A metastable hydrogen probe beam to measure static and oscillating electric fields in plasma

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A new diagnostic to measure directly an electric field in vacuum or in a plasma has been developed. It is based on the emission of the Lyman-α line by a hydrogen probe-beam in the 2s state when the beam passes through a region where an electric field is present (Electric Field Induced Lyman- α Emission). The electric field couples 2s and 2p atomic hydrogen levels, the 2s lifetime is shortened and this level decays via 2p to the ground state. By measuring the intensity of the subsequent Lyman- α radiation, it is possible to determine the magnitude of the field in a defined region.

Absolute measurements of a static electric field between two polarized metallic plates in vacuum or in the sheath between a plasma and one of the plates have been successfully performed[1].

We now address the case of oscillating fields: measurements of a radiofrequency field (in function of injected power and frequency in the range 800-1400 MHz) compare well to simulations of our experimental device including the measurement method. We observe a spectrum with very narrow peaks associated to resonant modes of the cavity. Signal intensity at the measurement point depends on many unknown parameters such as the transmission factor of the detection optics, the neutral beam density, and the electric field the beam encountered all along its path. Thus calibration is not straightforward. However, we can draw conclusions about possible ways to calibrate measurements in the RF case.

References:

1. L. Chérigier-Kovacic et al., Review of Scientific Instruments 86, 063504 (2015)