MAX-PLANCK-INSTITUT
FÜR PLASMAPHYSIK

OP2 NBI+ECRH density peaking and performance

Presented by Oliver Ford on behalf of the W7-X Team

(Contribution to program-days talk by Olaf Grulke)

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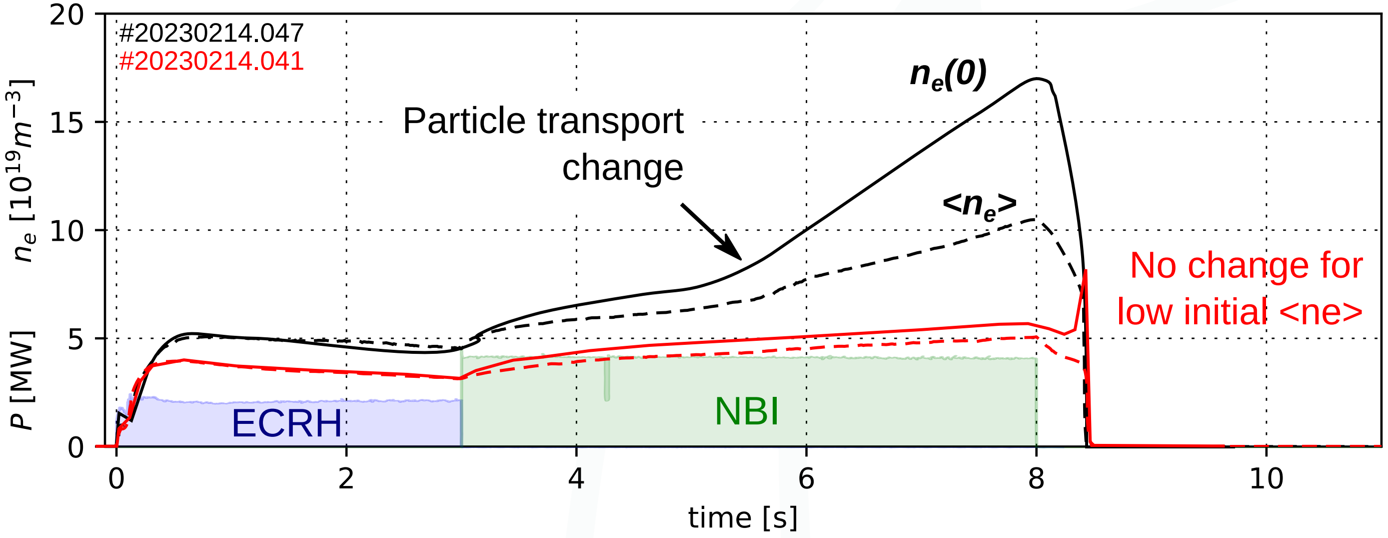
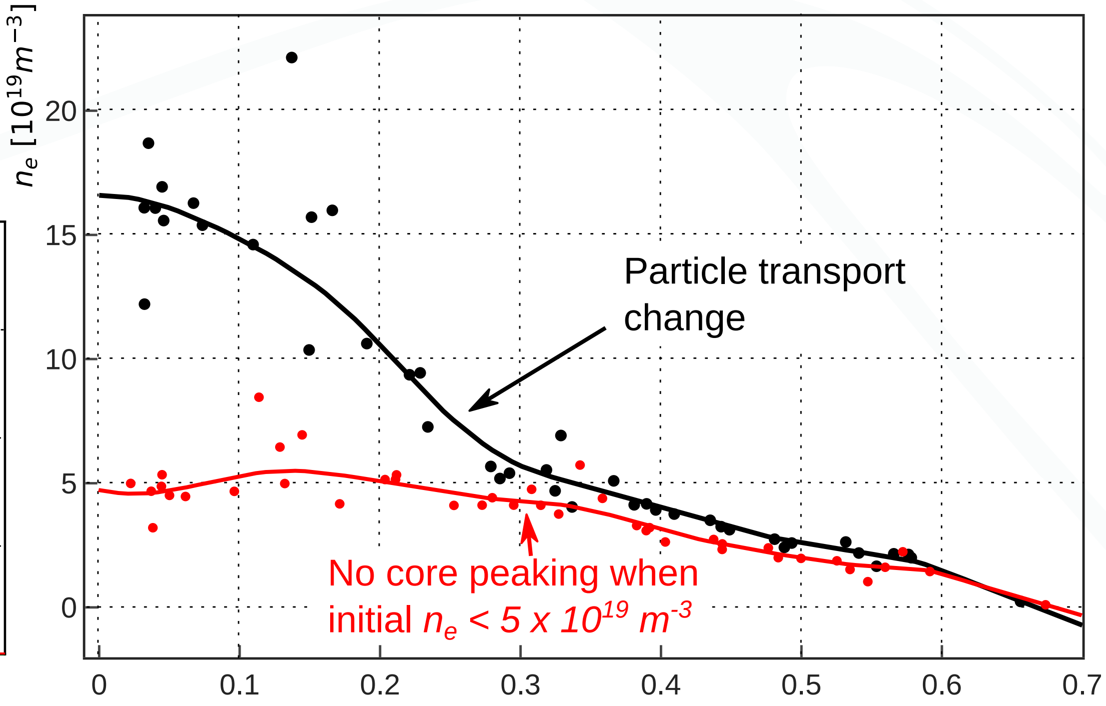
NBI core density peaking

Core density peaking with NBI (observed in OP2.1b) examined in detail.

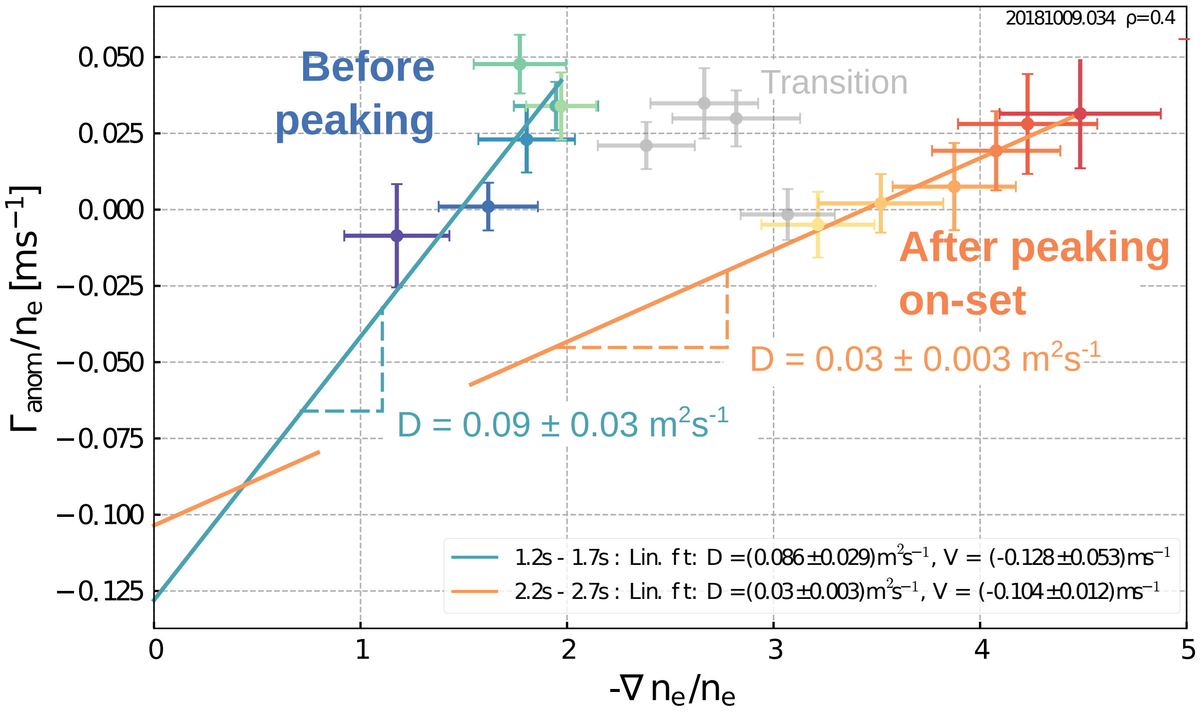
- On-set dependence on initial density confirmed
- Abrupt change of particle transport within fixed radius when passing some threshold.
- Radial location appears to change with configuration
- Co/counter source selection has no significant effect.
- Scaling of peaking with source rate not clear (varied number of NBI sources).

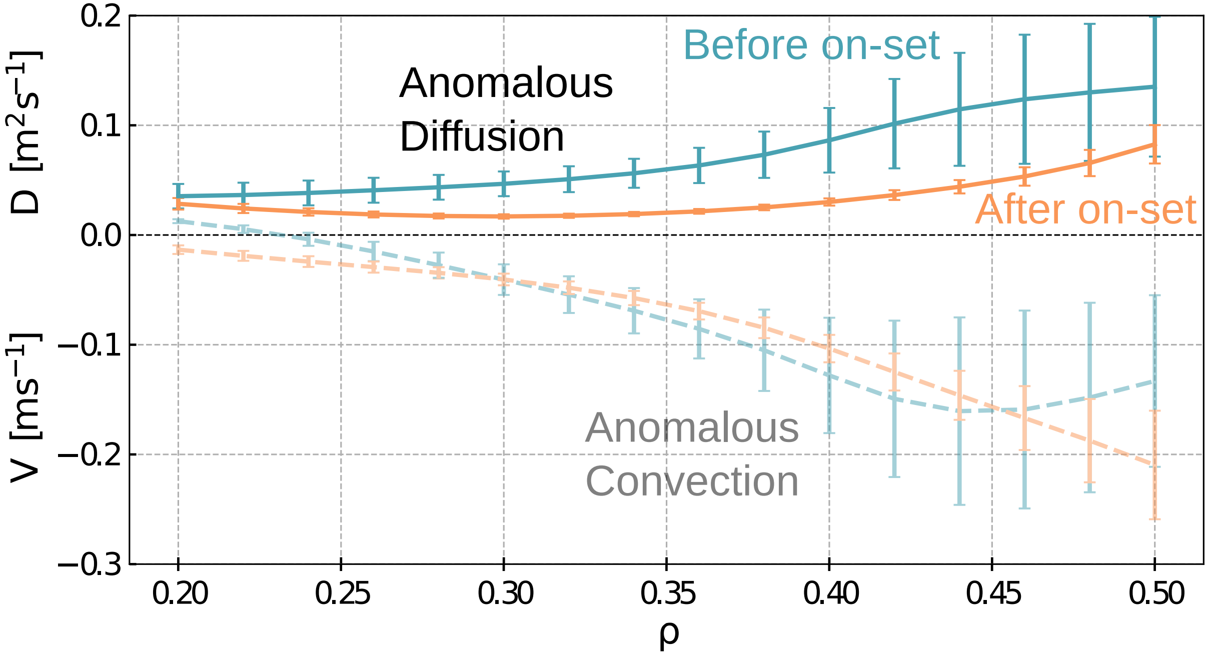




NBI core density peaking

In depth study of OP1.2b data reveals signficant drop in anomalous particle diffusion [S. Bannmann].
Change in particle transport appears across campaigns and in several magnetic configurations.





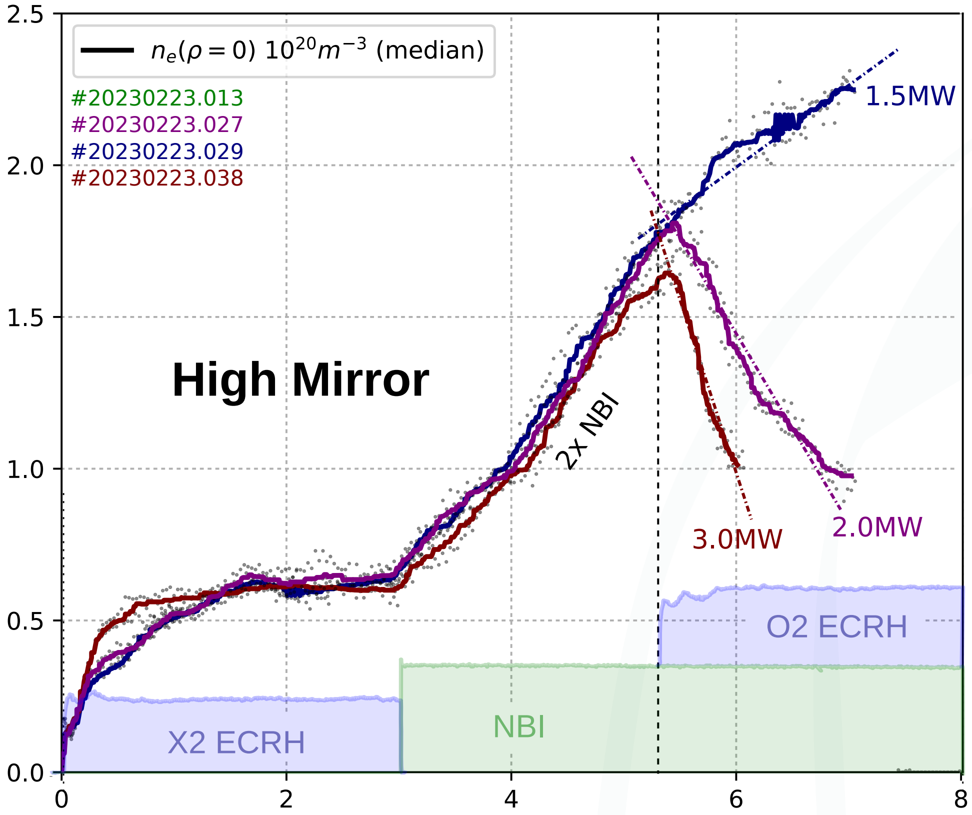
ECRH pump-out

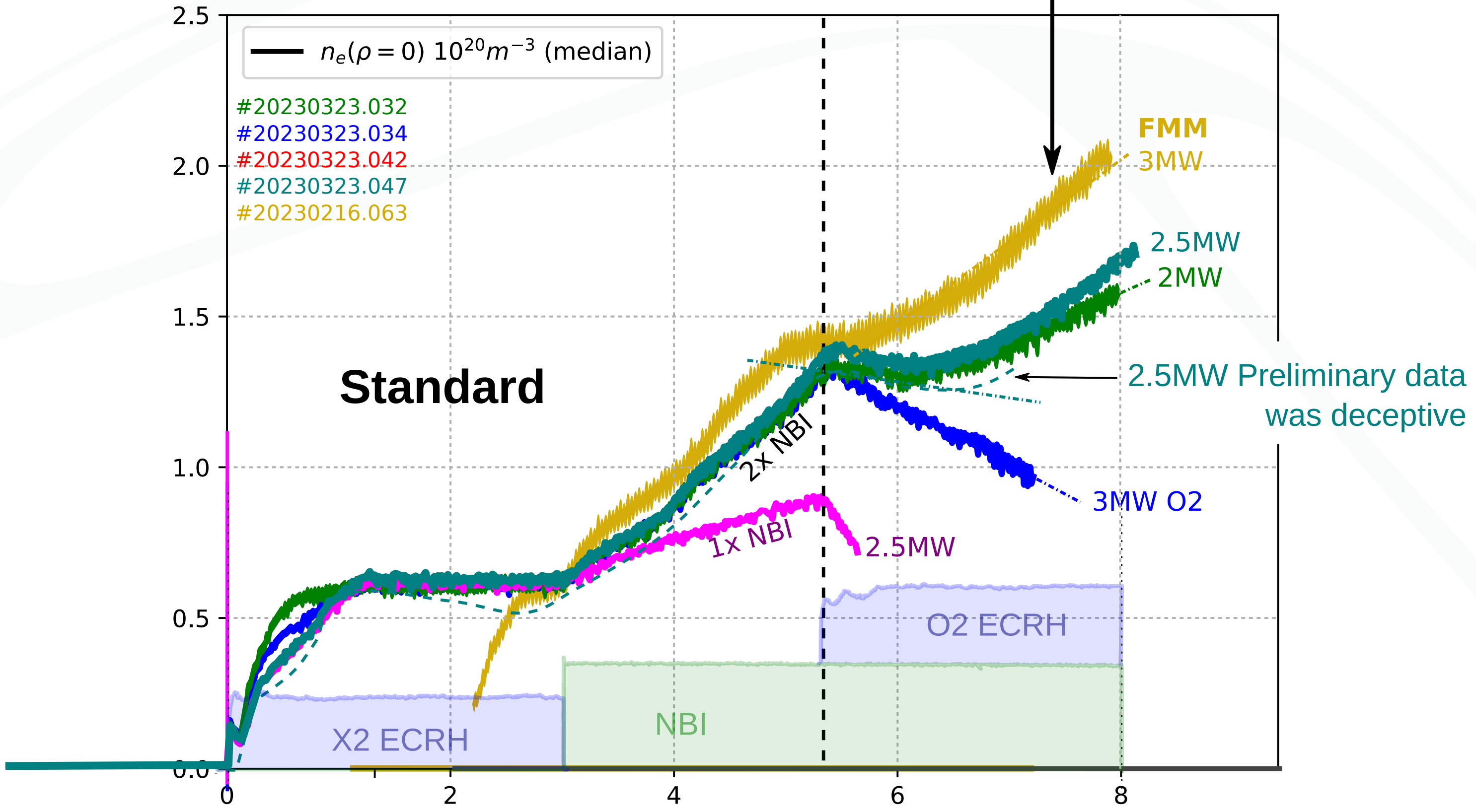
- Re-introducing ECRH pumps-out density and impurities.
- Investigated effects on pump-out rate:

Significant:
- ECRH power.
- NBI source rate
- Initial density
- Magnetic configuration

Not significant:
- O2 vs X2 absoption
- O2 off-axis (gyrotron choice)

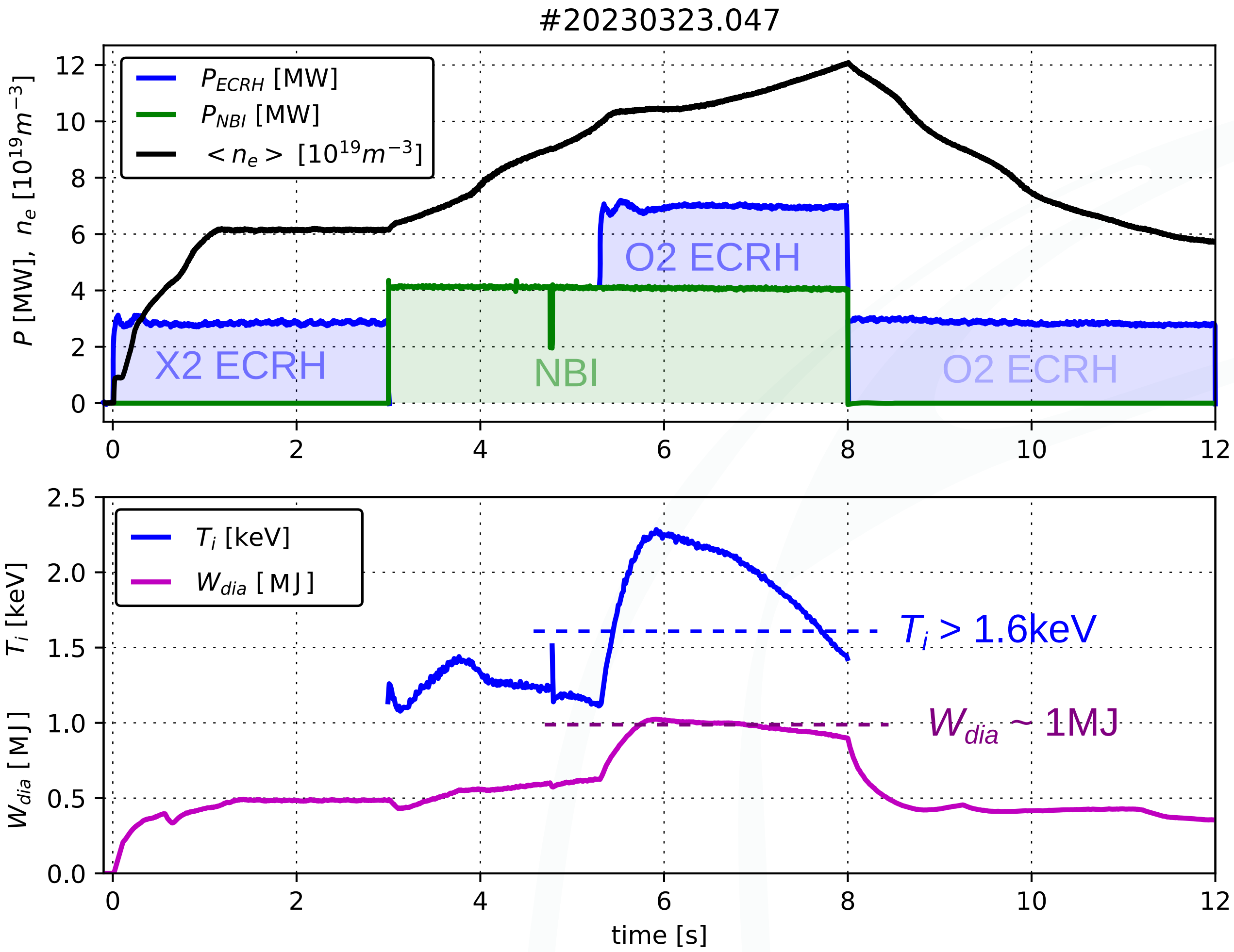
FMM configuration: Limited pump-out even at 3MW ECRH
--> High-performance candidate.
... really config or initial n_e condition?





NBI +O2 ECRH reintroduction

- Find a balance of NBI core density peaking with ECRH:
  - Too much ECRH --> Gradients collapse --> Strong turbulent transport --> T_i ~ 1.6keV
  - Too little ECRH --> Reduced transport but density+impurity accumulation --> low power/particle --> T_i ~ 1.6keV



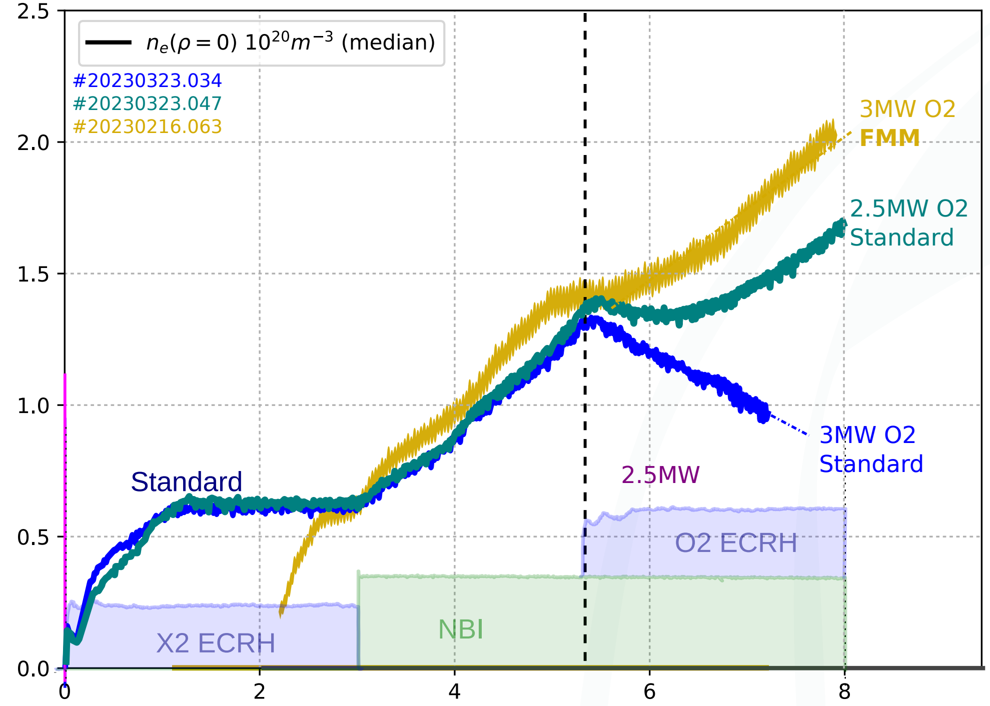
- Held T_i > 2keV, Wdia ~1MJ for 1.0s before density rises further.
  --> Possible indefinitely with real-time control of ECRH power against central density.

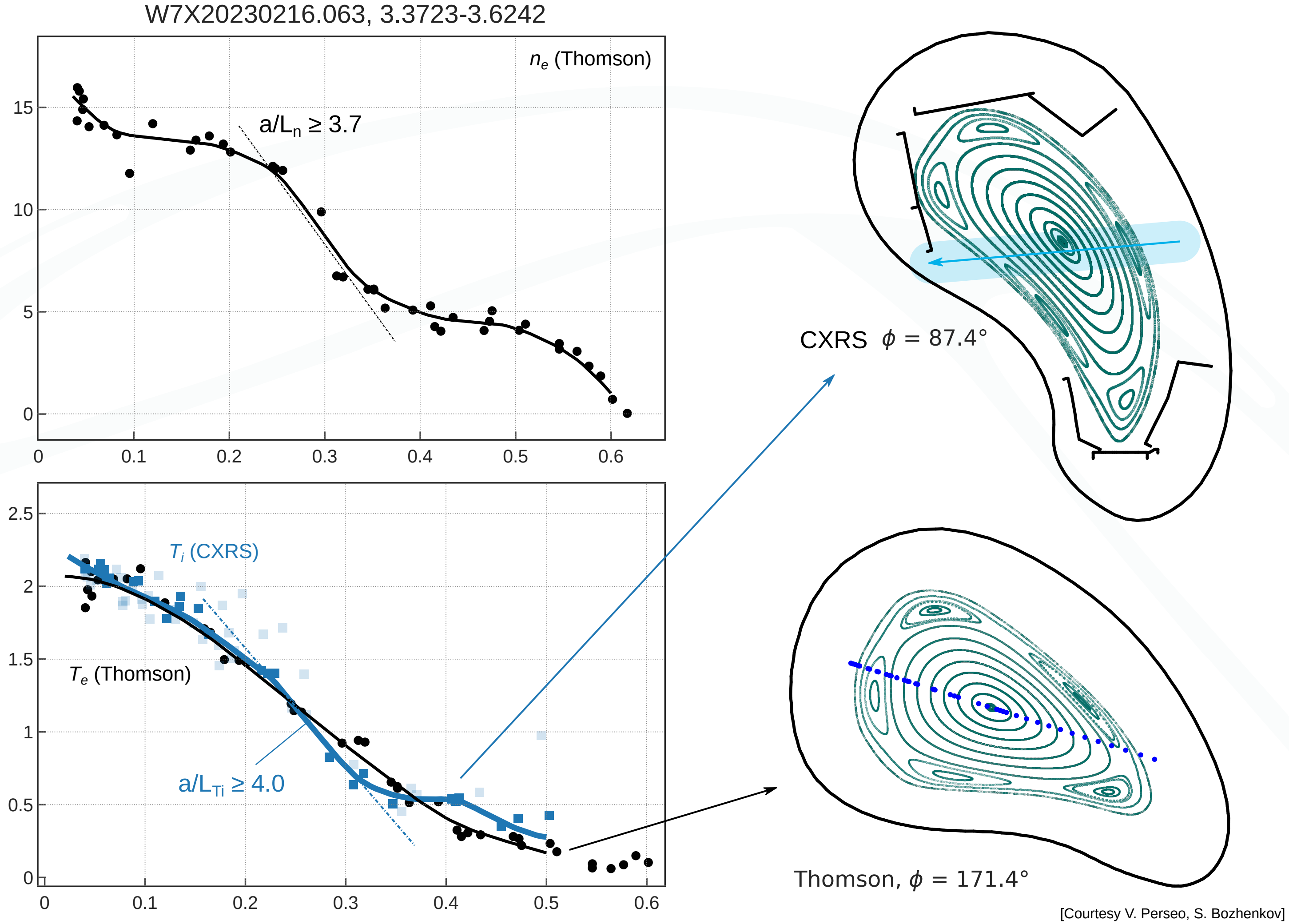
In the meantime, we have a method to dial in reduced turbulent transport scenarios on relevant timescales (t >> τ_E).

FMM002 Configuration

- Density rise is a little faster? --> might be related to initial condition (gas).
- Pump-out effect much less for higher power? --> might be due to higher a/L_n at ECRH reintroduction.
- Slightly higher W_{dia} = 1.2MJ.
- Limiter configuration with very strong gradients inside a chain of internal islands. CXRS sees island O-point, Thomson sees X-points.

--> Can we optimise gradients via configuration?

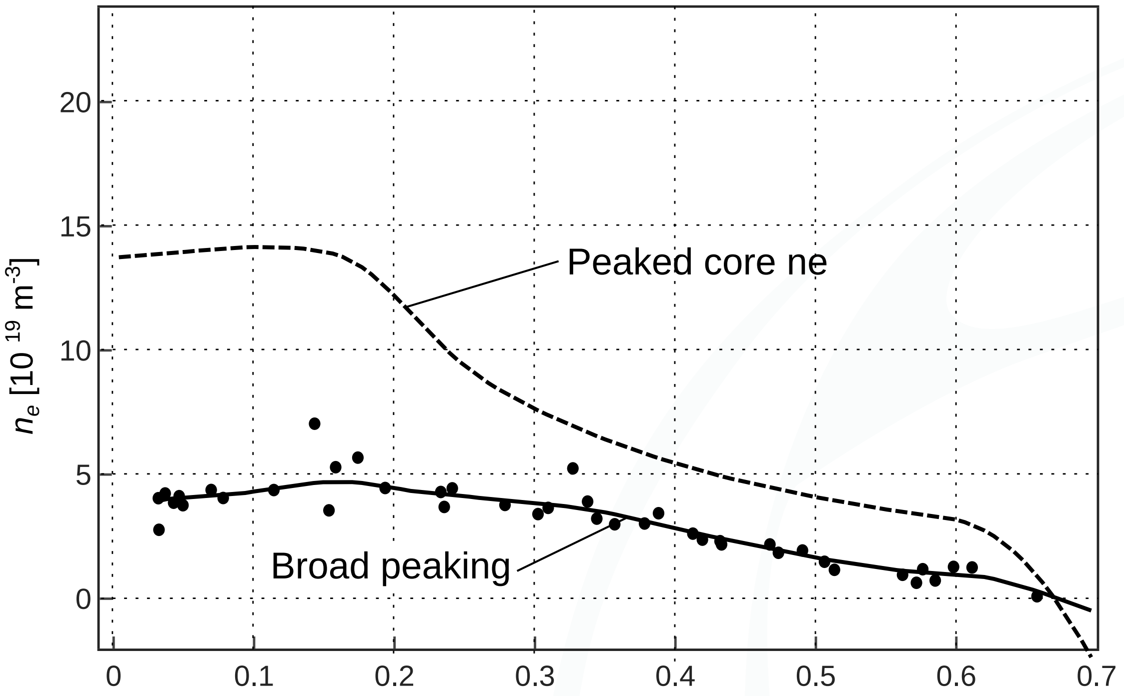


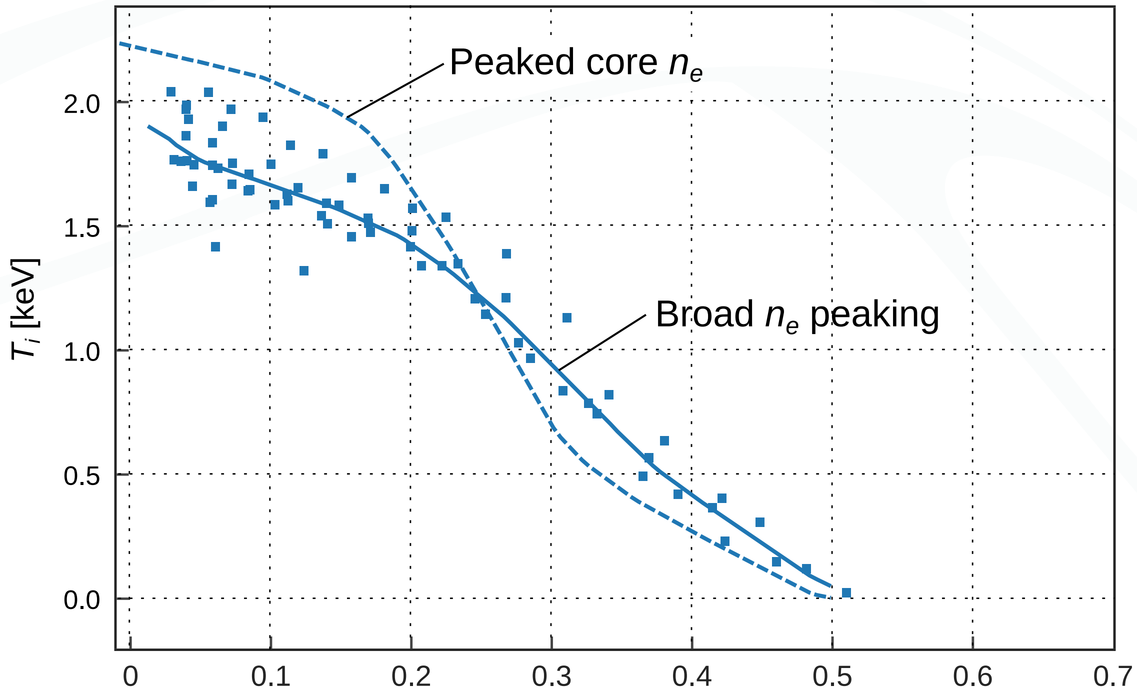


[Courtesy V. Perseo, S. Bozhenkov]

NBI+ECRH high performance

- Another scenario was found in OP2.1 with broadly peaked density (no strong core peaking!), but with higher T_i.
- Fully stable T_i ~2keV (above 1.6keV clamping limit) for 4s, but lower $<n_e>$ and W_{dia}.
- Indicates importance of recycling conditions.
- Allows wider range of possible profiles:





NBI+ECRH high performance

- (A.Langenberg has a better plot of these now.)
- Slowly making progress....
- These are **very very** rough numbers! No dilution (Zeff), no integrals etc etc.