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

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UNIVERSITY OF PATRAS  
ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΑΤΡΩΝ

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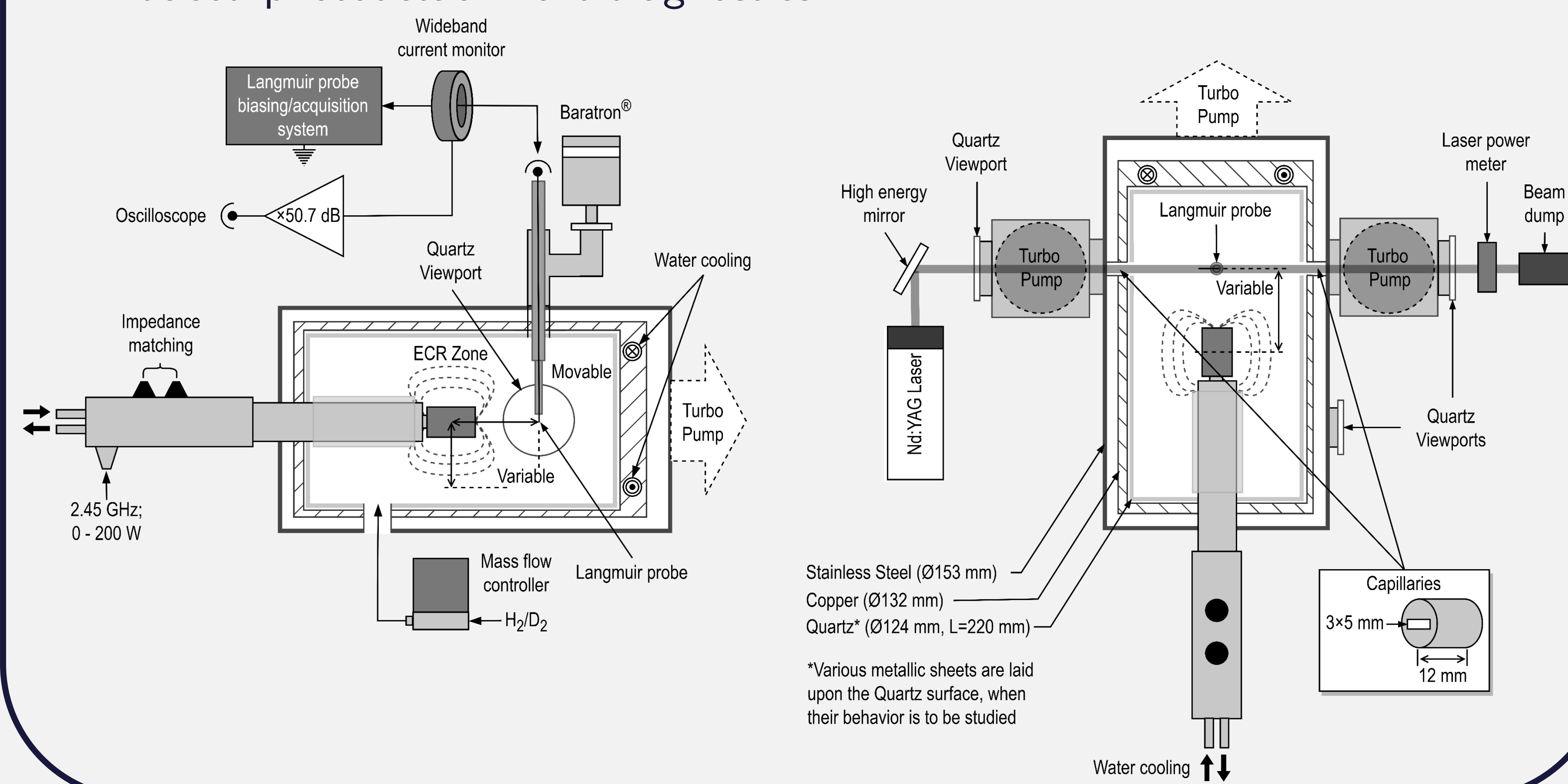
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Discharges sustained in the pulsed mode of operation are of great interest on a fundamental level as they may unveil important information on the plasma kinetics. The present work is devoted to an experimental setup tailored to study **time-resolved 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, 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**.

## EXPERIMENTAL SETUP

### The SCHEME-II+ reactor

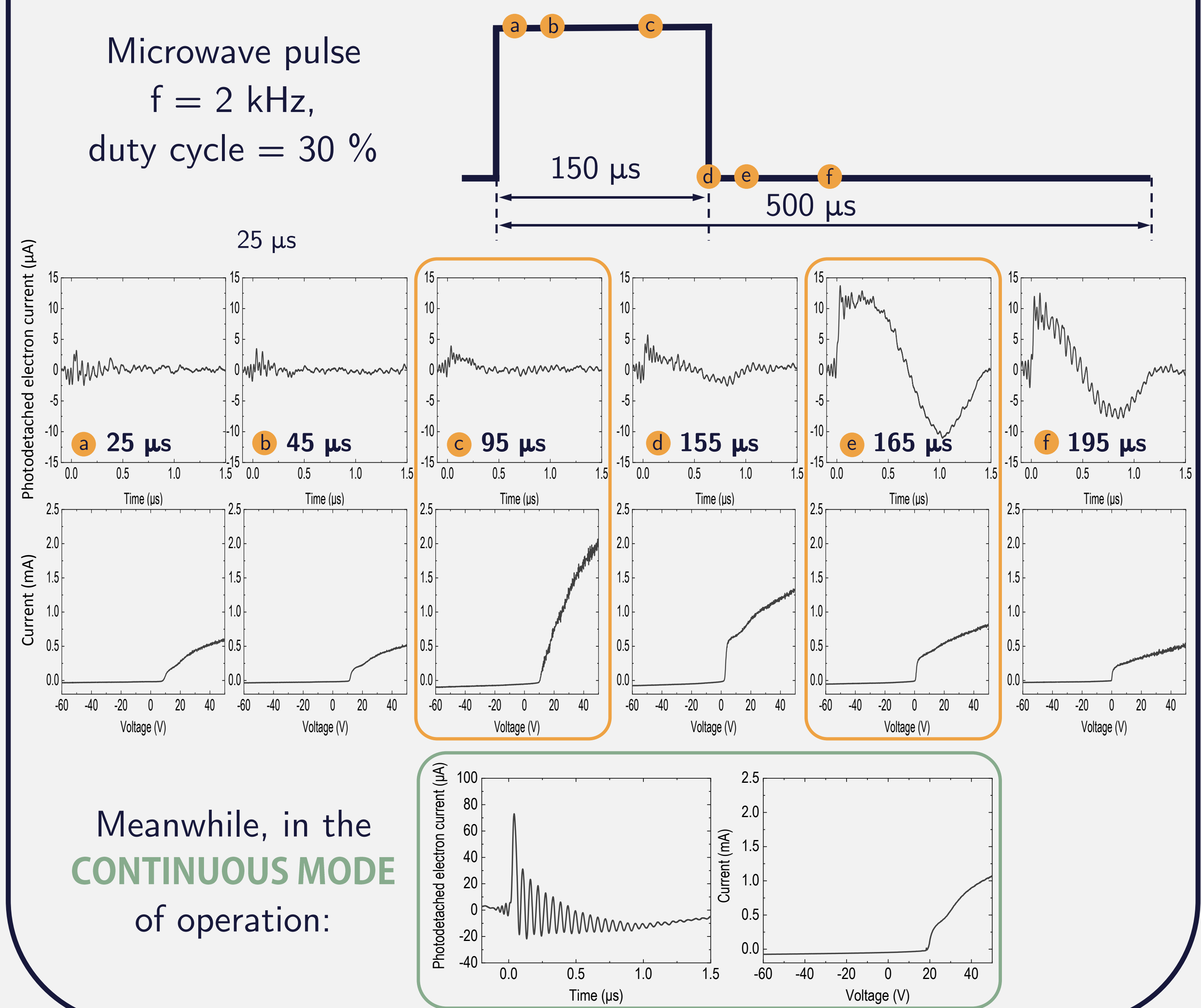
- Designed to evaluate plasma-surface interactions relevant to the volume production of  $H^-$  ( $D^-$ ) ions via dissociative electron attachment (DEA).
- $H_2$  ( $D_2$ ) plasmas are produced by a single dipolar ECR module (2.45 GHz, 0-200 W, pulsed with variable frequency and duty cycle).
- Simultaneous, time-resolved, application of the Langmuir-probe and laser-induced photodetachment diagnostics.



## RESULTS

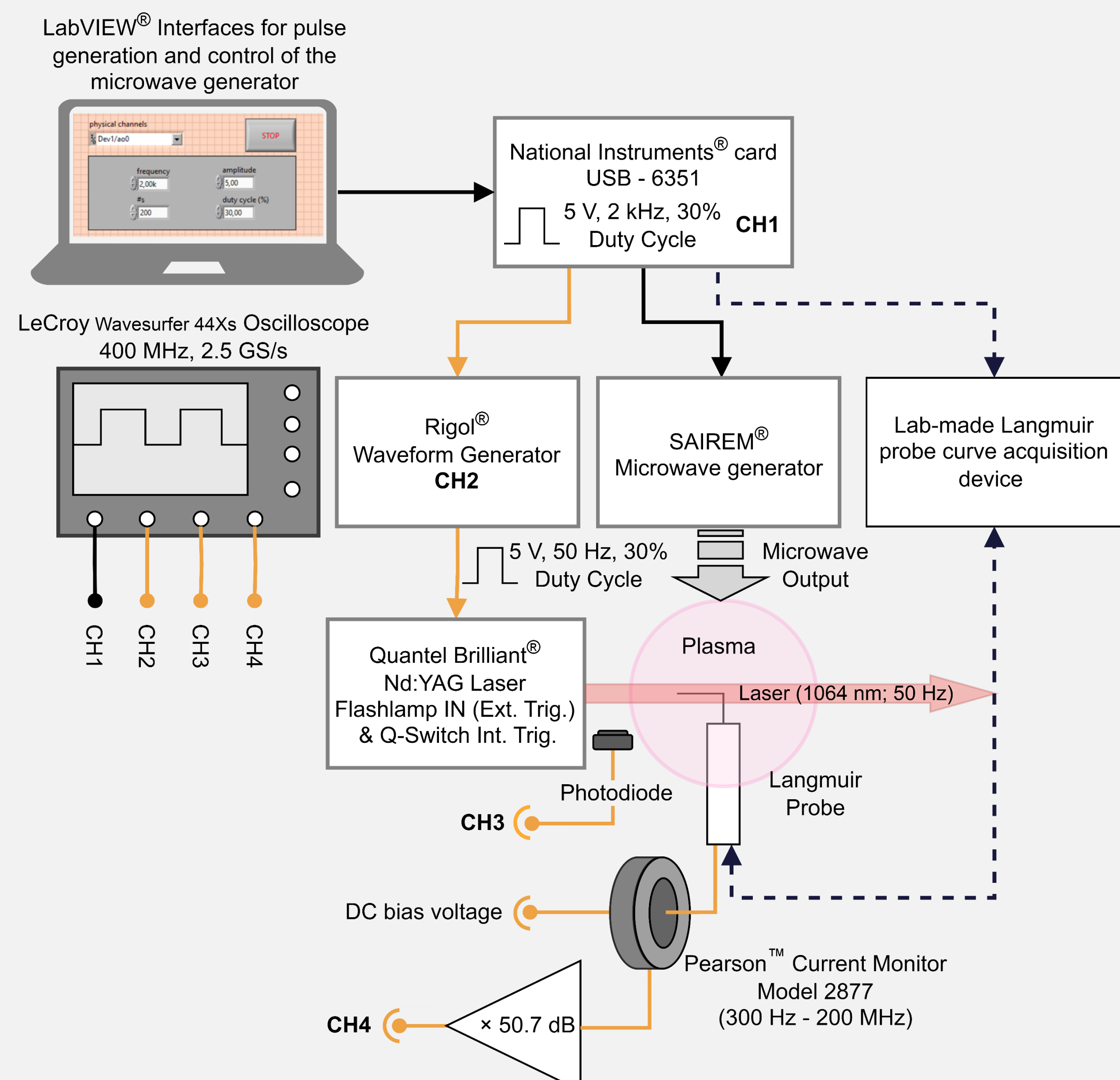
- Probed area within the plasma volume: 75 mm downstream the mid-plane of the magnet of the ECR module
- $D_2$  (1.6 Pa, 150 W), 100% Quartz coverage of the reactor interior

Microwave pulse  
 $f = 2$  kHz,  
duty cycle = 30 %

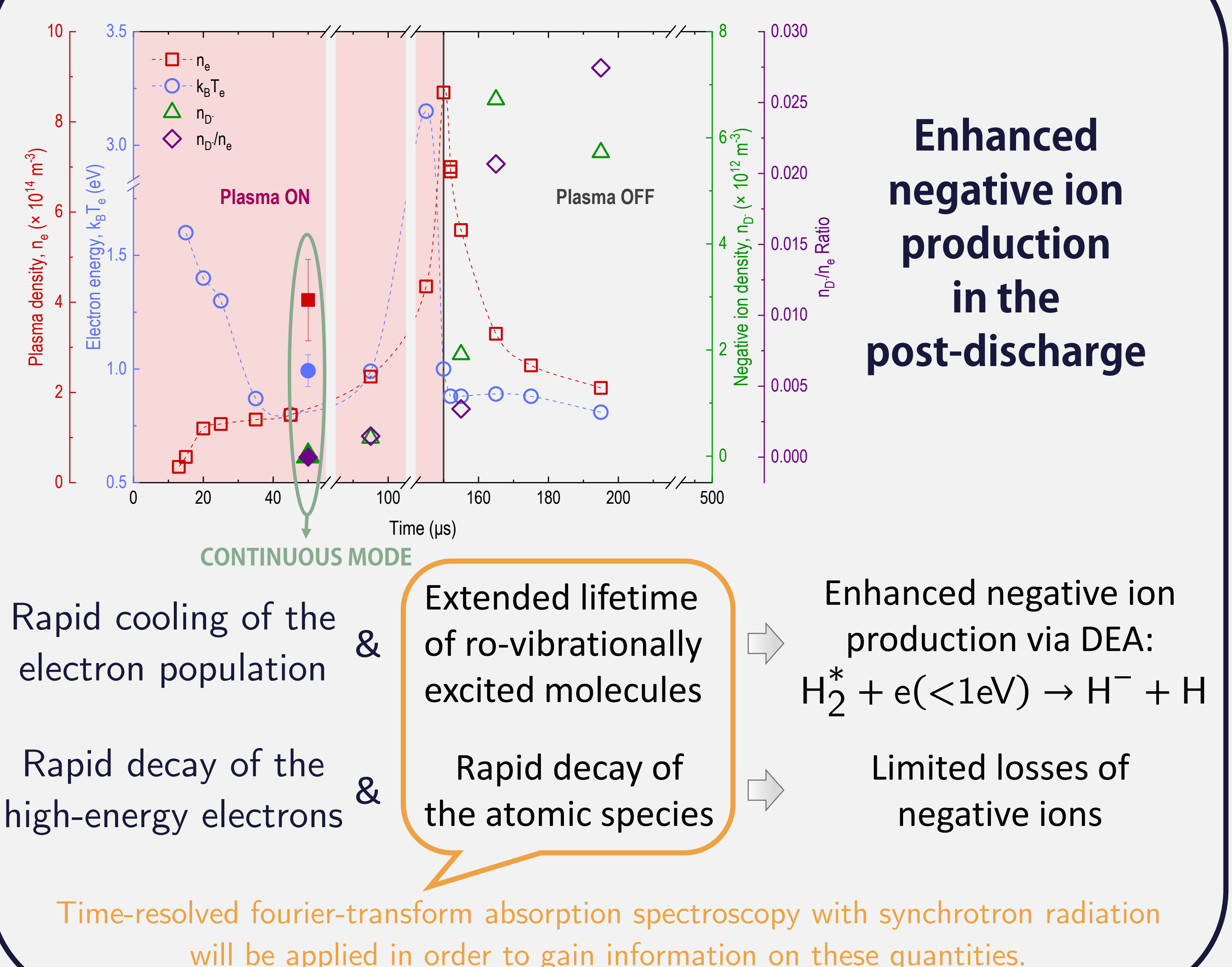


## METHODOLOGY

Time-resolved measurements require proper synchronization of the laser and Langmuir-probe systems with the driving microwave pulse:



## CONCLUSION



Enhanced negative ion production in the post-discharge

Rapid cooling of the electron population & Rapid decay of the high-energy electrons

Extended lifetime of ro-vibrationally excited molecules & Rapid decay of the atomic species

Enhanced negative ion production via DEA:  $H_2^* + e(<1\text{eV}) \rightarrow H^- + H$   
Limited losses of negative ions

Time-resolved fourier-transform absorption spectroscopy with synchrotron radiation will be applied in order to gain information on these quantities.

### References:

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- [2] M. Bacal, Rev. Sci. Instrum. **71**, 3981 (2000).
- [3] T. Mosbach *et al.*, Plasma Sources Sci. Technol. **7**, 75-81 (1998).

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### Recent publications:

- [1] M. Mitrou, P. Svarnas, S. Béchu, "*H<sup>-</sup> and D<sup>-</sup> production efficiency in a multi-dipole ECR-plasma source as a function of gas pressure*", J. Phys.: Conf. Series **2244**, 012007 (2022).
- [2] M. Mitrou, P. Svarnas, S. Béchu, "*Experimental study on dynamic effects of H<sup>-</sup> and D<sup>-</sup> negative ions in an ECR-plasma source*", J. Phys.: Conf. Series **2244**, 012006 (2022).
- [3] F. Taccogna *et al.*, "*Last experimental and theoretical advances in the production of negative ions in Cesium-free plasmas*", The European Physical Journal D **75**, 227 (2021).

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