(Bilous, Kondratiev, Sobey, Hassall and LOFAR PWG)

LOFAR Pulsar Census (HBA)

Observing all normal pulsars in selected sky region

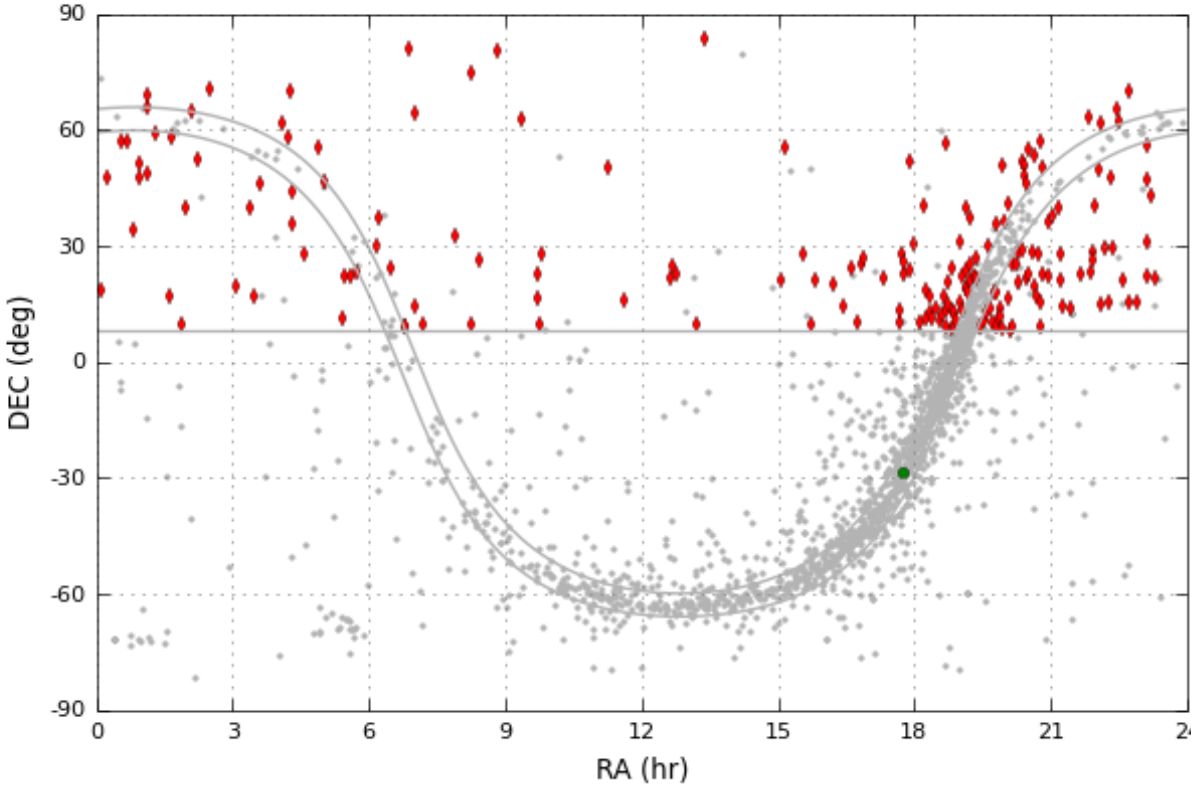
↓

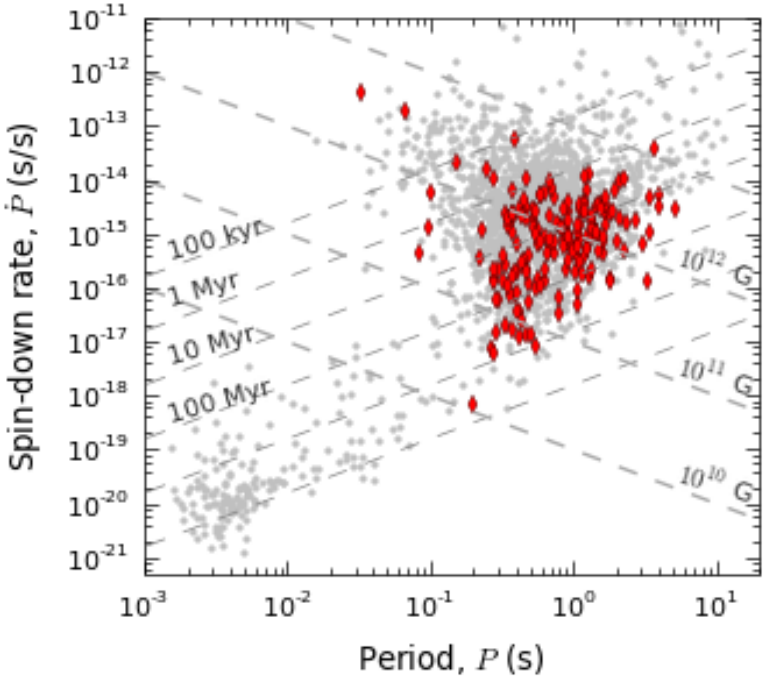
Studying pulsar radio emission and ISM properties

+ Large uniform sample of sources

+ Unique low-frequency data

Sample PSRs: 194 northern non-MSPs outside galactic plane.





1) DECJ > 8deg & |GB| > 3 deg
2) Not MSP

3) Not in globular cluster
4) Well-known coordinates
   (uncertainty < 0.5 of LOFAR beam)
5) Known DM (previously detected in radio)

Note: No selection by (estimated) flux or scattering – ready for unexpected.

Observations:

- Cycle 1 (LC1_003)
- LOFAR HBA
- 20 min per source or 1000 pulses (77 hours total)

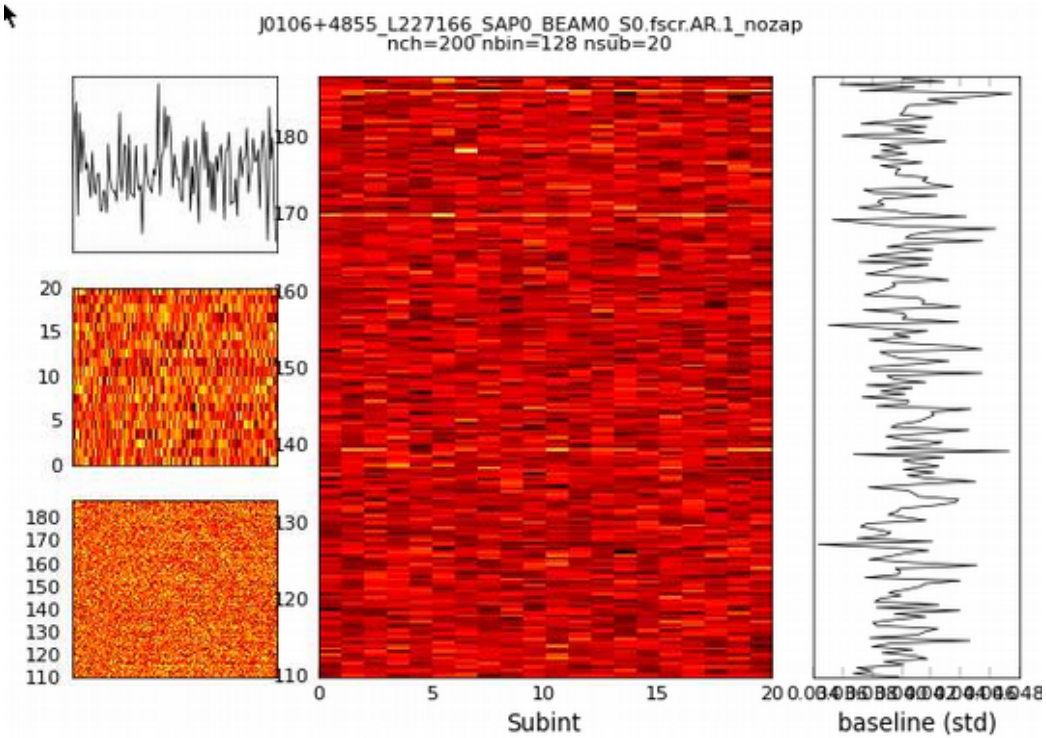
- all available Core stations at the time of obs
- coherent Stokes,
- 8-bit sampling
- 400 subbands,
- variable # of channels / time resolution
- incoherent dedispersion

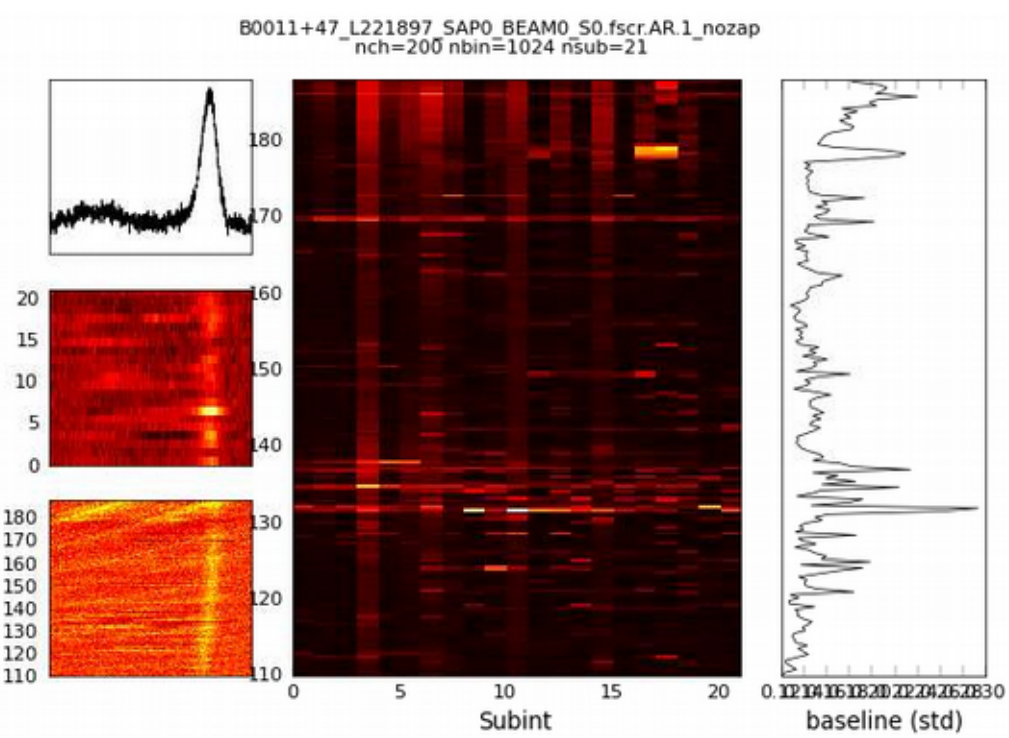
All observations and pipeline processing done by Vlad Kondratiev

RFI situation:

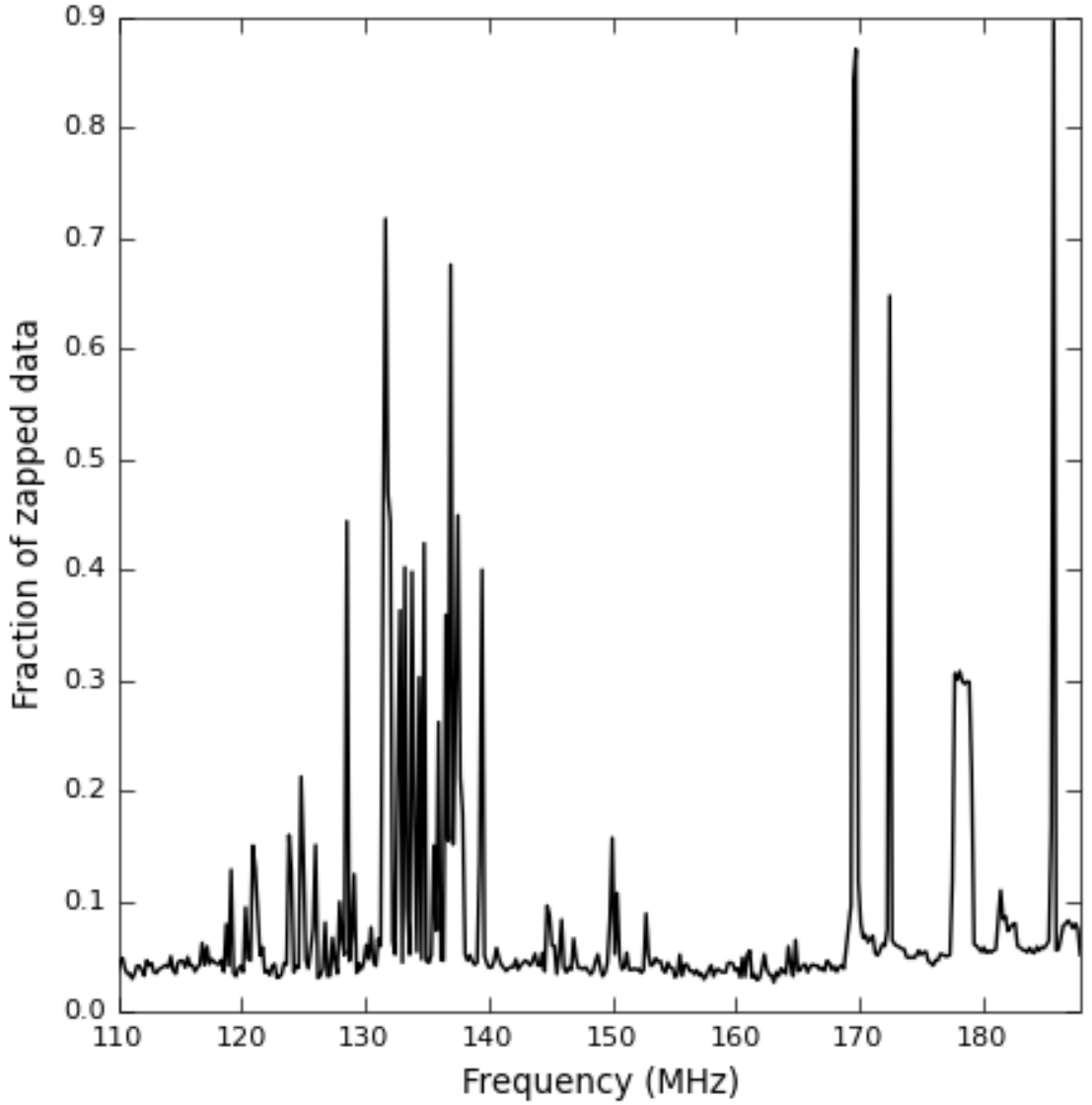
- **Varying between observations**
- **Ranging from**

“good” **to** **“horrible”**





Fraction of zapped data vs. frequency



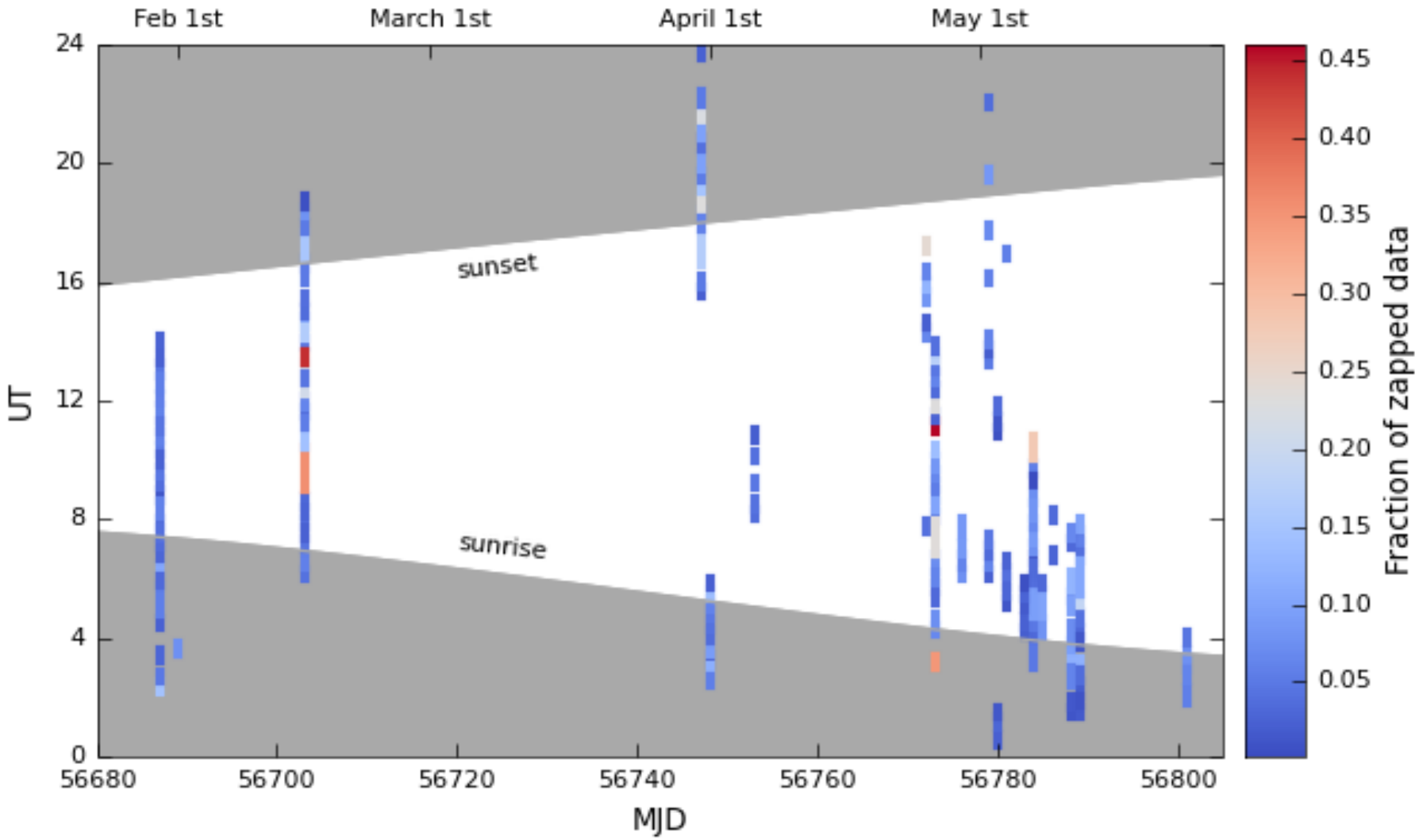
Zapping RFI on data files with

– 0.195 MHz channels

– 60-s integrations

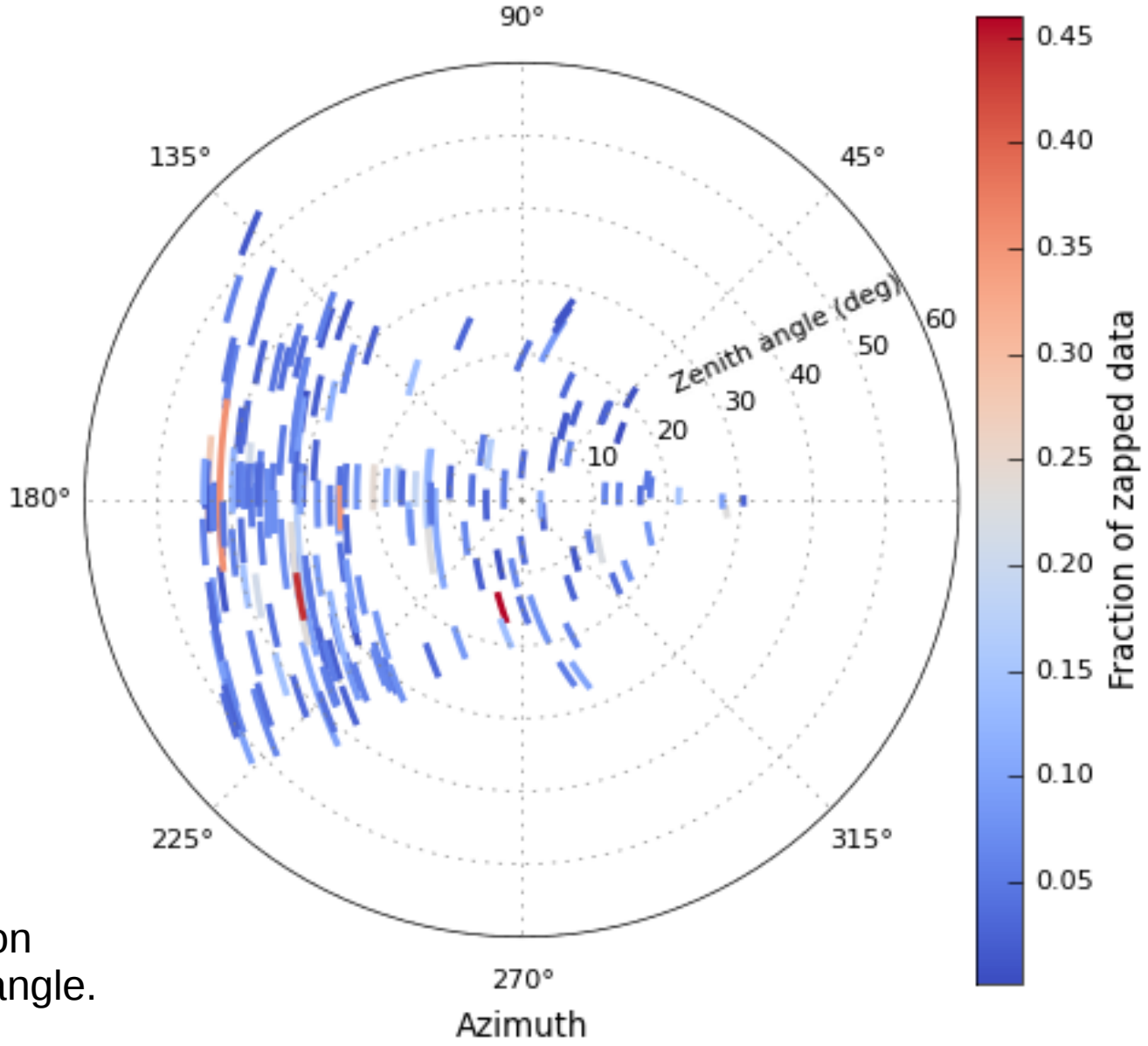
Large fraction of RFIs are narrower than the frequency/time resolution.

Fraction of zapped data w.r.t. day/night



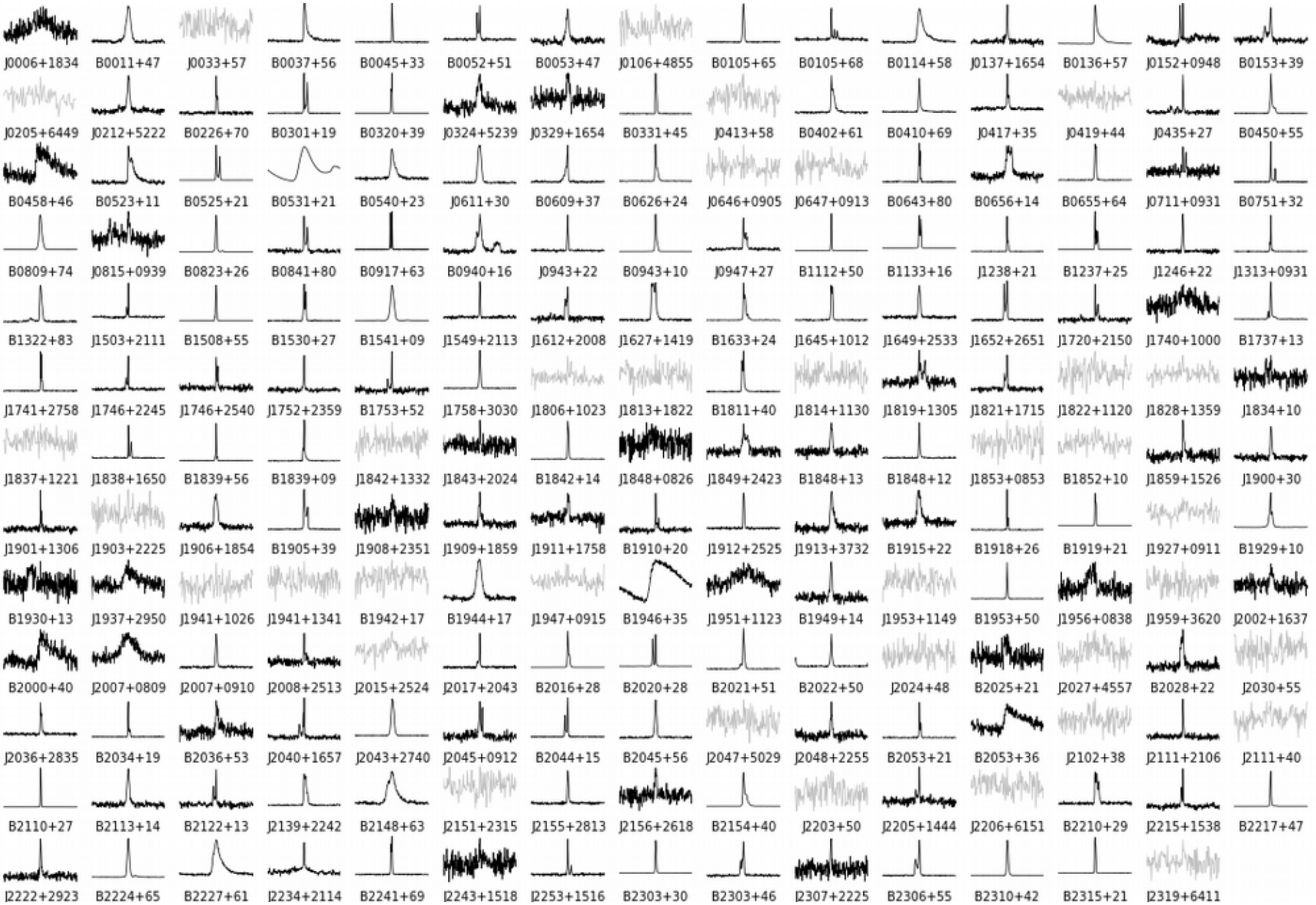
Poor night coverage, but no clear dependence on the time of day.

Fraction of zapped data w.r.t. azimuth & zenith angle



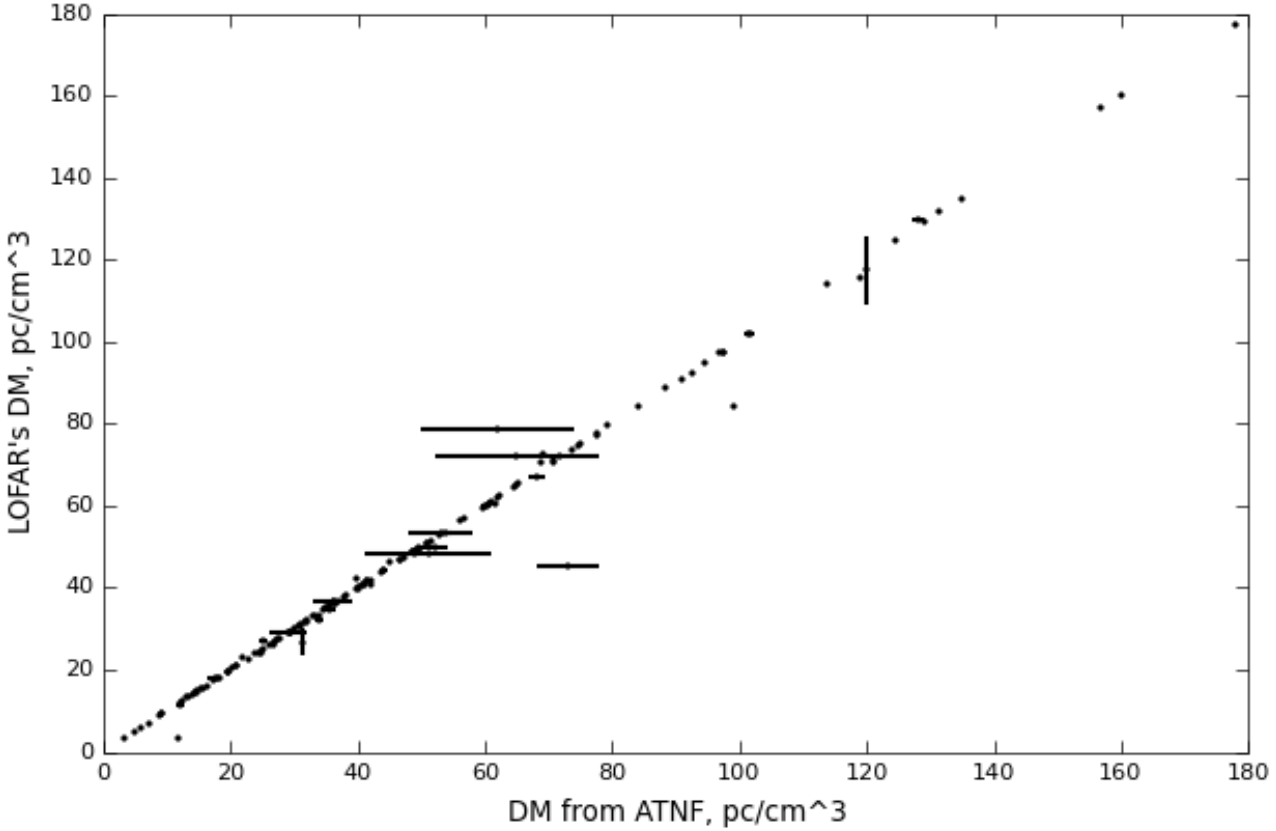
No dependence on azimuth / zenith angle.

In total, 158 PSRs detected (81%). 153 had peak S/N > 10.



Bilous et al in prep

First scientific result: improving DM values from the ATNF catalogue



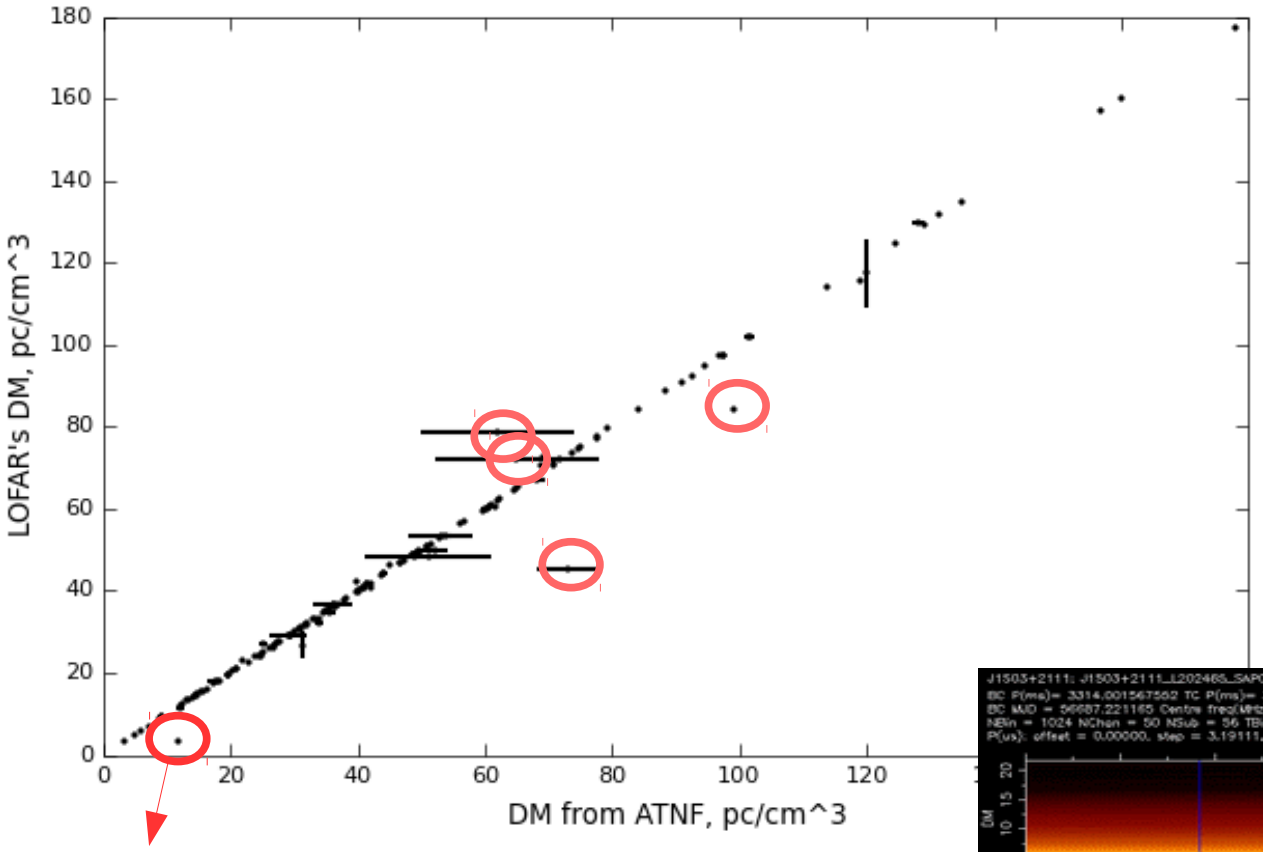
Median DM_err in ATNF: 0.025 pc/cm^3

Median DM_err in our data: 0.0015 pc/cm^3

Median correction: |dDM|/DM = 0.18%

Median significance of DM corrections: |dDM|/DM_err = 43

First scientific result: improving DM values from the ATNF catalogue



J1503+2111

DM_atnf = 11.75 +/– 0.06 pc/cm^3
DM_lofar = 3.260 +/– 0.004 pc/cm^3

For a few sources
ATNF DM is incorrect.

Median DM_err in ATNF:
0.025 pc/cm^3

Median DM_err in our data:
0.0015 pc/cm^3

Median correction:
|dDM|/DM = 0.18%

Median significance of DM corrections:
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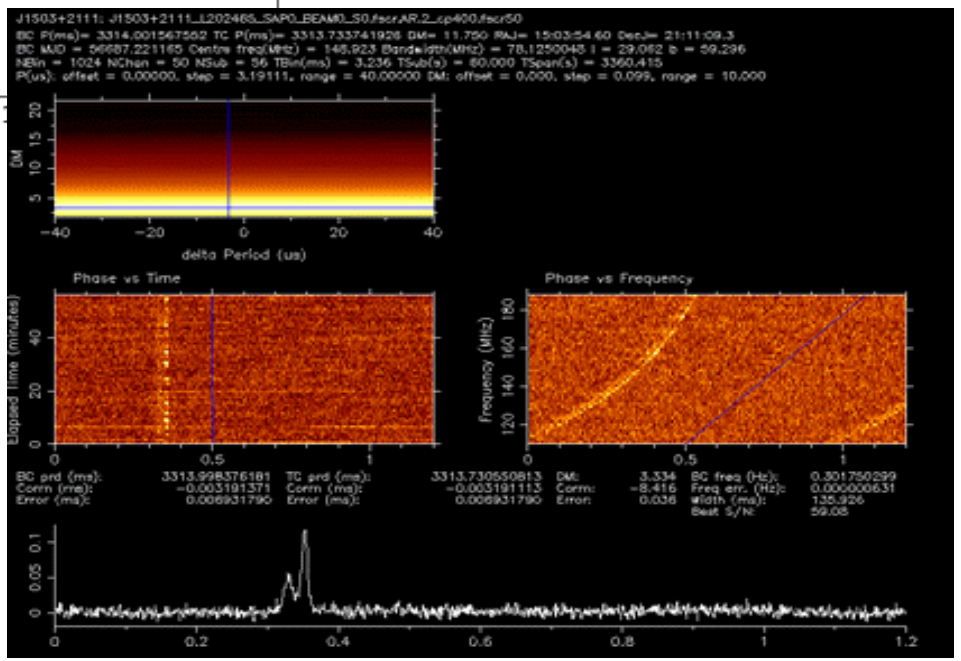


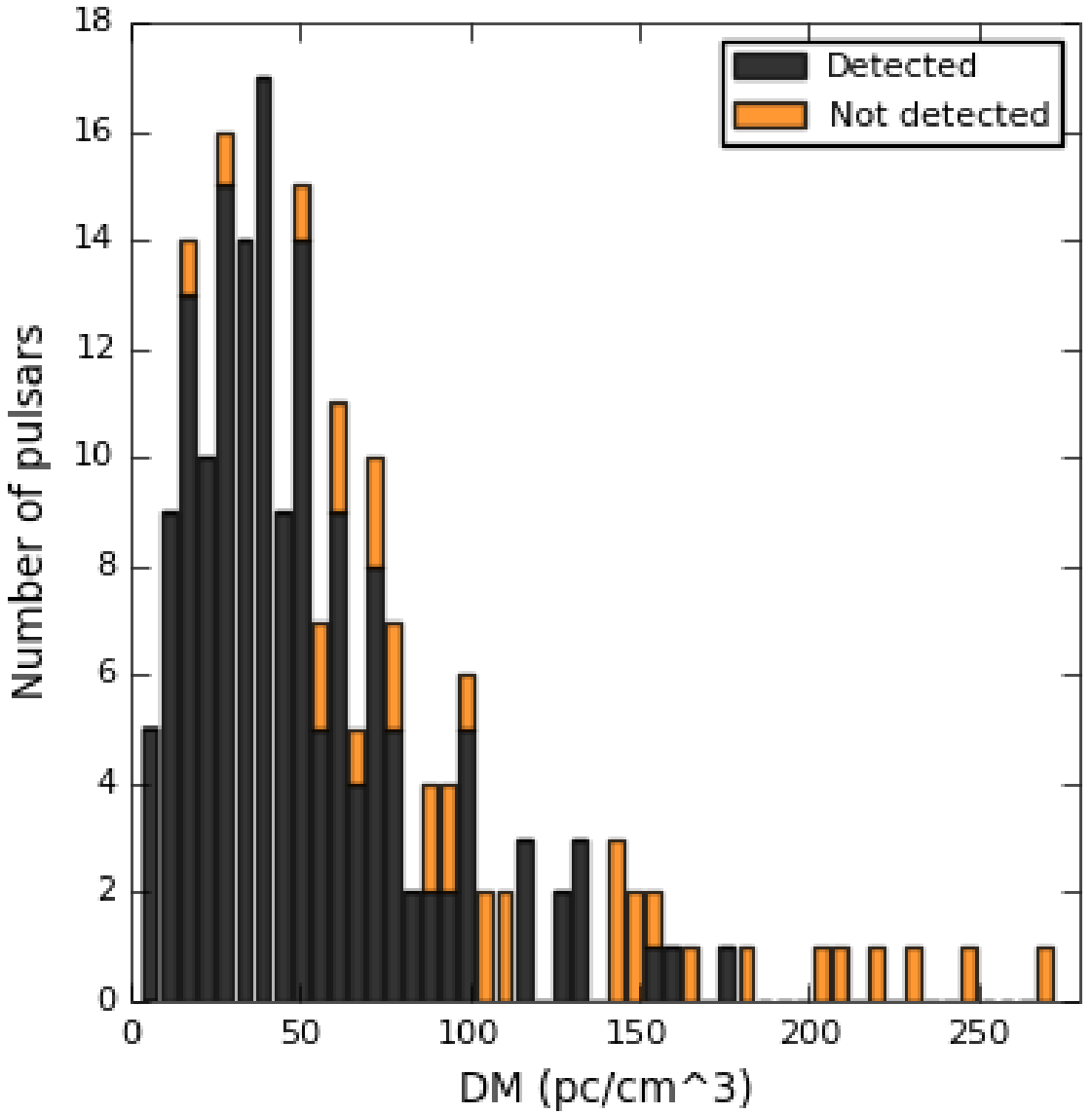
Next stage:

- profile sample & fluxes (Anya Bilous)
  – Vlad Kondratiev's flux calibration software (lofar_fluxcal.py)

- RMs (Charlotte Sobey)
  – 57 detected PSRs with previously unpublished RMs, far more precise RMs for 71 more sources.

Stay tuned!

Distribution of detected pulsars on DM



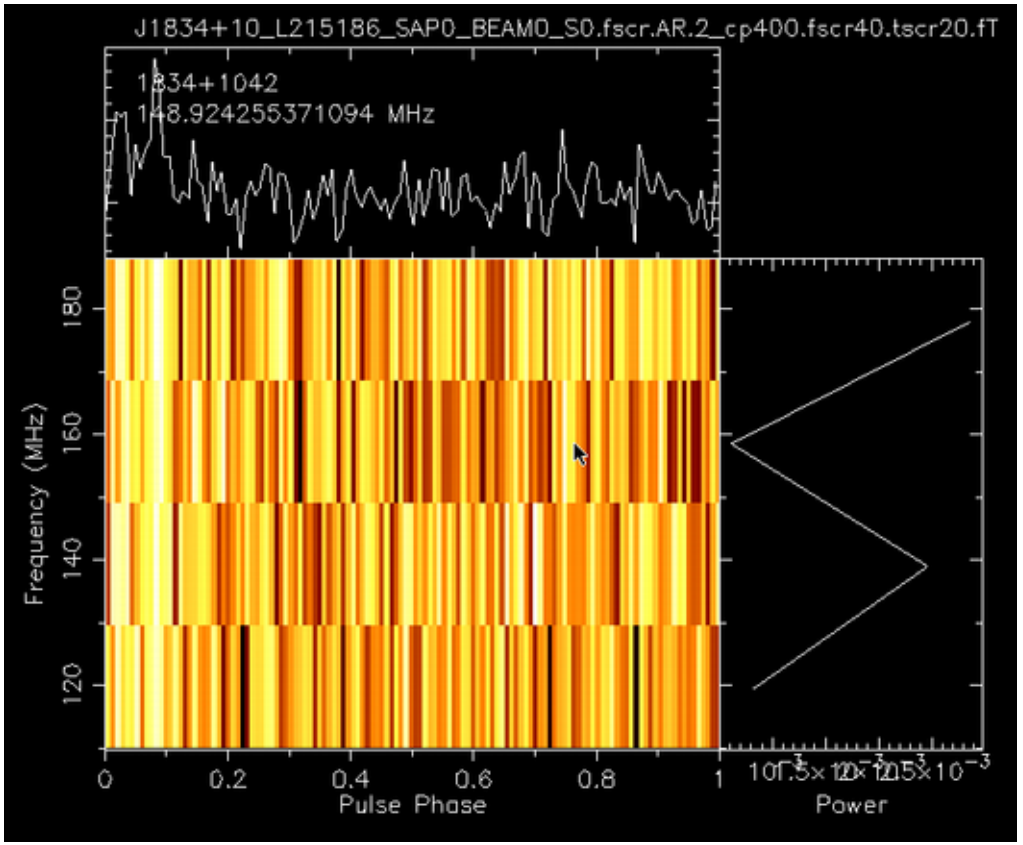
The larger DM →
larger scattering
smaller probability of detection

max DM – 180 pc/cm^3

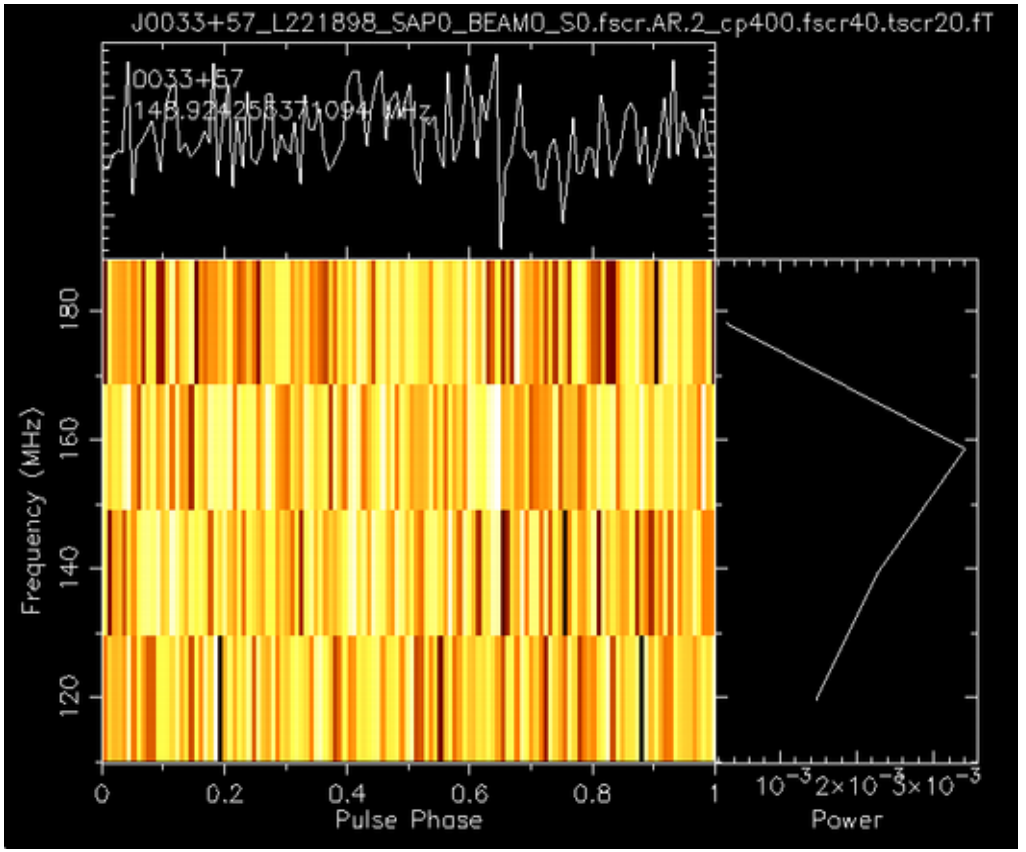
Detection:

the decision was based on human scrutiny (examination of scrunched spectra and waterfall plots)

J1834+10, detected

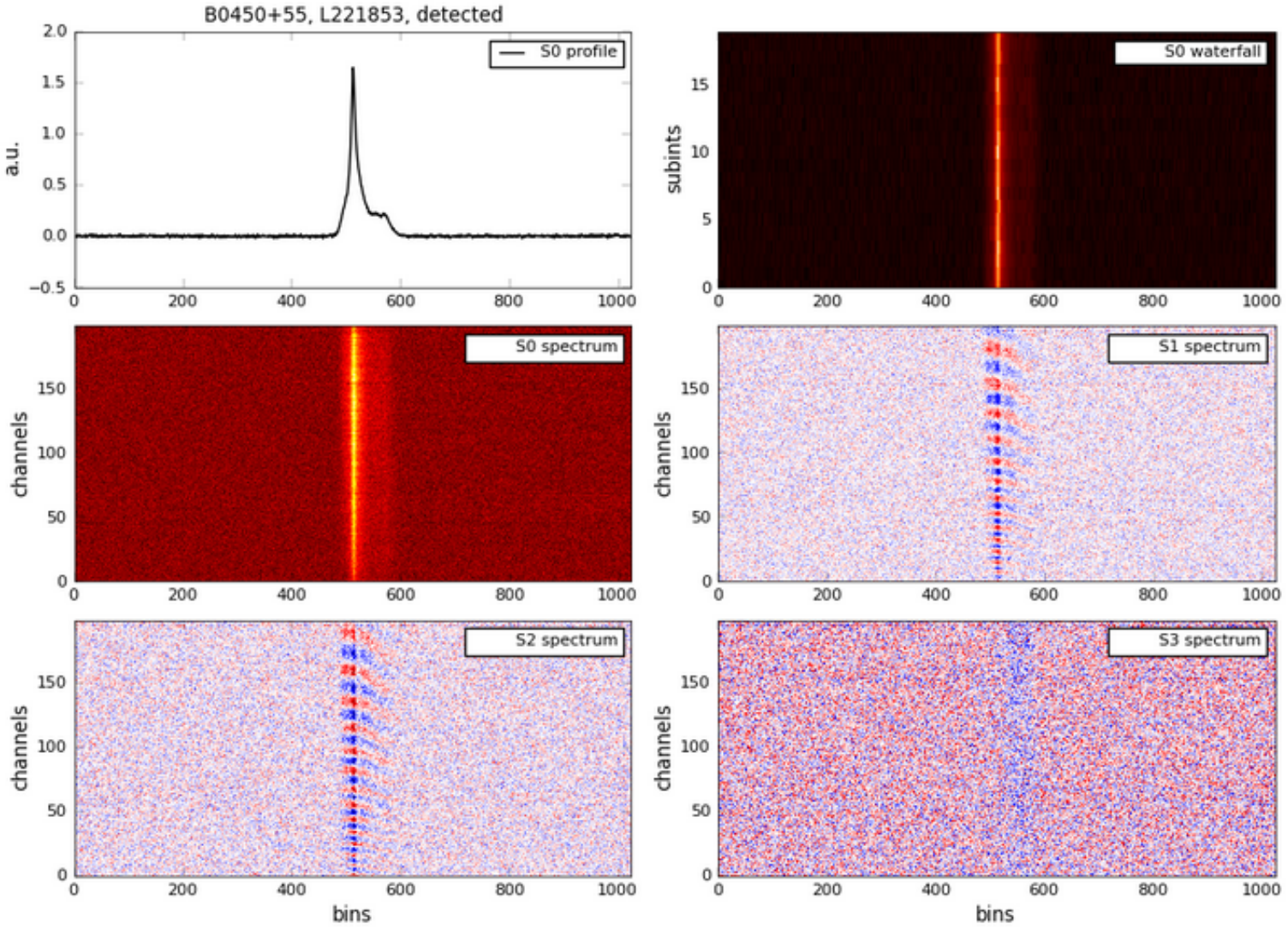


J0033+57, not detected



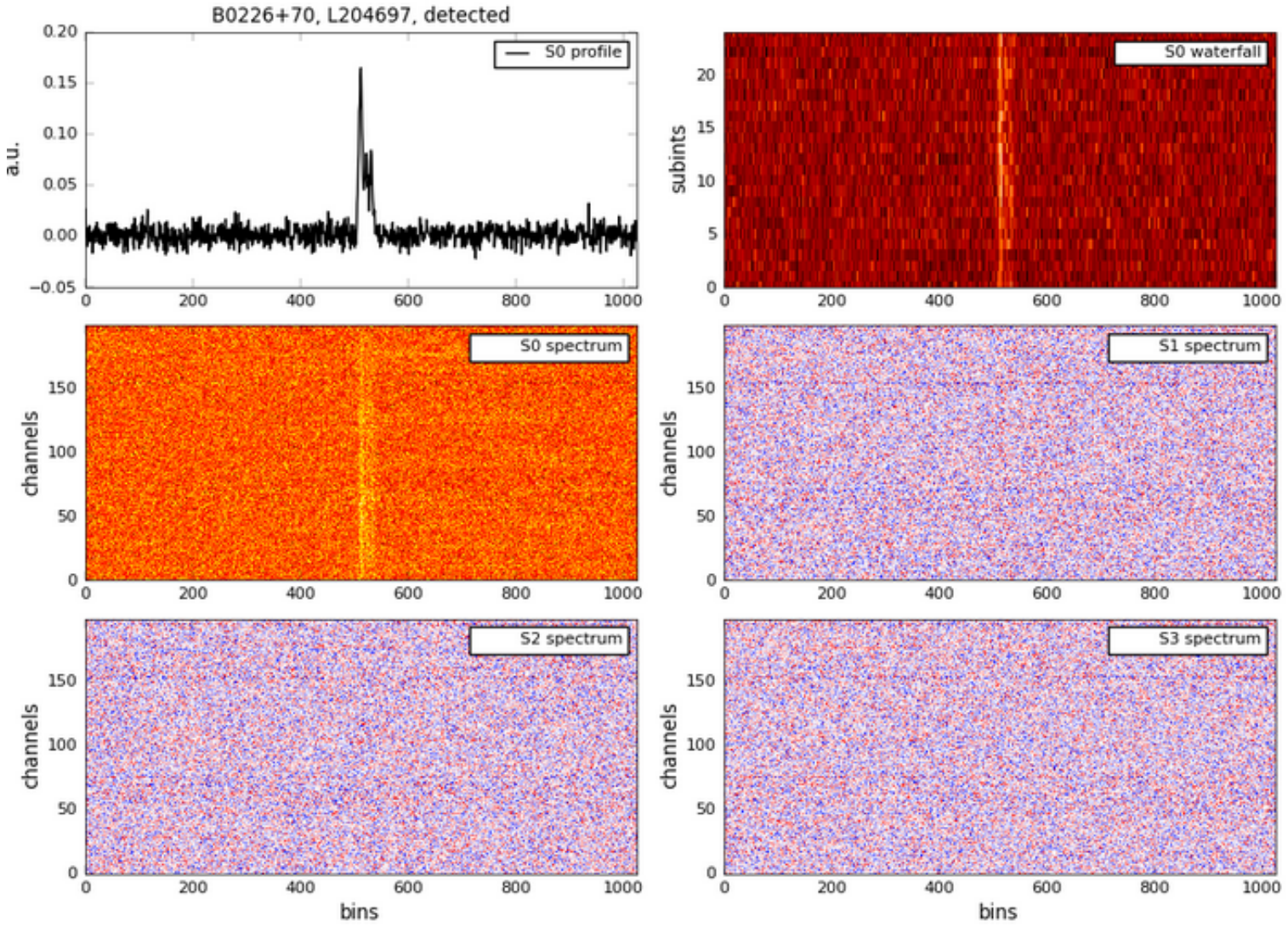
In total, 159 PSRs detected (82%)

Examples of **uncalibrated** IQUV spectra



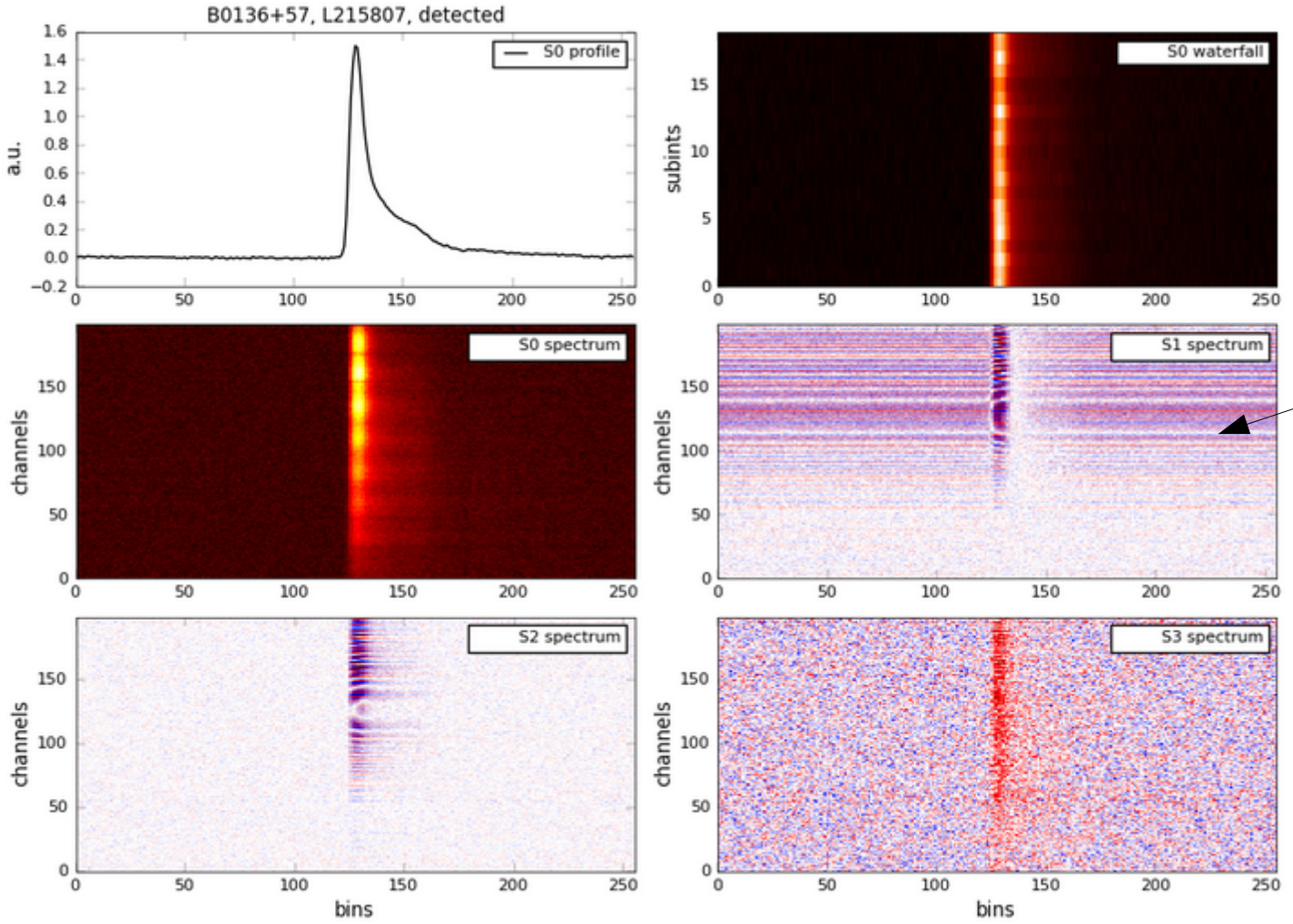
Some of the pulsars look really nice.

Examples of **uncalibrated** IQUV spectra



Most of the fainter pulsars do not have visible linear (RM is too big?) or circular polarisation.

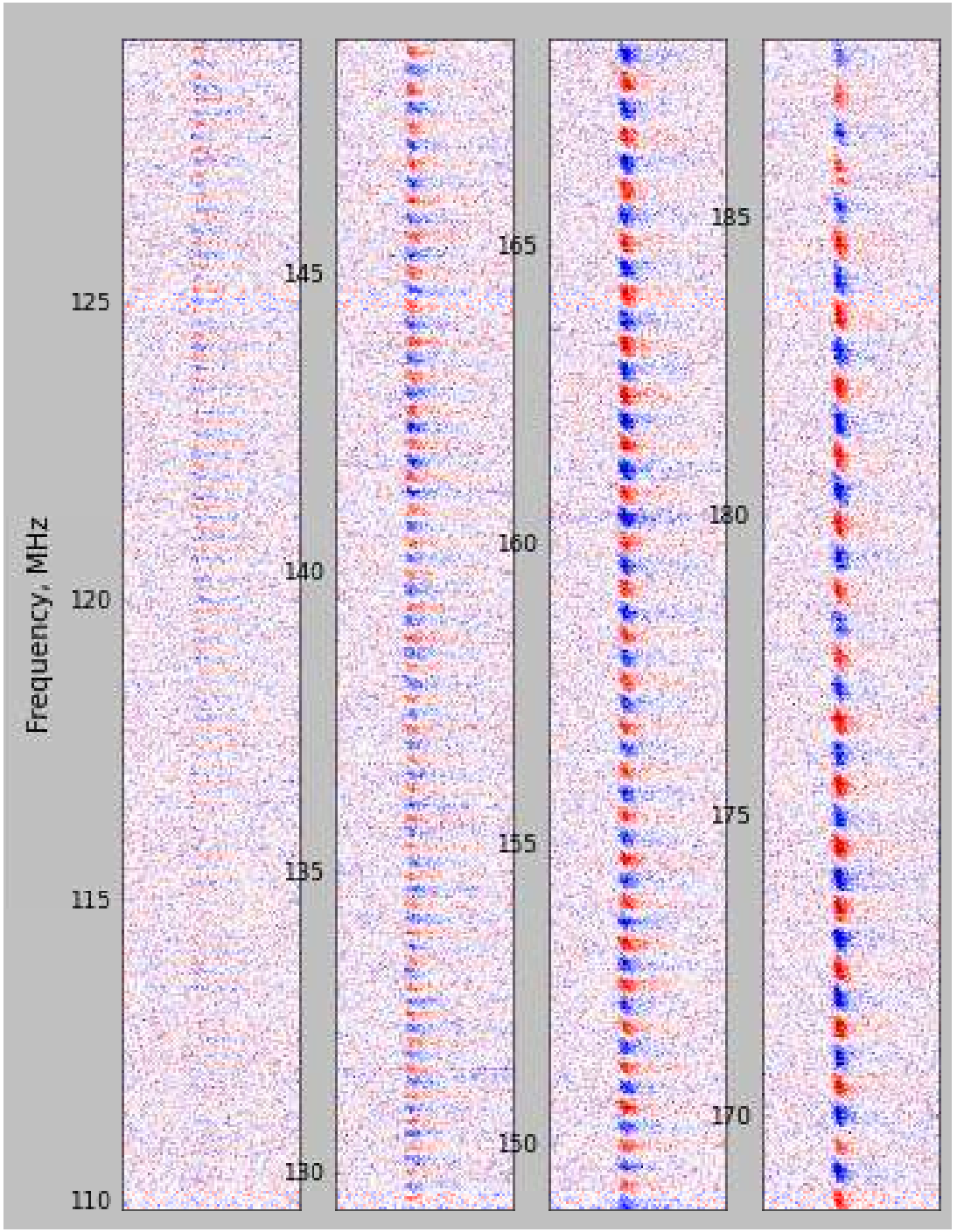
Examples of **uncalibrated** IQUV spectra



baseline removal artifact

Sometimes one can see a hint of Faraday rotation going below the frequency resolution limit (400 channels here).

Examples of **uncalibrated** IQUV spectra



Same pulsar, S1,
a bit better frequency resolution
(6400 channels)