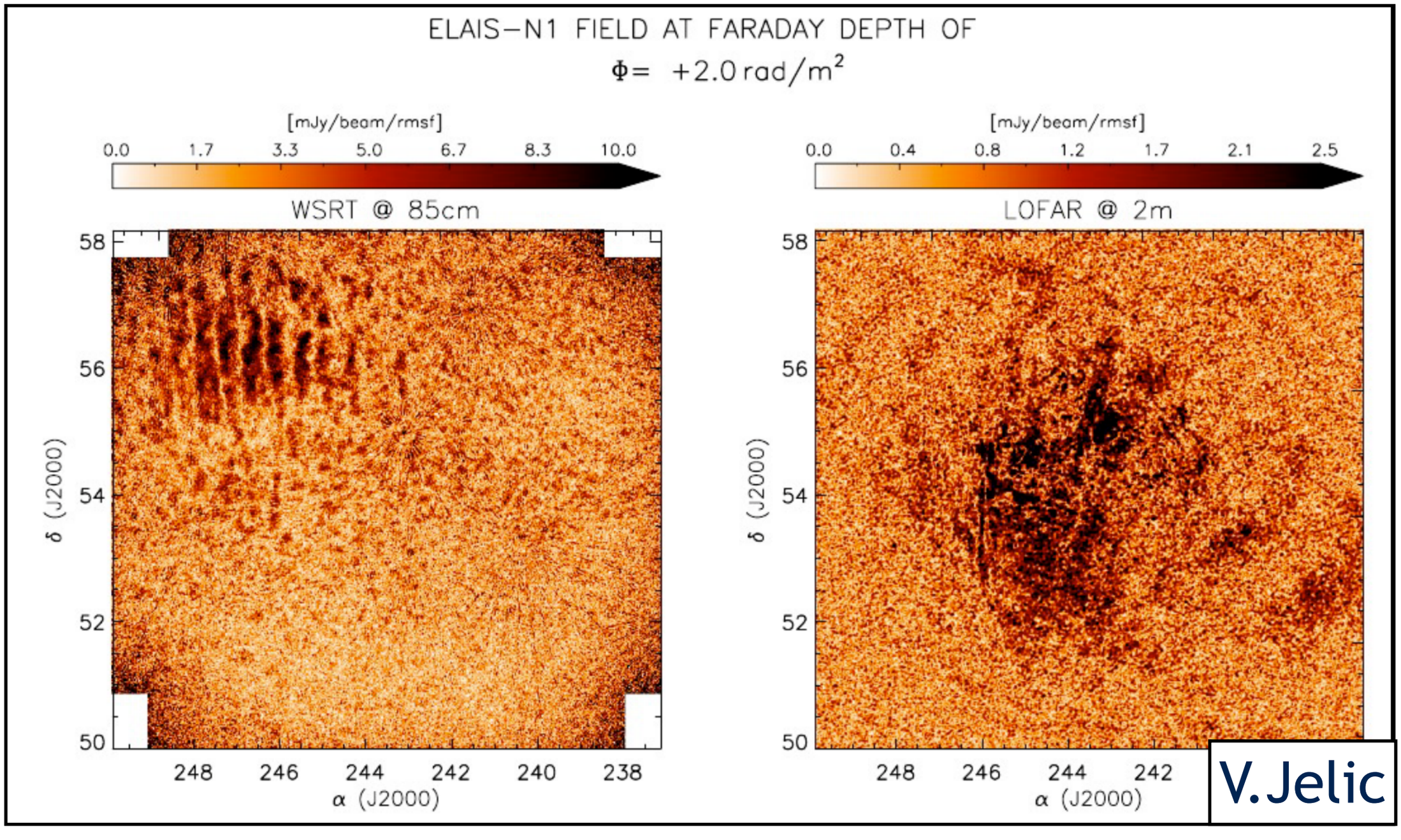
LSM Status update from the LOFAR polarisation busy week

David Mulcahy
University of Manchester

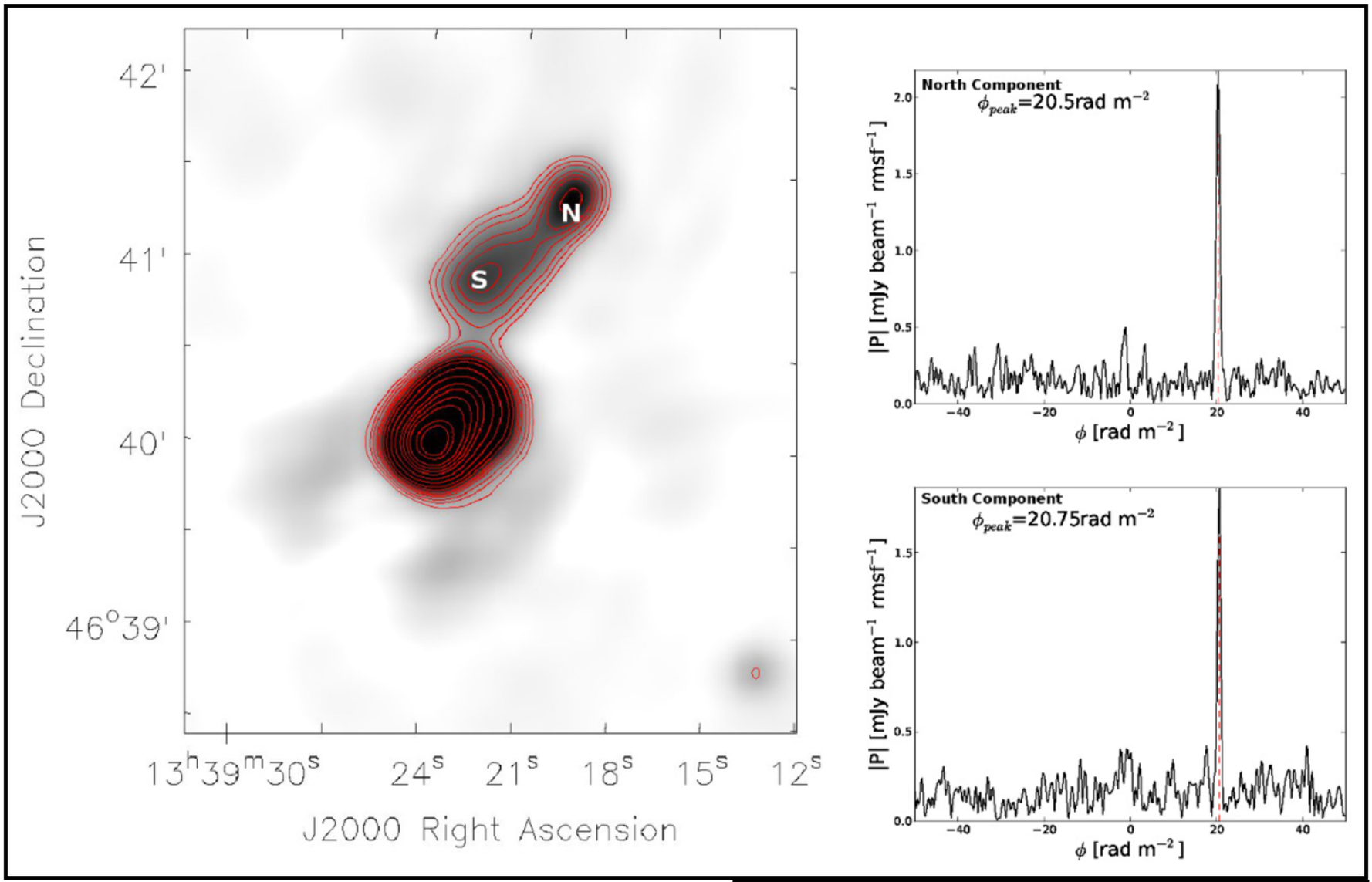
Observing Polarisation with LOFAR

Polarised foreground observations observed in many observations already such Iacobelli (2014) and Jelic (2014)



Observing Polarisation with LOFAR

Polarisation has been observed for extragalactic sources, 6 polarised sources found in a single field.



Mulcahy et al. 2014

LOFAR Polarisation Busy Weeks

There is a need to properly calibrate and understand LOFAR polarisation data.

Restarting polarisation busy weeks

- polarisation calibration workshop
  take place in Manchester

- polarisation analysis workshop
  take place in ASTRON (next in November)

Occurs alternatively every 2 months

Restructuring polarisation busy weeks

- Recently revived polarisation busy weeks focusing ONLY on polarisation commissioning.

Polarisation Calibration Busy Weeks

LOFAR-specific polarisation calibration problems.Develop a working calibration guideline including correcting for Ionospheric Faraday correction and instrumental polarisation.

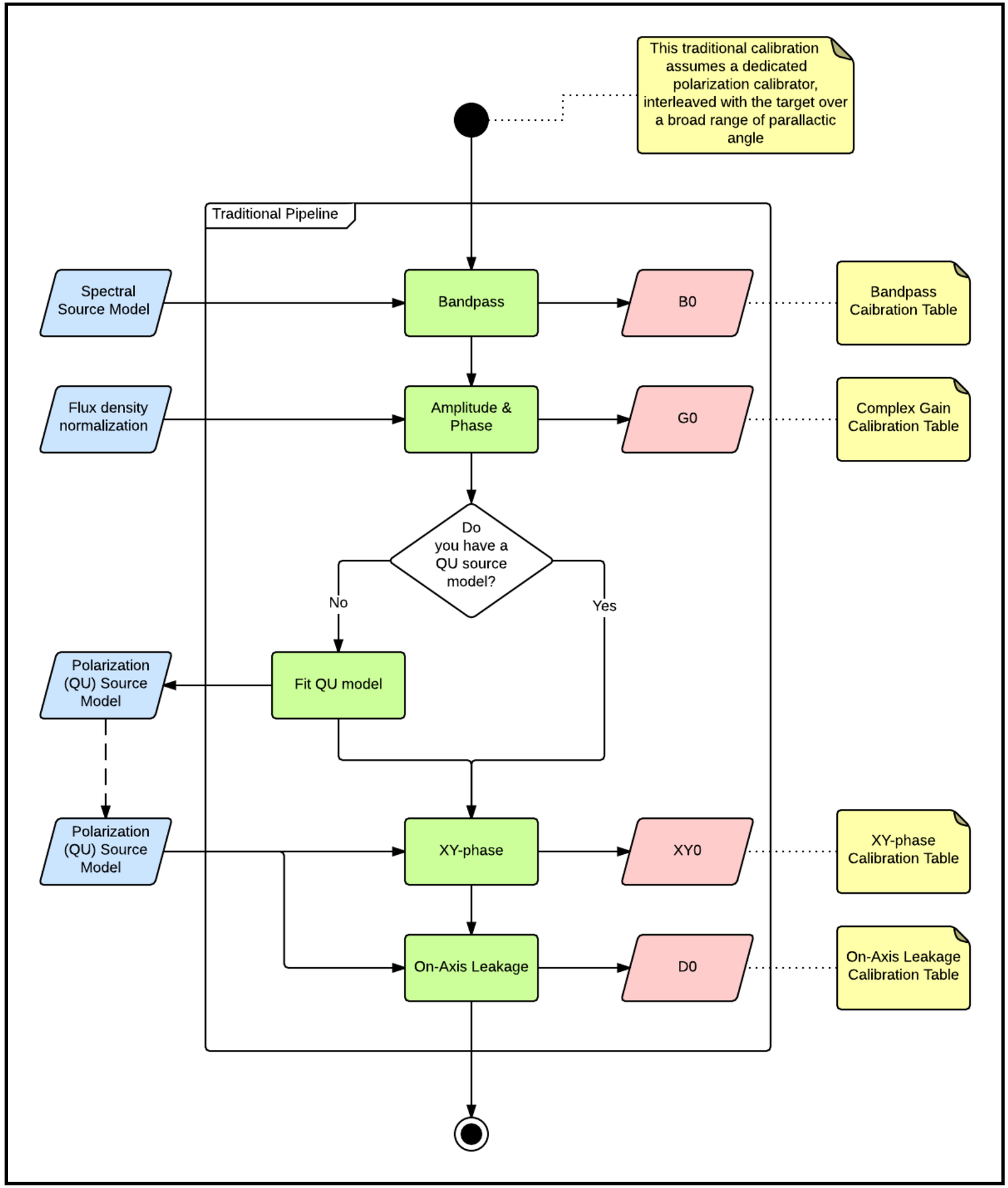
Polarisation Analysis Busy Weeks

Develop strategies for LOFAR-specific polarisation imaging: advanced RM-Synthesis techniques,source finding, image analysis. Test and develop needed software.

2nd Polarisation calibration busy week

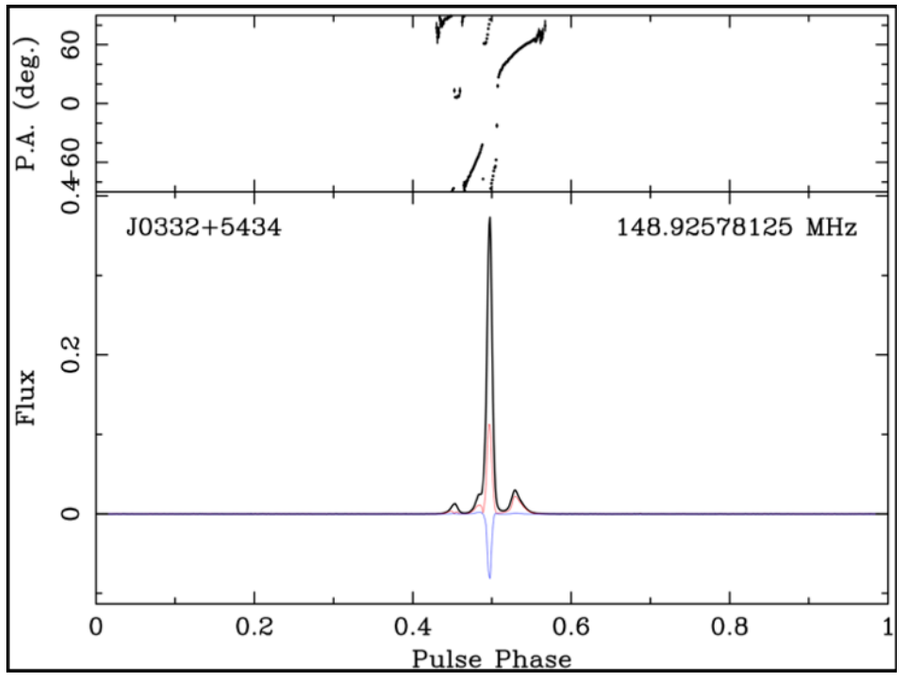
Took place from the 26-28th August at the University of Manchester.
10 participants with several more online for discussions

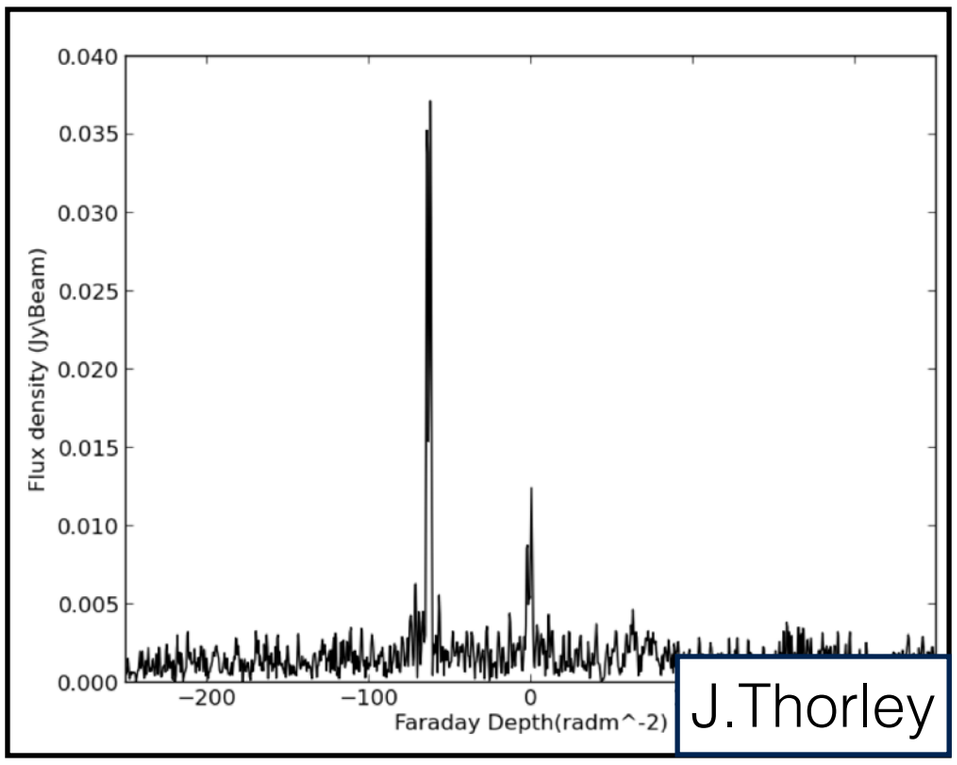
Therese Cantwell (University of Manchester)
Alex Clarke (University of Manchester)
Volker Heesen (University of Southampton)
Andreas Horneffer (MPIfR)
Henrik Junklewitz (University of Bonn)
David Mulcahy (University of Manchester)
Sarrvesh Sridhar (University of Groningen)
Rosita Paladino (IRA)
Valentina Vacca (MPA)
Cameron Van Eck (University of Nijmegen)


This traditional calibration assumes a dedicated polarization calibrator, interleaved with the target over a broad range of parallactic angle
Traditional Pipeline
Spectral Source Model
Bandpass
B0
Bandpass Caibration Table
Flux density normalization
Amplitude & Phase
G0
Complex Gain Calibration Table
Do you have a QU source model?
No
Yes
Polarization (QU) Source Model
Fit QU model
Polarization (QU) Source Model
XY-phase
XY0
XY-phase Calibration Table
On-Axis Leakage
D0
On-Axis Leakage Calibration Table

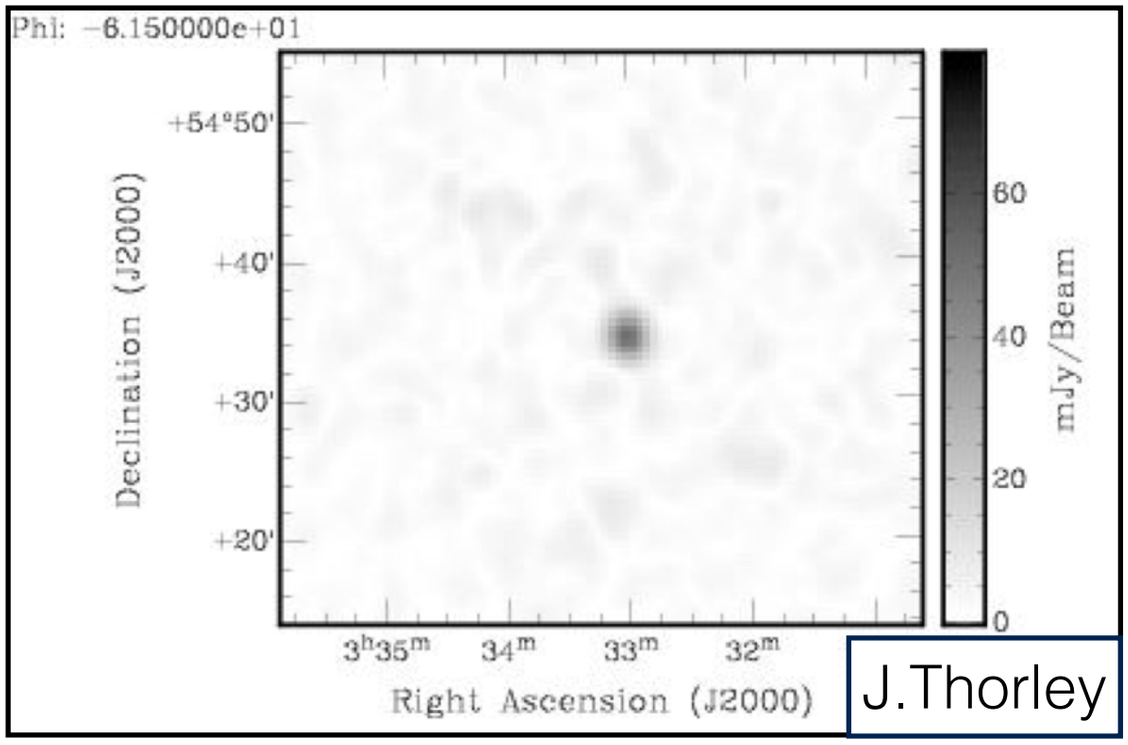
Commissioning Observation of PSRJ0332+5434

- We proposed a new 8 hour observation with HBA_DUAL pointed at PSRJ0329+54.
- This pulsar has a Faraday depth of **-61.7 rad^2** with a linear polarisation degree of 34% (815 mJy)and a circular polarisation degree of 11%.

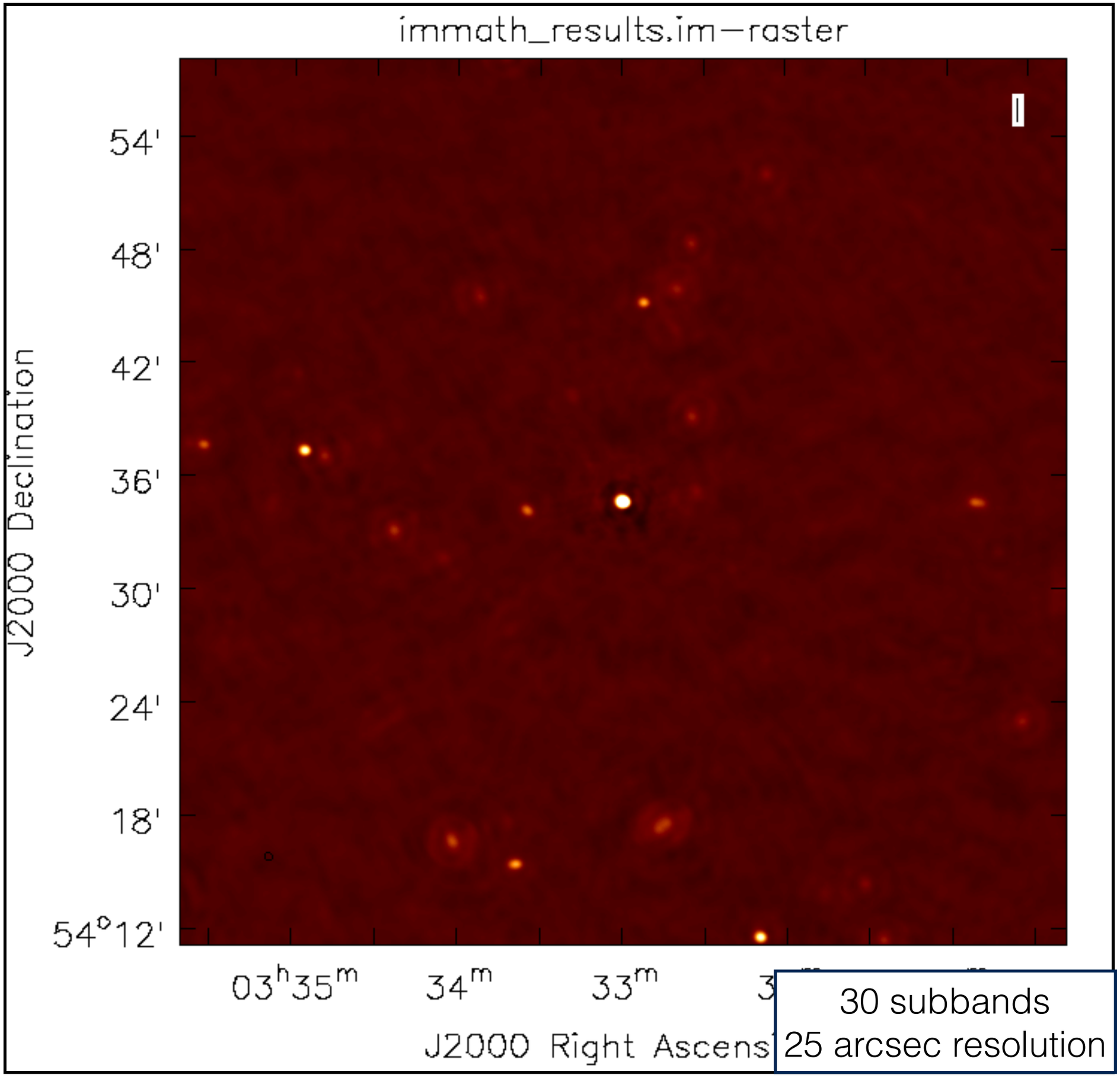




J.Thorley



J.Thorley


immath_results.im—raster
54'
48'
42'
36'
30'
24'
18'
54°12'
J2000 Declination
03h35m
34m
33m
J2000 Right Ascens
30 subbands
25 arcsec resolution

Task 1

Testing of RMextract on commissioning dataset
Need to test and compare Ionospheric correction on full 8 hour observation with polarised pulsar.
—> C. Van Eck

Task 2

Testing of Spectral Index information in pyrmsynth
Need to test adding spectral information into pyrmsynth.
—> V.Vacca

Task 3

Creating Q & U models from data
Q and U fitting from g_{xx} and g_{yy} —> D.Mulcahy & T.Cantwell
Ambiguity resolution from Vxy and Vyx —> A.Clarke & S.Sridhar

Task 4

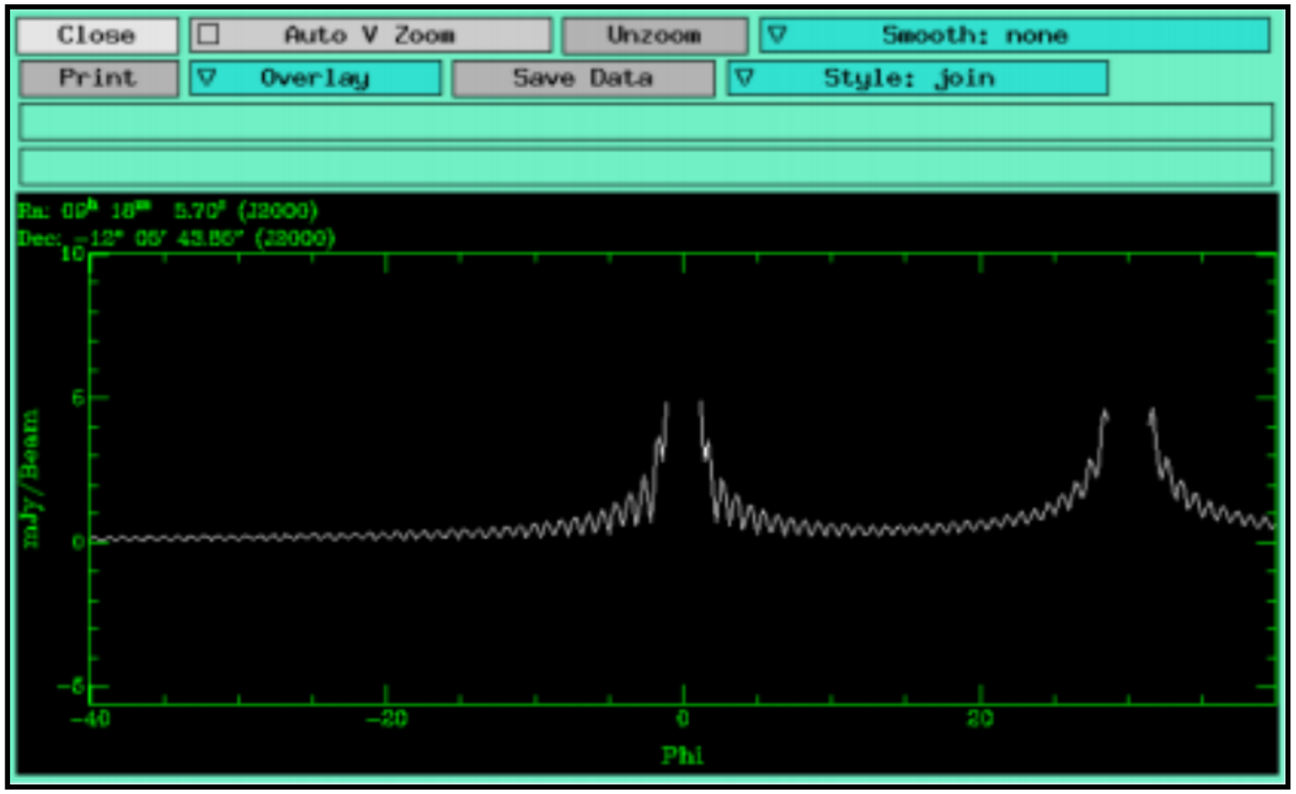
Extracting calibration parameters
Creating a simulated dataset with instrumental polarisation leakage.
—> A. Horneffer & H.Junklewitz

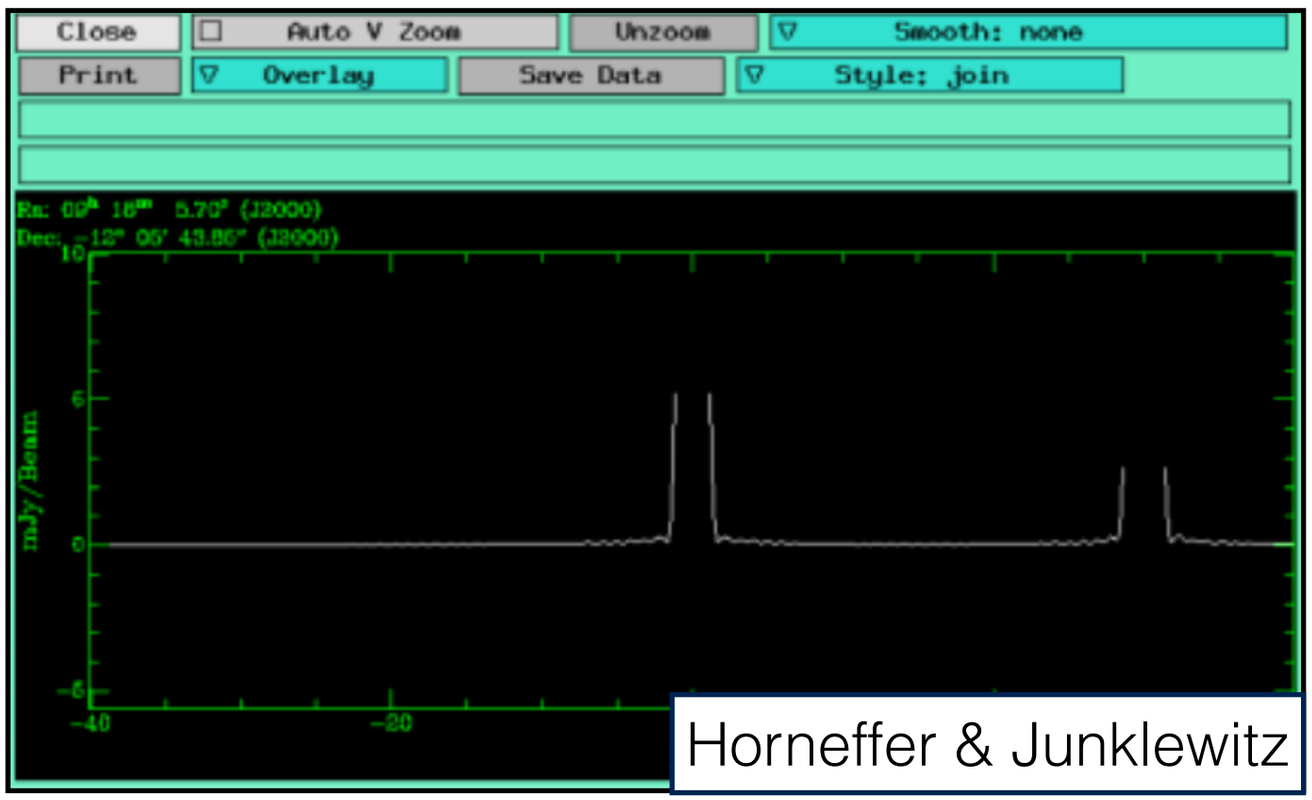
Task 5

Investigating Q & U models extracted from pulsar data
Attempting to self calibrate using Q and U values obtained from beam-formed data.
—> R.Paladino & V.Heesen

Task 2-Testing of Spectral Index information in pyrmsynth

- Implemented spectral information into pyrmsynth
- Dividing spectral function from Faraday spectrum.
- Simulations show reduced side lobes.
- Useful in disentangling real polarisation from instrumental

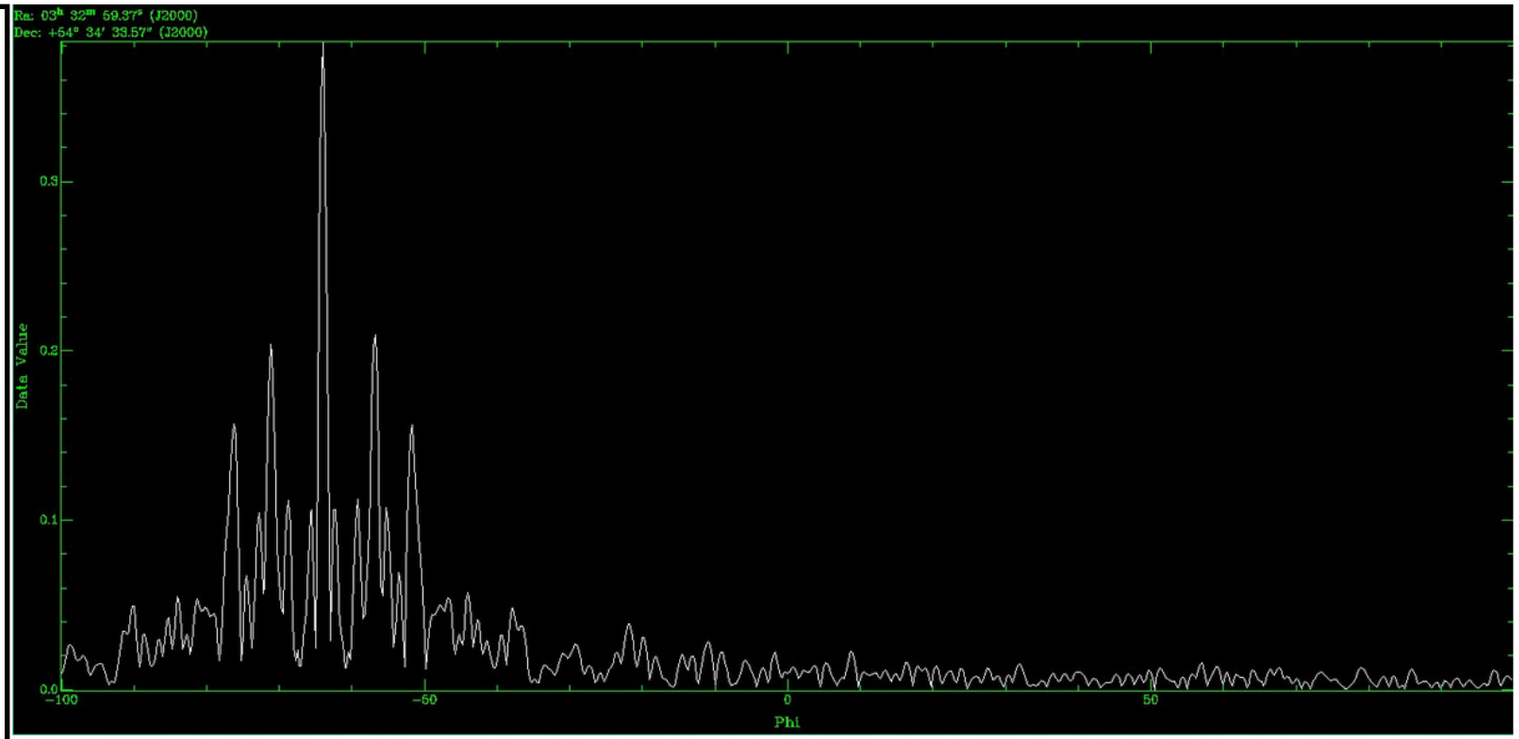


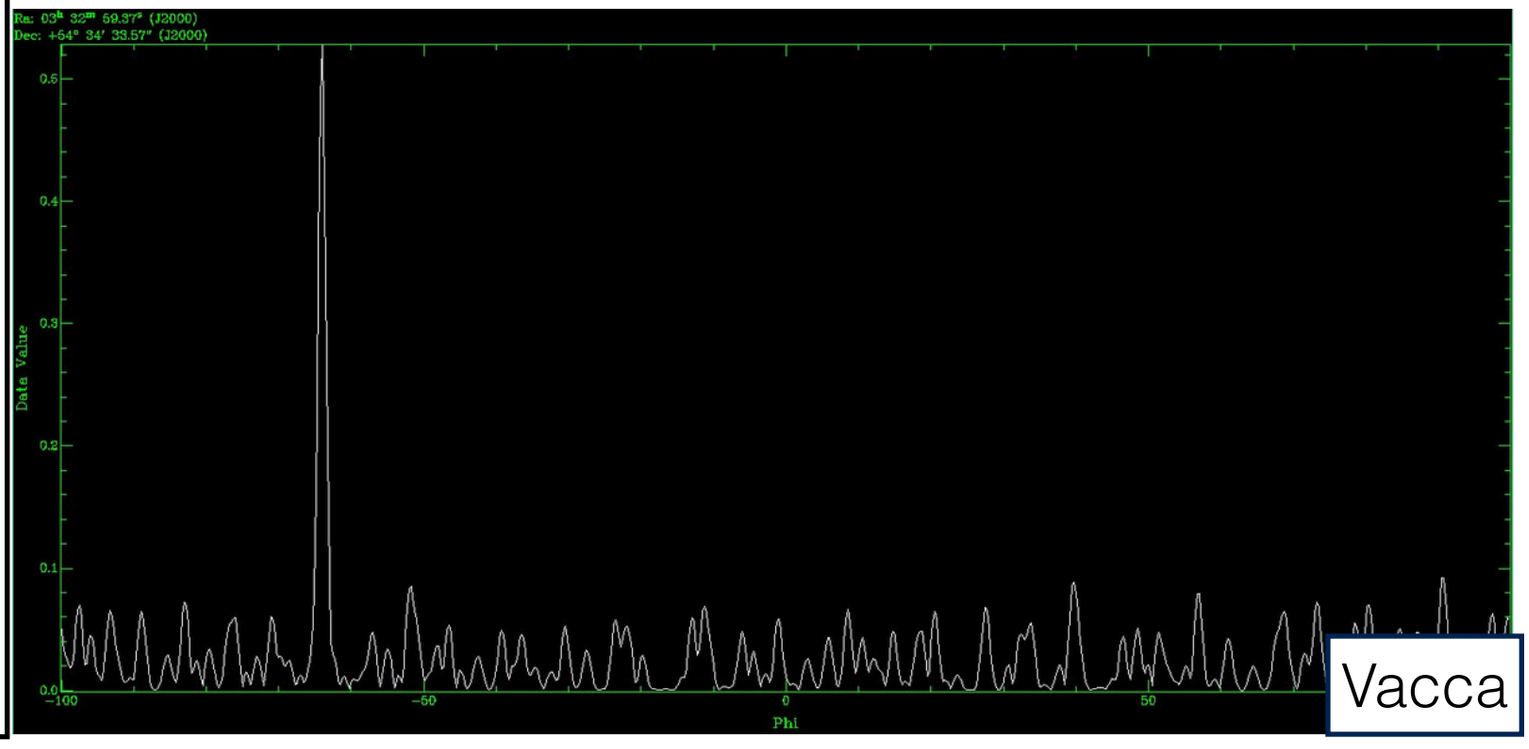


Horneffer & Junklewitz

Task 2-Testing of Spectral Index information in pyrmsynth

- Need less clean iterations to eliminate side lobes.
- Small change in Faraday depth —> 0.1 rad/m^2.
- Need to check effect on instrumental polarisation.
- Need to further investigate choice of the reference frequency used.





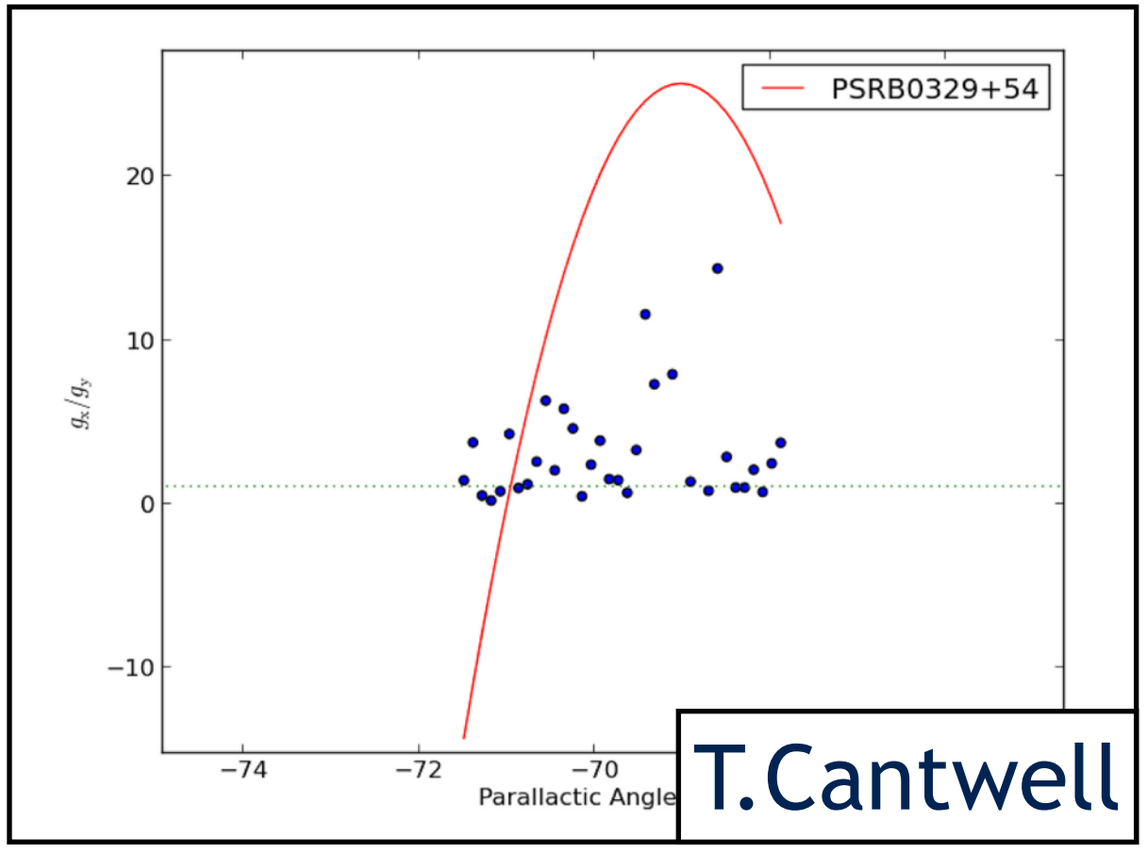
Vacca

Task 3-Creating Q & U models from data

$$V_{XX} = I + Q_\Psi$$
$$V_{YY} = I - Q_\Psi \qquad \text{where} \quad Q_\Psi = Q\cos 2\Psi + U\sin 2\Psi$$

$$\frac{g'_X}{g'_Y} = \left(\frac{g_X}{g_Y}\right)\left(1 - 2Q_\Psi/I\right)^{0.5}$$

- Work was done on isolating the gains of the pulsar.
- Also a start was made on the coding for the Q and U fitting.



T.Cantwell

Task 4-Extracting calibration parameters

- Successfully created a script that models parmdb tables which contain gain values that have D-terms.
- A second script takes as input a factor that it multiplies to the beam-Jones to generate the D-terms.
- Model datasets have been generated and will be tested in next busy week.

Further work

- Future work in the next calibration busy week will continue this work and investigate the effects of facet calibration has on polarisation.
- Next busy week will take place early next year.
- In the meantime, a polarisation analysis meeting will take place in November at ASTRON