Crab observations: polarisation and RFI from aircraft

Olaf Wucknitz

wucknitz@astro.uni-bonn.de

Argelander-
Institut
für
Astronomie

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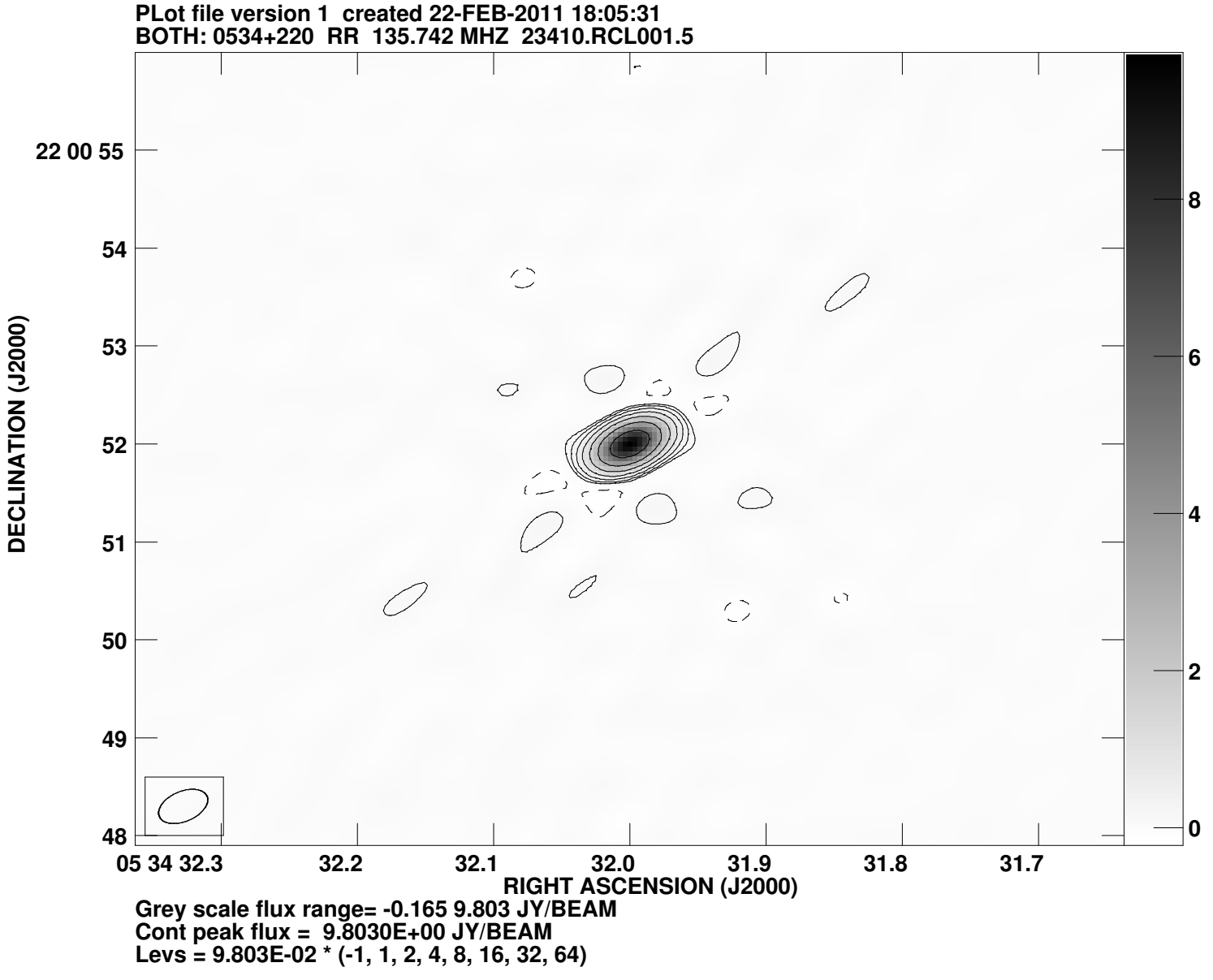
Crab observations: polarisation and RFI from aircraft

- polarisation of the crab pulsar
  - ⋆ expectation
  - ⋆ POSSM plots (spectra)
  - ⋆ RM synthesis
- wide-band RFI from aircraft
  - ⋆ RFI spikes
  - ⋆ mapping the signal (3-d)
  - ⋆ aircraft trajectory
  - ⋆ what is it?

Observations

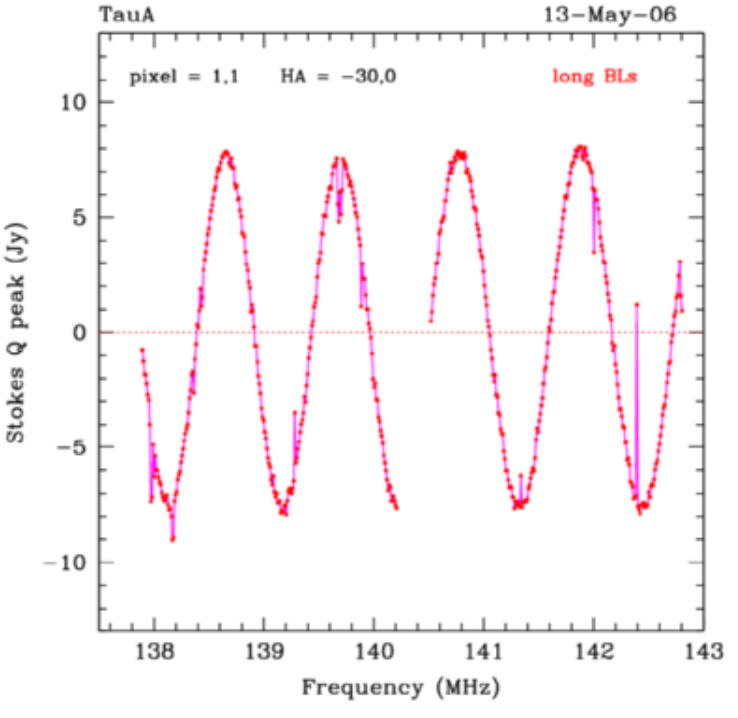
- 12 h on 13/14 Feb 2011 L2011_23410
- 115–160 MHz
- international stations: DE601, DE603, FR606
- NL stations: CS032, RS106,205,208,306,307,406,503
- problems
  - ⋆ DE601 failed
  - ⋆ 50 % of subbands bad in blocks of 30/31
    `https://proxy.lofar.eu/redmine/issues/80`
  - ⋆ significant ionospheric delays, differential Faraday rotation

Early long-baseline image of the pulsar



Polarisation: expectation

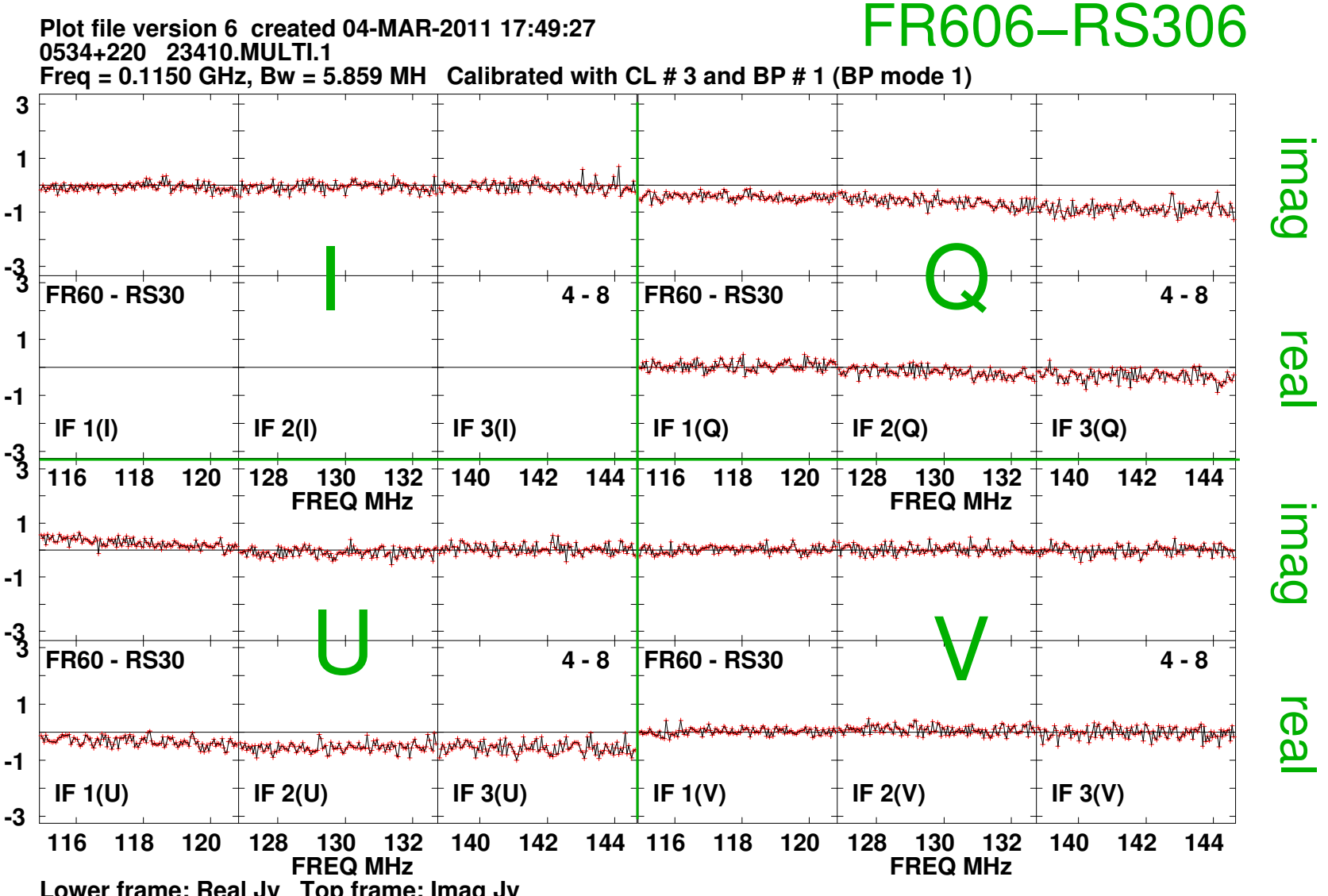
- pulsar is (sometimes) linearly polarised
- sometimes 30 %, sometimes much less
- RM$= -42\,\mathrm{rad/m^2}$ (or -45?)
- see Ger de Bruyn, LSM 29 Oct 2008



- ⋆ periodicity about 1 MHz
- ⋆ 'leakage' terms more constant
- ⋆ separate the two without full calibration
- ⋆ polarised and unpolarised at same time

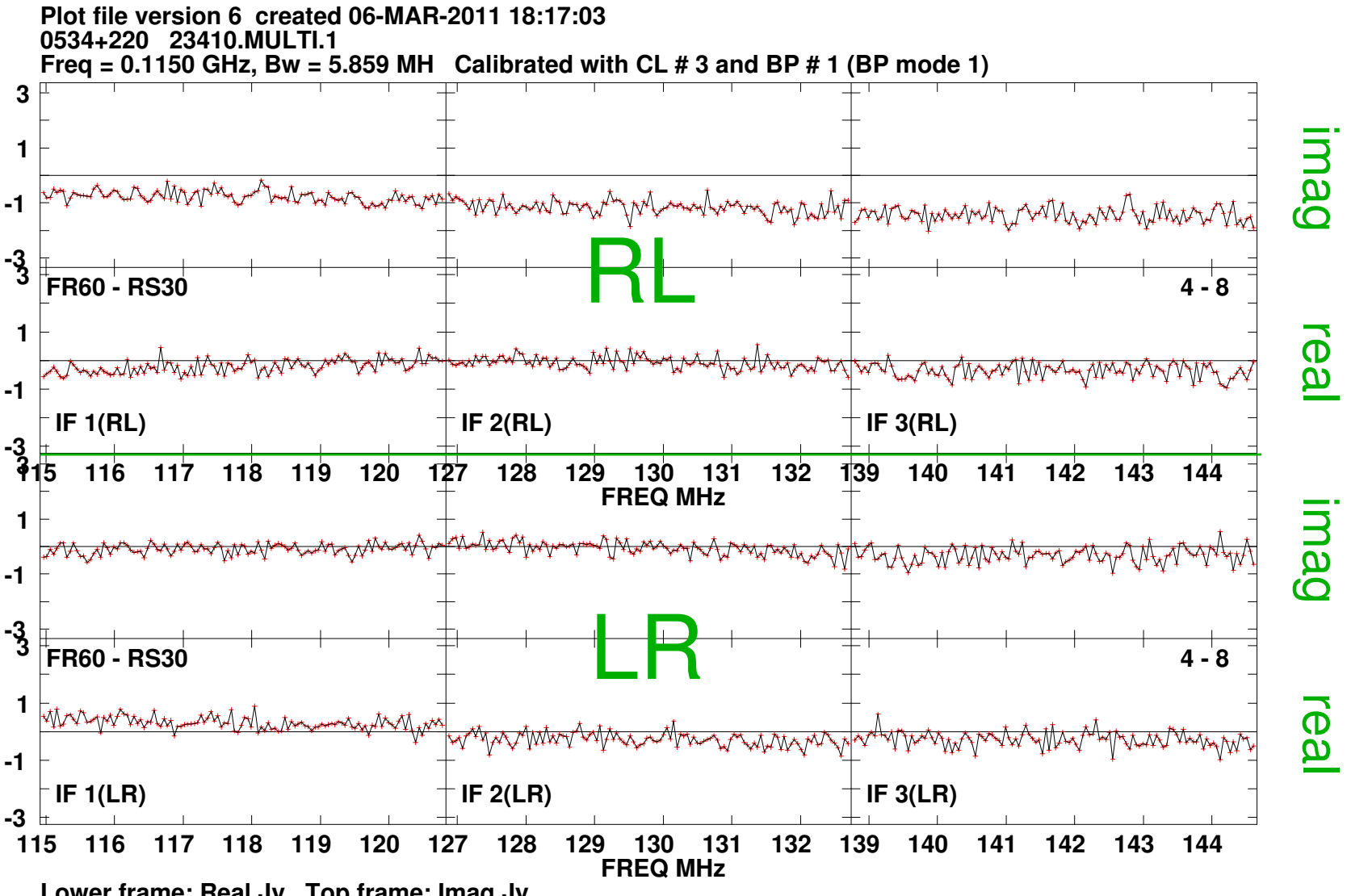
POSSM plots: IQUV (set I to 10 Jy)

calibrated RR and LL, averaged over 30min

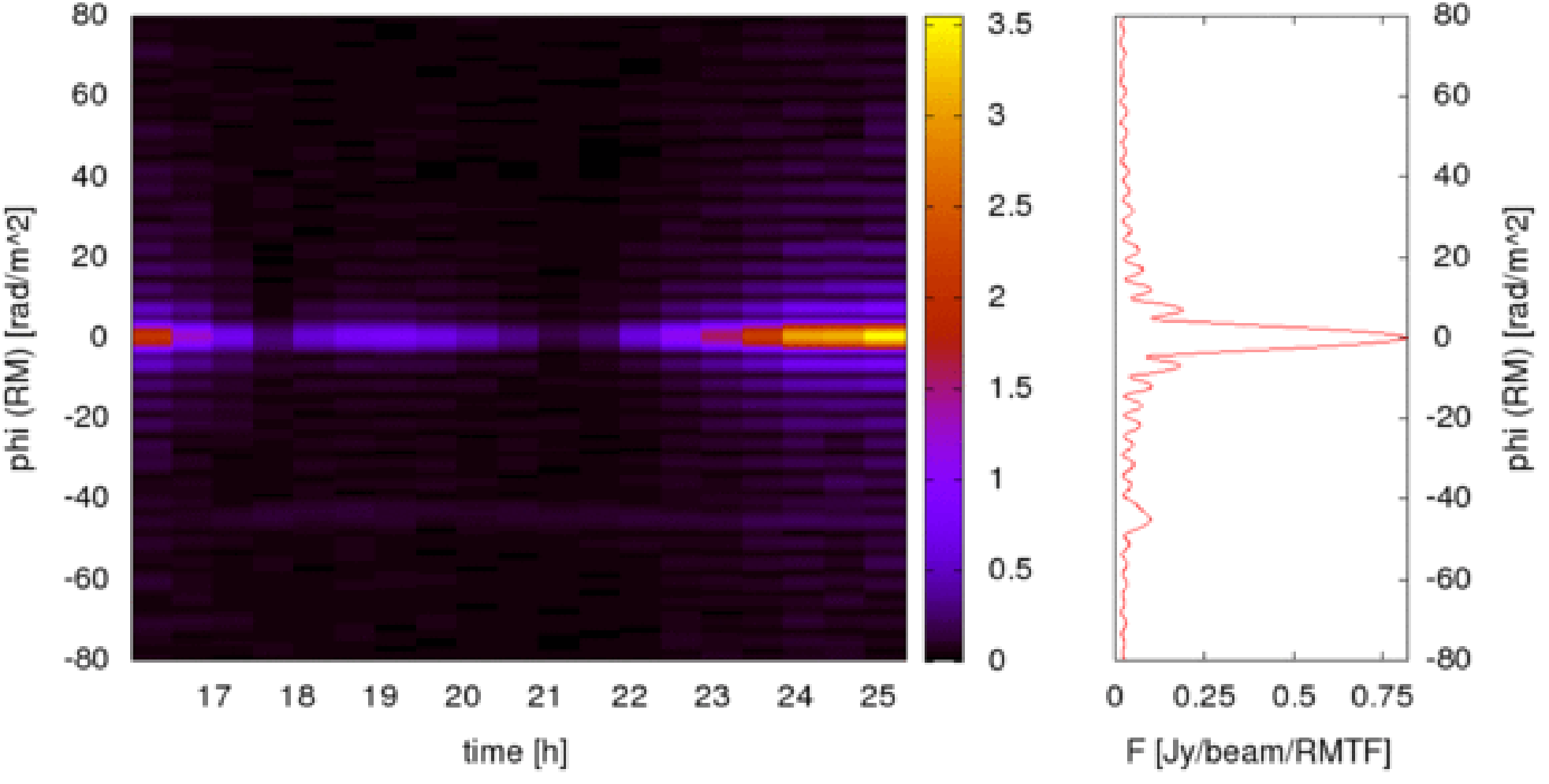


POSSM plots: RL and LR

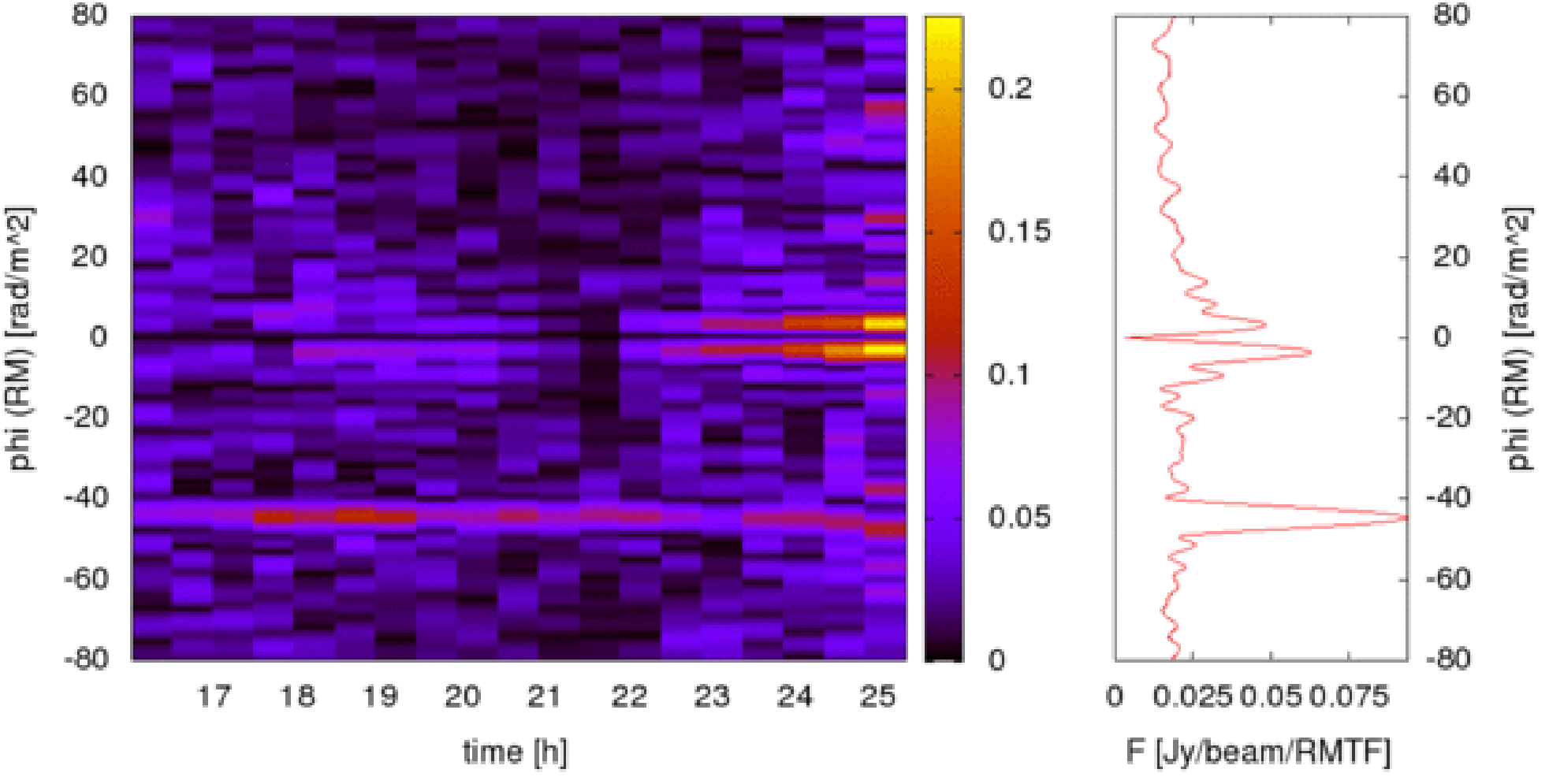
$RL = Q + iU \quad LR = Q - iU$



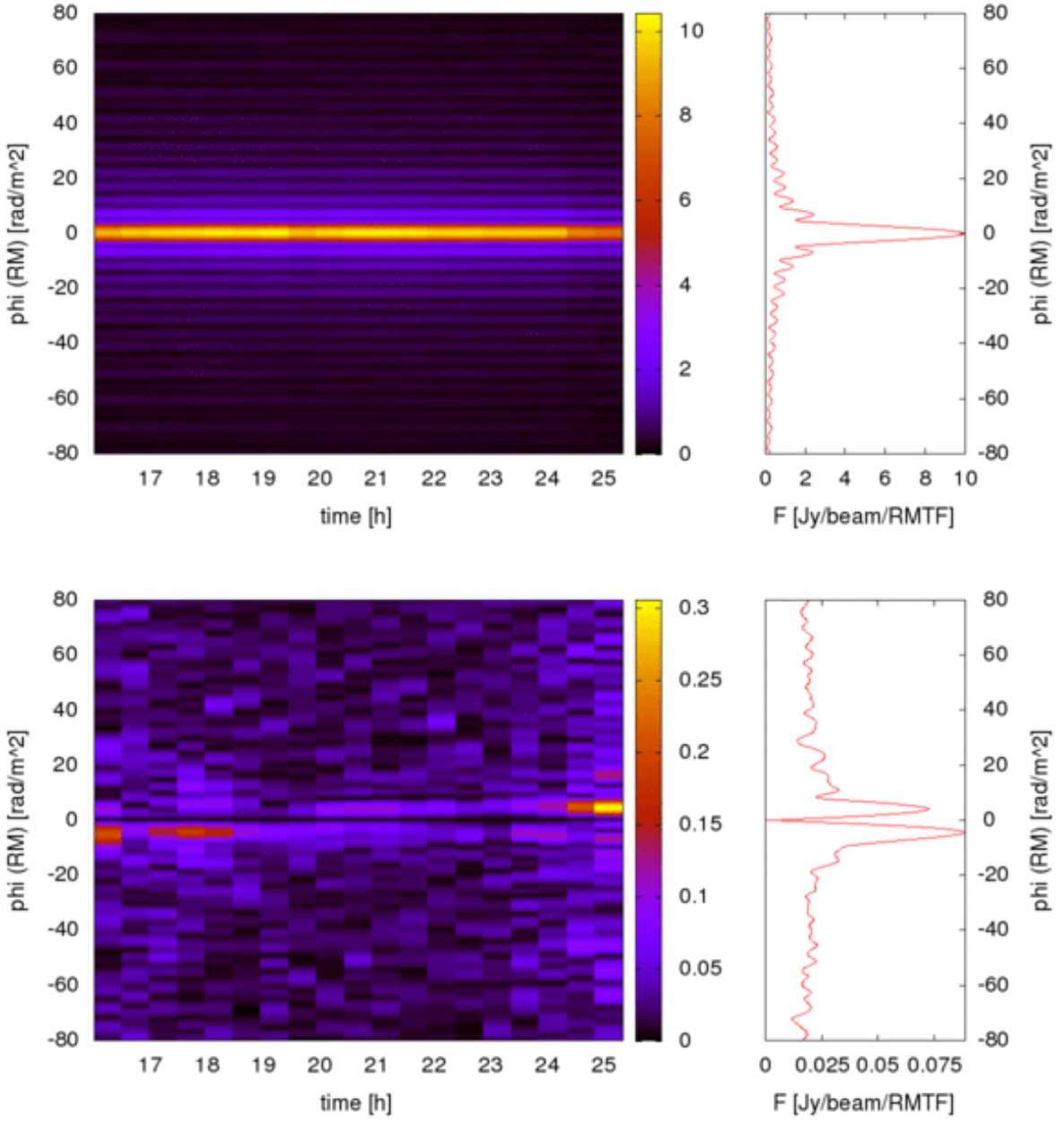
Faraday dispersion function from Q and U (30 subbands)



After subtraction of leakage peak (one CLEAN iteration)

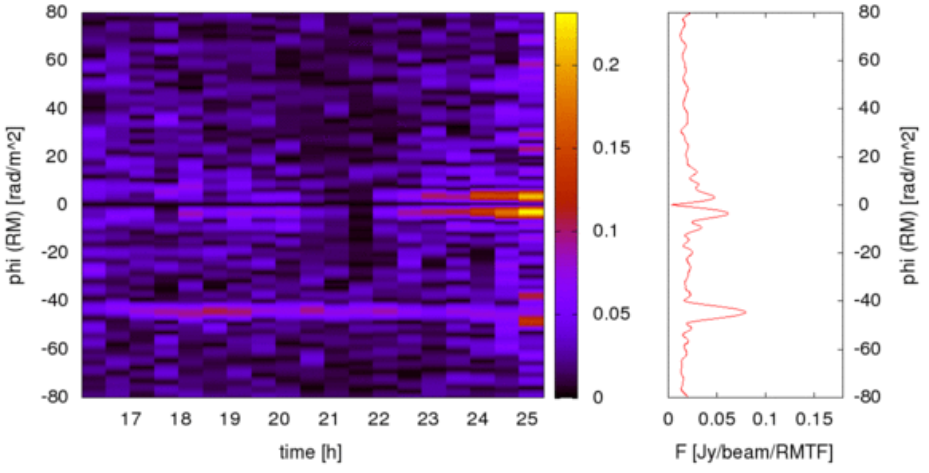


Test with Stokes I

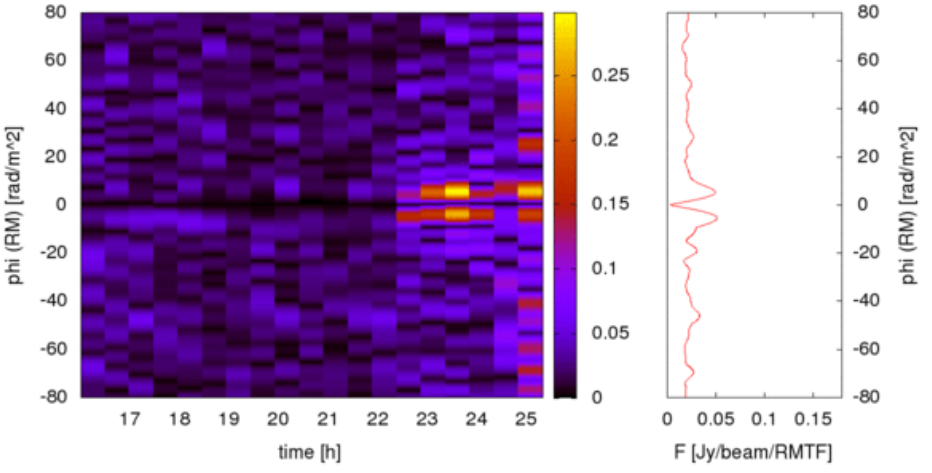


As function of frequency: blocks of 30 subbands each

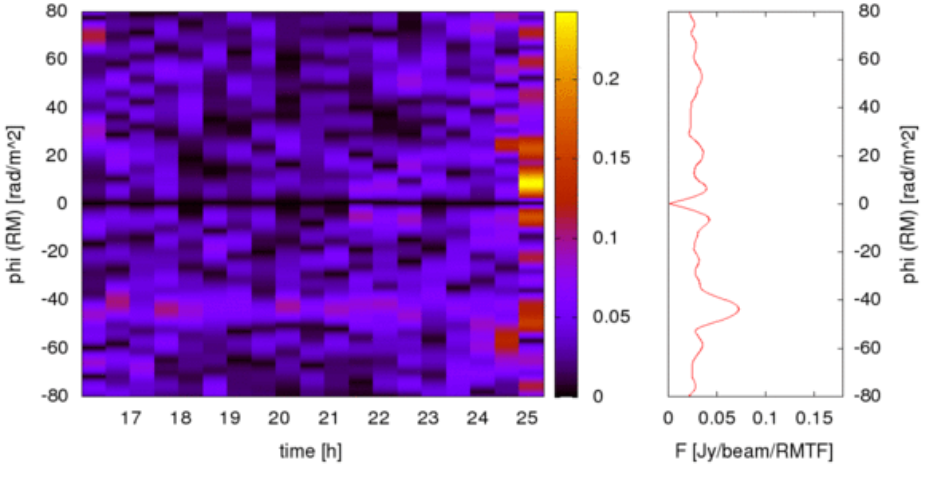
115.0 – 120.9 MHz



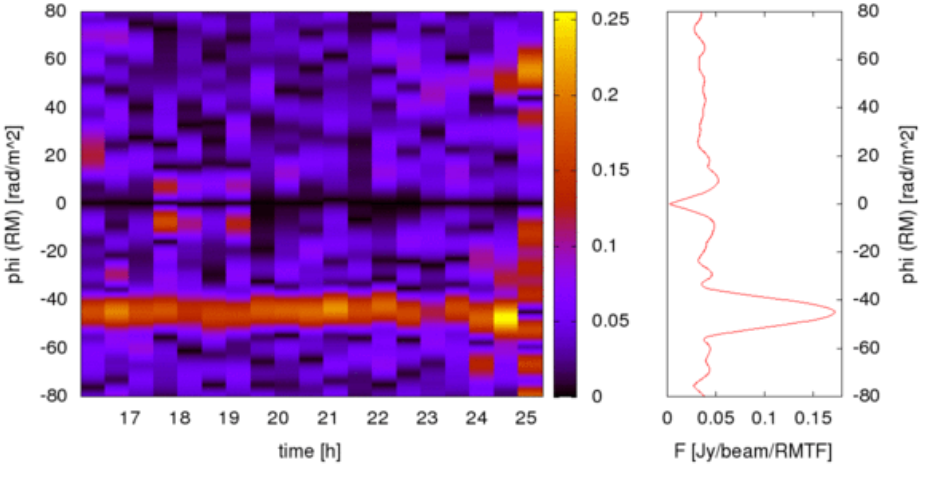
127.0 – 132.8 MHz



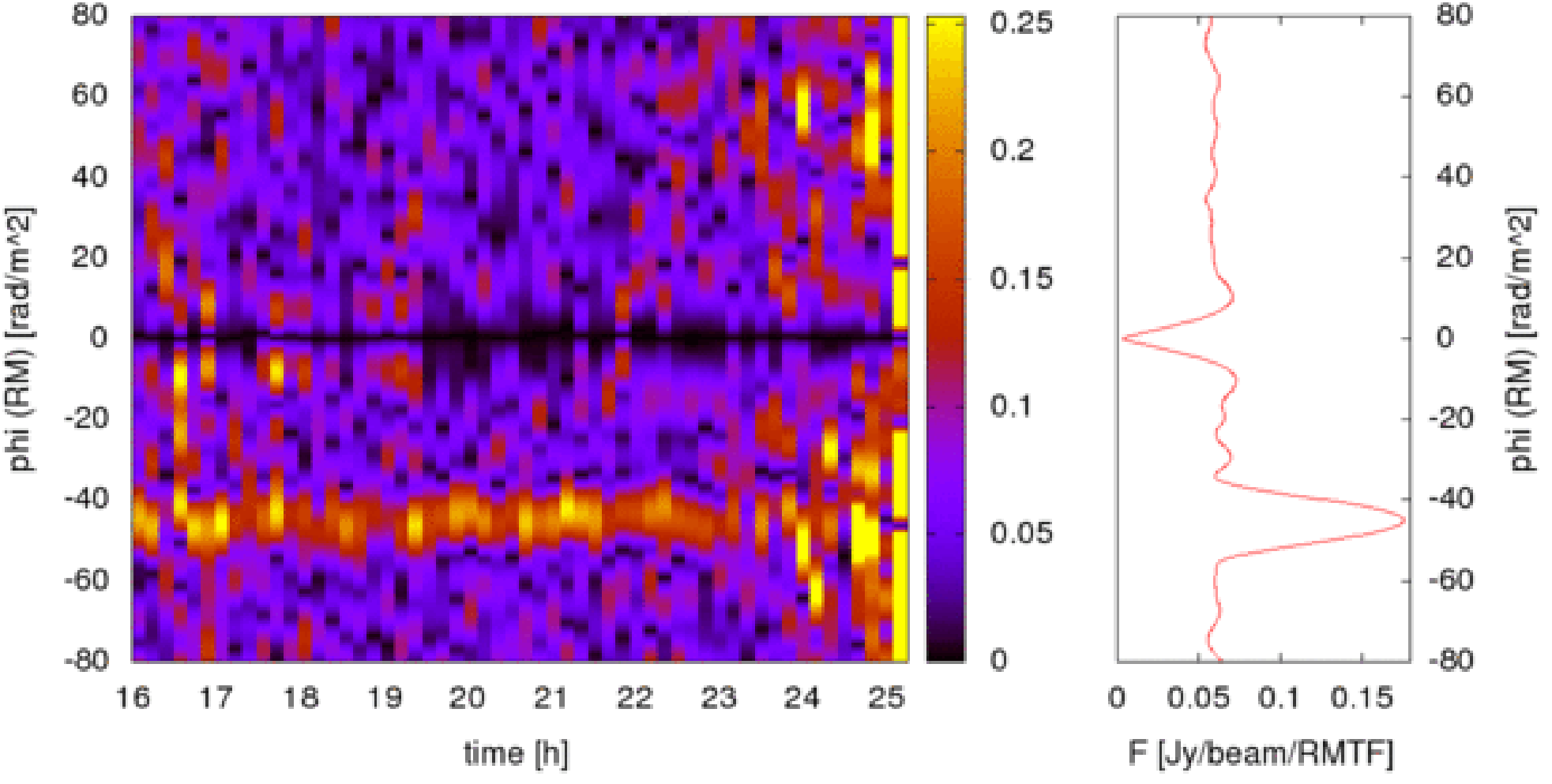
138.9 – 144.7 MHz



150.8 – 156.6 MHz



Shorter integrations: 10min (highest block)

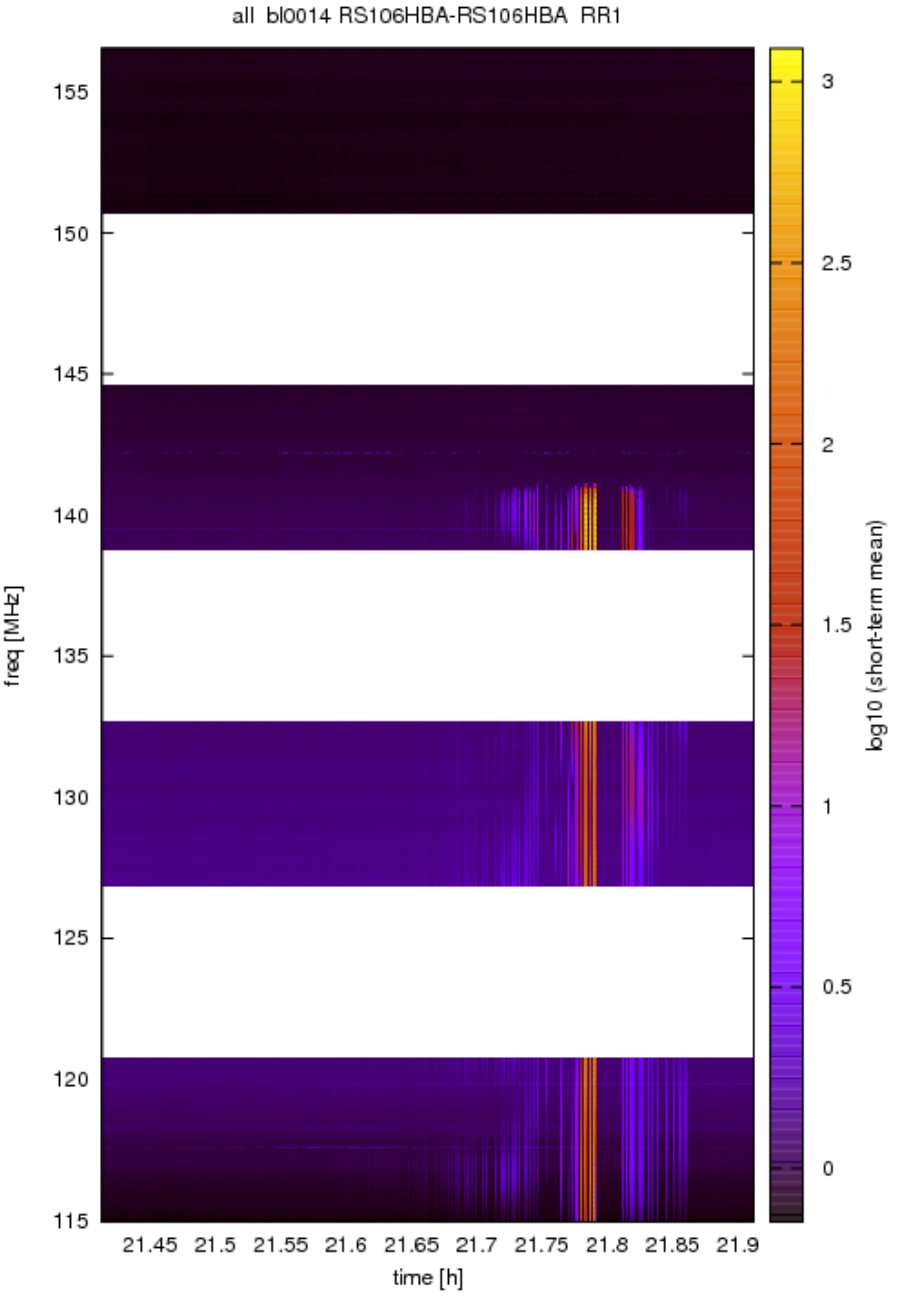


Conclusions polarisation

- weak linear polarisation
- correct RM recovered
- RM synthesis disentangles leakage and intrinsic polarisation
- frequency dependence of percentage: 0.9 / <0.5 / 0.7 / 1.7
- time-resolved (pulse phase) measurement will be interesting!
- more info:
  `http://www.astro.uni-bonn.de/~wucknitz/wiki/doku.php/lbg:tau_a:polarisation`
  `http://usg.lofar.org/forum/index.php?topic=579.0`
- estimate by Sarod Yatawatta and Ger de Bruyn: 5 % !
- Questions for this part?

RFI spikes

- strong spikes ($< 1\,\mathrm{sec}$) left after initial flagging
- had consistent phases and sometimes small delays
- seen on all Dutch baselines
- wide: $< 115\,\mathrm{MHz} - \sim 141\,\mathrm{MHz}$
- beyond airband
- detectable for about 30 min

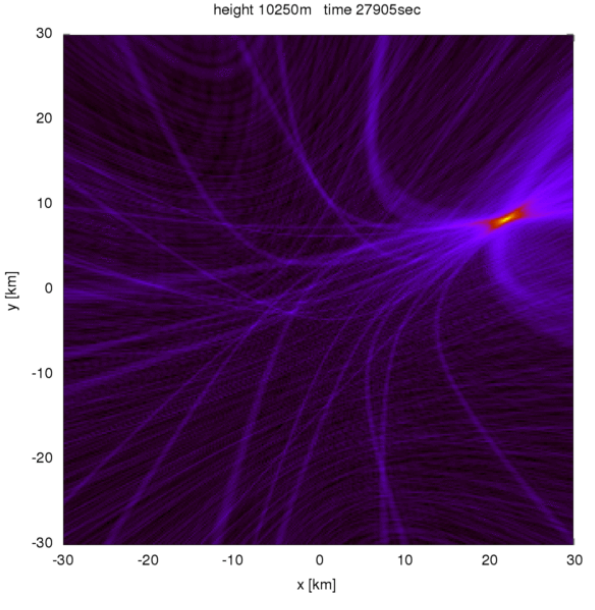


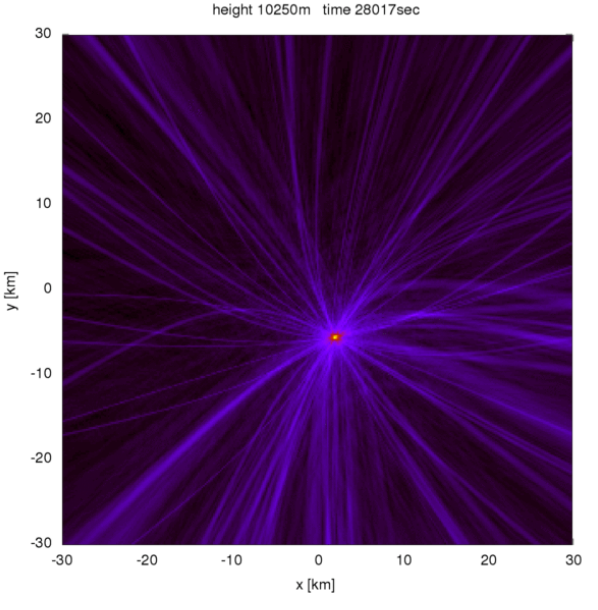
Mapping the signal

- phases not calibrated
- can measure delays on Dutch baselines
- constant delay corresponds to hyperboloid
- 3 baselines sufficient to determine position (in 3d)
- add all baselines incoherently
- scan in 2d or 3d
- first attempt: 2d scan of sky positions (at infinity)
  - ⋆ giant pulses?
  - ⋆ exotic transient?
  - ⋆ scan shows no clear peak

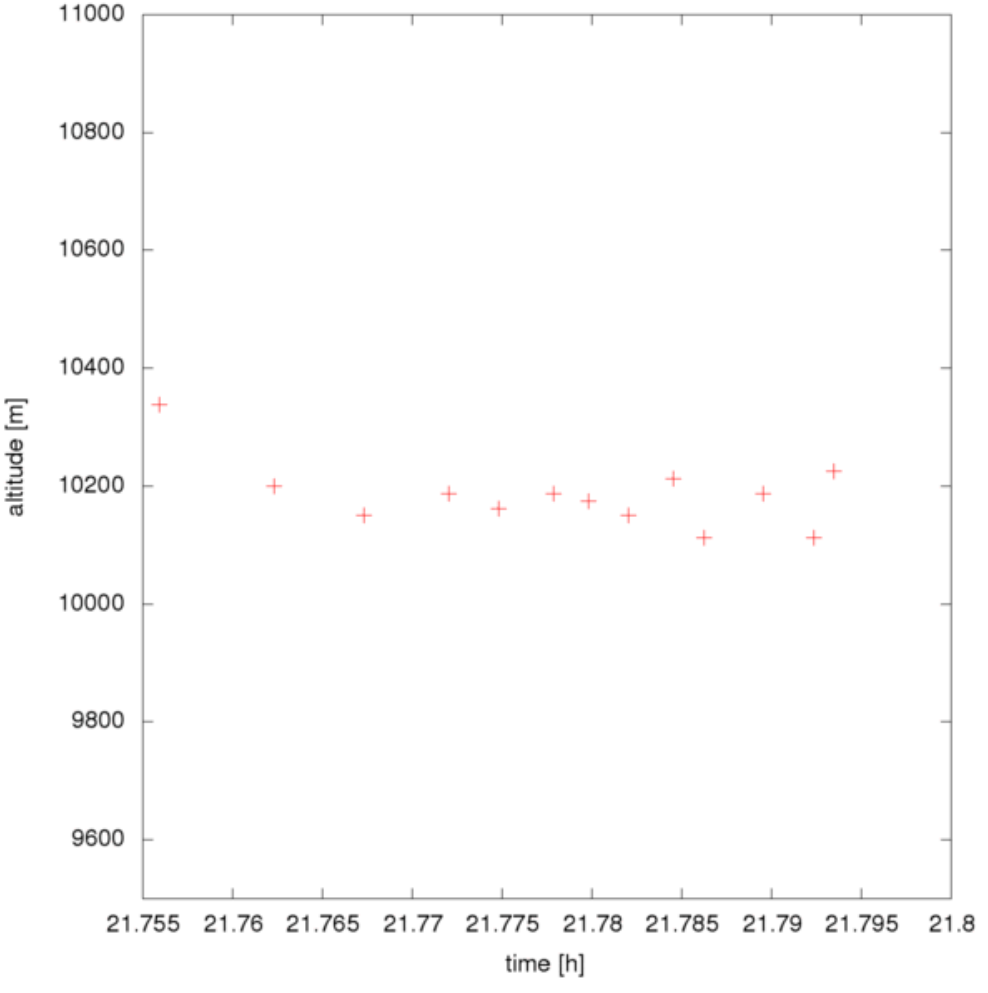
Terrestrial RFI?

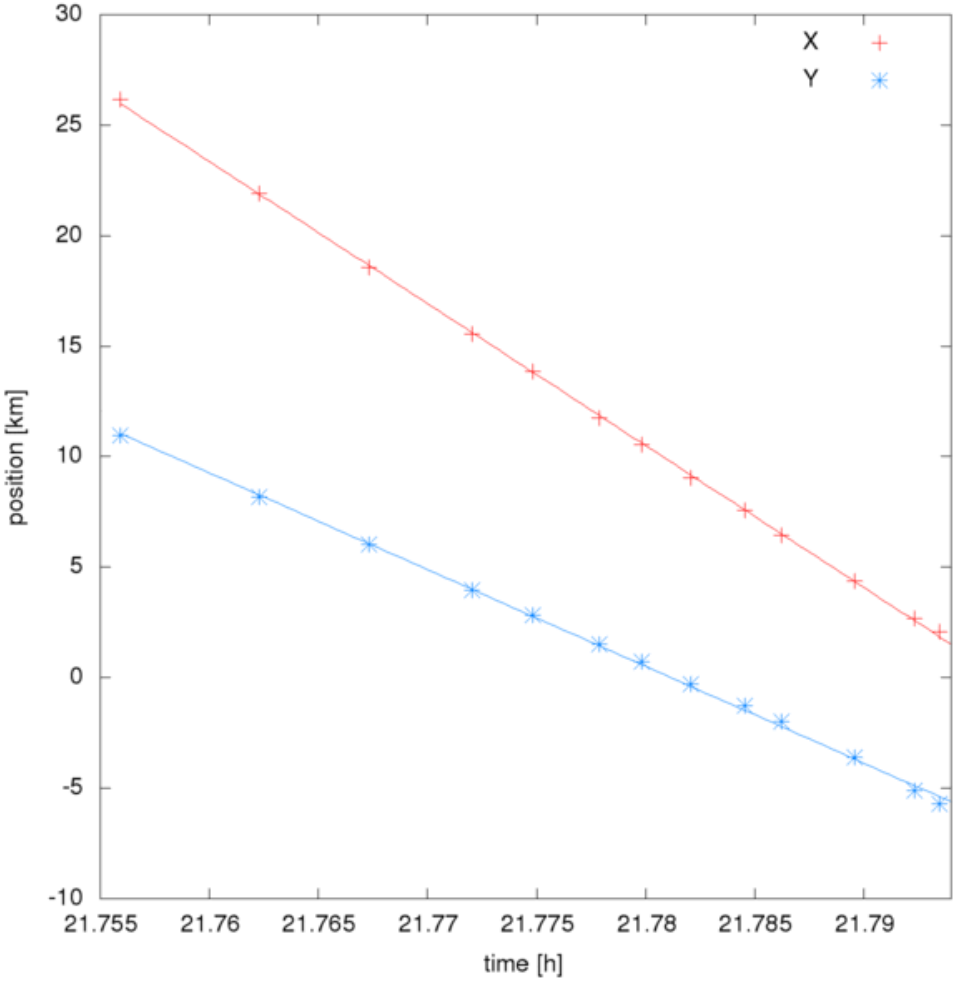
- 2d scan at ground level
  - ⋆ no sharp peak but large blob
  - ⋆ moving with time: aircraft?
- 2d scan at 10 km height
  - ⋆ find clear moving peak, scans with 8–60 subbands



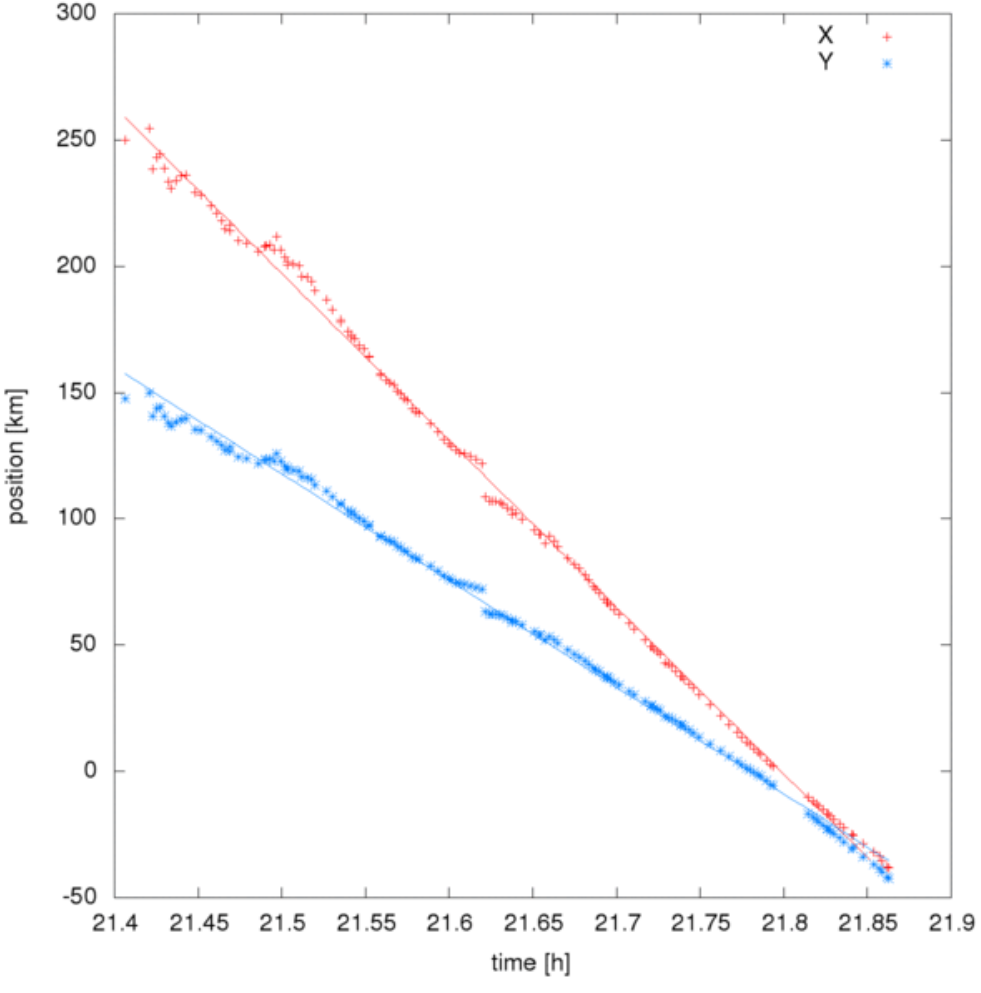


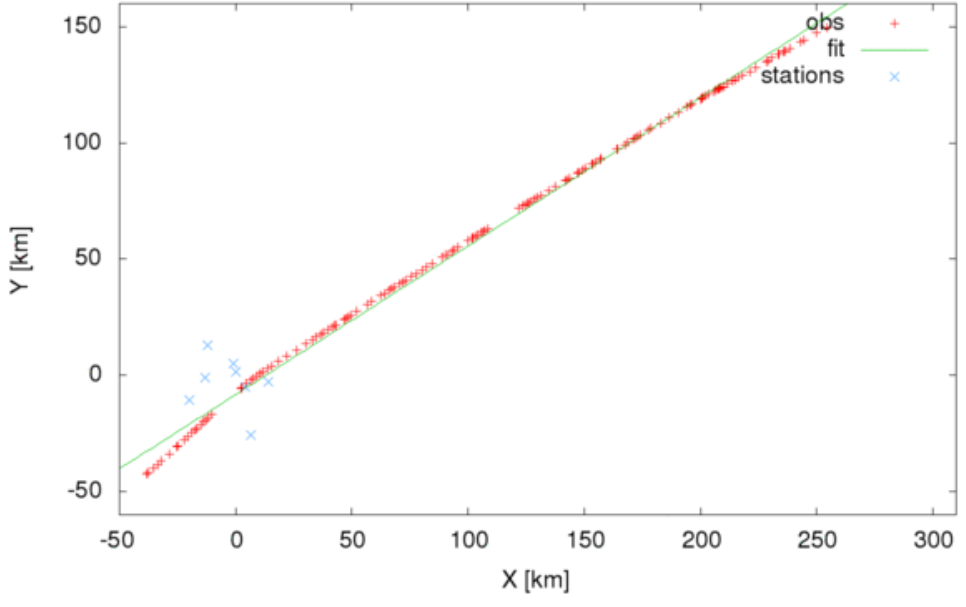
Altitude and nearby trajectory (3d scans)

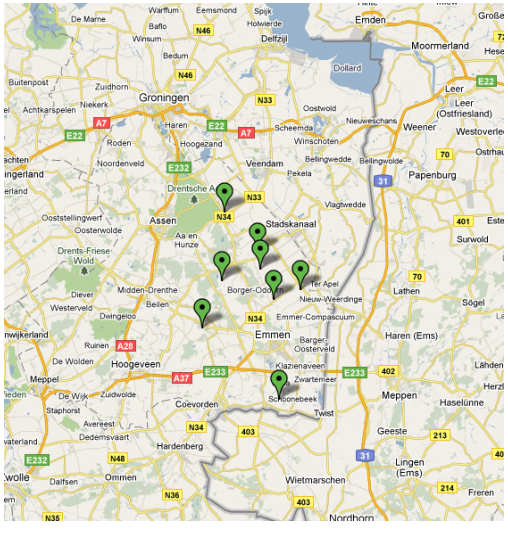




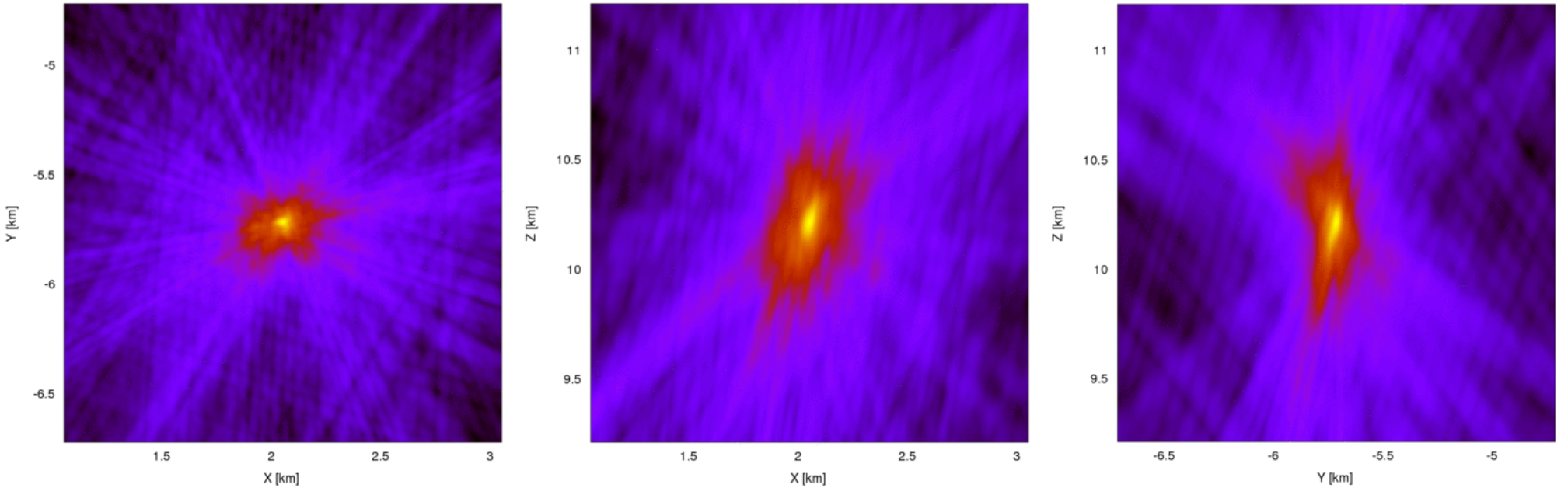
Full trajectory focused at 10200 m (2d scans)







The 3d peak: cuts in XY / XZ / YZ



- almost directly overhead
- 30 subbands
- accuracy 50–100 m
- can be improved with more subbands
  but: mind the gaps!

Conclusions aircraft

- strong spikes (flux not measured yet)
- can be flagged, but may flag transients!
- aircraft at altitude of 10 km
- speed ca. 780 km/h
- first detection at distance of 350 km (horizon)
- what is it?
  - ⋆ communication is narrow-band, more restricted
  - ⋆ reflections from the ground?
  - ⋆ only one such source over 12 hours!
  - ⋆ higher-frequency radar? no non-linearity
  - ⋆ military jamming equipment?

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