



# Ground Vibration Measurements, Status and Plans

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DESY

# motivation

- comparison of „cultural noise“ impact at several accelerator laboratories
  - ➔ site comparison for future accelerators
    - > linear collider
    - > synchrotron light source

approach: measurements with always the same equipment and data analysis technique  
-> comparable data sets

# equipment

- broadband seismometers (GÜRALP)

measurement of acceleration, output signal: velocity

three components: vertical, 2x horizontal

integrated 24bit ADC, 200Hz sampling rate

data acquisition via notebook / PC

frequency ranges: 360s – 80Hz CMG-3T (old)  
120s – 80Hz CMG-3T (new)  
60s – 80Hz CMG-6T



- geophone system (KEBE)

SENSOR SM-6 geophones with nonlinear high gain amplifier

measurement of velocity, output signal: velocity

separate sensors for vertical or horizontal

16bit USB-ADC, 500Hz sampling

data acquisition via notebook / PC

frequency range: 3Hz – 250Hz

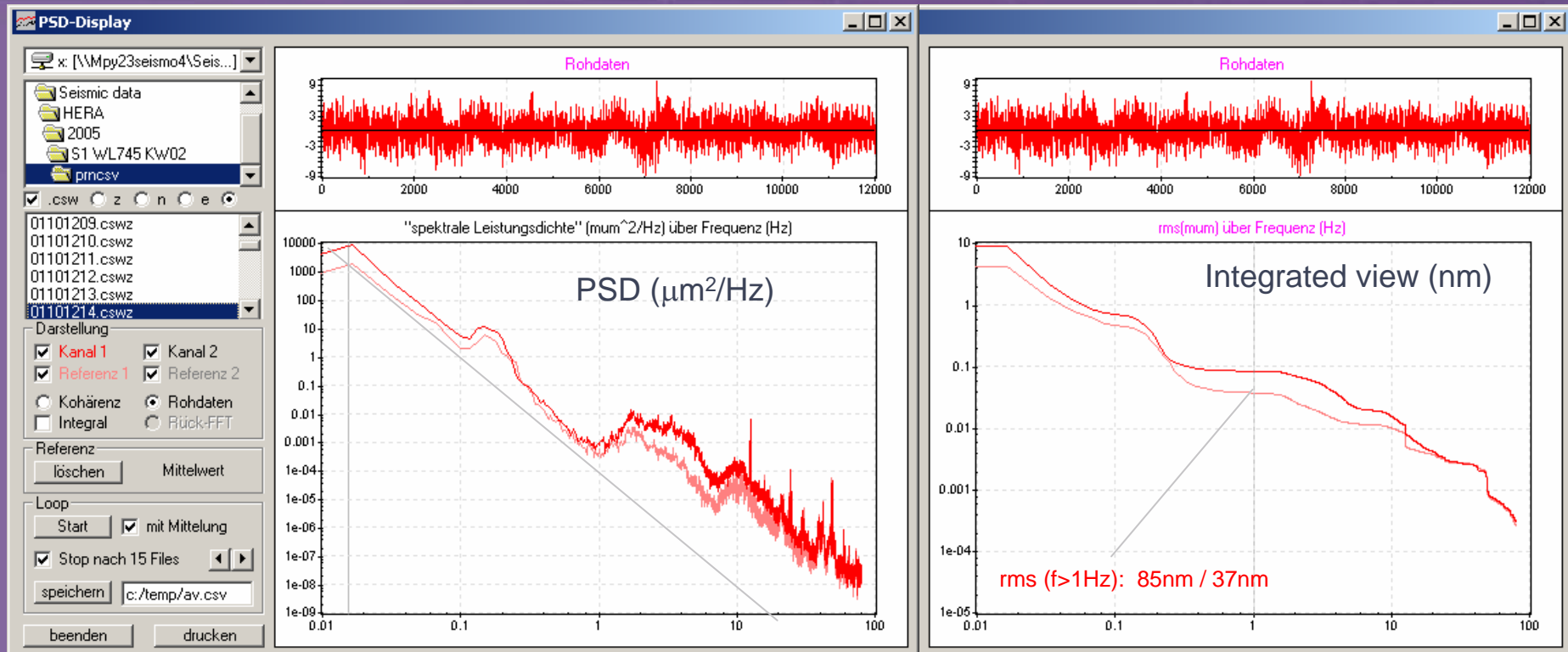


# data taking and analysis (standard)

- continuous data acquisition for 24h or more
- one dataset per minute
  - > 700MB per day and sensor
- “FFT” based on this file structure
  - > 1/60Hz lower frequency limit
- integration (velocity -> motion)
  - > **power spectral density (PSD) of motion**
- integration above cut frequency
  - > **rms-value of motion (in nm) versus f**
- interactive Visual Basic programs
- automated online analysis
  - focus on: **vertical** component

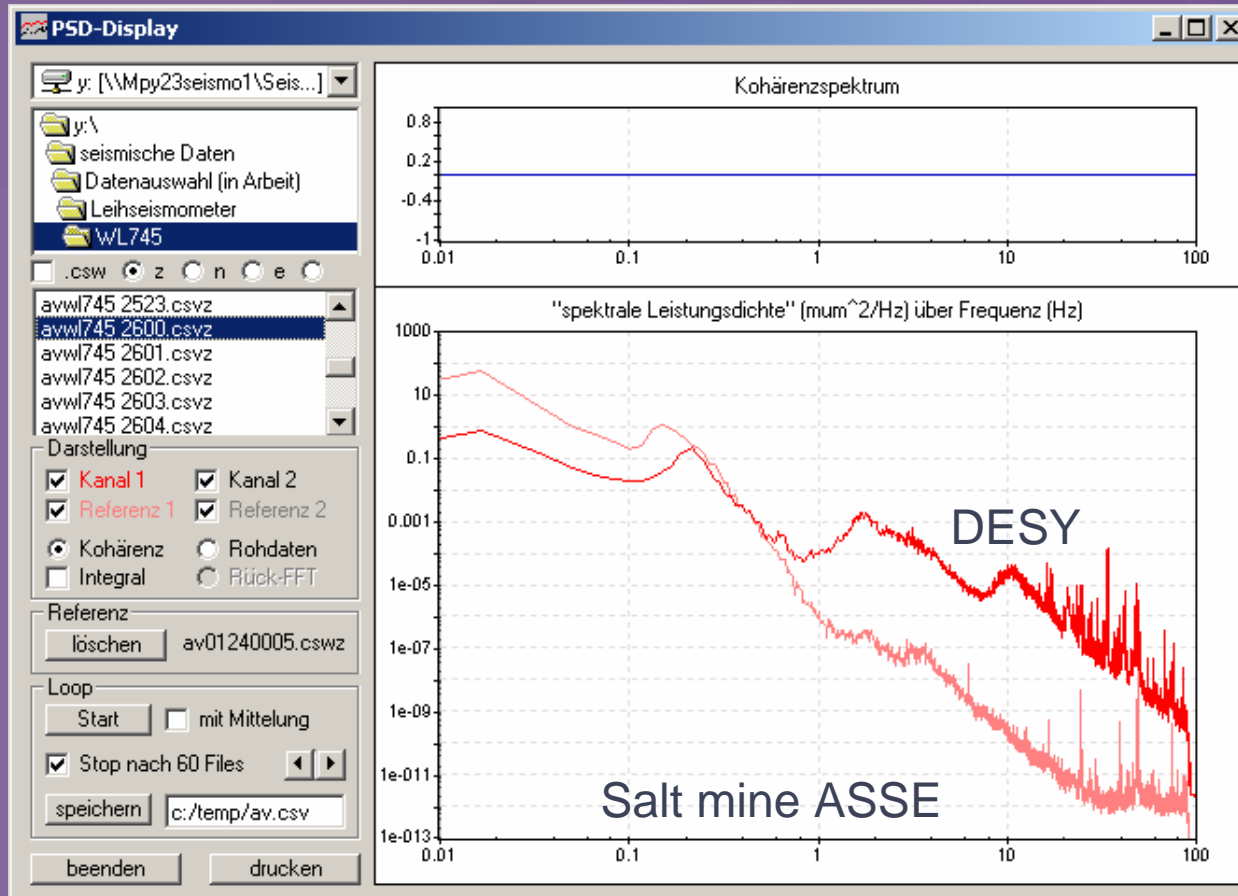
# typical PSD

measurement inside the HERA tunnel at WL745,  
15min average, 0h (light red) and 12h (red)



- $1/f^4$  drop
- microseismic peak (seven second hum) at 0.1-0.2Hz
- $f > 1$ Hz: cultural noise -> uncorrelated

# example: comparison of a salt mine with DESY



rms  $f < 1$ Hz:

DESY, in HERA:  
40nm

Asse, 900m deep:  
1nm

-> clear signal of  
cultural noise above  
1Hz at DESY

HERA tunnel at WL745m (red) and salt mine ASSE, depth: 900m (light red),  
15min average at midnight

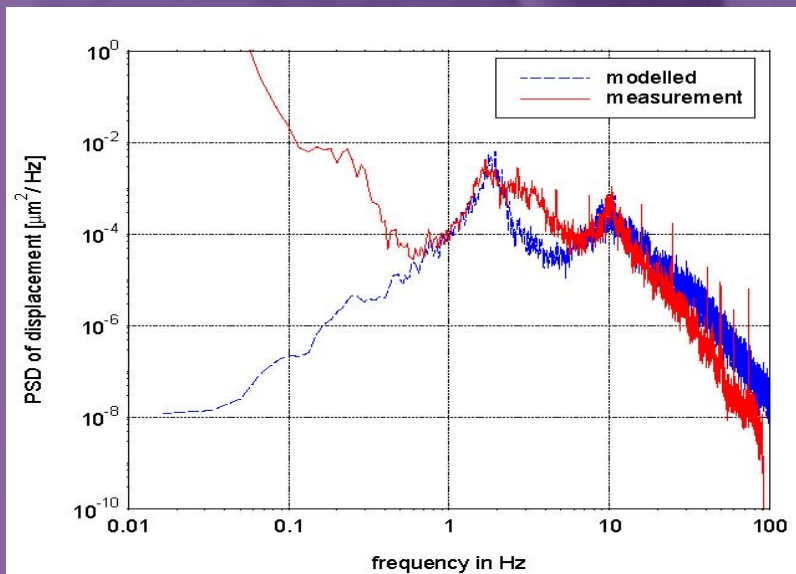
# modelling of cultural noise

-> numerical ground mechanical model for street or rail traffic

Inputs: number of cars, trucks ..., masses, damper characteristics,  
unevenness of street/rail, distance to the street/rail  
soil parameters

*in cooperation with TU HH (technical University of Hamburg Harburg)*

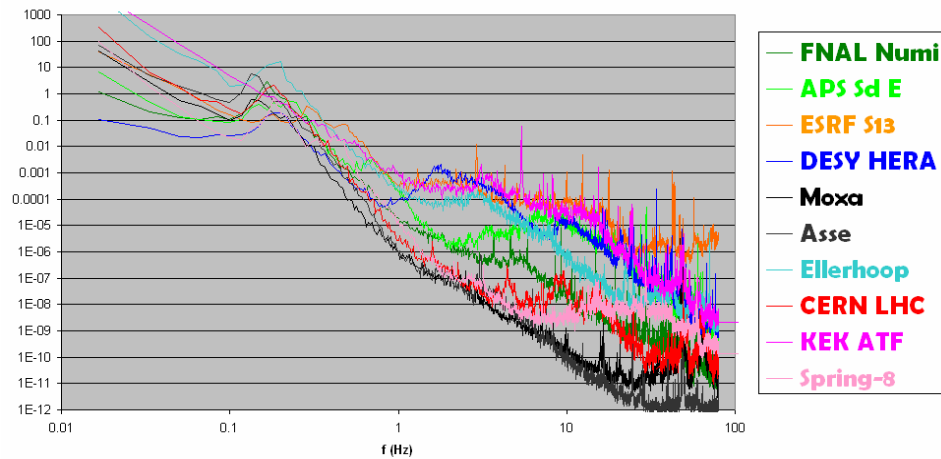
*preliminary* result:



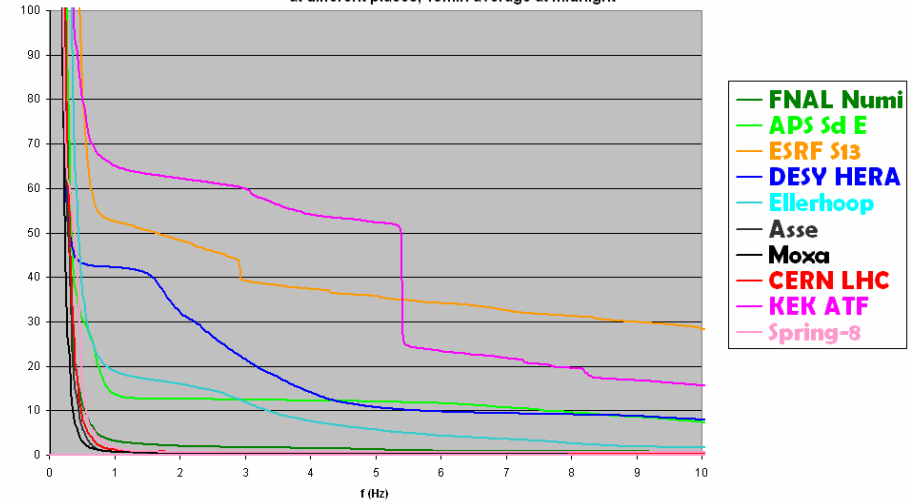
⇒ street (rail) traffic seems to be the main reason for “cultural noise”

# site comparison

power spectral density ( $\mu\text{m}^2/\text{Hz}$ )  
of the vertical motion at different places, 15min average at midnight



rms-value of vertical motion (nm) versus cut frequency  
at different places, 15min average at midnight



very good (<2nm)

good (<5nm)

medium (<20nm)

bad(>20nm)

Asse

SLAC

APS

KEK ATF

Moxa

FNAL Numi

FNAL surface

ESRF

CERN LHC

CERN surface

Ellerhoop

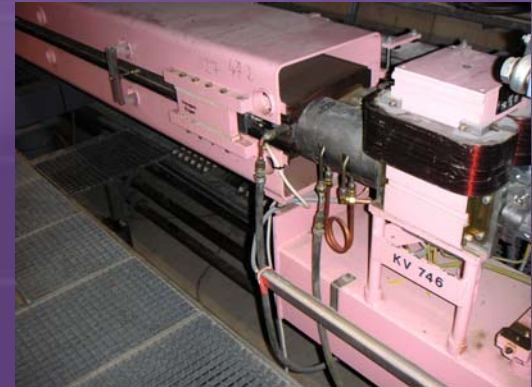
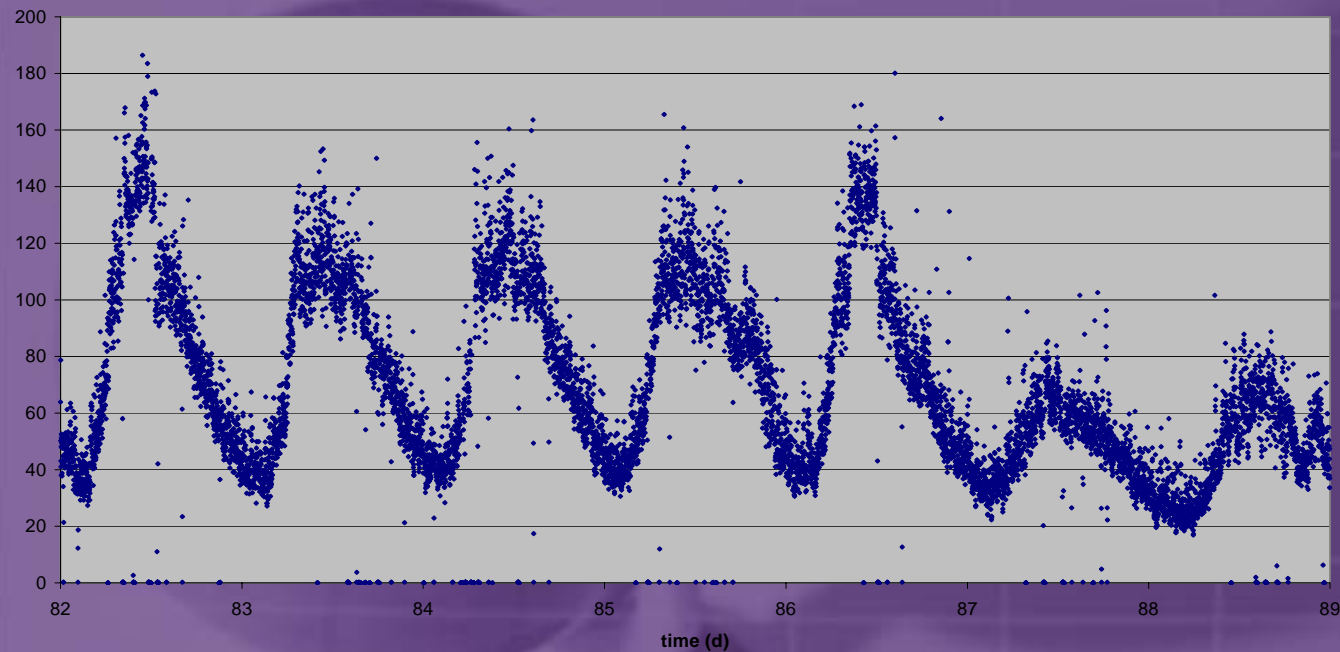
DESY

Spring-8



# “seismic station” HERA WL745

rms value of vertical motion (nm) for  $f > 1\text{Hz}$  vs. time,  
HERA tunnel at WL745m, calendar week 13 (2004)

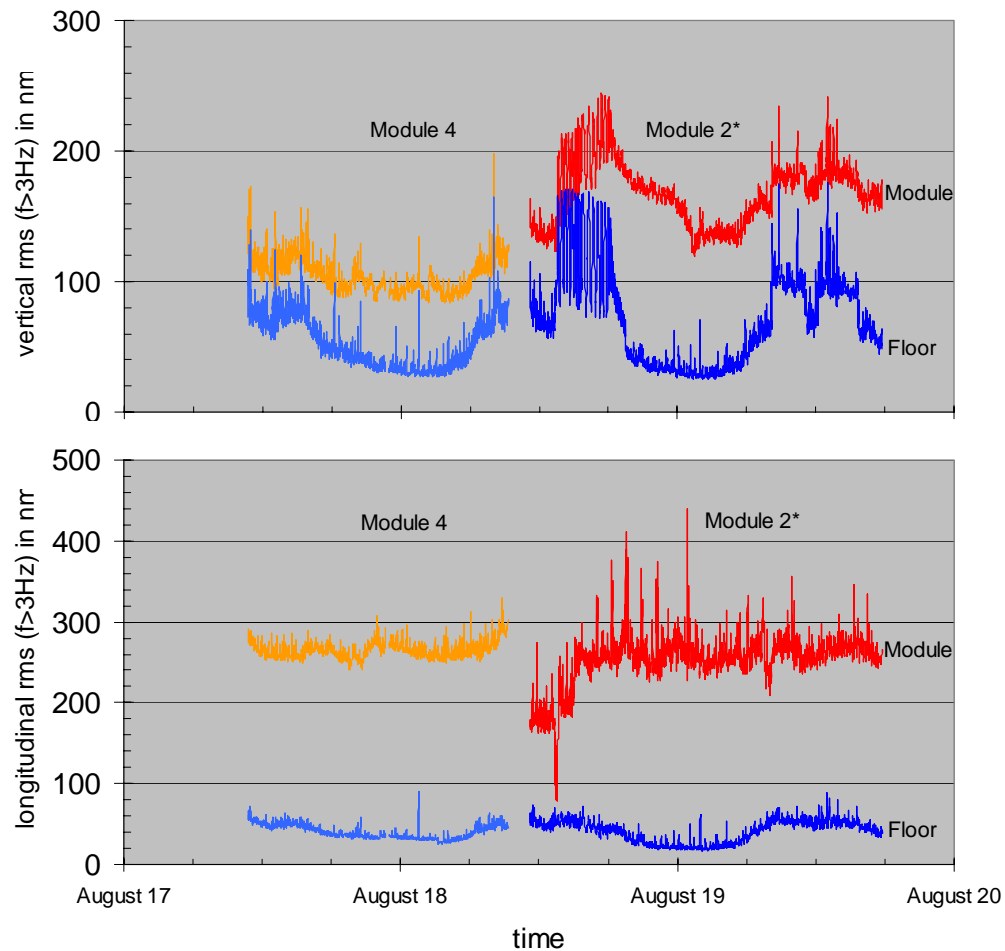


- permanent data acquisition
- data transfer to the University of Hamburg -> seismic network
- soon: live data in the web
- online data available for everybody (on request) -> [SCREAM](#)

# TESLA module vibration

in the TTF tunnel

rms value of motion for  $f > 3\text{Hz}$  versus time



⇒ strong module vibration

⇒ vacuum installation?

⇒ module installation itself?

⇒ further investigation is necessary

# activities within EUROTEV and ILC

- site comparison for potential ILC sites
  - > further measurements at all ILC site candidates
  - > *data base*
- modelling of cultural noise (TU HH)
  - > *further understanding of noise sources*
- vibration of the cold quadrupoles (new postdoc)
  - > measurements inside the modules
  - > identification of sources or design problems
- active stabilisation concept (LAPP)

# acknowledgements

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# ... in action

