SAND2023-04132C

Sandia National Laboratories

Tomographic Optical Imaging of a Pulsed Atmospheric Pressure Plasma Jet

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I. Abstract

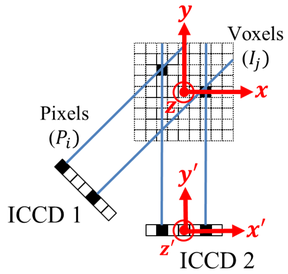
Applications of non-thermal atmospheric pressure plasmas often involve transitions to surface ionization waves (SIWs) on dielectric surfaces. The SIWs experience variable geometrical and electrical material properties that can lead to complex 3D configurations that are non-symmetric and difficult to analyze. Here, an approach for 3D plasma structure diagnostics using tomographic optical emission spectroscopy (Tomo-OES) is evaluated.

II. Optical Tomography

- Cameras measure projections of the light intensity [1]
- Each pixel intensity, P_i, is related to the intensity within a voxel, I_j, by

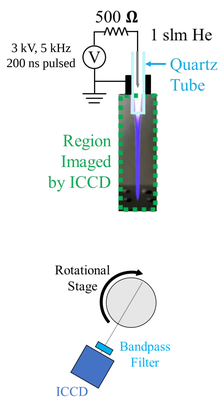
$$P_i = \sum_j W_{ij} I_j$$

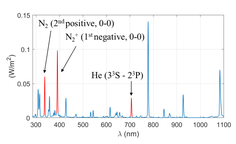
- Where W_{ij} represents the contribution of the jth voxel to the $i$the pixel [1,2]

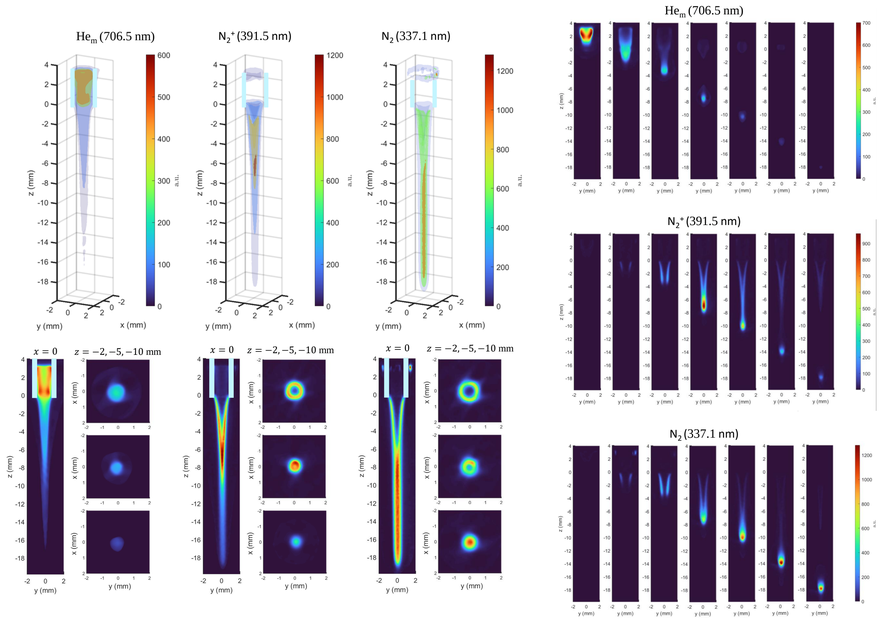


III. Atmospheric Pressure Plasma Jet (APPJ) Tomographic Reconstructions

- Multiplicative algebraic reconstruction technique (MART) recovers I_j



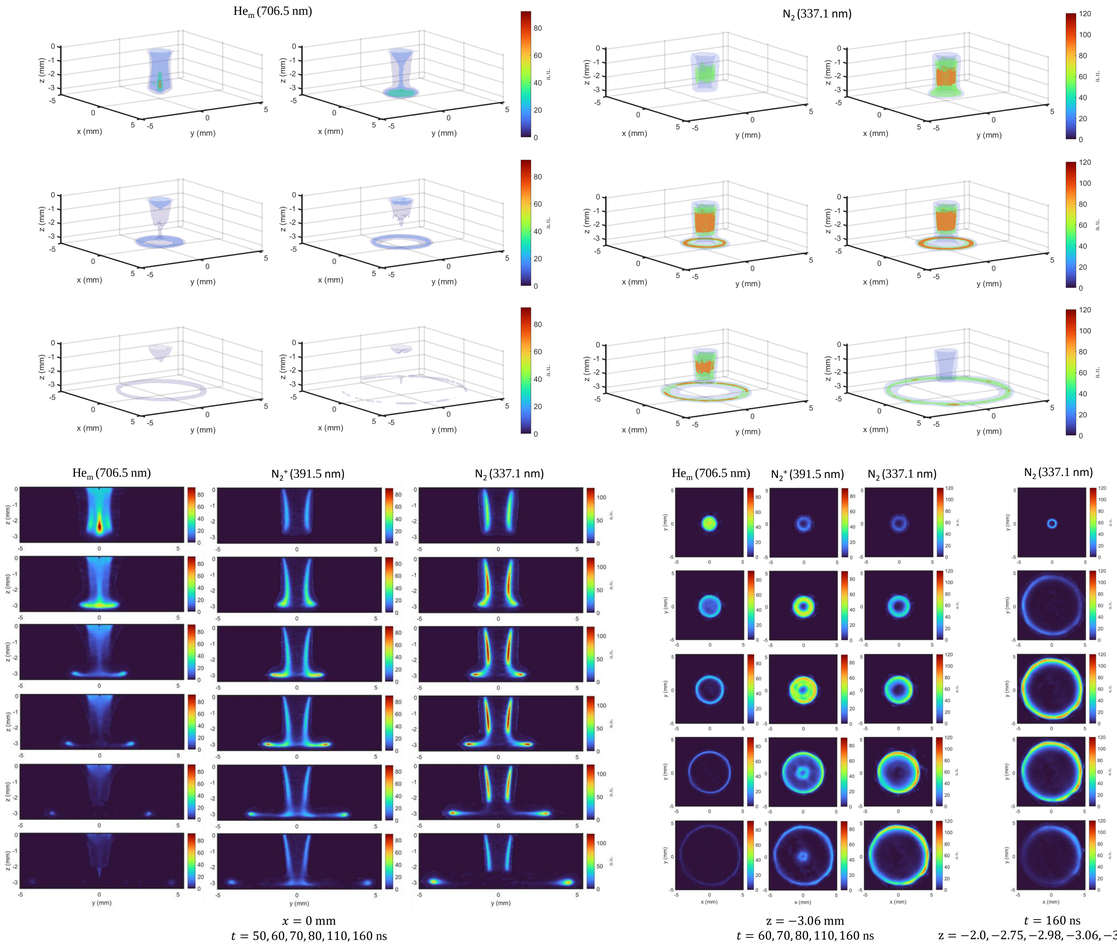




5 ns ICCD gate width $x = 0$ mm
$t = 20, 40, 60, 100, 130, 180, 240$ ns

IV. Surface Ionization Waves (SIWs) on a Planar Surface (3.3 Relative Permittivity)

- Surface charging leads to fields parallel to the surface and propagation of the SIW



$x = 0$ mm
$t = 50, 60, 70, 80, 110, 160$ ns

$z = -3.06$ mm
$t = 60, 70, 80, 110, 160$ ns

$t = 160$ ns
$z = -2.0, -2.75, -2.98, -3.06, -3.196$ mm

V. Conclusions

Results revealed that Tomo-OES is suitable for volumetric reconstruction of guided streamers and SIWs with acceptable temporal (5 ns) and spatial (7.4 μm) resolutions. Future work will examine effects of structured dialectic surfaces and multiple SIWs.

Acknowledgements: DOE FES (DE-SC0020232) and Sandia LDRD program

References:

[1] C. Atkinson and J. Soria, *Exp. Fluids* **47**, 2009.
[2] M. Mirzaee, M. S. Simeni, and P. J. Bruggeman, *Plys. Plasmas*, **27**(12), 2020.
[3] B. Z. Bentz, *Plasma Sources Sci. Technol.*, (submitted).

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