Seismometer and Hydrophone Test und Calibration setup

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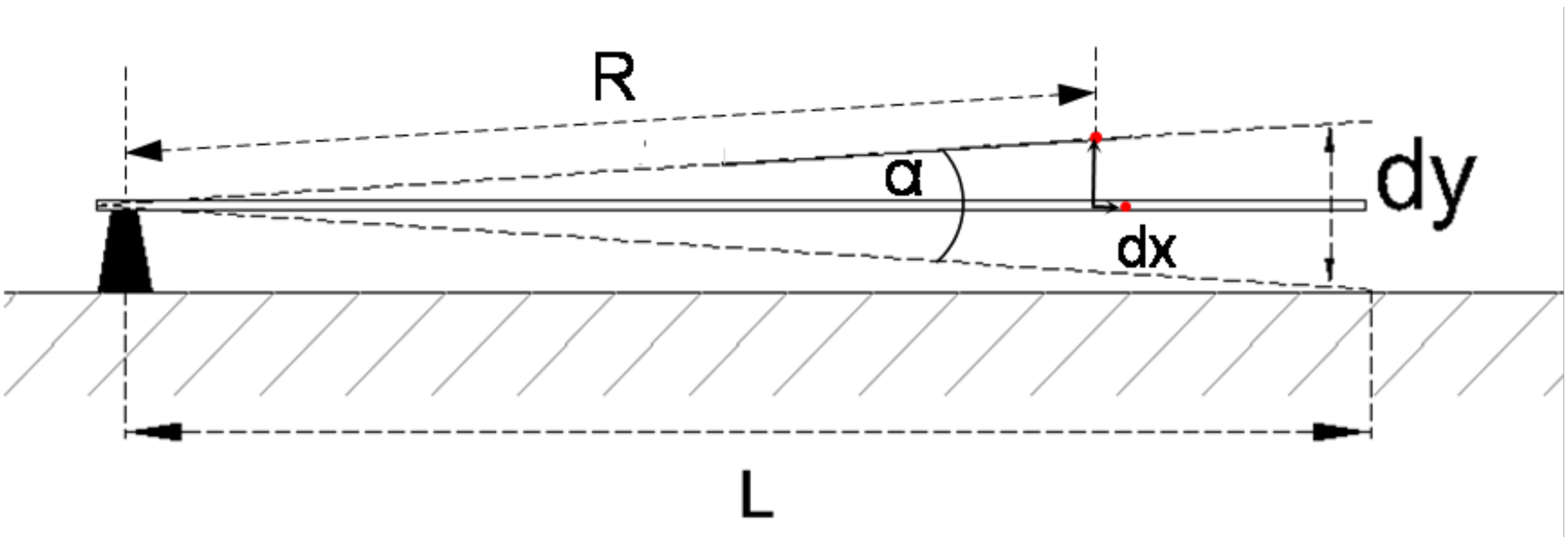
Principle

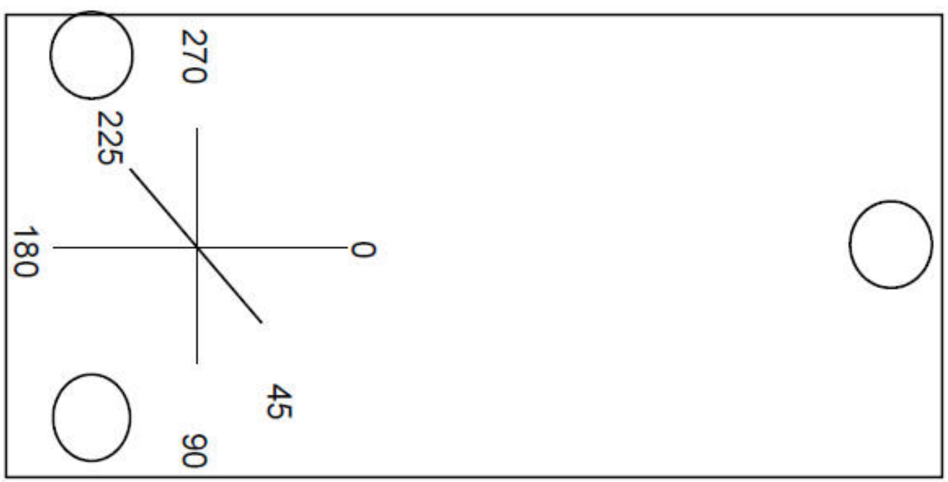
- Lift and sink of a rigid body on a fulcrum generate acceleration and displacement.
- This Tilt excites all 3 Components of a Seismometer.



Principle

The Sensors must be placed in the same position every time .

- Seismometer on the tiltplate placed with North at 45 Deg, so that every horizontal component gets the same stimulation

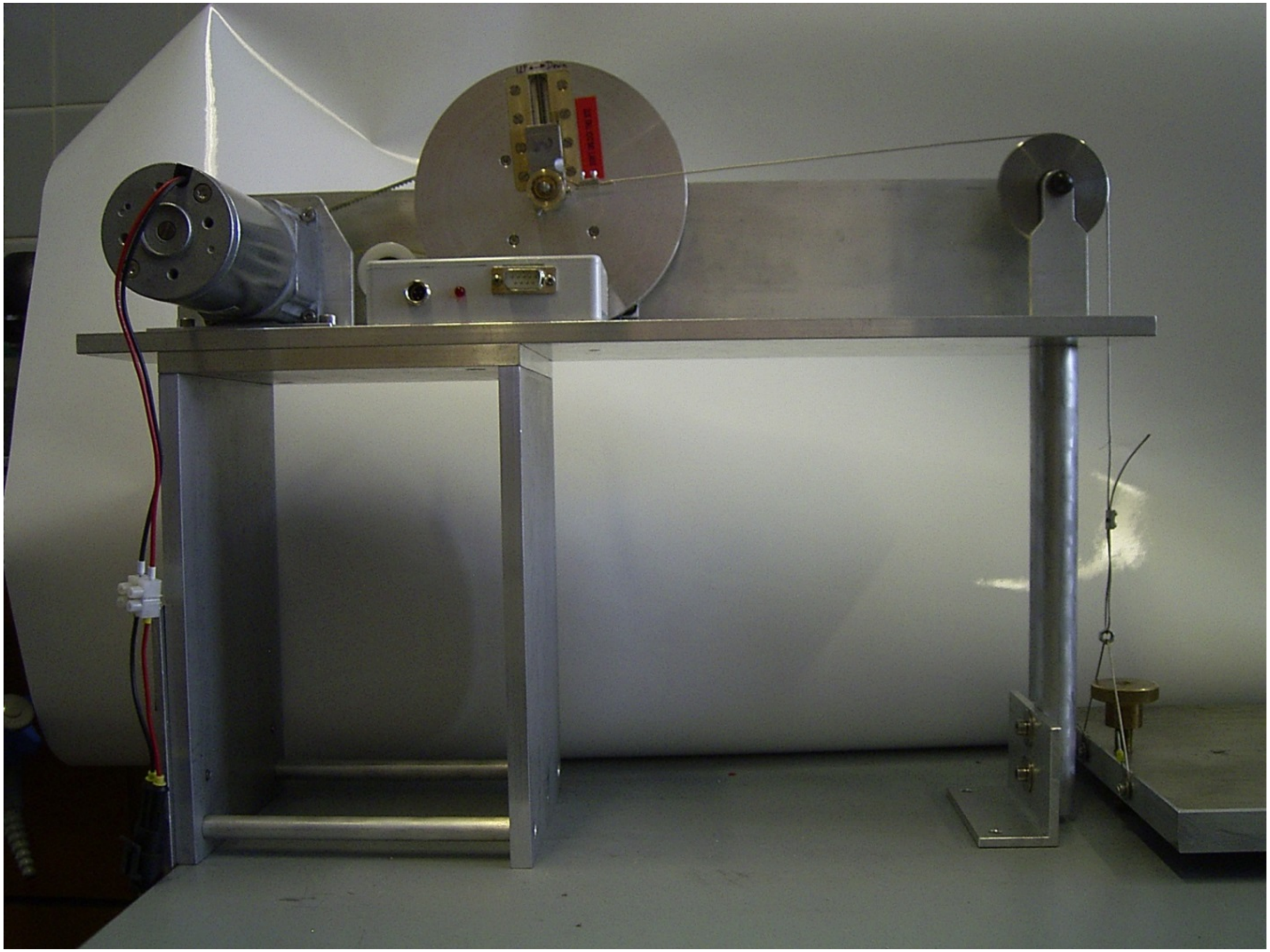


Technical Design - Seismometer

Technical Design - Seismometer

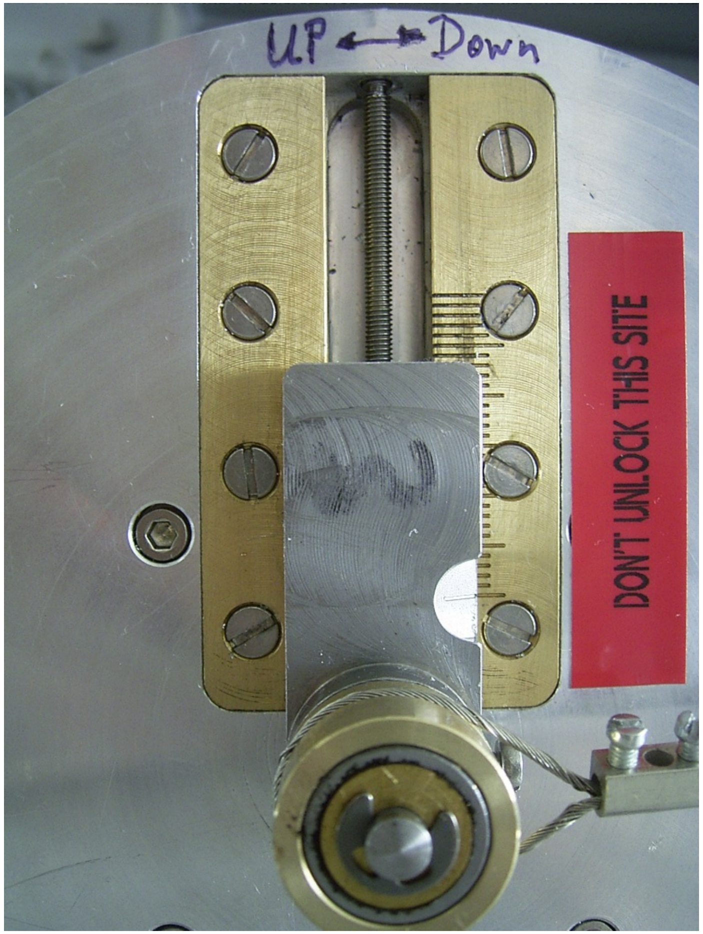
- The excenter will be driven by a DC engine with gear and a programmable power source. The Data connection between PC and power source is RS232.
- The DC engine receives power steps from 1,5V – 40V. This generated frequencies from 0,002 - 0,08 Hz (engine 14.7 rpm) and 0,02 – 0,8 Hz (engine 147 rpm)
- By changing the gear wheel on the DC engine and the excenter, we can increase the frequencies.
- But higher frequenciese produce more self noise.
- Every rotation of the excenter will be recorded by an trigger pulse. This is used for analysis later.

Technical Design - Seismometer



Technical Design - Seismometer

- lift and sink from 0 (ca 3µm) to 3cm can be produced by moving excenter



Technical Design - Seismometer

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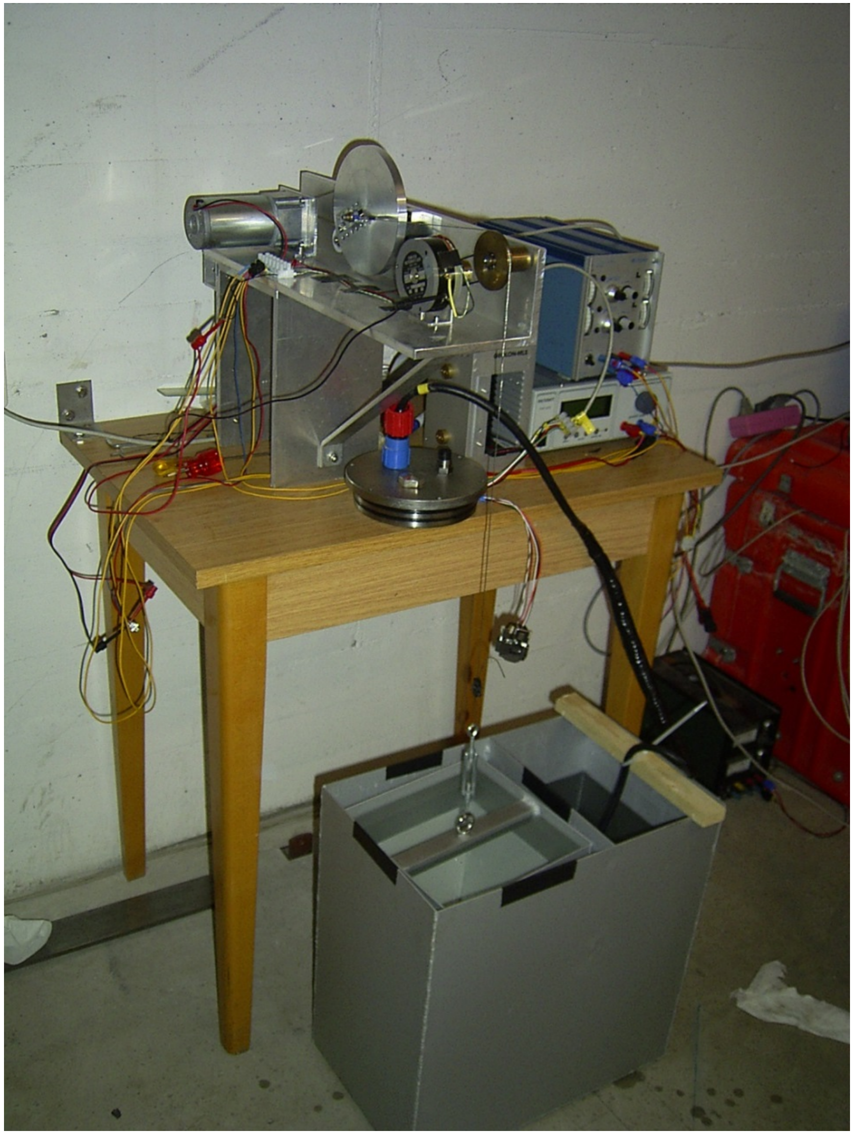
Technical Design - Hydrophone



Technical Design - Hydrophone

- Lift and sink of an sinkbody varies the waterlevel in the basin.
- Calculate the waterlevel difference from the difference in area of the sinkbody and the aera of the basin. This is the **pressure difference**
- With our basin we get pressures differences of 8 – 460 Pa .
- To generate the frequencies we use the same programmable power supply
- The power supply generates frequencies from 0,002 - 0,08 Hz (engine 14.7 rpm) and 0,02 – 0,8 Hz (engine 147 rpm)
- But in reality I can generate frequencies up to 0.7 Hz.
  - Over 0.7 Hz, the construction of my basin produces interference waves and the results are lower or higher amplitude
- This device is therefore good for exploring low frequencies of hydrophones.

Real test

- Test unit (Seismometer)
  - programmable power source and PC
  - Power source and datalogger
  - GPS Signal to synchronize datalogger

- The laboratory should have low noise levels
- Python script controls the power source in 1V steps.
- The lowest power is 1,5V, below that the torque is too low to move the mechanics.
- the Python script logs every step (start time, end time, and volts) that is needed for analysis.
- For a good calculation of the mean it is best to log 30 rotations or more.
- for the low frequencies test, ca. 27 hours are needed, for high frequencies 4,5 hours

Real test

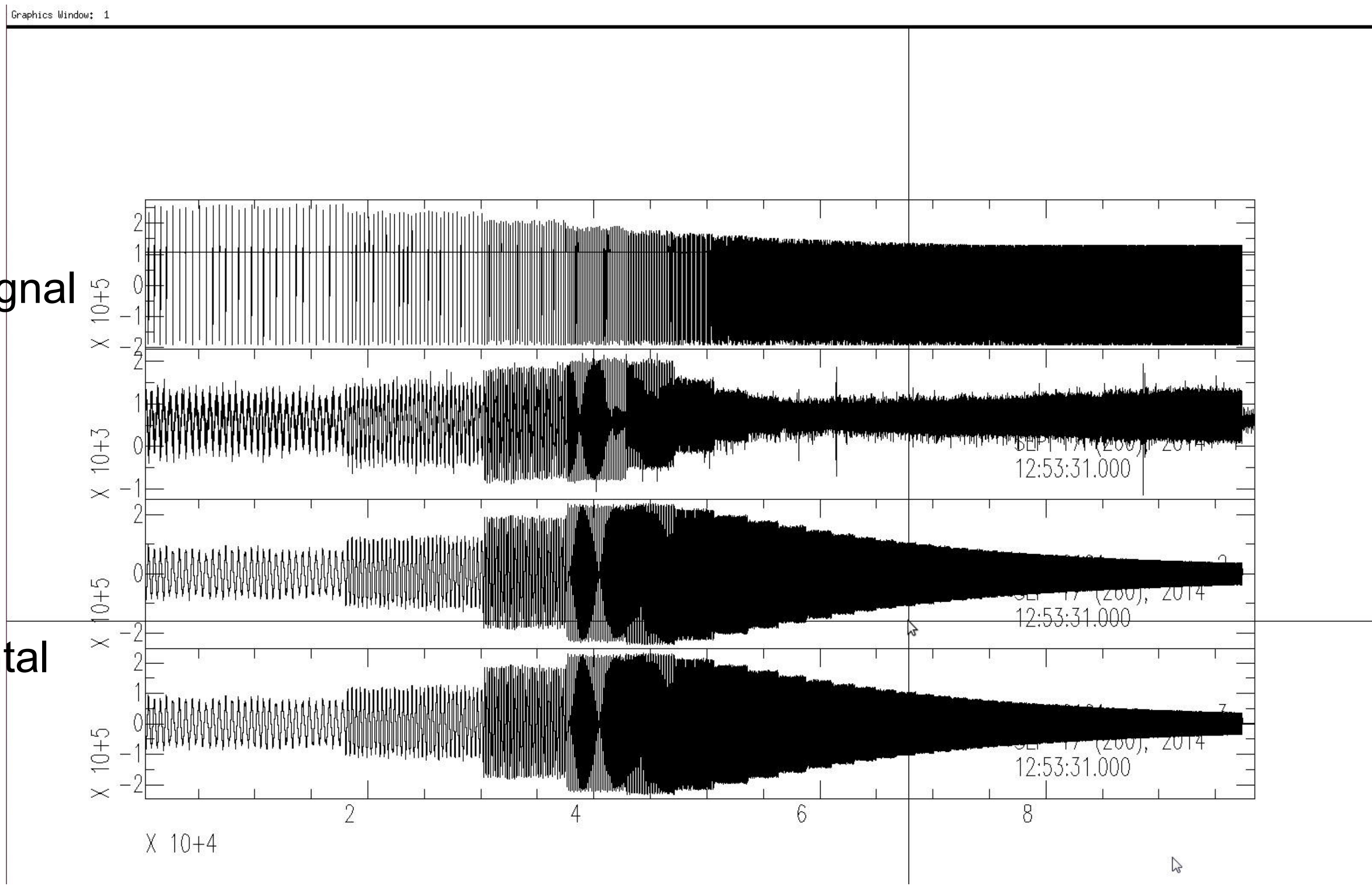
- For a good signal to noise ratio, the highest possible tilt is generated that seismometer and logger can manage (below clip/maximum output)

Interpretation Seismometer

Trigger signal

Vertical

2xhorizontal



continuous Datastream MLS Recorder engine 14.7 /min (SAC –Plot STS2)

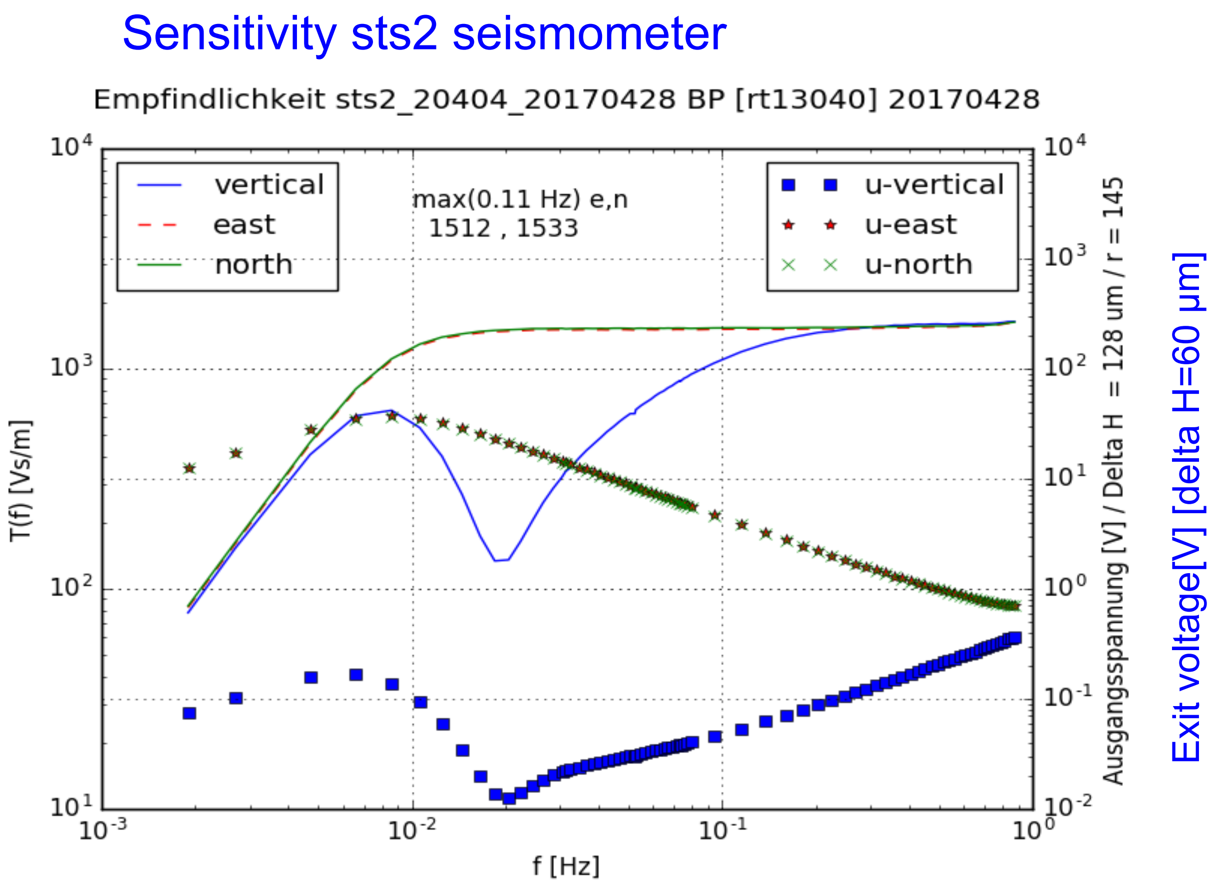
Plotting

- Convert data to sac or miniseed
- Log data of the power source gives start and end time of each power step
- The data stream is cut into parts for each power step
- Together with the recorded trigger signal, the real frequencies within each power step is determined
- I calculate Frequency, Minimum, Maximum of Amplitude (Counts) for every power step.
- For graphical representation of the Transfer function of Broadband Seismometer like. STS2, Güralp, Trillum:

$$U(\omega) = \left(i.\omega.I_d(\omega) + \frac{I_a(\omega)}{i.\omega} \right).T_v(\omega)$$

- (Source of math calculation Prof. Dr. Torsten Dahm, Celia Rios)

Plotting Seismometer



Plot of STS2 Data recorded with RefTek 130 recorder type

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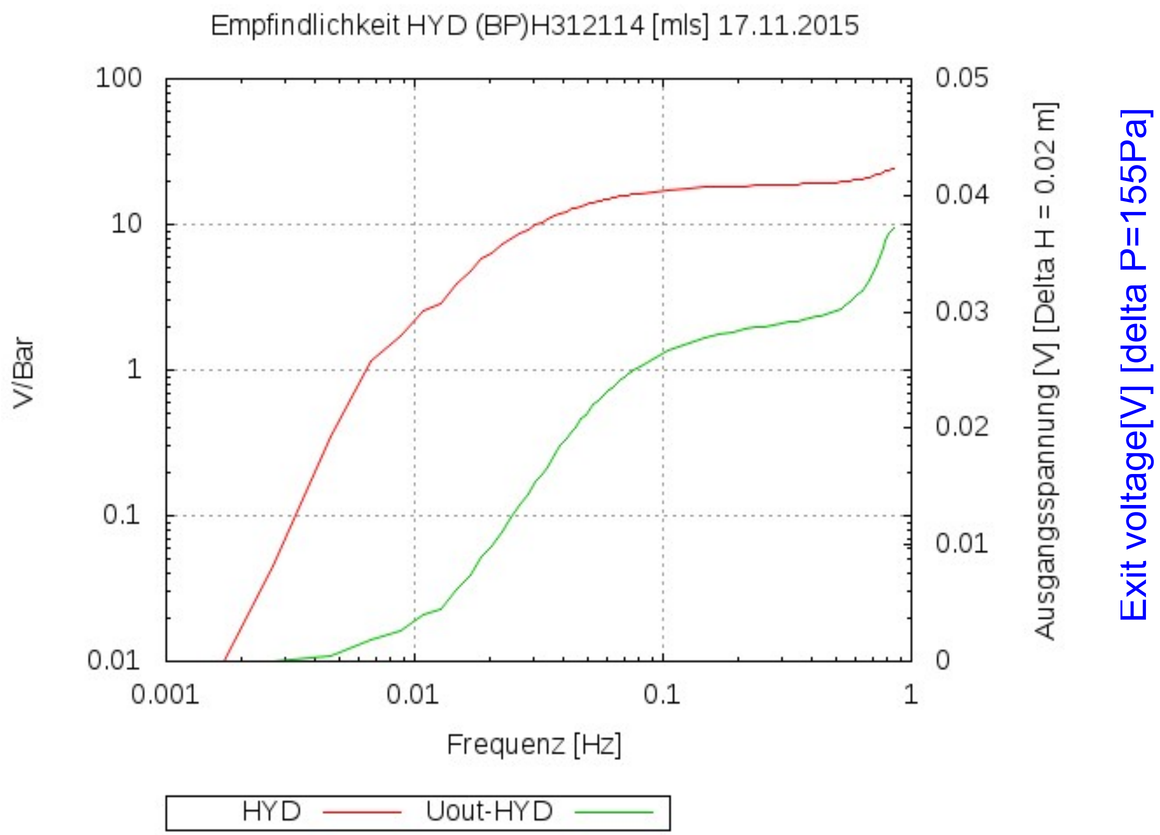
Plot of Hydrophone

Sensitivity Hydrophon HTI (MLS)



Plot of Hydrophone HTI-04-PCA-ULF Amplifier LOWN21