STANFORD UNIVERSITY

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Radial selection issues for primordial non-Gaussianity detection

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Radial issues

- Decoupled from angular selection:
  - One average N(z) for all (simplest possible case).
  - Worry about photo-zs.
  - Wrong redshifts.
- Coupled to angular selection

Need redshifts

- Spectroscopic or photometric redshifts (photo-zs).
- Photo-zs also require spec-zs – for calibration.
- Spec-zs, require photometric pre-selection.

Spectroscopic Issues

- Incompleteness
- Failures (wrong redshifts)
- Sample variance (for photo-z calibration).

Radial spec-z issues for spectroscopic surveys

Example - **Wigglez**

When spec-zs go wrong, they go wrong bad

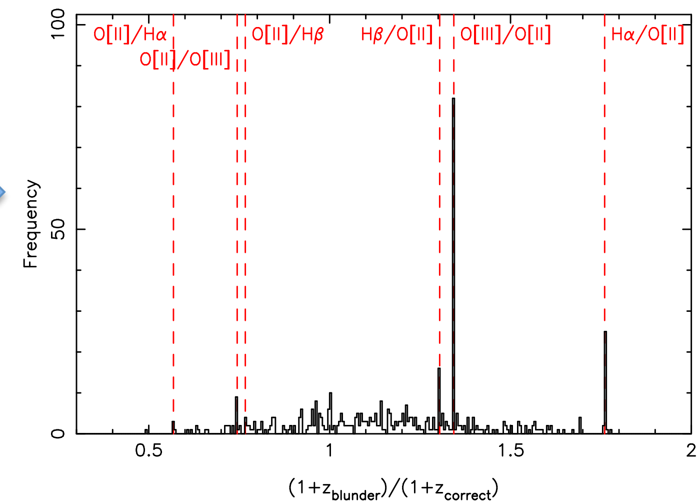


Figure 11. Distribution of values of $(1 + z_1)/(1 + z_2)$ for inconsistent repeat redshifts derived from pairs of spectra with quality flags $Q = 3$ (redshift z_1) and $Q \geq 4$ (redshift z_2). The vertical lines indicate the ratios expected in the cases where Hβ, [OIII] and Hα are mis-identified as [OII].

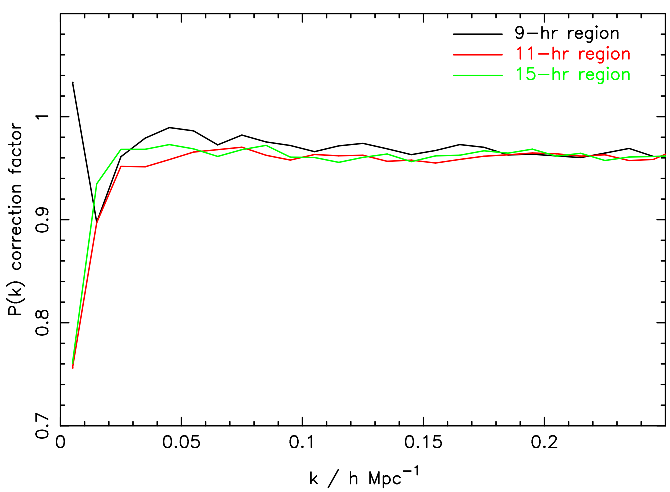


Figure 13. The power spectrum correction factor due to redshift blunders for each of the survey regions analyzed in this paper, for a redshift range $0.3 < z < 0.9$. The measured power spectrum must be divided by this factor in order to obtain an unbiased estimate of the true power spectrum.

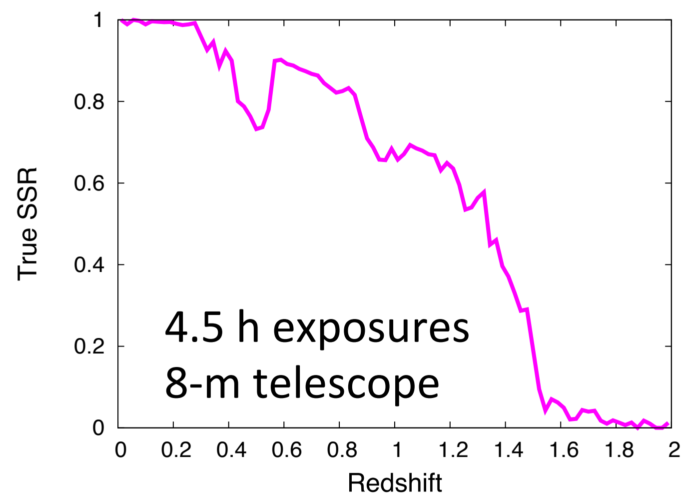
Effect is largest at large scales

Blake et al 2010

Radial spec-z issues for photometric surveys

Issues:

- Spectroscopic samples are very incomplete
  - Need to apply spectroscopic selection to photometric sample.
- Sample variance of spec. sample.
  - Area of samples is too small.
- Spectroscopic failures (wrong redshifts).



Case study:

DES photometry + VVDS-like spec-z's

Cunha et al. in prep.

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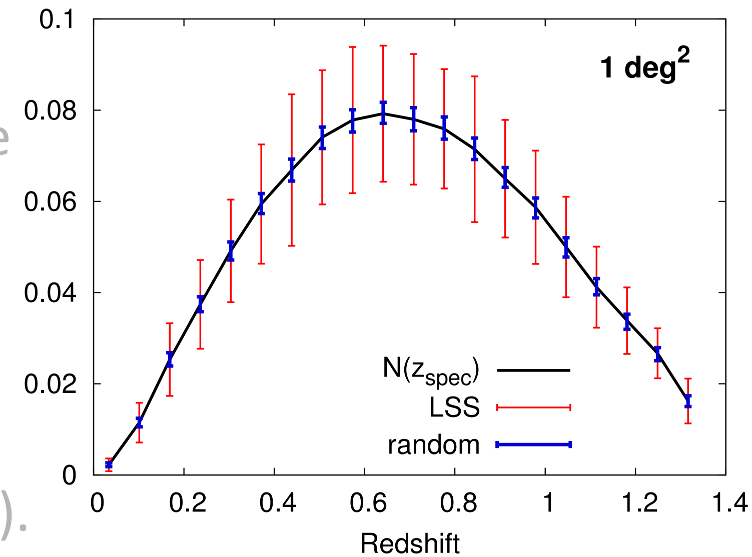

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Cunha, Huterer, Busha & Wechsler 2012

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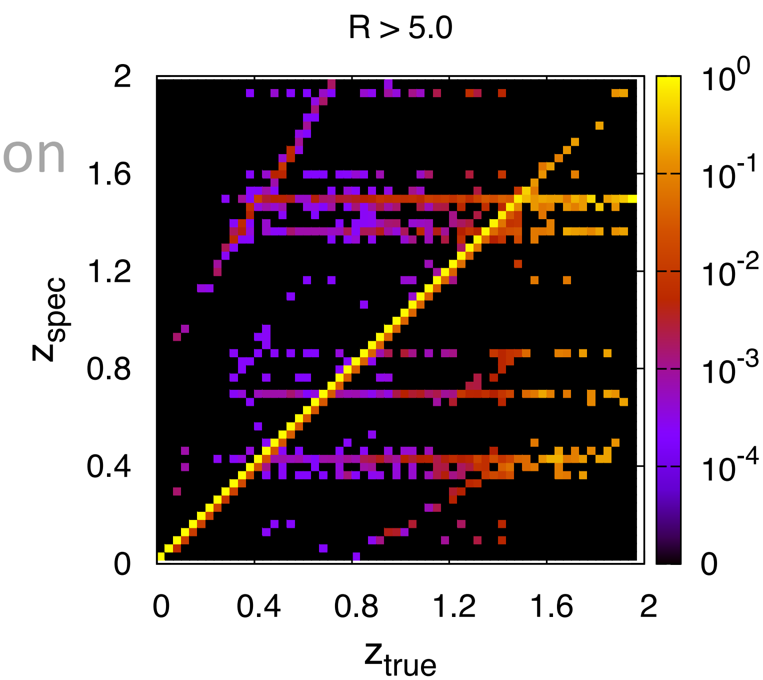

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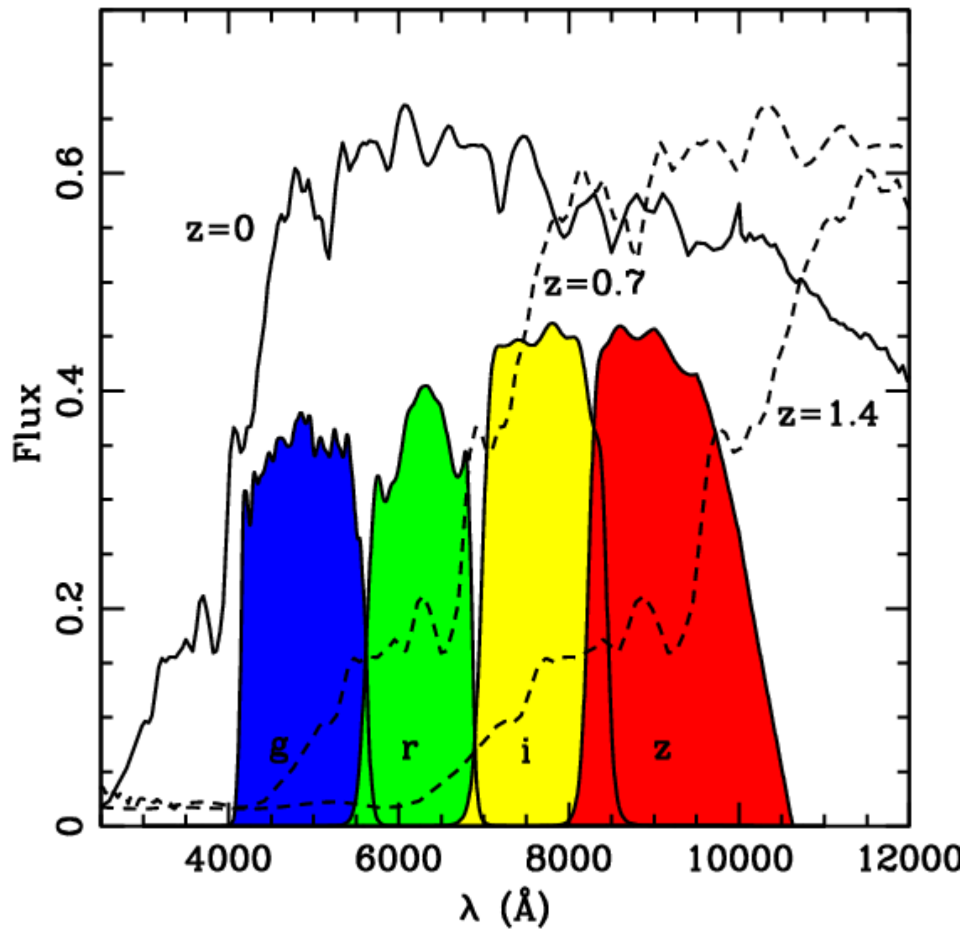
Radial-Angular correlations

Photometric surveys for theorists

- Collect light from galaxies in several broad-band filters in optical and near-IR.
- grizY (DES) + JK (Vista)
- Use flux in each filter to determine:
  - type:star/gal./QSO
  - gal. type: spiral, elliptical, …
  - (photometric) redshift
- Also have angular and shape information



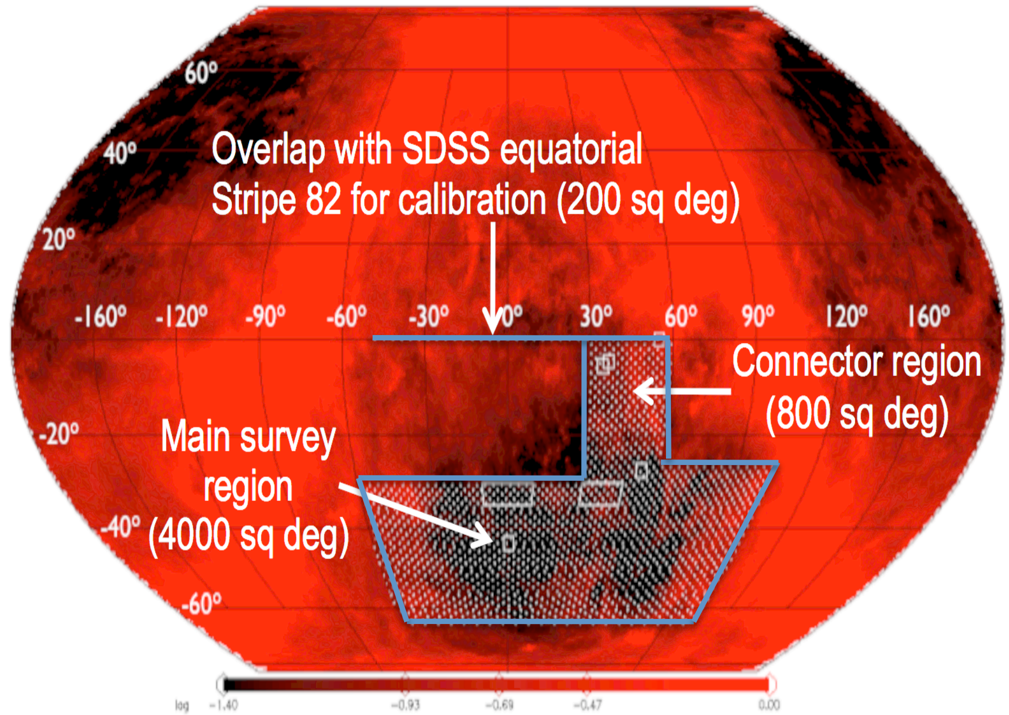
Terminology:

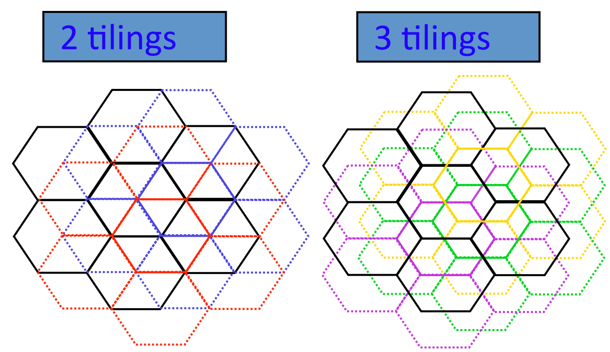
magnitude = A – log(flux)
color = magnitude - magnitude

DES Photometric Calibration

- Deal with: telescope/camera, atmosphere, seasons, Moon, Milky Way.
- Multiple overlapping tilings with varying orientations + standard stars + …
- DES: 2 survey tilings/filter/year
- Need contiguous area that overlaps existing surveys.

DES Goal: 1% photometry over all survey area (BaO requirement is 2%).





Photometric calibration is complicated

- Deal with: telescope/camera, atmosphere, seasons, Moon, Milky Way – over several years.
- Multiple overlapping tilings with varying orientations + standard stars + …
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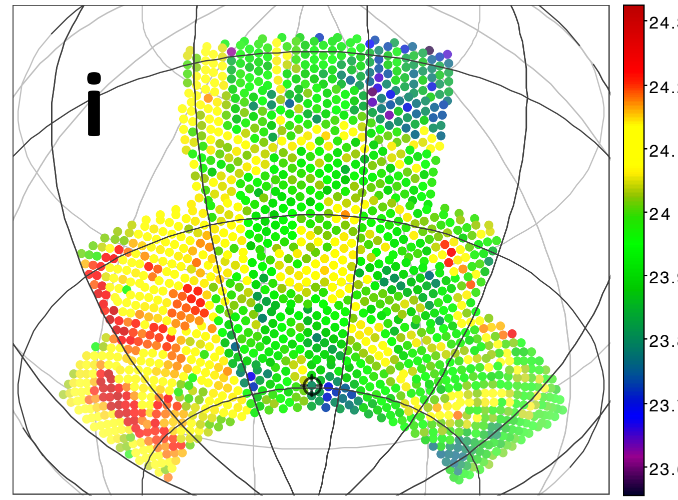
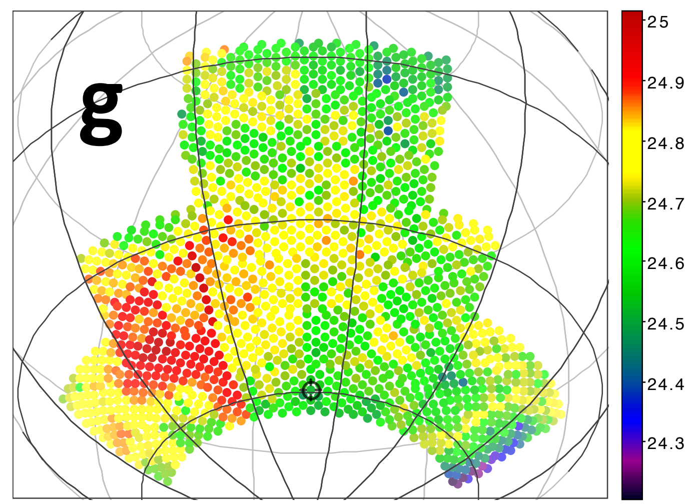
DES 5yr mag – limits

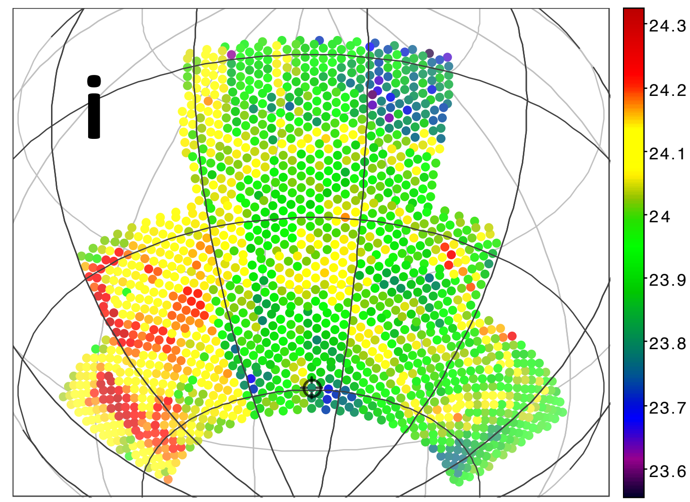


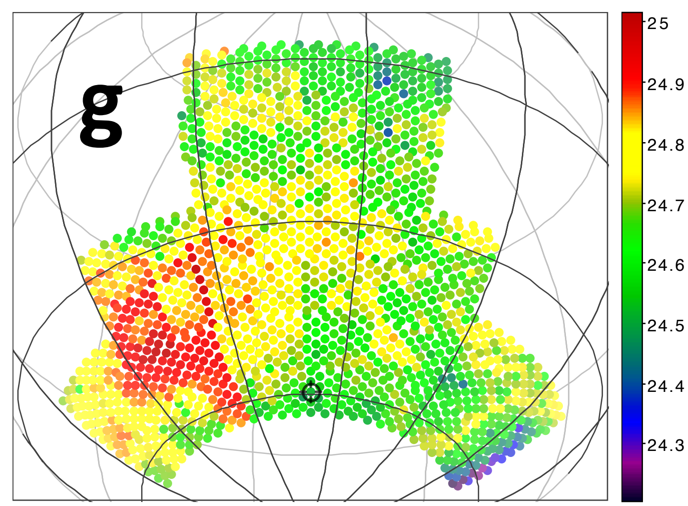


Photometric calibration is complicated

- Mag. limits affect redshift distribution -> coupling between angular and radial effects (problem is worse if using photo-zs).
- Varying colors, affect galaxy types being selected.
  - Different types have different HODs, with different biases.
  - variation in color -> scale-dependent halo bias
- Need to couple radial-angular mask
- Uncertainty in calibration will still be a problem.

DES 5yr mag – limits



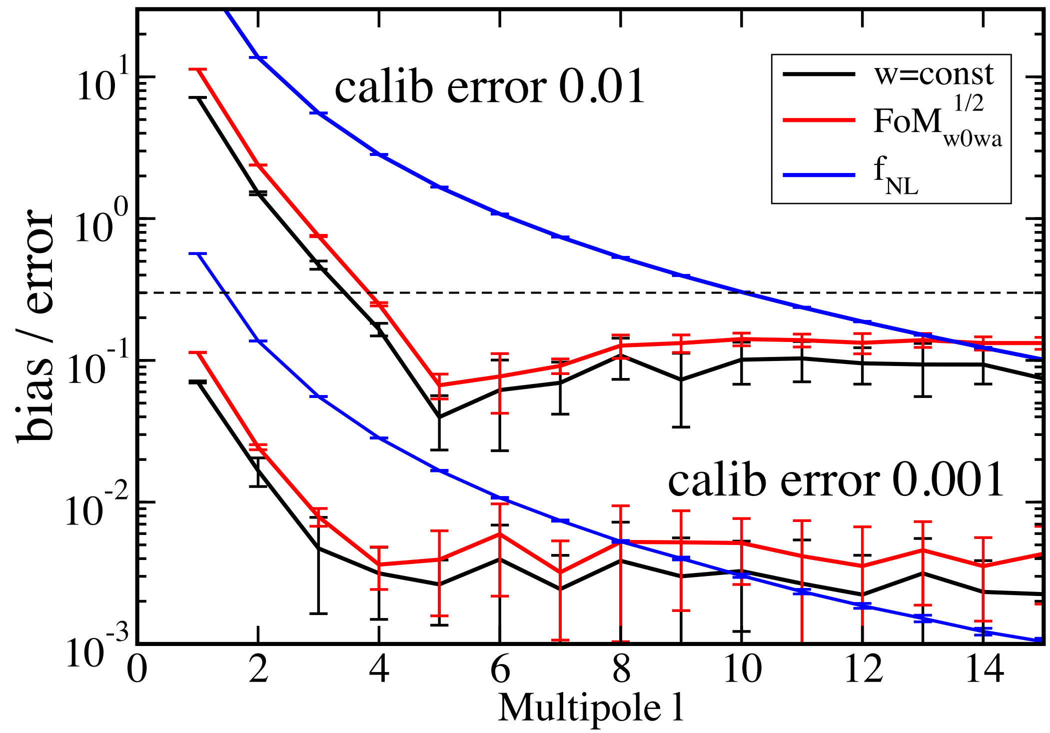


Uncertainty in calibration

$$e_{calib} = \frac{\delta N}{N} \approx 3\frac{\delta m}{m}$$

N: Number of galaxies
m: magnitude

Error bars: variations from alocatting e_{calib} to different m.



Huterer & friends, in prep.

Conclusions

- Spectroscopic selection is a major challenge for upcoming surveys, particularly photometric surveys (because they go deeper).

- Survey calibration on the largest scales is a tough challenge.
- Lots of work to be done before trustworthy constraints can be extracted from large-scale clustering.

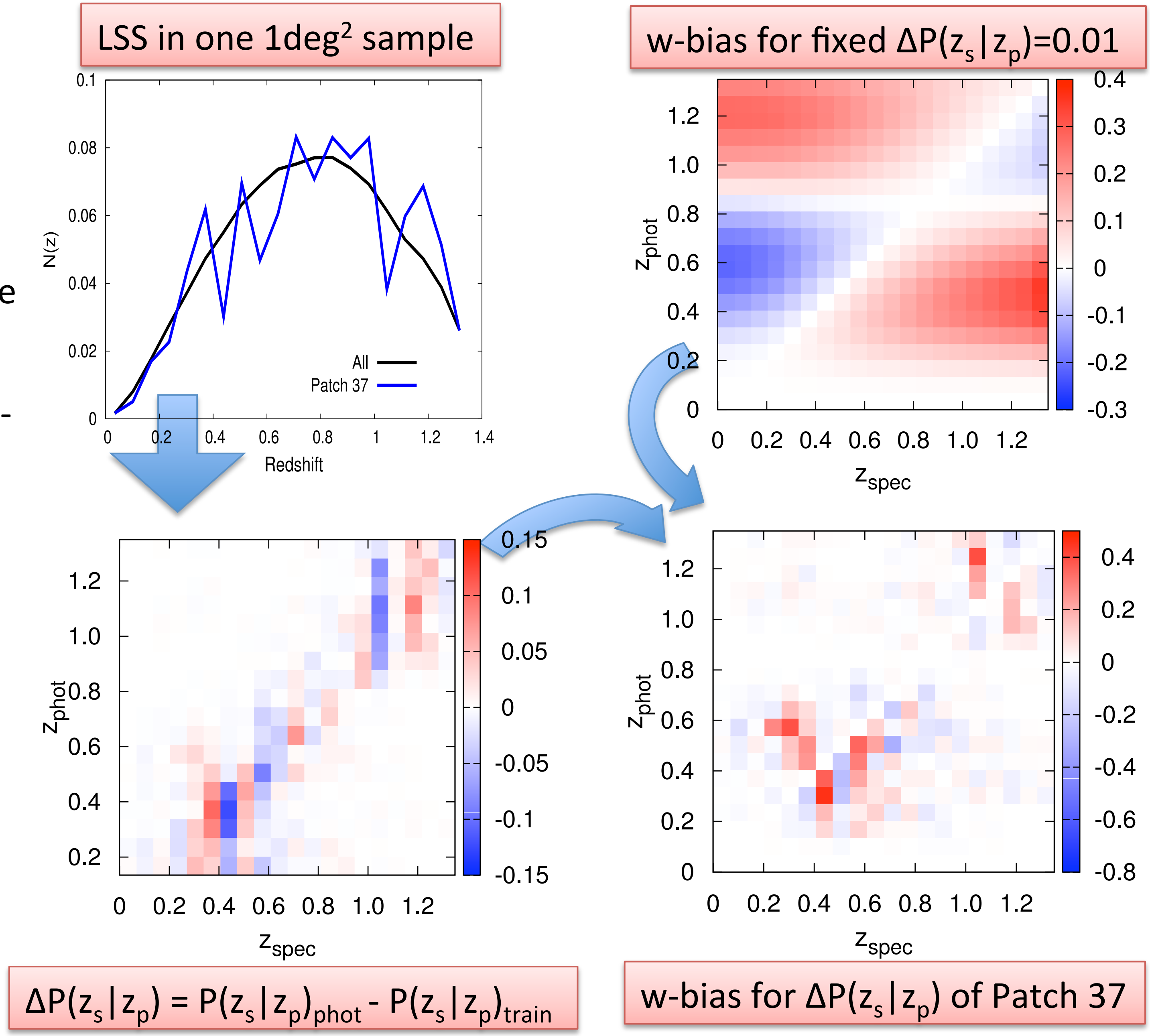
An example:

- Template photo-zs.

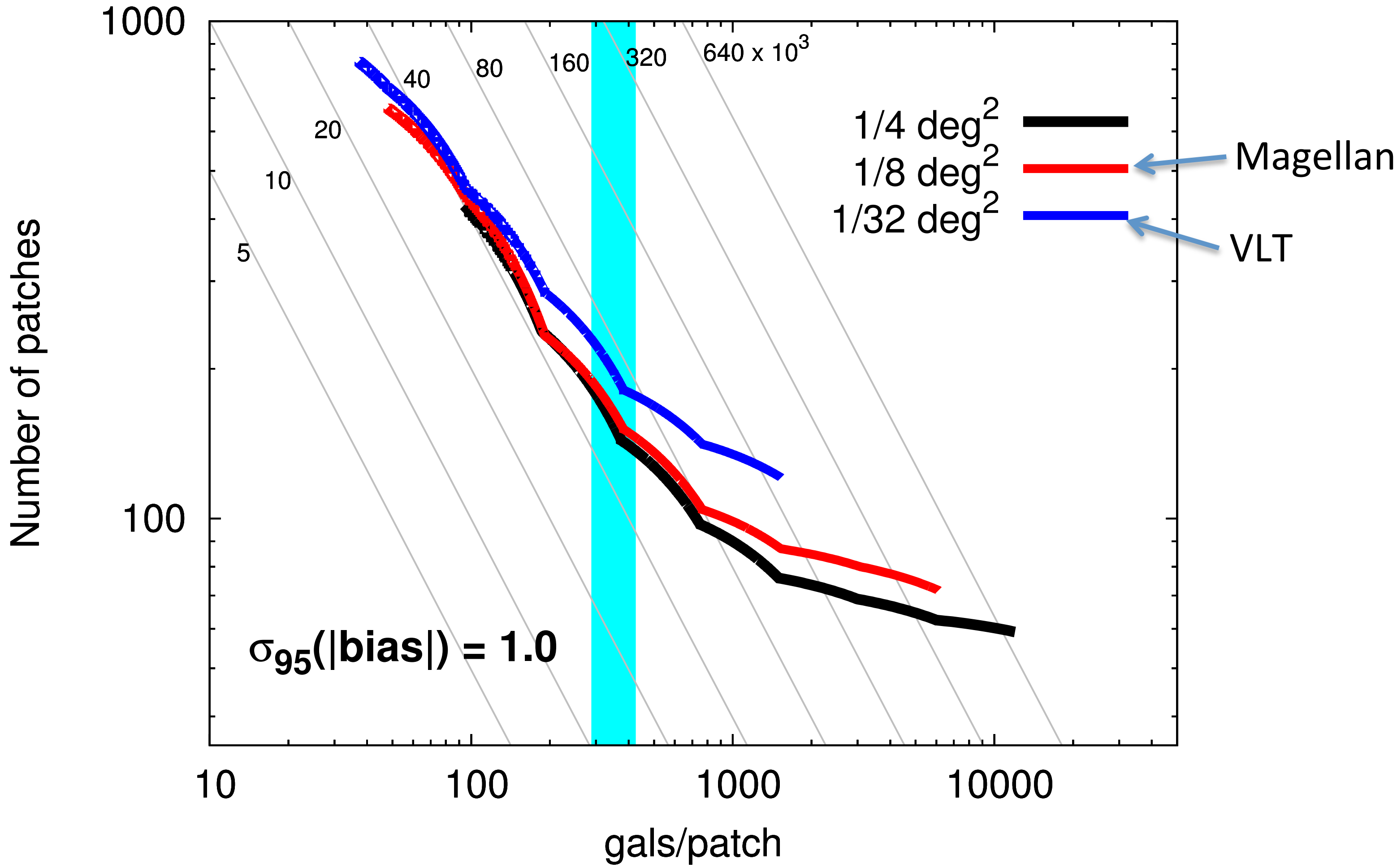
- Calibration using one field with 1 deg^2.

- Weak Lensing shear-shear tomography.

- Difference between true $P(z_s|z_p)$ and that of calibration sample generates biases in cosmology.



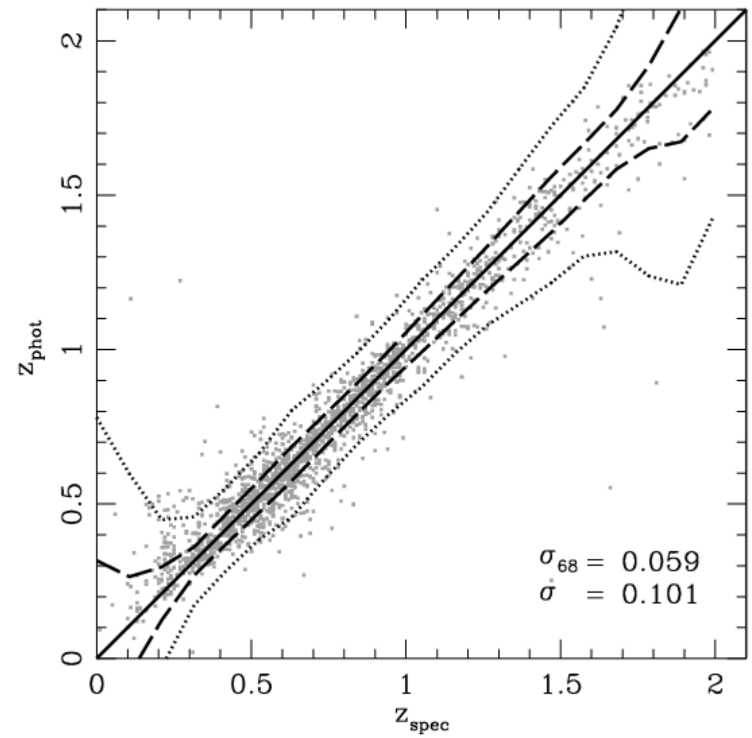
Survey Calculator



Cunha, Huterer, Busha & Wechsler
arXiv: 1109:5691

DES Photo-zs

- Combination DES (optical)+Vista (IR) yields robust photo-zs.
- LRGs have even better scatter.
- Errors need to be modeled carefully, but f_{NL} requirements weaker than WL.
- For clusters σ_z=0.02.

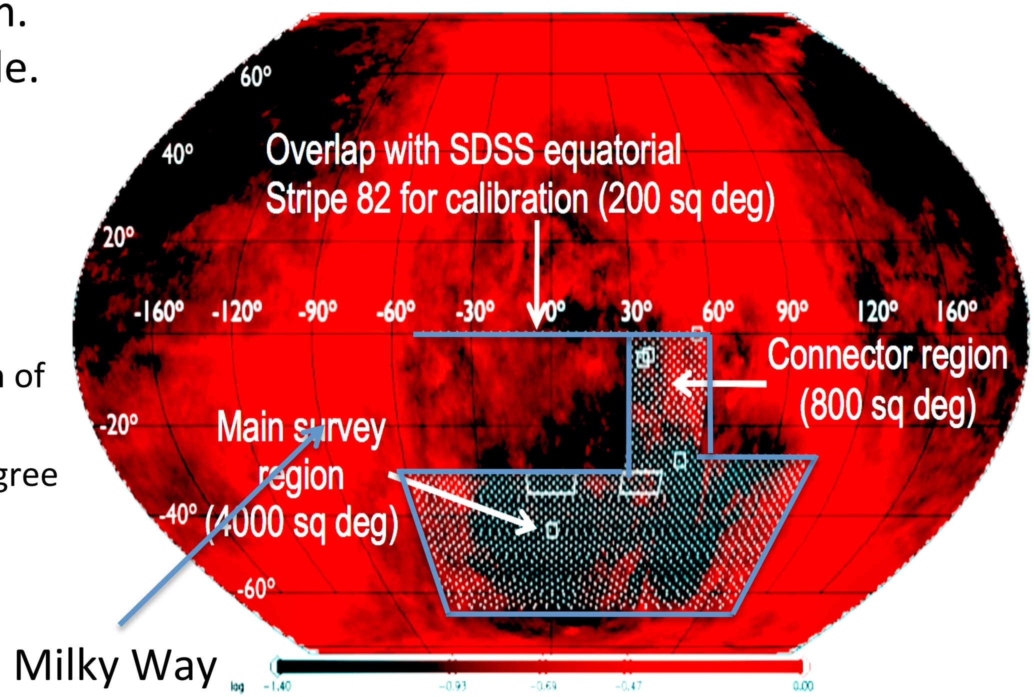


Rough numbers:
Δz=0.1 ➔ Δd_c =1-2×$10^2 h^{-1}$ Mpc over survey redshift range.

100 Mpc ≈ 3 deg at z=1.

Star/Galaxy separation

- Distribution of stars is not random. Pronounced variation with latitude.
- Classification using colors (magnitudes)
- BAO requirement:
  - probabilities accurate to 1%
  - stellar contamination and distribution of misclassified galaxies smaller than 9% over all survey (< 2% on scales < 4 degree
- Good enough for f_{NL}?



The Dark Energy Survey

www.darkenergysurvey.org

- Study Dark Energy using
  4 complementary techniques:
  I. Cluster Counts
  II. Weak Lensing
  III. Baryon Acoustic Oscillations
  IV. Supernovae

- Two multiband surveys:
  Main: 5000 deg^2 ≈ 5 (h^{-1}Gpc)^3
  300 million galaxies
  g, r, i, z, Y to 24th mag
  SNe: 15 deg^2 repeat

- Build new 3 deg^2 FoV camera
  and Data management sytem in Blanco
  4-m telescope
  Survey 2012-2017 (525 nights)
  Camera available for community use
  the rest of the time (70%)

Observational issues for f_{nl} measurement

- Artificial correlations can mimic f_{nl}. For $f_{\rm NL}^{\rm local}$, separations >100 Mpc (several degrees) are crucial.

Because of $1/k^2$ scale dependence of bias

$$b(k) = b_G + f_{NL} \frac{const}{k^2}$$

- Artificial correlations can be due to:
  - photometric calibration
  - photometric redshifts
  - star/galaxy separation

  More relevant for galaxies than clusters (photometric redshifts, star/galaxy separation)

- Clusters have own selection issues