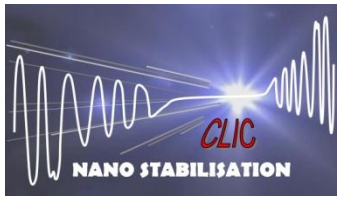
European Organization for Nuclear Research



CERN VIBRATION SENSOR PROPOSAL

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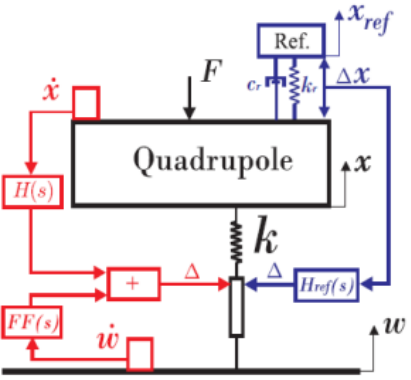
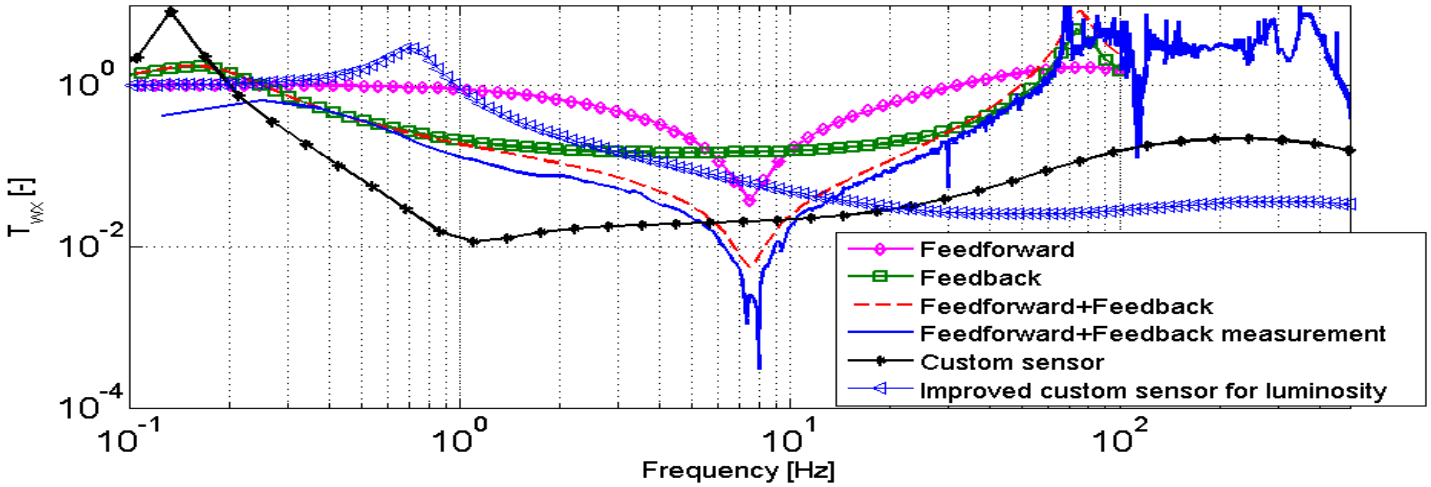
The research leading to these results has received funding from the European Commission under the FP7 Research Infrastructures project EuCARD

Outline

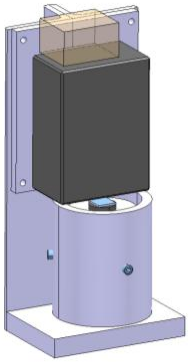
- Vibration Control with sensor
- Proposed sensitivity curve
- Proposed noise curve
- Environmental conditions
- Form of tender
- Some tests made

Integrated luminosity simulations





Commercial Seismometer

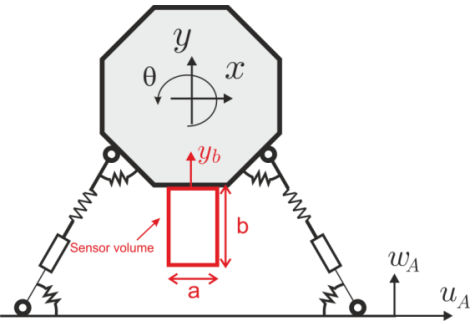


Custom Inertial Reference mass

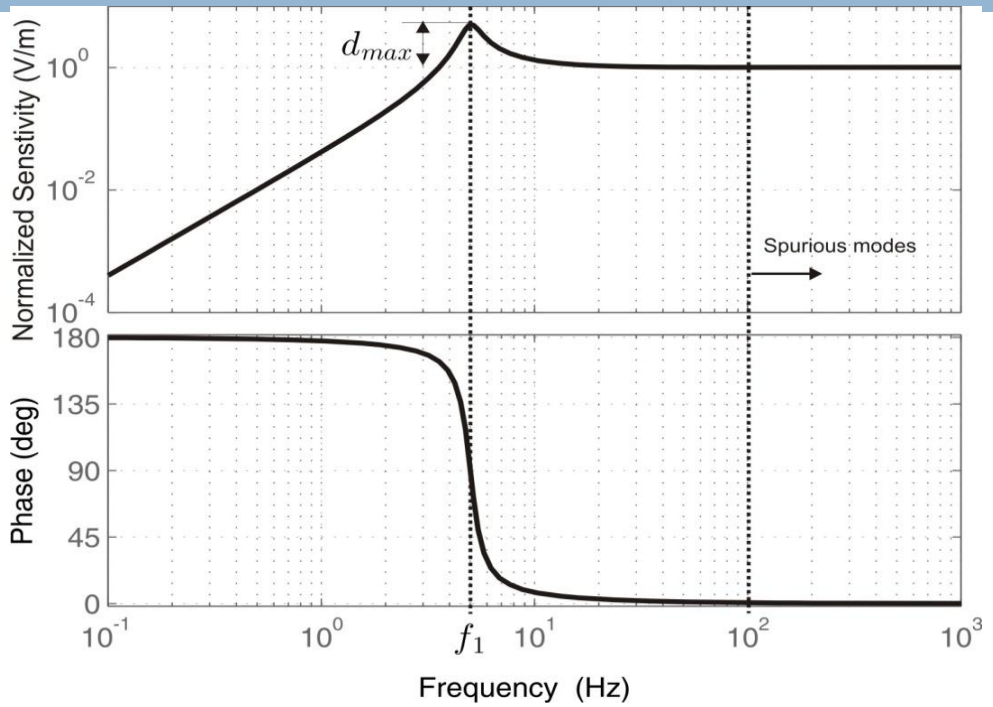
No stabilization	68% luminosity loss
Seismometer FB maximum gain	13%
Seismometer FB medium gain	6% (reduced peaks @ 0.1 and 75 Hz)
Seismometer FB maximum gain +FF	7%
Inertial reference mass	11%
Inertial reference. mass. + HP filter	3% to 0.7% for higher freq

Courtesy J. Snuverink *et al.*

Sensitivity curve



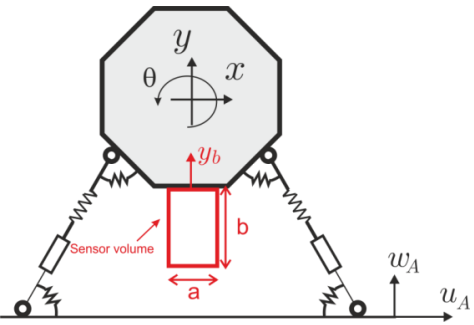
Step 1:
Vertical sensor
Non collocated

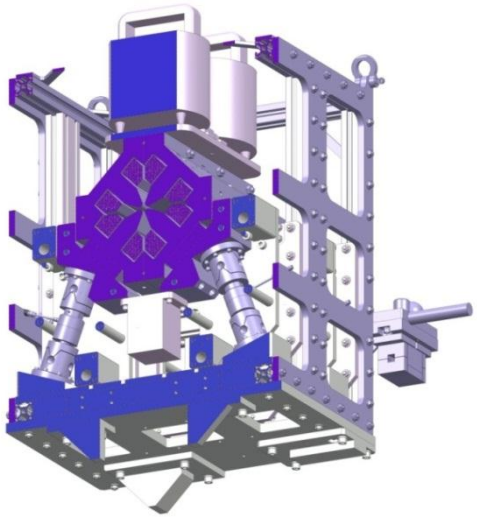


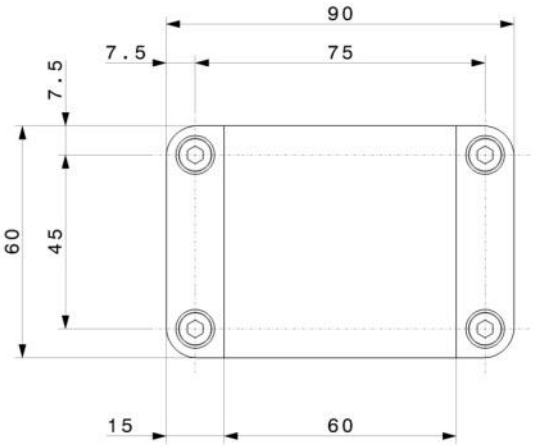
Requirement	Value
f_1	5 Hz->manufacturability
d_{max}	2 dB
f_s	>300 Hz
S	0.05 V/10^{-6}m and 1 V/10^{-6}m
Linearity	90 dB
Max DC offset	0.5 V
m	<1.5 kg

Requirement	Value
Orthogonal rejection	>55 dB
Sensitivity change due to tile +/-0.5deg	<1%
Sensitivity change due to tile +/-0.5deg	<1%

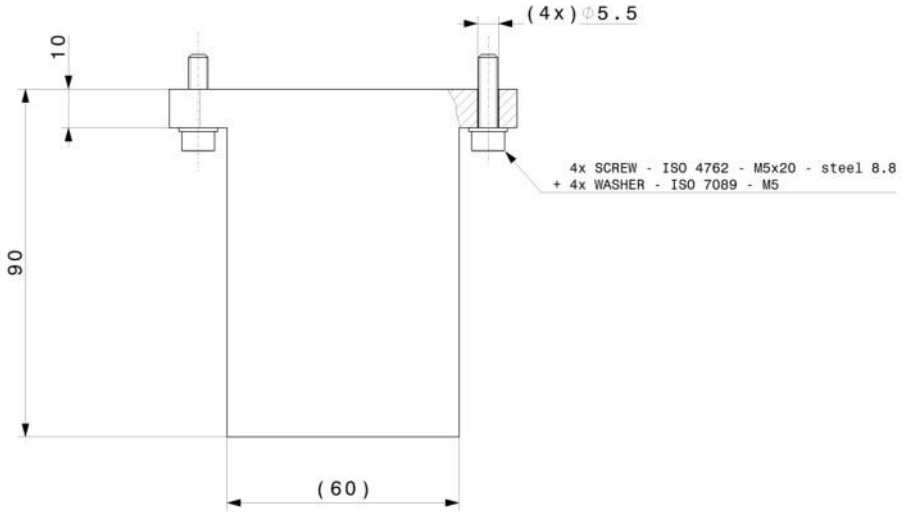
Geometric requirements



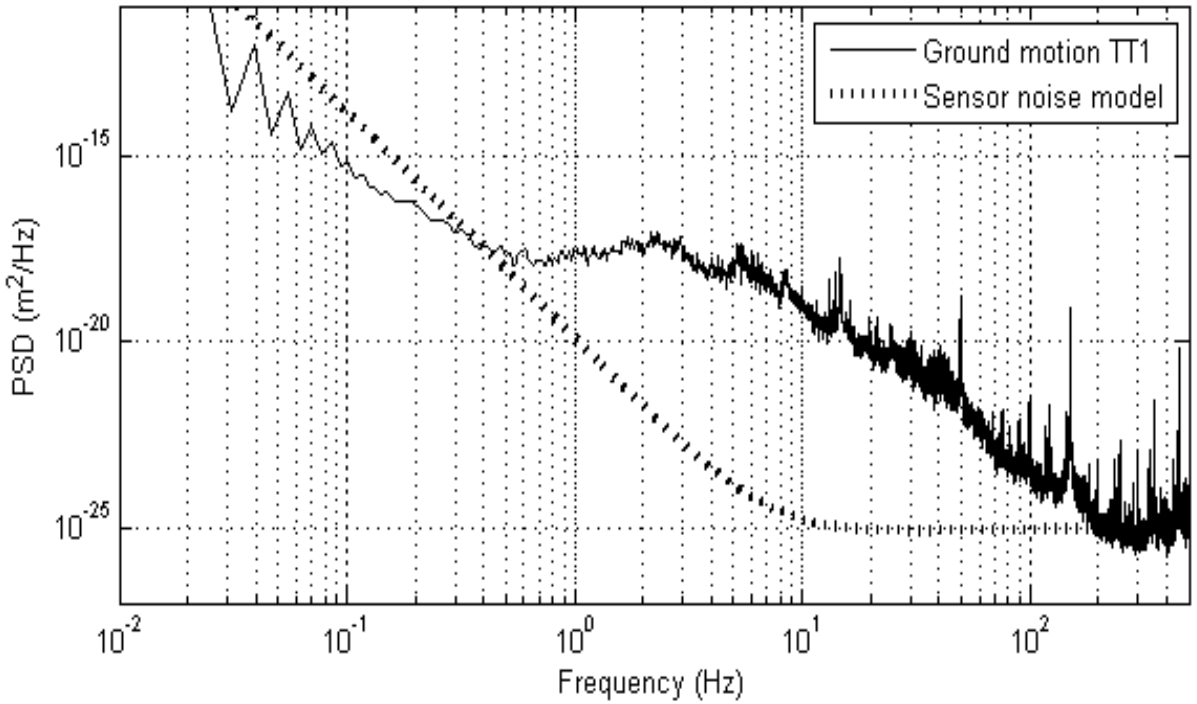




Under the magnet
Limited volume available (60x60 mm)
4 screws for attachment



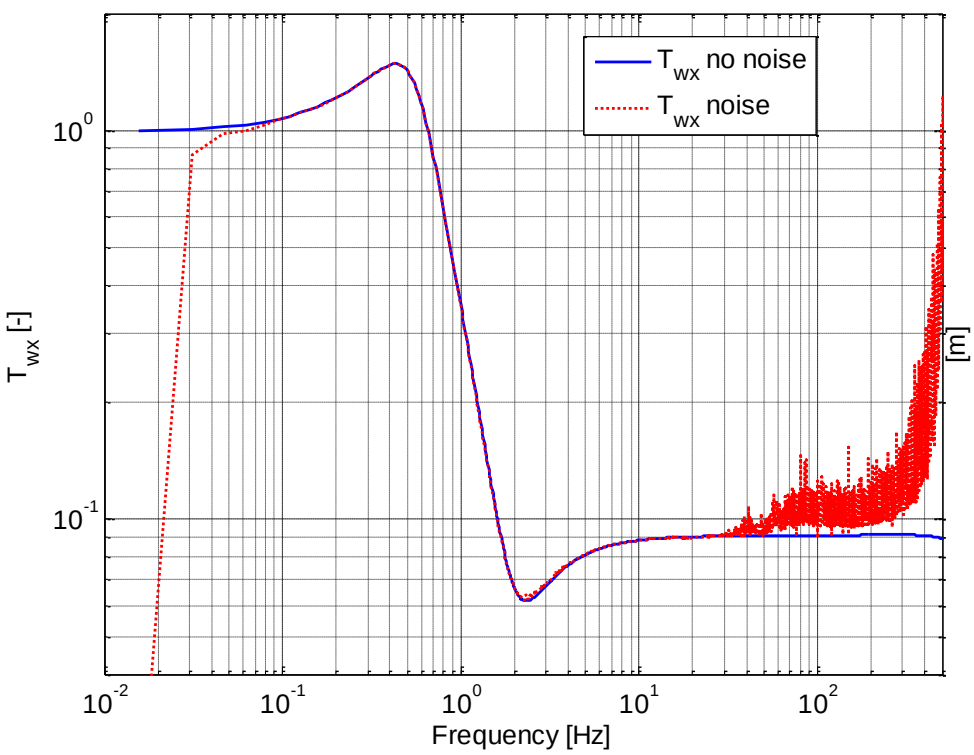
Noise requirements

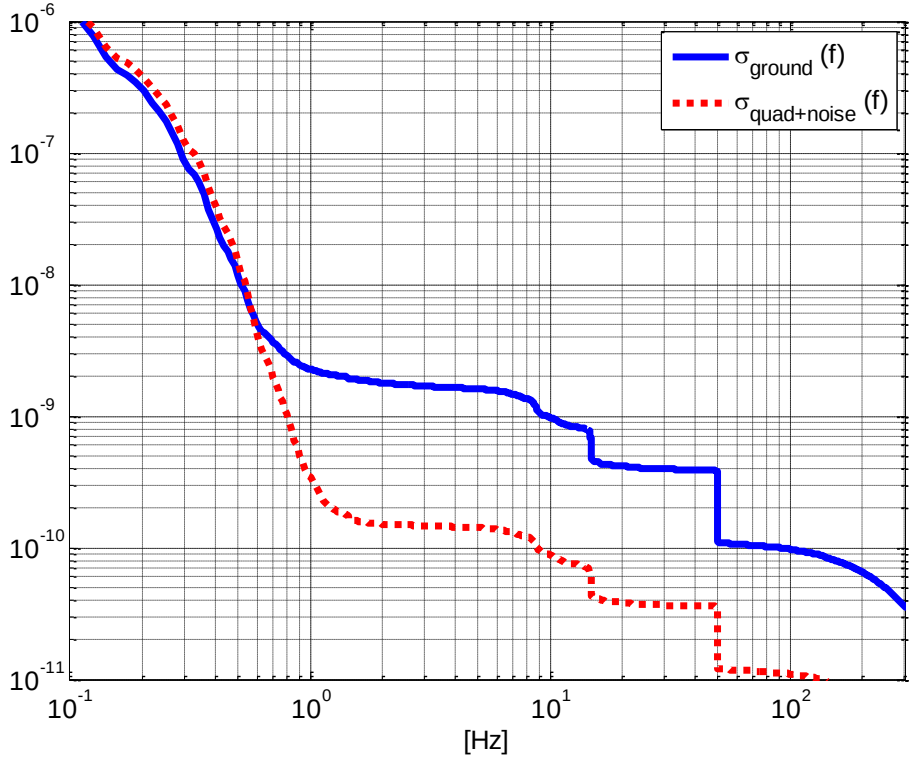


- Defined Max. noise curve
- 6th order drop off with
- flat bottom
- Enough room at low frequency (no control over microseismic!)

6 poles	**[0,0,0,0,0,0]**
6 zeros	3x [2π7+10i, 2π7-10i]
Gain	10^{-25}

Noise requirements



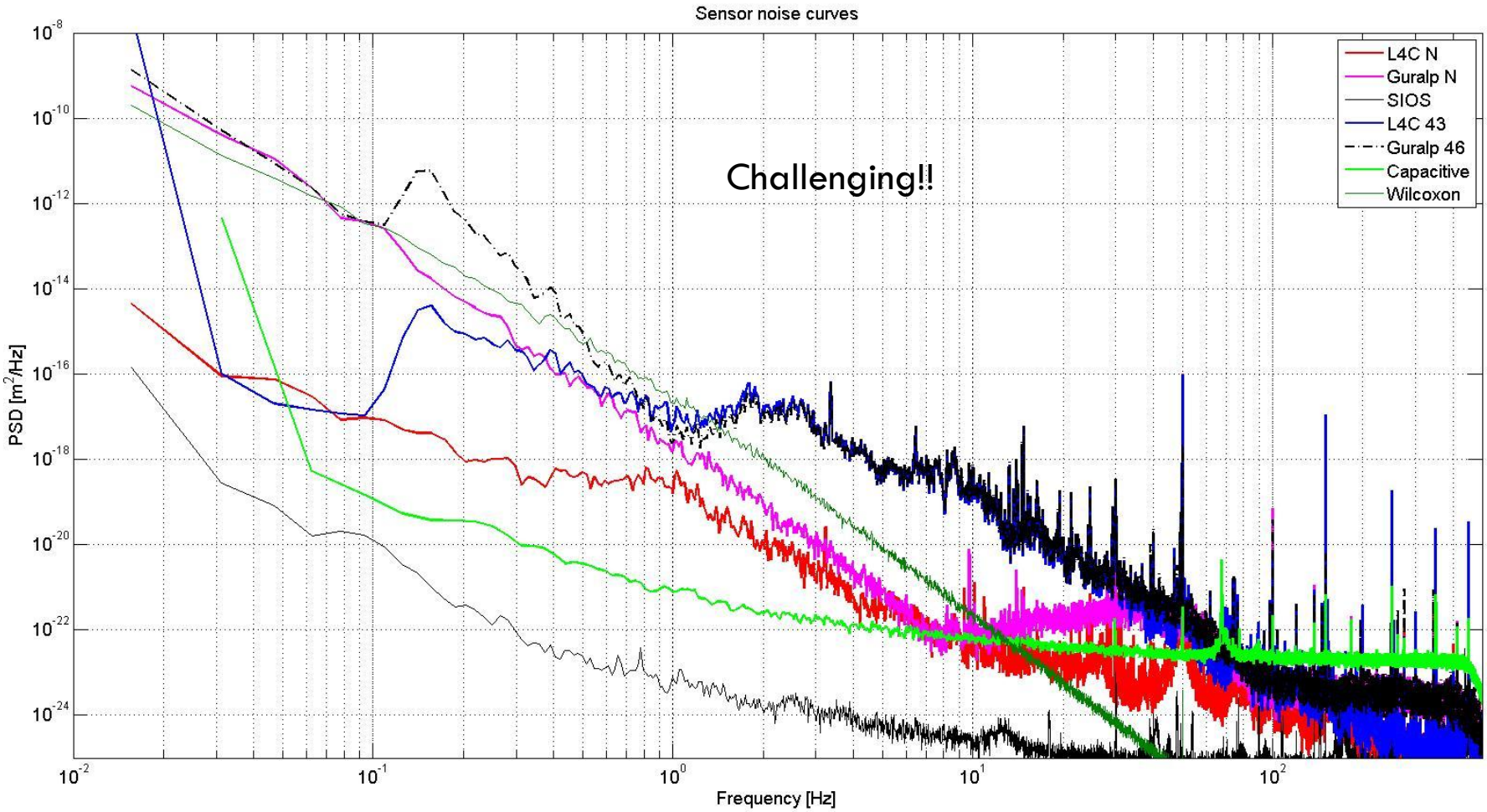


Noise limit reached >200 Hz

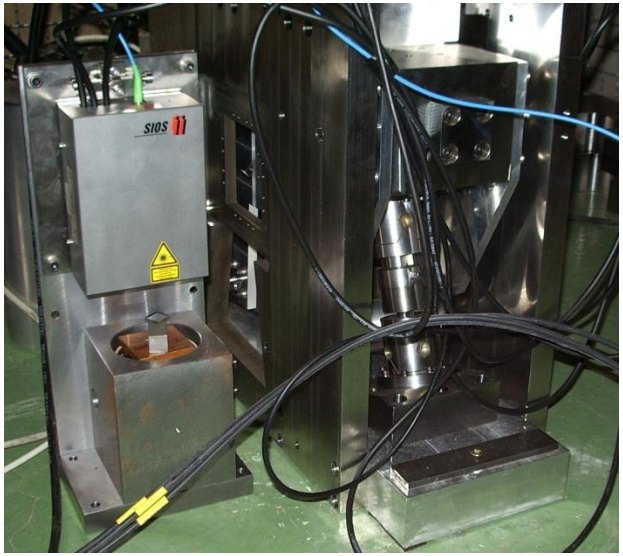
Addition to r.m.s. negligible ->0.2 nm integrated r.m.s. @1 Hz

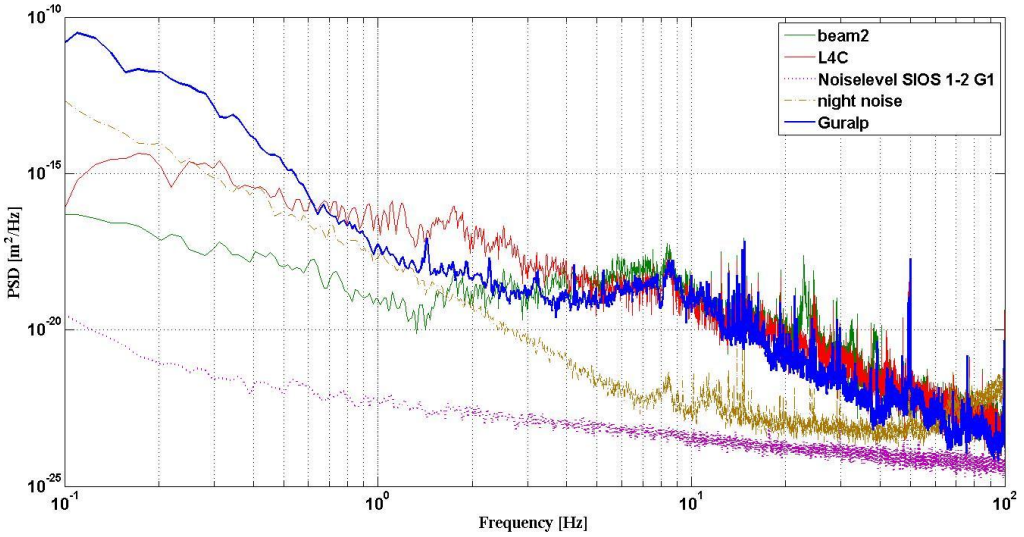
Is this noise request realistic?

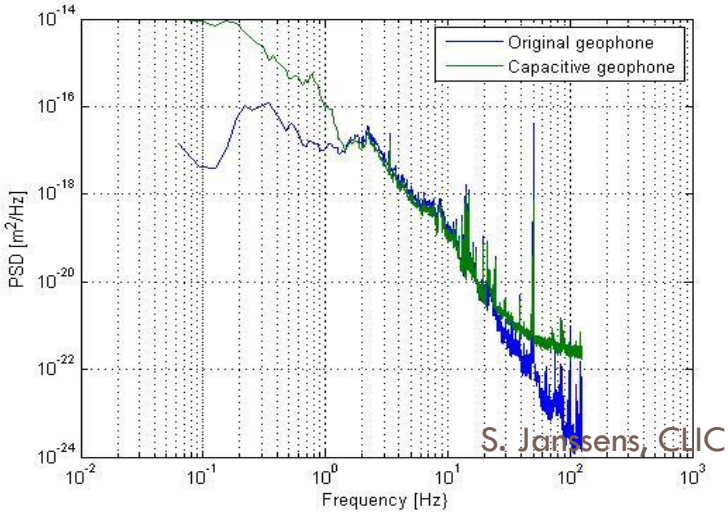
Noise requirements

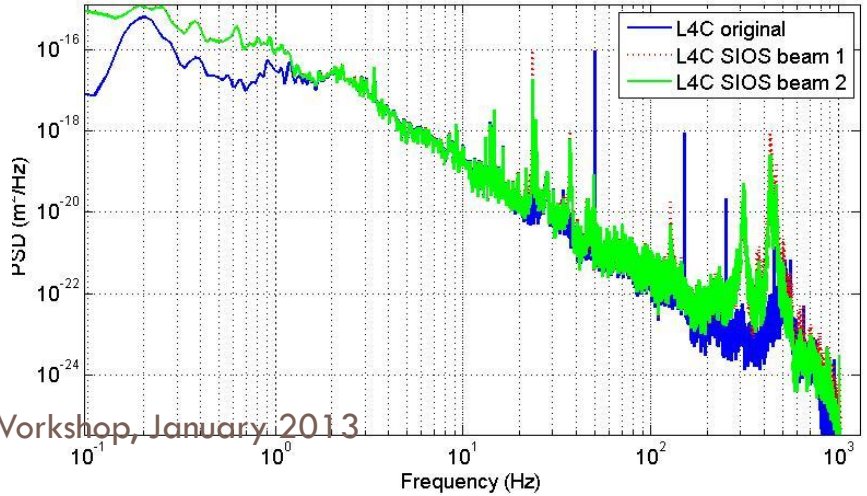


Inertial reference mass proto (v3): With interferometer/with capacitive gauge







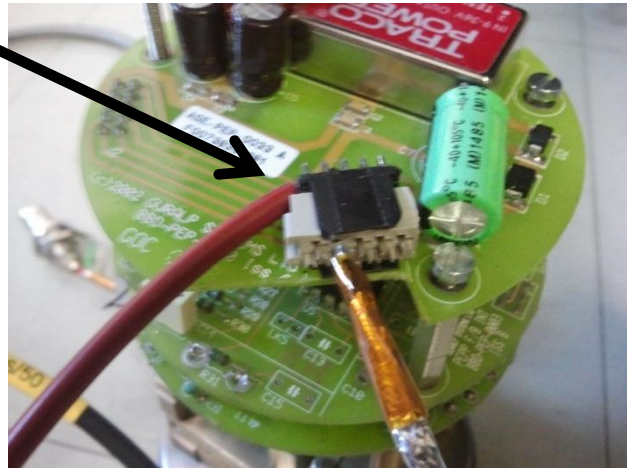


Guralp mass position tests

Measured several pins on the top pcb connector based on pcb reverse engineering Pablo Fernandez

10 pin connector:

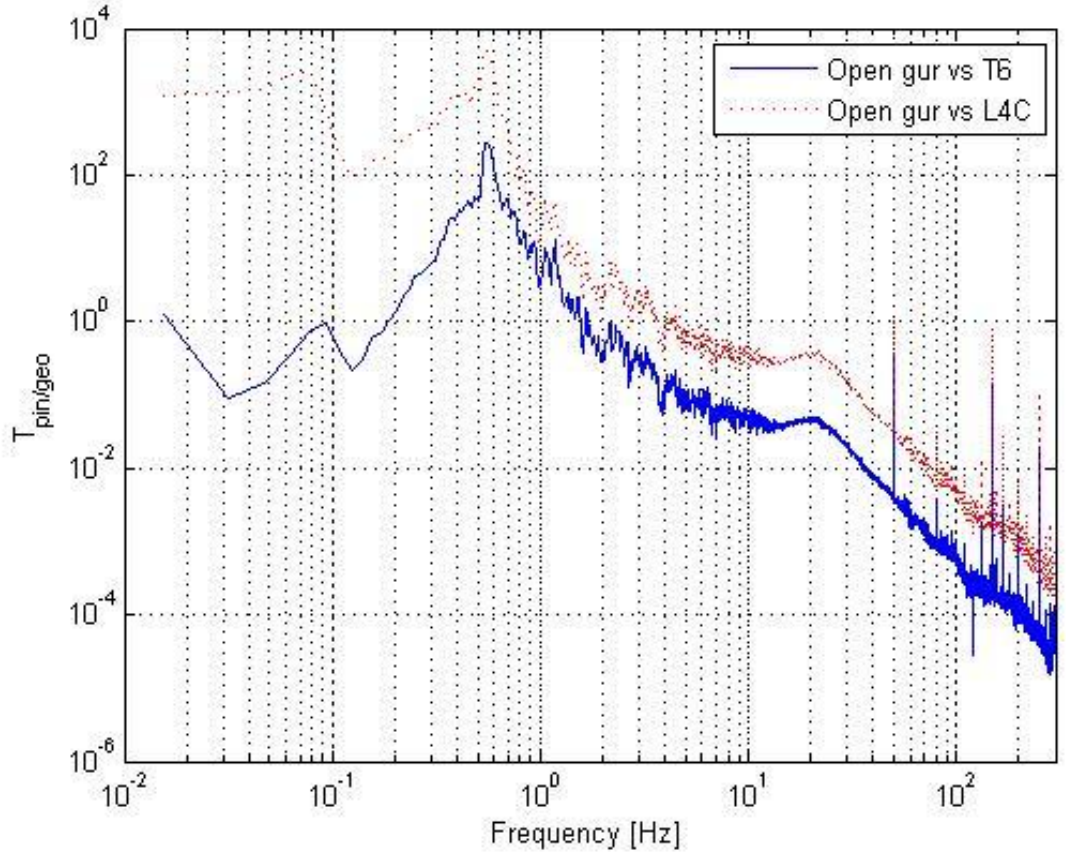
Pin 1 Mass position
Pin 4: GND
Pin 10: Vel +



Guralp mass position tests

Pin 1 Mass position

- High resonance with drop off
- Secondary mode
  not disconnected filter?



Environmental parameters

Temperature

- The operation temperature of the air surrounding the sensor will vary between 20°C and 40°C.
- The sensitivity curve and the noise curve should not change more than 1%
- The DC offset voltage created by the temperature drift should stay within 0.8 V.

Magnetic field

- The stray field of the quadrupole is 0.15E-4 T (0 Hz).
- Drivebeam (?)
- Kicker stray fields (?)

Radiation

- Difficult as very high near magnet (1000-10000 Gy (source: S. Mallows))
- Electronics away from beam (except adapted resistors, capacitors etc.)

Activities

Activities at the Contractor's Premises

The contractor shall execute the following activities at his premises:

- Design
- Prototyping
- Manufacturing
- Calibration
- Measurement sensitivity curve and noise curve

Activities on the CERN Site

The contractor shall execute the following activities on the CERN site:

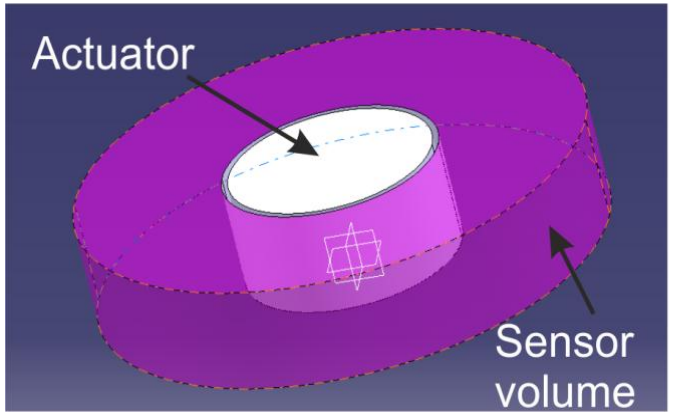
- Measurement of the sensitivity curve in a low vibration back ground
- Measurement of the noise curve in a low vibration back ground

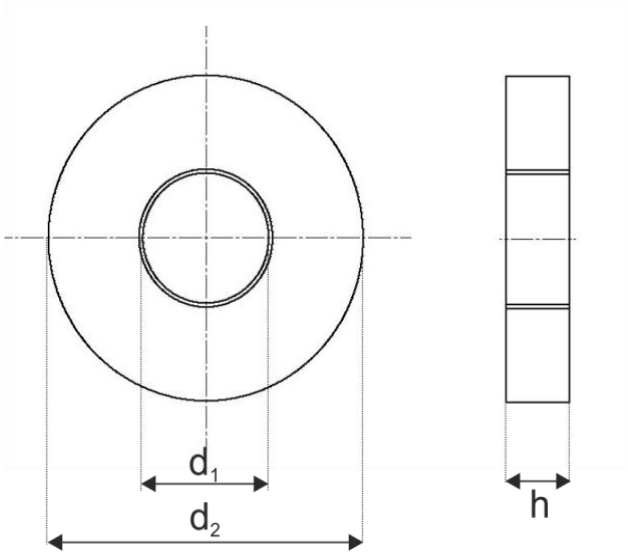
Items and Services Supplied by CERN

CERN will supply the following items and services:

- CERN will provide a place with low vibrations
- CERN will provide during the measurement of the sensitivity curve, a Guralp 6T seismometer with calibration certificate.
- CERN will provide the shielding around the power supply, the conditioners and electronics.

Collocated sensor





Requirement	Value	Tolerance
d1	39.8 mm	
d2	67 mm	
h	20 mm	
l	5 m	
θ	20 degrees	+/-3
m	0.6 kg	

Same noise and sensitivity curve
Same Environmental parameters
For a later stage?

Conclusion

- From beam simulations a preferred sensor sensitivity is determined
- The volume to fit in the type 1 and type 4 full stabilization is limited to 60x60x60 mm
- The chosen maximum noise curve is challenging but possible
- The environmental parameters are standard except for the radiation => electronics outside of highly radiated area

Note: 20th of March we will have visitors from the Fraunhofer institute to test their accelerometer