# Letter of Intent

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

**Date:** May 10, 2025

**From:** Padova/Trento/Trieste group, Contact Person: Jean-Pierre Zendri, email zendri@pd.infn.it

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

Dear Sir/Madam,

This letter serves as a formal expression of interest by Padova/Trento/Trieste group (hereinafter referred to as "PdTn") 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

PdTn is a research group within the Universities of Padova, Trento, Trieste and Parma and the INFN sections of the same cities specializing in quantum noise reduction technologies, modeling characterization and suppression of scattered light, advanced optical coatings research, adaptive optics, electronic and data analysis algorithms. Our expertise and ongoing research activities are highly relevant to the operation, commissioning, and potential upgrades of gravitational wave interferometers.

We know that details about the VirgoLab organization should still be completely defined and clarified, and we understand that this letter does not imply any formal commitment. Nevertheless we believe that our participation in VirgoLab has the potential to 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 development and implementation of methods for reducing the detector quantum noise. In particular we coordinated and participated in the construction/commissioning of the Virgo FDS source which is currently the highest performing one developed in the world (together with that of LIGO which however was developed later). In this context the group has made significant contributions in developing the SC laser line, RF electronics (PLL and DDS), new type of mode matching sensors and in general in the development of several controls for the FDS source alone and its integration into the interferometer. We believe that our ongoing research can significantly impact the sensitivity of the next upgrade (and beyond). In this case our participation would primarily impact on the quantum noise reduction team, .

- We have an expertise in sizing the impact of stray light in GW detectors and in particular on that originated by dust particles deposited on the optical components. In this context we have setup a dust monitoring campaign in several Virgo labs at EGO, including also the vacuum towers of the test masses. At Padova we have developed an experimental facility to characterize quantitatively the scattering properties of test samples, by measuring both the BRDF and the TIS at 1064nm and 532nm. We have also the expertise and the instrumentation to perform detailed surface characterization, which aids in estimating the scattering properties. We have developed a simulation software to predict scattering by surfaces where dust has deposited and can trace ghost beams in GW interferometers with the commercial Zemax software.
- We have a strong expertise in coating research, with a material - science approach and access to a large number of characterization facilities, including Ion beam analysis. Ellipsometry, X-ray scattering and so on. We also have several deposition facilities, some of them under construction specifically designed for coating research for GW interferometers.

## 3. Description of the Proposed Contribution

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

- **[Specify the area of contribution clearly, linking it to VirgoLab Projects and Technical Teams. Examples:]**
    - Contributing to the design, development, and testing of the upgrades planned for the FDS source with a significant, but not exclusive, commitment to the development of new high-performance electronics and controls.
    - Specific technology: development of new materials for mirror coatings and support to the coating research and production by means of available characterization facilities.
    - Contributing to the choice of mirror wedges by detailed analysis of the ghost beams. Design and develop ghost beam and stray light absorbers for some subsystems of DET. Contributing to keep under control the accumulation of dust in different environments and subsystems of Virgo and the stray light this originates.
    - Contribute to the commissioning of mode matching sensors and the installation of actuators for adaptive optics.
    - Contributing to the monitoring and mitigation of quantum noise.

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 (45 members, 23 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 access to the central building and the electronics department and also to be supported for travel expenses for the commissioning period of the FDS system (several weeks) and for a similar period for the installations in charge of the group.

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 RF electronics, ghost beam and stray light absorbers, other components of the FDS source 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 University of Padova. Parma, Trento, Trieste and INFN.

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,

Jean-Pierre Zendri

On behalf of Padova/Trento group

May 10, 2025