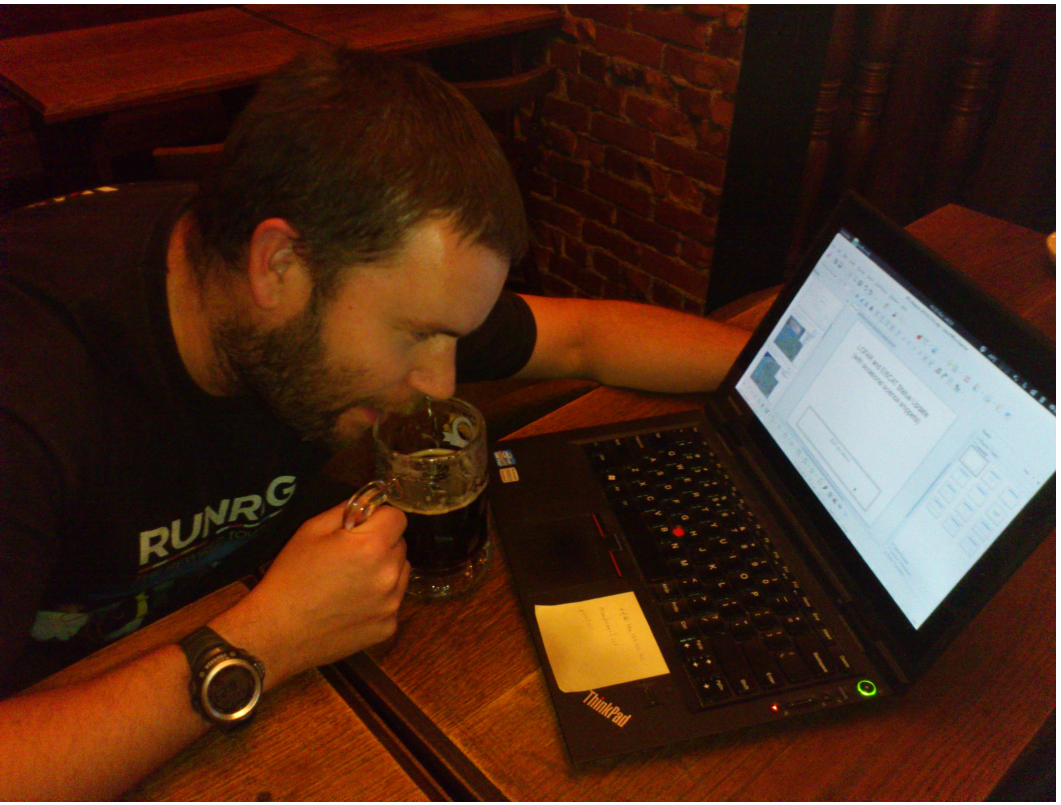
LOFAR and EISCAT Status Update (with occasional science snippets)



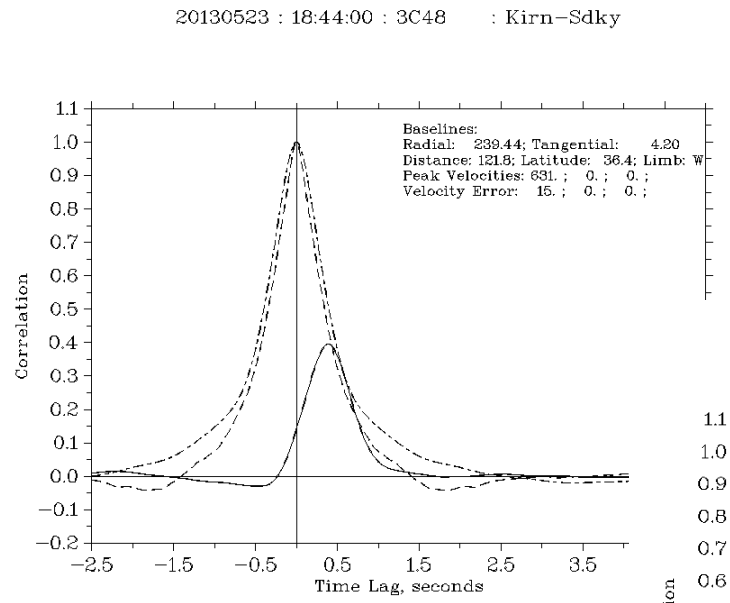
RAF and Mario

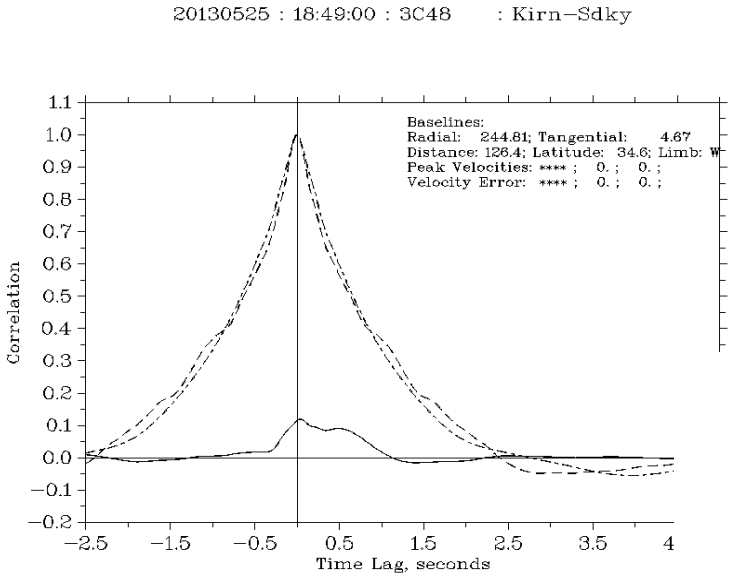
EISCAT

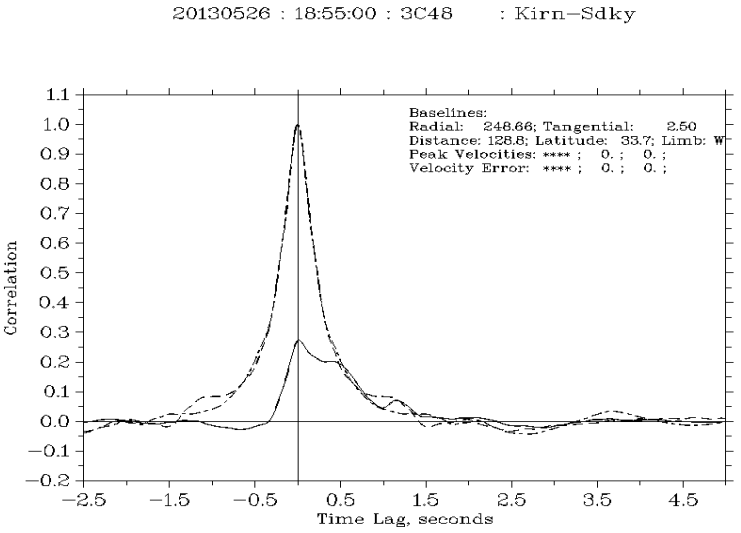
EISCAT @ VHF – the story so far...

- EISCAT remote antennas (Kiruna and Sodankyla) converted to VHF (224 MHz) in the last year.
- Tromso remains at 928 MHz.
- 1420 MHz still possible on request, but requires one day per site and a crane...
- Occasional cross-correlations seen, but **big** issue with zero time-lag correlation.

EISCAT @ VHF – the story so far...

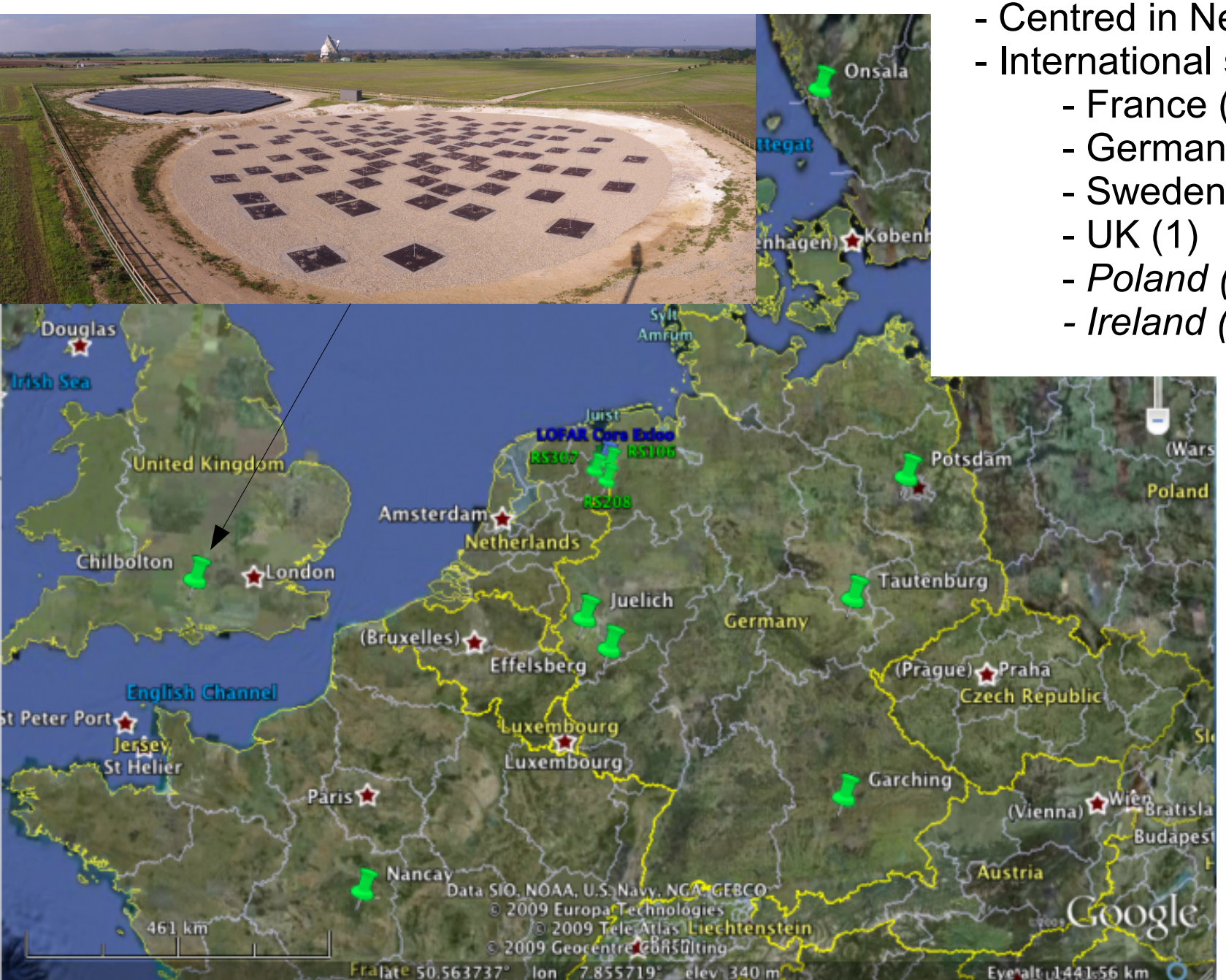






LOFAR

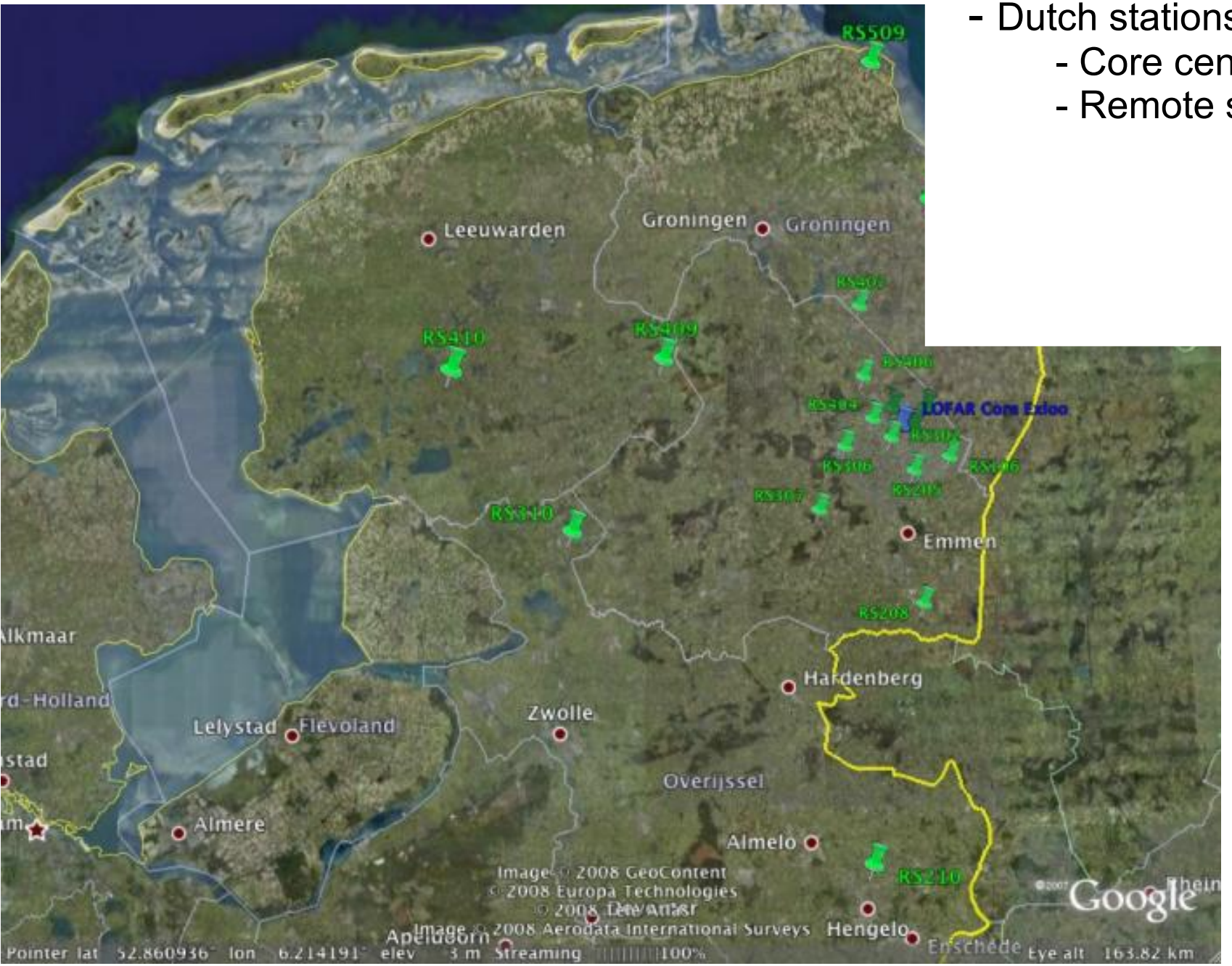
Array Location



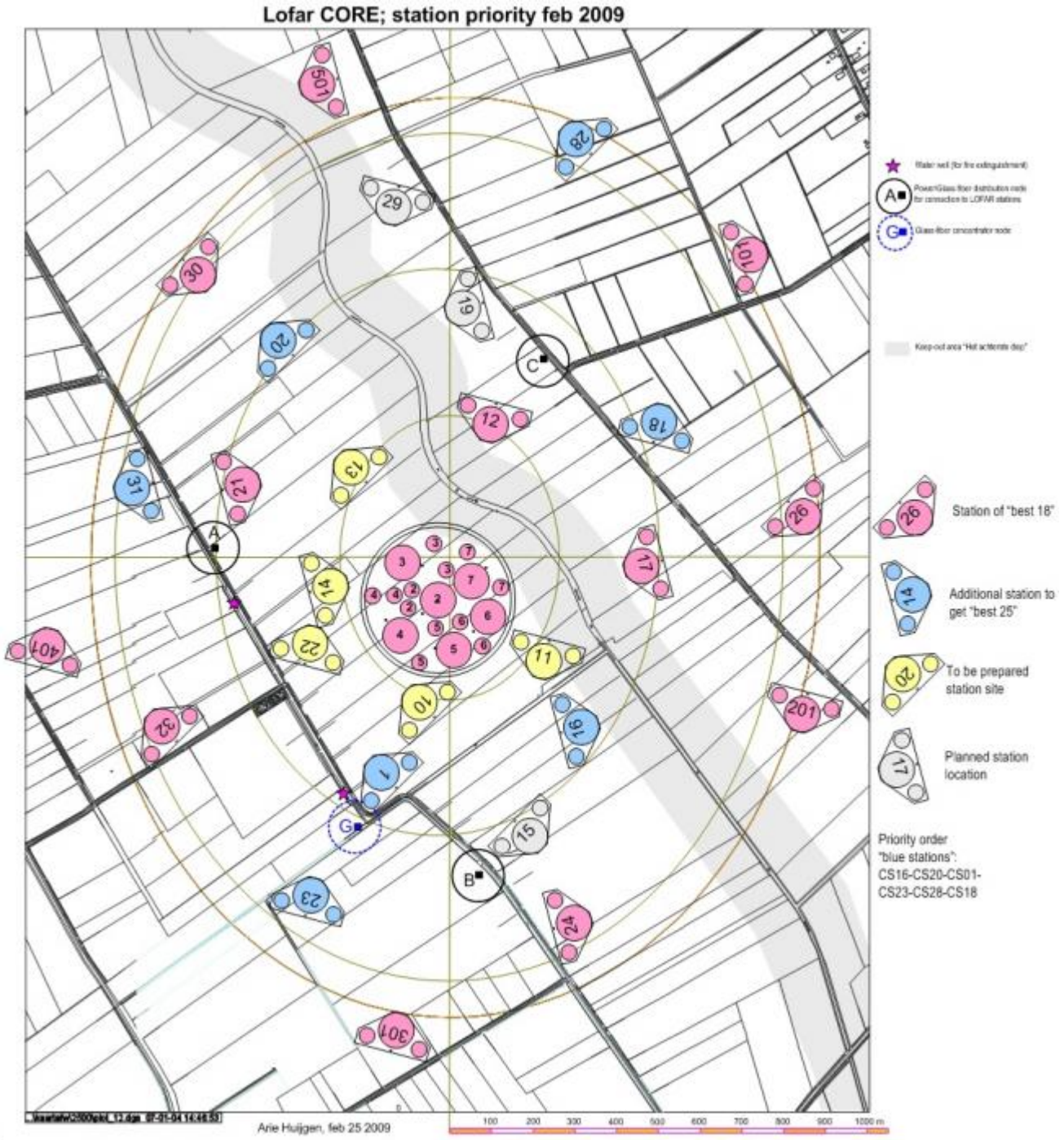
- Centred in Netherlands
- International stations:
  - France (1)
  - Germany (5)
  - Sweden (1)
  - UK (1)
  - *Poland (3)*
  - *Ireland (1)*

Array Location

- Dutch stations:
  - Core centred on Exloo
  - Remote stations



Array Location



- Core stations:
  - Central area of stations with area diameter of 2km.
  - “Superterp” of six stations in centre.

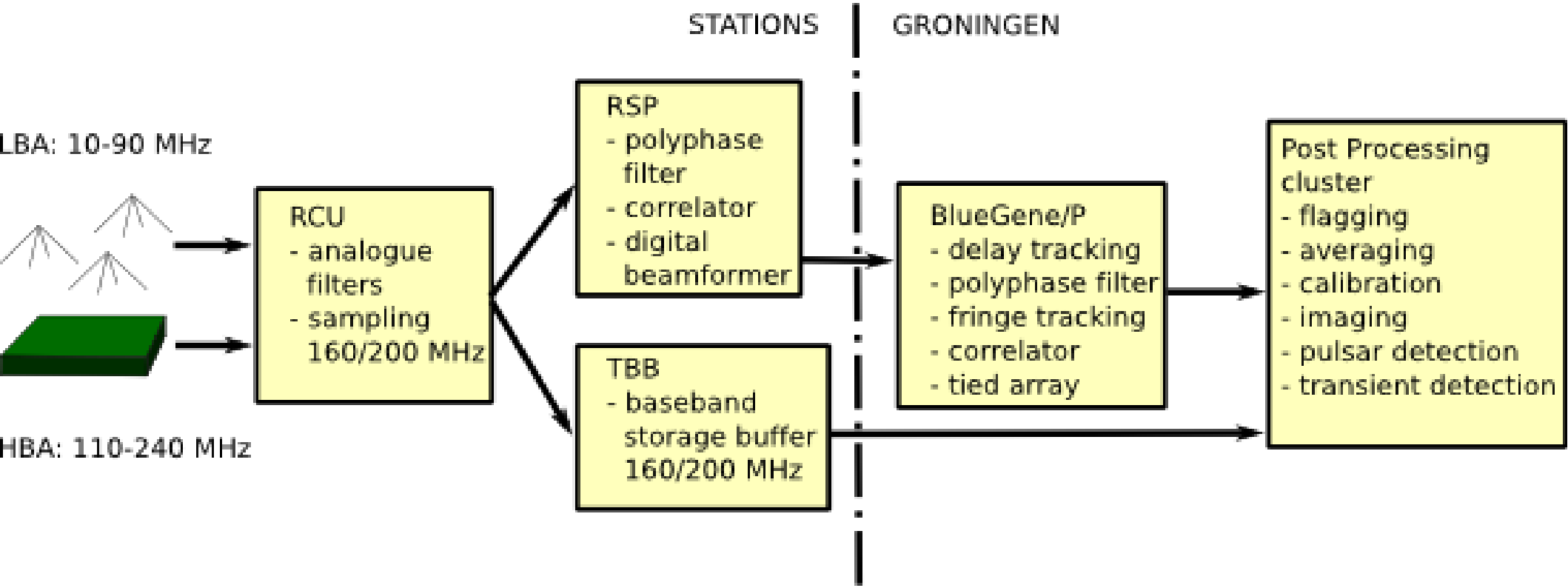
Array Location

LOFAR

ASTRON

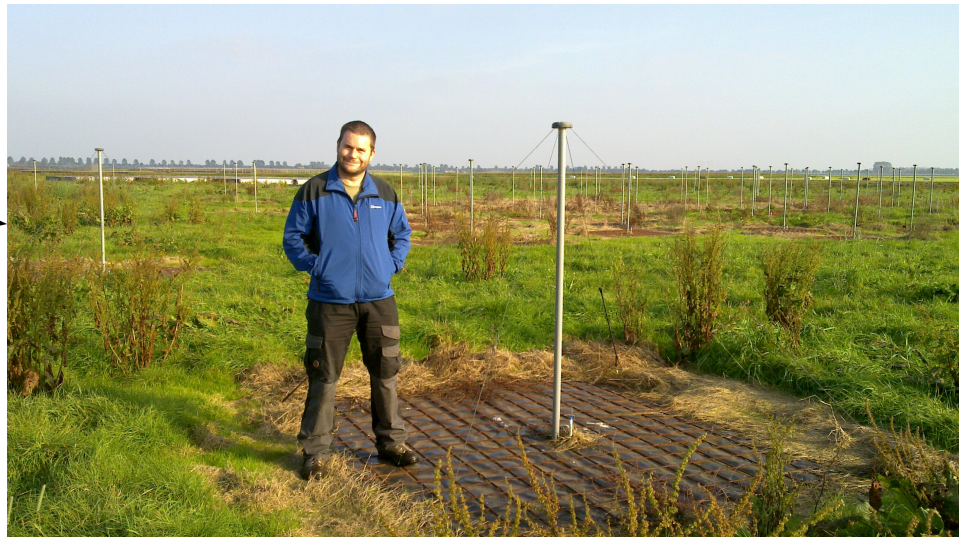
- Superterp

Data Path


STATIONS
GRONINGEN
LBA: 10-90 MHz
HBA: 110-240 MHz
RCU
- analogue filters
- sampling 160/200 MHz
RSP
- polyphase filter
- correlator
- digital beamformer
TBB
- baseband storage buffer 160/200 MHz
BlueGene/P
- delay tracking
- polyphase filter
- fringe tracking
- correlator
- tied array
Post Processing cluster
- flagging
- averaging
- calibration
- imaging
- pulsar detection
- transient detection

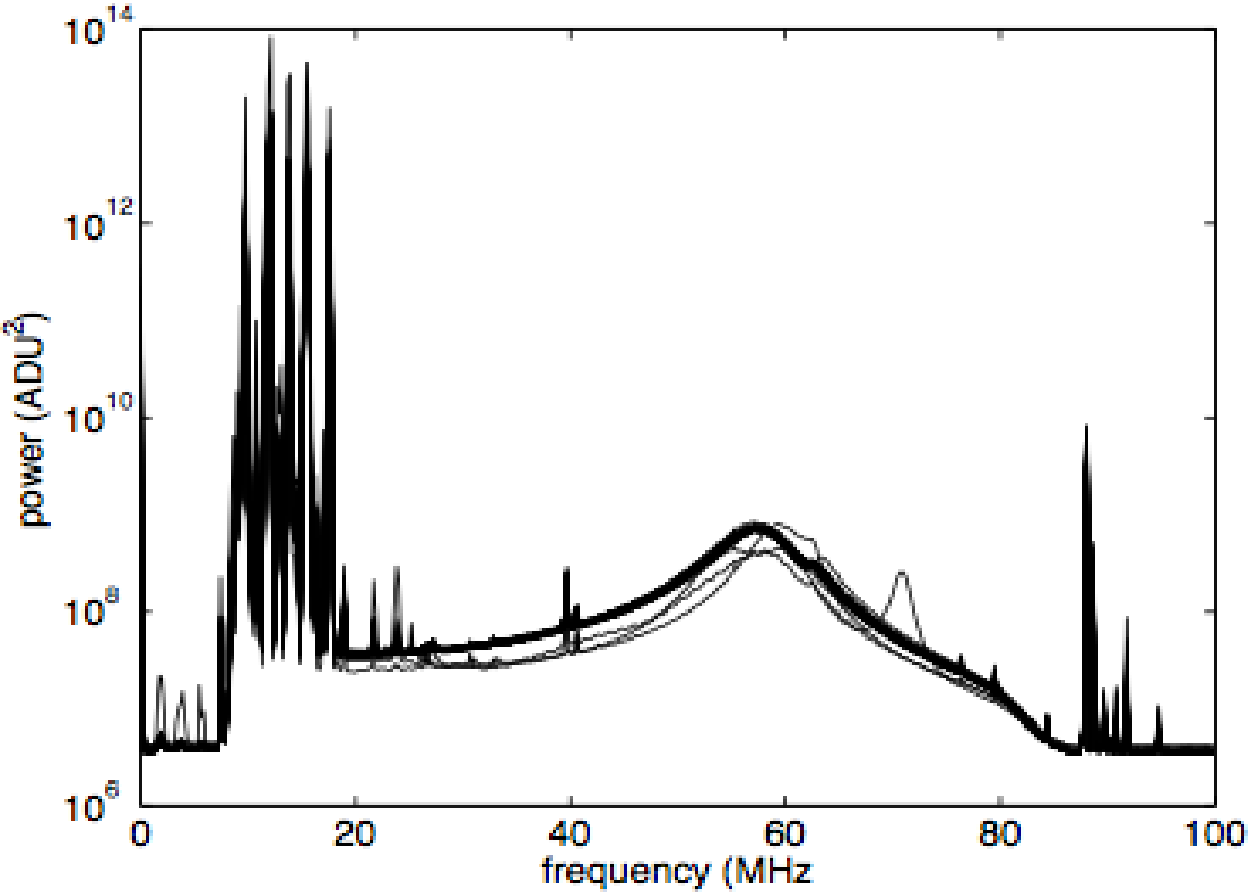
Antennas

Each site contains two arrays of antennas.
Low-band (LBA):
10-90MHz
High-band (HBA):
110-250MHz



Low-Band Antennas

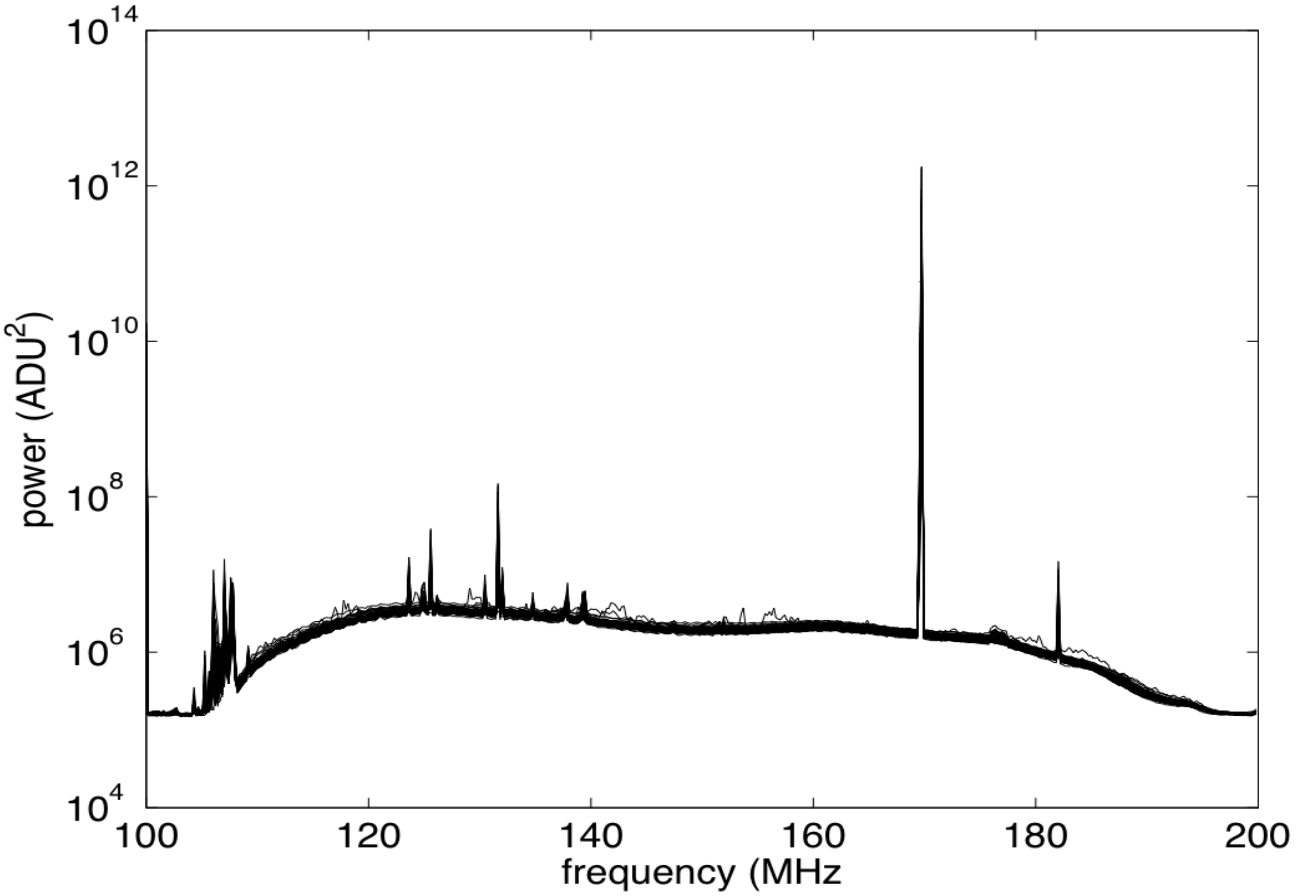
- Wire dual dipoles set at 45 degrees
- Held in place by rubber tensioners
- “Random” distribution within station to reduce sidelobes

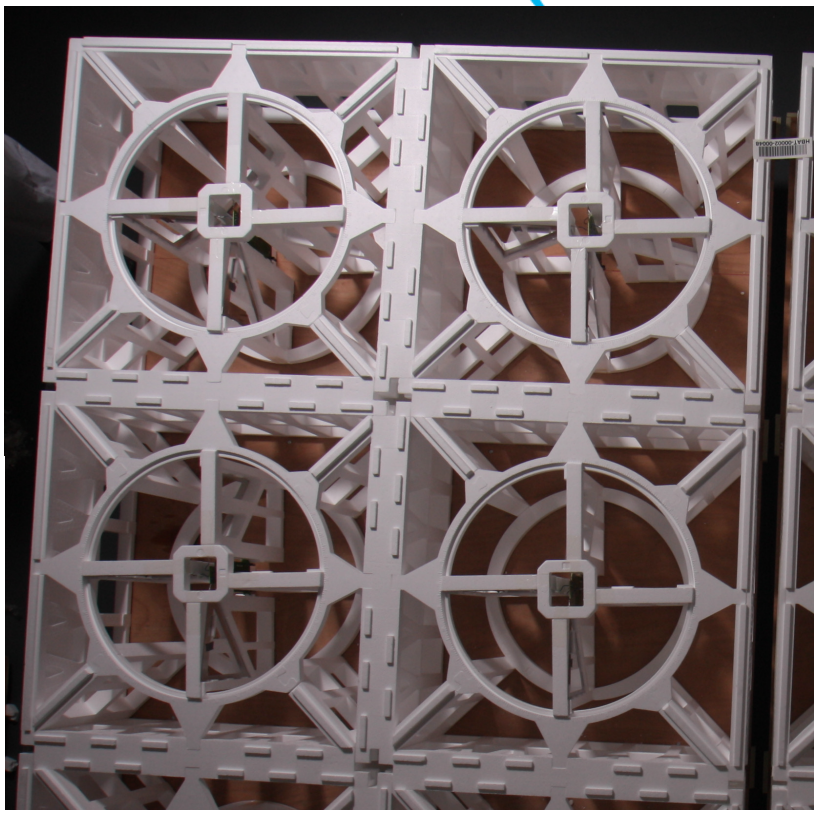


- Usable band:10-90 MHz
- Below 30MHz, ionospheric contamination
- Above 88MHz, FM waveband

High-Band Antennas

- Metal plate “bow-tie” dual dipoles, encased in polystyrene
- Grouped into “tiles” of 4x4 antennas, with tile spacing of 1.25m (1 wavelength at 240MHz).
- Analogue beam-former “points” tile in given direction, ~30 degree beam width

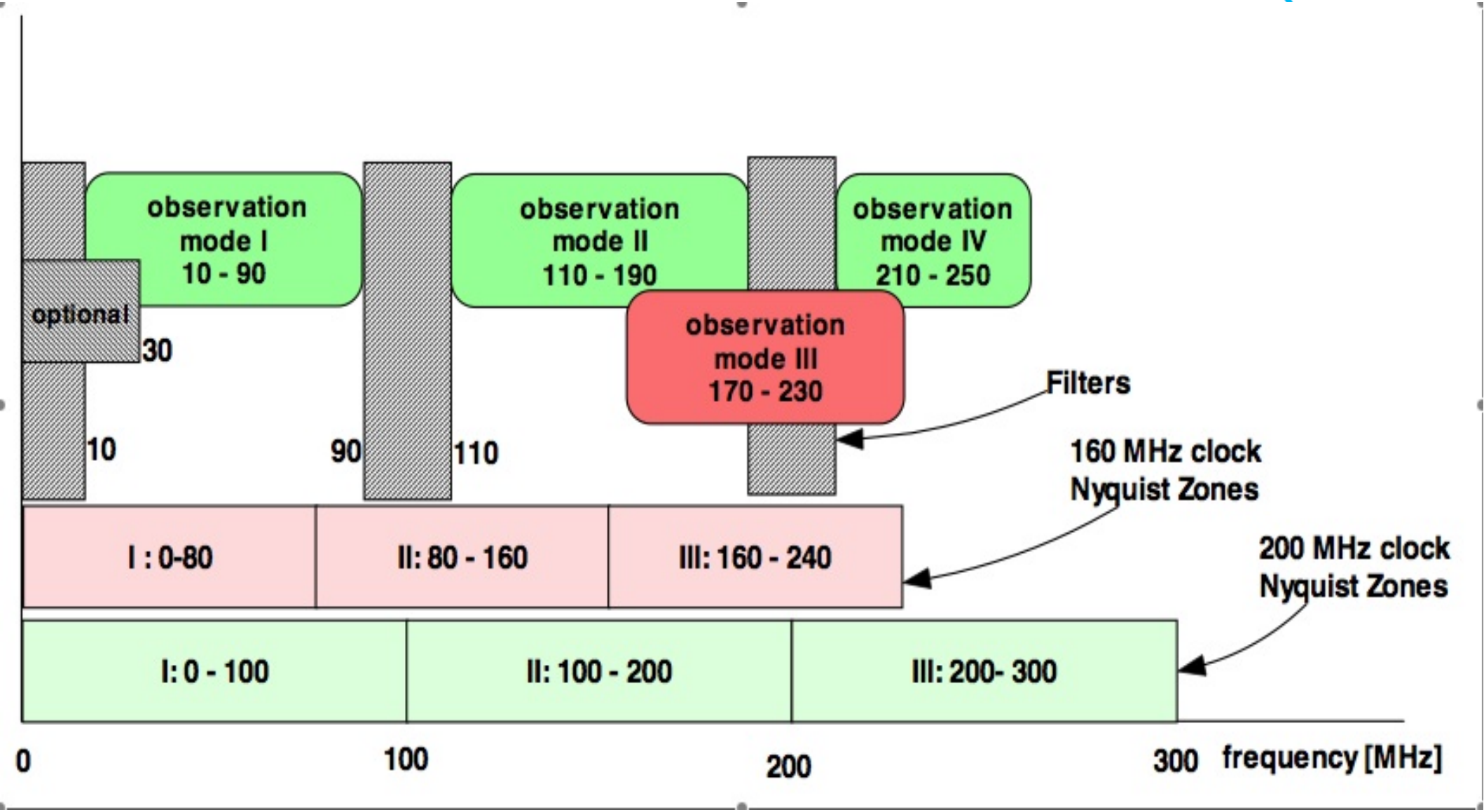




- Usable band:110-250 MHz

- Three filters: 110-190MHz, 170-230MHz, 210-250MHz

Clock and Filter Selections



Frequency and Time Resolutions

Full bandwidth of the digitised signal (100MHz or 80MHz depending on the clock) split into 512 “subbands”.

Up to 488 subbands, covering 96/76MHz in total, can be returned to Central Processing (CEP) due to data rate limitations.

Frequency resolution is 0.1953125/0.156250 MHz.

Time resolution at this stage is 5.12 μs.

In CEP, subbands can be split into channels (16 to >256) with a corresponding decrease in time resolution.

Beam Definitions

Dipole/Tile beam:
- Sensitive to whole sky >30 degrees elevation (LBA) or ~30 degrees wide (HBA tile)

Station beam:
- 2 to >8 degrees wide, depending on station size and frequency.

“Tied-array beam”:
- Form array of stations.
- <1 degree wide, depending on frequency and number of stations used.

Observing Trade-offs

Observing with **single** stations:

- Each sub-band corresponds to a “beamlet” at station level.

- Hence, bandwidth must be balanced against number of beams at station level.

Tied-array beams:

- **Additional** beam-forming done in the correlator.

- Only available with core stations.

- Allows formation of up to ~190 beams using the full bandwidth.

Final Data Products

Data returned can be combined to return raw visibilities for imaging:

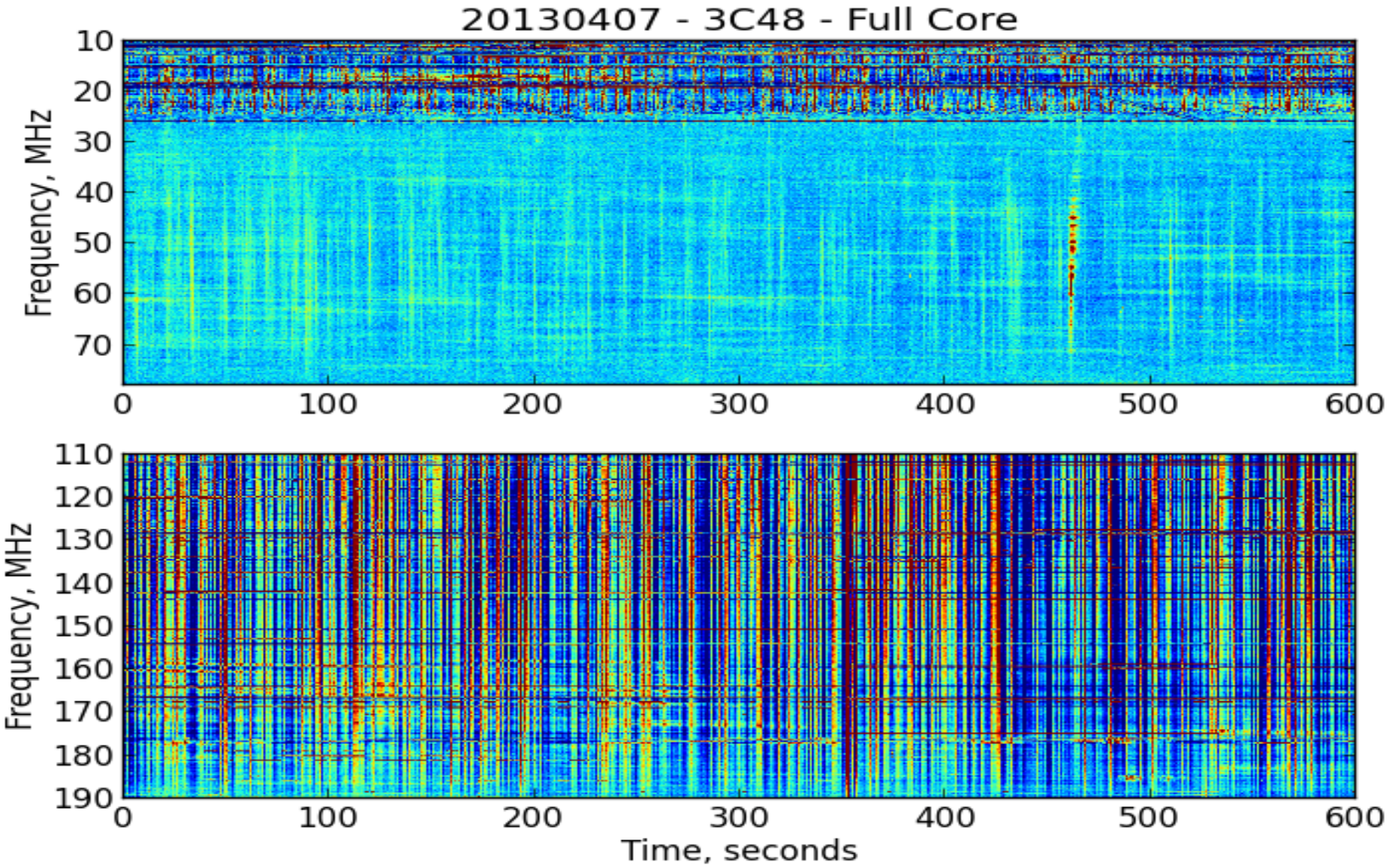
- Imaging data “pipeline” will return sky images, as specified by the user.

Or they can be returned as “beam-formed” data:

- Equivalent to single-dish measurement.
- Time/Frequency data returned for combined array and/or individual stations.

Or both simultaneously...

IPS with LOFAR: the Science we didn't show...

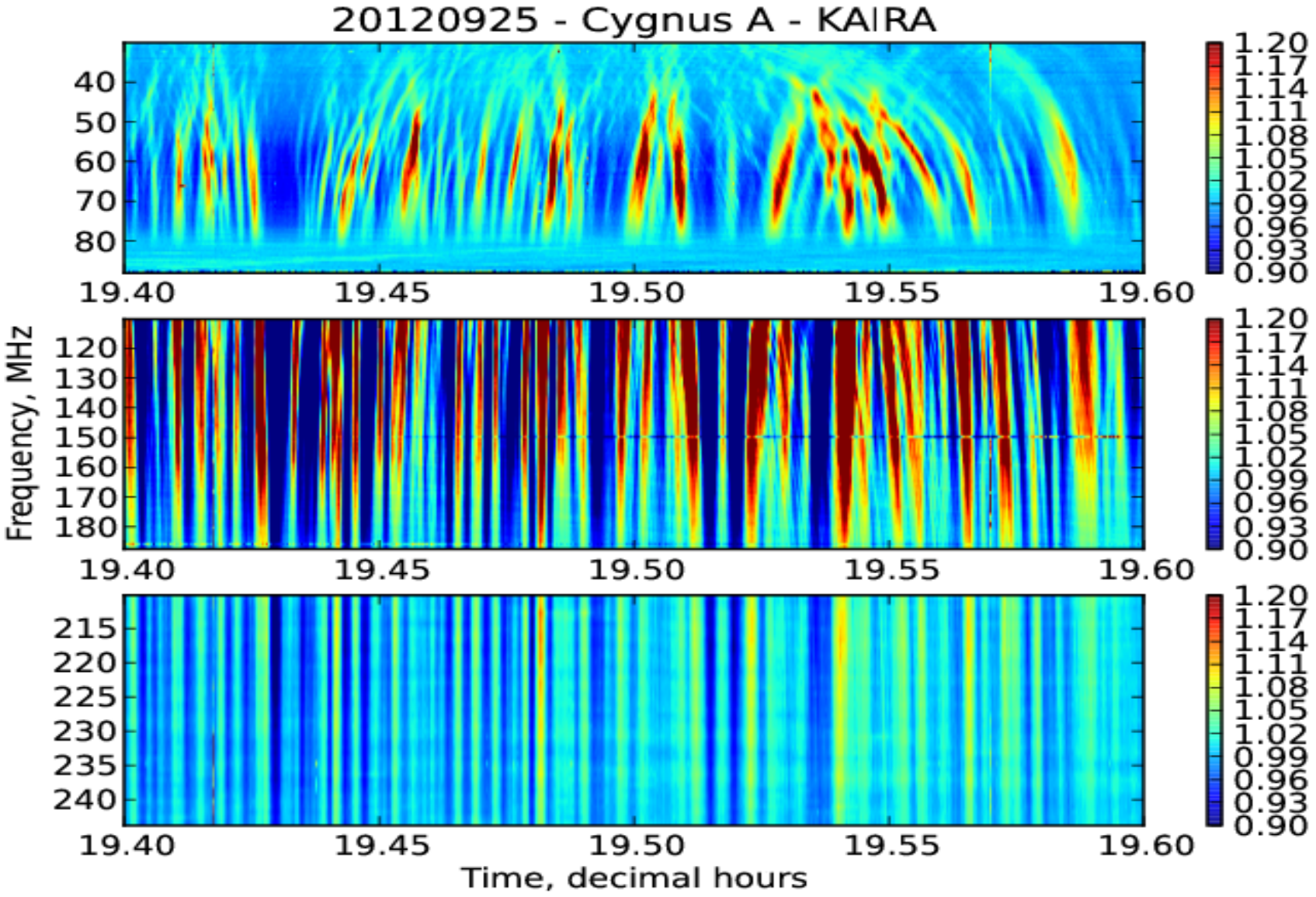


Mode “357” - Combining LBA and HBA modes

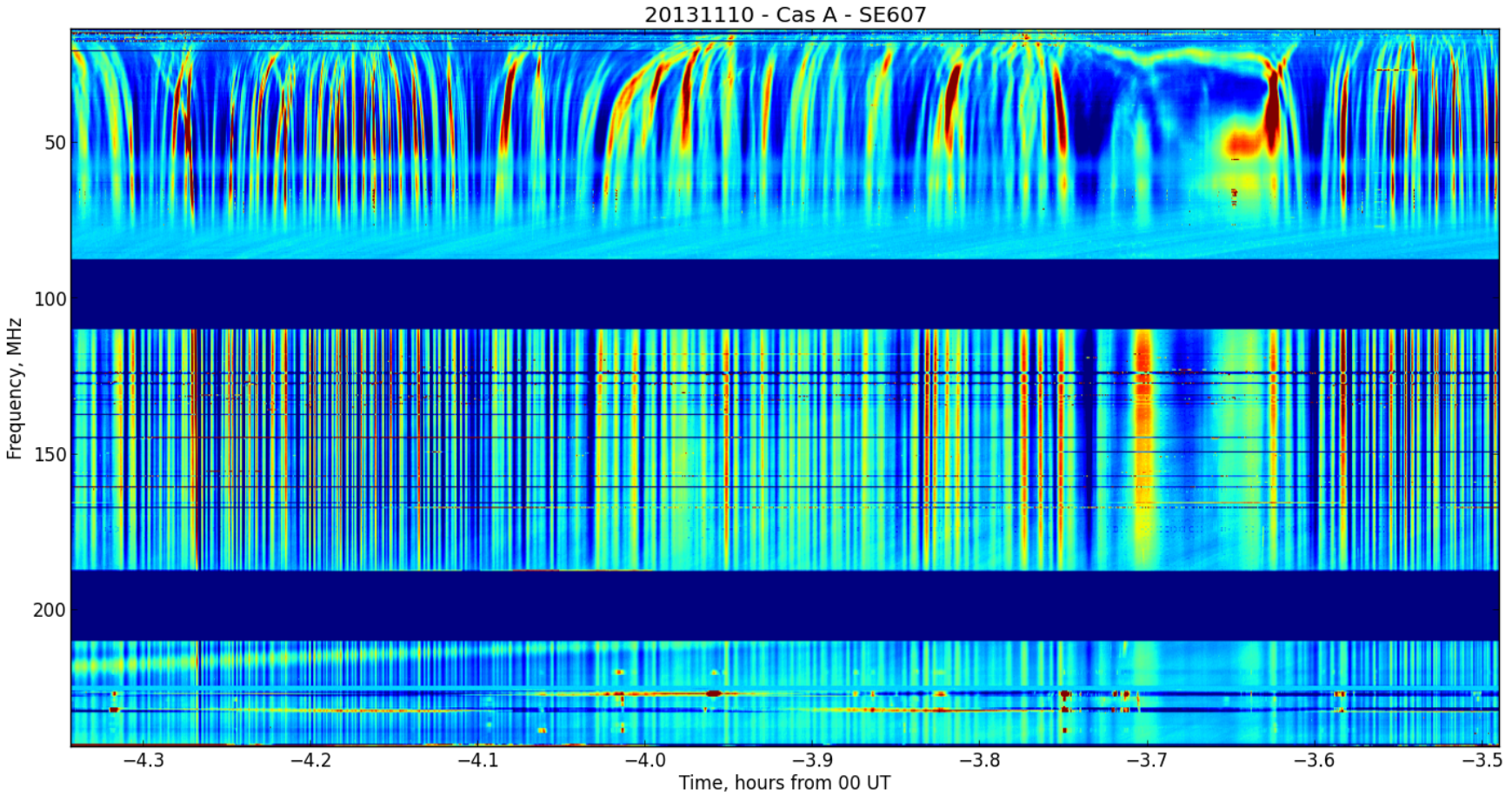
- A third of the LBAs in mode 3 (10-90 MHz)
- A third of HBAs in mode 5 (110-190 MHz)
- A third of HBAs in mode 7 (210-270 MHz)
- Specify beams such that all available subbands are spread over the three modes.

- Caveats:
  - Sensitivity is seriously reduced.
  - Spread of subbands results in gaps between them:
    - In 8-bit mode, can cover every third subband

Ooh... Pretty...


20120925 - Cygnus A - KAIRA
Frequency, MHz
40
50
60
70
80
120
130
140
150
160
170
180
215
220
225
230
235
240
19.40
19.45
19.50
19.55
19.60
1.20
1.17
1.14
1.11
1.08
1.05
1.02
0.99
0.96
0.93
0.90
Time, decimal hours

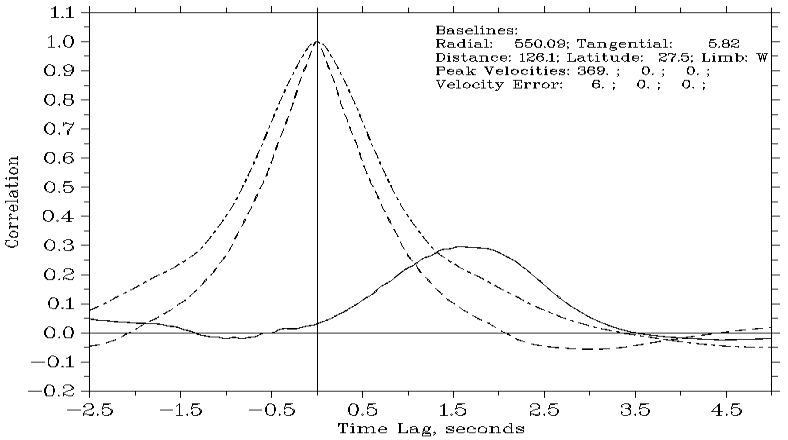
4-bit mode – 192 MHz of bandwidth



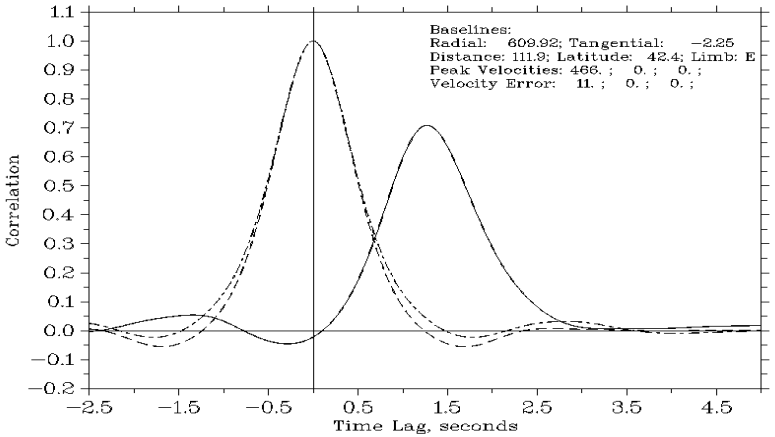
Issue with peak sensitivity of LBA saturating. Need to use maximum attenuation, but some saturation still visible.

IPS Cross-Correlations – the curse of zero-lag correlations...

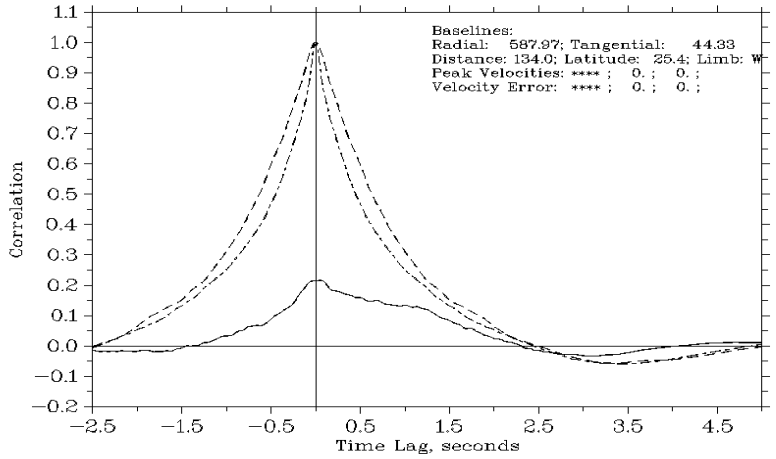
20130531 : 09:10:00 : 3C55 : D605−U608



20130531 : 16:15:00 : 3C147 : F606−D602

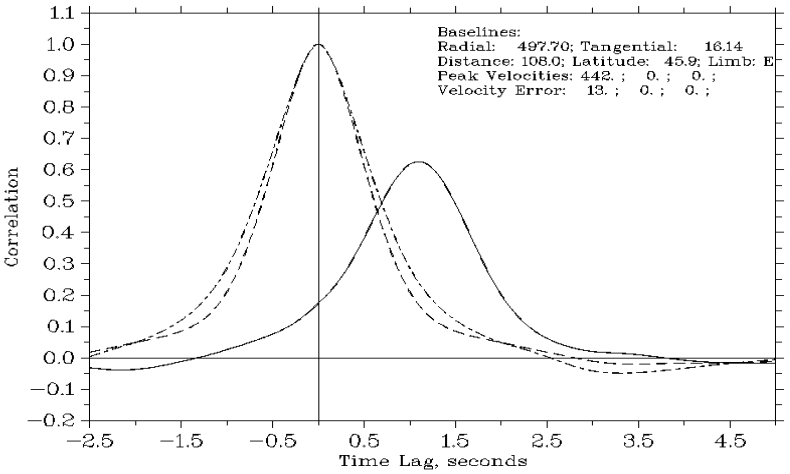


20130603 : 09:15:00 : 3C55 : D601−U608



Weaker source

20130603 : 07:50:00 : 3C147 : F606−U608



Strong source