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The Magnetic Dipole Model

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The Gravitational Waves (GWs) interferometers are very big facilities and the choice of the material to build their arms is crucial within the scope of the project.
The second generation (2G) of GWs antennas have been built using austenitic stainless steel like 304L (LIGO, Virgo, KAGRA) and 316L (GEO600), which are no magnetic materials. However, the third-generation (3G) detectors, being larger and more sensitive than their predecessors, may find cost-prohibitive the use of these steels.
Einstein Telescope (ET) is a third-generation GWs antenna, which present design foresees six interferometers with 10 km arms ("xylophone"configuration) but also a "2L-shape"configuration formed by interferometers with 15 km arms is being discussed. For ET, the use of ferritic steel for the pipes is being explored as a more cost-effective alternative than an austenitic solution.
However, the residual magnetization of ferritic steels should be considered as a potential source of noise that could affect the ET sensitivity curve.
This study aims to present a model, named the Magnetic Dipole Model, which predicts how a ferritic tube impacts the sensitivity curve of a given instrument, using actual seismic noise data. The model primarily uses data from Sos enattos, more precisely the 90th percentile from the north-south channel of a seismometer (HHN instrument), and a key magnetic parameter like the coercive force (Fc). The model has been supported by the characterisation of three different ferritic steels samples (AISI 430, 444 and 441). The whole process was carried-out in collaboration with CERN, using the split-coil permeameter for the measurements of the coercive force.
Our model indicates that the primary contribution of magnetic noise from the tested ferritic materials occurs between 1 and 2 Hz. It is critical to highlight also that the model is very sensitive to the distance "d"between the tube and the mirror, correlating to the length of the cryotrap.
According to the model, the magnetic noise contribution from the tube results to be five orders of magnitude lower than the ET sensitivity. Although this model has numerous potential enhancements, two notable improvements include incorporating seismic data from different potential sites and updating the model to account for the "2L-shape"configuration.

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