C^{+2} Flow Measurements at DIII-D Using a Coherence Imaging Spectrometer

by
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with
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Focus of Talk: C^{+2} Flow in the Divertor

- **Impurity flows in the SOL & divertor influence**
  - Density and impurity control (pumping)
  - Divertor detachment physics
  - Material migration (erosion and redeposition)

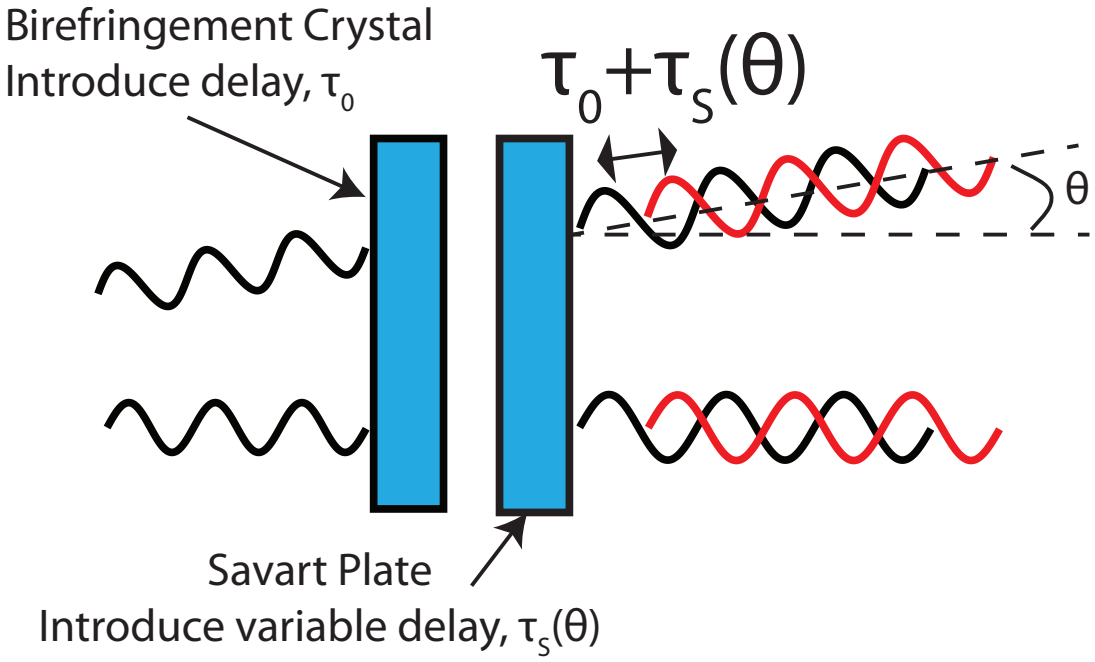
- **New diagnostic enables 2D impurity flow measurements previously unavailable**

- **New data allows direct comparison with fluid simulations (UEDGE)**

New 2D Measurements of Carbon Flow

- New spectrometer measures ion flow velocities (John Howard, ANU)
- Preliminary physics results show strong C^{+2} flow towards divertor plates for an L-Mode plasma
- UEDGE modeling is consistent with experimental data

Spectrometer Measures Flow Velocities with a Spectrally Encoded Camera Image



John Howard, *Review of Scientific Instruments*, 2010

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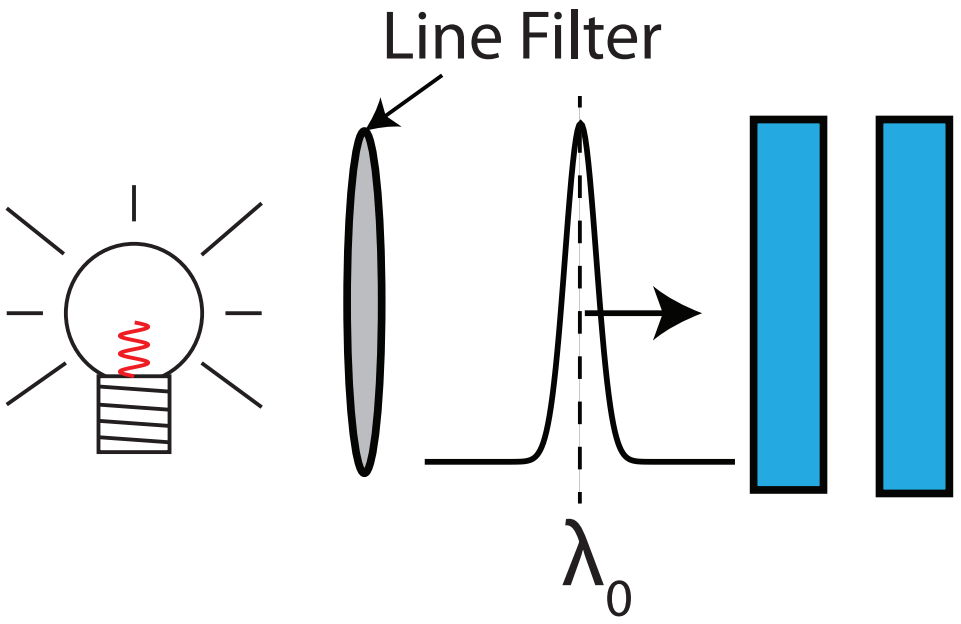

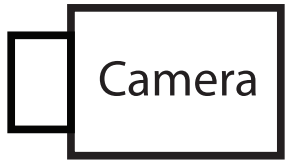

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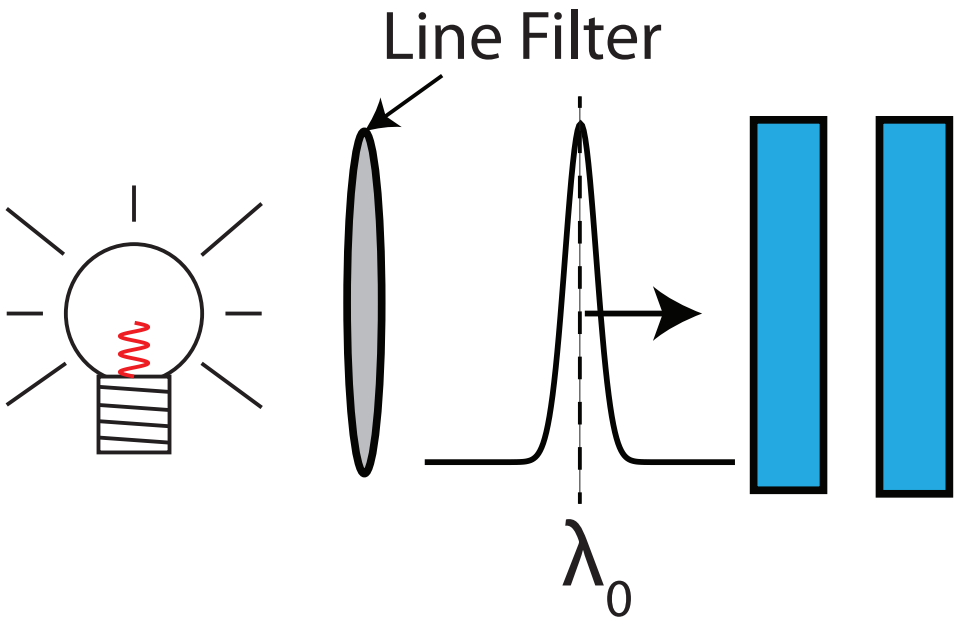

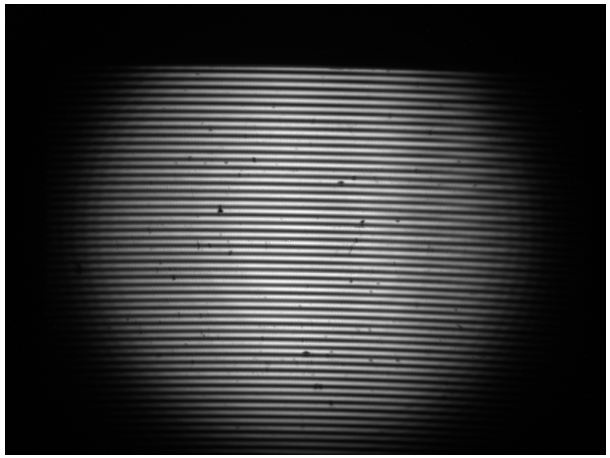

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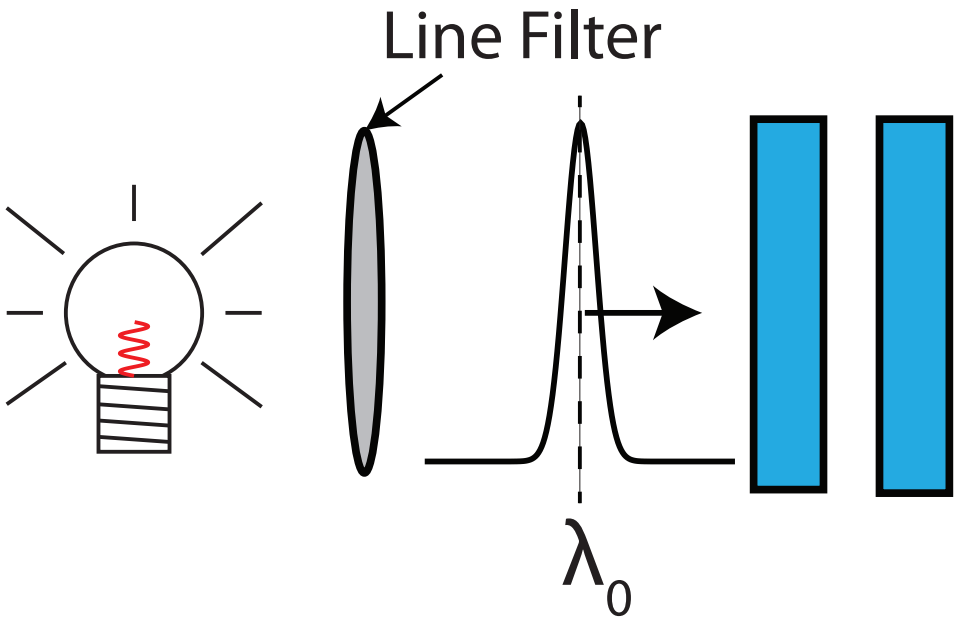

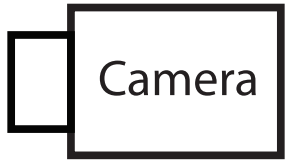

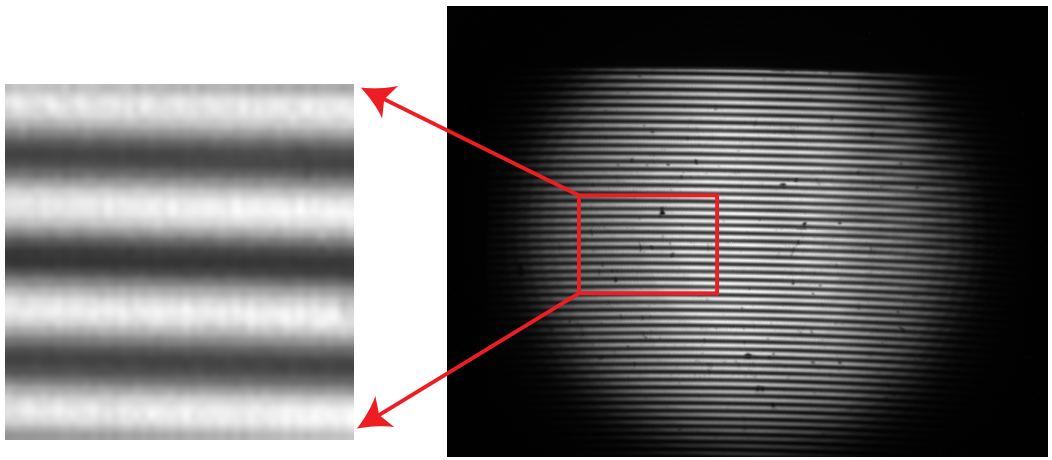

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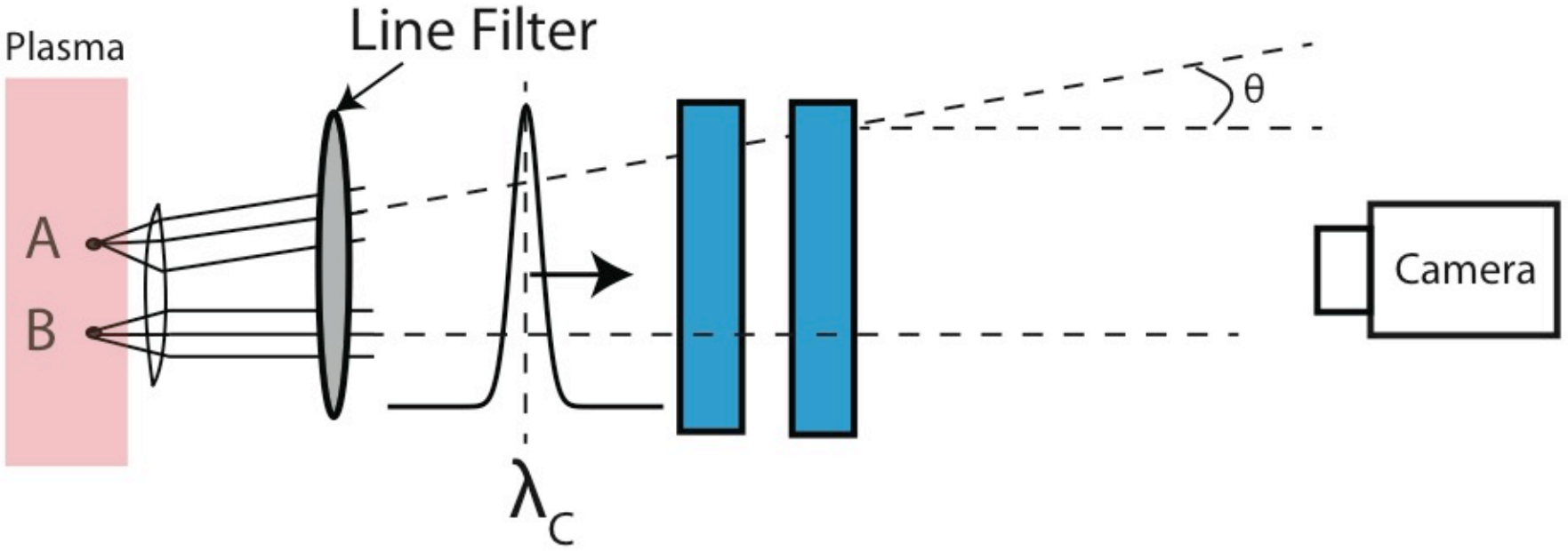

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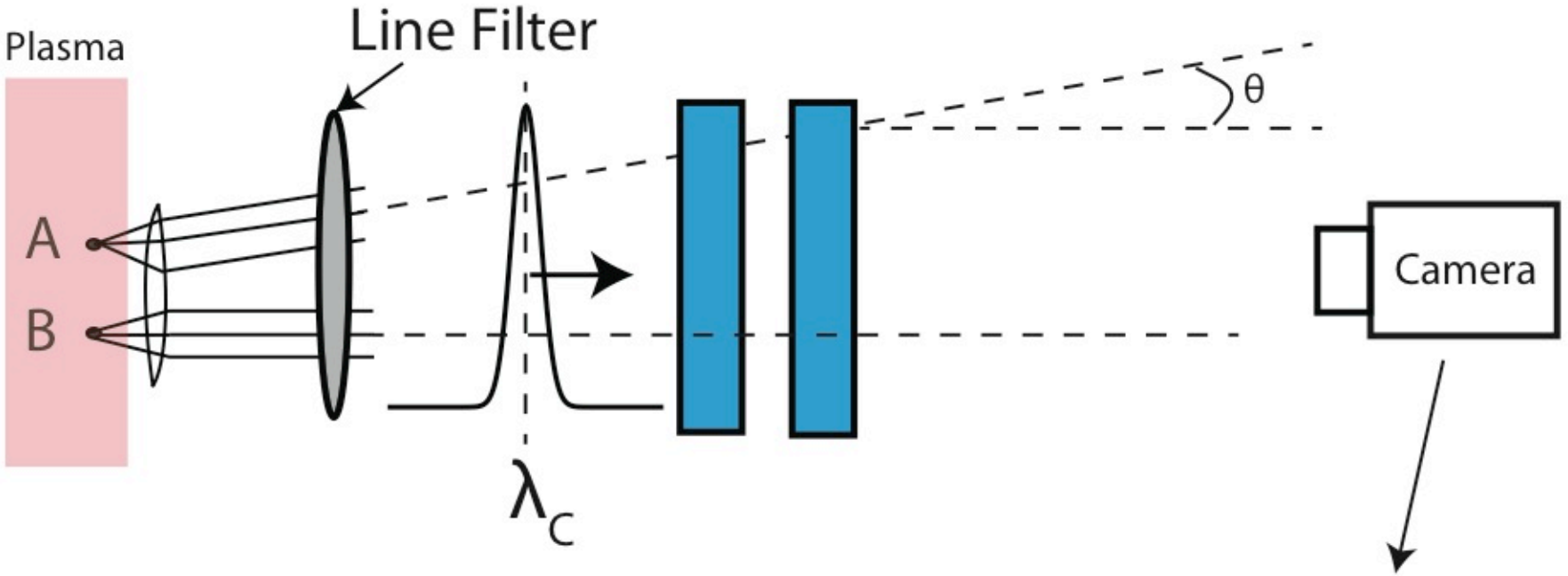

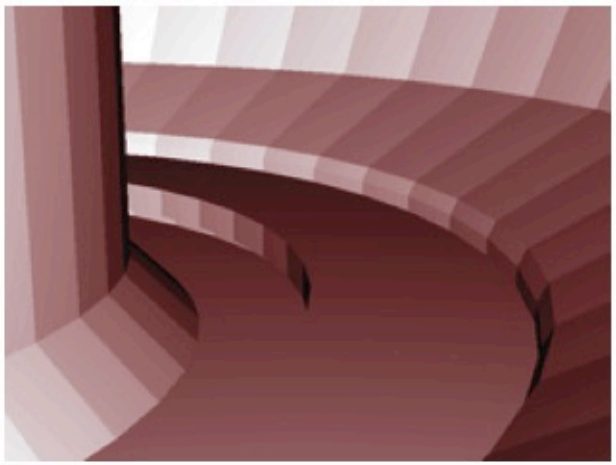

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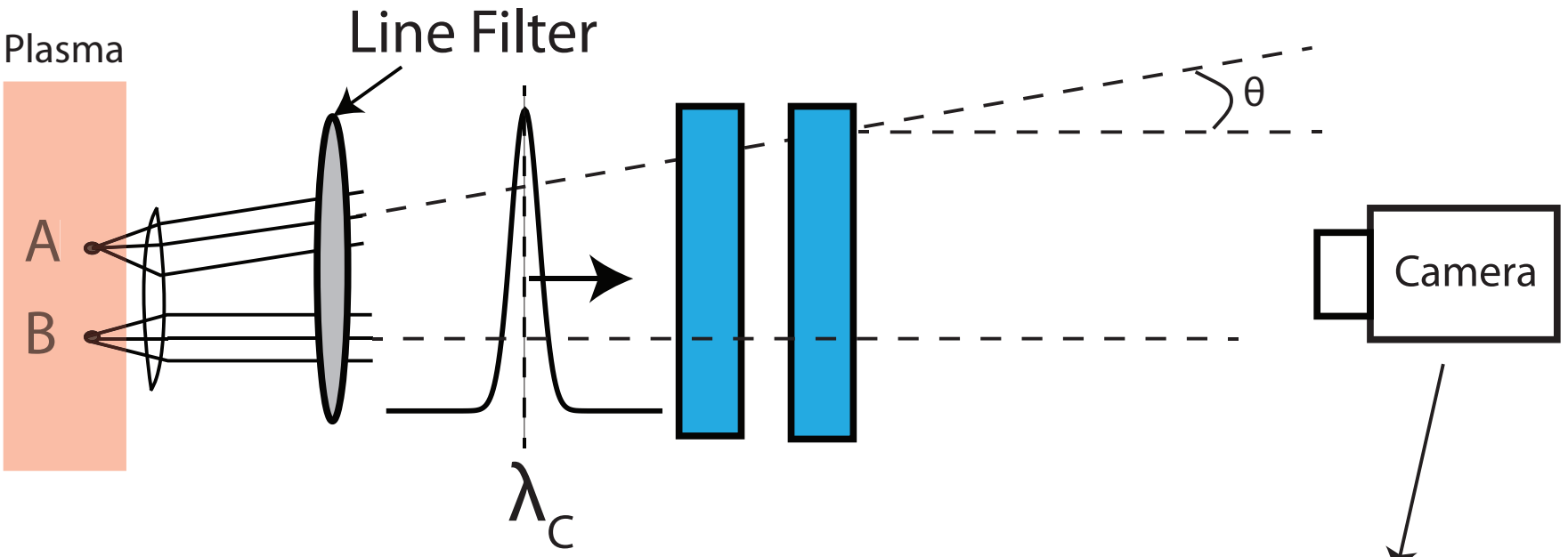

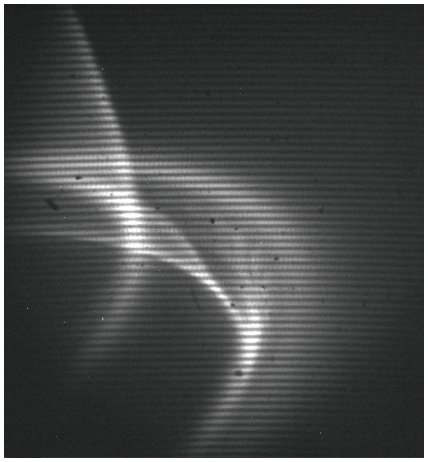

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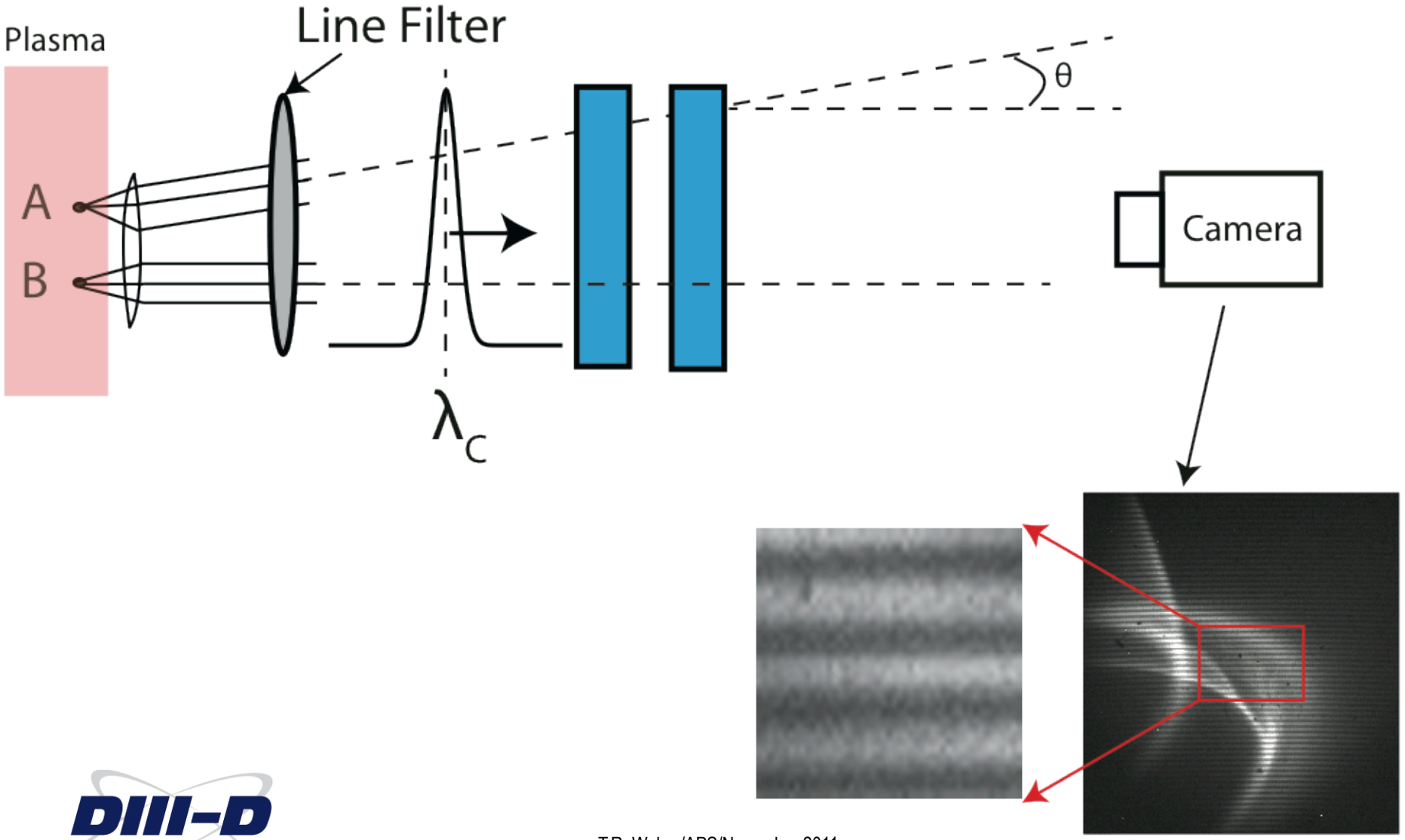

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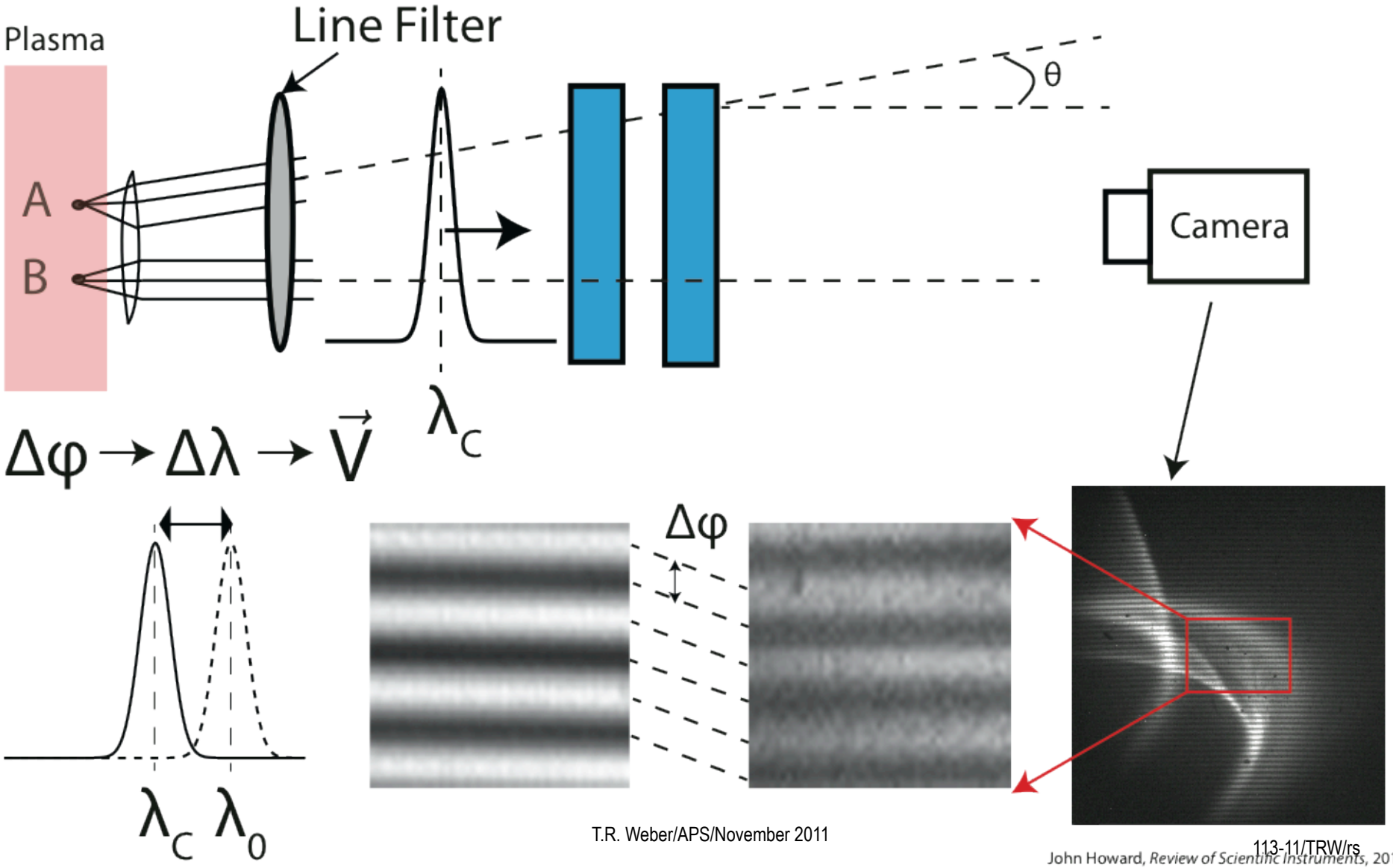

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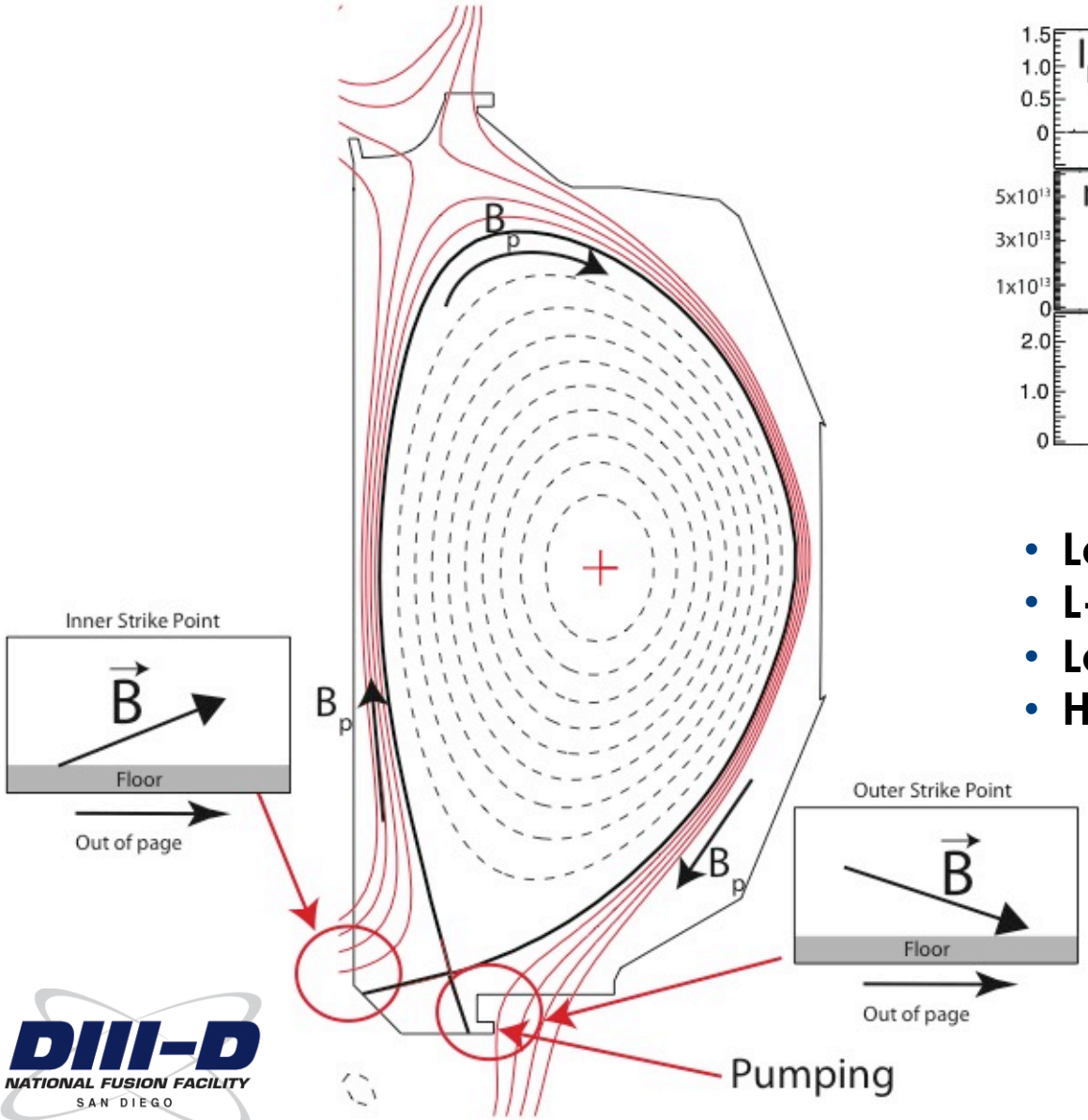
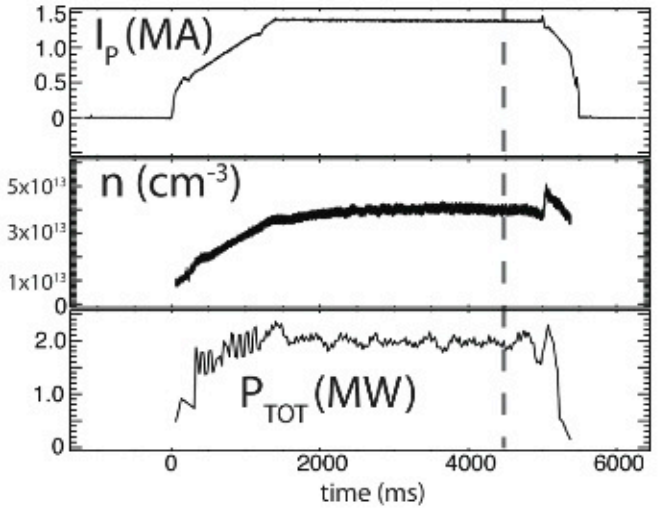
Preliminary Data Analysis Looks at L-Mode Plasma





- Lower single null
- L-mode plasma
- Low density
- Homogenous flow at 4500 ms

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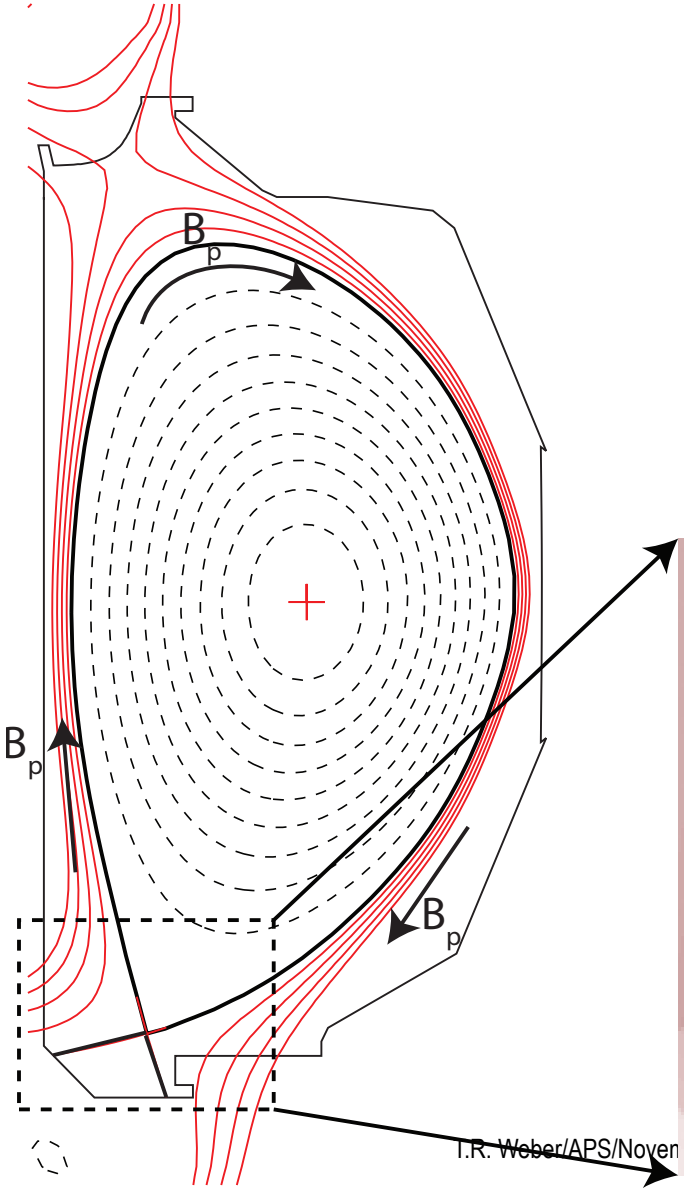

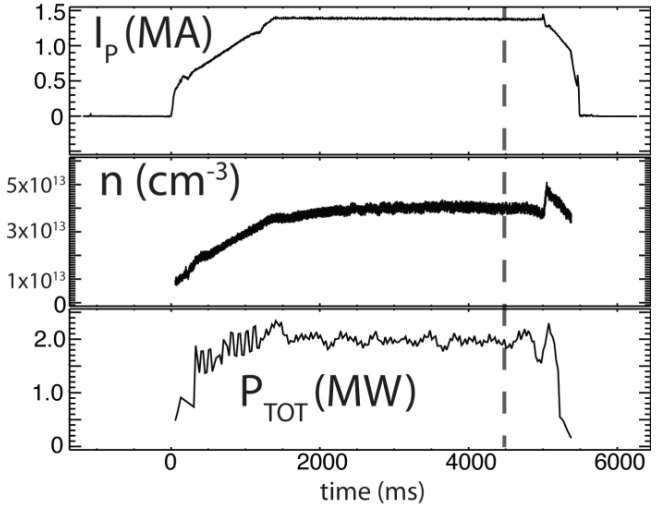

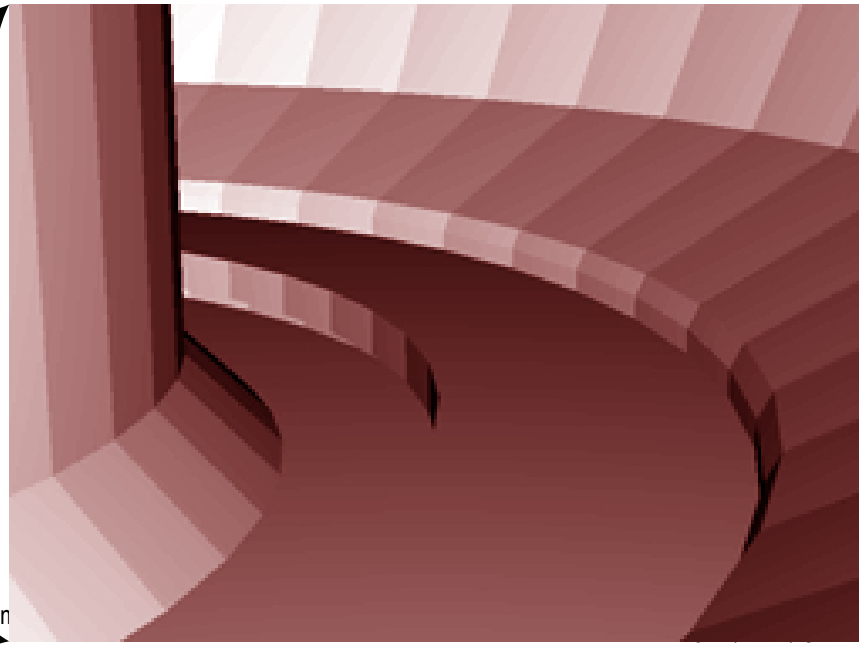

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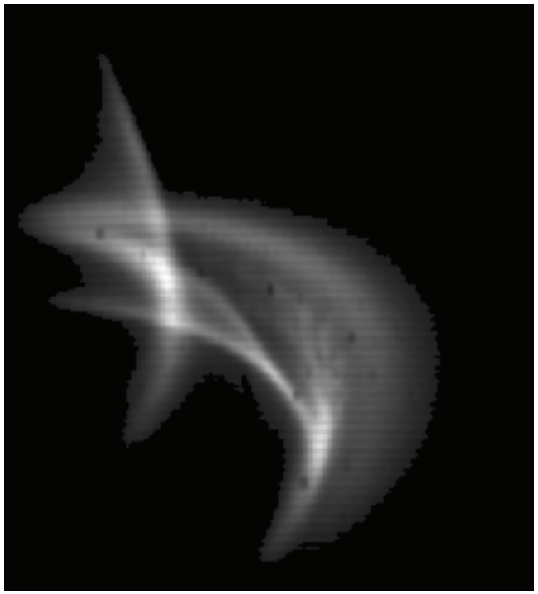
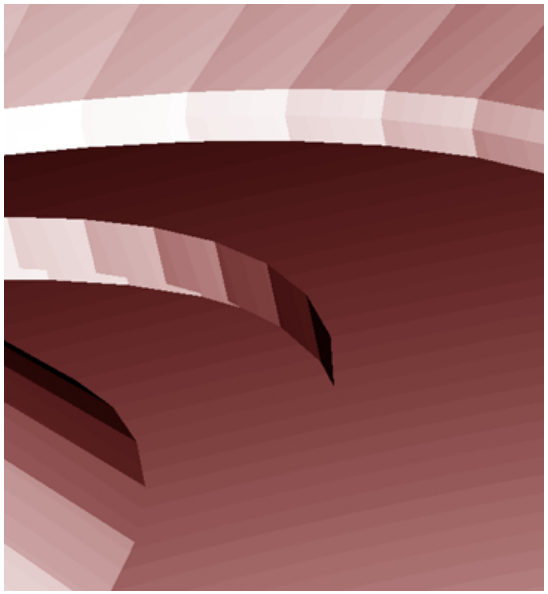
Average Over Fringes to Obtain Line Integrated C^{+2} Emissivity

C^{+2} Image



Simulated View



- **First step in data analysis**
- **Next step: reconstruct C^{+2} emissivity in plasma from image**

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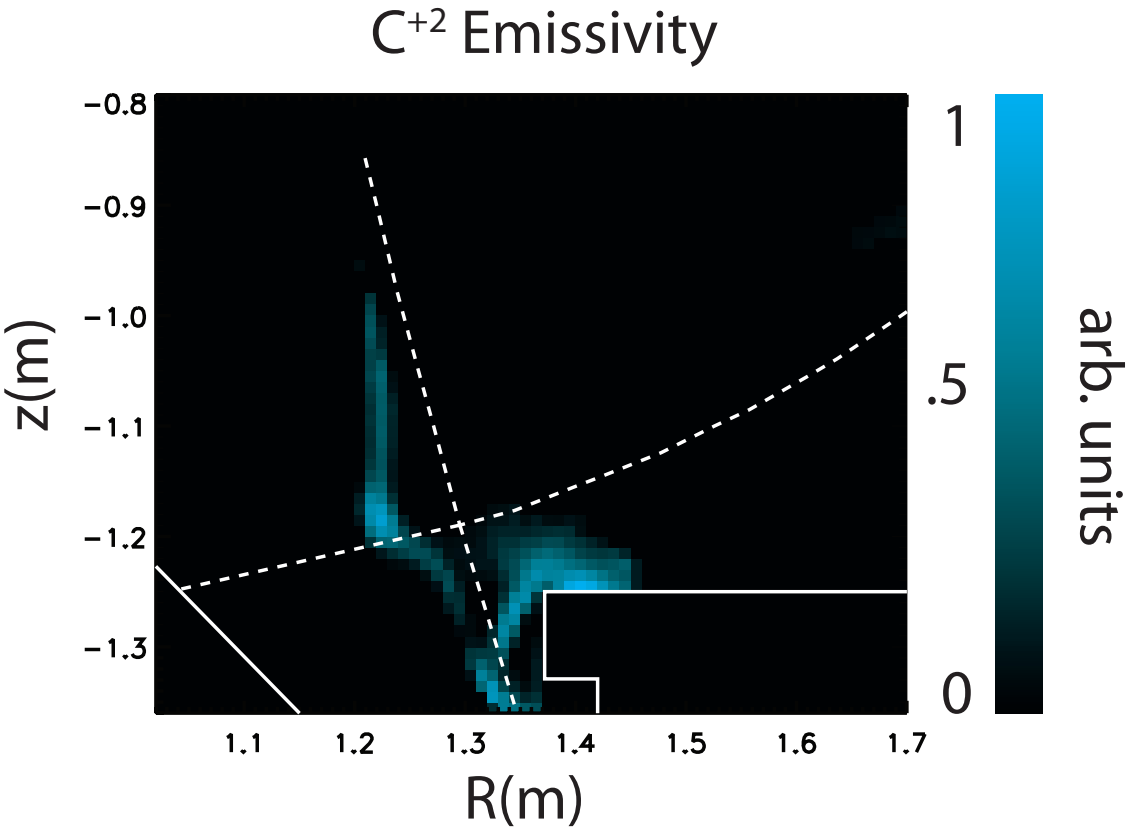
Tomographic Reconstruction of C^{+2} Emissivity

- **Assumes toroidal symmetry and requires knowledge of camera location**



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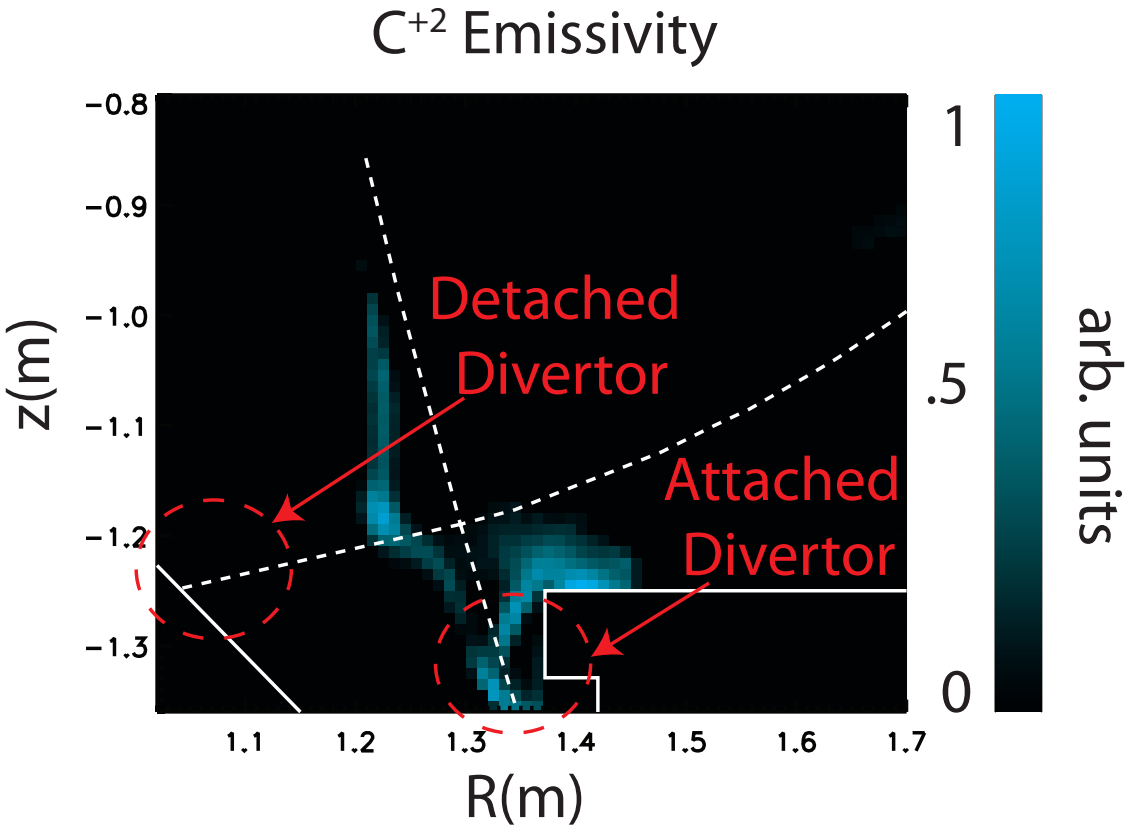
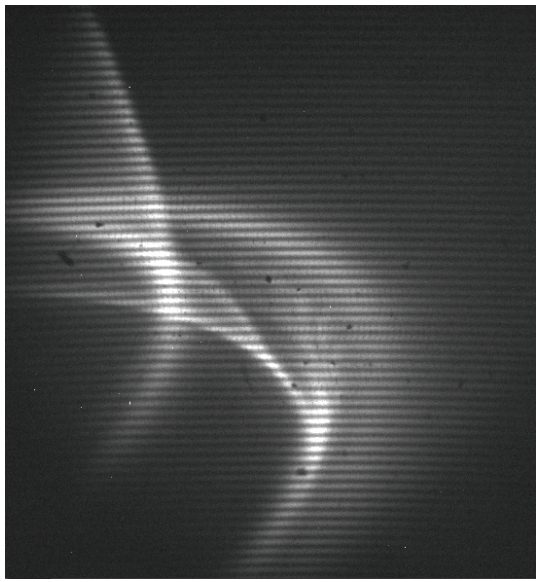


Image Analysis Yields C^{+2} Flow Velocities in Plasma

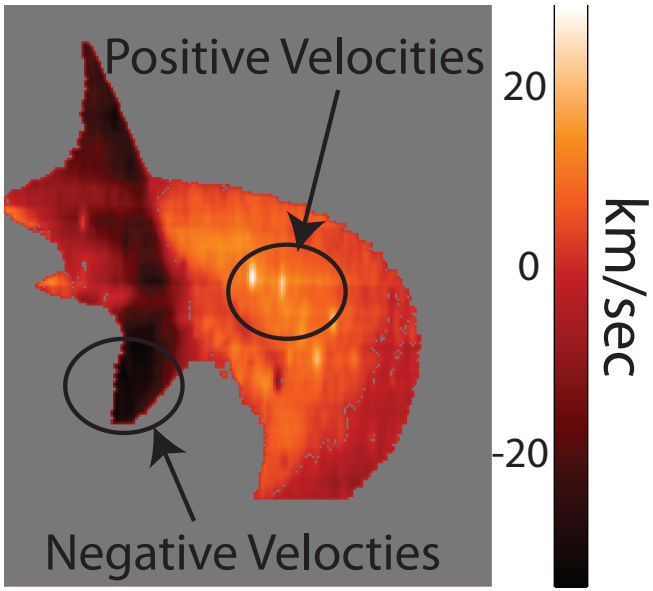
- **Each resolvable phase shift yields a velocity**

C^{+2} Image with Fringes



Fringe Demodulation

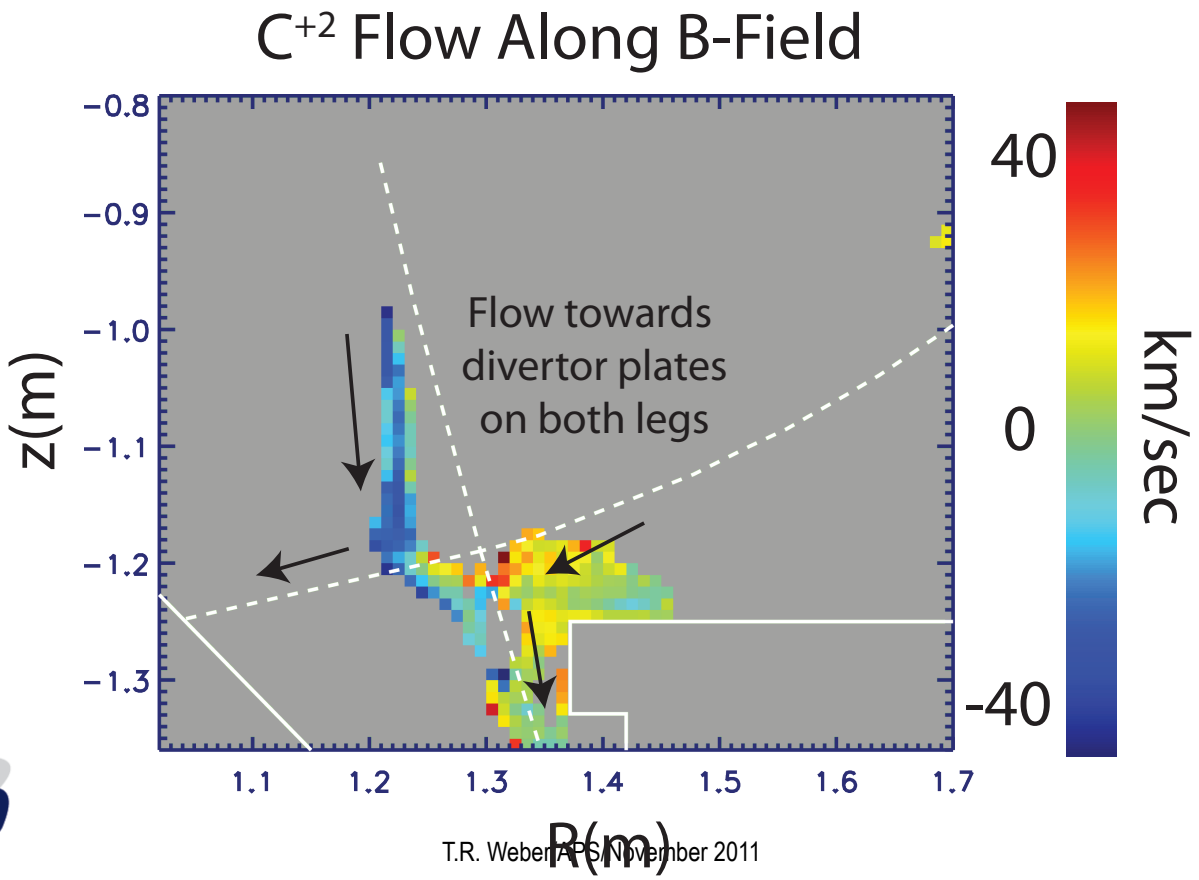
C^{+2} Flow Image



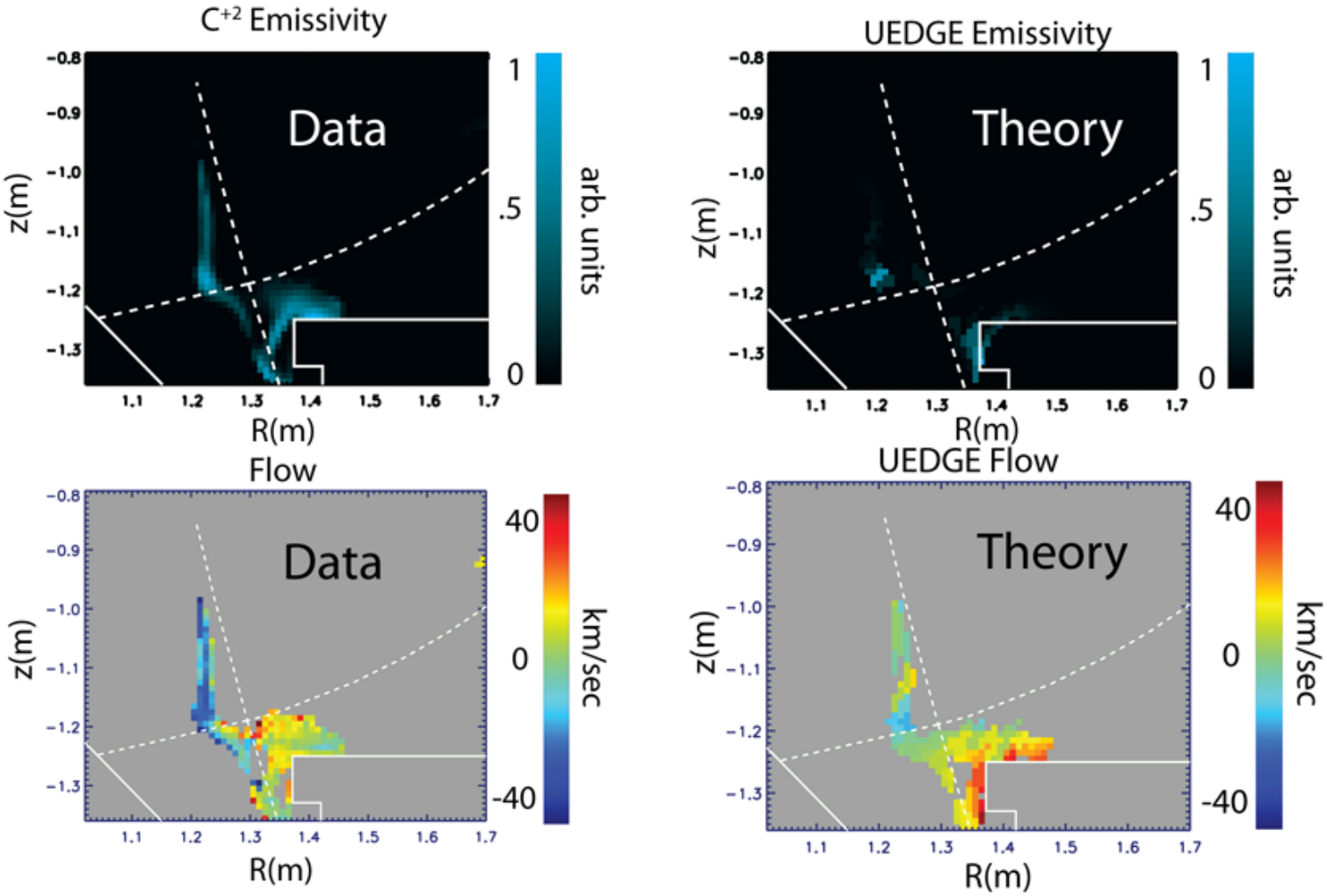
- **Image represents the line integrated average velocity weighted by the emissivity**

Tomographic Reconstruction of C^{+2} Flow

- **Assumes toroidal symmetry and that flow is parallel to the magnetic field**
- **Requires knowledge of camera location**



Emissivity and Parallel Flow Agree with UEDGE Predictions



Conclusion

- **New flow diagnostic enables ion flow measurements over large plasma region**
- **Preliminary results agree with UEDGE and show strong C^{+2} flows towards the divertor plate**
- **Next step:**
  - 2nd view of upper divertor
  - Fast intensified camera to resolve ELMs
  - Look at other ion species
  - Measure ion temperature using fringe contrast