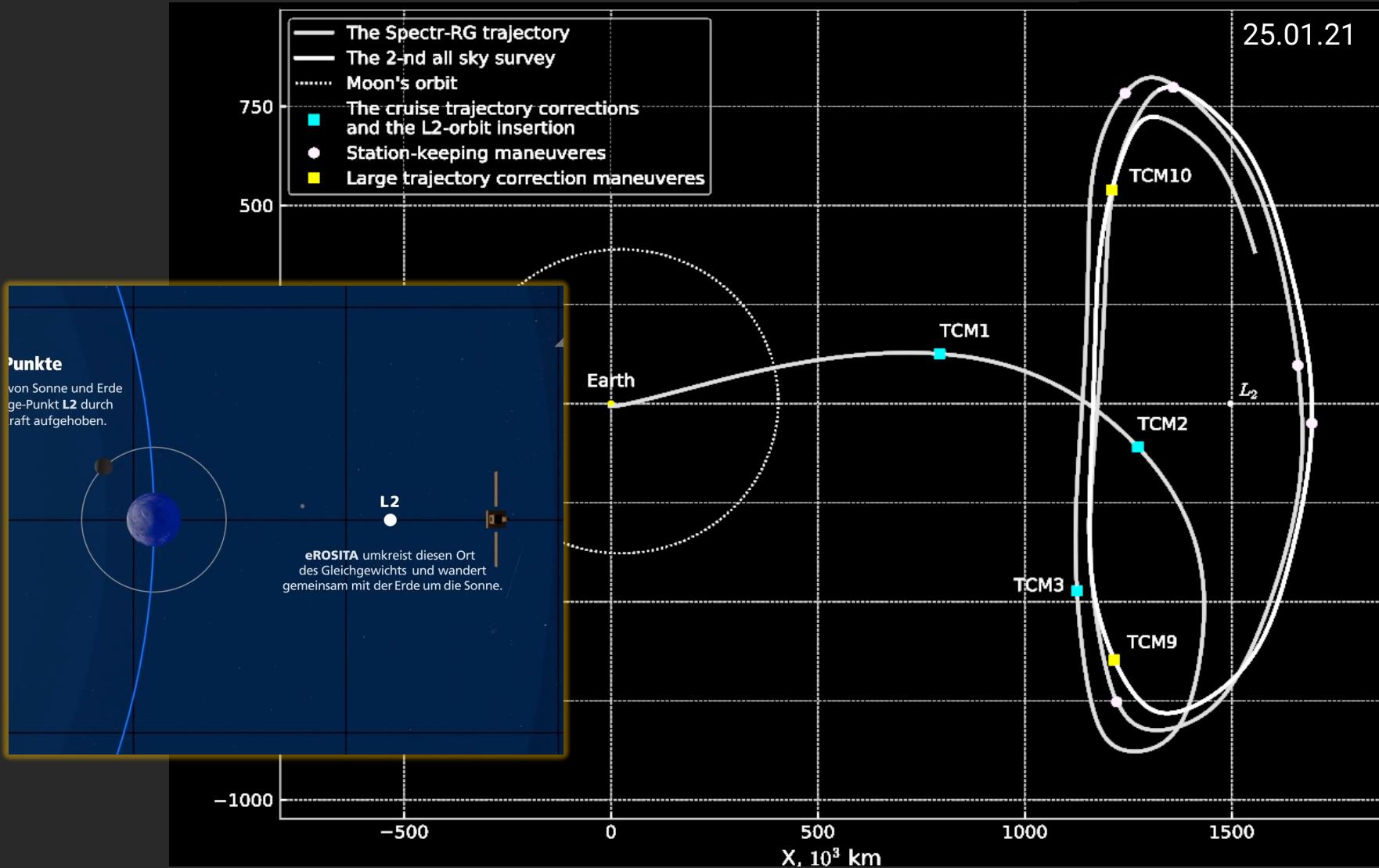


A large Halo L2 Orbit:



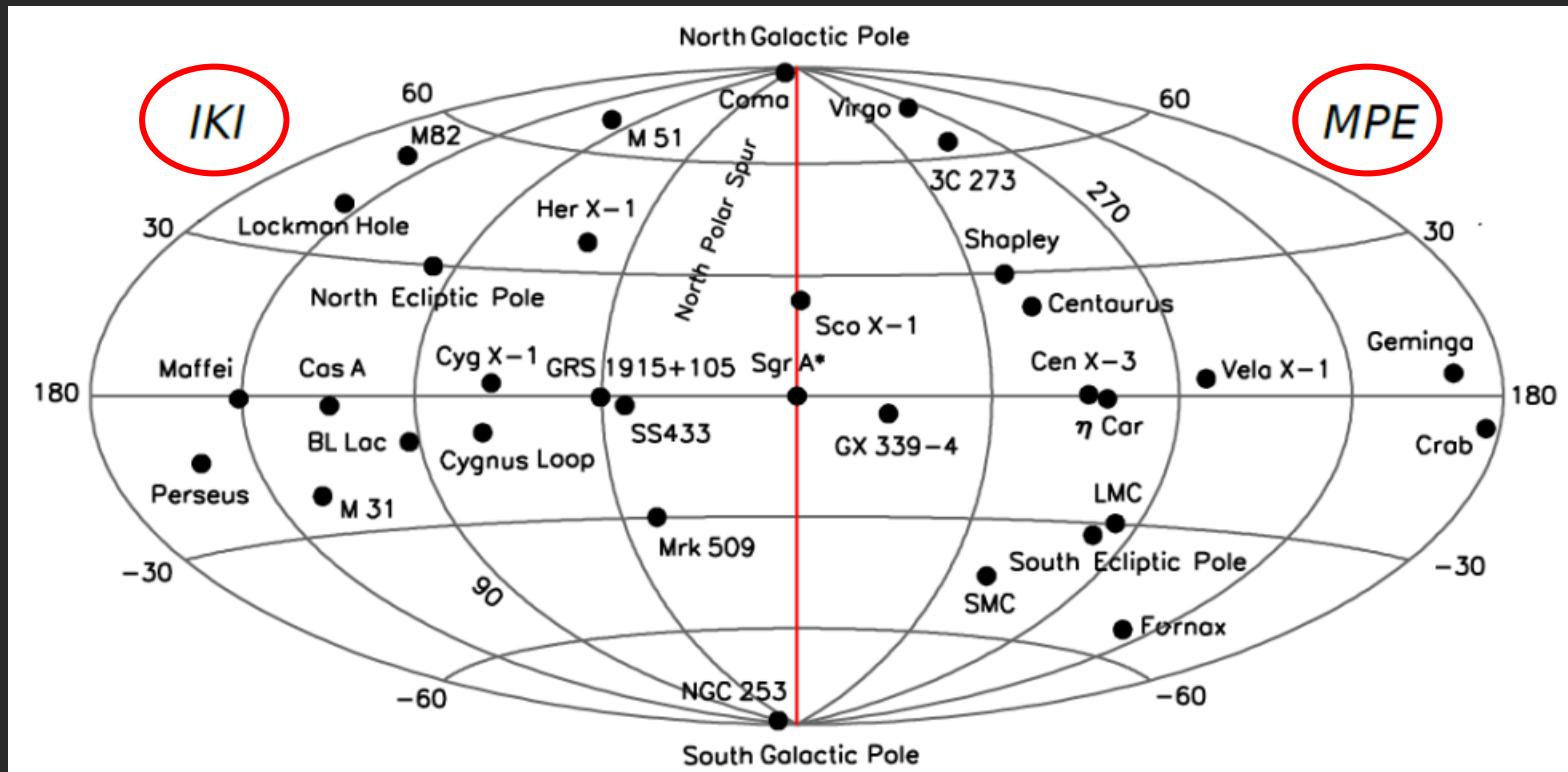
- ◆ 4 years: 8 all sky surveys (eRASS 1 - 8, 6 rotations/day)
- ◆ 2.5 years: pointed observations

Sunyaev et al. (2021)



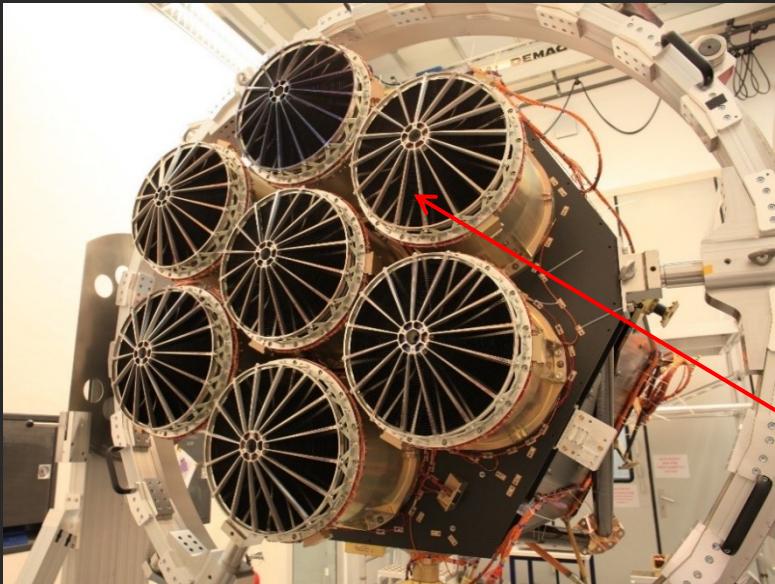
Data sharing

- ◆ Memorandum of 2007 between Roscosmos and DLR: SRG/eROSITA data belong in equal parts to the German and Russian scientists
 - Constructing all-sky X-ray maps and creating X-ray source catalogs: German scientists are responsible for the processing and publication of data in one hemisphere of the sky, and the Russian scientists provide this in the other hemisphere

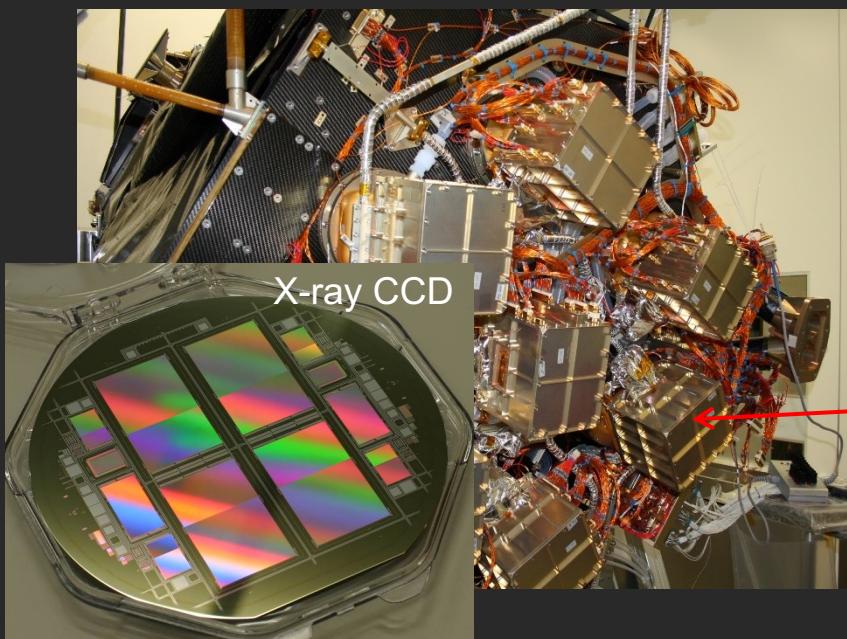
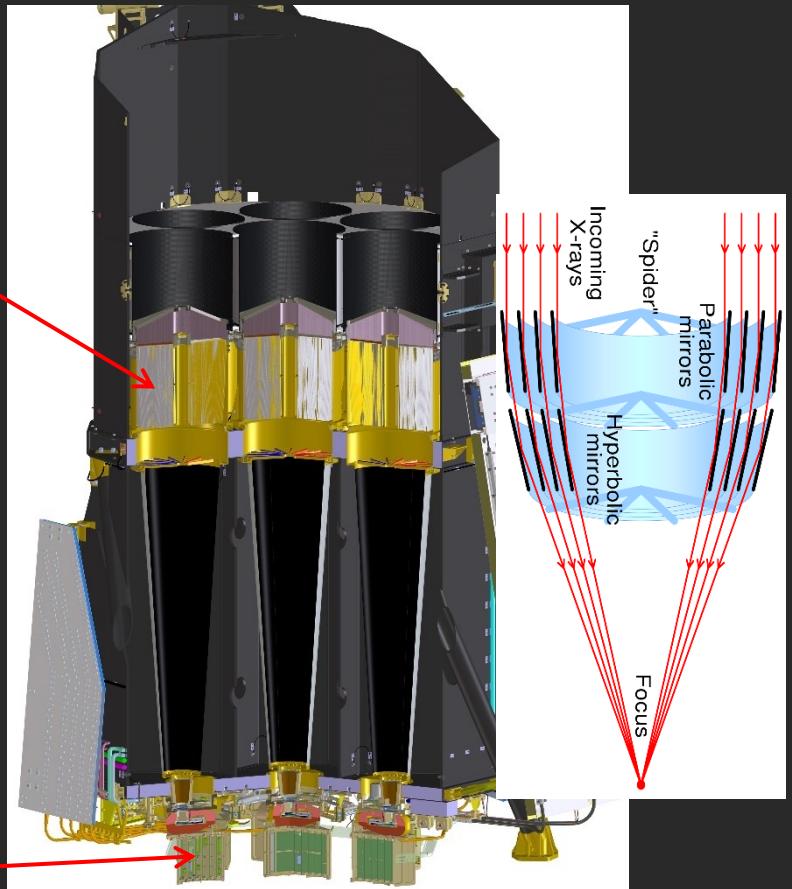


- ◆ All data obtained by the ART-XC telescope belong to the scientists of IKI
 - Area of 200 square degrees around the north ecliptic pole: IKI + MSFC

eROSITA X-ray Telescope



378 X-ray Mirrors
in 7 parallel Telescope Modules



7 X-ray CCD Cameras, 9 Electronic-Boxes
Predehl et al., A&A 647, A1 (2021)

eROSITA Technical Parameters

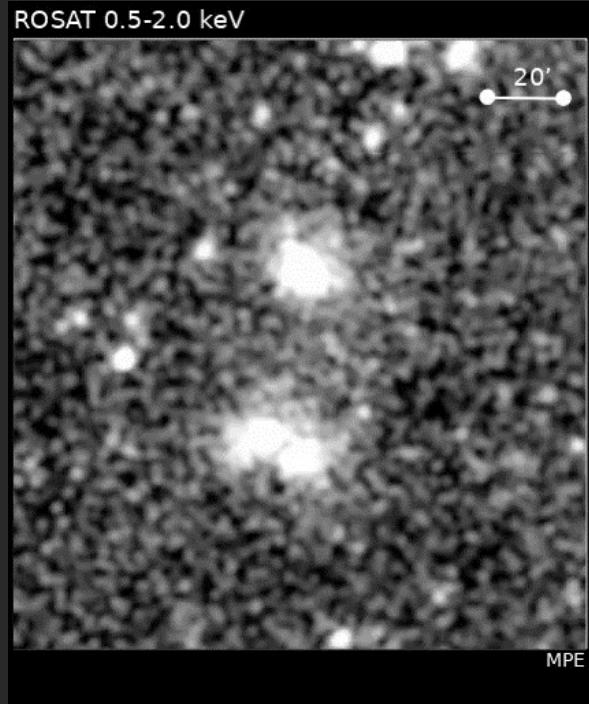
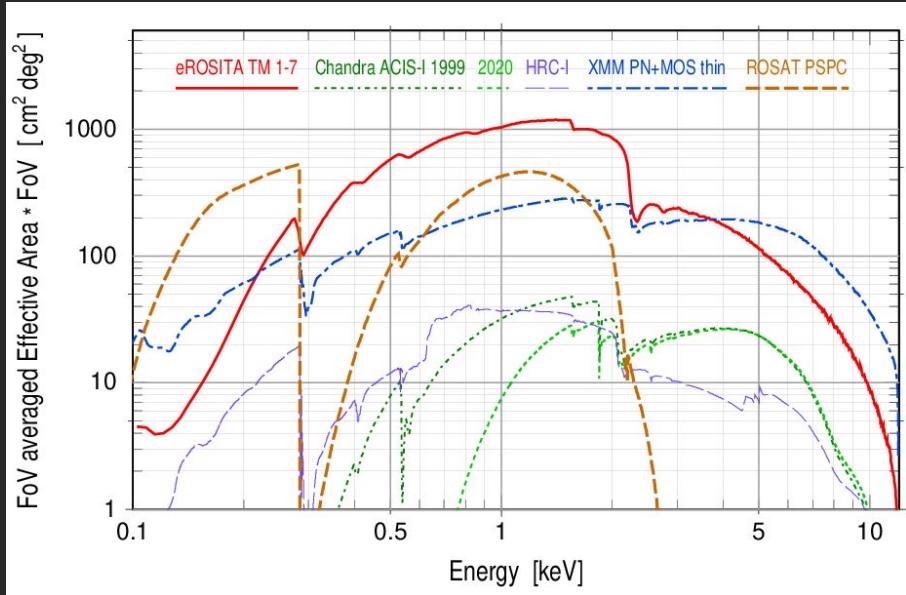


- ◆ X-ray focusing telescope optimized for surveys
 - large field of view, high quality mirrors and sensitive CCD cameras.



Instrument		7 Mirror Assemblies		7 Camera Assemblies	
Size	1.9 m $\varnothing \times$ 3.5 m	Diam. of outer shell	358 mm	CCD image	$2.88 \times 2.88 \text{ cm}^2$
Mass	808 kg	Number of shells	54	Pixel size	$75\mu\text{m} \times 75\mu\text{m}$
Power	522 W max.	Focal length	1600 mm	Time Resol.	50 ms
Data rate	600 MB/day max.				

eROSITA Performance



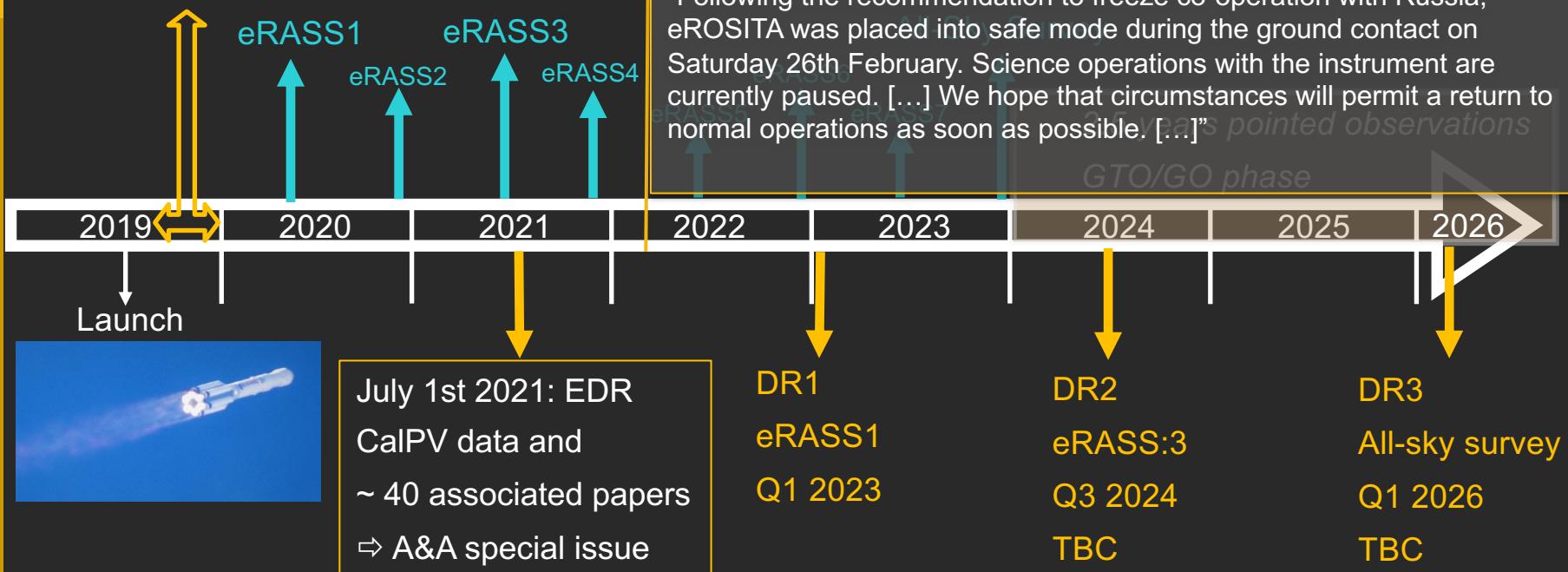
Large Effective area	~ 1300 cm ² @1keV \Rightarrow ~XMM-Newton
Large Field of view	1 degree (diameter) \Rightarrow Grasp ~5 x XMM
Half-Energy width (HEW)	~ 18" (on-axis, point.) / ~30" (FoV avg., survey)
Positional accuracy	~ 4.5" (1 σ)
X-ray baffle	92% stray light reduction
pnCCD with framestore	very good detector uniformity, little T dependence
384x384x7 pixels	$\sim 10^6$ pixels (9.4"), no chip gaps, no 'out of time' events
Spectral resolution at all measured energies within specs (~80eV @1.5keV)	

Programmatics / Data Releases

eRASS = eROSITA All-Sky Survey

CalPV:

Calibration and
Performance Verification

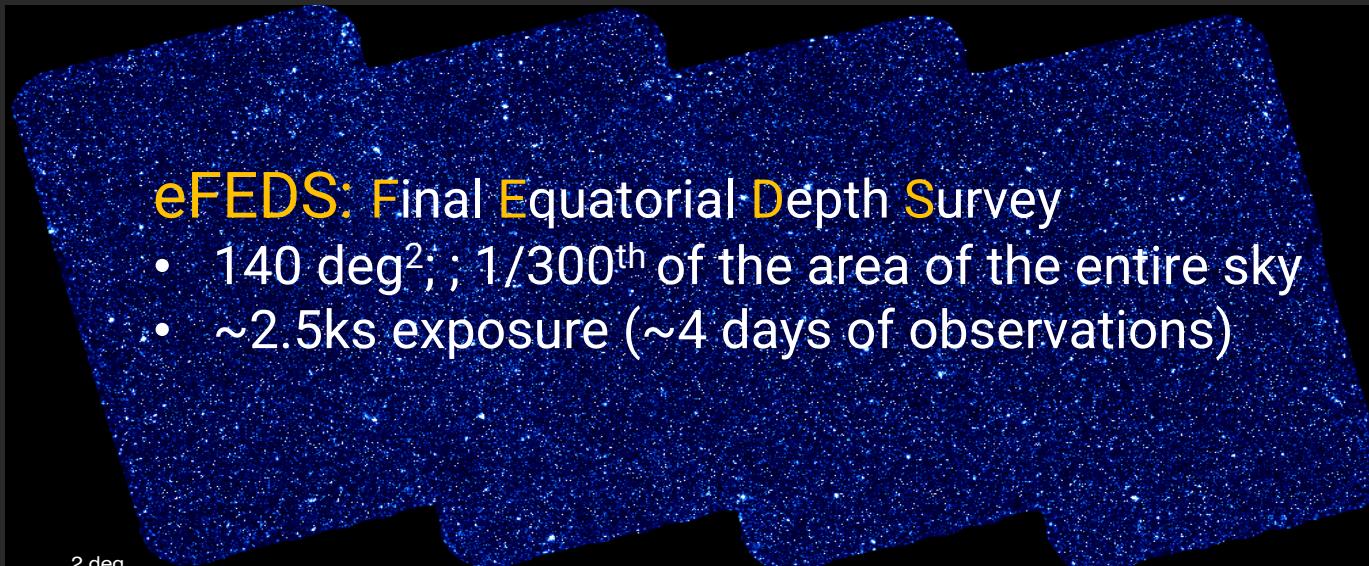


- ◆ Preparation ongoing for DR1: final re-processing of eRASS1 completed in January
- ◆ Future DR plan will be revisited depending on the development of the collaboration with IKI

Cal-PV observations



- ◆ Individual Pointings (> 100) + Field Scans, 4 Categories:
 1. Survey Fields:



eFEDS: Final Equatorial Depth Survey

- 140 deg²; ; 1/300th of the area of the entire sky
- ~2.5ks exposure (~4 days of observations)

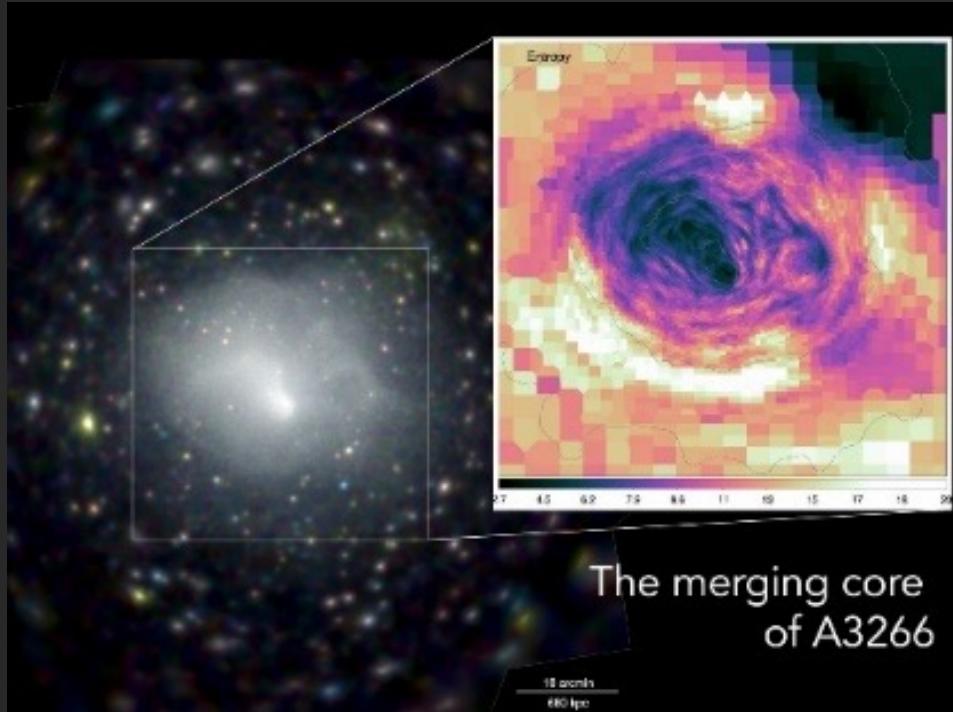
2. Magellanic Clouds,
3. Galactic Fields,
4. Extragalactic Fields

Brunner et al. (2021)

- ◆ Early Data Release (EDR) site: <https://erosita.mpe.mpg.de/edr/>
+ eROSITA Science Analysis Software System (eSASS)
- ◆ A&A special issue 661 (2022): <https://erosita.mpe.mpg.de/publications>

Cal-PV observations

- ◆ Individual Pointings (> 100) + Field Scans, 4 Categories:
 1. Survey Fields: proof-of-concept survey
 2. Magellanic Clouds,
 3. Galactic Fields,
 4. Extragalactic Fields



Sanders et al. (2021)

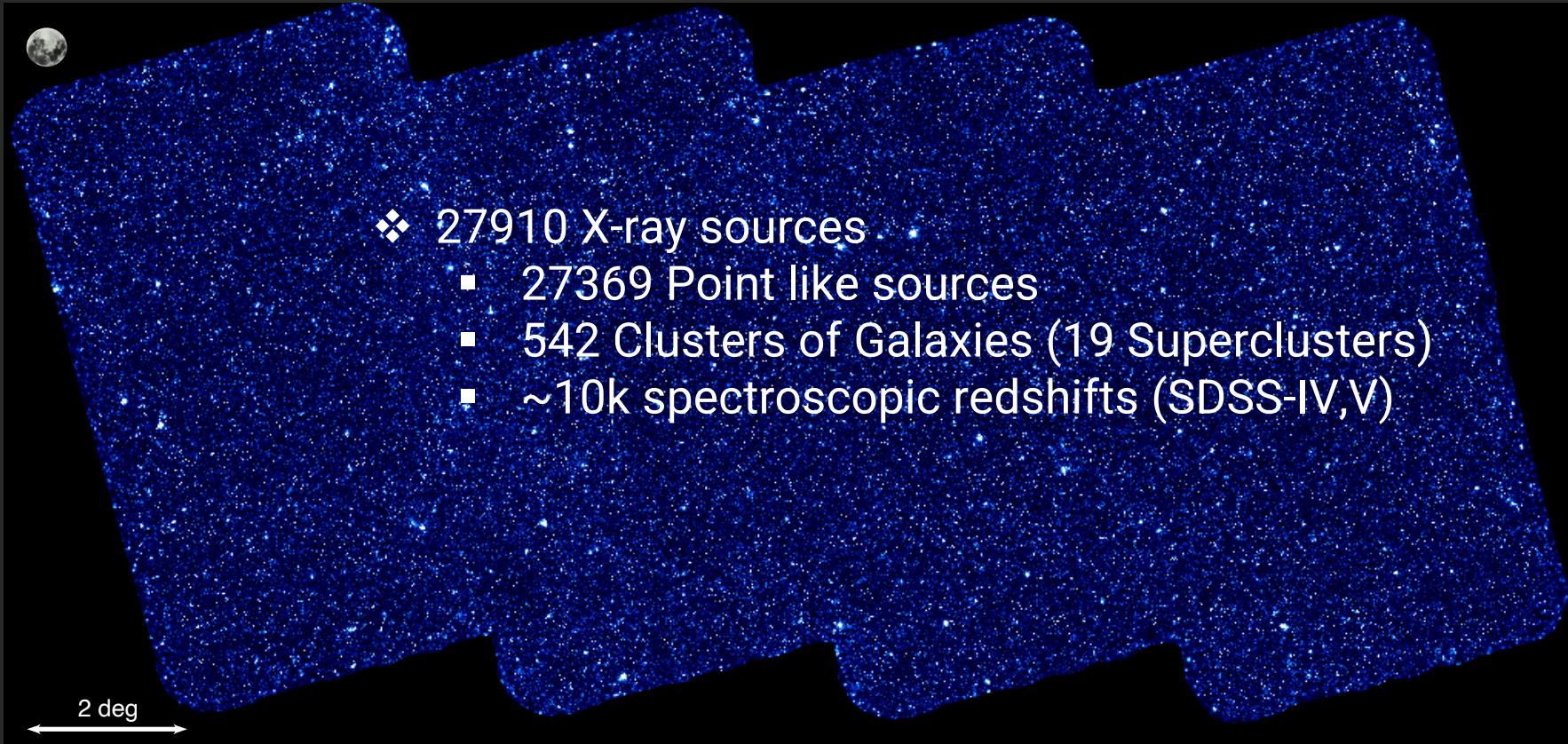
- ◆ Early Data Release (EDR) site: <https://erosita.mpe.mpg.de/edr/>
+ eROSITA Science Analysis Software System (eSASS)
- ◆ A&A special issue 661 (2022): <https://erosita.mpe.mpg.de/publications>

eFEDS: a preview survey



Exposure corrected image in the 0.5–2.0 keV band

Flux limit (0.2 – 2.3 keV) $\sim 7 \times 10^{-15}$ erg/s/cm²



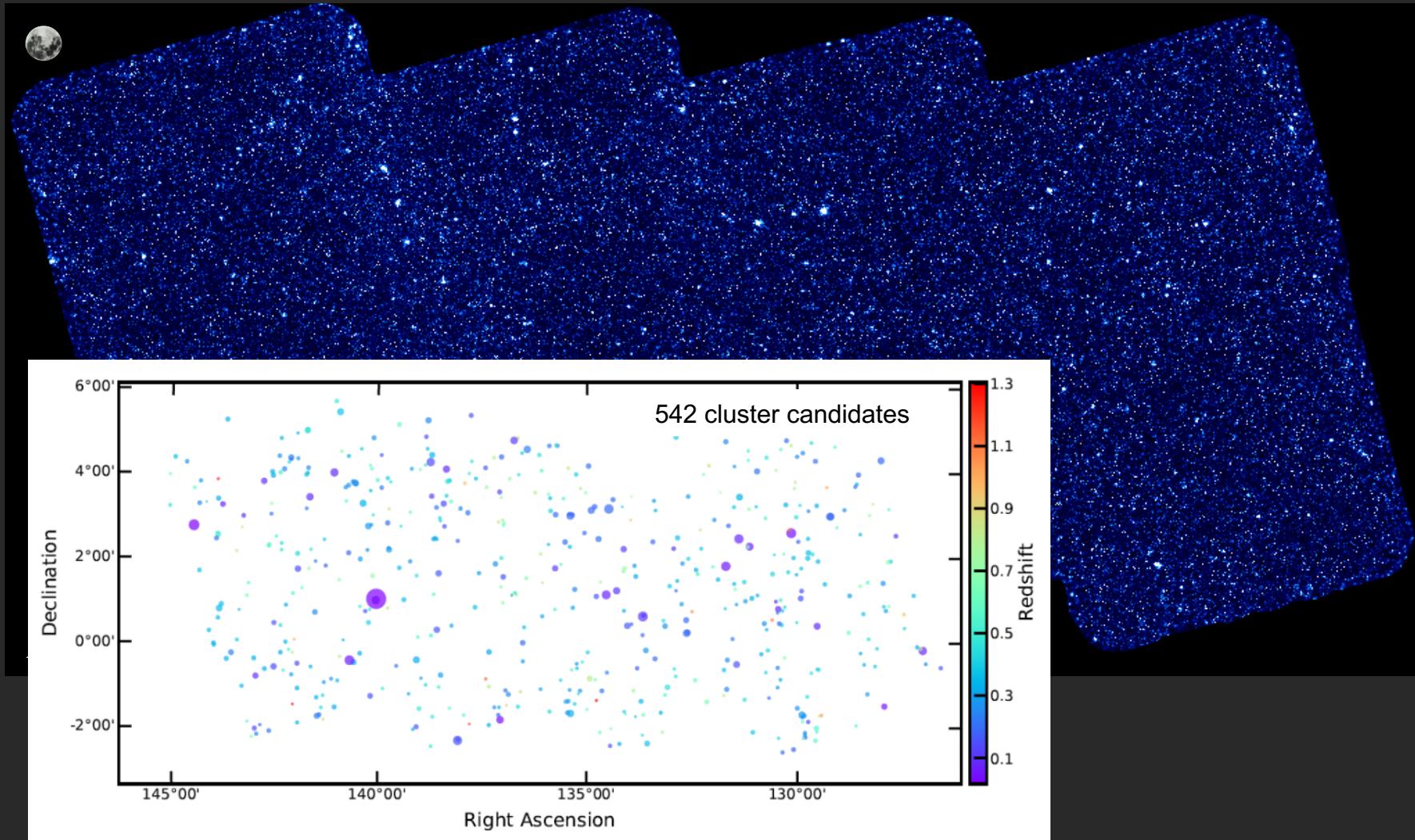
- ❖ 27910 X-ray sources.
 - 27369 Point like sources
 - 542 Clusters of Galaxies (19 Superclusters)
 - ~10k spectroscopic redshifts (SDSS-IV,V)

eFEDS: a preview survey



Exposure corrected image in the 0.5–2.0 keV band

Flux limit (0.2 – 2.3 keV) $\sim 7 \times 10^{-15}$ erg/s/cm²

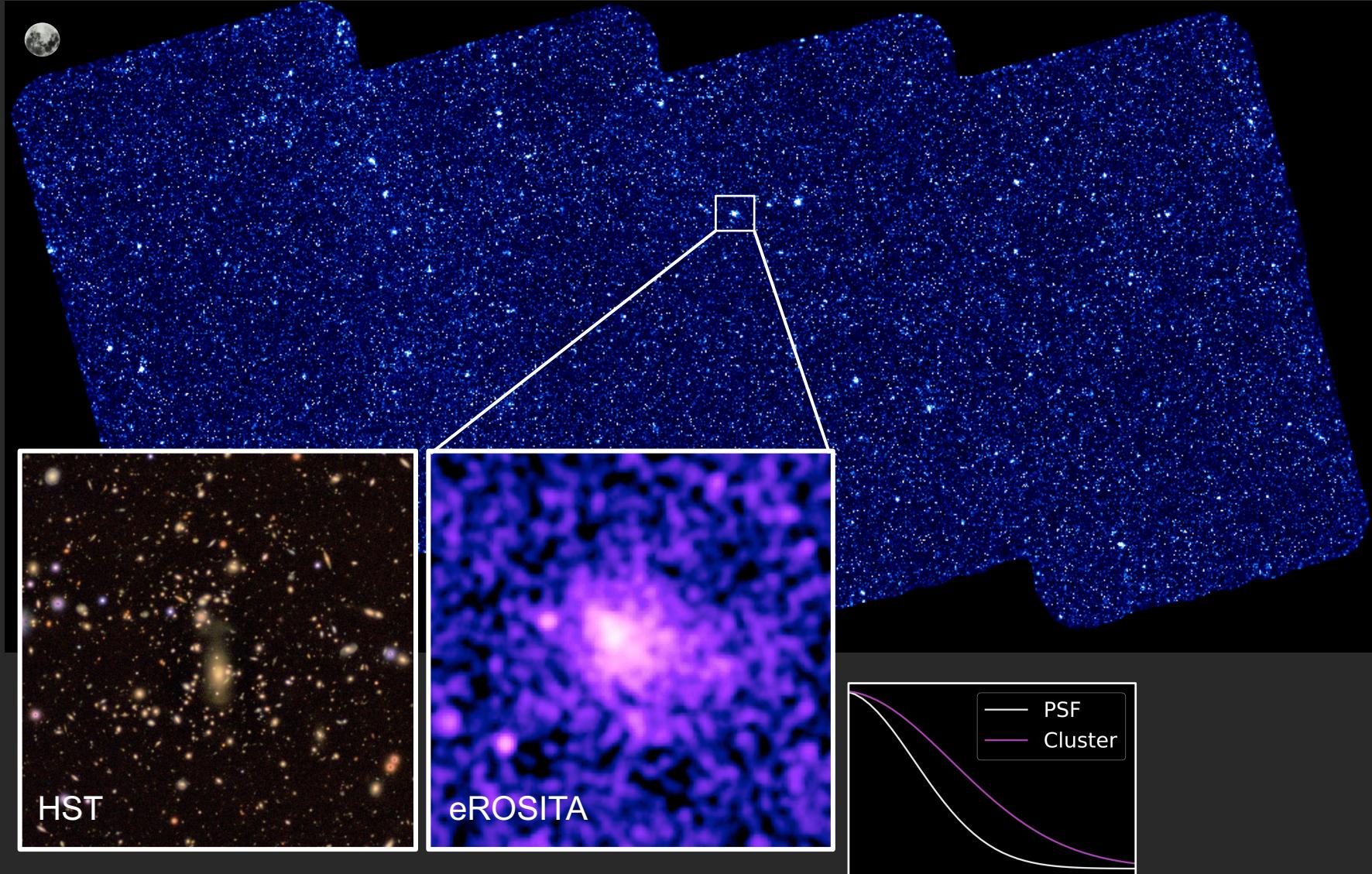


eFEDS: a preview survey



Exposure corrected image in the 0.5–2.0 keV band

Flux limit (0.2 – 2.3 keV) $\sim 7 \times 10^{-15}$ erg/s/cm²

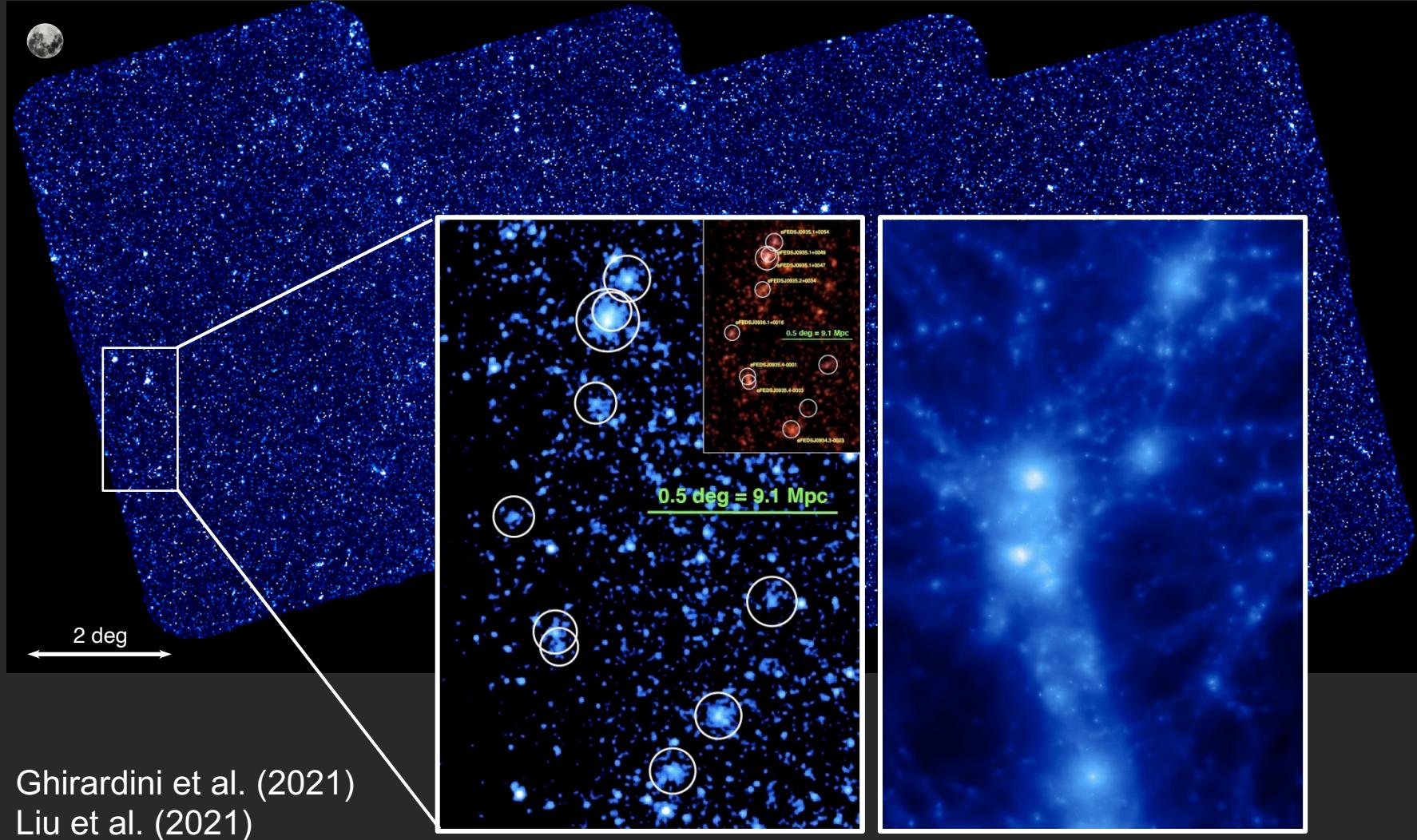


eROSITA's First Supercluster



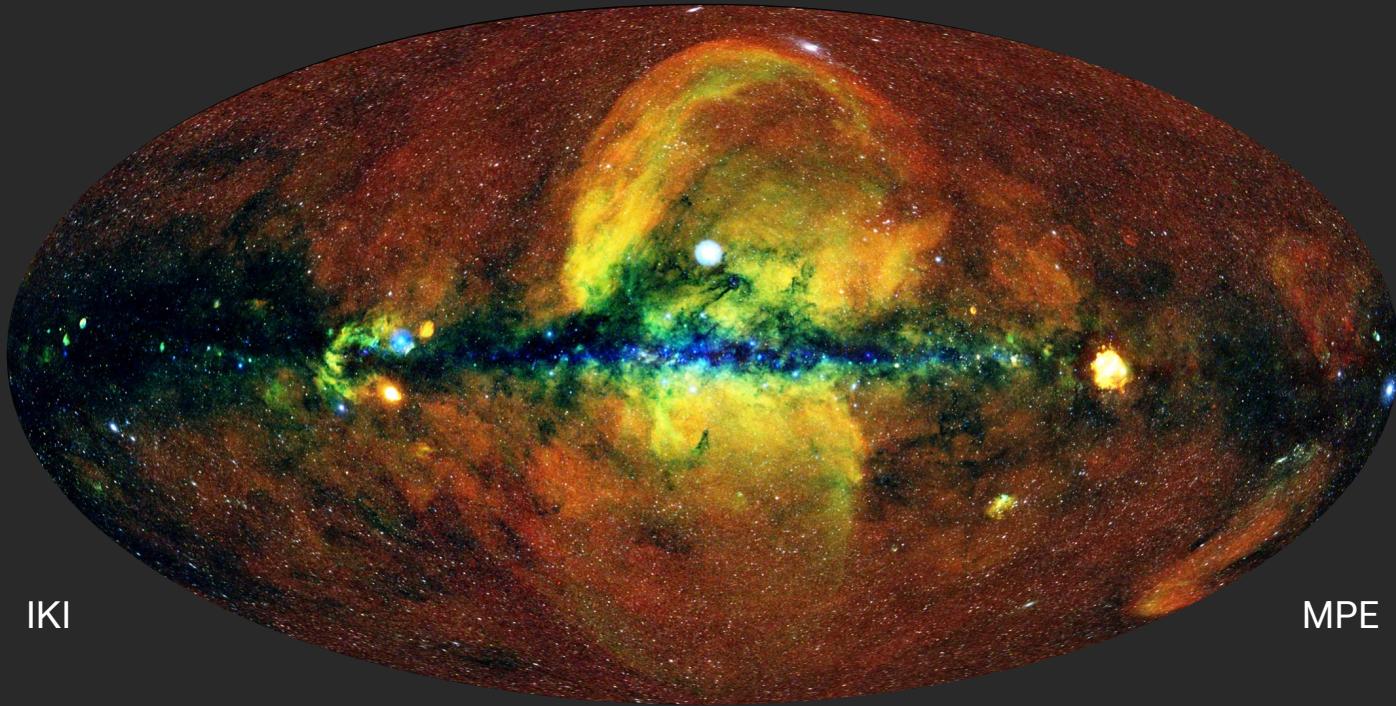
Exposure corrected image in the 0.5–2.0 keV band

Flux limit (0.2 – 2.3 keV) $\sim 7 \times 10^{-15}$ erg/s/cm²



The first Sky-Survey: eRASS 1

eRASS-1: 13.12.19 – 11.06.20 (182 days)



SRG/eROSITA 0.3 – 2.3 keV RGB Map (red: 0.3-0.6 keV, green: 0.6-1.0 keV, blue: 1.0-2.3 keV)

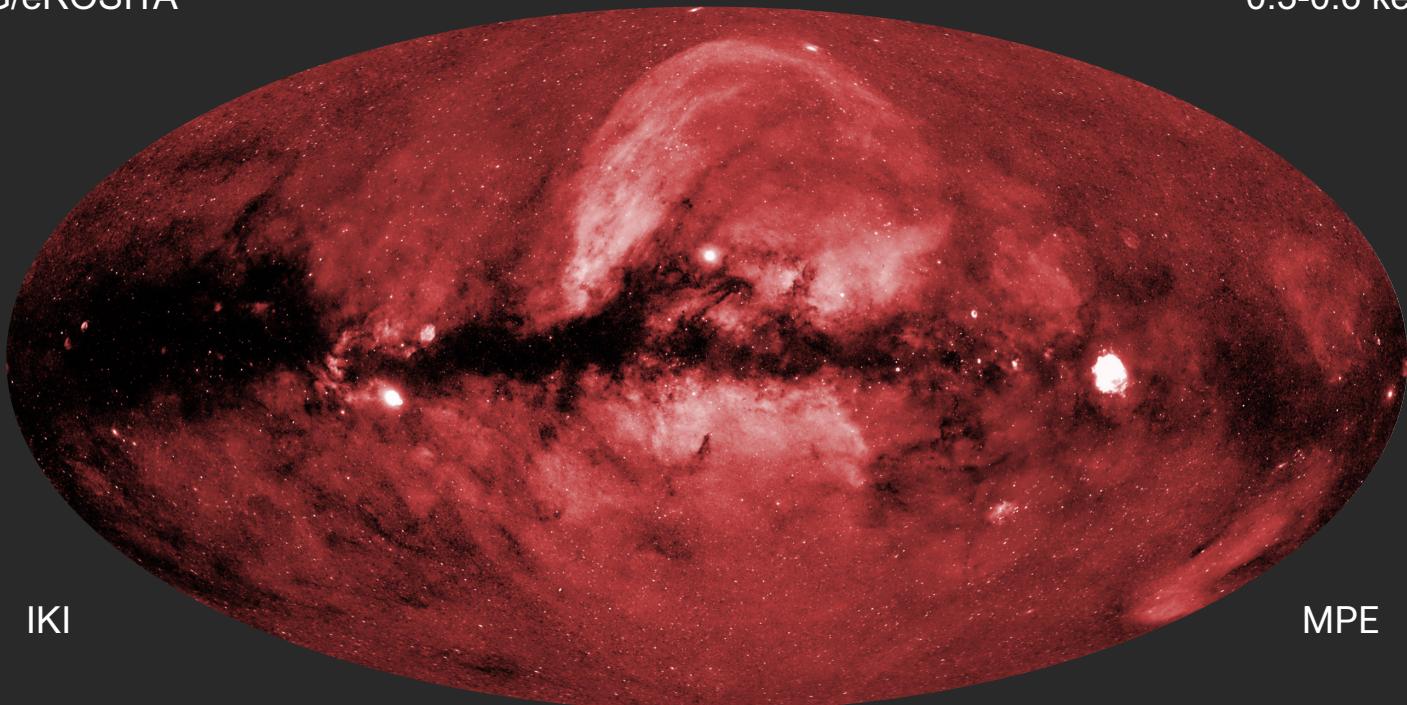
~1.000.000 X-ray sources

Diffuse Emission = hot gas

The first Sky-Survey: eRASS 1

SRG/eROSITA

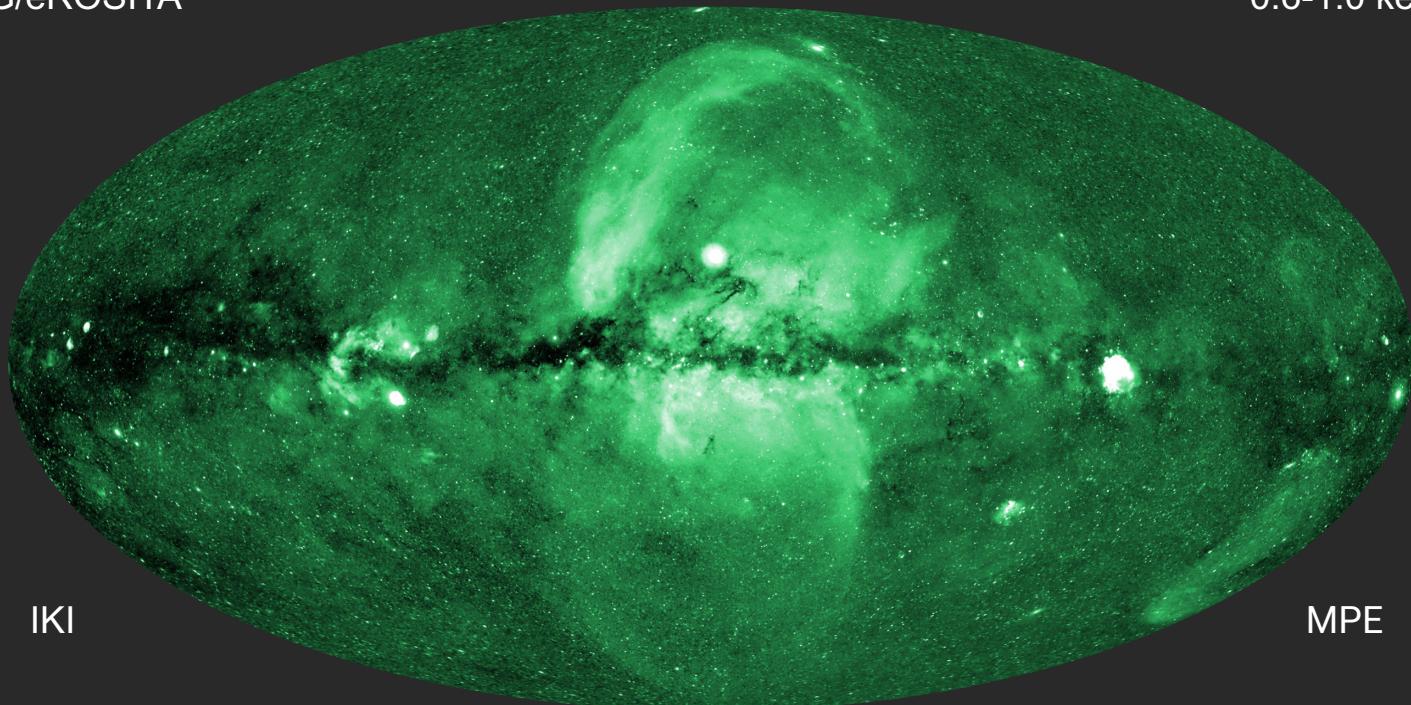
0.3-0.6 keV



The first Sky-Survey: eRASS 1

SRG/eROSITA

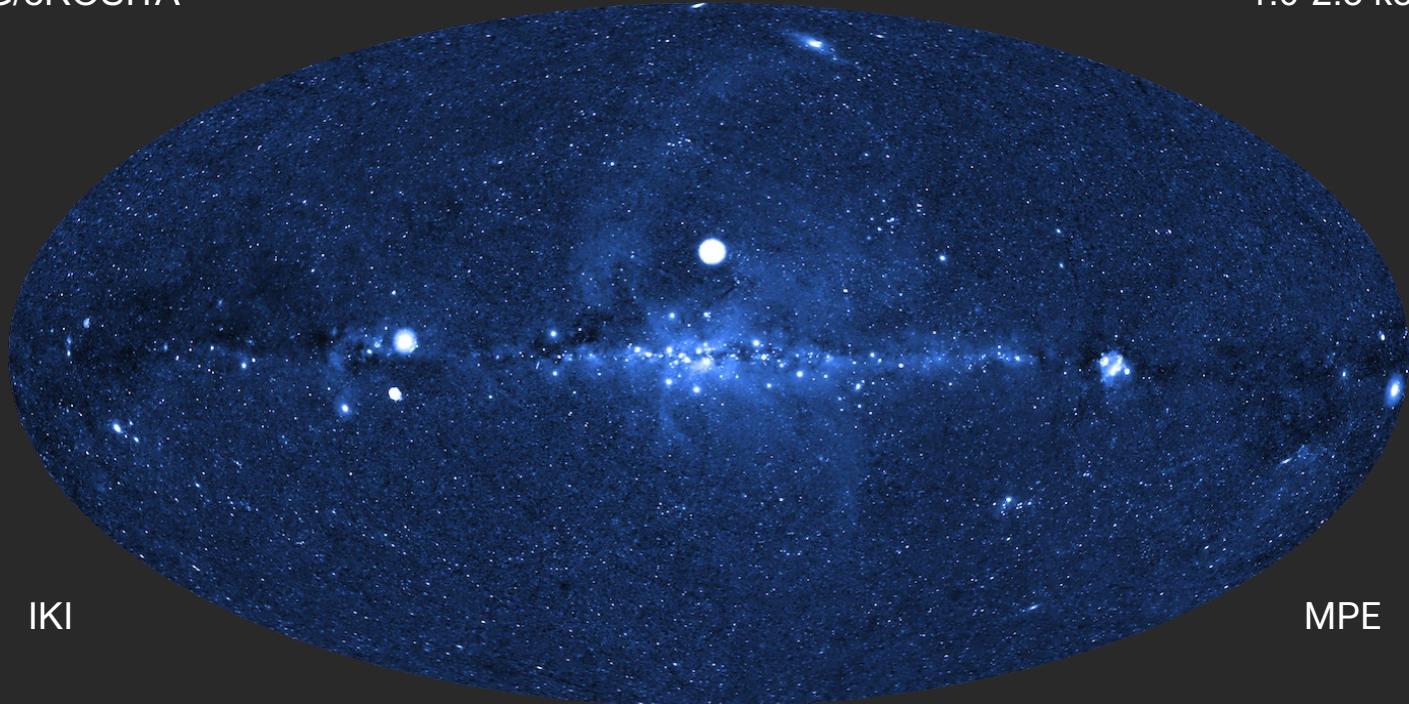
0.6-1.0 keV



The first Sky-Survey: eRASS 1

SRG/eROSITA

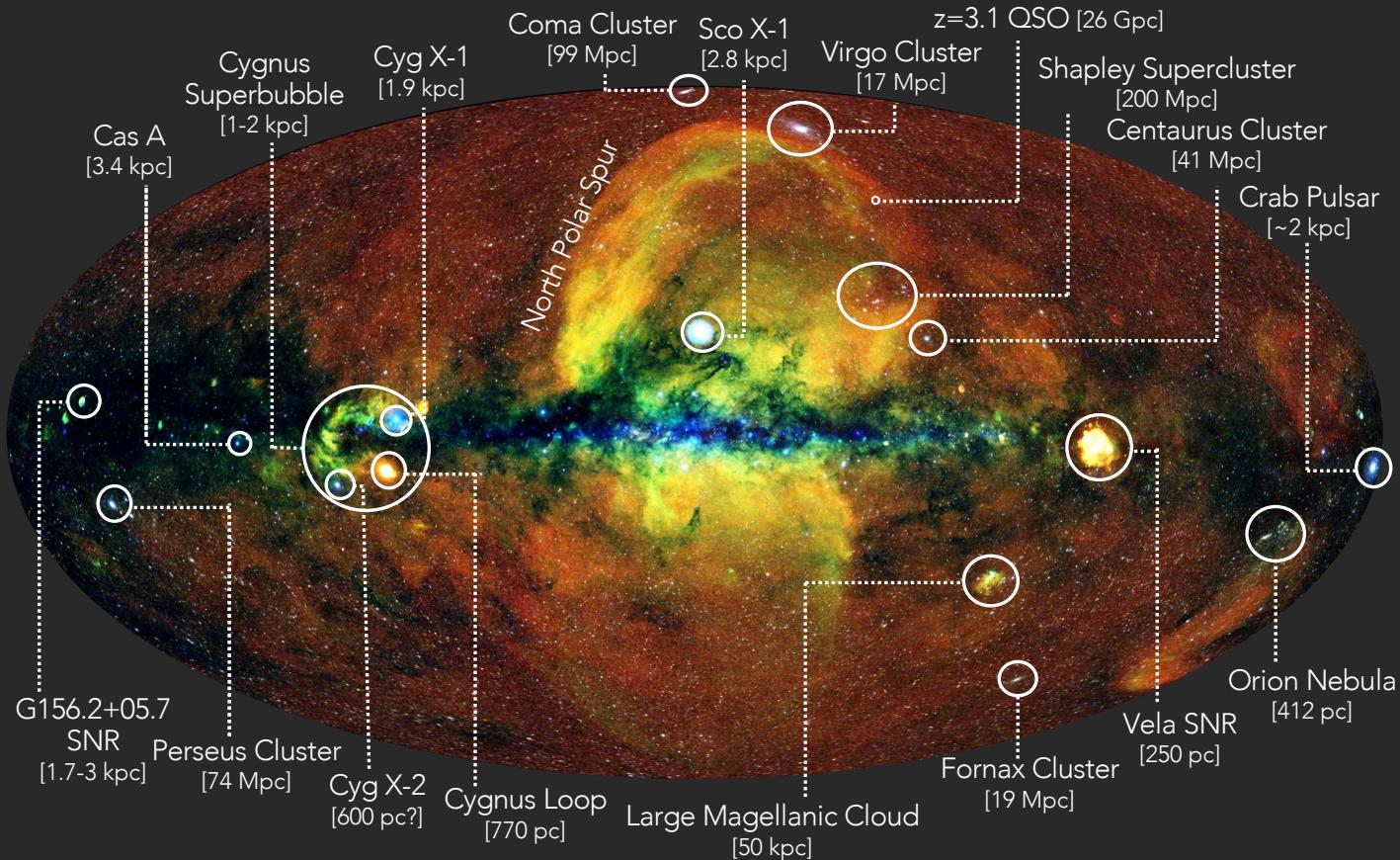
1.0-2.3 keV



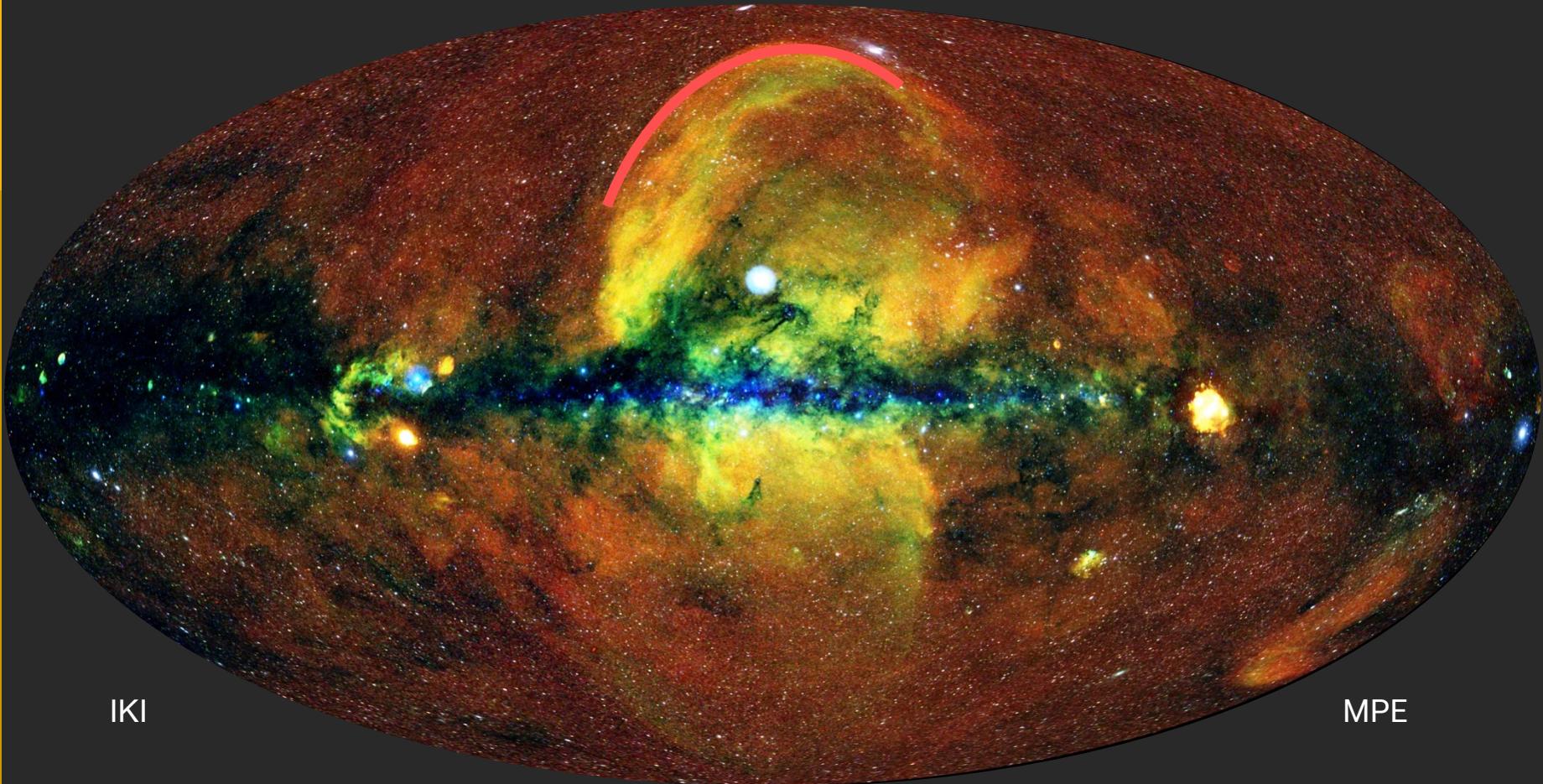
IKI

MPE

The first Sky-Survey: eRASS 1



eROSITA Bubbles

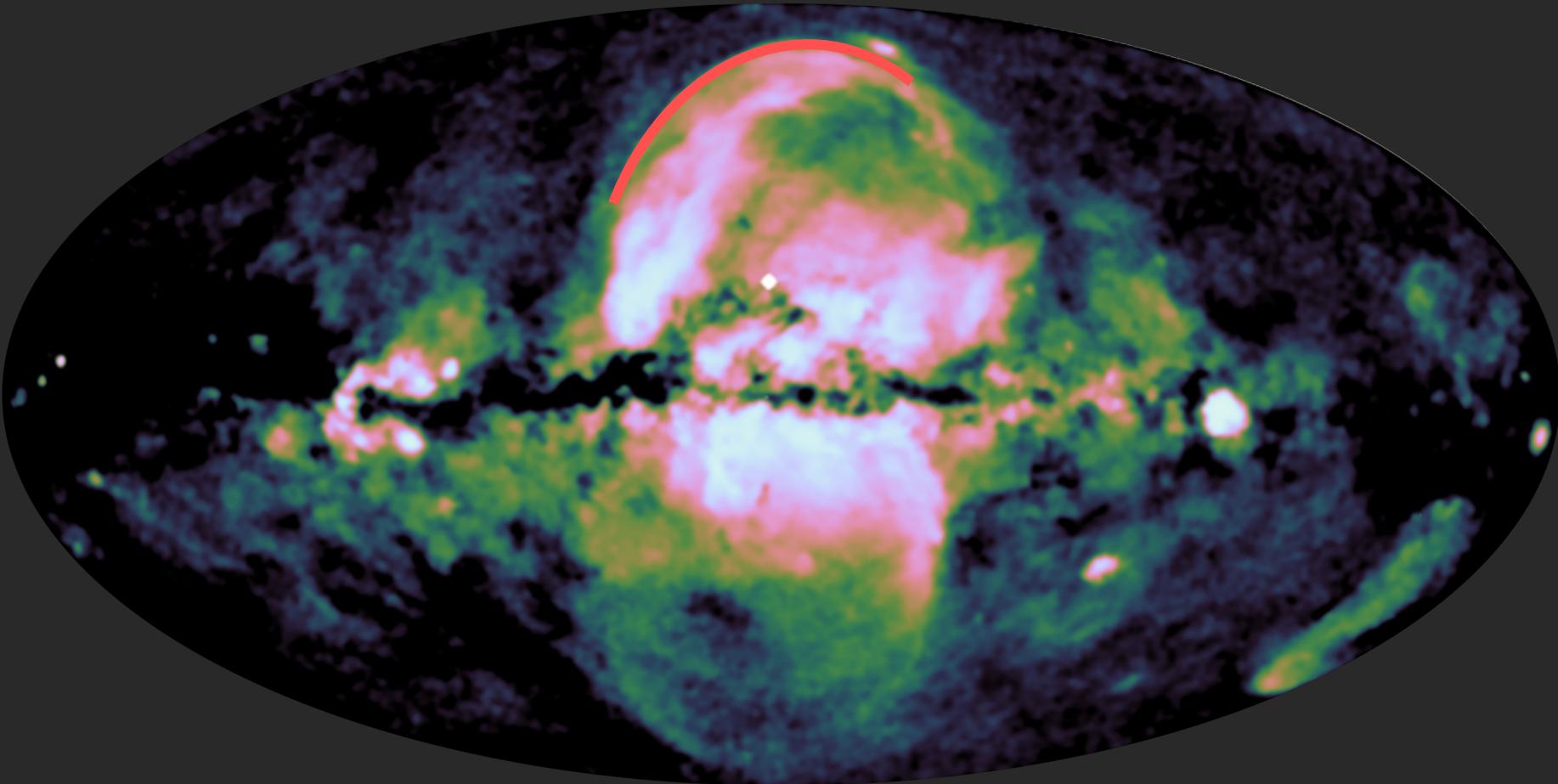


Predehl, Sunyaev, et al., Nature, 2020

eROSITA Bubbles



0.6-1.0 keV, point source subtracted

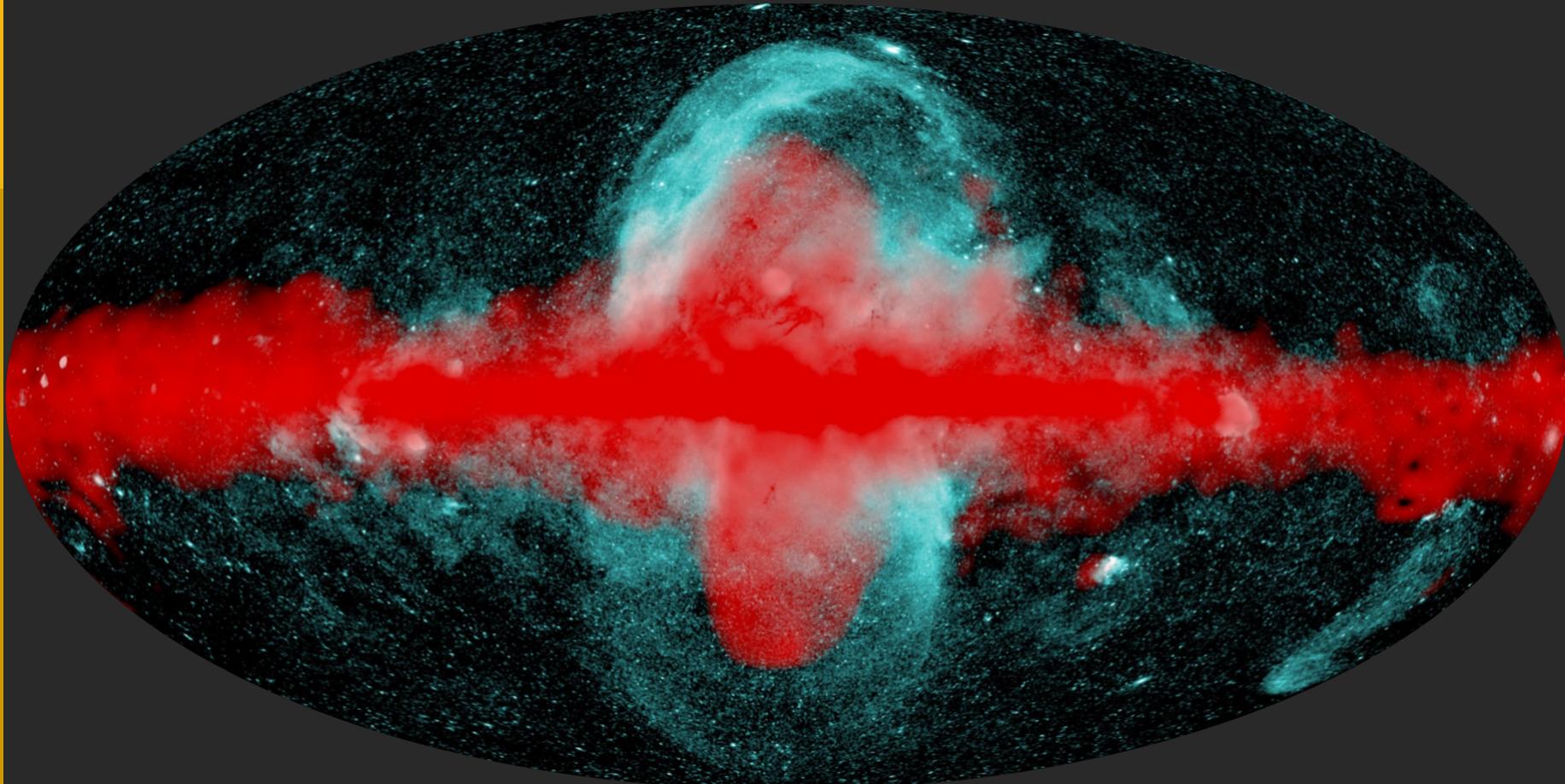


Predehl, Sunyaev, et al., Nature, 2020

eROSITA & Fermi Bubbles

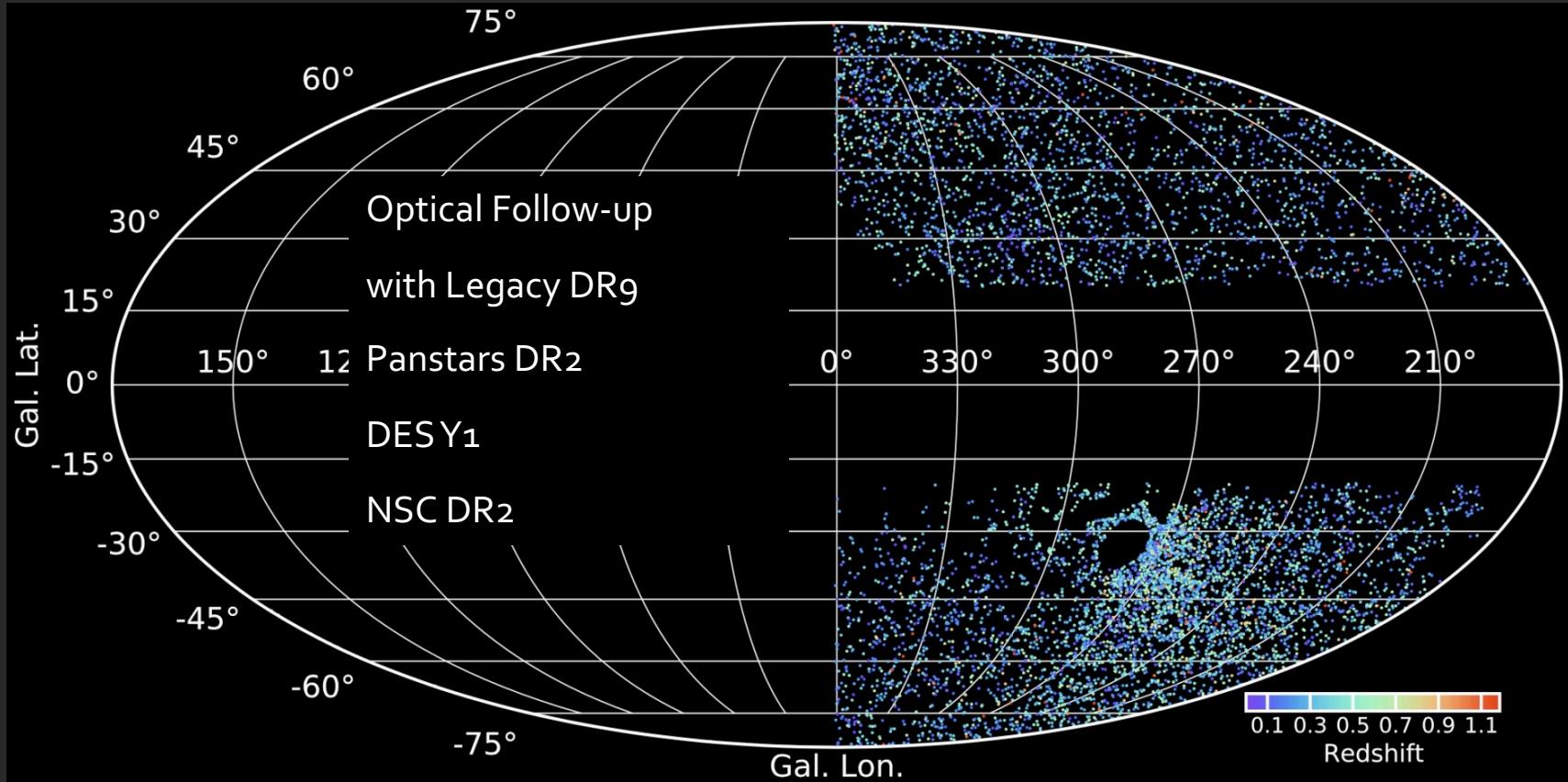


⇒ Talk by H.-Y. Karen Yang: *Fermi/eRosita bubbles as relics of the past activity of Sgr A**



Predehl, Sunyaev, et al., Nature, 2020

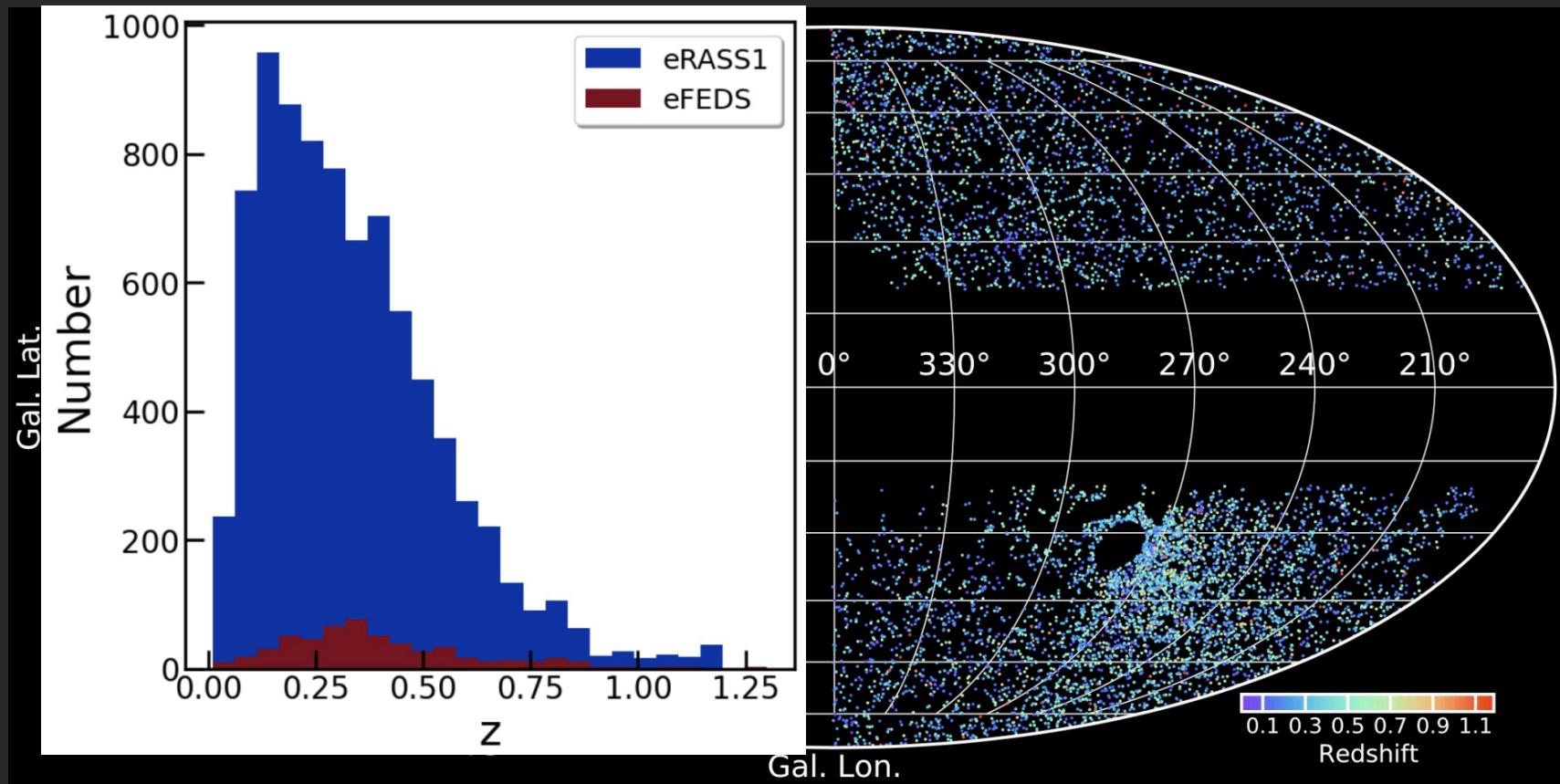
eRASS1 \Rightarrow 17000 Cluster Candidates



eRASS1 \Rightarrow 17000 Cluster Candidates



- Scientific motivation for eROSITA: detect and spatially resolve a large number (about 10^5) of clusters over a wide redshift range (up to at least $z \sim 1$) in order to constrain cosmological parameters



8157 clusters are confirmed in 15000 deg^2

> 6500 new clusters

(Bulbul+, Ider Chitham+)

Summary

- ◆ eROSITA on SRG is in operation since more than 2 years. All subsystem are working with minimal losses
- ◆ We have completed ~4.3 all-sky surveys, 3.7 to go!?
- ◆ Thanks to its large Grasp, stable background and observing cadence eROSITA opens up new parameter space for X-ray astronomy across different source classes
- ◆ eFEDS demonstrates the all-sky survey design requirements can be met
- ◆ The completed all-sky survey will represent a unique legacy dataset that will be unsurpassed for many years
- ◆ The list of science highlights has become too long for a summary slide...