VIRGO EGO European Gravitational Observatory

REALIZATION OF A WIND SHIELD FOR INFRASOUND

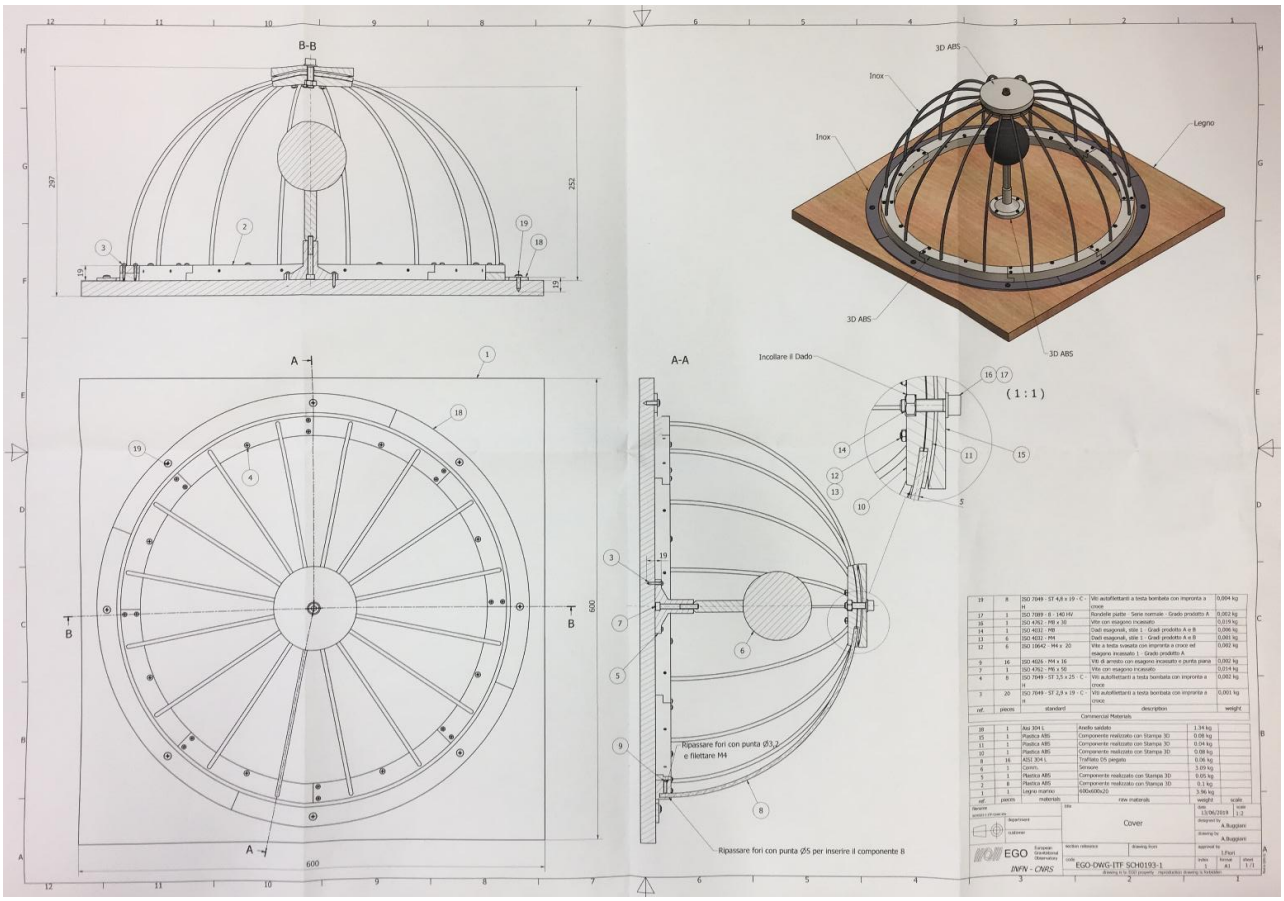
Gazzetti Alessandro, Petrai Vittorio, Porri Nicola

Liceo Scientifico F.Enriques, Livorno

Stage at EGO

1-5 July 2019

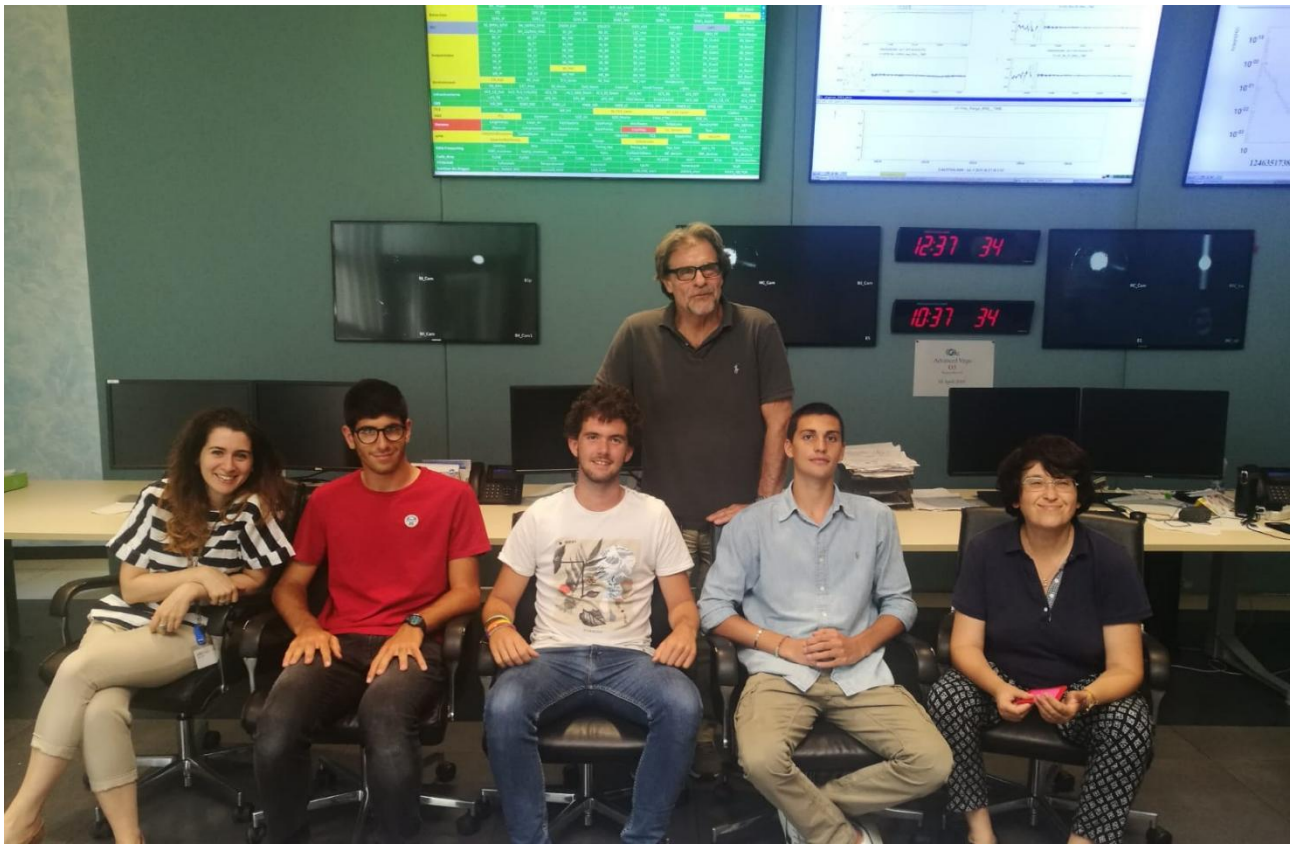
VIR-0735A-19



General introduction

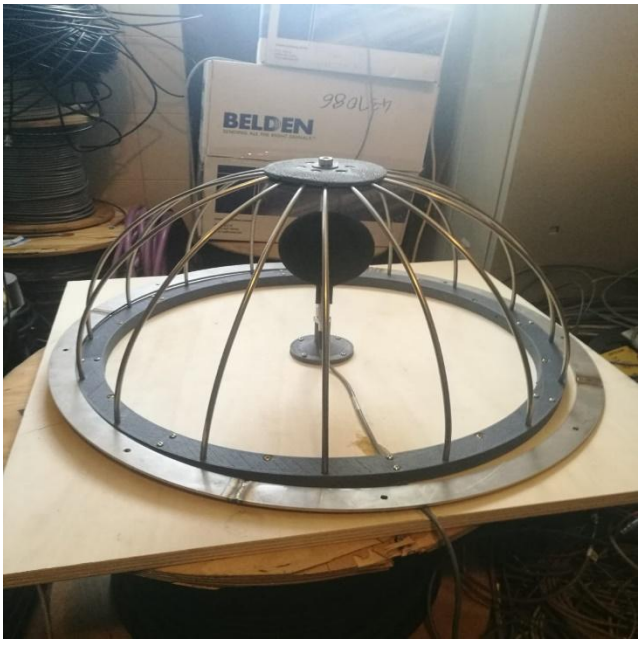
In the week running from 1st of July to 5th of July 2019 we, three students attending the Liceo Enriques school based in Livorno, have taken part into a project under a work-school exchange at the European Gravitational Observatory in Santo Stefano a Macerata, Cascina, Pisa. The aim of the project was to elaborate a shield to protect audio sensors from interference generated by wind or others sources of noise. Along these sources of environmental noise that can affect negatively the Gravitational Waves study also figures the Newtonian Noise which was the one on which we focused during these five days. NN is caused by moving or vibrating objects and can be divided into two types: seismic and atmospheric. Seismic NN has already been investigated and there are attempts taking place at the moment to reduce its impact on the interferometer so our work was centred on Atmospheric NN. This type follows the pattern of the Newton's Law and so it depends

directly on the masses of the objects and it is inversely proportional to the distance between them. These means that masses of air being transported by winds can result, further than in the noise generated by the turbulence, in a very heavy NN and so there is a huge need to find a way to be able to measure also this latter noise. In order to get this done, a structure covering the audio sensors able to decrease the noise generated by the turbulence is needed.



Monday 1st July 2019

As we arrived to the building, we were introduced to the EGO centre by Federico Paoletti and Irene Fiori who provided us with essential information about the VIRGO project and about all the work that is hidden behind it. After this introduction, we were presented the shield project realized by Alessio Buggiani who unfolded us some important notions related to the assignment. Following the instruction given, we assembled all the pieces of which the protection is made up in the electronic laboratory by using the tools that we were equipped with. Once we finished the construction, the result was a cage-shaped structure with metallic, plastic (3D printed) and wooden components covered by a length of an extremely specific cloth. Named Sumbrella Sling, this fabric is used in military fields (e.g. CTBTO) to obtain accurate acoustic measurements.



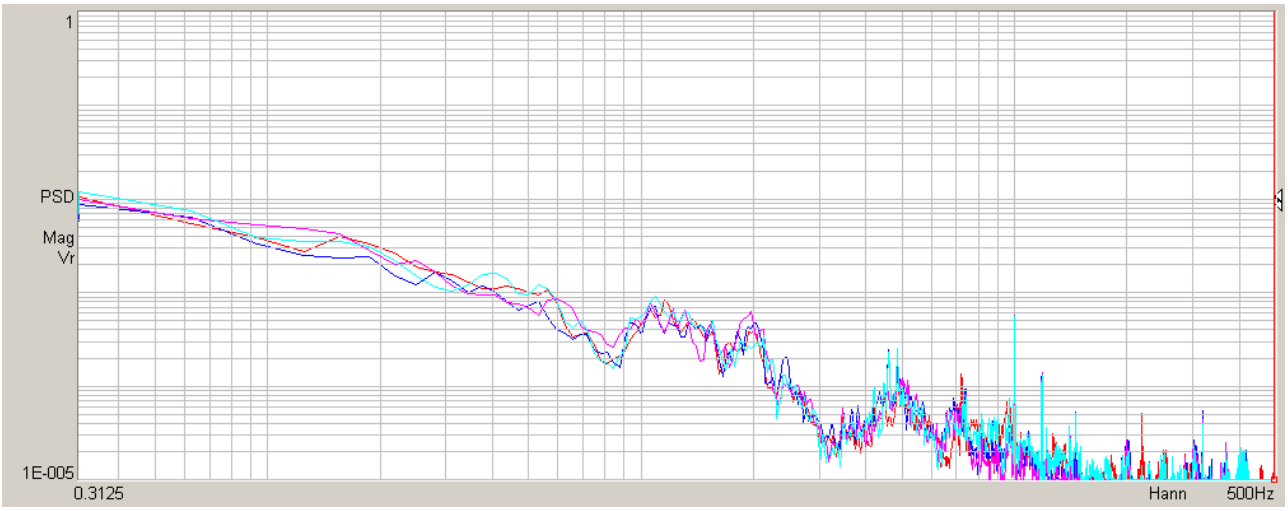
Tuesday 2nd July 2019

We started the second day with an extremely interesting visit of the EGO site guided by our tutors. We were allowed to enter the core buildings since Tuesday morning is the period of the week dedicated to maintenance and cleaning operations. The tour moved from the central building towards the North end following the North arm. As we returned to the laboratory, we were introduced to some basic instruments (e.g. oscilloscope, power supply…) and eventually to the Ono Sokki FFT Analyzer which would have been the one we used the most.

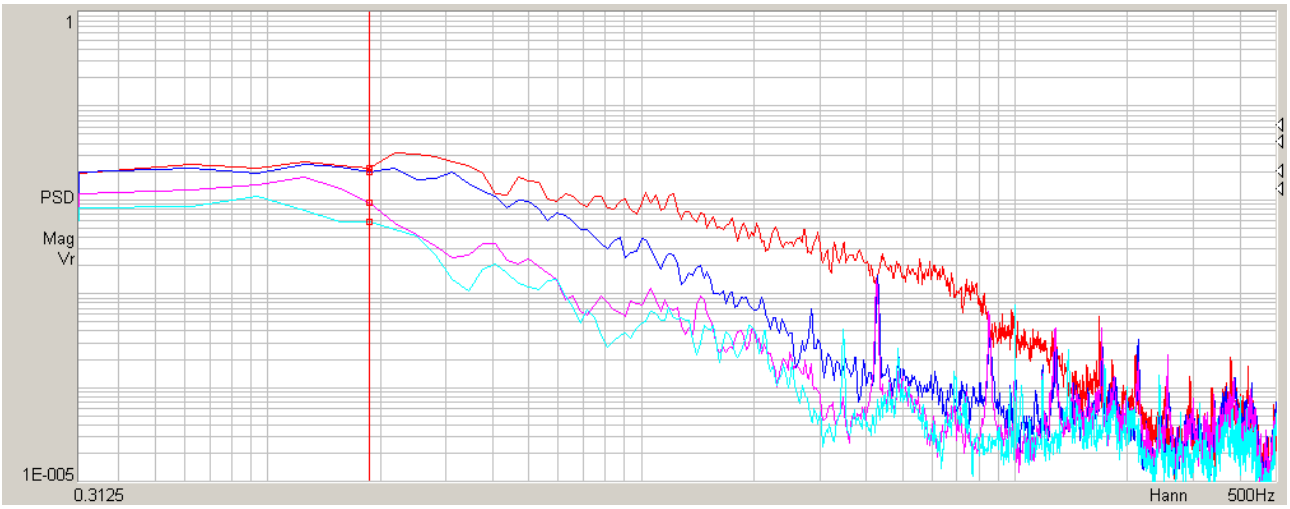
Wednesday 3rd July 2019

In the first part of the morning we attended three speeches held within the bounds of the VIRGO week by Jo van den Brand (spokesman of VIRGO), Stavros Katsanevas (EGO director), and Alessio Rocchi (commissioning coordinator) and then we started the experiments involving the shield built on Monday to prove its effectiveness inside a room of the laboratory. Using the FFT Analyzer, we managed to collect data about the ability of the shield to protect the microphone placed under its shelter from the noises generated by a fan headed towards it. We measured the correlation between frequencies and power of the noise (Power Spectrum) and we repeated the experiment changing the fan speed and changing what covered the microphone (shield, pop filter, none).

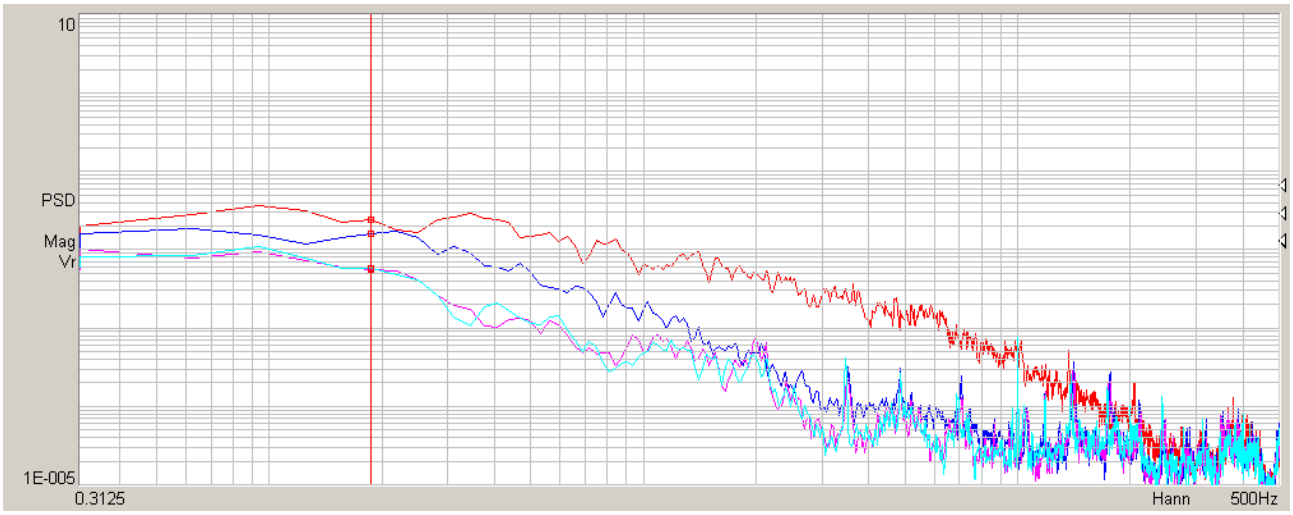
The table on the right is to be considered valid for all the graphs showed in this report.	COLOUR	SETUP
		No cover
		Pop filter
		Shield
		Shield + Pop filter



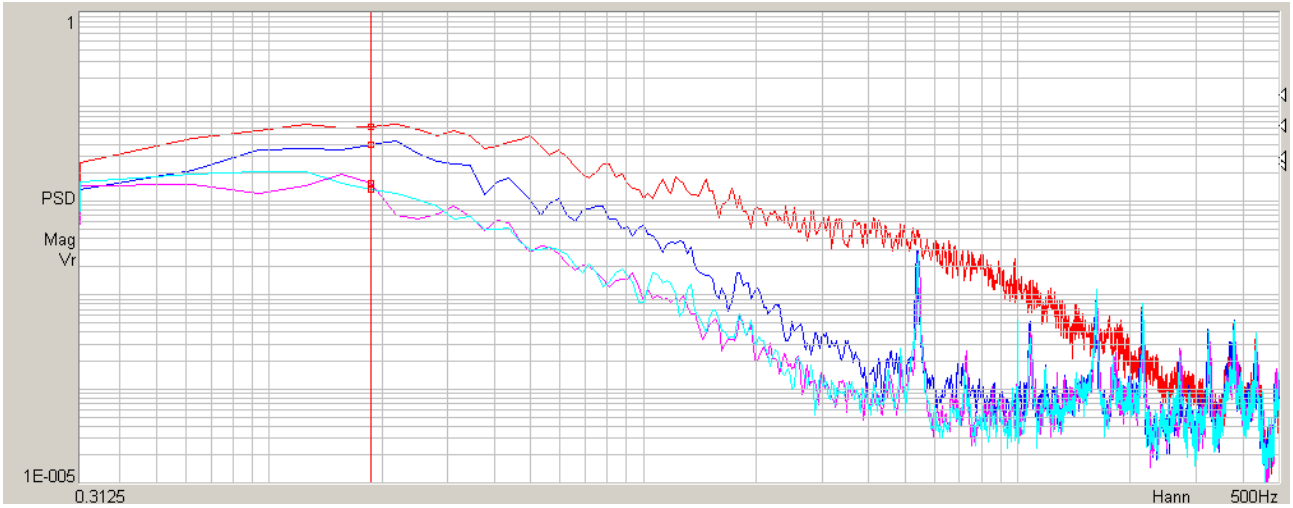
Graph 1: experiment performed with the fan switched off



Graph 2: experiment performed with the fan at its lowest intensity



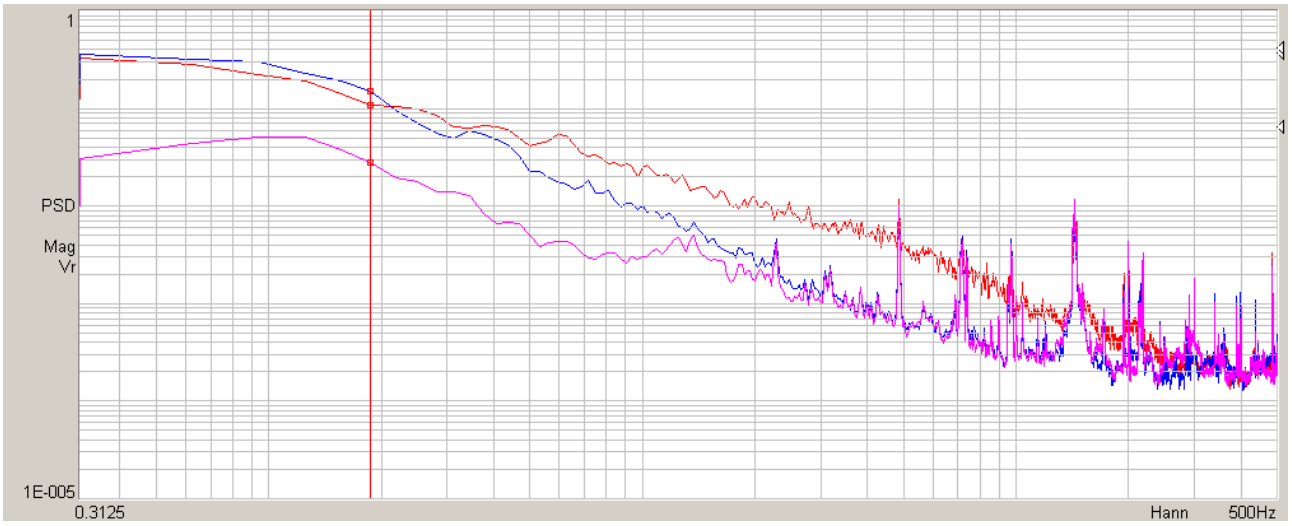
Graph 3: experiment performed with the fan at its medium intensity



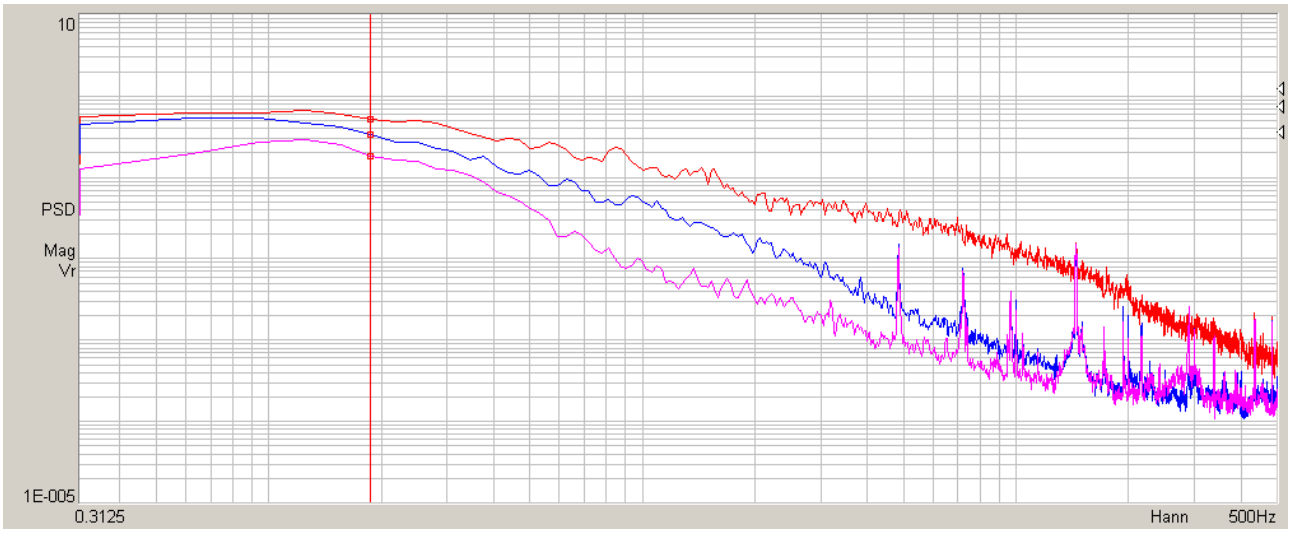
Graph 4: experiment performed with the fan at its highest intensity

Thursday 4th July 2019

We spent all the day repeating the experiment placing the apparatus outside in order to work at natural conditions without need to recreate the wind with a fan aiming to get as precise as possible results. We were forced to use two microphones at the same time since carrying the experiment out at environmental conditions did not allow us to make the wind speed being constant (as we instead managed to do the day before thanks to the fan which could be regulated).



Graph 5: experiment performed with 3-10 km/h speed of wind



Graph 6: experiment performed with 16/18 km/h speed of wind

Friday 5th July 2019

The last day of our staying at the EGO centre has been spent collecting all the data from the various instruments that we had been using and we plotted them into graphs in order to let them being more comprehensible for all those people who could need to read them in the future. We then wrote the report you are reading and eventually we greeted all those members of the EGO centre that have contributed to make our work/school experience as much interesting and entertaining at the same time as it has been.

Conclusions

The results of the experiment we have carried out are that the Sumbrella Sling shield is an extremely performing phonic protection especially for those sounds which has frequency range of 1-10 Hz if compared with the setup usually worn on microphones (pop filter). The unlike conditions in which we have worked varied the intensity of the noise recorded by the microphone with each setup built on but the pattern of the graphs fits always the same shape that is, from the setup resulting in the louder noises recorded to the one resulting in the softest, no cover-pop filter-shield-shield plus pop filter(where present). The experiments that we have carried out during this week and the data that we have collected through them push towards the conclusion that the wind shield designed by Alessio Buggiani that we had assembled is suitable for collecting useful information about Newtonian Noise and so to contribute to the improvement of the interferometer accuracy.

References

- *M.Falxa, D.Fiorucci, F.Paoletti, J.Harms and M.Barsuglia, "Acoustic characterization of Advanced Virgo buildings", VIR-0673A-18*
- *J.Noble, R.Raspet, "Infrasound wind noise reduction via porous fabric domes"* The Journal of the Acoustical Society of America 135(4):2409 · April 2014 DOI: 10.1121/1.4877982, https://www.researchgate.net/publication/267758514_Infrasound_wind_noise_reduction_via_porous_fabric_domes/citation/download