Analysis status of record shot

"What we think we know about the ECRH reintroduction scenario"

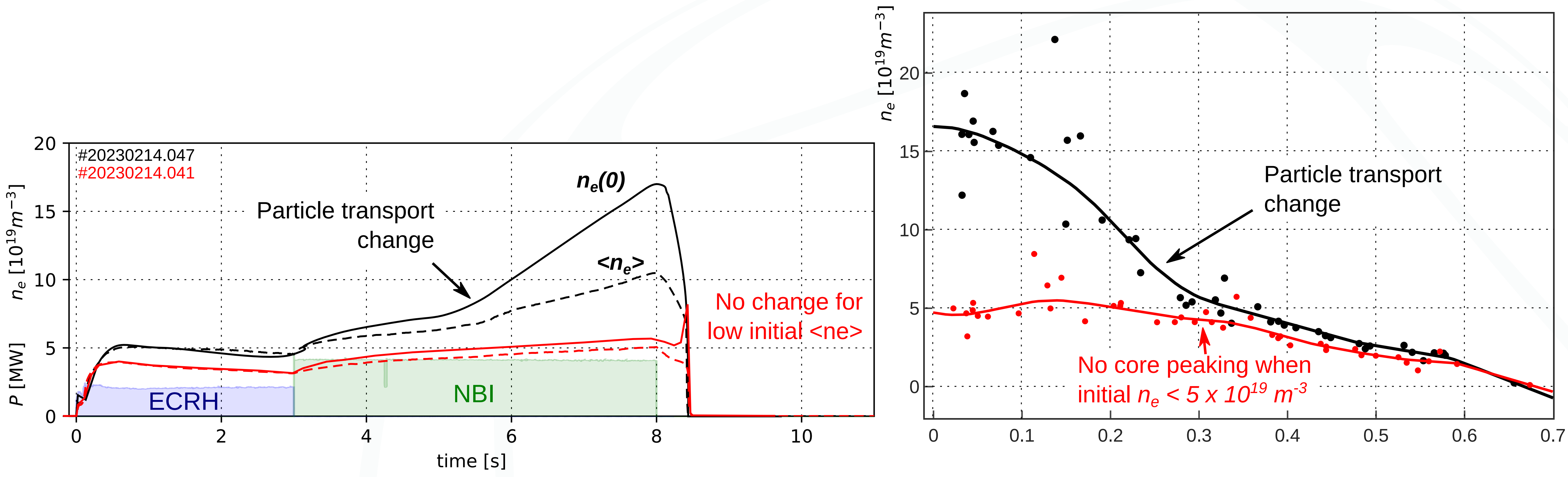
(and will later find out is wrong)

O. P. Ford, S.Bannmann, T. Stange, R. Lopez Cansino

TG core scenarios 29.01.2025

The ECRH reintroduction scenario

1) During pure-NBI peaking, particle transport changes and density peaks strongly inside ~mid-radius.



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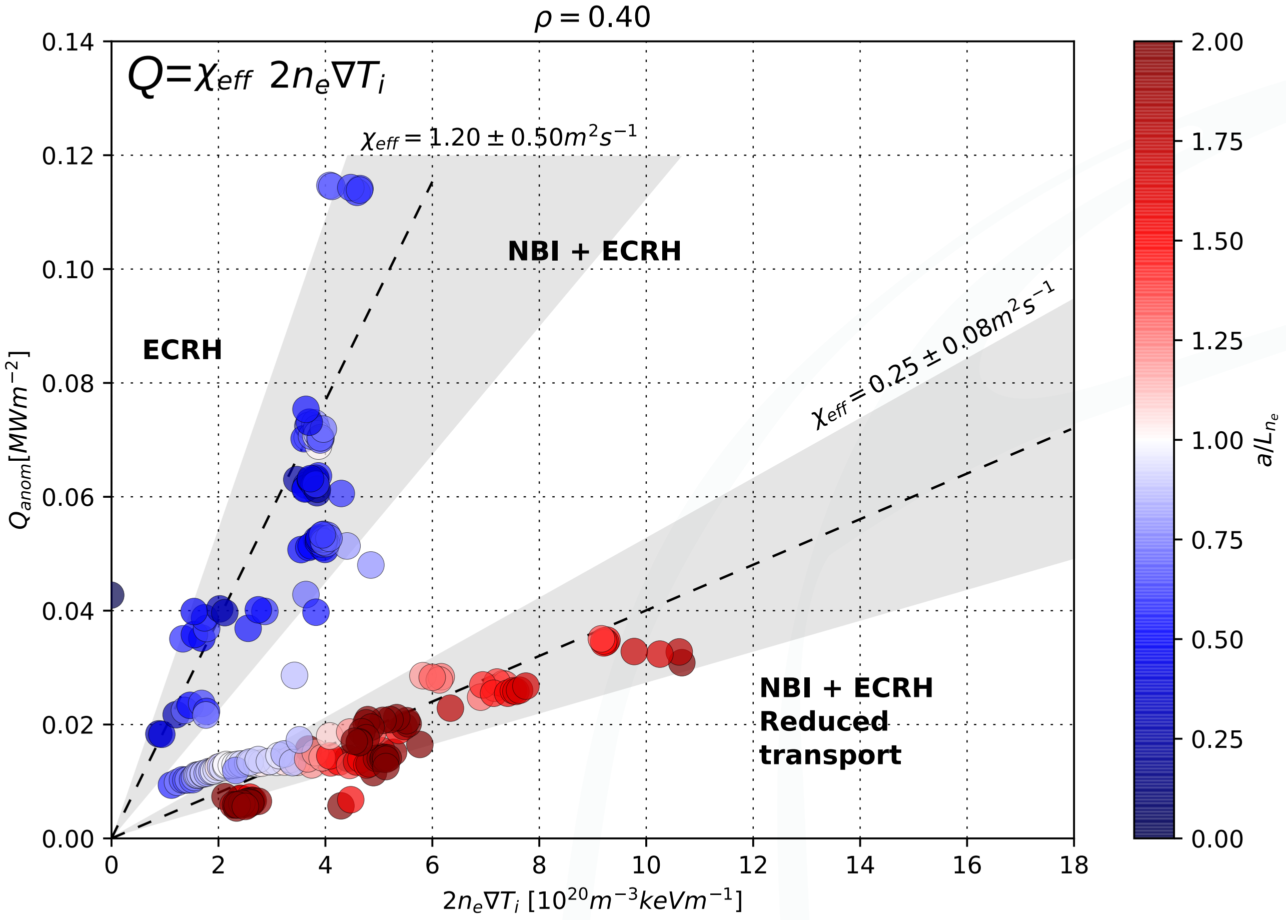
1) During pure-NBI peaking, particle transport changes and density peaks strongly inside ~mid-radius.
2) With peaked density profiles (roughly a/Ln > 1.0), heat diffusivity is 4 times lower.
3) Add ECRH to take advantage of low χ_{eff}.
4) ECRH 'pumps-out' density. Too much and we fall below required a/Ln --> back-transition to high χ.



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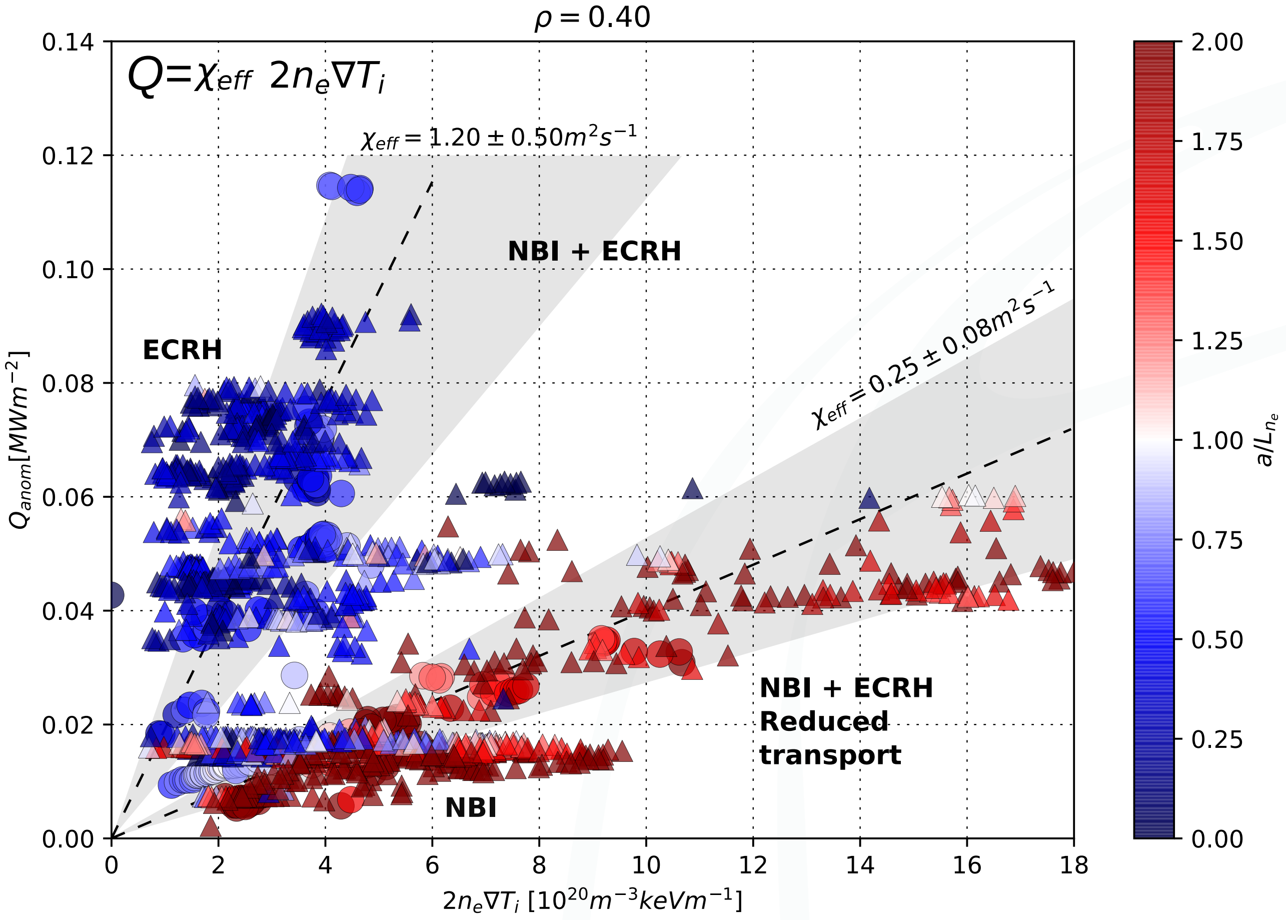

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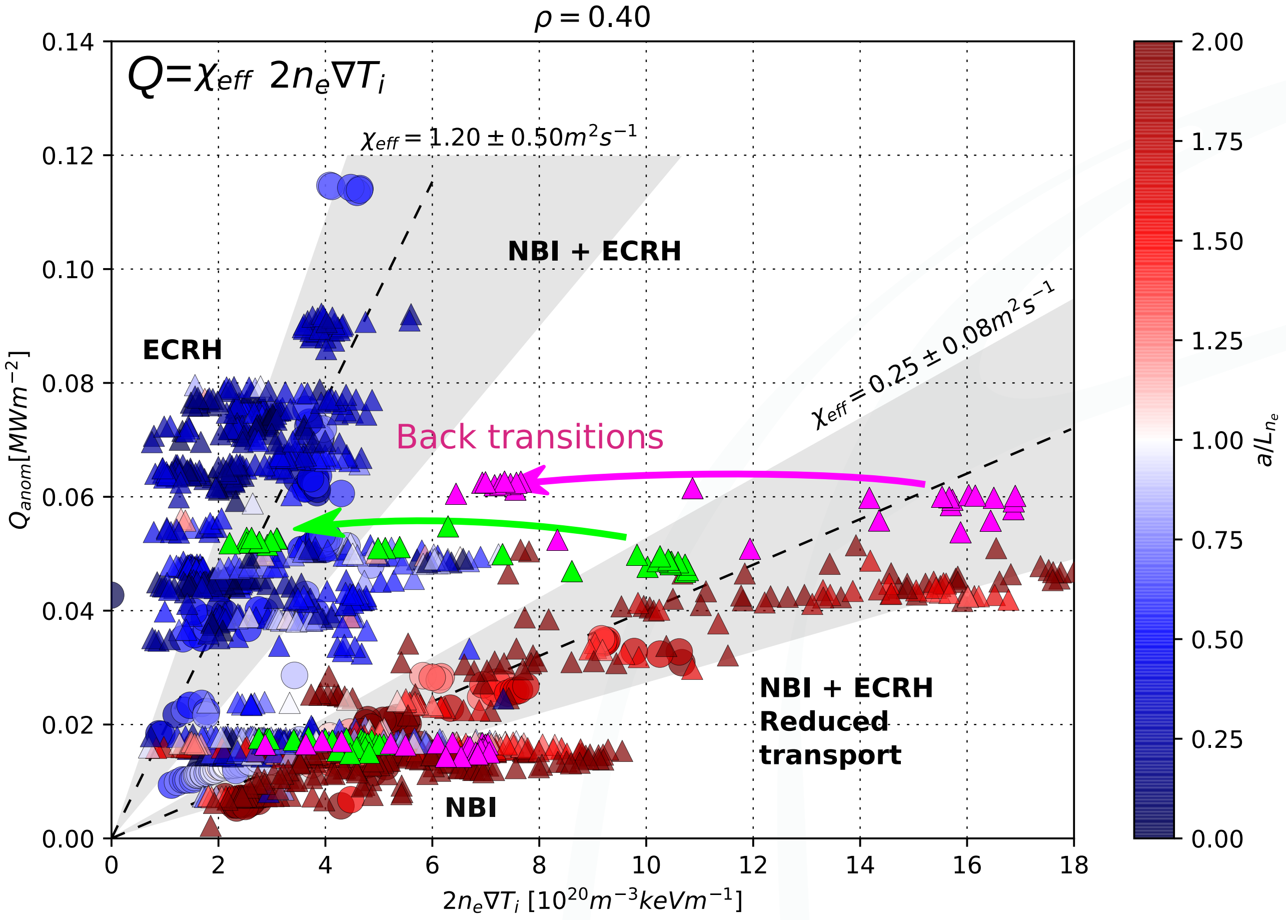
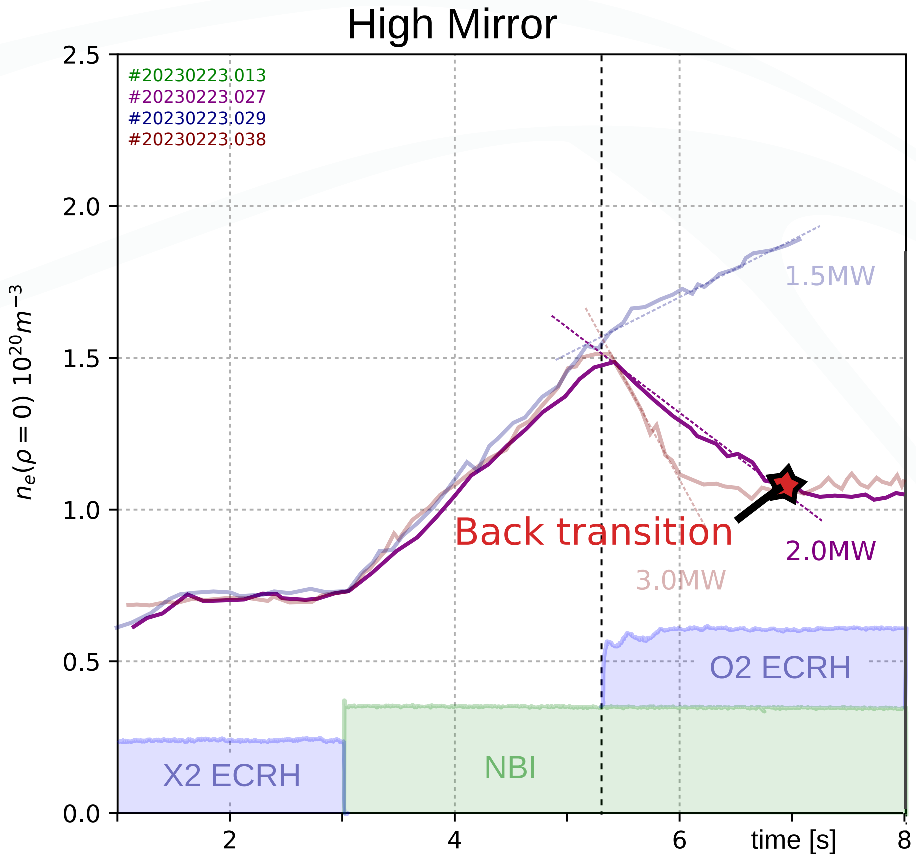




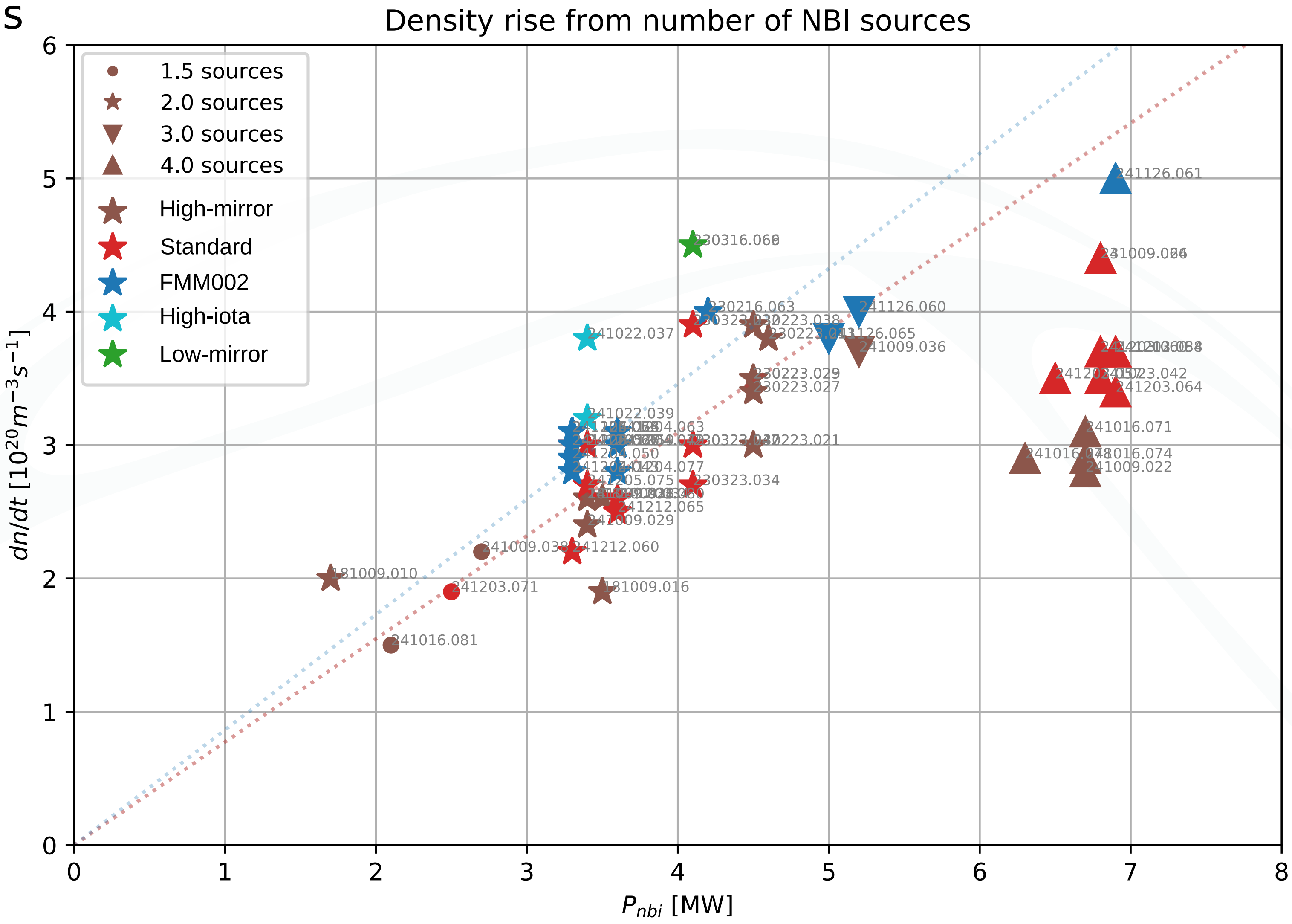
Configuration dependence

- Density peaking of pure-NBI depends on NBI particle source rate.

- Doesn't seem to depend *much* on configuration.

- Particle source doesn't scale up to 4 sources. e.g. in KJM:
  ne(NBI x4) < ne(NBI x3)

  - FMM002 does roughly scale to 4.



ECRH pump-out

- ECRH 'pump-out' effect increase with more power. This doesn't seem to be linear.

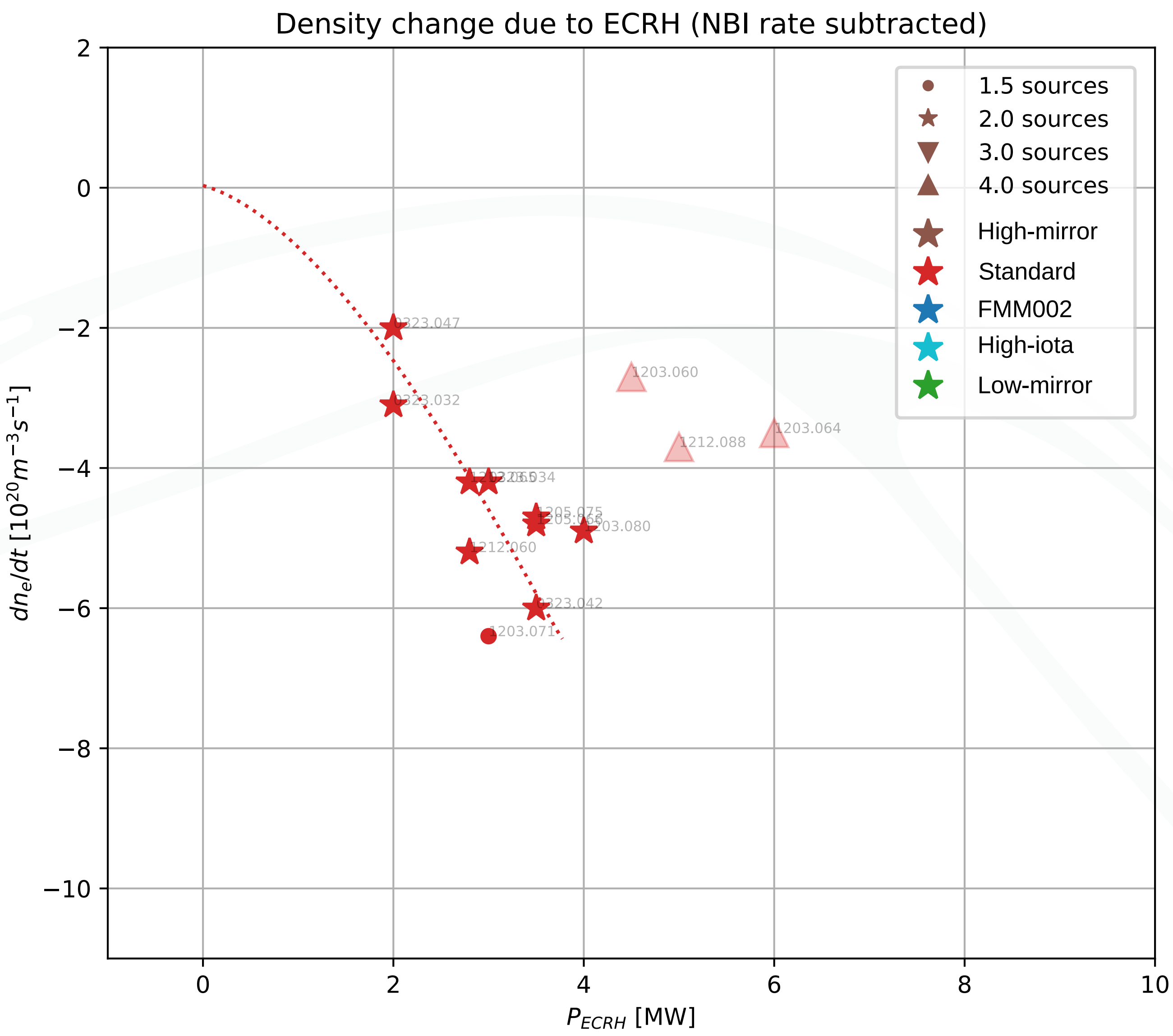
- The effect is *very* configuration dependent.

This gives a maximum power we can put into a given configuration for a given number of NBI sources:
e.g. for 2 sources:

High/low mirror: ~1.5MW
Standard: ~2.3MW
FMM002: 3.5MW

So we chose FMM002, obviously.
(FTM is probably similar)

Is some other configuration even better???
maybe!



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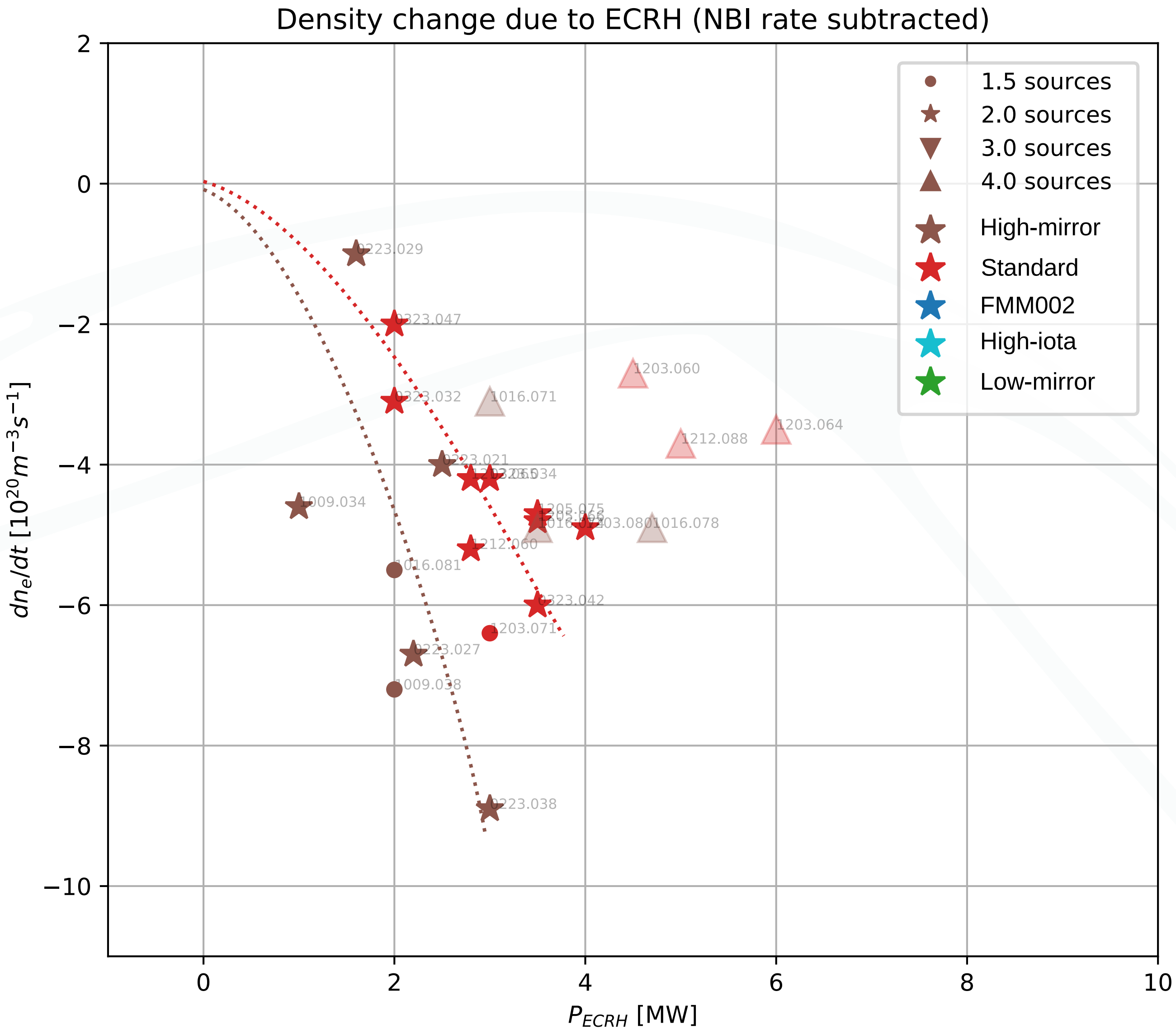

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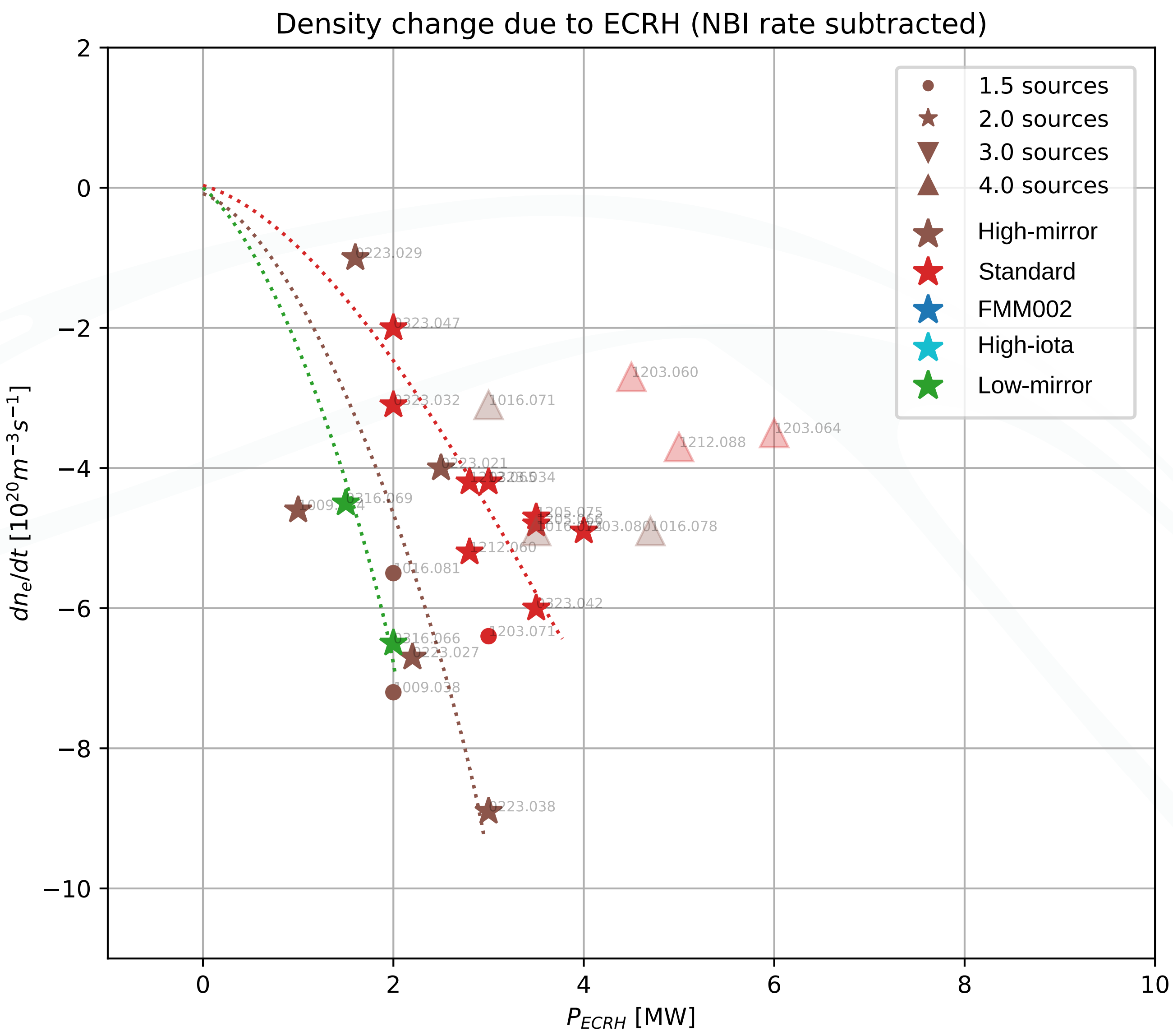

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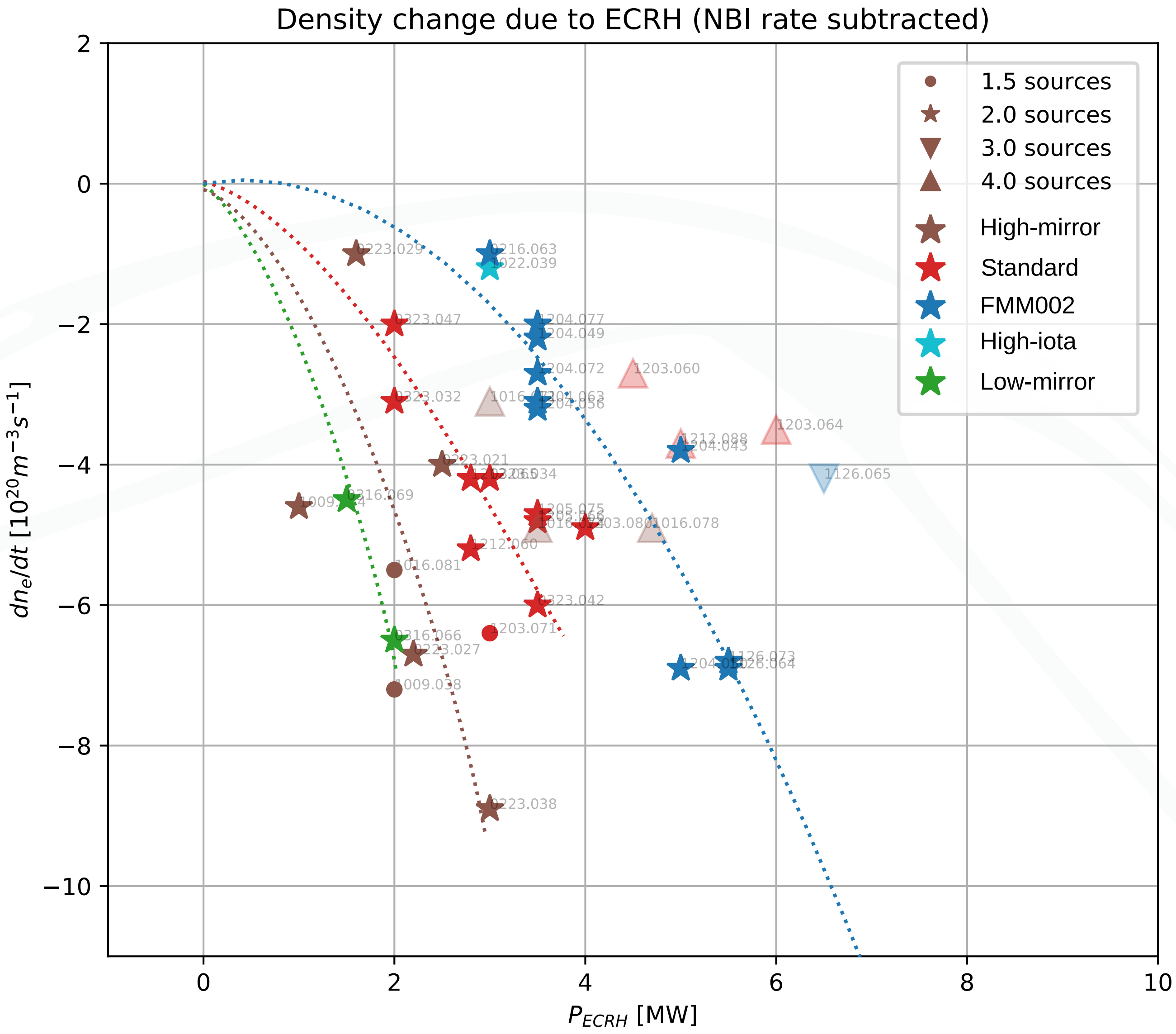

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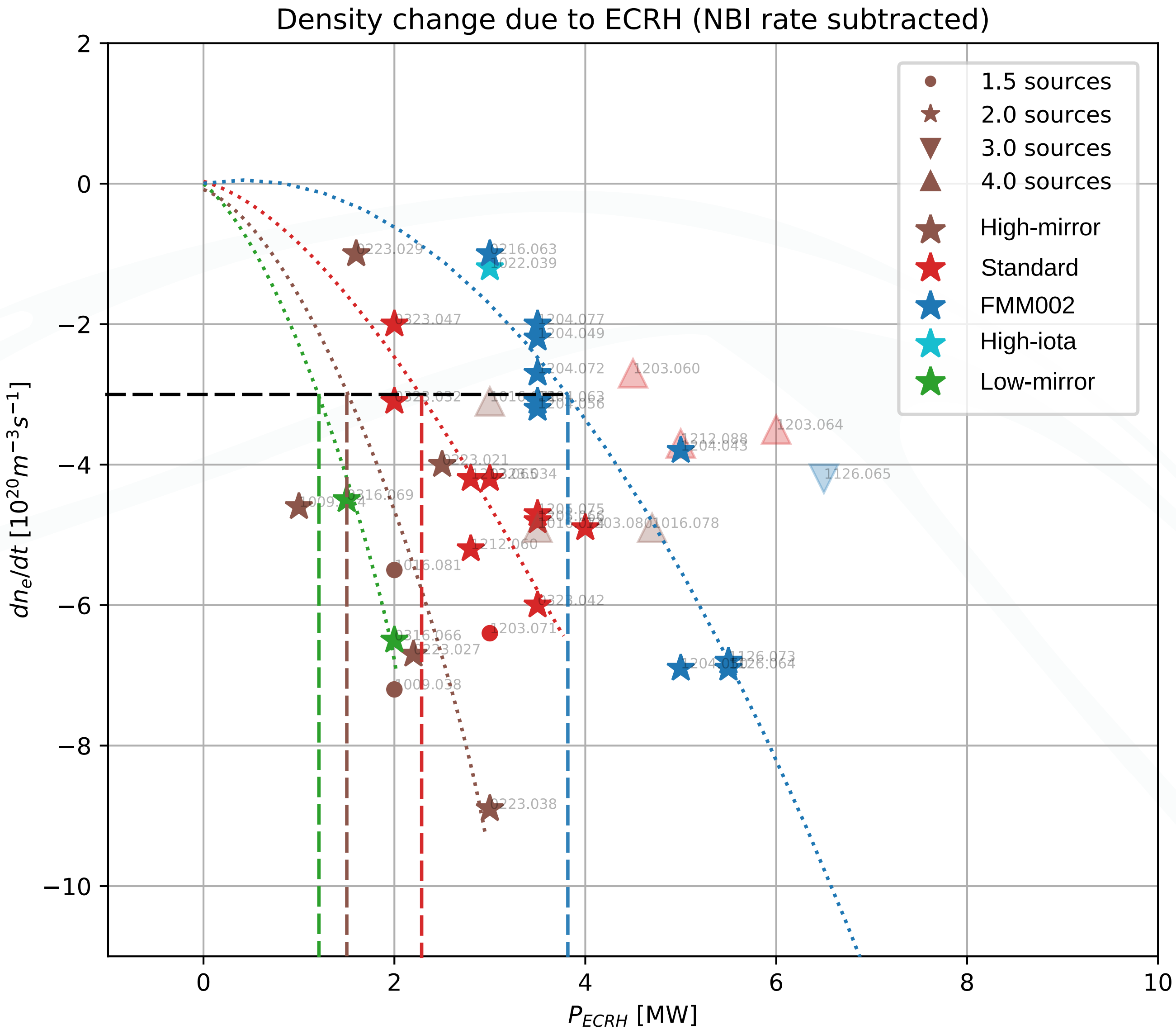


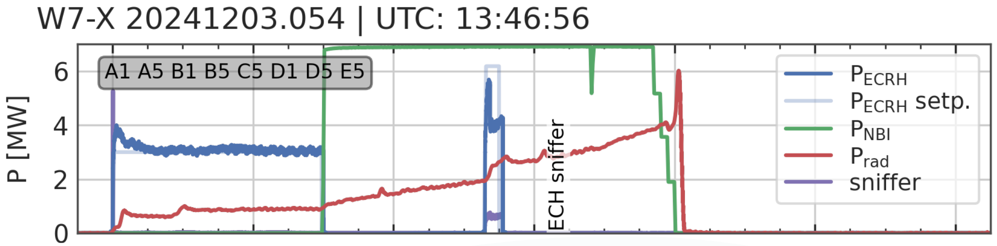
ECRH absorption

- ECRH is with O2 polarisation. Very difficult to get good absorption.

- Lots of work by Torsten in OP2.2 to fix this:

  1) Field scans to get deposition location right.

  2) Improvement of sniffer interlock settings.



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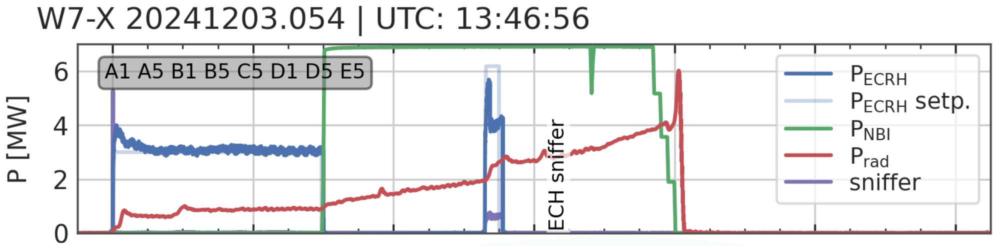
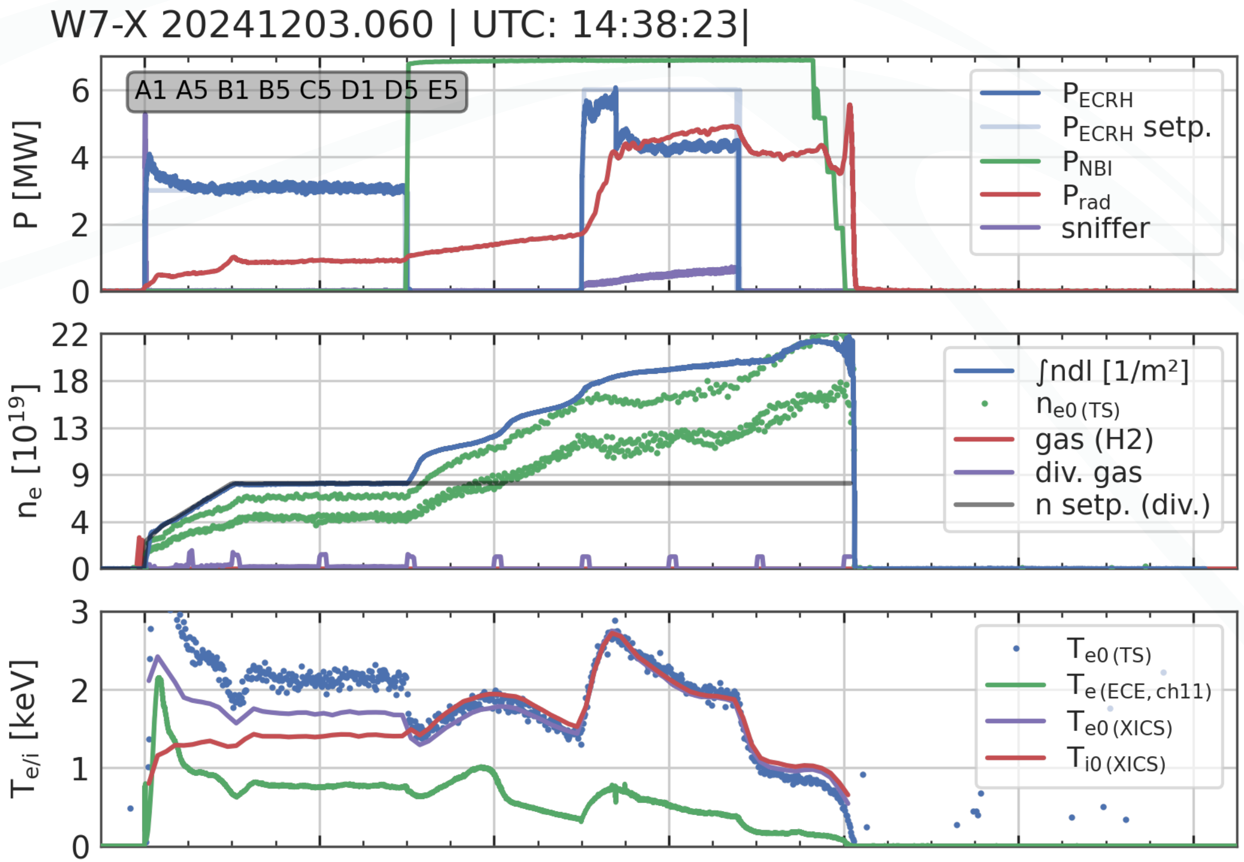
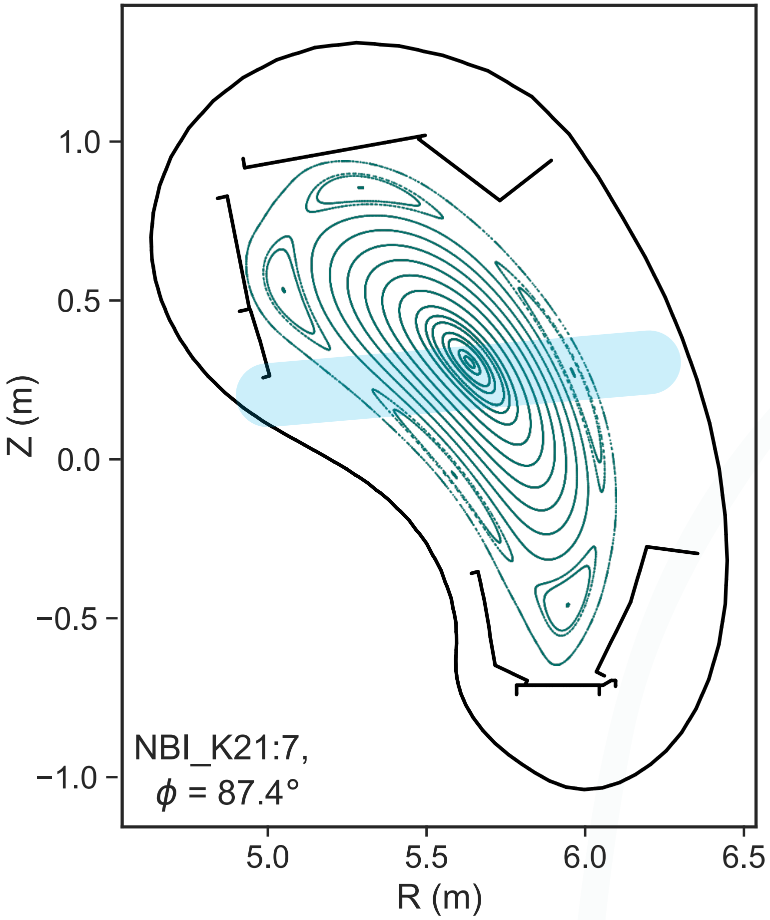
Sometimes we have falling T_e and T_i despite constant density and radiation.
is this absorption related??

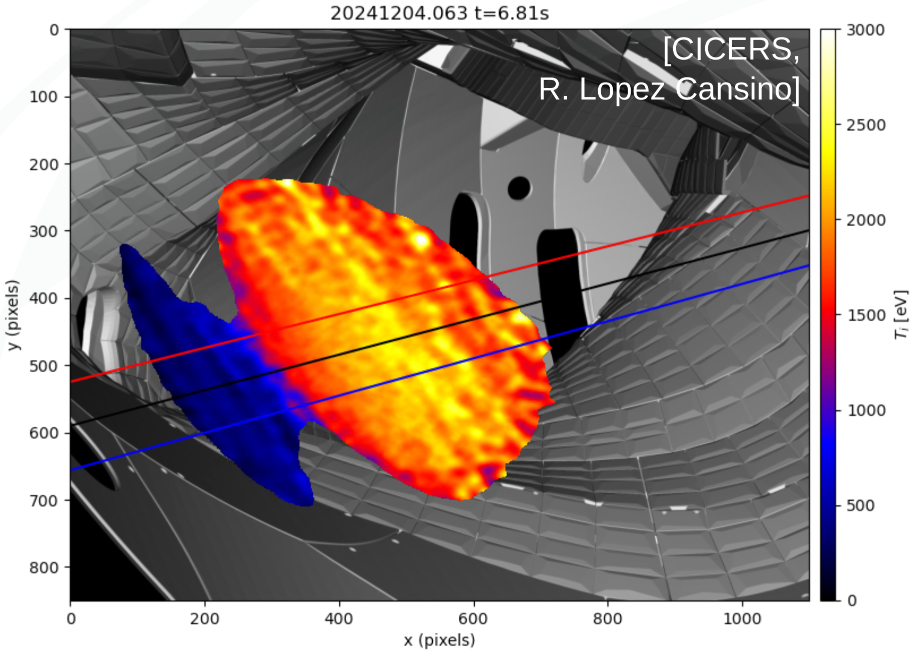


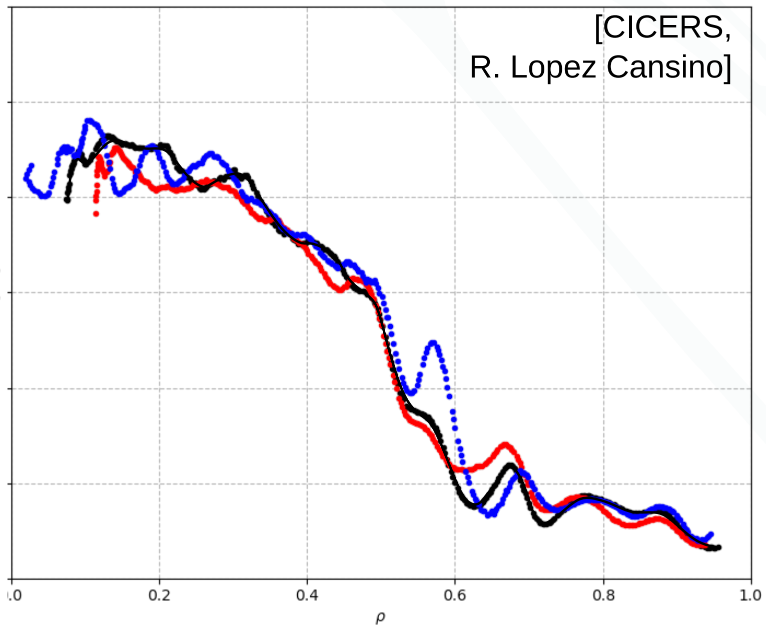


FMM002 internal islands

- FMM002 balance for 2x NBI = 3.5MW ECRH was quite good (T_i ~ 2.3keV, W_{dia} ~ 1.2 MJ)
- FMM002 is a limiter configuration with internal islands.
- T_i is flattened in the islands - visible in 2D with CICERS diagnostic (only in reintroduction phase!).

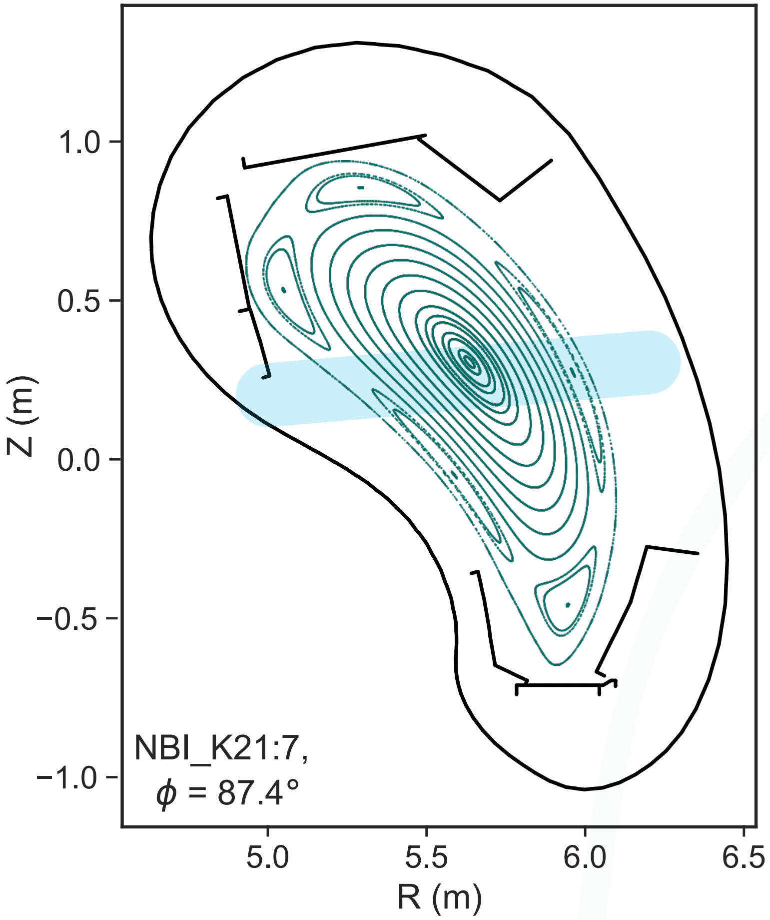


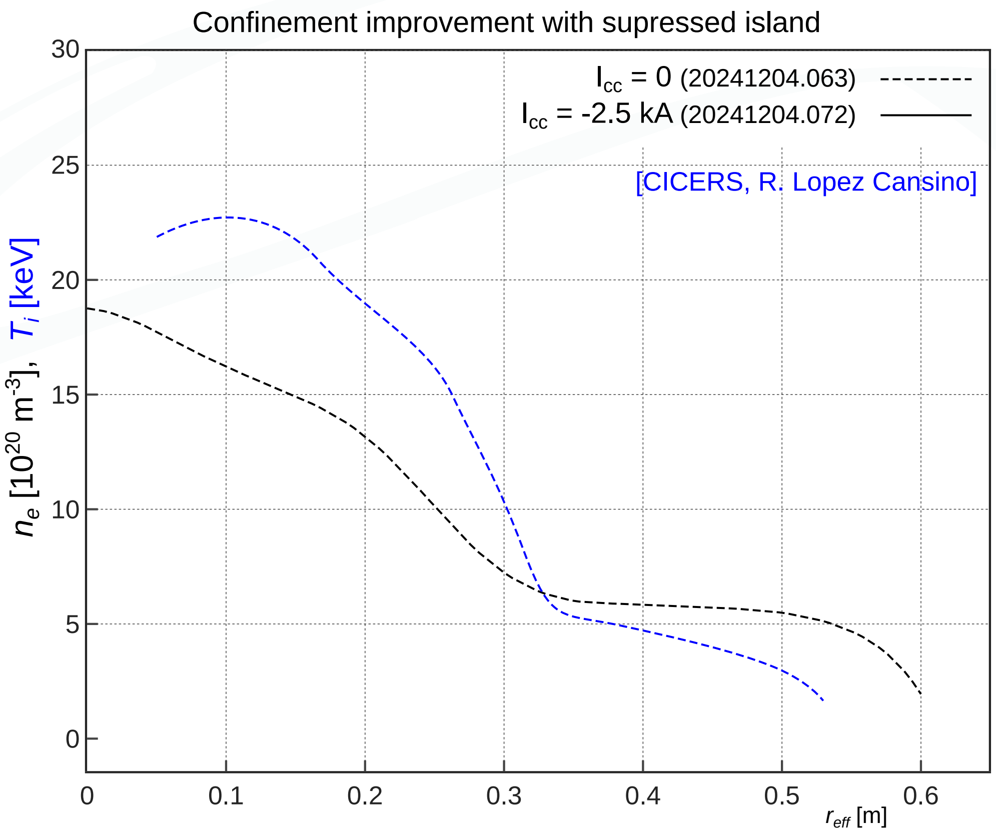




FMM002 internal islands

- Experiments to use control coils to change size of FMM002 islands.
- With I_{cc} = -2.5 kA, we could squish the islands, and get more effective volume.





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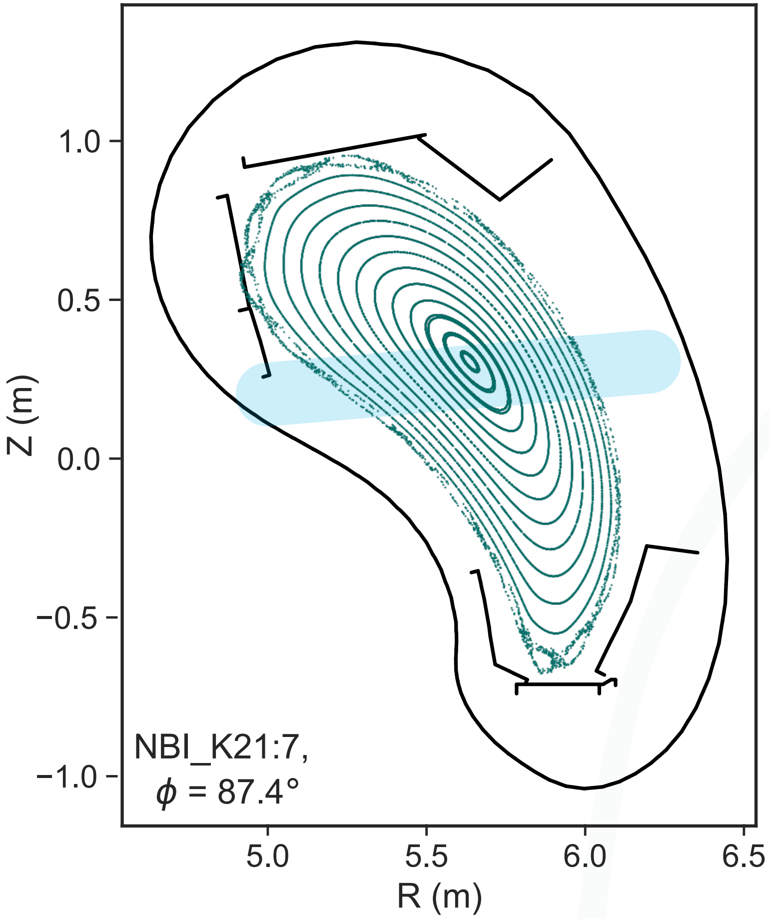

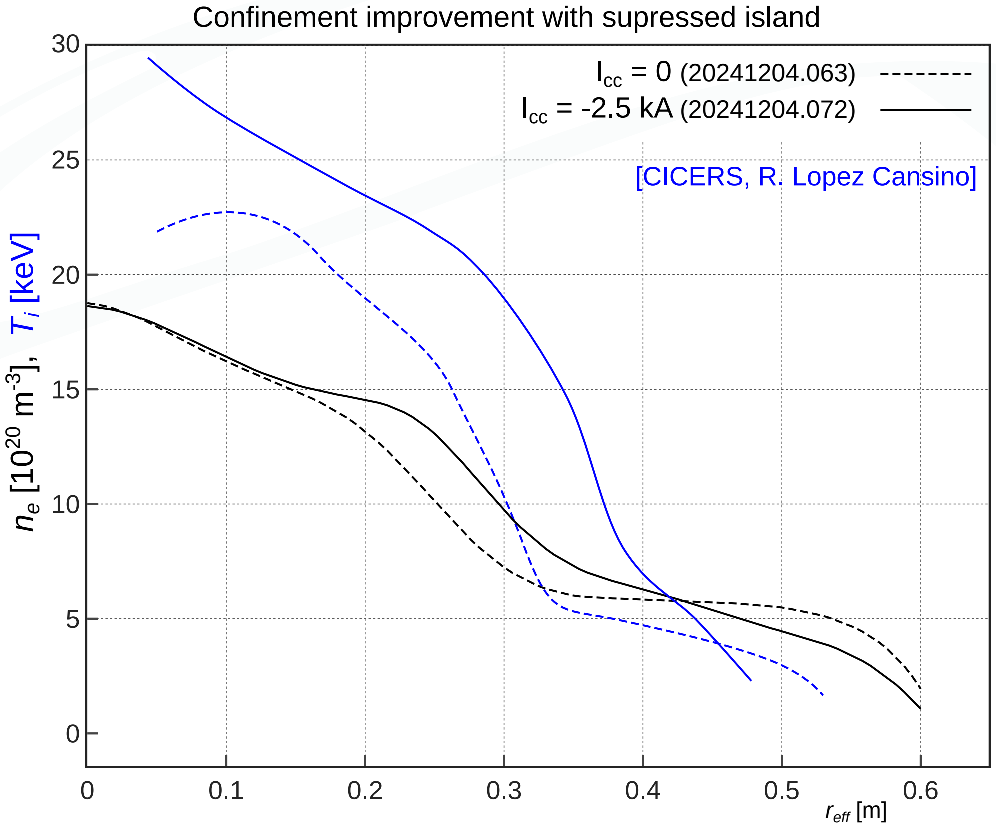

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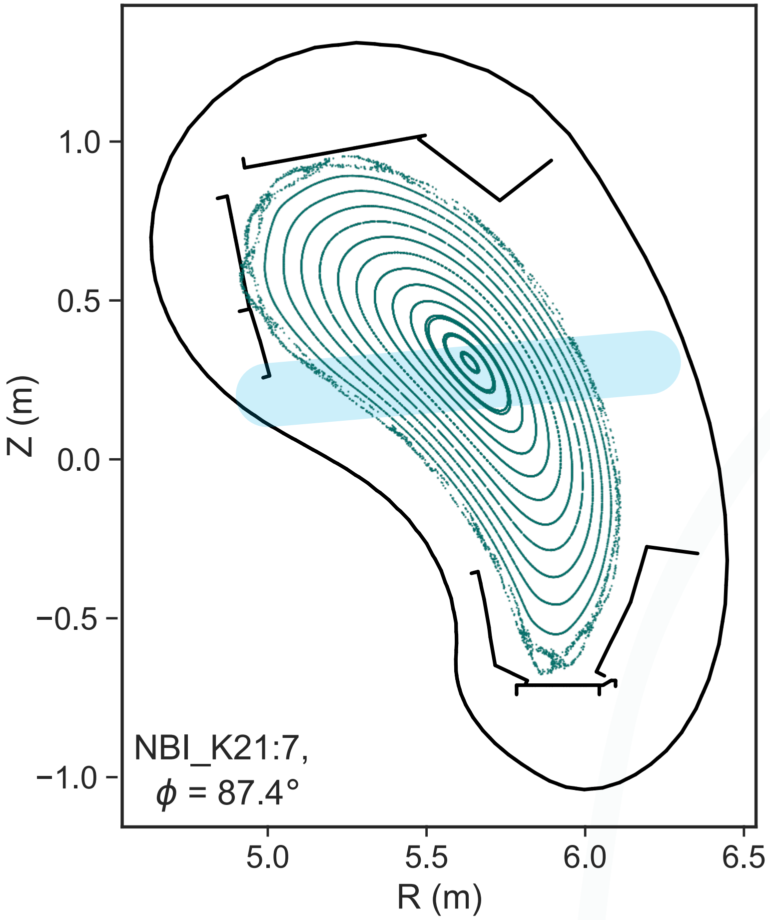
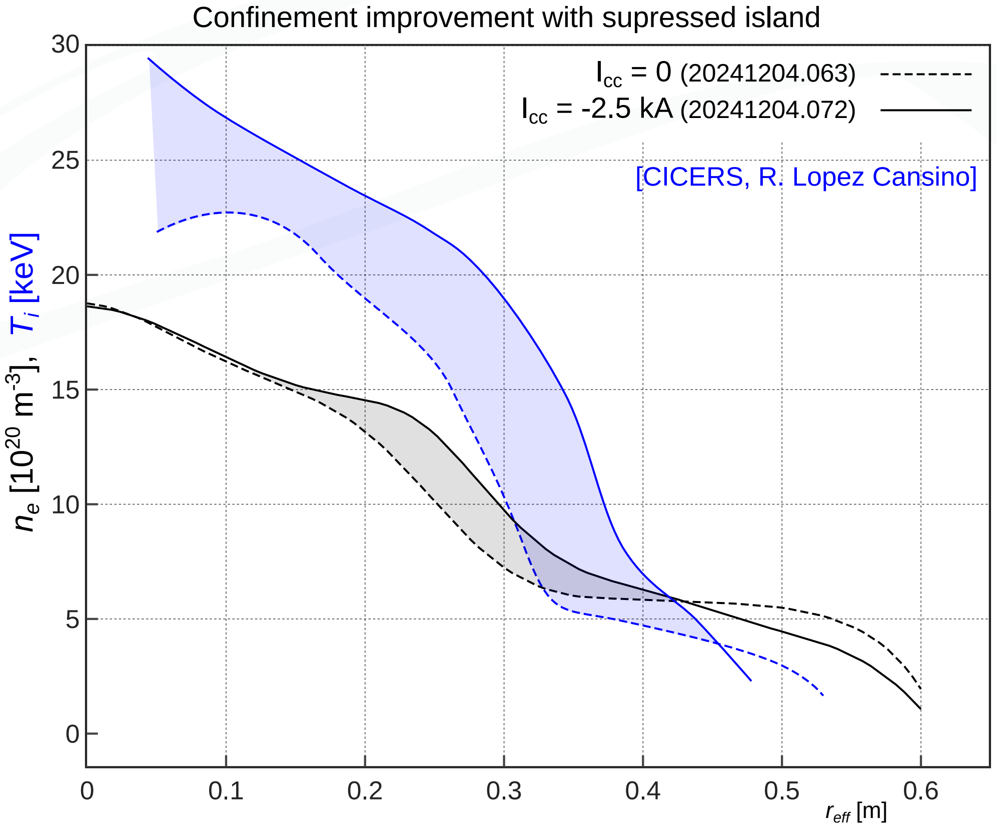
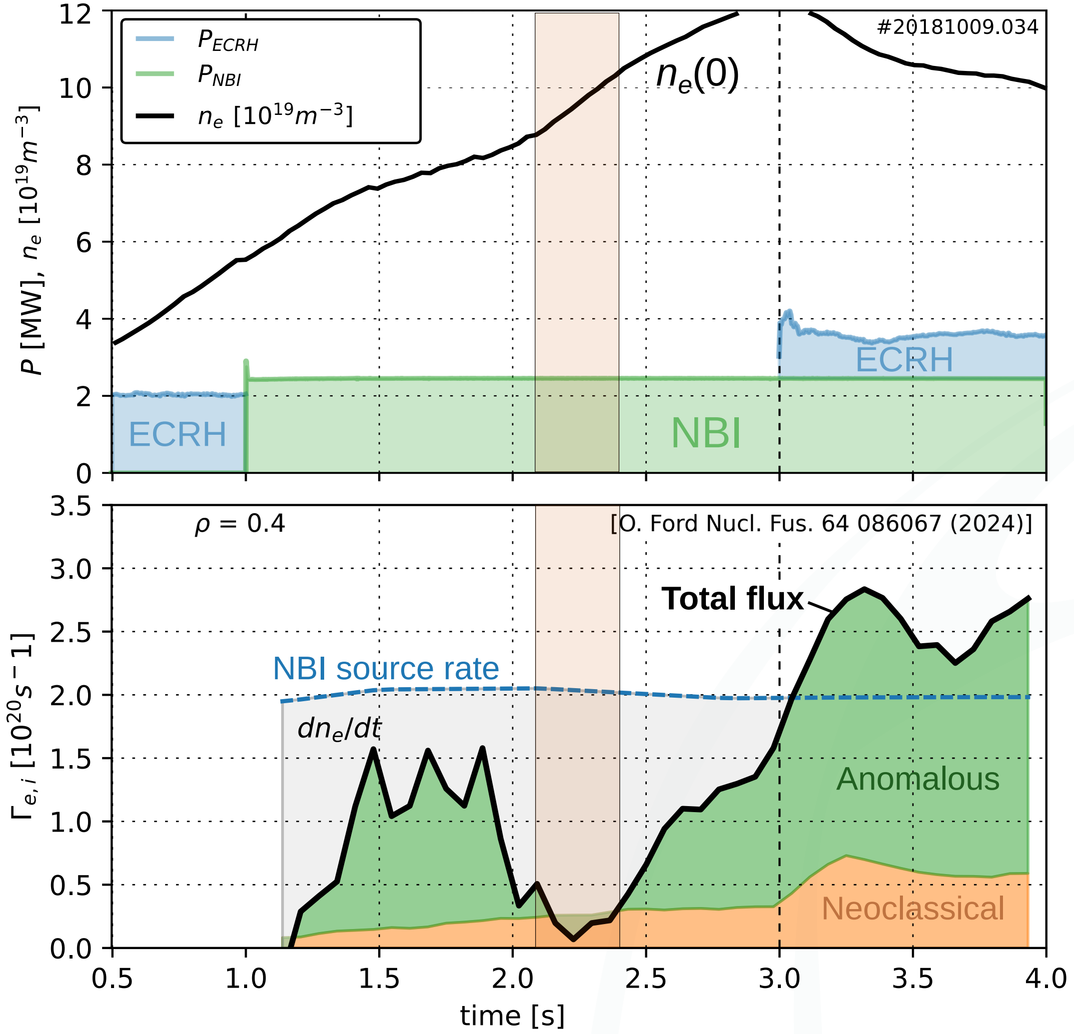




Data issues



1) Non-linearity problems of interferometer are critical to us, as *dn/dt* may not be real.

- Previously published sudden drops of main ion particle flux (as left) ***may*** not be real! but... particle transport change is still definitely there.

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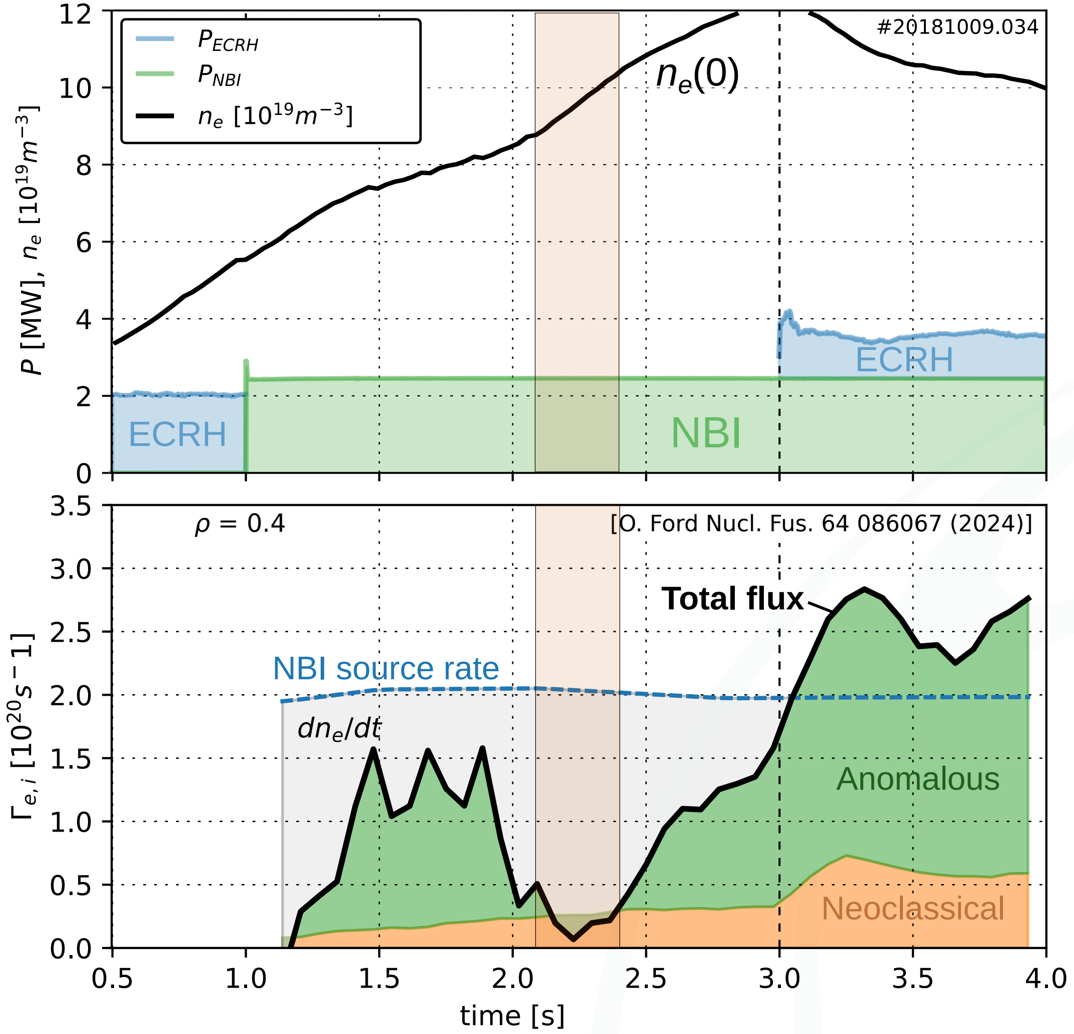

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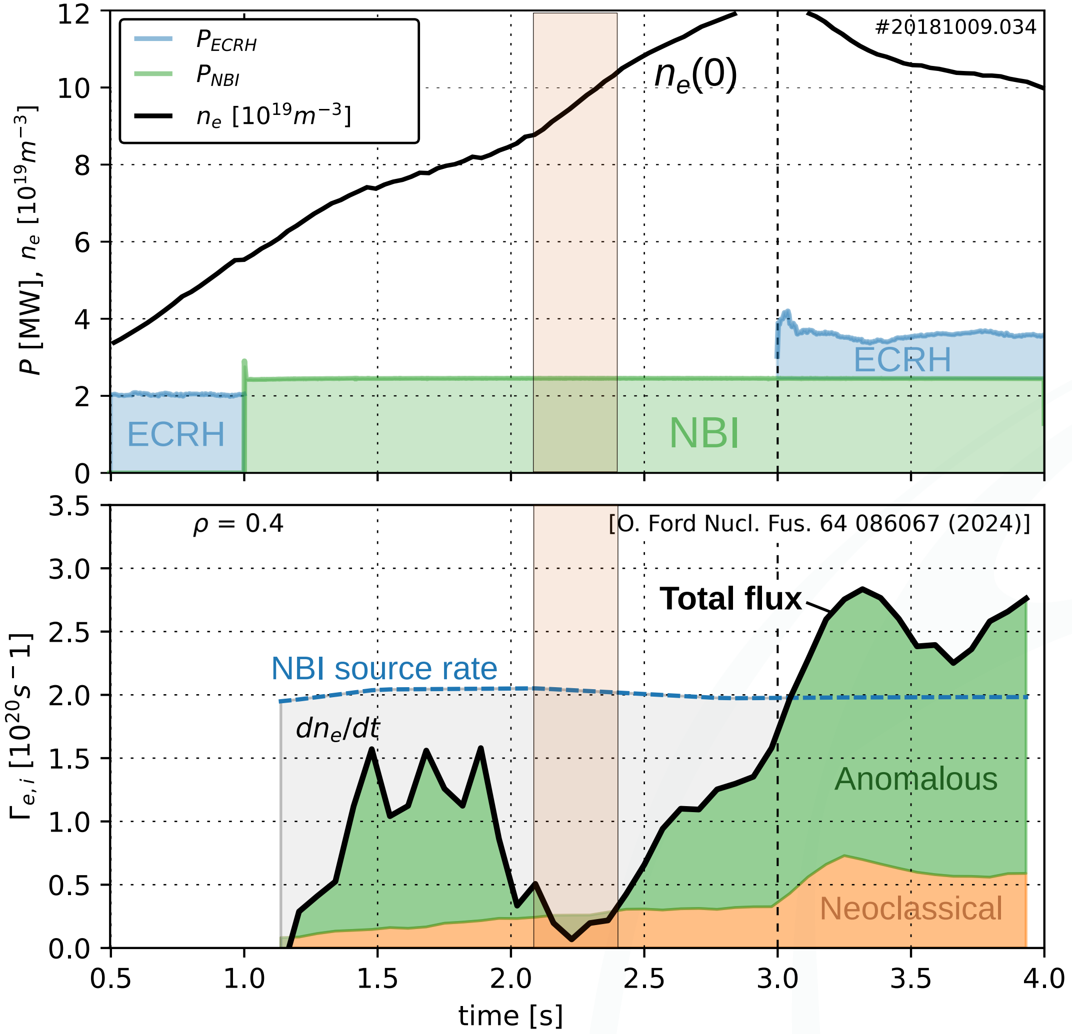

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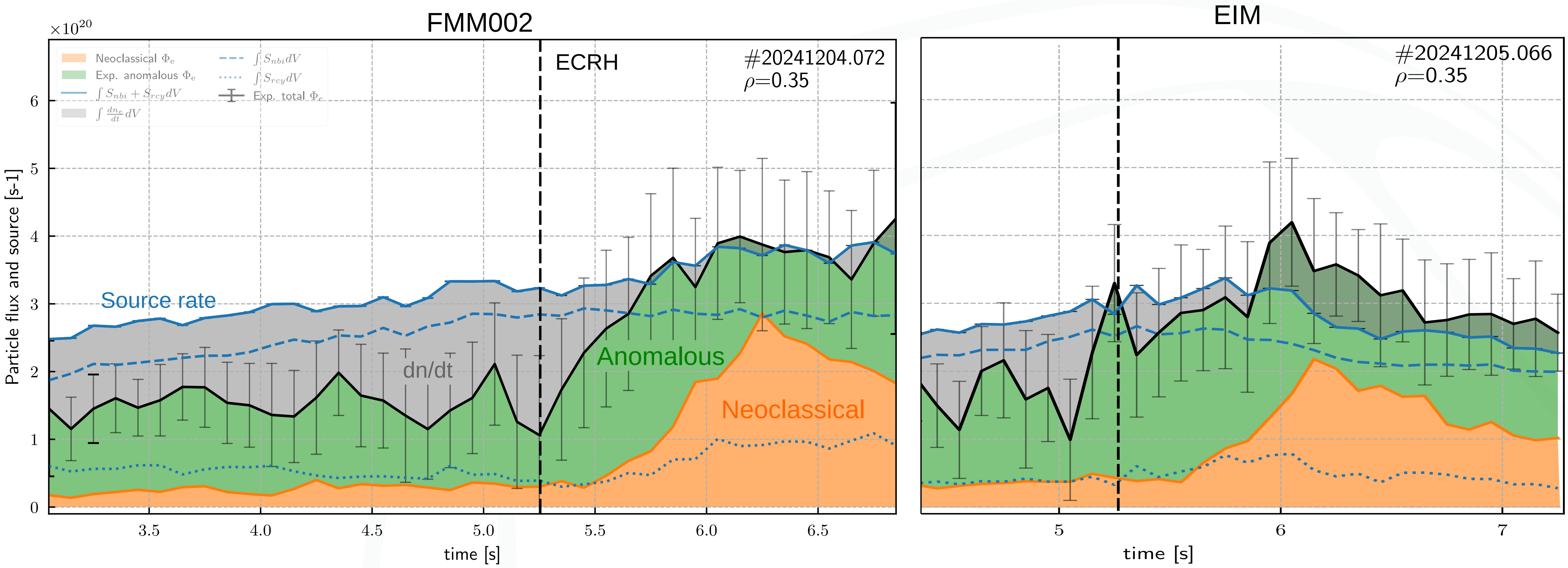
3) NBI power signal and dn/dt seem lower in OP2.2 than OP2.1, but calorimetry says power is the same.
--> Need BES validation again.

Particle fluxes

- Particle balances of some shots already done [S. Bannmann]
- Neoclassical particle flux is a big part of ECRH pump-out in reintroduction phase.
  However... not if configurations are different in neoclassical, anomalous or even source (edge density).



Summary

- Overview of the ECRH reintroduction scenario.
    - High T_i / W_{dia} achieved given density gradient in core.
    - Each configuration has a specific ECRH/NBI balance to maintain the density gradient.

- Record shot had three main ingredients:
    1) Balance ECRH pump-out. Use FMM002 has balance with maximum ECRH power.
    2) Tune field strength for best ECRH absorption to avoid sniffer interlock.
    3) Supress/shrink islands in FMM002 to avoid T_i flattening.

- Data analysis beginning. Spreadsheet of 43 reintroduction shots with main values.
- Lots of data to still be carefully checked:
    - Interferometry corrections
    - NBI power / particle deposition.
    - Good TS profiles
    - T_i profiles from main CXRS and CICERS.
    - E_r profiles from CXRS and DR
    - Particle balance
    - Power balance
    - Turbulence simulations