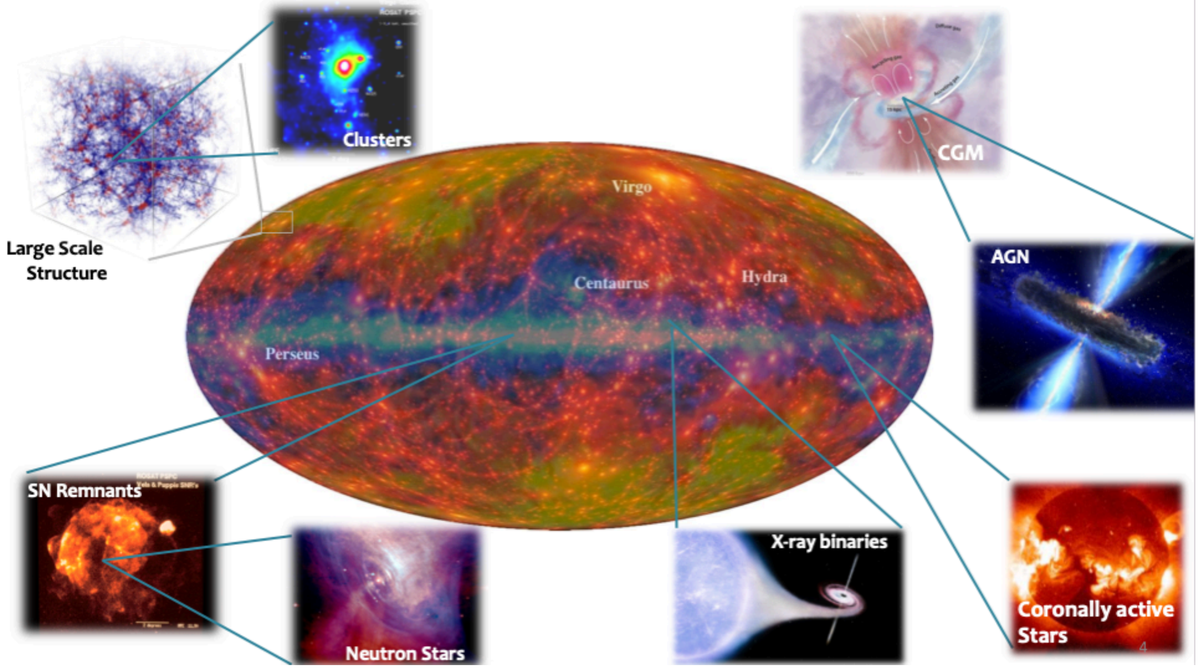
eROSITA DR1 and the AGN content

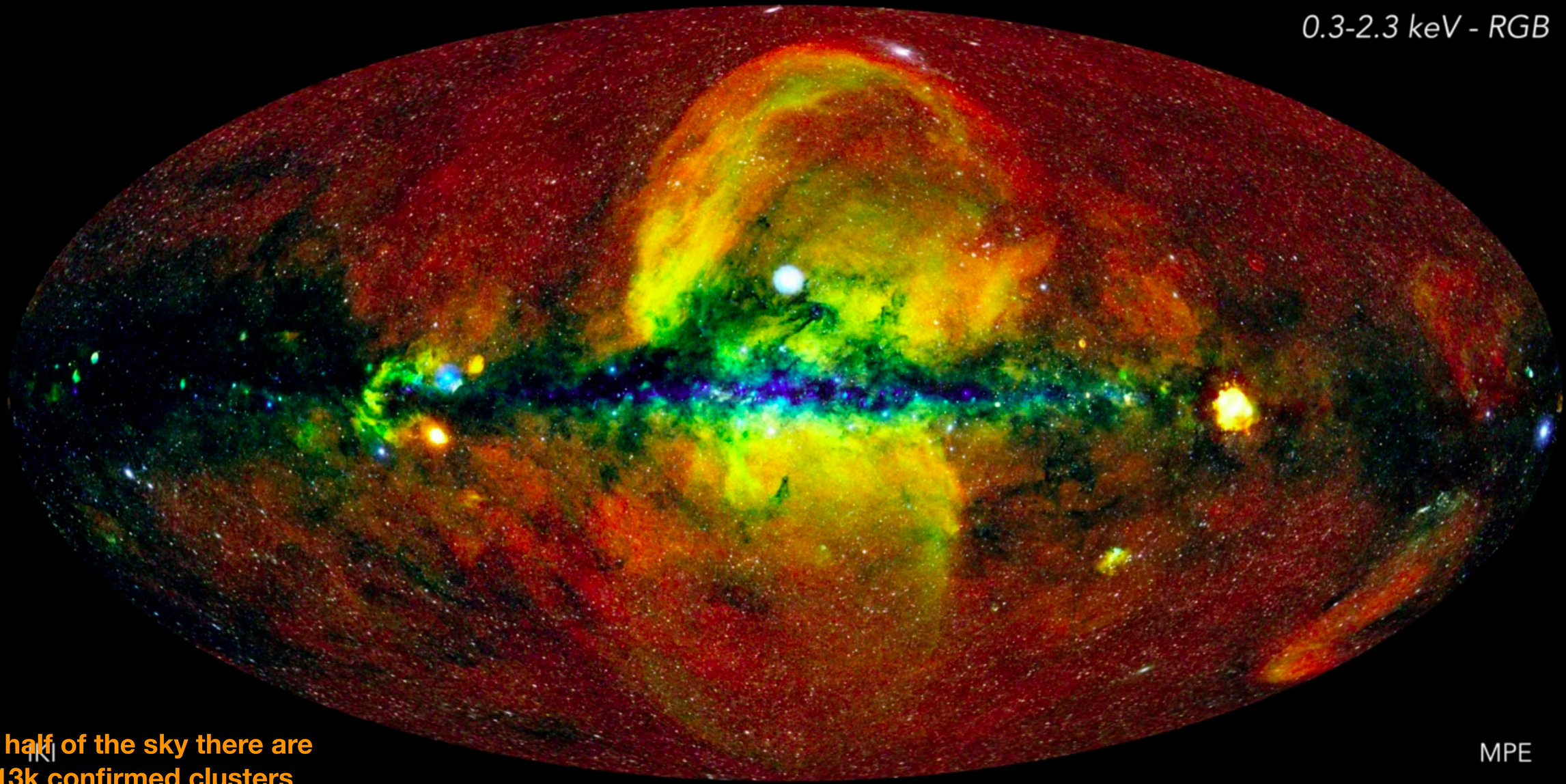
Mara Salvato (MPE)
On behalf of the eROSITA-DE team

Outline

- SRG/eROSITA Mission
  - Technical characteristics, Scientific justification
- eROSITA science results
  - recent highlights
  - AGN content (preliminary)
- Navigating eROSITA DR1



The sky as seen by eROSITA in the first pass



in half of the sky there are
13k confirmed clusters
~700k active SMBH (AGN)
140k coronal stars

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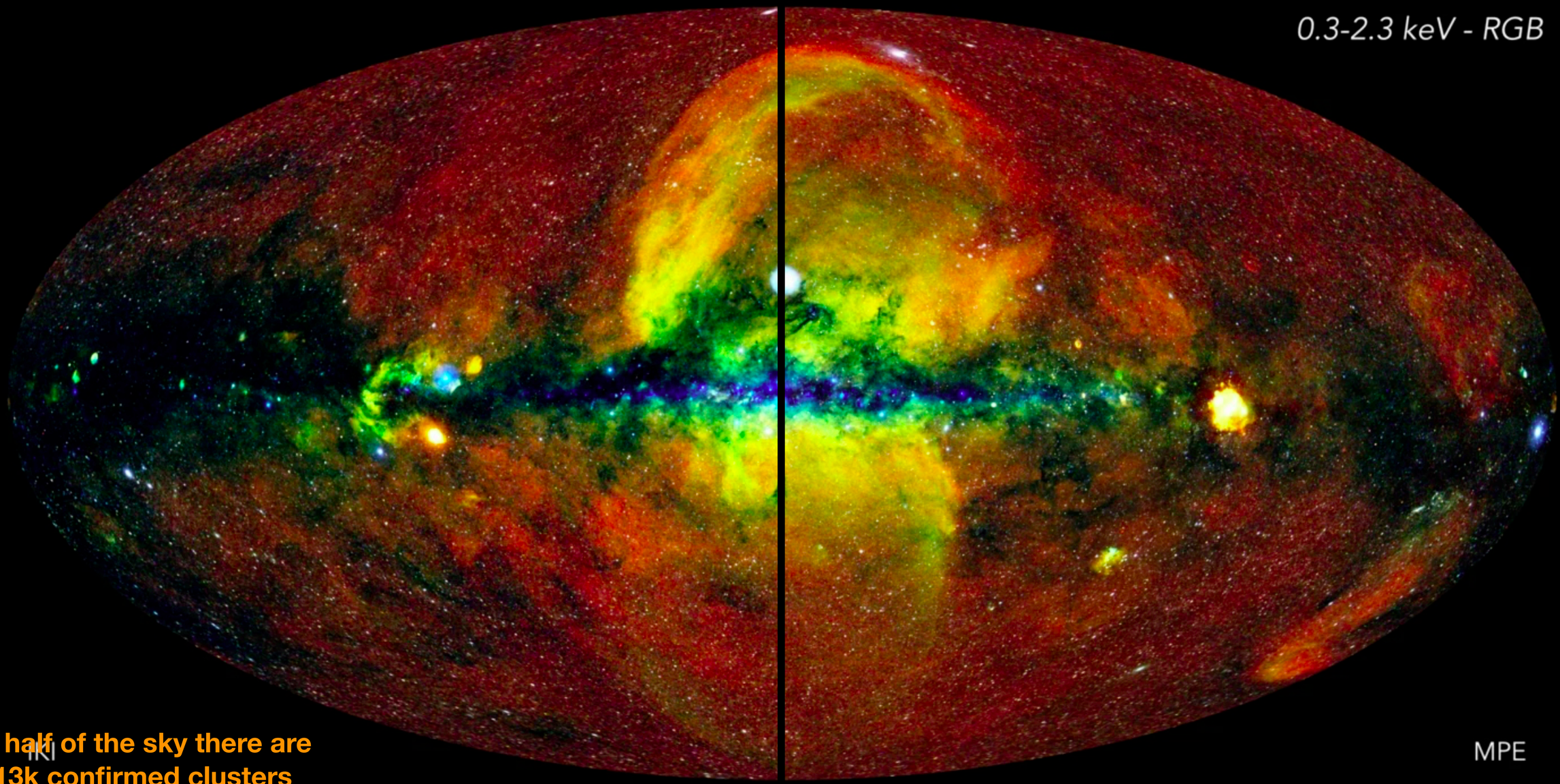

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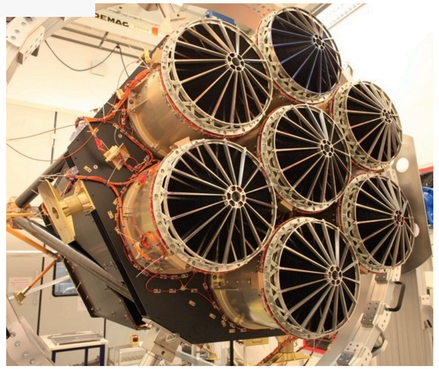
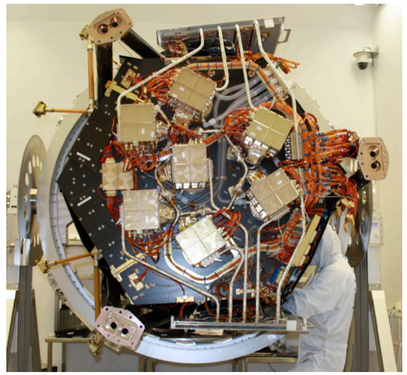
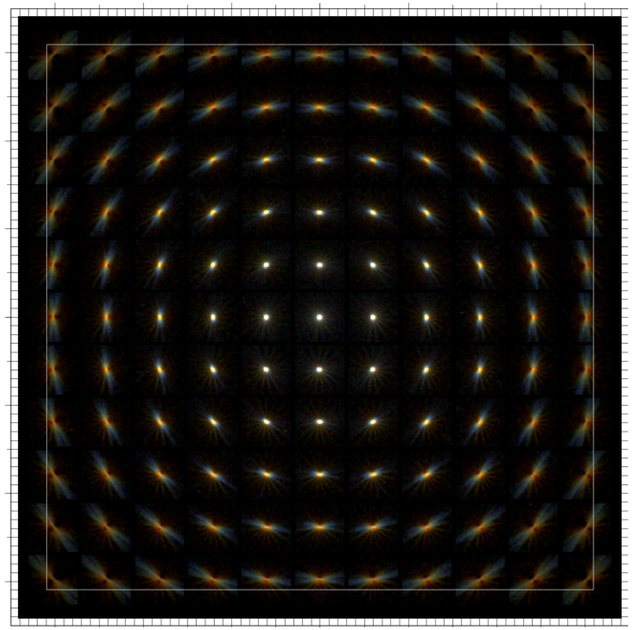
eROSITA technicalities in one slide





Number of telescopes	7 w/ 54 mirror shells each
HEW on axis/survey	18”/30”
Energy range	0.2-10 keV
Spectral Energy Resolution	138 eV @ 6 keV (~XMM) 80ev@ 1.5 keV (R~20)
Focal Lenght	1.6 m
FoV	0.81 sqdeg
Effective Area	1700 cm^2

Predehl et al 2021,
Merloni et al 2012



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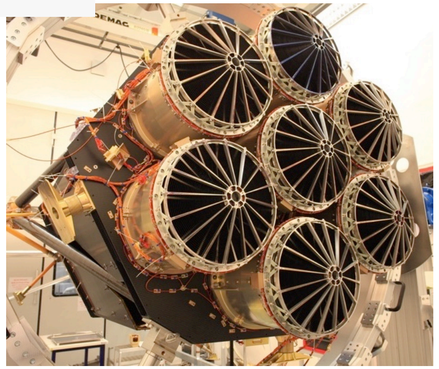

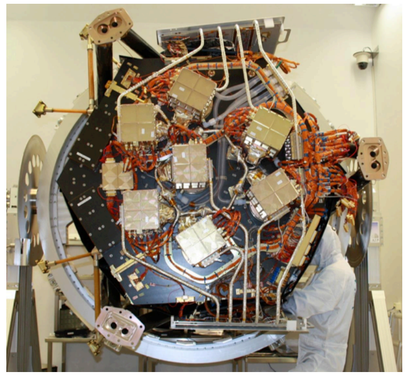

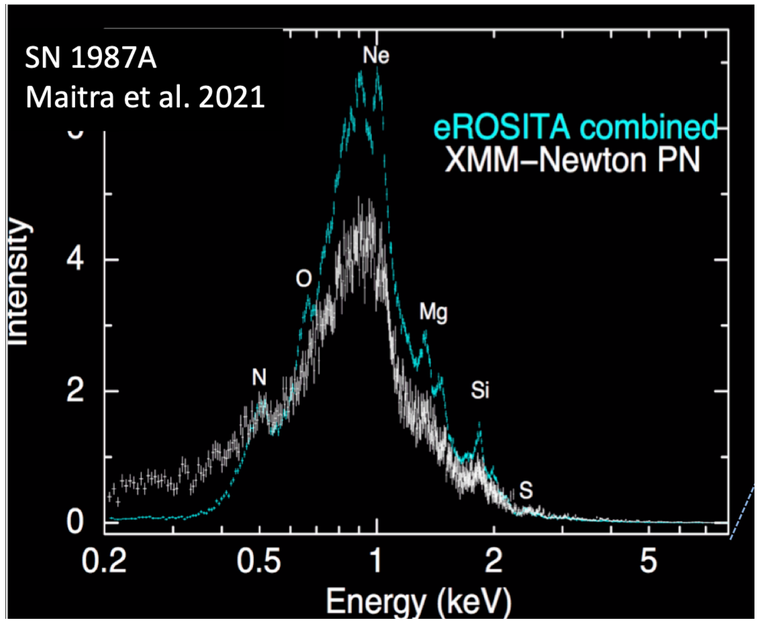

best CCD camera available in space
high spectral resolution (~100 eV)

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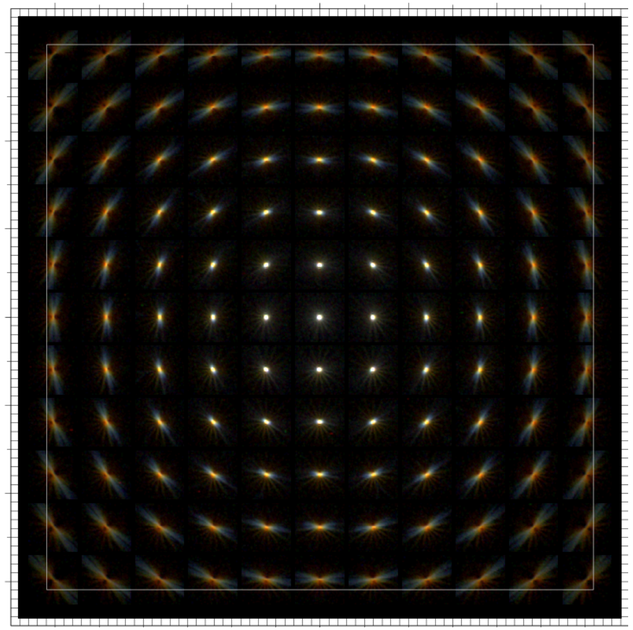

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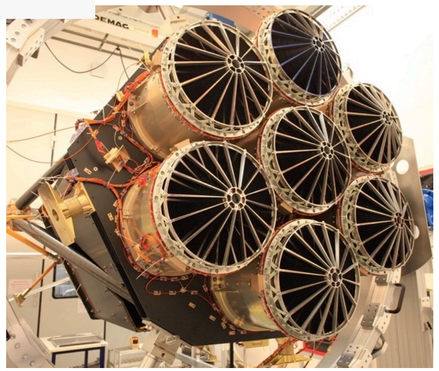

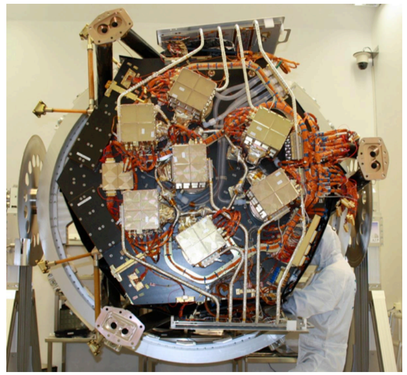

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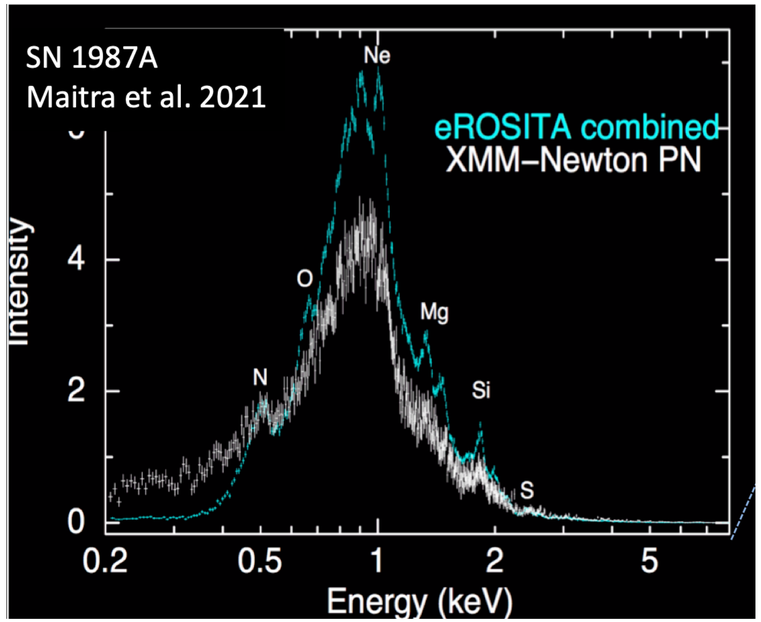

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Predehl et al 2021,
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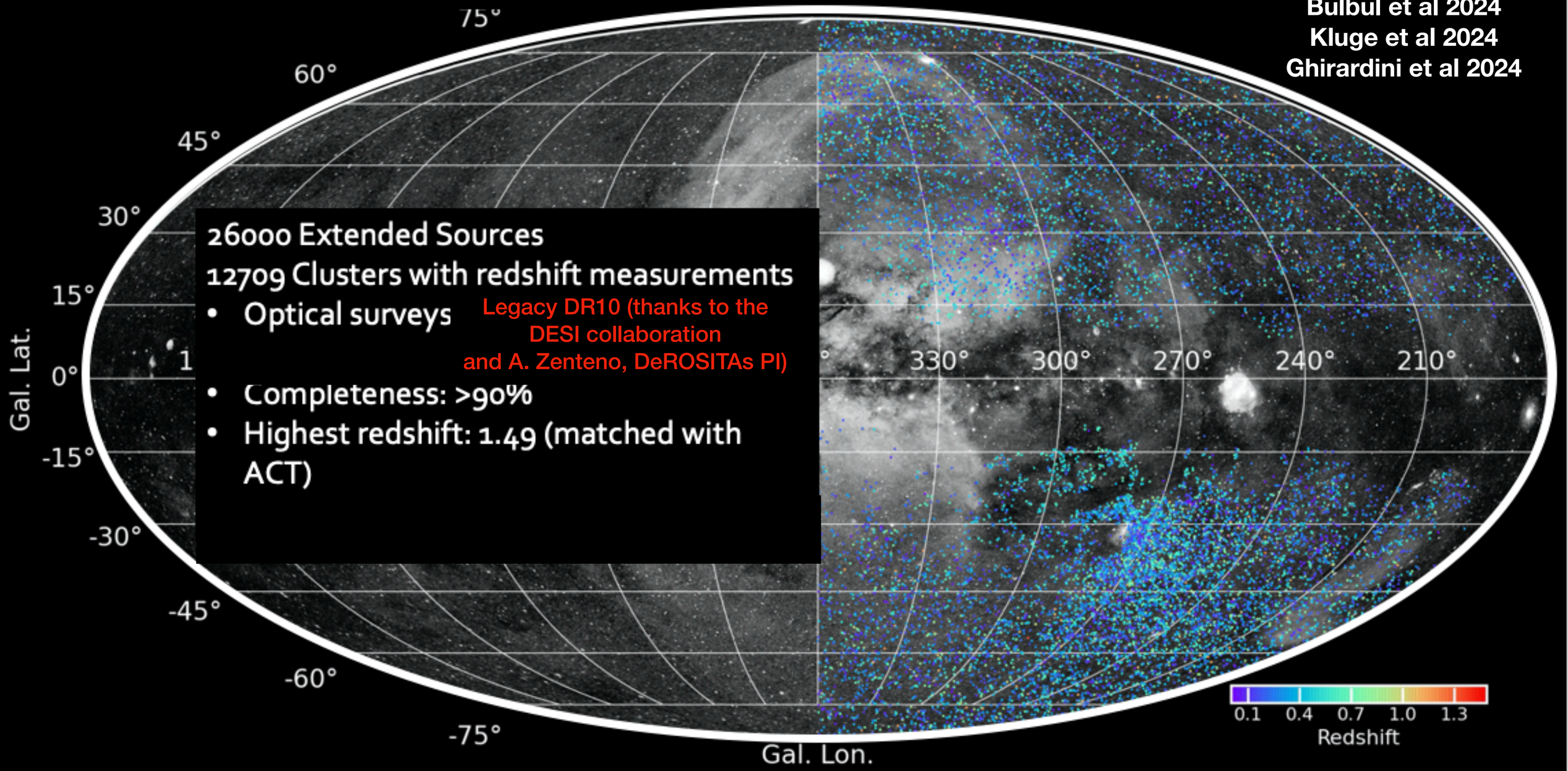
Stable &homogeneous background

Clusters and Groups in the First eROSITA All-Sky Survey

Bulbul et al 2024
Kluge et al 2024
Ghirardini et al 2024

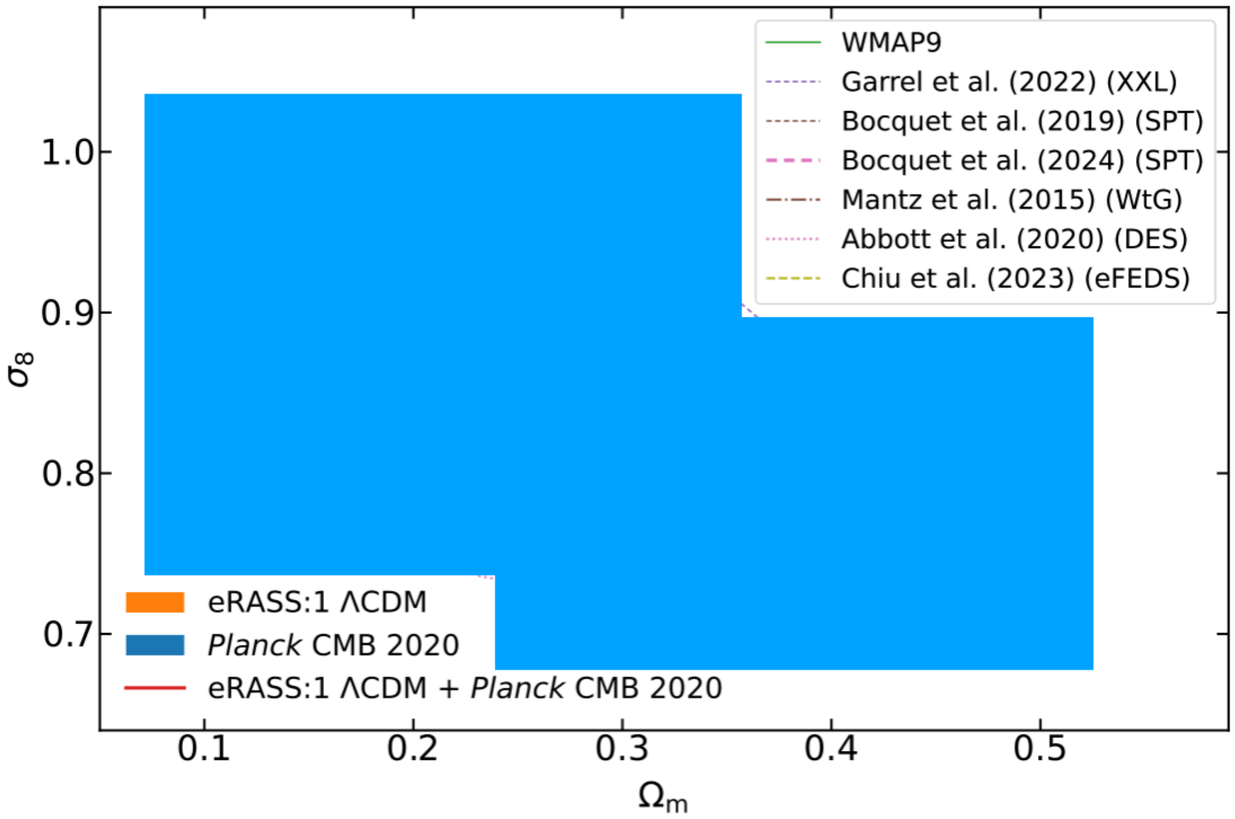


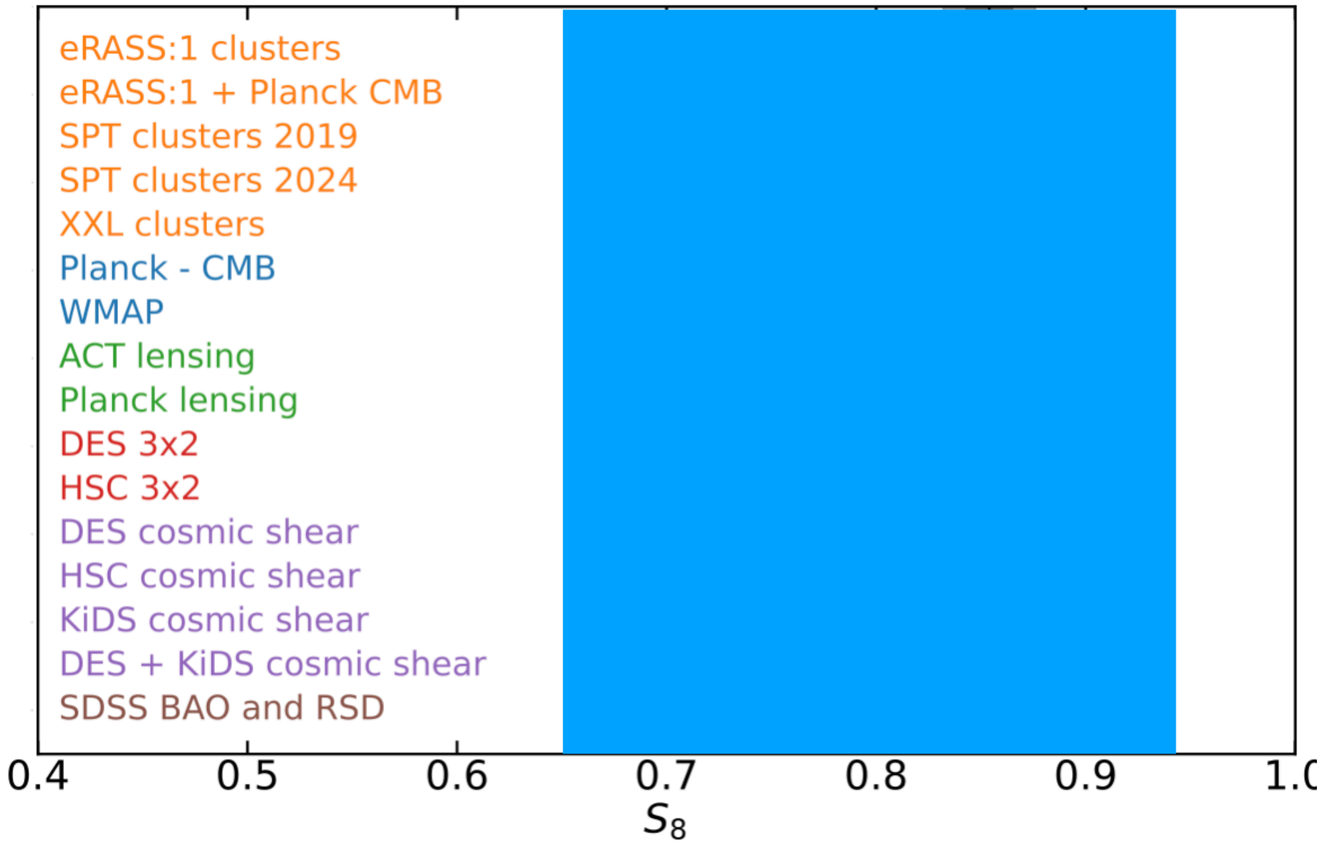
26000 Extended Sources

12709 Clusters with redshift measurements

- Optical surveys — Legacy DR10 (thanks to the DESI collaboration and A. Zenteno, DeROSITAs PI)
- Completeness: >90%
- Highest redshift: 1.49 (matched with ACT)

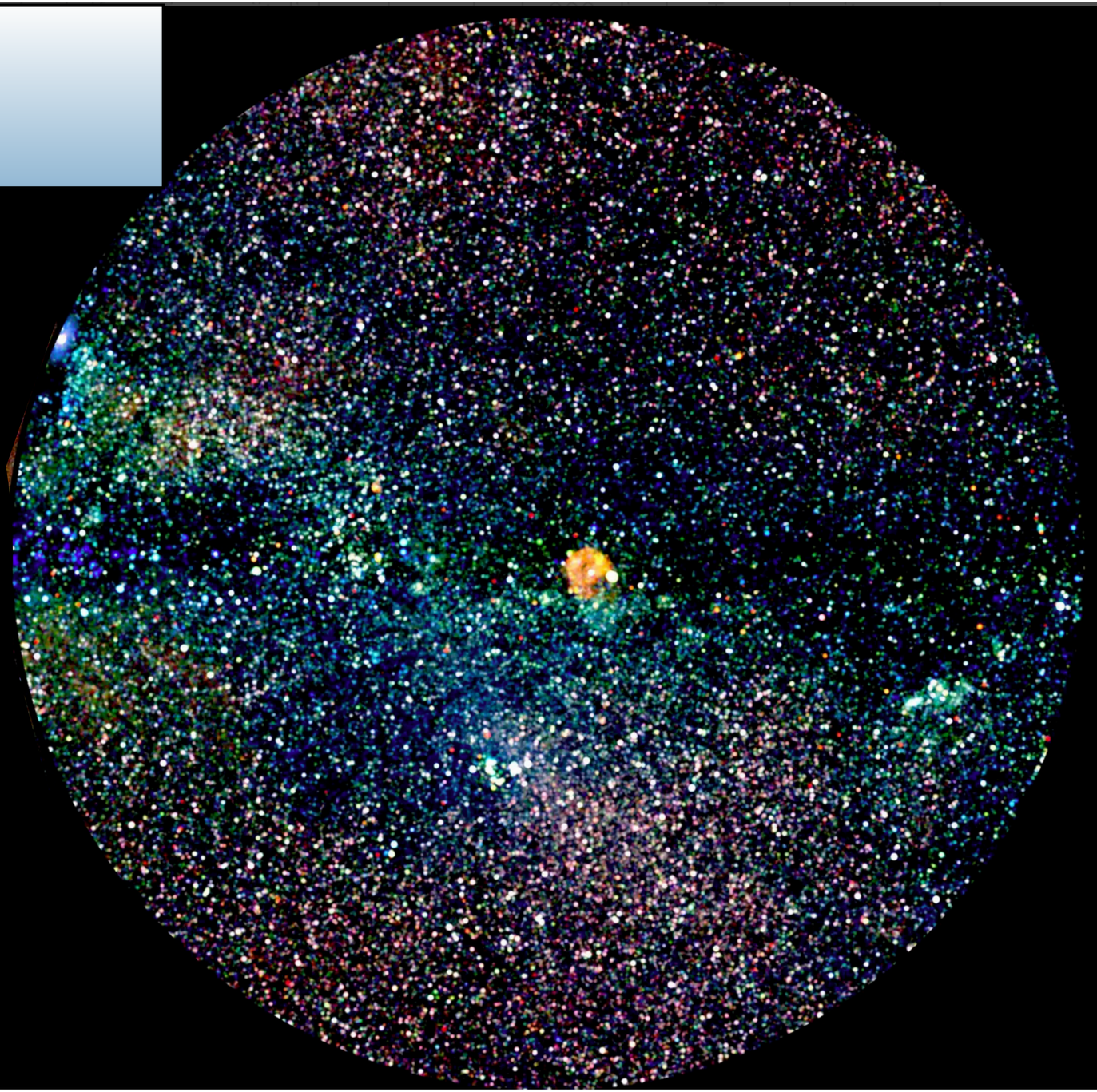
COSMOLOGY with eROSITA: PR on 14/2/2024!!





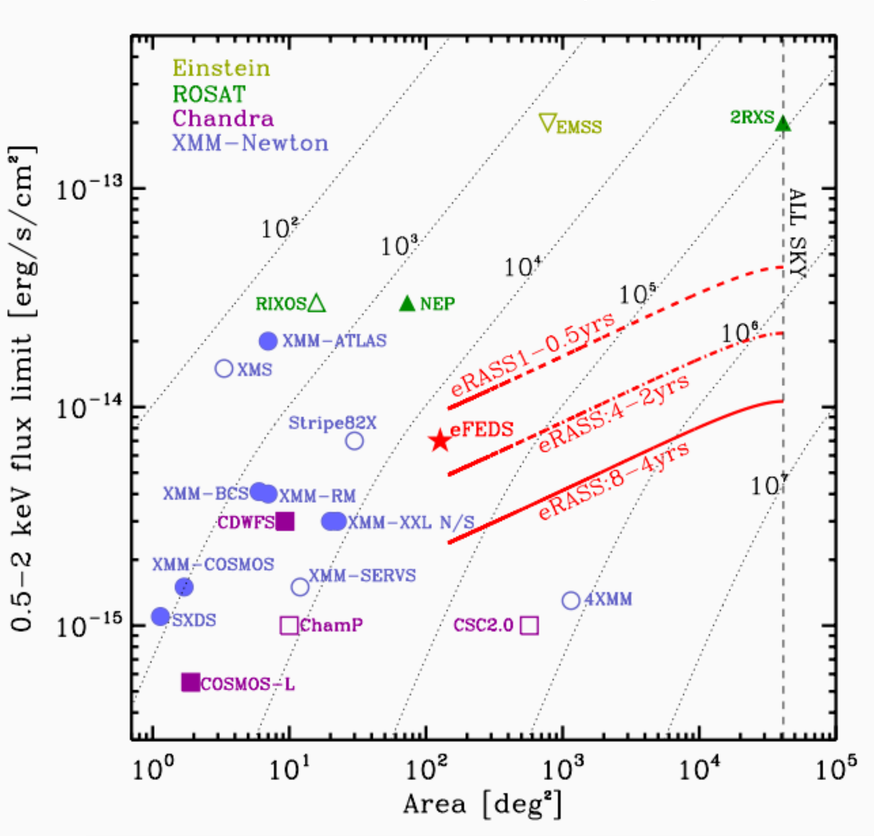
Ghirardini et al 2024

eROSITA
point-sources content



eROSITA AGN surveys in contest

Point-like sources (AGN)



All sky: ~10^{-14} (0.5-2 keV) [erg/cm²/s]

Poles: 3x10^{-15} (0.5-2 keV) [erg/cm²/s]

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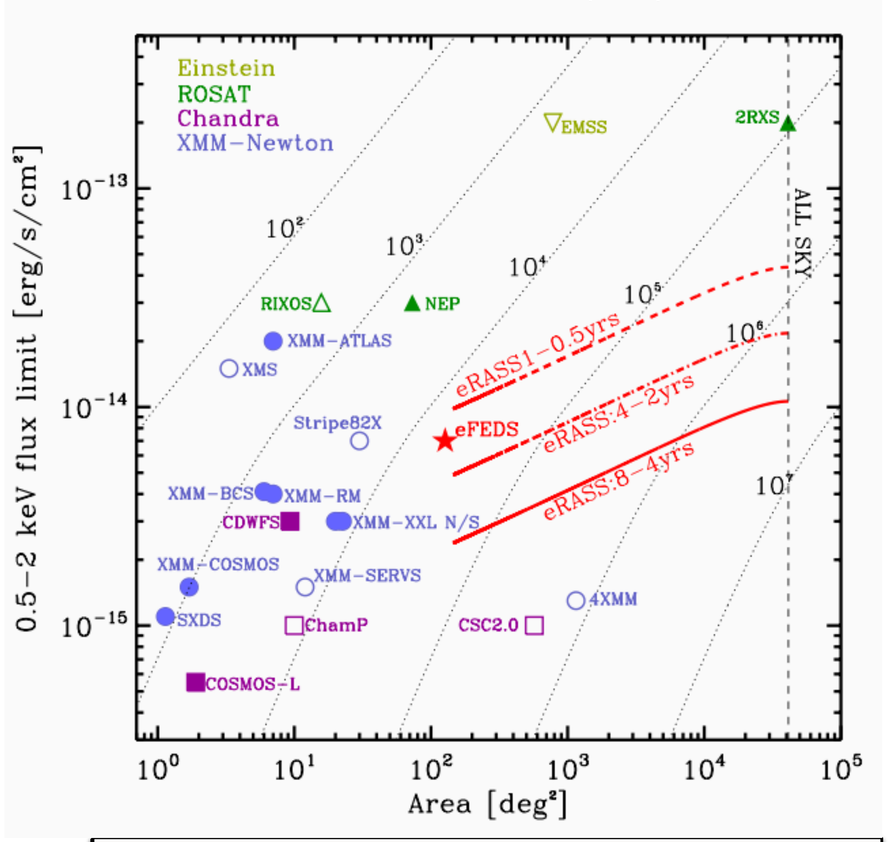

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2×10^{-13} (2-10 keV) [erg/cm²/s]

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4×10^{-14} (2-10 keV) [erg/cm²/s]

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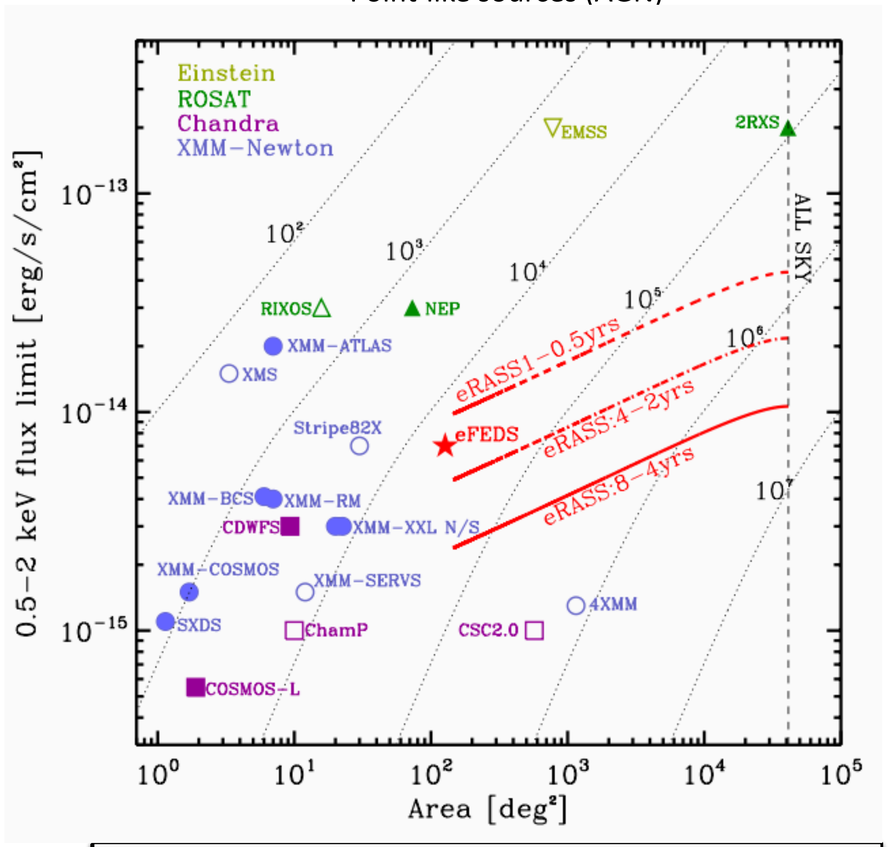

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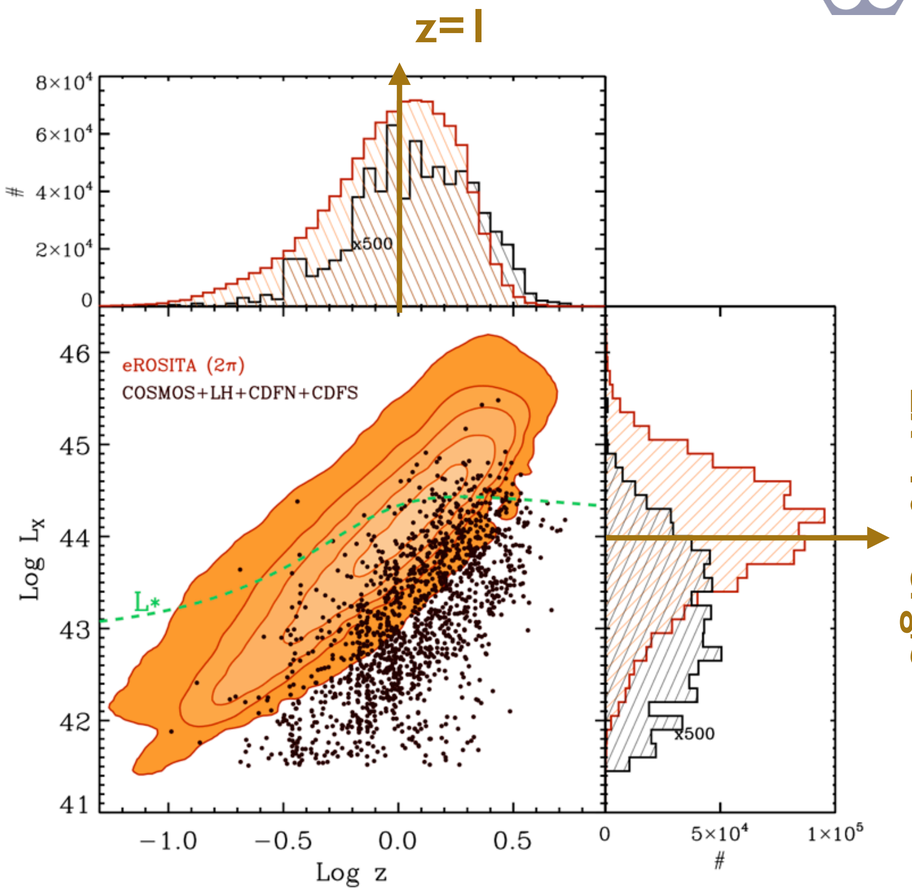

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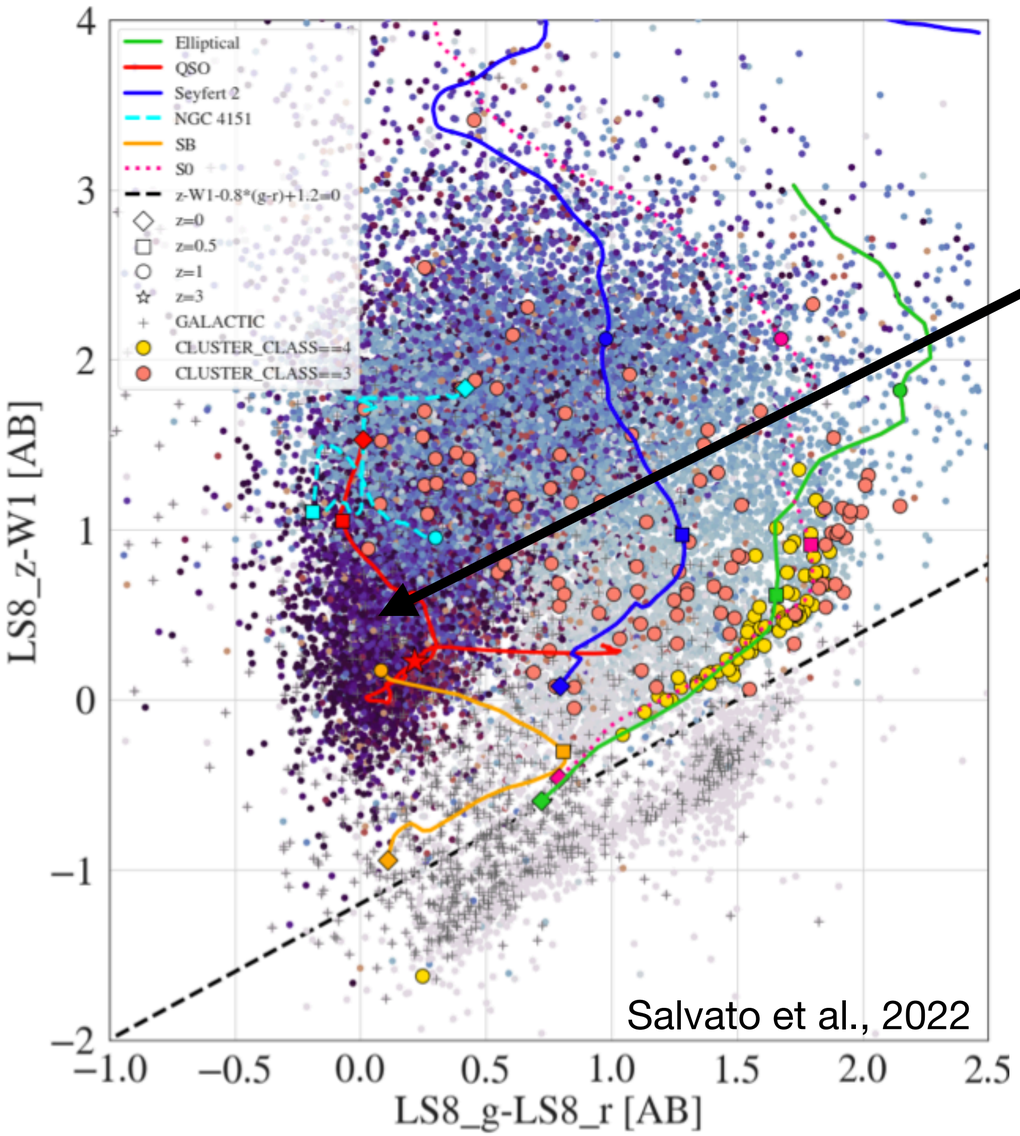
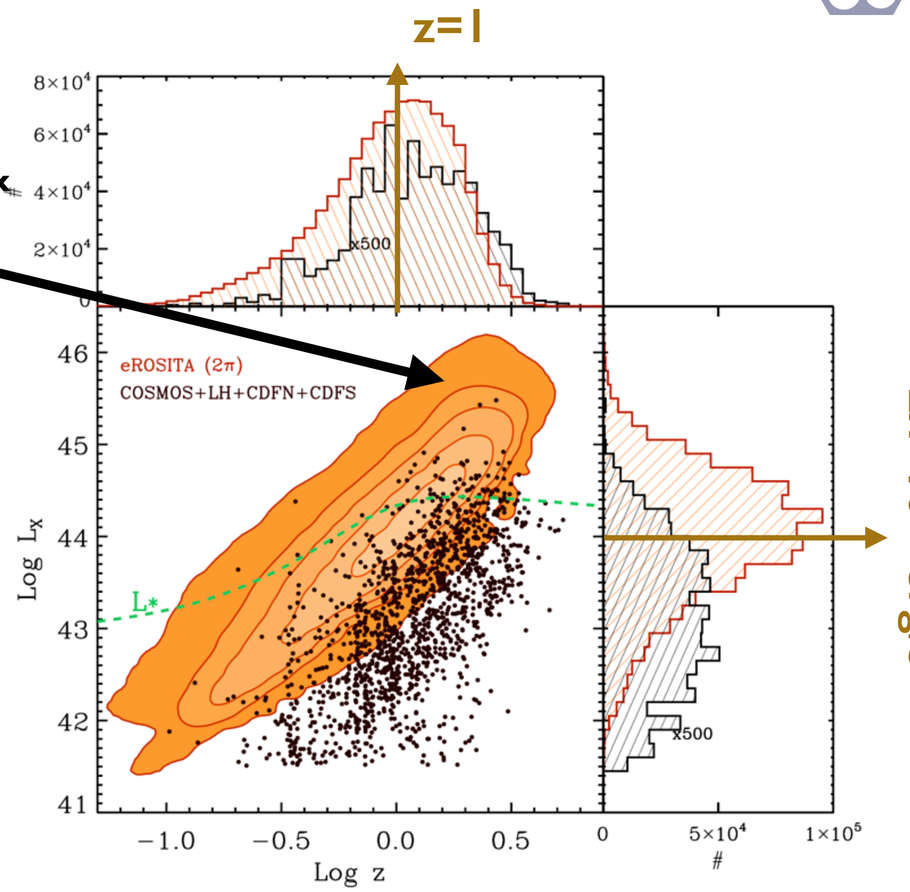


The most luminous AGN, tracers of large-scale structure: the "quasar" mode of AGN feedback



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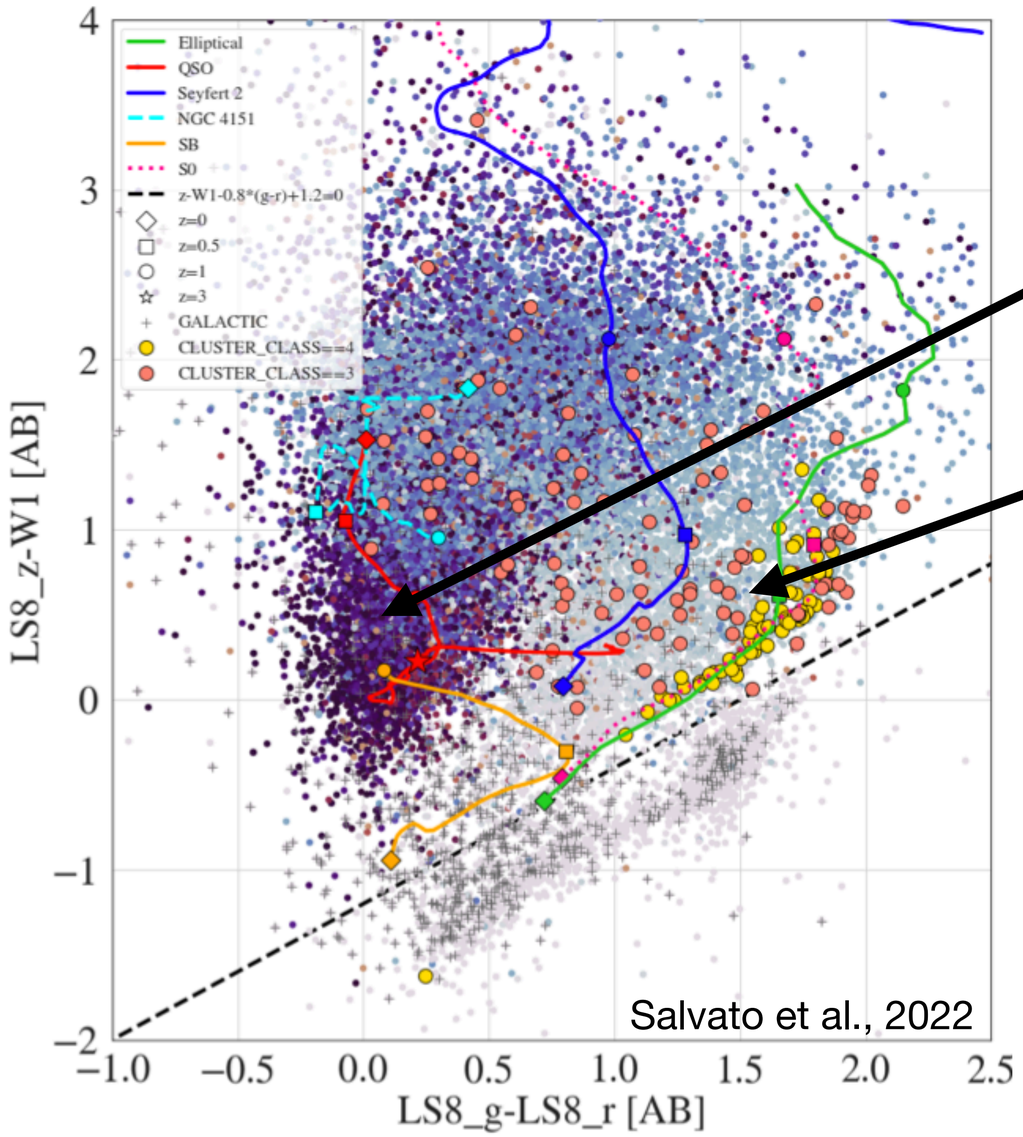

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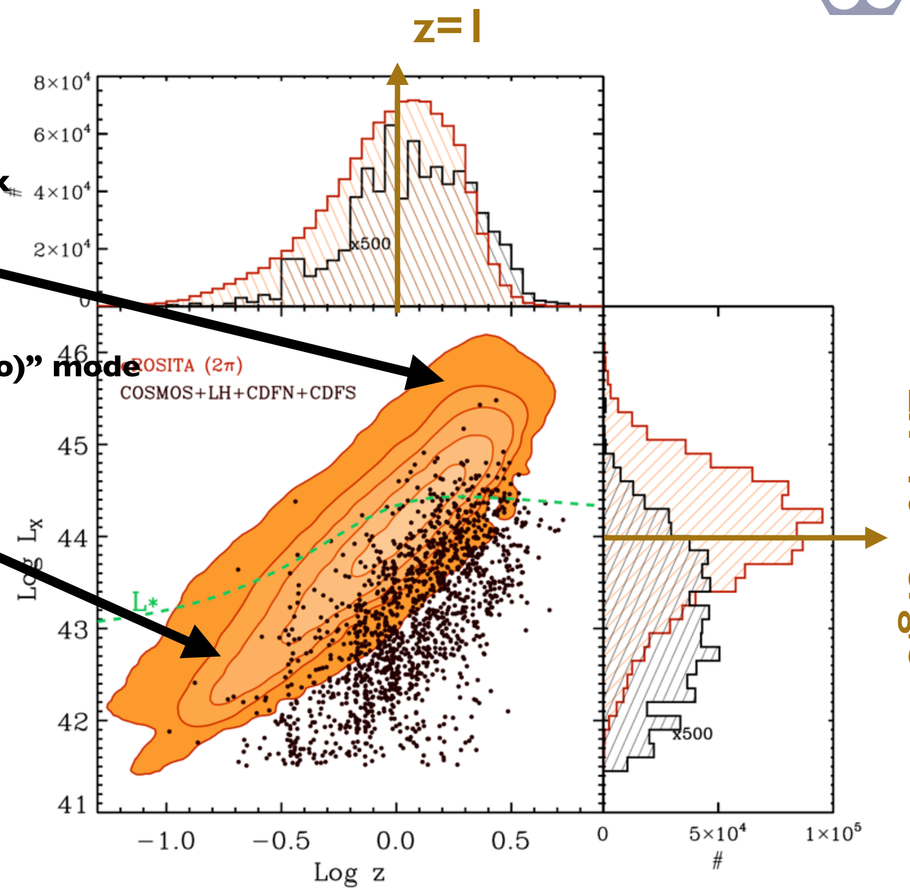
Nearby LLAGN: the "kinetic (radio)" mode of AGN feedback



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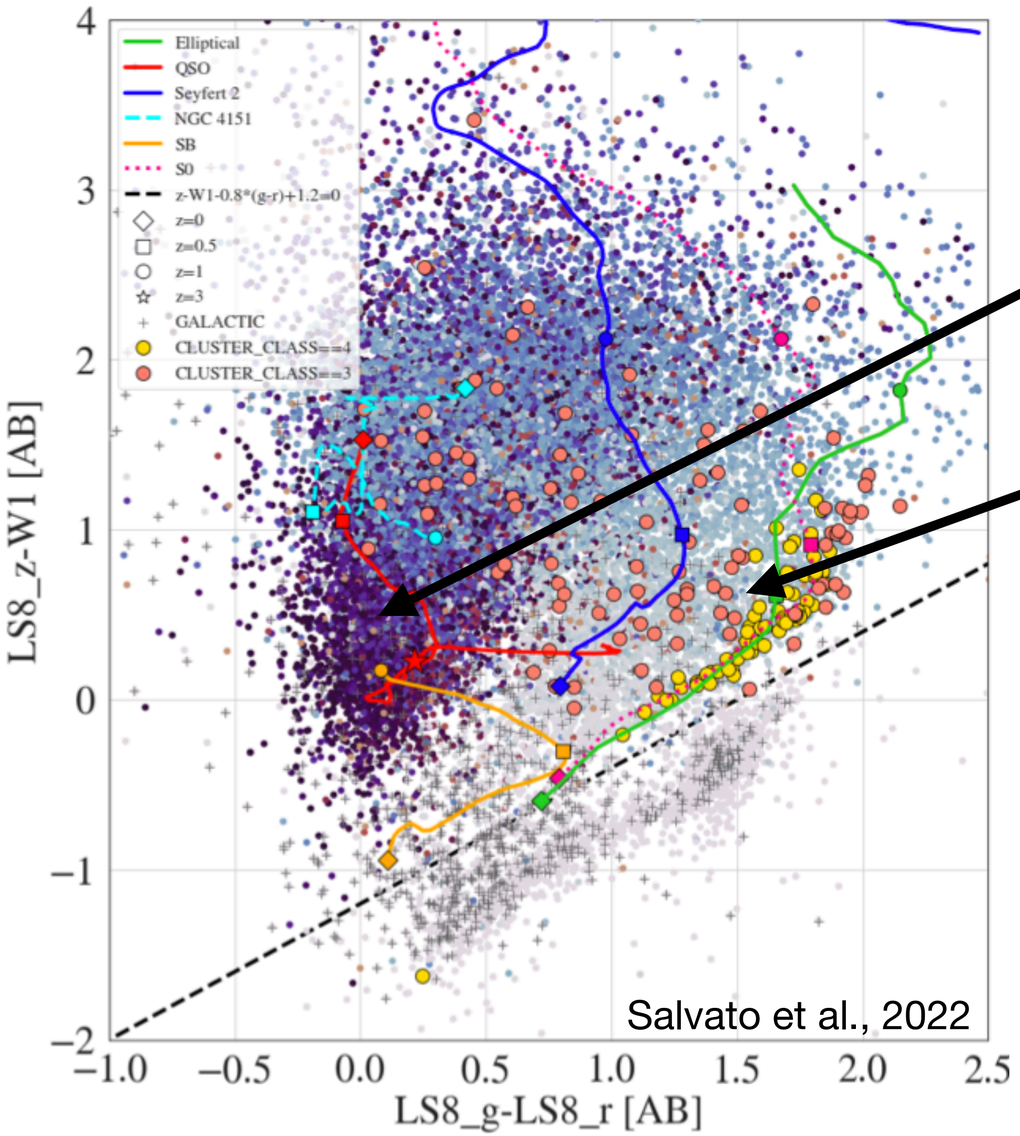

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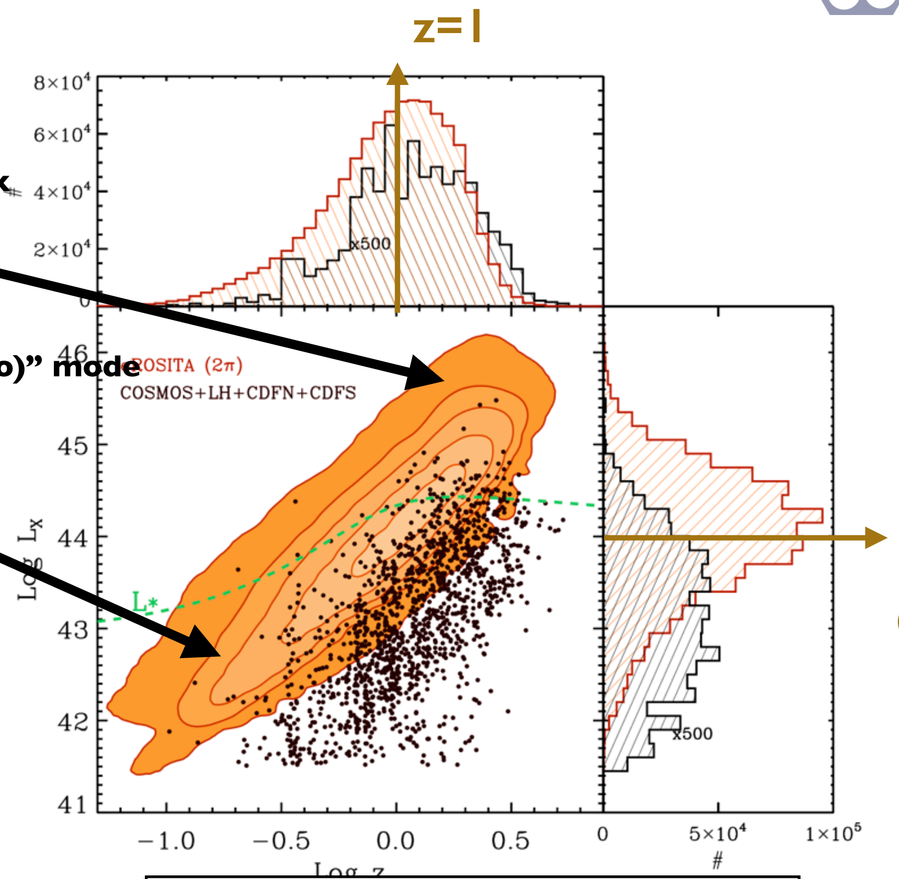
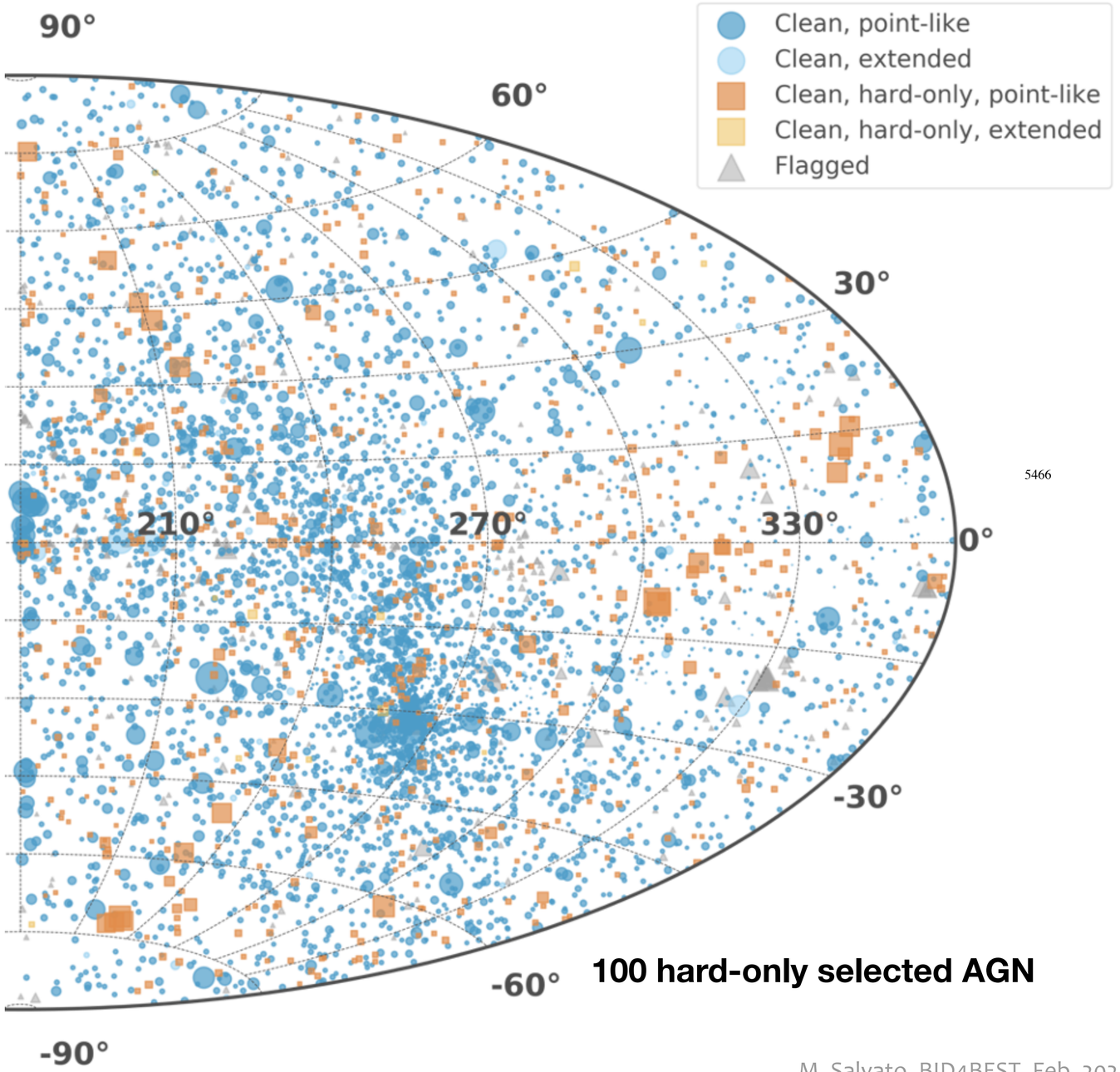


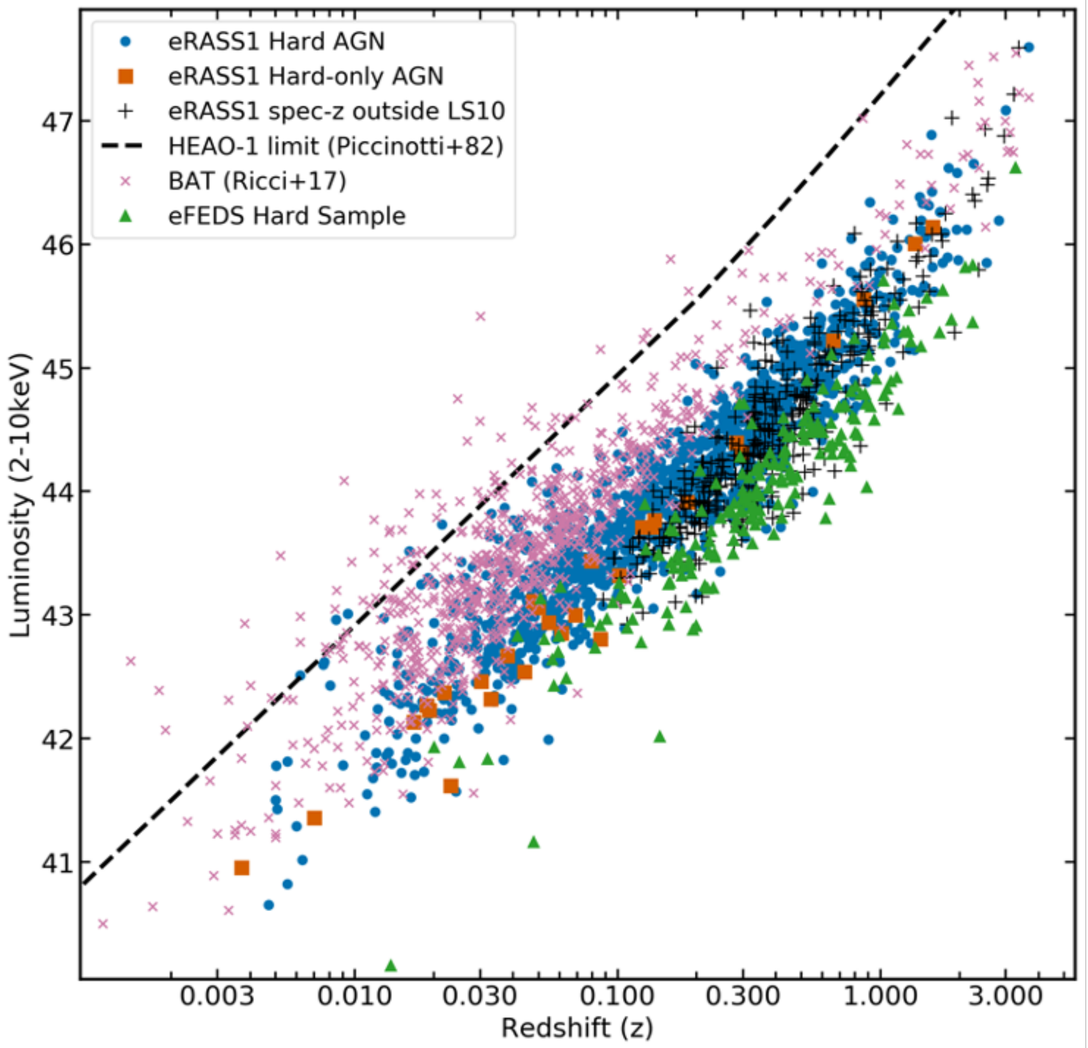
eROSITA will cover uniformly the redshift range 0<z<3
Ideal! Large samples available to study AGN at different L, z, N_H, M_*, SFR, Radio emission

5466 Hard X-ray selected AGN in eRASS1 (Waddell et al.)



5466

100 hard-only selected AGN



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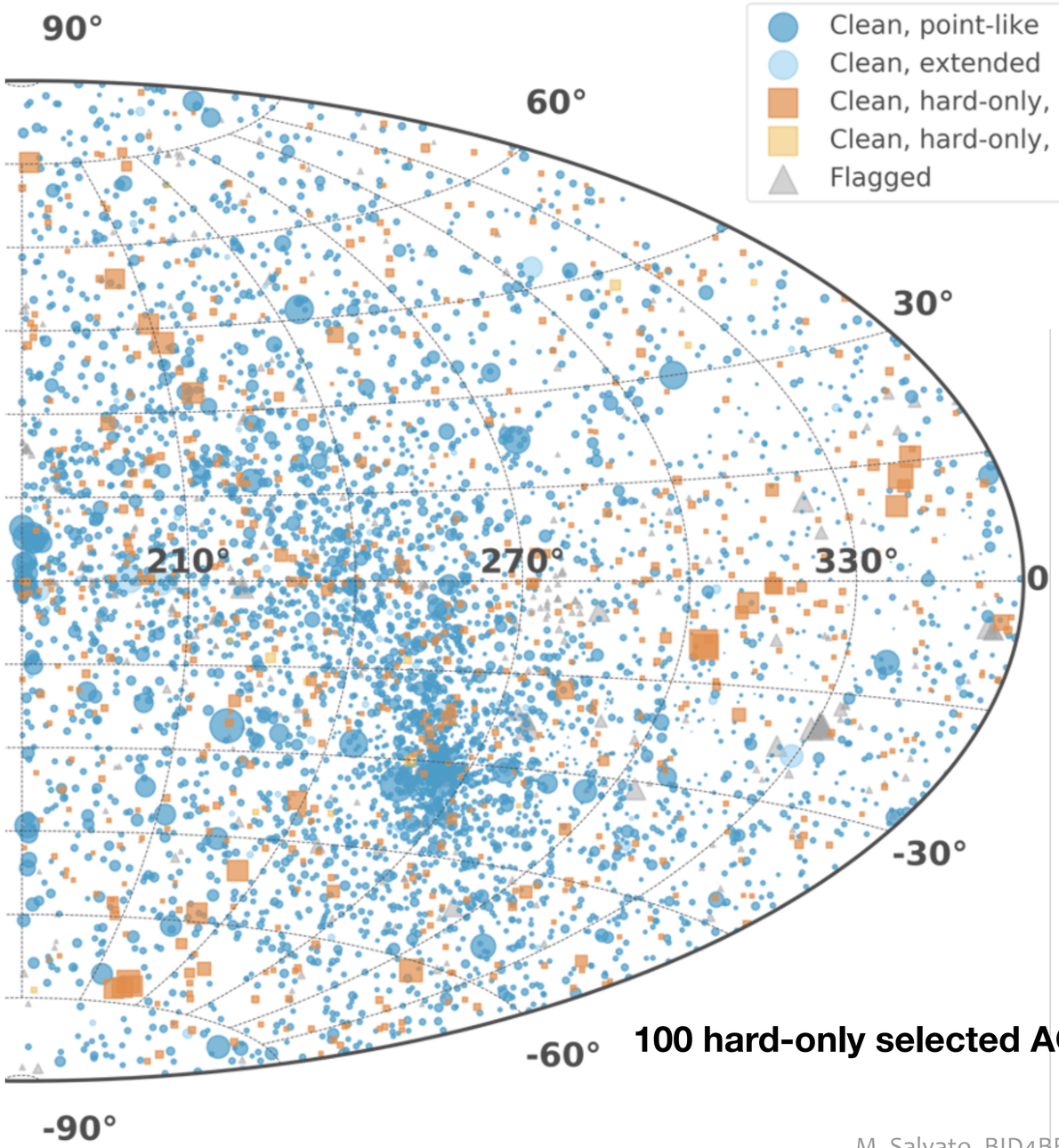

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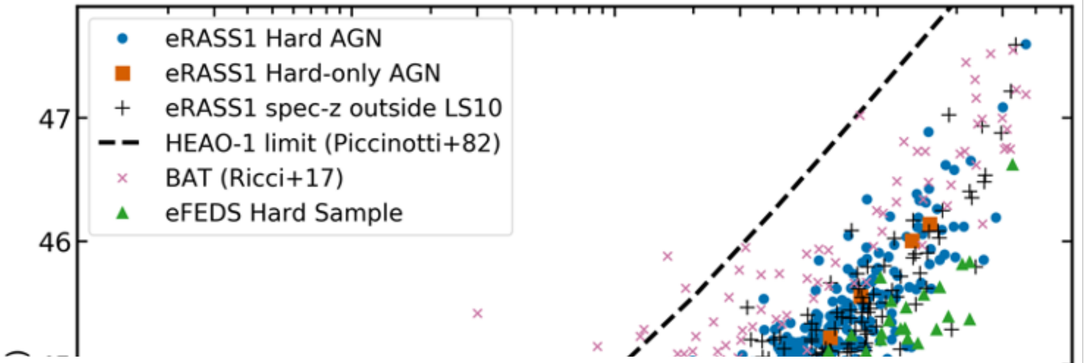
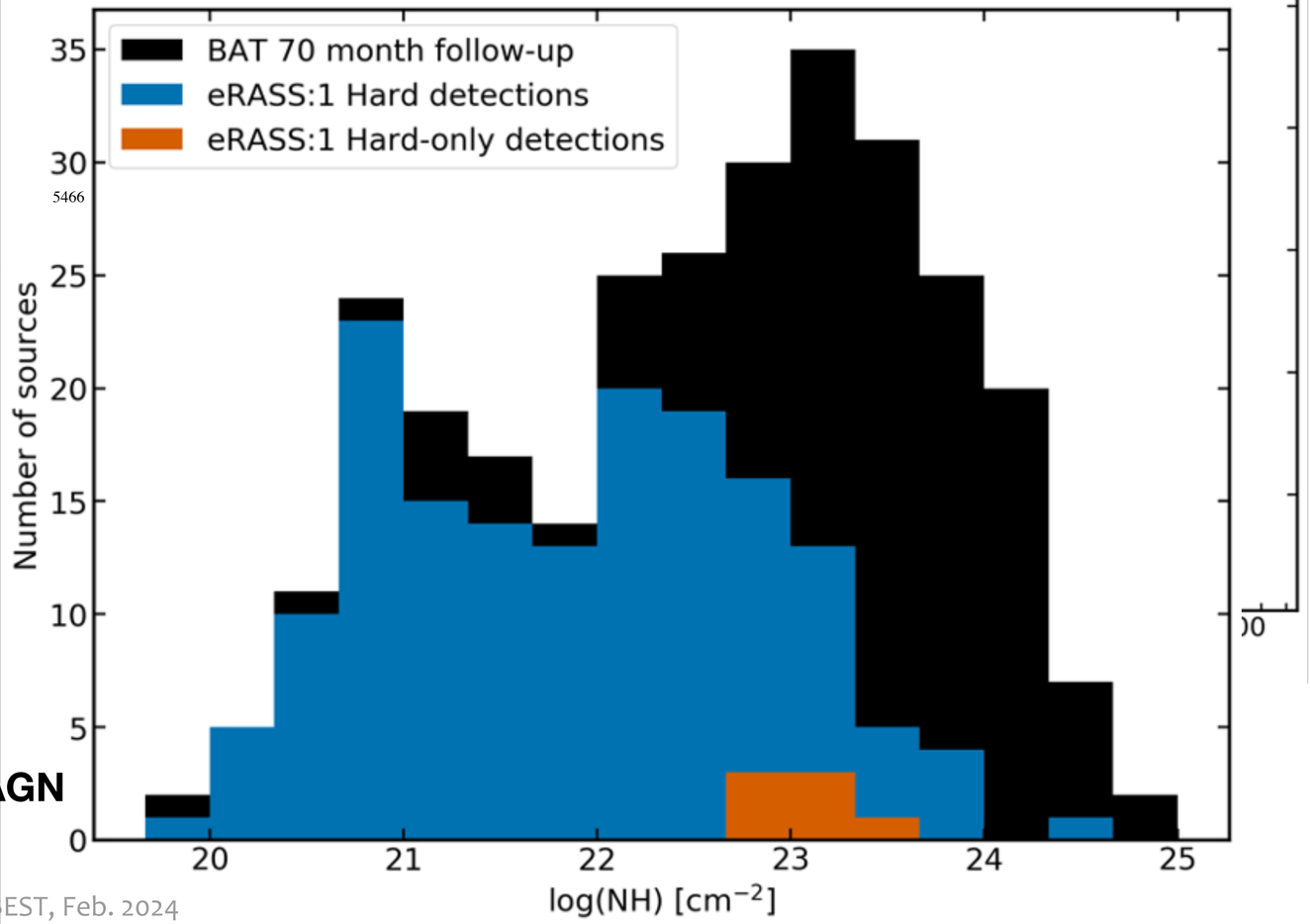
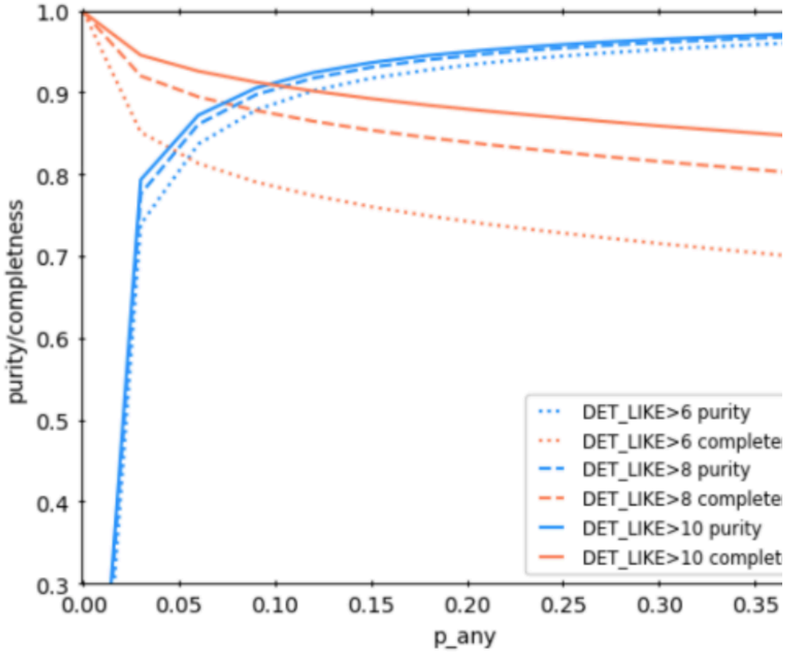


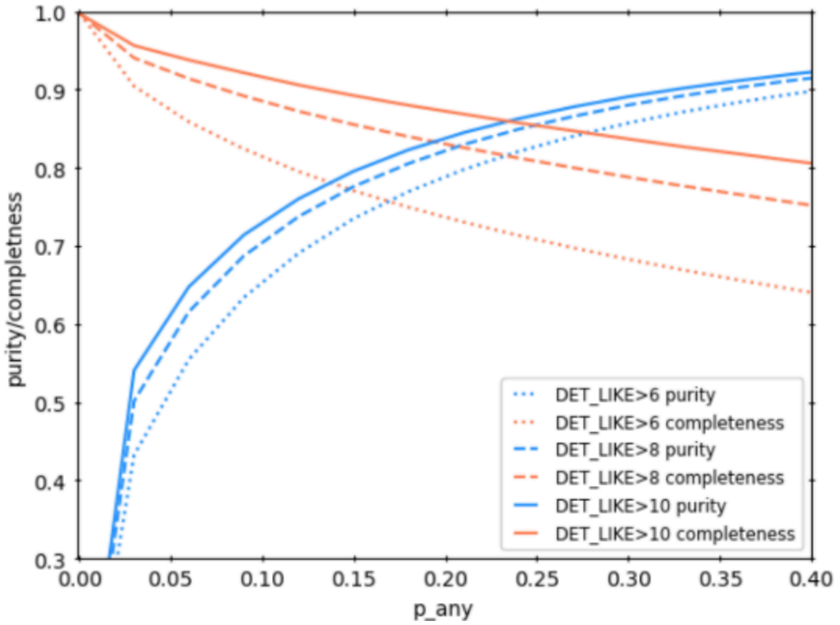


eRASS1 counterparts (NWAY,Salvato+2018)

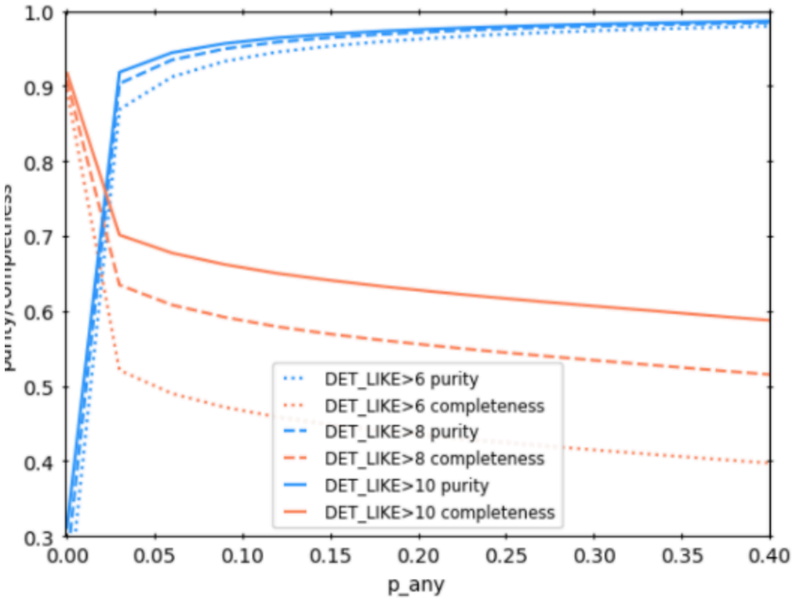
LS10



CW2020



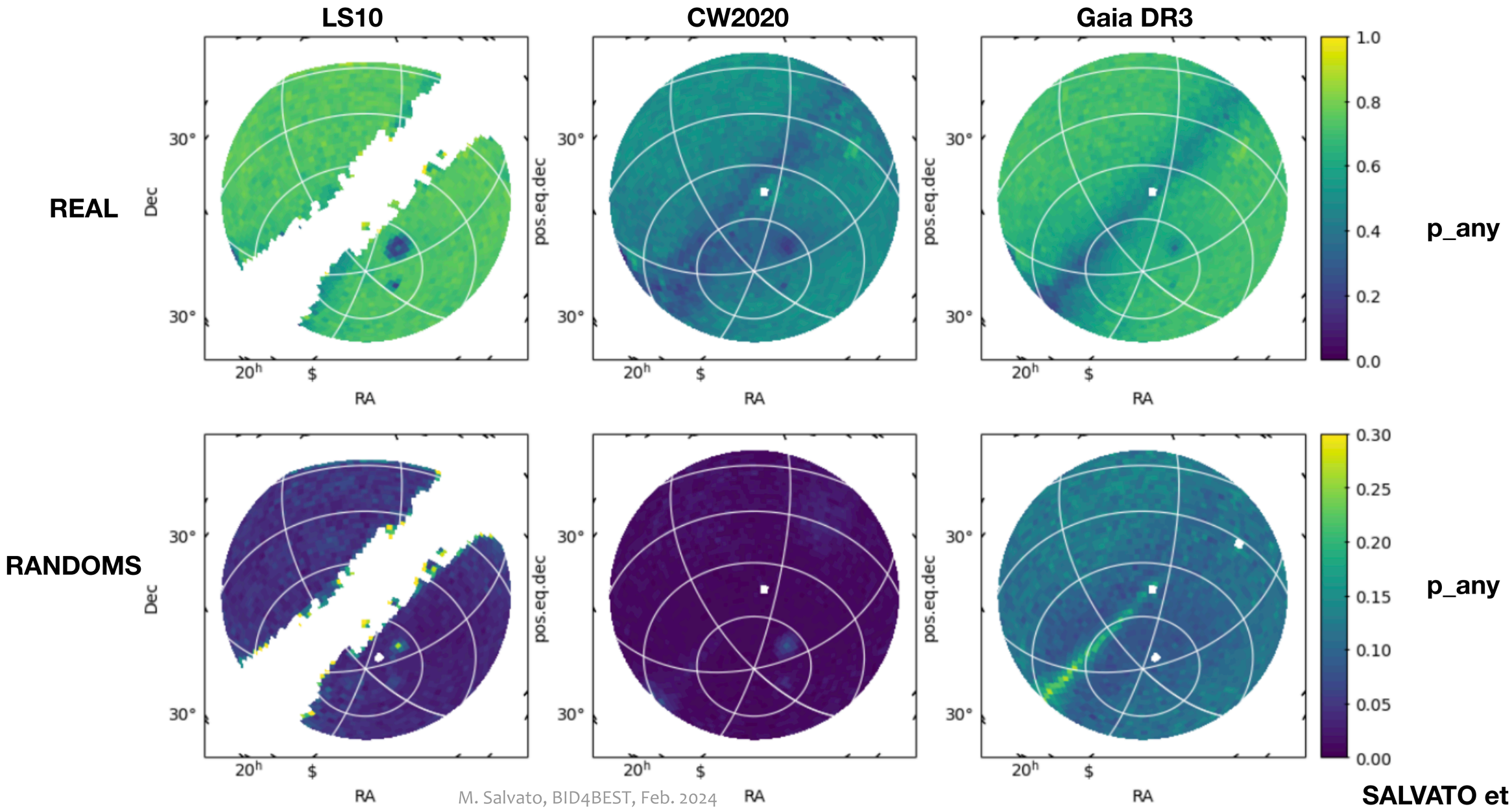
Gaia DR3



averaged completeness and purity

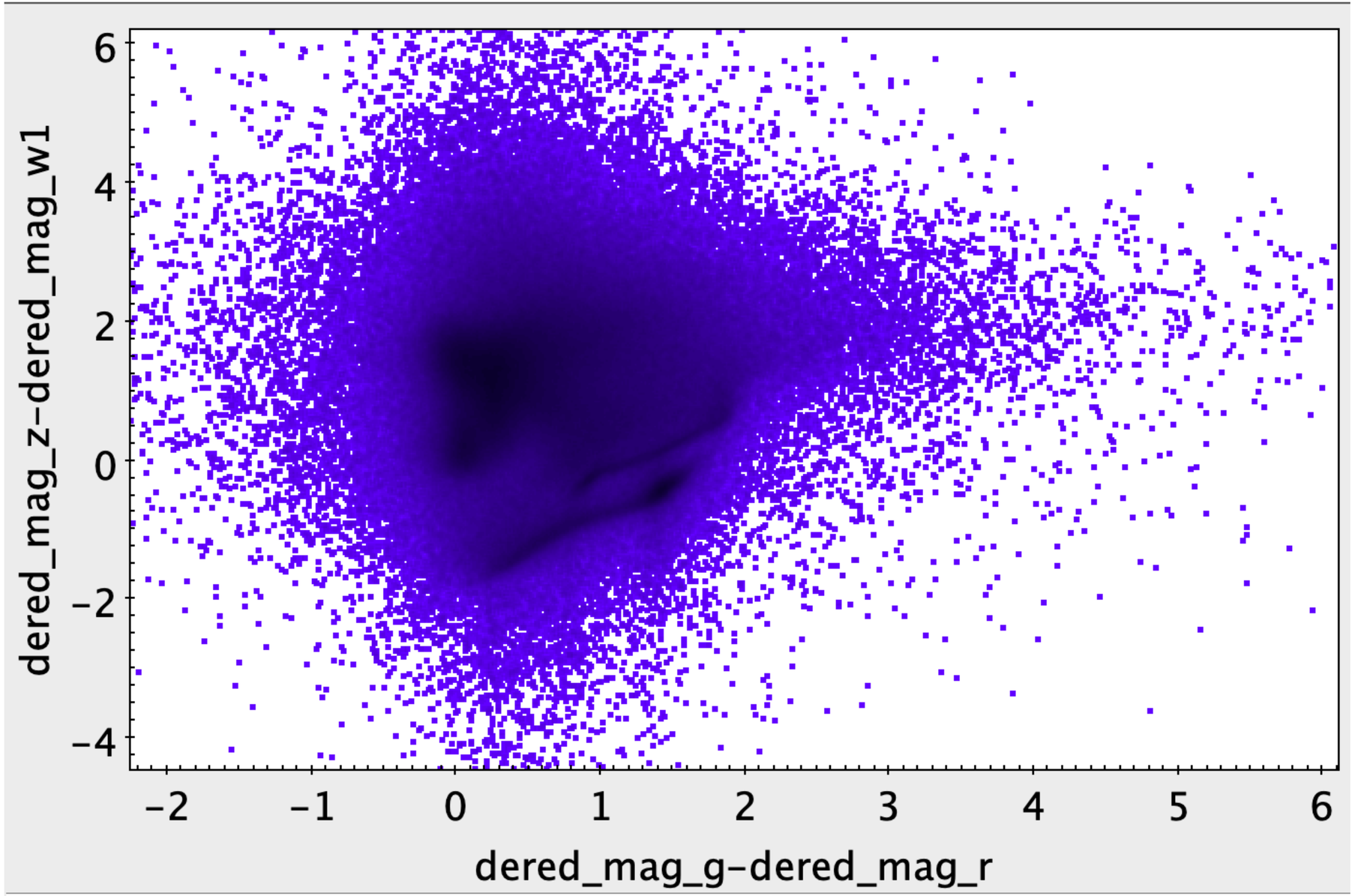
SALVATO et al 2024

completeness and purity are coordinates depending

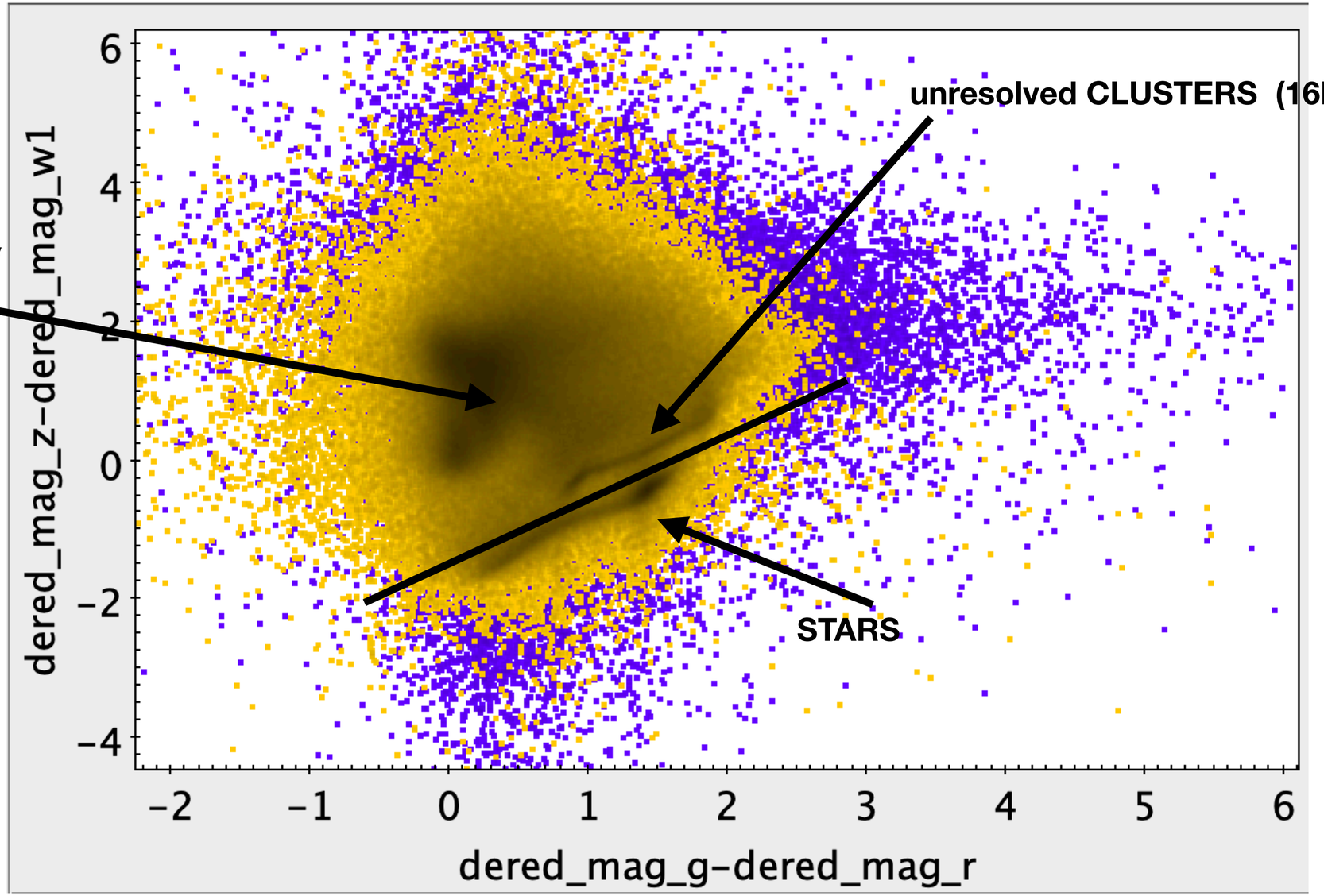


SALVATO et al 2024

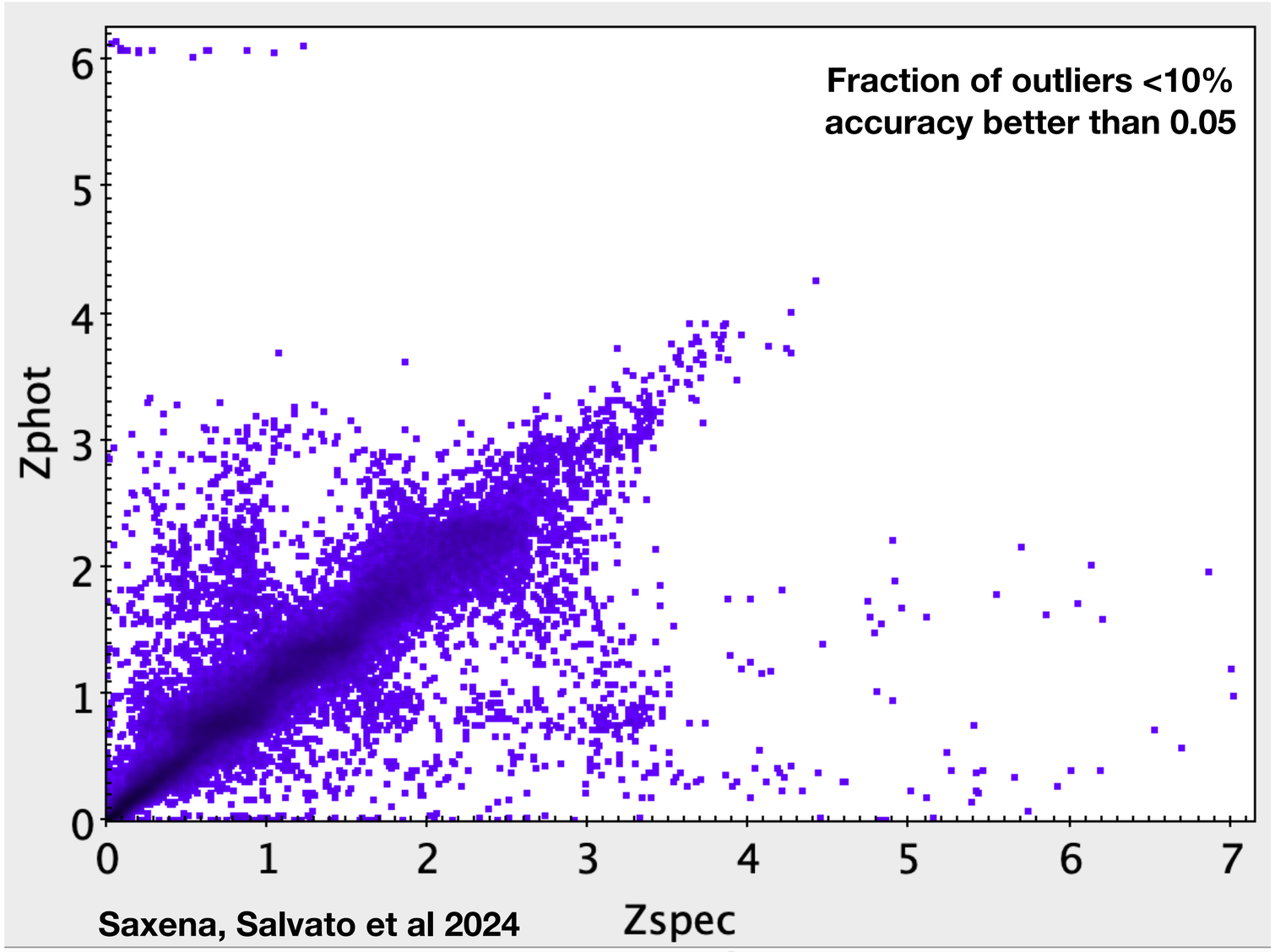
750 000 sources in the LS10 area



609 000 sources with good photometry in all bands in the LS10 area



secure counterparts with superb photoz!



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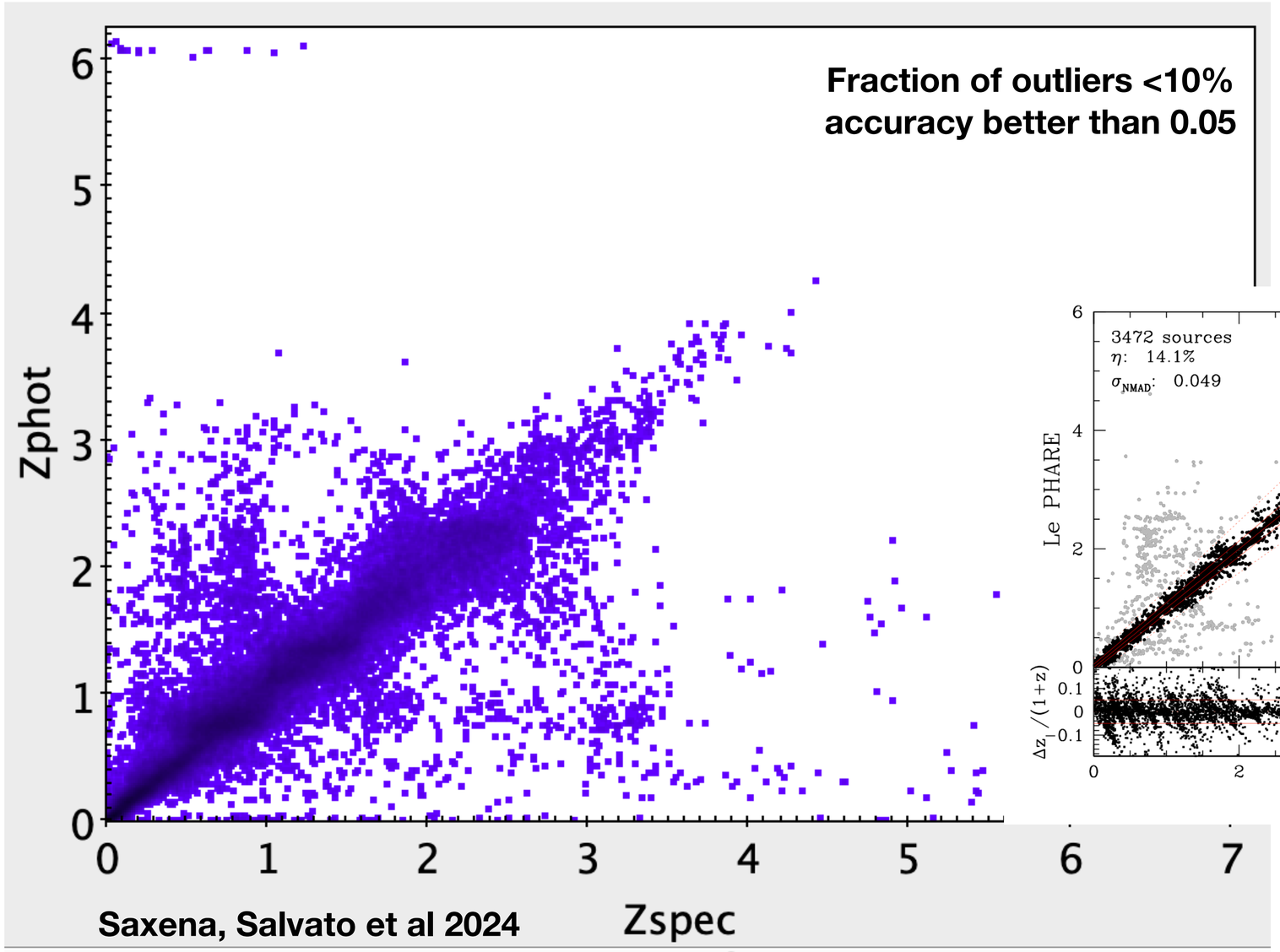

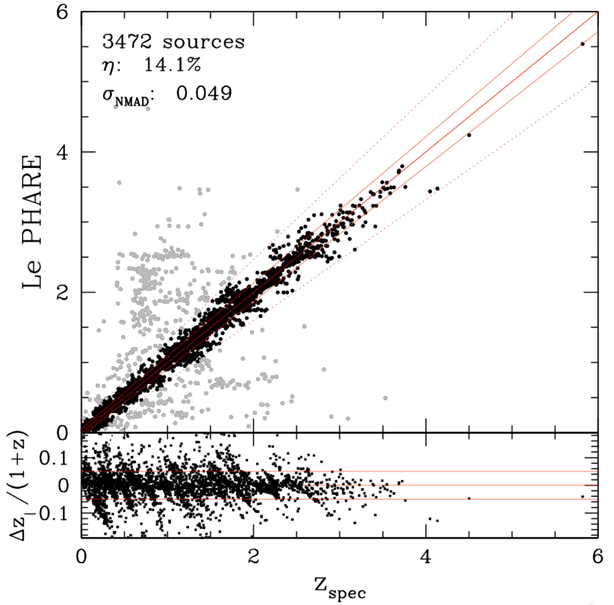

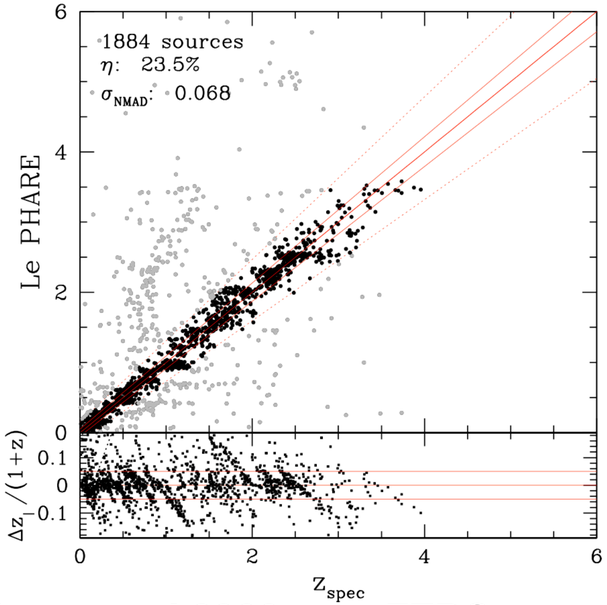

Salvato et al 2022, on eFEDS

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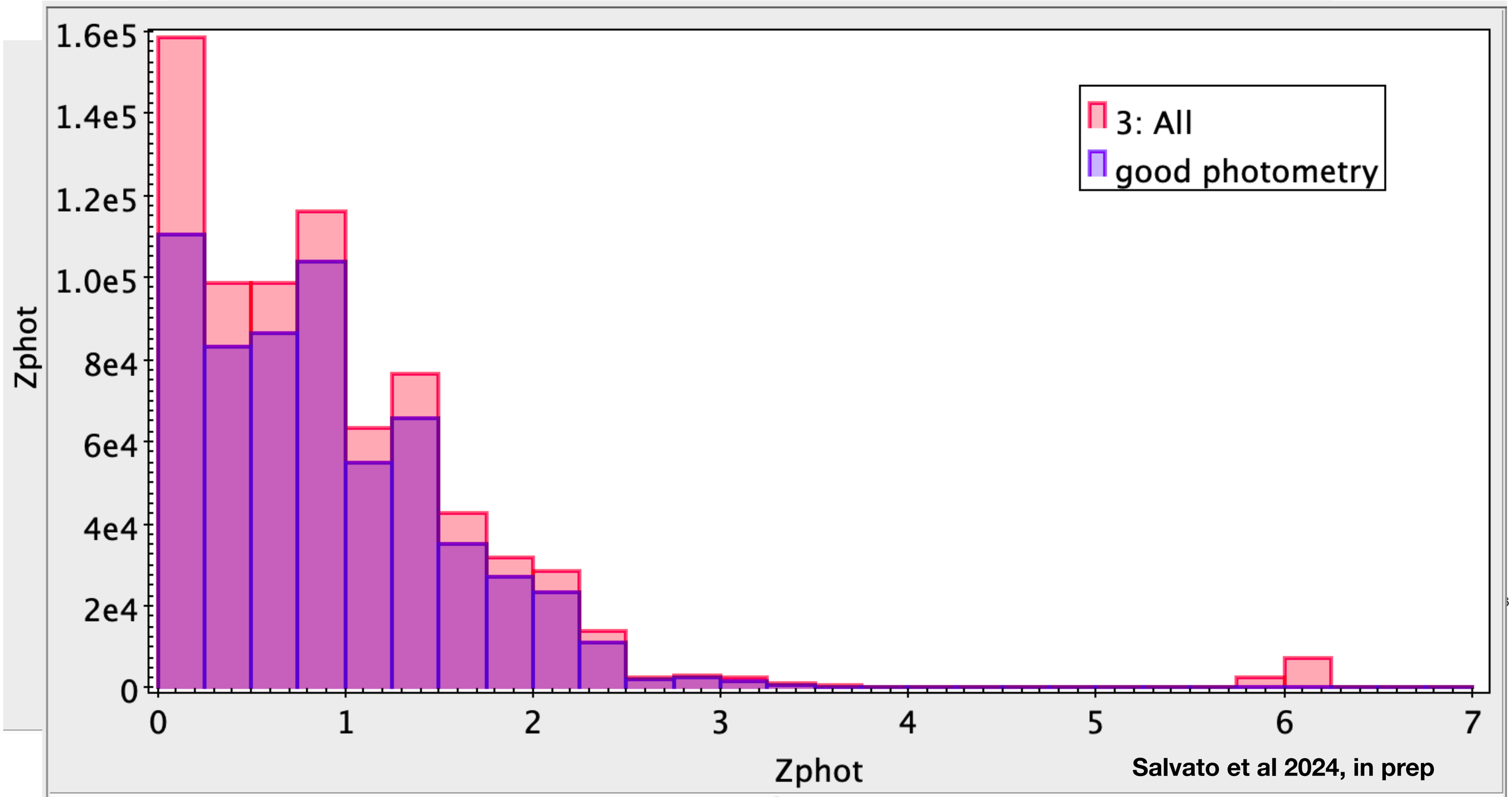


Salvato et al 2024, in prep

The Chimeras benchmark

Pure galaxy sample
- COSMOS, isolated, clean photometry
- Remove X/IR/BL AGN
- spec-z

(M*, SFR estimated)

Laigle+15

Random pair at same z

Pure QSO sample

Shen+11

- SDSS (logL>46)
- Spec analysis
- Lbol

L(AGN) estimated

sum fluxes

QSO weight:
0.001% (logL~42) to 100%

hybrid object

Truth known:
M_*, SFR, L_{AGN}

Model-free!

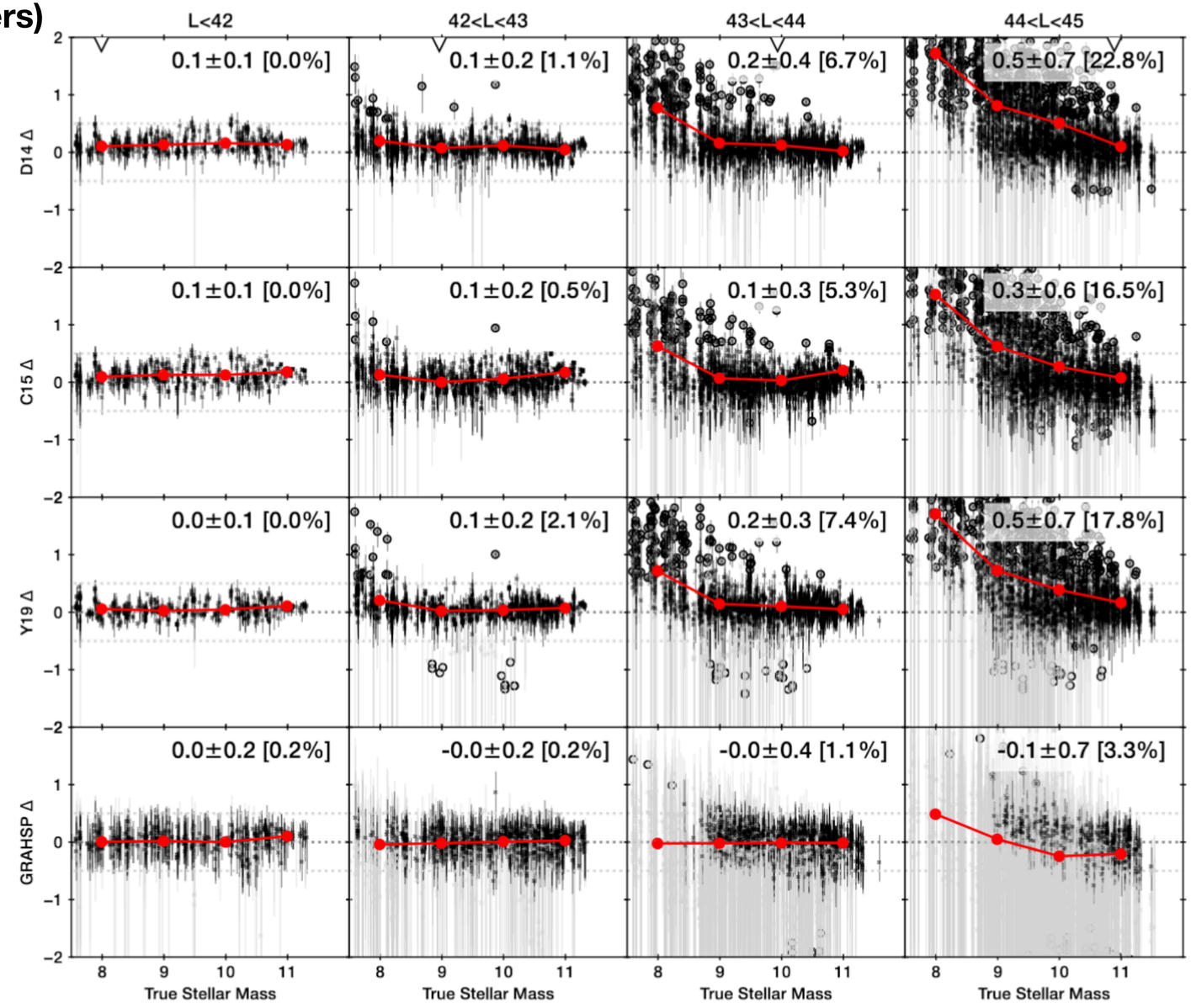
Validate SED fitting codes

Do not use for training
(Goodhart's law)

Johannes Buchner, Hattie Starck, Mara Salvato, TBS

unlike usual recipes for AGN/host decomposition, GRAHSP does not overestimate stellar masses

Bias, error, (frac outliers)



GRAHSP,
Buchner et al 2024, submitted

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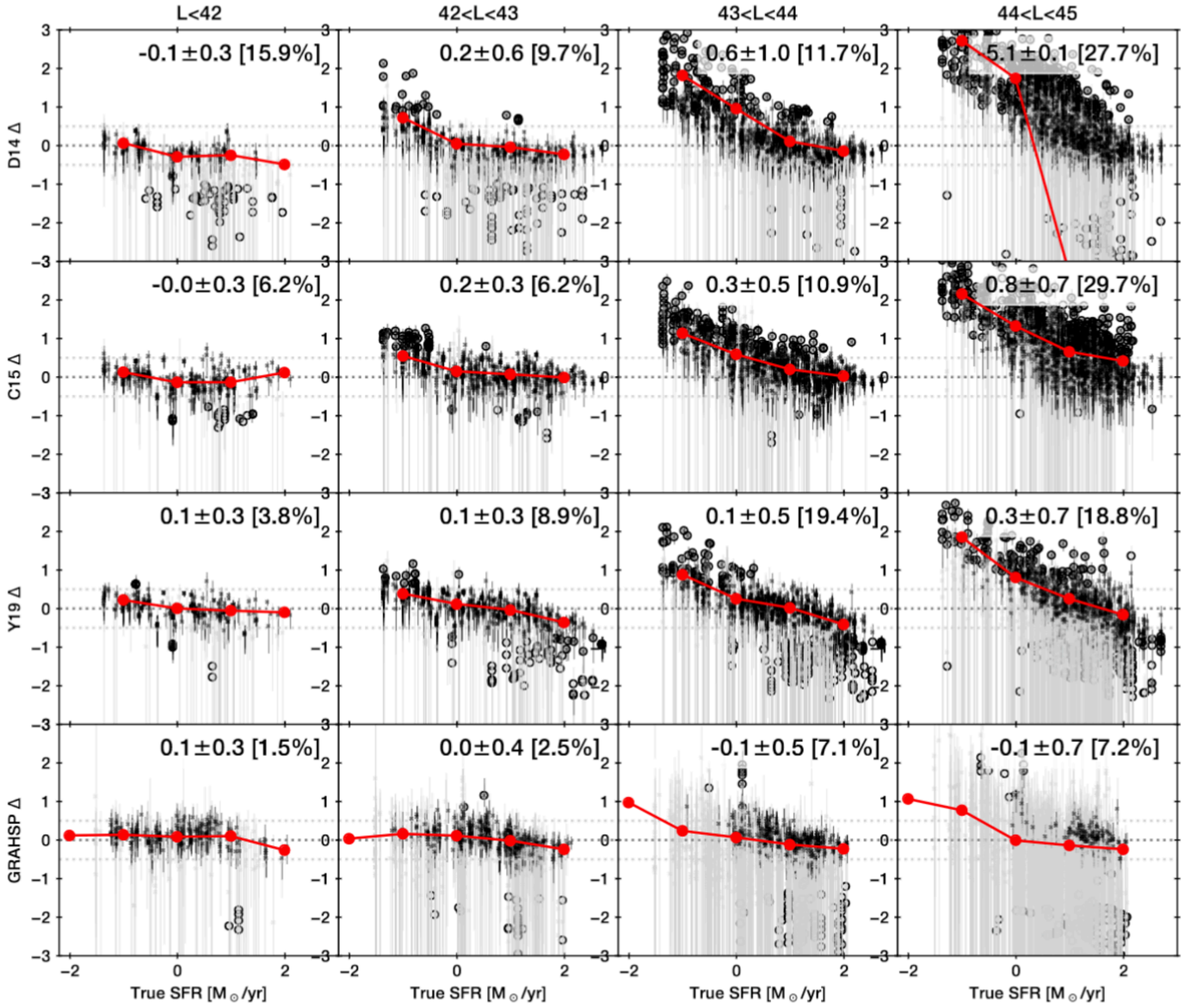
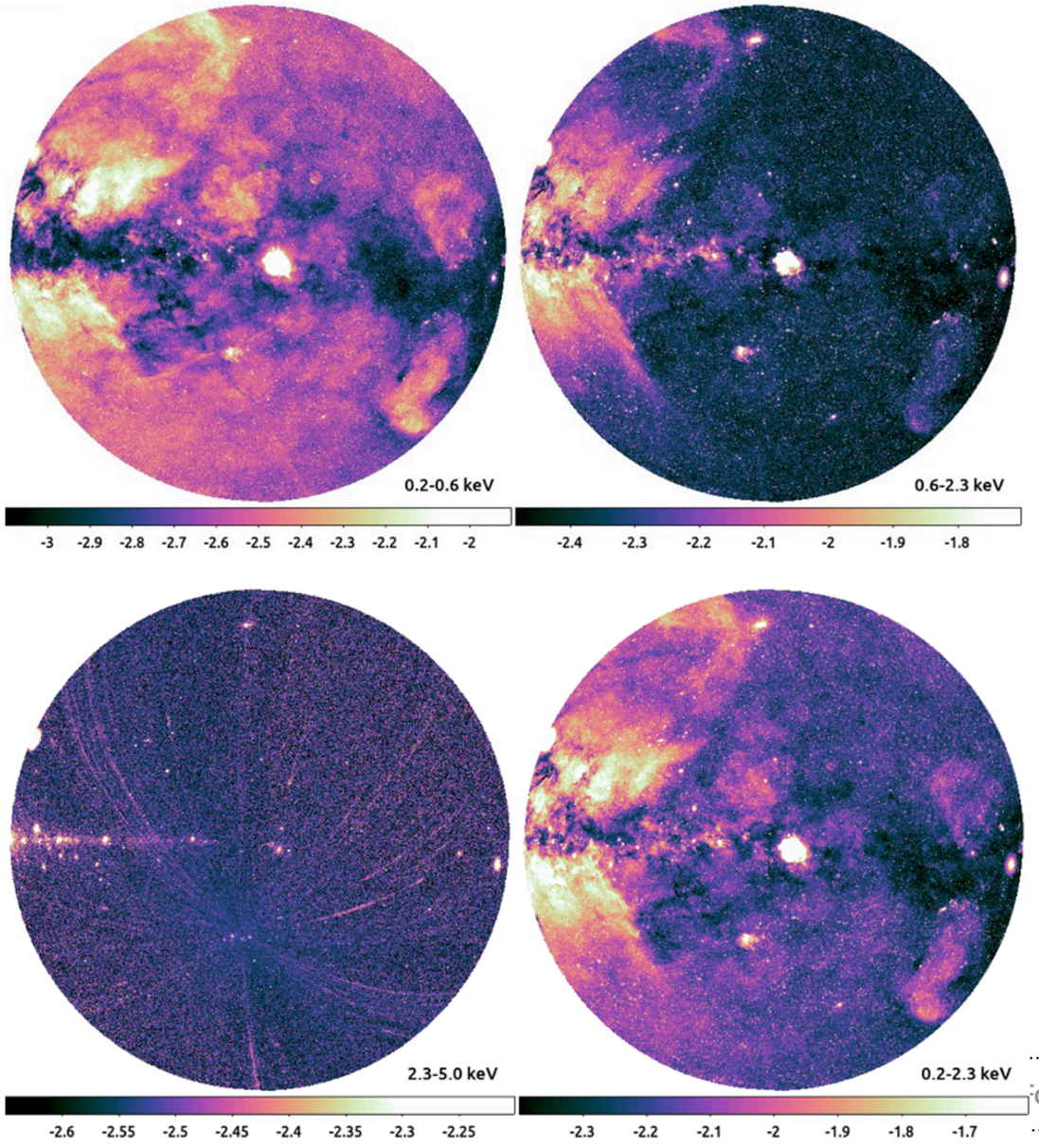


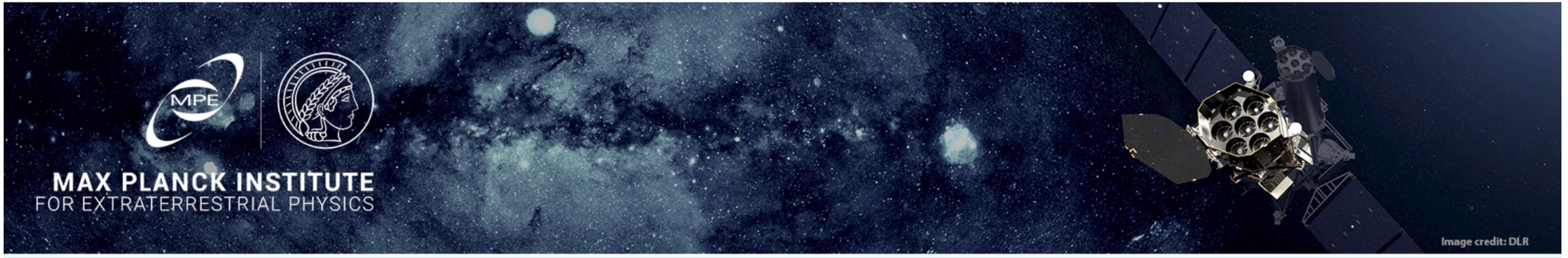
GRAHSP,
Buchner et al 2024, submitted

DR1 products



- Software
- Calibration DB
- Attitude files
- Exposure maps
- Events
- Count rate maps
- Source catalogues
- Upper limit server
- Light curves
- Spectra

Merloni et al., A&A, in press



Upper limit for a single position

Find an upper limit on the sky for a single sky position. Please either enter a position directly (in decimal degrees or sexagesimal), or give an object name and click resolve, to find the position using the Sesame name resolver.

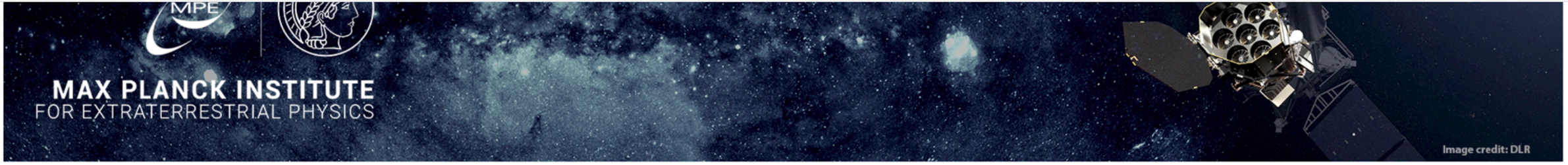
Please see this page and Tubín-Arenas et al. (2024) for further details. Both Tubín-Arenas et al. (2024) and Merloni et al. (2024) should be referenced if these upper limits are used.

Object name: [ ] Resolve

Longitude: 180 Latitude: -45 Coordinate System: ICRS

Band: 024 (0.2-2.3 keV)

Submit query | Defaults



Upper limits for multiple positions

Find upper limits for a list of positions given by an uploaded file. Please see this page and Tubín-Arenas et al. (2024) for further details. Both Tubín-Arenas et al. (2024) and Merloni et al. (2024) should be referenced if these upper limits are used.

- Input files should be text, consisting of two or three columns.
- The columns should be separated by whitespace, pipes ("|"), semicolons or commas (choose below).
- If there are three columns, the first should be a name for the object, and the next two the longitude and latitude of its coordinates (RA and Dec for equatorial coordinates).
- If there are two columns, these should contain longitudes and latitudes.
- The coordinates can either be given in decimal degrees, or in sexagesimal form following the format 11:22:33.3 or 11h12m3.3s / -11d12m3.3s.
- Comment lines can be prefixed by a hash symbol ("#").
- Up to 1000 entries are supported.
- Invalid values in output text or JSON are written as -9999.
- Processing many sources can take a few minutes.

Choose file No file chosen

Column Separator: Whitespace

Coordinate System: ICRS

eROSITA-DE sky only: ☑

Output format: Web page

Band: 024 (0.2-2.3 keV)

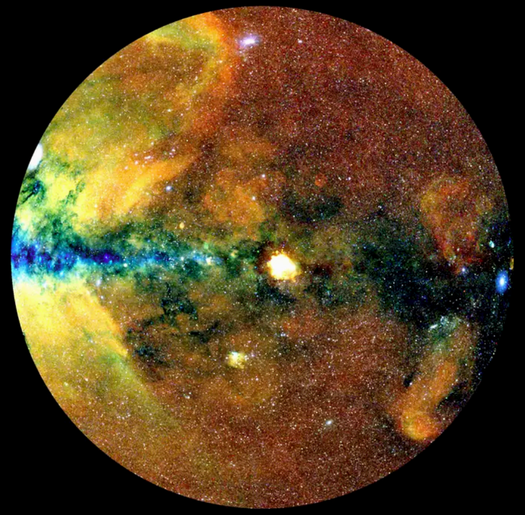
Submit query

SUMMARY

eROSITA on SRG has been operating for more than 2 years and
4.4 all-sky surveys are completed. In safe mode since 26.02.

Thanks to its GRASP, stable background, and observing cadence,
eROSITA opens new parameter space for X-ray astronomy across different source types.

The all-sky surveys represent a legacy that will remain unsurpassed for years.

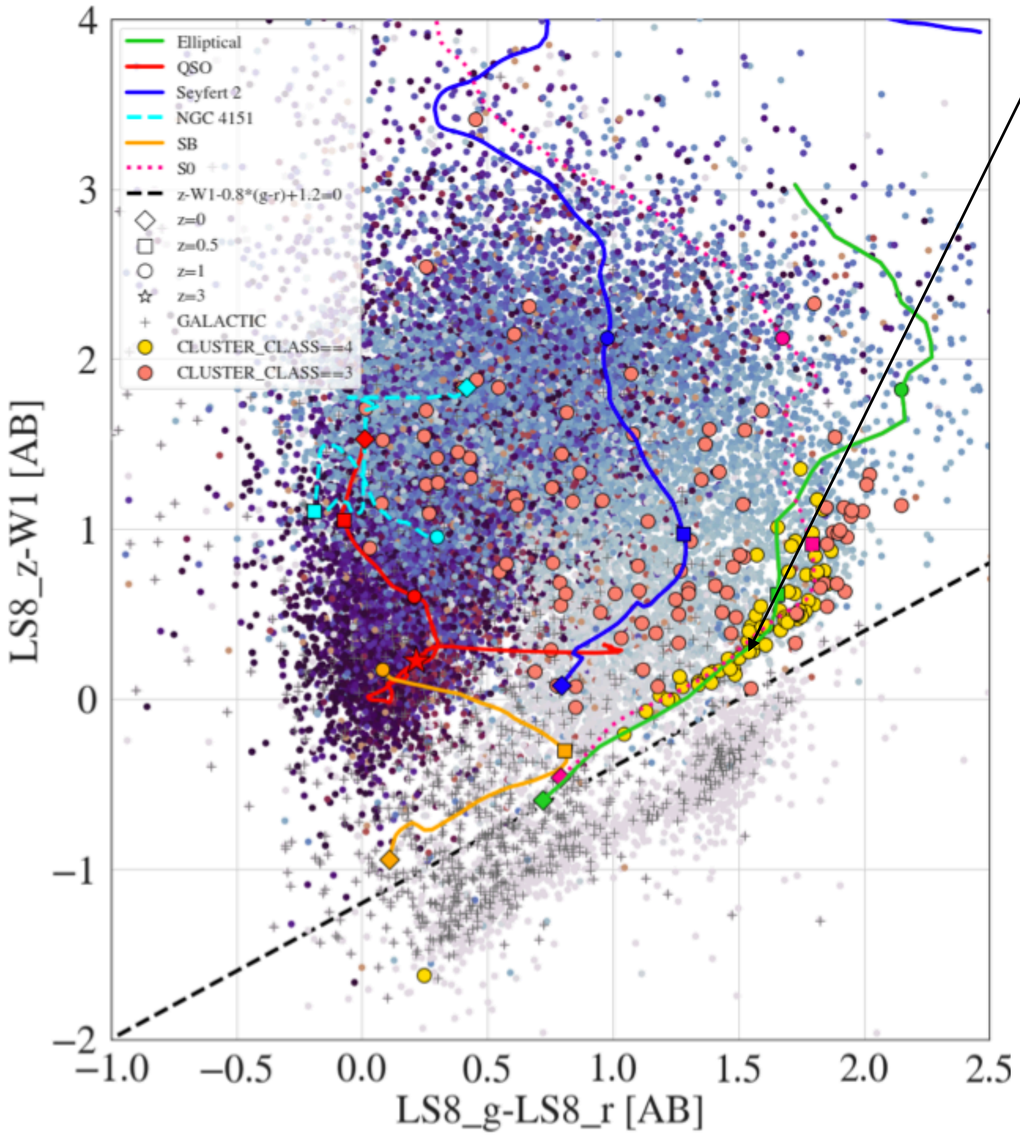


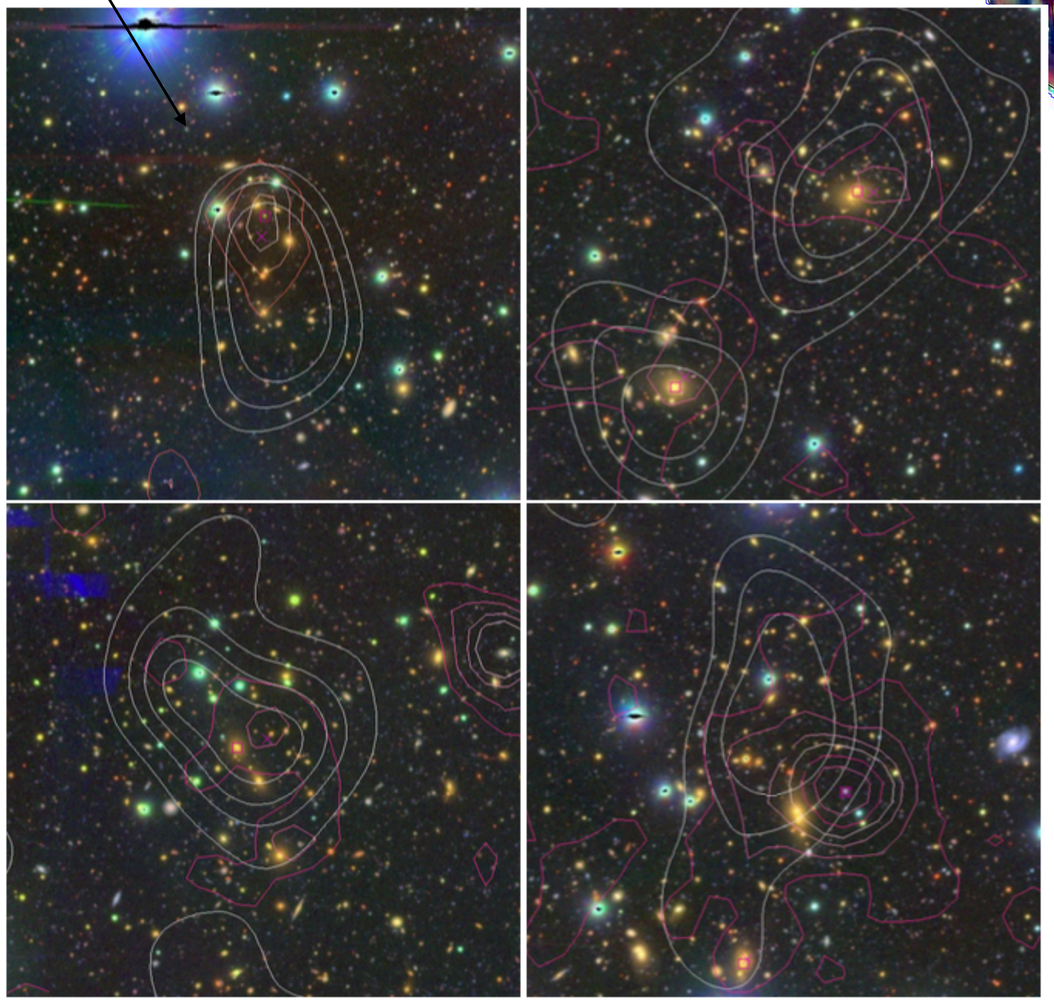
On 31/1/2024 we have released ALL data and software on eRASS1
~700k AGN in the first all-sky (80% of known Blazars already identified)
13k confirmed clusters
140k stars

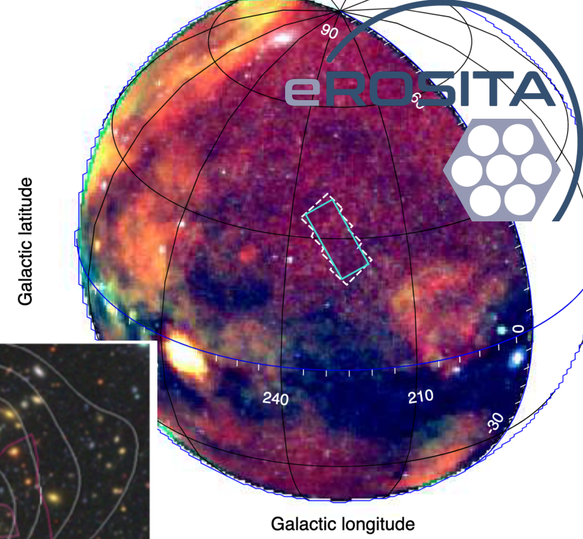
While we have reelased the catalog of Hard selected sources (Waddell et al) we are still working on the paper that release the ~700k AGN detected in the Main catalog, including very reliable photoz.

All is in place to harvest the AGN related science!

Clusters in disguise in eFEDS







Salvato et al 2022, Bulbul et al 2022