

DENSITY AND PECULIAR VELOCITY FIELDS IN THE NEARBY UNIVERSE

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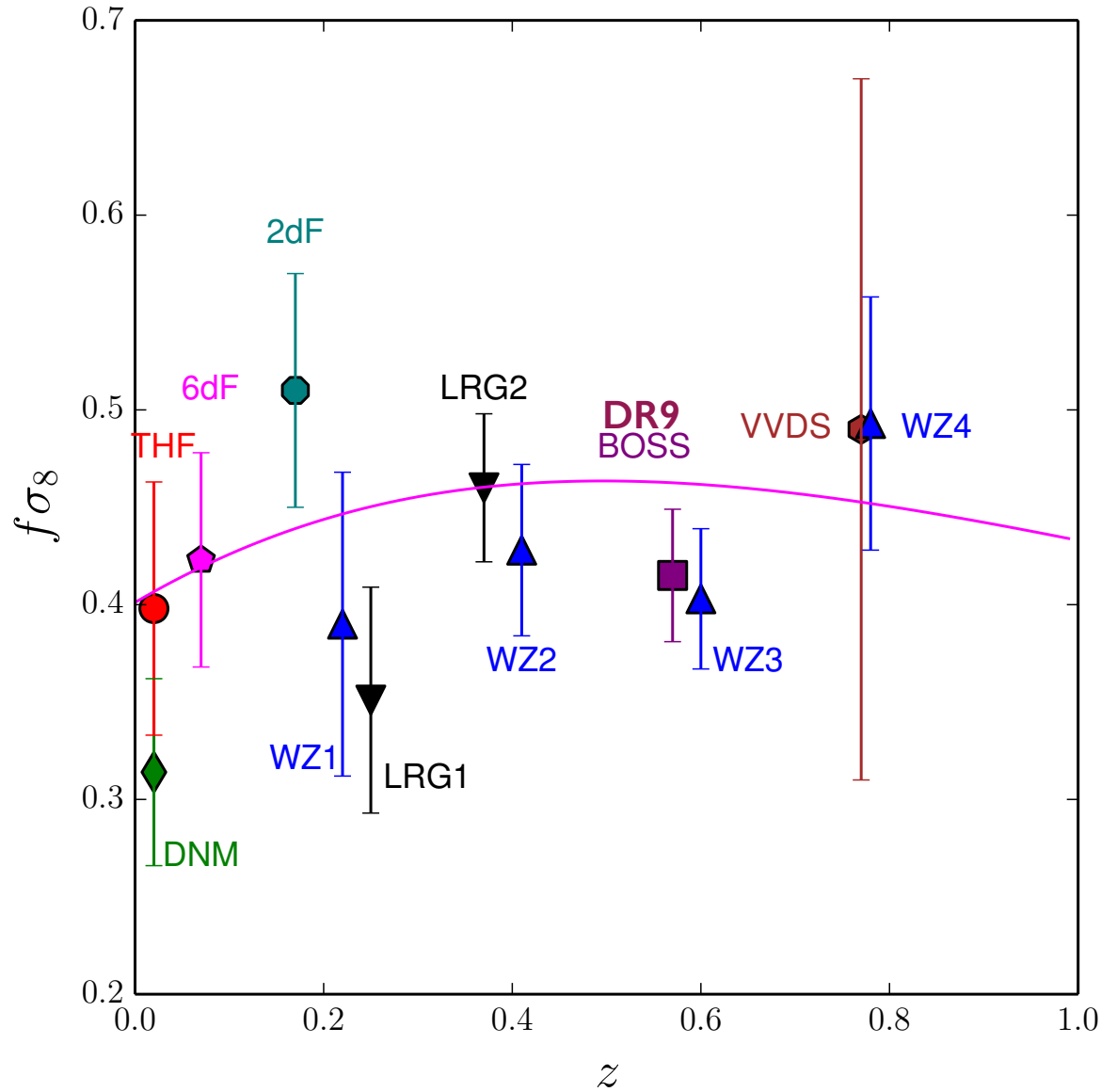
S. Turnbull

Tallinn, June 25, 2014

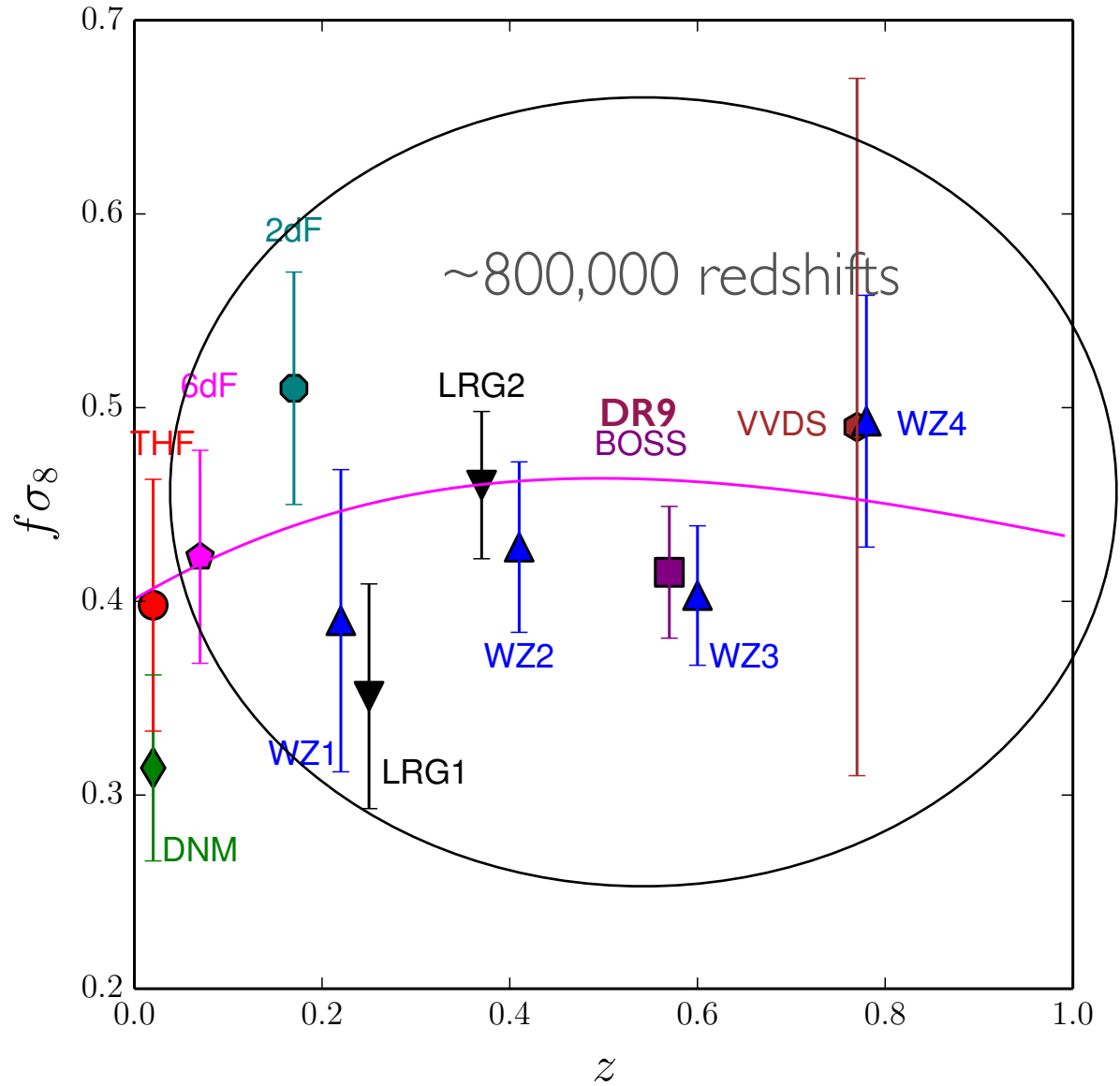
WHY PECULIAR VELOCITIES?

- Measure growth factor f and σ_8 (also test gravity):
infall
- Measure the *matter* power spectrum on very large (\sim Gpc) scales in the low z Universe : **bulk flow**

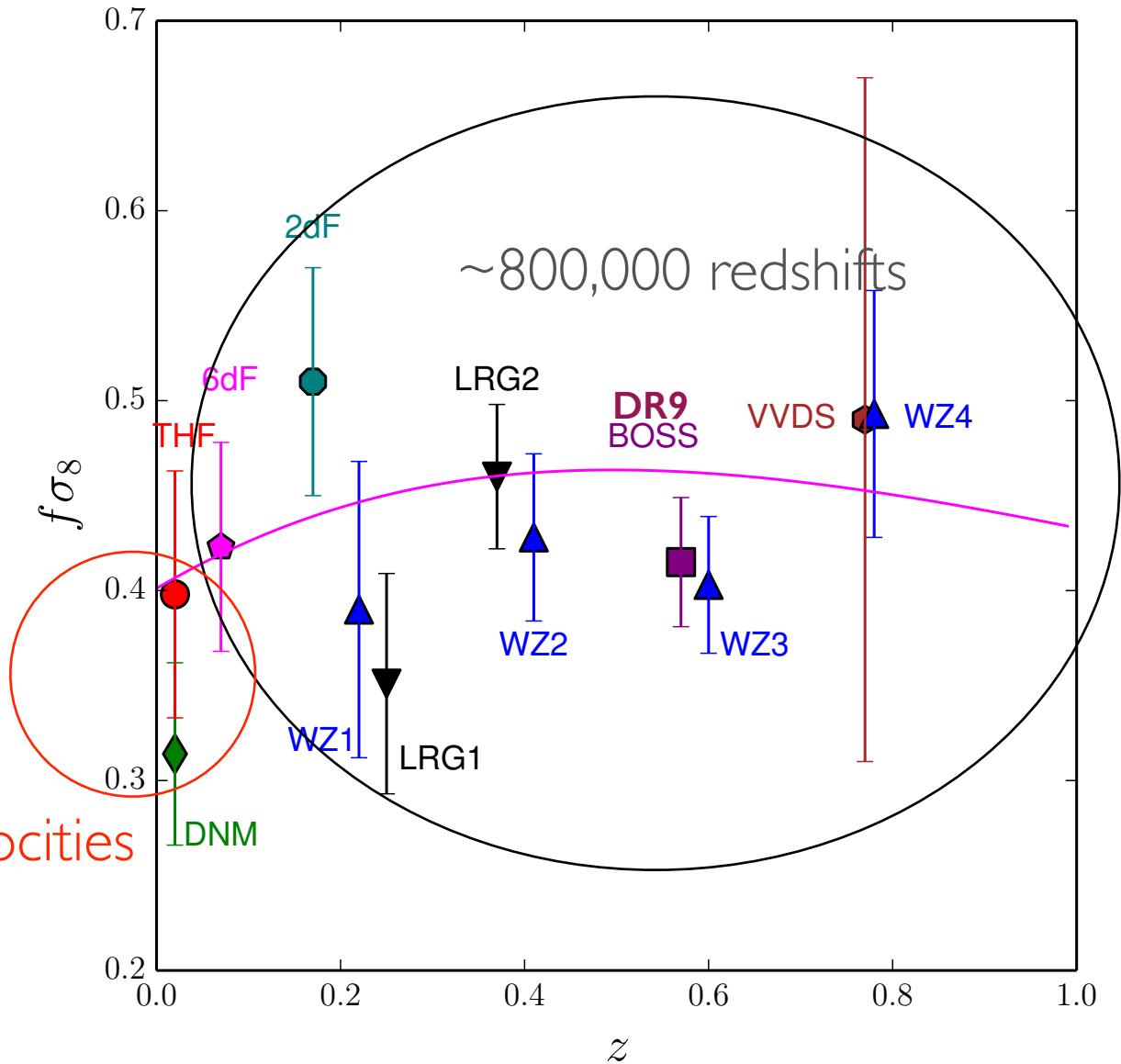
USING ONLY
PECULIAR
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~5000 peculiar velocities

PREDICTING PECULIAR
VELOCITIES USING THE
GALAXY DENSITY FIELD

β

$$\mathbf{v}(\mathbf{r}) = \frac{f}{b} \frac{H_0}{4\pi} \int_0^{R_{\max}} d^3\mathbf{r}' \delta_g(\mathbf{r}') \frac{(\mathbf{r}' - \mathbf{r})}{|\mathbf{r}' - \mathbf{r}|^3} + \mathbf{V}_{\text{ext}}$$

$$\delta_g = b\delta$$

$$f(\Omega_m) = \Omega_m^\gamma$$

$$\sigma_{8,g} = b\sigma_8$$

$$\beta = \frac{f}{b}$$

$$f\sigma_8 = \beta\sigma_{8,g}$$

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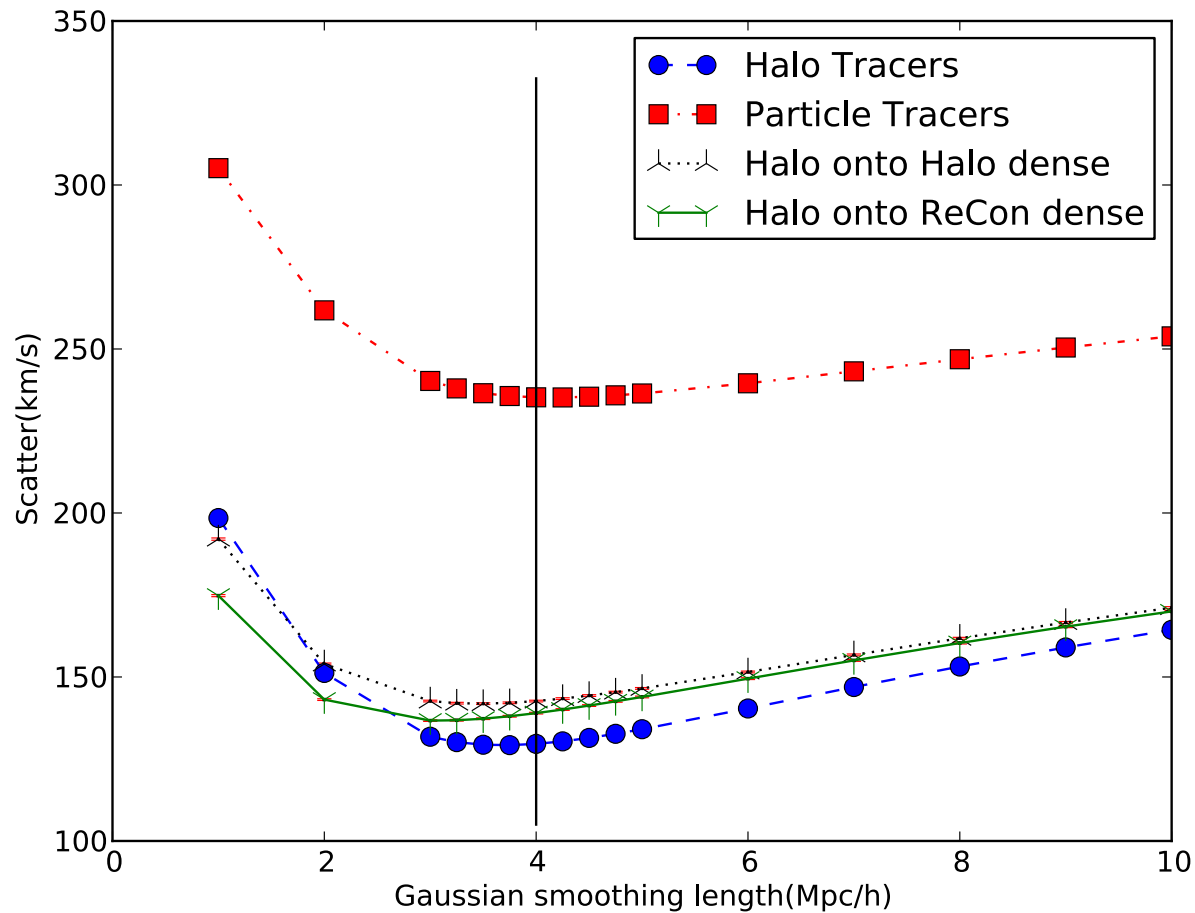
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Measurable

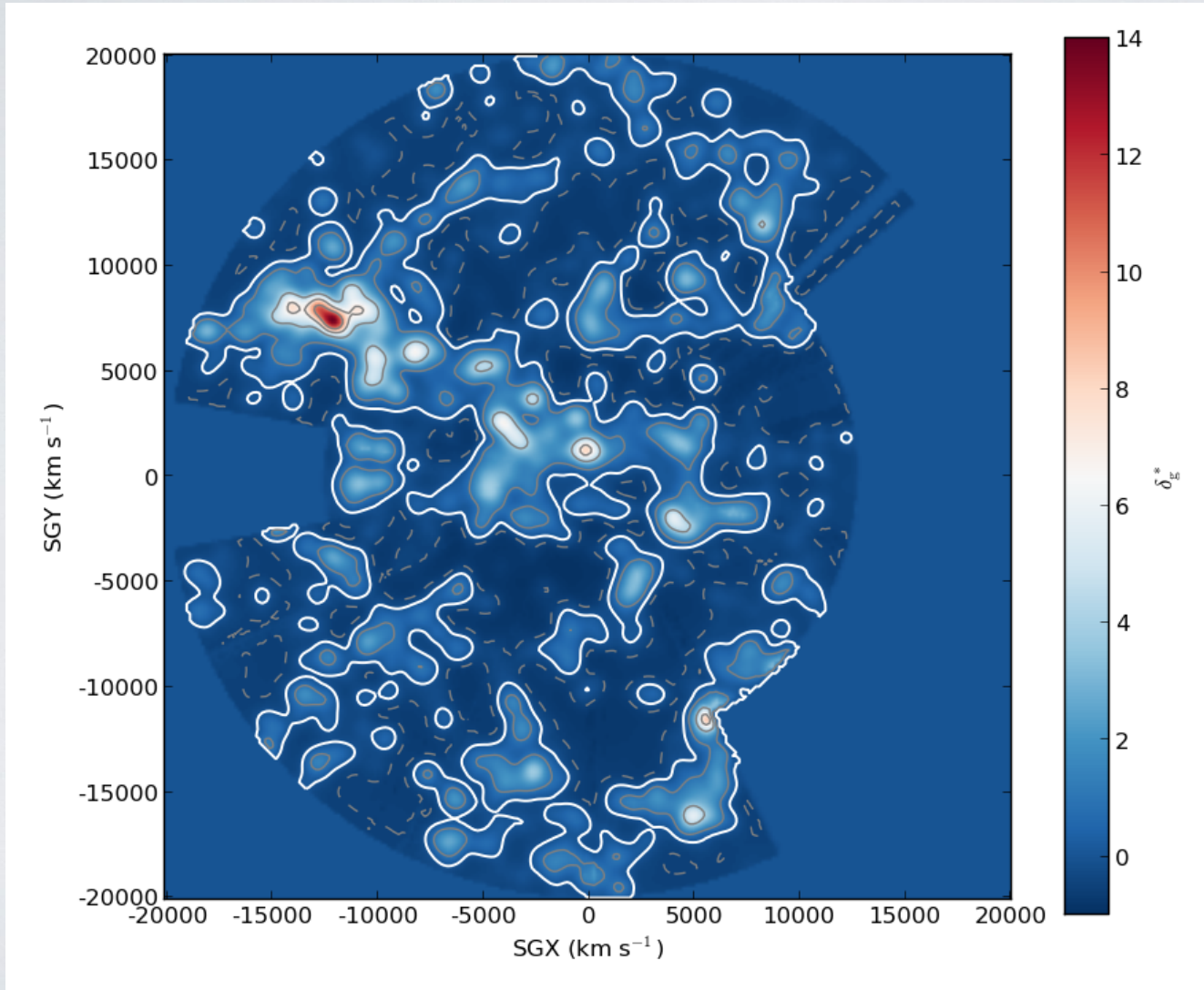
$$f\sigma_8 = \beta\sigma_{8,g}$$



TESTS ON SIMULATIONS

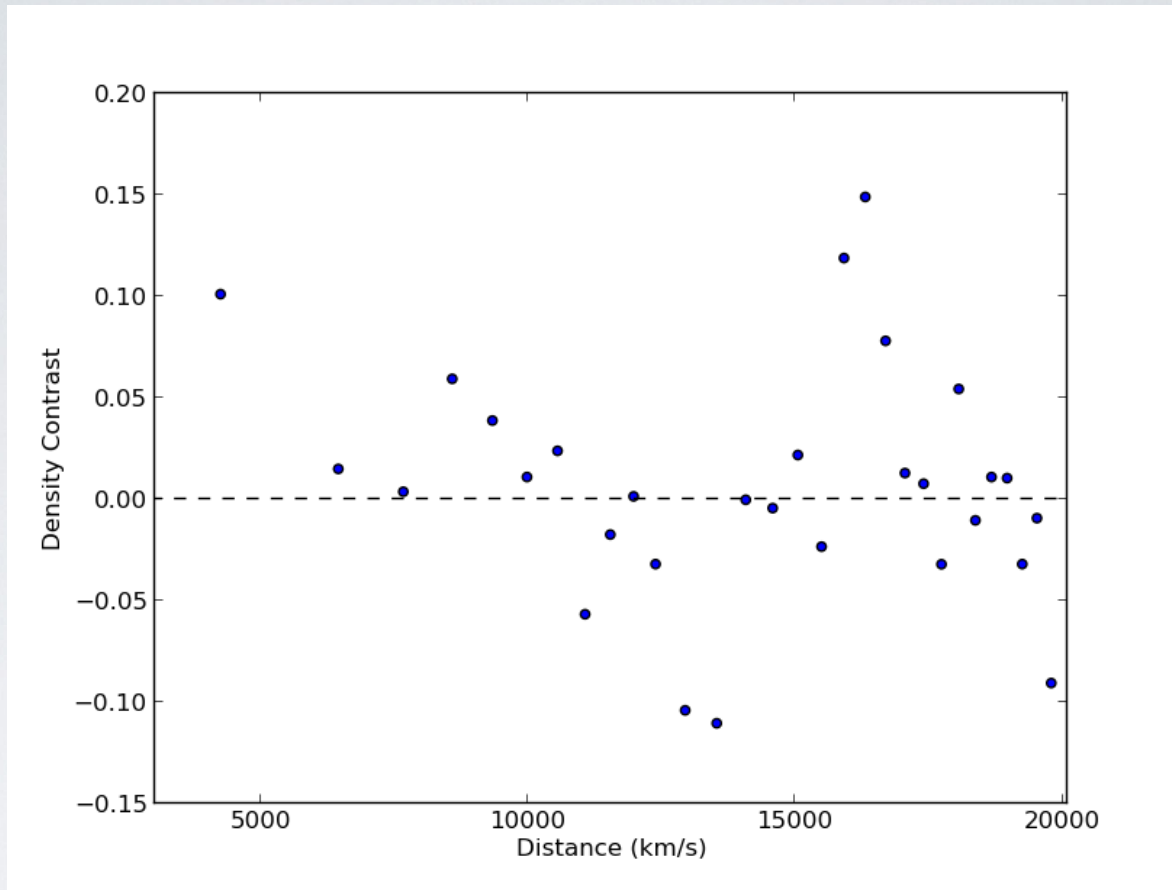
Scatter around linear theory is ~ 140 km/s for a Gaussian smoothing of 4 Mpc/h. Slope is unbiased at this smoothing

2M++ RECONSTRUCTION



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14

Preliminary



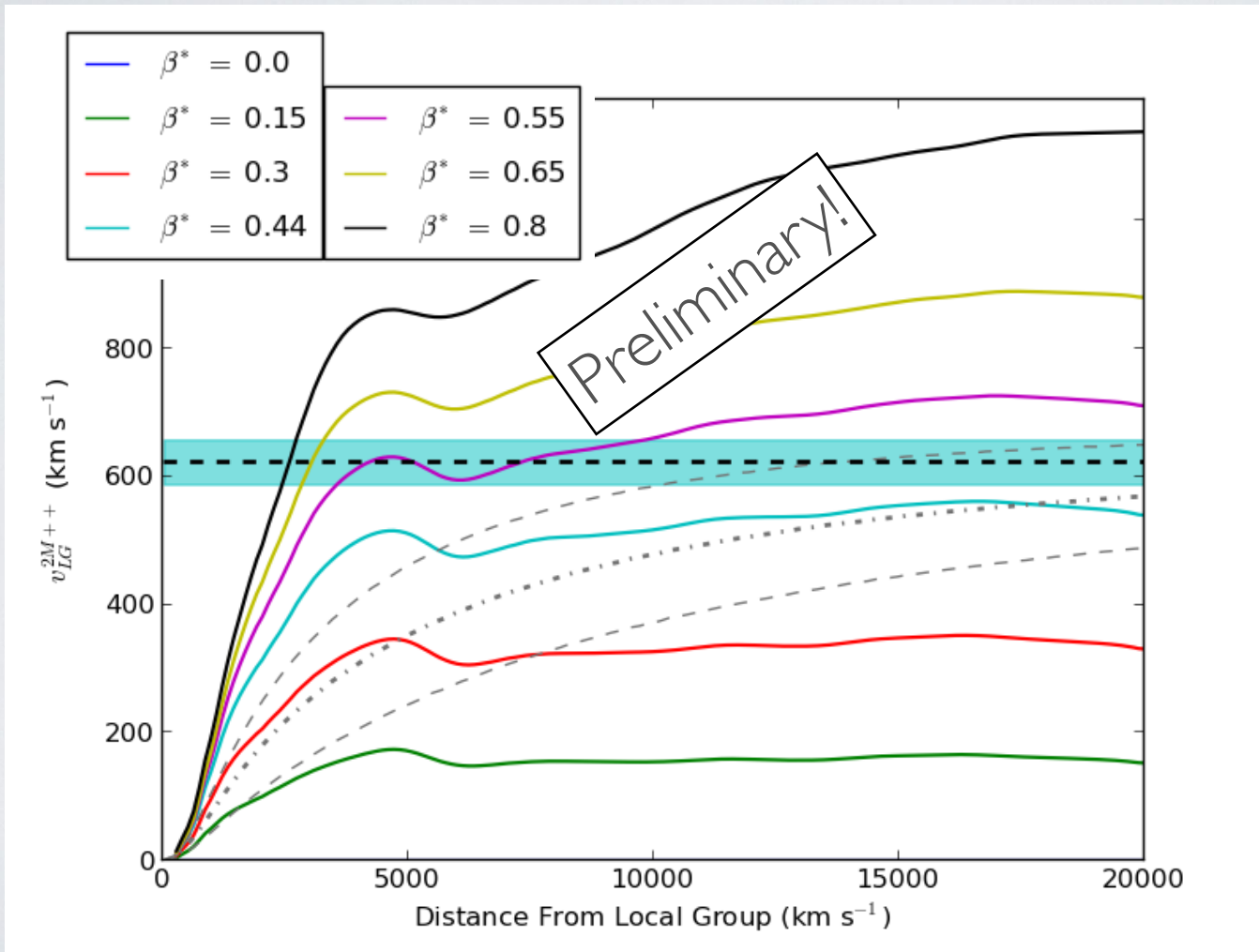
NO UNDERDENSITY

within 200 Mpc/h ($z < 0.07$)

Carrick
et al 14

Preliminary

2M++ GRAVITY DIPOLE



Alignment ~ 10 degrees

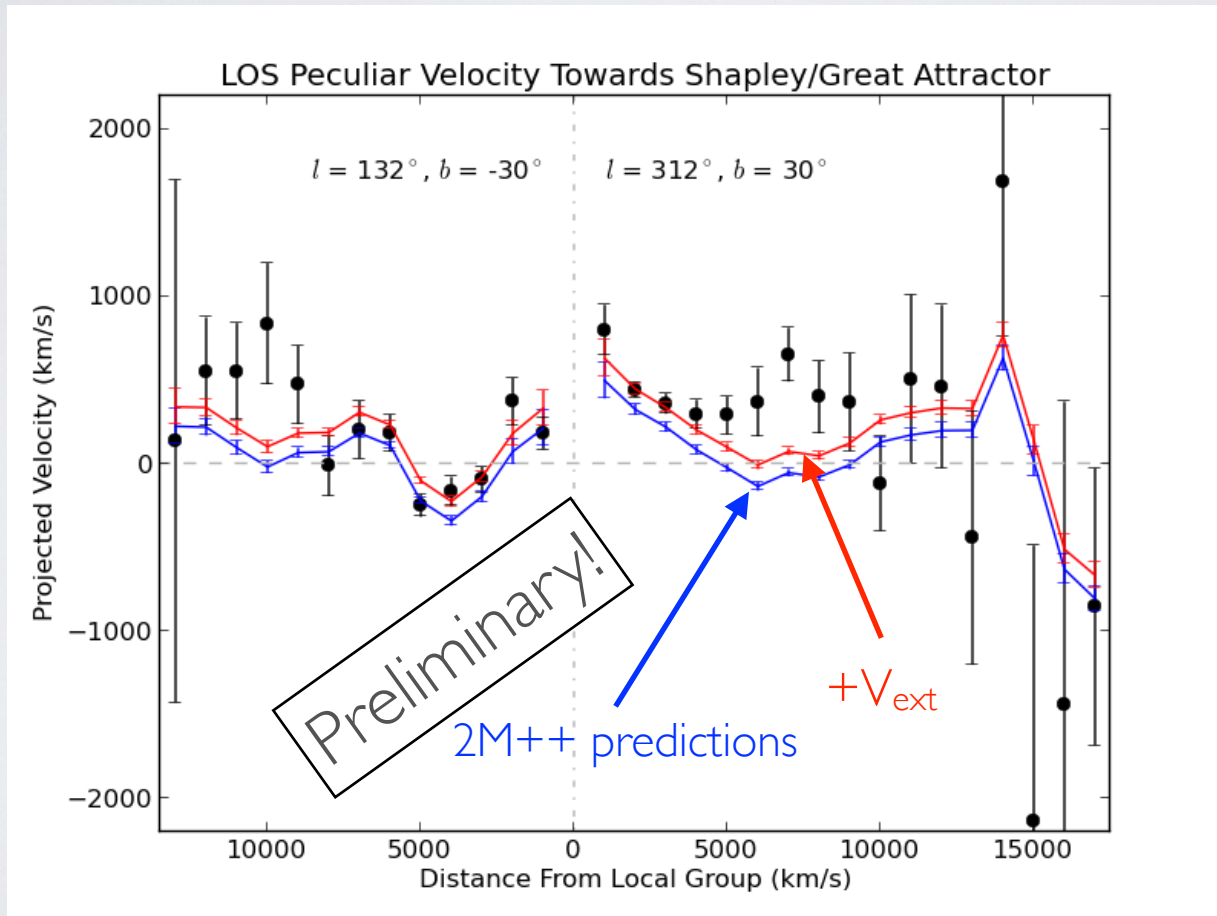
ΛCDM we expect ~ 40 km/s per component from material beyond 20000 km/s.

If $\beta^* \sim 0.45$ for this sample, then we have recovered much of LG dipole.

PECULIAR VELOCITY DATA

- **SFI++** (Spiral Field I-band)
 - Masters et al 2006, Springob et al 2007
 - Cut to exclude faint, low linewidth galaxies (similar to Davis et al)
- **“First Amendment” SNe** (245)
 - Compiled by Turnbull et al 2012

PREDICTIONS VS. OBSERVATIONS



- SFI++ data look quite good at distance of Shapley
- Reduced $\chi^2 \sim 1$

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Preliminary

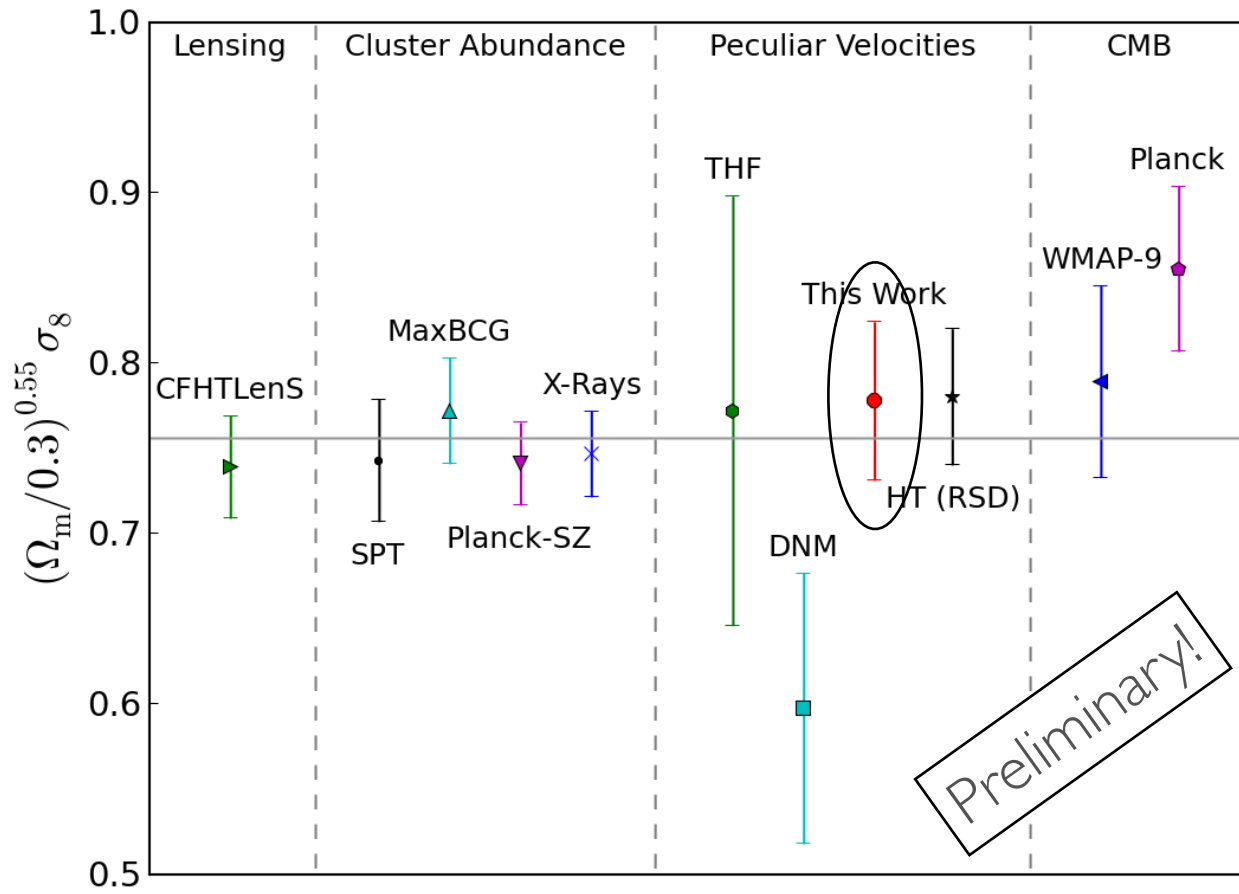
COSMOLOGICAL PARAMETERS

Combined with galaxy clustering measurements, peculiar velocities yield:

$$f \sigma_8 = 0.401 \pm 0.024$$

Preliminary!

Peculiar velocities are consistent with other cosmological probes on small (~ 20 Mpc/h) scales.



$f\sigma_8$ from different probes

Carrick et al

RESIDUAL BULK FLOW

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linear biasing not adequate?

FUTURE

- Deeper *all-sky* redshift surveys (TAIPAN + WALLABY+ WNSHS + ? ...) will help to identify sources
- New large peculiar velocity datasets from FP (6dF +TAIPAN), TF (WALLABY), SNe, and Planck kSZ

KINETIC SUNYAEV-ZELDOVICH FROM GALAXIES

Lavaux, Afshordi & MH '13, MNRAS, 430, 1617

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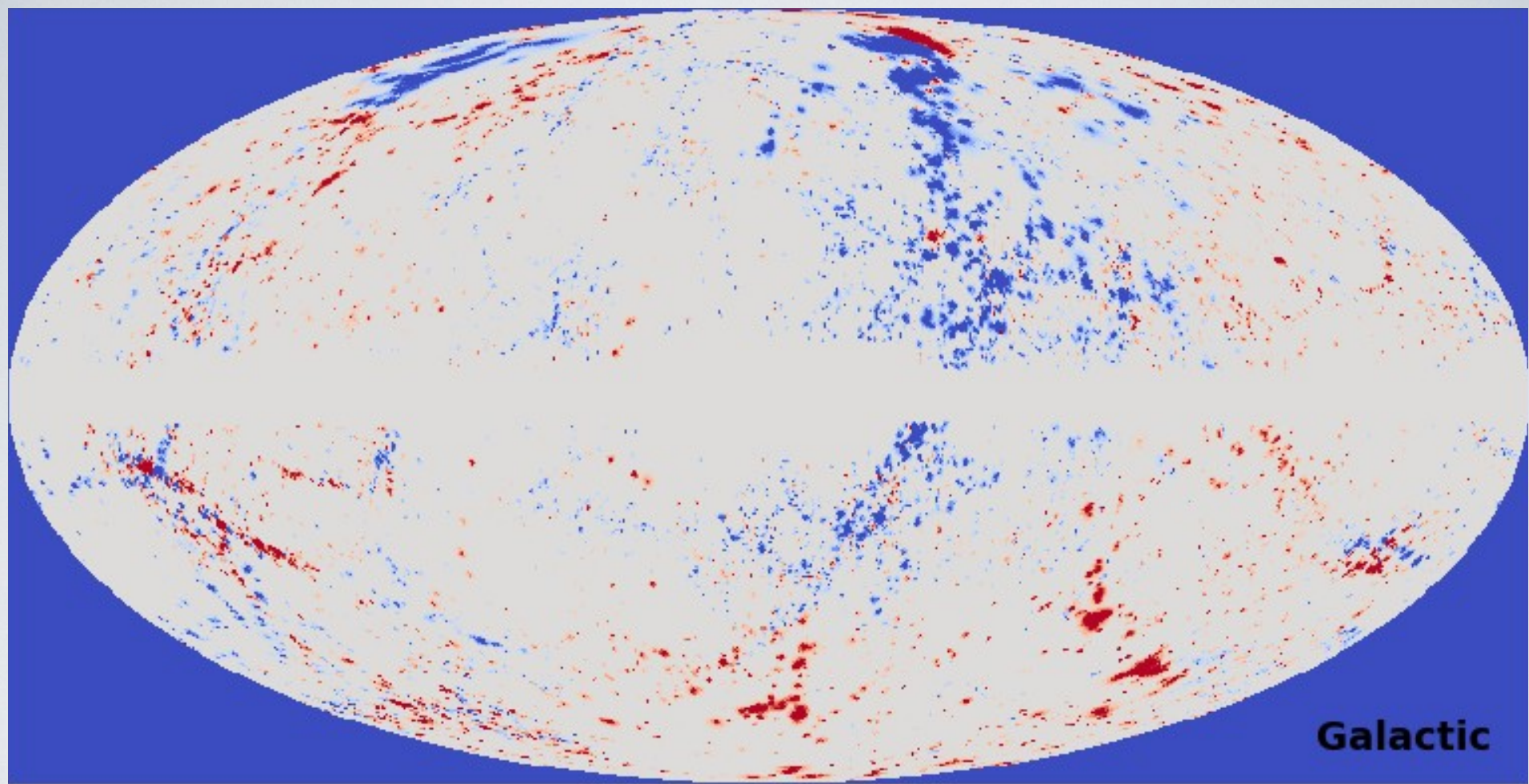
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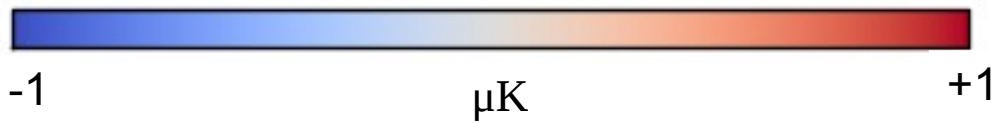
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- $V = 533 \pm 263$ km/s , in the direction $l \sim 324^\circ$, $b \sim -7^\circ$ similar in amplitude and direction to previous measurements on this scale (~ 50 Mpc/h)



Galactic



-1

μK

+1

FUTURE

- Deeper *all-sky* redshift surveys (TAIPAN + WALLABY+ WNSHS + ? ...) will help to identify sources
- New large peculiar velocity datasets from FP (6dF +TAIPAN), TF (WALLABY), SNe, and Planck kSZ
- Better treatments of “biasing” (halo model)
- Better non-linear treatment of predicted peculiar velocities (e.g. 2LPT, MAK, etc)

SUMMARY

- Only ~ 6000 peculiar velocities give competitive constraints on $f \sigma_8$.
- 2M++ recovers most of the LG motion *wrt* CMB, but there remains a significant “external” contribution.

Cosmic flows estimated from direct peculiar velocity estimates have great potential : need systematic SDSS-like surveys!