Use of HHFW heating to increase the non-inductive current fraction in NBI-produced H-mode plasmas

M.G. Bell, S.P. Gerhardt, H. Yuh

Research Forum for FY2011
Advanced Scenarios and Control Topical Science Group

- Addresses high-priority research goals
  - Realize high non-inductive current fraction plasmas with high-beta under sustained conditions (ASC-TSG)
  - Utilize HHFW heating and current drive to assist non-inductive plasma current ramp-up and sustainment (WEP-TSG)
  - Research Milestone (R12-3): Assess access to reduced density and collisionality in high-performance scenarios
  - Research Milestone R(12-2): …"Early NBI and HHFW heating and CD will be applied ... to assess non-inductive sustainment."

XP-829 (2008), HHFW Successfully Heated Electrons in H-mode LSN Plasmas Produced by NBI

- ~1.8g lithium had been applied over 17 shots in the morning but was discontinued before the preceding shot

- Effects of lithium appeared to continue through next 3 shots (129386, *8, *9)

  – Low H-mode power threshold: <2MW at 1.0MA, 0.55T

  – Discharges became ELM-free (and radiated power began to rise)

  – Central density remained relatively low

- Discharges did not meet requirements of XP and were abandoned
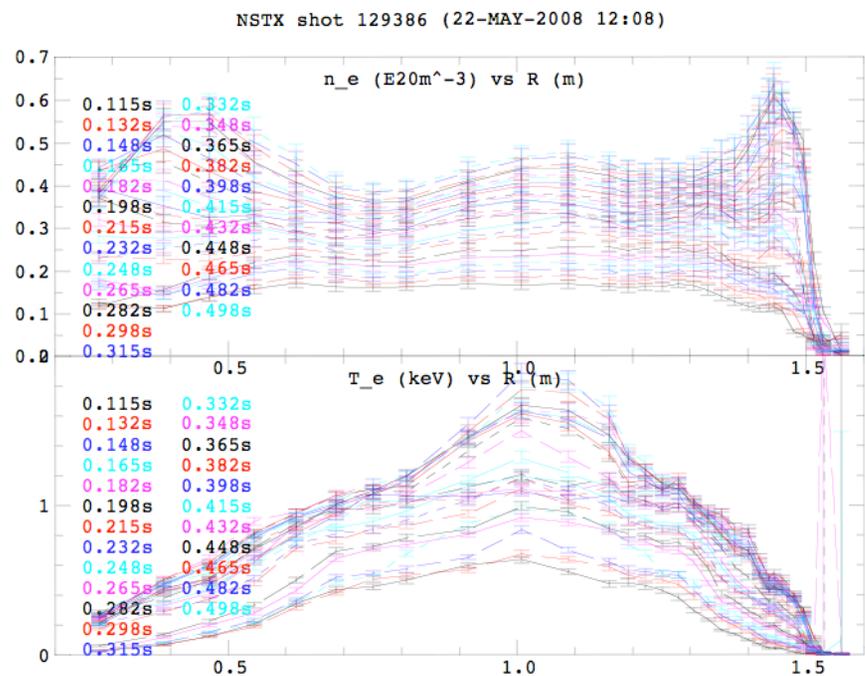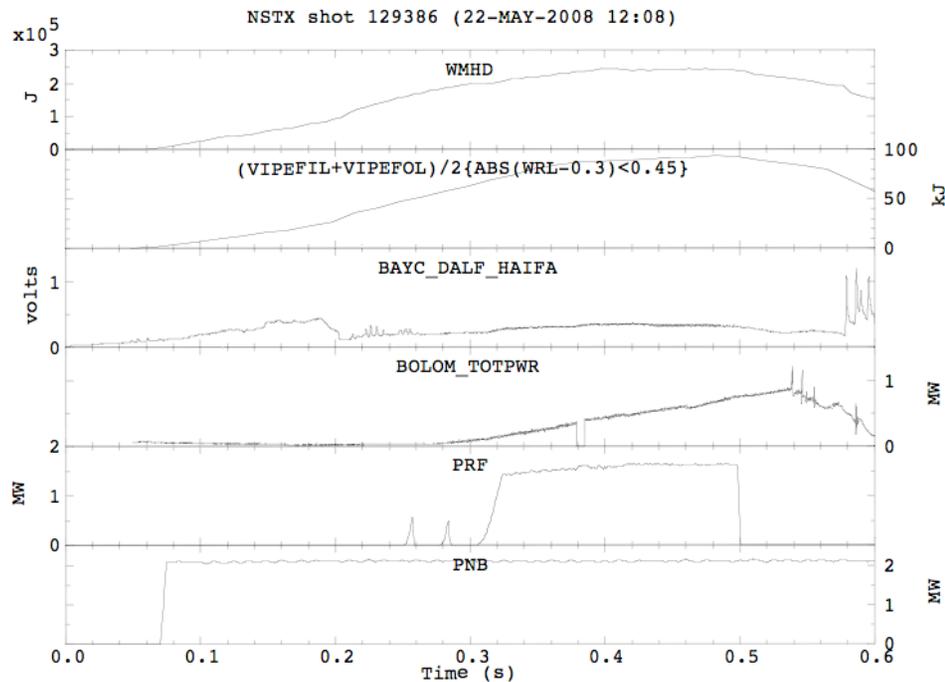
Build on XP-829 Success Using New HHFW Capabilities and Operational Strategies

- Aim: Optimize $P_{NB} T_e(0)^{3/2} / n_e(0)$ during HHFW and document conditions
- Start with conditions of 129386: LSN, 1.0MA, 0.55T, $P_{NBI} \approx$ 2MW
  - Optimize LITER rate to achieve H-mode and control ELMs
  - Start with $P_{HHFW} \sim$ 2MW in heating phasing then investigate CD phasing
  - Increase NB power to 4MW, possibly 6MW
  - At highest NB power with clear $T_e(0)$ rise, increase HHFW power
- In parallel, apply ELM-pacing if P_{rad} or n_e is rising
  - Magnetic triggering by pulsing EFC coils
  - Notch HHFW power
- Prerequisites
  - B_T to 0.55T; LITERs; NBI
  - HHFW system ready to couple >3MW, preferably in CD phasing
  - EFC system with odd parity and qualified for up to 2kA pulsed waveforms
- Experimental time: 39 – 45 shots
- Analysis: Full kinetic analysis in TRANSP, including RF package