SAND2022-12810C

Sandia National Laboratories

Update on Sandia National Laboratories Plasma Research Facility (PRF)

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I. Abstract

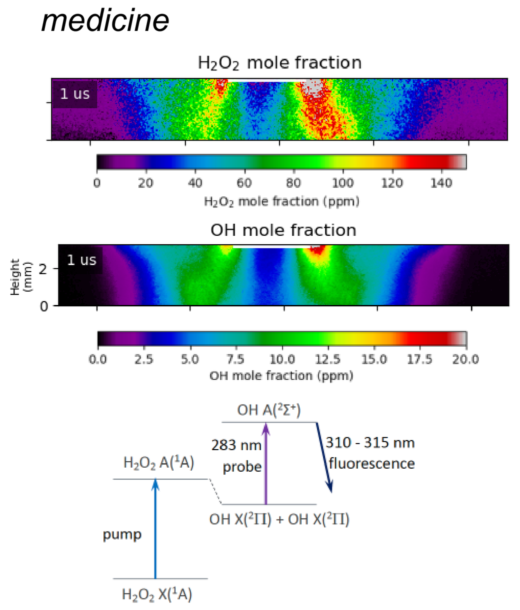
Sandia's Low-Temperature Plasma Research Facility (PRF), funded by DOE Office of Science, Office of Fusion Energy Sciences, General Plasma Science, is a resource available to anyone in the international Low-Temperature Plasma (LTP) community to access the advanced capabilities available at Sandia (not restricted to the US collaborators). Collaborations are initiated through an annual proposal process which opens immediately following the GEC conference.

II. Optical Diagnostics

A. Photofragmentation Laser-Induced Fluorescence (PF-LIF) enables detection of key non-fluorescing species.

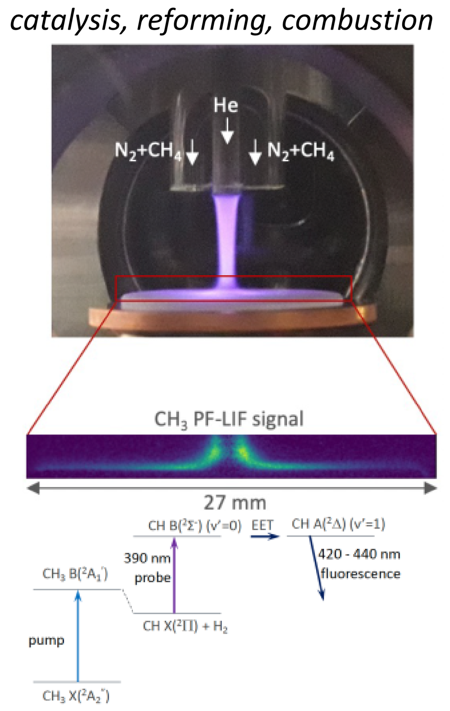
Hydrogen peroxide (H_2O_2)

Key species in interactions of plasma with water and tissue: decontamination/sterilization, plasma medicine

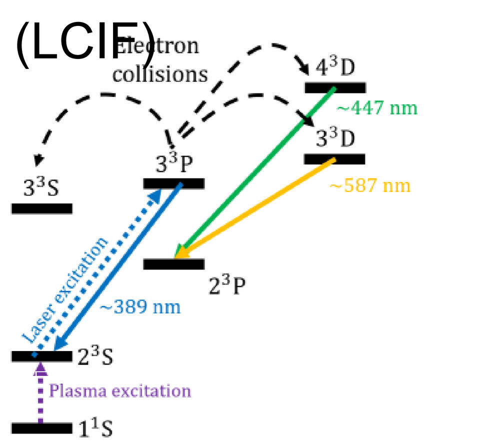


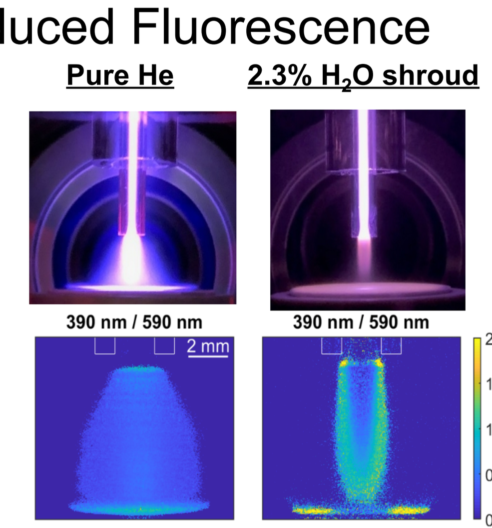
Methyl (CH_3)

Key intermediate for plasma-assisted catalysis, reforming, combustion

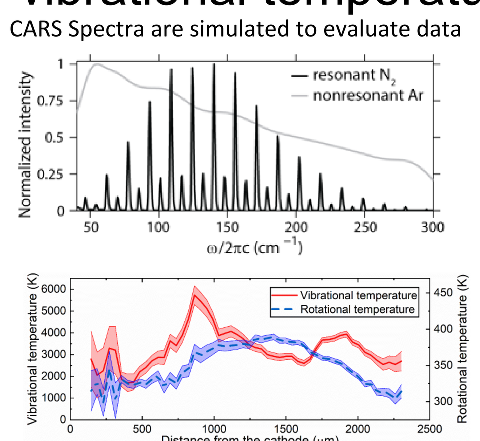


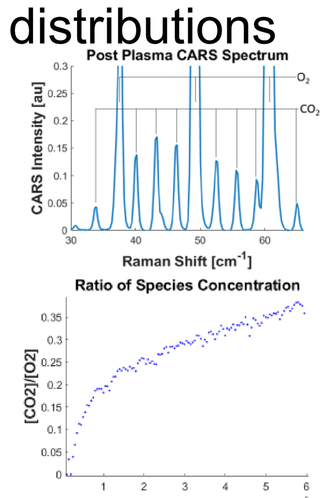
B. Laser-Collision-Induced Fluorescence (LCIF)

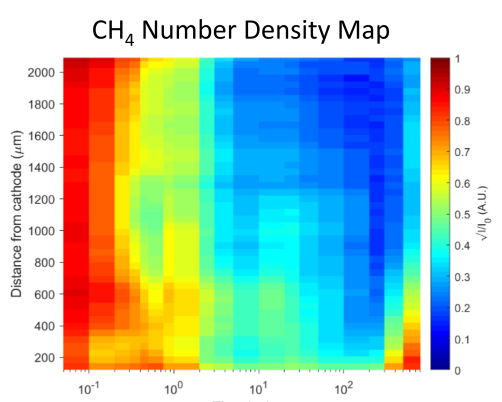




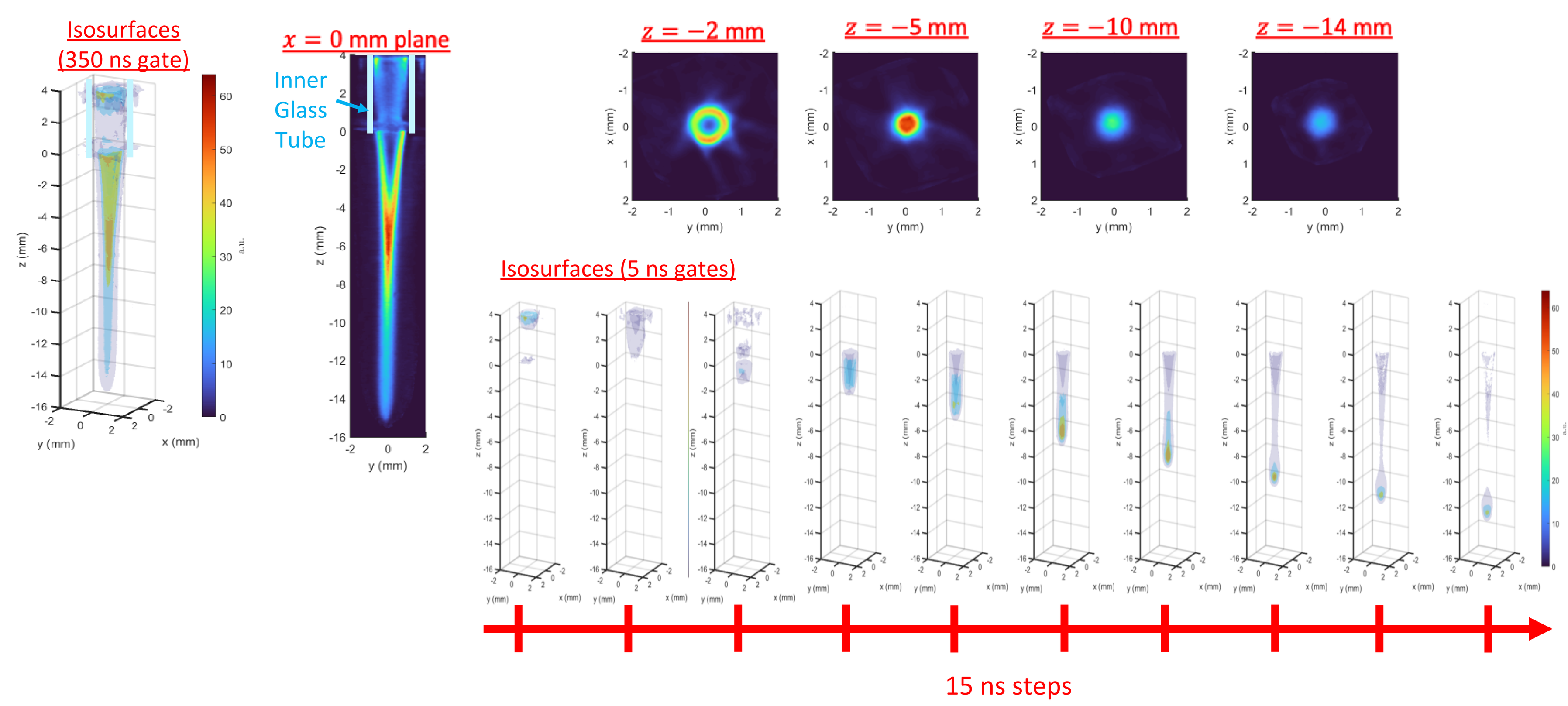
C. Coherent Anti-Stokes Raman Spectroscopy (CARS) enables the time and spatially resolved imaging of major chemical speciation and nonequilibrium rotational and vibrational temperature distributions



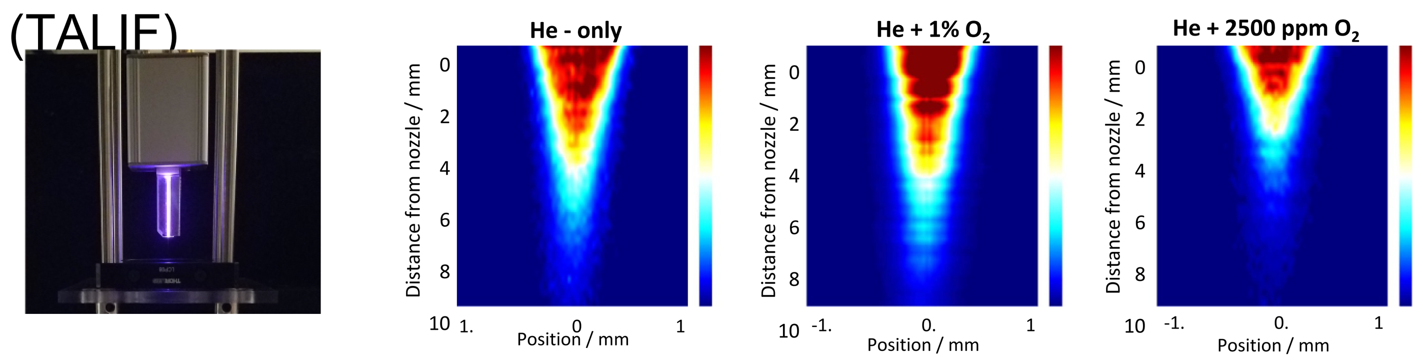




D. Optical Tomography



D. Two Photon Absorption Laser-Induced Fluorescence (TALIF)

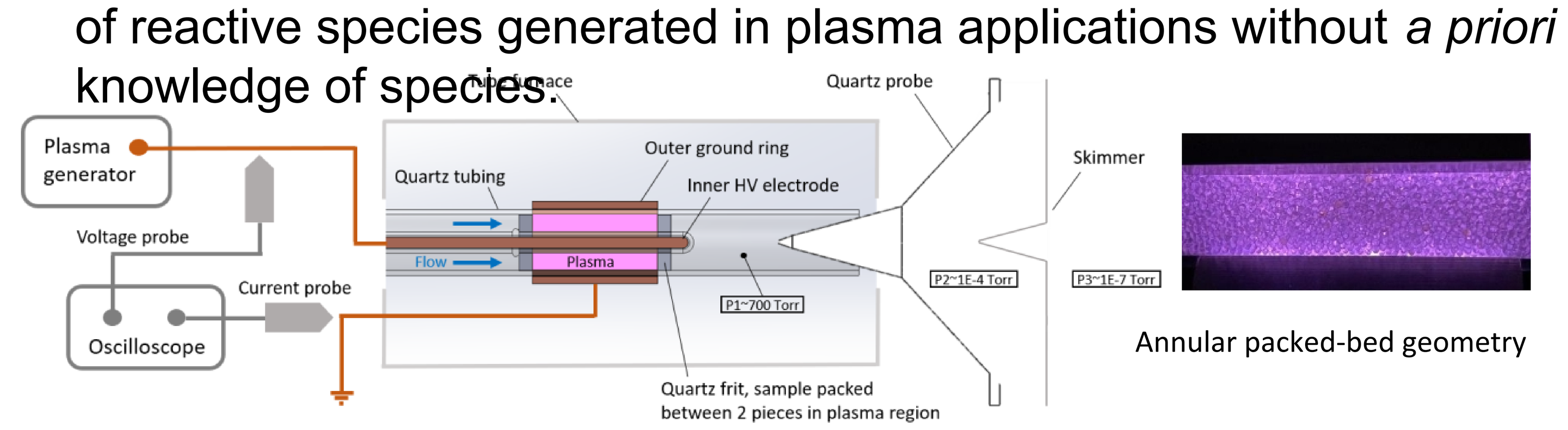


Spatially resolved TALIF signals of atomic oxygen, normalized to counts per second, in the effluent of the COST jet operated with admixtures of helium-only, helium with 1% oxygen, and helium with 2500 ppm of water

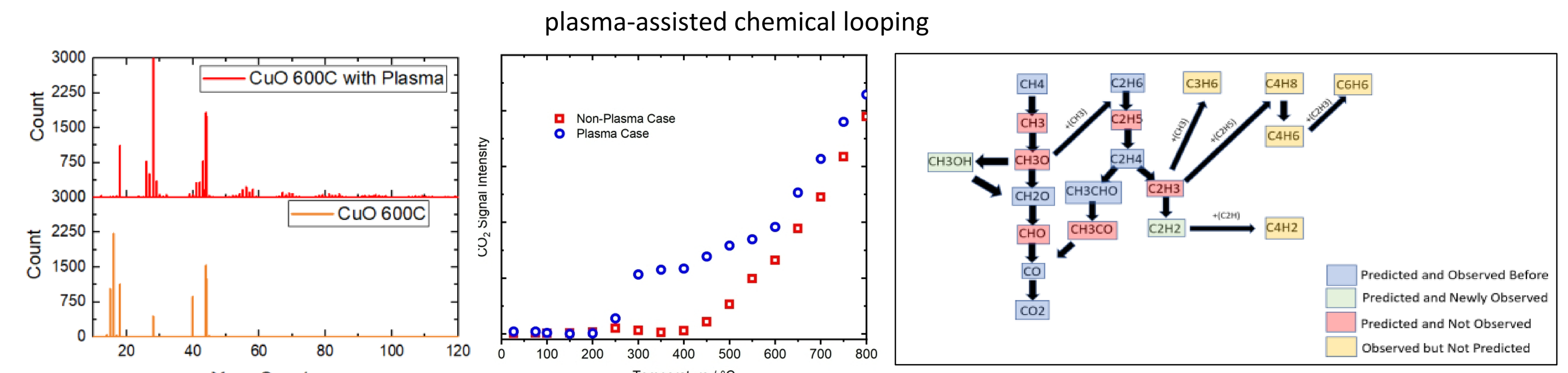
Brayden Myers, Edward Barnat, Katharina Stapelmann, "Atomic oxygen density determination in the effluent of the COST Reference Source using *in situ* effective lifetime measurements in the presence of a liquid interface," J. Phys. D: Appl. Phys. **54**, 455202.

III. Mass Spectroscopy Diagnostics

Molecular Beam Mass Spectroscopy (MBMS) enables measurement of reactive species generated in plasma applications without *a priori* knowledge of species.



plasma-assisted chemical looping



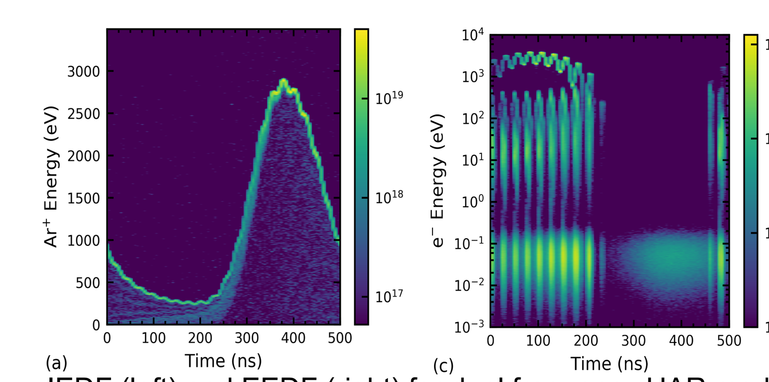
IV. Modeling / Simulation Capabilities

Aleph, PIC-DSMC tool

1D, 2D, 3D
Unstructured FEM (compatible with CAD)
Electrostatic
Fixed B field

Charged and Neutral Species

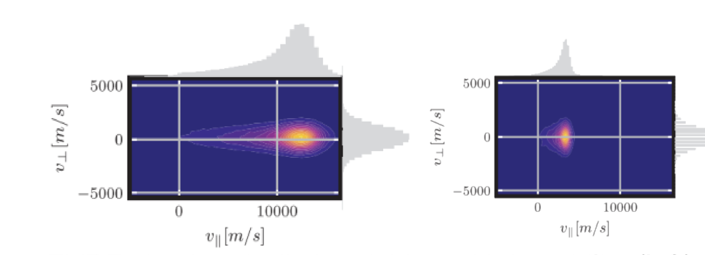
Massively parallel
Advanced particle weighting methods
Dynamic load balancing
Currently utilizing up to 64k processors (>1B elements, >1 B particles)



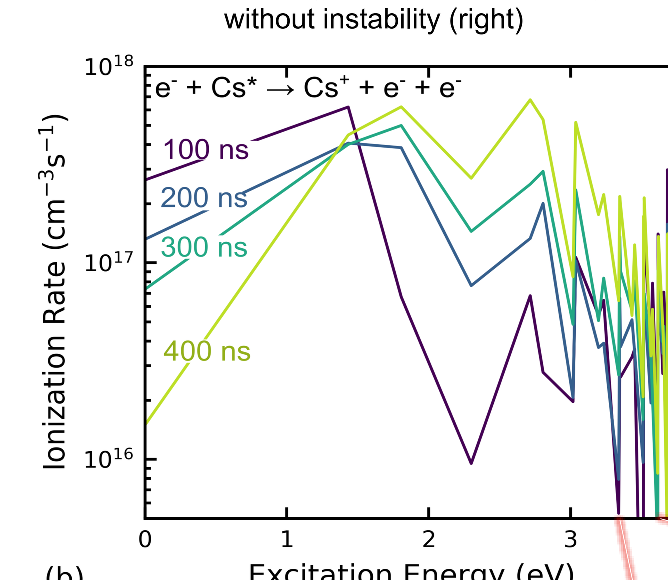
IEDF (left) and EEDF (right) for dual frequency HAR model.

High Fidelity Distribution Functions

Massively parallelized – high particle counts (1000s per cell)
Highly-resolved EDFs and VDFs



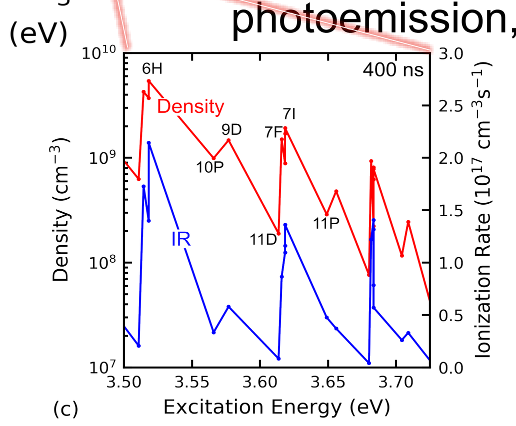
EVDFs in sheath distinguishing with instability (left) and without instability (right)



Complex Plasma Chemistry:

Electron-heavy: elastic, excitation, ionization, dissociation
heavy-heavy: elastic, charge exchange, reaction;
charge-charge via Nanbu: ion-ion, ion-e$^-$, e$^-$ - e$^-$
rate-based interactions: recombination,
photonic interactions: radiative decay, photoexcitation, photoionization, photoemission, non-equilibrium spectrum

Cesium system involving 52 excited states (to n = 11), and 862 total processes. High-fidelity detailed excited state distributions.



Propose a collaboration at: www.sandia.gov/prf

Proposal Call

Opens: October 10, 2022
Closes: December 16, 2022

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Sandia National Laboratories' Plasma Research Facility is funded by the U.S. Department of Energy's Office of Science, Fusion Energy Sciences. Sandia National Laboratories is a multimission laboratory managed and operated by National Technology &Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.
SAND No. SAND2022-

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