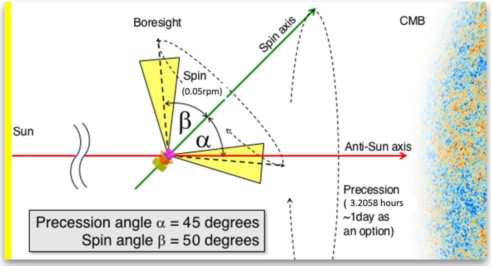
Instrument Performance Model

Louise Mousset for the IMo_Perf team

Instrument Model (IMo)

a versioned and consistent database to store and share instrumental parameters within the collaboration
+ a documentation of the conventions, and assumptions for each IMo version

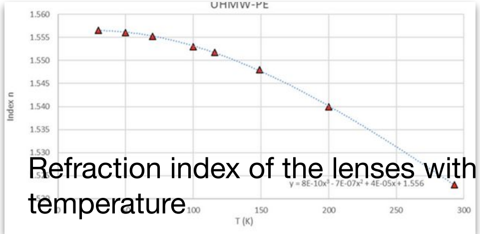
Scanning strategy



LiteBIRD Instrument Model (IMo):

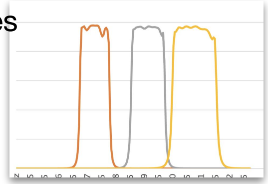
"low-level" parameters + errors required for predictions of the Instrumental response

"high-level" parameters required for simulations & data analysis eg: quaternions for beams, NEP deduced from instrumental design, pointings

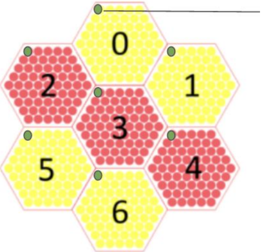


Refraction index of the lenses with temperature

Bandpasses



Focal planes and conventions



HWP

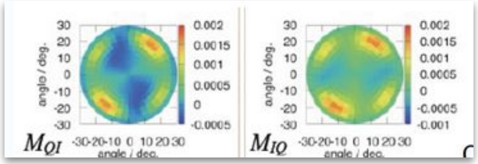
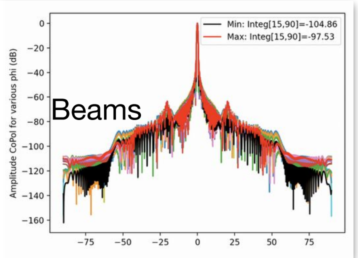


Table 2. HFT detector model.

Parameter	Value
Efficiency	0.75
Absorptance	0.15 (T_r = 0.10K)
Reflectance	0.10 (T_r = 0.17K)



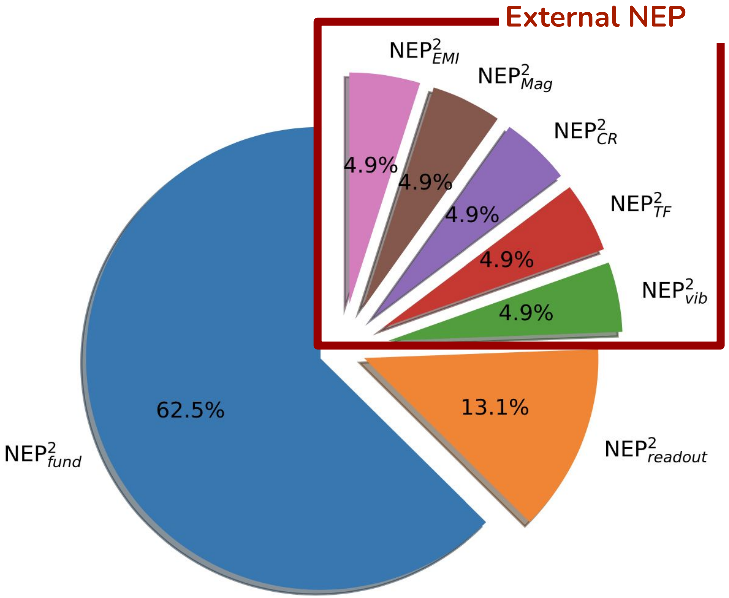
Beams

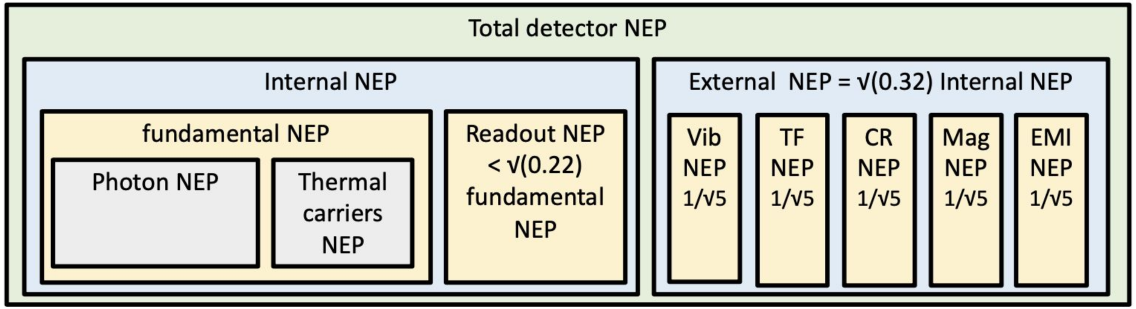
Credit: slide from S. Henrot-Versillé

Error budget

Main scientific driver: $\delta r < 0.001$

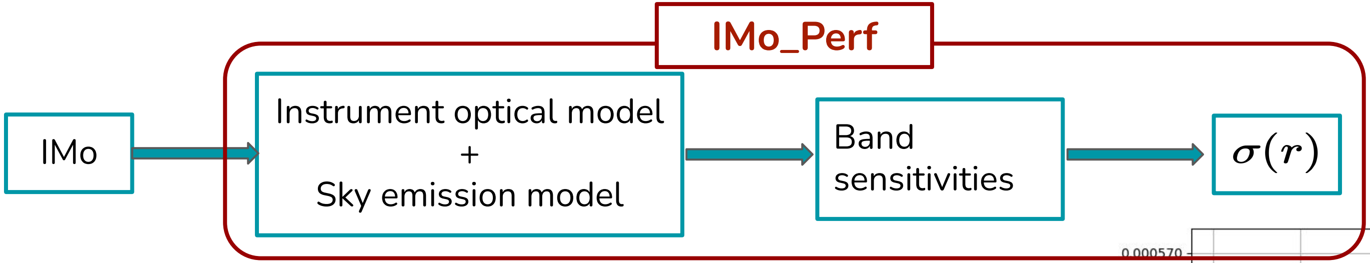
Noise Equivalent Power (NEP) allocation:



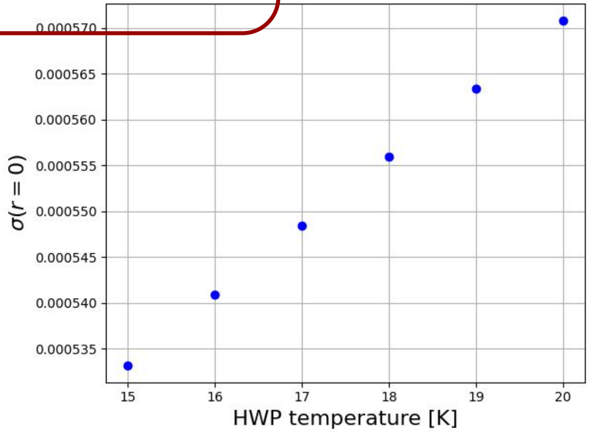


Instrument performance model code (IMo_Perf)

Performance code is made to provide sensitivities from instrumental parameters:
- based on a previous code that was developed first for LFT and then extended to MHFT.
- available on the collaboration GitHub: https://github.com/litebird/LiteBIRD_perfo_model.git
- as modular as possible so that we can easily include design update, refined model…

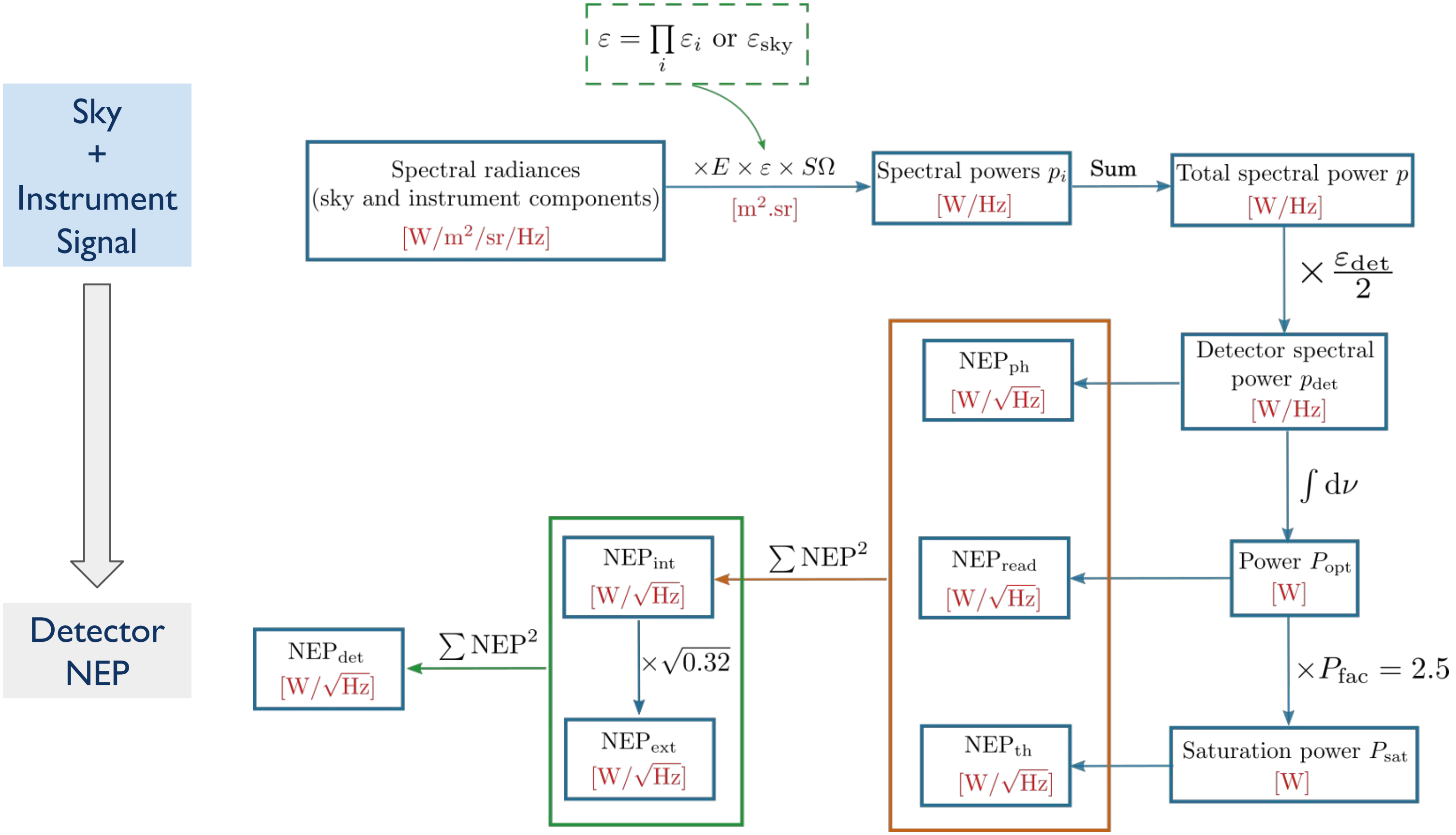


This code treats **statistical uncertainties, NOT systematic uncertainties** which are treated by other frameworks.

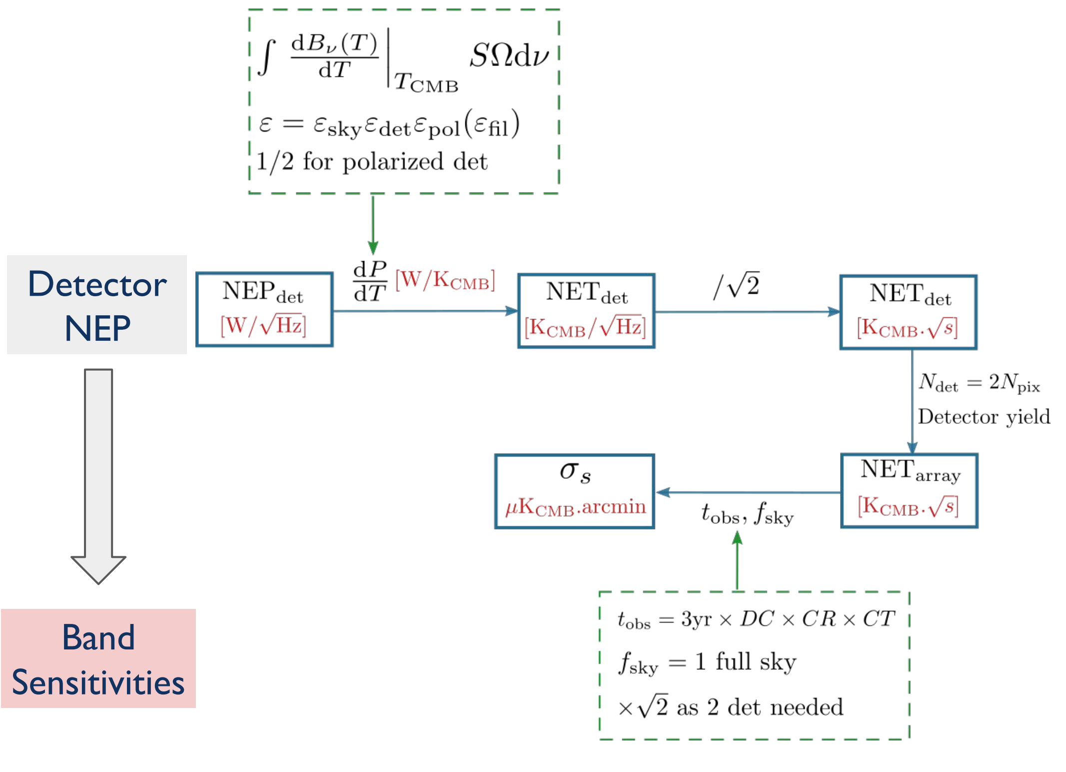


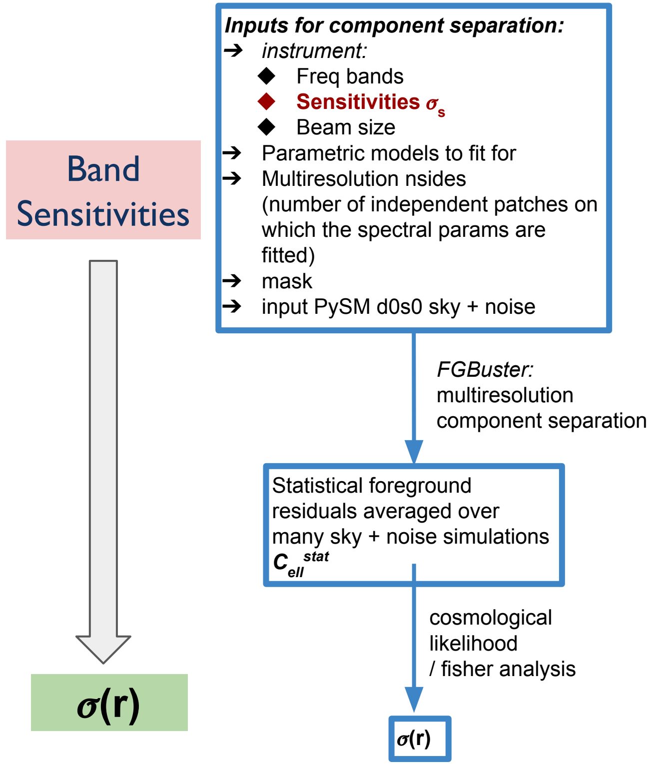
Main usages:
- Assess the impact of any instrument parameter on the scientific performance => See what parameter has to be improved
- Compare several designs => Improve the instrument design

NEP computation



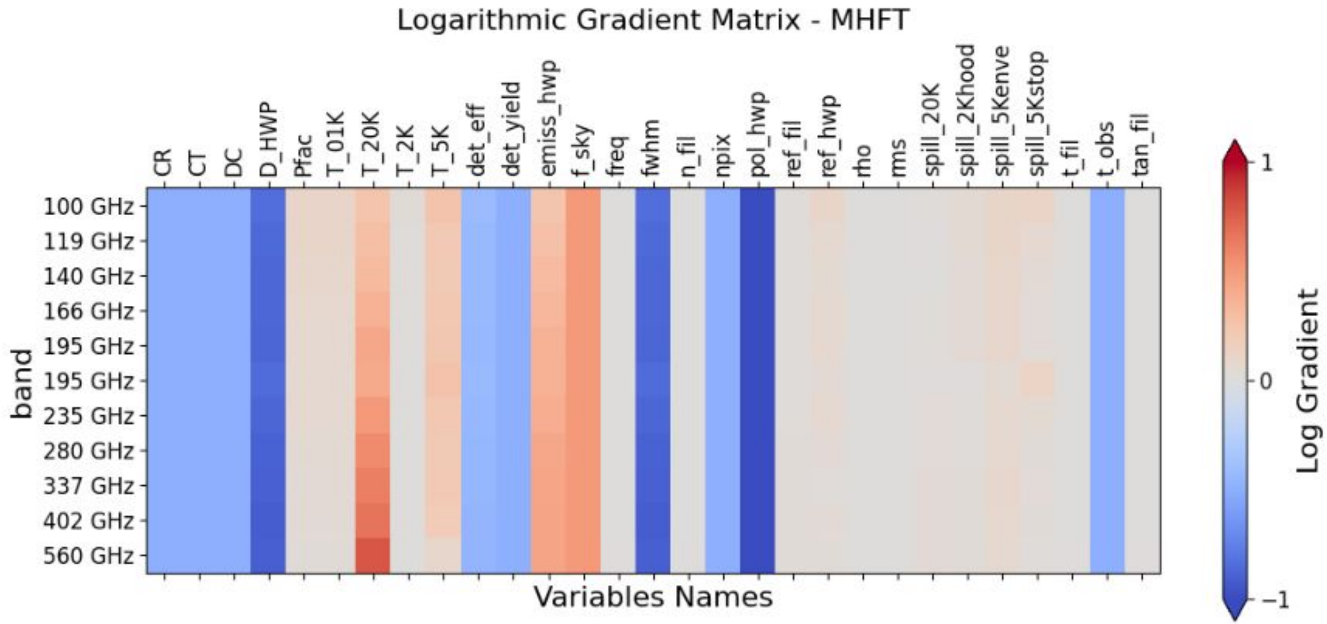
From NEP to sensitivities and σ(r)





Autodifferentiable framework

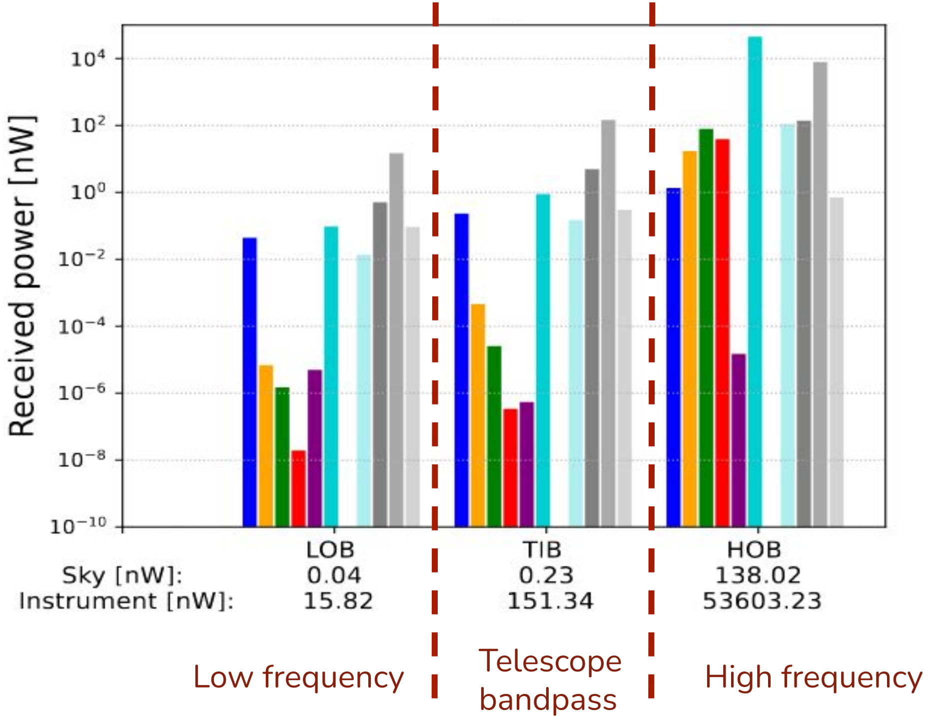
Recent improvement by E. Carinos:
The computation of the band sensitivities is made in JAX.
=> We have access to the gradient of any variable
=> Allows to see very quickly the impact of each instrument parameter



Additional feature: thermal heat load

Thermal heat load computation on any optical element (for MHFT only):

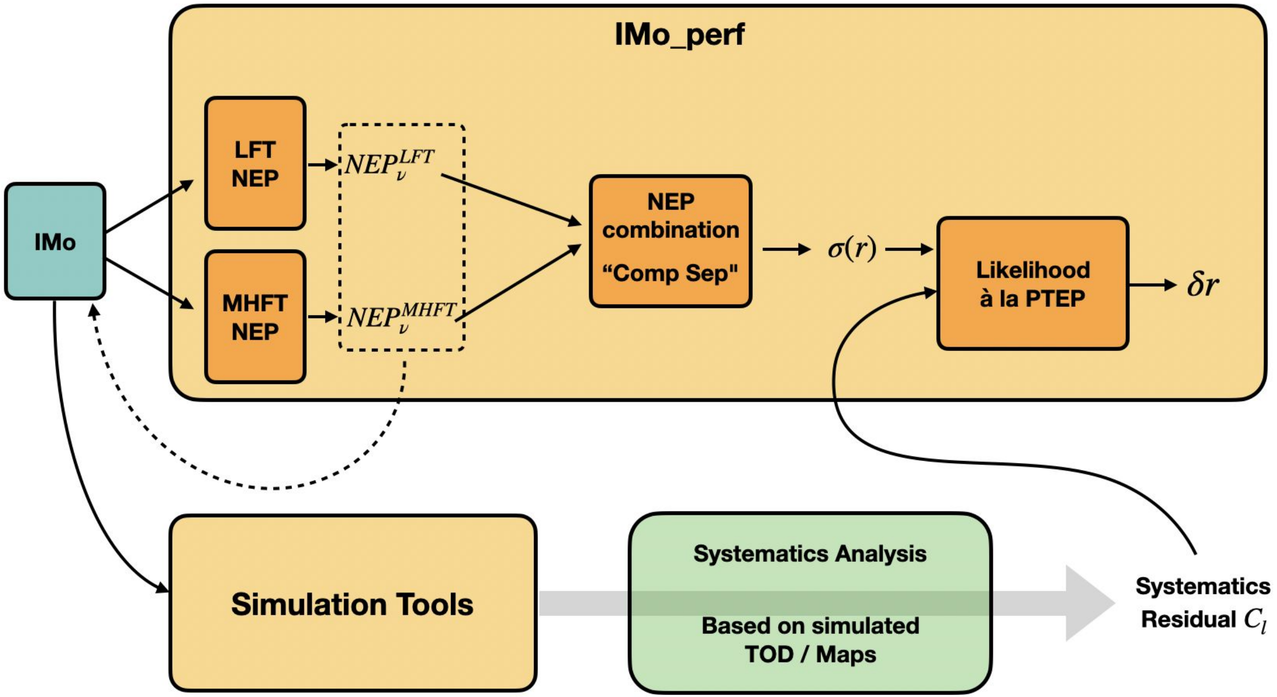
Power on lens L1:



Summary

- IMo_Perf is a powerful tool to guide the instrument design.
- Available to the LiteBIRD collaboration
- Connected to the Instrument Model database (IMo)
- New functionalities and design refinement are added progressively

Thank you for your attention !


IMo_perf
IMo
LFT NEP
MHFT NEP
NEP_ν^{LFT}
NEP_ν^{MHFT}
NEP combination
"Comp Sep"
$\sigma(r)$
Likelihood à la PTEP
δr
Simulation Tools
Systematics Analysis
Based on simulated TOD / Maps
Systematics Residual C_l