MHD stability of JT-60SA Initial Scenarios

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Motivation and goals

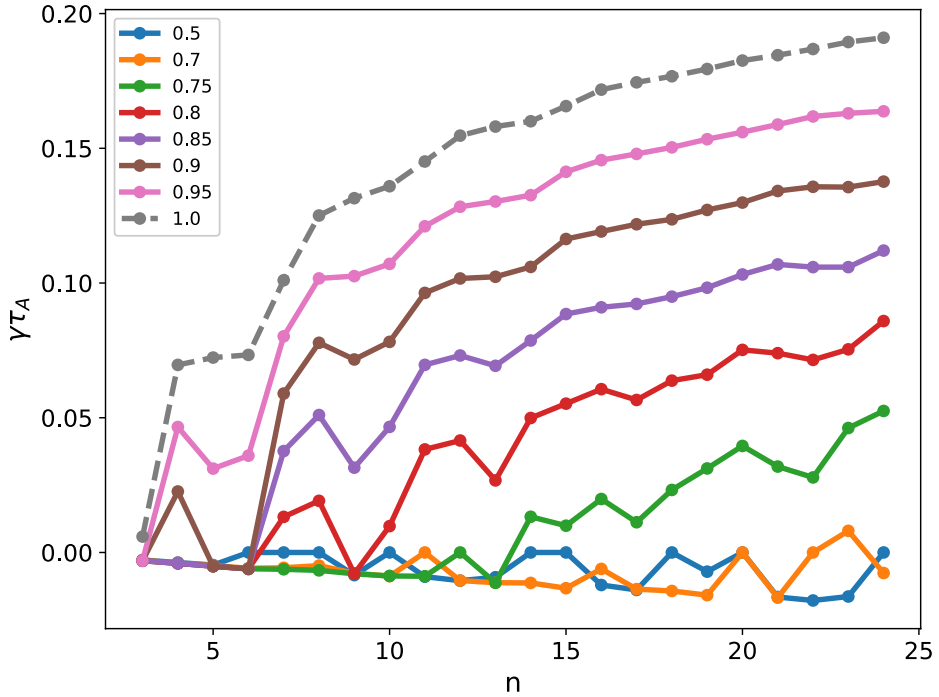
- Investigate MHD stability of Initial research phase scenarios of JT-60SA
  - JT-60SA initial research phase I and II, in H and D, with reduced power and C-PFC are “approaching”
  - Despite the “reduced power”, it entails already 33 MW (N-NB of 10 MW, P-NB of 20 MW, ECRF of 3 MW). The high heating power and high plasma current will enable access to the ITER and DEMO regimes of βN, f_{BS}, ρ* ν* and electron heating ratio !
  - It is relevant to characterize the ***hierarchy*** of potentially hazardous ***MHD modes*** (from internal kink in the deep core up to peeling-ballooning at the pedestal) i.e. which modes dominate ?
- Use routinely MHD stability workflow for the analysis
  - Provide training on usage

Summarizing Scenarios 2-5

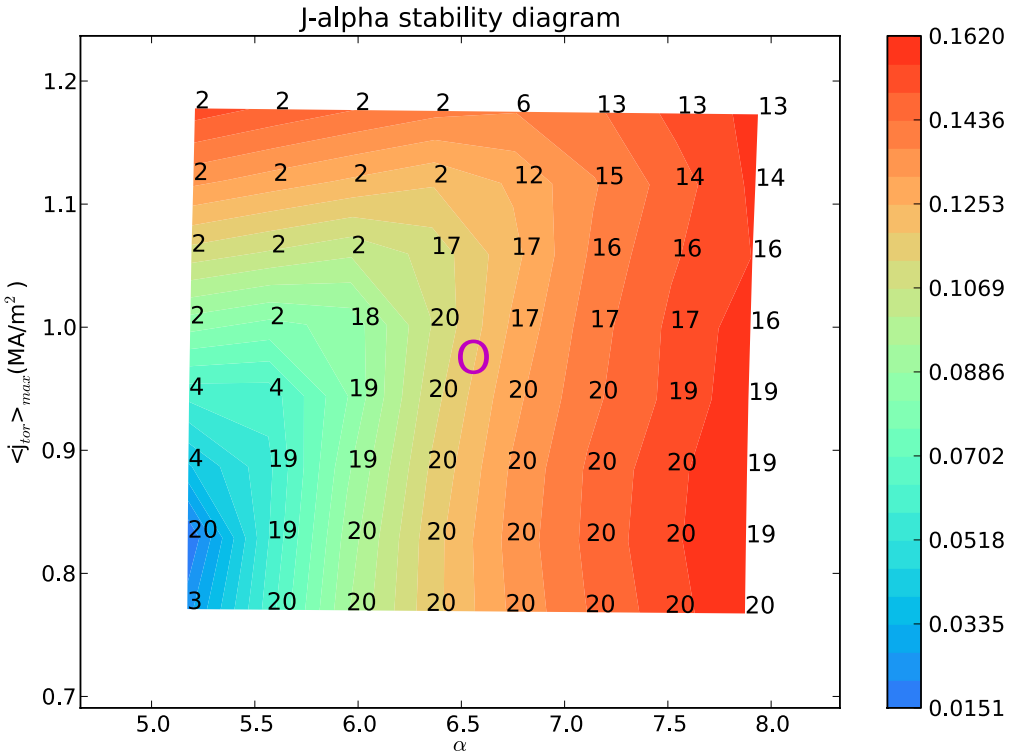
- In *all scenarios* q_0<1 so *ST activity* is already accounted for.
- In *all scenarios* pedestal pressure and J_{BS} is noticeable → ELM-y plasmas
- ***Scenarios 2-3*** (fully non-inductive, highest I_p) have noticeable plasma pedestal pressures/currents → PB pedestal dominated ($\gamma\tau_A \sim 0.12\ for\ scenario2, scenario3\ less\ unstable$).
- ***Scenario 4*** (hybrid, internal ion temperature ITB) is dominated by ideal infernal-ballooning very unstable modes ($\gamma\tau_A \sim 0.2$ at highest ∇p region), PB at $\gamma\tau_A \sim 0.07$
- ***Scenario 5*** also unstable to internal ballooning modes $\gamma\tau_A \sim 0.08$ (*for n=30, n→∞ might hover ~0.12 though*)

Some highlights

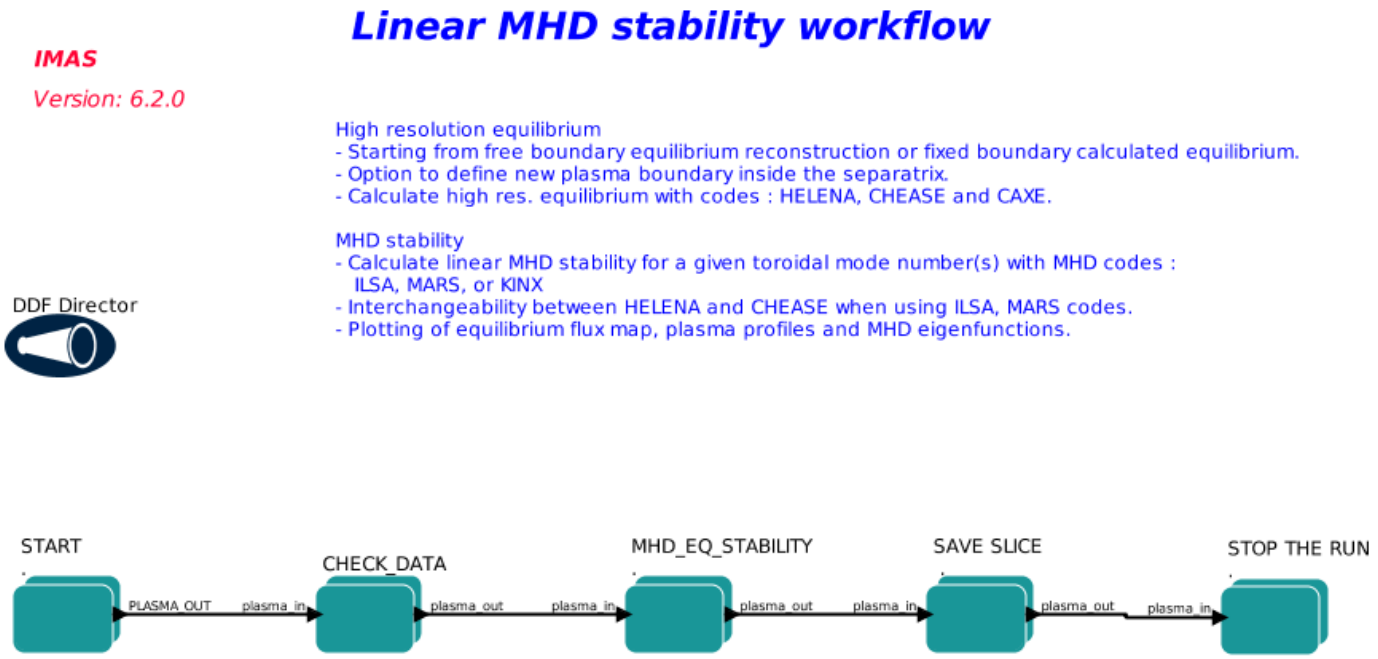
- Scenario 4 (hybrid-ITB) needs 30% drop in β_N to stabilize modes at ITB.



- Scenario 2 (low density) operates at large PB unstable region → very ELM unstable



Toolset to be used

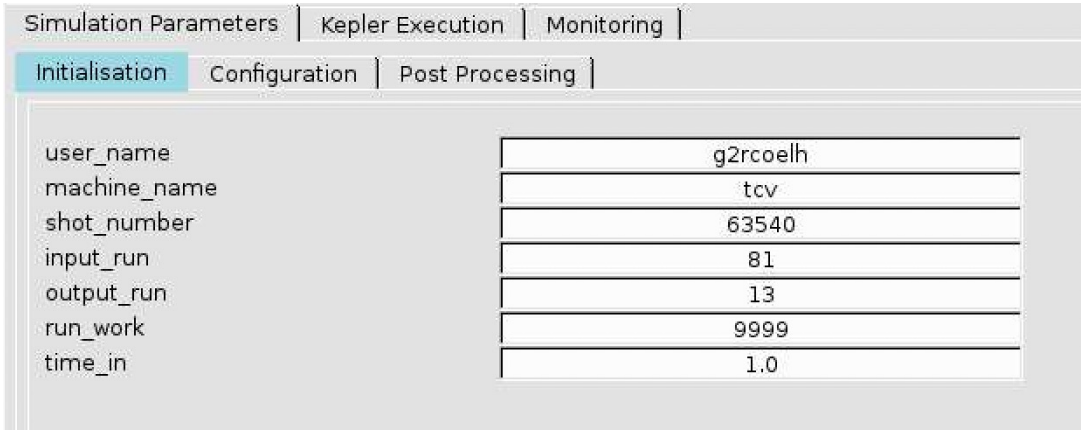


Documentation: *https://iterphysicswiki.euro-fusion.org/index.php?title=EQSTABIL_workflow_documentation*
https://wpcd-workflows.github.io/es.html

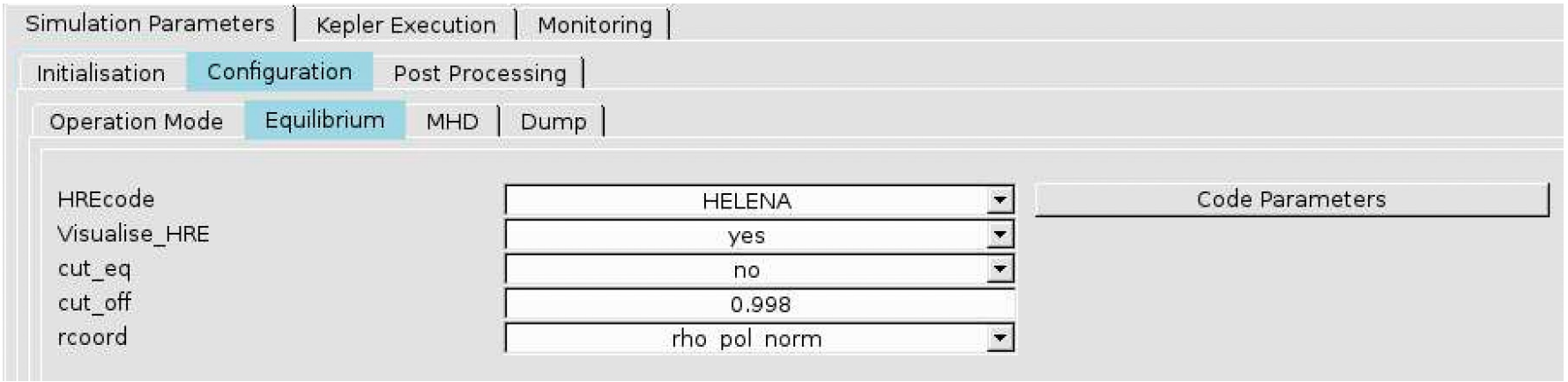
- Consolidated workflow for single mode ideal MHD stability (ITM/WPCD)
- Large case basis (JET, AUG, TCV, JT-60SA)
  - Ideal for training
- Seamless link to the ETS (very similar plasma bundle structure)
- ***KEPLER → AutoGUI*** based interface (***same as ETS workflow***)
- Python → GUI based workflow being consolidated (*amenable for j-alpha analysis*)

AutoGUI based workflow

- Simple interface to set/control/execute the workflow
  - Saved parameter file fully embeds workflow settings + code parameters ensuring subsequent ***traceability*** & ***reproducibility***



- Fully *multi-device* compatible
- *Multi-code* compatible
- Visualization of results included
- Interactive/batch execution



Modelling plans

- Obtain the plasma scenarios from JETTO/ETS (preferably in IDSs)
- Perform the stability scan at *time slices of interest* (ramp up, flat-top, pre/post heating transitions,…) for the "*community*".
  - Focus on core modes but pedestal might also be considered though flat top might be pre-set/piloted to marginal stability (?)
- Determine MHD limits if required e.g. beta limits (*RWM excluded*)