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Laser Diagnostic for Interrogating High Electron Densities in Low Pressure Plasma Environments

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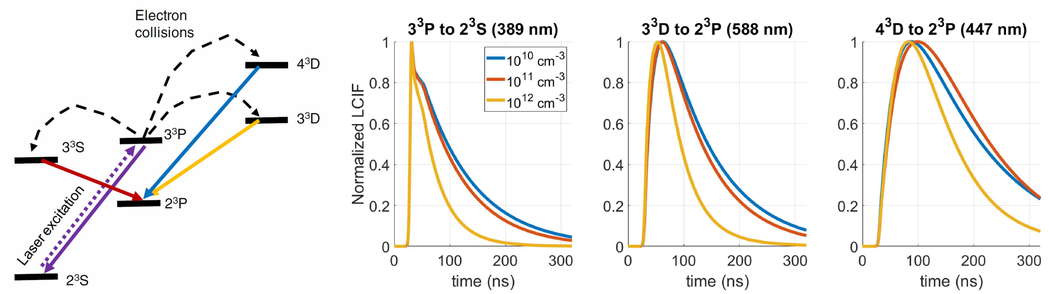
I. Abstract

Laser-collision induced fluorescence (LCIF) diagnostics allow interrogation of electron densities and temperatures. However, regions above 10^{12} cm^{-3} remain a challenge because of short lifetimes. Here, we interrogate an expanding arc with densities up to 10^{14} cm^{-3} by measuring the temporal response of the LCIF emission.

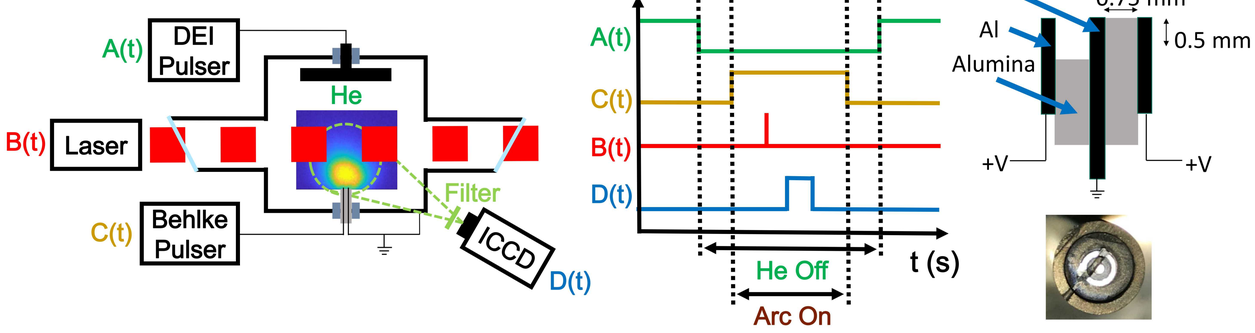
II. Diagnostic

- Fluorescence lifetime is reduced by electron collisions
- He atomic system described by collisional radiative model (CRM) [1,2]
- Pressure broadening is important at high densities



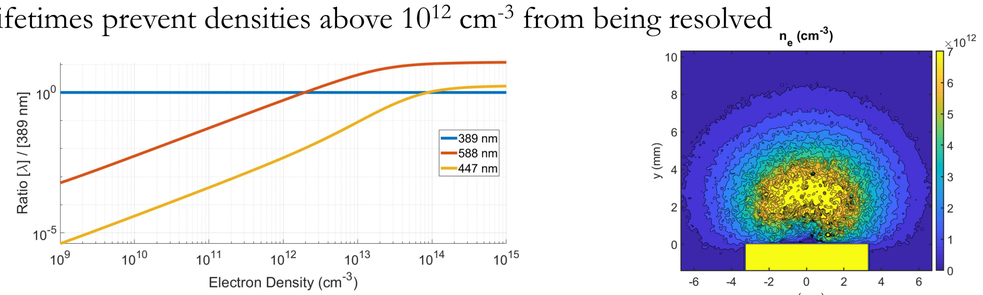
III. Experiment

- DEI pulser creates He metastables and laser light sheet excites fluorescence
- Delays varied to capture desired temporal response
- Stable arc source allows repeated measurements at 65 mTorr He

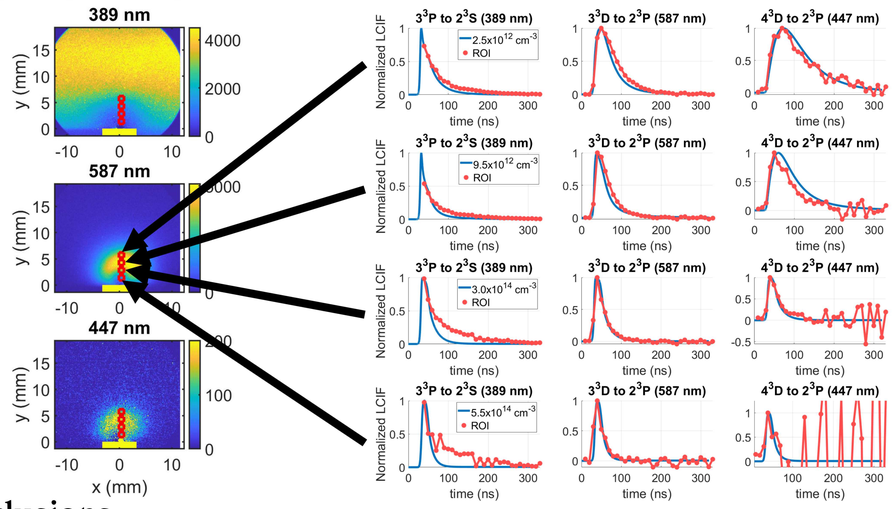


IV. Results

- Temporally integrated line ratios are limited for electron density
- Short lifetimes prevent densities above 10^{12} cm^{-3} from being resolved



- Fitting temporal response allows 10^{14} cm^{-3} to be resolved ~1.3 mm above arc source



V. Conclusions

Vacuum arcs can reach densities over 10^{14} cm^{-3} 1 mm above the source, and matching the LCIF temporal response is required to investigate this region. Future work will consider shorter laser pulse widths and spectral broadening to image even closer.

Acknowledgements: Gary Pettee

References

[1] E. V. Barnat and K. Frederickson, *Plasma Sources Sci. and Technol.* 19(5), 055015 (2010)
[2] Y. R. Ralchenko, R. K. Janev, T. Kato, D. V. Fursa, I. Bray, and F. J. De Heer, *At. Data Nucl. Data Tables* 94(4), 603 (2008)

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