Laser Induced Fluorescence Using Frequency Modulated Light

E.E. Scime, T. Gilbert, T. E. Steinberger

Department of Physics and Astronomy, West Virginia University, Morgantown, WV 26506, USA

The small signal-to-noise ratio (SNR) of conventional laser induced fluorescence (LIF) measurements using a continuous wave laser, either diode or dye, is typically overcome by amplitude modulating the laser at a specific frequency and then using lock-in amplification to extract the signal from measurement noise. Here, we present LIF measurements of the neutral helium velocity distribution function in a rf plasma using frequency modulated (FM) laser injection. A pulse train of 100% amplitude modulation is generated synthetically with a random sequence of pulse lengths. The FM signal then drives an acoustic optic modulator placed in the path of the injection beam in an LIF measurement. The signal from a fast photomultiplier tube is digitized and cross-correlated with the known modulation signal [1]. The resultant FM-based LIF signal outperforms a conventional lock-in-based LIF measurement on the same plasma in terms of SNR and precision.

[1] Scime E., J. Freeze, T.J. Gilbert, and T. E. Steinberger, Rev. Sci. Instrum. **95**, 08355 (2024); DOI: 10.1063/5.0219309.

*escime@wvu.edu