Combined H-mode / ITB Scenario Development on NSTX

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Combined ITB and H-mode may result in better Performance

Review & Motivation

- Obtained long duration high performance H-modes last run
- Plasma performance may be improved with combination of ITB core and H-mode edge
- H-Mode power threshold experiments done
  - P_{beam} at threshold as low as ~ 315 k kW

  Must expand the operating space to investigate further
- New capabilities – Better n_e profiles at edge, CHERS now available
- Use mostly NBI - But also expect to use RF (especially for core heating)
- Some scenarios developed last run may help
  - Work by Menard and Gates and Maingi

Experience with Combined ITB and H-modes Scenario: NSTX already has Scenario Experience with Promise.

- DIII-D obtained combined ITB/H-mode using counter injection with n_e control
  - Began with very low density H-mode regime
  - Now have the quasi-double barrier (QDB) mode
- On TFTR -- obtained ITB in ERS mode
  - Found $\omega_{ExB} >> \gamma_{Lin}$ at transition due to large excursion in V_{pol}
  - E × B shear maintained low transport until "turned off"
  - no ERS with H-mode edge attempted
- But
  - obtained H-mode edge in supershot and high β_{pol} plasma
  - highly conditioned walls to control n_e (especially edge)
  - improved with I_p rampdown (more with Li condition)

Low edge neutrals, bi-directional NBI

Experience with Combined ITB and H-modes Scenario

(continued)

- JET-pellet enhanced mode combined with H-mode
  - — used large central heating using either NBI or ICRH
  - — clear evidence of ITB in optimized shear discharges
- In most cases, no consensus in a P_{th} for ITB formation
  - — DIII-D — get QDB $P_{th} \sim 2.5$ MW with co-NBI but 9 MW for counter-NBI
  - — JT-60 found the opposite, with co-NBI a disadvantage
  - — However, in general all found ExB shear favorable and part of the process, whether ∇_p, V_θ or V_ϕ driven
- New capabilities on NSTX

  Better conditioning and better control of n_e
  - — new 350° bake; inner wall gas puff

Experimental Approach

- Use longer duration H-modes (emphasis on NBI)
- Heat H-mode core with NBI and/or RF
  - High beam voltage is a knob for core heating.
- Use I_p ramp-down and I_p control to get ITB
- Test other methods of triggering (lower P_{th}?) L-H transition.
- Where applicable make use of scenarios developed last run.