

Polarization Busy Week & Commissioning Progress

Michael Bell
on behalf of the MKSP

Introduction

- In this status update:
 - October polarization busy week observations of the pulsar J0218
 - Future observing/commissioning plans
- Polarization and RM Synthesis commissioning handled by
 - MKSP - <http://www.mpifr-bonn.mpg.de/staff/rbeck/MKSP/mksp.html>
 - DFG “Magnetisation of Interstellar and Intergalactic Media - The Prospects of Low-Frequency Radio Observations”

Pol. Busy Week Goals

- Familiarize new MKSP members (there are many) with LOFAR imaging procedures
- Test the current capabilities of LOFAR to do polarimetry (without any calibration...)
- Image a polarized source at known Faraday depth (i.e. RM)
 - Track changes in FD & stokes Q,U w/ time
 - Try to determine variation due to ionospheric changes (particularly at sunrise/set)

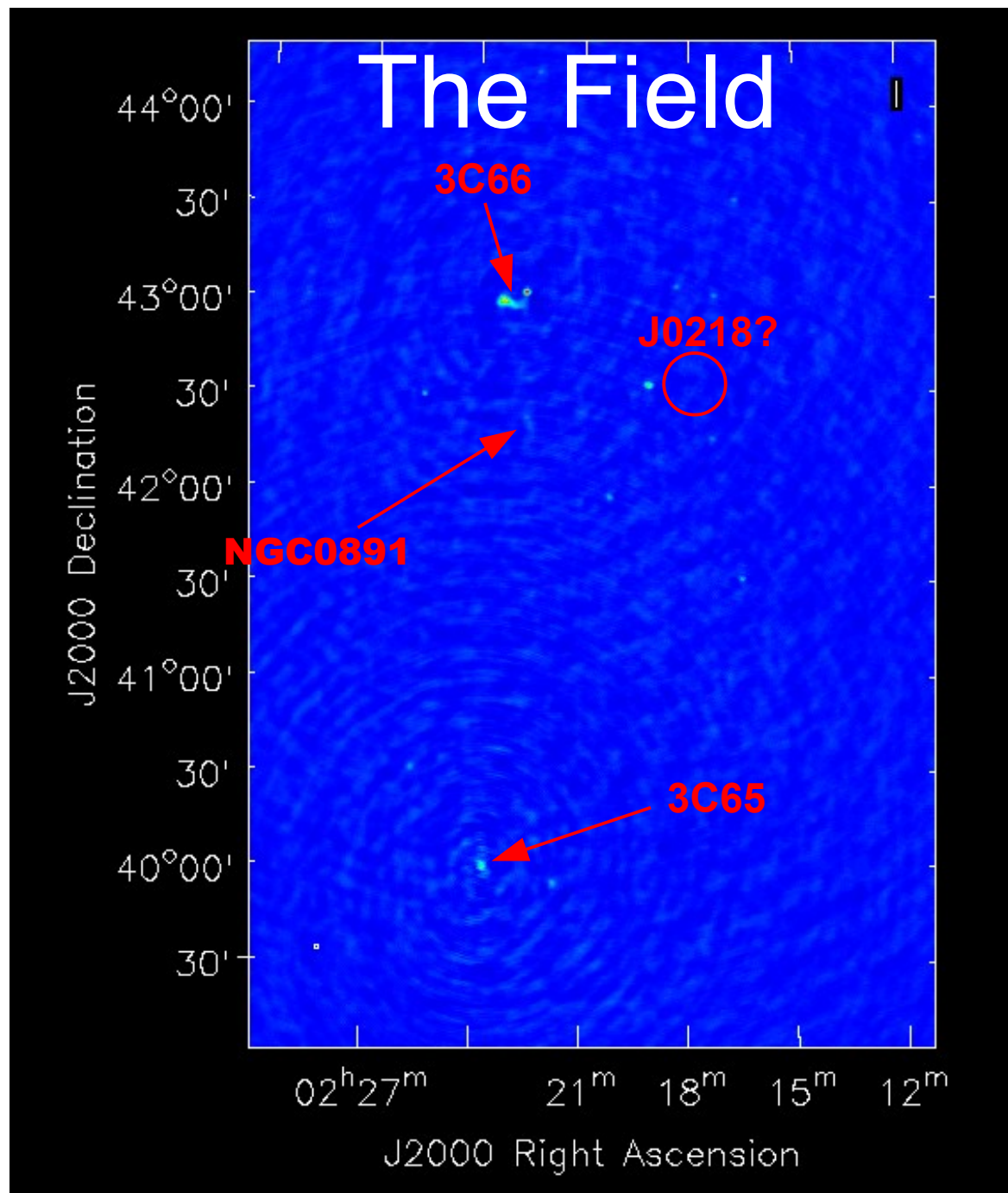
Participants

- Rainer Beck (MPIfR Bonn)
- Rene Giessuebel
- Andreas Horneffer
- Masaya Kuniyoshi
- Halime Mir Aghaee
- David Mulcahy
- Aris Noutsos
- Charlotte Sobey
- Michael Bell (MPA Garching)
- Henrik Junklewitz
- Alice Di Vincenzo (TLS Tautenburg)
- Matthias Hoef
- Jana Koehler
- Sandra Schumann
- Marco Iacobelli (Leiden)
- Carl Shneider
- Wojciech Jurusik (Jagiellonian, Cracow)
- Jongsoo Kim (Cambridge)
- Arpad Miskolczi (Ruhr Univ, Bochum)
- Carlos Sotomayor
- Emanuela Orru (Nijmegen)
- Rosita Paladino (Univ Innsbruck)
- Amrita Purkayastha (Argelander Bonn)
- Monica Trasatti
- Ger de Bruyn (ASTRON)
- Marijke Haverkorn
- George Heald
- Roberto Pizzo

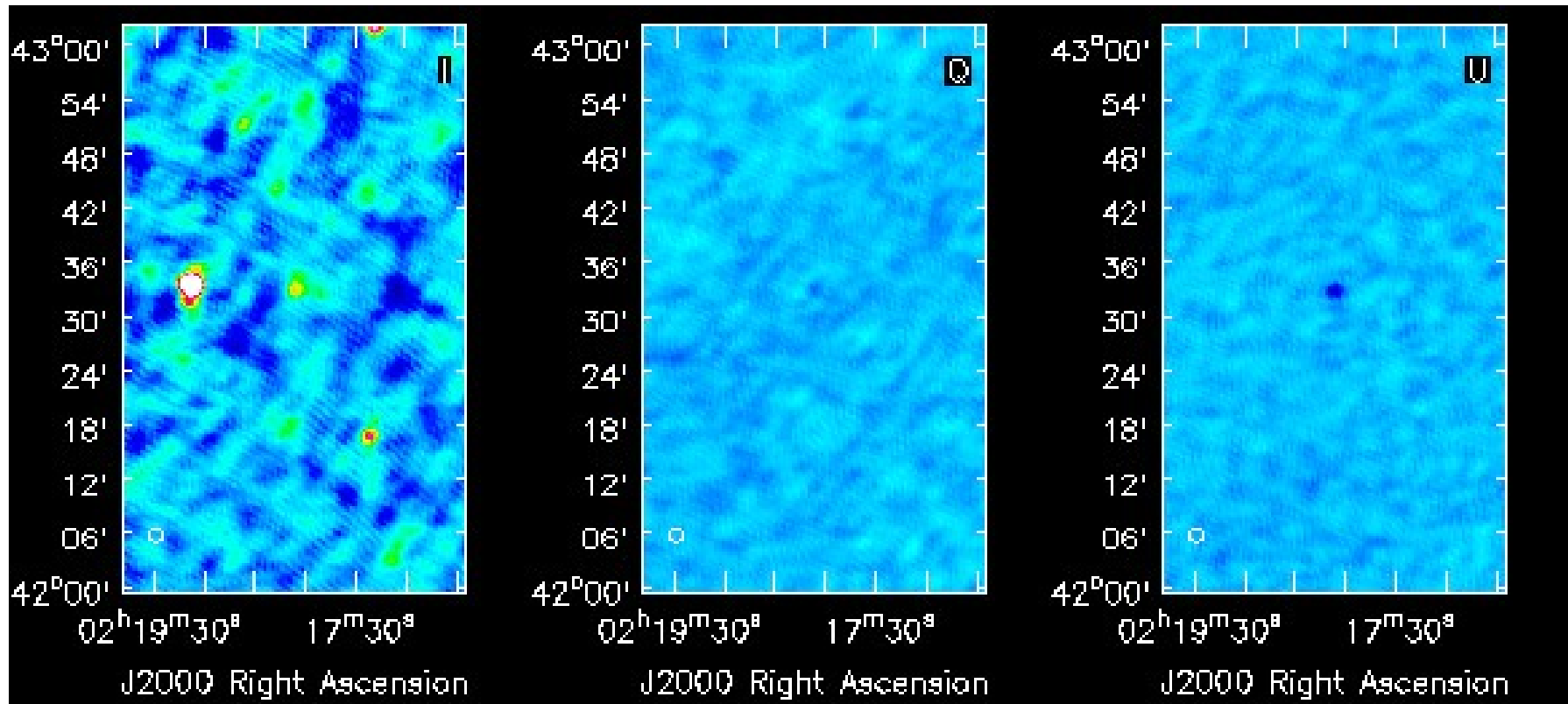
October 2010 Polarization BW

- 4 X 4 hour observations centered on J0218
 - RM = -61 rad/m²
- L2010_20905, 20907, 20909, & 20911 (16:30 to 8:45)
- HBA (110 – 190 MHz)
- Averaged channels to ~46 kHz (4 per subband)
 - Amounts to ~10-30 deg rotation across the channel
- The pulsar is in transit during 20907, this is where most of the work has been done so far
- Also made beamformed observation of 2 polarized pulsars

***For more results, see the FORUM thread titled
“Polarization Busy Week Oct 2010”
in the Magnetism KSP area***



Polarization imaged!

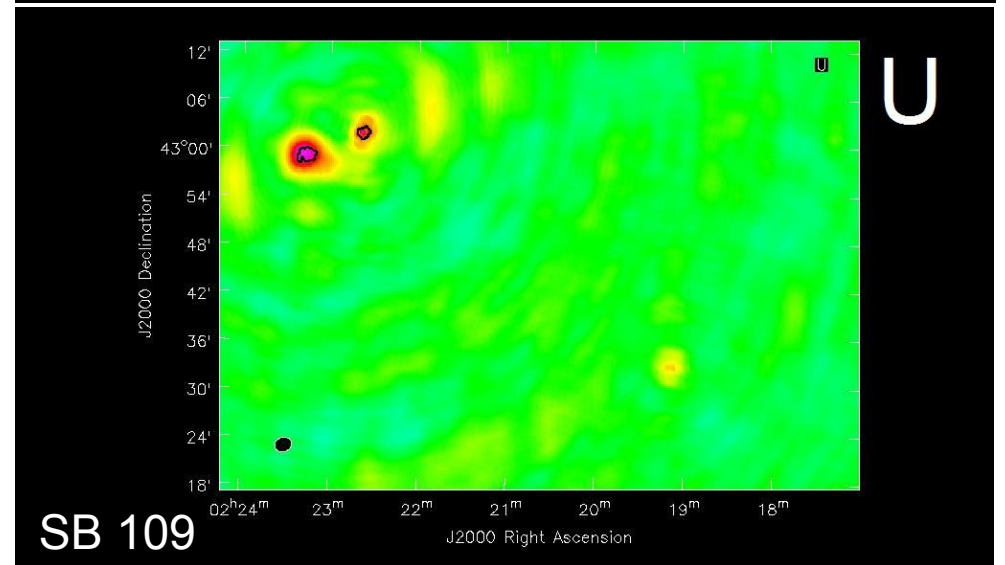
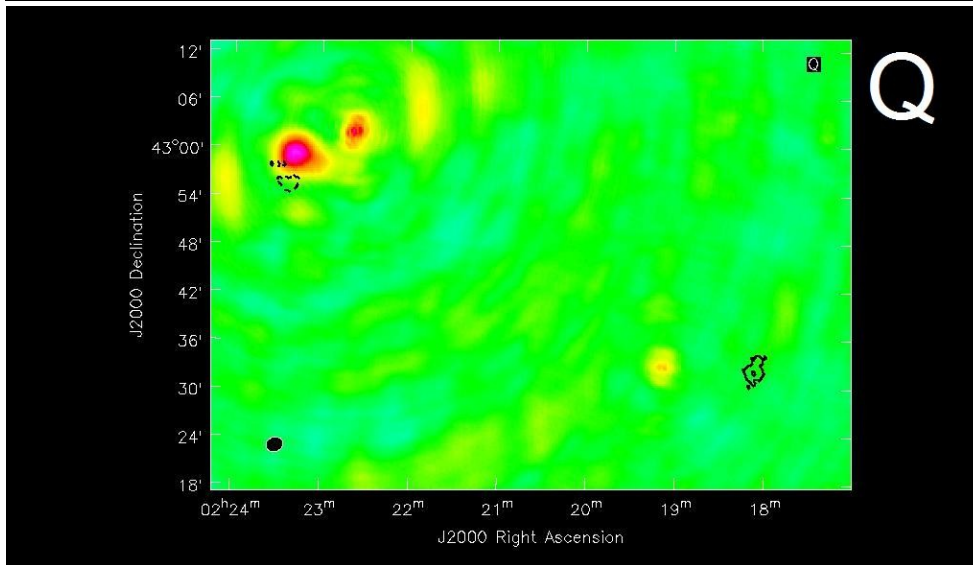
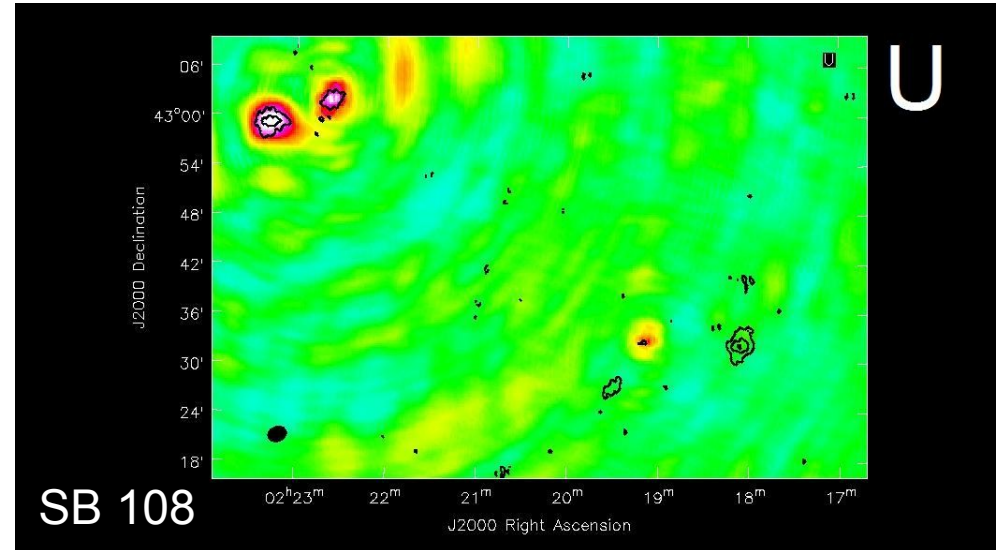
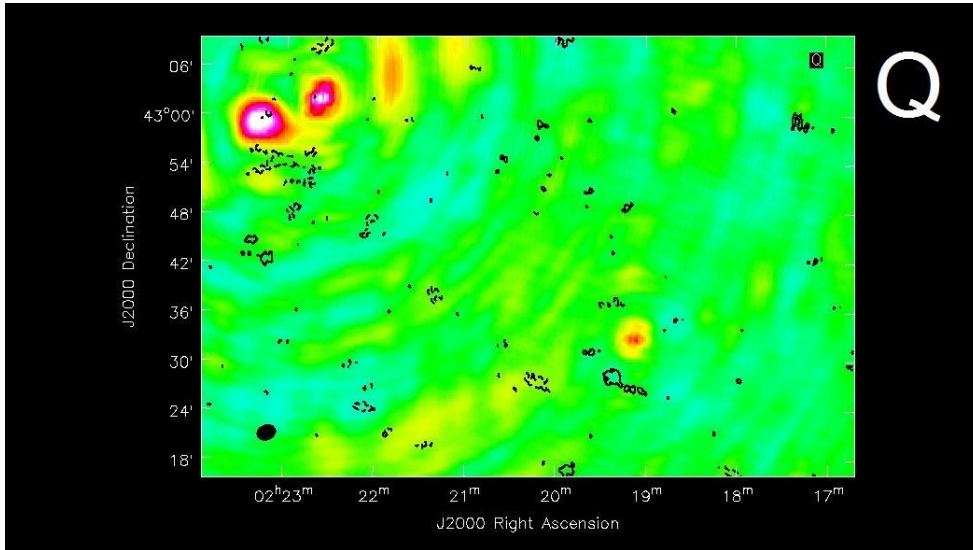


146.898 MHz Image courtesy Andreas Horneffer

Nearly everyone managed to image the pulsar in Q/U by the end of the week

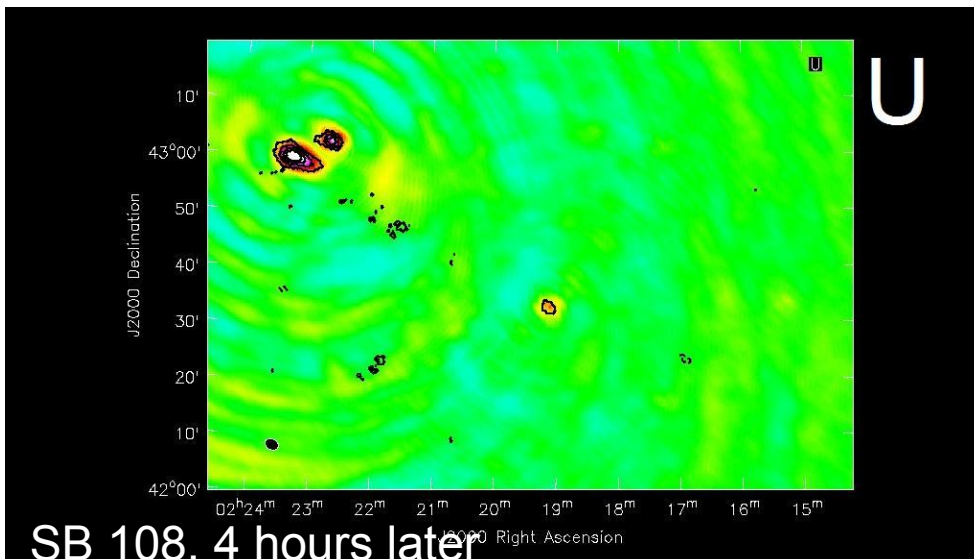
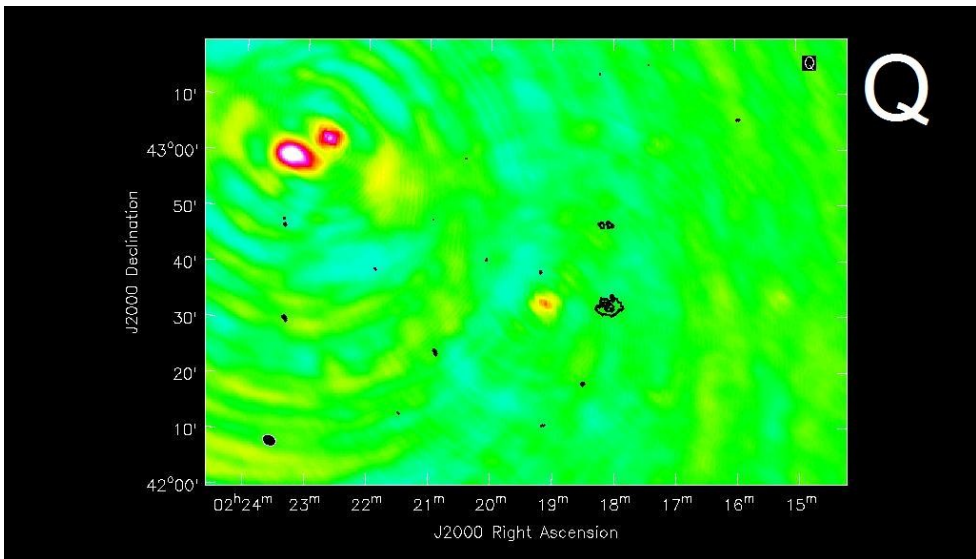
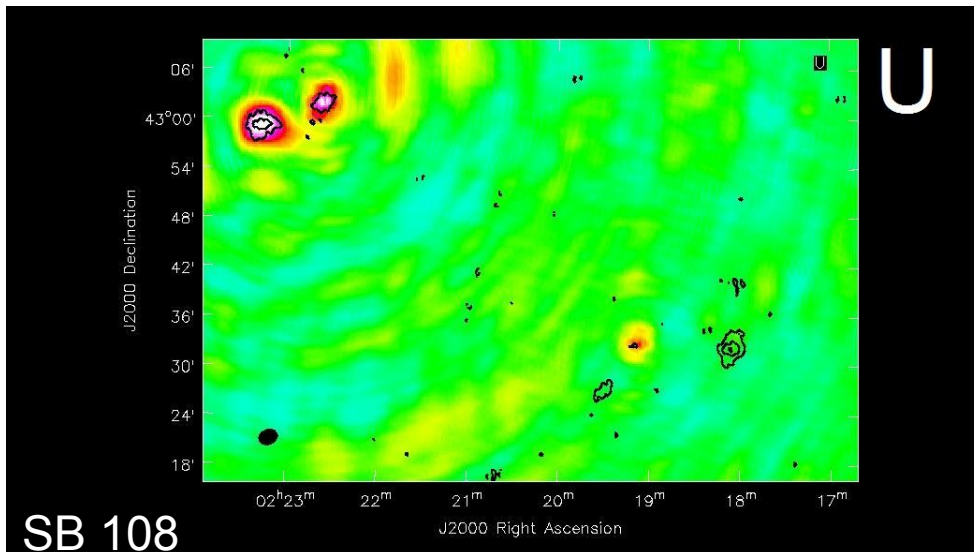
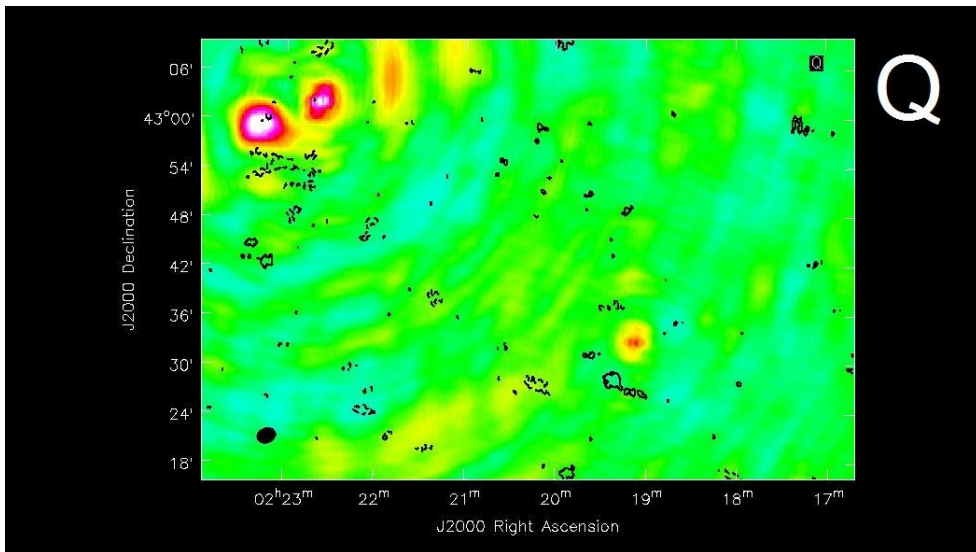
A few managed to find it in Stokes I as well

Subband Variability



Images courtesy of Halime Mir Aghaee

Time Variability

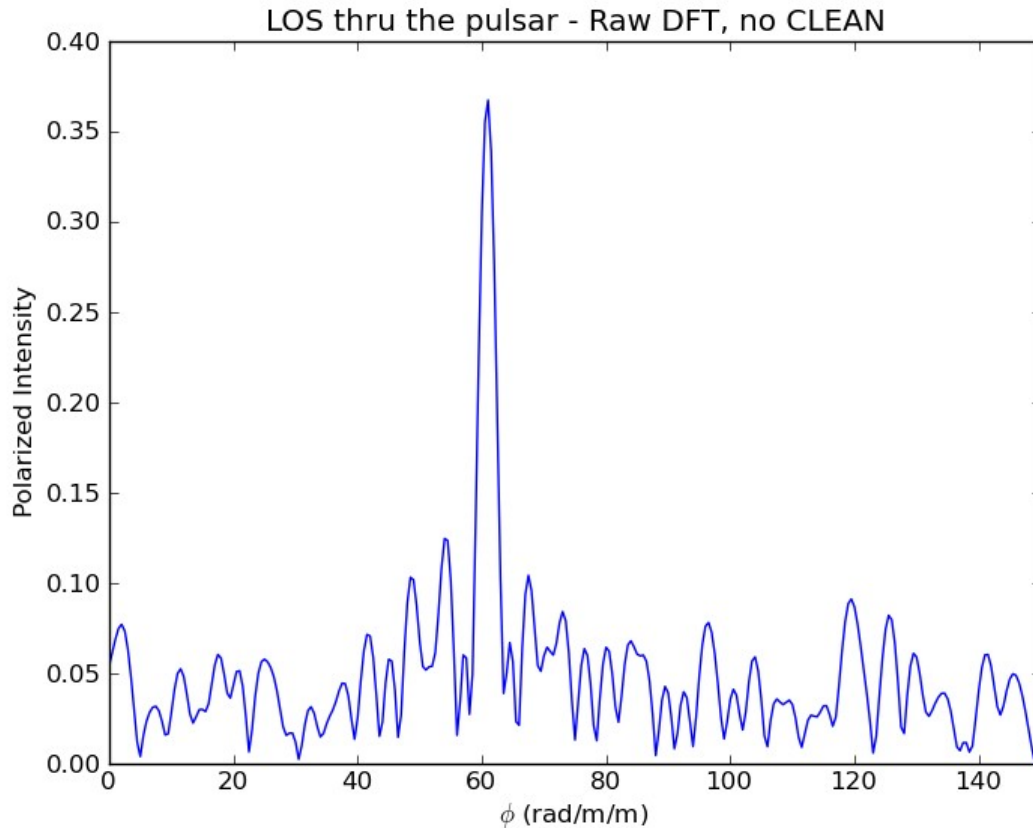


Images courtesy of Halime Mir Aghaee

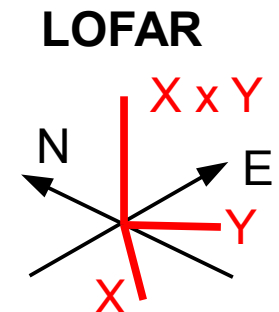
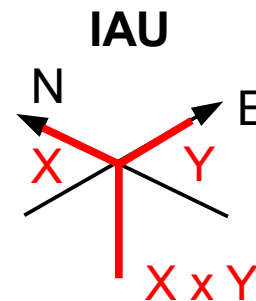
Imaging with the Pipeline

- Andreas Horneffer imaged 192 subbands using the pipeline
- First the pipeline was run with BBS using a sky model derived from a single subband
- Concatenate groups of subbands into a single Measurement Set (MS)
- Image these MSs & get a new skymodel for each group (skymodels do not include spectral variation)
- Run the pipeline separately for each group, with the different skymodels and a final imaging and fits-export stage

Faraday spectrum



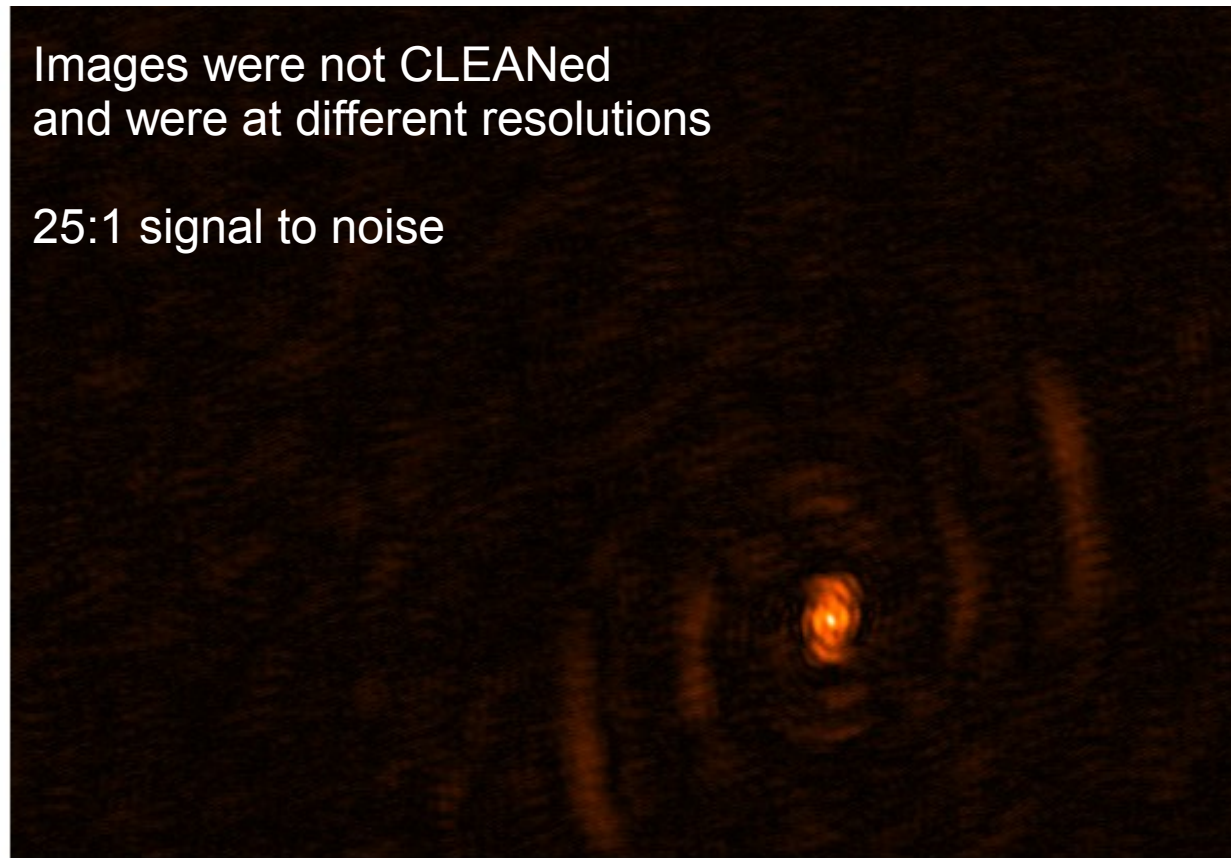
- RM measured to be 61 rad/m²
- But pulsar RM is known to be -61 rad/m²... Why the sign error?
- LOFAR dipoles not defined using IAU conventions
 - IAU: positive X points north, positive Y to the east
 - LOFAR: positive X points SW, Y points SE
 - Cross-products of these point in opposite directions... this is the issue?



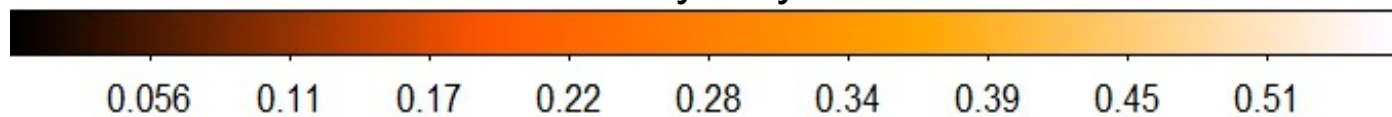
Polarized field at 61 rad/m²

Images were not CLEANed
and were at different resolutions

25:1 signal to noise

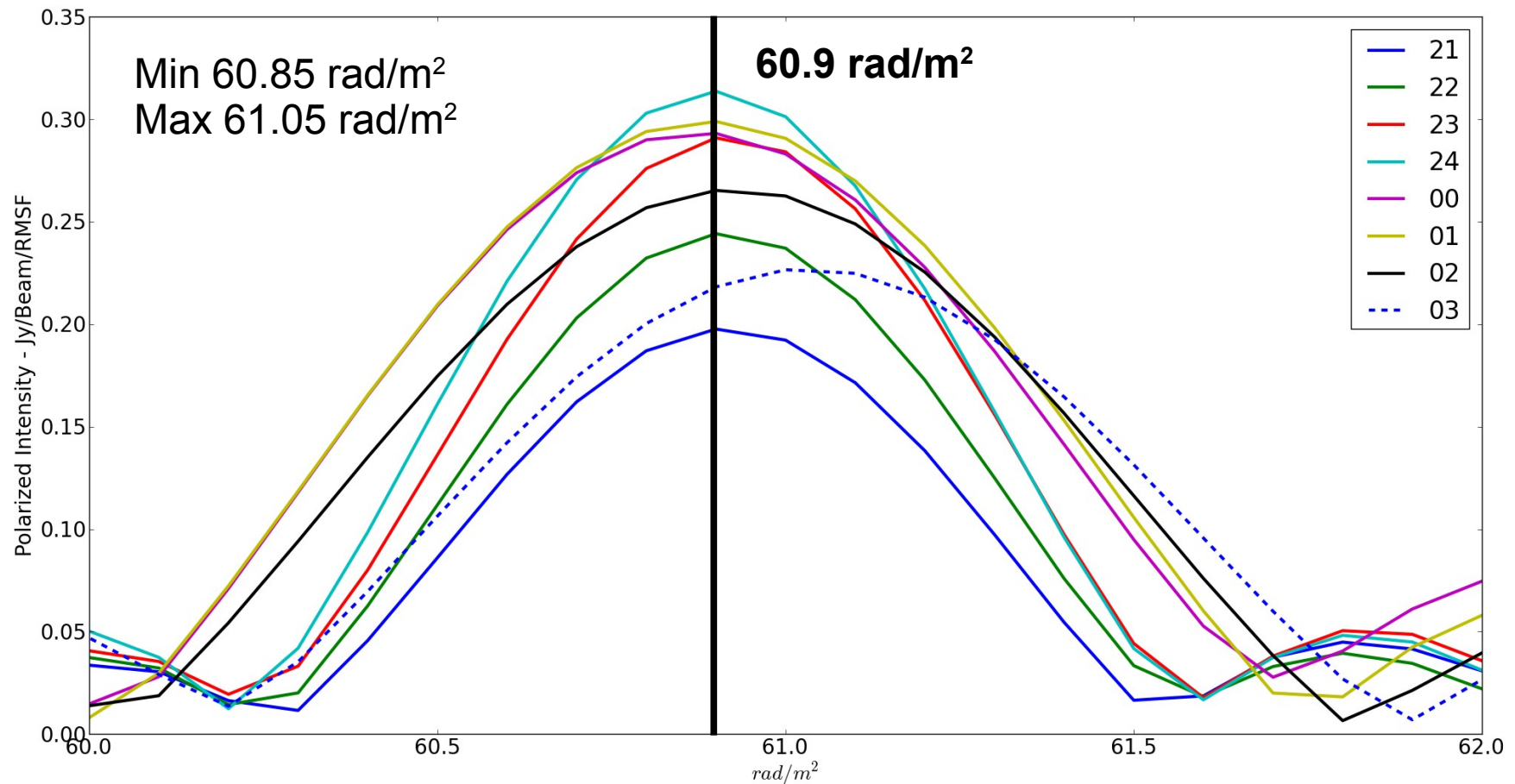


Polarized intensity – Jy/Beam/RMSF

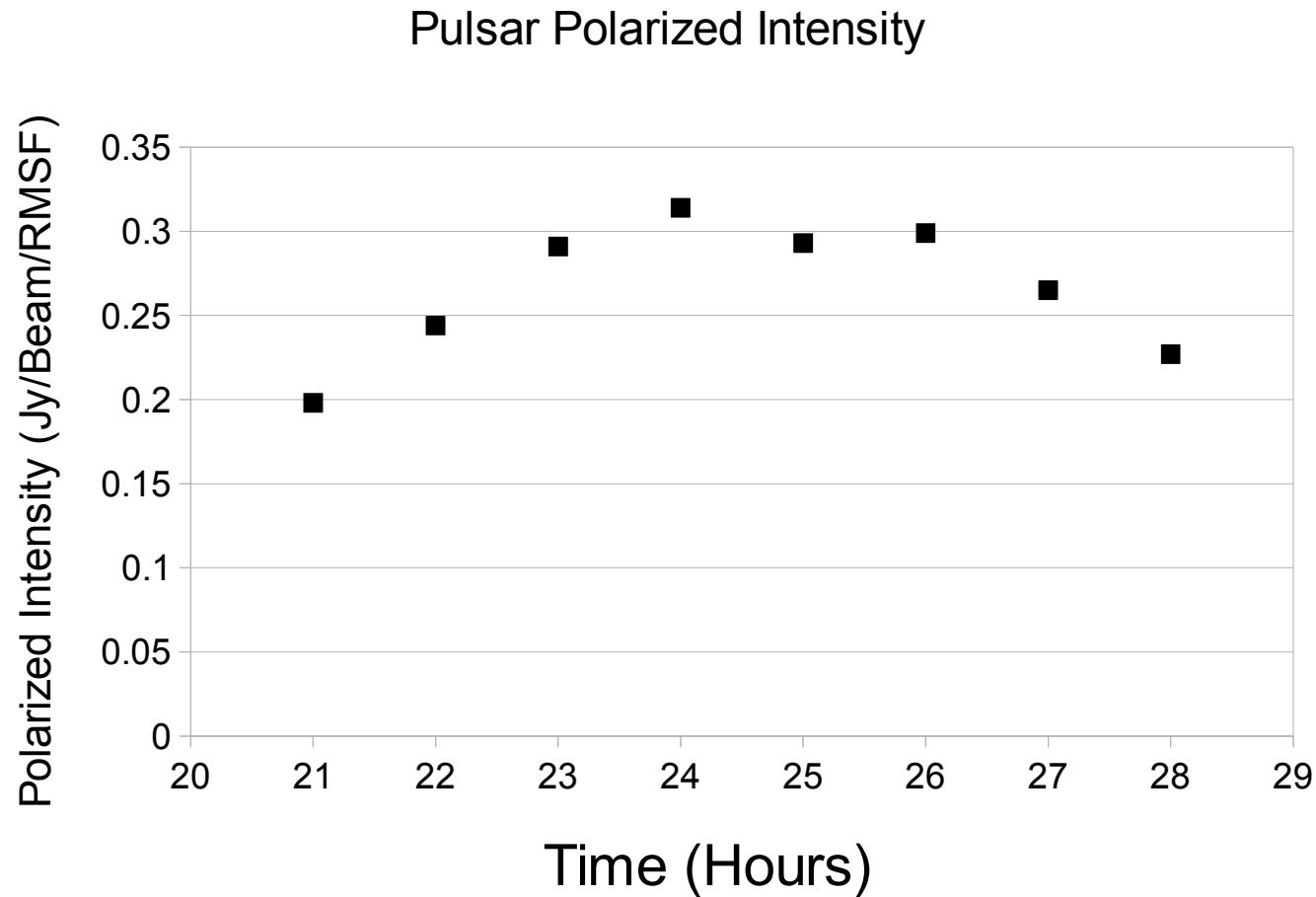


1 Hour Time Slices

- Split observations 20907, 20909 into 8x1 hour blocks, Andreas imaged with the pipeline
- RM doesn't vary much – Carlos Sotomayor found similar results with 17 subbands

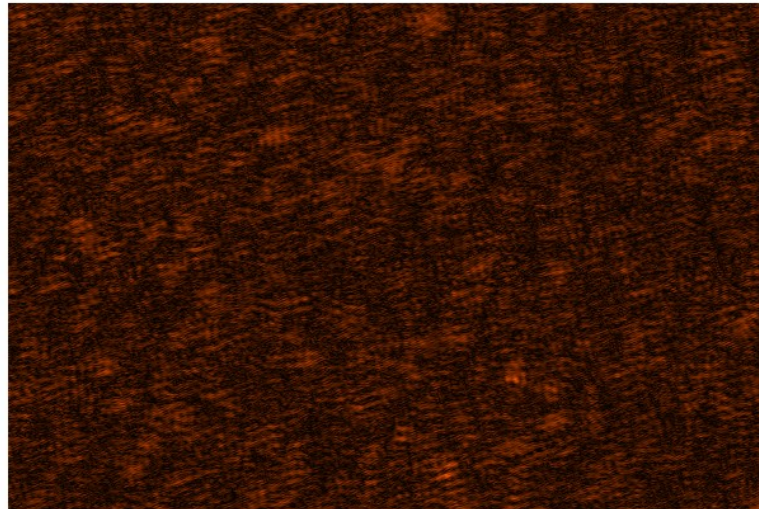


Pulsar Intensity Over Time



Polarized intensity at 0 rad/m²

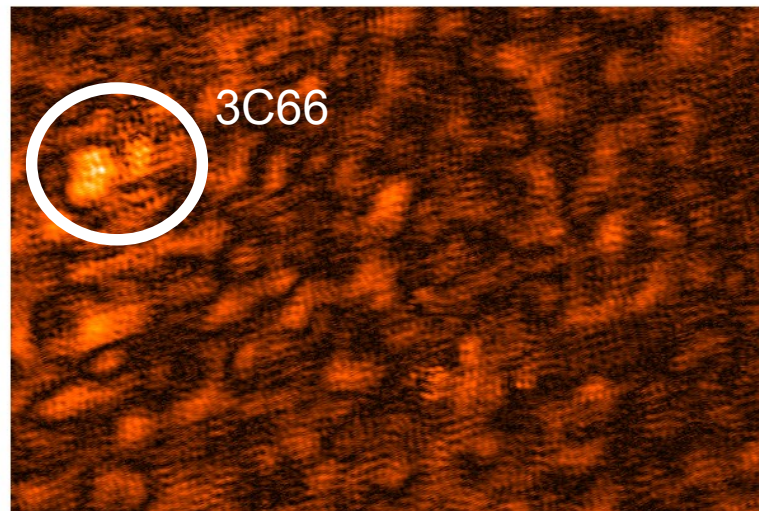
-14 rad/m²



Polarized intensity – Jy/Beam/RMSF

0.015 0.03 0.045 0.06 0.075 0.09 0.1 0.12 0.14

0 rad/m²

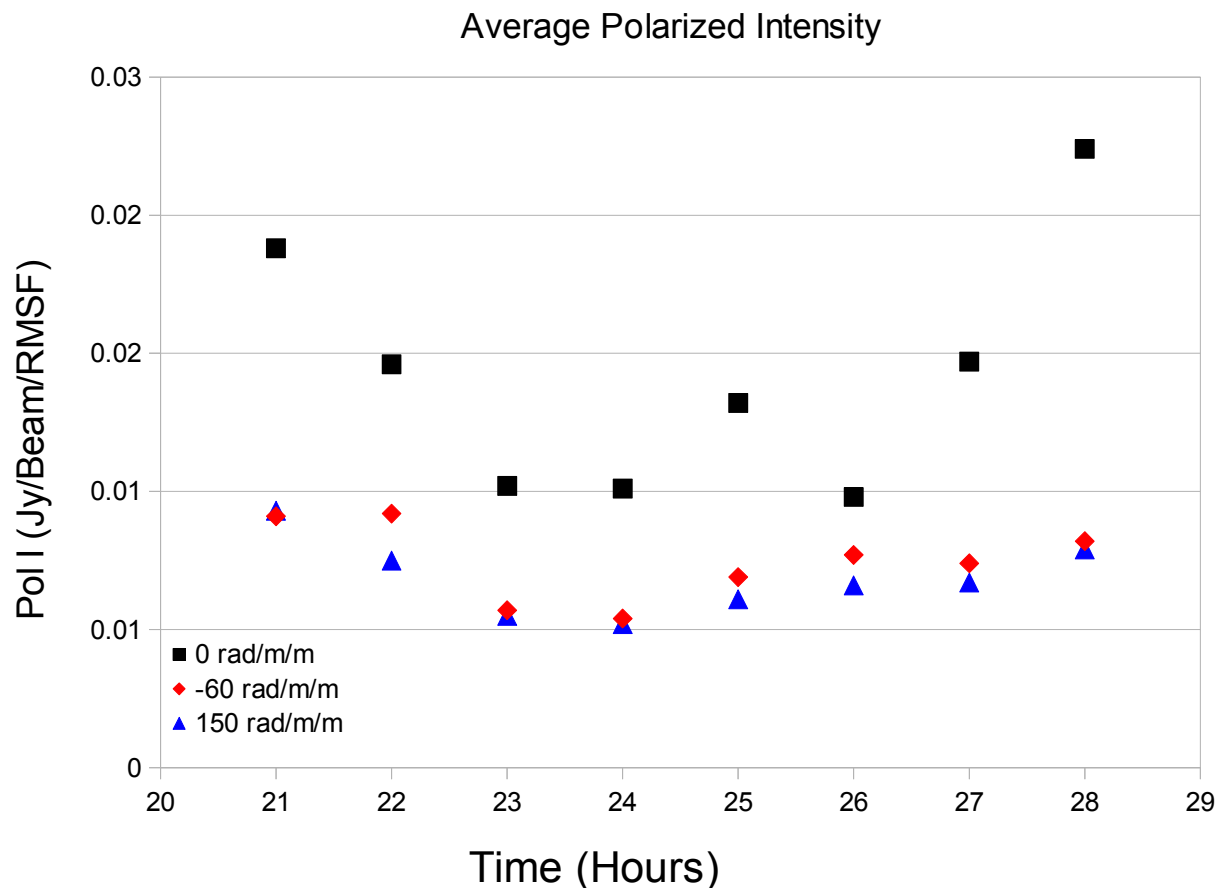


Polarized intensity – Jy/Beam/RMSF

0.015 0.03 0.045 0.06 0.075 0.09 0.1 0.12 0.14

Polarization at 0 rad/m² a good diagnostic of polarization leakage

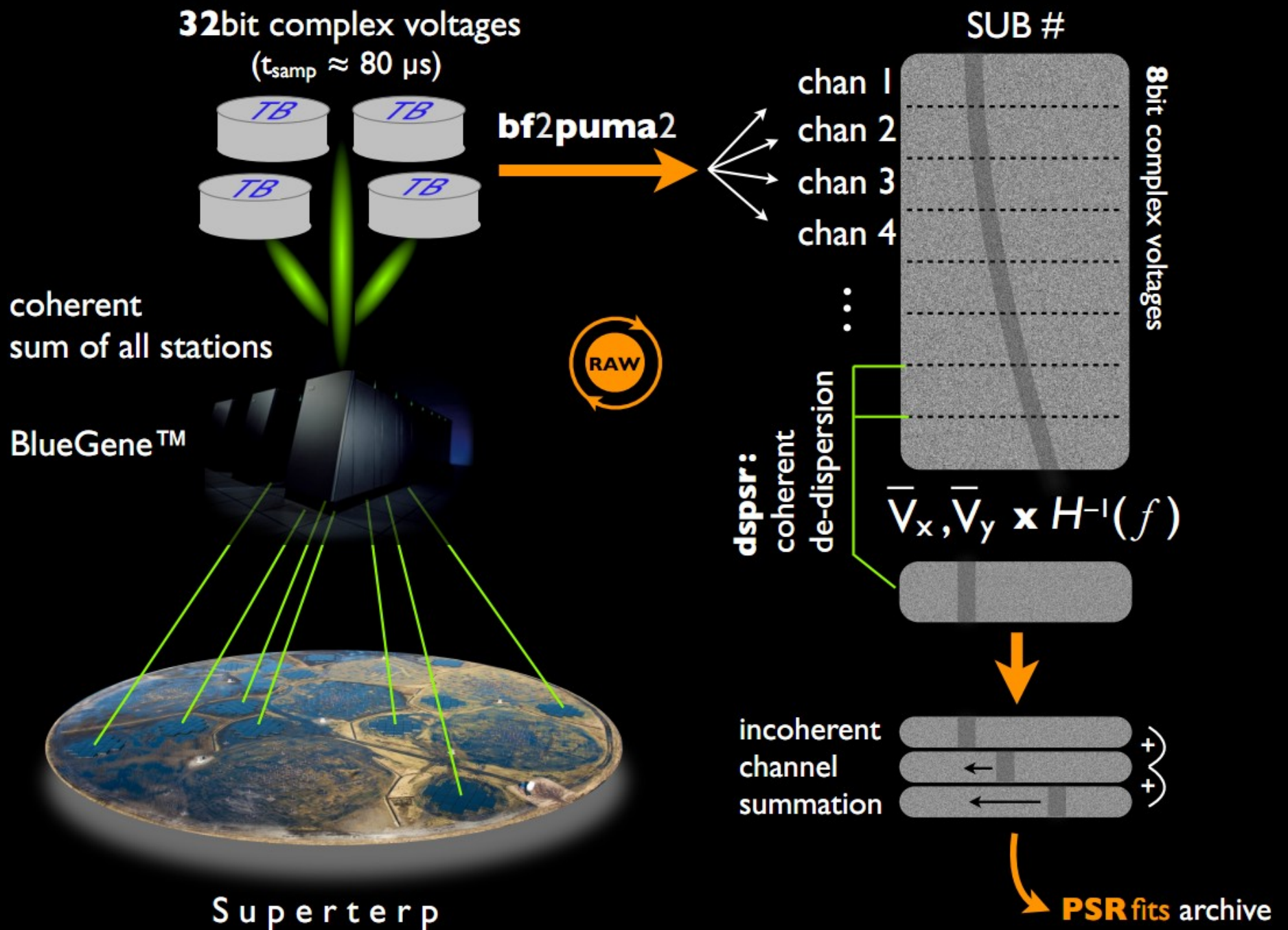
Average pol. intensity over time for different RM values



Averaged over 50 sq. pixels (500x500")

State of Polarimetry w/ LOFAR

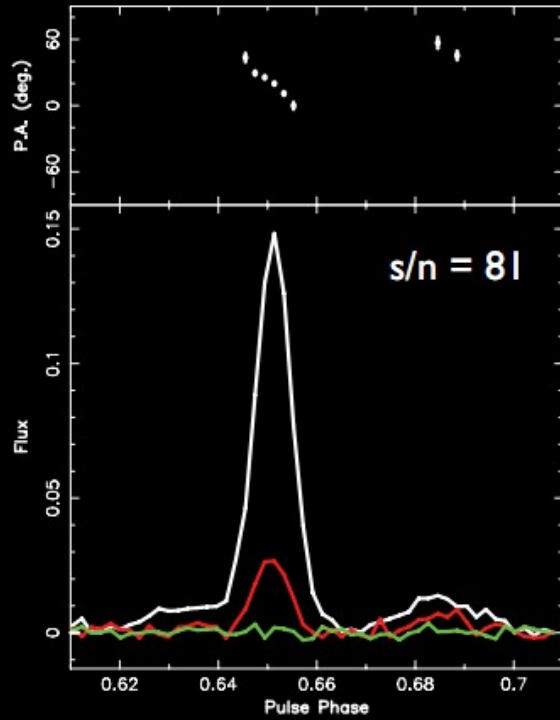
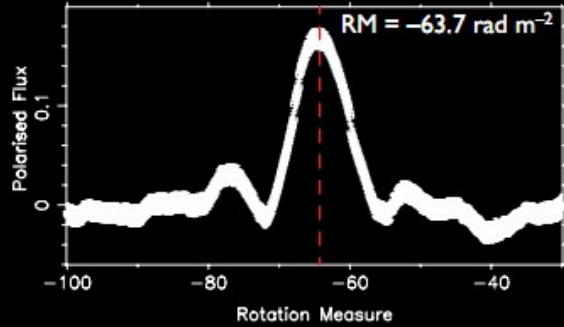
- We have successfully imaged polarized emission!
- Pol. calibration can't be done because
 - We're working to find calibrator sources
 - Beam model in BBS must be tested (correction for elevation dependent leakage, also needed for absolute PAs)
 - BBS doesn't deal with differential Faraday rotation over the channel/between stations
 -
- Currently restricted to sources at high elevation
- PA calibrator sources also needed, low priority for now



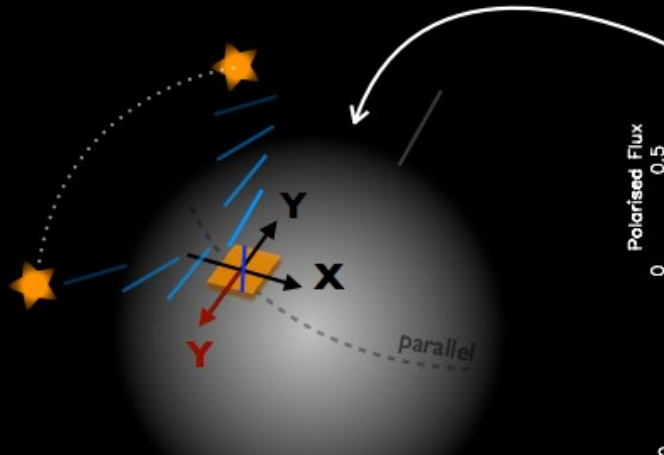
Courtesy of Aris Noutsos
LOFAR Status Meeting

PSR B0329+54

- **Single** core station
- **5 min**
- **6.2 MHz bandwidth**



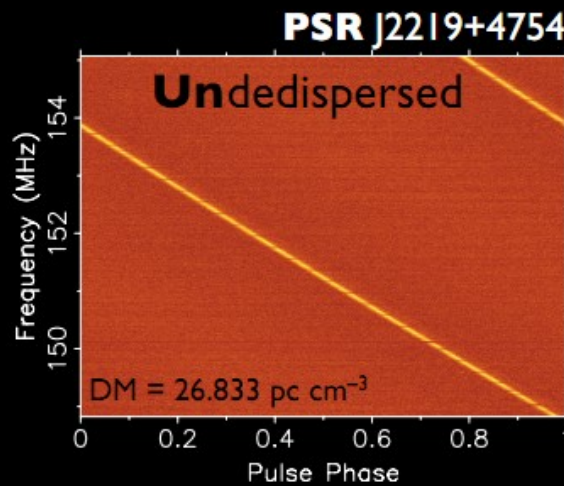
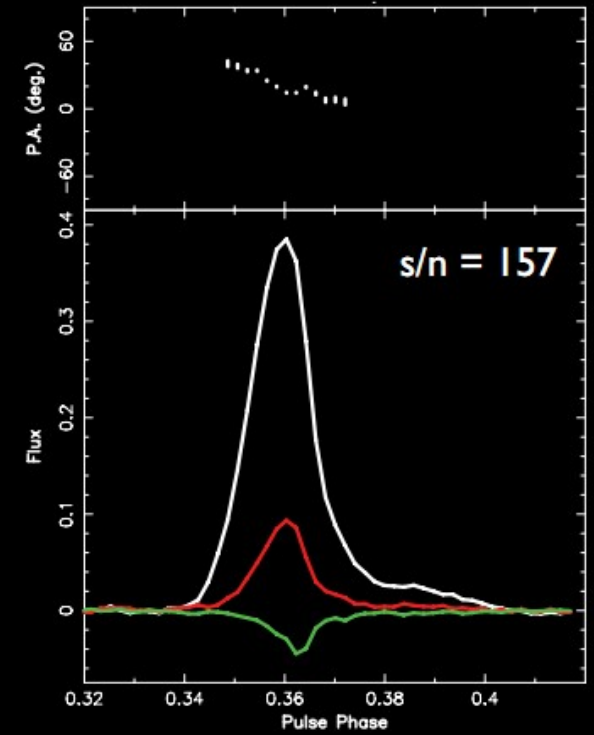
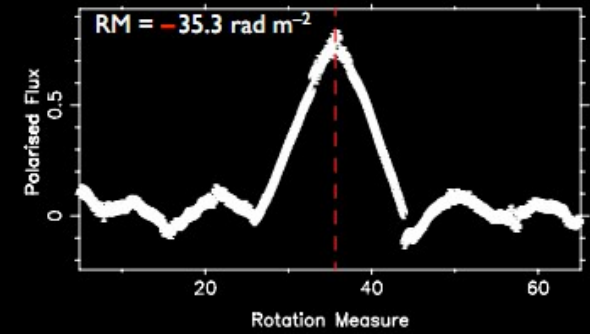
UNCALIBRATED DATA



the RM sign can be opposite either side of the station's parallel: one of the senses 'flips' relative to the source

PSR J2219+4754

- **6** core stations
- **10 min**
- **6.2 MHz bandwidth**



Courtesy of Aris Noutsos

Feedback from BW participants

Problems encountered:

1. The software pieces have different logical structures and are hard to use without continuous checking the Cookbook.
2. Software is far too slow.
3. Bad solutions of BBS are not deleted, intensive flagging of the calibrated data is required.
4. The pipeline cannot be used extensively and smoothly yet, but is crucial for deep mapping and even more crucial for the PhDs of our students.

Proposals:

1. Someone needs to homogenize the software structure.
2. Crucial parameters need to be identified and tasks to test them should be distributed among our commissioning teams.
3. More software engineers are needed. LOFAR should seriously discuss this, also with international partners.

RM Synthesis Pipeline

- Features:
 - FFT based synthesis
 - RMCLEAN & Wiener Filter deconvolution for now, more algorithms developed/tested in the future (Wavelets)
 - Support for several image formats
- Status:
 - Most functionality has been implemented, much testing is needed
 - Last hurdle – I/O! We have been awaiting HDF5 LOFAR data formats, are moving forward without since there is no delivery date in sight
 - Need feedback from community about file types to support (FITS file(s) or ?, written using CASA or ?) & obtain sample files, extract necessary metadata

Near-term Commissioning Plans

- New observation of NGC4631 done last weekend
- Recently made joint imaging/beam formed observations of Jupiter to look for circular polarization. Dynamic spectra show expected results, we'll be imaging/BBS-ing the imaging observations next week.
- Repeat J0218 experiment in pulsar observing mode to determine how station calibration has improved S/N
- Search for extended polarized emission (in e.g. galaxies, the fan region)
- Find calibrator sources (pulsars for now)

Next Pol Busy Week: 21st → 25th March in Bonn