EUROPEAN FUSION DEVELOPMENT AGREEMENT

Advances in sawtooth control for NTM prevention in JET

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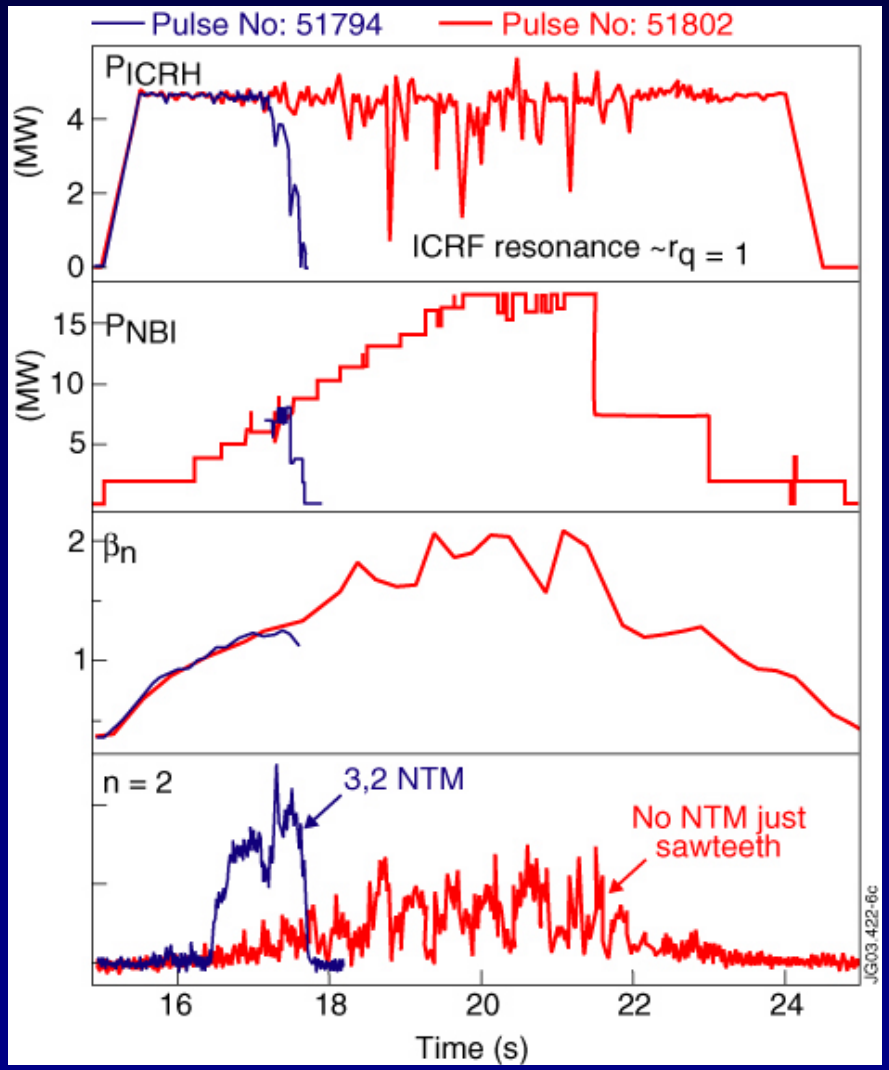
Outline

- NTM triggering by long sawteeth
- Sawtooth destabilization by ICCD
- Sawtooth destabilization by counter-NBI

Long sawteeth trigger (3,2) NTMs at low β_N



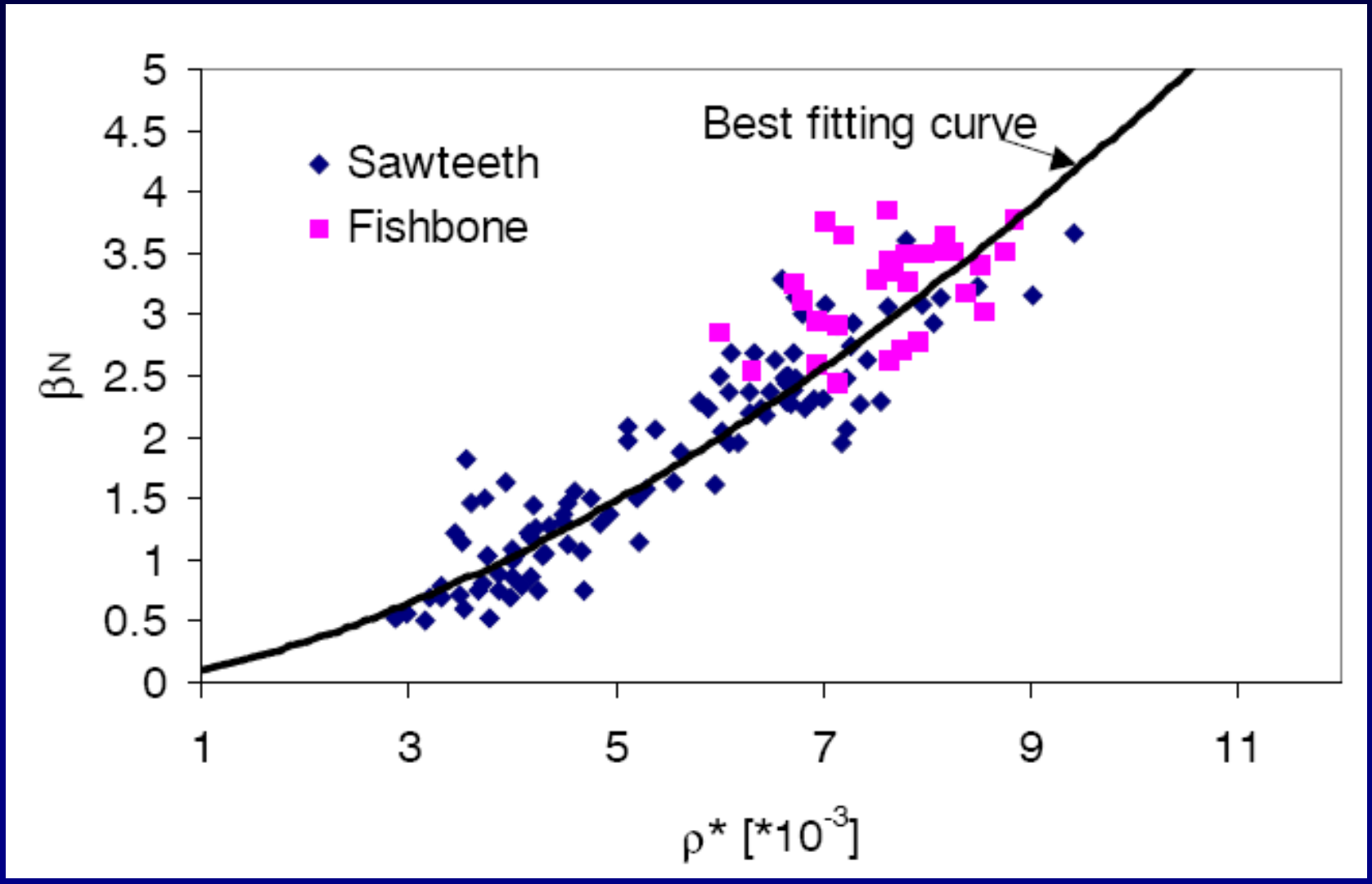
Avoidance strategy:

destabilize sawteeth

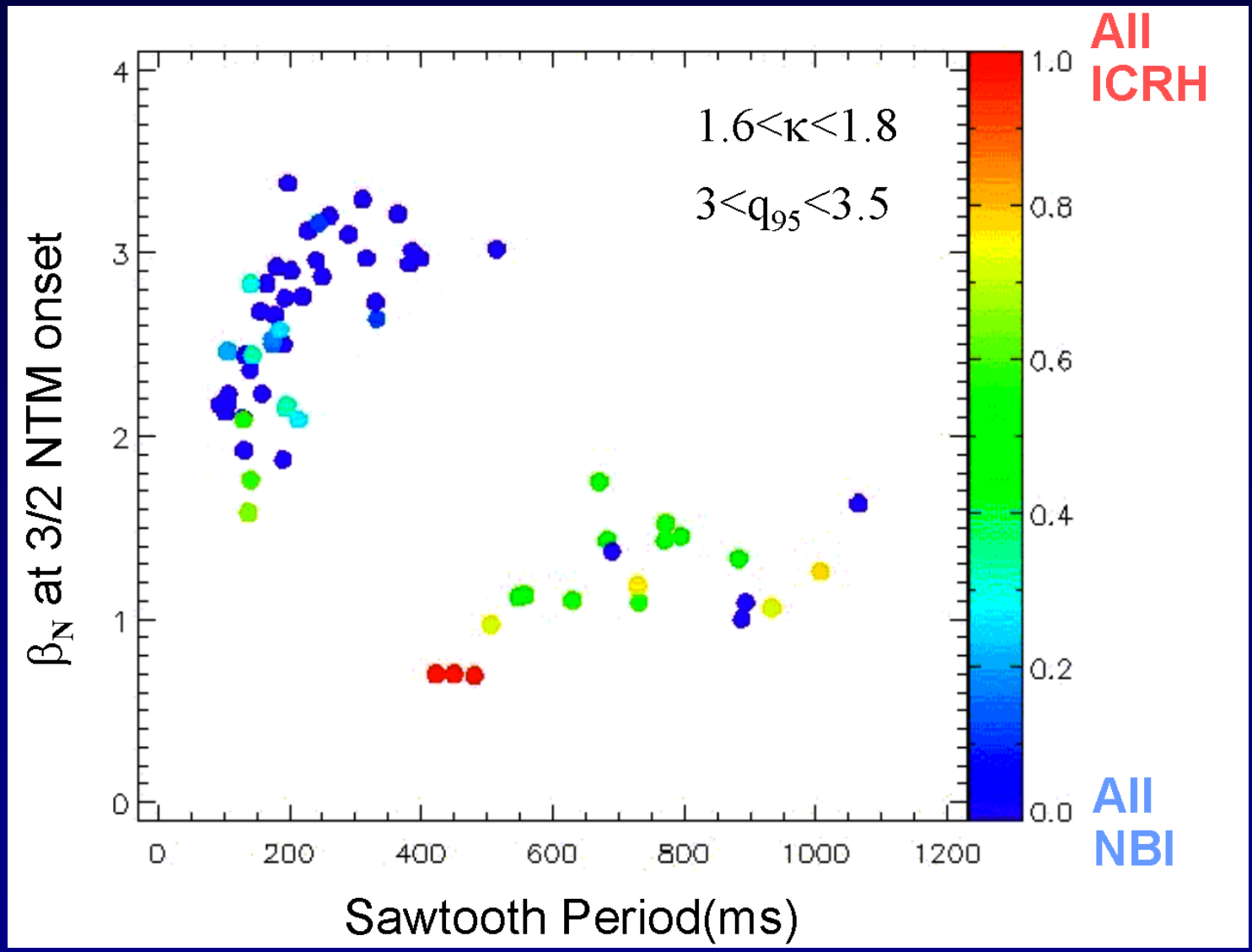
⇨keep seed island small

*O. Sauter et al., PRL **88**, 105001 (2002)*

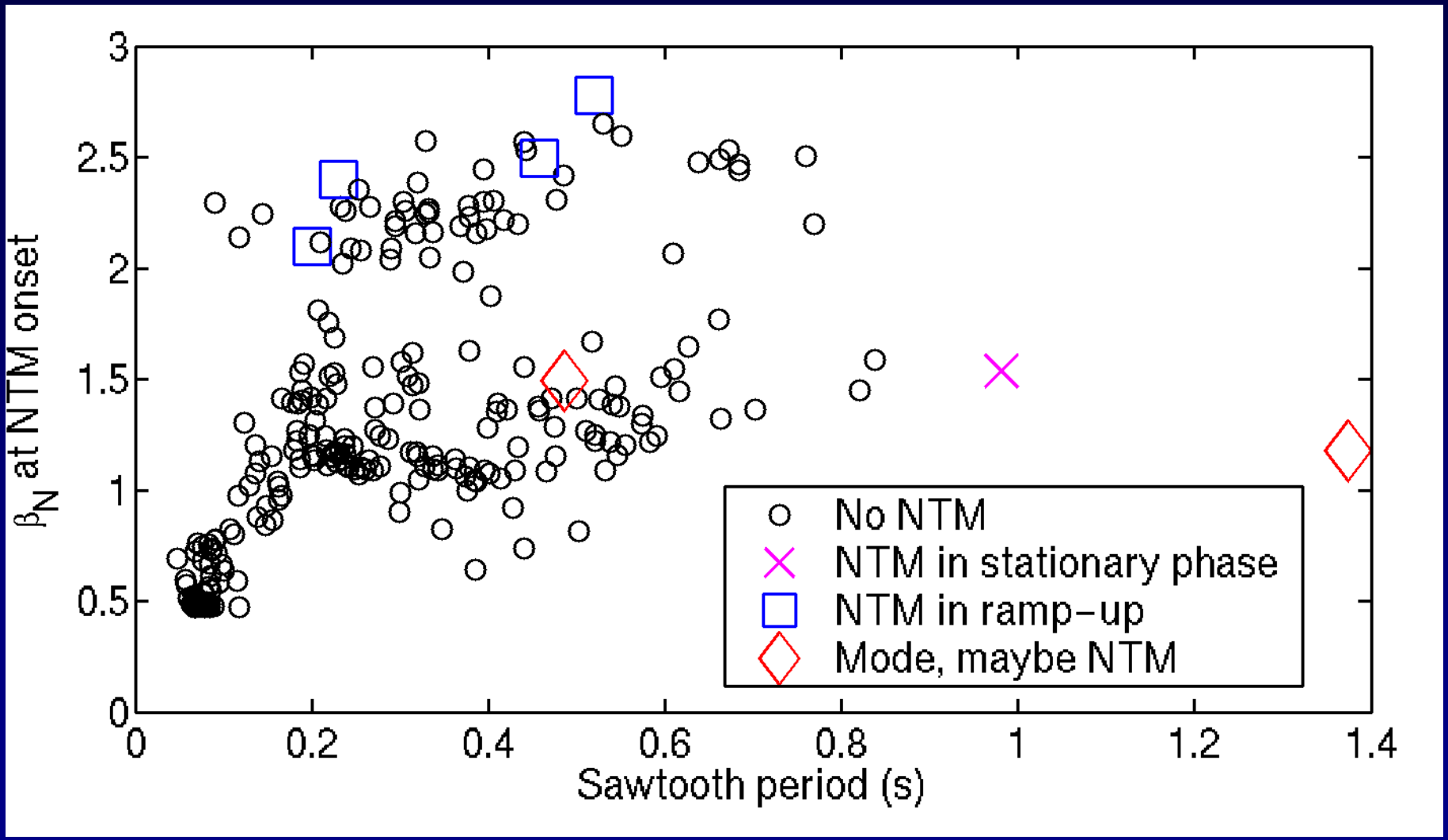
Fishbones are less of a concern



Discrete jump in β_N at long T_{st}…

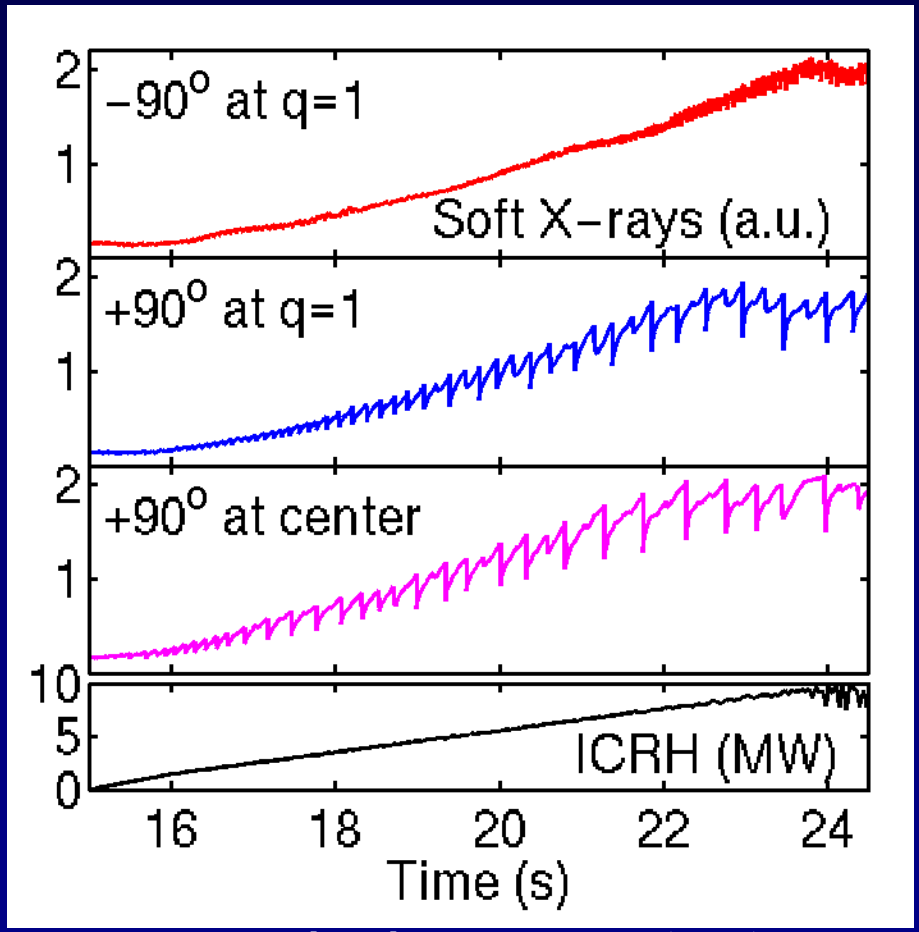


…but β_N vs. T_{st} not really so simple

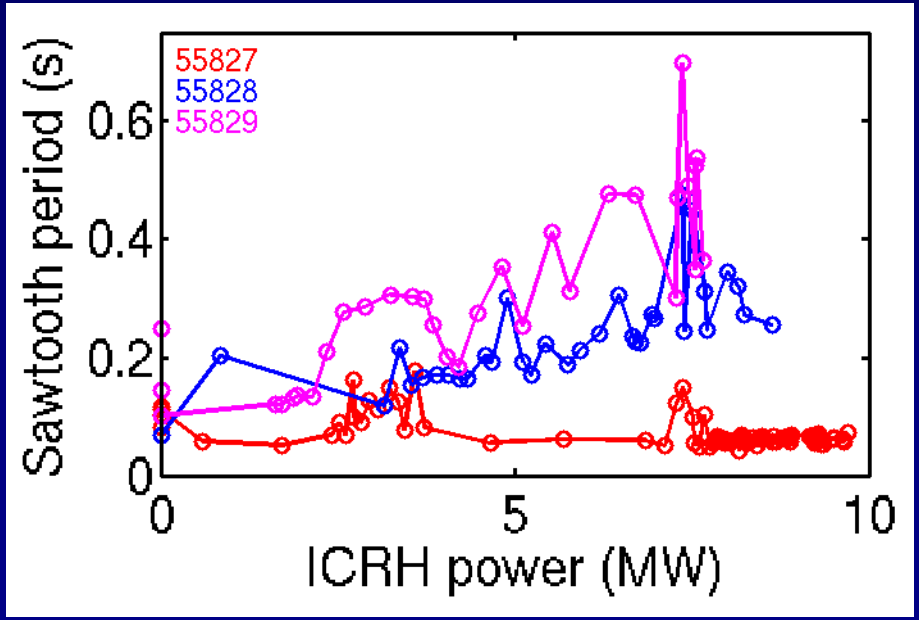


ICRH control of sawtooth period

- $+90^0$ at center: max fast-ion stabilization
- -90^0 at q=1: max ICCD destabilization

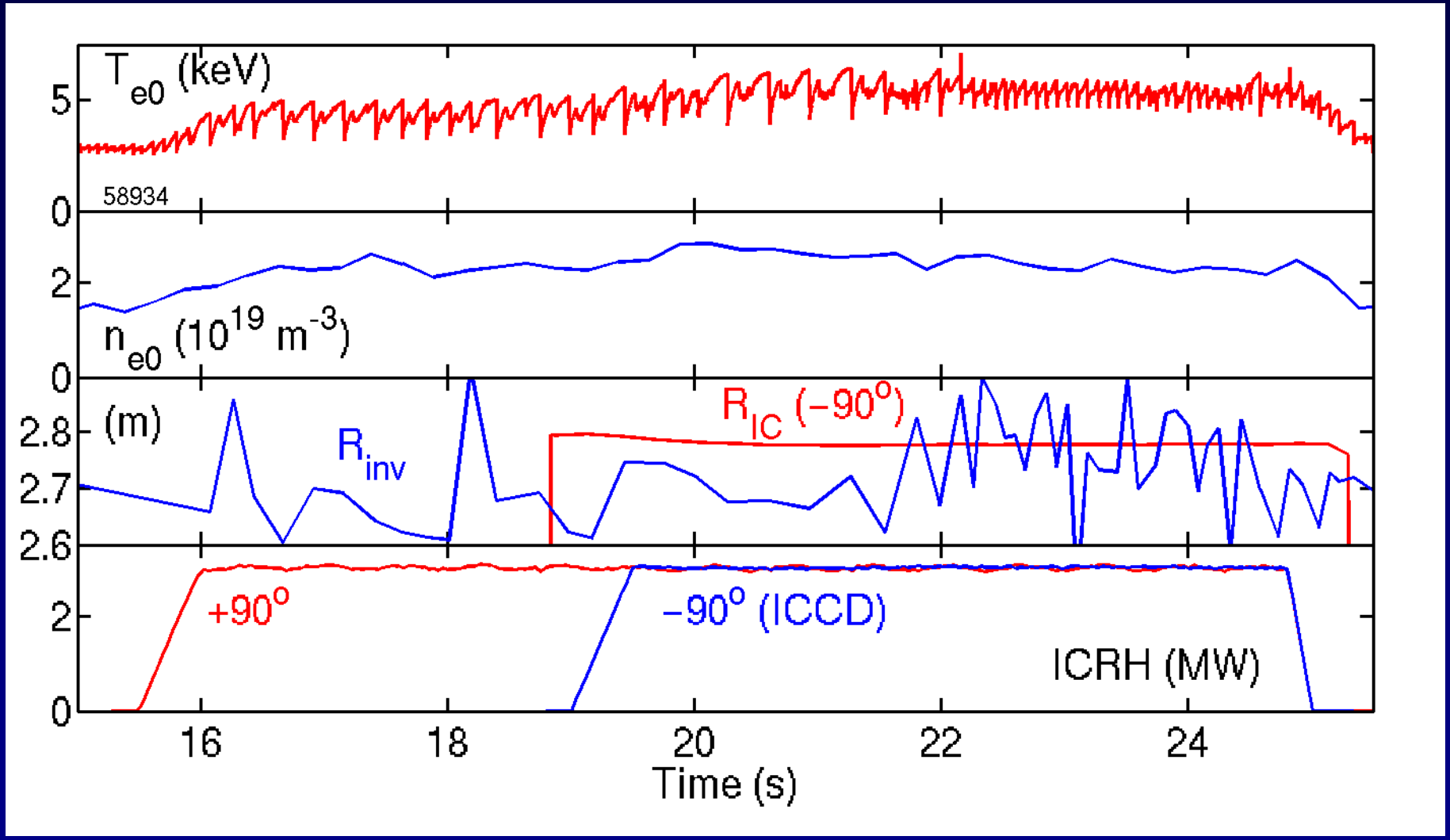


Both effects increase with ICRH power



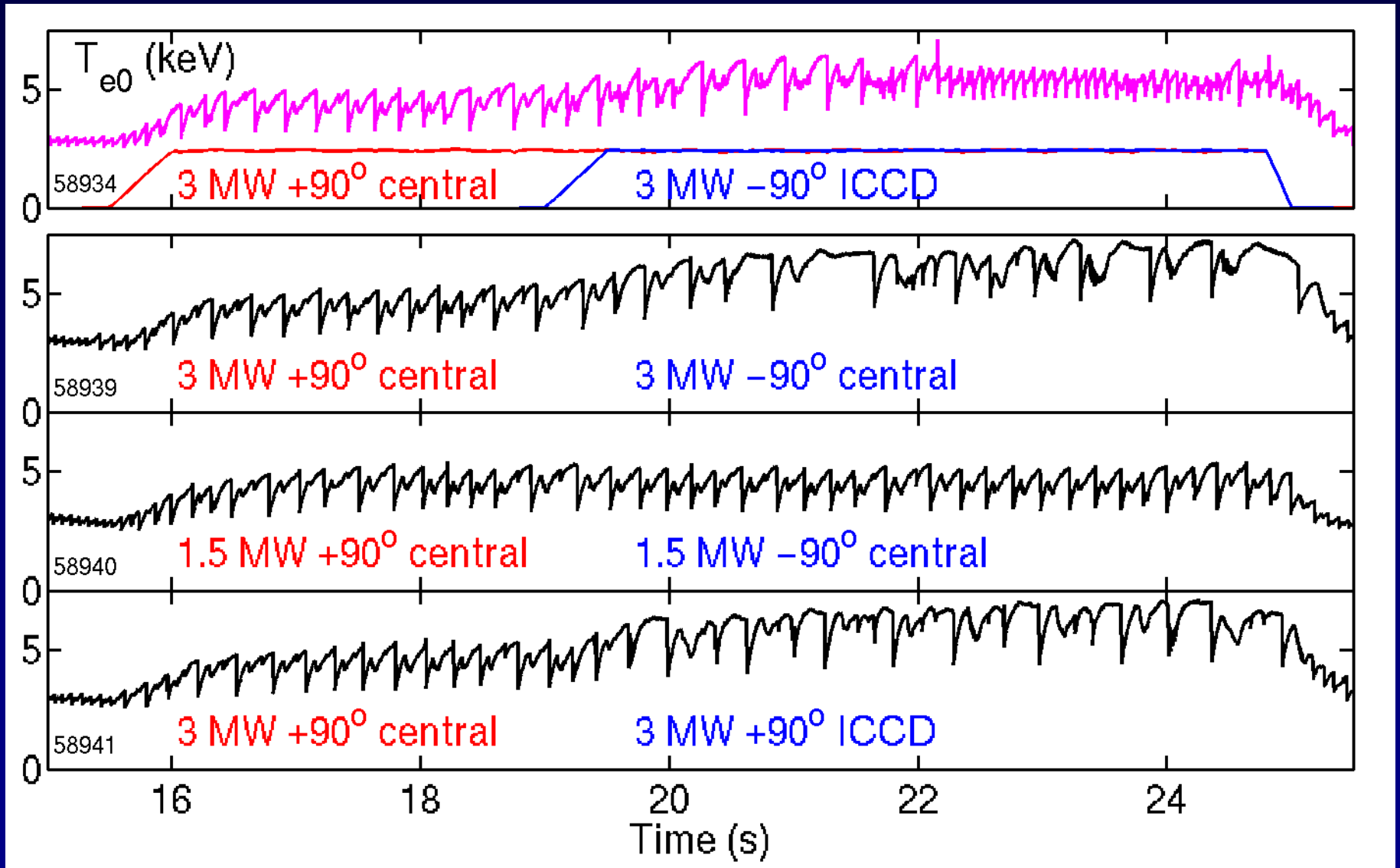
*M.-L. Mayoral et al., PoP **11**, 2607 (2004)*

ICCD destabilization of fast-particle-stabilized sawteeth

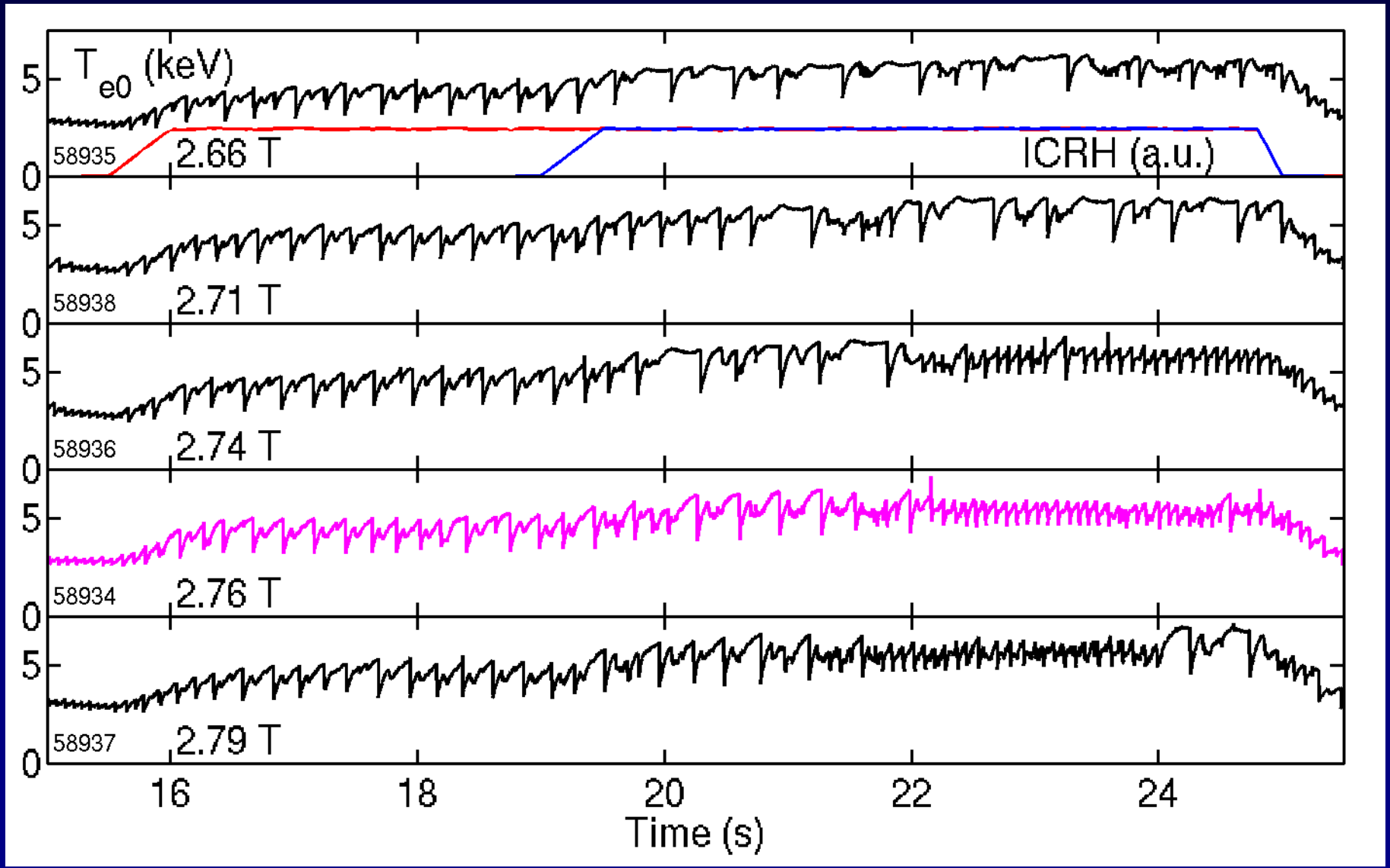


*L.-G. Eriksson et al., PRL **92**, 235004 (2004)*

Control experiments: fast ions vs. ICCD

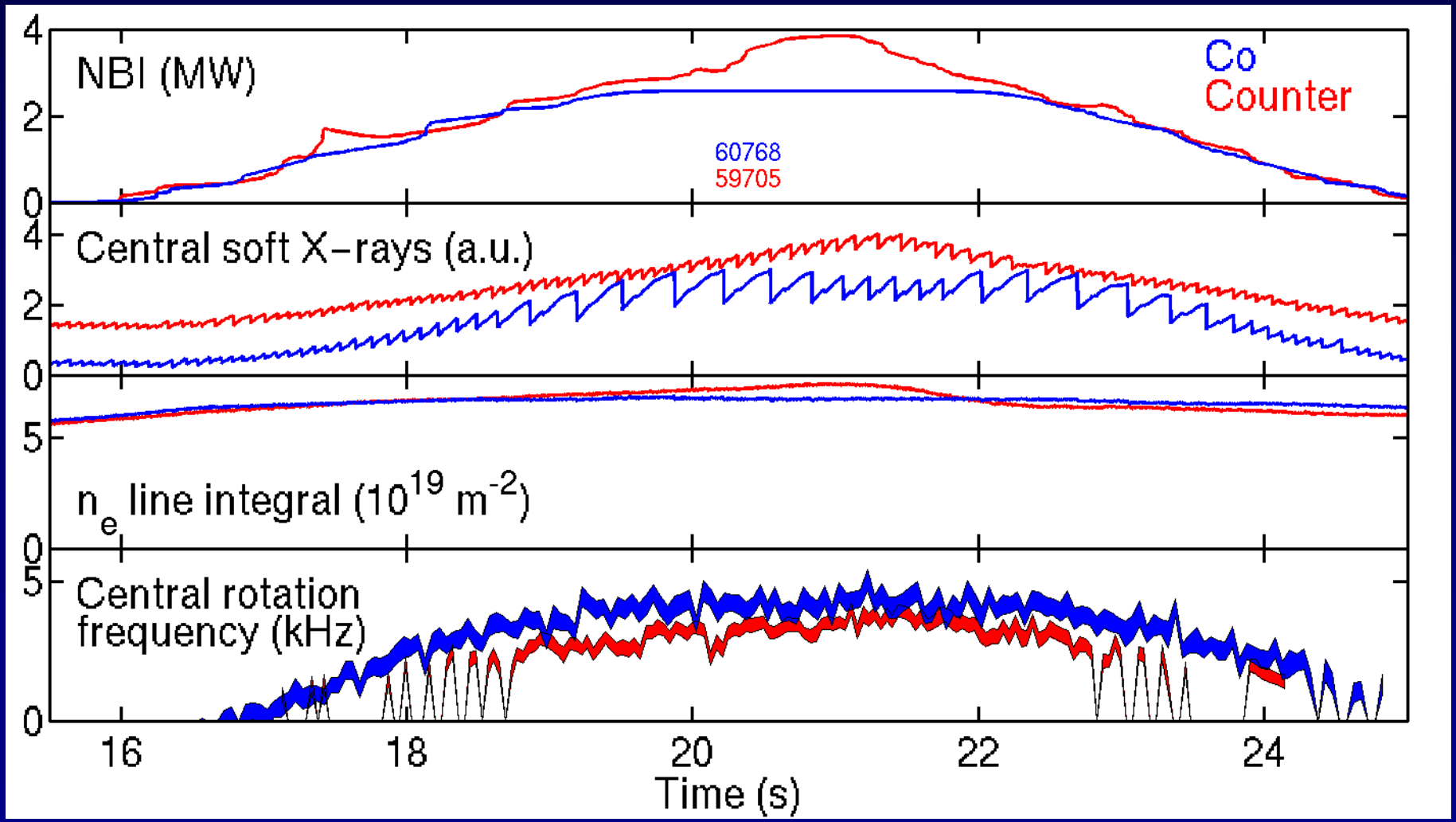


Control experiments: B-field scan



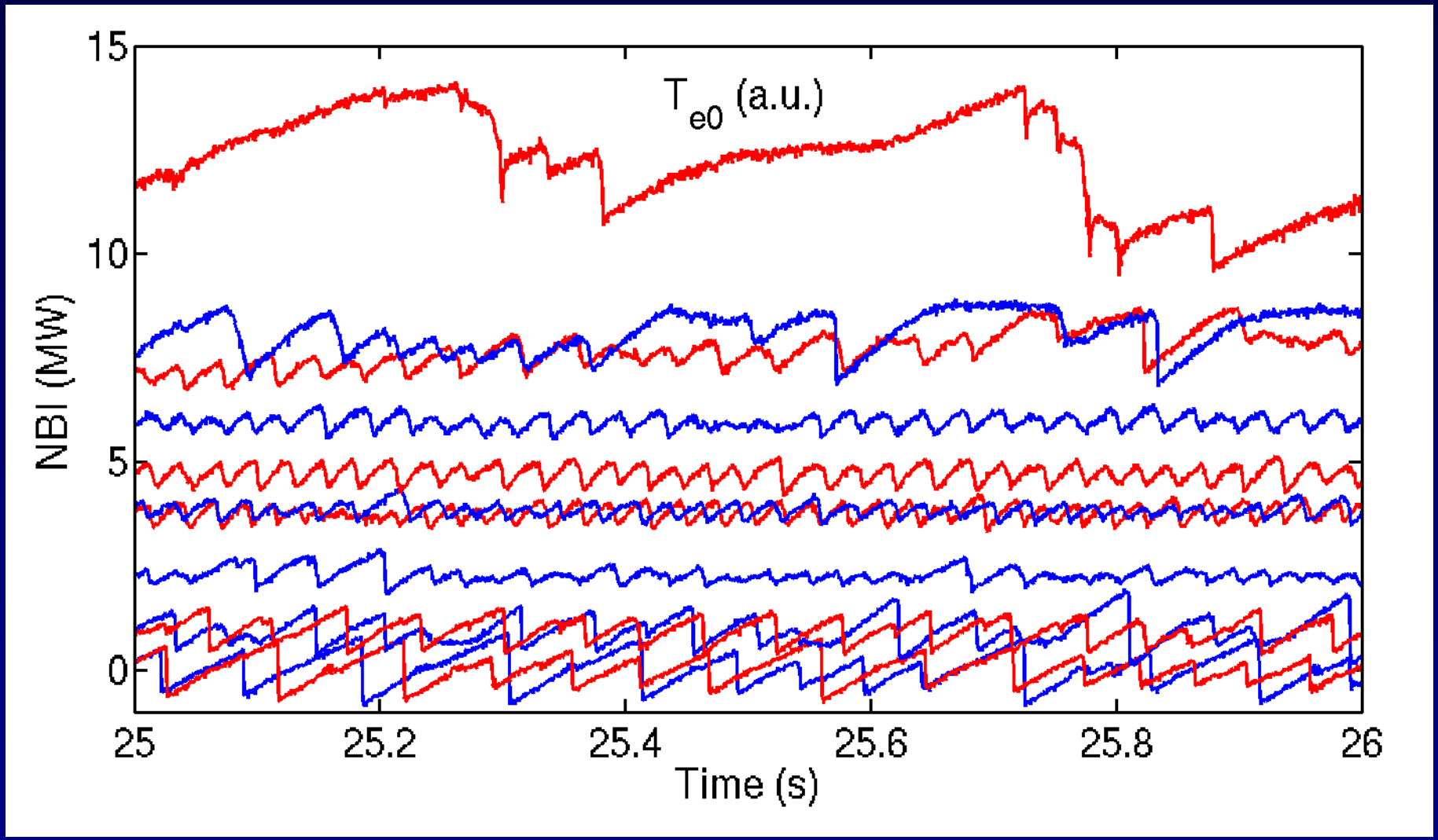
Sawtooth destabilization by counter-NBI

- Sawteeth shorter with counter- than co-NBI

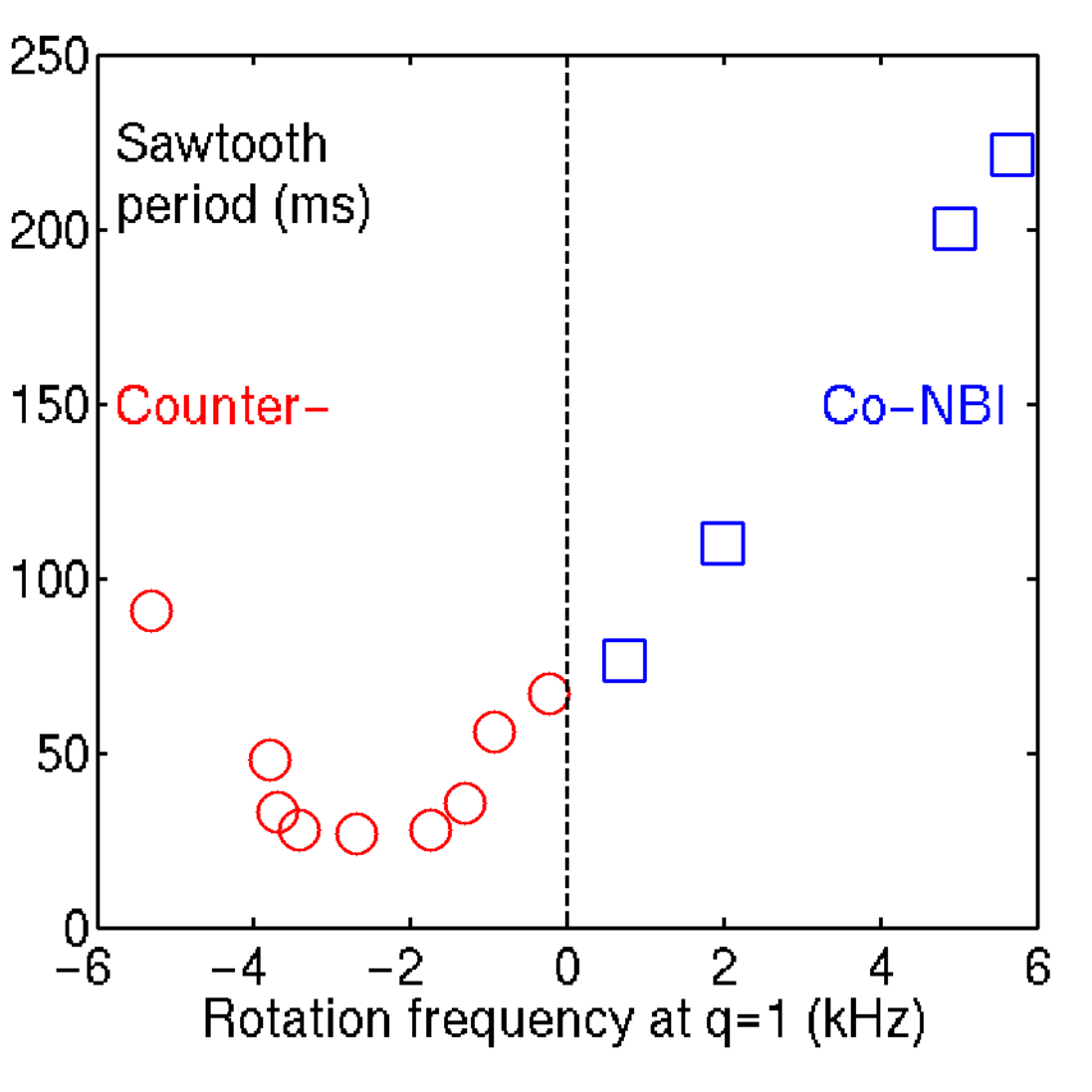


Rotation scan in counter-NBI

- Sawtooth period is minimum at P~4 MW



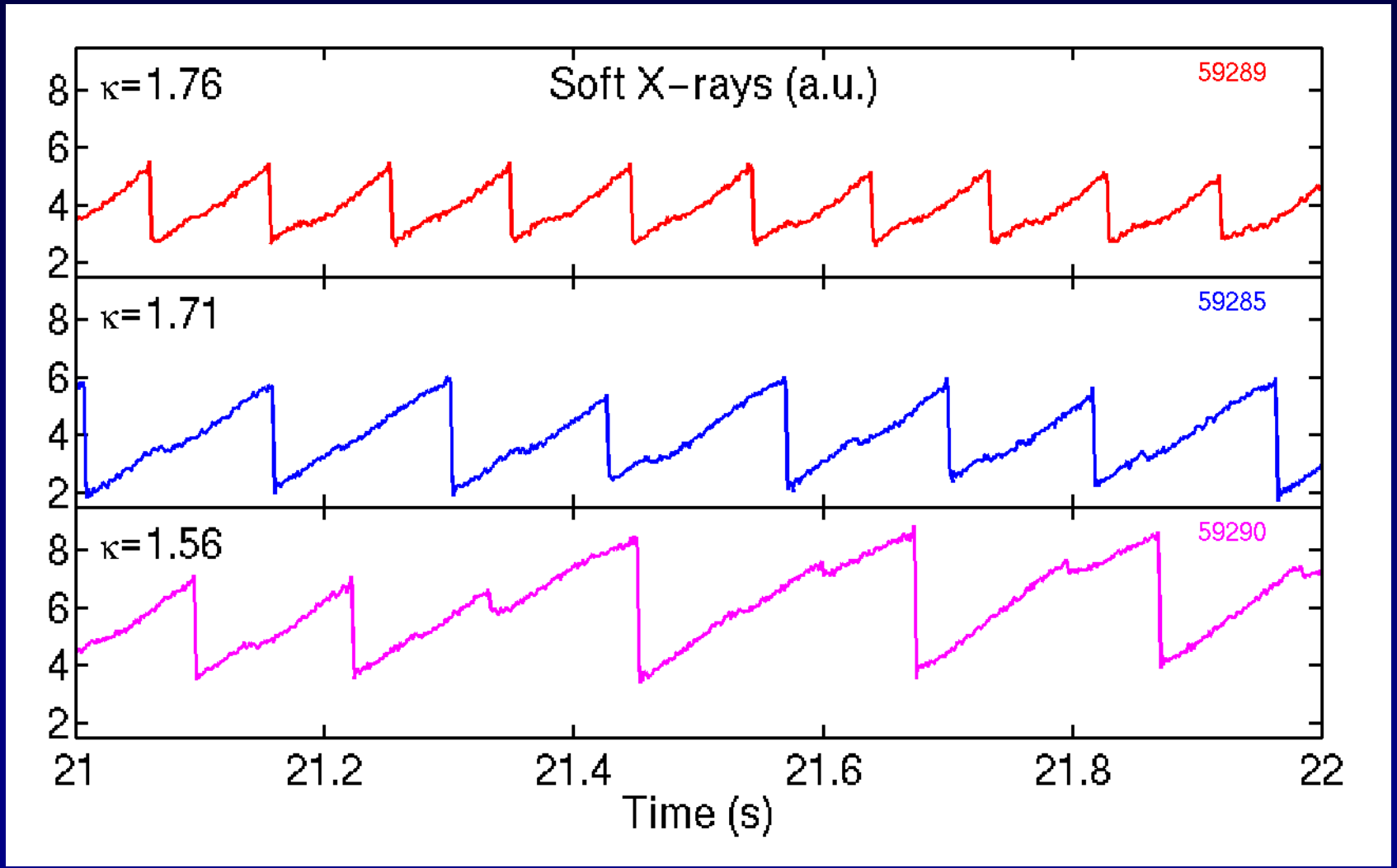
Minimum T_{st} found at finite rotation



Explanation?

- NBCD unlikely
- Fast ions unlikely
- Promising candidate: internal kink stabilization by sheared rotation

Shape also affects sawteeth



Conclusions

- NTMs are expected to be excited in ITER by long sawteeth stabilized by α-particles
- ICCD at q=1 has been proven to be an effective means of shortening sawteeth, even with large fast-ion pressure, thus preventing NTMs
- Additional sawtooth destabilization tools demonstrated on JET: rotation in counter-NBI and higher elongation

Plans for coming campaigns

- Demonstrate NTM prevention scenario with combined sawtooth stabilization/destabilization scheme
  - Attempt feedback on ICRH frequency for scenario optimization
  - Use new ICRH antenna for better coupling during ELMs
- Further characterize NTM triggering in a wider range of plasma parameters