Present Status of TPE-RX Experiment

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IEA RFP Workshop

at Madison

28 Feb. - 1 Mar. 2000

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Reversed Field Pinch Machine, TPE-RX

R / a = 1.7175m / 0.45m, Vol. = 7 m^3

Designed Max. Ip = 1MA, t_{dis} = <100 ms

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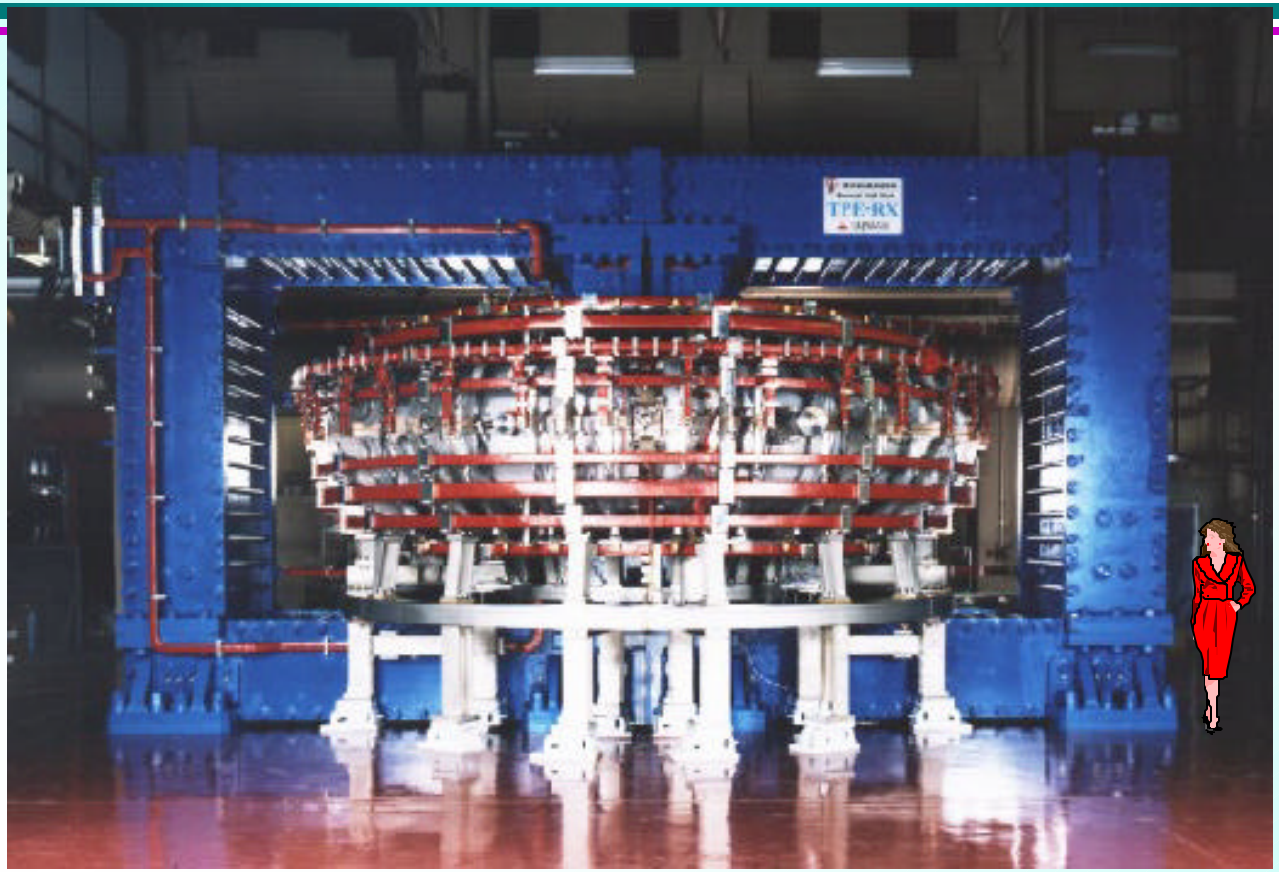

Aims of TPE-RX

To find a way to improve RFP confinement.

Vloop <10V & b_p >0.1 in the same time => t_E = 5 - 10 ms

Recent Activities of TPE-RX

Almost two years since experiment start (March 1998).

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1. **Operation range, Ip <~500kA,**
   duration up to 100ms with ~220kA
2. **Temperature Measurement and Estimation of β_p, tau-E, etc.**
   High Te ~ 640 eV, medium Ti ~ 320eV with low ne ~ 5E18/m3
   β_p ~ 6-10%, tau-E ~ 0.5-1ms (will be presented by Dr. Yagi)
3. **Analysis of locked mode (will be presented by Dr. Yagi)**
   Magnetic, Spectroscopy, Halo current measurement
   Comparison of discharges with and without locked mode.
4. **Spectroscopy**
   Plasma rotation, Toroidal & poloidal radiation profile.
5. **Density Control by Gas Puff**
6. **Trial of PPCD**

Typical RFP Plasma in TPE-RX

Ip = 260kA, Rp*Ip ~ 15V, duration 90ms

Without locking mode

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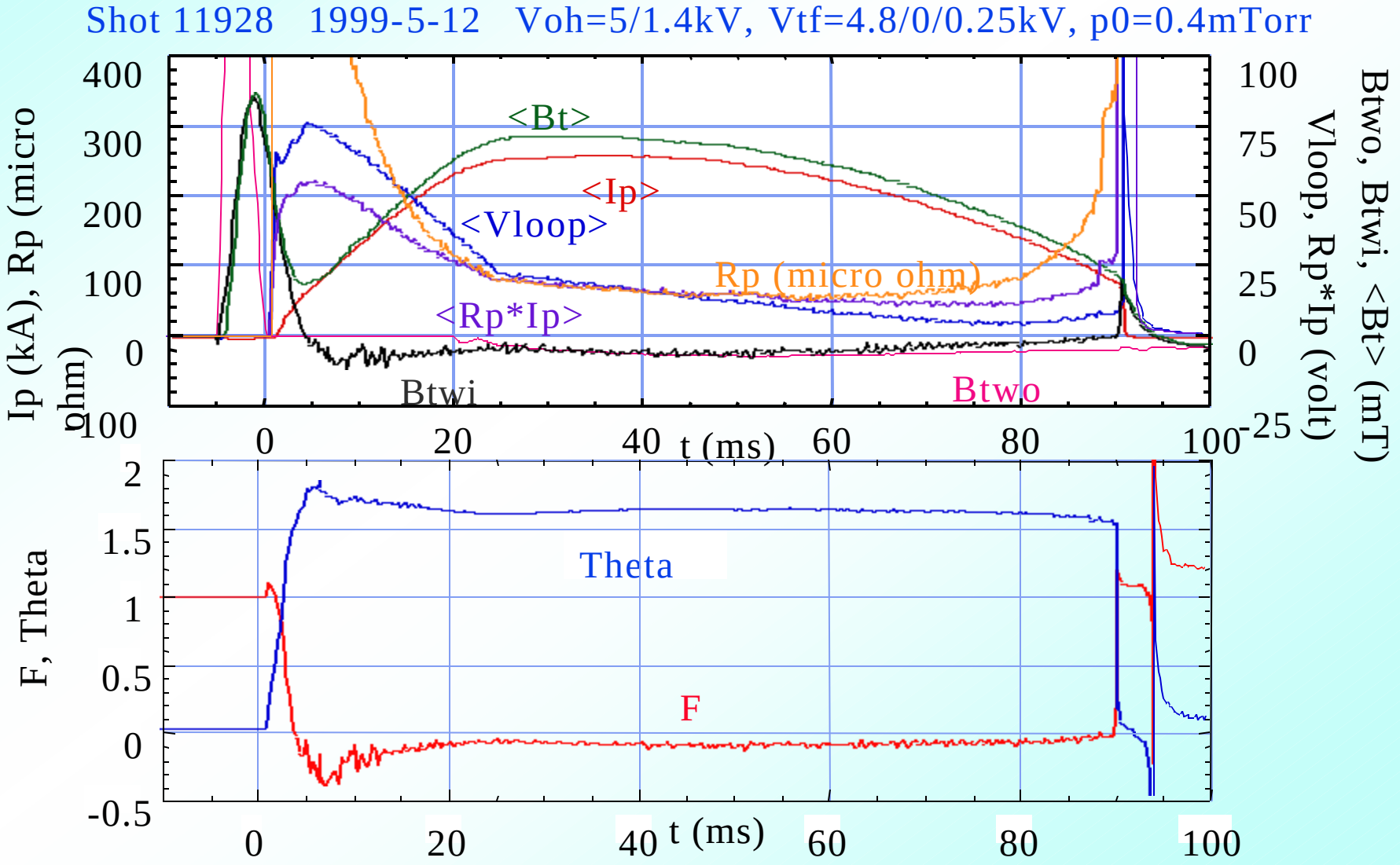

The longest discharge
Ip-peak ~ 200kA & 100ms duration

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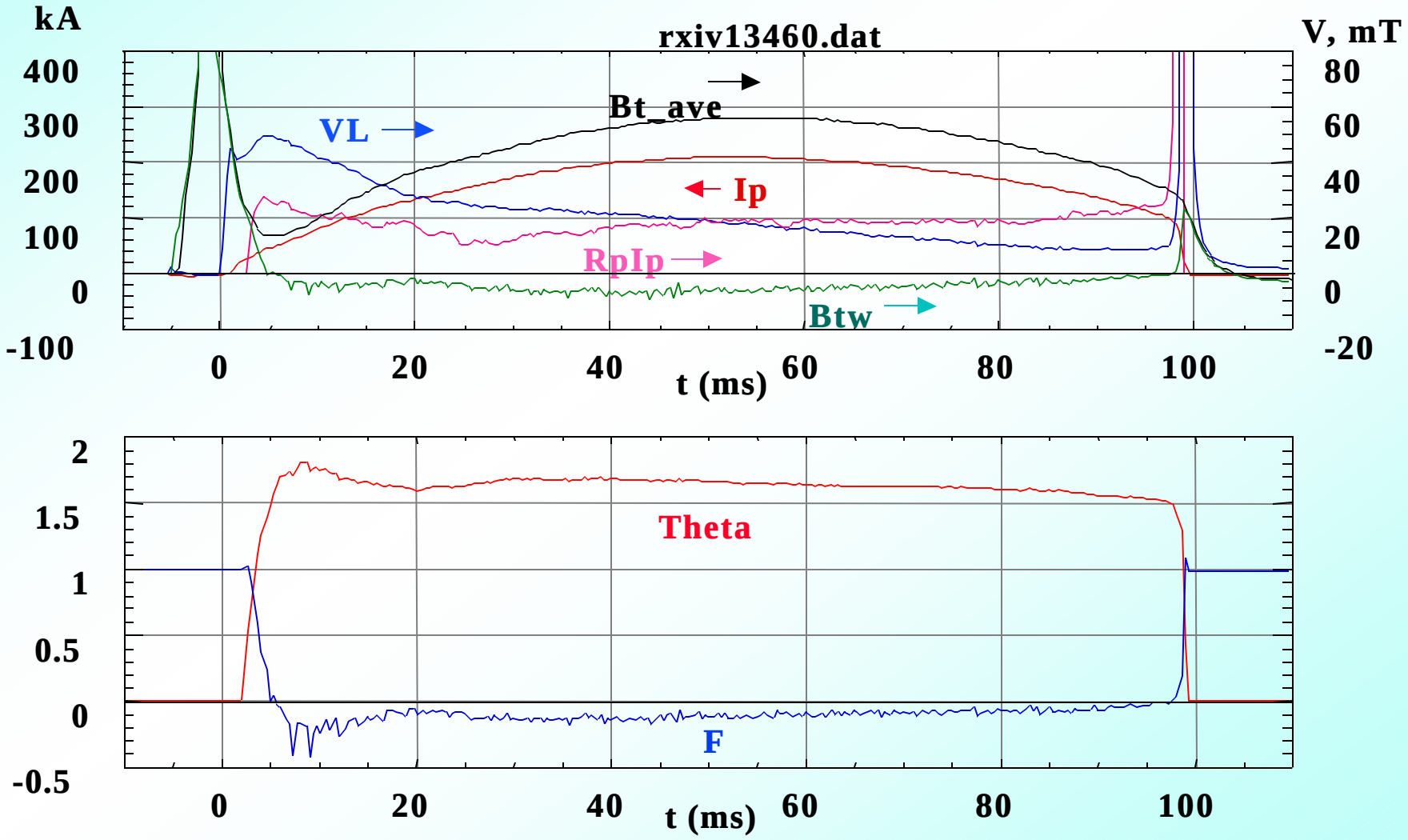

Variation of Non-inductive Part of Vloop with shot mber and Ip

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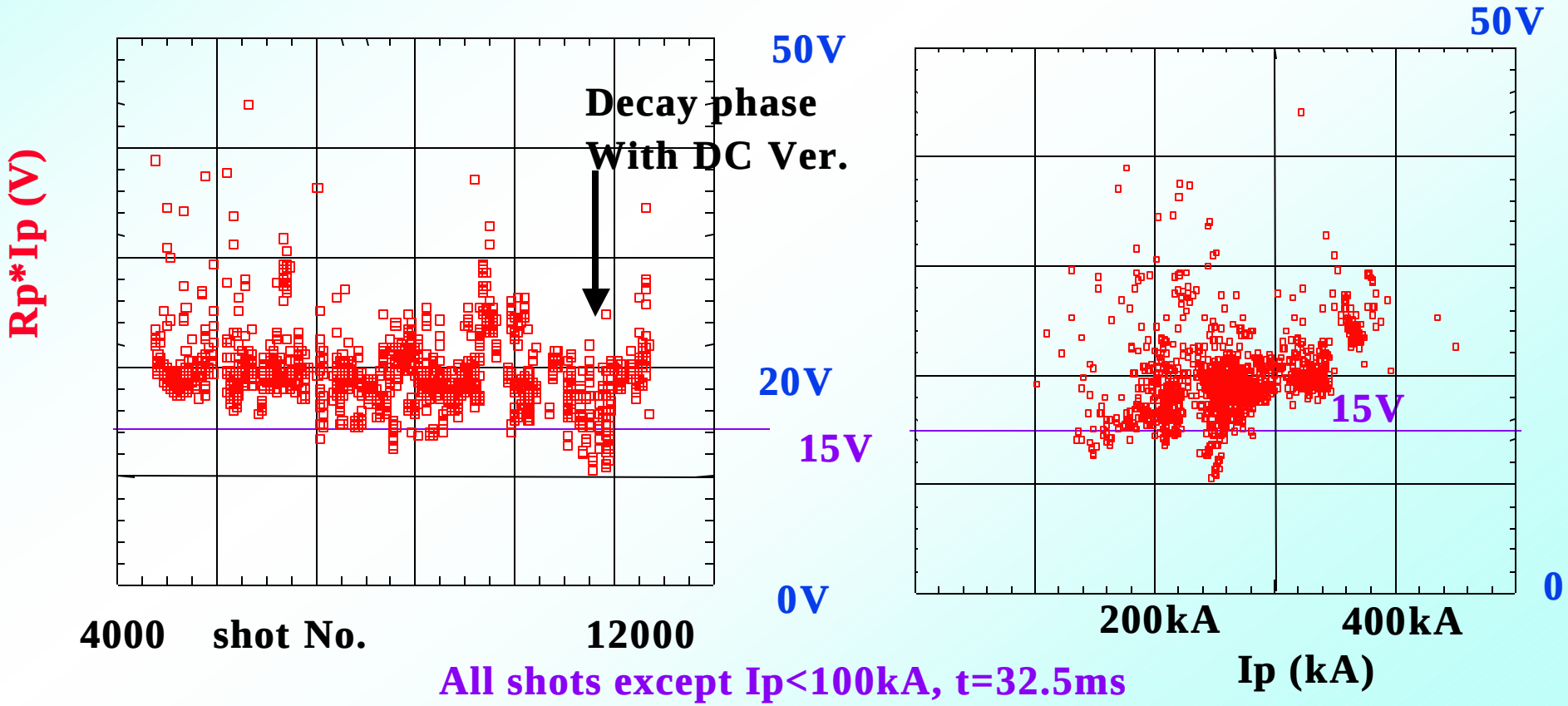
RpIp now stays almost constant level, (~10 - 20V at Ip~250kA)
Situation that Vloop increases with Ip does not change.
Further wall conditioning (Ti gettering and/or Boronization) ??



All shots except Ip<100kA, t=32.5ms

Reduction of RpIp by DC Bv

From 17-18V to 13-15V at Ip 270kA

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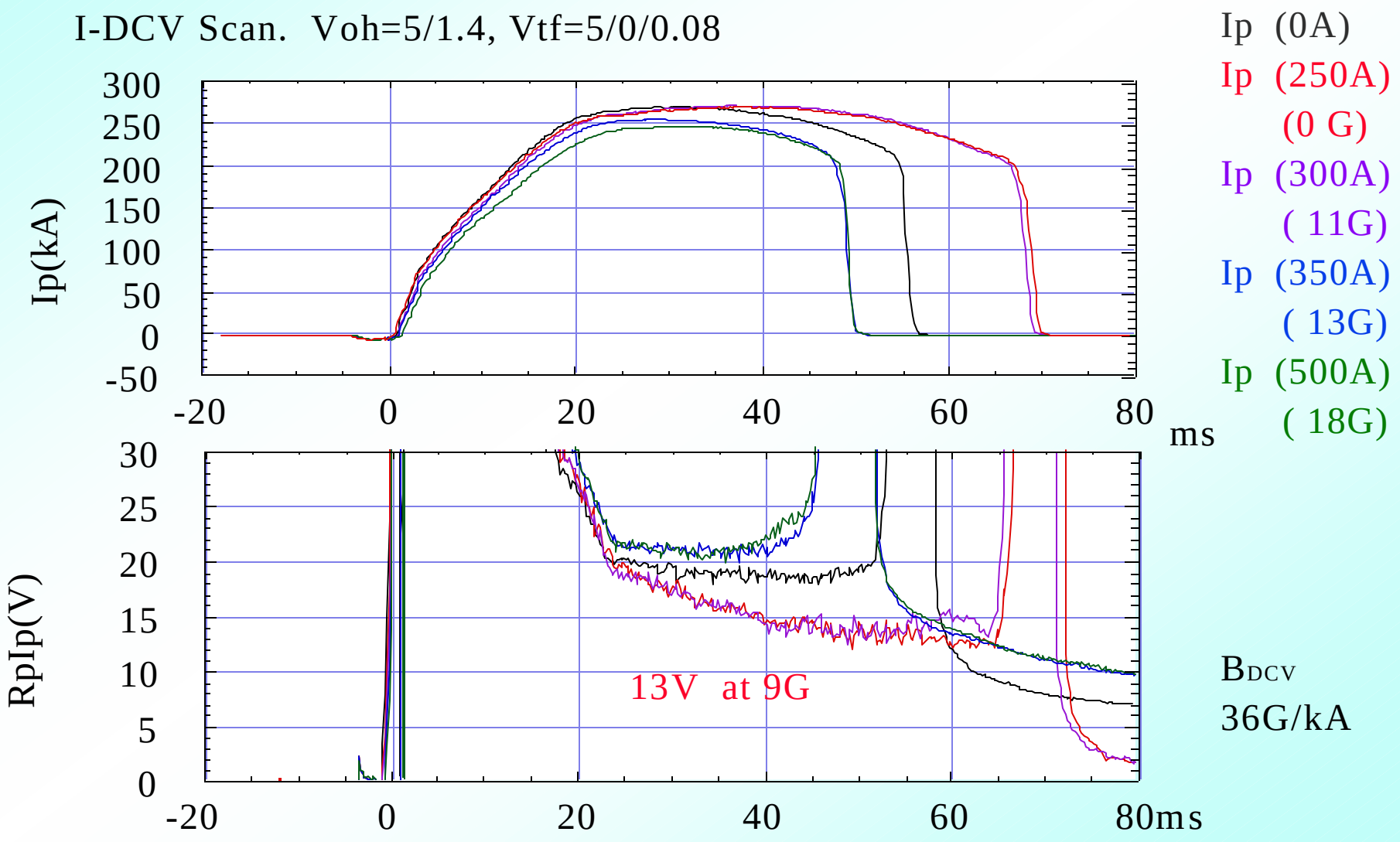

Reduction of RpIp in Ip decay phase

From 17-18V to 10V at Ip 240kA

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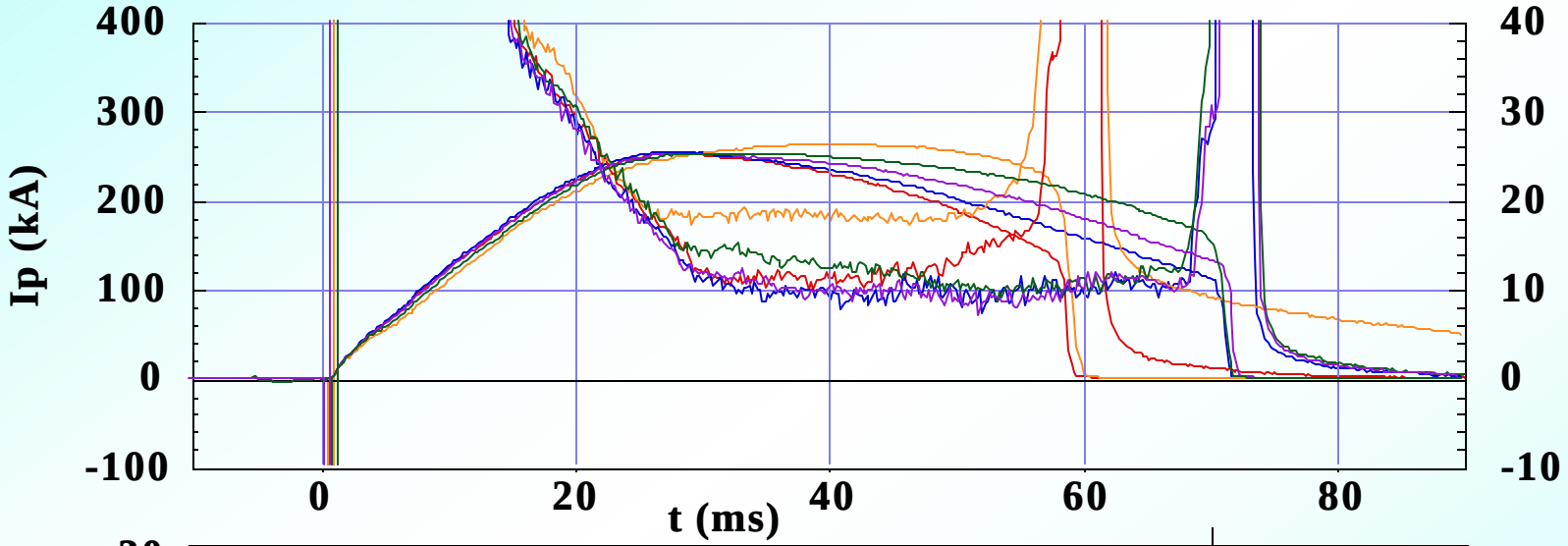

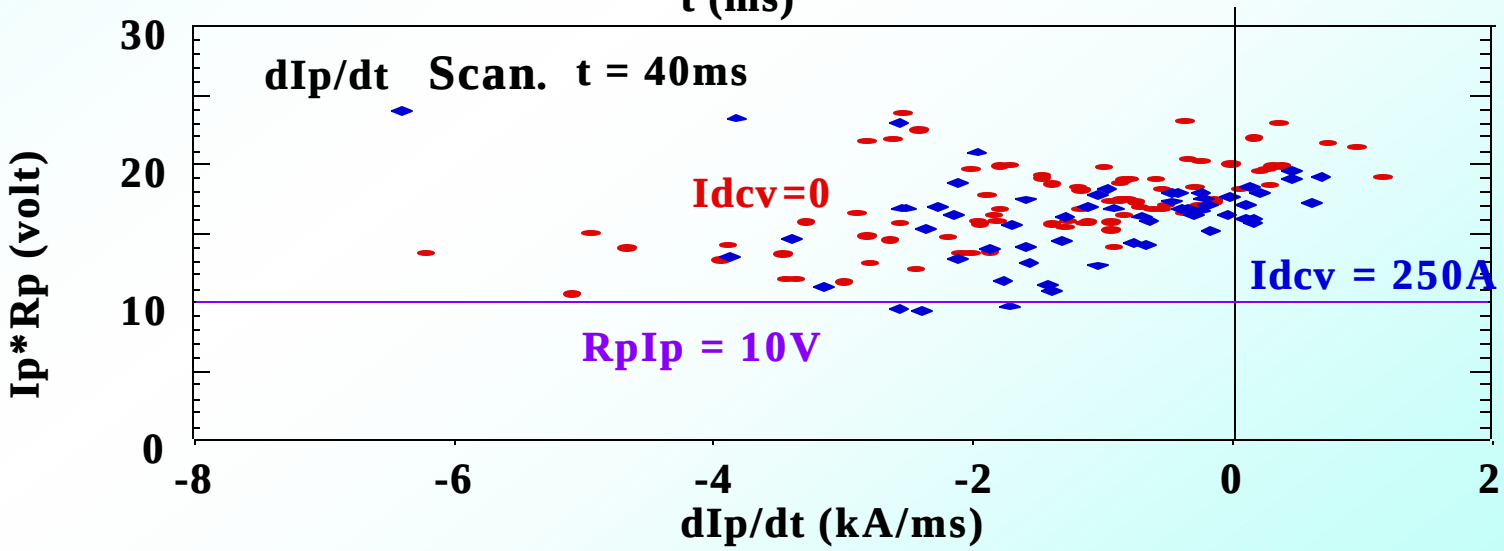

Discharges without locked mode and with locked mode
Marginal conditions at Ip ~ 250kA
Duration is longer and SBD is larger without LM.

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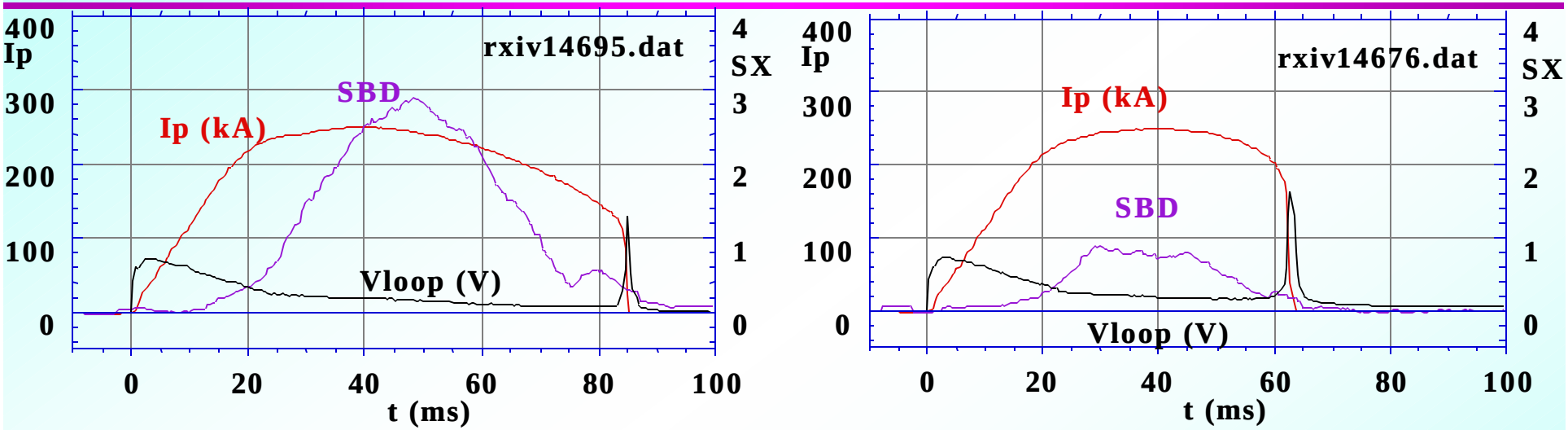

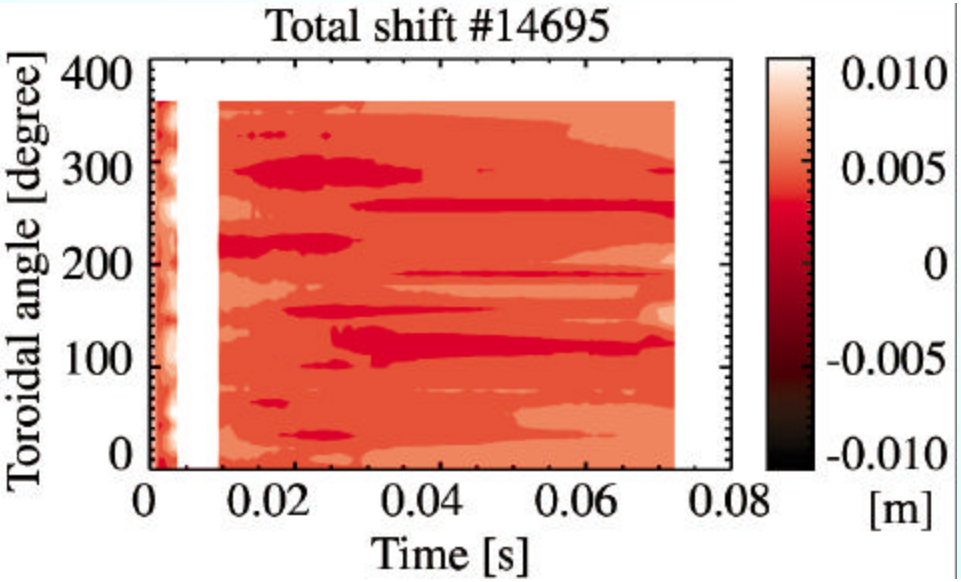

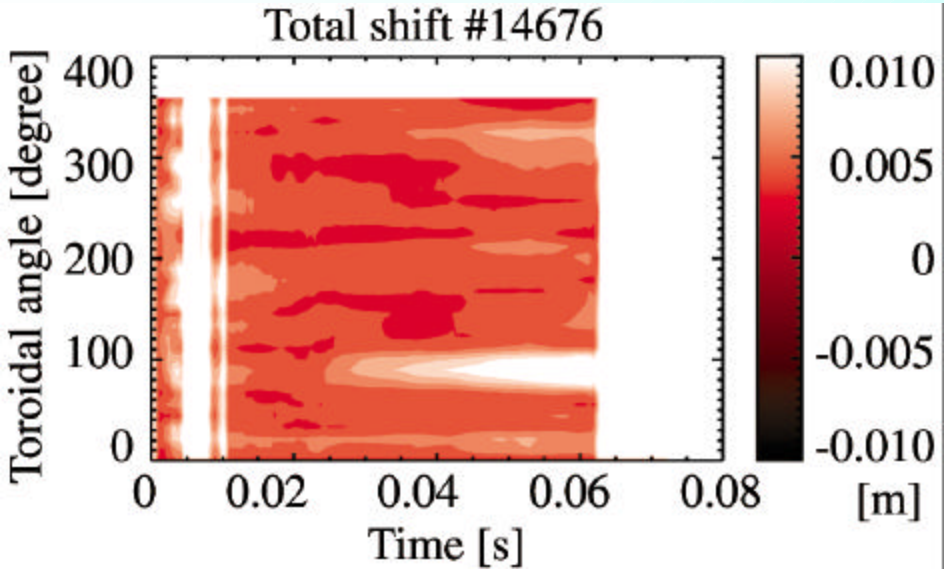

Shortening of discharge duration by the Locked Mode

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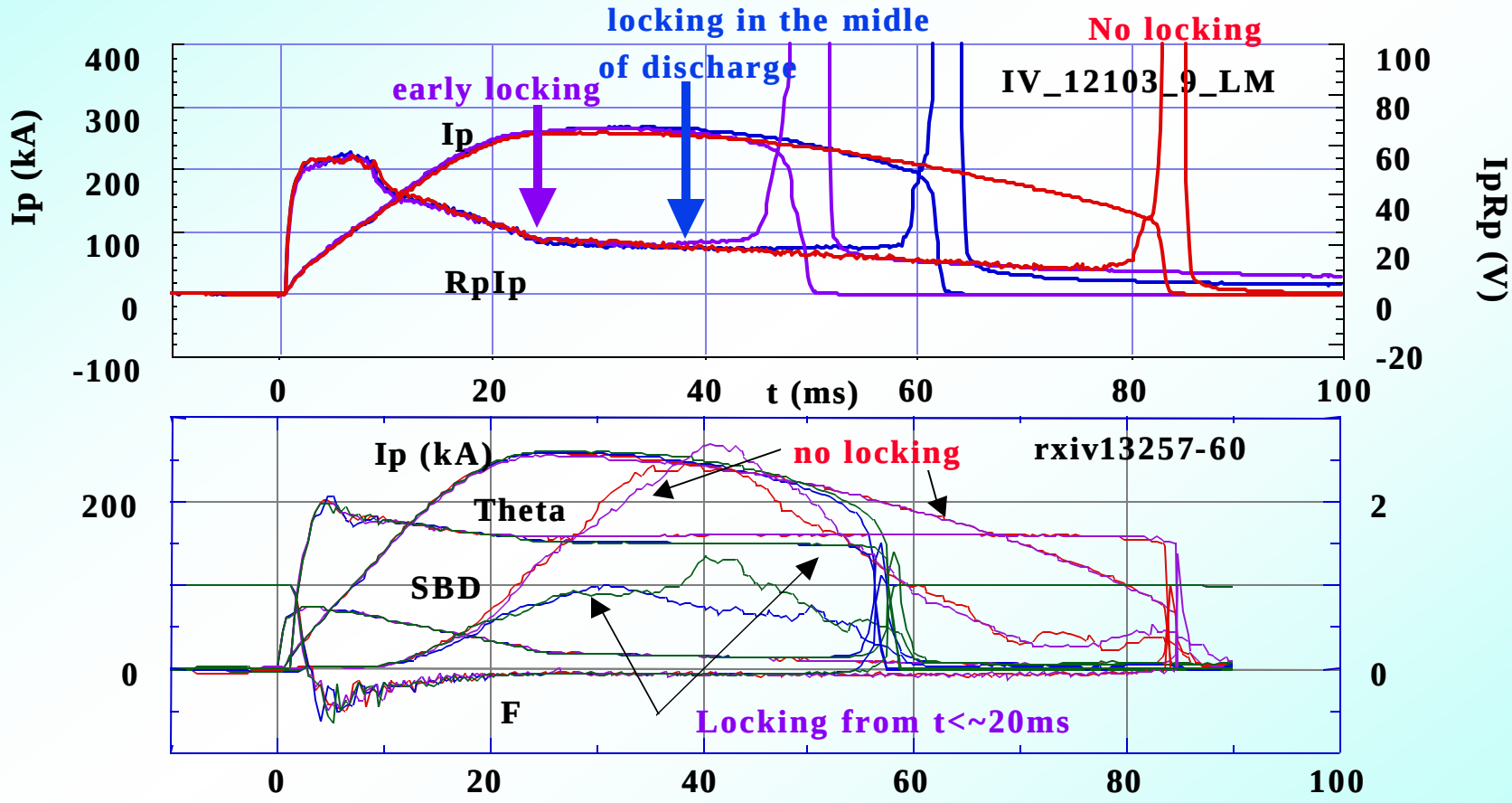
But it shows little effect on RpIp at the time of locking



No clear difference before locking

Clear difference in SBD but little difference in Ip, RpIp, F after locking except before termination. Theta with locking < that w/o locking

Plasma Rotation in TPE-RX

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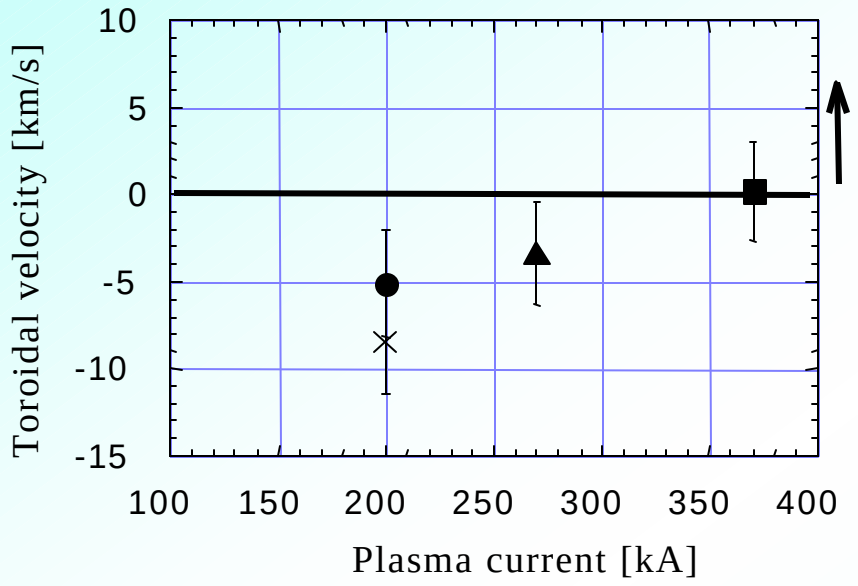
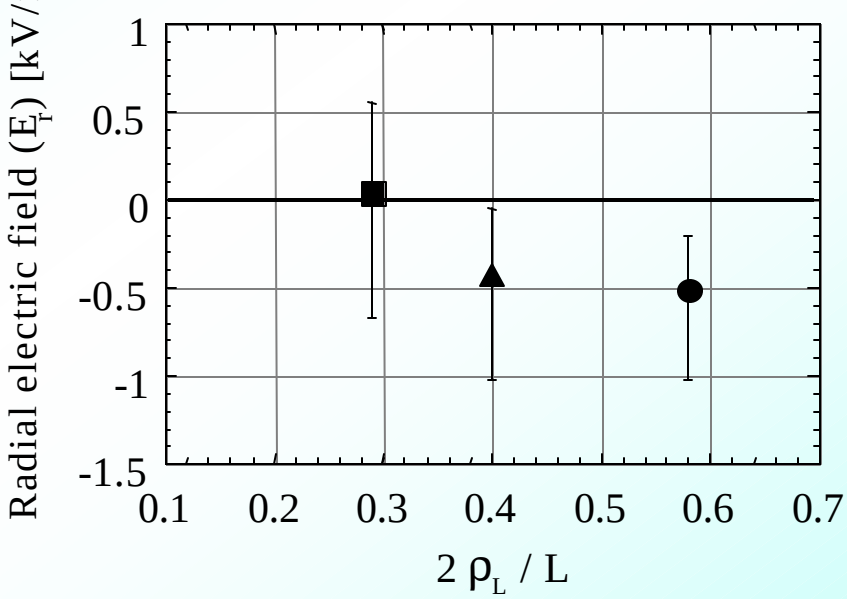


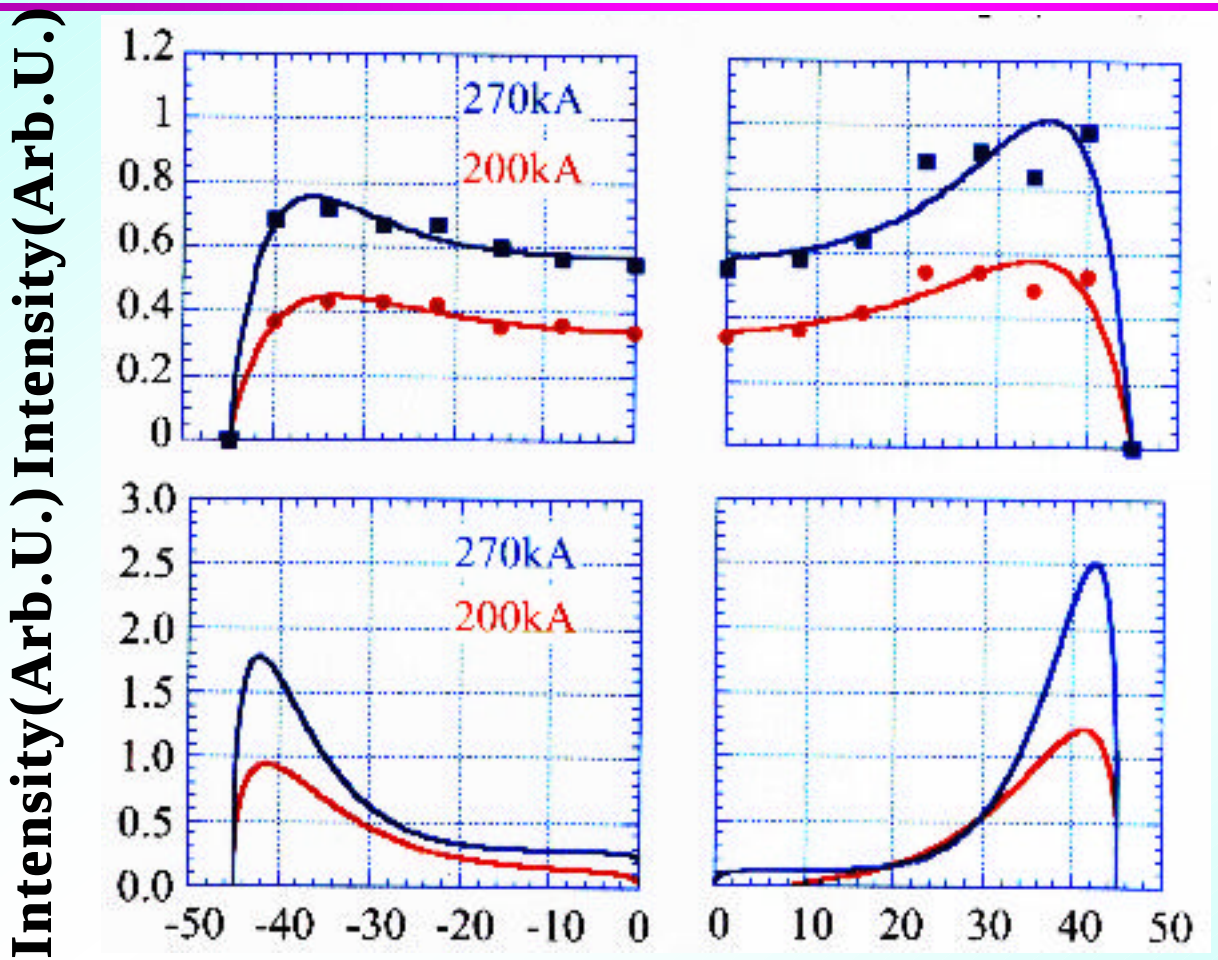


Net toroidal plasma rotation velocities of C^{4+} ions around r/a~0.9 as a function of the plasma current. Solid symbols show the locked mode cases. Cross symbol shows an unlocked case.

H. Sakakita, Y. Yagi et al.; J. Phys. Soc. Jpn. Vol. 69, No. 3 (2000).

Radial profile of CV (227.1nm) line radiation

Fitting function ; y = exp[C2{(r/a) - C1}] - exp[C4{(r/a) - C3] + C5



Raw data (chord integration)

After inversion

S.Sekine, T. Osakabe. et.al., Journal of Plasma Fusion Research, Vol.2(1999)192

Density Control by the Gas Puff, No fatal effect on discharge

Increase of <ne>

0.4E19 => 0.7E19 => 1.5E19 /m^3 at Ip ~ 270kA

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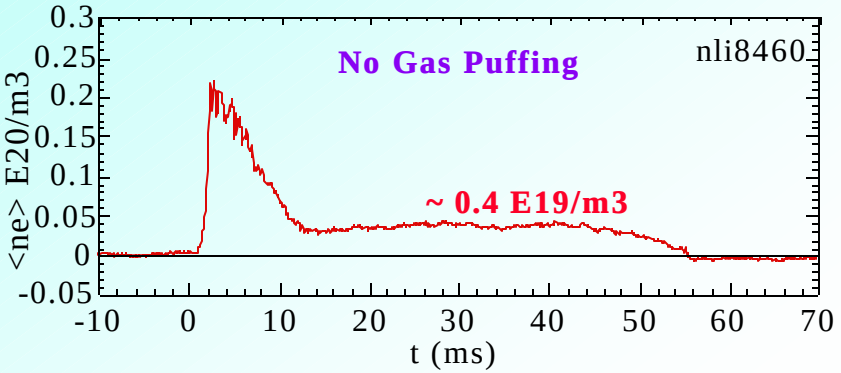

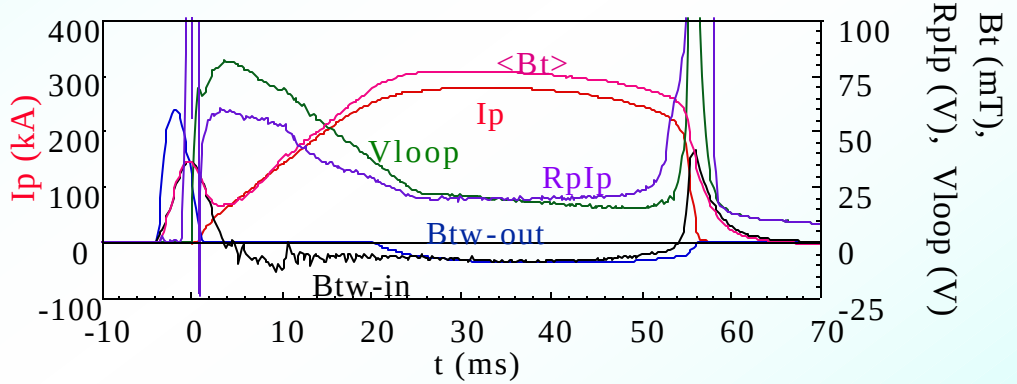

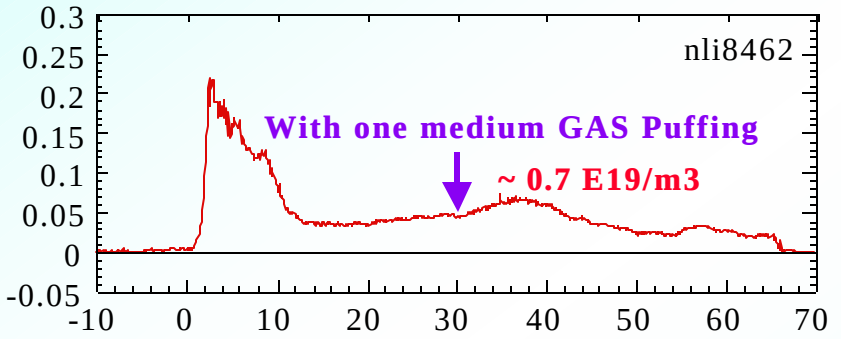

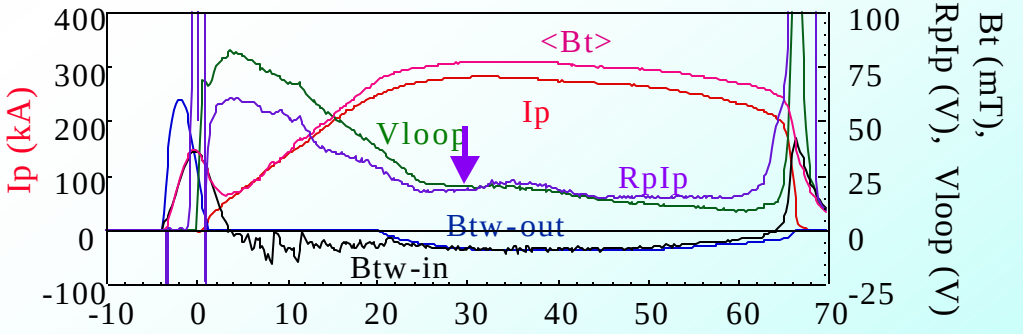

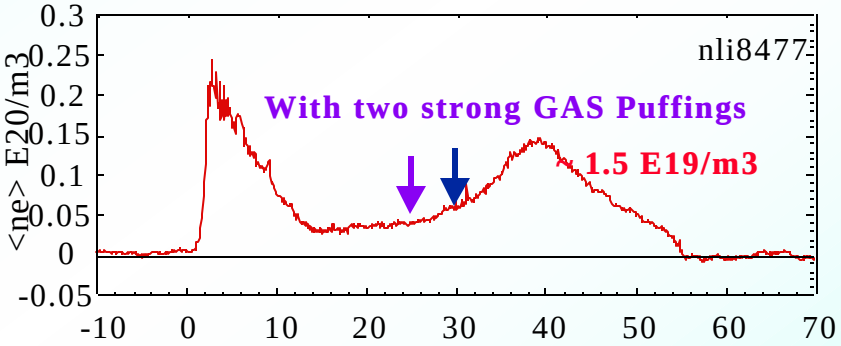

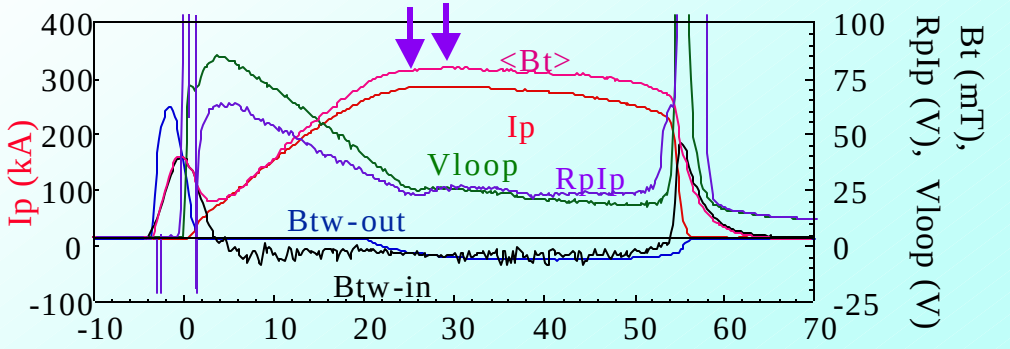

Density control with Gas Puff in TPE-RX

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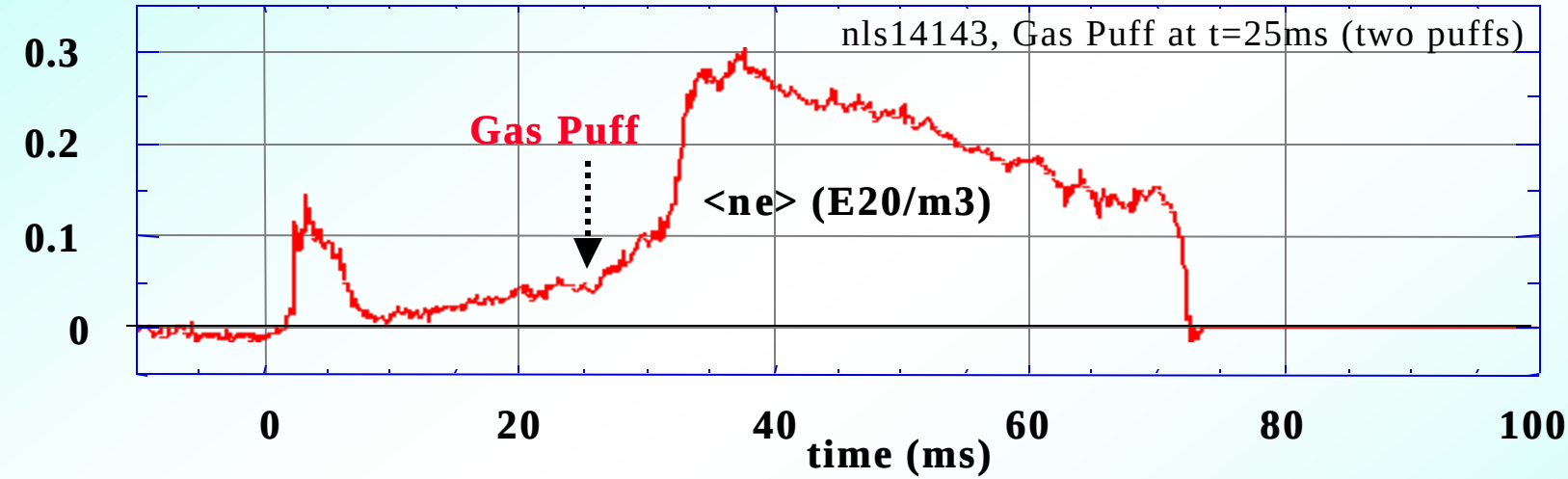

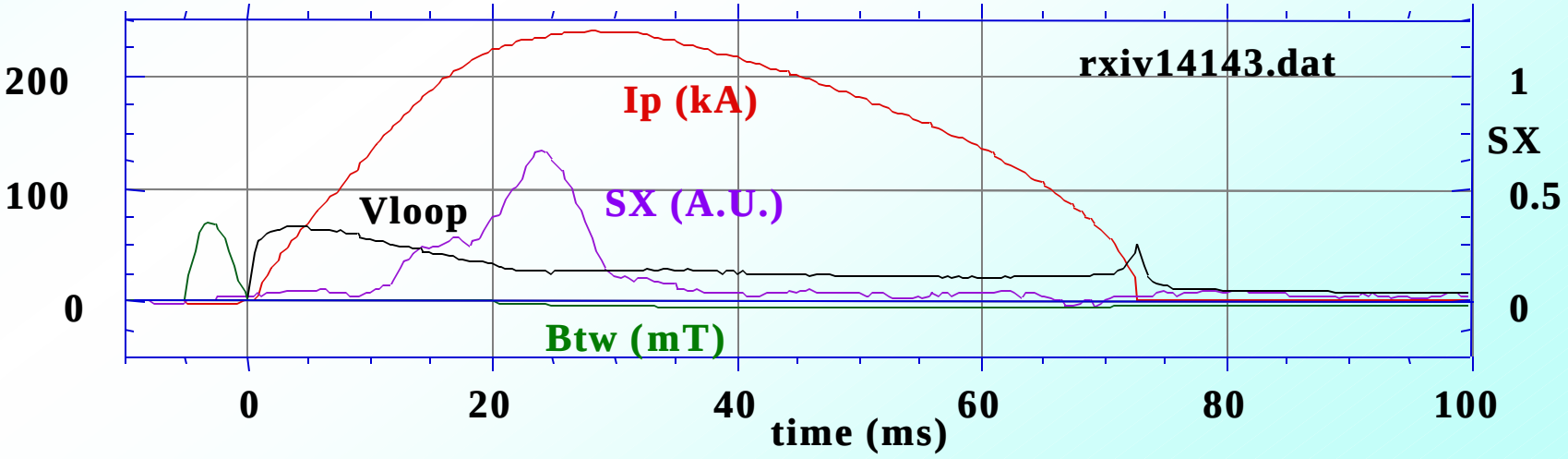

DMR (Deep Magnetic field Reversal) Exp. in TPE-RX

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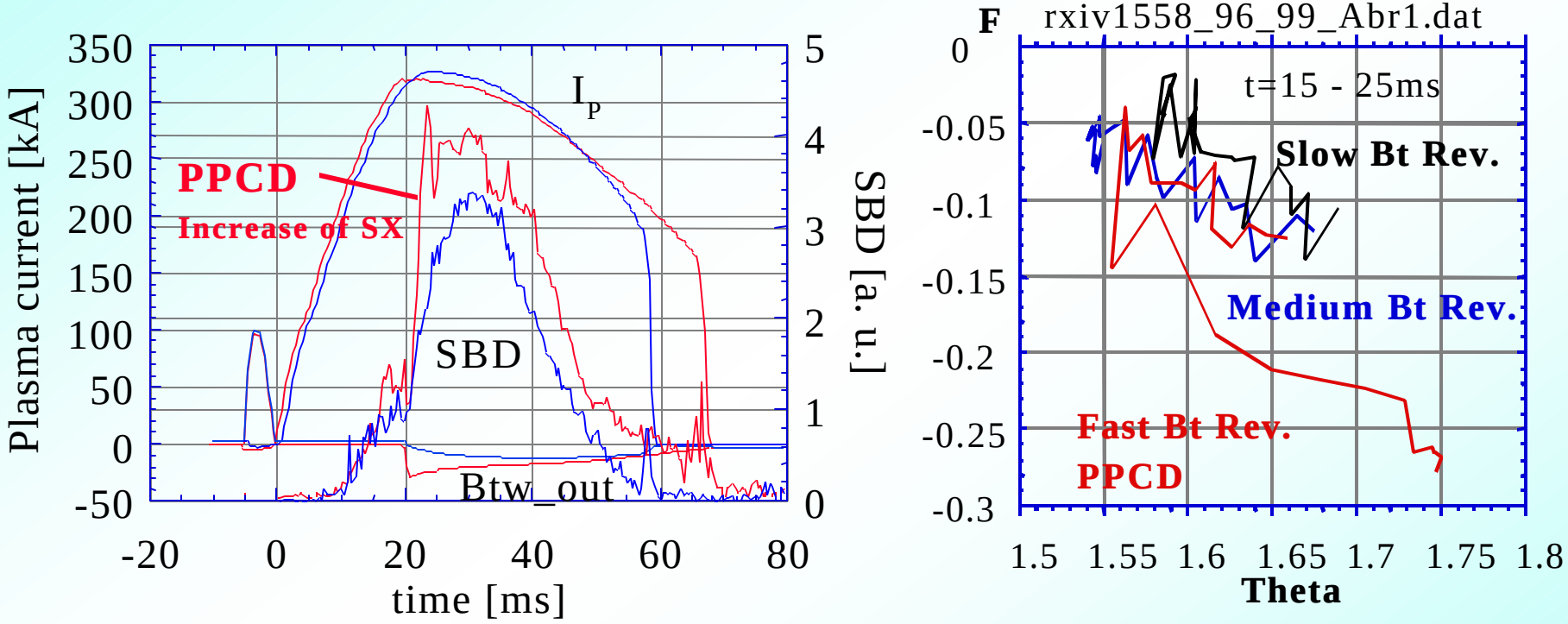
(Initial PPCD Exp.)



F-Theta curve becomes close to relaxed state in Fast Btw reversal.

Both radial magnetic fluctuations and D_a intensity at r/a~0.9 are suppressed.

Toroidal plasma rotation velocity (C^{4+} ions) shows no extinct behavior in the present conditions.

Summary

Almost two years since experiment start

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1. Max. Ip ~500kA. Max t-dis ~100ms for Ip ~ 220kA.
2. High Te (<~1000eV) is realized with low density (~5E18/m^3)
   Similar to TPE-1RM20 & 1RM15. High I/N ~10^{-13}A/m
3. RpIp has not been reduced to < 10V, remains at high value ~15V
   Vloop anomaly is ~ 50% of RpIp (H~10 & Zeff~5 are assumed)
4. Comparison of discharges with and w/o locked mode.
   LM causes strong PWI; reducing t-dis & limiting high Ip Op.
5. Plasma rotation depends on Ip (5km/s at Ip~200kA, 0 at 370kA)
6. Density control is successfully done.
   ne can go up to 3E19/m^3
7. PPCD seems to be promising, sharp increase of SX(Te & ne)
   Further investigation is planned.