Recap of 4th Polarisation Busy Week

David Mulcahy on behalf
of the Magnetism Key Science Project

LOFAR Magnetism
Key Science Project

Restructured polarisation busy weeks

- Revived polarisation busy weeks focusing ONLY on polarisatio
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.

4th Polarization calibration busy week

Took place from the 22-24th April based at the University of Manchester but took place mostly online
6 participants with several more online for discussions

Therese Cantwell (University of Manchester)
Alex Clarke (University of Manchester)
Andreas Horneffer (MPIfR)
Henrik Junklewitz (University of Bonn)
David Mulcahy (University of Manchester)
Blazej Nikiel-Wroczynski (University of Krakow)

Special thanks to
Marco Iacobelli and Science Support and Andre Offringa

Task 1

Tests on Polarisation with Prefactor

Calibrate fields with known polarized sources with prefactor and "the normal" way, run RM-synthesis on both datasets and then compare the results.

—> Andreas Horneffer and Blazej Nikiel-Wroczynski

Task 2

Imaging tests on Polarisation with WSclean

Testing WS clean polarisation features on modelled data and observed data and testing reliability of polarisation outputs

—> Therese Cantwell and David Mulcahy

Task 3

Implementing RM Selfcal

Working on the implementation of M.Brentjens RM self cal method

—> Alex Clarke and Henrik Junklewitz

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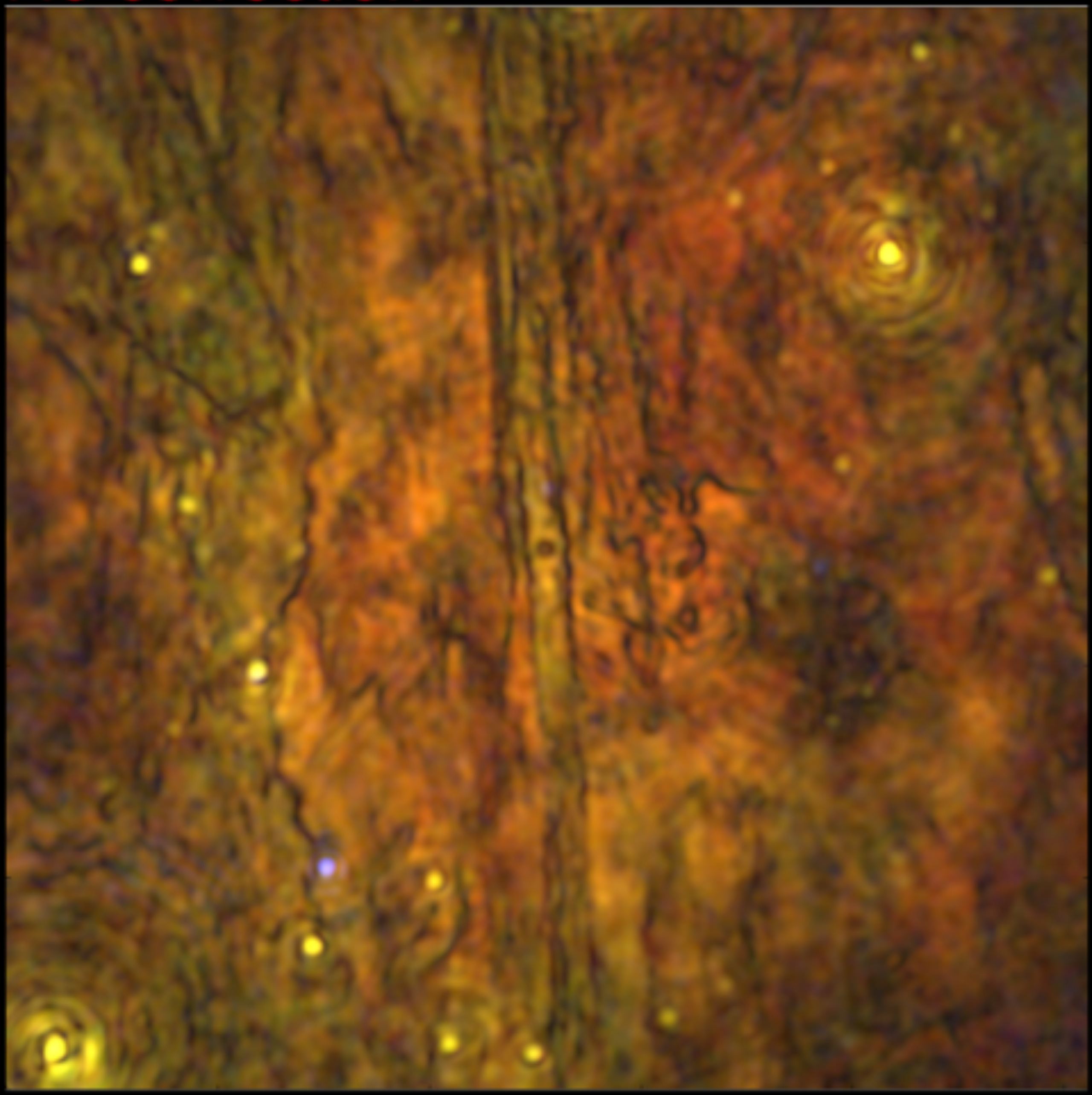
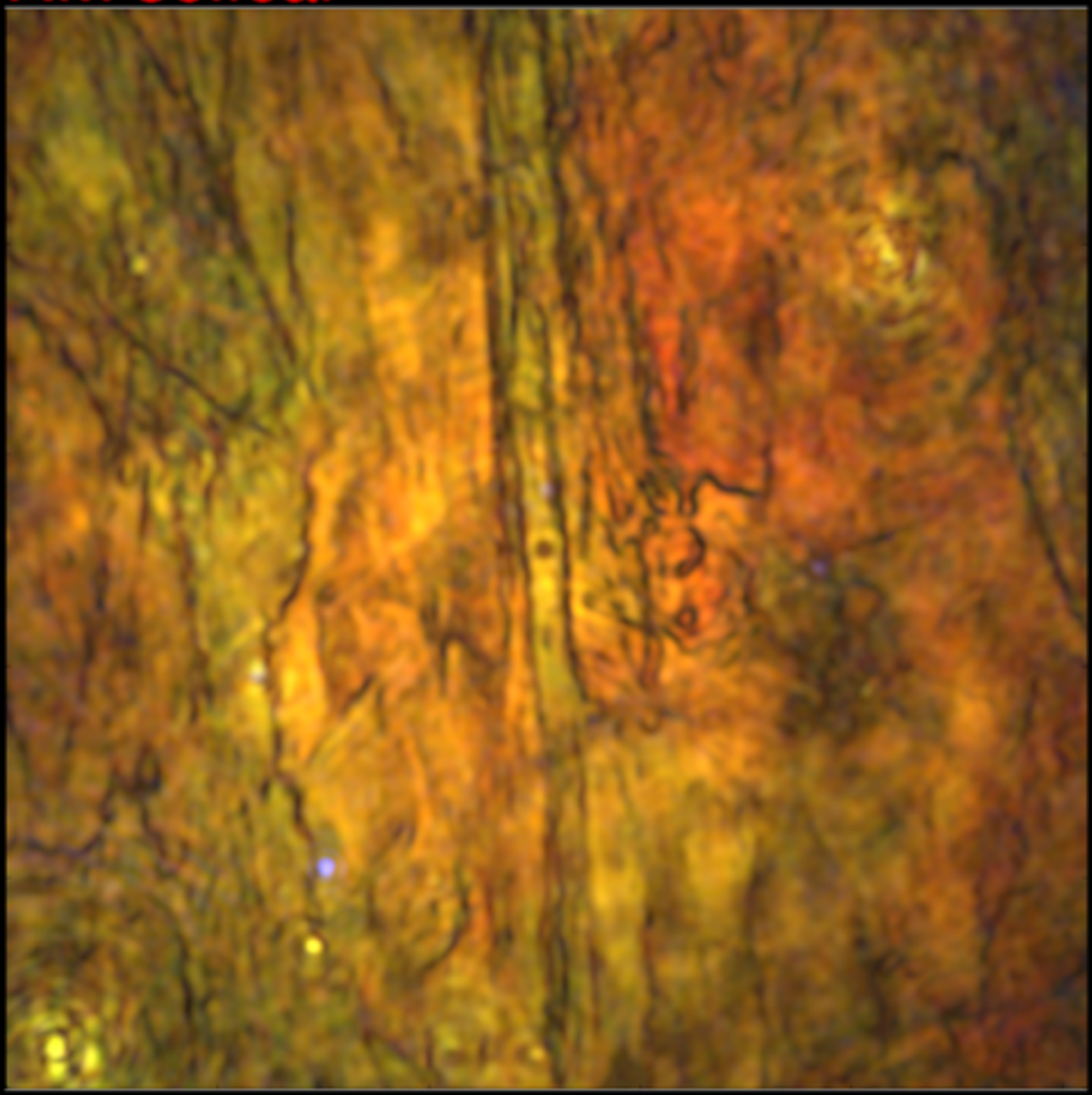
No correction



RM selfcal



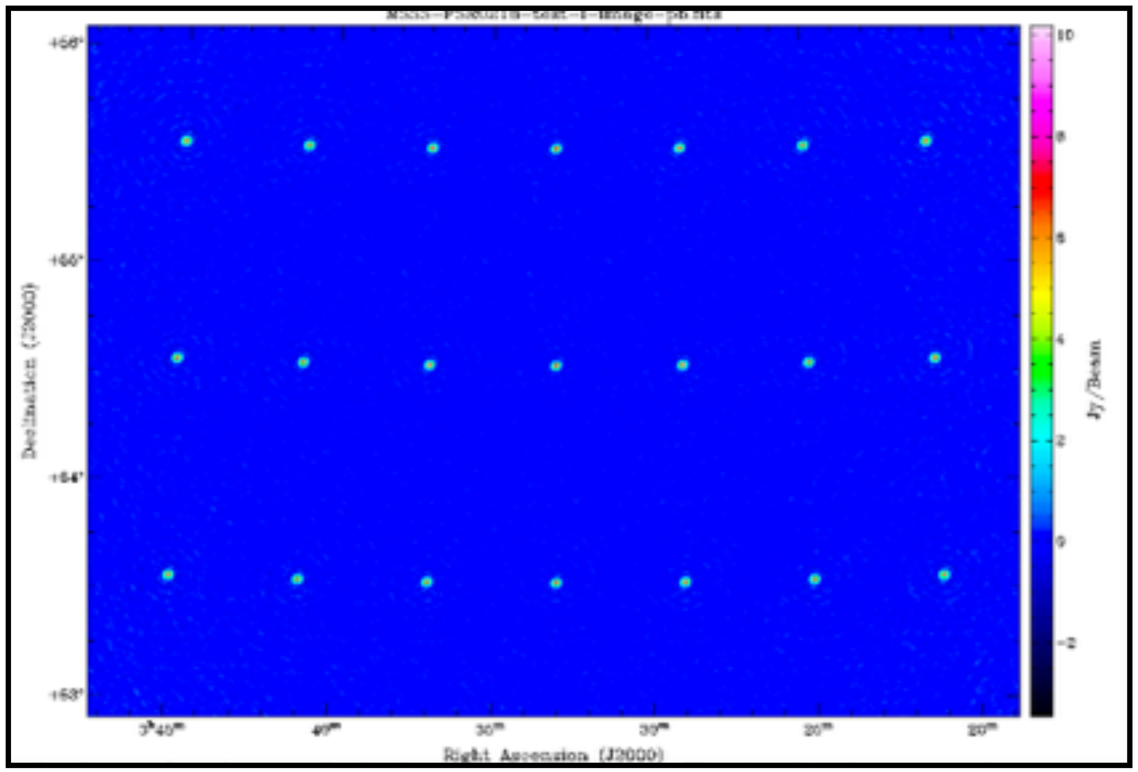
Courtesy of M. Brentjens

Testing WSclean with model data

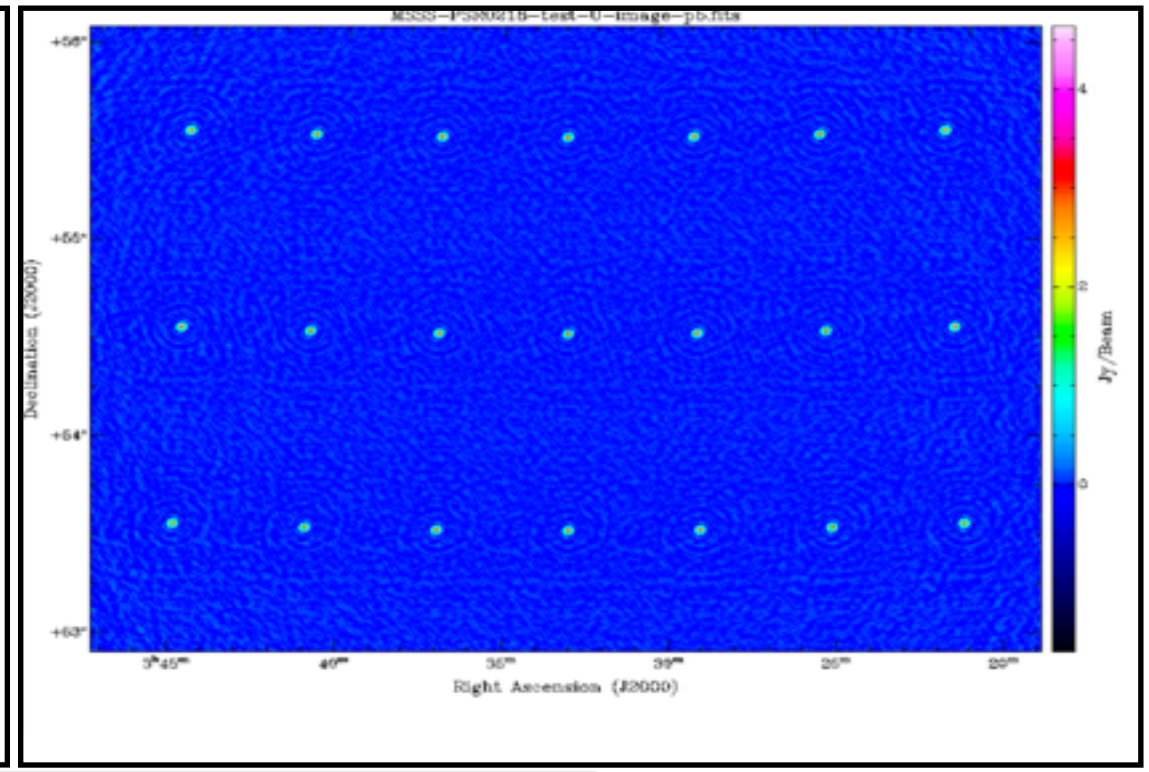
50% degree polarisation and 33 degree polarisation angle

phase_center1, POINT, 03:36:59.368, +54.34.43.57, 10.0, 2.033, 4.56, 0, , [-0.0, -0.0]

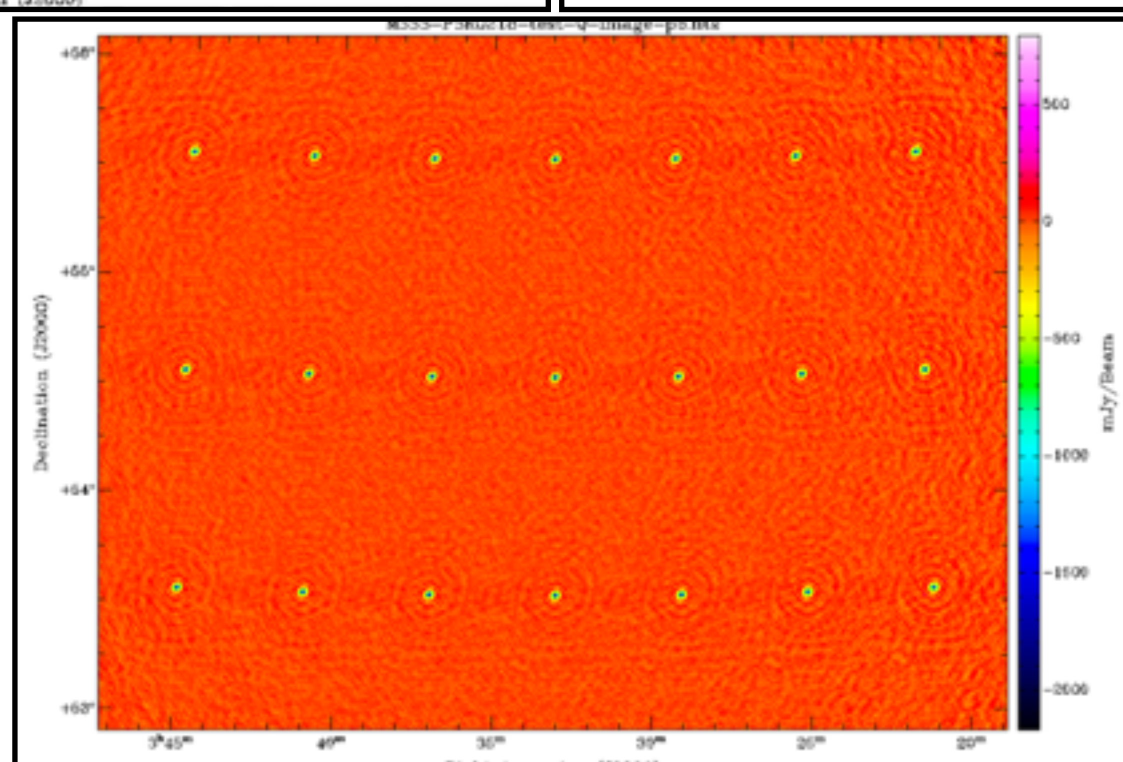
Stokes I



Stokes U

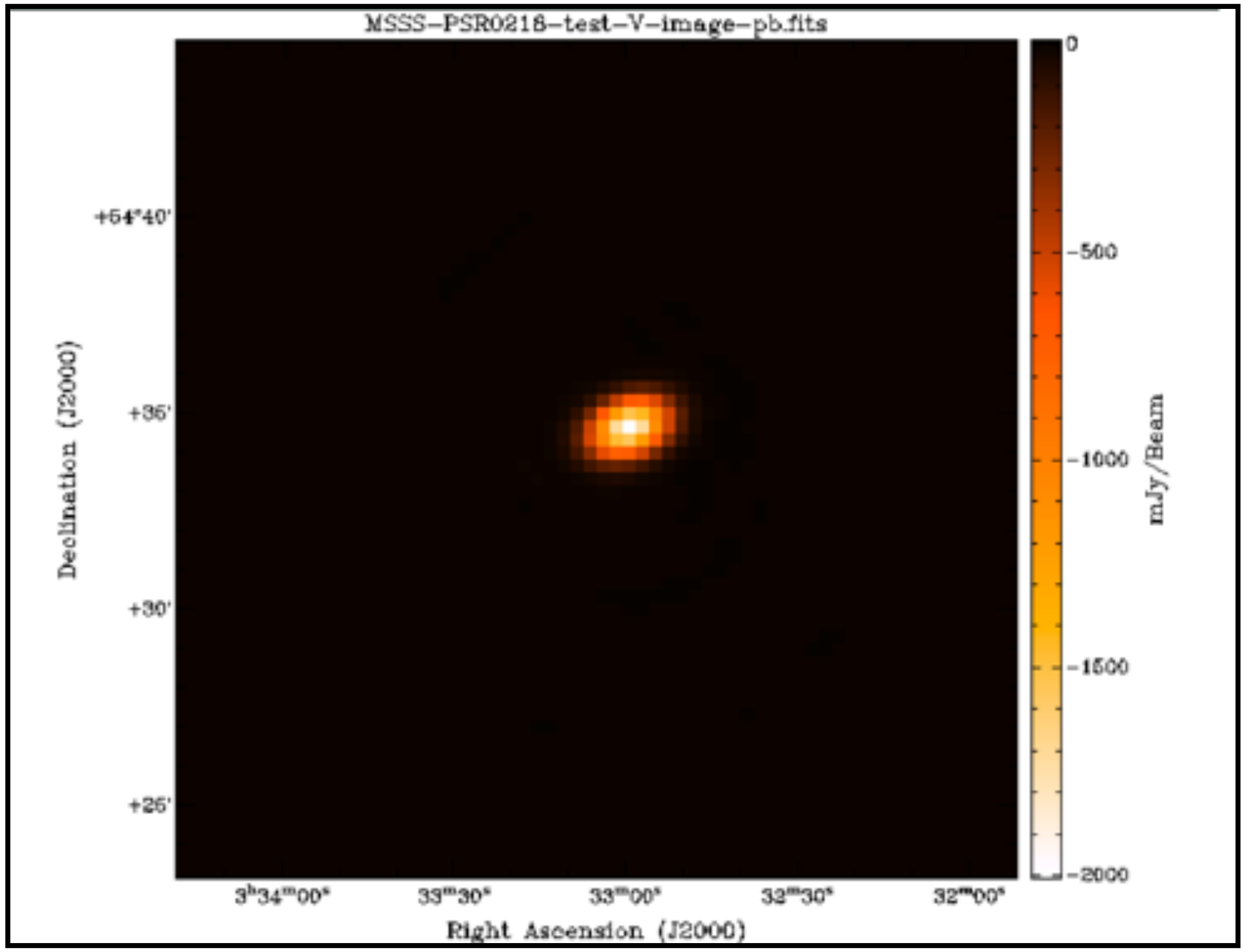


Stokes Q



X/Y dipole swap

phase_center, POINT, 03:32:59.368, +54.34.43.57, 10.0, 2.033, 4.56, 2.0, , [-0.0, -0.0]

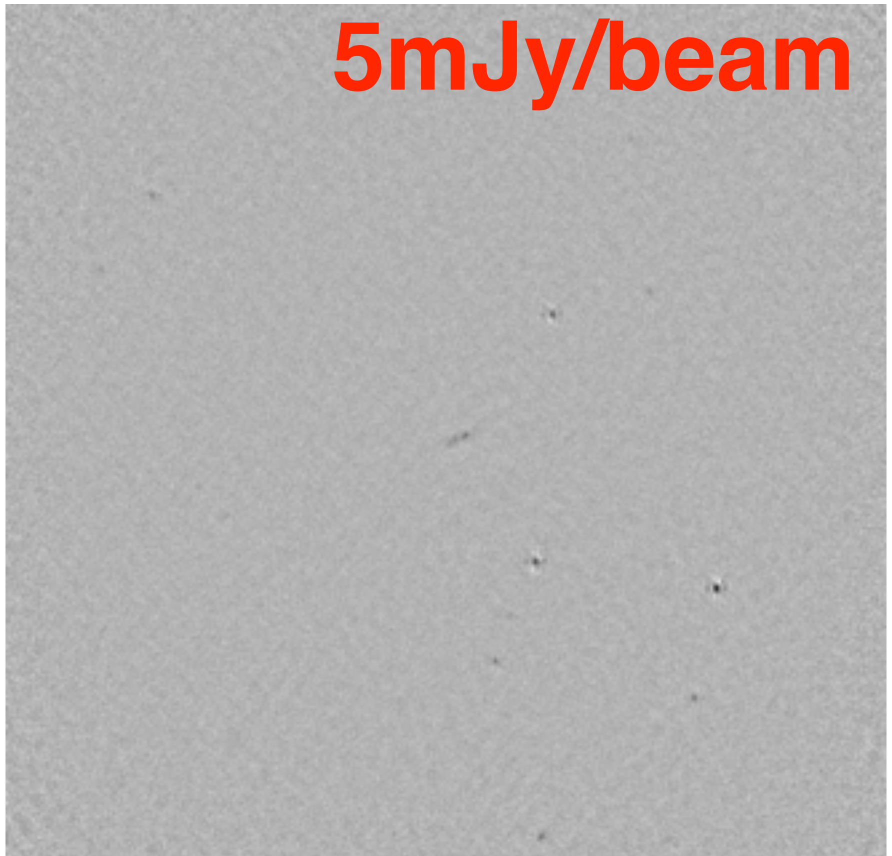


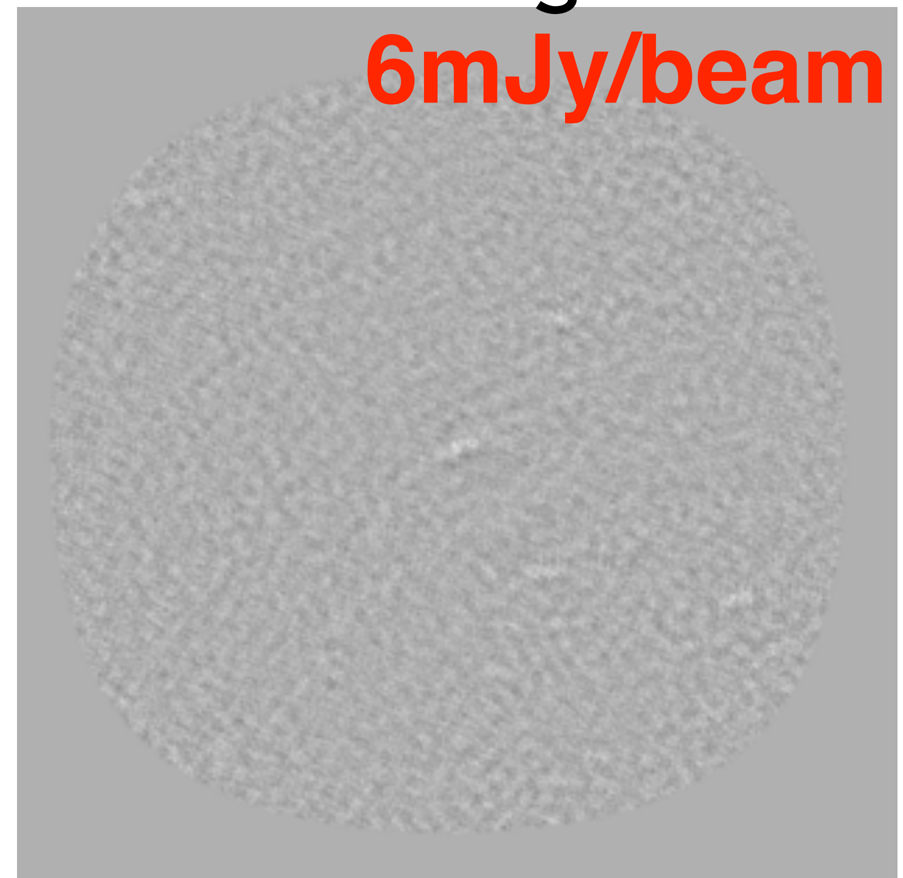
Stokes V shown above comes out as -2 Jy rather than +2 Jy. Consistent with a X/Y swap.

Comparison between imagers with real data

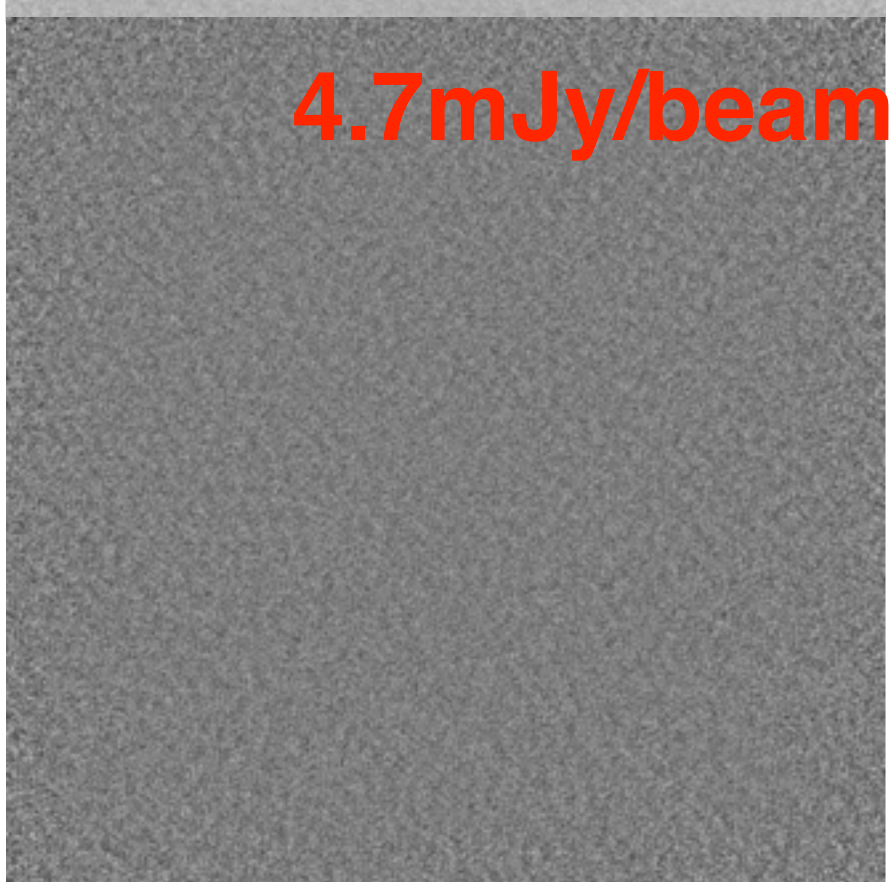
WSCLEAN | AWimager

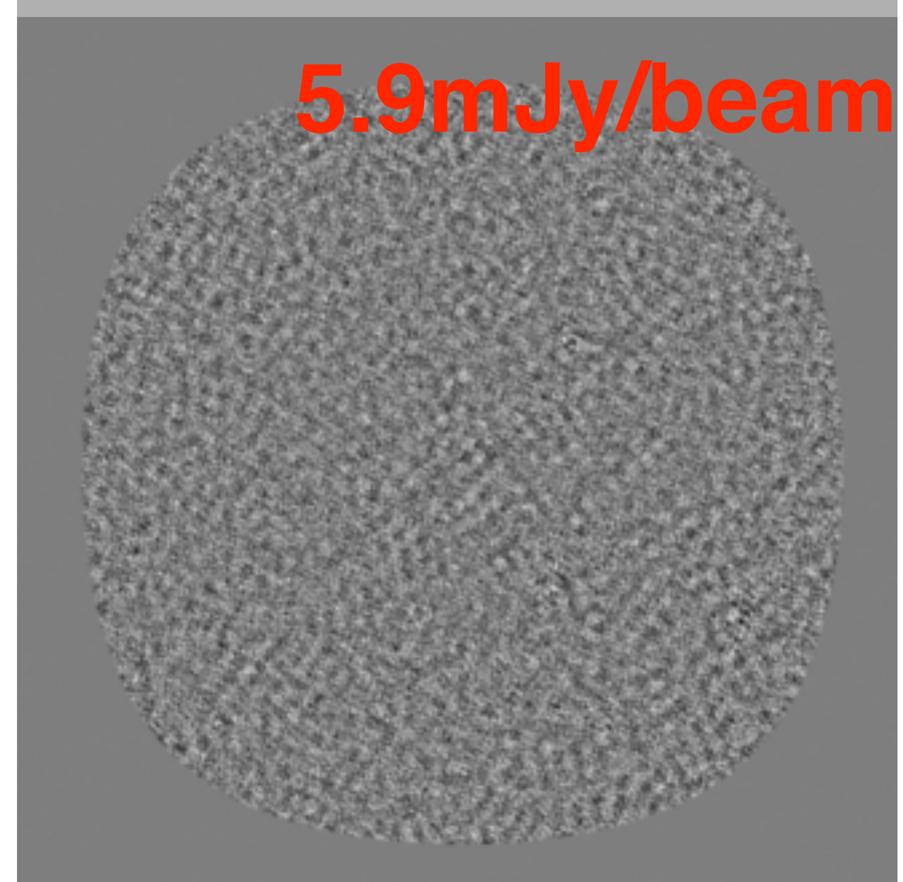
Stokes Q





Stokes U



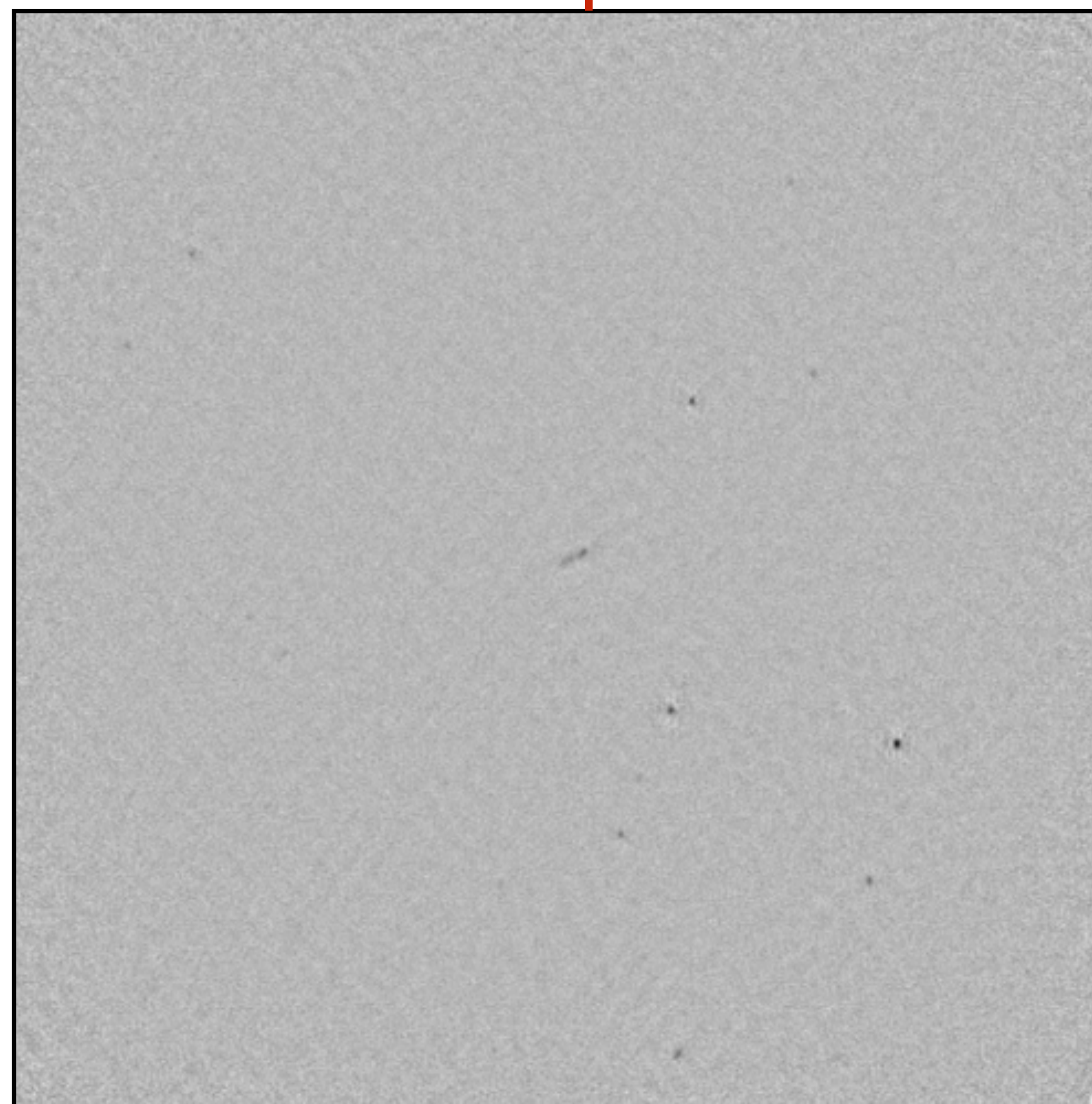


Testing advanced polarised options in WSclean

-joinpolarizations -joinchannels -squared-channel-joining
Cleaning is performed in sum over channels of Q_ch^2 + U_ch^2.

No extra options

Extra options



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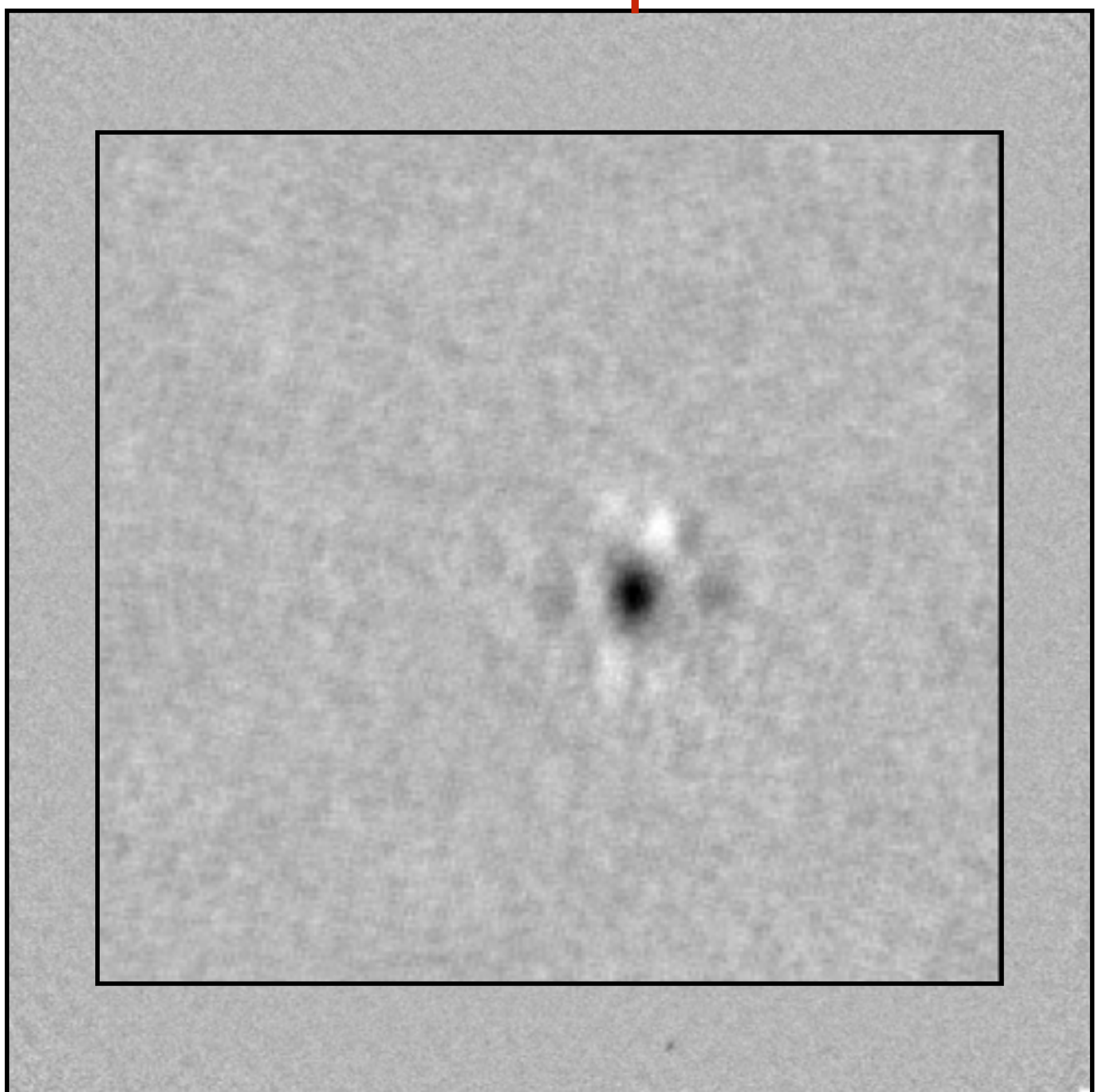

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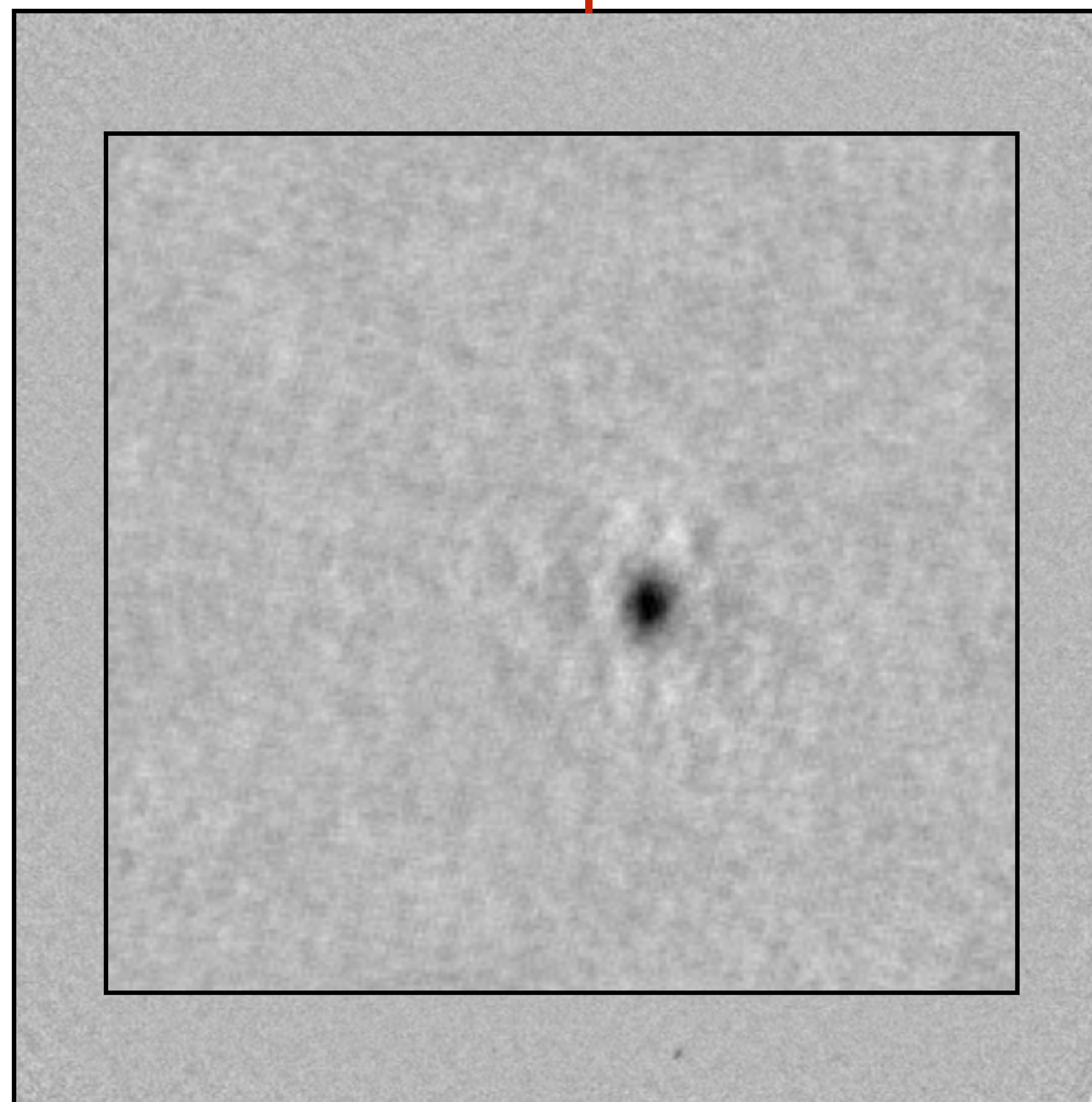
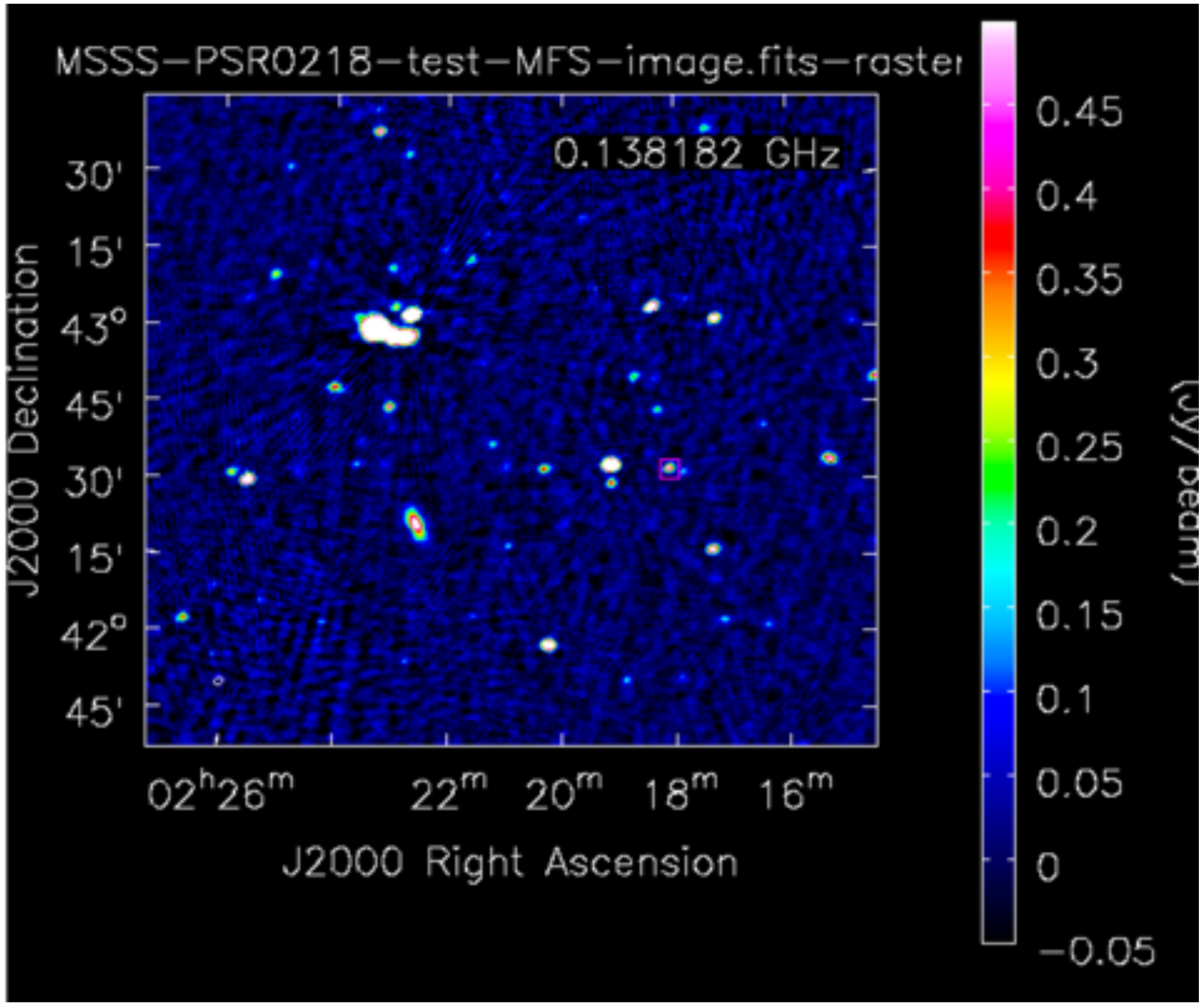


Testing prefactor on MSSS data

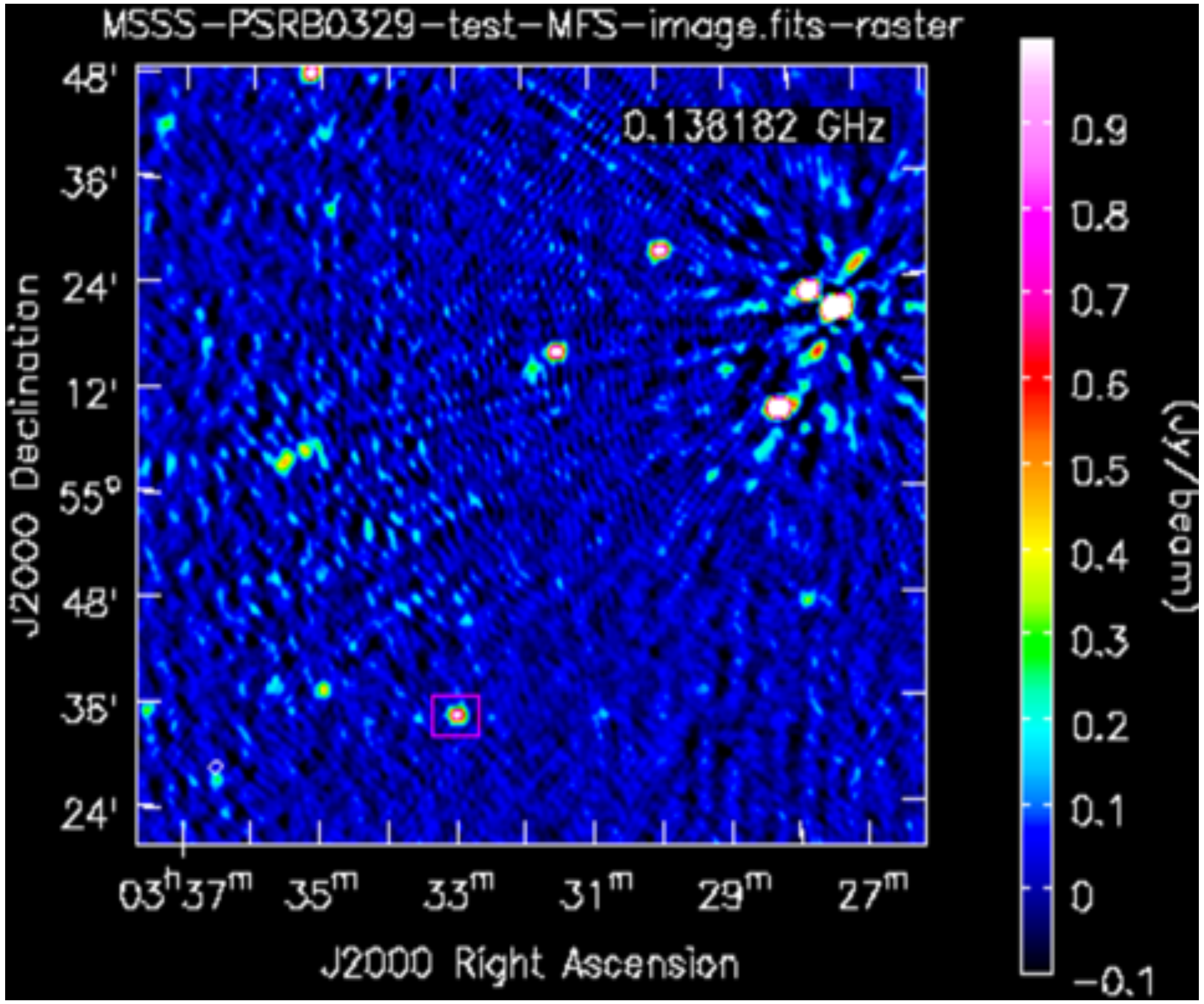
Test on two pulsars with well known Faraday depth with MSSS data.

Pass MSSS data through PreFactor pipeline and compare to existing already calibrated MSSS data

PSRJ0218+4232



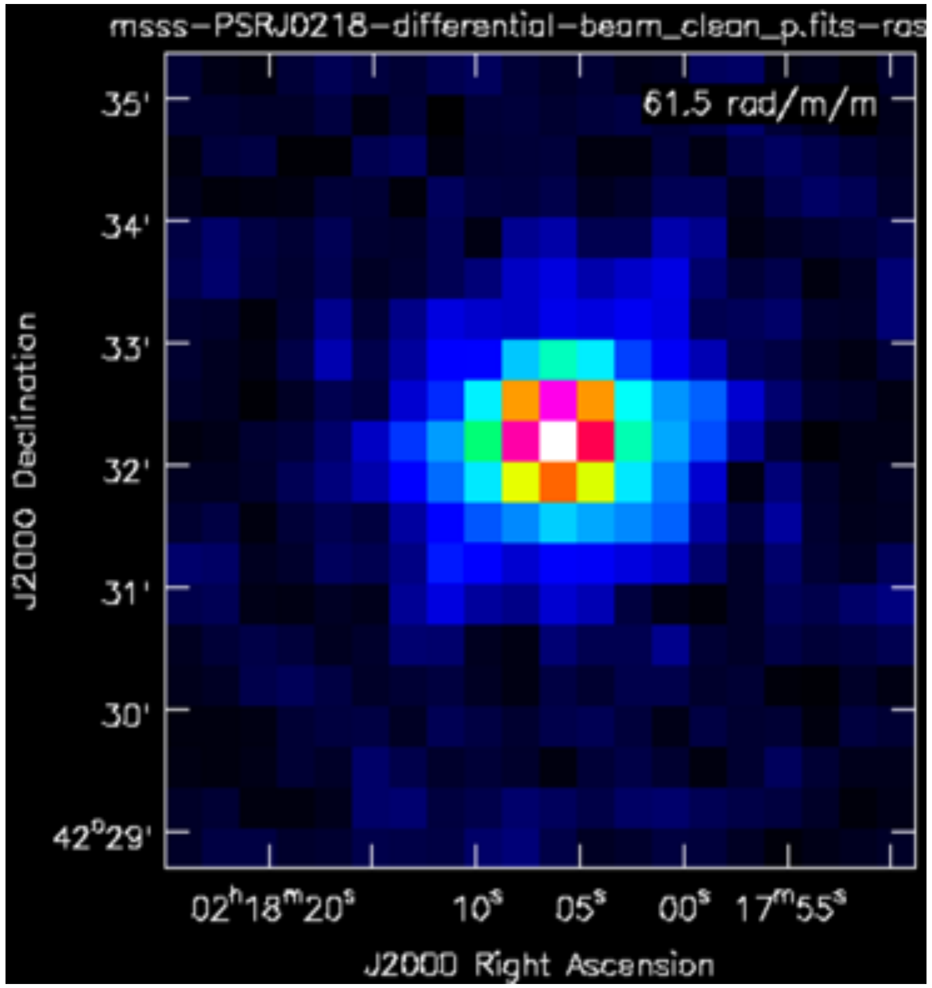
PSR B0329+54



PSRJ0218+4232

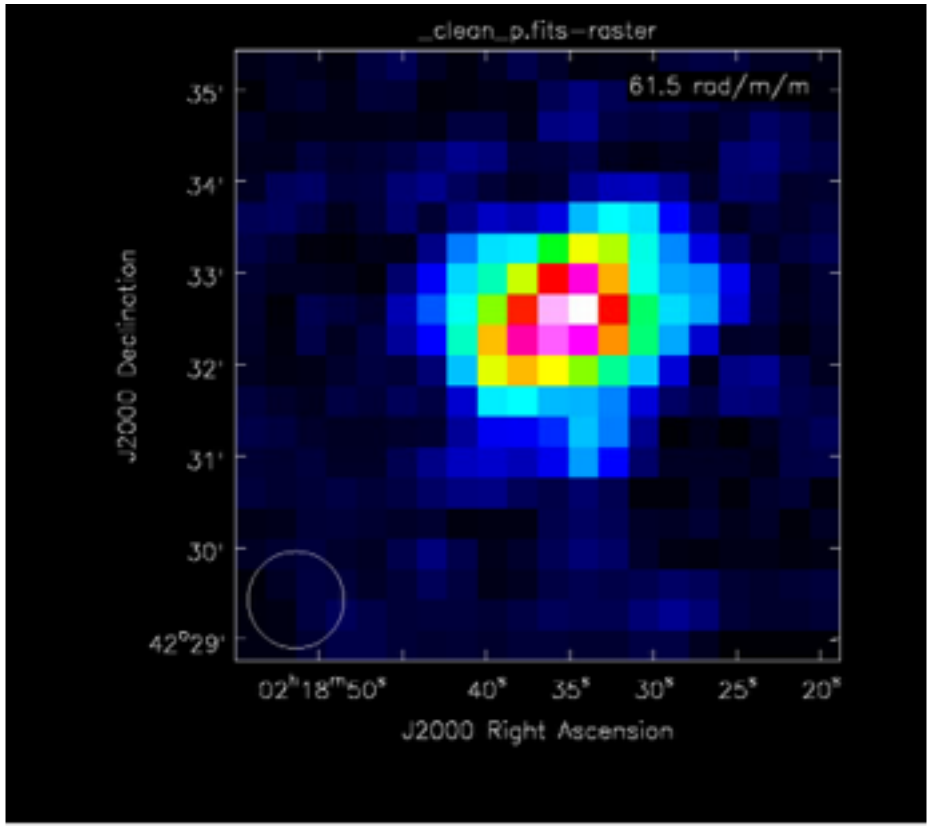
PreFactor

Faraday depth +61.5 rad/m^2
Peak polarized flux (brightest pixel) is: 0.362 Jy, i.e. a fractional polarization of 61%



Normal MSSS data

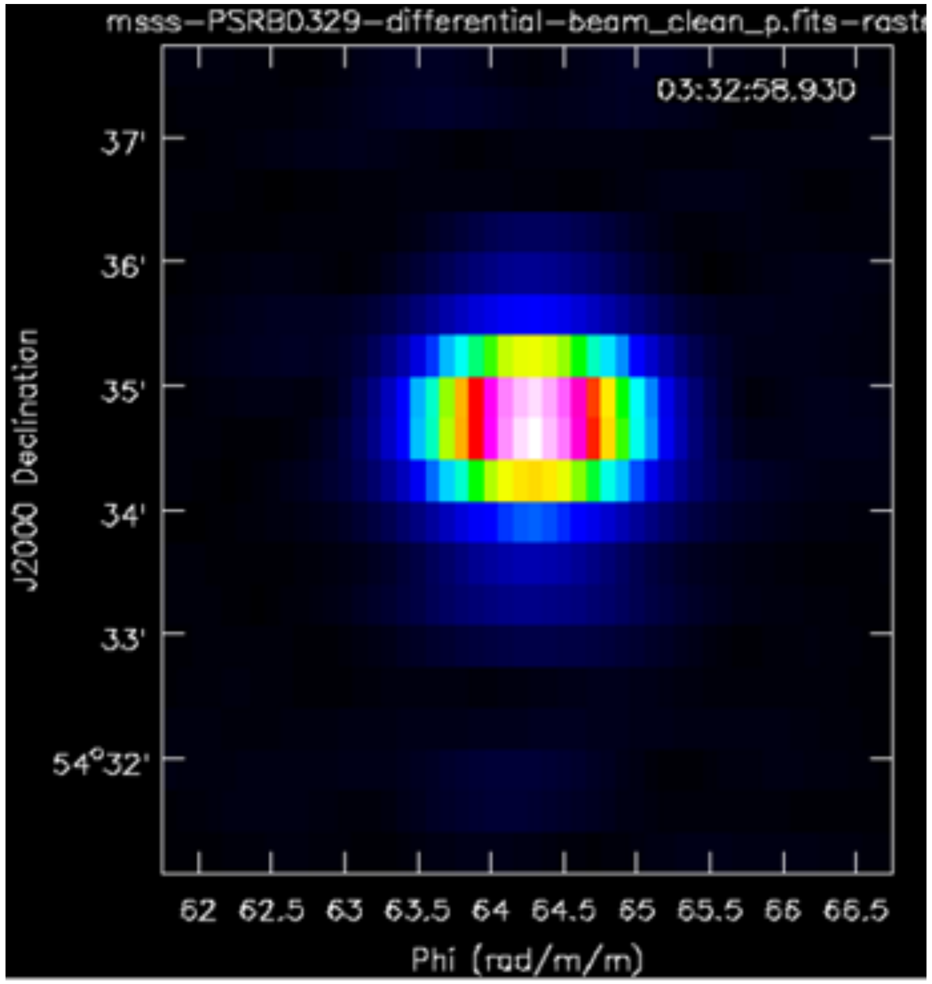
Faraday depth +61.5 rad/m^2
Peak polarized flux (brightest pixel) is: 0.323 Jy, i.e. a fractional polarization of 49.5%



PSR B0329+54

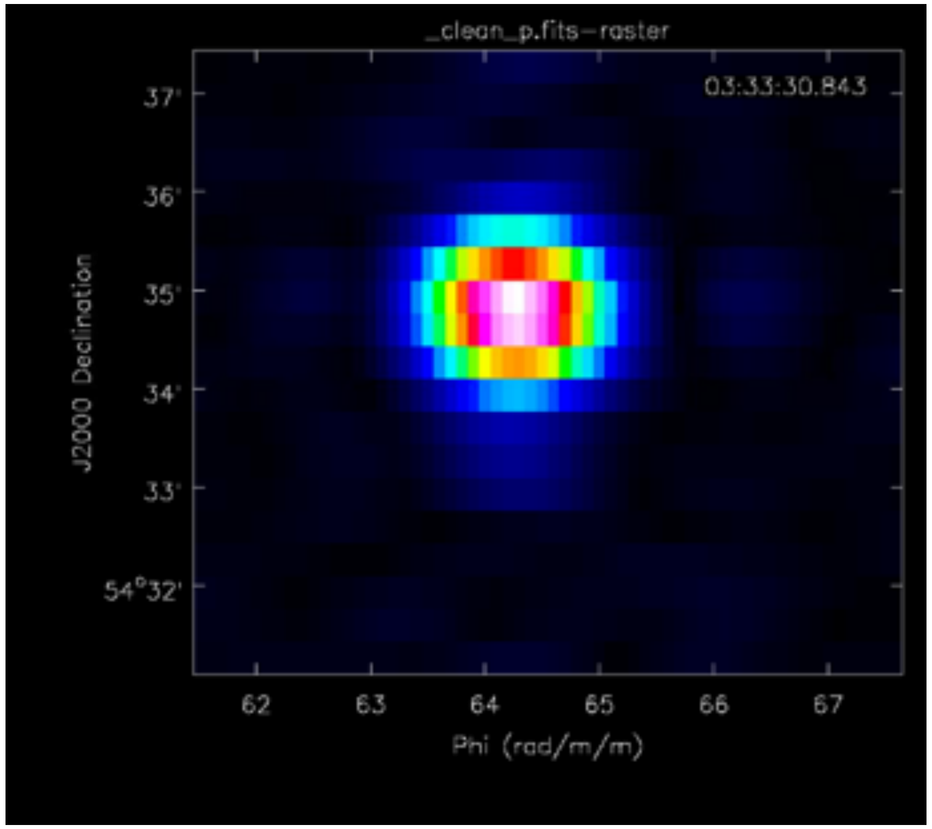
PreFactor

Faraday depth +64.3 rad/m^2
Peak polarized flux (brightest pixel) is: 0.34 Jy, i.e. a fractional polarization of 24%



Normal MSSS data

Faraday depth +64.3 rad/m^2
Peak polarized flux (brightest pixel) is: 0.322 Jy, i.e. a fractional polarization of 23%



Stokes V emission from PSR B0329+54

PreFactor

3C source ->Instrumental polarization +0.5%
other sources have about the same level of fractional polarization.
B0329+54
-0.16 Jy Stokes-V ->12% fractional circular polarization
negative Stokes-V -> sign flip caused by WSClean

Normal MSSS data

-0.133 Jy Stokes-V -> 9% fractional circular polarization.

Summary of findings from Busy Week

- WSclean outputs better polarisation images compared to awimager especially when advanced polarisation commands are used.

- WSclean gives reversed Faraday depth due to the incorrect X/Y definition. Andre has corrected this in wsclean and will be implemented in next version. Will test this at next busy week.

- No sign that prefactor negatively affects the polarized signal.

- Results from prefactor seem to be better calibrated than the “normal” MSSS data,we see a higher polarized fraction in the data out of prefactor.