Debriefing F18: Runaway electrons

FTU Experimental Campaign 2019-C1-A

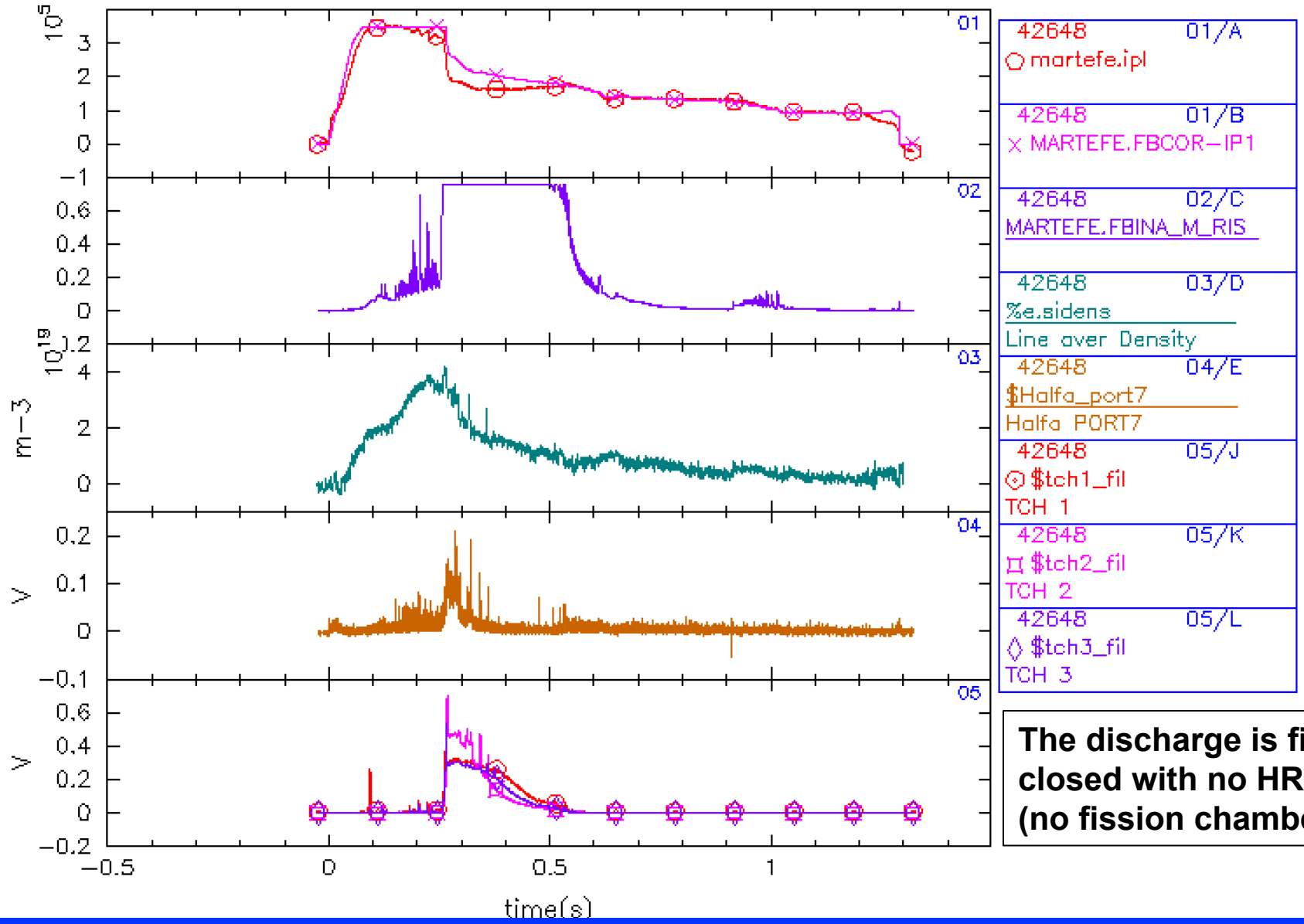
Tuesday 9/04/2019 (Early & Late)

D. Carnevale, L. Boncagni

RdO: O. Tudisco, O. D'Archangelo, A. Romano

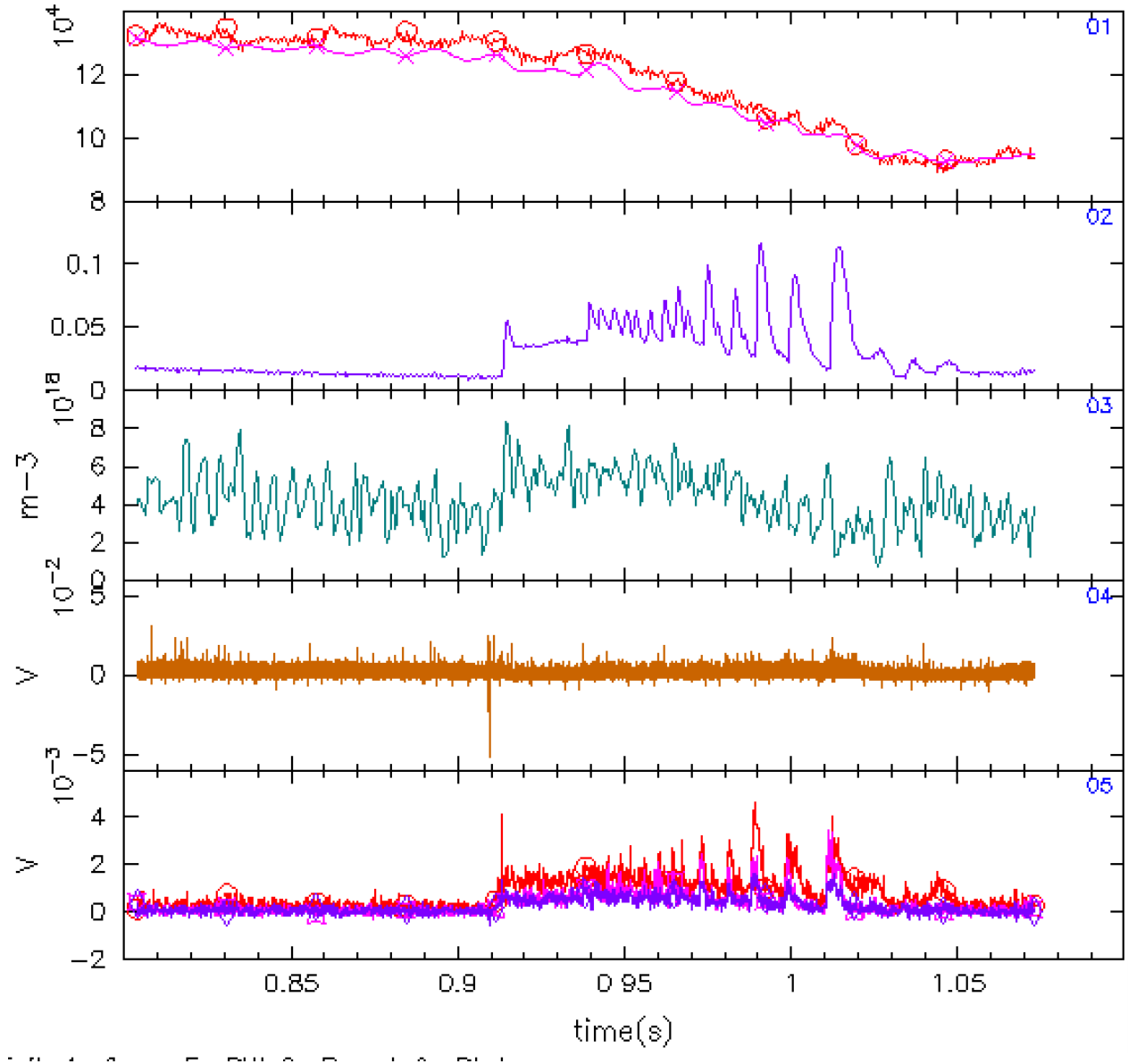
PiC: C. Mazzotta, F. Napoli

RE beams conversion: LBO injection



The discharge is finally closed with no HRX spike (no fission chambers...)

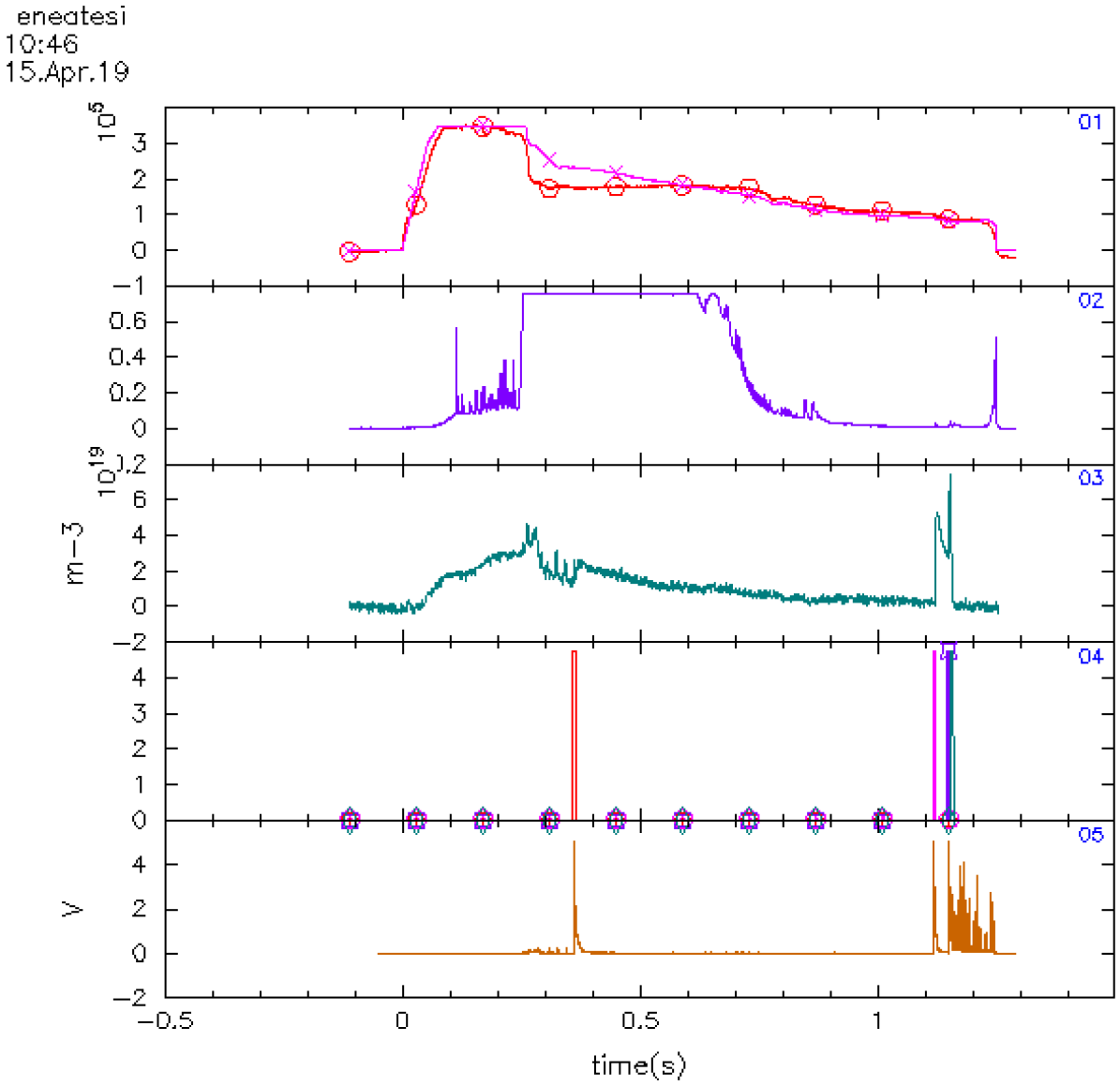
RE beams conversion: LBO injection



LBO has been injected into "early" RE beams and no effect has been seen: the beam is cold and ionization does not take place.

When injected at 0.9s, after a long ramp-down, electrons with sufficient (thermal) energy form again.

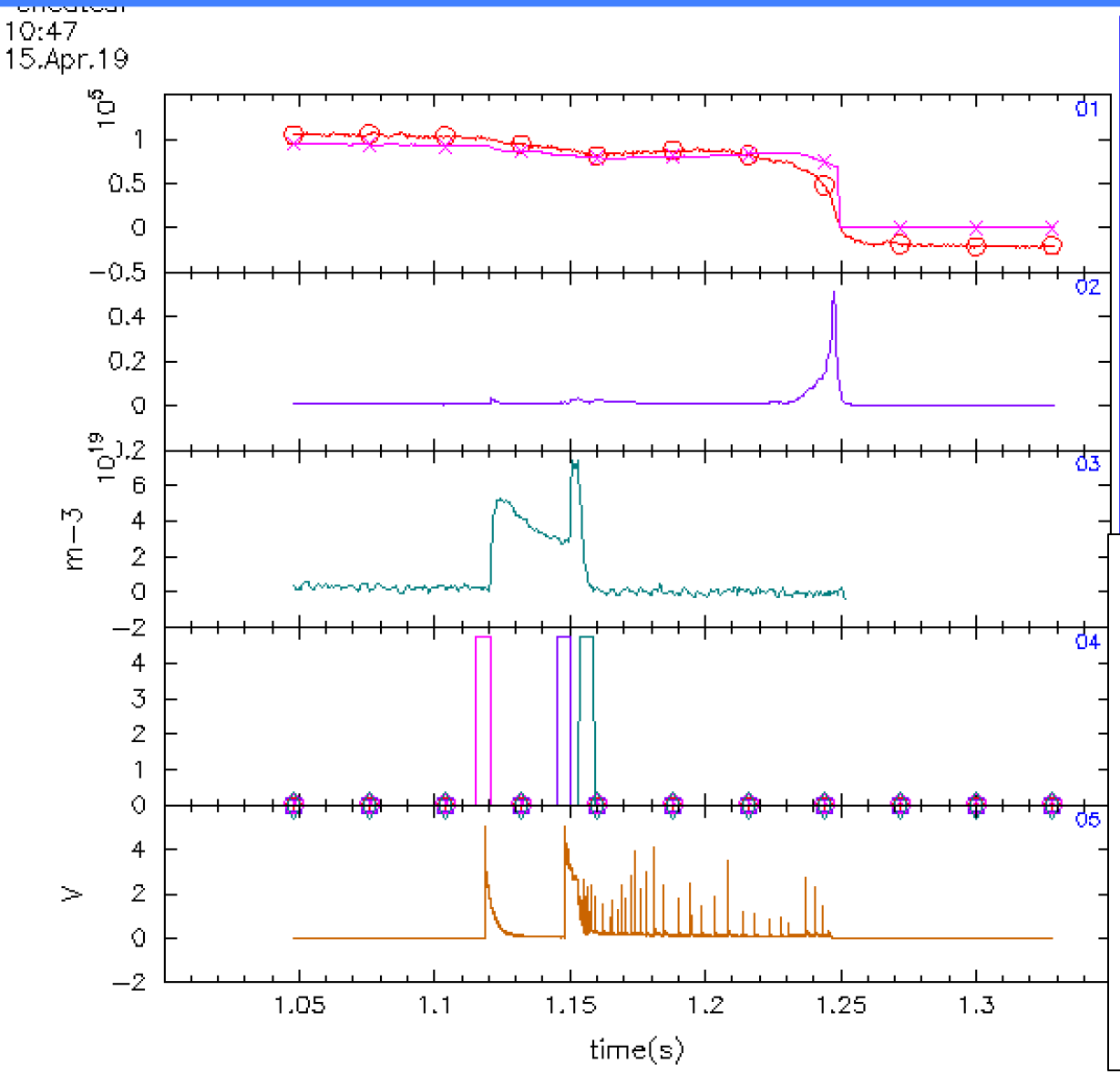
RE beams conversion: Pellets injection



As for LBO, pellet injected in the "early" RE beam phase are ablated but not ionized (recombination)

The second pellet (1E20) is ionized, also the third one (2E20) even though partially, the last one (2E20) cool down to recombination.

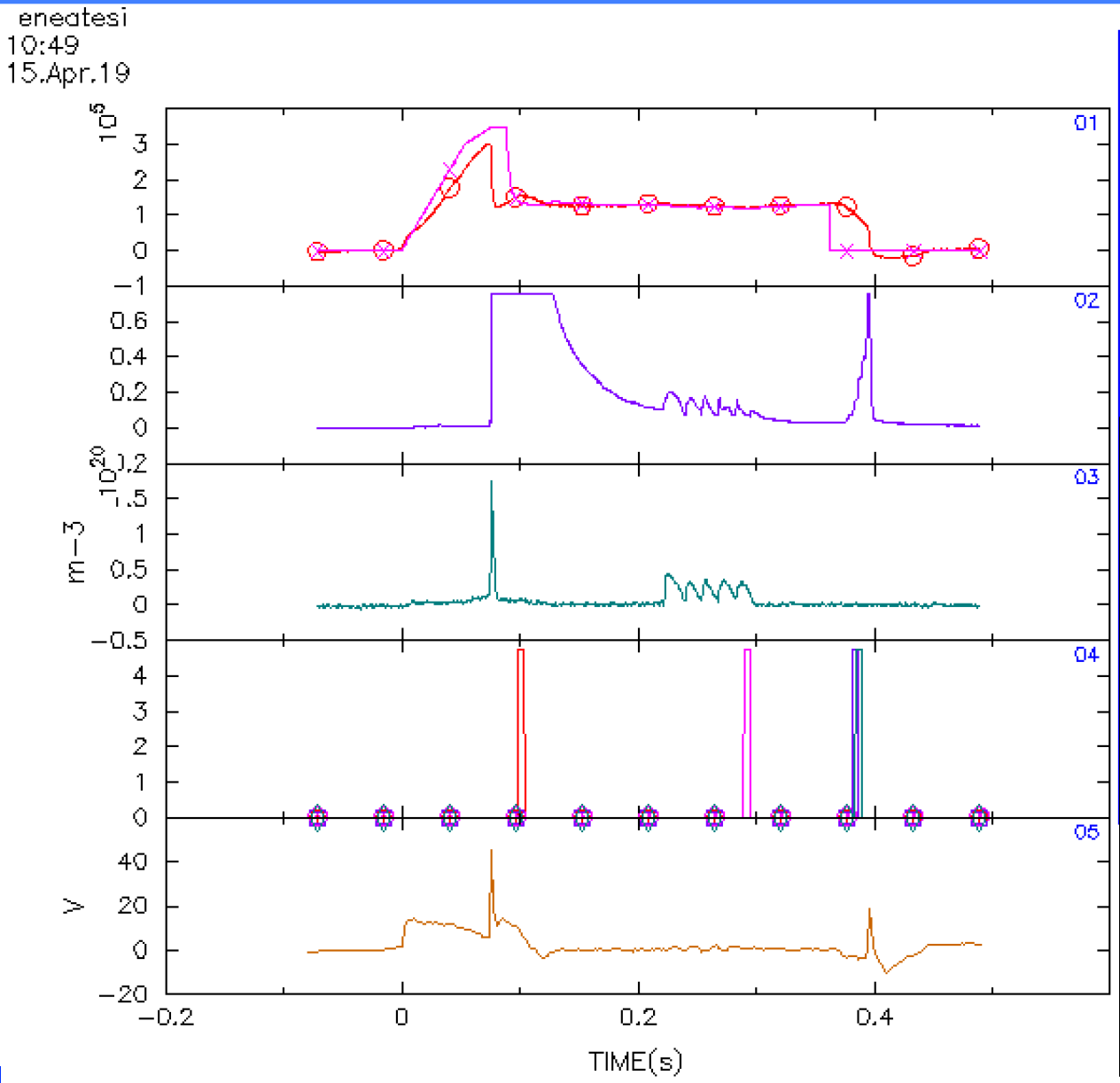
RE beams conversion: Pellets injection



As for LBO, pellet injected in the "early" RE beam phase are ablated but not ionized (recombination)

The second pellet (1E20) is ionized, also the third one (2E20) even though partially, the last one (2E20) cool down to recombination.

RE beams instability: pellet stabilization?

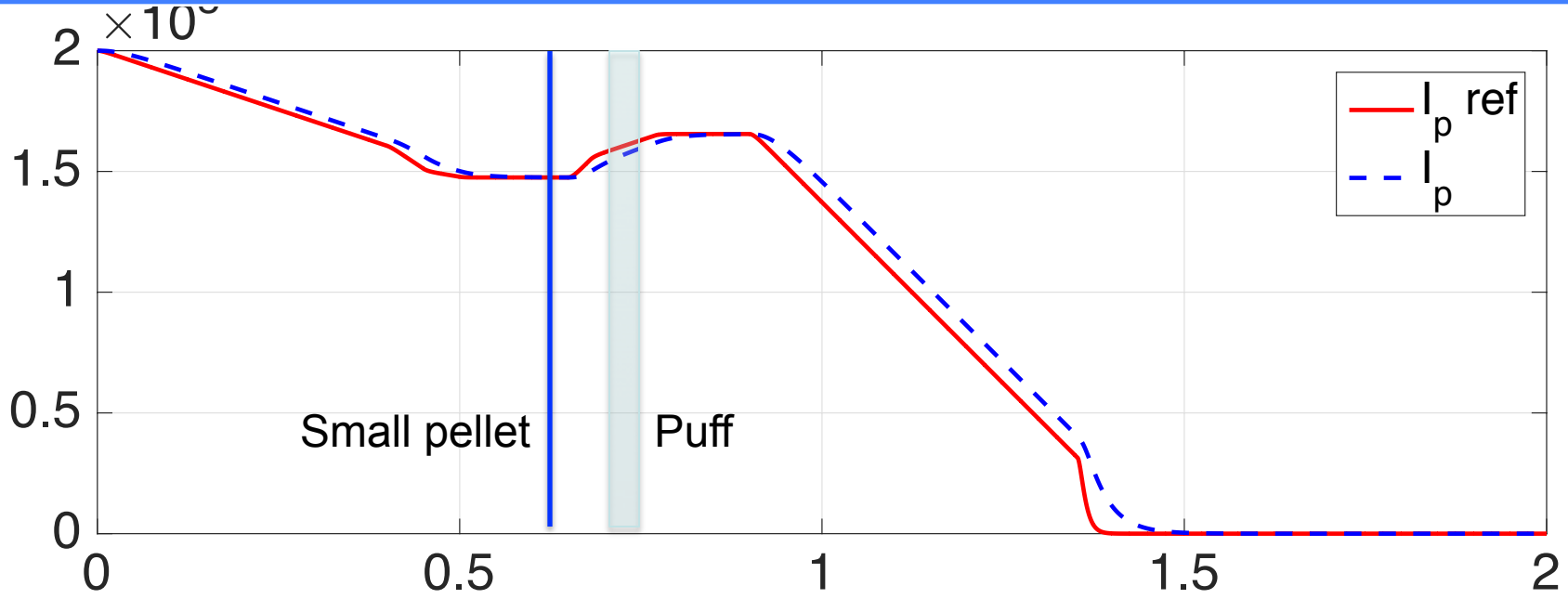


A pellet has been injected into a RE beam with Anomalous Doppler instability (HXR-ne spikes): the instability disappears.

Density is extremely low along all the discharge (natural disruption + early pellet): flat plateau

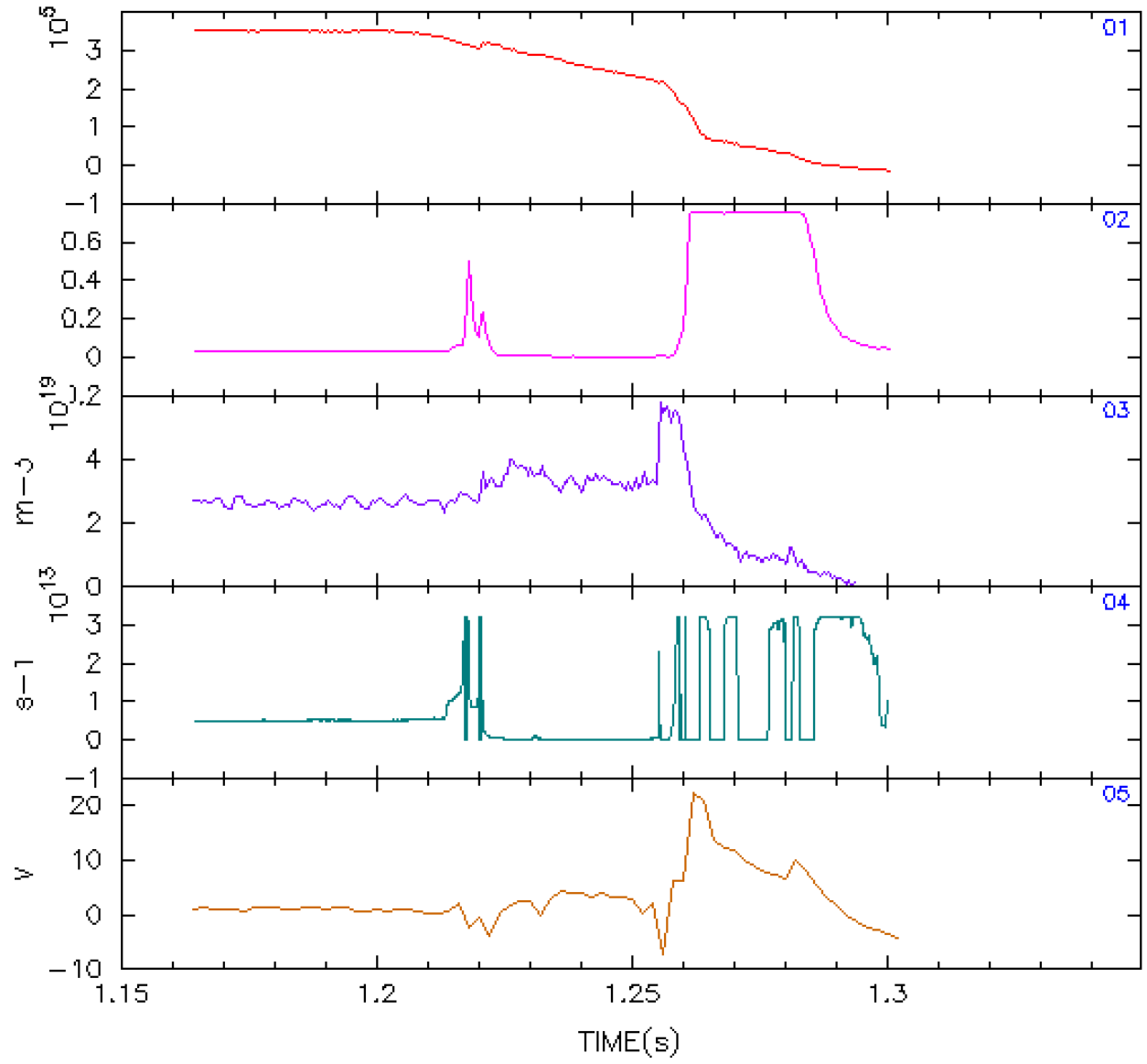
Discharge closed due to "bad gas"-> change policy?

RE beams: restart the discharge



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

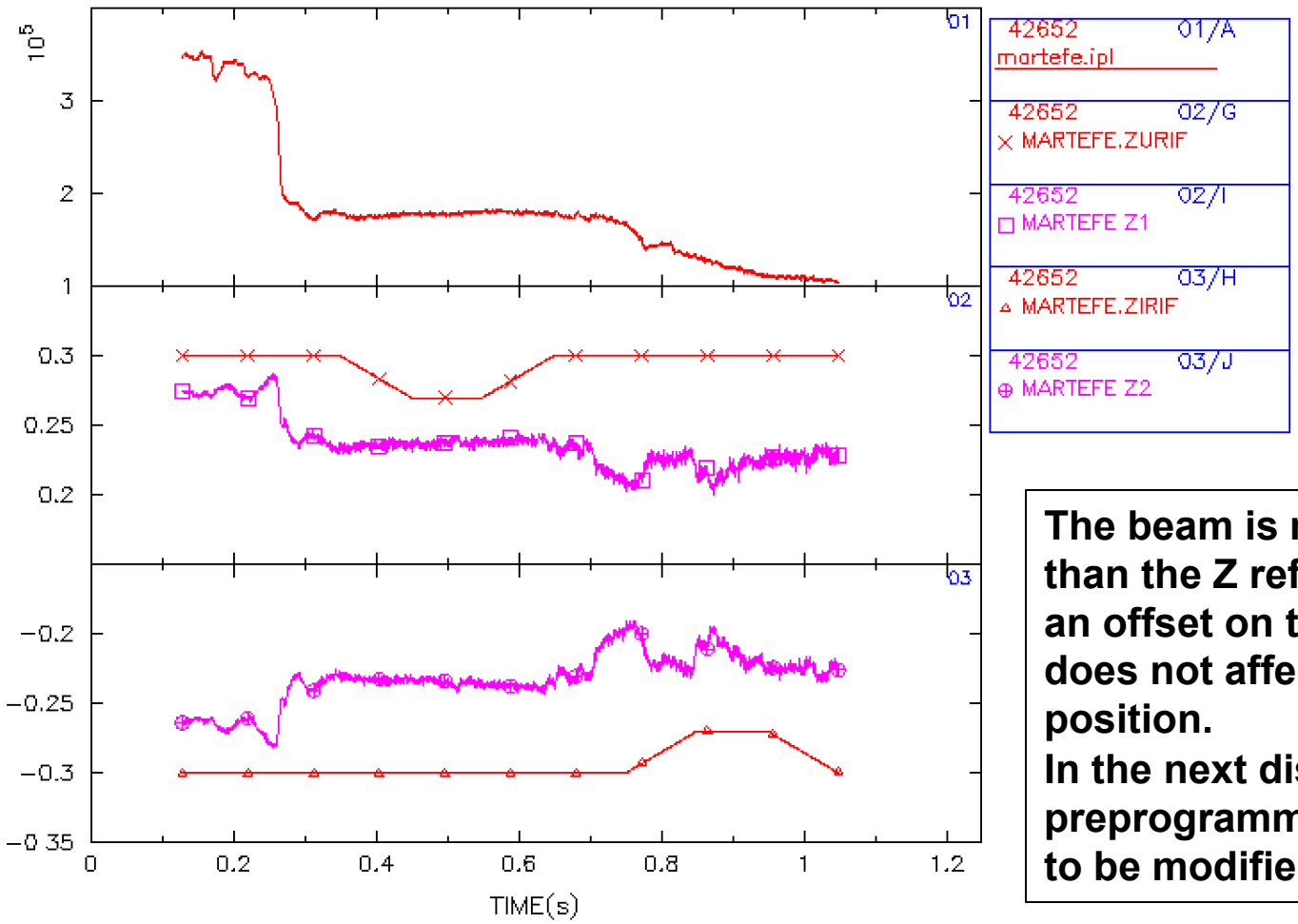
LBO on quiescent runaways



42647	01/A
martefe.ipl	
42647	02/C
MARTEFE.FBINA_M_RIS	
42647	03/D
%e sidens	
Line aver Density	
42647	04/J
%E.NEU213	
neutrons	
42647	05/I
%e vloop10	
VL10_from_VL12	

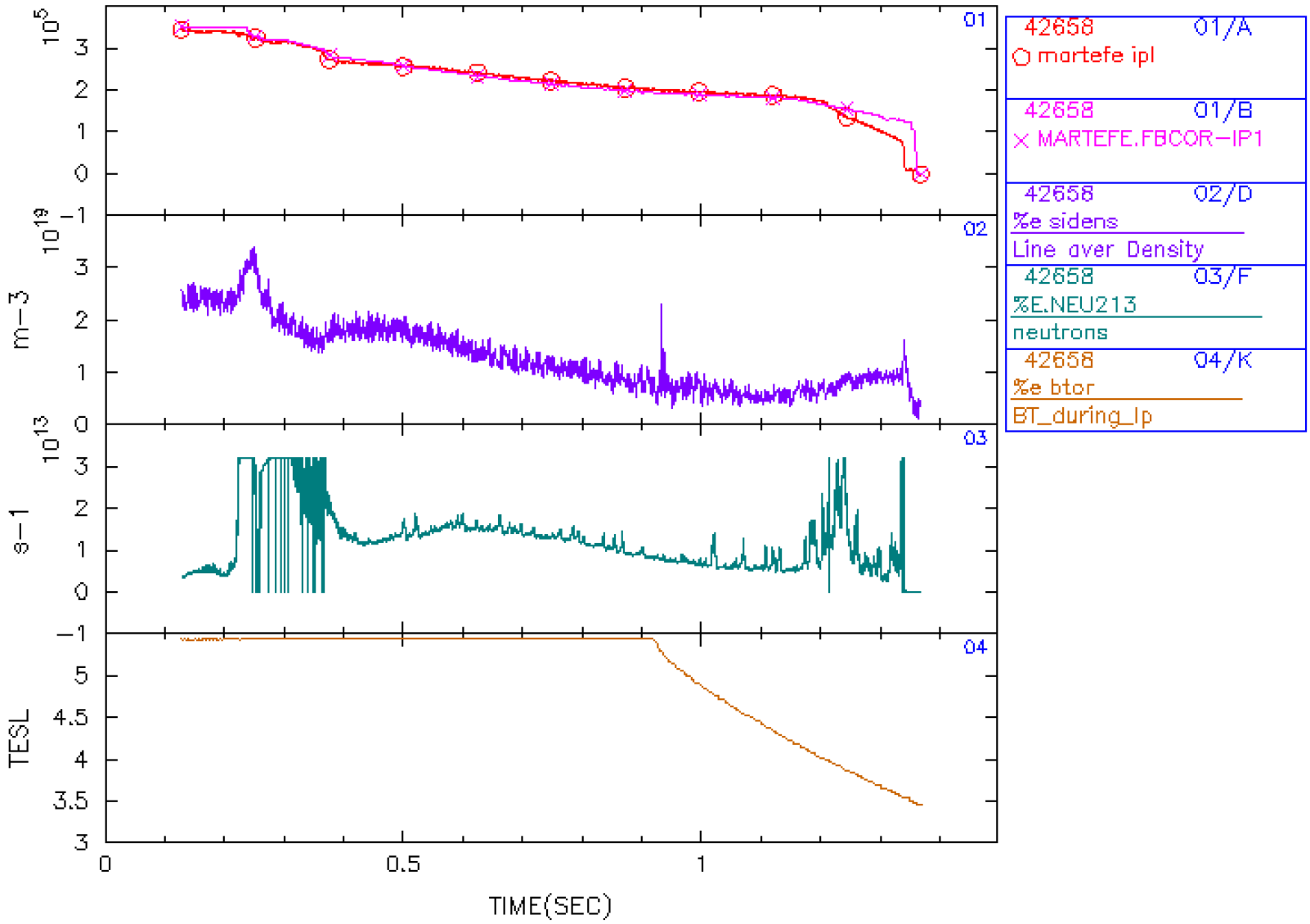
Fe seem to induce MHD modes leading to RE expulsion as seen in many (not all) discharge in flat-top

Z sweep: change approach

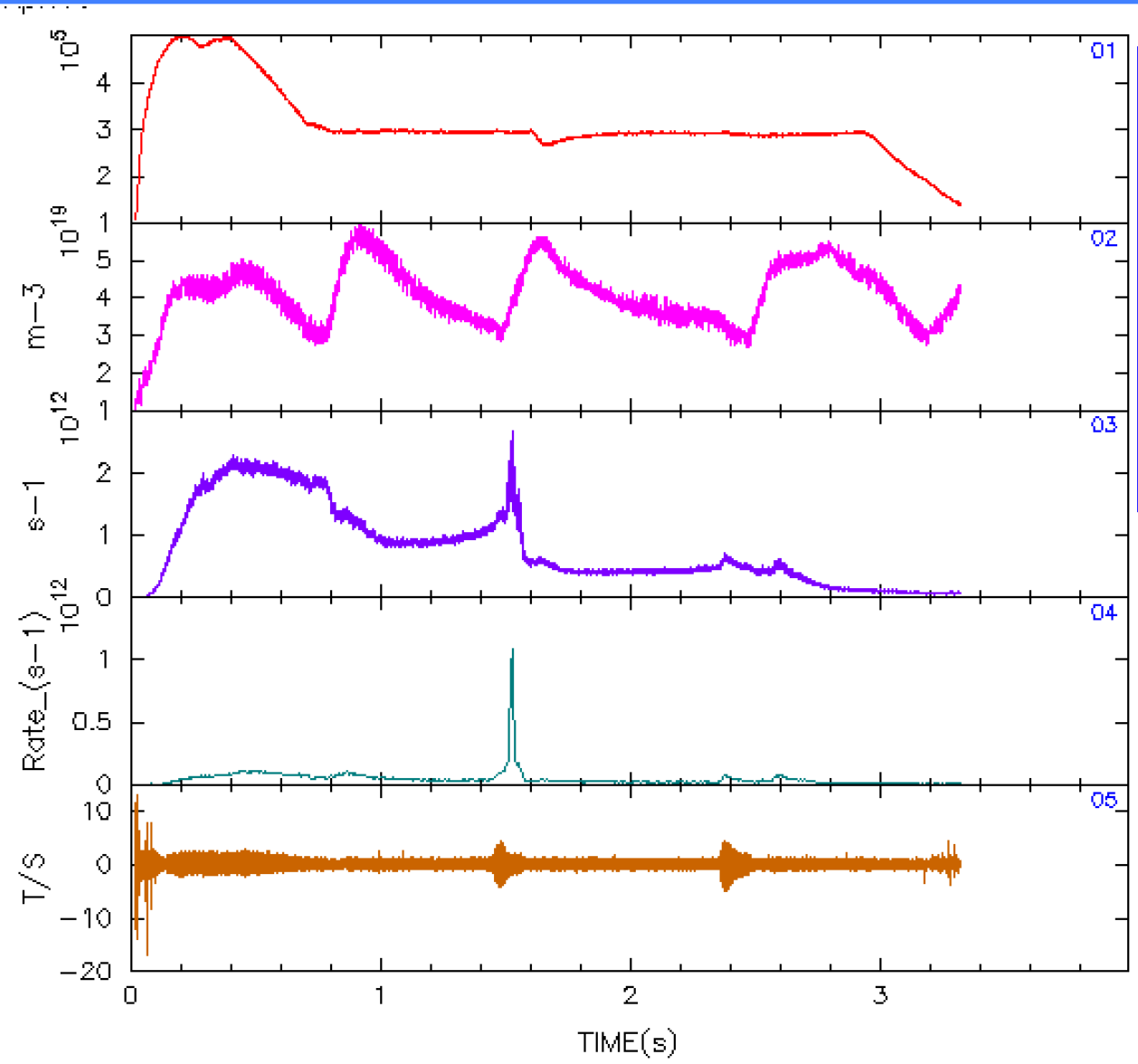


The beam is much smaller than the Z references: even an offset on the reference does not affect the central position.
In the next discharge the preprogrammed I_h is going to be modified.

RE waves program: Bt exp-ramp down



Long discharge: density oscillations



42666	01/A
martefe.ipl	
42666	02/D
%e.sidens	
Line over Density	
42666	03/J
%E.NEU213	
neutrons	
42666	04/K
%E.BF3AVRAT(0)	
Y:1.53E+11_Nor_c	
42666	05/L
MHDFST.CH04	
9D021P0	

Generation of REs has been seen but MHD activity has largely influenced the result. A different density reference can improve the generation/ suppression dynamics.

Pulse Plan (1/2)

Title: Runaway Electrons

Author(s): D. Carnevale, L. Boncagni

Aim & method (write a few sentences to explain the aim and method of the proposal):

1) Move the RE beam vertically in the vacuum vessel to assess its controllability.
2) Continue the LBO scan on quiescent REs
2) Long discharge with density sweep to obtain necessary data to validate generation and suppression runaway dynamics codes
3) A runaway current ramp-down followed by D injection performing a small restart.

Reference pulse number(s): #42531 (the other two discharges for 1), 2) have already been prepared and 3) is under simulation and testing

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

Toroidal magnetic field BT (T): 4(long) – 5.3T

Plasma current Ip (MA): 0.30 – 0.50 (0.70, possible standard recovery)

Electron density ne (1E20 m-3) 0.1 – 0.7

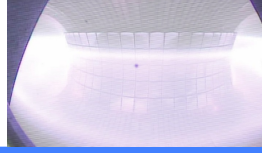
Diagnostic requirements (*list mandatory diagnostics or special diagnostic settings*):

HXR, FC, Interferometer, ECE, Soft-X (and temperature profiles), Da , Mirnov coils,
Cherenkov, (Showb if available)
Special requirements: Ne, Poloidal Limiter 2 cm inside for all shots, allocator active in IFREF mode, Pellet injection, LBO, LONG DISCHARGE (without change the commutation resistances)

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

JETTO, MARS (offline)

Pulse Plan (2/2)



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

7 (+ 2 zeros + 1-2 recovery) = 7 - 9

Pulses (*briefly describe changes to be made pulse-by-pulse*):

1. Zero at 5.3T
2. Discharge **TO BE** prepared from S53M35ALZ2. With/without pellet/Ne in the early stage [**2 shots**, **RE beam plateaus**].
3. Recover standard 500kA, ne 0.4E20. [**1** (depending on residual density) shot]
4. As #42531, no Ne, no Pellet, prefill 0.6, Fe LBO shot at 0.9s [**1** shot].
5. S53M35ALS5 with current recovery [**2 shot, RE beam plateaus**]
6. Zero at 4T, change on LONG DISCHARGE
7. LAST DISCHARGE (S40M30R35S,#38980): the long (3.5s) one with low prefill and gas density programmed in order to have a sweep in density and get generation and suppression of runaways [**1** shot]