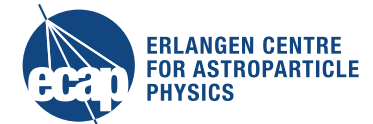


# Welcome

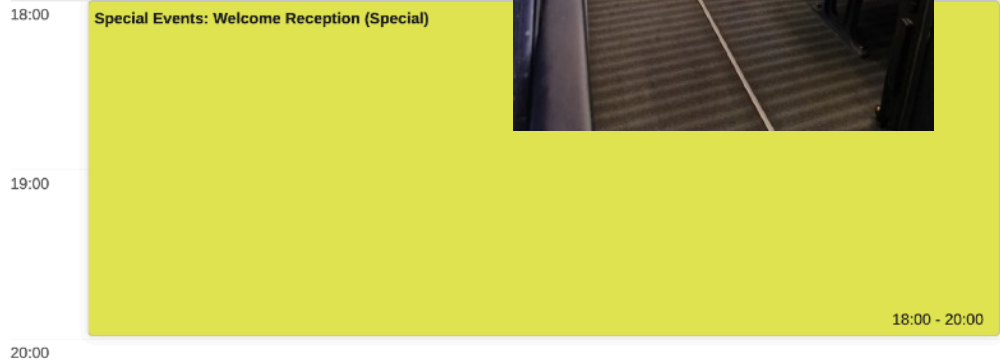
On day 2

Anna Nelles



# Why not on day 1?

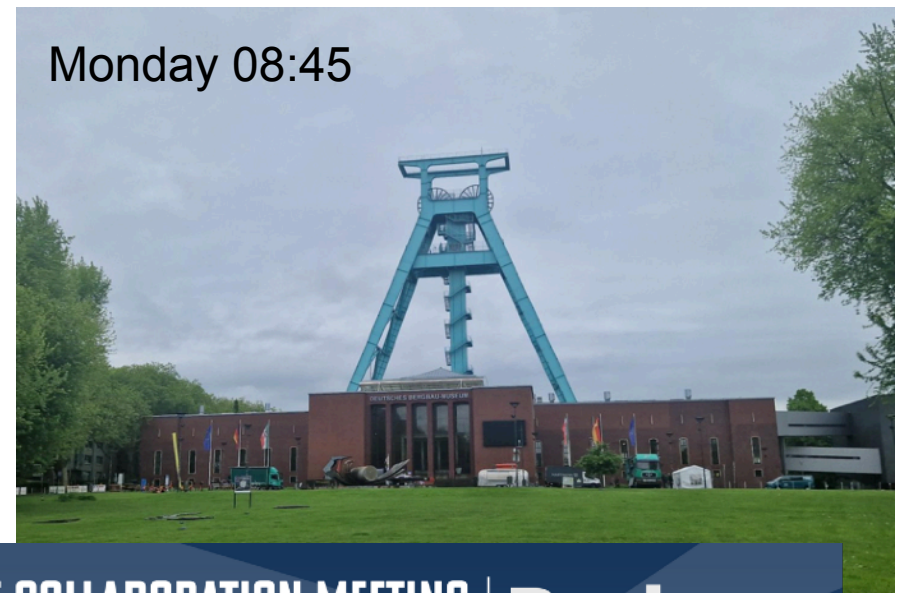
I would have much rather done this on day one ...



Federal Ministry  
of Research, Technology  
and Space



Monday 08:45



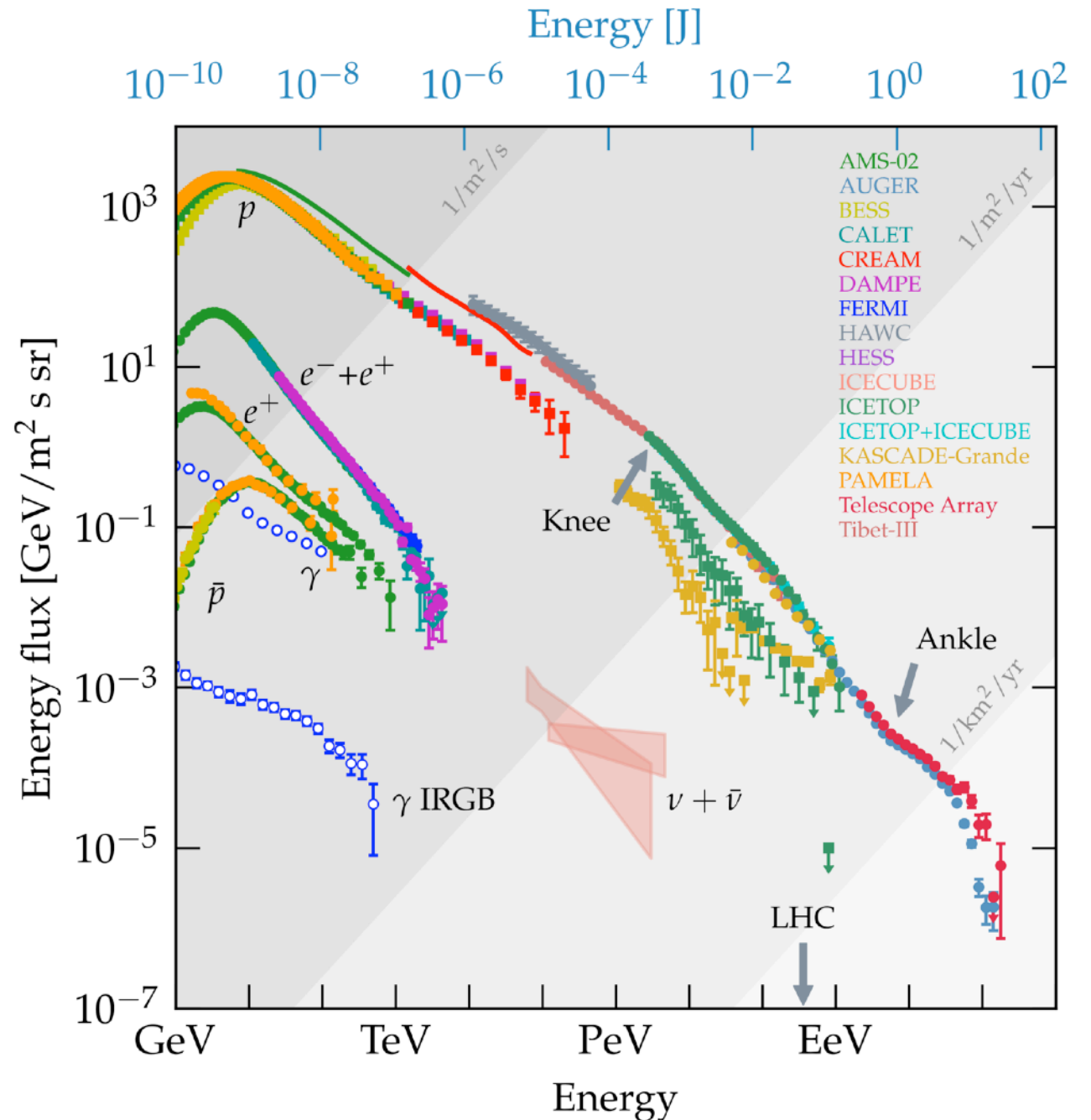
Monday 16:59



# Cosmic-rays today

## What we know today

- The Universe provides an impressive wealth of particles
- We only know only the origin of about half of them
- In particular beyond EeV energies, the situation is unclear, likely extra-galactic sources



# Radio emission of showers

Are we sure that we really have understood this?

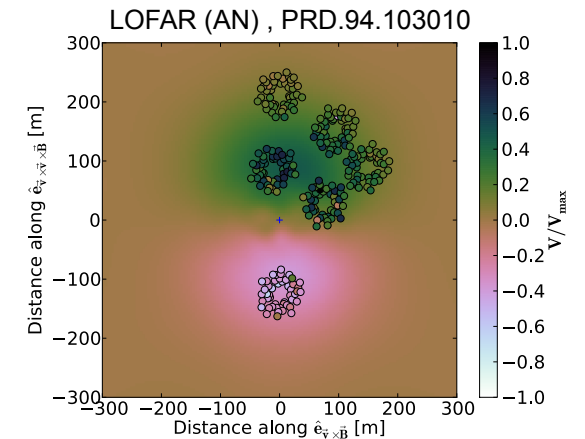
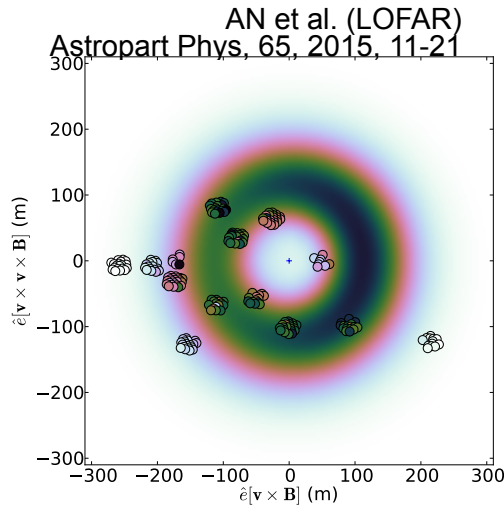
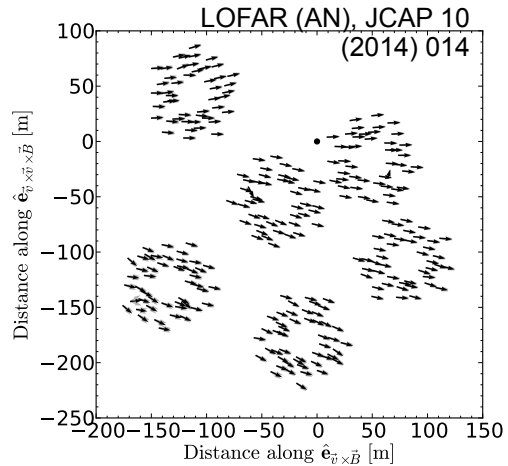
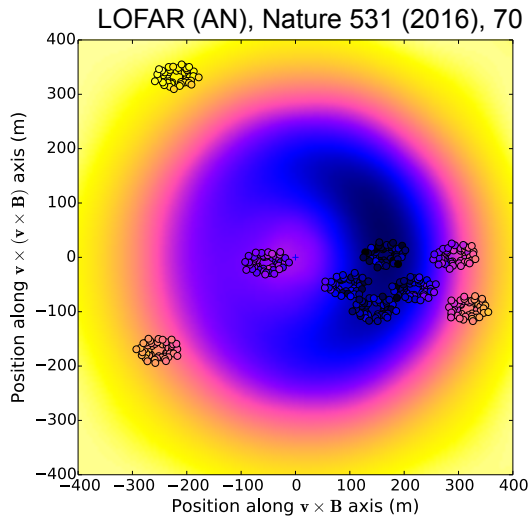
- First proposed in 1960s by Askaryan
- *After that a long controversy how this actually works, how it scales with energy, whether one would ever be able to detect this, ...*
- By now I am confident to say: **Yes we do!**

# Radio emission of showers

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- First proposed in 1960s by Askaryan
- *After that a long controversy how this actually works, how it scales with energy, whether one would ever be able to detect this, ...*
- By now I am confident to say: **Yes we do!**

- Signal distribution ✓
- Signal amplitude ✓
- Signal polarization ✓
- Signal frequency spectrum ✓
- Dependence on magnetic field ✓
- Propagation effects ✓
- Detector characterization ✓



# The question of strategic options

## Build your own or use an existing telescope

- **Radio Neutrino Observatory in Greenland (RNO-G)**
  - No compromises with respect to technical requirements
  - In a polar environment that has very little RFI and is very quiet
  - But experiment only, mostly relevant for astroparticle physics



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- **LOFAR and SKA-Low**
  - Using a shared instrument for many different science cases provides great opportunities
  - But one has to be a bit creative when sharing



# The question of strategic options

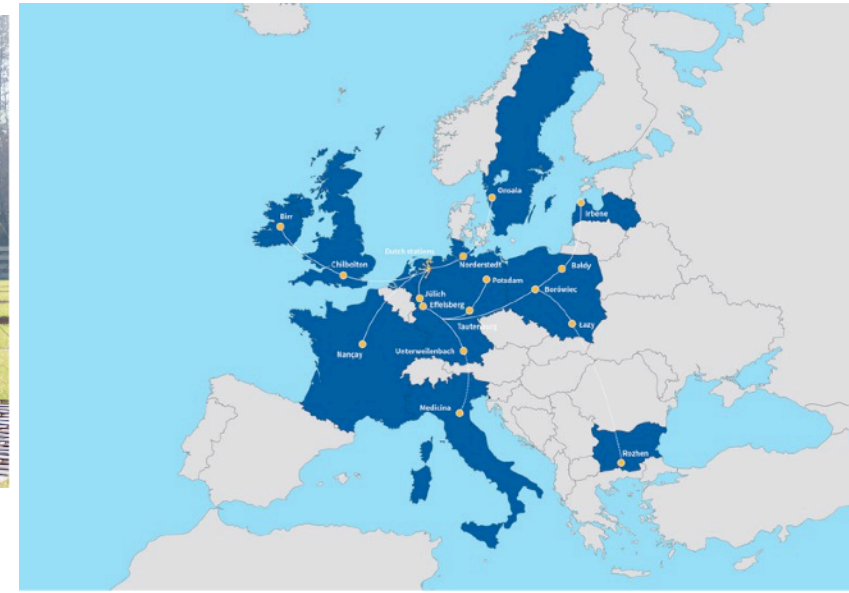
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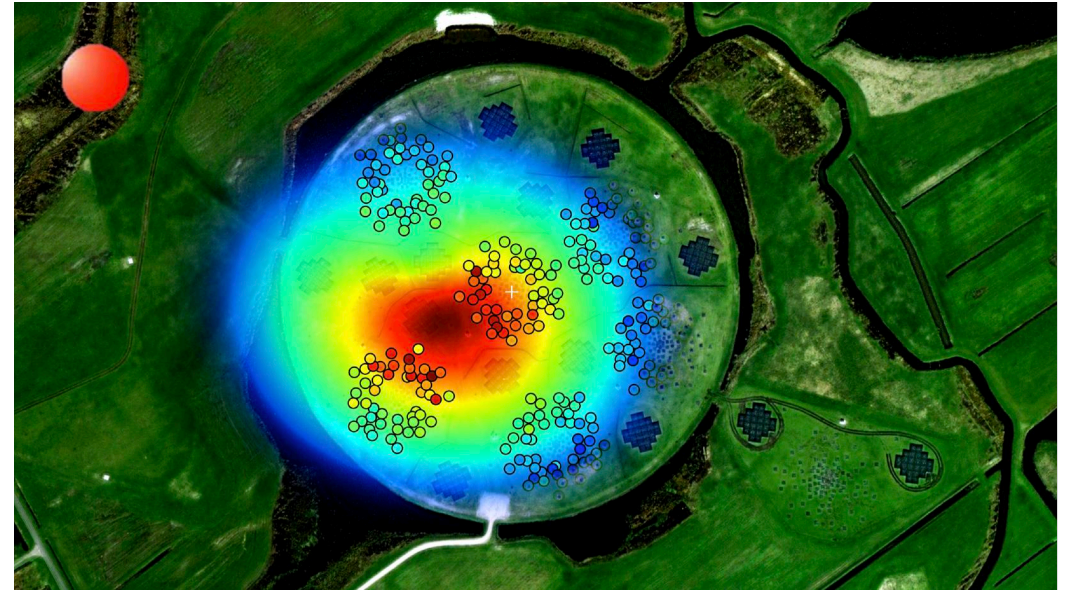


# LOFAR

Use an existing telescope



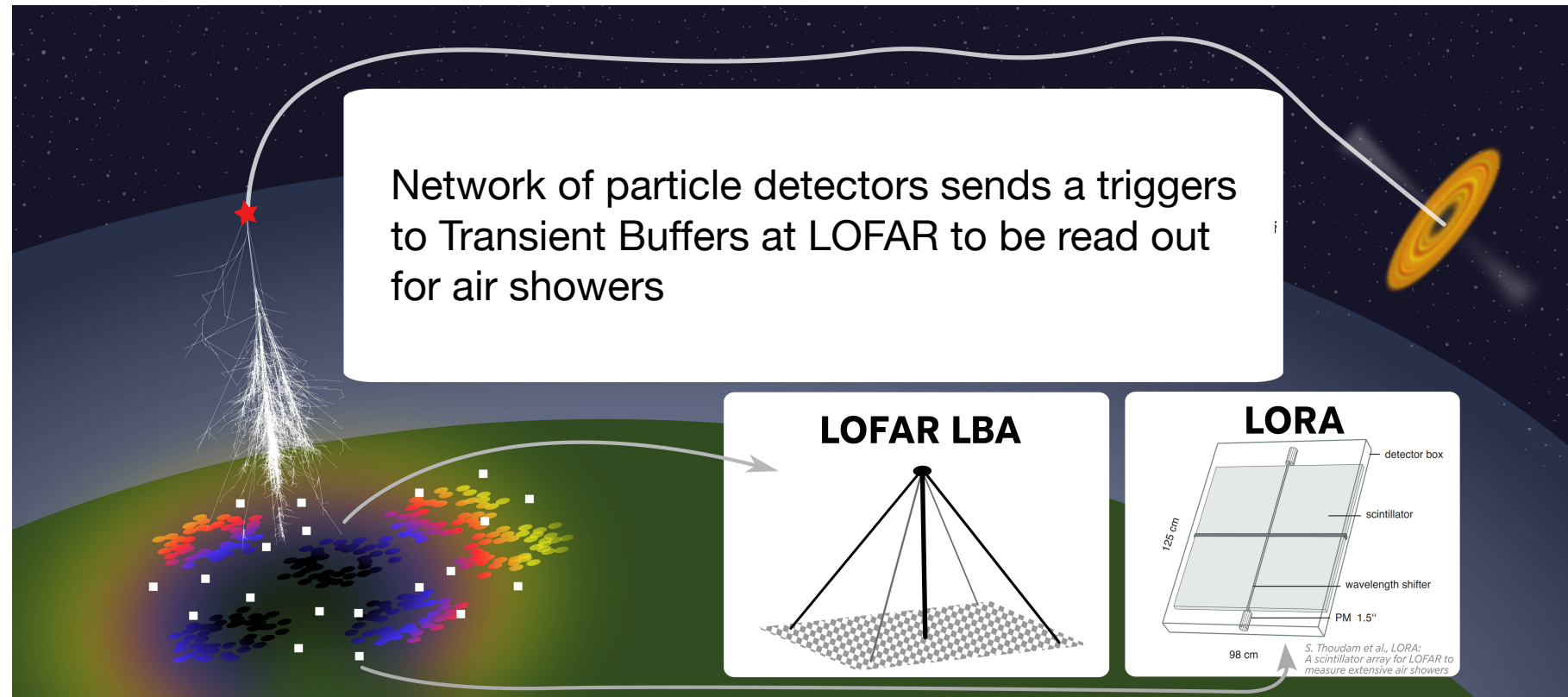
- LOFAR has the ability to record the raw antenna output - no filtering, no beamforming, no sub-bands
- Excellent air shower observations from LOFAR 1.0
- LOFAR 2.0 is just around the corner



# LOFAR 2.0

## Sharing an instrument, limiting the data-rate, external triggering

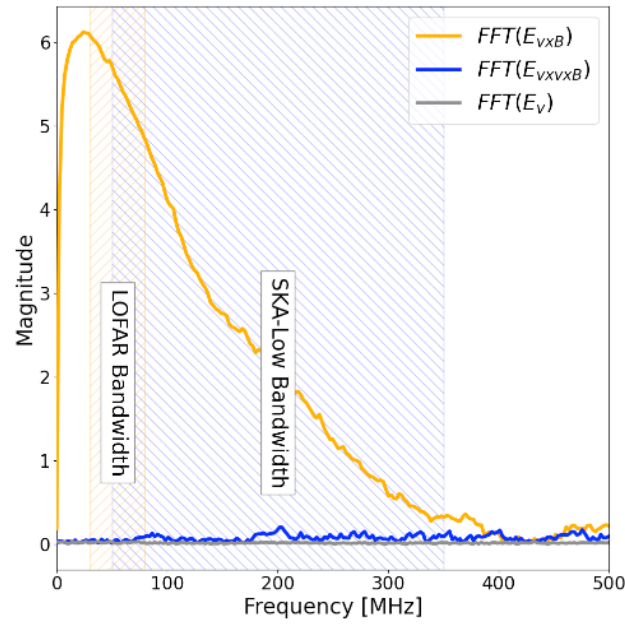
- In principle, one could trigger on the pulses in background to on-going observations
- But: high-rate of false positives, if not very smart algorithm is implemented on hardware - too high load on the system (it is shared after all) — but we have ideas
- Simultaneous HBA and LBA observations
- Self-trigger?



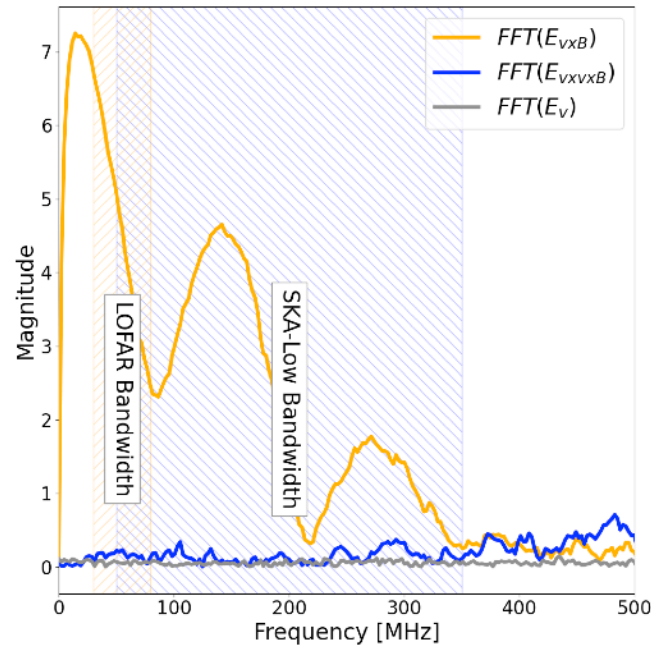
# SKA Science with air showers

## Not just more antennas

Buitink et al.

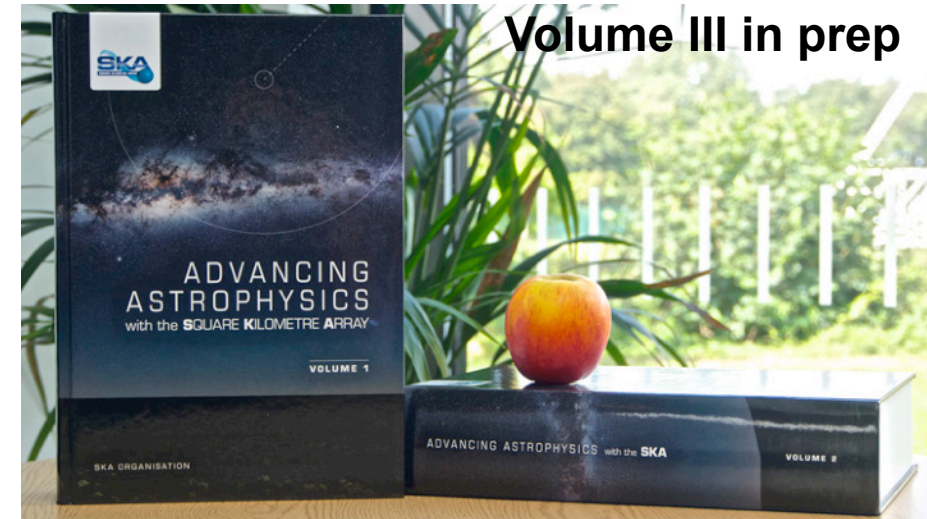


'Normal' air shower pulse



BSM physics

- Not just many more antennas, but also much larger bandwidth allows more complex analyses
- But will also require to understand the system response to tiny details, so work cut out for us!



- SWG High Energy Cosmic Particles now spans a wider range of topic:
  - cosmic rays and astrophysics
  - gamma-rays
  - particle physics
  - novel methods and machine learning
  - lightning

# SKA-Low

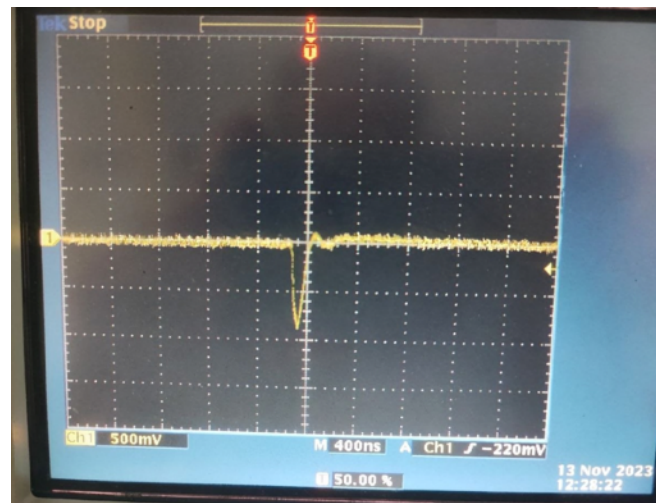
## Many opportunities and open questions

### Practical questions

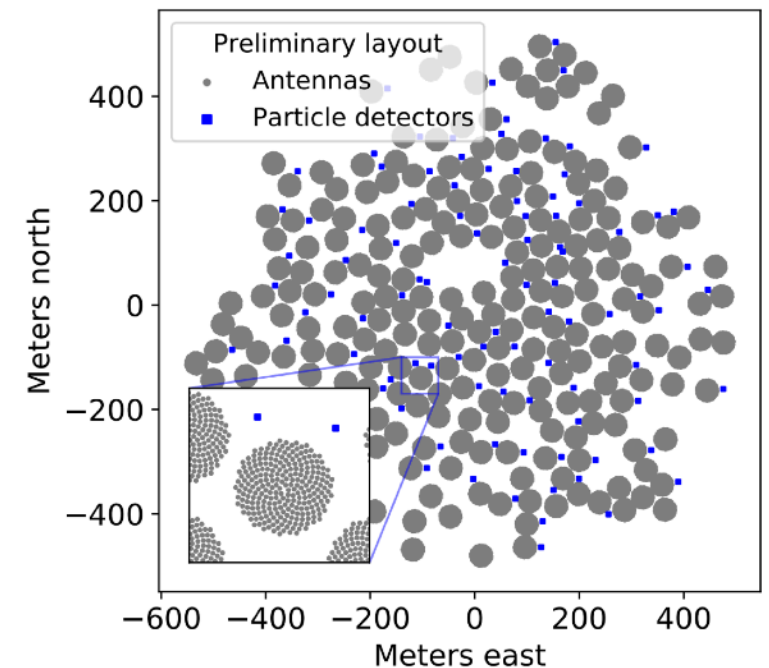
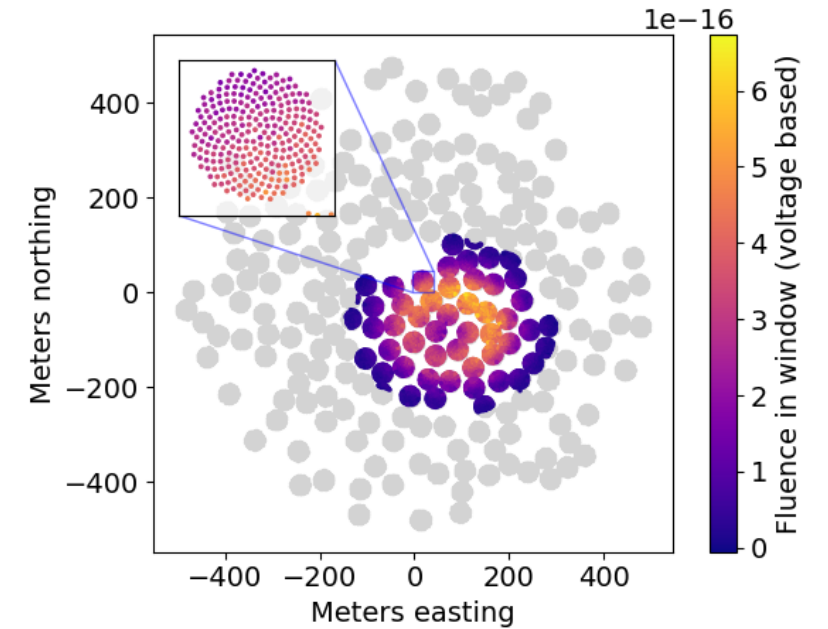
- What type of particle detectors should we build at SKA?
  - Just a helper function or auxiliary data?
  - When, where, how to access the core and transfer data?
- Can we trigger on the radio data itself?
  - What are the boundary conditions of the instrument available in parallel (or as stand-alone time)?



Prototype at MWA



KIT detectors meeting SKA hardware



# So now the official welcome!

I worked on this first in 2012 — and I still like it

- It is pretty exciting to work with a small team to get stuff done — big collaborations have this huge overhead — so let's get some stuff done!



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