Studies of low- and high-Z dust transport in NSTX-U

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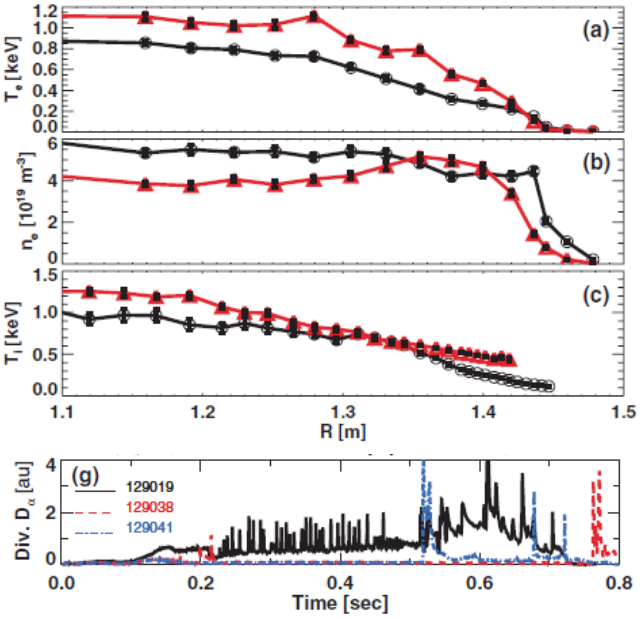
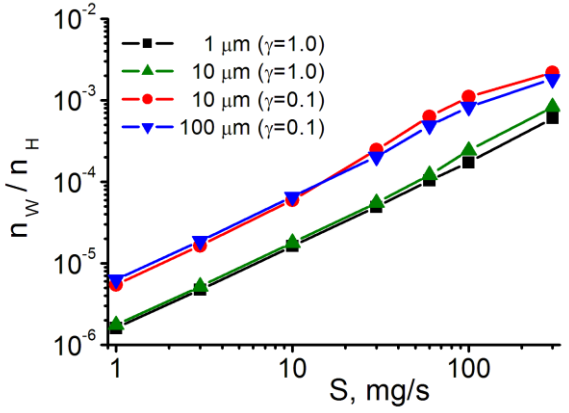
Motivation

- Dust injection into SOL plasma either intentional or due to damage of PFCs by ELMs can have significant both positive (Li dust) and negative (high-Z dust) impact on plasma performance.
- *In situ* lithiation of NSTX-U PFCs using dust injection is considered to facilitate continuous hydrogen pumping by the PFCs in enhanced H-mode regimes.
- Dust ablation in the plasma provides a volumetric impurity source, potentially serious effects of which on plasma performance need to be investigated.
- The big dust grains (>10μm) are of most interest due to large material content and the ablation cloud shielding effects. The existing dust-plasma interaction models need improvement and validation to account for the shielding.

Li enhanced NSTX discharges[1]



W dust impurity in ITER[2]



[1] R. Maingi et al., PRL **103**, 075001 (2009)
[2] R.D. Smirnov et al., PoP **22**, 012506 (2015)

Experiments and modeling

Goals:

- Experimental validation and improvement of dust-plasma interaction models, in particular, of ablation cloud shielding for big (>10μm) dust grains.
- Quantification of volumetric impurity source produced by dust and its impact on plasma parameters and stability.
- Interpretive simulations of coupled dust-plasma transport in NSTX-U enhanced H-mode regimes with lithium dust injection.
- Development of predictive modeling capabilities for evaluation of dust impact on ITER performance.

Plan:

- Controlled rate (up to 100mg/s) injection of high-Z (tungsten) and low-Z (lithium) dust (sizes ~1,10,100μm) in NSTX-U SOL plasma using the “dropper” injector. W (pre-lithium) and Li (post-lithium) dust injection require 0.5+0.5(piggy-back) days.
- Monitoring of dust trajectories and edge plasma parameters, including impurity concentration profiles, with stereoscopic fast cameras and available plasma diagnostics.
- The acquired data on dust transport and plasma characteristics will be used for simulations of coupled dust-plasma transport with DUSTT-UEDGE code allowing benchmarking of the dust shielding and ablation models and interpretation of the experimental results.