Poster Appendix
EGU 2024

P. Turekova

Monte Carlo Error Analysis of Lightning Interferometry with LOFAR

turekova@astron.nl

TRI-D

Summary

- **T**ime **R**esolved **I**nterferometric 3-**D**imensional imager
- Extracts 3-dimensional (+time) location and polarization information of a lightning flash
- LOFAR data

- Time resolution: 100 nanoseconds
- Spatial resolution: ~1 meter
- Sensitivity: 2 orders of magnitude lower than noise

O. Scholten 2022

TRI-D Main steps

1. Split sky into voxels
2. Outline a box in the sky (determined by Impulsive Imager) that includes the flash
   - Box has 4 dimensions – 3 spatial and 1 time dimension
3. For every voxel, coherently sum signal from all antennas
   - This accounts for geometric **time delay** between voxels, **polarization** and **antenna function**
   - This is beamforming
4. For every voxel, calculate the interferometric intensity
5. Voxel with maximum intensity is the location of the source

O. Scholten 2022

TRI-D Parameters

- **Spatial grid size** : 120x120x40 m3
  - ±60 easting(x), ±60 northing(y), ±40 altitude(z) [m] from the source position
  - One cell is 6x6x4 m3 (=voxel)
- **Temporal grid size**: 2000 ns
  - Integration time=time window
  - 400 x times samples (5 ns)
  - 400/50 = 8 time slices in a time window (50x5ns=250 ns each)
- Antenna range = 100 km

O. Scholten 2022

LOFAR

- **Lo**w **F**requency **Ar**ray
- World's largest low-frequency radio telescope
- Baseline length up to 100 km
- Core in Northern Netherlands
- Low band antennas (LBAs): 10-90 MHz
- High band antennas (HBAs): 100-250 MHz
- 36 dutch stations, 96 LBAs and 48 HBAs per station
- 24 stations in the core
- TRI-D: 6 LBAs/station (Superterp)
  - ~130 antennas total

G. Heald 2018

Source: ASTRON