Present activity on ET program in Moscow State University: Newtonian noise estimation in BNO & Overview of CaF_2 mirrors cryogenic experiment.

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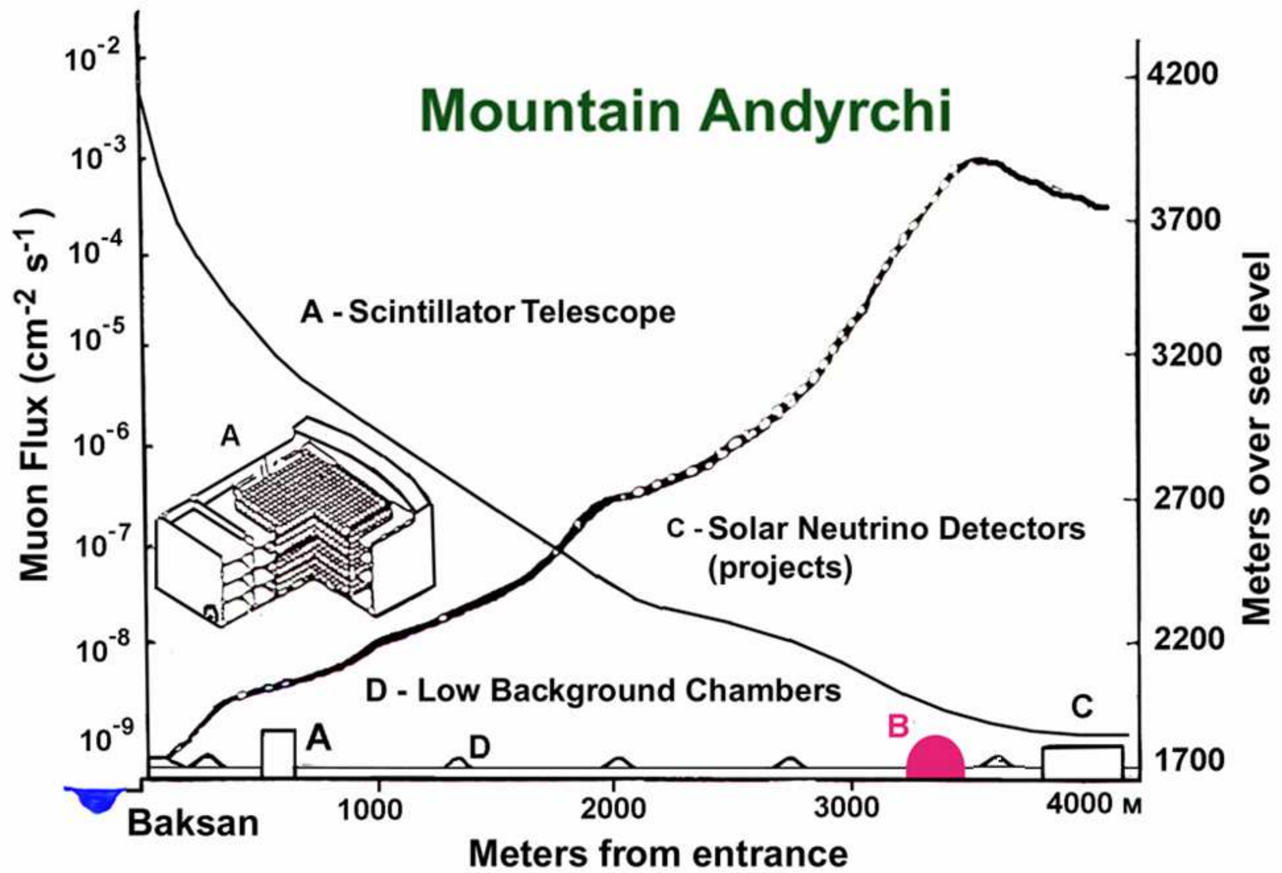
Experimental research of seismic and gravitational backgrounds was foreseen in the frame of ET_W2 program. Measurements of the seismic noise level were performed along the horizontal tunnel of the Baksan Neutrino Observatory (BNO) Russian Academy of Sciences, having 4 km length under the Andyrchi mount (3700 m).

Photo of the Andyrchi mountain

Surrounding rock geological minerals are the plagio gneiss down to the depth 800 m, and plagio granites at more deep levels. A density of these rock species practically is equal in average 2.8 g/cm^3.



BNO tunnel and amount of rocks

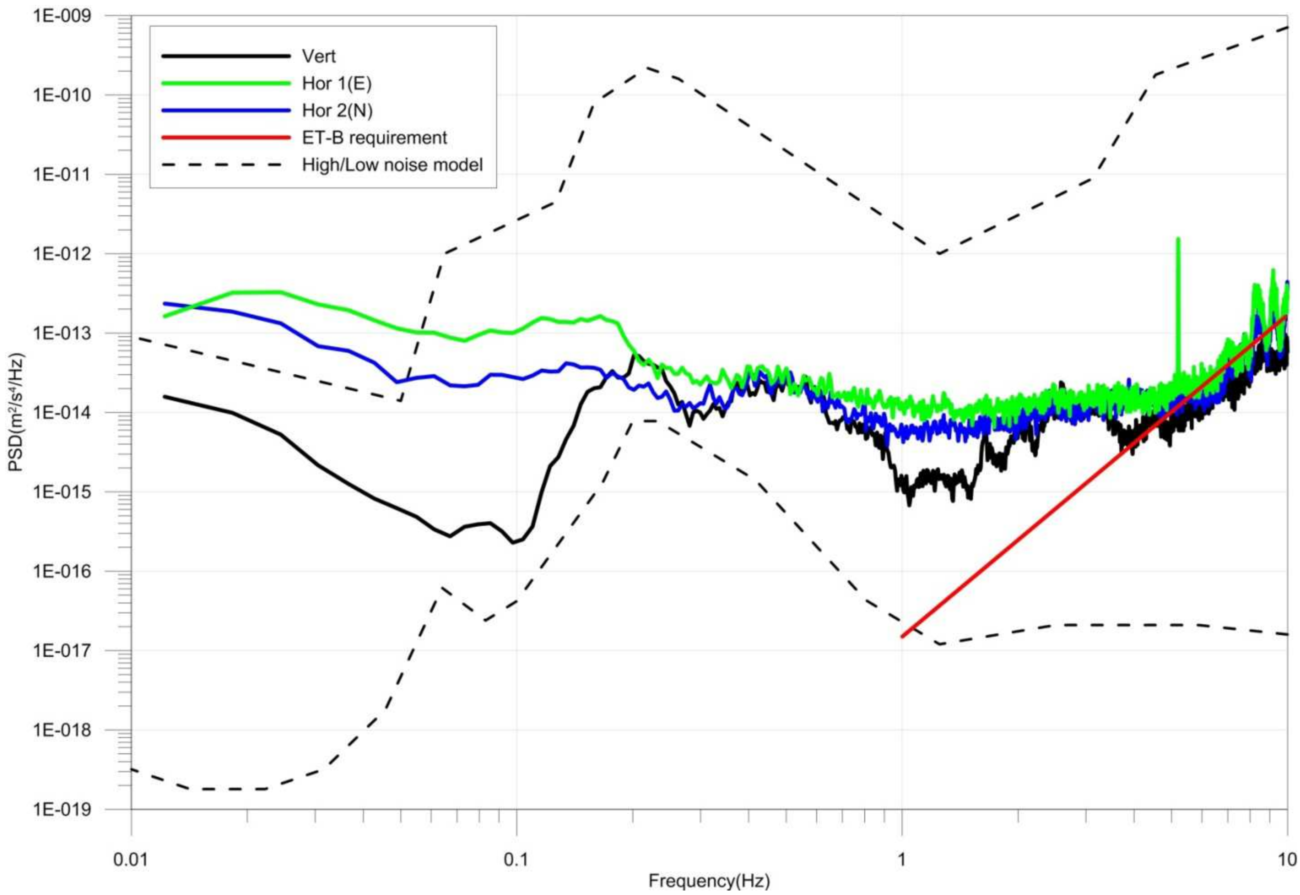
A simple estimate of correspondent spectral intensity of the Newtonian Gravitational Noise associated with the measured seismic background was found using Saulson model.

According to this model, stochastic displacements of the interferometer's mirror under the action of the variable Newtonian gravity field induced by seismic perturbations can be calculated through the following formula

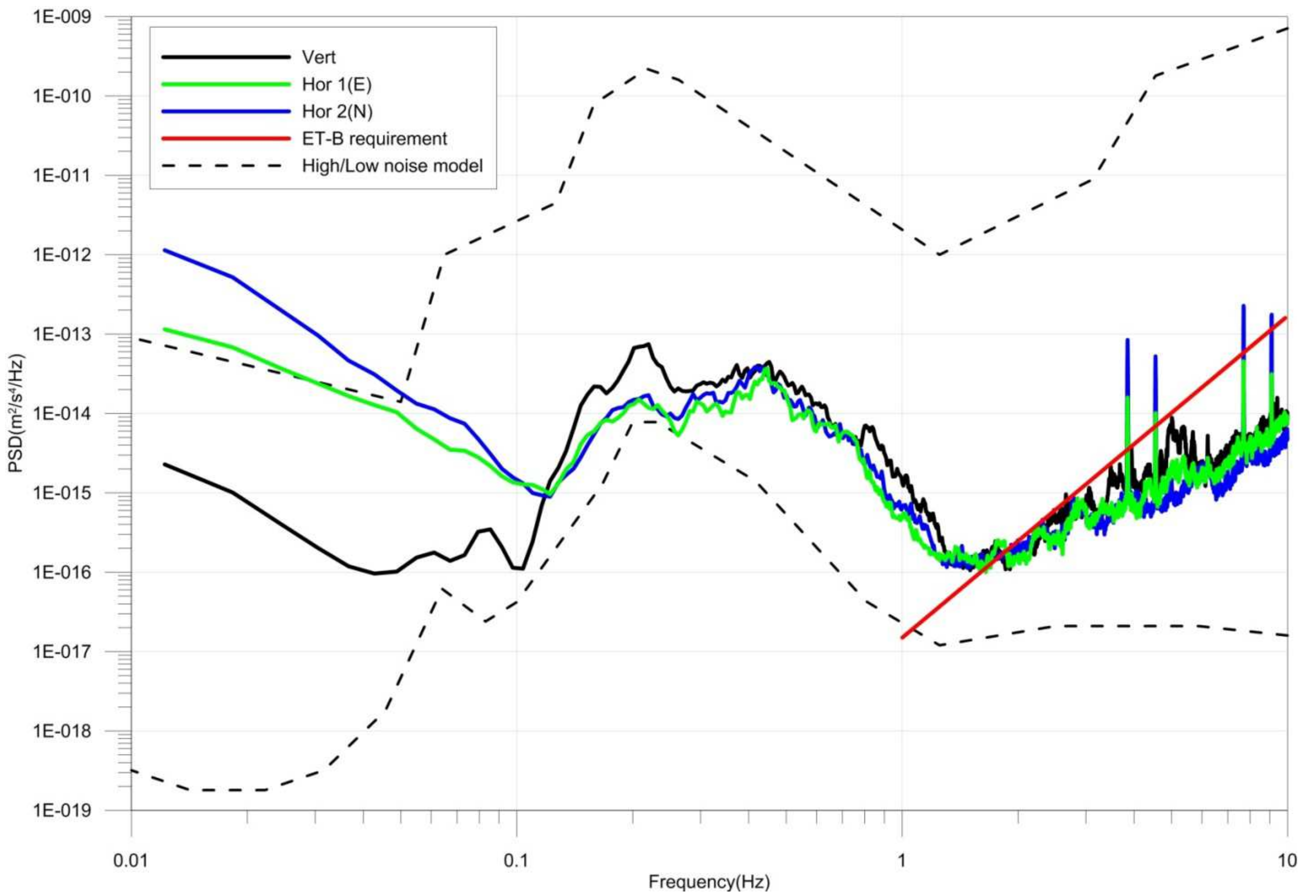
$$\left|\Delta x(\omega)\right|^2 = \frac{16\pi^2}{3}\frac{G^2\rho^2}{\omega^4}\left|\Delta X(\omega)\right|^2$$

where |Δx(ω)|2 is the spectral density of mirror's displacement (along the x-axis) produced by the stochastic Newtonian force generated by rock density variations associated with the seismic spectrum |ΔX(ω)|2 ; ρ is the average rock density and G is the Newtonian constant.

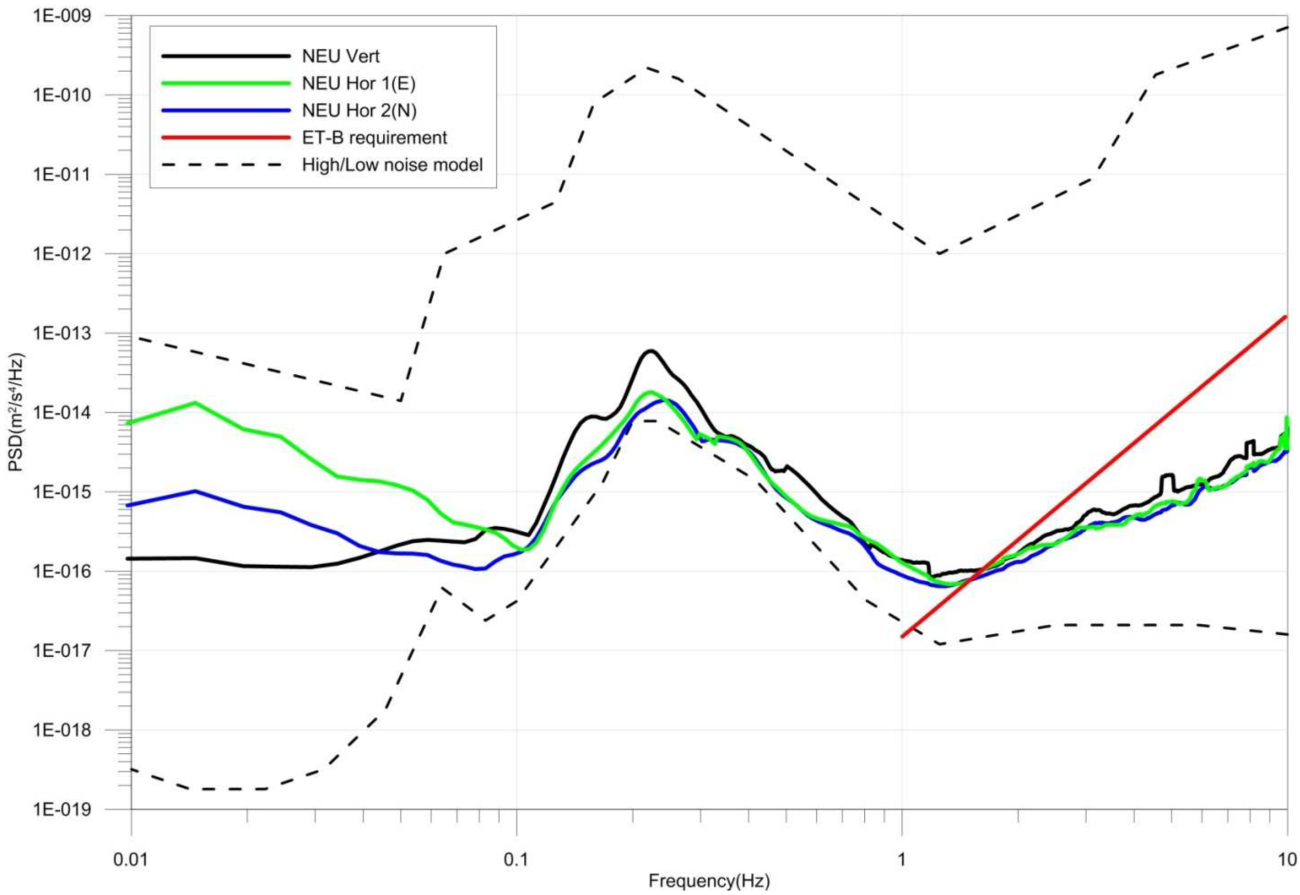
We supposed that seismic spectrum is homogeneous and corresponds to the measured spectral intensity given above for these selected marks. Also the length of conceivable probe interferometers, which can be placed at each mark, is supposed to be long enough for to consider stochastic displacements of the front and end mirrors as uncorrelated. Then a variance of mutual mirror's displacement will be twice time larger comparing with the previous formula.



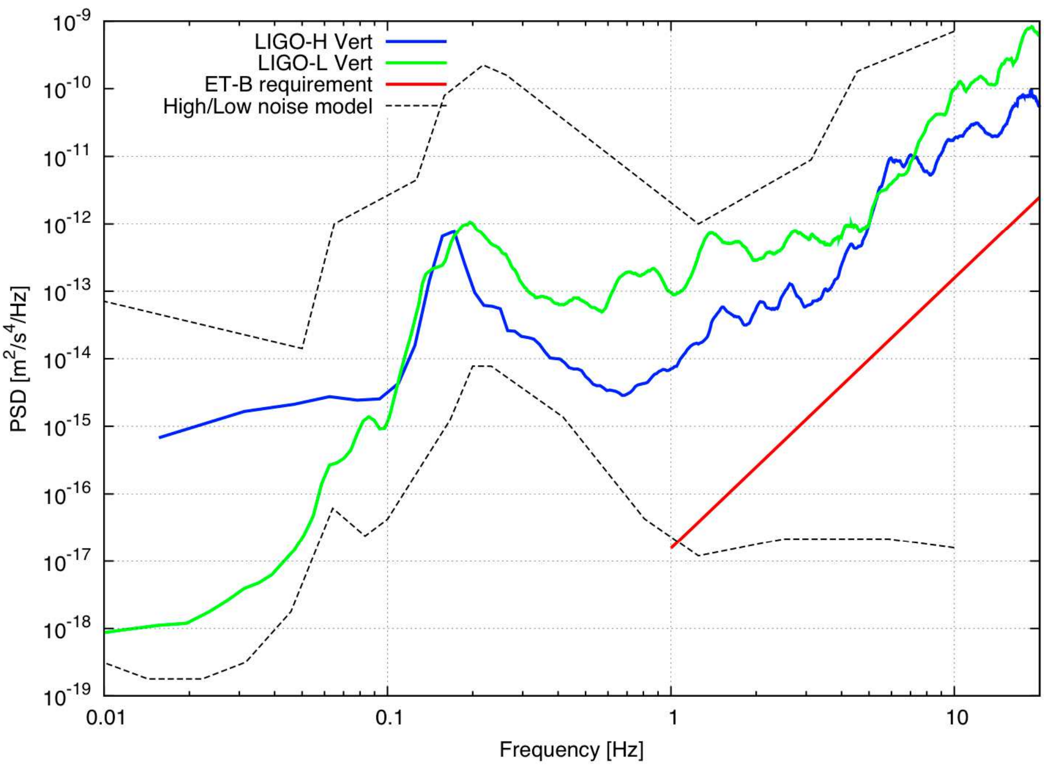
Acceleration spectrum at the mark 300 m



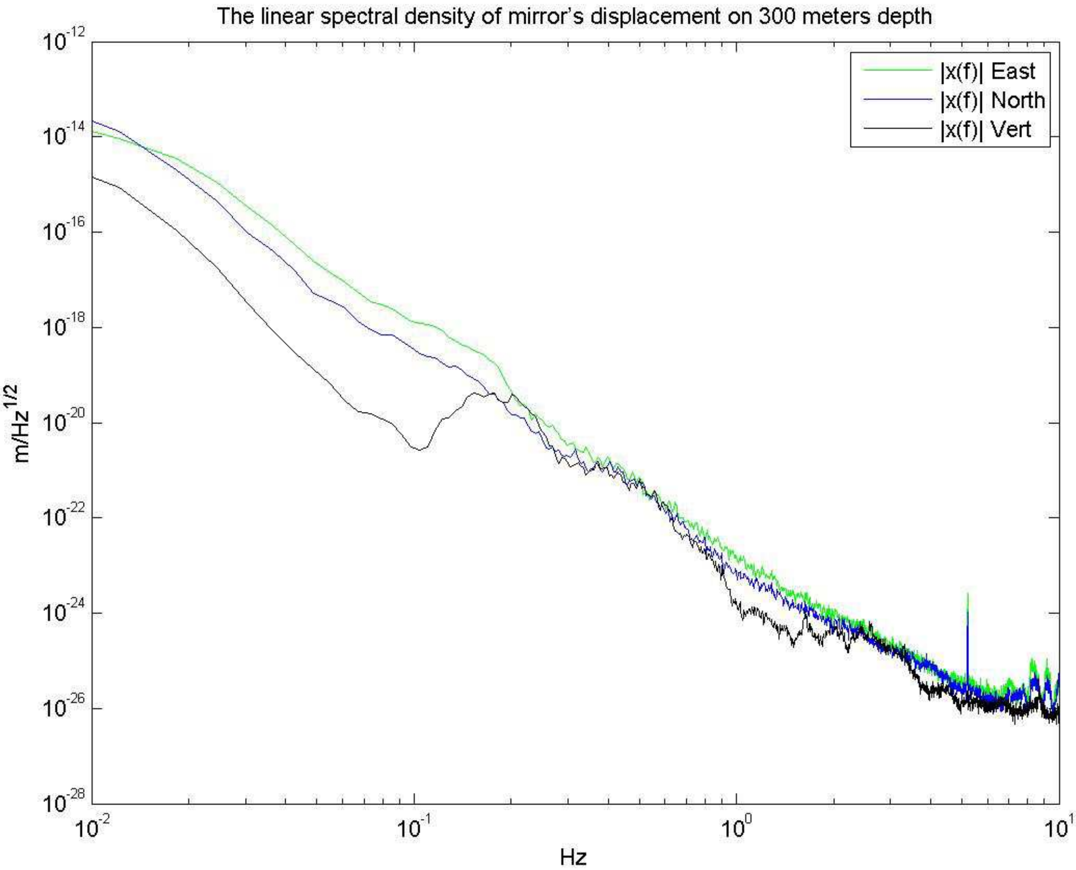
Acceleration spectrum at the mark 1500 m

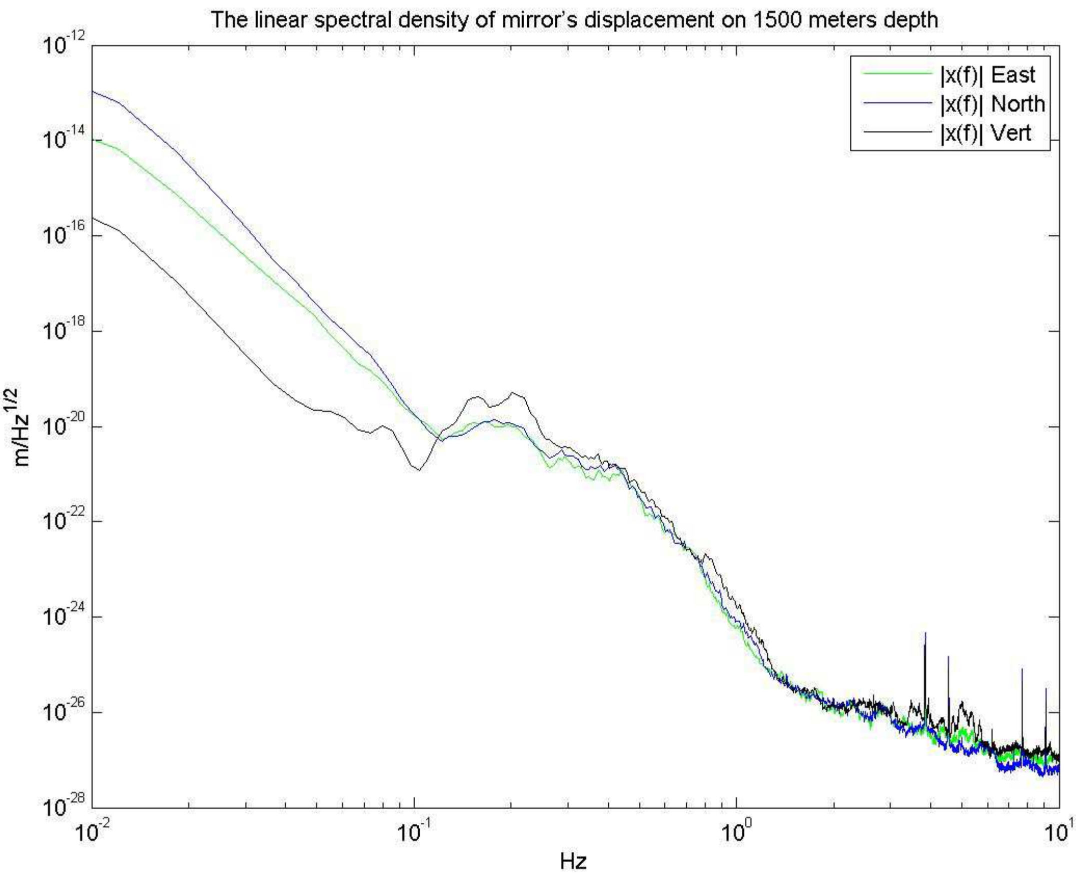


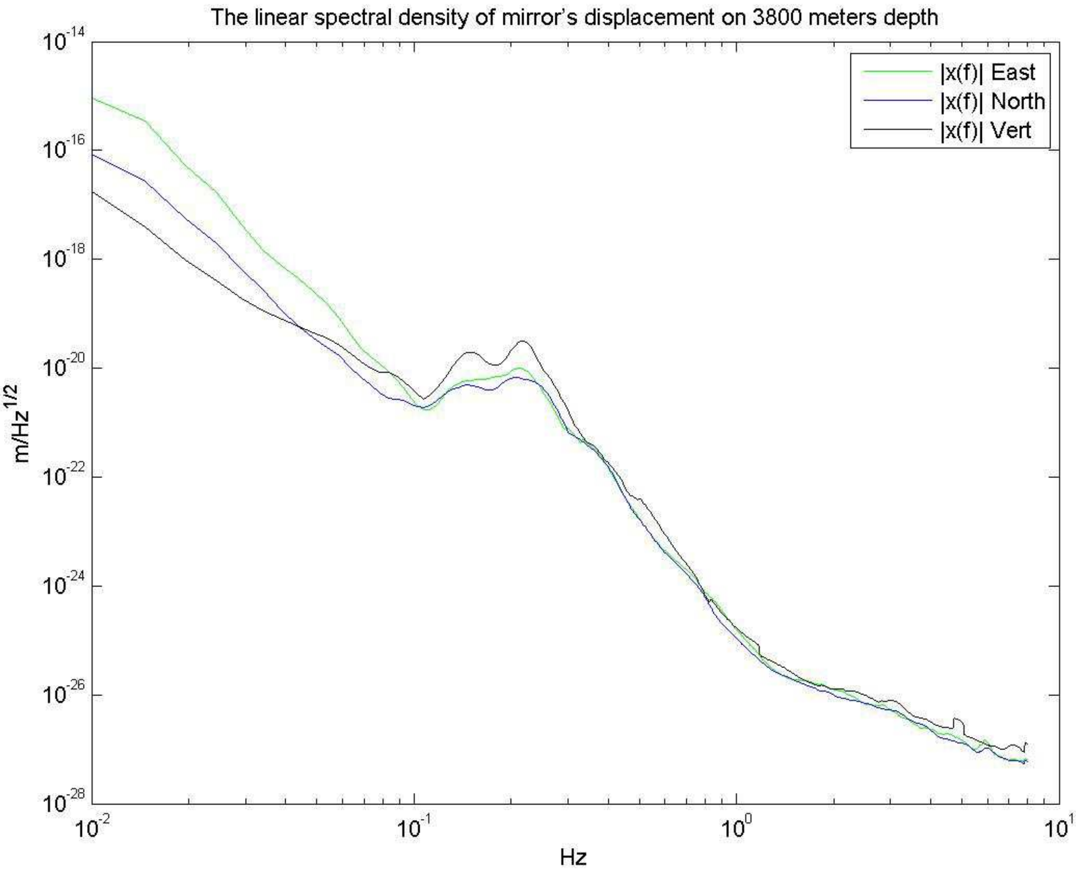
Acceleration spectrum at the mark 3800 m (averaged)



LIGO seismic noise.


The linear spectral density of mirror's displacement on 300 meters depth
|x(f)| East
|x(f)| North
|x(f)| Vert
m/Hz^1/2
Hz

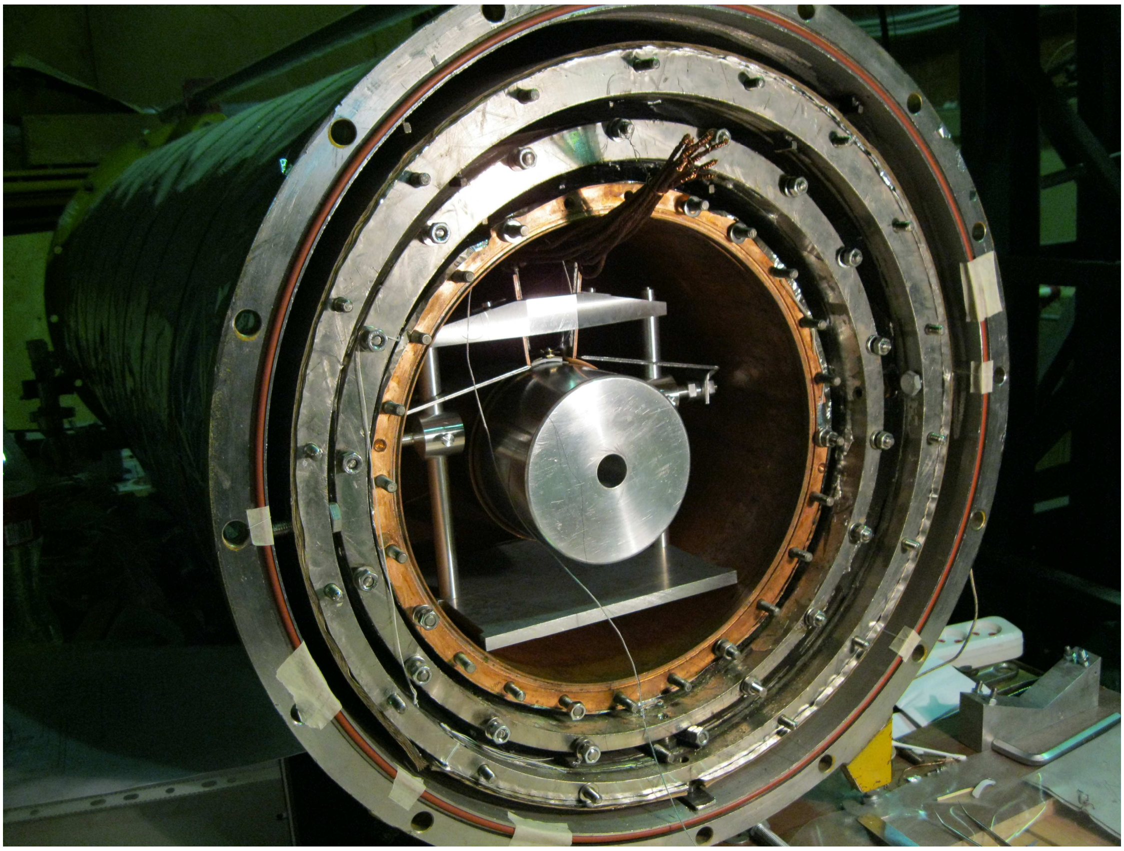

The linear spectral density of mirror's displacement on 1500 meters depth
|x(f)| East
|x(f)| North
|x(f)| Vert
m/Hz^1/2
Hz



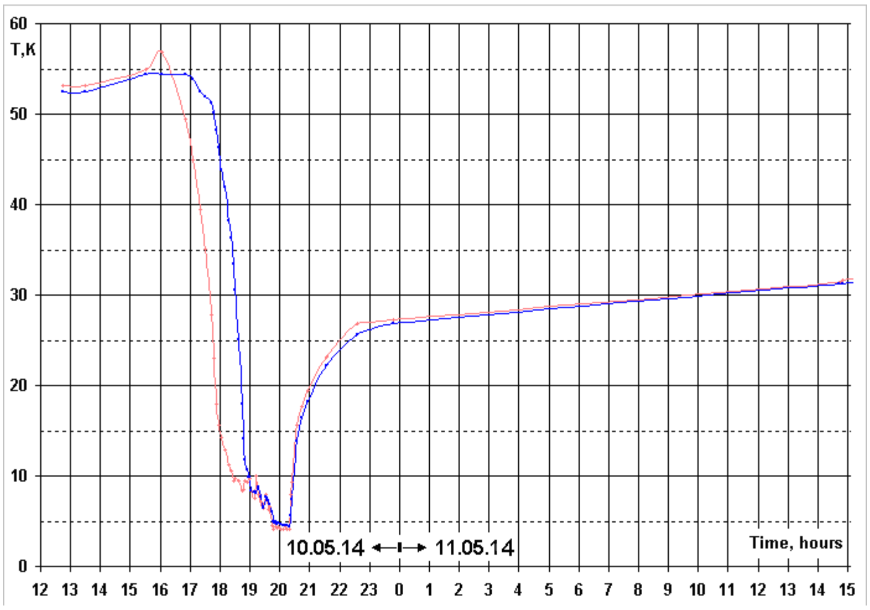
The linear spectral density of mirror's displacement on 3800 meters depth
|x(f)| East
|x(f)| North
|x(f)| Vert
m/Hz^1/2
Hz
10^-14
10^-16
10^-18
10^-20
10^-22
10^-24
10^-26
10^-28
10^-2
10^-1
10^0
10^1

Cryogenic experiment with CaF_2 mirrors

Investigation of the of the substrate and mirror coating behaviors at low temperature is important task in the frame of ET_W2 program.
The cryostat for the cooling of relatively large volume was elaborated in SAI MSU.

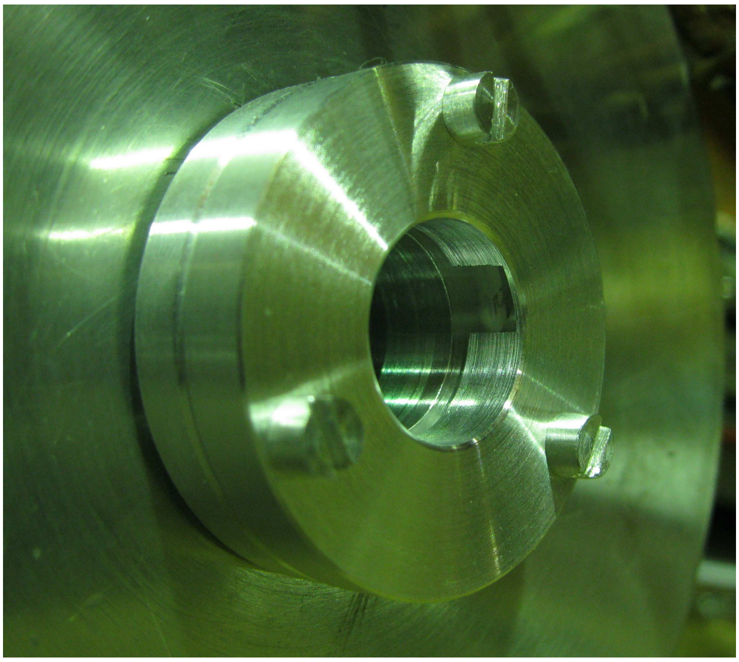


The cryostat with test body inside.



Temperature behavior during cooling process.
Red line – temperature on the inner shield; Blue line – test body temperature.

The cryostat was allowed to reach a temperature near the boiling point of liquid helium on the test body.
The direct measurement of the Finess characteristics of the Fabry-Perrot interferometer during cooling process was chosen in the cryogenic mirrors experiment in SAI MSU. For this task the Fabry-Perrot interferometer from the mirrors with CaF_2 substrates was constructed, attached to this test body for the good thermal conductivity.



The place-holder for the thermal sensor on the back-side of the mirror

The first experiment with test CaF_2 mirrors was negative – the coating surface was destroyed. We suppose that this is due to bad quality of the substrates.