JO6.00002: Laser Pre-Heat Studies for MagLIF with Z-Beamlet

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57th Annual Meeting of the APS Division of Plasma Physics

A. Harvey-Thompson: (GI3.00005, 11:30), **Most talks this session**
K. Hahn, R. McBride, J. Reneker: (posters yesterday), **E. Harding:** UO4.00014 (Thursday)

SAND2015-10007C

Exceptional service in the national interest

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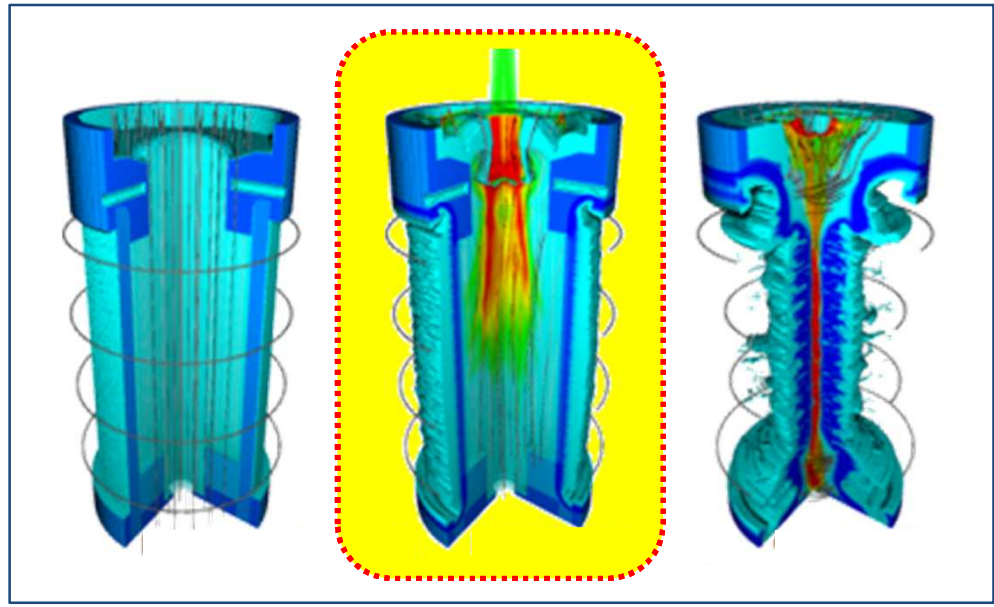

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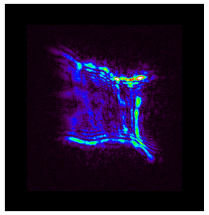
Pre-Heat Challenges

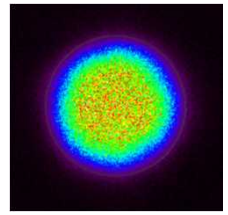
- ***High initial energy density requires high gas density***
  - *High pressure at room temperature*
  - *Thick window: 180 psi D_2 requires 3.5µm kapton across 3mm*
  - *Very high laser absorption in the window*

- ***Laser spot size is always a compromise***
  - *Small spots burn easily through Laser-Entrance-Hole (**LEH**) window*
  - *Large spots are more efficient in fuel heating*

- ***Laser Plasma Instabilities (LPI): SBS, SRS, TPD, …***
  - *Hard to correctly predict or simulate*
  - *Lead to redirection and loss of energy*
  - *Caused by high intensities (small laser spots)*
  - *Caused by inhomogeneities of intensity (laser spot quality)*
  - *Dominant at high densities target.*



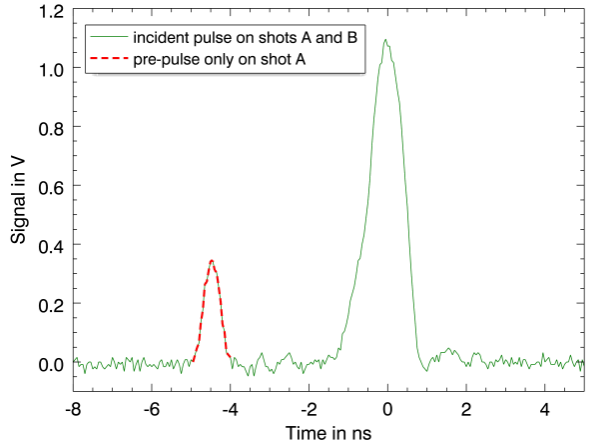
Previous ZBL-spot, defocused:
Poor illumination, modulated.

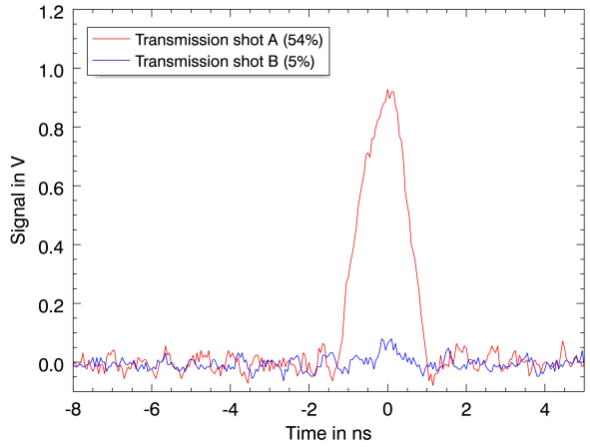


New: with phase plate
(ideally + polarization smoothing
and temporal smoothing/SSD)

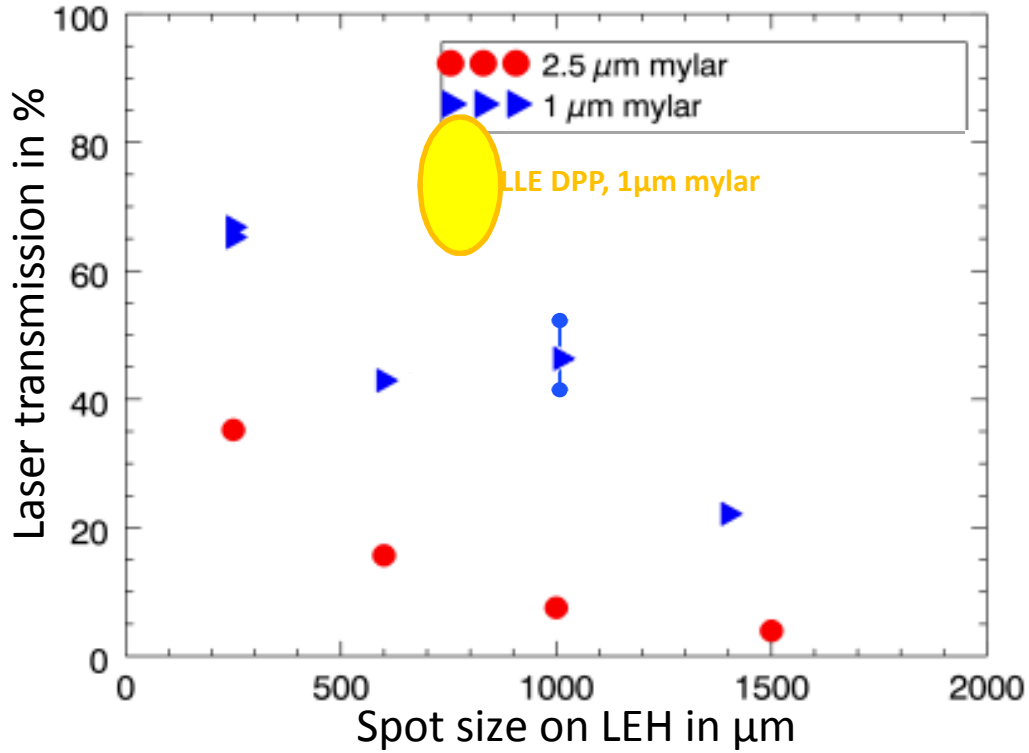
Transmission Studies

Importance of a Pre-Pulse





Importance of LEH Thickness

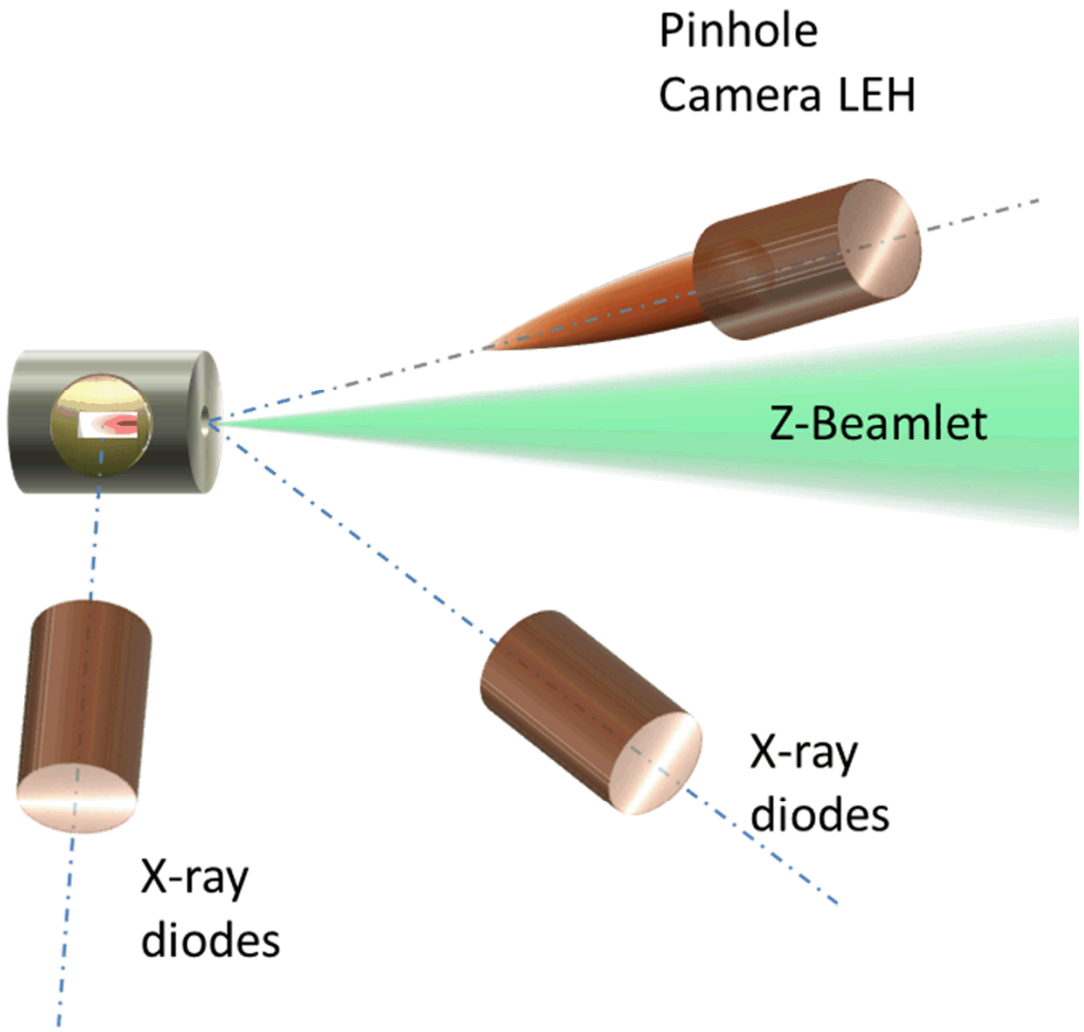


(0.5 + 2) kJ pulse energies, 1 μm mylar window, no DPP.

PECOS Chamber Gas Cell Experiments

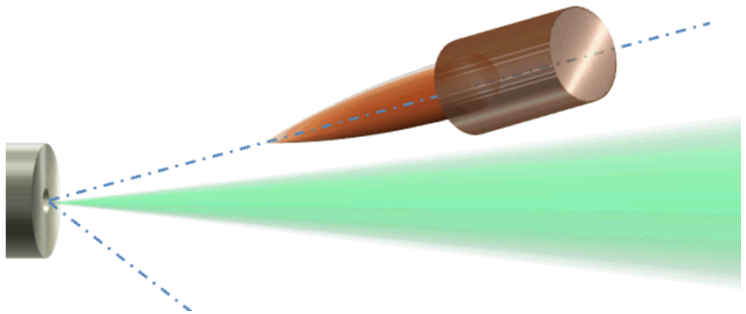
Neon dopant (~1 keV K-shell):

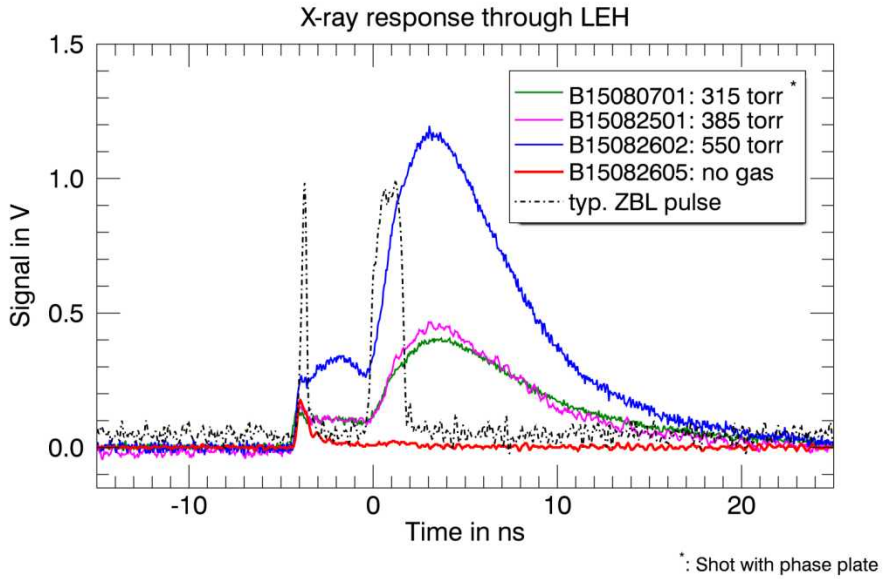
- Effective for low temperatures and long time scales.
- Observable through Laser-Entrance-Hole (LEH)!



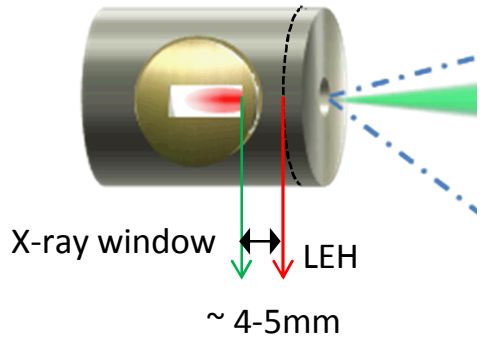
Pecos X-ray Diode Measurements

Through-LEH

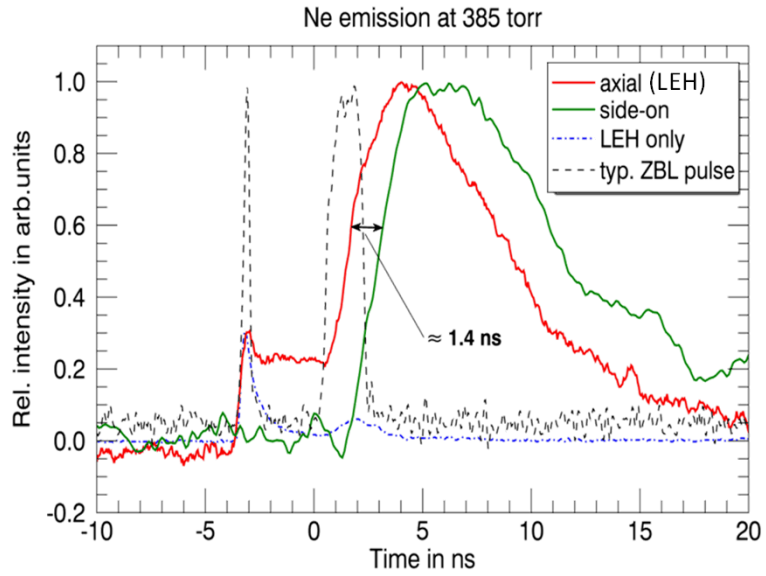




Side-On



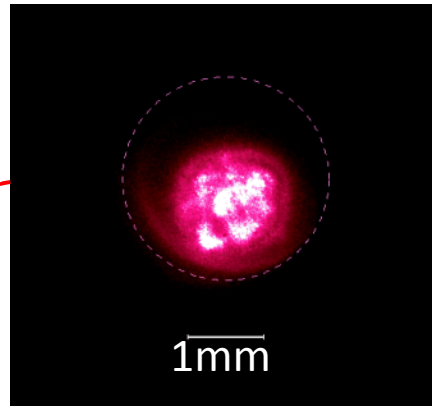
The laser drills into gas at around 3000 km/s, which is in agreement with simulations!



Ne-Emission through LEH

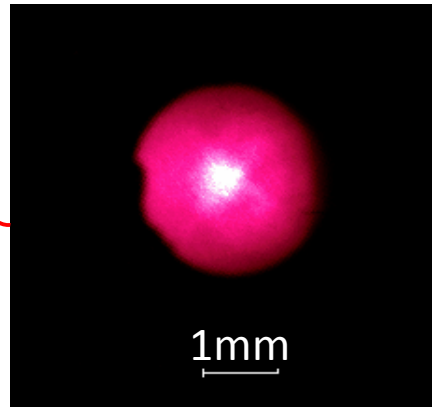
time integrated

No gas fill



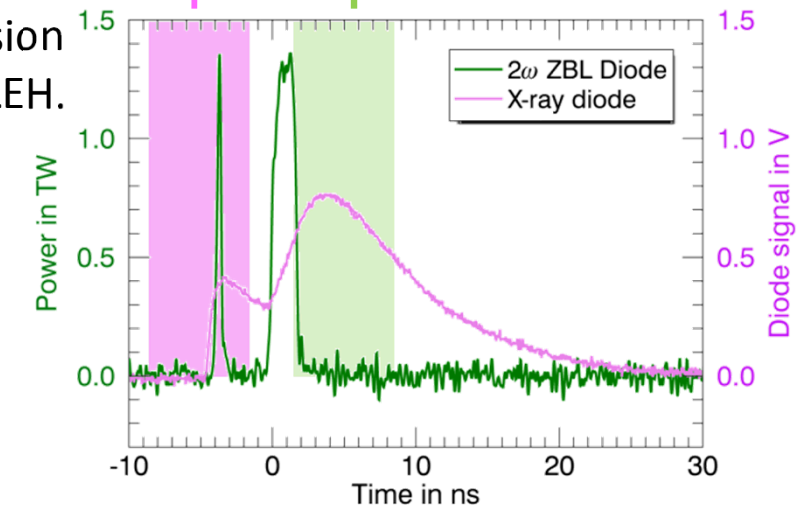
Only area irradiated by the laser lights up.

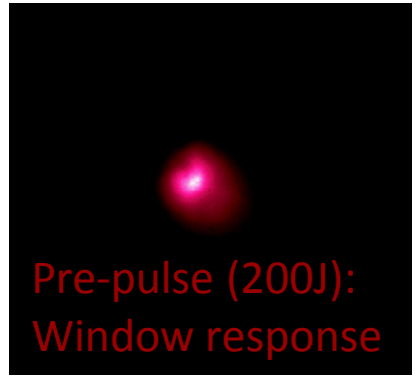
250 torr Ne

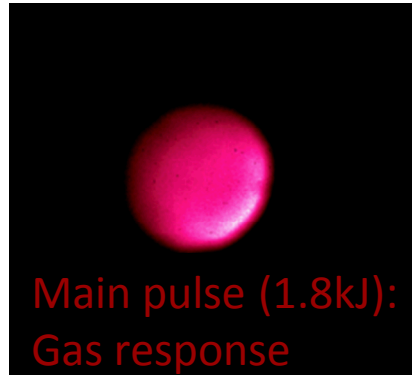


Neon emission fills entire LEH.

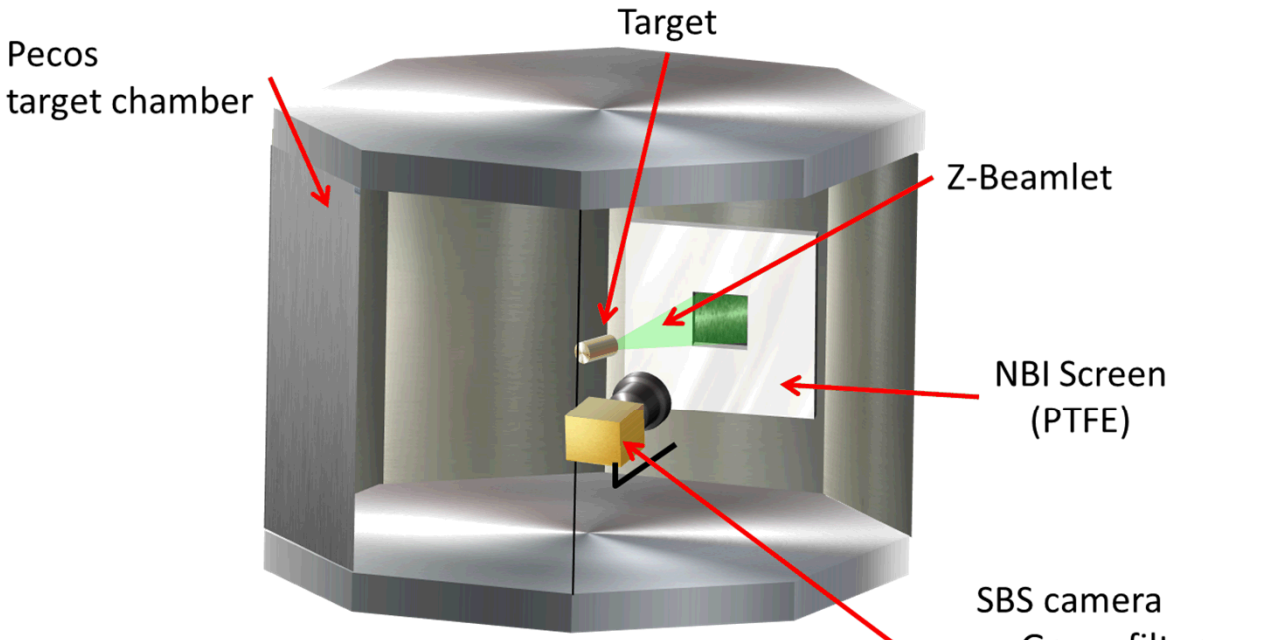
temporally resolved

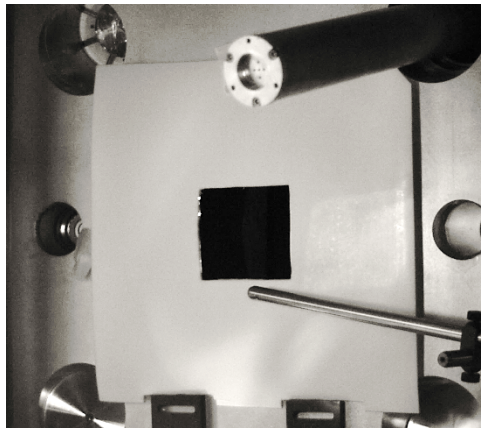


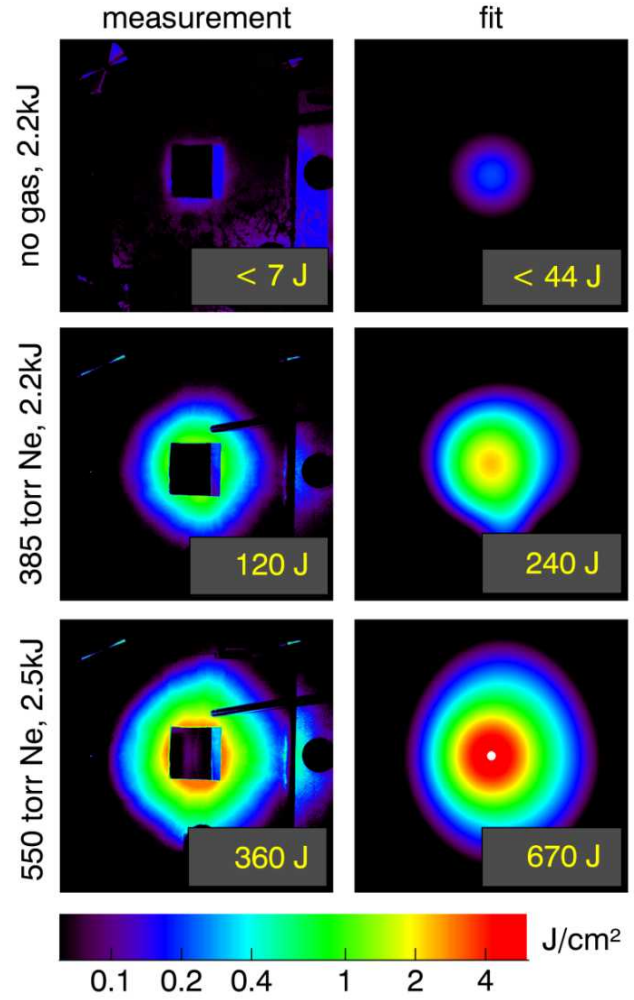




SBS Backscatter Measurements

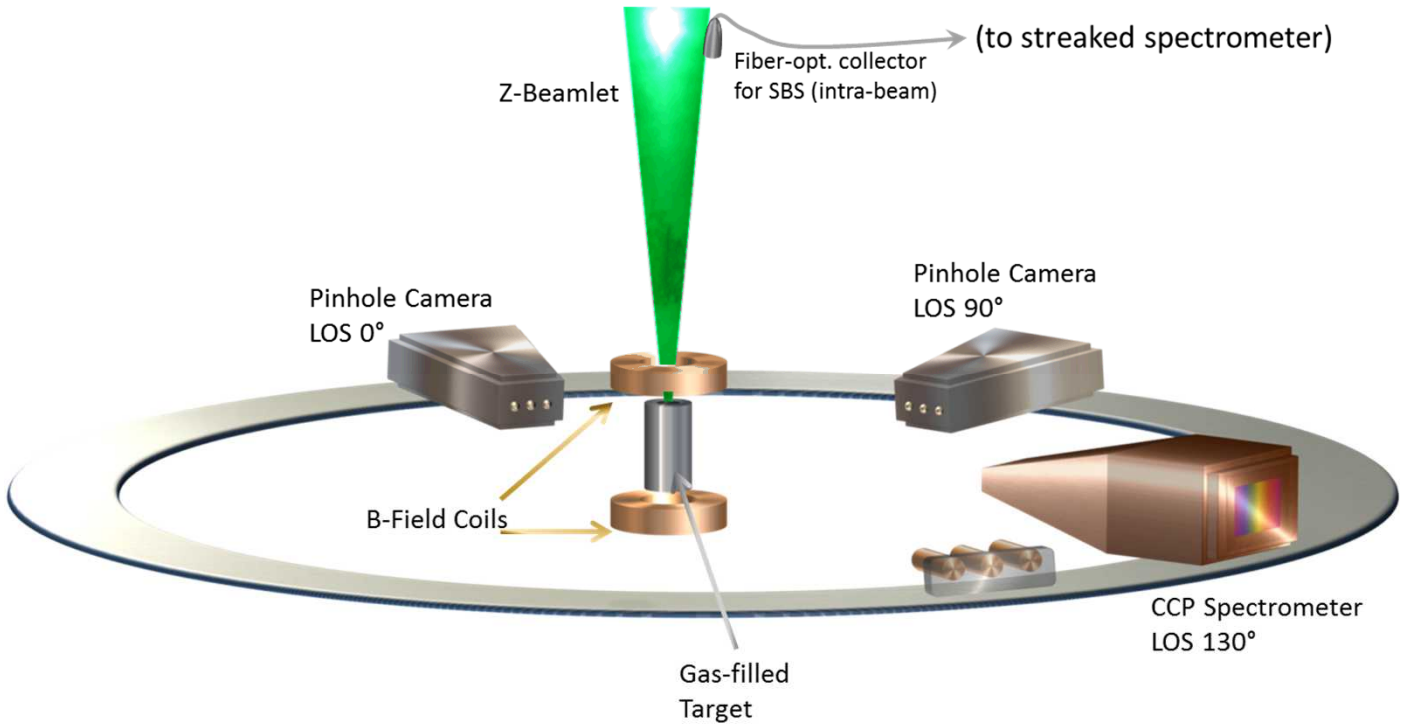


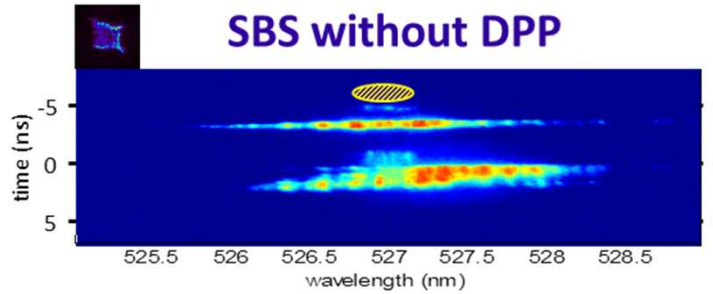




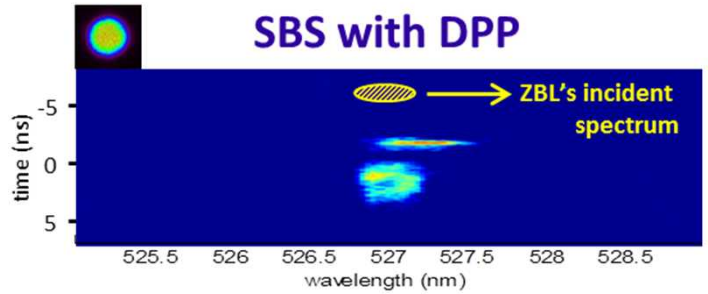
All data without phase plate

Experiments in Z Center Section





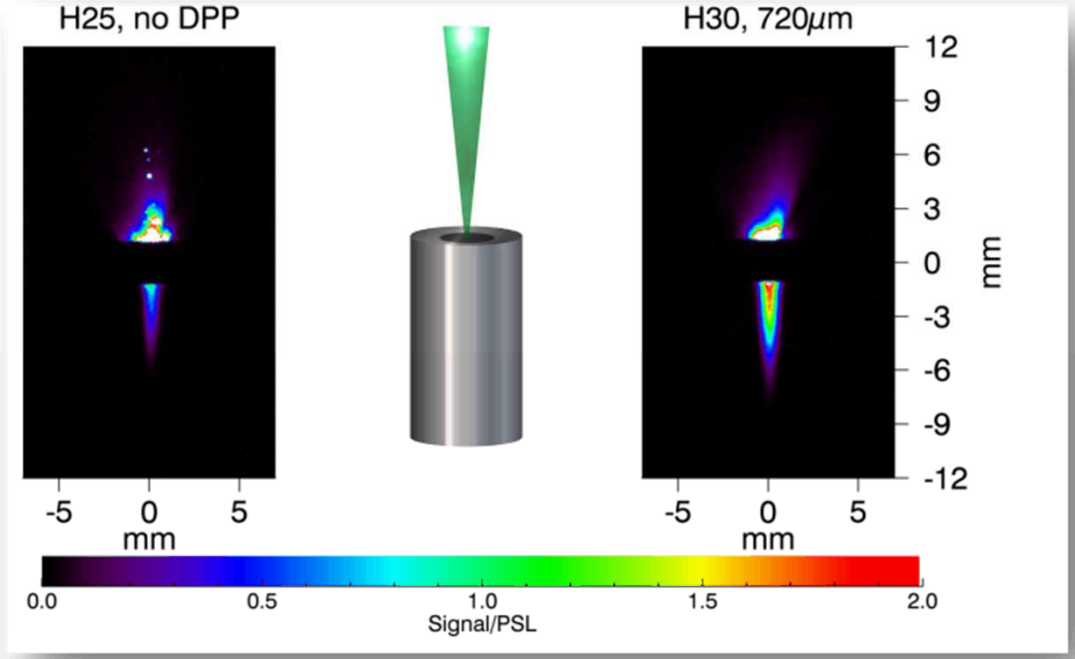
Courtesy of David Bliss

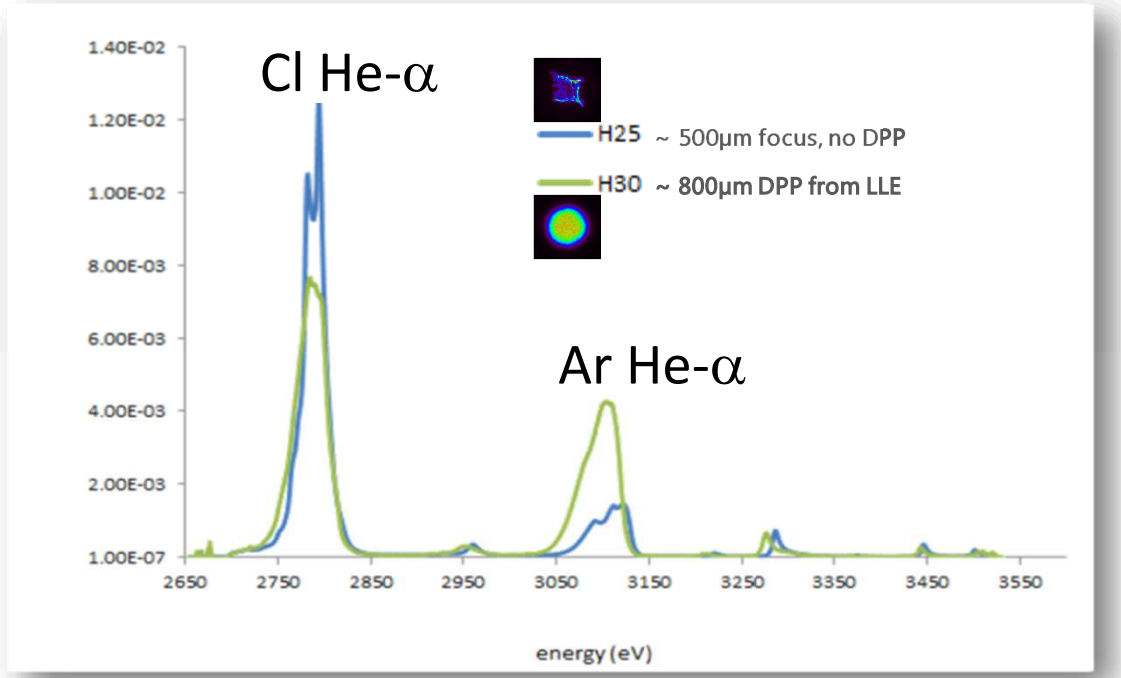


Poor beam quality:

- **More SBS**
- **Bigger $\Delta\lambda$ (filamentation)**
- **Spectral shift**

Experiments in Z Center Section





Courtesy of Stephanie Hansen

- 1.6 mm depth increase for X-ray emission
- 2x emission from gas for argon K-shell radiation

- Phase plate reduces LEH contamination
- Phase plate improves coupling into gas

Summary

- *Pre-pulse is important. Potential to optimize (timing, energy).*
- *Phase plate is important, 0.75mm and 1mm to be delivered any day!*
- *Neon is promising as dopant for axial diagnostic.*
- *Significant difference between pre- and main pulse interaction!*
- *Check for - and stay away from - LPI such as SBS (possibly ~1kJ), SRS, TPD, etc…*
- *To do:*
  Characterize mix, optimize diagnostics, more experiments with phase plate, SRS, try thinner windows (cryo-cooling), analyze, analyze, analyze…