# Laser-driven ion acceleration and neutron generation from near-critical plasmas exploiting nanostructured targets and the Vega-3 laser

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We present our experimental results on hadron acceleration from laser-plasma interaction with near-critical Double-Layer Targets (DLTs) [1] obtained during a campaign at the Centro de Láseres Pulsados (CLPU) with the 1 PW Vega-3 laser system [2].

DLTs [1], where near-critical layers (e.g. carbon foams) cover micrometric substrates (e.g. solid Al), can allow increasing the energy and number of particles from laser-generated plasmas. Thus, they can play a relevant role in accessing different plasma regimes and, at the same time, fulfilling several application requirements [3]. Applications require developing a reliable particle source based on laser-plasma interaction. To this aim, quantitative characterization of the accelerated particles is fundamental.

Here, we present the results achieved with fully optimized DLTs and the Vega-3 laser (~30 J, 30fs, 12 μm FWHM focal spot, $\sim 2 \times 10^{20}$ W/cm$^2$ peak intensity). The near-critical layers and substrates are deposited by exploiting Pulsed Laser Deposition and Magnetron Sputtering techniques to finely tune the DLT properties [4]. We performed a broad scan over substrate and foam thicknesses to investigate the effect of plasma properties on the ion acceleration. Proton spectra are detected with diagnostics (Thomson Parabola, Time-of-Flight and RCFs) available at CLPU. Furthermore, we tested a novel calibrated photodiodes-based proton spectrometer developed in collaboration with the RayLab Company. We compare the spectra achieved with our spectrometer and conventional detectors. Lastly, we studied neutron generation from protons accelerated with DLTs and a LiF converter. Neutrons are characterized using the Diamon spectrometer [5] provided by RayLab and several other detectors.

Our results show the reliability of DLTs for high-energy hadron production, as well as the feasibility of a new application-oriented detection solution.

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