Tokamak edge plasma stability analysis using Thomson scattering measurements

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Content

- Motivation
- MHD stability analysis
- Thomson scattering diagnostics
- Plans
- Summary

Edge plasma - pedestal physics

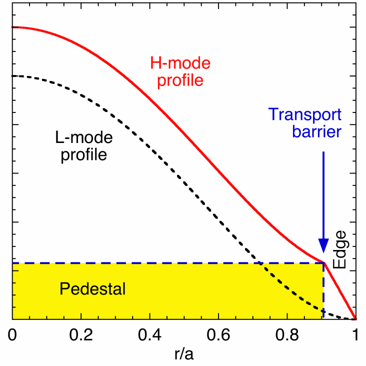
- H-mode scenario is the most promising operation regime for tokamaks
- To understand H-mode experiments, understanding pedestal physics is crutial
- Edge plasma MHD stability analysis provides insight to the pedestal behaviour

Thomson scattering diagnostics

- Measured plasma parameters are essential for MHD stability analysis
- Enhance reliability and precision

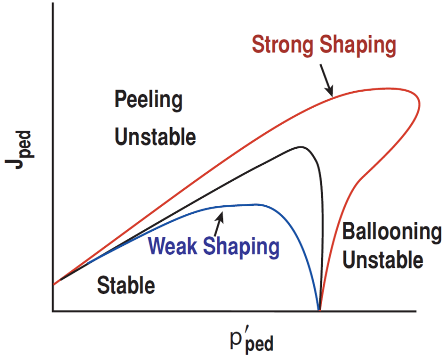
Pedestal physics basics

- Pedestal is the steep pressure gradient region in the plasma edge
- High pedestal ∼ high confinement
- But can trigger ELMs



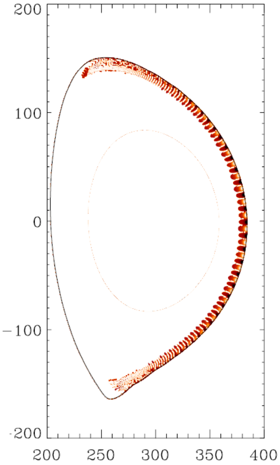
- Pedestal modelling tries to answer:
  - pedestal height determination (confinement)
  - ELM triggering process

- Describes the MHD stability in the edge plasma
- Is a possible ELM generation mechanism

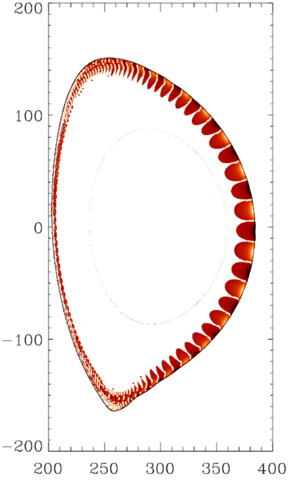


Schematic diagram of peeling–ballooning stability boundaries as a function of pedestal pressure gradient and current. [P B Snyder et al 2004]

Peeling-ballooning mode ELMs

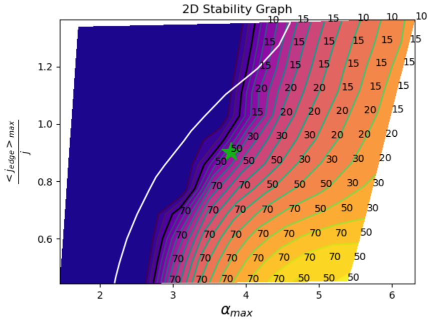


Ballooning mode - high n



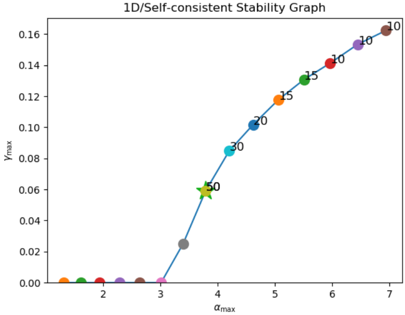
Intermediate n-mode

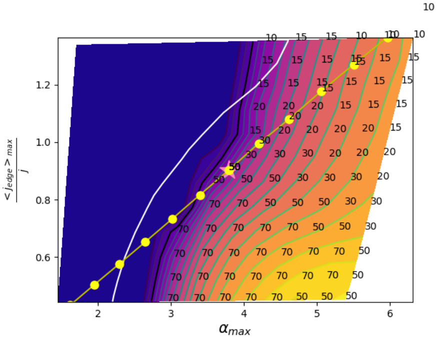
- Experimental data used for equilibrium with self-consistent bootstrap current
- MHD stability codes used to determine equilibrium stability
- Vicinity of experimental point is examined



- star: experimental point
- blue area: stable
- contour: growth rate
- black line: stability boundary
- white line: $n = \infty$ ballooning limit
- numbers: mode numbers with highest growth rate

- Pedestal height varied to find self-consistent distance to stability boundary
- Variation of either temperature or density profile

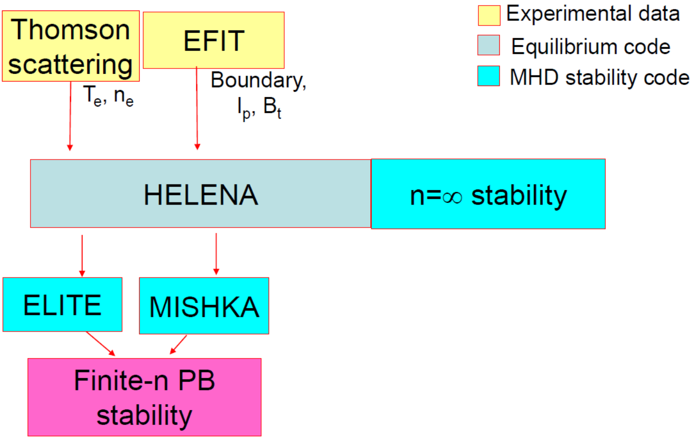




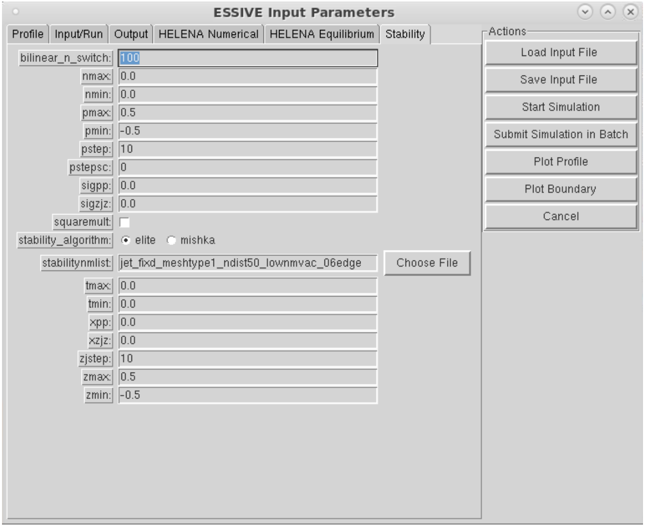
How does it work

- Scheme of the algorithm
- Used codes
  - Equilibrium: HELENA
  - Stability: ELITE/MISHKA
- Inputs:
  - Pressure profile → temperature and density profiles → Thomson scattering diagnostics
  - Plasma boundary → EFIT
  - Plasma current, magnetic field and Zeff
- New GUI written in python called **ESSIVE**
  - user-friendly wrapper

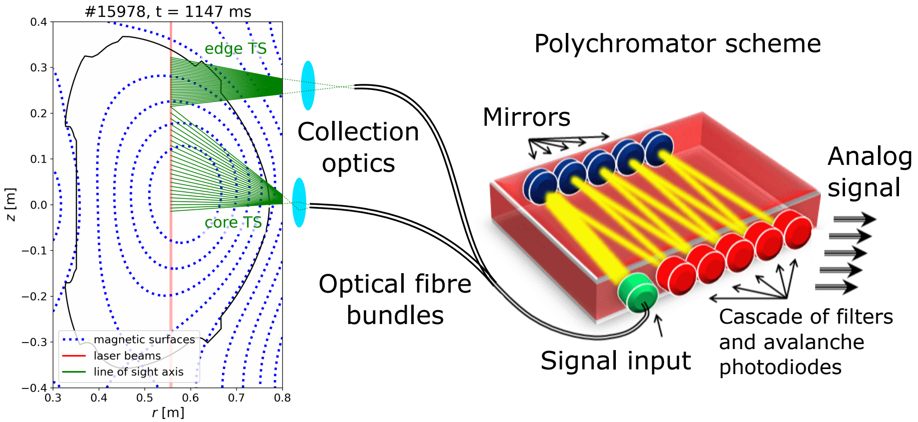
- Scheme of the MHD stability analysis calculation



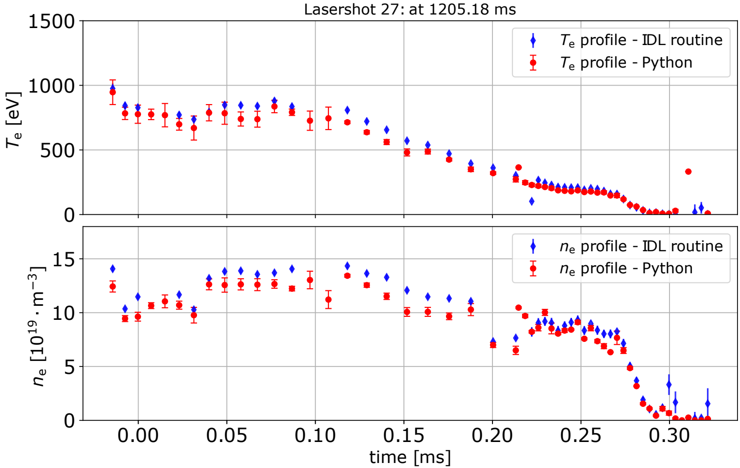
- GUI description



Diagnostics description



Typical results



MHD stability analysis - plans

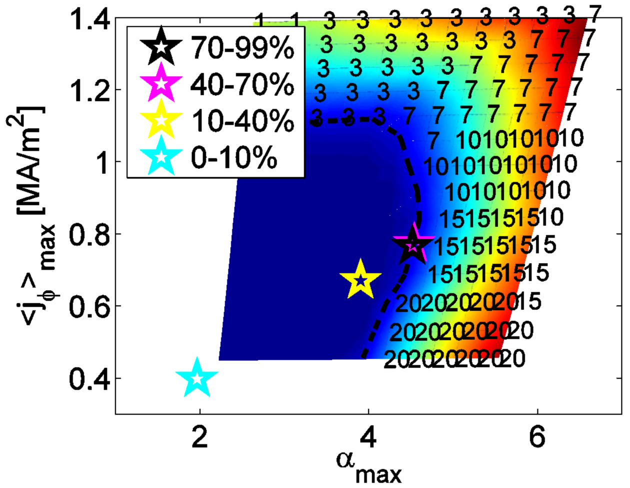
Plans on JET

- Impact of ion temperature profile tailoring on the MHD stability
- Impact of plasma rotation on the MHD stability

Plans on COMPASS

- ELMs characterization
- Analysis of experiments with ELM mitigation

- JET highlights



Edge pedestal stability analysis

- Better understanding of the edge plasma physics
- Clasification of ELMs

Thomson scattering measurements

- Increase reliability and precision

Thank you for your attention