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Global Confinement Properties of TPE-RX

The first results of the Thomson scattering and NPA are reported with the estimation of the global confinement properties.

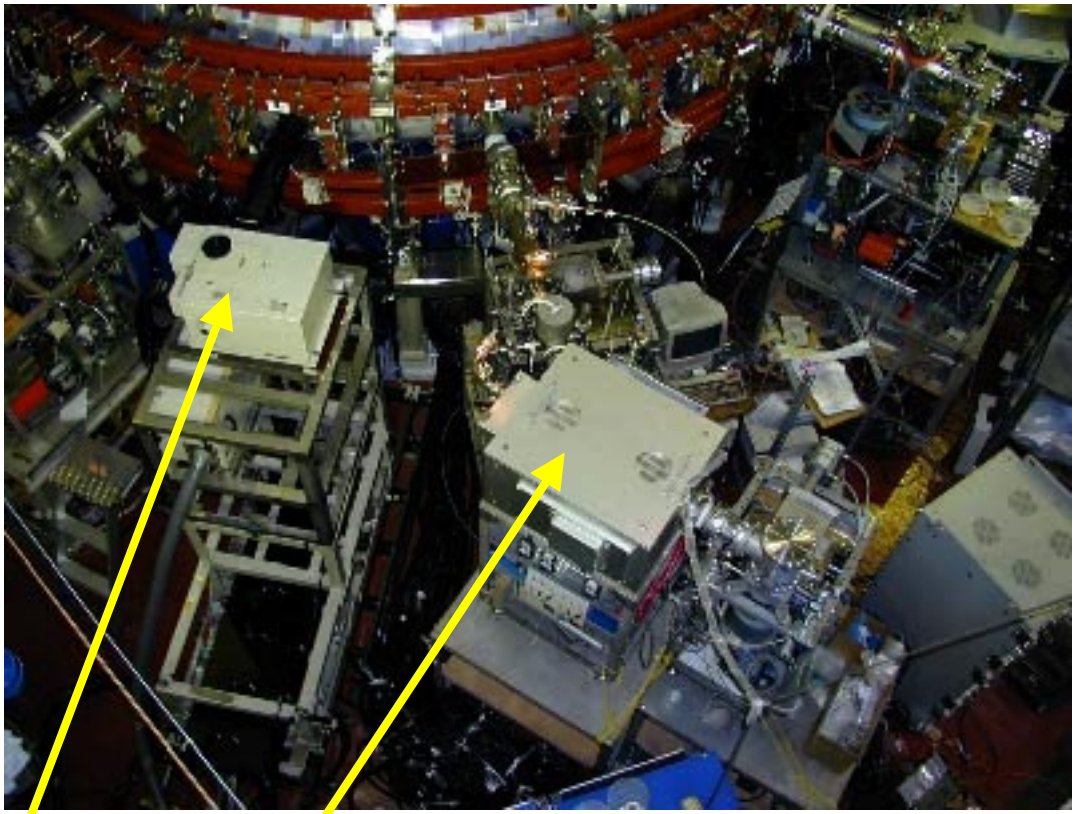
Electrotechnical Laboratory

Y. YAGI and TPE-RX Group

Outline

- Thomson scattering (LS) and neutral particle energy analyzer (NPA) system
- Energy distribution of electrons and ions
- Temporal evolution of T_{e0}, T_i, n_{el}*, β_p and τ_E
- I_p-dependence of T_{e0}, T_i, n_{el}*, β_p and τ_E
- Comparision with other RFPs
- Preliminary result of the single PPCD
- Summary

LS / NPA on TPE-RX



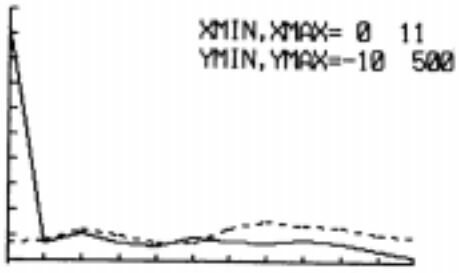
LS => port 6 (135˚ from the Gap)
Single point, single pulse, 10 wave-length channels, Ruby laser (Max. ~15 J, 4-5 J for measurement)

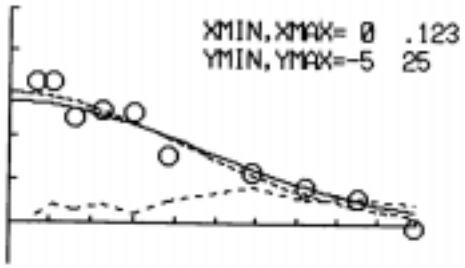
NPA=> port 7 (157.5˚ from the Gap)
Electrostatic type, 8 energy channels, deflection plate voltage = 1.5 kV

Typical shot data < LS >

- Net scattered light levels in the 10 wavelength channels are evaluated after subtracting the plasma light, stray light and the shot-noise level from the measured signals. They are fitted to Maxwellian distribution function to obtain T_{e0} and n_{e0}.

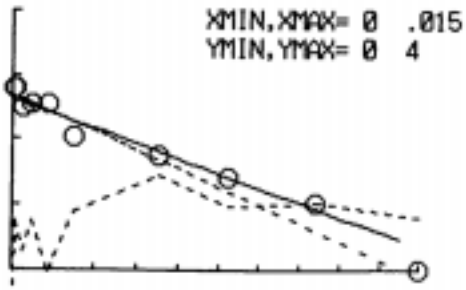
```
USED CAL. FAC. FOR NE          .552
ELECTRON TEMPERATURE(LOG,DIR) : 834.561  671.339 (eV)
B,   C,   R,   S,   N0,   NED,   NNQ,   NPQ
 153.076   2.63691 -.977442   .631086   .51126   .491736   1   5
```





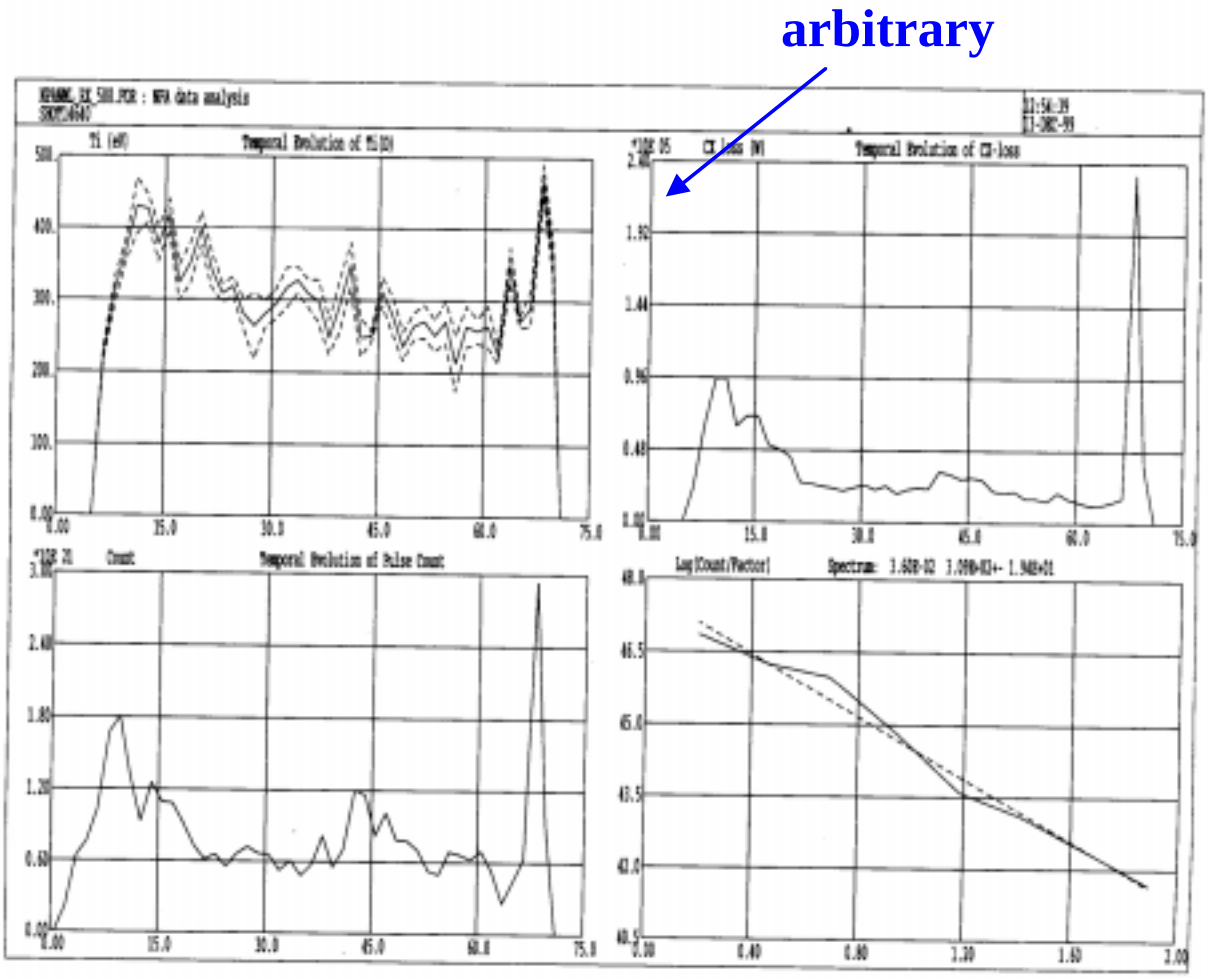
X0=> 6943 X1=> 6883.9 X10=> 6185.5

SHOT=14515
TEL= 834.561 TED= 671.339 (eV)
NEL= .51126 NED= .491736
(1E(13)cm(-3))



Typical shot data < NPA>

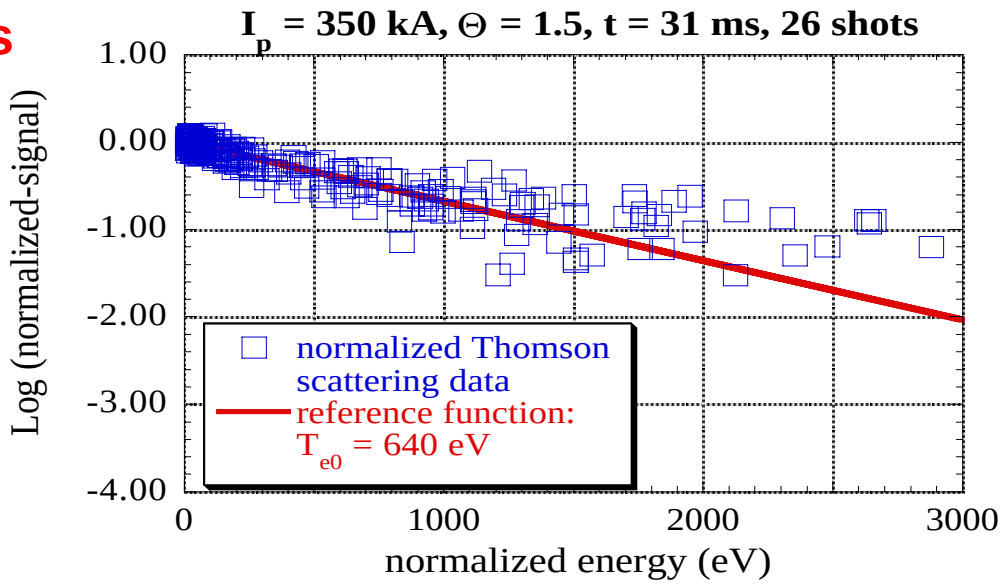
- Temporal evolution of T_i is obtained every 1 ms time period, which is comparable to the D-D equi-partition time.
- Absolute calibration is necessary to obtain the charge exchange flux.



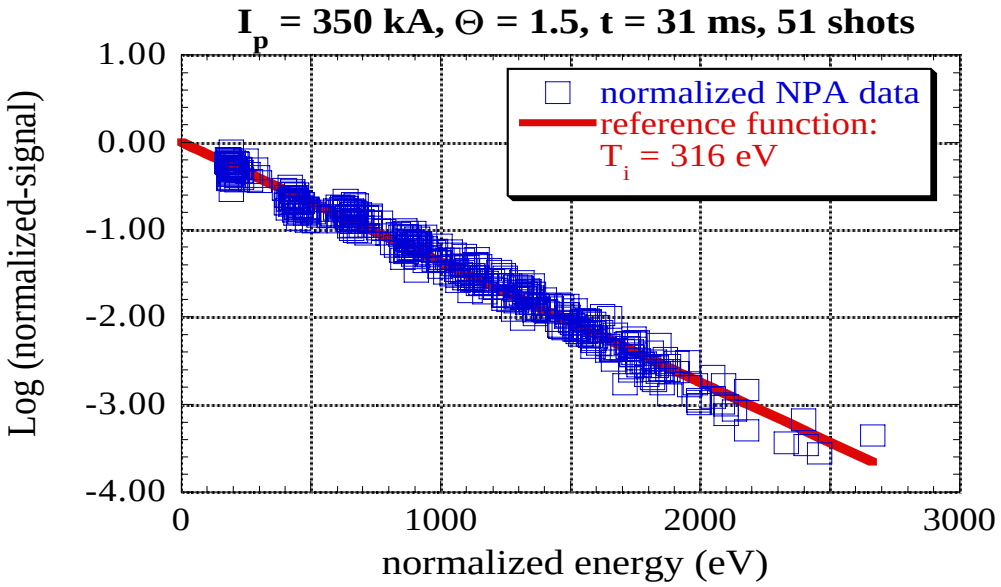
Energy distributions

- **Energy distribution of electrons and ions are well fitted to Maxwellians.**
- **LS has a smaller dynamic range of the signal than NPA. T_{e0} has a larger shot-to-shot deviation than T_i.**

Electrons

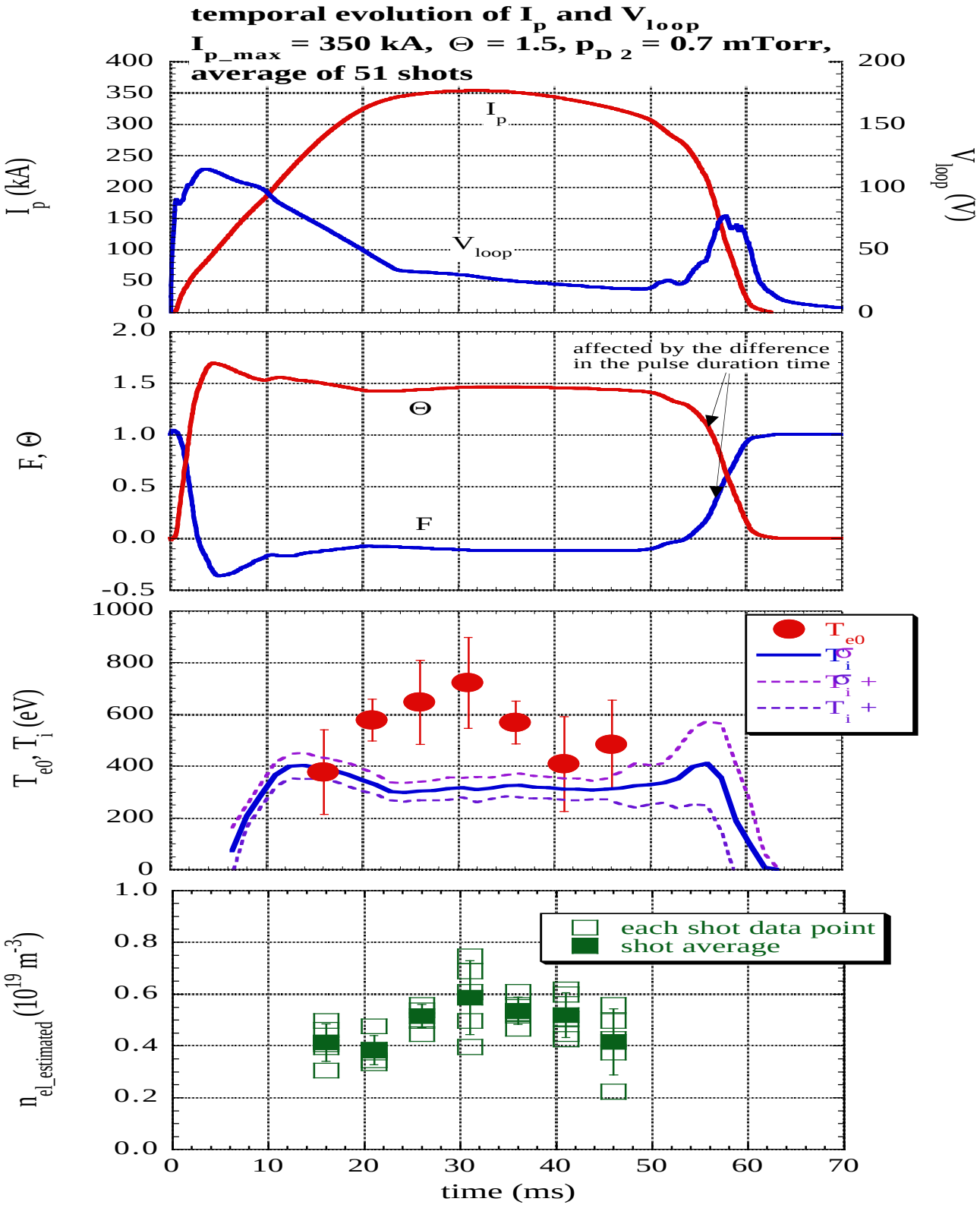


Ions



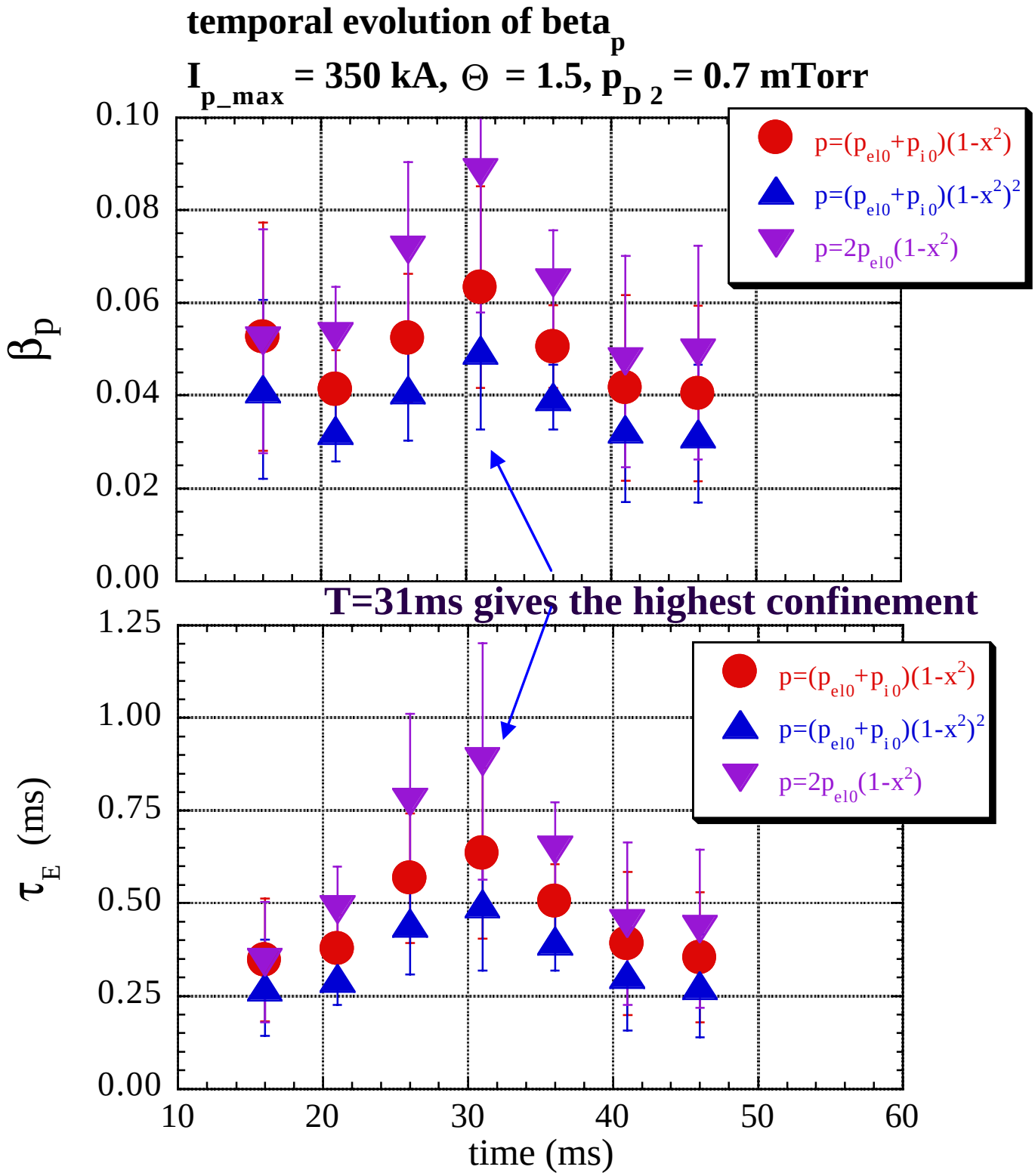
Temporal evolution (1-1)

- I_p=350kA, Θ=1.5, p_{D2}=0.7mTorr.



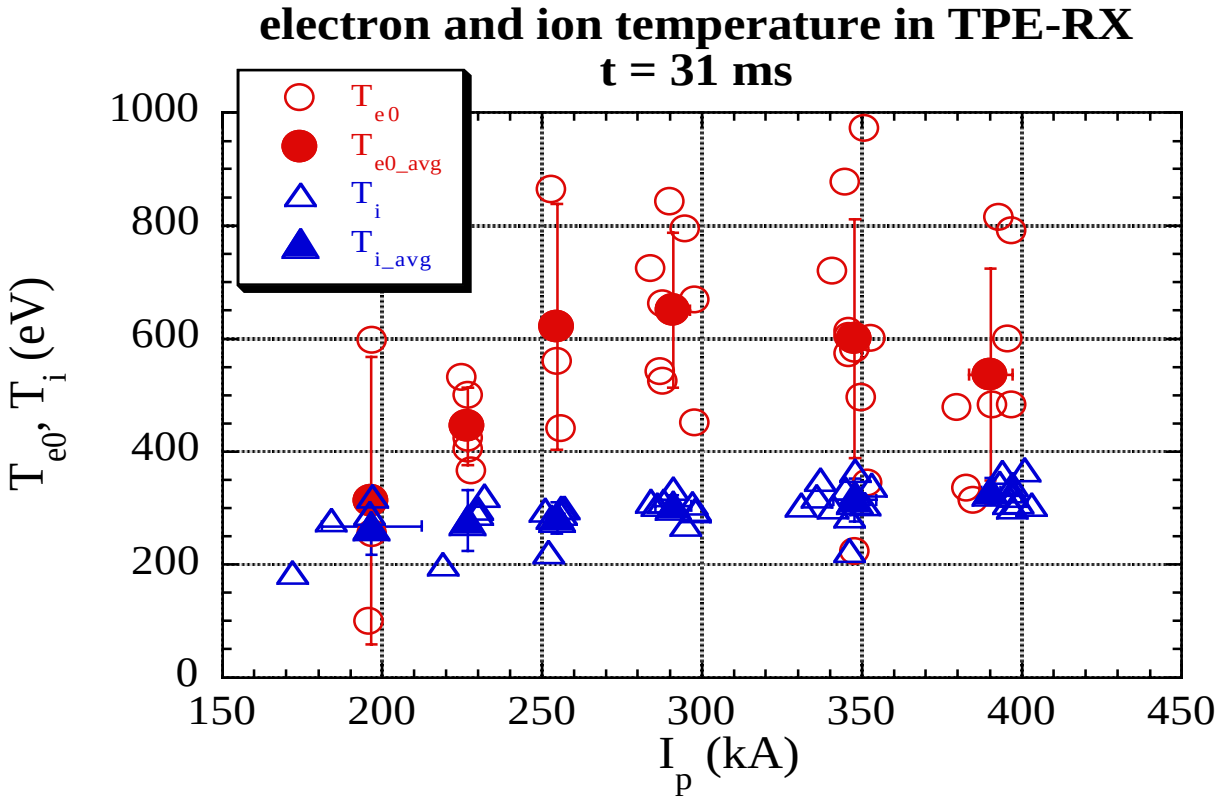
Temporal evolution (1-2)

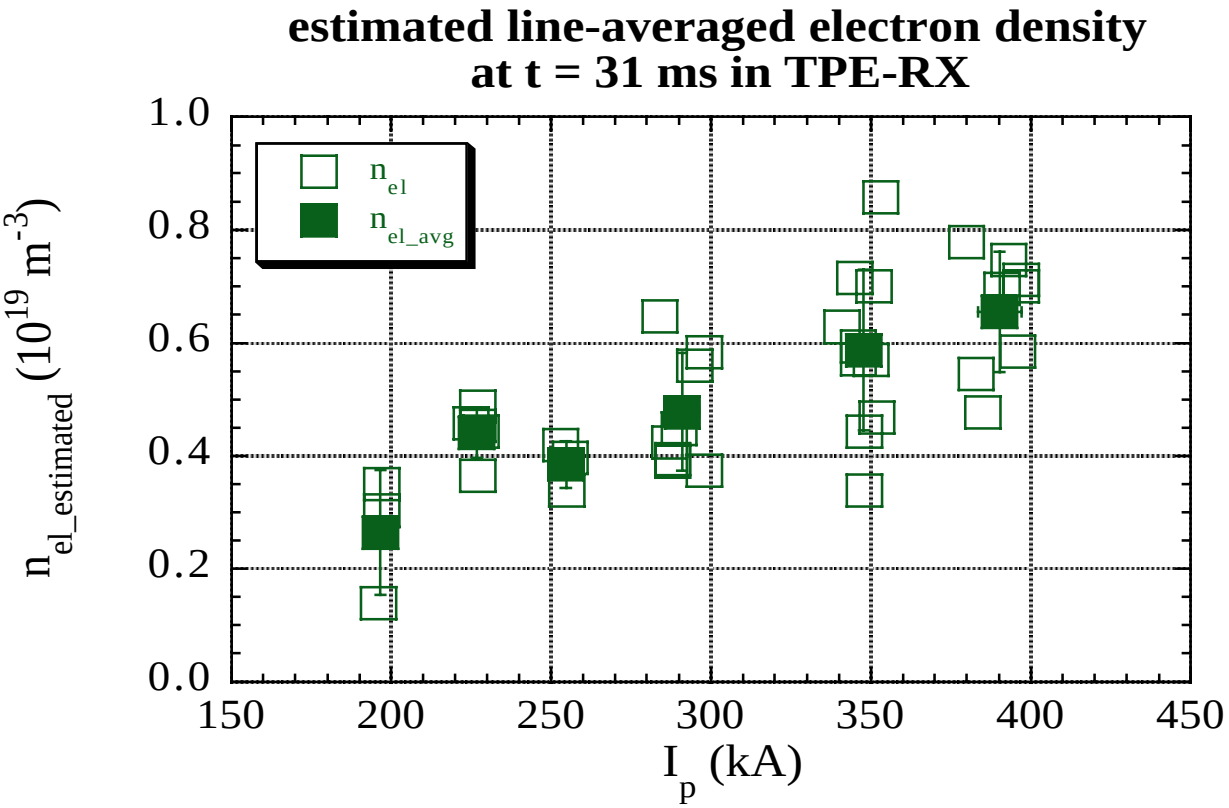
- I_p=350kA, Θ=1.5, p_{D2}=0.7mTorr.



I_p-dependence (1)

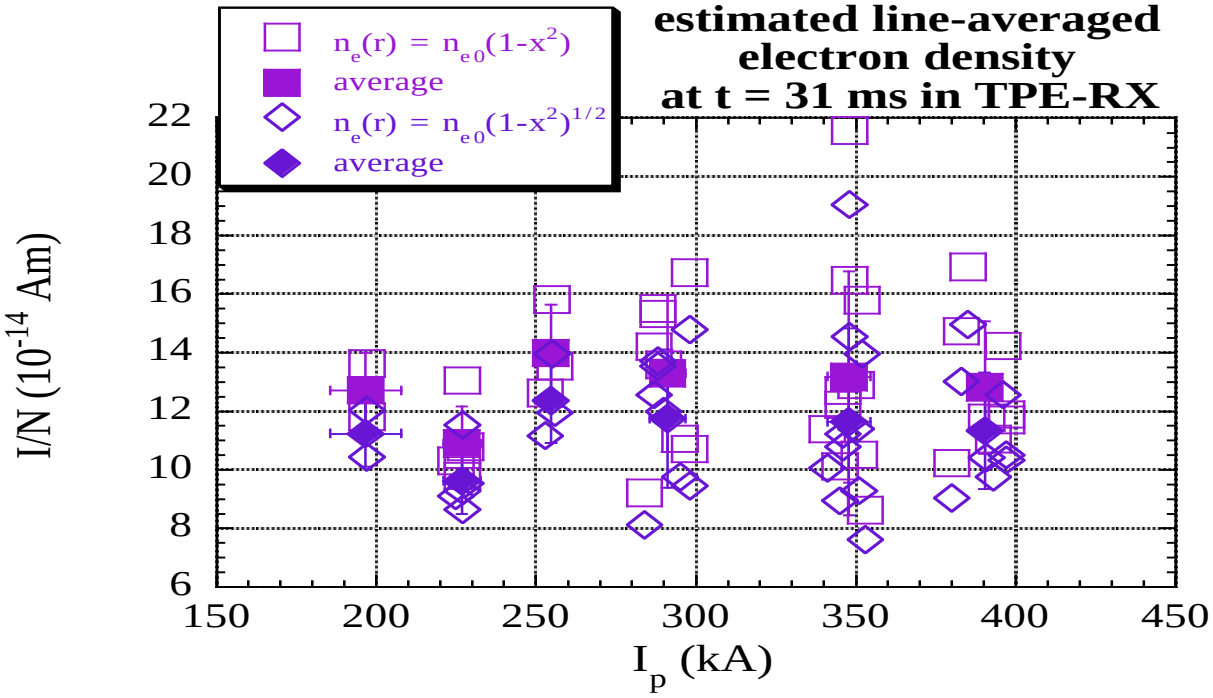
- Θ=1.5, p_{D2}=0.7mTorr, t=31ms

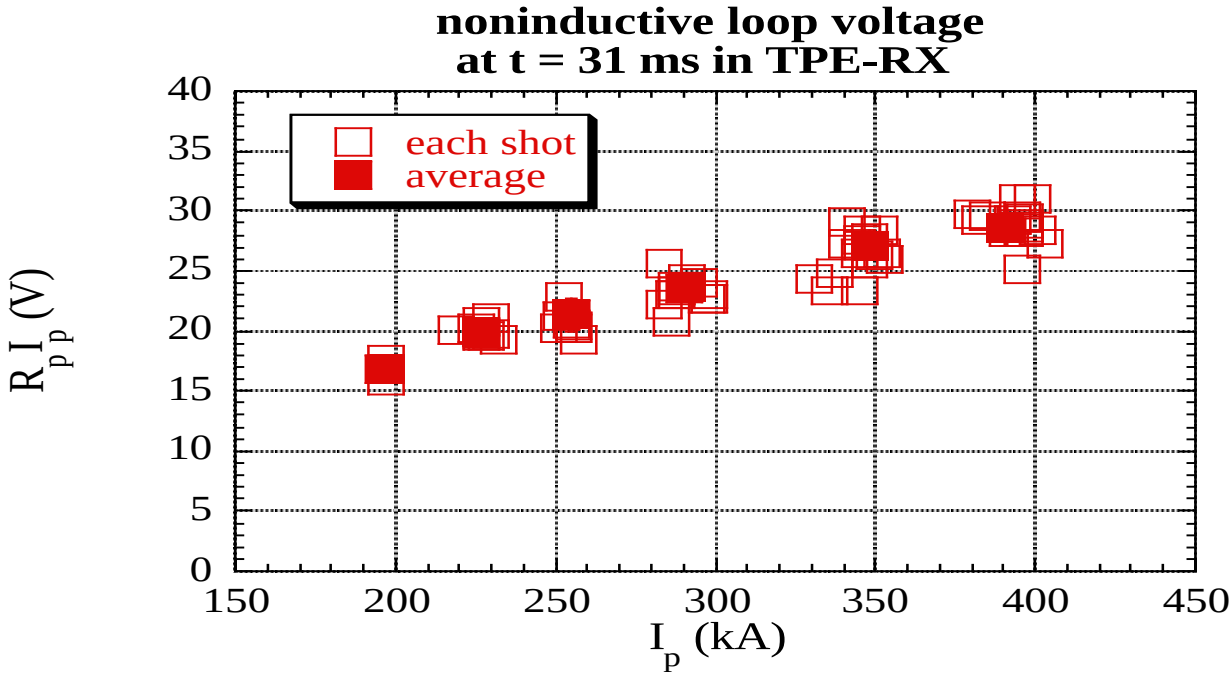




I_p-dependence (2)

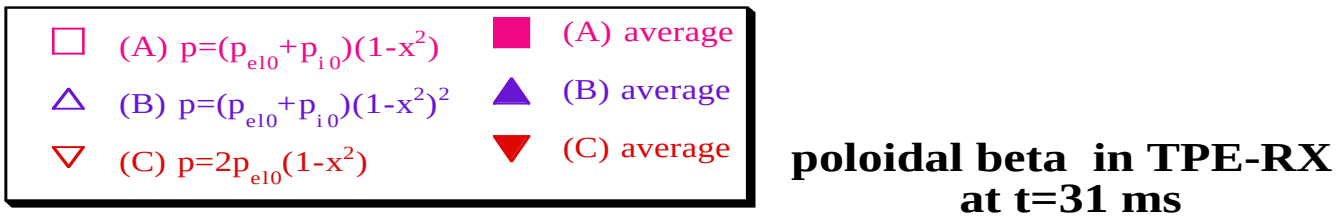
- Θ=1.5, p_{D2}=0.7mTorr, t=31ms
- I/N is as large as TPE-1RM15 and 20.
- $R_pI_p$linearly increases with I_p.

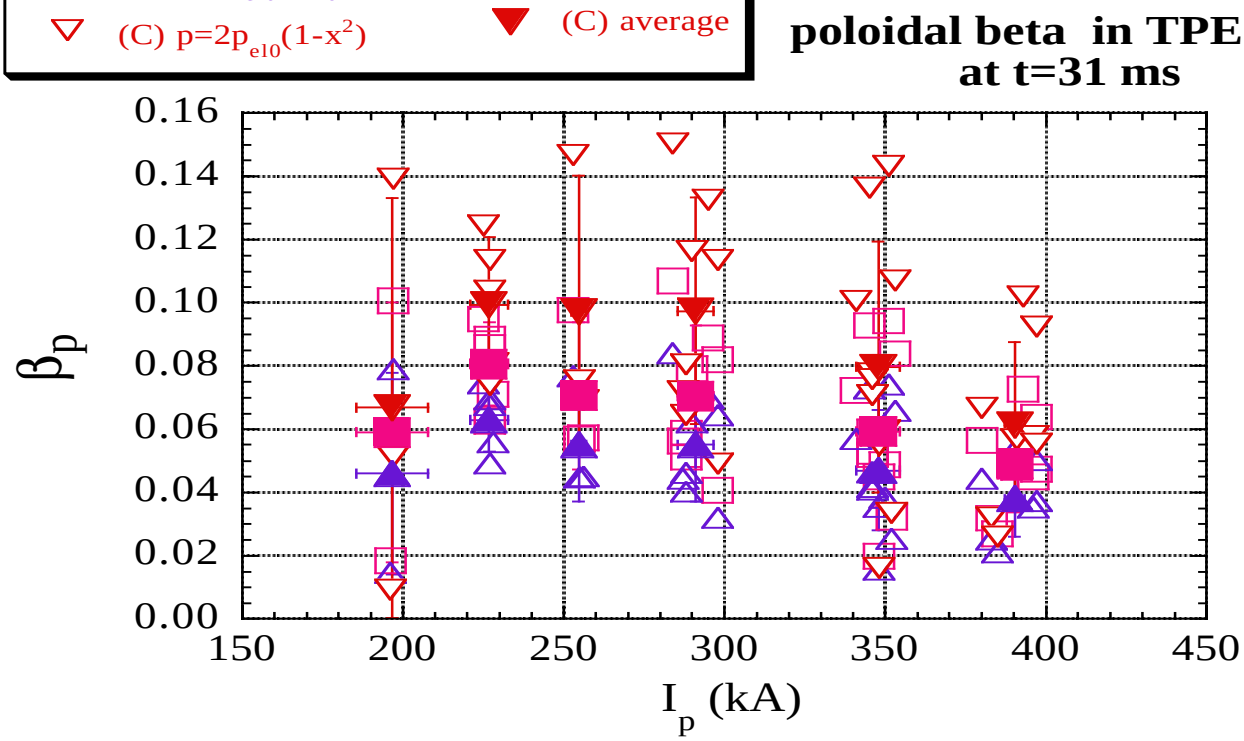


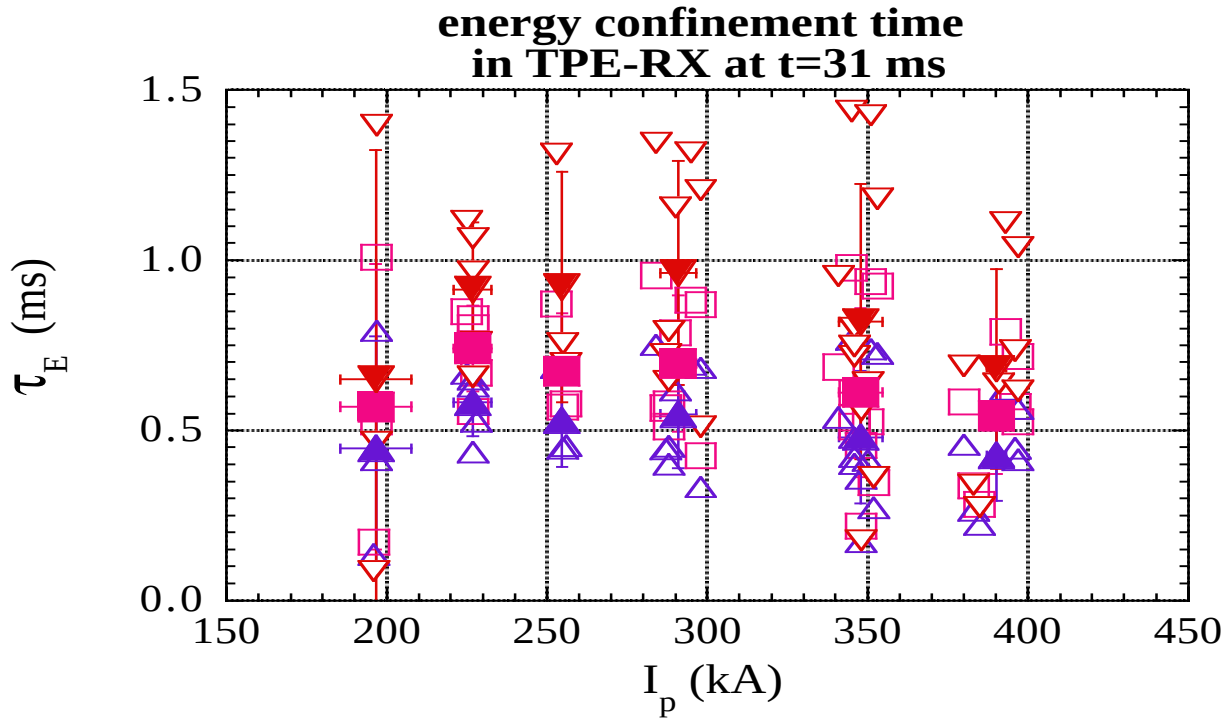


I_p-dependence (3)

- Θ=1.5, p_{D2}=0.7mTorr, t=31ms

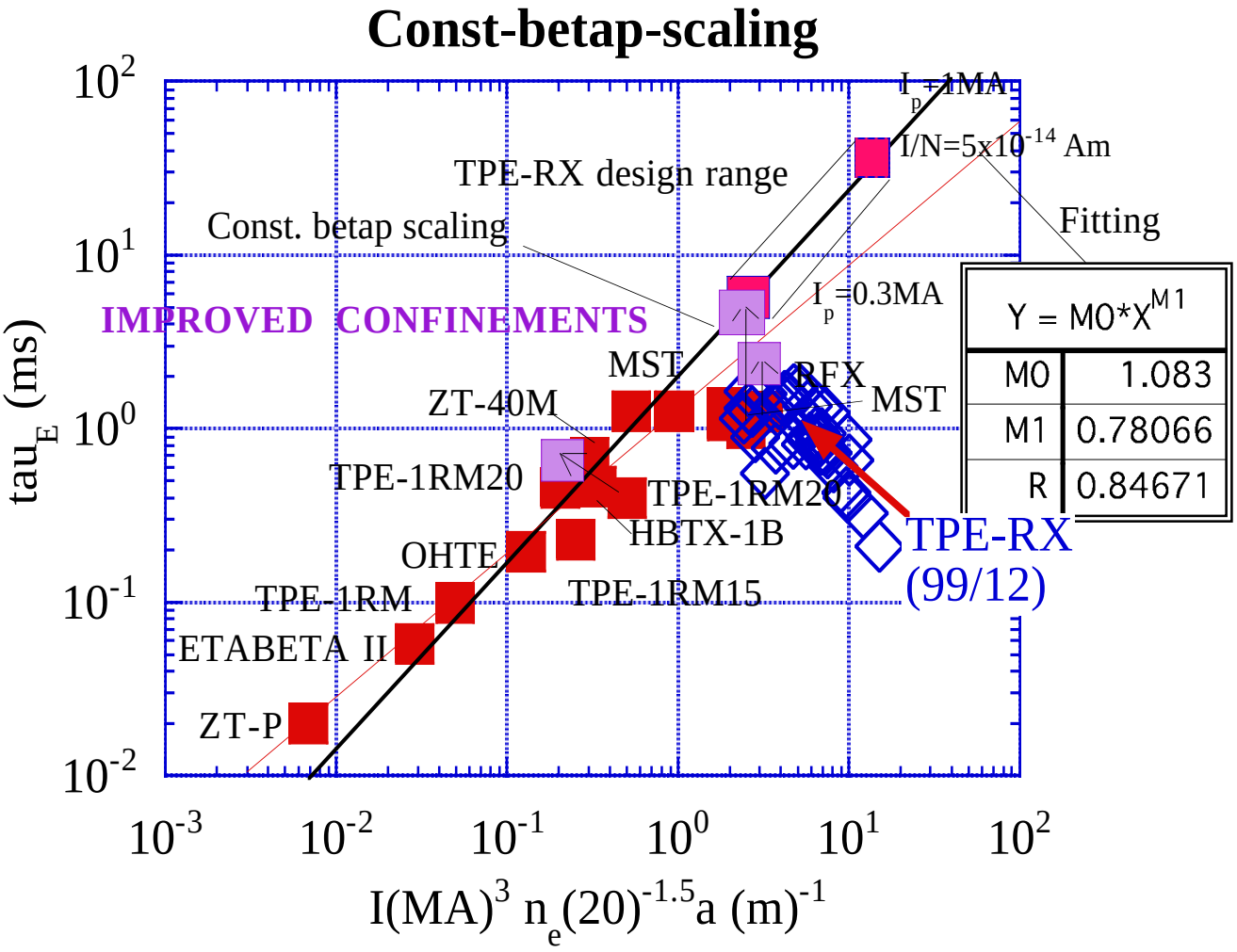






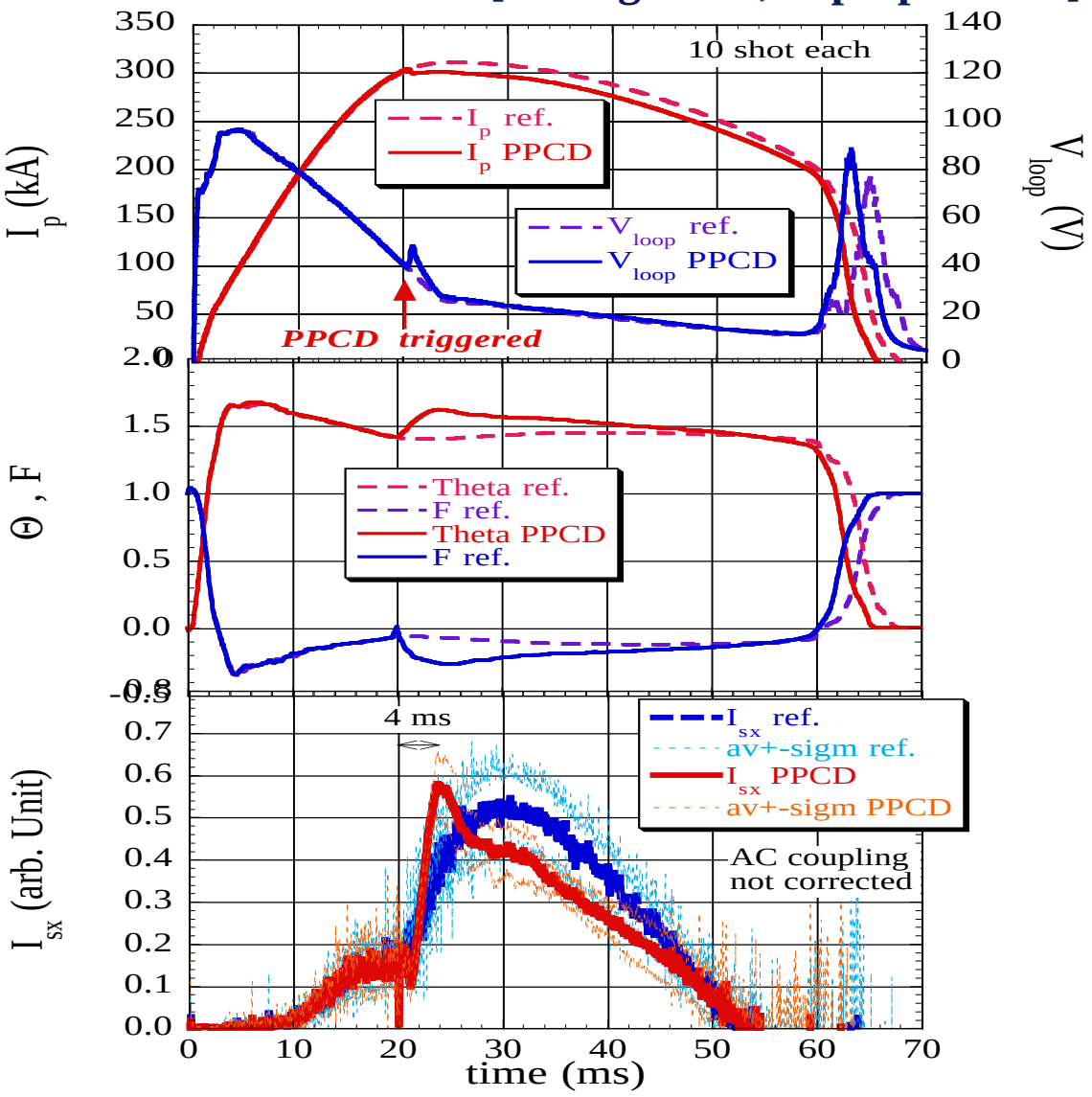
Where we are now

- Case (C) is used for comparison with other data.
- Values of τ_E are comparable to those in the normal operating conditions in MST (S. Hokin et al., PoF B3 (1991) 2241.) and RFX (V. Antoni et al., Proc. 15th IAEA Conf., Vol.2 (1995) 405). **Improvement is necessary.**



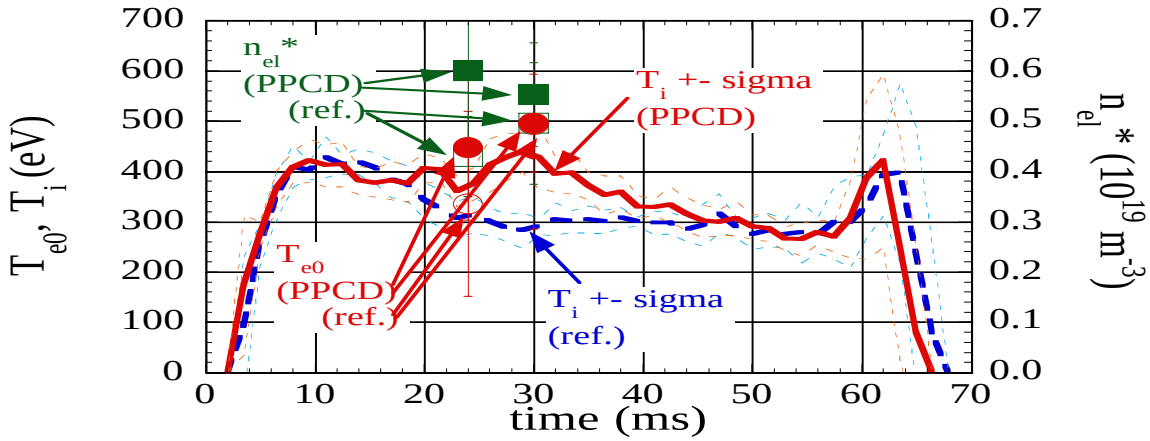
PPCD (1)

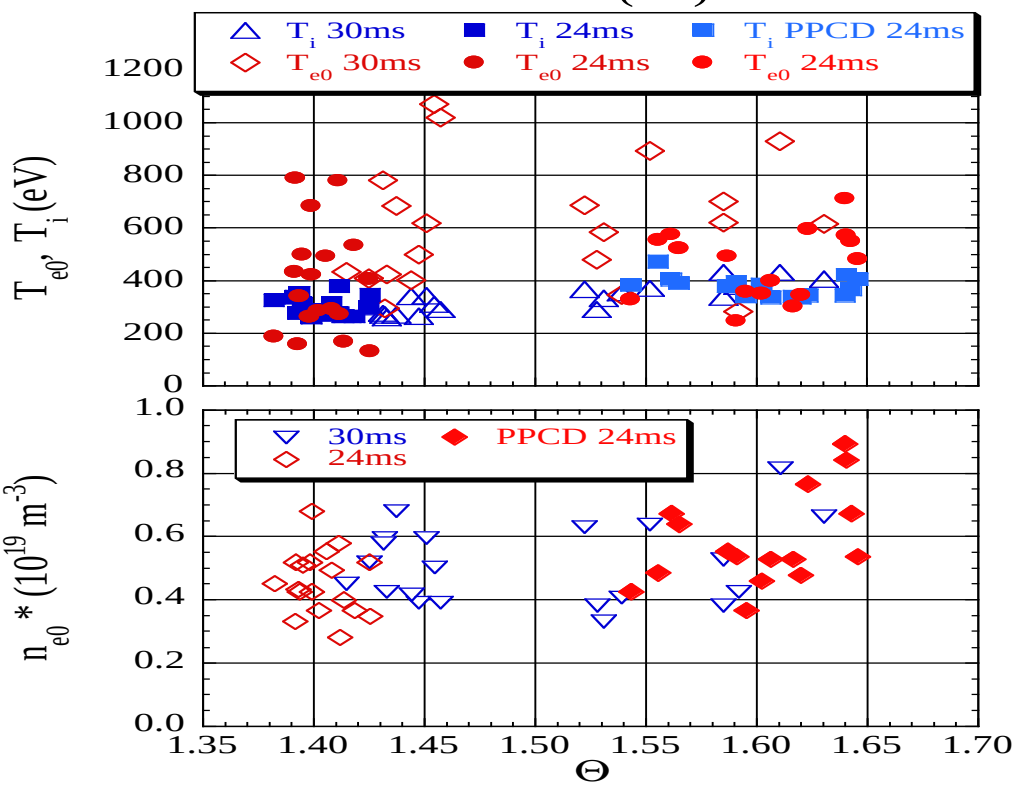
- **Single PPCD [J. Sarff et al., PRL 72 (1994) 3670, PRL 78 (1997) 62] has been tried in TPE-RX. Equilibrium and confinement in the *transient* phase during the PPCD are compared with the *steady state* F-Theta scan [Y. Yagi et al., in preparation].**



PPCD (2)

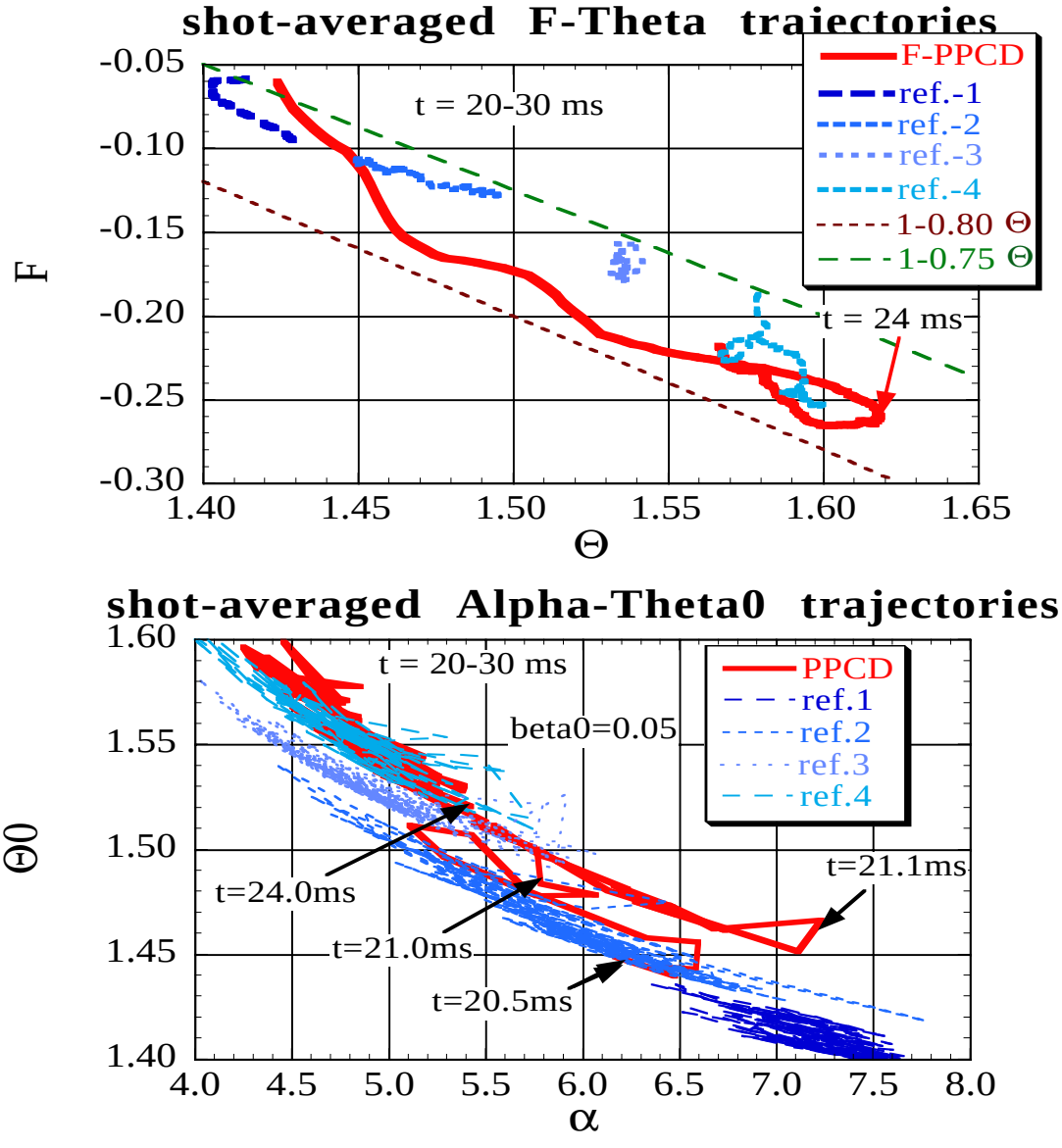
- **Te0 and ne0 increases after 4 ms and Ti increases after 10 ms from the start og the PPCD. Similar increases are observed in n_{e0} and T_i but not in T_{e0} in the shot-by-shot F-Theta-scan.**





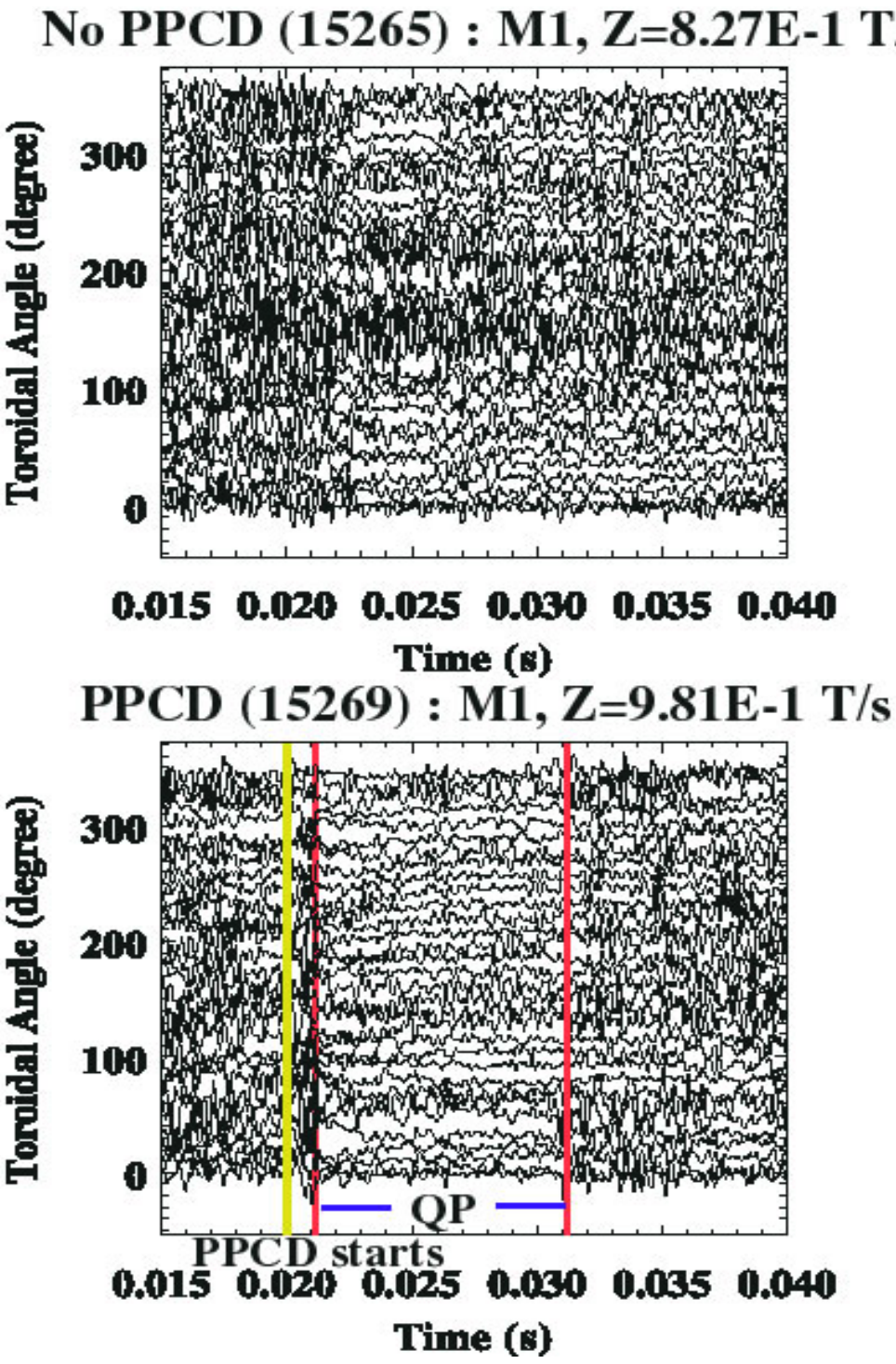
PPCD (3)

- **Trajectories in the F-Theta and Alpha-Theta0 planes are compared between PPCD and theta-scans. Attained regions are comparable while the PPCD pops up to a different curve *in shot*.**



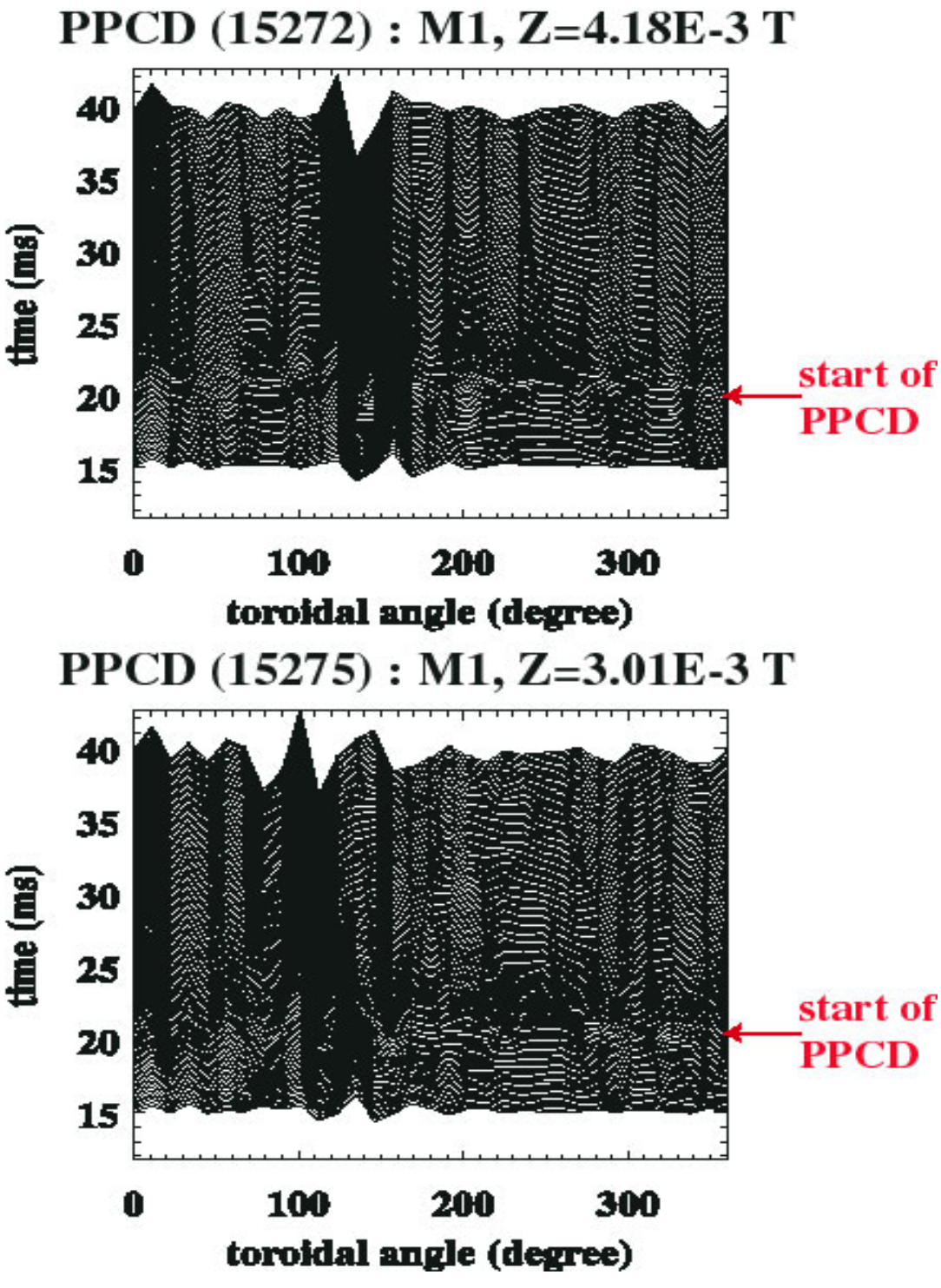
PPCD (4)

Amplitude of dBr/dt fluctuation decreases in PPCD



PPCD (5)

No change in the locked amplitude in PPCD



Summary

Global confinement properties are estimated for the first time in TPE-RX from the measured T_{e0}, (LS) T_i (NPA) and estimated n_{el}* (LS, IF).

I_p < 0.5 MA, With no active density control

- **Energy distribution of el.s and ions are well-fitted to Maxwellians.**
- **I/N = 12 x 10^{-14} Am, same as TPE-1RM15, 20.**
- **T_{e0}<1 keV, T_i<0.4 keV, 0.5<T_i/T_{e0}<1, 0.5<β_p<1, 0.5<τ_E<1 ms**
- **These values are comparable to the normal discharges in MST and RFX, and suggest necessity for improvement.**
- **Preliminary result of PPCD shows an increase of p(0). A deeper reversal experiment is promising. Trend of T and n vs. theta in the PPCD is similar to those in the theta-scan for n_{e0} and T_i.**