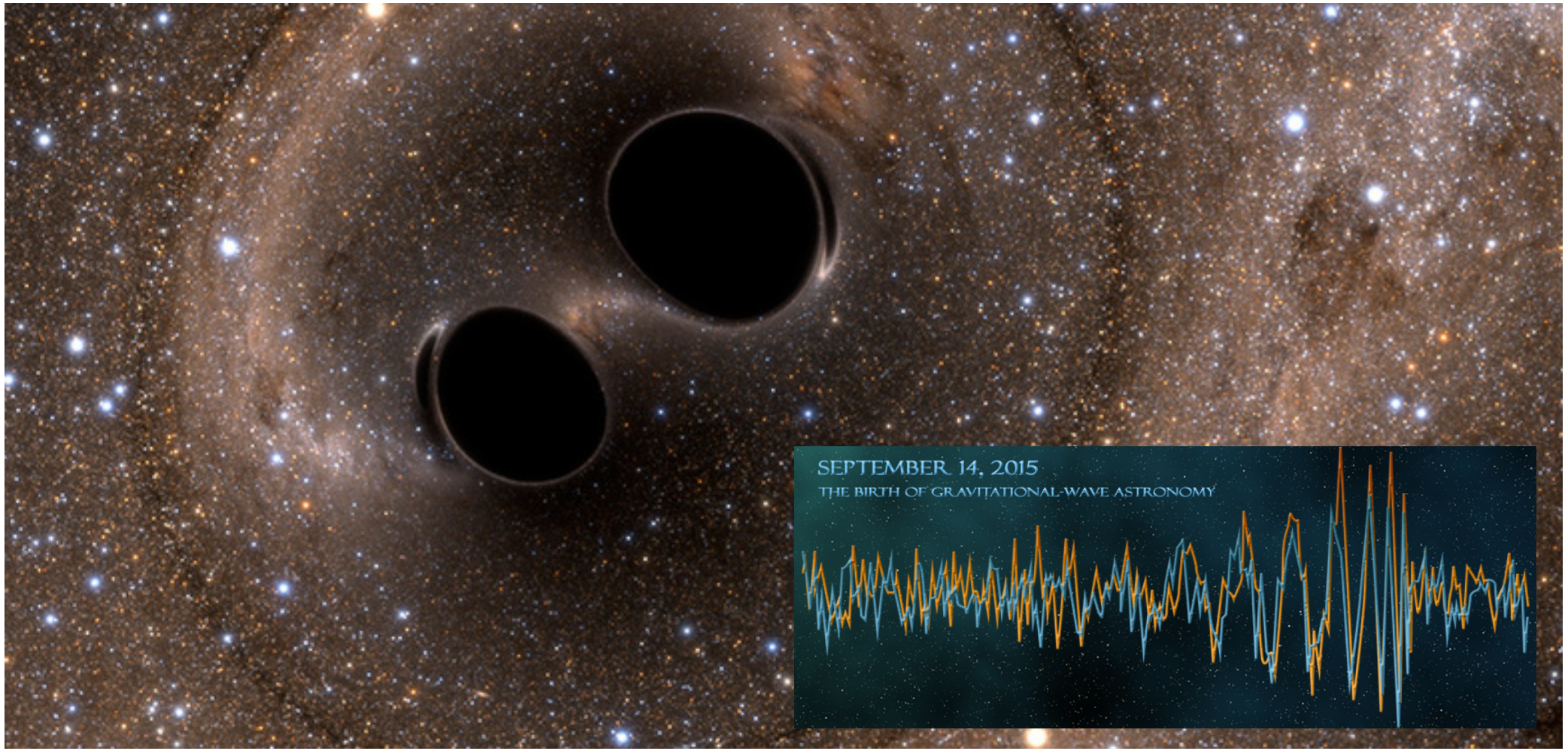
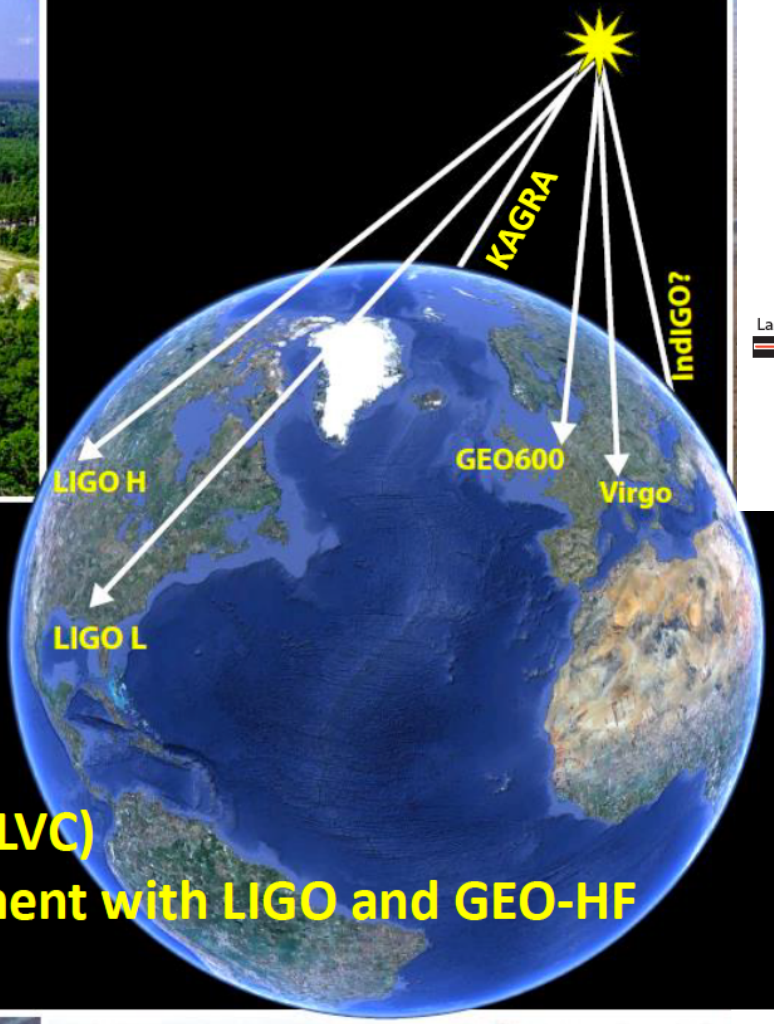
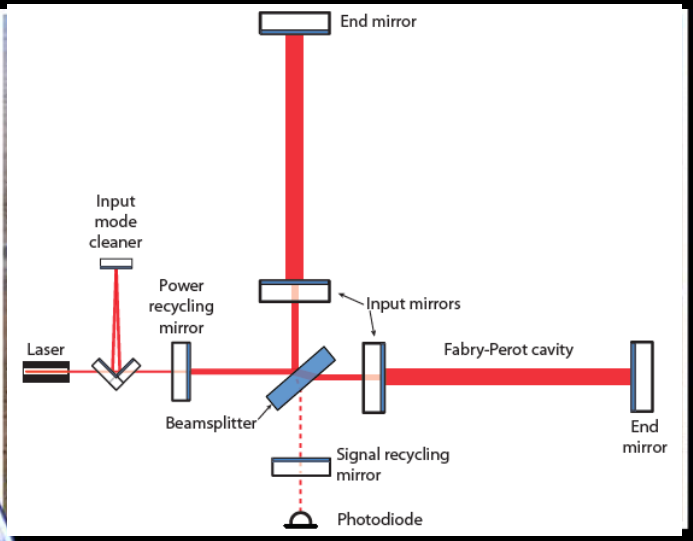
The sixth sense

A new detector to observe the universe

N.A. van Bakel on behalf of the Nikhef R&D and Gravitational Physics groups



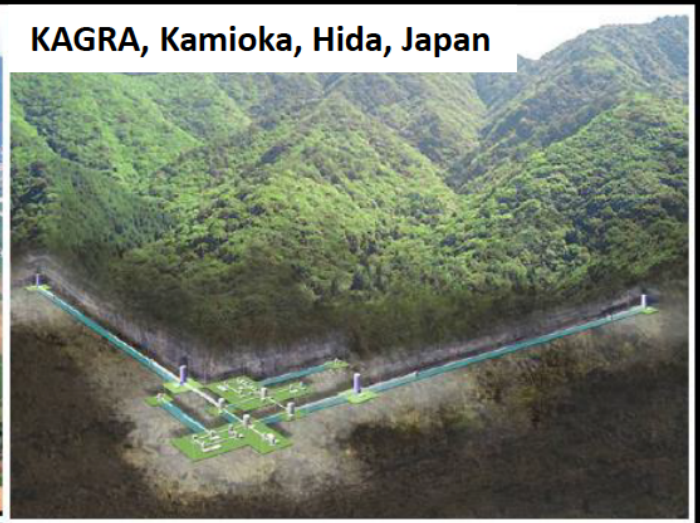




Improve factor
10^{12}

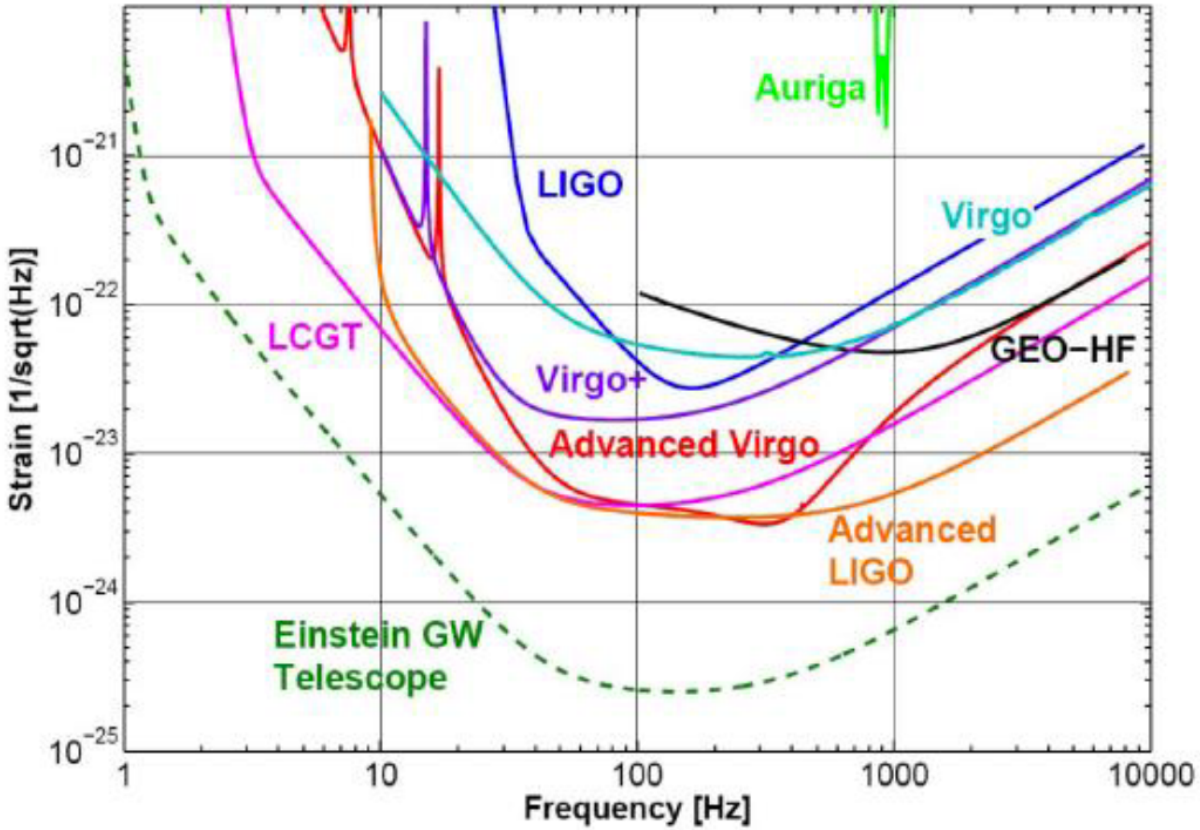
LIGO Virgo Collaboration (LVC)
Completed first measurement with LIGO and GEO-HF

KAGRA in 2020
LIGO India approved!

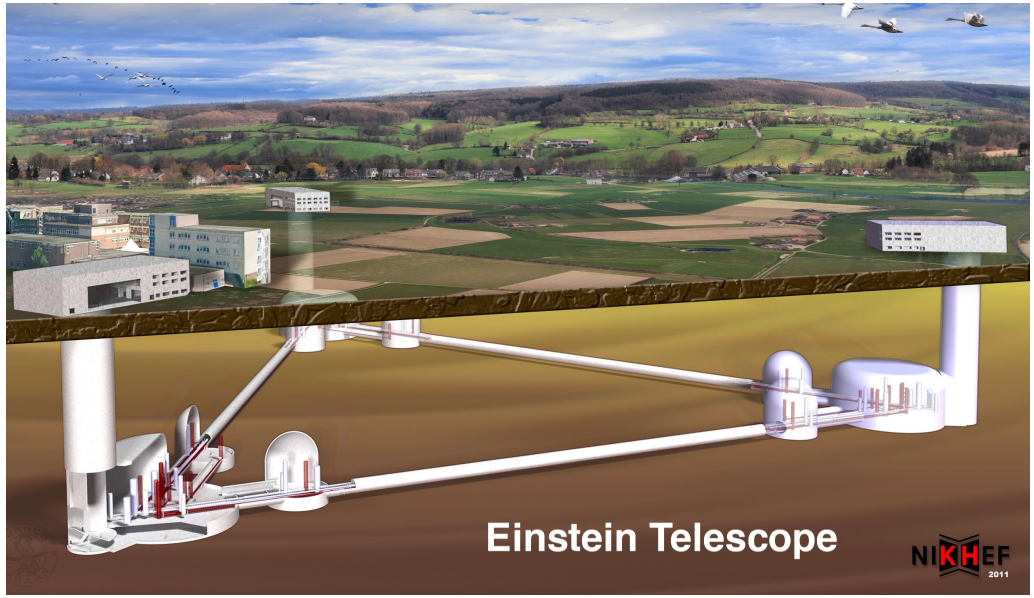


Sensitivity

Sensitivities of GW detectors from the first to the third generation

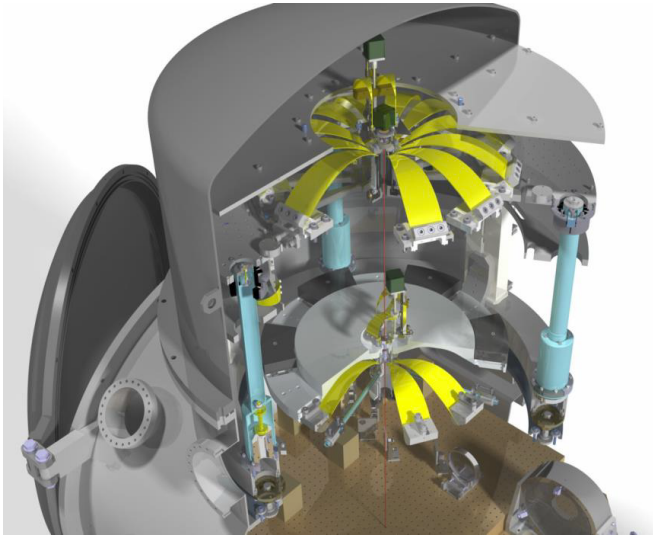


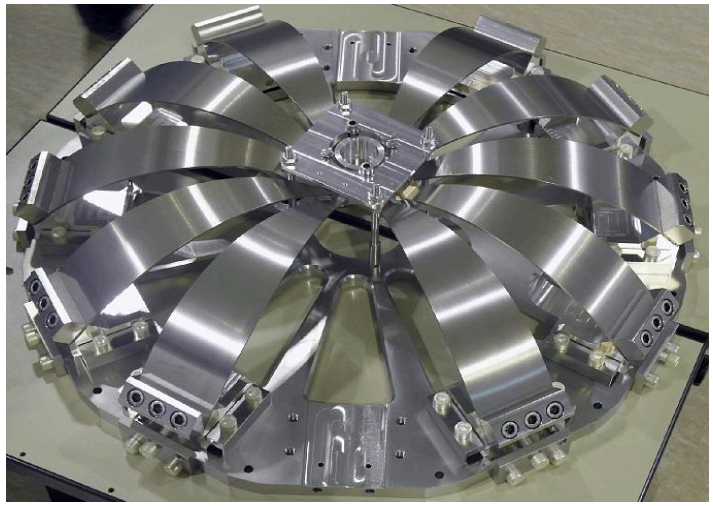
- **High-freq (>300 Hz):**
  - ✓Laser shot noise
    - ➡ Increase laser power
- **Mid-freq (40-300 Hz):**
  - ✓Thermal noise
    - ➡ Improve mirrors
- **Low-freq (<40 Hz):**
  - ✓Seismic noise
    - ➡ Vibration isolation



Vibration isolation

A suppression of seismic motion by about 10^{10} is required: use anti-spring technology in the Advanced Virgo seismic noise filters to reduce the system stiffness

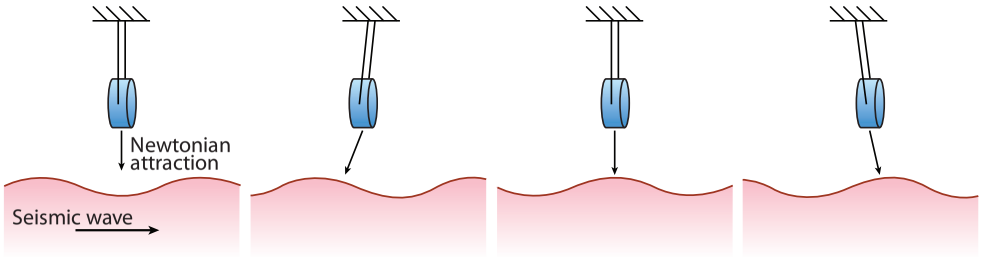


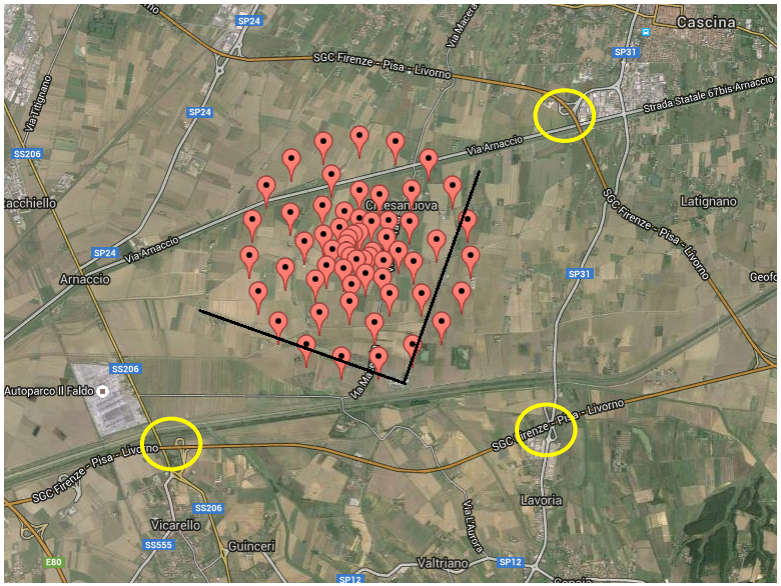


Vibration monitoring - Newtonian Noise

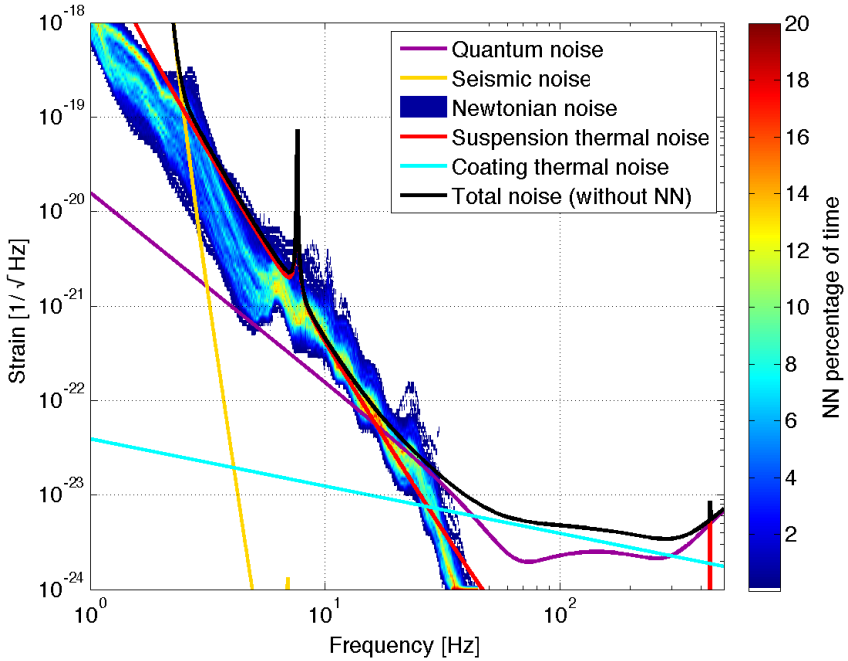
No Newtonian noise model ⇒ to develop subtraction schemes, we have to measure the seismic wave fields with arrays of seismic sensors

Newtonian interaction between seismic wave field and interferometer mirrors





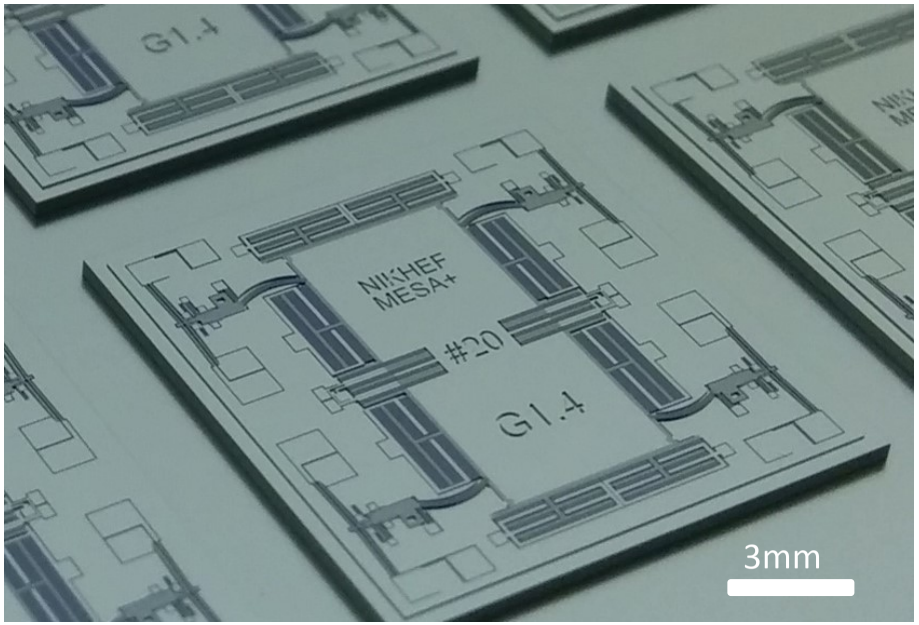
AdV during high seismic activity

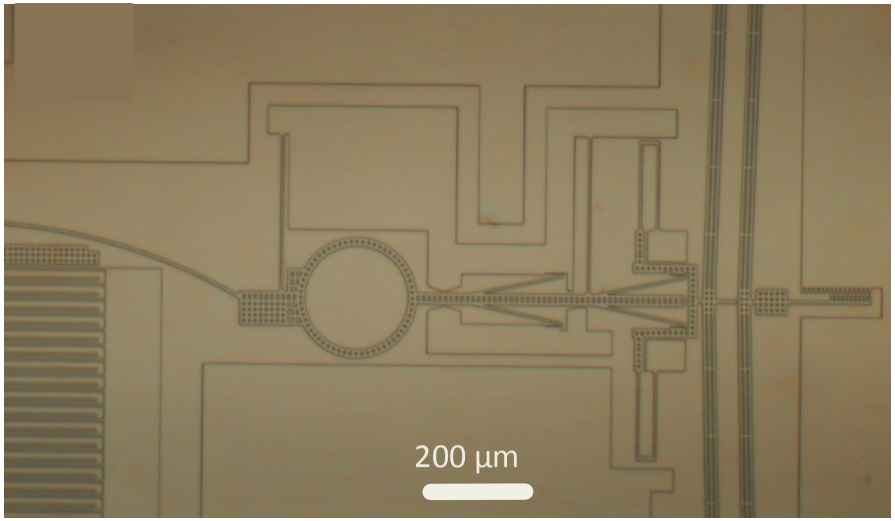


Vibration monitoring - MEMS sensor

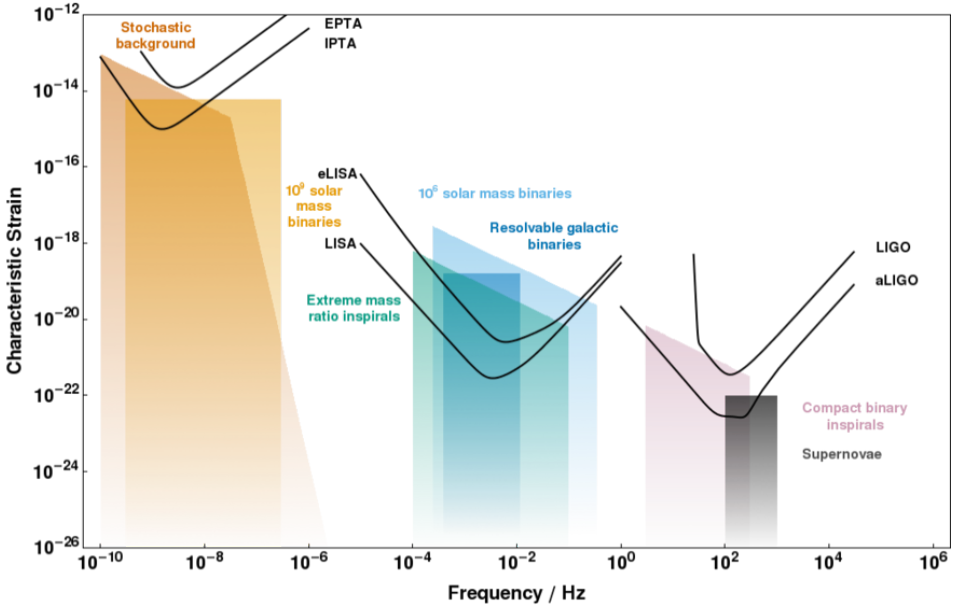
Our goal is to develop a new type of MEMS accelerometer with integrated readout electronics

Parameter	Automotive	Navigation	Seismic
Full-scale Range	±50g (airbag), ±2g (vehicle stability)	±1g	< ±1g
Bandwidth	DC-400Hz	DC-100Hz	< 100Hz
Noise Floor	< 1 mg/√Hz	< 10 µg/√Hz	~ 1 ng/√Hz





“Sixth sense” - Detection of Gravitational Waves



- Build various gravitational detectors next 10 - 15 year: Einstein Telescope (ground based), eLISA (in space), ..
- Technological innovation lies in the combination of opto-mechanics, electronics and sensor systems
- Socio-economical impact