# Systematic effect induced by misalignment in a Polarization Modulator for CMB, and application to the LiteBIRD case

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# About me

1st year PhD student

# Wedge-like effect in HWPs

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## Systematic effect induced by misalignment in a reflective polarization modulator for CMB, and application to the LiteBIRD case

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S. Stellati *et al*
JCAP02(2026)003

# Wedge-like effect in HWPs

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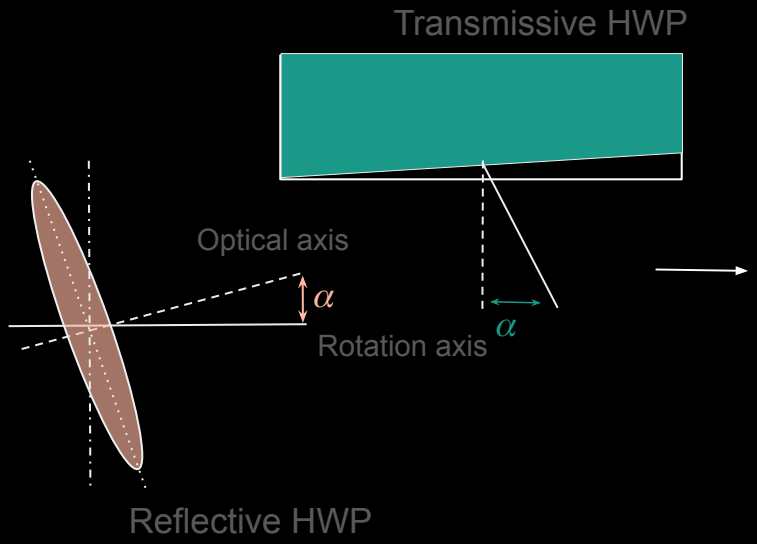
A rotating Half-Wave Plate (HWP) modulates polarization at 4 times the HWP rotation frequency.



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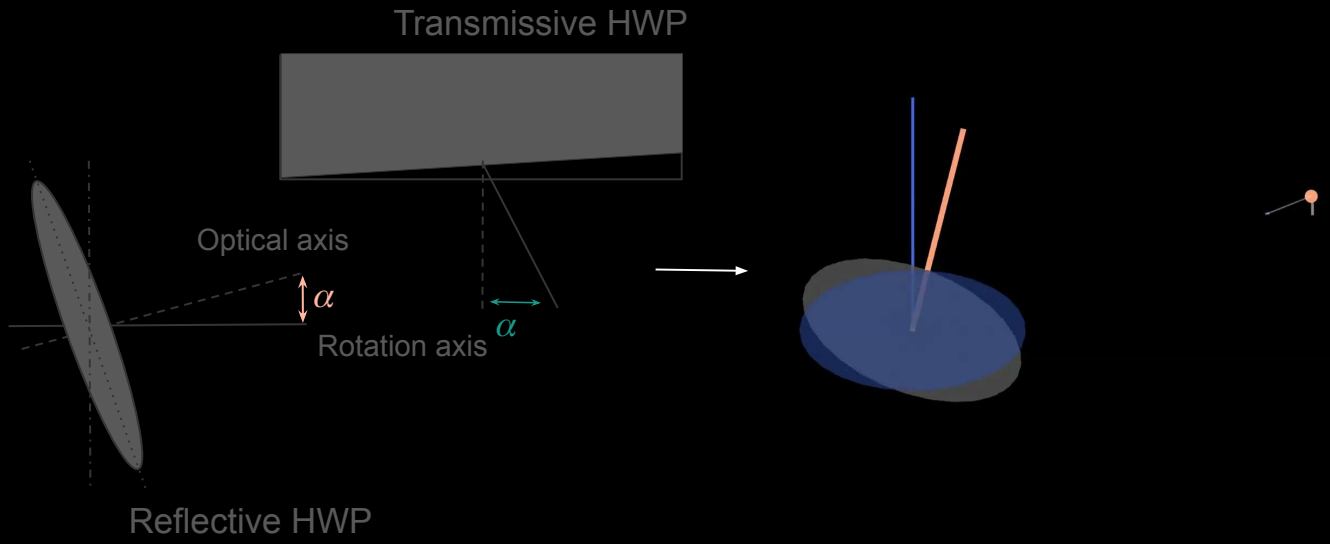

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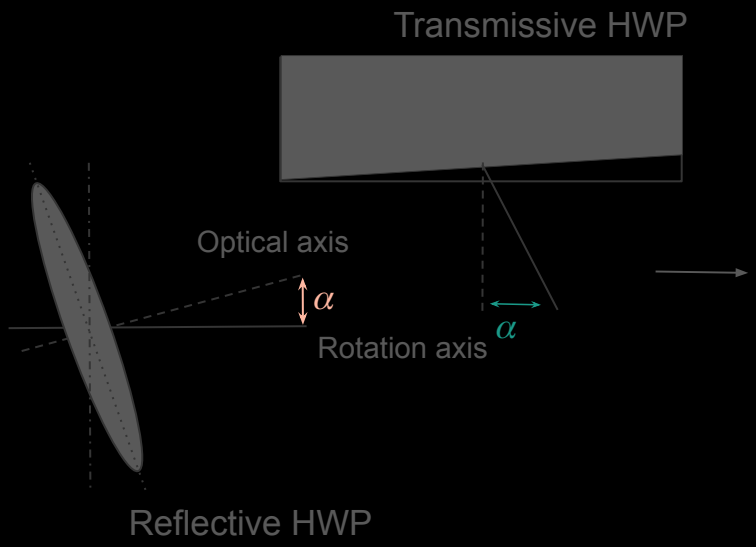


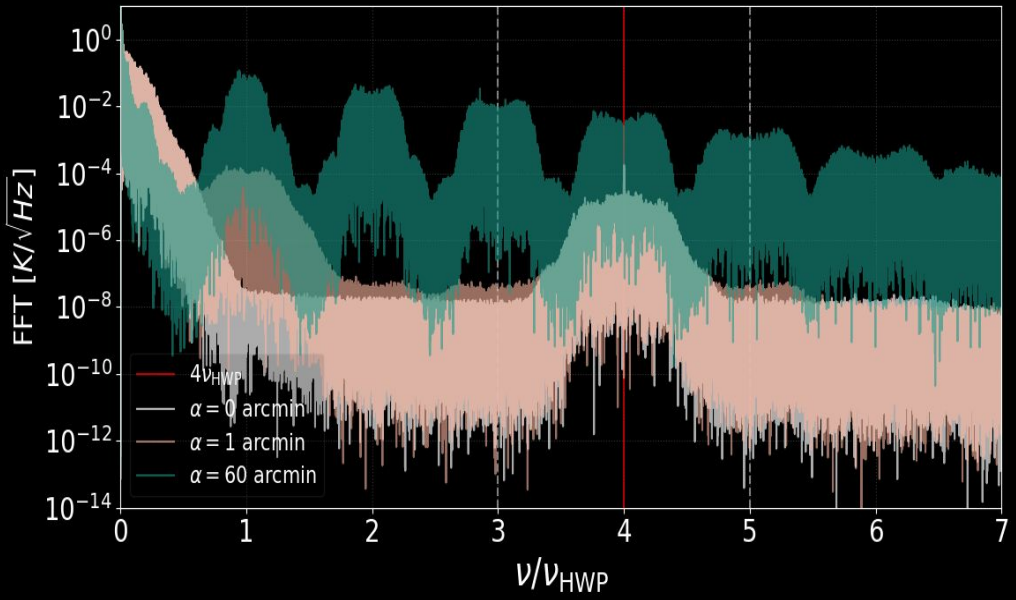

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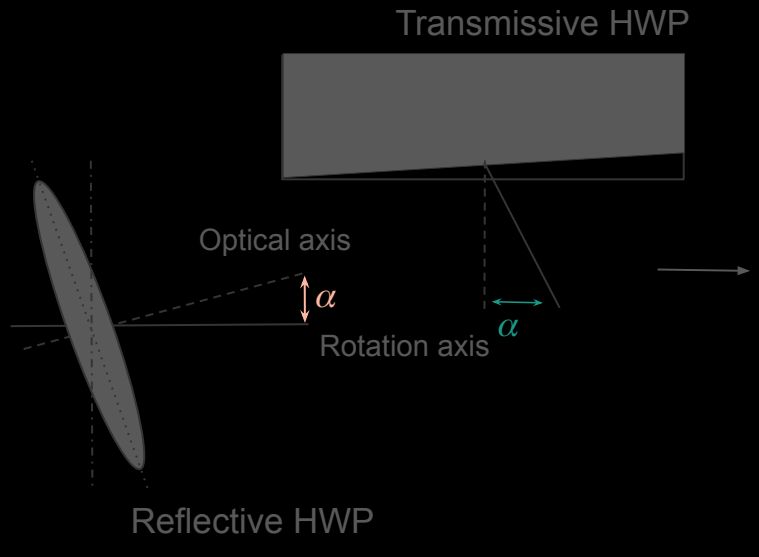


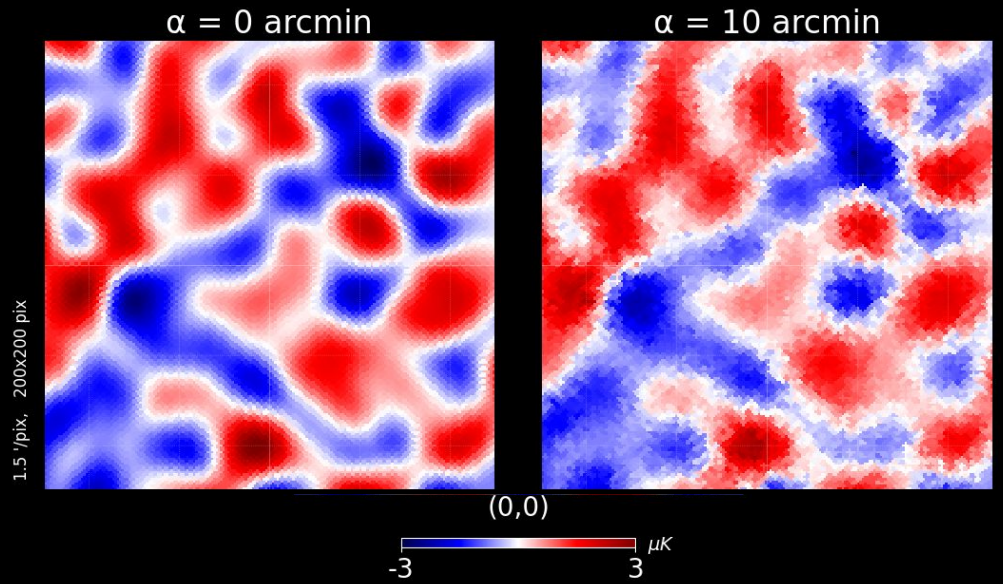

# Simulating the Wedge-like effect

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The analysis was carried out through CMB-only end-to-end simulations using the LiteBIRD simulation framework.

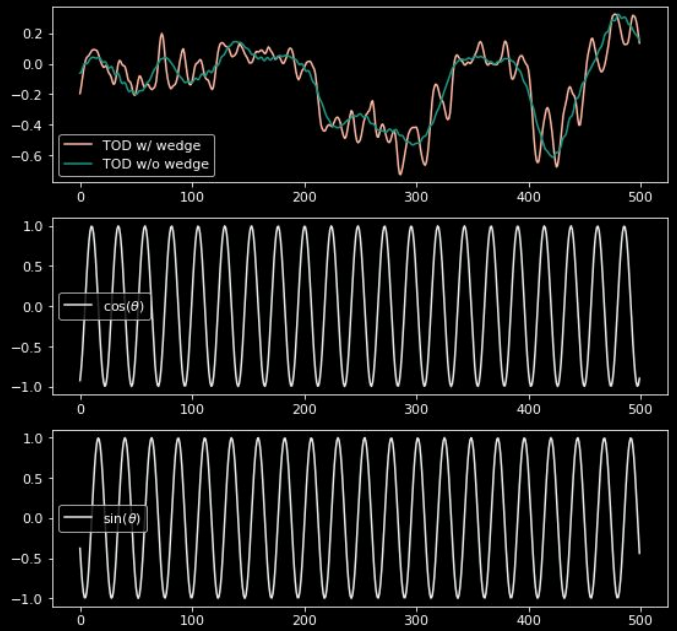
Timeline → periodogram → mapmaking → angular power spectra → bias on r
→ wedge pointing error requirements

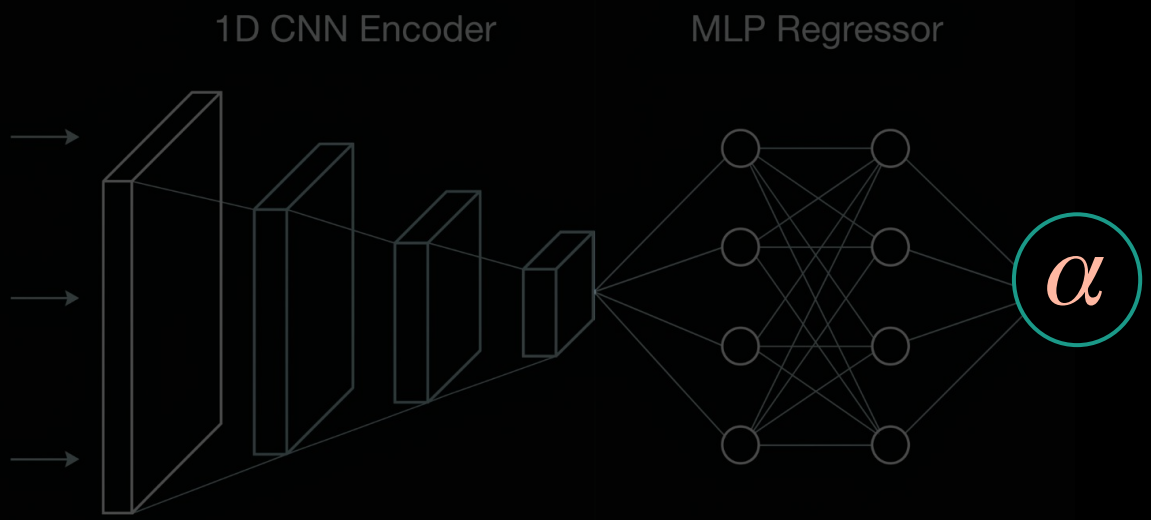
The wedge leads to additional noise resembling the lensing spectra rather than primordial one (Fake lensing).

$$C_\ell = rC_\ell^{\mathrm{tens}} + (A_L + a)C_\ell^{\mathrm{lens}}$$

# Self-calibration through CNN

If the wedge angle could be calibrated exactly, there would be no systematic effect, since we could perfectly reconstruct the pointing matrix.



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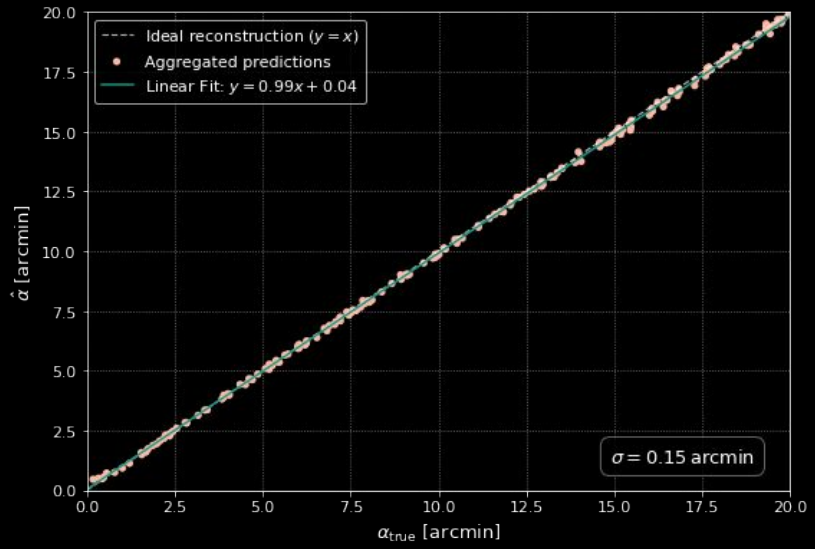
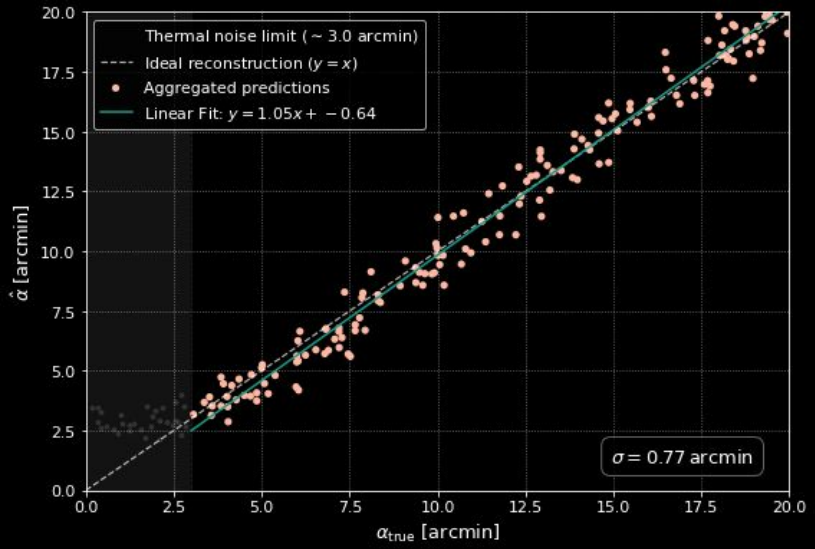
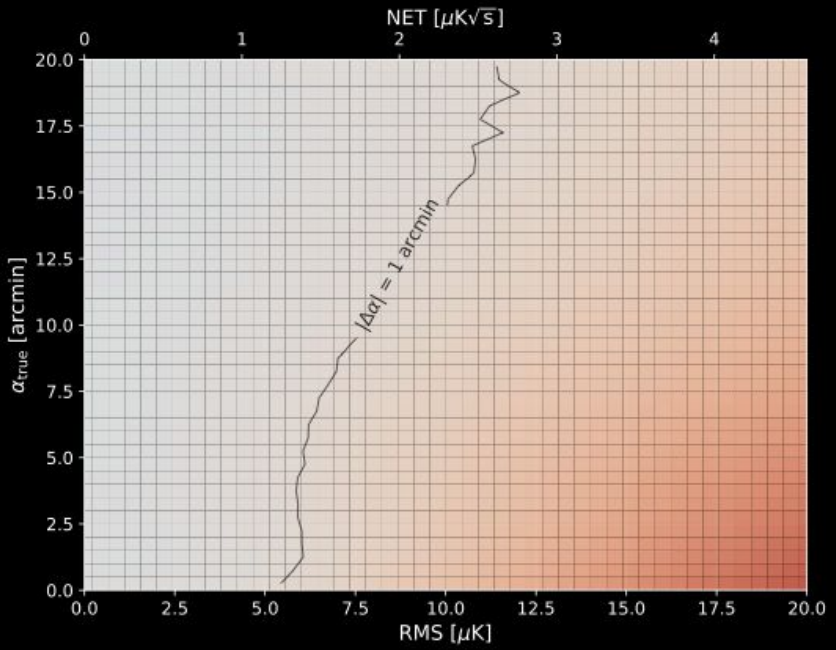



Noiseless

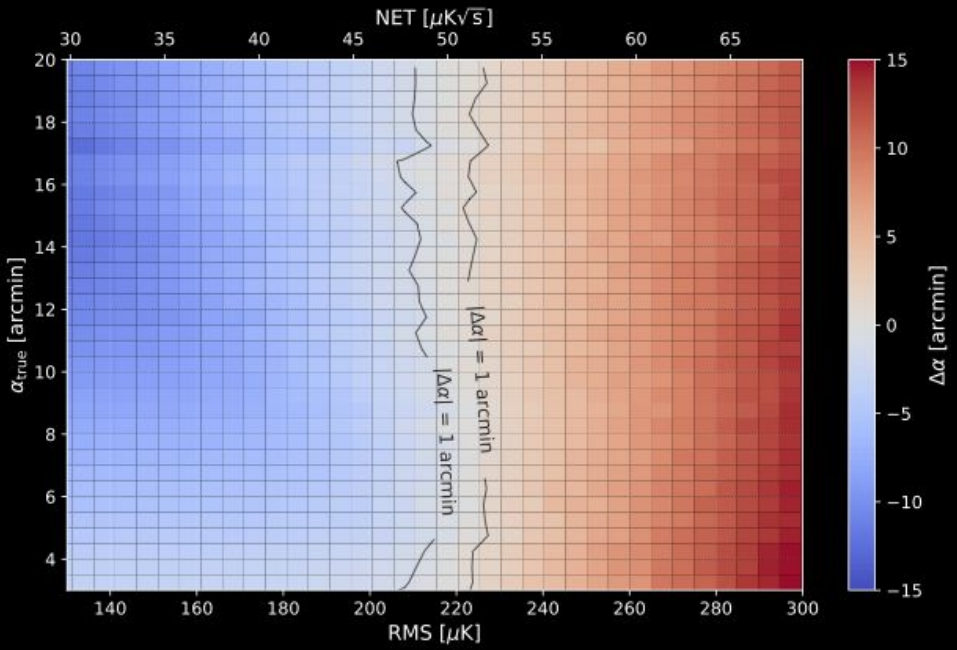



$NET_{DET}$ = 50 μK√s

# Noise fluctuations robustness

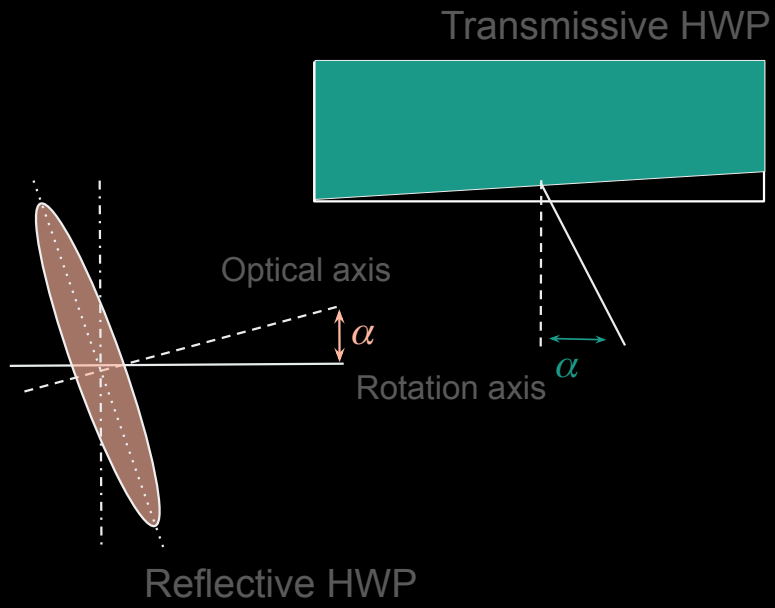


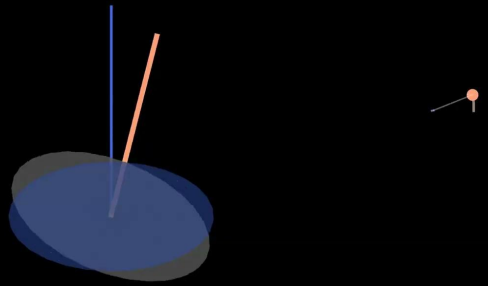

Noiseless

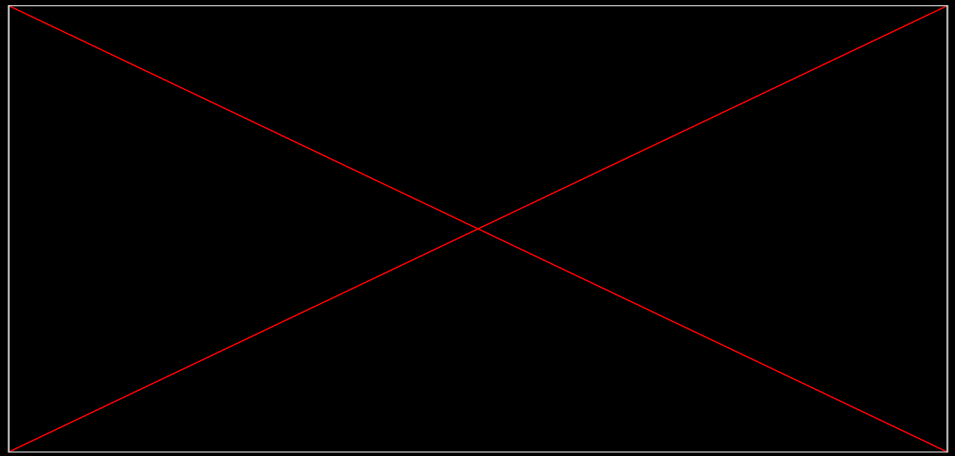



$NET_{DET}$ = 50 μK√s

# HWP wobbling mitigation strategy

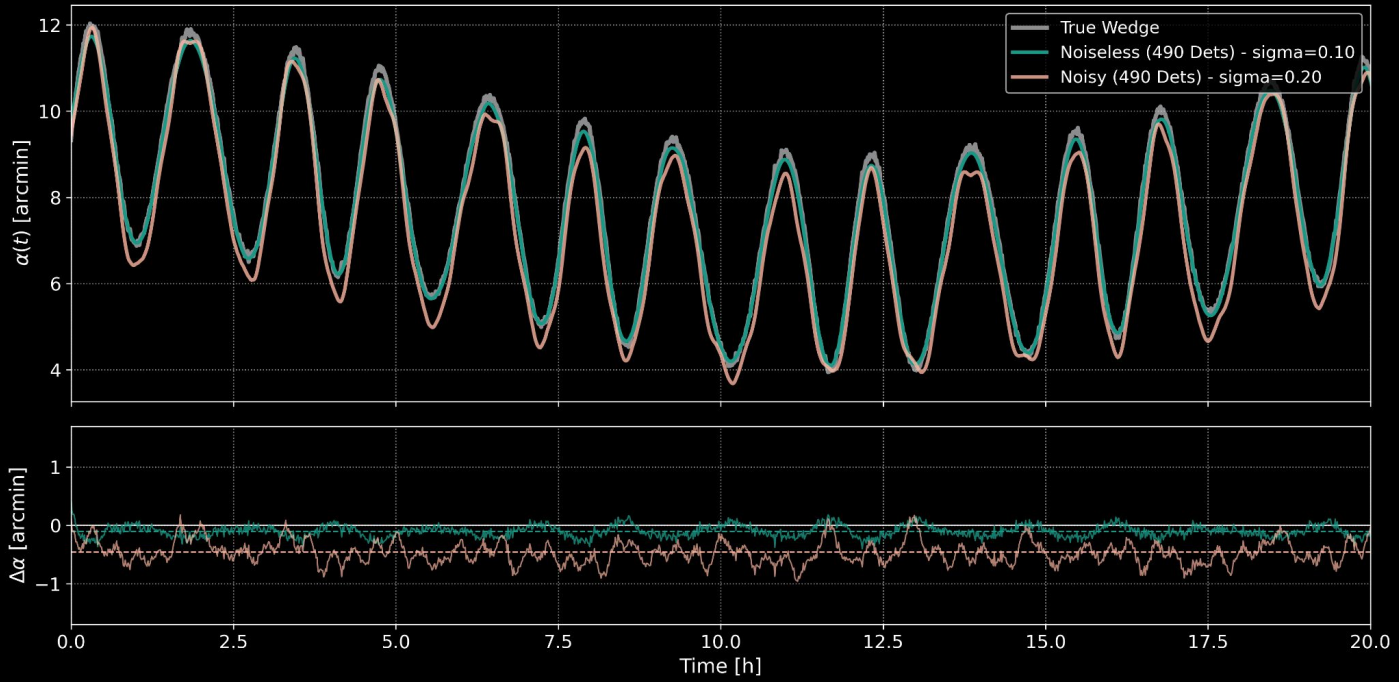




# HWP wobbling mitigation strategy

By applying our network over a sliding integration window of ~7 minutes, advanced in 1-minute steps, the framework intrinsically acts as a dynamic estimator. Then we can aggregate predictions of all dets.



# Cosmological validation Pipeline

1yr cmb-only simulation from TOD to r for 2 dets

Wedged Timeline → ML calibration & pointing matrix update → mapmaking → angular power spectra → bias on r?

We compare ML calibrated results with cases w/ and w/o HWP wobbling

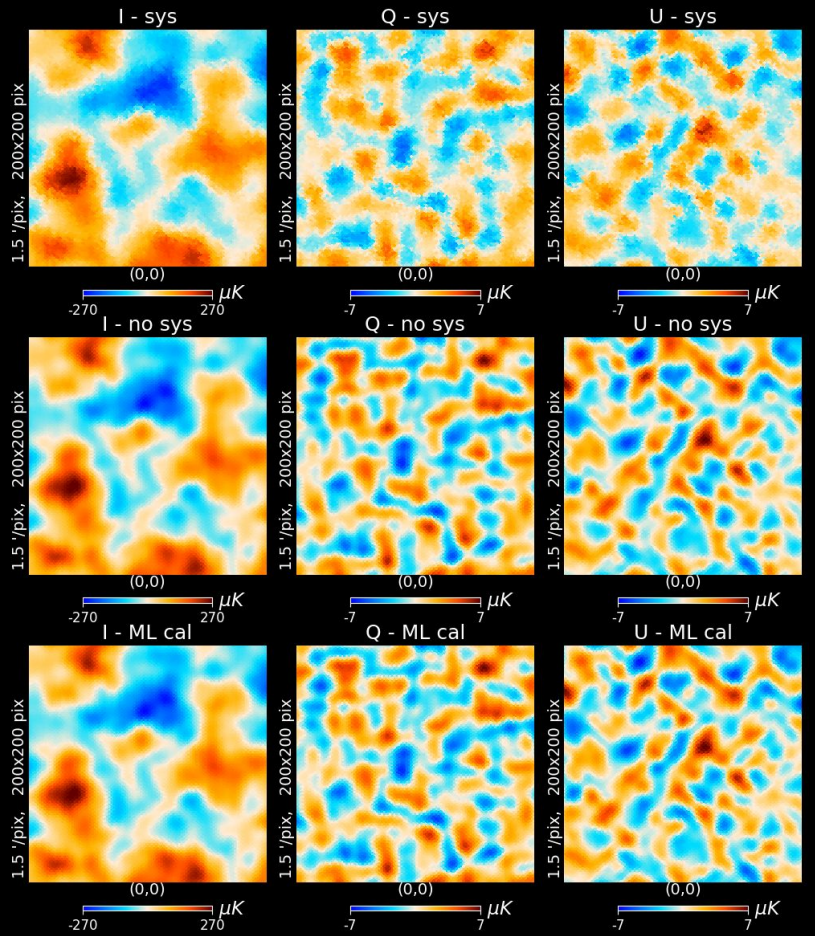
# Map-making analysis

Output maps

w/ wobbling

w/o wobbling

ML calibrated



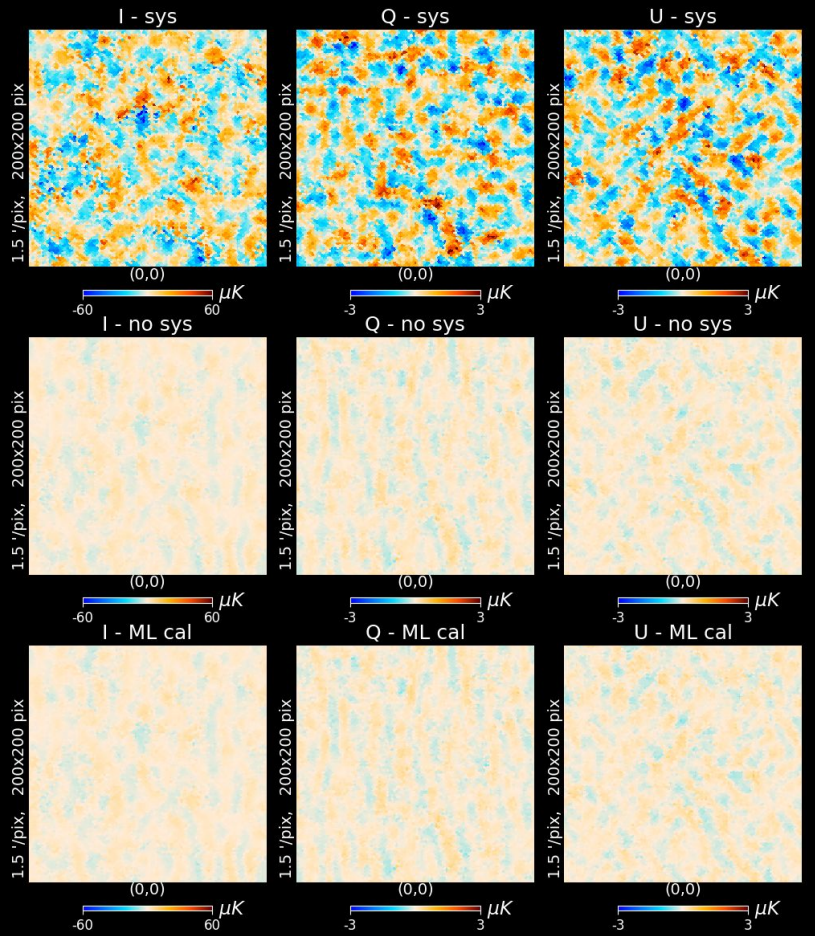
# Map-making analysis

Residuals maps
(output - input)

w/ wobbling

w/o wobbling

ML calibrated



# Residuals (output - input) Angular power spectra

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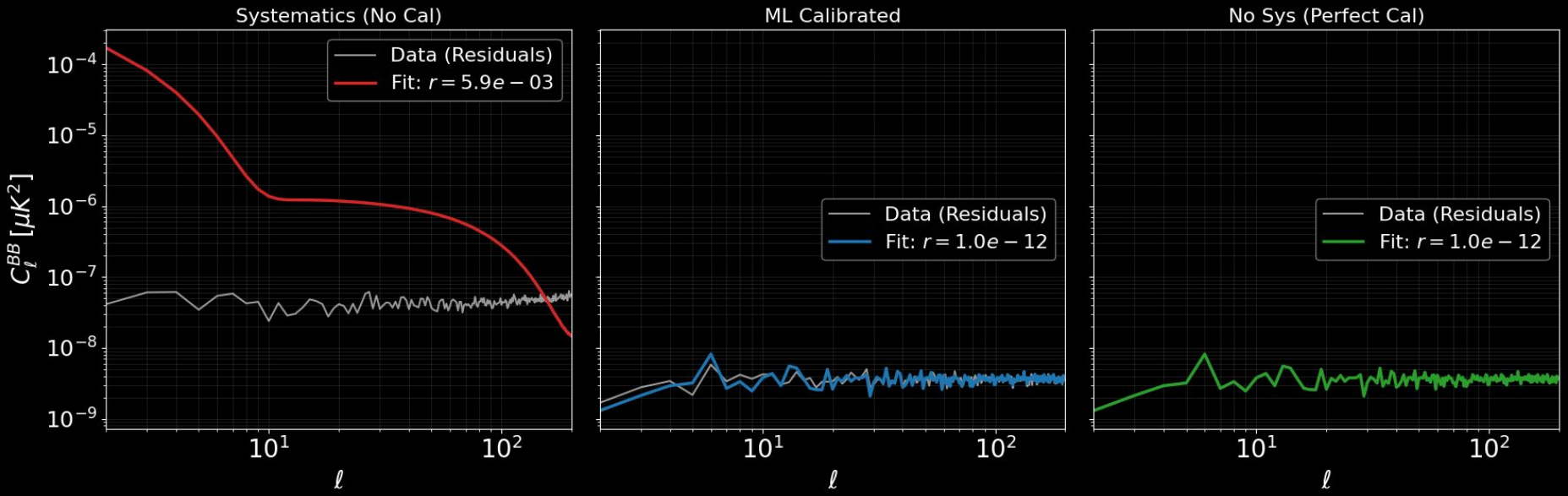
$$C_\ell = rC_\ell^{\rm tens} + C_\ell^{\rm lens}$$




w/ wobbling

ML calibrated

w/o wobbling

# Residuals (output - input) Angular power spectra

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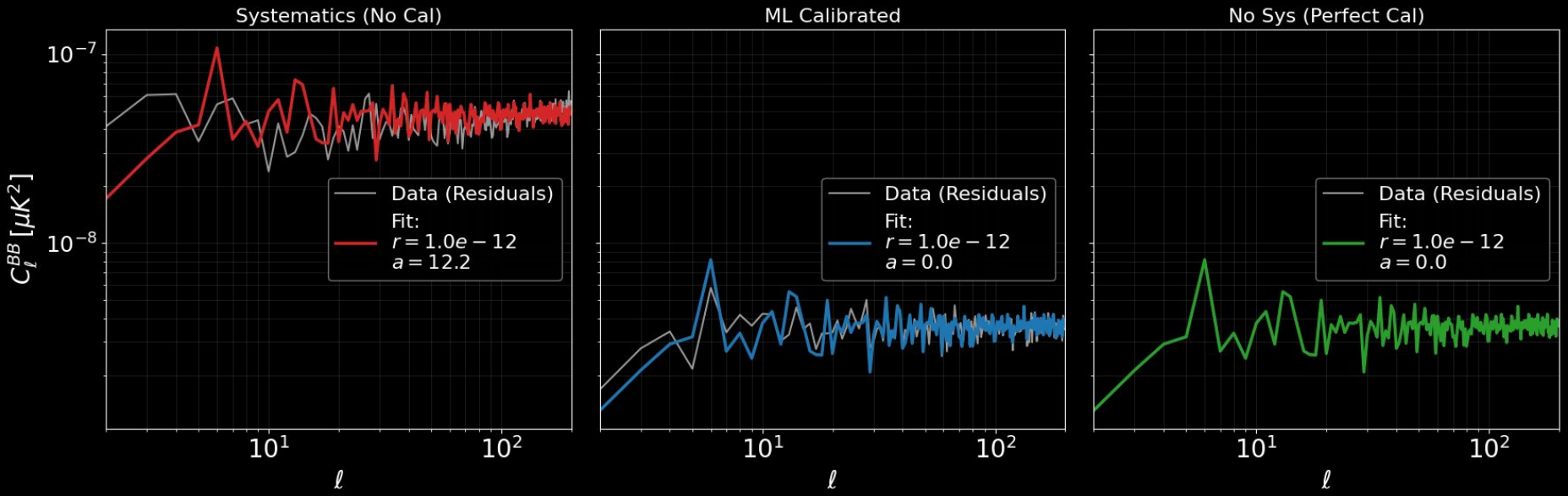
$$C_\ell = r\, C_\ell^{\rm tens} + (A_L + a)\, C_\ell^{\rm lens}$$




w/ wobbling

ML calibrated

w/o wobbling

# Future projects

Extending the framework to mitigate a wide range of systematic effects.

Find out more!

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