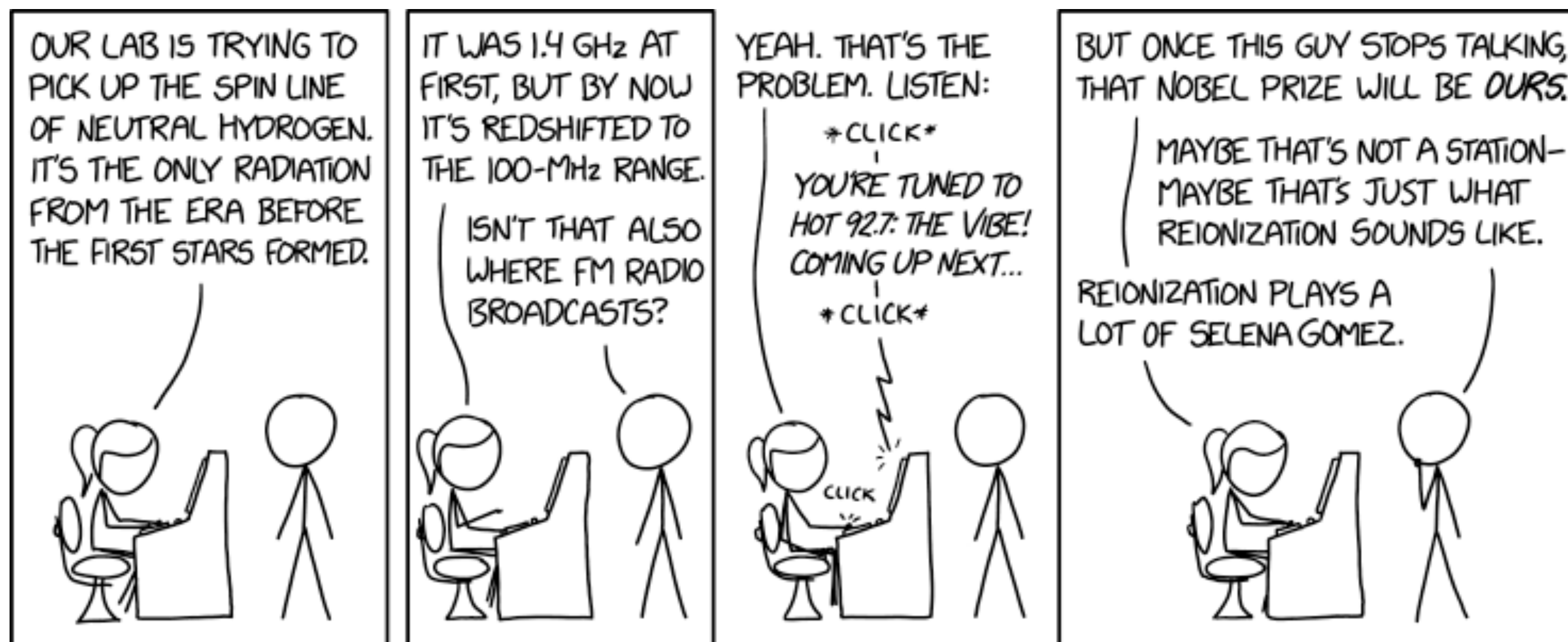


Evidence of Ultra-faint RFI in Deep 21-cm Power Spectra

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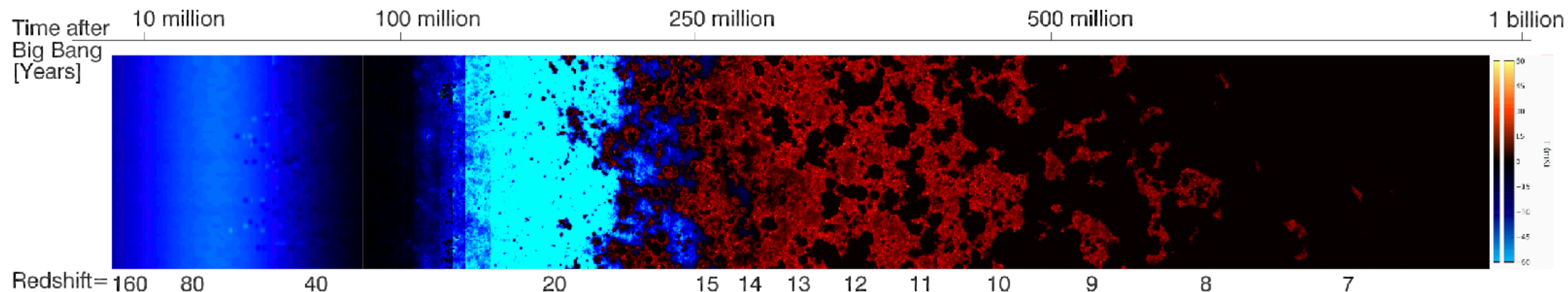
Talk Outline

-
- Why RFI is a problem in 21-cm power spectrum estimation
 - Basic study design of 2014 Highband Data
 - Data analysis (RFI statistics, power spectrum jackknife tests)
 - Deepest integration/power spectrum upper limit

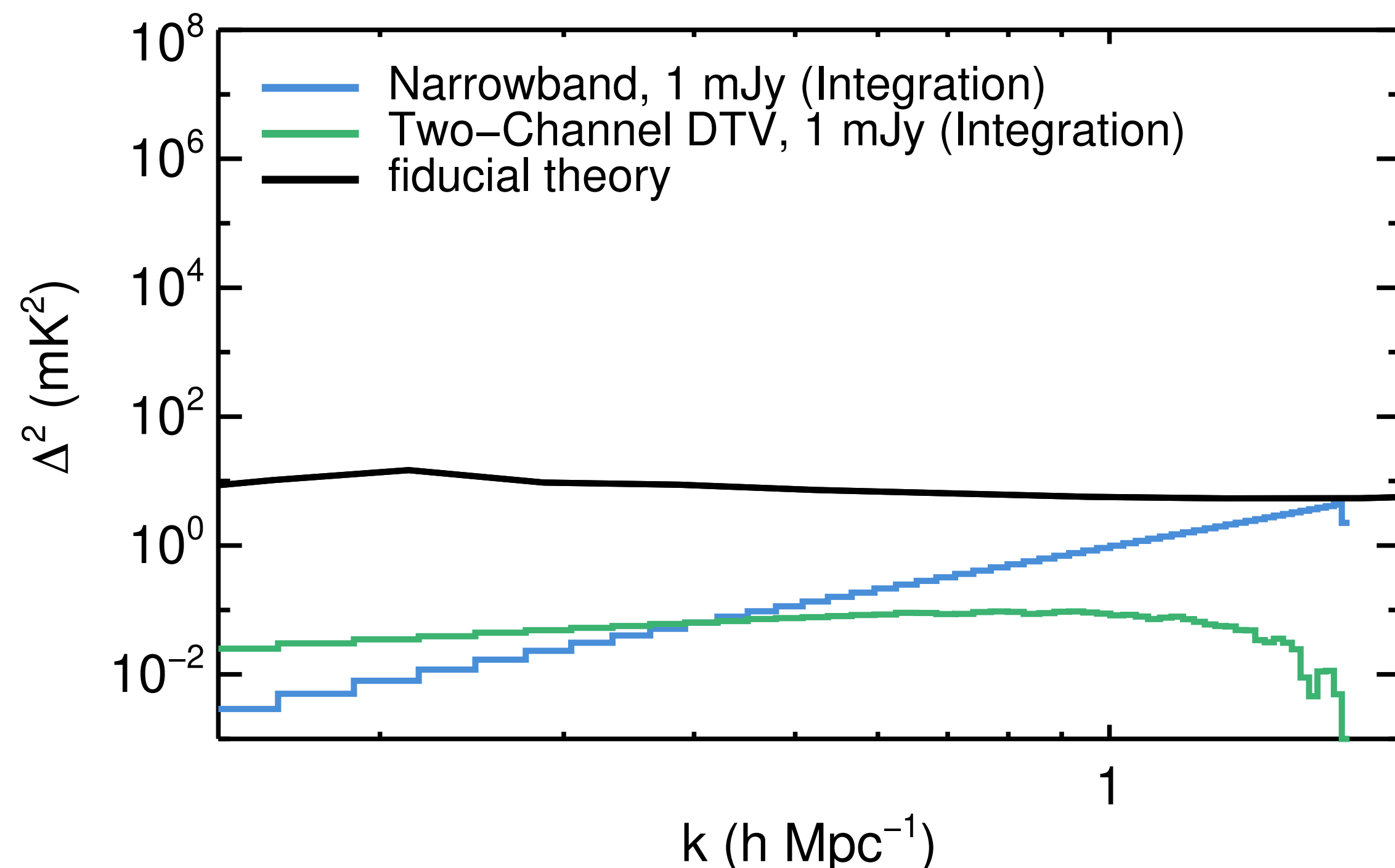
Why RFI is a problem pt. 1

- The 21-cm signal is very faint
- We are using the frequency axis as a “line-of-sight” distance axis
- Contaminants with significant spectral structure are hard to separate from the signal
- RFI has spectral structure

Source: <https://arxiv.org/abs/1109.6012>



Why RFI is a problem pt. 2

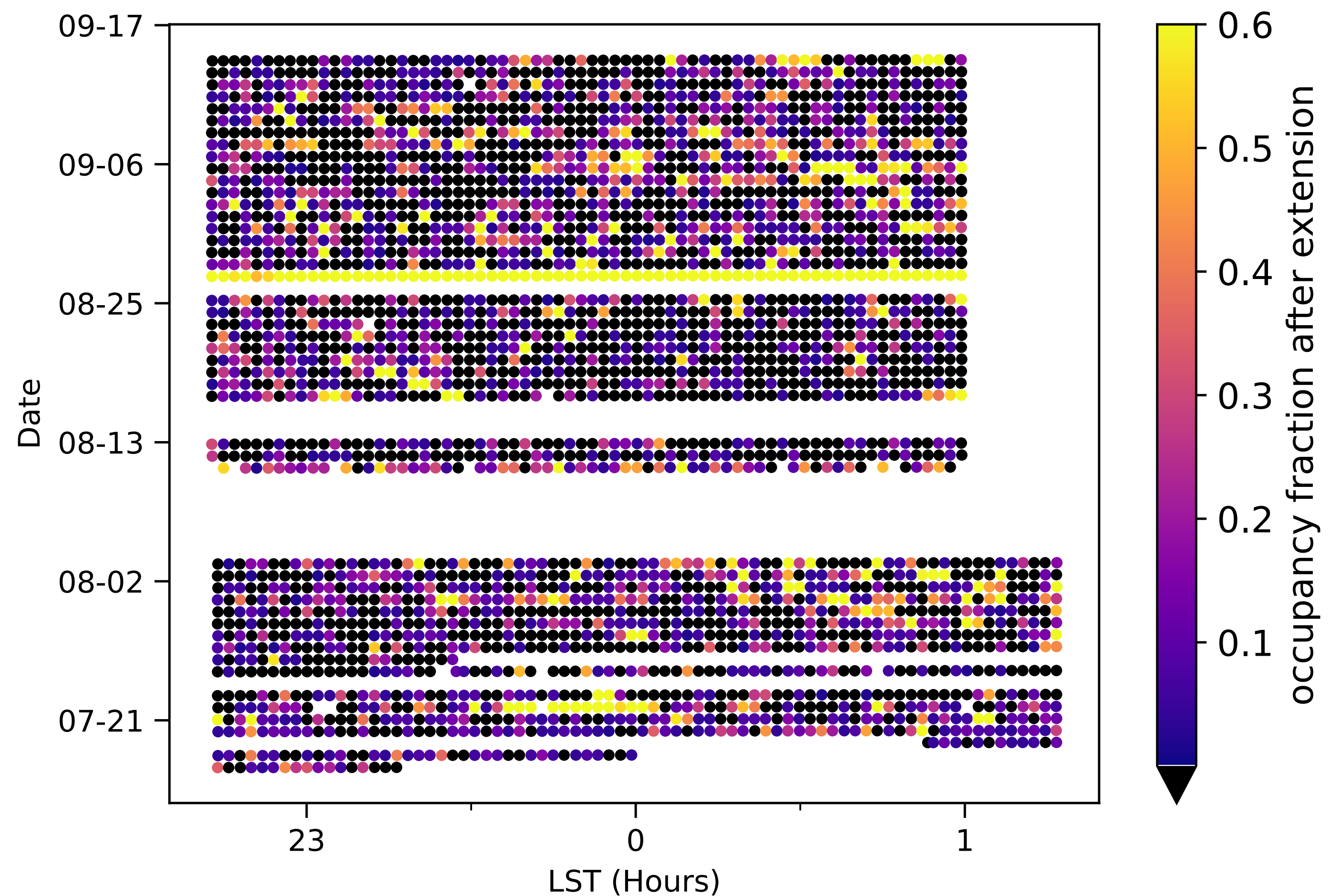


- Depending on the wave mode and type of RFI, the EoR PS signal is (probably) about as bright as that of a ~ 10 mJy RFI source
- But how much RFI is in our deep integrations? No groups have a great quantitative handle on this, but also no one sees systematics that are obviously associated with RFI.

Basic Study Design

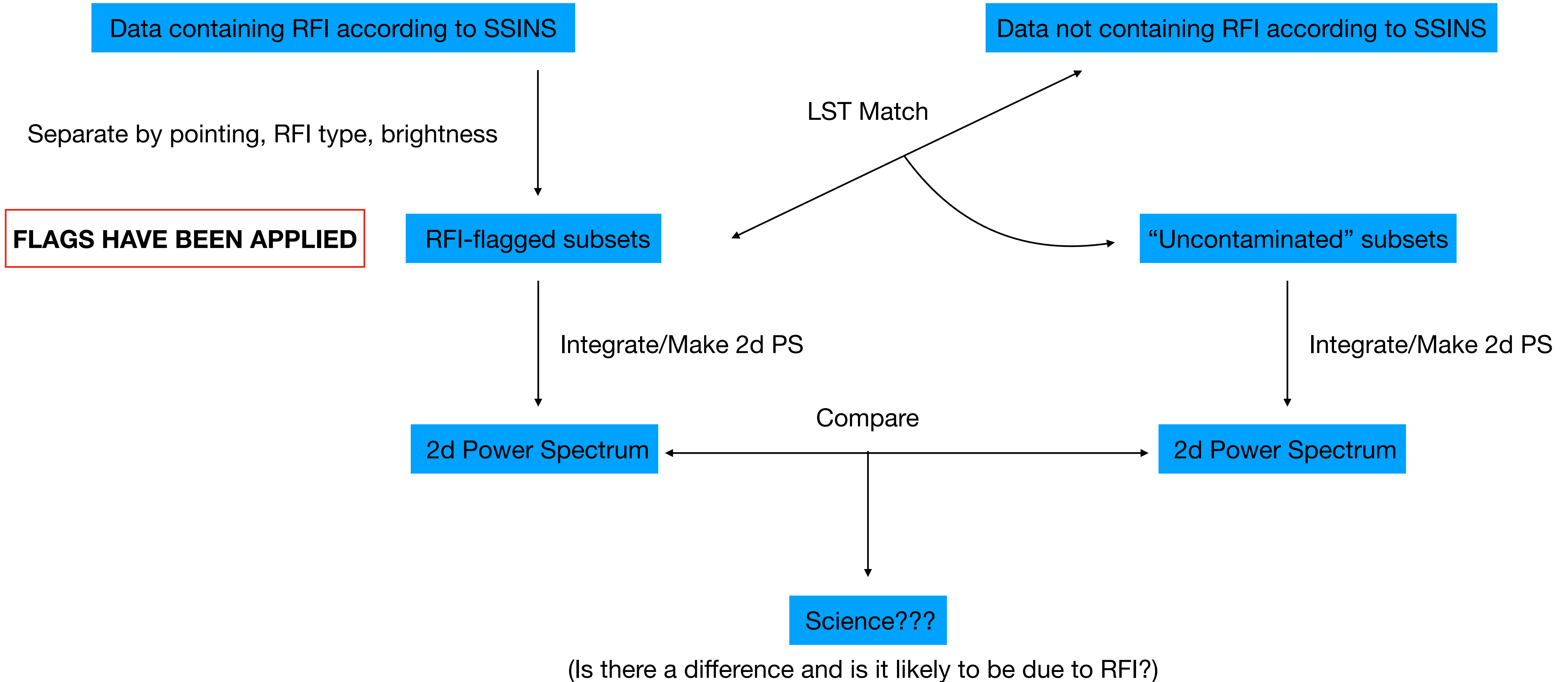
- Take a fairly large data set (1 season; 2014 EoR highband data)
- Separate data by RFI content (as seen by SSINS)
- See if we can find stuff in the power spectra of different subsets at different integration depths
- Make a power spectrum upper limit (any effect?)

RFI Content

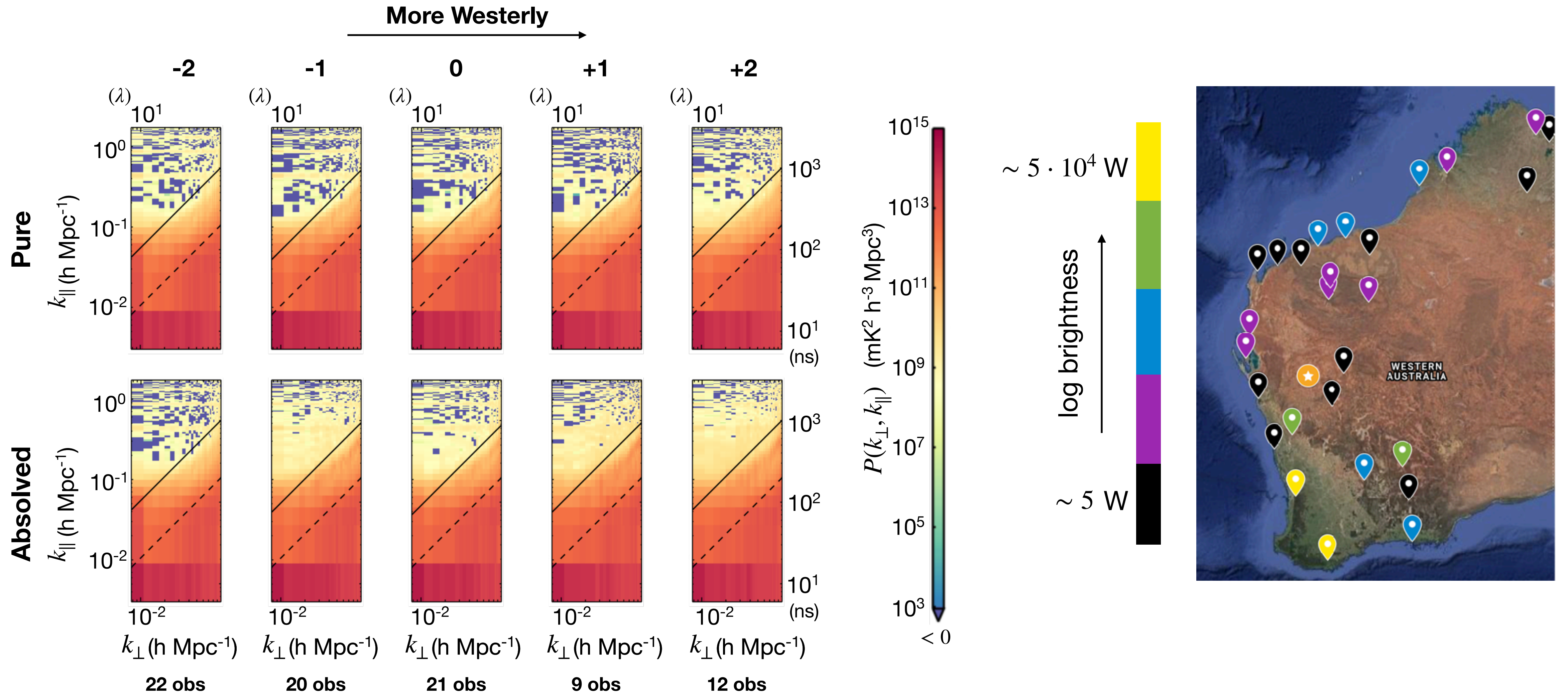


- RFI flagged using SSINS (finds fainter things than AOFlagger, did not use AOFlagger flags)
- RFI tends to appear in “runs” (it clusters in time; physically expected)

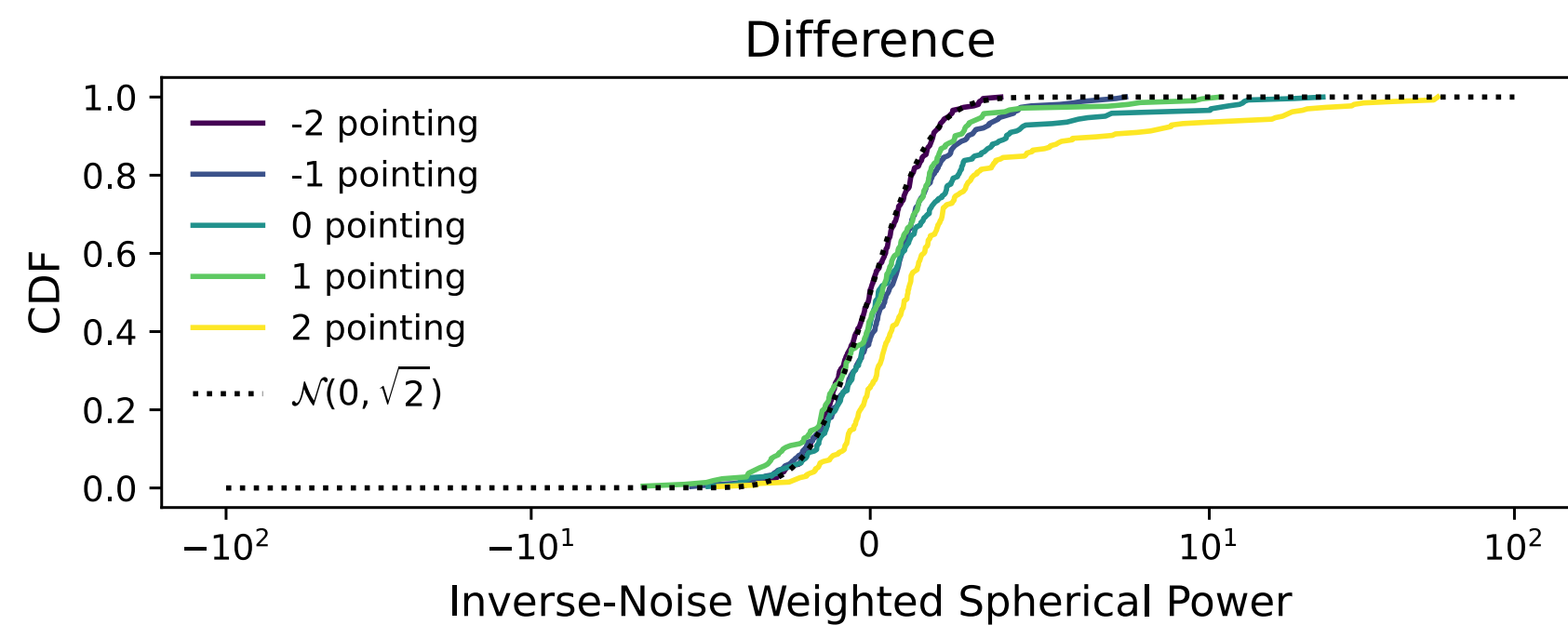
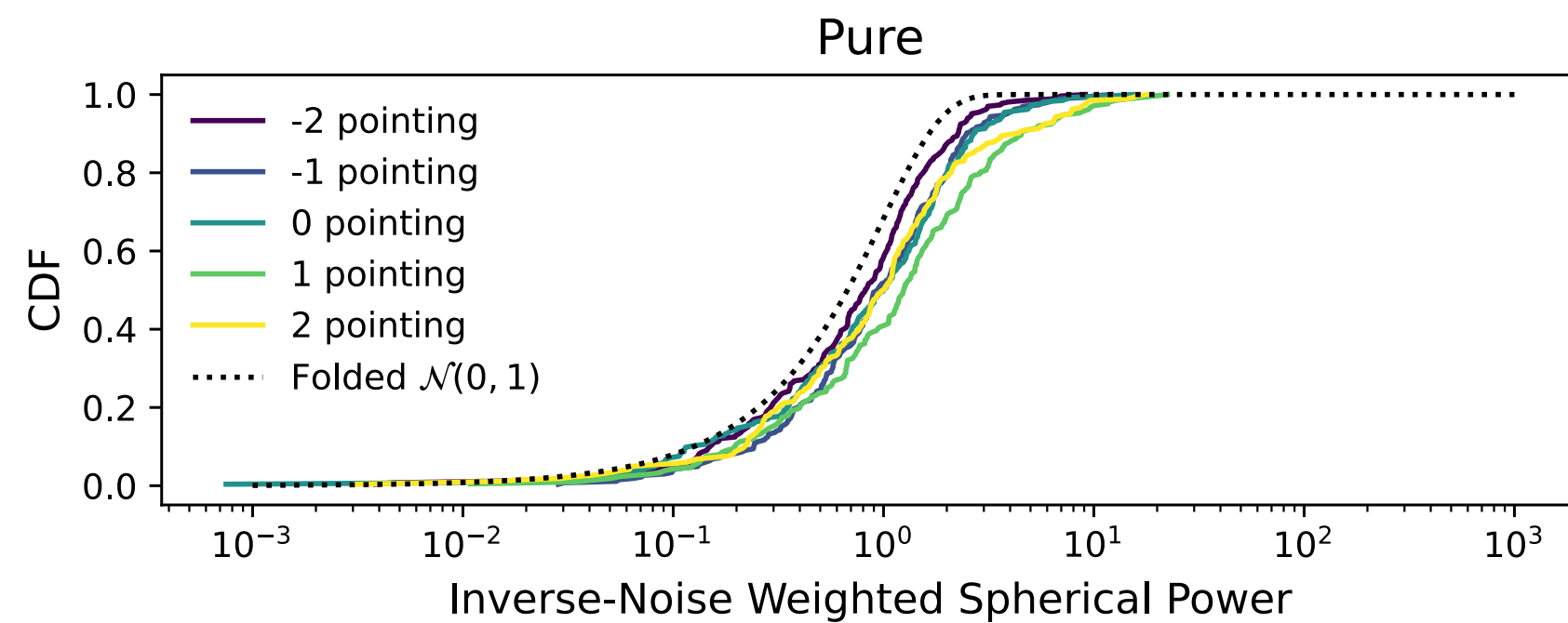
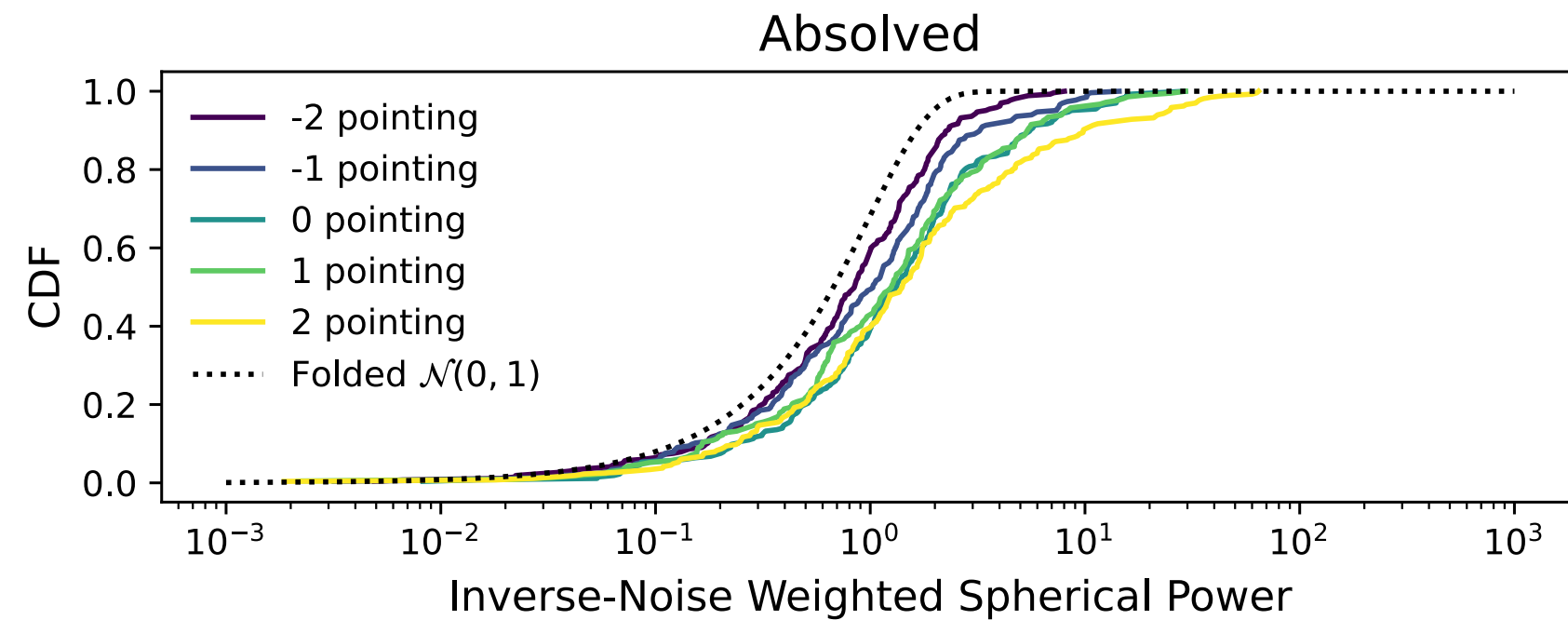
Where there's RFI, there's probably fainter RFI



Seems to be worse in Western Pointings, pt. 1



Seems to be worse in Western Pointings

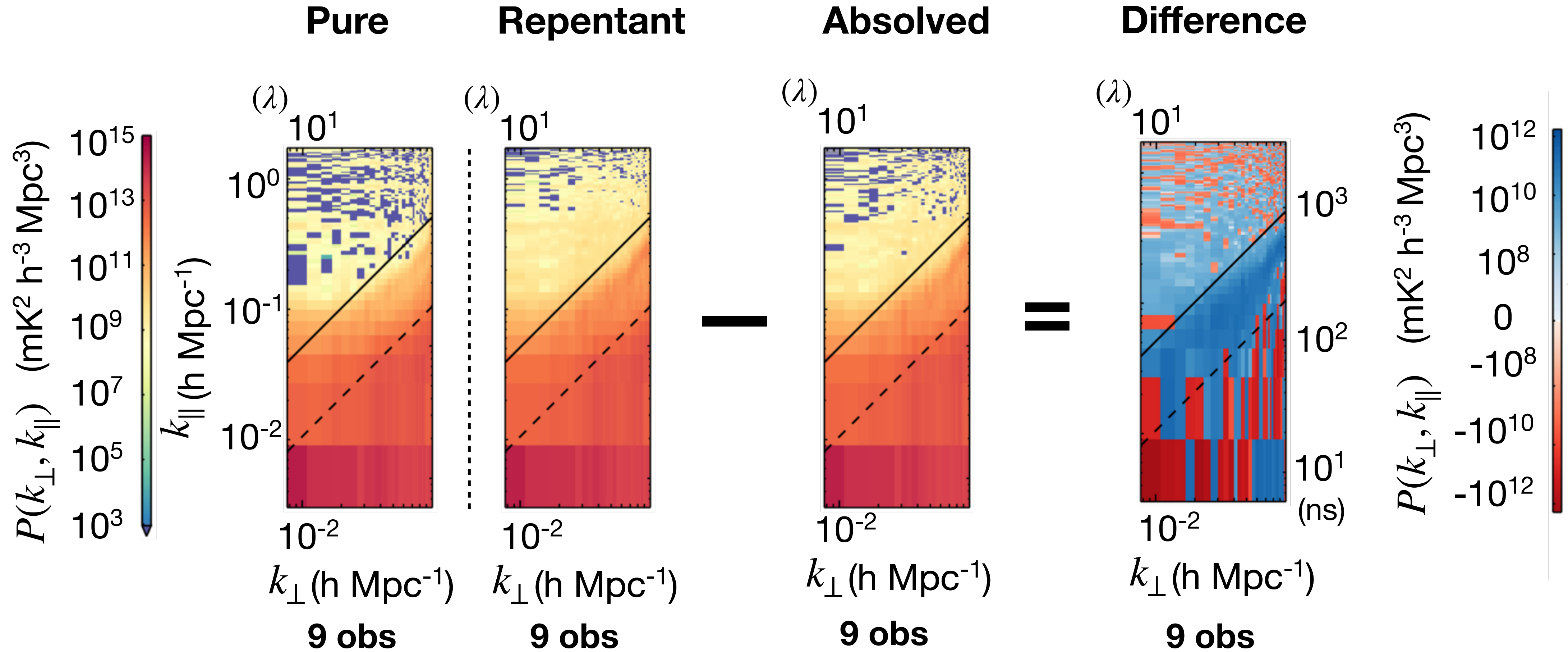


- More Western pointings further to the right in “Absolved” observations

- Also somewhat true of the “pure” observations, but really only at high significance

- Difference indicates that the systematic is worse in the absolved than the pure

PS Footprint is Enhanced when we turn off flags



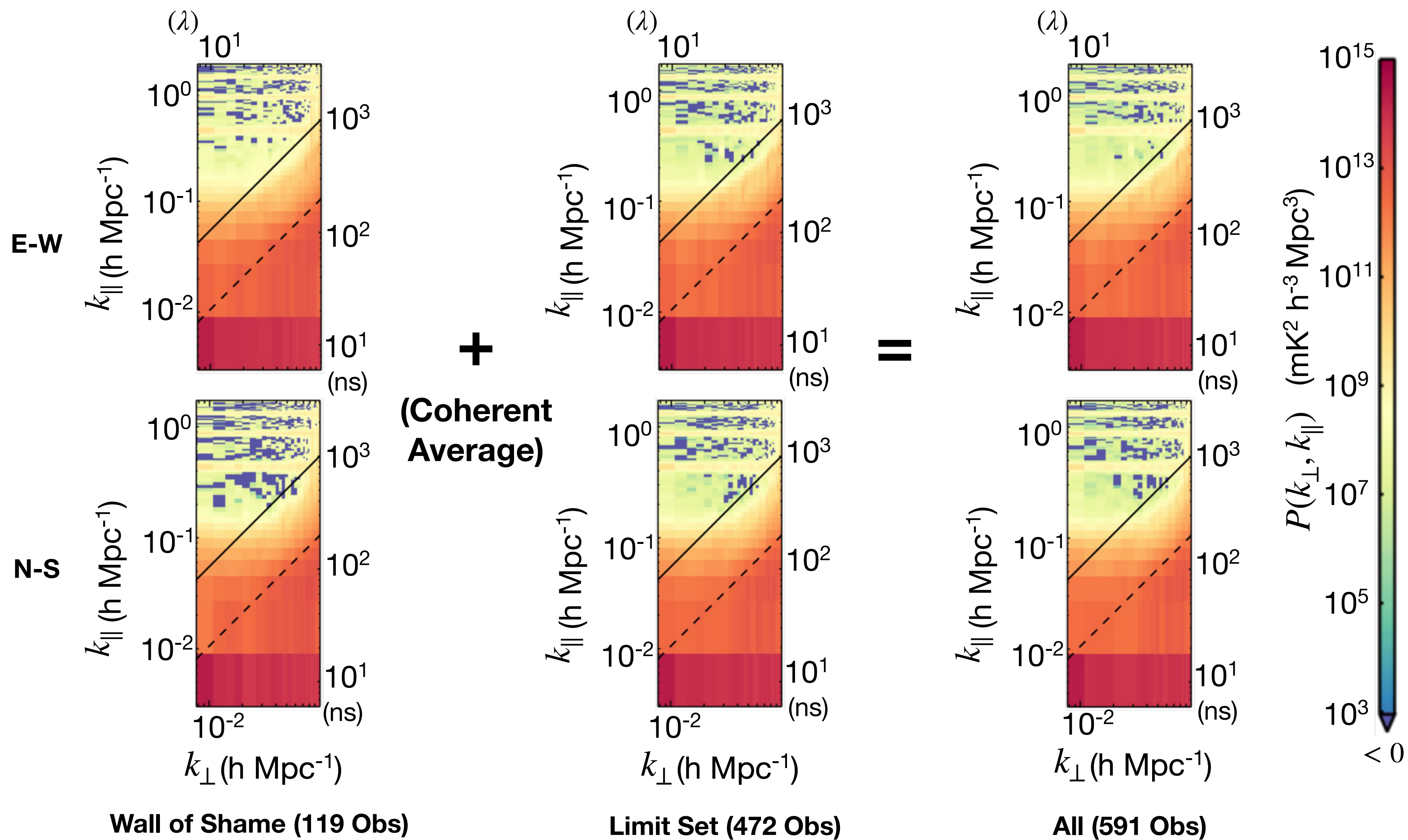
Some puzzles from the jackknives

-
- Brighter RFI events in the SSINS don't necessarily correlate with worse contamination in the integrated power spectra
 - Different RFI types don't seem to correlate with different PS shapes (counter to theoretical expectation)
 - There seems to be an optimal integration depth of ~half an hour — suspect this is due to subsets of this size having fewer nights involved

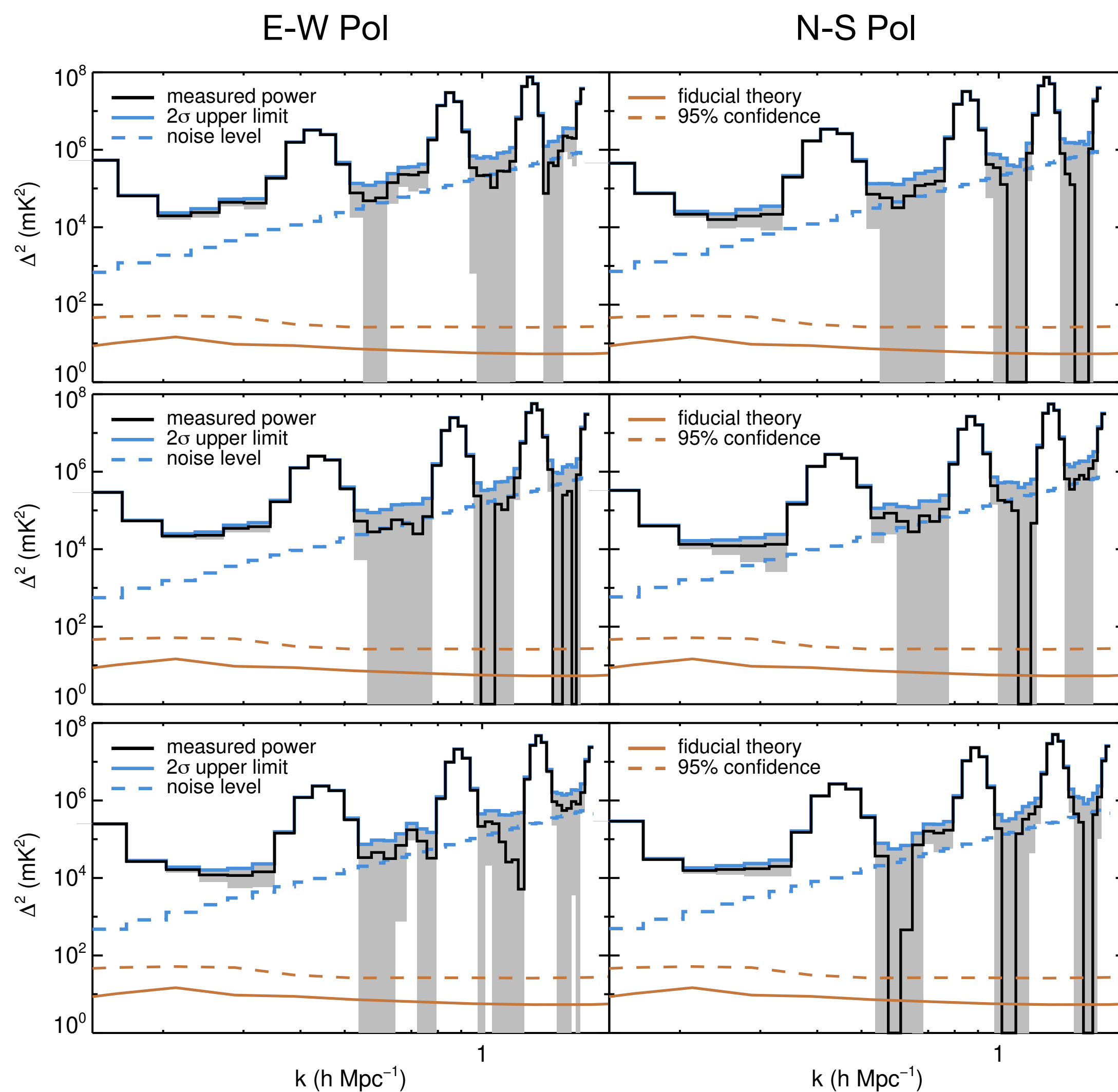
Making a limit

-
- Cut any observation with sub-excellent ionosphere or for which we could not calculate a metric (RTS fail)
 - Cut all absolved observations since there is probably residual RFI in them as seen in jackknife tests
 - Cut a few additional small subsets of “pure” observations that seemed to obviously show the RFI footprint

Some Deep PS



Final Limits



$z=7.1$

$z=6.8$

$z=6.5$

- Not our deepest limit (in fact high by a factor of a few)
- However almost every bin between the coarse band harmonics is noise limited

Conclusion

- Residual RFI exists despite significant improvements in RFI flagging
- Seems to correlate with pointing, and is more noticeable at shallow integration depths
- Exhaustive RFI cutting based on PS metrics seems to clean up regions of spherical PS b/w coarse band harmonics
- Potential threat of extremely faint RFI and nontrivial integration behavior suggests we should attack this problem harder to better understand the actual risks