André Offringa – Juli, 2011

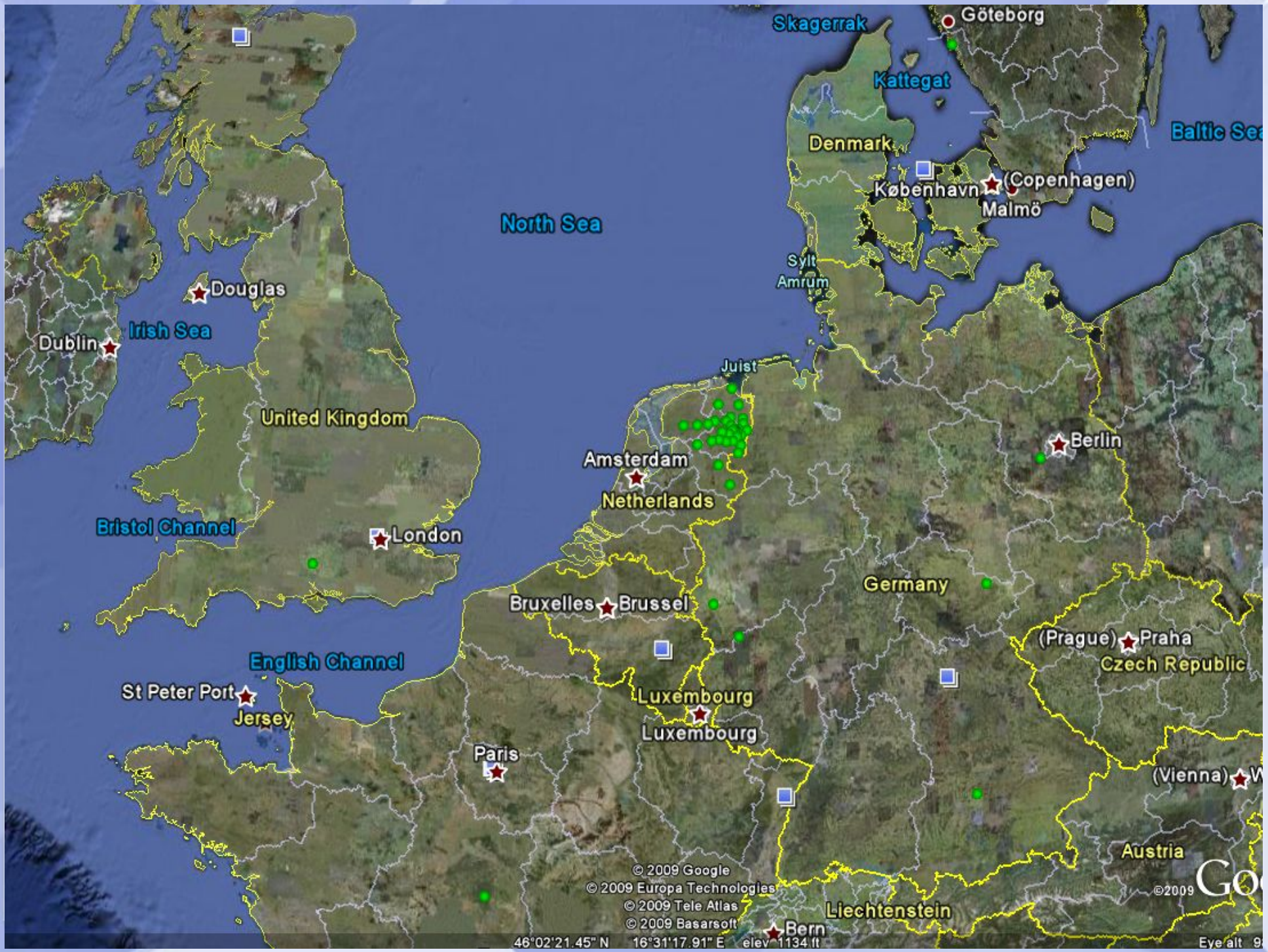
The LOFAR-EoR project and RFI mitigation

The LOFAR telescope

LOFAR's key properties:

- 10-90 and 110-300 MHz
- Beamformed stations from dipoles, tiles
- Wide field of view
- Very flexible observing modes
- Large collecting area
- Core in the Netherlands
- International baselines up to 1000 km.

The low and high band antennas


Skagerrak
Göteborg
Kattegat
Baltic Sea
Denmark
København
(Copenhagen)
Malmö
North Sea
Sylt
Amrum
Douglas
Irish Sea
Dublin
Juist
United Kingdom
Berlin
Amsterdam
Netherlands
Bristol Channel
London
Germany
Bruxelles
Brussel
(Prague)
Praha
Czech Republic
English Channel
St Peter Port
Jersey
Luxembourg
Luxembourg
Paris
(Vienna)
Austria
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Liechtenstein
Bern
46°02'21.45" N 16°31'17.91" E elev 1134 ft
Eye alt

RS503
WSRT
CS302
RS106
RS307
RS208
Midden-Drenthe
Drenthe
Emmen
Coevorden
E232
N366
31
N391
N379
408
N862
E233
402
N34
N382
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Superterp core stations

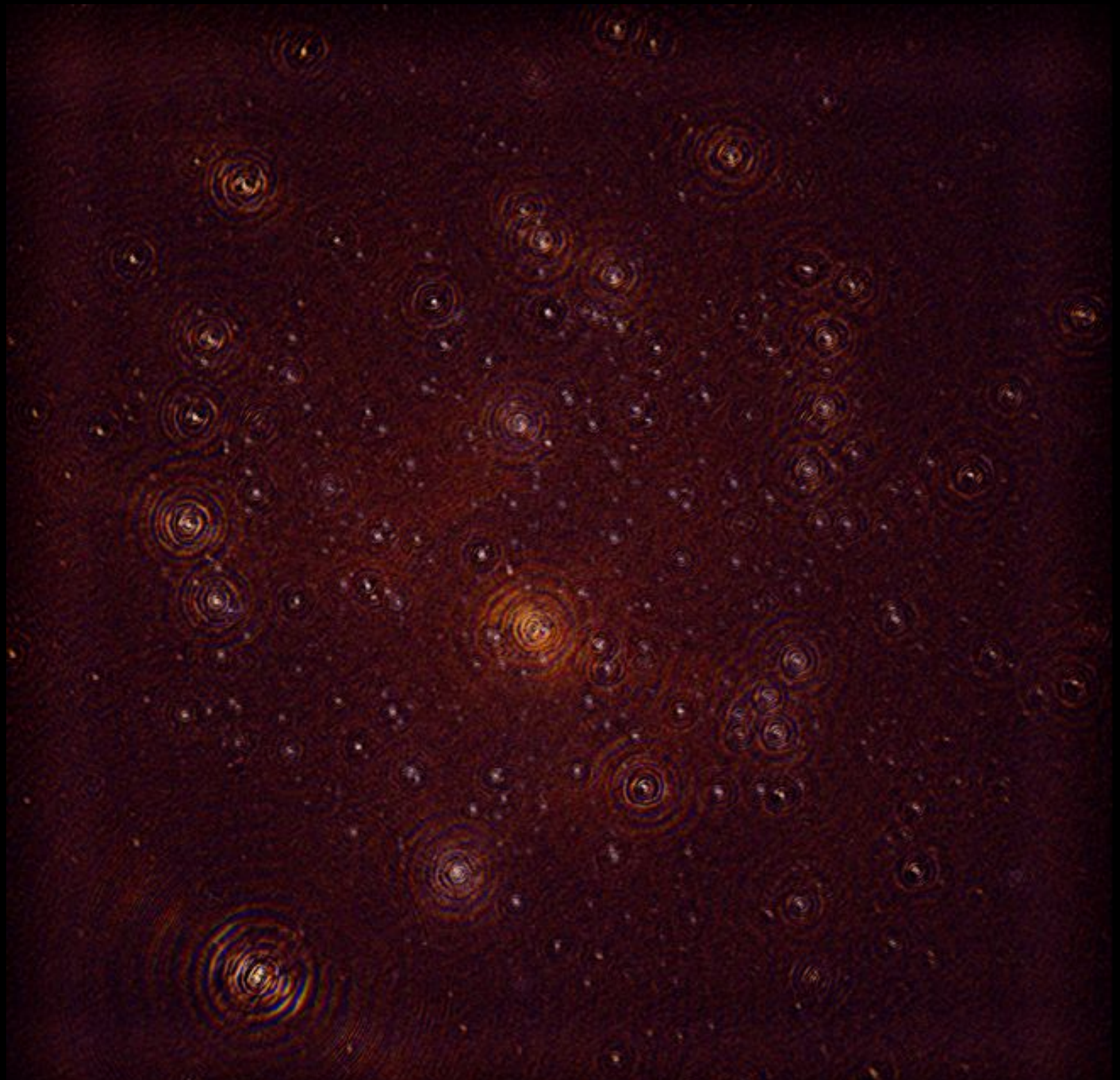
The LOFAR – EoR project

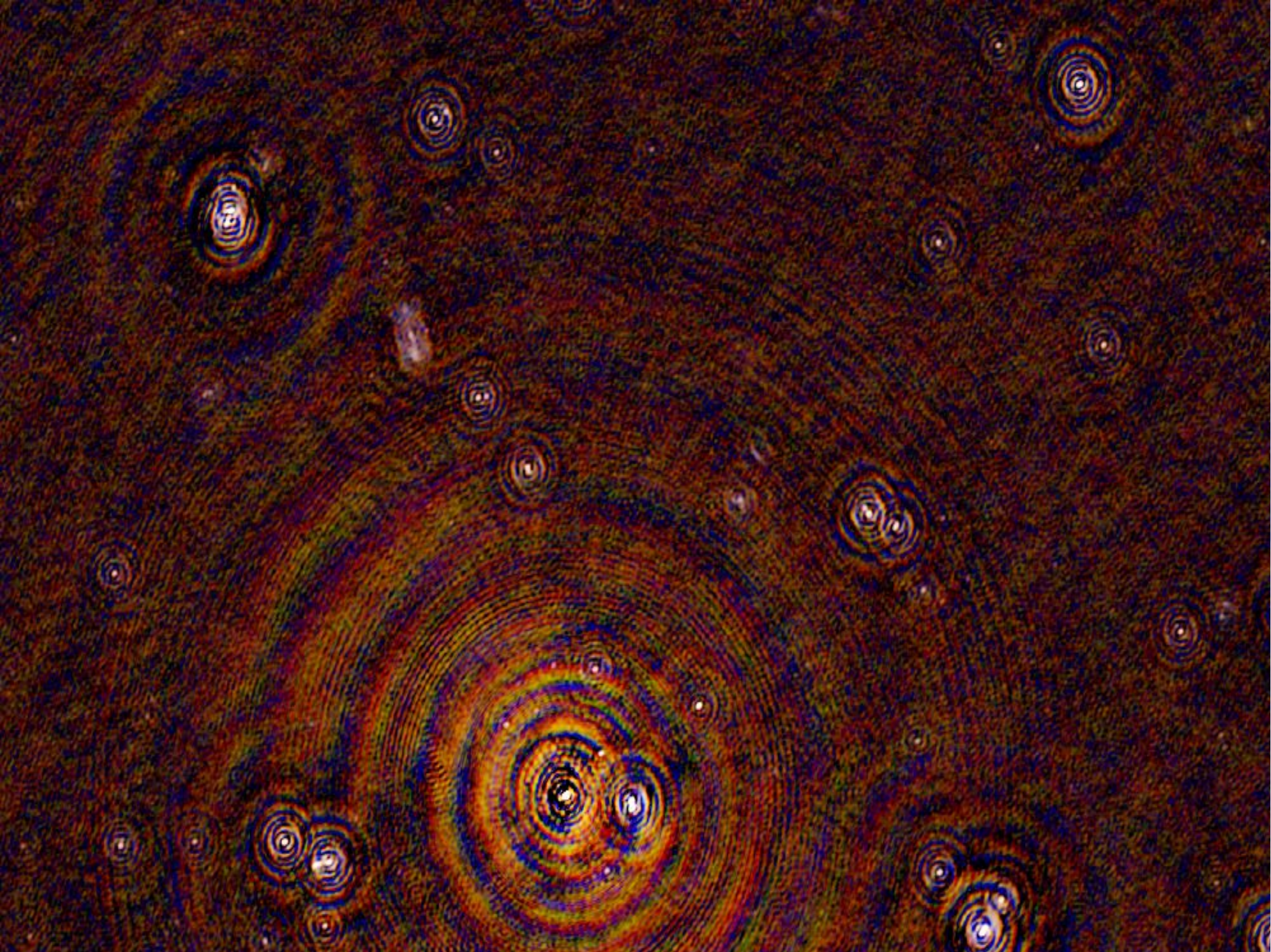
- Exposure/field: 100 x 6h
- 112-190 MHz
- Raw resolution: 1s / 0.76 Khz
- After RFI detection, average time and freq 5-10 times.
- Raw data rate: 30 TB/h
- Averaged data rate: 0.2 – 0.4 TB/h

EoR fields

Name	α	δ	b	Why?
NCP	all	+90°	+27°	Stationary beam
3C 196	8 h	+48°	+33°	Dominated by easy source
Elais N1 ?	16 h	+56°	+45°	Deep field at other wavelengths
NGH	9 h ?	...	high	Low background
SGH	3 h ?	+30° ?	high	Low background

LOFAR imaging result





Radio frequency interference

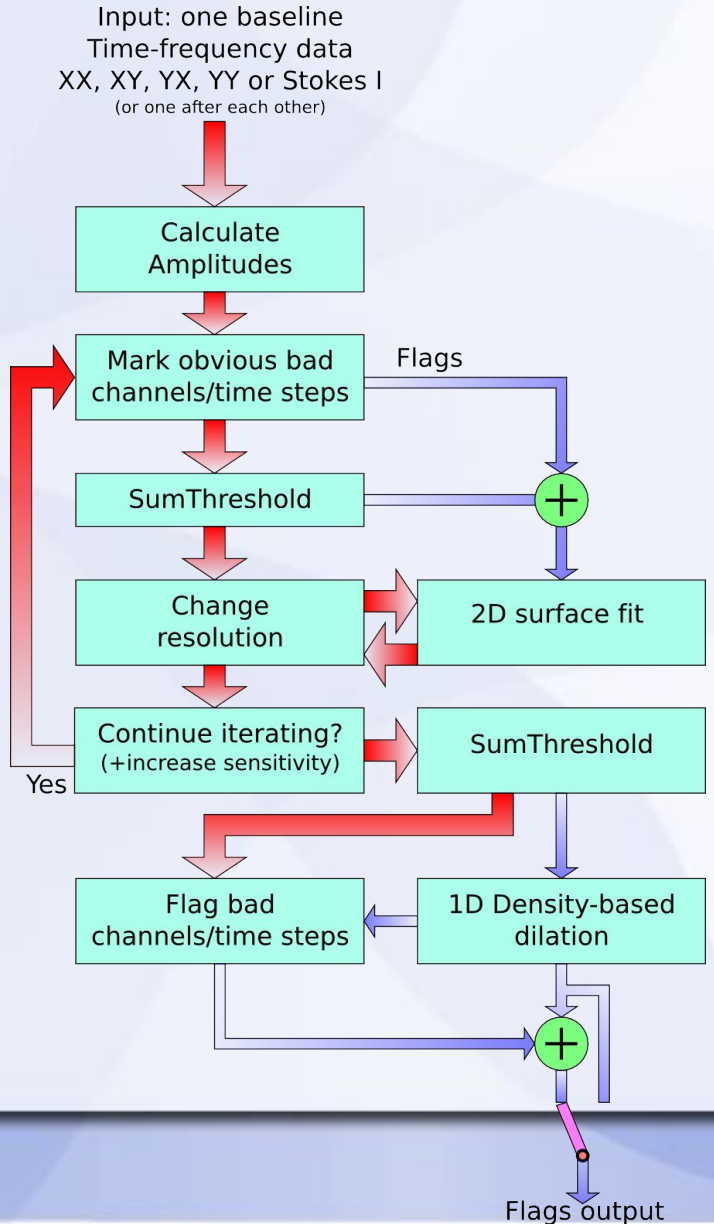
Issues concerning interference:

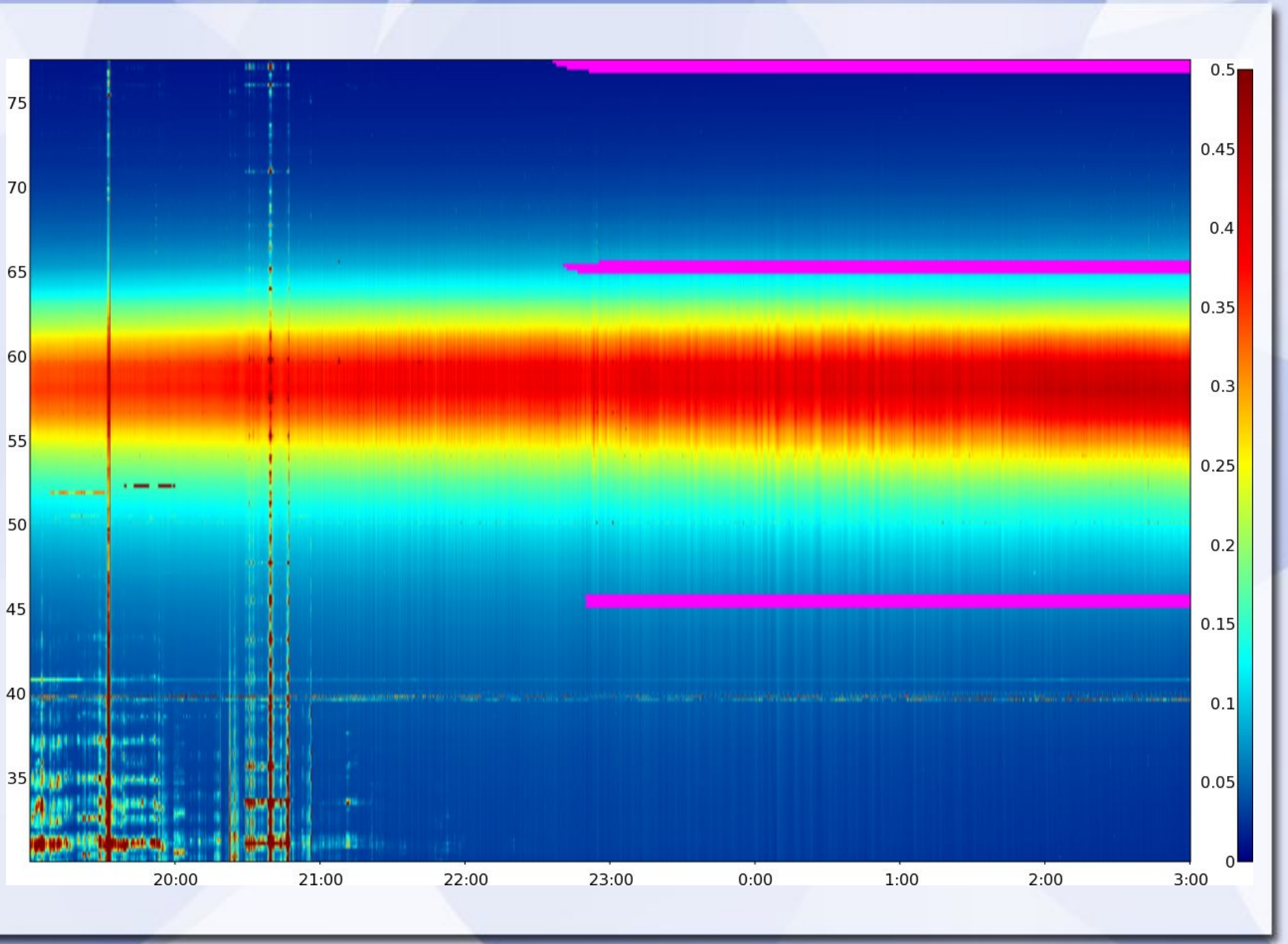
- Frequency range includes interference from e.g. airtraffic, electric fences and wind turbines
- Enormous data volumes
- High data quality required for EoR

- First approach: flag bad data

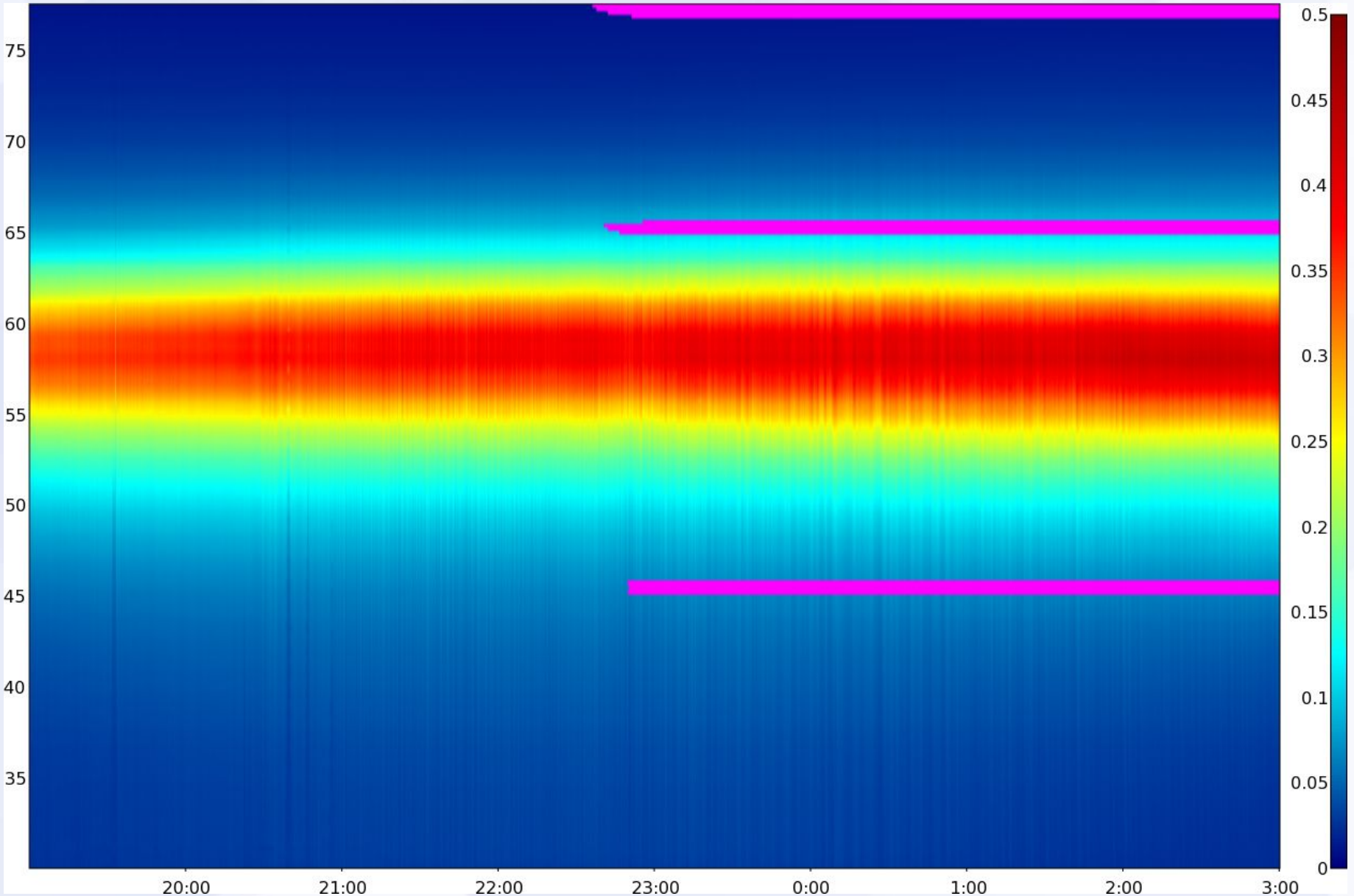
AOFlagger

- Very fast & accurate
- Rough estimate of astronomical data
- SumThreshold
- Iterative (2.5x)
- Density dilation



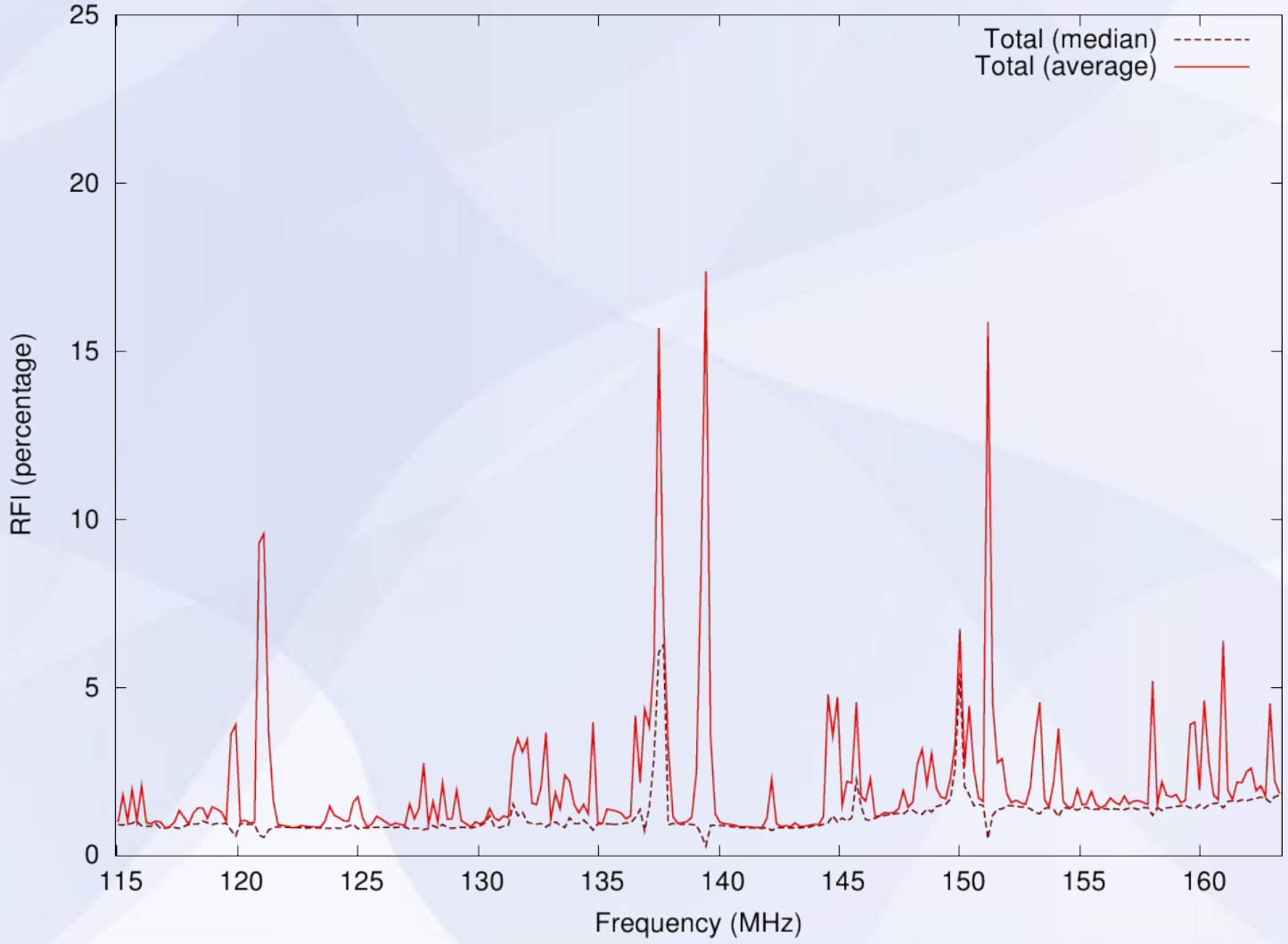


LBA Total power, before flagging



LBA Virgo, total power, after flagging

HBA RFI


Total (median)
Total (average)
RFI (percentage)
Frequency (MHz)
0
5
10
15
20
25
115
120
125
130
135
140
145
150
155
160

LOFAR offline processing

- Offline processing on cluster of ~100 nodes
- Sub-bands are concurrently processed.
- Averaging + flagging takes 25%-50% of observation time.

LOFAR and RFI

- Good RFI environment
- Few percentage of data requires flagging

Because of:

- High frequency resolution
- Antennas on the ground

Summary

- LOFAR works
- EoR observations & reduction have started
- RFI environment is benign