3D sky map reconstruction and residual power spectrum after foreground removal

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Method overview

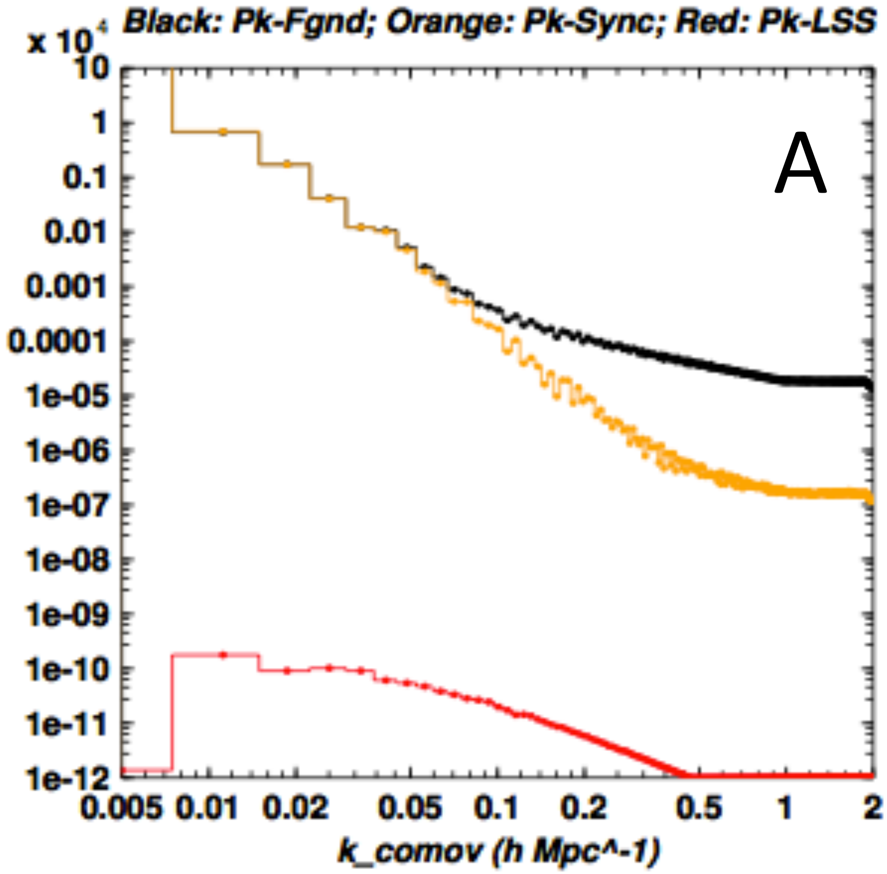
- 3D sky map $I(\alpha,\delta,\upsilon)$ reconstruction for a transit instrument from visibilities.
- α: RA, East-west; δ: DEC North-South; υ: Frequency.
- Fourier: $(\alpha,\delta)\rightarrow(u,v);I(\alpha,\delta,\upsilon)\rightarrow F(u,v,\upsilon)$
- For each frequency plane, we could use the program which we have developed for 2D sky map reconstruction.
- Sum up all frequency, we will get the "observed" 3D sky map:

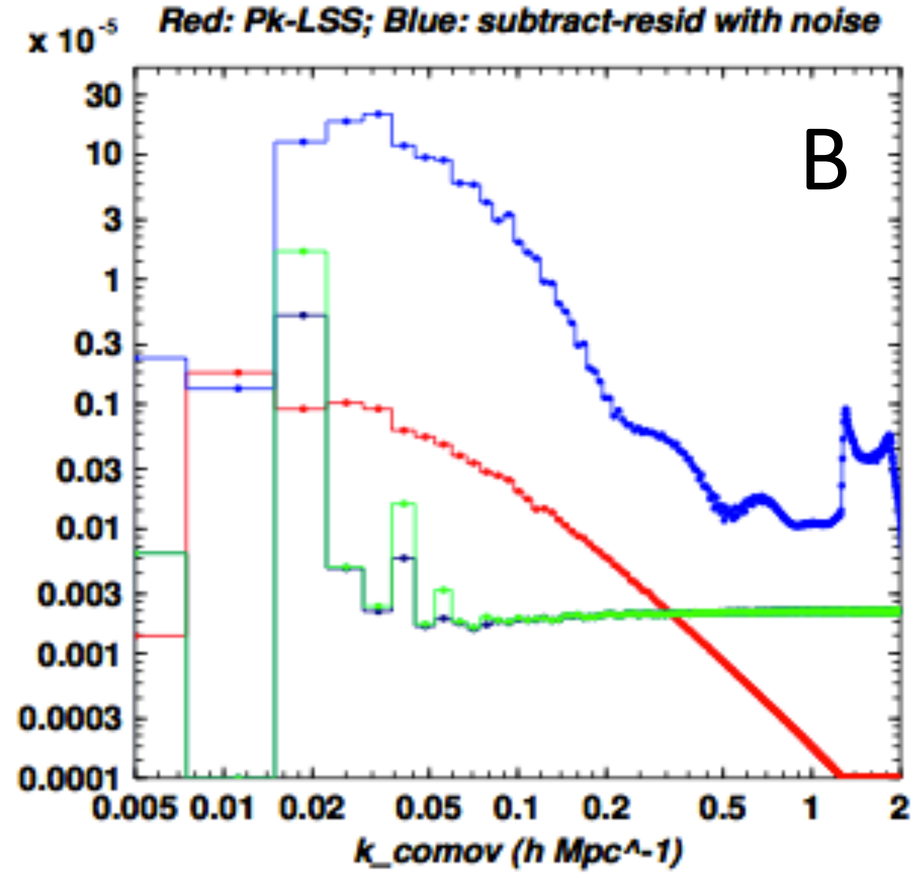
$$\hat{F}(u,v,\upsilon)$$

- Compute power spectrum for 3D sky map.
- Subtract foreground to compute the power spectrum of residual sky map.
- Apply beam correction to optimize the effect of foreground subtraction.
- Comparing foreground subtraction performance for 2 interferometer configurations
- The overall strategy for foreground subtraction is the one described in the Ansari et al (A&A 450 (2012))

A: Comparison of foreground and 21 cm signal power Spectrum.

B: Performance of residual power spectrum after foreground subtraction.

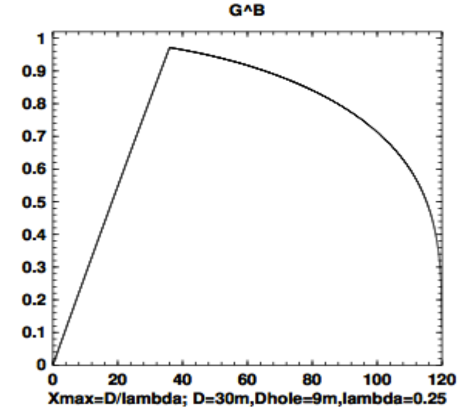




Beam correction optimization apply to the "observed" sky map

$$W_2(u,v) = \begin{cases} 1, & \sigma_F^2(u,v) \leqslant wthr \\ \frac{wthr}{\sigma_F^2(u,v)}, & \sigma_F^2(u,v) > wthr \end{cases}$$

$$\mathscr{C}^B(u,v,\nu) = \begin{cases} \frac{W_2((u,v);\nu_{min}) \times G^B(u,v)}{W_2((u,v);\nu) \times B((u,v);\nu)}, & |\mathscr{C}^B(u,v,\nu)| < 3 \\ 3, & |\mathscr{C}^B(u,v,\nu)| \geqslant 3 \end{cases}$$



$$\widehat{F}_{keep}(u,v,\nu) = \widehat{F}(u,v,\nu) * W_2((u,v);\nu) * \mathscr{C}^B(u,v,\nu)$$