**Development of a Two-photon Absorption Laser Induced Fluorescence Diagnostic for Proto-MPEX**

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**ABSTRACT**

Two-photon laser induced fluorescence (TALIF) provides a non-perturbative method to directly measure mean bulk flow, temperature, and absolute densities of neutral deuterium in fusion-like plasmas. Implementation of TALIF on the ProtoType Material Plasma Exposure eXperiment (Proto-MPEX) produces several technical challenges to overcome. First, probing neutral deuterium requires high intensity, VUV light creating significant difficulties for transmitting laser light through a beam path (r ~ 20 m) and standard vacuum windows. Second, limited optical access complicates design for TALIF injection and collection optics. Lastly, absolute density measurements require calibration, usually using krypton or xenon gas. We present designs for beamline path, confocal injection optics, and shot-to-shot calibration to address each challenge. TALIF will be used to measure neutral deuterium densities, temperatures, and flows in the helicon source region and ultimately in front of a target exposed to fusion-like conditions.

**OPTICAL CONFIGURATIONS**

**TALIF LASER SYSTEM GENERATES 205 nm PHOTONS**

- Spectra Physics Quantaray Pro 270 Nd:YAG pulsed laser converts 1064 nm light to 532 nm
  - 20 Hz
  - 8 ns pulse length
  - ~ 10 mm beam diameter
- Quantaray pumps Sirah Cobra Stretch dye laser equipped with tripling stage
  - 532 nm is converted to 615 nm light via Rhodamine 610 + 640 solution
  - 615 nm is frequency doubled to 307.5 nm
  - 307.5 nm and 307.5 nm are mixed to produce 205 nm
  - ~ 5 mm beam diameter
  - $E_{205} = 5 \text{ mJ/pulse}$

**CONFOCAL COLLECTION REQUIRES ONE LINE-OF-SIGHT**

- UV beam compressed and passed through hole in mirror
- Single axis injection/collection requires single diagnostic access point
- Injection between magnets 1 and 2 (upstream of source)
- Translation stage allows radial profile measurements

**TALIF APPARATUS PROVIDES INITIAL "CALIBRATION" MEASUREMENTS**

- Quartz test cells filled with krypton or isotopically pure xenon are interchangeable
  - $P_K = 5 \text{ Torr}$
  - $P_X = 1 \text{ Torr}$
- Focused injection
- Perpendicular collection
- Mounted to linear translation stage

**NUCLEAR DEUTERIUM PROFILE IN TALIF COLLECTION LOCATION**

- Neutral pressure is steady at ~ 0.2 Pa at TALIF injection region
- Assuming neutrals are at room temp implies $n_N \sim 10^{13} \text{m}^{-3}$ (monatomic)

**REFERENCES**


