

Summary on Suspension activity (Filtering seismic noise and local disturbances @ optical level)

III Workshop ET-LF Integration
(28 September-1 October 2025)

Simulation activity (M. Pinto)

A significant activity concerning the ET-LF conceptual design of the seismic attenuation has been done.

Starting from a Virgo-like 17m-long *Superattenuator* (2011, reviewed in 2020), **a shorter configuration ~12 m height was studied**. A deeper activity has been done optimizing the simulation code for future uses/application .

A baseline cryogenic payload has been included into the model. A detailed study has been done to model and analyse the system performance and noise projection.

Focus was put on a single cavern LF configuration considering a preliminary geometry of the Base-Tower. **Tilt and Hierarchical control must be considered as well as the cryostat content constrained by cryogenic parameters.**

So far simulation did not include thermal links: next step activity will include the structure of the heat links

Open Points and next steps:

- a. Longitudinal actuation noise study on Reference solution + Cryo-PAY (Hierarchical Control);
- b. Implementation of heat-links on mechanical model.

Seismic Isolation System (F. Frasconi)

A guide-lines document with qualitative info on the Filtering Performance ((High Performance Filtering, Intermediate Performance Filtering, and Low Performance Filtering) for different mechanical structures is URGENT. This becomes an important guide for the development of different systems for seismic noise suppression. Important impact on the cavern excavation.

- Cryogenic Payload demands larger Base-Tower for the cryostat presence. Larger Base-Tower implies difficulties in the underground installation and handling.
- Heavy cryogenic payload (600-800 kg) has important impact also on the suspension mechanical structure upper part (open question: SA as a recoil mass of the cryo payload; improvement of the ground connection of the base-tower and suspension upper part).
- Importance of the **bottom-top approach** in the design and development of the SIS with heavier payloads.
- Importance of the **payload geometry for a better definition of the Feedback Control strategy**
- **Additional sensors/actuators point along the suspension chain** as a function of the payload geometry.

ET-LF Test Masses Superattenuator for Double Cavern (F. Spada)

Starting from the AdV Superattenuator scheme installed in a single cavern, it has been considered the possibility to suspend an heavier payload to be maintained inside a cryostat (600-800 kg).

A detailed evaluation of the crucial parameters (improvement of IP legs diameter size, blade thickness, mechanical filter diameter, etc.) will have an important impact on the vacuum system (improved dimension of the single vacuum vessel and base-tower).

The viability of the geometrical scheme adopted in AdV is confirmed as well as the compliance with ET requirements.

The Double Cavern solution has additional impact on the final design. The cryostat and Payload will be confined into a bottom cavern, while the top cavern will be reserved to the seismic isolation system with a short IP and the Filter Zero. Standard filters are installed on the bottom cavern together with Cryostat and large Base Tower.

The equipment installed on both cavern and connected with a very long suspension wire (**about 20 m long**), could create potential problem from feedback control point of view.

Some difficulties come from the larger dimensions of the mechanical filters with important impact on the dimension of the vacuum vessel.

General Remarks

- It has been put in evidence **the need to use a common jargon for the names of elements suspended all along the pendulum chain**. This will improve the communication among different groups working on the same items avoiding confusion.
- A set of **measurements, coming out from seismic characterization of the Candidate Sites to host the ET Interferometer**, is wishfully. This would avoid additional confusion during the performance comparison of different subsystem solutions.
- The complexity of the LF Payload and all the mechanical elements included into the vibration isolation system, seems to be a potential bottle neck of the project. Thanks to the experience gained in operating the 2nd generation detectors, **would be possible to do an intermediate step with a smaller/heavier mirror (350 mm diameter and 80 kg) for future upgrade of the Payload ?**