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# Experimental characterization of double pulse laser-induced plasmas on Aluminum and Tungsten targets

AURÉLIEN FAVRE<sup>1</sup> ‡, VINCENT MOREL<sup>1</sup>, CHRISTIAN GRISOLIA<sup>2</sup>, ARNAUD BULTEL<sup>1</sup>

<sup>1</sup> CORIA, UMR CNRS 6614, Normandie Université, 76801 Saint-Étienne du Rouvray, FRANCE

<sup>2</sup> CEA, IRFM, Site de Cadarache, 13108 Saint-Paul-lez-Durance

‡ aurelien.favre@coria.fr

## CONTEXT & OBJECTIVES

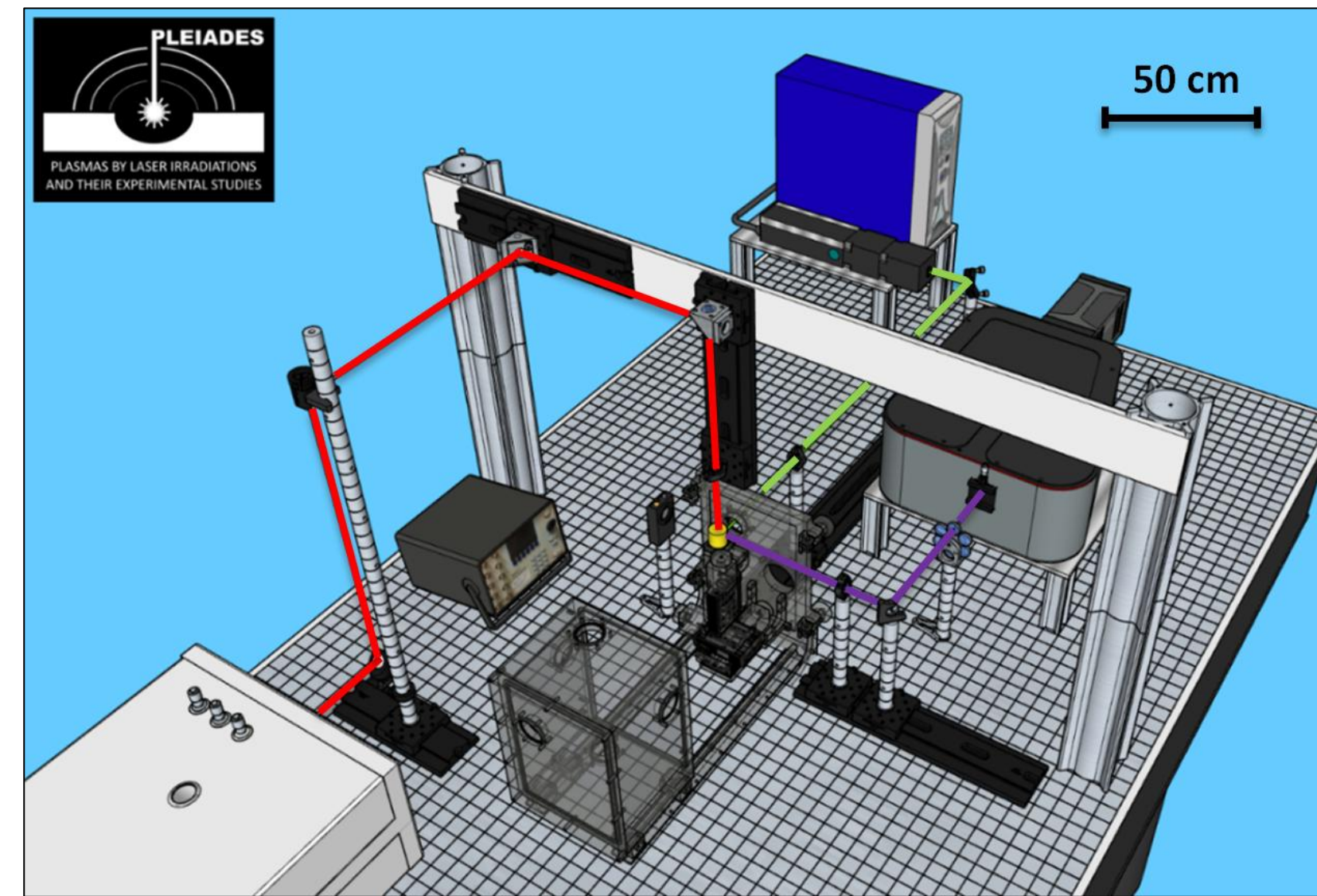
### Diagnostic technique LIBS (Laser-Induced Breakdown Spectroscopy)

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 common transitions are at high energy (10 eV or more) the maximization of the output signal is mandatory. One efficient technique is to heat up the plasma with a second 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 roughly electron and low level number densities

## EXPERIMENTAL SETUP

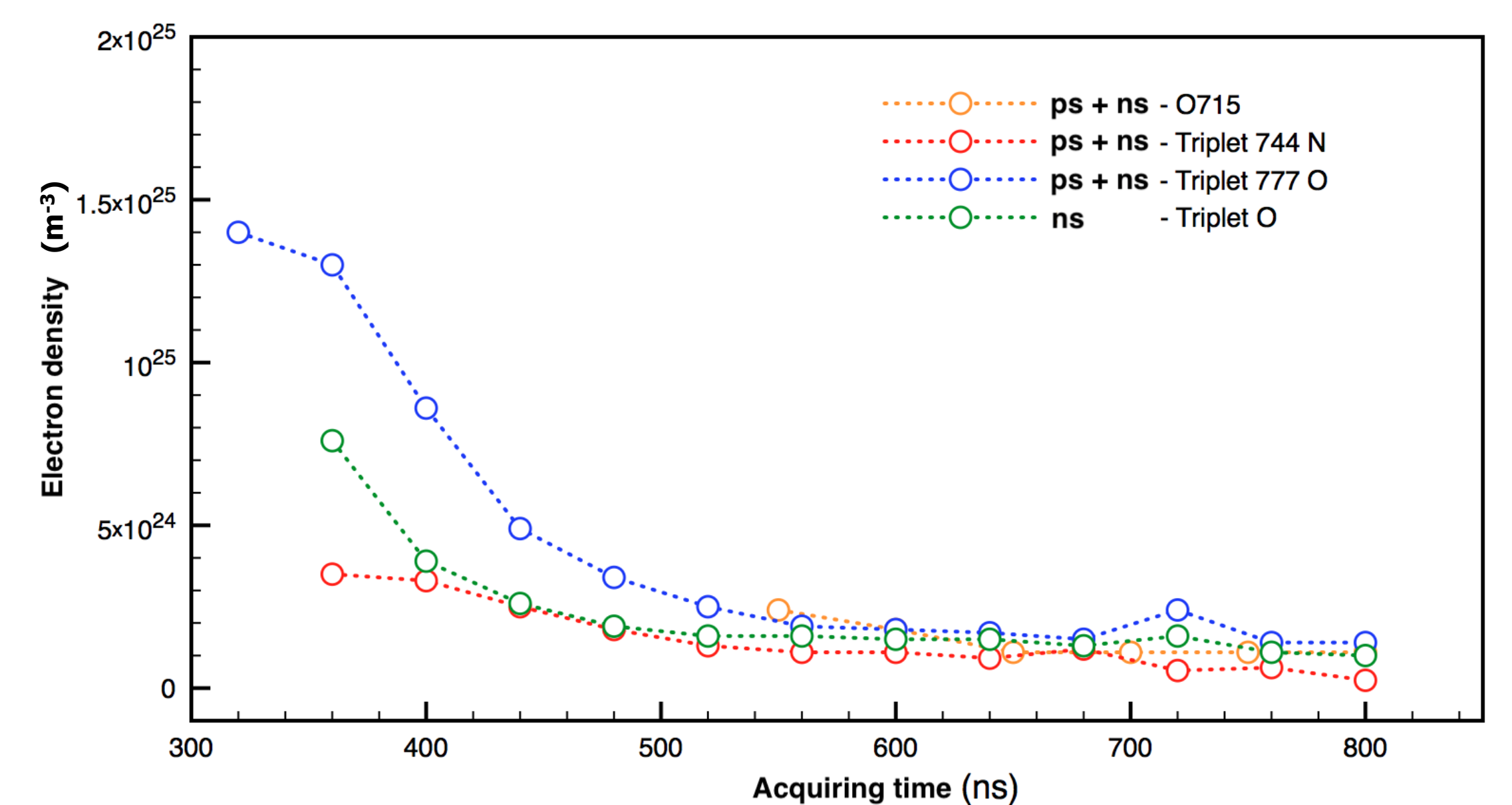
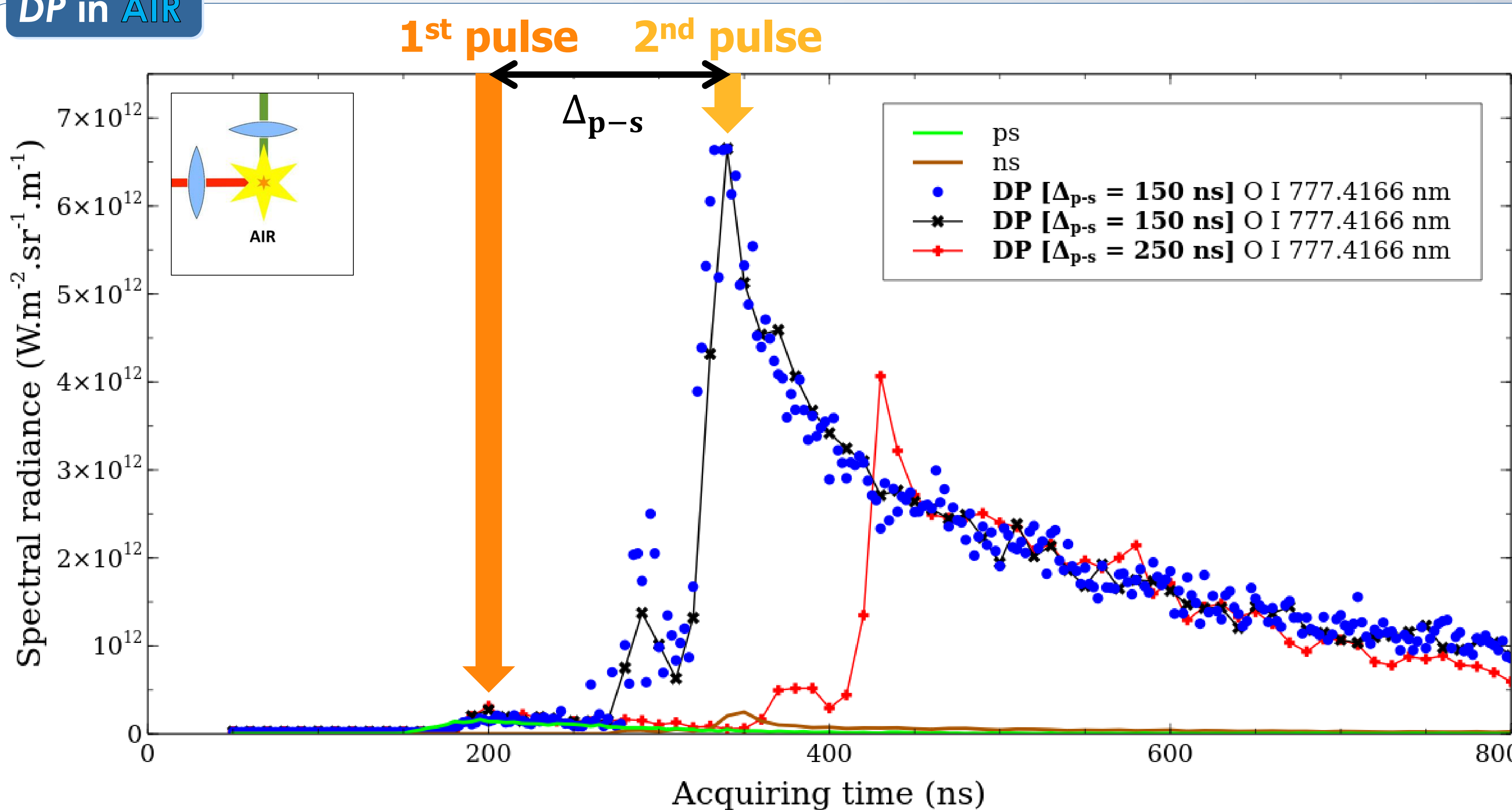


The **first pulse** (1064 nm, 30 ps, 14 mJ) is focused to produce a plasma. The **second pulse** (512 nm, 6 ns, 65 mJ) is focused in this plasma with a temporal shift of  $\Delta t$ . Heated plasma's radiation is collected along a **third optical axis** to be analysed with our SCT-320 spectrometer.

### LASERS:

- EKSPLA PL-2251: **30 ps**
- QUANTEL U100: **5 ns**

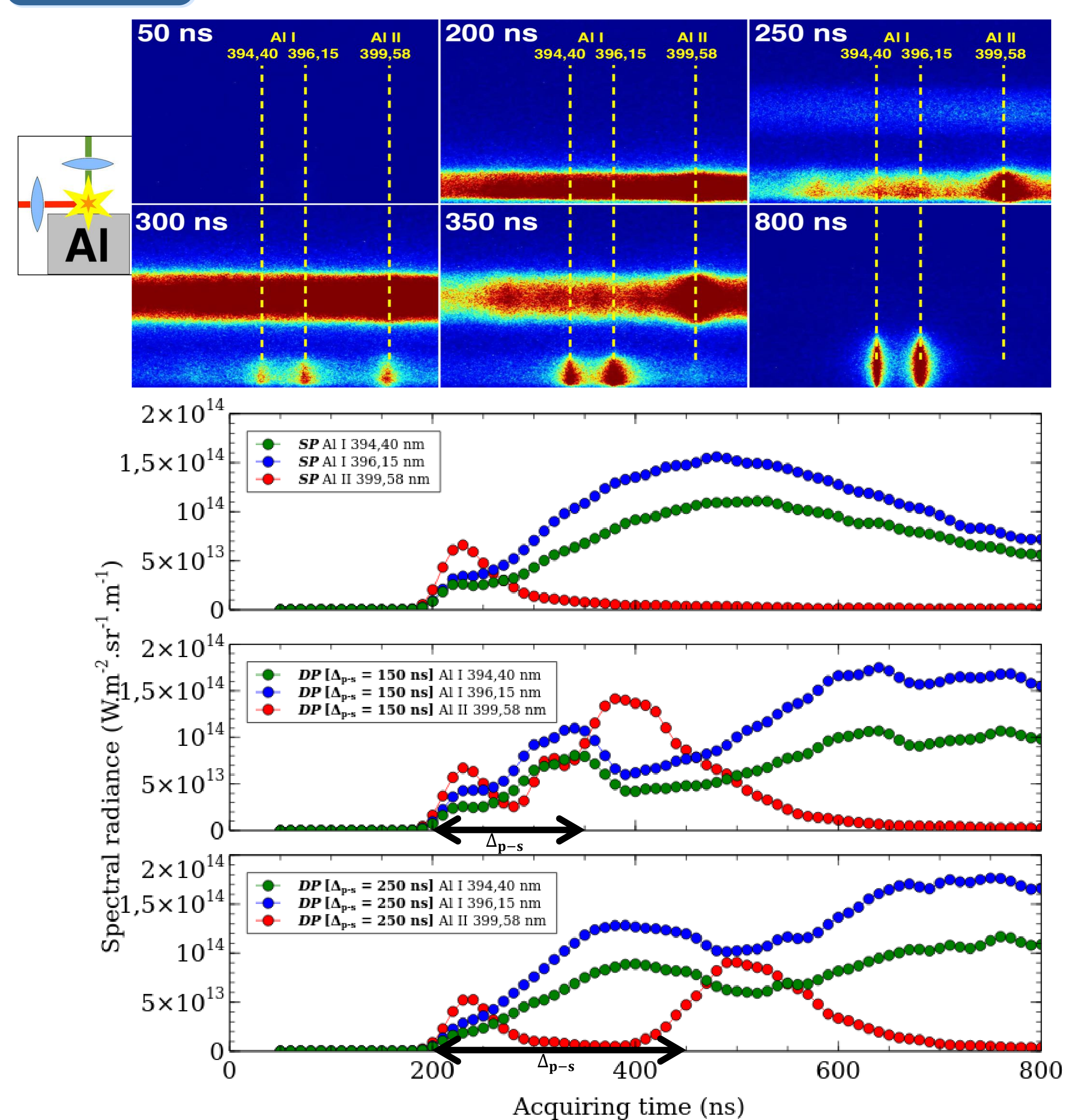
## DP in AIR



### Comments

- Efficient double pulse setup
- Optimal time shift to improve the output signal:  $\Delta t = 150$  ns
- First determination of electron density

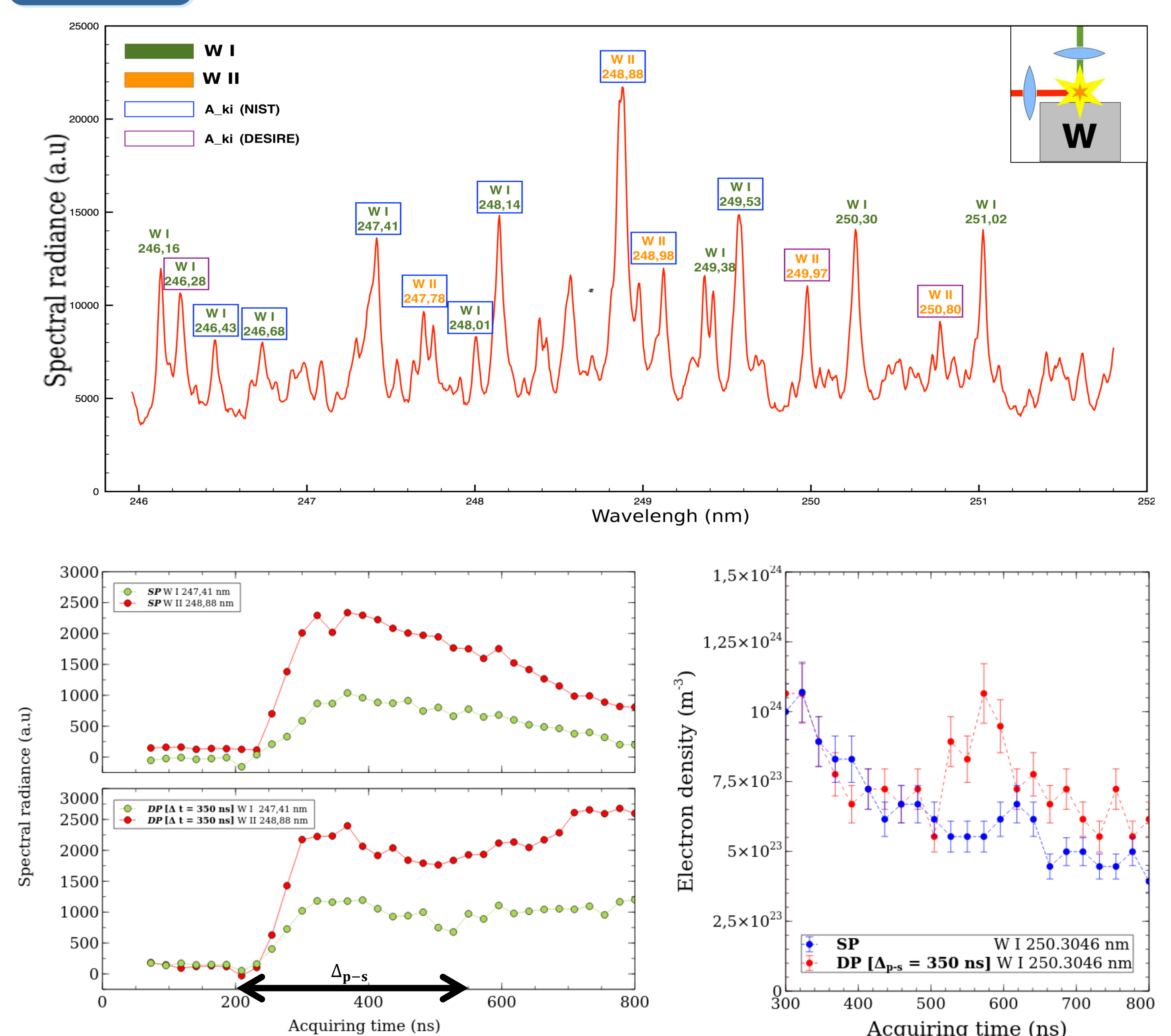
## DP on AL



### Comments

- Al II lines only observed in double pulse
- Recombination (ionic emission decreasing for the benefit of atomic one's)

## DP on W



### Comments

- Tungsten transitions description is limited (about 7% of W I and W II on NIST)
- Recombination dynamics seems to be less obvious
- Electron density increases while second pulse occurs

## CONCLUSIONS & PERSPECTIVES

- Efficient temporally and spatially controlled double pulse setup
- Detection limits are strongly enhanced, output signal is at least 5x multiplied
- Determination of electron density
- Possible characterization of states with lower energy by absorption spectra

- Accuracy can be strongly improved by working with a higher spectral resolution and signals with accumulations
- Absorption efficiency can be significantly enhanced by heating the plasma with an infra-red pulse (Inverse Bremsstrahlung)
- Detection of light elements such as H isotopes in heavy matrices like W remains our long-term objective