The Linear MHD Stability Analysis Chain

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Linear MHD Stability Analysis

MHD stability analysis of the plasma edge in tokamaks

- Plasma edge stability crucial for plasma operation: ELMs (edge localized modes)
- Linear analysis computationally ‘cheap’ compared to fully non-linear simulations
- Parameter scans possible to improve theoretical understanding and to build database, e.g. for transport simulations or plasma operations
- Ideal use case for GRID/CLOUD computing:
  - Serial or small parallel jobs
  - Limited runtime
  - Rather small size of output
  - Large number of independent jobs needed

Use case: j-α Stability Analysis

3 major components (actors):

- HELENA: high resolution fixed boundary equilibrium solver (serial, 1-3 GB shared memory, 0.5 CPU hour per run)
- JALPHA: numerical tool for profile modifications (pressure, current), (serial, < 1GB shared memory, < 0.01 CPU hour per run)
- ILSA: linear MHD stability analysis code (serial/OpenMP, 3 GB shared memory, 3 – 72 CPU hours per run for unstable/stable equilibria)

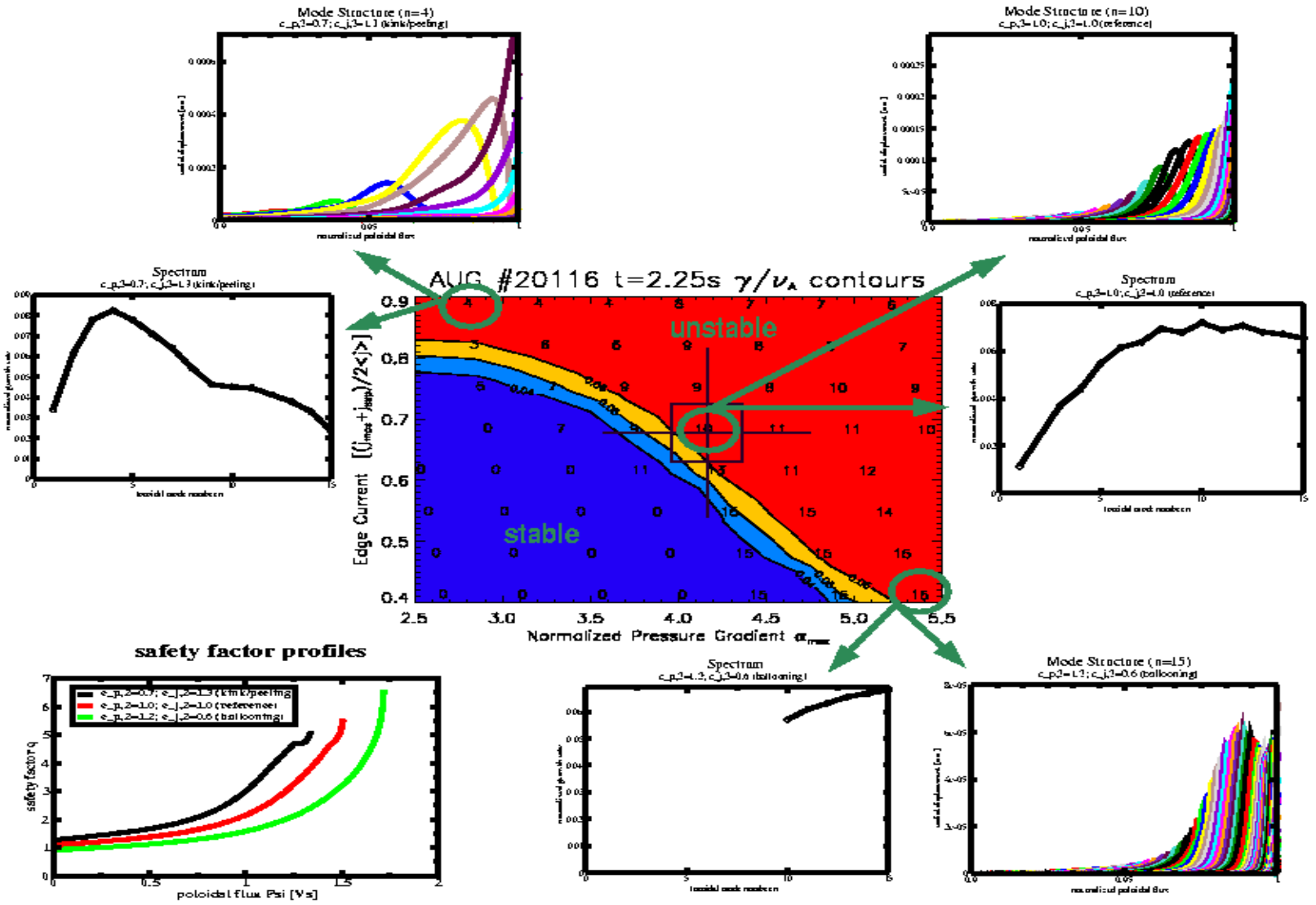
All actors use EFDA-ITM standardized data structures (CPOs) for I/O.

Workflow: j-α Stability Analysis

6 Steps:

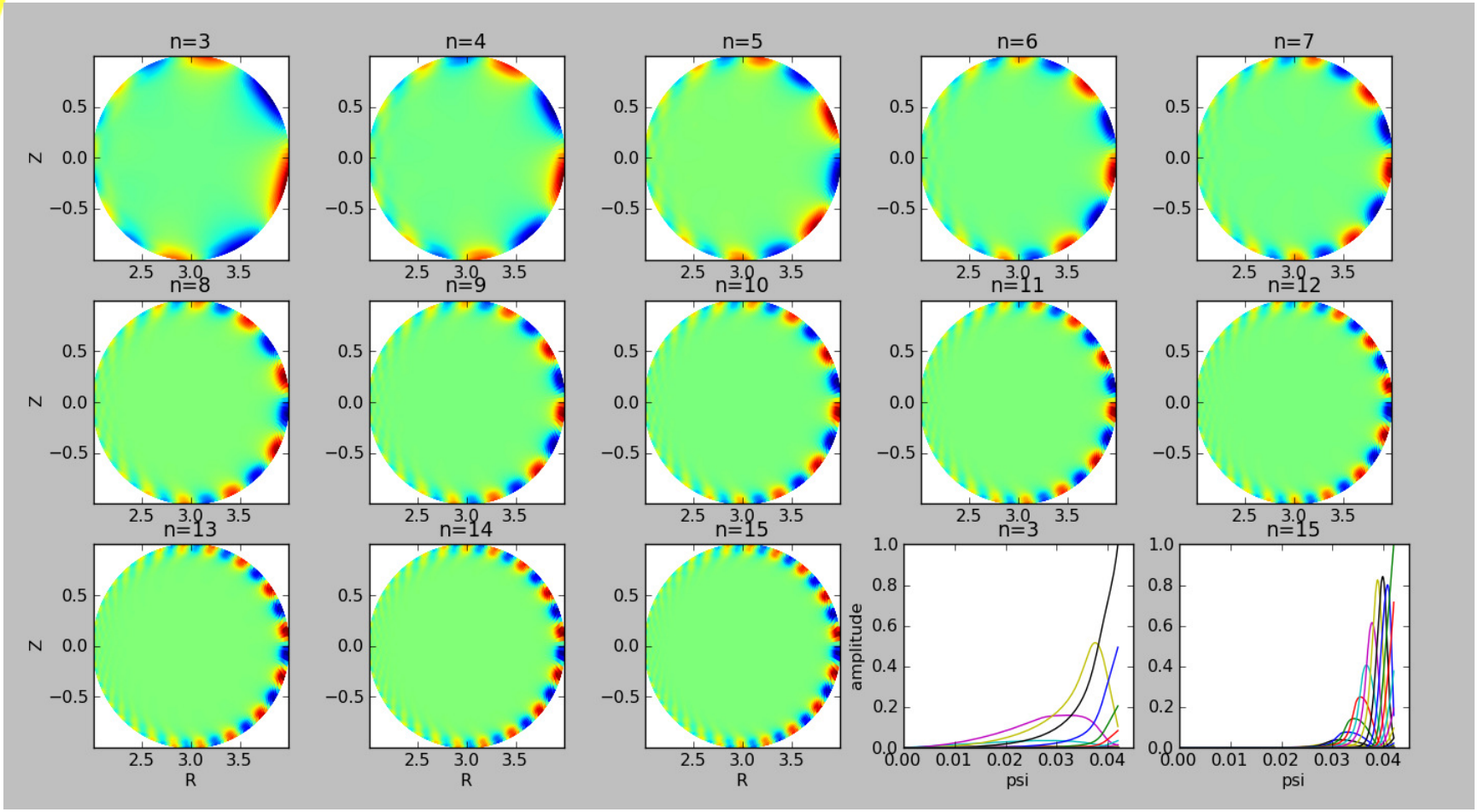
- Calculate reference equilibrium (HELENA), single GRID job, retrieve data
- Modify reference equilibrium using j-α scan parameters (JALPHA): typically 11x11=121 GRID jobs (2D scan), combined with
- Calculation of modified equilibria (HELENA): 11x11=121 GRID jobs, results remain remote, combined submission with
- Linear MHD stability analysis of modified equilibria (ILSA): 11x11=121 GRID jobs
- Check and retrieve combined output from JALPHA/HELENA and ILSA: 121 directories
- Postprocessing: analysis of instability spectra, j-α diagram (stability map), done via shell scripts so far (minor human interaction still required), visualization (Kepler)

j-α-diagram



Maggi et al., NF 50(2), 025023 (2010)

Edge Localized Mode: Peeling-Ballooning



Generated using EUFORIA's **ualpyactor** (JRA4) inside Kepler

Thank you for your attention!