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Bolometric measurements of ultra-low absorption level of Gravitational Wave optical materials.

Three years ago, the LIGO-Virgo collaboration announced the first detection of gravitational waves generated by a merger of two black holes. This happens one hundred years after the predictions of Einstein and this event is the beginning of a new way to observe universe. Gravitational wave detectors are modified Michelson interferometer in which both 3km arms are Fabry-Perot cavities, each cavity being composed of two mirrors. Since 14 September 2015, five more signals were detected and more sensitive detectors are needed to acquire more signals in order to better understand universe and its formation. At the present time, detection is mainly limited by thermal noise of the Bragg mirror coatings which is directly connected to mechanical losses (also named internal friction) via the fluctuation-dissipation theorem.

One possibility to reduce thermal noise is to operate the interferometers at cryogenic temperatures and in that case a completely new set of materials need to be developed because the ones used today are performant only at room temperature. In particular optical absorption at wavelenghts of 1064 nm, 1550 nm and 2000 nm is of particular interest because they are the radiations at which sapphire and silicon are transparent.

In this context, we propose a master subject on the development of an experimental setup able to measure ultra-low level of absorption (in the range of 1 part per million) using the bolometric technique. In this technique the energy deposited by the laser into the material is measured through the temperature increment of the sample itself.

The student doing this activity will learn how to work with vacuum equipment, how to develop sensors able to measure temperatures in the μK range and how to create a user friendly interface with Labview to control the measurement.

Gianpietro Cagnoli and Valérie Martinez belong to Virgo collaboration and Gianpietro Cagnoli is the leader of the coating group (Virgo coating R&D). This internship is part of a project financed by the French research agency (ANR) and it could lead to a PhD thesis.