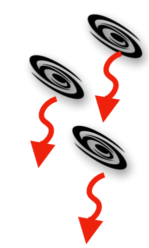
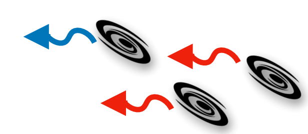
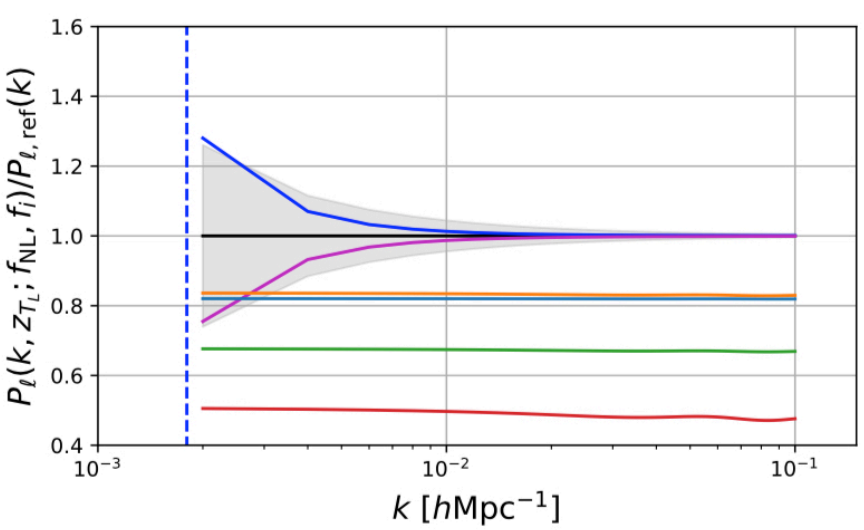
Local PNG with interlopers in Euclid

Pierros Ntelis

CNES Post Doctoral Researcher







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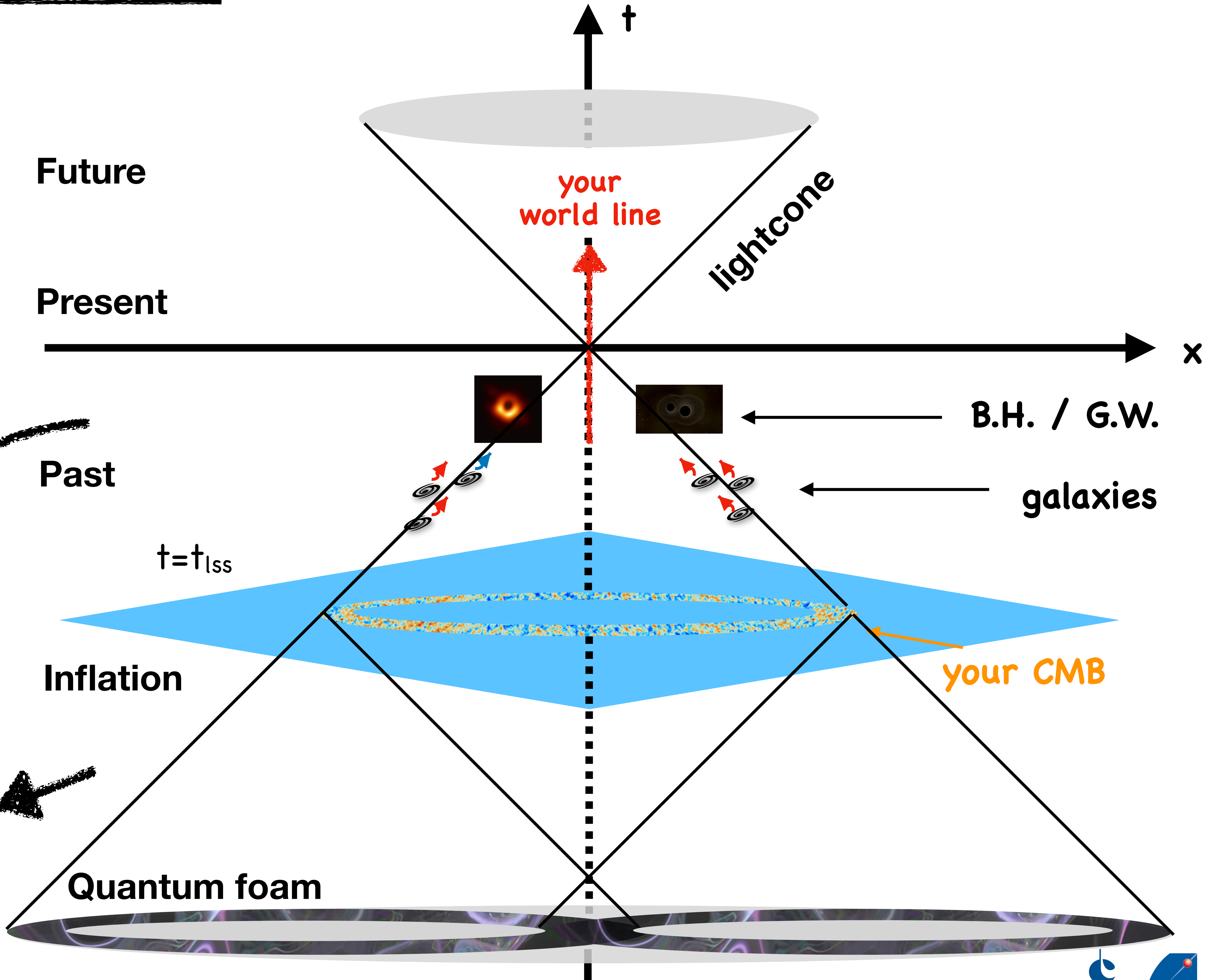
INAF, INFN, MPE, UPCT teams
on behalf of Euclid Consortium

Outline

- Physical Principle
- Euclid NISP Instrument
- Line-Misidentification
- Impact on fNL
- Conclusion and Outlook

Inflation Is Imprinted In LSS

Primordial Non-Gaussianity Signal



- The late time universe is also Non-Gaussian (NG) due to non-linearities (NL) BUT at large scales the NG from NL is quite insignificant

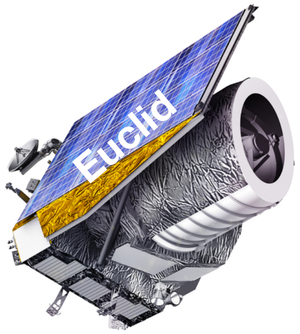
- Highly biased tracers are going to capture the PNG signal through a scale dependent bias on the Power spectrum as:

$$b(z;b_0) \rightarrow \tilde{b}(k,z) \equiv b(z;b_0) + \tilde{\Delta}b(k,z)$$

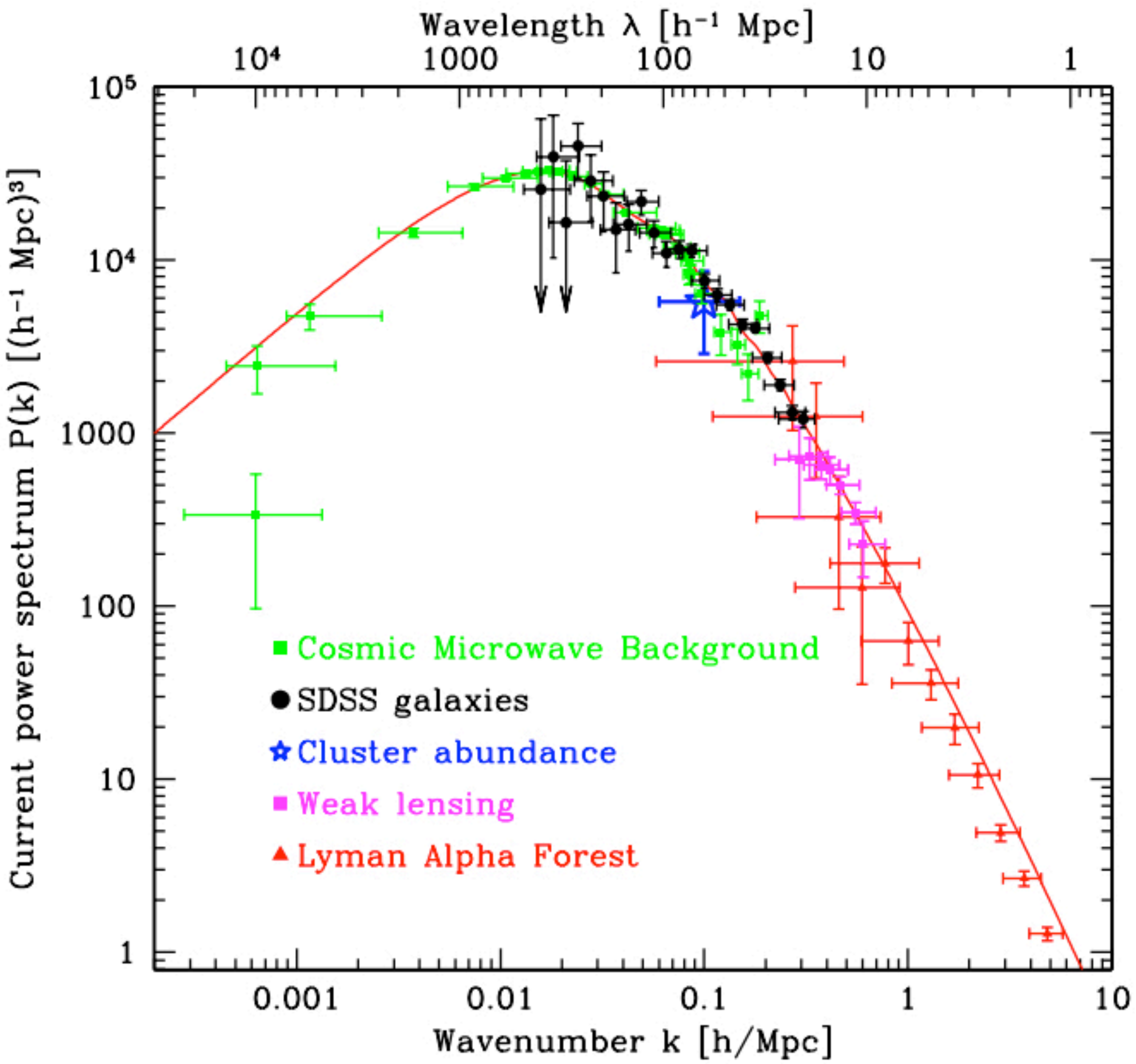
$$\tilde{\Delta}b(k,z) \propto f_{\rm NL}^{\rm loc} k^{-2}$$

[A. Slosar et al 2008 Ansatz model]

- Objectives:
  - Dark Matter (Weak Lensing)
  - Dark Energy (Galaxy Clustering)
  - Large Scale Structure Science



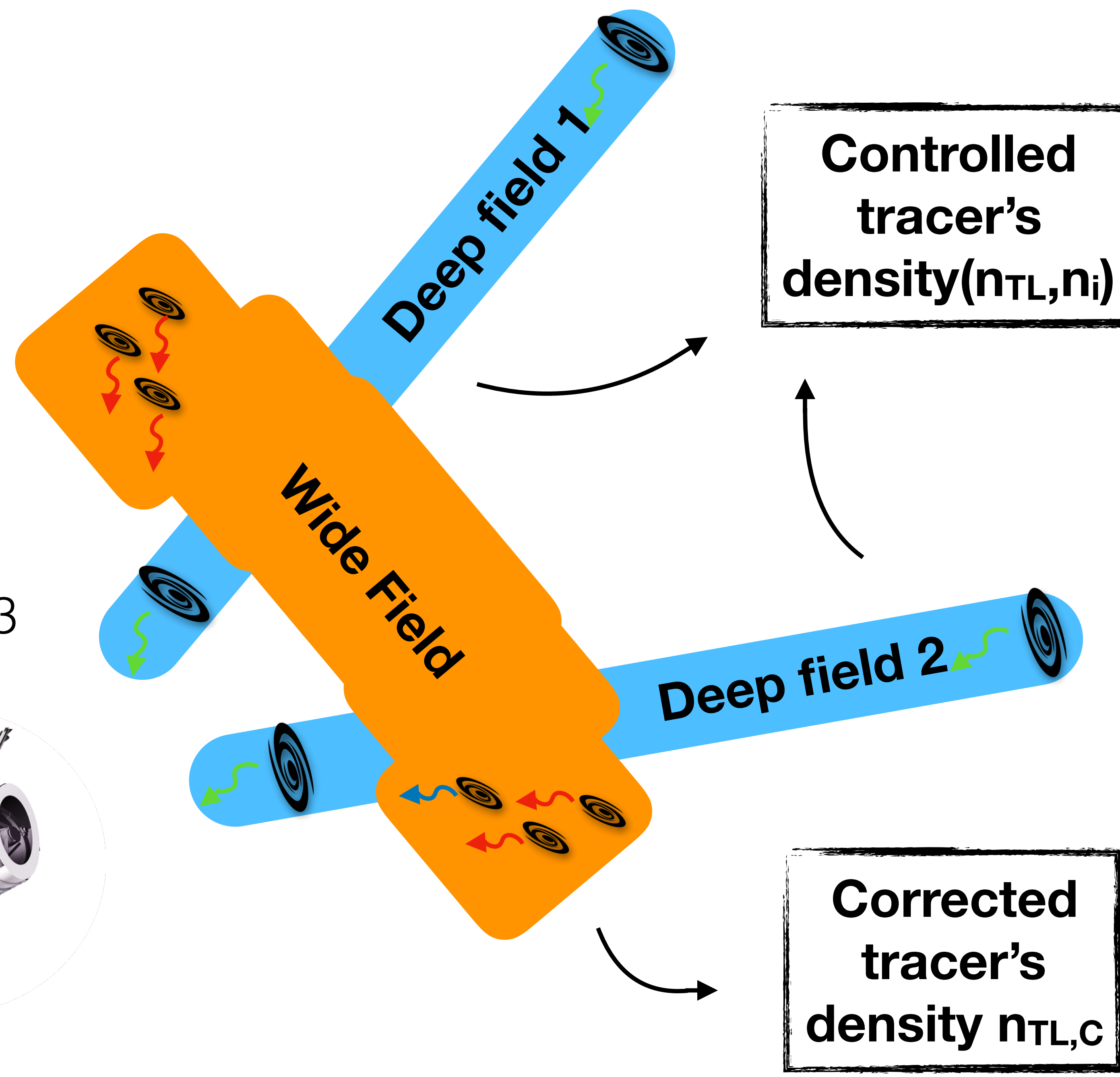
Mainly Update



Tegmark et al. 2003

Launch P.N.G./Inflation
Euclid →
2022 m_ν M.G. 2029

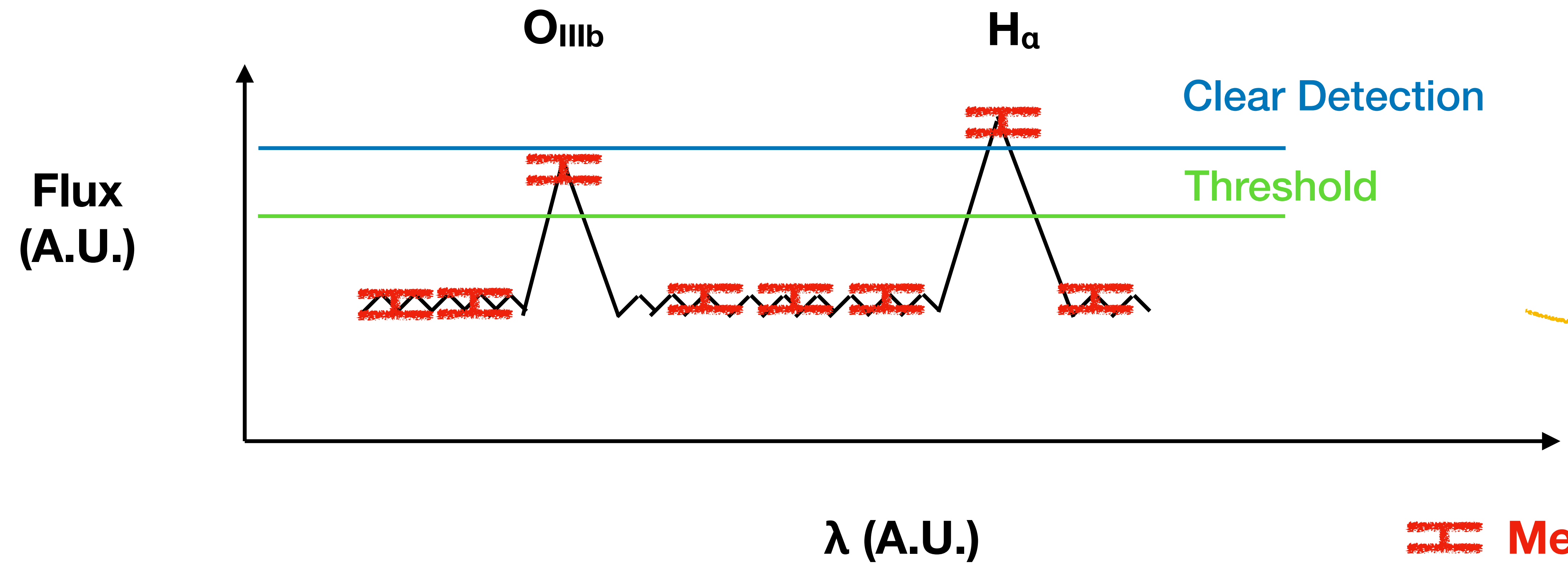
- Main project:
  - Sun-Earth L2 point for 6 years
  - 1.2 SiC mirror telescope
- Imaging VIS
  - $550 < \lambda/nm < 900$
- Photometry NISP (Y,J,H) Filters :
  - $950 < \lambda/nm < 2000$
- Slitless Spectroscopy NISP Grisms :
  - $920 < \lambda/nm < 1850$
  - $\Delta\lambda/\lambda=380$
- A_{surv}: 15000 deg^2
- 5×10^7 H_α Emission Line Galaxies @ $z < 2.3$

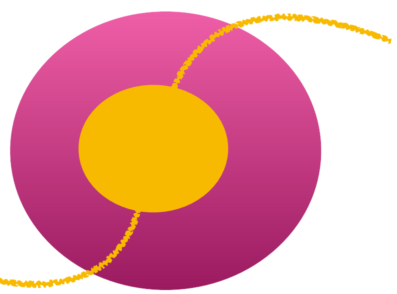


L2

Interloping effect

Suppose line-Identification on Flux





Pullen, A. R., C. M. Hirata, O. Doré, et al. 2015
Wong, K., A. Pullen, and S. Ho 2016

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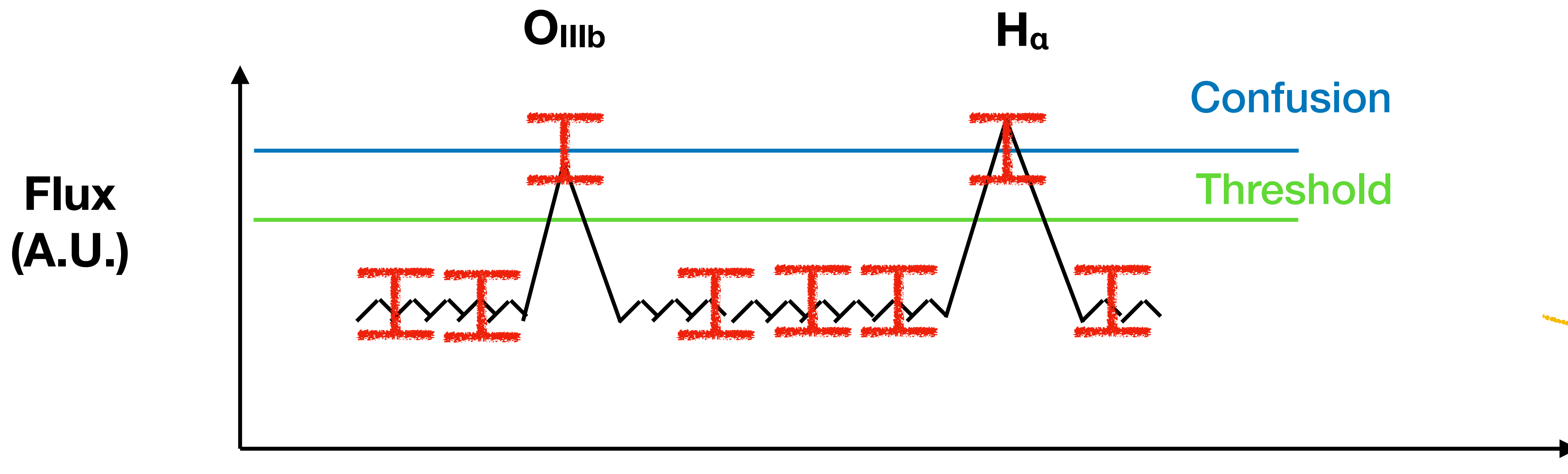
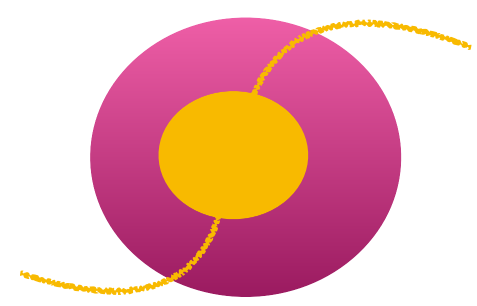
Interloping effect

Suppose line-Identification on Flux

Line misidentification: confusion of Hα with O_{IIIb}





Due to noisy instrument
noisy flux measurement

Pullen, A. R., C. M. Hirata, O. Doré, et al. 2015
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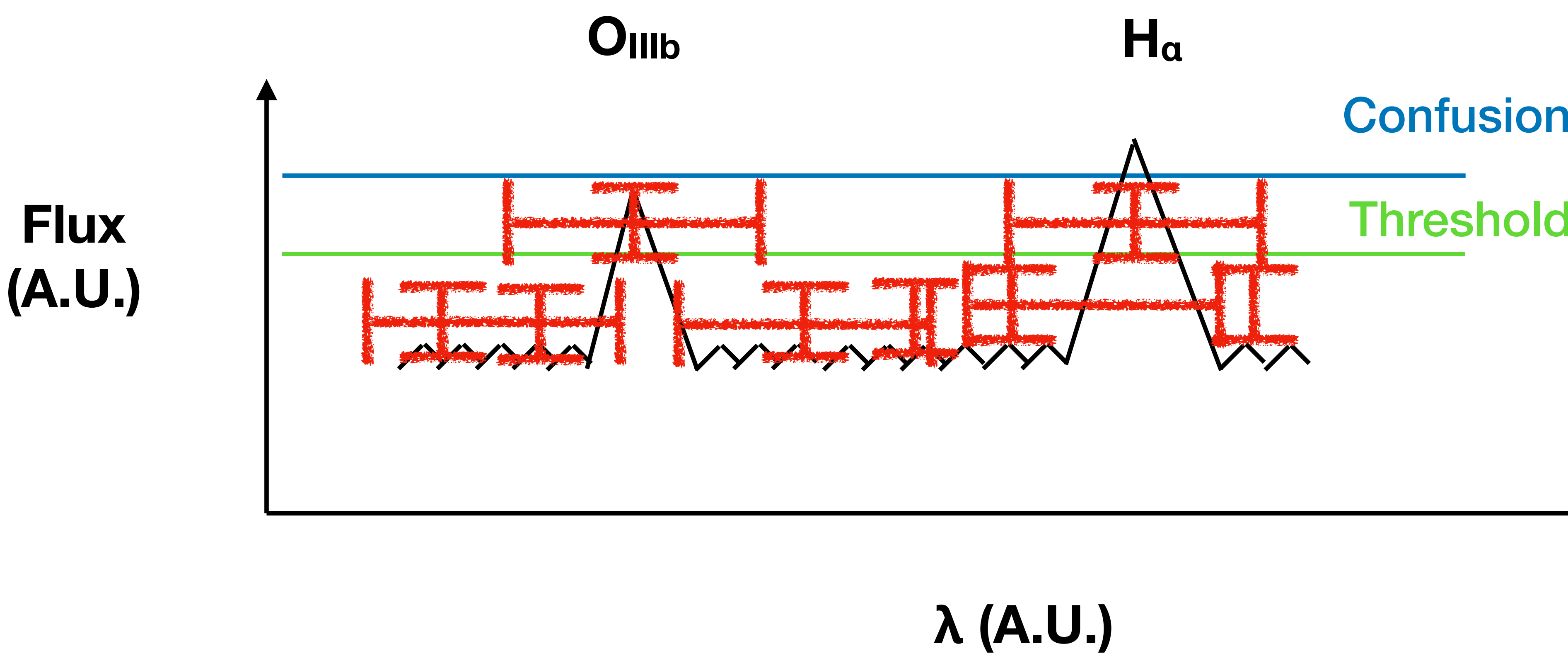
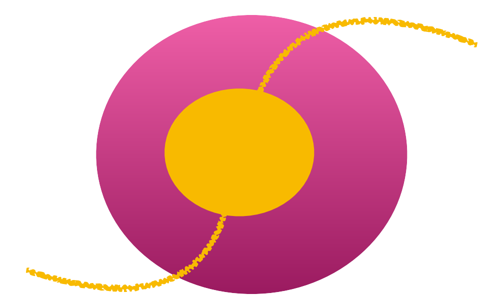




Measurement

REALITY

Due to noisy instrument
noisy flux measurement

Pullen, A. R., C. M. Hirata, O. Doré, et al. 2015
Wong, K., A. Pullen, and S. Ho 2016

A Contaminated galaxy sample from interlopers will have additional wavelengths:

$$\lambda_{i\to T_L^i} = \frac{1+z_i}{1+z_{i\to T_L^i}}\lambda_i$$

Observed at a new position:

$$\vec{X}_{obs} = \left\{\gamma_{||} Y_{||}, \gamma_{\perp}\vec{Y}_{\perp}\right\}$$

Affecting Power Spectrum as:

Normalisation **shift**

$$P_{obs}(k,\mu) = \left(1-\sum_{i=1}^{N_{\rm inter}} f_i\right)^2 P_{T_L}\left(k,\mu,z_{\rm T_L};b(z_{\rm T_L})\right) + \sum_{i=1}^{N_{\rm inter}} f_i^2\gamma_{\perp,i}^2\gamma_{||,i}P_i\left(z_i,q(k,\mu),\mu_q(\mu);b(z_{\rm i})\right)$$

A Contaminated galaxy sample from interlopers will have wavelength:

$$\lambda_i = \frac{1 + z_{T_L}}{1 + z_i} \lambda_{T_L}$$

Observed at a new position:

$$\vec{X}_{obs} = \left\{ \gamma_{||} Y_{||}, \gamma_{\perp} \vec{Y}_{\perp} \right\}$$

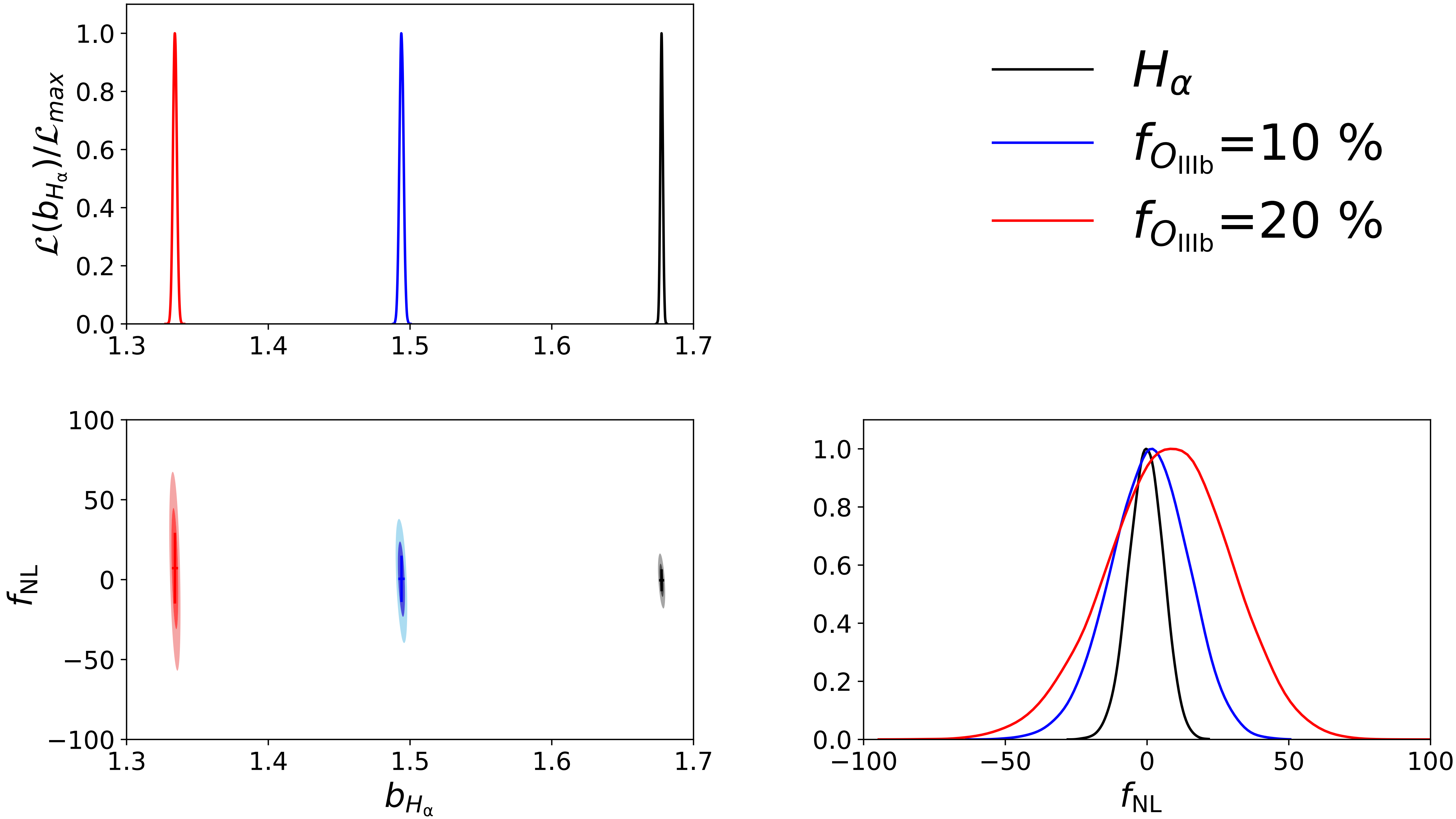
Introducing PNG we have:

$$P_{obs}^{\mathrm{TH}}(k, \mu, z_{T_L}, z_i; f_i, f_{\mathrm{NL}}) = \left(1 - \sum_{i=1}^{N_{inter}} f_i\right)^2 \left(b(z_{T_L}) + f_{\mathrm{NL}} C_{ng}(z_{\mathrm{T_L}}, k)\left[b(z_{\mathrm{T_L}}) - p\right] + f(z_{\mathrm{T_L}})\mu^2\right)^2 P_m(z_{T_L}, k)$$
$$+ \sum_{i=1}^{N_{inter}} f_i^2 \gamma_{\perp,i}^2 \gamma_{||,i} \left(b(z_i) + f_{\mathrm{NL}} C_{ng}(z, k)\left[b(z_{\mathrm{i}}) - p\right] + f(z_i)\mu_q^2(\mu)\right)^2 P_m\left(z_i, q(k, \mu)\right)$$

Model Does Not Know About Interloping

Local PNG with Euclid | Impact on fNL

contaminant: O_{IIIb} f_i=20% => 3 σ_{fNL}
=> f_{NL} + 1.6σ_{fNL}



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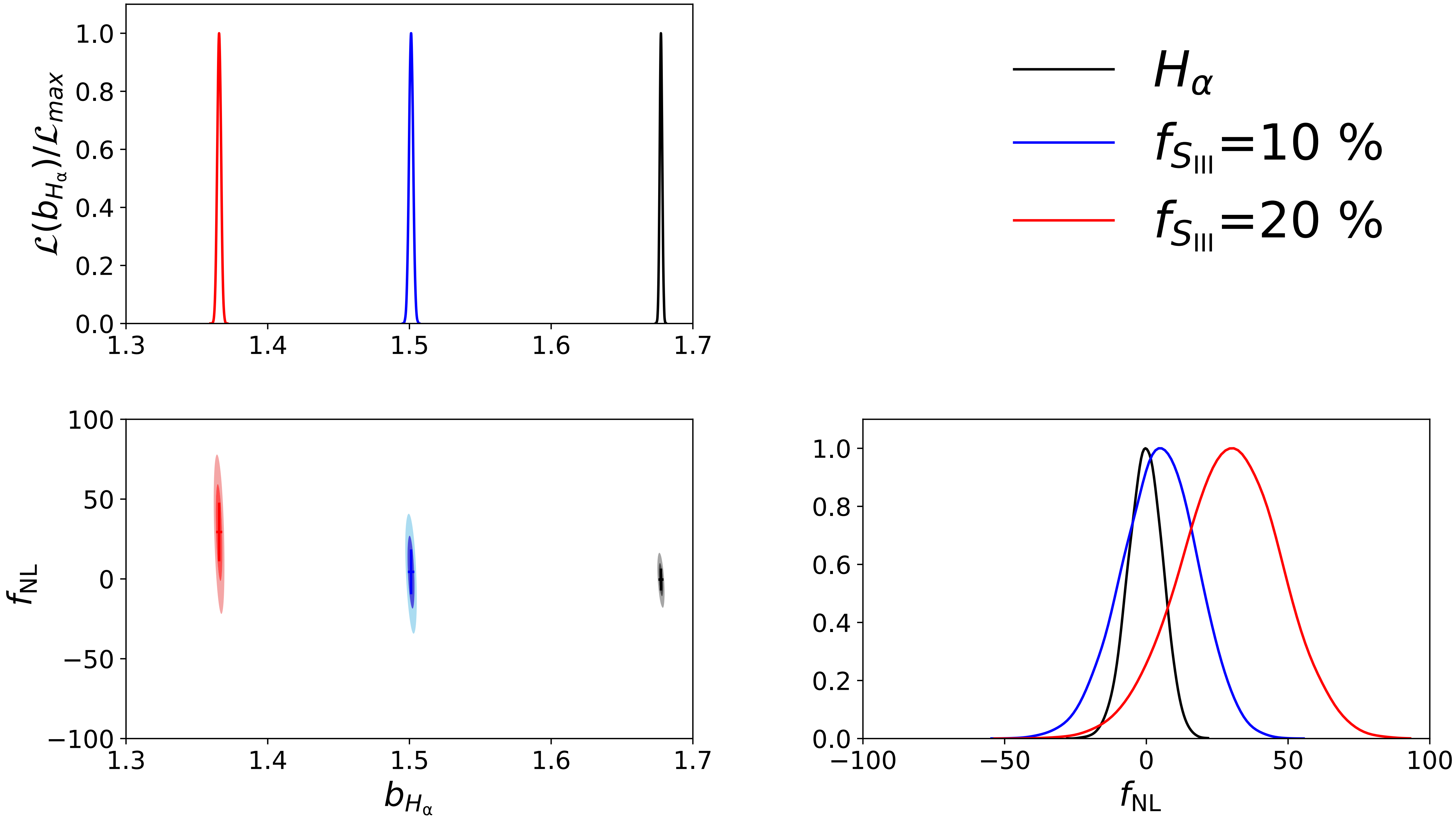
Model Does Not Know About Interloping

Local PNG with Euclid | Impact on fNL

contaminant: S_{III}

f_i=20% => 3 σ_{fNL}
=> f_{NL} + 5σ_{fNL}



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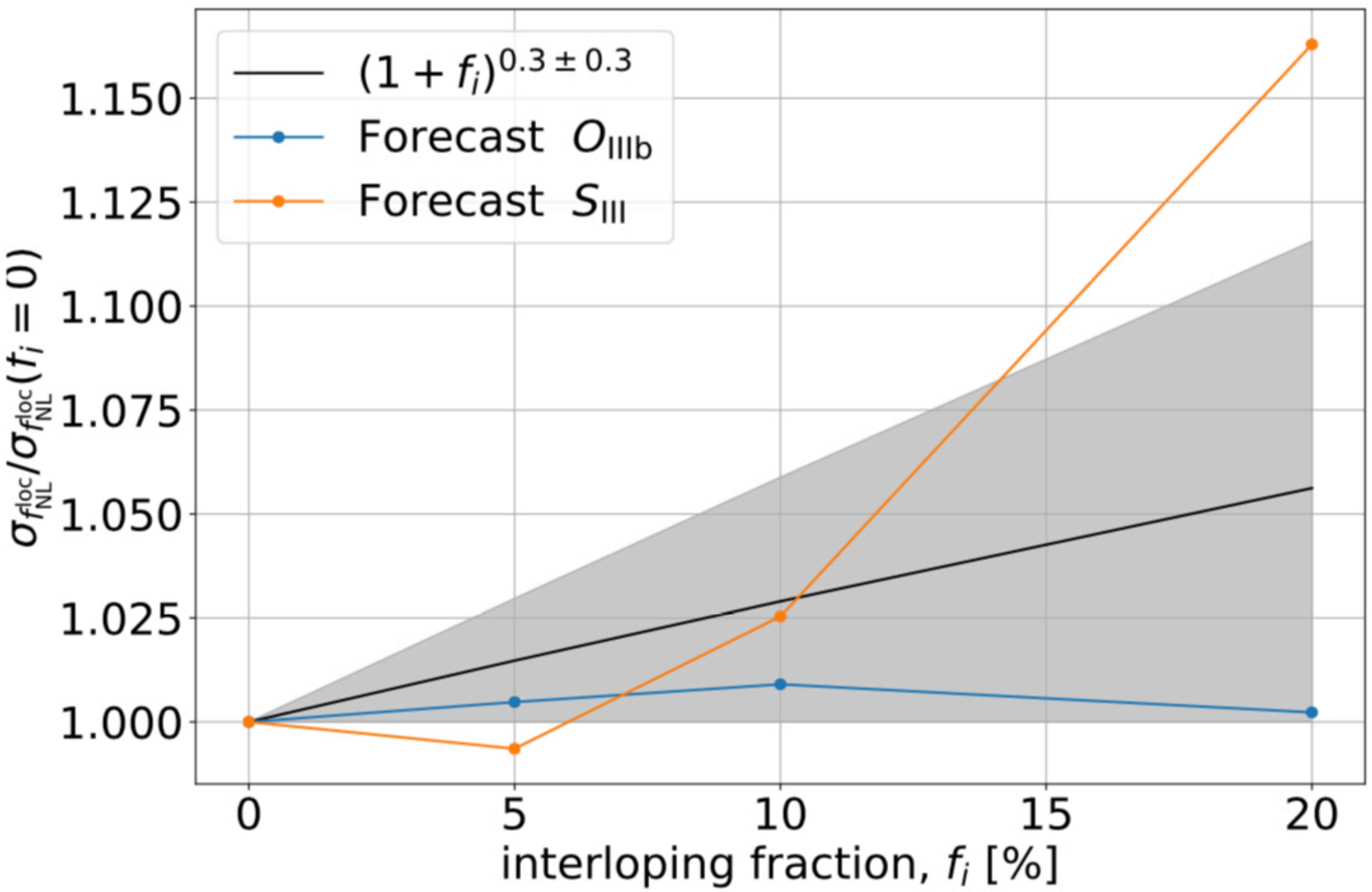


Fig. 5. Forecast of primordial non-Gaussianity uncertainty at 68% C.L. as a function of different interloping rate normalised. The scenario of the uncertainty is given by the $\chi^2_3(b_{H_\alpha}, f_{\rm NL}, b_i, f_i|\sigma_{b_{0i}} = 0.1, \sigma_{f_i} = 0.01)$, where we consider only the interloping from interloping from $O_{\rm IIIb}$ and $S_{\rm III}$ colourcoded (blue and orange respectively) individually with dotted continues lines. We present some approximate proportional laws of this uncertainty increase. [See sections 5, 6]

$S_{\rm III}$ line impacts a lot fNL

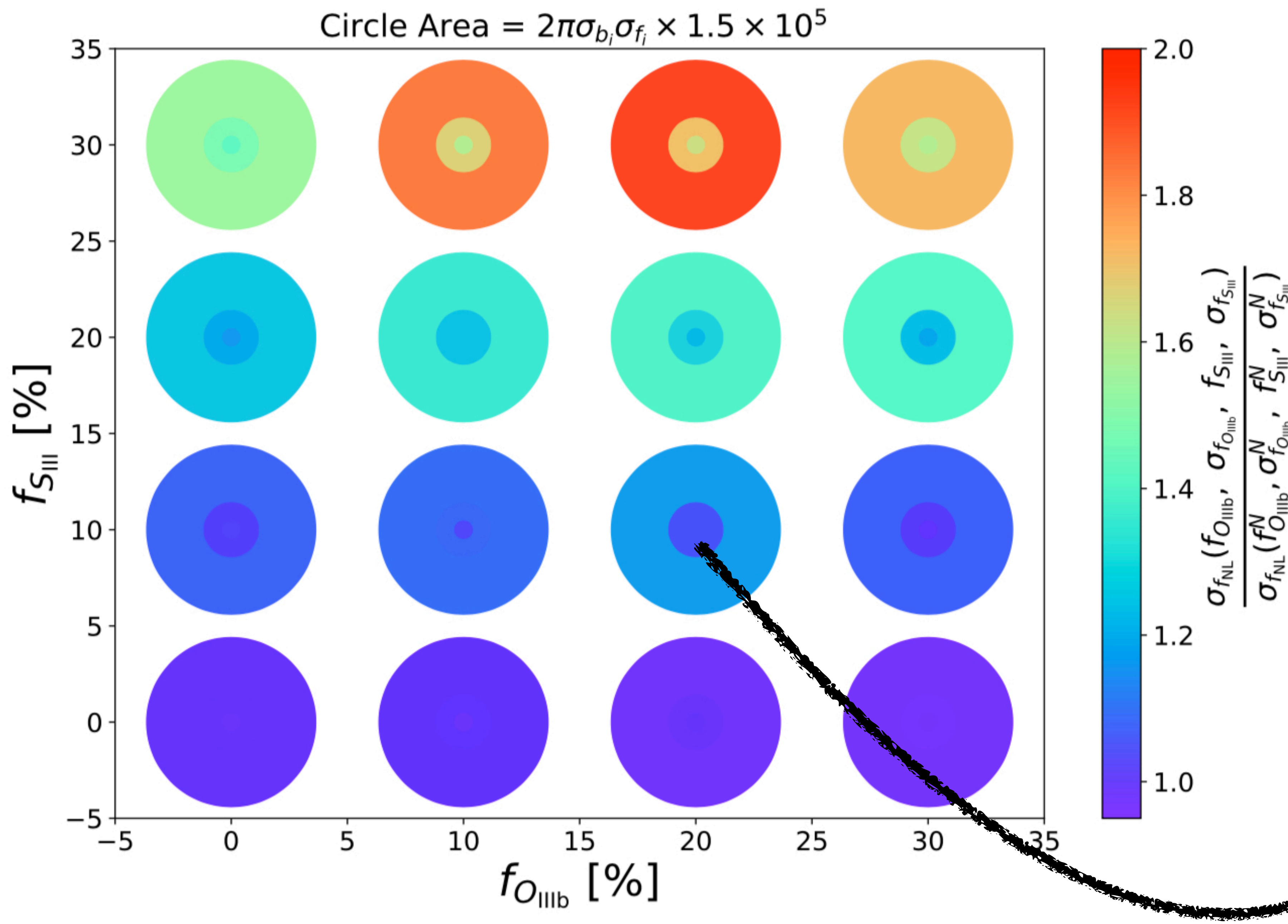
10-20%
Interloping fraction

=>

3-16%
PNG Uncertainty Increase

Model Knows About Interloping

Local PNG with Euclid | Impact on fNL



6%-18% Increase of PNG uncertainty

Dependence on the uncertainty of bias and fraction of Interloper

Local PNG with Euclid

Conclusions:

- Great Science with Euclid
- $\sigma_{f_{NL}} \sim= 10$ from $P_{0,2}(k)$ (Power Spectrum Monopole+Quadrapole)
- Line-Misidentification bottleneck for future slitless spectroscopic surveys
- But modelling provide precise helpful insights
  - Contaminant O_{IIIb} , S_{III} controlled uncertainty increase
  - Solvable with Euclid Deep Field

Outlook:

- Characterisation of Other Systematics
- Survey Simulations Tests

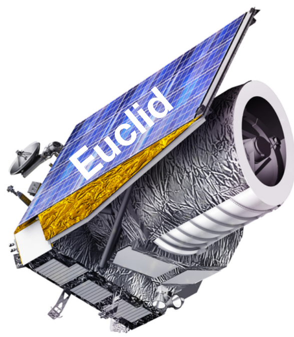
Thank You for your Attention!

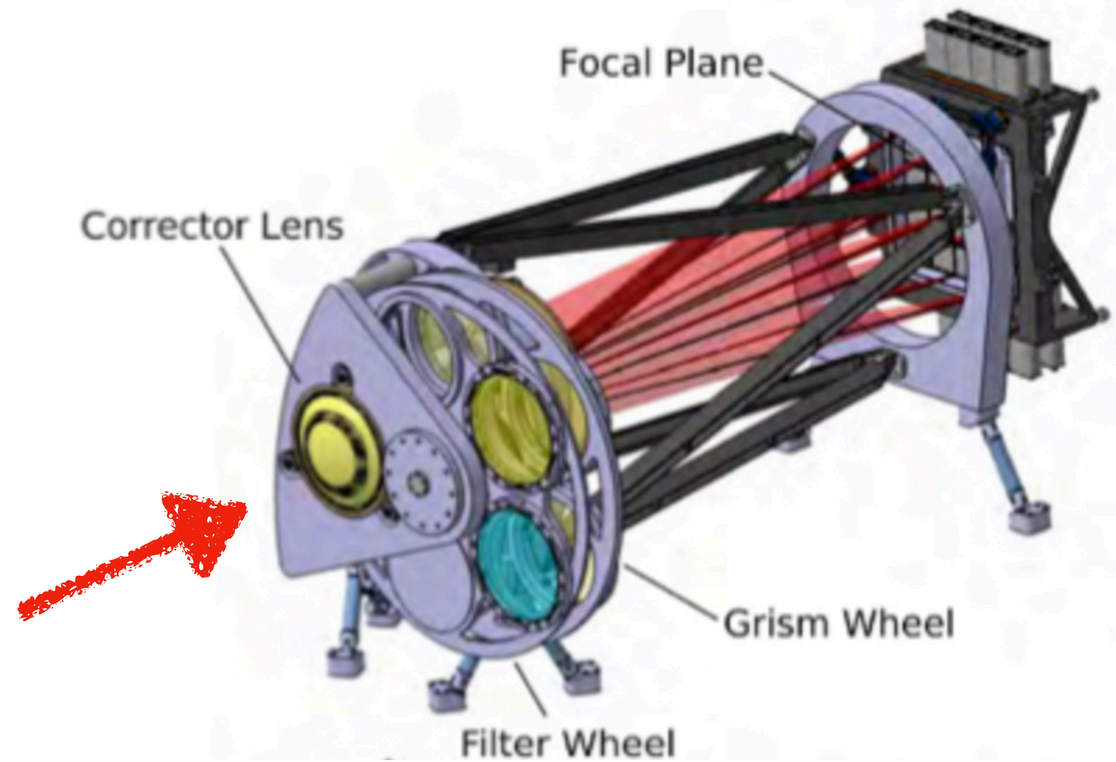
Local PNG with Euclid

Back up

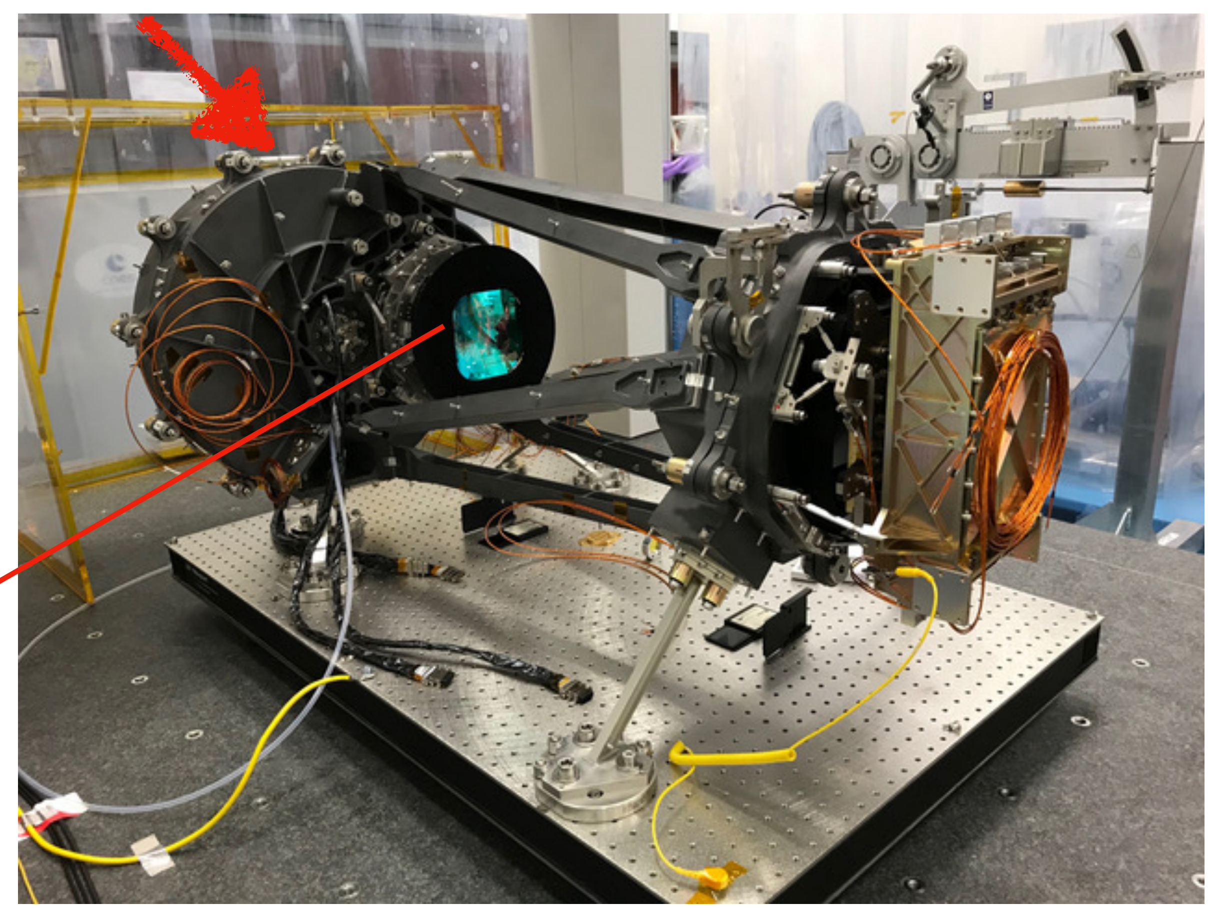
Near Infrared Spectrometer and Photometer (NISP) Instrument

light





CAmera
Lens
Assembly



Taken from L.A.M.