

# Single shot, non-resonant, four-wave mixing laser diagnostics for low temperature plasmas

A. Gerakis<sup>1\*</sup>

<sup>1</sup> *Luxembourg Institute of Science and Technology, Belvaux, 4422, Luxembourg*

We experimentally demonstrate the use of single shot coherent Rayleigh-Brillouin scattering (CRBS) for the measurement of the velocity distribution function (VDF) of neutral species in a glow discharge, from which macroscopic quantities, such as the flow velocity, density and translational temperature can be extracted. In CRBS, a four-wave mixing technique, a high energy optical lattice of precisely tailored chirped frequency interacts with the medium, such as neutral or ionized gas. The variation of the CRBS signal intensity at different optical lattice phase velocities allows for the restoration of the VDF and the resulting CRBS lineshape is a direct mapping of the medium's VDF. CRBS has already been demonstrated to be the coherent analogue of spontaneous Rayleigh-Brillouin scattering and has already been demonstrated in the measurement of nanoparticles in an arc discharge<sup>1</sup>.

Single-shot CRBS is applied to measure simultaneously the temperature and density of neutral species in a weakly ionized DC glow discharge plasma. The DC glow discharge is generated at a pressure range of 15 Torr using xenon gas. For this application, we employ a newly developed dual-color CRBS scheme<sup>2,3</sup> where the frequency doubled 532 nm beam serves as a probe beam to achieve a higher signal-to-noise ratio at the low-pressure environment versus the most employed single color CRBS approach. The temperature and density of neutral xenon particles inside the DC glow discharge is evaluated simultaneously by analyzing the resolved single-shot CRBS lineshapes and is characterized as a function of the discharge current, successfully demonstrating the use of CRBS in a partially ionized plasma environment. A simulation model of the glow discharge is also developed and there is good agreement between the simulation and the experimental measurements in the glow discharge.

[1] Gerakis, Alexandros, Yao-Wen Yeh, Mikhail N. Shneider, James M. Mitrani, Brentley C. Stratton, and Yevgeny Raitsev. "Four-wave-mixing approach to in situ detection of nanoparticles." *Physical review applied* 9, no. 1 (2018): 014031.

[2] Bak, Junhwi, Robert Randolph, and Alexandros Gerakis. "Torr-level, seedless, non-resonant velocity distribution function measurement with a dual-color, single-shot coherent Rayleigh-Brillouin scattering scheme." *Journal of Physics D: Applied Physics* (2023).

[3] Bak, Junhwi, Robert Randolph, and Alexandros Gerakis. "Dual color, frequency, pulse duration and shape agile laser system for particle spectroscopy and manipulation." *Optics Express* 30, no. 23 (2022): 41709-41723.

\*Presenting author: alexandros.gerakis@list.lu