Real time low frequency transient search with AARTFAAC

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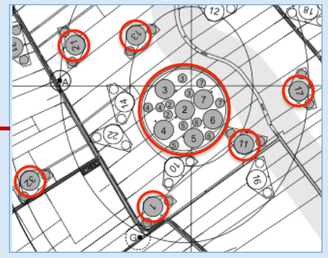
Abstract:

The Amsterdam ASTRON Radio Transient Facility And Analysis Centre (AARTFAAC) telescope is designed to discover very bright (>20 Jy), low frequency (30-80MHz) transients with timescales down to 1 second. This area of (brightness, frequency, duration) parameter space has only recently been populated with sources of unknown origin. But such sources must be extreme coherent emitters such as FRBs, or perhaps the prompt counterparts of gravitational-wave events.

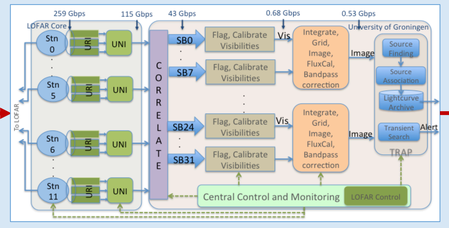
We are in the late stages of commissioning. Hundreds of hours have been archived over the past few months and is being analyzed offline. And our pipelines which create images, extract sources for analysis, and provide triggers with a few-second latency is largely in place, and will be running in real time within a few months.

System design

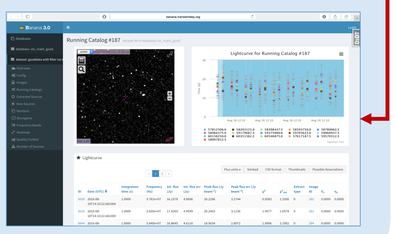


AARTFAAC is an add-on to the central 12 LOFAR stations which operates in parallel during regular observations.

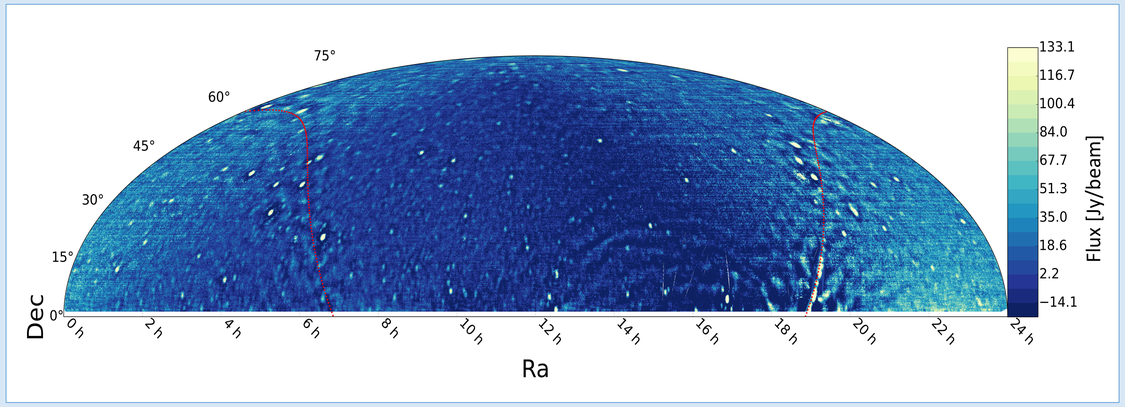
The architecture of the AARTFAAC all sky monitor. Our system converts 259 Gbps of raw dipole data to source light curve databases (Prasad et al. 2016).



Source databases created by the LOFAR Transient Pipeline (TraP, Swinbank et al. 2015) are then explored via Python scripts or Banana, our web interface.

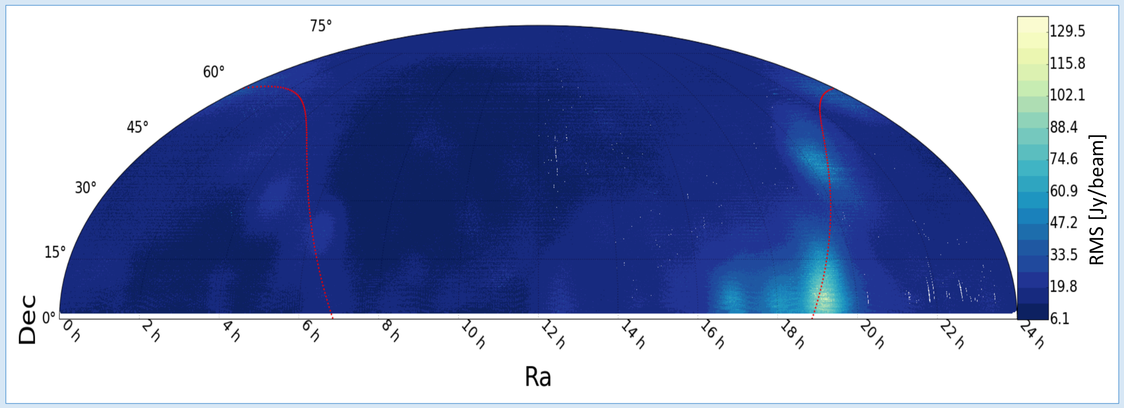


The AARTFAAC sky



AARTFAAC observes the full northern hemisphere over 24 hours. Flux calibration is done by boot-strapping a flux scale from known low frequency calibrators, then inferring the flux of the other sources to create the AARTFAAC catalog. The AARTFAAC catalog contains the flux and positions of all sources observable with SNR > 5, spanning the northern hemisphere. The full catalog is then used to calibrate the flux scale of each snapshot image.

All-sky sensitivity



The RMS is highest, and therefore the sensitivity lowest, along the Galactic plane (red dotted, above). This is a result of imperfect Galactic emission subtraction, and the bright, densely packed sources along the plane of the Galaxy.

References
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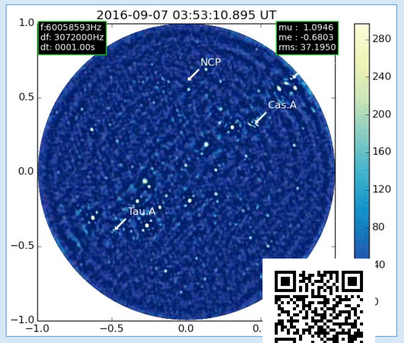
AARTFAAC.org

Also search AARTFAAC on YouTube for archived observations!

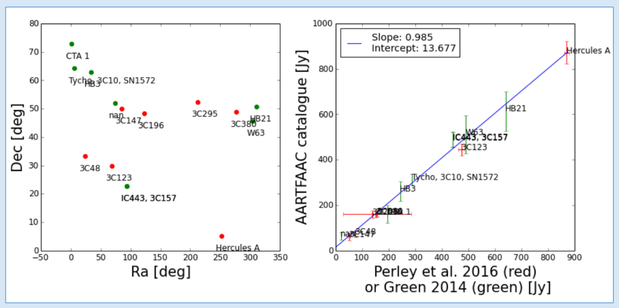
1 second snapshot

Snapshots are created with a bandwidth of 3.01MHz at a cadence of 1 second, Galactic emission and the brightest sources are removed in order to perform the transit search in the image plane.



See the full video!

Source measurement and catalog comparison



The AARTFAAC source catalog is compared to recently published low frequency calibrator catalogs, Perley & Butler 2016 (red) and Green 2014 (green).

Probability density distribution of sensitivity

Integrating the full 3.01MHz bandwidth allows us to create snapshots with sensitivity such that 40% of the visible sky has an RMS < 10 Jy/beam, and 90% < 21 Jy/beam.