Data Analysis of Data Challenge 4

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DARK ENERGY SURVEY

DC4 evaluation

1. We test the DC4 data.

2. We test to improve the simulations to match the universe and the camera

3. We test to improve the data analysis codes to the point where we understand them.

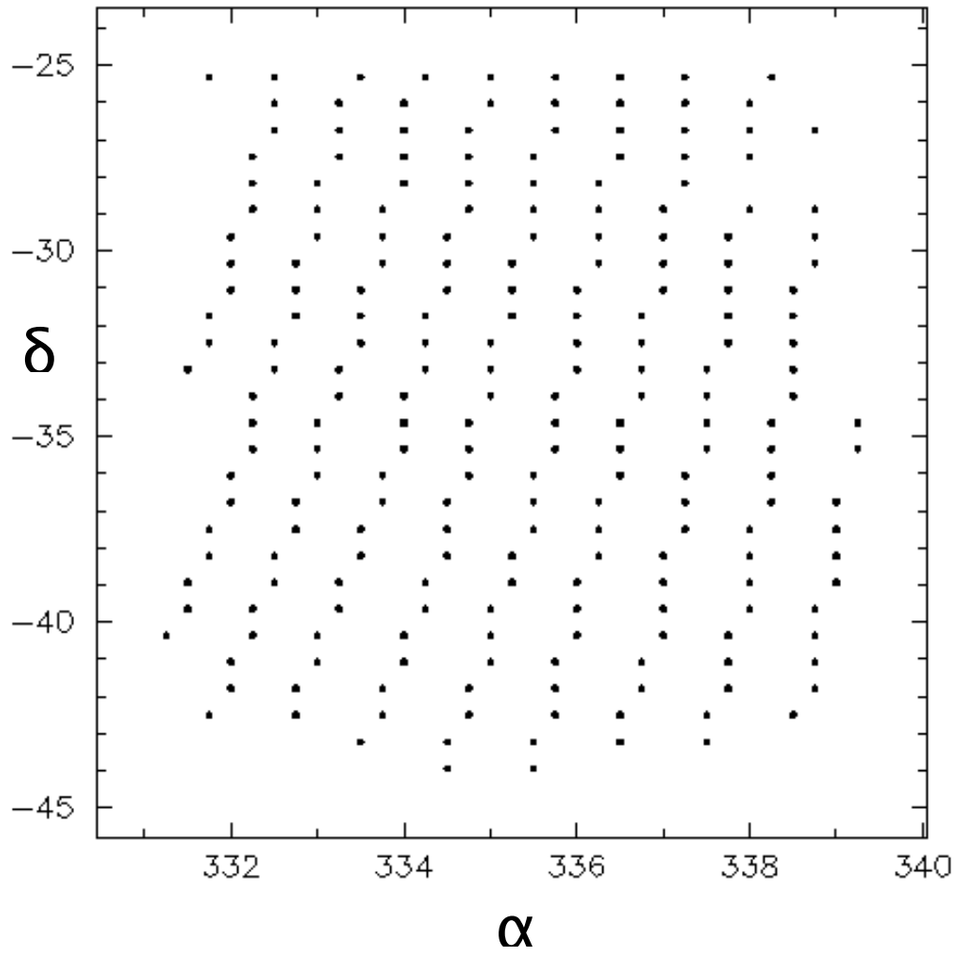
4. We aim to turn these tests into science commissioning tests for use in May 2011.

5. Goal in 2009: construct a galaxy catalog useful for cluster finding.

   - Issues are marked in red.

I. The initial data

1. We start from the catalog of tiles on disk, testing the secondary archive
   - The SWGs are testing the portal interface.
2. The catalogs of the tiles - 0.75x0.75 degree
   - Directories labeled by processing date
     1. No way to tell which processing date to use.
     2. We adopt the 2008-12-* processing
        - Eliminate multiple processings near this date
        - Eliminate dates without coadd dirs
- Eliminate everything at Dec > -20
- 233 tiles in final list.



The location of the 233 tiles on the sky.

II. Overlapping tiles

1. The tiles have overlapping boundaries.

   - What is the algorithm to reject duplicate objects?

     1. If geometric, the cuts is not uniform in RA and Dec.

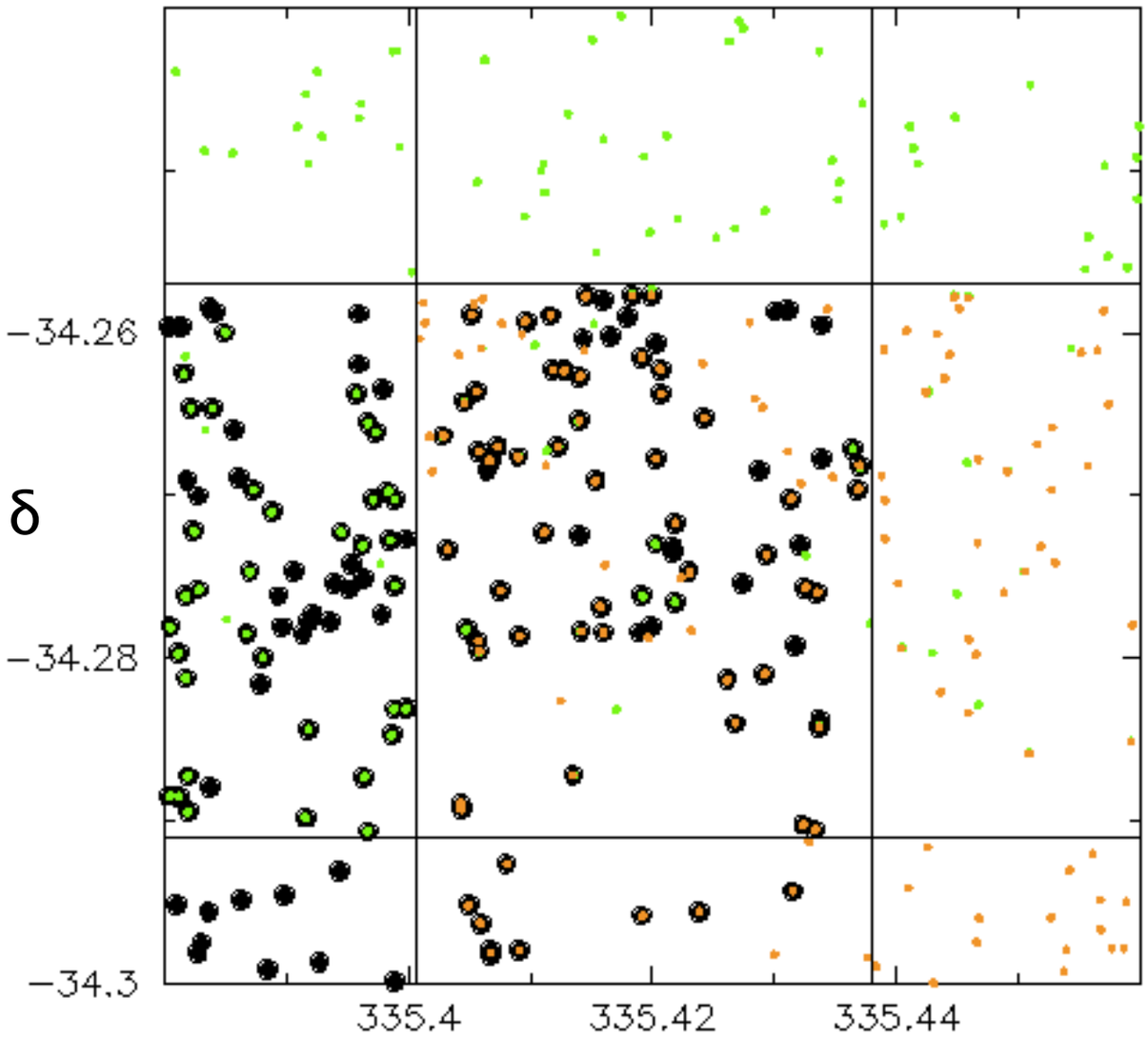
     2. If RA, Dec matching then objects from different tiles contribute to the final catalog

        - There is no entry in the catalog reporting which tile an object came from. This is needed in order to report and debug problems.

- We assume a 1’ overlap on every side.

Difference in depth due to background variation?

Black- tile 1 Green- tile 2 Orange- tile 3



A corner of overlapping tiles. The lines show the approximate boundaries of the objects in the individual tiles. Note the rectangular shape which is not made square by a cos(δ) correction.

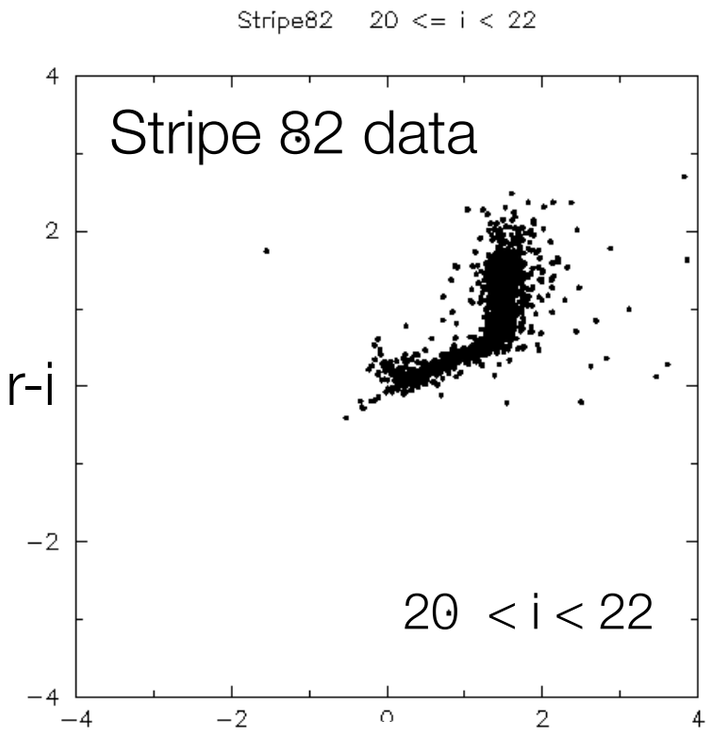
III. Star/galaxy separation

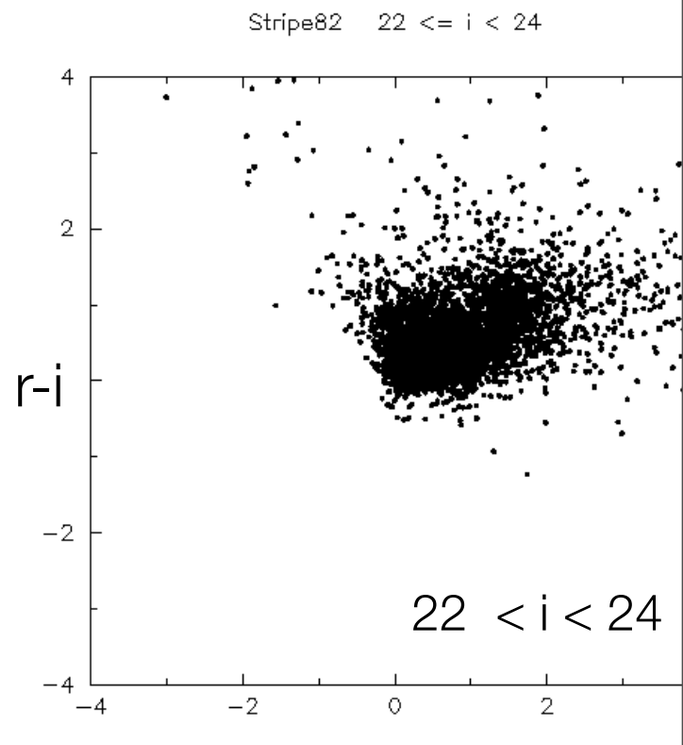
1. Using class_star(i) >= 0.98 as star separator is non-optimal
   - SDSS stripe 82 works past i=22
   - Sextractor star_class becomes uncertain near i=21

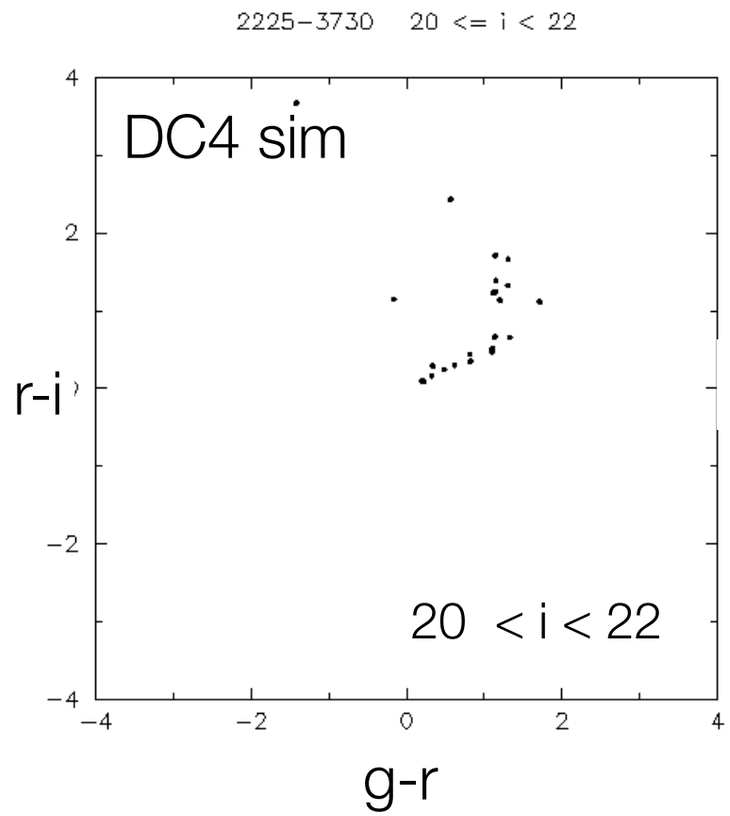
2. What is the star/galaxy separation algorithm?

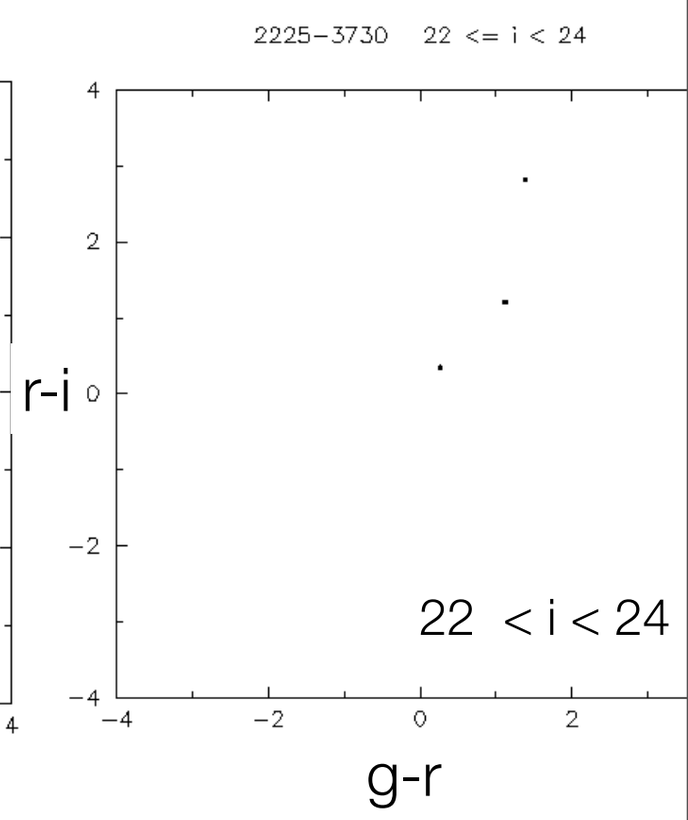
In this tile, even at 20<i<22 the s/g separator reports uncertainty about almost all objects.

In 22<i<24 bin galaxies mis-classified as stars dominate.



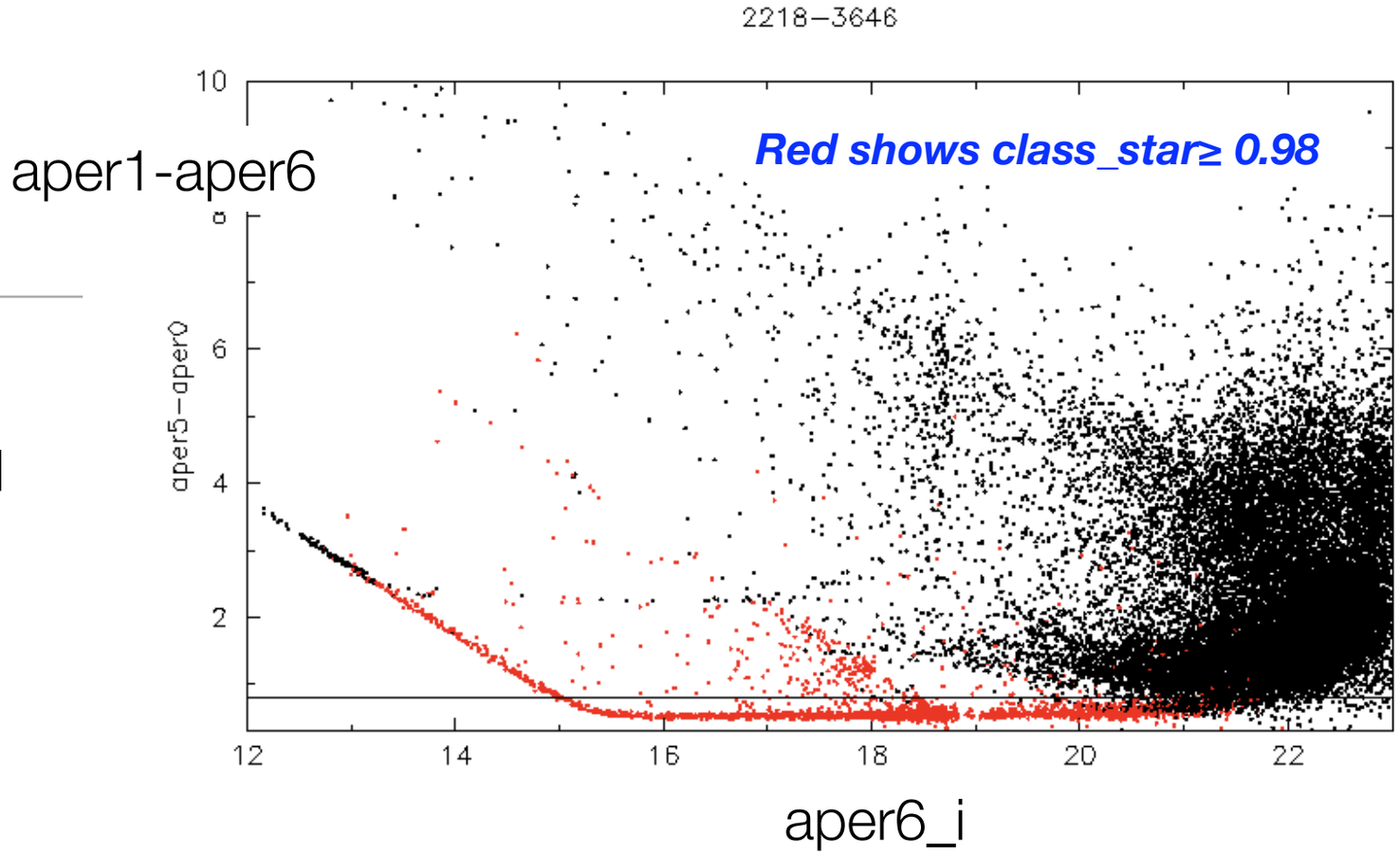


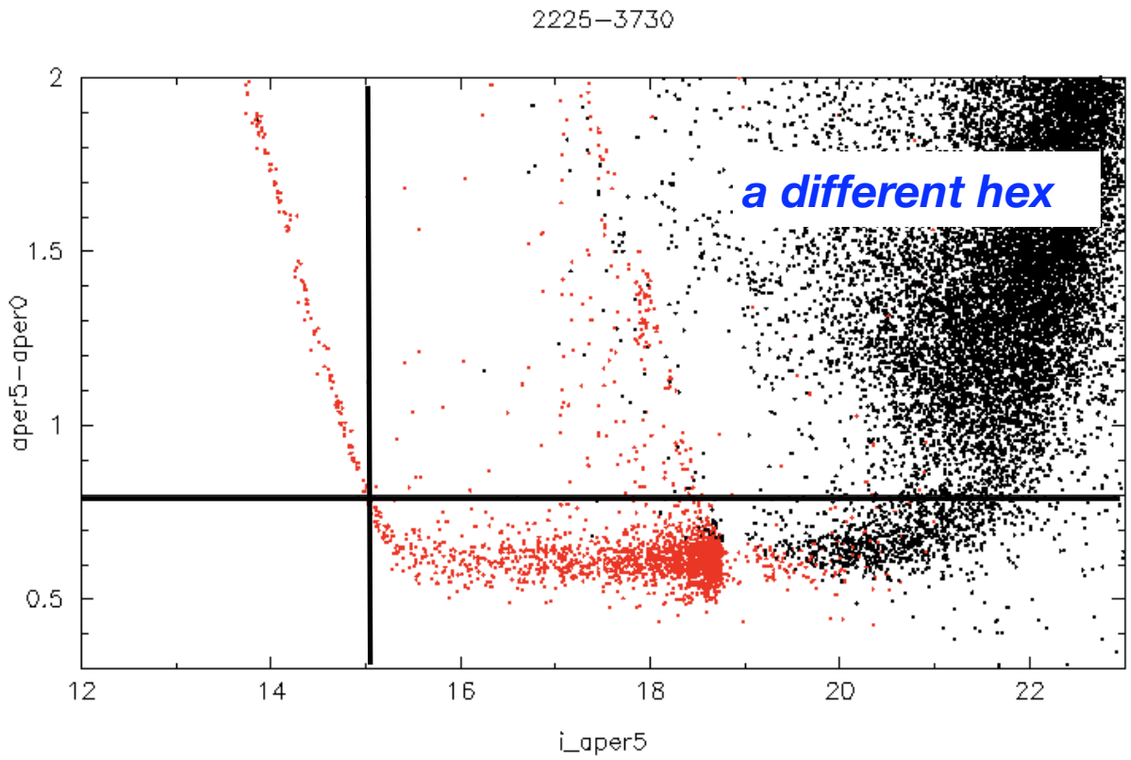


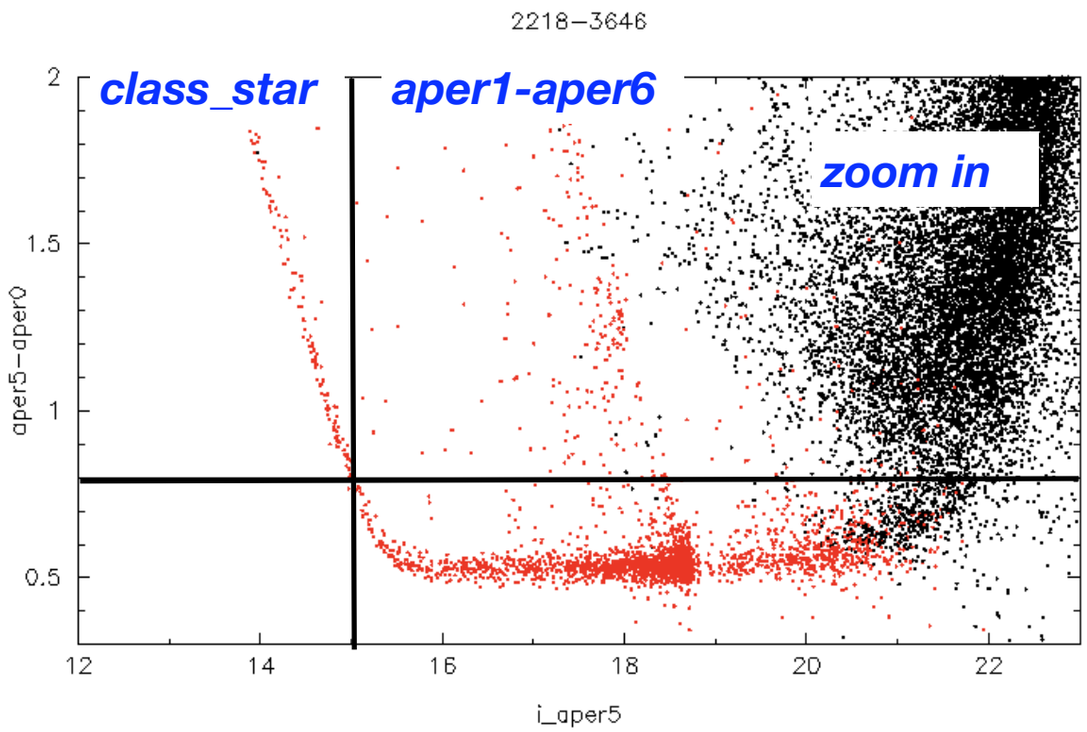


An aper1-aper6 S/G separator

1. A pretty good separator:
   - i-band decision, used for all
   - i ≤ 15 class_star ≥ 0.98
   - i > 15 aper0-aper5 ≤ 0.85





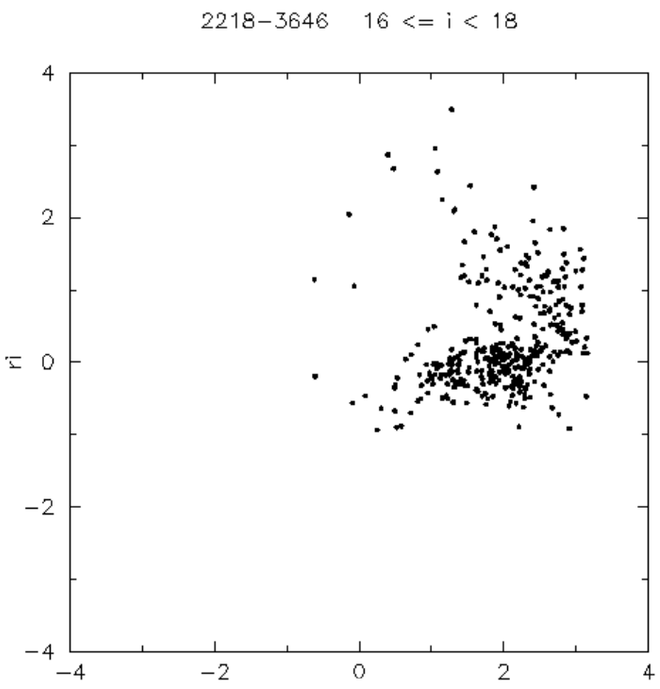


DARK ENERGY SURVEY

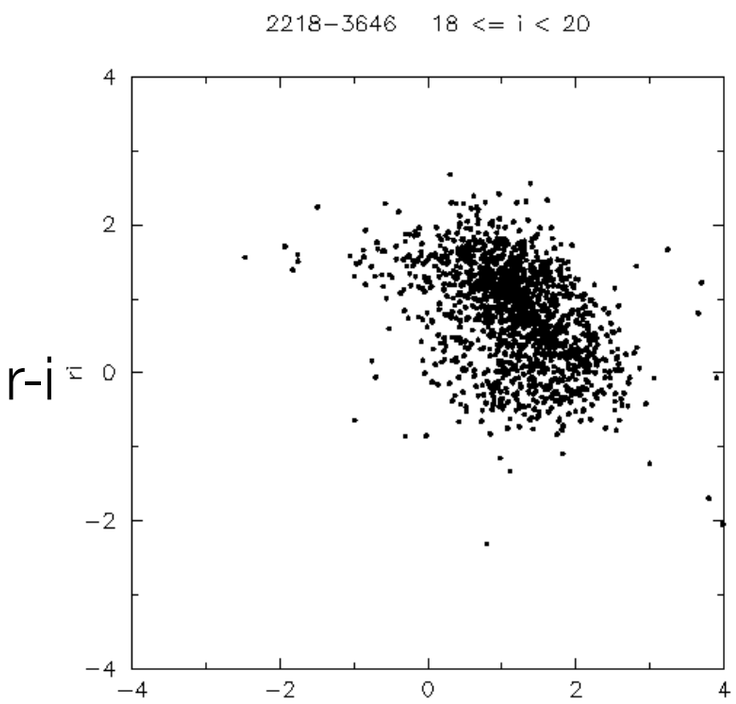
Stars in 2218-3646

New S/G separator
mag_aper1 mags

16 < i < 18



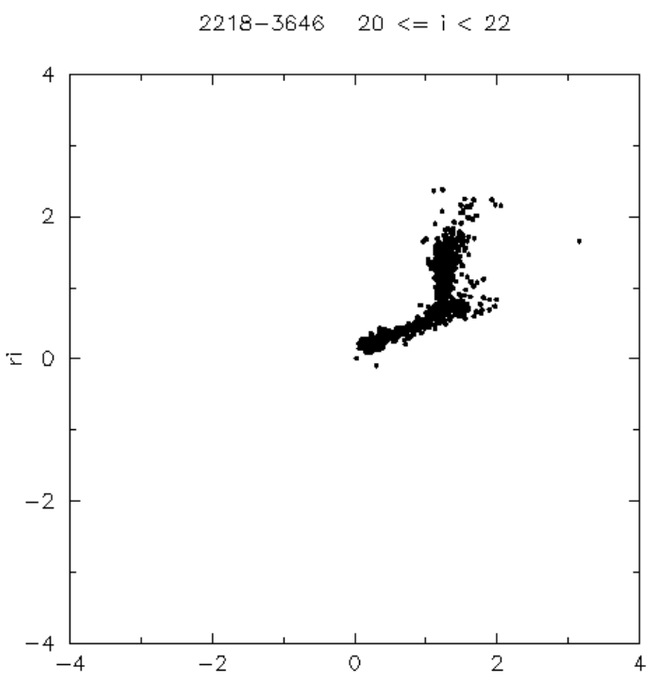
18 < i < 20



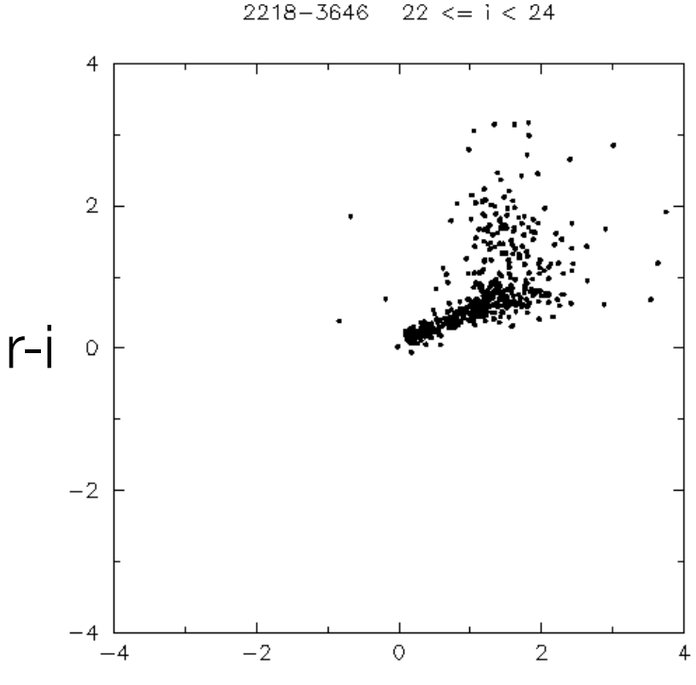
At bright magnitude the universe is noisy.

At 20<i<22 the universe is similar to our universe.

20 < i < 22



22 < i < 24



At faint magnitudes one can now still examine the stellar locus.

DARK ENERGY SURVEY

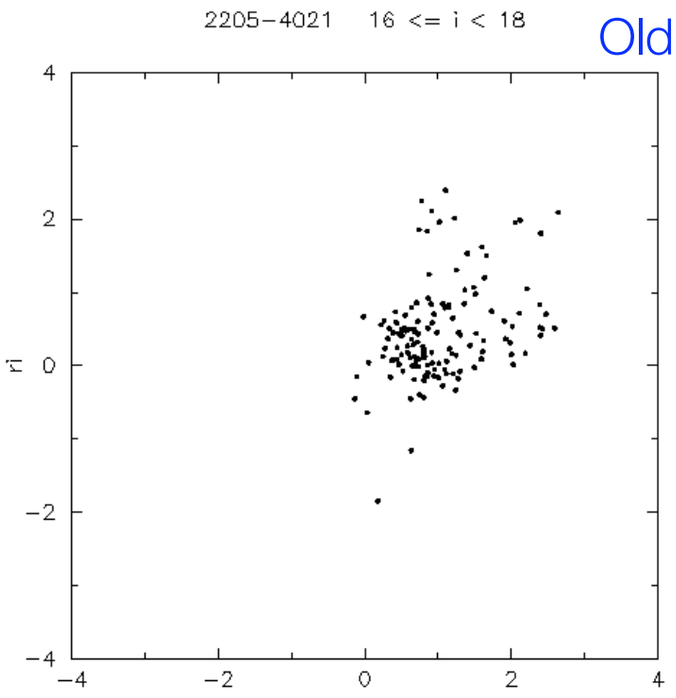
Stars in 2205-4021

Using the new S/G separator.
There remain issues in the data.

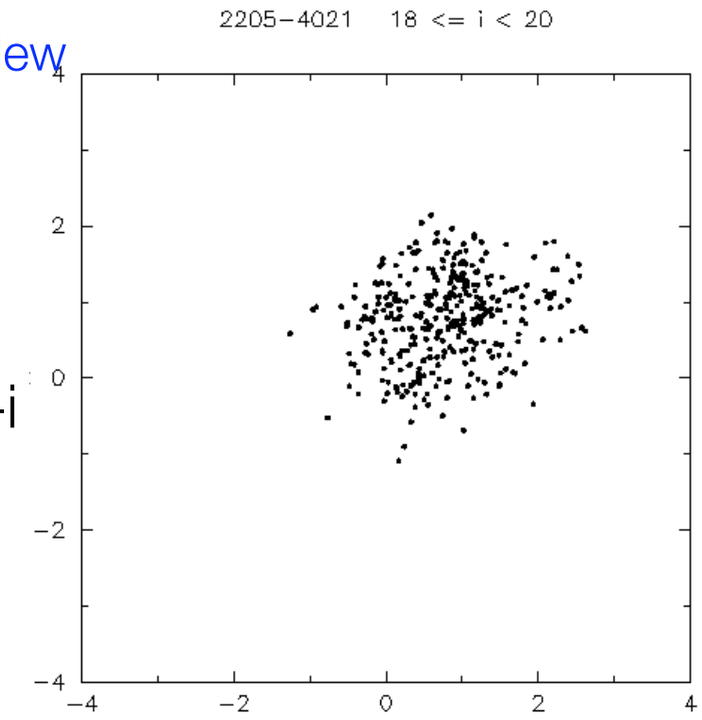
Old

New

16 < i < 18



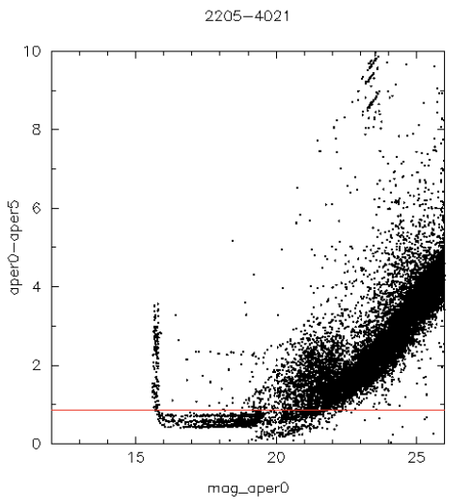
18 < i < 20



No stars because the difference between aper1 and aper6 rises.

Multiple stellar loci!

20 < i < 22



DARK ENERGY SURVEY

III. Astrophysics: Stellar Locus

1. The stellar locus is very thin. This can be used as a calibration test tool.
   - e.g., Ivezic et al 2007, Covey et al 2007, High et al 2009 submitted
2. We outline a first pass at this, using the blue branch of the g-r/r-i locus and all of the r-i/i-z locus.
3. The procedure will be to pick a fiducial field, measure the locus, and examine the statistics of the variations about the fiducial locus.

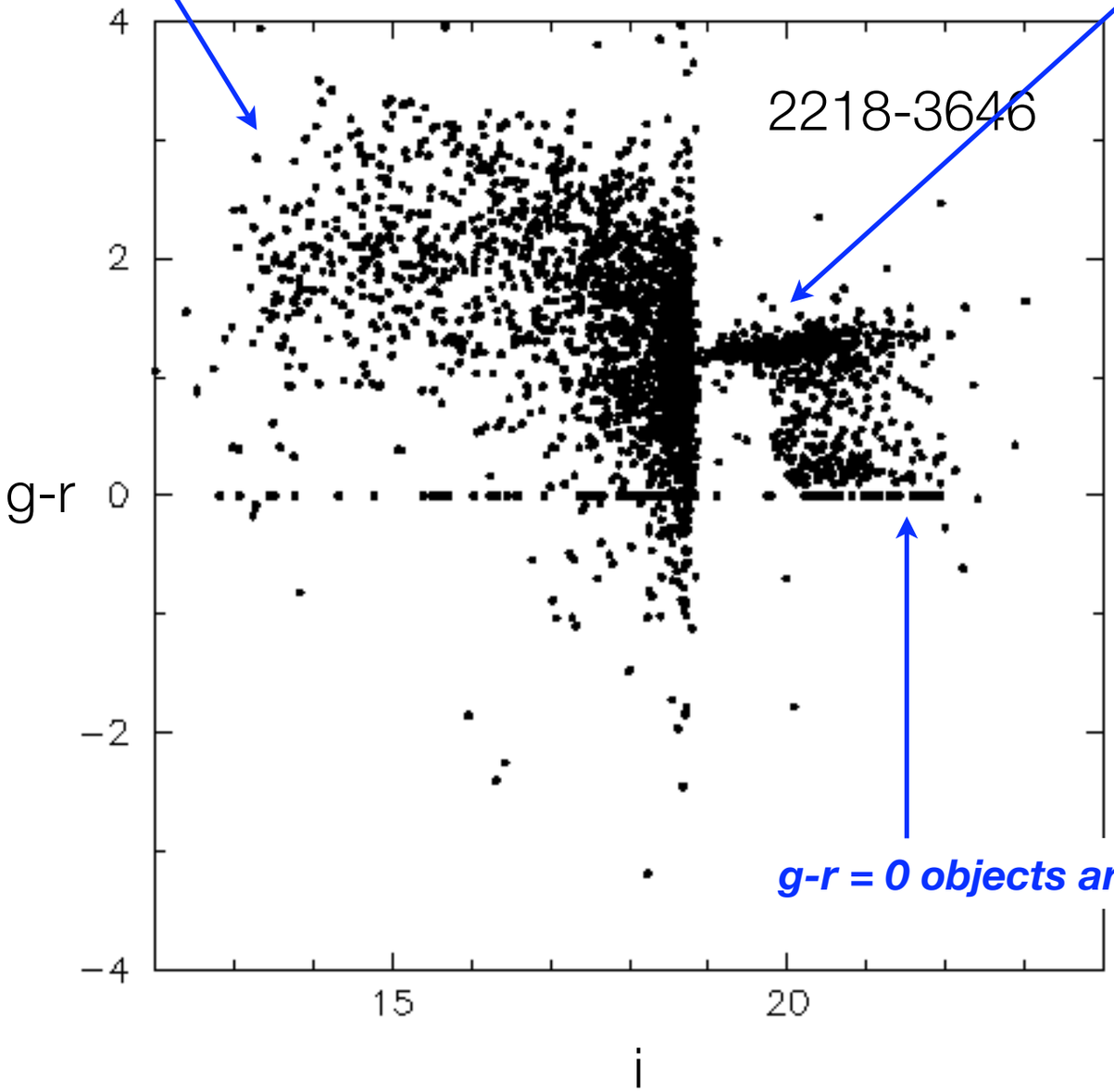
The universe in the simulation

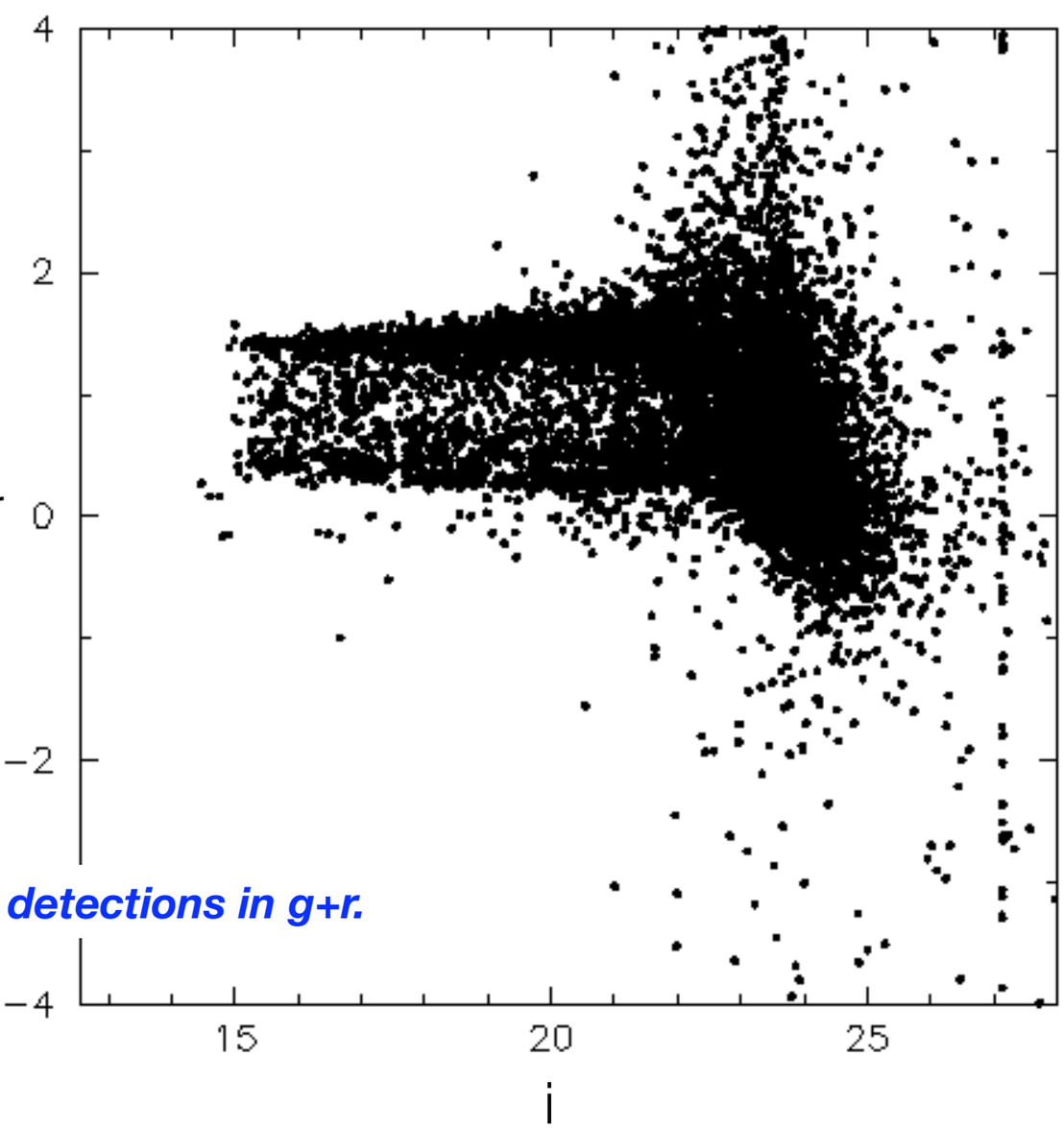
The universe in the DC4 simulation is different from that in the real universe. We will proceed with tests regardless.

Stars at i<19 are from USNO-B and the scatter in the colors reflects the photometric scatter in the USNO-B catalog.

Stars at i>19 are from the Besacon model and use Besacon SDSS colors.

Suggest using USNO-B colors to select SED, then SED to compute colors for DC5.



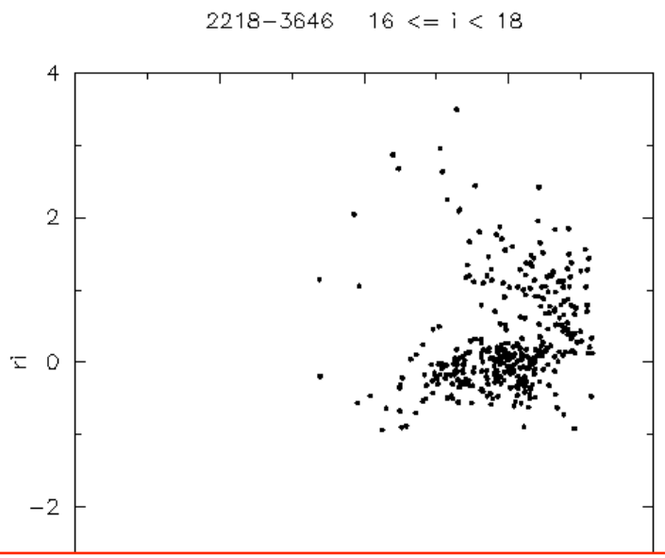


g-r = 0 objects are null detections in g+r.

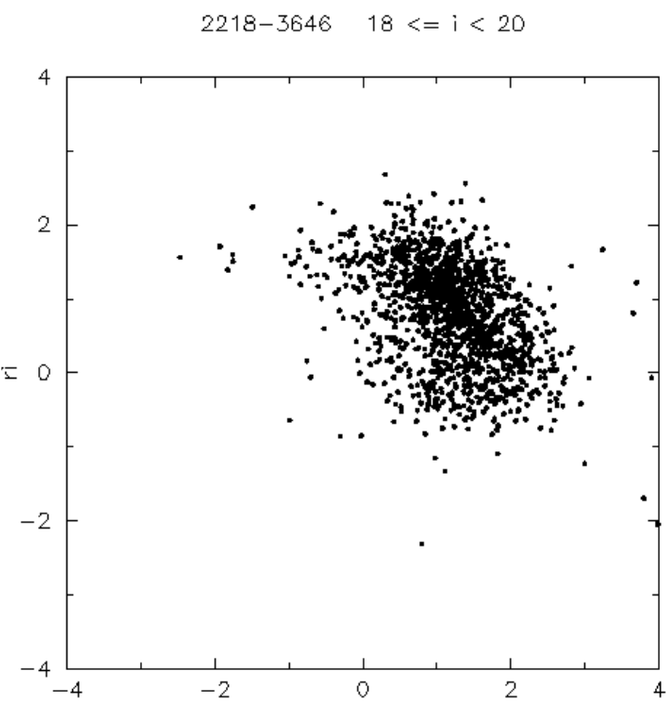
Stars in 2218-3646

New S/G separator
mag_aper1 mags

16 < i < 18

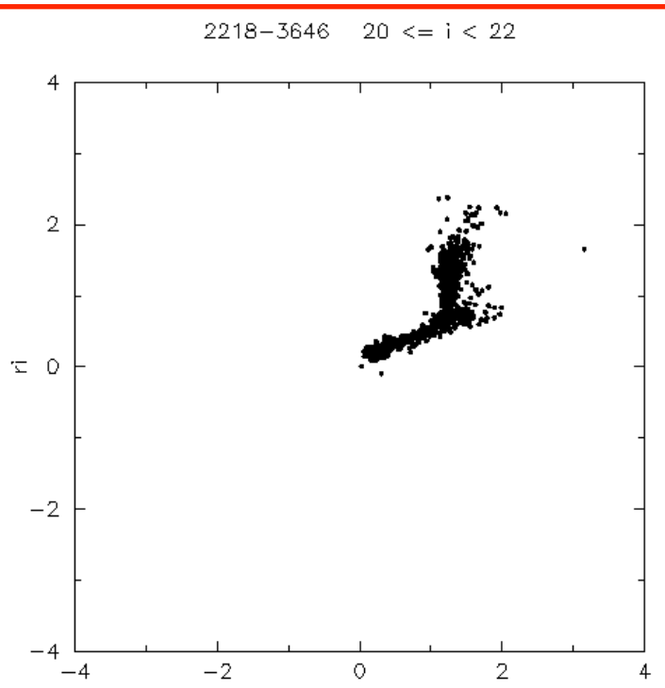


18 < i < 20

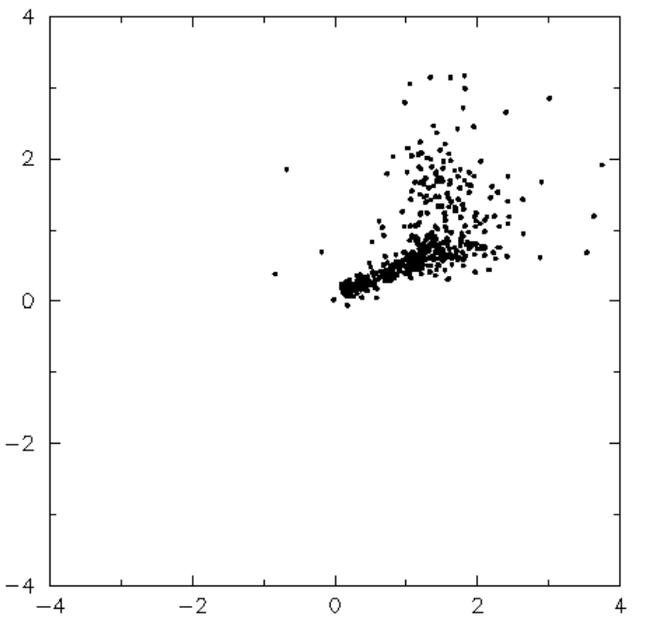


At 20<i<22 the universe is similar to our universe, and noise should be small. We use this magnitude range to explore the calibration.

20 < i < 22



22 < i < 24

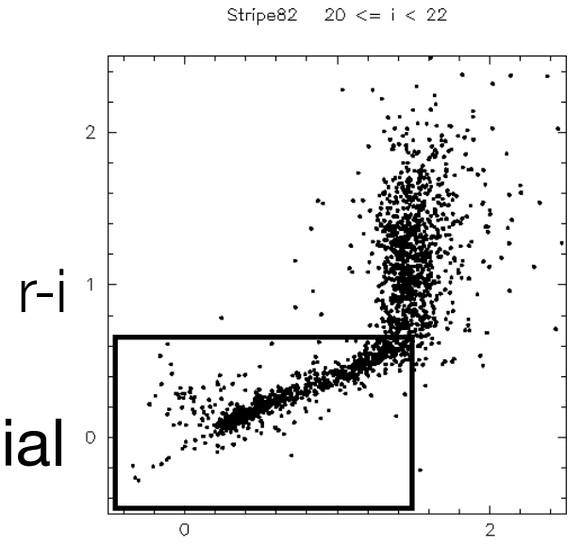


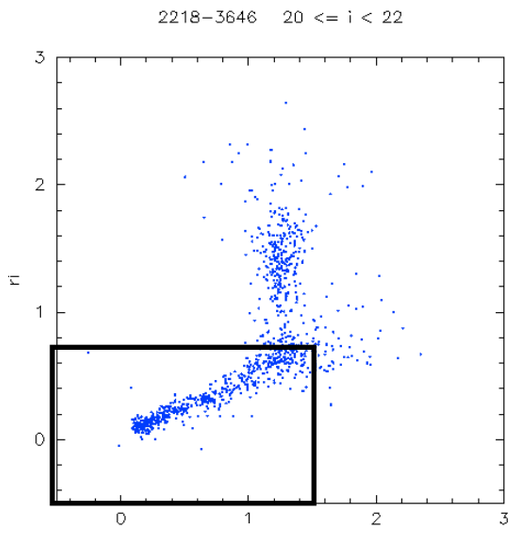
Stellar locus

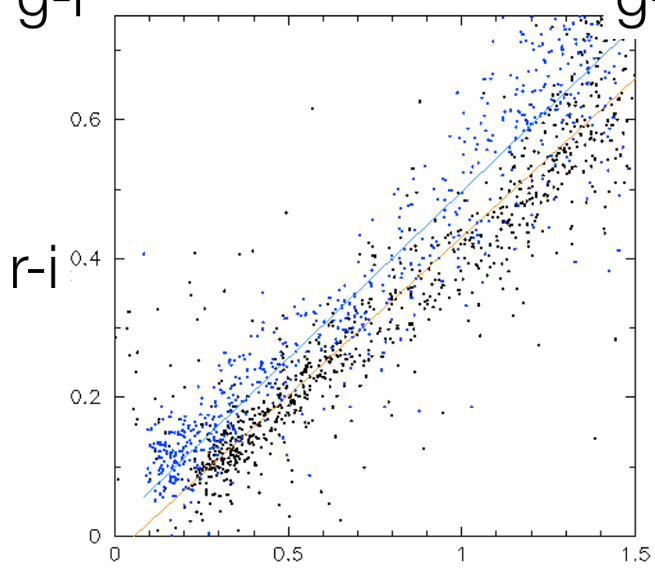
1. We measure statistics about a fiducial locus in the g-r/r-i and r-i/i-z color-color diagrams

2. SDSS Stripe 82

   - g-r/r-i σ = 0.054
   - r-i/i-z σ = 0.071



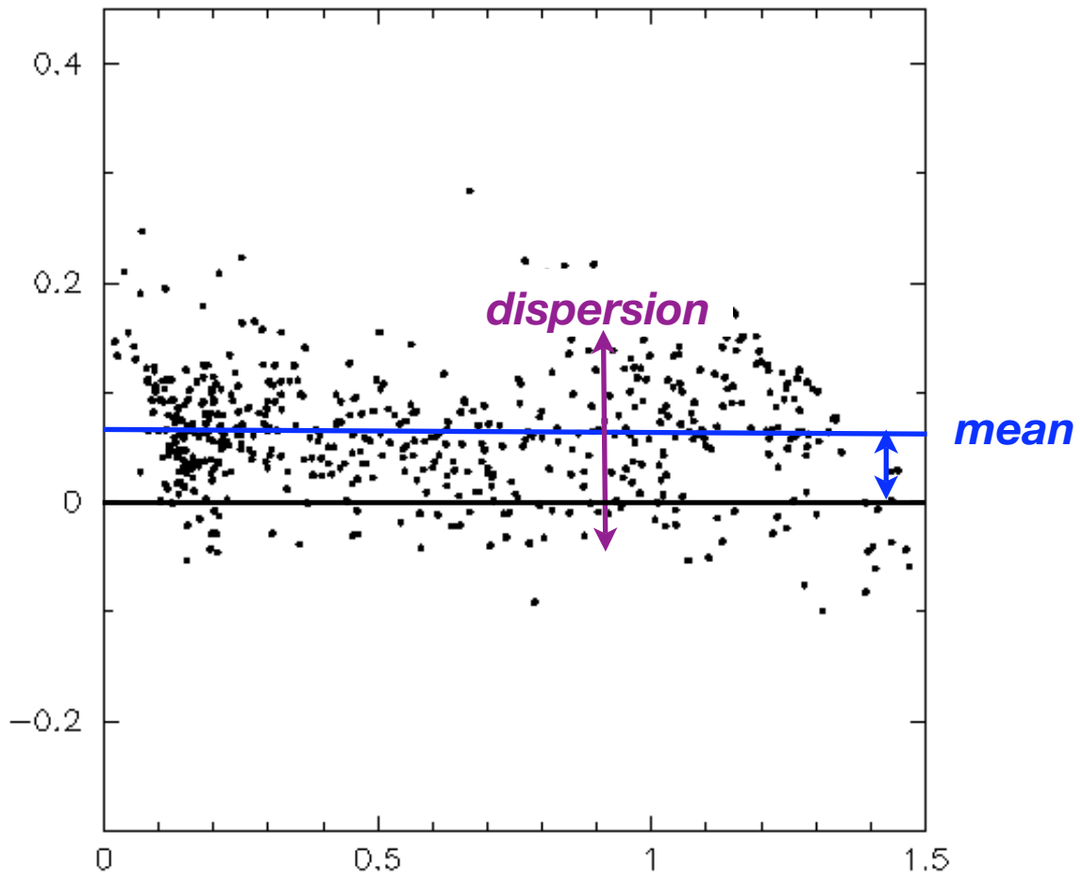


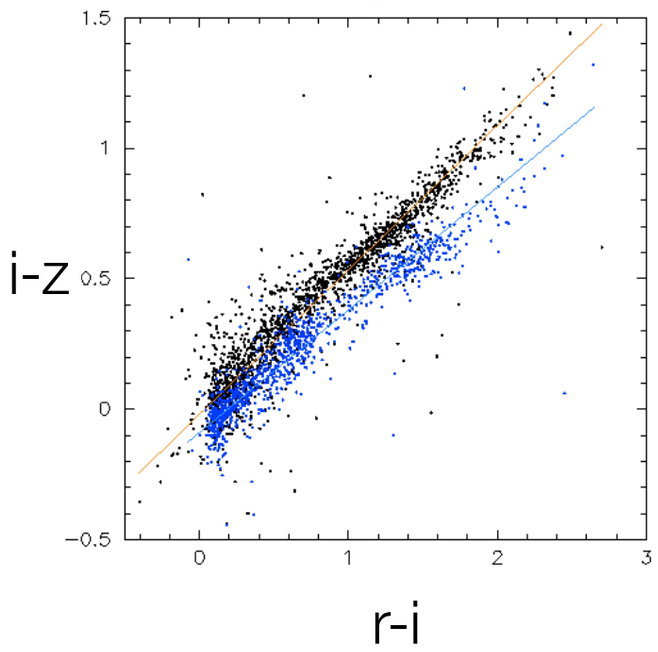


mag_aper<3>

20 < i < 22

sigma clipped mean,sigma





Statistics of the stellar loci

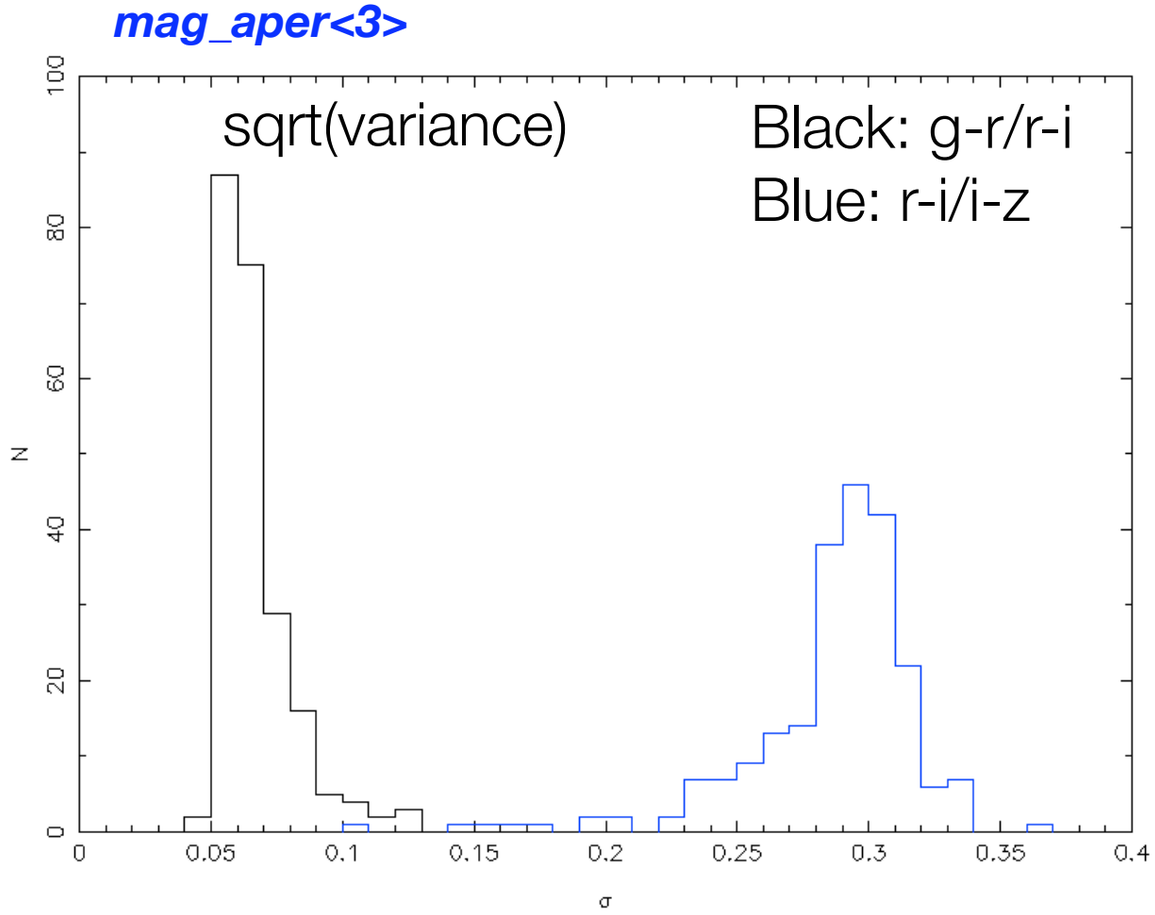
1. 223 tiles measured relative to fiducial fit.

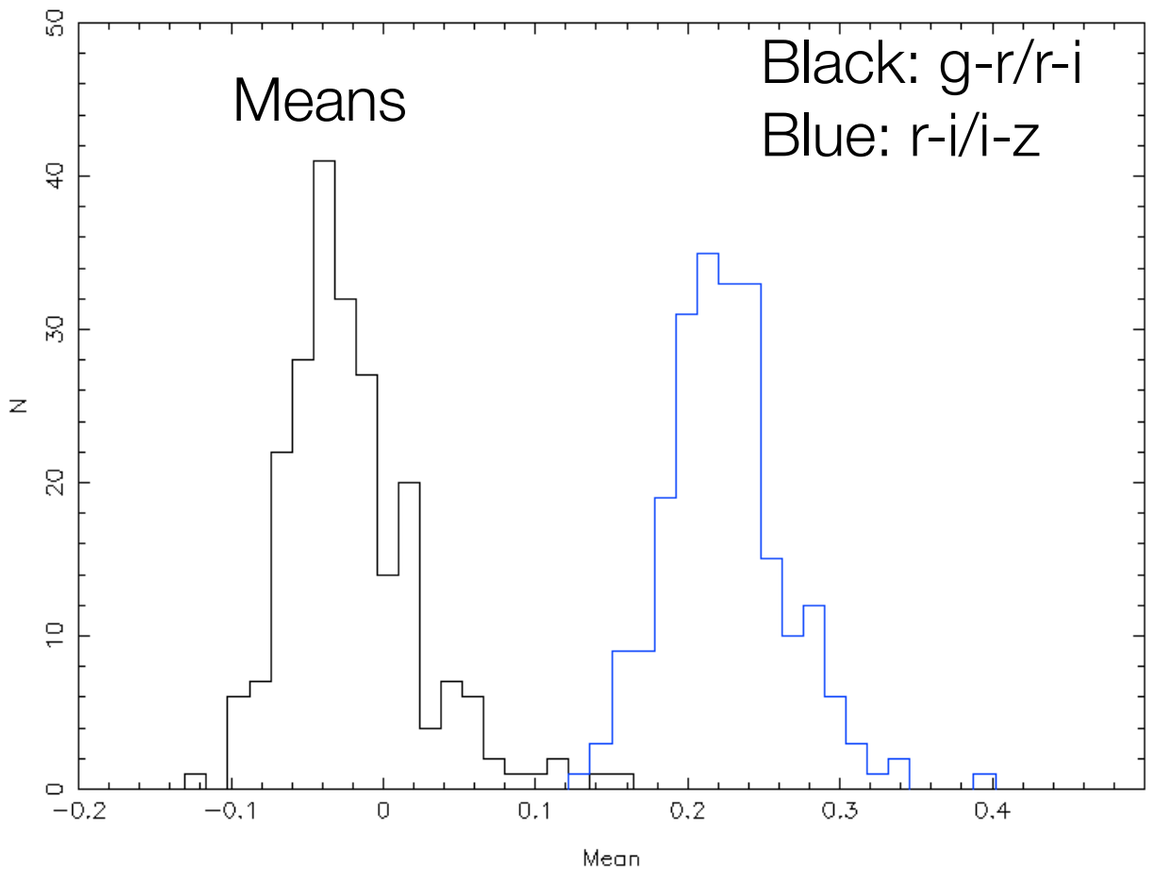
2. The mean of the variance about the fit is measurement scatter, both instrumental and software.

   - mean g-r/r-i σ= 0.067
   - mean r-i/i-z σ= 0.29

3. The variance of the means is the calibration scatter.

   - σ(g-r/r-i) = 0.043
   - σ(r-i/i-z) = 0.040





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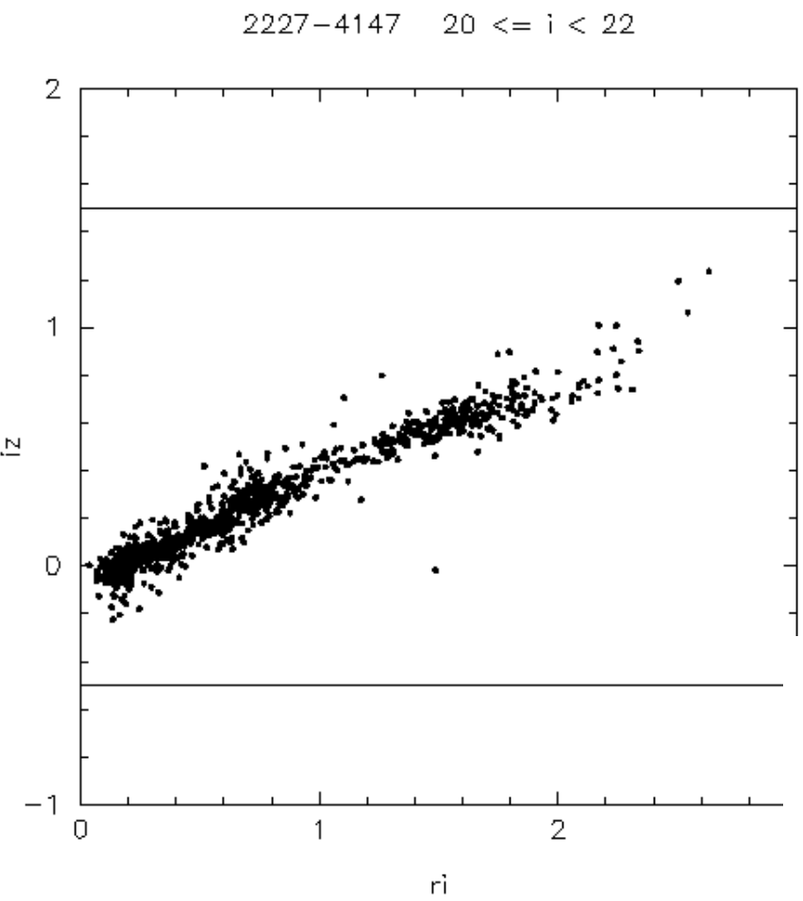
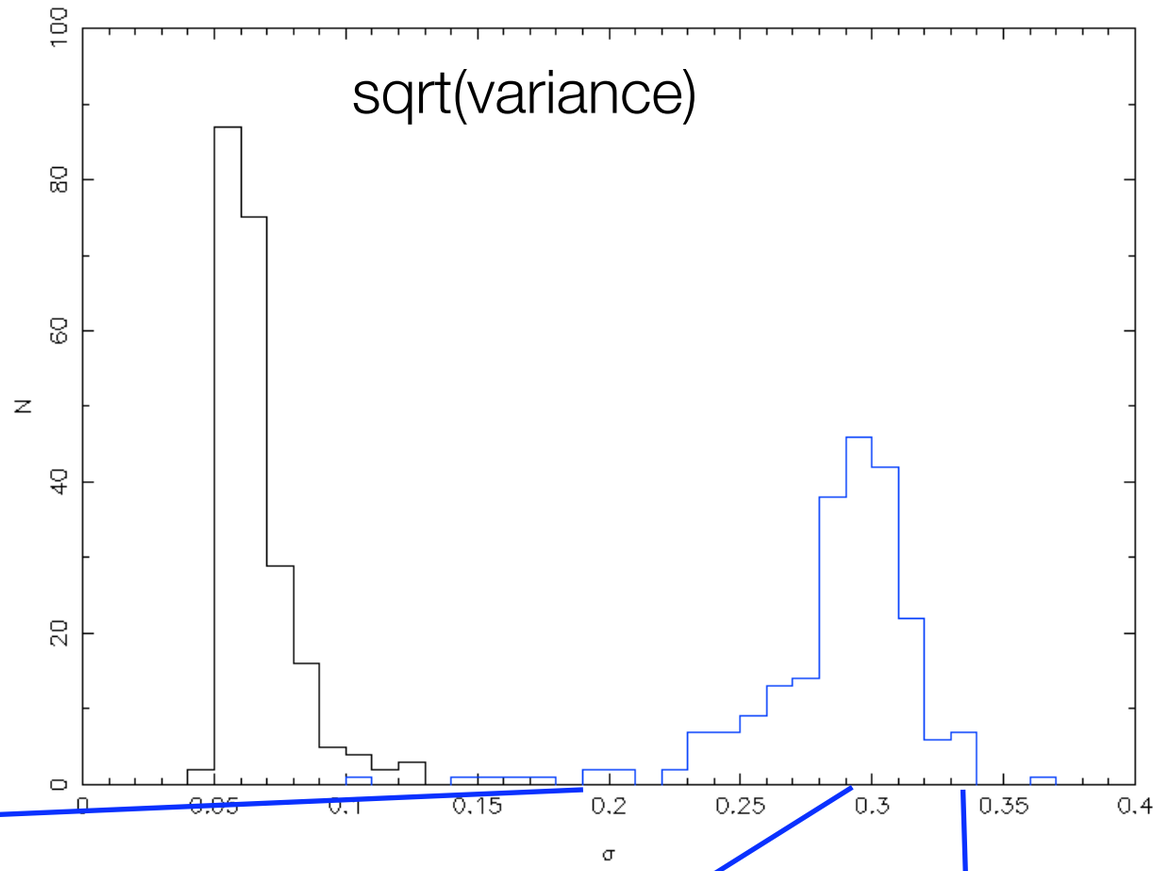
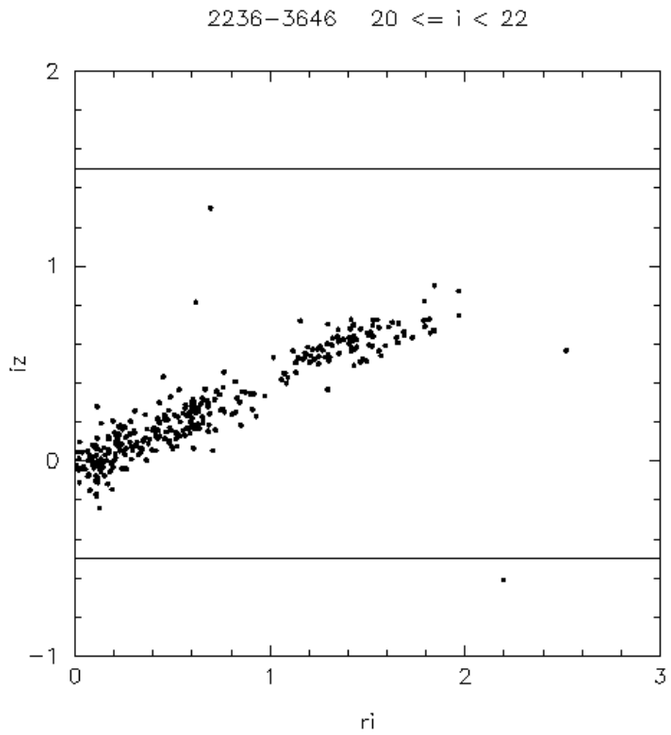
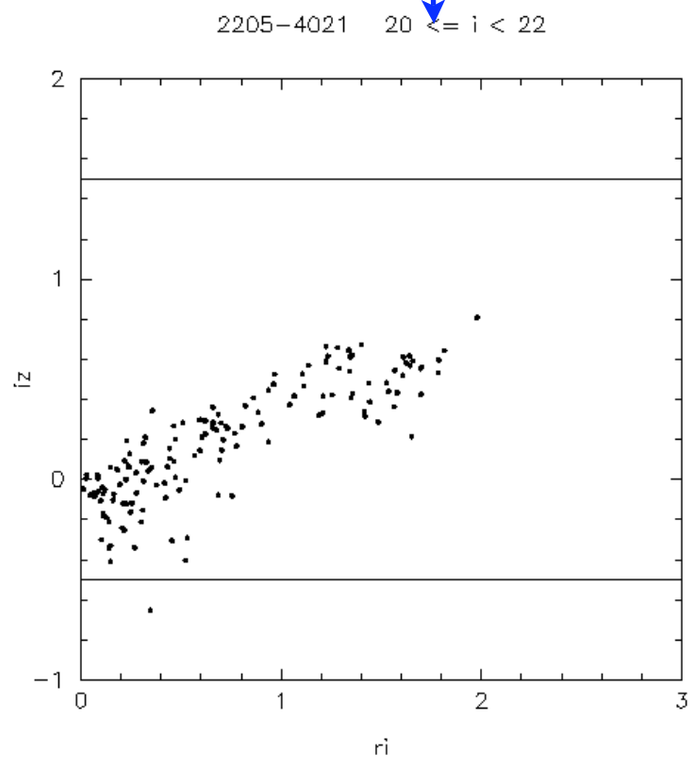
Variance: noise





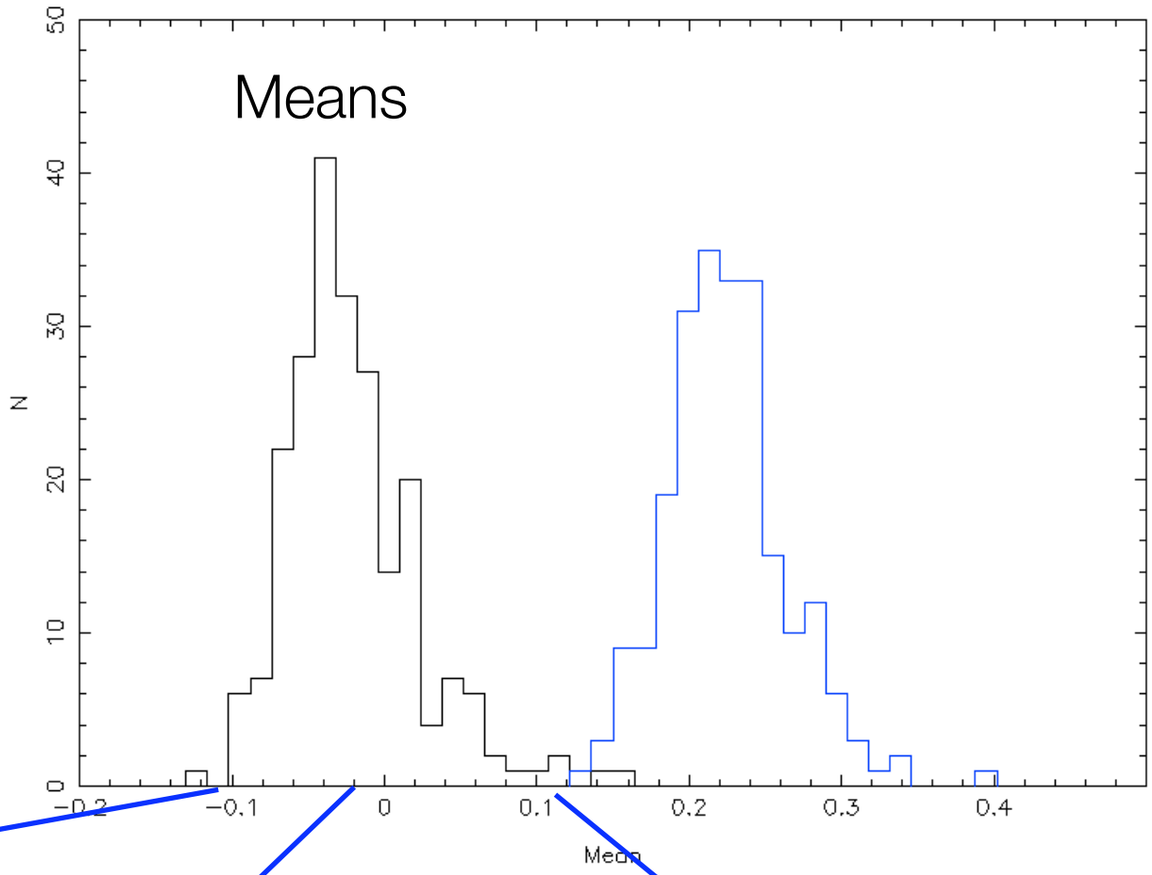


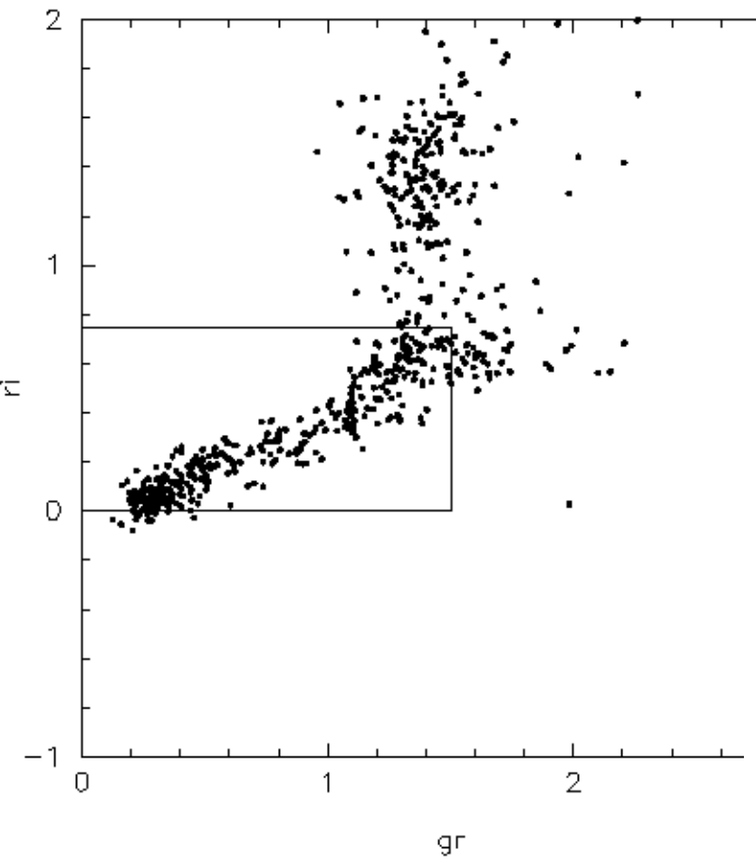


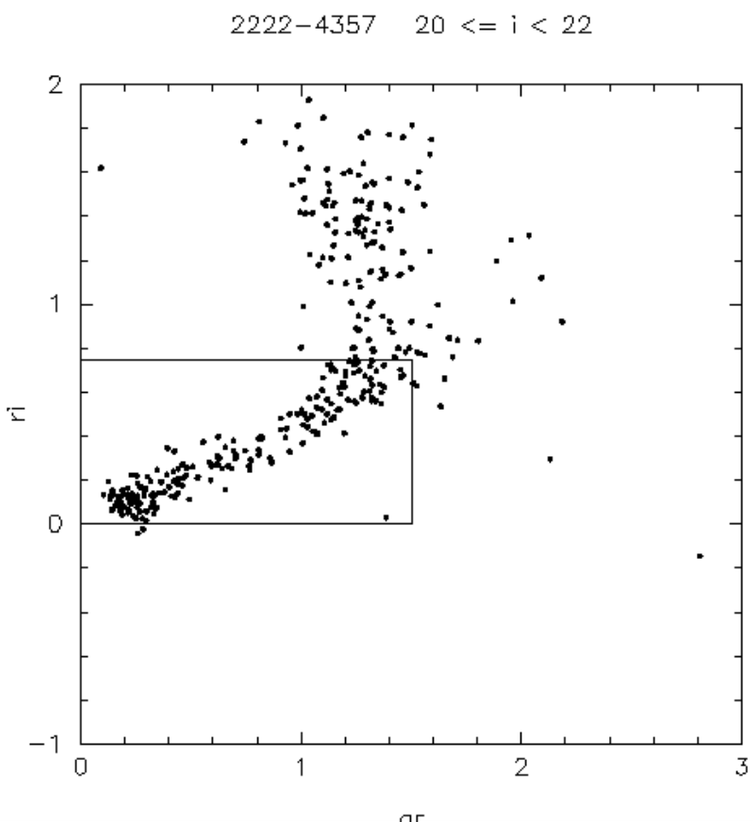
Looking at a handful of tiles from a range of the distribution, we see that the variation in scatter.

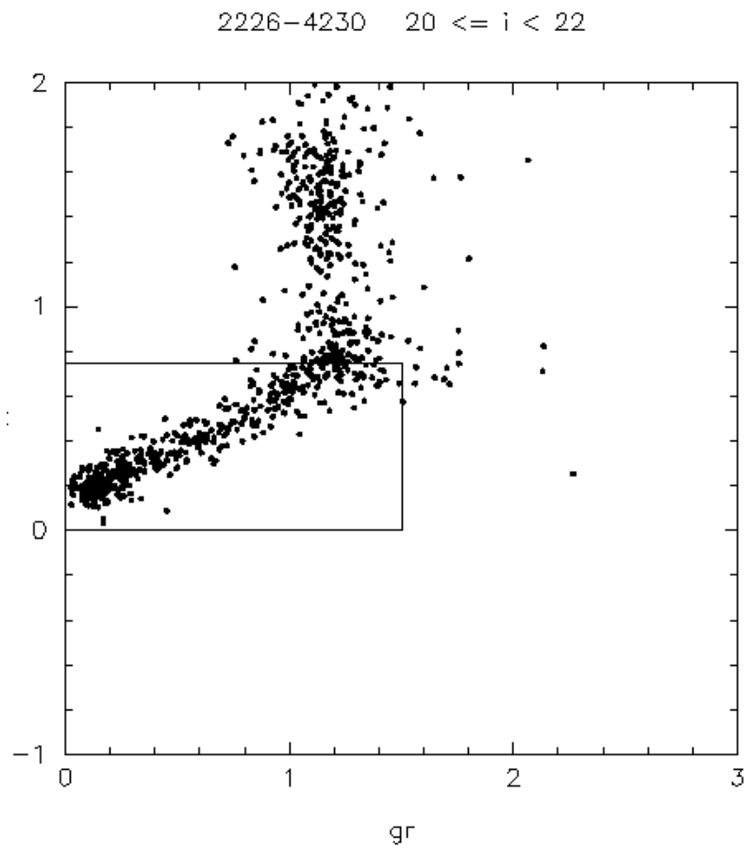
DARK ENERGY SURVEY

Means: calibration









Looking at a handful of tiles from a range of the distribution, we see that the movement of the stellar locus that indicates calibration issues.

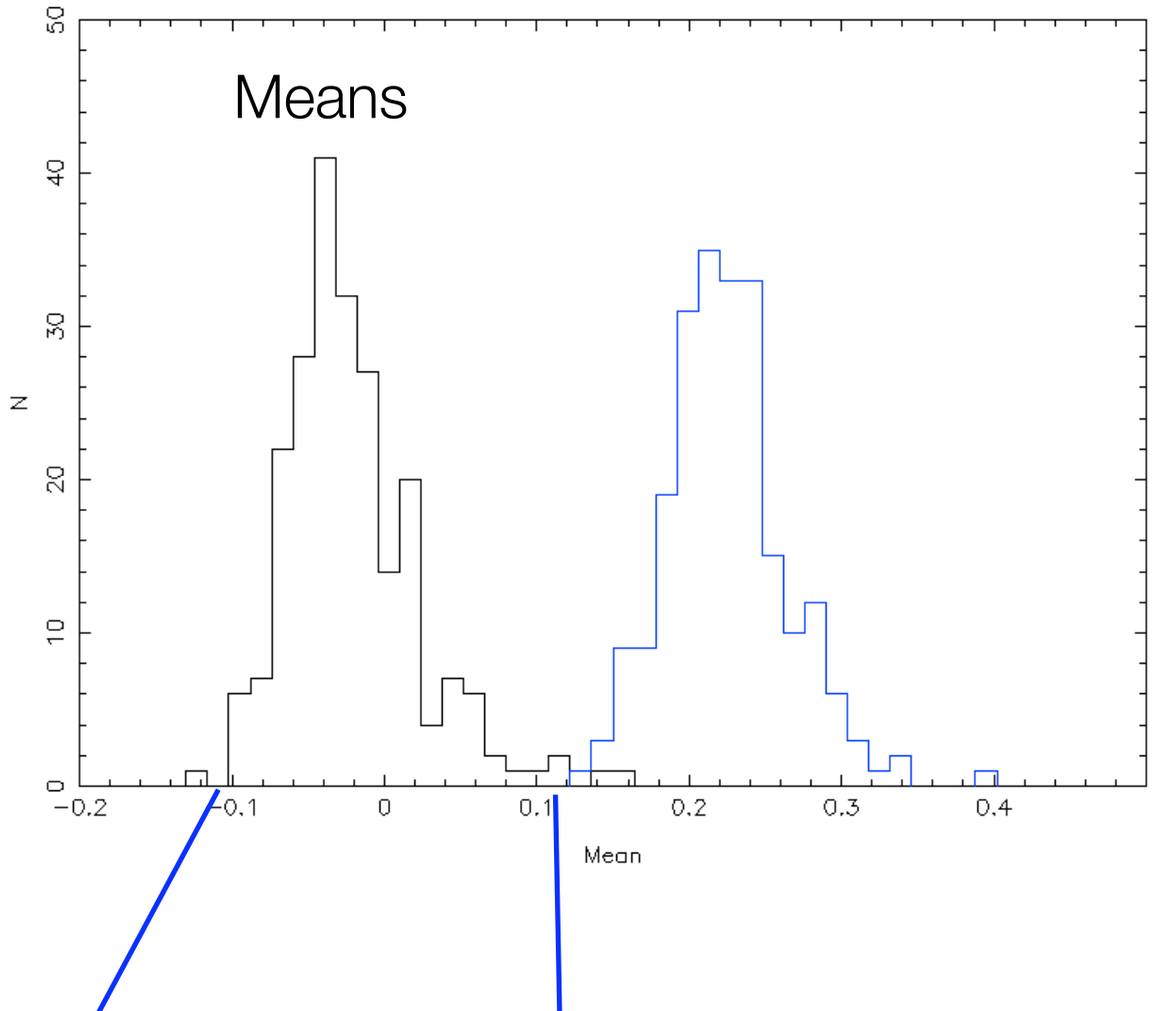
Means: calibration

1. Check with truth tables
   - 20 < i < 22, stars
2. Plot 1
   - Measured mag- truth mag
3. Plot 2
   - Medians in 0.1 mag bins

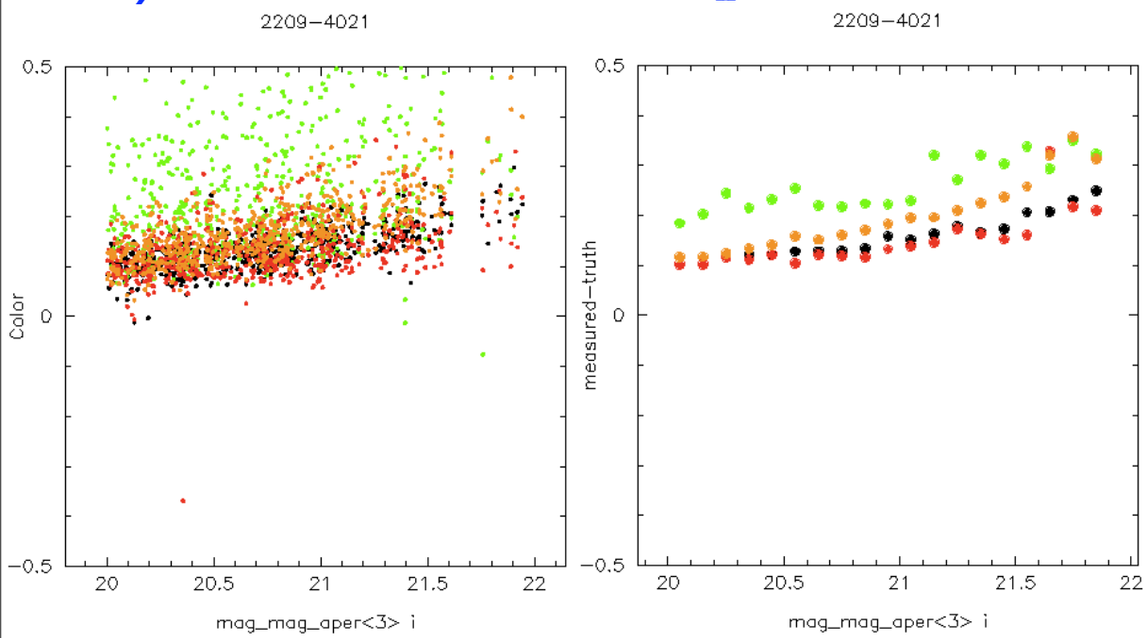
These offsets show

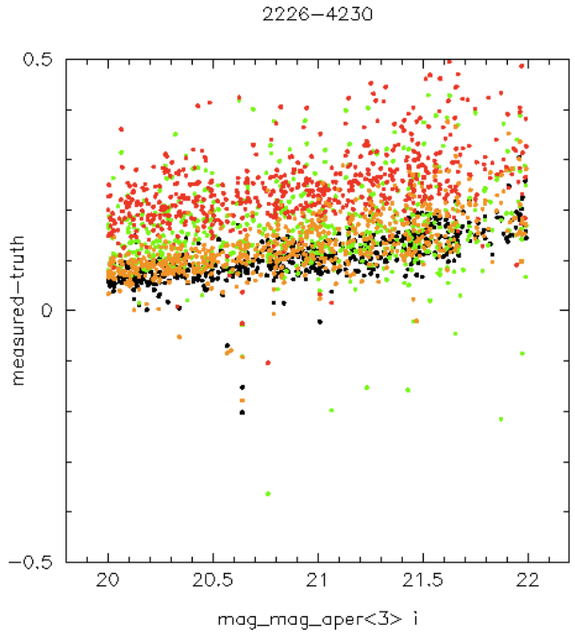
a) single bandpasses with offset calibrations.

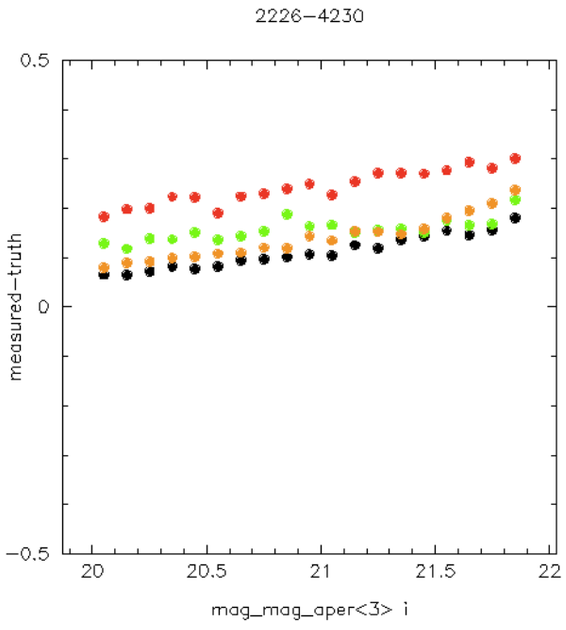
b) variation of delta with mag



Looking at the truth tables confirms that there are zeropoint variations.







Statistics of the stellar loci

1. We examined the statistics in 4 magnitudes.

2. mag_aper1 shows calibration issues at the 10% level.

3. mag_aper3,6 and mag_auto show calibration issues at the 4% level.

4. All magnitudes show a large scatter in measurements in the r-i/i-z locus- 30%.

	mean(σ) g-r/r-i r-i/i-z	σ(mean) g-r/r-i r-i/i-z
mag_aper<1>	0.10 0.30	0.13 0.12
mag_aper<3>	0.067 0.29	0.040 0.043
mag_aper<6>	0.085 0.28	0.049 0.041
mag_auto	0.067 0.29	0.043 0.040

10σ limiting magnitude calculation

1. Take from DC4 measurements.

2.Measure by noting 10σ is 0.1 mags.

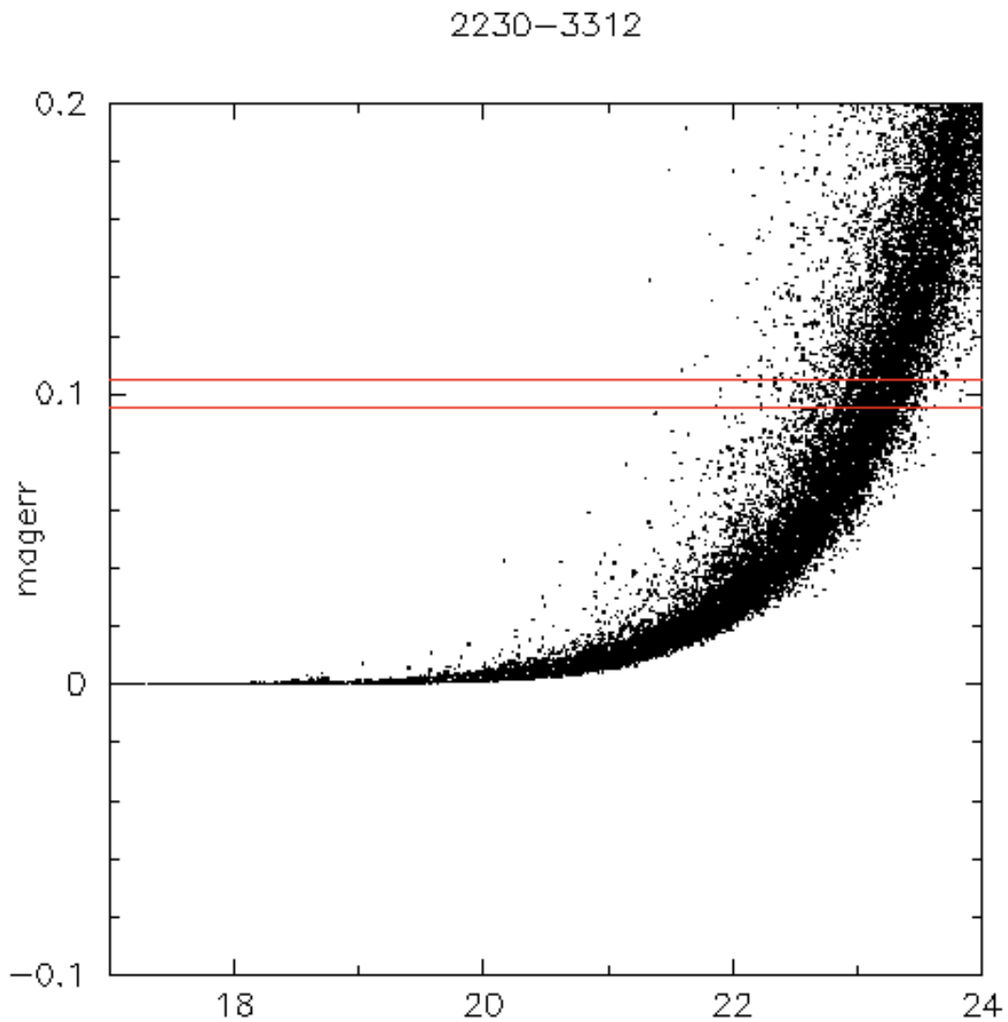
3. Select mag errors in a small range

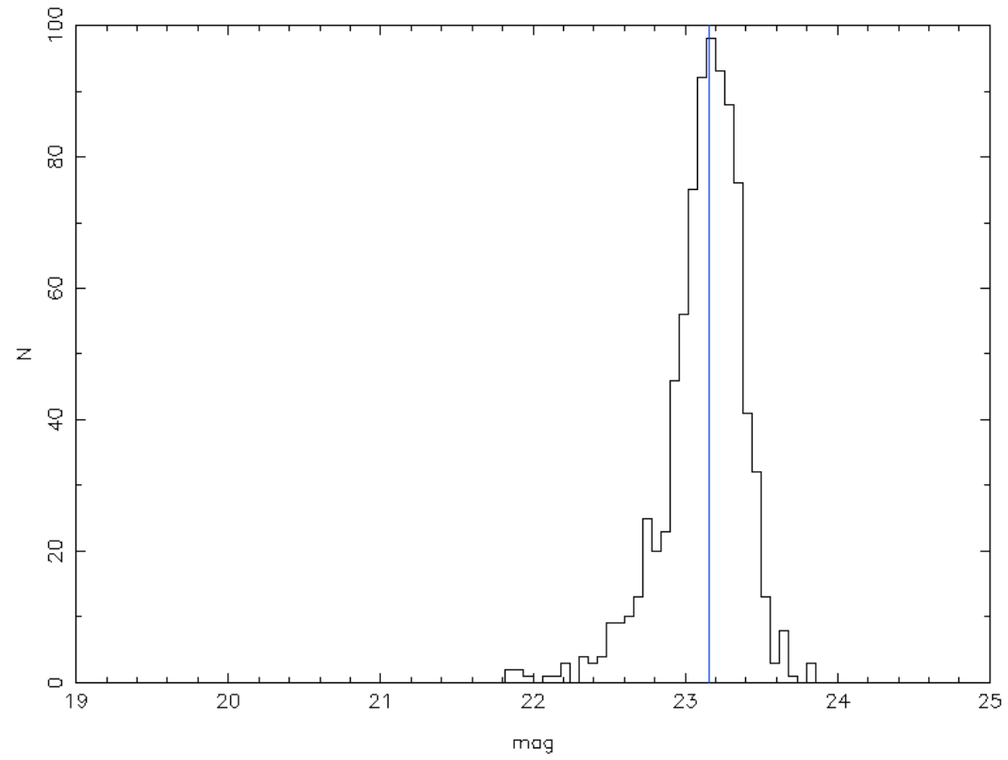
   - 0.095 <= magerr_aper<3> <= 0.105

4. Measure median of corresponding magnitudes

   - Median of the mag_aper<3> in that range.

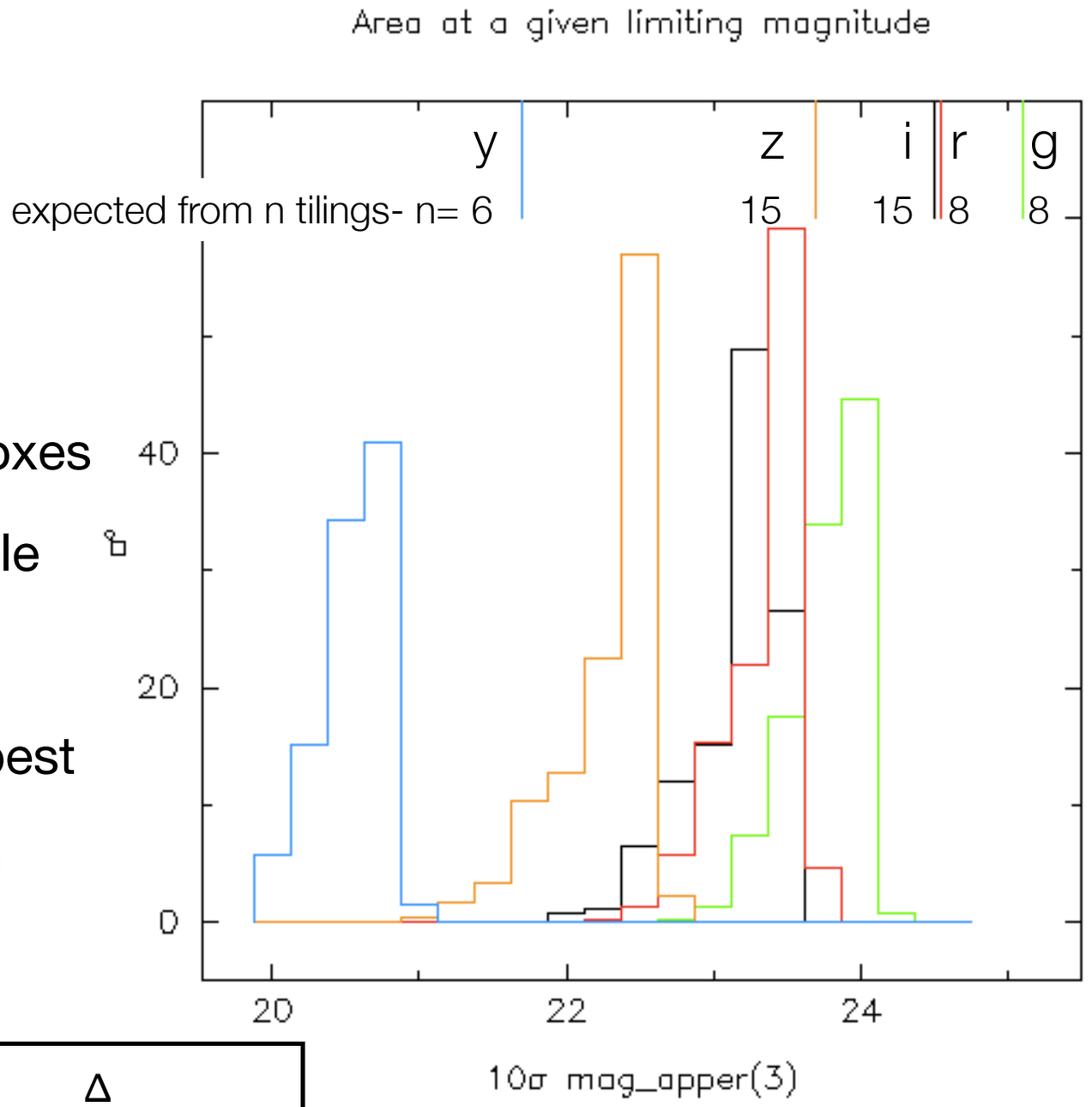
   - In this example, i = 23.16





10σ limiting magnitude

1. 233 tiles
   - each tile sub-sampled into 25 0.15 □° boxes
   - measure limiting mags in each subsample
   - sum boxes to find area surveyed
   - ~50% of the area is shallower than deepest
   - Catalogs are ~0.75 mags shallower than expected at deepest.



	10σ in 1.5" aperture g r i z y	Aperture correction mags	Δ (predicted-measured) mags
predicted	25.1 24.7 24.6 23.8 21.8		
mag_aper<1>	24.2 23.9 23.8 22.9 20.9		0.9 0.8 0.8 0.8 0.9
mag_aper<3>	23.8 23.4 23.2 22.3 20.5	~0.75	0.6 0.6 0.7 0.8 0.6
mag_auto	23.6 23.2 23.0 22.2 20.4	~0.75	0.8 0.8 0.9 0.9 0.7

The predicted mags are calculated in a 1.5" aperture.

mag_aper1 is ~1.5"

mag_aper3 is ~4"

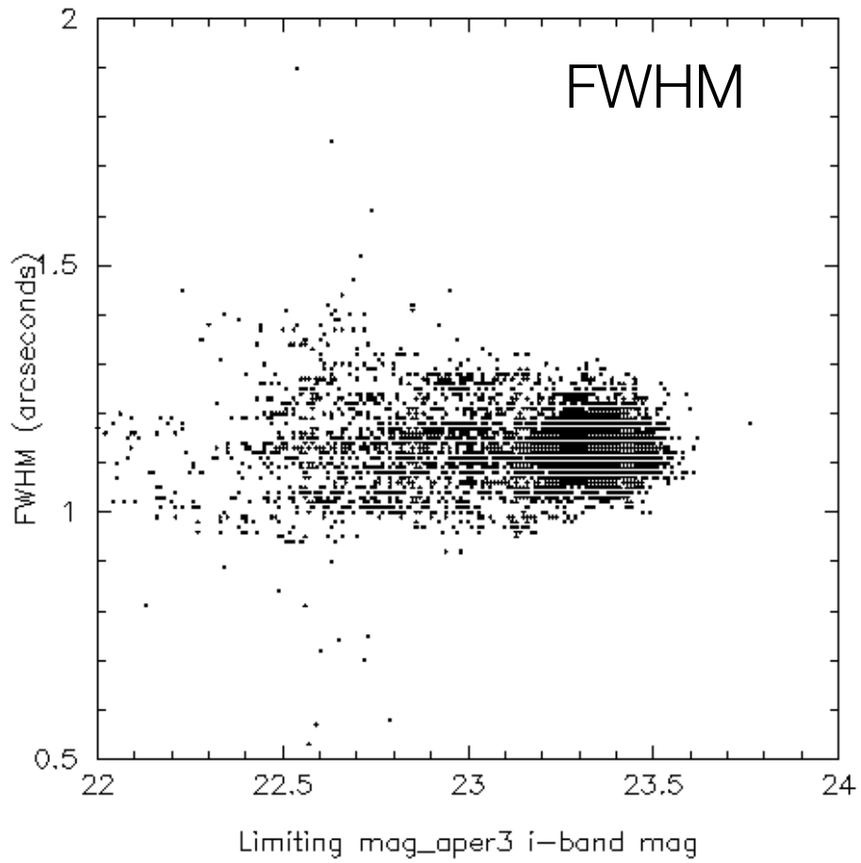
mag_auto is ~total magnitude

Assume aper3 and auto ~ total mag, and that mag_aper1 contains half the light.

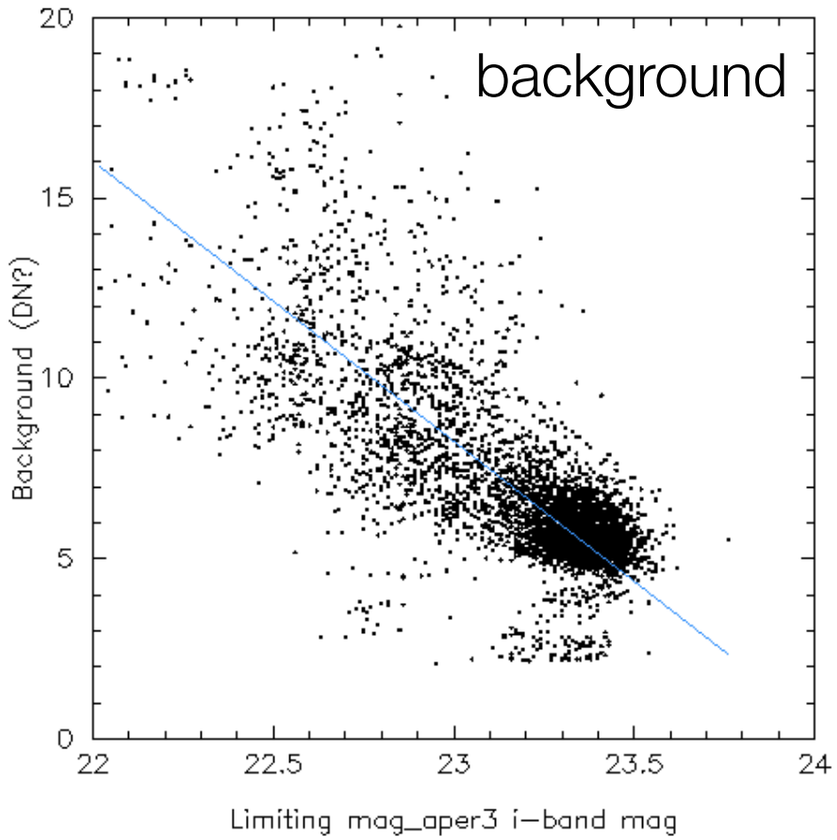
What sets the limiting magnitude?

1. FWHM?
   - i < 22 && star_class = 1
   - FWHM is fwhm_global
   - median is 1.1”
   - no correlation with mag_lim
2. Background?
   - background from each object
   - good correlation between background and mag_lim
   - The 4” aperture of mag_aper3 is too big.

mag_aper<3>



mag_aper<3>



limiting mag = 23 - (DN-8.5)/7.8

DARK ENERGY SURVEY

Summary of Issues

1. Catalog construction:
   - We find no way to know which processing date to use
   - We do not know how to eliminate duplicate objects
   - If by RA,Dec matching, then there is now way to tell which processing a given object came from.
   - What is the star/galaxy algorithm to use, given that star_class is non-optimal?
   - What magnitude to use? (We suggest mag_aper3 for DC4.)
2. Astrophysics
   - Simulations should use USNO-B to select an SED, not transform USNO-B colors
3. Calibrations
   - ≥ 4% calibration errors. Scatter likely due to seeing.
4. Measurements
   - ~0.75 mag shallower than expected. Likely limited due to sky noise.