

EXTREME LIGHT INFRASTRUCTURE- NUCLEAR PHYSICS (ELI-NP)

ELI-NP THE MOST POWERFUL LASER IN THE WORLD

Extreme Light Infrastructure (ELI) is a **new Research Infrastructure** (RI) of pan-European interest and the first European Strategy Forum for Research Infrastructures (ESFRI) roadmap project to be built and operated in new Member States of the European Union. The facility is based on **three sites**, presently being implemented in the Czech Republic ([ELI Beamlines](#)), Hungary ([ELI-ALPS Attosecond](#)) and Romania ([ELI-NP](#)).



Extreme Light Infrastructure - Nuclear Physics (ELI-NP), a major European project, represents **the greatest investment** ever made in a scientific research project in Romania's history. It values more than **320M Euro** and is co-financed by the European Commission and the Romanian Government from Structural Funds via the **European Regional Development Fund (ERDF)**. Due to its unique characteristics this infrastructure will provide **new opportunities** for the study of fundamental processes occurring in light-matter interaction and will focus on laser-based nuclear physics. Here you will find **new European laboratories** with a broad range of science covering frontier **fundamental physics**, new **nuclear physics** and **astrophysics** as well as **applications** in nuclear material, radioactive waste management, material science and life sciences that will actively promote its applications **for the benefit of society**.



The ELI-NP project is implemented by the **Horia Hulubei National Institute of Physics and Nuclear Engineering (IFIN-HH)**, which contributes with almost 10% to the national scientific output.

The ELI-NP project, unique in the world due to the **performance of the equipment**, places Romania in the premier league of the Scientific Research and will put our country on the map of **the most prestigious infrastructures in the world**. The core of the facility is a multi-PW laser system with two Front Ends.

2 X 10 PW LASER SYSTEM

Two synchronized arms with:

outputs: 10 PW/0.1Hz, 1PW/1Hz, 100TW/10Hz

Based on the Chirped Pulse Amplification (CPA) technology the laser system makes it possible to experimentally investigate highly nonlinear processes in atomic, molecular, plasma and solid-state physics and to access previously **unexplored states of matter**.

CPA is a revolutionary technique, invented by Gerard Mourou and Donna Strickland, the **Nobel Prize Laureates in Physics** in 2018, that takes low-intensity light, stretches and amplifies it, then compresses it back into incredibly short, ultrafast pulses. The laser system at ELI-NP is the **pure application of this technology**.

This High Power Laser System (HPLS) with unprecedented characteristics is developed and delivered by **Thales Optronique France** in consortium with **Thales Romania**.

The Gamma (γ) Beam system will be produced via **Compton backscattering** of a high frequency laser beam on an electron beam. The characteristics of the ELI-NP γ beam will be beyond state-of-the-art: the **brilliance** and the **bandwidth** of the γ beam will be orders of magnitude better than any existing gamma beam in the world.

HIGH INTENSITY GAMMA BEAM SYSTEM

- Max. γ energy: 19,5 MeV; Spectral density: 10^4 ph/s/eV
- Bandwidth: < 0.5 %
- Production method: Compton backscattering of light photons on relativistic electrons

Several types of **experiments** will be possible at ELI-NP, e.g. laser-driven experiments in single or double pulse-shot mode on target, γ beam experiments in narrow or wide-bandwidth mode and combined laser and gamma beam experiments. Based on the unique features on the high-power laser and γ beams, the scientific programme **ELI-NP White Book** is the result of a large international collaboration of more than **100 scientists** from 30 countries.

ELI-NP RESEARCH

FUNDAMENTAL

- Understanding laser-driven acceleration mechanism;
- Exotic nuclei and photo-fission;
- Vacuum properties and particle creation in laser-gamma beam interactions;
- Nuclear structure and astrophysics studies.

APPLIED

- Materials under extreme irradiation for space science;
- Management of Nuclear materials;
- Industrial tomography;
- Brilliant positron source for materials/ processes characterization;
- Radioisotopes for medical applications.

ELI-NP **has been selected** by the most important science committees in Nuclear Physics in Europe - **NuPECC** - in the Nuclear Physics Long range Plan in Europe **as a major facility**.

The ELI-NP facility covers an area of approximately **33,000m² of high quality**, energy efficient buildings, distributed in **8 experimental halls**. The 5 MW necessary power for the building is provided by a geothermal system consisting of one thousand wells **120m deep**. The laser room, the gamma beam area and the experimental areas are situated on an **anti-vibration platform** aiming to decouple the system from any outside vibration. The platform weights **one hundred and twenty thousand tons** and lies on a complex system of **dumpers and springs**.

ELI-NP has the potential to be, for many years, in the forefront of worldwide science from theoretical physics to biology. The project has a great flexibility to cover various interdisciplinary areas, as a consequence of the possibility to employ, simultaneously in experiments, multiple radiation types, produced by equipment that will be unique at the moment of entering operation.

The scientific program of ELI-NP can be divided in 3 major categories:

- Nuclear Physics experiments to characterize laser – target interaction;
- Exotic Nuclear Physics and astrophysics, complementary to other ESFRI Large Scale Physics Facilities (FAIR-Germany, SPIRAL2-France);
- Applications based on high intensity laser and very brilliant gamma beams.

ELI-NP is close to the transition between the implementation phase and the operational one. The access policy to the facility intends to ensure the attraction of the best scientific users and a generation of excellent scientific results and it involves not only performing experiments, but also joint technological development, training and <mind-sharing> as well. The opportunities offered at ELI-NP aim to attract users from all around the world and our goal for the future is to build up a strong international user community. ELI-NP team will also practice a vigorous technology transfer to European SMEs and large firms providing R&D outreach and strengthening the collaboration with industry and stimulating spin-off industries from research.

Further information: **www.eli-np.ro**

Extreme Light Infrastructure ELI-NP

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