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Materials in Extreme Environments at ELI-NP

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The ELI-NP (Extreme Light Infrastructure -Nuclear Physics) facility, currently under construction in Magurele, Romania, will make possible experiments with high power lasers with peak powers of 100 TW, 1PW and 10PW.
One of ELI-NP research direction will focus on the field of materials in high radiation fields, temperature and pressure conditions, taking advantage of the ultrashort time scales of secondary radiation pulses and the relatively broadband spectrum of radiation, complementary to the traditional nuclear physics research laboratories. Further specificity of the proposed experimental environment for tests at ELI-NP is that it simultaneously provides two or more types of radiation at the same time and on the same target. The planned radiation beams at the beginning at the ELI-NP operation will be: photon radiation (maximum energy of 19 MeV and maximum intensity 10^9 photon/pulse), laser driven electron beam (maximum energy 2 GeV and maximum intensity 10^8 e/pulse), laser driven proton and ion beams (maximum energy 100 MeV and maximum intensity 10^9 p/pulse) and laser driven neutron source (maximum energy 20 MeV and maximum intensity 10^7 n/pulse).
The study of materials behaviour in extreme environments will be a central topic, with a direct application to the development of accelerator components, understanding of structural materials degradation in next generation fusion and fission reactors or the shielding of equipment and human missions in deep space missions. Testing of novel materials for accelerator components at the future high–power facilities like FAIR, High Lumi-LHC, FRIB, neutrino factories and ESS in conditions of radiation, temperature and pressure reproducing operation scenarios would be possible by using "cocktails" of laser driven particles and laser induced shock waves. ELI-NP through experimental areas E5 (1PW at a repetition rate of 1Hz) and E4 (100TW at a repetition rate of 10Hz) offers an unique testing facility complementary to accelerator irradiation. The availability of two high-intensity short-pulse lasers would enable pump-probe experiments using laser based diagnostic enabling structural degradation studies during irradiation on a much finer time scale.

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