Observations of NGC6946

LOFAR Survey of Nearby Galaxies – LCO_043
LOFAR Cycle 0

MKSP meeting, 09 March 2015, Ravenstein

Wojciech Jurusik
Astronomical Observatory of the Jagiellonian University

Krzysztof Chyży, Rainer Beck, Andreas Horneffer, David Mulcahy, John Conway, Bjoern Adebahr, Anderson James M, , Michael Bell, Rob Beswick, Ralf-Juergen Dettmar, Rob Fender, Rene Giessuebel, Marijke Haverkorn, George Heald, Volker Heesen, Frank Israel, Uli Klein, Enno Middelberg, Blazej Nikiel-Wroczynski, Raymond Oonk, Rosita Paladino, Huub Rottgering, Anna Scaife, Carlos Sotomayor, Fatemeh Tabatabaei, Carmen Toribio, Marek Urbanik

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Scientific motivation

- NGC 6946 in one of the largest galaxy in the sky
- Detection of extended radio emission
- Cosmic ray propagation, diffusion
- Studies of thermal absorption, total spectrum, in the galaxy core and HII regions
- Detection of polarised emission, RM Synthesis technique

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Observations setup

- The galaxy NGC 6946 was observed in HBA LOFAR band during 8 hours night session on 15/16 July 2013

- Observation in beam switching mode: 32 x 12 min. - NGC6946, 31 x 1 min. - the calibrator – 3C380

- Pre-processing: 324 Subbands (SB000 [115.04 MHz]– SB323 [178.125 MHz]) – One Subband: 6s timestep, 8 channels

- The calibrator 3C380 resolved at HBA frequencies

- Demixing of Cyg A and Cas A was applied

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Data processing

- 12 blocks of continuous coverage between 115 MHz and 178 MHz: One block – 27 Subbands

- Calibration of individual 3C380 subbands (full gain matrix)

- Calibration transfer by individual subbands

- Concatenation of pre-calibrated NGC6946 subbands in Blocks of 27 subbands. Editing of data, automatic/manual data flagging (AOflagger, plotms)

- Few loops of phase only calibration (direction independent) on large NGC6946 Measurment Set (27 SBs) (1. model from gsm.py, 2. model from calibrated data – awimager, ...)

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Status of data processing

Block	0	1	2	3	4	5	6	7	8	9	10	11
Calibrator 3C380	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Solution transfer	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
GSM phase calibration	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Phase selfcal 1	✔	✔	✔	✔		✔	✔	✔	✔			
Phase selfcal 2	✔		✔	✔		✔	✔	✔	✔			

Limited computing resources in Krakow delayed project
Solution and plans for future: Blazej report

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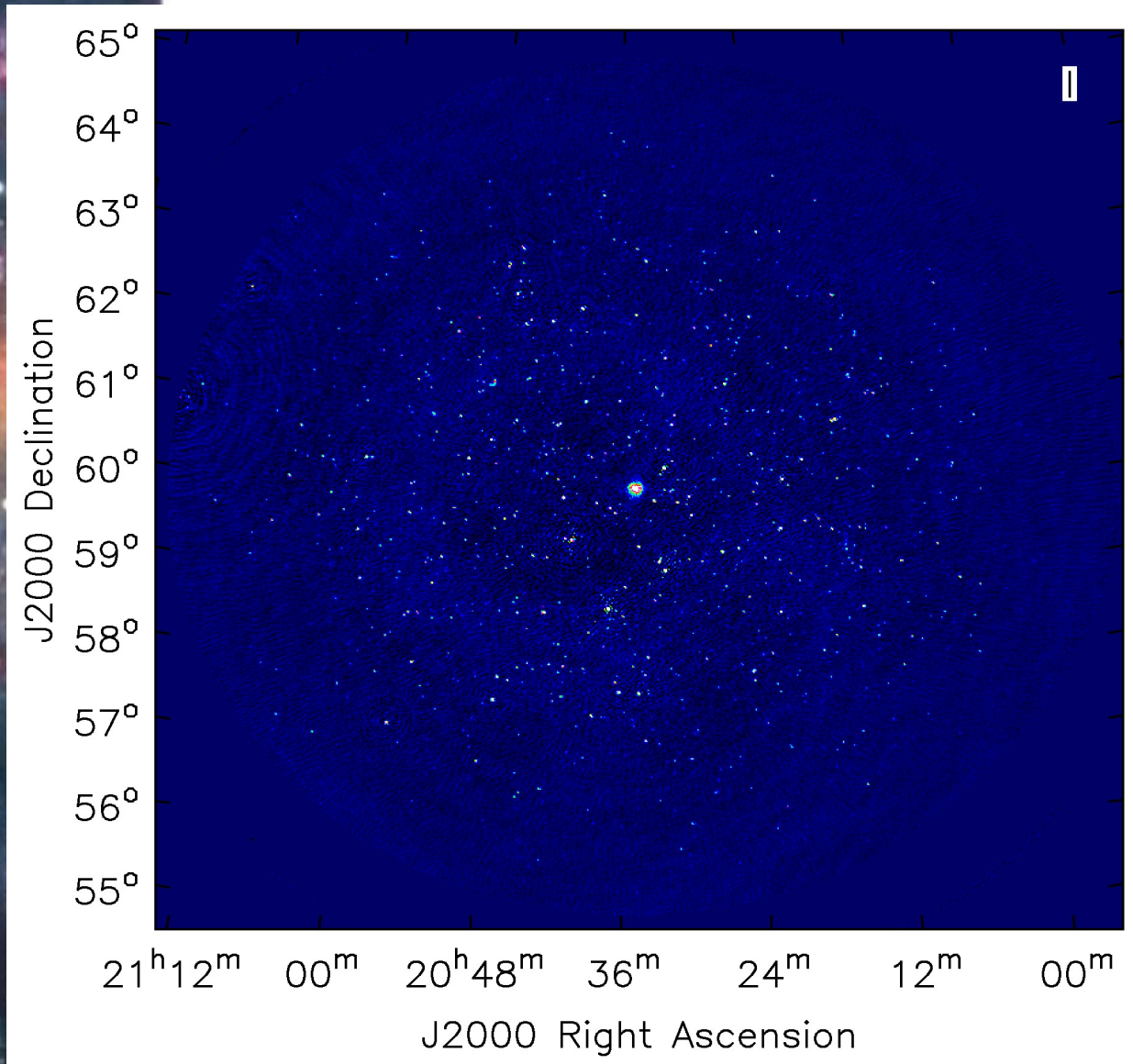

Full field of view

Cleaning in awimager

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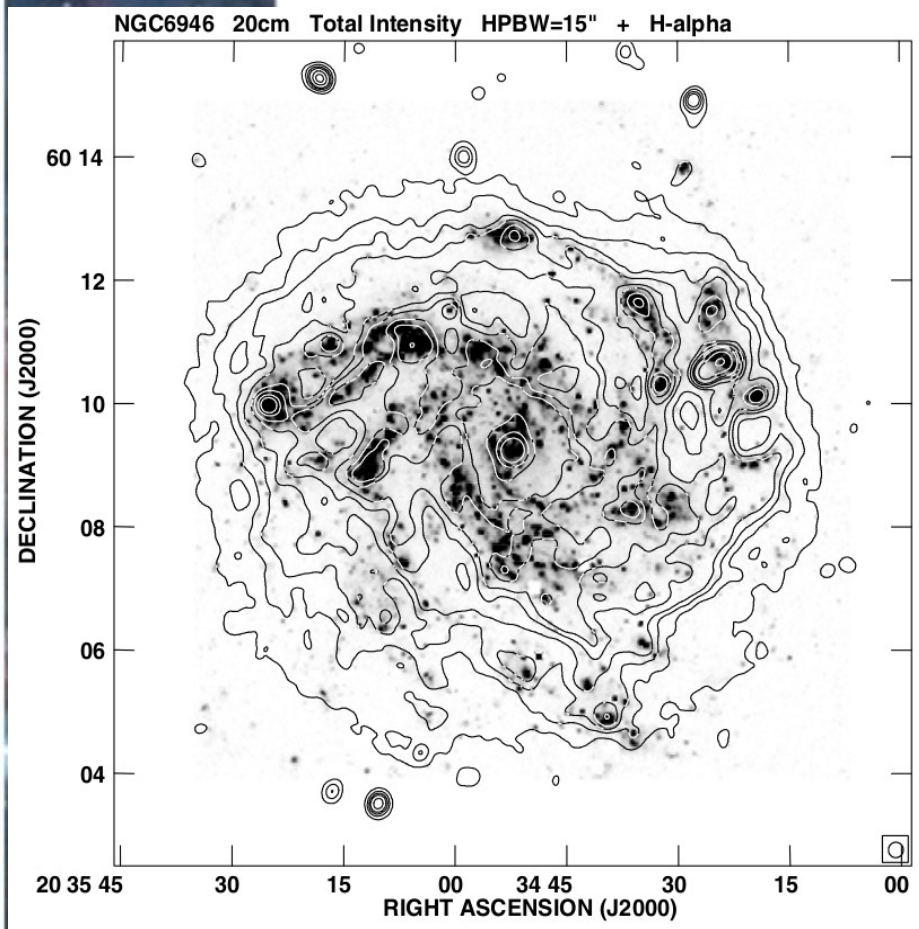
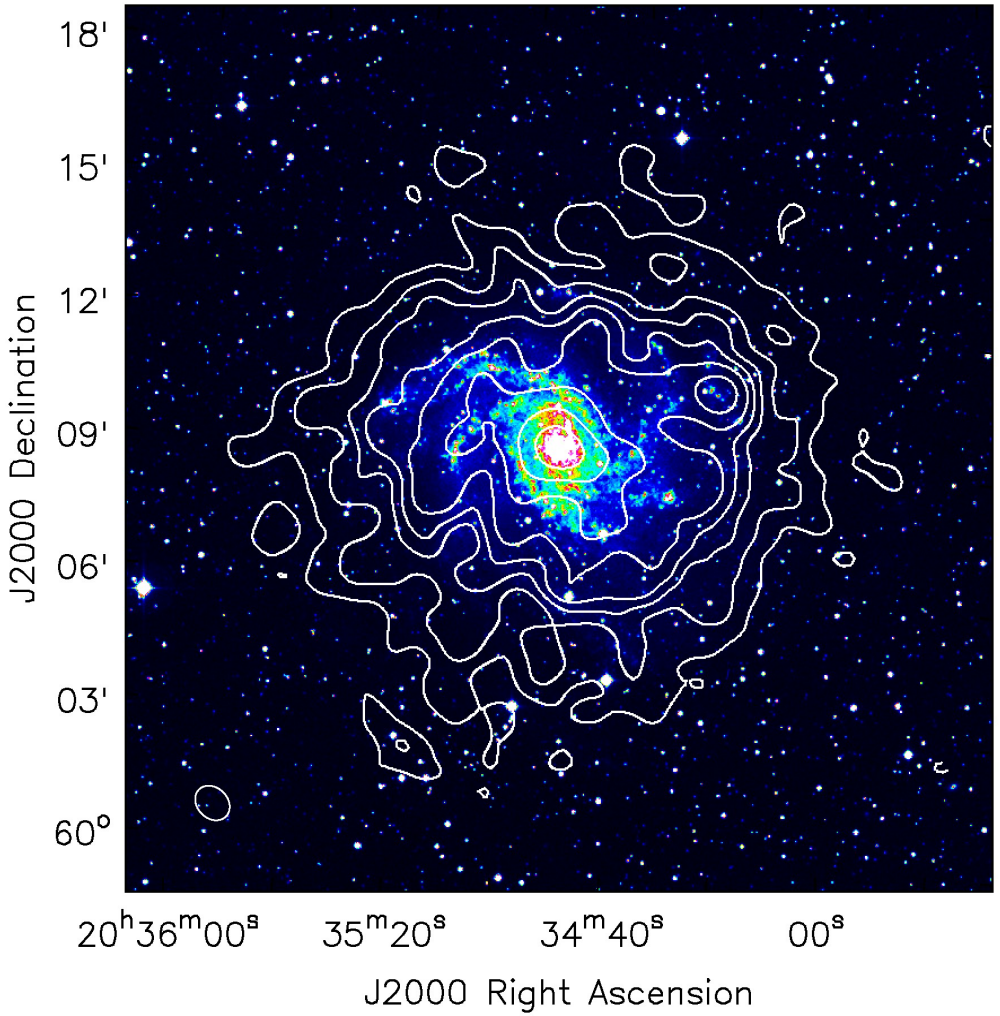
Representative map from Band2 vs 20 cm VLA+EFF





Beck, R A&A, 2008, 470 , 539

An envelope of radio emission is only a little more extended at LOFAR HBA frequencies

HPBW 53x42"

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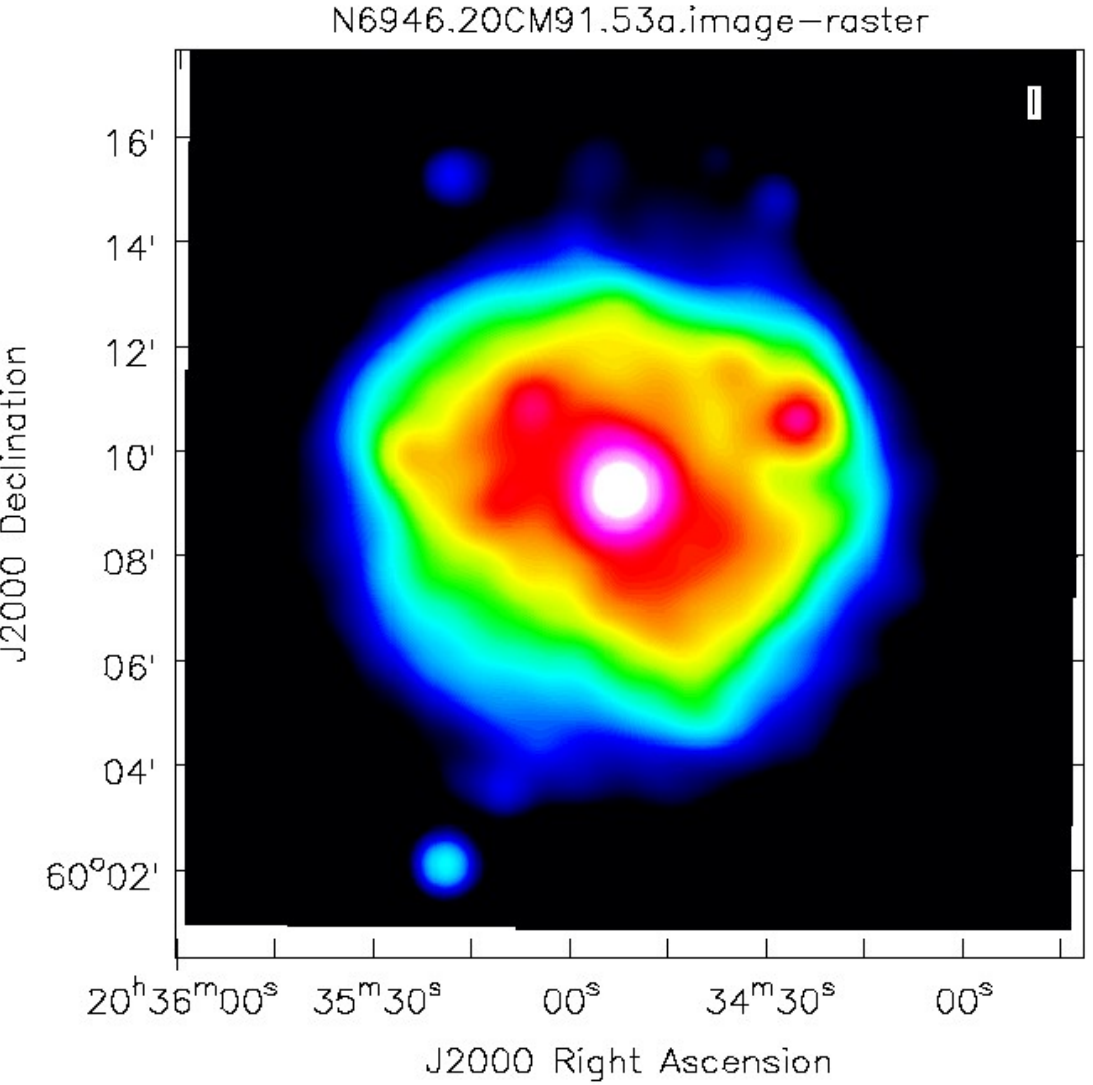

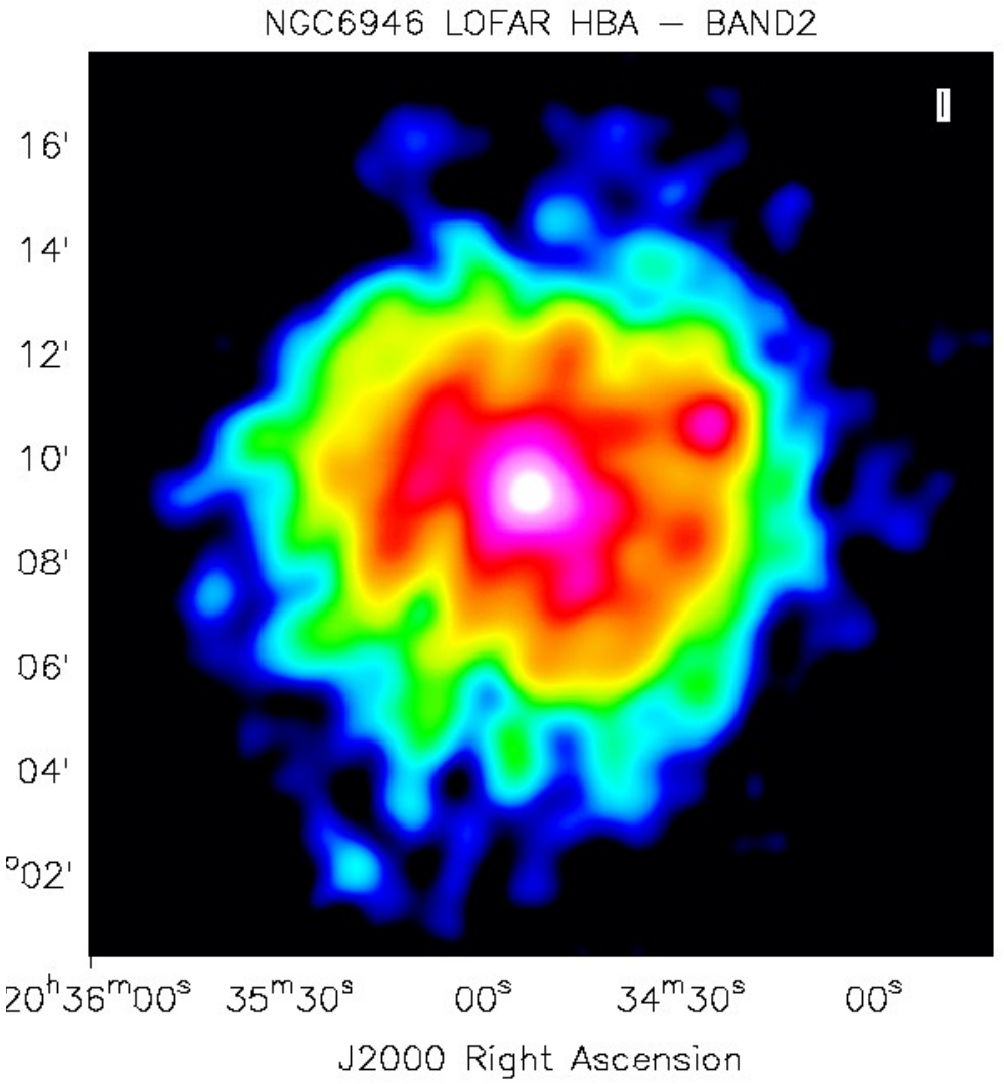

Beck, R A&A, 2008, 470 , 539
20 cm VLA+EFF

Both maps convolved to 53"

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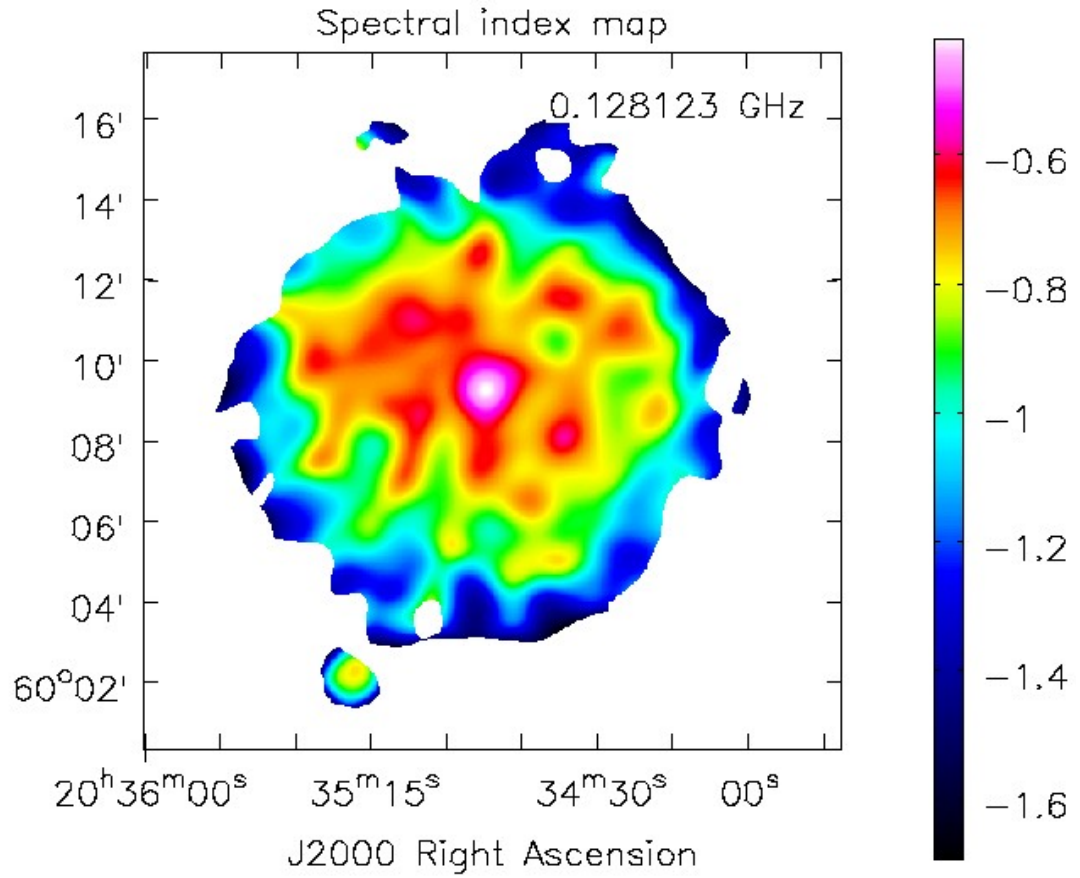
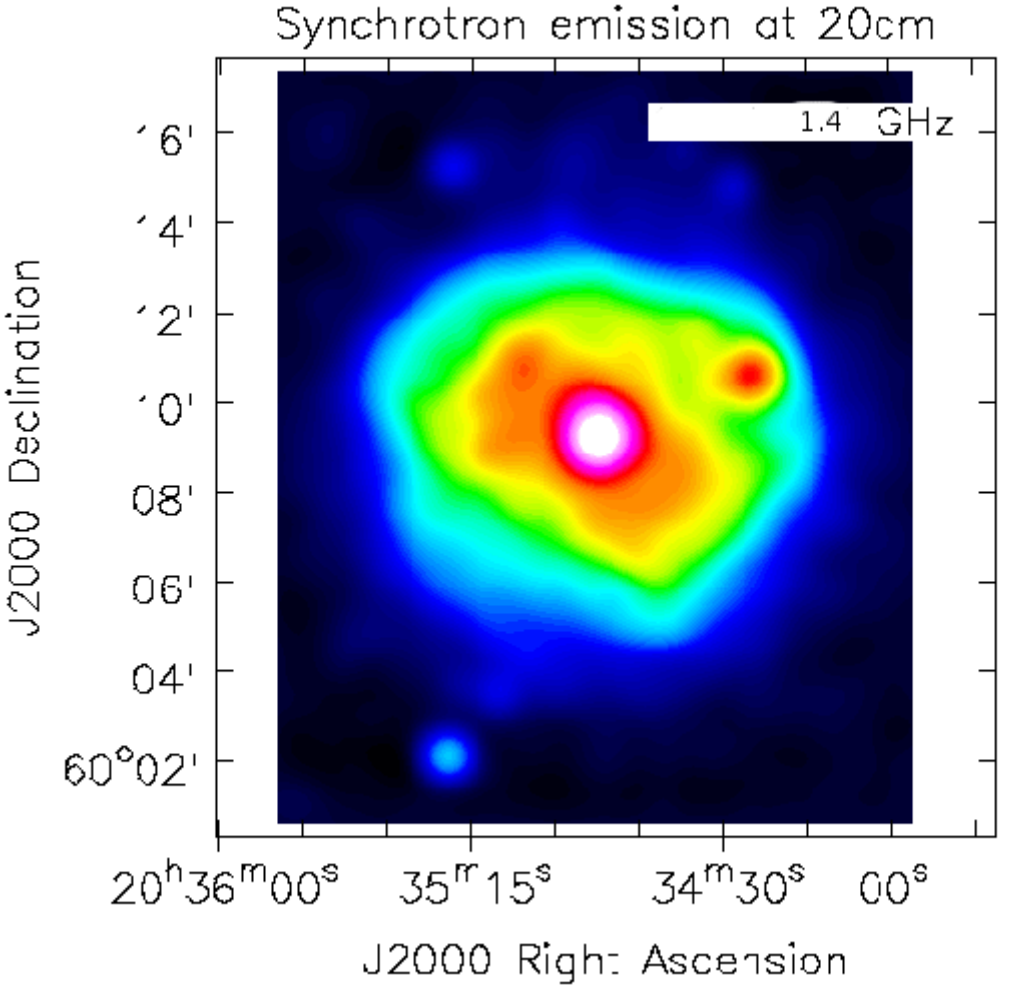
Spectral index map vs **nonthermal** emission at 20 cm (Tabatabaei et al, 2013)





20 cm VLA+EFF (Beck 2008)

Resolution 53"

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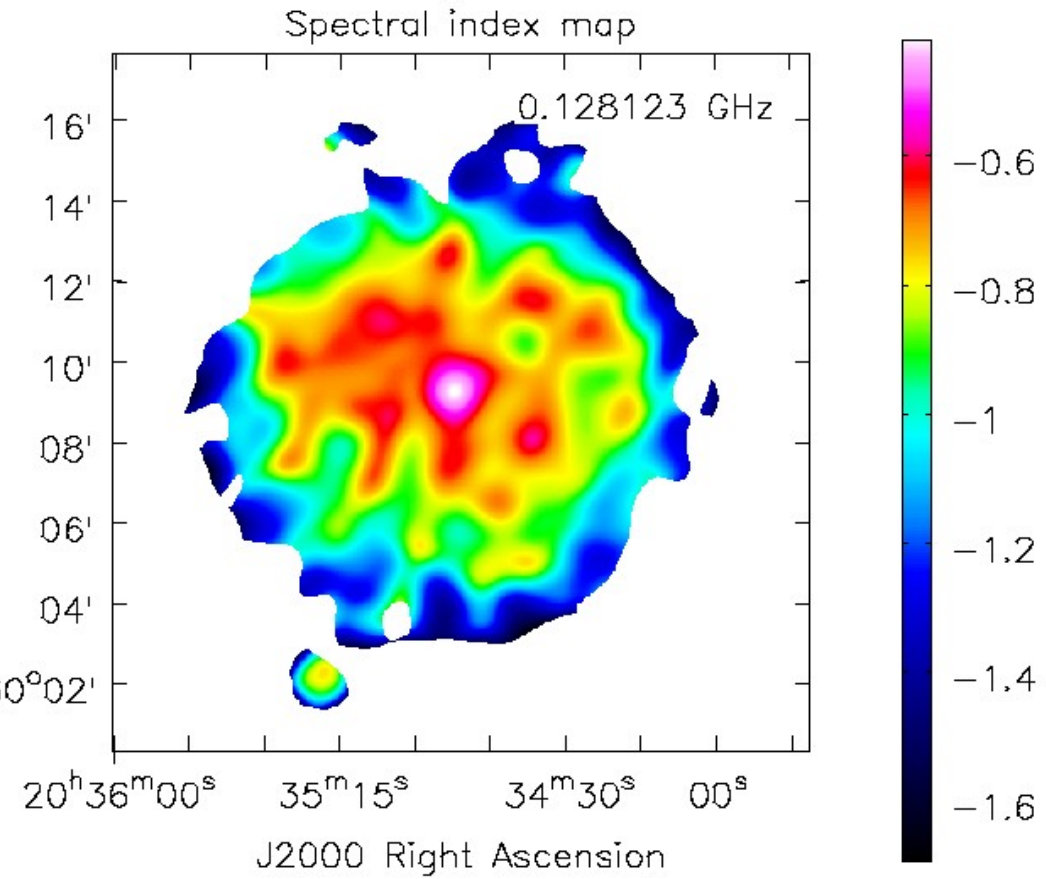
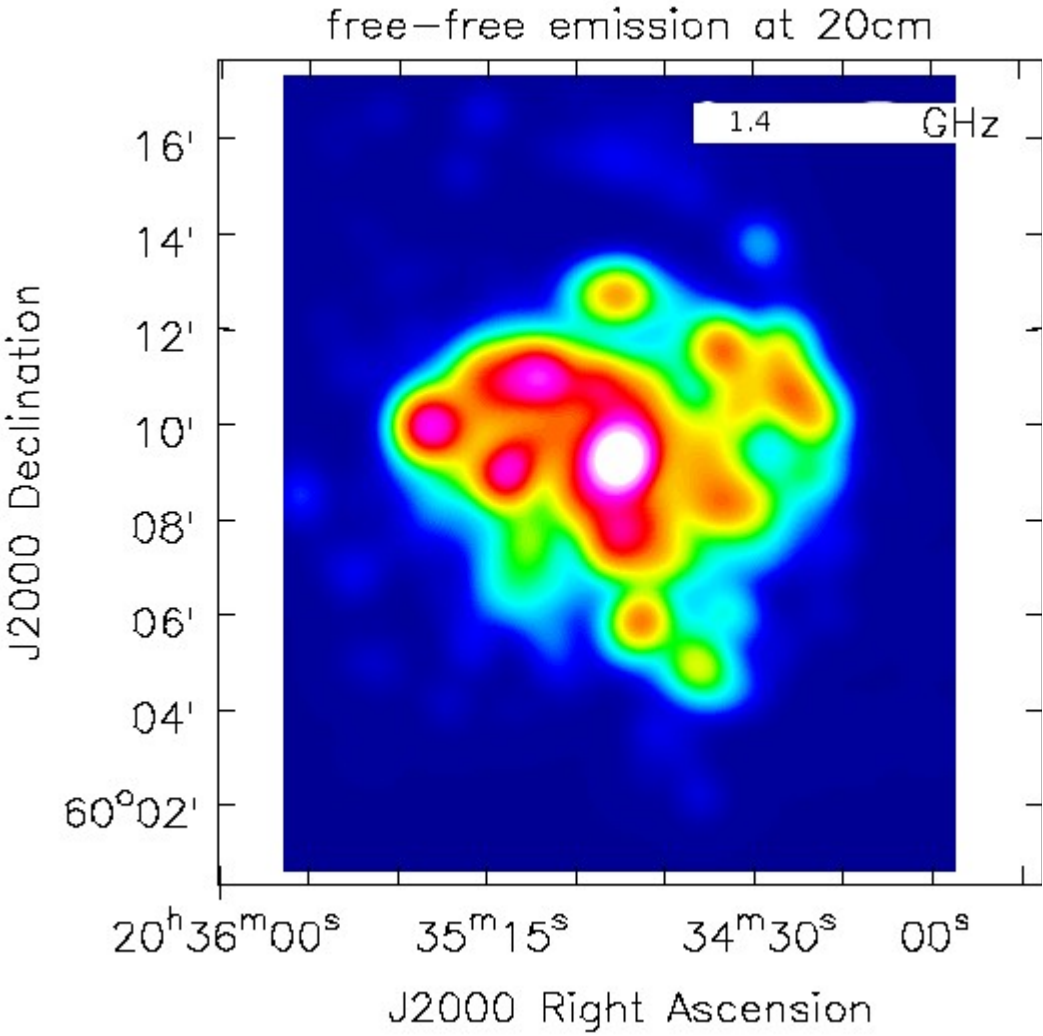
Spectral index map vs free-free emission at 20 cm (Tabatabaei et al, 2013)





Resolution 53"

Spectral index is better correlated with thermal emission, Giant H II regions

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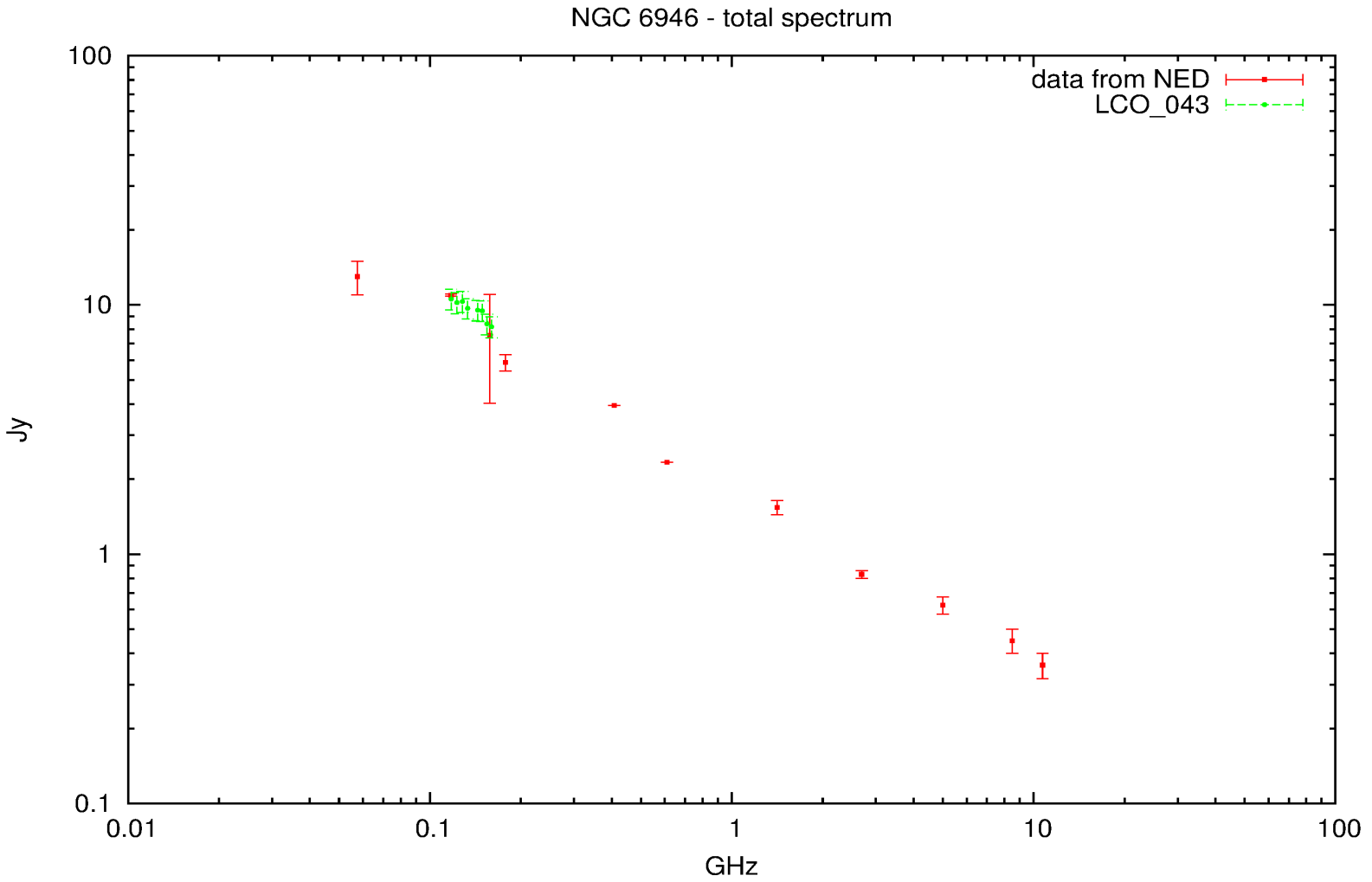
Total radio spectrum of NGC6946 with LOFAR data (green points)



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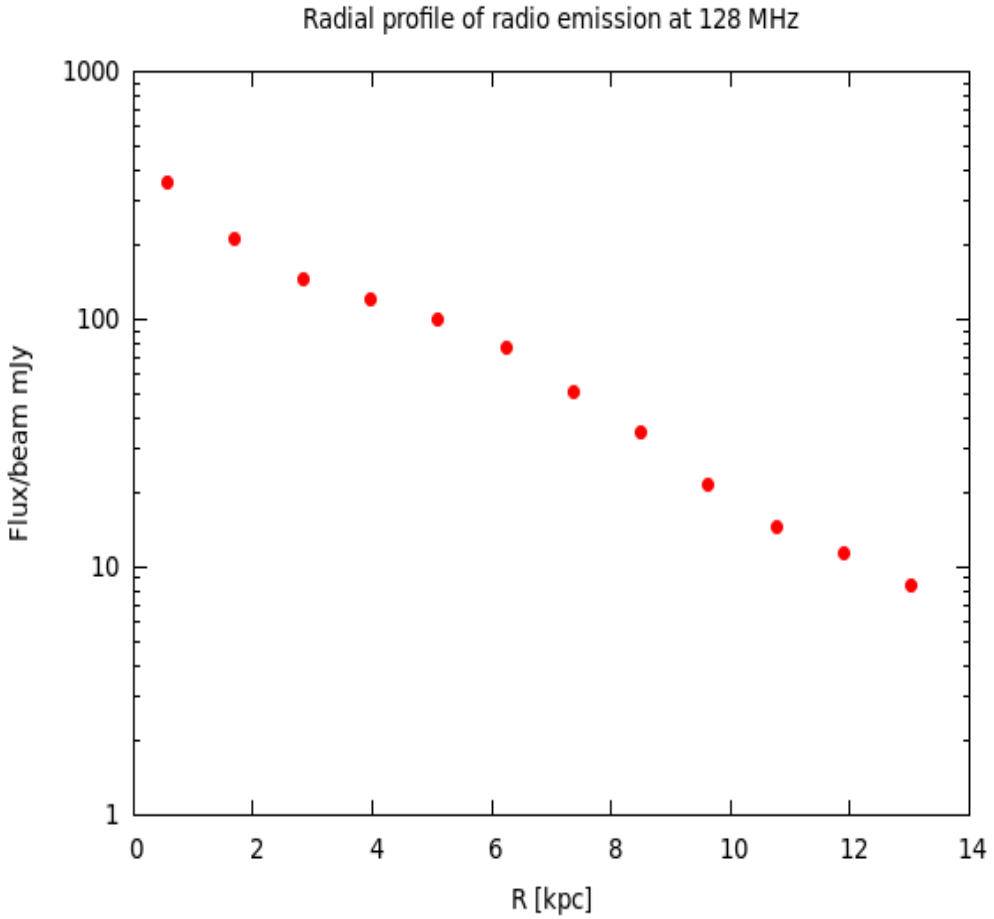
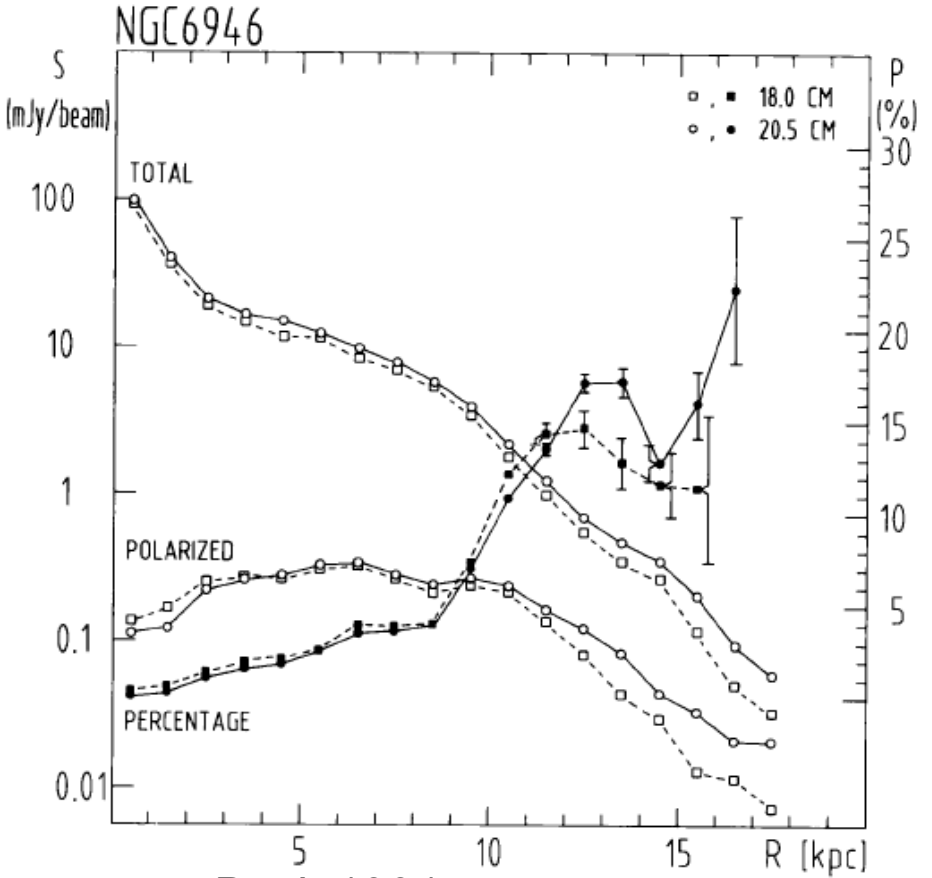
Radial profile of averaged radio emission 128MHz vs 1.4GHz





Beck 1991

Radial profile at 128 MHz behaves in the same way as at 1.4 GHz

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Summary/ Next steps

- Presented preliminary results from few blocks of data: total power map, total flux of the galaxy and spectral index map are promising.
- Complete of direction independent selfcalibration
- Direction depend selfcalibration – crucial to improve results
- Improving spatial resolution to 20 arcsec. (uvrange <20 Klambda).

We plan the following studies:

- Processes that shape total spectrum of NGC 6946 and local thermal absorption in galaxy core and H II regions
- Extended radio ermission, CRE propagation
- RM Synthesis technique