Neutral Transport Simulations of Gas Puff Imaging Experiments

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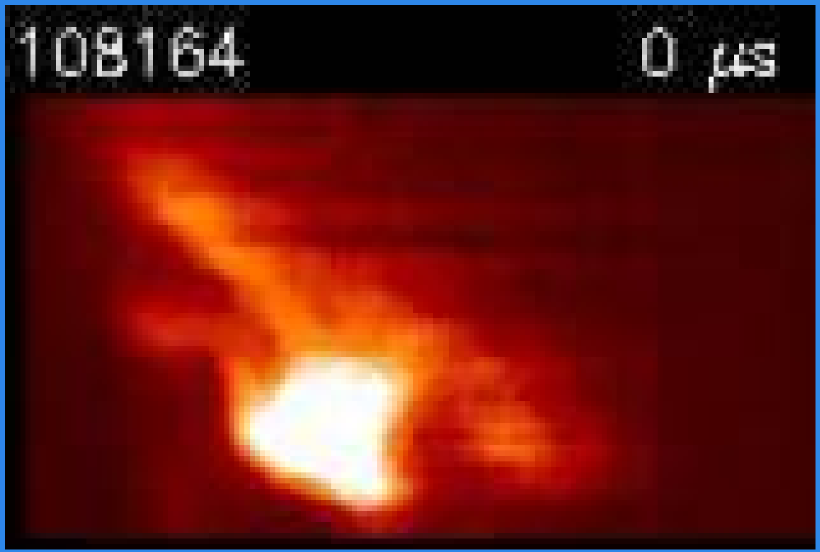
NSTX Results & Theory Review
September 11, 2002

Examine Relationship Between Observed Emission Patterns & Underlying Plasma Turbulence



Maqueda & Zweben

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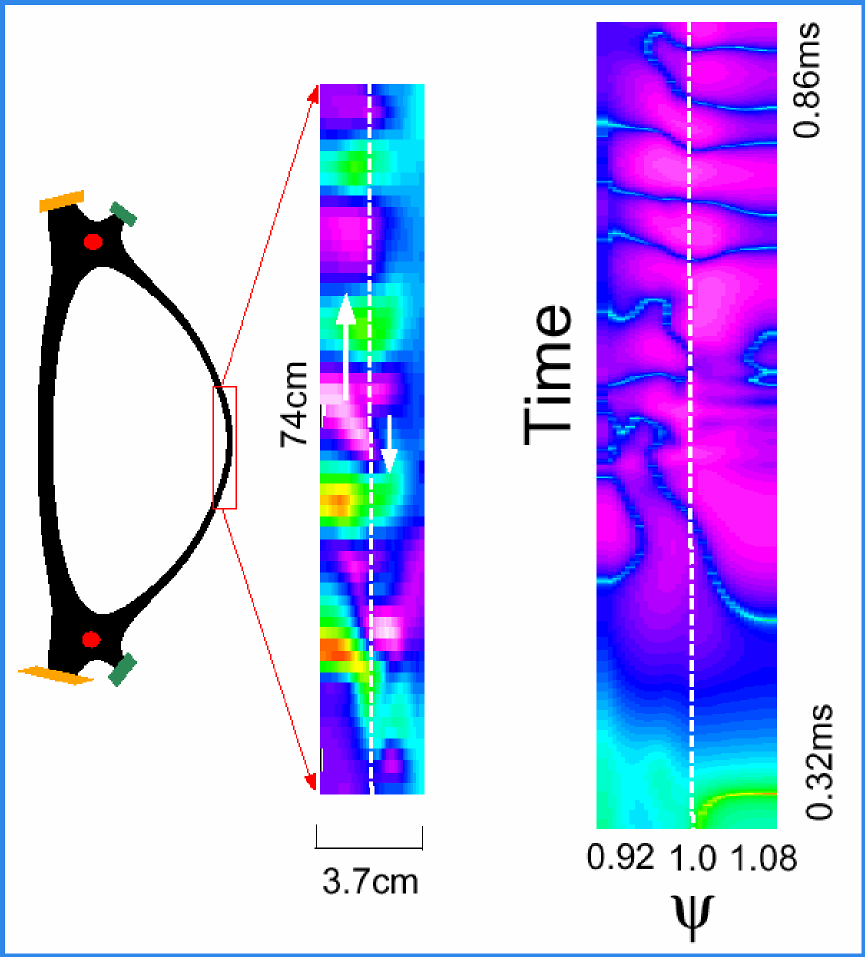

X. Q. Xu

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DEGAS 2 Simulations

- Start simple:
  - 2-D, steady-state neutral transport,
    - Plasma data input to code,
    - Compute neutral density & line emission,
    - Get emission in poloidal plane ~ camera view.
    - 3-D & time-dependence later.
  - Use time-averaged $n_e(R)$ & $T_e(R)$,
    - Compare with observed avg. cloud size & location.
  - Or, add ad-hoc 2-D perturbation,
    - Compare spatial structure of emission with perturbation.
- Consider D_2 (D_α) and He (5877 Å) puffs.

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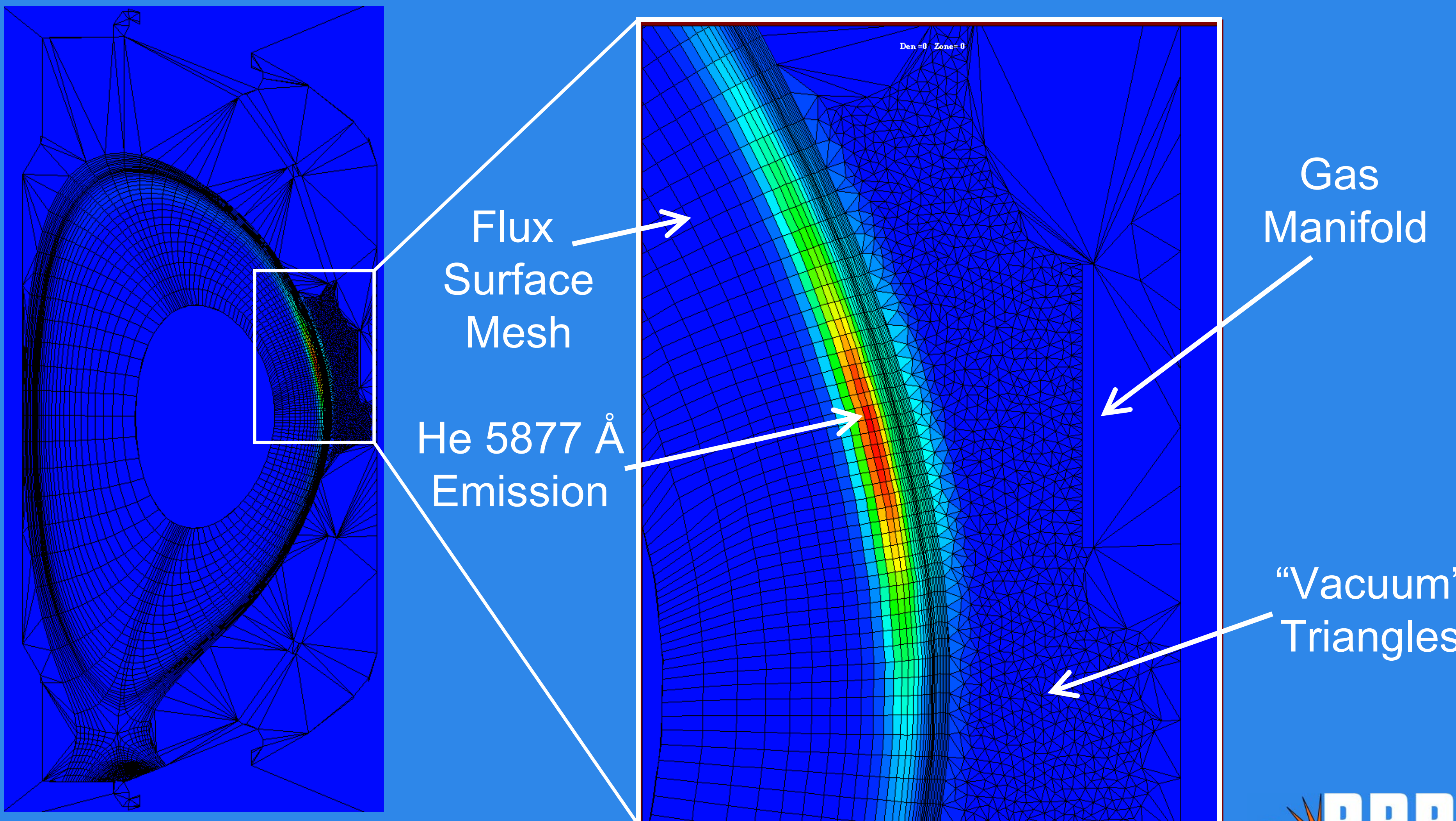
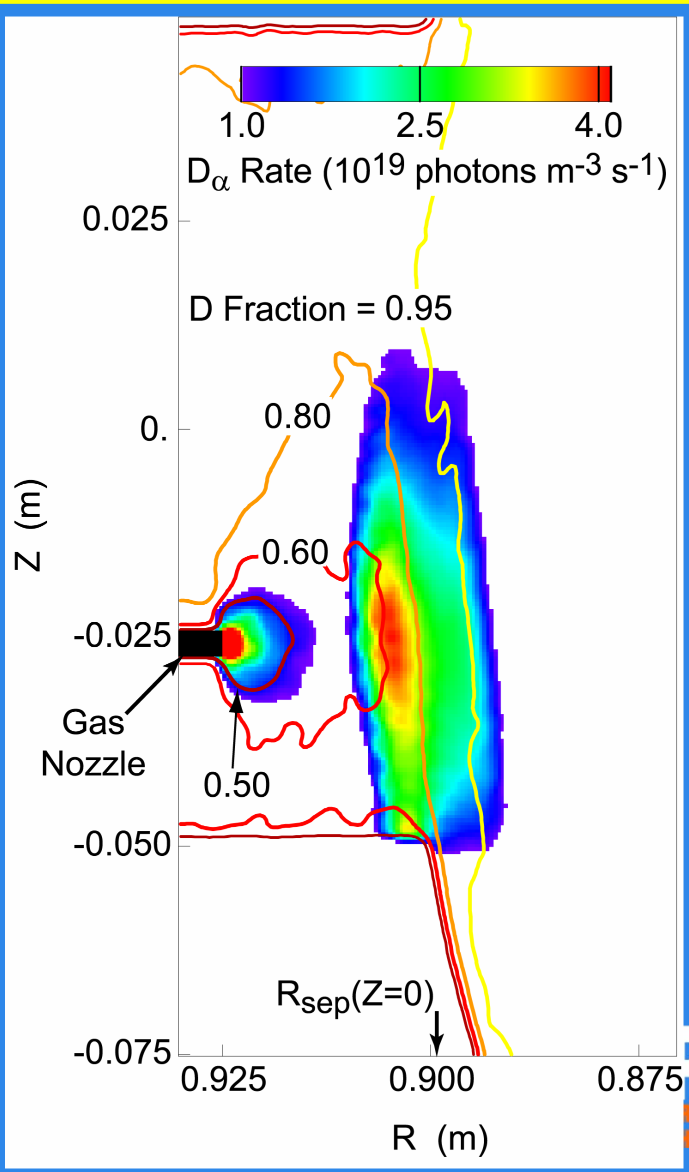
Realistic, High Resolution Geometry
NSTX Shot 108321, 187 ms



For D_2 Puff, D_α's From D_2, D_2^+ Dissociation Important

- Simulations of C-Mod GPI experiments.
- Most emission from excitation of D atoms,
  - E.g., $e + D(1s) \rightarrow e + D^*(n=3) \rightarrow D^*(n=2) + D_\alpha$
- Some comes from dissociation,
  - E.g., $e + D_2 \rightarrow e + D(1s) + D^*(n=3)$
  - Surprise was how much.



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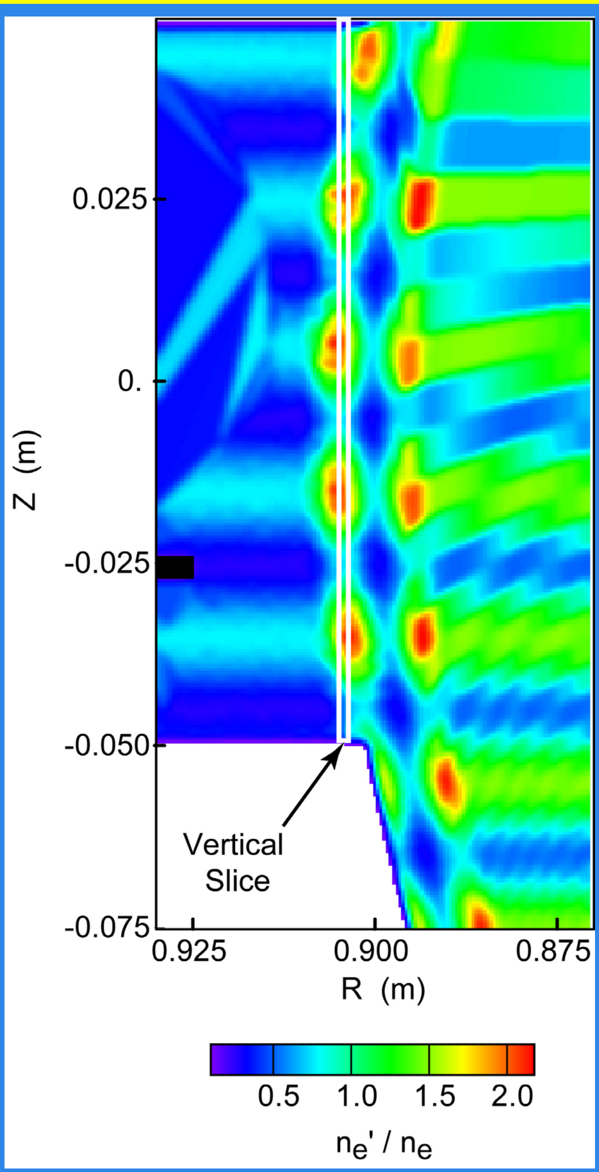
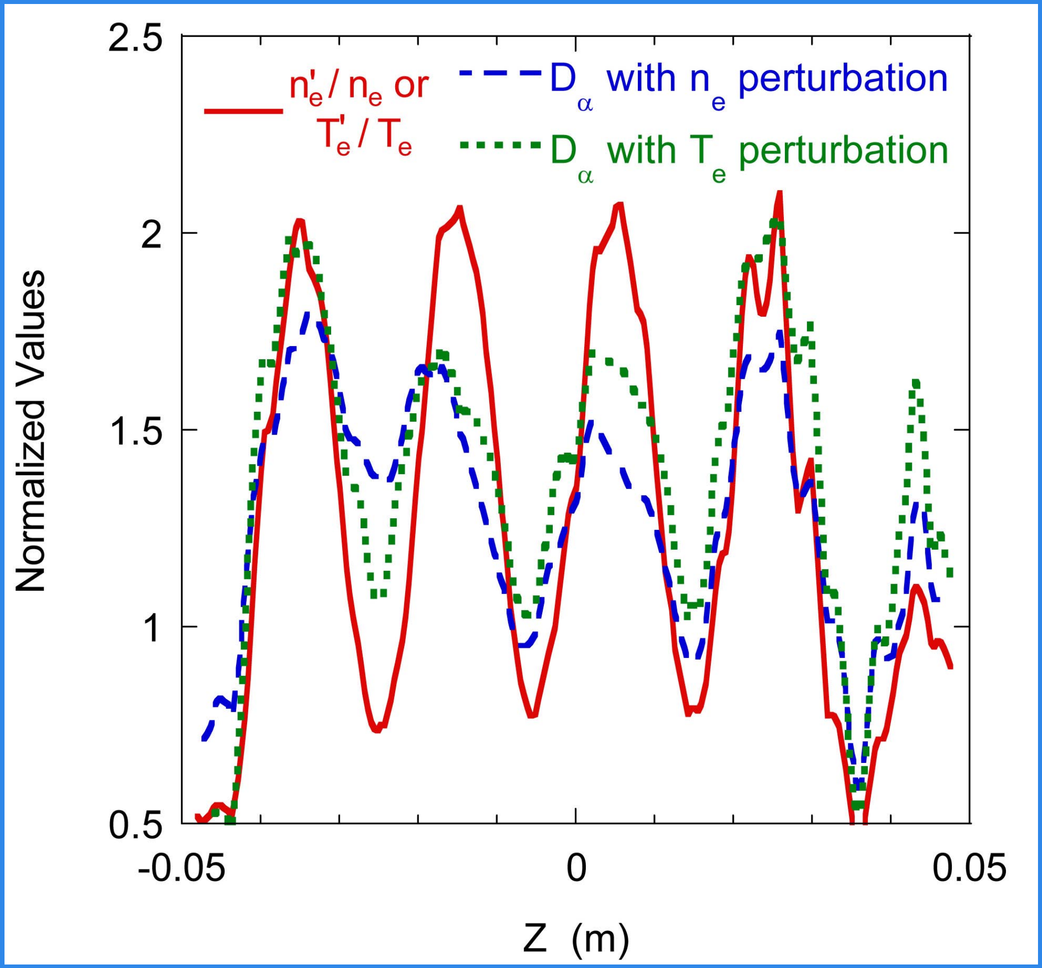
Spatial Structure of Plasma Variation Apparent in Simulated Emission





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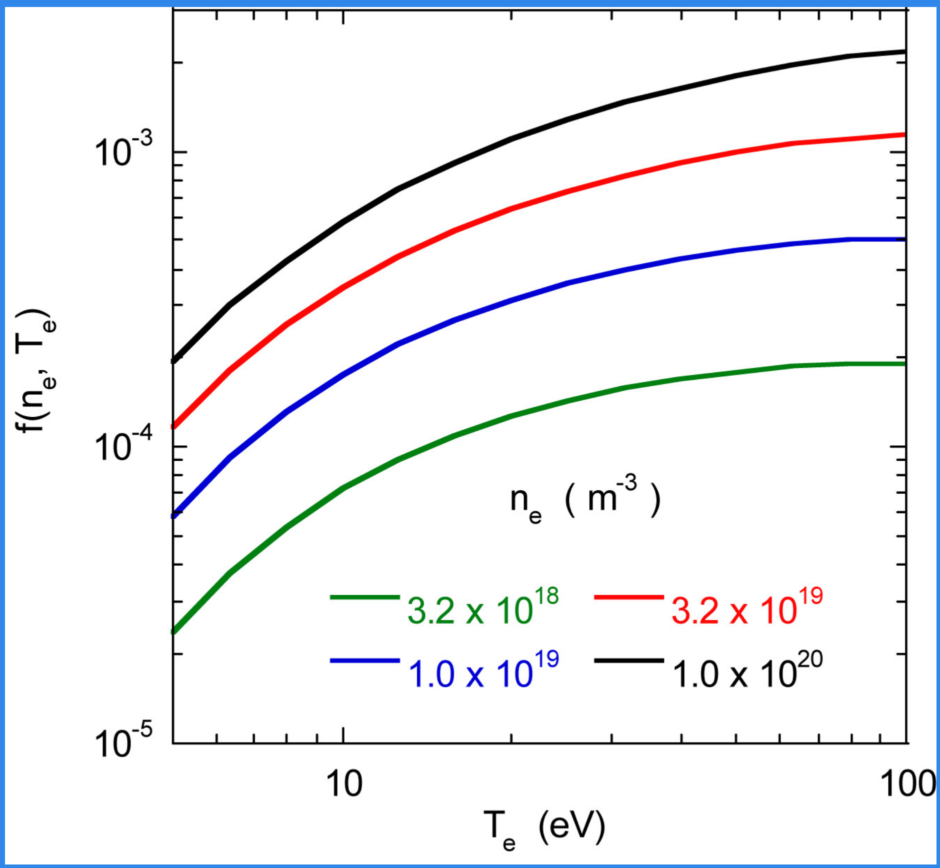
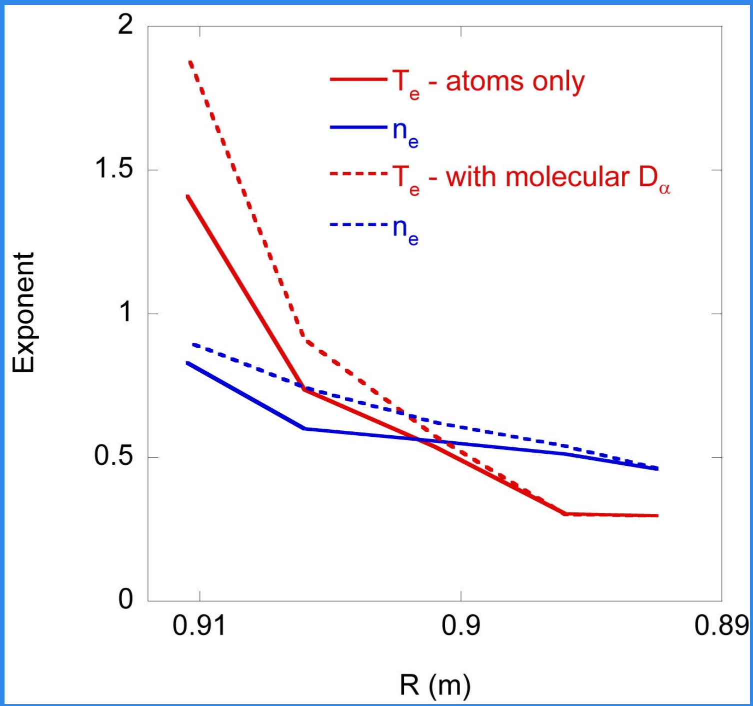
Relationship Between Emission & Plasma Determined Mostly By Emission Rate

$$S_{D\alpha} = \sum_{j=D,D_2,D_2^+} n_j f_j(n_e, T_e)$$

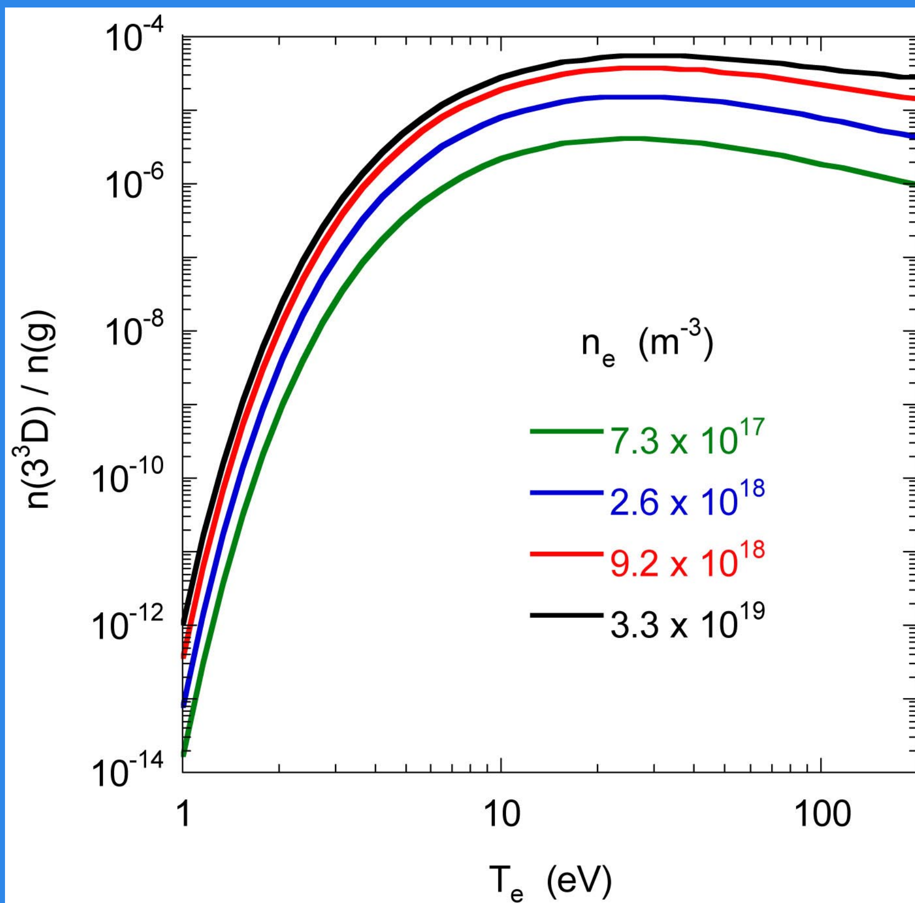
n_e, T_e Dependence of D_α Due to Atoms

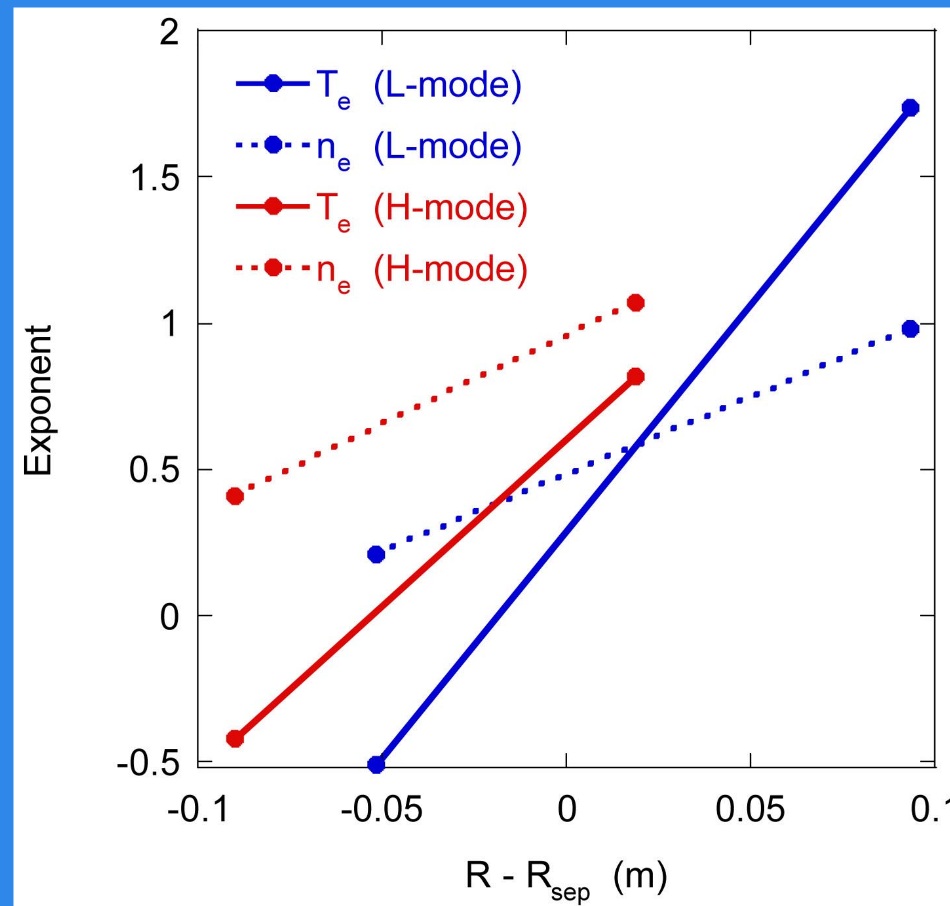


Effective Scaling of S Across C-Mod Profile



Scaling of Emission Rate for He 5877 Å Also Varies Across Profile





NSTX Shot 105710

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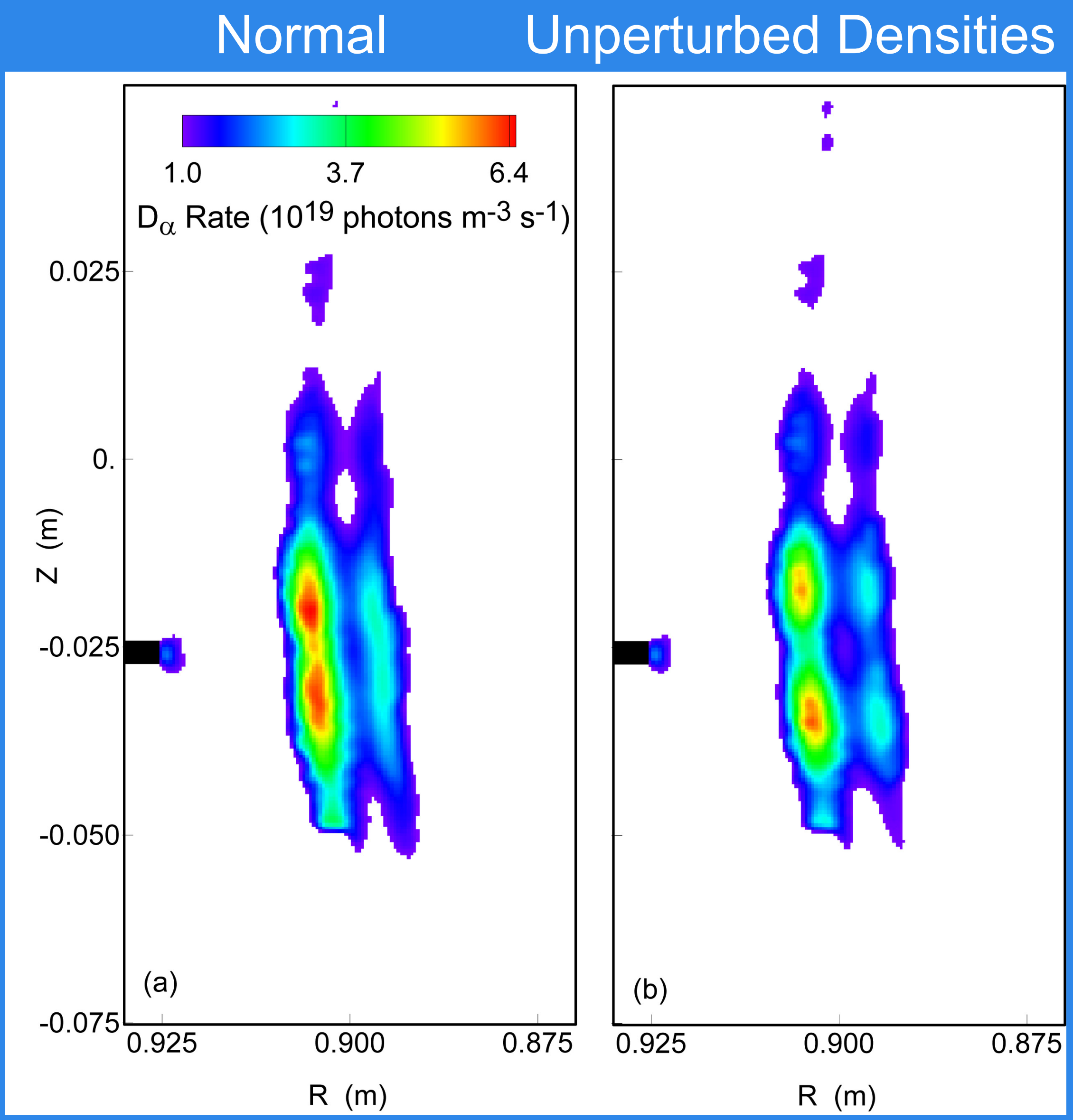
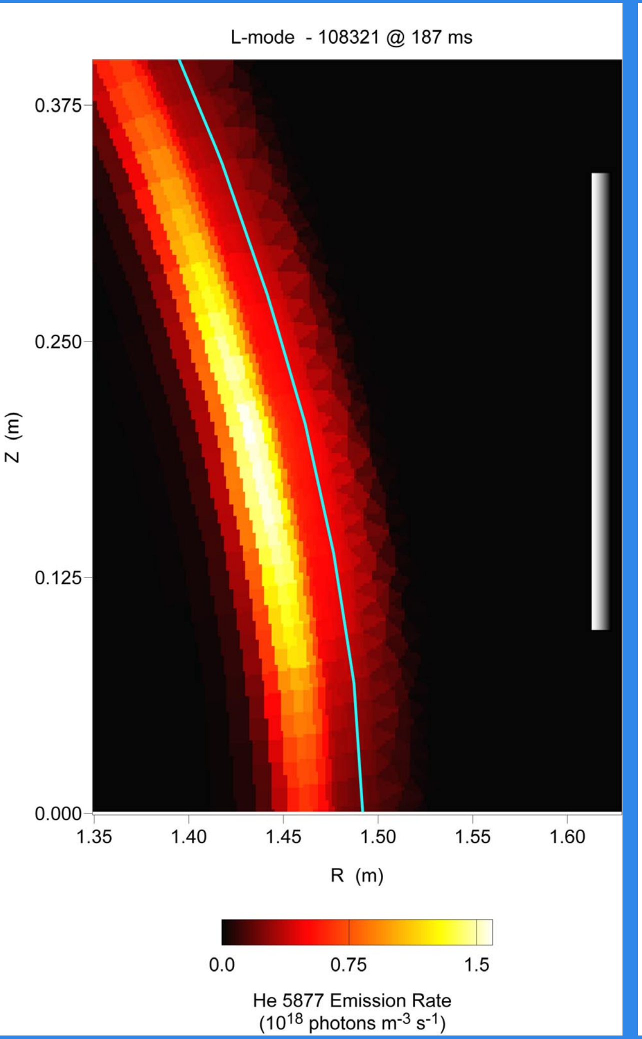
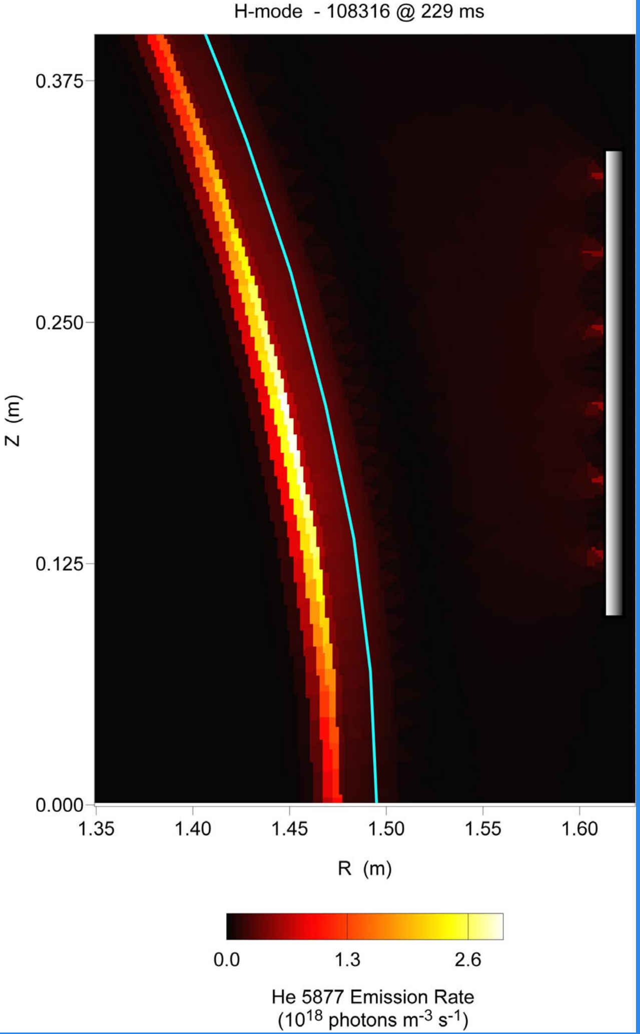
Impact of Turbulence on Neutral Density Can Cause Smearing or Shadowing

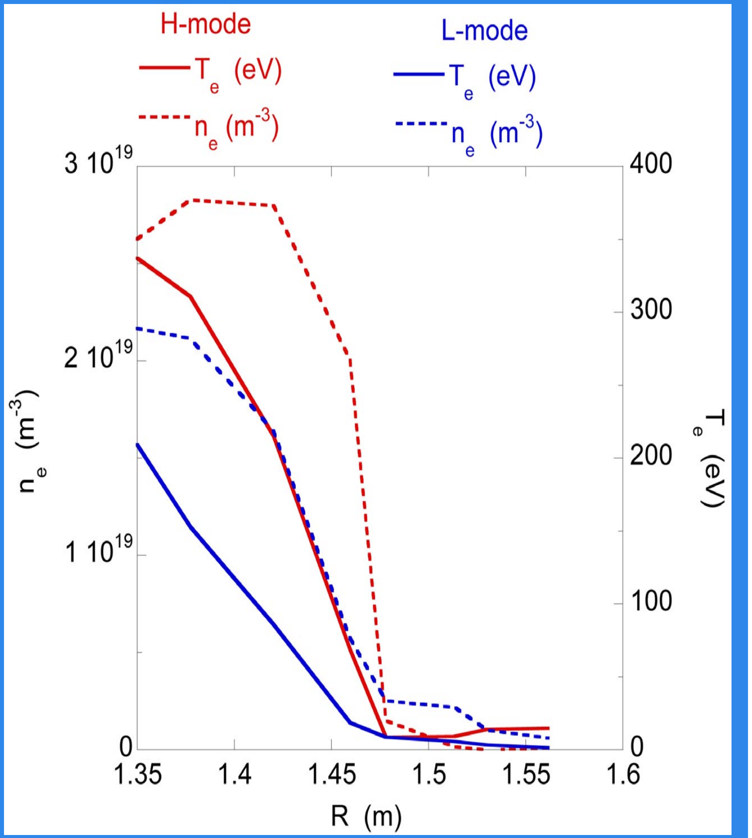
- See effect by comparing perturbed $\mathcal{S}$ with that computed with unperturbed n_j,
  - $\Rightarrow$ Smearing.
- Quantified for C-Mod:
  - Not a problem for D,
  - But significant for D_2 and D_2^+.
- Will be examining quantitative effect on k spectrum.



Width of Emission in NSTX Simulations Determined by Profiles







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