



# Non-linear modeling of the Edge Localized Mode control by Resonant Magnetic Perturbations in ASDEX Upgrade



ASDEX Upgrade

- Plasma response to  $n=2$  RMPs and ELM/RMP interaction modeled with non-linear resistive 2-fluid MHD code JOEUK, using experimental ASDEX Upgrade data.
- Strongest ELM mitigation observed in experiments explained in modeling by largest resonant response to RMPs (ergodic edge, lobe structures near X-point):
  - resonant component amplified by coupling with edge peeling-kink modes excited by RMPs.
  - edge kink: large displacement near X-point → Fig.1
  - good agreement with MARS-F, M3D-C1, VMEC and experimental ECEI measurement.
  - footprint patterns in modeling (Fig.2b) match heat flux measured by IR thermography (Fig.2a).
- Preliminary ELM/RMP modeling:
  - in resonant case, strong coupling of even edge localized modes with  $n=2$  RMP + damping of odd modes prevents ELMs to grow as P-B modes.
  - in non-resonant case, RMP-drive too weak to significantly damp ELM growth.
  - may explain stronger ELM mitigation when resonant response to RMPs.

FIG1: Density @ X-point when kink VS no kink

