

# Plan and progress of the seismic and magnetic noise monitoring studies in the EMR-region

Shahar Shani-Kadmiel, Michael Kiehn\*, Frédéric Nguyen

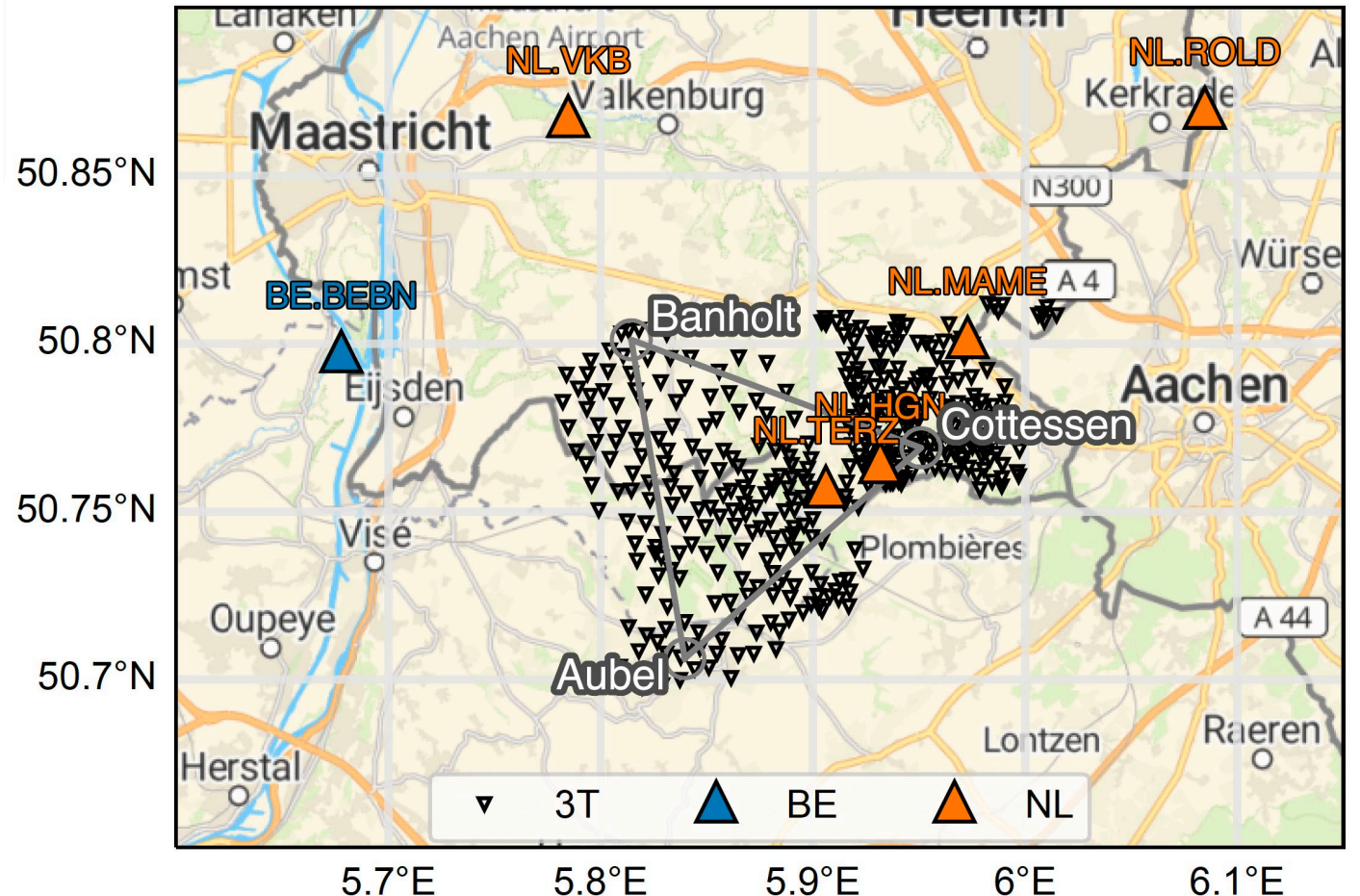
+ E-TEST team (UniBonn Kristoffer Kerkhof and Andreas Kemna)  
(RWTH Marius Waldvogel, Florian Amann, Peter Kukla, Raphael Burchartz, Hamdi Pooya and co.)



# Seismic noise monitoring previous work : E-TEST



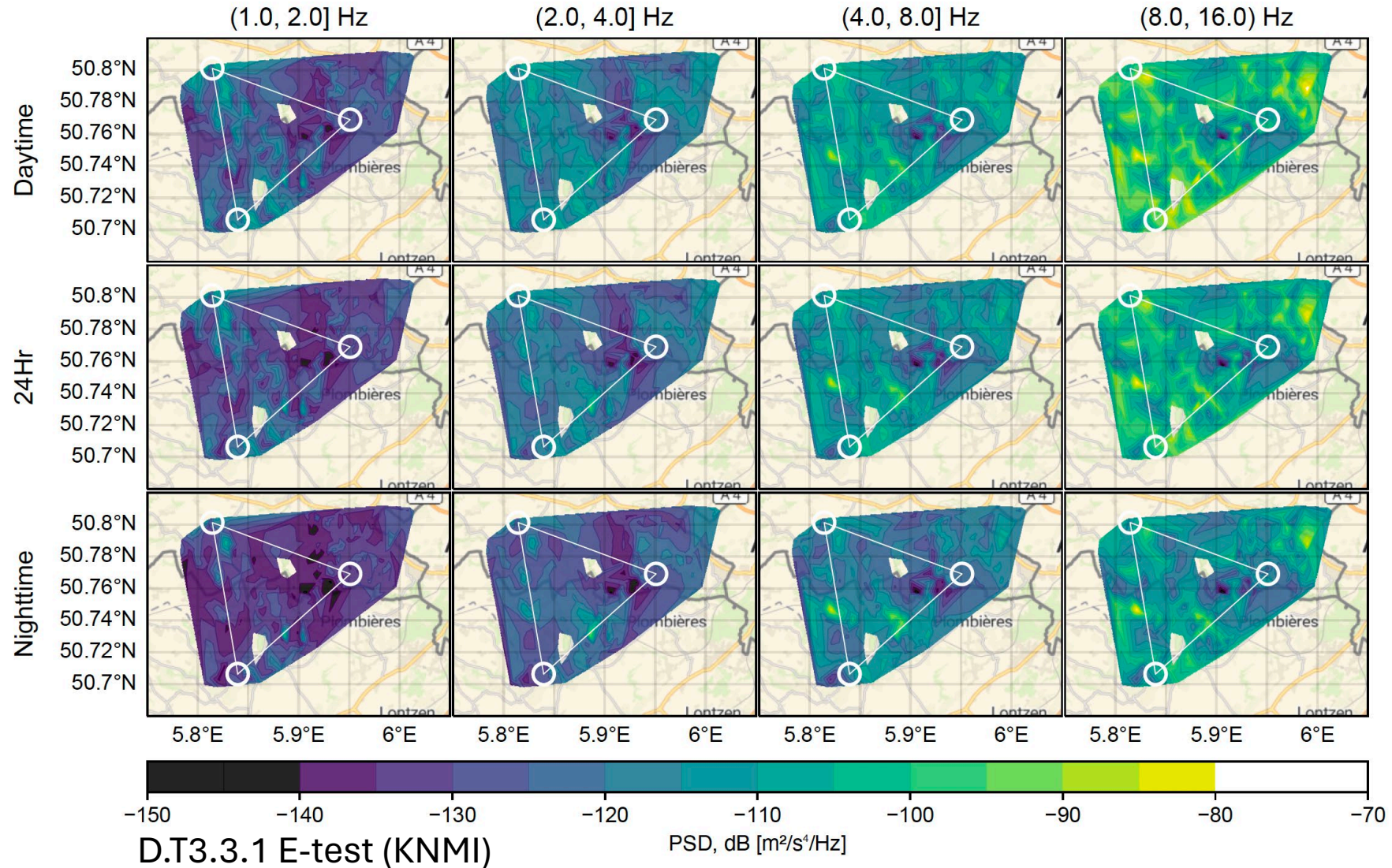
D.T3.3.1 E-test (KNMI)



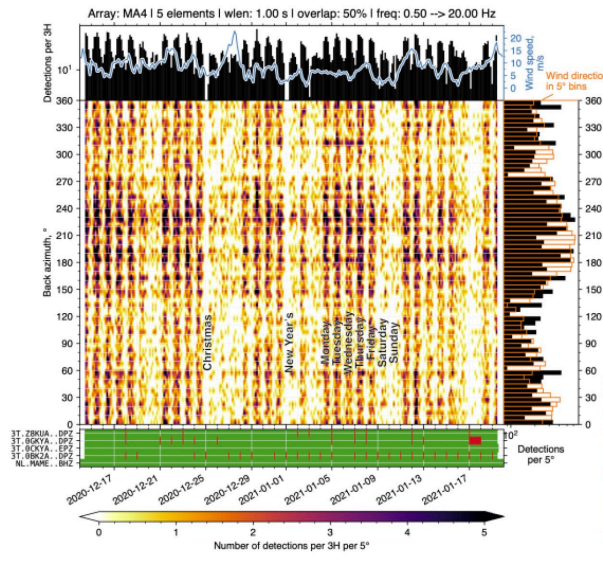
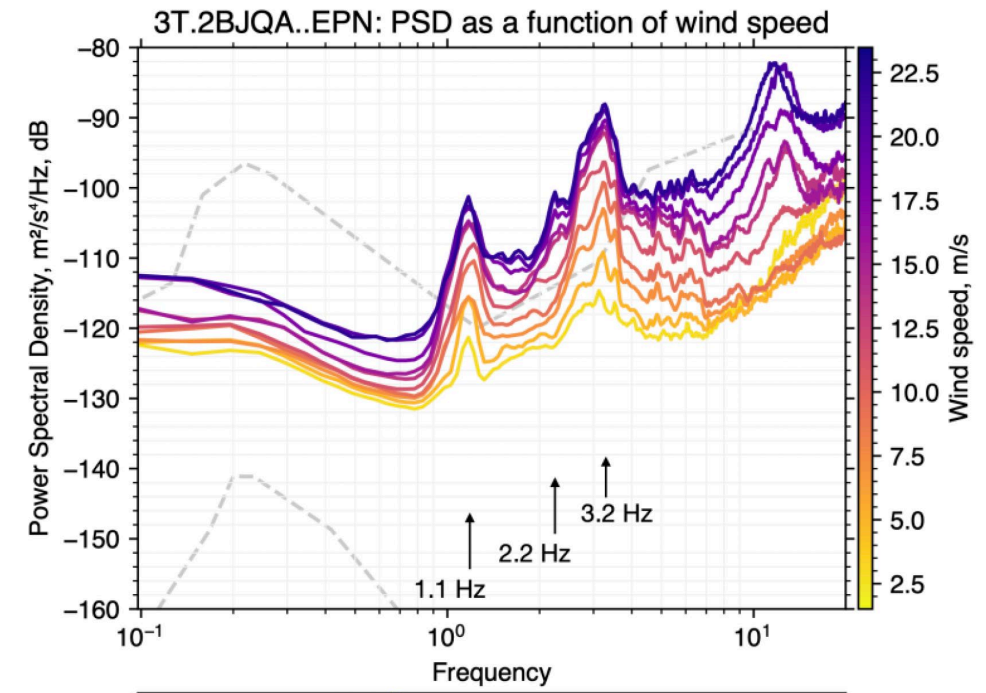
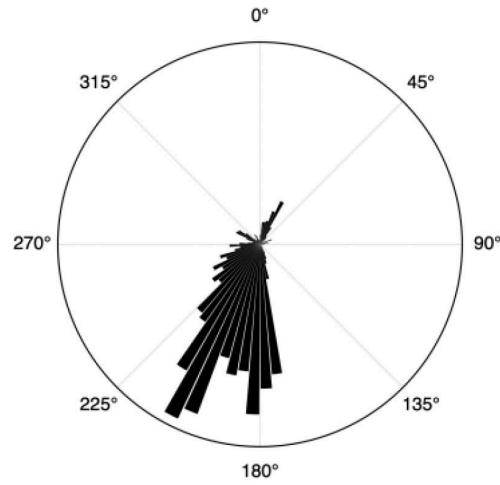
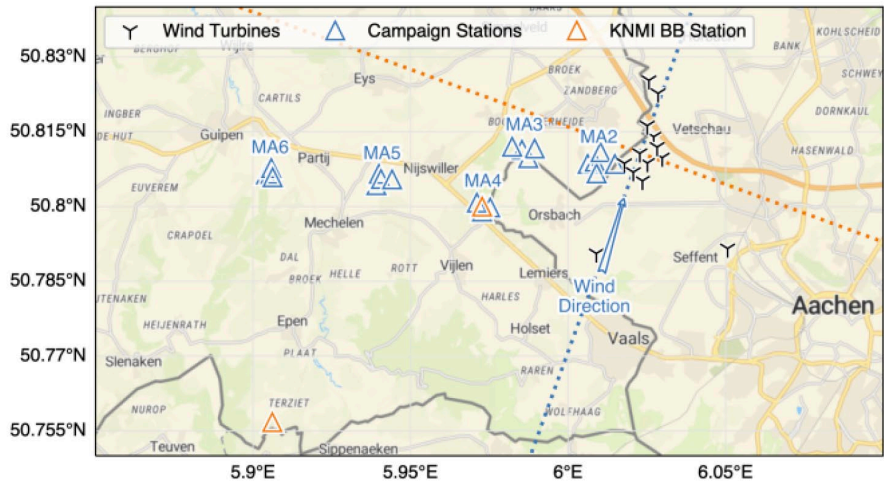
3T survey: Four to six weeks, using 5 Hz vertical geophones.

D.T3.3.1 E-test (KNMI)

# Seismic noise monitoring: E-TEST



# Seismic noise monitoring : E-TEST



Identification of peaks related to windturbines and potential sources anchored in the bedrock  
D.T3.3.1 E-test (KNMI)

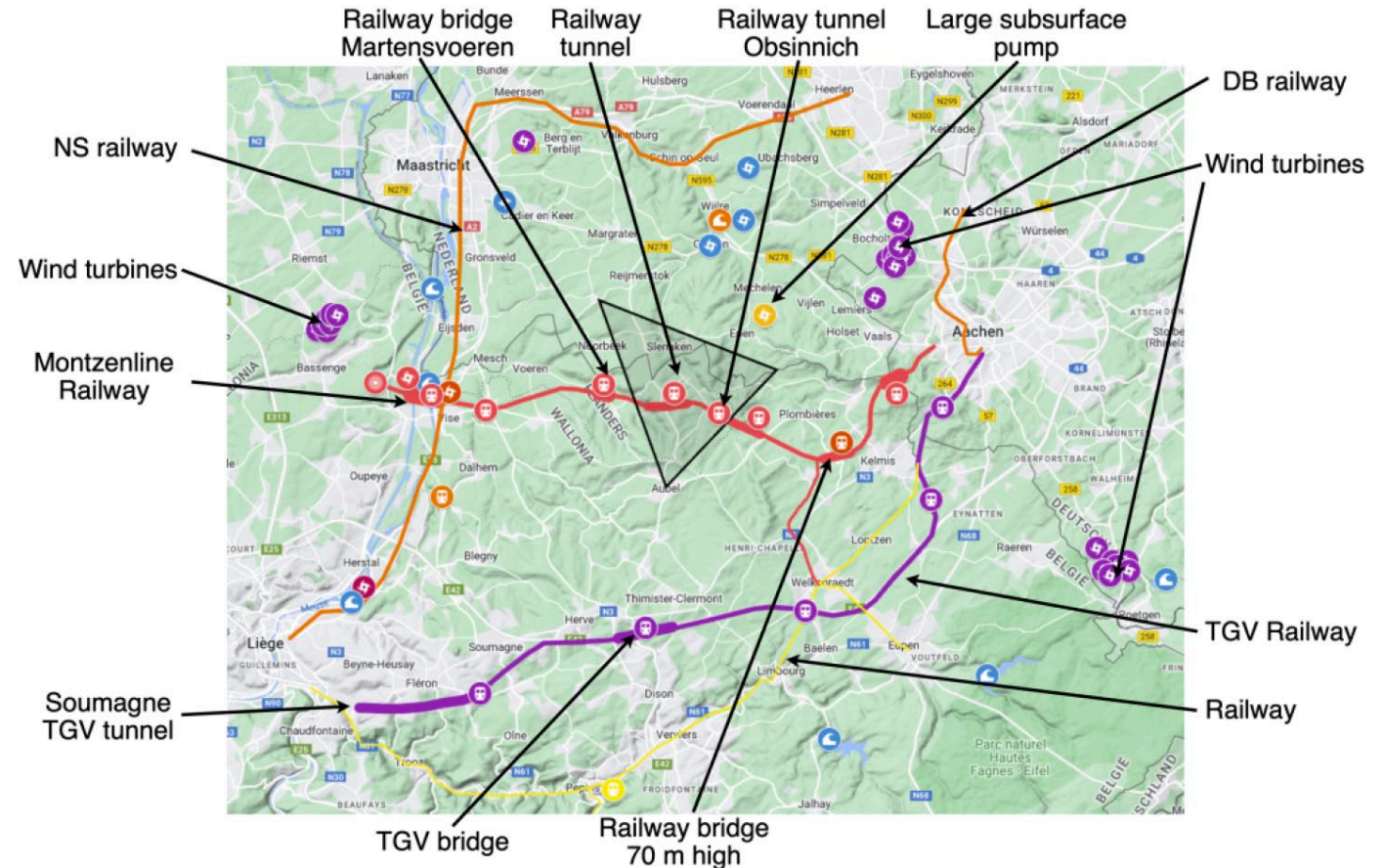
# Seismic noise monitoring : future surveys (starting this June)

- Current noise spectra at Terziet already accounts for existing sources
- Further identification and characterization of sources to understand their impact and potential mitigation solutions (e.g. windmills foundations)



400 3C 5Hz SmartSolo Geophones getting calibrated at KNMI site

## D.T3.3.1 E-test (KNMI)



See also Reumers et al. (023, SPB Workshop 3)

# Seismic noise monitoring at depth: Status and plans

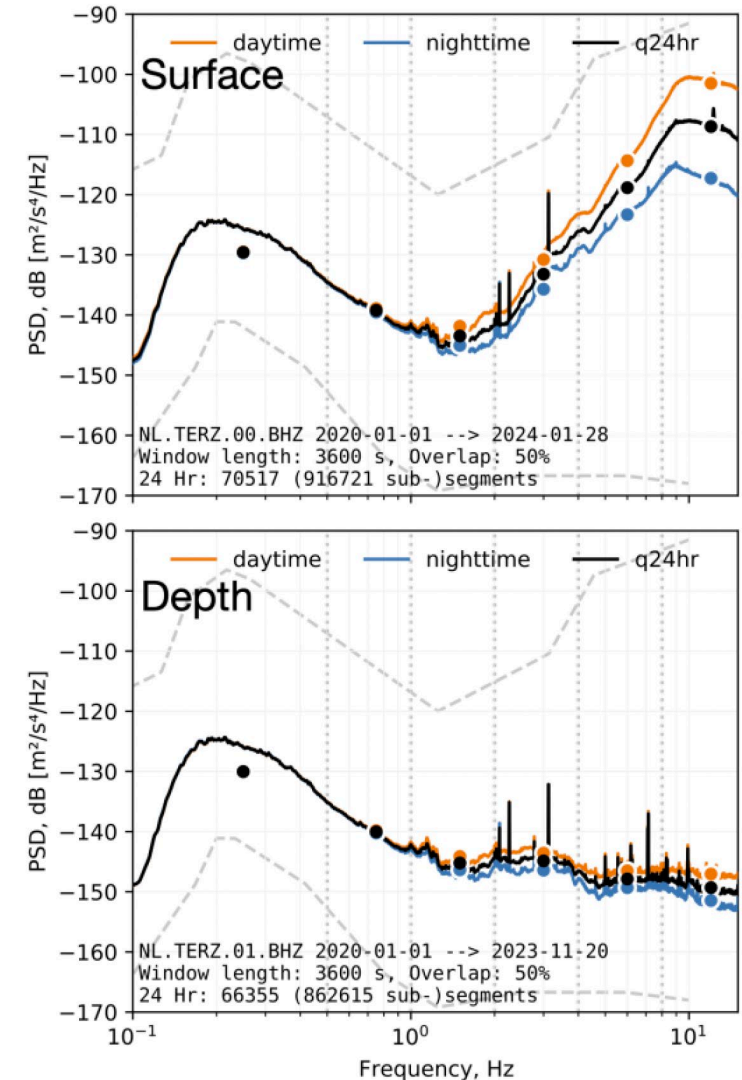
- Surface and borehole seismometers at each location
- Terziet: online
- Cottessen and Banholt (E-TEST): installed but working on data quality checks (not online yet).
- To be installed in 2024 (ongoing drilling campaign):
  - **Teuven**
  - **Obsinnich**
  - **Henri Chapelle**
  - **Vijlen**
  - **Aubel**



Cottessen borehole with fiber optics  
and 3C seismometers

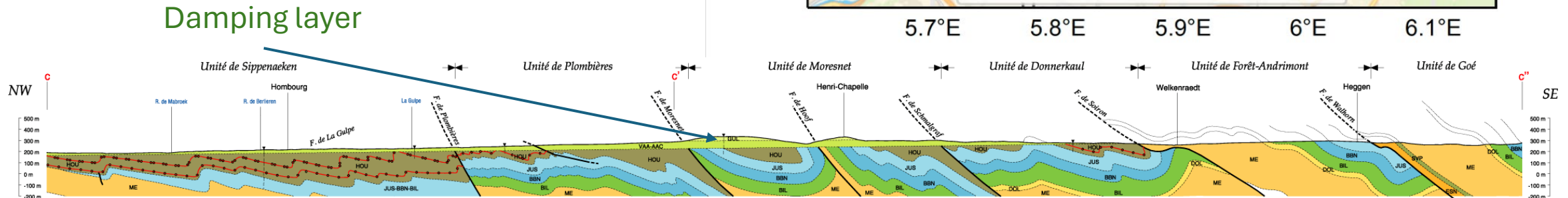
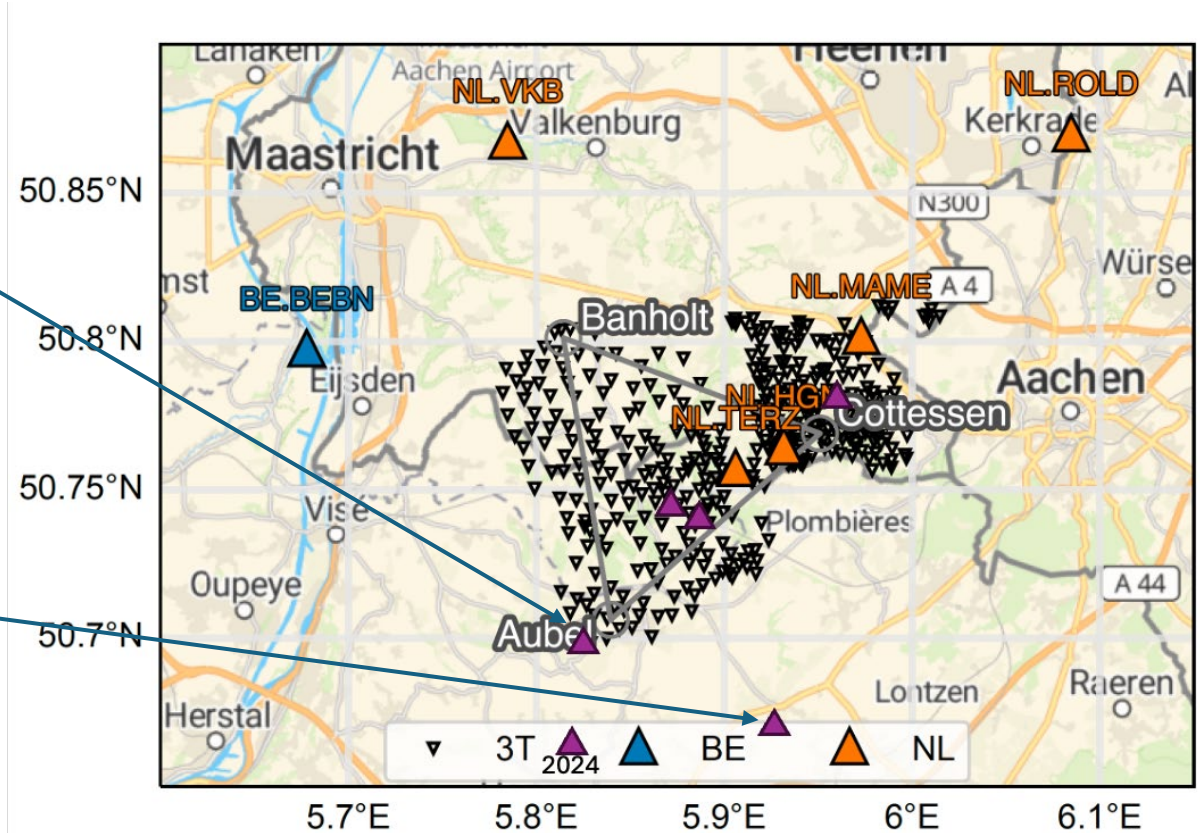
# Seismic noise monitoring : boreholes installation

- **Daytime** and **nighttime** PSD variation as measured at NL.TERZ seismic station between January 2020 and January 2024 at the surface and at depth:
  - Seismic noise registered at depth is 20-30 dBs lower than on the surface,
  - The  $\sim 1.1$ ,  $\sim 2.2$ , and  $\sim 3.2$  Hz peaks still prominent. These have been clearly associated with the wind turbines in the region



# Seismic noise monitoring : the need to have additional borehole seismometer in the bedrock

- Aube exhibited good rock quality for potential corner point
- Exploring the area further South (Henri-Chapelle) due to challenging rock conditions in Banholt

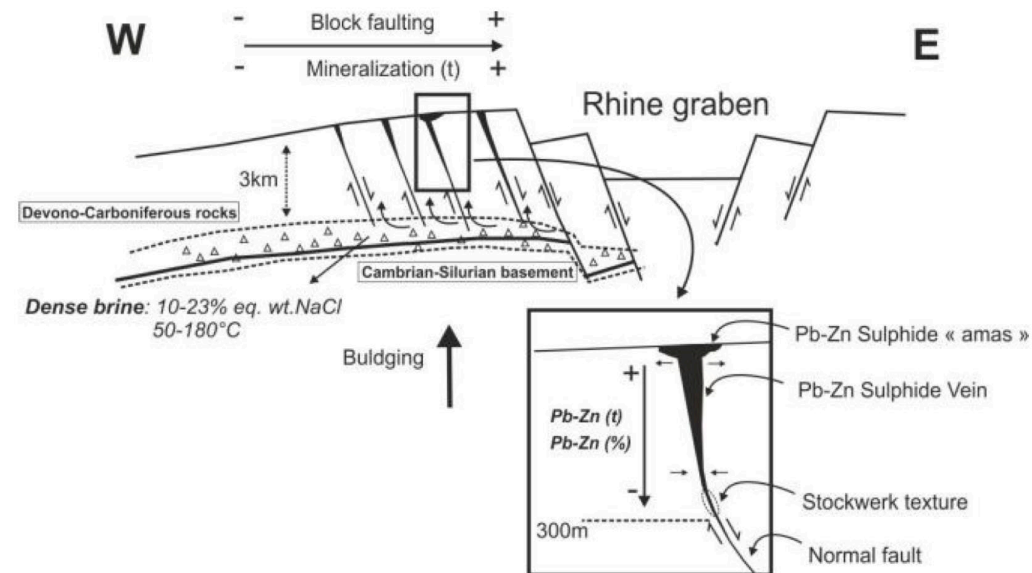
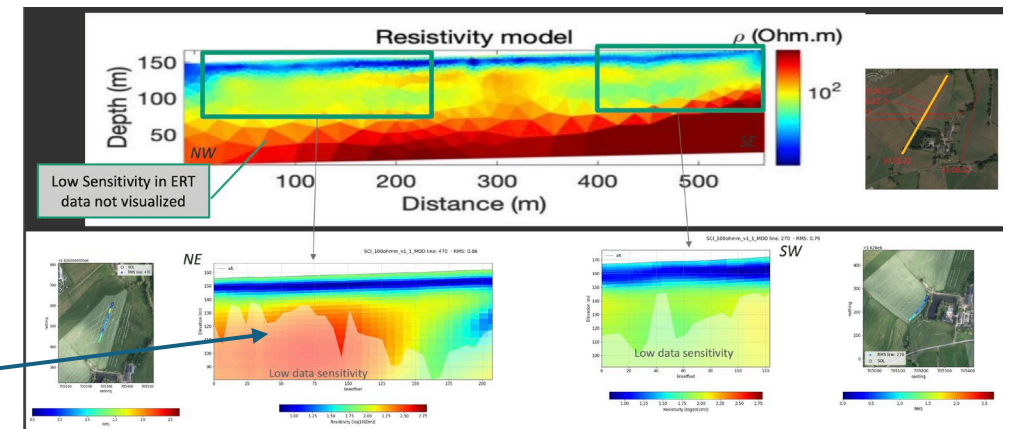




# Magnetic noise monitoring: plans for 2024

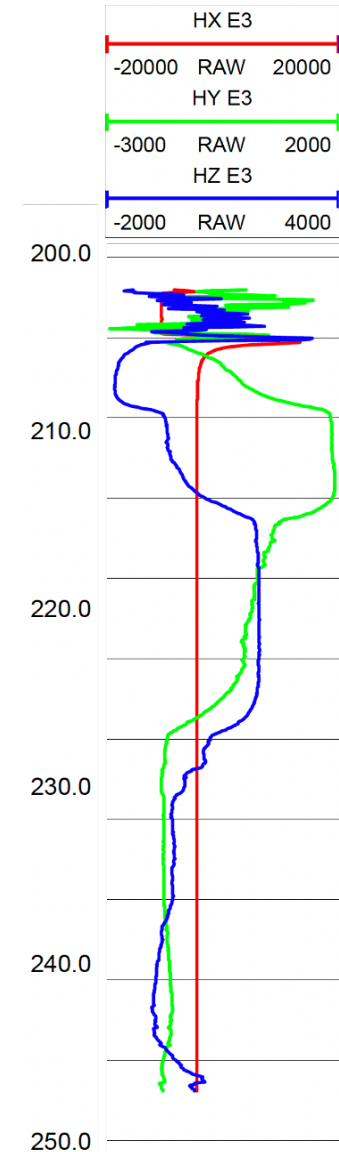
Panzner et al., 2023 SPB

- EM noise can perturbate electronic and magnetic materials over a wide range of frequency for ET
- Due to natural sources and artificial sources
- EM field strongly attenuated if conductive layer, see also EMI test in EMR
- High magnetic susceptibility minerals (e.g. magnetite  $\text{Fe}_3\text{O}_4$ ) can distort locally the magnetic field
  - Mostly Pb-Zn sulphide, but if present, 10 SI for magnetite, 0.01-0.5 SI for pyrrhotite in mineralization
  - Sedimentary host rock does not exhibit high magnetic susceptibility



# Magnetic noise monitoring

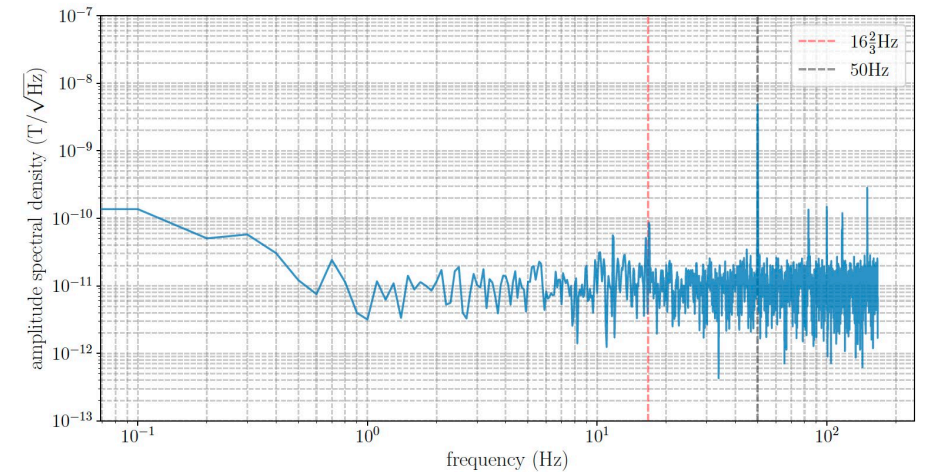
- $H_x$ ,  $H_y$ ,  $H_z$  measured at the surface and downhole (part of geophysical logging) in addition to estimating  $\kappa$  (in-hole and on cores)
- Future measurements to be performed with broadband induction magnetometer (MFS-06)
- Downhole installation planned for 3-5 wells
  - **Teuven?**
  - **Obsinnich?**
  - **Henri Chapelle**
  - **Vijlen**
  - **Aubel**
- Dealing
  - with (steel) casing issue, should be retracted if can be replaced by fiber glass casing
  - Seismometer and current carrying cables interaction needs attention



Banholt mag data, E-TEST  
DT3.1.1 (RWTH)

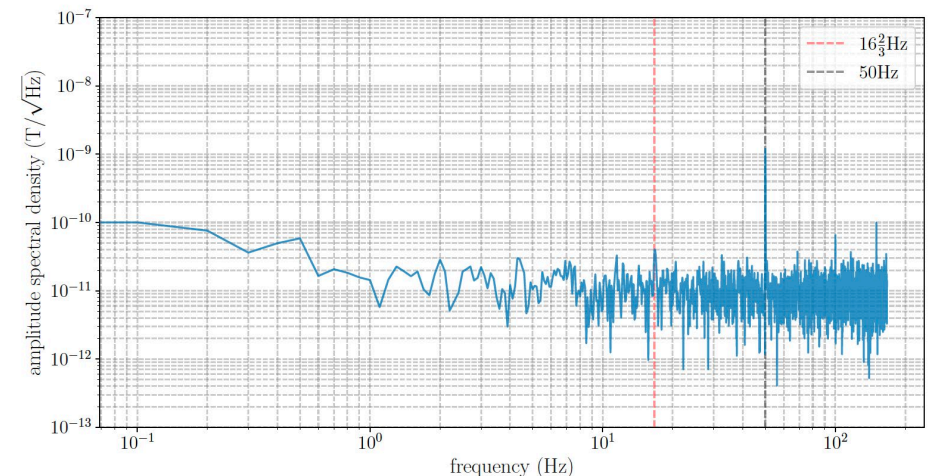
# Magnetic noise monitoring

- Potential corner points
- Dry holes
- Centaur data logger available (Banholt + 2) for 3C magnetometer(e.g. surface) in addition to 3C broadband seismometer
- Stream to KNMI servers directly
- Complementary we could acquire a 5 channels dedicated data logger metronix ADU-10e (512 Hz sampling rate inc. GPS antenna, network, 32 bits A/D) for multiple site configuration for more flexibility
- Horizontal components impossible at this stage to measure at depths
  - At surface, ~20cm deep buried



Surface (top) and 115m (bottom) Aabel  
3ms sampling for 1 minute using a fluxgate  
E-TEST DT3.1.1 (UniBonn)

**! Steel casing left in place due to instability**



## The Financiers

**Interreg**  
Euregio Meuse-Rhine



Wallonie



VLAAMS-  
BRABANT

AGENTSCHAP  
INNOVEREN &  
ONDERNEMEN



Vlaanderen  
is ondernemen



provincie limburg



Ministerie van Economische Zaken  
en Klimaat

Ministerium für Wirtschaft, Innovation,  
Digitalisierung und Energie  
des Landes Nordrhein-Westfalen



## The Partners



Koninklijk Nederlands  
Meteorologisch Instituut  
Ministerie van Infrastructuur en Waterstaat



Maastricht University



UCLouvain