COMPASS
INSTITUTE OF PLASMA PHYSICS ASCR

Investigation of pedestal stability in edge plasma region of the COMPASS tokamak

Miroslav Sos[1,2,*], Matej Peterka[1,3], Samuli Saarelma[4], Petr Bohm[1], Petra Bilkova[1], Jan Hecko[1,2], Tomas Markovic[1,3], Ondrej Grover[1,2], Jakub Seidl[1], Ondrej Kovanda[1], Vladimir Weinzettl[1], Martin Hron[1]

[1]Institute of Plasma Physics of the CAS, v.v.i., Za Slovankou 1782/3, CZ-180 00 Prague 8, Czech Republic
[2]Faculty of Nuclear Sciences and Physical Engineering, Czech Technical University, Brehova 7, CZ-115 19 Prague 1, Czech Republic
[3]Faculty of Mathematics and Physics, Charles University, Prague, Czech Republic
[4]CCFE, Culham Science Centre, Abingdon, OX14 3DB, UK

* contact: sos@ipp.cas.cz

COMPASS TOKAMAK

- medium size tokamak: R = 0.56 m, a = 0.18 m
- B_T = 0.8–2.1 T, κ = 1.6, $I_p \leq$ 400 kA
- divertor plasma with ITER-like cross-section
- NBI heating – 2 × 300 kW
- H-mode both Ohmic and NBI assisted

THOMSON SCATTERING DIAGNOSTICS (TS) ON THE COMPASS TOKAMAK

- 4 Nd:YAG lasers – each λ = 1064 nm, E ≈ 1.5 J, 30 Hz, FWHM 7ns pulse

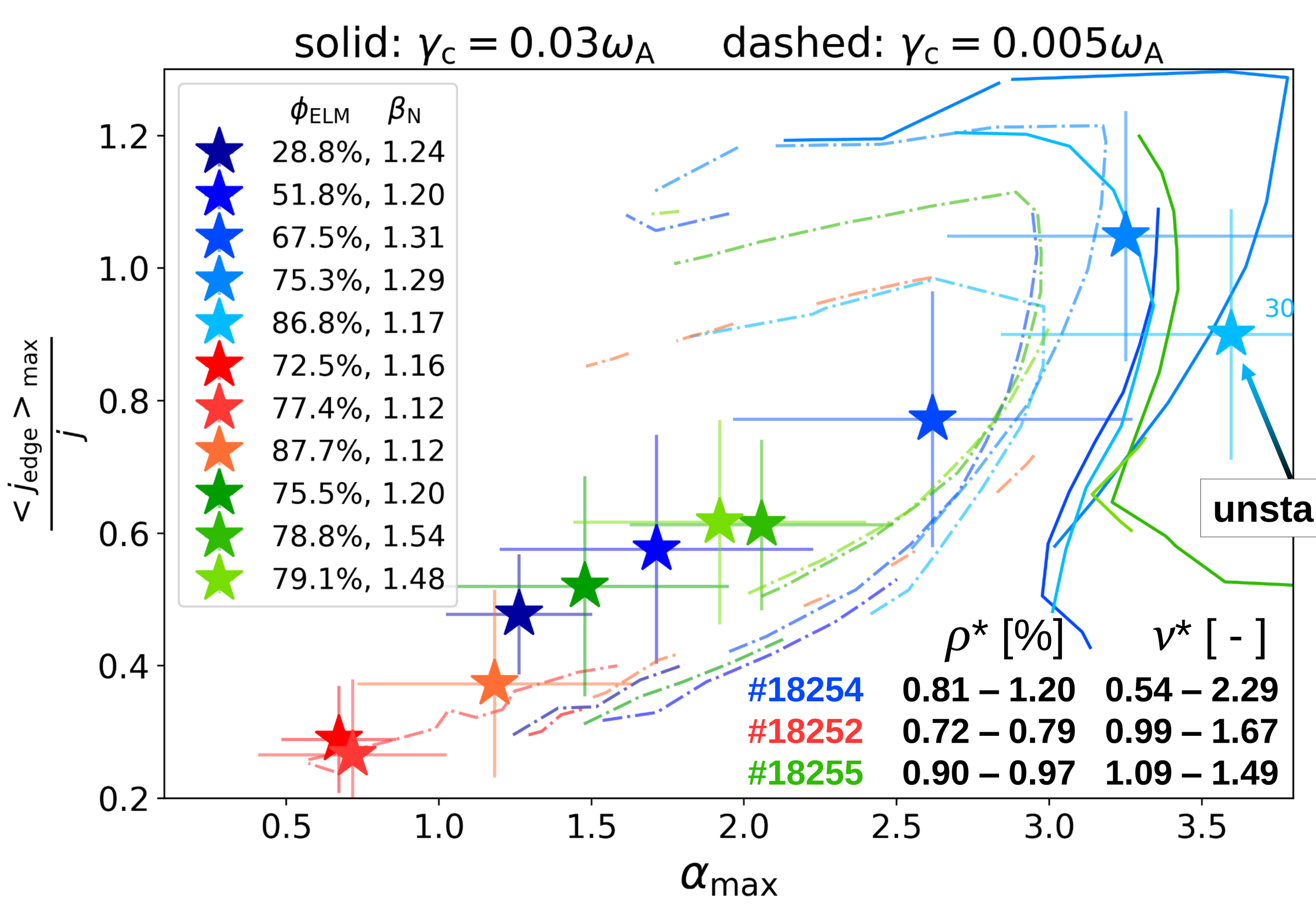
	Core TS	Edge TS
Field of view	-15 – 213 mm	215 – 322 mm
Spatial points	24	30
Resolution	9 – 12 mm	3.6 – 3.8 mm

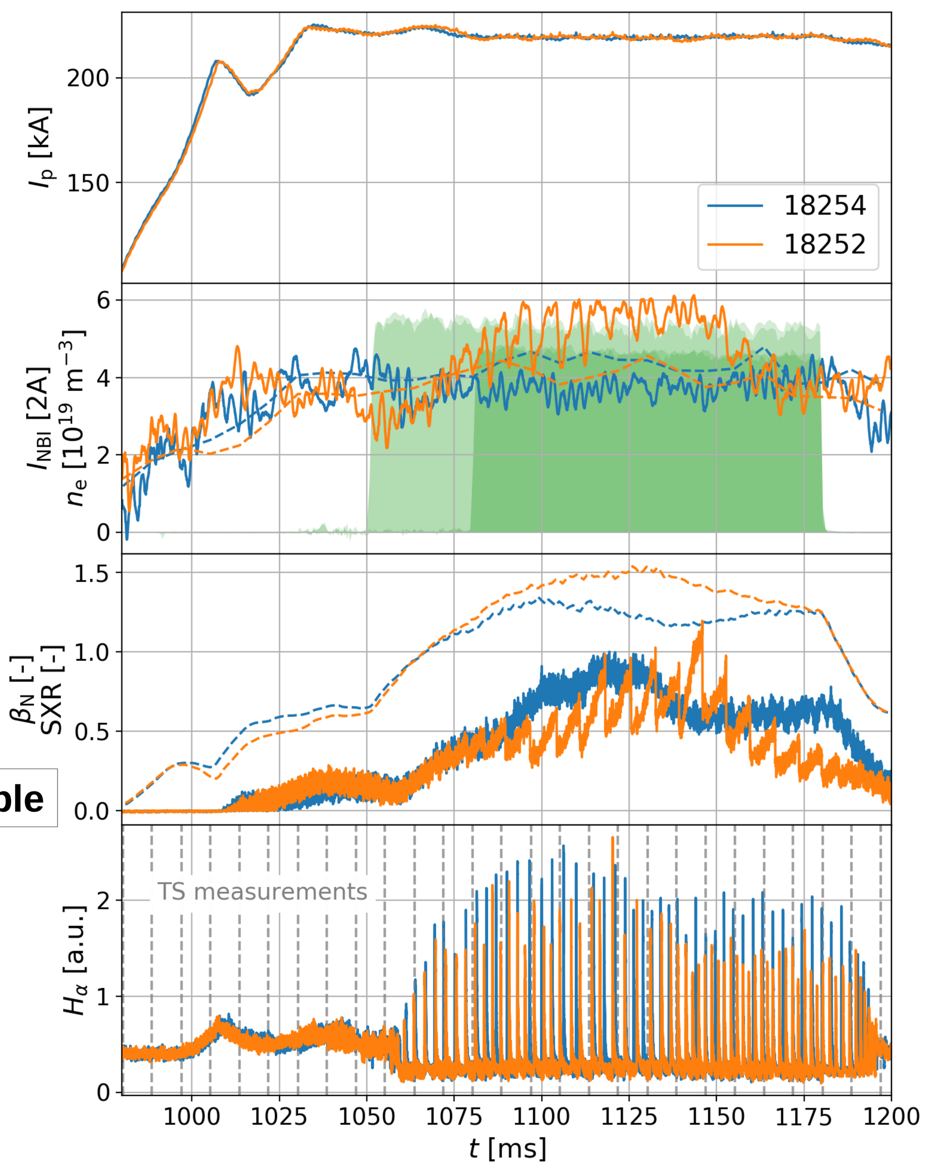
MOTIVATION

For most cases pedestal stability analysis of COMPASS tokamak discharges shows peeling-ballooning stable regime. Initial idea of studying higher triangularity discharges during ELM mitigation by RMP campaign revealed an outlaying result located in the PB unstable region. This case was further analysed in order to understand its physical aspects, which leads to establishing PB unstable case. Most significant impacts seems to be related to β_N evolution and strong MHD activity.

SCENARIO OVERVIEW AND THE METHOD OF PEDESTAL STABILITY ANALYSIS

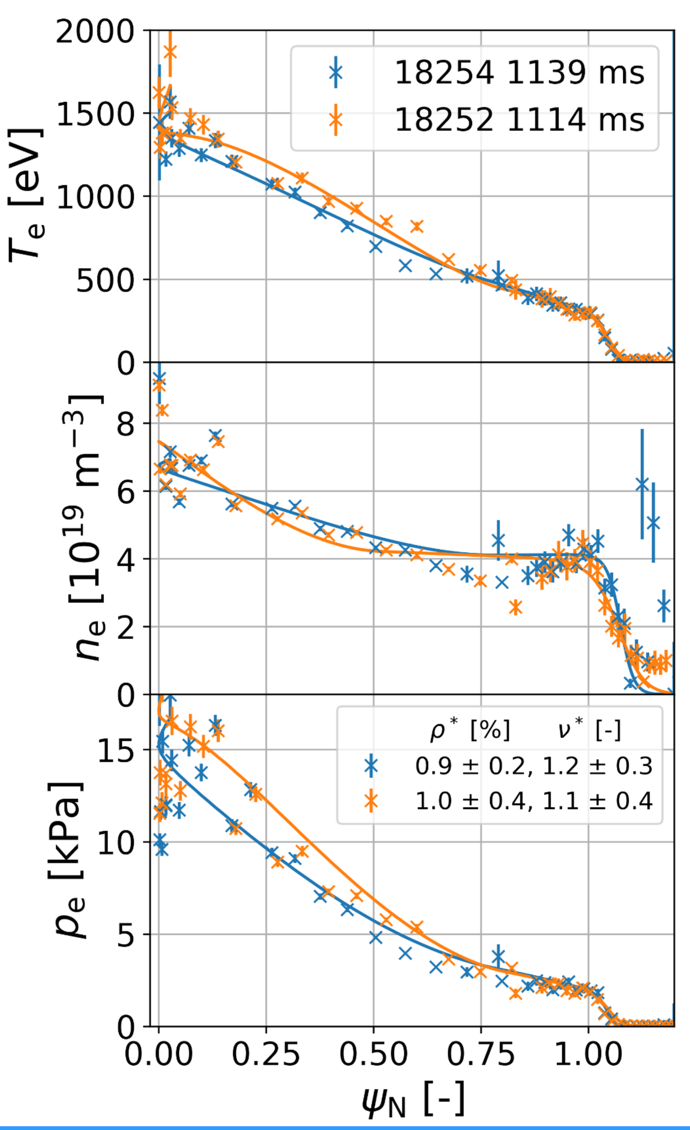
- Several COMPASS discharges from same campaign analysed
  I_p = 220 kA, B_T = 1.5 T, $n_e \approx 4\cdot10^{19}$ m^{-3}, $q_{95} \approx 3.7$, two **NBIs** ≈ 300-350kW)
- Equlibrium code HELENA + MHD codes ELITE/MISHKA
  => the pedestal stability
- PB boundary given by γ_{crit} (usually 3% of Alfén frequency)
- **Stability analysis shows consistent results from variety of COMPASS discharges at different parameters and ELM phase**
- PB boundary and the operational space (α_{max}, j_{edge}) well mapped

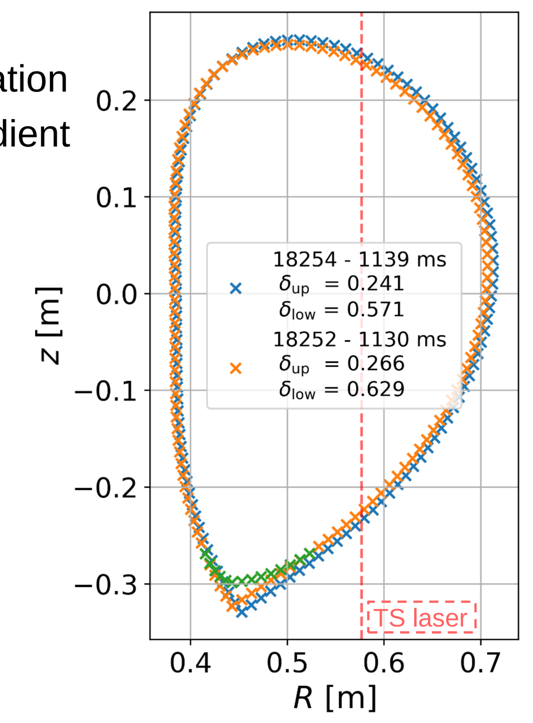


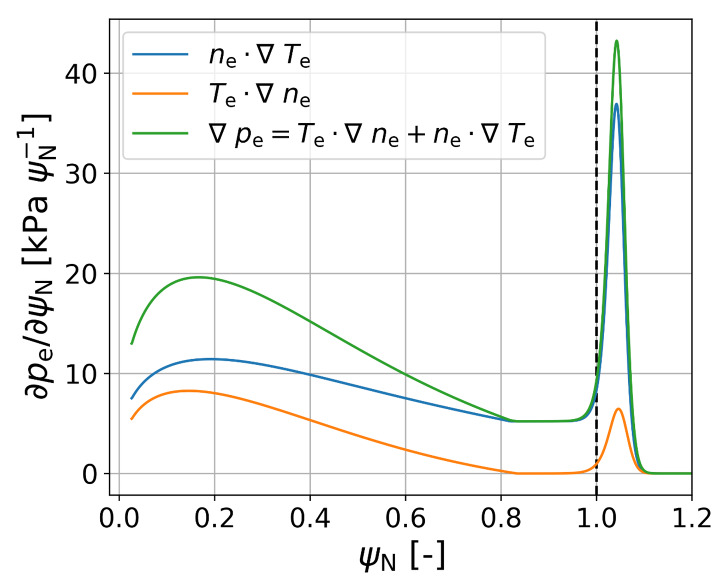


INPUTS FOR THE STABILITY ANALYSIS

- T_e and n_e profiles <= TS with 120 Hz resolution
- Plasma boundary + ψ_N (approx.) <= EFIT calculation
- Pedestal pressure gradient mostly given by T_e gradient

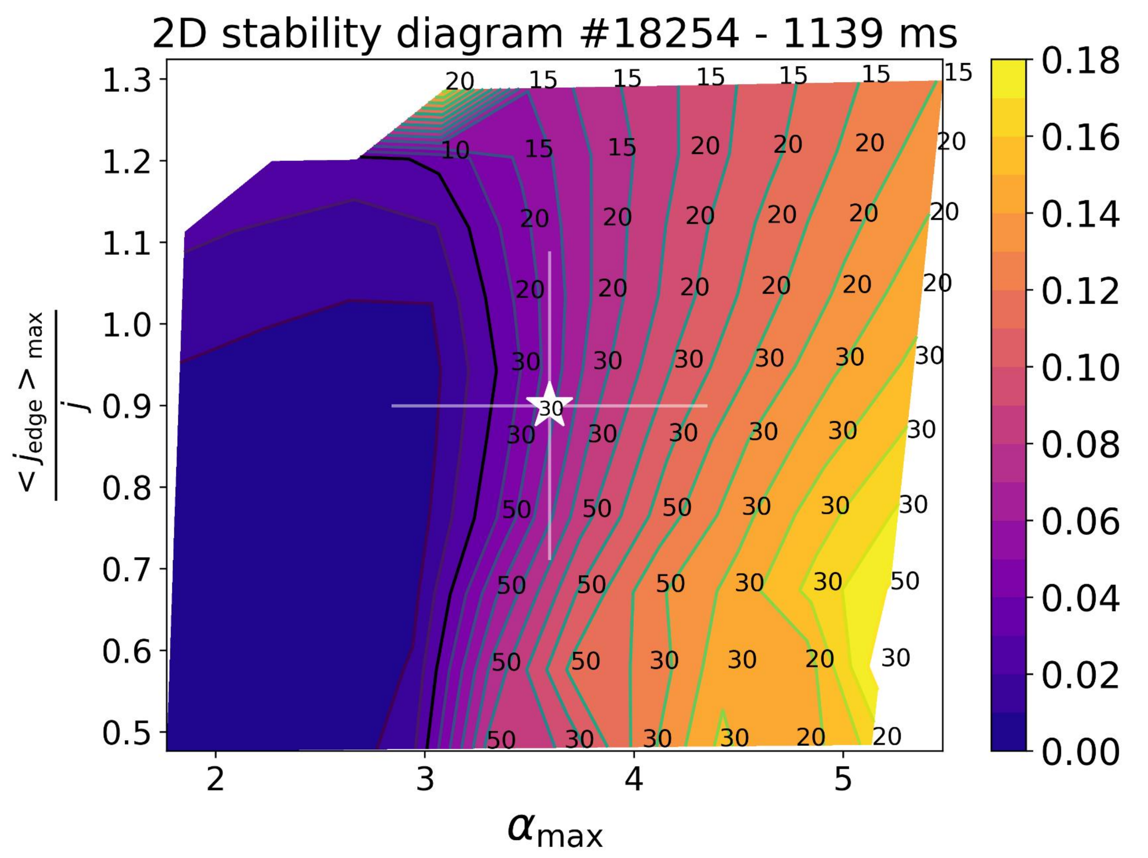






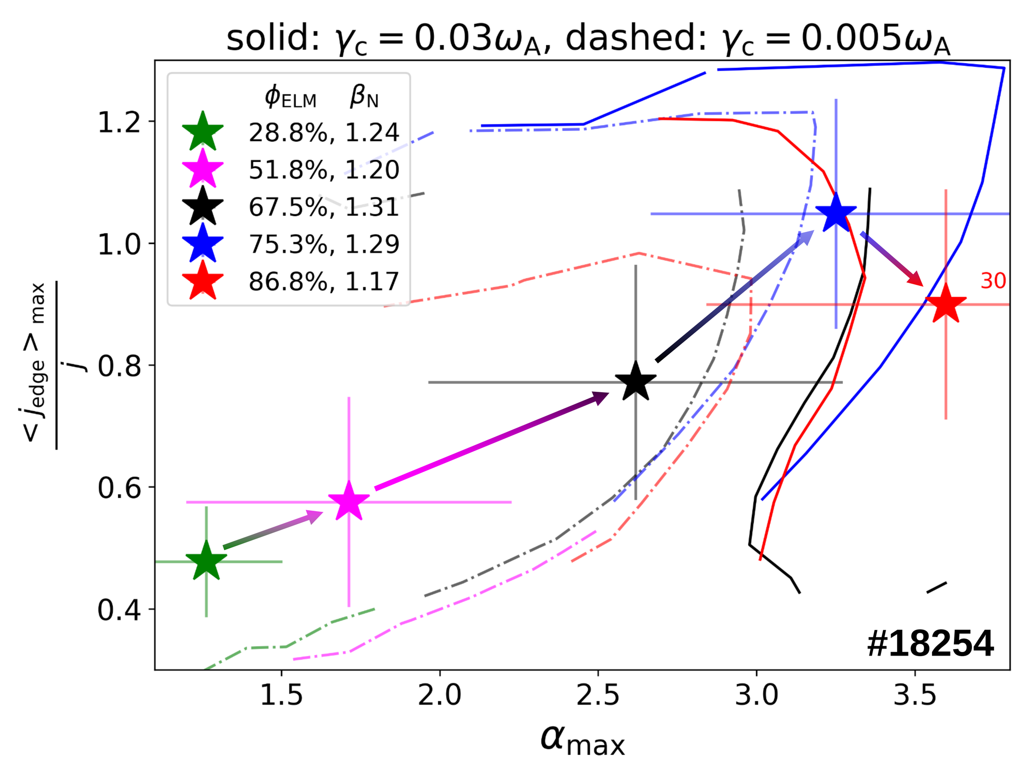
EXTRAORDINARY CASE ON THE PB BOUNDARY

- One of a kind **outlying case** observed over the PB boundary
- P_{NBI} ≈ 700kW, low β_N **= 1.17**, last 15% of ELM cycle



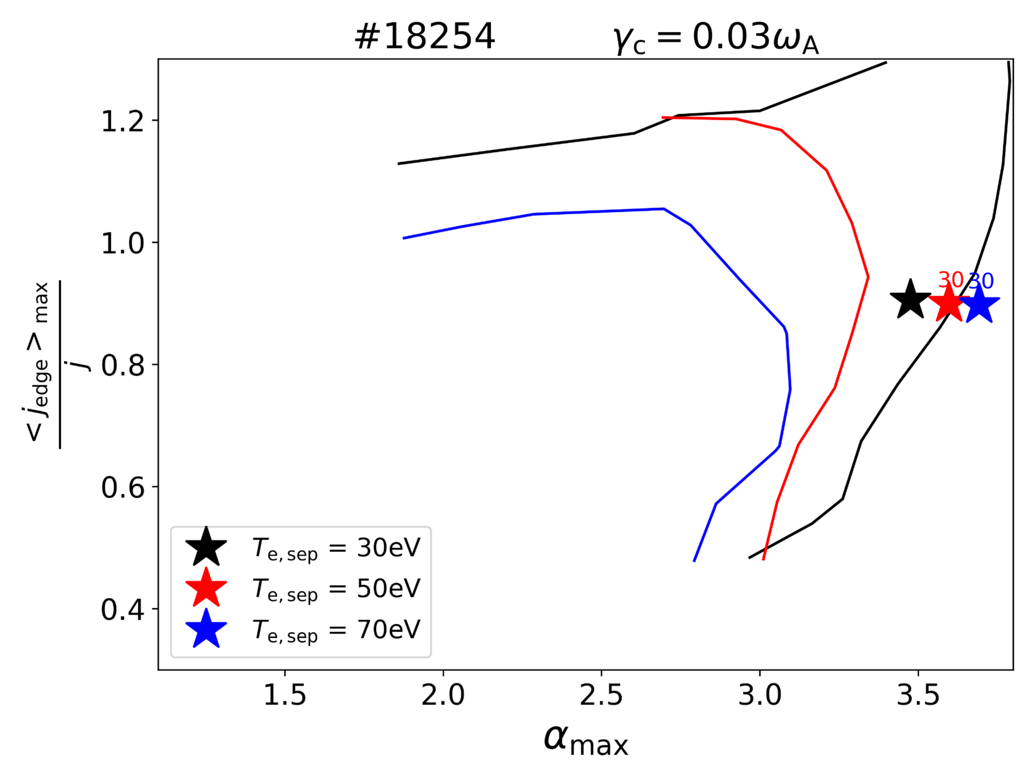
INTER-ELM EVOLUTION OF PEDESTAL

- Evolution of PB boundary with reference to ELM cycle phase
- When approaching ELM both pressure and edge current gradients are increasing (from **green** to **blue**)
- Then β_N **drops**, PB boundary is shifted => becomes unstable



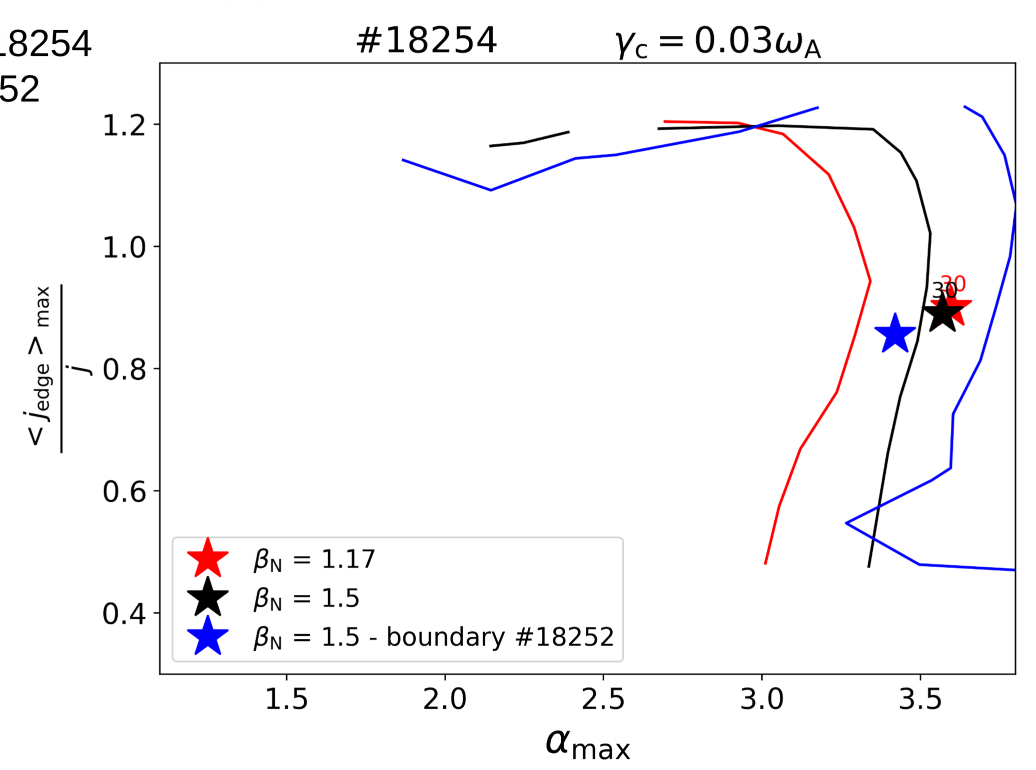
EFFECT OF SEPARATRIX TEMPERATURE

- EFIT does not provide proper sep. position => T_e profile shifted to match given $T_{e,sep}$ (density shifted accordingly)
- Scan of $T_{e,sep}$ (30 – 70 eV) => stabilization by lower $T_{e,sep}$
- **Reasonable value of $T_{e,sep}$ = 50eV was chosen for all cases**



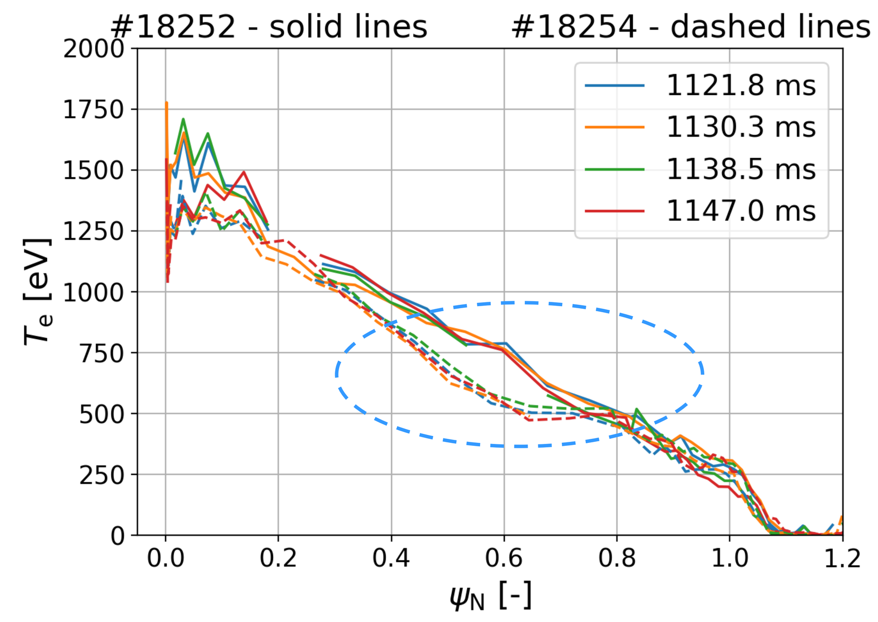
IMPACT OF HIGHER β_N ON THE PB BOUNDARY

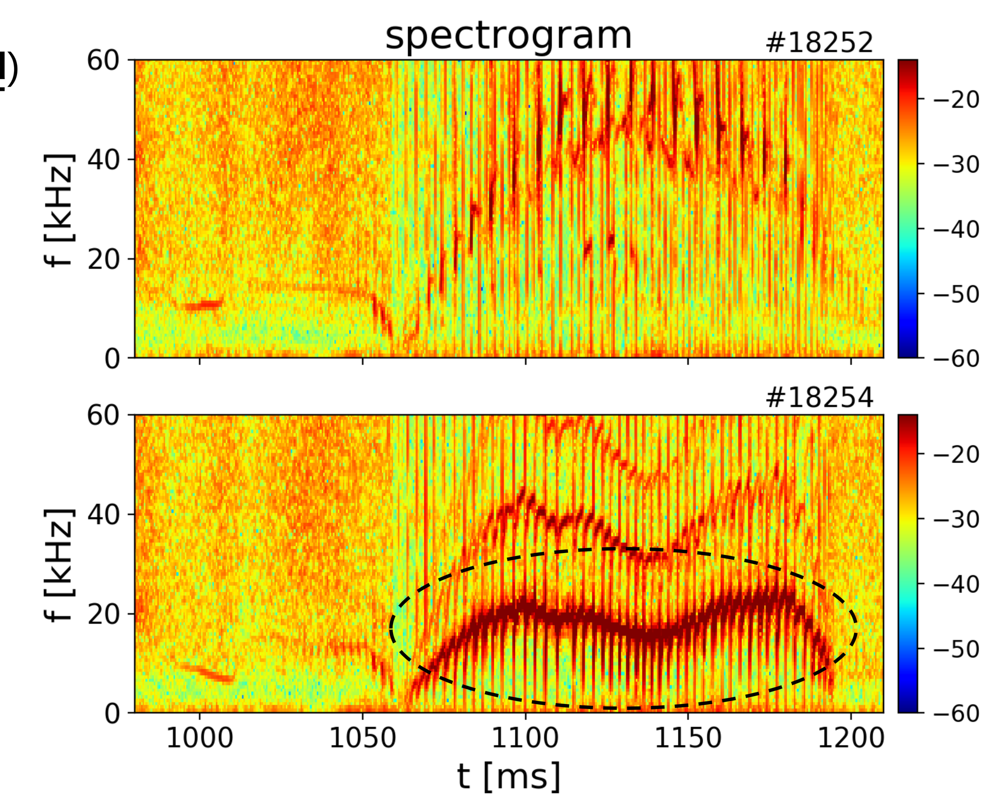
- Model situation for exp. case #18254
  => increased β_N to match #18252
- In the second case #18252 EFIT boundary used
- Significant shift of PB boundary
- Position of experimental point almost unchanged
- Increase of β_N
  => not only responsible for PB bound. behaviour



STRONG MHD ACTIVITY

- Well observed MHD activity (**magnetic island**) during #18254 on Mirnov coils
- T_e profile (TS) flattened at $\psi_N \approx 0.7$ (where $q \approx 2$)





SUMMARY

- First promising results were obtained using pedestal stability analysis
- Several cases within one experimental campaign **show comparable results – PB stable**
- Extraordinary case on the PB boundary => low β_N does not clarify => thorough analysis required to understand reasons and consequences of this case

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