Mocks for DESI BGS

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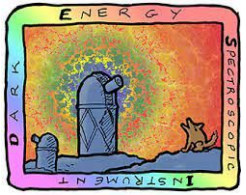
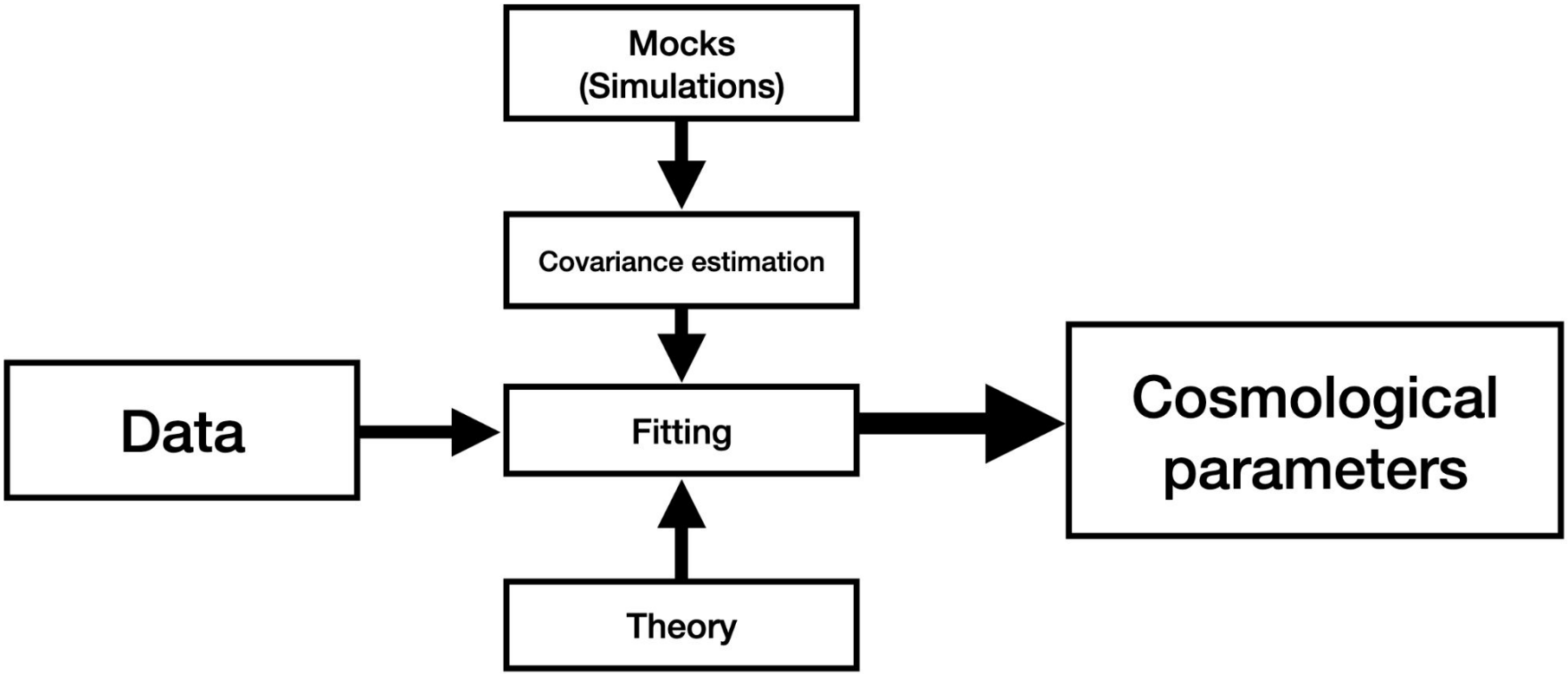
LPNHE
PARIS

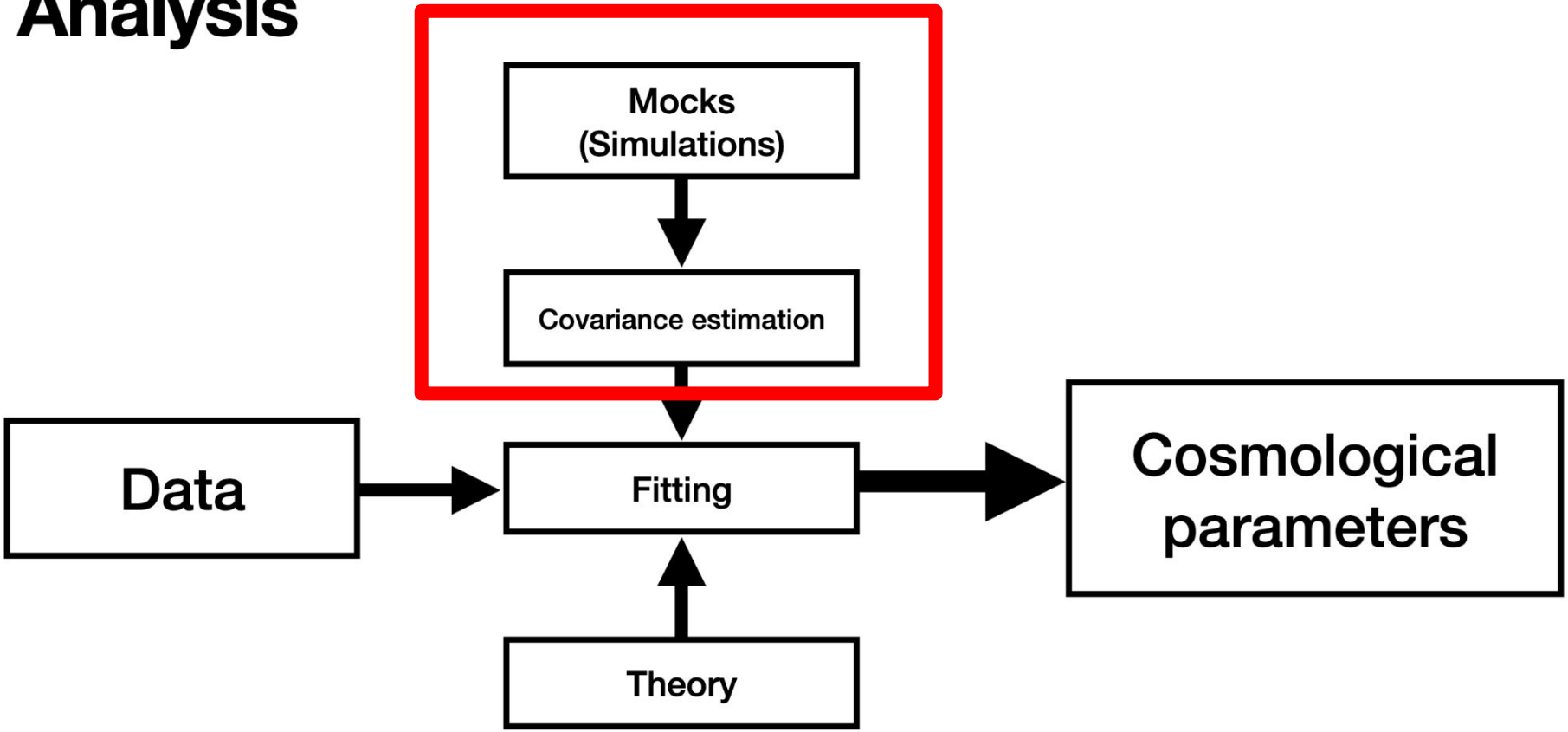


FONDATION CFM
POUR LA RECHERCHE

Analysis


Mocks
(Simulations)
Covariance estimation
Data
Fitting
Cosmological
parameters
Theory

Analysis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Precise covariance estimation

Analytic

+ Cheap computationally
+ Precise
+ Have super-sampling covariance

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+ Allow a natural implementation of observational effects

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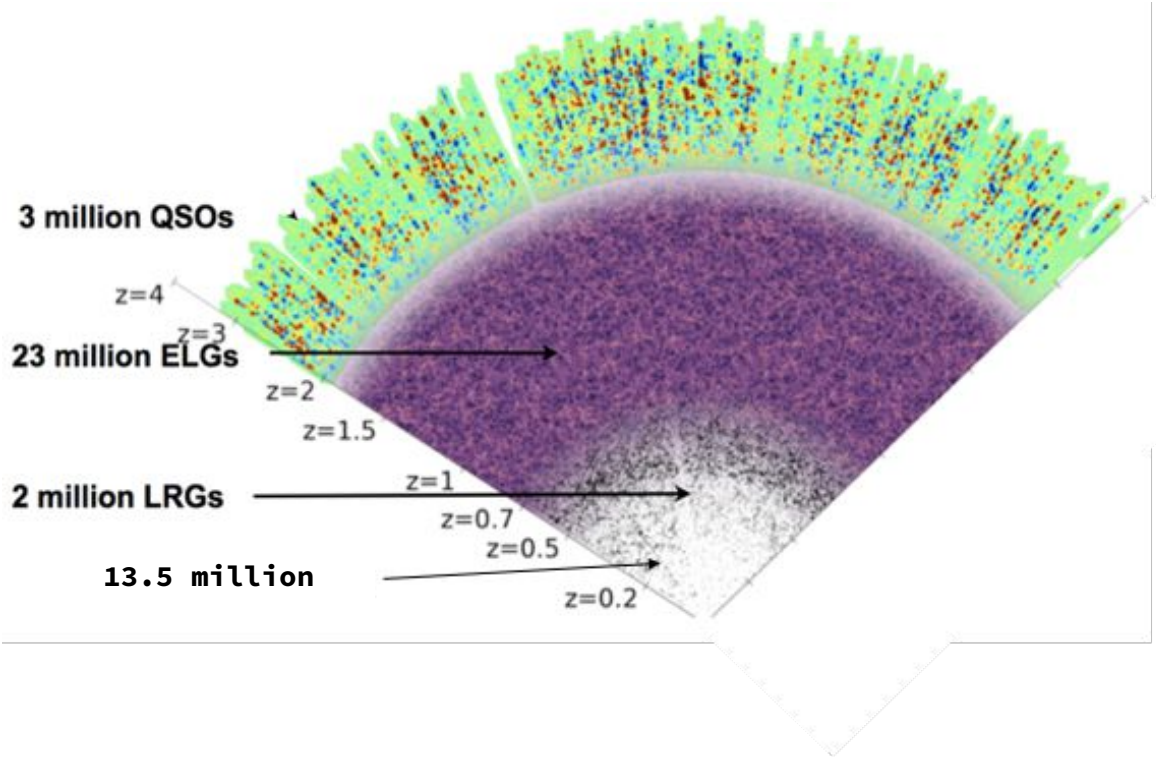
extra (if time left)

Hybrid approach: fitted covariance ?

Trusov et al. 2023 (arXiv:2306.16332)

Bright Galaxy Survey and why it is difficult to simulate



Tracer	Number density [h^3/Mpc^3]
BGS Bright	$>10^{-2}$
LRG	$\sim 5\times10^{-4}$
ELG	$\sim 10^{-3}$
QSO	$\sim 3*10^{-5}$

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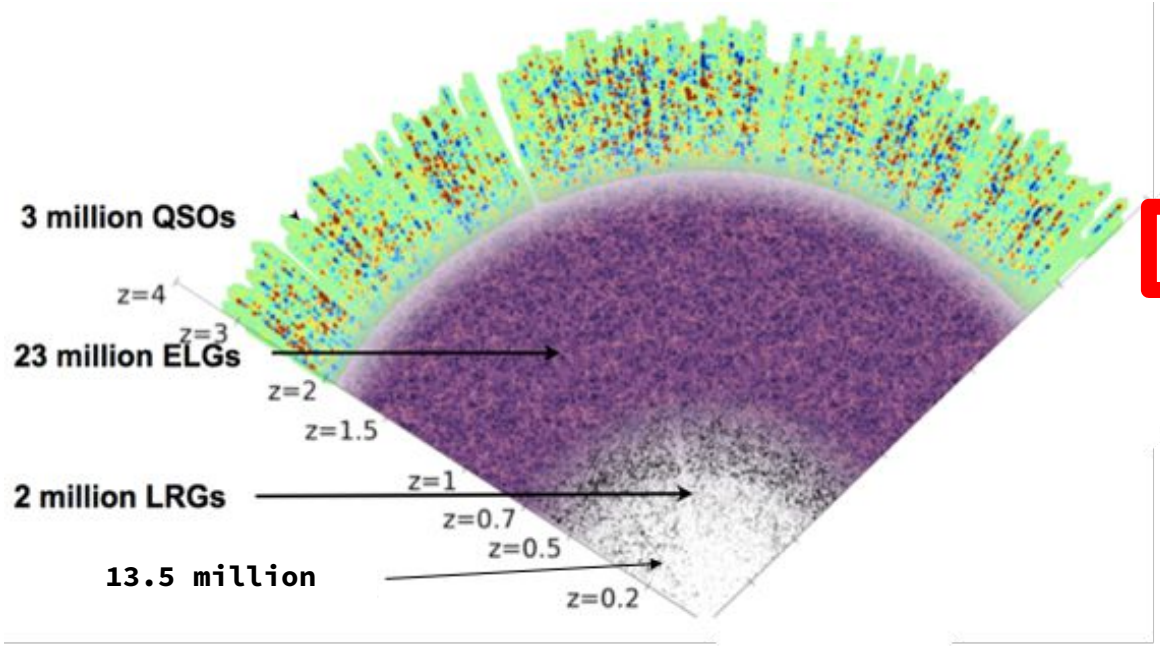

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BGS can be up to 2 orders of magnitudes denser than the other tracers!

Compromises are needed

Make a cut on the BGS to reduce the number density (and statistics)

VS

Reduce the simulated volume size

Make a cut on the BGS to reduce the number density (and statistics)

- **Current baseline approach**
- Lowers number density to $5x10^{-4}$ with a magnitude cut
- Allows for creation of the EZmock and much faster analysis
- Disables possibility of analysis beyond standard

VS

Reduce the simulated volume size (need to use replications)

- Instead of the required volume the simulation features only a part of it, which is later replicated
- Allows for alternative types of analysis (Multitracer, Density split)
- Mocks take much longer to produce

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EZmock BGS

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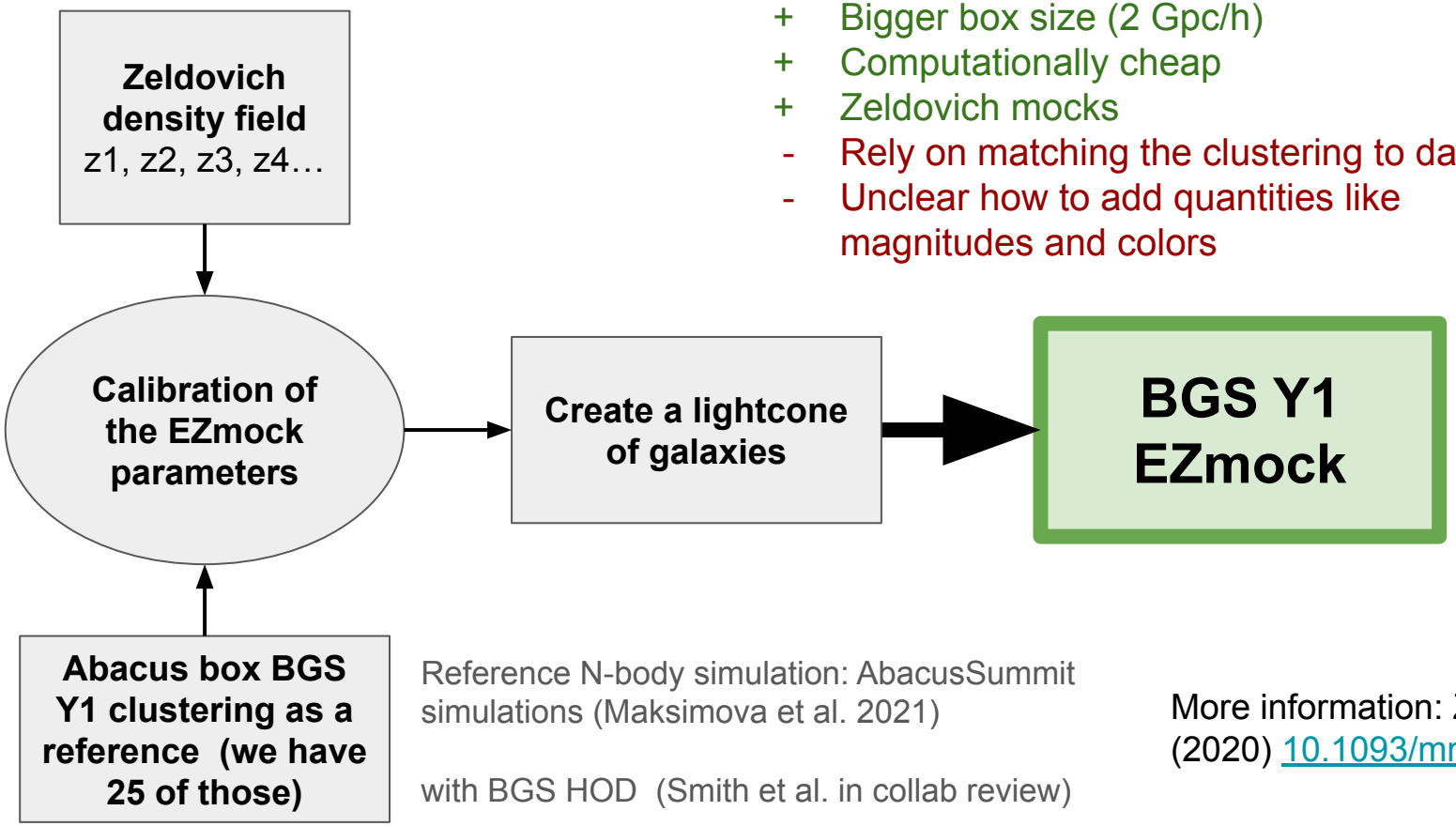
GLAM BGS

BGS Y1 EZmock



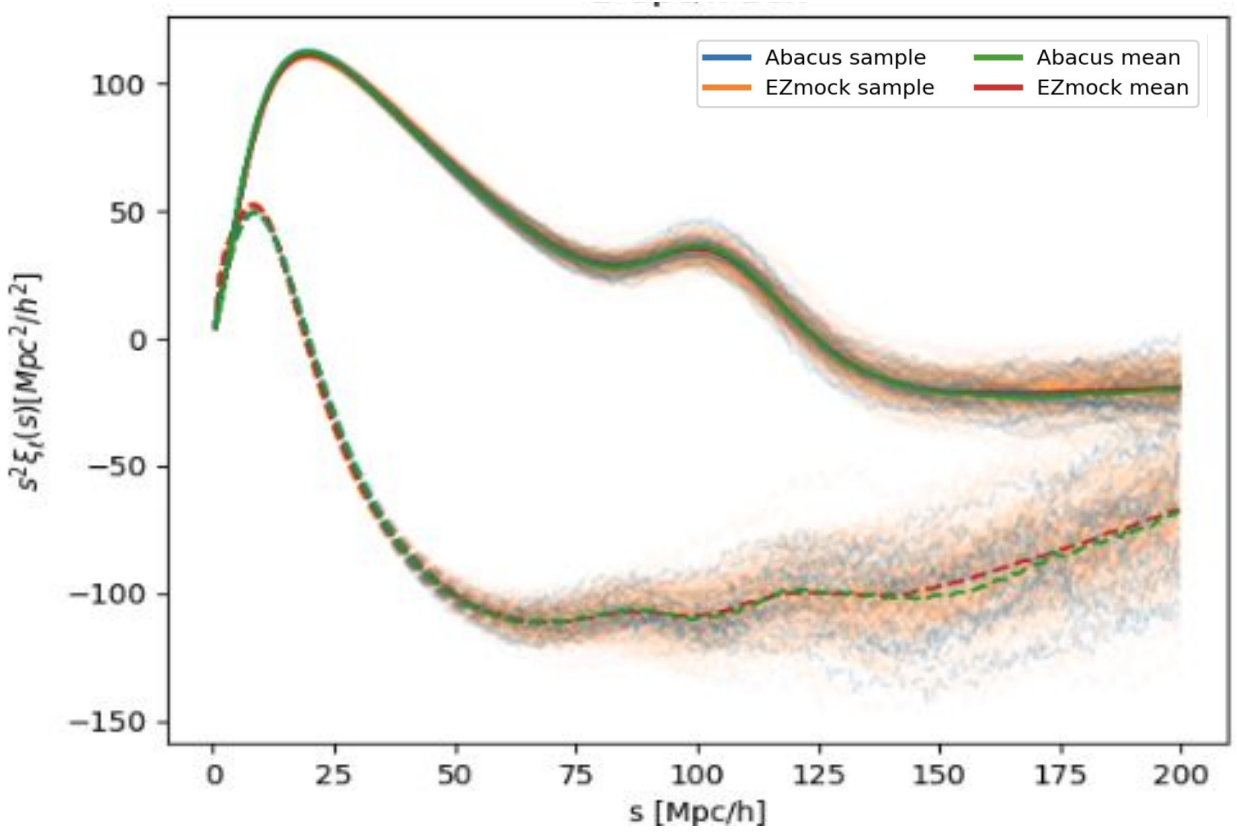
Reference N-body simulation: AbacusSummit simulations (Maksimova et al. 2021)

with BGS HOD (Smith et al. in collab review)

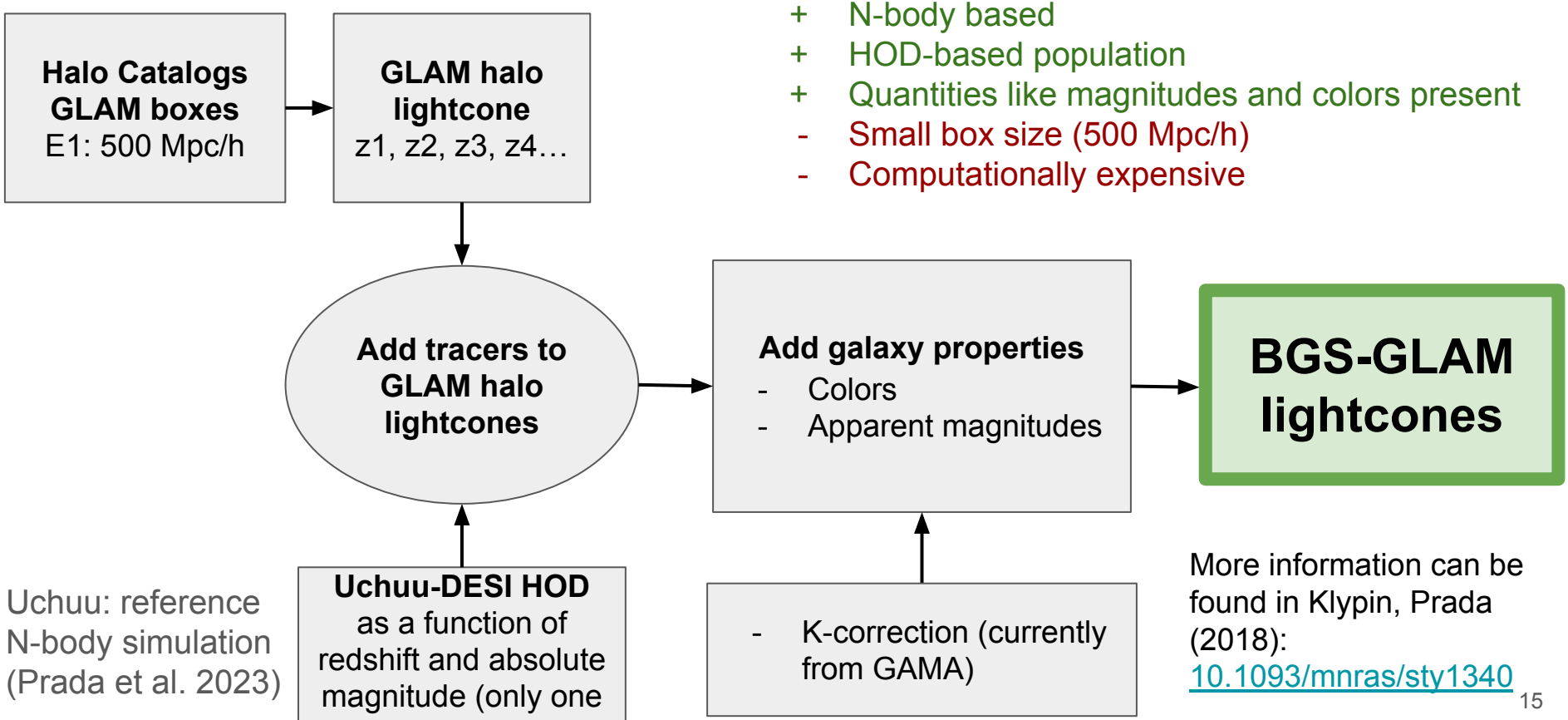
EZ mocks

\+ Bigger box size (2 Gpc/h)
\+ Computationally cheap
\+ Zeldovich mocks
\- Rely on matching the clustering to data
\- Unclear how to add quantities like magnitudes and colors

More information: Zhao et al (2020) 10.1093/mnras/stab510


Abacus sample
EZmock sample
Abacus mean
EZmock mean
100
50
0
−50
−100
−150
0
25
50
75
100
125
150
175
200
s [Mpc/h]
$s^2\xi_\ell(s)[Mpc^2/h^2]$

BGS GLAM mocks



Uchuu: reference N-body simulation (Prada et al. 2023)

GLAM mocks

+ High resolution
+ N-body based
+ HOD-based population
+ Quantities like magnitudes and colors present
- Small box size (500 Mpc/h)
- Computationally expensive

More information can be found in Klypin, Prada (2018): 10.1093/mnras/sty1340

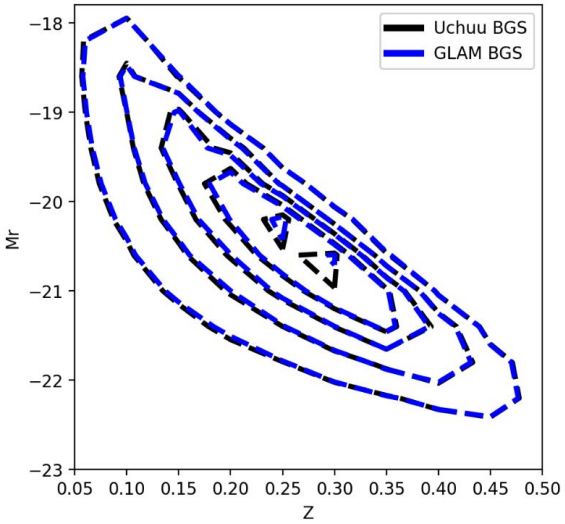
Features of the GLAM-BGS lightcones:

1) Based on GLAM E1

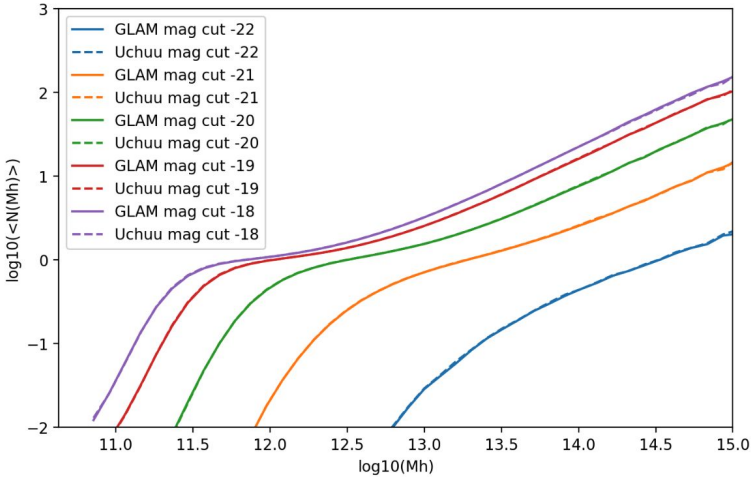
2) Clustering evolution is present

3) Color, absolute and apparent magnitudes, other properties are present

4) Lightcone represents BGS up to mag < 20.0

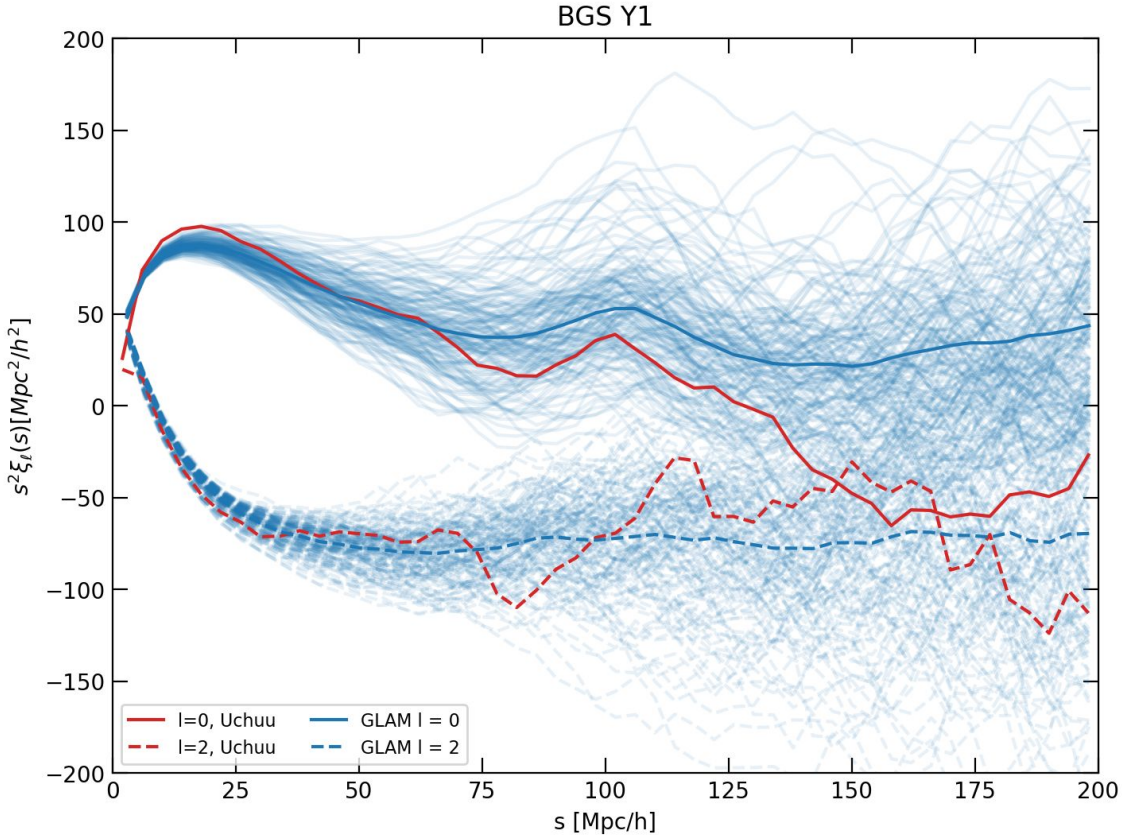


$^{0.1}M_r^h$ vs. z



HOD

BGS Y1 lightcone clustering



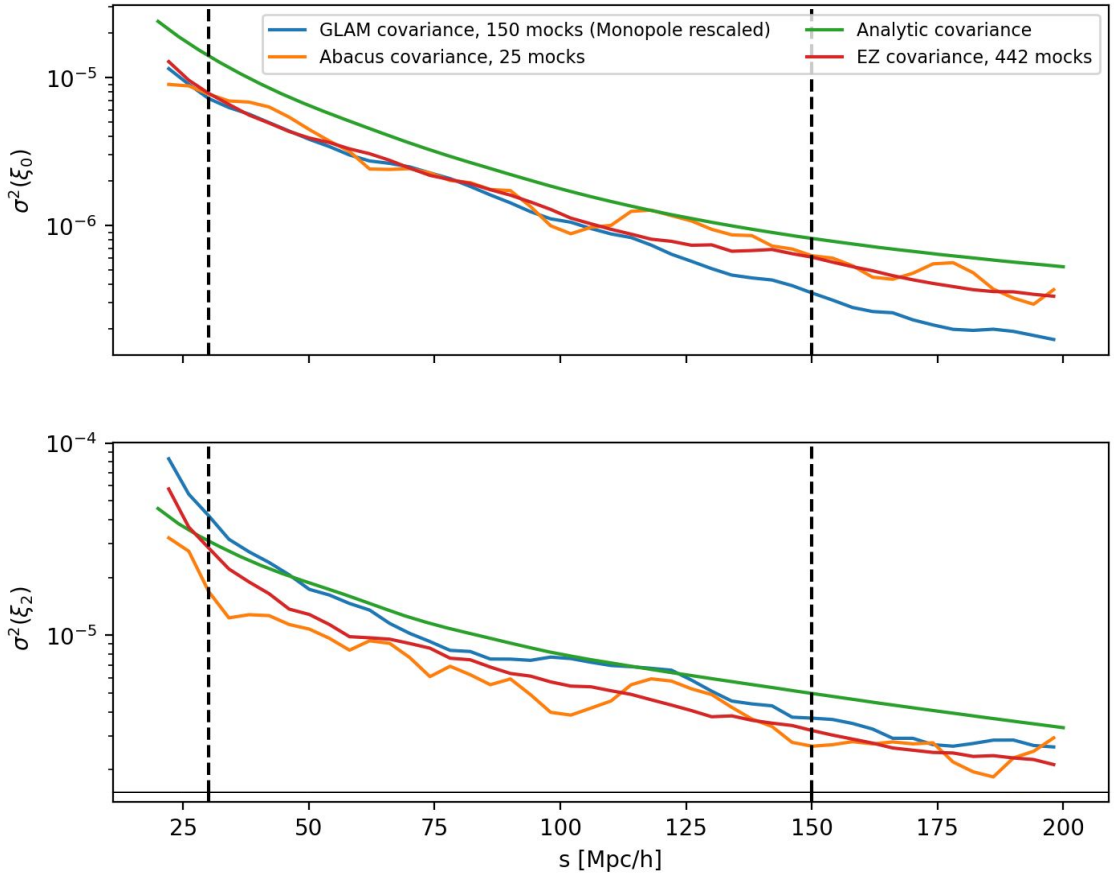
BGS Y1 sample

z = [0.1-0.4]

Apparent magnitude cut: r < 19.5

Absolute magnitude cut: Mr < -21.5

BGS Y1 lightcone/cutsky covariances



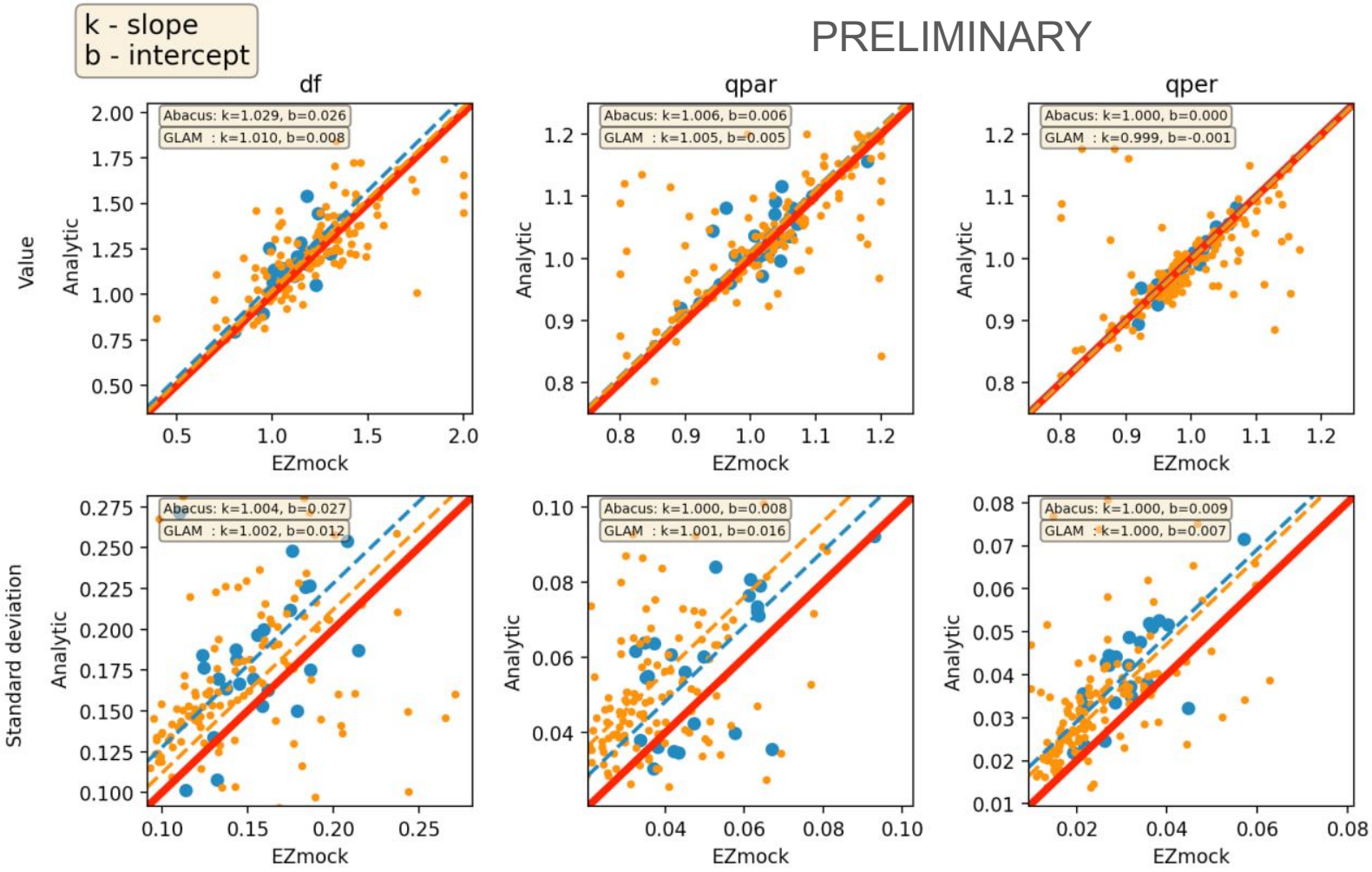
Current progress:

1000 EZmock BGS mocks

200 GLAM BGS mocks
(800 more needed)

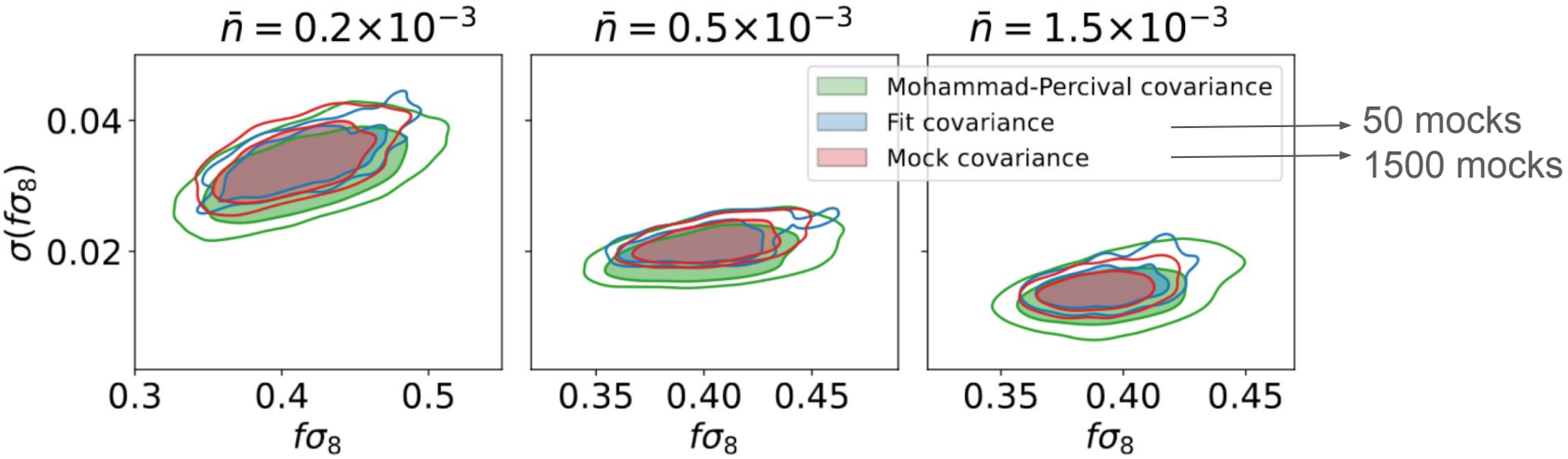
Because of the box size that implies replication, some rescaling of the covariance is needed.
(More details on demand)

PRELIMINARY



Fit covariance: Hybrid approach

Using resampling of several mocks and a correction factor that is fitted on this reduced set of mocks, it is possible to drastically reduce the number of simulations needed for a proper covariance estimation, by a factor of ~20-30.
More on that: Trusov et. al. (2023) arXiv:2306.16332



Current status of the mock production

1) Version 1 of EZmock BGS is ready: 1000 mocks produced
2) Version 2 of EZmock BGS with fixed velocities (bug in the reference BGS Abacus mocks) is in the production
3) GLAM mocks: 200 ready, 800 more in production

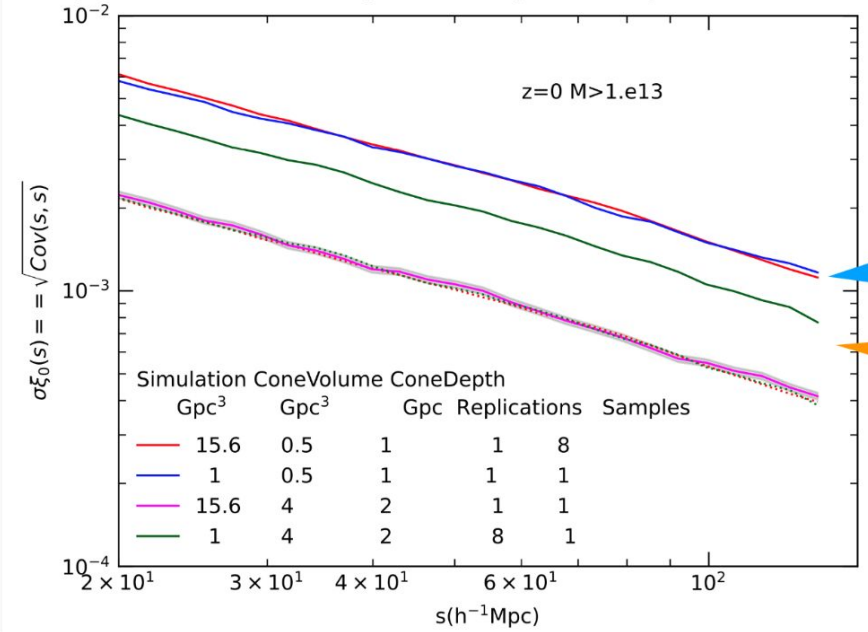
Further plans

1) Finish the production of version 2 EZmocks and compare with other methods
2) Finish the production of GLAM mocks and test GLAM covariance matrix
3) Add systematics to the mocks and verify their impact
4) Perform cosmological analysis using BGS Y1 mocks

Thank you!

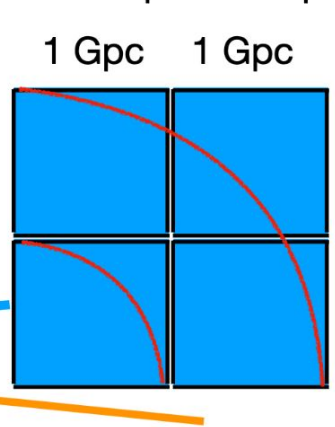
Scaling of covariance matrix

Key: find volume that gives independent pairs



See dotted curves which were rescaled to 4 Gpc^3 volume from green and red curves. Note: those are NOT fits.

Cone depth = 2 Gpc



Slide from A.Klypin

What is the difference of sqrt(Cov(s,s)) for 1 Gpc box and 1 Gpc-deep cone (no replications) and 2 Gpc-deep cone with 8 replications? (green and blue curves). From the plot the ratio is about 1.4. How we estimate it from geometry?

Volume of 2 Gpc cone is 4pi/3, but independent pairs are coming only from 1 Gpc cube. Volume of 1 Gpc-deep cone is pi/6. The sqrt(ratio of volumes) = sqrt(6/pi) = 1.38.

Scaling of all results is simply

$$\sigma_{\xi_2} = \sqrt{\frac{VolumeCone_1}{VolumeCone_2}}\,\sigma_{\xi_1}$$

with volumes that provide independent pairs.

Box covariances