Masks and Randoms for PS1 LSS

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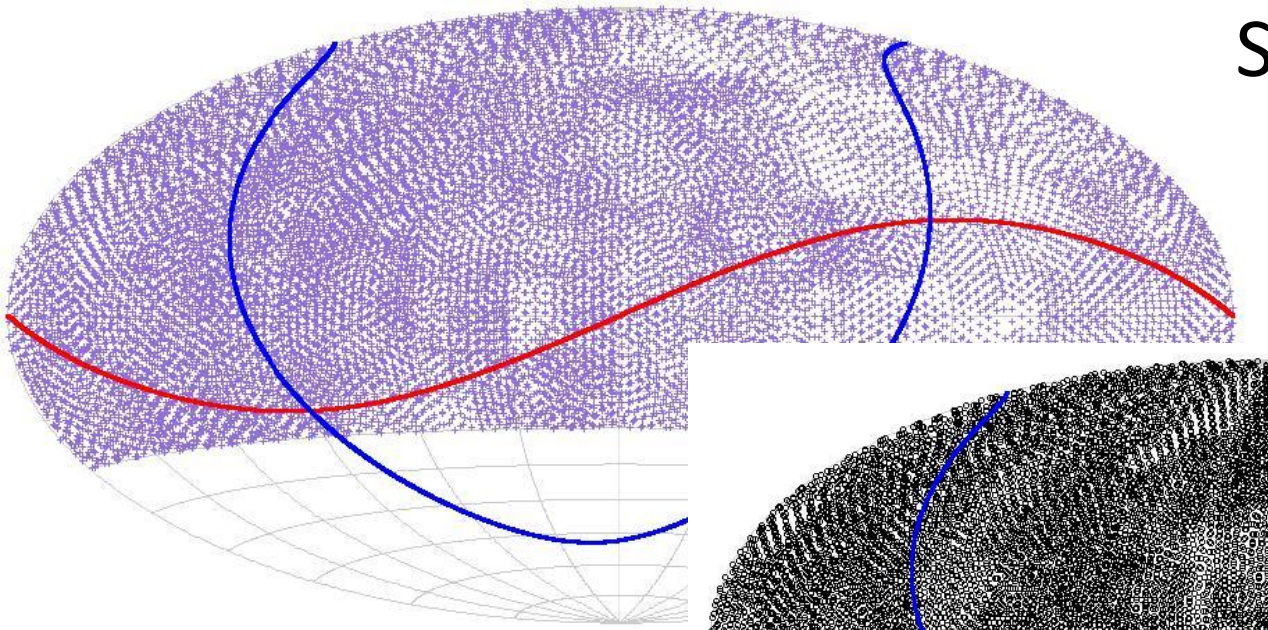
Outline

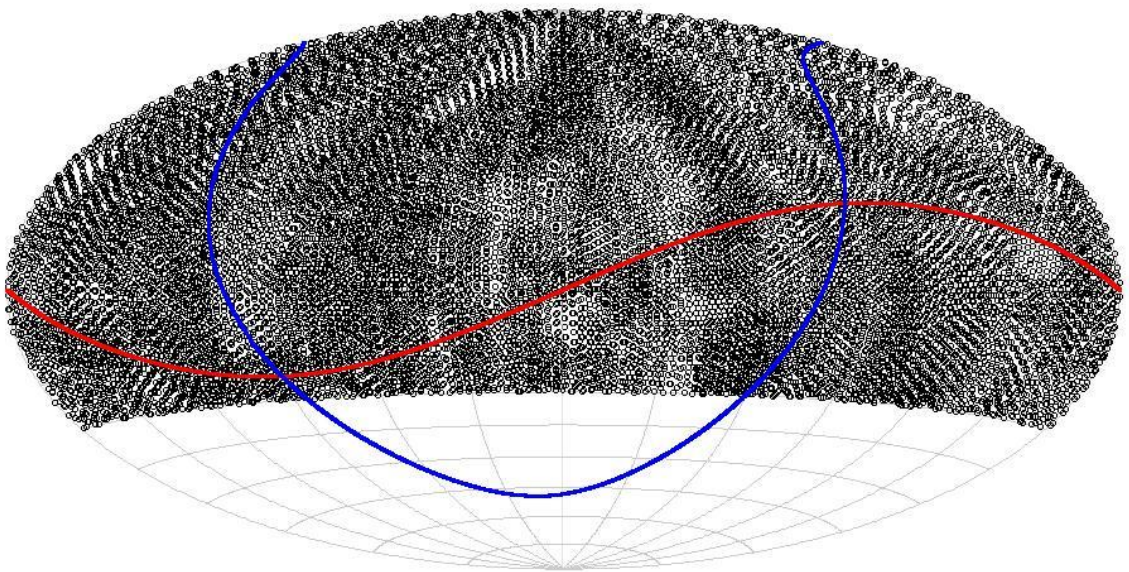
- Motivation
- Possible Approaches
  - Primary Resolution
  - Practical/Size constraints
- Discussion

The Strengths of 3Pi

Sky coverage



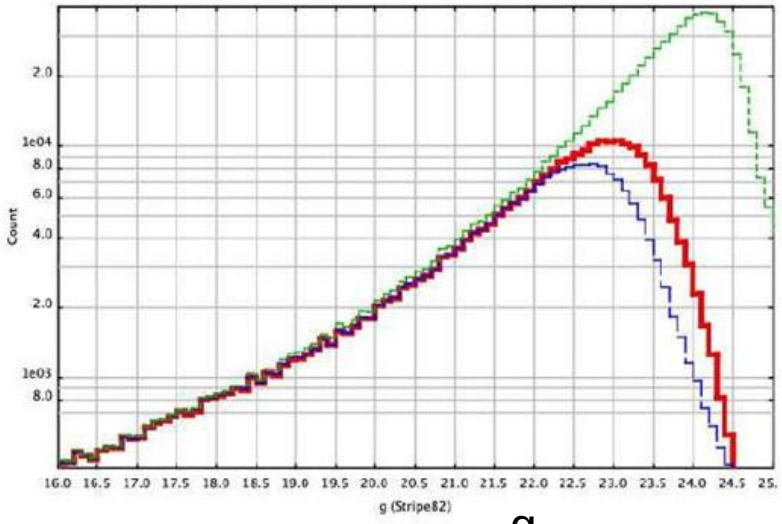
i band



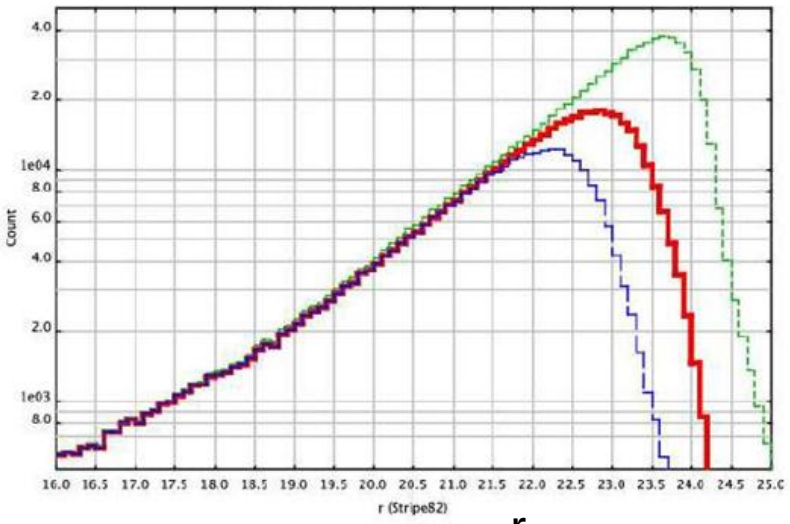
z band

The Strengths of 3Pi

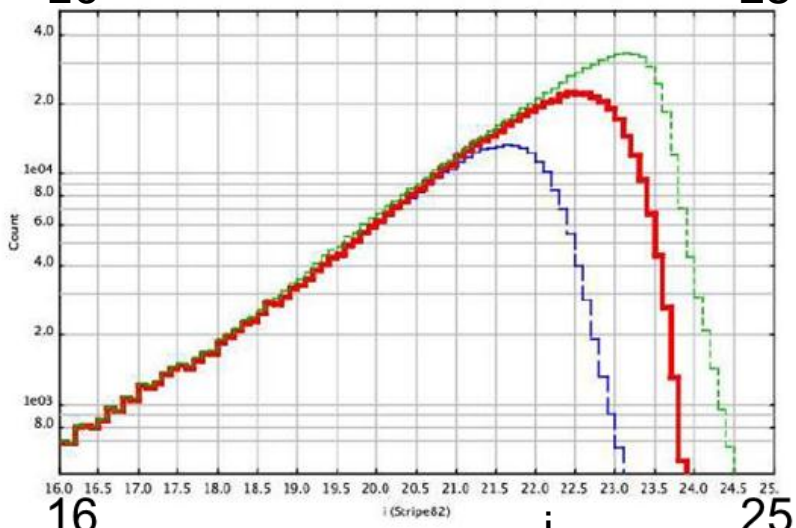
Depth



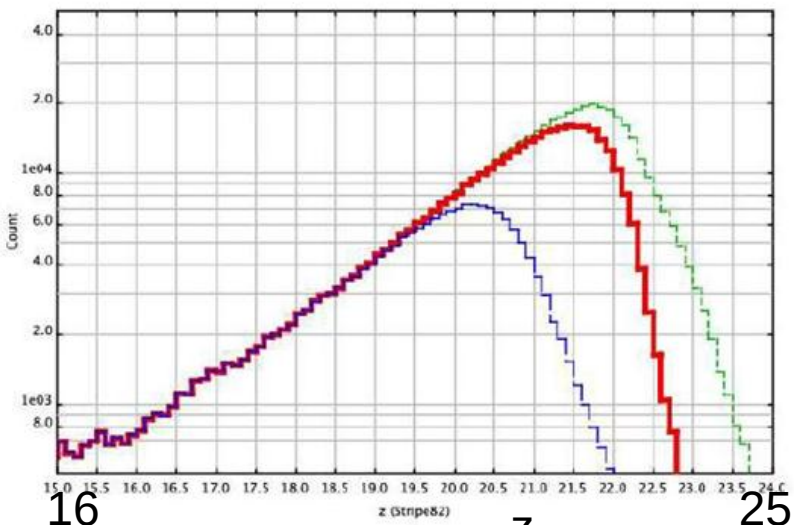
16 g 25



16 r 25



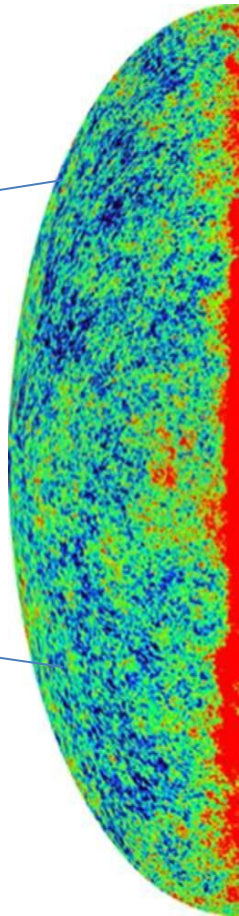
16 i 25



16 z 25

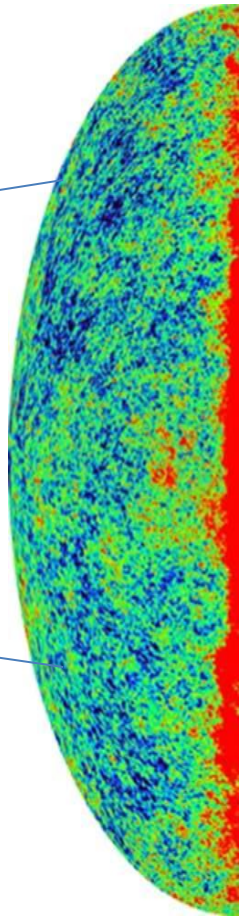
ISW

- An example of where the 3Pi has something to contribute



ISW

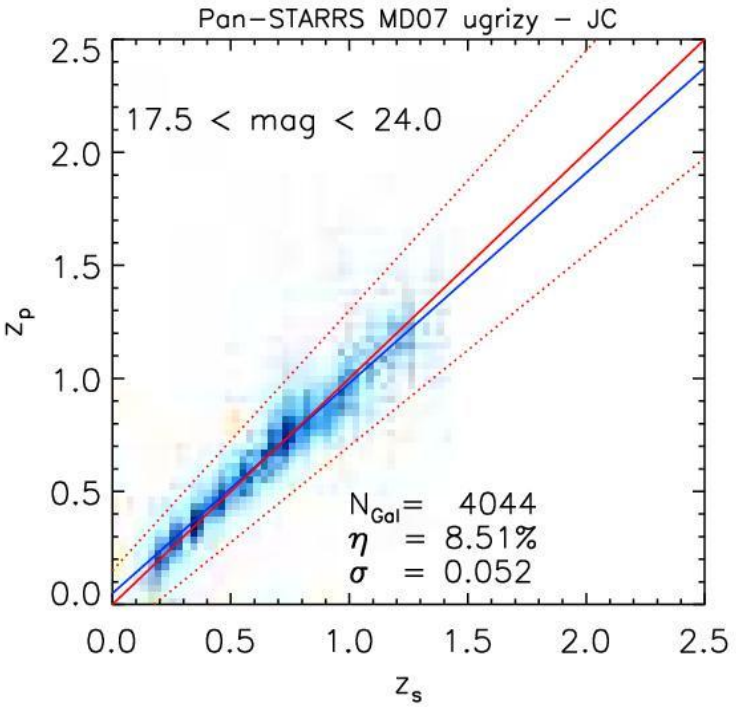
- Best constraints to date 4.5sigma by combining surveys (Giannantonio et al 2012)
- Single survey with single calibration is preferable



ISW

- Expect a positive correlation (6 sigma) due to dark energy driven expansion causing the decay of gravitational potential perturbations.

- In principle determining the redshift dependence using photo-z slices can constrain w
- False positives / junk less of a problem.



Masks and Randoms

- Need to estimate galaxy over density, $\Delta(\theta, z)$

$$\Delta(\theta, z) = n_G(\theta, z) / n_R(\theta, z)$$

- For 3Pi $n_R(\theta, z)$ depends in a non-separable way on both θ and z.

- (Also need to model stellar contamination)

Randoms: SDSS spectroscopic survey

- Effectively a uniform magnitude limit.
- Hence on can use the empirical N(z) and simply randomize angular positions within the survey footprint.

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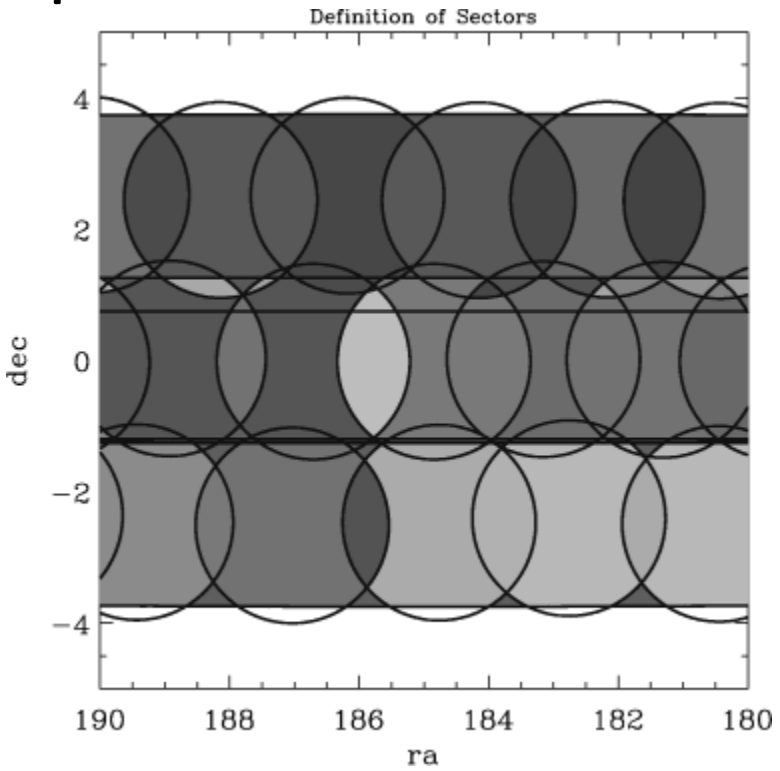
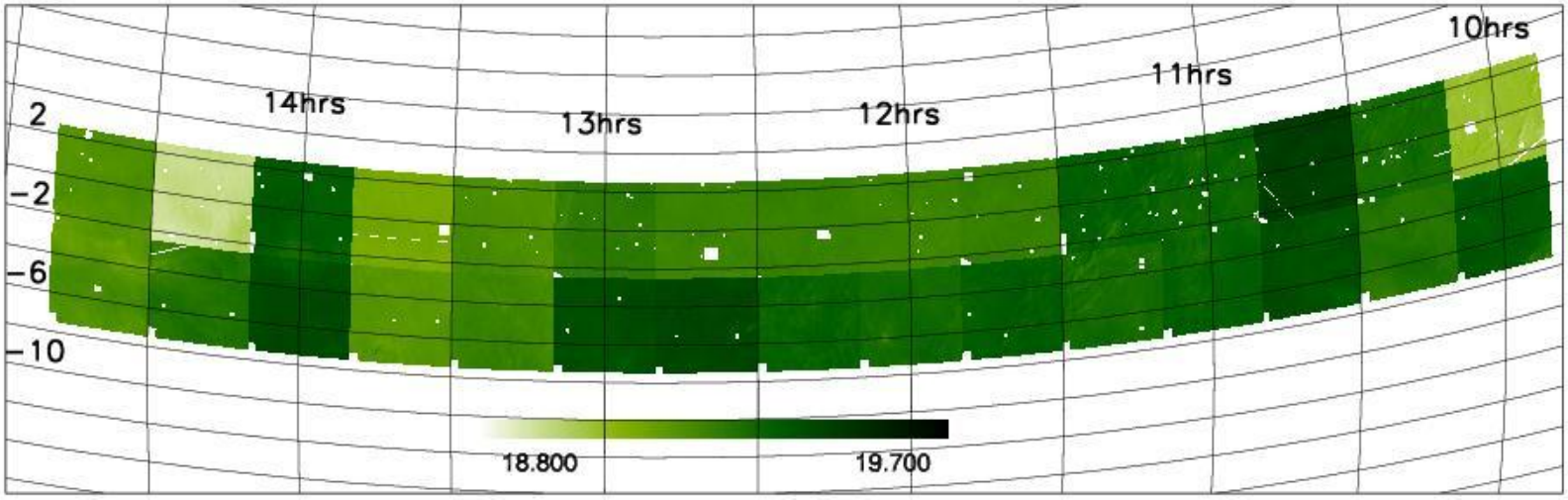
Variable redshift completeness in SDSS is a separate issue that we are not concerned with here.



Randoms: 2dFGRS



2dFGRS has a variable magnitude limit to due initial plate-to-plate variations in the photometric zero point errors and updates to the Galactic extinction map.

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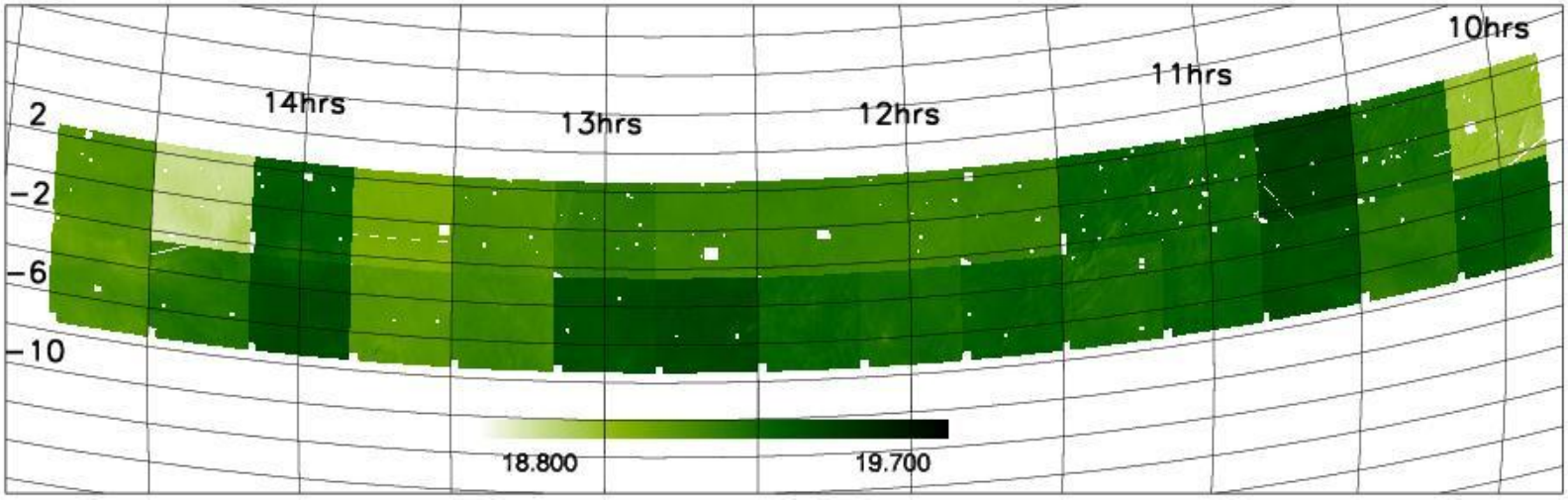


Construct an empirical luminosity function and then model the variation of N(z) with position/depth of the survey.

Randoms: PS1

Variable depth in 5 bands means the (multi-variant) luminosity function approach is not viable.

One approach

- Construct (in each band) a “mask” that gives the depth (magnitude error) at any point in the survey.
- Select galaxies at random from a MDS catalogue that is complete to, say, r=23.
- Place at random on the 3pi sky and assign “measured” apparent magnitudes using the mask.
- Compute a photo z as per the genuine data.

Problems facing mask construction

- “Primary resolution” -- duplicate objects in overlaps

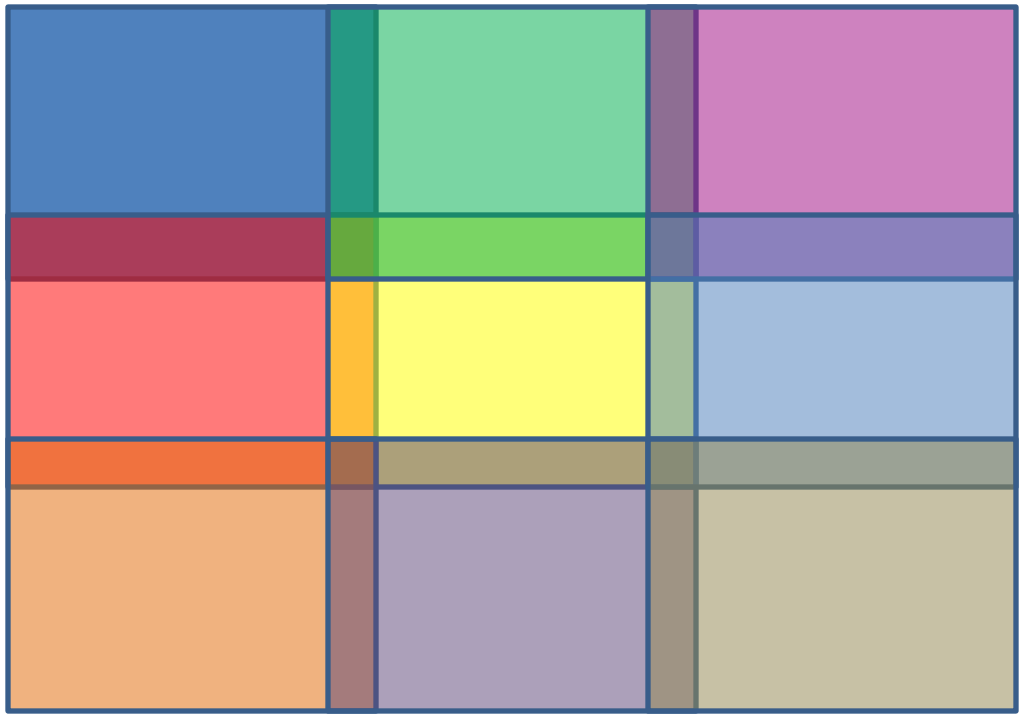
- Size in Gbytes of the mask!

Primary Resolution

The basic building block of the PS1 surveys are the ~6000x6000 pixel skycells

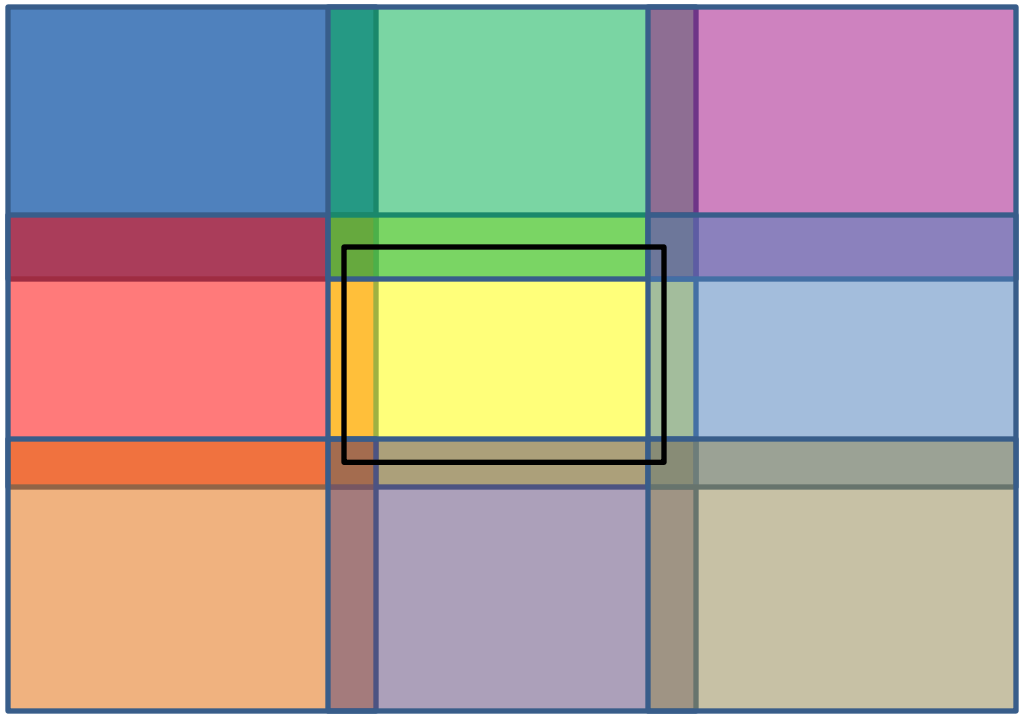
Primary Resolution

There are overlaps between the skycells and hence duplicated detections in the stack catalogues.



Primary Resolution

Within a *projection cell* the skycells are aligned in a rectangular grid with integer pixel offsets and so here the *primary* region of each skycell is easily identified.

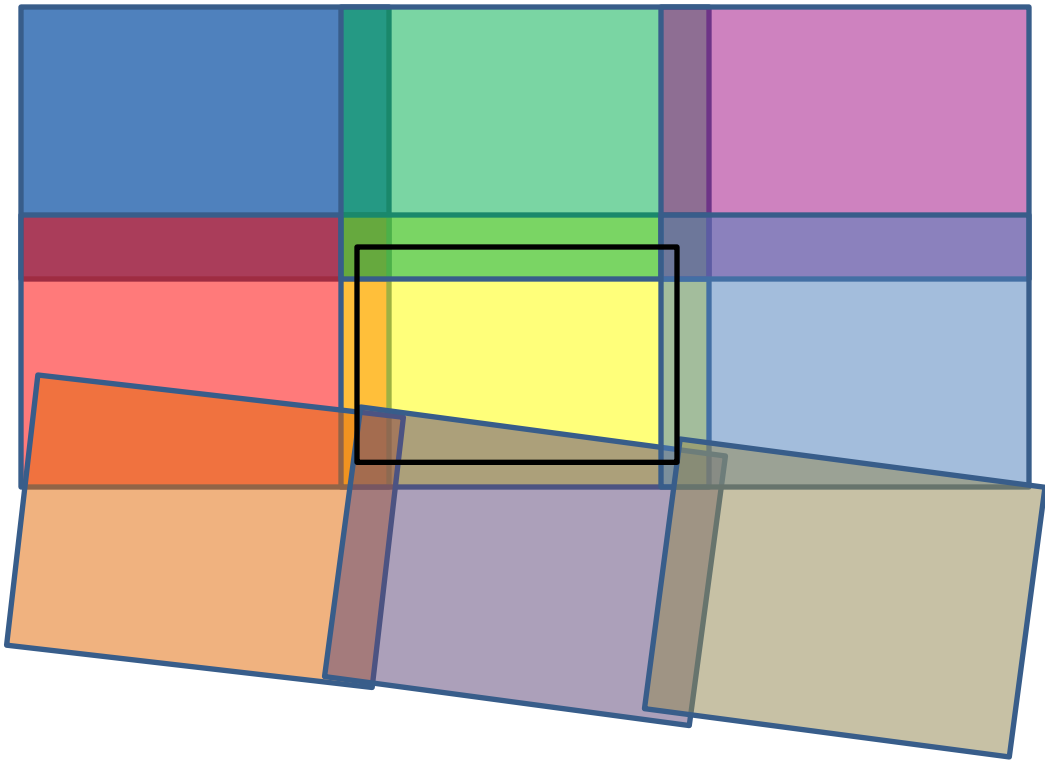


Why do we care…?

Primary Resolution

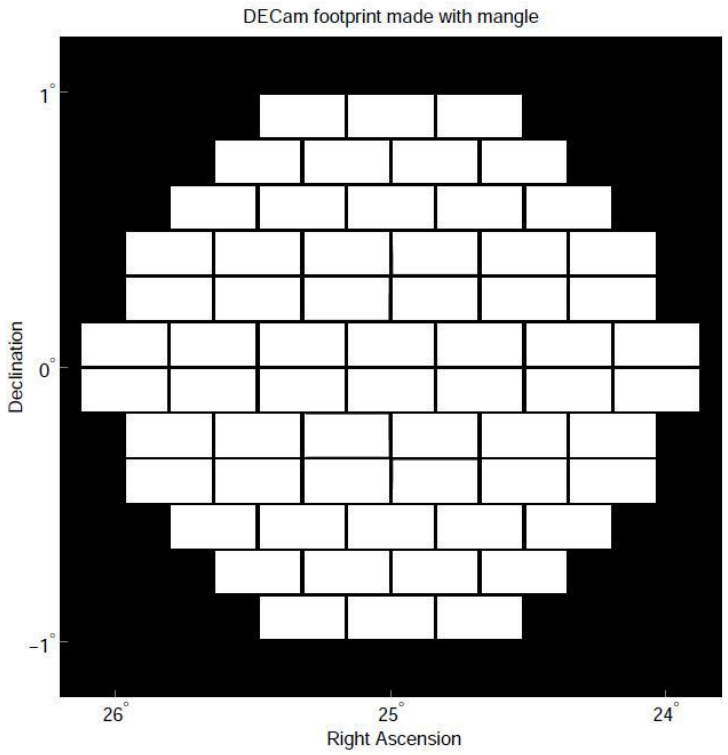
Across projection cell boundaries skycells are rotated and distorted with respect to each other.

Need to use Gene's code to identify the primary region of each skycell.



Resolution issues

- Other surveys (e.g. DES, SDSS) have opted to use MANGLE
- For PS1 there is not an obvious data compression benefit as our camera has structure down to the pixel scale



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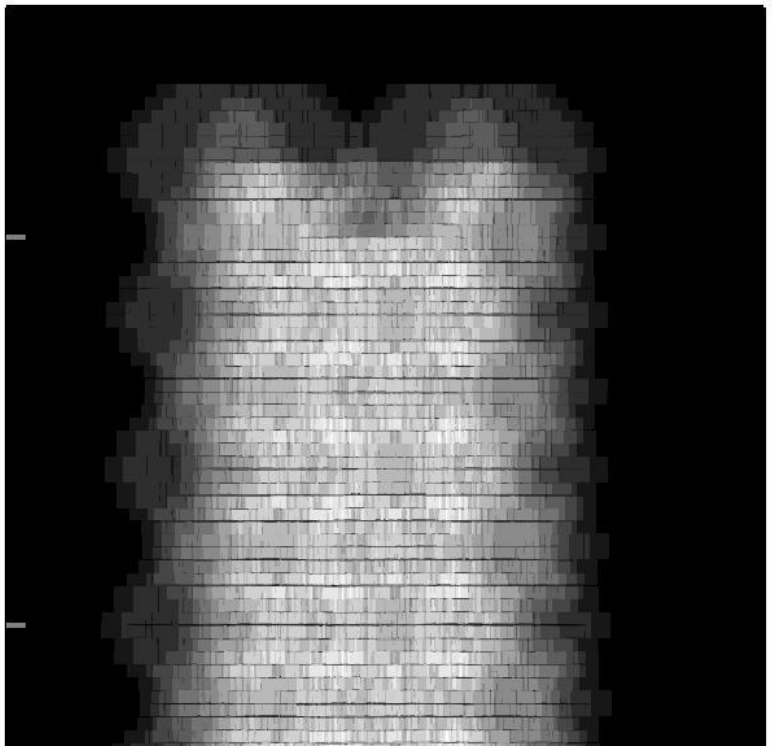

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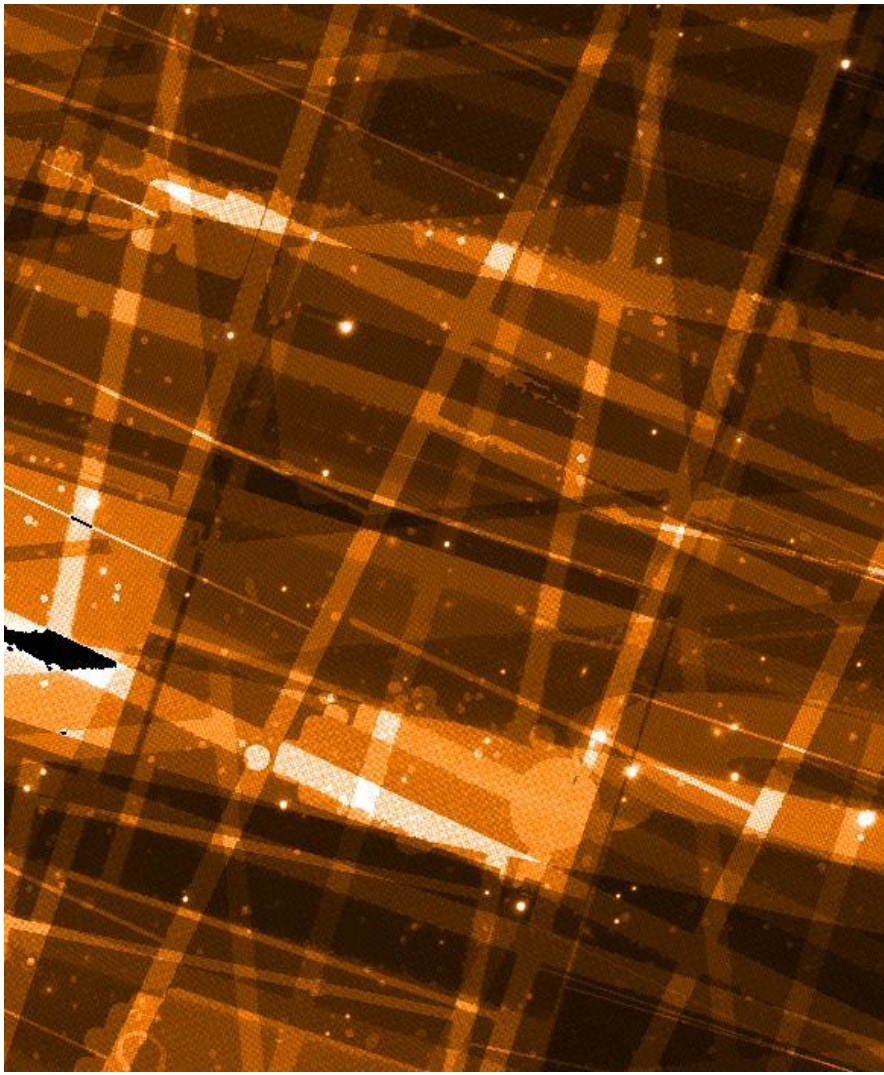

Resolution issues

- Danny Farrow's SAS2 mask used 3x3arc sec pixels
- 4×10^{10} pixels in 3Pi !
- If we set a limit of 10^{9} pixels then the resolution would be only 20 arc sec
- Not ideal as $n_R(\theta, z)$ is a non-linear function of the noise variance

  (At z=0.2, 1 Mpc/h equates to 30 arc min)

Maskless Randoms

- Generate a dense set of angular positions for a set of randoms
- At these positions look up the variance (once) from the full resolution maps and store away.
- Generate randoms by placing galaxies cloned from the MDS onto these random points and perturbing magnitudes as before.

Maskless Randoms

- r-band galaxy counts give 2x10^4 per sq deg at r=22.5
- 6x10^8 galaxies over the full 3Pi
- Hence if you wanted 10x more randoms than data this would be 6x10^9 values.

Discussion

- Is there demand for this sort of infra structure for other projects?

- Other approaches?