Baryonic Acoustic measurements of WiggleZ and BOSS

Eyal Kazin

In collaboration with:
Chris **Blake**, Ariel **Sánchez**, Jun **Koda**
The **Wigglez** Dark Energy Survey
The SDSS-III **B**aryonic **O**scillation **S**pectroscopic **S**urvey

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ARC CENTRE OF EXCELLENCE FOR ALL-SKY ASTROPHYSICS

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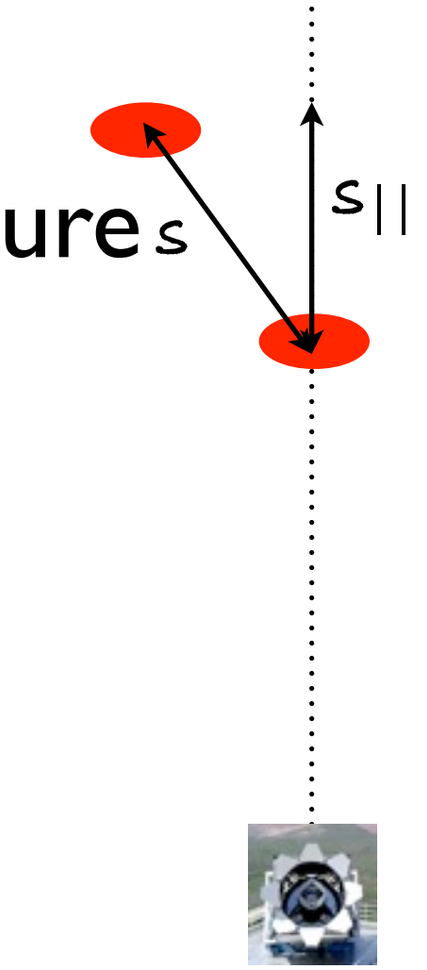
Outline

- Anisotropic BAO with ***clustering wedges***
- ***Improving geometric results*** with the ***reconstruction*** of the baryonic acoustic feature



$$\xi(\mu,s)$$

$$\mu = s_{||}/s$$

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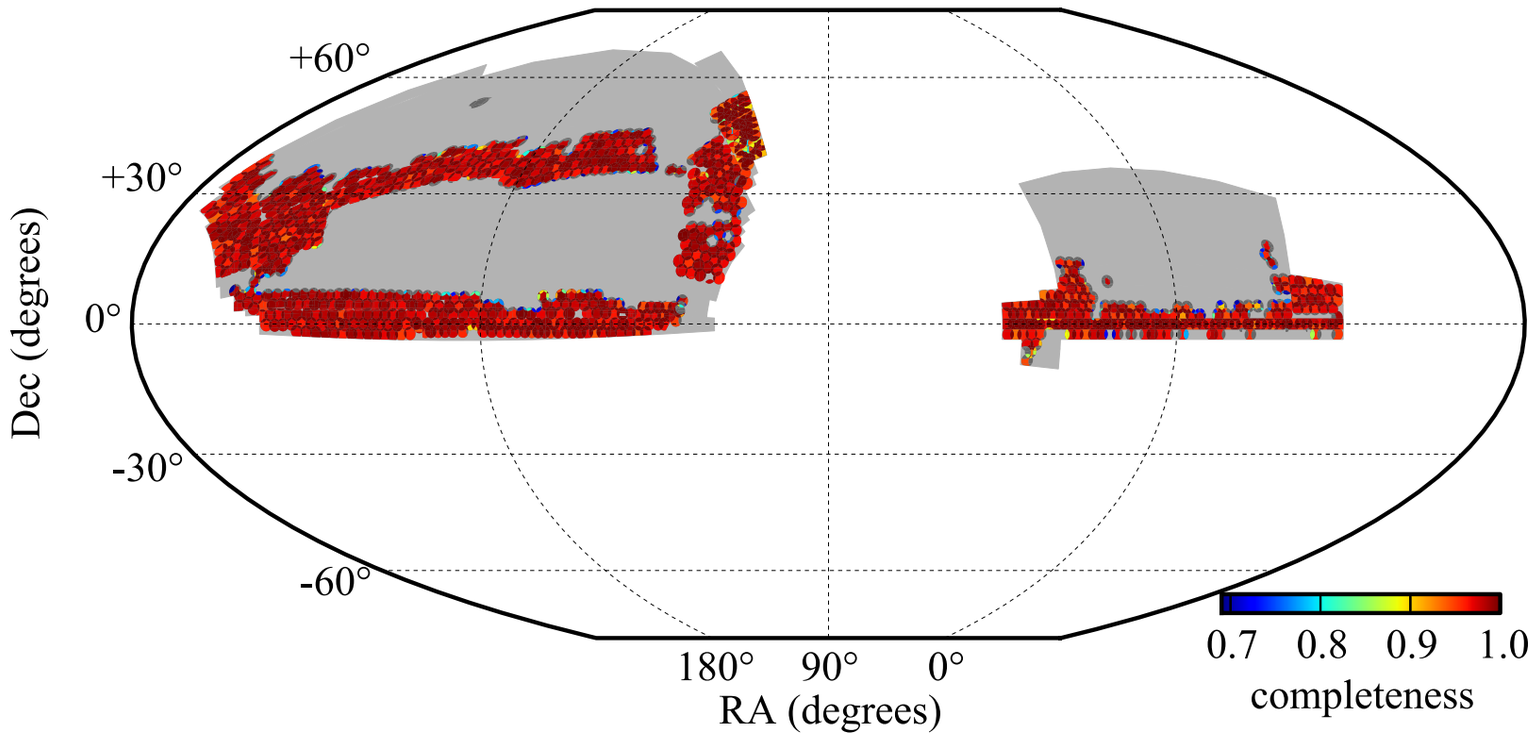
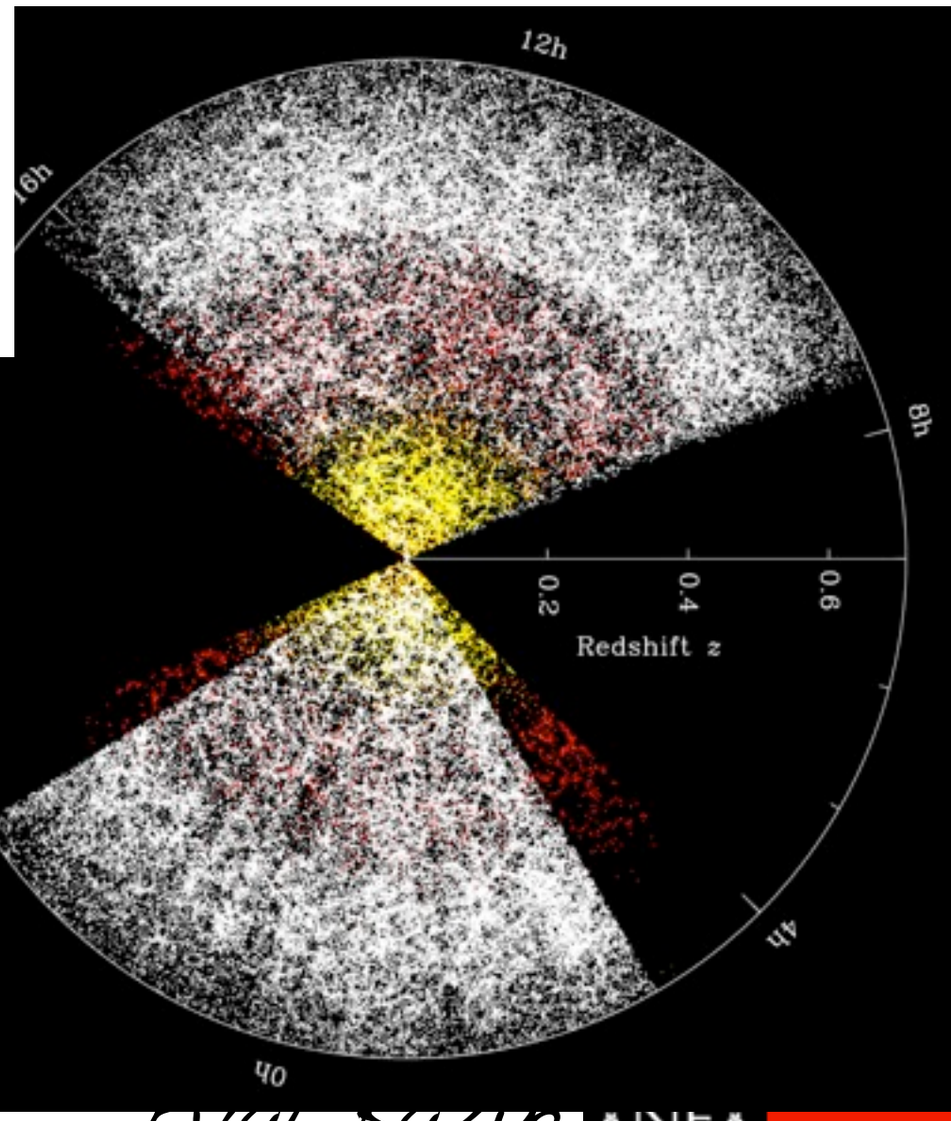
the SDSS-III BOSS

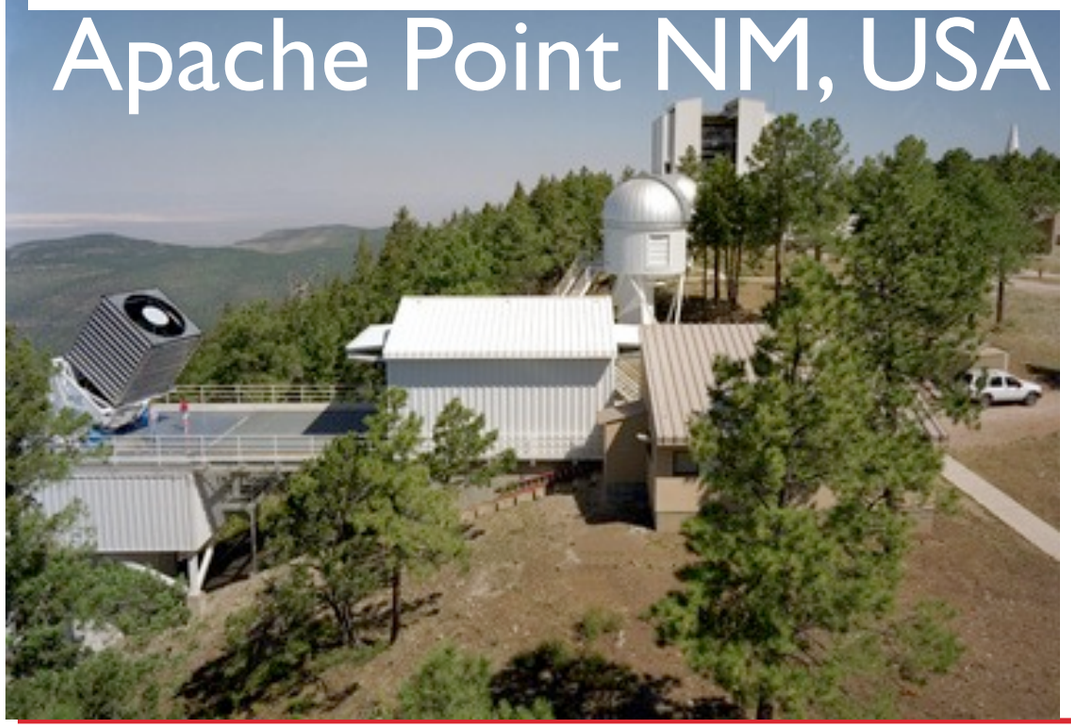


CMASS sample:

- 264,000 massive galaxies
- $0.43<z<0.7$ $\langle z\rangle=0.57$
- Volume of 2.2 Gpc^3
- density ~ $3\cdot10^{-4}h^3Mpc^{-3}$



Apache Point NM, USA



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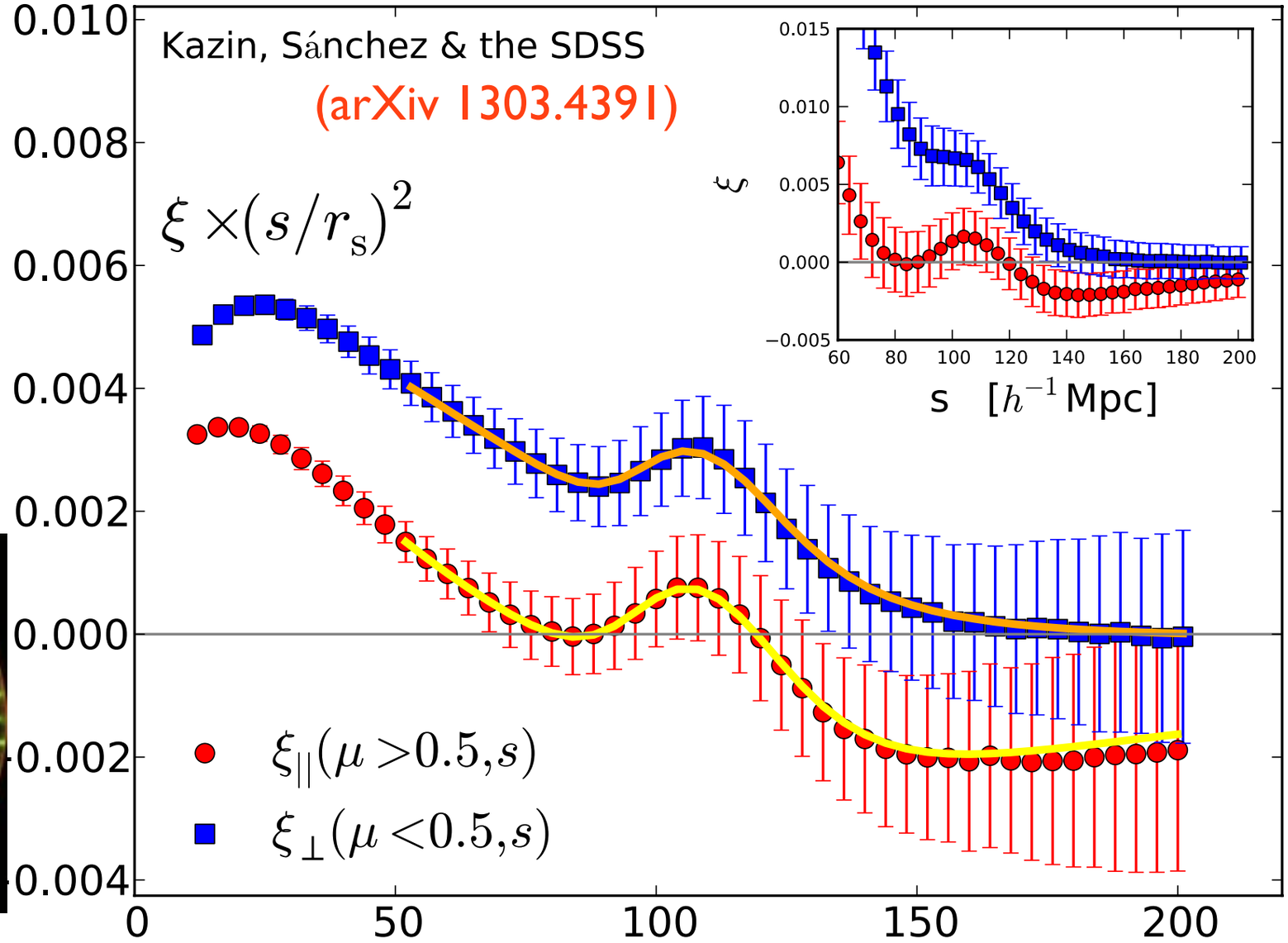
Clustering Wedges: BOSS Simulations

Averaging 600 PTHalo BOSS volumes by Manera et al. (2012)

Clustering Wedges



$\xi_{\perp} \rightarrow D_A$

``yard stick"

$\xi_{||} \rightarrow H$

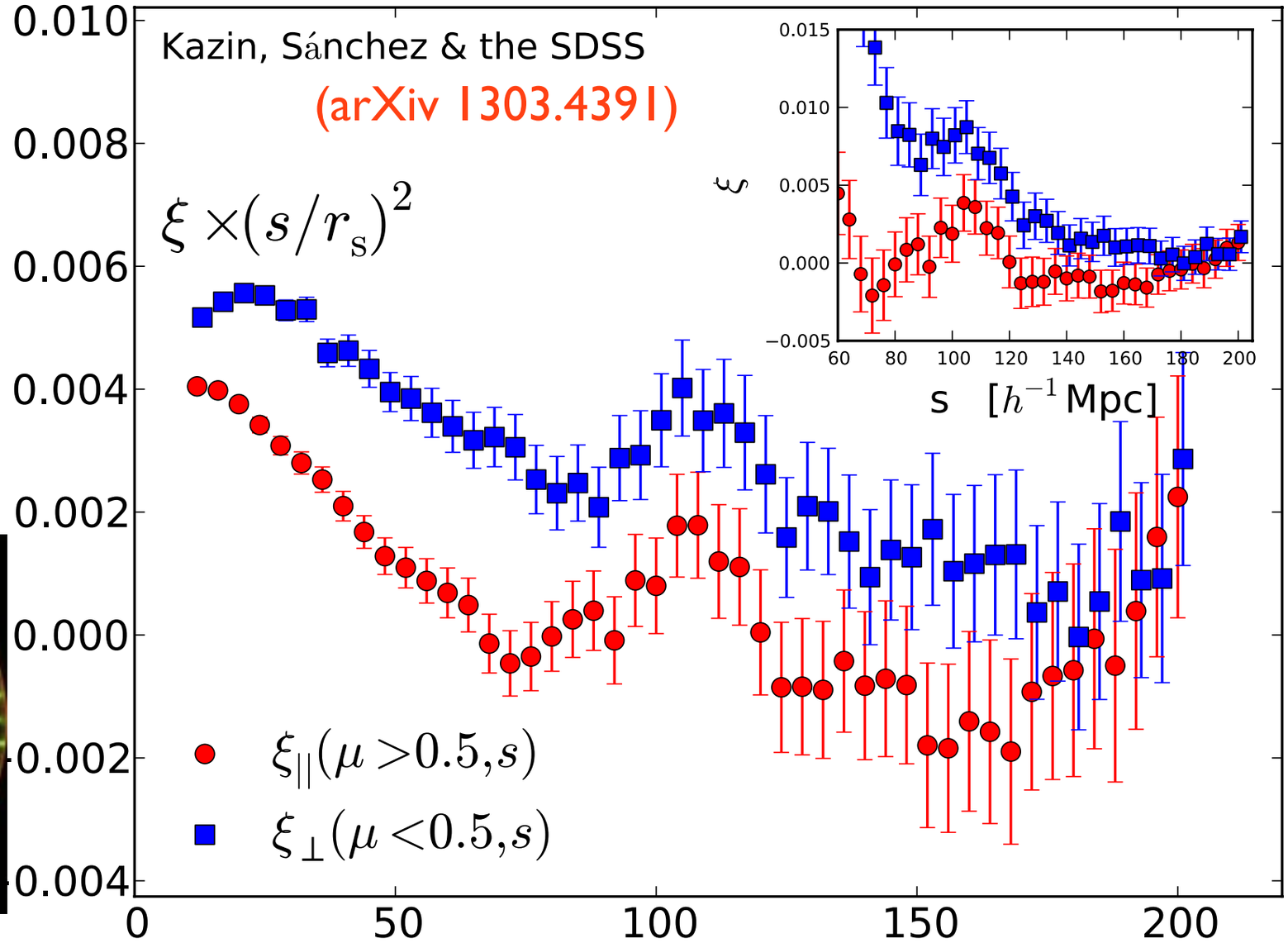
``speedometer"

Note: all points are covariant

$$\xi_{\Delta\mu}(\mu_{\min}, s) = \frac{1}{\Delta\mu} \int_{\mu_{\min}}^{\mu_{\min}+\Delta\mu} \xi(\mu, s) d\mu.$$

BOSS Data

Clustering Wedges



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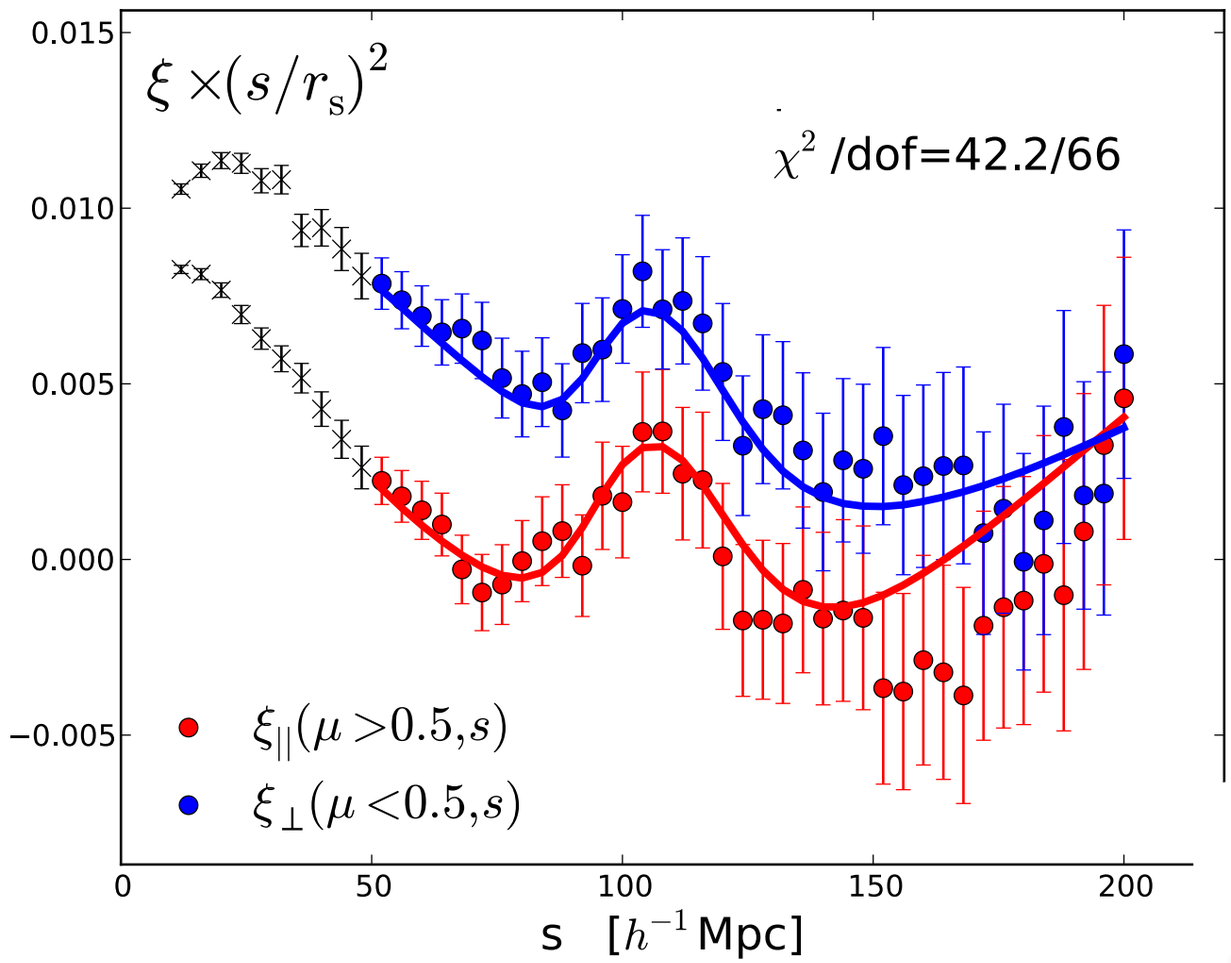
BOSS BA Feature: Measuring $H(z)$, $D_A(z)$ from BA Feature only

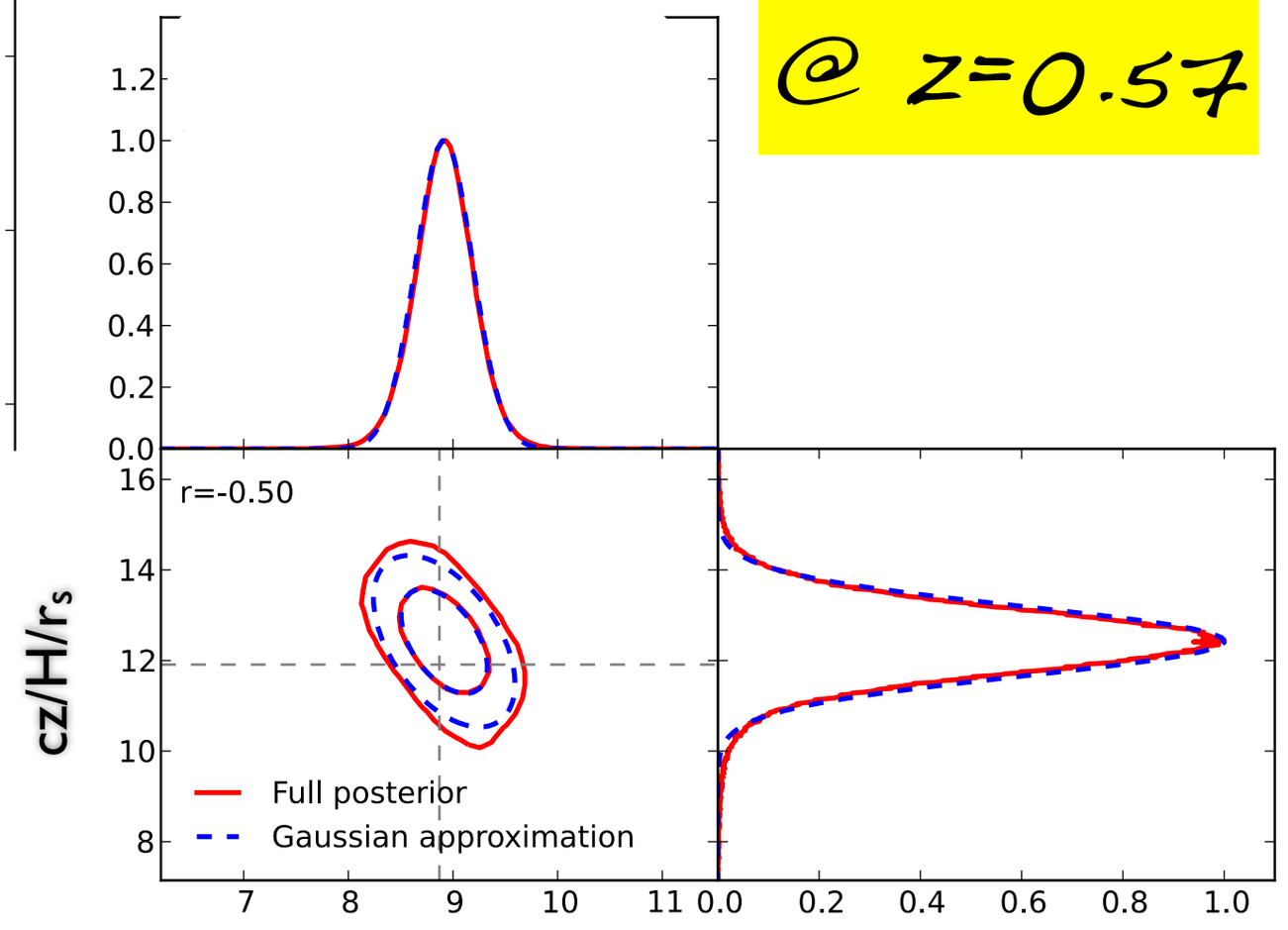
Model independent constraints:*

$\Delta H/H \sim 6.5\%$

$\Delta D_A/D_A \sim 3\%$

@ z=0.57





Note: all points are covariant

* based on peak position, not full shape

Kazin, Sánchez & SDSS (arXiv 1303.4391)

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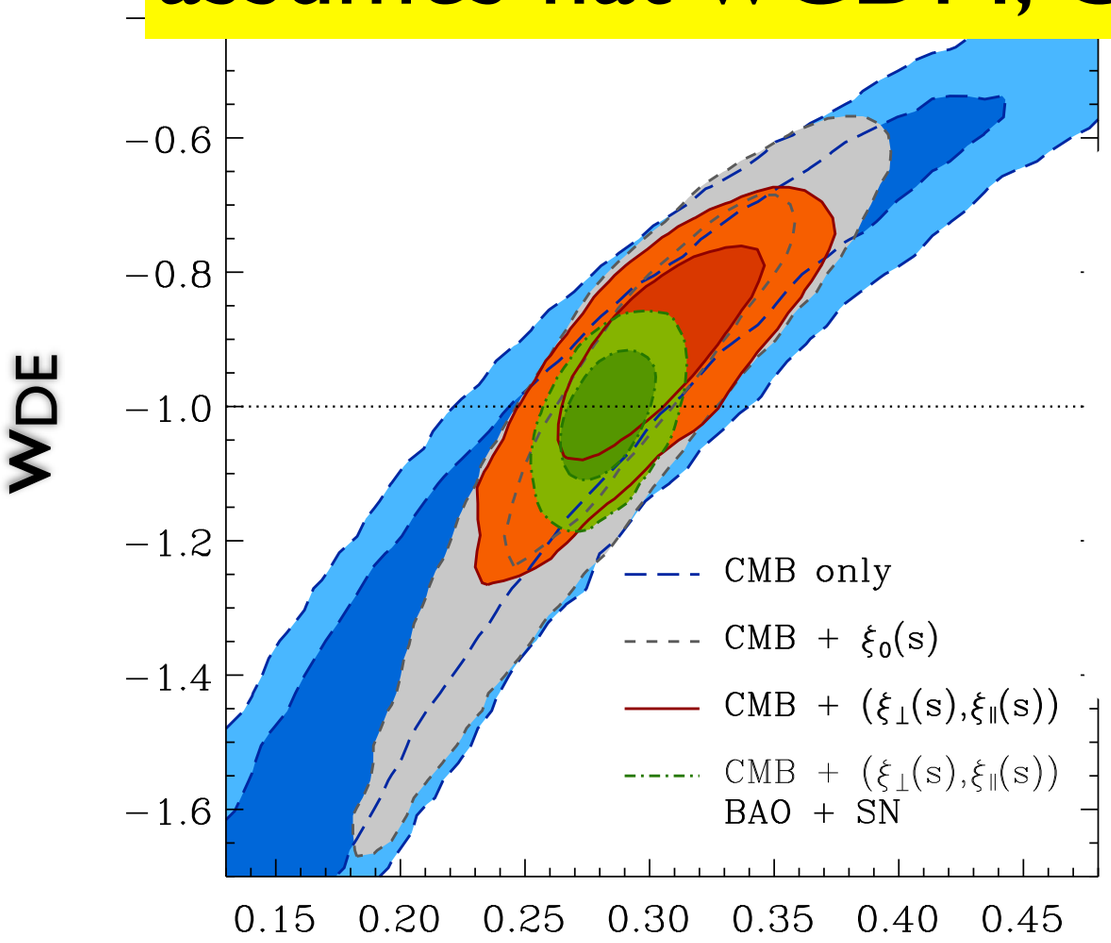
Cosmology from BOSS (pre-Planck) constraints

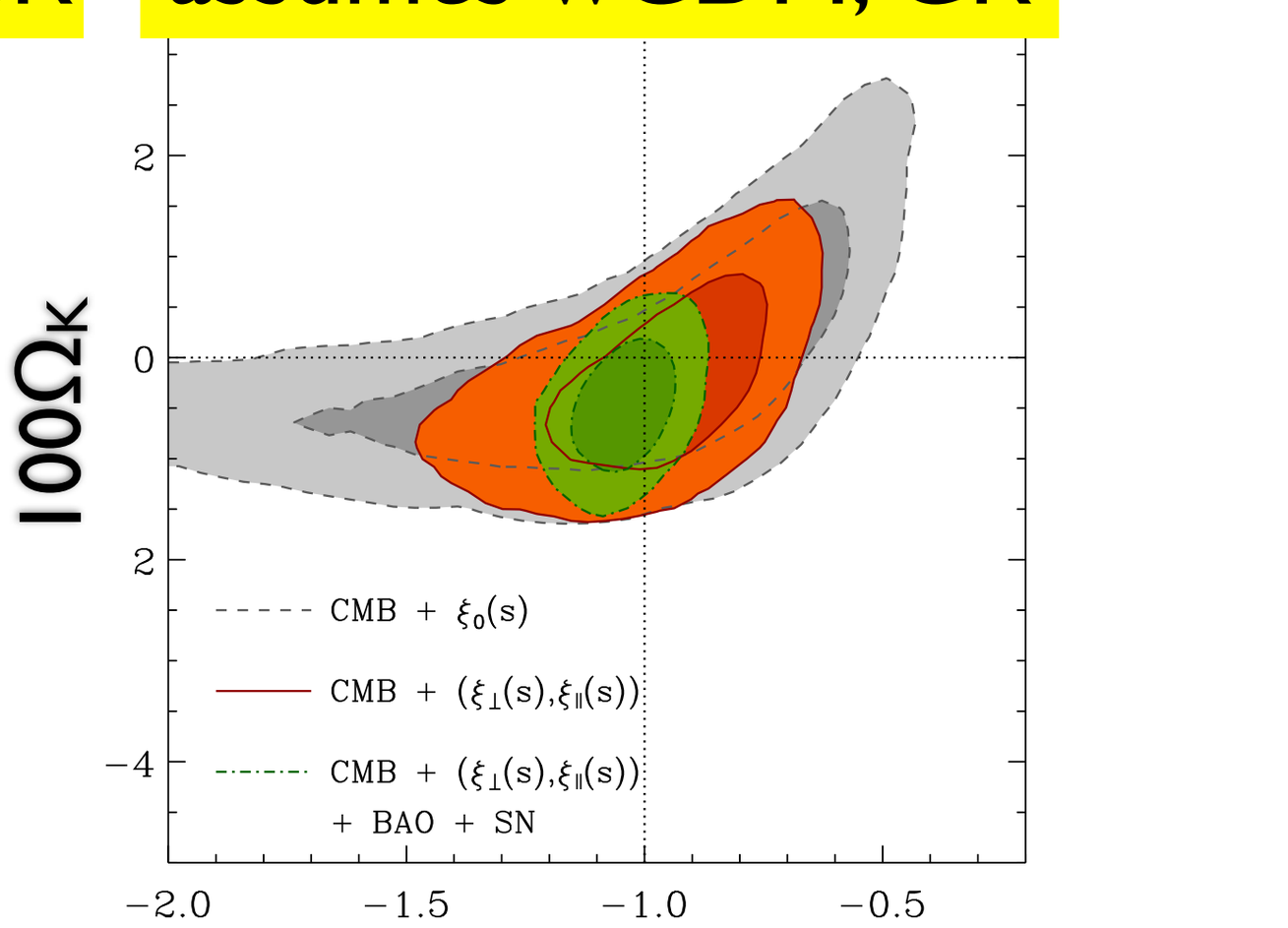
assumes flat wCDM, GR



clear improvement, when using LSS 2D signal

Sánchez, Kazin & the SDSS (arXiv 1303.4396)

assumes wCDM, GR



from:

WMAP9, (+BOSS monopole)
+BOSS wedges, +
SN & other LSS isotropic

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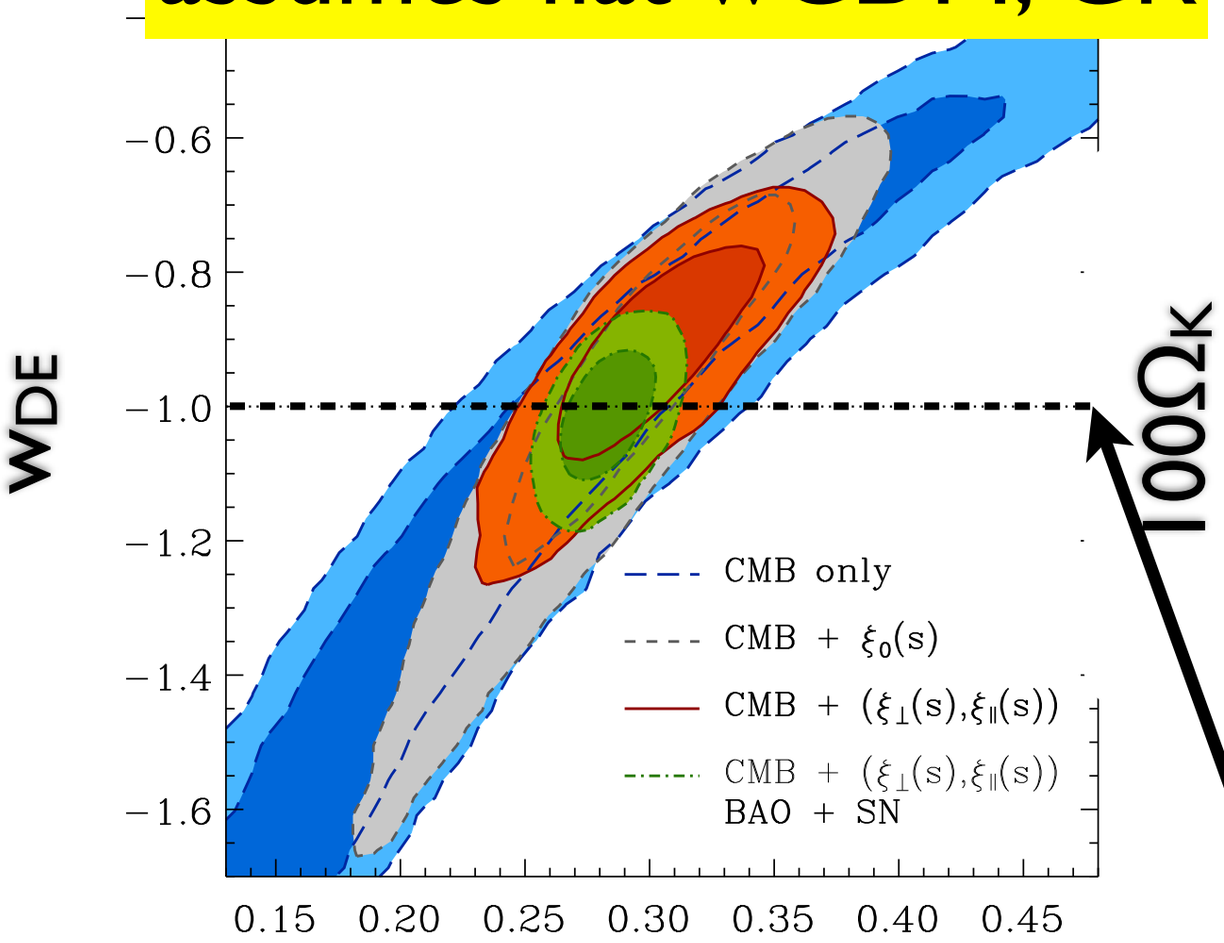
Cosmology from BOSS (pre-Planck) constraints

assumes flat wCDM, GR



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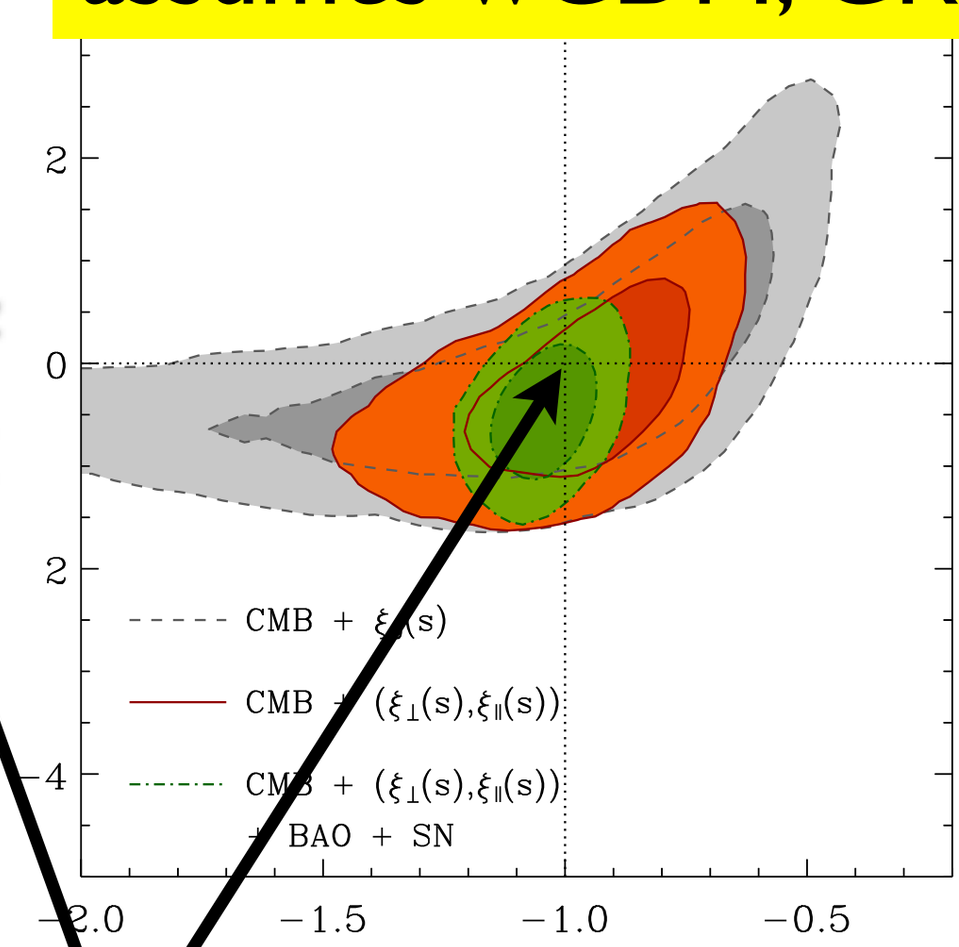

fr… W… +B… SN & other LSS isotropic…)

flat ΛCDM is still a non-ridiculous theory (according to observations)

Sánchez, Kazin & the SDSS (arXiv 1303.4396)

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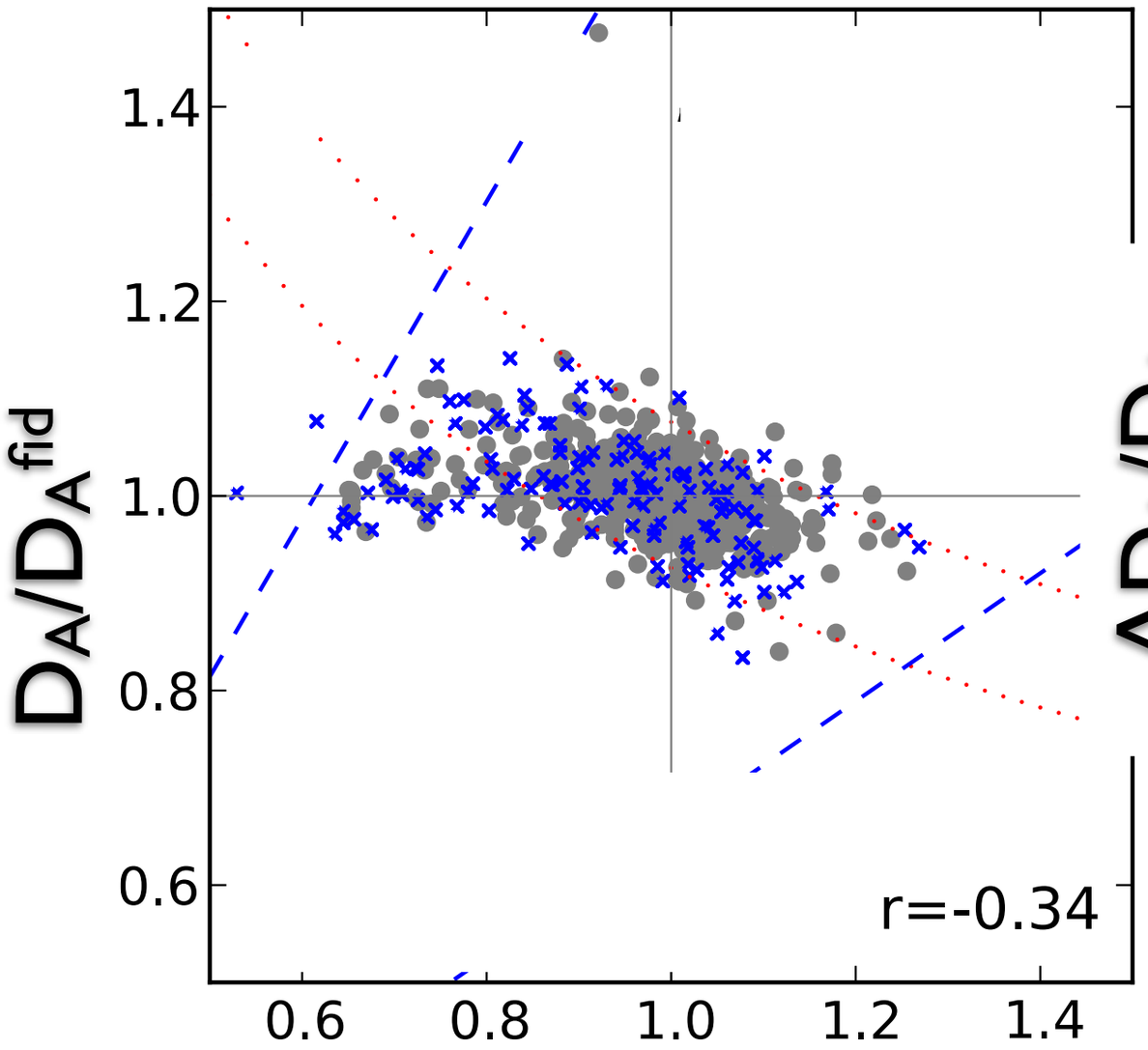
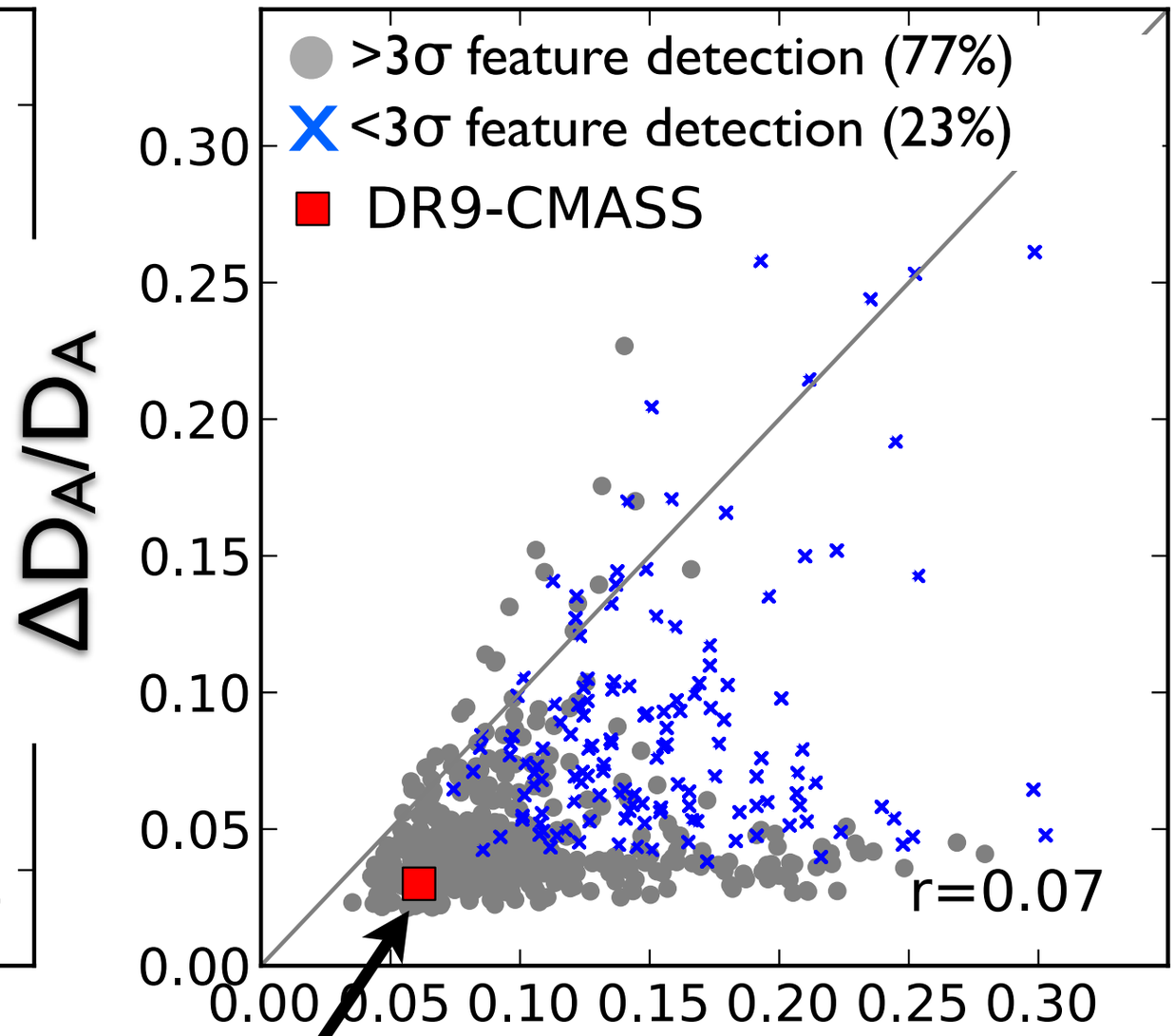
BOSS DR9 $H(z)$, $D_A(z)$ against expectations from mocks

Testing for bias



Constraining power



Our result

Kazin, Sánchez & the SDSS (arXiv 1303.4391)

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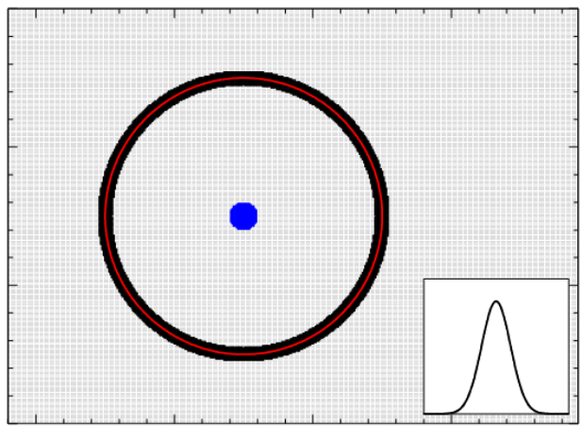
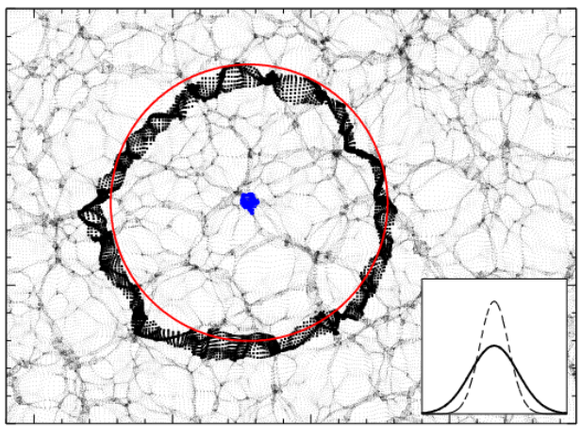
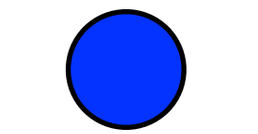
Damping of the Baryonic Acoustic Feature

Initial Field



z=0 Field



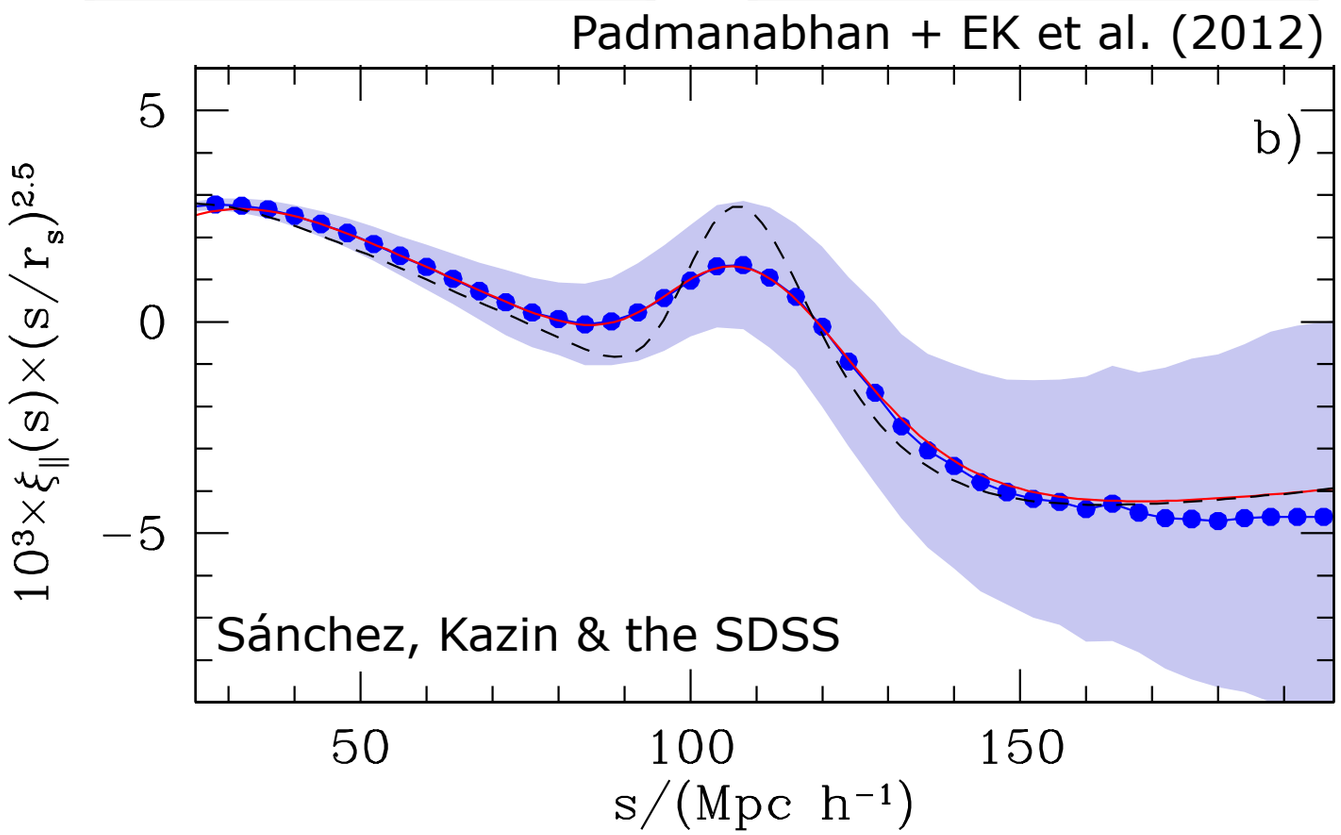


simulated signal

simulated r.m.s region

linear theory

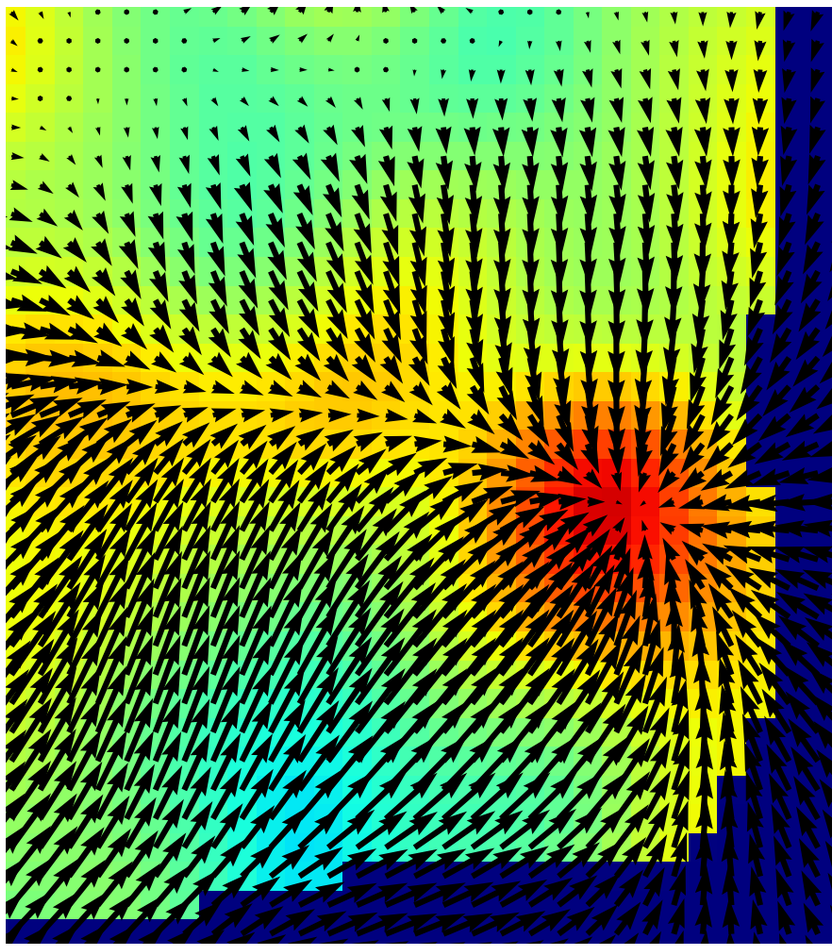
non-linear (damped)



- Bulk flows cause non linearities that push galaxies by 3-10 Mpc.
- This weakens the usage of baryonic acoustic feature as a standard ruler/sphere
- *This can be remedied!*

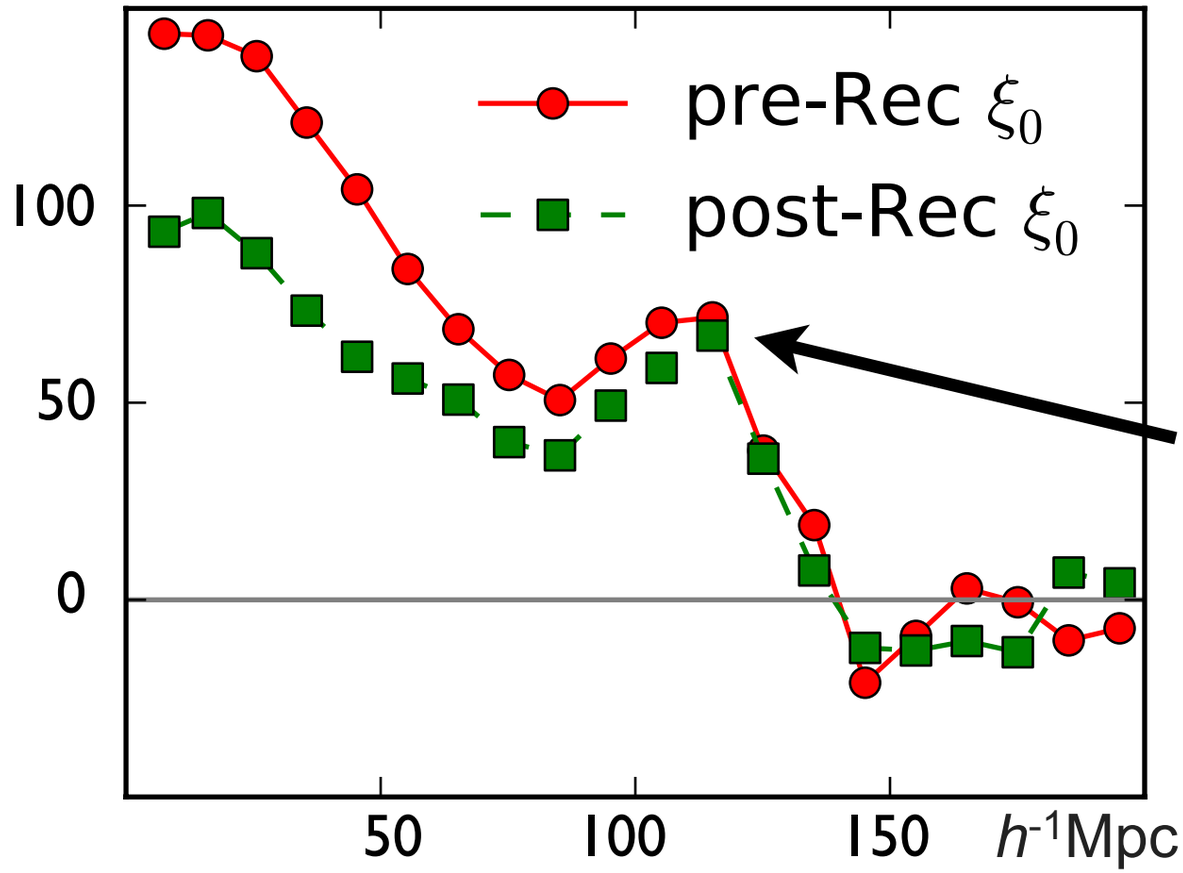
Reconstruction on the GiggleZ simulation

Density field and displacement vectors ($5h^{-1}$Mpc slice)



$35h^{-1}$Mpc

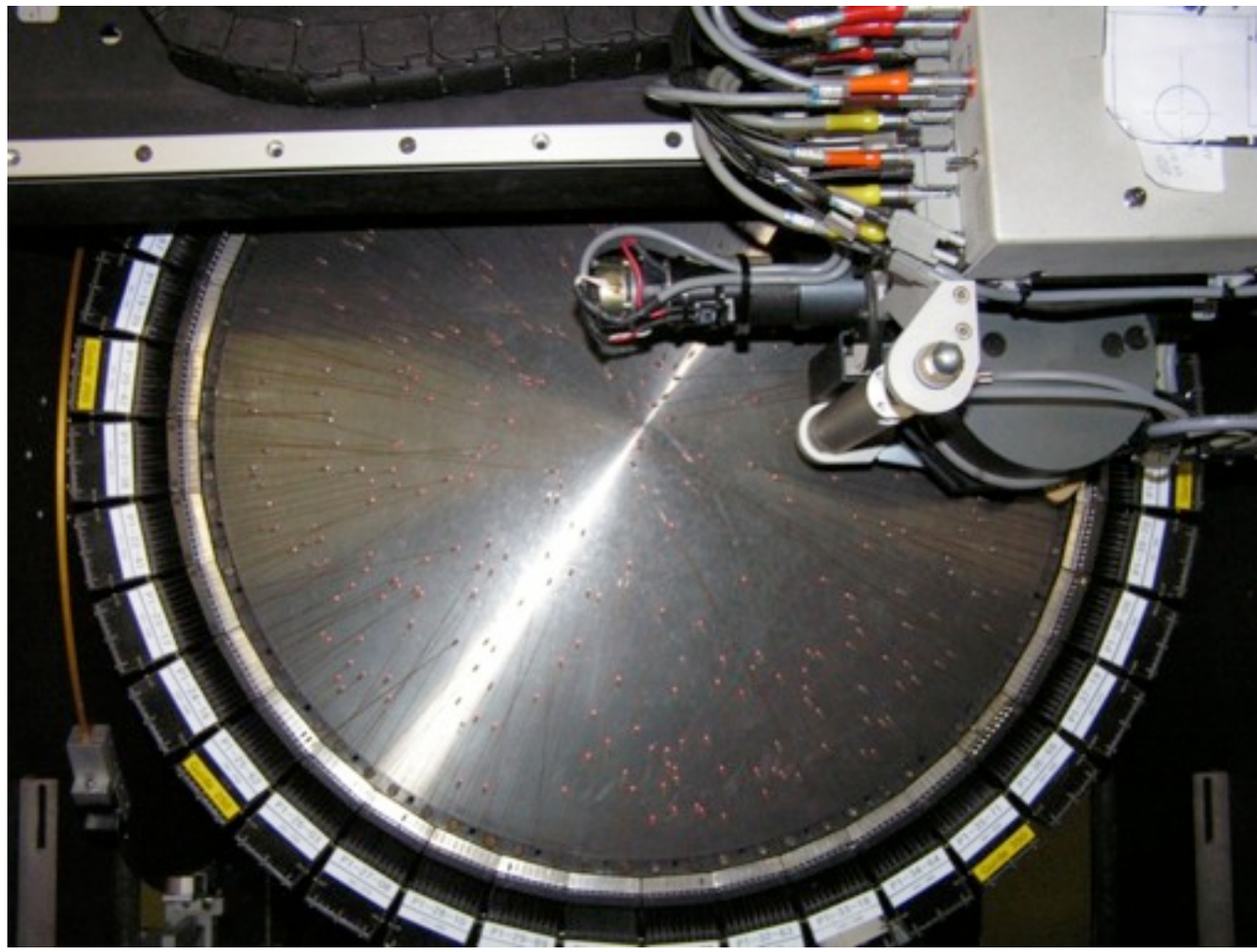
Correlation functions



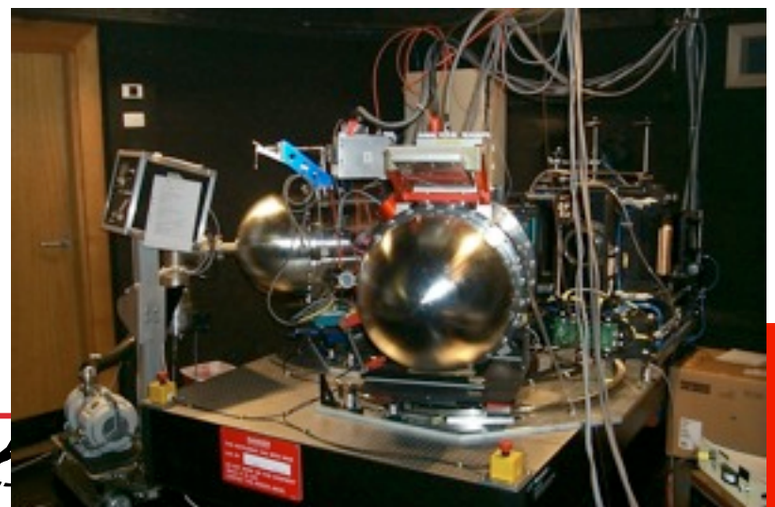
(From talk by Chris Blake)

The WiggleZ Dark Energy Survey

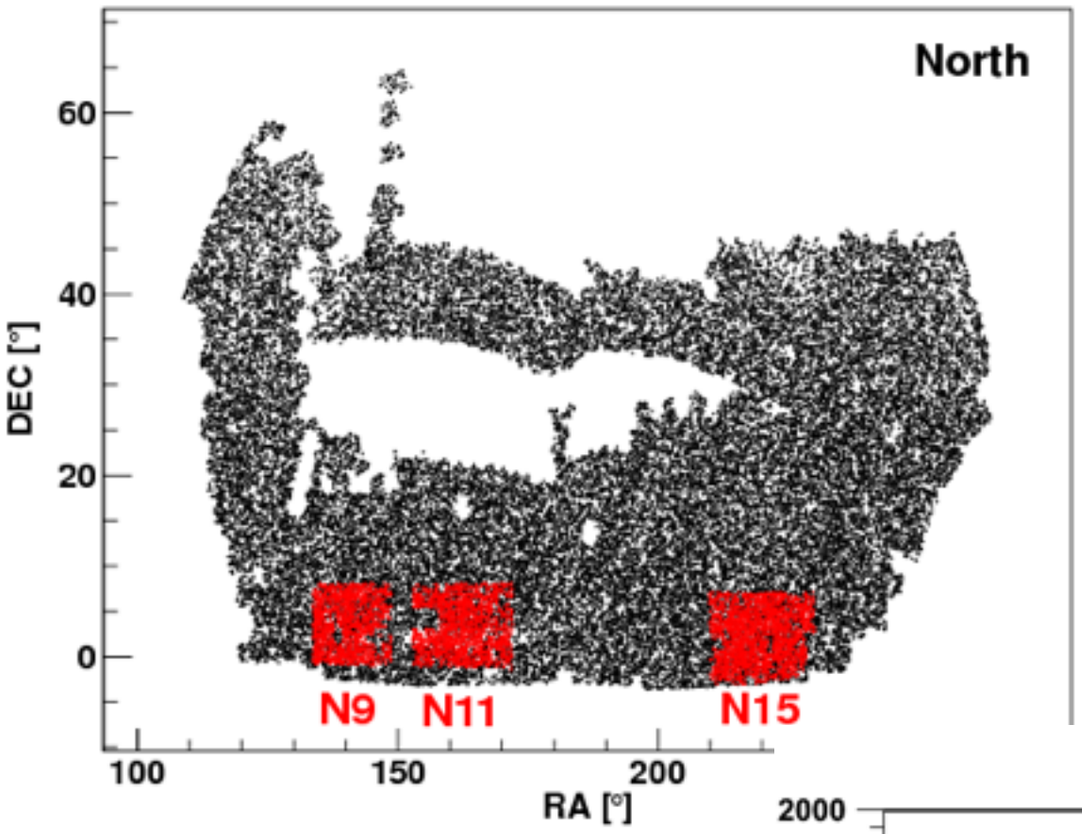
http://wigglez.swin.edu.au

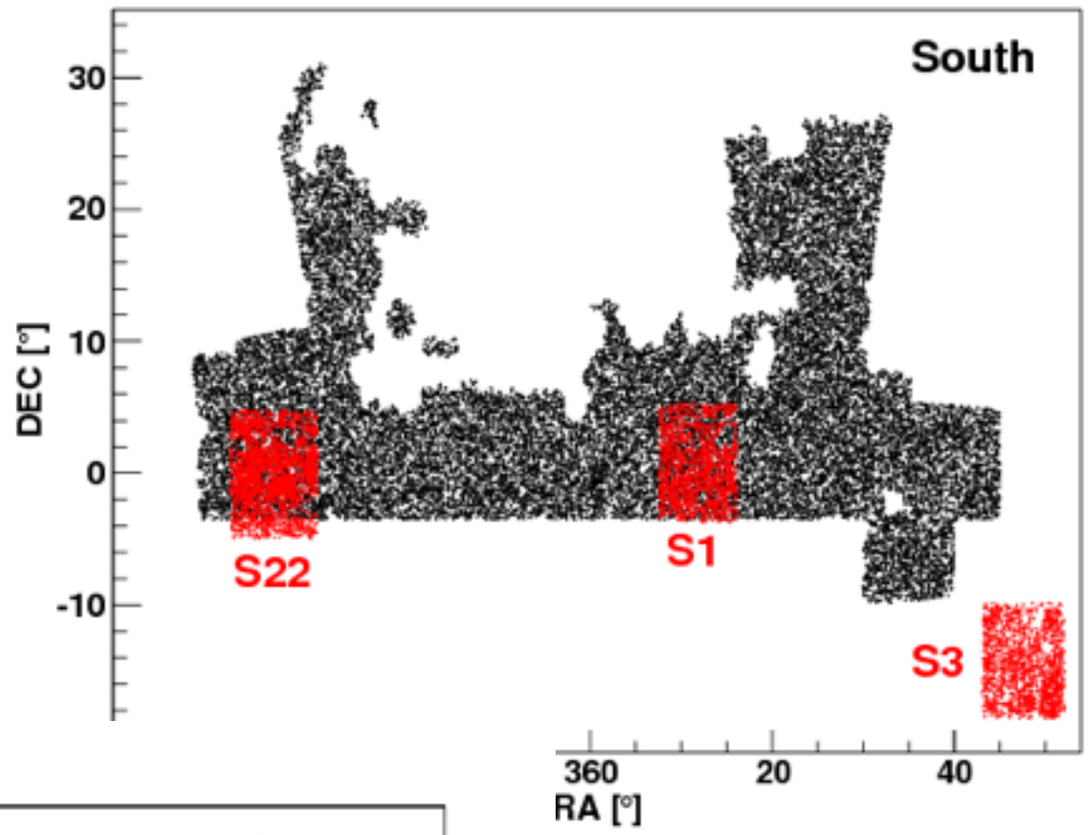


- 1000 sq deg , 0.2 < z < 1.0
- 200,000 redshifts
- blue star-forming galaxies
- 2006-2010

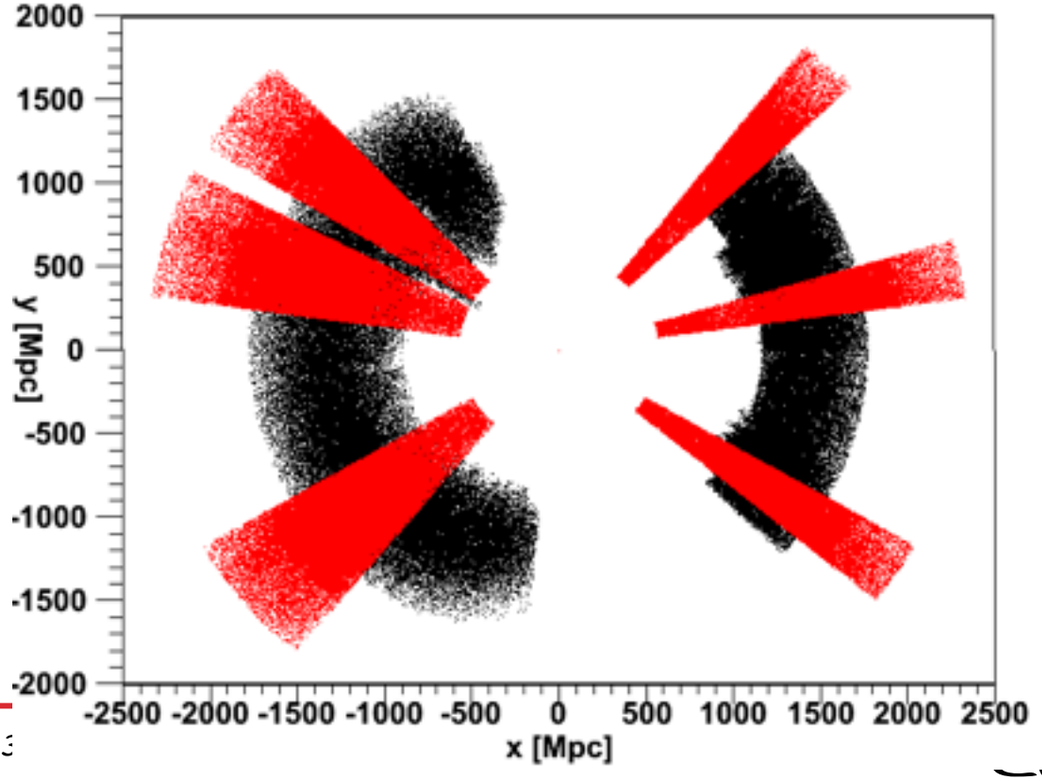


BOSS DR10 & WiggleZ Overlap Analysis





- BOSS DR10
  (release: July 2013)
- WiggleZ



Credit: Florian Beutler

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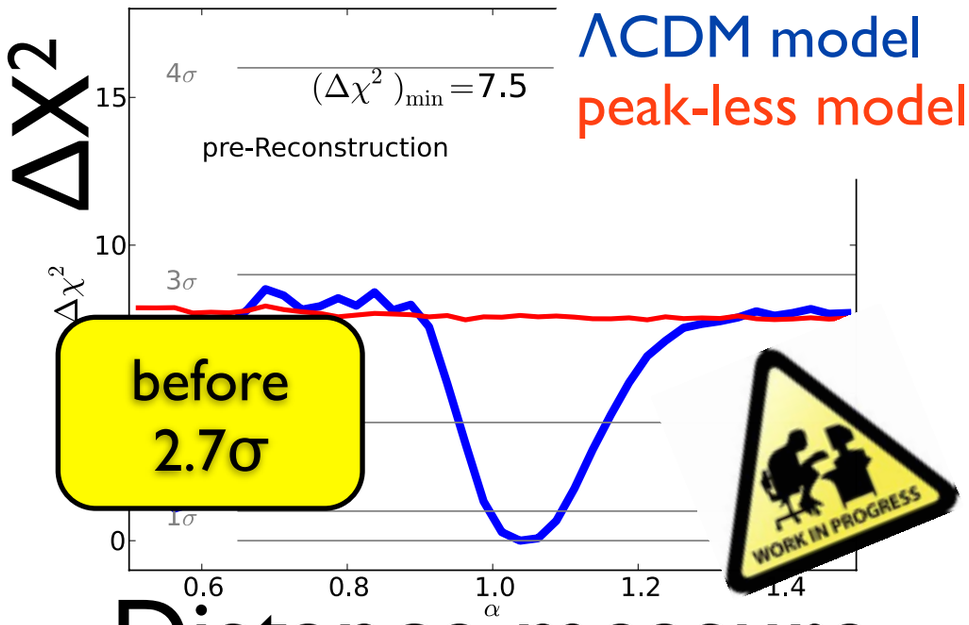
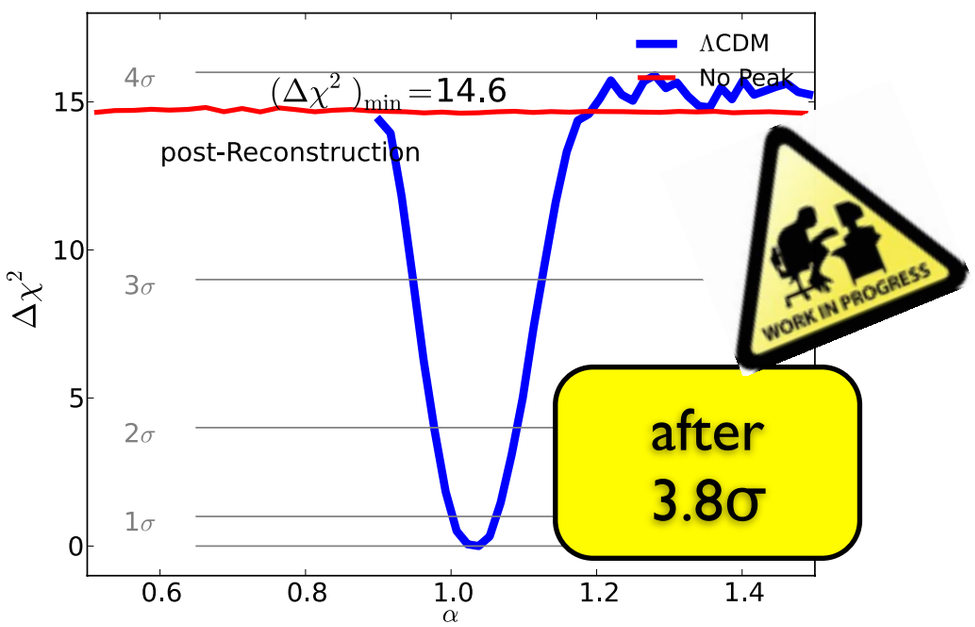
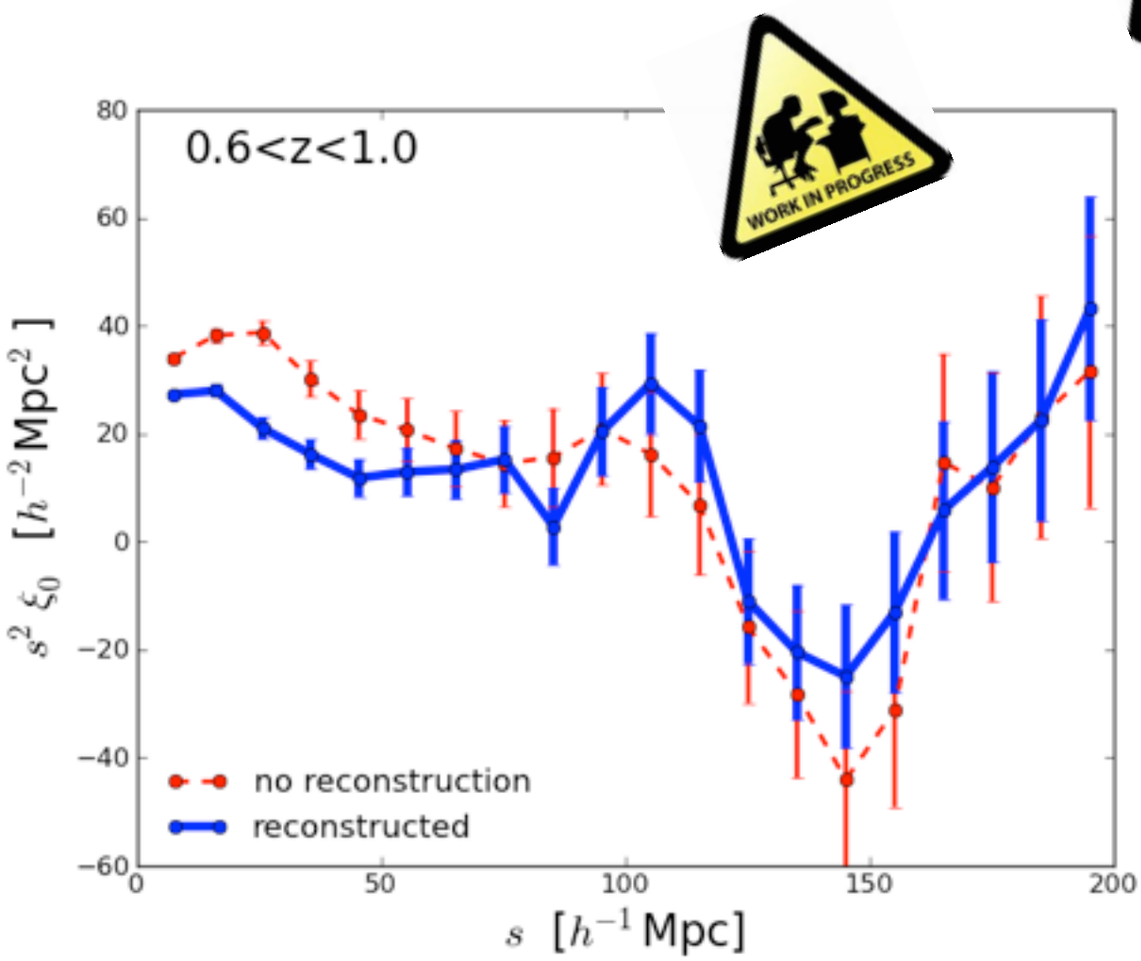
Reconstructed WiggleZ yields substantial improvements



Distance measure





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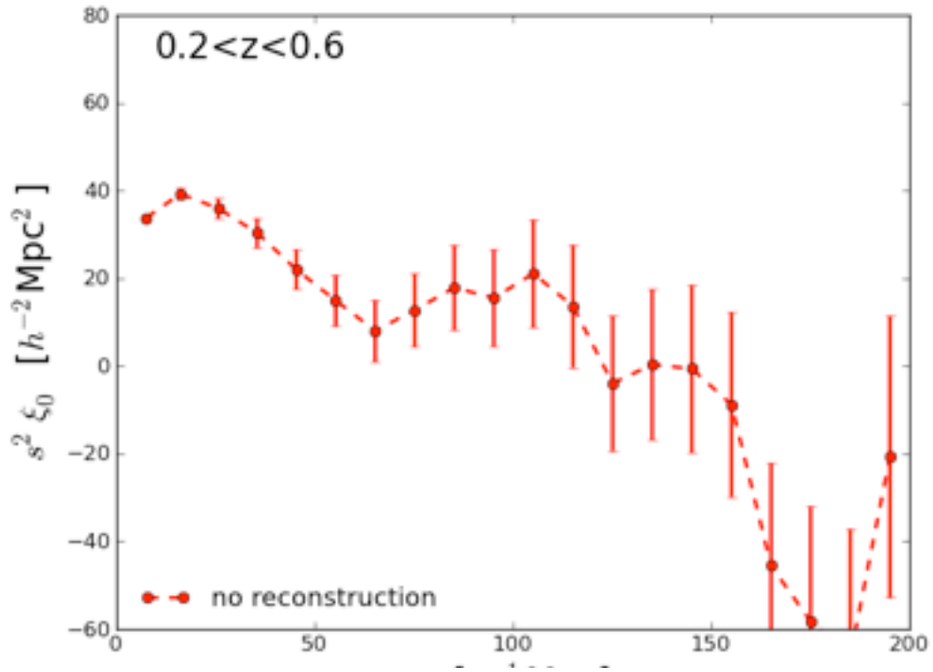
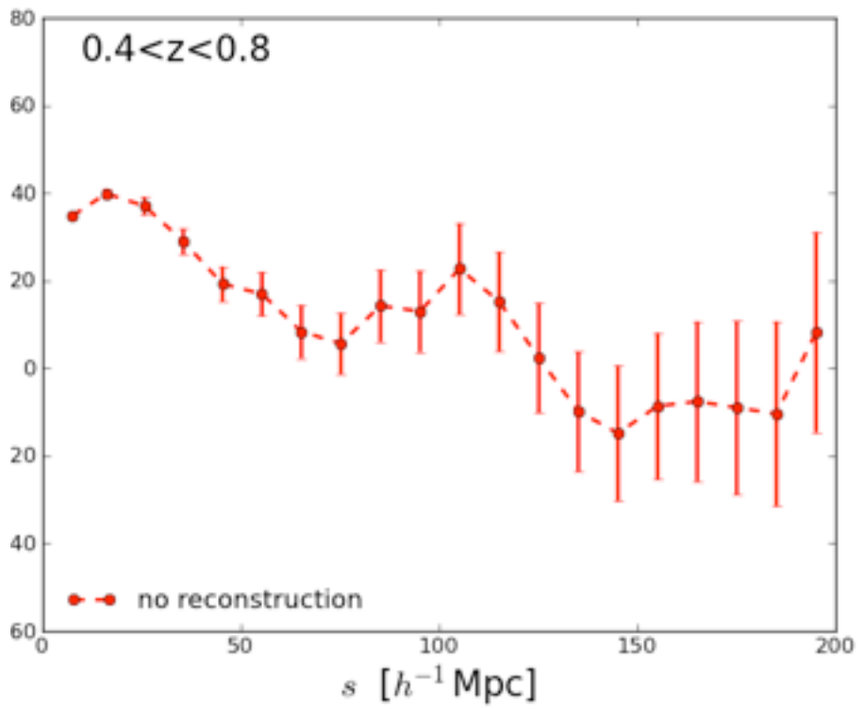
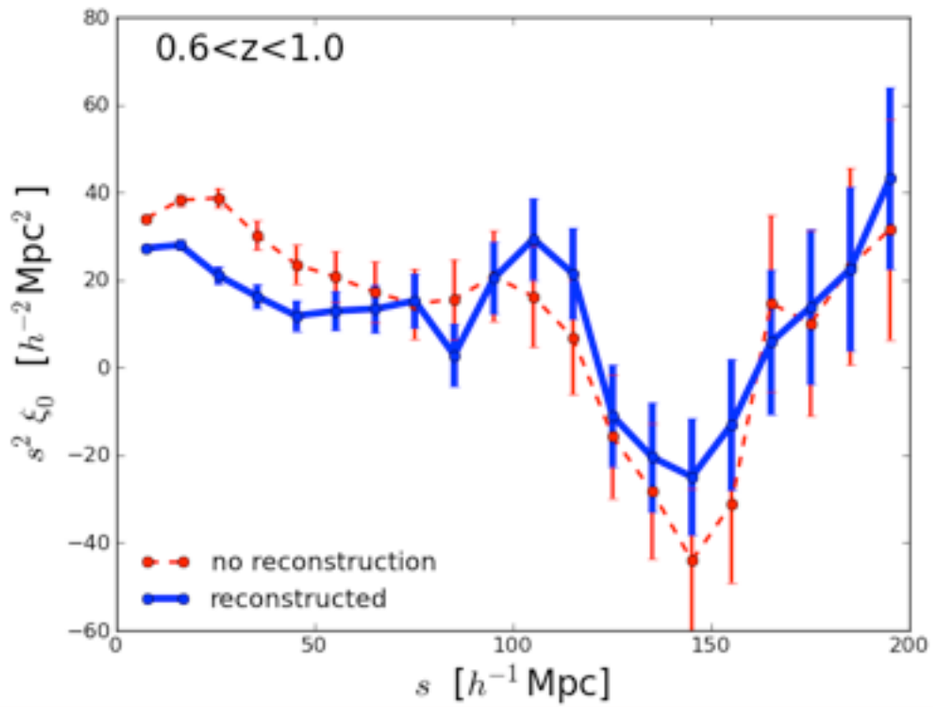
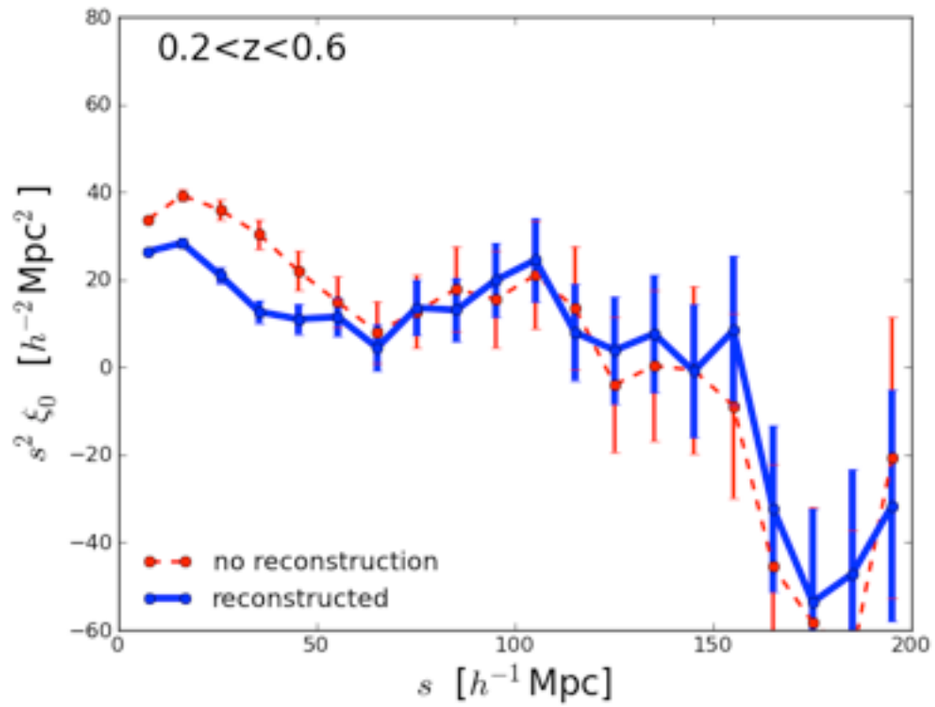
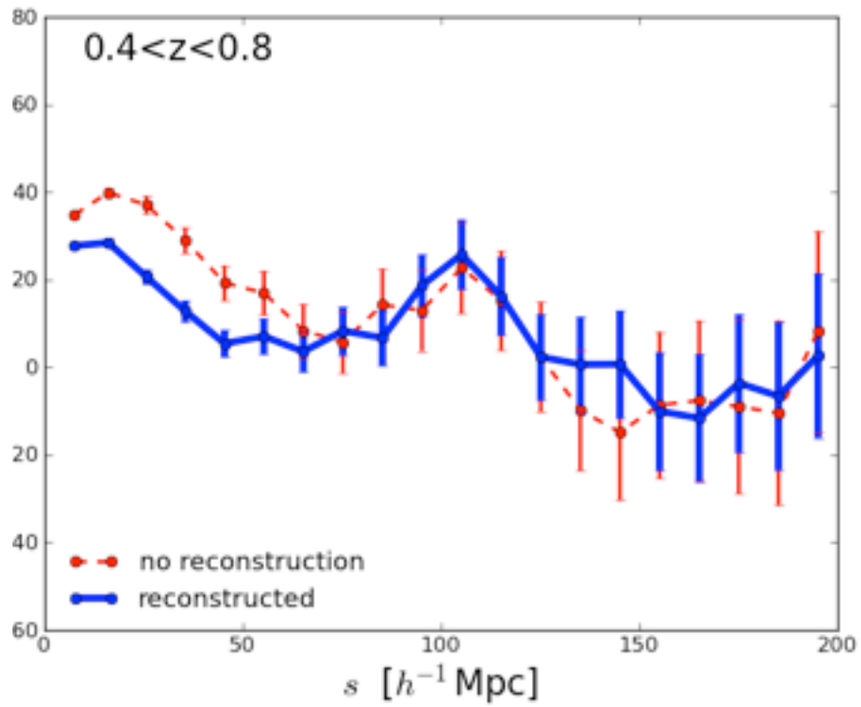


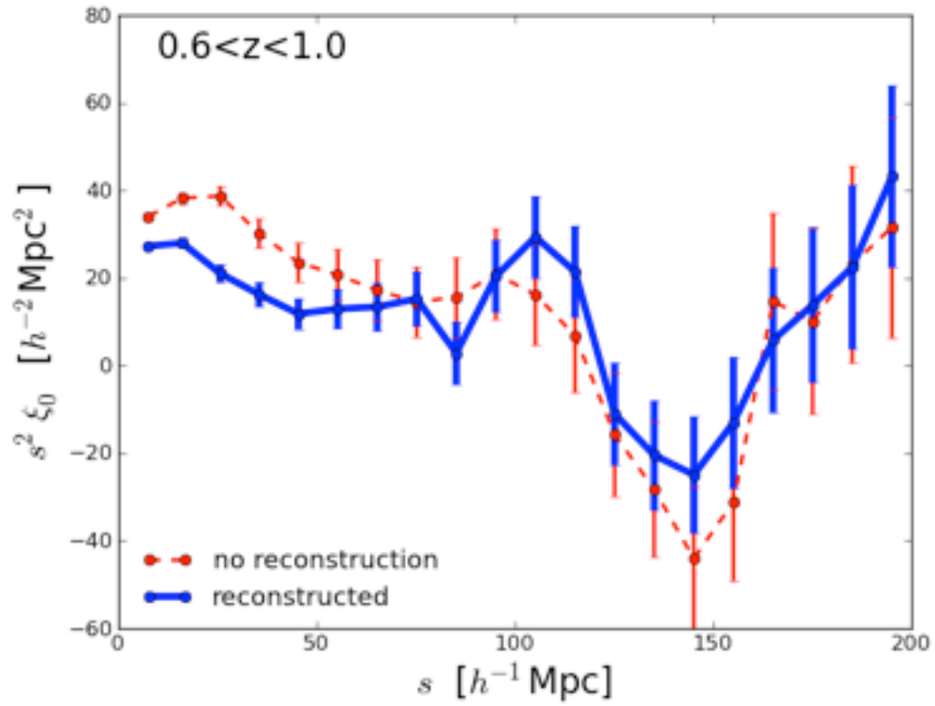




Reconstructed WiggleZ yields substantial improvements







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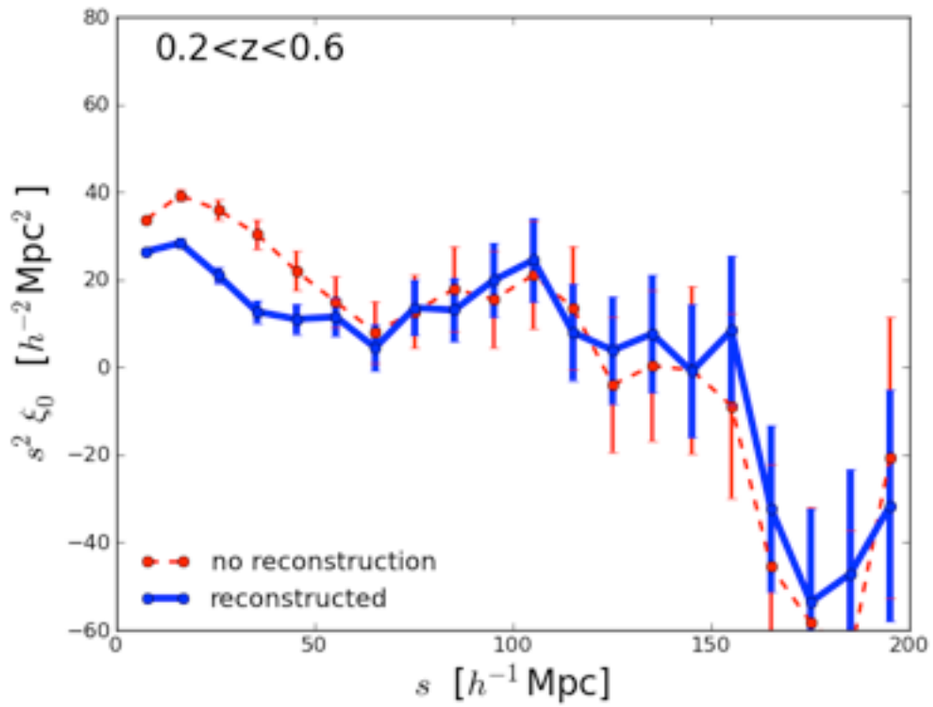

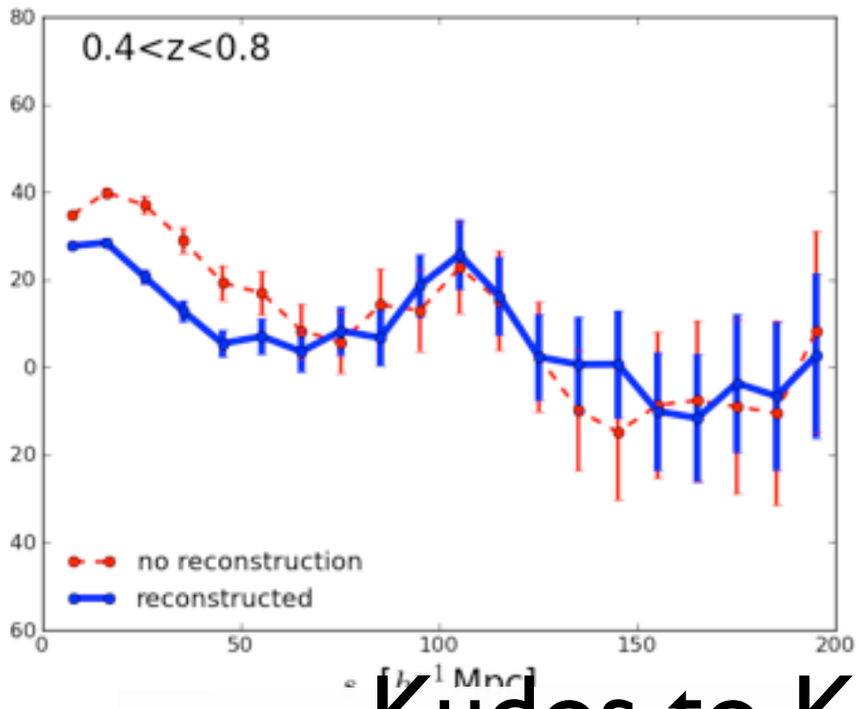

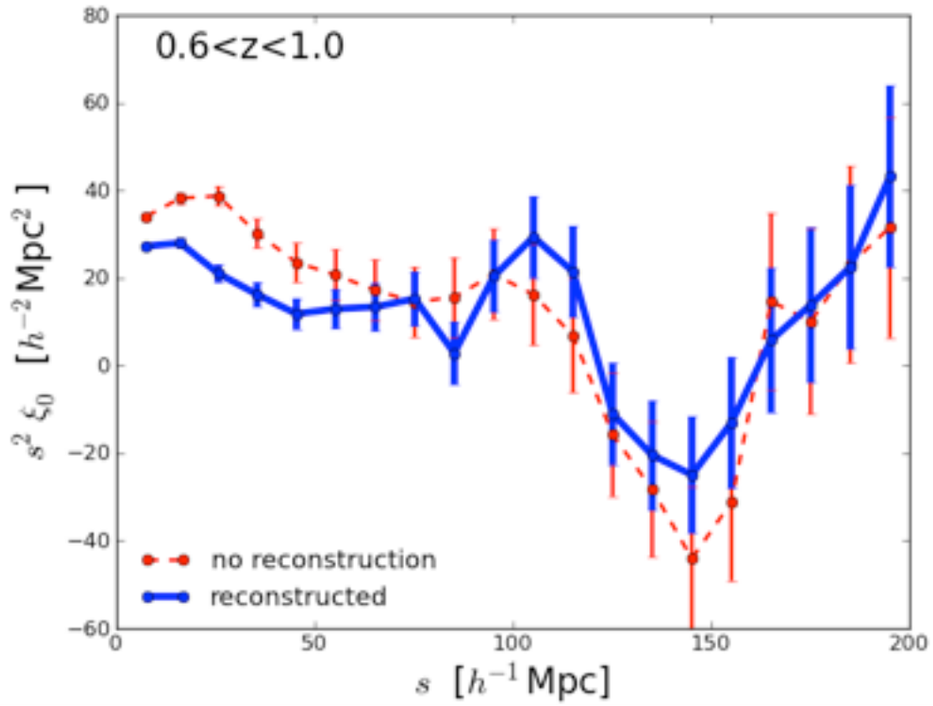

Kudos to Koda (Jun)

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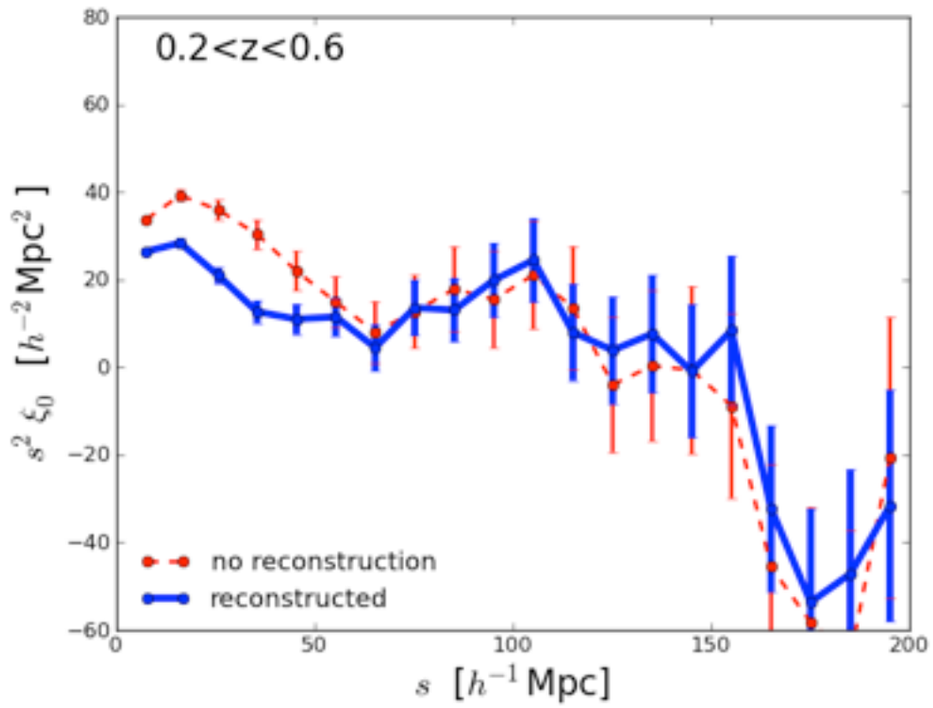
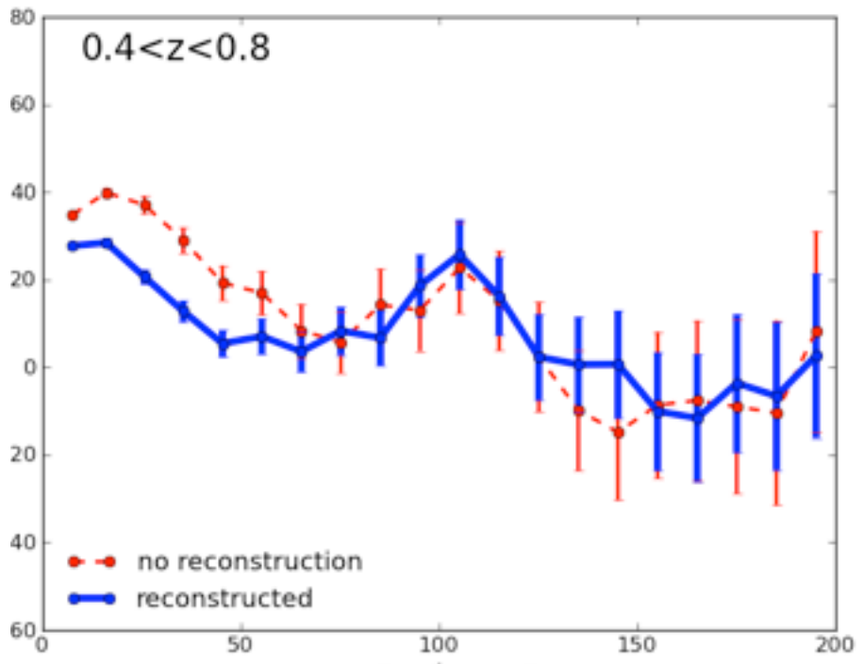
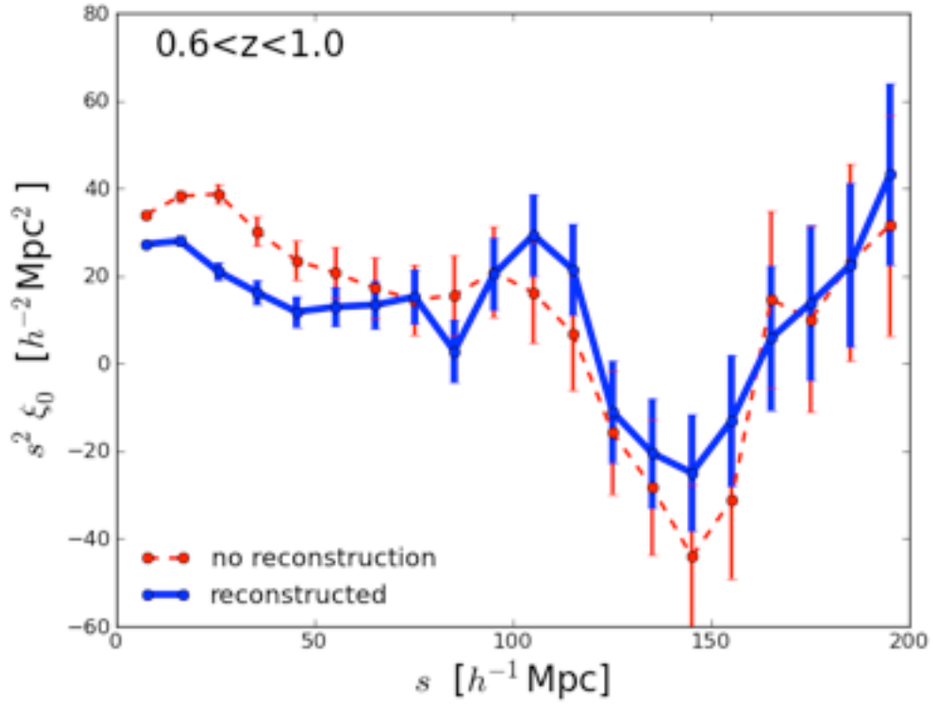
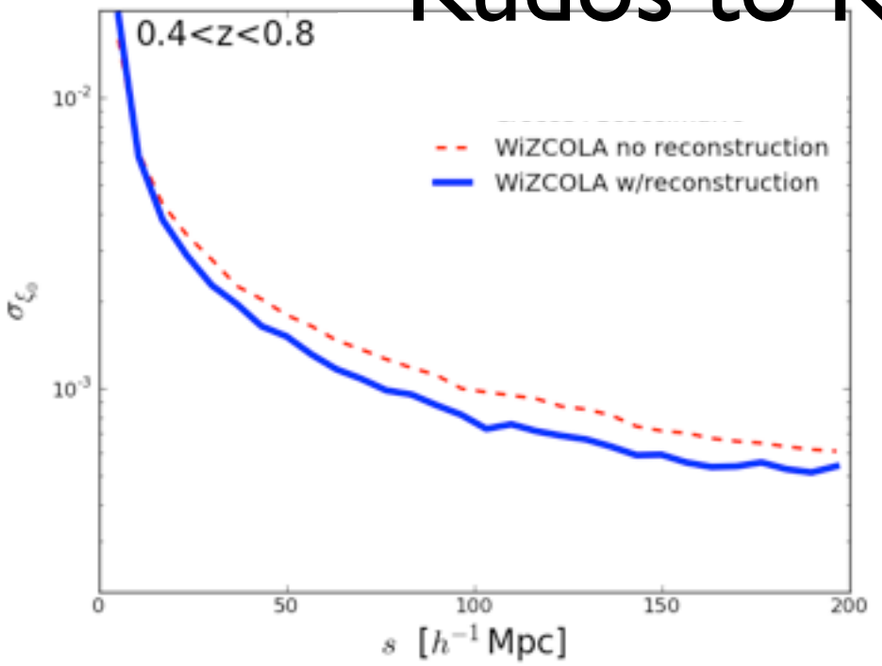








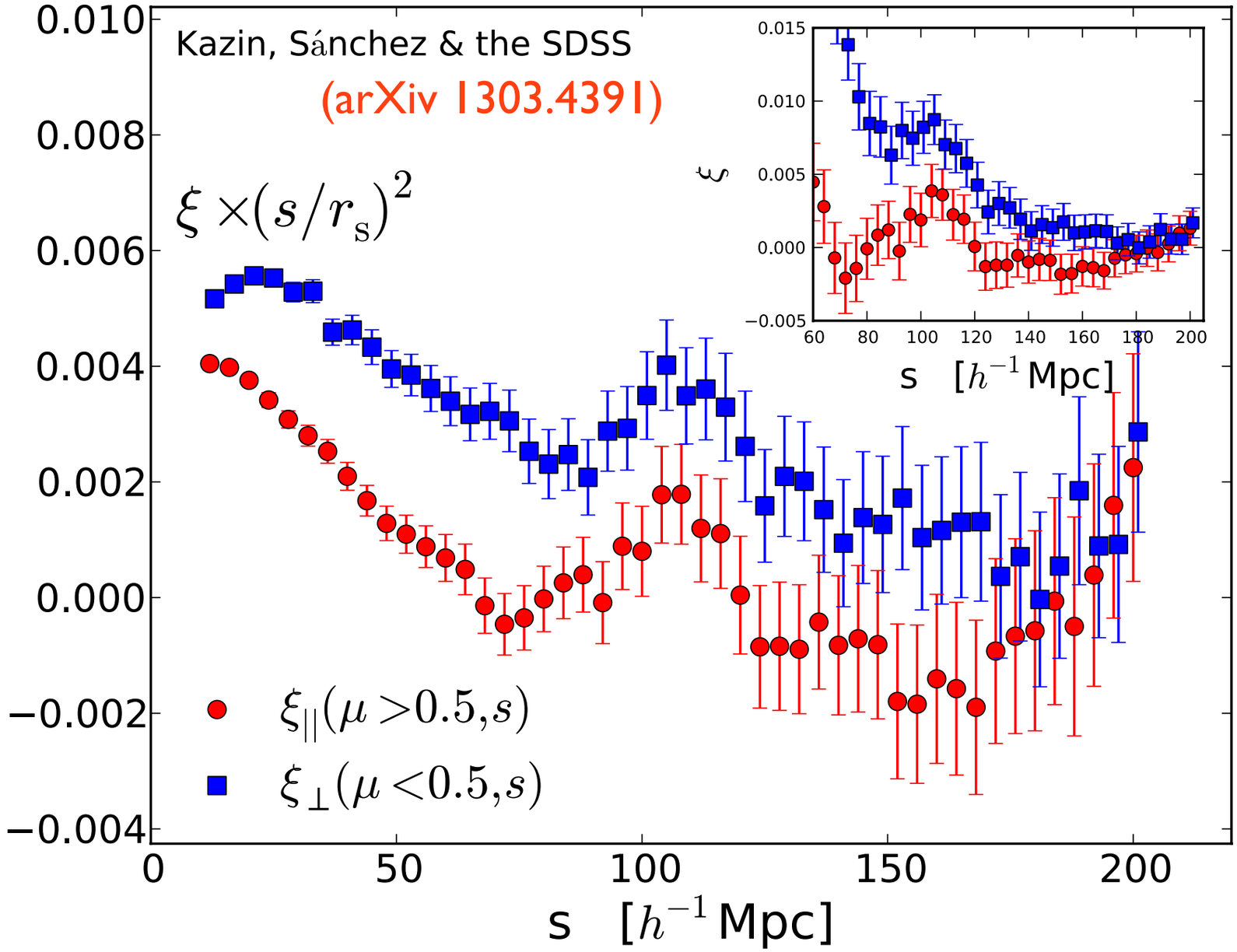
Kudos to Koda (Jun)

uncertainties at $100h^{-1}$Mpc improve by 20-30%

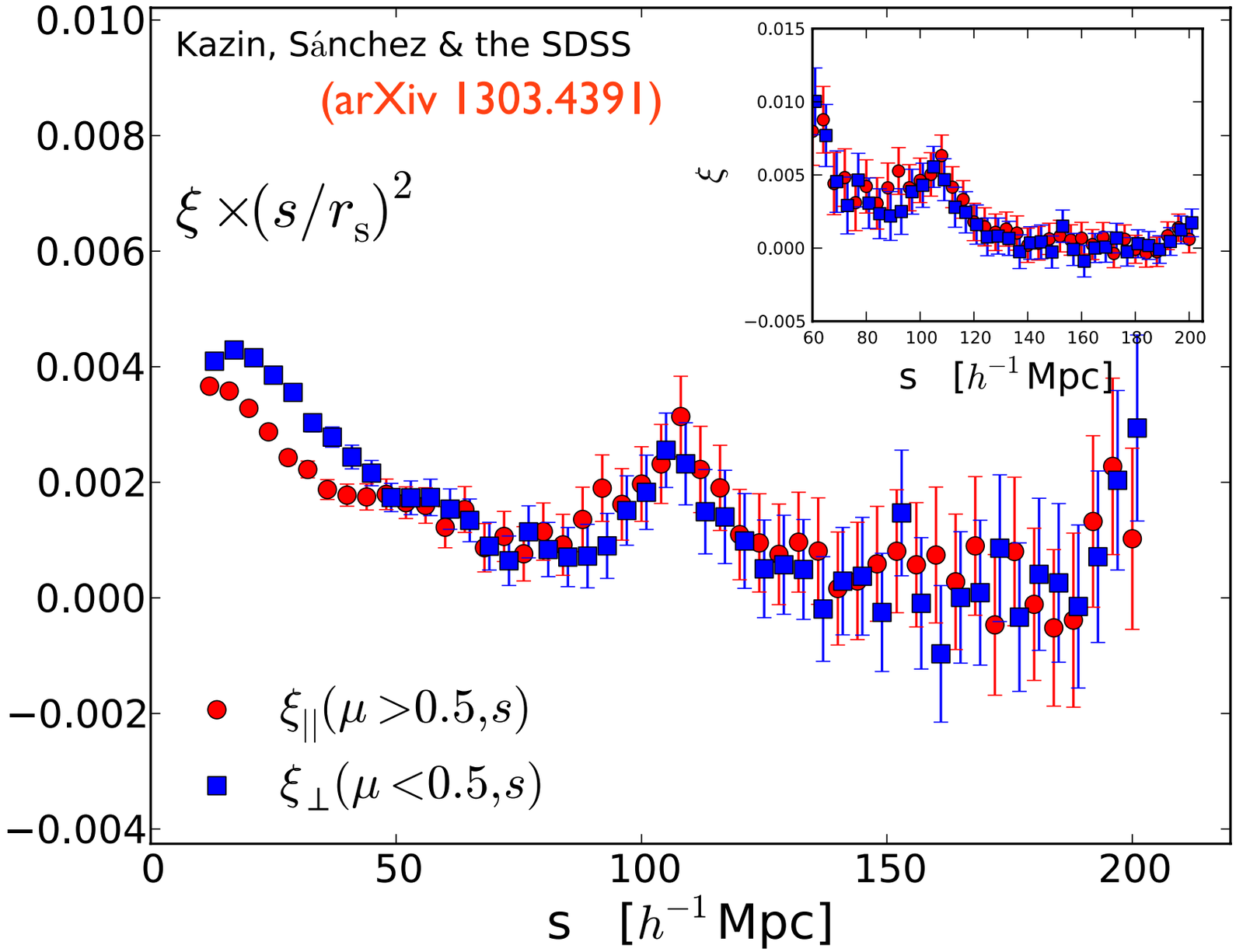
D_V/r_s statistical uncertainty levels ($D_A^2/H\ /r_s$) from WiggleZ

<z>	Full shape no recon (Blake et al.)	BAO only w/recon
0.44	7.8%	**5.1%**
0.6	4.7%	**3.5%**
0.73	5.4%	**2.8%**

BOSS Results: pre- Reconstruction Data



BOSS Results: post-Reconstruction Data



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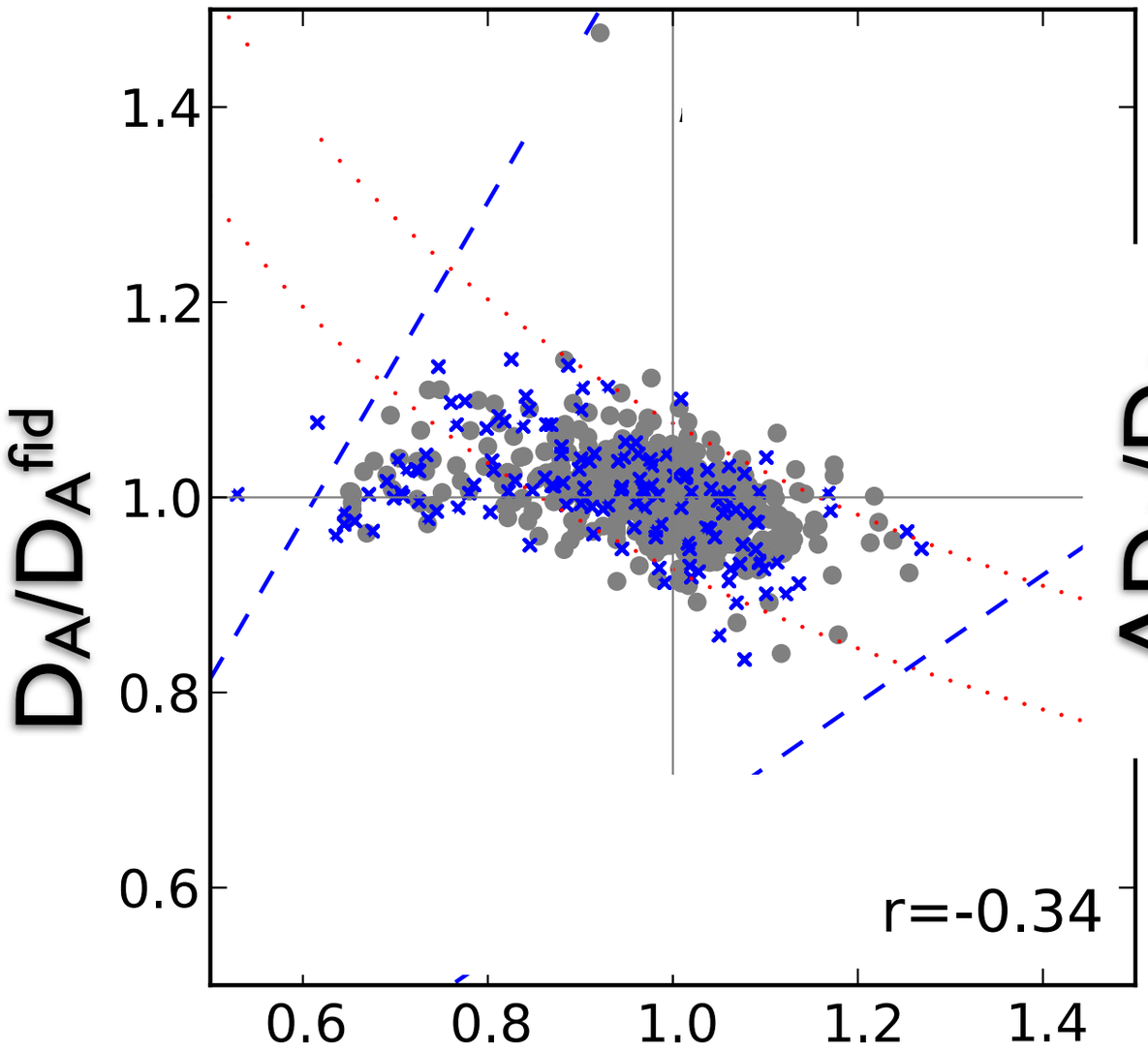
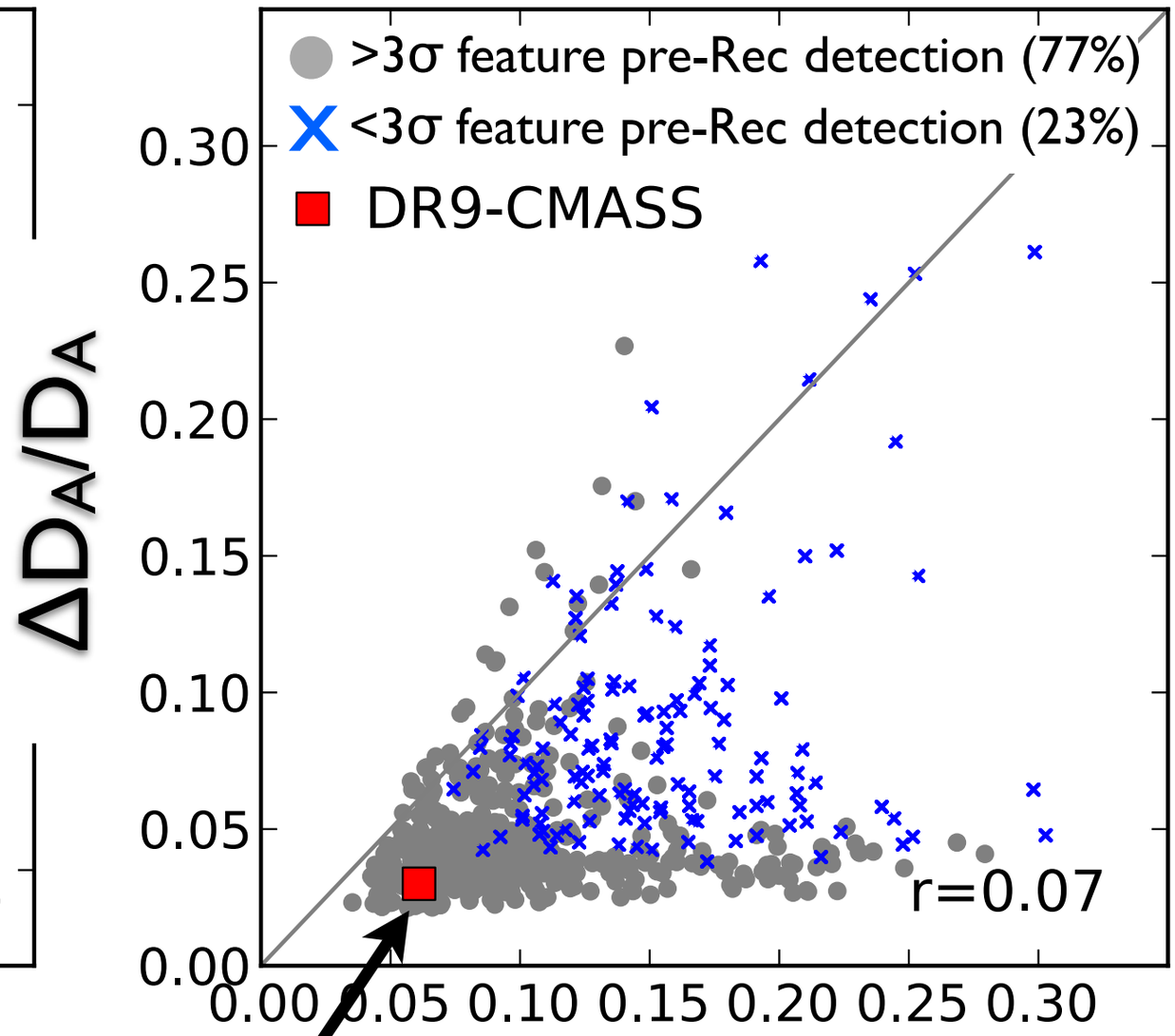
DR9 $H(z), D_A(z)$ expectations pre -Rec from mock catalogs

Testing for bias



Constraining power



Our result

Kazin, Sánchez & the SDSS (arXiv 1303.4391)

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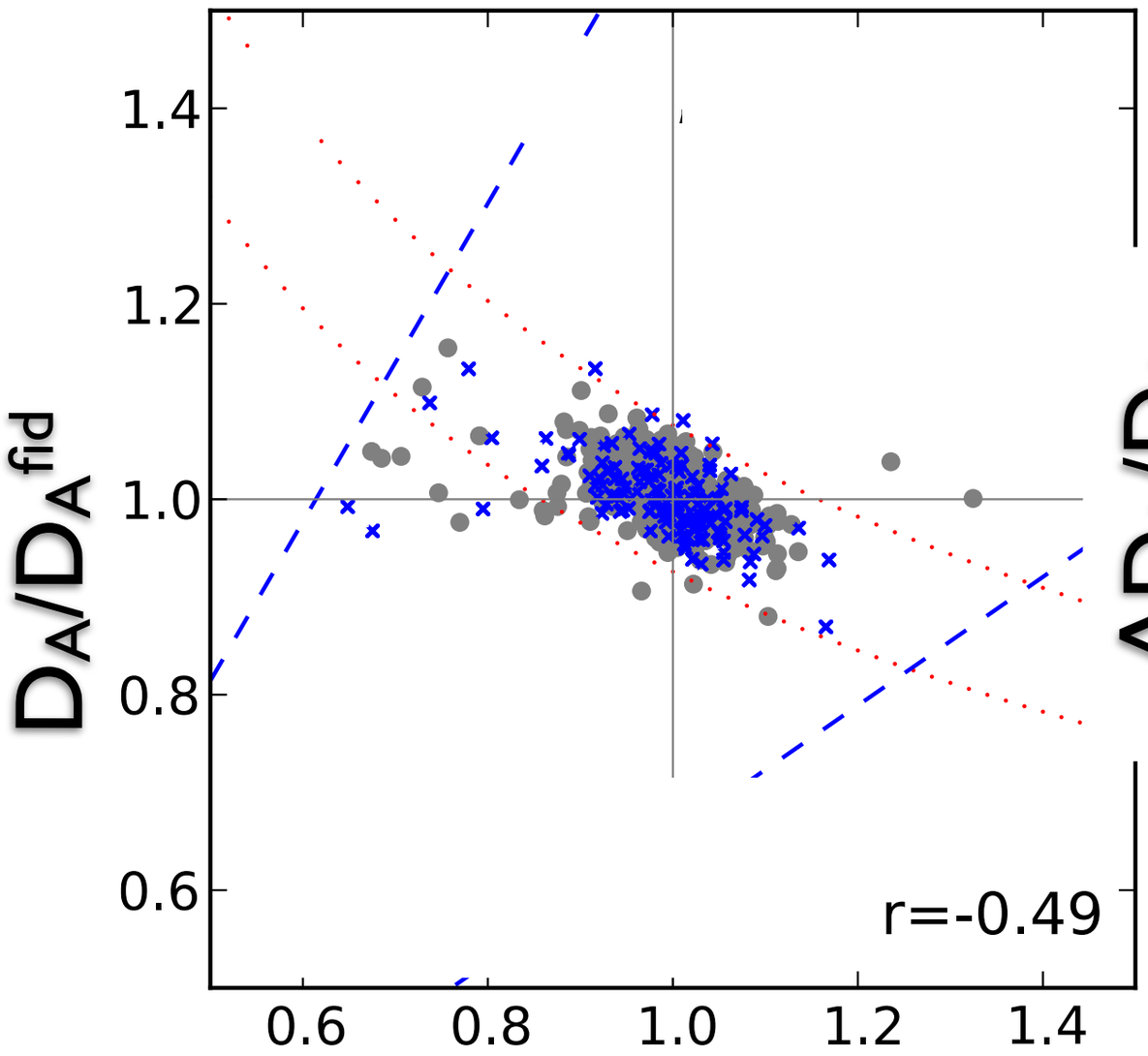

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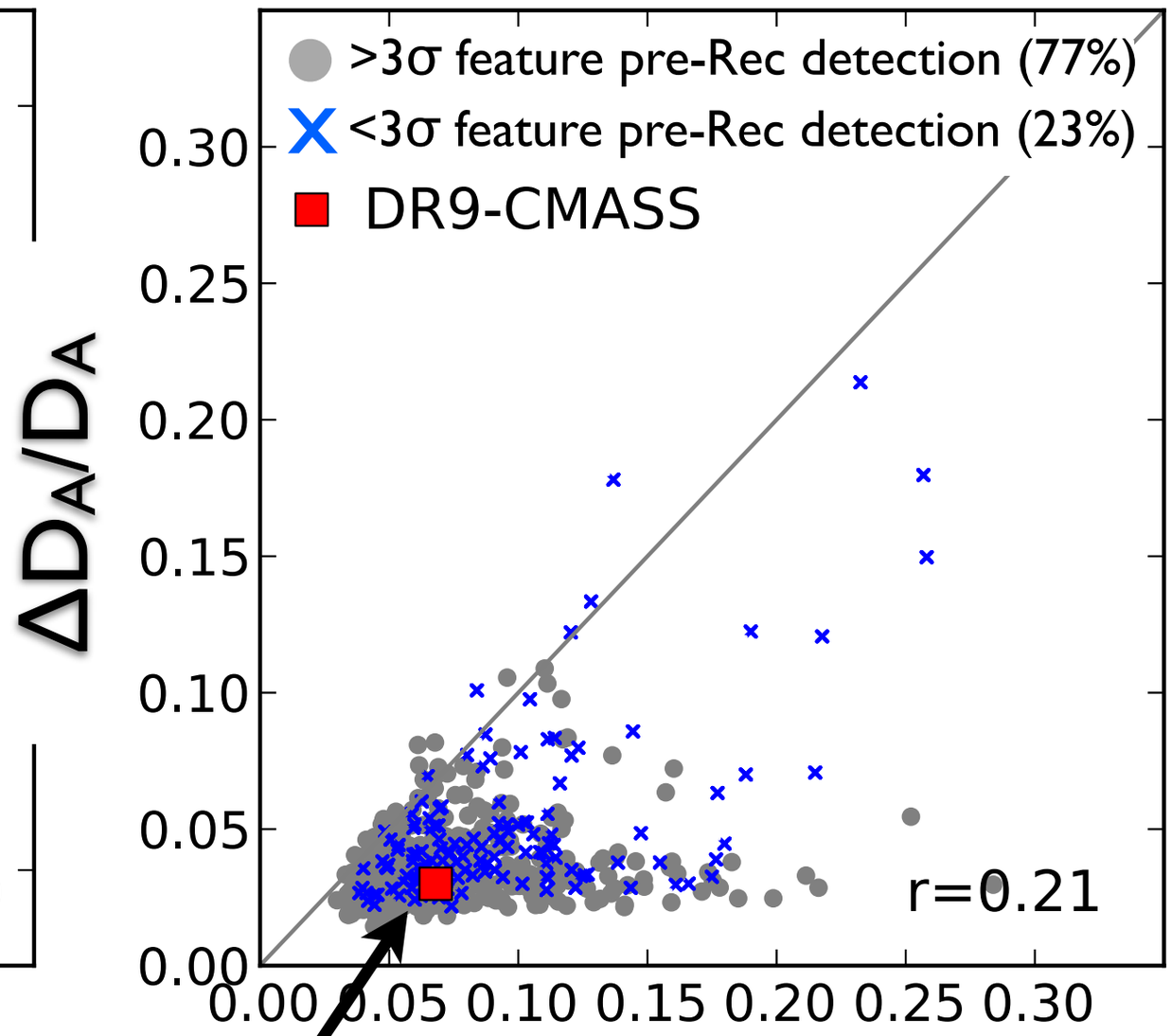


Our result

On average, reconstruction improves constraints by 30%

Kazin, Sánchez & th

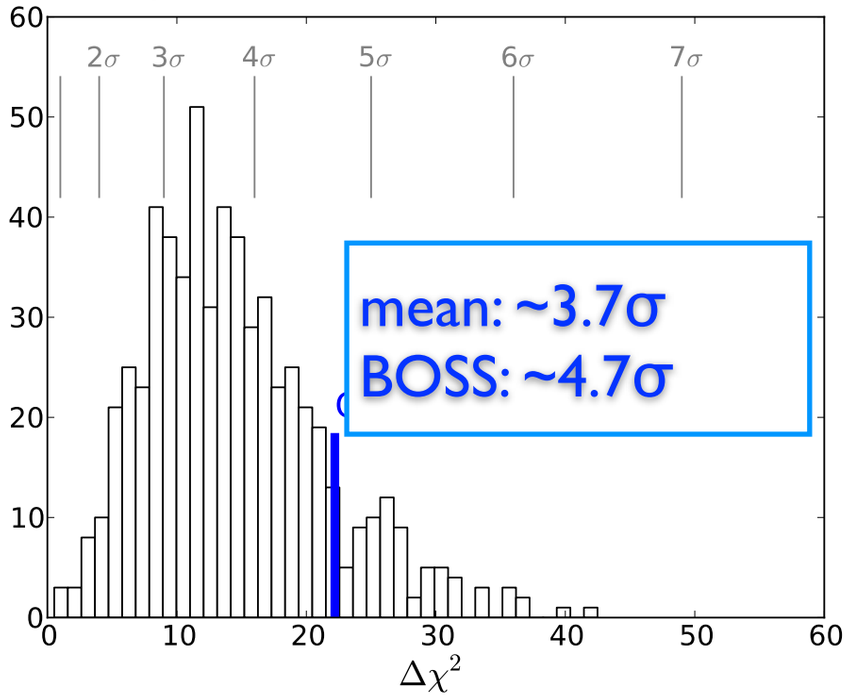
SWIN

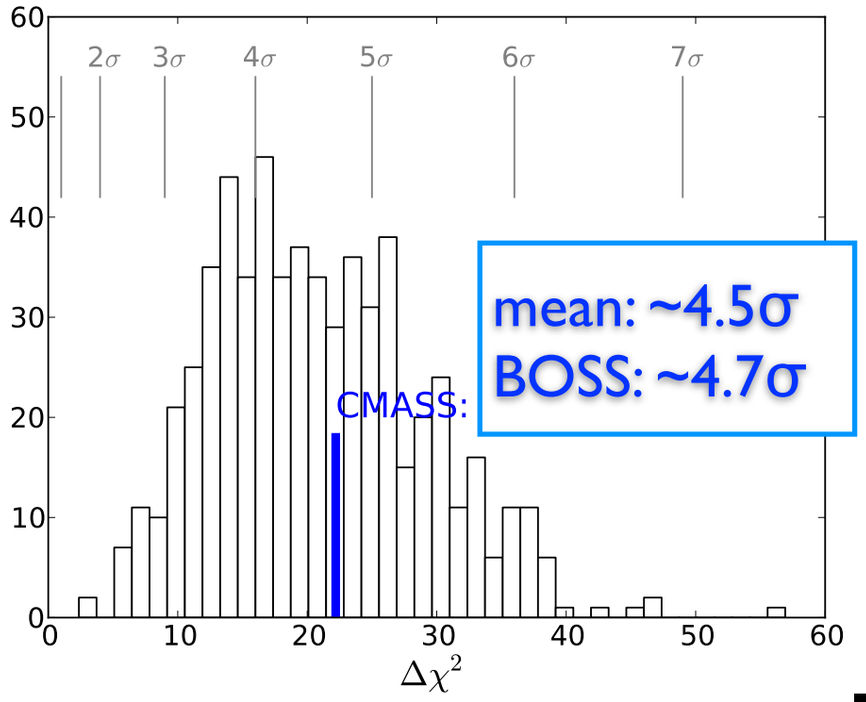
BOSS BA Feature: Significance of Detection 4.7σ

BOSS compared with 600 mock realizations

before reconstruction	after reconstruction

Kazin, Sánchez & SDSS (arXiv 1303.4391)





Summary

Take aways:

- The **BOSS** DR9 anisotropic baryonic acoustic feature has been **detected at a significance of 4.7σ** (* compared to a no feature model).
- Information from the anisotropic baryonic acoustic feature yields **tighter** cosmological **constraints** than the angle averaged.
- On average, reconstruction improves $H(z)$, $D_A(z)$ constraints by 30%.
- **Reconstruction** appears to work on **WiggleZ**, and should substantially **improve distance constraints**.
- Beutler, Blake et al. (in prep): **BOSS and WiggleZ may be treated independently** in cosmo constraint analysis (due to small overlap)