AstroCeNT

Analysis of the connection between the seismic sensor and earth in seismic measurements

Research group 2: Seismic Sensors

http://www.astrocent.camk.edu.pl

Project is implemented as part of the International Research Agendas programme of the Foundation for Polish Science, supported by the European Regional Development.

Comparison of seismic sensors

Commercial seismic sensors placed on the ground

Adjustable stands

http://seismoschoolnp.org/?page_id=572

https://www.gfz-potsdam.de

http://www.terrindo.co.id/index.php/products/details/trillium-compact

Comparison of seismic sensors

Commercial seismic sensors driven into the ground

- With skewer

https://www.sercel.com

http://www.innoseis.com/

Comparison of seismic sensors

Commercial seismic sensors driven into the ground

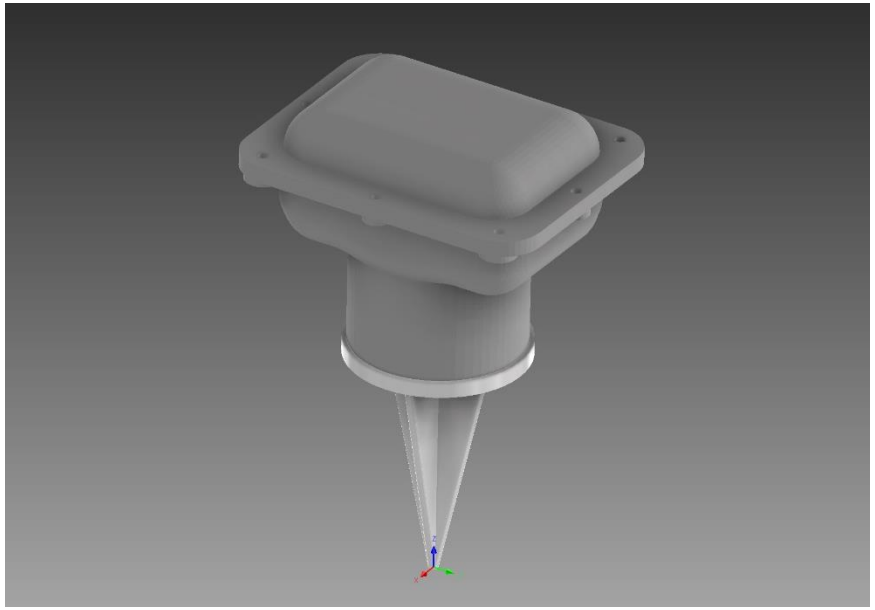
- With anchor

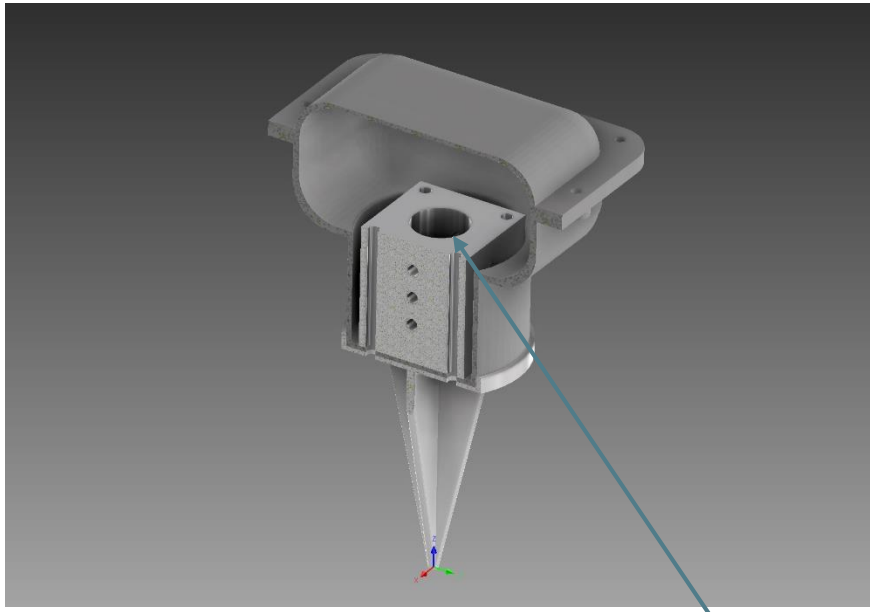
https://smartsolo.com/

https://www.sercel.com

Comparison of seismic sensors

Our seismic sensor





- Driven into the ground
- Sensor holder, housing, base ended with anchor
- Everything screwed together
- Material: unknown yet

Sensor

European Funds Smart Growth
Republic of Poland
FNP Foundation for Polish Science
European Union European Regional Development Fund
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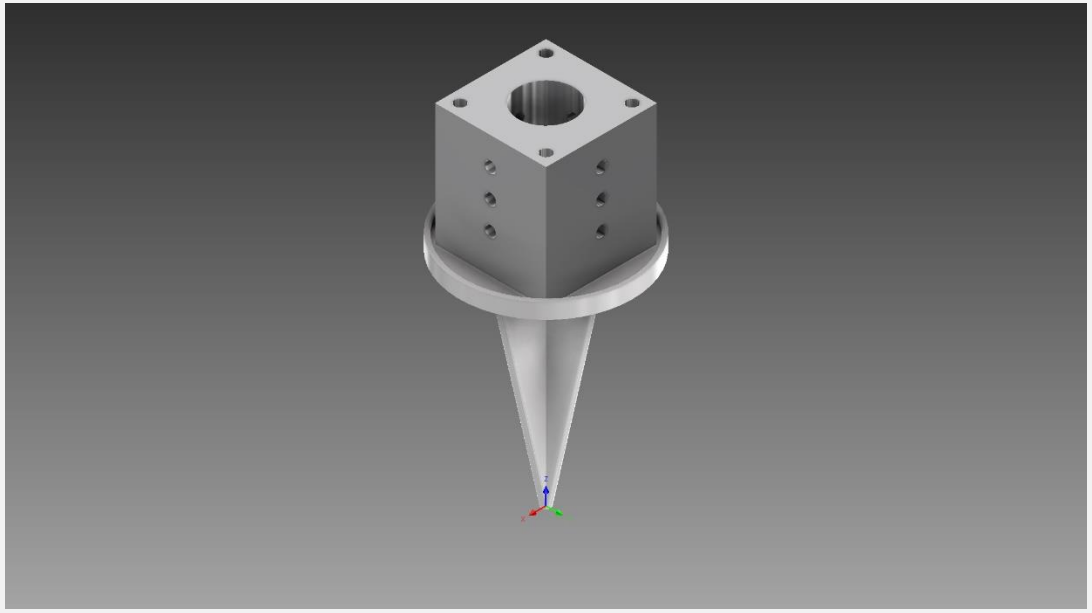
Research problem

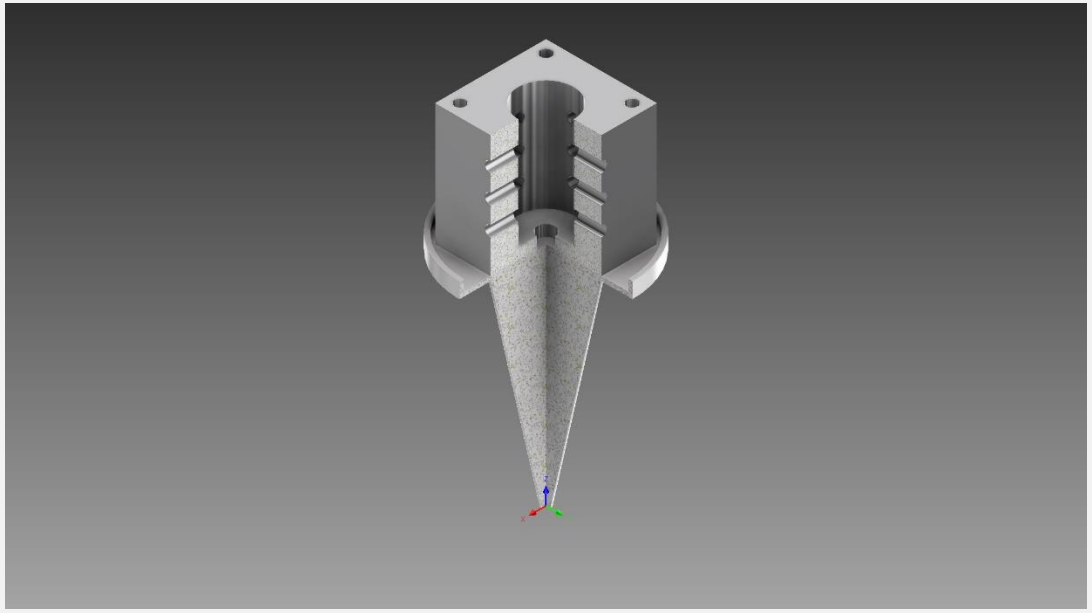
Our goal is to optimize the connection between the sensor and the ground to better measure seismic waves.

As part of the research, we want to answer the following questions:

1. What should be the length, width and shape of the sensor base and how deep should it be driven into the ground,
2. Whether the mounting receives vibrations symmetrically on all sides.

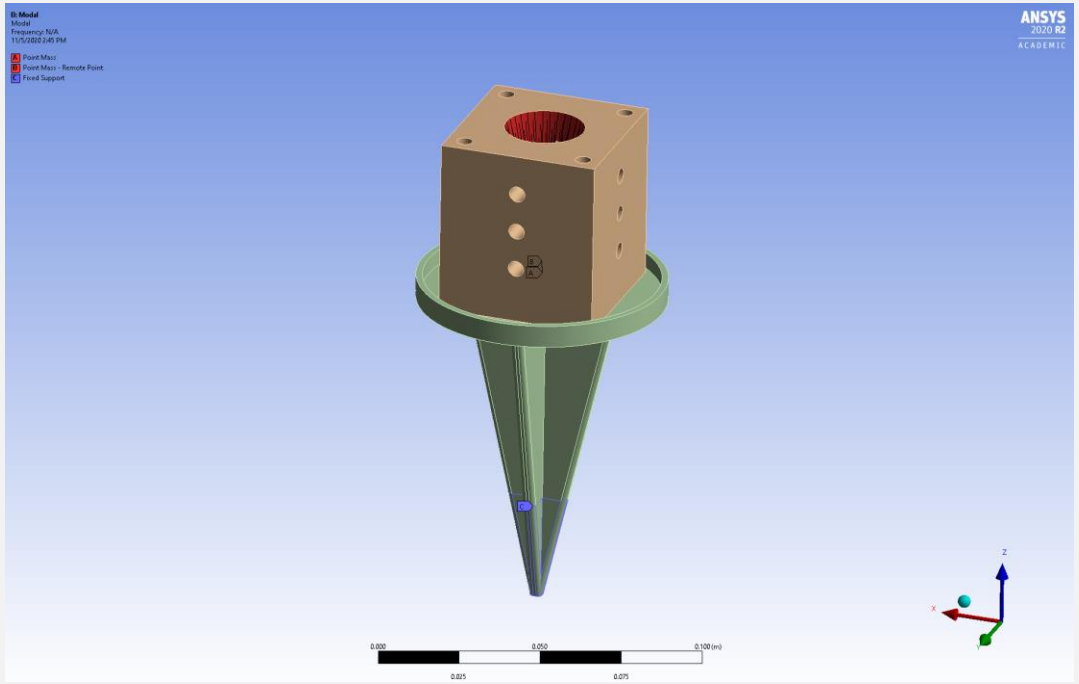
The problem we are considering has been considered technically so far, but has not been investigated yet.

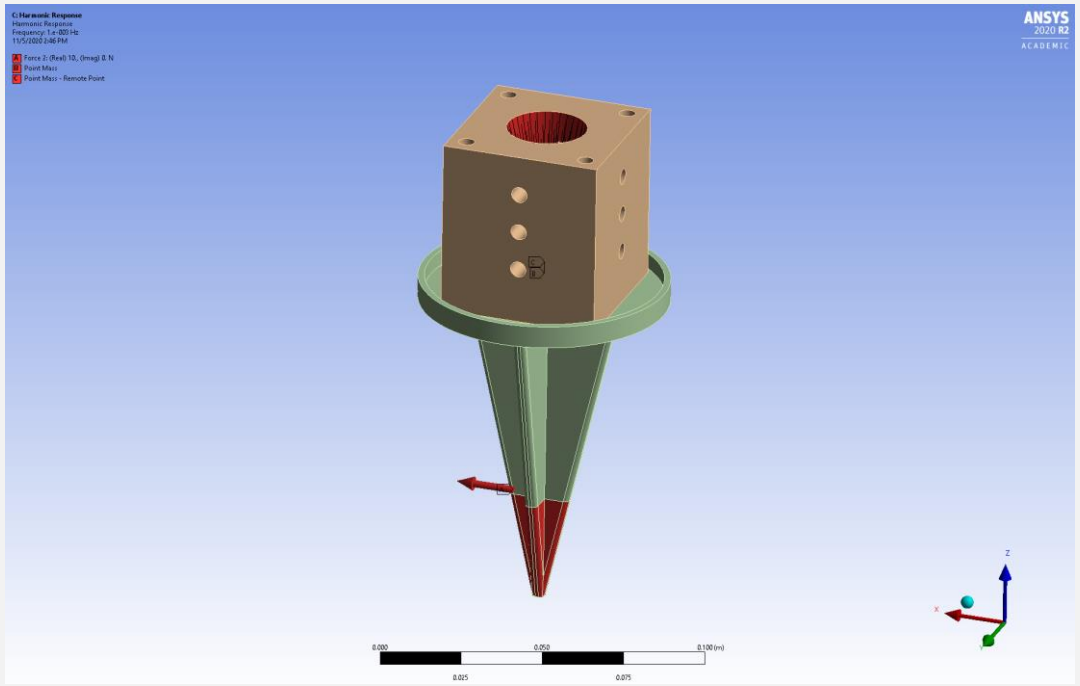




Mounting geometry

- CAD model of our idea for the holder and sensor base
- Our mount consists of a sensor holder and a base. They are bolted together.
- The holder for the sensor is in the form of a cube with dimensions of 50/50/55 mm, and the base is in the form of a plate with a diameter of 78 mm, ended with an anchor. Currently both of these elements are made of aluminum.
- The assembly is symmetrical about the ZX and ZY plane.





Ansys simulation

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Simulation parameters and assumed variants:

- Analysis frequency range from 0.1 Hz to 1 kHz
- Rotation of the seismometer from 0 to 45 degrees
- Digging depth 33.3 mm, 66.6 mm, 90.0mm (all ~10 cm)
- Sensor with fixed support at the base
- Simulated force 10 N
- Recorded simulated response by the sensor

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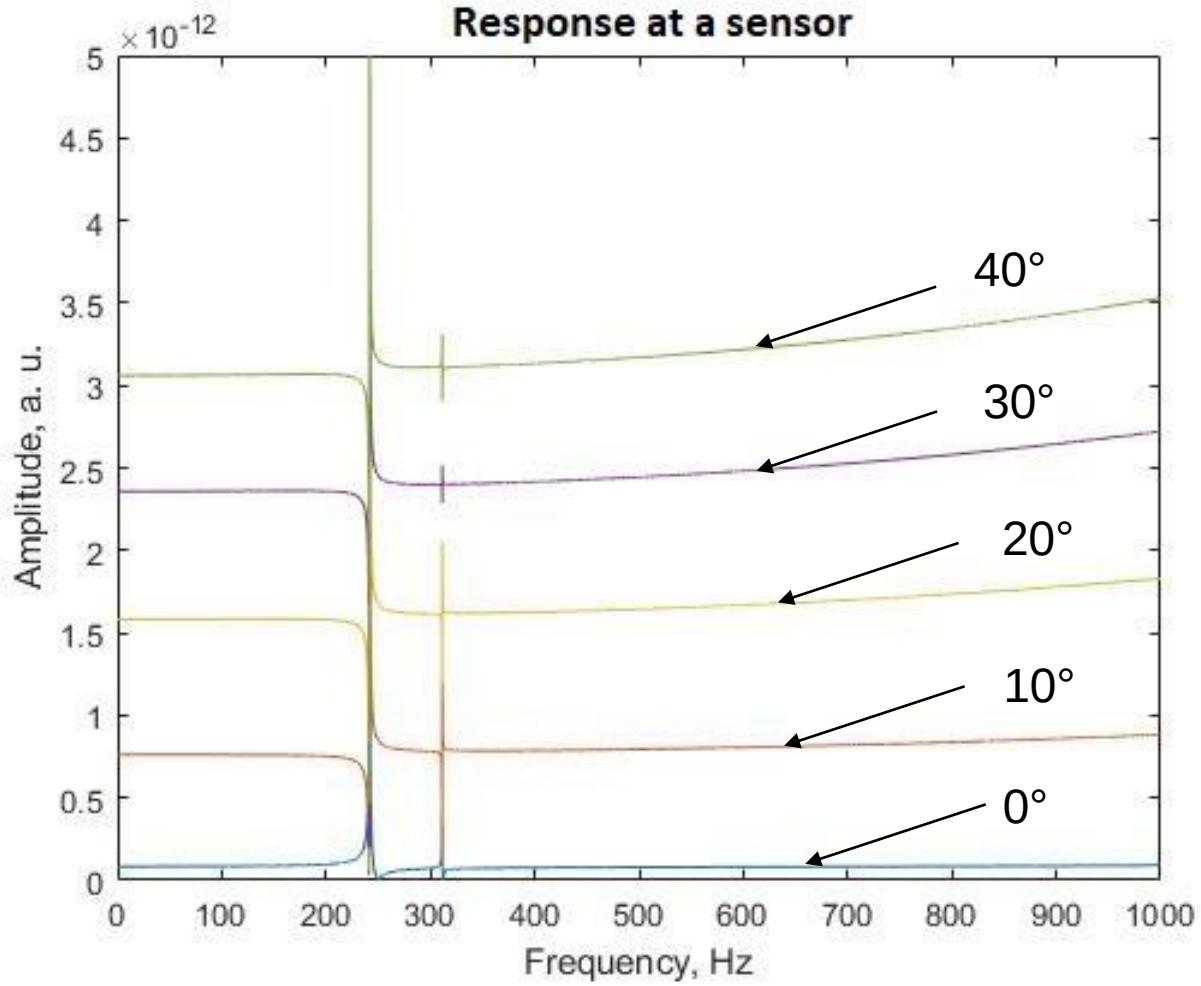
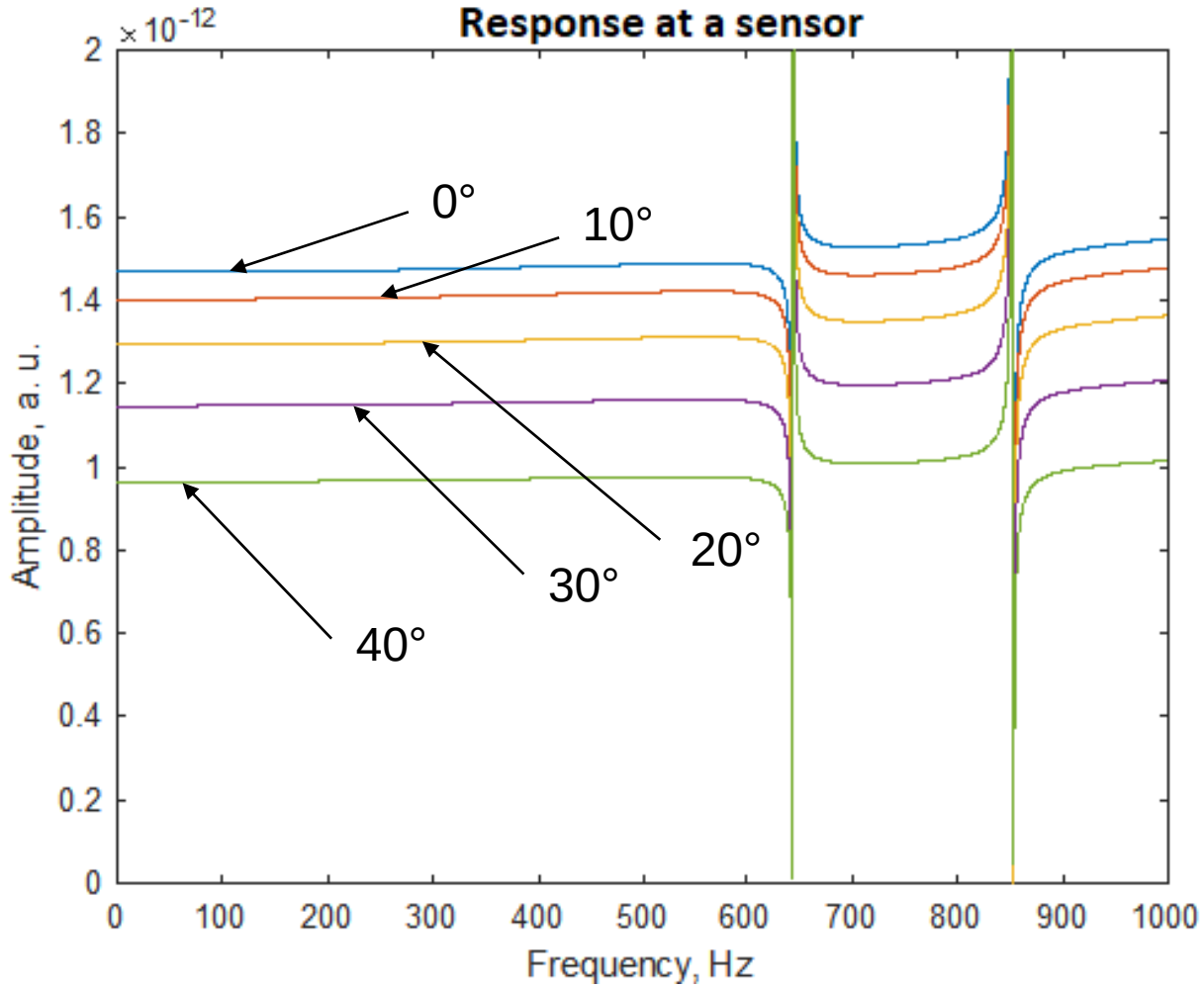
Simulation results - depth 33.3 mm



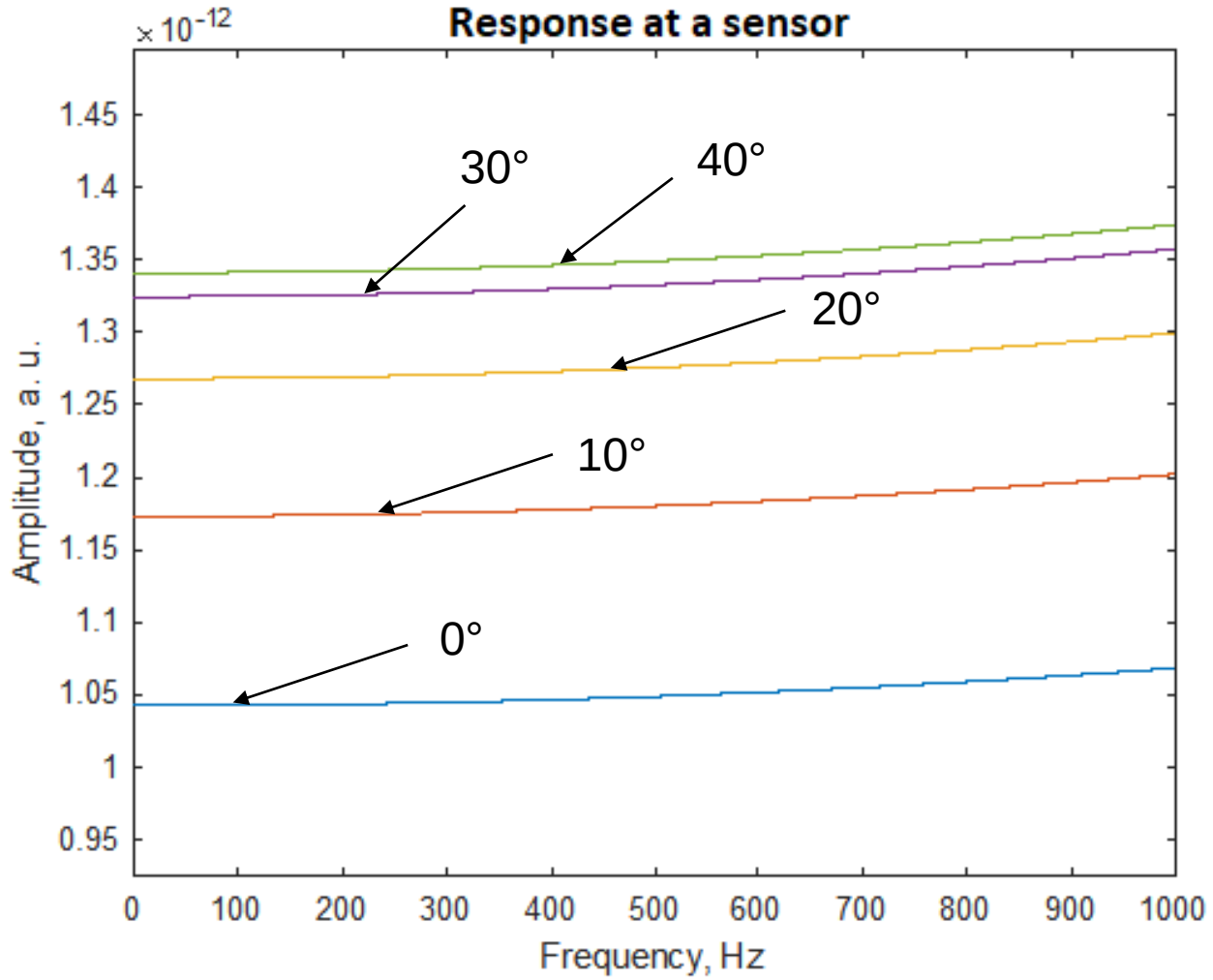
- resonant shape response
- amplitude changing depending on the angle (from 0.1 to 200 Hz)
- for about 240 Hz high resonant amplitude

Simulation results - depth 66.6 mm



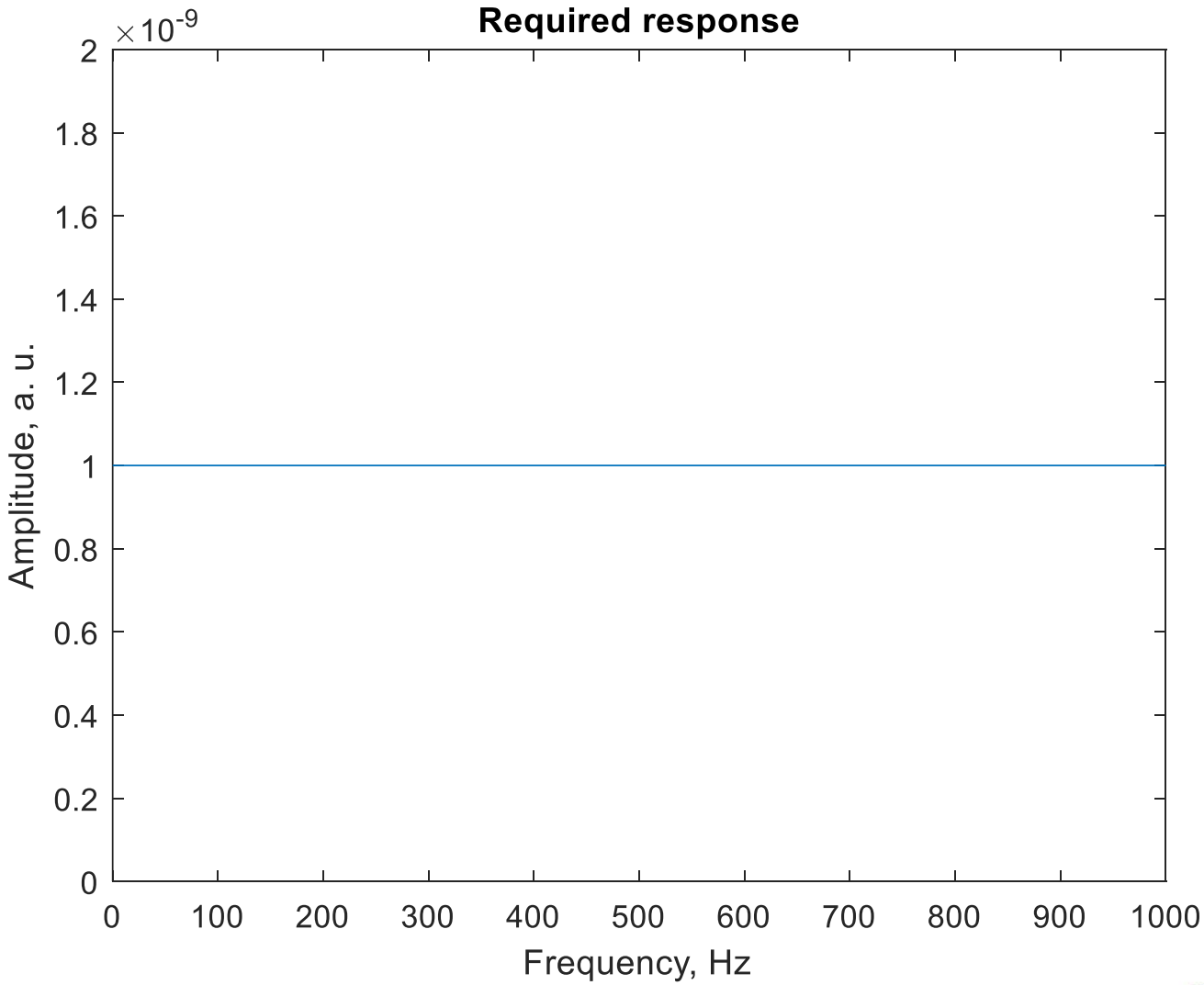
- resonant shape response
- amplitude changing depending on the angle (from 0.1 to 600 Hz)
- for about 650 and 850 Hz high resonant amplitude

Simulation results - depth 90.0 mm



- resonant shape response
- amplitude changing depending on the angle (from 0.1 to 1800 Hz)
- for about 2000 Hz high resonant amplitude

Expected response



- flat response
- constant amplitude for a frequency of 0.1 to about 700 Hz
- optional: at the end of the frequency range, e.g. from 800 Hz, decreasing amplitude

Conclusions

- Far from ideal response of the sensor, resonant frequency response
- Expected response – flat or close to flat
- Resonance arises from the element above the ground to the sensor
- Depending on the depth of the burial, the resonant frequency shifts - wherein the sensor is buried deeper in the resonant frequency increases
- For seismic sensors we are interested in frequency range from 0,1 to 100 Hz
- We are working on 3D model which would visualize our simulation

THANK YOU

Contact:
mkuzwa@camk.edu.pl