

Double pulse laser-induced plasmas on W and Al for estimate of hydrogen-deuterium by ps-LIBS in tokamak-like conditions

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CONTEXT & OBJECTIVES

(Laser-Induced Breakdown LIBS Diagnostic technique Spectroscopy)

LIBS enables concentrations determination in a target using optical emission spectroscopy. For a target composed of elements in very low concentration or whose upper levels of usual transitions are at high energy (> 10 eV) the maximization of the output signal is mandatory. One efficient technique is to heat up the plasma with a second laser pulse shifted in time. This experimental process is called *double pulse* (DP).

Objectives

- Obtain an experimental setup accurately controlled in time and space
- Estimate the improvements in terms of output spectral radiance
- Quantify the electron density enhancement and the increase in number densities of weakly excited states







Double pulse laser-induced plasmas on W and Al for estimate of hydrogen-deuterium by ps-LIBS in tokamak-like conditions

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EXPERIMENTAL SETUP



The first pulse (τ_1 , λ_1 , E_1) is focused on the target to produce a plasma. The second pulse (τ_2, λ_2, E_2) is focused in this plasma with a temporal shift of Δt_{1-2} . The Heated lasma's radiation is collected along a third optical axis to be analysed using a SCT-320 spectrometer.

Laser sources

- EKSPLA PL-2251, τ₁ = **30 ps**
- QUANTEL Q-SMART 450, $\tau_2 = 5$ ns







DP on W targets

WI



• Electron density increase observed due to the absorption of the second laser pulse • Many transitions observed in spectra, but few of them are well characterized in the usual database (about 7% of W I and W II on NIST)

• Dynamics similar to the one observed for Aluminum



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> The **ps pulse** (τ_1 =30 ps, λ_1 =1064 nm, E₁=20 mJ) is focused on the sample using a lens of 125 mm focal length. The ns pulse $(\tau_2 = 5 \text{ ns}, \lambda_2 = 532 \text{ nm}, E_2 =$ 15.2 mJ) is delayed by Δt_{1-2} and is tangentially focused (with a lens of 150 mm focal length) in the plasma produced by the ps pulse at a distance H (=0 or 1 mm) + 0.62 mm above the sample's surface.

Laser attenuation for AL



• Maximum mean spectral absorptivity of 0.53

DP on H-D-W targets

• Limit of observation of H or D in W: 0.5 % at.

PERSPECTIVES

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• Study in collinear configuration (same optical axis for both pulses)

 Study in the VUV spectral range on the resonance lines of H and D