The Polarized Radio Emission of the Microquasar SS 433
&
3-D Faraday Rotation Imaging

Outlook & Progress

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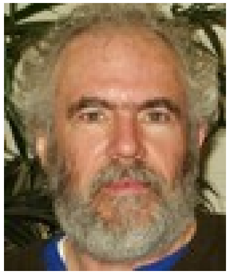
Outline

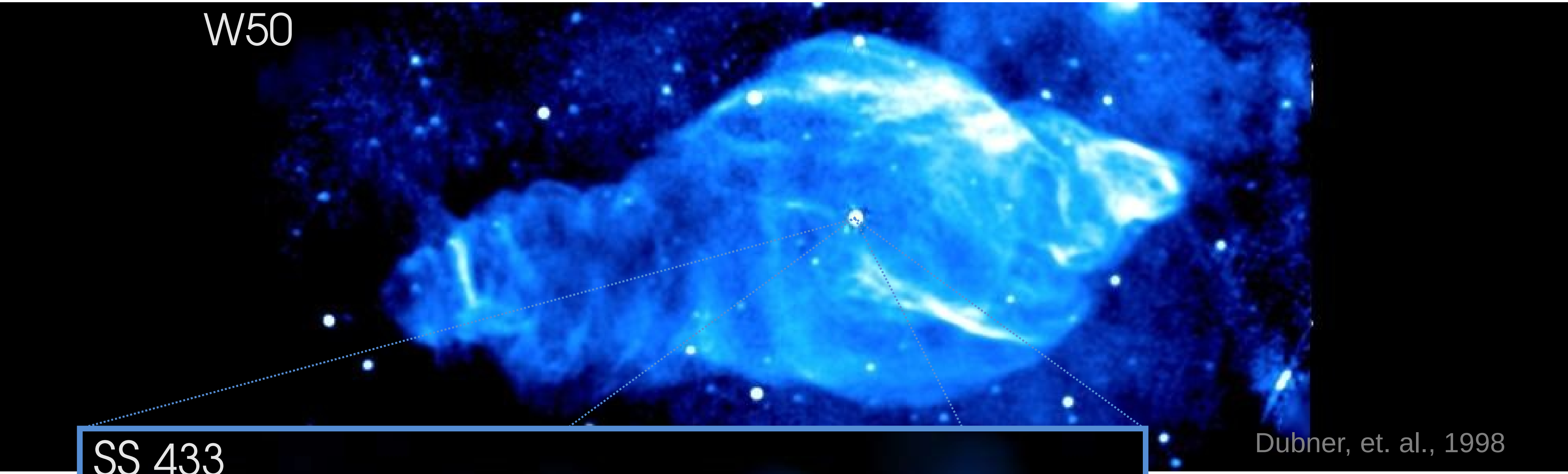
- 'Previous' work
  - The microquasar SS 433
  - VLA Imaging
  - Interpreting the polarized emission
- Current project: 3-D RM imaging
  - Signal reconstruction algorithms
  - Practice w/ 2+1D implementation
  - Generation of test data – Hammurabi
  - Reconstruction of test data
- What's next?

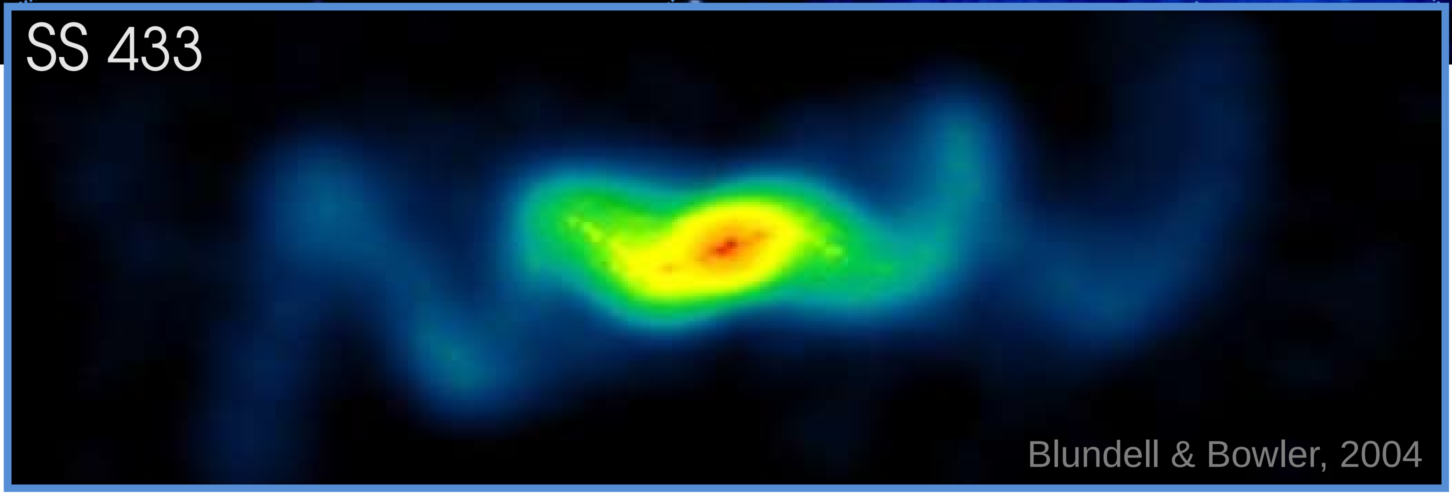
Previous Work



Brandeis University

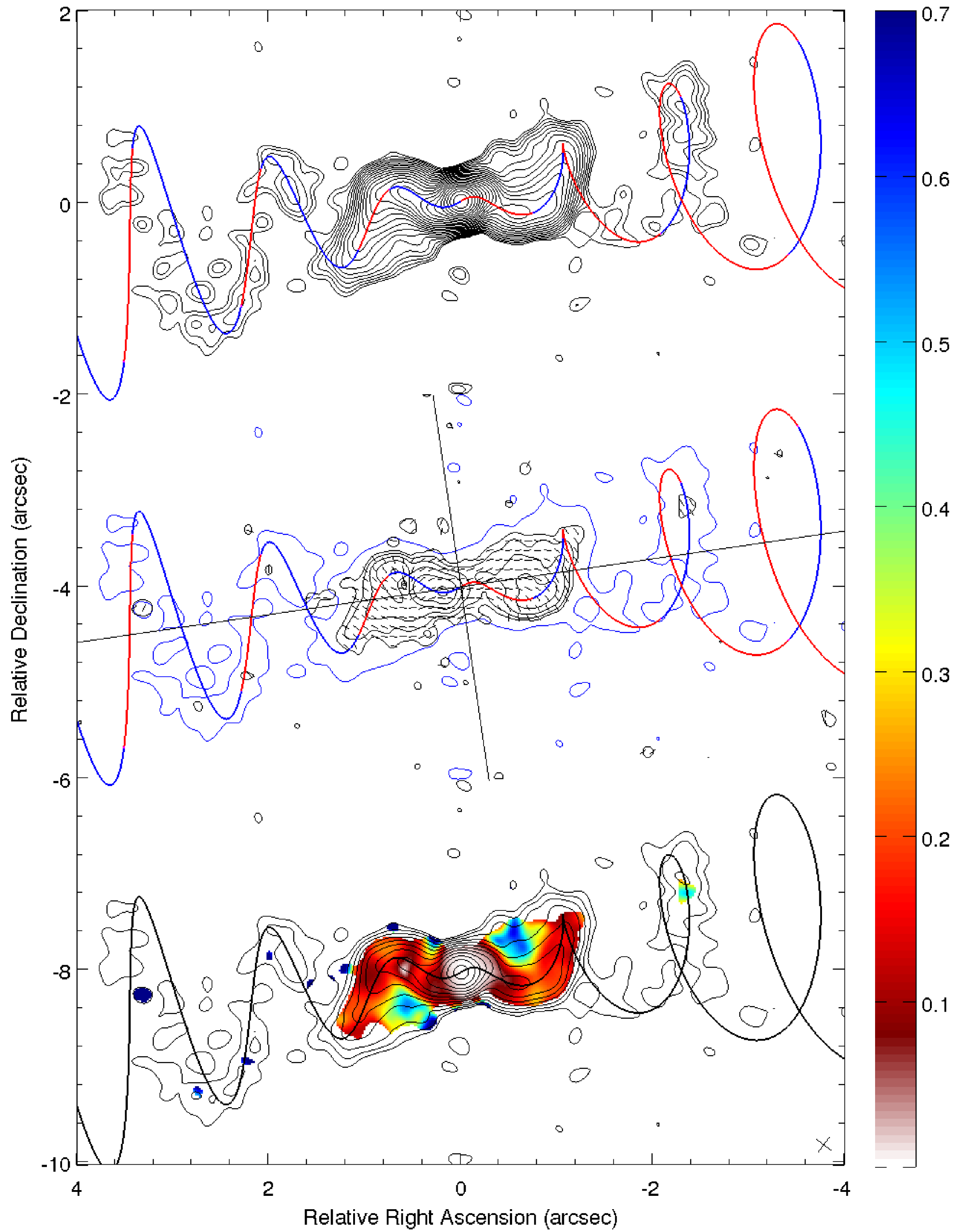
John Wardle – Dave Roberts



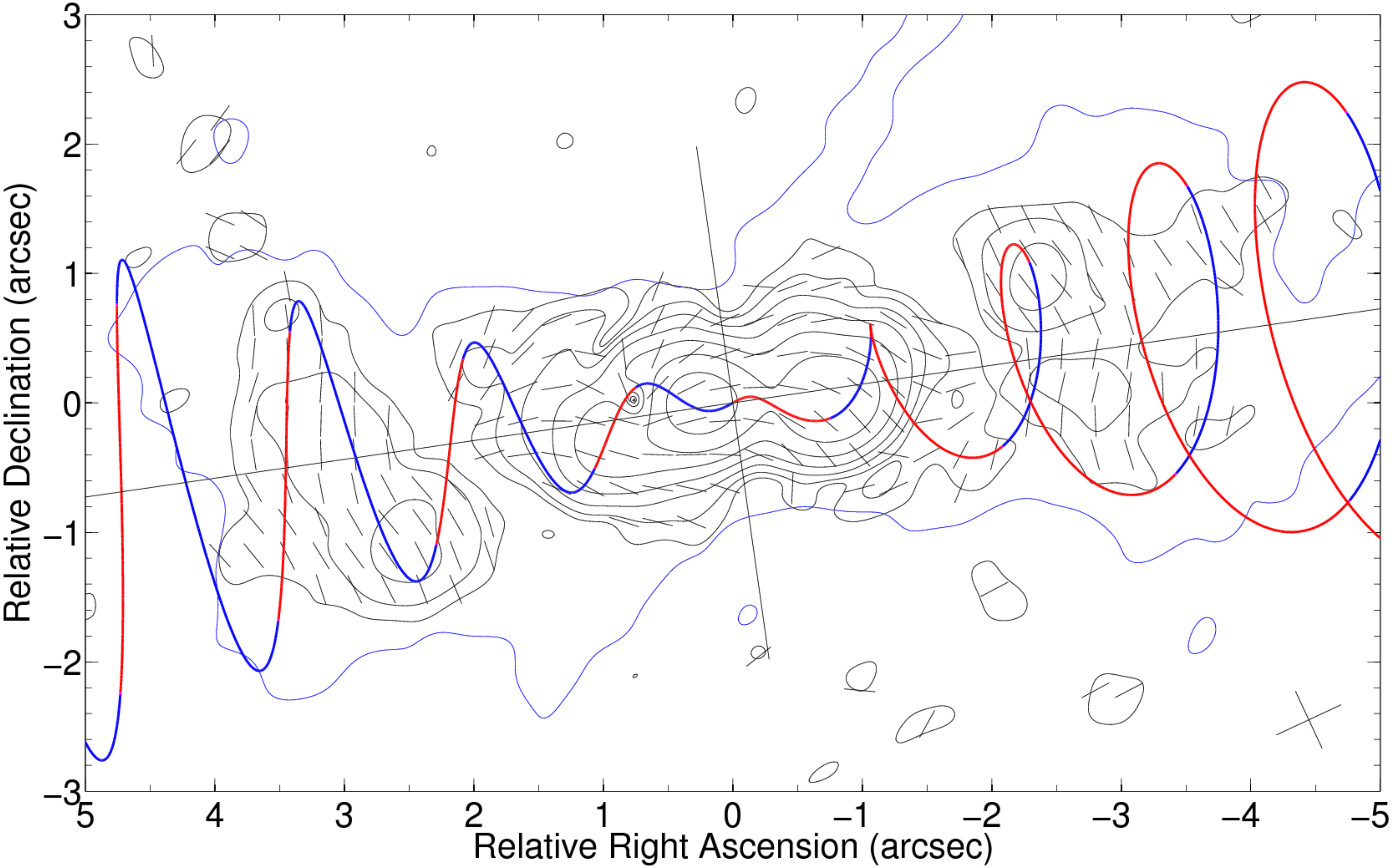


Observations

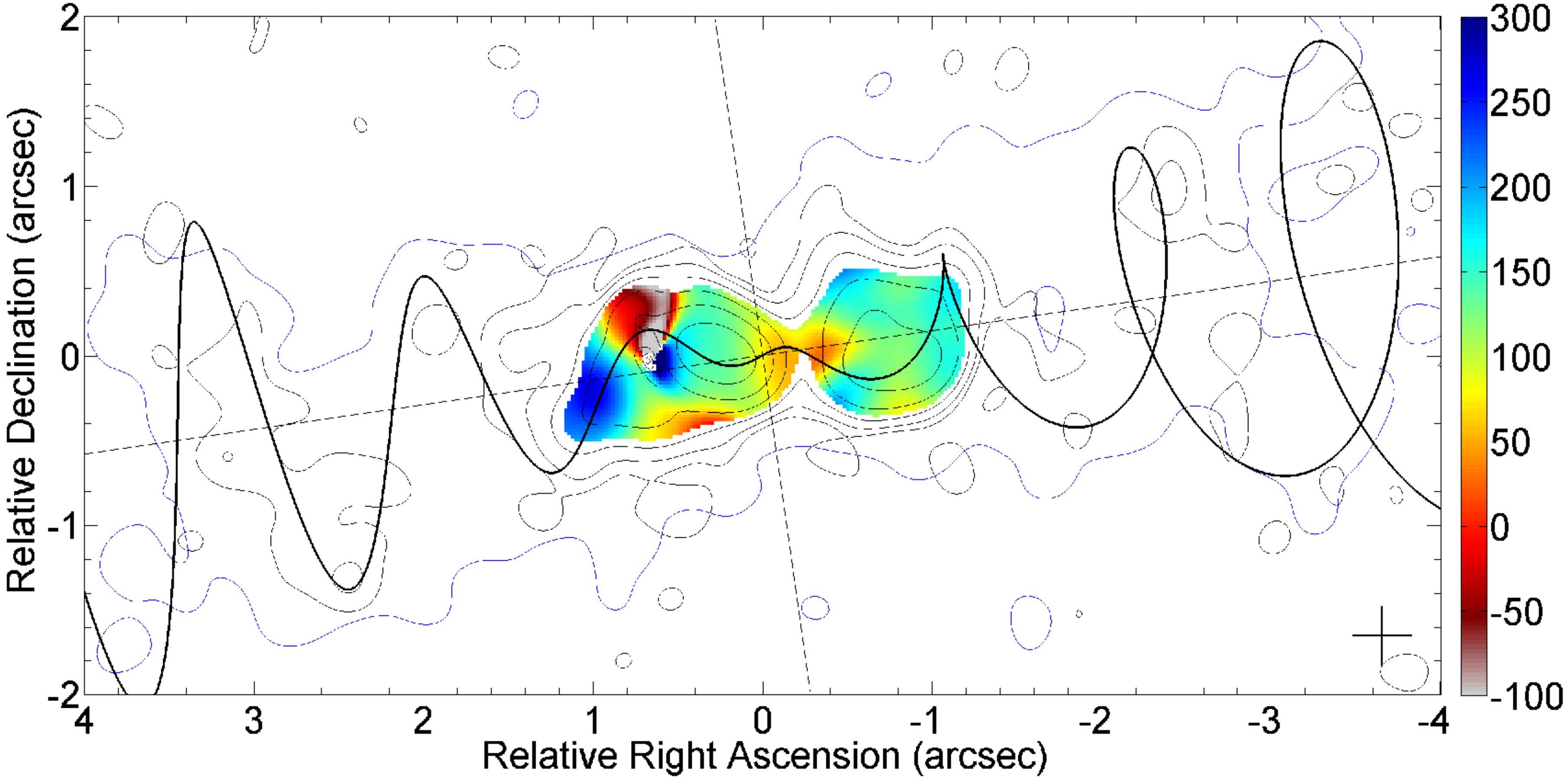
- Five VLA A-array observations
- 5 & 8.5 GHz
- Particularly interested in polarized flux
  - Highly polarized
  - Complex EVPA structure
  - Very highly polarized emission in off-jet region



Changing EVPA behavior

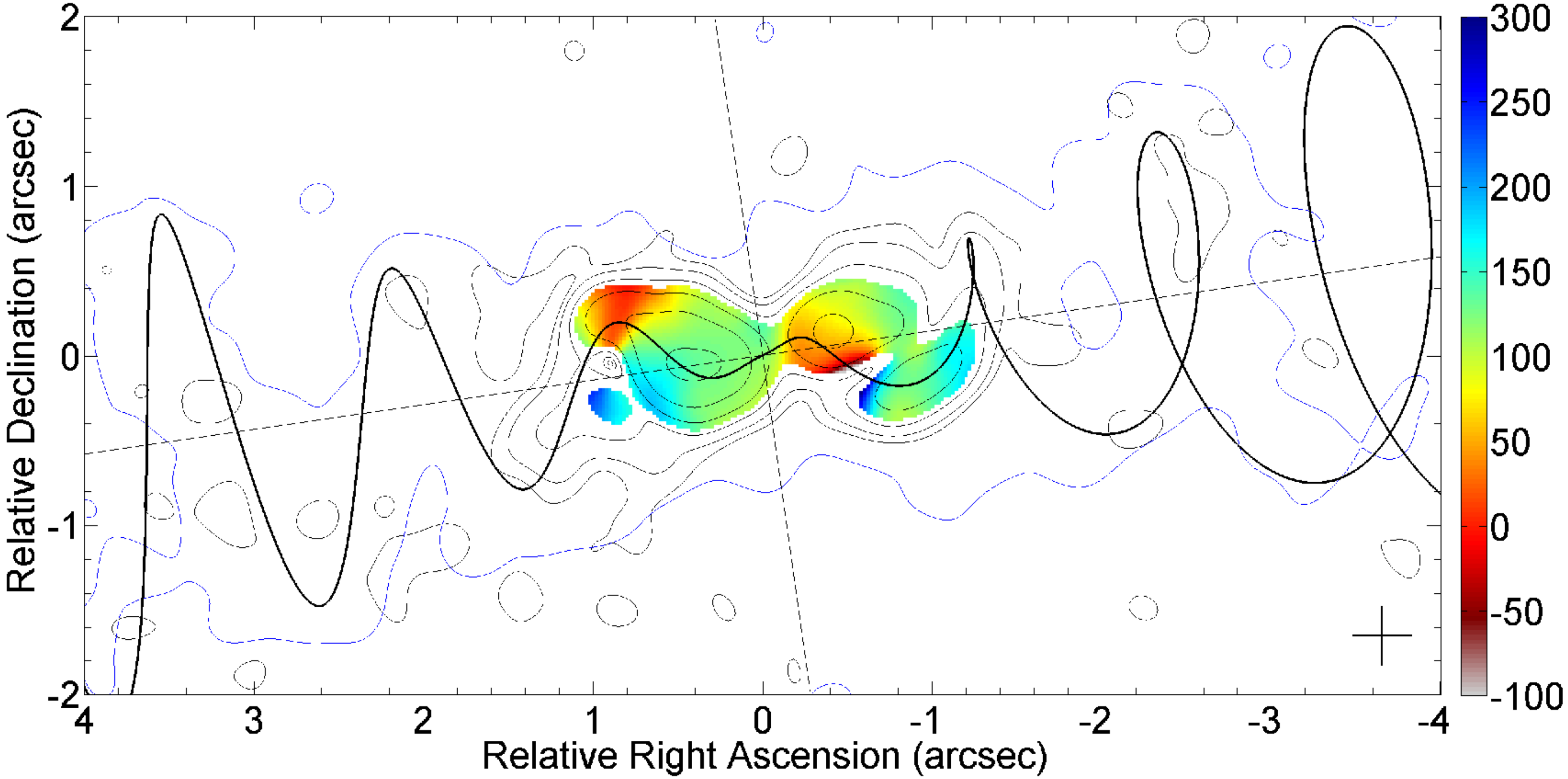


Rotation Measure



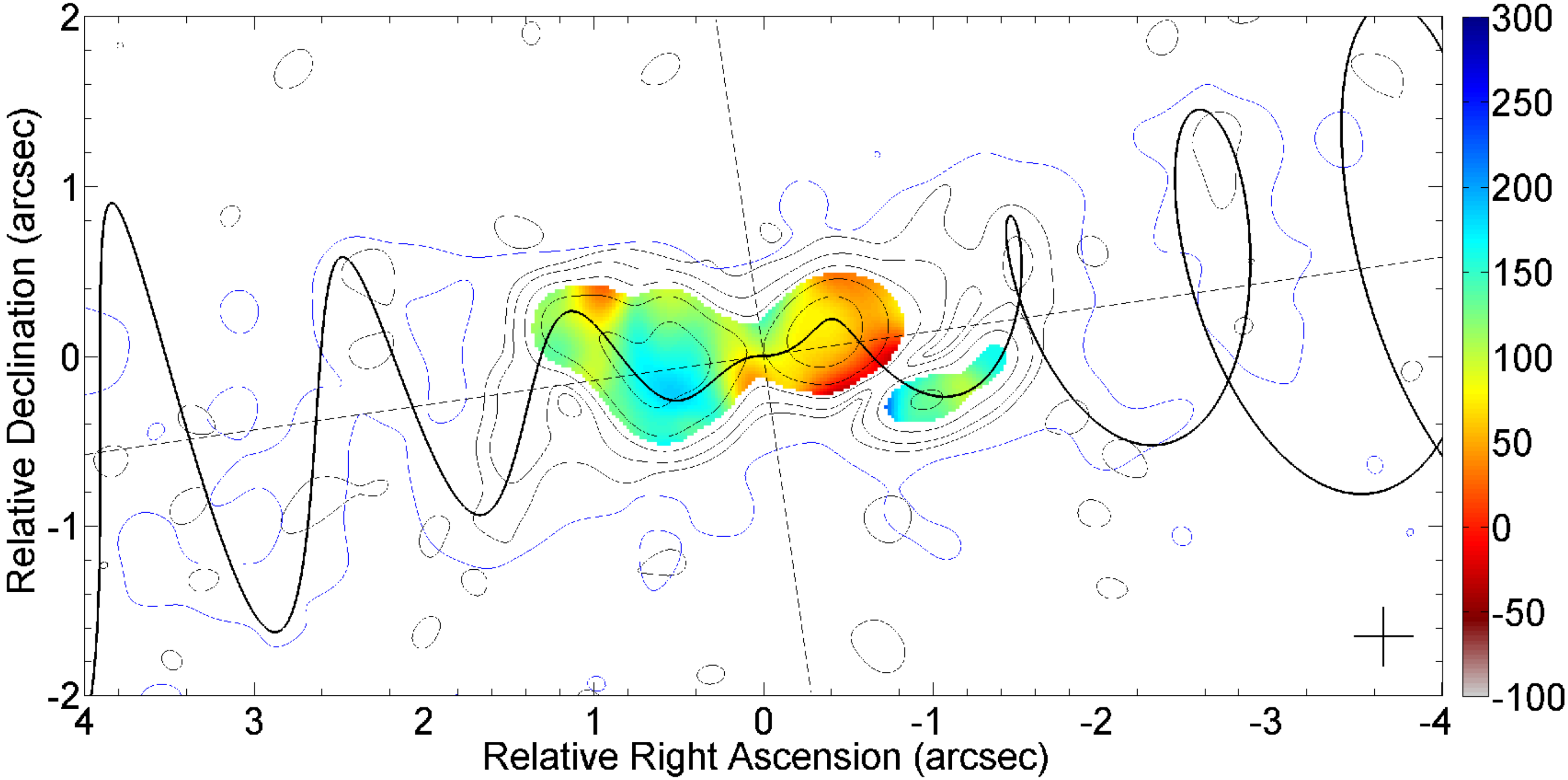
June 8th

Rotation Measure



July 1st

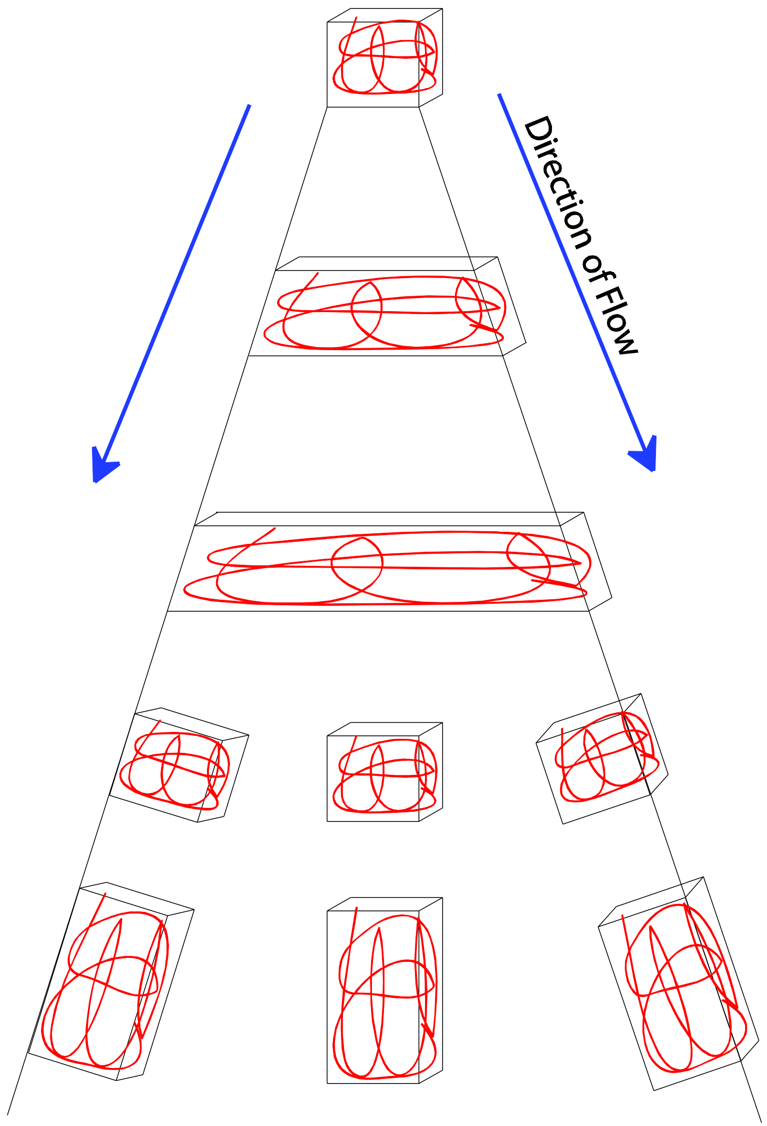
Rotation Measure



August 5th

What is going on?

- We propose:
  - Jet tube is stretched as material flows outward
  - Jet breaks up due to instability
  - Individual`blobs' elongate



In my free time...

- Still active on this
  - Toy Magnetic field model
  - Publish some results
- Just proposed follow-up eVLA observations
  - C band: Confirm RM structure, observe EVPA transition
  - K band: Observe inner 1″ in detail, model will be highly testable

3D RM Synthesis

- RM synthesis and synthesis imaging in one step

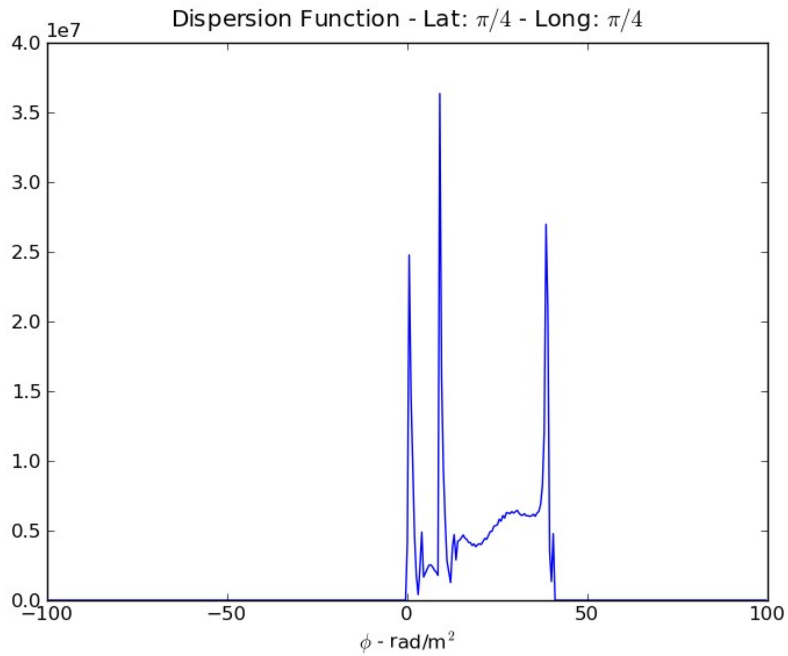
$$P(u, v, \lambda^2) \propto \int\int\int F(l, m, \phi) \mathrm{e}^{2\pi i (\phi \frac{\lambda^2}{\pi} - ul - vm)}$$

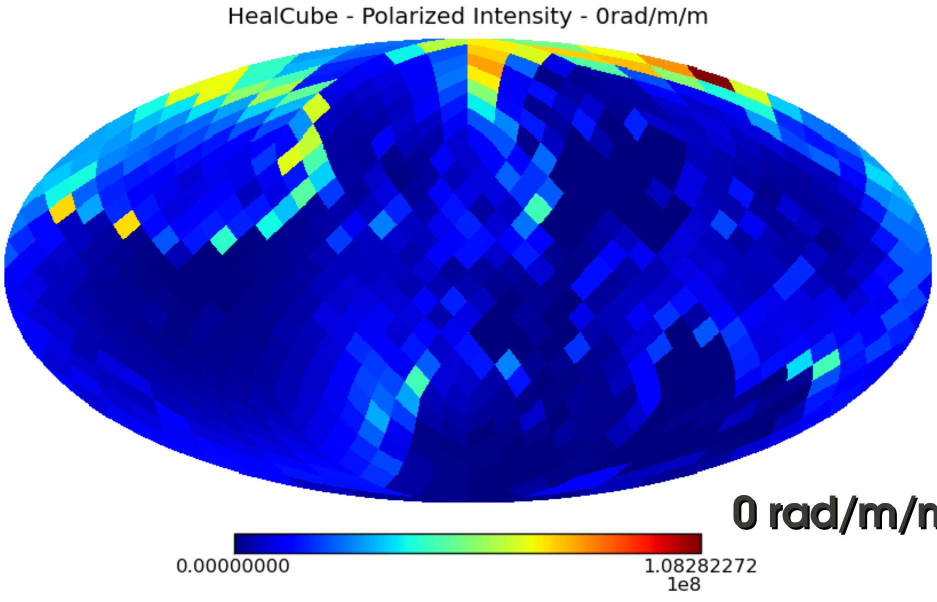
- But first... practice in 2+1D
  - Implement and test algorithms
  - Simulated data set: HAMMURABI

Testing

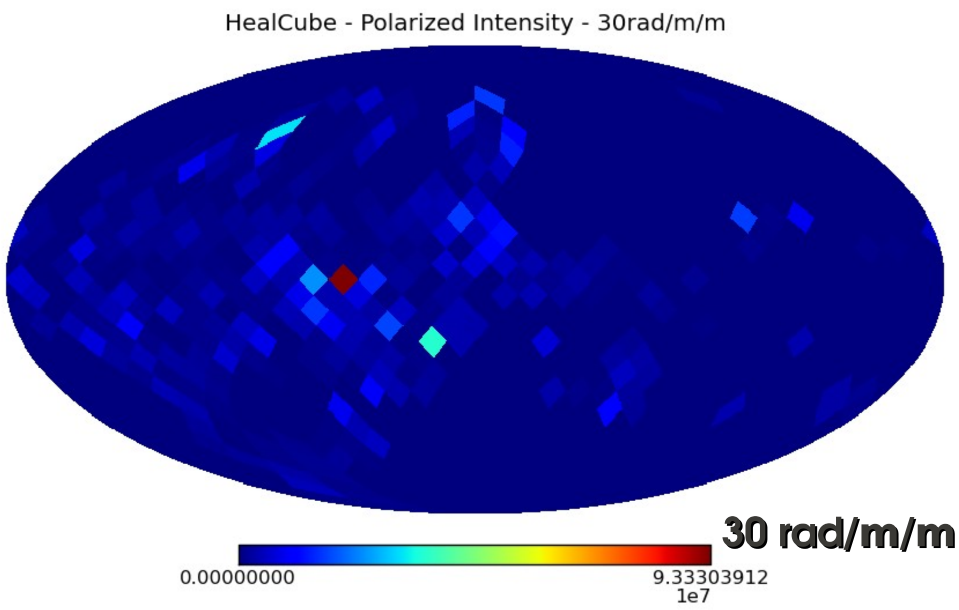
- Hammurabi (Waelkens et al., 2008)
  - Simulation of galactic synchrotron emission
  - User defined model of B field, CRE, n_e
- My modifications...
  - Compute dispersion function as we integrate along the L.O.S.
  - Fourier transform gives $P(\lambda^2)$
- Proof of concept with realistic signal
  - Test different reconstruction techniques
  - Later apply to real data: GMIMS survey

Galactic Dispersion Function

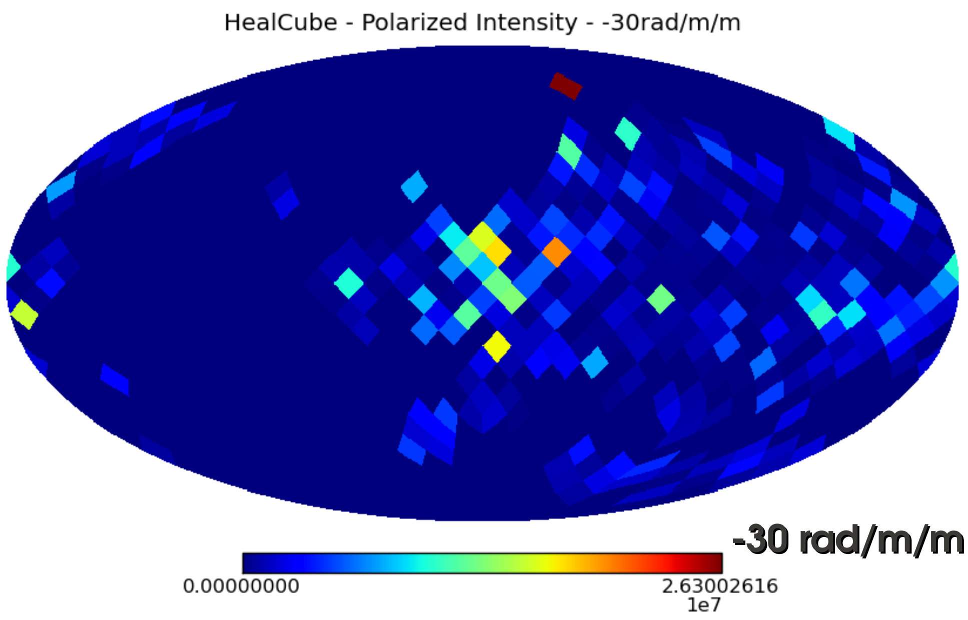




0 rad/m/m

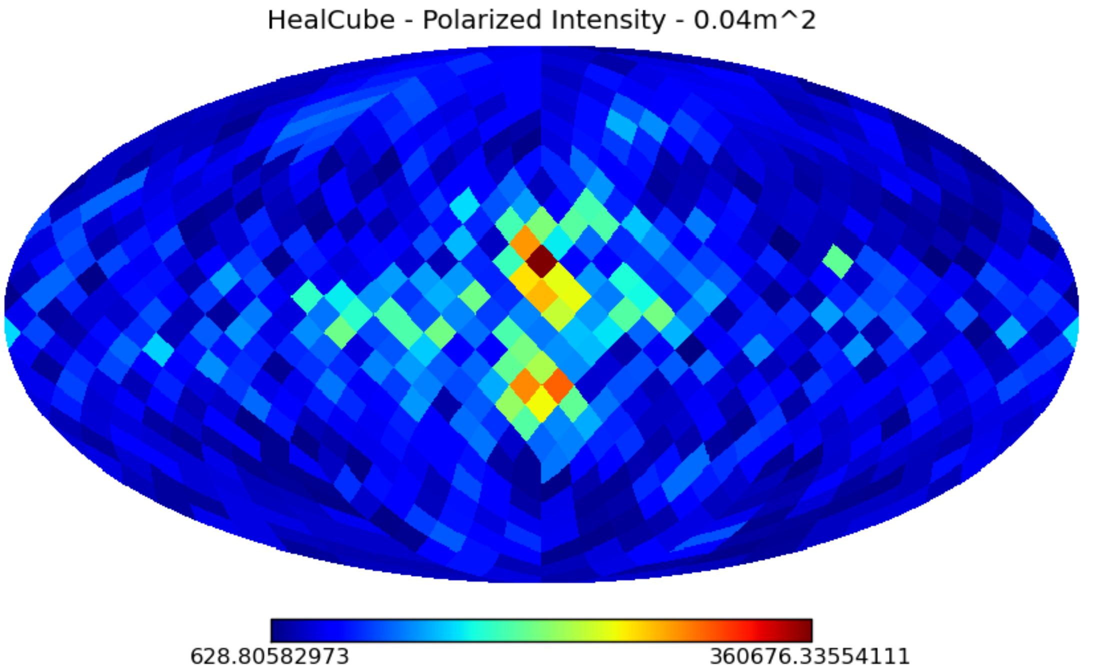


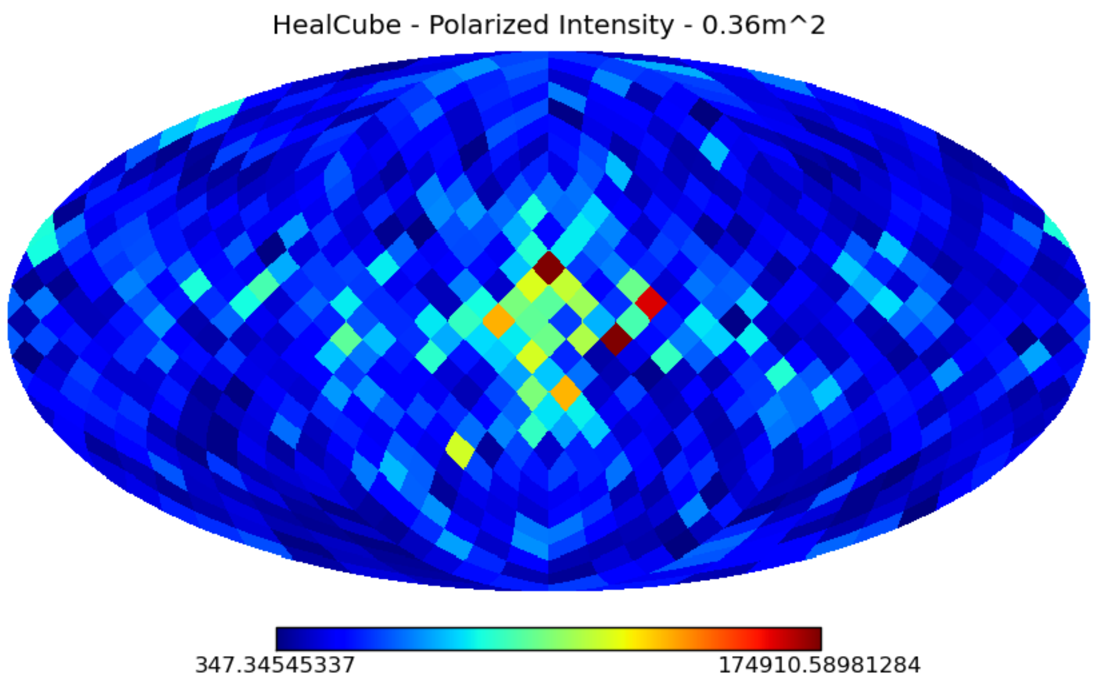
30 rad/m/m



-30 rad/m/m

Simulated Maps





- Very low resolution

  (for now...)

  50 sq. deg. per pix

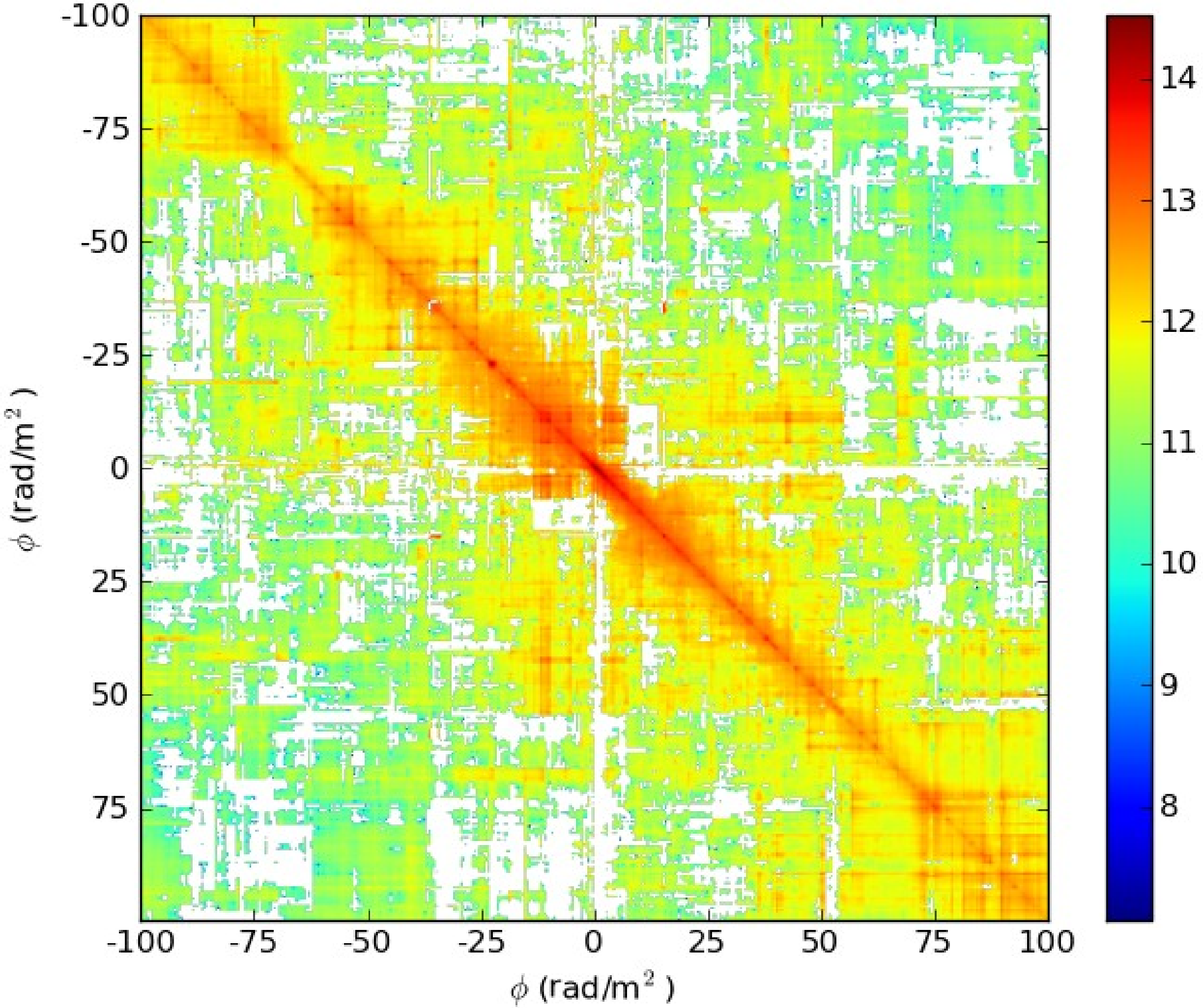
- FFT of dispersion function

- Examples

  Top: 1.5 GHz

  Botton: 500 MHz

Signal Covariance Matrix



$P(\lambda^2)$ FFT $F(\varphi)$

The Wiener Filter

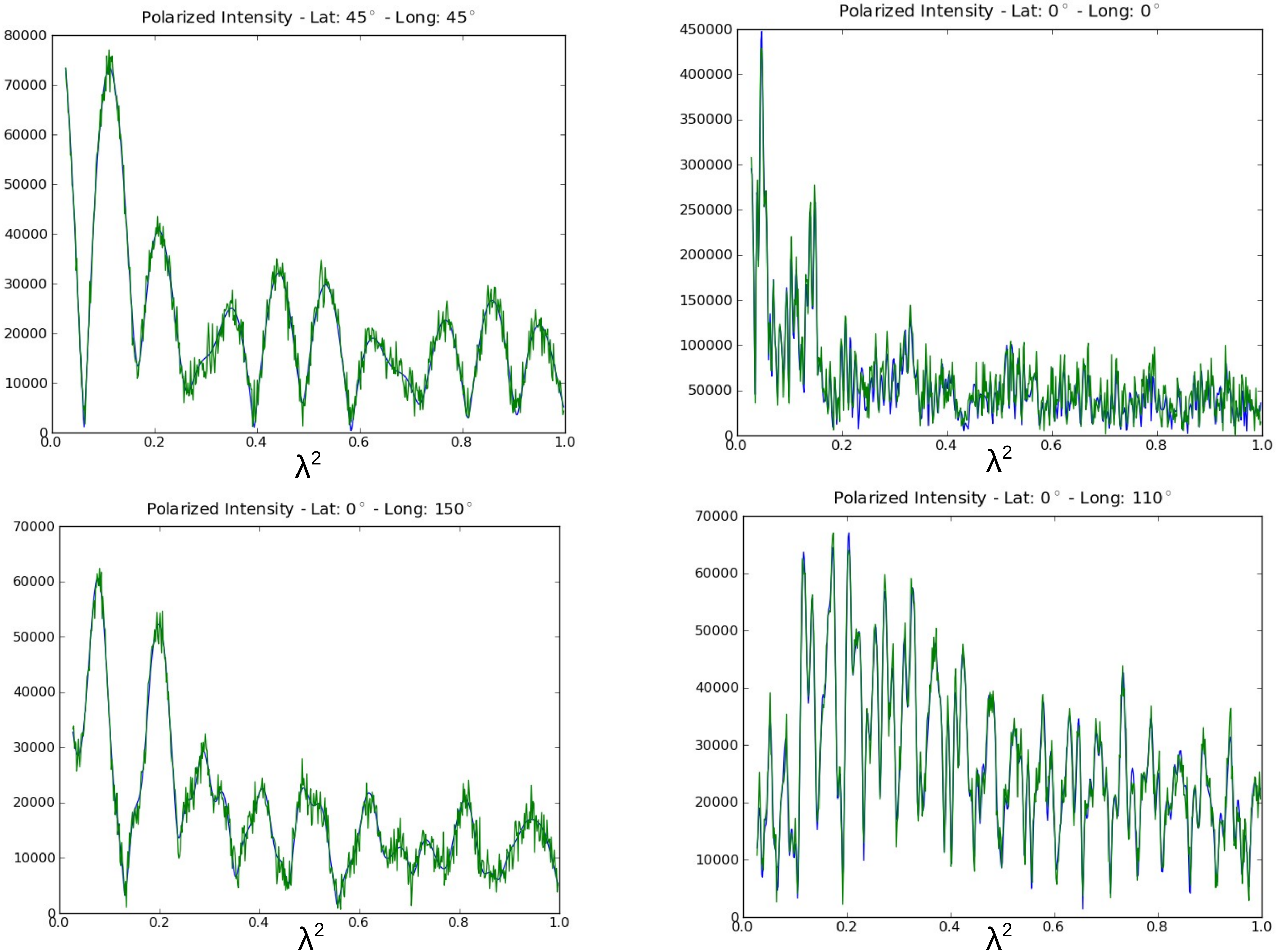
$$d = Rs + n$$

Gaussian signal prior
w/covariance matrix S

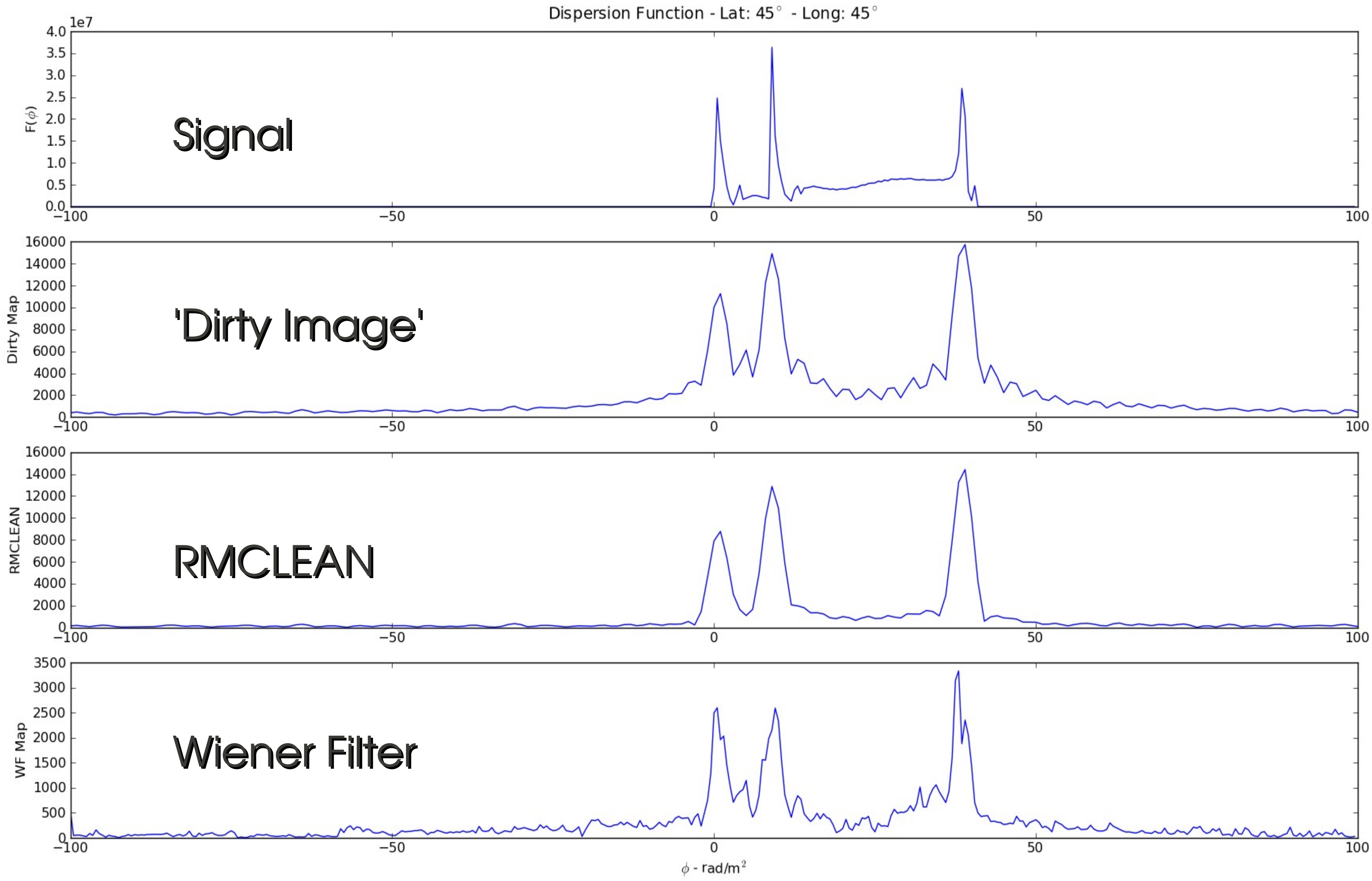
Gaussian noise prior
w/covariance matrix N

$$WF = (S^{-1} + R^{\dagger}N^{-1}R)^{-1}R^{\dagger}N^{-1}$$

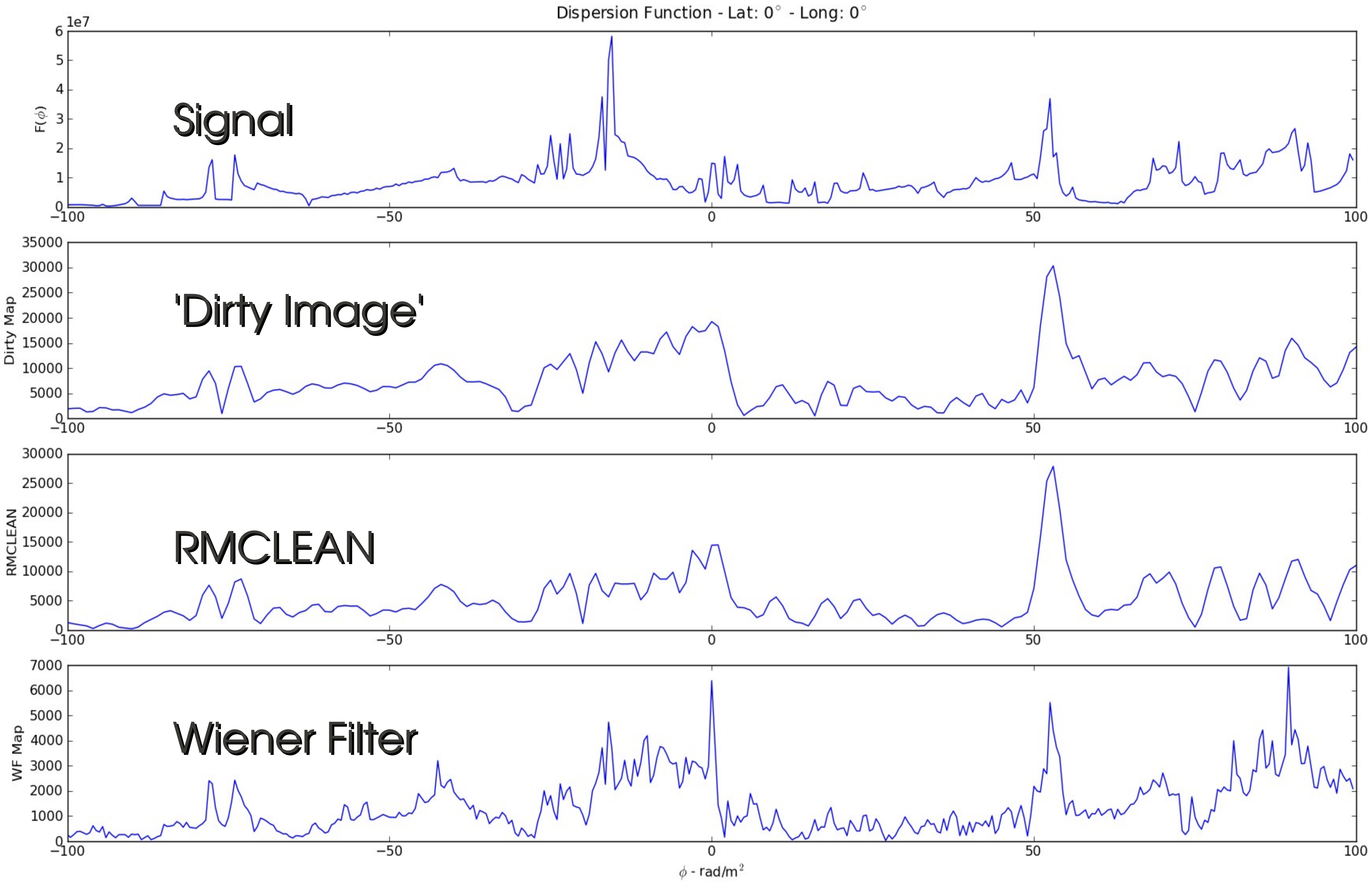
'Observing' the simulations



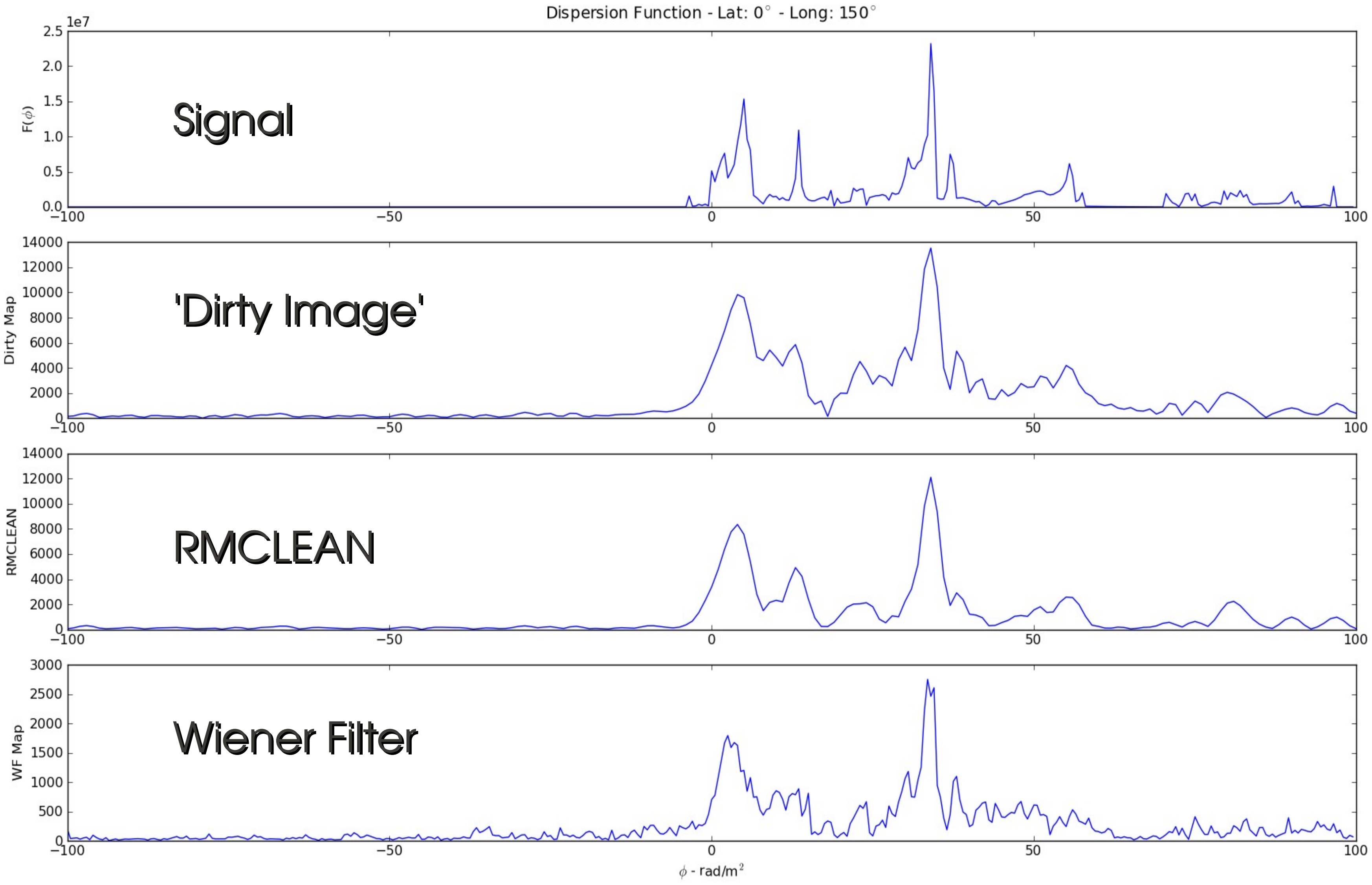
Reconstruction



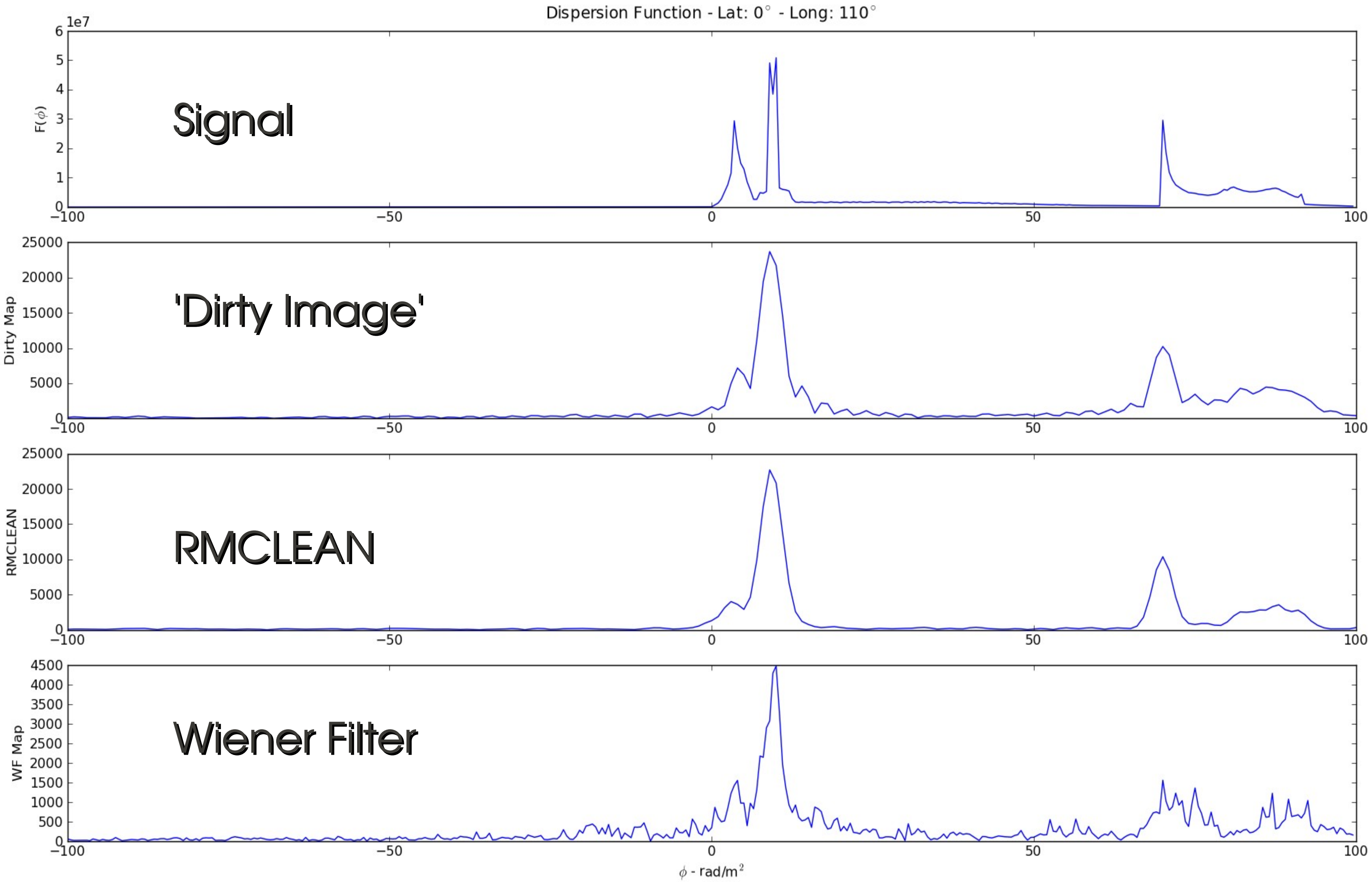
Reconstruction, cont.



Reconstruction, cont.



Reconstruction, cont.



Now what...

- Continue to test algorithms
  - Compute S from data (iteratively)
  - How does each perform in specific situations?
- Working with Thomas Riller on LOFAR RM pipeline
- Very soon: Begin development of 3D Imaging software

THANKS!