**Spectroscopic Temperature Determination of a Hydrogen Plasma**

S. Arjmand1,2, M. P. Anania2, A. Biagioni2, M. Ferrario2, M. Galletti2, V. Lollo2, D. Pellegrini2, R. Pompili2, A. Zigler3,

*1 Sapienza University, Rome, Italy*

*2 National Laboratories of Nuclear Physics, Frascati, Italy*

*3 Racah Institute of Physics, Hebrew University of Jerusalem, Jerusalem, Israel*

We report the theoretical and experimental activity on the plasma-discharge capillary for plasma-based accelerators (PBAs) at the SPARC\_LAB test facility. Nowadays, in the particle accelerators field, plasma-based accelerators are highly demanded to reduce the barriers of the conventional accelerator structures. In fact, one of the essential characteristics of plasma- based accelerators is their compactness due to small-scale (mm to cm) plasma modules, providing extremely high accelerating gradients up to hundreds of GV/m. In this experiment, a gas-filled plasma-discharge capillary is tested, ionizing Hydrogen gas with a high-voltage electrical discharge (HVDC). The principal target of this innovative technique is monitoring and characterizing the produced plasma, which depends on the qualities of the particle bunch to be accelerated via an intense laser pulse technique (LWFA) or an energetic electron beam scheme (PWFA). The plasma characterization plays a fundamental role in determining the neutral gas distribution inside the capillary; therefore, the generated plasma in a Hydrogen-filled capillary is targeted by spectroscopic technique to investigate the plasma electron density and temperature. The plasma electron density and electron temperature have been studied as functions of time through the Stark broadening profiles for several ionic species. The line intensities of subsequent ionization stages of the Oxygen element have also been considered for electron temperature analyses.