

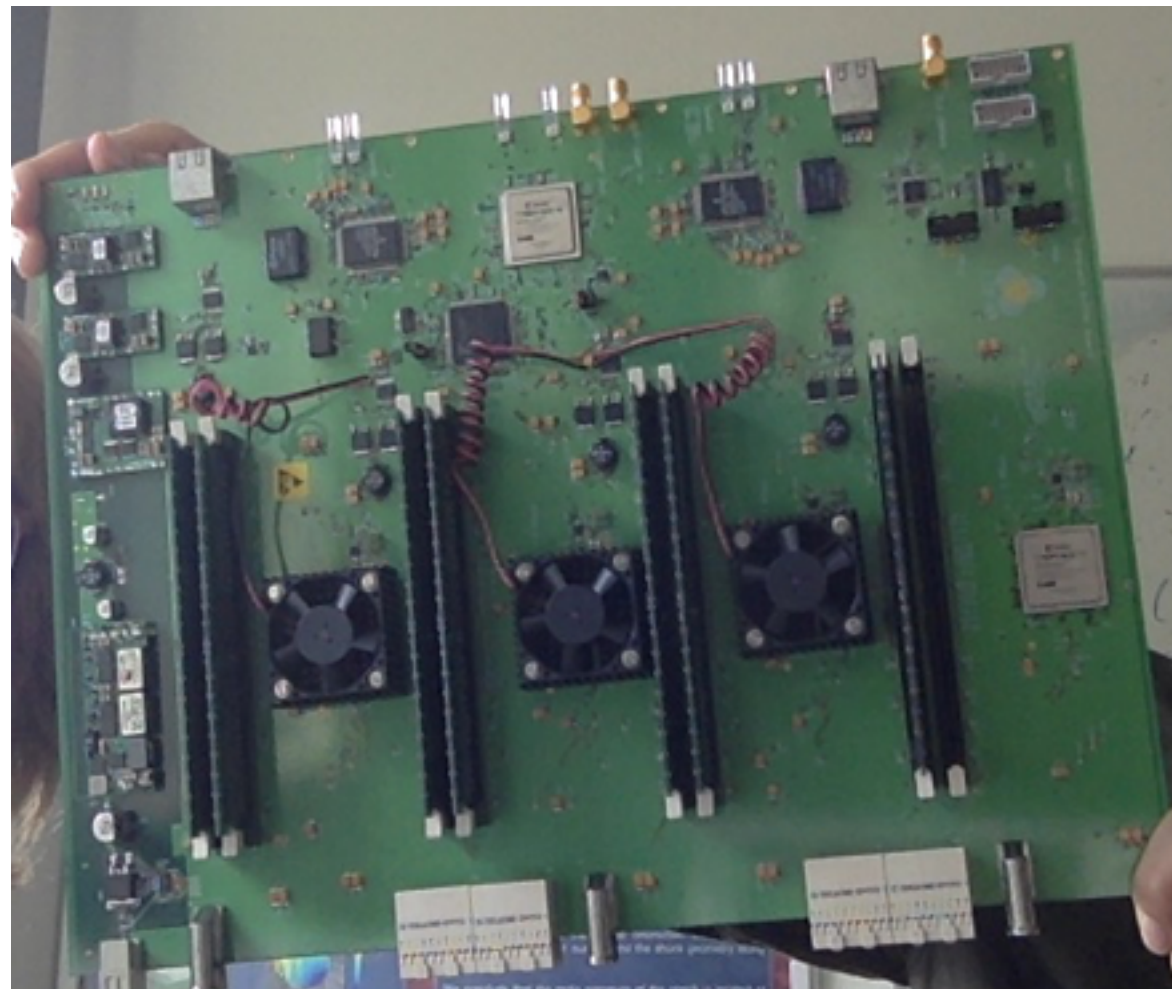
# Observing at ns time resolution with TBB

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LOFAR  
DATASCHOOL  
2021



# Outline

- Introduction to TBBs and TBB science
- Tutorial introduction
- This afternoon 13:40-15.40 Hands-on session TBB

# Transient Buffer Boards (TBB)

- Store signal of individual channels (antenna/tile)
- Stores raw data (200 MHz, 5ns samples)
- 5.2 second buffer
  - (most international stations 1.3 s)
- Alternatively, store subbands ( $N \times 195312.5$  kHz, 5.12  $\mu$ s samples)

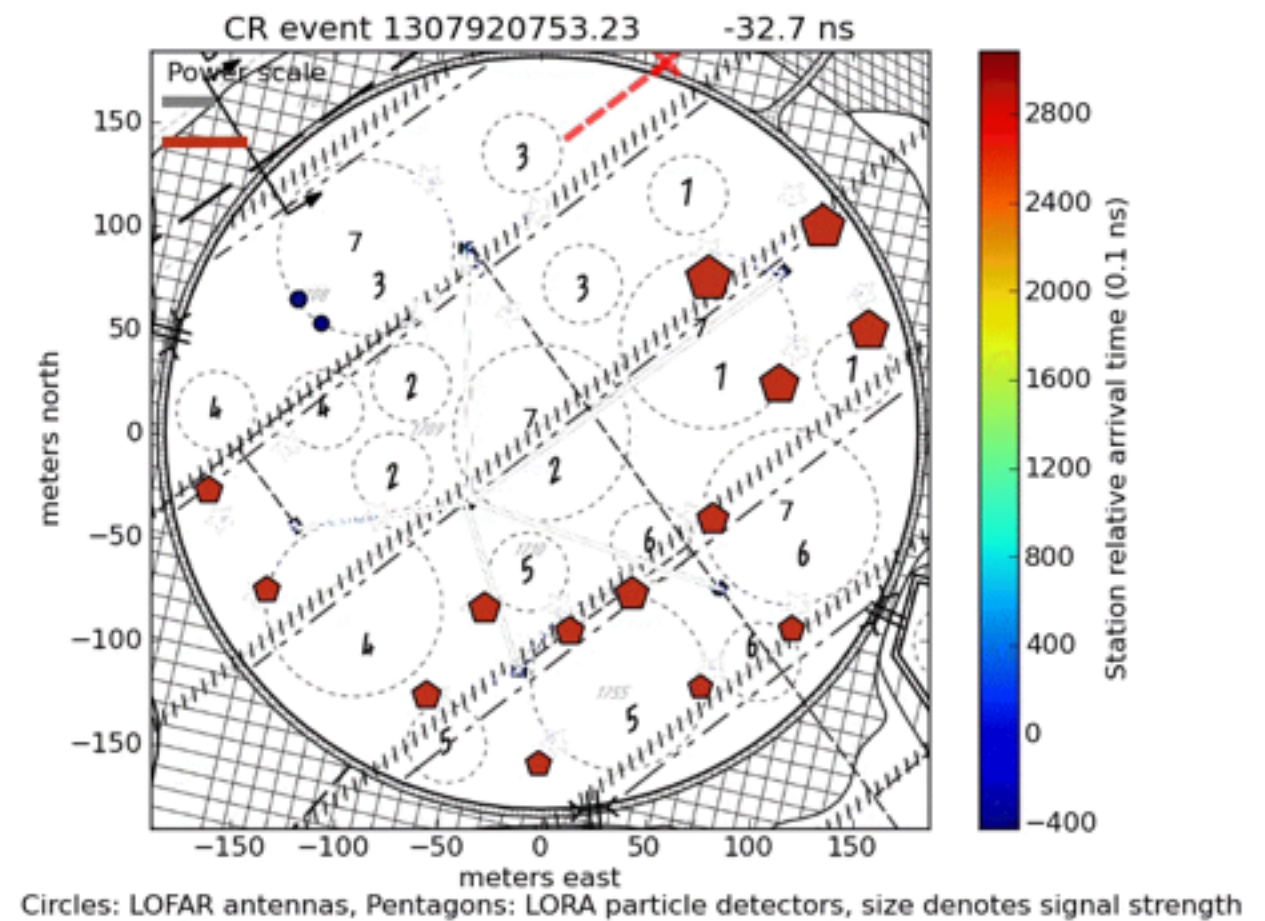
# Triggered observations

- Use external source to decide there will be interesting data
- Freeze TBBs ASAP
- Read out relevant part of the data (e.g. 2 ms or full 5 seconds)

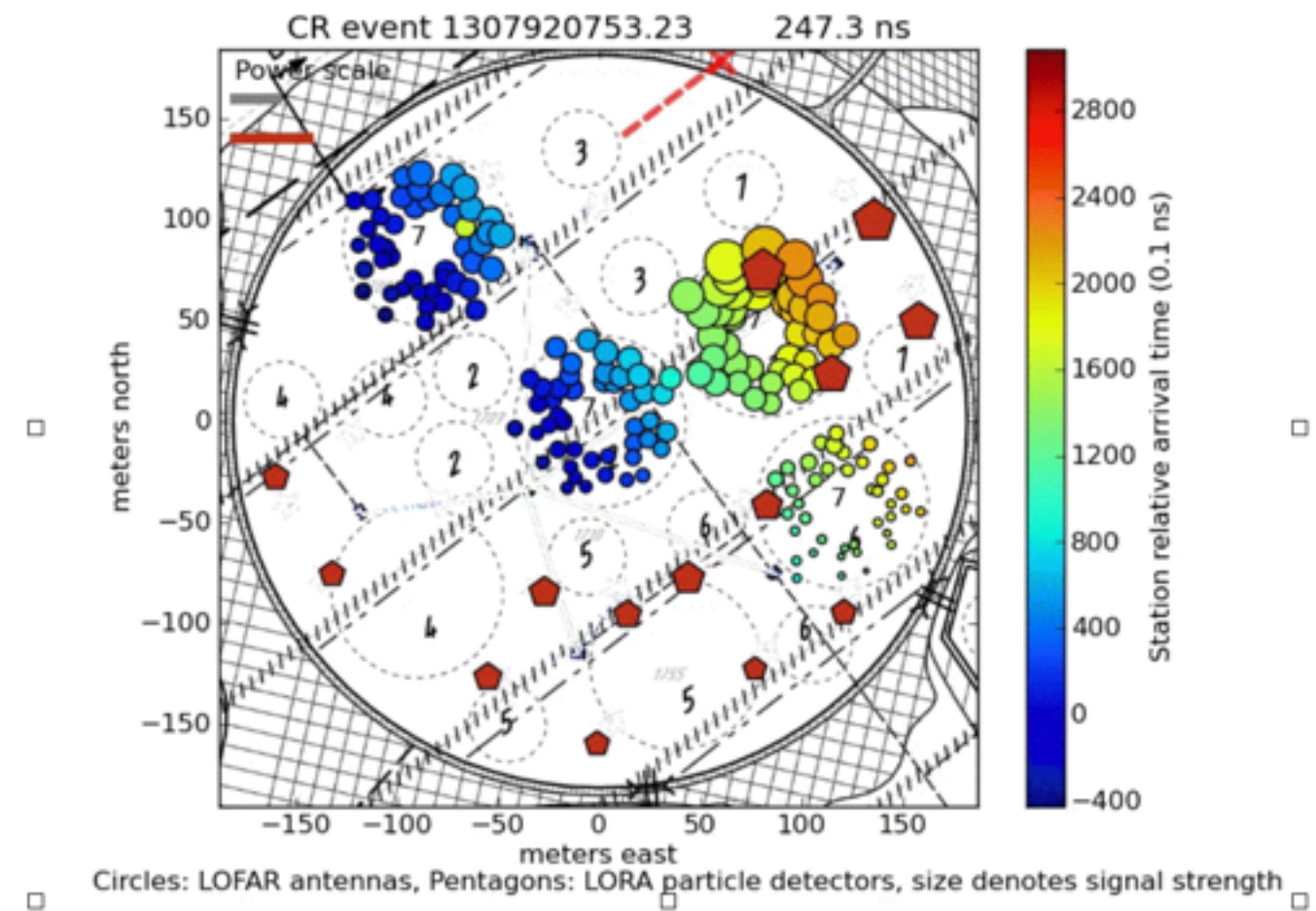
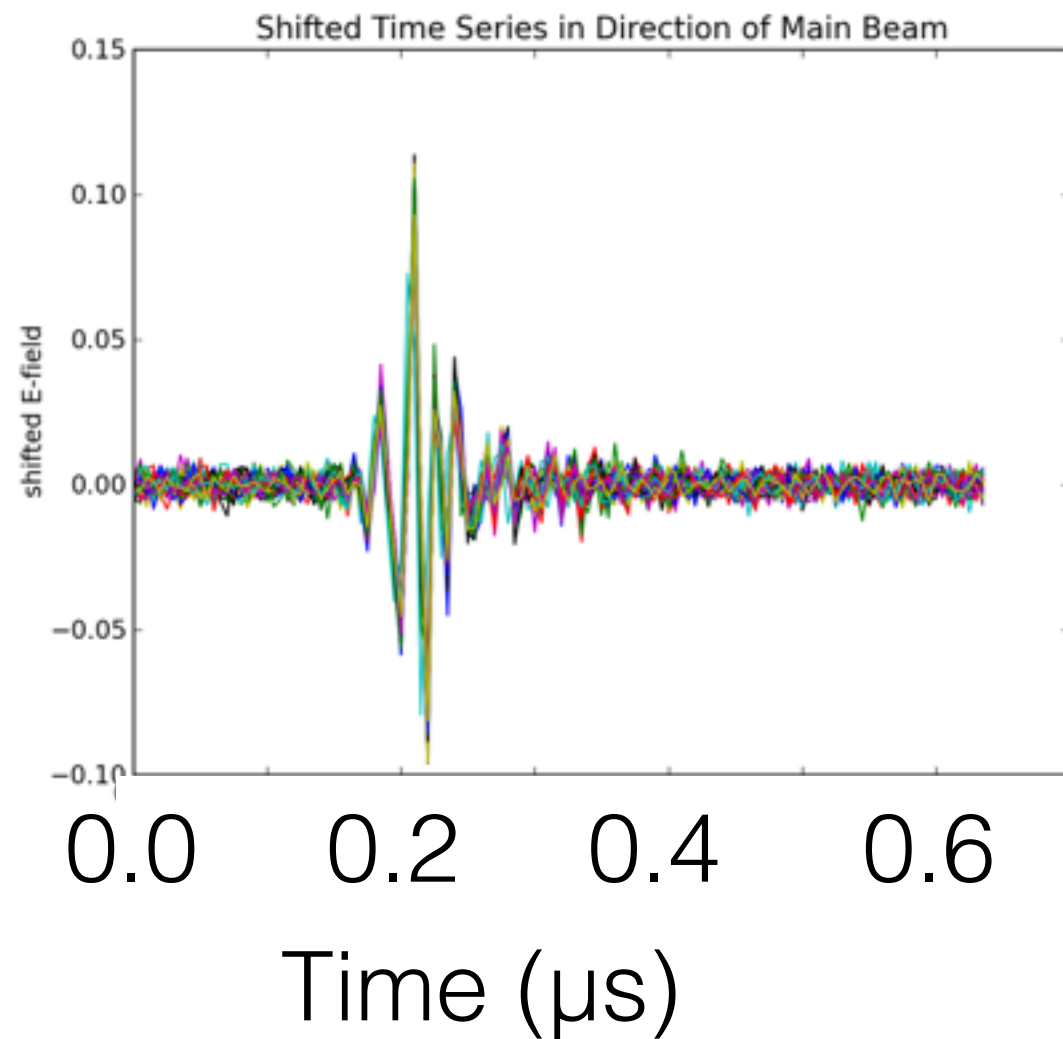
# Triggers

Phenomenon	Trigger source	Trace duration
Cosmic Ray	Particle detector Radio self-trigger	2 ms
Lightning	<a href="http://www.lightningmaps.org">www.lightningmaps.org</a> Radio self-trigger	2 s
Fast Radio Burst	Detection on LOFAR beam formed data Detection with another telescope (e.g. APERTIF)	5 s

# Single antenna - Cosmic Ray data



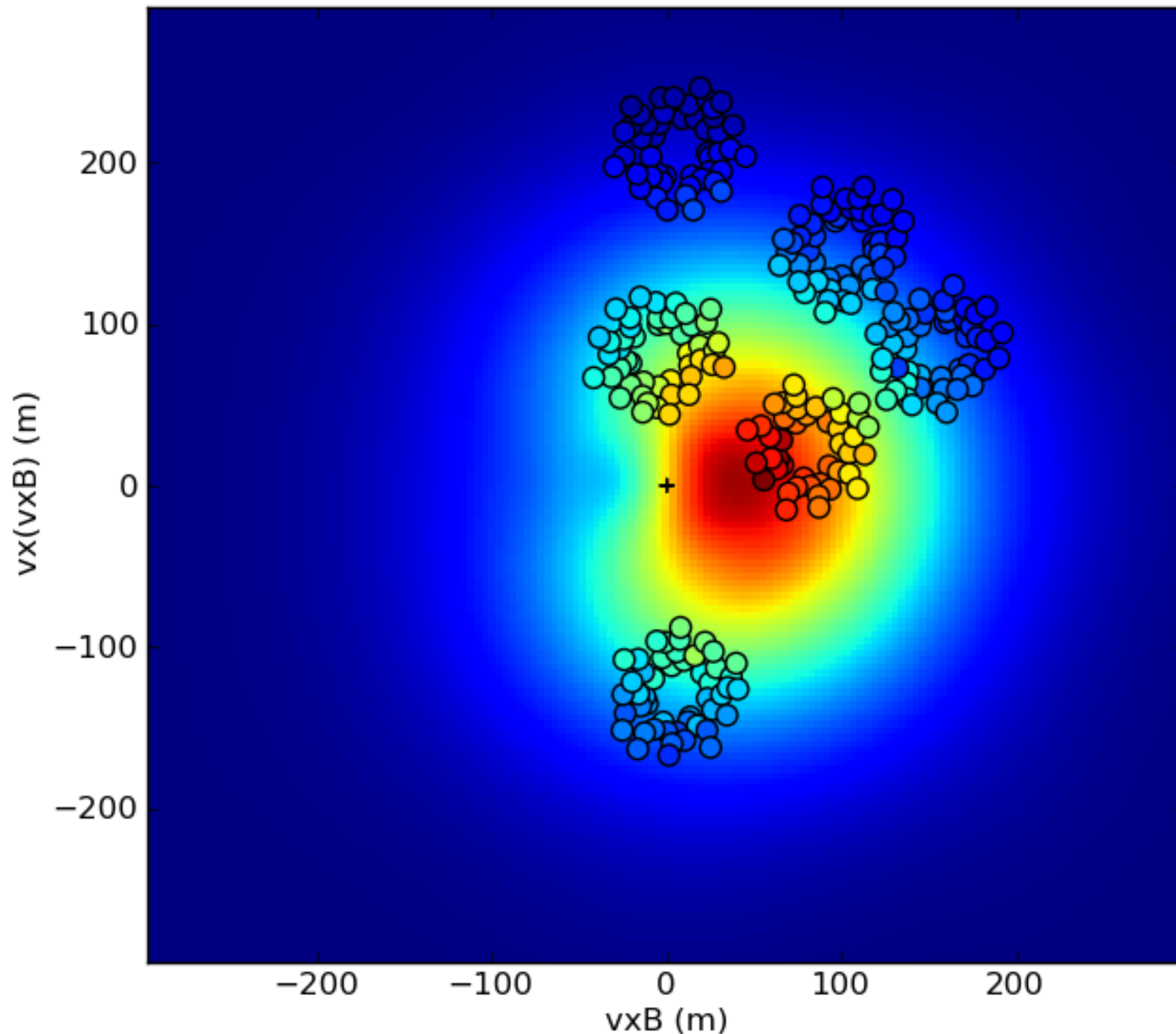
# Single antenna - Cosmic Ray data





# Cosmic Rays

Radiation profile in shower plane



Compare simulations  
(background) with  
measurements  
(circles).

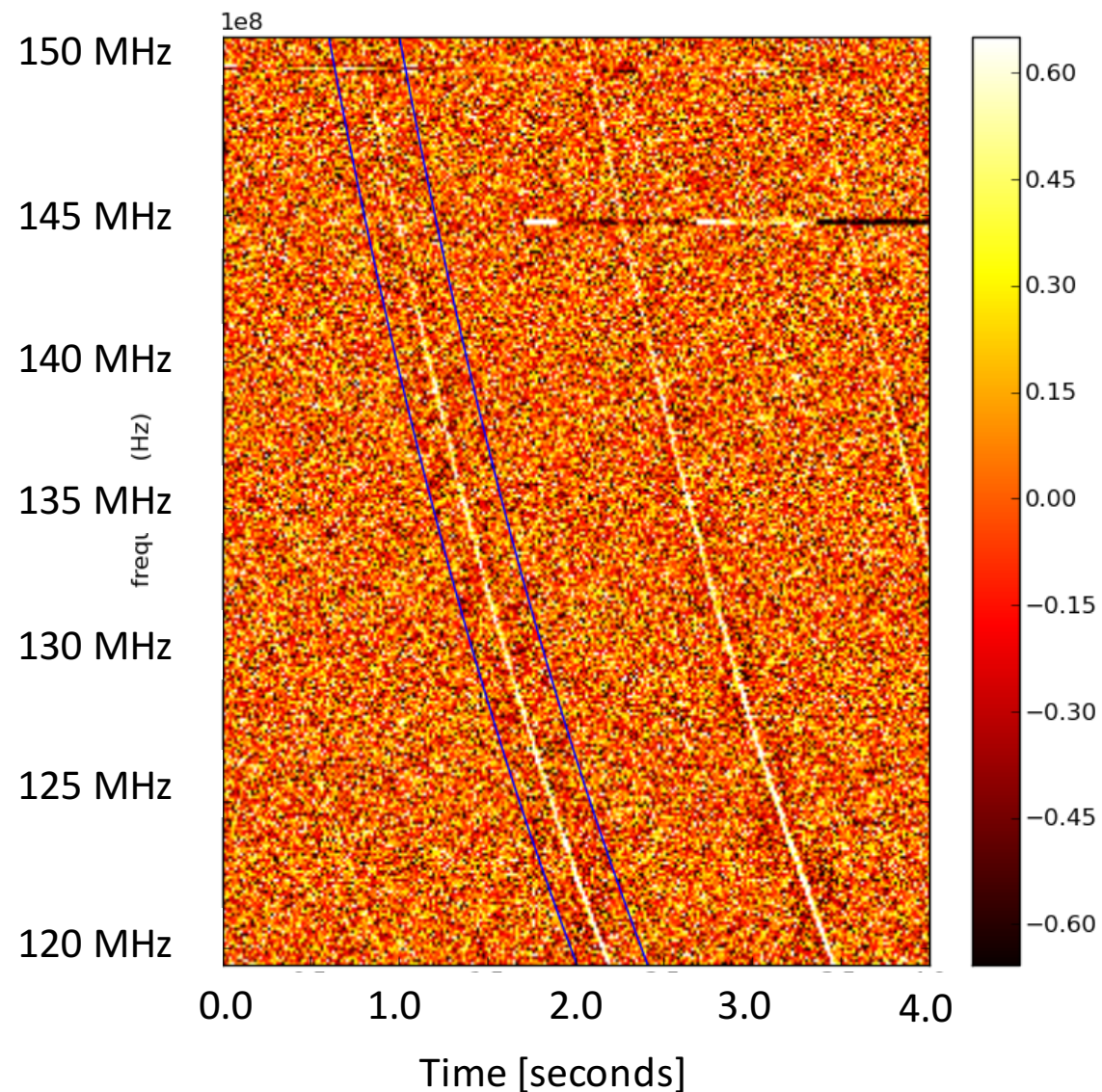
Determine:  
Energy  
Direction  
Composition



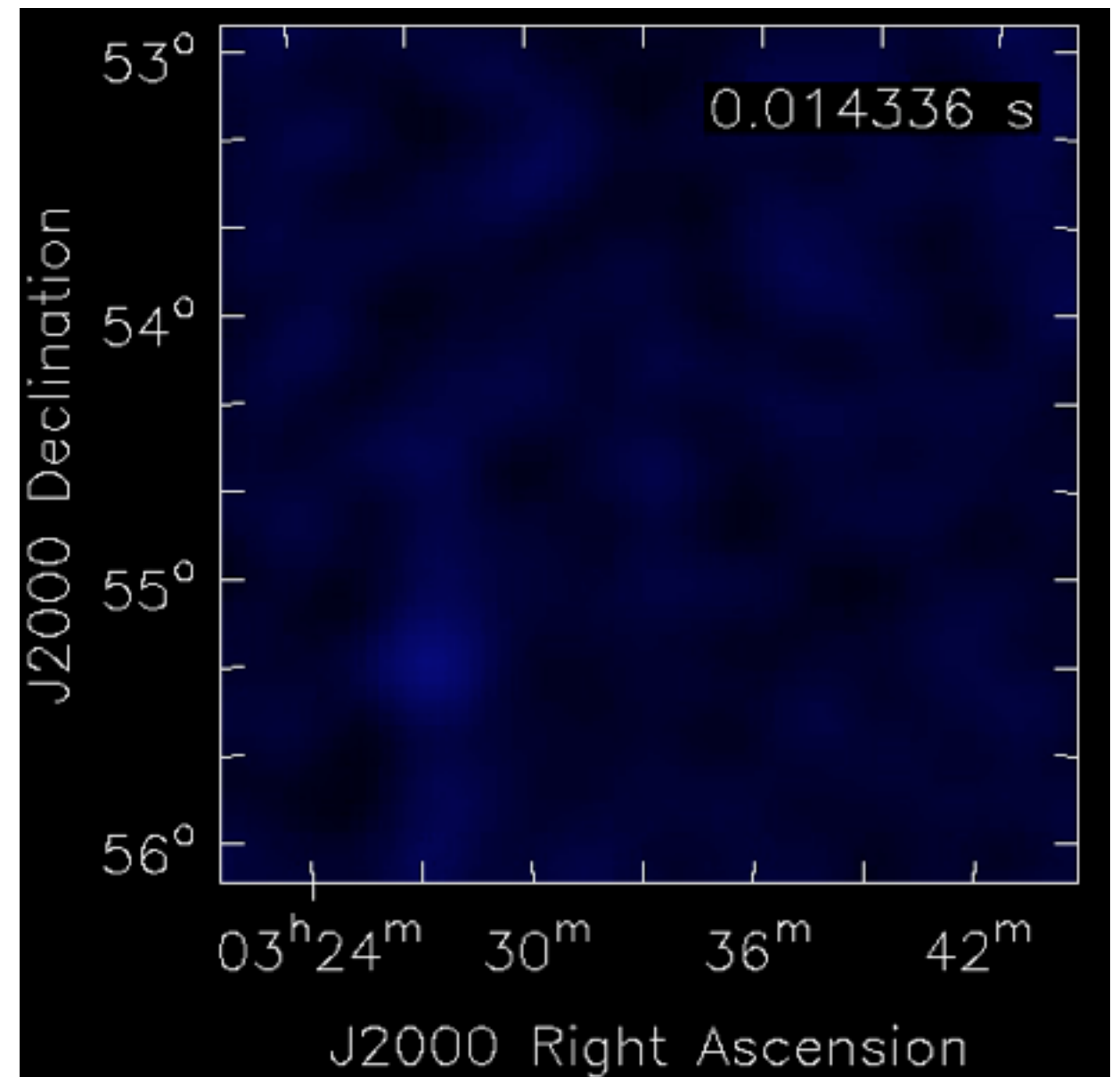
# Localisation

## Fast Radio Burst

Beam formed data  
on PSR B0834+26



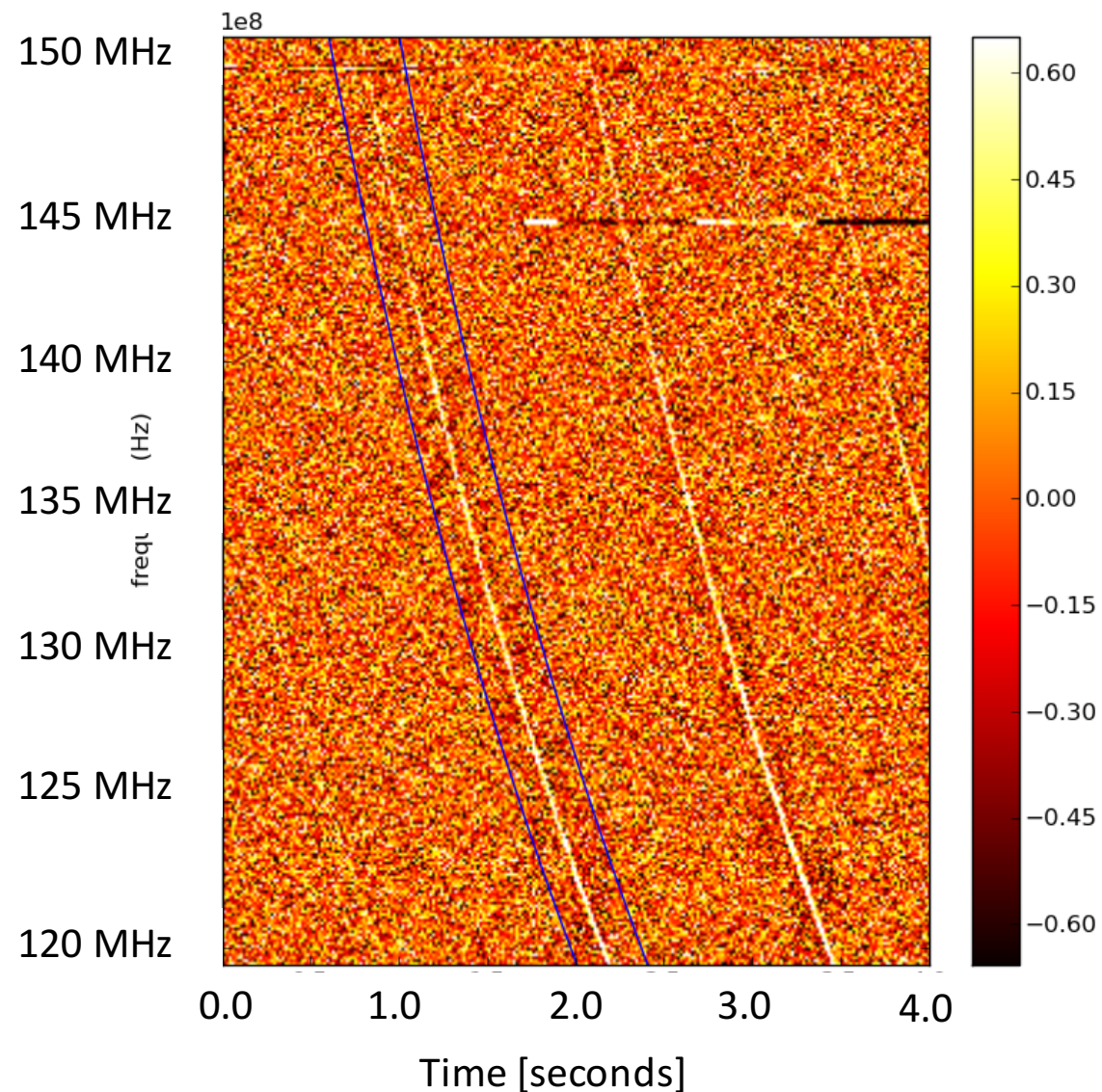
Movie from TBB data  
of Crab Pulsar



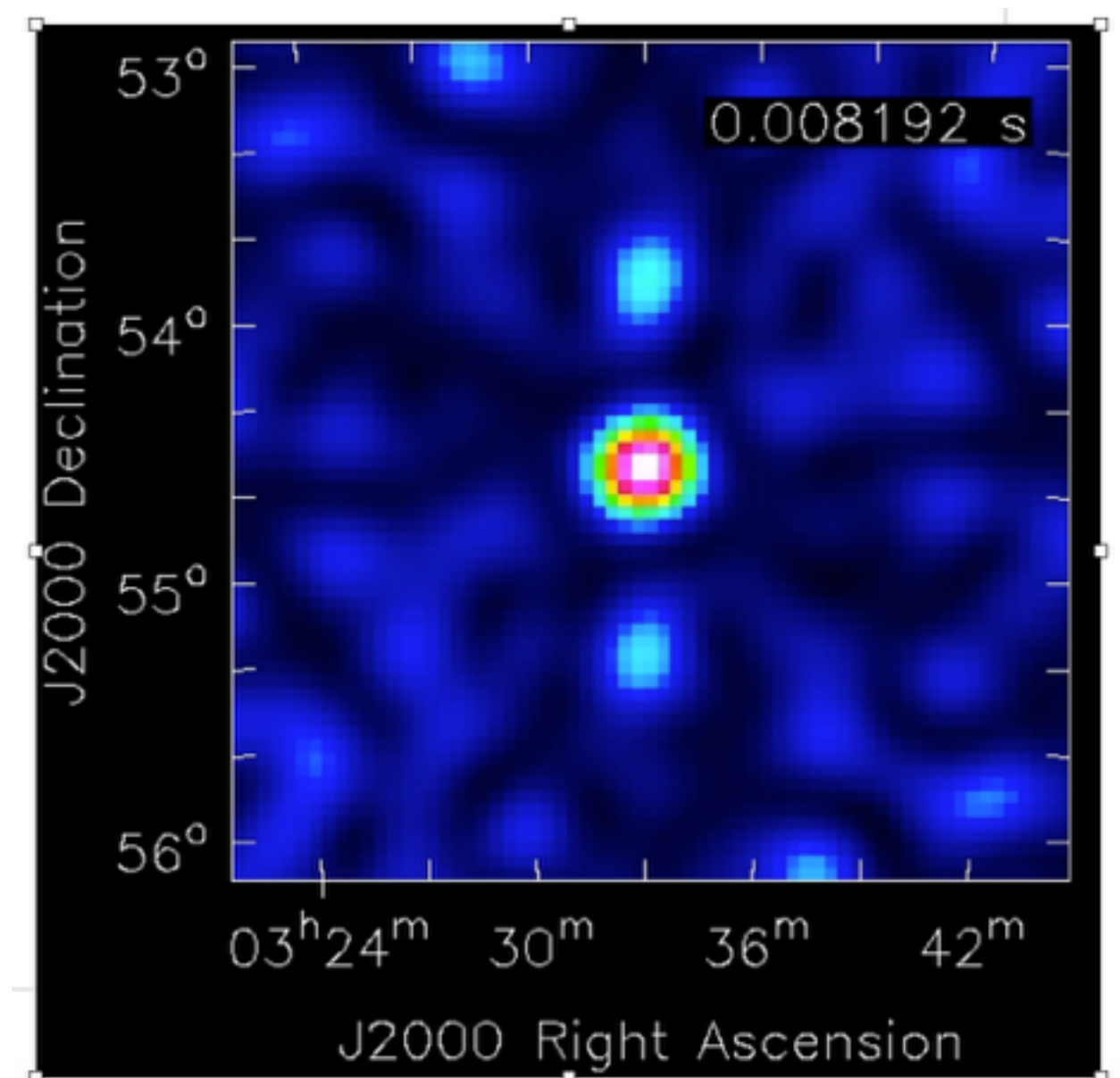
# Localisation

## Fast Radio Burst

Beam formed data  
on PSR B0834+26

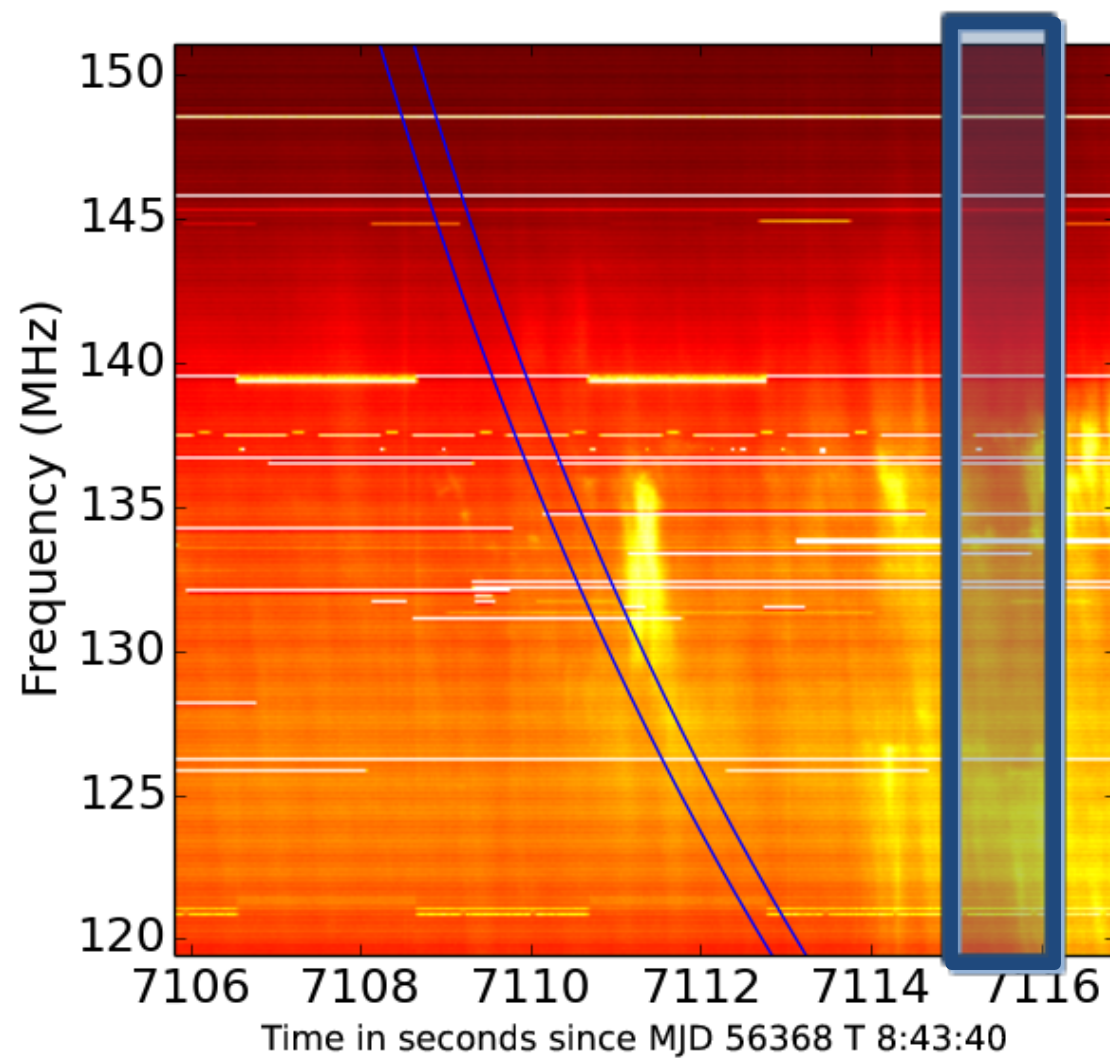


Movie from TBB data  
of Crab Pulsar

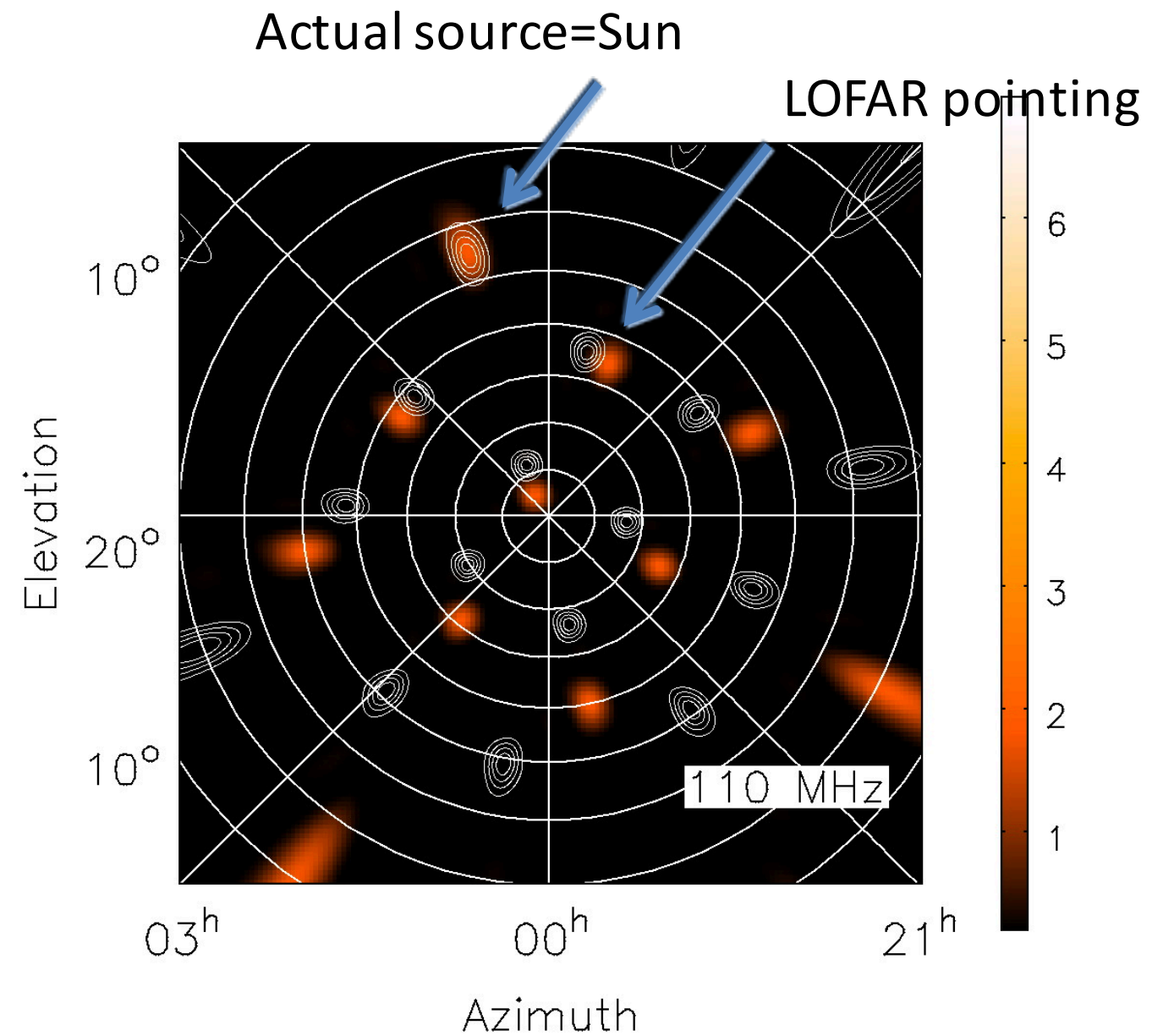




# Solar Radio Burst



Beam formed data

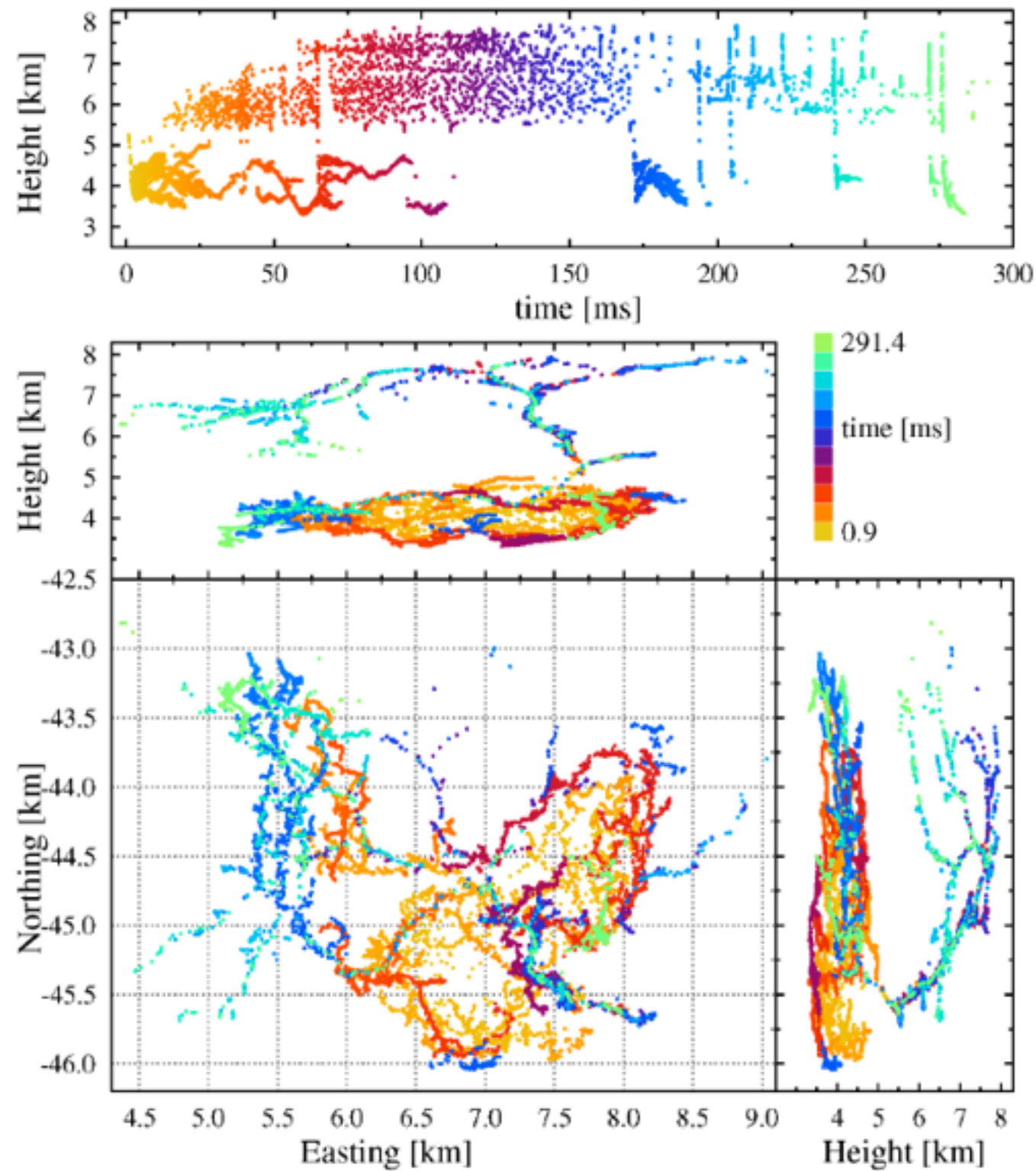


TBB Image

# Lightning

Movie time

# Lightning



Scholten et al. 2021

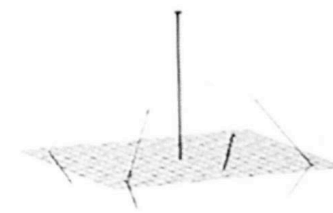
# TBB Observations

- Parallel mode: using Filter of main observation (e.g. LBA 10-90 MHz)
- Parallel data read-out
- Expert mode (Talk to me (Sander ter Veen), before submitting a proposal)

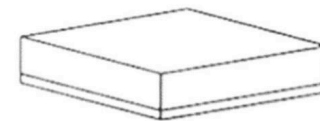
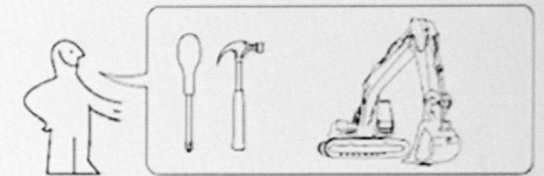
# Data analysis

- This is just an introduction
- “Build your own telescope”
- Include all appropriate delays

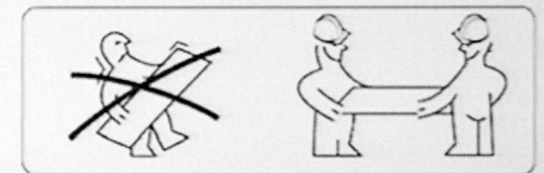
## LÖFÅR



96x



48x



1x

