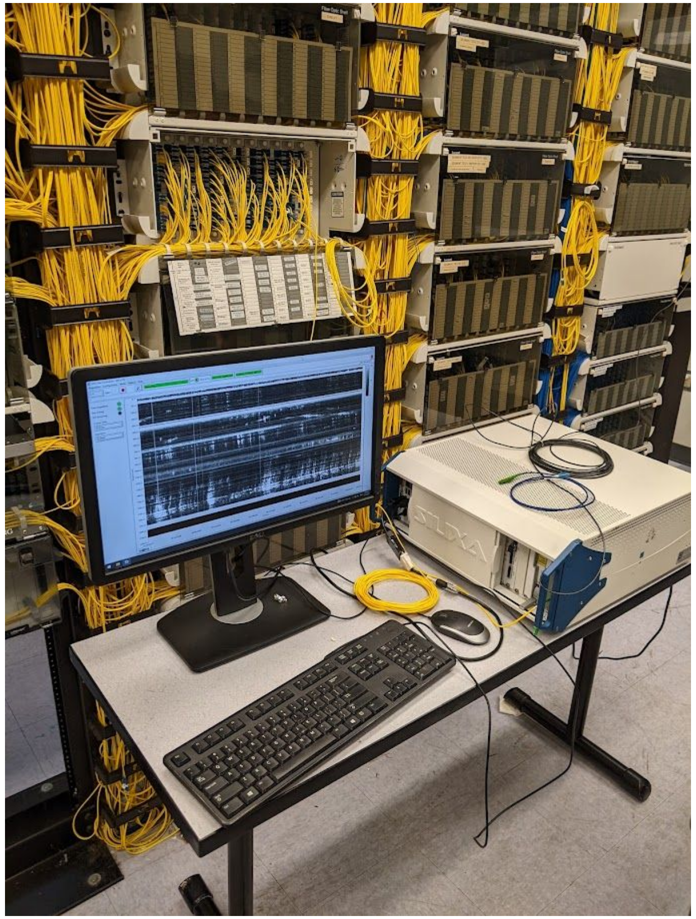
The DAS experiment using MIT telecommunication dark fibers



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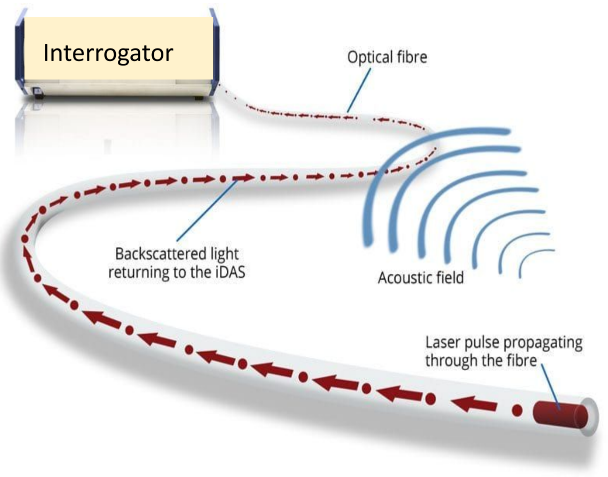
In collaboration with Nori Nakata

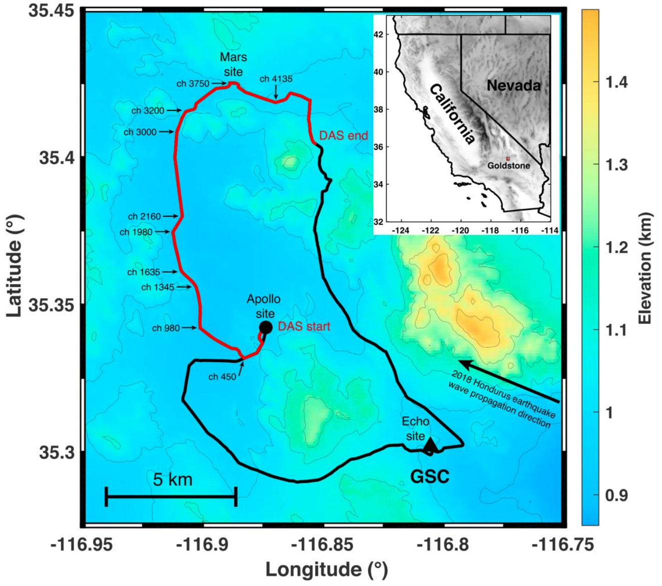
May 25, 2022

Telecom cable as seismic antenna

- With Distributed Acoustic Sensing (DAS): Measuring strain rate.
- Applications
  - Traffic monitoring
  - Shallow/deep structure
  - Subsurface properties changes monitoring



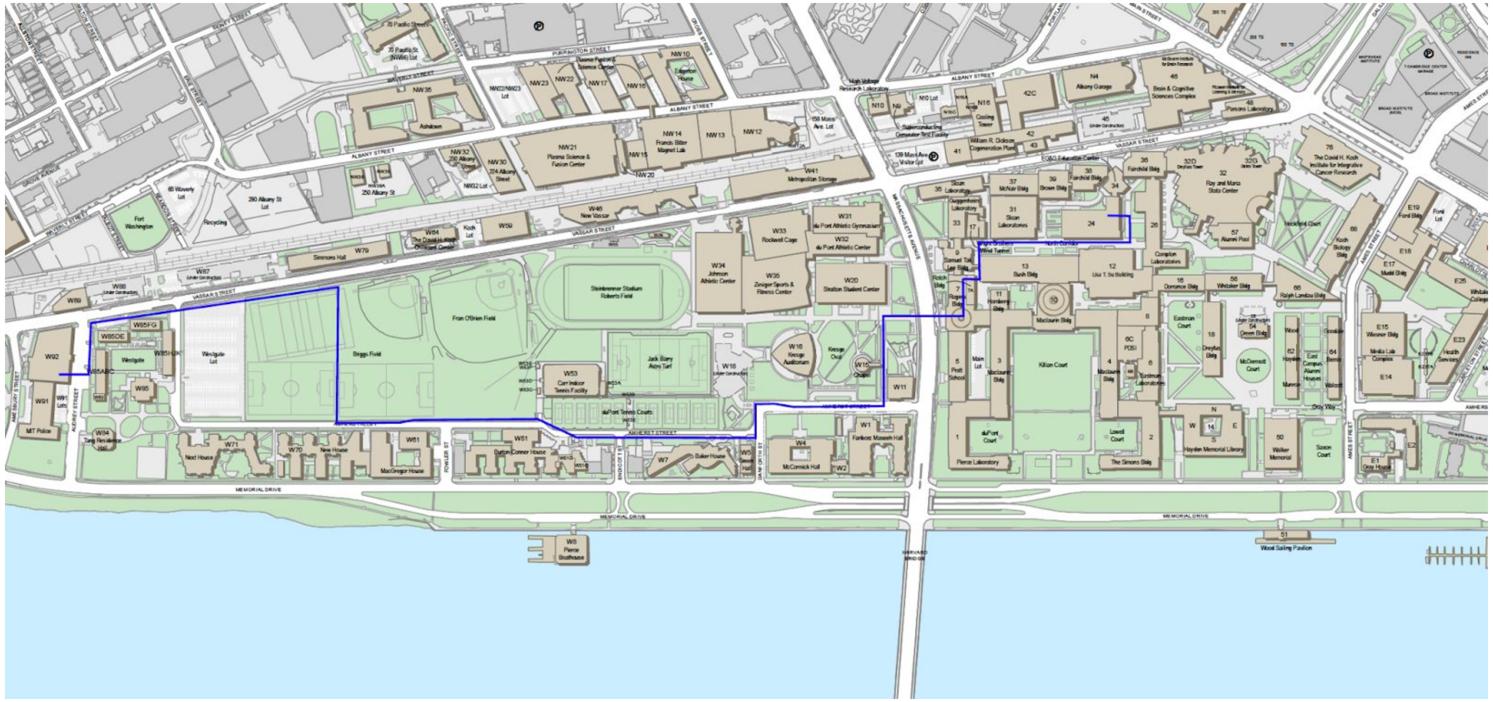
Stanford (Lindsey et al., 2020)



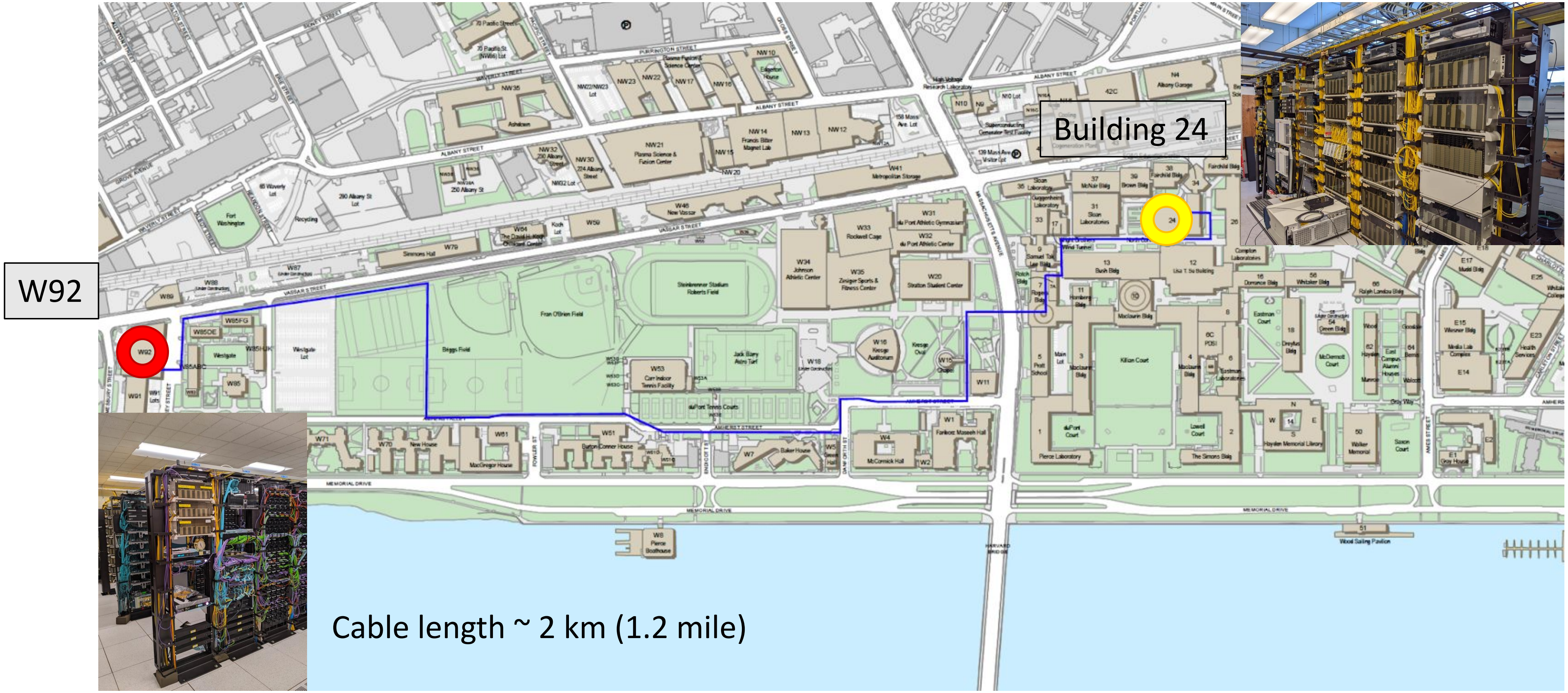
Goldstone (Yu et al., 2019)

Content

- The DAS experiment overview
- What is in the data?
- Bonus:
  - Collocated active geophone survey
- Analysis in progress

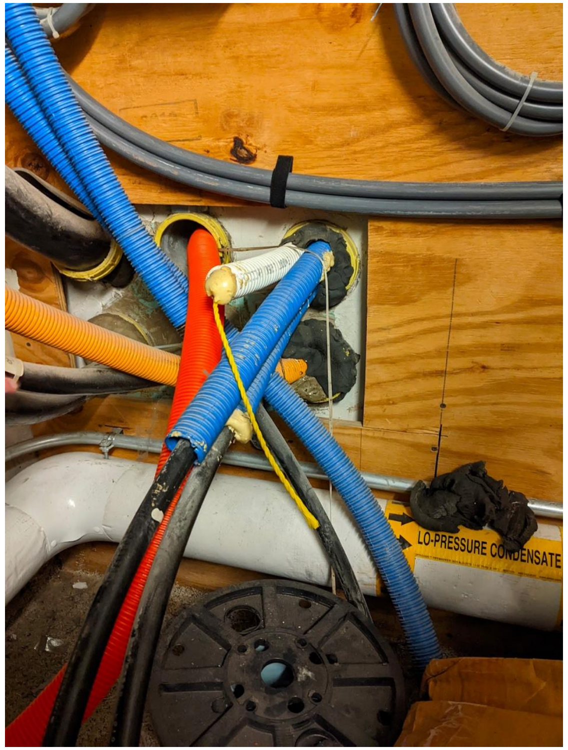


The dark-fiber underlying the MIT campus

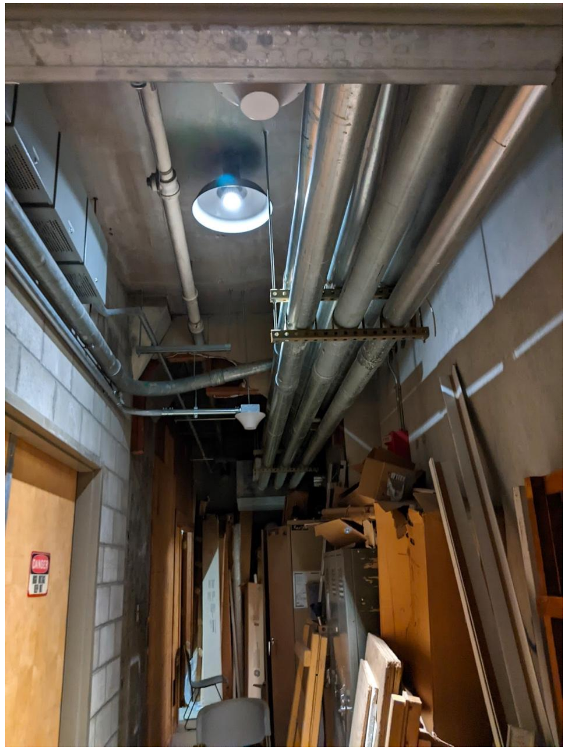


The dark-fiber underlying the MIT campus

Buried at 2—5 ft depth underground



Bundled in layers of polyethylene and plastic tubing.

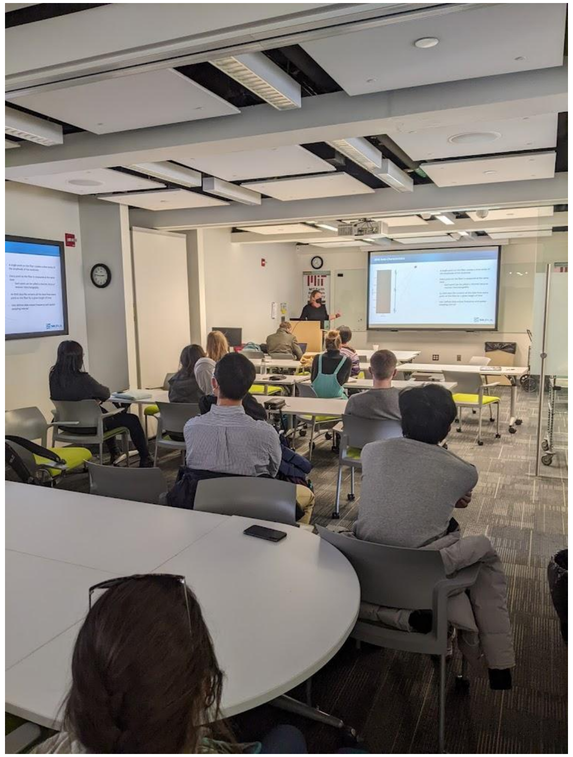


Suspended when passing main buildings.

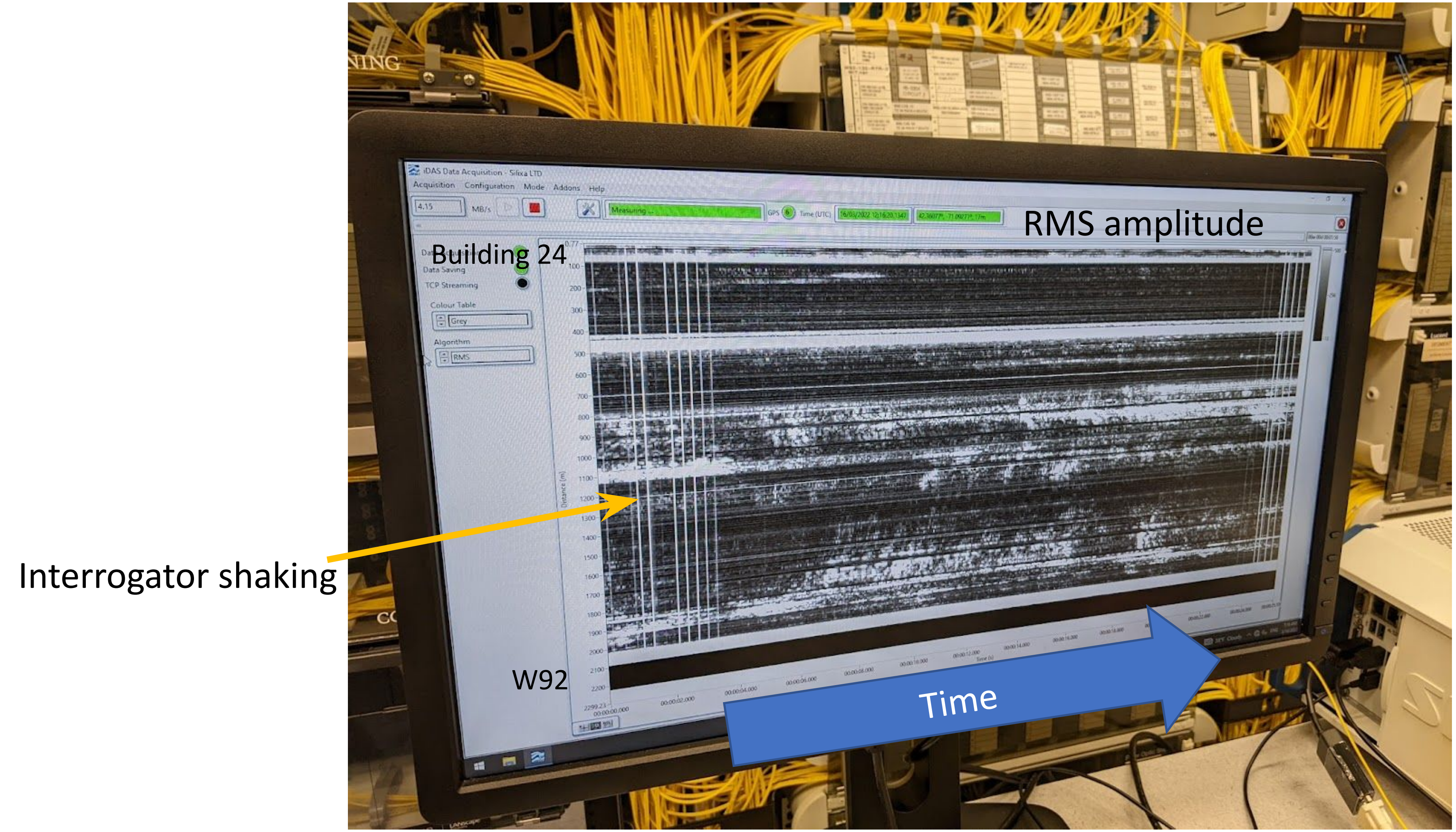
On-campus DAS demonstration with Silixa

1. Tutorial in the classroom.

2. Setting up in the telecommunication cable hub
at Building 24.



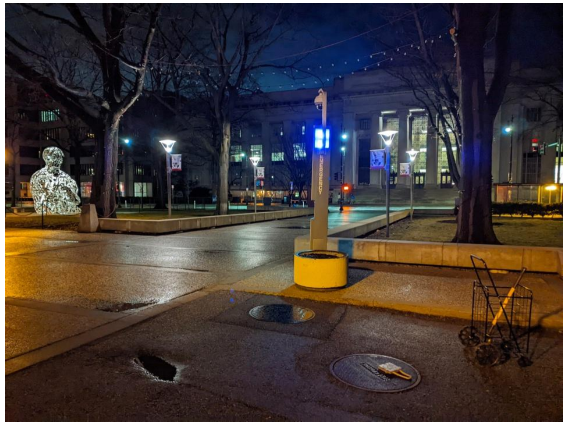
Real-time monitoring

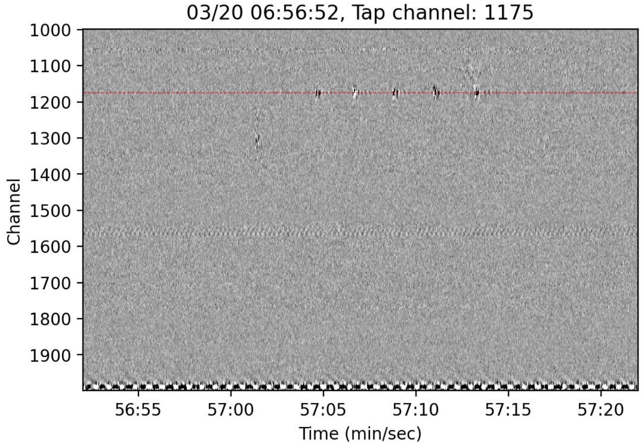


https://drive.google.com/file/d/1L8ZcDbf9SHfFfHENttMm_K92NNT7gVhZ/view

Locate the DAS channels on the map

- Using tap test during quite time

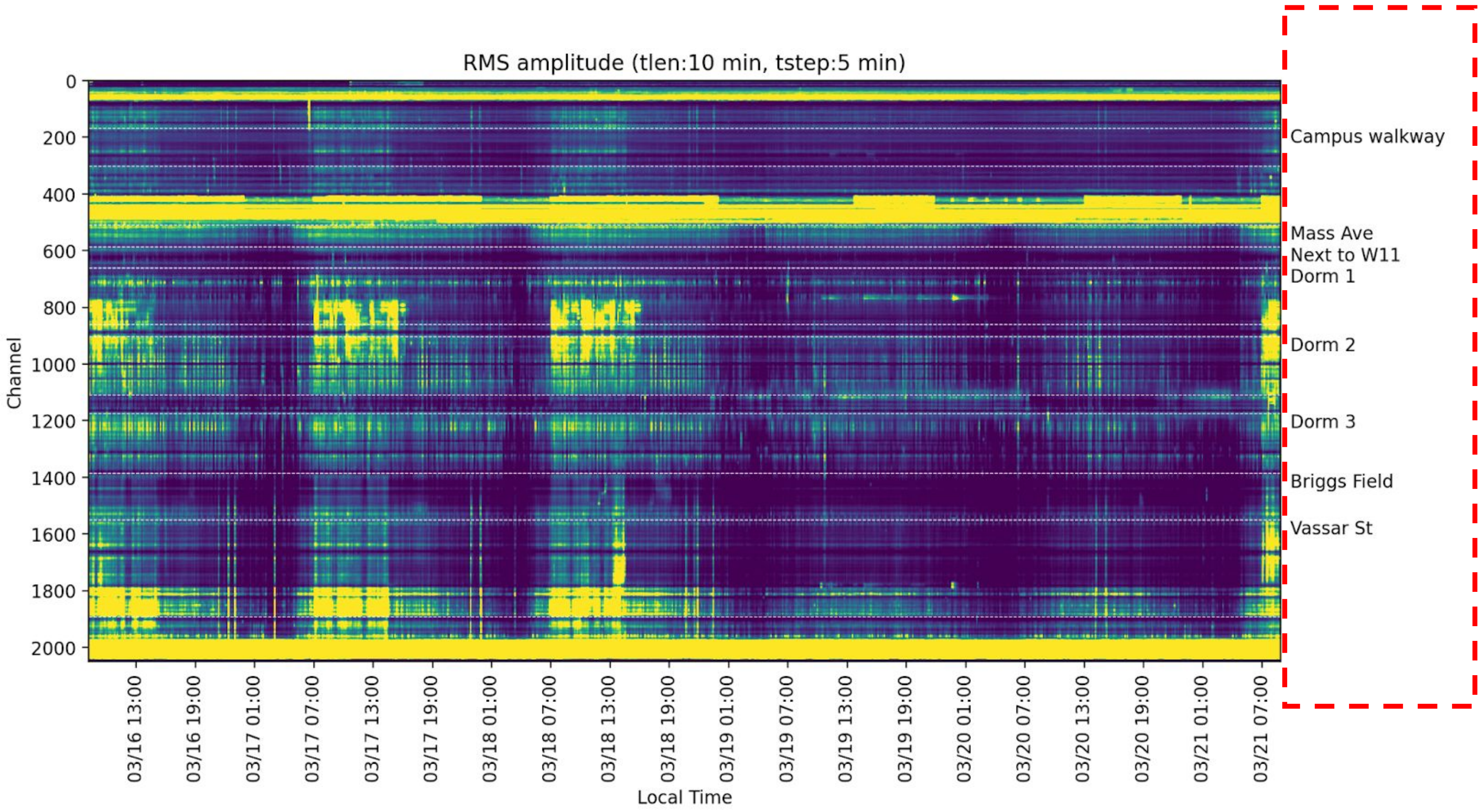




What is in the data?

- 5 days of continuous data

Corresponding locations identified by tap test



What is in the data?

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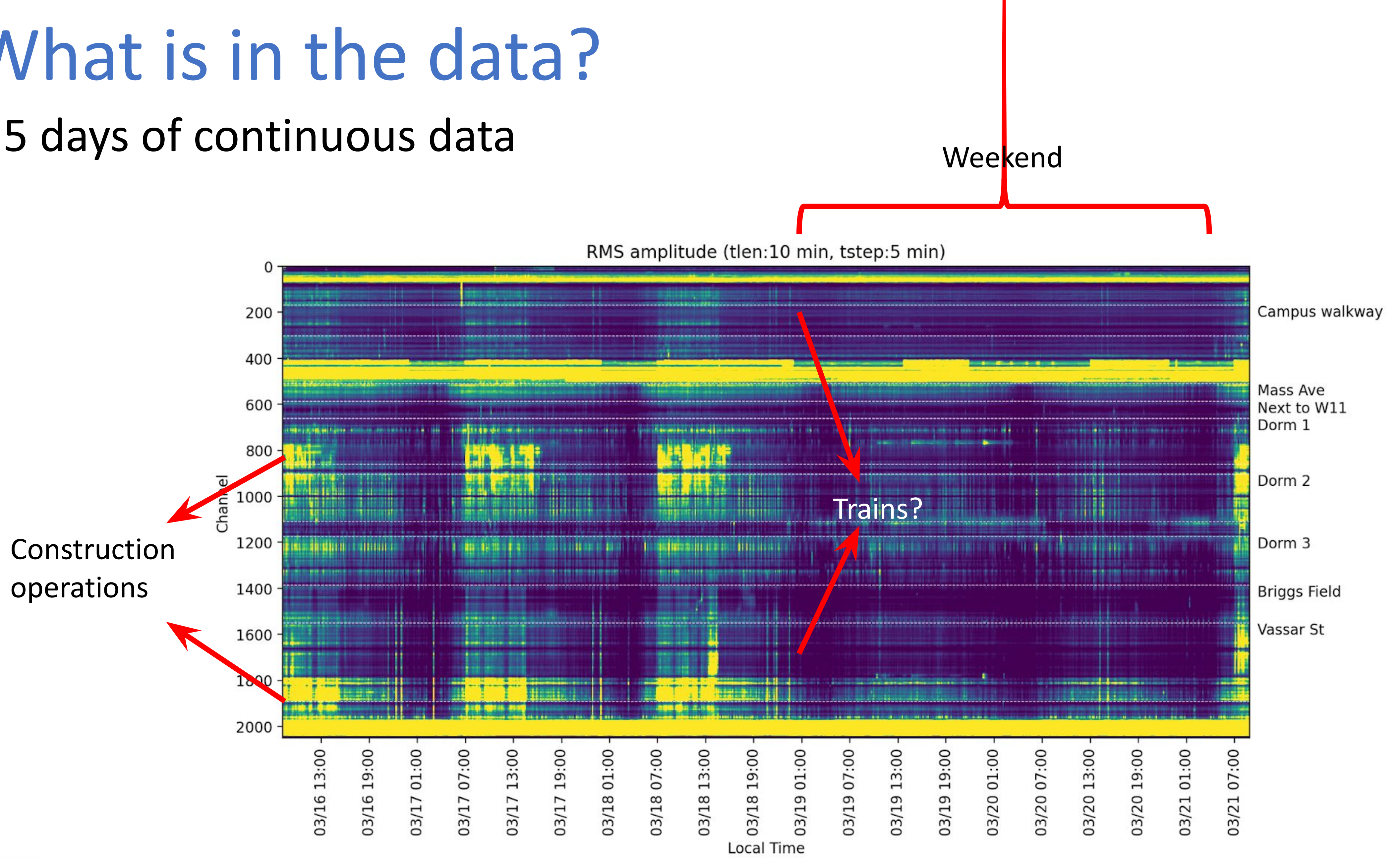
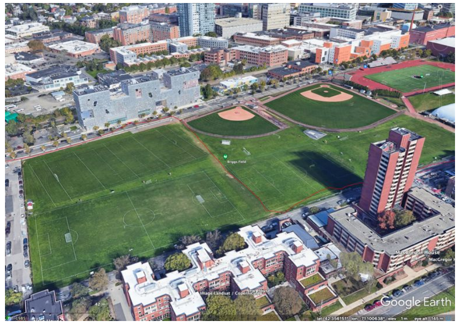


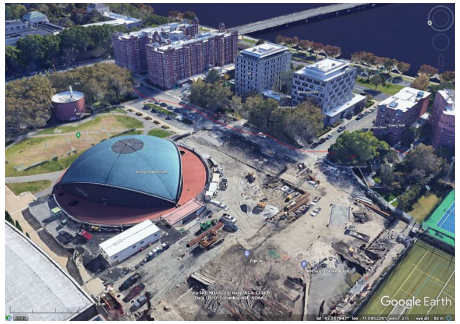
Dominant frequency band 0.1–30 Hz

- Evolution of spectra (strain rate)

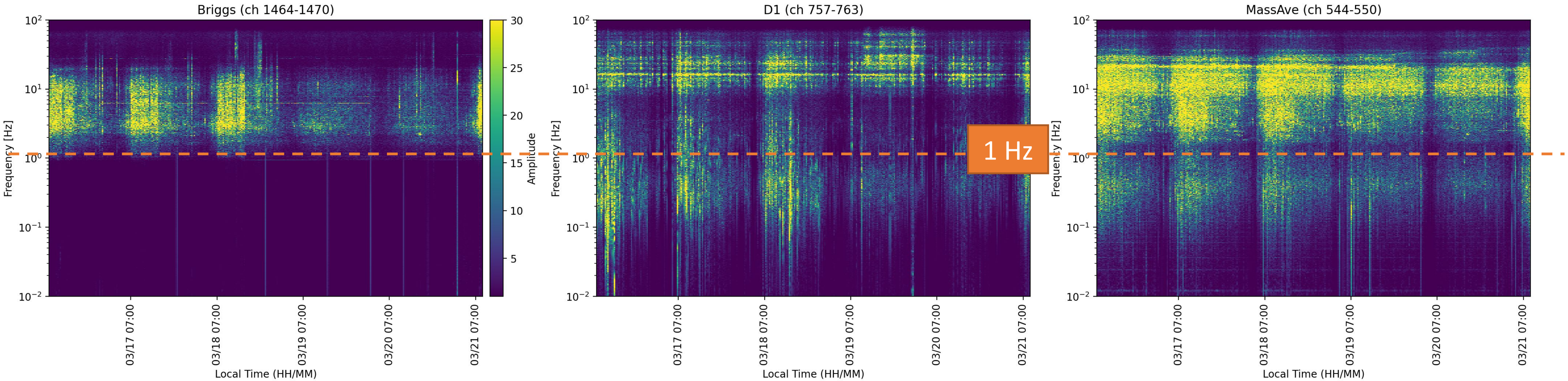
The Briggs Field



The Kresge construction site

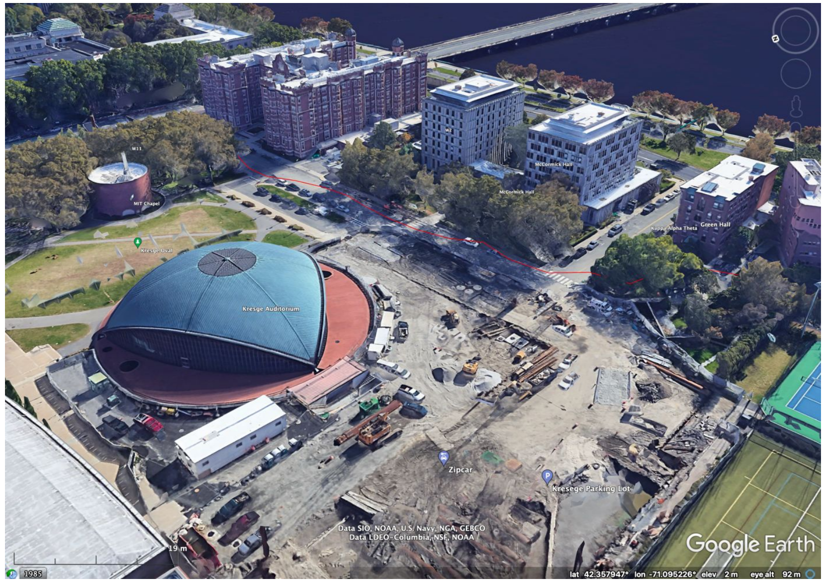


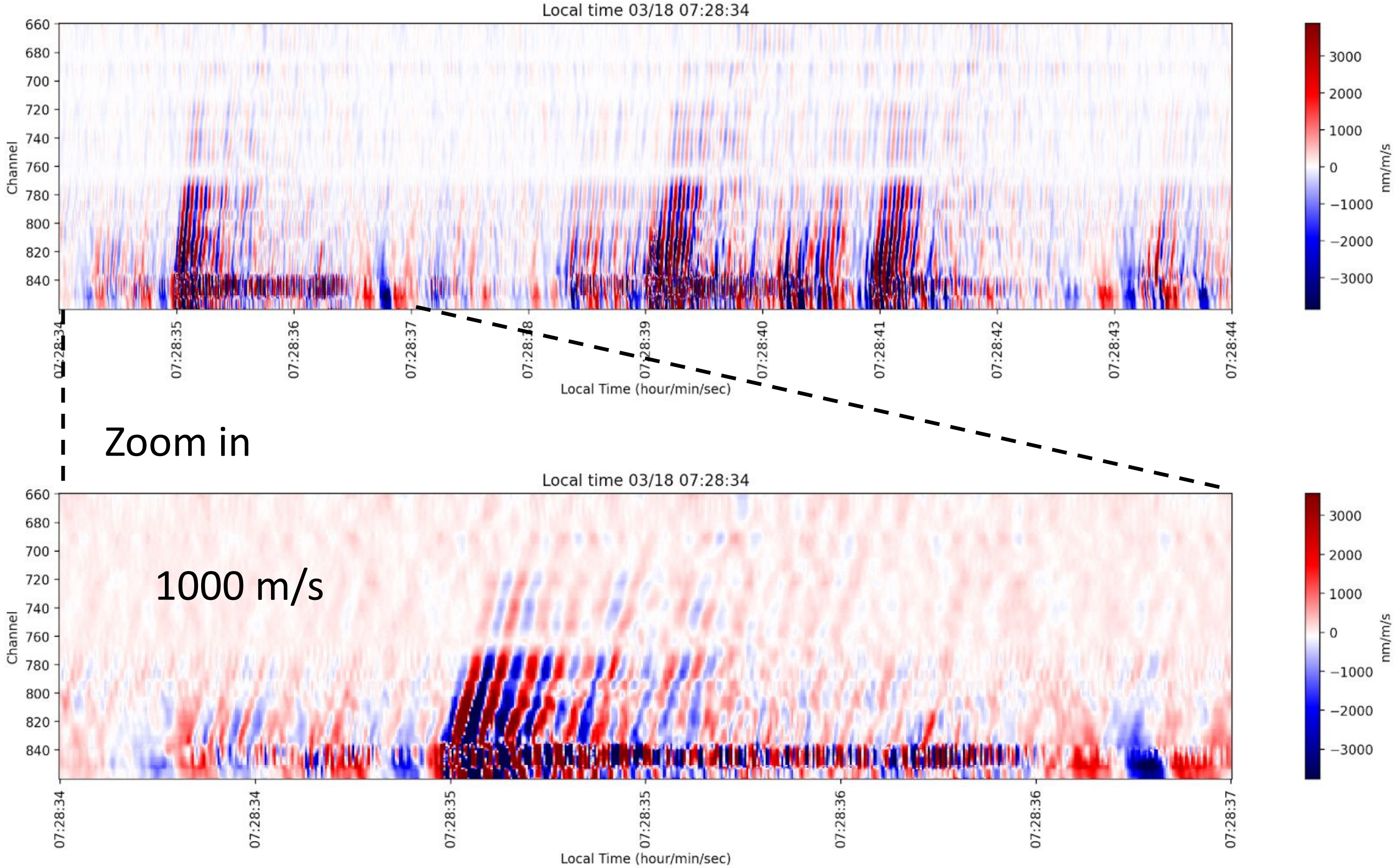
Mass Ave



Construction operations

The Kresge construction site

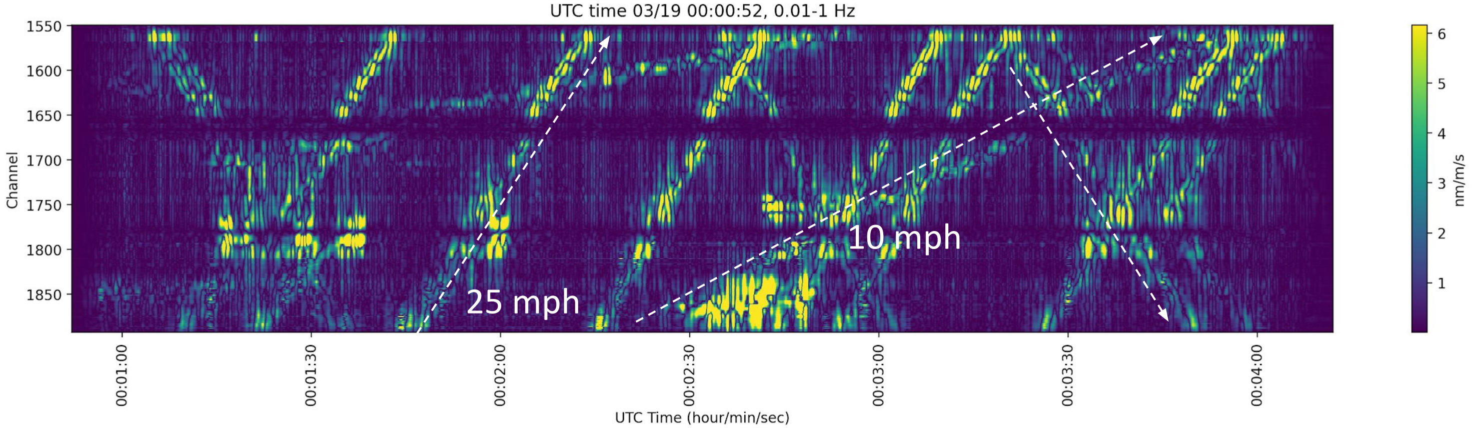




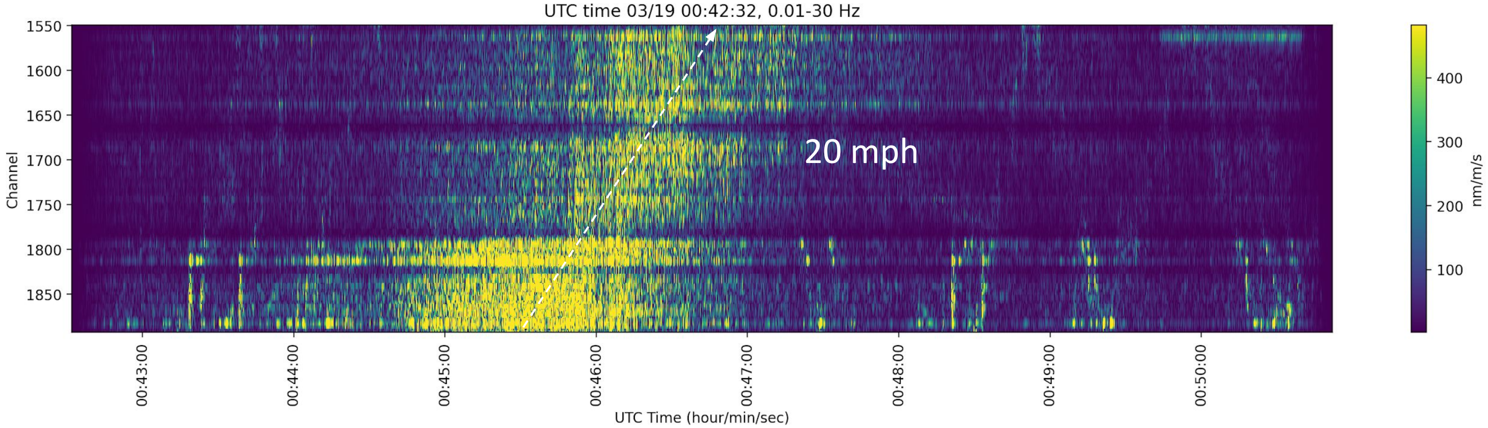
Traffic and train tracks

Vassar Street

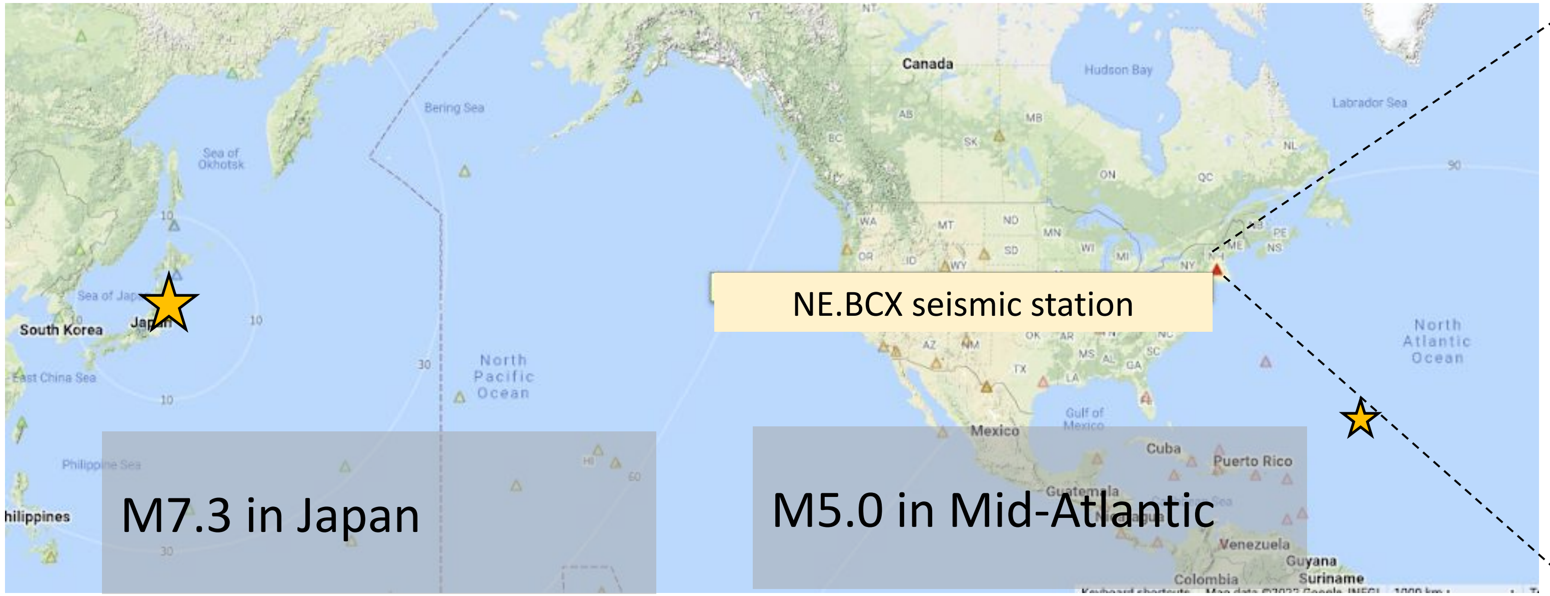
Vehicles along Vassar street



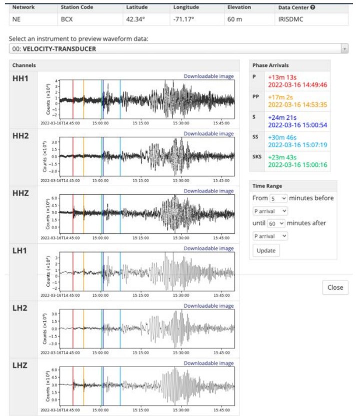
Small train passing

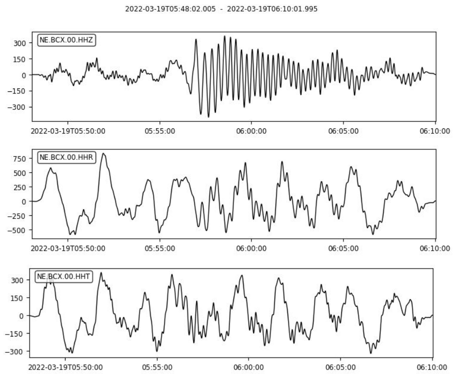


Target teleseismic earthquakes in the 5 days.



BCX seismic station recordings





Earthquake arrived at busy time is buried behind local noises.

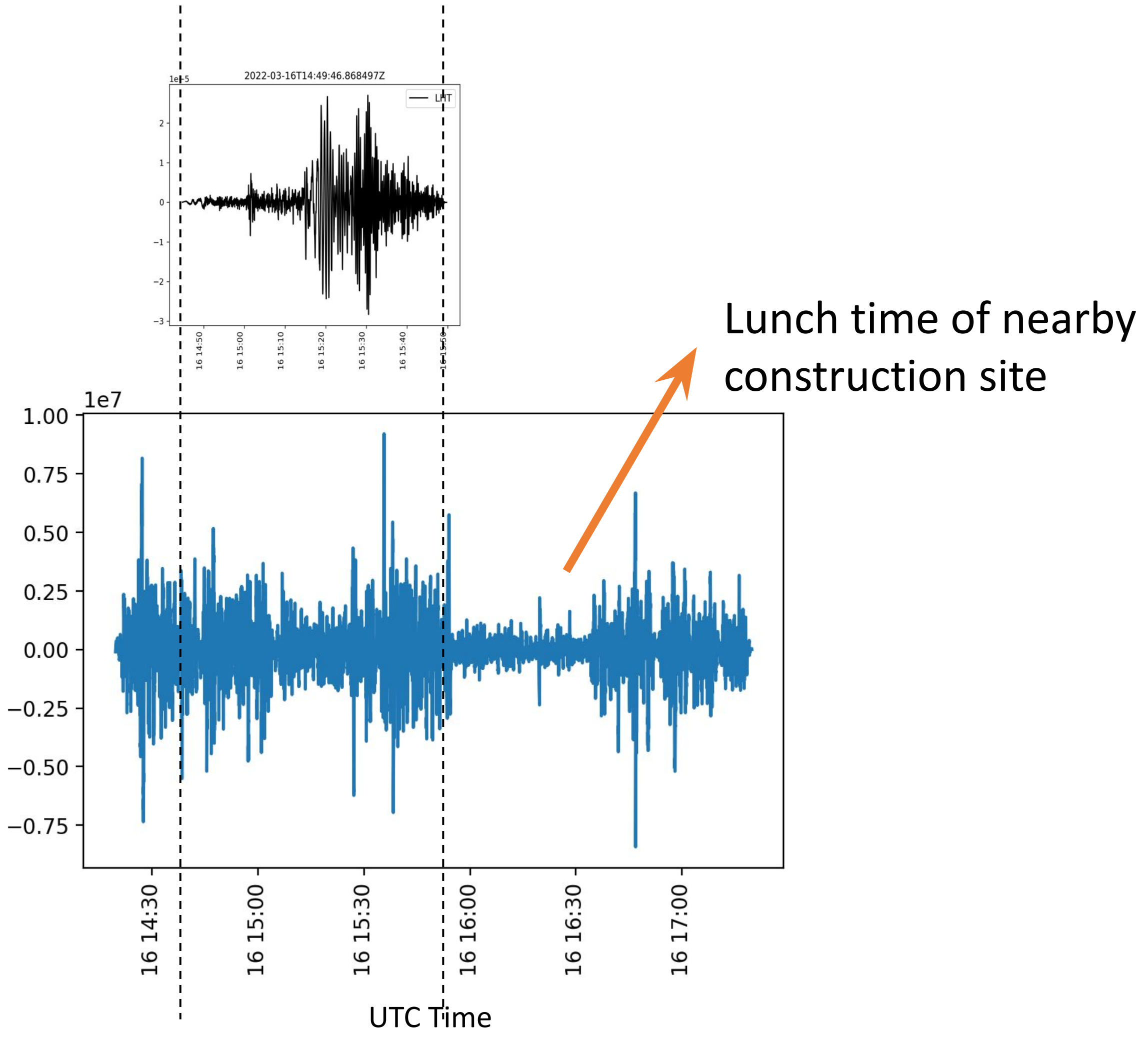
- M 7.3 in Japan

BCX station

Particle Velocity

DAS strain

Stacked along Vassar street (~300 channels)

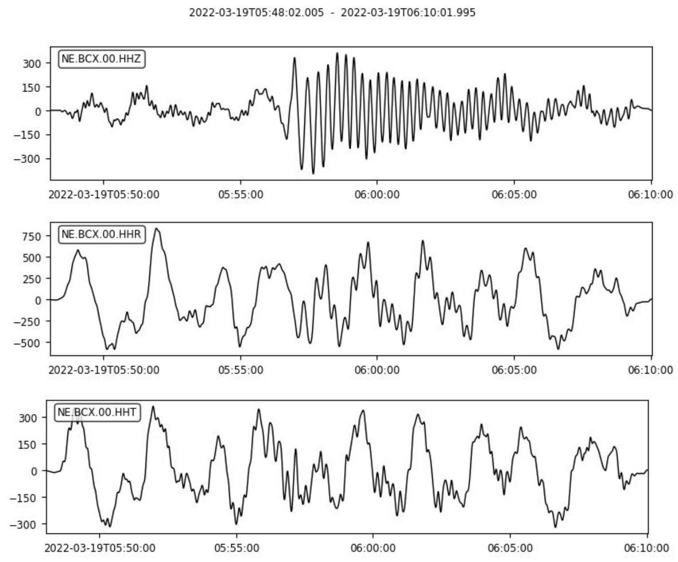


Earthquake arrived at quite time have better chance to be identified.

- M5.0 Mid-Atlantic

BCX station

Particle Velocity

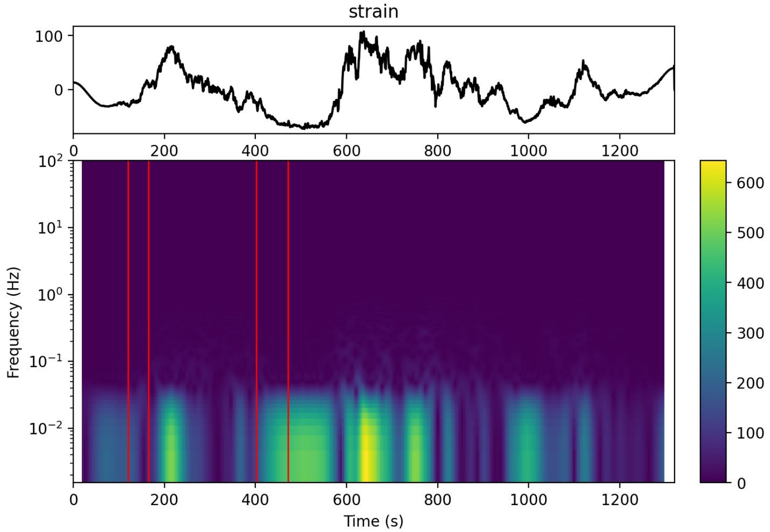


DAS strain

Stacked all NE-SW oriented cable sections (~1400 channels)

Phase-weighted stacking

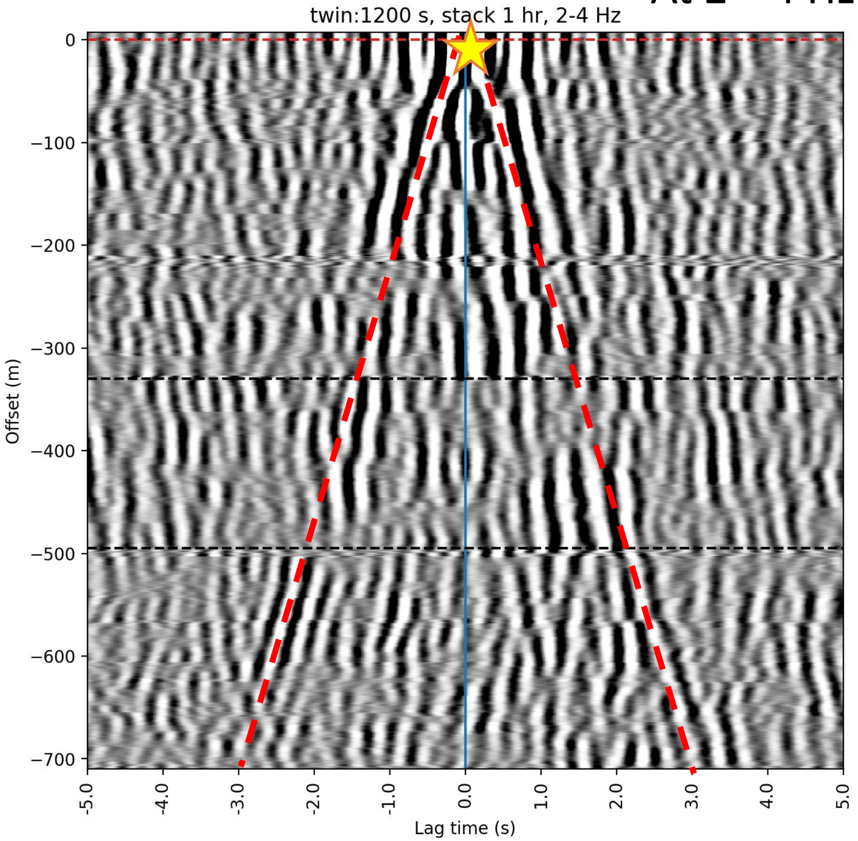
$$s(t) = \frac{1}{N}\sum_{j=1}^{N} x(t)_j c(t)^{\nu}$$



Potential for subsurface monitoring

- Using interferometry to extract signals.

230 m/s
At 2—4 Hz



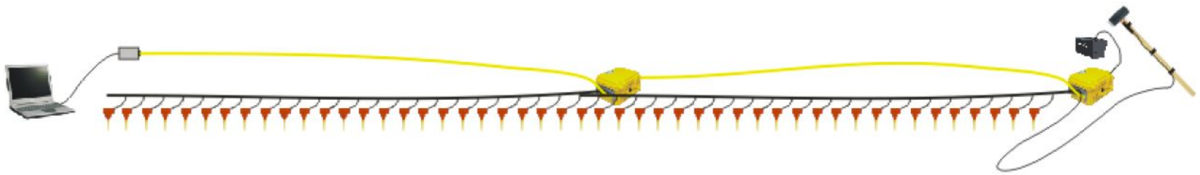
Vassar st

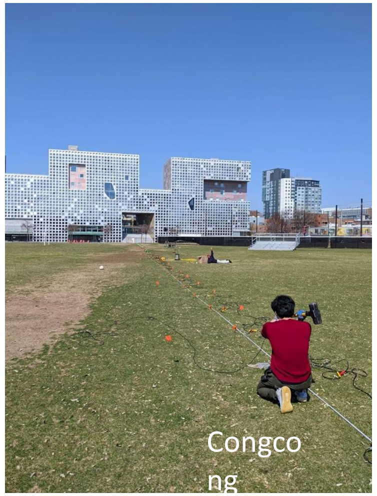
Briggs field

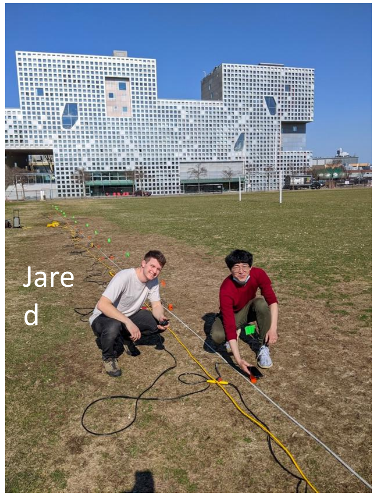
Dorm 3

Collect co-located active geophone data

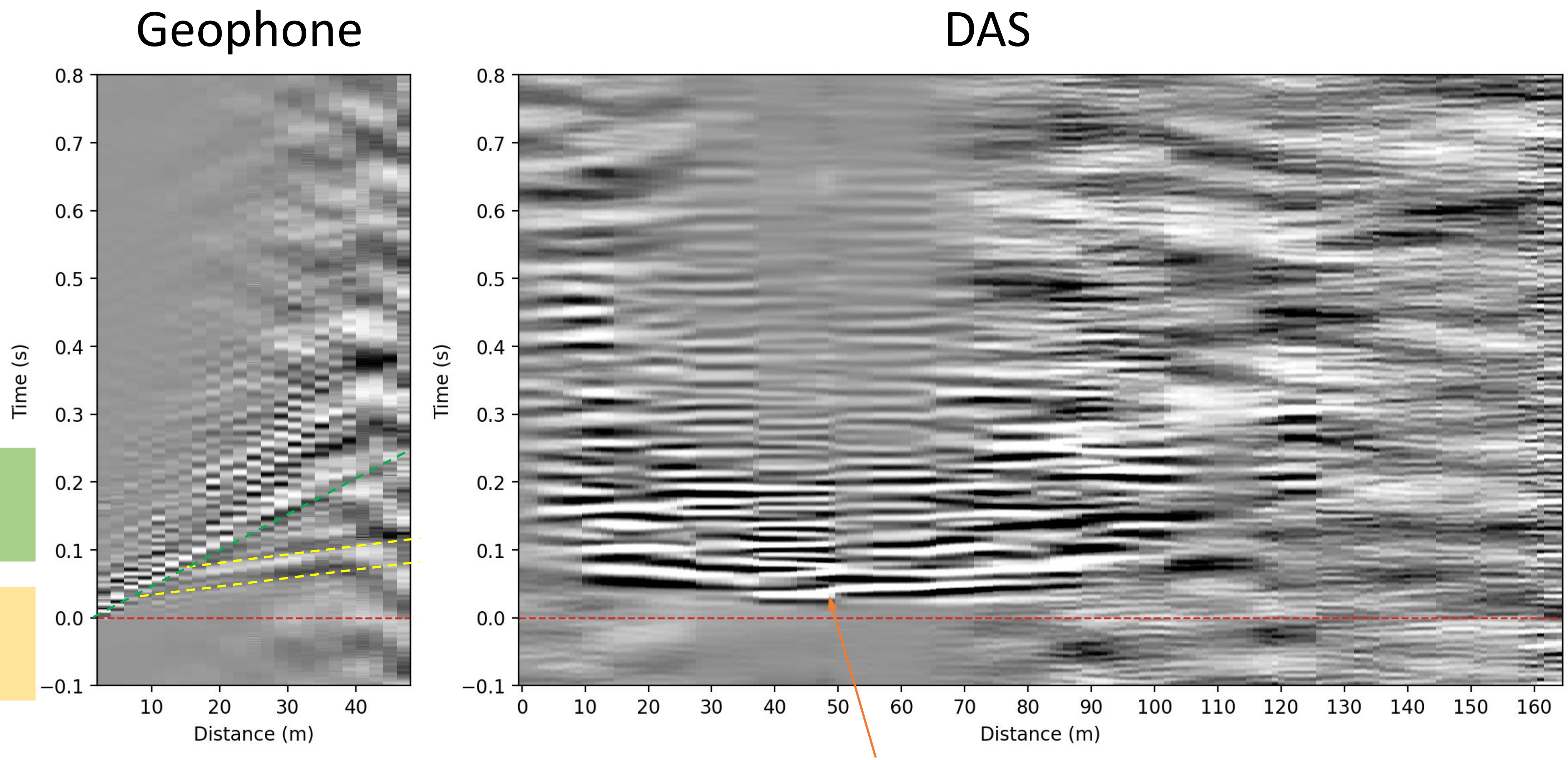
- Hammer source







Geophone data can be used as constraints



Surface wave
200 m/s

Shear wave?
900 m/s

Agree with previous DAS observations.

Vibration due to poor coupling.

Analysis in progress

- Receiver functions
  - Explore different processing strategy to enhance teleseismic signal.

- Subsurface properties analyzing/monitoring
  - Using local sources (source distributions?).
  - Compare with geophone data.

- Traffic monitoring.

Acknowledgements to

- **John Morgante** for selecting cable, providing map, and showing me the exact cable locations; also **Errol Morrison** for accessing the cable.
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