# Modelling of kick-triggered ELMs at JET - current status

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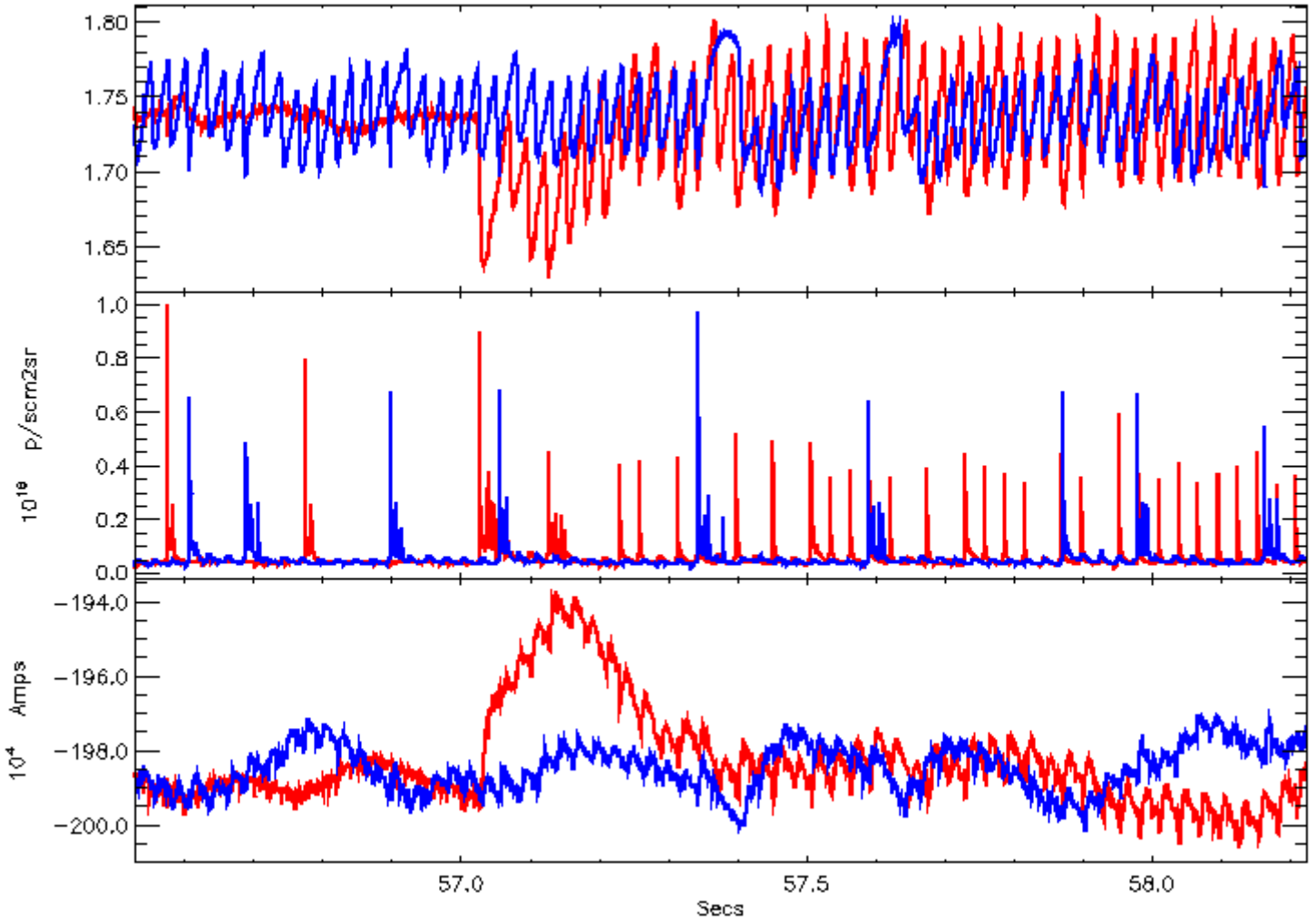
**Objectives / Motivation:**

- Technique of ELM triggering by plasma kicks induced by a variation of PF coil currents is an efficient option for ELM mitigation at JET and requires detailed analysis to assess its viability and effectiveness in dependence plasma conditions.
- Integrated simulations considering free boundary equilibrium (CREATE-NL) and plasma transport (JINTRAC) could help to identify the possible cause and type of instabilities responsible for ELMs triggered by kick events.

**Modelling task:**

- Simulations of JET experiments (#77640, #73247, #73244) with varying kick amplitude:
  - Simulations considering ballooning mode instabilities
  - Simulations considering peeling mode instabilities
- Simulations with forced kick-triggered ELMs to analyse density depletion behaviour

#73247 – strong kicks
#73244 – weak kicks

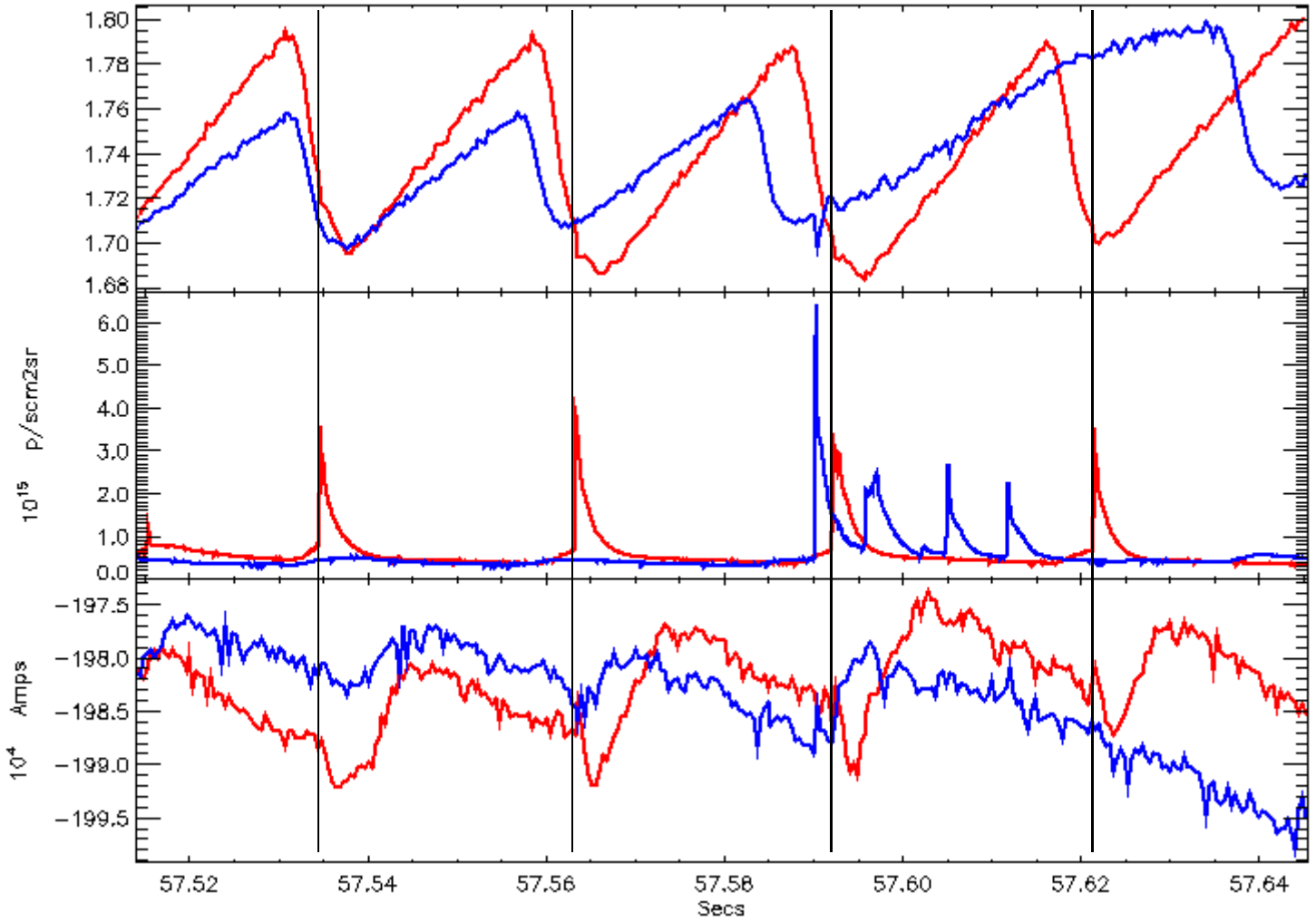



Upper Z Point

Dα

Plasma current

#73247 – strong kicks
#73244 – weak kicks



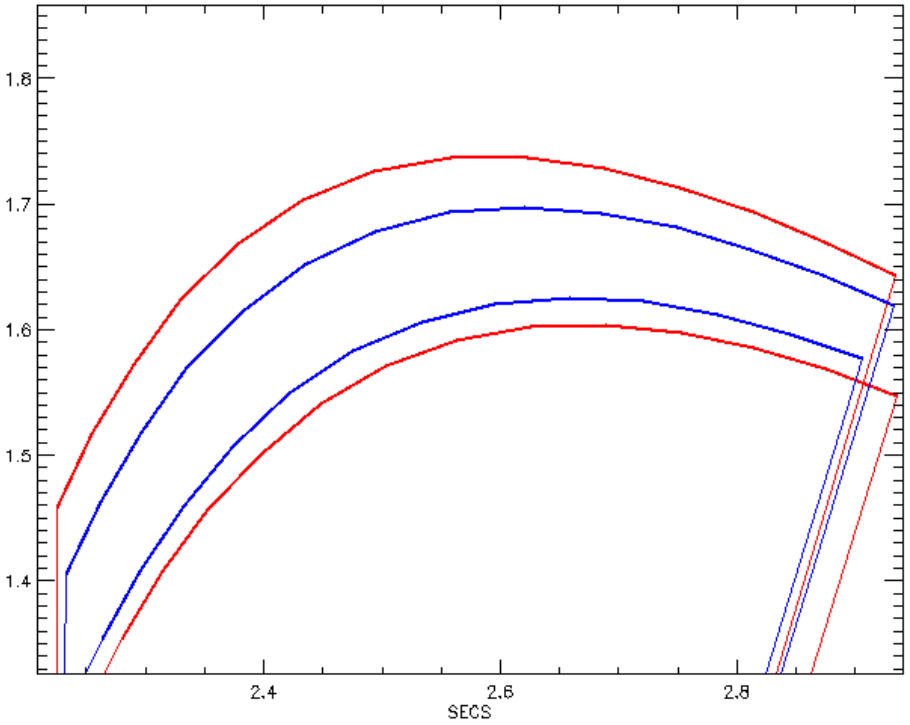

Upper Z Point

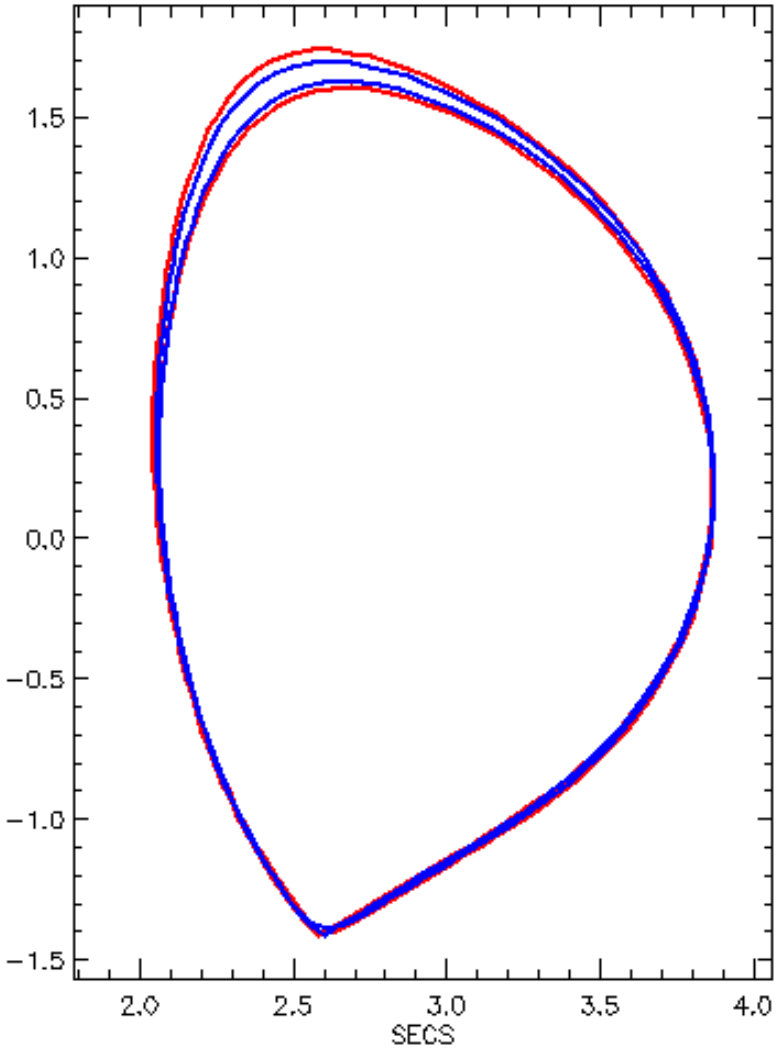
Dα

Plasma current

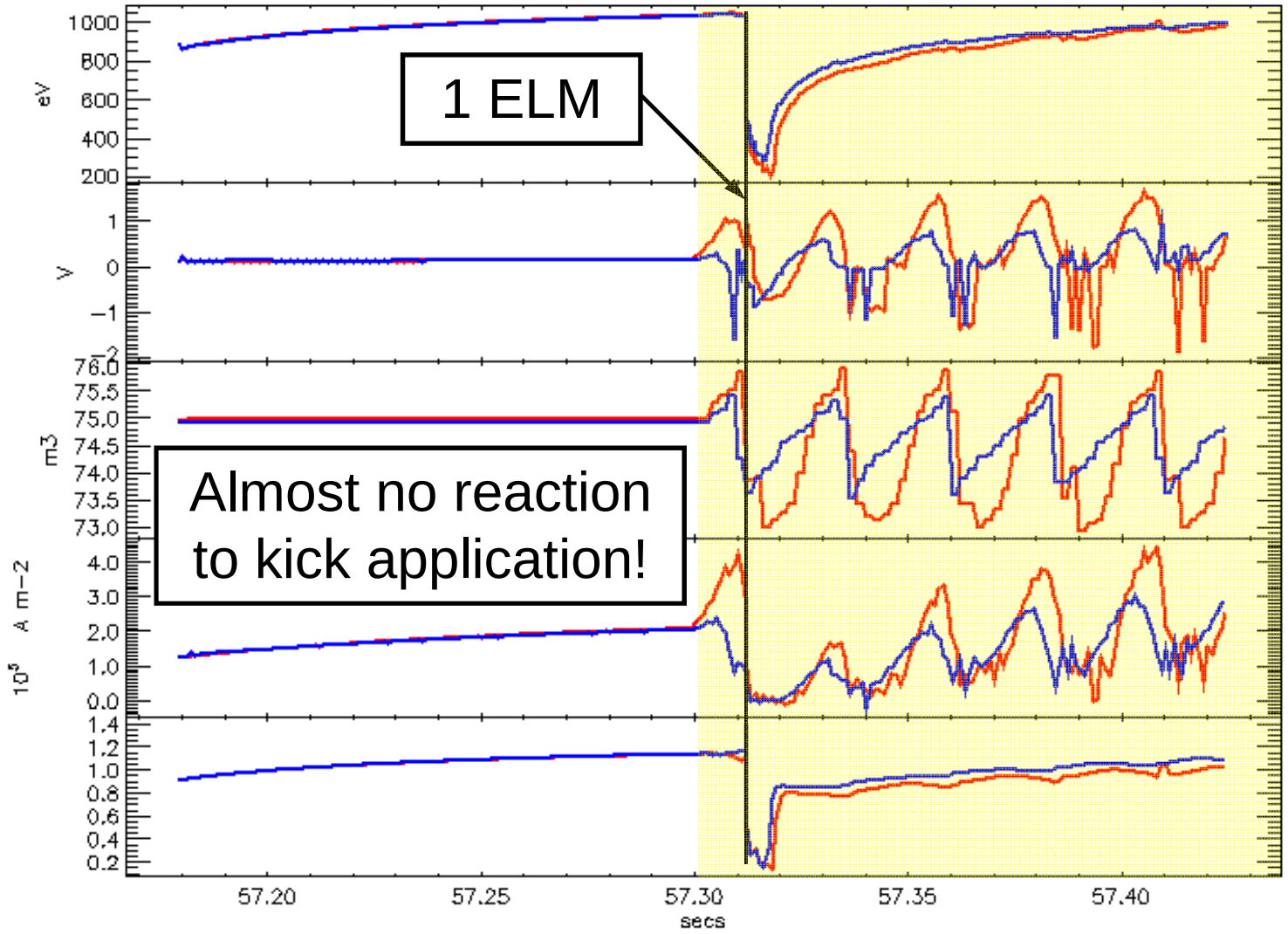
#73247 – strong kicks
#73244 – weak kicks

**Plasma boundary shape variation during kick cycles (CREATE-NL):**



**Consideration of ballooning mode instabilities:**




**Te_ped**

**Loop voltage**

**Plasma volume**

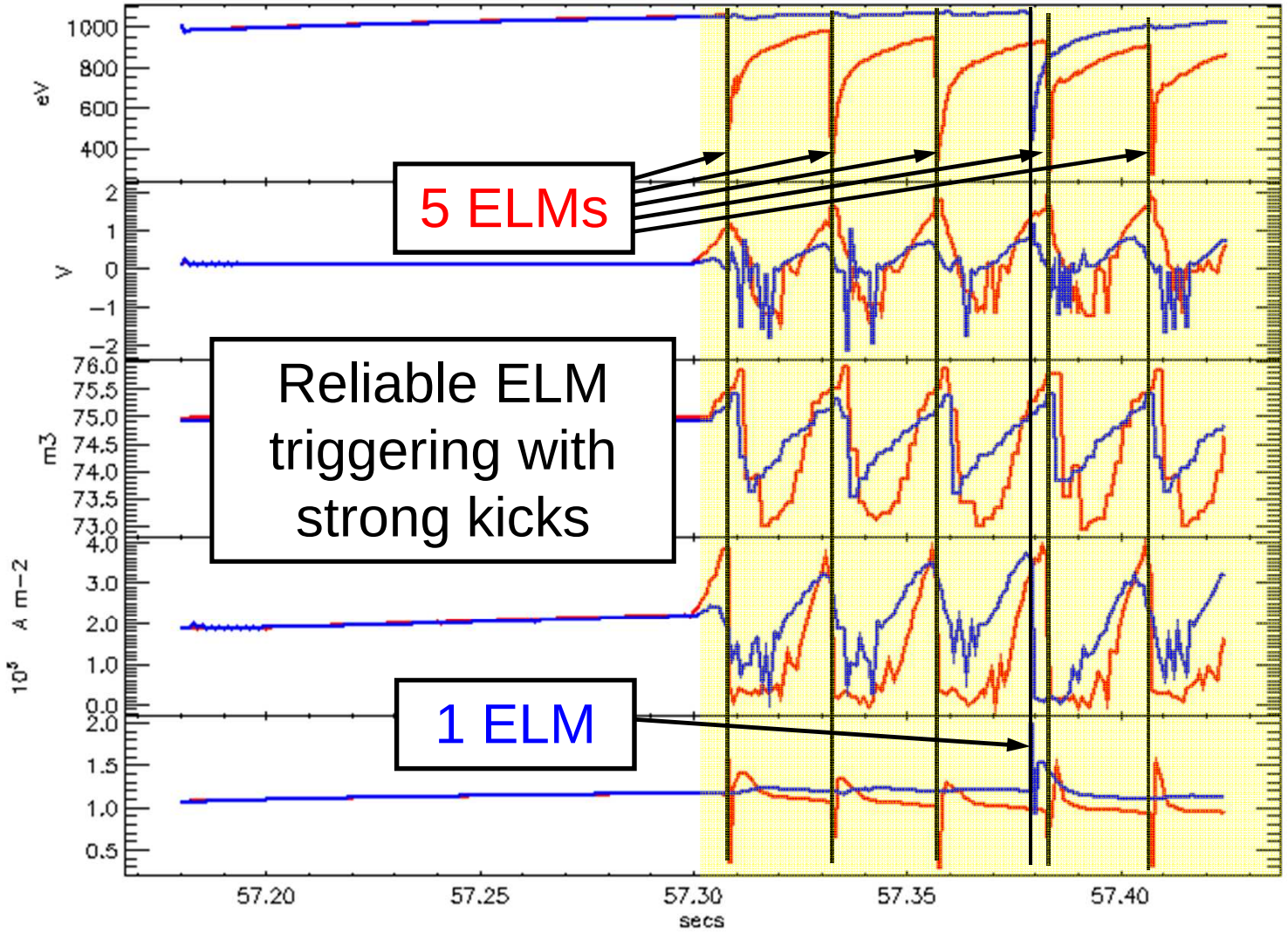
**Jz @ ρ = 0.98**

**α @ ρ = 0.94**

**No kick events** **5 kick events**

**#73247 – strong kicks**
**#73244 – weak kicks**

**Consideration of edge-located peeling mode instabilities:**




**Te_ped**

**Loop voltage**

**Plasma volume**

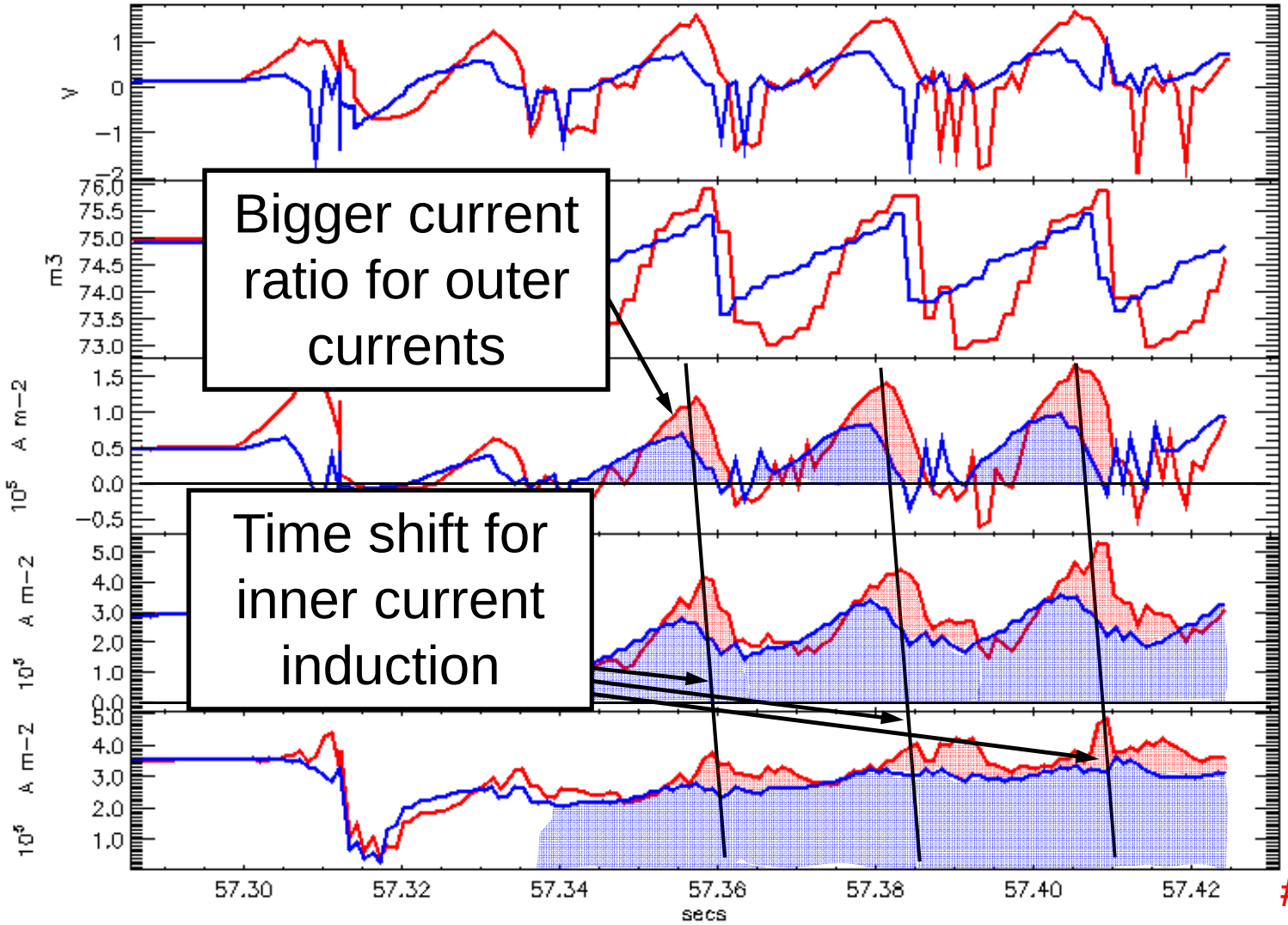
**Jz @ ρ = 0.98**

**α @ ρ = 0.94**

**No kick events** **5 kick events**

**#73247 – strong kicks**
**#73244 – weak kicks**

**Evolution of current density in the pedestal in case of no ELMs (ballooning mode assumption):**




**Loop voltage**

**Plasma volume**

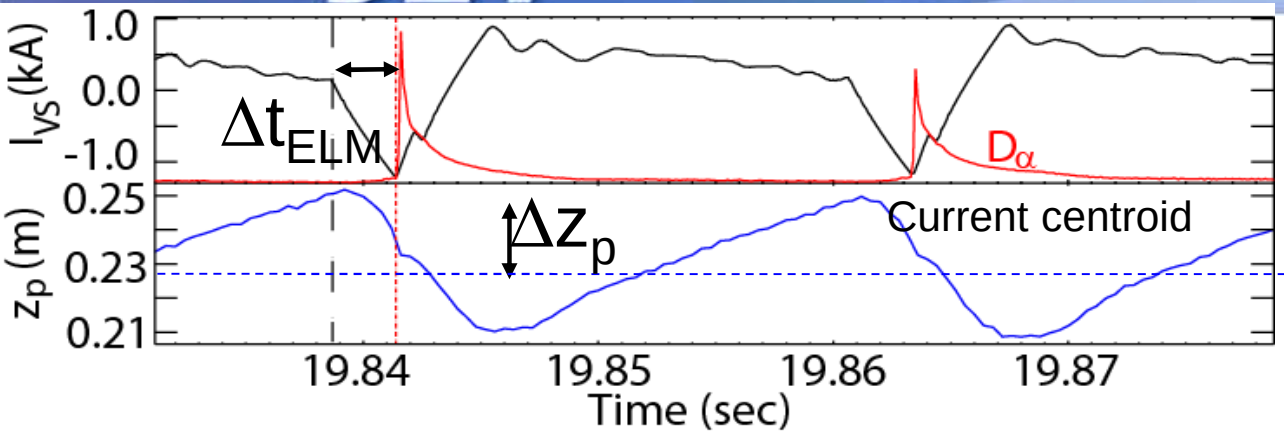
**Jz @ ρ = 0.99**

**Jz @ ρ = 0.96**

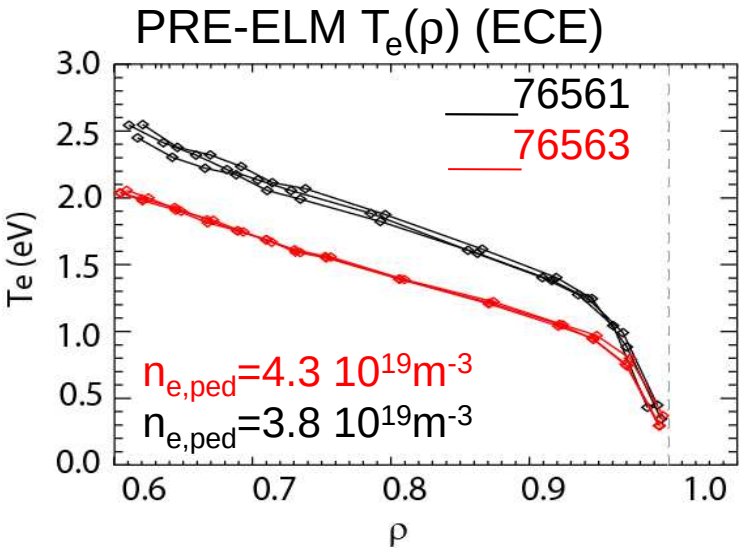
**Jz @ ρ = 0.93**

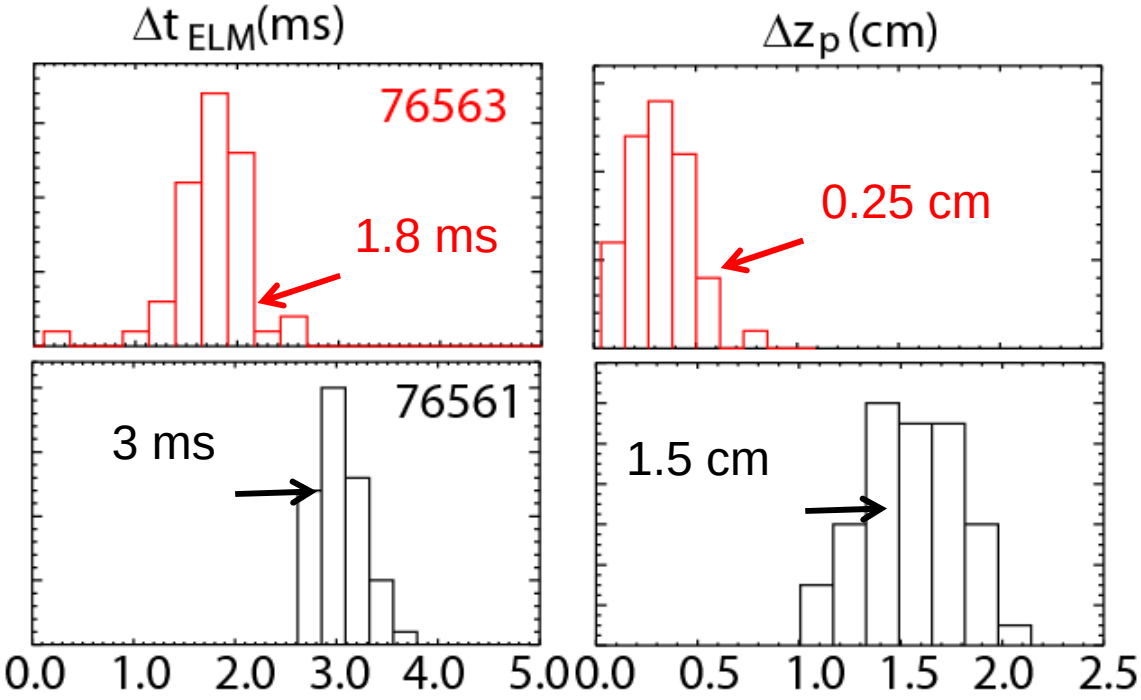
**#73247 – strong kicks**

**#73244 – weak kicks**




$f_{kick}$ =40 kHz

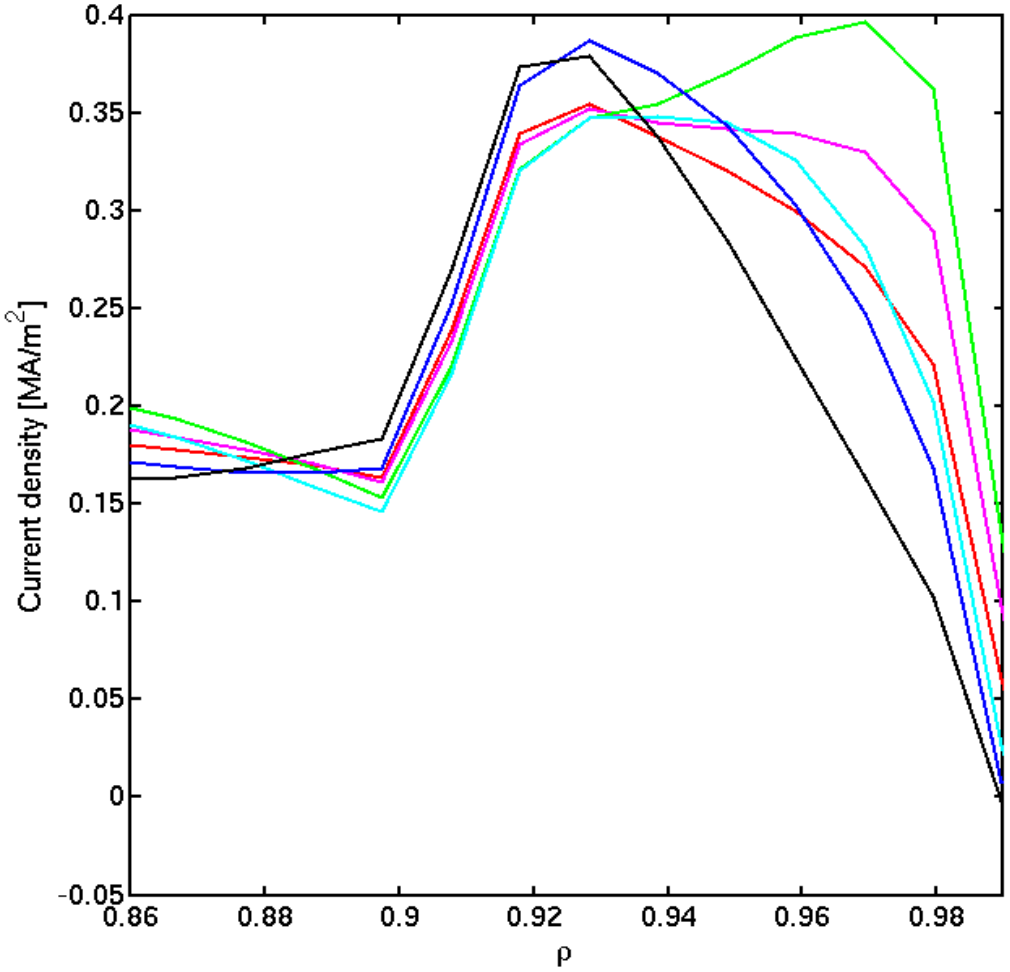


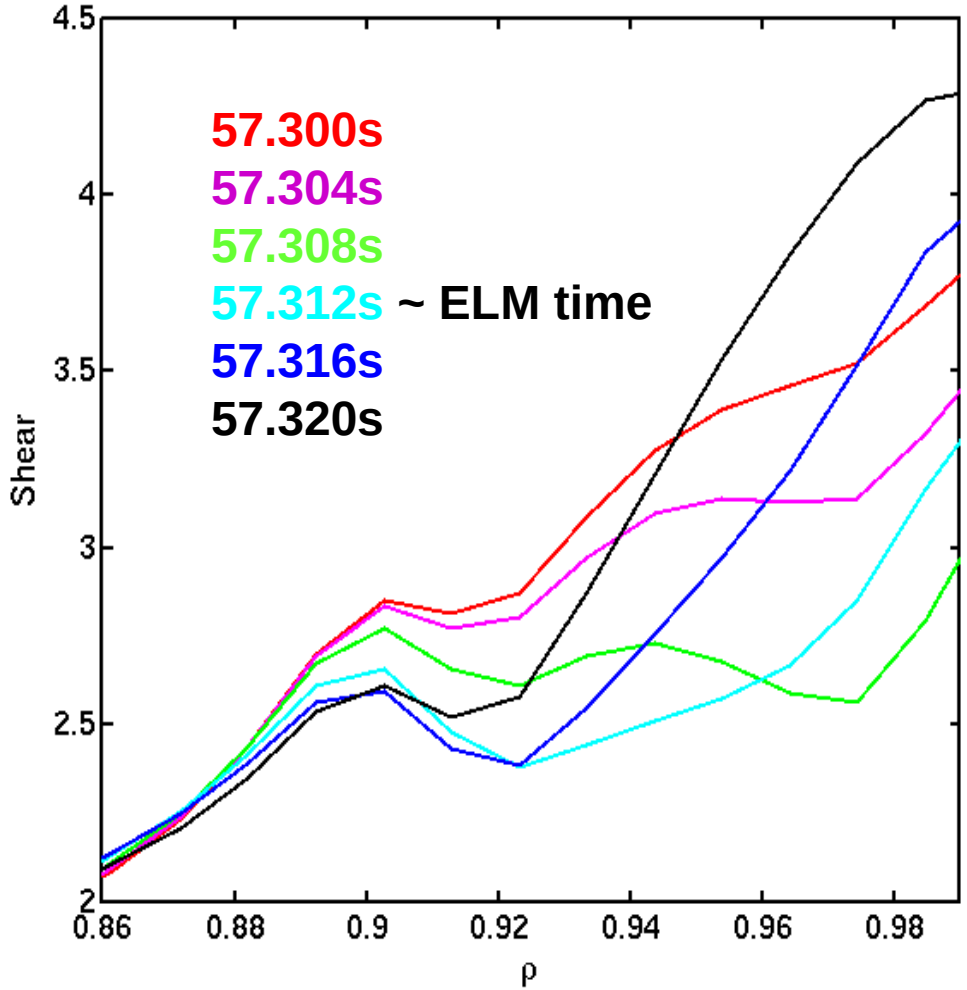




Lower $T_{e,ped}$ → faster current penetration

**E. de la Luna, IAEA 2010**

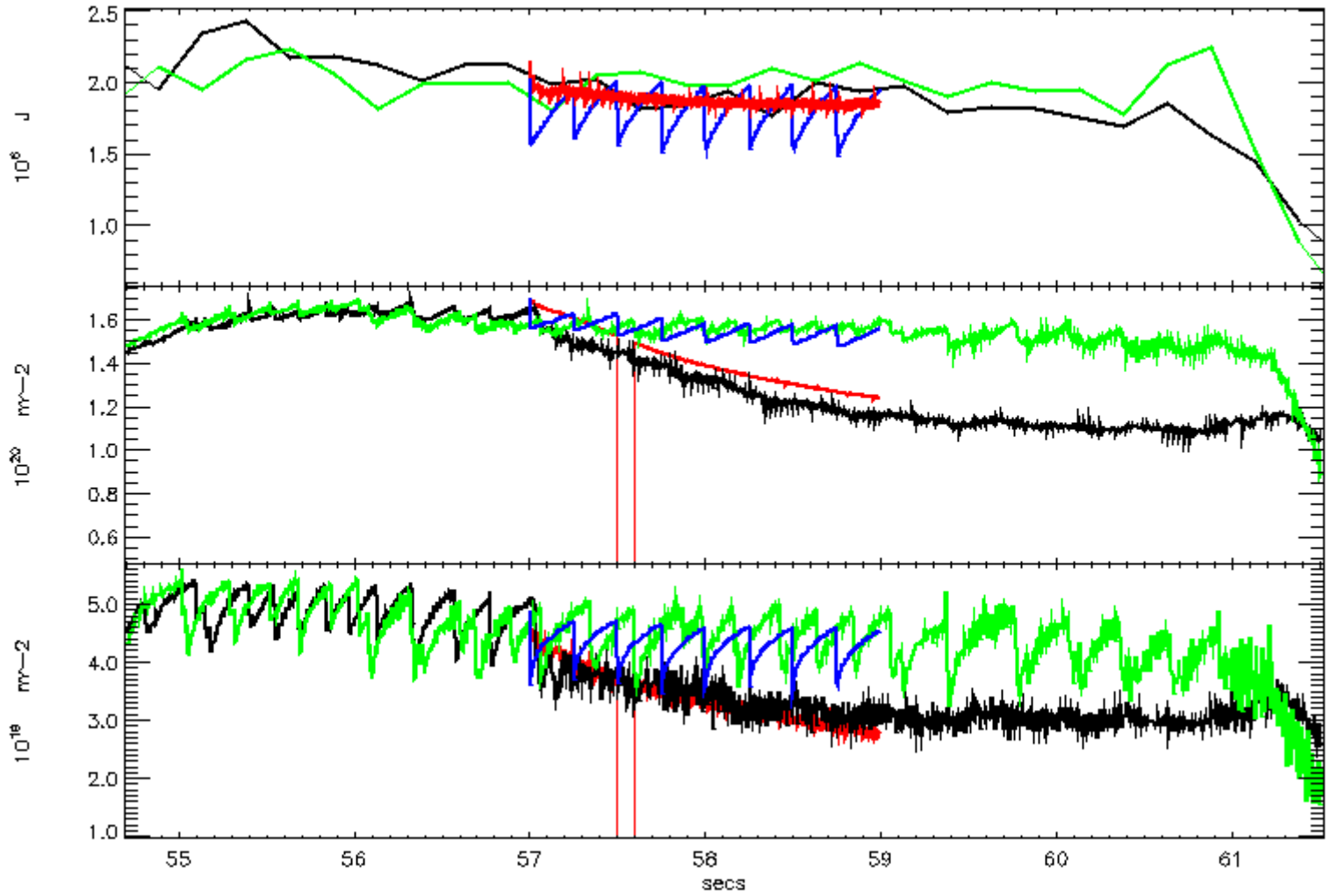
**Current density and magnetic shear profile evolution during a kick cycle:**



**Density pump-out at high ELM frequency, assuming small edge-localised ELMs:**

**#73247 – simulation** **#73247 - experiment**
**#73244 – simulation** **#73244 - experiment**




**Electron thermal energy**

**Core density (line-int.)**

**Edge density (line-int.)**

**Summary:**

- Kick-triggered ELMs can be reproduced assuming peeling mode instabilities, pressure perturbation too small to reach $\alpha_{crit.}$ for natural ELMs.
- Induced edge-located current differs considerably for varying kick amplitude but would lead to wrong timing of ELM triggering.
- Current that is induced further inside could trigger ELMs at a later time, but relative change with respect to kick amplitude becomes smaller.

**Work in progress:**

- Consideration of measurement data processed by TRANSP (I. Voitsekhovitch).
- Improved consideration of plasma edge current response to boundary flux variation; one possibility: strong coupling between CREATE-NL and JINTRAC.
- MHD analysis of a kick cycle, sensitivity scan.