

Statistics Detection of kSZ Effect using ACTPol+Planck Maps

Dr. Mthokozisi Mdlalose, Prof. Yinze Ma,
School of Chemistry and Physics, University of KwaZulu-Natal

Application of Quantum Information in Astrophysics and Cosmology
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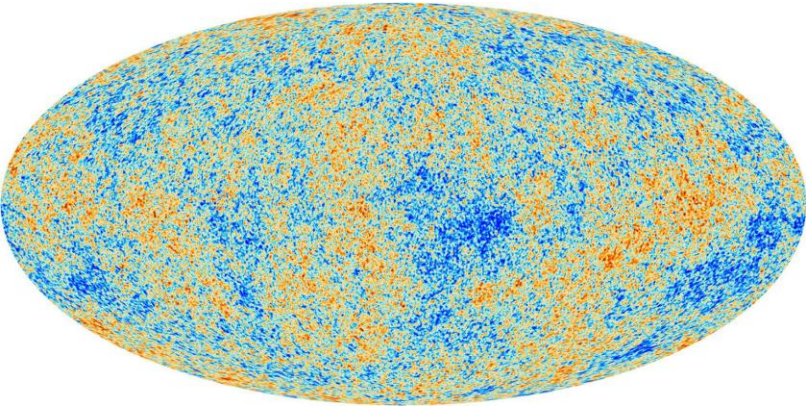


Outline

- Motivation
- What is kSZ Effect?
- What are the techniques to Detect kSZ?
- What are available Data to detect kSZ?
- What is status quo?
- What are future plan?

Motivation

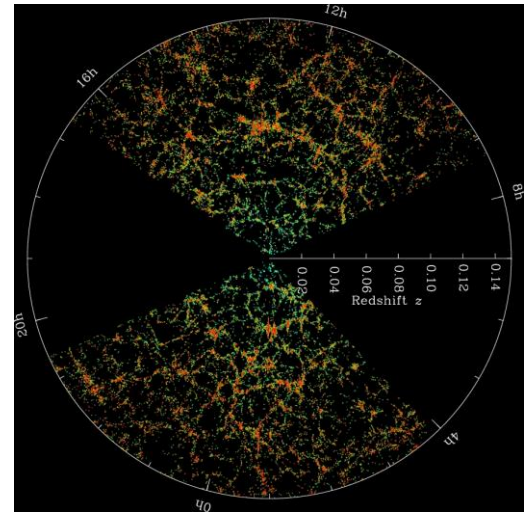
CMB MAP (“Initial Conditions”)



Credit: Planck, European Space Agency



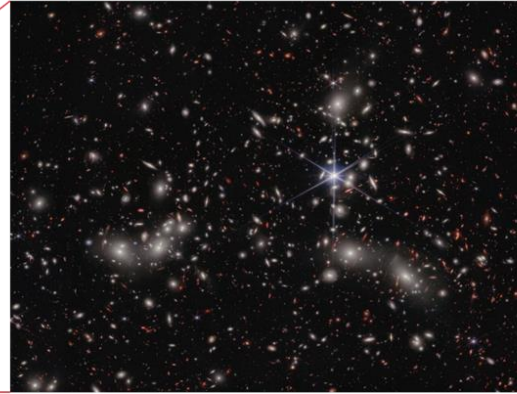
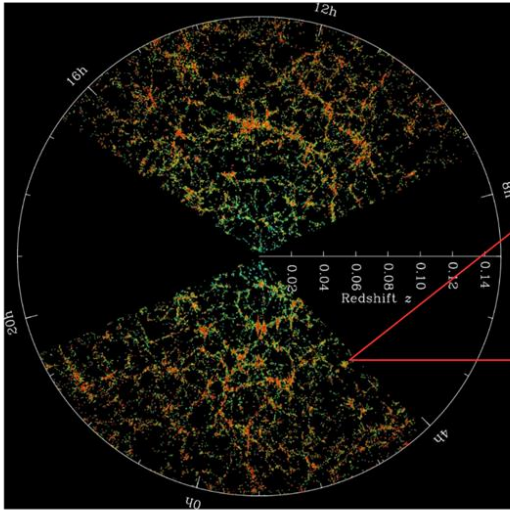
Galaxy Distribution (“evolved initial condition”)



Credit: *M. Blanton and the Sloan Digital Sky Survey.*

Motivation

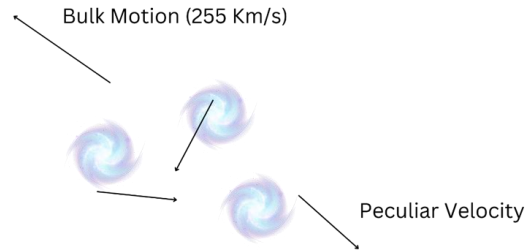
Abell 2744 aka Pandora Galaxy Cluster
image credit -[@nasawebb](#)



Credit: *M. Blanton and the Sloan Digital Sky Survey.*

Motivation

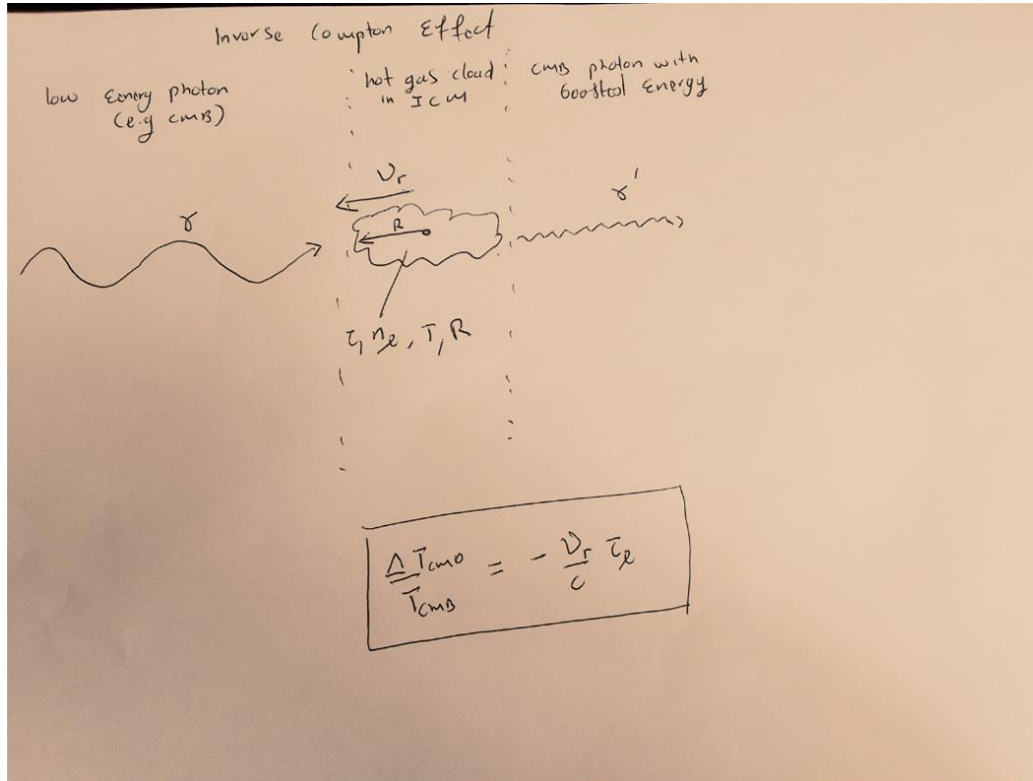
Galaxy Cluster Kinematic



Gravitational Potential promotional to kinetic of galaxy cluster



Kinetic Sunyaev-Zel'Dovich Effect (kSZ)

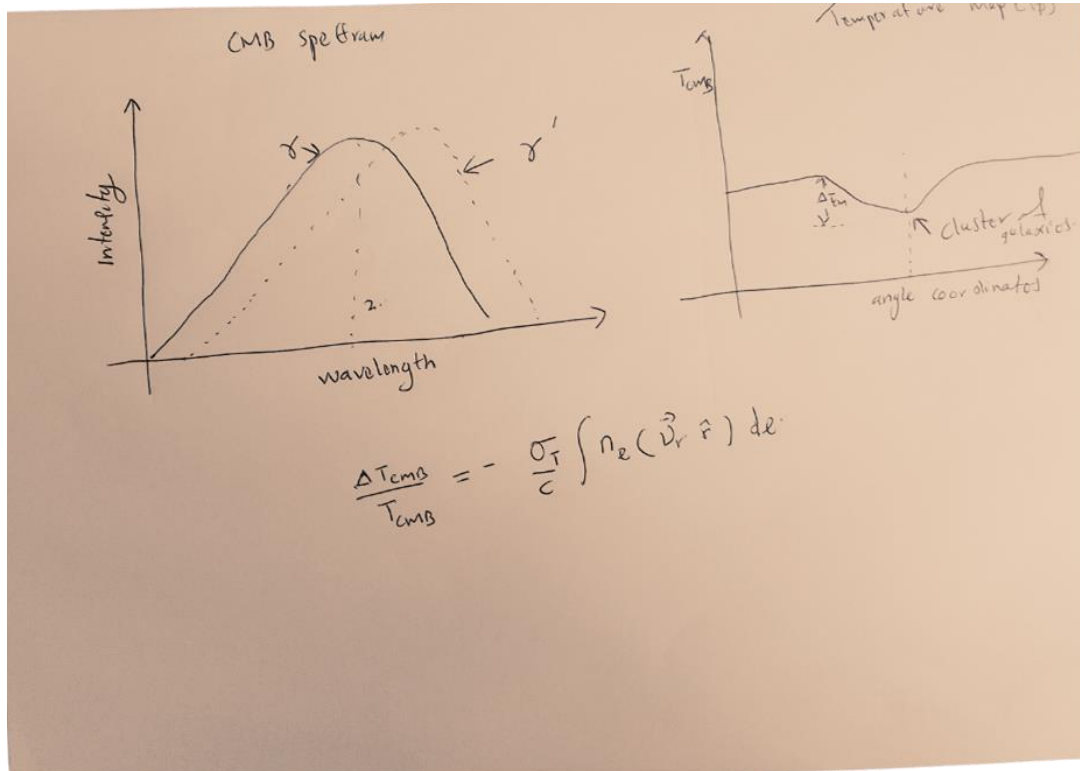


Sunyaev & Zeldovich 1972;

Birkinshaw 1999;

Carlstrom et al. 2002

Kinetic Sunyaev-Zel'Dovich Effect (kSZ)



Sunyaev & Zeldovich 1972;

Birkinshaw 1999;

Carlstrom et al. 2002

Techniques to Detect kSZ

Pairwise Momentum Estimator

- Hand et al. 2012, ACT Map
- Planck intermediate results. XXXVII. Evidence of unbound gas from the kinetic Sunyaev-Zeldovich effect, et al.2016

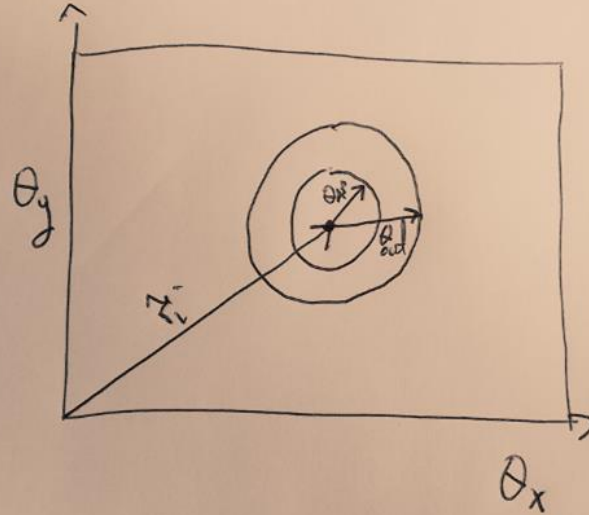
Matched Filter

- Ma et al.2013 and Ma. et al.2018

Aperture Photometry

- Sugiyama et al. 2017

Aperture Photometry



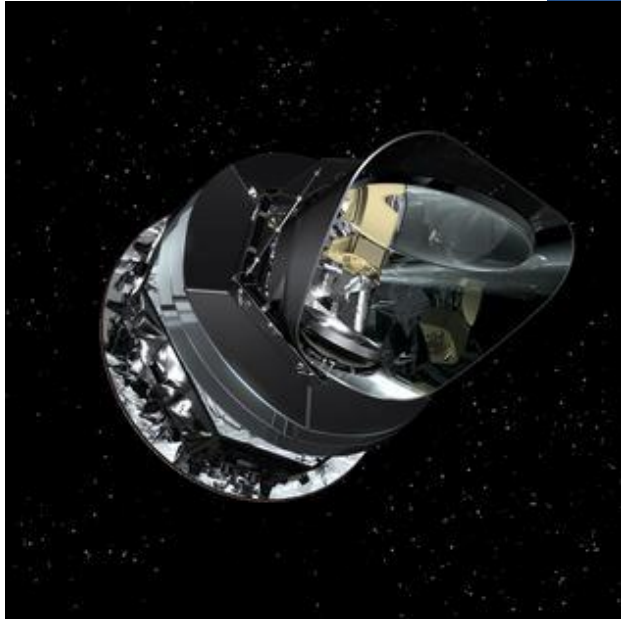
$$\theta_{\text{inner}} = \theta_{\text{AP}} = \frac{R_{\text{vir}}}{D_A}$$

$$\theta_{\text{out}} = \sqrt{2} \theta_{\text{AP}}$$

$$\delta T_i^c = T_i^c - \bar{T}_{(\theta_{\text{AP}} < \theta < \sqrt{2} \theta_{\text{AP}})}$$

ACT + PLANCK

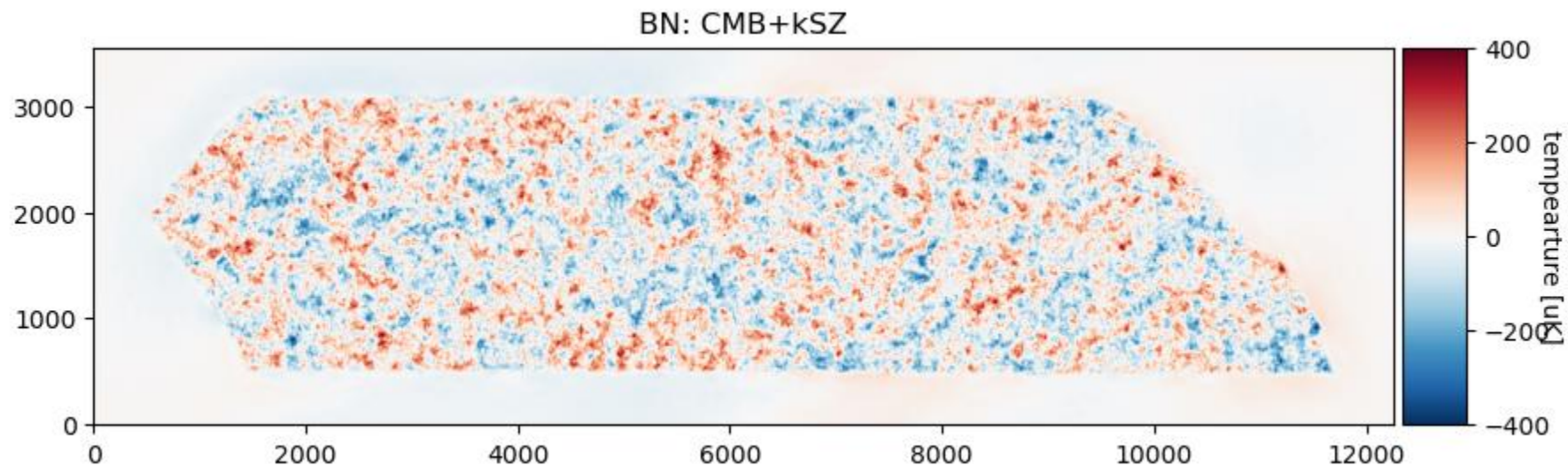
Planck



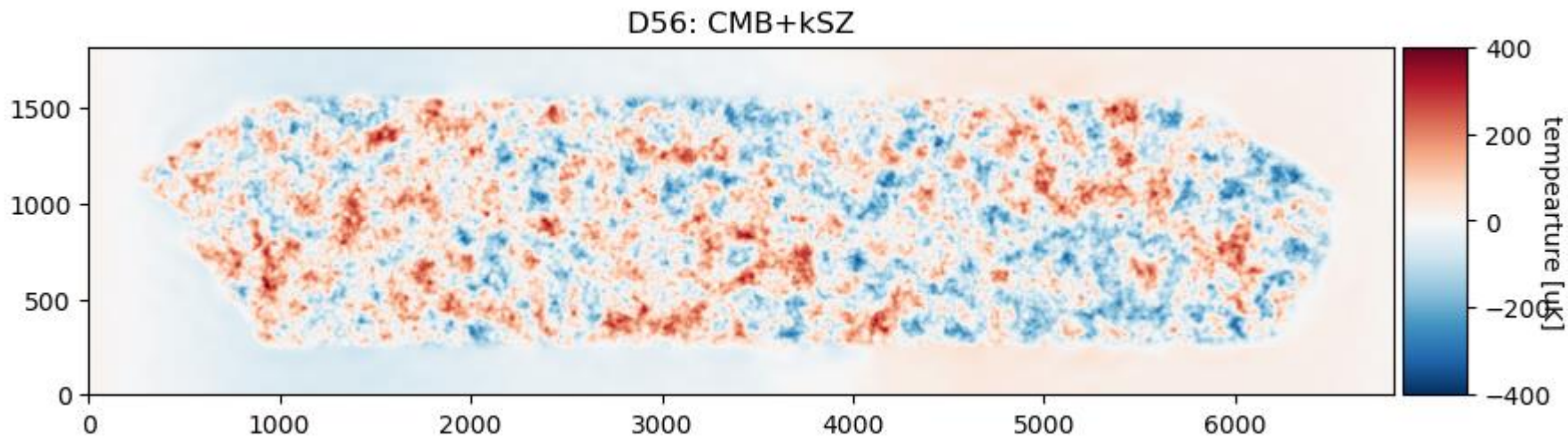
Atacama Cosmology Telescope



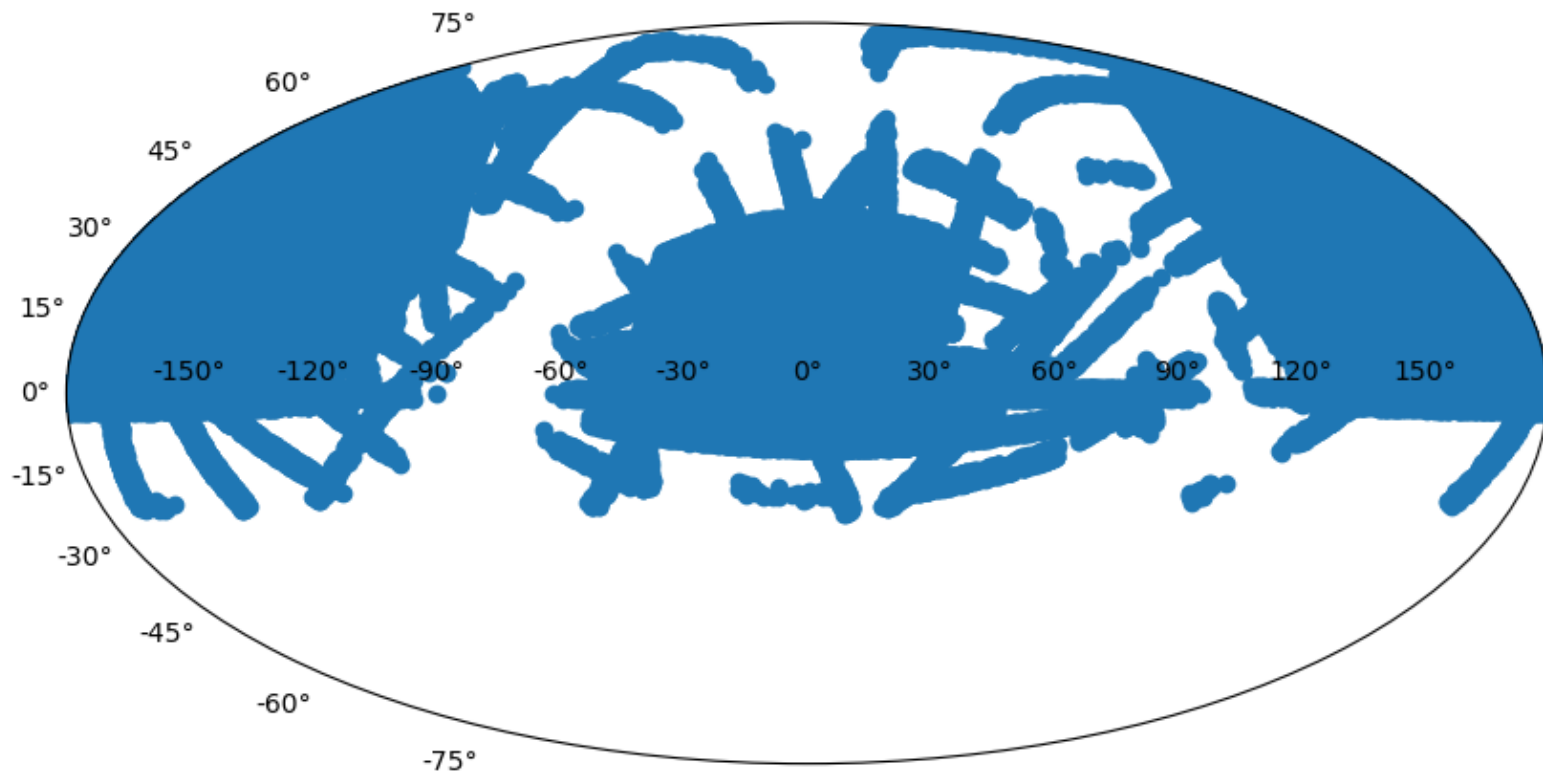
CMB + kSZ Co-Added Map



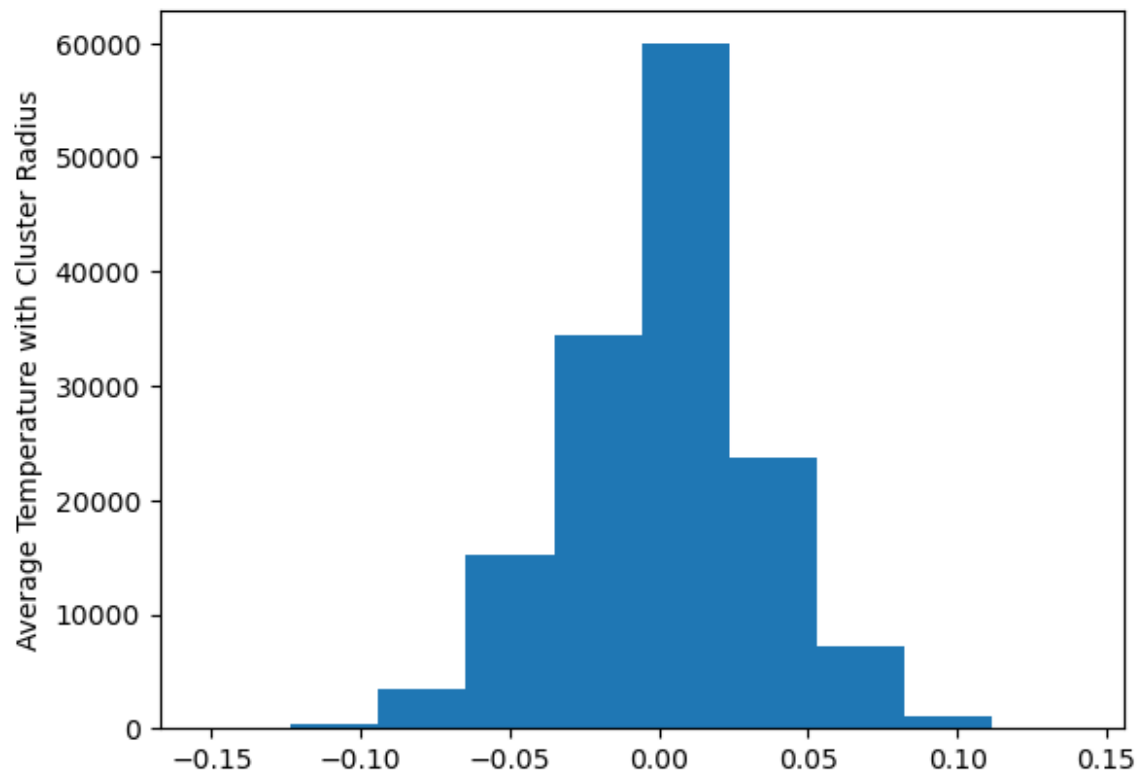
CMB + kSZ Co-Added Map



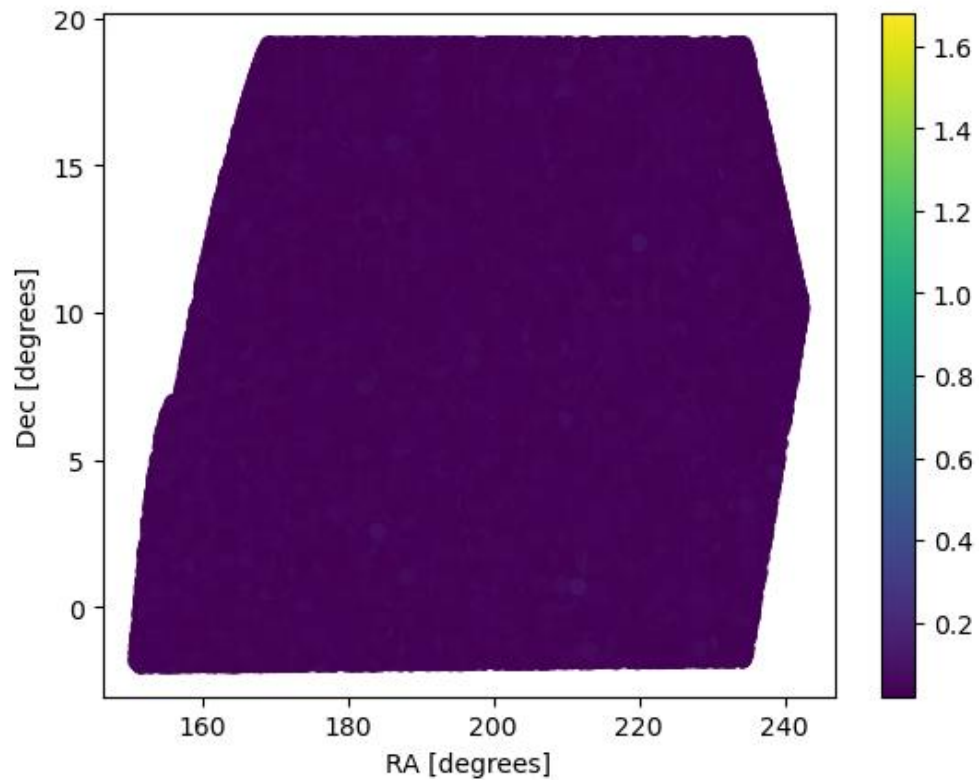
SDSS + DES Cluster Catalogue



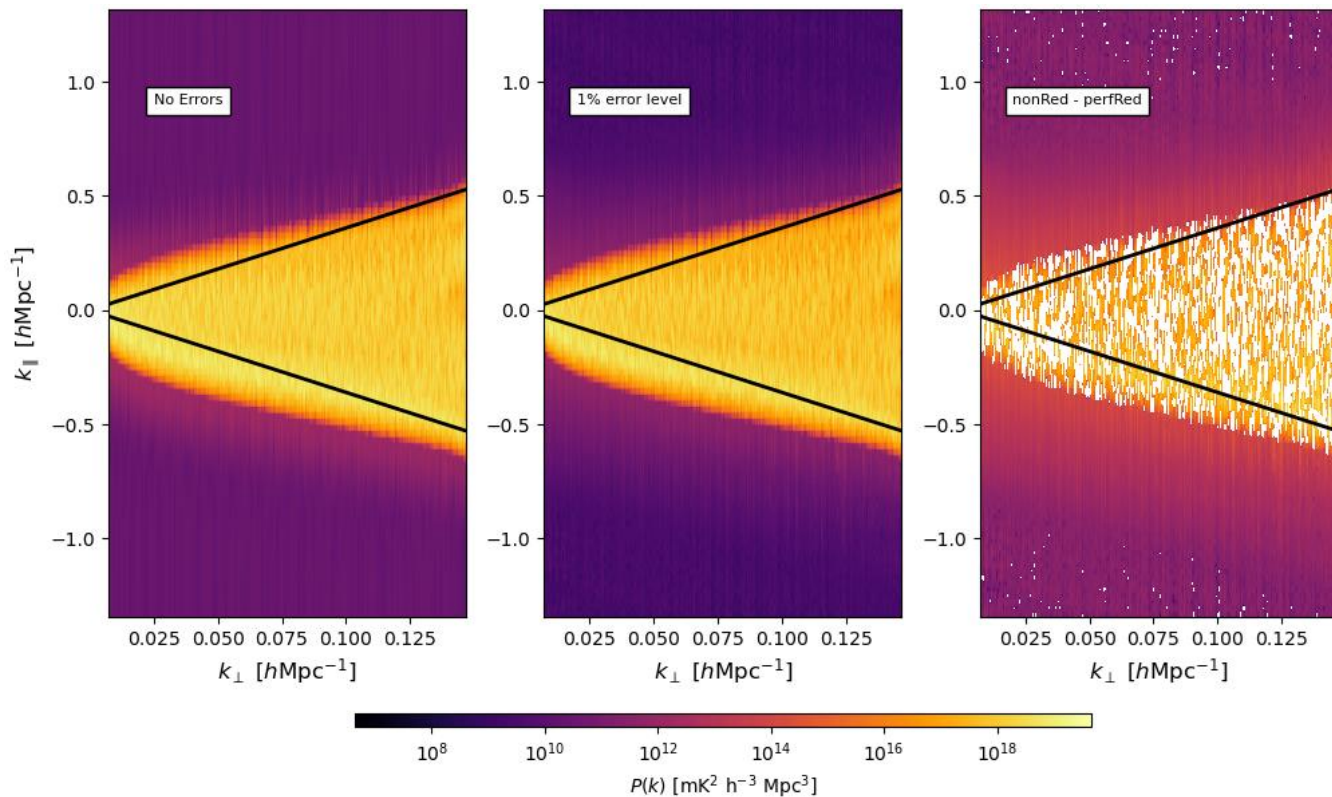
Status Quo



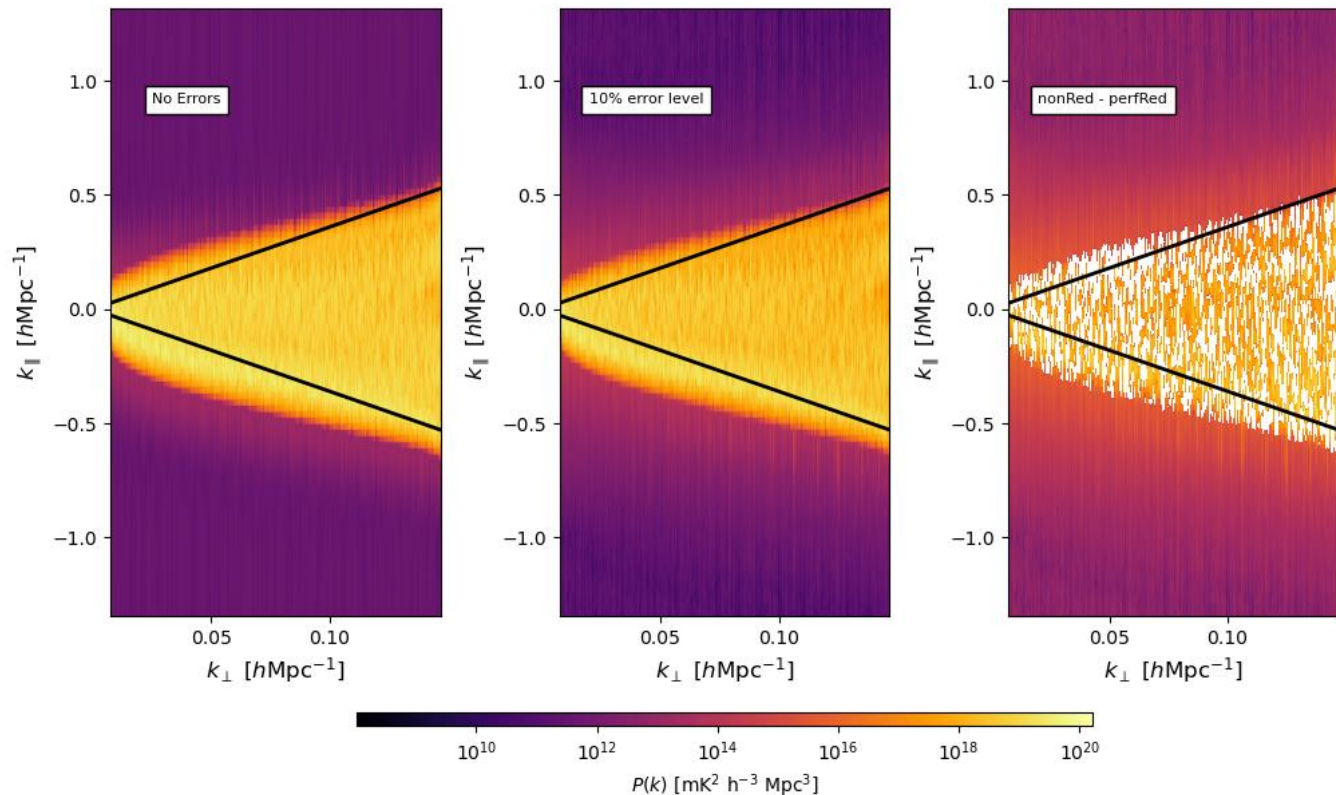
Future Work



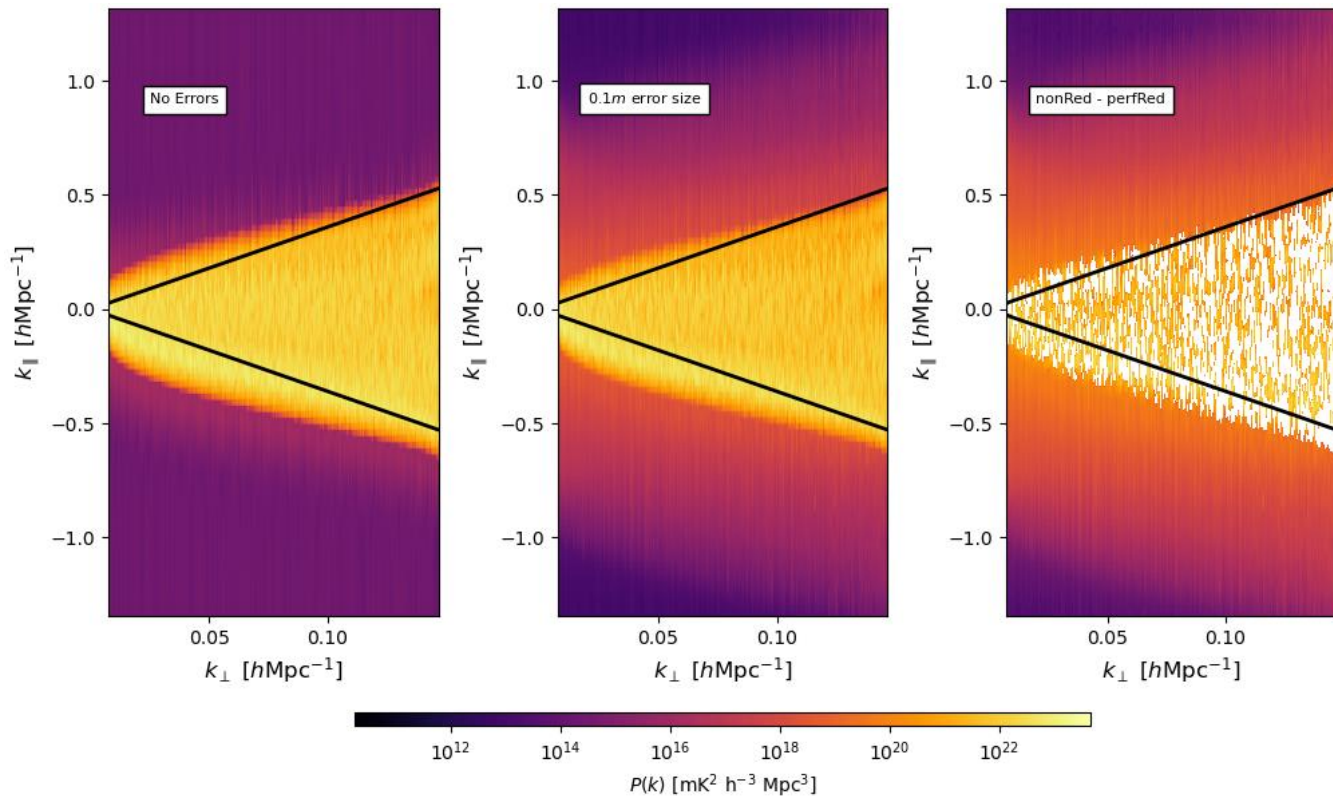
Delay Power Spectrum : 1% Position Errors



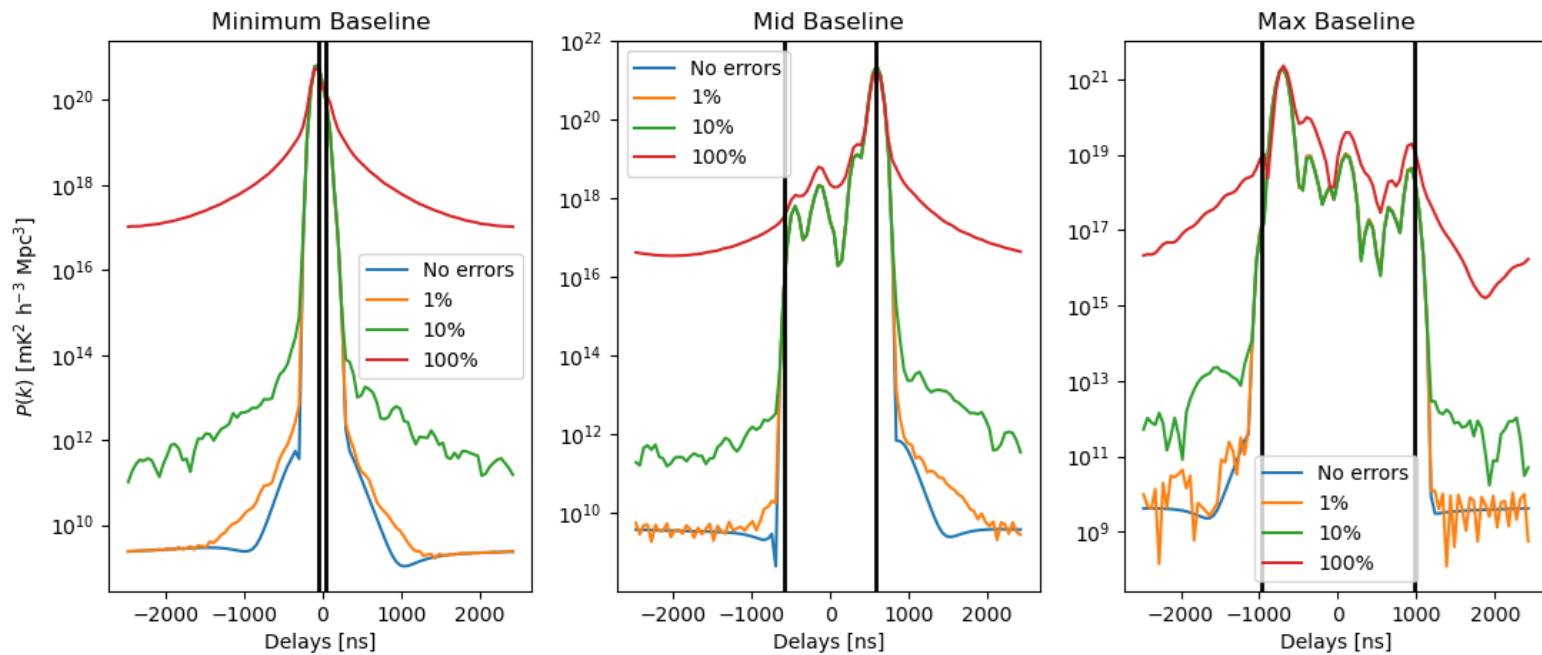
Delay Power Spectrum : 10% Position Errors



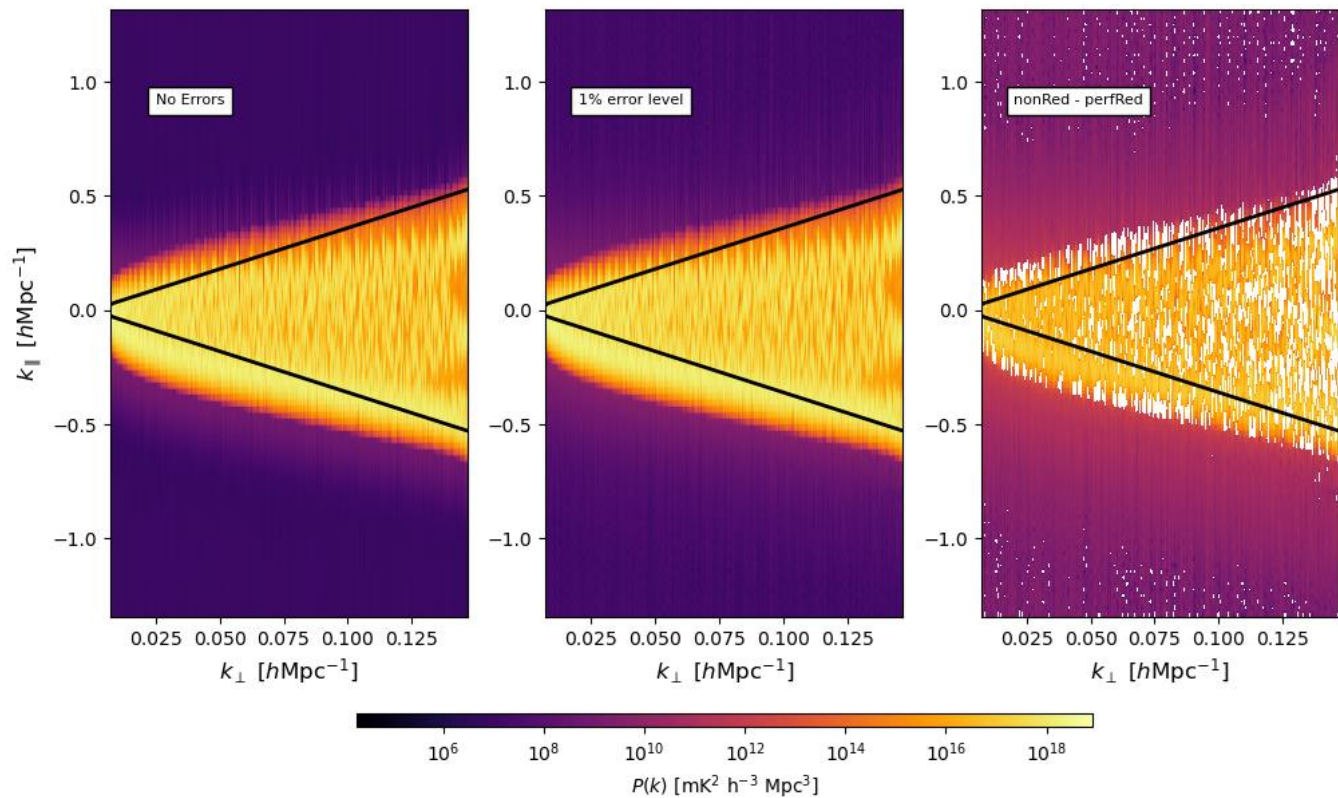
Delay Power Spectrum : 100% Position Errors



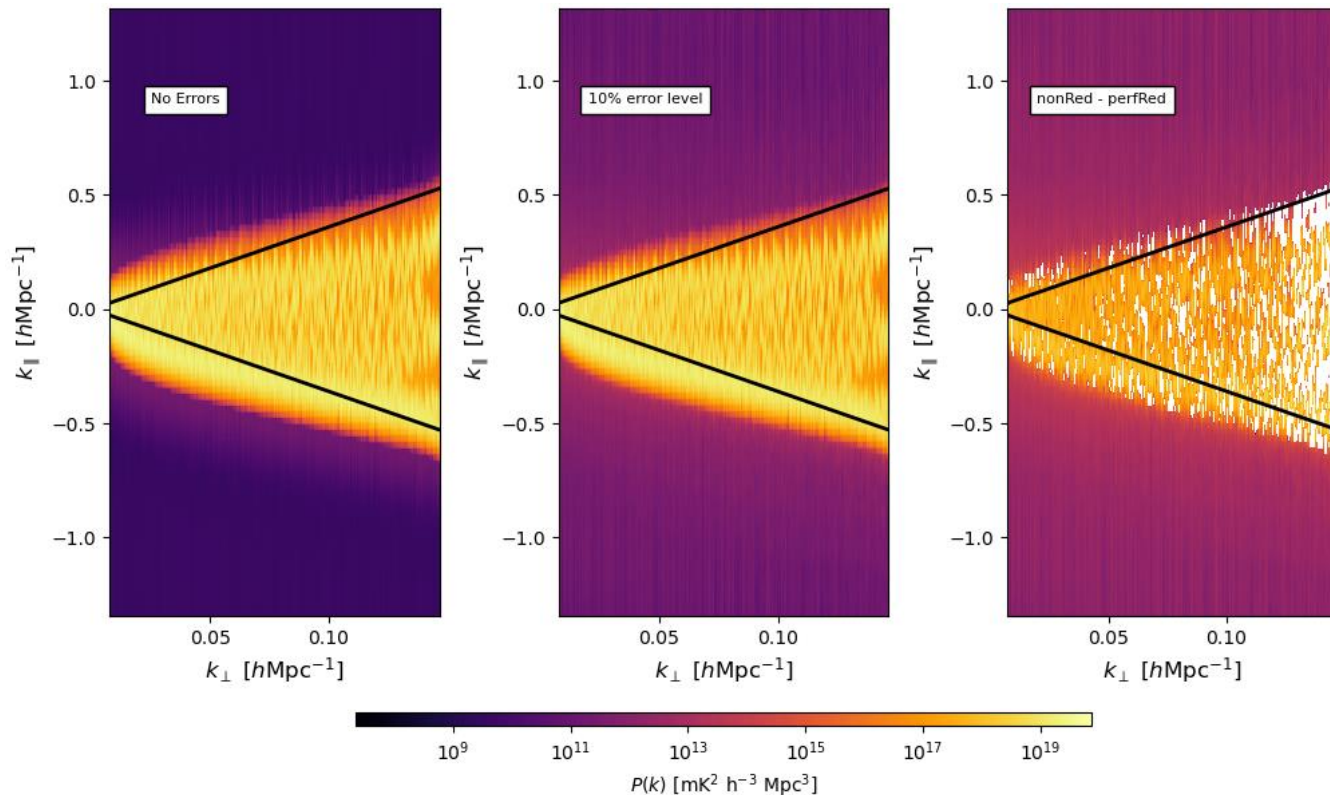
1D Delay Power Spectrum : Beam size errors



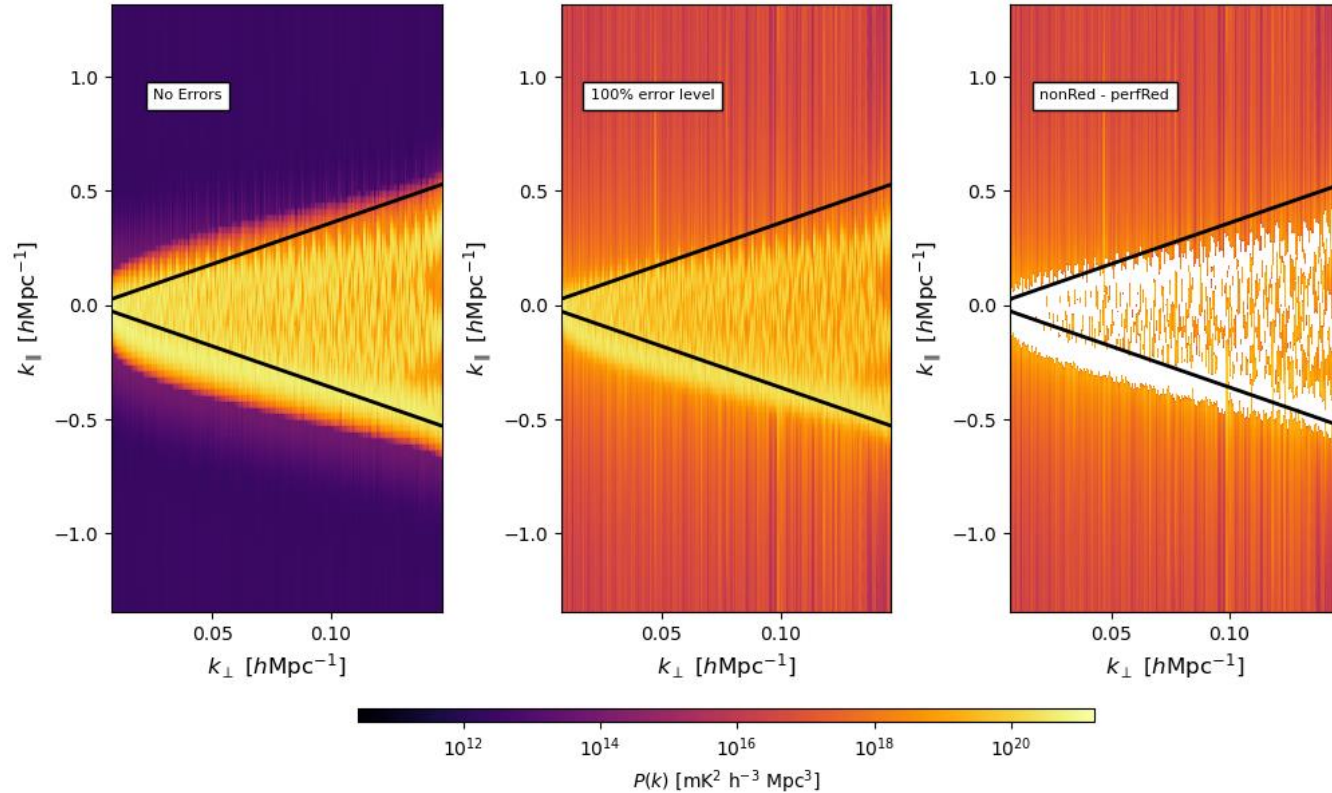
Delay Power Spectrum : 1% Beam size errors



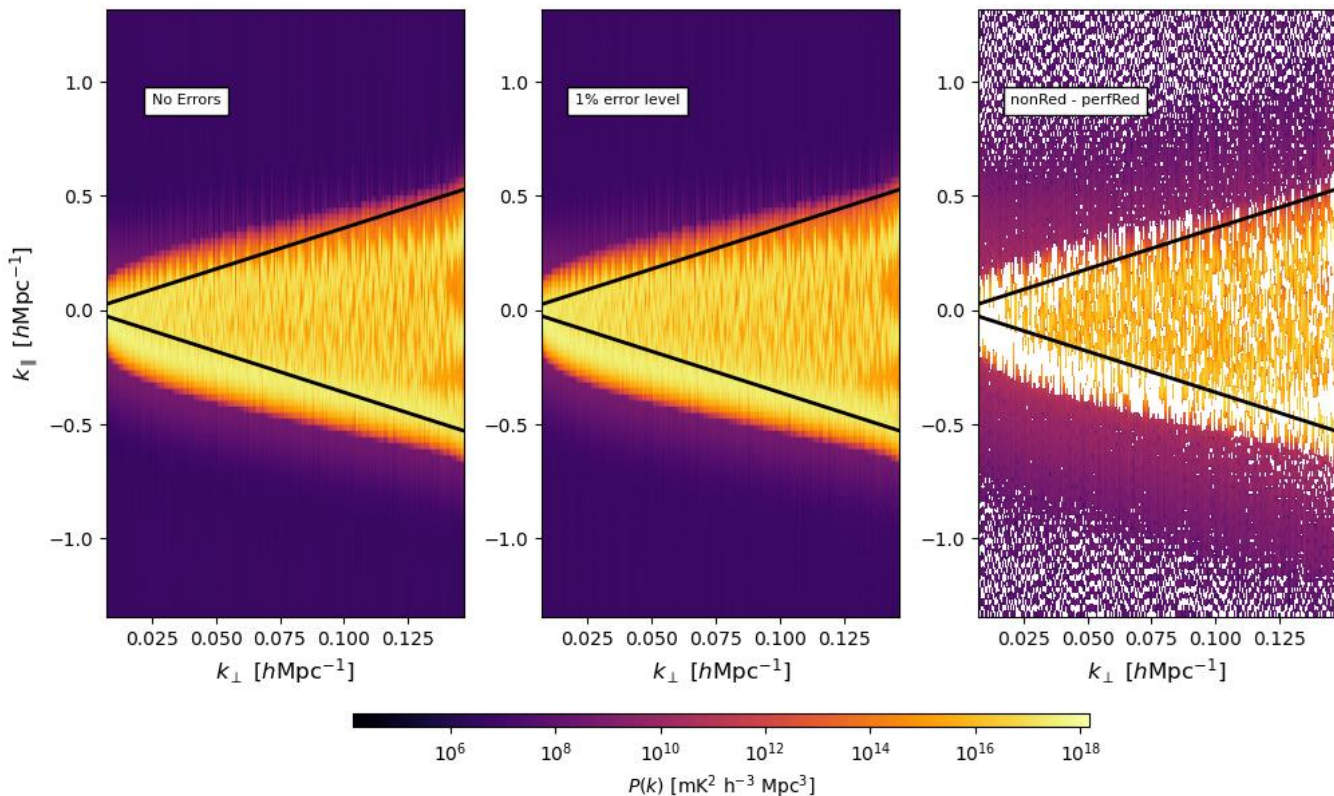
Delay Power Spectrum : 10% Beam size errors



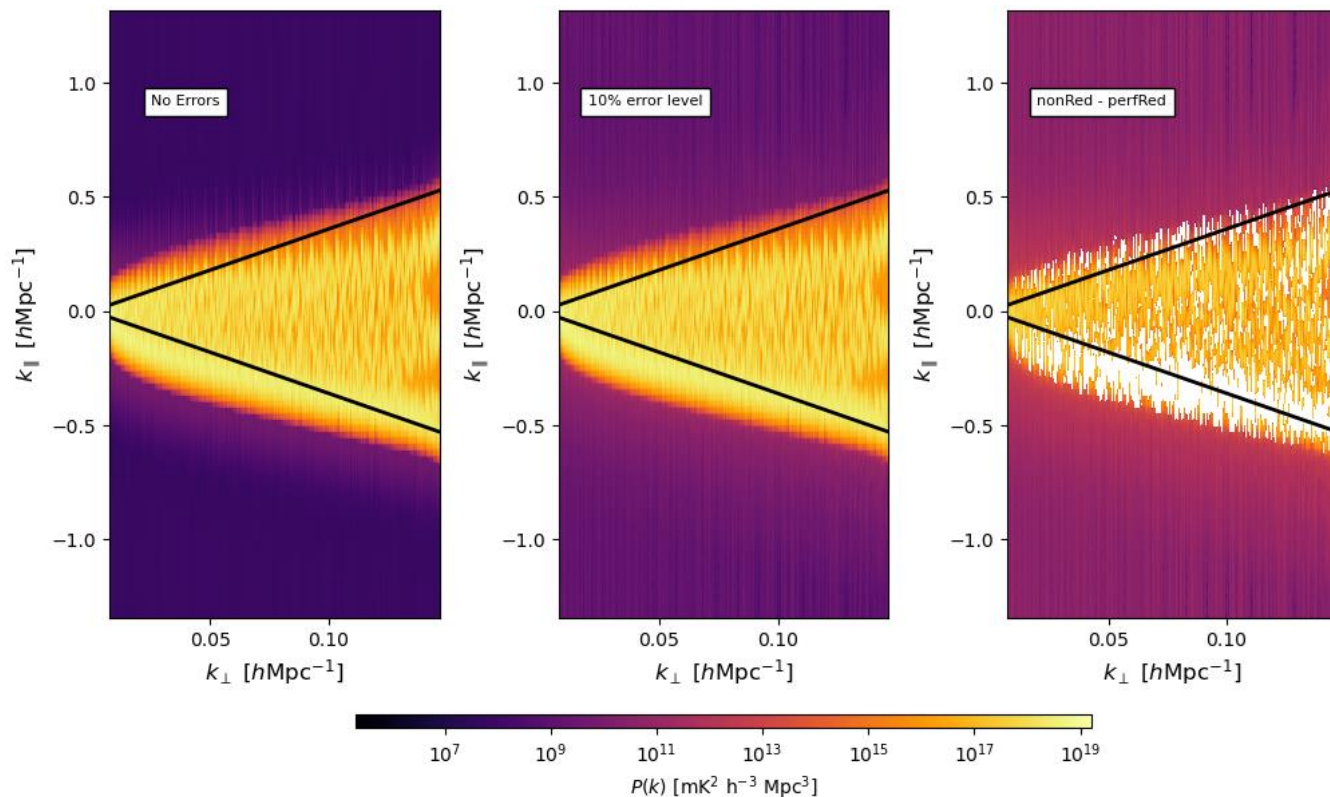
Delay Power Spectrum :100% Beam size errors



Delay Power Spectrum : 1% Beam pointing errors



Delay Power Spectrum : 10% Beam pointing errors



Delay Power Spectrum : 100% Beam pointing errors

