PROCEEDINGS OF SCIENCE

Virtual visits to the Virgo Gravitational Wave detector for schools across Europe and beyond

Emmanouil Chaniotakis[a,*] **and Elisa Velcani**[b]

[a] *Ellinogermaniki Agogi,*
Dimitriou Panagea, Pallini, 15351, Attica, Greece
[b] *European Gravitational Observatory,*
Via Edoardo Amaldi, 56021 Cascina (PI), Italy

E-mail: echaniot@ea.gr, elisa.velcani@ego-gw.it

Virgo, hosted at the European Gravitational Observatory (EGO) in Cascina, is one of Europe's most advanced physics research centres. As part of its educational and scientific outreach mission, Virgo virtually opens its doors to schools around the world through remote guided tours in English. During the tour, a researcher guides middle and high school students on a journey of discovery about gravitational waves and the only observatory in Europe capable of detecting them, offering a direct experience of the place where science is developed. This contribution presents the first results of the evaluation of the educational and communicative value of the virtual tour programme. The impact of the initiative is analyzed through questionnaires submitted to students before and after the tour, with the aim of understanding how this experience improves their understanding of scientific content and brings them closer to the world of STEM disciplines.

39th International Cosmic Ray Conference (ICRC2025)
15–24 July 2025
Geneva, Switzerland

ICRC 2025
The Astroparticle Physics Conference
Geneva July 15-24, 2025

*Speaker

PoS(ICRC2025)1258

1. PICO Project

Cutting-edge physics research has transformed our understanding of the universe, yet these topics often remain far from everyday knowledge and traditional school curricula. To bridge this gap, the EU-funded PICO (PhysICs fOr all) project [1] promotes the learning of fundamental physics and its impact on daily life, with a strong focus on equity, diversity, inclusion, and gender equality.

As part of the PICO Project, EGO [2], with the support of Ellinogermaniki Agogi[3], launched a program of virtual guided tours of the Virgo[4] detector. During the 2024–2025 school year, more than 1,500 students from 50 schools around the world participated. Thanks to the online format, schools from Europe (Greece, Spain, Italy, Romania) as well as from the United States, Brazil, India, Mexico, and Uzbekistan joined the tours, overcoming geographical distances and time zone challenges. The initiative brings STEM education closer to students everywhere, inspiring the next generation through direct contact with frontier science.

2. Virgo: The European Gravitational Wave Detector

The Virgo interferometer is one of the three largest and most sensitive gravitational wave detectors in the world, along with the two US LIGO [5] detectors. Gravitational waves, predicted by Einstein, are imperceptible space-time oscillations generated by violent cosmic events, such as the merging of black holes or neutron stars. To detect these imperceptible ripples in spacetime, Virgo uses the interference of two laser beams traveling through ultra-high vacuum tubes along its two perpendicular arms, each 3 kilometers long. In this way, Virgo can measure changes in the length of its arms caused by the passage of a gravitational wave with extraordinary precision, equivalent to one-thousandth of the diameter of a proton (one millionth of a billionth of a millimeter).

Virgo is located at EGO in Cascina, in the province of Pisa, the research infrastructure financed by the Italian INFN, the French CNRS, the Dutch NIKHEF and Belgium FWO and FNRS.

The Virgo experiment is conducted by an international scientific collaboration involving nearly 1000 researchers from 150 institutes across 15 countries, mostly in Europe.

Figure 1: Aerial view of Virgo interferometer

3. Virtual Tour to Virgo

The Virgo virtual tours, filmed through a mobile phone streaming directly to the Zoom call, are guided by an EGO/Virgo researcher who leads students through areas of the experiment. The virtual visit is conducted in English, as students come from schools from all over the world. However, since it is often not their native language, it may represent a barrier to full comprehension; for this reason, the support of teachers in this activity plays a fundamental role.
The virtual tour lasts approximately 90 minutes and is structured in the following stages.

- Introductory seminar: designed to introduce the concepts of spacetime, Einstein's theory of gravity, gravitational waves and their sources, and interferometry, starting from the basics and without assuming any prior knowledge. Students are not yet familiar with these concepts; their background is primarily based on Newtonian physics studied at school.

- Exhibits in the EGO Main Building Hall: including an interferometer model which helps students connect theory with practical applications.

- The Virgo tunnel: one of the most striking moments of the visit. Even through video streaming, the view of the tunnel conveys the scale and ingenuity of the project.

- The Control Room: the operational center from which the entire interferometer is controlled. Here, students can observe the complex control system as well as the huge collaboration of people that makes scientific work possible.

- Q&A sessions: at the end of each stage, students are encouraged to ask questions. Direct interaction with the scientist is considered fundamental to foster curiosity and deepen understanding.

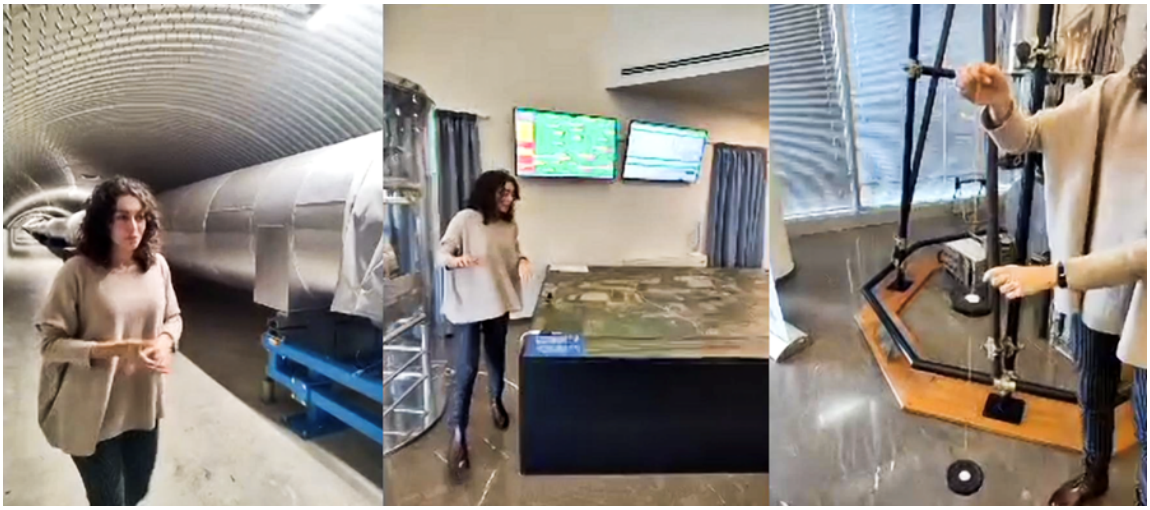

Figure 2: Highlights from the Virgo virtual tours

4. Methods

The present study aimed to answer the following research question:

What is the impact of guided tours in terms of outreach and pedagogical value?

The evaluation of the guided tour activities is an essential tool for assessing whether they effectively engage students and create a meaningful impact.
The impact of the activity was evaluated using survey instruments, including pre- and post-experience questionnaires administered to participants. Comparative analysis of the responses allowed assessment of how the virtual tour influenced their responses, also providing demographic data to characterize the audience profile.

4.1 Demographic data

Overall, 1500 high school students representing 50 schools from 11 countries participated in the visits. The schools came primarily from European countries such as Greece, Spain, Italy, and Romania, but also from other parts of the world, including the United States, Brazil, India, Mexico, and Uzbekistan—overcoming even the challenges posed by different time zones. 76 students provided answers in the questionnaires.

4.2 Key findings

After the virtual tour experience, participants' confidence in explaining Virgo (a 5 point Likert scale question) increased significantly ($p < 0.01$) by 53%, demonstrating the effectiveness of the visit to raise awareness about Virgo.

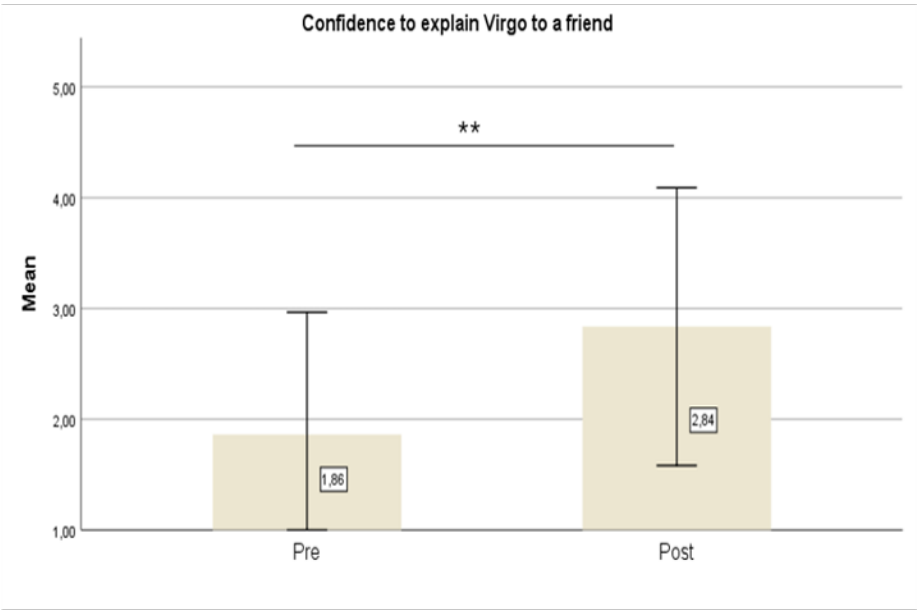

Figure 3: Students' answers to the question "How confident are you to explain Virgo to a friend"

In order to investigate students' understanding of key concepts presented in the visit, they were asked to choose what they understood best.

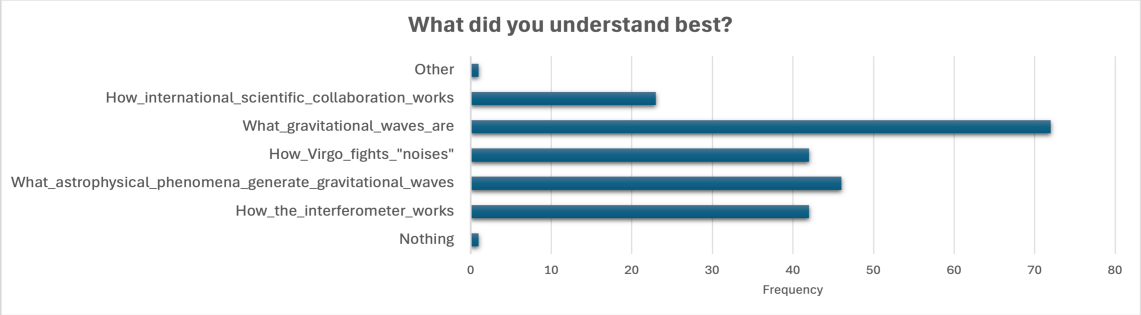

Figure 4: Students' answers to the question "What did you understand best"

We observe that gravitational waves, their production and the functioning of the interferometer were among the most successfully learned concepts.
These results confirm the educational value of the proposed activity.

Overall, 87% of the students rated the experience positively, confirming its engaging value. Participants valued the opportunity to learn new things and visit a unique place, highlighting the educational dimension of the experience.

5. Discussion and Conclusions

The Virgo remote guided tours have demonstrated significant outreach value by serving as an effective tool for science communication. They successfully engage a broad and international audience, breaking down geographical barriers and making complex scientific concepts—such as gravitational waves—accessible to diverse groups. This capacity to reach people worldwide contributes to raising public awareness of cutting-edge research while fostering a sense of global scientific community.

From a pedagogical perspective, these tours have proven valuable in stimulating students' interest in physics and astronomy. By providing insight into the processes of gravitational wave production and detection, they help students gain familiarity with authentic scientific practices. Furthermore, the tours offer a unique educational experience that allows students to interact directly with researchers, promoting meaningful engagement and enhancing their understanding of contemporary scientific work in a real-world context.

References

[1] https://picoproject.eu/

[2] https://www.ego-gw.it/

[3] https://ea.gr/en/index.asp

[4] https://www.virgo-gw.eu/

[5] https://www.ligo.caltech.edu/