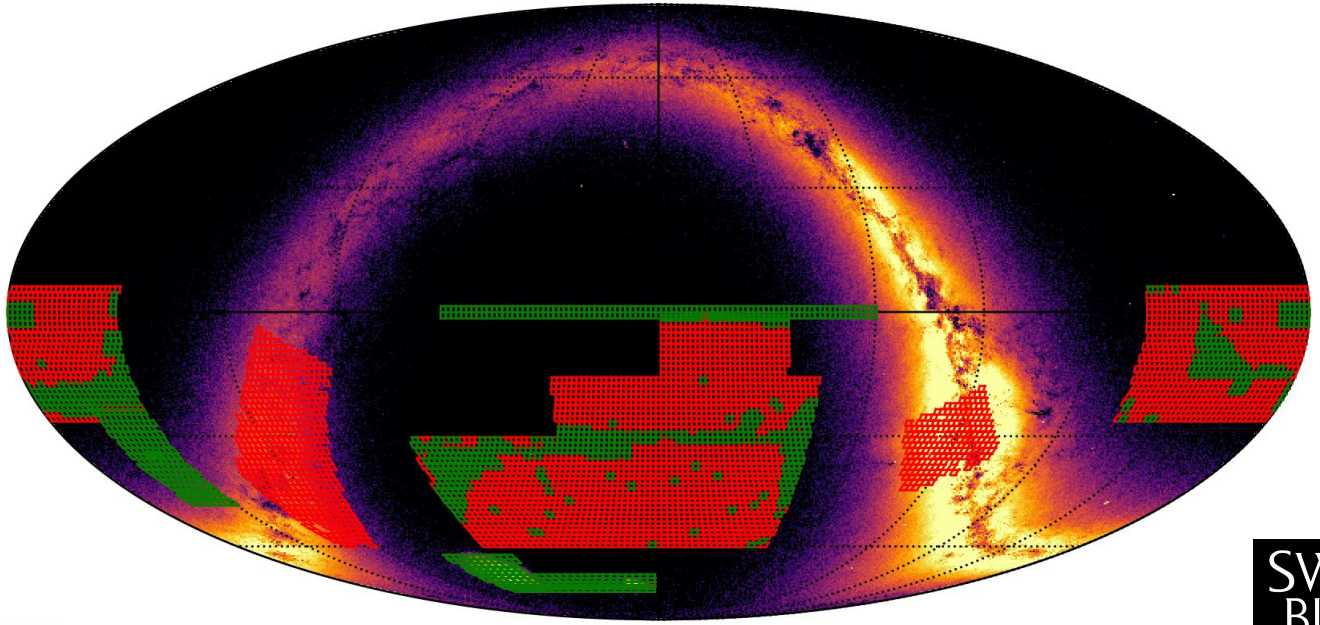
Masking, data characterization and photometric redshifts for S-PLUS DR3



Maria Luísa Buzzo

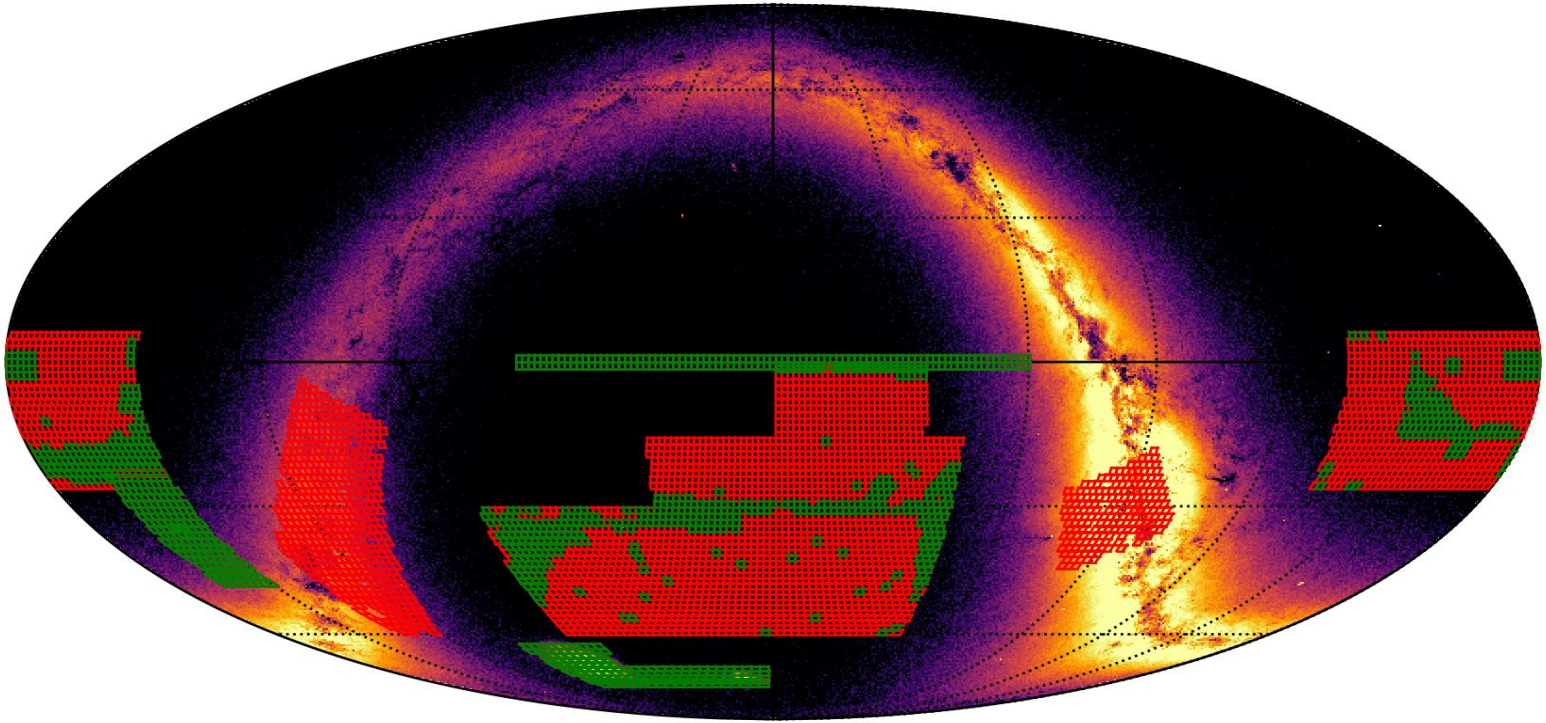
with R. Overzier, F. Almeida, F. Herpich, C. Queiroz and C. M. de Oliveira for the S-PLUS Collab.

Outline

- Masking:
  - Mask of problematic regions
  - Bright stars, gals., nebulae, GCs, borders.
- Point/extended source separation:
  - Gaussian mixture models;
  - Gaia proper motion;
  - Concentration;
  - HDBscan.
- Data characterization/ matches:
  - Properties of the survey:
  - FWHM, Depth, Density…
  - Matches and final catalogues.
- Photometric Redshifts:
  - Template fitting.
  - +UV/near-IR/IR.
  - Photo-zs + physical SEDs.

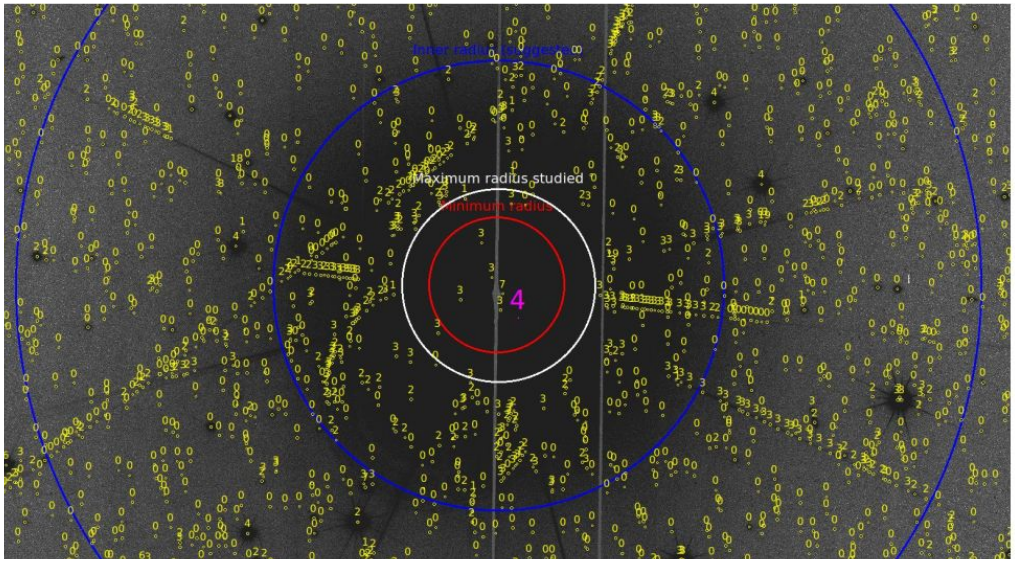
Masking

Data used in this talk: entire iDR3 with the following selections applied: s2n_Det_iso>5



Stellar masks

- Based on visual inspection and number density analysis of PF = 0 / PF = all, we advise the following circular masks (unless your science demands otherwise):

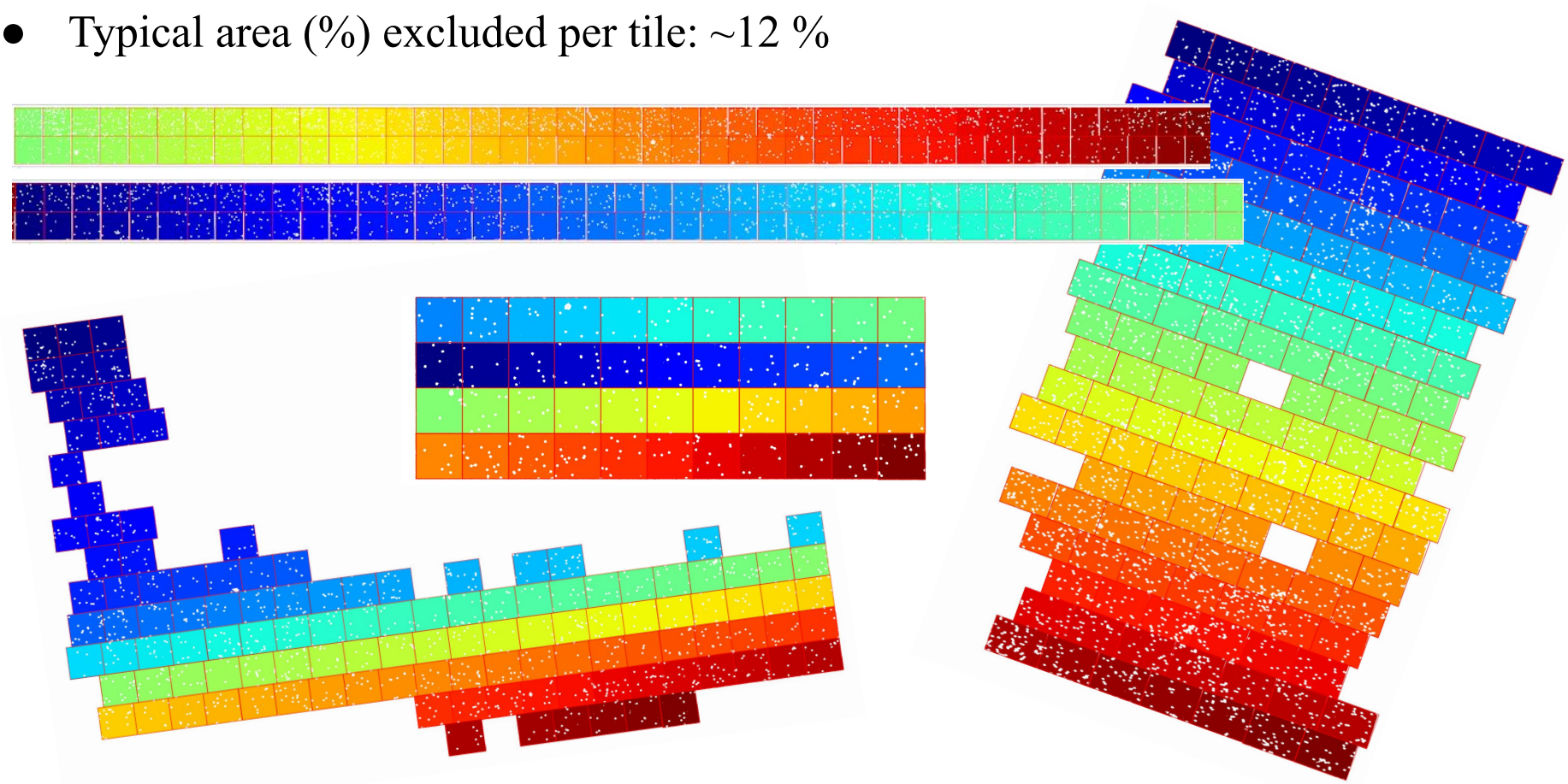


GSC Magnitude (B mag)	Minimum radius (arcsec)	Suggested radius (arcsec)
$4.0 \leq mag_\star \leq 5.0$	700	1500
$5.0 \leq mag_\star \leq 6.0$	270	1000
$6.0 \leq mag_\star \leq 7.0$	210	800
$7.0 \leq mag_\star \leq 8.0$	160	700
$8.0 \leq mag_\star \leq 9.0$	90	450
$9.0 \leq mag_\star \leq 10.0$	50	250
$10.0 \leq mag_\star \leq 11.0$	40	200

- Red circle: radius at which PF = 0 objects appear
- Minimum radius: recommended minimum mask radius
- Suggested radius: when accuracy is more important than numbers (and stars are not the science goal)

Stellar masks

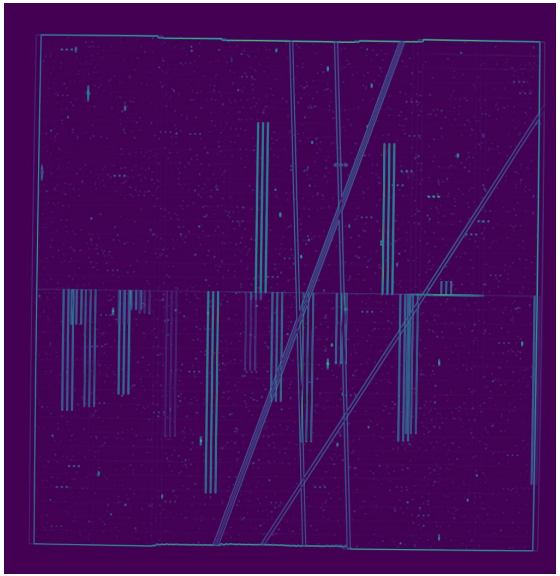
- Typical area (%) excluded per tile: ~12 %



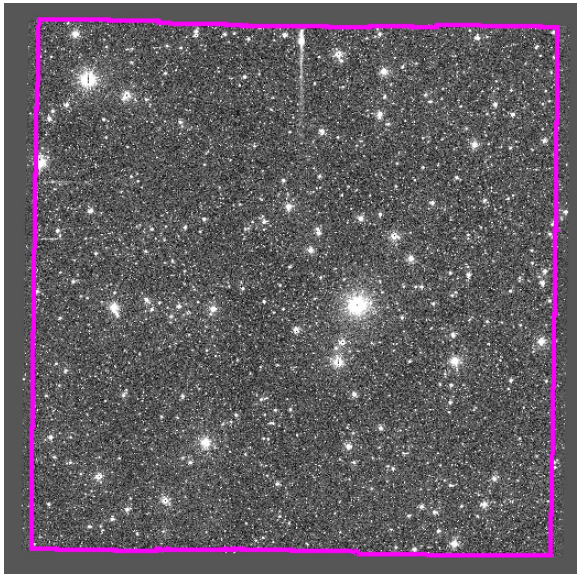
Border masking

- ➔ Tiles are not perfect squares (irregular edges of low weight) and slightly rotated
- ➔ Edge detection applied to the detection weight maps gives more accurate borders

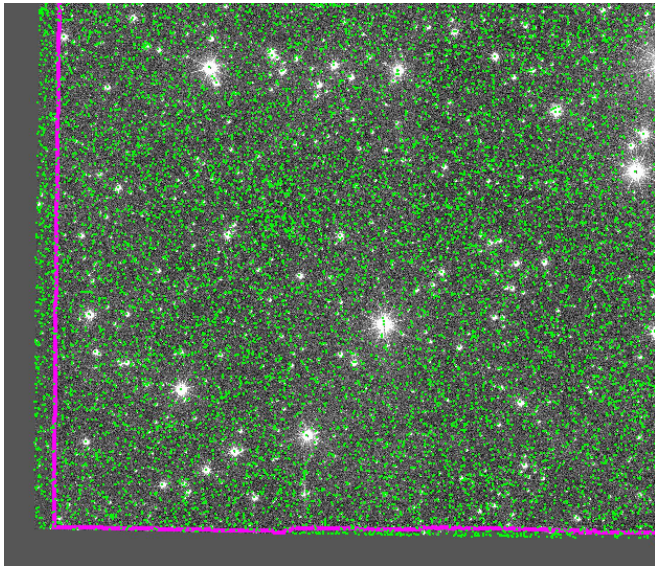
Edge detection



Outer edge mask

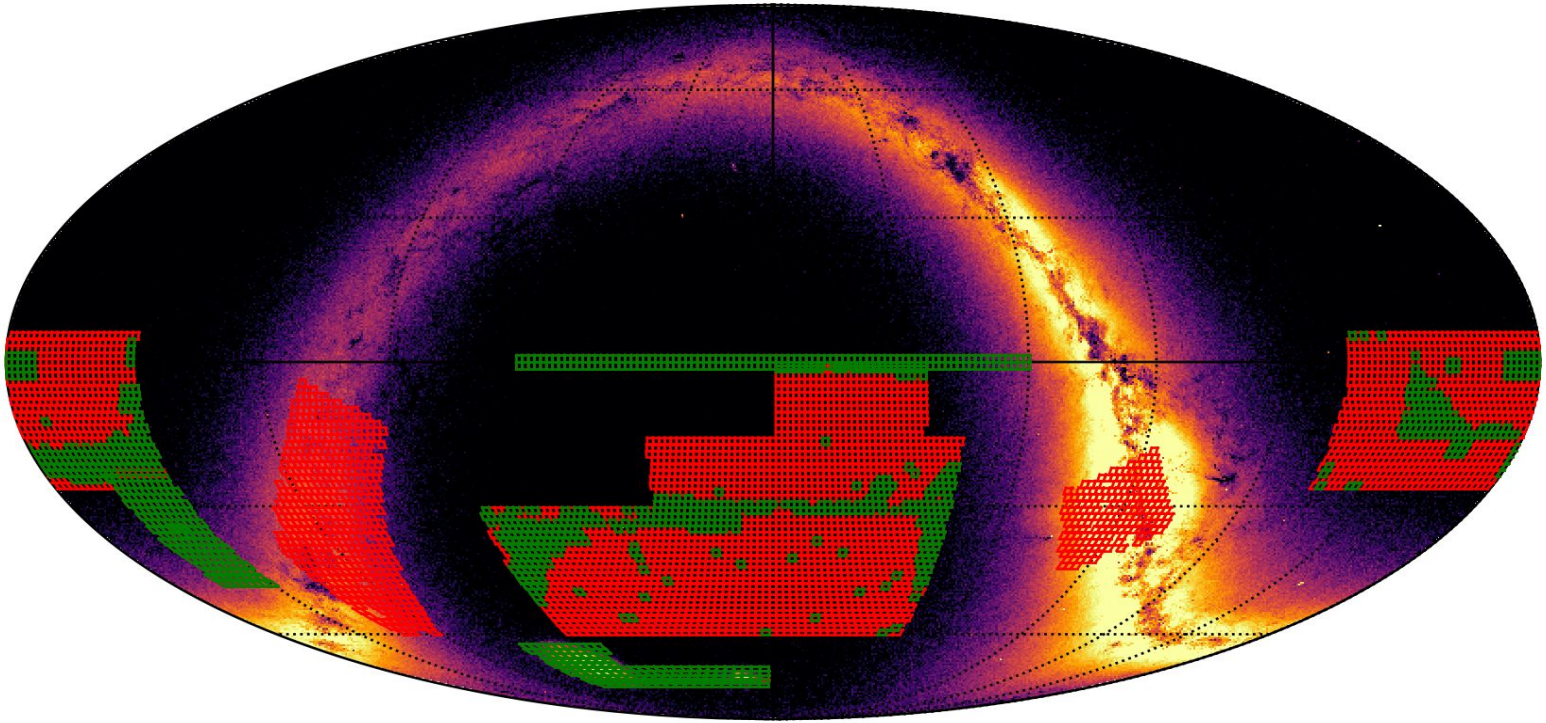


Detail of iDR3 sources and mask



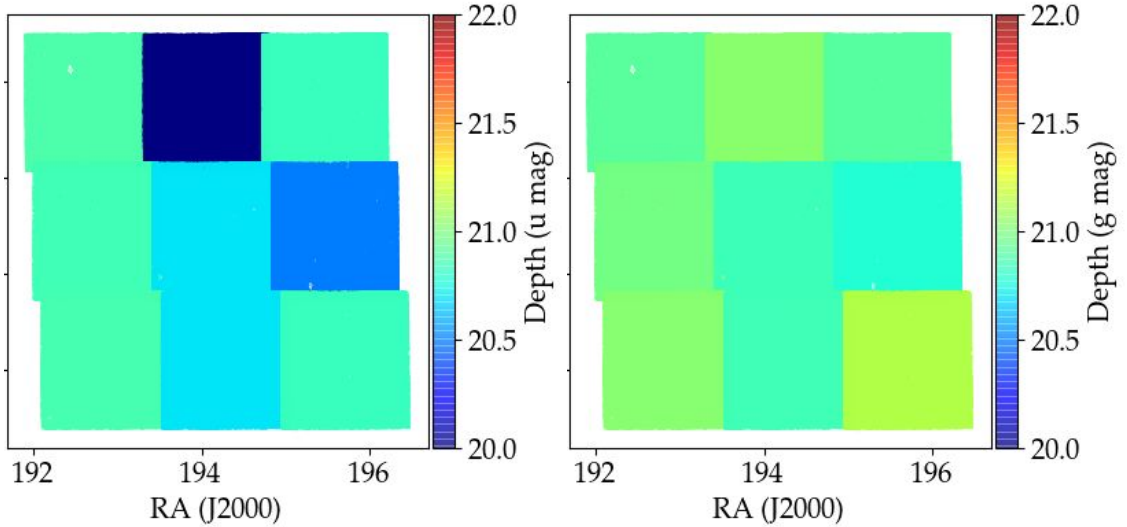
all masks will be provided as astropy.regions (sources = tile.contains(cat)) and flagged in the catalogs

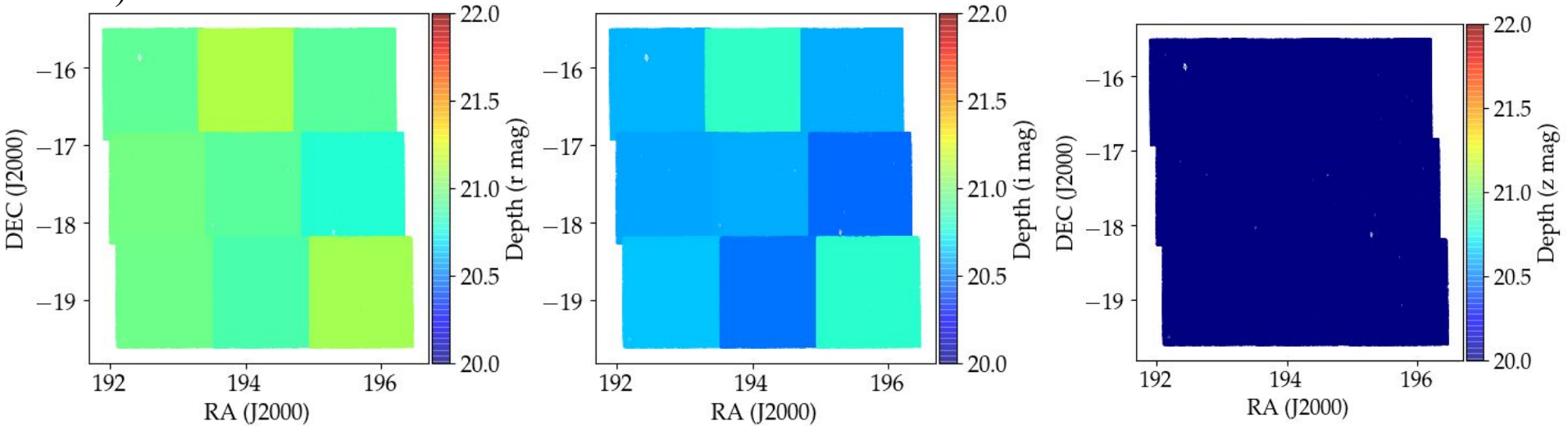
Data Characterization



Depth (3σ)

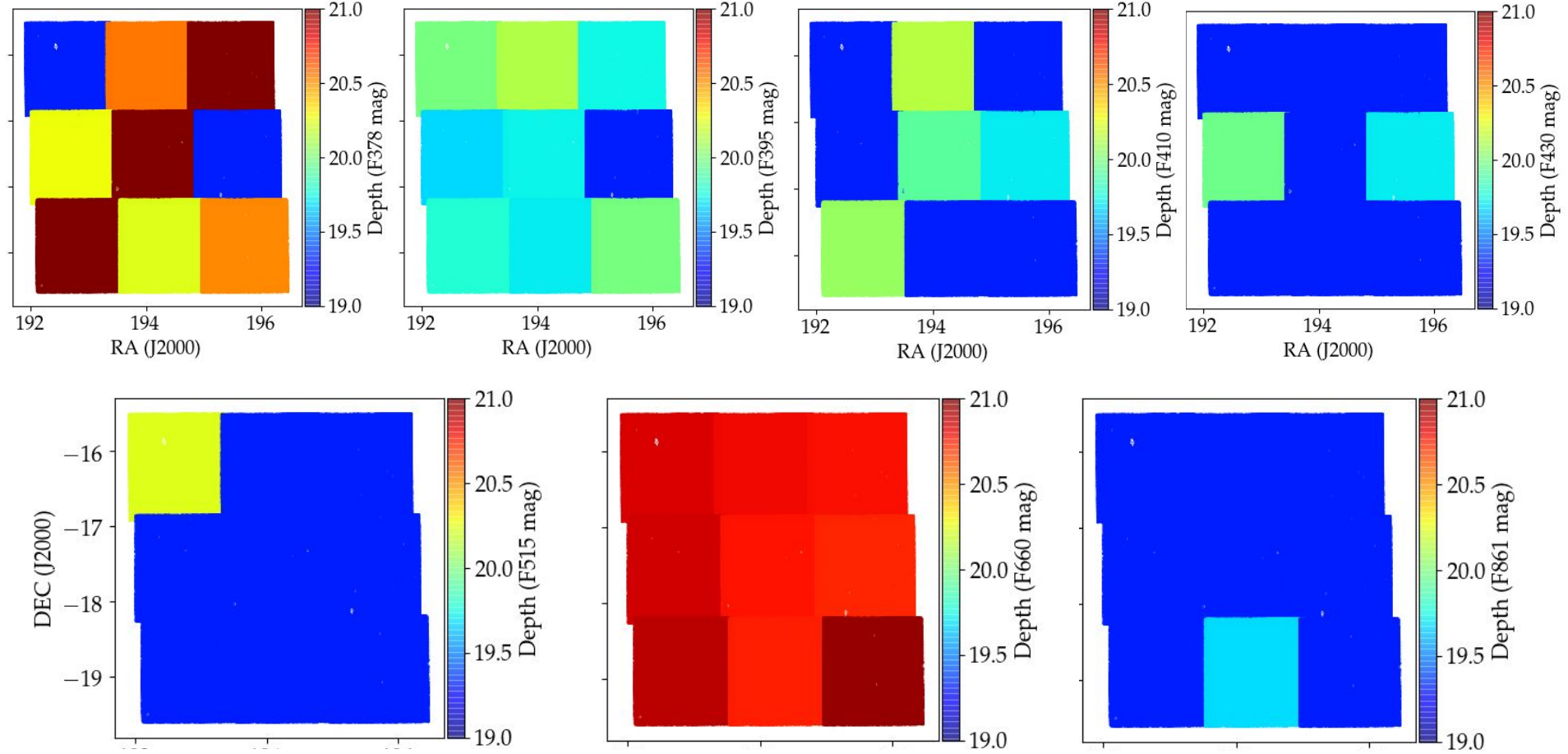
- Turnover of counts of sources detected at >3**σ** defines the image depth in each filter and across the survey
- Depths are ~19-21 mag (3σ) in ugriz (fainter in blue compared to red filters)





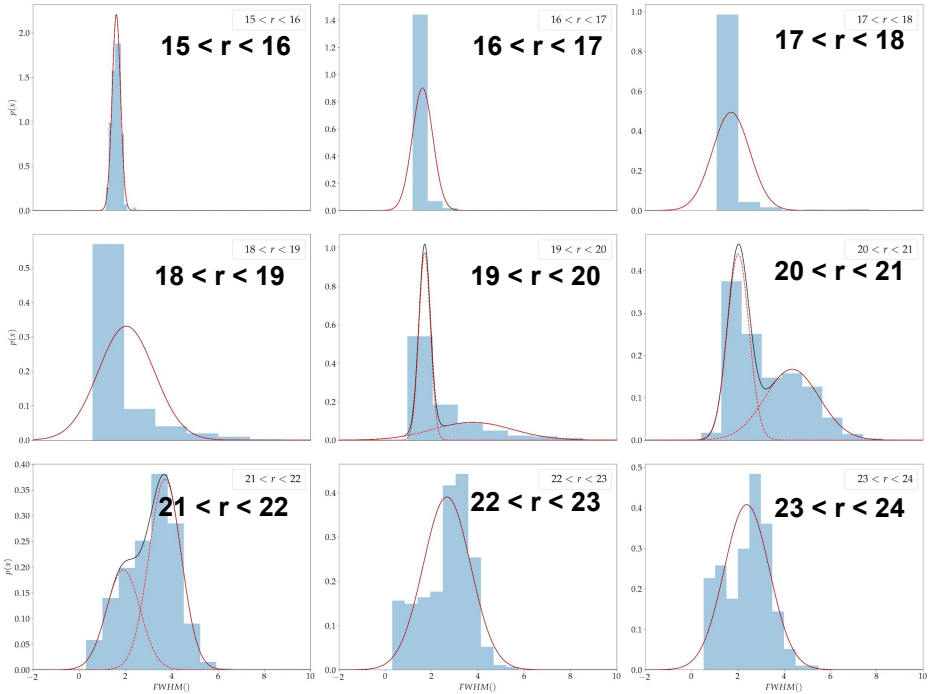
Depth (3σ - auto)

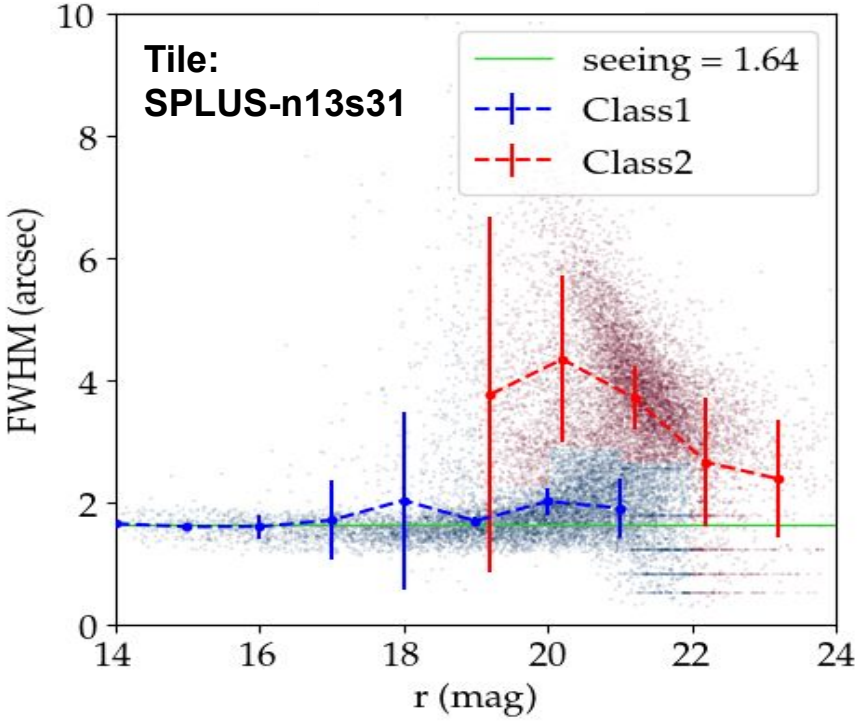
For each tile, the 3, 5 and 10 sigma limits were calculated in auto, petro and aper6 for all bands.



Tile seeing (fwhm)

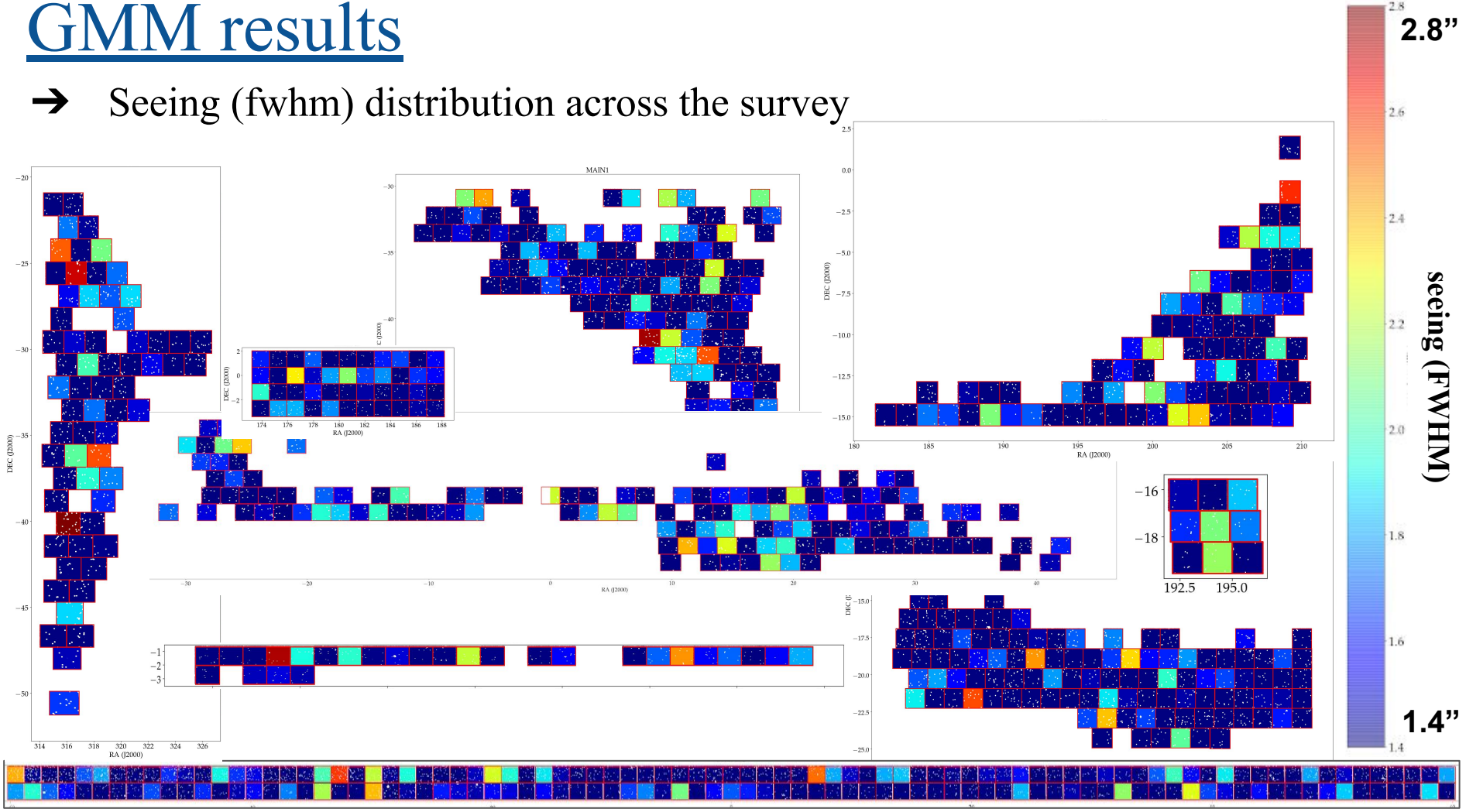
- ➔ We run a Gaussian Mixture Model (GMM) on each tile, resulting in:
  - Point/extended source separation (will help photo-z estimation)
  - Measurement of the seeing based on the point-like sources (stars)





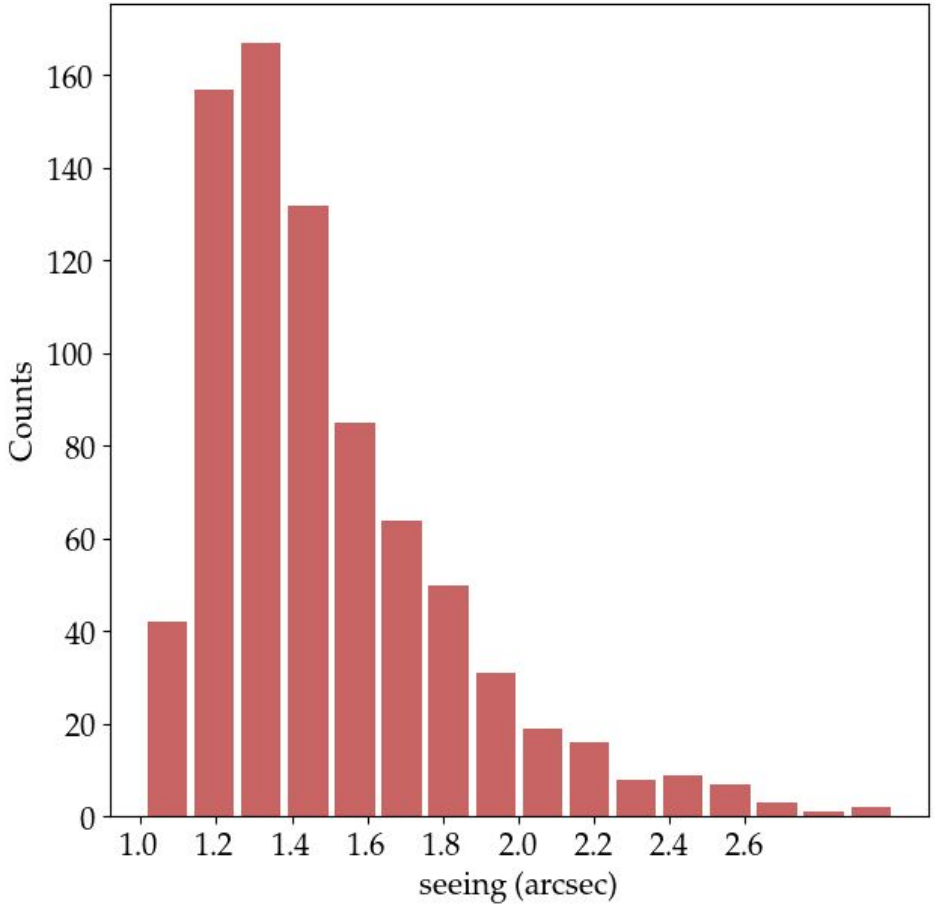
GMM results

➔ Seeing (fwhm) distribution across the survey



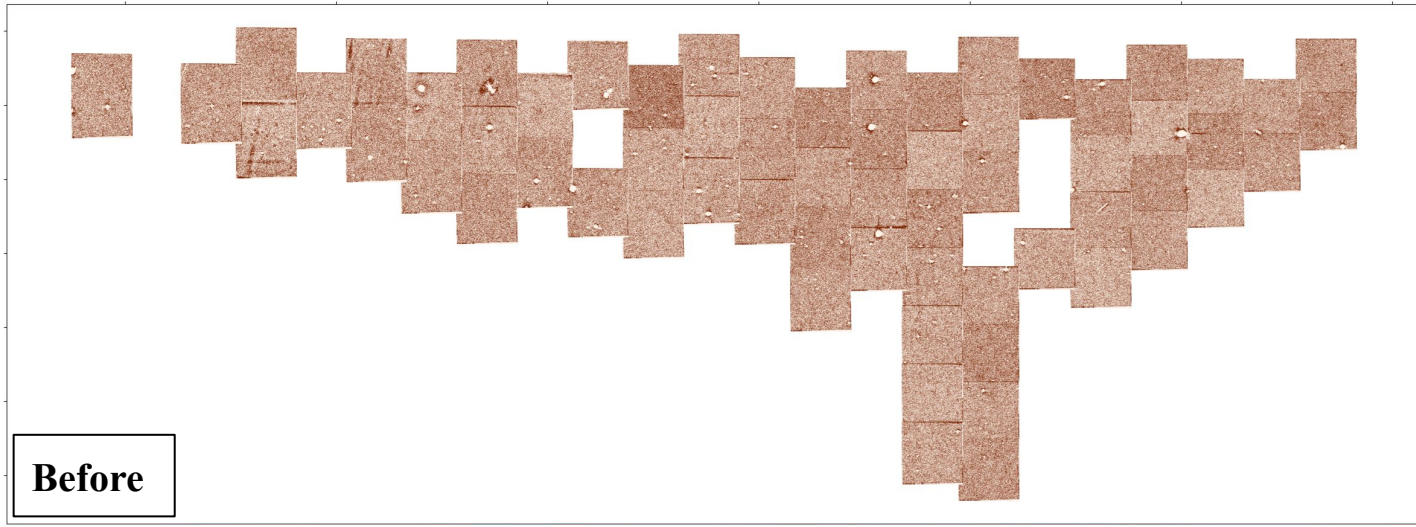
Seeing distribution (802 tiles)

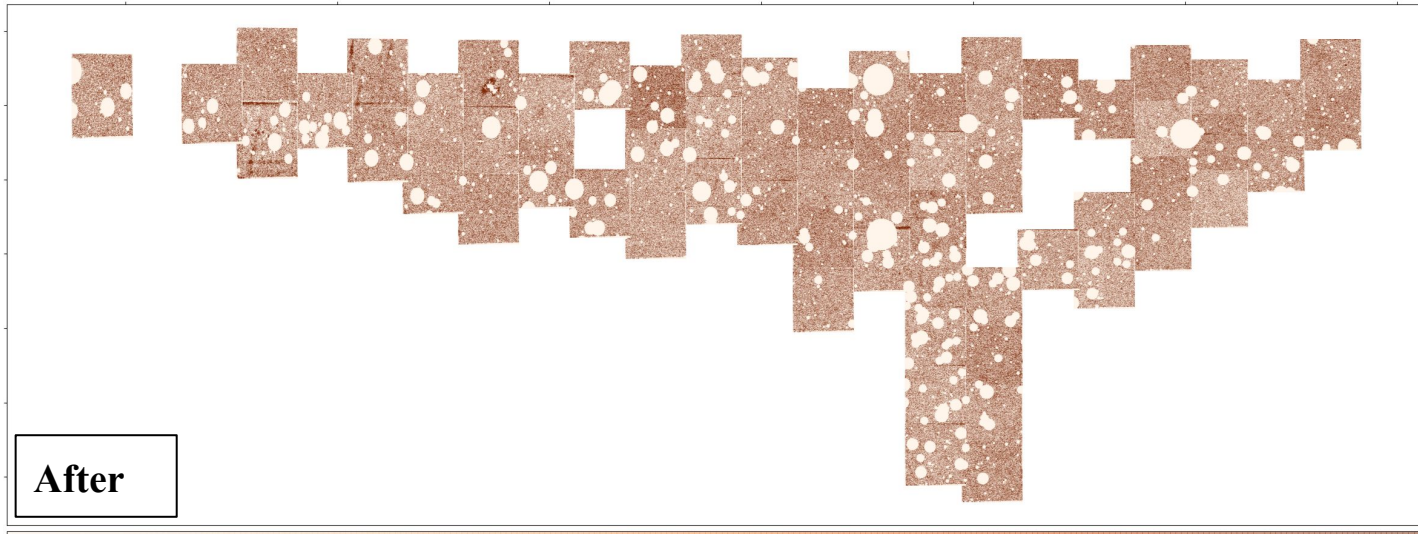
- median survey seeing is ~1.3” FWHM with some fraction of tiles having seeing above 2”



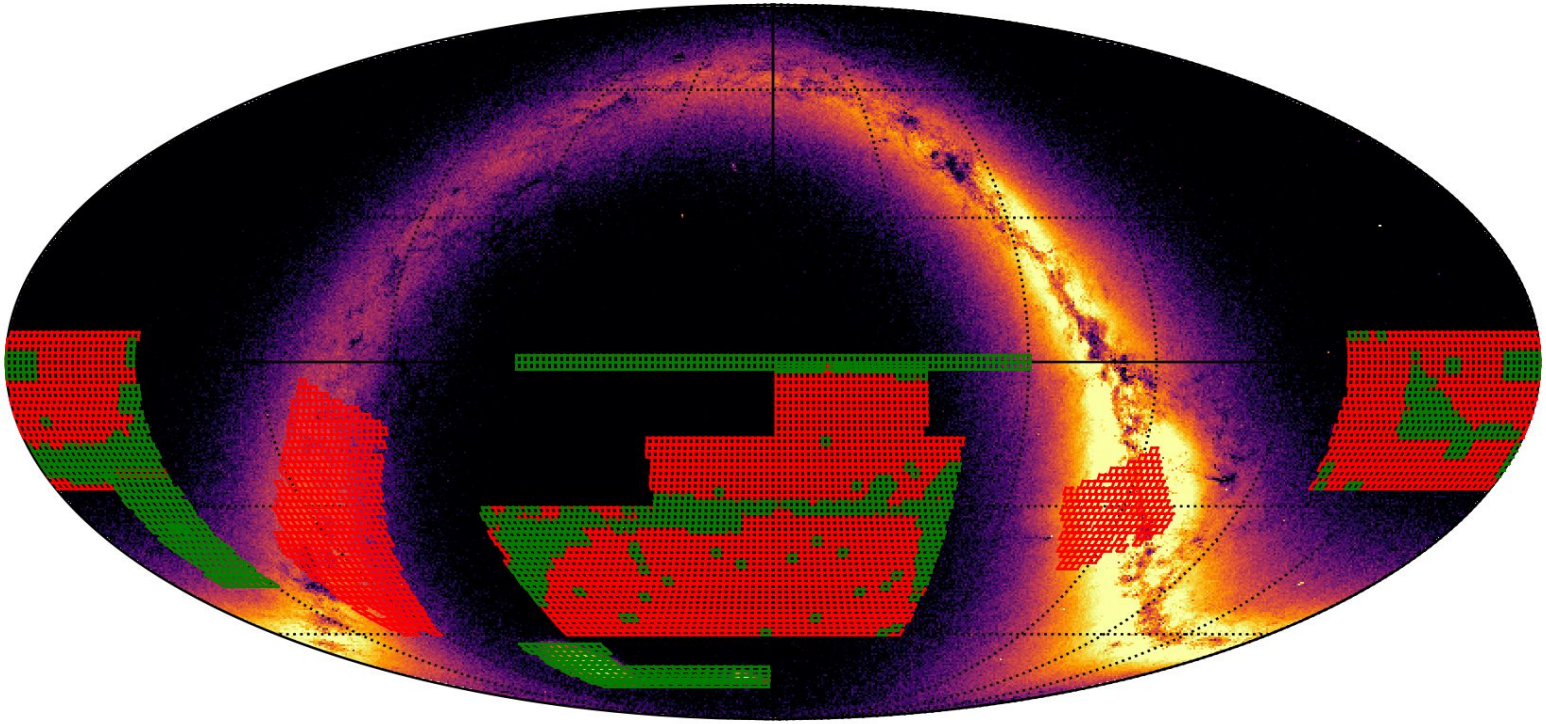
Density

- after applying the masks, the source surface density distribution is relatively smooth across the whole survey area





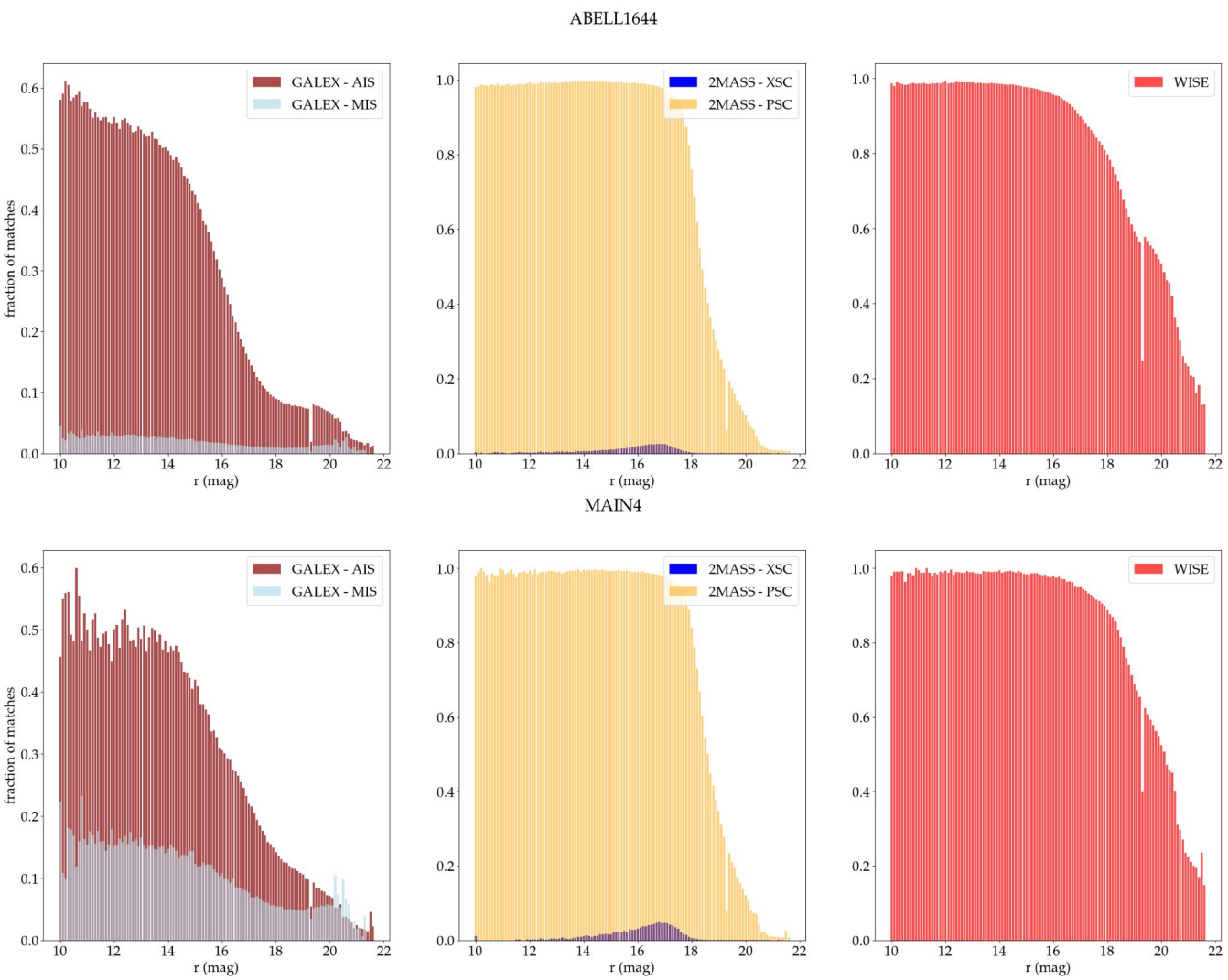
Matches and final catalogues



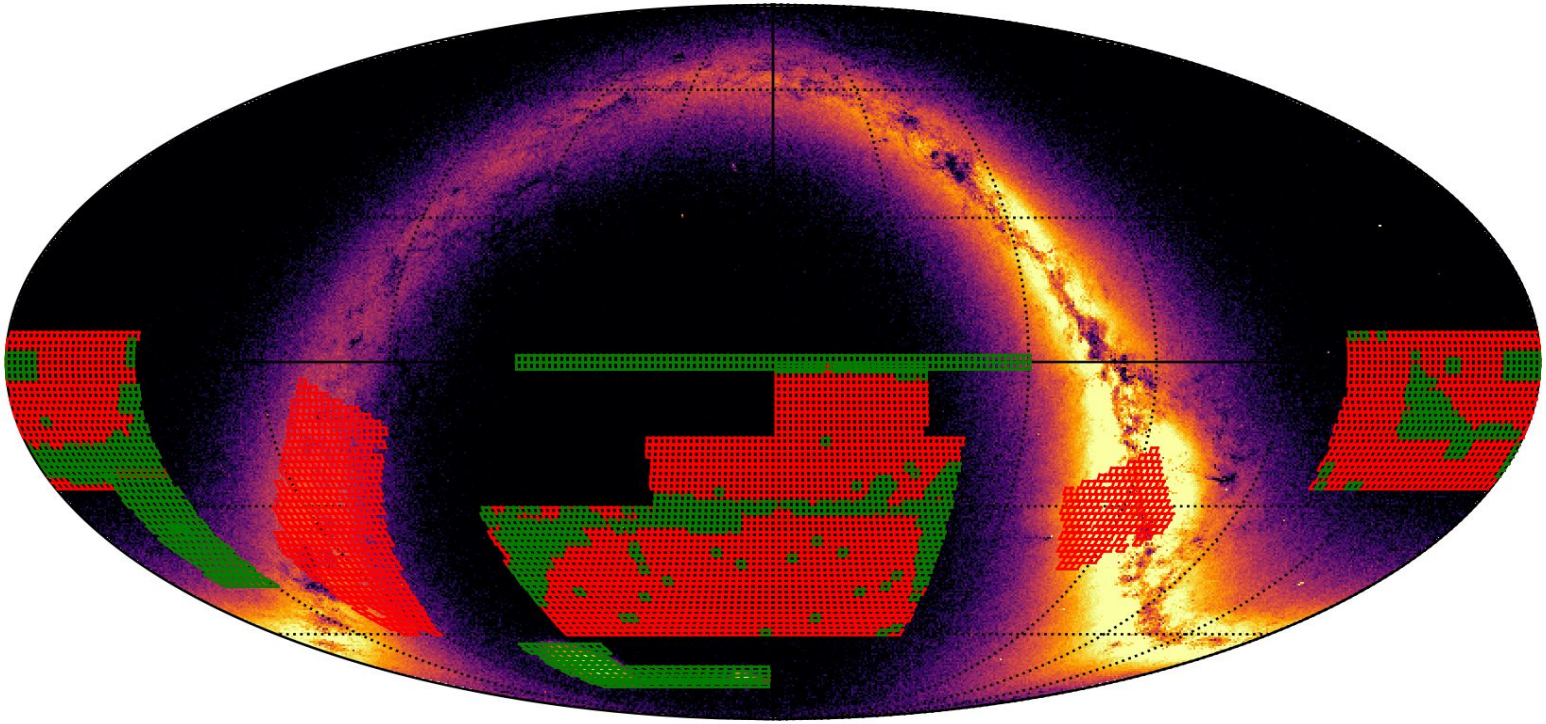
Matches

- Matches were performed with GALEX DR6+7, 2MASS PSC, 2MASS XSC and WISE all-sky surveys.
- 3 sigma limits were applied.
- Search radius: 5 arcsec.

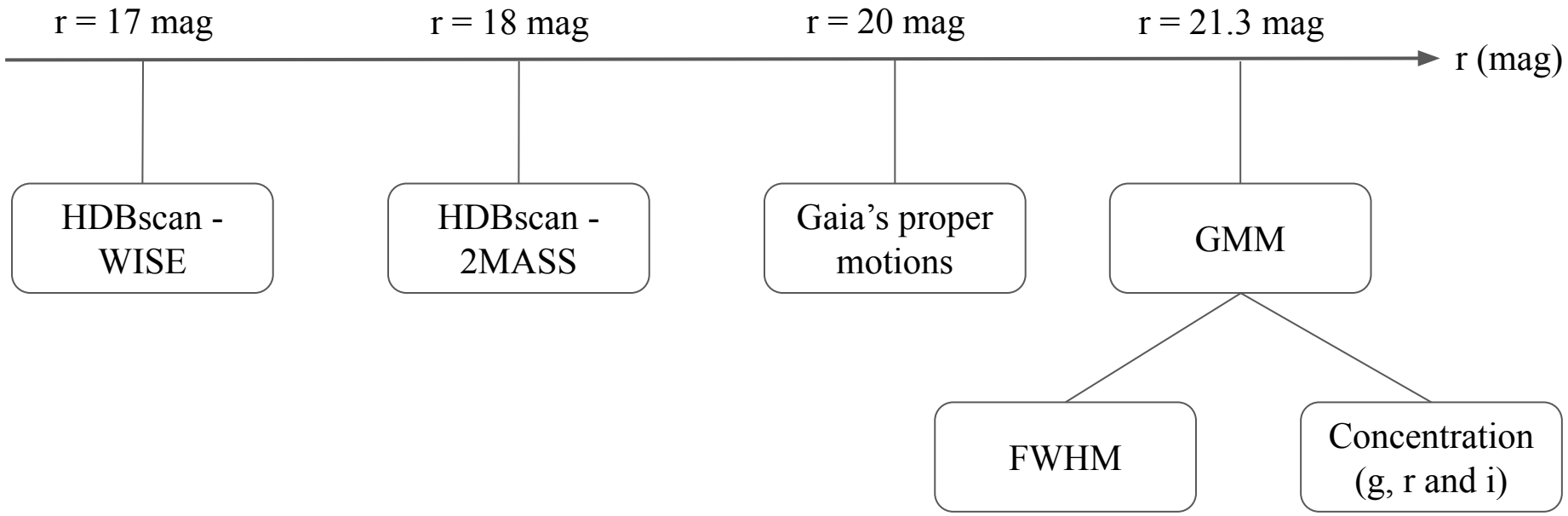
★ Gaia and zspec (1 arcsec)



Star-Galaxy separation

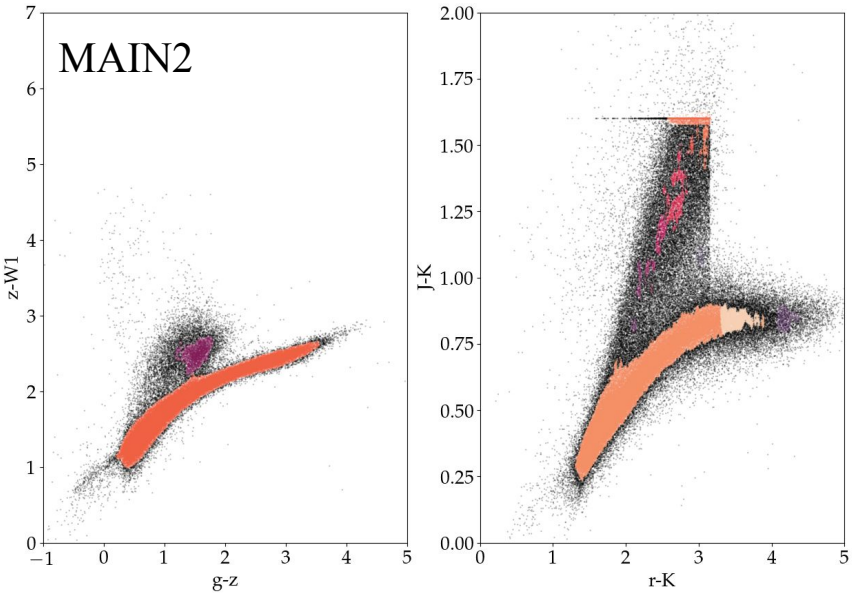


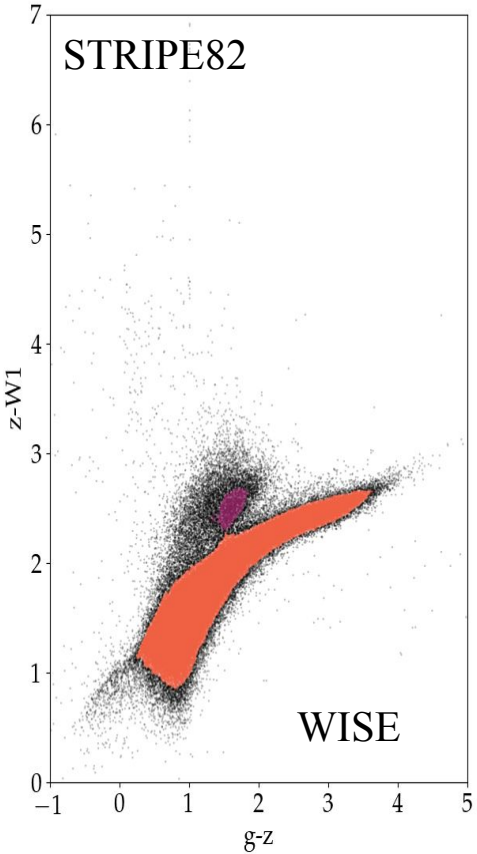
Star-Galaxy separation

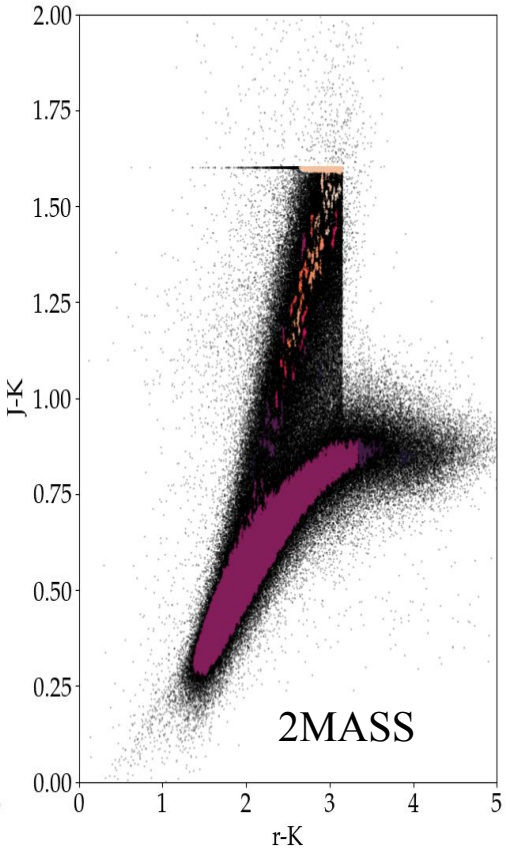


HDBscan

- Clustering based on near-infrared and infrared colors.
- Used to identify stellar streams and exclude stars of the final sample.





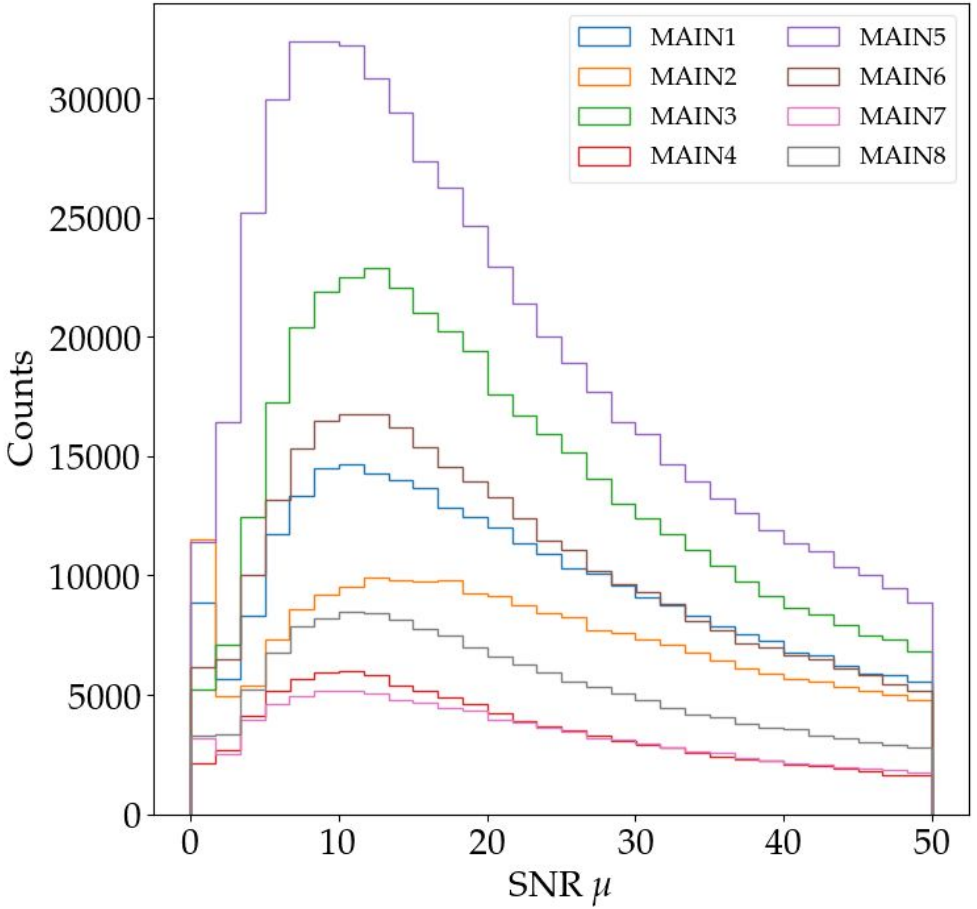


Definite stars with Gaia

- Proper motion to separate definite stars.

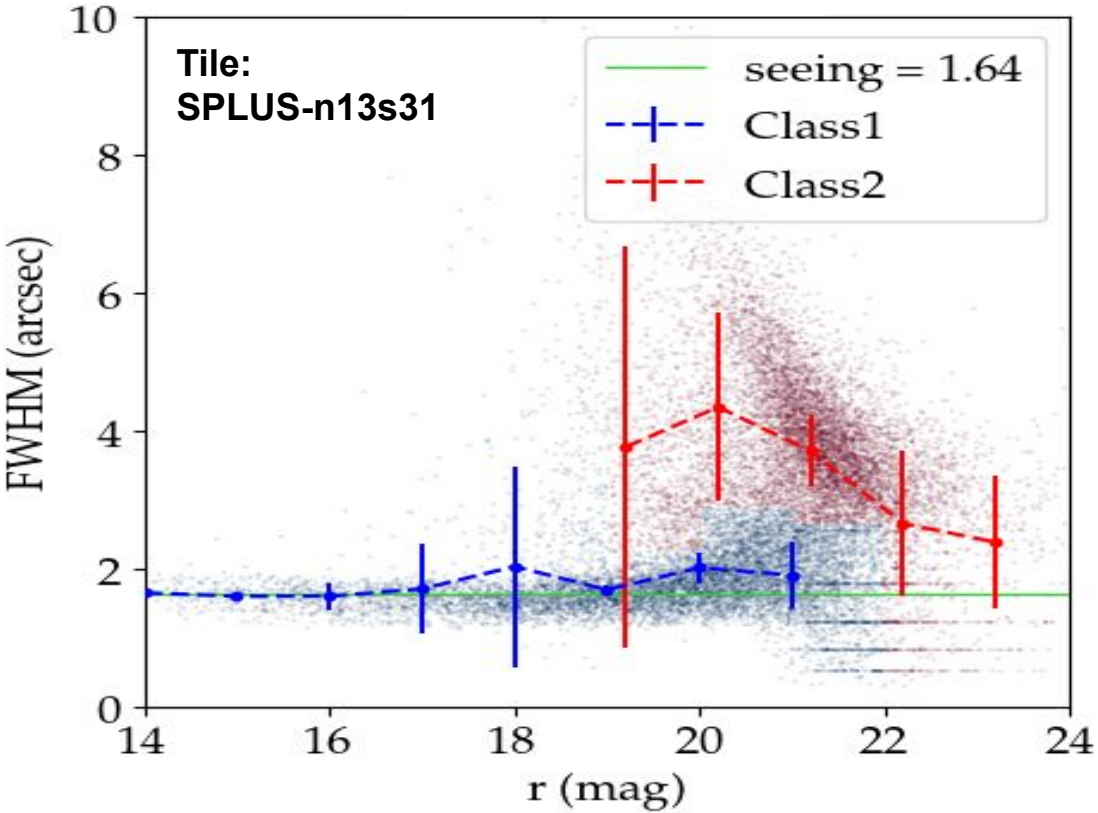
$$\mathrm{SNR}_{\mu} = \sqrt{\mu_{\mathrm{RA}}^2 + \mu_{\mathrm{DEC}}^2} \Big/ \sqrt{\sigma\mu_{\mathrm{RA}}^2 + \sigma\mu_{\mathrm{DEC}}^2}$$

- Non-stars are expected to have proper motions consistent with 0 at the 3σ confidence level, while genuine stars are expected to have SNRμ>3.



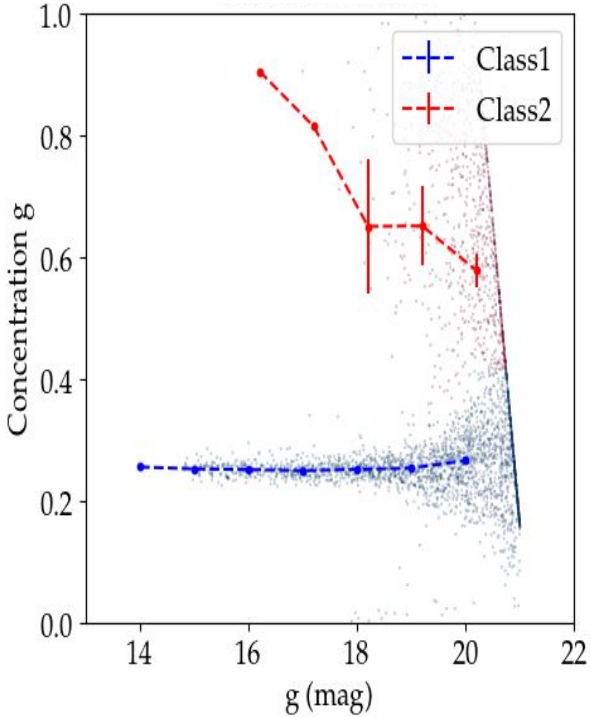
GMM - FWHM

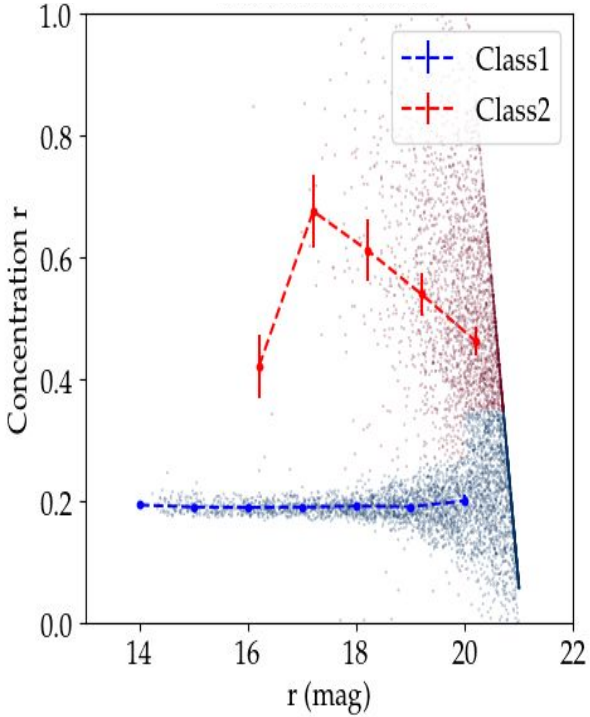
- GMM -> objects are classified as 1 (point sources) or 2 (extended sources).
- Classification and probabilities of every object.

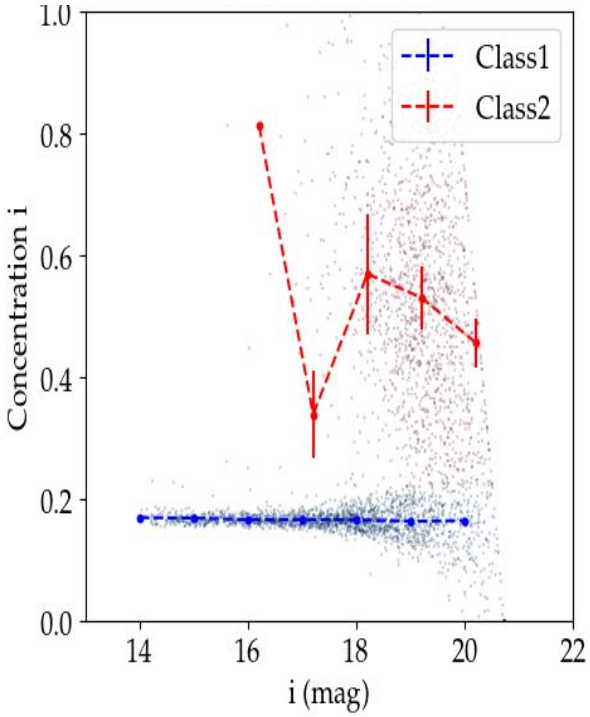


GMM - Concentration

- C = aper3 - aper6

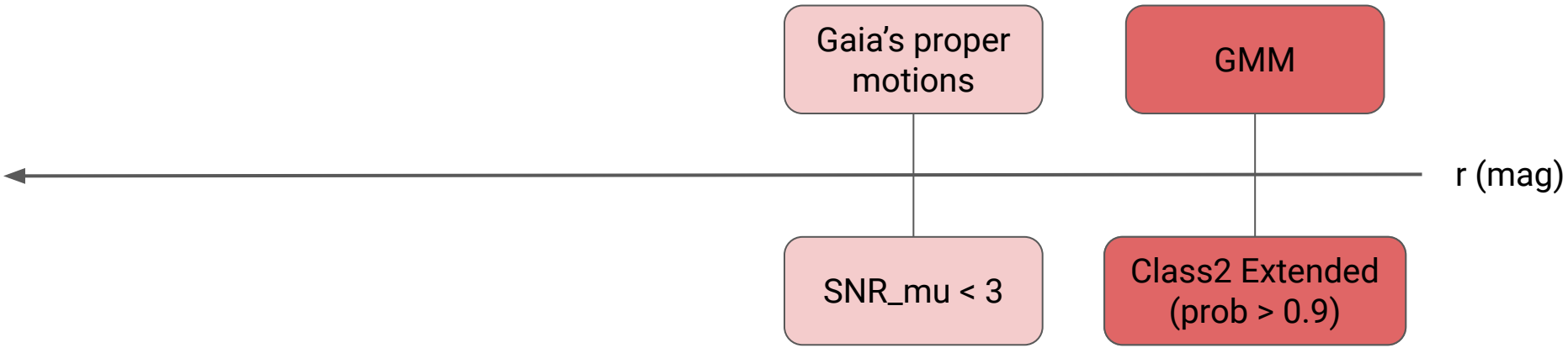




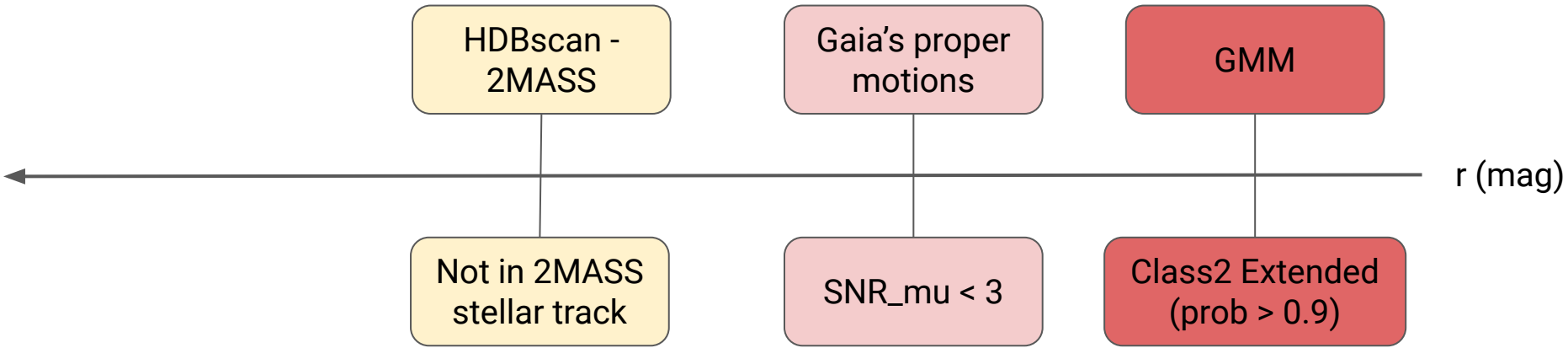


Star-Galaxy separation

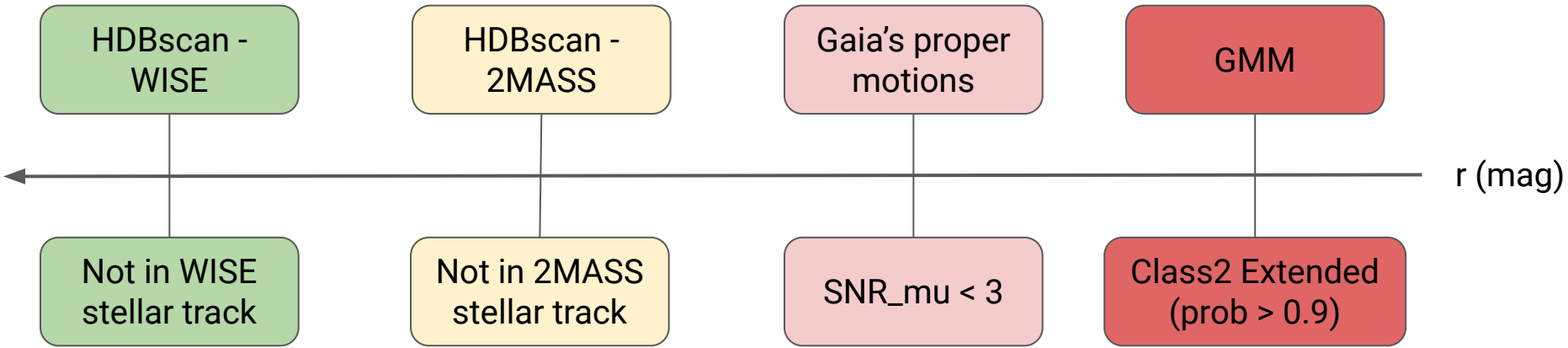
Star-Galaxy separation



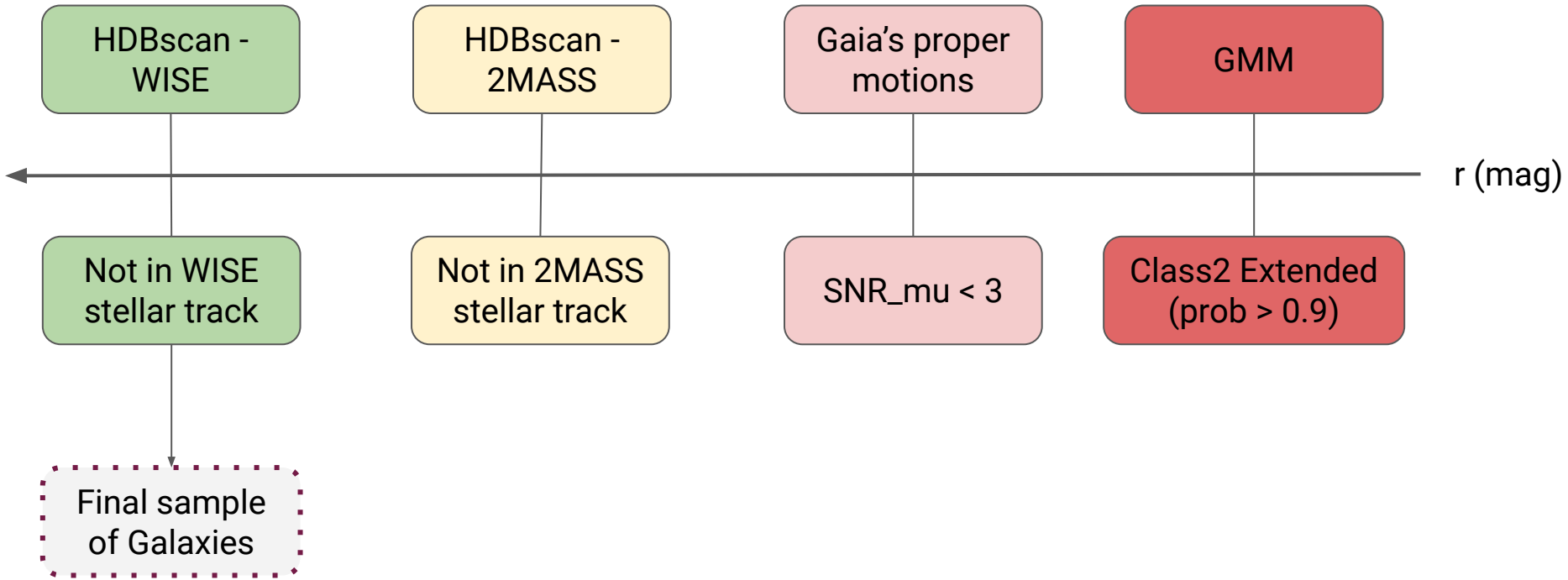
Star-Galaxy separation



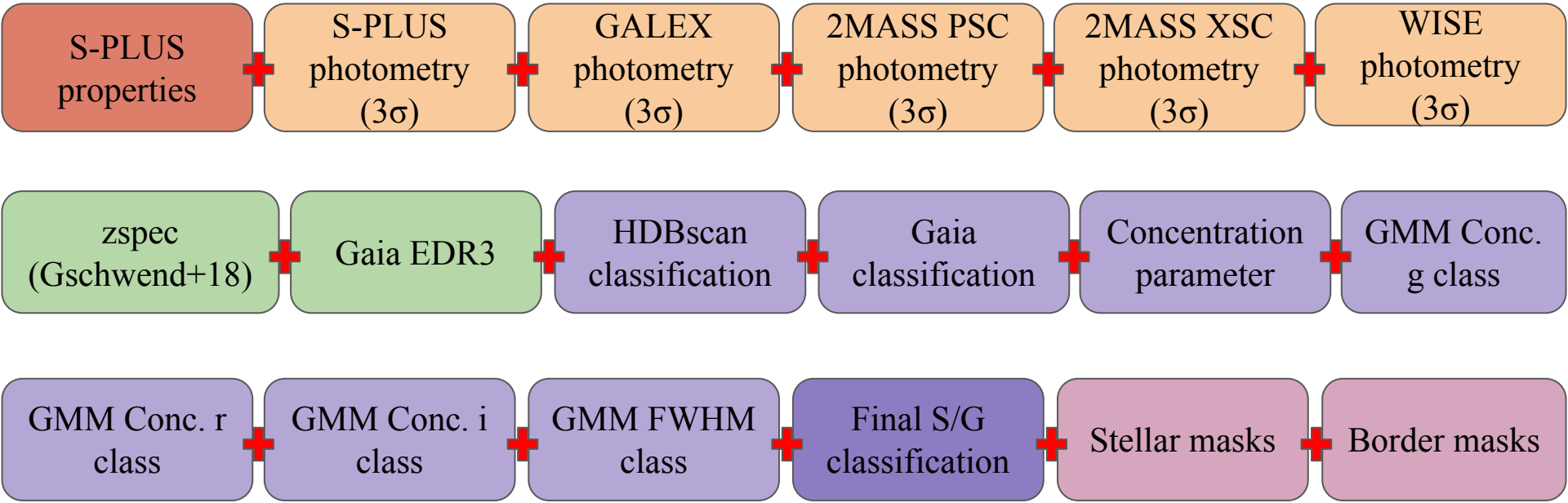
Star-Galaxy separation



Star-Galaxy separation



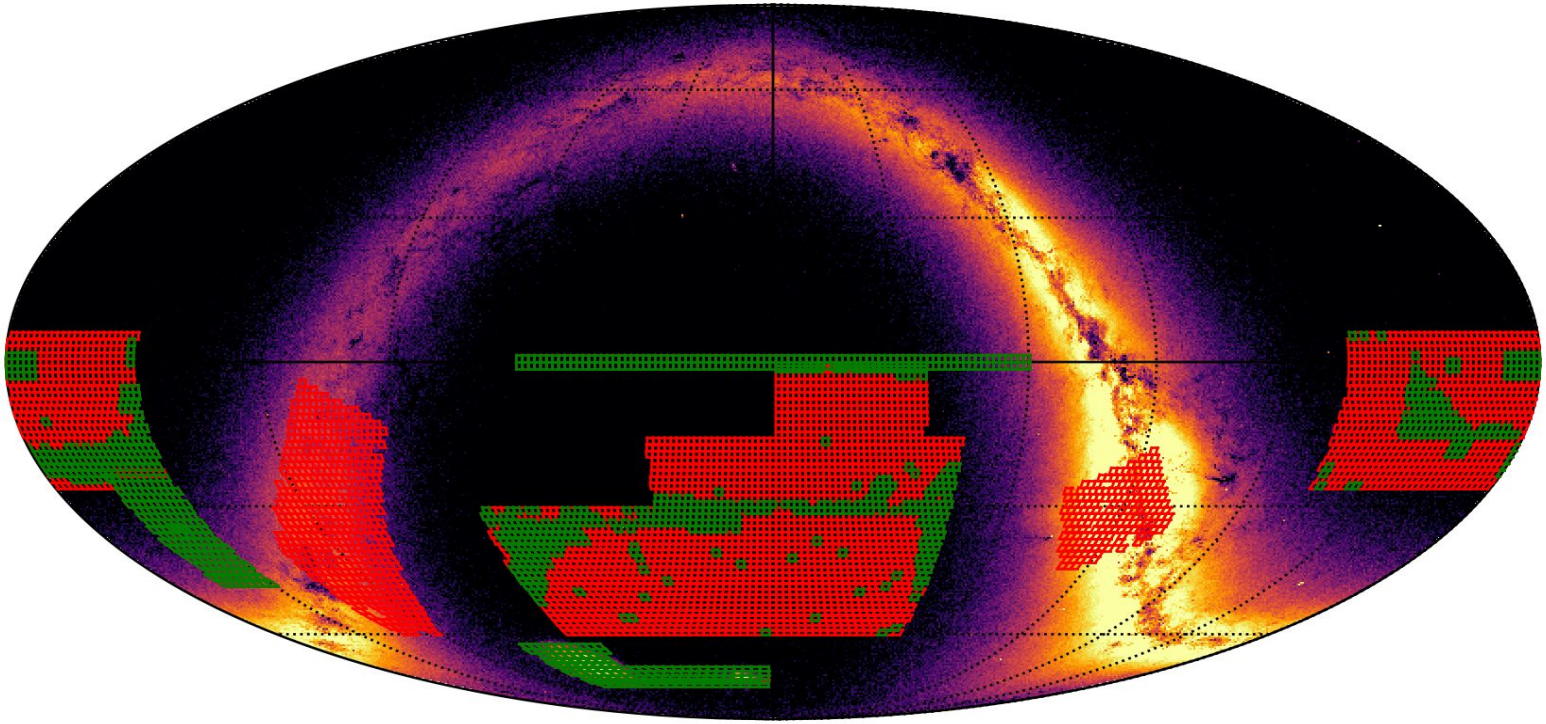
Final catalogues



Two subsamples for photometric redshifts:

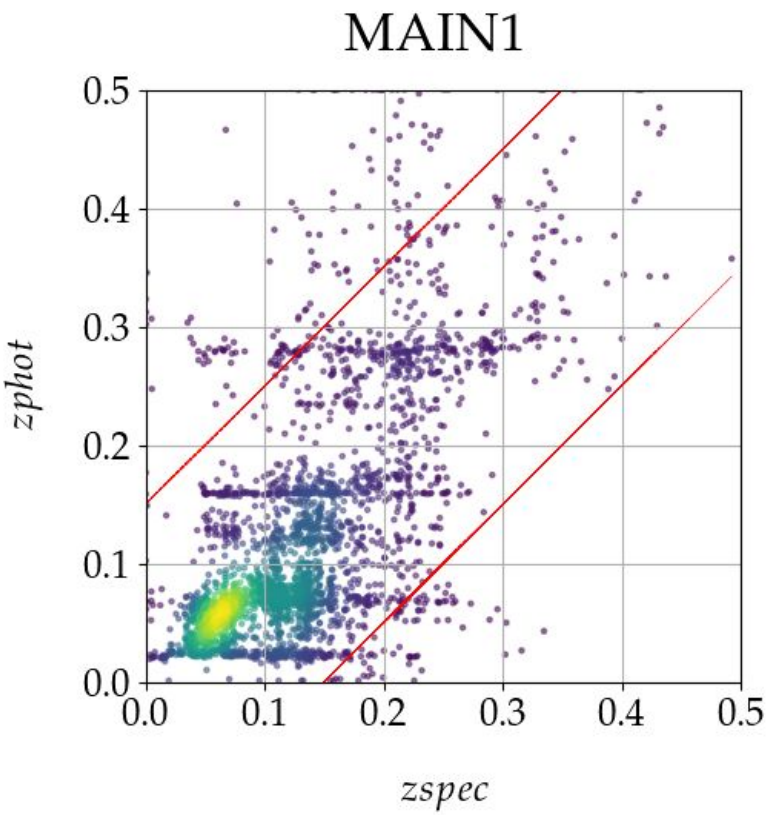
1) Those with spectroscopic redshift (testing);
2) Those classified as galaxies (consolidation).

Photometric Redshifts

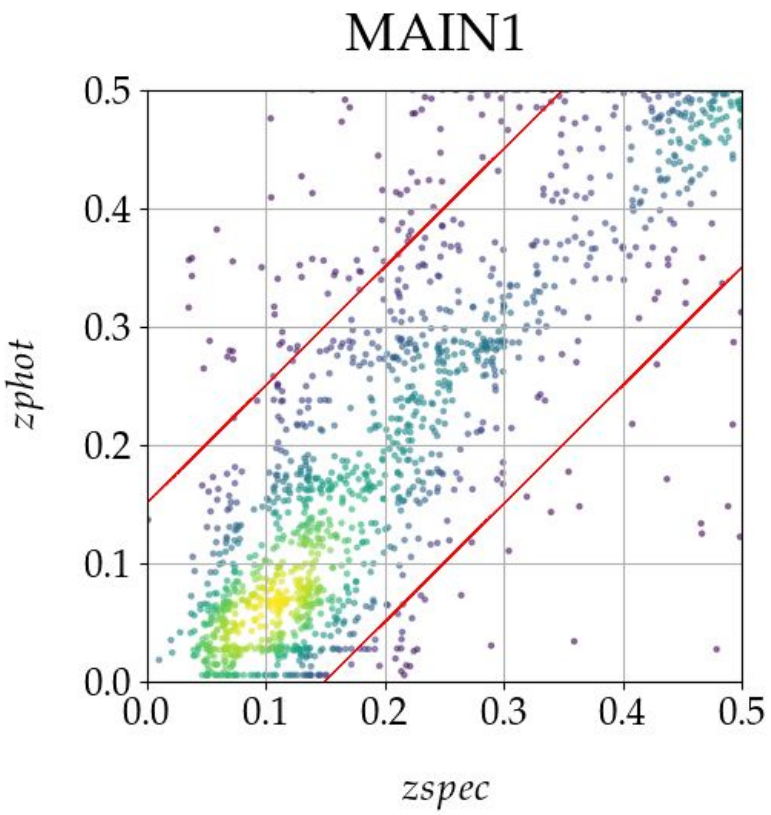


zphot vs. zspec

- S-PLUS:



- GALEX+S-PLUS+2MASS+WISE:

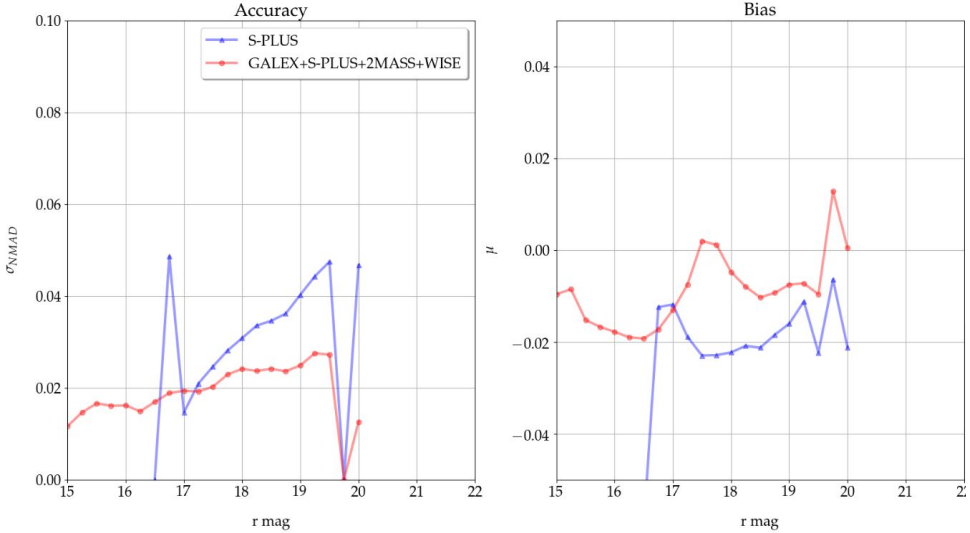


Photometric redshift performance: magnitude

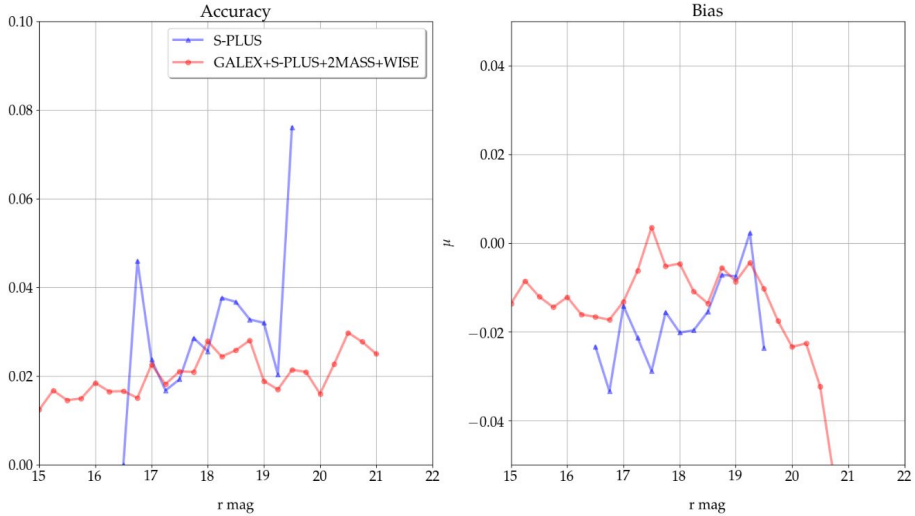
$$\sigma_{NMAD} = 1.48 \times median\left(\frac{\delta_z - median(\delta_z)}{1+z_{spec}}\right) \qquad \mu = \overline{\delta_z} = \overline{z_{phot} - z_{spec}}$$

- 21 bands vs. 12 bands:
  - red $\chi 2 < 5$ (80% of the results)
  - $\sigma < 3\%$ for all r (21 bands)
  - $\mu < 2\%$ for all r (21 bands)

MAIN2



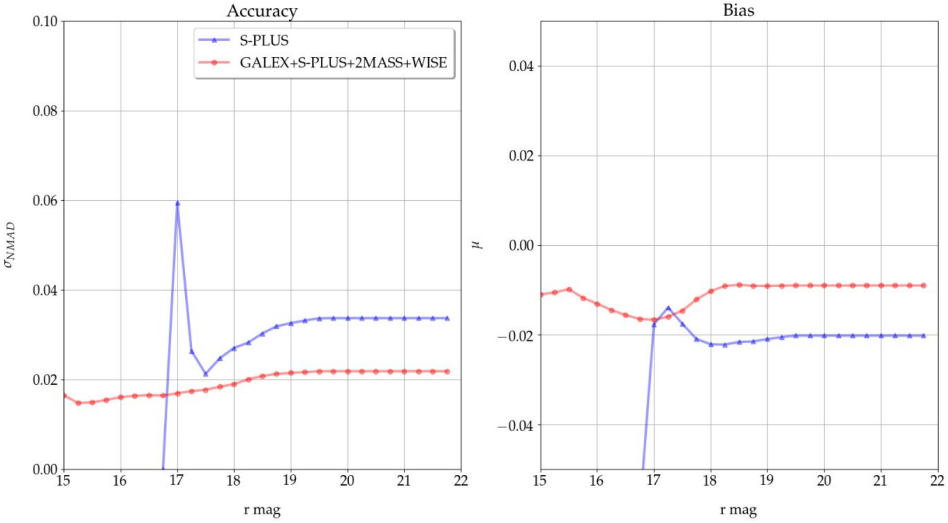
MAIN1

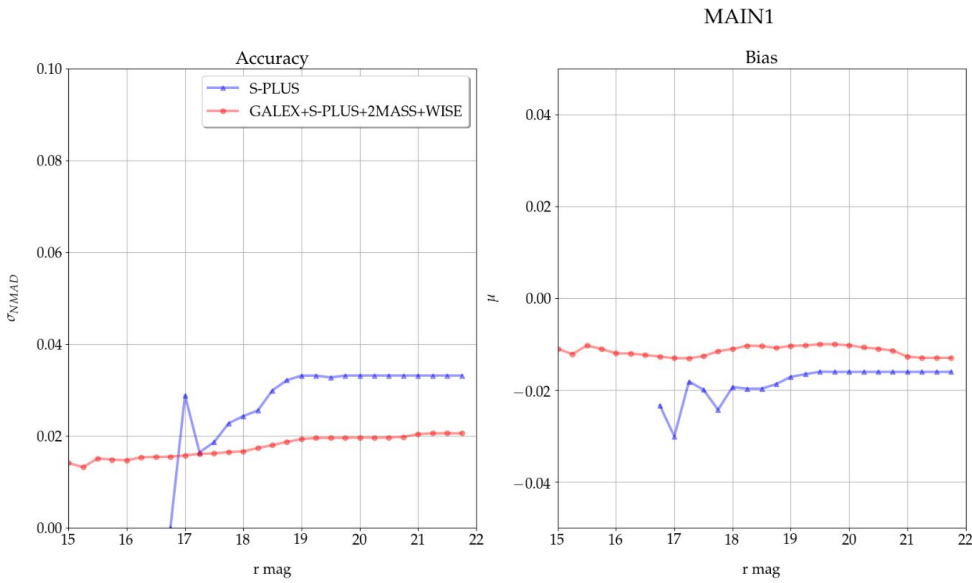


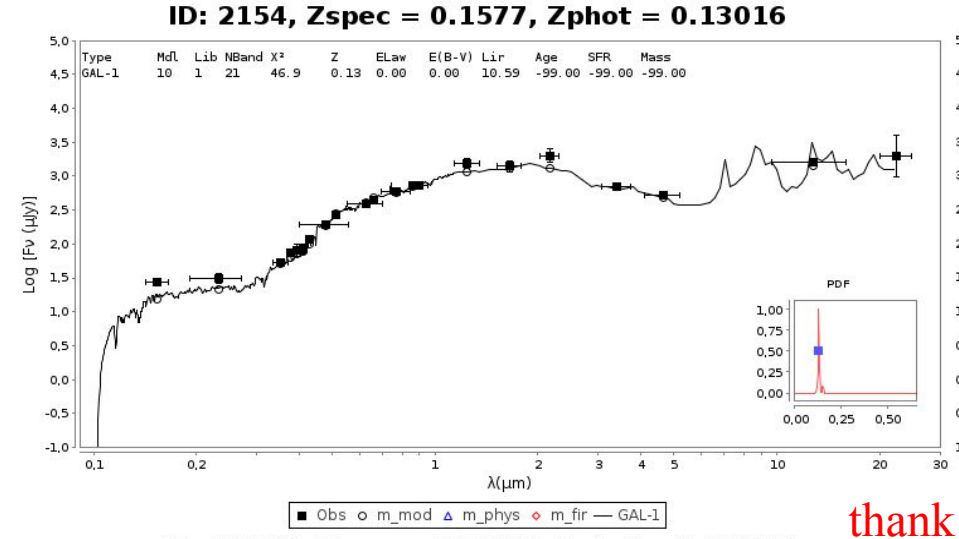
Photometric redshift performance: cumulative

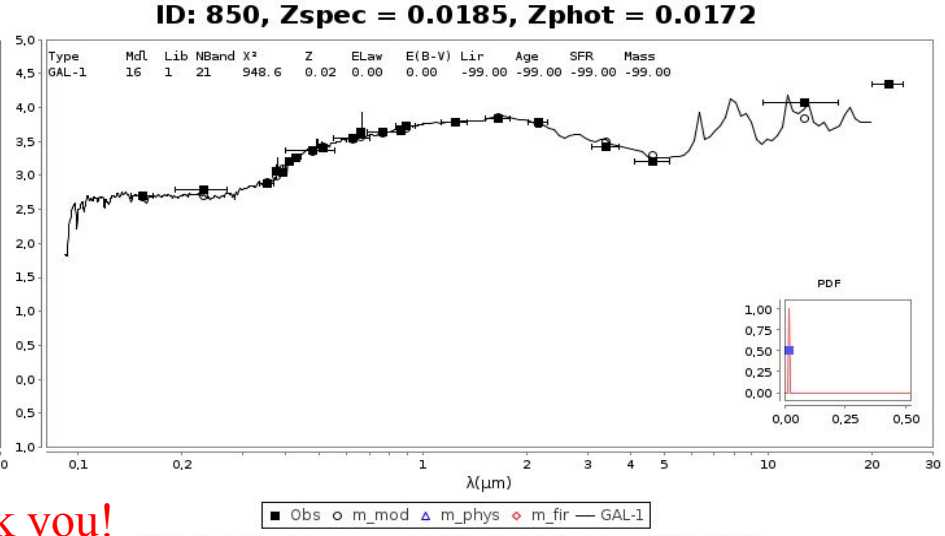
$$\sigma_{NMAD} = 1.48 \times median\left(\frac{\delta_z - median(\delta_z)}{1+z_{spec}}\right) \qquad \mu = \overline{\delta_z} = \overline{z_{phot} - z_{spec}}$$

- 21 bands vs. 12 bands:
  - red $\chi 2 < 5$ (80% of the results)
  - $\sigma < 2\%$ (21 bands)
  - $\mu < 1\%$ (21 bands)

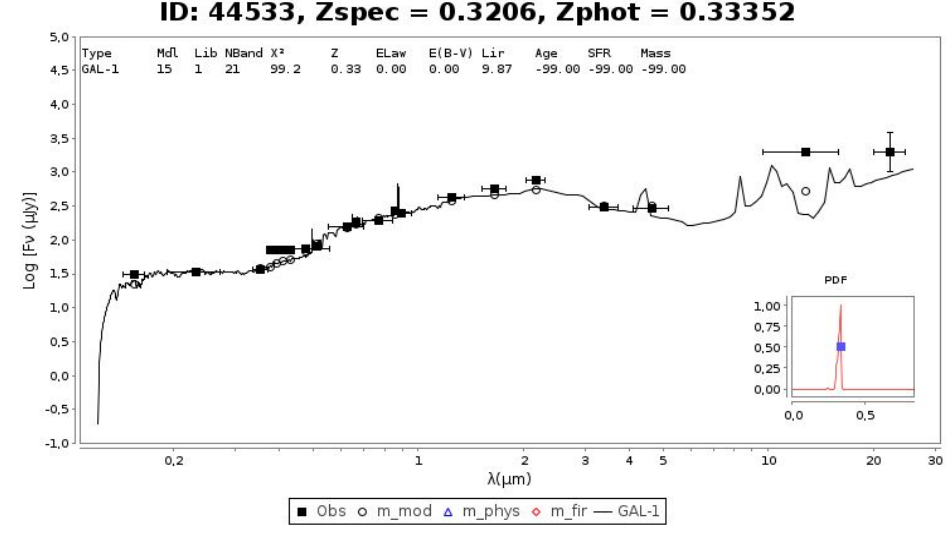


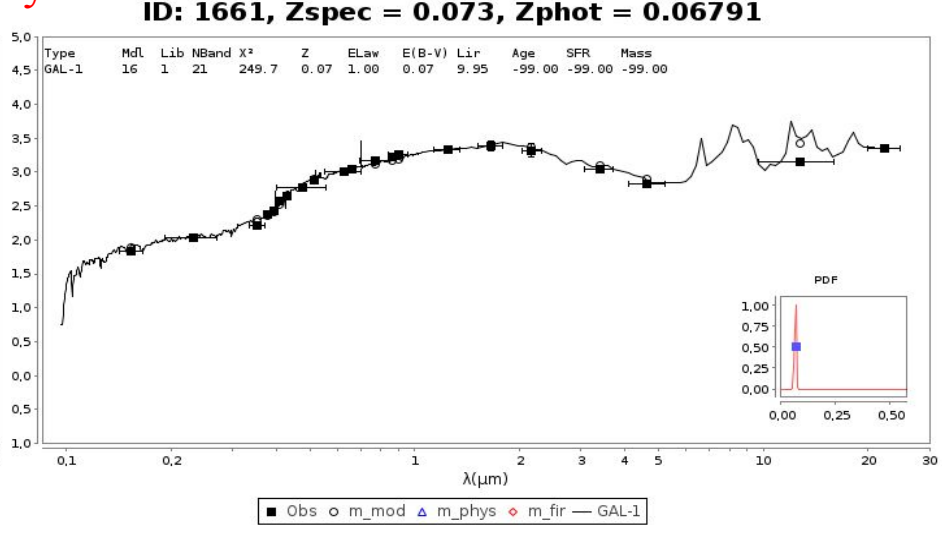



ID: 2154, Zspec = 0.1577, Zphot = 0.13016
Type Mdl Lib NBand X² Z ELaw E(B-V) Lir Age SFR Mass
GAL-1 10 1 21 46.9 0.13 0.00 0.00 10.59 -99.00 -99.00 -99.00
PDF
Log [Fν (μJy)]
λ(μm)
Obs m_mod m_phys m_fir GAL-1


ID: 850, Zspec = 0.0185, Zphot = 0.0172
Type Mdl Lib NBand X² Z ELaw E(B-V) Lir Age SFR Mass
GAL-1 16 1 21 948.6 0.02 0.00 0.00 -99.00 -99.00 -99.00 -99.00
PDF
λ(μm)
Obs m_mod m_phys m_fir GAL-1

thank you!


ID: 44533, Zspec = 0.3206, Zphot = 0.33352
Type Mdl Lib NBand X² Z ELaw E(B-V) Lir Age SFR Mass
GAL-1 15 1 21 99.2 0.33 0.00 0.00 9.87 -99.00 -99.00 -99.00
PDF
Log [Fν (μJy)]
λ(μm)
Obs m_mod m_phys m_fir GAL-1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Type Mdl Lib NBand X² Z ELaw E(B-V) Lir Age SFR Mass
GAL-1 16 1 21 249.7 0.07 1.00 0.07 9.95 -99.00 -99.00 -99.00
PDF
λ(μm)
Obs m_mod m_phys m_fir GAL-1