Radio Interferometric Observations of the Sun
With High Time and Frequency Resolution

*John A. Garzone*
*Georgia Institute of Technology*
*Dr. Divya Oberoi*
*MIT Haystack Observatory*
Overview

- Small Radio Telescope (SRT) Interferometry
- Software Development
- Data Analysis – 2006 and 2007 Data
- Future Analysis
The Small Radio Telescope (SRT)

- Relatively Inexpensive (About $7,500)
- Diameter – 2.3m
- Beamwidth – 6º
- Frequency Range – 1370 MHz to 1800 MHz
- Utilized Frequency – 1415 MHz
SRT Interferometry (3-Element)

- The SRT’s VLBI mode provides a bandwidth of 4 MHz with a time resolution of up to 1ms with 256 frequency channels.
- Baselines used ranged from 8 meters to 70 meters for 2007 data and from 8 meters to 27 meters for 2006 data with three baselines in each case.
- Resolution of Baselines:
  - 8 meters $\approx 1.5^\circ$
  - 27 meters $\approx 0.45^\circ$
  - 70 meters $\approx 0.17^\circ$
- Angular Size of Sun $\approx 0.5^\circ$
- VLBIProc (Correlation)
- Gives Visibility information with amplitude and phase.
Type II, III Radio Bursts

GBSRBS 20050531

Frequency (MHz)

Summed light curve

Time (UT) 20050531
Software Development

Statistical Analysis

• Identify Part of the Band with the Signal
• Time Series (Average in Frequency)
• Bandshape (Average in Time)
• Normalized Bandshape
• Compute median, robust mean, and robust RMS
• Identify 5 sigma, 7 sigma, 10 sigma data points
• Histogram
Data Analysis (Quiet Sun)
Data Analysis (Interesting Data)

- Intensity vs. Frequency
- Intensity vs. Time
- Amplitude Histogram
- Frequency Channel vs. Time (10 ms)
Data Analysis (Bandshape)

Bandshape plots from 2006 data (Day 160) on baseline 2-3 (long baseline) taken approximately four hours apart
Data Analysis (Time Series)

Time Series plots from 2006 data (Day 160) on baseline 2-3 (long baseline) taken approximately four hours apart
Data Analysis (Histogram)

Intensity Histograms created with 2006 data (Day 160) on baseline 2-3 (long baseline) taken approximately four hours apart
Data Analysis (Amplitude Plot)

Amplitude plots from 2006 data (Day 160) on baseline 2-3 (long baseline) taken approximately four hours apart.
Software Test (2005 Data)
Software Test (Results)

Intensity vs. Frequency

Frequency Channel

Intensity vs. Time

Time (10 ms)

Amplitude Histogram

Number of Occurrences

Intensity (K)

Intensity vs. Frequency

Frequency Channel

Time (10 ms)

Intensity (K)
Summary / Future Research

- More Comprehensive Look at Data
- Explore Fitting a Gaussian and Looking for Departures
- Correlate With Observations at Other Wavelengths
- MWA Application
Acknowledgements

A Special Thanks to:
My Mentor, Dr. Divya Oberoi
Dr. Preethi Pratap
Dr. Alan E.E Rogers
Phil Shute
Richard Crowley
Michael Albu
And
Joshua Suresh, Ryo Saotome, the remaining REU Students