

**INITIAL LASER INDUCED FLUORESCENCE  
MEASUREMENTS IN THE MADHEX EXPANSION  
CHAMBER AND ELECTRON TEMPERATURE  
SCALING WITH PULSED RF POWER\***

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A flowing argon helicon plasma is formed in a 10 cm diameter, 1.5 m long Pyrex chamber with an axial magnetic field in nozzle or flat configuration, variable up to 1 kG in the source region. A new expansion chamber has been constructed and initial laser induced fluorescence (LIF) results including ion velocities and temperatures are presented. Microwave interferometry (105 GHz), collisional radiative spectroscopic codes and diamagnetic loops are used to measure electron density and temperature during pulsed (5 ms) RF operation. Calculated variation of the RF frequency (from 12 MHz to 15 MHz) during the pulse allows for low (<3%) reflected powers during the gas breakdown and the approach to and formation of the steady state plasma. The scaling of electron temperature with RF power is also examined for high (>3 kW) RF powers. The effect of different flow rates, magnetic field expansion variation and pressures are measured to observe the variation of the ion distribution function via LIF and the axial variation of acceleration due to neutral depletion. Possible double layer creation and sustainment in the downstream (relative to the RF antenna) transition to the expansion chamber is also examined at low flow rates and high RF powers.

Low-pressure discharge initiation results are also summarized [1] and new experiments at higher powers and lower flow rates (1-20 sccm) are discussed. A static magnetic field threshold for discharge initiation is seen at low flow rates, where discharges will not start above a certain magnetic field value that depends on RF power and flow rate. This threshold is a consequence of the multipactor effect, which is the dominant mechanism for breakdown when the electron-neutral collisional mean free path is longer than the system dimensions. A magnetic field ramping technique for starting discharges at these low flow rates is described.

1. M. Wiebold, H. Ren, C. M. Denning, J. E. Scharer. "Low pressure helicon discharge initiation via magnetic field ramping." *IEEE Transactions on Plasma Science* vol. 37, no. 11, 2009.

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