Student Visit to Europe's Most Powerful Research Facility: The Măgurele Laser

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Abstract

The Extreme Light Infrastructure – Nuclear Physics (ELI-NP) facility in Măgurele, Romania, stands as one of Europe's most advanced research infrastructures, achieving a record-breaking laser power of 10 petawatts. This article describes a recent educational visit by students from the Centre of Excellence of the West University of Timișoara, organised by Victor Paunescu. It provides an overview of the facility's capabilities, technological achievements, and applications in fundamental and applied research.

About the Visit and Its Purpose

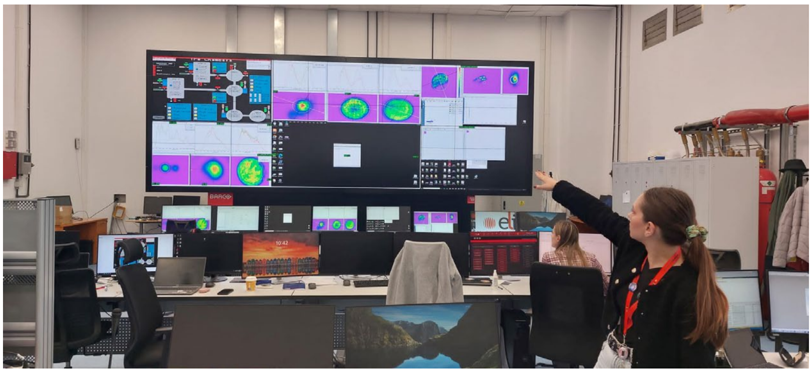

Figure 1: In the surveillance room

A group of students from the Centre of Excellence at the West University of Timișoara recently visited the ELI-NP facility in Măgurele, near Bucharest – an extraordinary opportunity made possible through the support of the Romanian Physics Society, the ELI-NP project, and the West University of Timișoara Foundation. The visit offered participants first-hand insight into one of Europe's most remarkable scientific centres and the most powerful laser system in the world.

The Extreme Light Infrastructure (ELI) is a pan-European initiative under the ESFRI (European Strategy Forum on Research Infrastructures) framework, dedicated to studying light–matter interactions at unprecedented intensities and time scales. The Romanian pillar of this initiative, ELI-NP, has become a cornerstone of scientific progress in Eastern Europe.

From Conception to Record-Breaking Performance

The Măgurele laser project represents an exceptional technological journey. Initial testing began in April 2017. On 7 February 2019, the facility reached a historic milestone when its laser system achieved 7 petawatts (PW) of peak power — the highest globally at that time. After further optimisation, the system achieved its full design power of 10 PW on 19 August 2020, marking a major leap forward in laser physics and high-intensity research infrastructure.

Technological Capabilities

The ELI-NP facility features two complementary experimental systems designed for distinct yet synergistic purposes.

Figure 2: Ultra-short pulse monitoring

1. **The Laser System**

   It comprises two ultra-short pulse lasers, each delivering up to 10 PW. Together, they can generate focused intensities up to 10^{23} W/cm^2 and electric fields exceeding 10^{15} V/m, placing the facility at the forefront of global experimental physics.

2. **The Gamma Beam System**

   This unique system produces highly brilliant gamma rays through the Compton scattering of photons on high-energy electrons, with tunable photon energies up to 19.5 MeV. It achieves a spectral density of over 10^3 photons/s/eV and a relative bandwidth of approximately 0.5%, offering exceptional precision for nuclear and particle physics research.

Applications in Fundamental and Applied Research

The ELI-NP's experimental capabilities extend beyond fundamental physics, contributing to diverse applied fields:

Space and Materials Research

Experiments simulating extreme radiation and vacuum conditions help scientists understand materials exposed to cosmic environments. Studies include the thermophysical properties of undercooled metallic alloys, droplet dynamics, crystal nucleation, and microstructure evolution — crucial for space materials engineering.

Nuclear Materials and Waste Management

Research at ELI-NP supports the development of safer and more efficient methods for handling spent nuclear fuel and radioactive waste.

Industrial Tomography

The facility's high-resolution imaging techniques enable non-destructive three-dimensional visualisation of internal structures, improving quality control and diagnostics in advanced manufacturing.

Positron Sources and Material Characterisation

Extremely intense positron sources developed at ELI-NP allow for unprecedented precision in analysing material properties.

Medical Radioisotopes

The production of novel radioisotopes for radiotherapy and diagnostics promises advances in cancer treatment, enabling higher selectivity in destroying malignant cells while sparing healthy tissue.

Conclusion

The visit of high school students organised by the West University of Timișoara to the Măgurele Laser facility offered an invaluable educational experience and highlighted the value of international collaboration in science. The ELI-NP stands as a symbol of European scientific excellence, continually pushing the boundaries of experimental capability with applications ranging from fundamental research to real-world technologies addressing global challenges.

We encourage schools and universities to organise similar visits to major scientific and technological centres — nationally or internationally. Such experiences can profoundly inspire young people to pursue studies and careers in physics and related sciences.

Figure 3: Group of students on the visit