

NBI Heating - Possible route to high performance?

TG Profiles / TG Confinement / TG Fast-ions

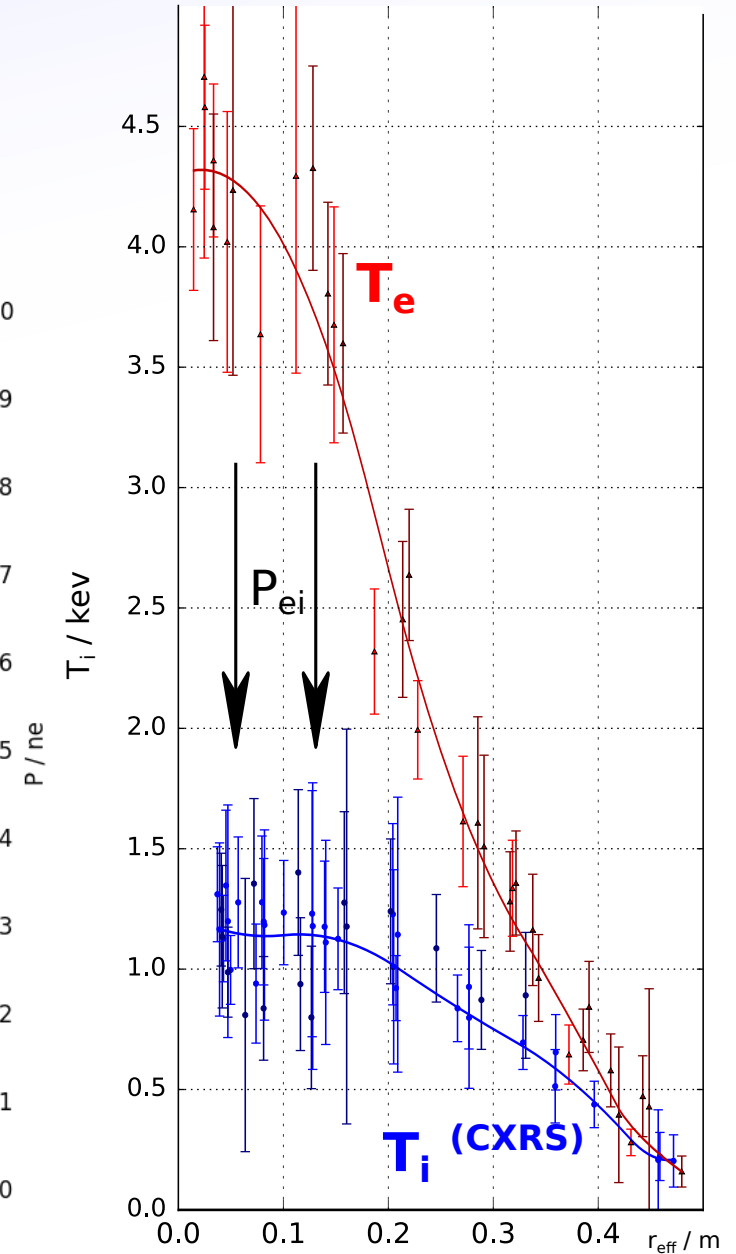
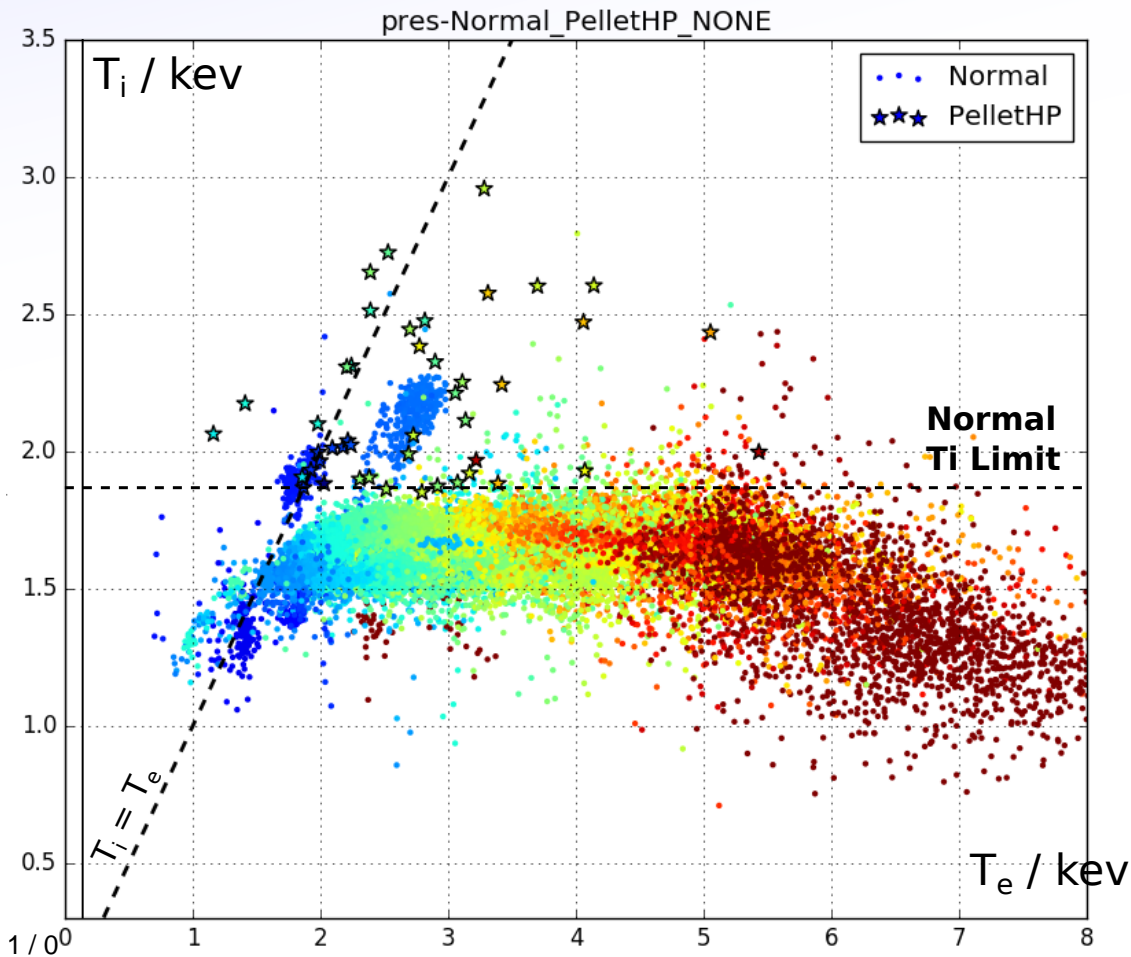
O. P. Ford¹, S. Bozhenkov¹, M. Beurskens¹,
S. Lazerson², N. Pablant², A. von Stechow¹, R. Wolf¹

1: Max-Planck Institut für Plasmaphysik, Greifswald, Germany

2: PPPL, NJ, US

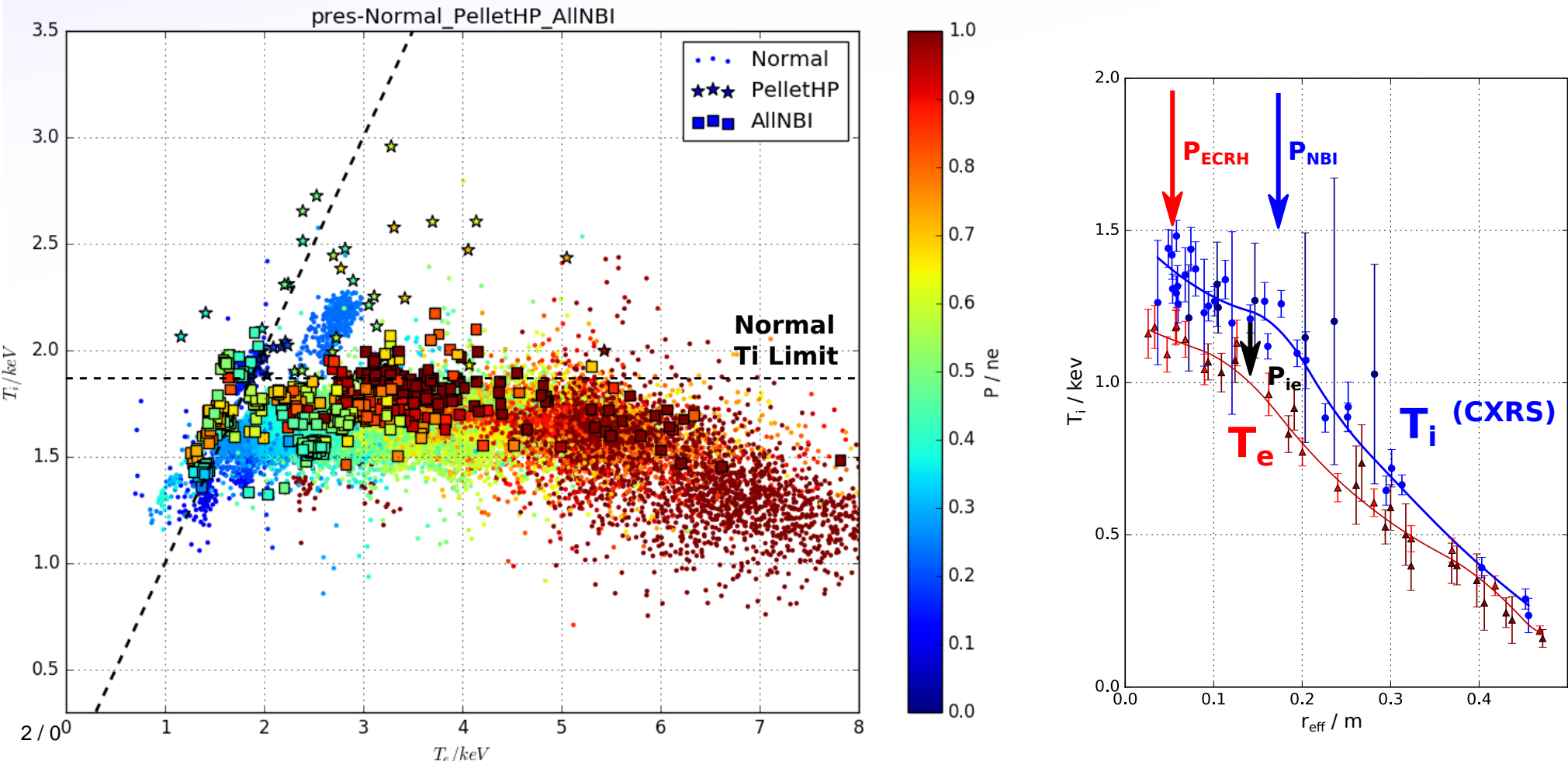
Ti profile resilience: ECRH

- Core Ti usually within same range and profile gradients similar regardless of P_{ECRH} and electron-ion coupling.
- Leads to effective Ti limit $\sim 1.8\text{keV}$ (XICS)
- Exceptions:
 - 1) High-Performance pellet discharges
 - 2) Some particular low P_{ECRH} cases.



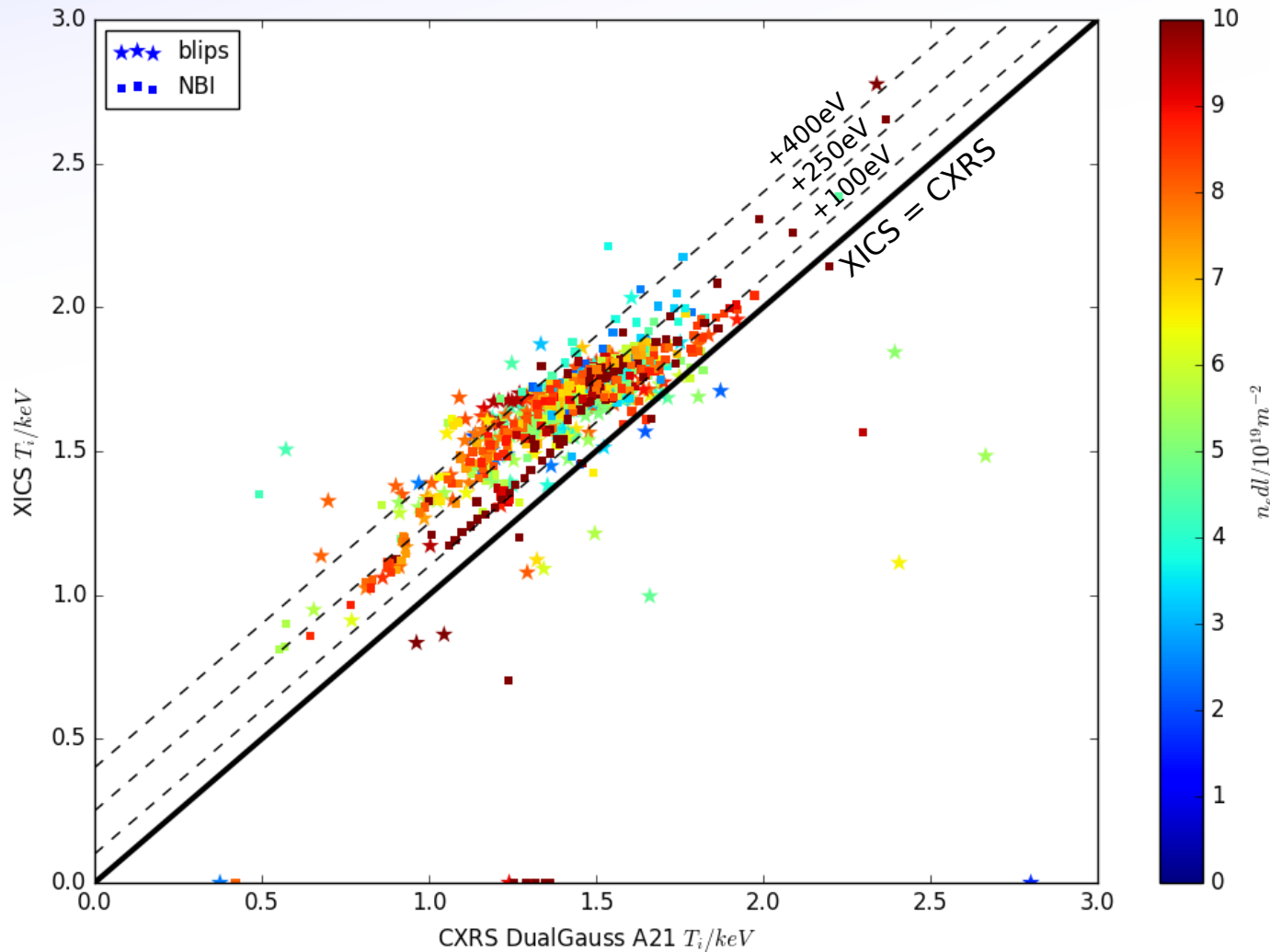
Ti profile resilience: NBI

- NBI does typically not raise Ti significantly in normal ECRH plasmas, despite significant direct ion heating (>50%).
- Consistent with the existence of a critical Ti gradient.
- NBI also shows some exceptions. For detail, look at CXRS Ti...



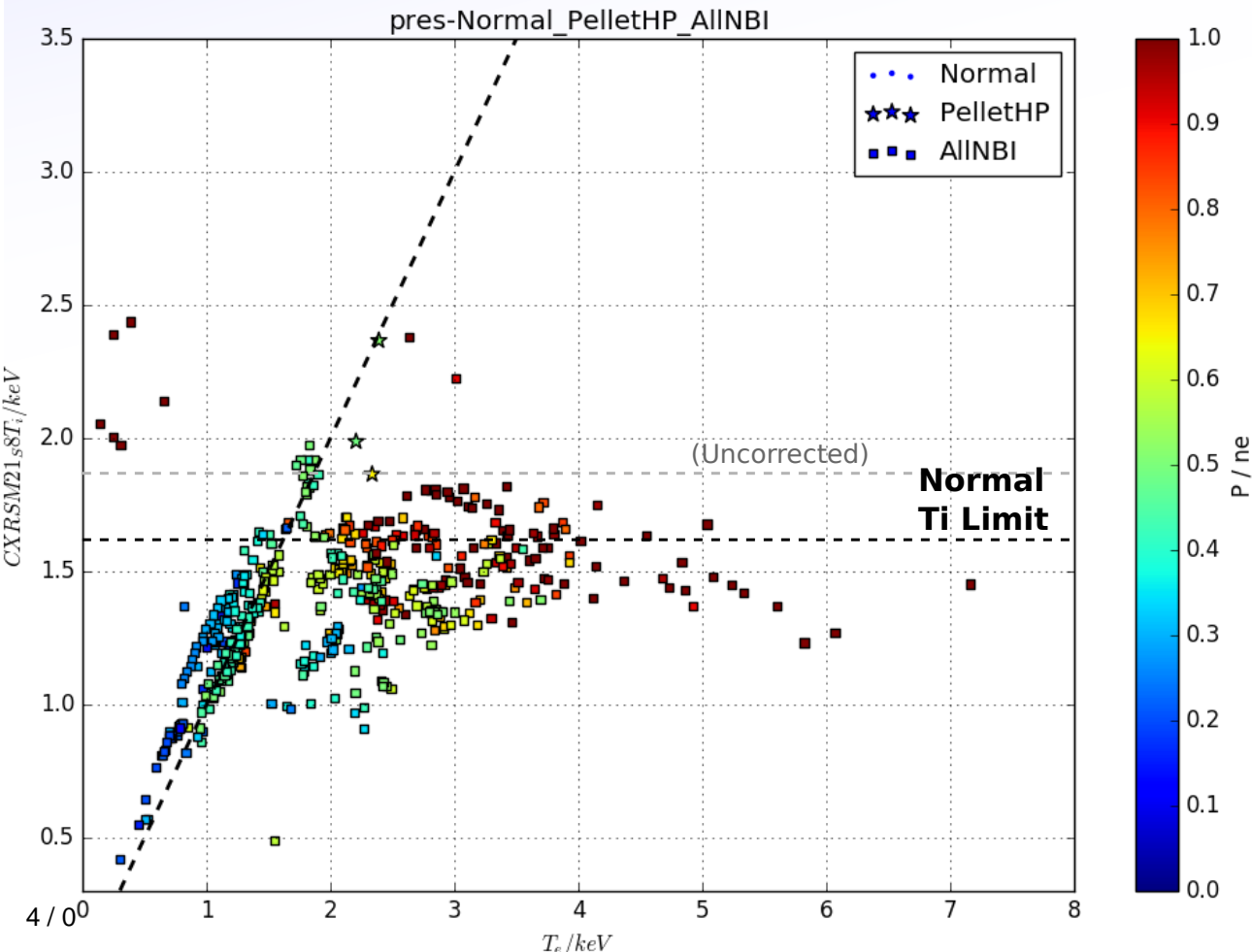
XICS --> CXRS

- CXRS gives higher resolution data, but only where NBI is on (~200 shots)
- To compare the two, we need to adjust for $\sim 250 \pm 150 \text{eV}$ higher core XICS T_i values:
(More on this in a later presentation)



XICS --> CXRS

- CXRS gives higher resolution data, but only where NBI is on (~200 shots)
- To compare the two, we need to adjust for $\sim 250 \pm 150 \text{ eV}$ higher core XICS T_i values:
- Trend is less obvious, but CXRS profiles don't change trend.

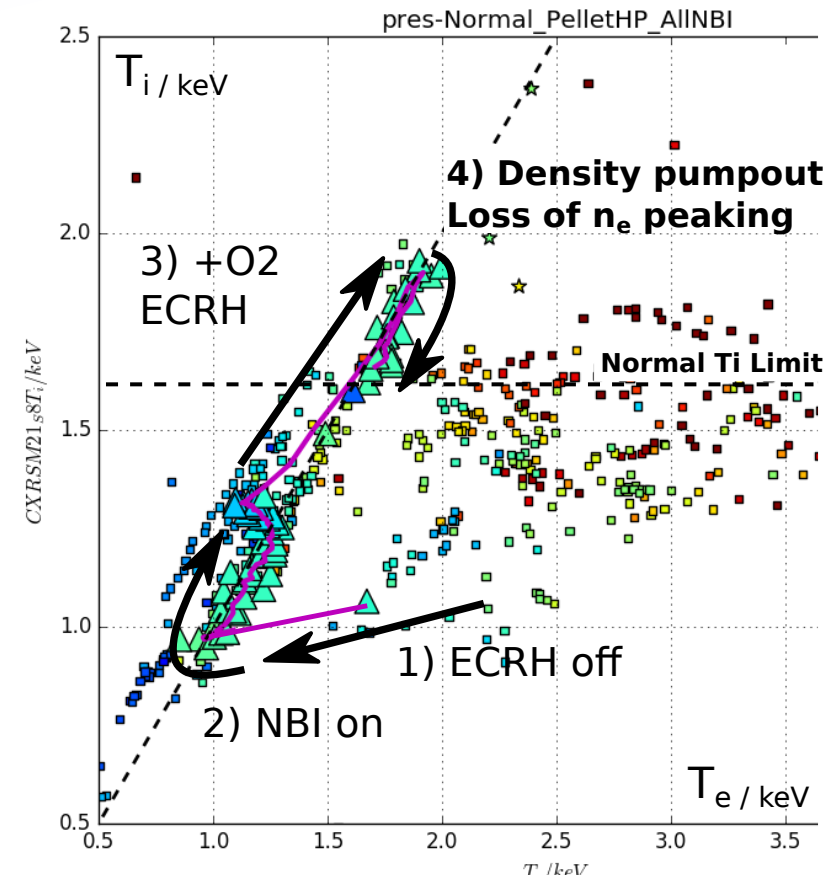
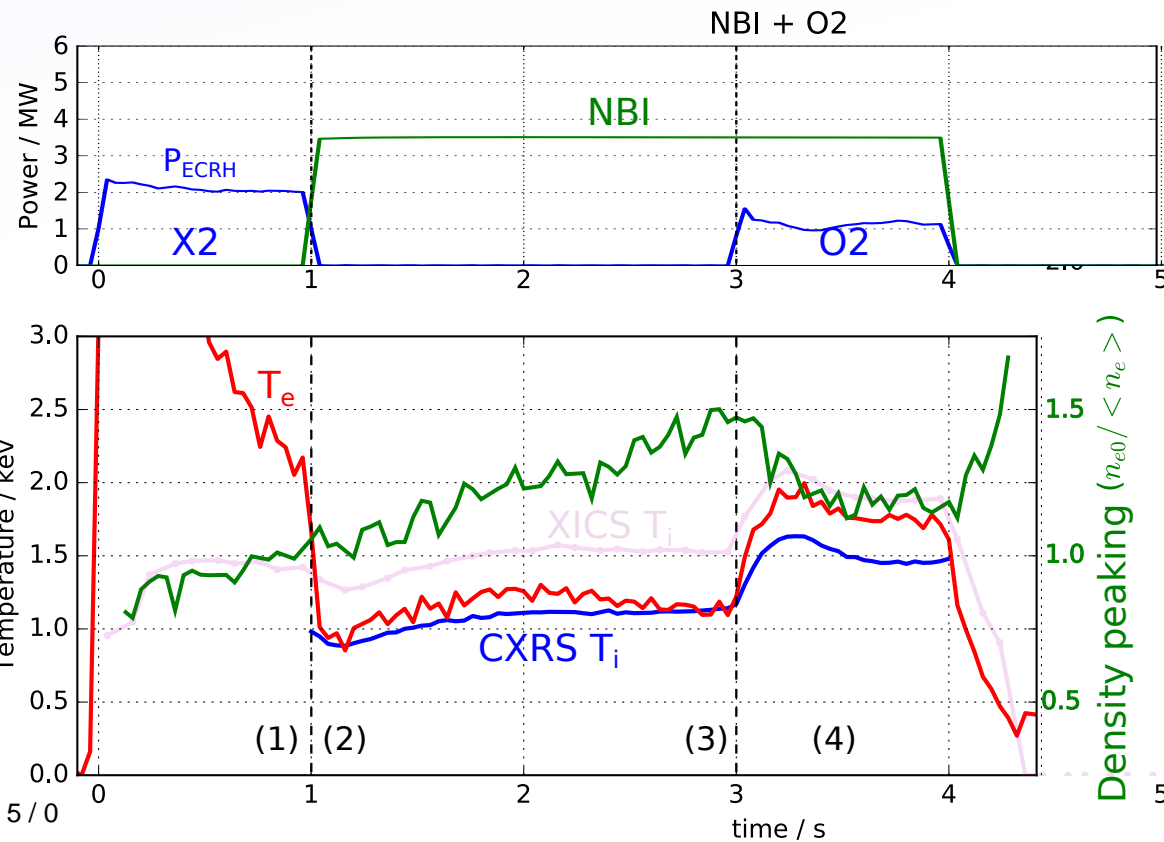


Case 1: NBI + O2

- Observed that NBI created peaked density profiles (similar to high-performance pellets) with steadily increasing density.

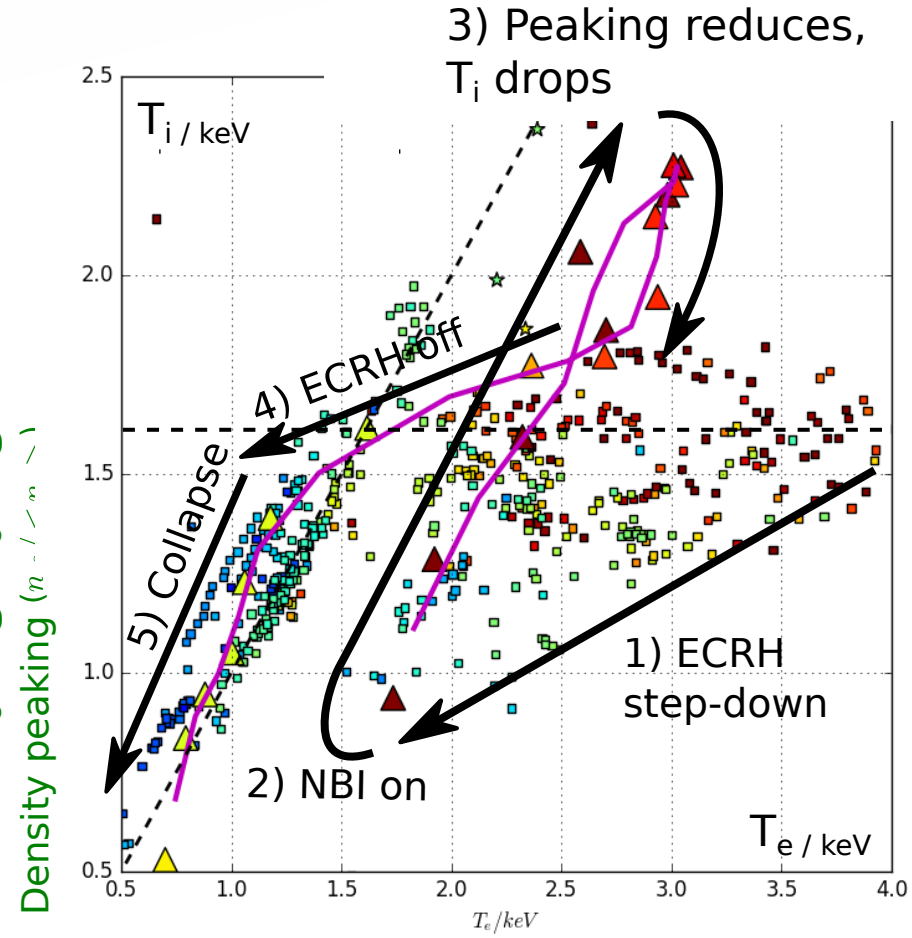
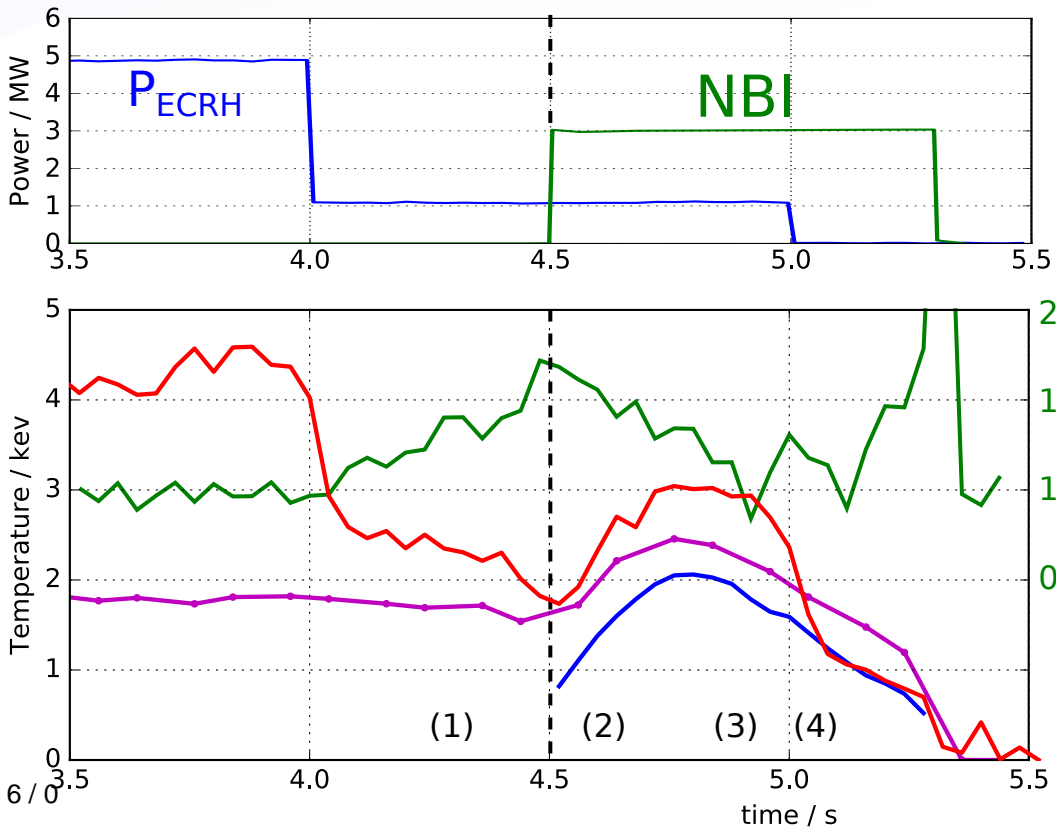
(S62/olfo_012): Can we use low power ECRH to control density level/peaking, expel impurities and increase T_e ??

- Core density drops after O2 reintroduction. (Also see explosion of Carbon)



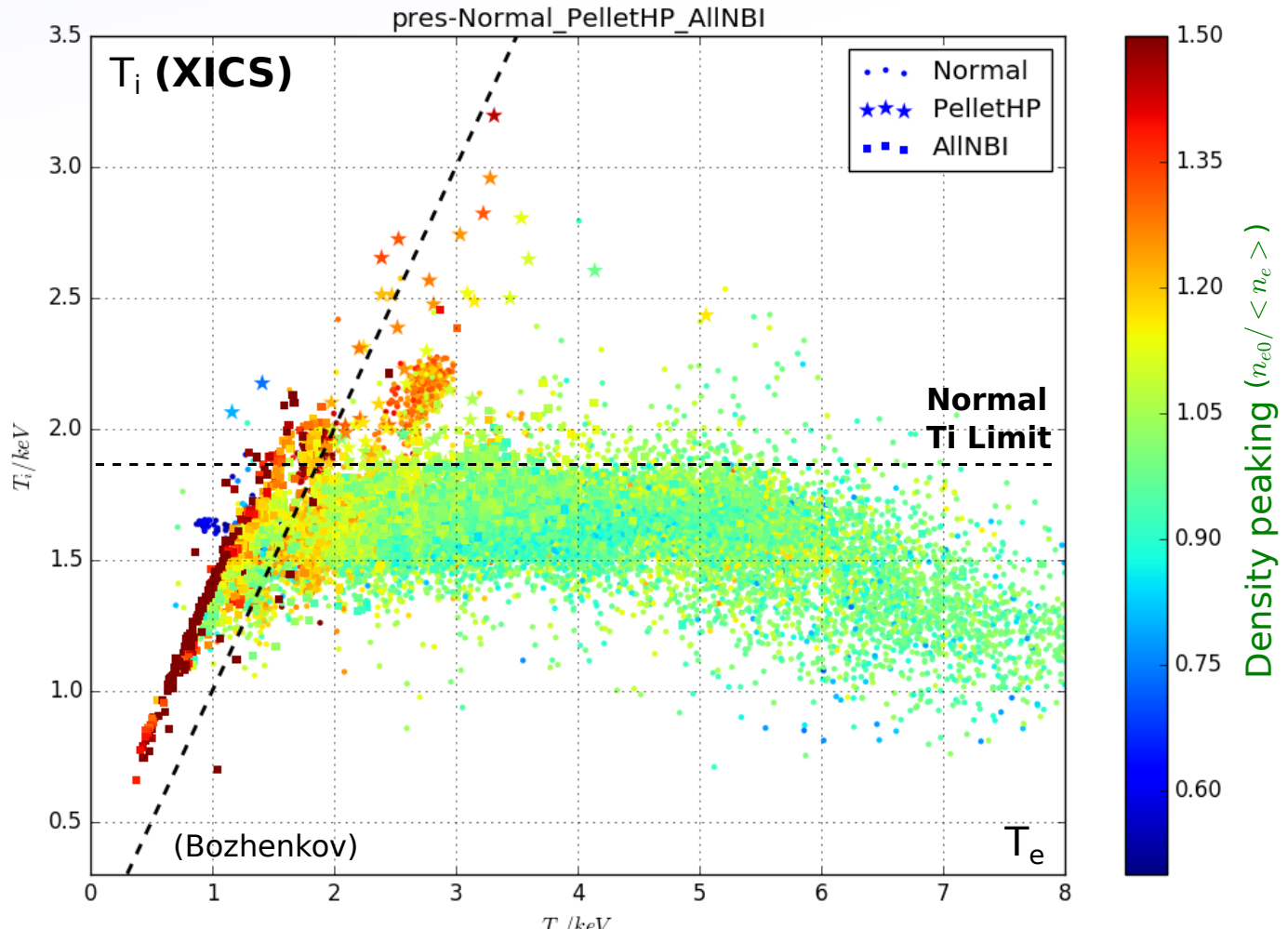
Case 2: NBI into collapse

- Observed that NBI after ECRH step-down can rise T_i .
- Extreme effect when NBI starts at plasma collapse, which also generates peaked density profile. ****<-- CHECK PROFILES****
- Like pellets, state is transient and retreats back towards normal maximum.



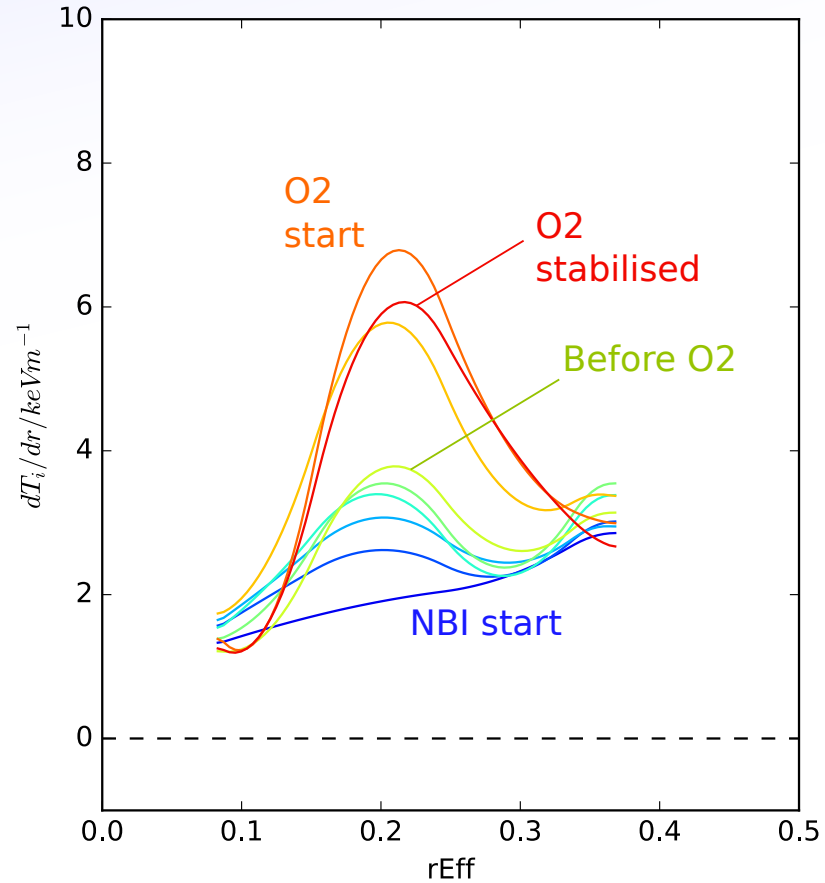
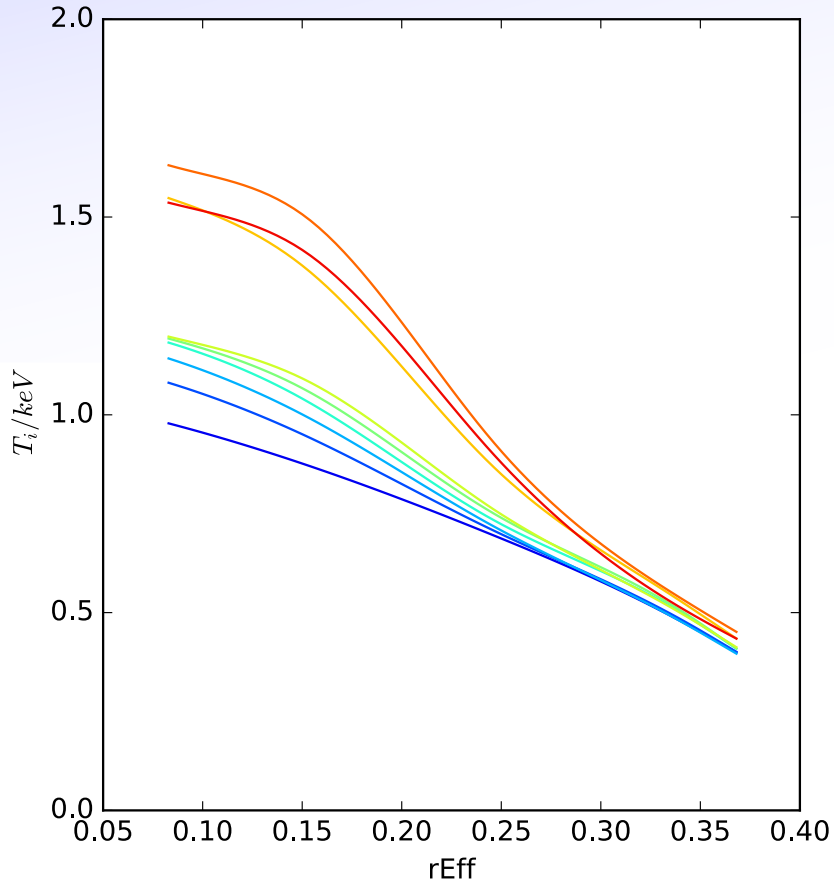
Density Peaking

- Density peaking is common to all cases of high(er) T_i / reduced transport:
- Currently seen in:
 - 1) High performance pellets shots
 - 2) High ΔT_i NBI
 - 3) Spontaneous slowly rising cases in ECRH
 - 4) Some TESPEL cases.



Profiles

Start looking at exactly where steeper T_i / density gradients are.
High resolution CXRS mode (all optics, all spectrometers). 6 point spline fit:



Where is the gradient, is it at $r_{\text{Eff}} = 0.22$??