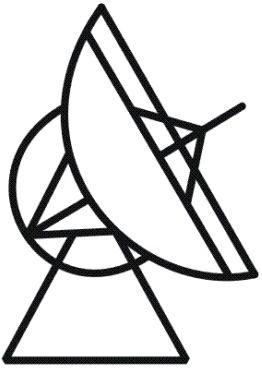


**LOFAR Science workshop @ Zandvoort aan Zee  
05.04.2016**



Max-Planck-Institut  
für Radioastronomie

**Universität Bielefeld**

# **Pulsar Science with single stations in Germany**

**Caterina Tiburzi**

MPIfR @ Bonn – University of Bielefeld

Joris Verbiest, Stefan Osłowski, Andreas Horneffer,  
Jörn Kunsemöller, Nataliya Porayko, Aris Noutsos

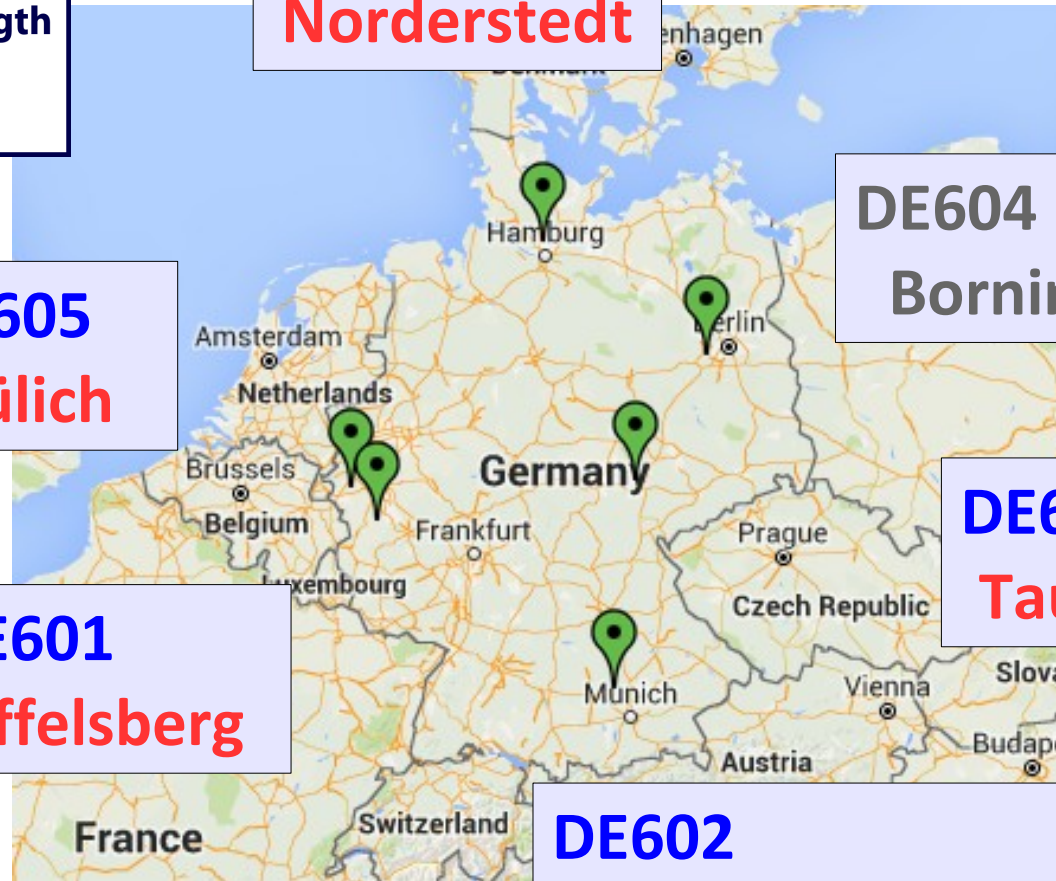
# Contents

- Station location
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# The GLOWing stations



The German  
Long Wavelength  
Consortium



**DE609**  
**Norderstedt**

**DE604**  
**Bornim**

**DE605**  
**Jülich**

**DE603**  
**Tautenburg**

**DE601**  
**Effelsberg**

**DE602**  
**Unterweilenbach**



**SE607**  
**Onsala**

# Core vs. German stations

## Core

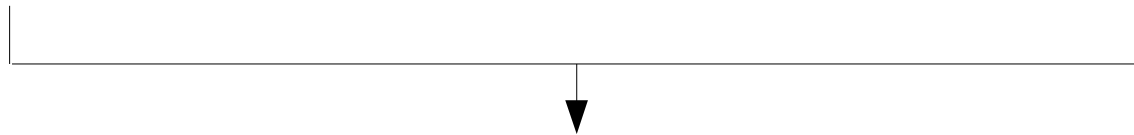
48 HBAs per station

24 phased-up stations

## German stations

96 HBAs per station

5 independent stations



Effective area differs by  
approximatively a factor of 12

Weekly observations  
thanks to owner's time

The German stations are complementary to the Core, providing less sensitive observations, but with higher cadence

# Computing resources

- Data streamed from each stations to 12 recording machines in Bonn
  - Raw data pre-processed on the recording machines
  - Pre-processed data copied to Bielefeld and Bonn
  - A third copy on tapes
- 
- A new computing facility is currently being finalized in Jülich (Germany)
  - Part of the raw data will be streamed and pre-processed in Jülich

*Current  
status*

*Future  
status*

Refer to Jörn Künsemöller (Bielefeld University) and  
Andreas Horneffer (MPIfR)

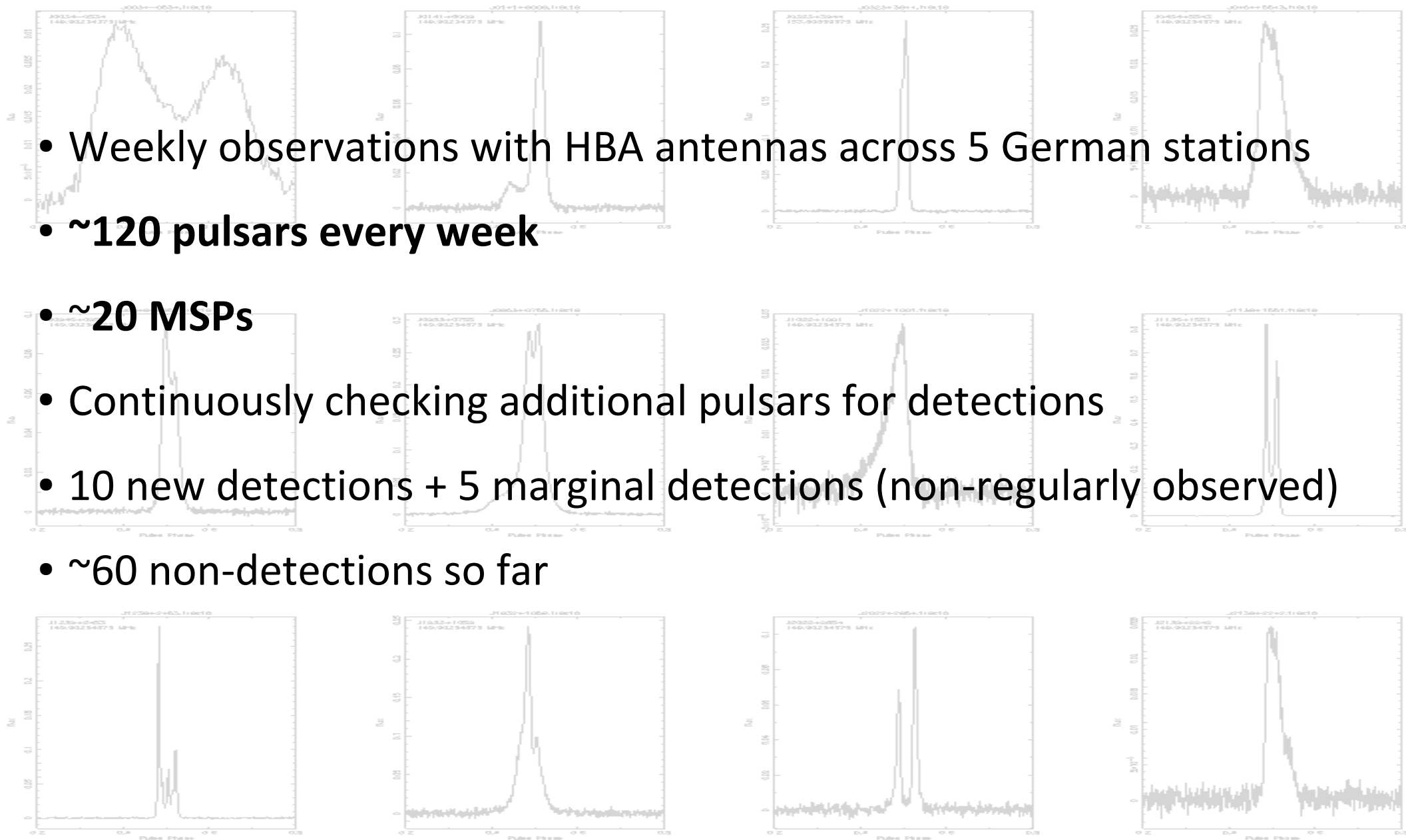
# Pulsar monitoring

- Weekly observations with HBA antennas across 5 German stations
- **~120 pulsars every week**

- **~20 MSPs**

- Continuously checking additional pulsars for detections
- 10 new detections + 5 marginal detections (non-regularly observed)

- ~60 non-detections so far

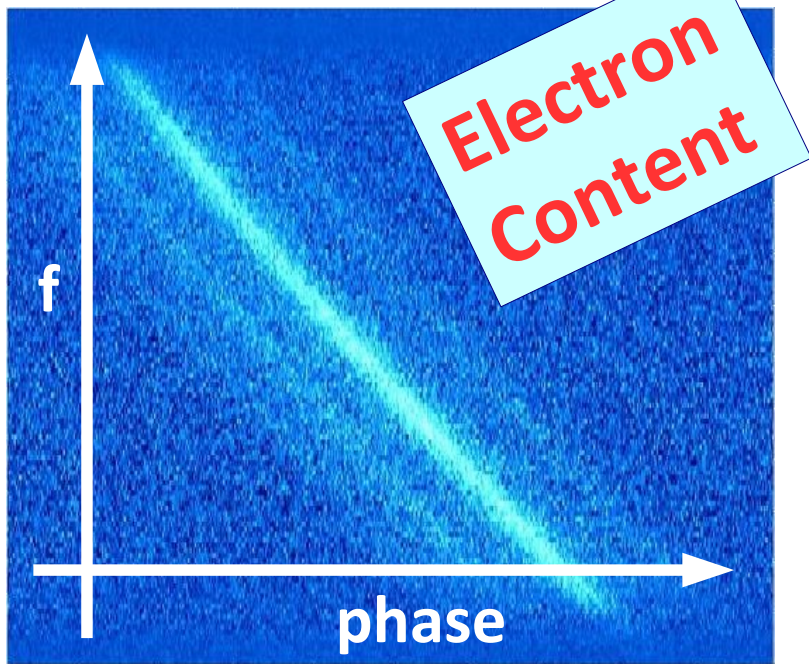


# Pulsars and interstellar medium

Pulsars are probes of the ionized part of the interstellar medium

$$\Delta t \propto \frac{DM}{f^2}$$

$$DM = \int_{\text{pulsar}}^{us} n_e dl$$

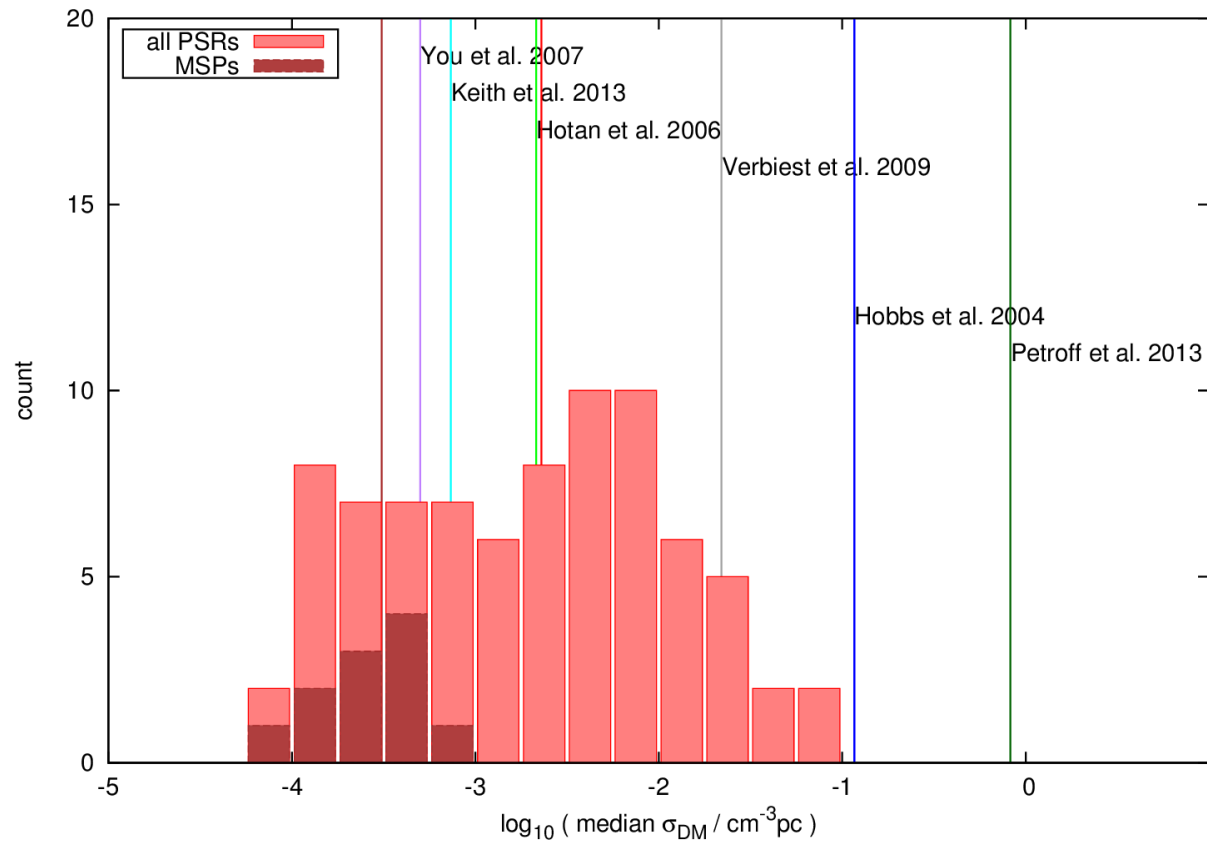


Effects such as **dispersion, scattering, scintillation, Faraday rotation**, have an **inverse dependence on observing frequency**



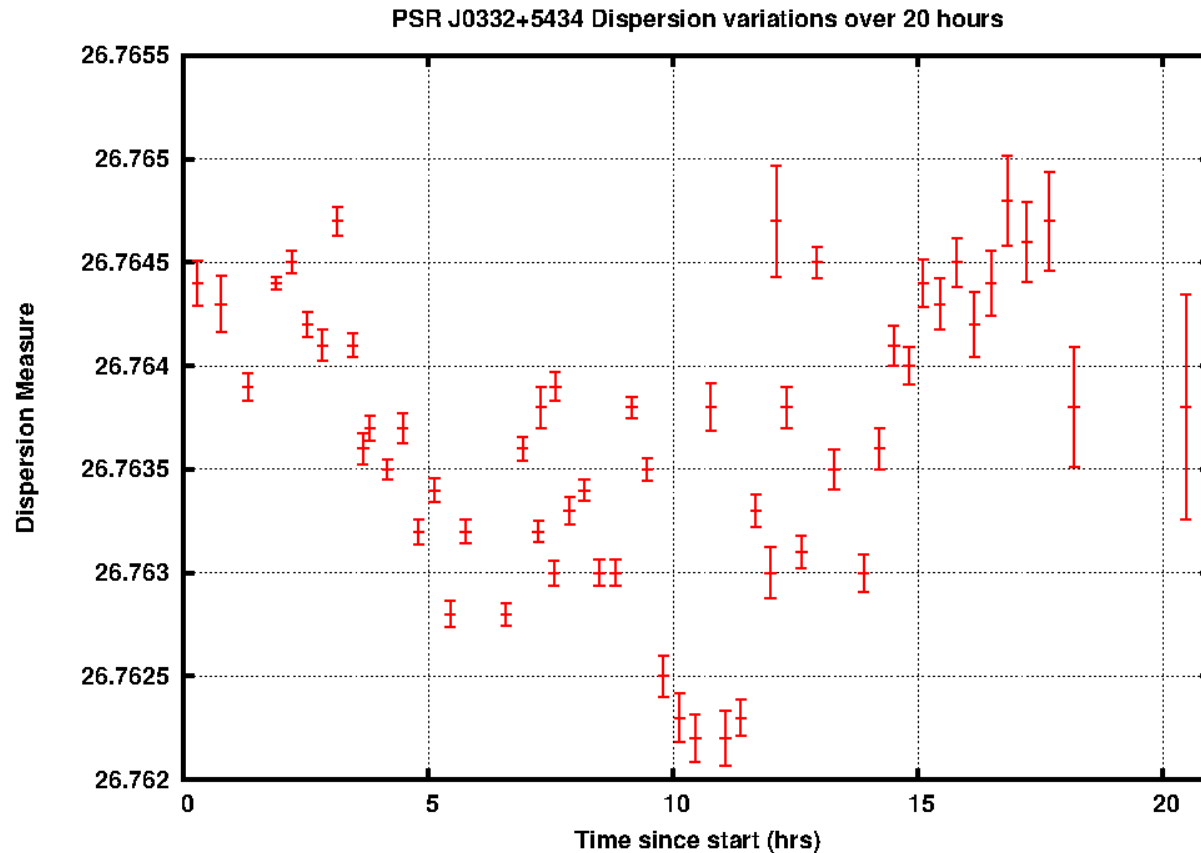
**HIGH PRECISIONS AT LOW FREQUENCIES**

# Science I: Probing structure and turbulence of the IISM

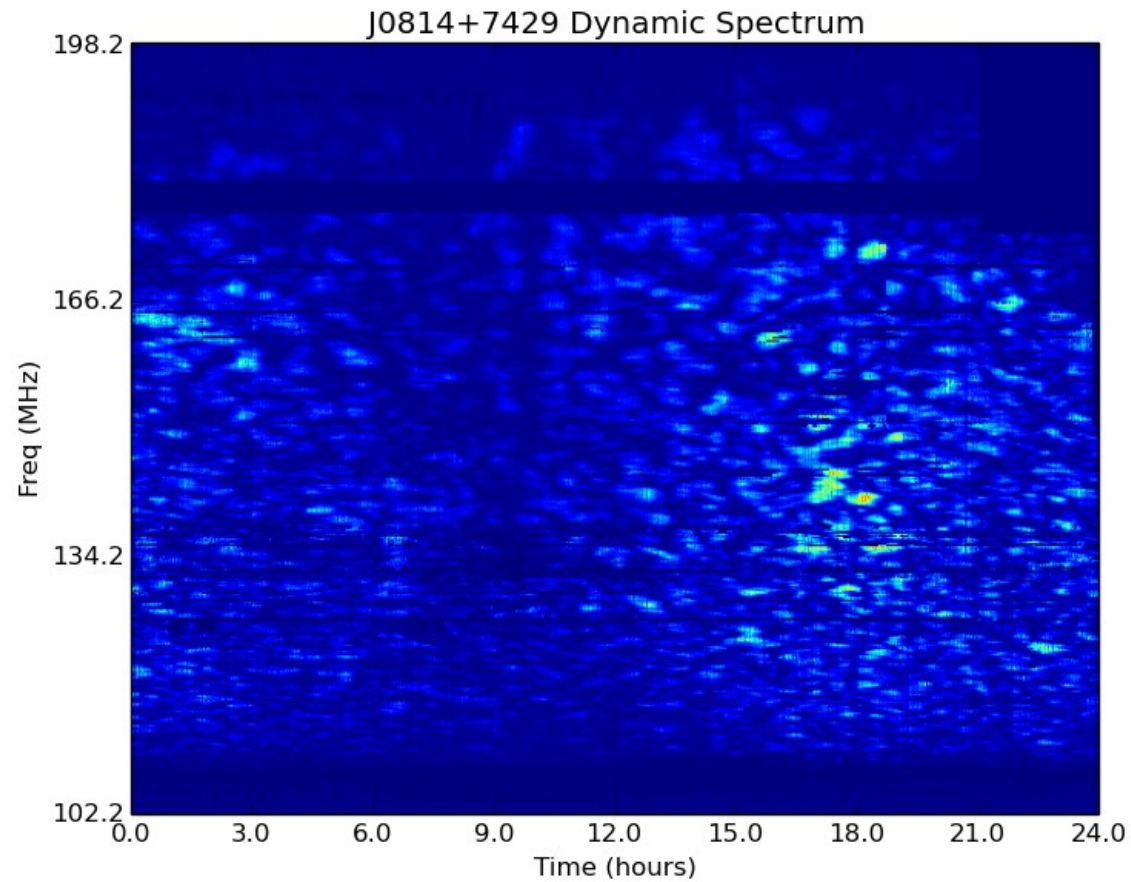




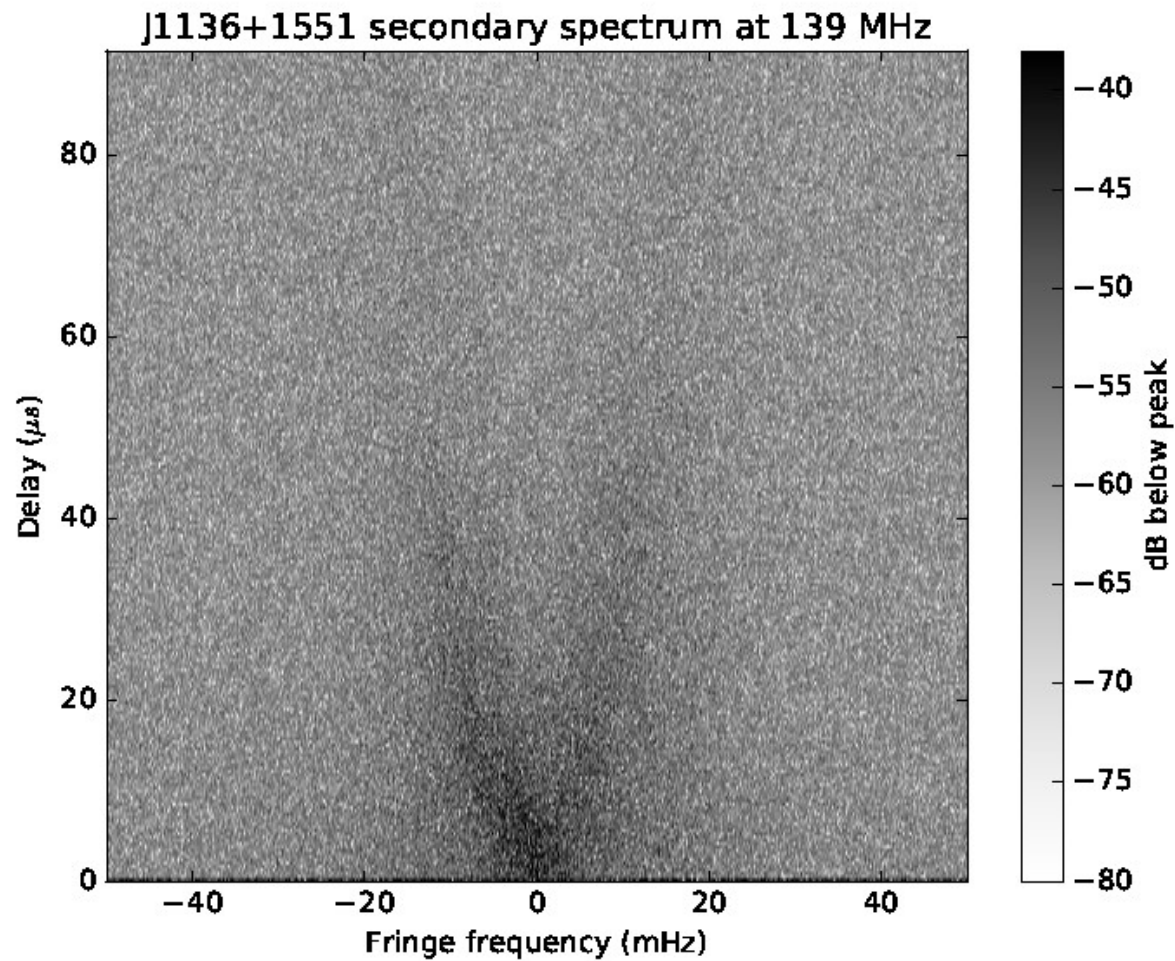
# Science II: Probing the intra-day variability of the IISM



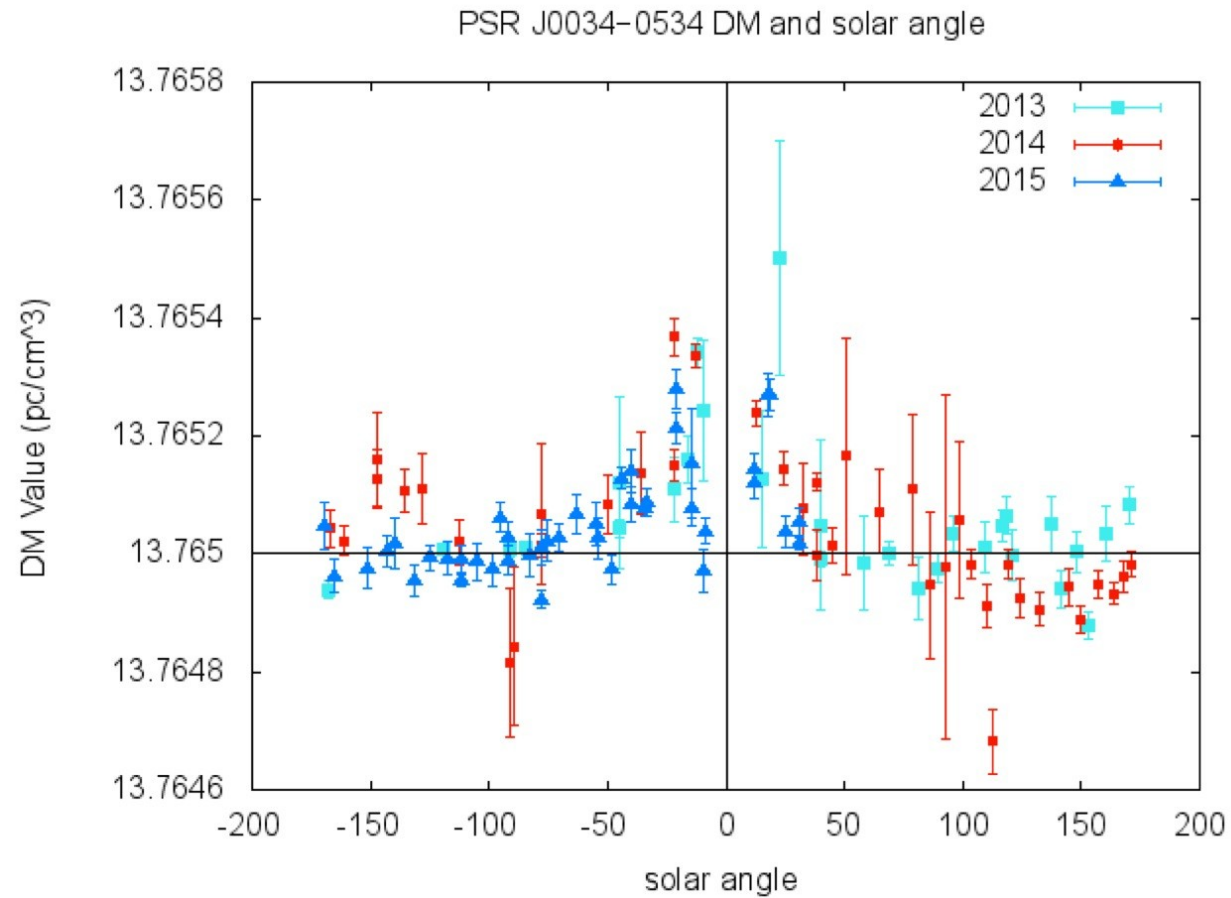
# Science III: Scintillation studies



# Science IV: Scintillation arcs



# Science V: Probing the Heliosphere



# Science VI: Long-term RM variations



See **Nataliya Porayko's**  
talk!

# Summary

- Weekly pulsar monitoring ongoing with 5 German stations and the Swedish station
- 120 pulsars being monitored
- New computing facilities at the last commissioning stages
- A large variety of ongoing ISM/IPM studies, reaching an unprecedented level of measurement accuracy