Max-Planck-Institut
für
Radioastronomie

Results from the Polarization Busy Week

Andreas Horneffer

for the LOFAR Magnetism KSP

- Location: MPIfR Bonn
- Date: 21. – 25. March 2011
- 20 Participants in Bonn plus 3 remote:

Arpad	Miscolczi	Emanuela	Orru
Björn	Adebahr	Rosita	Paladino
James	Anderson	Amrita	Purkayastha
Rainer	Beck	Sandra	Schumann
Alice	Di Vincenzo	Carl	Shneider
Rene	Gießübel	Charlotte	Sobey
Andreas	Horneffer	Carlos	Sotomayor
Marco	Iacobelli	Monica	Trasatti
Jana	Köhler		
Masaya	Kuniyoshi	Jörn	Geisbüsch
Halime	Miraghaee	Marijke	Haverkorn
David	Mulcahy	Roberto	Pizzo

Workgroups

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1. Pulsar Survey
   - Pulsar (time series) data for 22 pulsars
2. PSR J0218+42
   - 10h (imaging) observation of the objet of our last BW
     - with station calibration
     - from high till very low elevation
     - including the sunset
3. NGC 4631 (edge on galaxy)
   - 6h observation
4. Fan region
   - 6h observation
   - strong diffuse polarization and no total intensity

Pulsar Survey

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- 22 pulsars observed
  - most with 2x10min, two with 1x10min, one with 4x10min
- Processed with a script from Jason and then standard pulsar tools
- First success: speeded up *bf2puma2*: 10h → 2h
- Found polarization easily

PSR B1929+10

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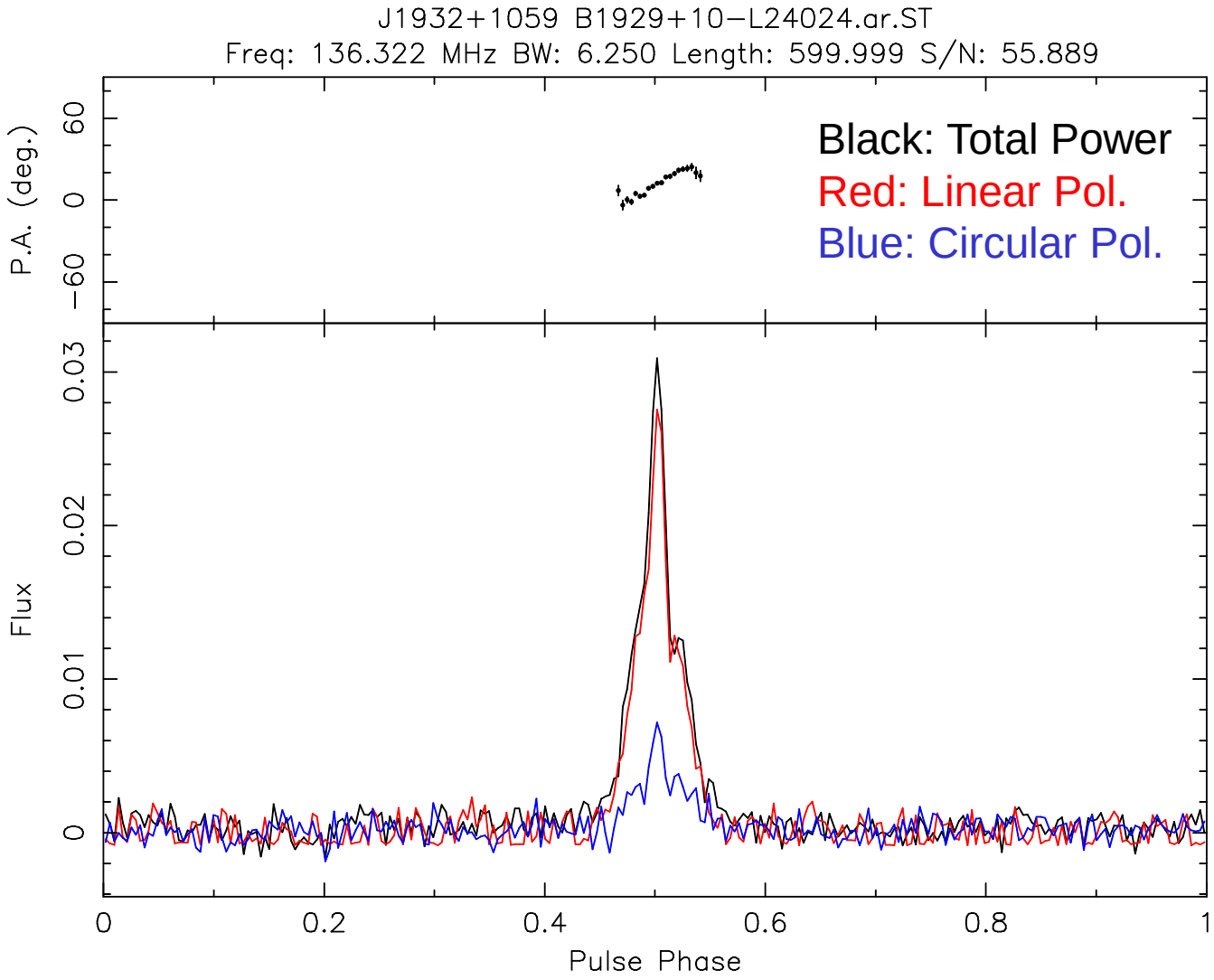

PSR B1642-03

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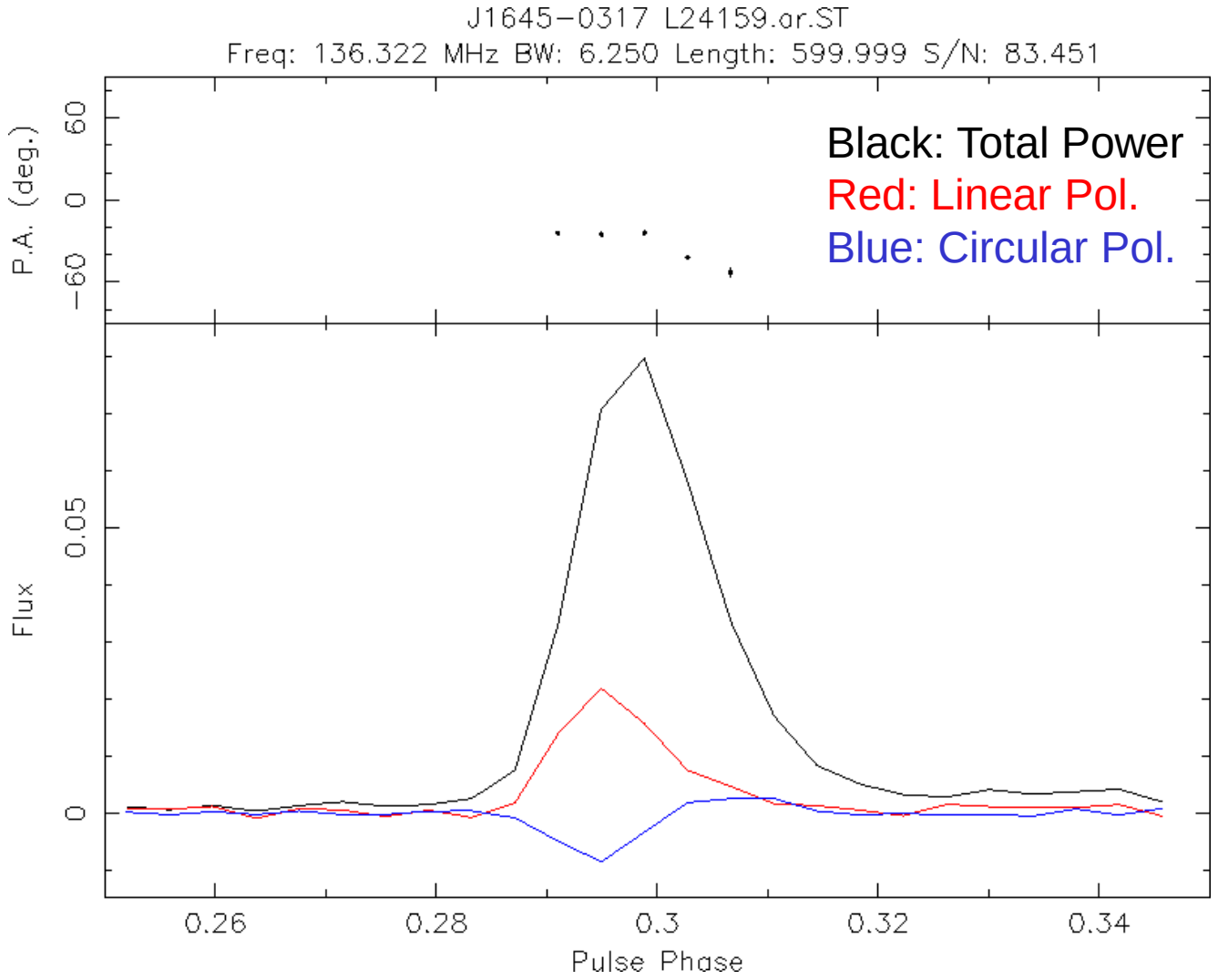

PSR B1642-03 RM-Synthesis

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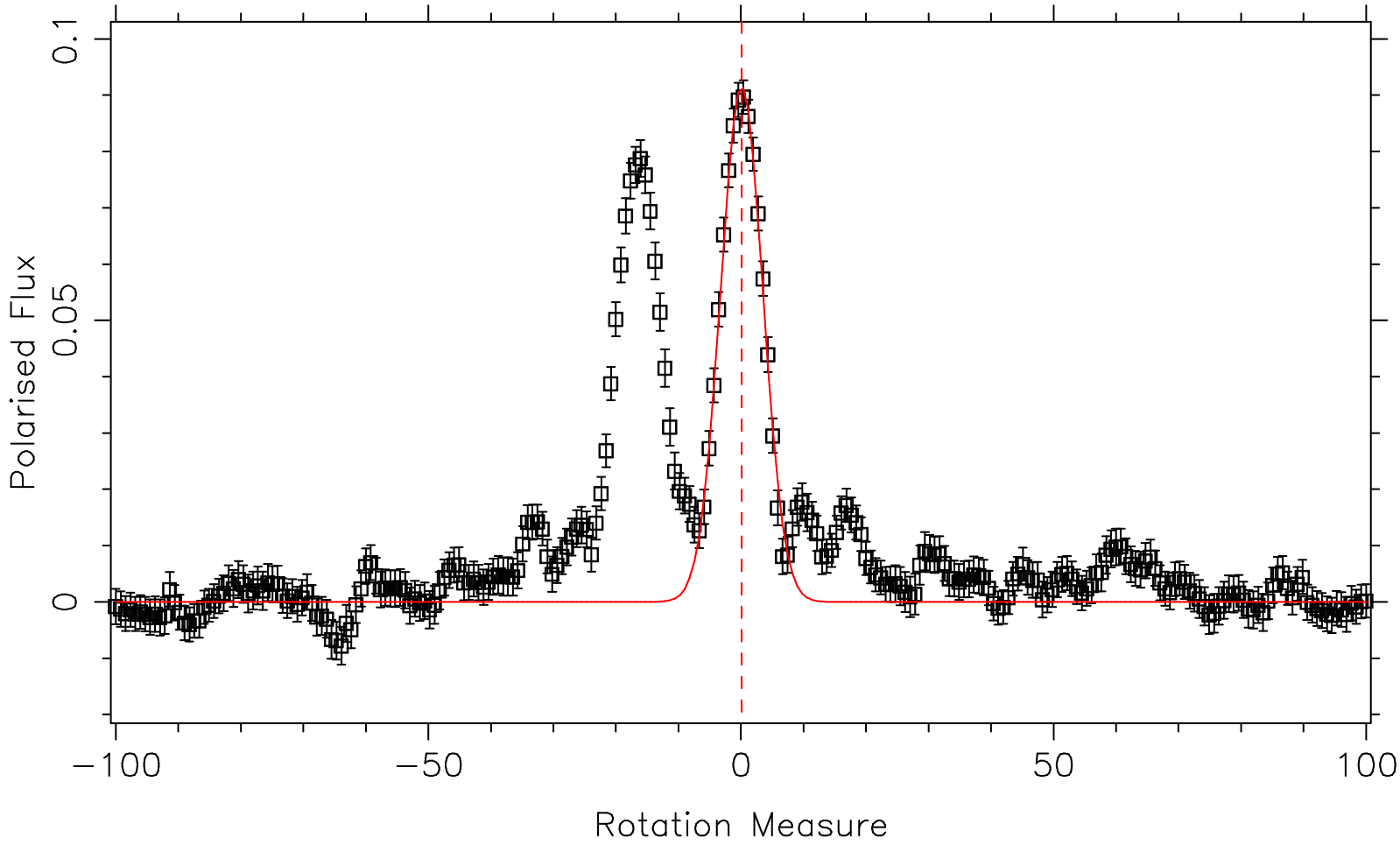

PSR B1642-03
FD over Phase

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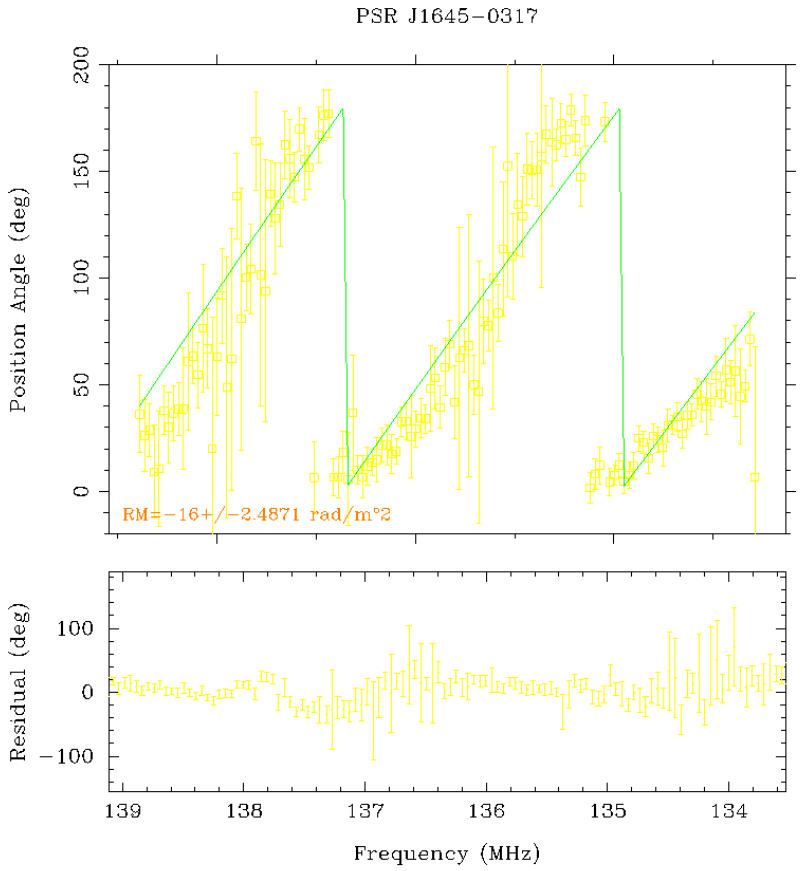
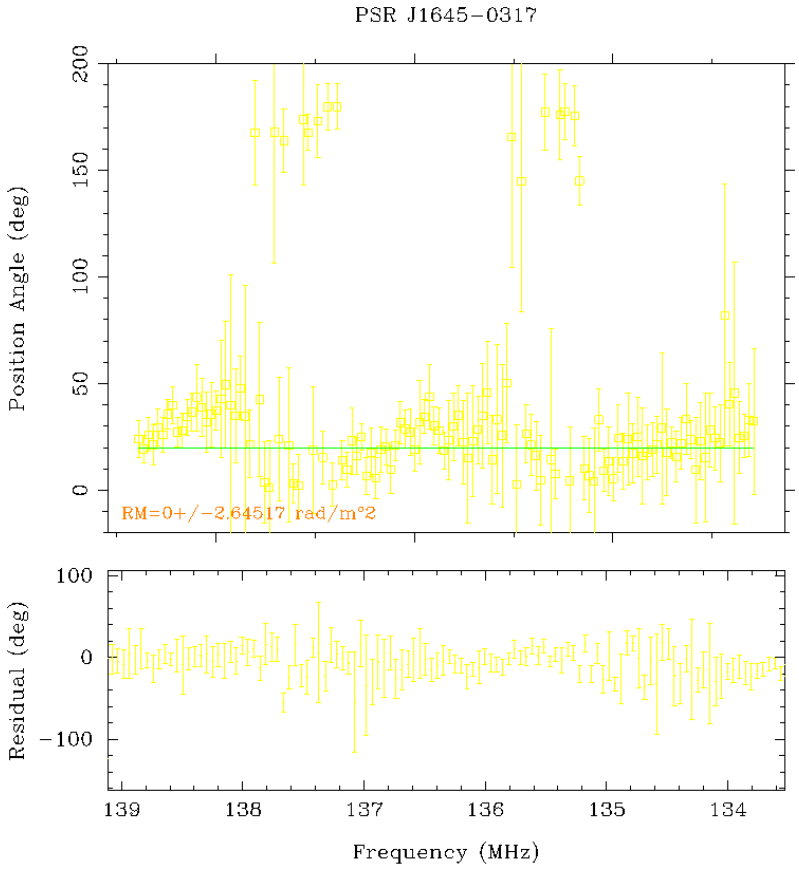
rmfit to phase 0.29-0.30



rmfit to phase 0.30-0.31



Results Table

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PSRB	OBSID	(L/I)%	ERR	RMfit (rad m^{-2})	ERR	PAfit (rad m^{-2})	ERR	PUBRM (rad m^{-2})	ERR	DATE	TIME (UT)	Az (deg)	Alt (deg)
0136+57	L24052	69	8	93	1	93	2	−90	4	13-03	14:00	343.68	84.39
0525+21	L24050	35	–	38	–	38	3	−39.6	0.2	13-03	18:00	330.21	39.35
0809+74	L24117	13	3	13.5	0.6	14	2	−11.7	1.3	14-03	20:50	354.25	68.16
0809+74	L24116	16	1	12.5	0.5	12	4	−11.7	1.3	14-03	21:40	346.18	66.86
0823+26	L24115	26	1	−5	–	−4	1	5.9	0.3	14-03	21:03	196.45	63.02
0823+26	L24114	25	2	−4	–	−3	1	5.9	0.3	14-03	22:13	226.35	57.45
0834+06	L24113	21	4	−26	–	−26	1	23.6	0.7	14-03	21:16	191.92	42.73
0834+06	L24112	22	4	−26	–	−27	1	23.6	0.7	14-03	22:30	215.51	38.22
0950+08	L24111	69	0.3	−2	–	−2	–	−0.66	0.04	14-03	22:00	181.13	45.03
0950+08	L24110	66	0.1	−2	–	−2	–	−0.66	0.04	14-03	23:00	201.78	43.22
1133+16	L24152	33	4	−4.5	–	−3	1	1.1	0.2	15-03	00:10	192.13	52.48
1133+16	L24151	32	6	−4	–	−2	1	1.1	0.2	15-03	01:20	217.72	47.99
1237+25	L24150	33	–	−0.6	–	−1	2	−0.33	0.06	15-03	01:00	188.52	61.80
1237+25	L24149	29	5	−0.2	0.3	−1	2	−0.33	0.06	15-03	02:00	215.23	58.39
1508+55	L23996	11	1	−1.8	0.4	0	2	0.8	0.7	13-03	04:00	298.10	83.55
1541+09	L24162	28	5	−17	1	−17	3	21	2	15-03	04:13	189.74	46.25
1642−03	L24010	19	1	−16.3	–	−17	1	15.8	0.3	13-03	05:00	181.35	33.83
1642−03	L24009	31	14	−16	3	−17	2	15.8	0.3	13-03	06:00	199.17	32.21
1642−03	L24160	17	2	−16	–	−17	1	15.8	0.3	15-03	05:00	183.71	33.77
1642−03	L24159	33	9	−17	–	−17	1	15.8	0.3	15-03	06:00	201.44	31.79
1919+21	L24006	17	3	16.4	0.4	15	2	−16.5	0.5	13-03	08:00	192.94	58.51
1929+10	L24025	79	2	5.6	–	6	1	−6.87	0.02	13-03	08:13	191.33	47.64
1929+10	L24024	81	3	5.8	0.6	6	1	−6.87	0.02	13-03	09:13	212.08	44.27
1953+50	L24022	9	4	20	2	22	5	−22	2	13-03	09:50	273.87	73.75
2224+65	L24035	18	13	22	2	21	7	−21	3	13-03	12:43	320.85	69.59

A. Nutsos

Pulsar Survey ToDo

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- Check possible RM sign flip.
  - (Right now all pulsars have the “wrong” sign.)
- Calibrate the data.
- Extend to 100+ pulsars
- Get absolute fluxes.
- Get the position angles.

PSR J0218+42

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- re-observation of known object
  - 10h observation
- goals:
  1. optimize calibration
  2. determine SNR with station calibration
  3. get time-resolved RM during sunset and at different elevations
- approach:
  - test calibration strategy on single subbands
  - process all subbands with the pipeline

Calibration Strategies

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1. “traditional”: Start with a simple sky-model and then do iterations
   - takes a long time
2. Start with a sky-model from a 150MHz WSRT image.
   - Managed to detect the pulsar in the first iteration.
3. Start with a simple sky model and peel away strong sources.

Effect of Beam Correction

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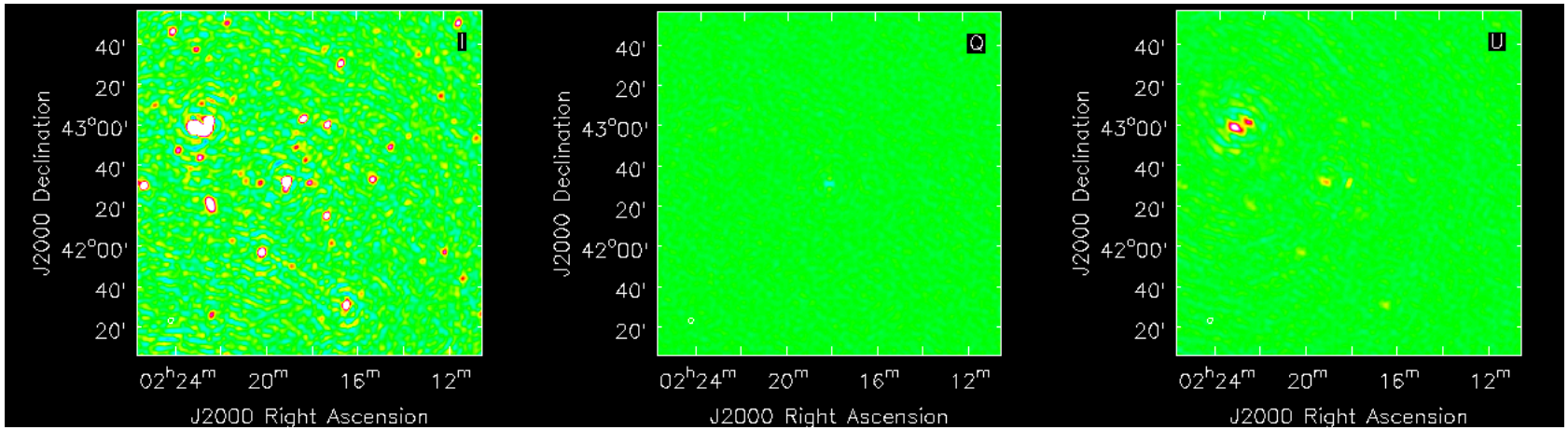
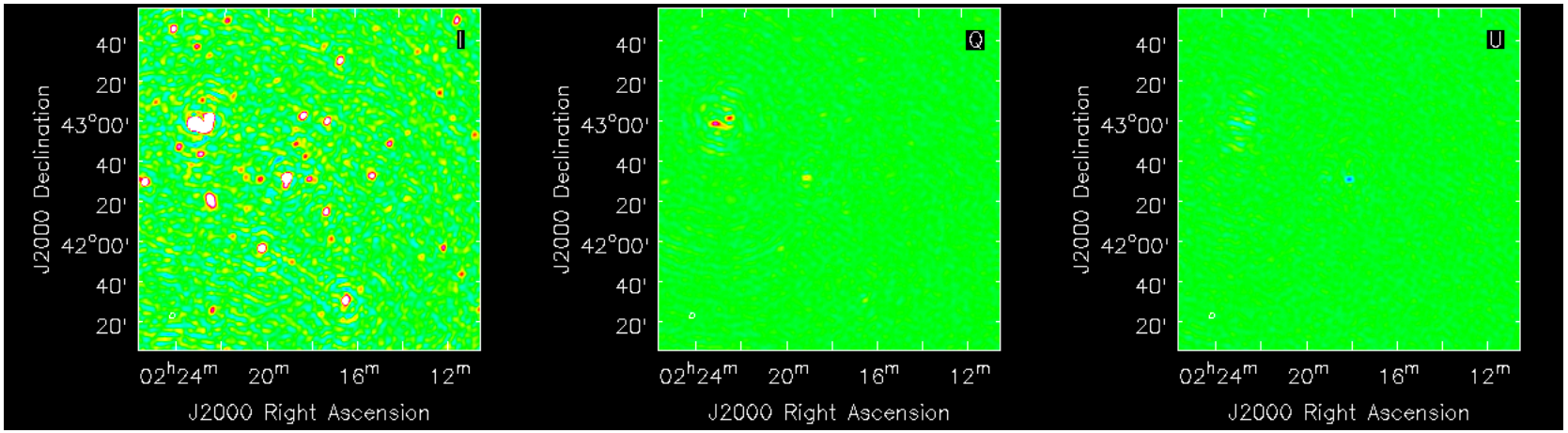
without beam-correction



with beam-correction



Map by A. Horneffer calibration by B. Adebar

Beam Correction in Numbers

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Without Beam Correction

- linear polarized intensity:
  PSR 218: 0.15 “Jy/beam”
- polarized fraction:
  3C66: 4%
  PSR 218: 43%

With Beam Correction

- linear polarized intensity:
  PSR 218: 0.19 “Jy/beam”
- polarized fraction:
  3C66: 3%
  PSR 218: 58%

Peeling

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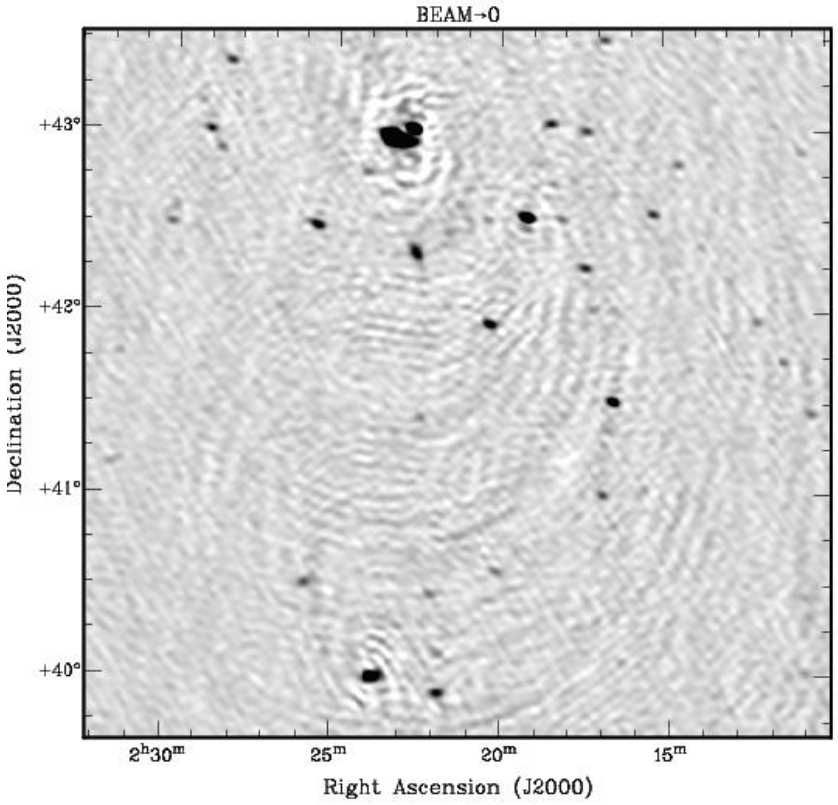
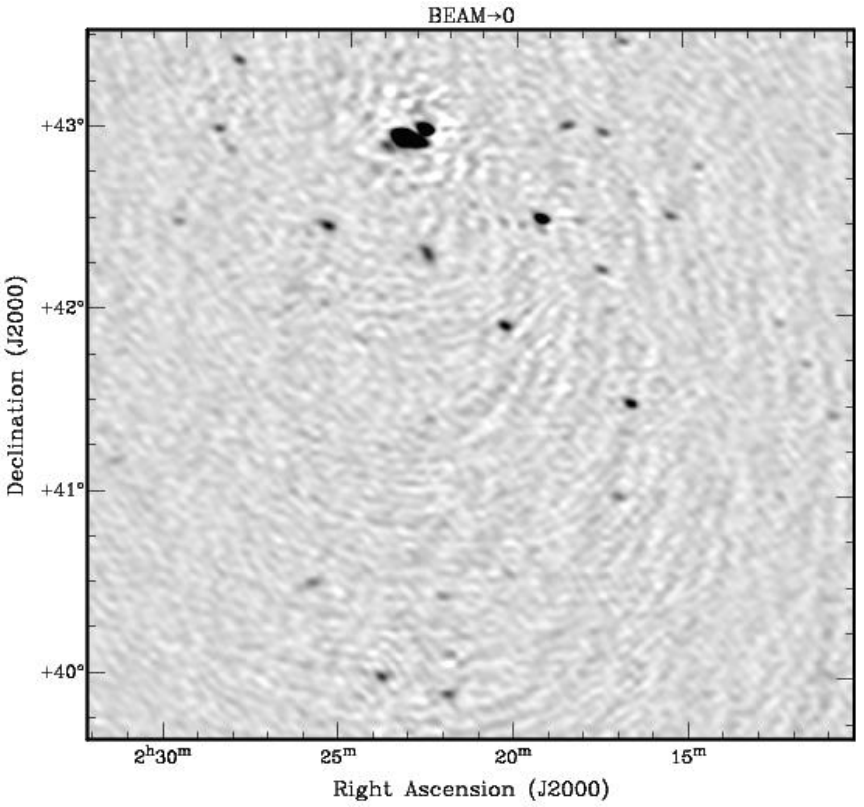
without peeling



3C65 peeled



C. Sotomajor

PSR J0218+42 Conclusions

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- Beam correction in BBS improves the result, but not as much as I expected.
- Peeling gives gradual improvement.
- Todo: Combine all calibration approaches:
  - (peeling, beam correction, iterations)
- We are working on time-resolved RM-Synthesis with the current calibration strategy.

NGC 4631

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- 6h observation during night time
- half the subbands were bad due to system bug
- goals:
  - get a good image of a galaxy for publication
  - search for extended polarized emission

NGC 4631 First Image

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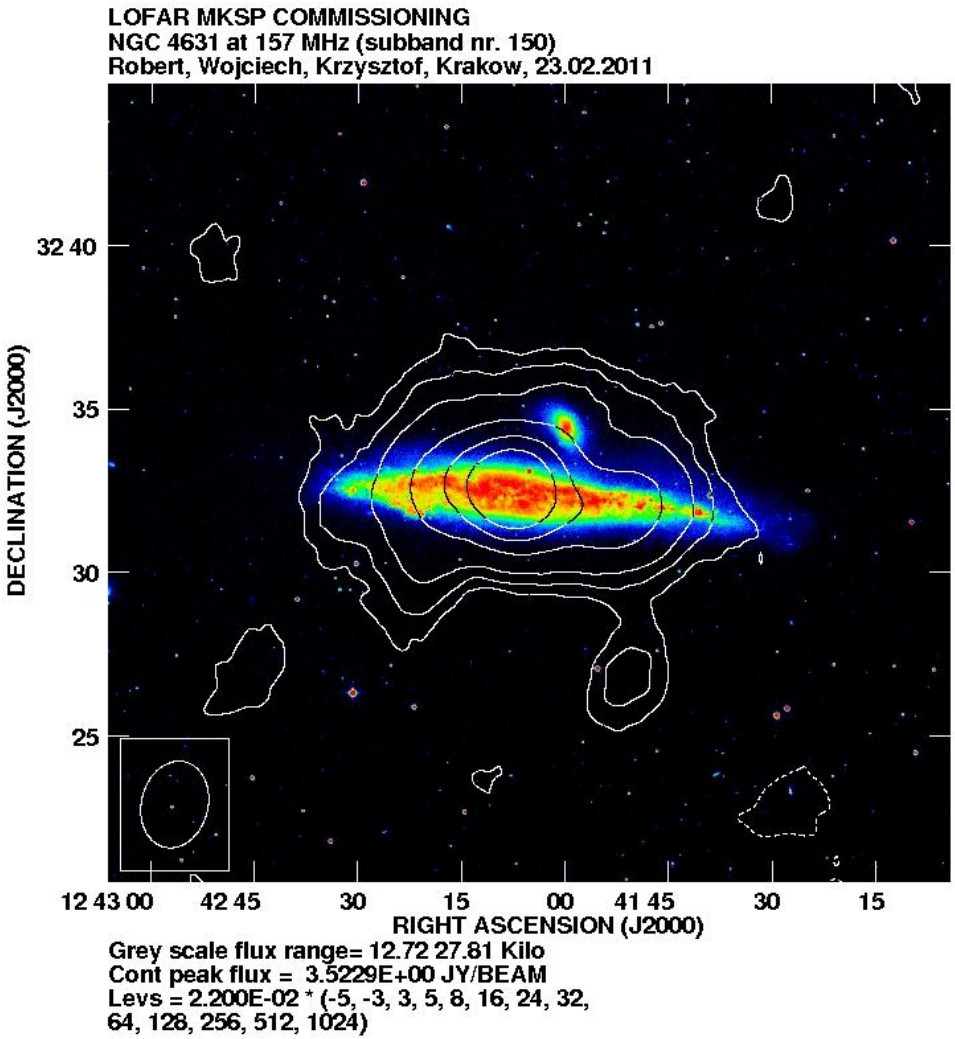

NGC 4631 Widefield

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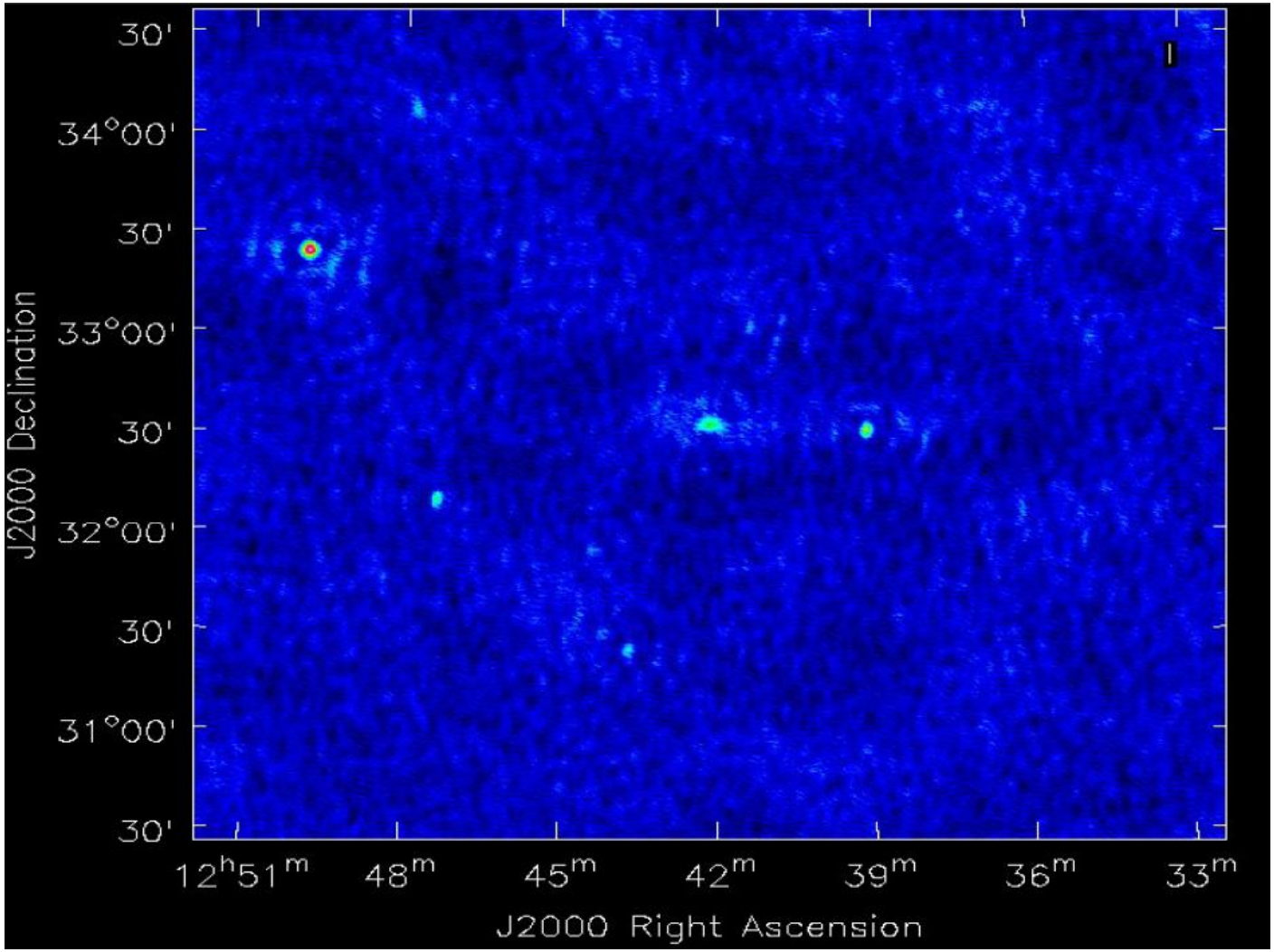

D. Mulcahy

NGC 4631 Conclusions

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- NGC 4631 was detected before busy week
- limited progress during busy week
  - lack of strong calibrator in the FOV
  - no improvements after several iterations
  - calibration solutions seem to be unstable
  - different versions of BBS give different results
- **new approach:**
  - re-observe with a second beam on a calibrator
  - re-think calibration
    - Is it better to use AIPS or so? (also internally disputed)
    - Go to circular polarized “feeds” for calibration?

Fan Region

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- observed on 12 March 2011 from 12:00 to 18:00
  - time resolution: 10 sec
  - frequency resolution: 4 channels per subband
  - frequency coverage: 126 MHz - 174 MHz
- goals for the busy week
  - inspect data quality
  - make good skymodel
  - calibrate, extra challenges:
    - no strong calibrator sources in the field
    - strong diffuse polarization *without* total intensity counterpart

Fan Region: Calibration Strategy

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- Skymodel for Fan Region:
  - simple model of 13 point sources
  - complex model with many gaussians
  - shapelet model
- Subtract Cas A (1-gaussian, multi-gaussian or shapelet) or not
- Flag first 1.5 hours (with Cas A?) of data or not
- Use directional gains or not
- Include a (Hamaker) beam correction or not

Fan Region: Results 1

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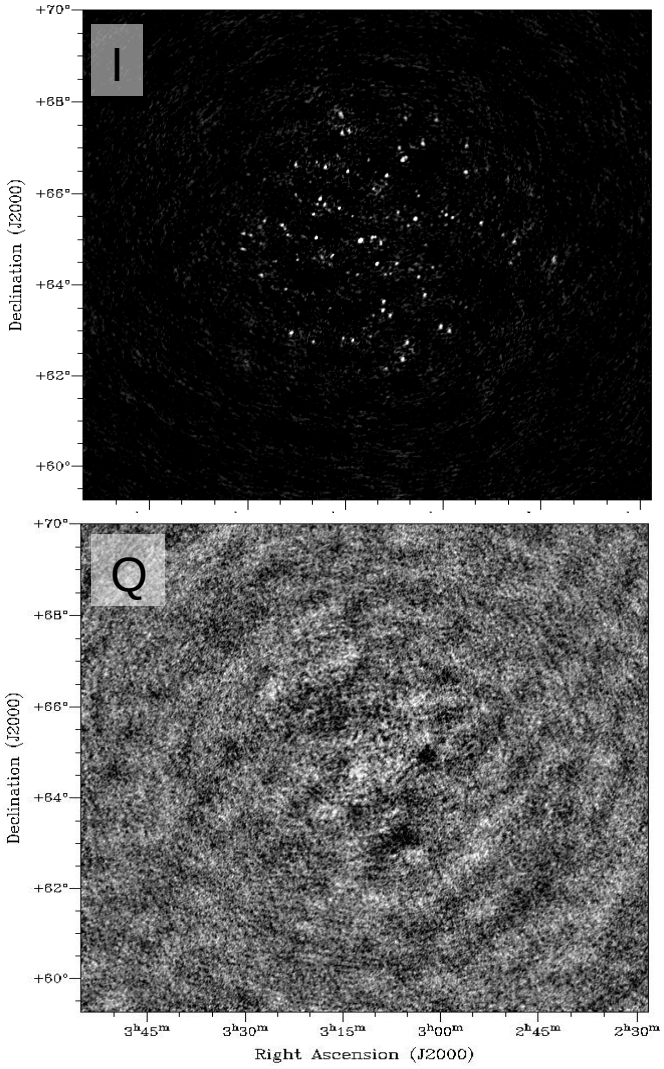

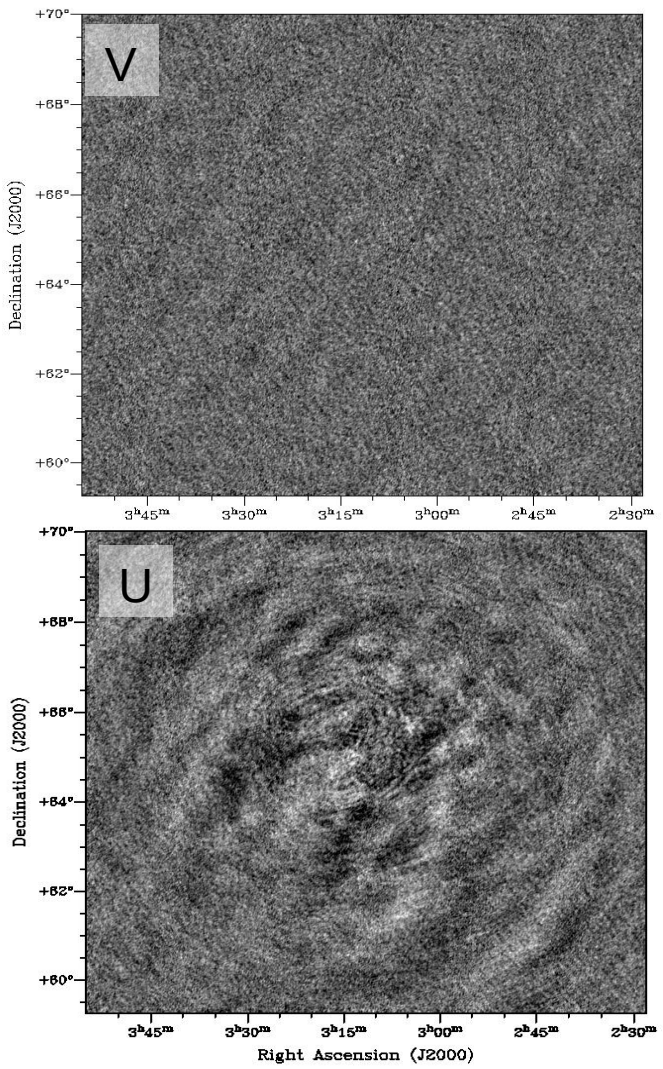

Maps by E. Orru & R. Pizzo

Fan Region: Results 1

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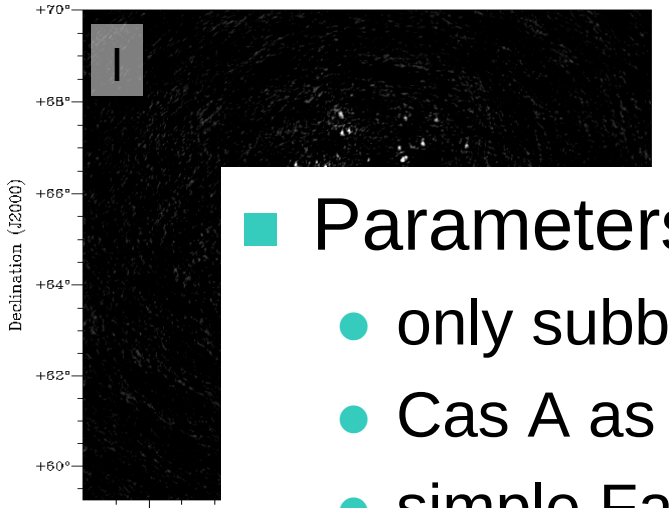
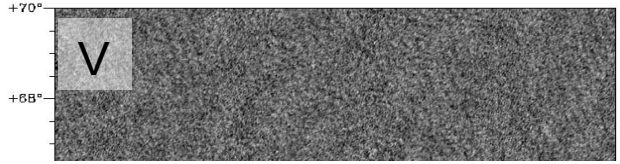
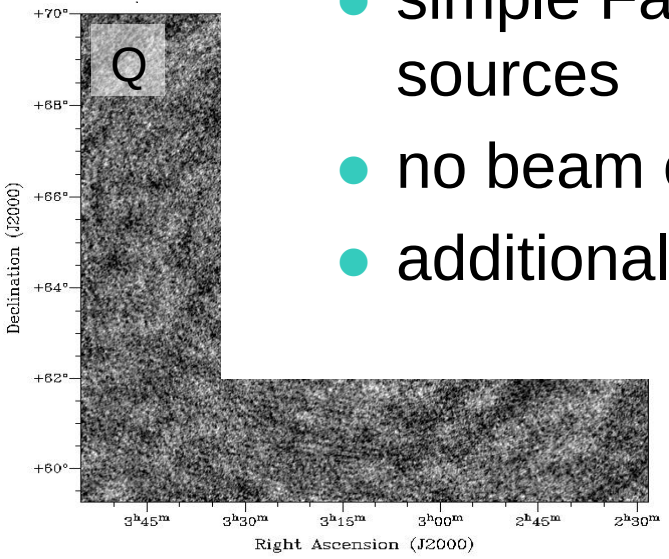
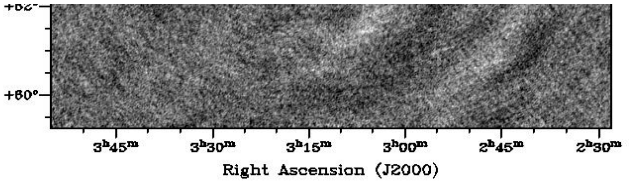




- Parameters used:
  - only subband 120
  - Cas A as a simple gaussian was subtracted
  - simple Fan Region skymodel of 13 point sources
  - no beam correction included
  - additional flagging after calibration





Maps by E. Orru & R. Pizzo

Fan Region: Results 2

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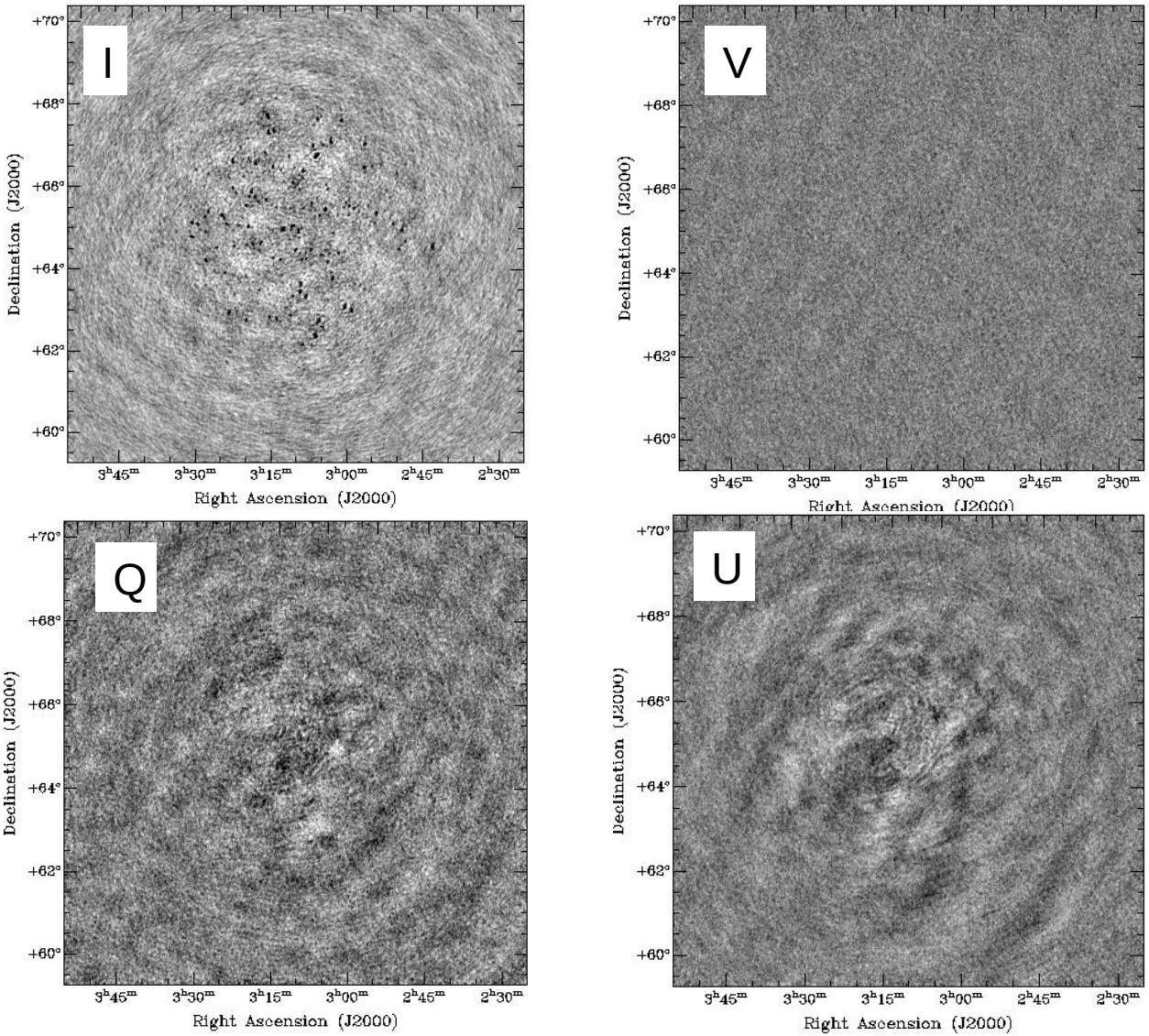

Maps by E. Orru & R. Pizzo

Fan Region: Results 2

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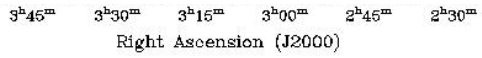
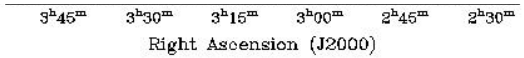
- **Parameters used:**
  - only subband 120
  - more complex model of Cas A was subtracted
  - sophisticated Fan Region skymodel of 300 components
  - no beam correction included
  - additional flagging after calibration

- **Results:**
  - dynamic range in I is ~200
  - Q and U extended signal up to S/N ~ 5
  - noise in Stokes V is about 2 mJy/beam
  - (instrumental) Stokes V only in central source of ~ 1%





Fan Region: Conclusions

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- Real diffuse polarization is detected in the Fan Region!
- But its structure still depends on the calibration parameters
  - subtracting Cas A is important
  - what about subtracting Cyg A, other A-team sources?
  - inserting a beam model makes a worse polarization map at this moment