The European Gravitational Interferometer VIRGO, on the Road Again

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The European gravitational interferometer.

The dedication ceremony for the second-generation European gravitational interferometer was held on Monday the 20th of February 2017. The ceremony took place at the European Gravitational Observatory (EGO) in Cascina PI, Italy, the site at which Advanced Virgo is located. The ceremony took place in the presence of the presidents of the institutions that have funded the project (INFN, IN2P3, Nikhef) and of representatives of the governments of the six nations whose laboratories are members of the Virgo Collaboration.

The procedure to lock the interferometer, implemented successfully in real time in front of those in attendance at the ceremony, showed the advanced state of the commissioning of the machine.

Five years of hard work, were necessary to modify the optical system by introducing heavier and higher-quality mirrors, to improve the input laser and increase its power, to upgrade the detection device, to introduce a sophisticated system to mitigate potential aberrations, to improve the super-attenuators that handle seismic

isolation, to introduce a diffused-light absorption system and to reach an ever more extreme ultra-high vacuum. After this, Advanced Virgo began the complex phase of commissioning in order to achieve a sensitivity suitable enough to jointly-operate alongside Advanced LIGO and to open the road for systematic astrophysics via gravitational waves.

The first and more demanding phase of the process will lead (by around 2020) to an increase in sensitivity by a factor of ten of the LIGO and VIRGO large interferometers. By that time, the volume of the universe open to exploration with the instruments will be larger by a factor of one thousand with respect to the first generation of instruments.

In the period 2011-2017, the physics of gravitational waves has undergone an impressive acceleration: full establishment of the LIGO-VIRGO global collaboration; achievement of the construction of second-generation interferometers; first detection of gravitational waves. Soon, VIRGO will also be operational. We await, alongside our LIGO colleagues, the conclusion of the commissioning of our interferometer: three detectors are essential to be able to proceed toward really substantial scientific programs. The identification of the transit of gravitational waves through the three interferometers, in addition to the reinforcement of the significance of the scientific information due to the structural differences in the typologies of LIGO and VIRGO, will also allow us to improve the localisation of the astronomical sources of the signals – reducing by a factor of one hundred the size of the window in the sky – making a real multi-messenger analysis possible, thanks to almost-real-time alerts sent from the interferometers to astronomical instrumentation.

VIRGO will become operational as the third pillar of gravitational-wave science, after having contributed with the ideas and technologies already adopted in the first generation, to crucially mark the progress toward the successful second generation; indeed, the determination of Adalberto Giazotto to improve the sensitivity of interferometers in the low-frequency region (below 100 Hz) proved essential to the first two detections of signals generated by binary black hole systems, and we hope, soon to detect binary neutron star or neutron star-black hole systems.

The addresses by D. Reitze, Executive Director of LIGO, M. Ohashi, Director of the KAGRA Observatory, K. Danzmann, Consortium lead of LISA, and S. Rowan, Chair of the Gravitational Waves International Committee, concluded the dedication ceremony by bringing a positive, confident and promising message from the major international partners and from the global community, which looks at Cascina with attention and enthusiasm.
It is well acknowledged that the school of Italian physics has played a major role in the research of gravitational waves; from Edoardo Amaldi and his collaborators with the conception and construction of various cryogenic bars – Explorer, Nautilus, Auriga – followed by Adalberto Giazotto, father of the VIRGO interferometer, while a scholar of Giazotto, Giovanni Losurdo, led the Virgo Collaboration in the project that concluded with the construction of Advanced Virgo.