Study of cosmic expansion anisotropy with type Ia supernovae from ZTF.

Chloé Barjou-Delayre,
Under the direction of Philippe Rosnet

UNIVERSITÉ Clermont Auvergne

LPC Particules pLasmas Univers applicationS
Laboratoire de Physique de Clermont

ZTF Meeting
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Simulation:

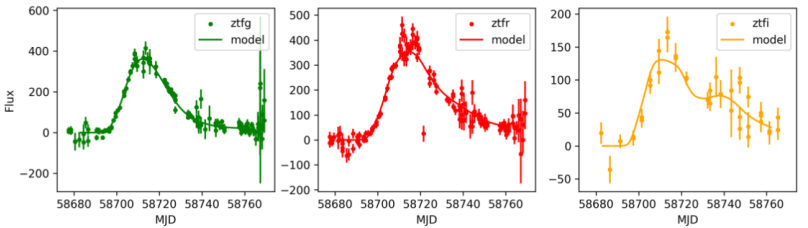
- Contains all observation information : maglim, field of observation, possible technical problem

ZTF observing logs

Skysurvey

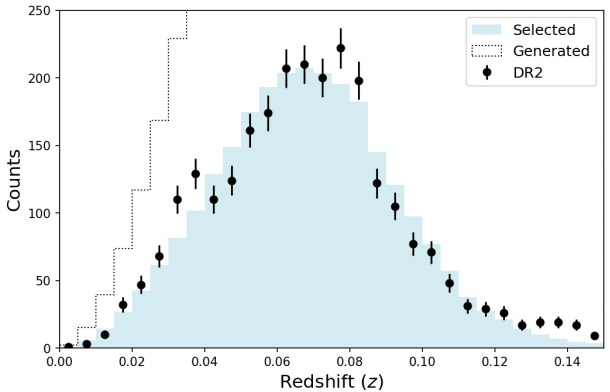
SN Ia model

- Sncosmo : SALT2



M.Amenouche et al., arXiv:2409.04650 (submitted)

- Simulates astronomical targets as they would be observed by a survey



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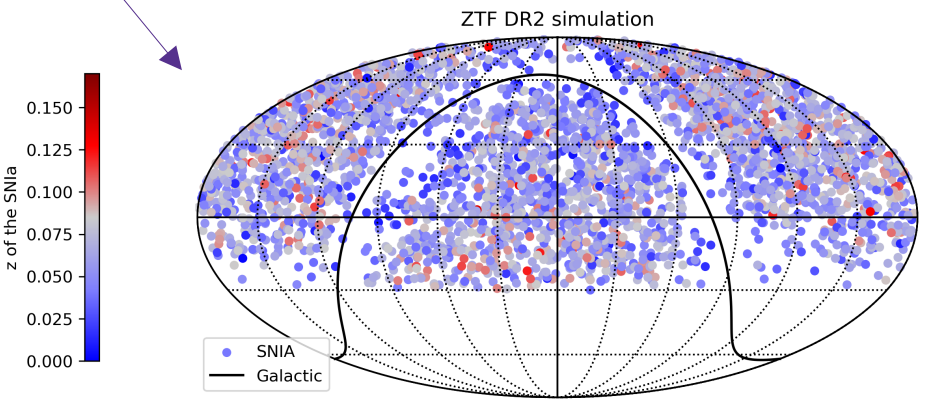
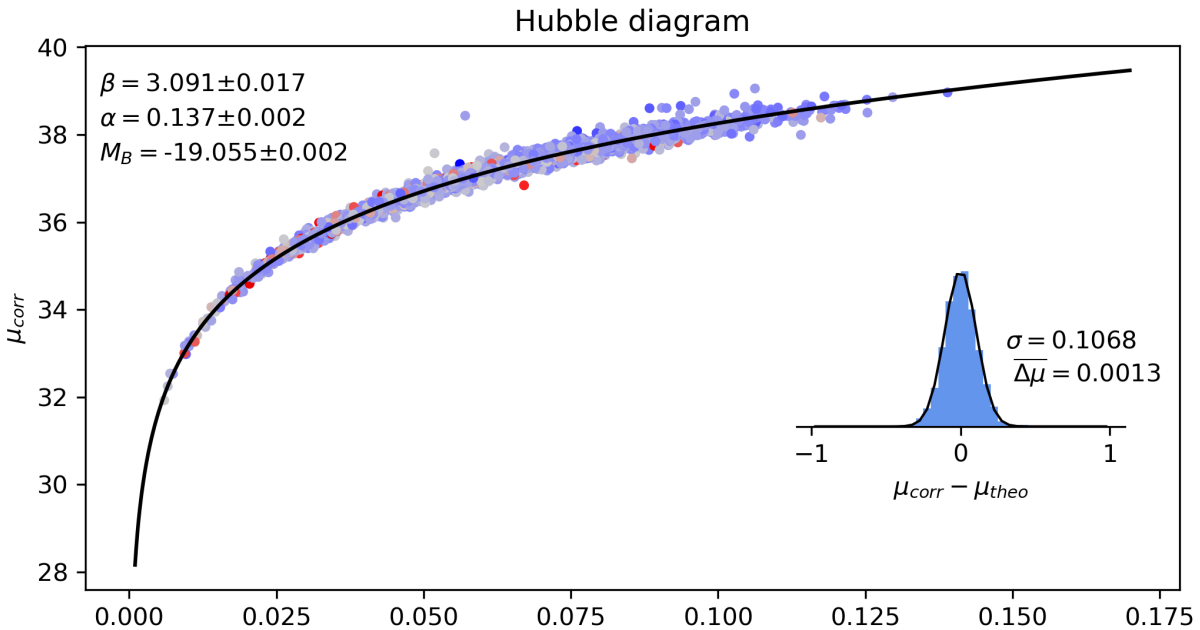


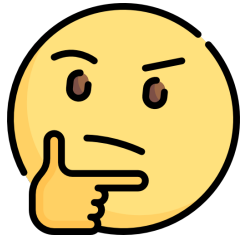
Hubble Diagram of a simulated survey after standardisation:



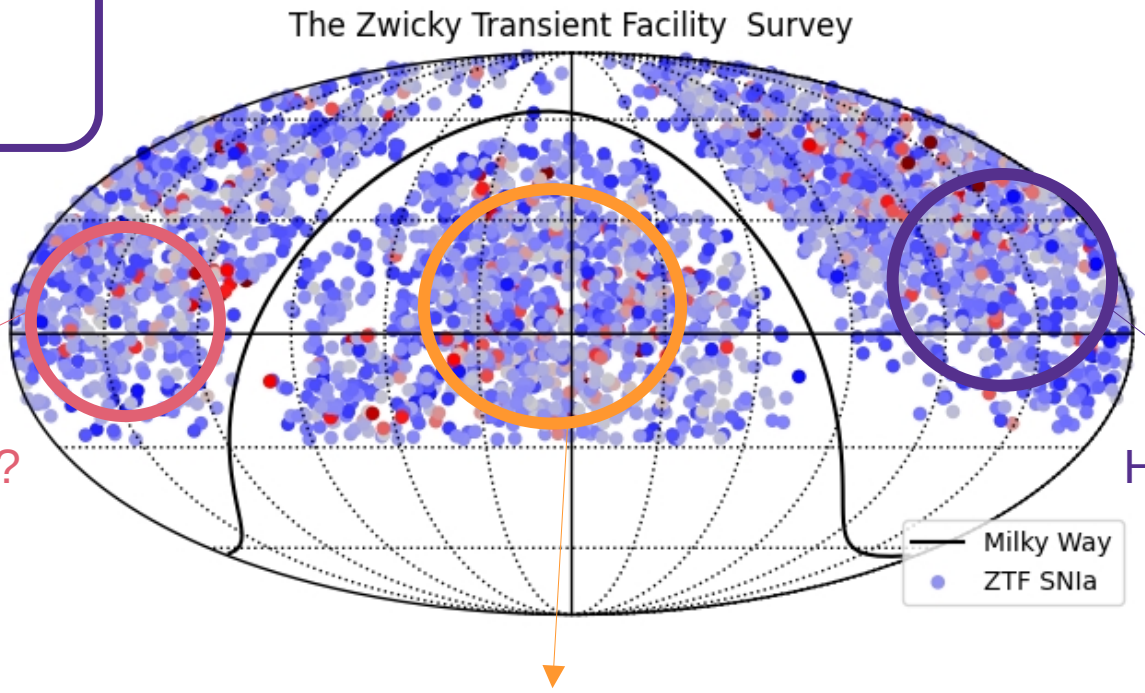
- Fit α, β, M_b for the survey

- With fixed cosmology :
  - Flat ΛCDM
  - $\Omega_m = 0.315$
  - $H_0 = 70$ km.s^{-1}.Mpc^{-1}

Anisotropy:



- With α, β, M_b and Ω_m fixed
- H_0 and σ free

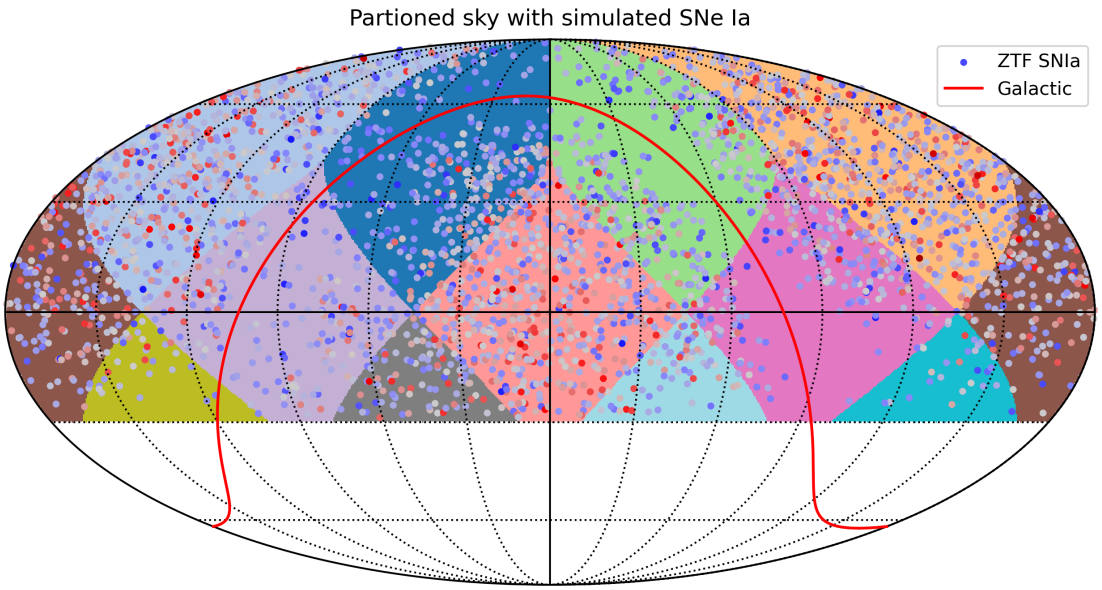


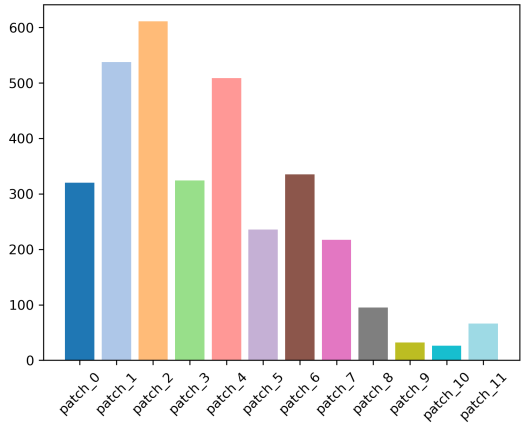
$H_0 = 68$ km.s^{-1}.Mpc^{-1} ?

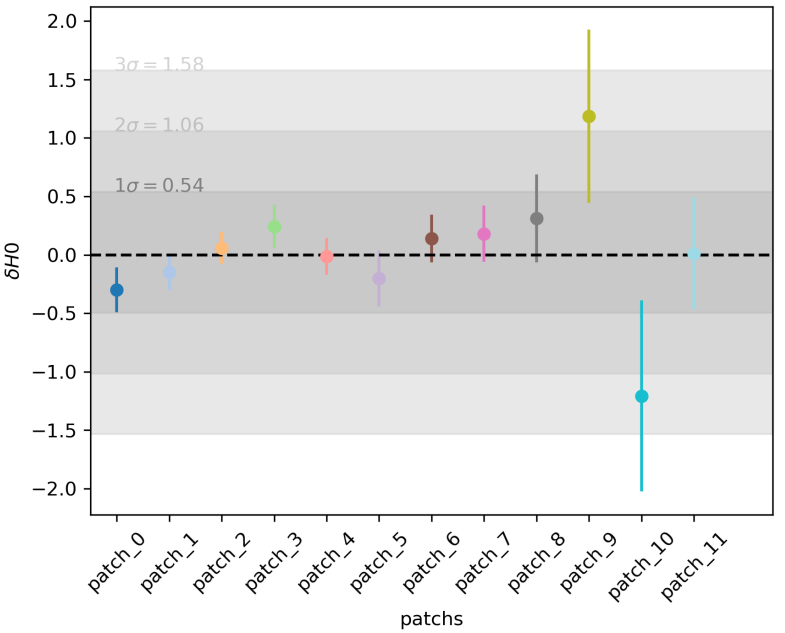
$H_0 = 73$ km.s^{-1}.Mpc^{-1} ?

$H_0 = 70$ km.s^{-1}.Mpc^{-1} ?

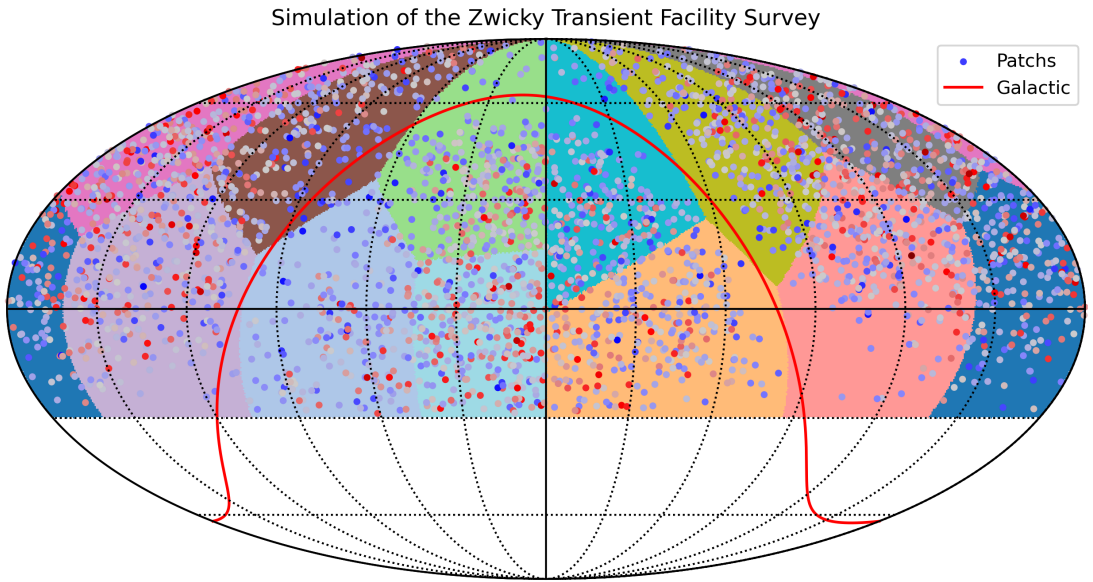
Healpy method (fixed patch):

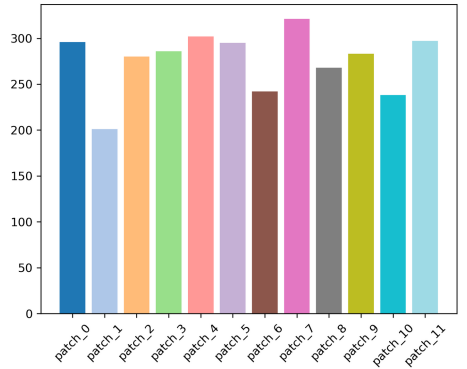


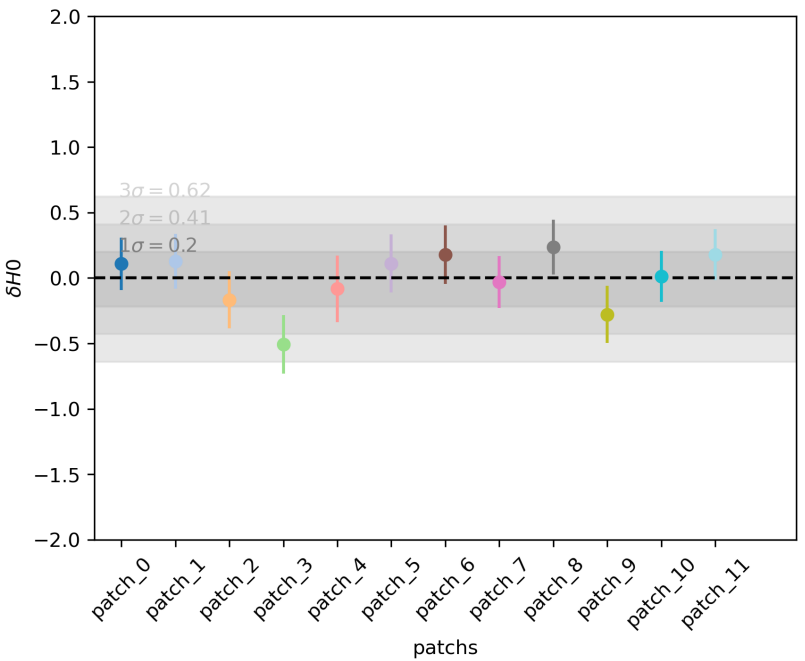




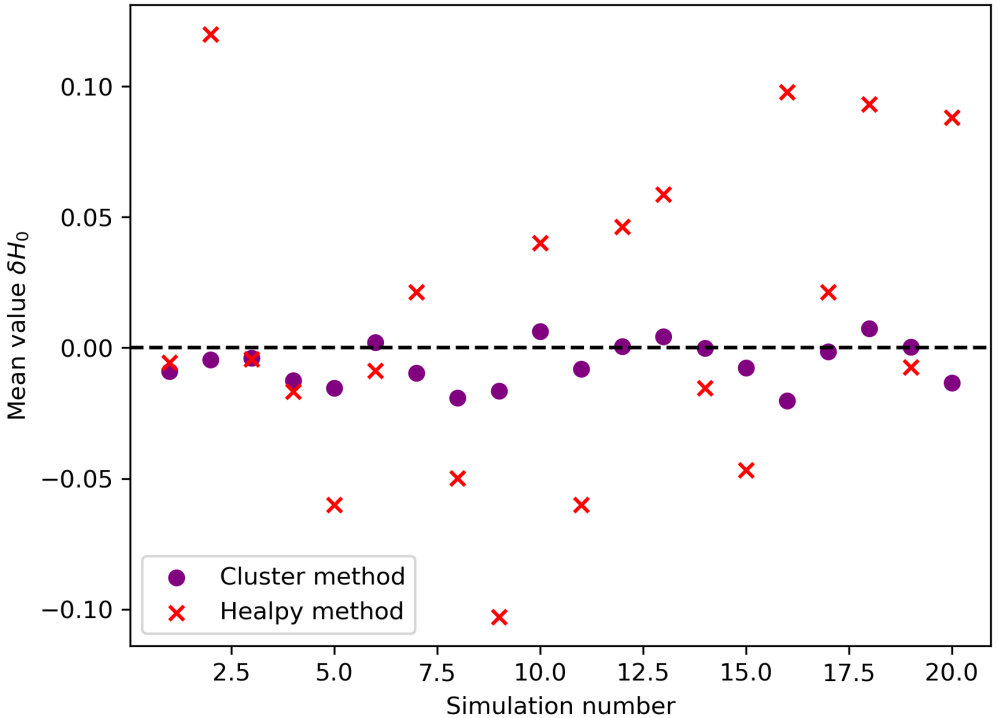
Cluster method (adapted patch):

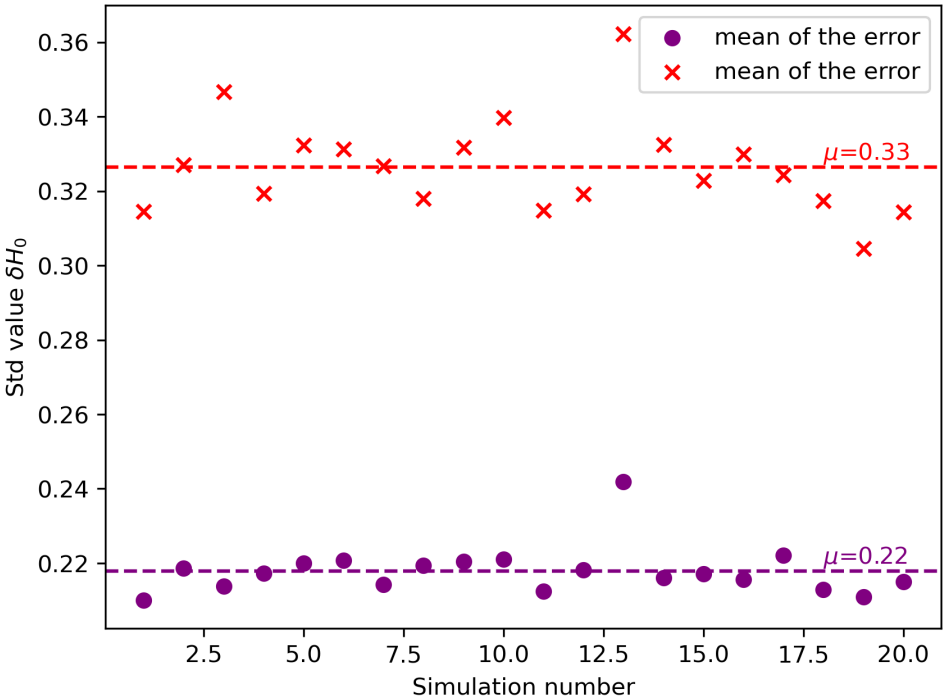






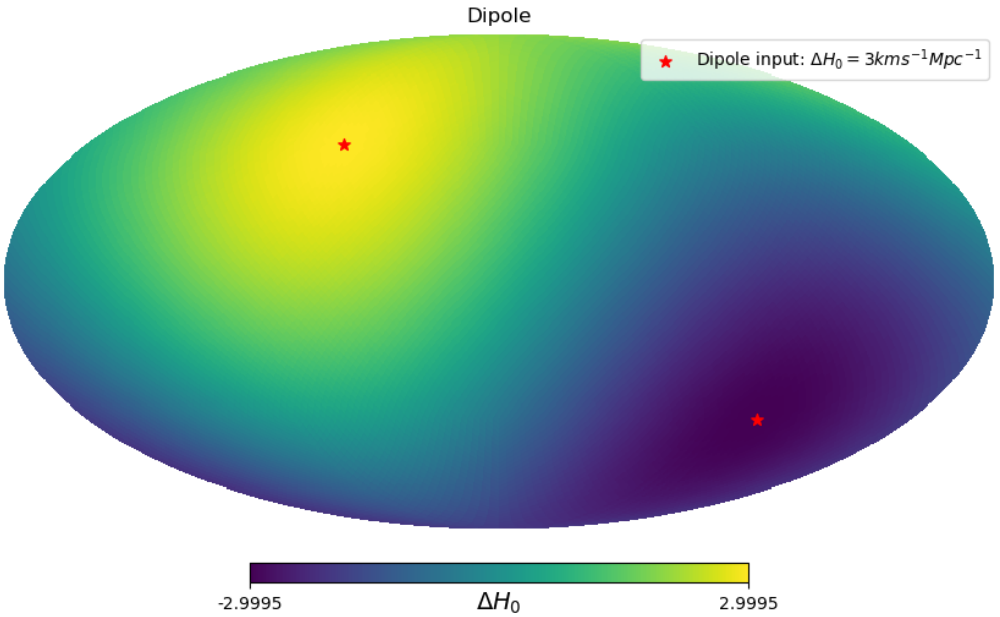
Several Simulation:





- Sensitivity of 0.22 km.s^{-1}.Mpc^{-1} at a confidence level of 1σ
- for Cluster method with no anisotropy effect in input.

Adding a dipole effect:



$H_0 = 70$ km.s^{-1}Mpc^{-1}

$\Delta\theta = \theta^{i}_{SNIa} - \theta_{dipole}$

$$cz' = H_0' d = \left(H_0 + \Delta H_0 \cos\left(\Delta\theta\right)\right) d$$

$$z' = \left(1 + \frac{\Delta H_0 \cos\left(\Delta\theta\right)}{H_0}\right) z$$

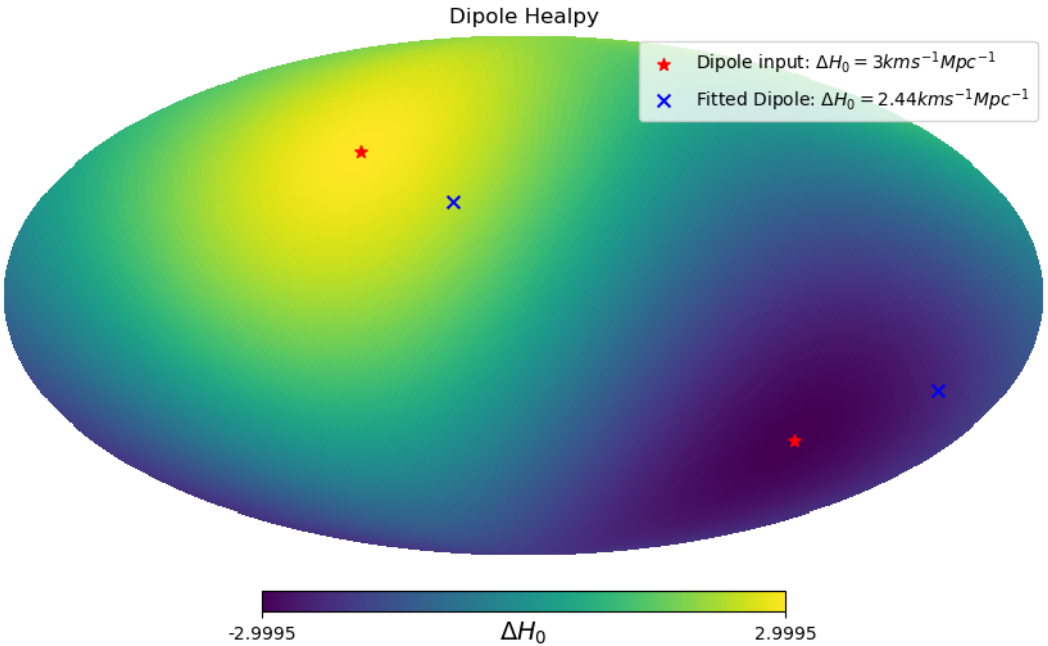
$\Delta H_0 = 3$ km.s^{-1}Mpc^{-1}

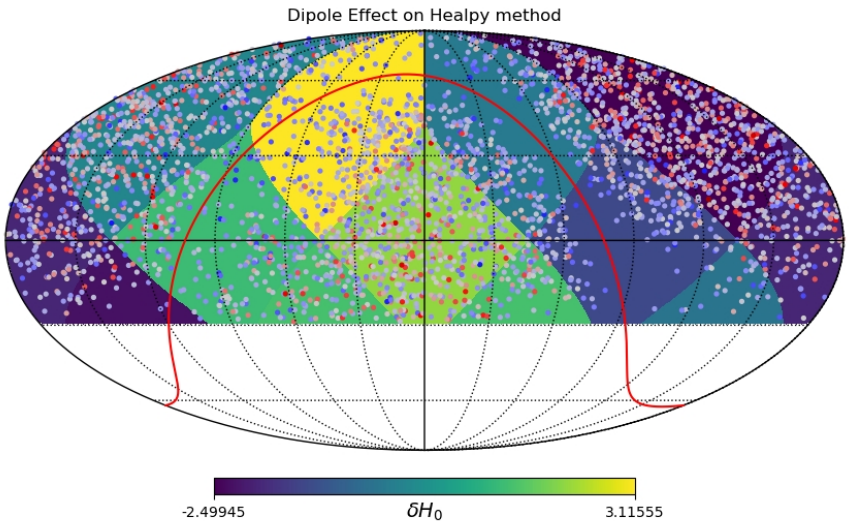
Fit a dipole for the Healpy method:

Free

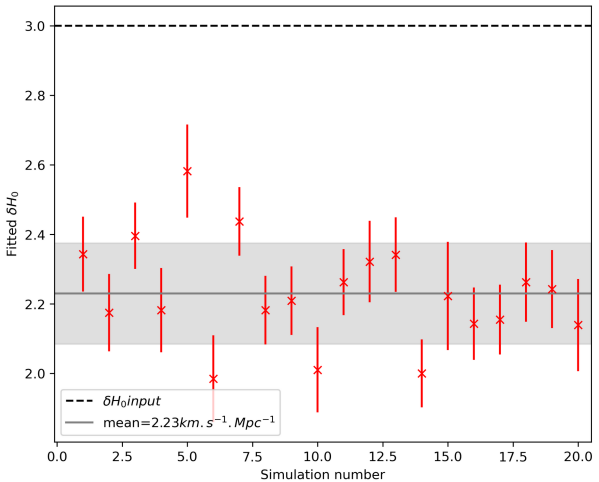
$$\chi^2 = \sum_{i=1}^{N_{patch}} \left(\frac{\delta H_0^i - \delta H_0^{th,i}(\theta_i, \theta_{dip}, \Delta H_0)}{\sigma_{\delta H_0^i}} \right)^2$$

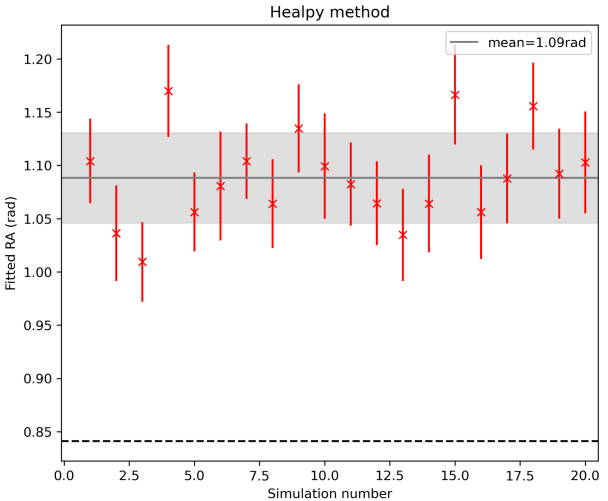
$$\delta H_0^{th,i} = \Delta H_0 \cos(\theta_i - \theta_{dip})$$

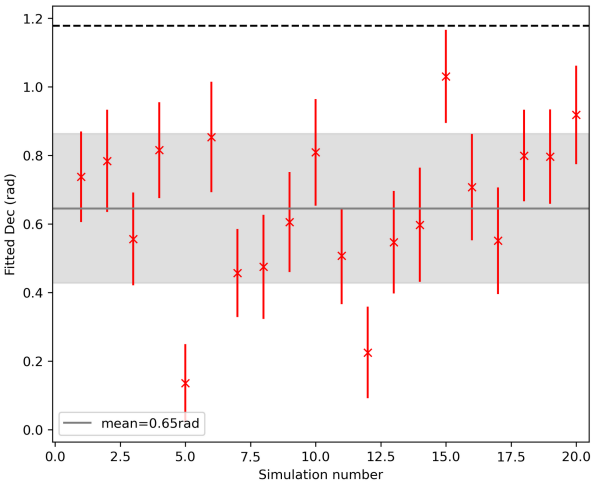


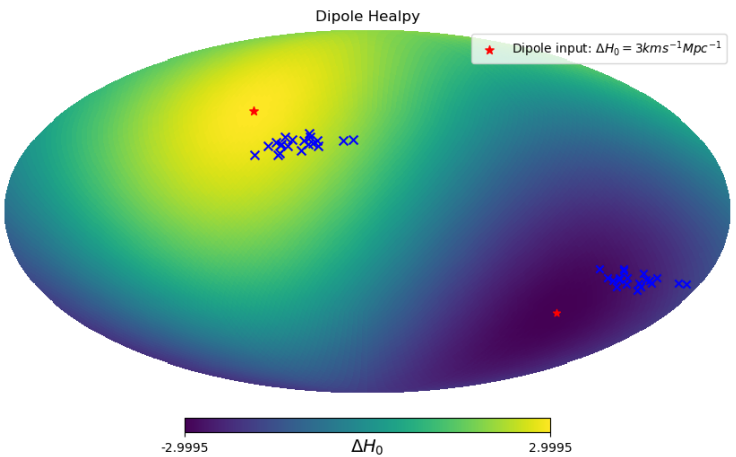


Healpy fit dipole:



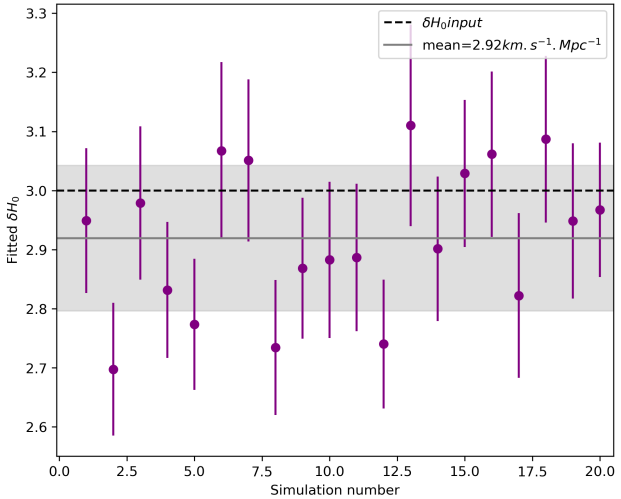


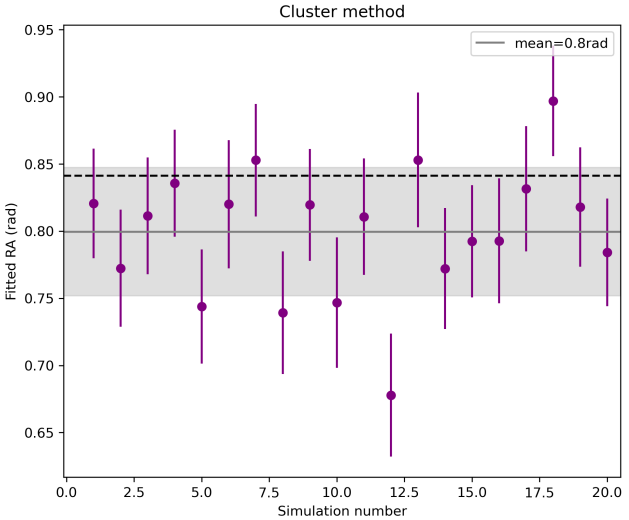


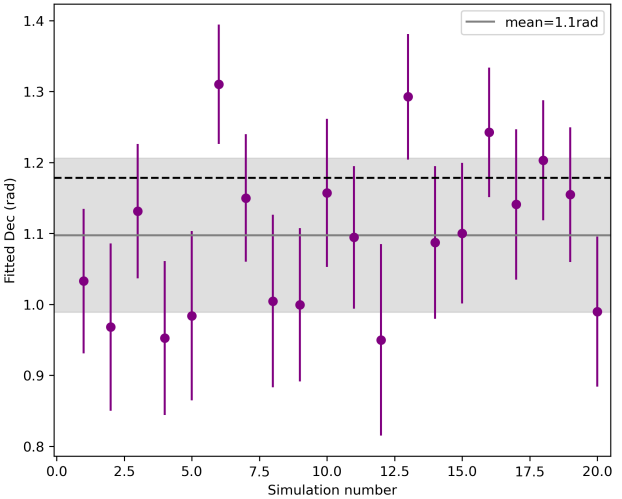


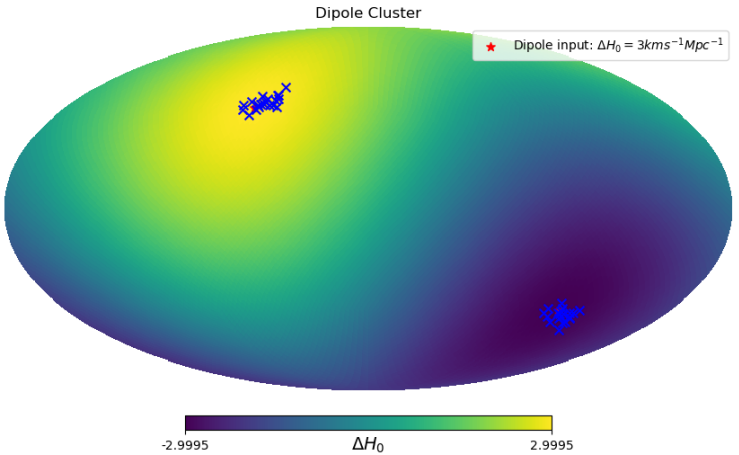
- Systematics bias

Cluster fit dipole:



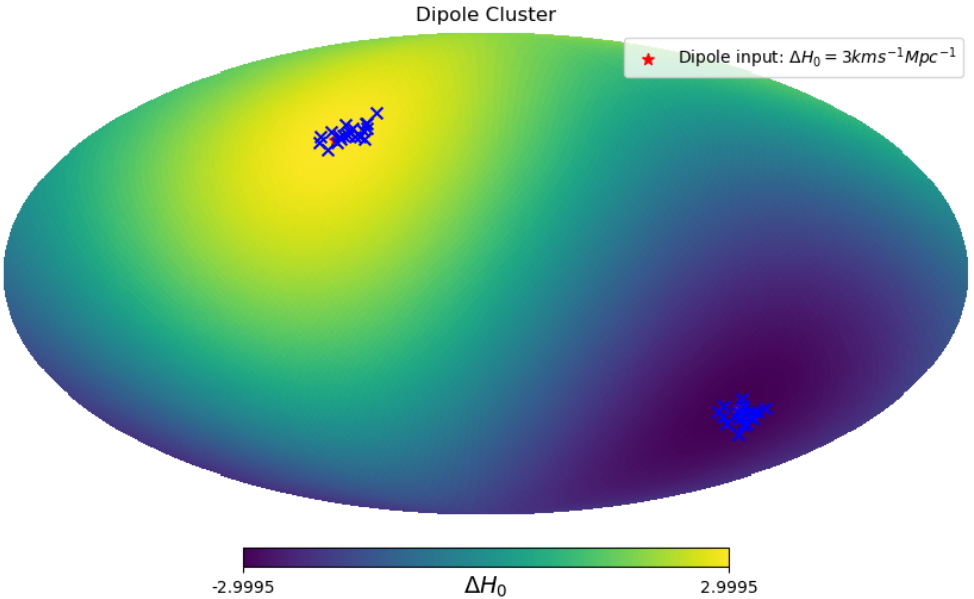


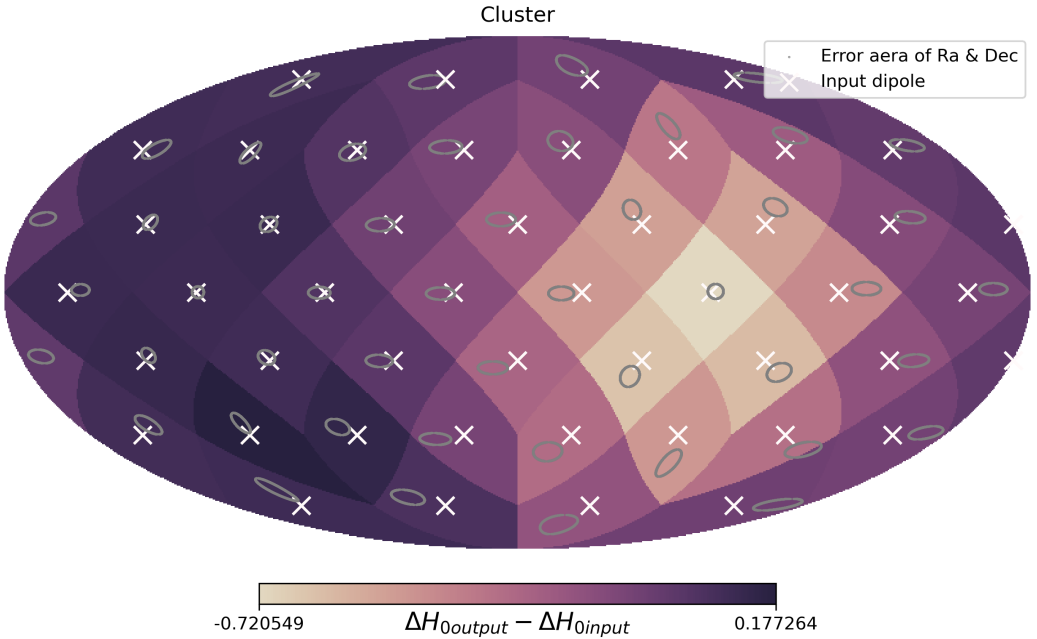




- No Systematic bias

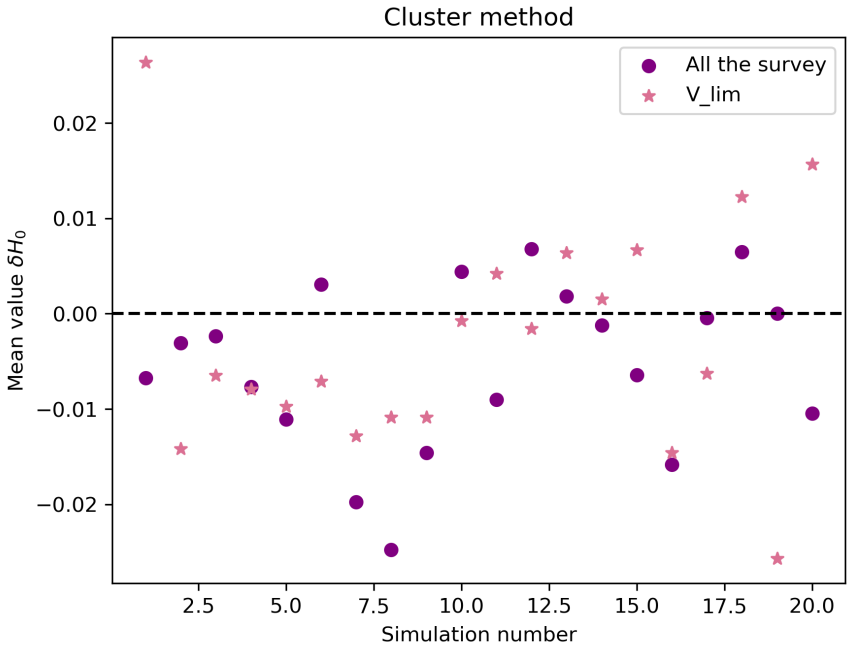
Cluster fit dipole:

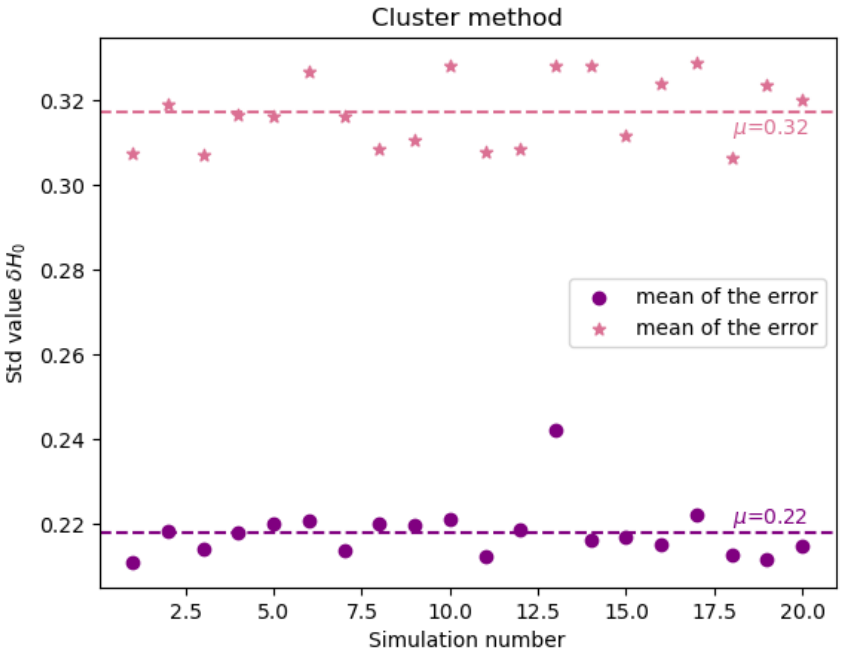




- More difficulty to fit the input dipole close to the south celestial pole.

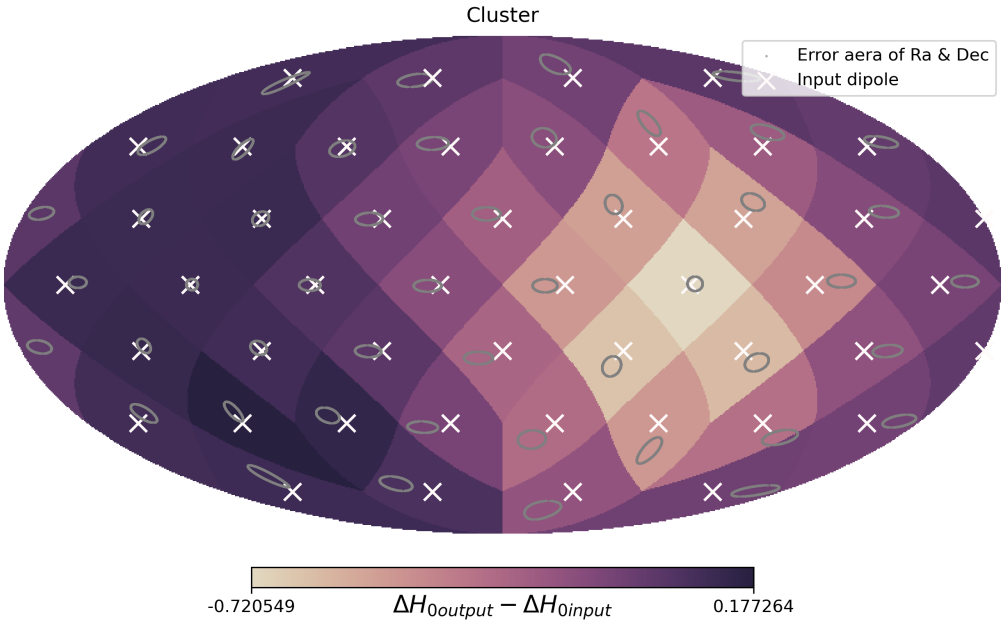
Volume limites :

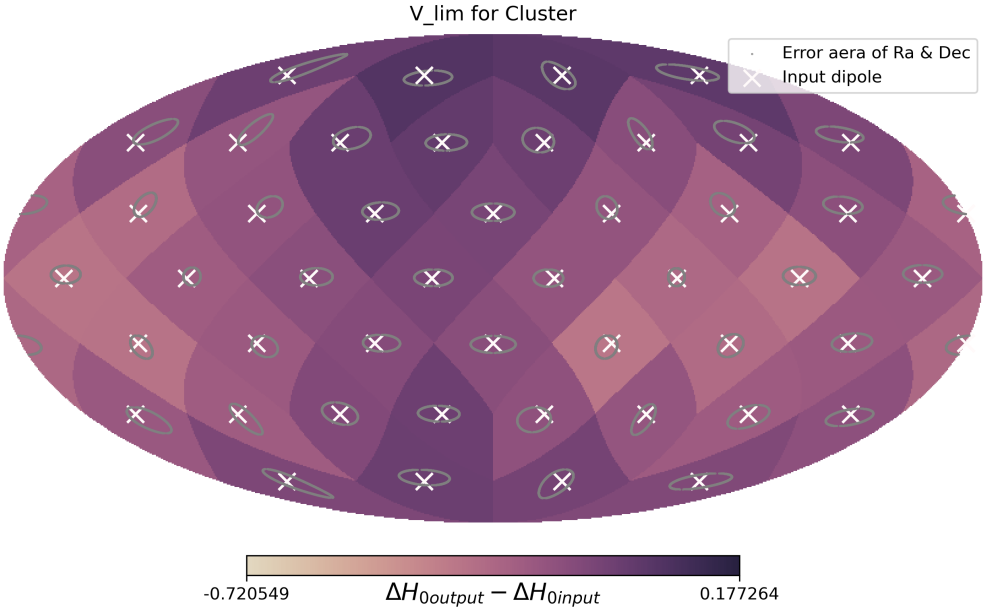




- Sensitivity of 0.32 km.s^{-1}.Mpc^{-1} at a confidence level of 1σ
- for the V_lim for the Cluster method with no anisotropy effect in input.

V_lim fit dipole:





- Less biased with the volume limited

Conclusion:

- Summary :
  - The clustering method is more precise and sensitive than Healpy methods.
  - Sensitivity of 0.22 $km.s^{-1}.Mpc^{-1}$ at a confidence level of 1σ for Cluster method with no anisotropy effect in input.
  - The healpy method introduce a bias in the reverse fit dipole.
  - Sensitivity of 0.32 $km.s^{-1}.Mpc^{-1}$ with the Volume limite and less biased.

- Perspective :
  - Anisotropy fit with MCMC.

  - Test the impact of different Dustmaps.

  - More complexe anisotropy effects.

  - Adding large scale structure in the simulations.

  - Test a continuous function

  - ..