Extreme Light Infrastructure - Nuclear Physics

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Extreme Light Infrastructure - Nuclear Physics (ELI-NP) is a research infrastructure where two scientific communities, laser physics and nuclear physics, have joined their efforts to extend the research in Nuclear Photonics to the interaction of extreme photon beams with matter. The infrastructure will provide high-power laser and gamma beams with unprecedented characteristics to be used for nuclear physics, plasma physics, quantum electrodynamics, and material science research.

The high-power laser system consisting of 2×10 PW lasers will create ultra-dense, ultra-short, high-energy and high-resolution nuclear beams as well as coherent X-ray sources. The gamma beams to be delivered at ELI-NP will exhibit a high spectral density of about 104 photons/s/eV, high monochromaticity (average relative bandwidth of less than 0.5%), and continuously tunable energy up to about 20 MeV, linear polarization of more than 95%. The high-power laser system will provide pulses with intensities as high as 1023 W/cm^2. First experiments with the high-power lasers at ELI-NP aim at measuring the magnitude and scaling of the achievable laser intensity via laser-gamma conversion efficiency. New ion acceleration schemes by using Radiation Pressure Acceleration and Target Normal Sheath Acceleration mechanisms will be investigated, aiming at achieving a better understanding and control of high-intensity laser-driven ion sources.

A broad biomedical research program anchored in the unique ELI-NP capabilities is currently being developed at ELI-NP and addresses topics such as the production of radiotherapy relevant nuclear beams and the radiobiological effects of laser and gamma nuclear beams, and medical imaging research with laser X-ray sources. Applications based on the use of intense, short-duration, mixed radiation pulses are planned with the aim of studying the behaviour of materials under extreme conditions.

Currently, ELI-NP is in a transition phase from implementation to operation. Following the successful commissioning of the high-power laser system and of the laser beam transport system, the commissioning of the experimental setups is now underway. The experimental setups will gradually be made available to users during 2022 and 2023. An overview of the ELI-NP research infrastructure and of selected research topics to be investigated at ELI-NP will be given.