

# Integrated Simulations of H-mode Operation in ITER including Core Fuelling, Divertor Detachment and ELM Control (EX/P6-44)

A.R. Polevoi, A. Loarte, R. Dux, T. Eich, E. Fable, S. Maruyama, S.Yu. Medvedev, F. Köchl, V.E. Zhogolev

- The scaling is derived for maximum divertor ELM load as a function of global plasma parameters
- The analytical expression is derived for the boundaries of the operating space (OS), where the ELM mitigation for divertor protection is not required.
- In this OS parameters of the ELM-pacing pellet injection are determined by the tungsten control to avoid the H- to L- transition, i.e. drop of  $P_{sol}$  below the L-H threshold  $P_{LH}$ :
  - a) due to prompt increase of radiation caused by pulse influx of tungsten sputtered by ELM,
  - b) due to gradual increase of radiation caused by accumulation of tungsten sputtered by ELMs.
- The scalings are derived for duration and amplitude of pulse influx of tungsten sputtered by ELM, basing on ASTRA, STRAHL and SOLPS simulations for ITER.
- 1.5D simulations for ITER scenarios with ELM induced tungsten fluxes are carried out with ASTRA code with diffusive and convective ELM loss models, with and without prompt re-deposition of the ELM-sputtered tungsten:
- For the worst case without prompt re-deposition tungsten transport can be more restrictive for the ELM size and frequency than the divertor erosion:
  - a) For prompt W-influx H-mode can survive for the ELM size  $\Delta W_{ELM} < 1.2$  MJ,
  - b) Gradual accumulation of tungsten is potentially dangerous for the baseline scenario  $B/I_p = 5.3$  T/15 MA,  $P_{sol} = 100$  MW for  $\Delta W_{ELM} = 0.6$  MJ at maximal pellet injection frequency  $f = 32$  Hz
    - => Safe range for H-mode w/o W prompt re-deposition:  $16$  Hz  $< f < 32$  Hz;
- for  $B/I_p = 2.65$  T/7.5 MA,  $P_{sol} = 50$  MW tungsten accumulation can cause the H-L transition for  $\Delta W_{ELM} \leq 0.4$  MJ for pellet frequencies  $f \geq 25$  Hz
  - => Safe range for H-mode w/o W prompt re-deposition:  $8$  Hz  $< f < 25$  Hz

