Simulations of the H to L transition in JET plasmas

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[b]See the Appendix of F. Romanelli et al., Proceedings of the 23rd IAEA Fusion Energy Conference 2010, Daejeon, Korea

- **Motivation**
  - In ITER the plasma position control system has a relatively slow (~2 s) reaction time to sudden changes in plasma parameters like rapid H-L transition.
  - There is no systematic study of the H-L transition on the different machines
- **Experimental observations**

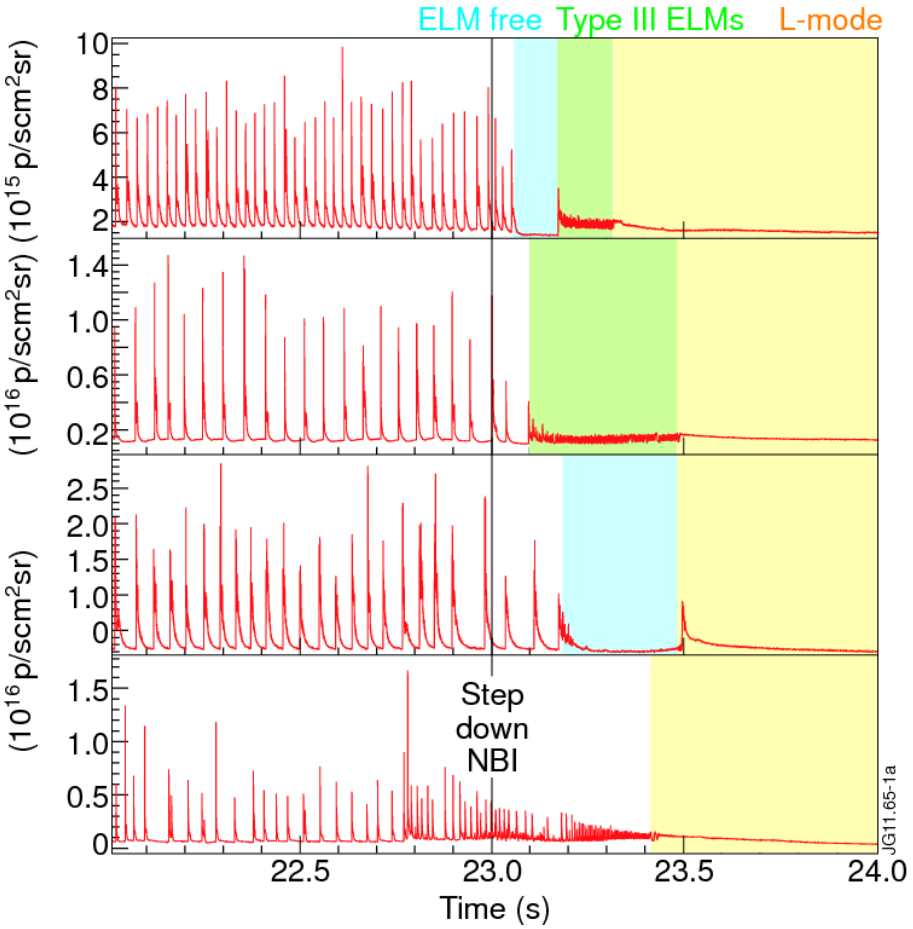
There are 4 different back transitions of back transitions were found:

a) The Type I-ELM free-Type III- L-mode

b) Type I -Type III- L-mode;

c) Type I- Lmode (plasmas with <ne>/n_{GR} >0.6) ;

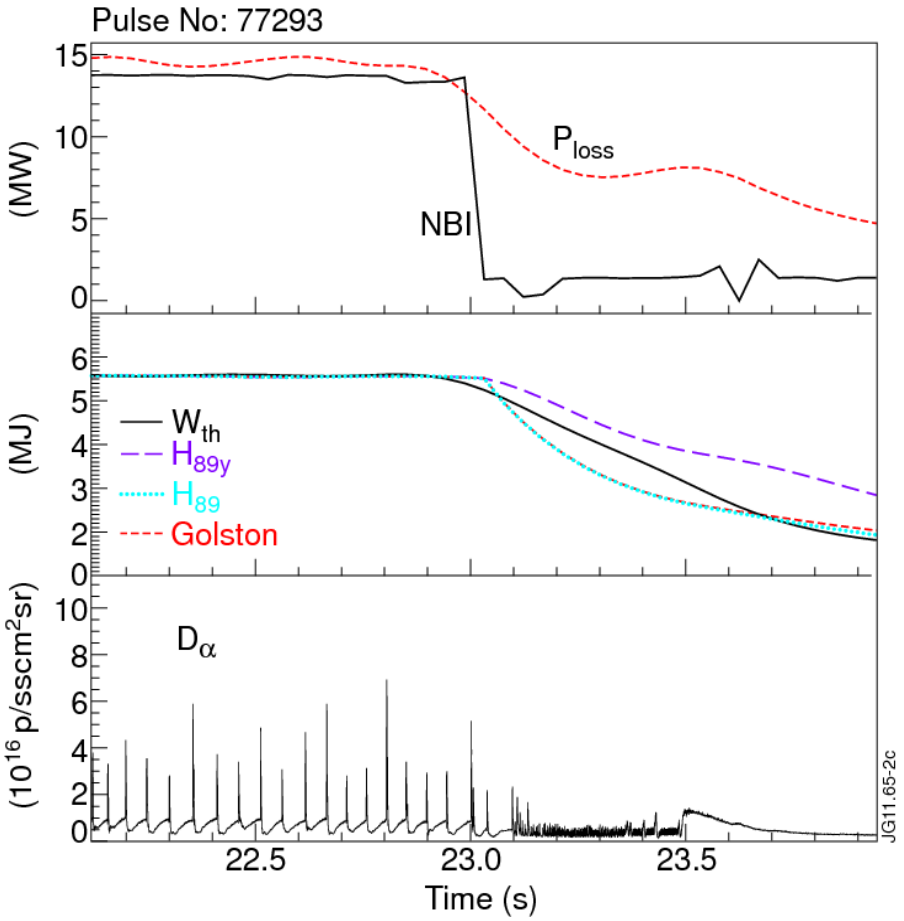
d) the ELM frequency increases and the amplitude decrease in amplitude of the ELMs before the plasma return to the L-mode.



	shots	a) (%)	b) (%)	c) (%)	d) (%)
$\delta > 0.3$	65	67.7	23.1	6.2	3.1
$\delta \leq 0.3$	164	20.1	54.3	14.0	11.6

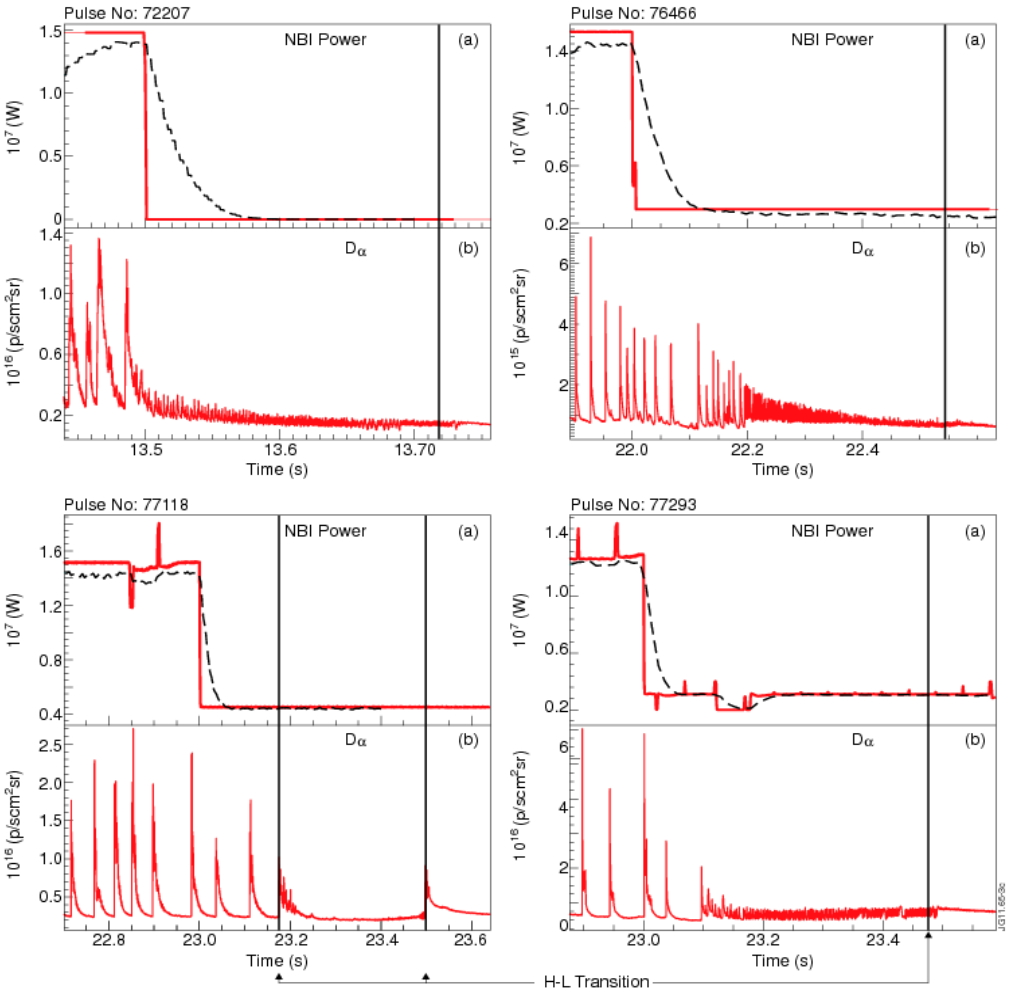
- **Simulations**
  - In 0D simulations the confinement follows the $H98_{y,2}$ between the step down of the NBI and the L-mode transition ($\Delta t = 0.5$ s) :

$$\frac{dW}{dt} = \left(P_{in} - P_{loss}\right) - \frac{W}{\tau_e}$$



1.5 D simulations

- JINTRAC: JETTO/ASCOT were done for the NBI fast particle for four JET plasmas using the experimental density and temperature profiles from: 2 low triangularity and 2 high triangularity.
- The JINTRAC gives a NBI fast particle decay times between 25 and 100 ms while the back transition is between 0.2 and 0.5 s around the plasma confinement time.



- JINTRAC: JETTO only was used in the L-H transition model. JINTRAC evaluates the sum of the electron and heat fluxes at the top of the pedestal, Pi-e=Pe+Pi, and compares it with a threshold power for the L-H transition, PL-H:

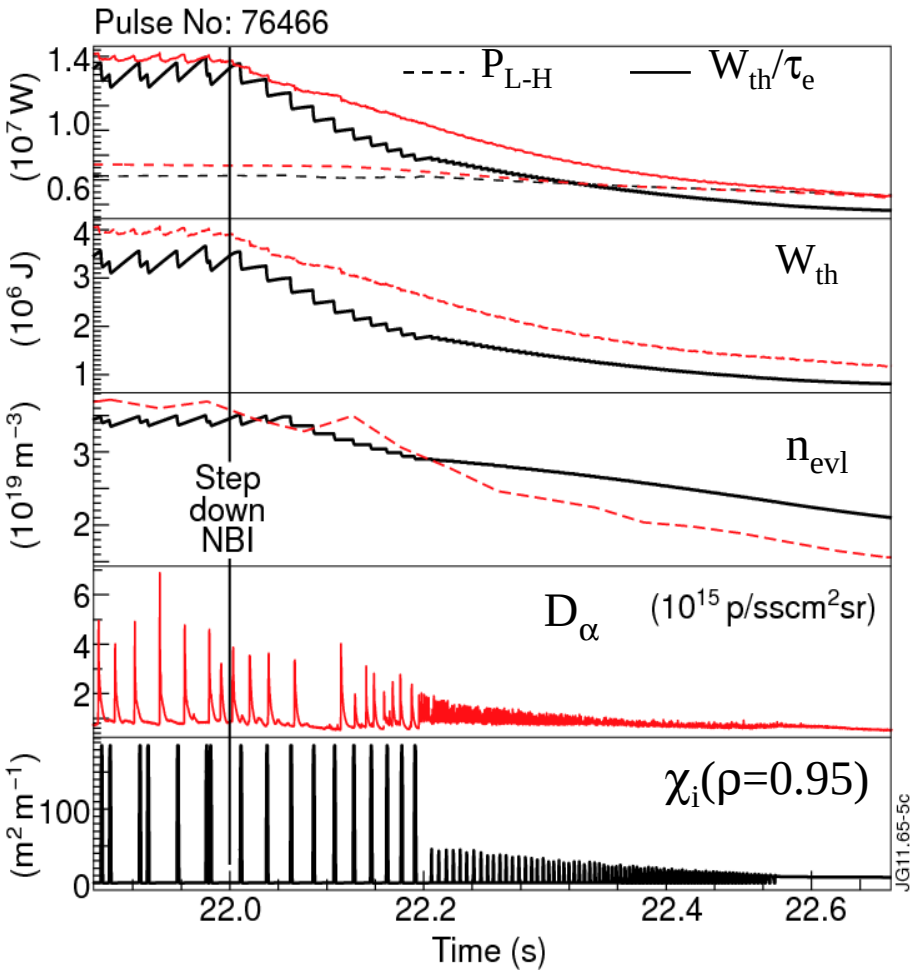
$$P_{L-H} = 0.0488 n_{e,20}^{0.717} B_T^{0.8} S^{0.941} (M/2)^{-1}$$

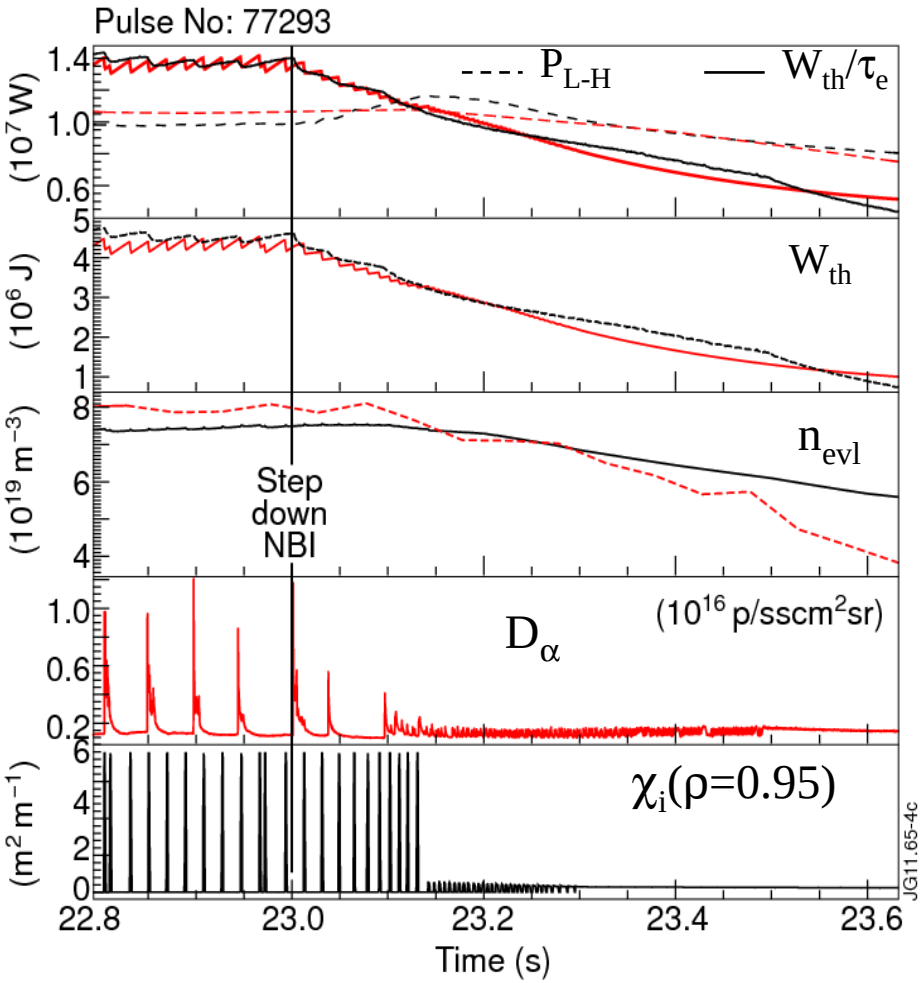
- The Bohm/GyroBohm empirical model was used for the L and H-mode phases. In JINTRAC increase of the transport within the ETB region during a ELM duration of 1ms, and are trigged when $\alpha_{crit}(\rho=0.9)$ exceeds

$$\alpha \equiv \frac{-2\mu_0 R q^2}{B_\phi^2} \cdot \frac{\partial p}{\partial r}$$

- Type I ELMs were trigged with a higher α_{crit} then for type III ELMs
- The transition from Type I→Type III is when $P_{i-e}=1.4P_{L-H}$
- The JINTRAC simulations were performed for two JET plasmas: 76466 and 77293.

Experimental data JINTRAC





Conclusions

- Type I→ELM free→Type III→L-mode is more common in $\delta > 0.3$ plasmas (68 %), while Type I→Type III→L-mode is more common in $\delta \leq 0.3$ plasmas (54 %).
- The simulated time evolution of Wth was closer to the experiments over the database when $\tau_{eIPB98(y,2)}$ is used.
- The fast particle energy decay time is not the main factor for determining how long the plasma stays in H-mode after the step down of NBI
- The model predicts well the time of the transitions from Type I→Type III ELMy H-modes and the Type III→L-mode for the (76466) plasma but it fails to predict Type III H-mode phase