Local Primordial Non-Gaussianity with Spec-S5 - "Leveraging the b_ϕ dimension of multi-tracer"

Fundamental Physics from Future Spectroscopic Surveys

Jamie Sullivan
(based on work w/ Uroš Seljak, Tijan Prijon)
arXiv:2303.08901

BERKELEY CENTER *for* COSMOLOGICAL PHYSICS
Berkeley UNIVERSITY OF CALIFORNIA
U.S. DEPARTMENT OF ENERGY | Office of Science

Measuring LPNG in Galaxy Surveys

Measure power spectrum

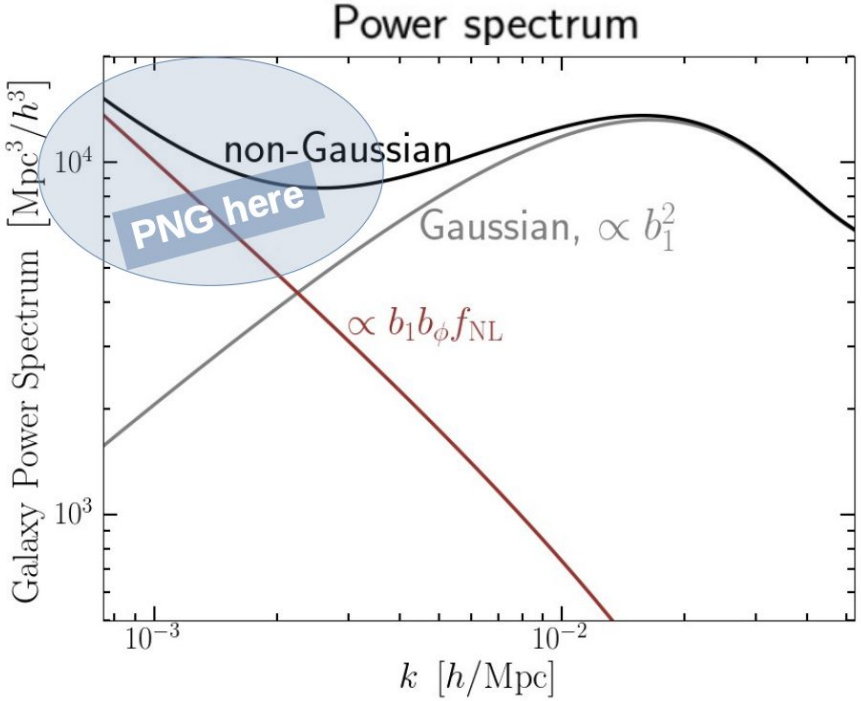
To model it need a galaxy bias model:

$$\delta_g = b\,\delta + \ldots$$

Galaxy overdensity **Matter overdensity**

15 years ago, it was realized there is an **extra** bias signal

Degeneracy! $\delta_g = b\,\delta + b_\phi\, f_{\rm NL}^{(\rm loc)}\,\phi + \ldots$



Planck15, Dalal+08, Slosar+08,McDonald08, image from A. Barreira

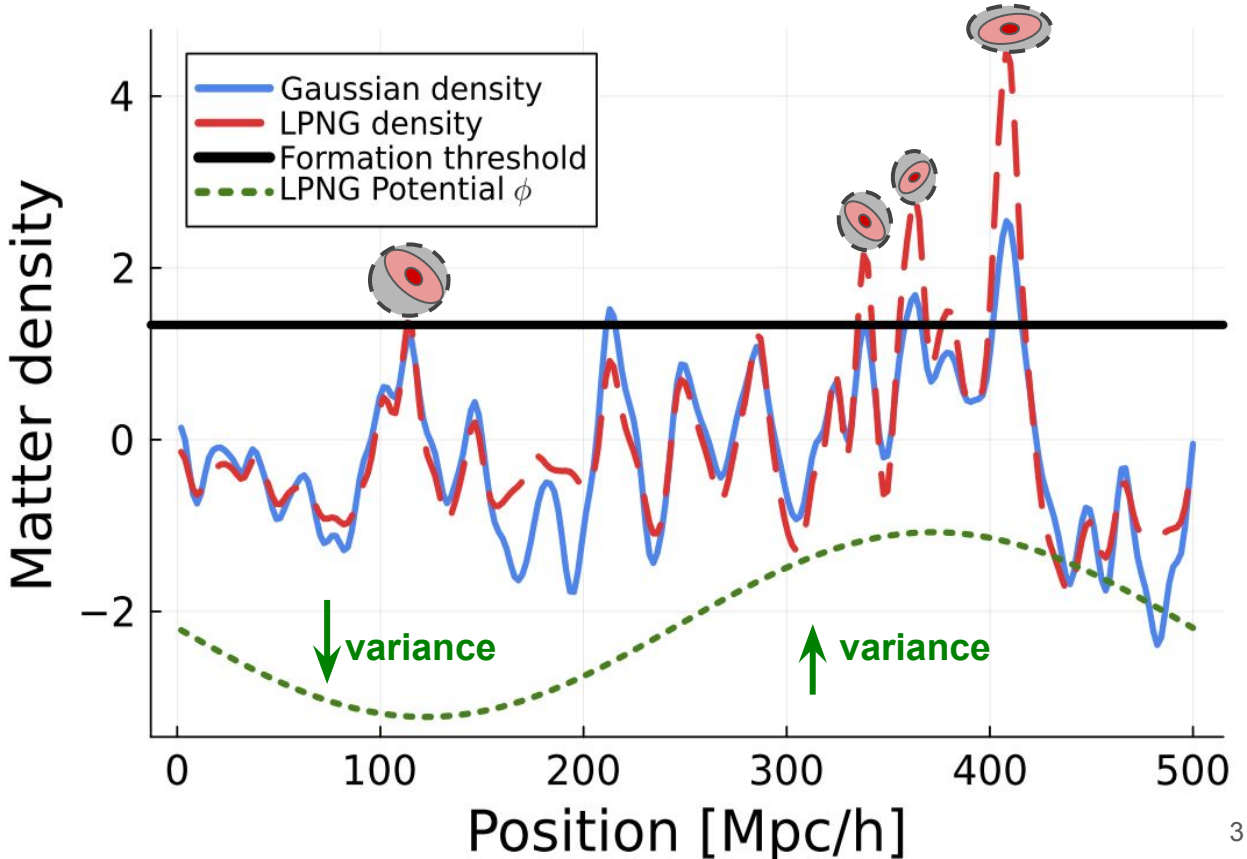
Universal Mass Function (UMF) & the *p* factor

LPNG "boosts local variance"

Halos form after crossing threshold, affected by LPNG

* **Most analyses assume UMF form**:

$$b_\phi(b, p) \propto b - p$$

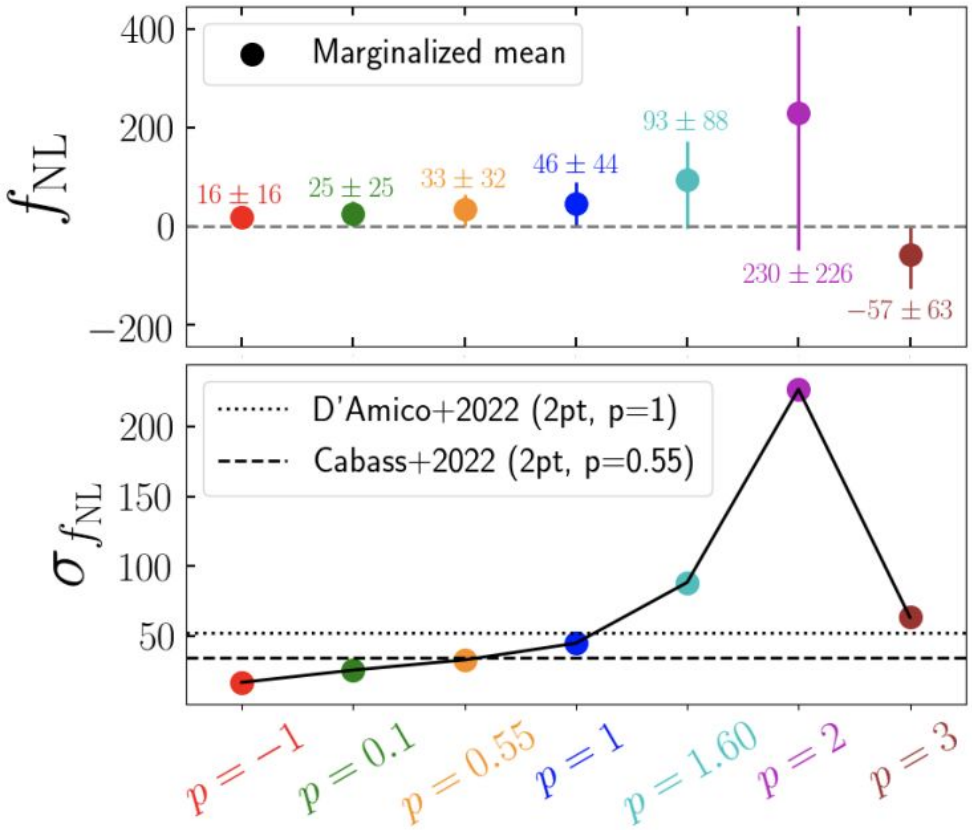


The *p* factor matters!

If we don't know *p*, lose constraining power on f_{NL}

What causes *p* to change?

Several things…



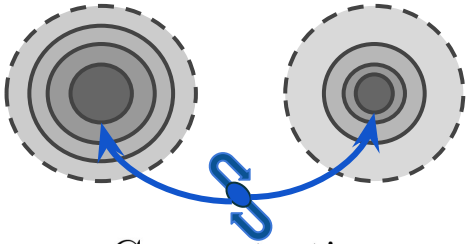
The *p* factor matters!

If we don't know *p*, lose constraining power on f_{NL}

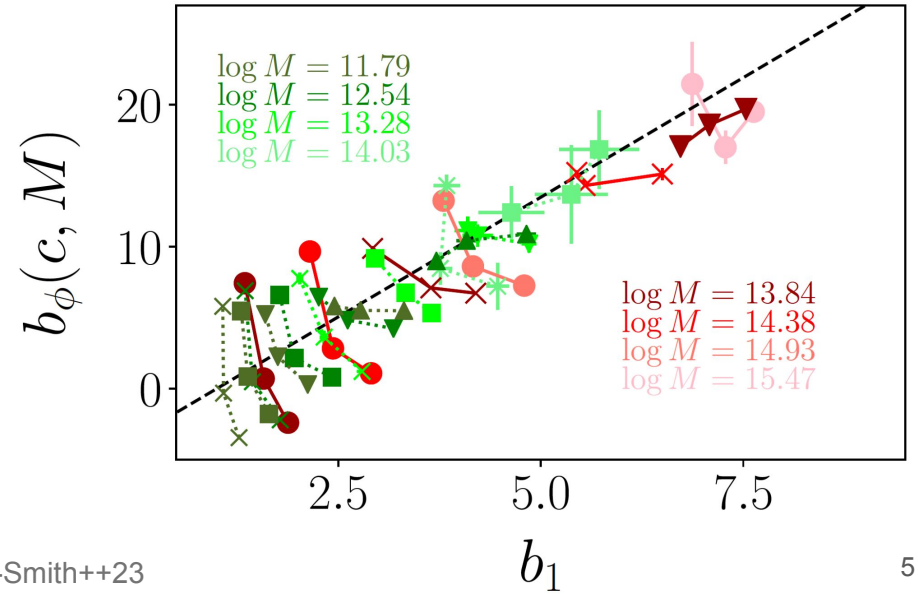
What causes *p* to change?

Several things…

Halo concentration *c* has a large effect



Concentration



Slosar+08, Reid+10, Barreira+20, Lazeyras+22, Barreira&Krause23, Lucie-Smith++23

The *p* factor matters!

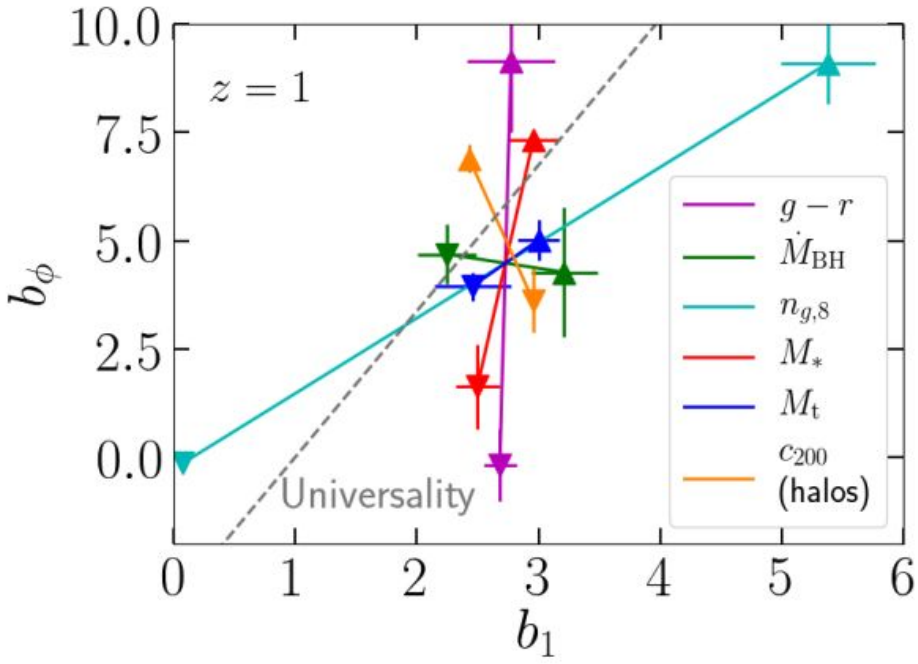
If we don't know *p*, lose constraining power on f_{NL}

What causes *p* to change?

Several things…

Halo concentration *c* has a large effect

Color is even bigger!



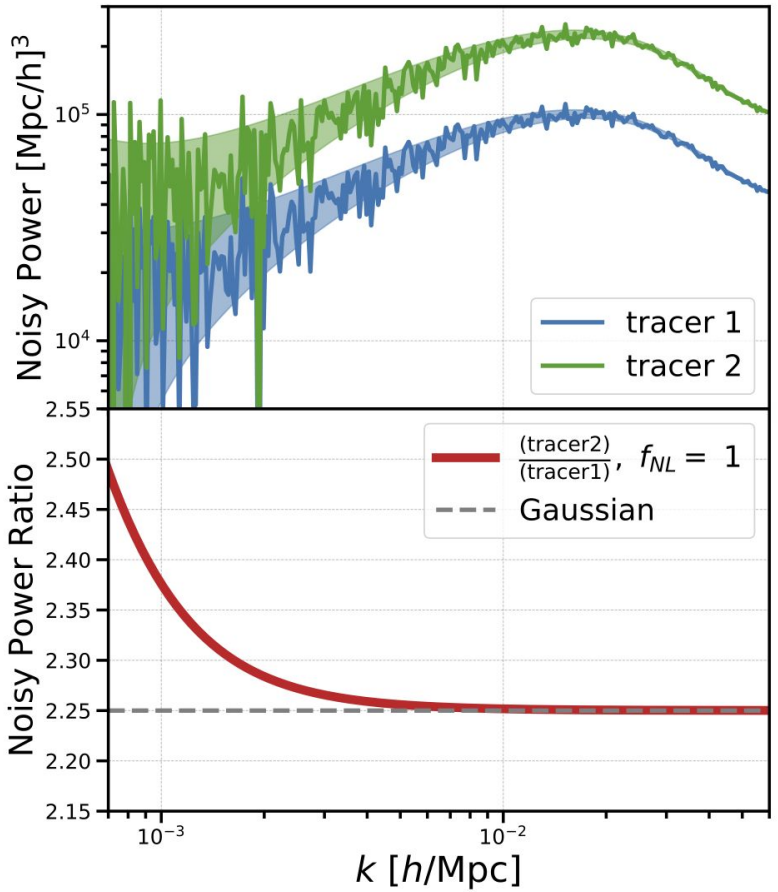
Slosar+08, Reid+10, Barreira+20, Lazeyras+22, Barreira&Krause23, Lucie-Smith++23

Sub-sample Multi-tracer

Identify multi-tracer sub-samples according to b_ϕ

Choose according to modeled assembly bias (somehow)

$$\sigma(f_{\rm NL}^{(\rm loc)}) \propto \left(\frac{b_{\phi,1}}{b_1} - \frac{b_{\phi,2}}{b_2} \right)^{-1}$$



Seljak09, McDonald+Seljak09, Schmittfull+Seljak18

Future LPNG Surveys - MT vs ST

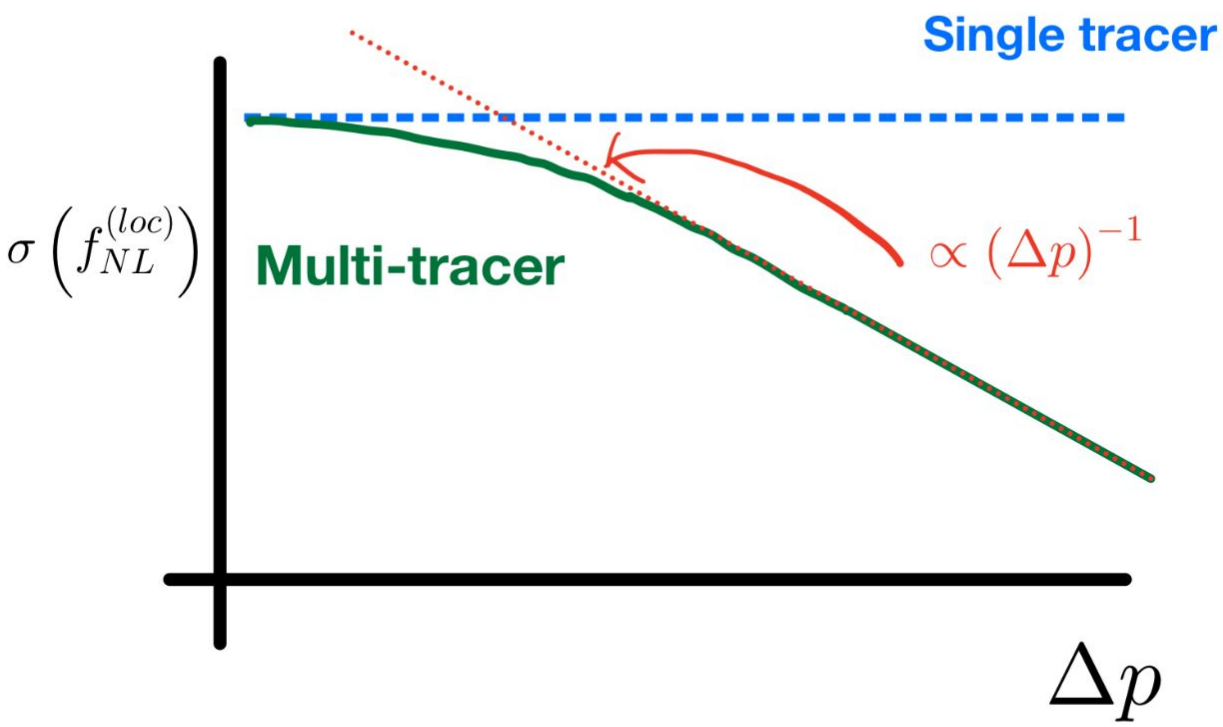
Recall:

$$\sigma(f_{\rm NL}^{\rm (loc)}) \propto \left(\frac{b_{\phi,1}}{b_1} - \frac{b_{\phi,2}}{b_2}\right)^{-1}$$

$$b_\phi(b,p) \propto b - p$$

Simplify and assume fixed *b*:

$$\sigma(f_{\rm NL}^{\rm (loc)}) \overset{\text{same b}}{\rightarrow} (\Delta p)^{-1}$$



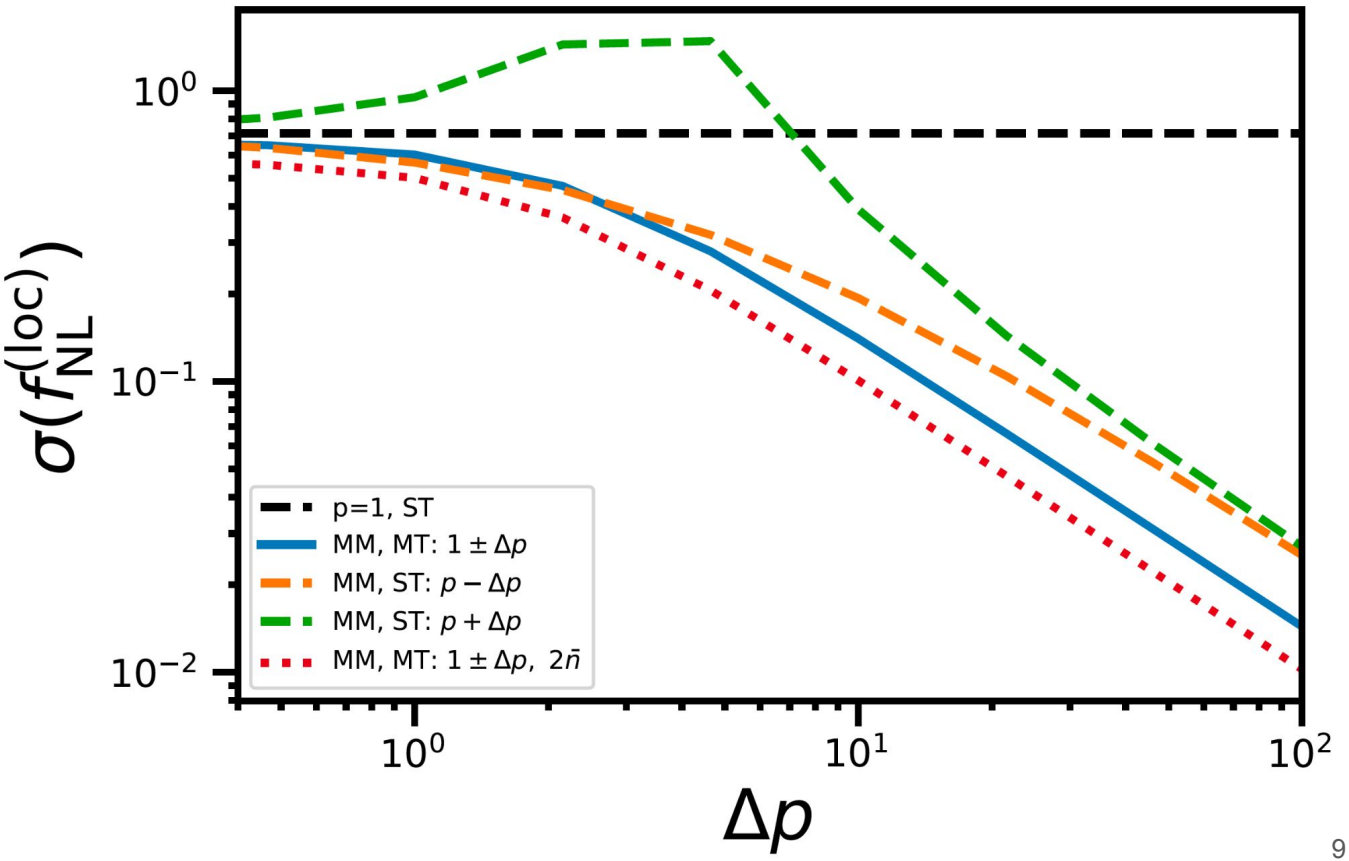
“Spec-S5” forecast - matches expectation

“MegaMapper”

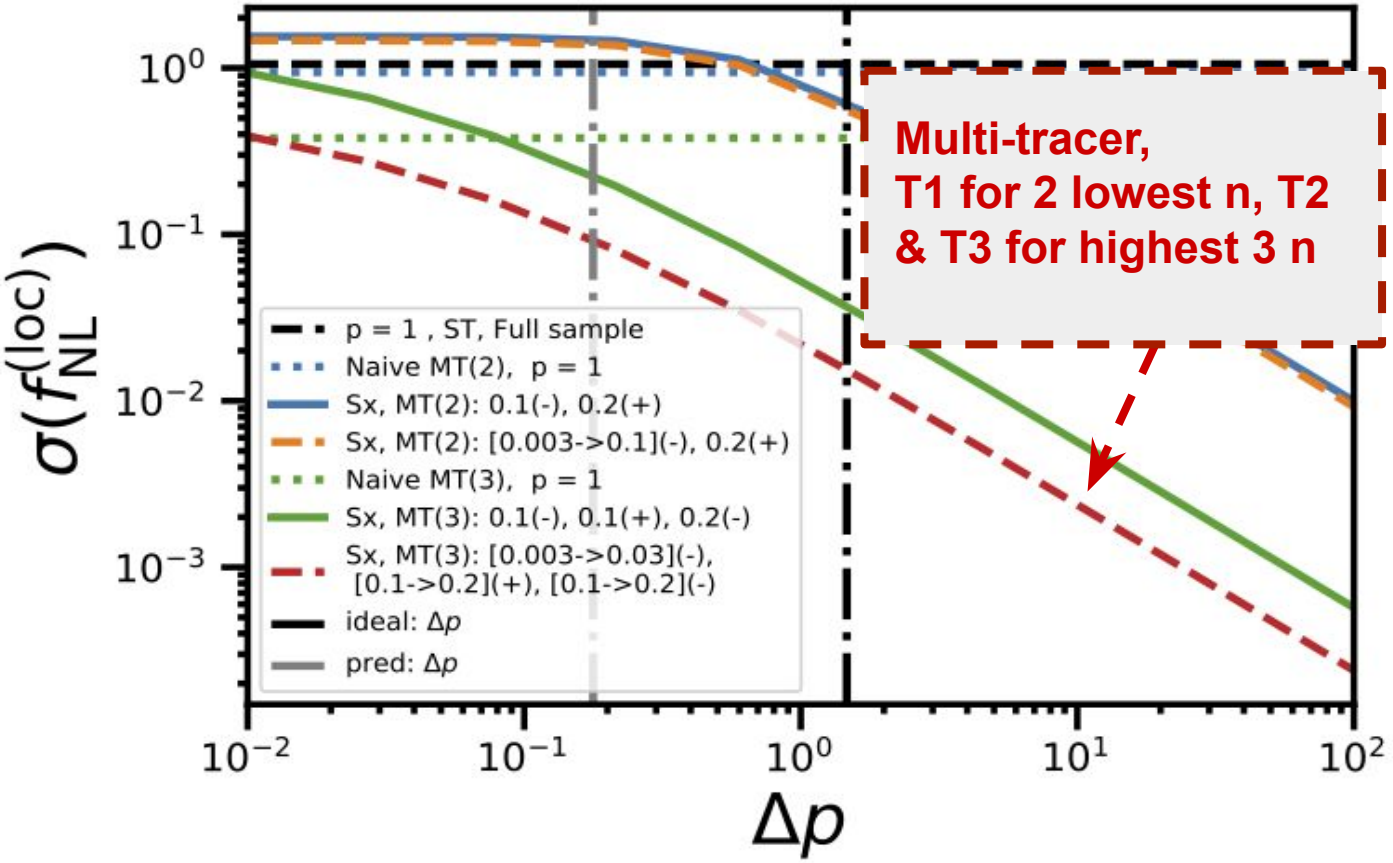
z = 2-5

Outdated, but number density about right

Large gains with *p* change



Extension to many samples (SPHEREx)



More realistic case (mock DESI samples)

Use multiple galaxy subsamples

Subsamples have different b_ϕ

Large improvement over "naive" multitracer!

ELG + LRG	$\sigma(f_{NL}^{\rm loc})$
$p = 1$	4.0
(2) ($\overline{\rm LRG}$, $\overline{\rm ELG}$), ideal	2.3
(2) ($\overline{\rm LRG}$, $\overline{\rm ELG}$), pred	2.3
(2) (LRG+, ELG+), ideal	1.4
(2) (LRG+, ELG+), pred	2.4
(3) (LRG-, LRG+, ELG-), ideal	0.8
(3) (LRG-, LRG+, ELG-), pred	2.0
(3) (LRG-, ELG+, ELG-), ideal	0.8
(3) (LRG-, ELG+, ELG-), pred	2.0
(3) (LRG-, ELG+, else), ideal	0.6
(3) (LRG-, ELG+, else), pred	1.5

Discussion Questions

- Can we design samples with very different b_ϕ ?
  - Reasonable limits to this?
- Can we model b_ϕ (or p) as a function of redshift?
  - Incorporating selection?
- Can we confidently split the data if number density is too low? At high redshift?
- Relation to "low-Δ" non-local f_{NL} (Green+23, Sam's talk)