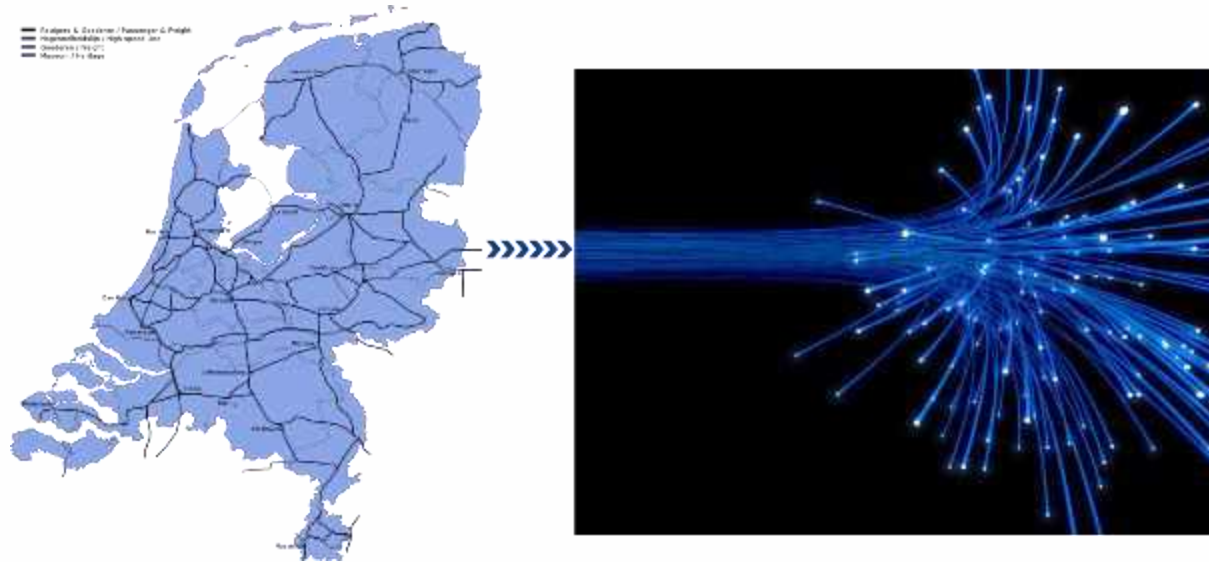


Fiber Optic Acoustic Sensing



Applications of Acoustic Fiber Optic Sensoring

IBBI Conference 4 february 2025



Cees-jan Mas
Project Manager / PO
Asset Management Innovation



Joost van 't Schip
Data Scientist
Innovation - Datalab

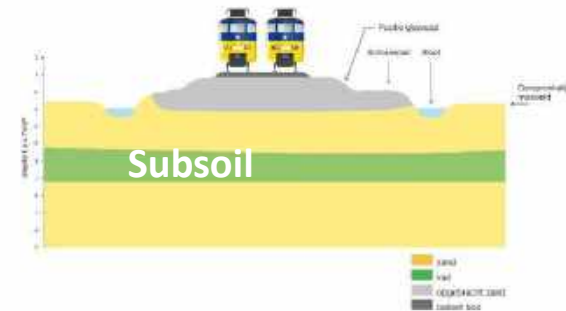
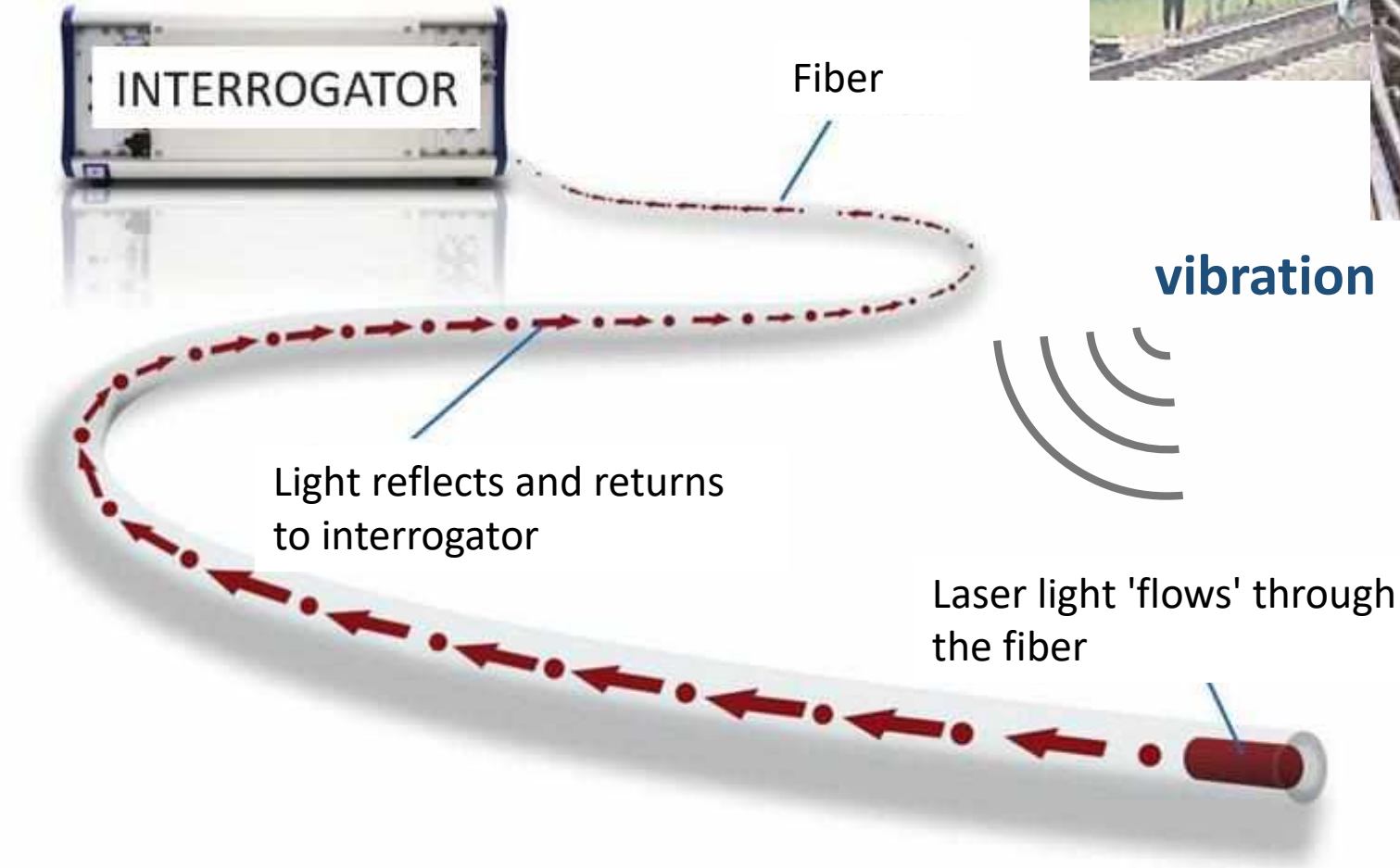


DAS Team

Agenda

- Short introduction to Distributed Acoustic Sensing (or Fibre Optic)
- The application of FOAS in 2 POCS @ProRail
- The results so far
- The step to burrowing animals

How does it work?



2500x per second

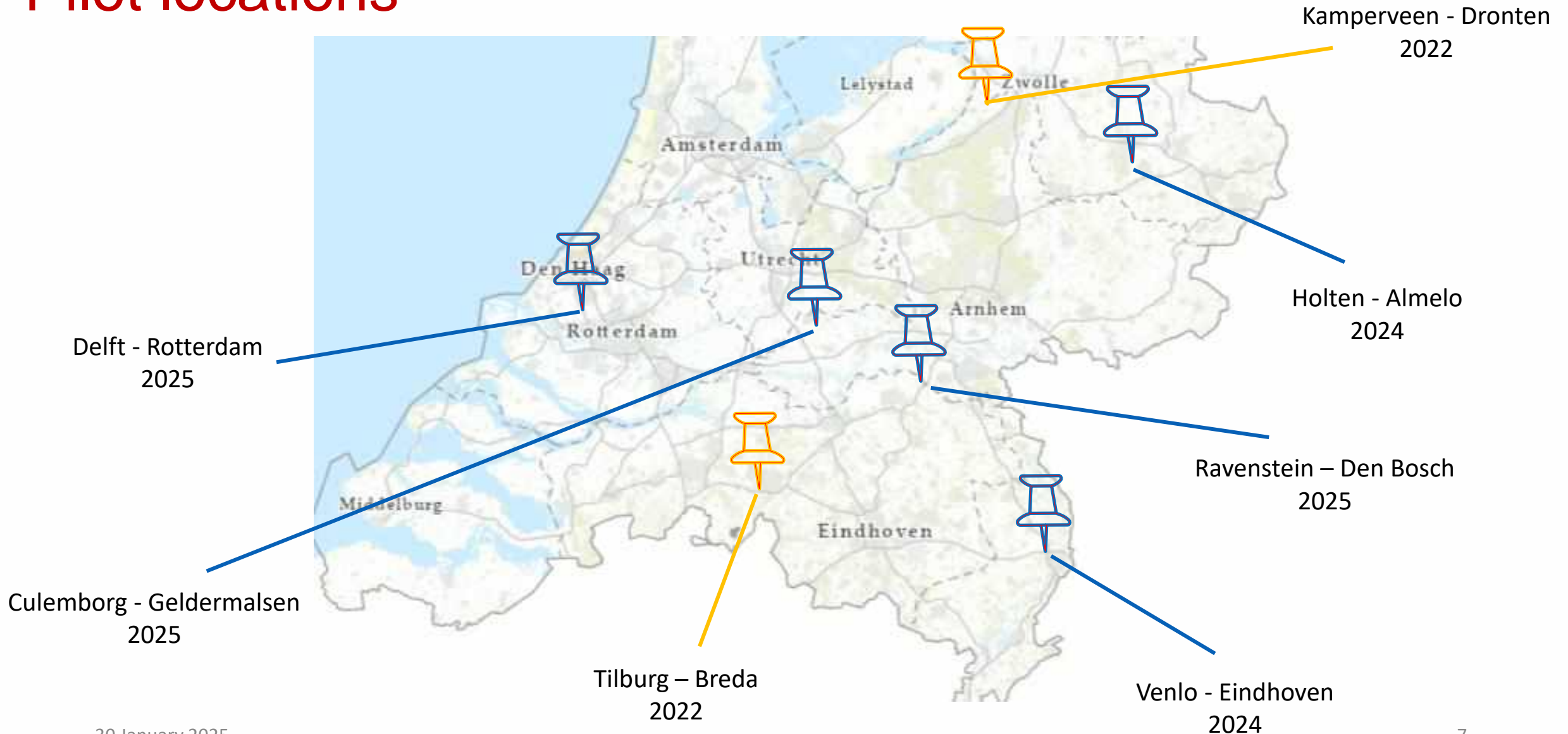
Vibrations in the environment cause 'disturbances' in the reflected light.

Since we have fiber optics along the tracks
practically everywhere.....

.....the existing ProRail fiber optic network is
potentially **one big measuring instrument!**

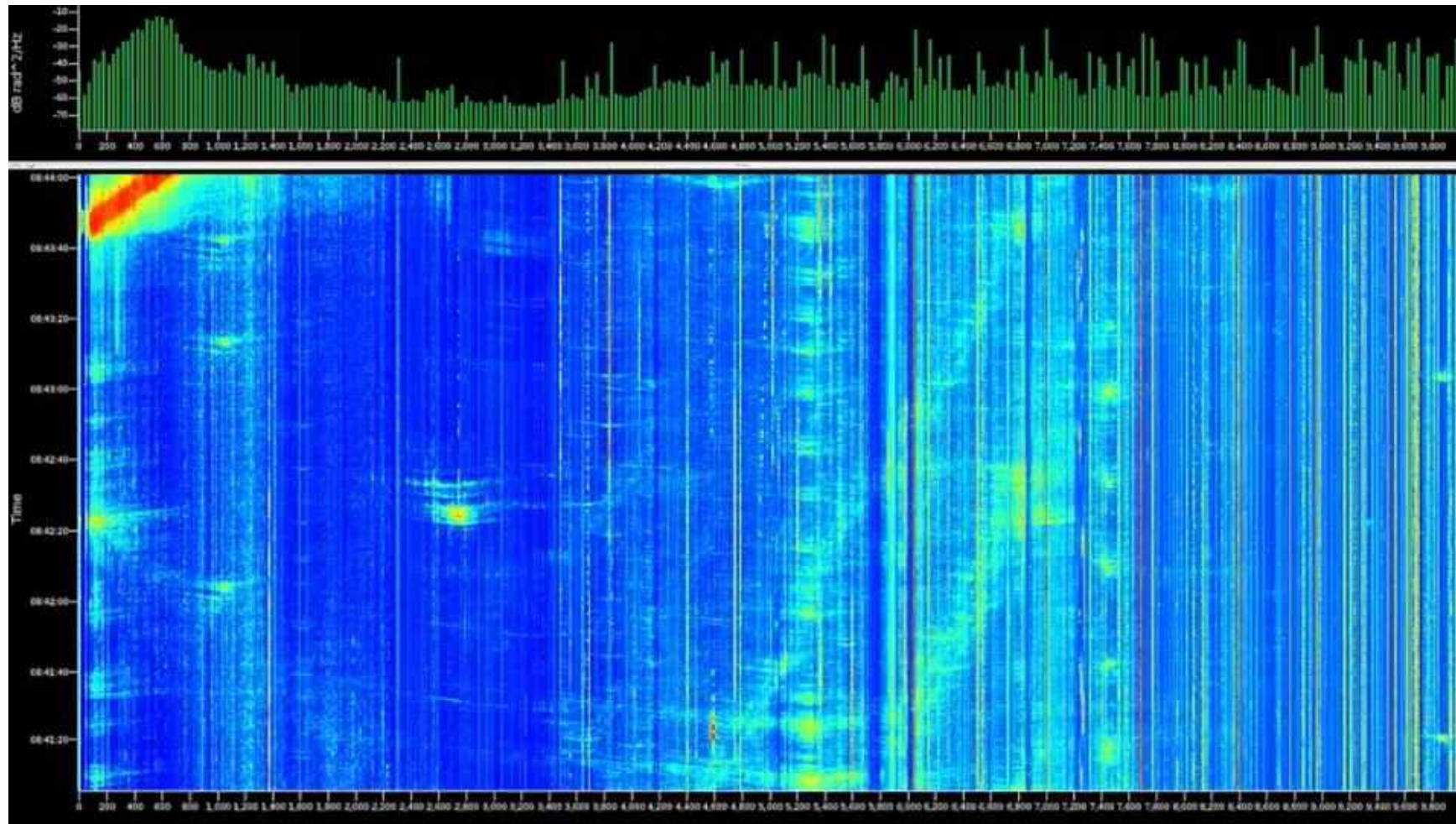


Pilot locations



What can you see on a interrogator? (Holten)

Time



Location

FOAS Pilot 2021 -2022

October 2021 - May 2022



May 2022 – October 2022



Use Cases



Train
detection



Insulated
joints



Trespassers



Critical
train speed



Loose
clamping
springs



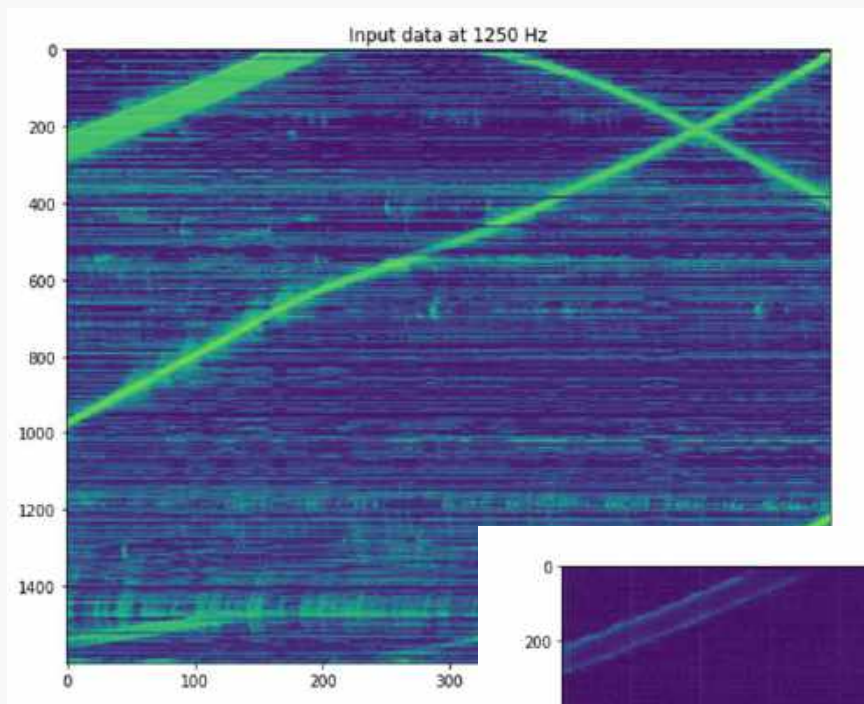
Wheel
defects



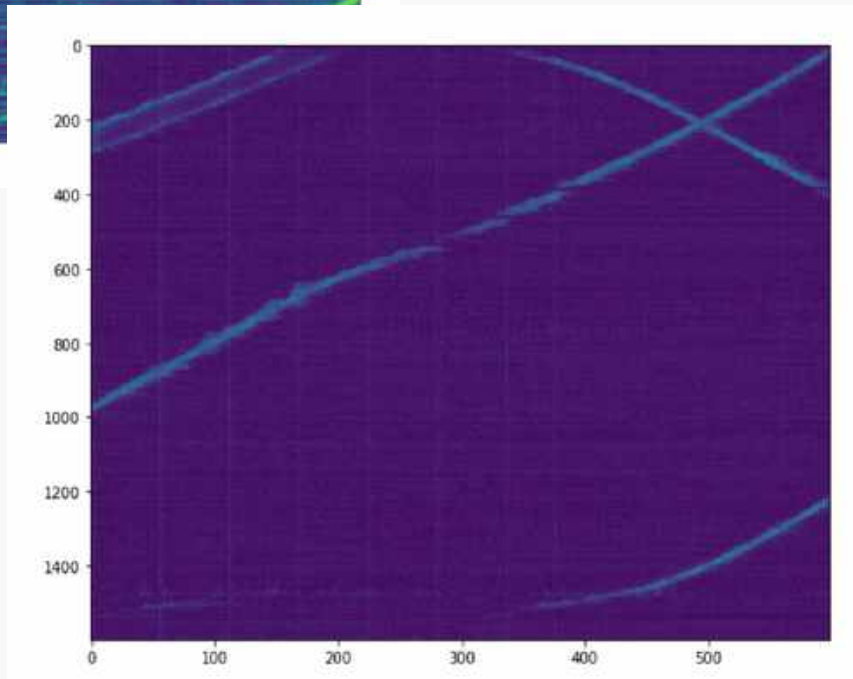
Level
crossing
traffic



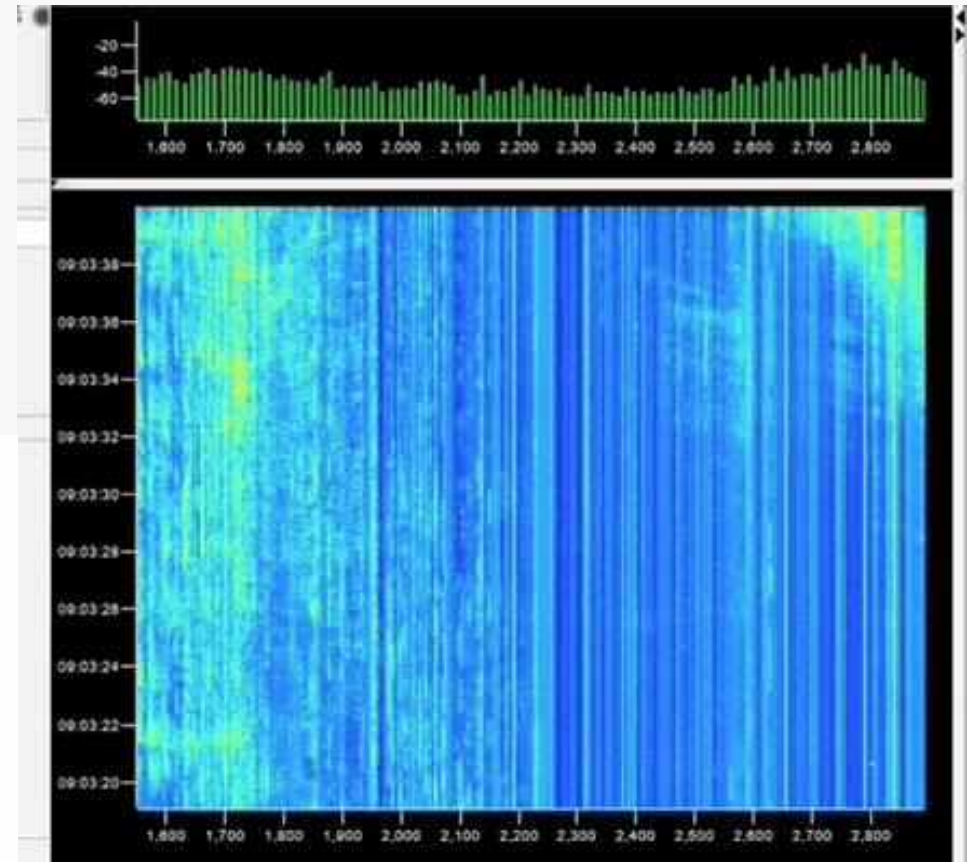
FOAS 2021: Train detection



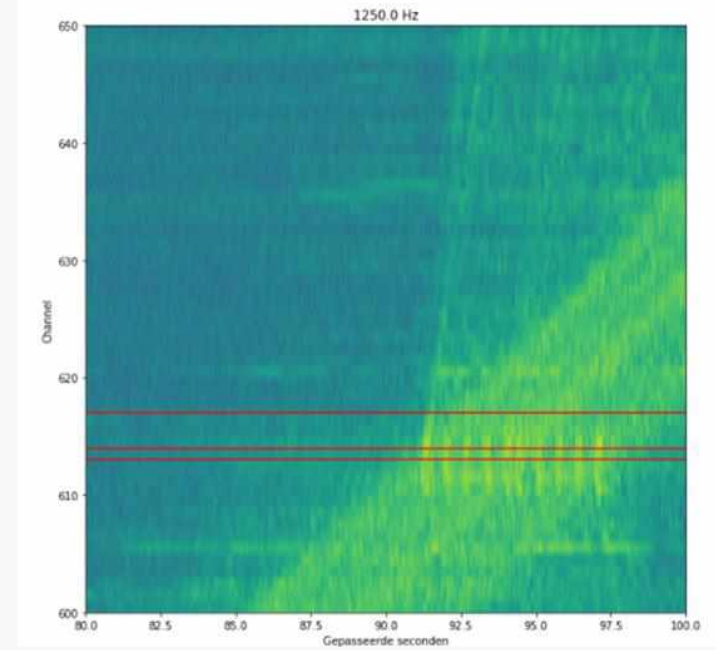
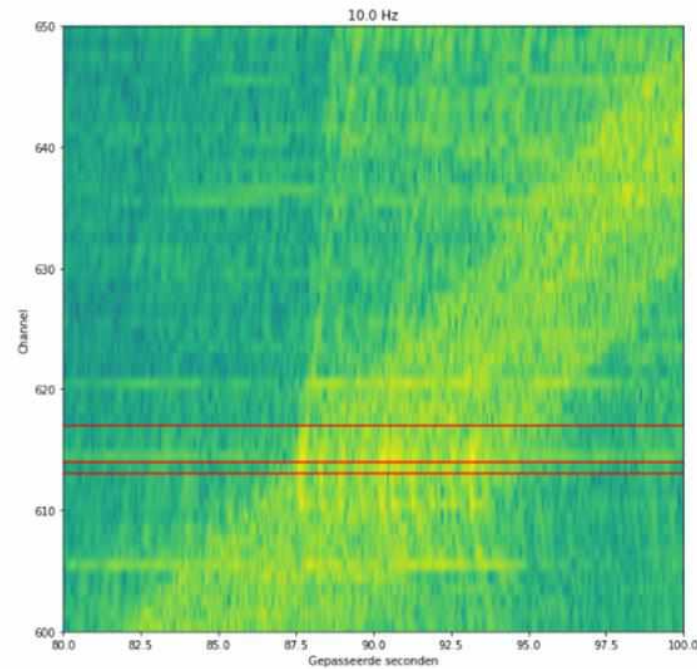
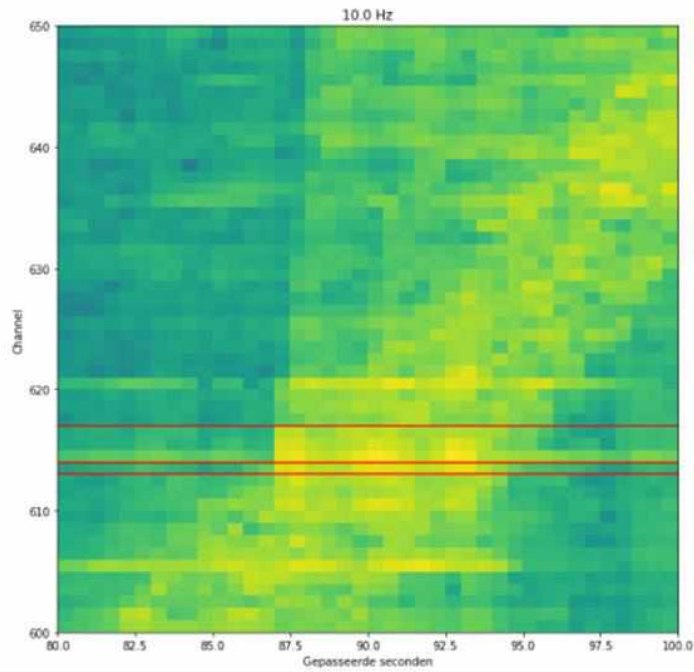
Neural net
based on U-Net



Recorded FOAS images of train passage
from Dronten to Kamperveen

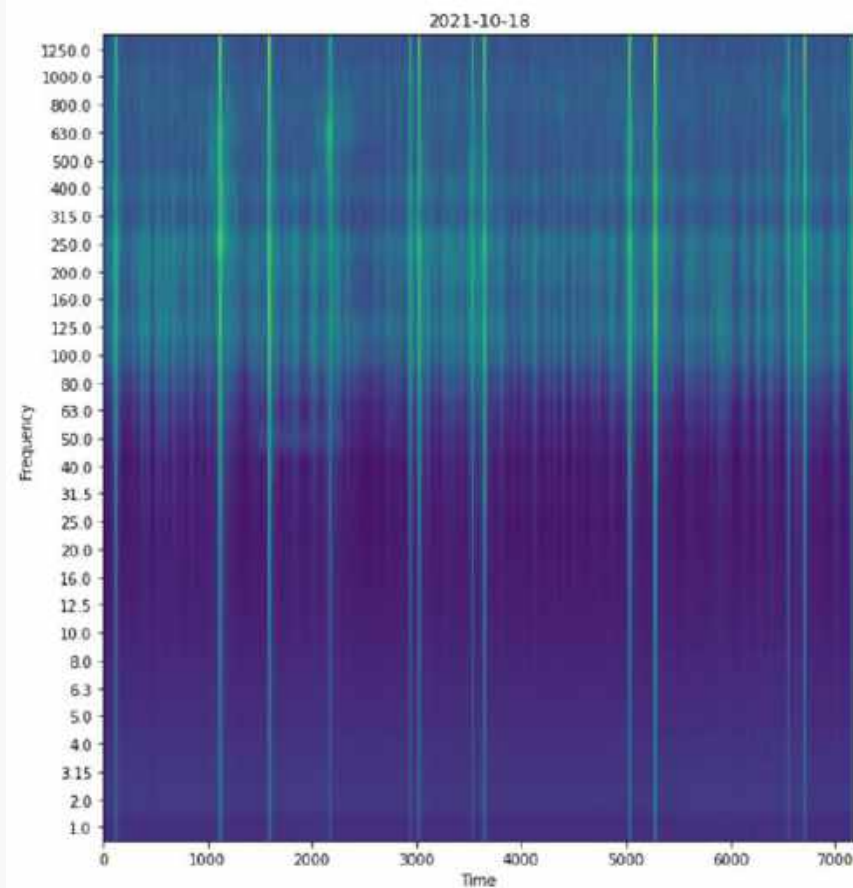


FOAS 2021: Isolation welds

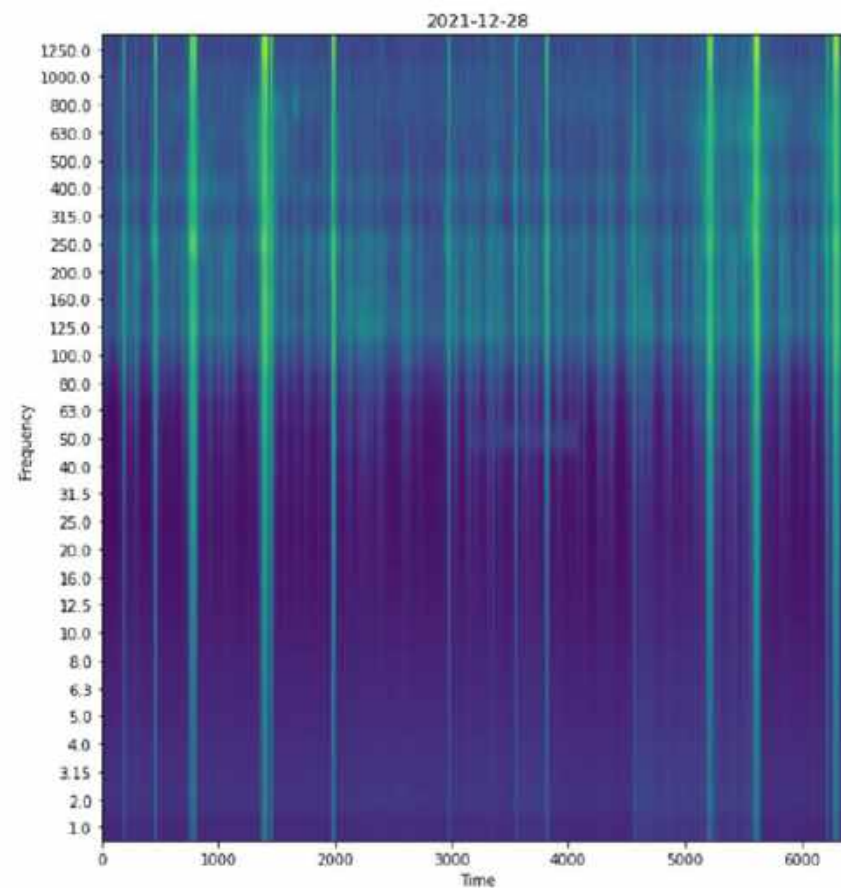


FOAS 2021: Loos spring clamps

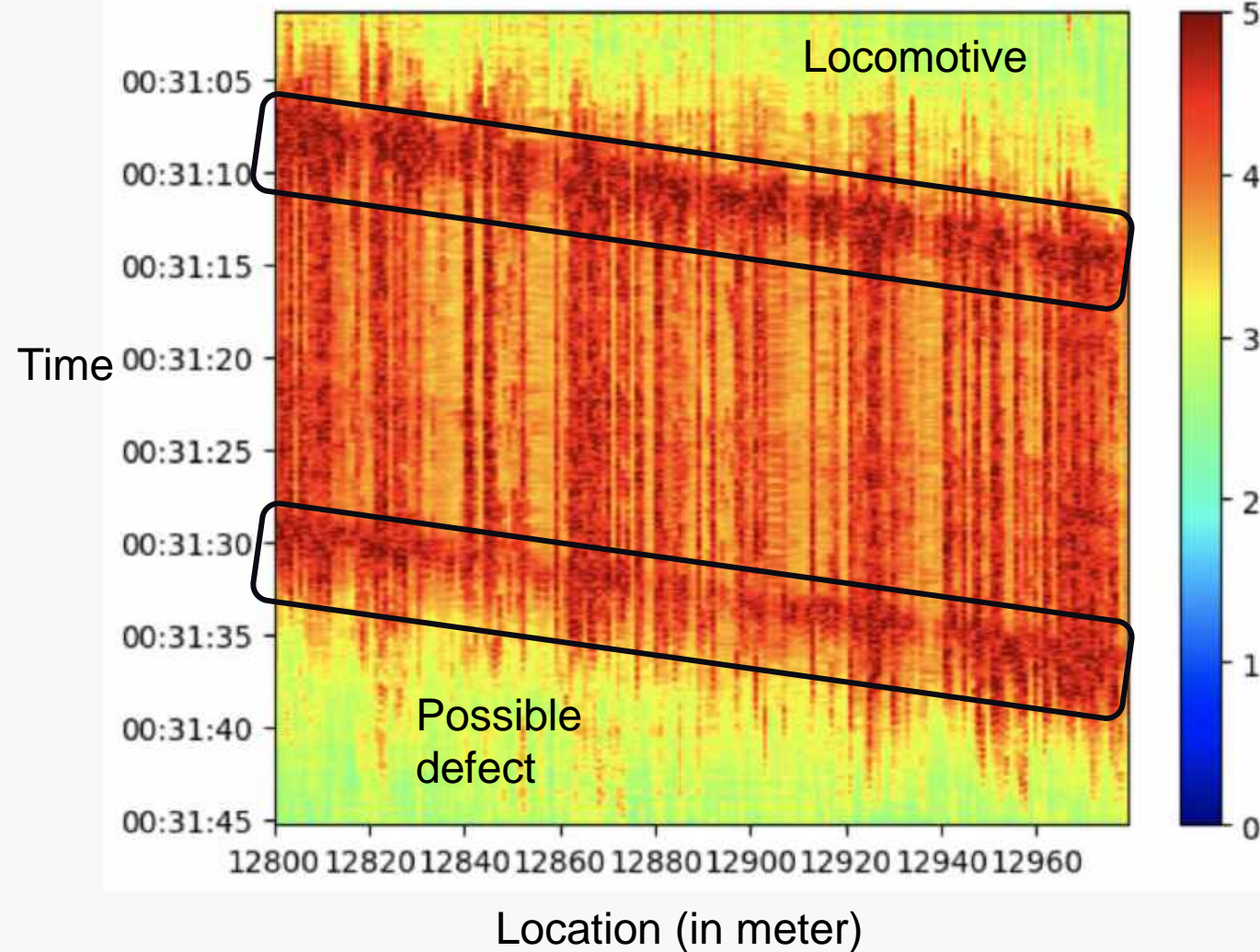
Before maintenance



After maintenance



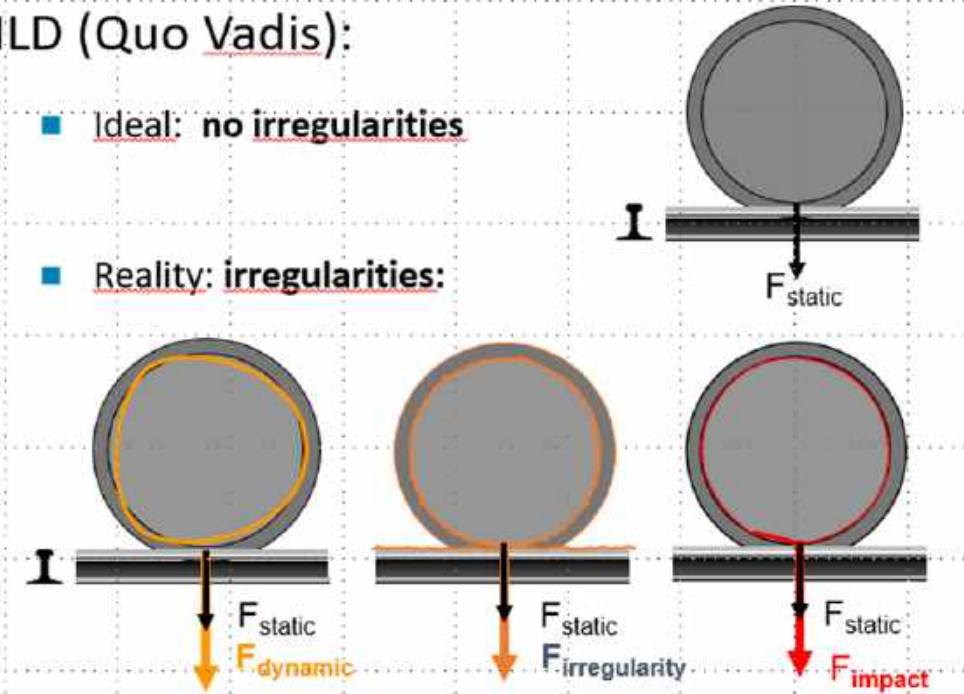
FOAS 2021: Wheel defects



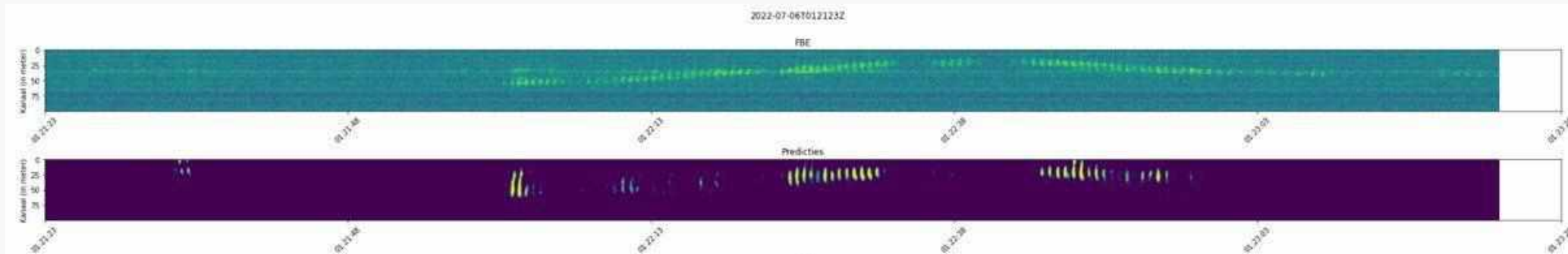
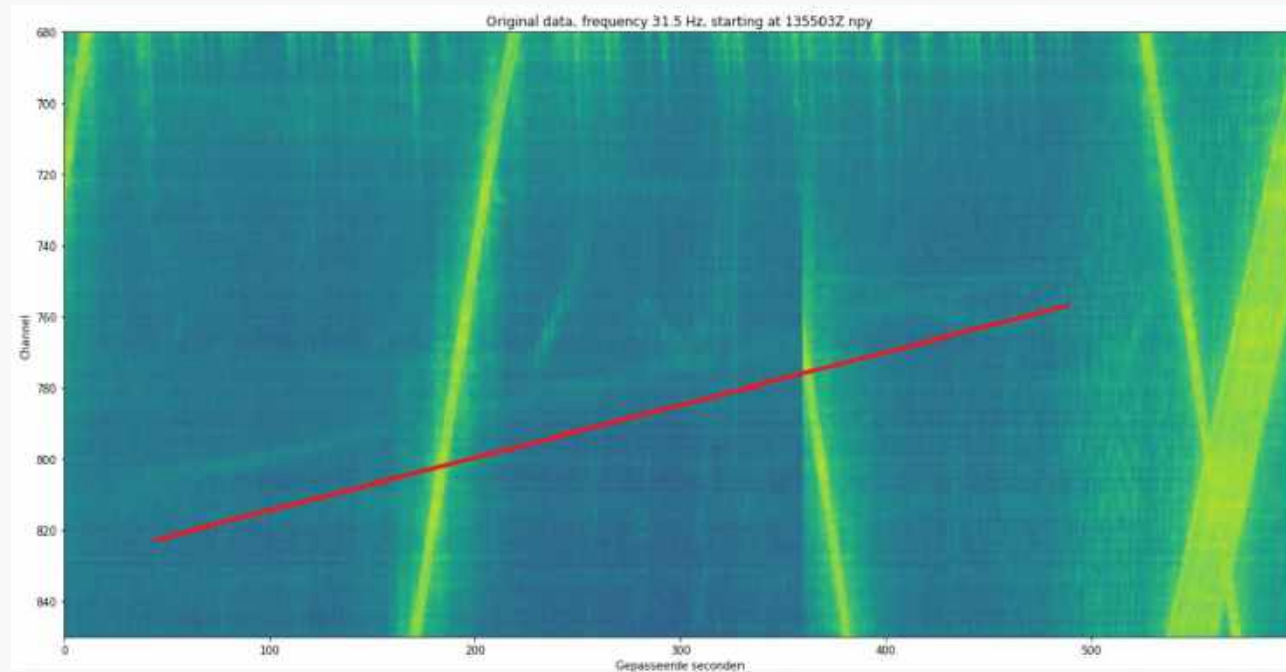
- WILD (Quo Vadis):

- Ideal: no irregularities

- Reality: irregularities:

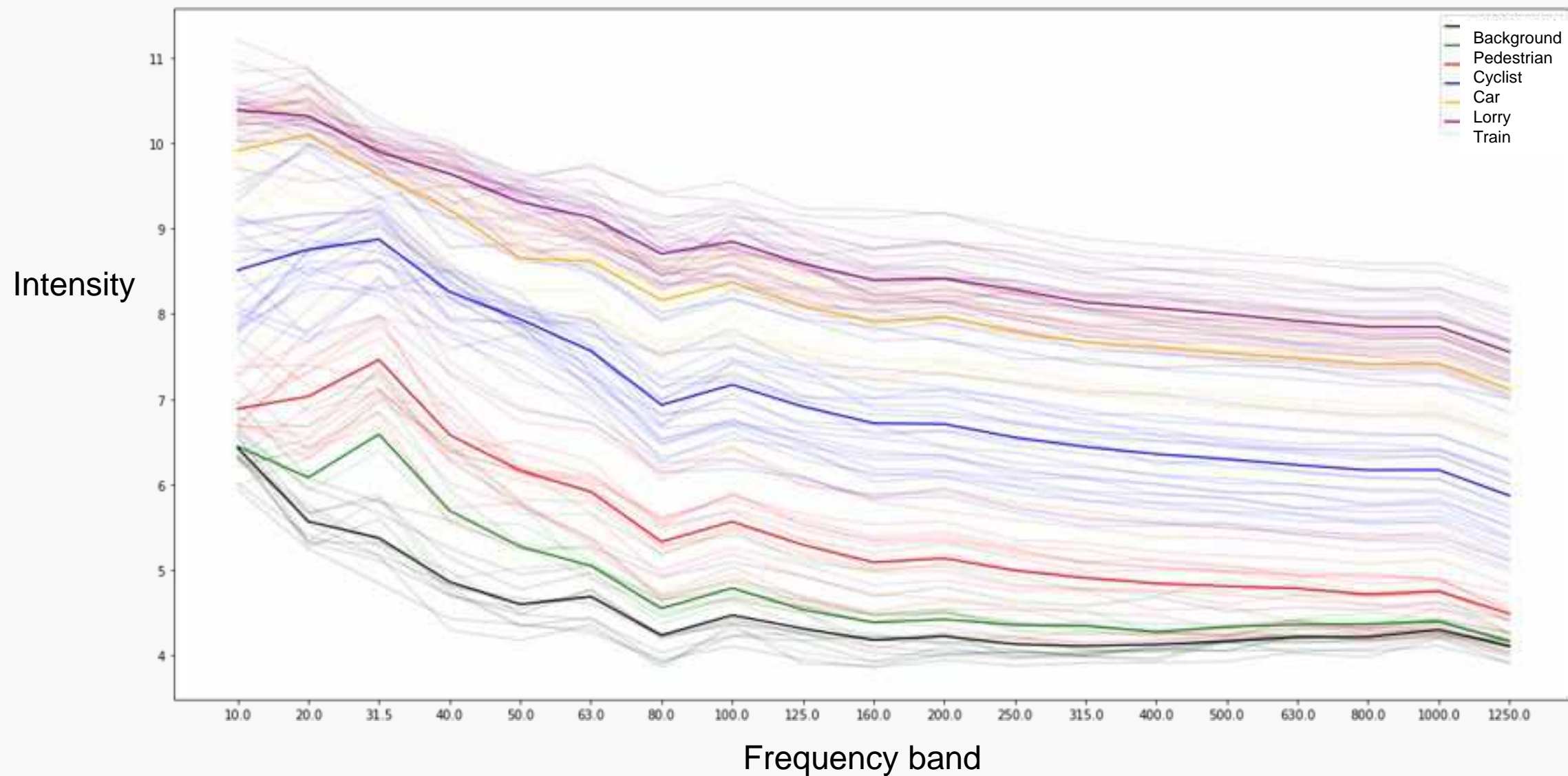


FOAS 2021: People on the tracks

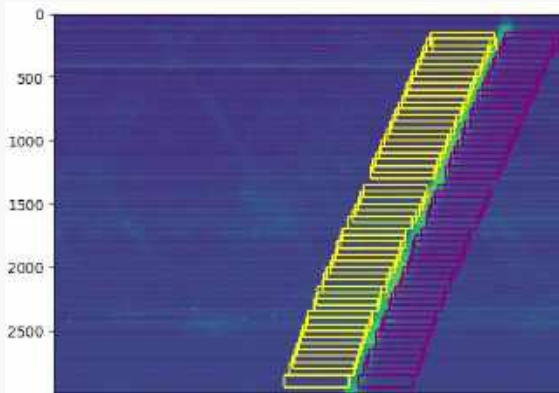


FOAS 2021: Level Crossing

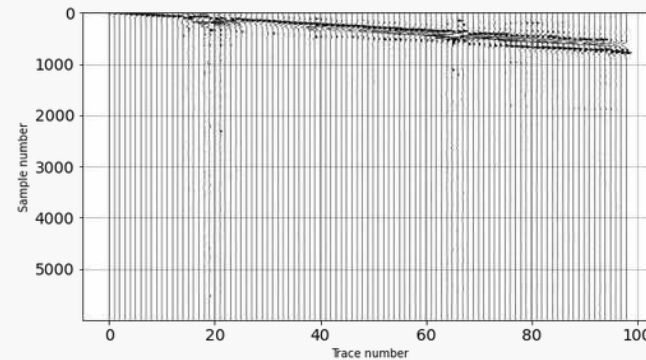
Intensity per frequency band per traffic type



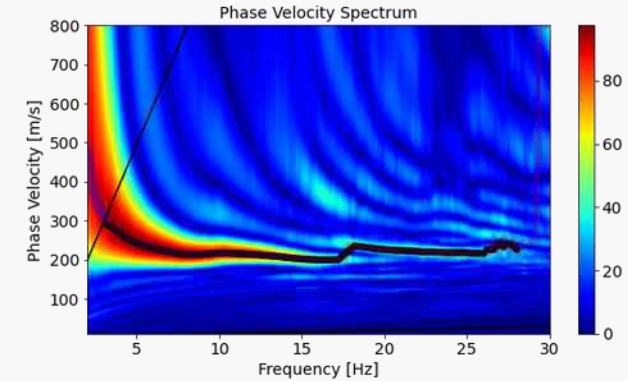
FOAS 2021: Critical train speed



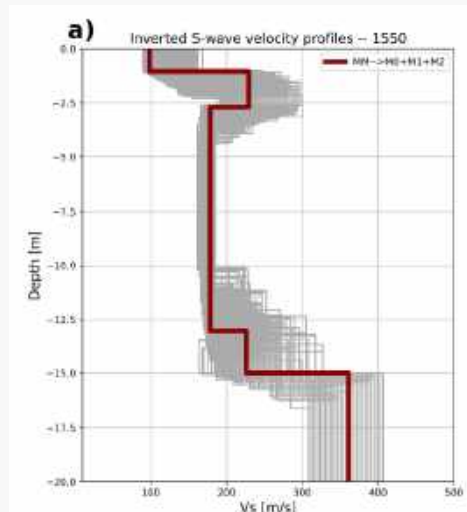
Bow/Tail golven



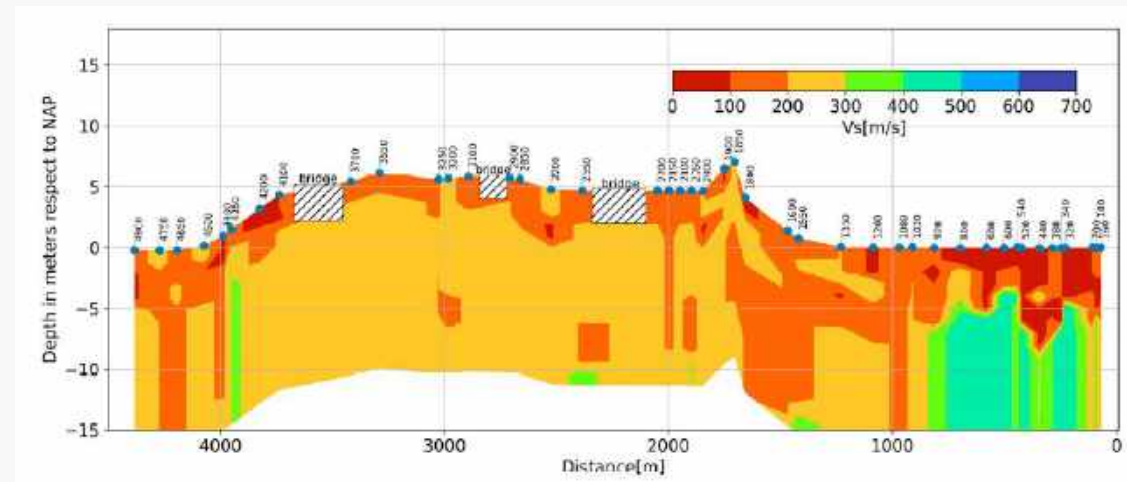
Cross correlation



Phase velocity spectrum



Speed in ground



Soil map



At the end of the 2022 trial we received the request for help for detecting beavers and badgers.....

Serious damage of underbankement and track by badgers at Esch and Workum in 2023.
Also serious hinder of train schedule in that period.
Increase of badger and Beaver activity near Rail in the Netherlands

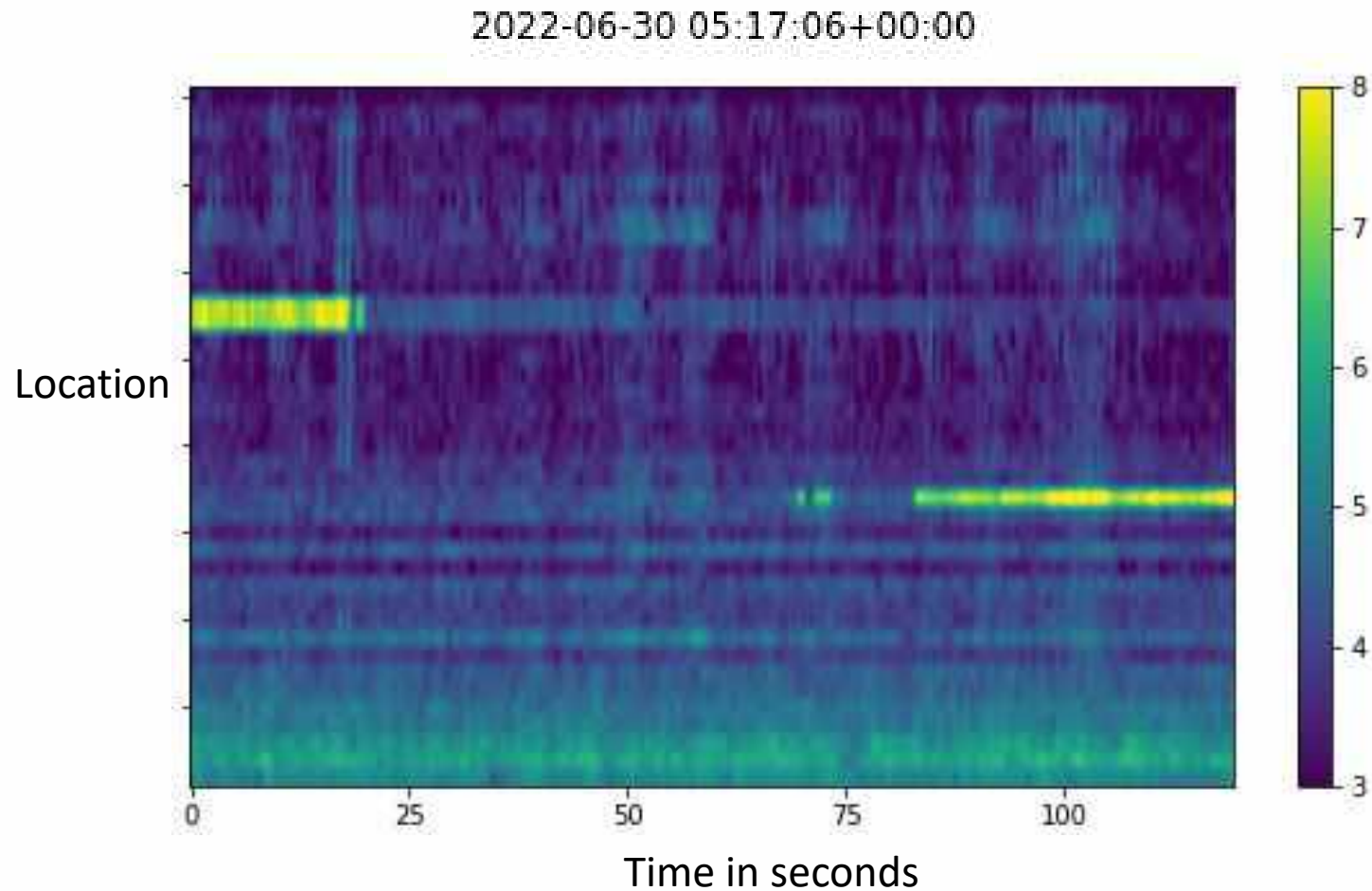
Esch



Workum



Movement at specific locations?



Burrowing animals!



Foas 2024 -2025



Wheeldefects



People on the tracks



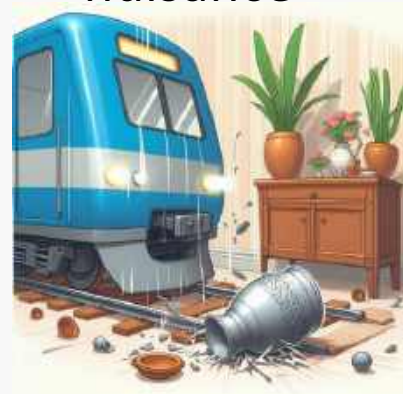
Badgers and Beavers



Critical train speed

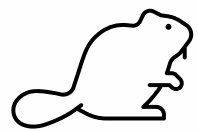
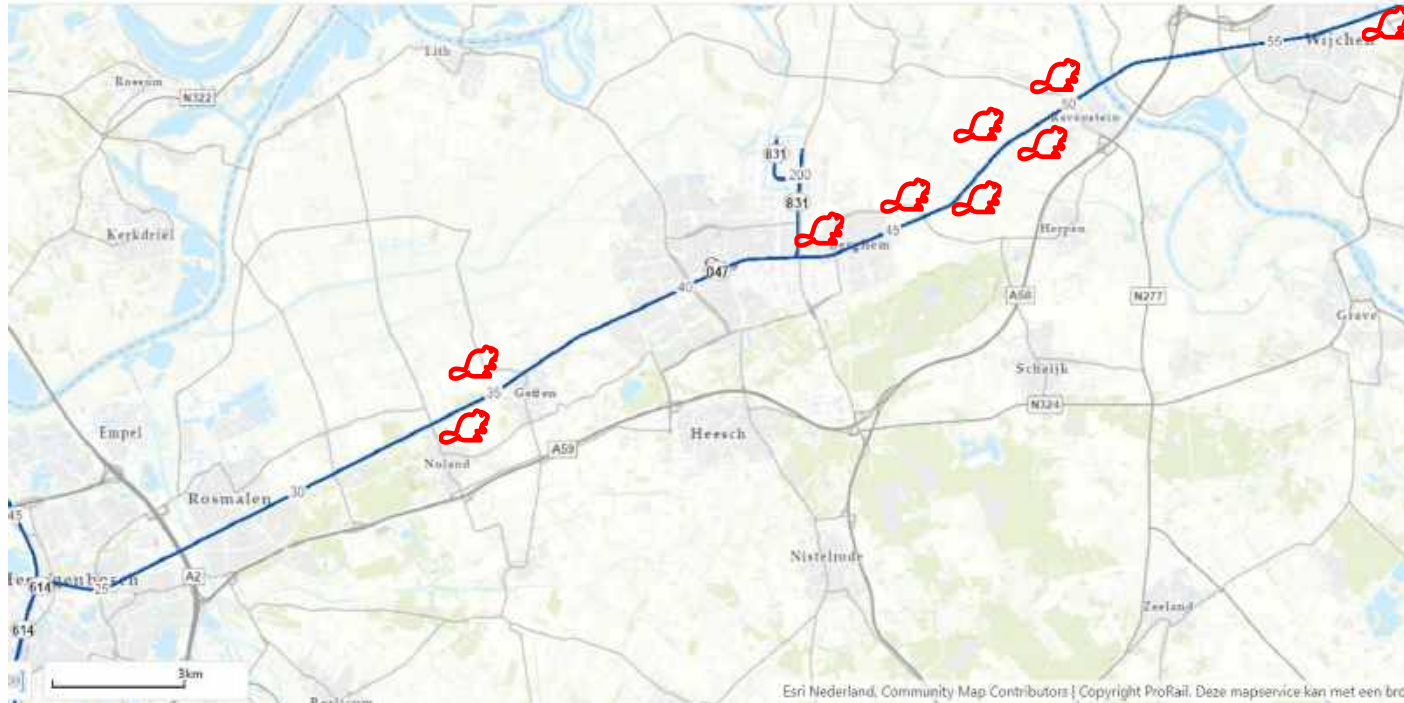


Vibration nuisance



Fieldtest 2025 (jan – may)

Nijmegen – Den Bosch



Can we hear digging badgers or beavers?
Can we detect cavities under the track?

Challenges

- One interrogator broke down
- Ground truth data
- Complex analysis
- Soil dependency
- Different equipment settings



Questions



- How do you see the application to burrowing animals outside the railway area?
- Is fiber optic used by other parties?
- Do you know how beavers dig?