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Studies on active and passive mitigation strategies for frost and electrostatic charging issues in future gravitational wave detectors

In the upcoming generation of gravitational wave detectors (GWDs), the use of cryogenic mirrors is a great technological challenge and may present potentially new noise sources limiting the desired sensitivity. As shown in KAGRA, frost formation on cold optics is a known severe issue for cryogenic GWDs. Also, the mirror charging, as observed in LIGO, may severely affect sensitivity, and the mitigation method based on a high N_2 gas flux, could not be used at cryogenic temperature since a thick N_2 layer will condense on mirrors affecting detection. As observed in Virgo, one contribution to optics charging comes from low energy electrons propagating from ion pumps and finally impinging on the test masses. We are developing a method that will reduce electron emission by using ad hoc designed electrostatic screens. Moreover, we have proposed and start validating the use of low energy electron irradiation («1 keV) as an active mitigation solution both for charging and frost formation.
Here we present the R&D activity carried out at LNF-INFN to develop active and passive mitigation strategies, compliant with cryogenics, both for charging and frost formation.

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