NSTX

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3D Reconstruction of Incandescent Lithium and Tungsten Dust Particle Trajectories in the National Spherical Torus Experiment

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A.L. Roquemore, J. Nichols, D.W. Mansfield,
C. H. Skinner, W. Davis, E. Feibush, W. Boeglin,
R.Patel, D. Abolafia R. Maqueda

Princeton University Plasmas Physics Laboratory
Princeton, N.J. 08543

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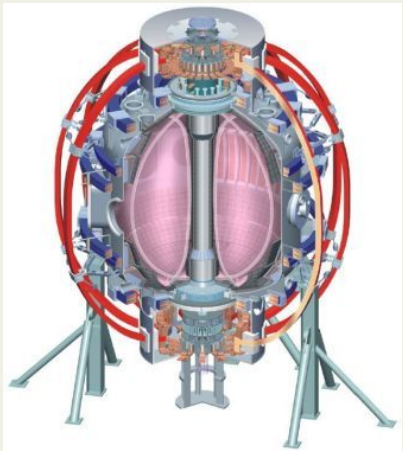
Monday Physics meeting

7/26/2010



PPPL
Lane Roquemore PSI-16, HTPD, Dust Workshop
Bill Davis
Ricky Maqueda (formally NOVA Photonics)
Dennis Mansfield
Eliot Feibush
Charles Skinner

Florida International University
Werner Boeglin (HTPD)
Raul Patel

Toms River High School
Ken Hartzfeld

SULI student
Jake Nichols (now at Princeton U.) (PSI-19)

The Bergen County Academies
Dan Abolafia

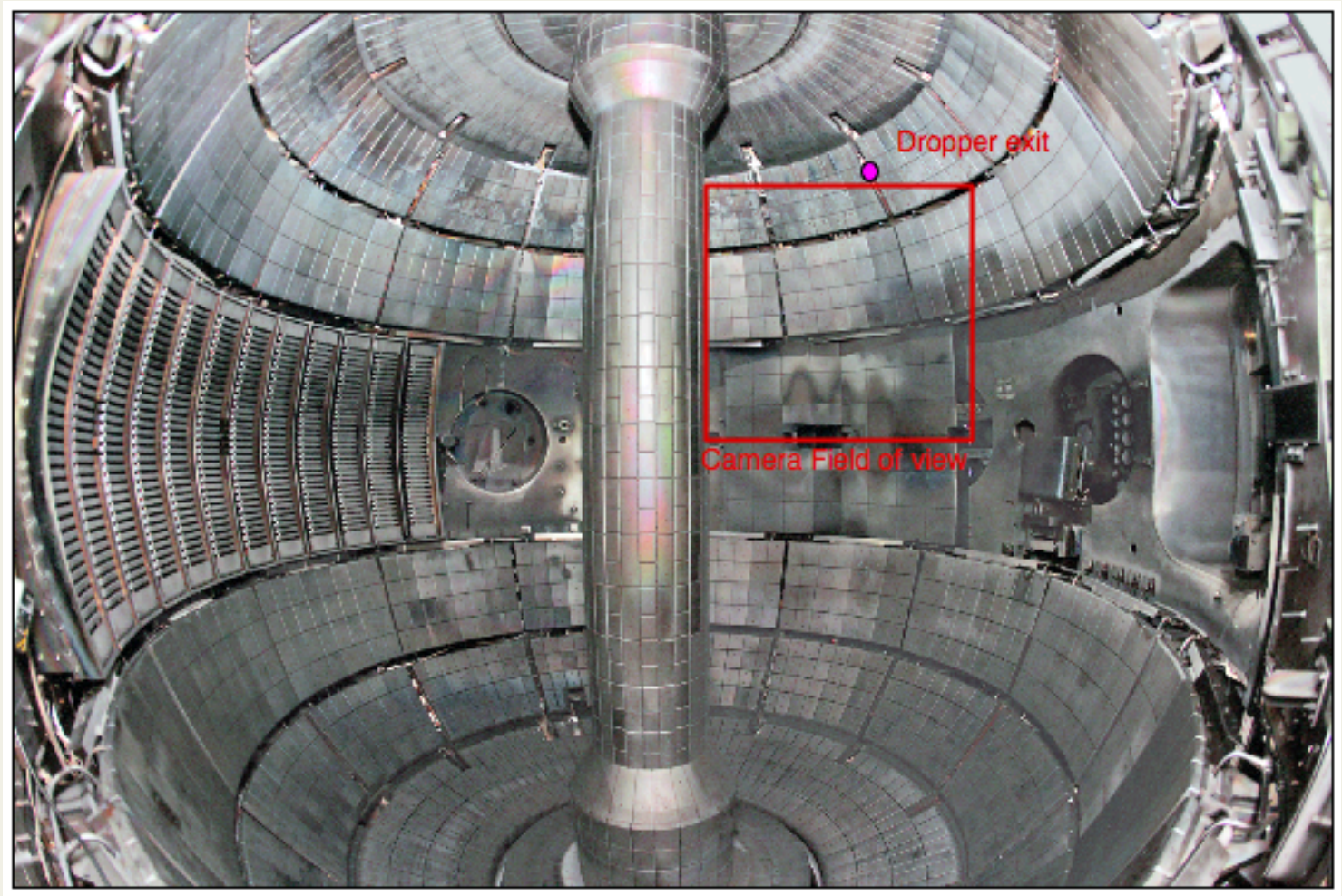
UCSD
Sergei Krasheninnikov
Sasha Pigarov
Roman Smirnov   (PSI-19)

LLNL
Joel Clementson   (HTPD-18)

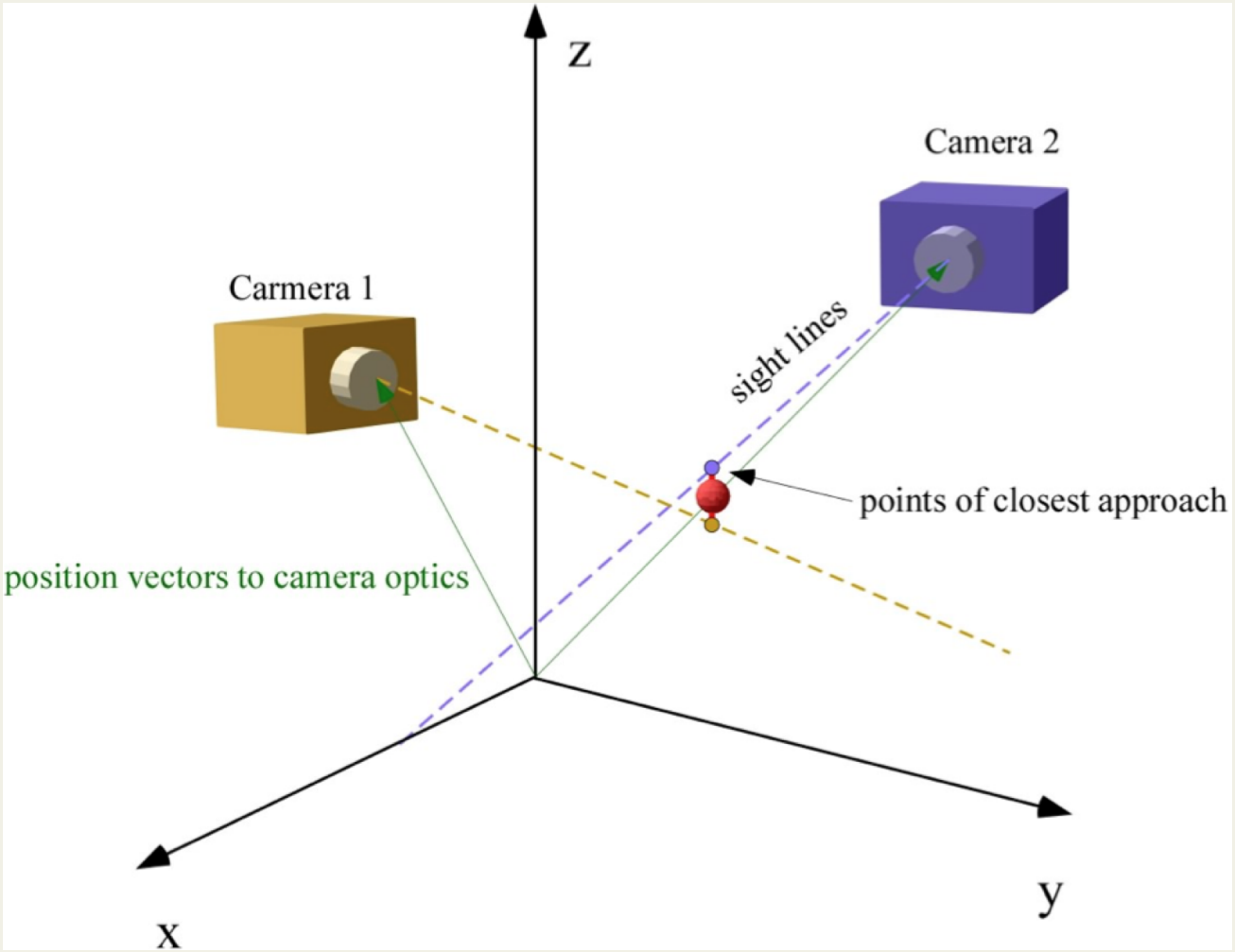
Motivation

- Provide 3-D trajectories of pre-characterized dust introduced into the SOL of NSTX to be used to verify the dust transport DUSTT/UEDGE. This work is in part motivated by DSOL-21.

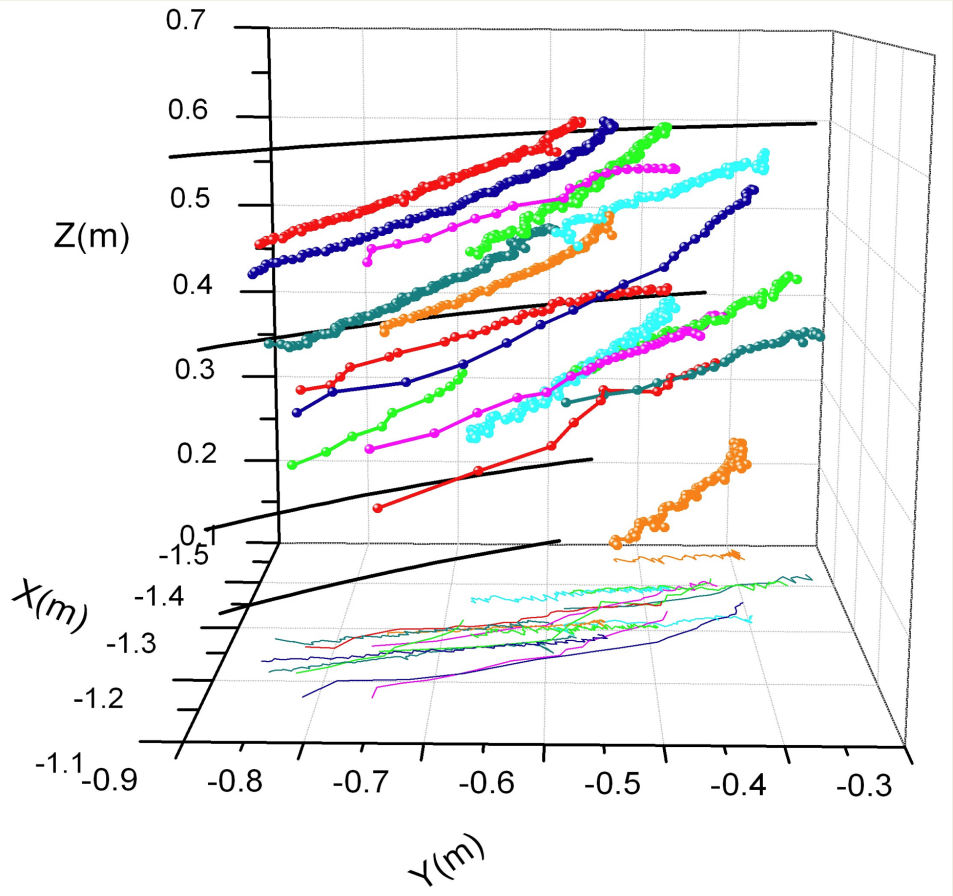
Fisheye view of NSTX showing the FOV of the cameras



Schematic representation of particle position reconstruction

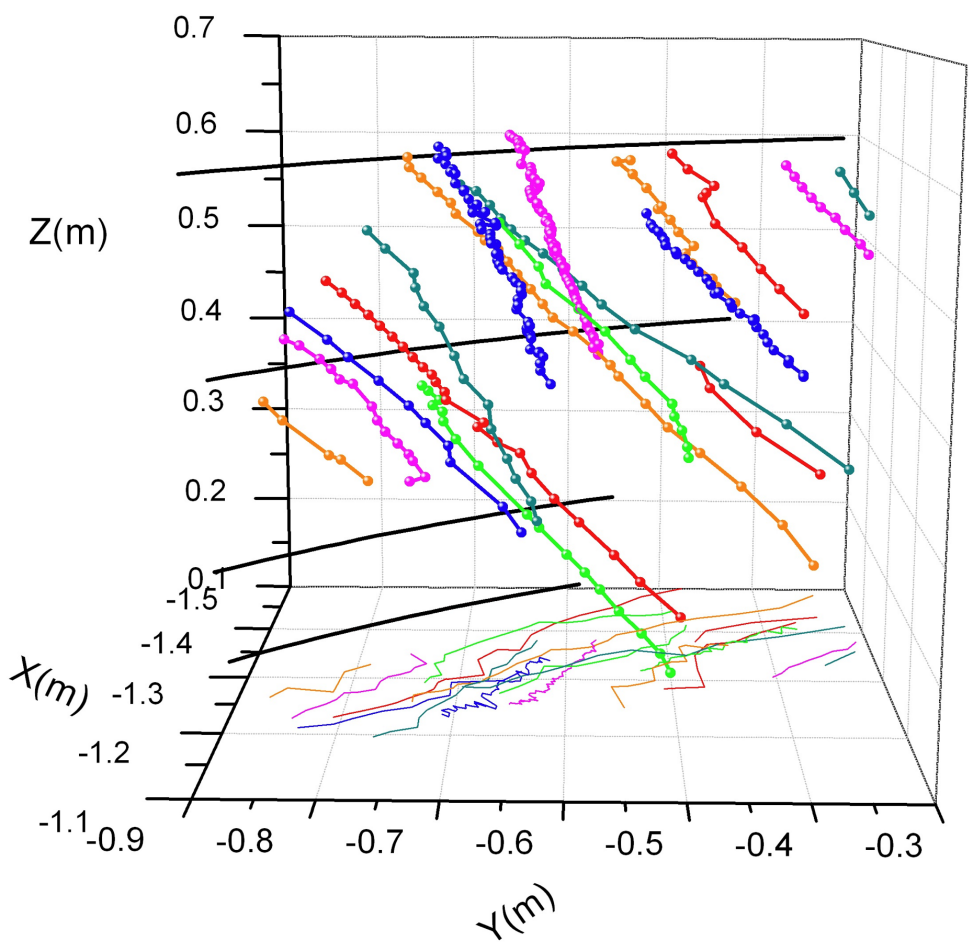


Li particles moving from top right to lower left



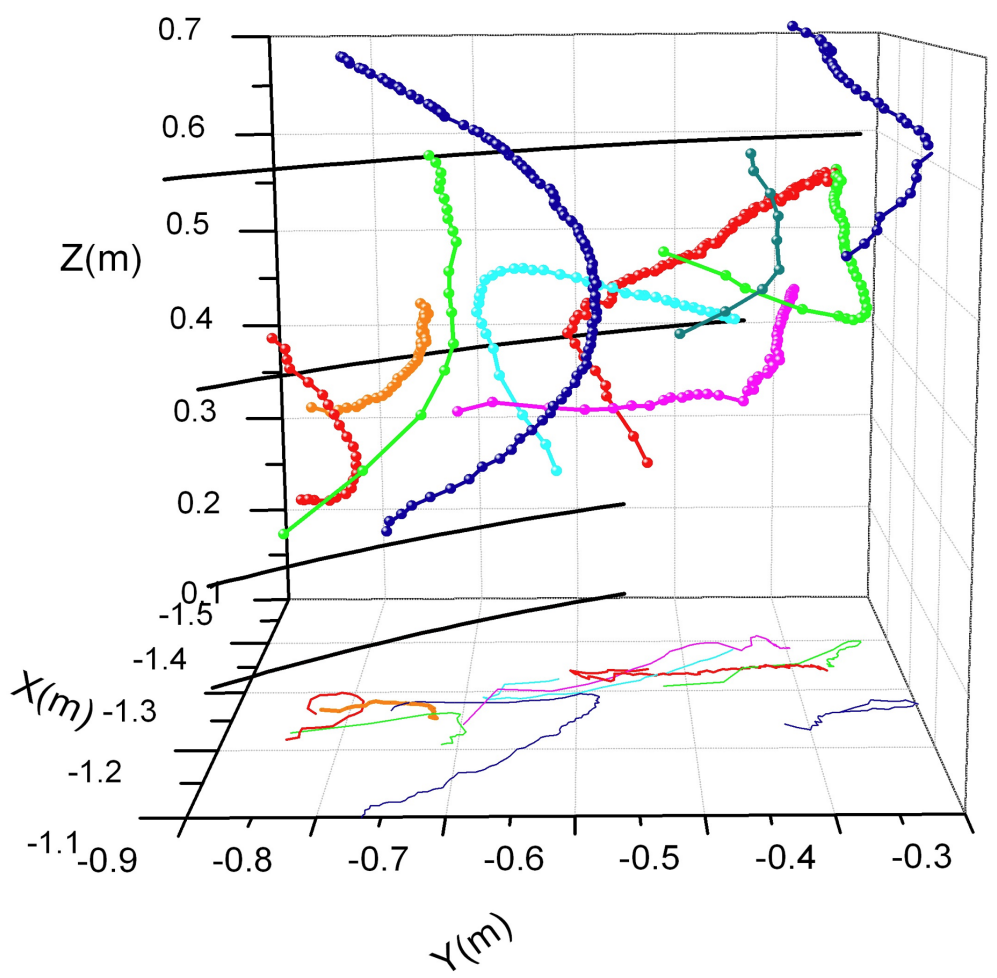
Greater than 90% of all particles dropped from above move across the magnetic field from top right to lower left in the figure with velocities of order a few 10's of meters per second. For predictive behavior, this class of particles are most common and therefore of most interest.

Li Particles with opposite trajectories



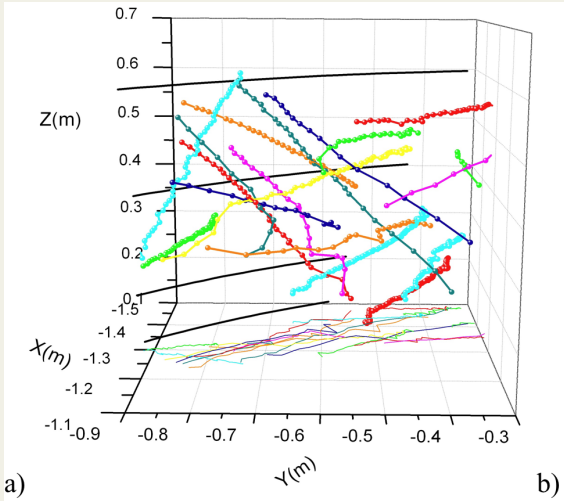
A small percentage travel in opposite directions (along magnetic field lines). These particles tend to travel faster than the above case reaching velocities up to ~100 m/s.

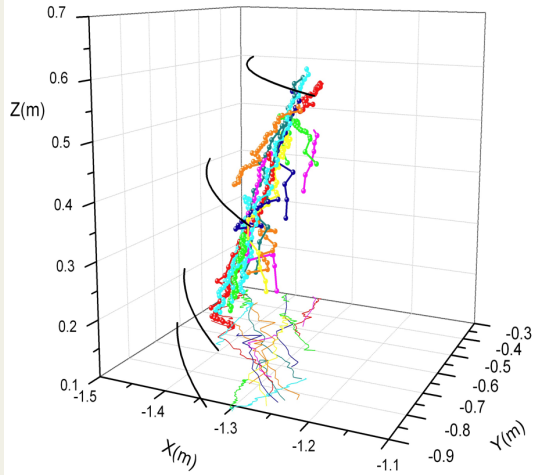
Mid-Flight course corrections



Li particles are often seen to undergo abrupt changes in their direction and velocity. This constitutes less than 1% of the particles and are statistically insignificant. However, they still require a scientific explanation.

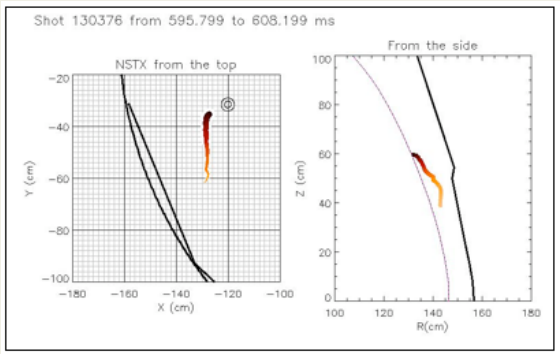
Random sampling of Li particle tracks

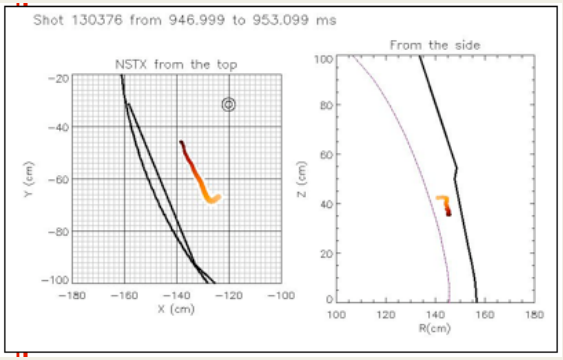


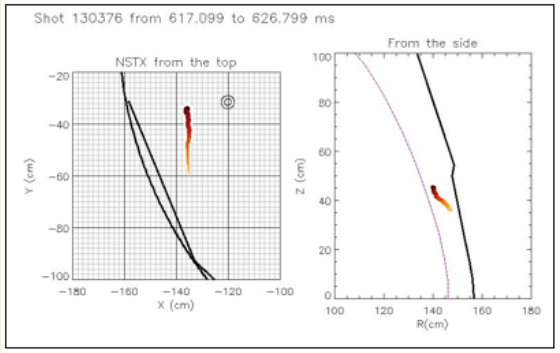


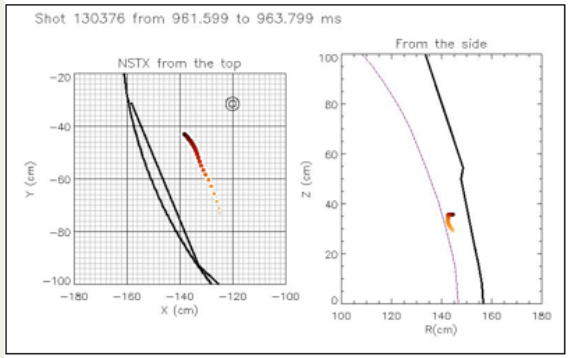
Top view is a random sampling of the Li trajectories. When viewed from the side, the particles line up along the SOL between the separatrix and the vessel wall. The black curved lines represent the vessel wall.

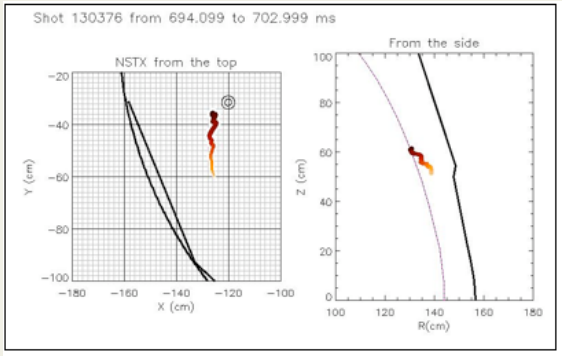
Li particle trajectories with respect to the separatrix as defined by EFIT

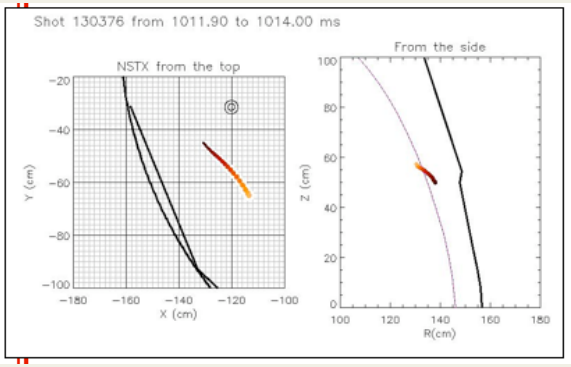






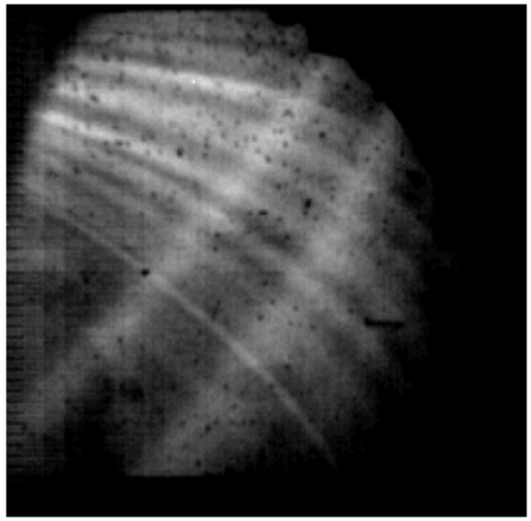




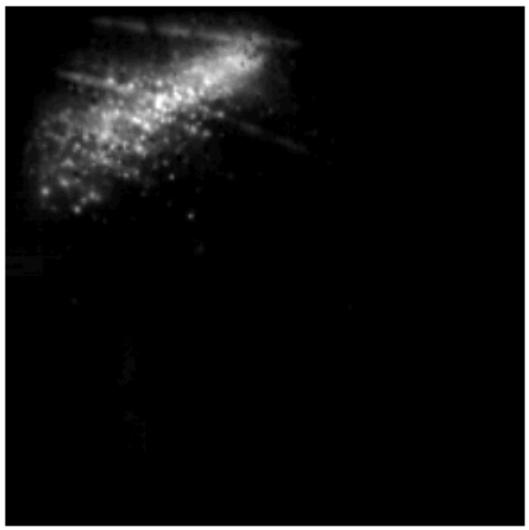


Each panel on the left shows a particle dropped from the drift tube (concentric circle in left of each panel). The left figure shows the top down view, the right shows the tangent view where the light grey line is the separatrix as defined by EFIT.

Filtered view of Li dust



Li II

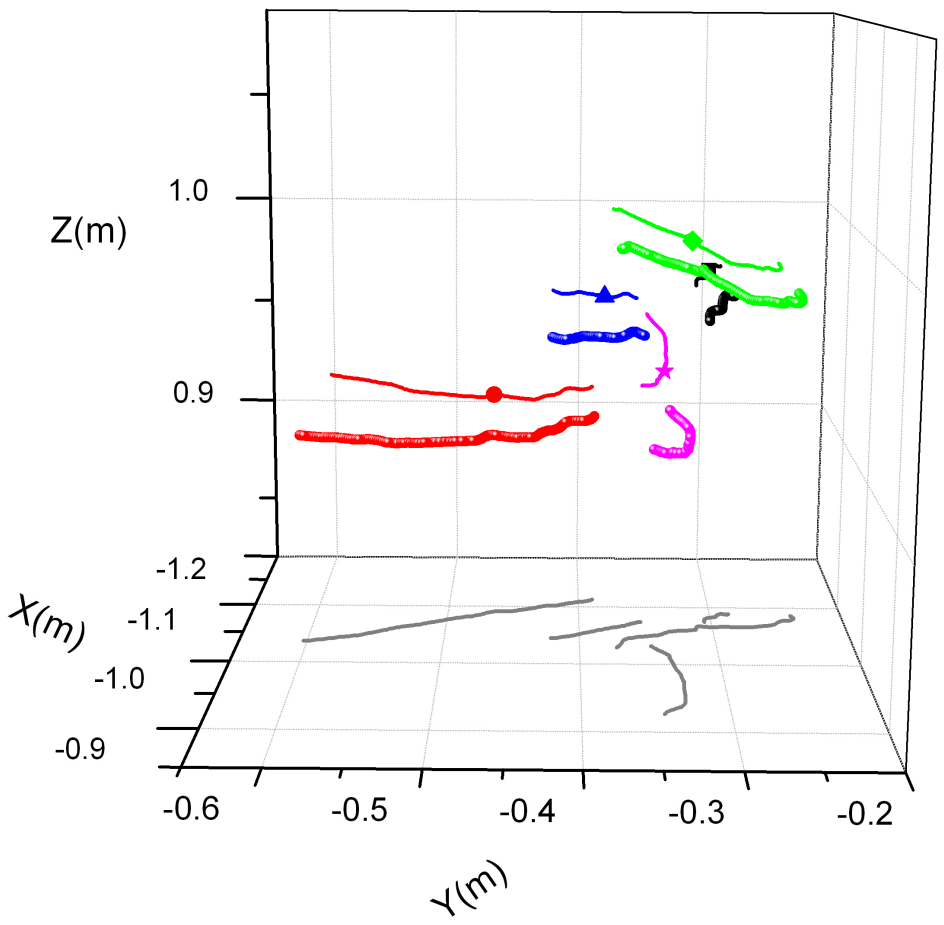


Li I

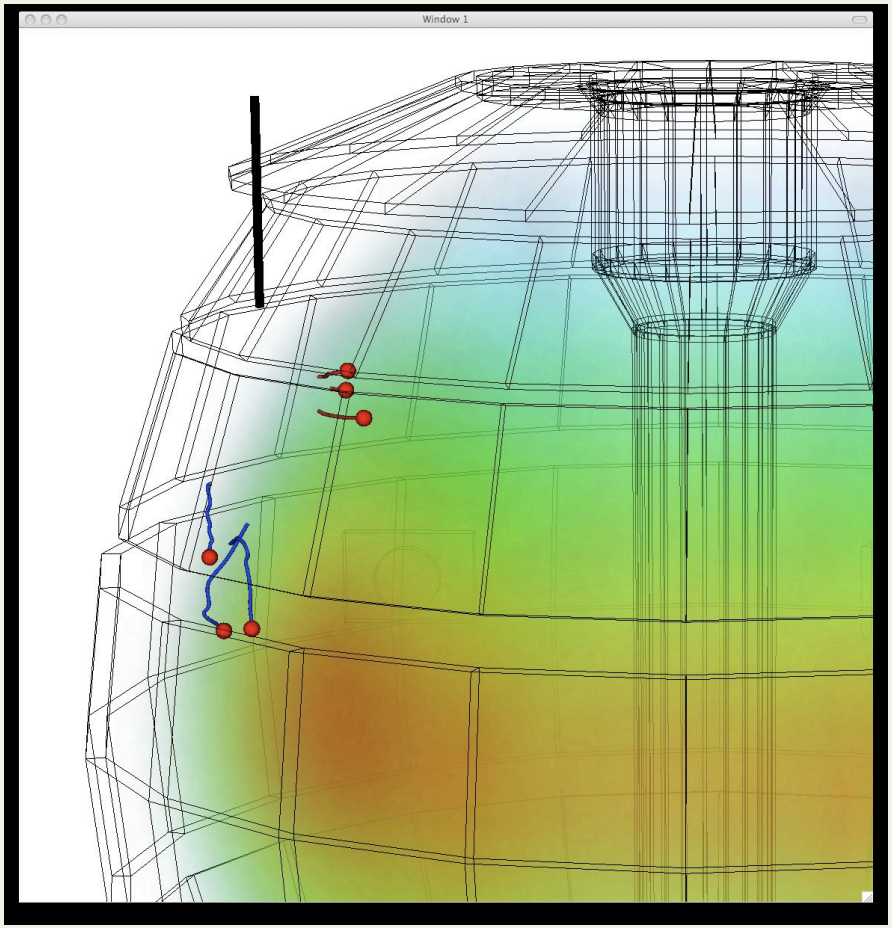
The top panel shot was taken of powder dropped into NSTX with a Li II filter at (548.5 nm- singly ionized). The individual Li particles are not visible and for most of the discharge, the frames are dark. Only the filaments are seen during events such as ELMs. A second unfiltered camera verified the presence of Li dust.

The lower panel was taken on a subsequent similar discharge with a Li I (670.8nm –neutral) filter clearly showing individual incandescent Li particles and indicating the ablation cloud around the particle is not ionized. Filaments are also visible for this case throughout this shot.

Tungsten trajectories



Tungsten was dropped into a reversed TF field configuration. The 10 μ diameter particles travel from right to left and display a slight upward drift in trajectories. They also have much slower velocity of .5 -1.7 m/s as compared to the Li particles (10-40 m/s) and are closer to and possibly cross the last closed flux surface. Relatively few trajectories are obtained because we were allowed only one discharge with tungsten injection.



- The visualization code shows a comparison between the tungsten and Li particle trajectories. The flight tube of the dropper is shown in black. The Li particles in blue slide along the SOL moving down and across the magnetic field.

- The tungsten particles were dropped into a reversed field configuration and have a slightly upward trend again across the magnetic field. They are smaller and more dense and appear to fall inside the SOL. They are clearly inboard of the Li particles and travel much slower.

Future Work

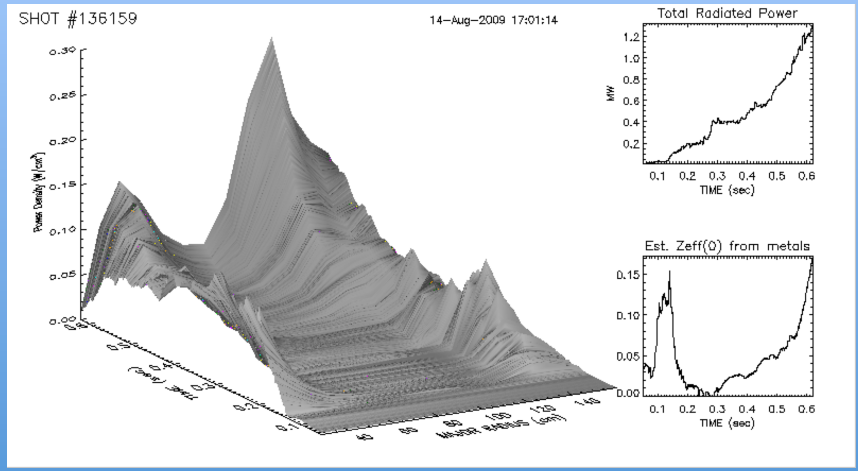
- Drop smaller amounts of Li dust into the SOL
- Drop tungsten dust into normal configuration plasmas for comparison with Li
- Drop C dust in different sizes
- Drop two component particles such as C dust with one side coated with Al to look for rocket effects.

XP 957: TUNGSTEN TRANSPORT ON NSTX: Radiated power profiles

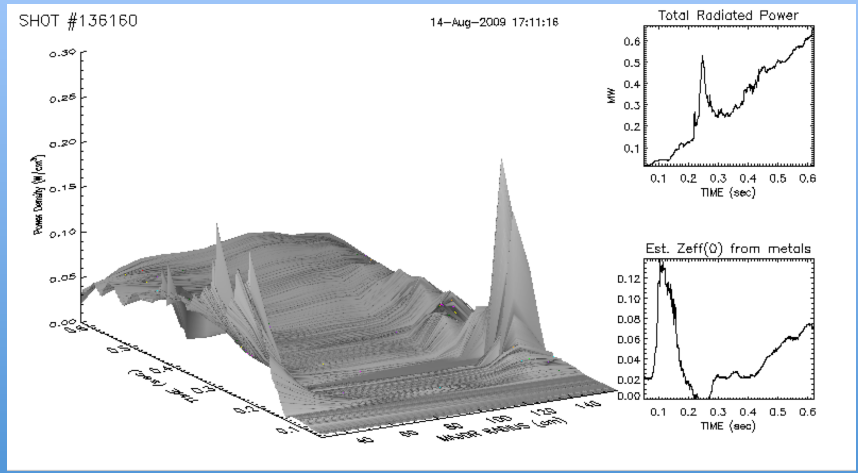
Discharge 136159 exhibited strong Prad profile peaking after .5 sec

The subsequent discharge showed little or no signs of peaked Prad profile

3D Prad profile with tungsten injection



3D Prad profile without tungsten

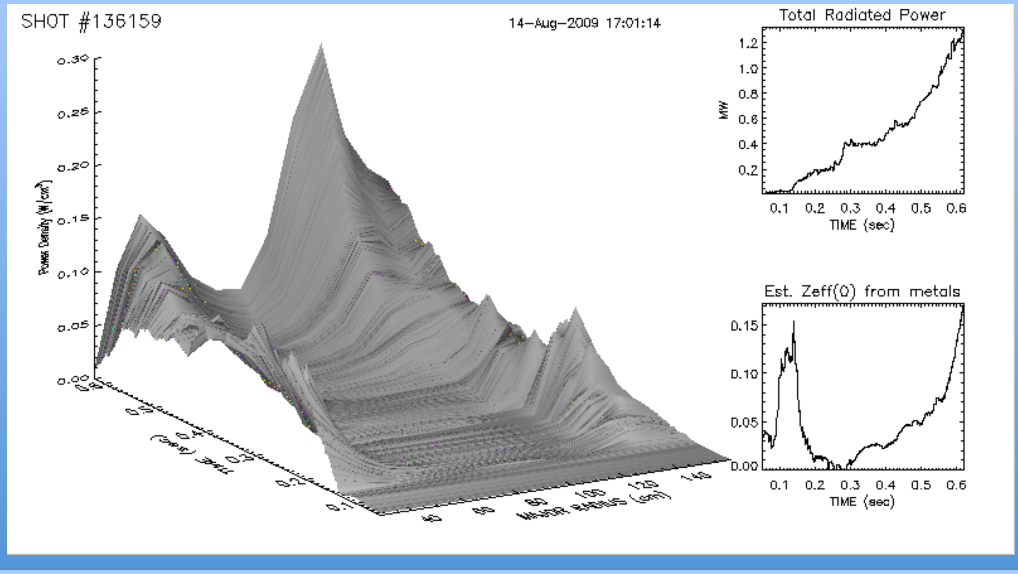


XP 957: TUNGSTEN TRANSPORT ON NSTX: Radiated power pro

Discharge 136159 exhibited strong Prad profile peaking after .5 sec

The subsequent discharge showed little or no signs of peaked Prad profile

3D Prad profile with tungsten injection



3D Prad profile without tungsten injection