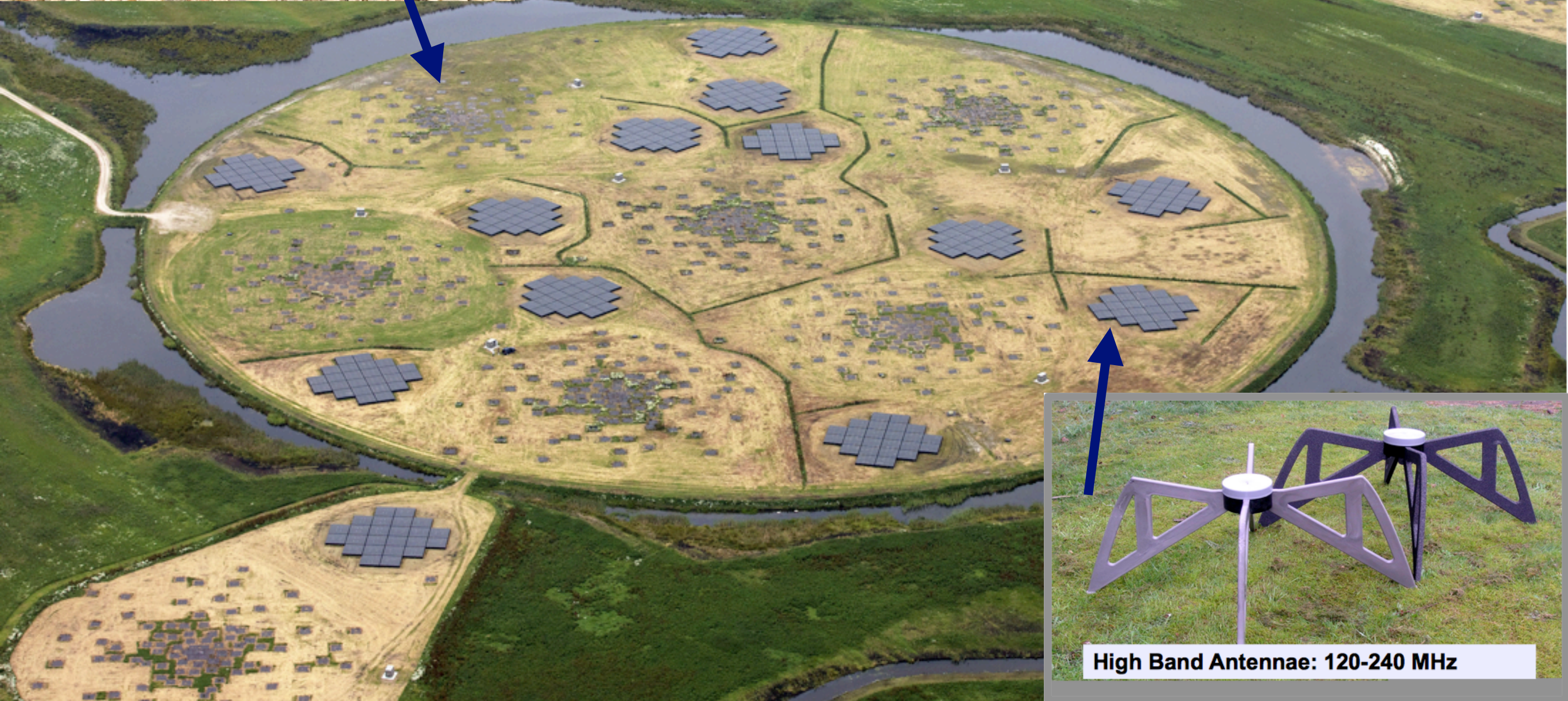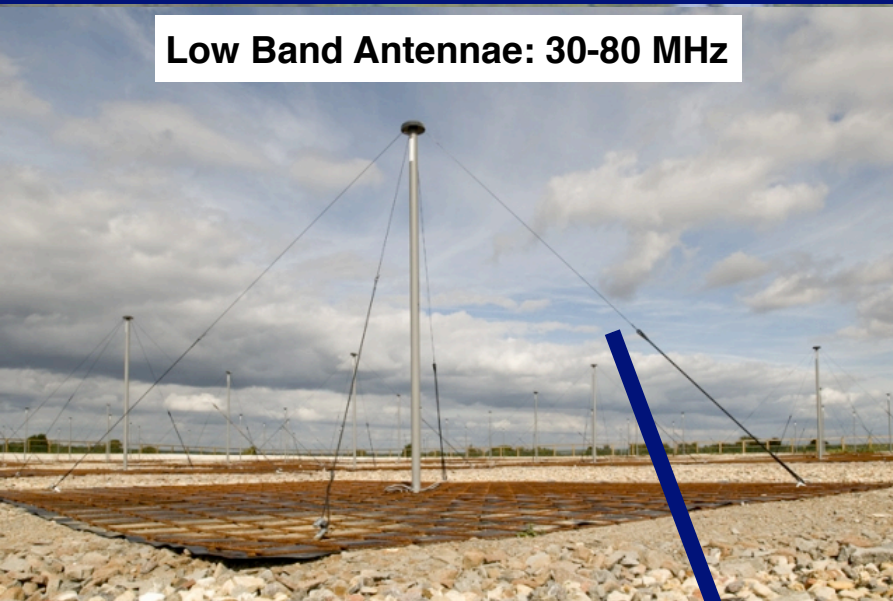# Observing transients with LOFAR and AARTFAAC
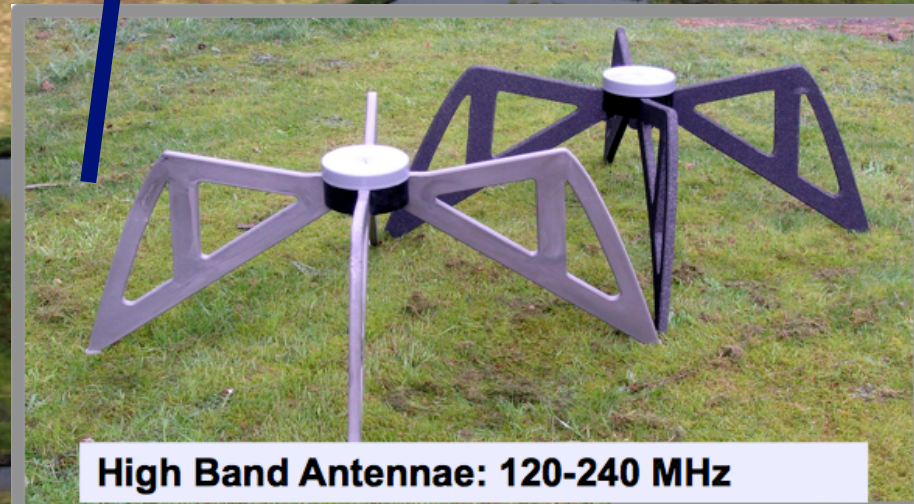
Antonia Rowlinson
on behalf of the LOFAR Transients Key Science Project
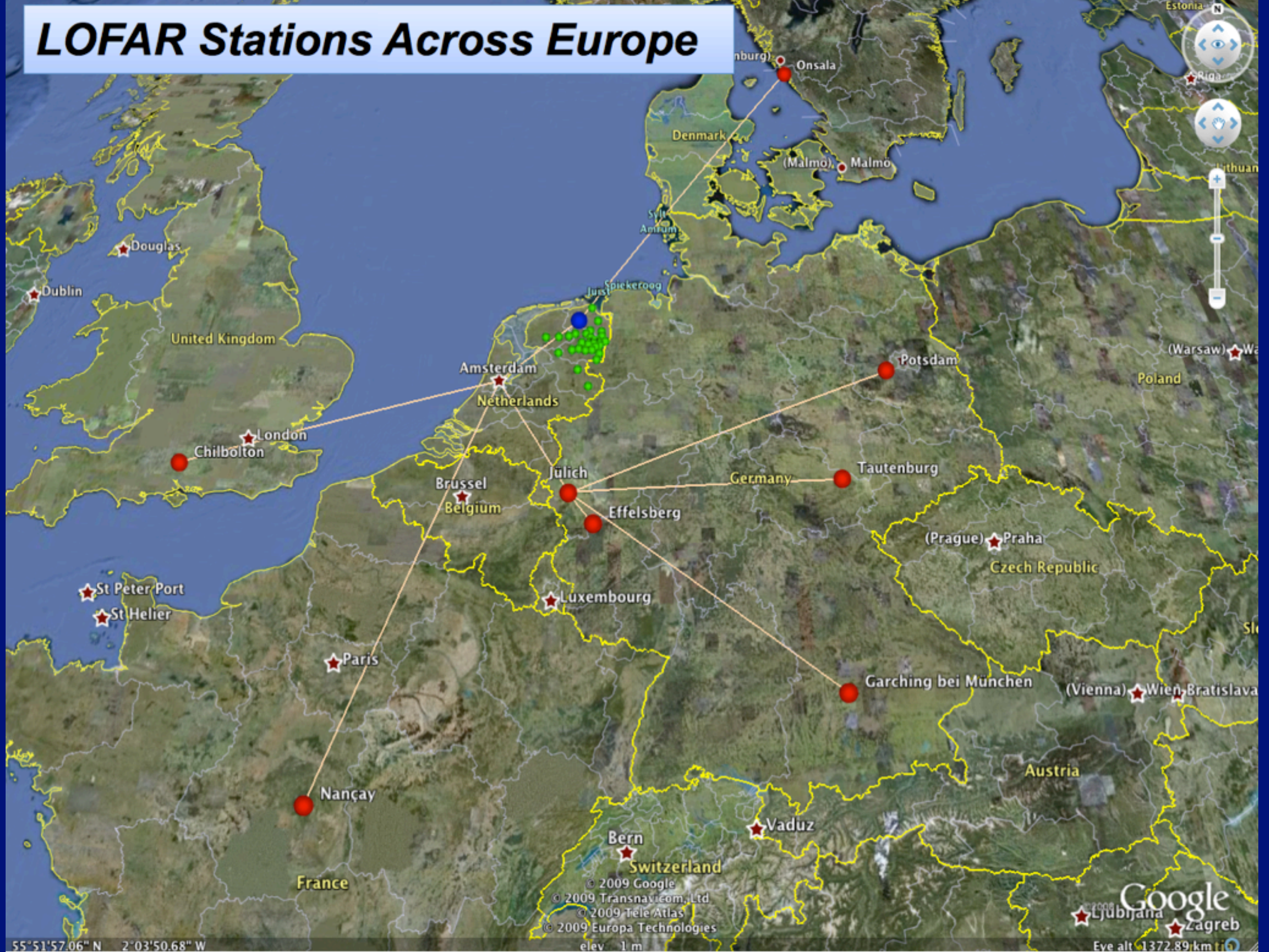
Low Band Antennae: 30-80 MHz

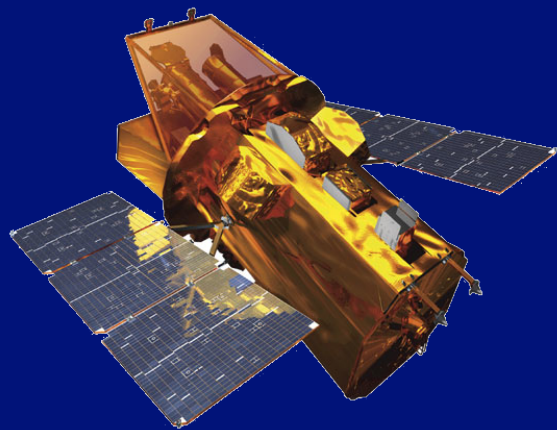High Band Antennae: 120-240 MHz

LOFAR Stations Across Europe

Automated response

Trigger from
VOEvents

e.g. Swift or even
from LOFAR itself

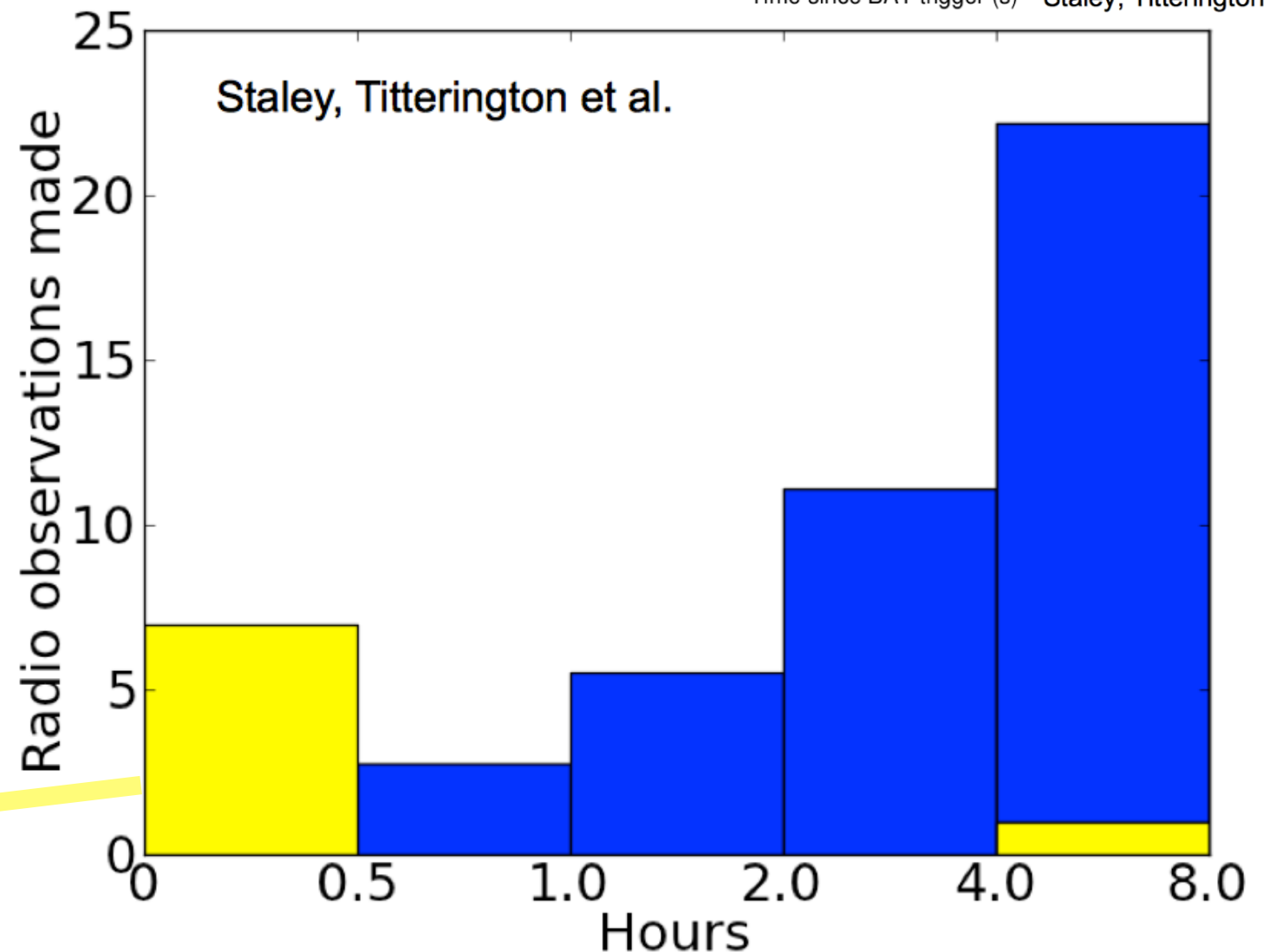AMI - telescope
slews to GRB
location

LOFAR - new beam
formed pointing to
GRB location

Rapid slews enable the study of the early emission from GRBs when reverse shocks may be observable

This is already in practice with the Arcminute Microkelvin Imager (AMI)

Staley, Titterington et al.

Chandra & Frail (2011)

BAT–XRT data of GRB 120308A
BAT: Black –– XRT: WT settling: Cyan; WT: Blue; PC: Red
~150 µJy limit at 15 GHz at 4-5 min
Staley, Titterington et al.

Staley, Titterington et al.
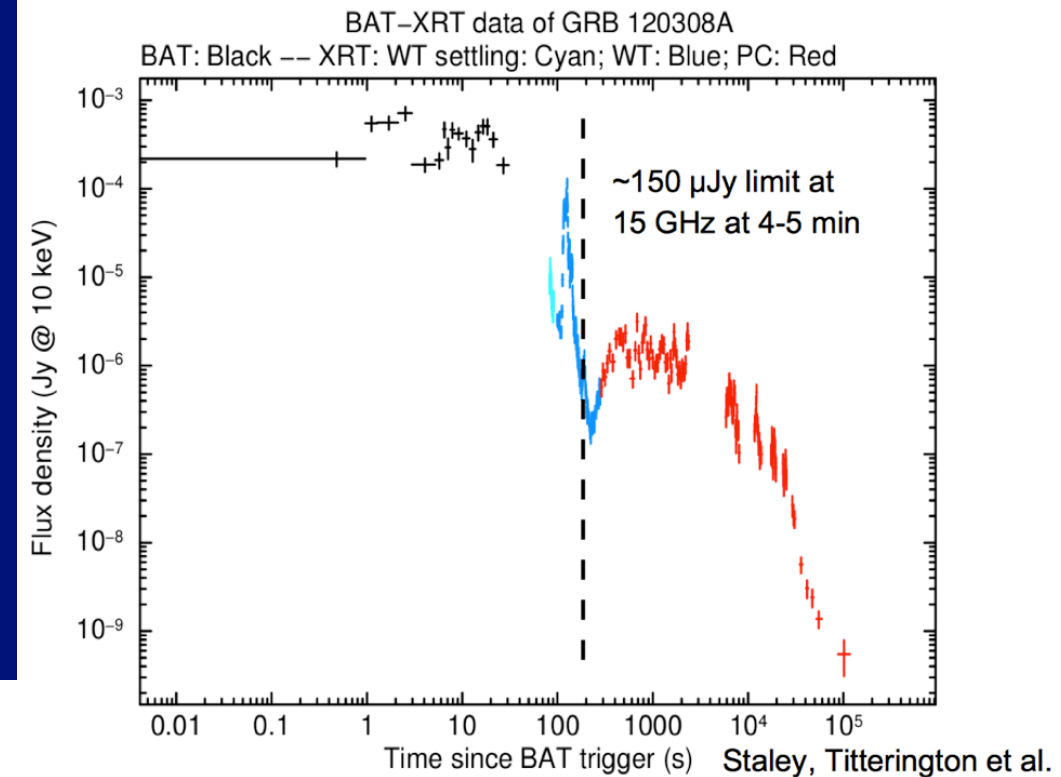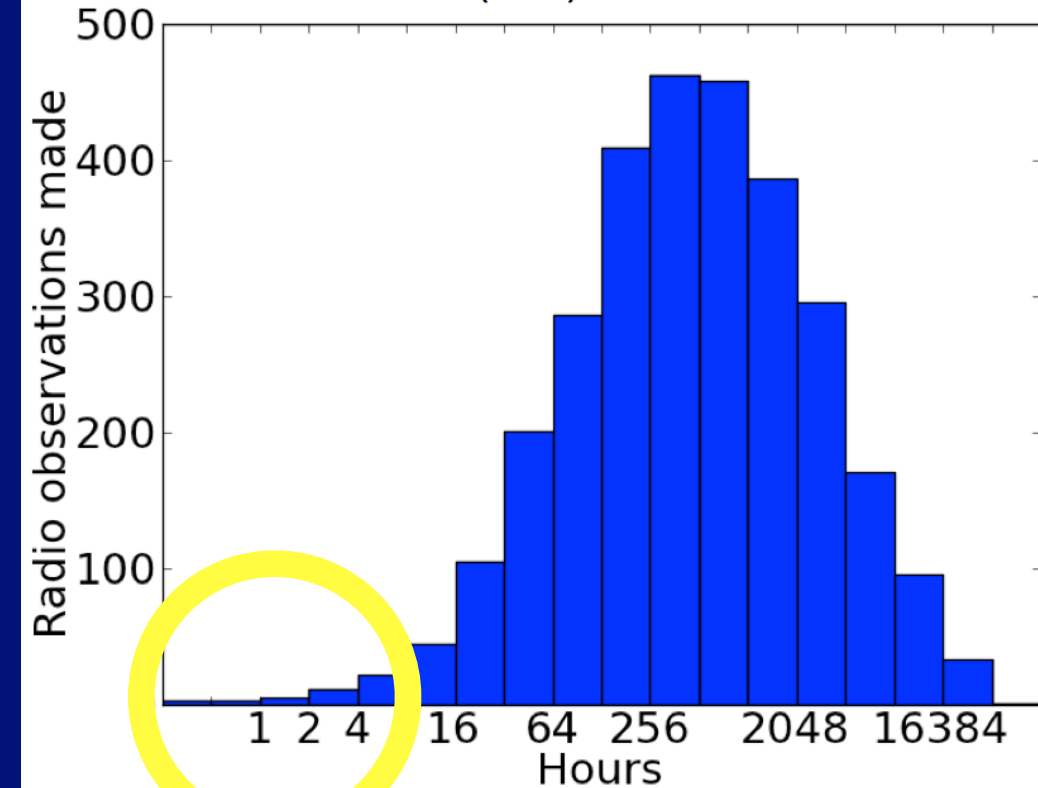
00:04:29.05
00:04:50.35
00:04:22.68
00:06:07.40
00:04:26.67
07:04:23.72
00:15:43.00
00:04:51.00

Transient Buffer Boards

- These are fitted on LOFAR antennae and store raw data (field of view: LBA - whole sky, HBA - 1000 deg^2)

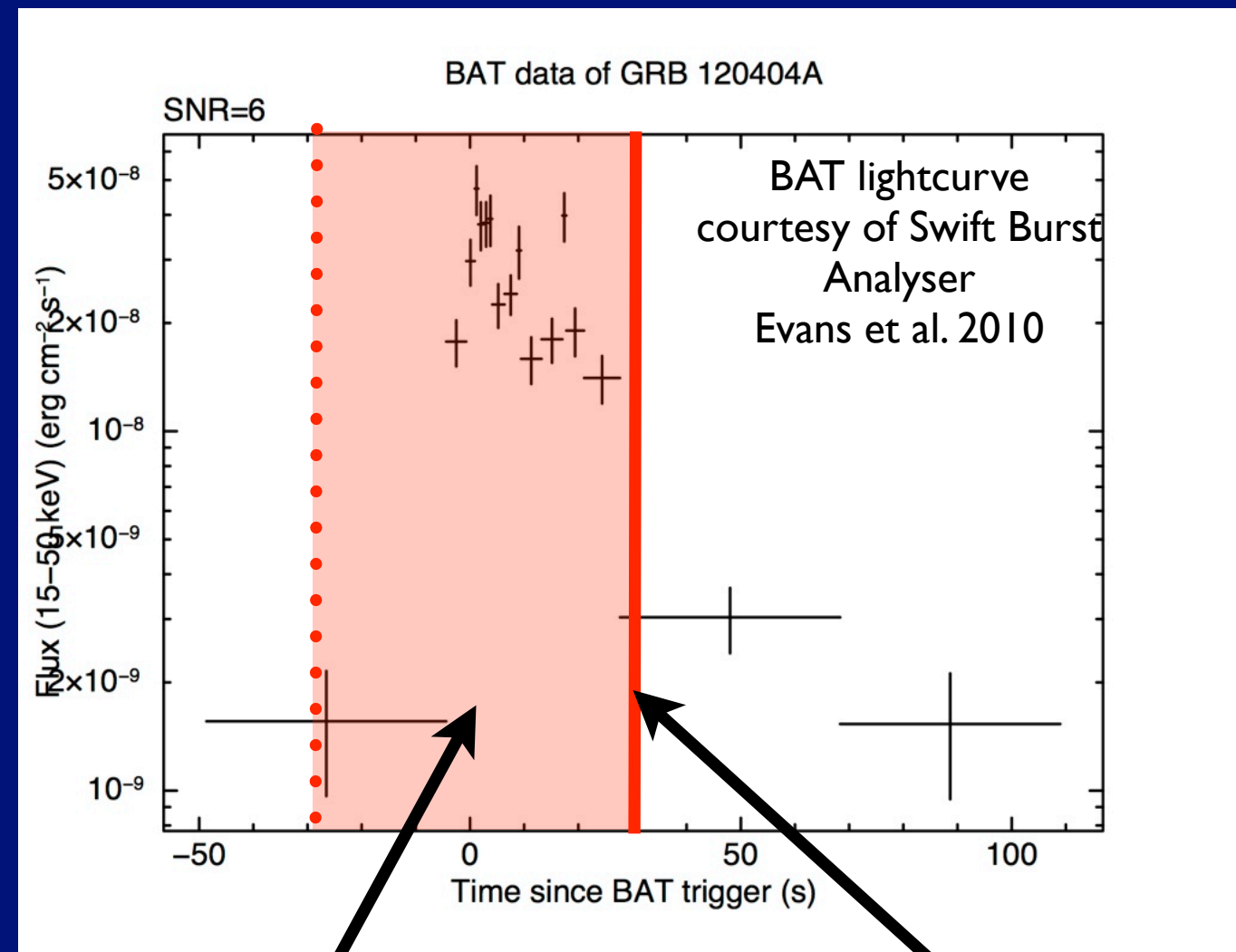- They will be frozen via a trigger, to be correlated and imaged at a later time. Full time series data will also be stored

- Currently can store 1.3 s (being upgraded to 5.3 s)

- Future upgrades will enable us to trade of bandwidth for time e.g. at 10% bandwidth they can store 53 s

BAT data of GRB 120404A

SNR=6

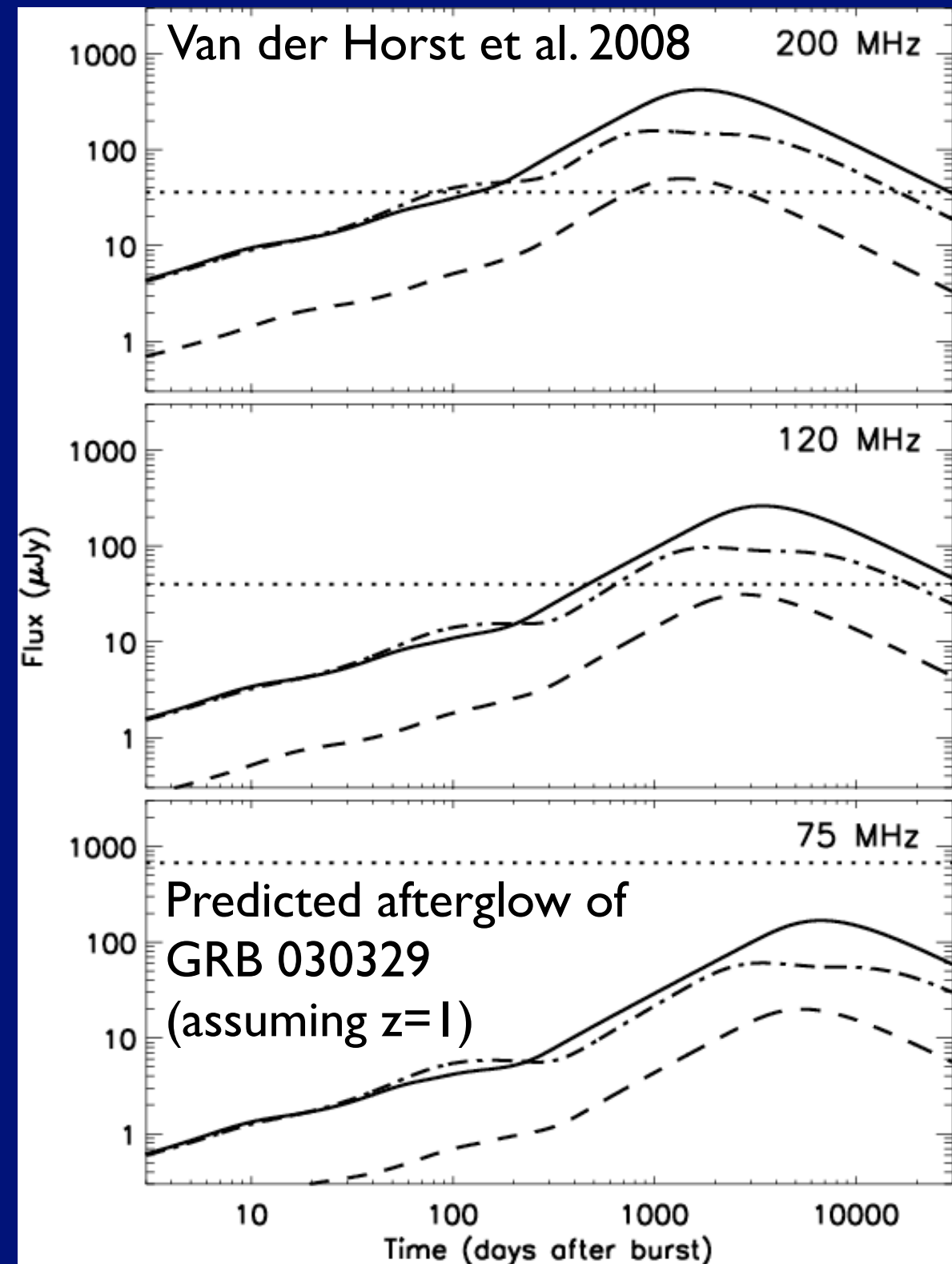BAT lightcurve courtesy of Swift Burst Analyser Evans et al. 2010

Data frozen on buffer boards (assuming 10% bandwidth) enabling imaging and coherent pulse searches during the prompt emission

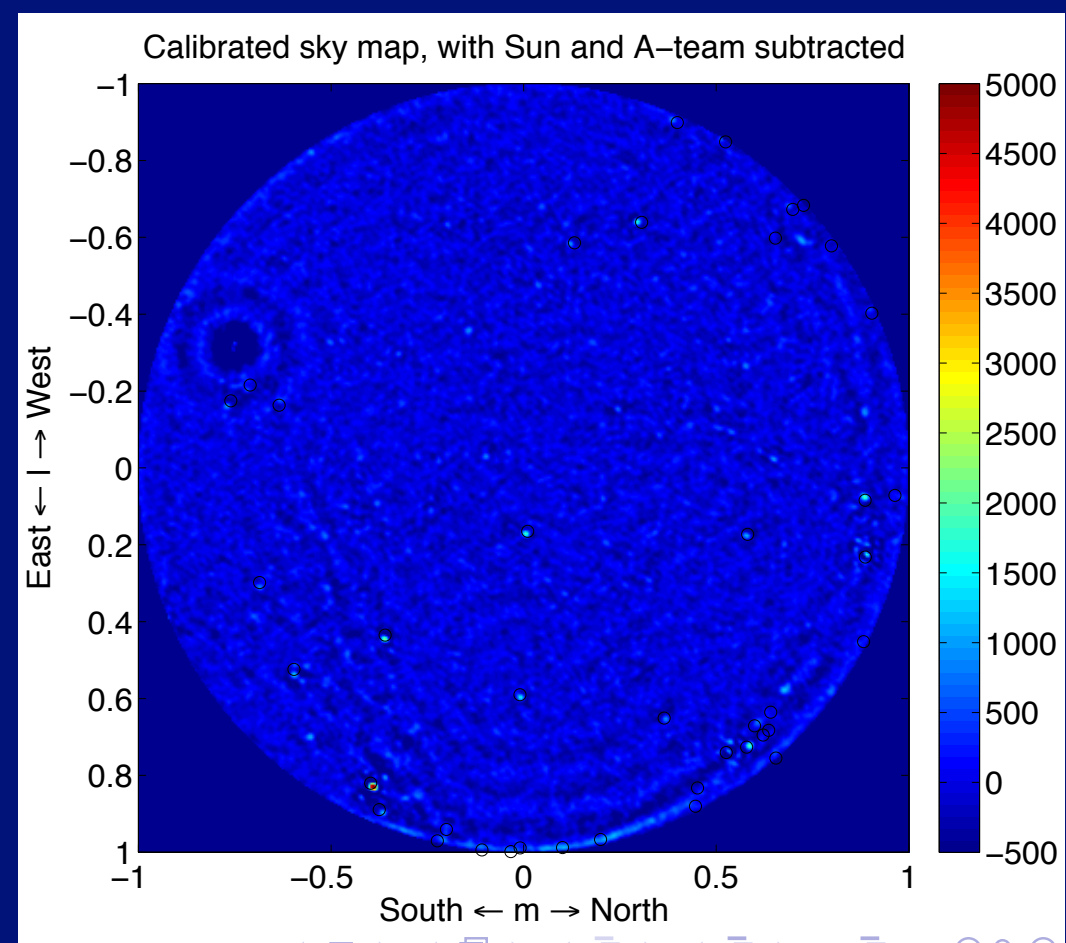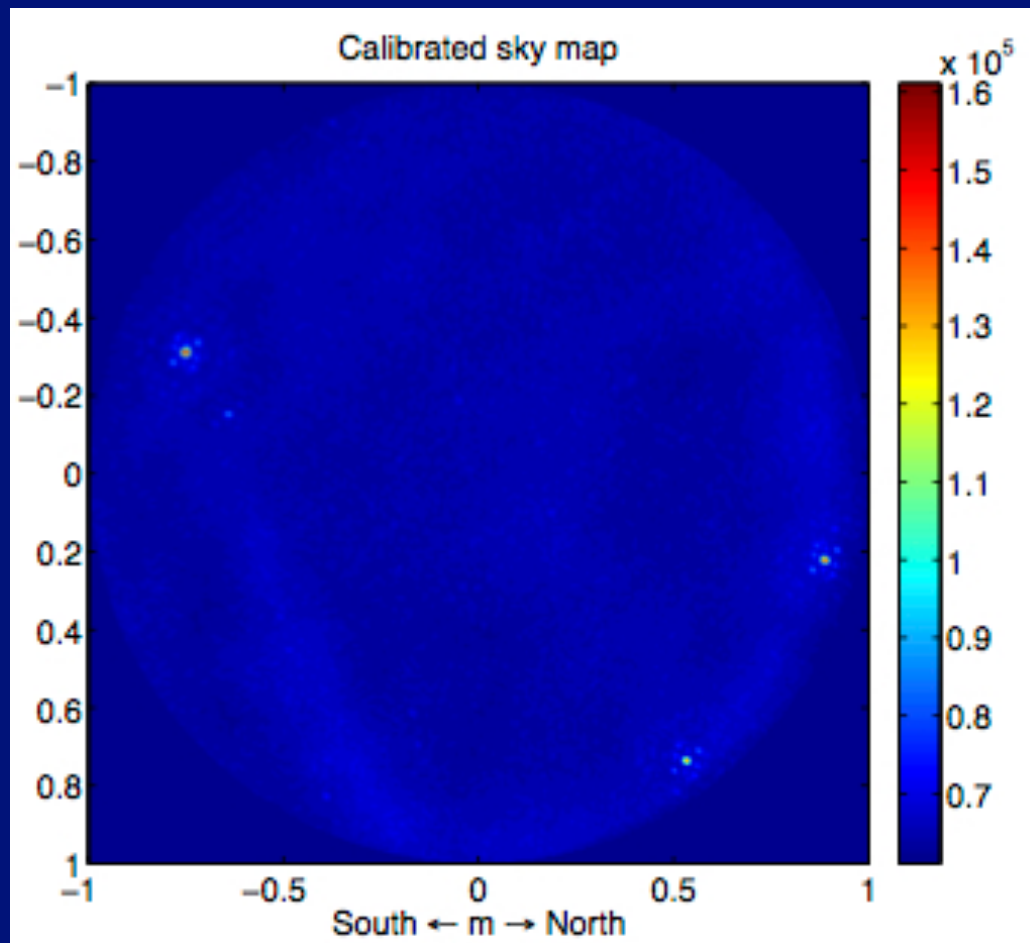Buffer boards triggered (e.g. from Swift)

Monitoring transient sources

- Future data produced by LOFAR will be analysed by the Transient Pipeline and new transients announced via VOEvents

- GRBs can be placed into a monitoring list, so the flux can be measured each time the position is observed by LOFAR, producing lightcurves for each GRB

- Afterglows can be detected and monitored on timescales from months to years after the GRB, enabling study of the non-relativistic phase of the afterglow

Van der Horst et al. 2008   200 MHz

120 MHz

75 MHz

Predicted afterglow of GRB 030329 (assuming z=1)

Flux (μJy)

Time (days after burst)

AARTFAAC

Amsterdam-Astron Radio Transient Facility And Analysis Centre

- 24/7 radio sky monitor to be fitted to the 6 central LOFAR stations

- Will operate in a piggy-back mode during all LOFAR observations, providing low resolution and low sensitivity images every second with a large field of view (LBA - whole sky, HBA - 1000 deg^2)

- Real-time triggering on very rare, bright transients - ? GRBs

Summary

- LOFAR will have many capabilities including:

    - automated observations in response to VOEvents
        - ➡ observations during the early emission stages of GRBs

    - transient buffer boards which can store several seconds of data prior to trigger time
        - ➡ imaging and coherent pulse search during the prompt emission

    - real-time transient pipeline to enable detection and monitoring of transient sources, to be communicated via VOEvents
        - ➡ long term monitoring of GRB afterglows

- AARTFAAC is a whole sky monitor which will find the brightest and rarest transients

    - ➡ ? GRBs