Summary

We describe an upgrade to our two-dimensional laser-induced fluorescence (LIF) diagnostic that enables measurements over a three dimensional volume of plasma. Using 3D LIF, we have measured the flow of ions in an argon near a grounded limiter plate in a helicon plasma. We also describe an update to a confocal LIF diagnostic system.

Laser Induced Fluorescence

- LIF is an absorption spectroscopy technique where a laser pumps a transition from a typically metastable initial state to a higher energy state. In non-resonant LIF, the upper state decays to a third final state.
- The absorption line is Doppler shifted due to the absorbing population’s thermal and drift motions.
- The emission intensity versus laser frequency provides a measurement of the velocity distribution (VDF) of the absorbing species along the direction of the laser beam.

Helicon Plasmas

- Radio frequency waves near the lower hybrid frequency couple energy into a magnetically confined plasma.
- The target of these measurements is an argon plasma. Typical parameters are given in the table below.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Helicon Source (Ar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( n )</td>
<td>(&lt; 1 \times 10^{16} \text{ cm}^{-3} )</td>
</tr>
<tr>
<td>( B )</td>
<td>( 0 - 1300 \text{ G} )</td>
</tr>
<tr>
<td>( T_e )</td>
<td>(&lt; 5 \text{ eV} )</td>
</tr>
<tr>
<td>( I_c ) (unheated)</td>
<td>(&lt; 1 \text{ eV} )</td>
</tr>
<tr>
<td>( L_c ) (chamber diameter)</td>
<td>15 cm</td>
</tr>
<tr>
<td>( L_c ) (chamber length)</td>
<td>150 cm</td>
</tr>
</tbody>
</table>

Confocal LIF

- A confocal LIF system would require only a single port.
- Multiple designs have been made and tested.
- Preliminary measurements have been taken with these configurations.
- A new design is needed to further minimize the depth of field to improve the spatial resolution of the instrument. (Figure 5)
- See Scime et al. Poster BP12.074

First 3D LIF Measurements

- 3D vector measurements have been taken in a single axial plane in Helix in the past. An upgrade was made to allow for measurements of the three dimensional flow structure.
- This upgrade was accomplished through attaching the existing apparatus to a cart-and-rail system which was then mounted to the HELIX chamber. The third dimension requires manual translation, but may be mechanized in the future for convenience.
- See invited talk T12.03: Models, assumptions, and experimental tests of flows near magnetized boundaries

References:
4. Soderholm et al., Improving Resolution of Confocal Laser Induced Fluorescence Measurements in Argon Helicon Plasma (Poster at APS DPP 2014)