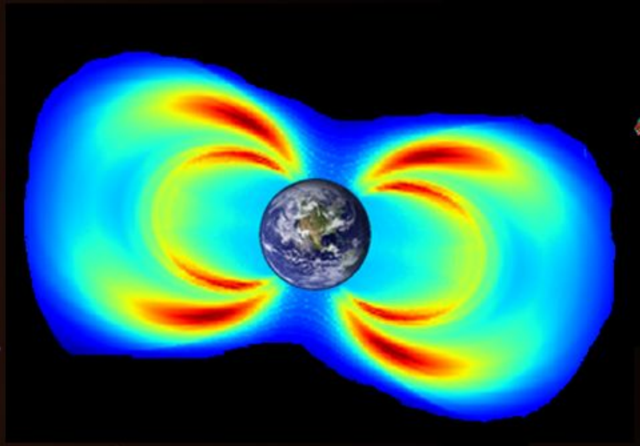
Localizing the Source of Type II Emission Around a CME with FARSIDE



Dr. Alexander Hegedus

NESS Site Visit

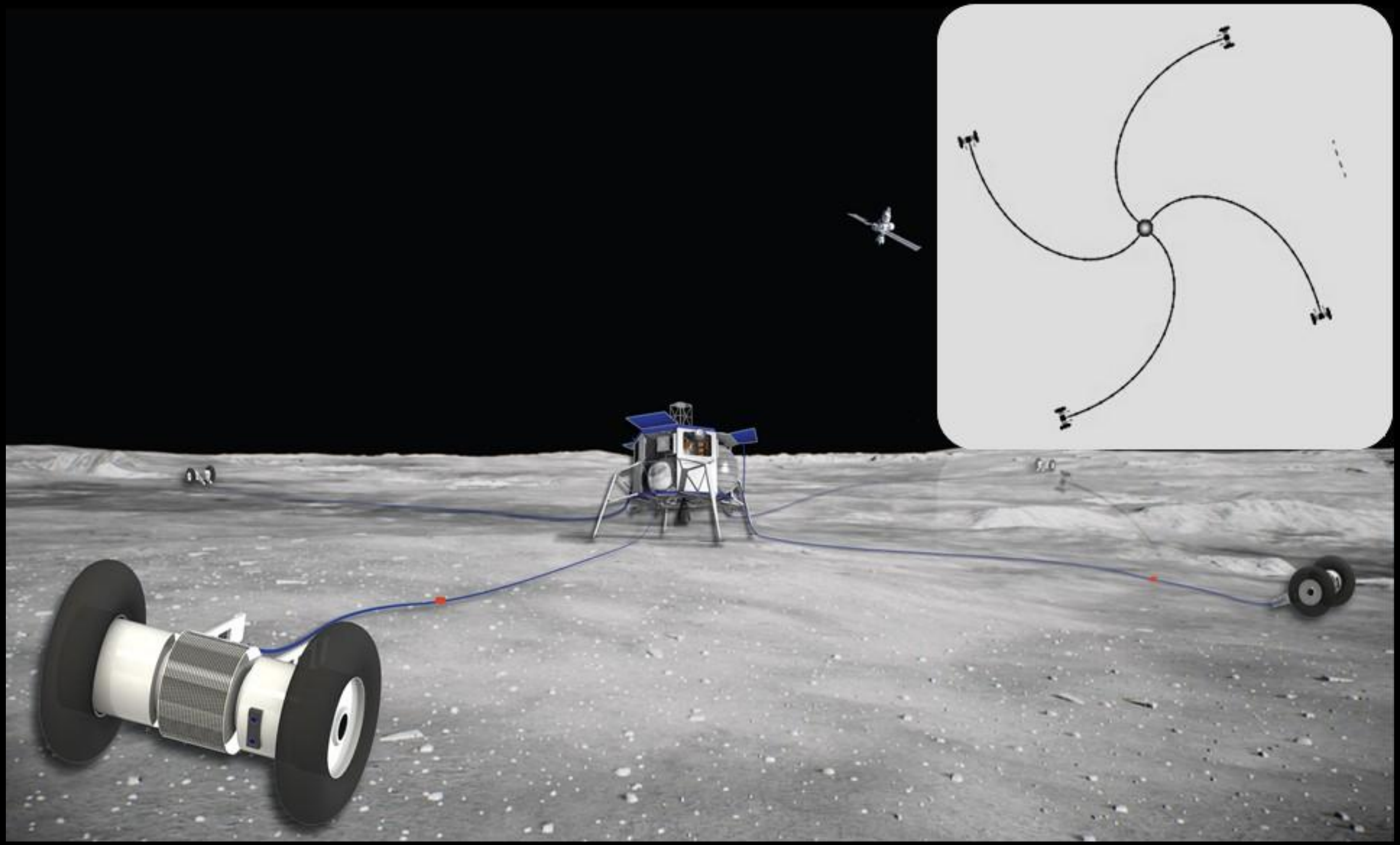
11/30/20

UNIVERSITY OF MICHIGAN

OUTLINE

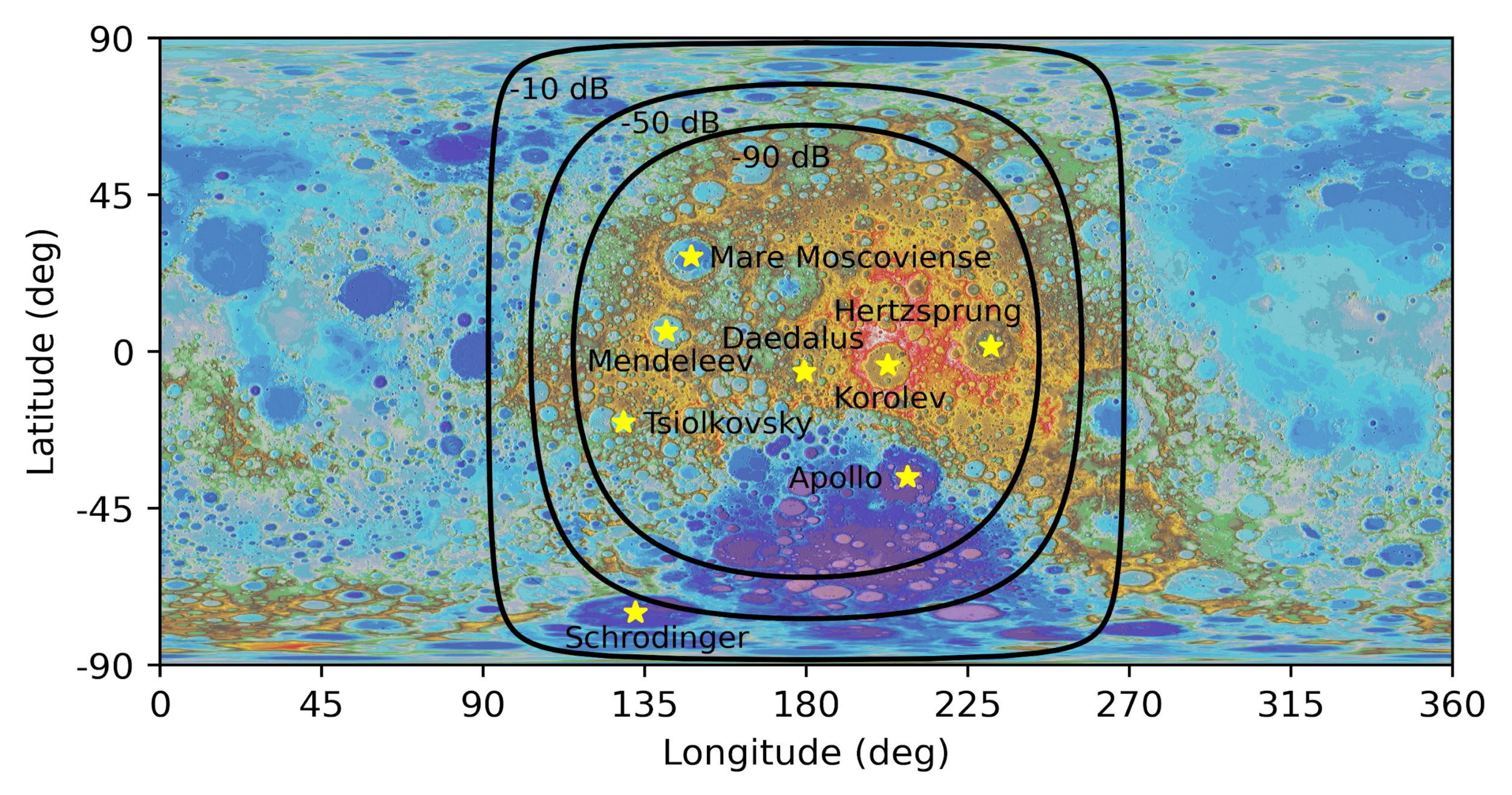
- FARSIDE Introduction
- Array Configuration
- Primary Science Targets: 21 cm Cosmology & Exoplanet Detection
- Secondary Science Target: Solar Type II & III Radio Bursts
- Intro to MHD and Simulation Pipeline
- Simulated FARSIDE Observations of Type II Burst
- Discussion & Conclusions

FARSIDE INTRO



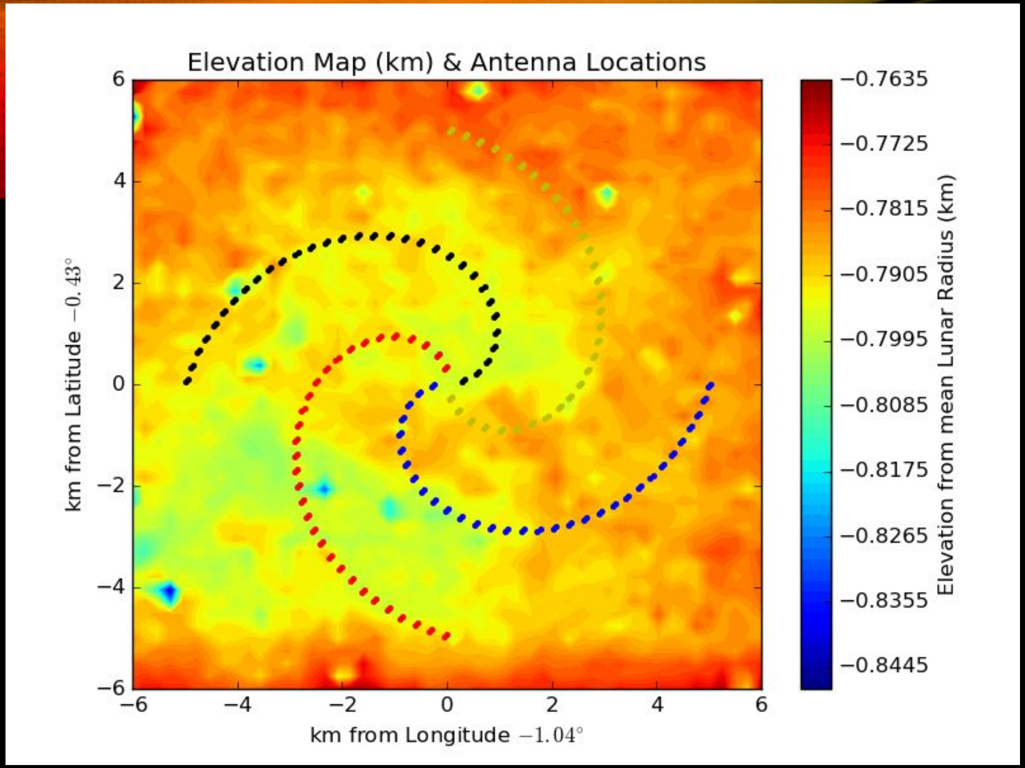
FARSIDE consists of three components: a commercial lander carrying the base station, four single-axel rovers to deploy antenna nodes, and a 128x2 (two orthogonal polarizations) node antenna array.

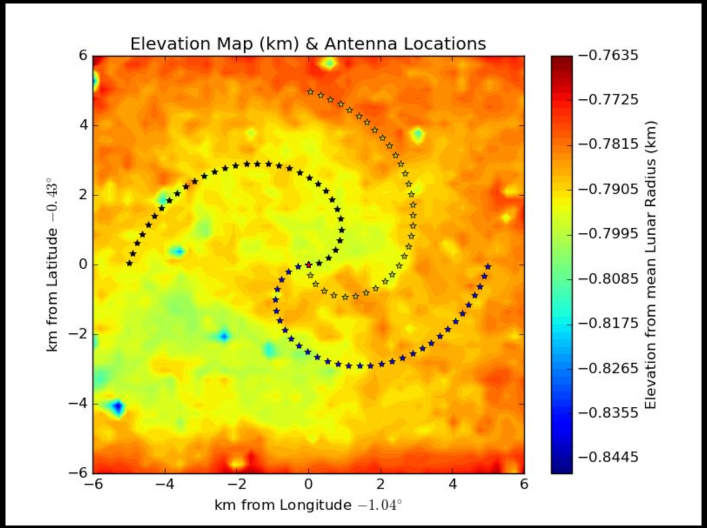
DESTINATION: LUNAR FARSIDE



Map of RFI suppression at 100 kHz based on numerical simulations from Bassett et al. (2020). Contours indicate suppression of -10, -50, and -90 dB relative to the incident intensity. Map colors indicate elevation. Potential landing sites are indicated by the yellow stars.

ARRAY CONFIGURATION

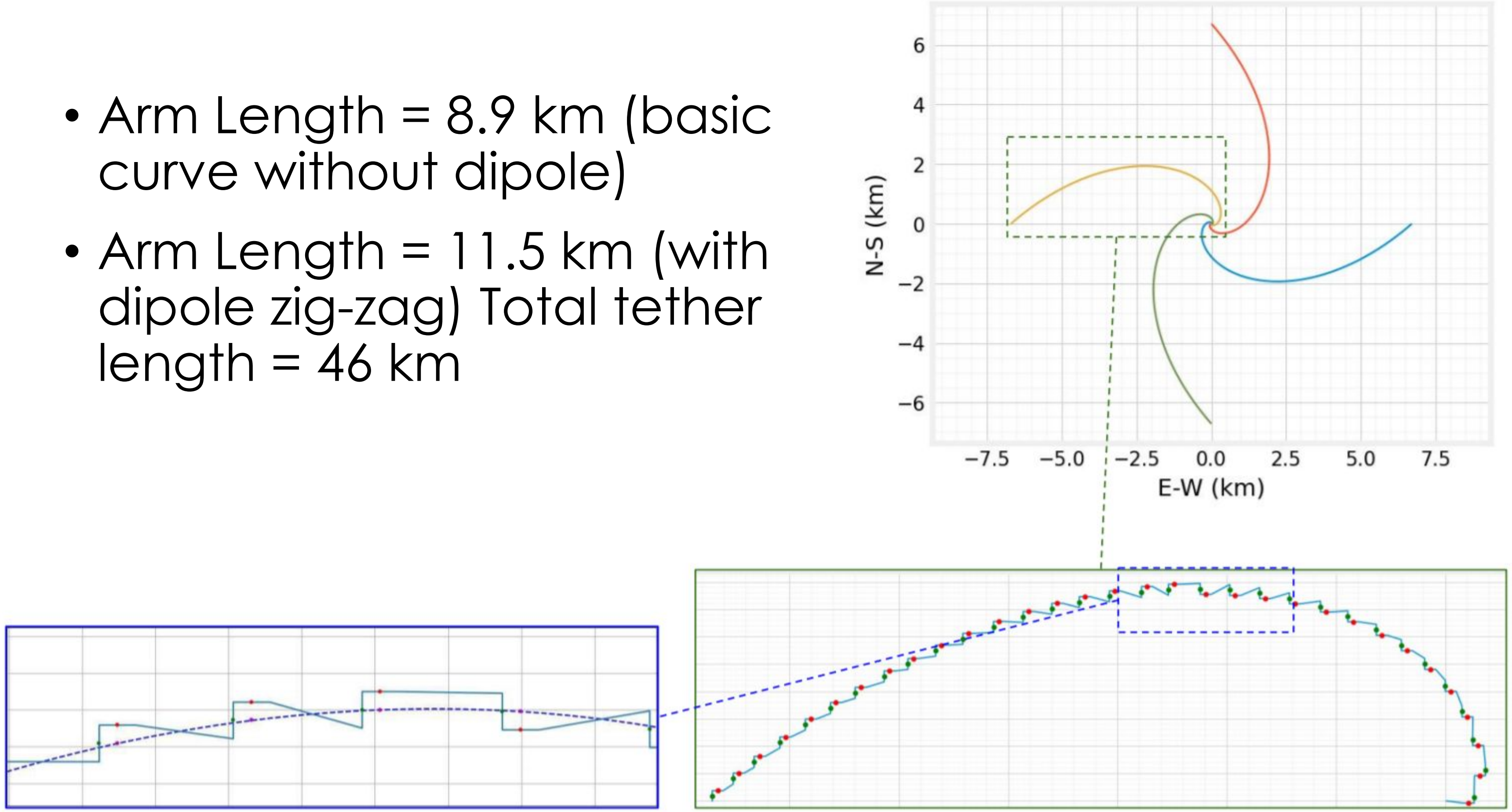




- Array defined on top of LOLA Elevation Data
- 256 antenna, 128 for each polarization
- 4 rovers, 1 per arm of the array
- Good performance even with 1 rover DOA

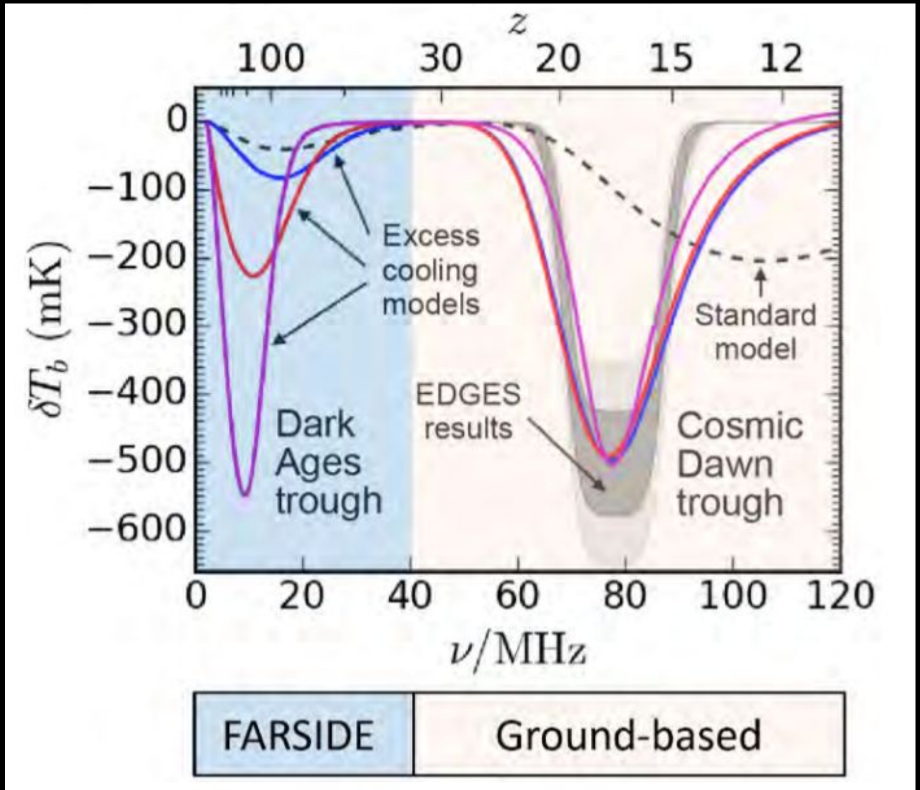
ZIG-ZAG PATH FOR BOTH POLARIZATIONS

- Arm Length = 8.9 km (basic curve without dipole)
- Arm Length = 11.5 km (with dipole zig-zag) Total tether length = 46 km



PRIMARY SCIENCE: 21 CM COSMOLOGY

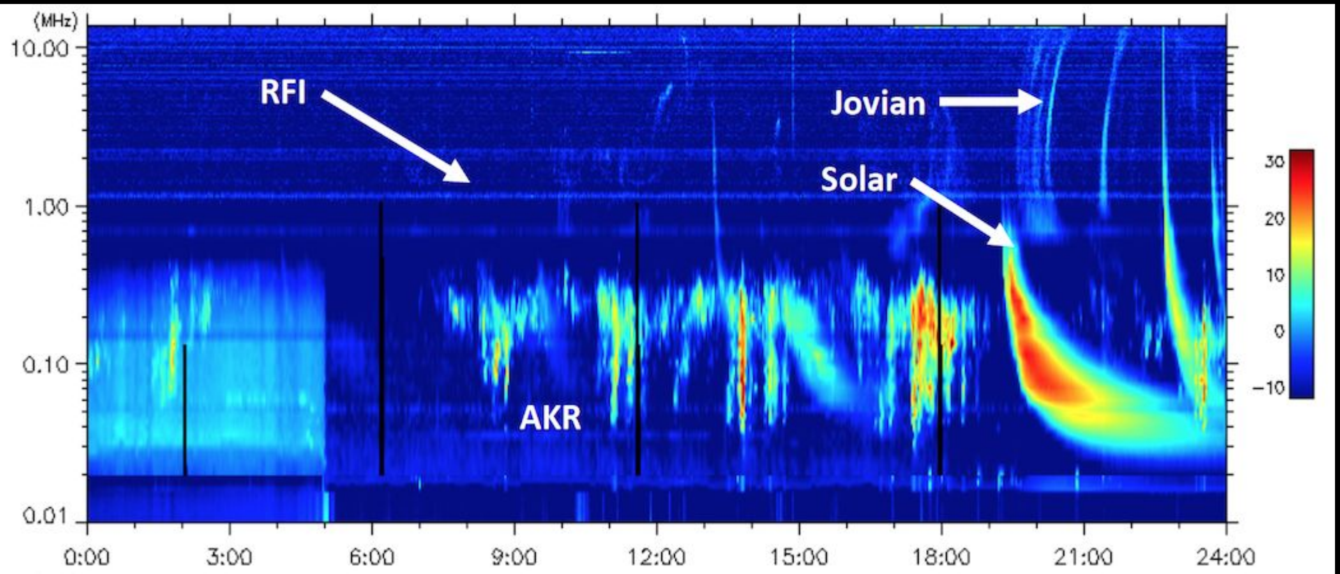
Measuring absorption troughs in the redshifted 21 cm signal can provide insight into early universe cosmology



PRIMARY SCIENCE: EXOPLANET DETECTION

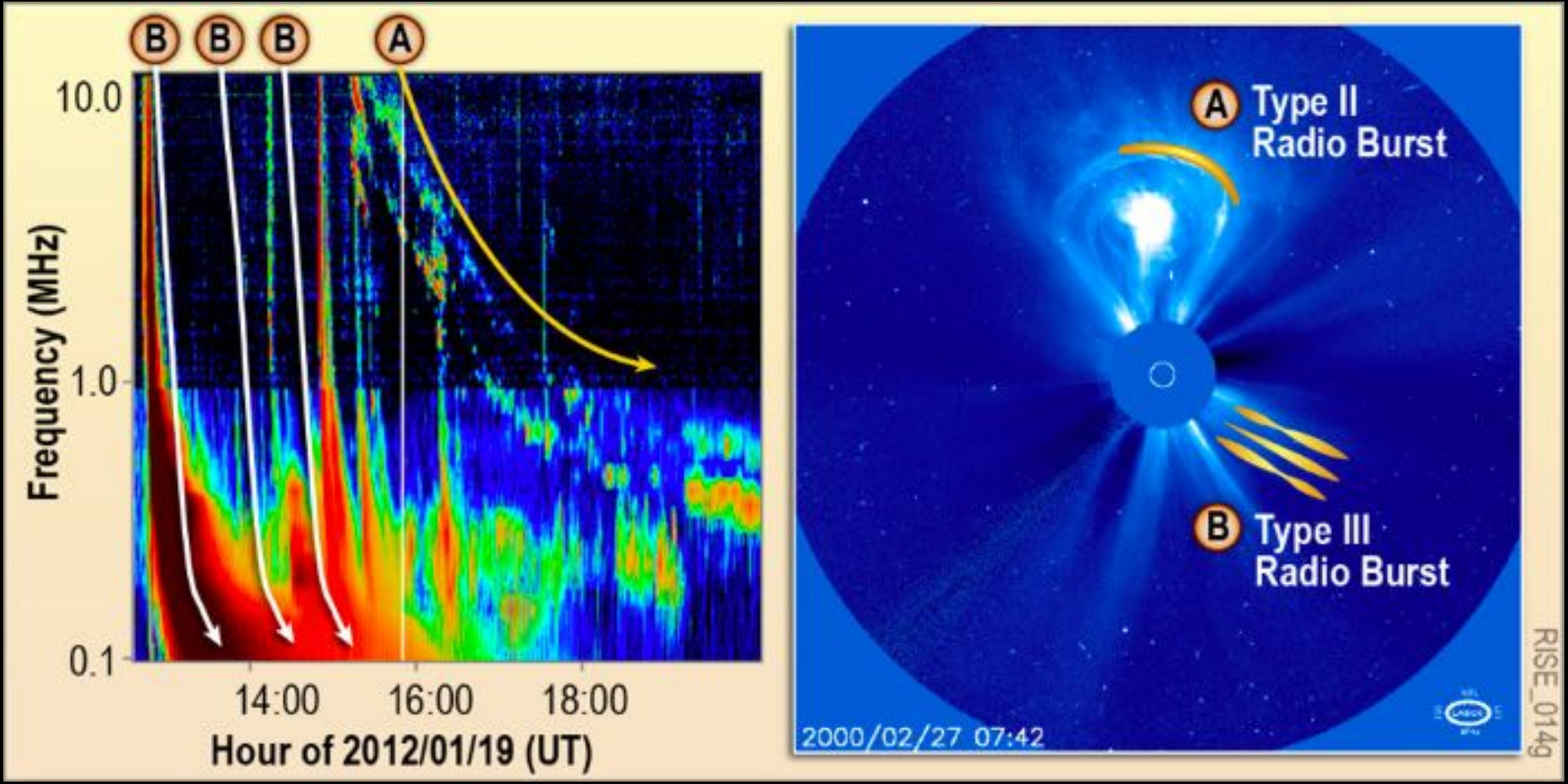
Wind radio data showing Jovian emission

Artists rendition of CME interacting with exoplanet, which then produces radio emission

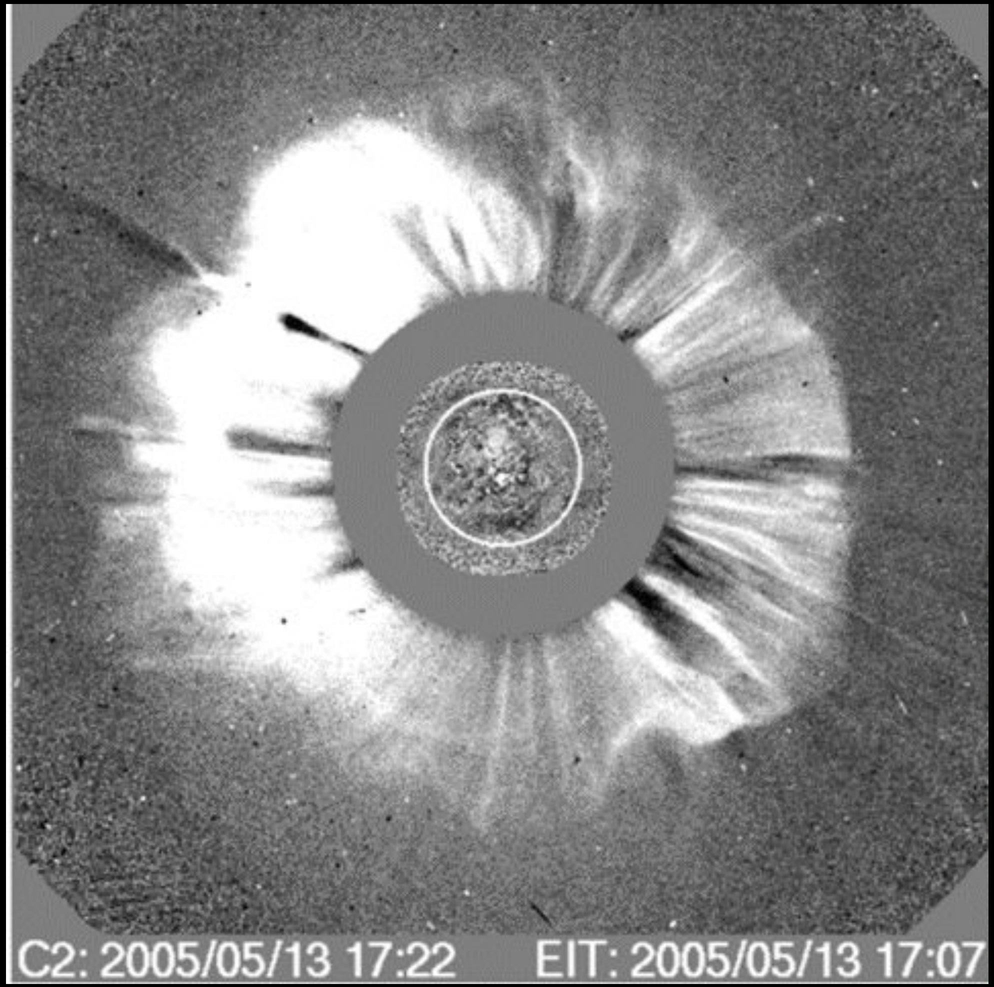


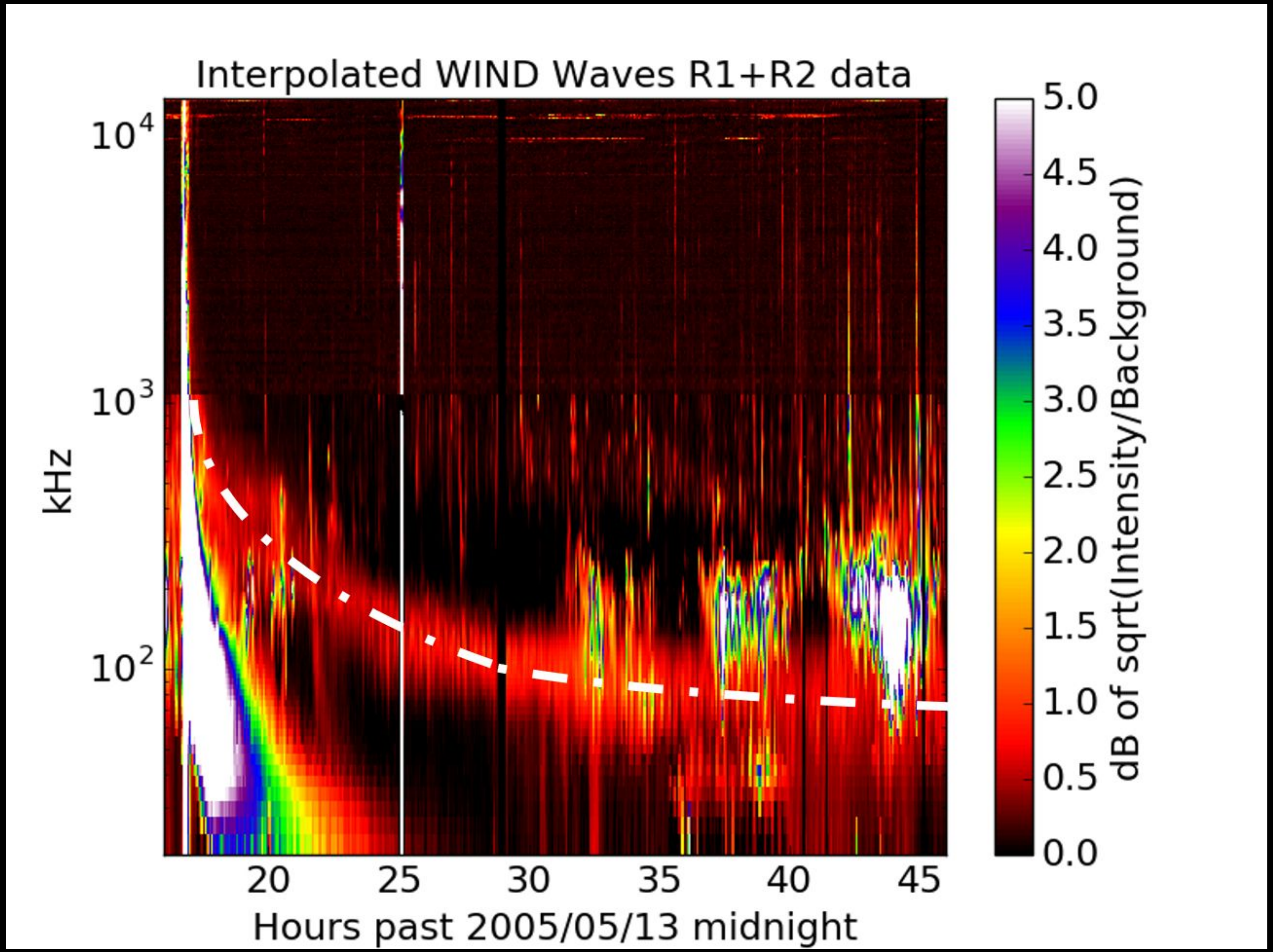
FARSIDE SECONDARY SCIENCE: SOLAR TYPE II & III BURSTS

$$f\,(\mathrm{kHz}) = f_p = 9\sqrt{n\left(\mathrm{cm}^{-3}\right)}$$



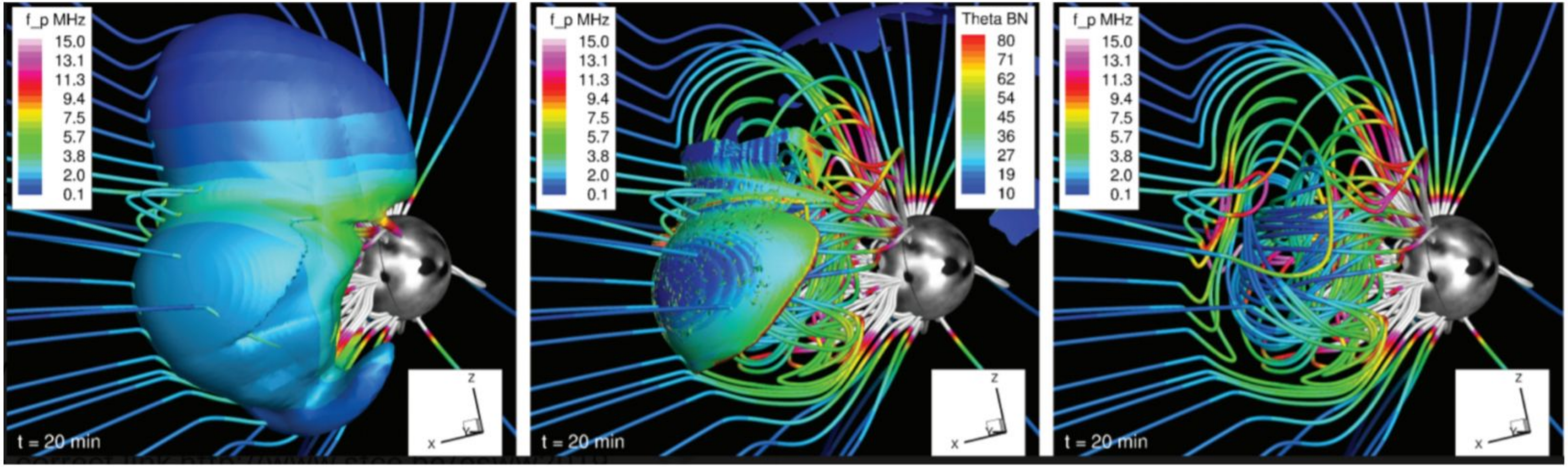
CASE STUDY: 2005/05/13 CME





MHD CME SIMULATION

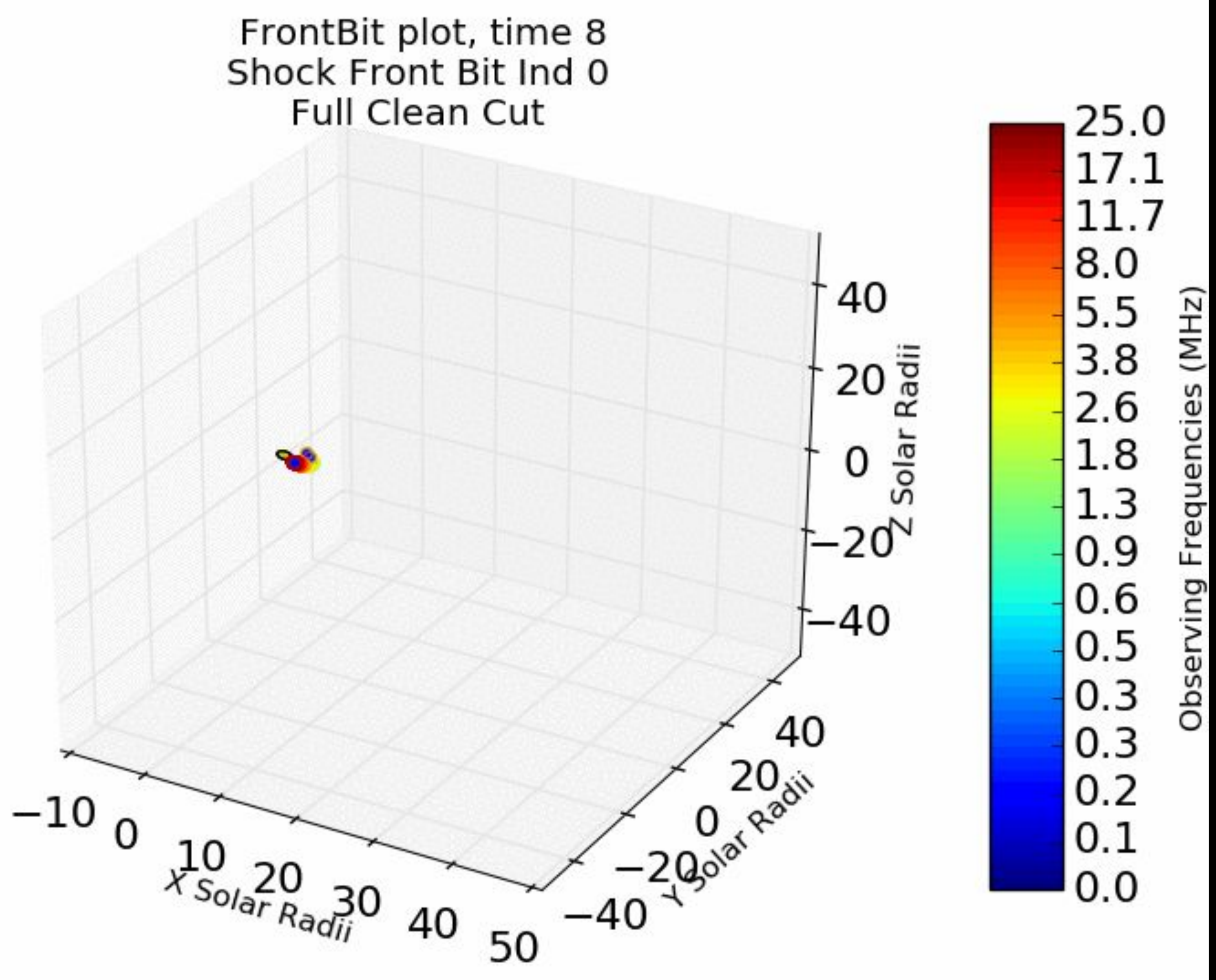
CME Density Enhancement | Entropy Derived Shock | Magnetic Field

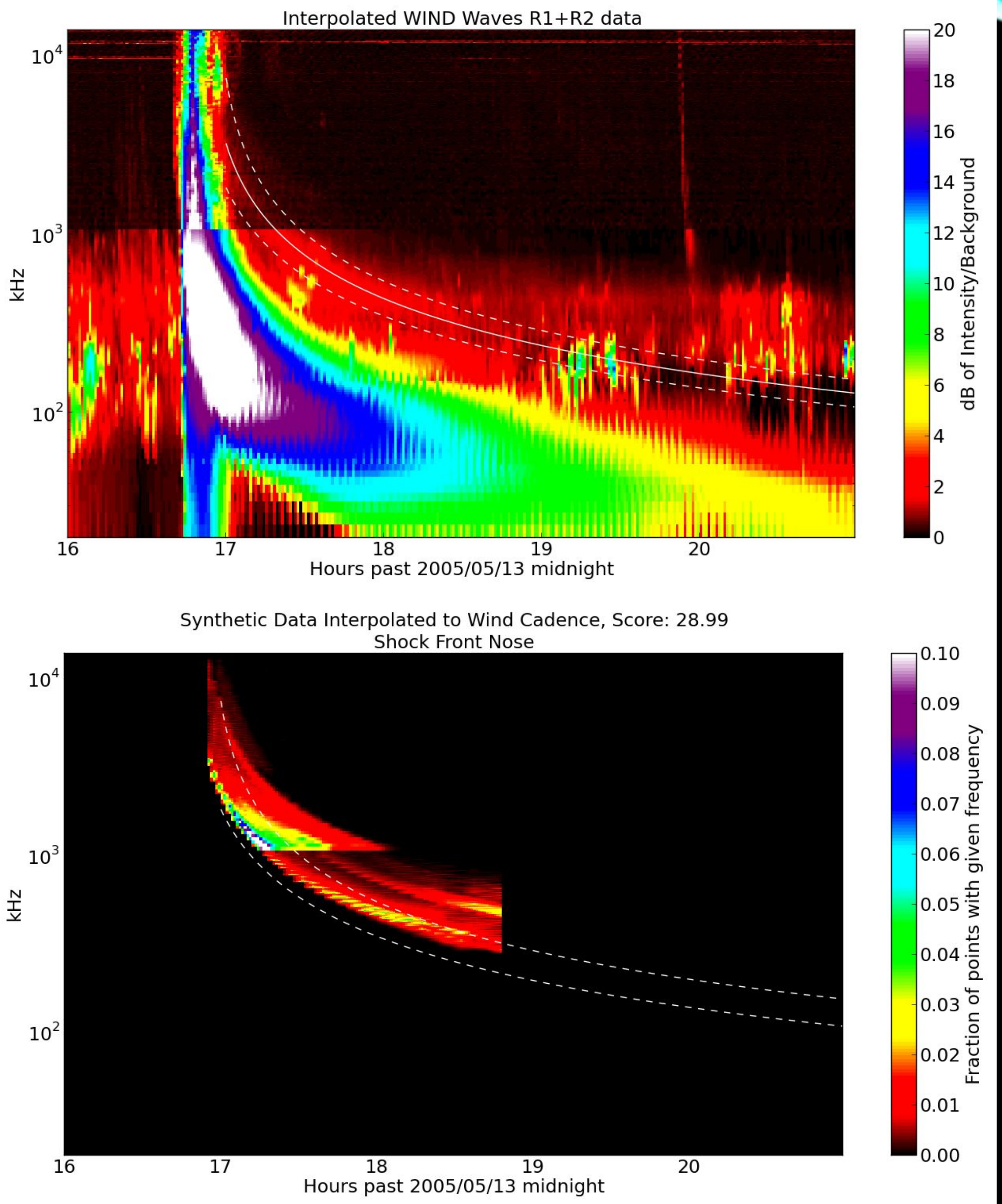


Snapshots from a AWSoM 2-Temperature MHD Simulation of a Radio-Loud CME on May 13, 2005

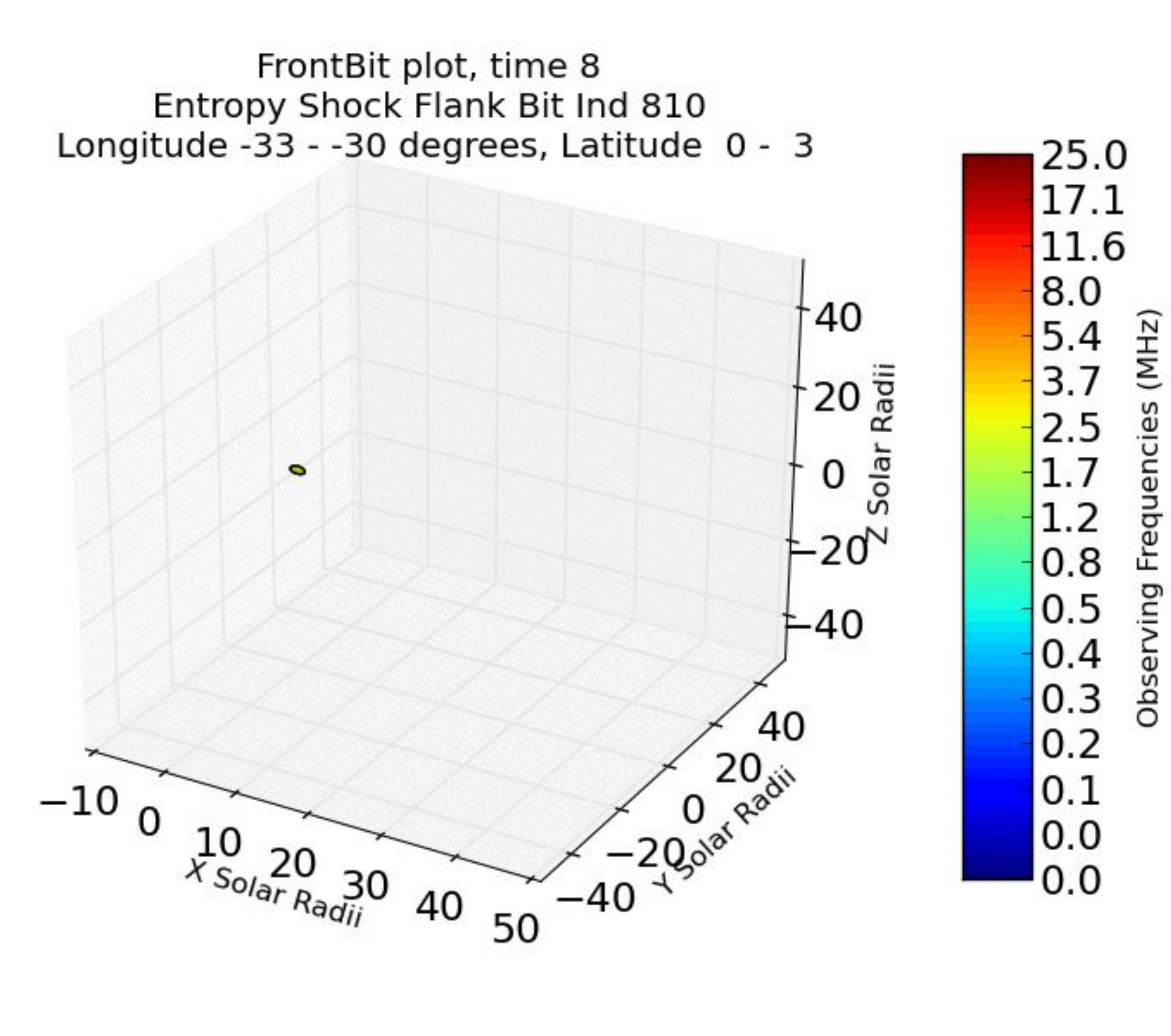
Manchester et al. 2014

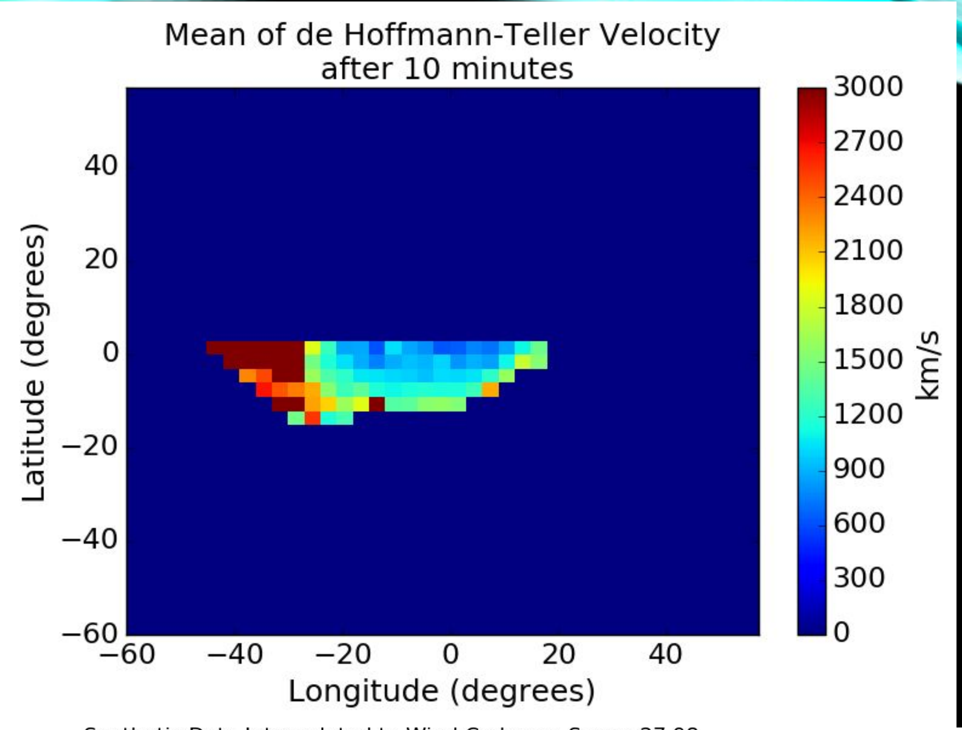
ZOOMING IN ON ENTROPY SHOCK

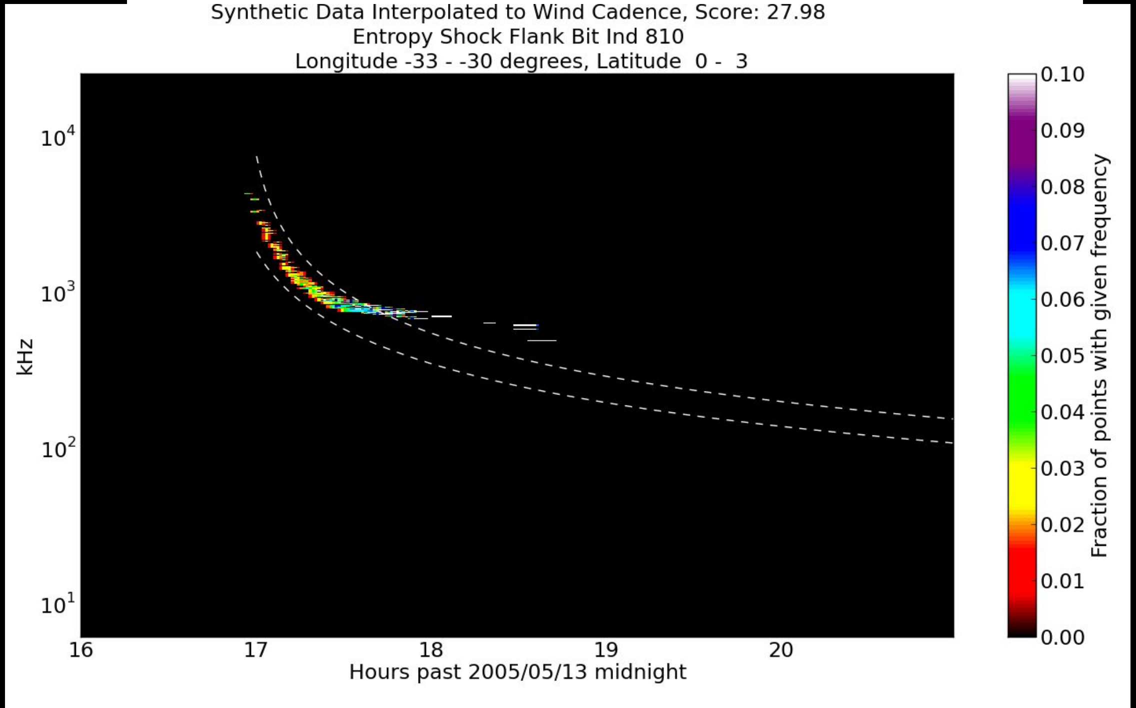




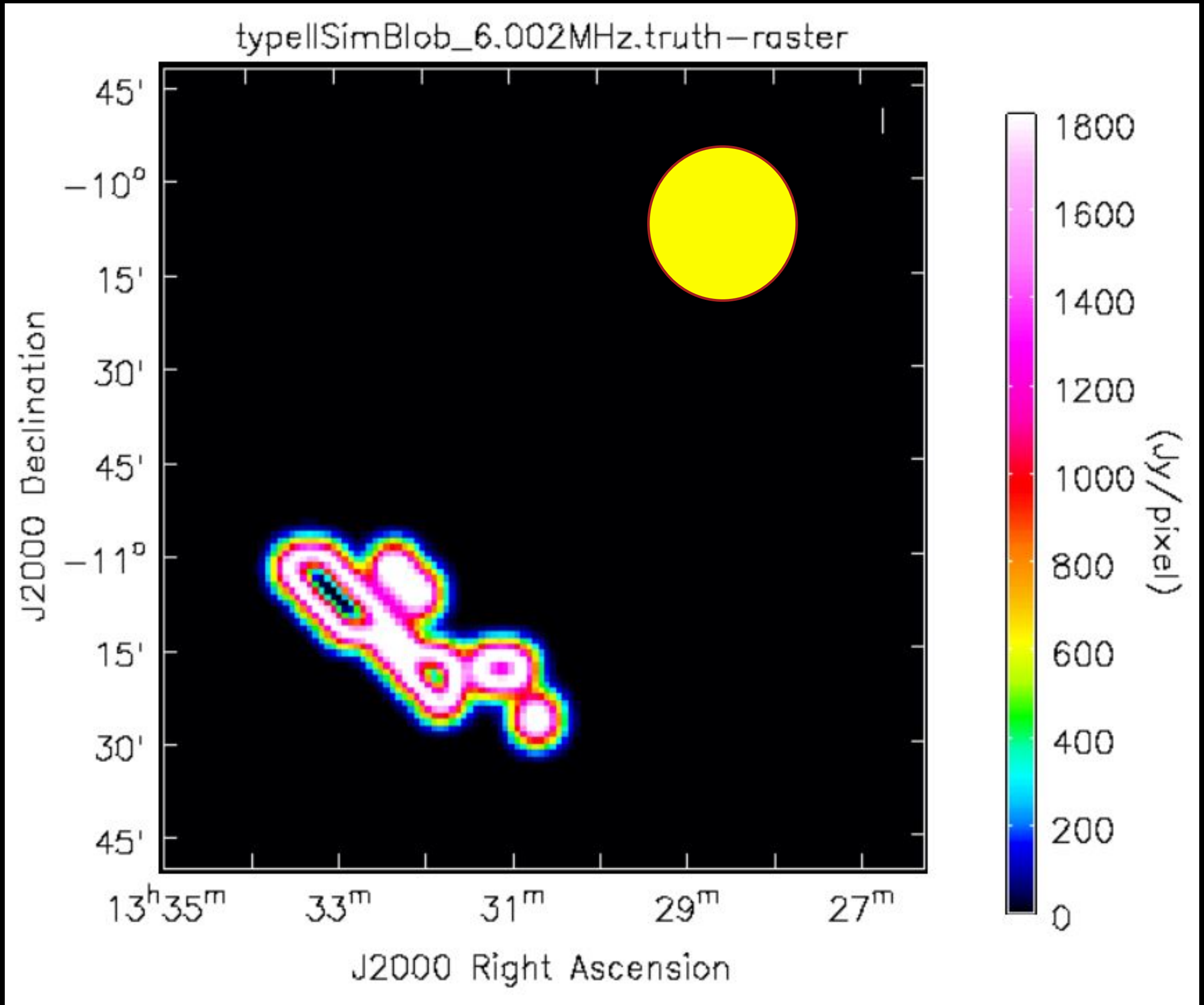
ZOOMING IN ON HIGH DHT VELOCITY





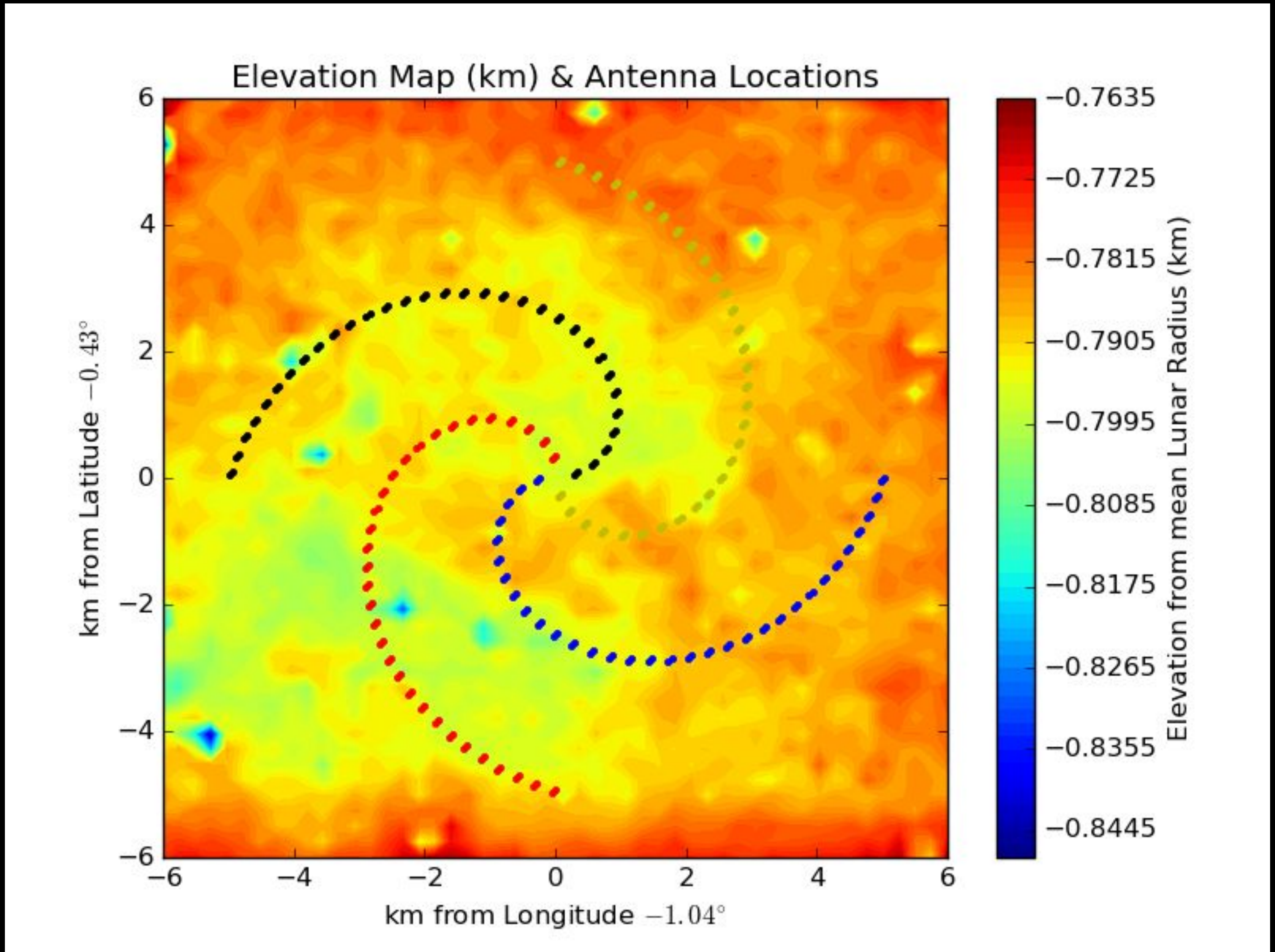


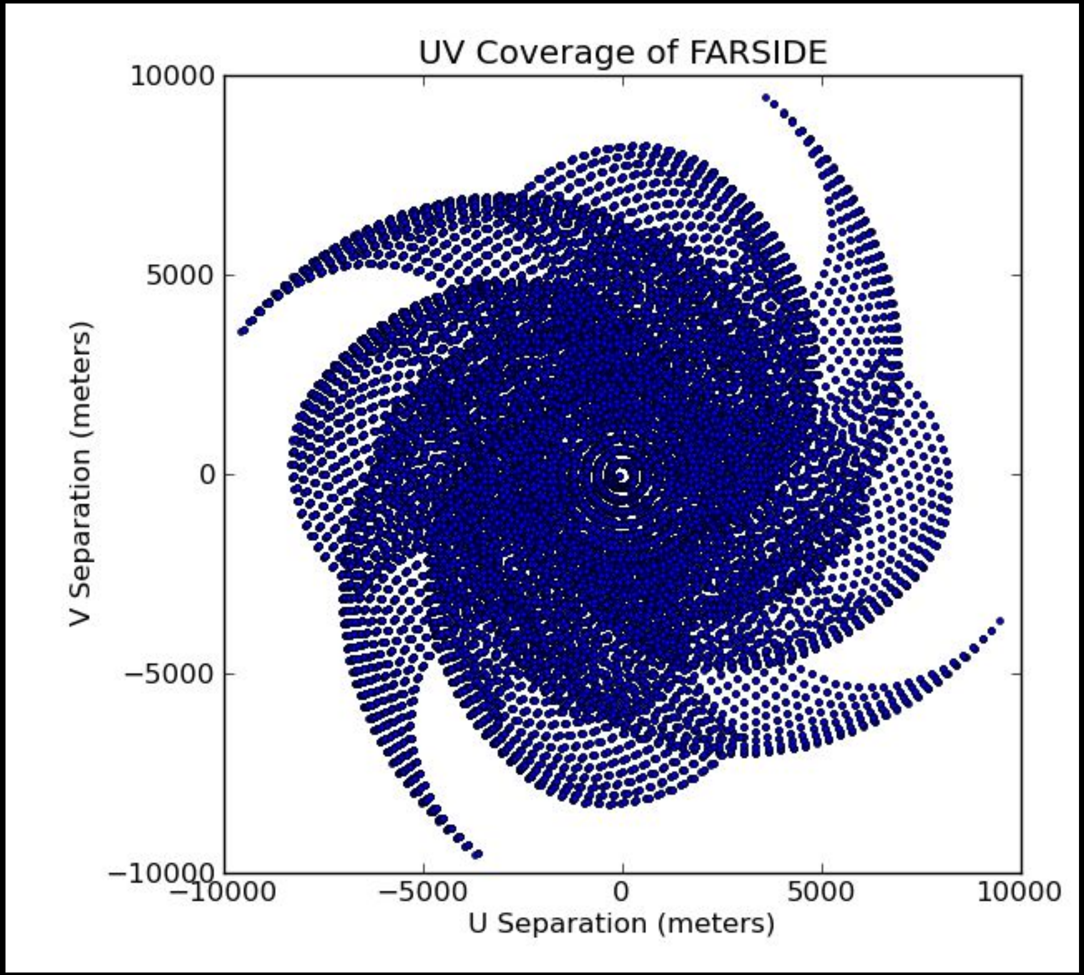
SIMULATION DERIVED TYPE II BRIGHTNESS



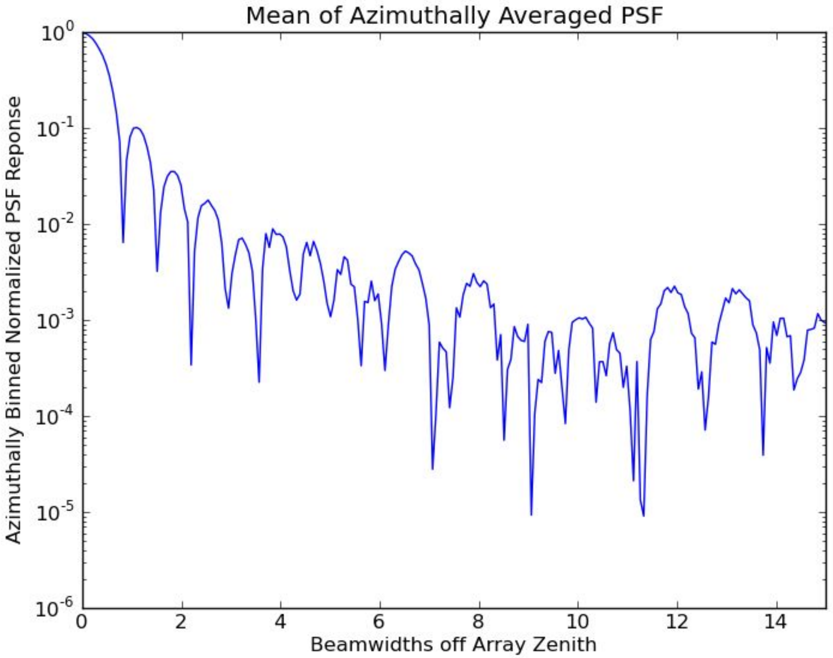
- 10 minutes into Simulation
- 3.5x enhanced Entropy and de Hoffmann-Teller speed cutoff of 2250 km/s
- 6-6.1 MHz upstream plasma frequency
- Sun to scale
- Brightness at 1e6 Jy

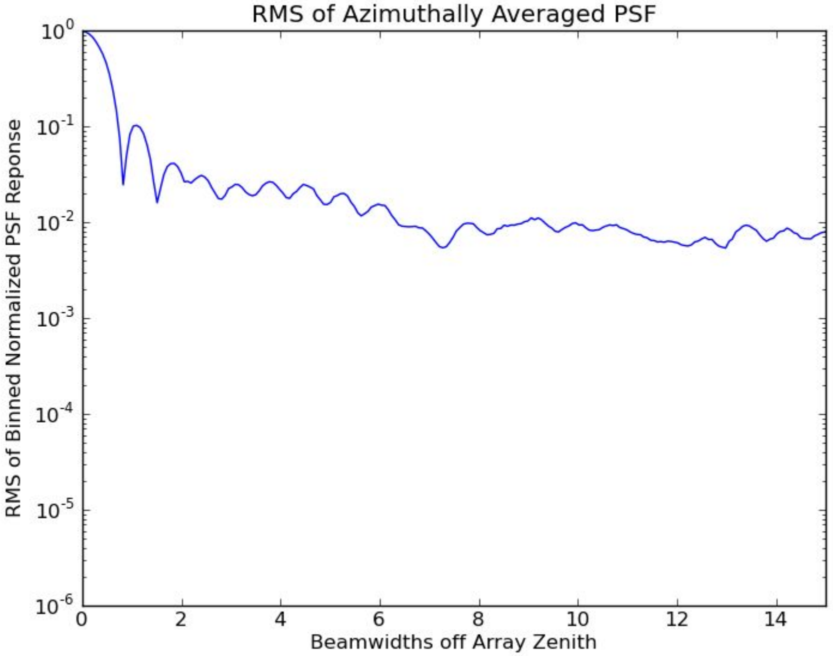
ARRAY CONFIGURATION & UV COVERAGE

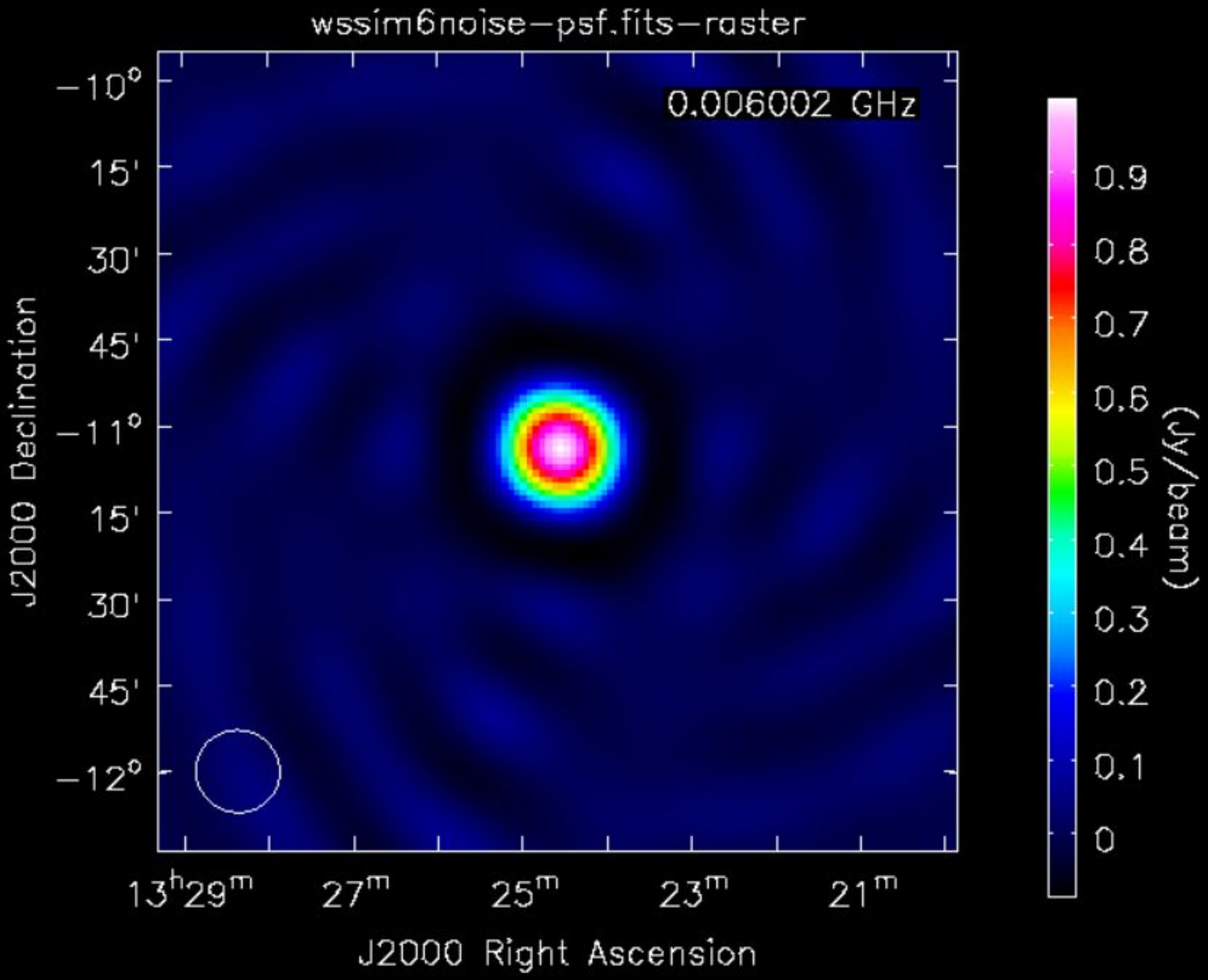




PSF SIDELOBES AT 1 % FAR FROM CENTER







RECEIVERS ARE SKY-NOISE DOMINATED

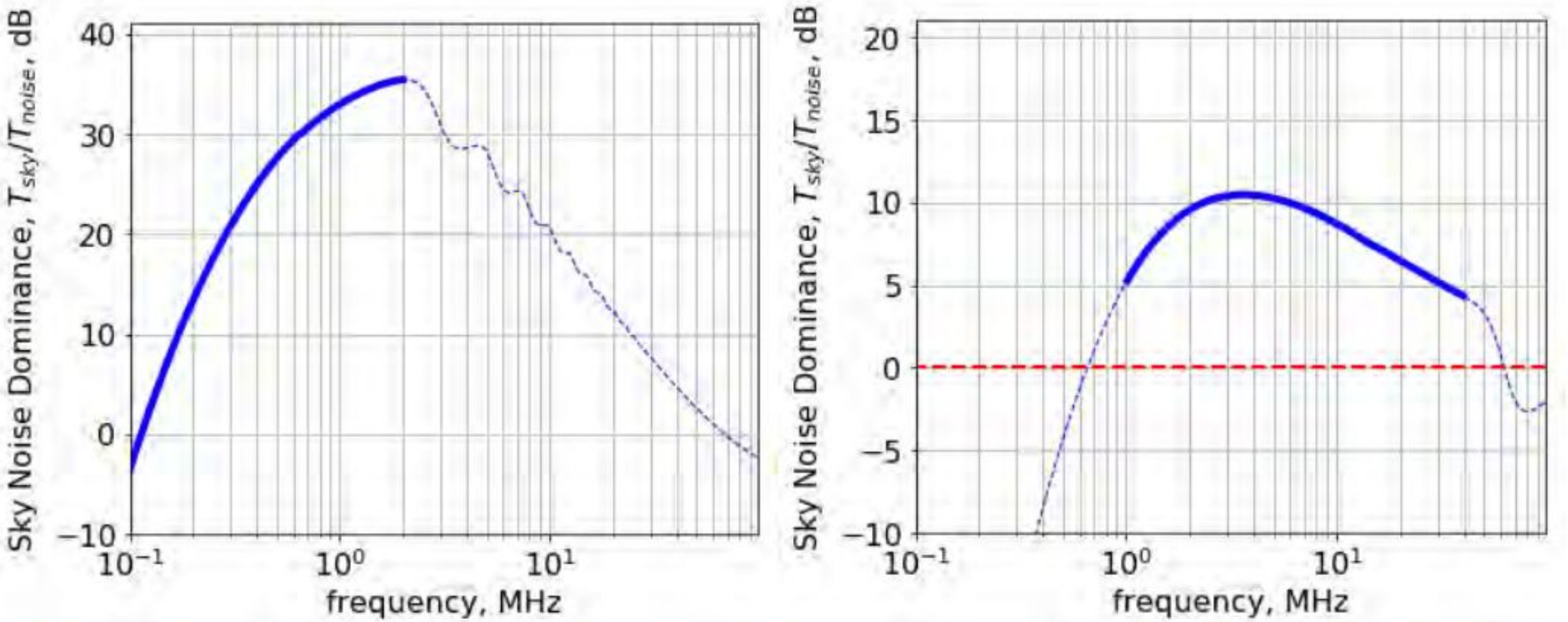
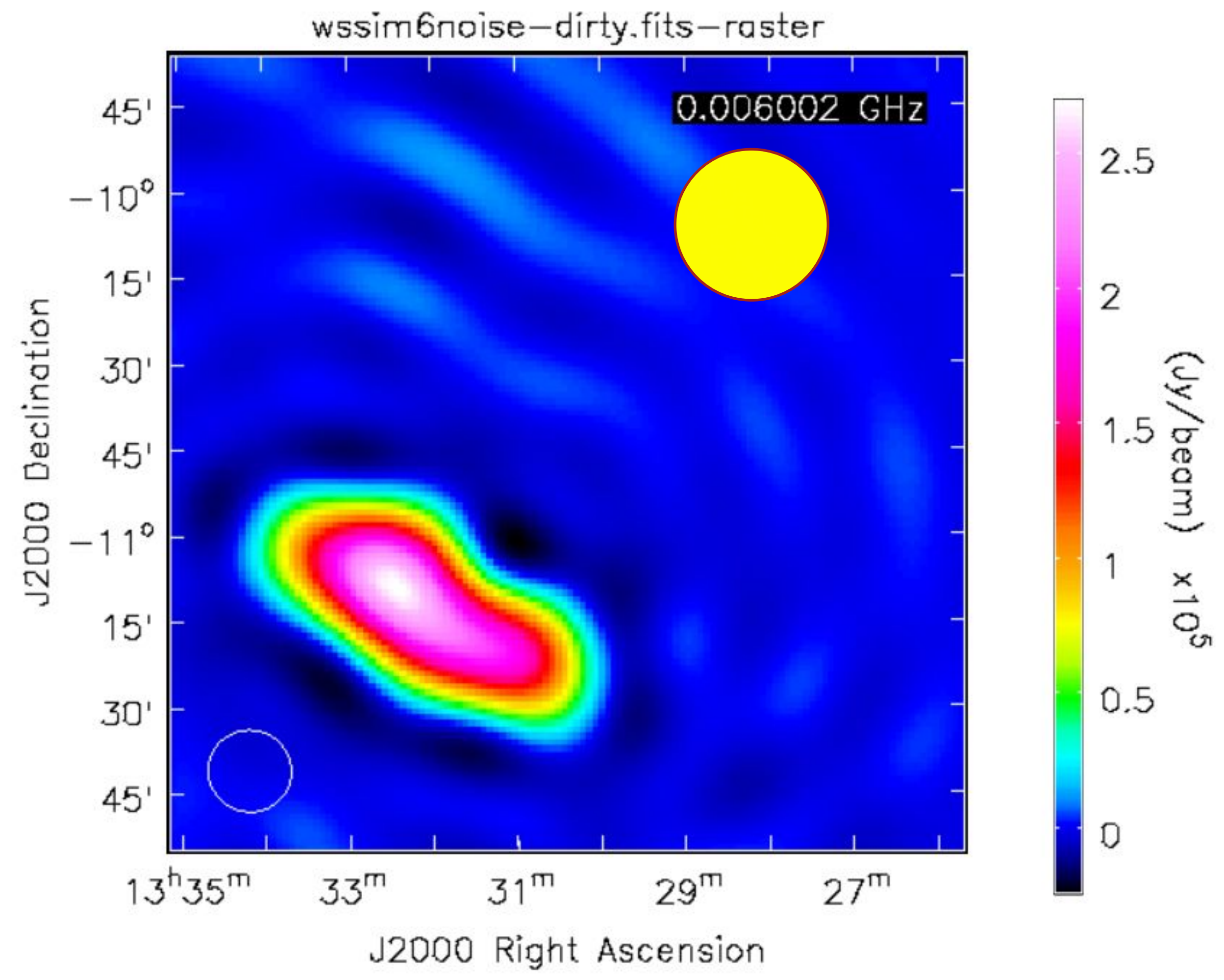
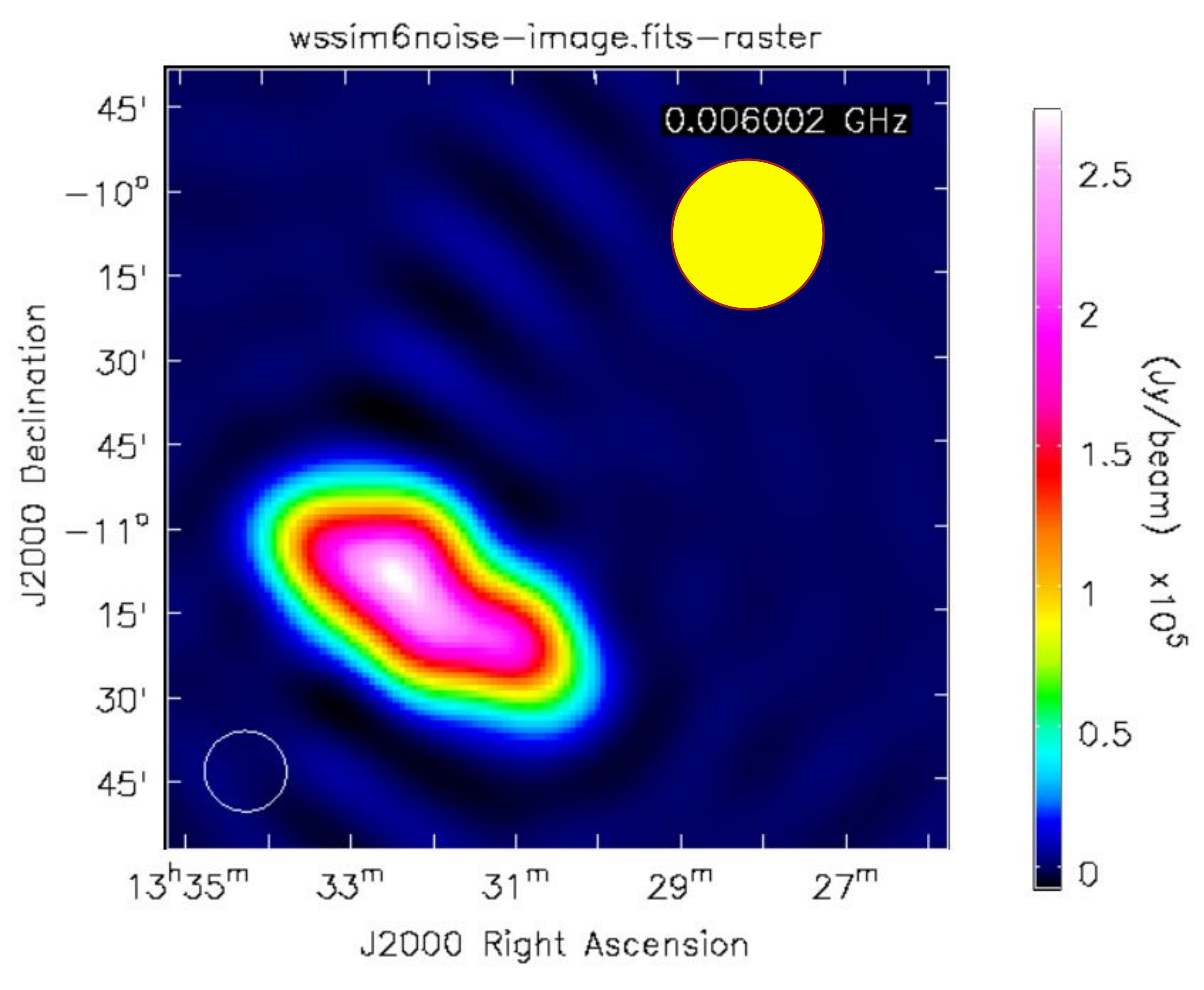


Figure 3.5-1. Sky noise dominance as a function of frequency are shown for the low band (*left*) and high band (*right*) antennas. The red dashed line at 0 dB indicates where sky noise would be equal to other sources of noise. The band of operation is shown as a thick line for each case.

DIRTY FARSIDE RECOVERED IMAGE



CLEANED FARSIDE RECOVERED IMAGE



DISCUSSION & CONCLUSIONS

- FARSIDE is poised for greatness!
- FARSIDE could easily image bright solar radio emission
- FARSIDE would provide unprecedented detail of type II brightness structure at low frequencies
- A simulation pipeline is in place for FARSIDE observations

QUESTIONS?