Advanced laser-driven ion sources and their applications in materials and nuclear science

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The investigation of superintense laser-driven ion sources and their potential applications offer unique opportunities of multisciplinary research [1]. Plasma physics can be combined with materials and nuclear science, radiation detection and advanced laser technology, leading to novel research challenges of great fundamental and applicative interest.

In this contribution, the main results obtained so-far within the framework of the ERC ENSURE project will be presented. Numerical simulations and experimental activities carried out at 100s TW and PW-class laser facilities [2,3] have shown that targets consisting in a solid foil coated with a nanostructured low-density (near critical) foam can lead to an enhancement of the ion acceleration process. Thanks to a deep understanding of the foam growth process via Pulsed Laser Deposition technique [4] and to the complementary capabilities of the High-Power Impulse Magnetron Sputtering, advanced multi-layer targets based on near-critical films with carefully controlled properties (e.g. density gradients over few microns length scales) can now be manufactured, with applications outreaching the field of laser-driven ion acceleration. This also stimulated a thorough numerical investigation of superintense laser-interaction with nanostructured plasmas [5-7]. In addition, a comprehensive numerical and theoretical work has allowed to design a realistic table-top apparatus for laser-driven Ion Beam Analysis and neutron generation, that exploits a double-layer target to reduce the requirements for the laser system [8].

References

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