Special Topics: AIPS

24 February 2012 – Socorro, NM USA

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Atacama Large Millimeter/submillimeter Array
Expanded Very Large Array
Robert C. Byrd Green Bank Telescope
Very Long Baseline Array

NRAO

Outline

- Data reduction sequence
- RFI Excision
- Switched Power Calibration
- Ionosphere Calibration (low frequency)
- Imaging issues
- Rotation Measure Synthesis

- More information:
  - http://www.aips.nrao.edu/

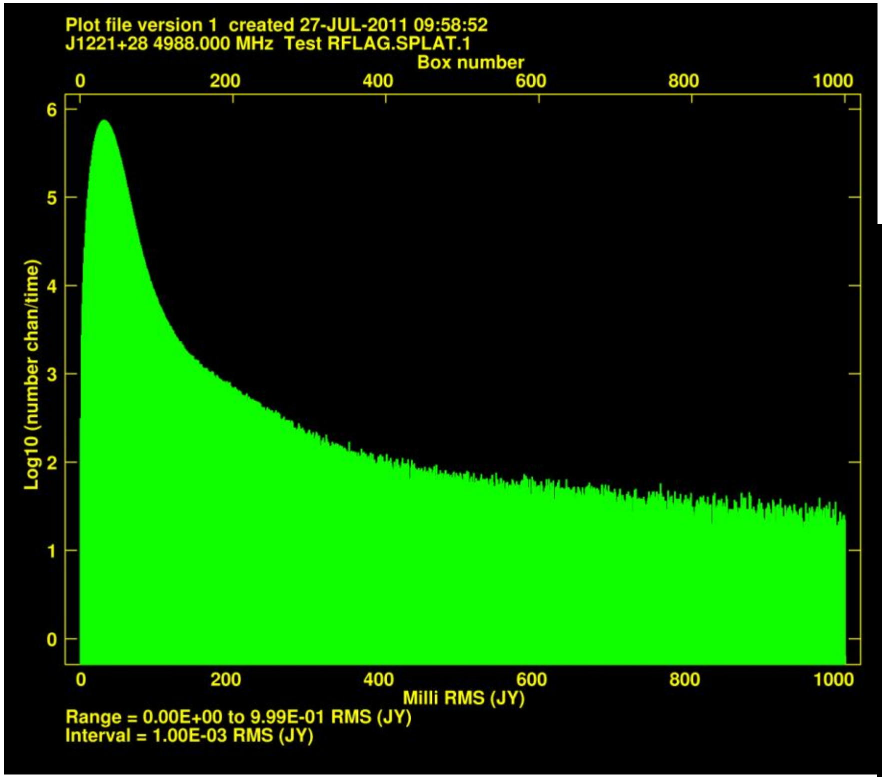
AIPS is alive and supporting commissioning

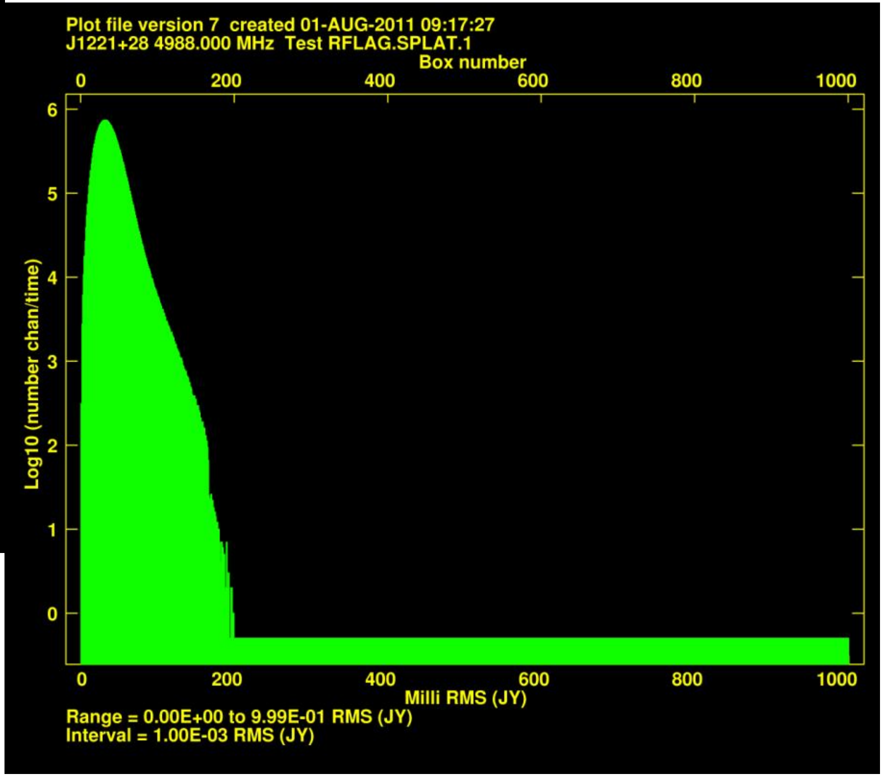
- CookBook Appendix E handed out, describes EVLA considerations
- Preliminary calibration:
  - Flag egregious data (missing antennas, extreme RFI)
  - Delay calibration (FRING), antenna position (VLANT)
  - Bandpass (BPASS)
  - Gain (SETJY, CALIB, GETJY)
- Serious flagging and basic calibration
  - RFLAG
  - SysPower tables: SNEDT, TYSMO
    - TYAPL
- Repeat FRING, BPASS, CALIB, GETJY

RFLAG

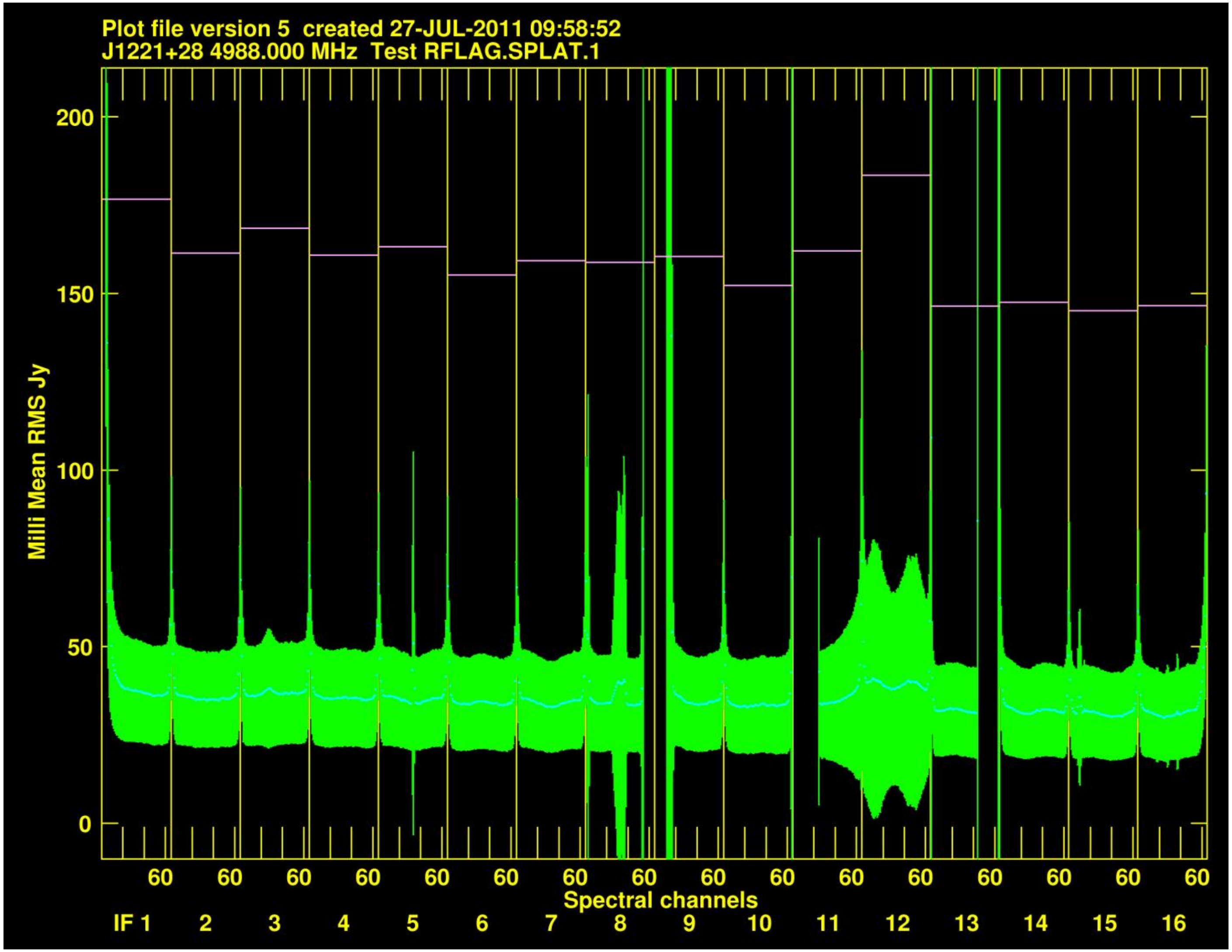
- Based on observation that RFI is quite variable in time and in frequency
- Uses rms in real and imaginary parts of visibility computed
  - per spectral channel, per spectral window, per polarization
  - over short time intervals (e.g. 3 or 5 samples)
  - in sliding buffer
- Optionally, also fits constant to real and imaginary over spectral channels
  - per spectral window, per polarization
  - At each time separately
- Flags those time groups whose rms is greater than specified limit in Jy
- Flags those spectral channels which deviate from the fit by a second specified limit, also in Jy
- Plots available to guide selection of limits: histograms, spectral plots

RFLAG histograms

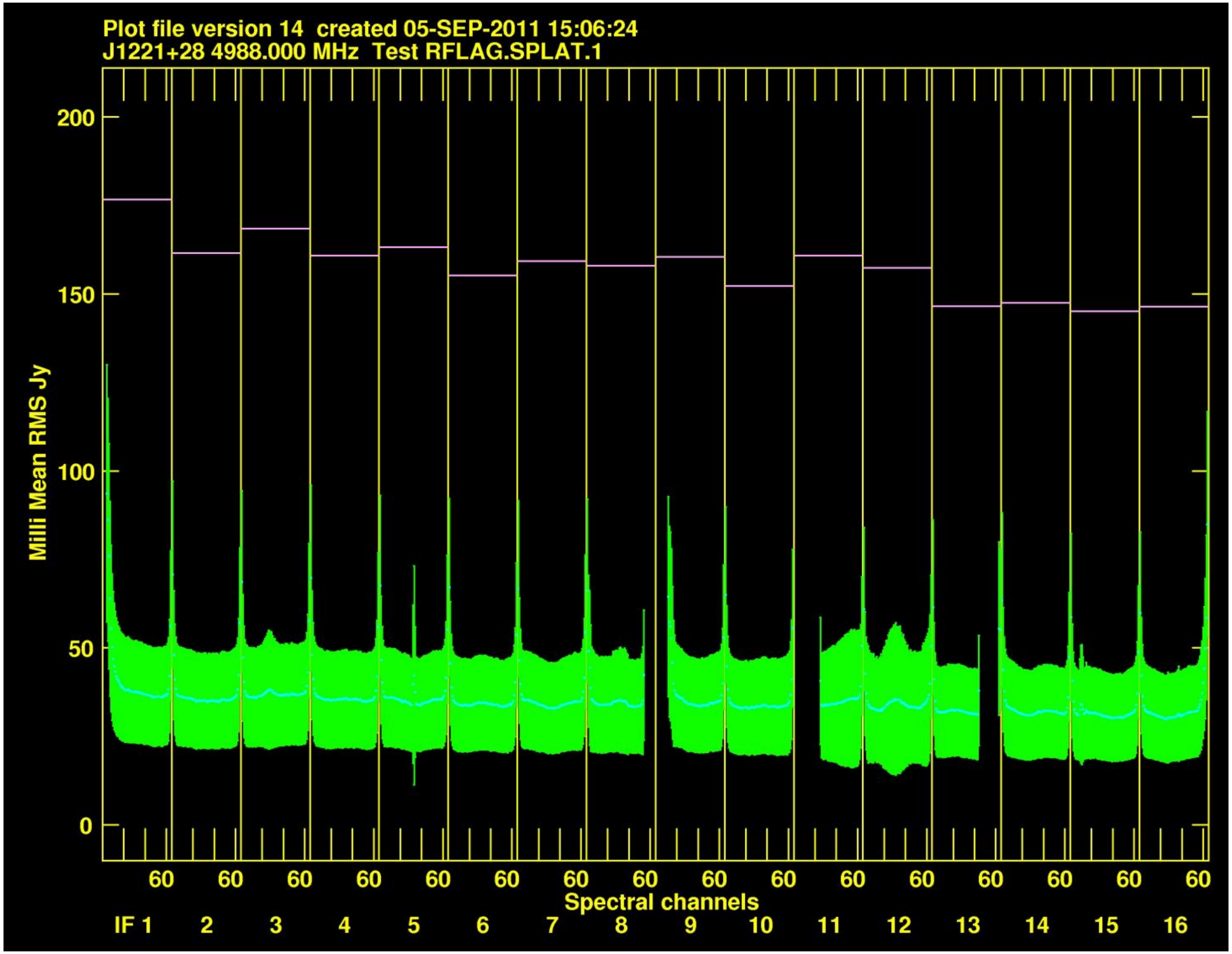




RFLAG spectral plots



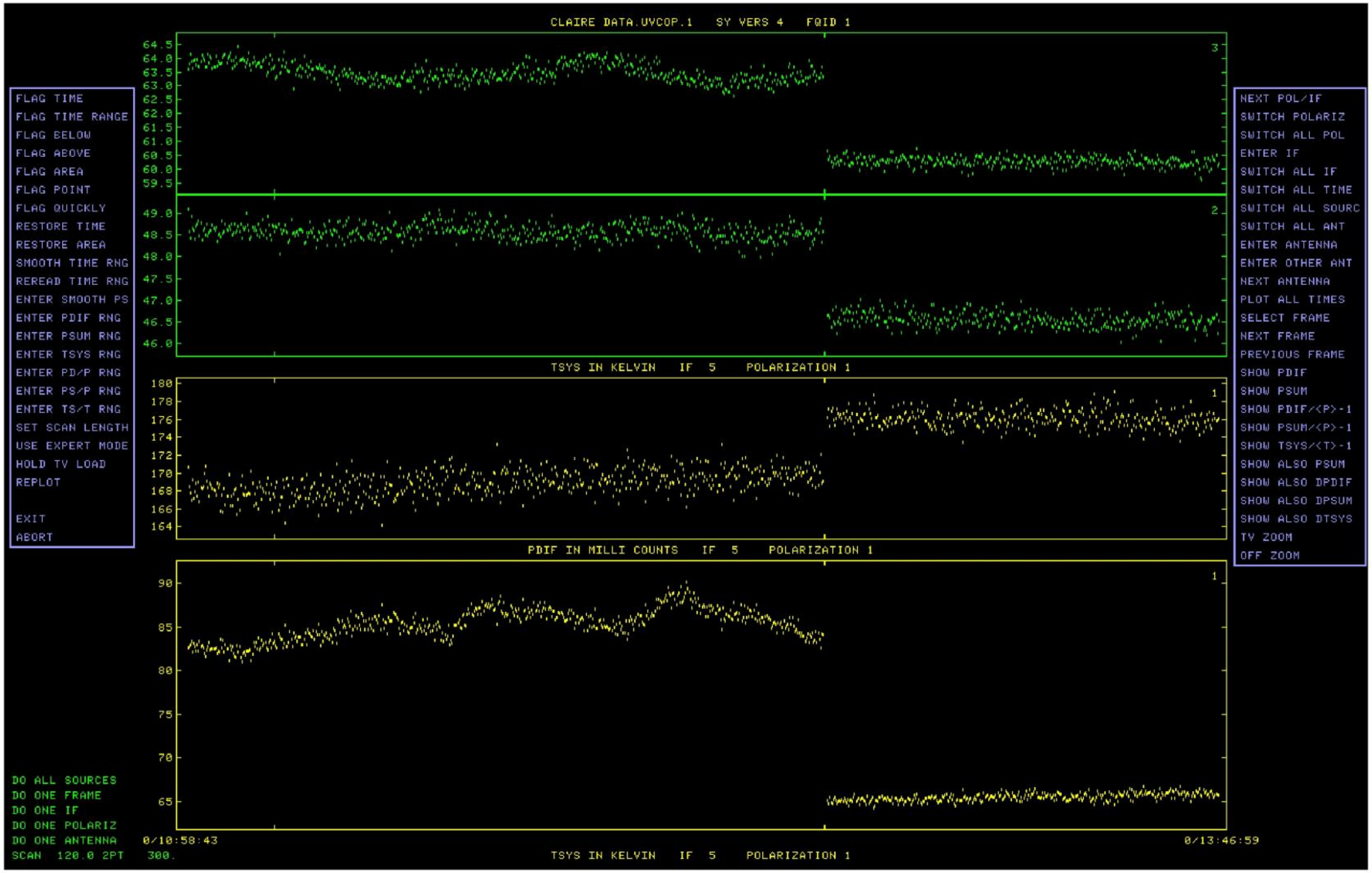
RFLAG spectral plots – after 1 round



SysPower data

- EVLA produces un-normalized cross-power visibilities
- Measures system gain with Pon and Poff plus noise tube values
- Available in AIPS iff the ASDM/BDF is read with BDF2AIPS (not CASA)
  - BDF2AIPS is an AIPS “verb” to invoke Bill Cotton’s OBIT task BDFIn
- Resulting SY table may be plotted with SNPLT to check values
  - Edit visibilities with SY using EDITA
  - Edit SY values with SNEDT and TYSMO
- Apply SY table with TYAPL
  - Brings amplitudes nearly on an already calibrated scale
  - Computes real 1/Jy{^2} weights, may be calibrated thereafter
  - Applies massive RFLAG flag table
  - Remaining amplitude calibration actually just correcting Tcal values

SysPower table: SNEDT example



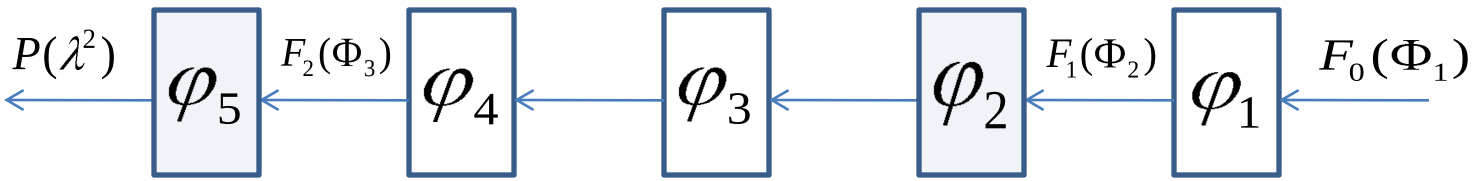
Polarization and the ionosphere

- To correct for ionospheric Faraday rotation:
  - Use VLATECR procedure to download IONEX files from cddis.gsfc
  - And to run TECOR to make an updated CL table
  - Model is global and every 2 hours, but is rather better than nothing
- RLDLY solves for right-left delay difference (often large)
- Now use PCAL to determine instrumental and source polarization
  - Available per spectral window or per spectral channel
  - Solutions saved in tables (AN, PD/CP, resp.)
  - PD and CP tables may be plotted with POSSM
- RLDIF is run to determine right-left phase difference from source of known polarization angle (3C286 is best)
  - As function of spectral window or of spectral channel
  - Corrects AN, PD, CP tables

AIPS and imaging

- AIPS handles multi-scale and wide-field imaging with multiple facets
  - SETFC recommends superior, overlapped facet pattern + NVSS, Sun
  - IMAGR now has 2 correct geometries it can use and many options
  - REWAY may be used to determine data weights
- Wide-band issues for spectral-line
  - Use "natural" Clean beam for each channel, recorded in CG table
  - Brightness units corrected to match Clean beam of header
  - CONVL is best way to make a constant resolution cube with correct units for both components and residuals
- Wide-band continuum not done with advanced algorithms
  - Frequency-dependence of primary beam may be corrected
  - Image of spectral index and curvature may be applied during Cleaning
  - Can be used in self-cal with procedure OOCAL

Faraday Rotation synthesis: Leonia Kogan



$$P(\lambda^2) = F_0(\Phi_1)\cdot \exp j2\Phi_1\lambda^2 + F_1(\Phi_2)\cdot \exp j2\Phi_2\lambda^2 + F_2(\Phi_3)\cdot \exp j2\Phi_3\lambda^2$$

$$\Phi_1 = \varphi_1 + \varphi_2 + \varphi_3 + \varphi_4 + \varphi_5$$

$$\Phi_2 = \varphi_2 + \varphi_3 + \varphi_4 + \varphi_5$$

$$\Phi_3 = \varphi_5$$

In the limit :

$$P(\lambda^2) = \int F(\Phi)\cdot \exp j2\Phi\lambda^2 \cdot d\Phi$$

Faraday Rotation synthesis

- "Faraday rotation synthesis" is a Fourier analysis of the previous equation
- FARS takes as input spectral cubes of Q and U
  - Frequency axis may be any collection of frequencies
  - Shifts and Fourier transforms wrt wavelength squared
  - Does 1-dimensional Clean, restores with Clean beam
  - DOFARS is a procedure to handle required transposes, etc.
- AFARS analyzes the FARS output cubes to make images of the
  - Rotation measure at the position of the maximum
  - Amplitude (Jy/beam) or phase at the maximum
- RFARS uses the AFARS output image to correct the FARS input images to make cubes of Q and U as they would be without the rotation measure
  - Checks for spectral features in the emission and
  - for failure of the single rotation measure model