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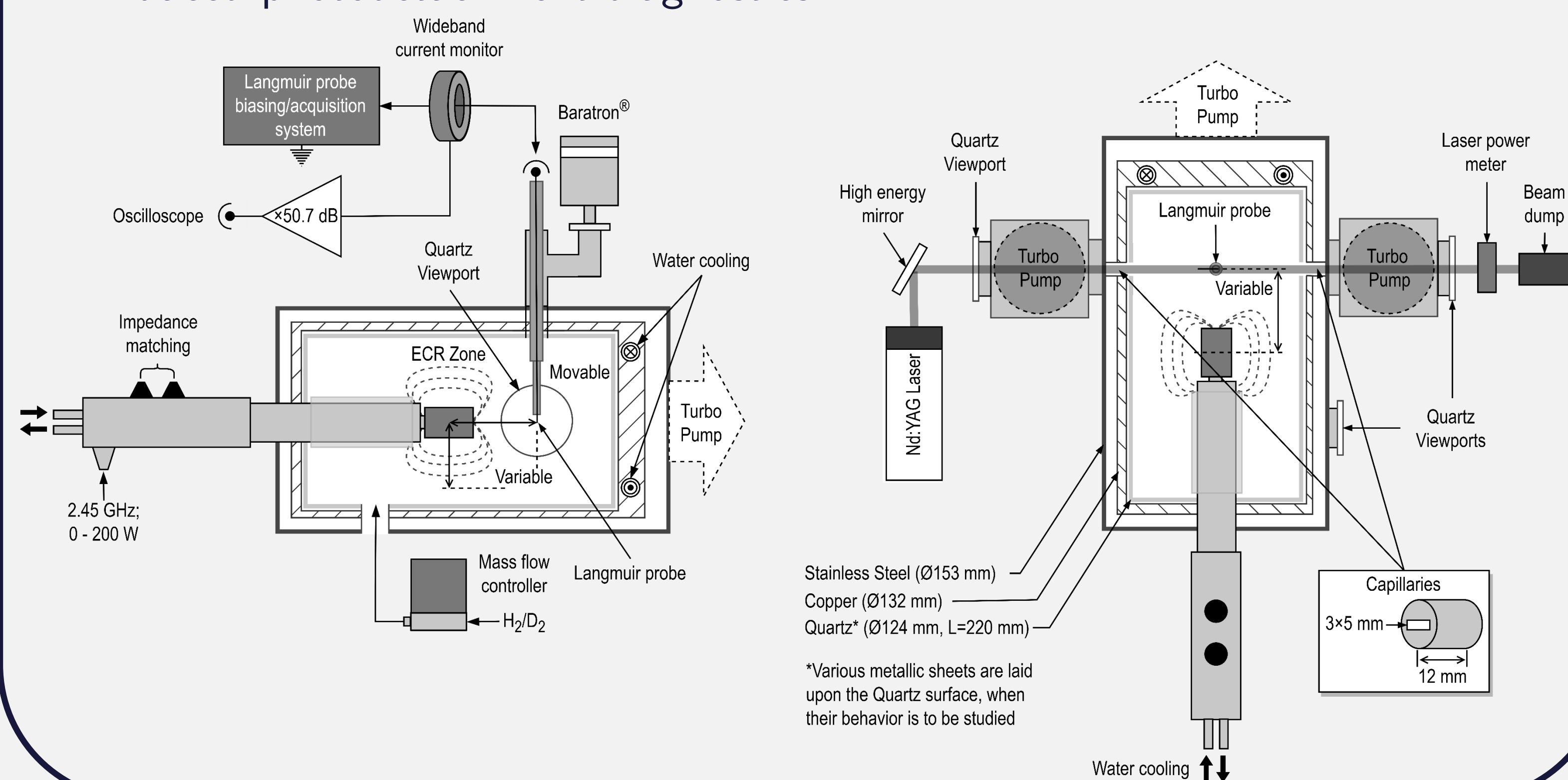
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Discharges sustained in the pulsed mode of operation are of great interest on a fundamental level as they may unveil important information on the plasma kinetics. The present work is devoted to an experimental setup tailored to study **time-resolved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

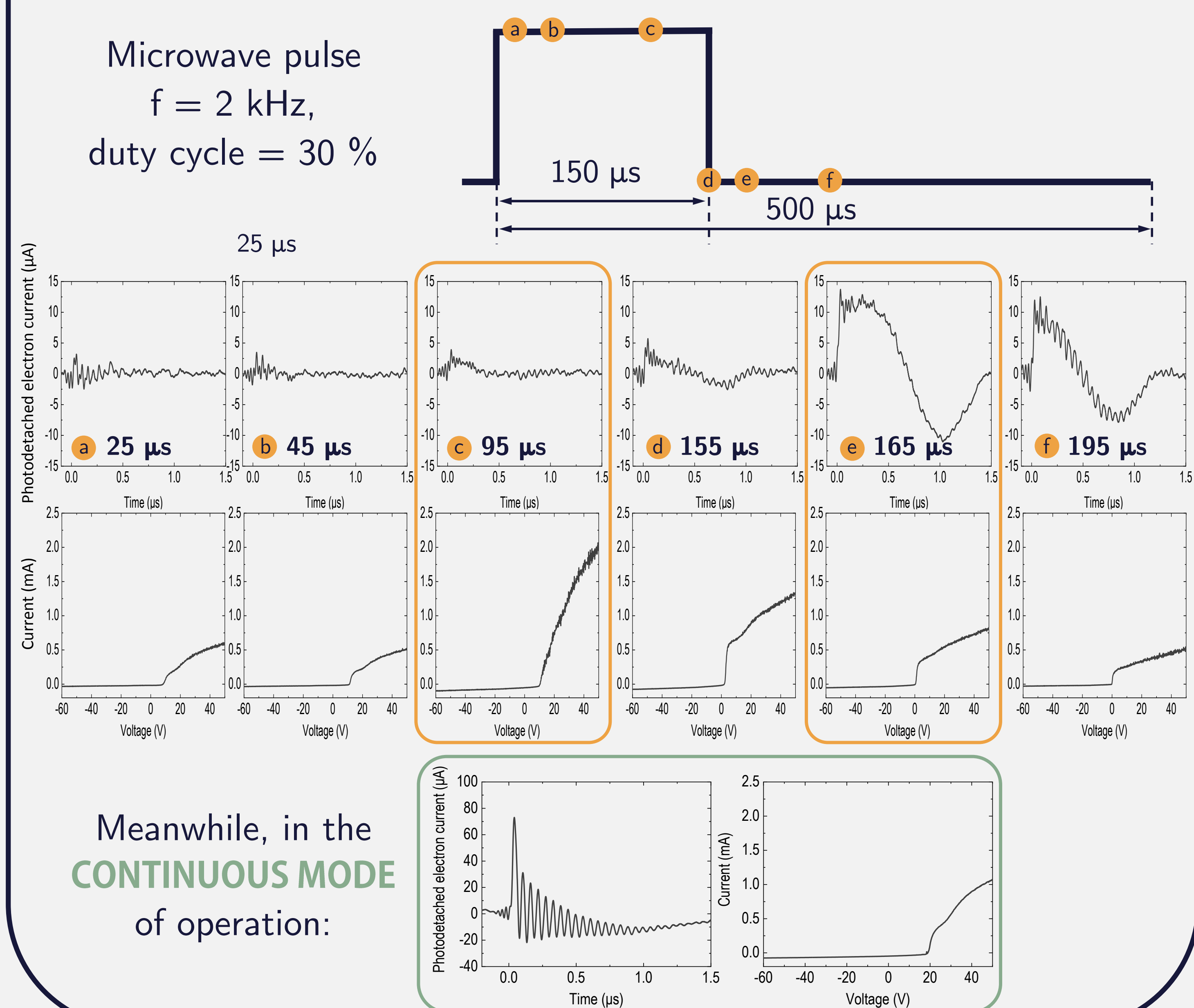
- Designed to evaluate plasma-surface interactions relevant to the volume production of H^- (D^-) ions via dissociative electron attachment (DEA).
- H_2 (D_2) plasmas are produced by a single dipolar ECR module (2.45 GHz, 0-200 W, pulsed with variable frequency and duty cycle).
- Simultaneous, time-resolved,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

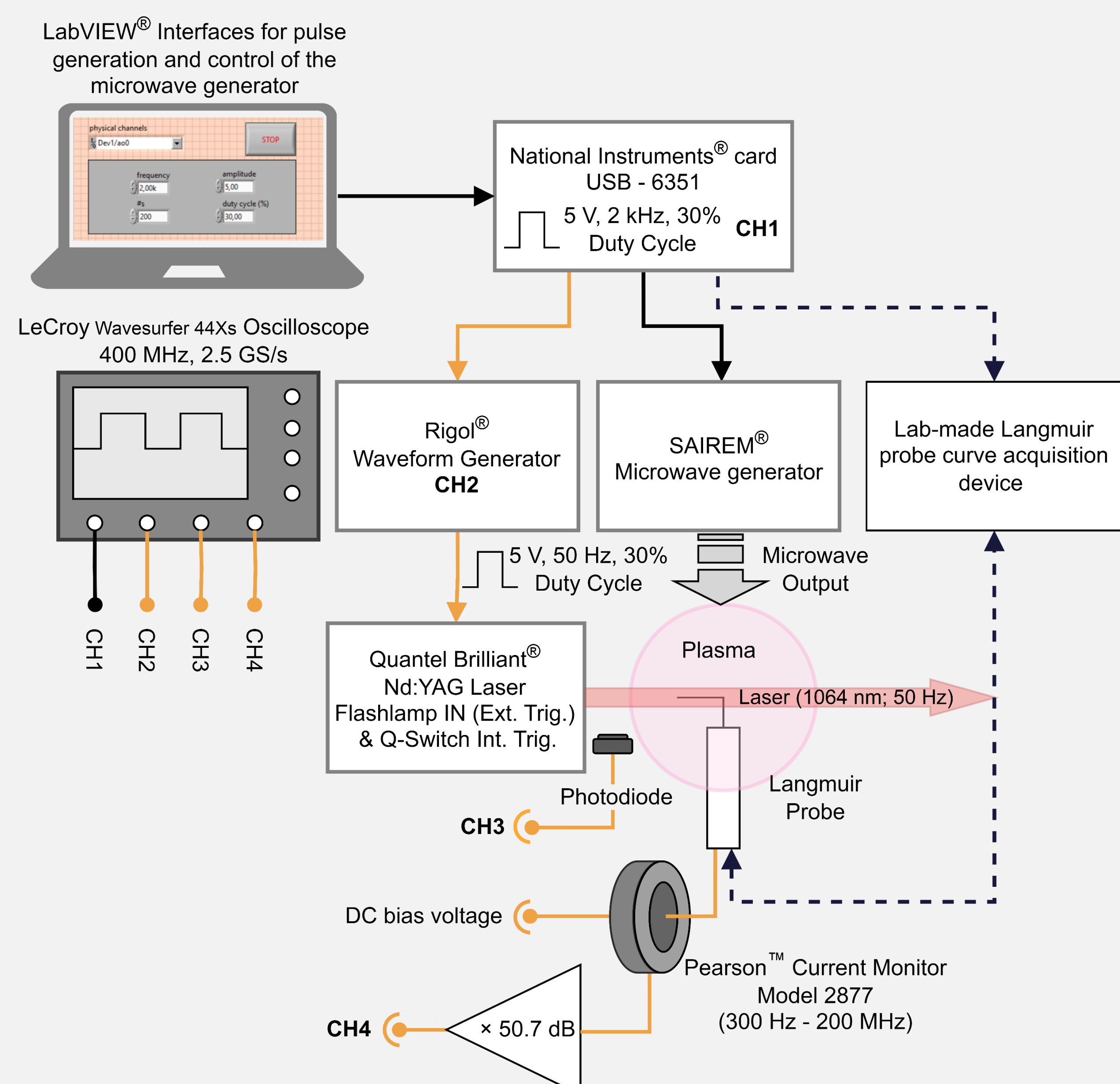
Microwave pulse
 $f = 2$ kHz,
duty cycle = 30 %



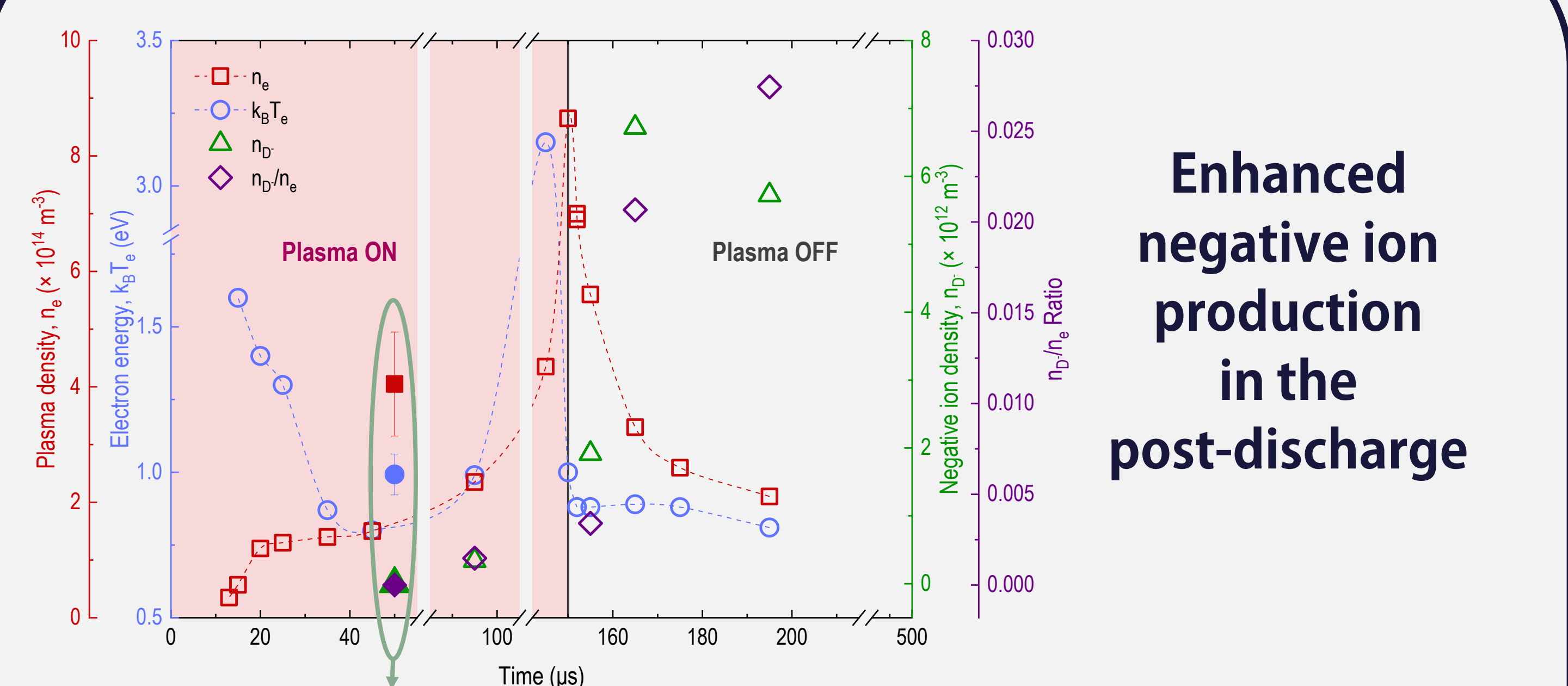
Meanwhile, in the **CONTINUOUS MODE** of operation:

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:

- [1] S. Béchu *et al.*, J. Quant. Spectr. Radiat. Transfer **257**, 107325 (2020).
- [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^- and D^- 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^- and D^- 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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