



MHD stability of JT-60SA Scenarios

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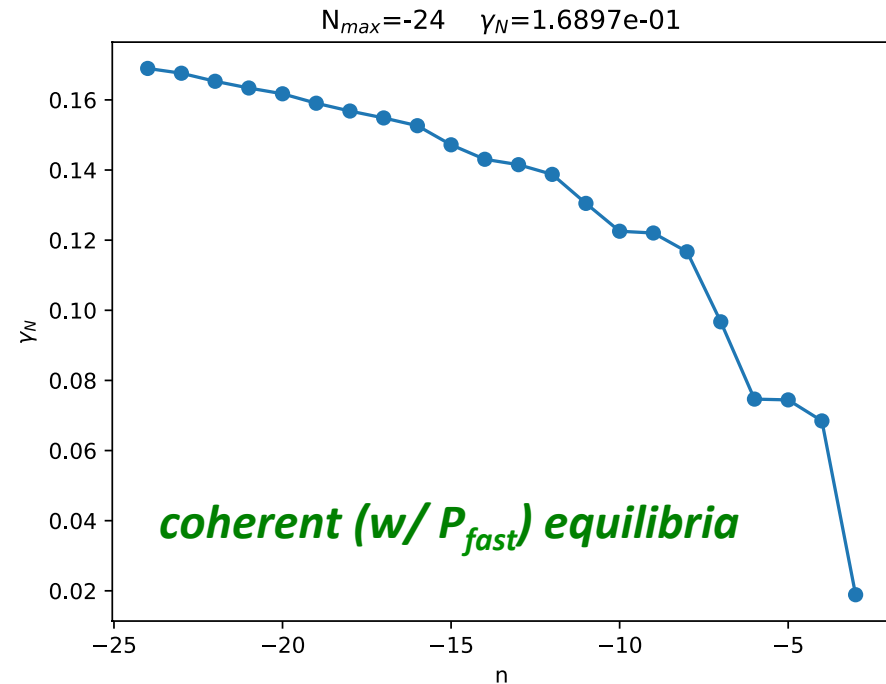
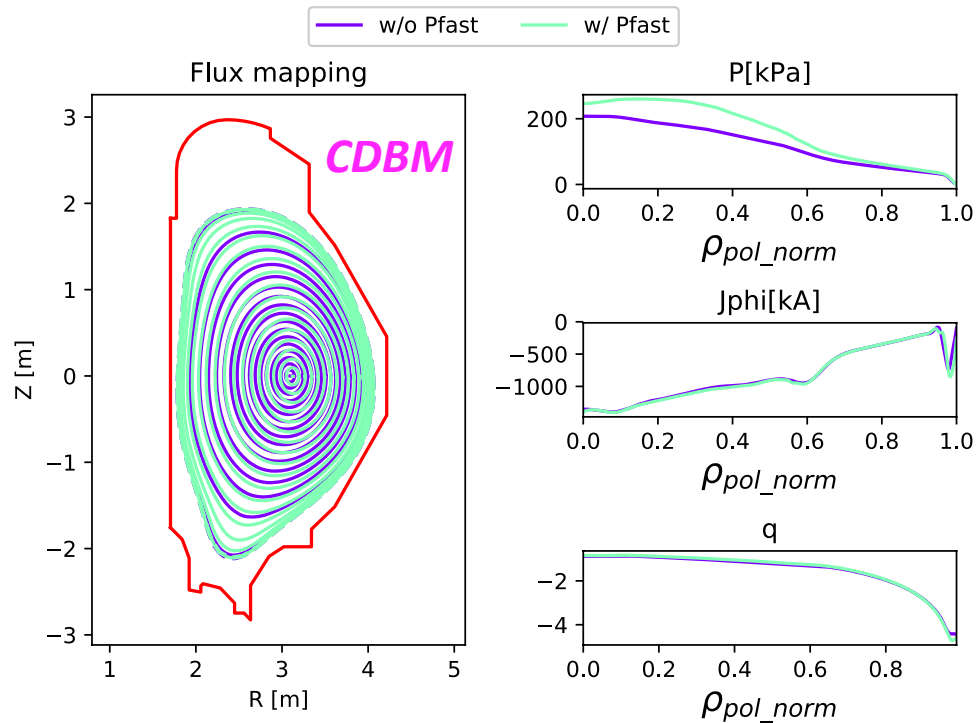


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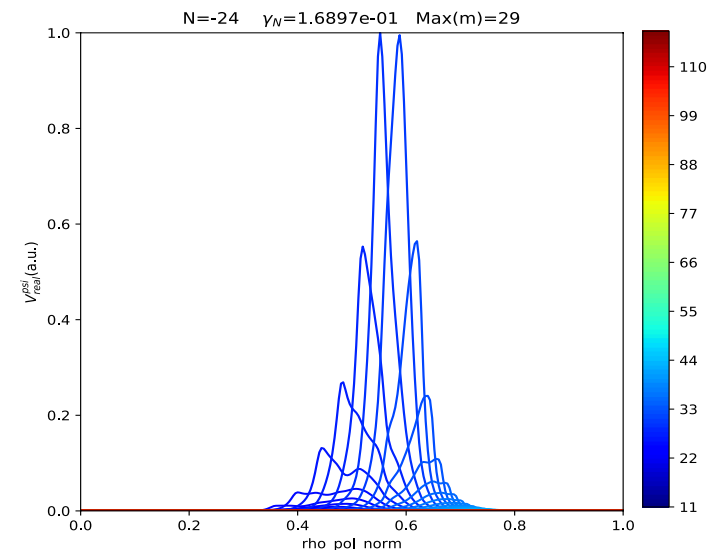


- The operational scenarios of JT-60SA are quite ambitious when considering MHD stability
 - High operational beta can lead to pressure driven instabilities e.g. core and pedestal
 - It is relevant to characterise the hierarchy of potentially hazardous modes (from internal kink in the deep core up to peeling-ballooning at the pedestal) i.e. which modes dominate ?
 - In case the scenario presents ITBs, will these be “mode-free” ?
- Preliminary results of the 2 variants of the **advanced hybrid Scenario 4** evidences that
 - Accounting for P_{fast} pressure in the equilibria leads to noticeably higher pressure on axis but magnetic shear increases only slightly.
 - **Infernal / ballooning** analysis of pressure driven core modes shows that these modes are indeed unstable.
 - Growth rate scaling with n-mode coherent with a dominant ballooning character → lower n are nonetheless closer to inferno.

Summarizing Scenario 4



- Scenario 4 with ITB at $\rho \approx [0.4-0.6]$
- Ballooning/infernal emerge as an interplay of pressure gradient and magnetic shear.
- Internal kink also unstable (*expect ST plasma*)



Toolset used



Linear MHD stability workflow

IMAS

Version: 6.2.0

High resolution equilibrium

- Starting from free boundary equilibrium reconstruction or fixed boundary calculated equilibrium.
- Option to define new plasma boundary inside the separatrix.
- Calculate high res. equilibrium with codes : HELENA, CHEASE and CAXE.

MHD stability

- Calculate linear MHD stability for a given toroidal mode number(s) with MHD codes : ILSA, MARS, or KINX
- Interchangeability between HELENA and CHEASE when using ILSA, MARS codes.
- Plotting of equilibrium flux map, plasma profiles and MHD eigenfunctions.

DDF Director



- Modus operandis
 - Use a perfect wall at the boundary to “eliminate” P-B modes.
 - Detect modes at internal resonance.
 - Make n-scaling to get growth rate spectra: scaling with n provides indication of the mode type (infernal vs ballooning)
 - Check eigenfunctions to confirm mode characteristics



- Explore Beta limits on scenario 4
 - What is the beta limit below which the ballooning (*upper limit*) and infernal (*lower limit*) modes are stabilised ?
 - Can we recover an infernal n-scaling at lower beta ?
 - What is the threshold beta below which no infernal modes are observed ?
 - Are there more than a single “family” of infernal type modes i.e. different modes at different growth rates ?
 - Do Scenarios 2,3 also bear similar limits/modes ?