

# Letter of Intent

**To:** EGO Director - EGO Council Chair - Virgo Spokesperson

**Date:** May 8<sup>th</sup>, 2025

**From:** Mateusz Bawaj [mateusz.bawaj@unipg.it](mailto:mateusz.bawaj@unipg.it), INFN Sez di Perugia, via A. Pascoli snc, 06123 Perugia (PG), Italy

**Subject:** Expression of Interest to join VirgoLab

Dear Sir/Madam,

This letter serves as a formal expression of interest by Virgo Perugia 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.

## 1. Introduction

Virgo Perugia is one of the INFN groups which funded the Virgo detector. Our group is officilized by the INFN Sez. di Perugia and gathers academic staff, research staff, technical staff and PhD students from the INFN, the University of Perugia, University of Camerino and Consiglio Nazionale delle Ricerche, Niels Bohr Institute (guardo VMD). We are specializing in thermal noise, monolithic payload, quantum noise reduction, advanced optical coatings and general relativity and multi-messenger astronomy. Our expertise and ongoing research activities are focused on gravitational wave detectors Virgo, KAGRA and ET, and are highly relevant to the development, 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 construction of interferometric gravitational wave detectors. In particular:

- Our group specializes in investigating thermal noise in gravitational wave detector suspensions through theoretical studies, finite element modeling and experimental validation. We focus on accurately characterizing material mechanical losses of wires/fibres and substrates on suspensions or using gentle nodal suspension technique (GeNS), disctructive tensile testing, microscopy (SEM-EDX), FTIR spectroscopy, x-ray diffraction and x-ray fluorescence to minimize intrinsic material influences, enhancing the performance and sensitivity of precision measurement systems.

- Our group with expertise in monolithic test mass suspension development, precision design, silicate bonding (so called HCB), and high-accuracy assembly focuses on developing ultra-stable, low-noise mechanical structures for high-precision instrumentation. Our work supports advanced detectors, such as those used in gravitational wave observatories, by enabling minimal mechanical loss and implementing our studies on thermal noise.
- Our scientific group includes members skilled in engineering, particularly in the mechanical design of systems related to seismic isolation, payload, mirrors and marionettes. Our expertise in this area covers mechanical component simulation, thorough design verification, and the production of technical documentation to support development and integration processes.
- We have strong expertise in vacuum technology and are currently involved in the development of large-scale vacuum infrastructure.
- Our group is supported by the local mechanical workshop in the development and fabrication mechanical components for scientific experiments. In particular in the handling boxes for all major Virgo optical components.

Above contributions mainly align with Mechanics & Vacuum technical team.

- Our scientific group specializes in the design and experimental validation of advanced optical coatings, with a focus on amorphous oxides and semiconductor materials. Our activities include detailed morphological, compositional, and structural characterization using techniques such as SEM-EDX, XRD, XRF, Raman, XAS, and Brillouin spectroscopy. We also collaborate with external laboratories for coating deposition, supporting high-performance materials development for precision applications.
- Our group is skilled in generating optical squeezed states, including frequency-dependent and advanced squeezing generation techniques, to enhance the sensitivity of precision optical systems. We also develop high-performance photodetectors and custom electronics tailored for use in advanced optical setups, supporting cutting-edge quantum optics and metrology research.

Above contributions mainly align with Optics & Light sources technical team.

- Our scientific group includes members skilled in engineering, particularly in software development and both low- and high-level programming. We design and implement control algorithms, such as those used in the Virgo experiment's Guardian system, to manage and automate complex scientific instrumentation and operations.

Above contribution mainly aligns with Controls & Simulations technical team.

- Members of our group have served as Principal Investigators on numerous international scientific projects and bring extensive experience in managing experimental teams and coordinating small to medium-scale research initiatives.

Above contribution mainly aligns with Project Management technical team.

### **3. Description of the Proposed Contribution**

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

- Monolithic and steel wire suspension development and service.
- Control software development, documentation and maintainment.
- Advanced coating research.
- Support for activities on vacuum system and super-attenuators.

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 including 7 researchers and 2 engineers of total man power availability approximately 5 FTE.

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 support in covering travel expenses toward EGO. We intend to keep sending to EGO our personnel already involved on site (researcher and technician), and to enable greater contributions from young people such as students and post-docs.

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 the steel wire baking facility, low sismical noise suspension test facility, support of mechanical workshop and technical staff, access to the laboratory for studies on advances suspensions CAOS, material characterization with GeNS and tensile strength tests, access to measurement facilities with SEM-EDX, XRD, XRF, Raman, XAS, and Brillouin spectroscopy, low noise measurement equipment (e.g. FFT and network spectrum analysers, optical benches...) 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 ready to work towards the establishment of a MoA with EGO should our application be successful.

### **5. Stakeholders and Requirements**

Our primary stakeholders are INFN, University of Perugia and University of Camerino.

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 eager 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,

Prof. Ing. Mateusz Bawaj on behalf of Virgo Perugia group and INFN Sez. di Perugia

Perugia, May 8<sup>th</sup>, 2025