

# Overview of Coordinated ST Research in Japan

Y. TAKASE<sup>a</sup>, A. EJIRI<sup>a</sup>, T. FUJITA<sup>b</sup>, K. HANADA<sup>c</sup>, H. IDEI<sup>c</sup>, M. NAGATA<sup>d</sup>, T. ONCHI<sup>c</sup>, Y. ONO<sup>a</sup>, H. TANAKA<sup>e</sup>, N. TSUJII<sup>a</sup>, M. UCHIDA<sup>e</sup>, K. YASUDA<sup>b</sup>, H. KASAHARA<sup>f</sup>, S. MURAKAMI<sup>e</sup>, Y. TAKEIRI<sup>f</sup>, Y. TODO<sup>f</sup>, S. TSUJI-IIO<sup>g</sup>, Y. KAMADA<sup>h</sup>

<sup>a</sup>The University of Tokyo, <sup>b</sup>Nagoya University, <sup>c</sup>Kyushu University, <sup>d</sup>University of Hyogo,

<sup>e</sup>Kyoto University, <sup>f</sup>NIFS, <sup>g</sup>Tokyo Institute of Technology, <sup>h</sup>QST, Japan

takase@k.u-tokyo.ac.jp

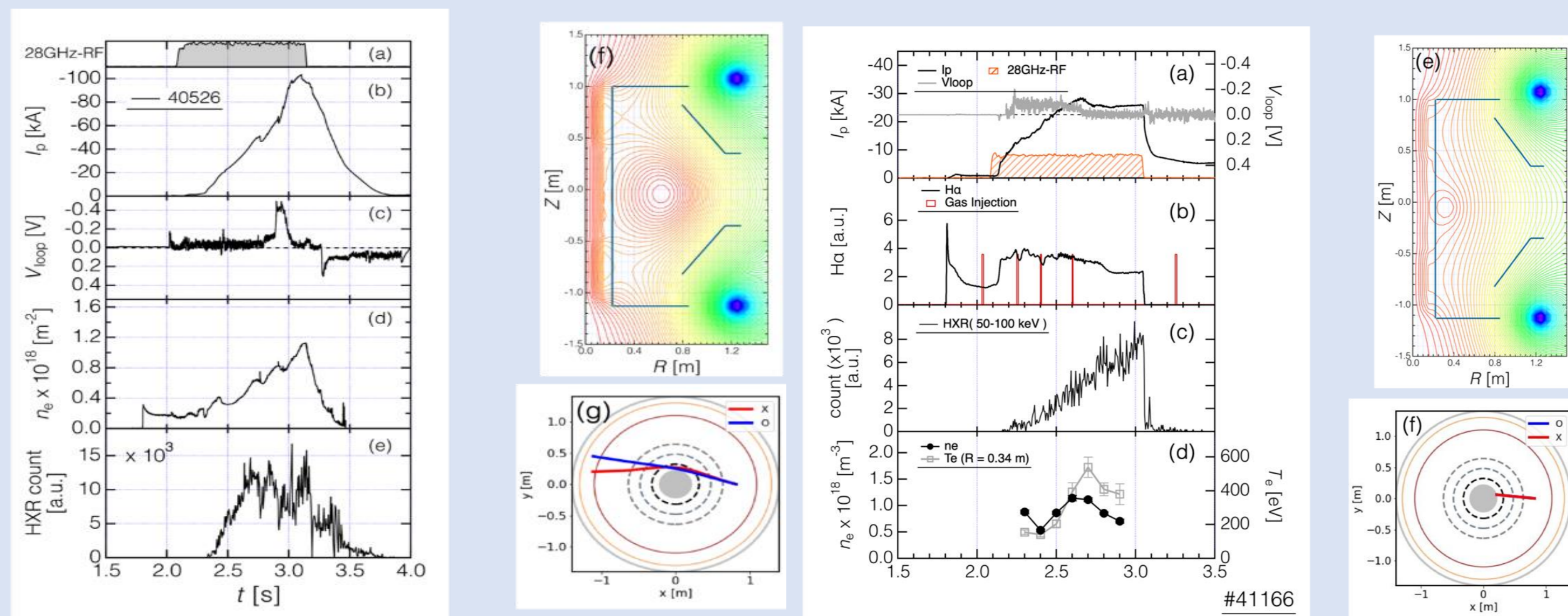
## Abstract

ST research in Japan has produced many innovative results:

- ECCD start-up to  $I_p > 70$  kA was achieved with  $N_{||} = 0.75$  and ECH to  $T_e > 500$  eV was achieved with  $N_{||} = 0.26$  on QUEST.
- RF-induced transport model and extended MHD equilibrium code were developed for fast electron dominated LHCD plasmas on TST-2.
- $30 \times n_{\text{cutoff}}$  was achieved by EBCD + e-beam injection on LATE.
- Plasmoid-mediated fast magnetic reconnection was identified on HIST.
- VDE stabilization by local helical field was demonstrated on TOKASTAR-2.
- 6h discharge was achieved by cool down of center stack cover on QUEST. Plasma duration limit is consistent with wall saturation time.
- Reconnection heating by plasma merging up to  $T_i = 2.3$  keV was achieved.

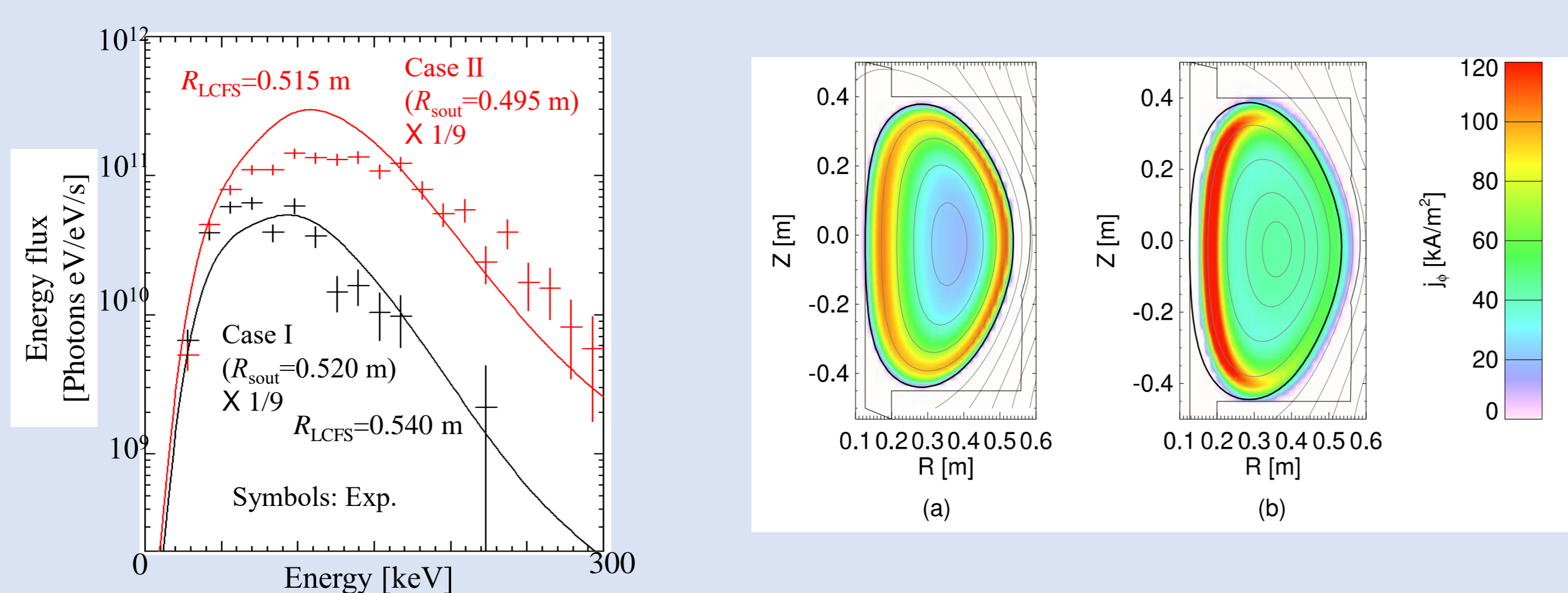
## ECCD and ECH (QUEST)

- Effective current drive up to  $I_p > 70$  kA was achieved by ECW with  $N_{||} = 0.75$ , and  $I_p > 100$  kA was achieved with additional inductive boost.
- Effective electron heating up to  $T_e > 500$  eV was observed with  $N_{||} = 0.26$ .



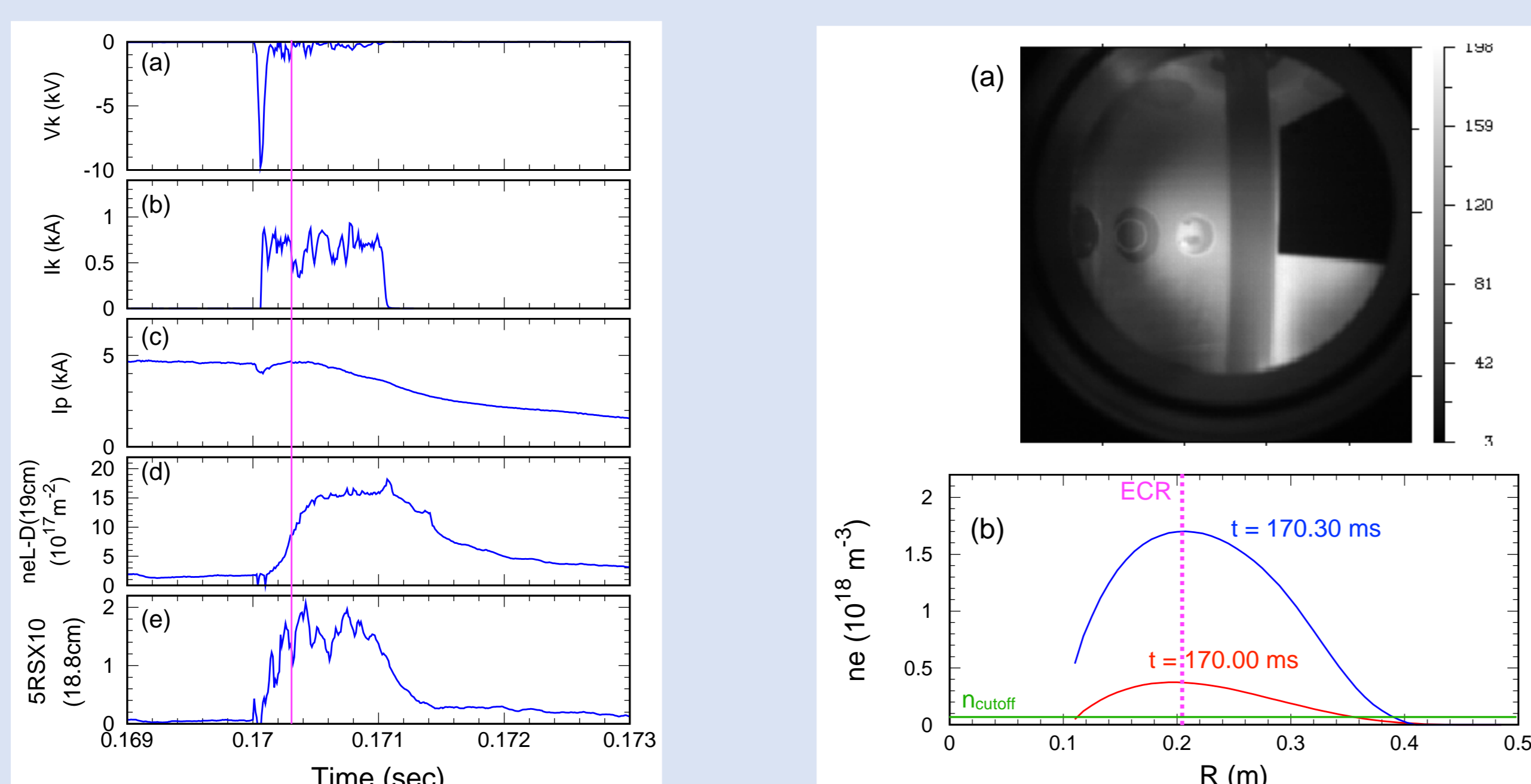
## LHCD (TST-2)

- Newly developed RF-induced transport model and X-ray emission model were able to reproduce the measured hard X-ray spectra.
- A new equilibrium reconstruction code based on extended MHD was developed to analyze LHW-driven start-up plasmas.



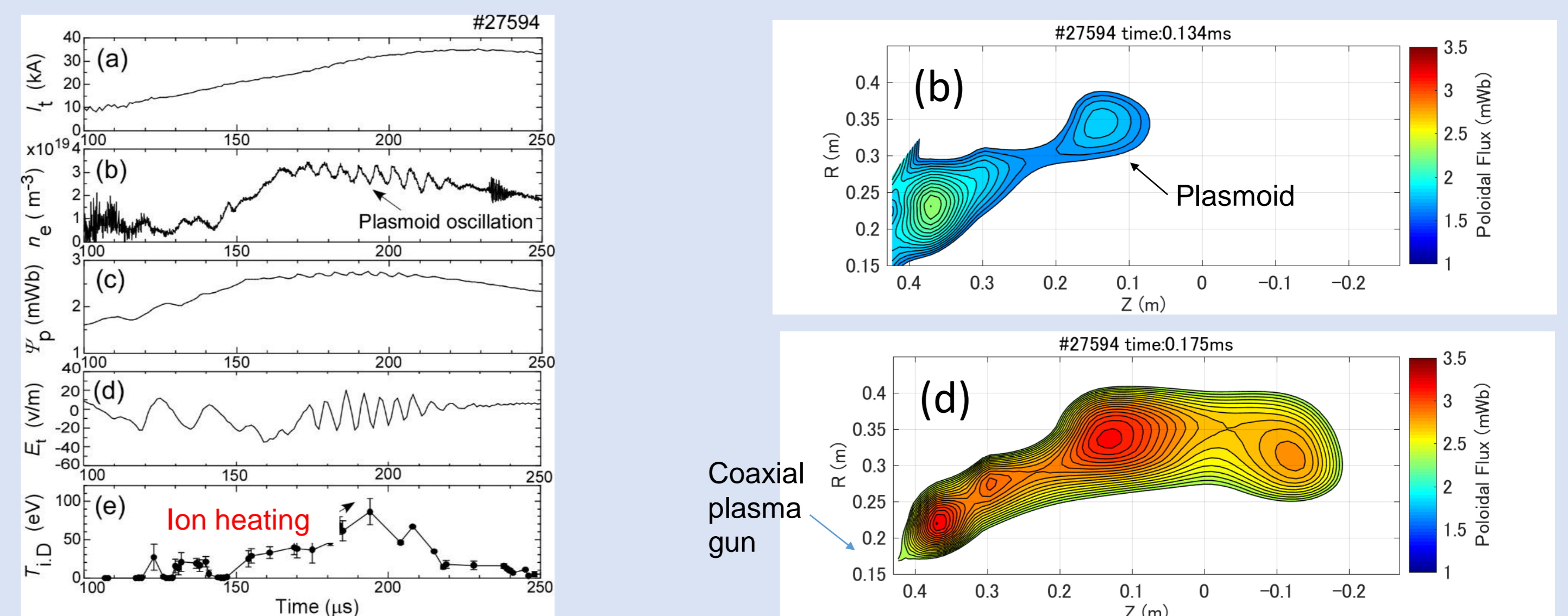
## $I_p$ start-up by e-beam injection (LATE)

- e-beam injected to EBW-driven ST plasma resulted in density increase up to 30 times the cut-off density.
- Significant core heating was observed, but not  $I_p$  increase.



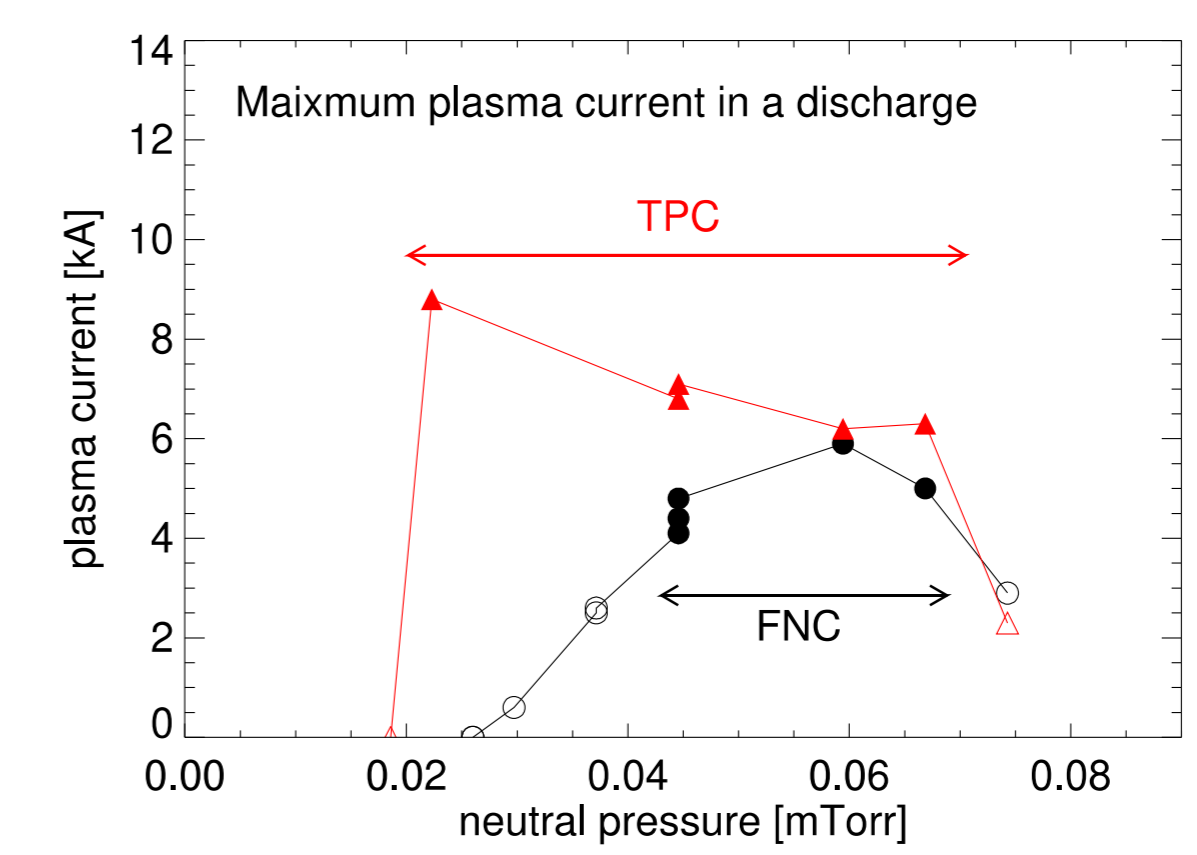
## Transient CHI (HIST)

- Plasmoid-mediated fast magnetic reconnection for flux closure and ion heating was identified for the first time.



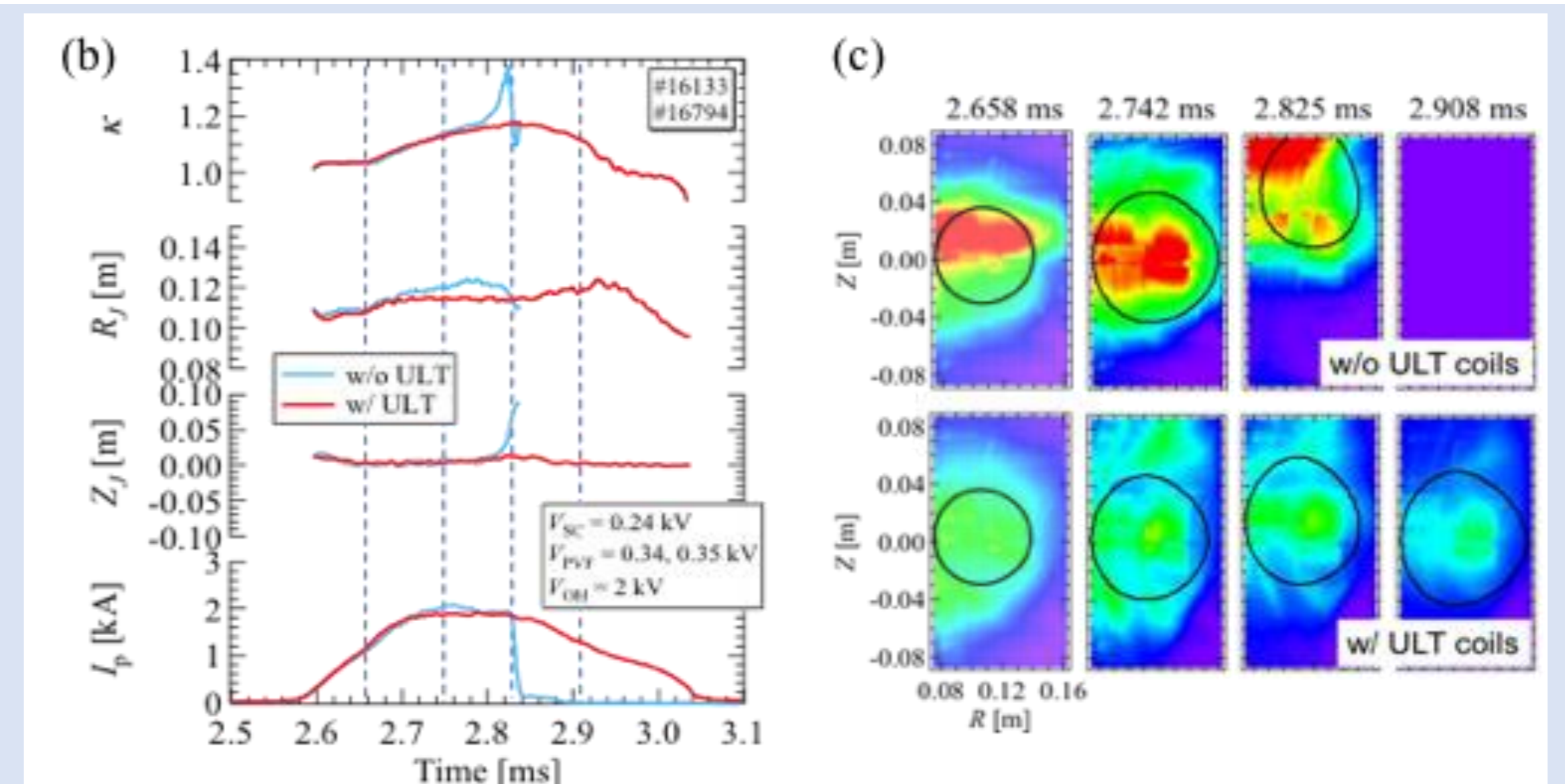
## Optimization of inductive $I_p$ start-up (TST-2)

- Low pressure limit for  $I_p$  start-up is extended in TPC.
- $I_p$  ramp-up rate is higher for TPC.



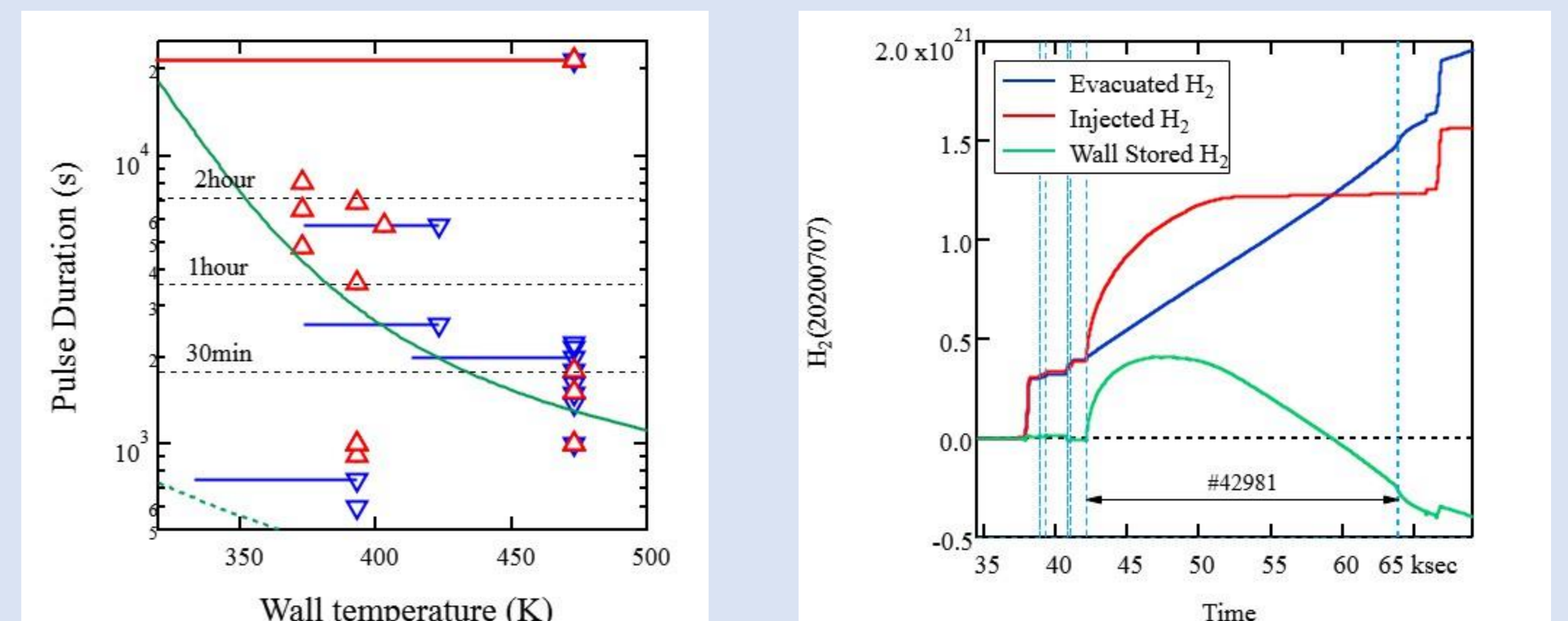
## VDE stabilization by helical field coils (TOKASTAR-2)

- VDE stabilization by only a set of upper and lower local helical (ULT) coils was demonstrated for the first time.



## Steady-state operation by wall temperature control (QUEST)

- Limitation of plasma duration is estimated by wall saturation time given by modelling.
- 6h discharge was achieved by cool down of center stack cover.



## Access to high temperature and/or high beta regime

- Reconnection heating energy increases proportional to the square of the reconnecting magnetic field, with  $T_i$  reaching 2.3 keV on ST40.
- This scaling suggests the possibility of direct access to burning plasmas by reconnection heating.

(see Y. Ono, et al., paper IAC/P4-3)