ELI-NP's Mission: Providing a Dual 10 PW Laser System

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The emergence of a new era reaching beyond the current state-of-the-art ultrashort and ultra-intense laser technology was enabled by the approval of 850 Million euros budget from structural funds in 2011-2012 by the European Commission. This led to the installation of Extreme Light Infrastructure (ELI) in Hungary, the Czech Republic, and Romania as the ELI three pillars. This challenging proposal is based on recent technical progress allowing ultra-intense laser fields focusing at an intensity as high as $I_0 \sim 10^{23}$ W/cm^2. This tremendous technological advance has been brought possible by the invention of chirped pulse amplification method by Professors G Mourou and D Strickland, the two Nobel Laureates in 2018. Romania is hosting the ELI-for Nuclear physics (ELI-NP) pillar in Magurele situated in the 10 km southwest of Bucharest by operating 100TW, 1 PW and 2 beams of 10 PW for the world users.

[ELI-NP laser system]
The high power laser system (HPLS) at the three output power levels has been fully operated. At 10 PW, the laser shot is possible at every one minute while 1 PW at 1 Hz and 100 TW at 10 H. The nominal laser parameters are the laser energy 230 J, the laser pulse width 23 fsec, the beam diameter 55 cm, the central laser wavelength 800 nm at 10 PW [1]. The laser beams are transported in vacuum to E1 (10 PW + short focal (f/3) length mirror), E4 (100 TW), E5 (1 PW), E6 (10 PW + long focal (f/60) length mirror) experimental chambers where the experimental preparation can be performed in parallel and independently.
The 10 PW output was demonstrated for 10 shots in 10 min. all the way in the HPLS amplifiers and at after the large compressor on Nov. 17, 2020 at the Inaugural 10 PW Laser and Users Symposium[2]. The shots were performed on zoom in front of 230 scientists and professors all over the world also with the presence of Prof G Mourou and D Strickland (2018 Nobel Physics Laureates).

[Experimental Stations]
The experimental stations have been activated and partially operational [3]. Early experiments have already started at 100 TW laser output experimental station E4. The early experiment was intended to test our readiness to conduct the experiments. The successful electron acceleration results show a good control of electron spectra up to 300 MeV either with mono energetic or broadband spectra. Further upgrade of this electron acceleration is being conducted at 1 PW laser output. After the early experiments, series of commissioning experiments are planned. The commissioning experiments are considered to test the laser performance by measuring the maximum energies of electrons and ions accelerated using various acceleration schemes such as laser wake field acceleration.

Then user experiments will follow the commissioning. The users from all over the world are supposed to submit their proposals. 78 letters of intent (preliminary version of the proposal) have been submitted already at the first user workshop in 2019. The physics advisory committee for the allocation of the laser machine times will scientifically evaluate the proposals.
The 10 PW experimental stations will be activated soon and will be available for the user experiments in 2023. The user access has been tested with the early and commissioning experiments and will be formulated coherently with the IMPULSE project guided by ELI-DC. The IMPULSE project is considered a ramp up of the three ELI pillars to become virtually connected laser institute in Europe.

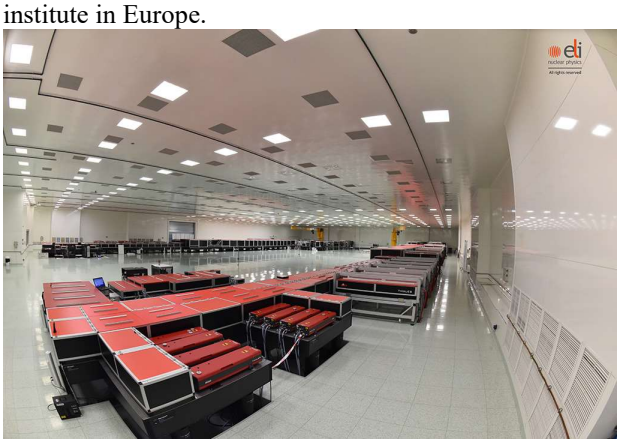

Figure High Power Laser System
Two beams of 10 PW laser output are guided to various experimental chambers from this laser bay. The laser specifications are 230 J(Energy), 23 fsec(pulse width), 800 nm (central laser wavelength), and 55 cm(final beam diameter).

References

1. F Lureau, G Matras, O Chalus, et al., High Power Laser Science and Engineering, **8**, e43 (2020),
2. http://www.eli-np.ro/2020-symposium/
3. KA Tanaka, KM Spohr, D Balabanski et al., Matter and Radiation at Extremes, **5**, 024402 (2020); S Gales, KA Tanaka, D. Balabanski et al., Report on Progress in Physics **81**, 094301 (2018)