The Clustering of the SDSS Main Galaxy Sample: BAO and RSD measurements at z=0.15

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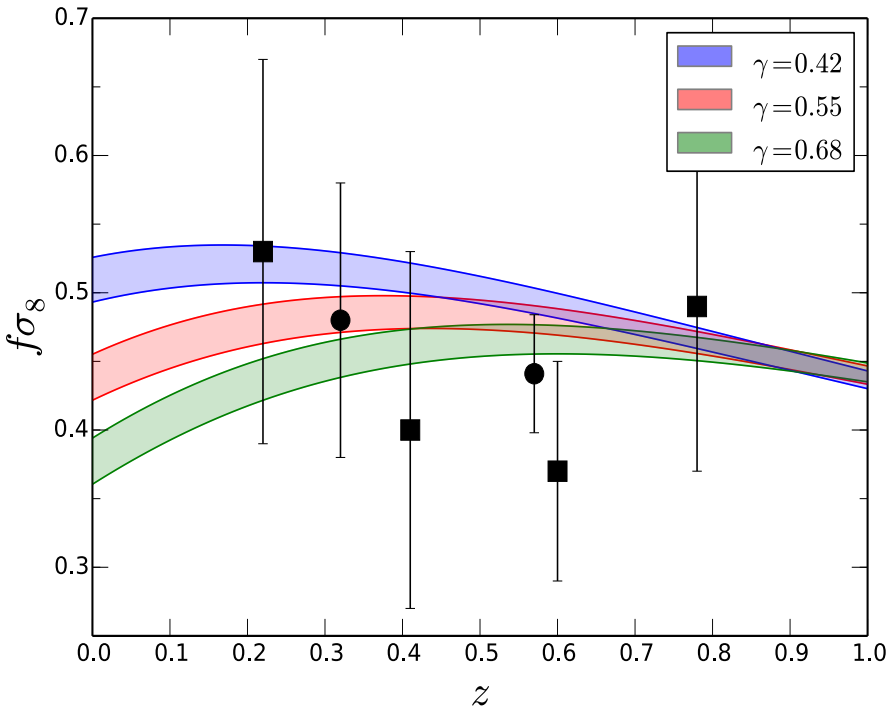
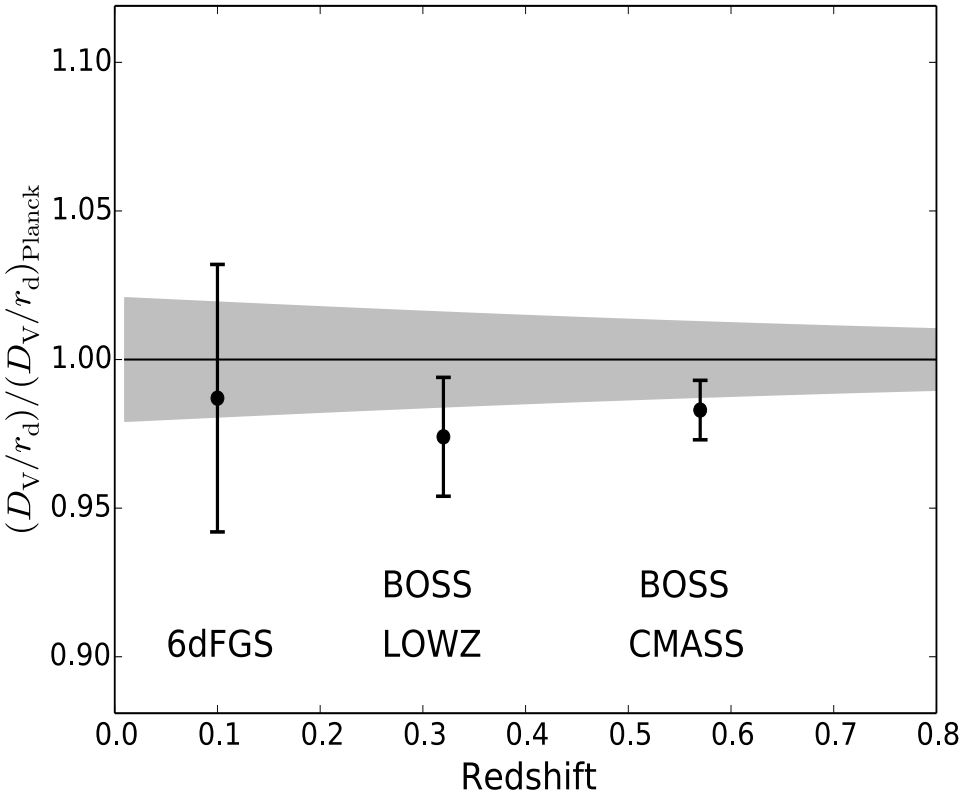
Motivation

Low redshift measurements have the greatest relative constraining power.





We can use the lessons learned in the last decade to improve analysis.

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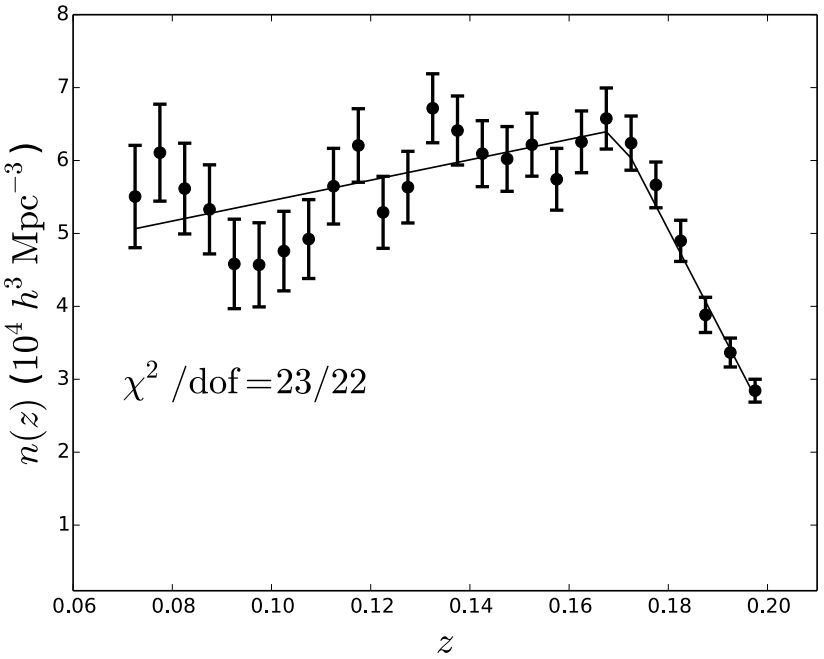
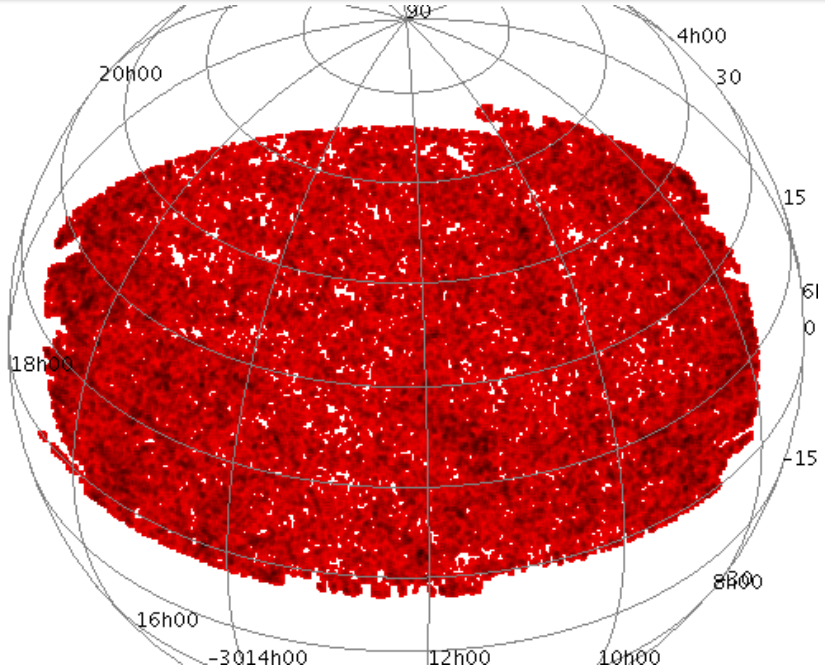
Sample

- Absolute Magnitude-limited, M_{ab}< 21.2, sample cut from SDSS DR7.
- Color cut to g-r > 0.8. Keep bright, red galaxies in massive halos.
- Overall, 0.07 <= z <= 0.2, with an effective redshift of 0.15.
- 63,163 galaxies with bias b ~= 1.5





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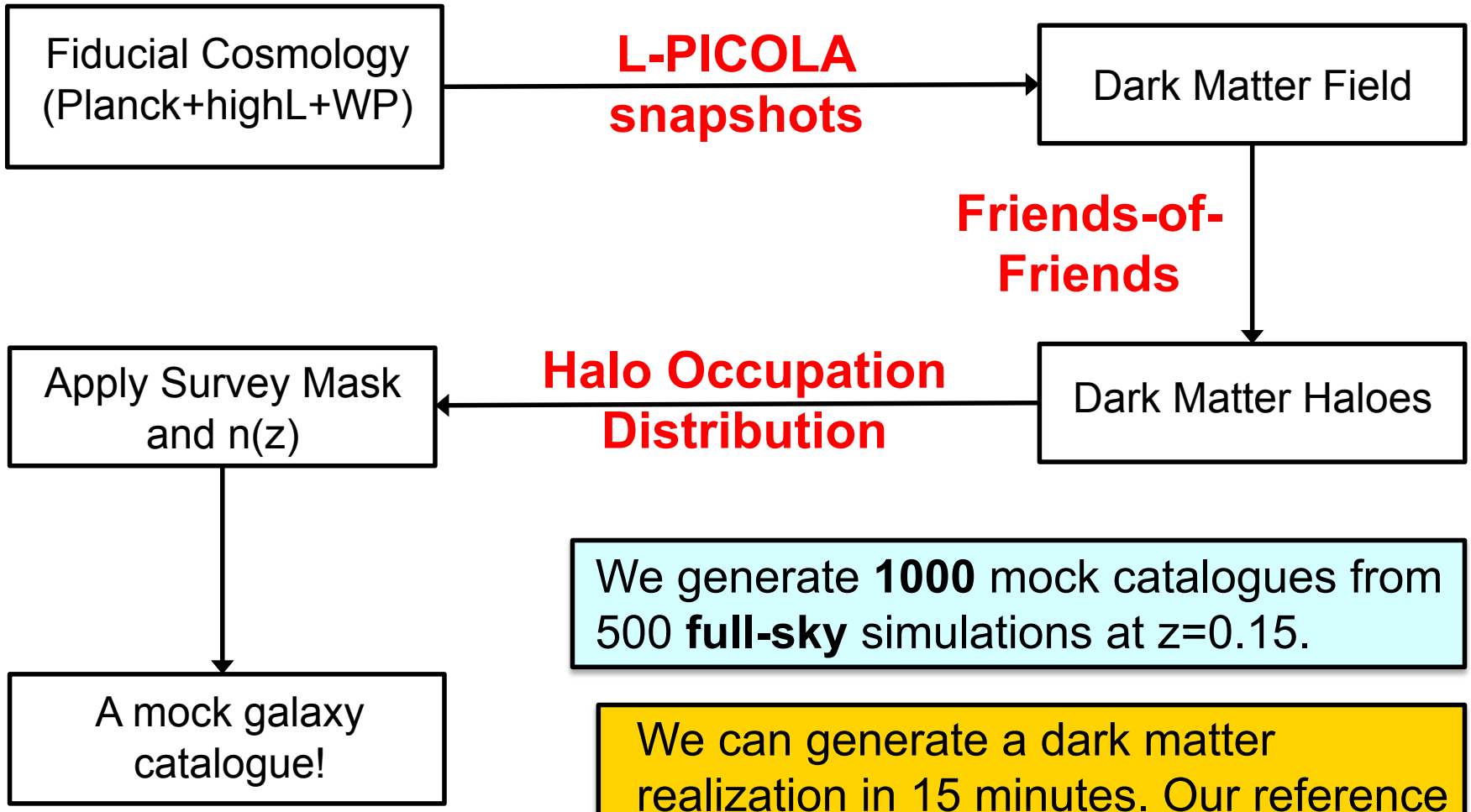
Simulations



We generate **1000** mock catalogues from 500 **full-sky** simulations at z=0.15.

We can generate a dark matter realization in 15 minutes. Our reference GADGET-2 run took 3 days.

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L-PICOLA

Fast, accurate, parallel, COLA (Tassev et. al., 2013) based code to generate dark matter simulations.

COLA position and velocity operators

$$v_{i+1/2} = v_{i-1/2} + \left(F(a_i) + Q(a_i)\frac{d^2 D_1}{da^2}\Psi^{(1)} + Q(a_i)\frac{d^2 D_2}{da^2}\Psi^{(2)} \right) \int_{a_{i-1/2}}^{a_{i+1/2}} \frac{da'}{Q(a')}$$

$$r_{i+1} = r_i + v_{i+1/2} \int_{a_i}^{a_{i+1}} \frac{da'}{a' Q(a')} + (D_i(a_{i+1}) - D_1(a_i))\Psi^{(1)} + (D_2(a_{i+1}) - D_2(a_i))\Psi^{(2)}$$

- Stand-alone, easy-to-use code with built in IC generator.
  - Primordial Non-Gaussianity.
- Lightcone simulations on-the-fly.
- Very memory efficient.
- Publically available on GitHub.

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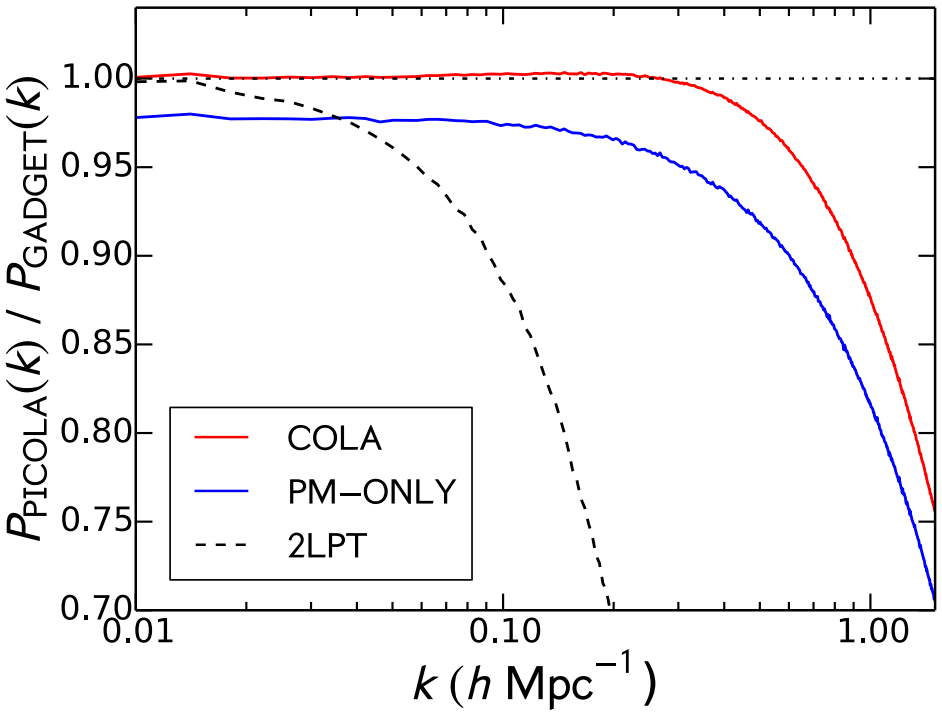
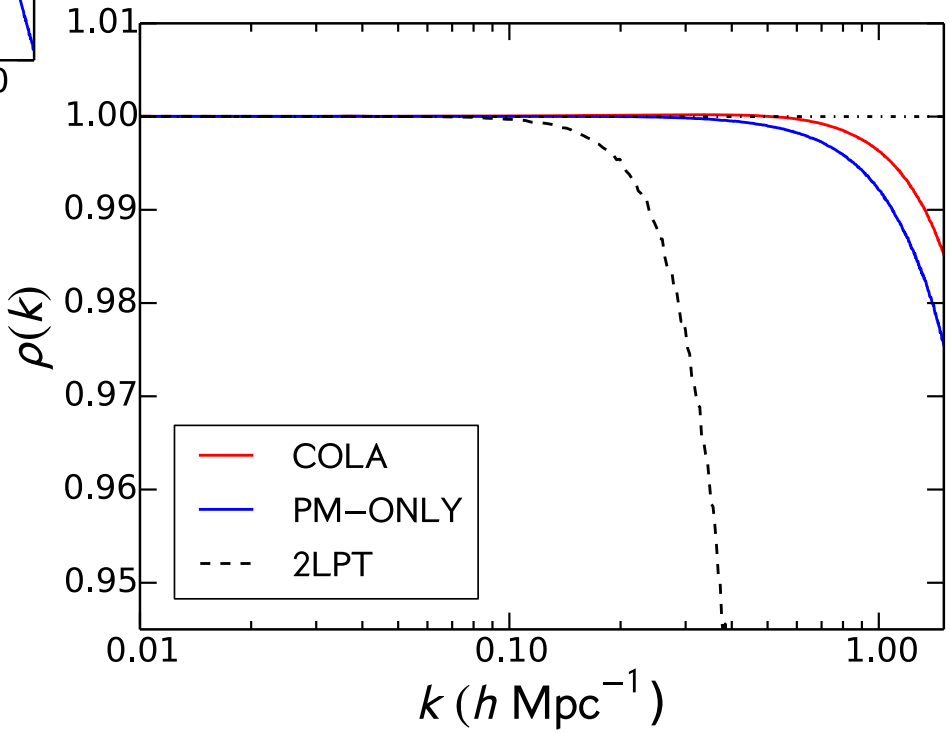


Recovers power spectrum to 2% on scales of interest to BAO and RSD measurements.

High cross-correlation ->
Very accurate covariance matrix



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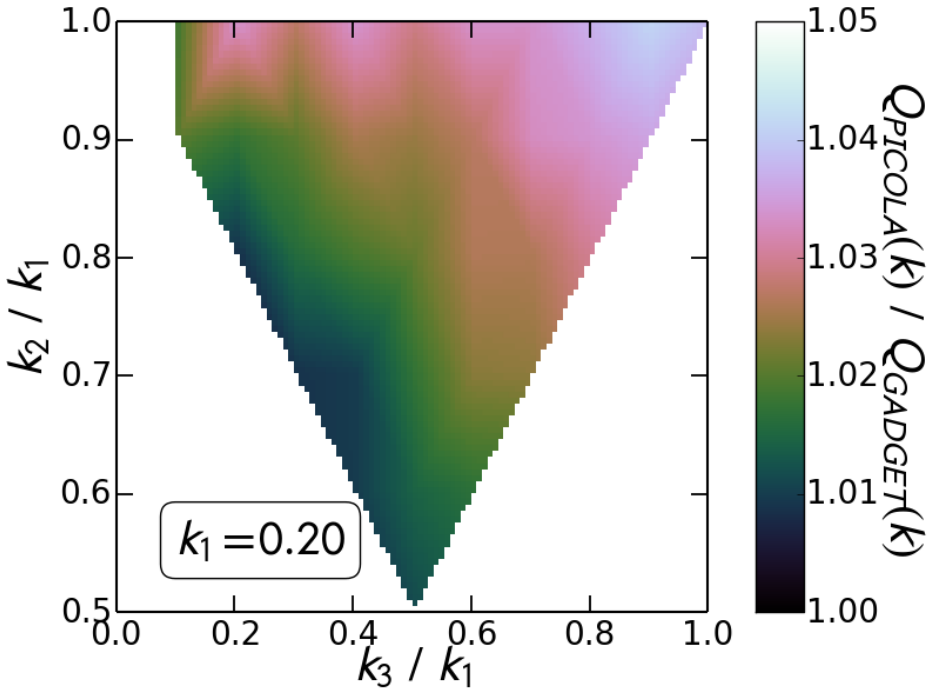
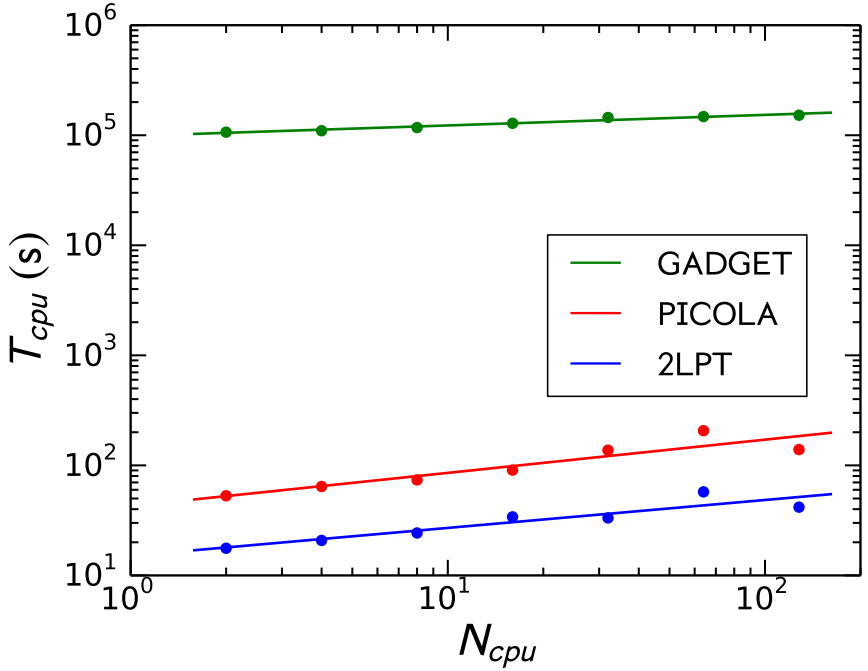
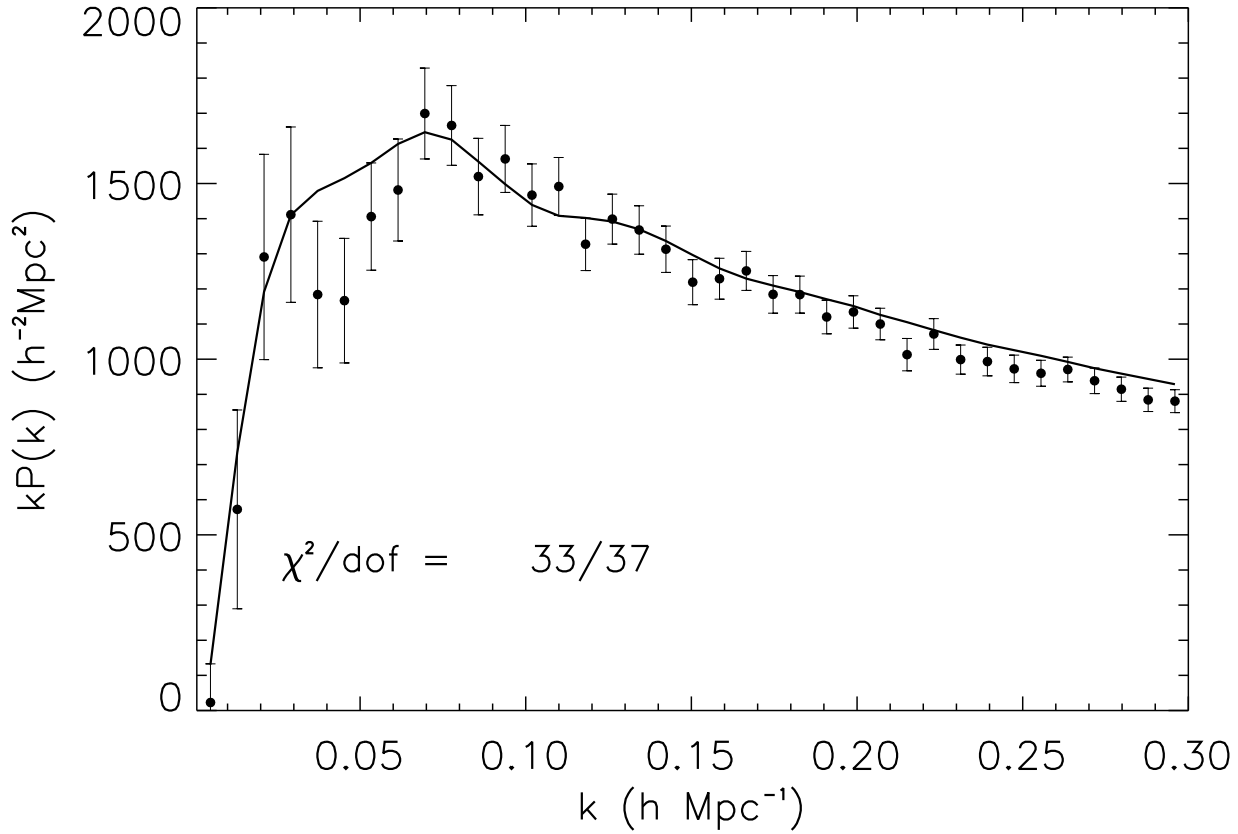




Also being used for DES:

- Lightcone simulations to z=1.4 for 1/4 of the sky, with ~12 x 68,000,000,000 particles.
- Takes less than an hour on 1024 processors.

MGS Clustering Measurements



We obtain good clustering measurements even with only ~63000 galaxies

Covariance is estimated using our 1000 mock catalogues

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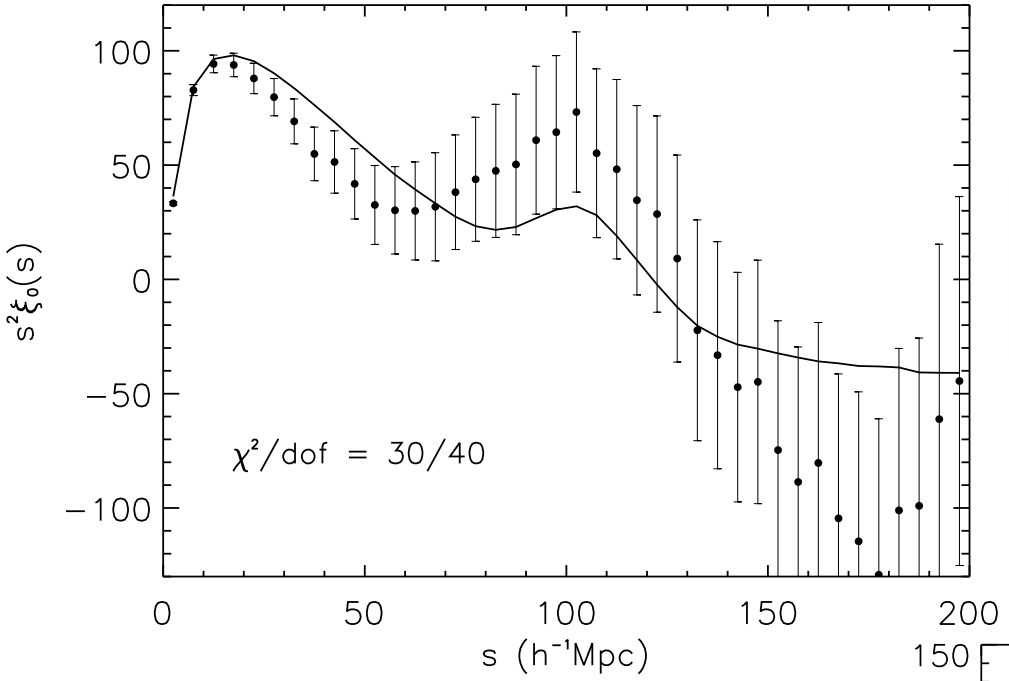
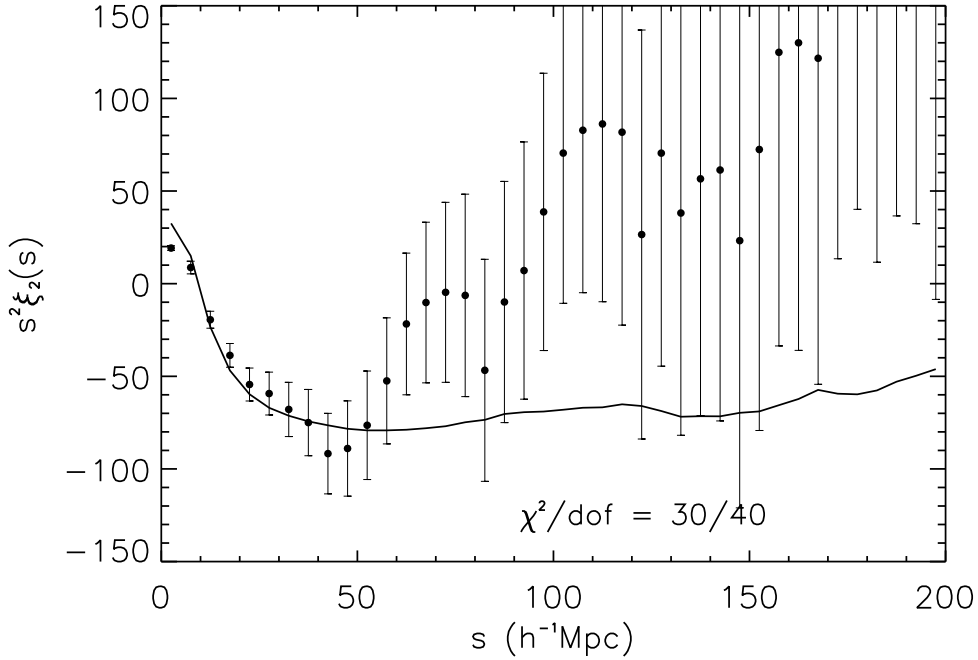


Good fit between mocks and data even for s=10Mpc/h



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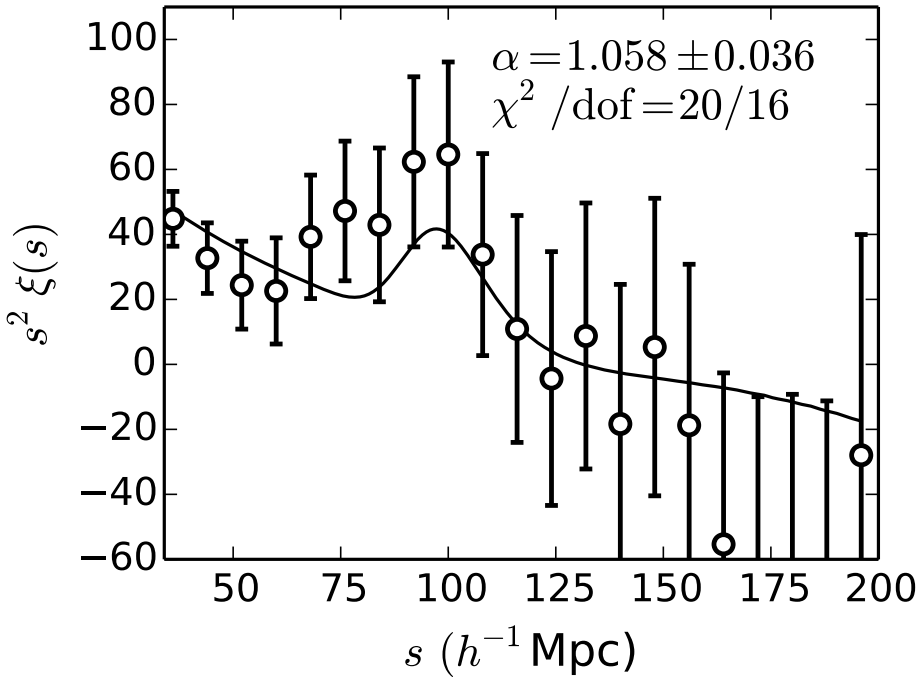
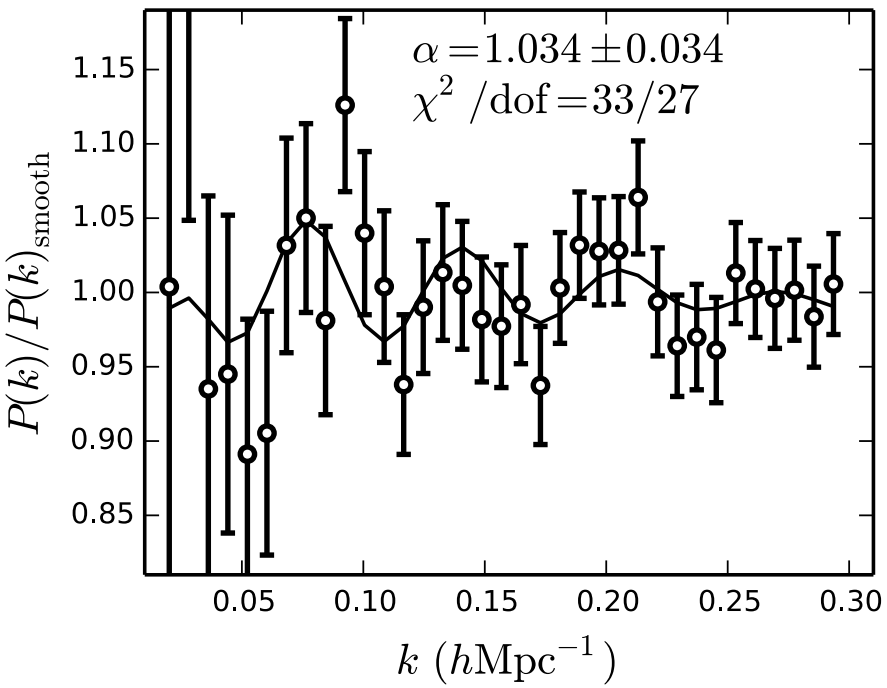
Post-Recon BAO measurements

- Reconstruction and latest BOSS techniques used to fit clustering.
- Huge improvement in accuracy post-recon, factor of ~2.5.
- Completely robust to fitting methodology.





Consensus:

$$\alpha = 1.040 \pm 0.037$$

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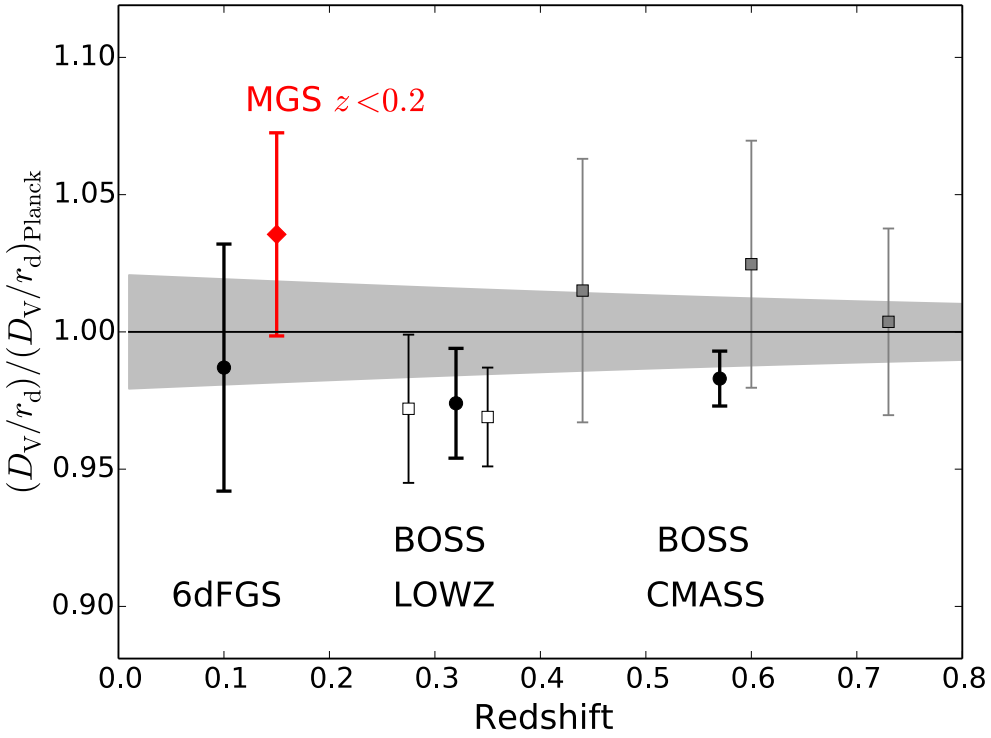
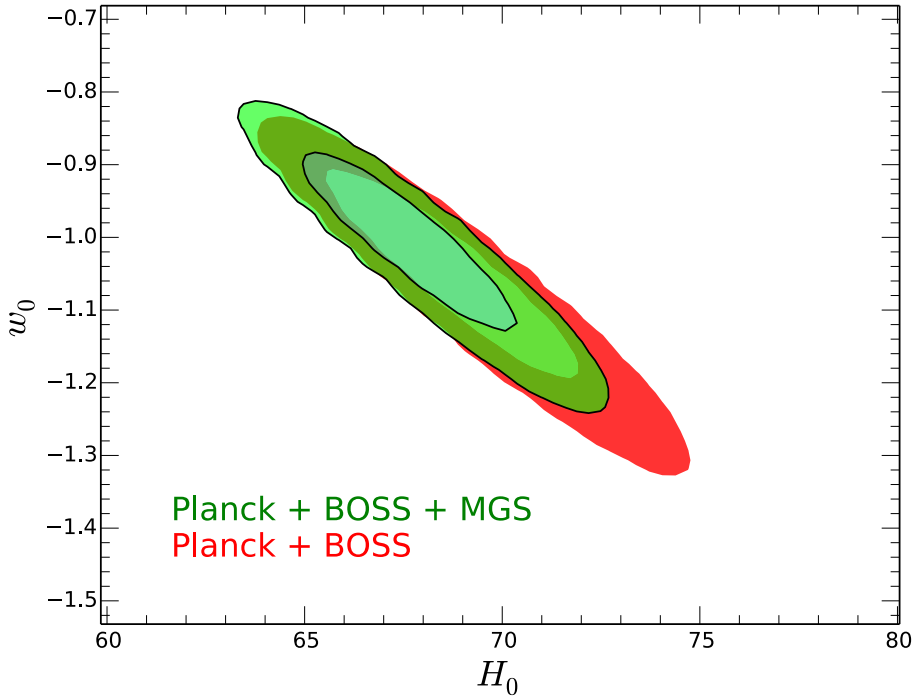
Cosmological Implications



Our data prefers a lower value of H_0

15% improvement on w_0 compared to Planck+BOSS



Planck+BOSS:

$$\omega_0 = -1.064 \pm 0.101$$

Planck+BOSS+**MGS**:

$$\omega_0 = -1.013 \pm 0.086$$

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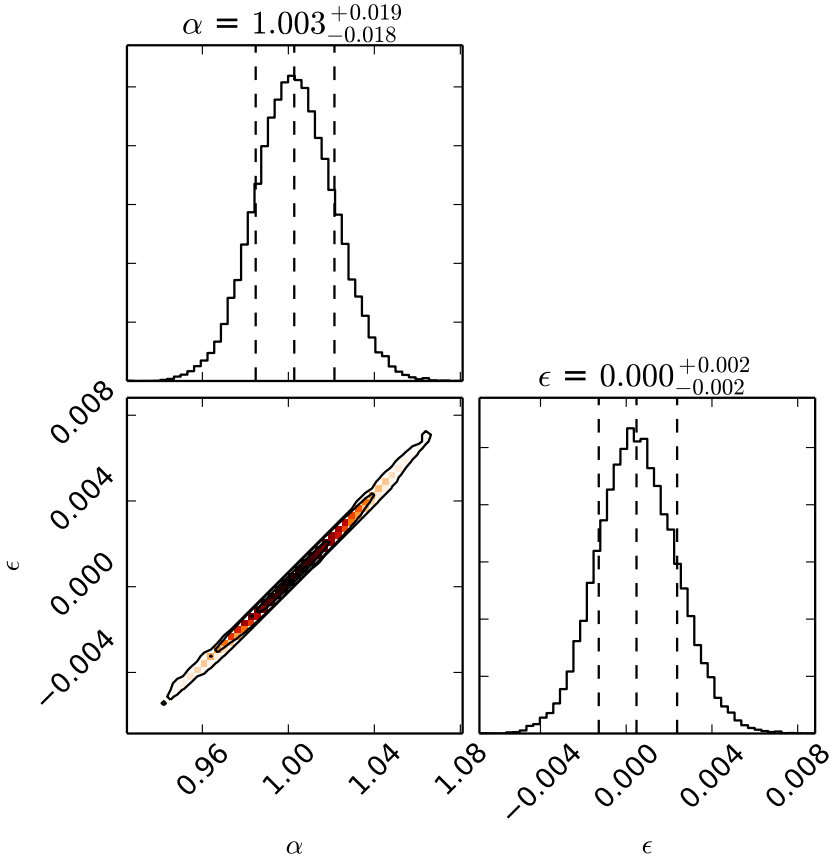
RSD measurements

We use full shape fitting of the redshift-space monopole and quadropole using the Convolution LPT and Gaussian Streaming Model of Wang et. al., 2013.

Measurements robust to changes in fitting method.



We also look at effect of fixing scaling parameters α, ε:

- Fixing α not supported by Planck! Small effect on $f\sigma_8$ constraints.
- Fixing ε is only supported if we assume ΛCDM. Larger effect on $f\sigma_8$

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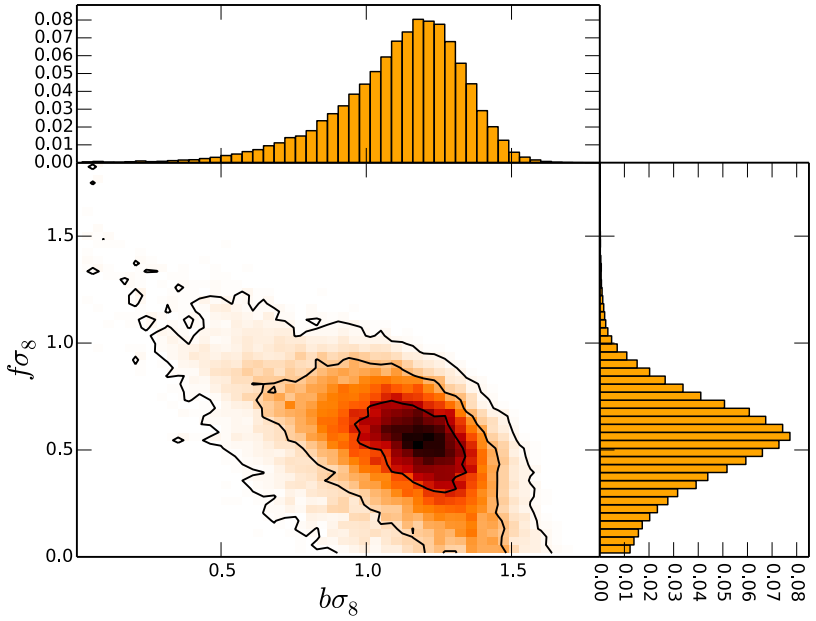
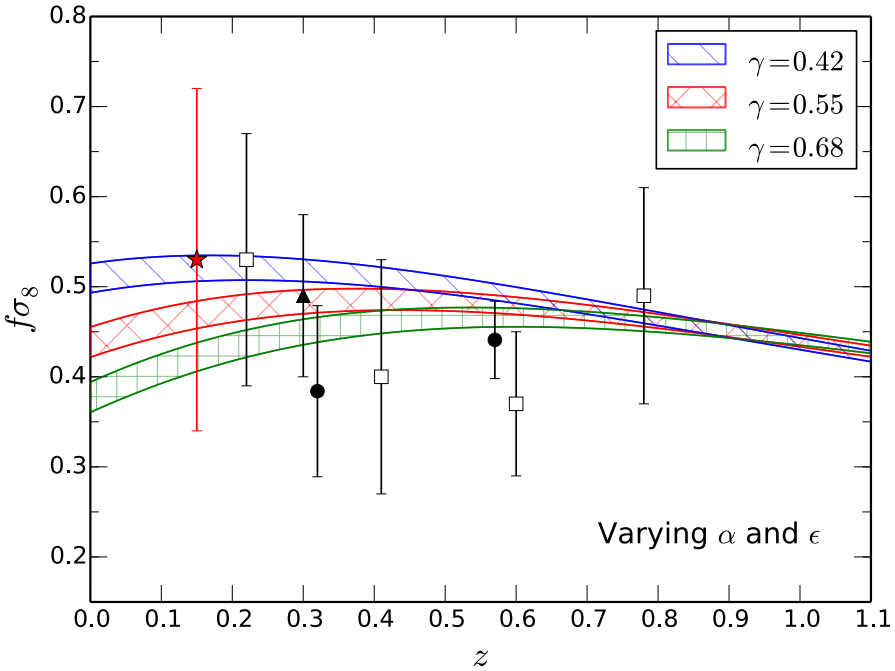


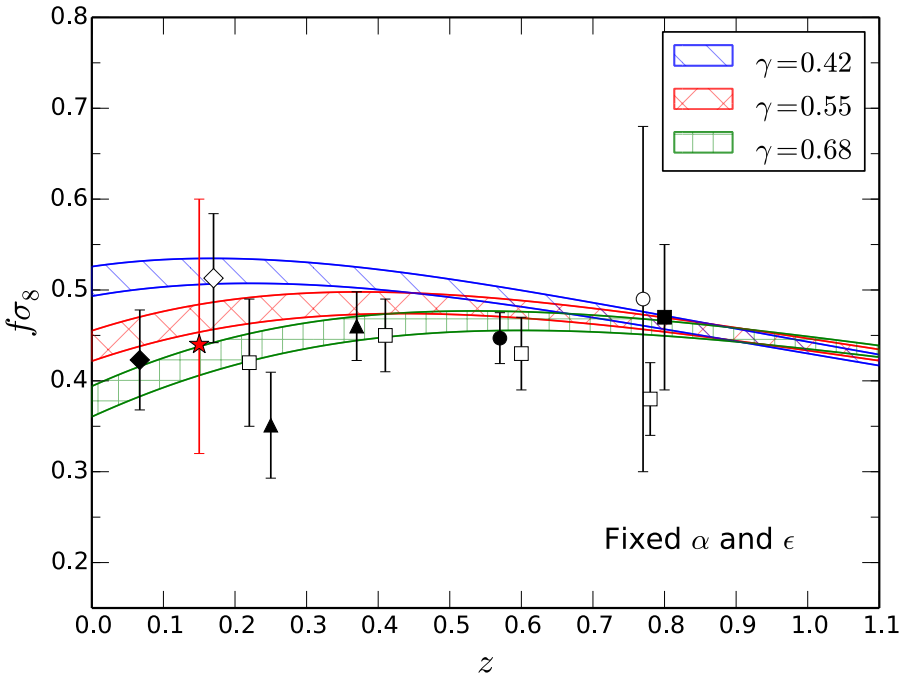
Fixed ε

$$f\sigma_8 = 0.49^{+0.15}_{-0.14}$$

Varying ε

$$f\sigma_8 = 0.53^{+0.19}_{-0.19}$$





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Conclusions

- We present a new, low-redshift sample of 63,163 SDSS-II galaxies
- Independent, sub 4% measurement of BAO scale at z=0.15 using latest techniques
- Independent RSD measurements using full-fits to the clustering at z=0.15
- Made possible by 1000 high accuracy L- PICOLA mock catalogues

For more info on MGS: ***Ross et. al., 2015: 1409.3242***
Howlett et. al., 2015a: 1409.3238

More info on L-PICOLA: ***Howlett et. al., 2015b: 1506.03737***

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