Combined Probes Analysis Strategies for the Precision Cosmology era

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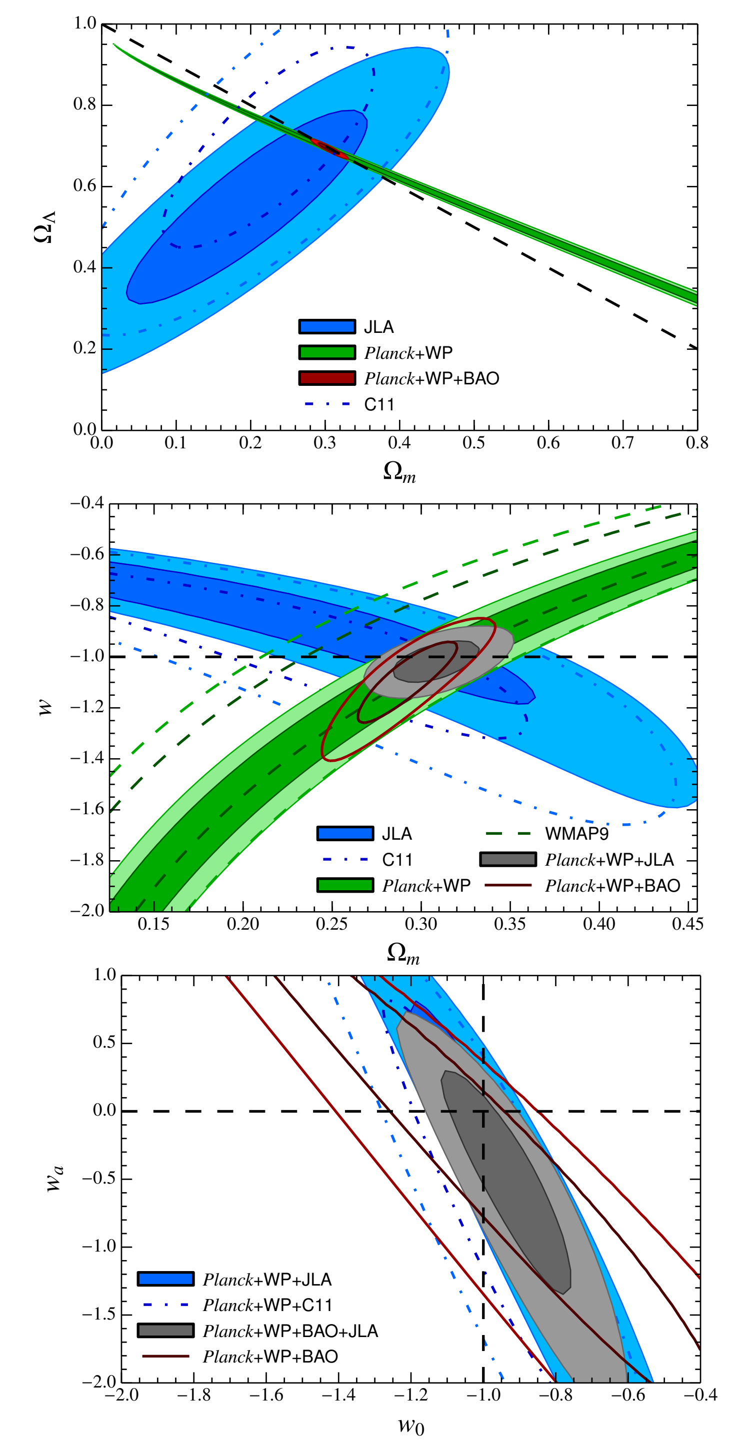
The Power of Combining Probes

- Best constraints obtained by combining cosmological probes
  - independent probes: multiply likelihoods
- Combining probes from same survey requires more advanced strategies
  - clustering, clusters and WL probe same underlying density field, are correlated
  - correlated systematic effects



Betoule et al. 2014

Joint Analysis Ingredients

Science Case

parameters of interest
which science?

large data vector
which probes + scales?

Likelihood Function

number counts: Poisson

2PCF: ~ Gaussian (?)

improvements needed for stage IV

Model Data Vector

self-consistent modeling of all observables

including all cosmology + nuisance parameters

Joint Covariance

large and complicated, non-(block) diagonal matrix

use template + regularization

$$p(\boldsymbol{\pi}|\hat{\mathbf{d}}) \propto p(\boldsymbol{\pi}) \int \mathcal{L}\left(\hat{\mathbf{d}}|\mathbf{d}(\boldsymbol{\pi},\mathbf{n}),\mathcal{C}\right) p(\mathbf{n})\, \mathrm{d}^n\mathbf{n}$$

Cosmology Priors

Nuisance Parameters

systematic effects
$|\mathbf{n}| \gg |\boldsymbol{\pi}|$
parameterize + prioritize!

Priors

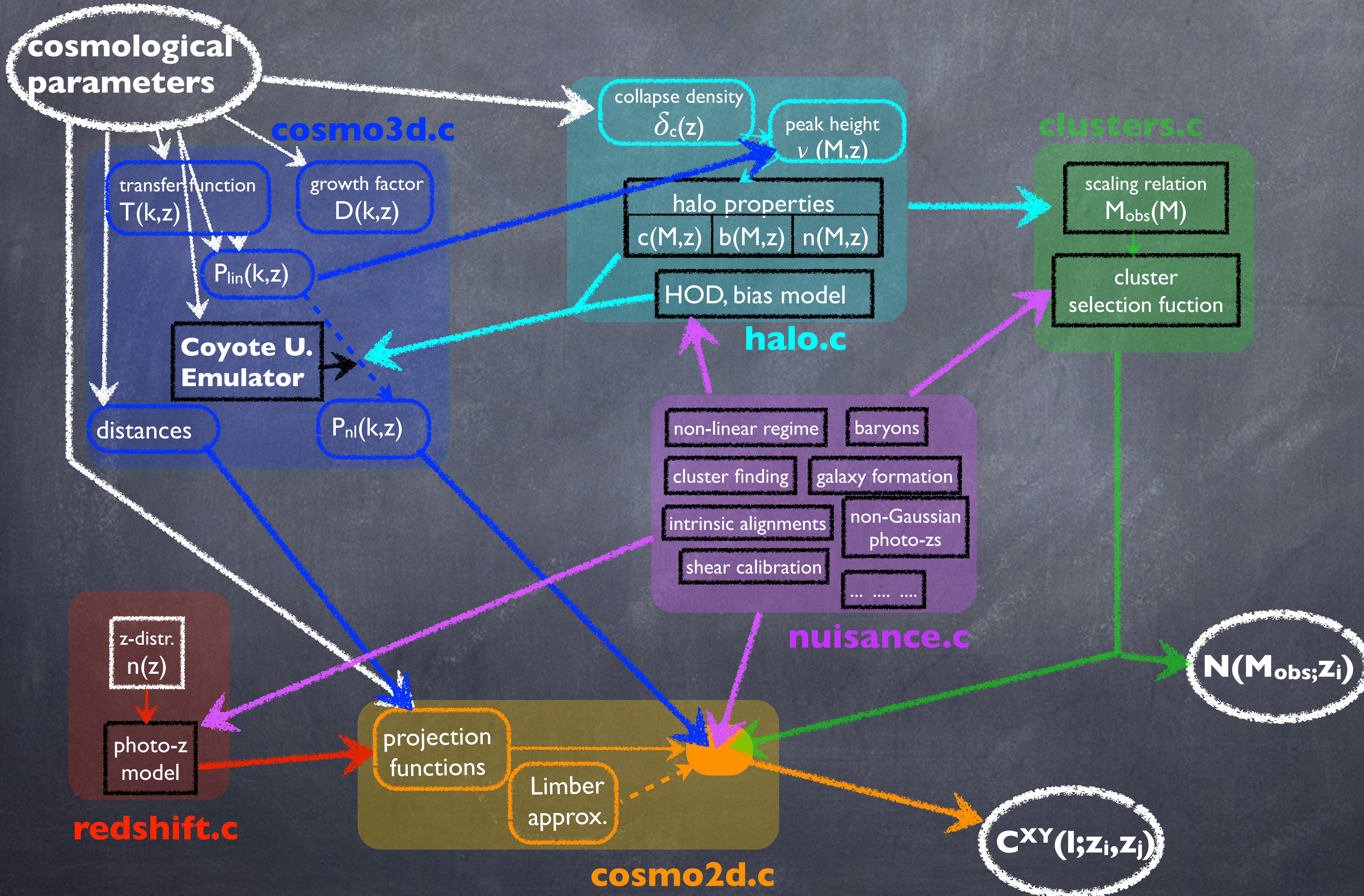
validate

External Data

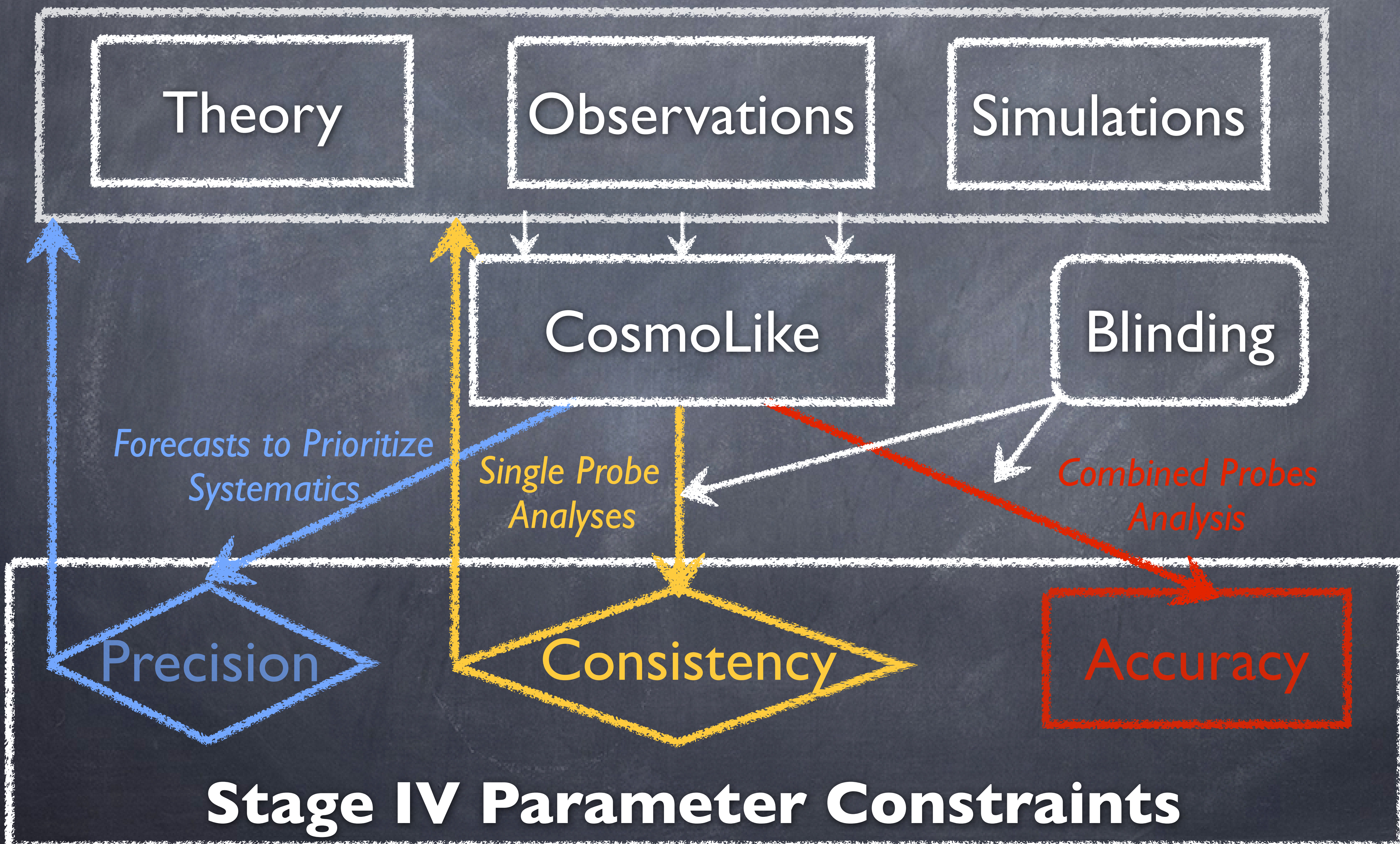
Introducing CosmoLike

- Likelihood analysis library for combined probes analyses
- Observables from three object types, and their cross-correlations
  - *galaxies* (positions), *clusters* (positions, N_{200}), *sources* (shapes)
  - separate n(z) + specific nuisance parameters for each object type
- Consistent modeling across probes
  - including systematic effects
- Computes non-Gaussian (cross-)covariances
- Optimized for high-dimensional likelihood analyses

CosmoLike Data Vector



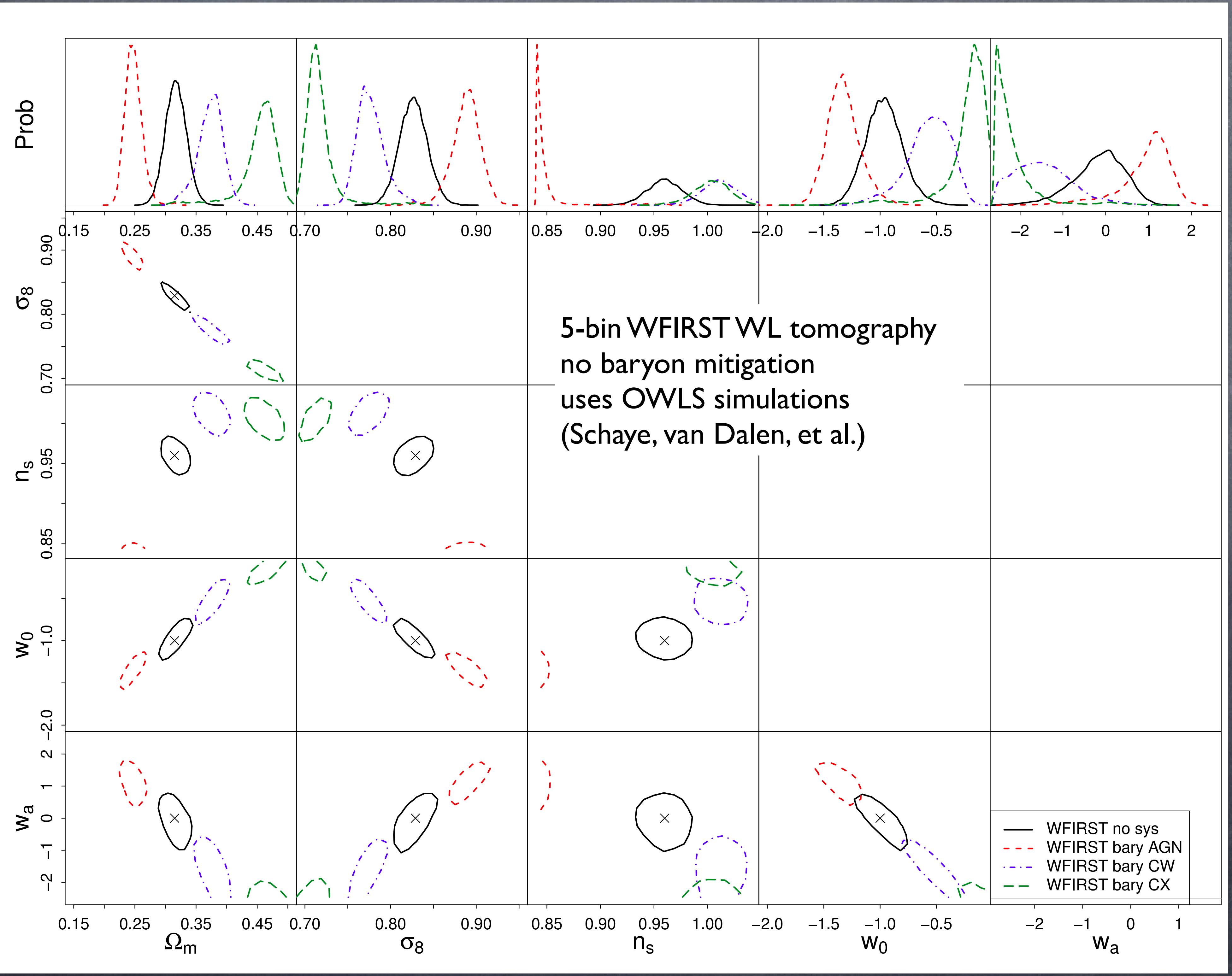
Joint Analysis Game Plan



Systematics Work Plan

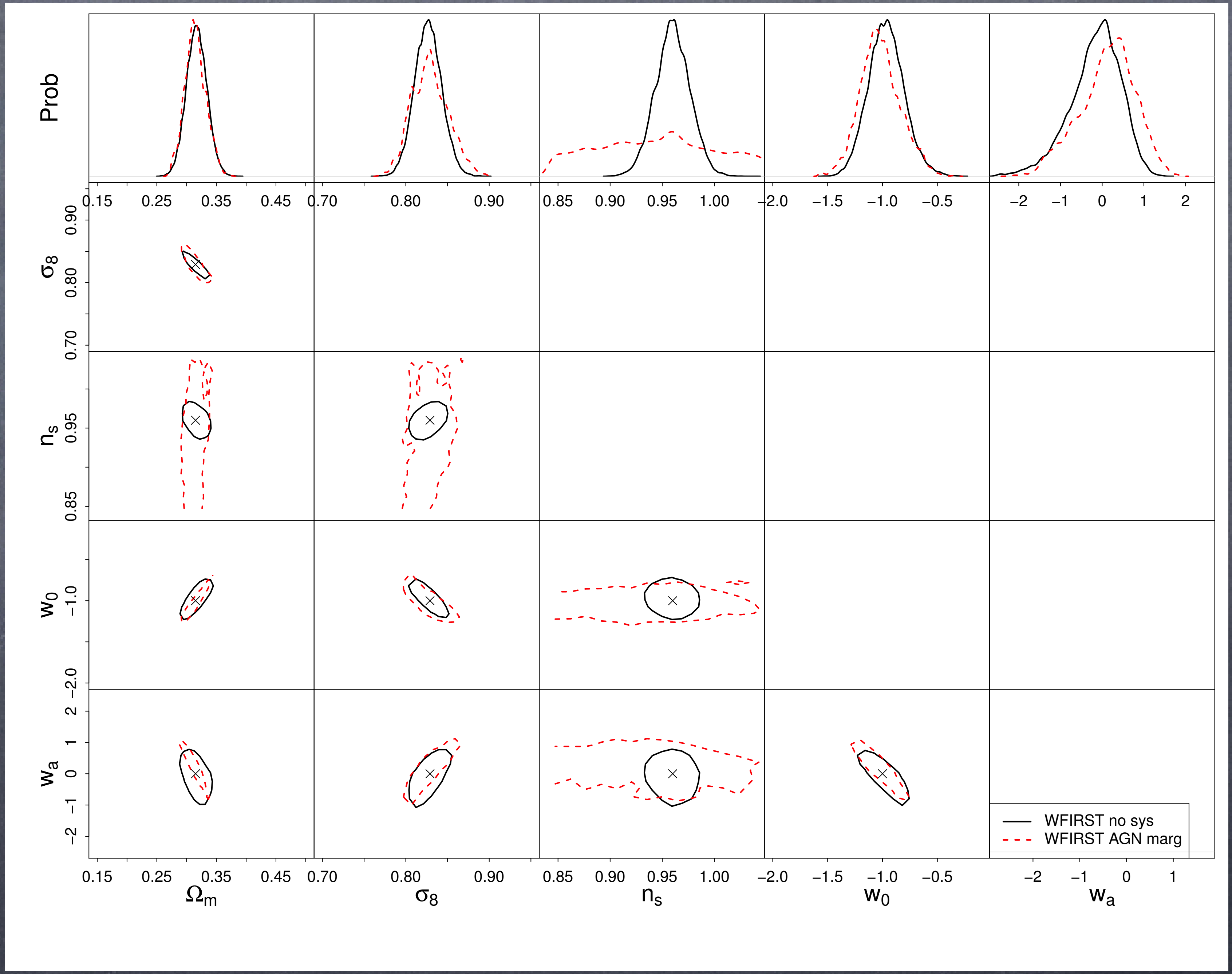
- Specify probes + scales (data vector)
- Identify + prioritize systematic effects
  - *find suitable parameterizations + limits*
  - needs to be consistent accoss probes
- Obtain constraints (priors) on nuisance parameters
  - independent observations
  - other observables from same data set
  - split data set
- Combine theory, simulation & data to improve priors
- Worked example: baryons. *See Tim Eifler's talk for WFIRST WL systematics.*

Impact of Baryons on WL



Mitigation of Baryons in WL

- PCA based mitigation strategy (Eifler, EK, et al. 14)
- Reduce FoM degradation by improving priors on range of baryonic scenarios
  - measure stacked halo profiles (e.g. SZ, X-ray)
  - update parameter range for hydro sims
  - feed these into updated marginalization scheme



Joint Analysis Game Plan