Galaxy Clustering + Galaxy-Galaxy Lensing

Youngsoo Park for the TCP WG

With contributions from WL + LSS + Sim WG's

DES Chicagoland Meeting, December 9th 2004

The Idea

- How does Dark Energy affect growth of structure?

- How do we investigate that with DES?

The Idea

- How does Dark Energy affect growth of structure?
  - Distinct histories: LCDM, wCDM, Modified Gravity, ...
- How do we investigate that with DES?
  - Galaxy positions and shapes

The Idea

- How does Dark Energy affect growth of structure?
  - Distinct histories: LCDM, wCDM, Modified Gravity, ...
- How do we investigate that with DES?
  - Galaxy positions and shapes
- Anatomy of the clustering observable

$$w(\theta) \rightarrow P_{gg}(k,z) \rightarrow b_g^2 \cdot D^2(z) \cdot A_s \cdot k^n T^2(k)$$

The Idea

- How does Dark Energy affect growth of structure?
  - Distinct histories: LCDM, wCDM, Modified Gravity, ...
- How do we investigate that with DES?
  - Galaxy positions and shapes
- Anatomy of the clustering observable

$$w(\theta) \rightarrow P_{gg}(k,z) \rightarrow \boxed{b_g^2} \cdot \boxed{D^2(z)} \cdot \boxed{A_s} \cdot k^n T^2(k)$$

The Idea

- How does Dark Energy affect growth of structure?
  - Distinct histories: LCDM, wCDM, Modified Gravity, ...
- How do we investigate that with DES?
  - Galaxy positions and shapes
- Anatomy of the clustering observable

$$w(\theta) \rightarrow P_{gg}(k,z) \rightarrow \boxed{b_g^2} \cdot \boxed{D^2(z)} \cdot \boxed{A_s} \cdot k^n T^2(k)$$

Galaxy Bias Growth History Initial Condition

The Idea

- How does Dark Energy affect growth of structure?
  - Distinct histories: LCDM, wCDM, Modified Gravity, ...
- How do we investigate that with DES?
  - Galaxy positions and shapes
- Anatomy of the clustering observable

$$w(\theta) \rightarrow P_{gg}(k,z) \rightarrow b_g^2 \cdot D^2(z) \cdot A_s \cdot k^n T^2(k)$$

Galaxy-Galaxy Lensing

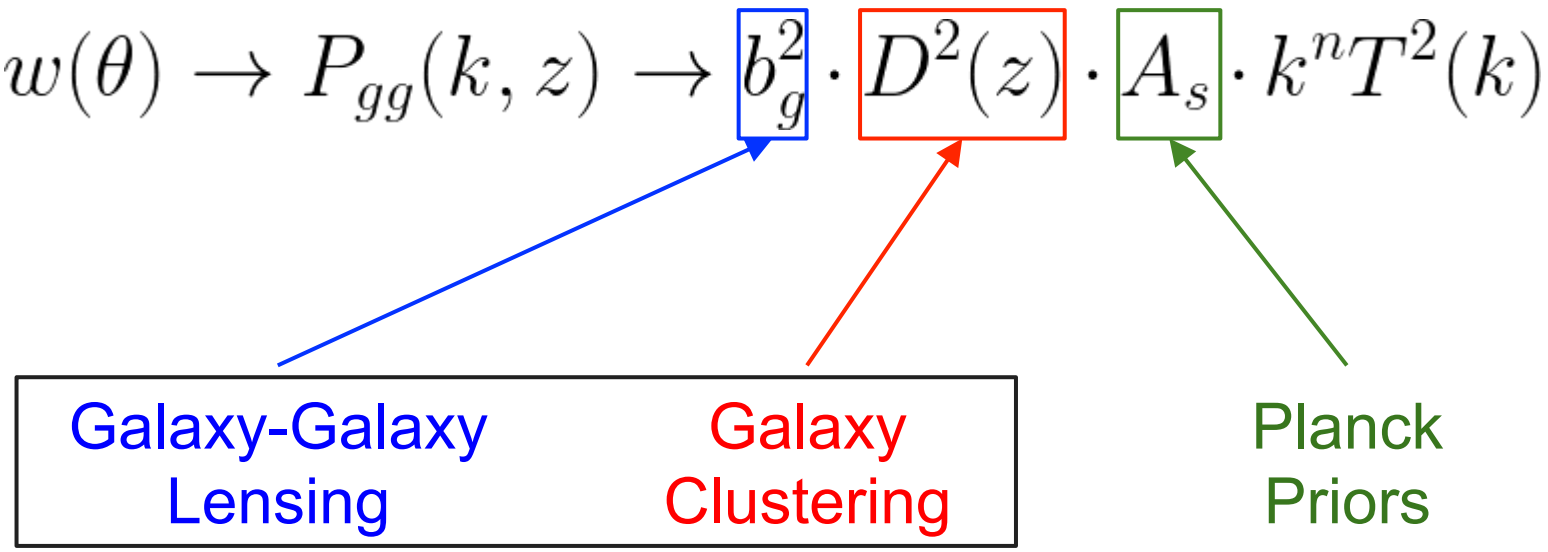
Galaxy Clustering

Planck Priors

The Idea

- How does Dark Energy affect growth of structure?
  - Distinct histories: LCDM, wCDM, Modified Gravity, ...
- How do we investigate that with DES?
  - Galaxy positions and shapes
- Anatomy of the clustering observable

$$w(\theta) \rightarrow P_{gg}(k,z) \rightarrow b_g^2 \cdot D^2(z) \cdot A_s \cdot k^n T^2(k)$$



Modeling Details

- Lensing: NFW gamma + satellites as off-centered NFW
- Clustering: Linear P(k) with linear Tinker bias
- Shared Systematics
  - Halo mass function + HOD for a threshold sample

$$\frac{1}{2}\left[1+\mathrm{erf}\left(\frac{\log M_\mathrm{h}-\log M^\mathrm{t}_\mathrm{min}}{\sigma^\mathrm{t}_{\log M}}\right)\right]\left[1+\left(\frac{M_\mathrm{h}}{M^\mathrm{t}_1}\right)^{\alpha_t}\right]$$

  - Gaussian photo-z scatter for lenses and sources

$$p(z_\mathrm{ph}|z)=\frac{1}{\sqrt{2\pi}\sigma_z}\exp\left[-\frac{(z-z_\mathrm{ph}-z_\mathrm{bias})^2}{2\sigma_z^2}\right]$$

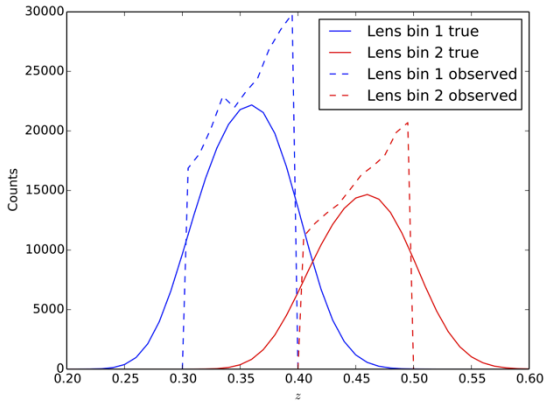
  - Multiplicative/additive shear calibration

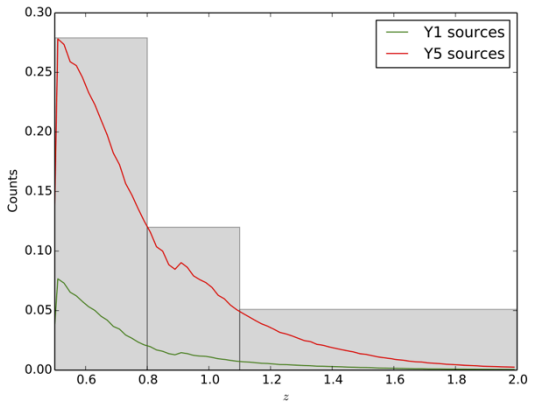
- Growth scaling parameters

$$\tilde{D}^2(z)=A_i D^2(z)$$

Mock BCC Catalogs

- Down-sampled BCC Aardvark catalogs
  - Y1: 1000 deg^2, $m_r < 23.0$
  - Y5: 5000 deg^2, $m_r < 23.5$
- Lens bins
  - $0.3 < z < 0.4$, $M_r < -21.5$
  - $0.4 < z < 0.5$, $M_r < -21.0$
  - Universal for Y1 and Y5
- Source bins
  - $0.5 < z < 0.8$
  - $0.8 < z < 1.1$
  - $1.1 < z < 2.0$



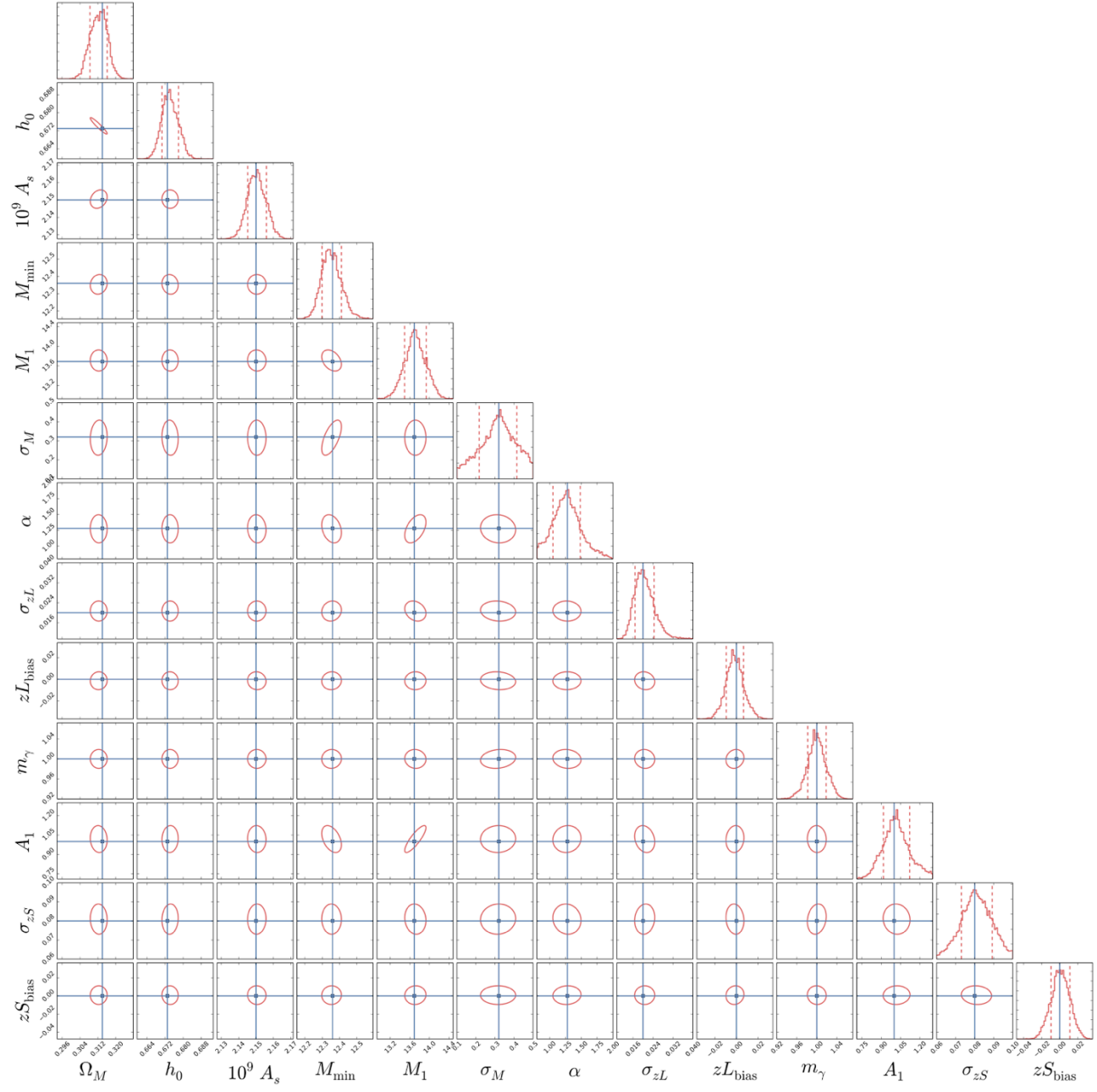


Likelihood Analysis

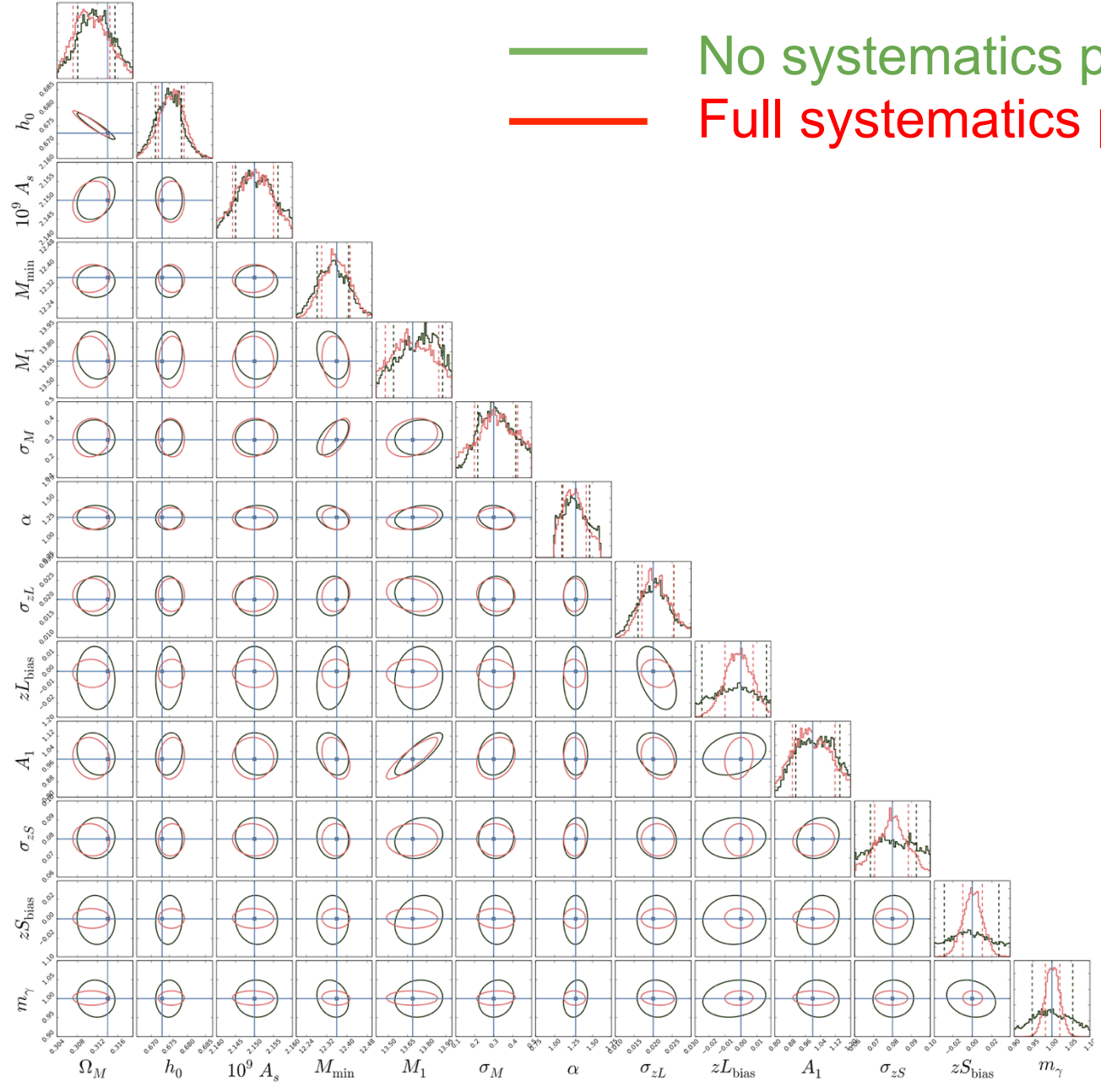
- Parameter Space

Cosmology	Ω_M, h_0, A_s	3
HOD	M_{min}, M_1, σ_M, α	4 X 2
Lens Photo−z	σ_{zL}, b_{zL}	2 X 2
Growth scaling	A_i	1 X 2
Source Photo-z	σ_{zS}, b_{zS}	2
Shear Calib.	m, b	2

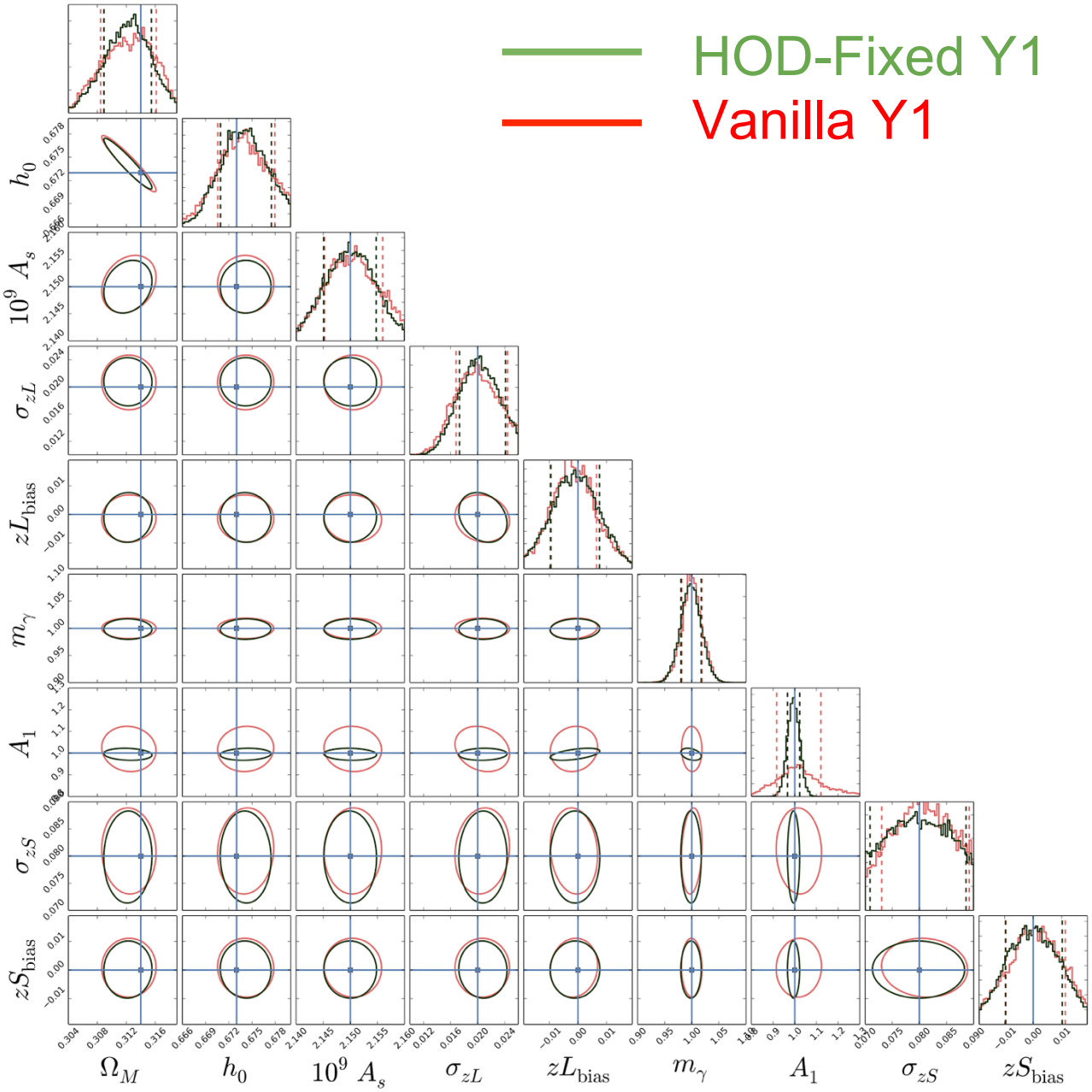
- Priors: Planck, Gaussian priors for systematics
- Simulated data, full joint covariance matrix from BCC



Full Y1 Forecasts



Impact of Systematics on Y1 Forecasts



Impact of HOD on Y1 Forecasts

Summary of Constraints

	Y1 w/o Systematics Priors	Full Y1	Y1 w/ Fixed HOD
Ω_M	±1.20%	±1.17%	±1.07%
h_0	±0.54%	±0.53%	±0.49%
A_s	±0.26%	±0.25%	±0.23%
M_{min}	±0.51%	±0.45%	.
M_1	±1.38%	±1.48%	.
σ_M	±29.6%	±32.5%	.
α	±12.5%	±11.4%	.
σ_{zL}	±24.7%	±20.5%	±17.1%
b_{zL}	±0.020	±0.0089	±0.0087
σ_{zS}	±13.4%	±10.6%	±10.6%
b_{zS}	±0.025	±0.010	±0.010
m	±4.88%	±1.89%	±1.89%
A_1	±10.9%	±10.9%	±2.81%

Conclusions and Lessons

- **We can constrain history of structure growth!**
  - **Y1: P(k,z) at 10% (D(z) at 4.9%)**
- Certain priors play important roles
  - Constraining power + *degeneracy breaking*
  - Planck priors on A_s
  - HOD Priors will have big impact
  - A_i is remarkably robust with respect to many systematics
- Near future goals
  - In full production mode, draft to internal readers by mid-Dec.
  - Attack SV data soon

Thank you!