MHD stability of JT-60SA Scenarios

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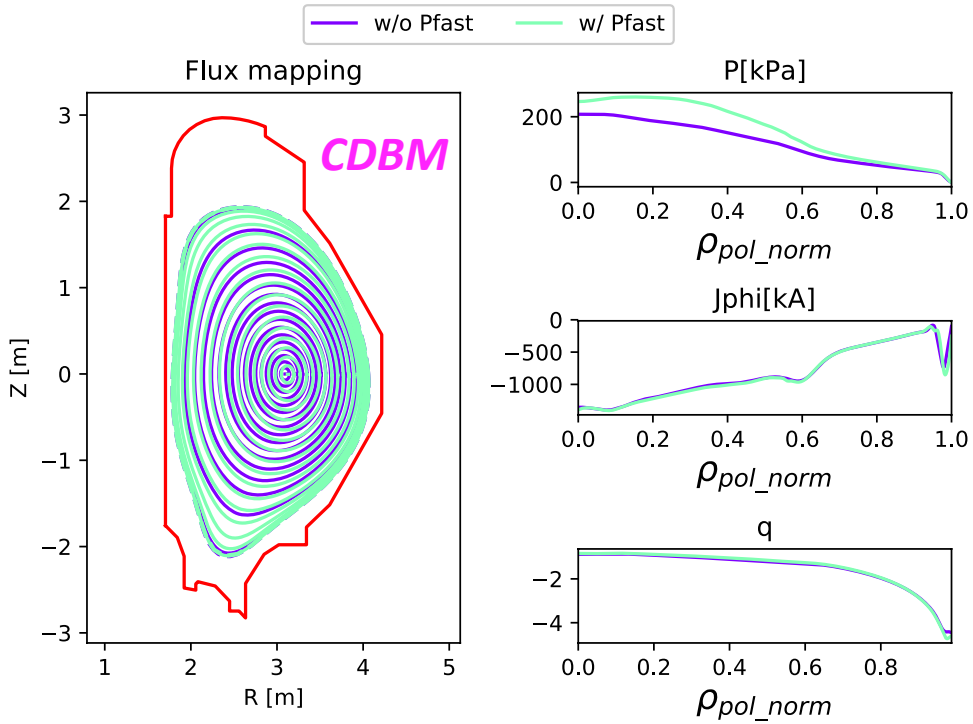
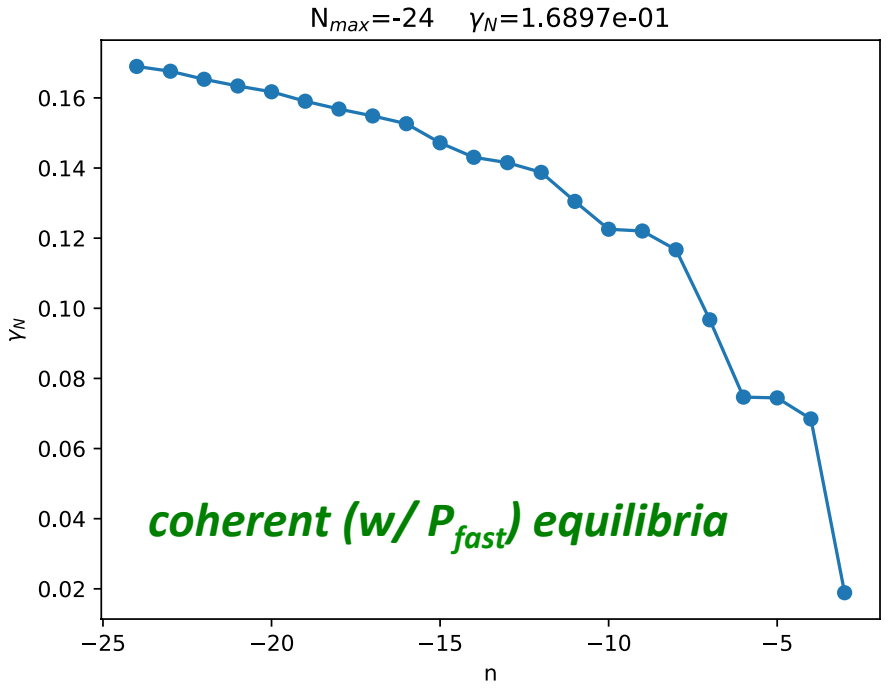
Motivation and goals

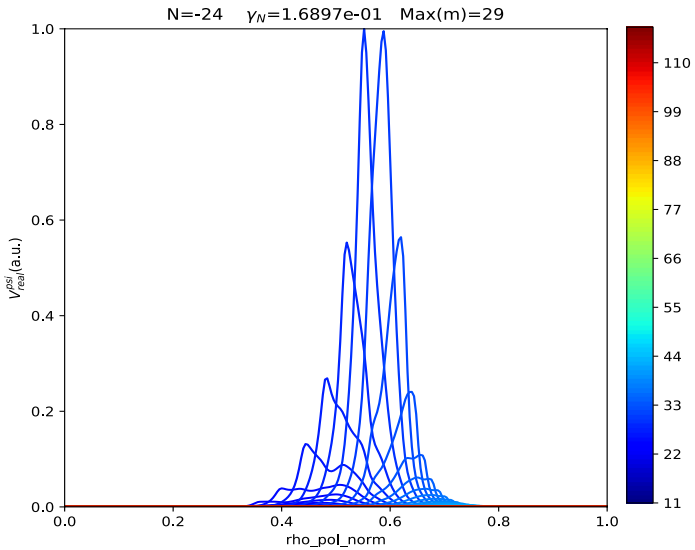
- The operational scenarios of JT-60SA are quite ambitious when considering MHD stability
  - High operational beta can lead to pressure driven instabilities e.g. core and pedestal
  - It is relevant to characterise the hierarchy of potentially hazardous modes (from internal kink in the deep core up 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

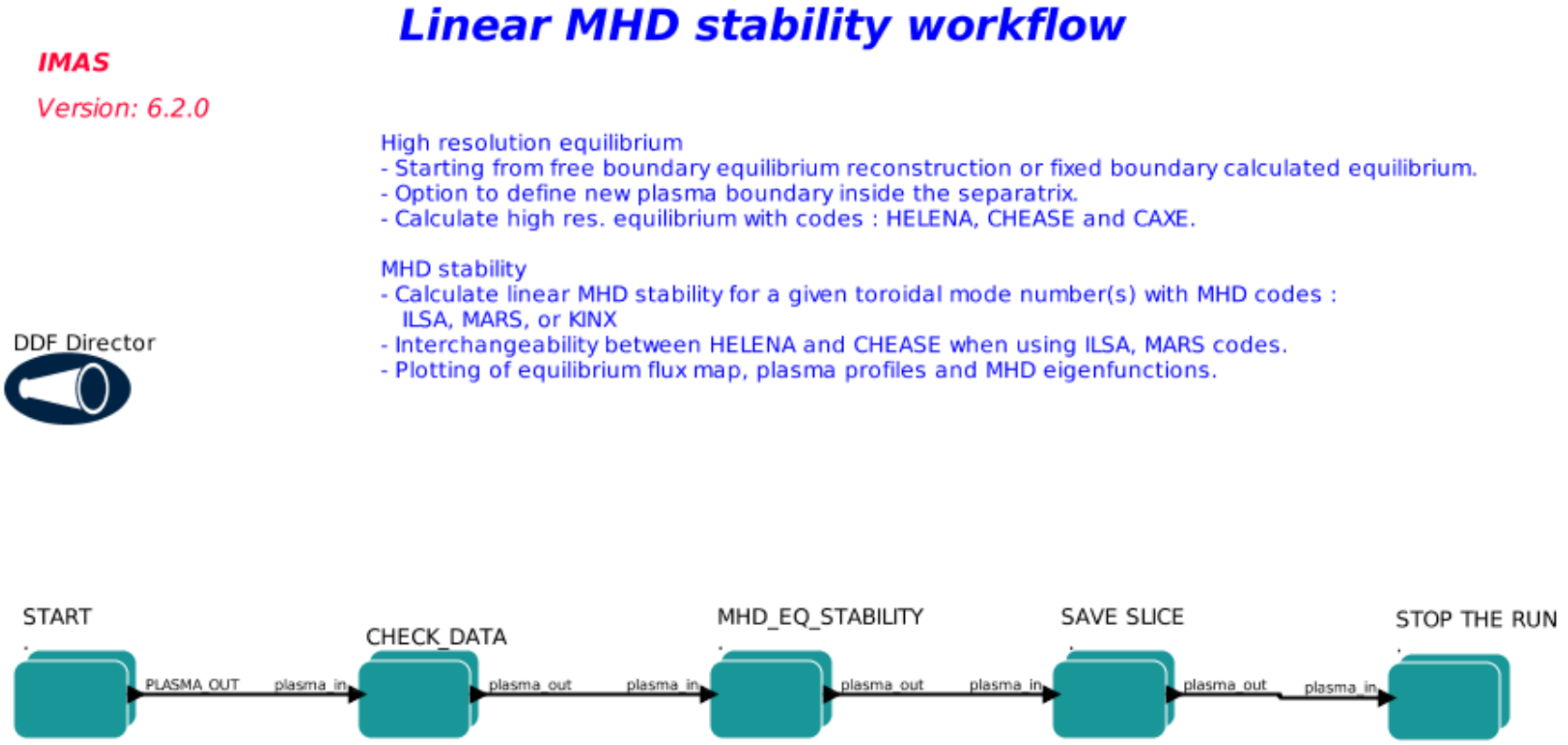






- Scenario 4 with ITB at ρ ≈ [0.4-0.6]
- Ballooning/infernal emerge as an interplay of pressure gradient and magnetic shear.
- Internal kink also unstable (*expect ST plasma*)

Toolset used



- 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

Objectives

- 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 ?