Detection on χ^2 coadds

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Current coadd detection in the science pipelines

- Detection is performed in each band using lsst.pipe.tasks.multiBand.DetectCoaddSourcesTask
- Detections in each band are merged using lsst.pipe.tasks.mergeDetections.MergeDetectionsTask
  - Peaks are matched across bands if they are within (by default) 0.3 arcsec
  - Peaks are culled in an attempt to remove spurious detections and removed if
    - Detected in a single band (default)
    - Are not sufficiently bright compared to the other neighboring sources in their footprint

χ^2 coadds

- References:
  - Szalay et al. 1999
  - Kaiser 2001
  - Lupton whitepaper (ask Robert for PDF)
  - DMTN-015
  - Jim's slides on coadds

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$$\chi = \sum_b \frac{I_b \otimes \phi^\dagger}{\sigma_b}$$

  - I_b = image in band b
  - $\phi^\dagger$ = reflection of the PSF
 - σ_b = median variance in band b

χ^2 coadd catalog notes

- χ^2 Detection catalog will be improved
  - Currently using SourceDeblendTask with no PSF smoothing or background subtraction
  - Needs background subtraction
  - Detection has not been tuned (eg. the threshold can be modified)
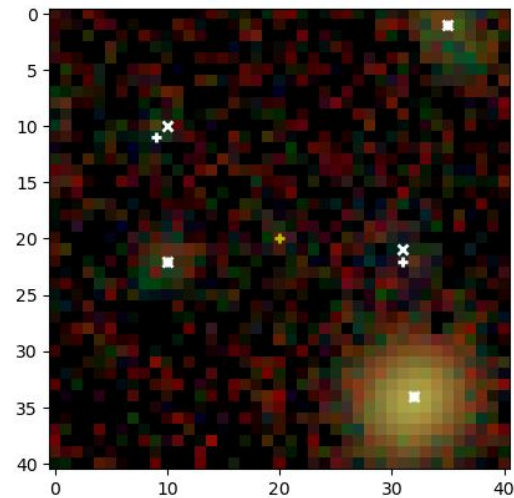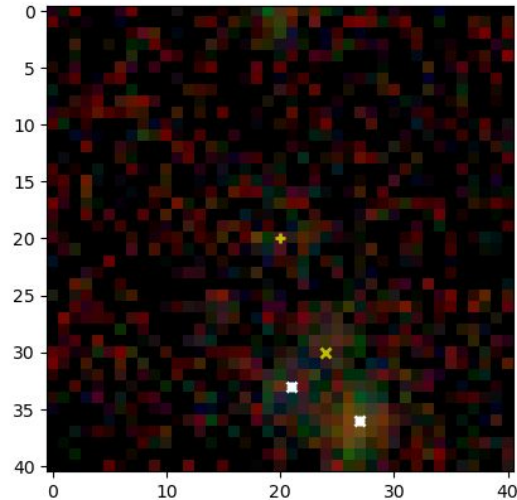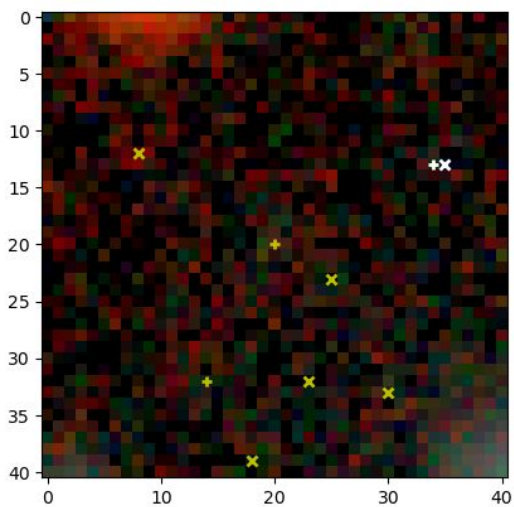- I am using the DC2 "truth_summary" catalog to compare catalogs

Comparison on HSC RC2 images

- Comparing the mergeDet and χ^2 catalogs in HSC RC2 tract 9813, patch 40
- Real data, no truth catalog
- Looking for qualitative differences between matches in one catalog and not the other

# Comparison on HSC RC2 images
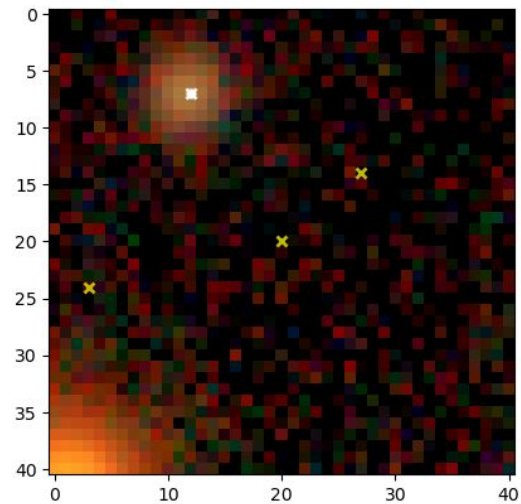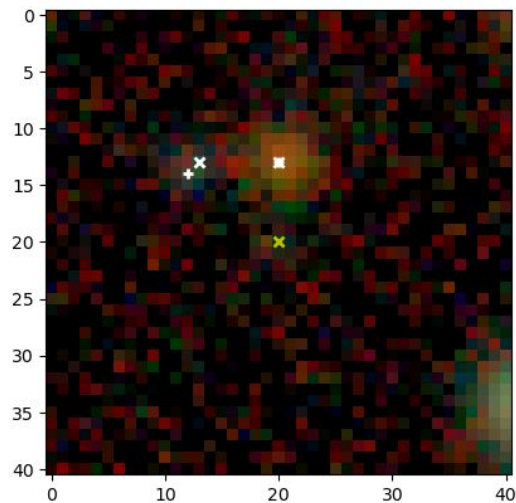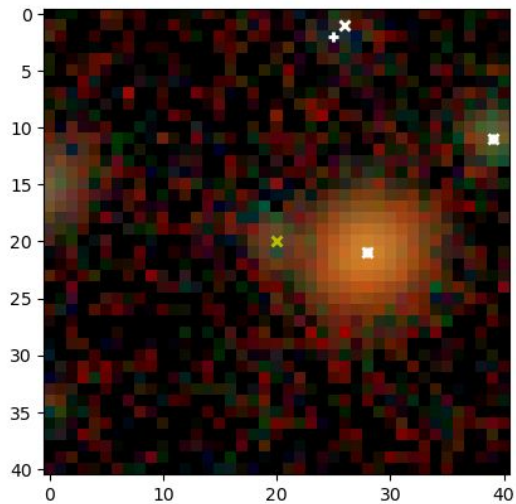
Comparison on HSC RC2 images

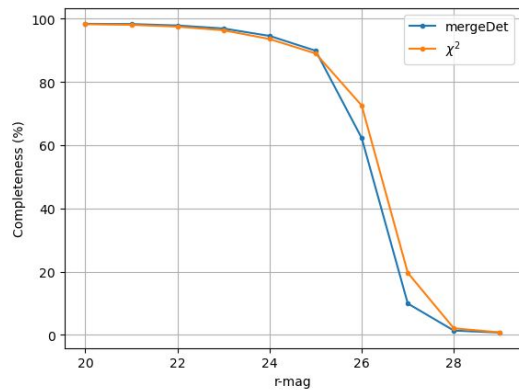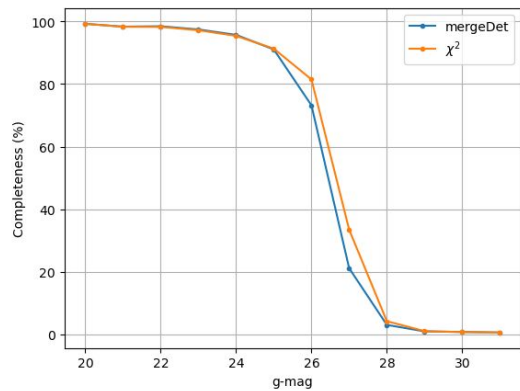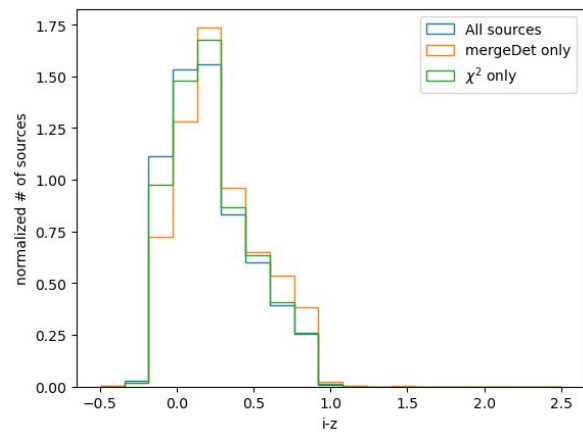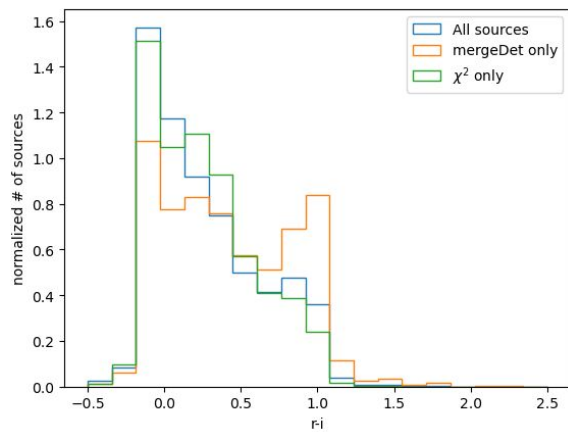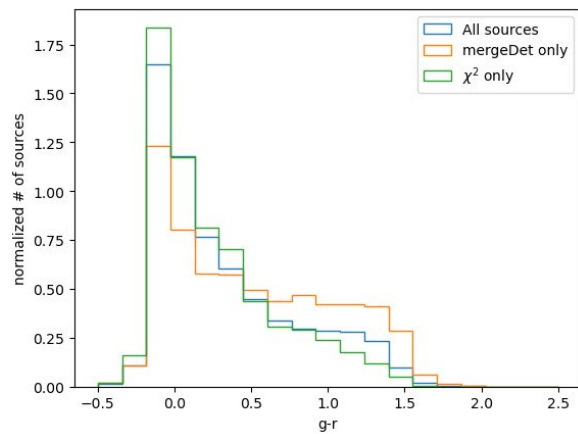# DC2 3828 Comparison with mergeDet (similar stats for 3829)

	mergeDet	χ^2
Total sources	895,355	1,039,368
False positives	207,828 (23%)	213,407 (21%)
Unique sources	687,018	825,219
Split sources	254	371

- 601,482 sources in both catalogs
- 85,536 sources in mergeDet (but not χ^2)
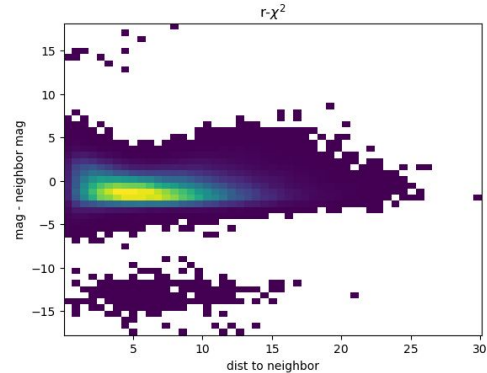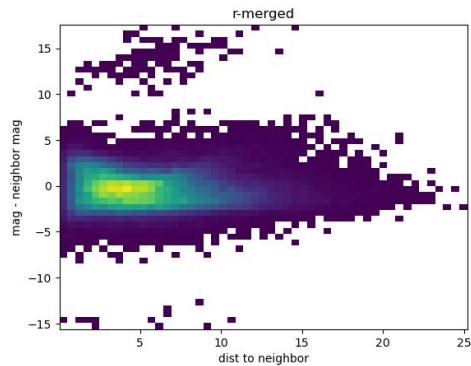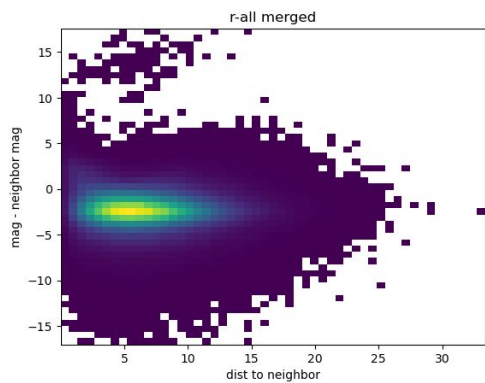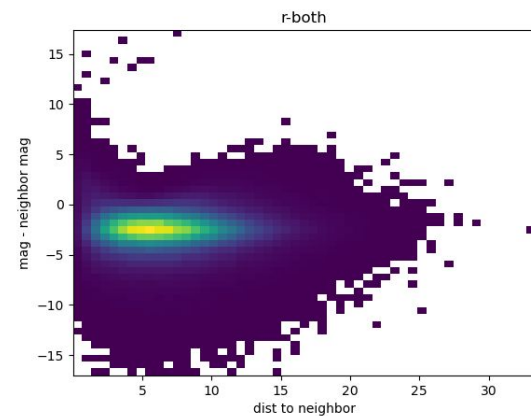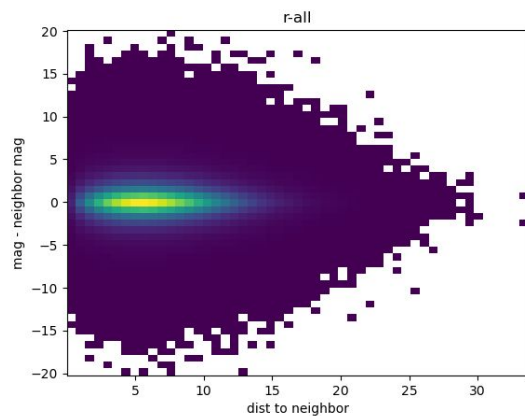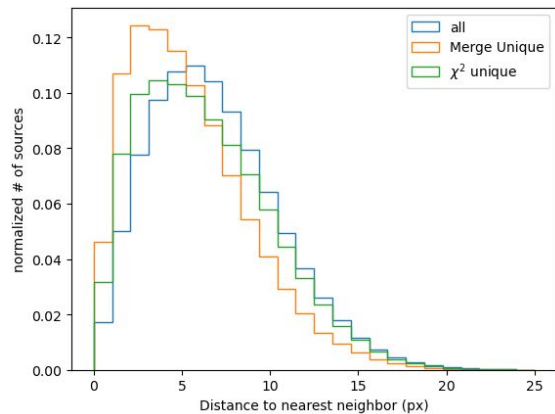- 223,737 sources in χ^2 (but not mergeDet)

Completeness
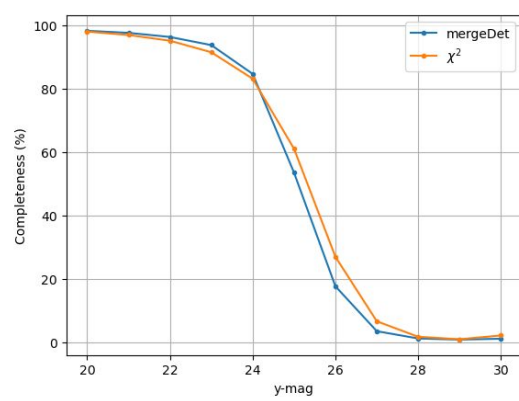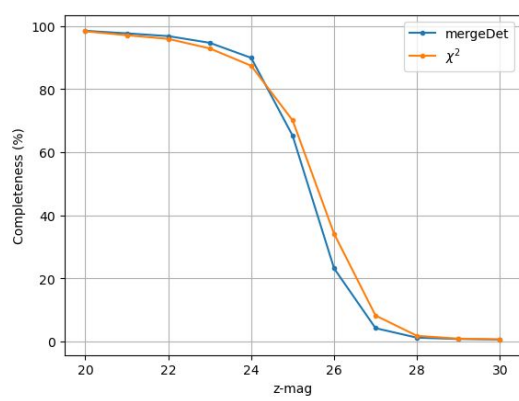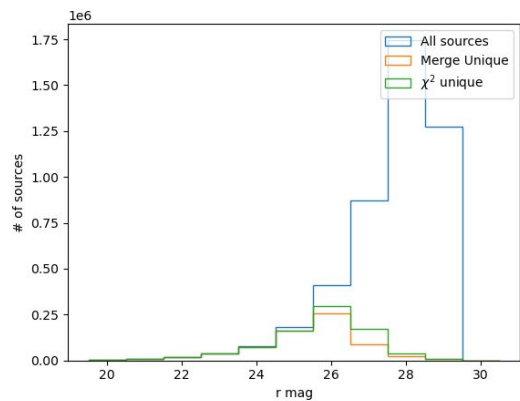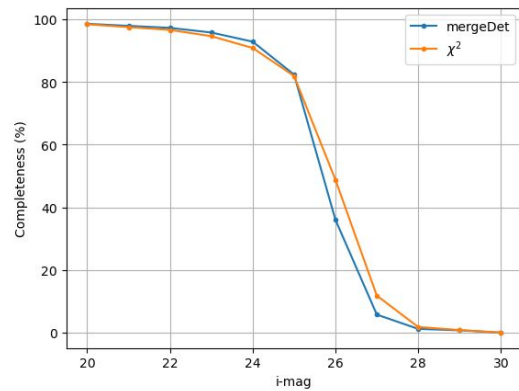
Color distribution

Nearest neighbor distance

Conclusion and Future work

- Detection needs to be improved in new task
  - Implement background subtraction
  - Tune threshold
- χ^2 catalogs have more true detections with a smaller (but still high) false positive rate
- χ^2 catalogs are biased to miss nearby sources with fainter magnitudes
  - Detection on difference images may be able to locate missing sources (credit Jim Bosch)
  - Any other ideas?
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