



Supported by



U.S. DEPARTMENT OF  
**ENERGY**

Office of  
Science

# XP-1160: Low Plasma Current, Fully Non-Inductive, HHFW H-Mode Plasmas

**G. Taylor**

D. Mueller, S. Gerhardt, J. C. Hosea, B. P. LeBlanc,  
C. Kessel, C. K. Phillips, S. Zweben

*PPPL*

R. Maingi, P. M. Ryan

*ORNL*

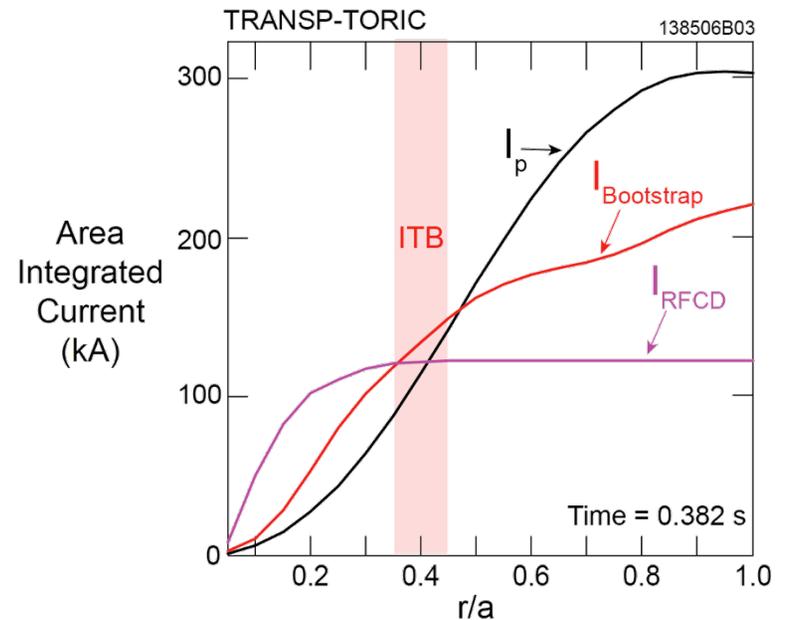
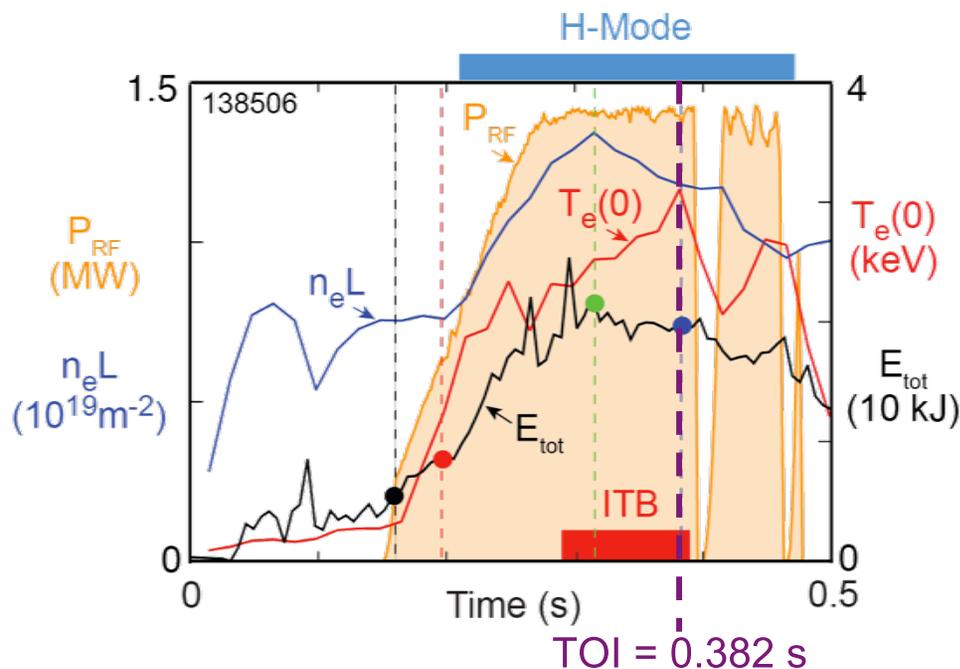
R. Raman

*U. Washington*

**SFPS TSG Meeting**  
**May 17, 2011**

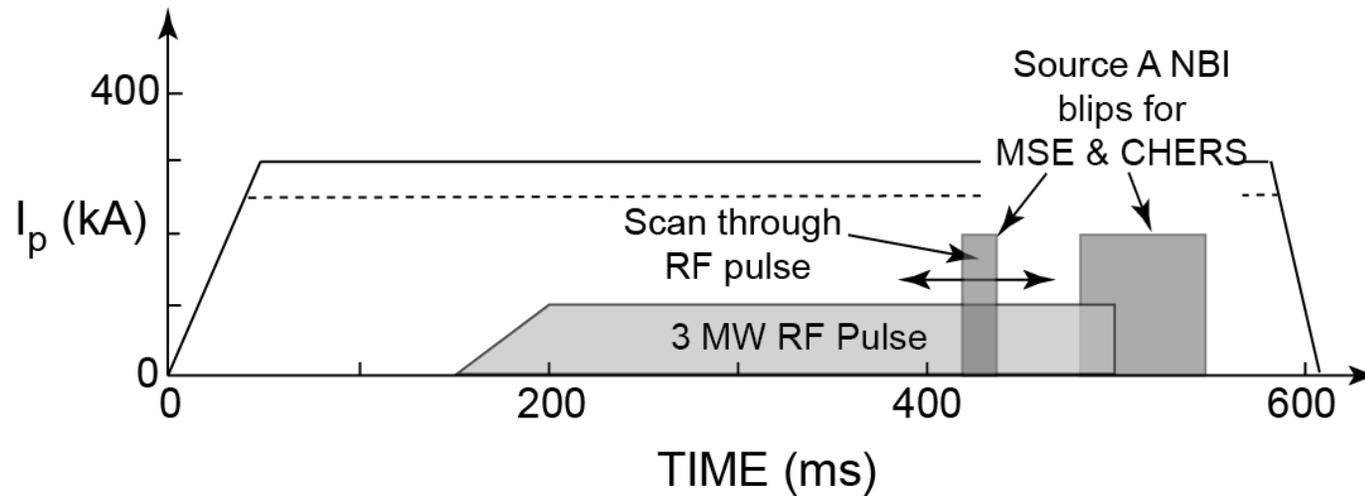
# XP1160 Low $I_p$ Fully Non-Inductive HHFW H-Modes: Overview/Justification

- $I_p = 300$  kA HHFW H-mode in XP-1009 achieved  $f_{NI} \sim 65\%$  with  $P_{RF} = 1.4$  MW:
  - ITB formed during H-mode
  - Positive feedback between ITB, high  $T_e(0)$  and RF CD



- Increase  $P_{RF}$  to  $\sim 3-4$  MW to achieve  $f_{NI} \sim 100\%$ 
  - Some work may be needed to further improve plasma position control
  - Repeat at  $I_p = 250$  kA

# XP1160 Low $I_p$ Fully Non-Inductive HHFW H-Modes: Run Plan - I



- Clamp OH coil current, instead of feeding back on  $I_p$
- Shots without HHFW power will have decaying  $I_p$
- When HHFW power is applied  $I_p$  will be sustained or decay more slowly depending on the amount of RF and bootstrap current drive
- May need some ohmic discharges with  $I_p$  feedback on to gain estimate of the OH current needed to minimize plasma motion at low  $I_p$
- Experiment requires 1-1.5 days to complete

# XP1160 Low $I_p$ Fully Non-Inductive HHFW H-Modes: Run Plan - II

1. Setup  $I_p = 300$  kA discharge similar to shot 138506
2. Once pulse is reproducible, add  $k_\phi = -8$  m<sup>-1</sup> (-90° phasing) power, using antenna settings from 138506. Increase  $P_{RF}$  to 3-4 MW, while adjusting antenna tuning, Li evaporation rate and gas injection rate to optimize RF coupling. Measure  $q(r)$  &  $T_i$  with source A NBI blips [10-15 shots]
3. Reduce  $I_p$  to 250 kA, couple 3-4 MW of  $k_\phi = -8$  m<sup>-1</sup> power and measure  $q(r)$  &  $T_i$  with source A NBI blips [10-15 shots]
4. At  $I_p = 300$  kA, move the RF pulse start time as early as possible in time and obtain data at 1.5 and 3 MW RF power levels [4-6 shots], with a 20ms NBI blip applied 100 to 150ms after start of TF flat-top. For FY12, increase the RF power level to >4 MW [9 shots]
5. If time permits repeat steps 1 and 2 with -60° antenna phasing

**Operational Requirements:**  $P_{RF} = 3-4$  MW with -60° & -90° phasing and rtEFIT isoflux control of outer gap. 90 keV source A blips

**Key Diagnostics:** MPTS, SOL reflectometry, ERD, CHERS, MSE, Visible & IR camera imaging of antenna & divertor

**Analysis/Modeling:** GENRAY-ADJ, TRANSP-TORIC