Long-baseline snapshot calibrator identification survey

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for the long baseline group

LOFAR Status Meeting
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Project summary

- Context:
  - Long baseline observations are completely reliant on a suitable calibrator source, bright and compact, to calibrate the effects of the differential ionosphere, station clocks, and correlator model errors.
- Aims of the project:
  - Find a computationally non-intensive approach for searching good long-baseline calibrators.
  - Estimate the distribution of bright and compact sources in the sky at 150 MHz.

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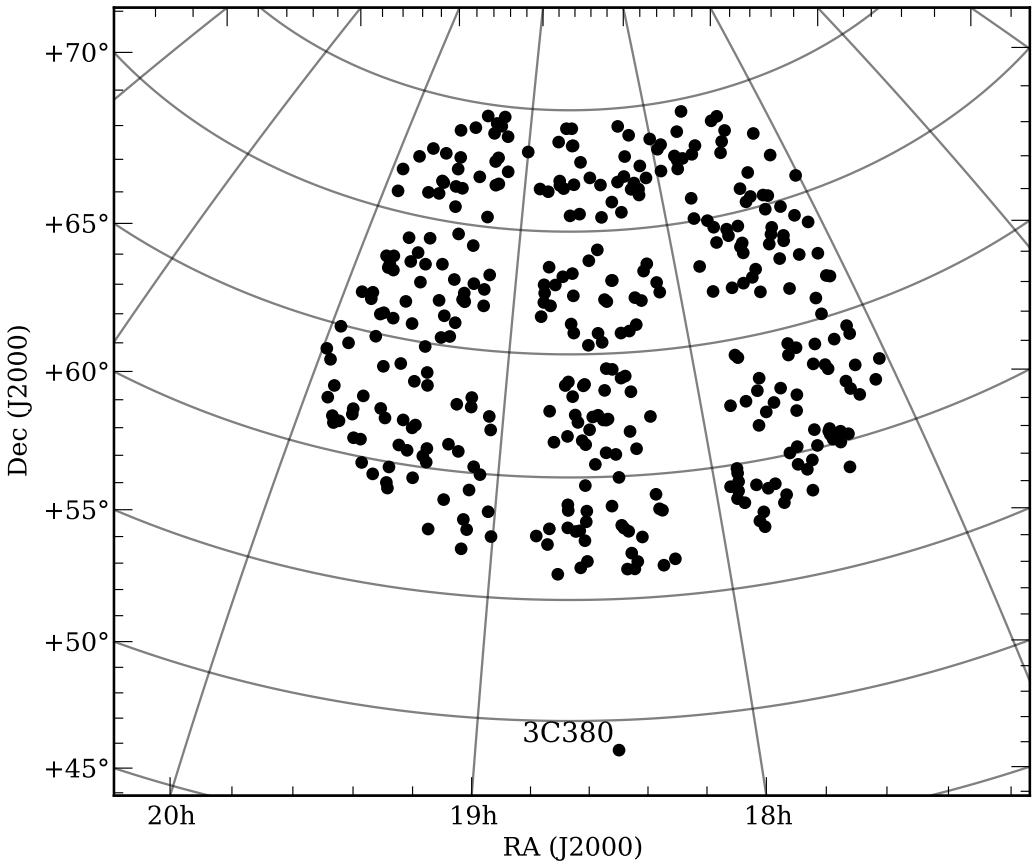
Catalogue selection criteria

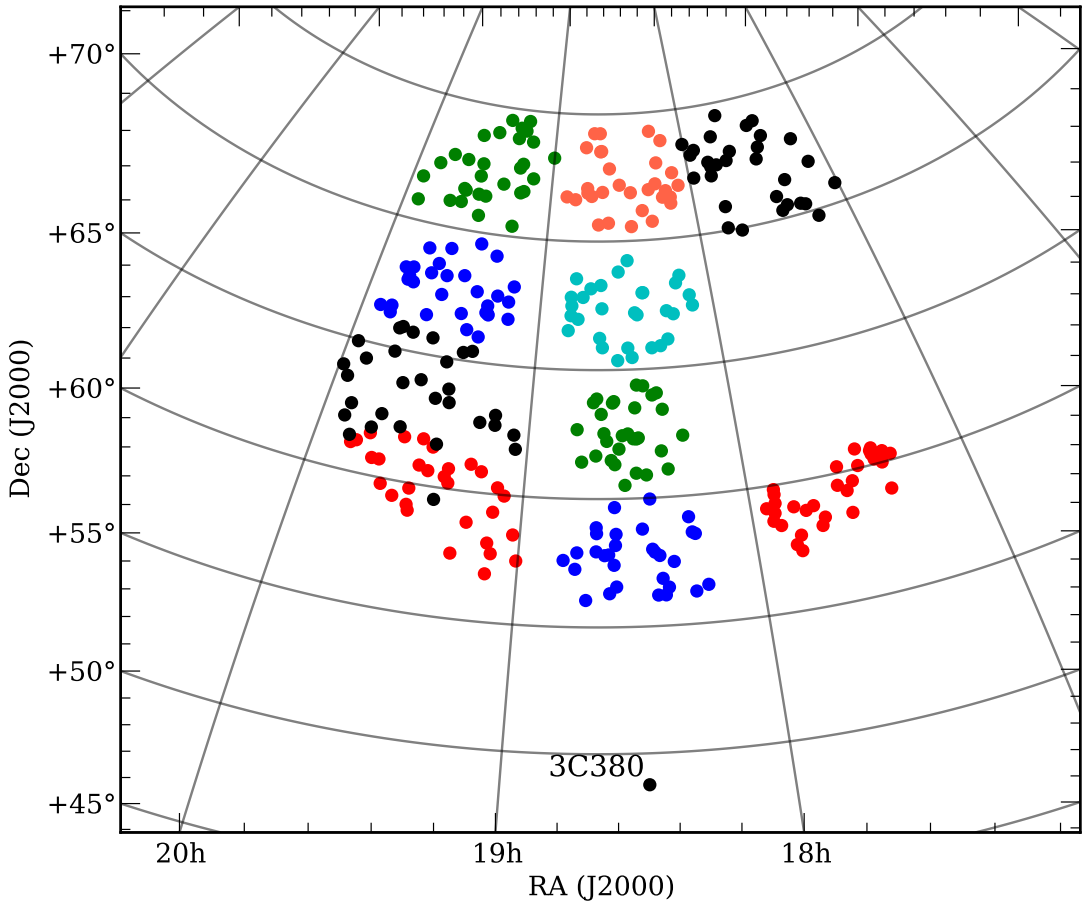


- We selected 360 sources close to 3C380.
- They are present in VLSS (VLA 74 MHz) and either:
  - Are in the VLBI calibrator list with a flux density of at least 100 mJy.
  - Have a flux density above 0.2 Jy at WENSS (WSRT 330 MHz).

Observations

- We conducted a 1-h observation with the HBA on May 2, 2013.
- The observation was divided in 12 blocks of 4 minutes each.
- We divided each block in 30 beams observing different candidates.
- All beams have an identical setup: 3 MHz contiguous bandwidth centered at 142 MHz in 64 channels per source.
- Simple pre-processing: RFI flagging and average to 2 sec.

Observations



- Two of the blocks were not observed due to technical problems.
- Therefore we have data on 300 sources.

Data Reduction

- Post-processing:
  - BBS on 3C380 to calibrate CoreStations for all pointings.
  - NDPPP to add the CS to form TS001.
  - Convert to RRLL polarization and export to FITS.
  - Phase calibration with task FRING in AIPS (phase, delay, rate).

- Analysis:
  - Statistics on the number of FRING solutions.
  - Delay for each antenna.
  - Asses compactness of sources based on solutions on the long baselines.

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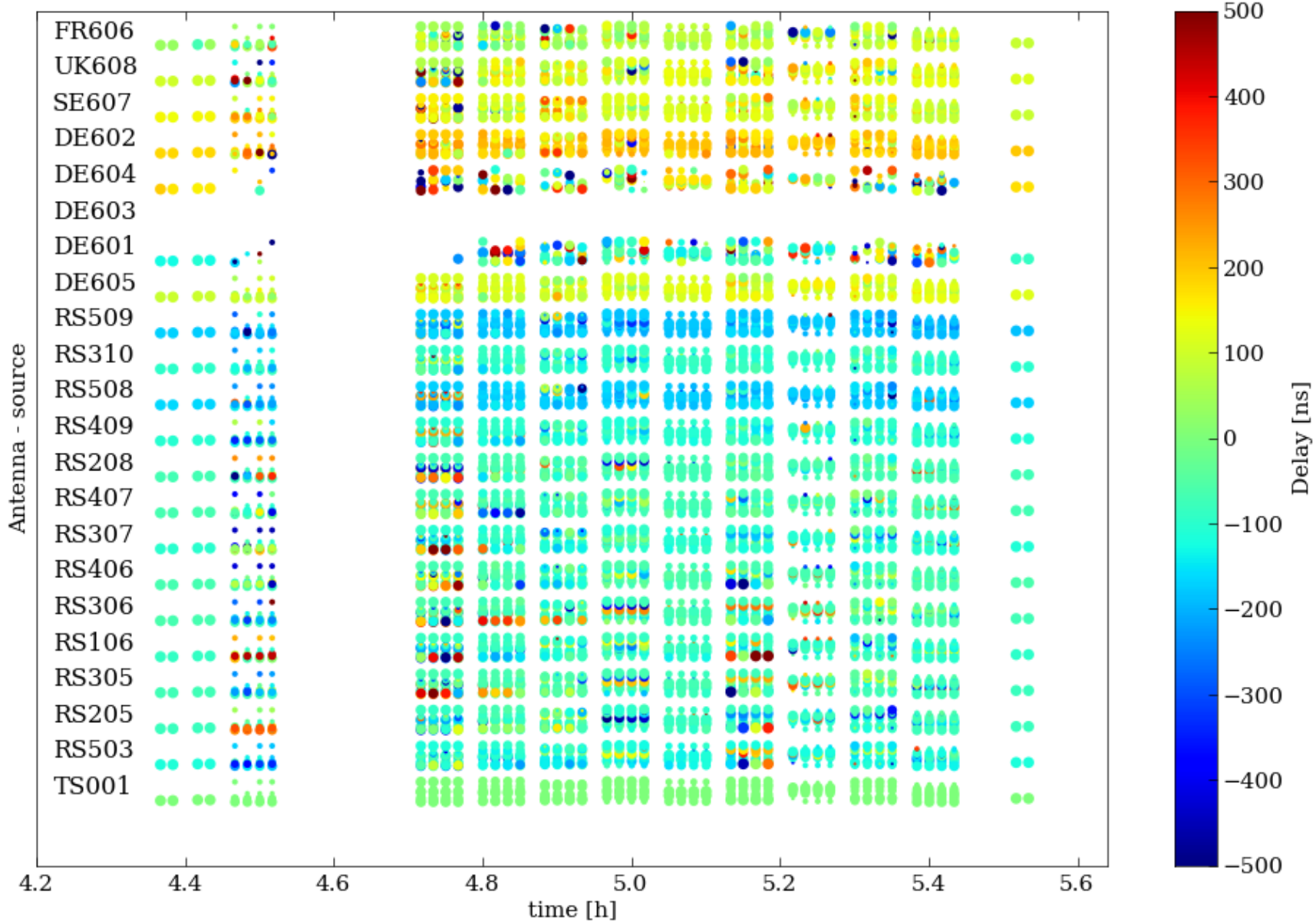
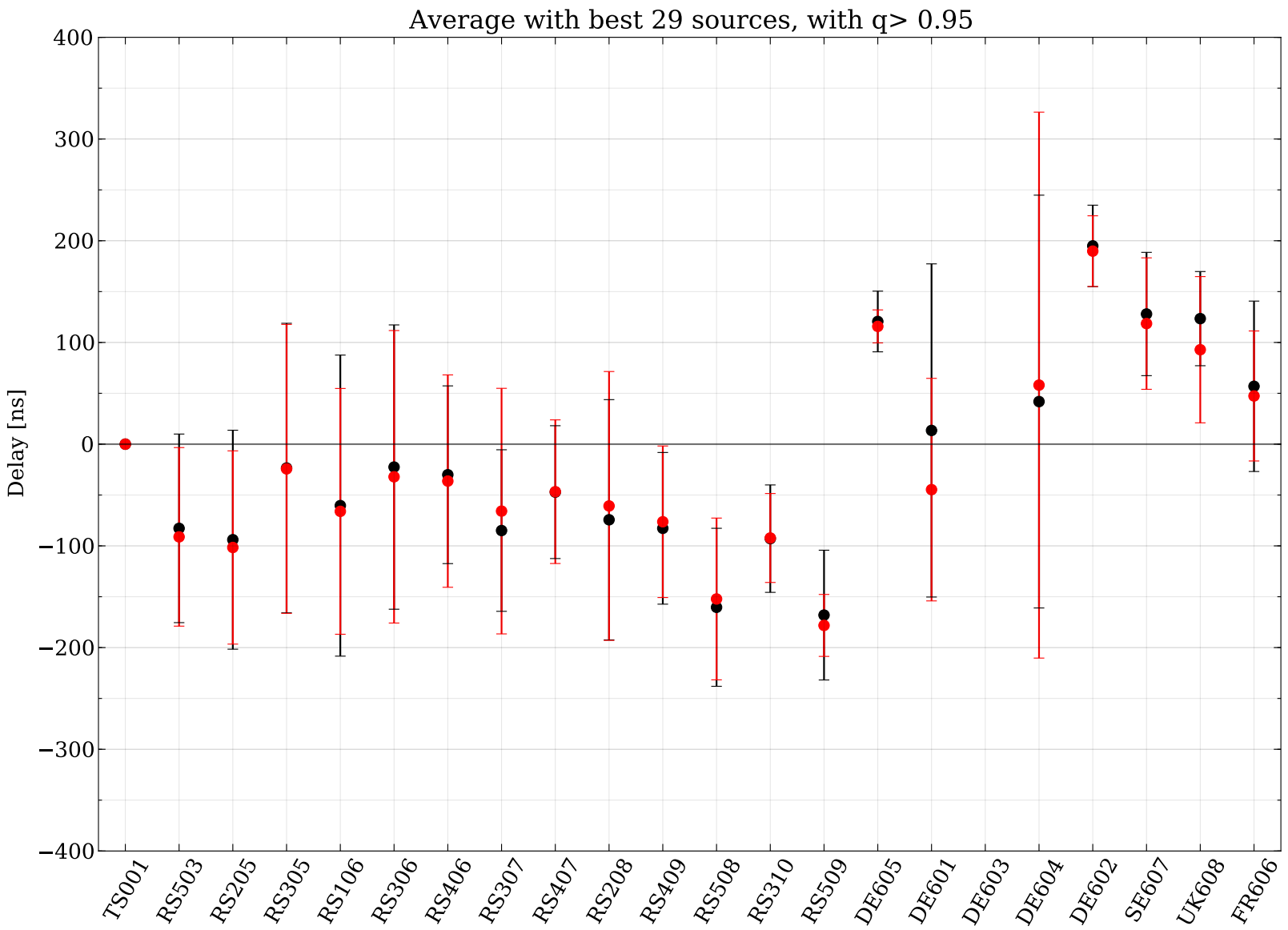
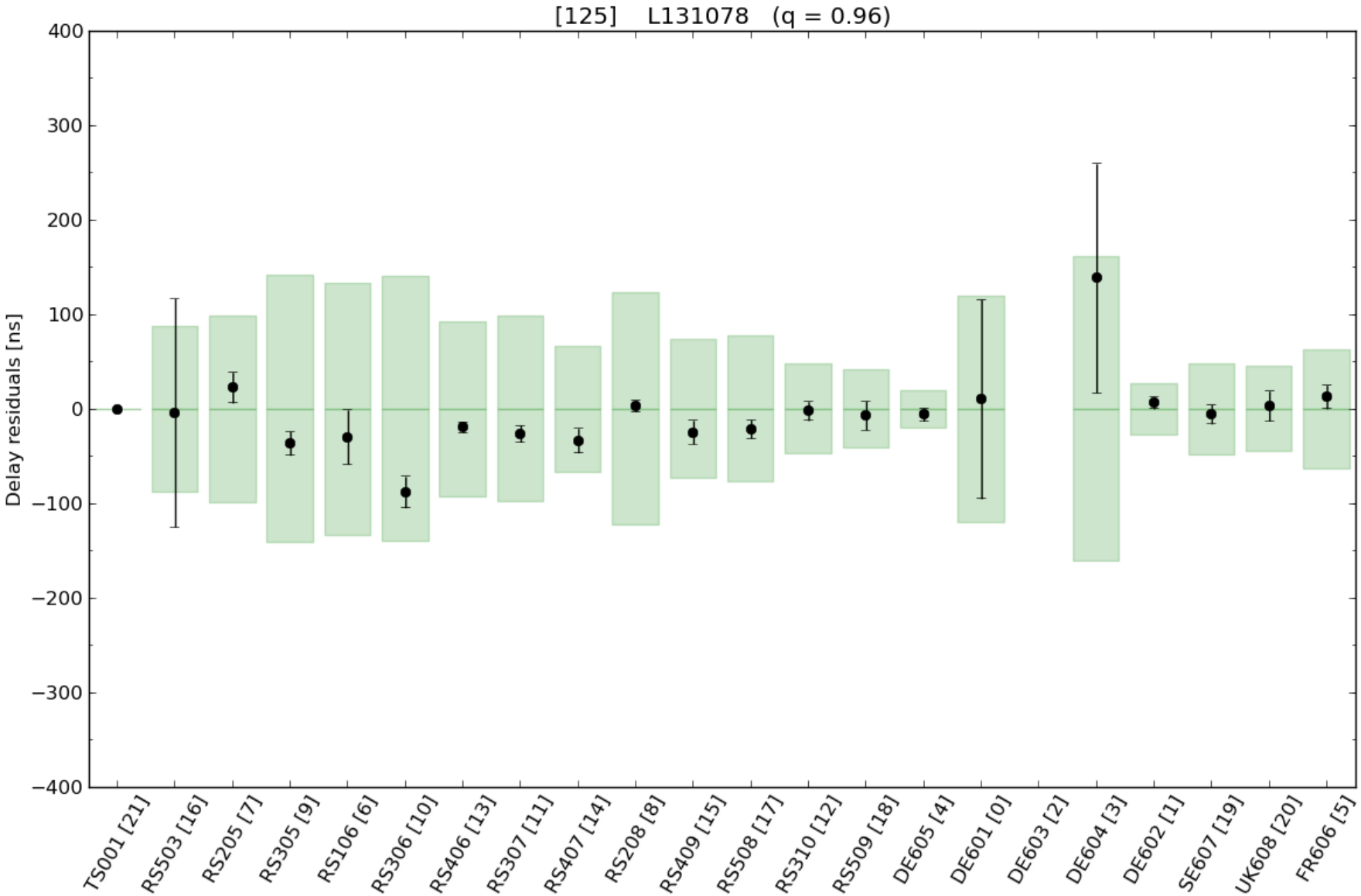
Delay


FR606
UK608
SE607
DE602
DE604
DE603
DE601
DE605
RS509
RS310
RS508
RS409
RS208
RS407
RS307
RS406
RS306
RS106
RS305
RS205
RS503
TS001
Antenna - source
4.2
4.4
4.6
4.8
5.0
5.2
5.4
5.6
time [h]
500
400
300
200
100
0
−100
−200
−300
−400
−500
Delay [ns]

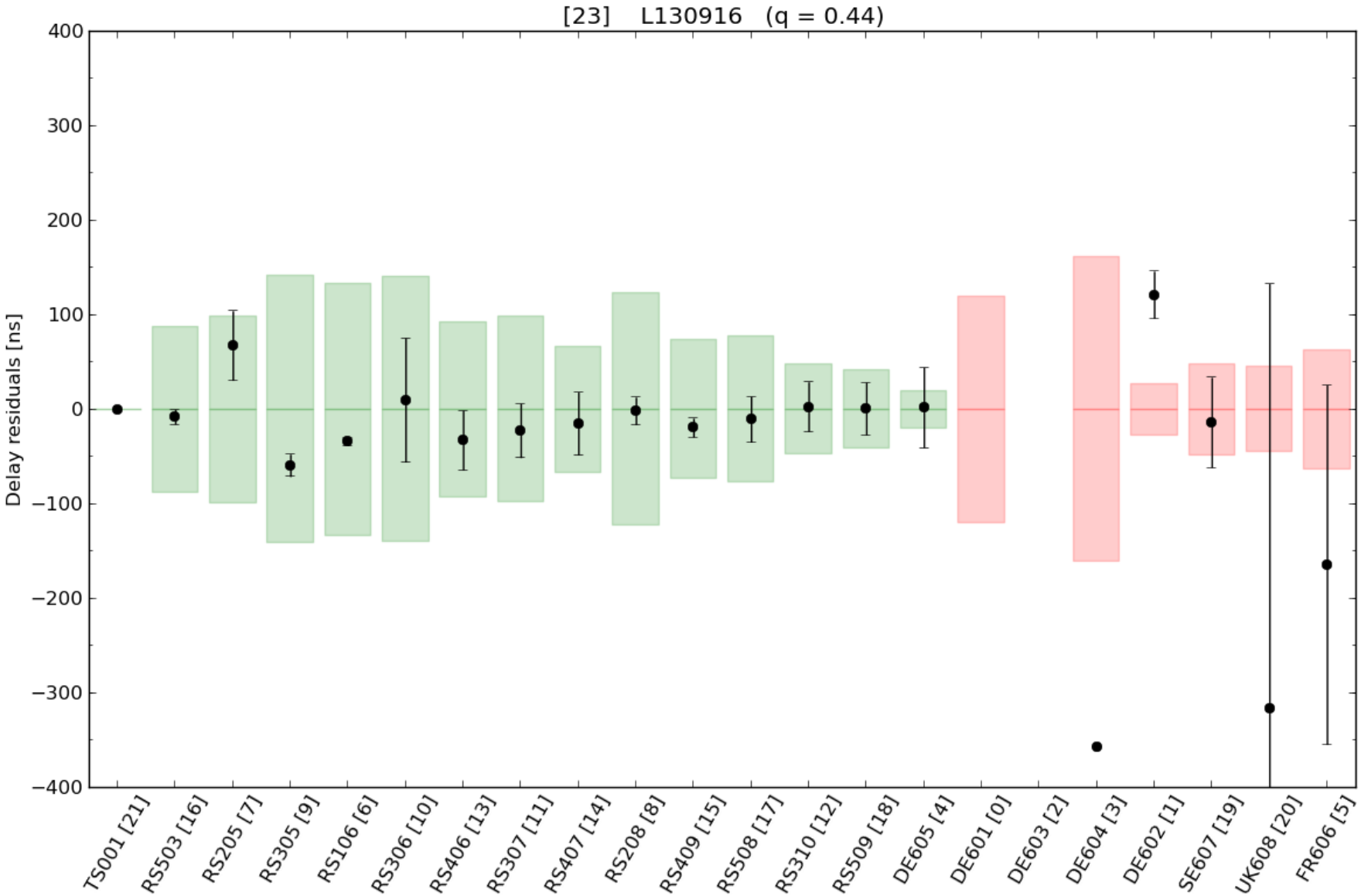
Average delay per antenna



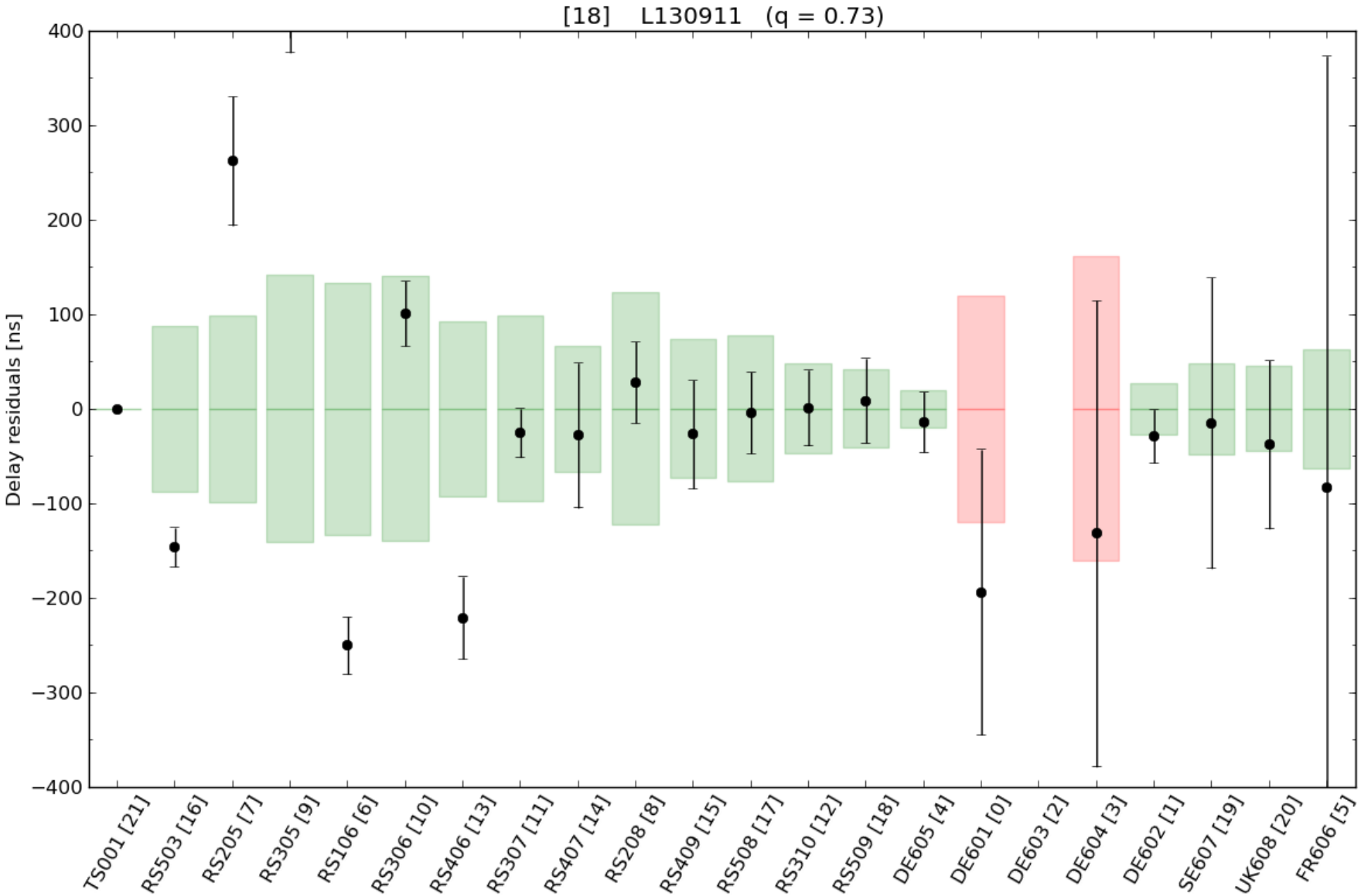
Example: Bright and compact source



Example: Bright but not compact source



Example: Diffuse emission or 2+ sources

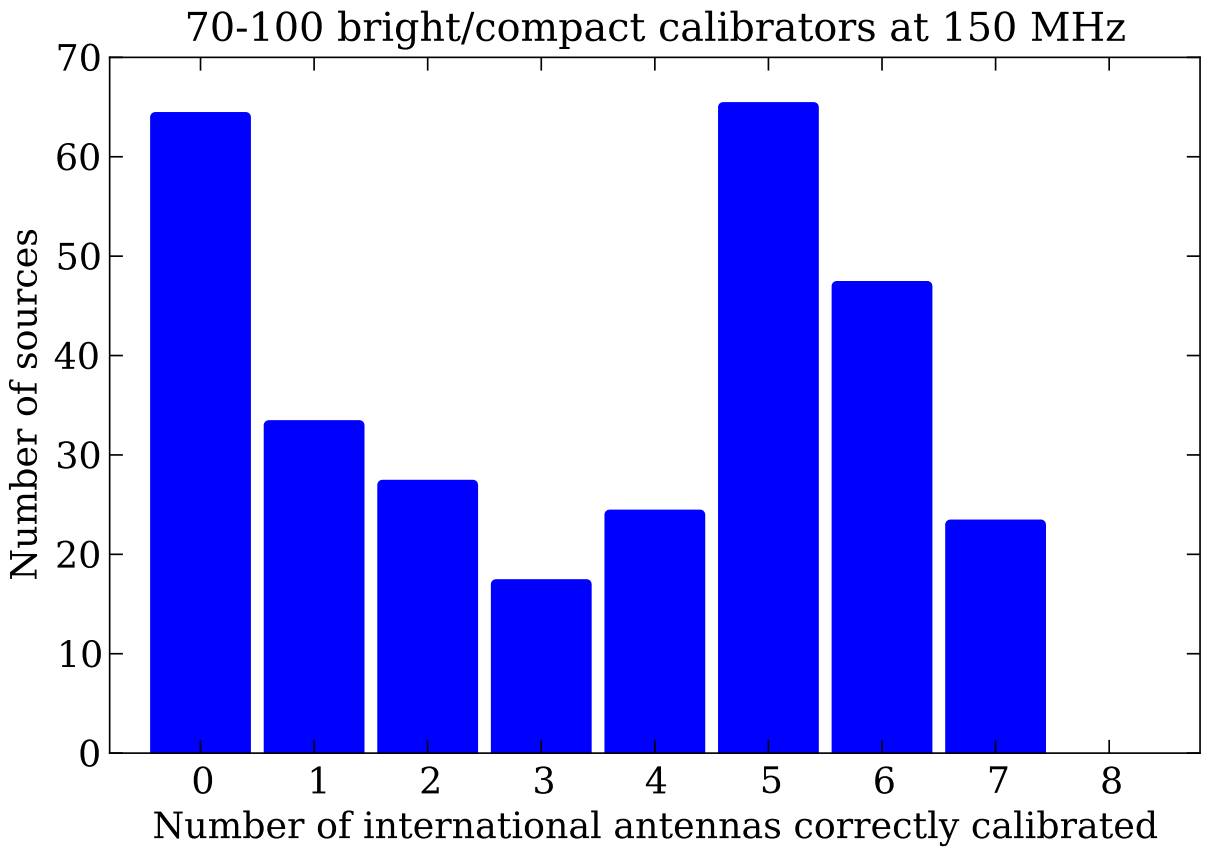


Quality factor

We define different quality factors. For example:

- Number of well calibrated international stations.
- With this data set we have uncertainty due to variability in DE601 and DE604, and the lack of DE603.
- Good calibrator when 7 good antennas, although under normal conditions the number of good antennas could increase by 1–3 for $\sim 40\%$ of the cases.

Preliminary results



- We see about 70-100 sources that are compact and bright enough.
- Our current selection criteria provides an efficiency of 20-30% for finding new calibrators.
- We observed 261 deg^2. Calibrator density $\sim$0.27–0.38 per deg^2.

Work in progress

- Analyse other possible quality factors.
- Cross correlation with radio catalogues:
  - VLSS (VLA 74 MHz).
  - WENSS (Westerbork 330 MHz).
  - NVSS (VLA 1.4 GHz).
  - VLBI calibrator catalogue.
- Improve the selection criteria based on dependence of quality with:
  - Flux density.
  - Instrinsic source size.
  - Spectral index.
- Unfortunately, preliminary results show vey low dependence with all three parameters.

Future work

- Based on these observations:
  - Improve selection criteria.
  - Optimize observational approach.
  - Observe different regions of the sky to search for calibrators.

- We aim to:
  - Determine calibrator distribution on the sky.
  - Find average distance to a good calibrator.
  - Find characteristics of compact and bright sources in other known catalogues.
  - Construct a calibrator catalogue from LOFAR data.

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