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Superattenuators for the ET era

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The development of the Superattenuator, over years of dedicated research and development by the National Institute for Nuclear Physics (INFN) in Pisa, has played a pivotal role in enabling the detection of gravitational waves signals down to an unprecedented 10 Hz frequency.

In fact, the Superattenuator, acting as a cascade of low-pass filters, has been a fundamental tool for the VIRGO interferometer, and then for Advanced VIRGO (AdV), in damping the ground motion - the main source of noise in the low frequency range - by more than 10 orders of magnitude.
As we set our sights on the next generation of gravitational wave detectors, with the goal of improving the sensitivity by more than one order of magnitude with respect to the 2nd generation detectors, and extending the detection band down to 2-3 Hz, it becomes evident that further improvements are necessary to push the boundaries of detection capability.

This necessitates a shift from conceptual innovation to targeted advancements in the design and mechanics of filters, sensors and actuators that build up the Superattenuator, for them to turn into real game changers and fulfill the ET design sensitivity.

We will focus here on some of the many aspects currently under consideration.

Concerning the filter concept, we will illustrate the redesign of the magnetic anti-spring (MAS) providing vertical attenuation, that aims at compacting and enhancing the symmetry of the system, thus pushing the crossbar vibration modes away from the low frequency range.

From the actuation point of view, we will report on the R&D efforts aimed at upgrading the seismic isolation platform into a six degrees-of-freedom active pre-isolator.

With the improvement of passive and active filters performances, the current state-of-the-art sensors will be way too noisy. This calls for the development of new accelerometers based on principles distinct from those currently employed. We will report on ongoing efforts in this direction.

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