Z-scaling of impurity (C, Ne) transport in beam heated NSTX H-mode discharges

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Motivation

- **Continue** the **impurity particle transport** studies in NSTX (done already for L-mode) for the **H-mode**, estimating the dependence of $\mathbf{D_Z}$ & $\mathbf{v_Z}$ for different **Z** and plasma parameters (ρ*).

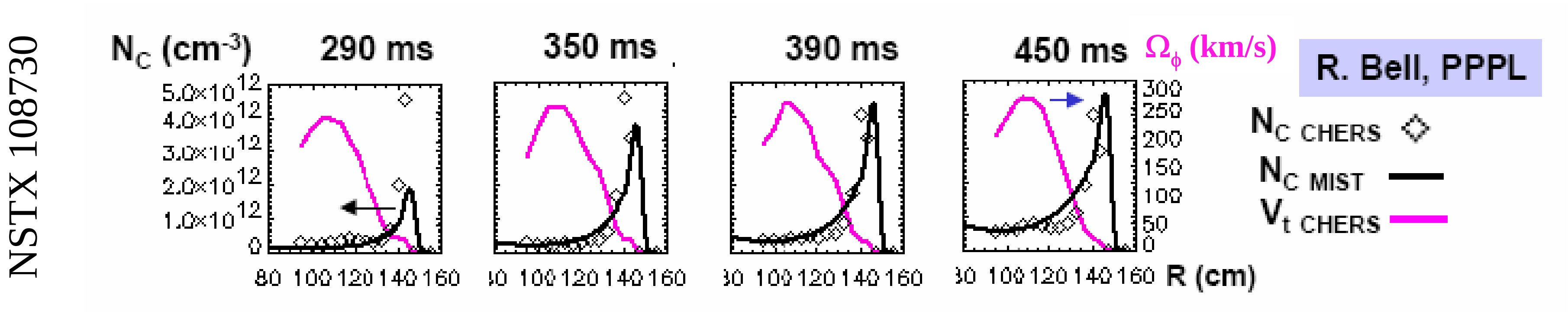
- Preliminary estimates in H-mode indicate that we might have **small** (close to neoclassical) impurity $\mathbf{D_Z}$ as well as $\mathbf{v_Z>0}$.

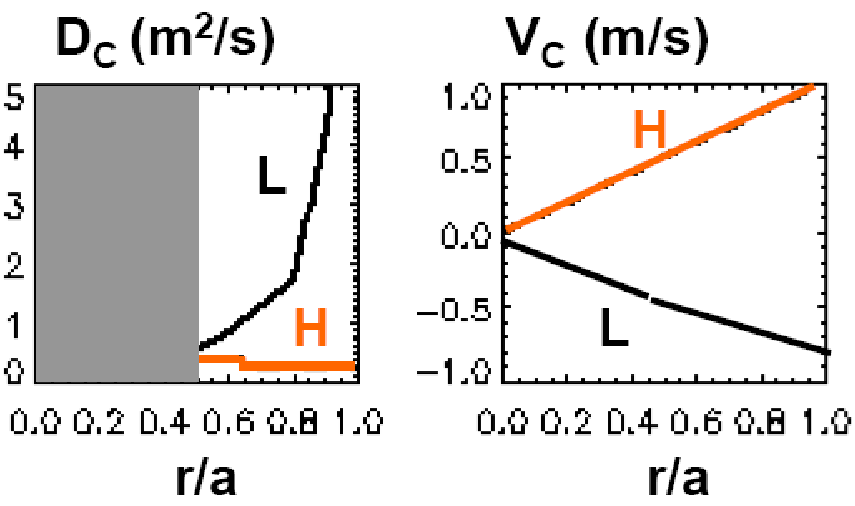
- Convective impurity transport **could play** an important role in NSTX (flat n_e and peaked T_i) H-modes, where **"temperature screening" might be shielding the plasma core from low Z impurities**.

- These impurities studies are **relevant for future STs** and **ITER** operational scenarios where **screening of high-Z impurities** is invoked to **shield** the plasma core.

First assessment of impurity transport in NSTX ***H-modes***

Hollow carbon distribution





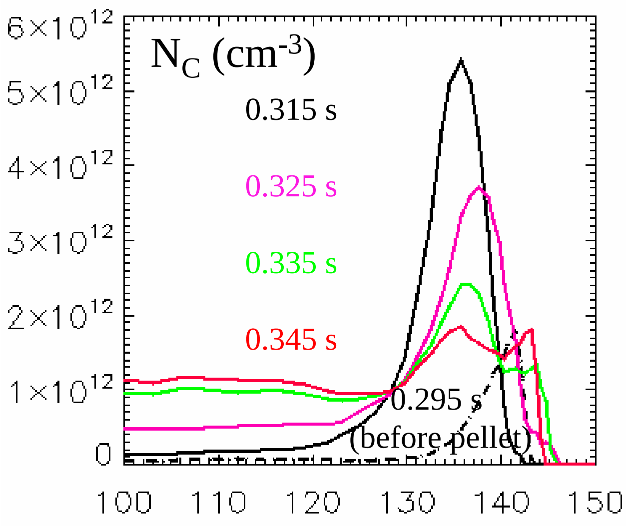
1. D_Z falling into the neoclassical range also *outside* r/a > 0.5

2. V_Z >0 (convective outward velocity)

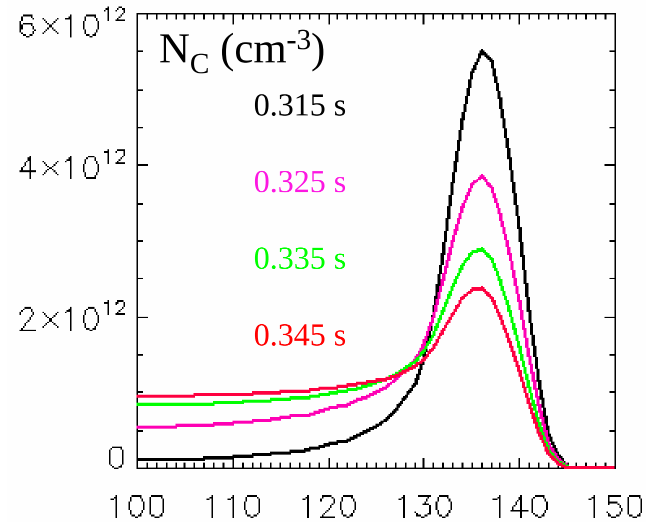
[1] D. Stutman, et. al., EPS Conference on Plasma Physics and Controlled Fusion (2002).

Impurity diffusivity for C pellet is also low (2005, 117994)

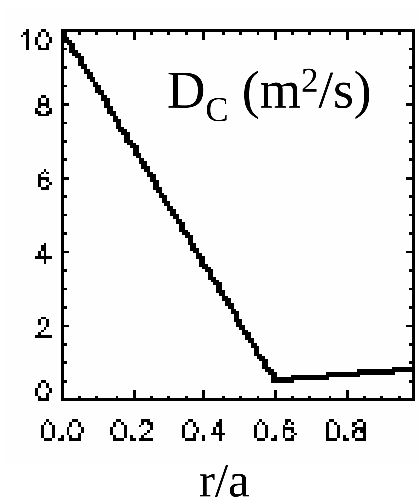
R. Bell, PPPL (CHERS)

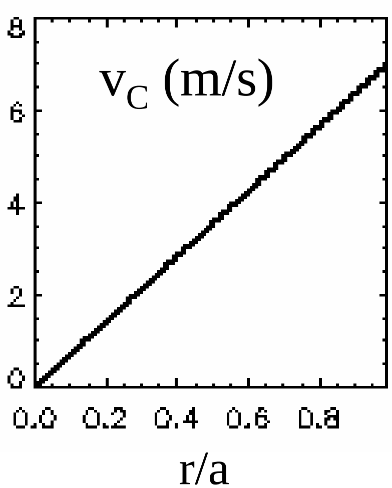


MIST simulation (preliminary)



- 0.5 mg C pellet
- Half speed

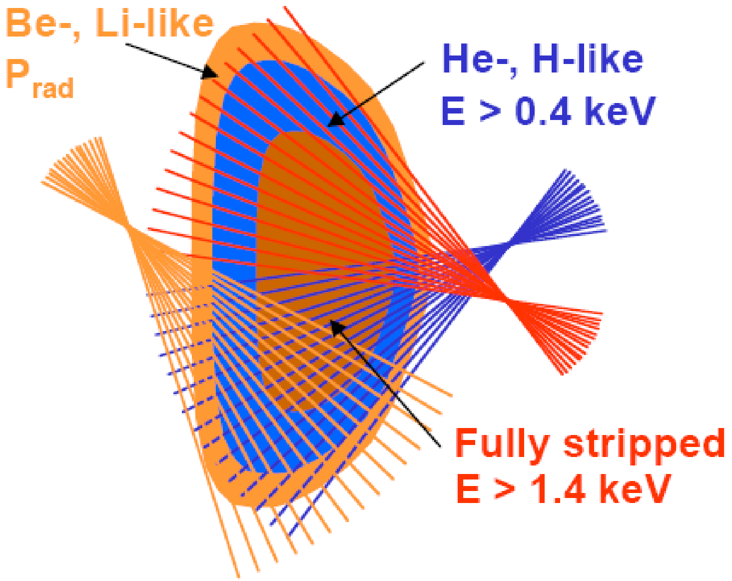




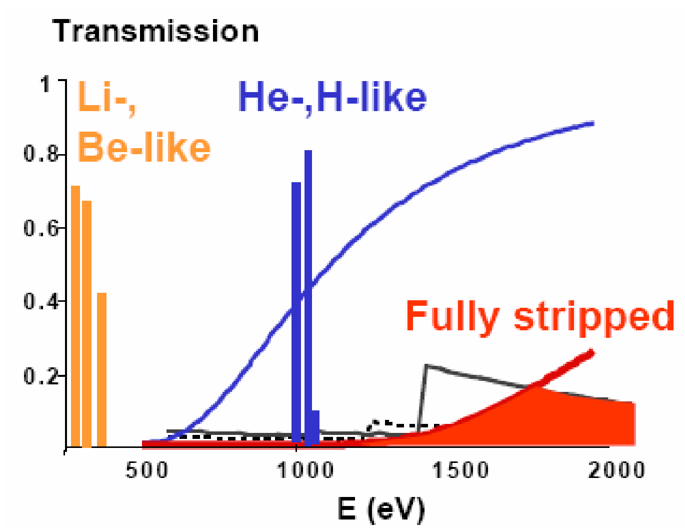
- D_C^{pert} < 1m^2/s outside r/a > 0.5
- $D_C^{eq} \approx D_C^{pert} \approx \chi_i^{PB} \rightarrow$ reduced low-k turbulence
- *Carbon profiles look different this run.*

[2] D. Stutman, et. al., Transport Task Force meeting, Myrtle Beach, NC (2006).

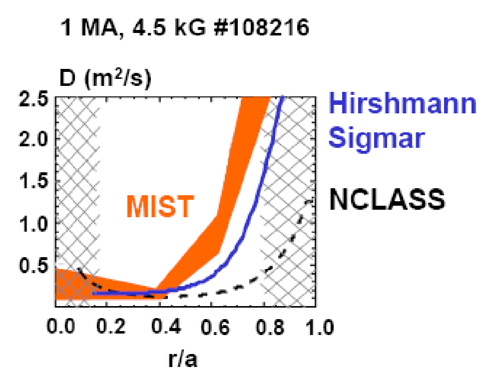
Impurity transport technique applied in NSTX ***L-modes***



- Filtered diode arrays measure peripheral, mid and core Neon ions.
- The Neon contribution is obtained from consecutive, reproducible shots.
- Inclusion of peripheral charge states (P_{rad}) improves D, V estimate



$\therefore$ D_{Ne} is in neoclassical range inside r/a < 0.5



[1] D. Stutman, et. al., EPS Conference on Plasma Physics and Controlled Fusion (2002).
[3] D. Stutman, et. al., POP, 10, 4387, (2003).

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- We want to establish the D_z and v_z dependence by using C & Ne impurities.
- Compare first CD_4 and N_e gas injections.
- Scan puff lengths (P_{plenum}~100 torr) ~ 50, 100 & 200 ms.

⬇

1. Use Bay B mid-plane puffers.
2. Use gases to perform the Z-scaling.
3. MIST simulations show ~ few hundred ms time evolution.
4. Need long pulse (~1.0 – 1.2 s).
5. Time average values of D_z and v_z will be obtained.

- Use Carbon pellets to probe time evolution of D_z and v_z (~30 ms).

1. First optimize pellet size and speed.
2. Scan pellet timing.

- If time permits, perform ρ* scaling to probe neoclassical effects.

Shot matrices

CD_4 & Ne injections

Baseline (**120428**, 1MA, 4.5 kG)	2 shots
Gas injection @ 350 ms (Δt~50 ms)	1 shot
Baseline + gas inj. (Δt~100 ms)	2 shots
Baseline + gas inj. (Δt~200 ms)	2 shots
Total (x2)	**14 shots**

Vitreous C pellet injections

Base. + pellet @ 350 ms (0.55mg, v_f)	2 shots
Pellet @ 350 ms (0.55mg, $v_f/2$)	1 shot
Pellet @ 350 ms (0.25mg, v_f)	1 shot
Pellet @ 350 ms (0.25mg, $v_f/2$)	1 shot
Time scan of optimized size/speed	
Pellet @ 650 ms	2 shots
Pellet @ 850 ms	2 shots
Total	**9 shots**