



MHD stability of JT-60SA Initial Scenarios

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- 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 β_N , f_{BS} , $\rho^* v^*$ 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

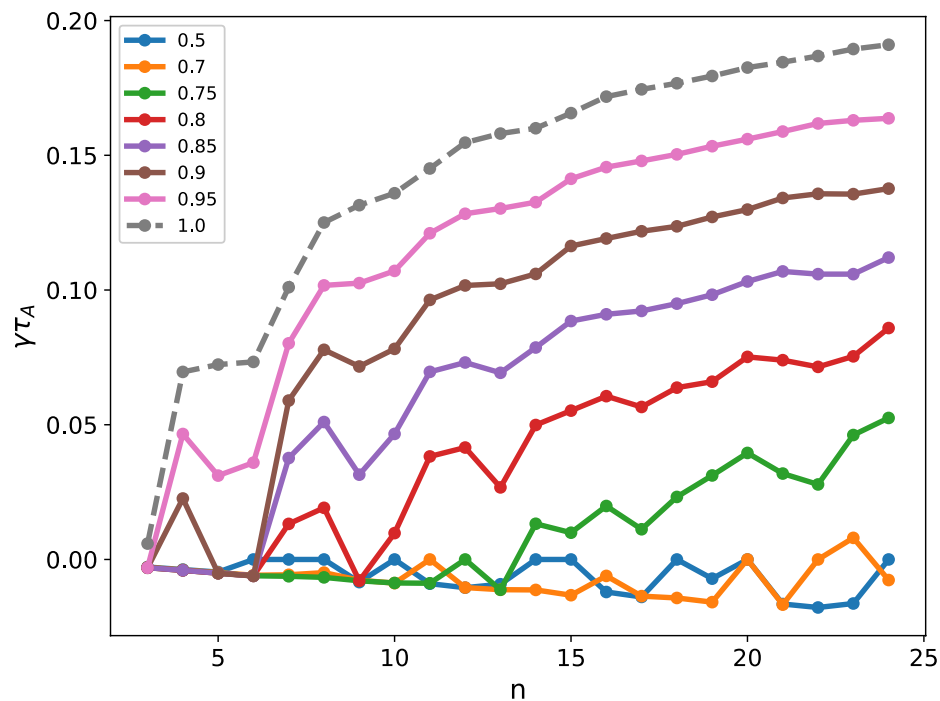


- In *all scenarios* $q_0 < 1$ so *ST activity* is already accounted for.
- In *all scenarios* pedestal pressure and J_{BS} is noticeable \rightarrow ELM- γ plasmas
- **Scenarios 2-3** (fully non-inductive, highest I_p) have noticeable plasma pedestal pressures/currents \rightarrow PB pedestal dominated ($\gamma\tau_A \sim 0.12$ for scenario 2, scenario 3 less unstable).
- **Scenario 4** (hybrid, internal ion temperature ITB) is dominated by ideal internal-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 $n=30$, $n \rightarrow \infty$ might hover ~ 0.12 though)

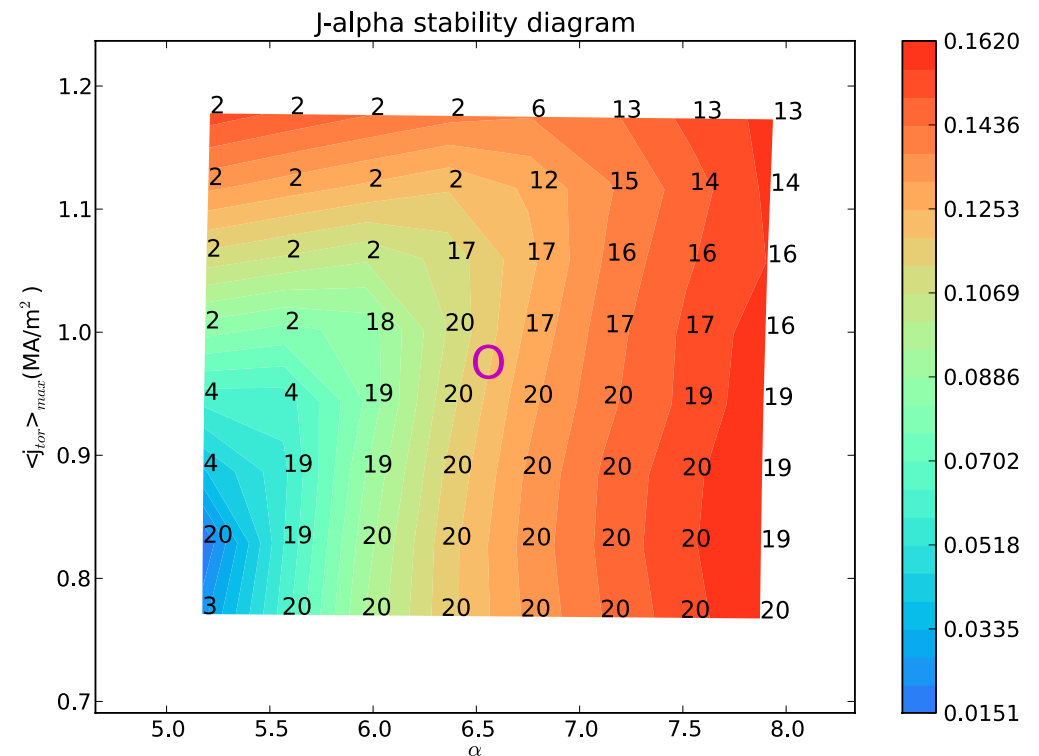
Some highlights



- 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 \rightarrow very ELM unstable





IMAS

Version: 6.2.0

Linear MHD stability workflow

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.



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***

Simulation Parameters | Kepler Execution | Monitoring |

Initialisation | Configuration | Post Processing |

user_name	g2rcoelh
machine_name	tcv
shot_number	63540
input_run	81
output_run	13
run_work	9999
time_in	1.0

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

Simulation Parameters | Kepler Execution | Monitoring |

Initialisation | Configuration | Post Processing |

Operation Mode | Equilibrium | MHD | Dump |

HREcode	HELENA	Code Parameters
Visualise_HRE	yes	
cut_eq	no	
cut_off	0.998	
rcoord	rho pol norm	



- 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*)