

Letter of Intent

To: EGO Director - EGO Council Chair - Virgo Spokesperson

Date: 21/05/2025

From: Institut de Física d'Altes Energies - IFAE, IFAE/UAB Campus Bellaterra, Barcelona 08193, Spain, Eugenio Coccia (IFAE Director) eugenio.coccia@ifae.es, Mario Martínez (IFAE-Virgo Team Leader) mmp@ifae.es.

Subject: Expression of Interest to join VirgoLab

Dear Sir/Madam,

This letter serves as a formal expression of interest by the Institut de Física d'Altes Energies - IFAE (hereinafter referred to as "IFAE") to join the VirgoLab, as described in VIR-1025B-24. We understand that VirgoLab operates, commissions, and upgrades the Virgo interferometer, and we are willing to contribute to its mission and to the achievement of its goals.

However, the final decision of joining VirgoLab remains subject to the availability of funds, a previous formal approval from our funding agencies, and is closely tied to significant hardware responsibilities.

1. Introduction

IFAE (www.ifae.es) is a consortium of the Generalitat de Catalunya and the Universitat Autònoma de Barcelona (UAB). IFAE is an independent research institute that conducts experimental and theoretical research at the frontiers of fundamental physics, namely in Particle Physics, Astrophysics and Cosmology. Within Virgo, IFAE specializes in stray light monitoring, data characterization and noise hunting, computing tasks and physics analysis. Our expertise and ongoing research activities are highly relevant to the operation, commissioning, and potential upgrades of gravitational wave interferometers.

We believe that our participation in VirgoLab would be mutually beneficial, allowing us to contribute our knowledge and resources to the advancement of gravitational wave science in Europe and beyond, while also providing our members with valuable experience and opportunities within a leading international collaboration.

This letter outlines our main areas of interest and potential contributions to VirgoLab.

2. Scientific / Technological Case or Context of Opportunity

Our group has a strong background in the areas of stray light control, monitoring and simulations; and computing. They relate to the VirgoLab activities as follows:

- **Stray light monitoring:** IFAE is making key contributions to the simulation of the stray light in the interferometer arms for those aspects relevant to the understanding of misalignments, loss reduction, and stray light control. Our expertise would be relevant to the Controls & Simulations Technical Team.
- **Instrumentation:** IFAE made significant hardware contributions in the form of non-instrumented baffles placed in different locations in the interferometer and an instrumented baffle at the IMC end mirror. IFAE is now engaged in the construction of instrumented and non-instrumented

baffles for the main optical cavities of the interferometer. Two instrumented baffles are being built and will be installed at the entrance of the end-mirror vacuum towers before O5 starts operations. In addition, IFAE maintains and operates the IMC instrumented baffle installed in 2021. Our expertise would be relevant to the Sensing & Actuation Technical Team.

- **Detector characterization and noise hunting:** IFAE has contributed to the reconstruction and calibration of the Virgo data, in the framework of the O3 and O4 commissioning efforts. IFAE contributed to the upgrade of the GW signal reconstruction code to include the signal recycling mirror, online noise suppression, and to increase its flexibility to adjust the optical response of the interferometer in real time. IFAE also contributed over the years to noise hunting and magnetic injection activities. Our expertise would be relevant to the Computing & Software Technical Team.
- **Computing:** IFAE is supported by its own computing center, PIC, a Tier1 LHC center fully integrated into the LIGO/Virgo distributed computing network. In the last few years PIC provided consistent computing resources at the level of 1% of the total CPU and 10% of the total GPU capacity of LVK. Our expertise would be relevant to the Computing & Software Technical Team.

In addition, IFAE carries out a competitive program on physics analysis of the LVK data.

3. Description of the Proposed Contribution

Our proposed involvement in VirgoLab would initially encompass the following potential contributions:

- **Technical Development:** Design, development, and testing of instrumented baffles within the Detector Upgrades project and the Sensing & Actuation, Controls & Simulations and Mechanics & Vacuum Technical Teams. This would involve detailed simulations, prototyping, testing and finally construction of the devices at our facilities in Barcelona, followed by their installation at Virgo vacuum towers and their integration into normal operations.
- **Instrumentation Support:** Contributing to pre-alignment of main arms, the monitoring of mirror performance, and the mitigation of stray light induced noise within the Detector Commissioning project and relevant Technical Teams. This could involve integrating the instrumented baffle signals into the Virgo operations and monitoring channels and developing novel analysis tools to facilitate the pre-alignment of the main arms using the instrumented baffles, the monitoring the mirror performance via modifications in the stray light as measured by the baffles, and studying correlations of the baffle signals with interferometer glitches induced by stray light changes in the arms.
- **Detector characterization and noise hunting:** Contributing to the general noise hunting and magnetic injection campaigns at EGO, in the framework of the O5 commissioning efforts, and to the development of online noise suppression tools. Our expertise would be relevant to the Computing & Software Technical Team.

We are also open to contributing to other areas based on the evolving needs of VirgoLab and the expertise within our group. We are keen to engage with the existing VirgoLab Technical Teams and Projects to identify areas where our skills and resources can be most effectively utilized.

4. Costs, Calendar and Resources

Initially, our contribution would primarily involve the effort of our existing personnel (as today the group is formed by 20 persons including 10 scientists (students, postdocs and faculty members) and 10 technical staff (engineers and computer scientists) corresponding to a total of 10 FTEs.

We understand that the successful accomplishment of VirgoLab tasks, particularly the timely installation and commissioning of the O5 upgrade, will demand strong and continual presence at EGO site. Our

group commits to support that effort as much as reasonably possible. We anticipate the need for partial financial support to maintain extended stays of IFAE staff at EGO.

We understand that Member Labs are in charge of maintaining and operating the equipment they provide, and we are prepared to discuss the provision of instrumented baffles and the necessary readout electronics and services as part of a Memorandum of Agreement (MoA).

We are aware that financial resources are allocated by EGO Council, national funding agencies, or research organizations. We will explore potential funding opportunities through our institution and national agencies to support our involvement in VirgoLab.

We are prepared to work towards the establishment of a MoA with EGO should our application be successful.

5. Stakeholders and Requirements

Our primary stakeholders are IFAE, the Generalitat de Catalunya, supporting IFAE's base funding, the Spanish Ministry for Science, Innovation and Universities, and the Spanish Agency for Research, providing competitive funding to develop IFAE's research activities.

We understand that as a contributing group, our main requirements would be to have effective communication channels within VirgoLab, opportunities for our members to actively participate in relevant projects and technical teams, and recognition for our contributions to the scientific and technical advancements of Virgo.

We are committed to adhering to the policies and procedures of VirgoLab, including those related to resource allocation and publications.

We are ready to discuss our potential participation further and provide any additional information that may be required. We look forward to the possibility of joining the VirgoLab and contributing to its continued success.

Sincerely,

Eugenio Coccia (IFAE Director)

Mario Martínez (IFAE-Virgo Team Leader)

On behalf of IFAE, 21/05/2025