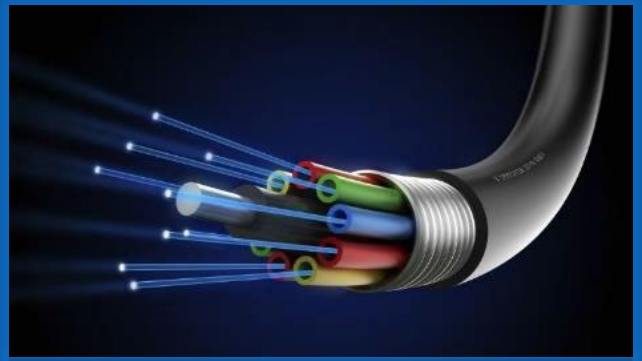
EFFICIENT SEISMIC EXPLORATION AND MONITORING OF GEOTHERMAL RESERVOIRS USING DISTRIBUTED FIBRE OPTIC SENSING ALONG EXISTING TELECOMMUNICATION INFRASTRUCTURE

- THE JOINT PROJECT SENSE -



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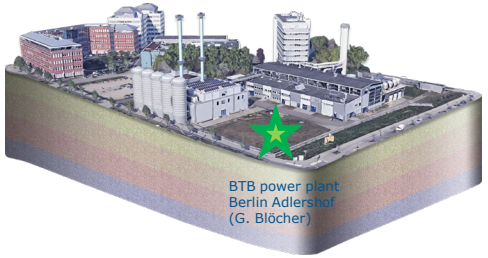
GFZ Helmholtz Centre Potsdam BAM DiGS gempa Federal Ministry for Economic Affairs and Climate Action HELMHOLTZ

Motivation: Efficient settling for geothermal

Supplement seismic exploration in urban areas with DAS

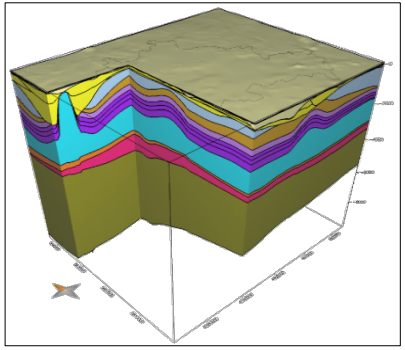
site criteria

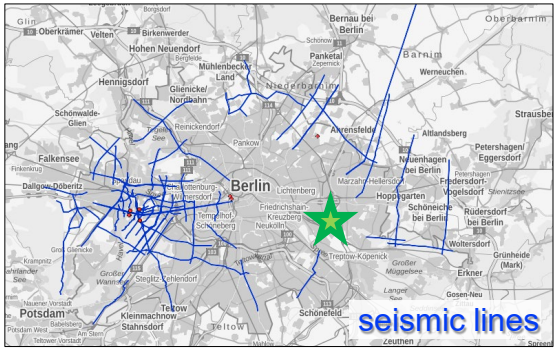
- location close to provider/user
- exploration of favorable geological structures

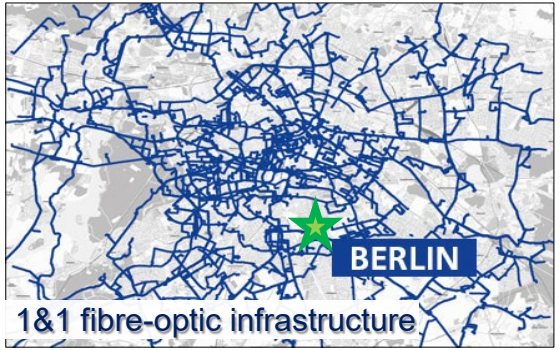


geology underneath Berlin

- shows typical lithology of Northgerman Basin
- contains volcanites for (very) deep geothermal ?







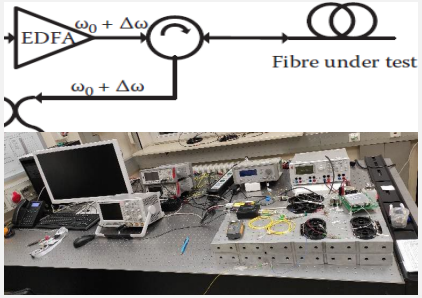
drilling of subsurface is expensive ➡ include DAS in portfolio for exploration and monitoring

The joint project SENSE spans from lab to field

Lab ~ field ~ visualisation ~ processing ~ application

WP1: phase-sensitive COTDR sensor (BAM)

- enhance strain resolution (artificial neuronal net)
- extend high-res survey length (5-10 km)
- real-time strain estimate
- drift compensation laser (λ)



WP2: field-ready demonstrator (DiGOS)

- hardware-software interface
- frontend for data acquisition plus data collection
- interface for data transfer to processing unit

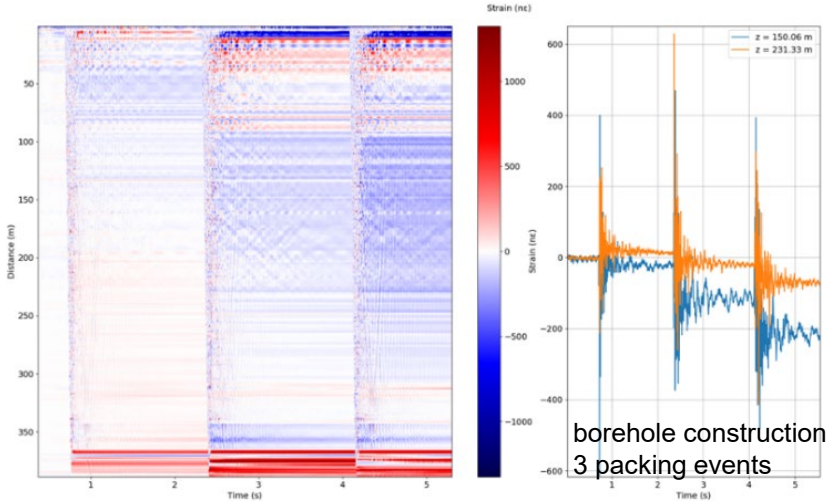
WP3: field, processing (GFZ, gempa)

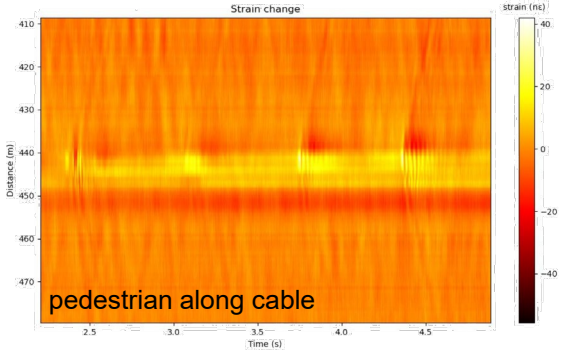
- passive + active seismics
- source localisation + characteristics
- dispersion analysis + model
- array processing

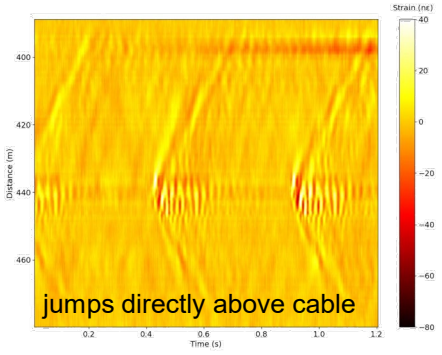
Sensor setup

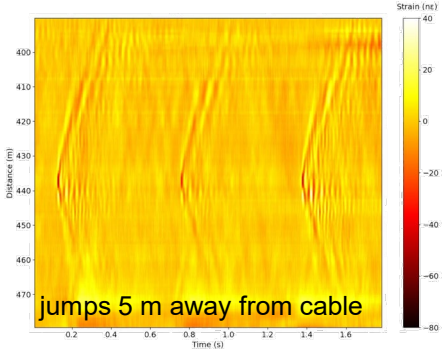
Simple layout and signals tested at Telegrafenberg and Adlershof

- 500 Hz repeating rate
- 20 ns pulse duration (2 m horiz. resolution)









Urban DAS at Berlin Adlershof

Use of dark fibre and city noise

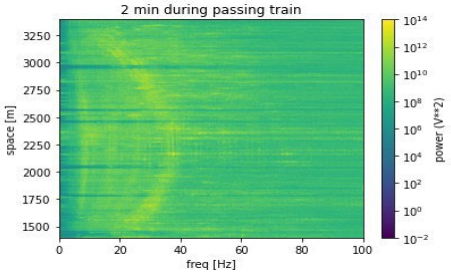
9 km long fibre geo-referenced @ 64 locations

6 km straight line with cars and trains along

3 km fibre probed for 4 weeks @ 8 m spacing

Urban DAS at Berlin Adlershof

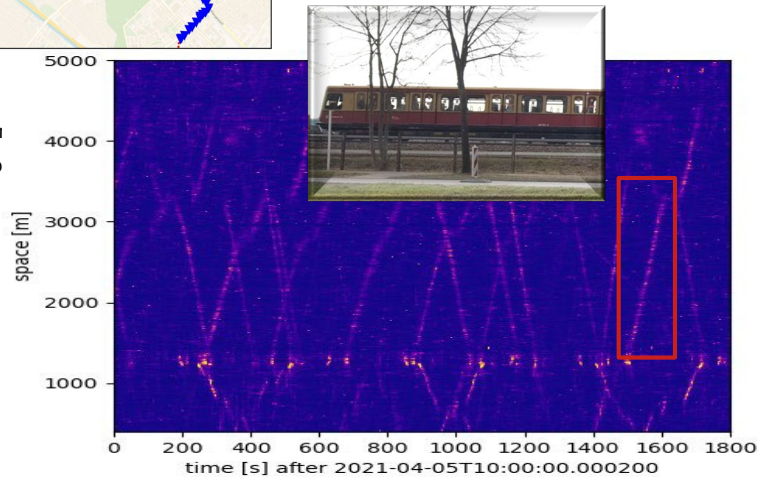
Use of dark fibre and city noise



9 km long fibre

6 km straight li

3 km fibre prob

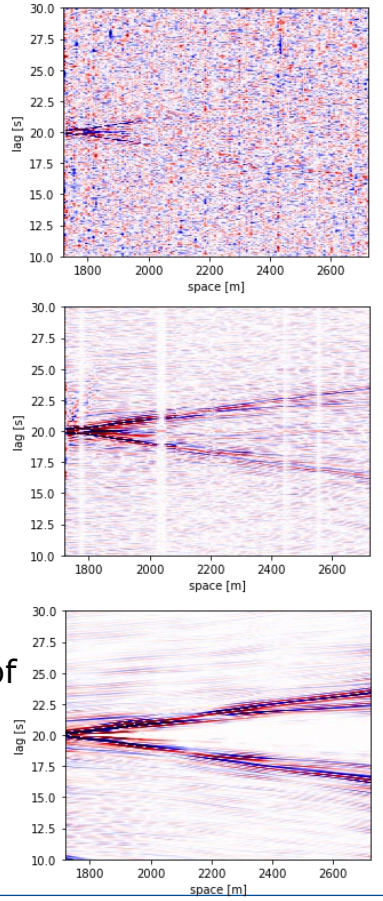


pre-processing (e.g. band pass filtering, tapering,whitening)

remove abnormal traces and poor cross-correlated results

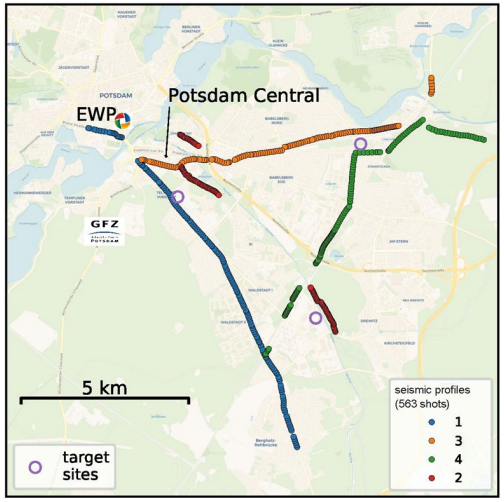
stack virtual shot gather calculated from data gathered during day and night

coherence-based enhancement of virtual shot gather

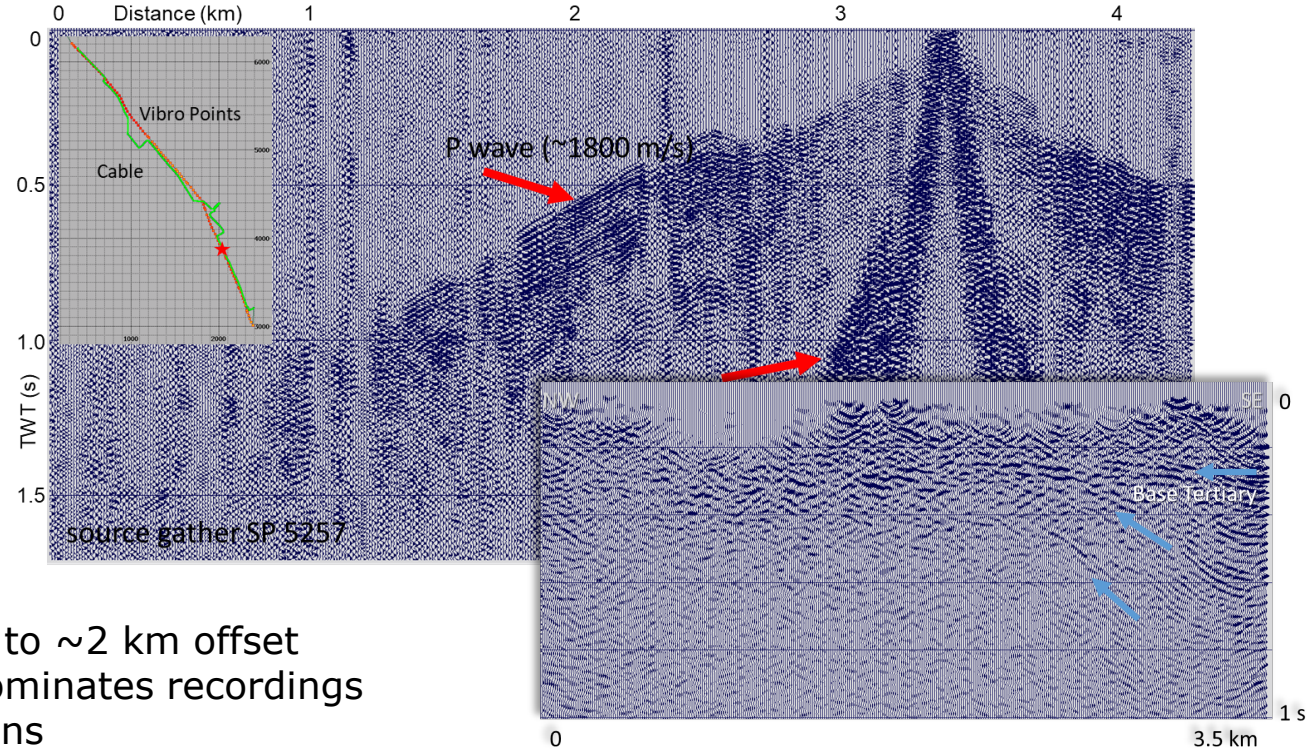


Active seismics with DAS is a challenge

Use of dark fibre and active source



4530 sensor nodes along dark fibre
106 vibro points as active source



- direct P-wave identified up to ~2 km offset
- high-amplitude air wave dominates recordings
- faint indications of reflections

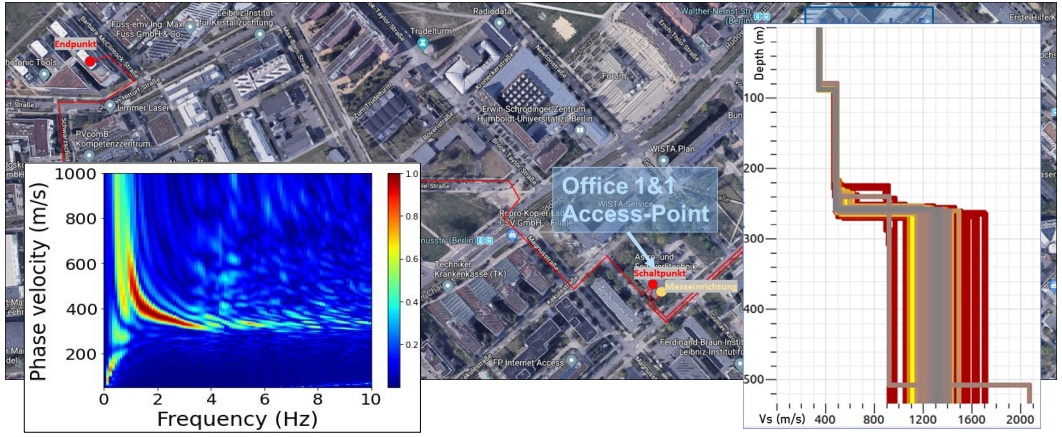
Summary & Outlook

Urban DAS for geothermal

dispersion processing yields vertical shear-wave velocity models (1D, 2D)

comparative field measurements help iterate sensor development

areal and borehole measurements will supplement for full picture



Thank you for your kind attention !