In-situ CARS generation, use, and referencing in harsh environments

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In recent years, we have seen a tremendous development in coherent Raman imaging spectroscopy (CARS) for determining scalars in harsh environments such as reacting-, plasma-, and high-enthalpy flows. New breakthroughs are available by powerful CARS techniques and advances in photonics, laser- and camera technology. The current state-of-the-art in ultrafast CARS can retrieve extremely accurate temperature, density, and species concentration directly in-situ these flows. The thermometric uncertainty is now below the dream limit of ~1 % and operating at relevant engine conditions, it should count for a new international measurement standard. Ultraprecise measurement capabilities are inevitable to progress a variety of innovative aerospace propulsion and power systems, and to quantify emissions and operability from new jet fuels (hydrogen and SAF) proposed for sustainable aviation. In this talk, I will summarize our recent contribution to CARS development for application in hydrogen propulsion flows [1] and discuss some new challenges for CARS diagnostics.

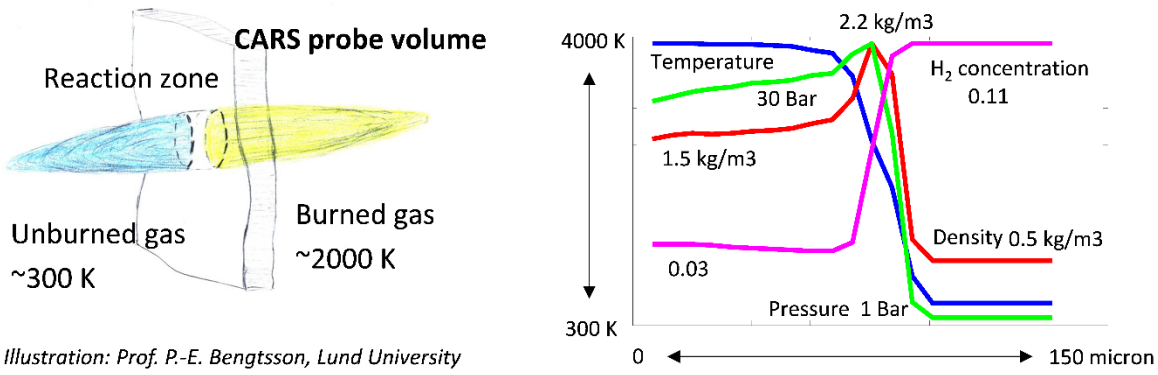

Figure 1. Spatial averaging effects in a deflagration reacting flow (left, illustration by Prof. P.-E. Bengtsson), DNS data from a canonical H_2+O_2 rotation-detonation-engine flow (right, courtesy by ISAE – ENSMA, Dr. Josué Melguizo Gavilanes at Shell Plc.).

1. F. Mazza, L. Castellanos, D. Kliukin, A. Bohlin (2024). Coherent Anti-Stokes Raman Spectroscopy (CARS). In: Singh, D.K., Kumar Mishra, A., Materny, A. (eds) Raman Spectroscopy. Springer Series in Optical Sciences, vol 248. Springer, Singapore.