

## **Virgo Vacuum System: Status and plans until 2025**

Antonio Pasqualetti

*EGO-Virgo, Cascina (PI) – Italy*

Virgo project has completed its third period of scientific observation, participating in the detection of a total of more than 60 gravitational waves events. More recently, Virgo has started a program of upgrades (AdV+) to prepare for the next observing periods O4 and O5, respectively in 2023 and 2026, doubling its sensitivity at each stage.

The community has also just begun to plan the long-term future (post-O5 phase), which is expected to take the Virgo apparatus to its limits.

The Vacuum system follows a corresponding program of improvement and modifications, to accommodate the new apparatuses and to fit with the increased science requirements. The list of needs is quite diversified:

- increase of the pumping speed and of vacuum diagnostics installed along the 3 km long UHV tubes achieving redundancy and reliability with low maintenance effort;
- development of suitable shields to limit the risk of dispersed charges from ion pumps;
- development of a device for the neutralization of the static charge accumulated on optics under vacuum;
- use a He(I) bath pumping system, already designed, to get a large speed and low environmental emissions in the most critical area of the apparatus. The current trend of increasing cost of cryogenic fluids prompts a re-assessment of this solution in the new context;
- ‘vacuum contamination’ and qualification methods for new materials: large parts potentially source of low-volatile molecules will be added close to critical optics, their realization will be a challenge;

Finally, with regard to post-O5 plans, in order to reach the ultimate vacuum level, we cannot exclude the need to bake-out the UHV tubes, a complex operation when applied on a giant 2 x 3 km chamber.