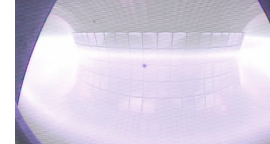


Briefing F18: Runaway electrons

FTU Experimental Day: 9 Luglio 2019

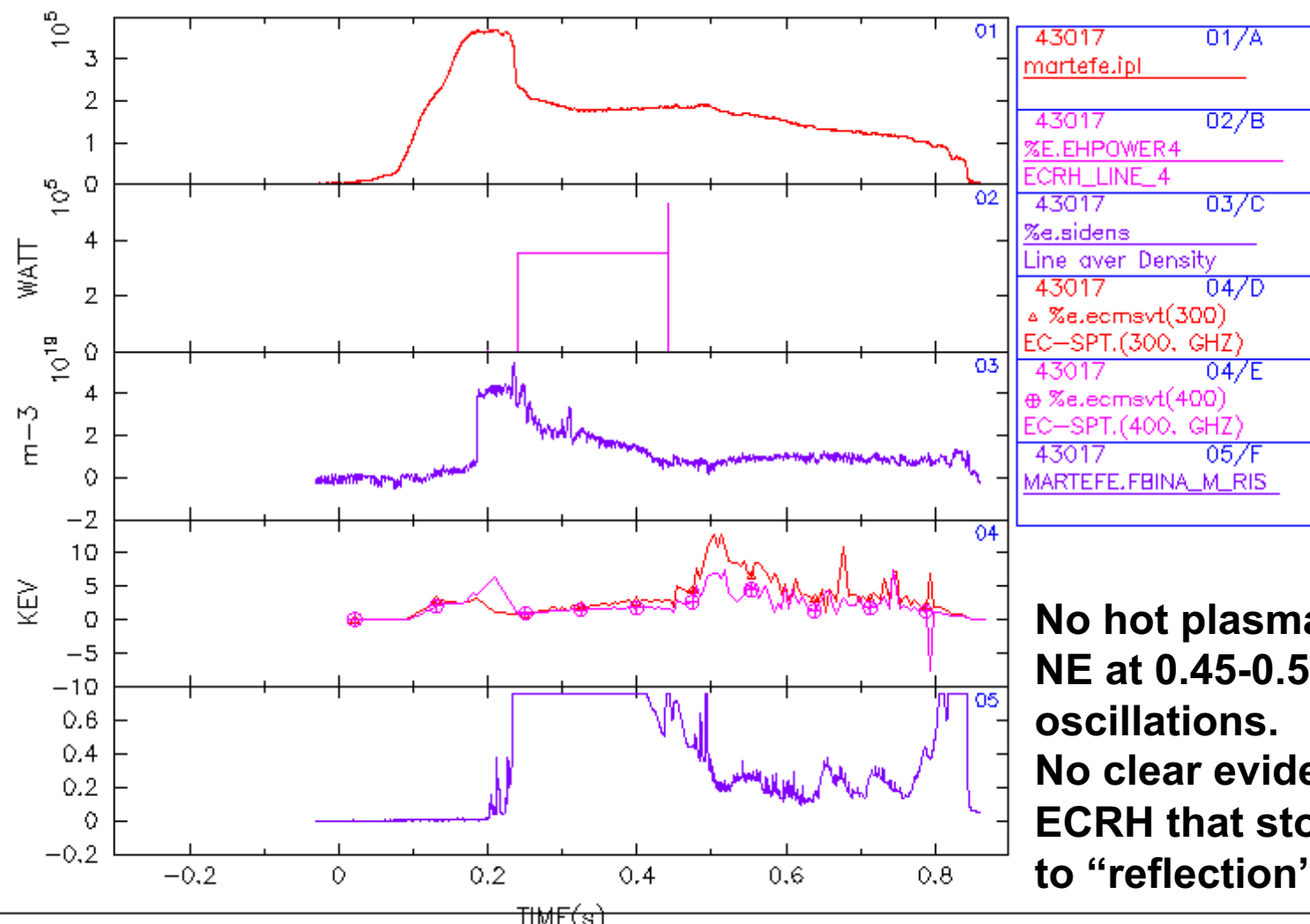
ENEA and TOR VERGATA teams





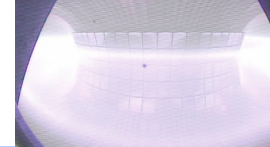
ECRH on RE beams: 43017

New recipe (no comm.): steepest lp ramp and small pellet at 0.18s.

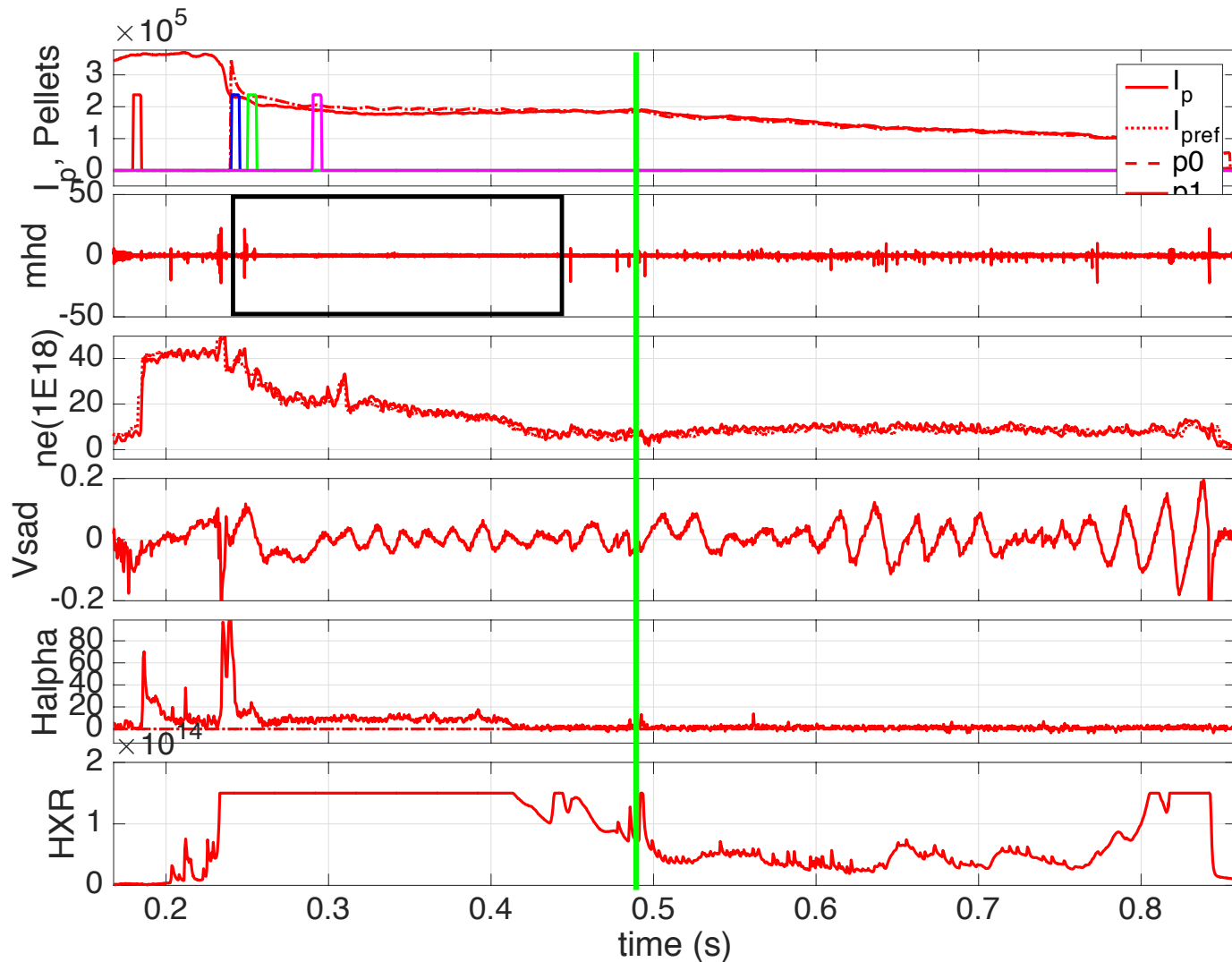


No hot plasma?
NE at 0.45-0.5s + Vloop
oscillations.
No clear evidence of
ECRH that stops due
to “reflection”.

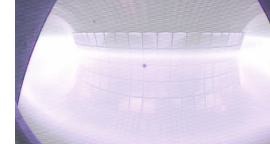
ECRH on RE beams: 43017



New recipe (no comm.): steepest I_p ramp and small pellet at 0.18s.

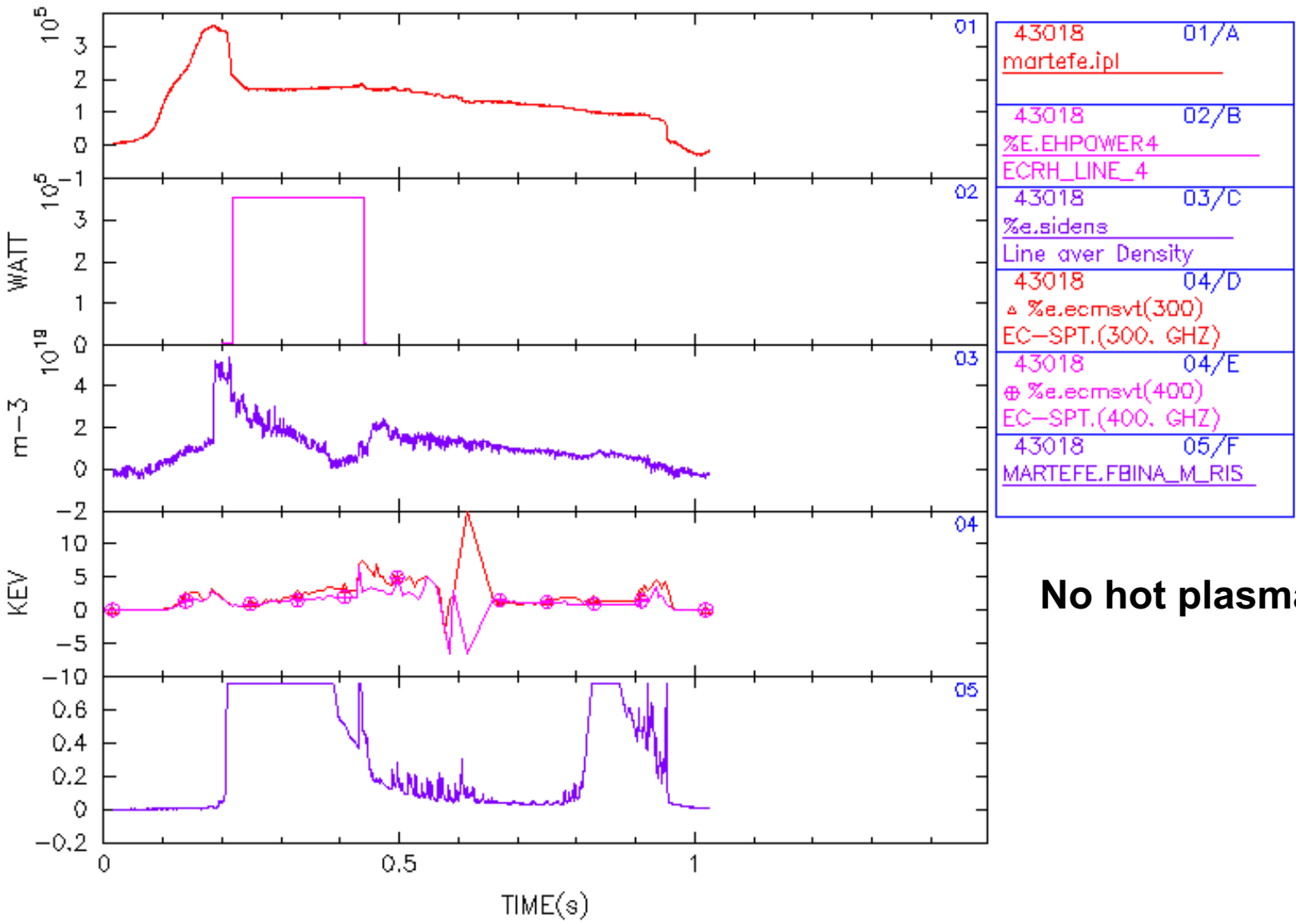


NE at 0.45-0.5s +
Vloop
oscillations.

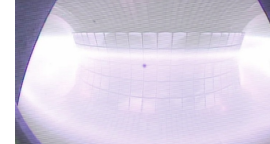


ECRH on RE beams: 43018

New recipe (no comm.): steepest lp ramp and small pellet at 0.18s.

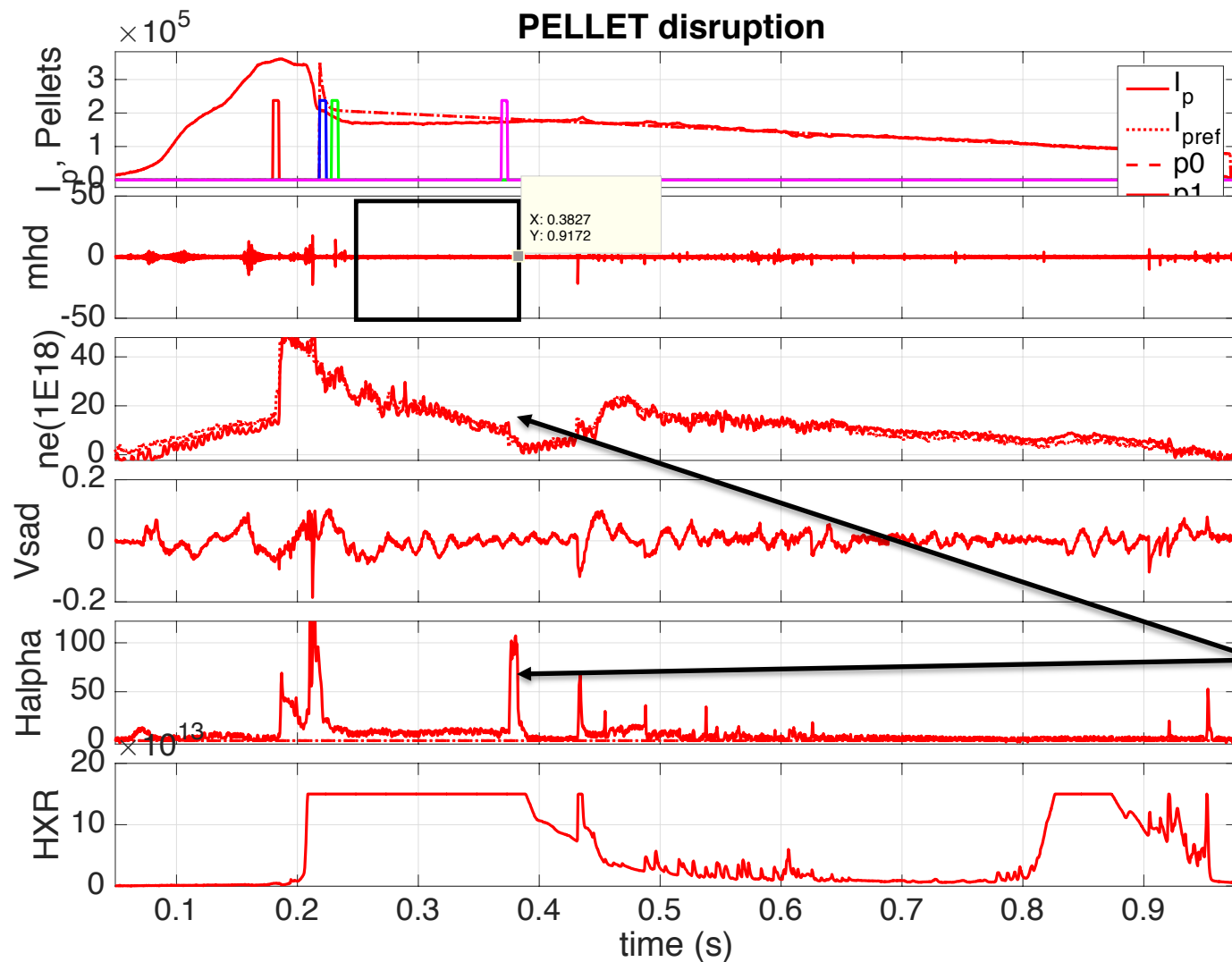


No hot plasma ?



ECRH on RE beams: 43018

New recipe (no comm.): steepest I_p ramp and small pellet at 0.18s.



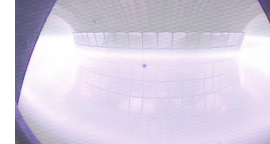
No hot plasma?

ECRH that stops
due to
"reflection".

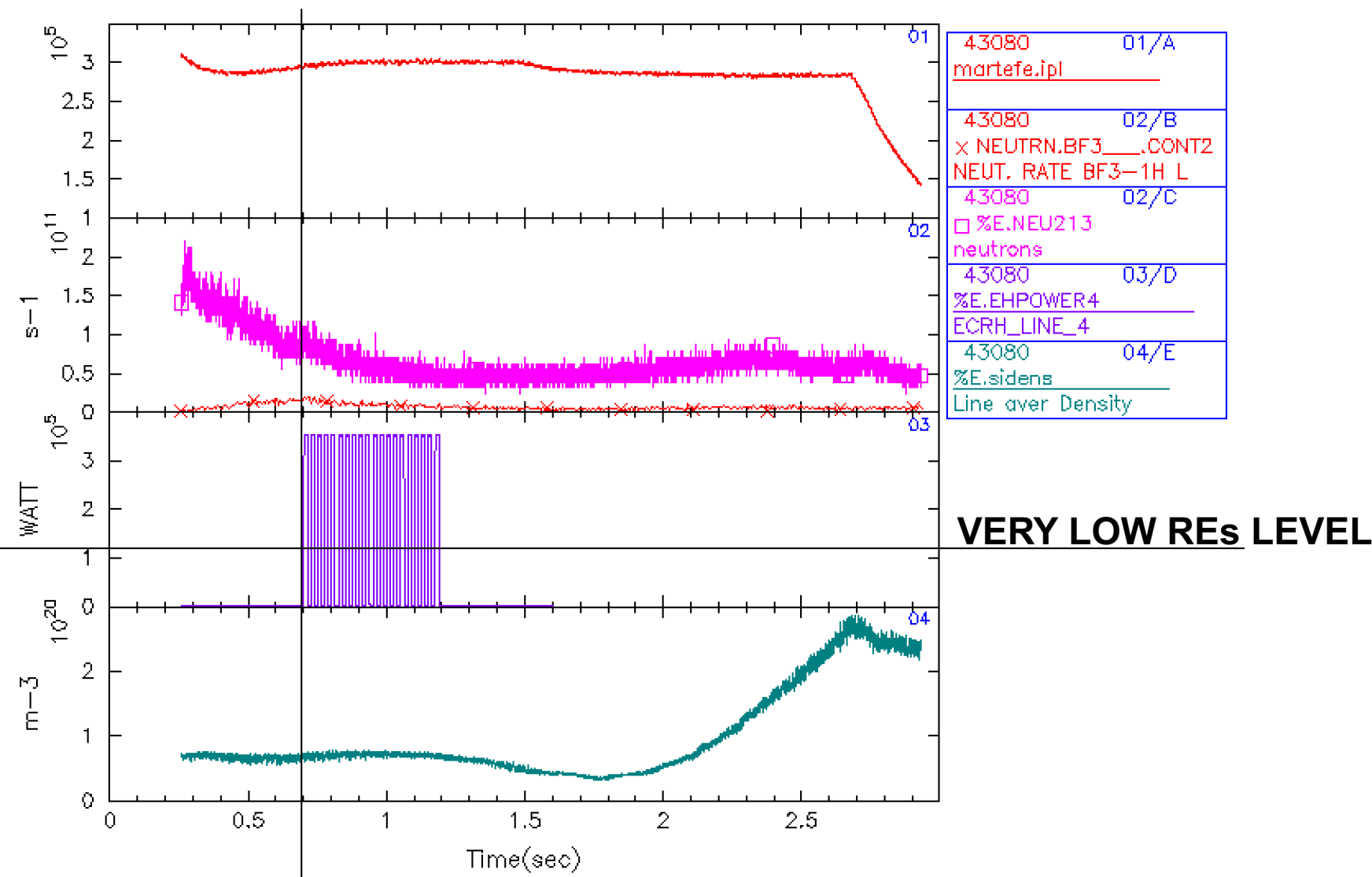
Pellet induces n_e
drop: there ECRH
begins failing.

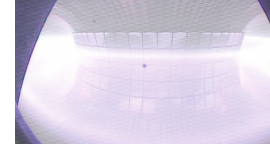
More power
needed?

ECRH on quiescent REs



LOW REs level, no signs of synchrotron emissions on the visible camera





ECRH on beam: **unclear results (continuous ECRH)**

- PWM on RE beam
- Shift ECRH (250ms after CQ)
- Change injection (poloidal) angle?
- Double gyrotrons
- ECRH, D puffs, increase the current reference to analyze the fraction of flux absorbed by “cold” and REs

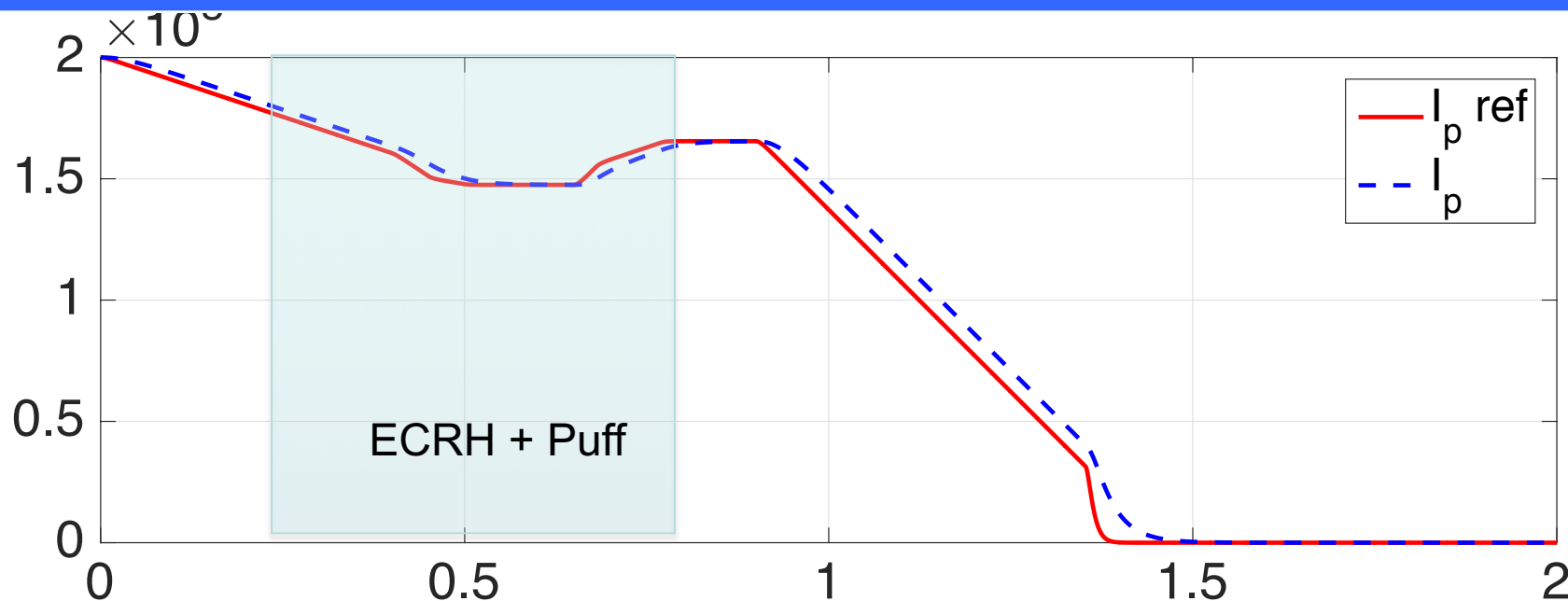
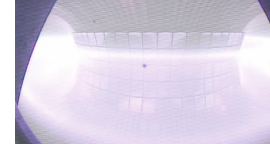
RE beam: pellets/D to see delayed instabilities

ECRH on quiescent REs: Larger REs population needed (short)

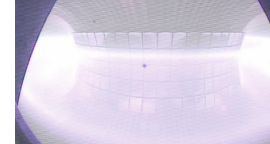
RE generation and suppression: long discharges.

New (slow) radial control and current reference to be tested on RE beams.

RE beams: restart the discharge



- New I_p reference triggered at runaway plateau/soft-stop
- HXR level considered
- Forced ramp-down before the end of the discharge
- Rate of I_p reference fixed within a range of I_T
- Forced ramp-down when current is below a given level (60kA)



Pulse list (1/2)

Aim & method:

- 1) Runaway current plateau level/energy as a function of density at CQ (D2 pellet injection, #42648) injecting deuterium pellets and using ECRH (if available) to increase ionization.
- 2) Long discharges with density sweep to obtain necessary data to validate generation and suppression runaway dynamics codes

Reference pulse number(s): #43018 for 1) and #43076 for 2) in density feedback.

Machine requirements *(list any specific requirements for B_T , I_P , heating, etc.):*

Toroidal magnetic field B_T (T): 4(long discharge) – 5.3T

Plasma current I_P (MA): 0.30 – 0.50 (0.70, recovery)

Electron density n_e (10^{20} m^{-3}) 0.1 – 0.7

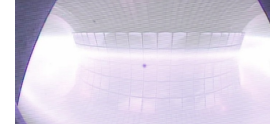
Diagnostic requirements *(list mandatory diagnostics or special diagnostic settings):*

HXR, FC, Interferometer, ECE, Soft-X (and temperature profiles), Da, Mirnov coils,

Cherenkov. Special requirements: Poloidal Limiter 2 cm inside for all shots, allocator active in IFREF mode, Pellet injection, New Diamond Sensor, LONG DISCHARGE (without change the commutation resistances), ECRH if possible.

Modelling requirements *(include names of required modelling codes):*

JETTO, MARS (offline)



Pulse list (2/2)

Number of pulses required (*state whether they are dedicated or parasitic*):

12 + (+ 2 zeros + 3 recovery) = 12 (17)

Pulses (*consider pulse by pulse to expose the **limiter tin***):

1. Zero at 5.3T
2. Discharge #43018 with 3 pellets in time feedback (early CQ, 100ms, 150ms) and no ECRH. *Slow Radial controller test*. (delayed instabilities?) [1 **shot**, **RE beam**].
3. Discharge #43018 one early pellet, Deuterium puff + **PWM ECRH** [2 **shot**, **RE beam**].
4. Recover standard 5-700kA, ne 0.4E20. [1 (depending on residual density) shot]
5. Discharge #43018, early pellet + Deuterium continuous puff with *NEW current Reference* [2 **shots**, **RE beam**] (*if the first is "good" move to 6 and then possibly come back to 5*).
6. Discharge #43018, early pellet + Deuterium continuous puff NEW current Reference + **PWM(?) ECRH** [2 **shots**, **RE beam**].
7. Recover standard 5/700kA, ne 0.4E20. [1 (depending on residual density)]
8. Discharge #43018, early pellet + Deuterium continuous puff after CQ [1 **shots**, **RE beam**].
9. Discharge #43018 with one early CQ pellet and no ECRH (compare). [1 **shot**, **RE beam**].
10. Recover standard 700kA, ne 0.4E20. [1 (depending on residual density) shot]
11. Zero at 4T, change on LONG DISCHARGE
12. LONG DISCHARGE #43078 (3.0s), REs in flat-top (quiescent), low prefill [2 **shots**]