

Cosmology and Astrophysics at Brookhaven

Erin Sheldon
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Cosmology and Astrophysics Group

- Morgan May
 - Group Leader
- Erin Sheldon
 - Assistant Physicist, joined 2008
- Anže Slosar
 - Assistant Physicist, joined 2009
- Zhaoming Ma
 - Postdoc, joined 2009

Group Goals

- **Cosmology and Astrophysics**
 - Composition, origin, and history of our universe
 - Distribution of matter in the universe
 - Connection between dark and visible matter
 - Properties of dark energy
- **Create surveys that facilitate our science goals**
 - Software infrastructure
 - Build tools to understand and calibrate the data

Current Surveys

- **Dark Energy Survey (DES)**
 - Erin Sheldon associate member
 - Zhaoming Ma



DARK ENERGY
SURVEY

- **Baryon Oscillation Spectroscopic Survey (BOSS)**
 - BNL is associate member
 - Erin Sheldon
 - Anze Slosar
 - Tom Throwe
 - Morgan May



Dark Energy Survey

- Imaging survey of 5000 sq degrees in 5 bands.
- New camera for 4-meter Blanco at CTIO
- Will cover the footprint of the South Pole Telescope survey
- **Probe Dark Energy**
 - weak lensing (WL)
 - WL+galaxy cluster counts
 - WL+galaxy distribution
 - Supernovae



DES: BNL Participation

- Erin Sheldon has been working on DES infrastructure since 2004, has data rights for himself, postdoc, students
- Sheldon+Jarvis (UPenn) are building the primary pipeline for galaxy shape measurement. Considered core infrastructure that facilitates all weak lensing studies. Pipeline is incorporated into data management system.
- Will process DES data in real time as it arrives, feed back into QA and development. Improvements will make it downstream for yearly data releases.

DES: BNL Participation (cont)

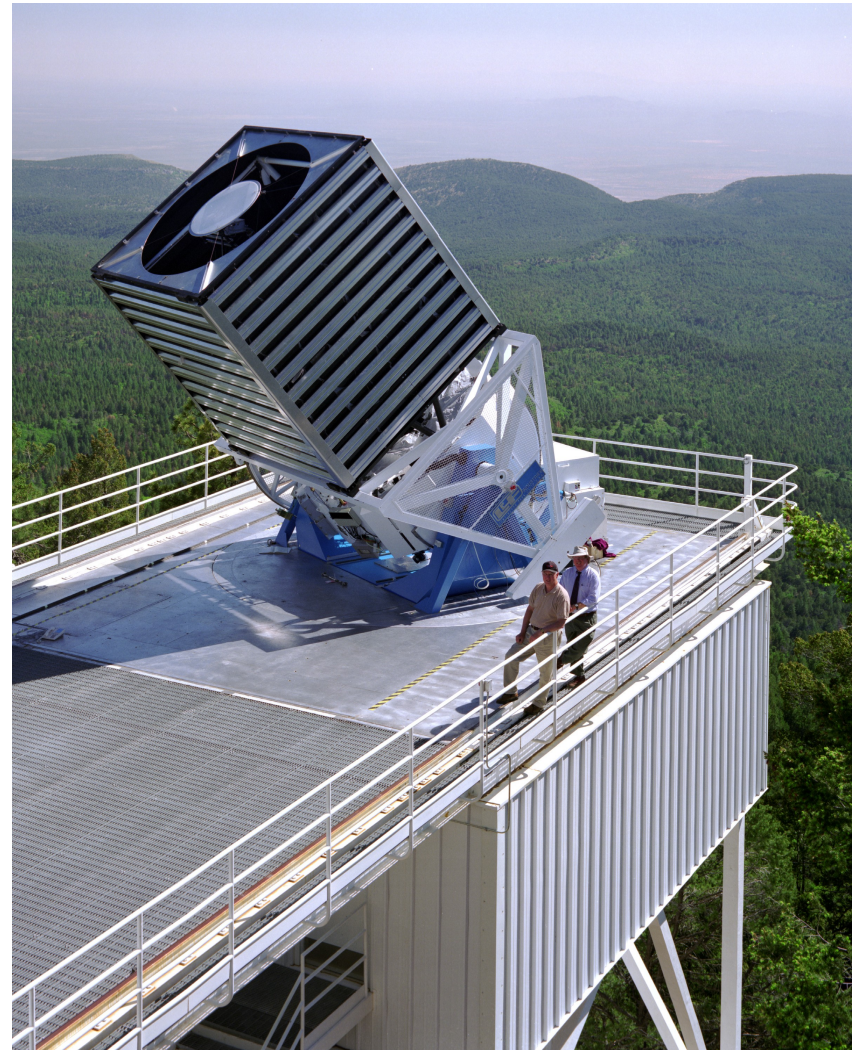
- The point spread function of the system (PSF) is the dominant source of error in lensing measurements, correction is required to calibrate lensing measurements and the inferred cosmological parameters.
- The information on a single image is insufficient to correct at the precision needed for DES science.
- Zhaoming Ma is building a code to characterize the global principle components of the PSF.

DES Science

- The counts of clusters as a function of mass is a key DES project and sensitive to dark energy properties. Weak lensing is the primary method for determining these masses.
- ES and ZM will measure these masses, straightforward extension of work in SDSS/BOSS.
- ES and ZM will participate in other WL studies, such as cosmic shear.
- ES,ZM technical papers 2011
- Science papers on first year data begin to appear 2012

BOSS

- Part of **SDSS III**, a 10^4 sq degree imaging survey, 5 bands in the north
- Study dark energy using the Baryon Acoustic Feature standard ruler at various redshifts
- Select galaxies and quasars for spectroscopic follow-up: z-distance relation and dark energy



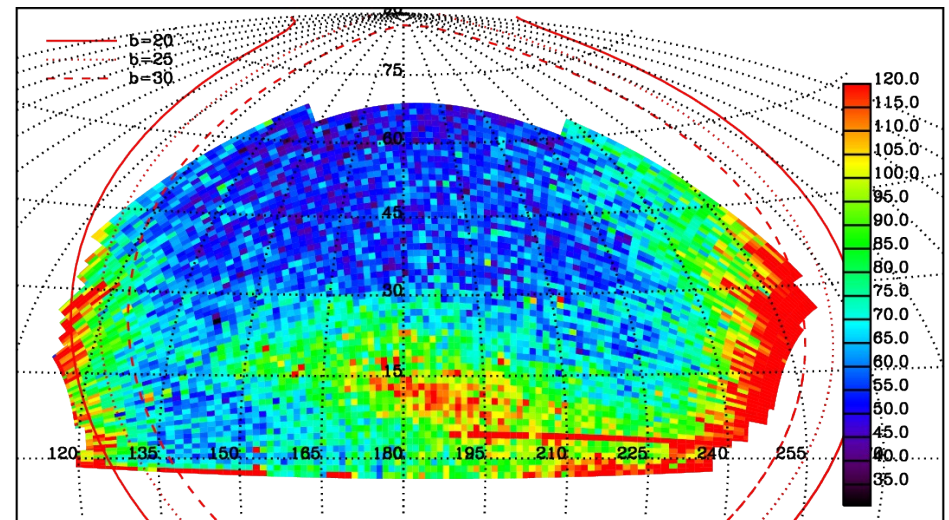
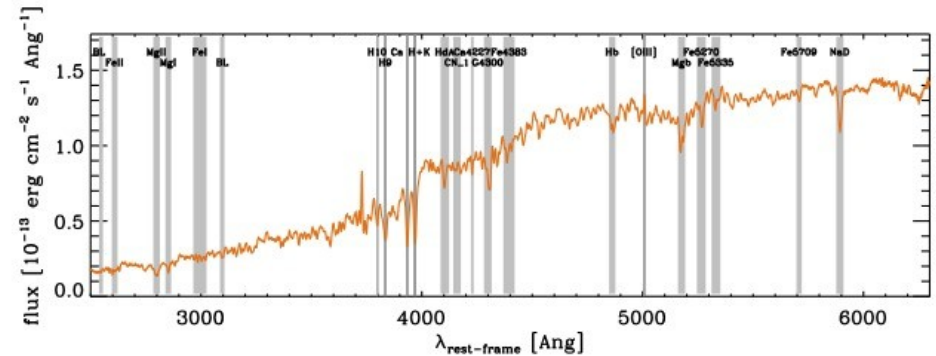
BOSS: BNL Participation

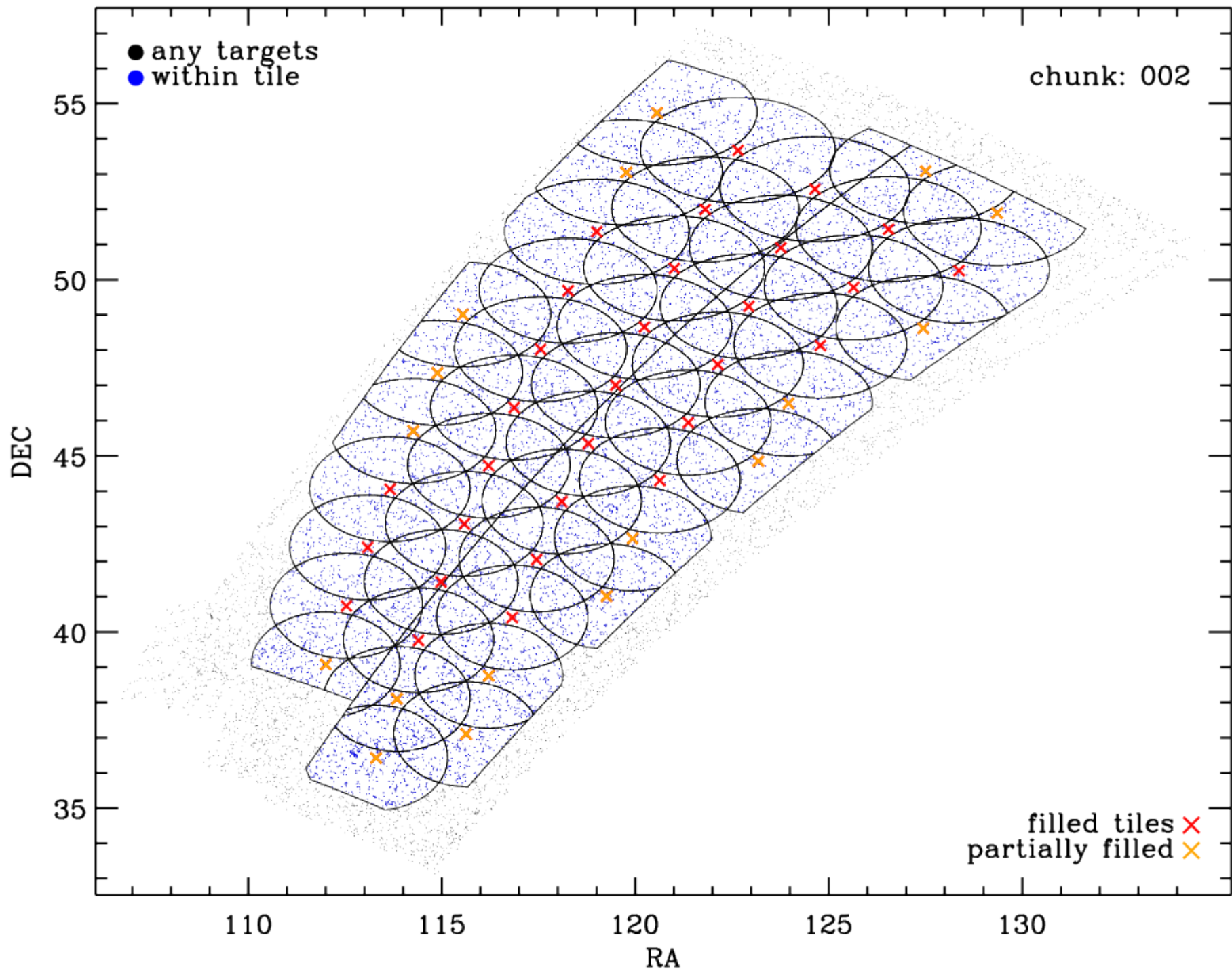
- BNL is an associate member
- Membership based on infrastructure contributions ES,TT
- ES target selection
- Tom Throw software support
- Anze Slosar leads LyA forest effort



BOSS: BNL Participation

- Erin Sheldon built the software framework for gathering spectroscopic targets from the imaging data (galaxies, quasars, standard stars).
- ES coordinates and balances the 8 selection algorithms, produces target lists, which are used to tile the sky and design plates.
- ES has been proposed for “architect status” in recognition of core infrastructure contributions.





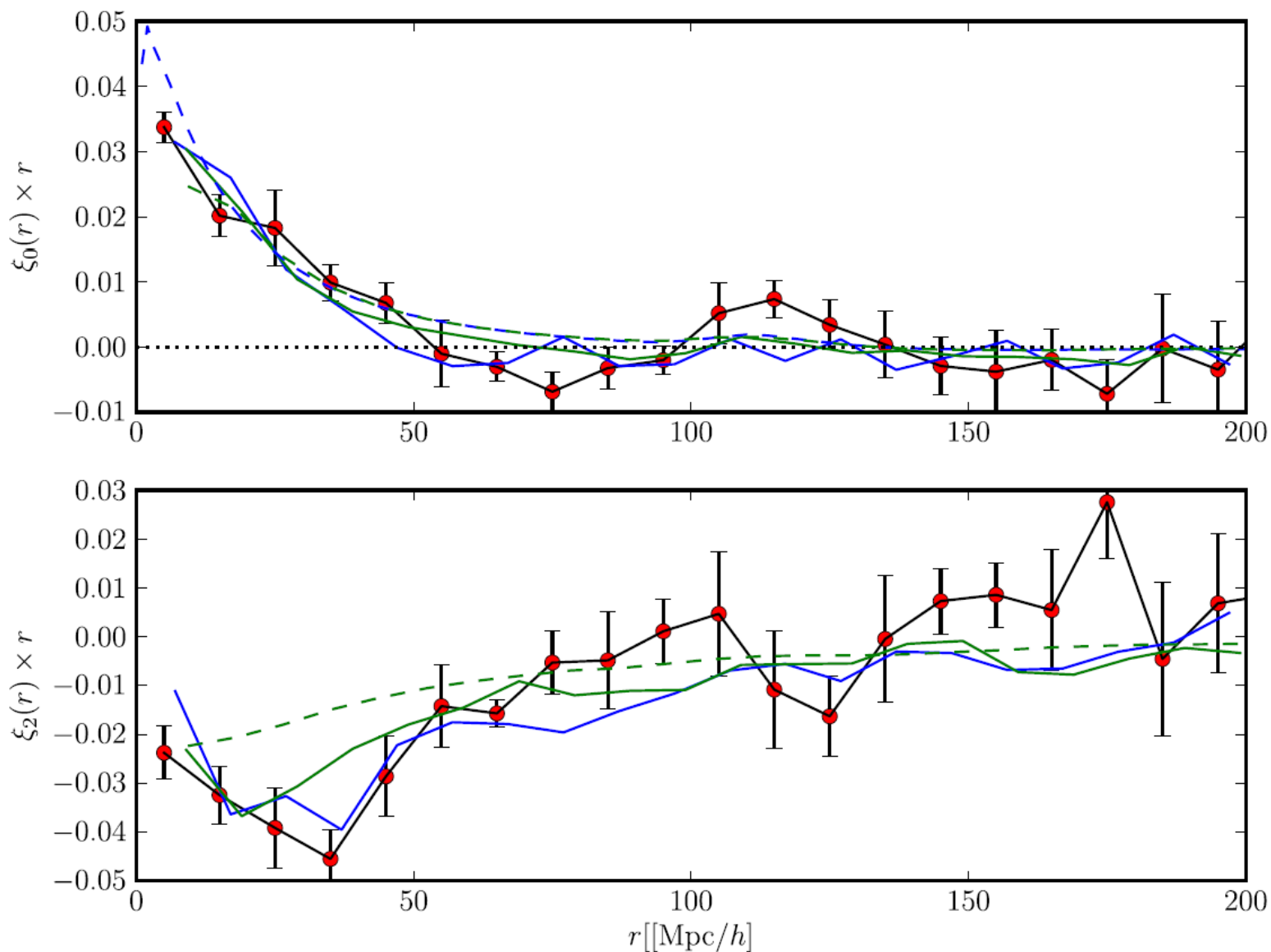
BOSS: BNL Participation (cont)

- Anže Slosar:
 - Convening the LyA cosmology working group
 - Inspecting the quasar data as they come in.
 - Understanding of noise-properties of instrument at the pixel level, crucial for LyA part of the project to succeed
 - Uncovered/tested a number of issues in the pipeline:
 - Spectro-photometric errors
 - Fiber-fiber correlated errors
 - Galactic Ca II absorption
 - Sky-fiber tests of beam and pixelization effects
 - Issues reported to pipeline group and acted upon

BOSS Science – Lyman-alpha forest

- Anže Slosar is leading the effort to measure the BAO feature using the LyA forest signal in quasar spectra.
- Coordinating the WG to ensure everything is getting done and that there is minimal duplication (some duplication useful as cross-check)
- Mock-creation progressing steadily with increasing fidelity
- Continuum fitting not yet production level, but improving
- Metal contamination, etc. in progress

BOSS Science – Lyman-alpha forest



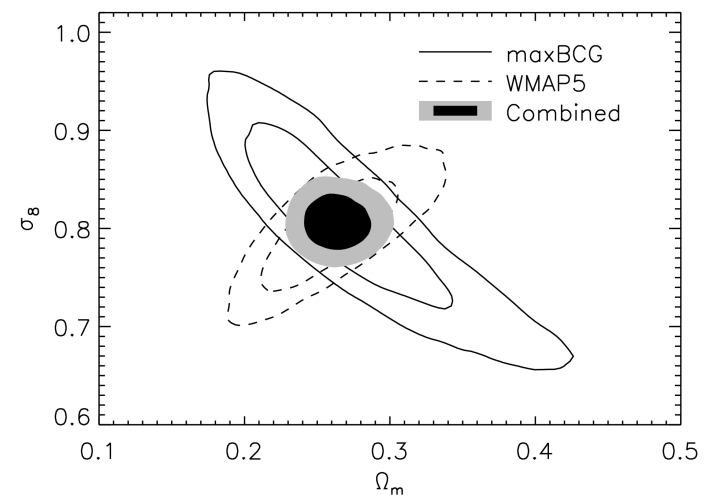
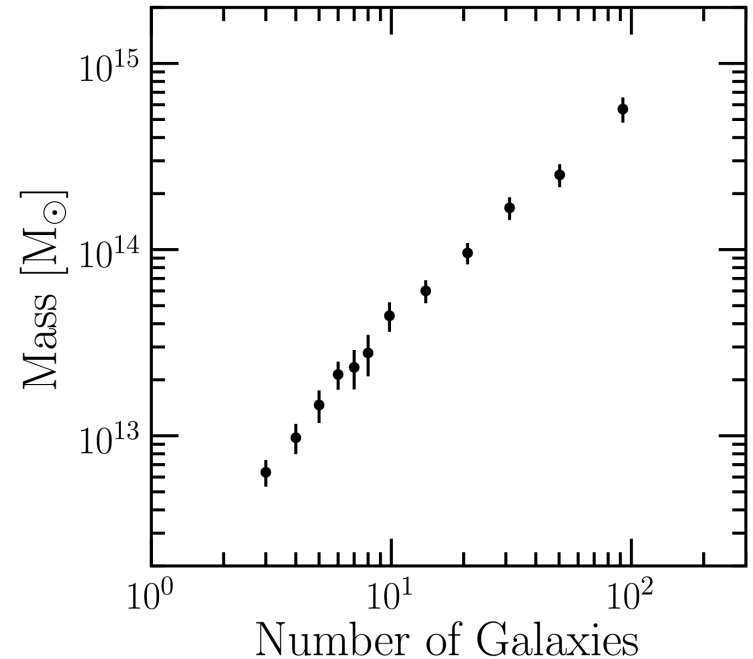
- Preliminary correlation function:
 - Monopole and quadrupole (redshift-space distortions) detected up to 50 Mpc/h.

BOSS Science – Lyman-alpha forest

- Methodological improvements progress along:
 - Optimal inverse covariance weighting impossible, but near-optimal using per-quasar inverse weighting is being developed
 - Gibbs' sampling inspired method being developed
 - 1D power spectrum, higher order correlators will happen
- First papers expected end of 2010.

BOSS Science

- Erin Sheldon is expanding earlier SDSS work on galaxy cluster lensing, galaxy lensing, photometric redshifts. Extracting cosmological parameters from these.
- Same techniques can be used in DES, LSST



Future Surveys

- Large Synoptic Survey Telescope (LSST)

- Essentially a much larger, deeper DES with a time-domain component.
- A new paradigm in optical astronomy: cosmology, revolutionary solar system and galactic studies.
- Weak lensing, supernovae, BAO, clusters, power spectrum, ...
- BNL instrumentation division assembling the focal plane
- For ES, science and infrastructure direct extension of DES.
- ES, ZM, MM are members of the lensing collaboration.
- AS member of LSS collaboration



Future Surveys

- **BigBOSS**
 - Get some details from Anze