

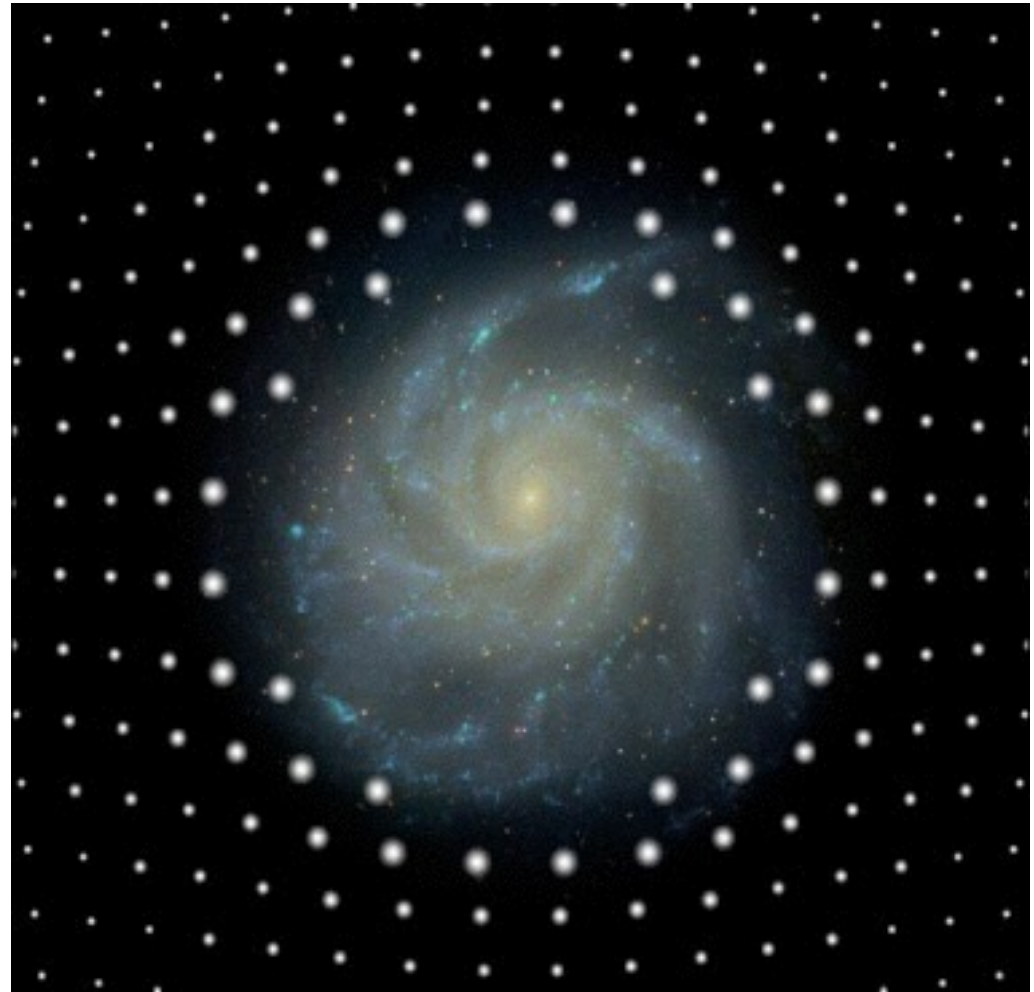
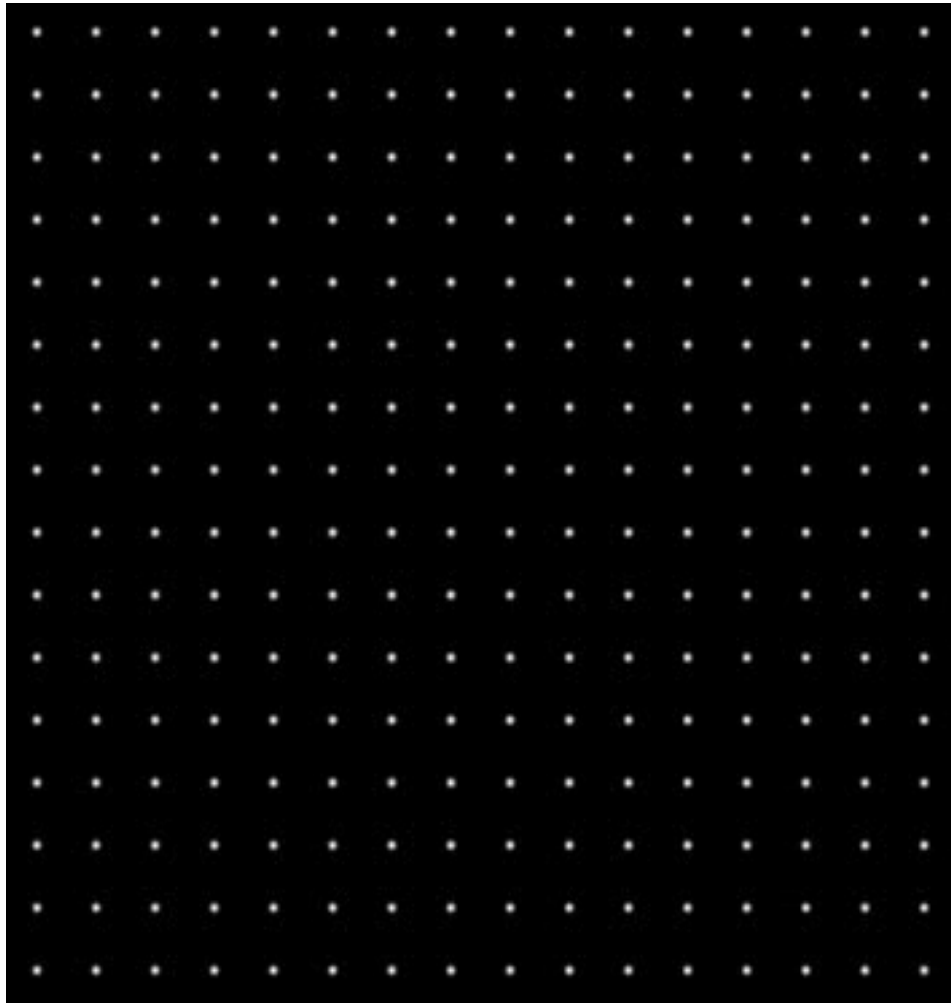
Weighted randoms for multi-epoch surveys: Application to CFHTLenS magnification and RCSLenS

Christopher Morrison
w/ Hendrik Hildebrandt
Argelander-Institut für Astronomie,
University of Bonn
Cosmo Cruise 4/9/2015

Outline

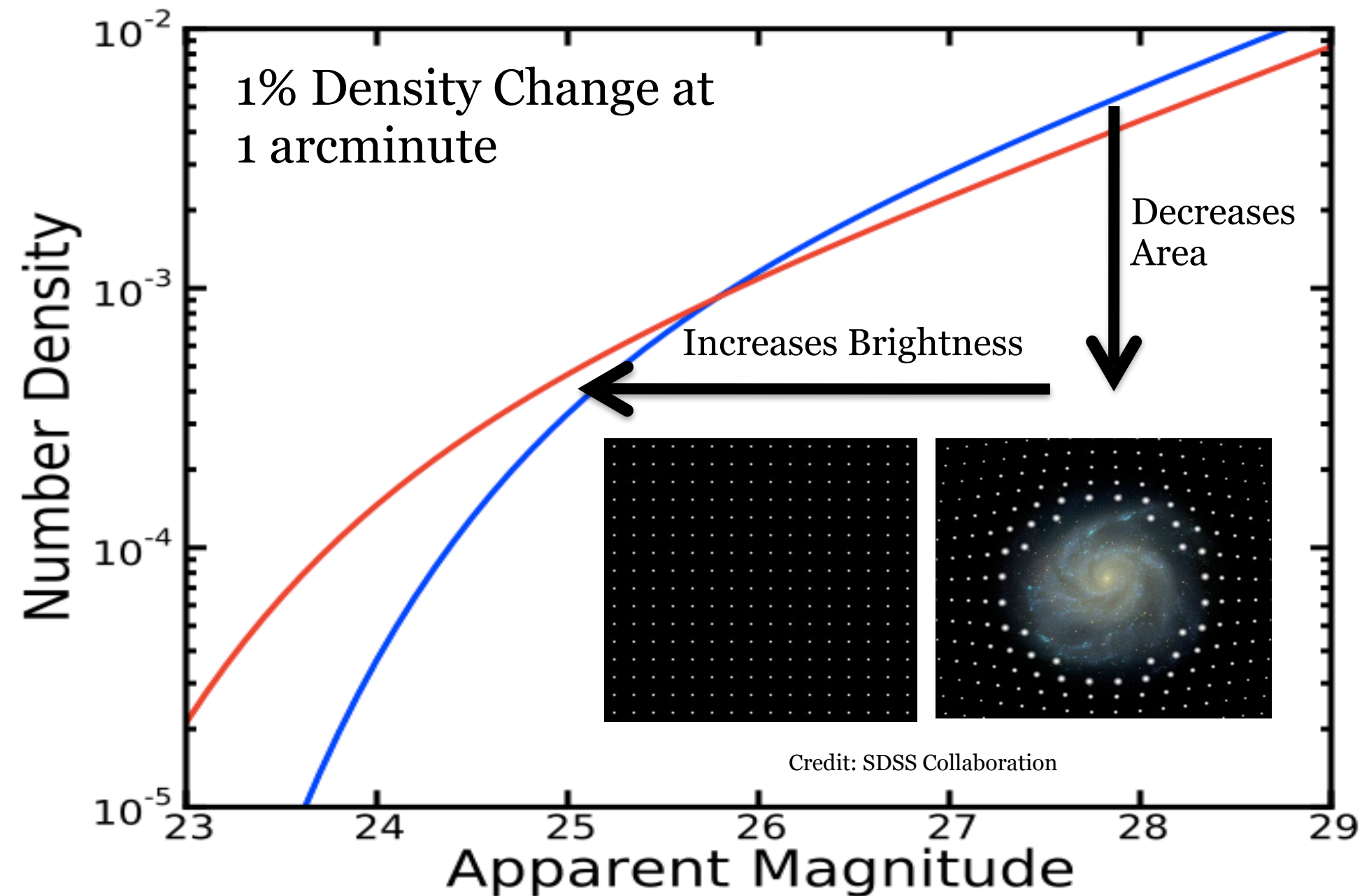
- Weak Lensing Magnification
- Inhomogeneities in Photometric Surveys
 - CFHTLenS Survey Systematic Variations
 - Density Variations
 - Correlations
- Modeling and Creation of Weighted Randoms
 - Mapping Survey Systematics to Galaxy Density
- Results
 - Correlations after modeling
- RCSLenS
- Conclusions

Weak Lensing Magnification

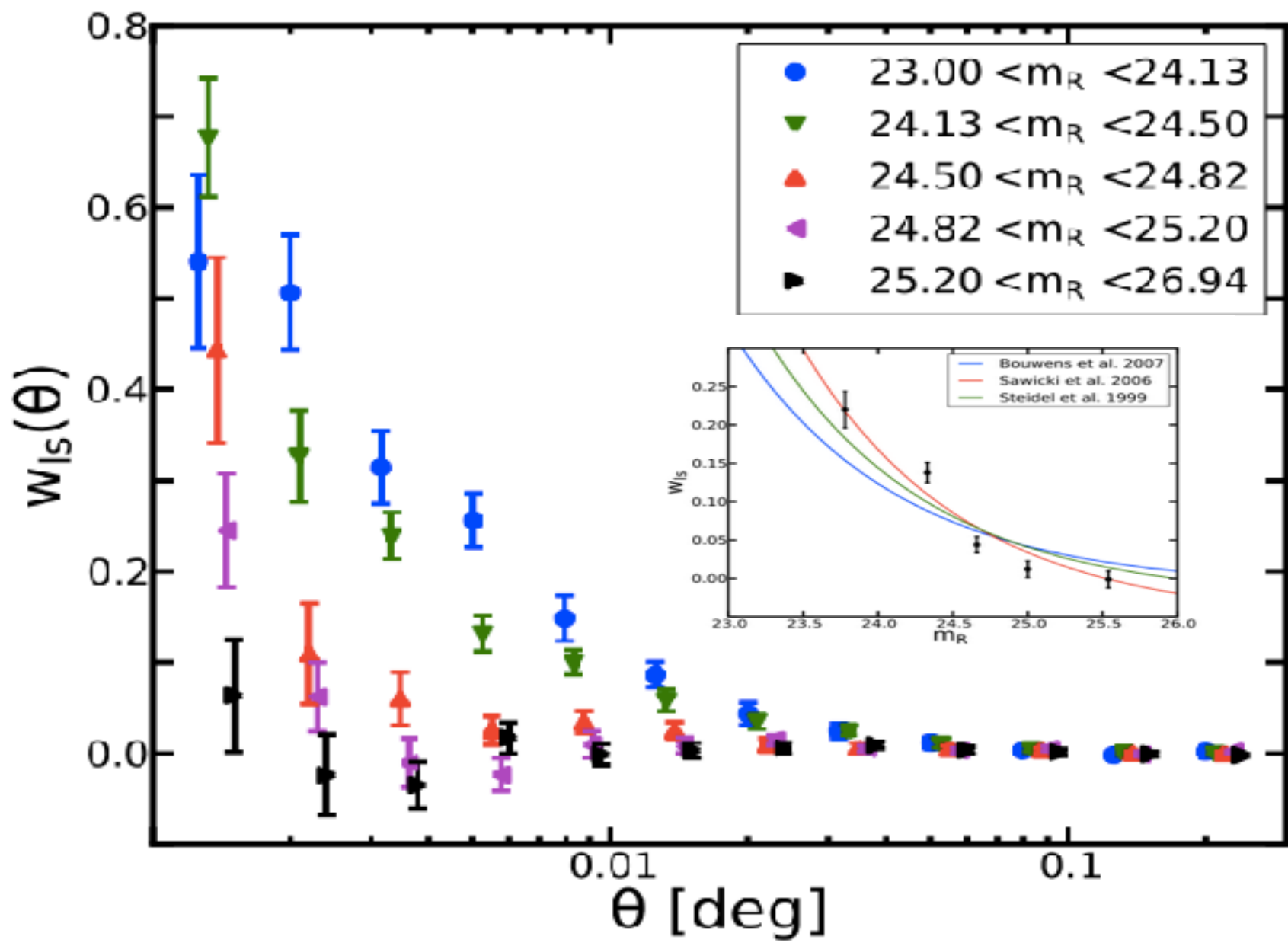


Credit: SDSS Collaboration

Measuring Magnification



Magnification scaling with Magnitude

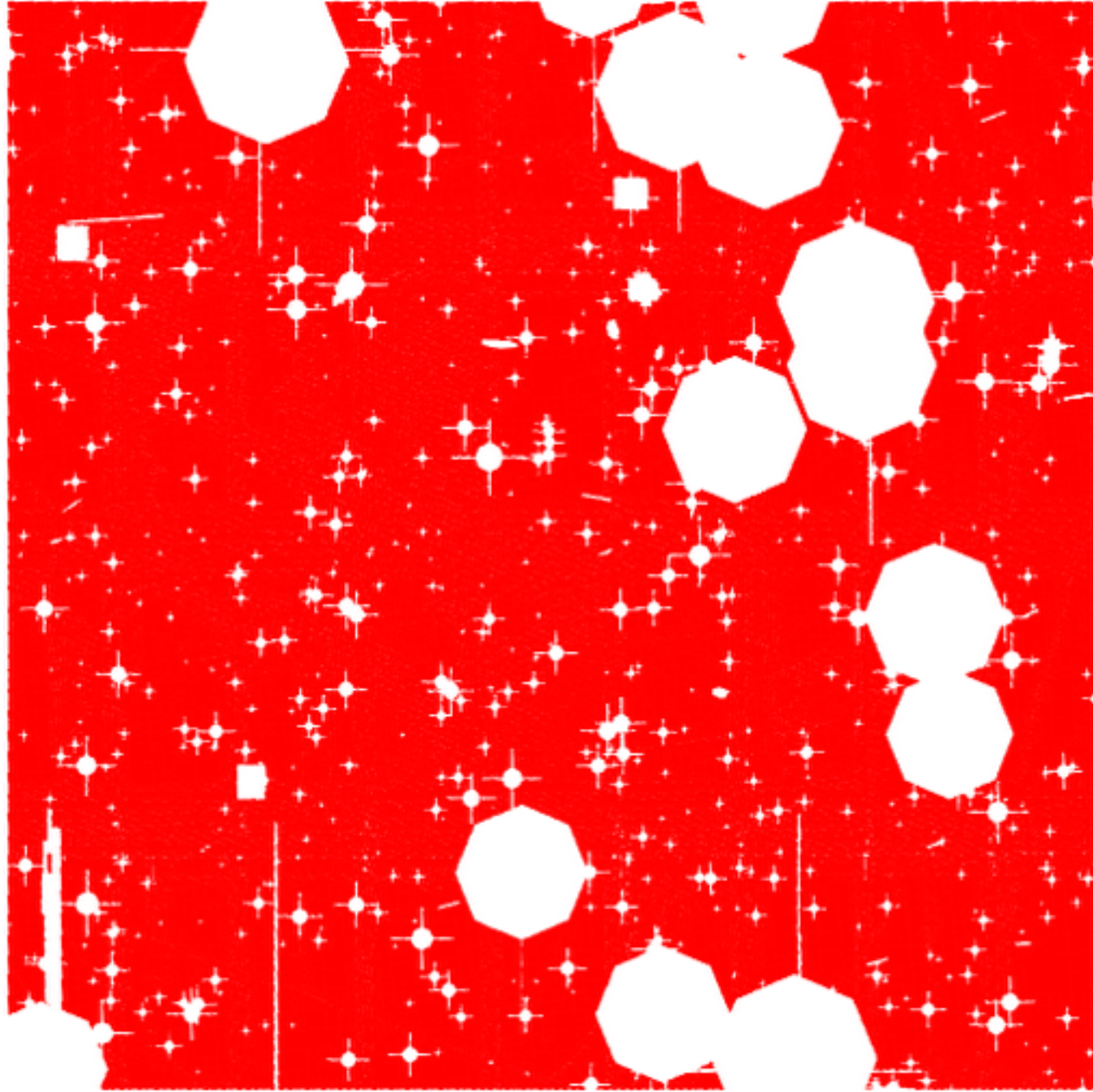


CFHT LenS

- 154 sq. deg. (*ugriz*) survey using the CFHT Legacy Survey data
- 171 pointings over 4 widely separated fields
- $i < 24.5$ 5σ detection
- Resolved sources: 17 gal. per sq. arcmin
- Mean redshift of $z \sim 0.7$
- Extensive calibration and systematics tests
 - Heymans et al. 2012, Erben et al. 2012, Hildebrandt et al. 2012, Miller et al. 2012

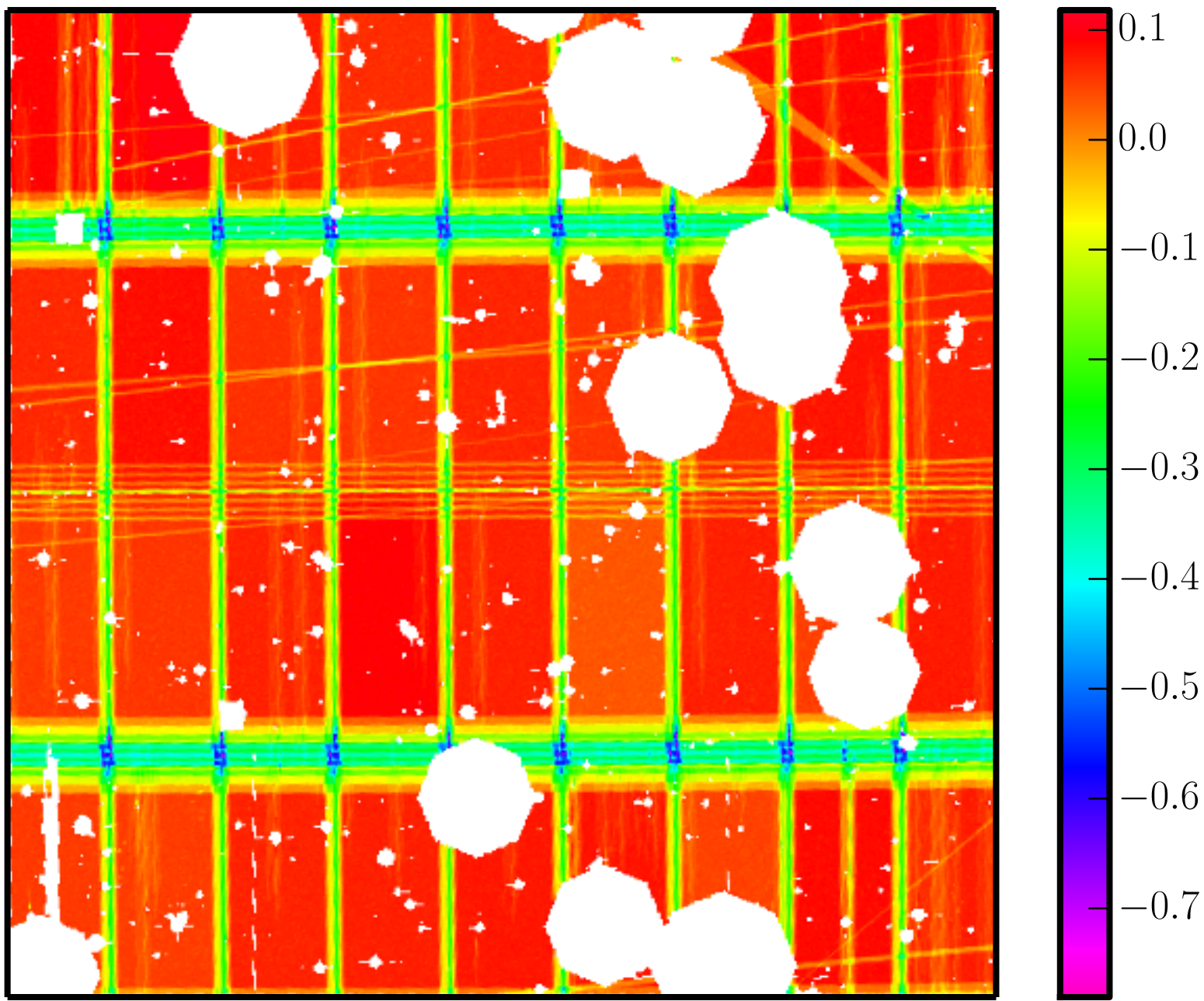


A Typical CFHTLenS Pointing



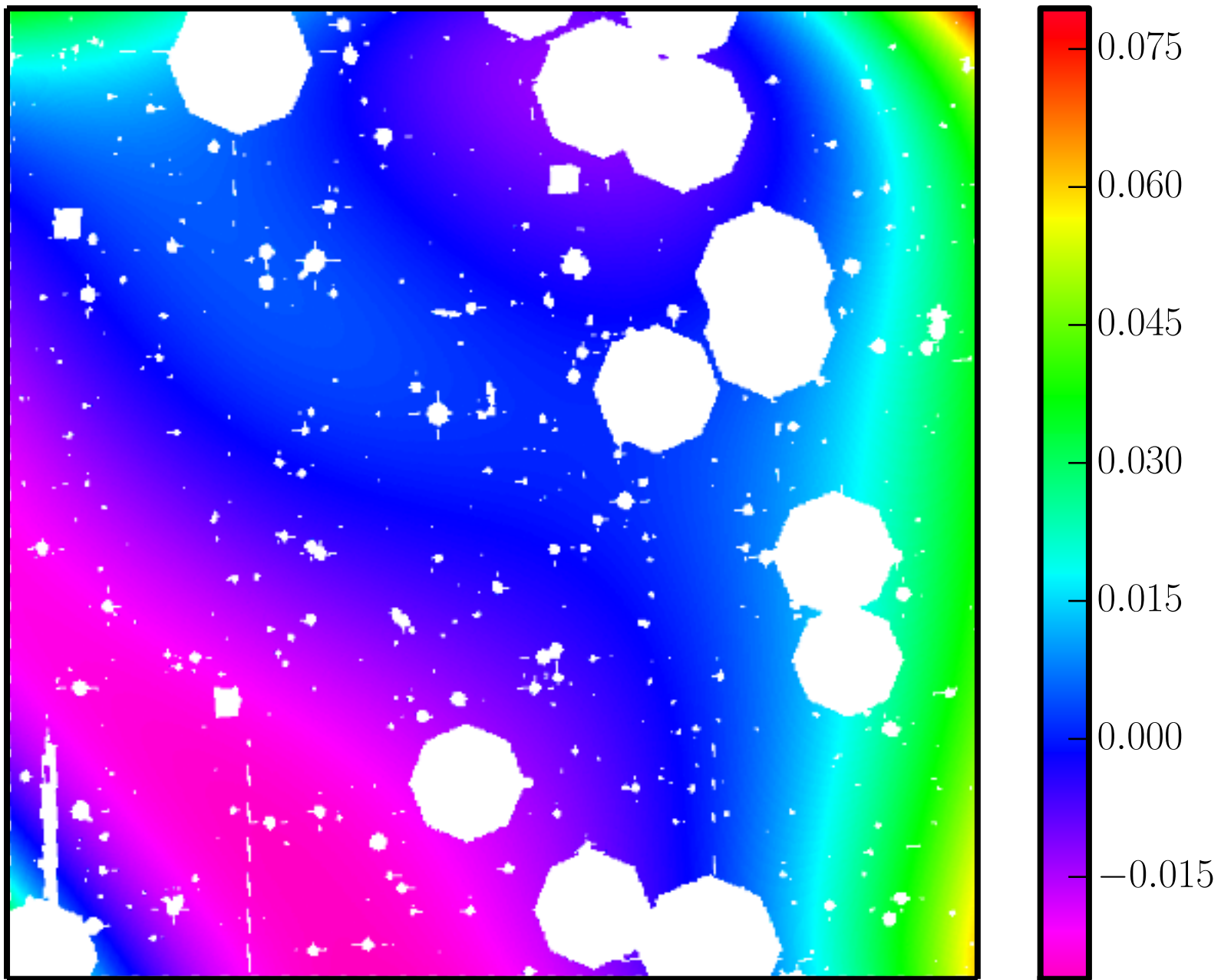
CFHTLenS Pointing

Δi_{lim} [MagAB]



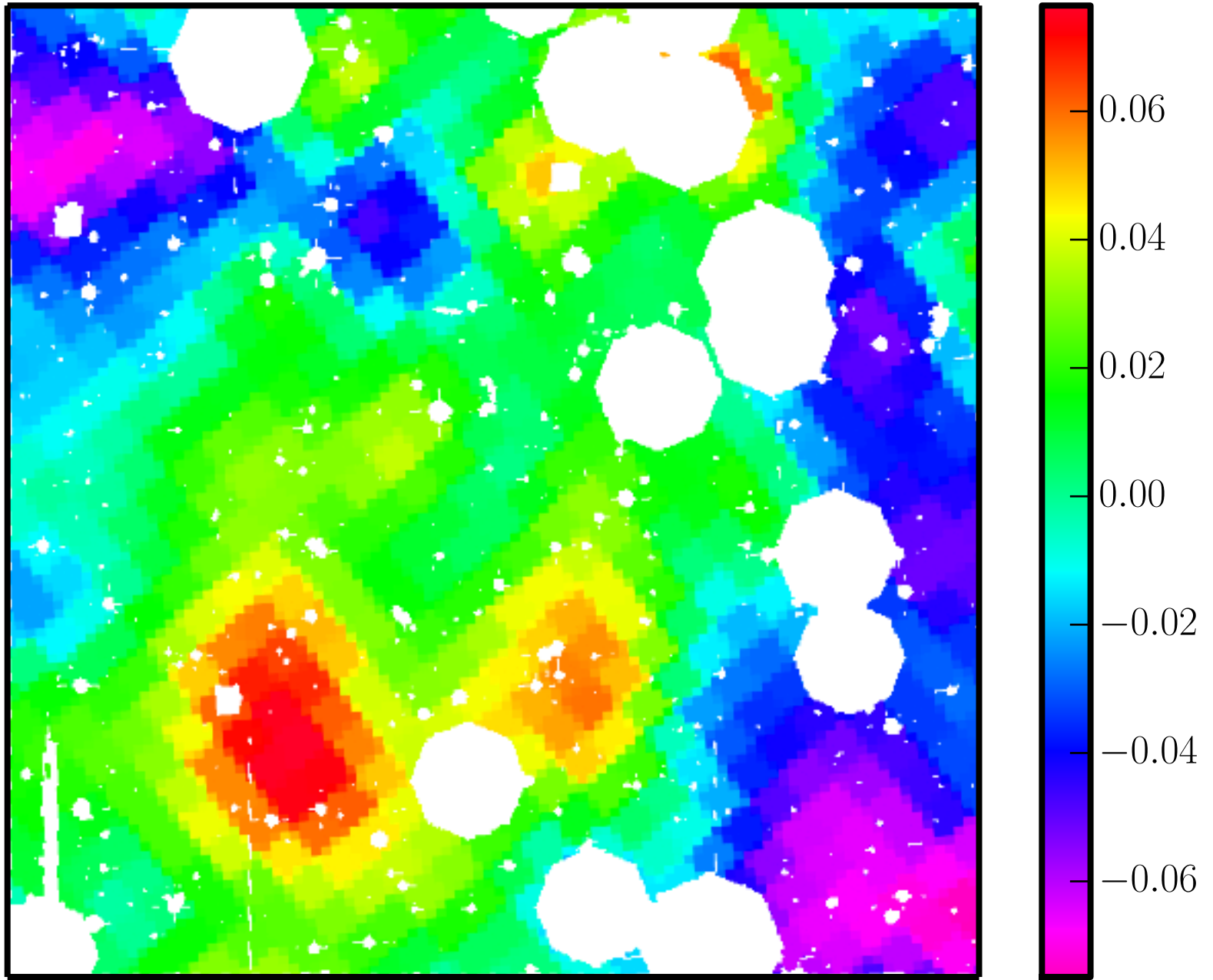
CFHTLenS Pointing

ΔFWHM_i [rel.dev.]

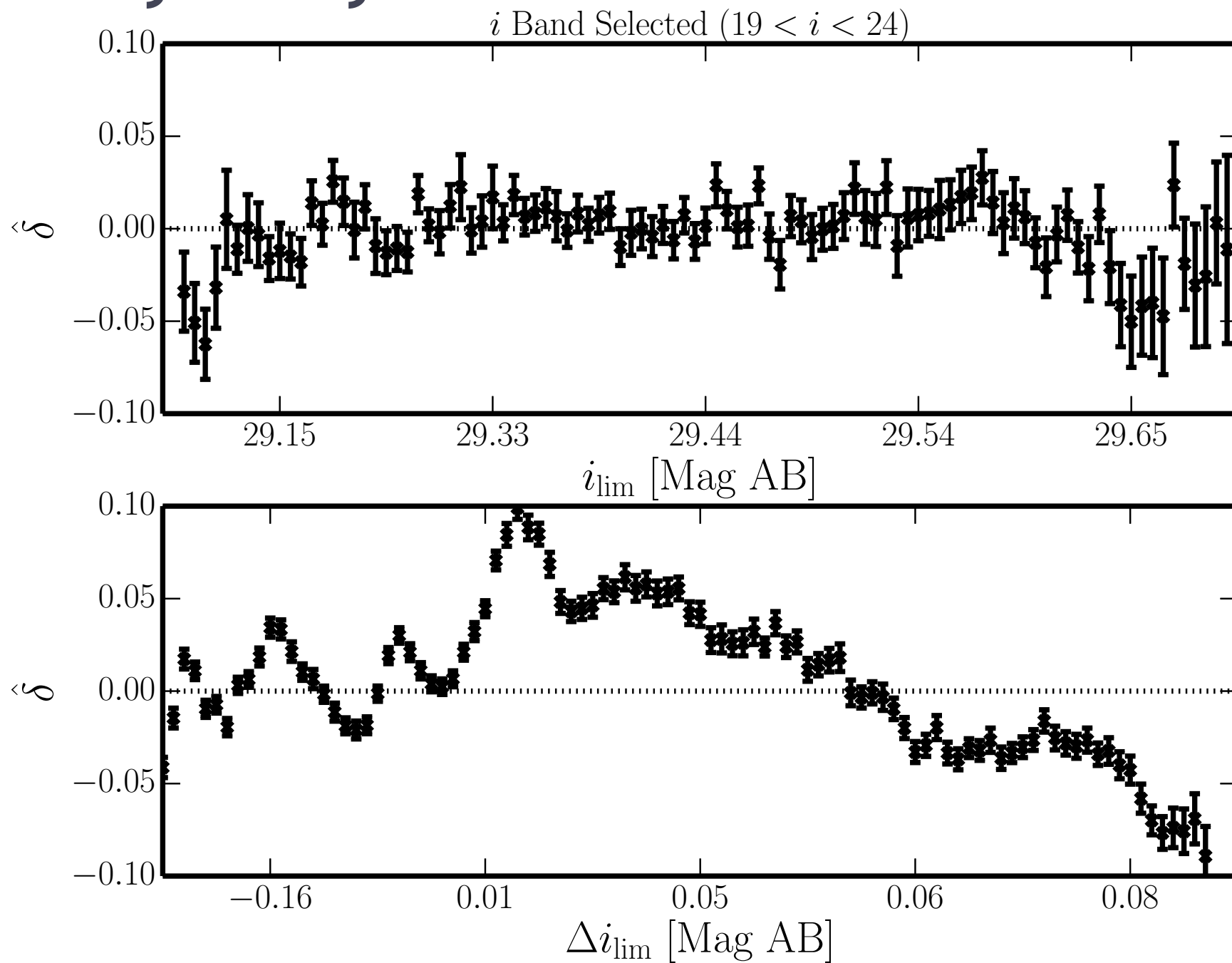


CFHTLenS Pointing

$$\Delta E(B - V) \times 10 \text{ [MagAB]}$$

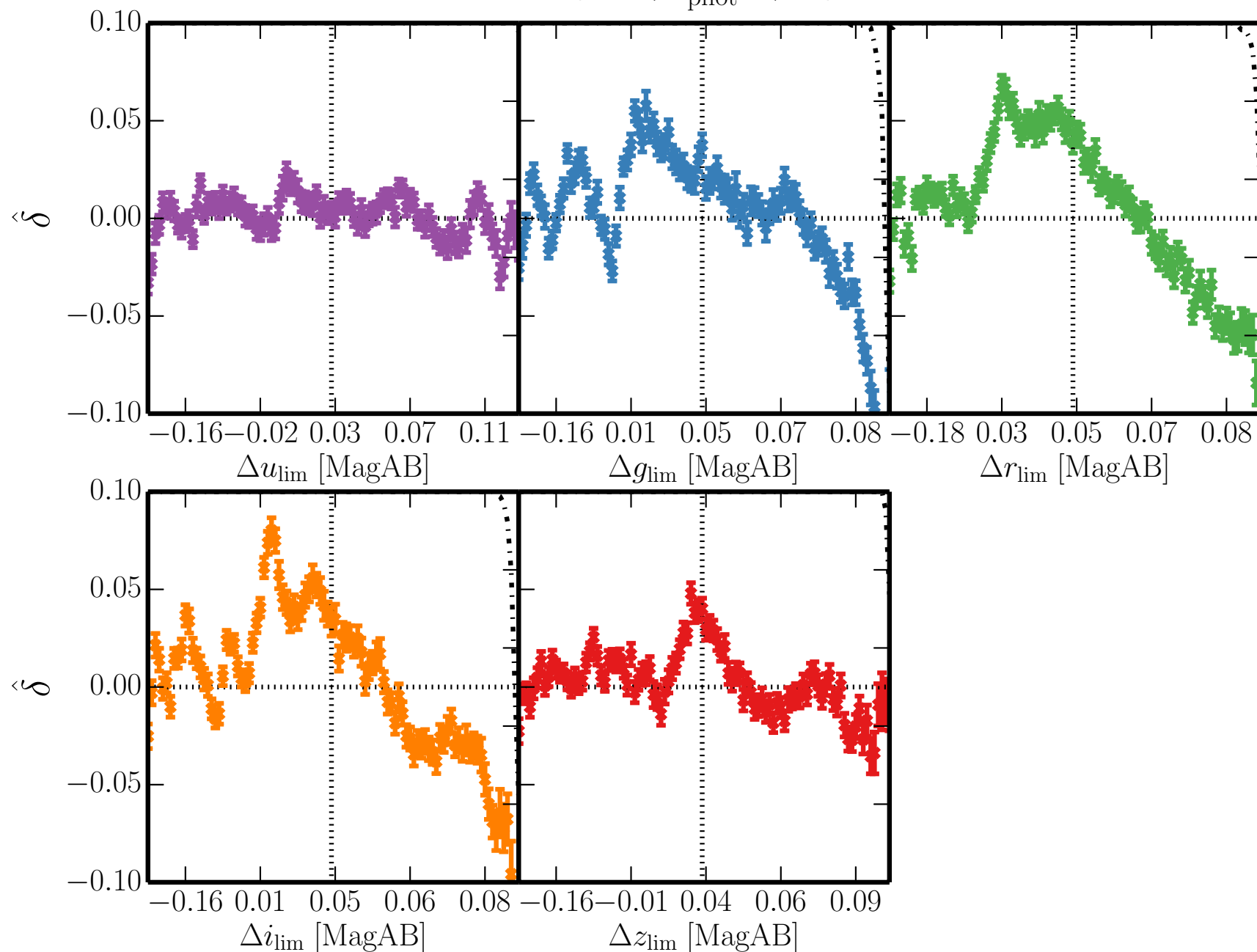


Density vs Systematics



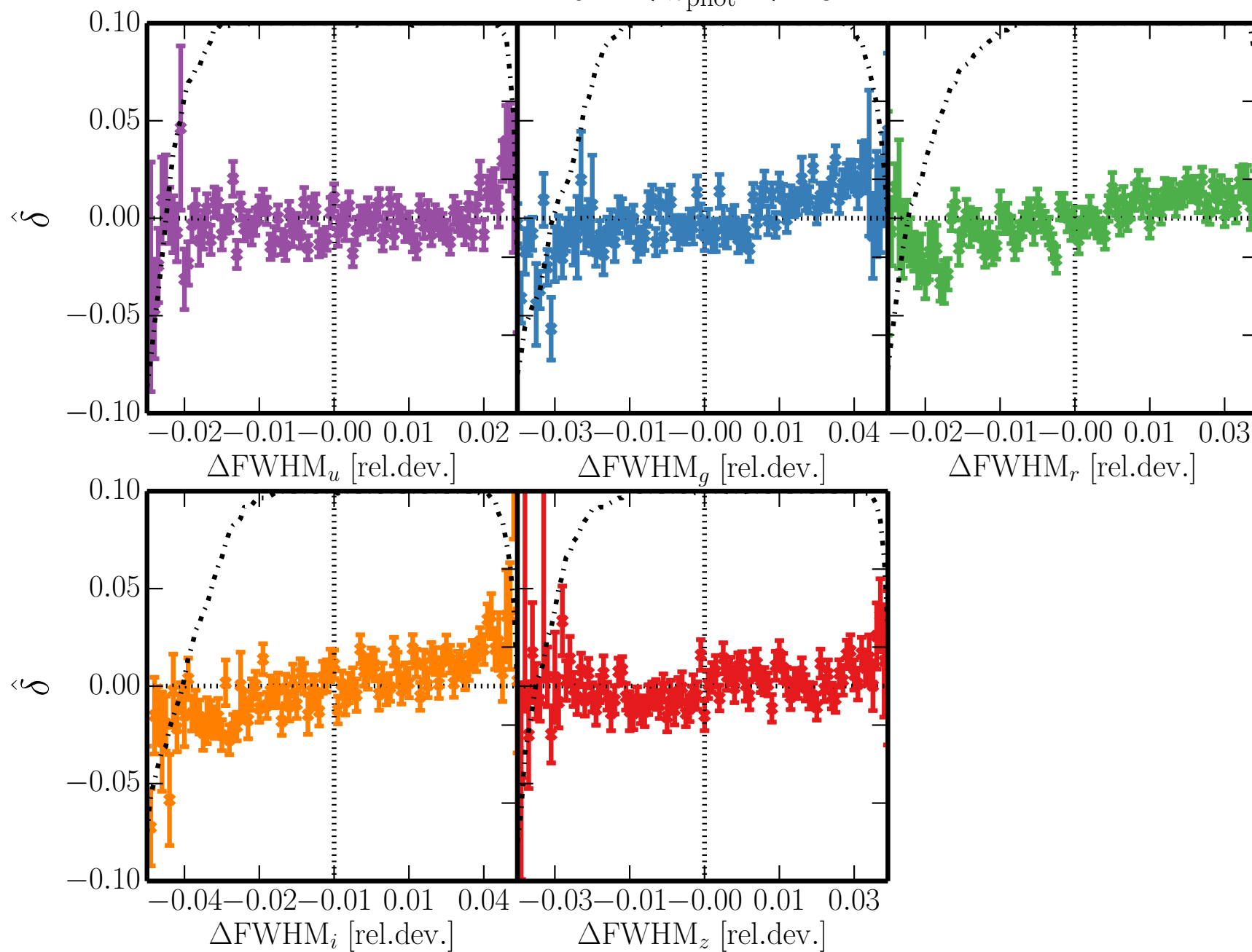
Density vs Systematics [Depth]

$0.1 < z_{\text{phot}} < 1.3$

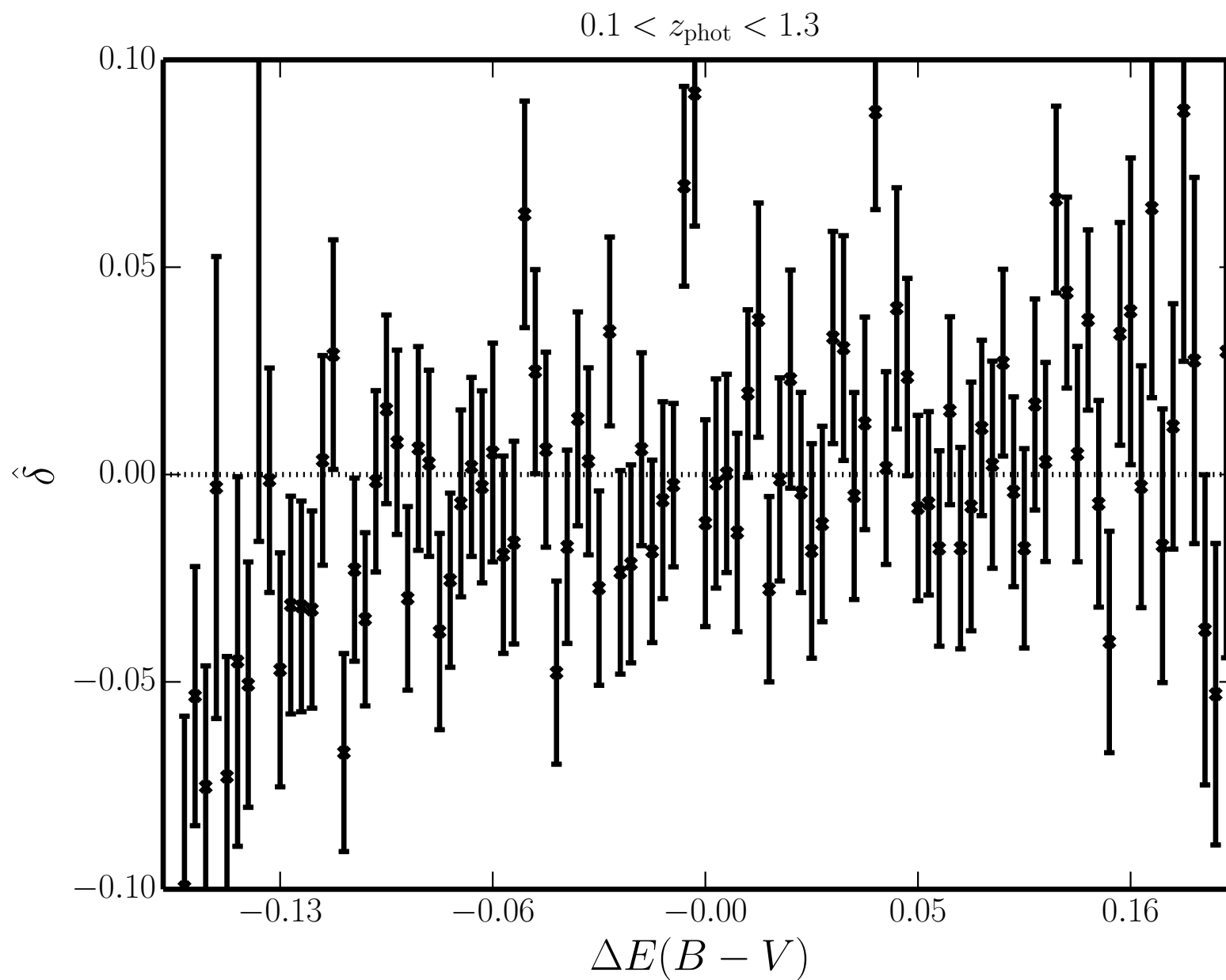


Density vs Systematics [PSF size]

$0.1 < z_{\text{phot}} < 1.3$

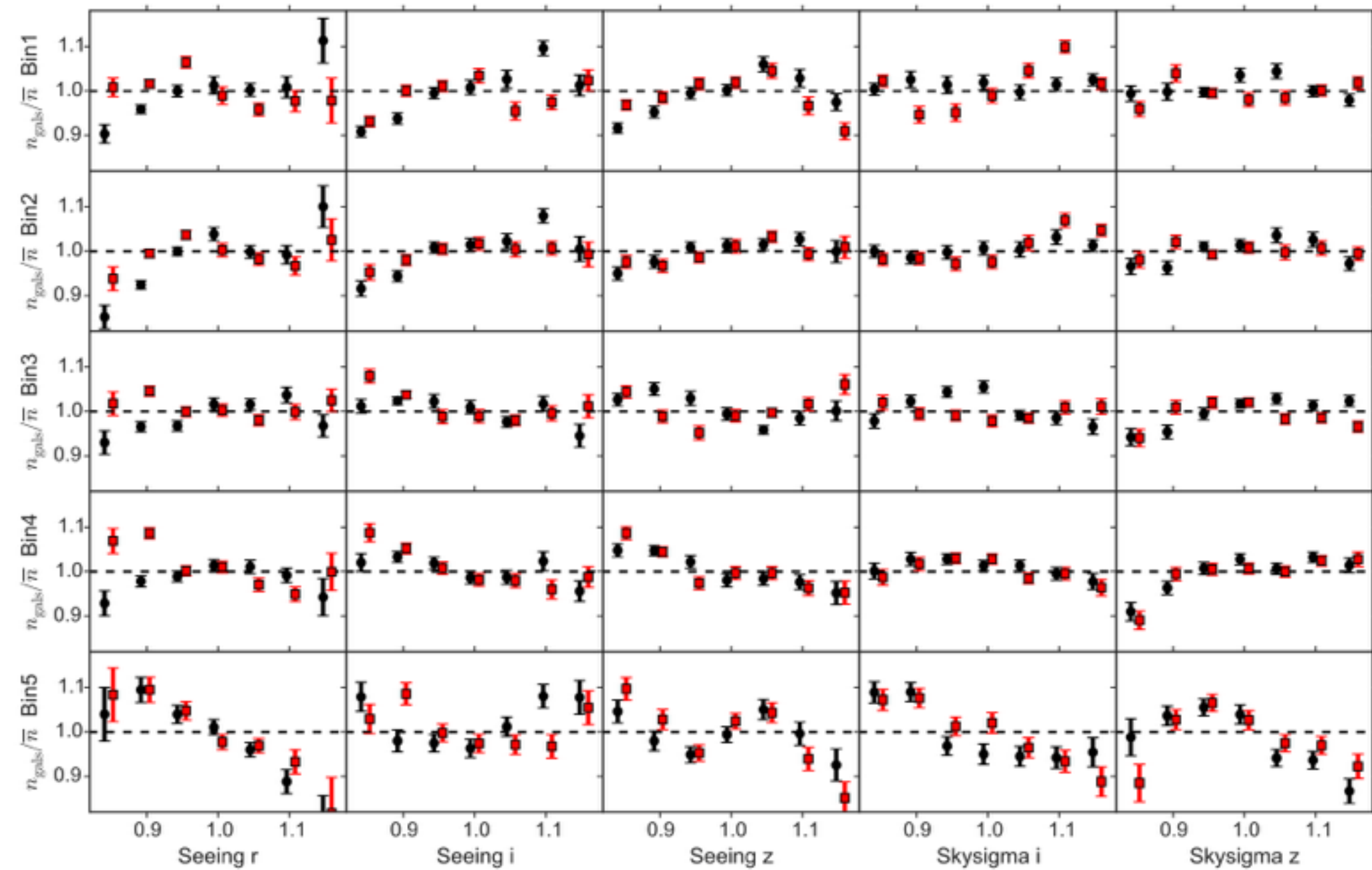


Density vs Systematics [E(B-V)]

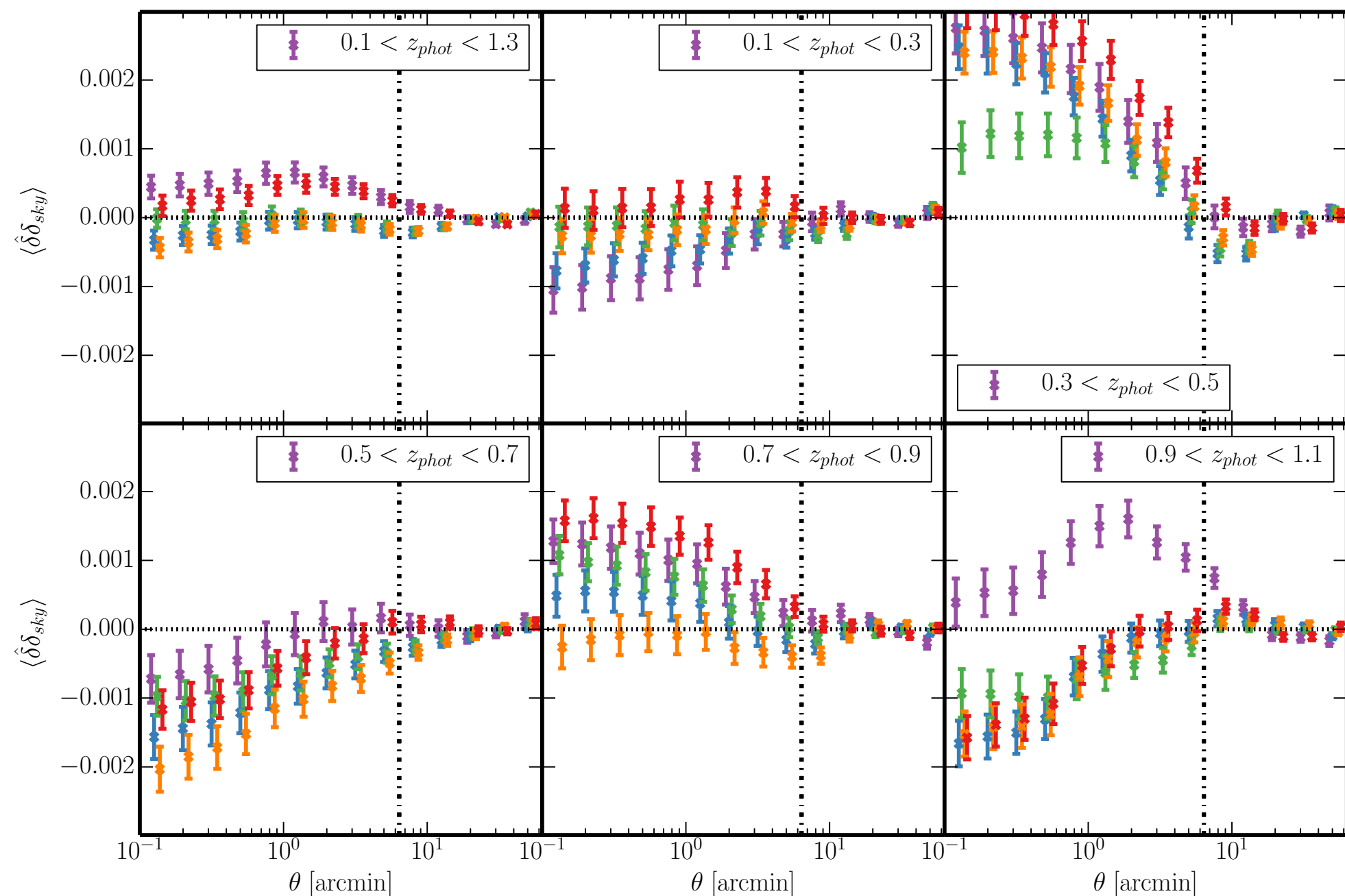


Another Example

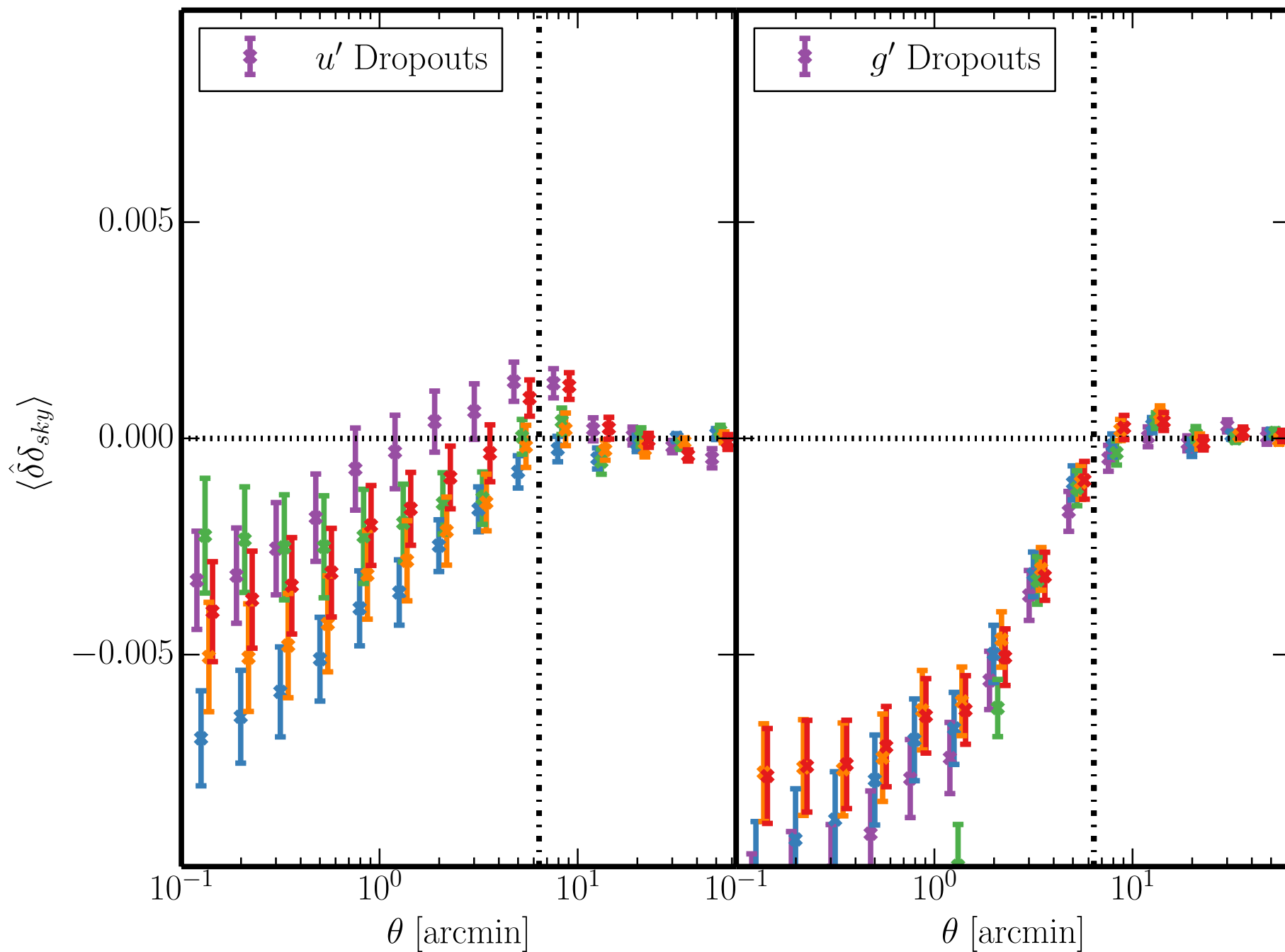
Leistedt et al. 2015



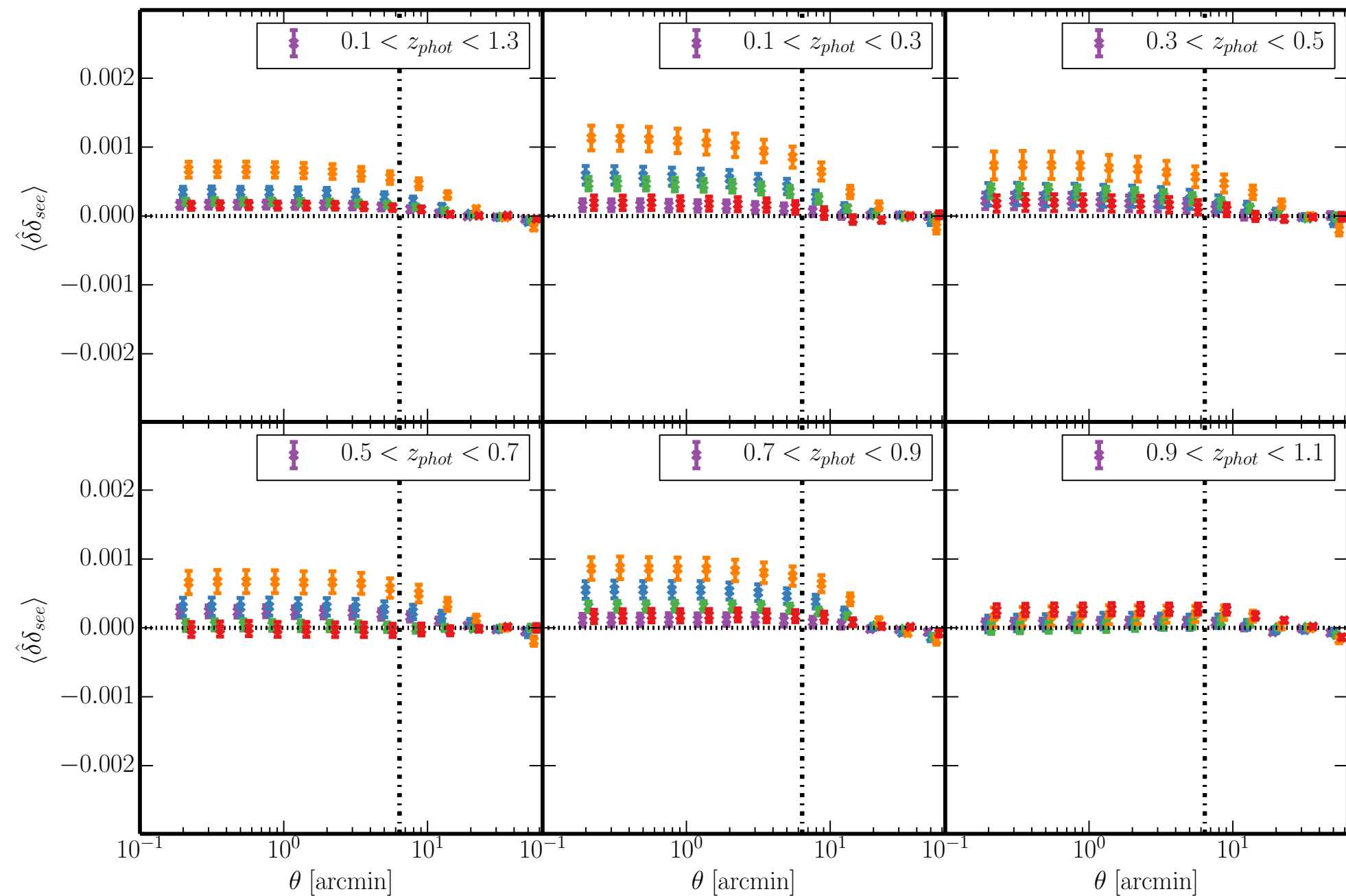
Systematics Correlations [Depth]



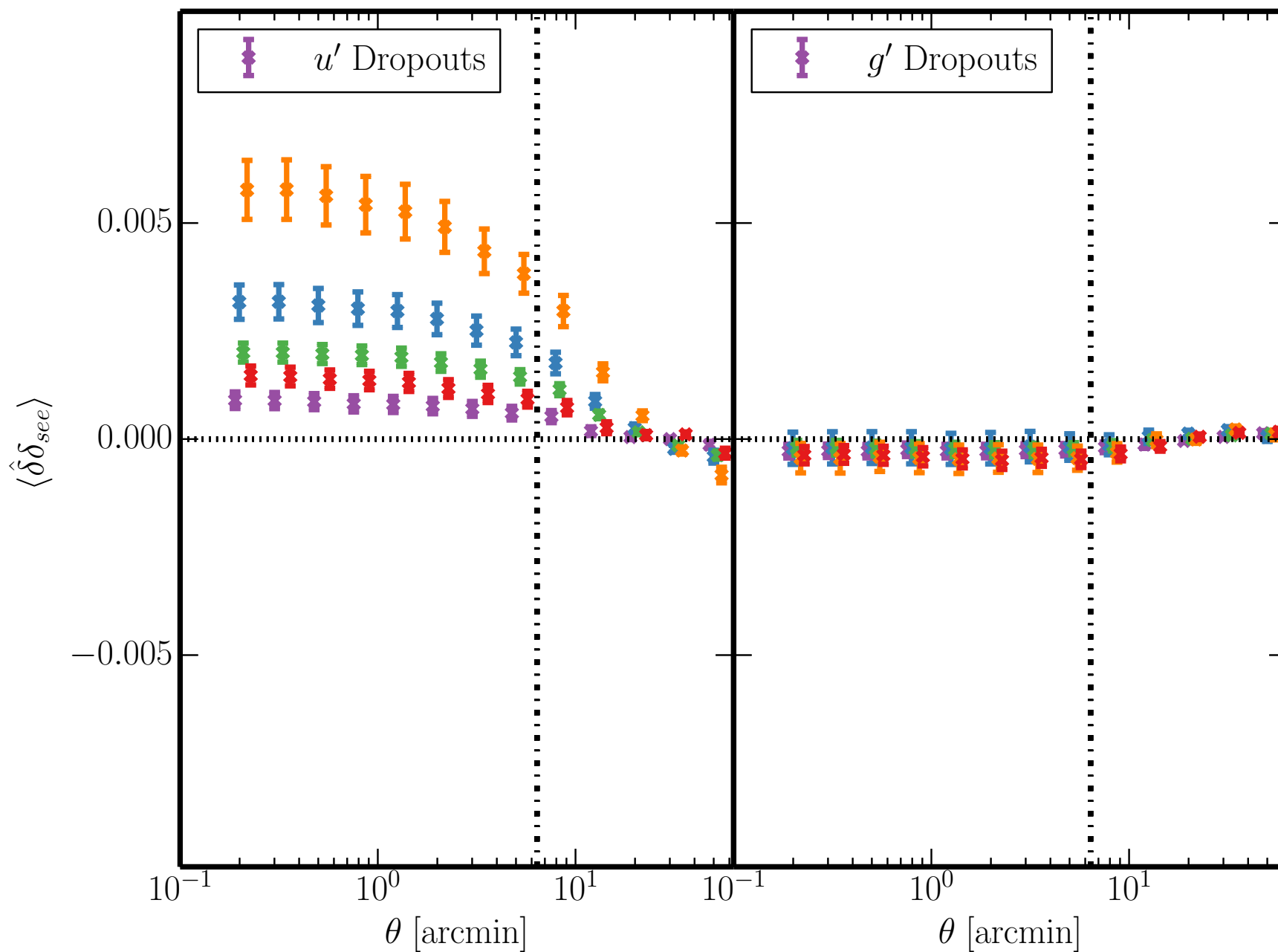
Systematics Correlations [Depth] (faint LBGs)



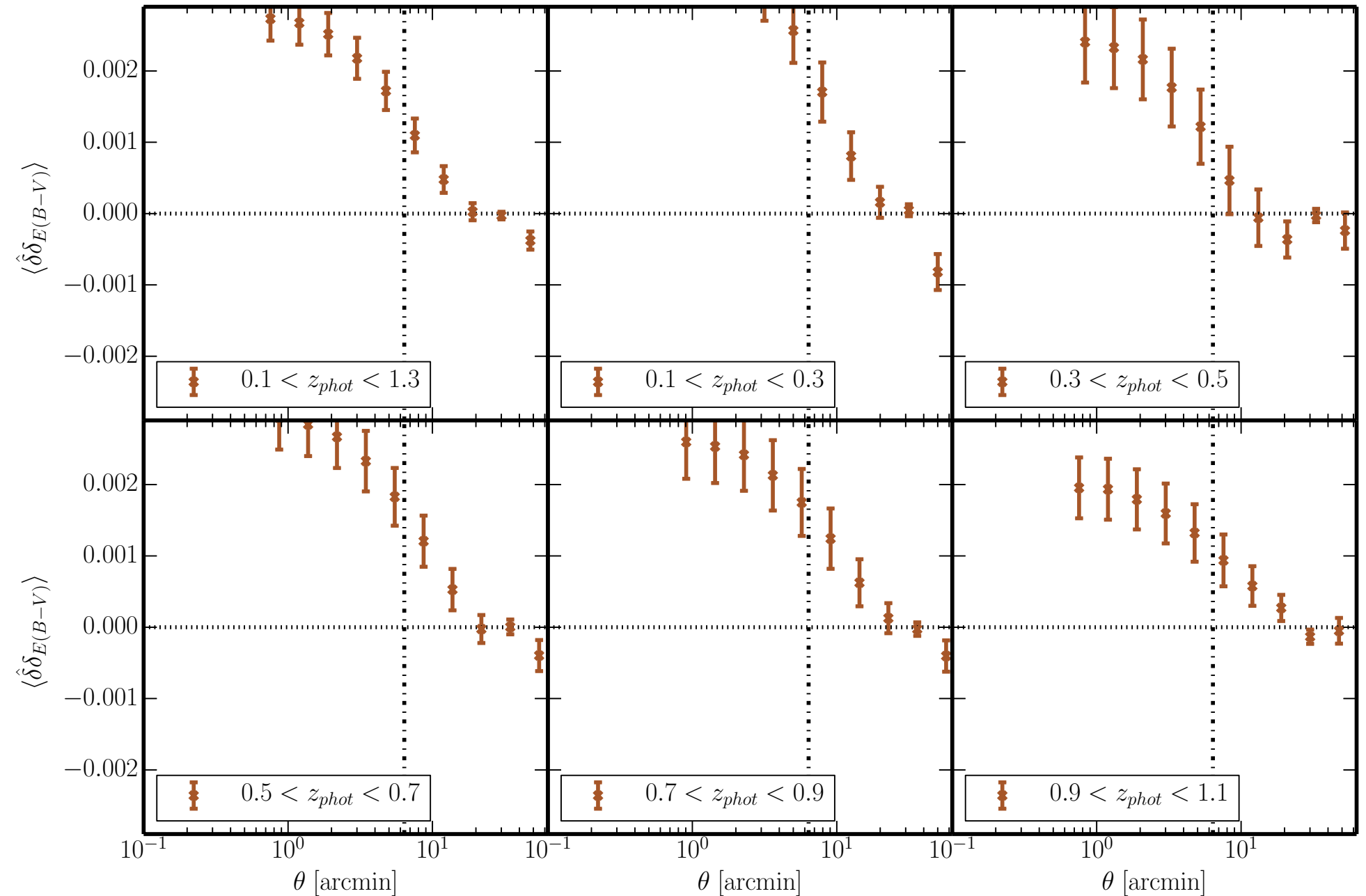
Systematics Correlations [PSF size]



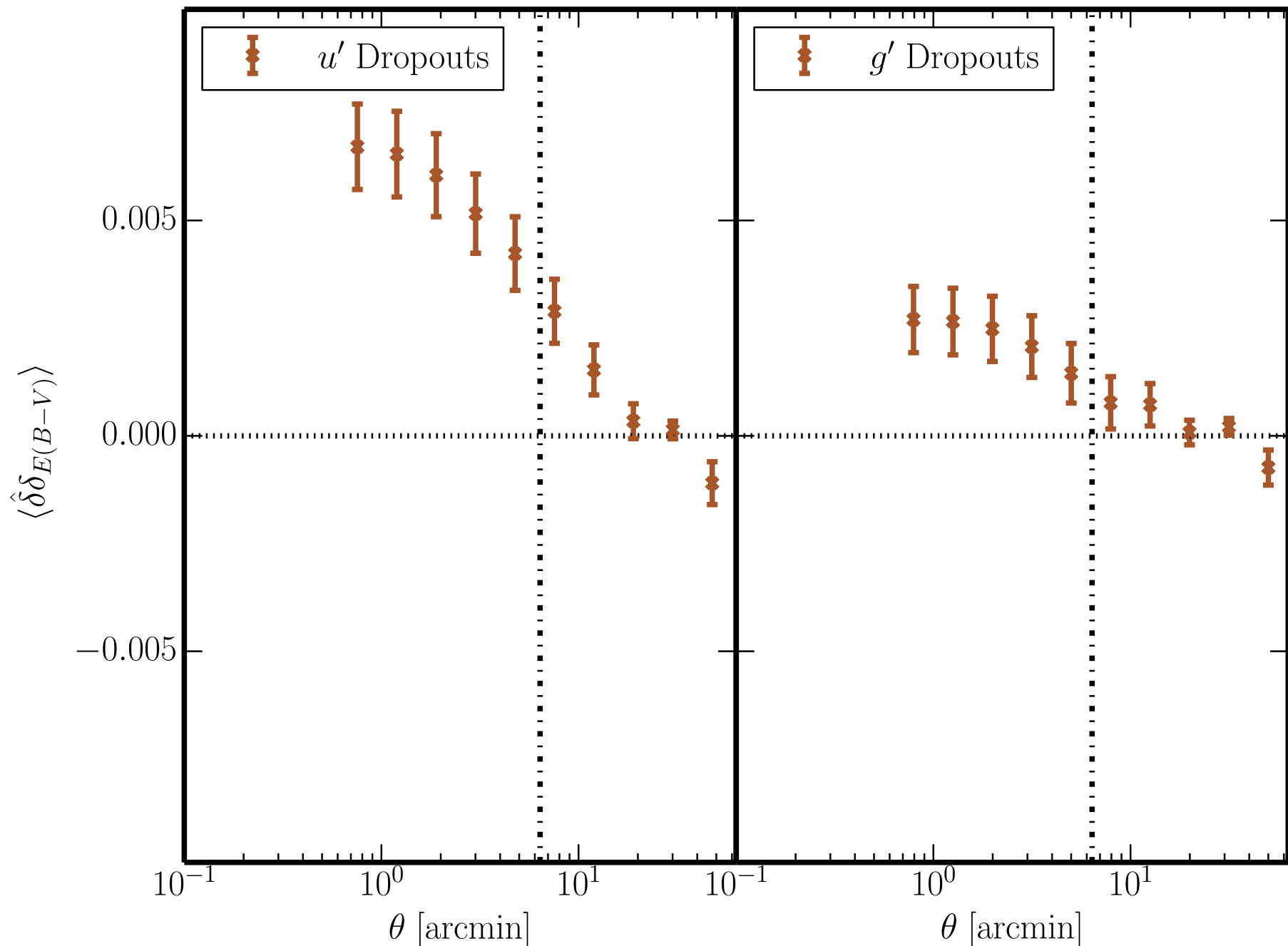
Systematics Correlations [PSF] (faint LBGs)



Systematics Correlations [E(B-V)]

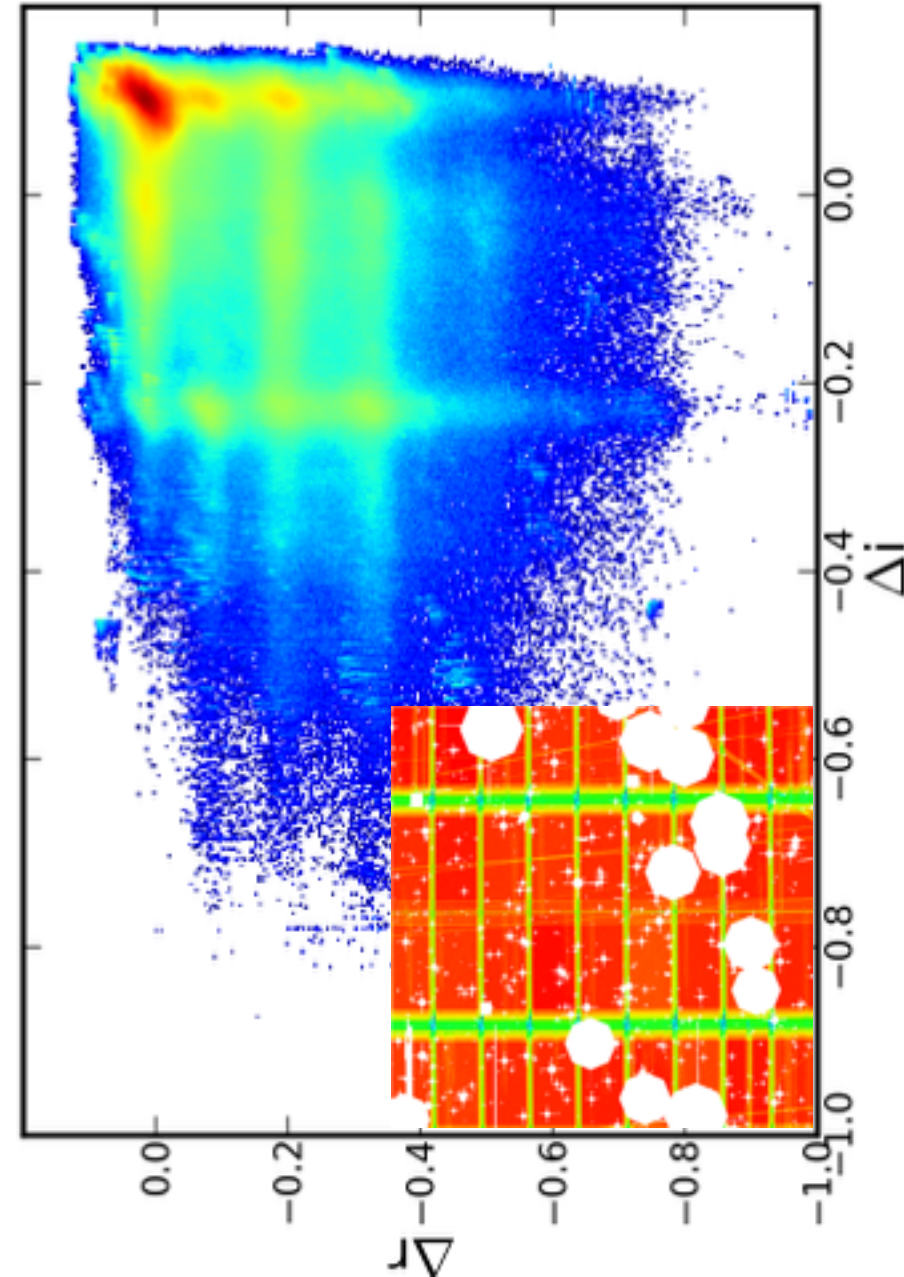


Systematics Correlations [E(B-V)] (faint LBGs)

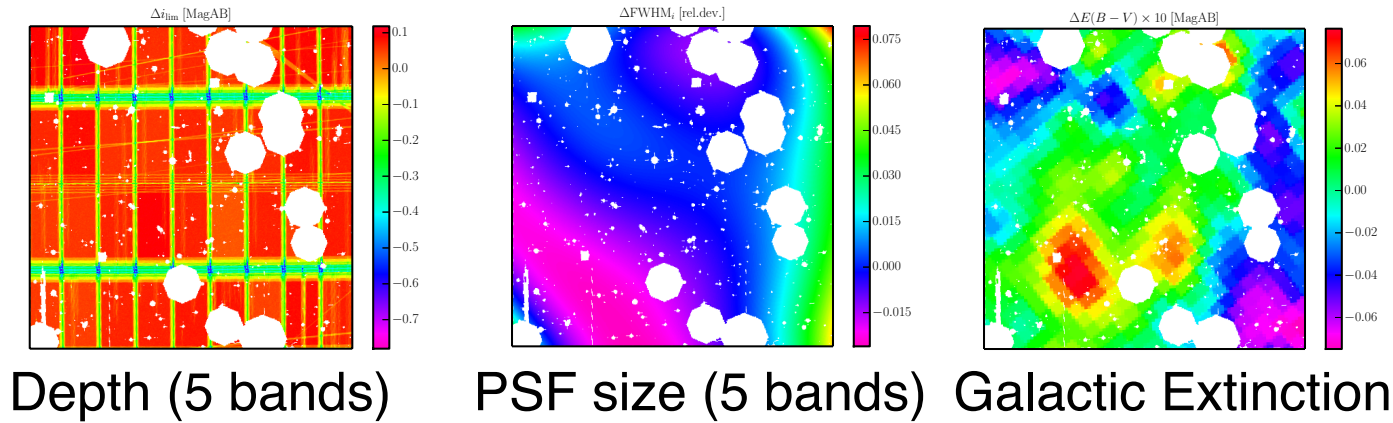


Empirically Modeling Density Systematics

- Parts of the survey with similar observing conditions should have similar sensitivities
- Create a map between survey systematic values and observed galaxy density. High dimensional problem
 - Employ machine learning to do this, we chose KMeans for simplicity
 - Average over survey to avoid destroying cosmic signal
- Use resulting weight map to draw randoms for L&S93 Estimator
 - $[DD - DR - RD - RR]/RR$



Method



Depth (5 bands)

↓

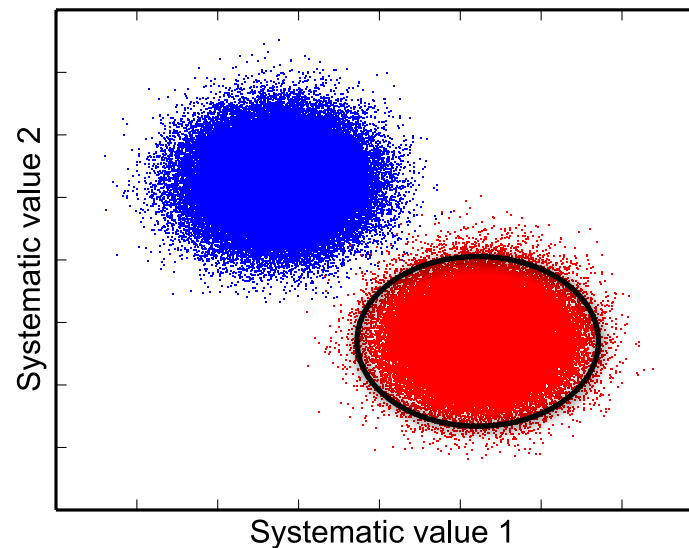
PSF size (5 bands) Galactic Extinction

↙ ↘

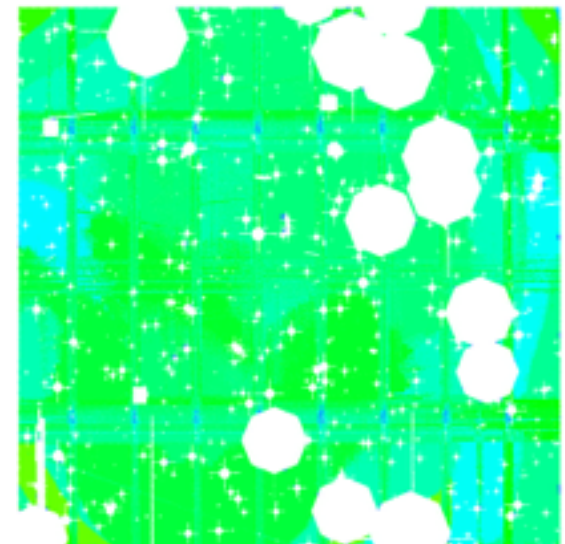
Estimate galaxy
sample density in
KMeans regions

↓

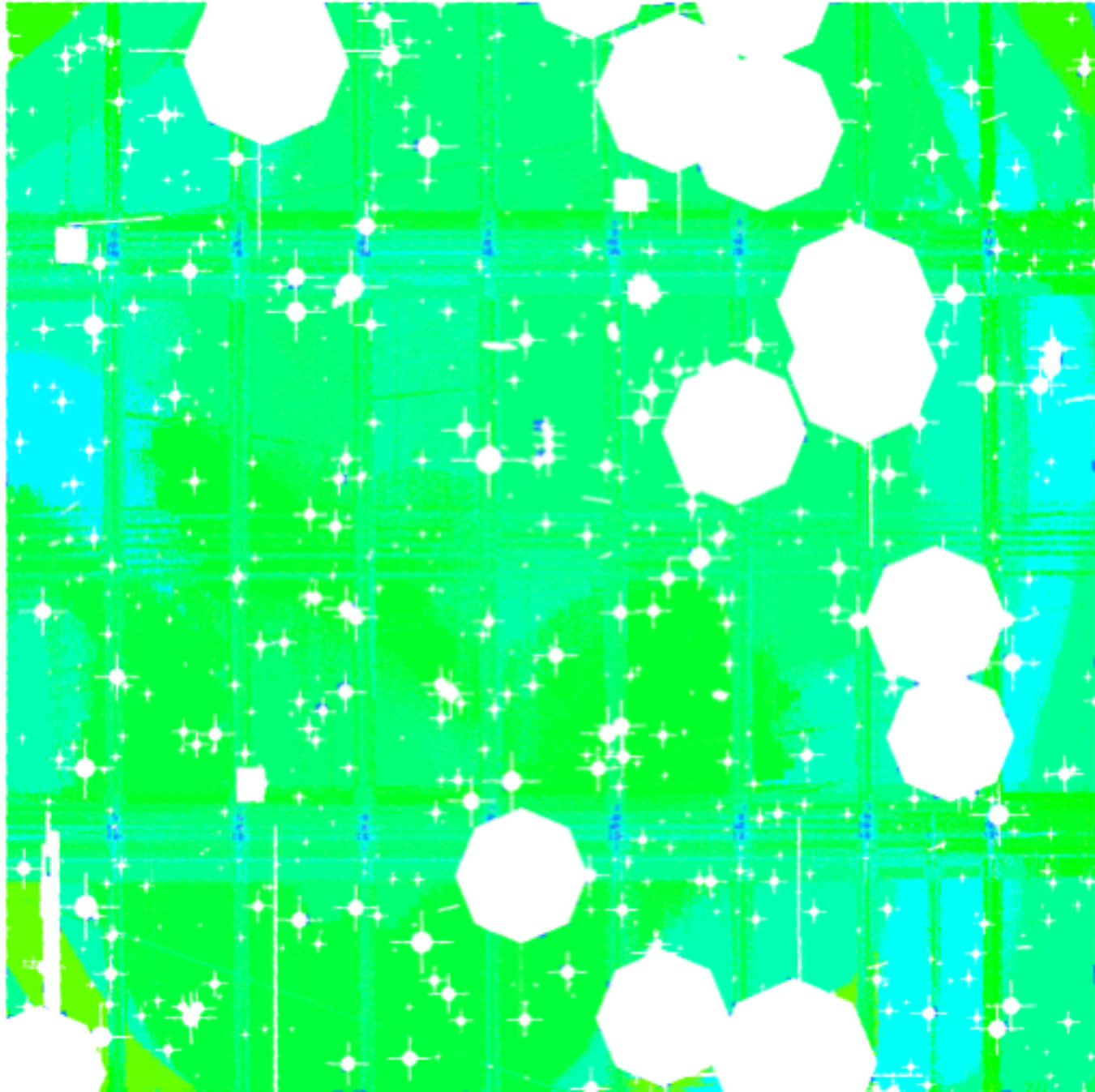
KMeans Cluster
Finder:
Identify regions in
survey with similar
systematics values



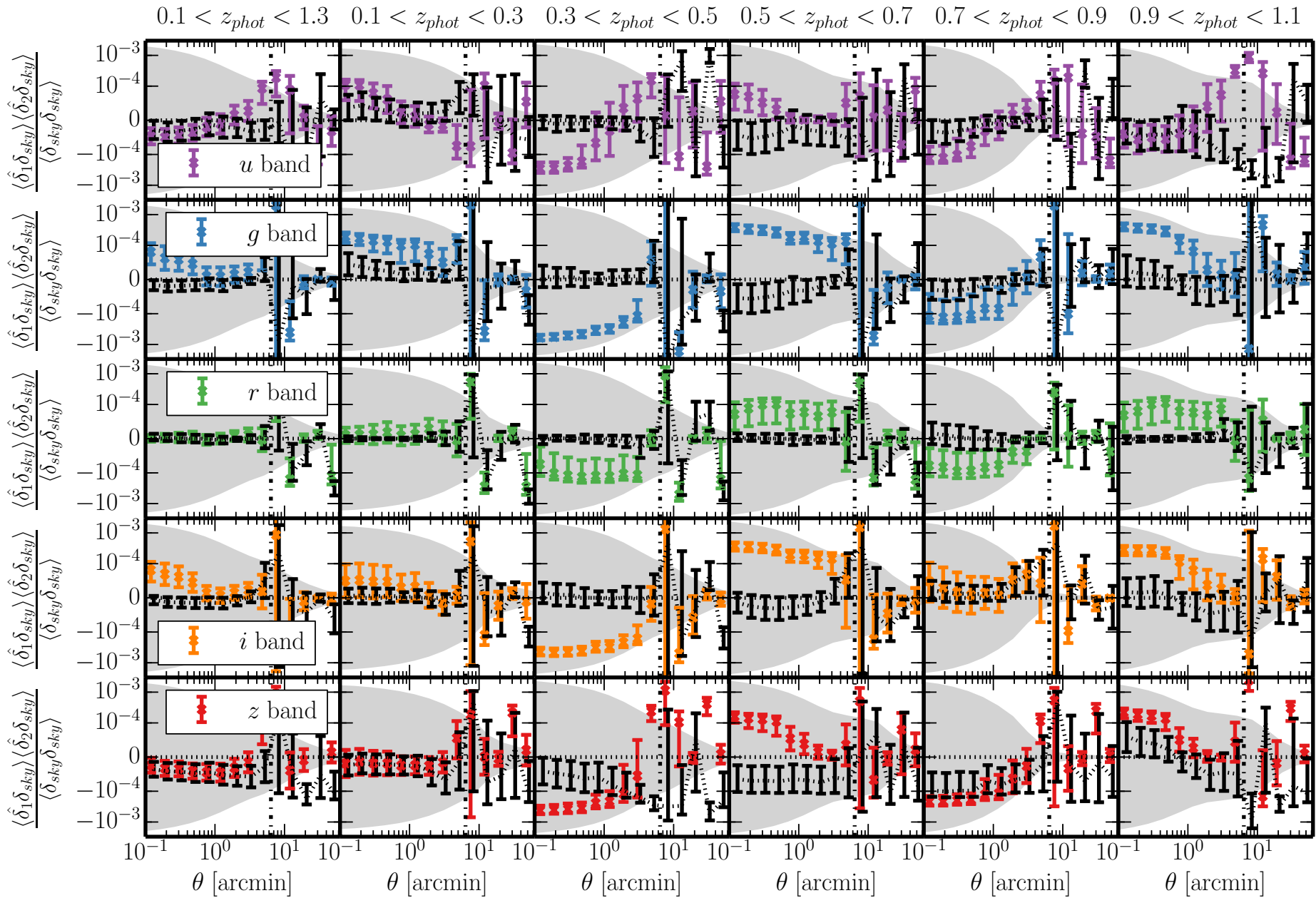
Resultant Weight Map



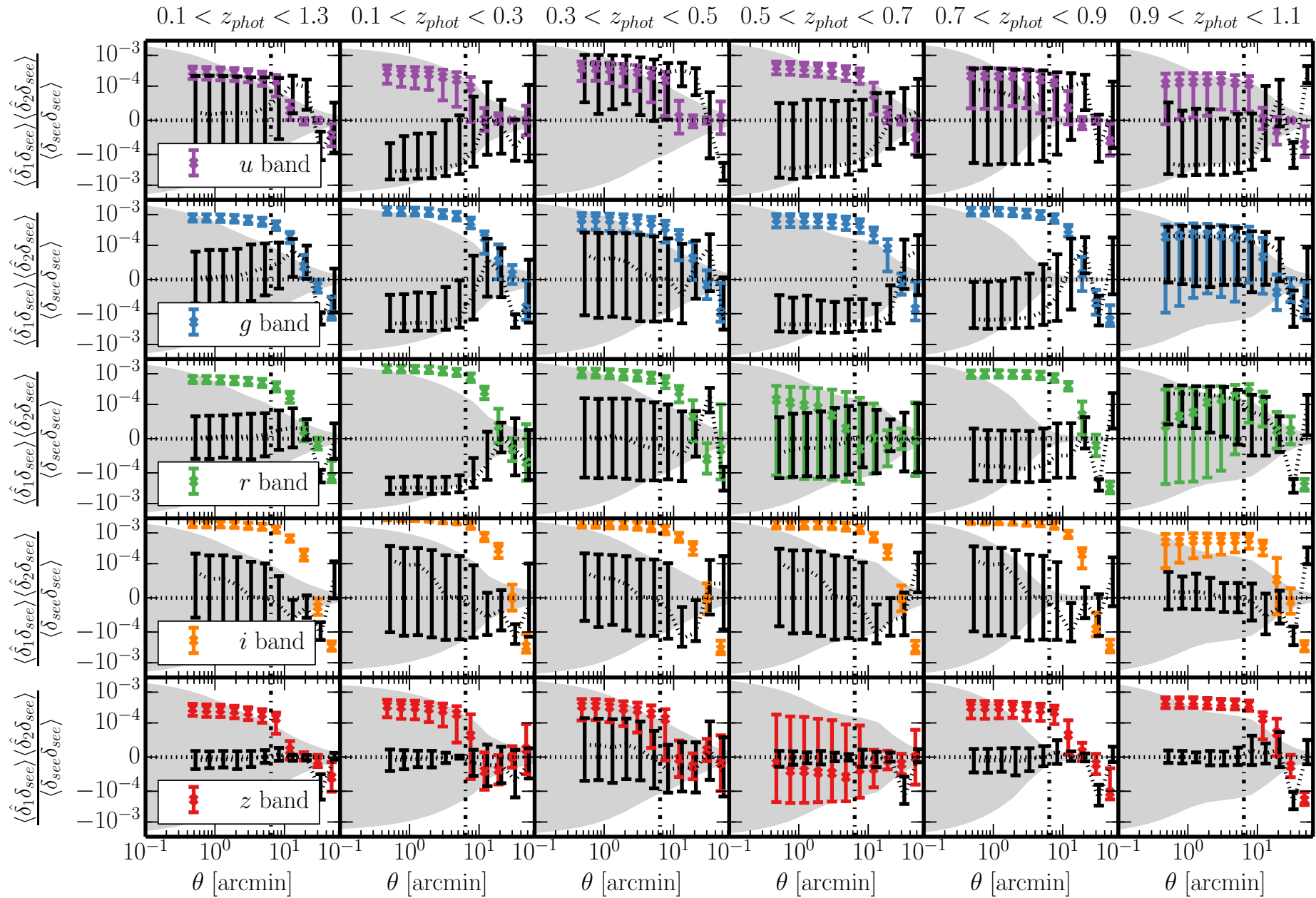
Resultant Weight Map



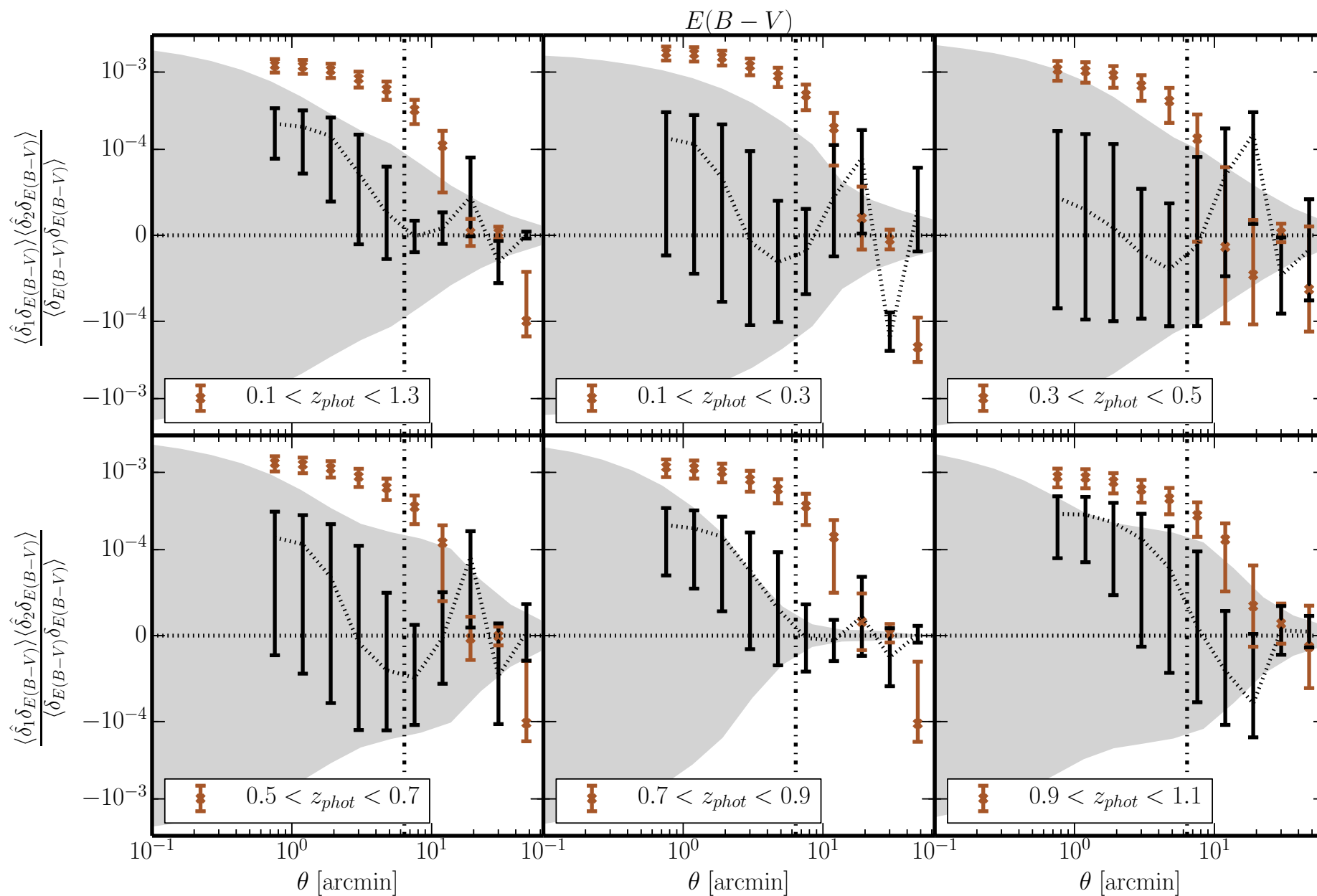
Correction: Depth



Correction: PSF size



Correction: Extinction

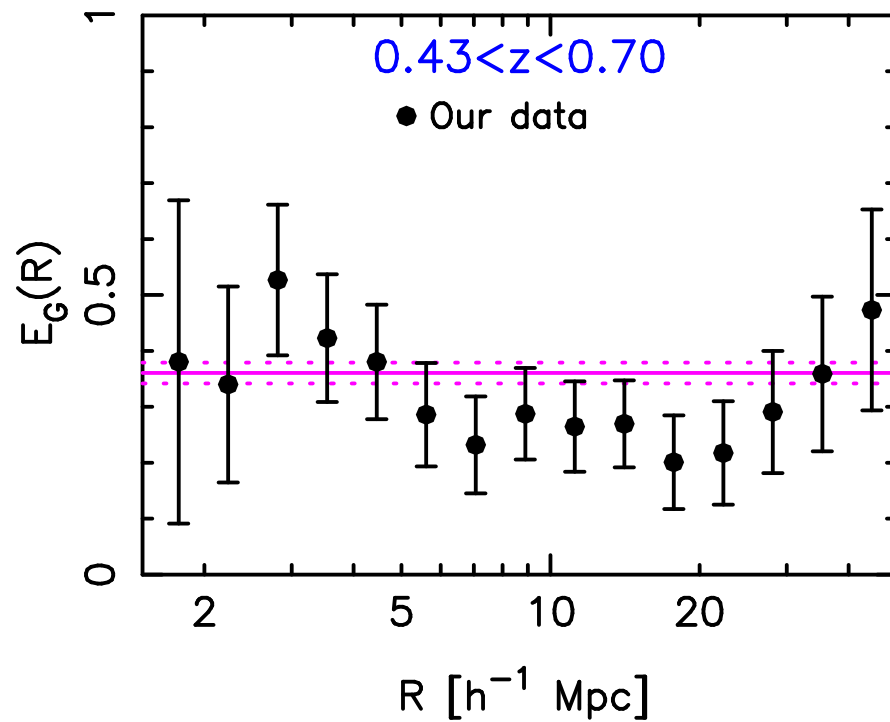
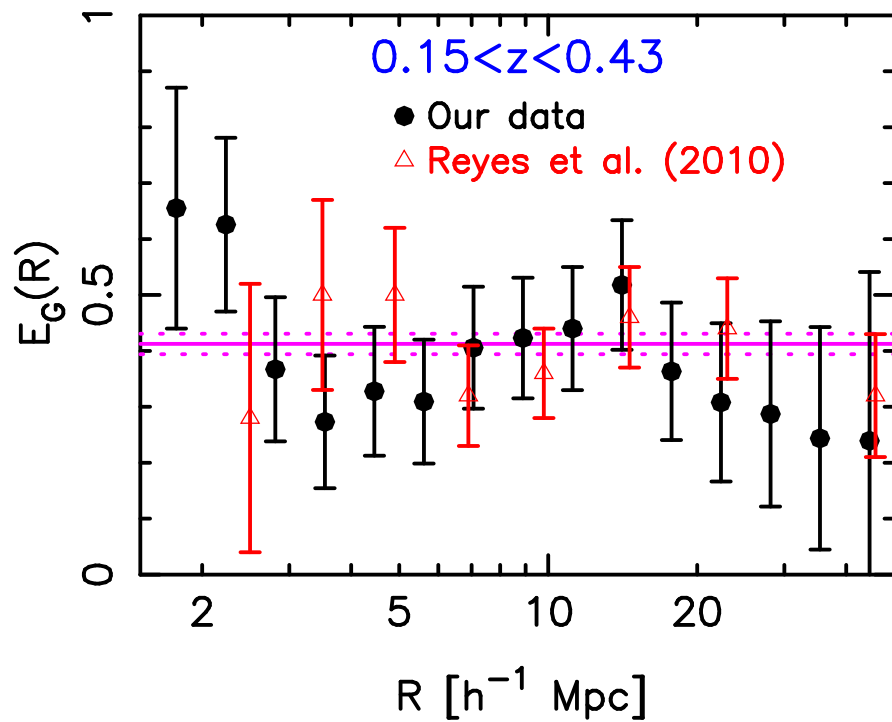


RCS LenS

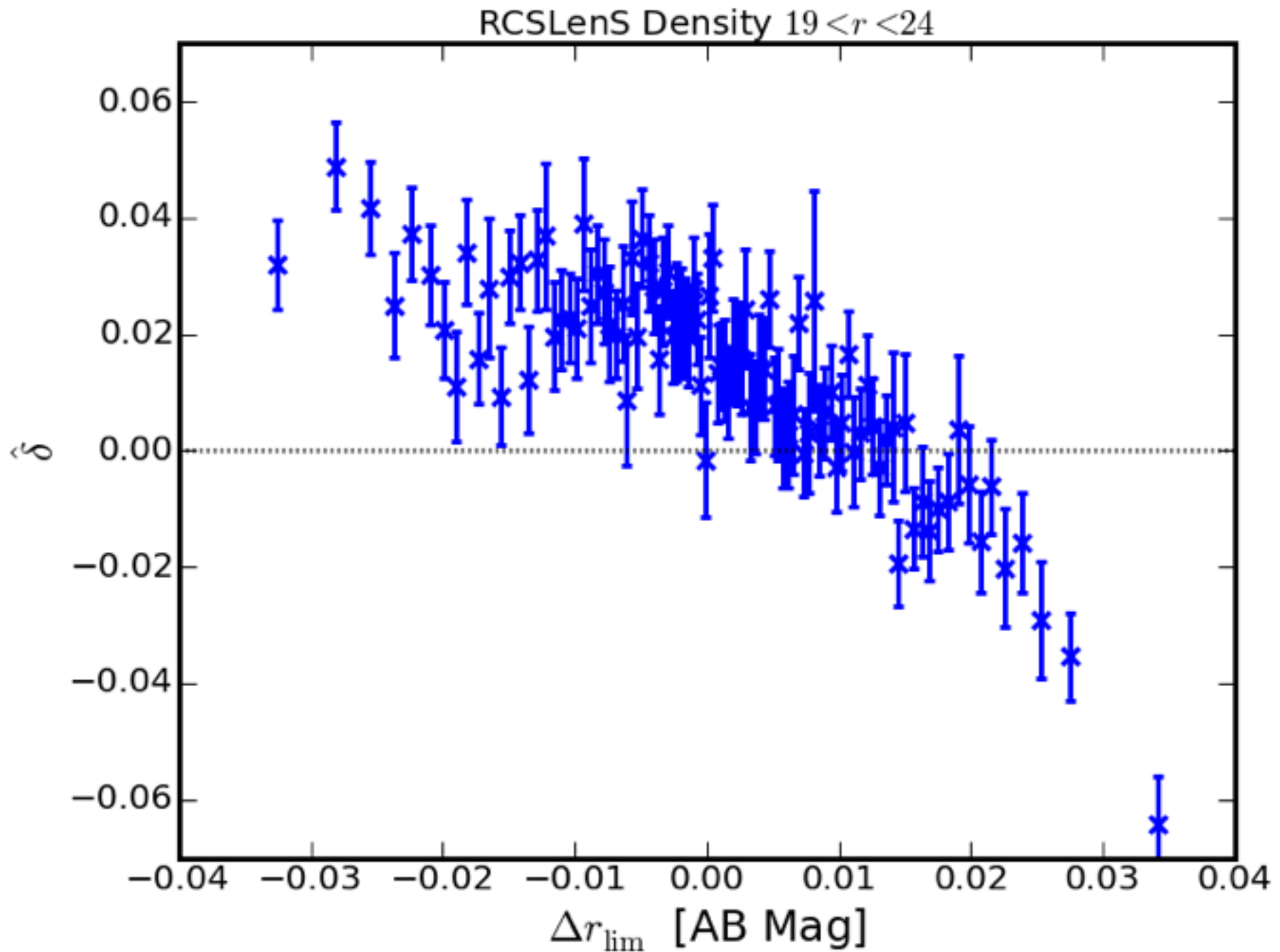
- Based on RCS2 data (*griz*) and CFHTLenS pipeline
- 785deg² imaging to $r \sim 24$ (7σ extended)
- Lensing catalogue: 5 gal. per sq. arcmin.
- Mean redshift of $z \sim 0.6$.
- Overlap with SDSS, WiggleZ, DEEP2
- Combined with CFHTLenS $\sim 1000\text{deg}^2$



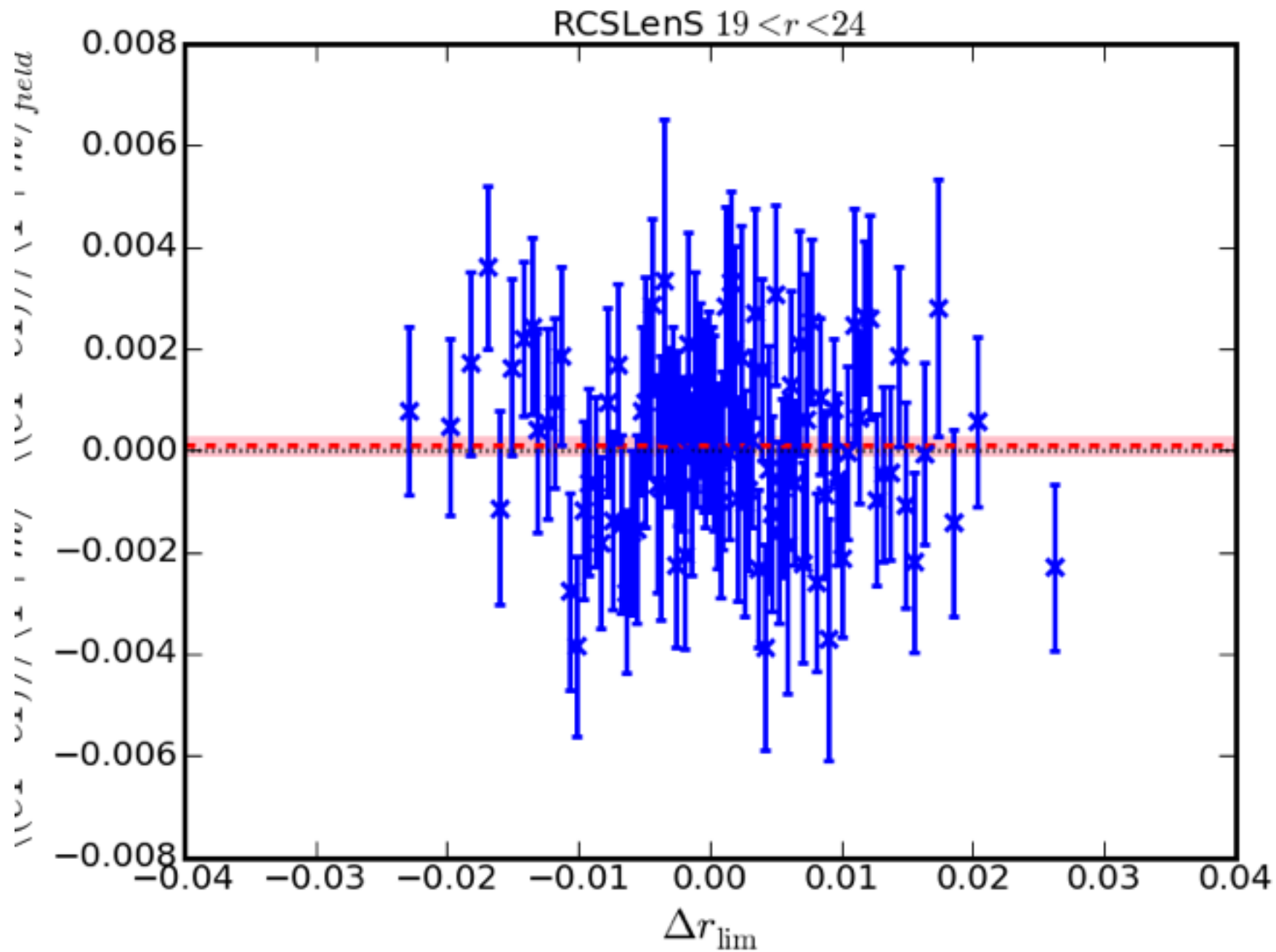
$$E_G(R) = \frac{1}{\beta} \frac{\Upsilon_{gm}(R, R_0)}{\Upsilon_{gg}(R, R_0)}$$



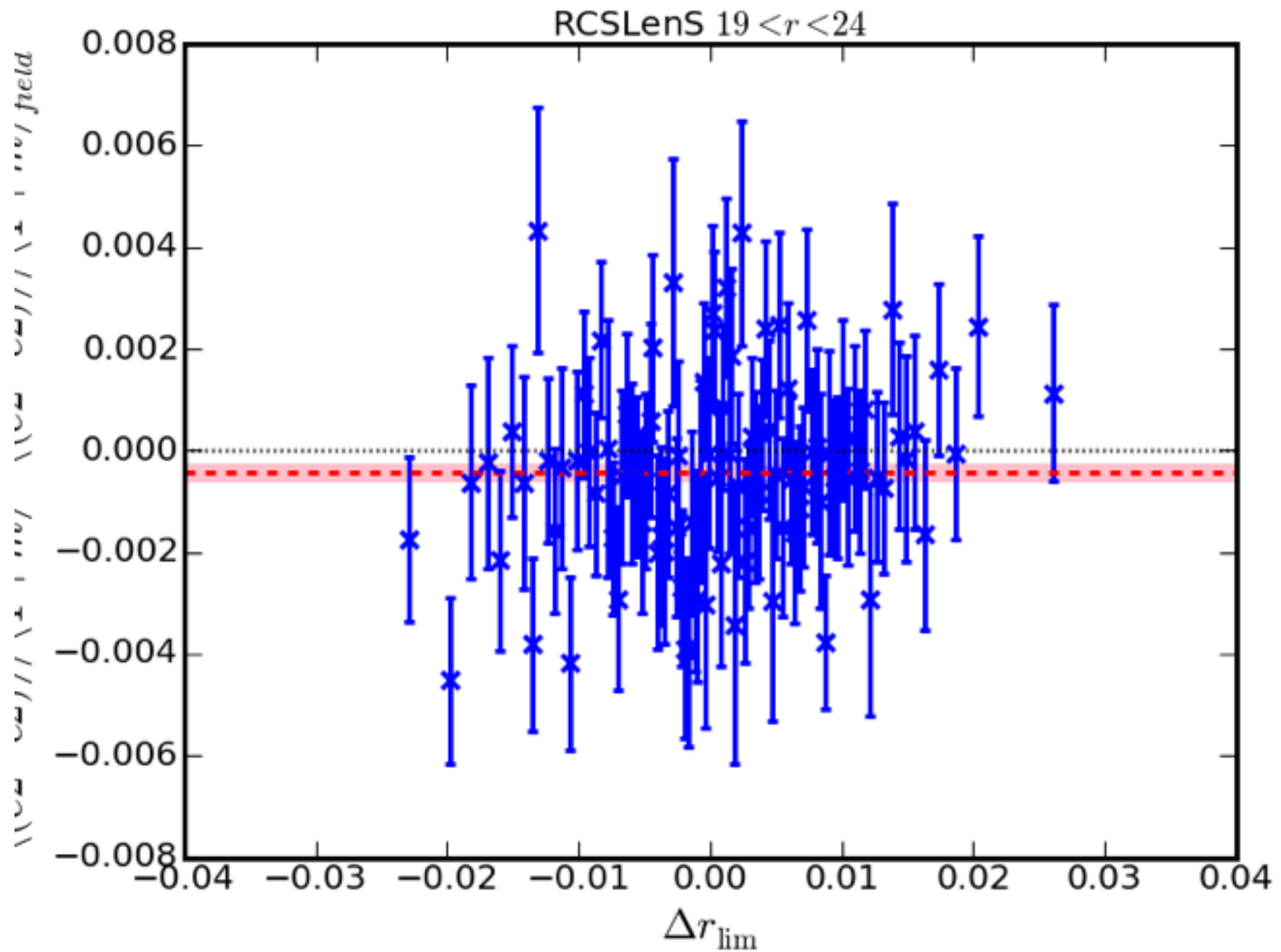
RCSLenS



RCSLenS

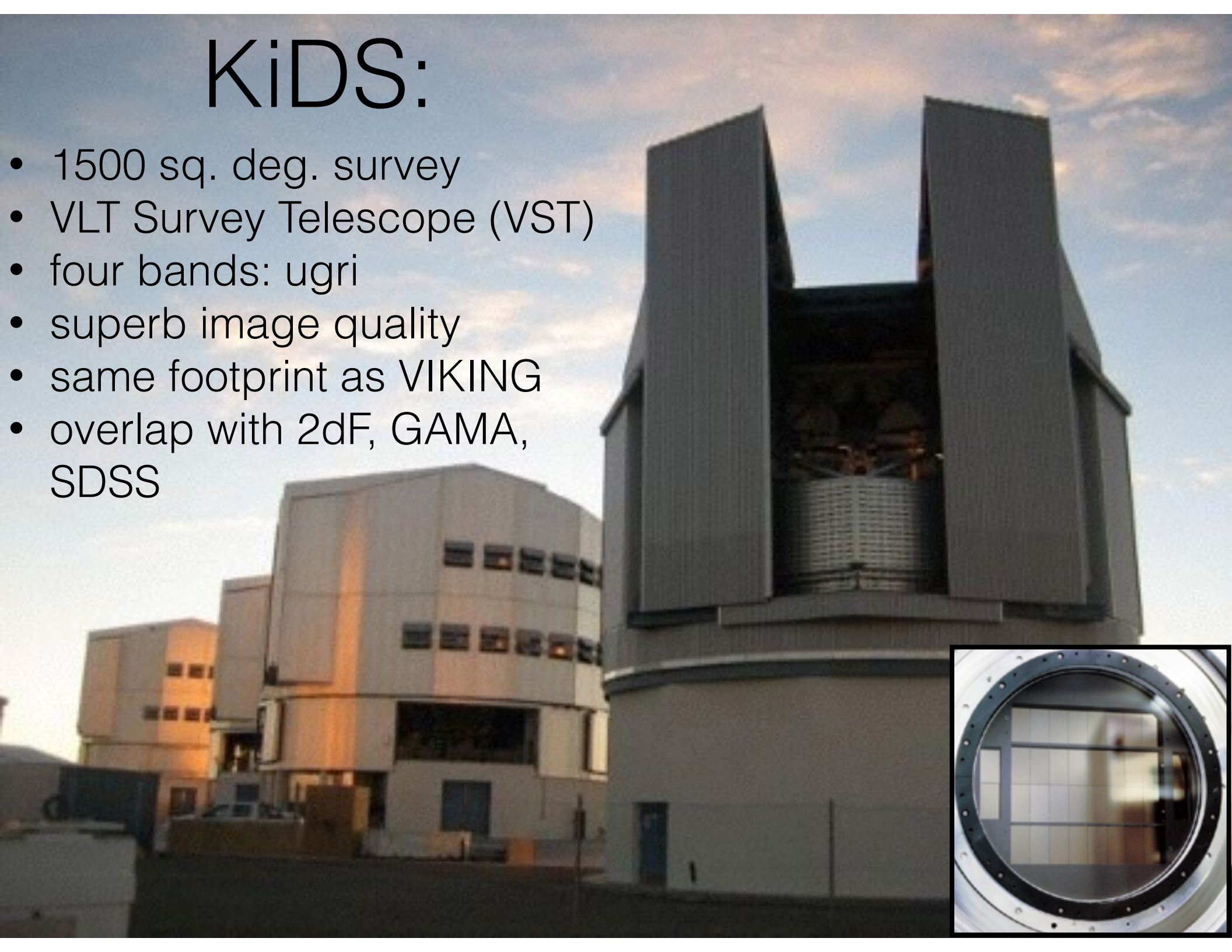


RCSLenS



KiDS:

- 1500 sq. deg. survey
- VLT Survey Telescope (VST)
- four bands: ugri
- superb image quality
- same footprint as VIKING
- overlap with 2dF, GAMA, SDSS



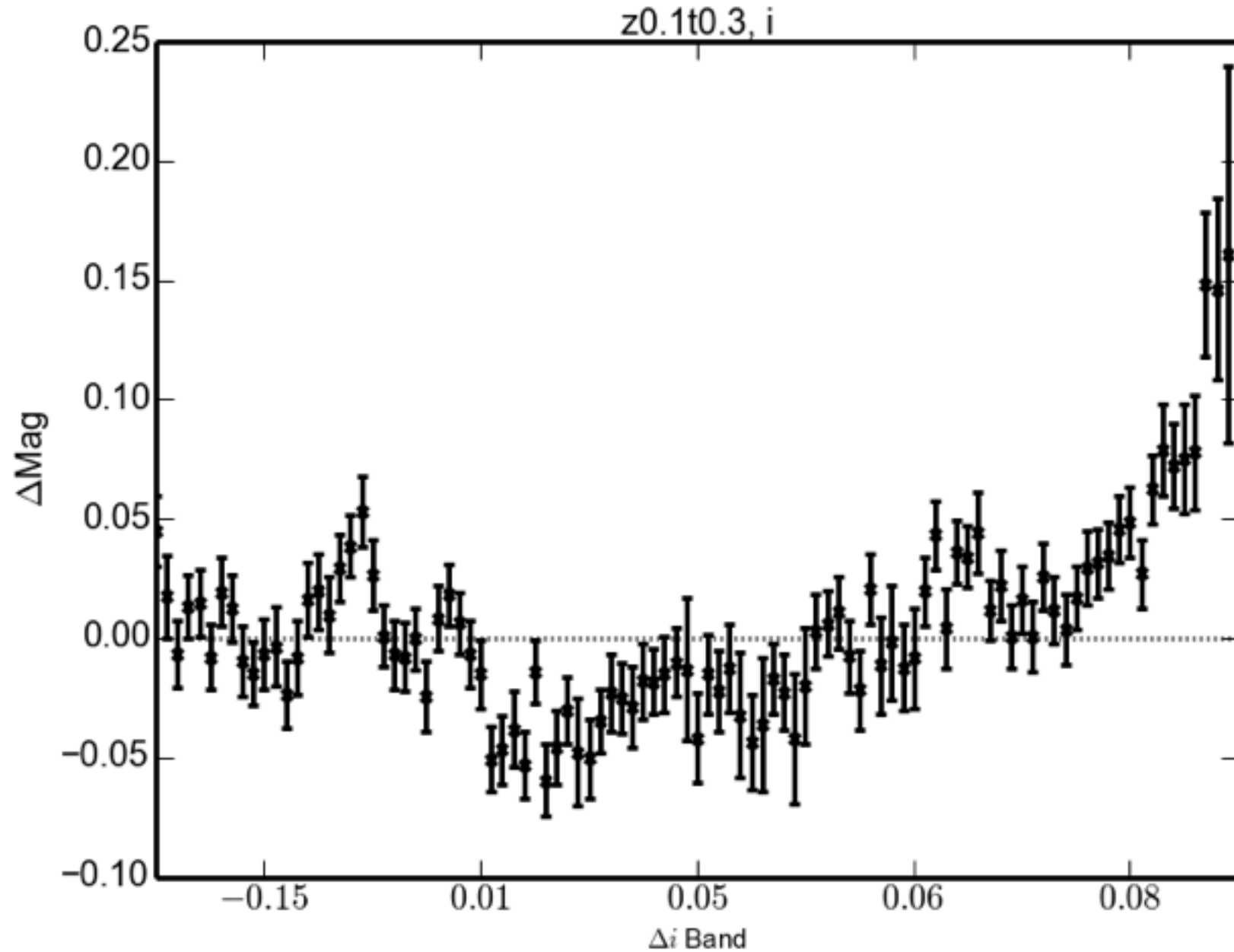
Conclusions

- Galaxy density variations caused by survey systematics can be a large effect
 - Especially for small signals such as weak lensing magnification
- Modeling these processes through the detection pipeline is non-trivial
 - Requires large simulated dataset
- Empirically modeling the relation of density to survey systematic is an option
 - Test other, more complex learning: SOM, Kernel Smoothing
 - Can even provide tests for how well the simulations are performing.
- Paper Submitted and coming soon
- As data volume increases, correcting for these effect becomes even more important
 - KiDS, DES, HSCLS, LSST

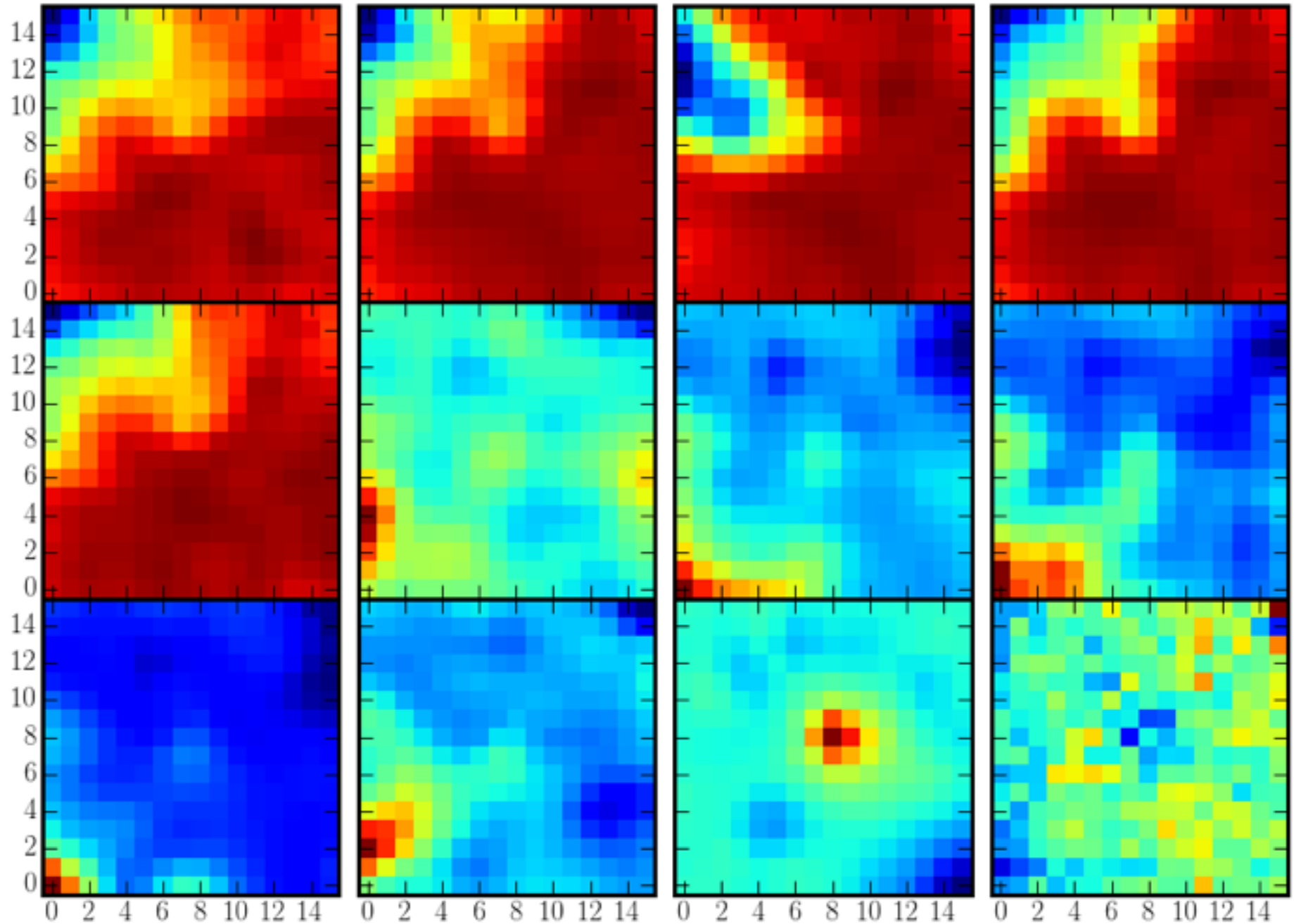
Backup Slides:



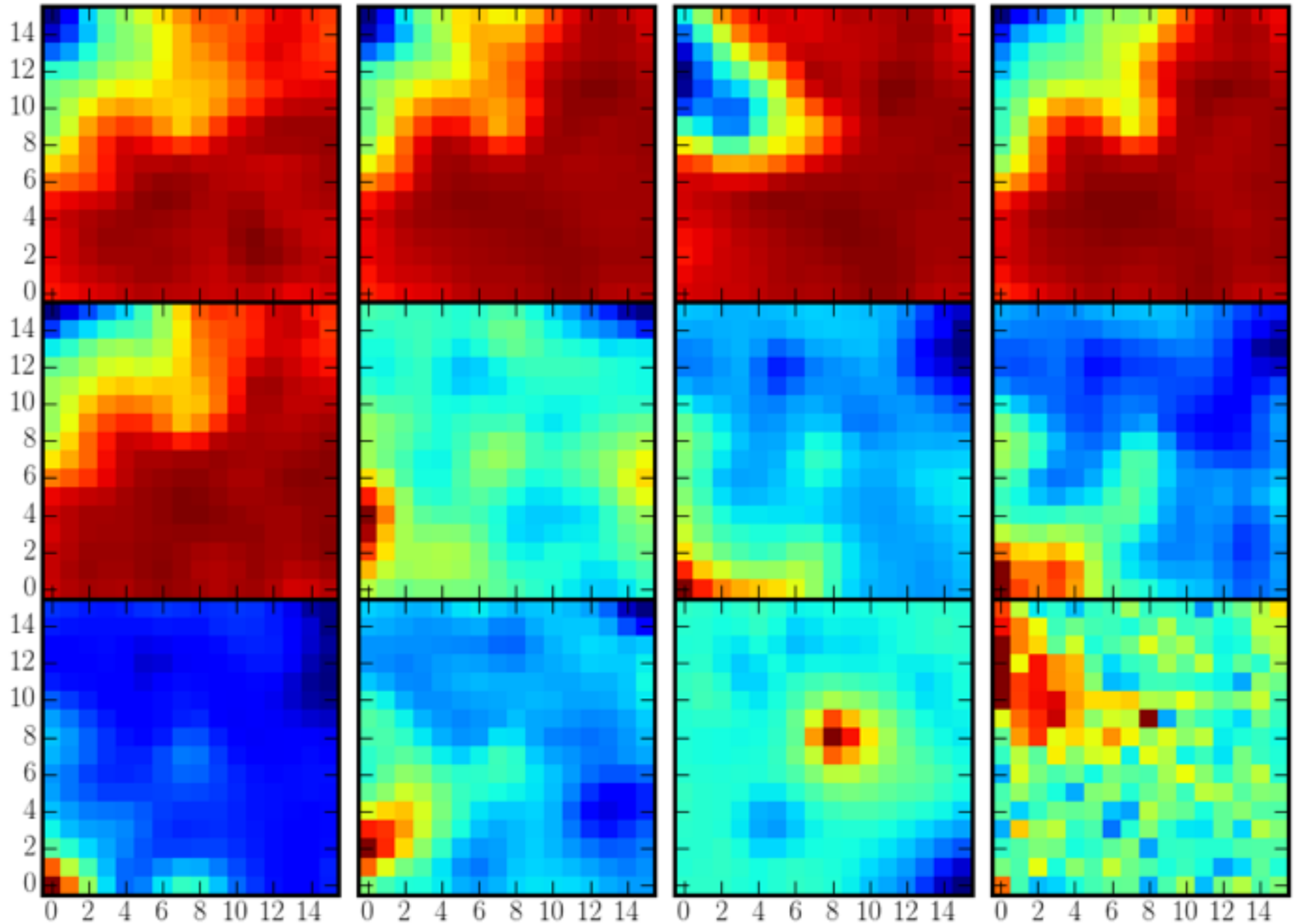
CFHTLenS Magnitude Shift



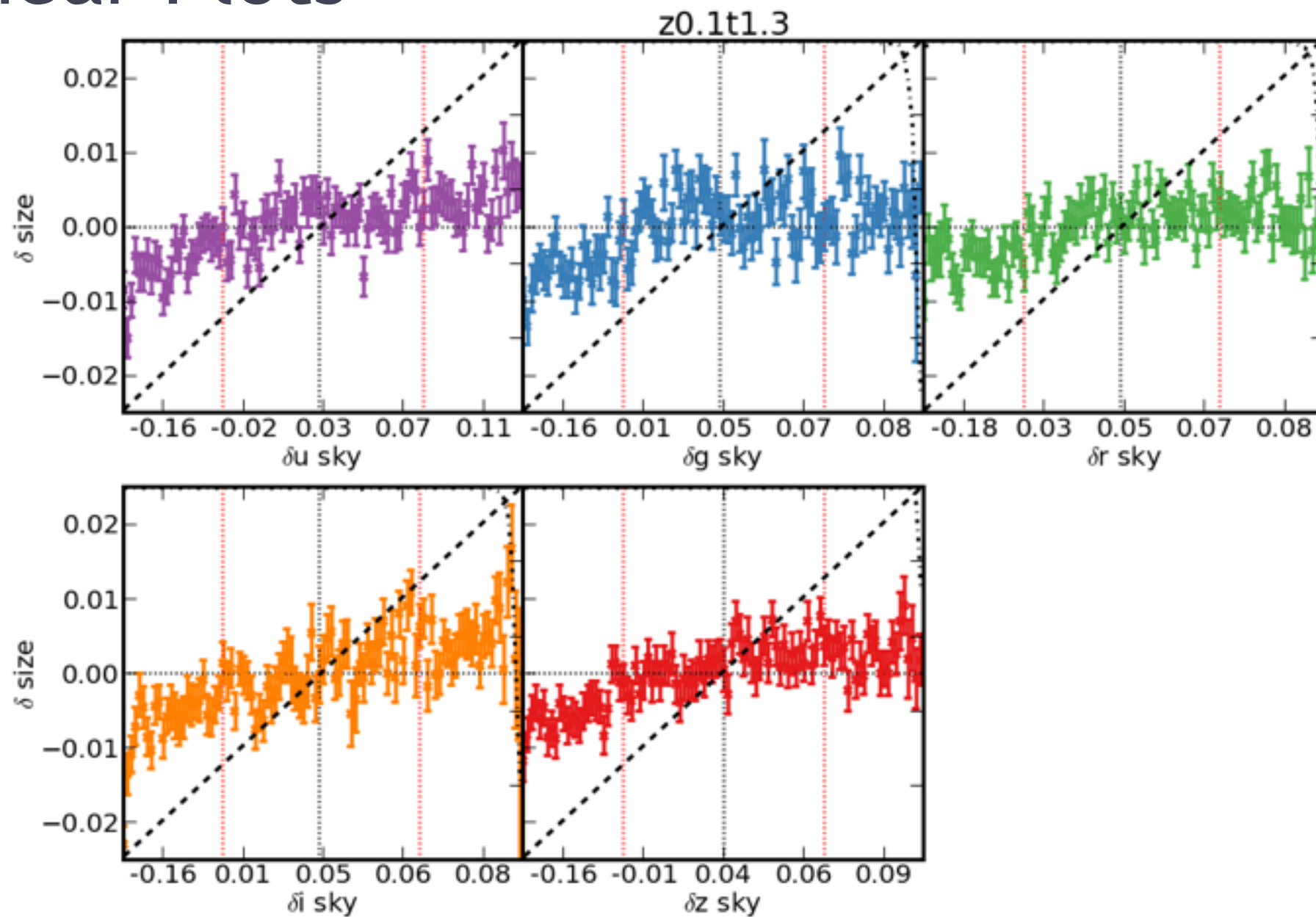
Self Organizing Maps



Self Organizing Maps



Shear Plots



Cross-Correlation with Weighted Randoms

