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Charge Monitoring of Test Masses in Gravitational Wave Interferometers

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The sensitivity of gravitational wave detectors is impacted by several noise sources. This presentation centers on noise mitigation associated with charge deposition on the test mass (TM). The main challenge involves the uncertainty surrounding the process leading to charge deposition on TMs, as well as the lack of precise knowledge regarding the distribution and intensity of the charge.

My proposed solution to overcome this challenge entails implementing a real-time monitoring system. Particularly, the study involved placing sensors on the cages surrounding the Virgo's test masses using COMSOL Multiphysics software. Conducting over 10,000 simulations with various Gaussian charge distributions, I employed data analysis techniques, such as Principal Component Analysis (PCA), to facilitate sensor ranking. The charge value and position reconstruction was accomplished through neural networks utilizing Matlab software.

Using just the best four sensors selected by PCA, promising results are achieved. With a Signal-to-Noise Ratio (SNR) of 20, the neural network accurately distinguishes whether the charge is located on the front or back face of the test mass and in which quadrant. Specifically, the accuracy is approximately 0.8 for front-back discrimination and 0.7 for quadrant determination.

Collaboration

Virgo - ET - INFN - Unige

Role of Submitter

I am the presenter

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