Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

CLUSTER OF EXCELLENCE
QUANTUM UNIVERSE

UHH – DESY

07.12.2020

SEISMIC NETWORK CONCEPT
OVERVIEW & HISTORY SO FAR

O. GERBERDING, INSTITUT FÜR EXPERIMENTALPHYSIK, UNIVERSITÄT HAMBURG

GRAVITATIONAL
WAVE DETECTION

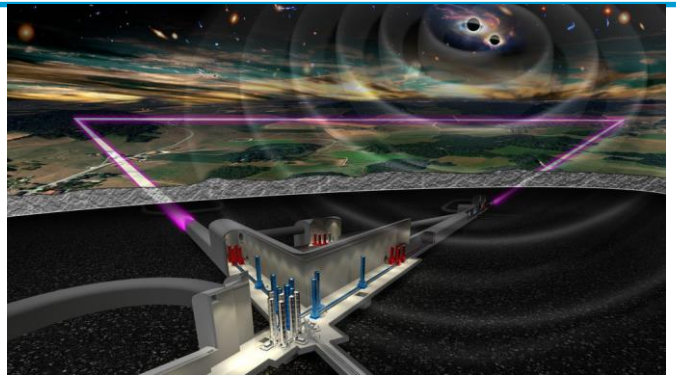
CREDIT: THE MILKY WAY GALAXY BY DEREK ROWLEY

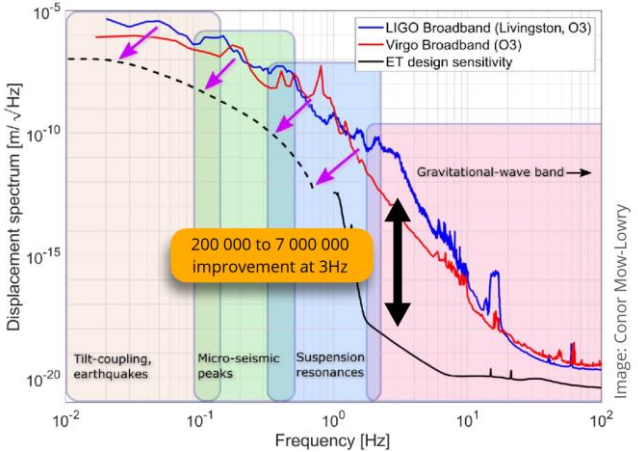
SEISMIC NOISE IN GW DETECTORS

- UHH has several groups working on future ground-based gravitational wave detectors like the Einstein Telescope
- The suppression of seismic (low frequency) noise is a major challenge for current & future detectors

We need laboratories on campus to study:

- Passive isolation systems
- Active feedback isolation with novel inertial sensors
- Active feed-forward isolation with machine learning & novel sensors

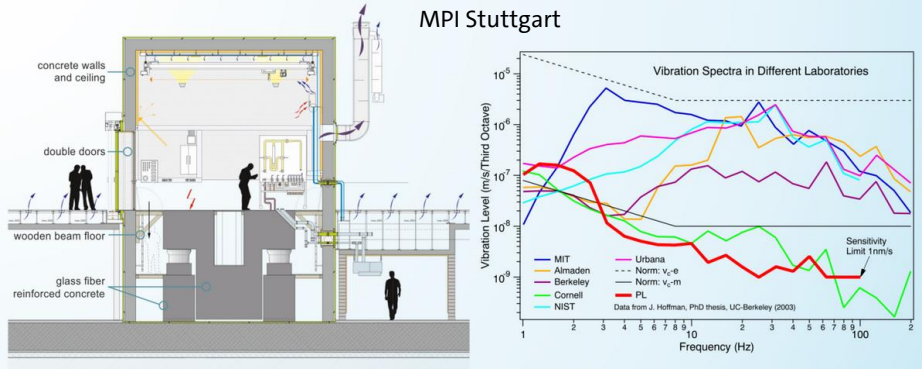




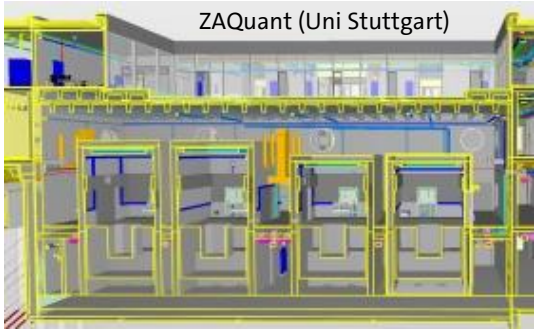
NEW RESEARCH BUILDING QUANTUM UNIVERSE

- The Institute for Experimental Physics is preparing a proposal for a new research building for particle, astroparticle and gravitational wave detection physics
- Based on previous research buildings we plan to have a “Tieflabor” with massive, isolated (passive/active) foundations (~130t): ***Gravityboxes***

MPI Stuttgart



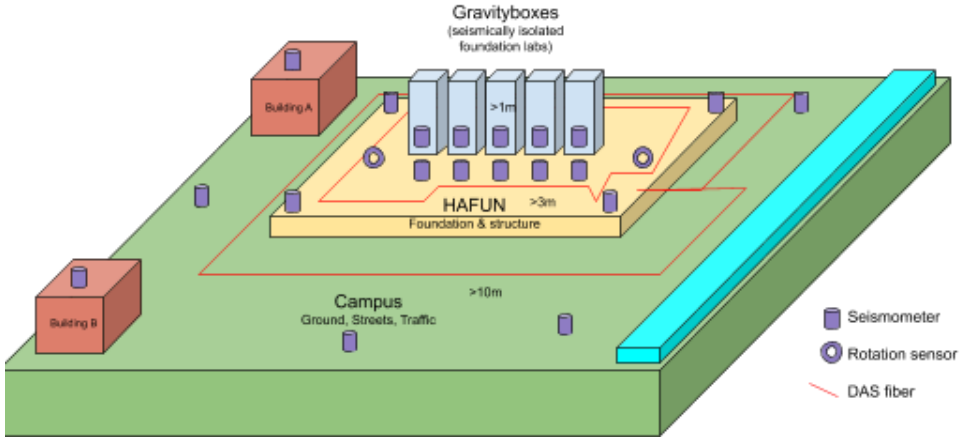
ZAQuant (Uni Stuttgart)

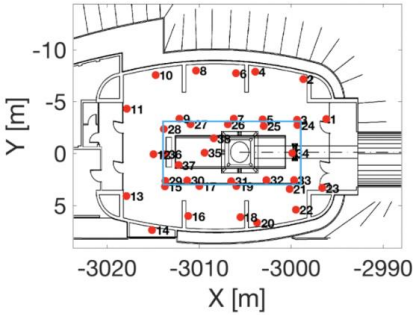


SEISMIC NETWORK IDEA

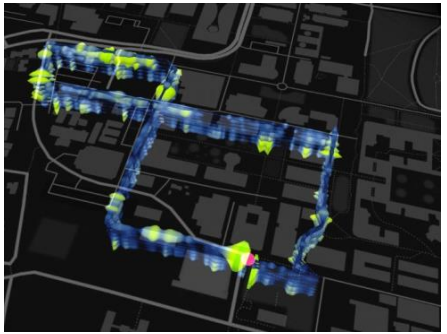
With additional feed-forward we can improve further

- Sensor networks are already studied for Virgo & ET
- Dirk Gajewski suggested to study distributed acoustic fiber sensors for ET & from that we thought to install them directly in the building
- Existing fiber networks (using dark fibers) have shown great results
- **The building will be fitted with seismometers and optical fibers**



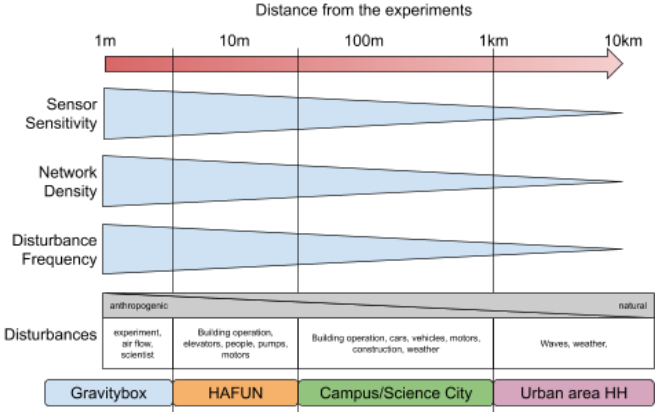


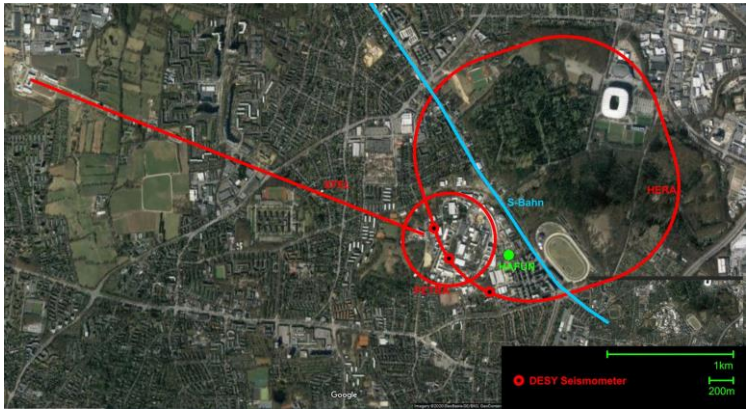
Beispiele seismischer Sensornetzwerke; Links: Virgo /M.C. Tringali et al. (Seismometer); Rechts: Stanford University (Fasern)



SEISMIC NETWORK CAMPUS BAHRENFELD

- Lower frequencies need larger spatial coverage (longer wavelength)
- Plenty of noise sources around the campus
- Many other sensitive experiments nearby (PETRA III & IV)
- Large interest in low seismic noise (S-Bahn)
- Science City project means every stone will be turned, plenty of opportunity to put fibers into the ground





SEISMIC NETWORK CAMPUS BAHRENFELD (WAVE)

What can we study with it and use it for?

- geo-acoustic processes
  (urban systems, ground-water, sink holes)
- Machine-learning (real-time, feed-forward)
- Improve precision experiments at UHH/DESY
- Seismic isolation for gravitational wave experiments

What do we need?

- Network Infrastructure (Seismometers,
  fiber sensors, processing facilities)
- Personnel (PhD students, postdocs, technicians)

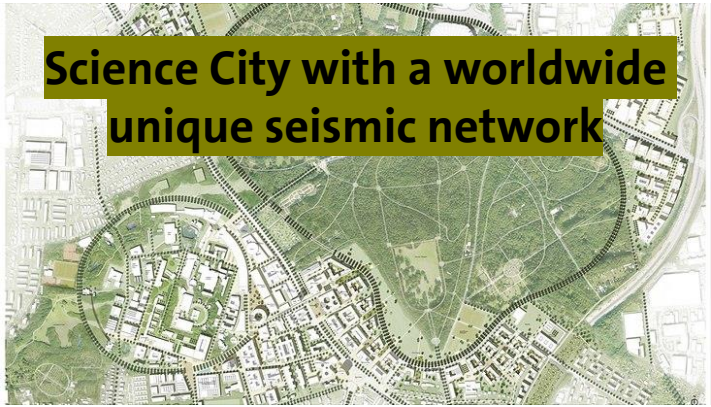
How do we start?

- Find interested partners & look for funding
- Develop a more refined concept
- Start with small experiments

Seismisches Netzwerk für städtische, geo-akustische Prozesse

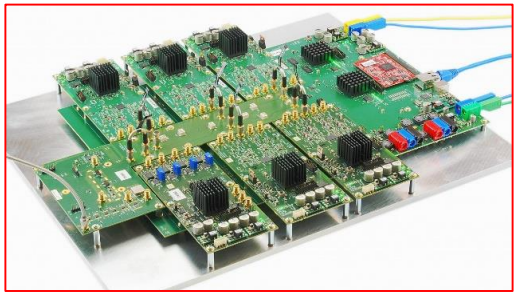
Skizze - Hamburg, den 25.05.2020

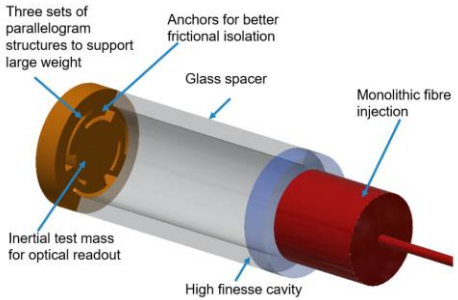
Beteiligte:
Prof. Dr. Dirk Gajewski, Institut für Geophysik
Prof. Dr. Oliver Gerberding, Institut für Experimentalphysik
Prof. Dr. Celine Hadziioannou, Institut für Geophysik
Prof. Dr. Roman Schnabel, Institut für Laserphysik

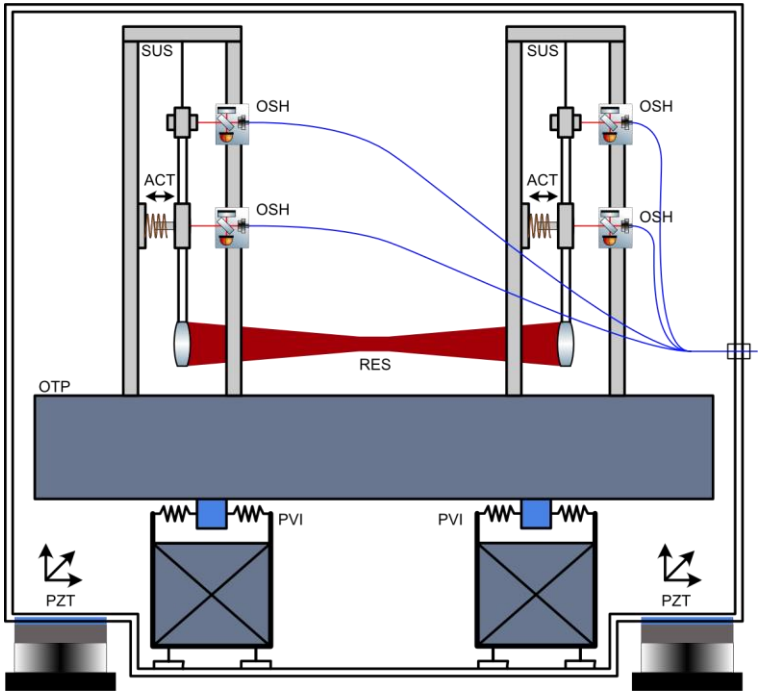


MY WORK: INERTIAL SENSORS AND SEISMIC ISOLATION

- Vacuum system with active seismic isolation
- Inertial sensors with laser interferometry
- Readout and feed-back control with real-time FPGA algorithms
- **Feed-forward with seismic sensors**







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