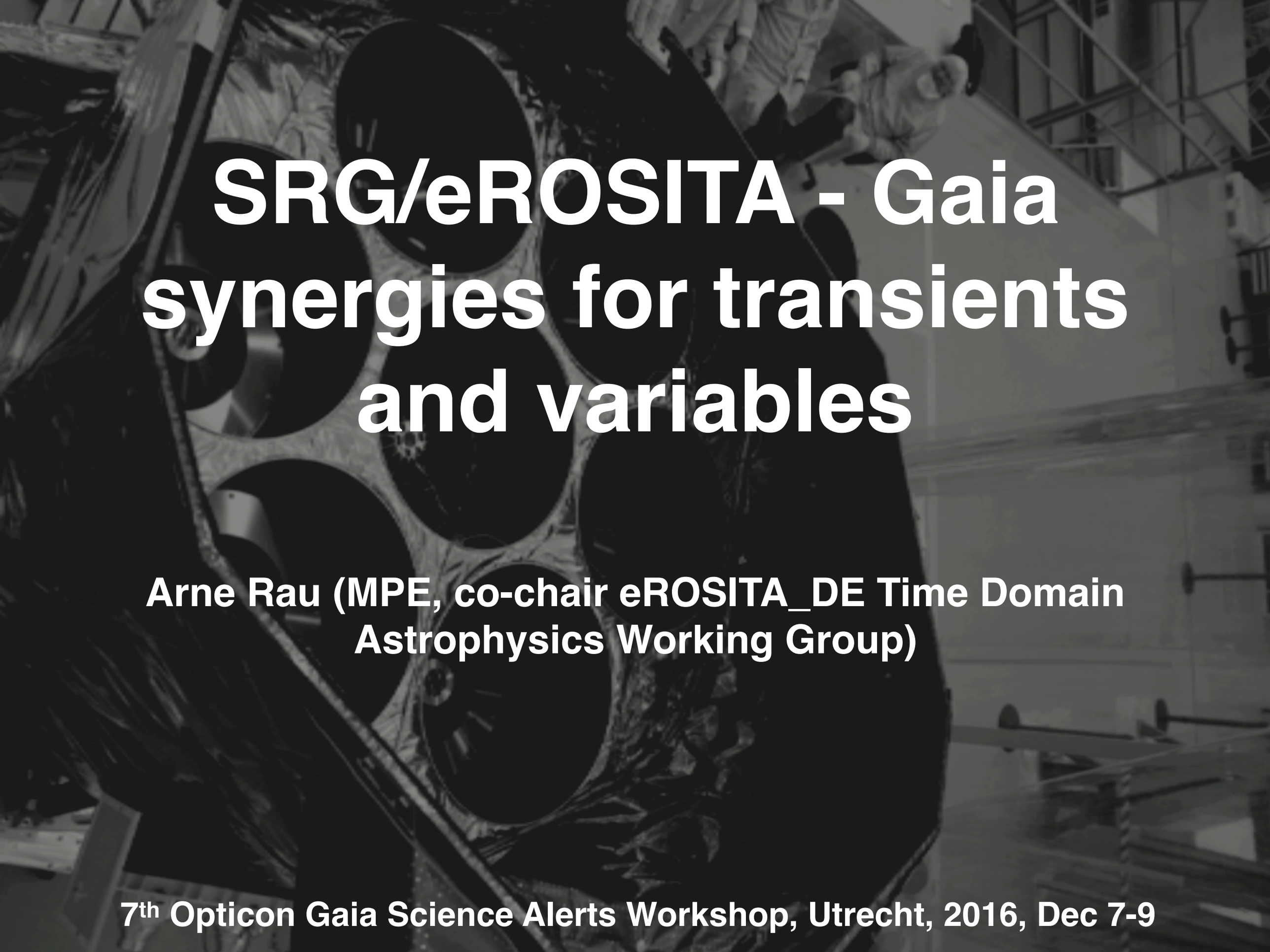


SRG/eROSITA - Gaia synergies for transients and variables

Arne Rau (MPE, co-chair eROSITA_DE Time Domain Astrophysics Working Group)

7th Opticon Gaia Science Alerts Workshop, Utrecht, 2016, Dec 7-9

eROSITA scientific motivation

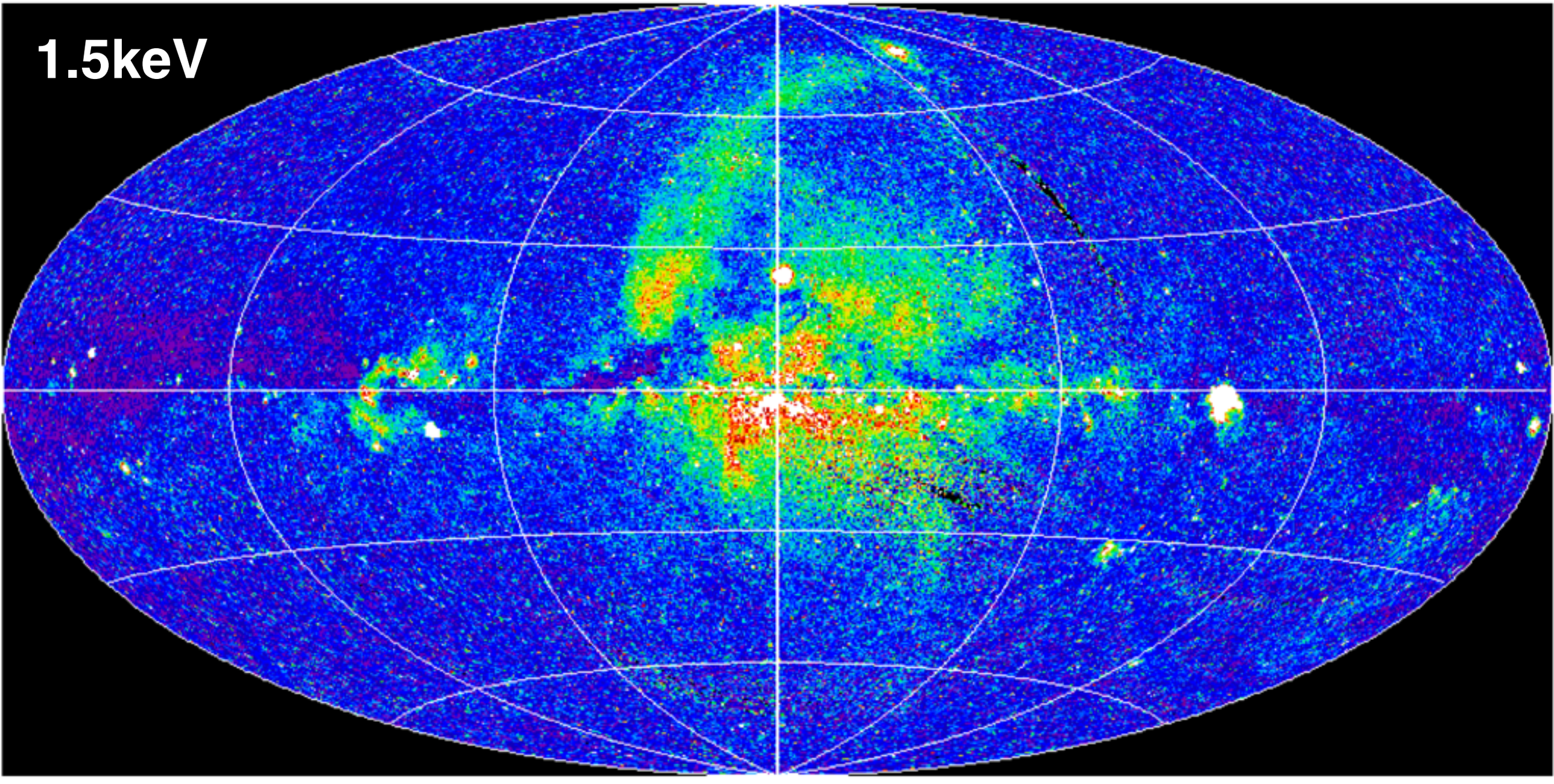
eROSITA instrument

time domain astrophysics with eROSITA

eROSITA synergies with Gaia

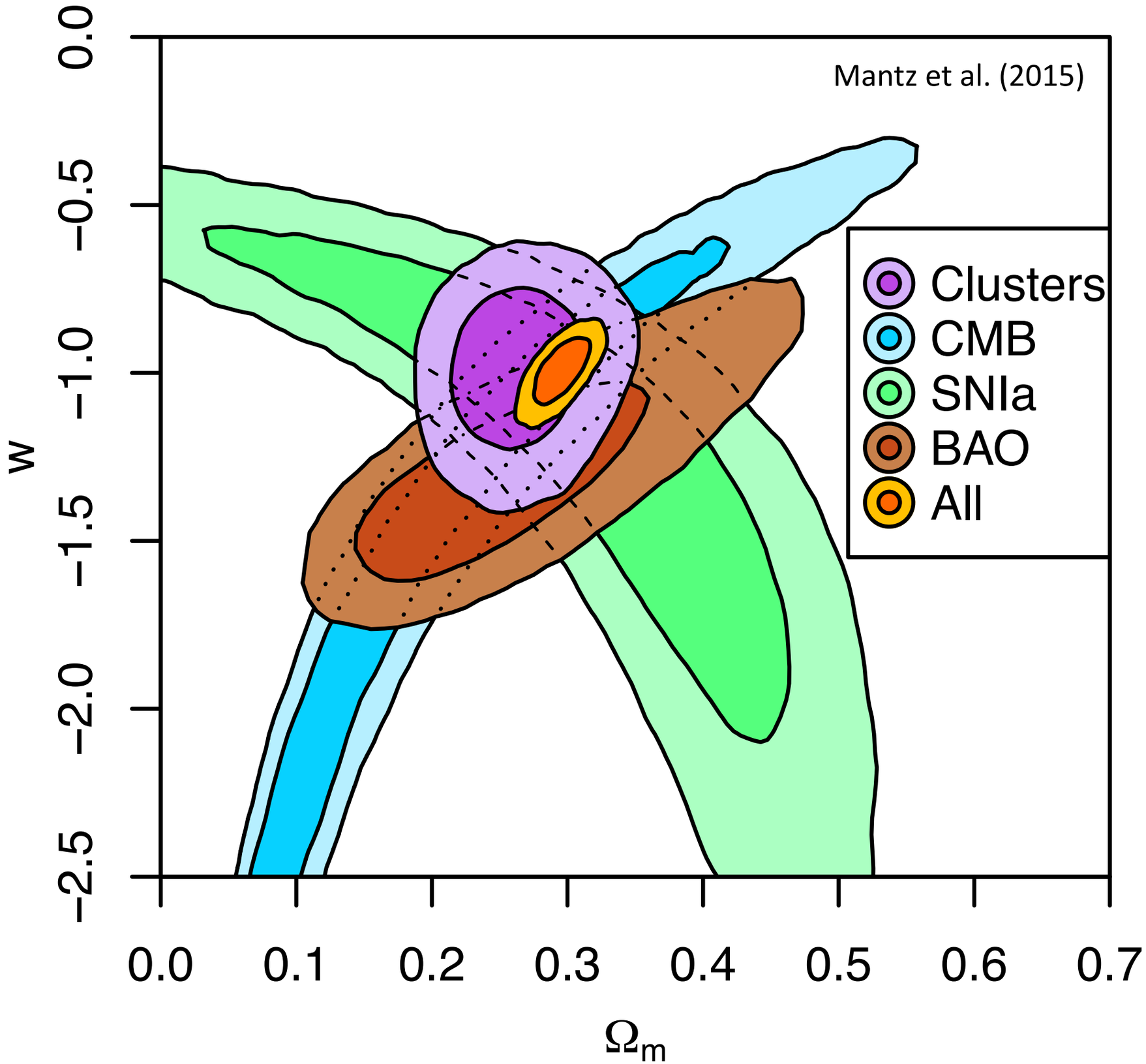
Why building eROSITA?

ROSAT (1990-98) provided the 1st X-ray all-sky survey with an imaging telescope.

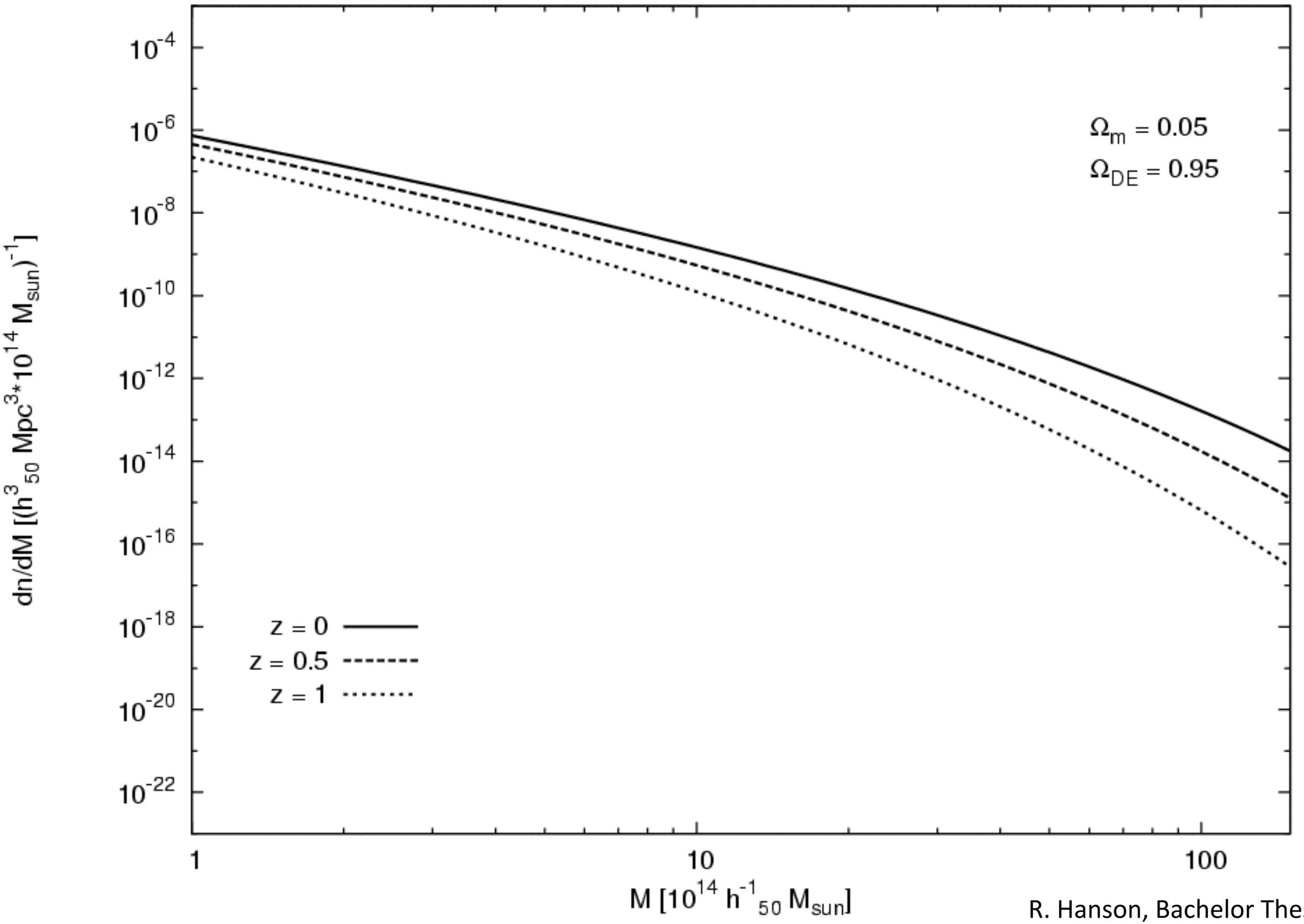


(Courtesy M. Freyberg)

Current constraints on Ω_{DE} and Ω_M from ~100 X-ray Clusters originally detected by ROSAT.

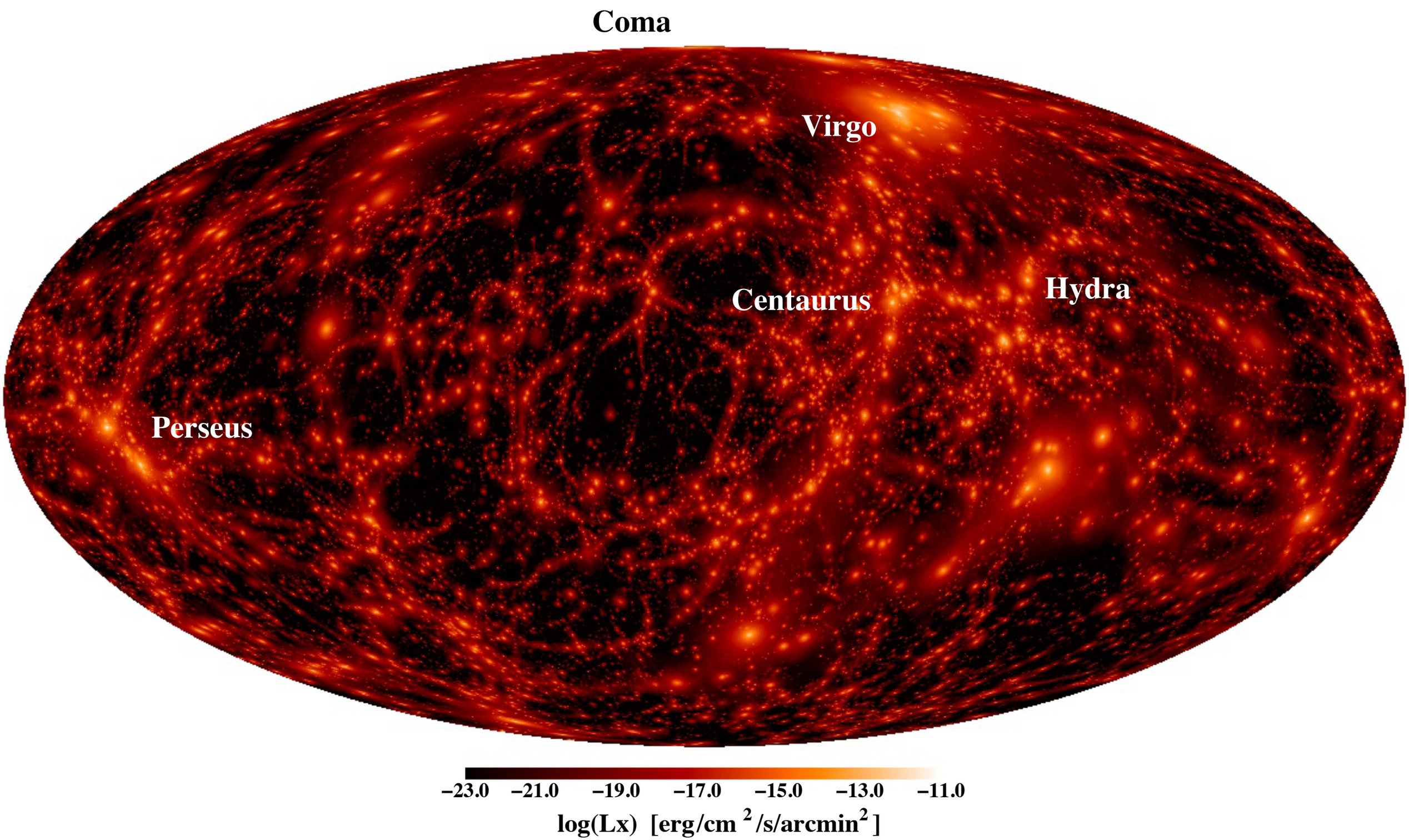


Structure growth depends on expansion rate, i.e. H(z), which depends on dark/baryonic matter density and dark energy density, and equation of state.



R. Hanson, Bachelor Thesis (2009)

eROSITA will be 30x deeper than ROSAT & its ~100.000 galaxy clusters will provide cosmological constraints competitive will Planck & SZ.



In addition to galaxy clusters, eROSITA will also detect ~3 Million AGN and ~500.000 stars all-sky.

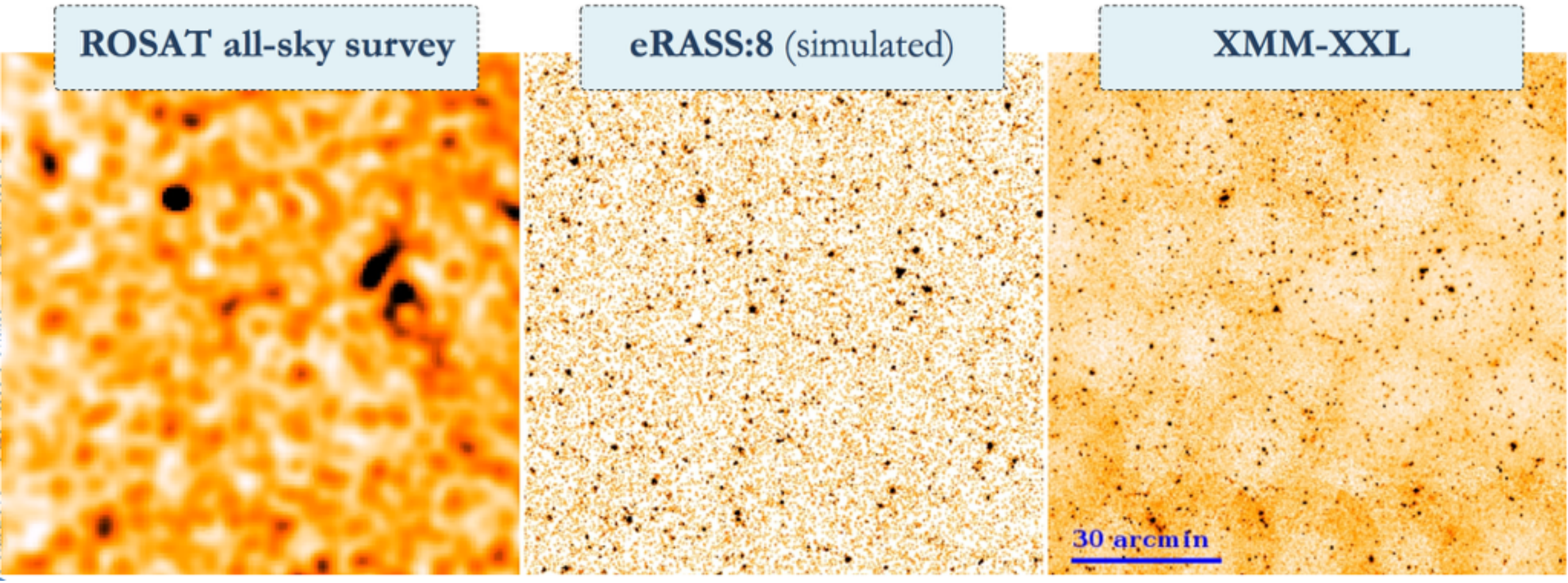
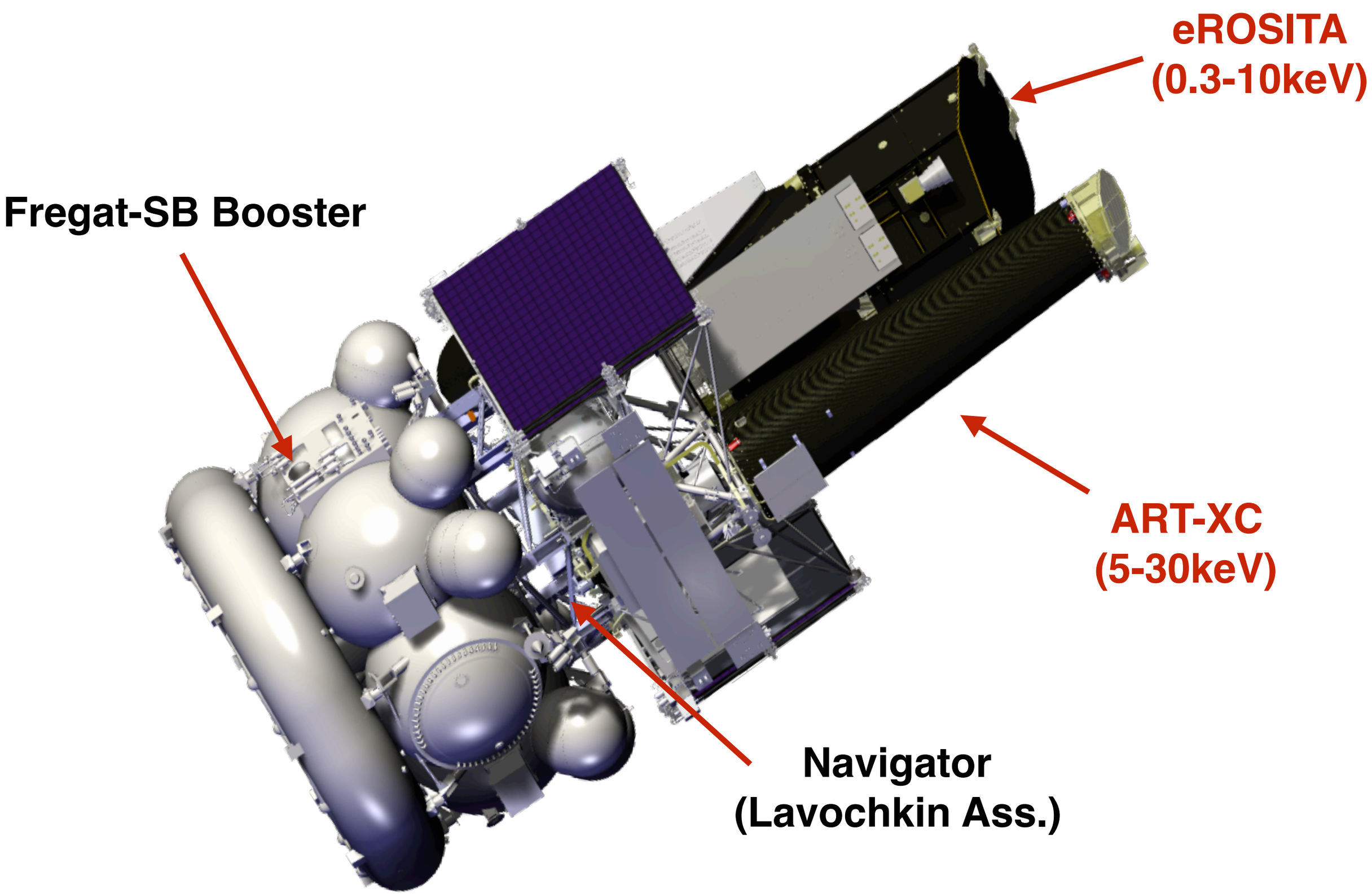


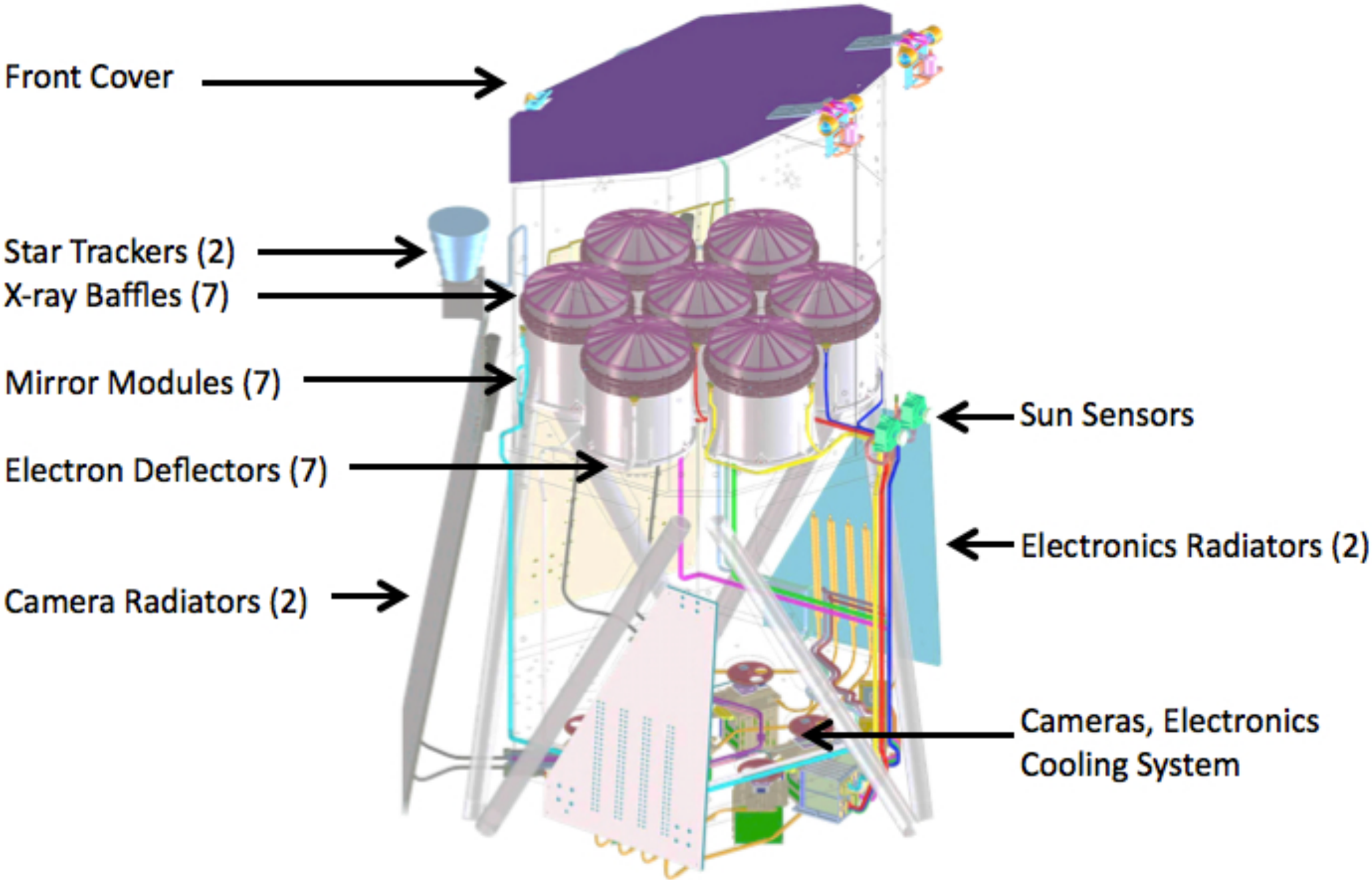
Image credits: MPE, eRosita_DE consortium, XMM-XXL

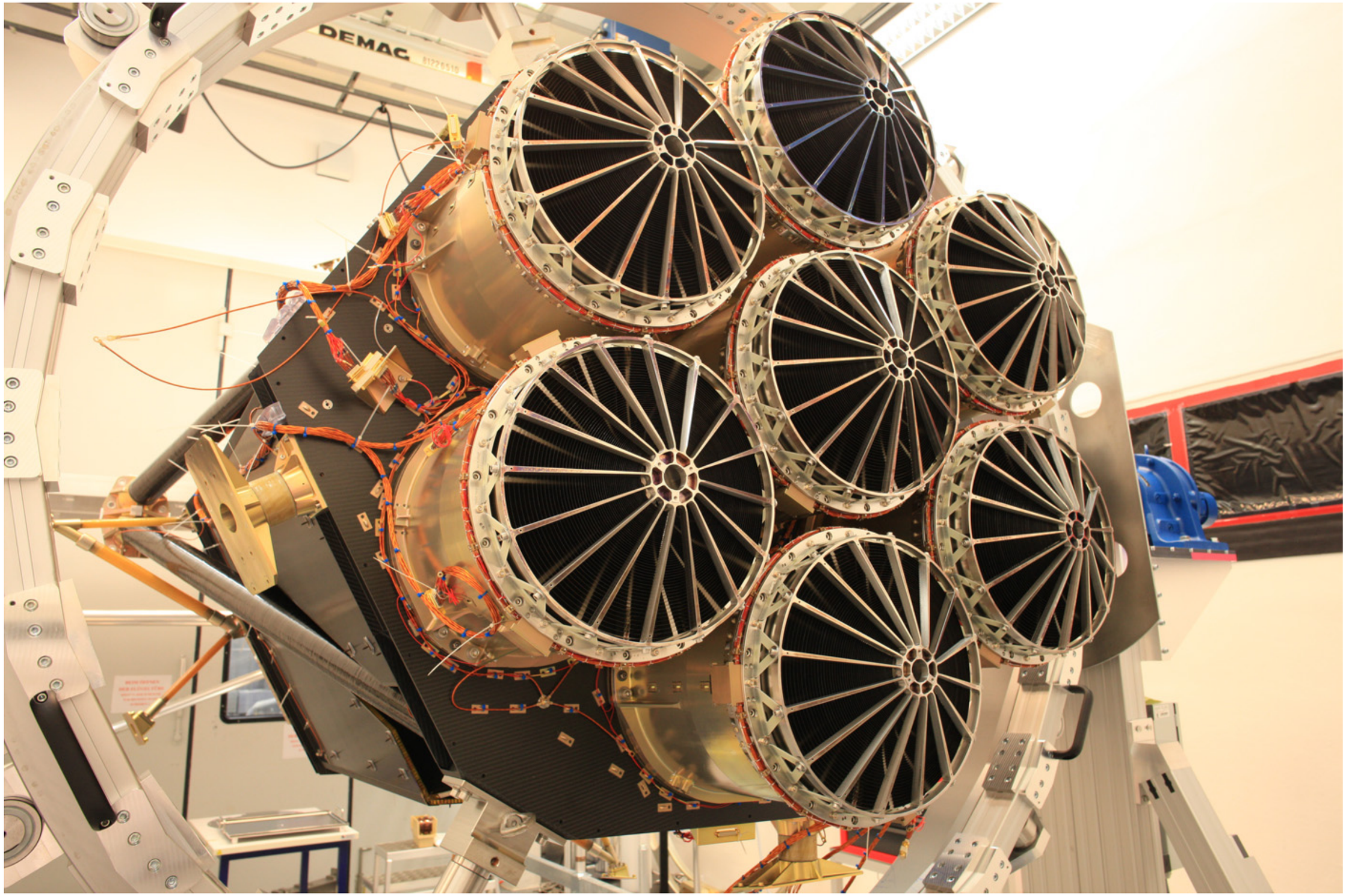
The eROSITA instrument onboard Spectrum-Roentgen-Gamma

SRG - Russian satellite with two scientific instruments, eROSITA lead by MPE, and ART-XC lead by IKI, to be launched from Baykonour into L2 ~Dec 2017.

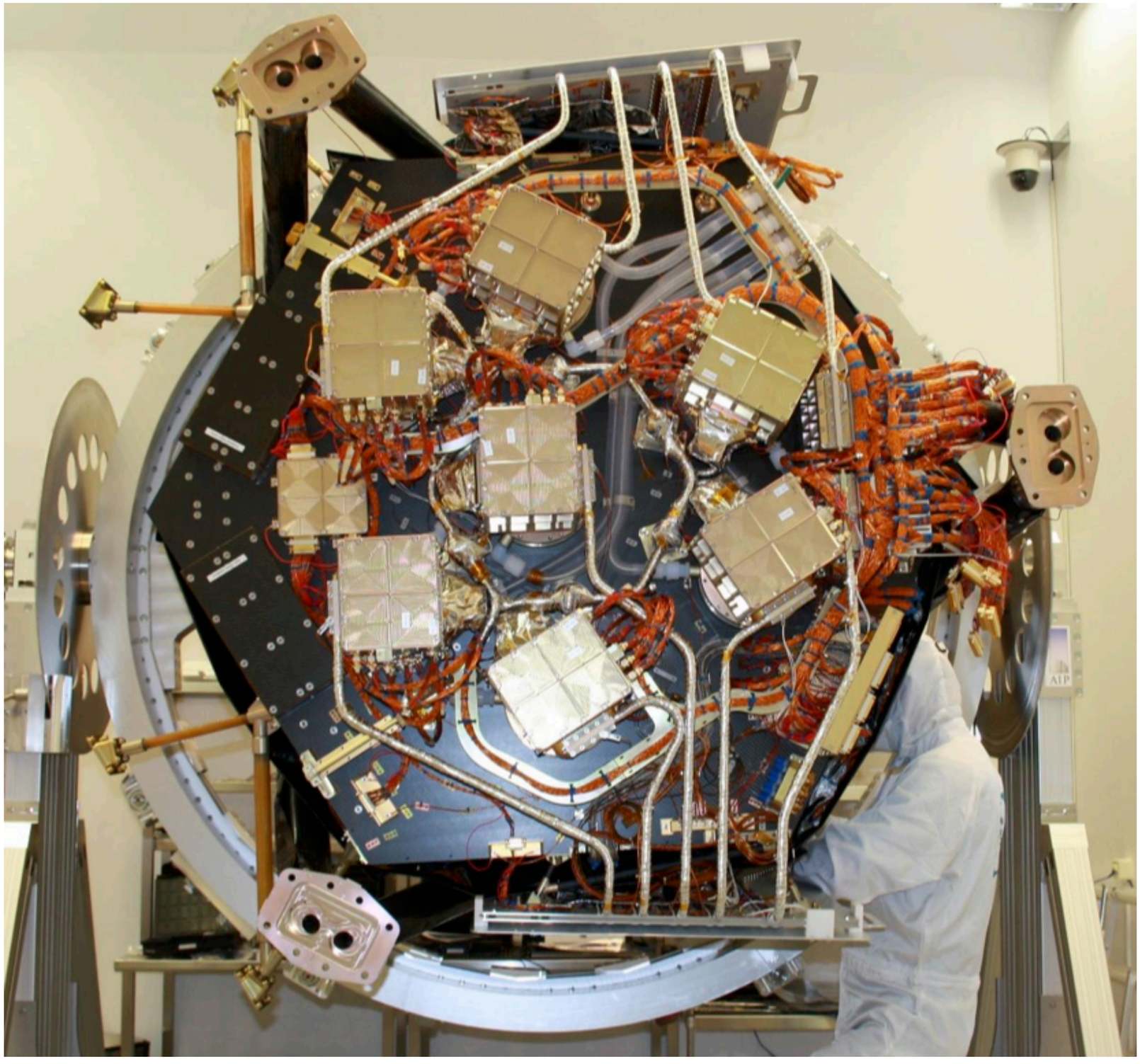


eROSITA consists of 7 identical telescopes, feeding 7 cameras. All observe a common ~1deg diameter field of view.



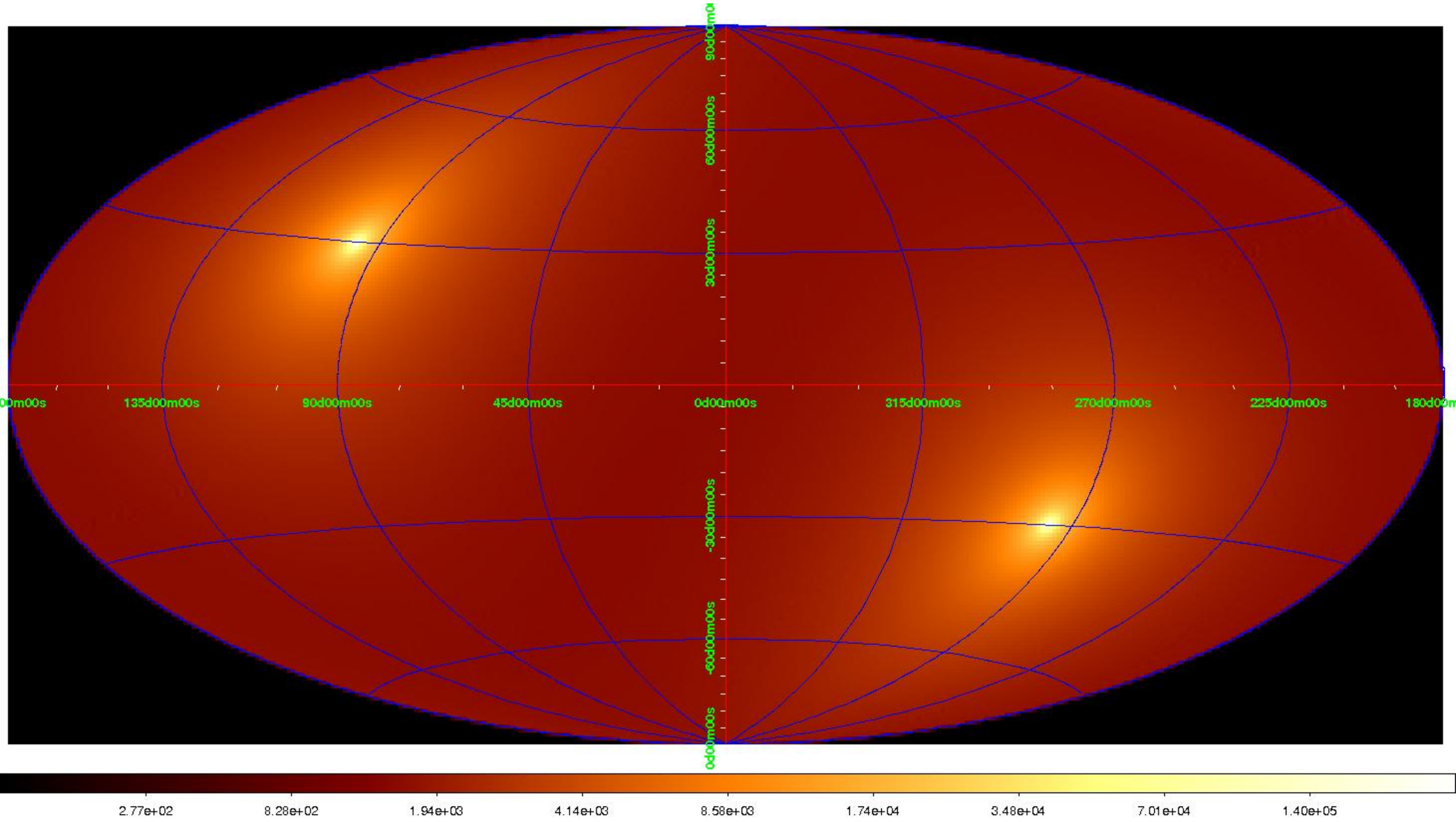


7x 54 nested gold-coated nickel mirror shells
1.6m focal length
on-axis HEW ~16”1



7 Framestore pnCCDs
Resolution of ~20 at 1.5keV, i.e. 77eV
effective area comparable to XMM x7

Survey strategy similar (but not identical) to Gaia.



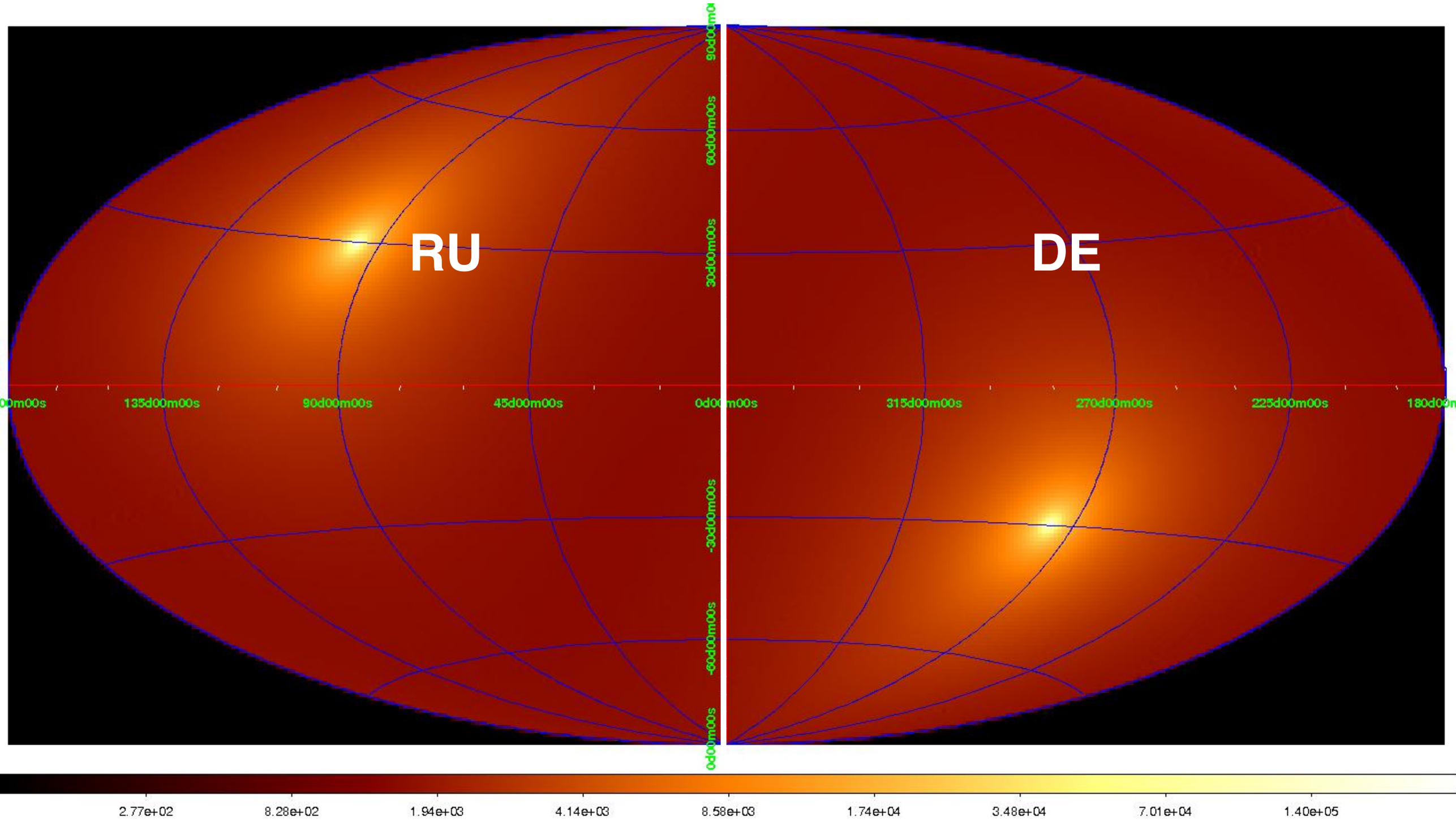
eRASS: full sky coverage in 1/2yr

eRASS1,2,..8: together form the 4-yr all-sky survey

each position covered >6x with 4hr cadence per eRASS

pointed phase afterwards

eROSITA sky is split between Germany (West in Gal. Coord.) and Russia (East).

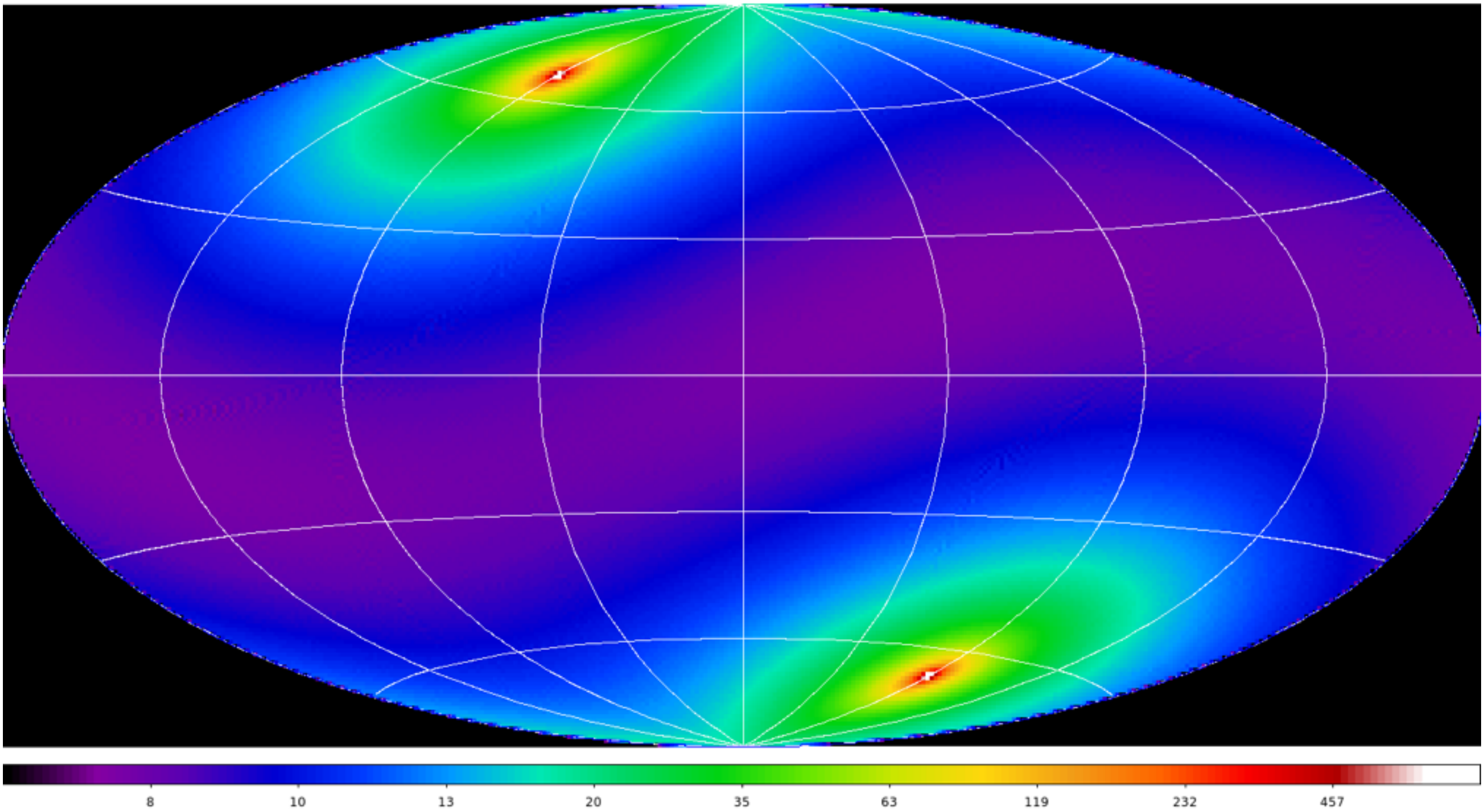


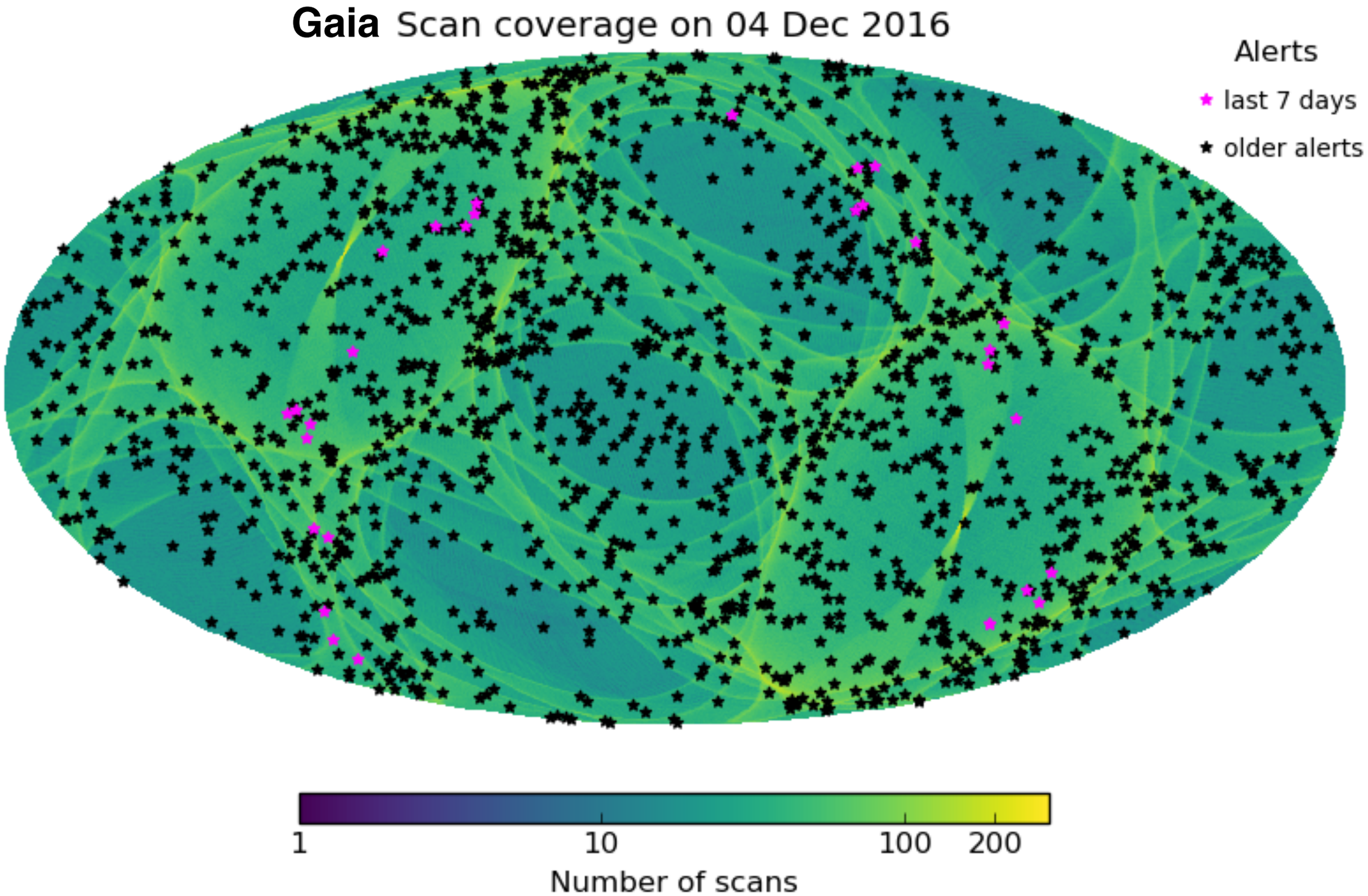
DE: eROSITA data reduced at MPE and to be made public in instalments (1/2yr, ?2yr, 4yr)

RU: tbd

eROSITA time domain astrophysics

Each position on the sky will have 8-500 visits (eRASS days) within 4yr.



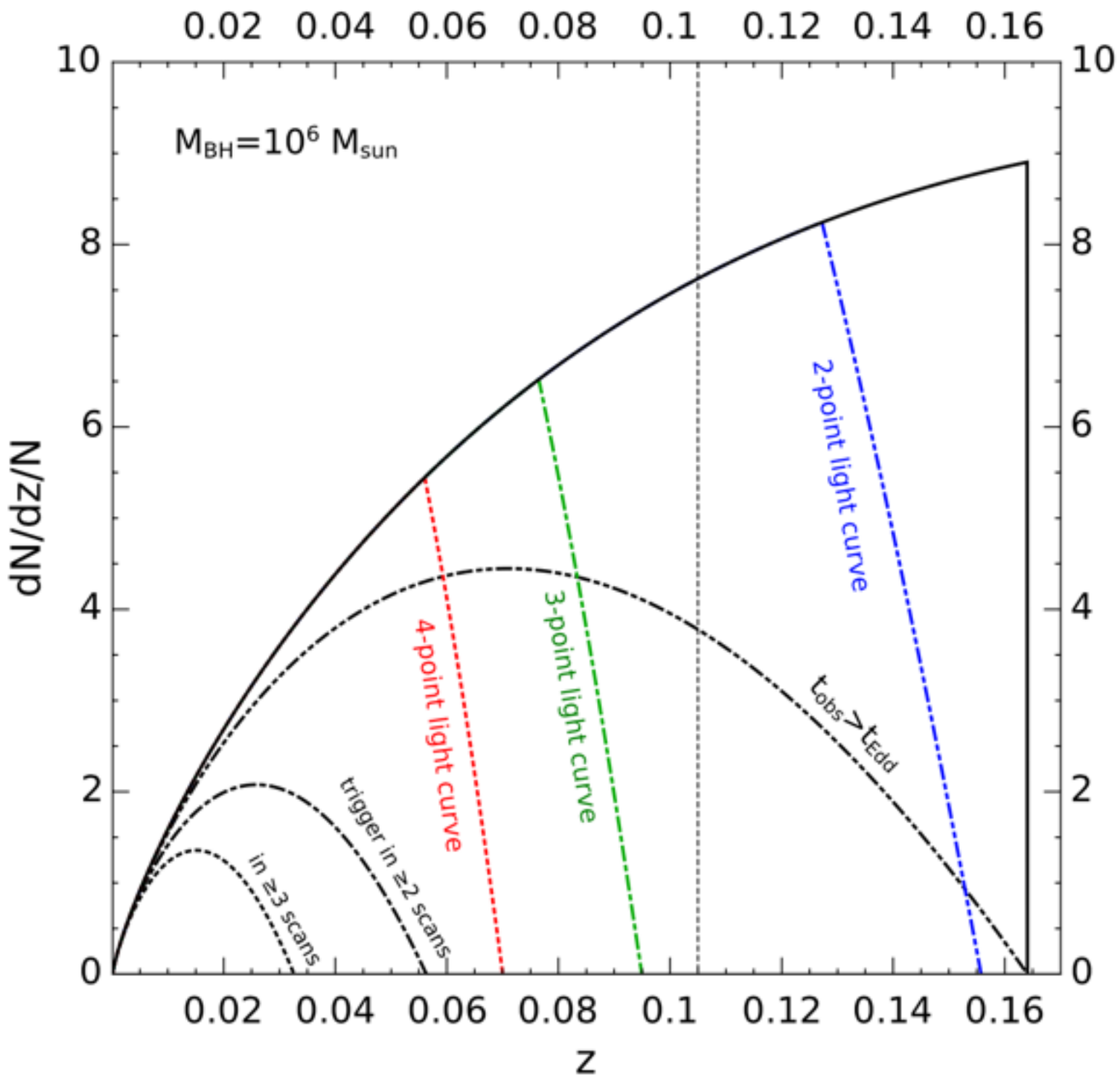


similar survey poles as eROSITA, i.e. highest coverage for same sky areas.

s
min
hr
d
month
yr
10^{50}
10^{45}
10^{40}
10^{35}
10^{30}
X-ray Luminosity (erg s^{-1})
GRB afterglow
AGN
SGR
Tidal Disruption
SN Ibc/II Breakout
z=1
1Gpc
ULX
Classical Nova
X-ray Binary
1Mpc
10kpc
Dwarf Nova
1kpc
Flare Star
10^{-2}
1
10^{2}
10^{4}
10^{6}
10^{8}
Variability Timescale (s)

Tidal Disruption Flares

Khabibullin et al. (2014)



- ~125 TDEs (all-sky) by comparing eRASS1 with RASS
- ~650 TDEs (all-sky) by comparing eRASS2 to eRASS1, eRASS3 to eRASS2, etc
- typically visible for 2-4 eRASS
- ~20 rising TDEs (all-sky) within 1 eROSITA day

log L_X	stars
26.0	late M dwarf
26.5	active VLM (M9) star
27.0	Sun, Altair (A7), Prox Cen (M5)
28.0	Procyon (F5), Eps Eri (K2)
29.0	low-mass CTTS, active M dwarf
30.0	EK Dra (active G2)
31.0	Algol, bright TTS, early B star
32.0	WR1, O type star
33.0	θ^1 Ori C (mag. O5)

Stellar Population Studies

-Activity vs. age, rotation,M, T

-Lx/Lbol rel. along hot star sequence

Dynamo theory

-Study of(super-)saturation effects and Lx/Lbol evolution

-Transition effects at fully connective boundary

Local SFH & Gal. Structure

-Young nearby stellar population

-early evolution of planetary systems

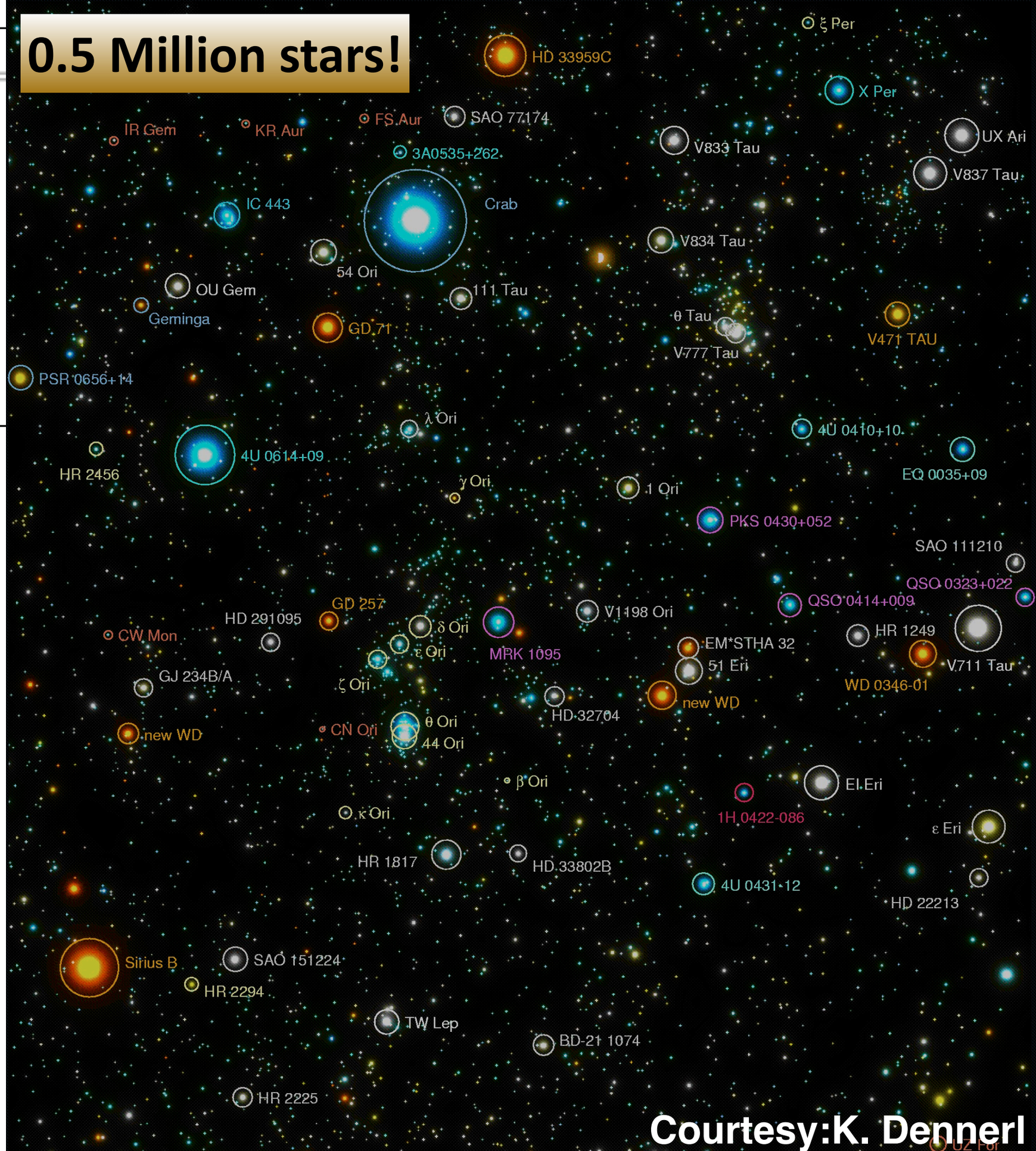
Properties of individual SFR

-masses, IMF, SFH

-models od SF& scenarios

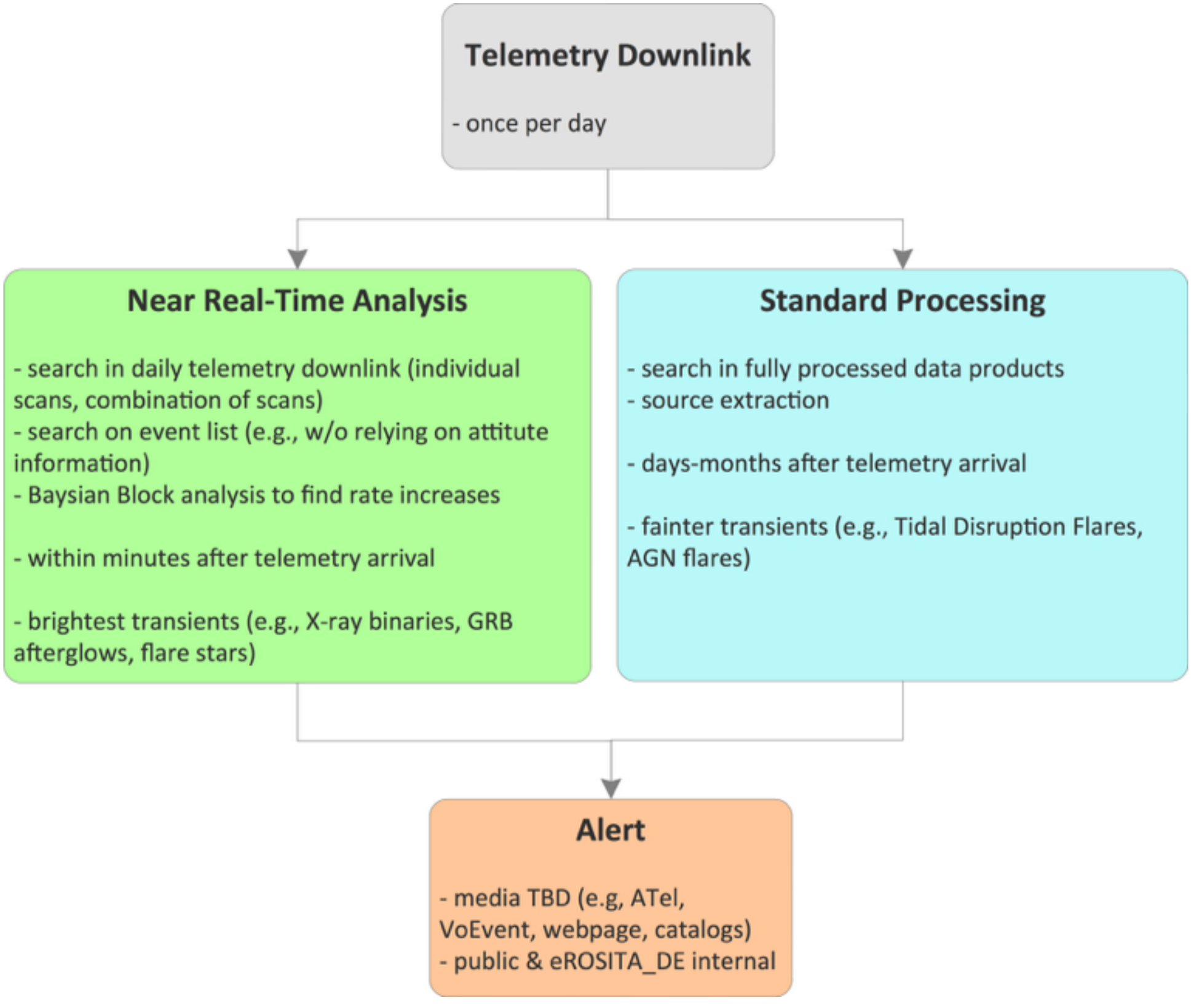
courtesy: J. Robrade, J. Schmitt

0.5 Million stars!



Courtesy:K. Dennerl

Transients and variables will be searched for in all time scales, from <30s to years. (Only in the German part of the sky!)



Some thoughts about synergies

Gaia data (obviously) important for eROSITA astrometry

whether Gaia and eROSITA detect the same transients will depend on the relative orbits and event timescales.

Survey poles offer common areas with large number of visits for joined variability studies

X-rays can help distinguishing unresolved nuclear SN from Gaia from TDEs

Gaia stellar classification (position, distance, space-motion, multiplicity, etc.) important for all eROSITA population studies of stars

Activity (X-rays) - rotation - age (optical) relation for stars

Gaia sources can be observed with dedicated pointed observations