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► **To cite this version:**

M Mitrou, S Béchu, P Svarnas. Laser-induced photo-detachment diagnostic for interrogating pulsed ECR-driven plasmas: Application to  $H^-$  – and  $D^-$  – negative ions. International Conference on Phenomena in Ionized Gases (XXXV ICPIG), Jul 2023, Egmond aan Zee, Netherlands. hal-04285360

**HAL Id: hal-04285360**

**<https://hal.science/hal-04285360>**

Submitted on 15 Nov 2023

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# Laser-induced photo-detachment diagnostic for interrogating pulsed ECR-driven plasmas: Application to $H^-$ and $D^-$ negative ions

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The present work is devoted to an experimental setup tailored to study time-resolved processes relative to negative ion formation in ECR-driven plasmas. It refers to a laser-induced electron photo-detachment system synchronized with  $H_2$  and  $D_2$  ECR-plasmas being sustained by 2.45 GHz bursts in the kHz range. The system is combined with electrostatic probe time-resolved measurements and information is obtained both on the formation path and the yield enhancement of  $H^-$  and  $D^-$  negative ions.

## 1 Introduction

The study of  $H^-$  and  $D^-$  negative ions relevant to the accelerator and fusion applications, may be supported by considering transient kinetics within the corresponding plasmas. This concept is here tested by: (i) generating electron cyclotron resonance (ECR)  $H_2$  and  $D_2$  plasmas, sustained by 2.45 GHz microwave bursts; and (ii) interrogating them by means of time-resolved photo-detachment (PD) and electrostatic probe (EP) techniques.

## 2 Experimental setup and method

$H_2$  and  $D_2$  plasmas are produced in the ECR-driven SCHEME-II+ reactor, which is designed to study volume-produced  $H^-$  and  $D^-$  negative ions with respect to surface-enhanced production of vibrationally excited molecules [1].

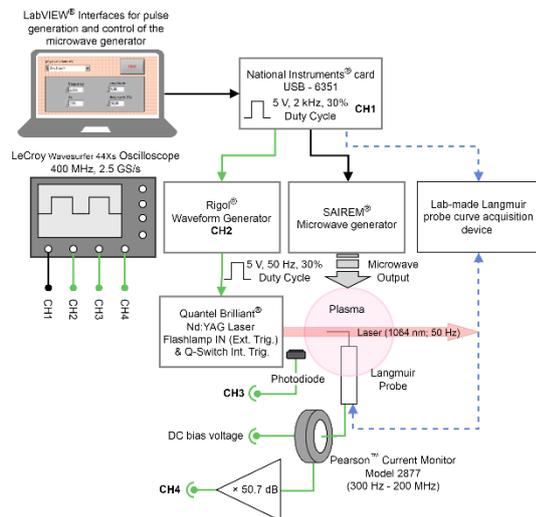


Figure 1. Generation of ECR-plasma bursts and scheduling for time-resolved PD and EP measurements.

Microwave power (150 W) is delivered from a solid-state 2.45 GHz generator and chopped to form bursts (repetition rate 2 kHz; pulse width 150  $\mu$ s). Laser-induced photo-detachment [2] (50 Hz) and electrostatic probe acquisition are both synchronized with the microwave bursts as explained in Fig. 1.

Measurements are carried out at 1.6 Pa and 75 mm downstream of the midplane of the ECR zone. Data are averaged over 100 and 1000 periods of the bursts for the EP and the PD experiments, respectively.

## 3 Results and Conclusion

Fig. 2 demonstrates indicative results from the  $D_2$  plasma, i.e., the signal of the electrons photo-detached from the  $D^-$  negative ions.

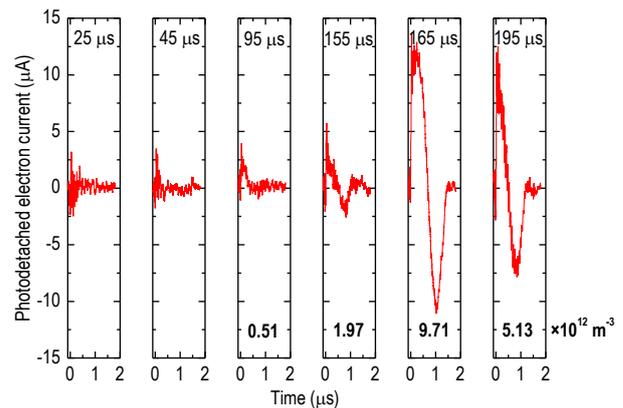


Figure 2. Representative time-resolved photo-detachment signals. Insets: corresponding time points of the acquisition and absolute  $D^-$  ion densities. The latter are calculated after factoring in the corresponding time-specific electron densities from the time-resolved probe I-V curves.

The above results stress the enhanced negative ion yield in the post-discharge phase ( $>150 \mu$ s). This may be attributed to the rapid decay of energetic electrons, atomic population, and positive ions involved in destruction reactions, along with the formation of vibrationally excited molecules of long lifetime [3] involved in the main volume production reaction of the  $H^-$  and  $D^-$  ions, i.e., dissociative attachment.

## References

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