

Letter of Intent

To: EGO Director - EGO Council Chair - Virgo Spokesperson

Date: 23/05/2025

From: Valeria Sequino on behalf of the INFN Napoli group, UniNA, UniSA.
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Subject: Expression of Interest to join VirgoLab

Dear Sir/Madam,

This letter serves as a formal expression of interest by INFN - Napoli (hereinafter referred to as "Napoli Group" if applicable) 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

The members of Napoli Group come from several institutions, but each member is associated with the Italian Istituto Nazionale di Fisica Nucleare (INFN), section of Napoli, when not staff of this institution. The group includes some INFN staff, while the majority comes from the Napoli University 'Federico II' (UniNA), and the remaining from Salerno University (UniSA). The group members' expertise spans from classical and quantum optics (optical system design, simulation and development), to environmental sensing and control, from suspension design and simulation, to mirror local controls; from Newtonian noise cancellation to data analysis.

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:

- **Frequency Dependent Squeezing for QNR**

The group has spent a big effort in the development of the QNR system for the Virgo Interferometer, being among the first groups in the collaboration to present the proposal for the QNR system for AdVanced Virgo and actively participating to the design and development both of the first squeezer source prototype in Virgo and to the FIS injection system for O3, having the responsibility of the injection system. For Adv+ QNR, members of the group participated actively in the design, construction, installation and commissioning of the FDS injection system, having, at beginning, the responsibility of the global design subsystem (SGD) and then of the external squeezing bench (EQB1). They are as well involved in the present FDS upgrade with derivables responsibility and in R&D research on alternative systems to Filter Cavity based for FDS.

- **Detector Injection System and stray light mitigation**

The group has experience in designing, development, characterization and simulation for Virgo Injection as well as for stray light mitigation systems, with past coordination and management roles in the relative Virgo detector subsystems.

- **Environmental Monitoring Sensors**

The group has responsibility for the environmental monitoring sensors subsystem. At the present is mainly working on the upgrade of the environmental sensors planned for the next O5 run and in the development of the new slow monitoring system for the upgrade. The group is also involved in the revision of the current seismic monitoring system as well as of other critical sensors. In addition, Noise Hunting activities are focused on the Magnetic Noise characterization and its coupling with the detector signals.

- **Newtonian Noise Cancellation**

Tiltmeters have proven to be valuable tools for reducing NN, which is predicted to limit the sensitivity of Gravitational Waves detectors in the future at frequencies below 20Hz. The tiltmeter designed and developed by Napoli group has been installed in Virgo to perform a first ground tilt characterization and NN estimation. At present it is used to validate ground tilt reconstruction performed by a seismometer array placed around the North End tower.

In the next future, the tiltmeter setup will be improved by adding optical elements in the read-out setup and mitigating stray light, improving the contrast defect of the interferometric readout. Moreover, signal modulation techniques will be implemented in order to reduce electronic noise (currently limiting low frequency sensitivity). These steps will allow us to improve the current sensitivity. An analysis of the coherence of the tiltmeter signal with the suspension signals will allow us to understand whether it is possible to contribute to the reduction of the seismic noise of the superattenuators in the frequency band below 1Hz.

- **Mirrors Local Control**

The Napoli Group developed this system in collaboration with the Roma group. It will continue with the maintenance of the local control (optical levers) and the planning of possible upgrades of local control electronics to improve the overall system sensitivity.

- **Suspension**

The group is contributing to the SAT signal monitoring to quantify the re-injection of the control noise on the output of the ITF.

3. Description of the Proposed Contribution

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

- **Technical Development:** Contributing to the design, development, and testing of new techniques for quantum noise reduction, new sensors for the measurement of tilt noise, novel electronics for environmental monitoring sensors, new electronics for noise injection systems within the Detector Upgrades project and the Optics & Light sources Technical Team. This would involve design, prototyping and performance tests in our laboratory, before the installation at Virgo site.
- **Detector characterization:** Participating in the development and implementation of algorithms for noise analysis, for sensors' effectiveness and noise injection control within the Detector Operations and Maintenance project, contributing to data quality characterisation and potentially low-latency analysis. This would involve the development of algorithms for data analysis, implementation of real time software for hardware control and use of Virgo data for correlation analysis.
- **Instrumentation Support:** Contributing to the monitoring and mitigation of environmental noises within the Detector Commissioning project and relevant Technical Teams, according to our expertise and experience; contributing to the commissioning in the Project SSs where the members are involved; contributing to the maintenance of the instruments under responsibilities of our group.

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: 17 researchers, with a present pledge of ~ 7 FTE in total.

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 *in agreement with the mandatory duties of our belonging institutions*.

We anticipate the need for travel to EGO in order for the development of all the mentioned activities.

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 spare components for the installed hardware 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 INFN - Napoli section, University of Naples and University of Salerno.

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.

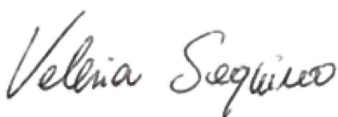
We are committed to adhering to the policies and procedures of VirgoLab, including those related to resource allocation and publications, *once these will be completely and clearly set-up and once we will verify that they are not in contrast with our belonging institutions' policies.*

We are ready to discuss our potential participation further, provide *or request* any additional information that may be *needed by either your side or ours.* We look forward to the possibility of joining the VirgoLab and contributing to its continued success.

Sincerely,

Valeria Sequino

On behalf of the Napoli Group



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23/05/2025



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