NSTX

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XP923: Thermal Transport in the boundary (FY2010 Joint Research Target)

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Rajesh Maingi

Need support from: J.-W. Ahn, S. Paul, J. Kallman, R. Maqueda, V. Soukhanovskii

NSTX Boundary Physics Topical Science Group
Princeton, NJ
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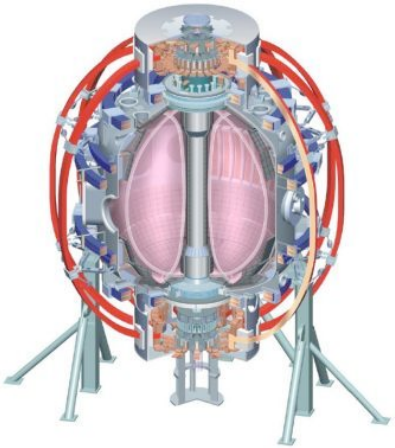

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FY 2010 Joint Research Target: thermal heat transport assessment

- Conduct experiments on major fusion facilities to improve understanding of the heat transport in the tokamak scrape-off layer (SOL) plasma, strengthening the basis for projecting divertor conditions in ITER.
- In FY2010, FES will measure the divertor heat flux profiles and plasma characteristics in the tokamak scrape-off layer in multiple devices to investigate the underlying thermal transport processes. The unique characteristics of C-Mod, DIII-D, and NSTX will enable collection of data over a broad range of SOL and divertor parameters (e.g., collisionality, beta, parallel heat flux, and divertor geometry). Coordinated experiments using common analysis methods will generate a data set that will be compared with theory and simulation.

Goals

- Three meetings with C-Mod and DIII-D scientists have helped define how to conduct experiments and modeling/analysis
- Basic idea: complete scans of several quantities known to affect the divertor heat flux profile (e.g. P_{NBI}, n_e, I_P, L- vs H -mode, NBI vs. RF)
- Basic modeling: simulation of data with 2-D codes (e.g. b2 /EIRENE, UEDGE, DEGAS-2) to assess how heat is transported between midplane -> X-point -> divertor
  - DIII-D and NSTX show dominant parallel transport; not sure in C-Mod
- Detailed modeling: prediction of SOL heat flux widths from turbulence models, e.g. SOLT code
  - D'Ippolito (Lodestar) participated in discussions @ UCLA

New data wish list for milestone

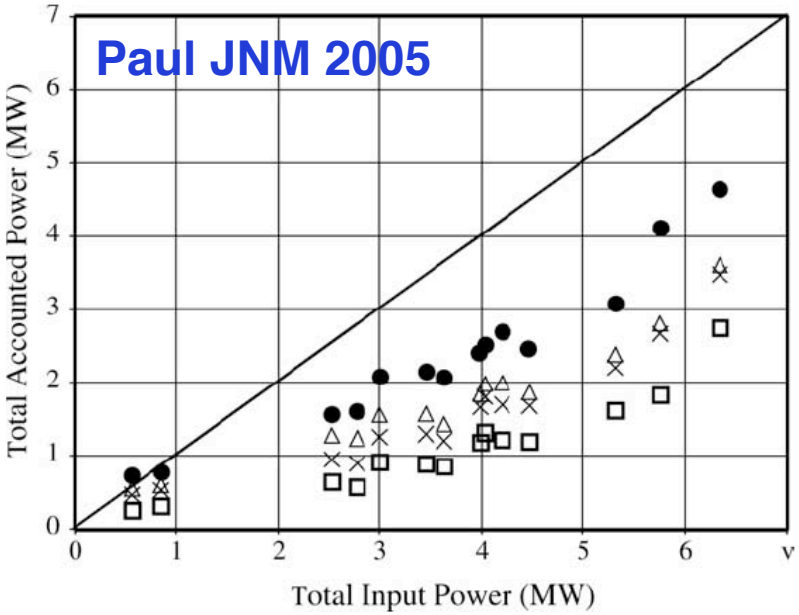
- Results of meetings w/C-Mod and DIII-D scientists:
  - Similar poloidal cross-section: κ=1.7-1.8, δ_L~0.5, LSN
  - I_p and B_t scans with combinations selected to match q_*
  - Desire overlapping midplane and divertor ν_e* ranges (density scan)
    - Desire data in both sheath- and flux-limited regimes
  - Power scan, including ohmic, and large as possible in L-mode (reversed grad-B drift?)
  - NBI and RF comparisons in NSTX and DIII-D to see effect of fast ions
- Additional wish list for NSTX center stack upgrade:
  - Desire to do elements of this also at κ=2-2.2, δ_L~0.7, LSN

Critical diagnostics

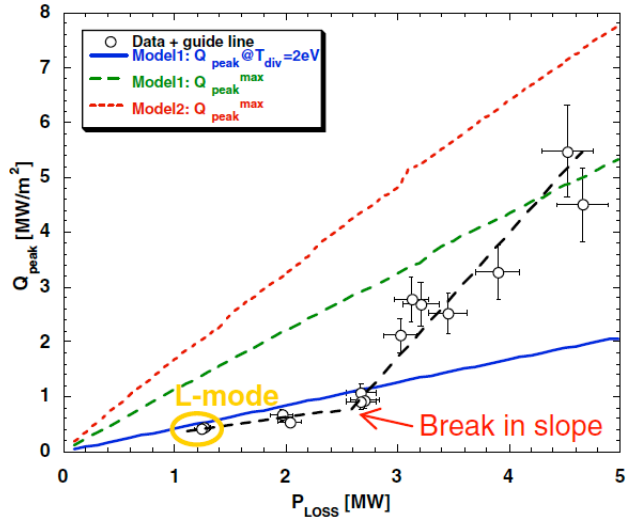
- New and existing divertor diagnostics in NSTX:
  - New fast divertor IR camera (Ahn)
  - New 20 channel divertor bolometer (Paul)
  - Slow IR cameras (Maingi)
  - 1-D CCD cameras: D_α, D_γ?, C-III (Soukhanovskii)
  - Divertor Langmuir probes: R=0.495m, 0.797m (Kallman)
  - Midplane gas puff imaging (Maqueda)
  - Divertor X-point imaging (Maqueda)

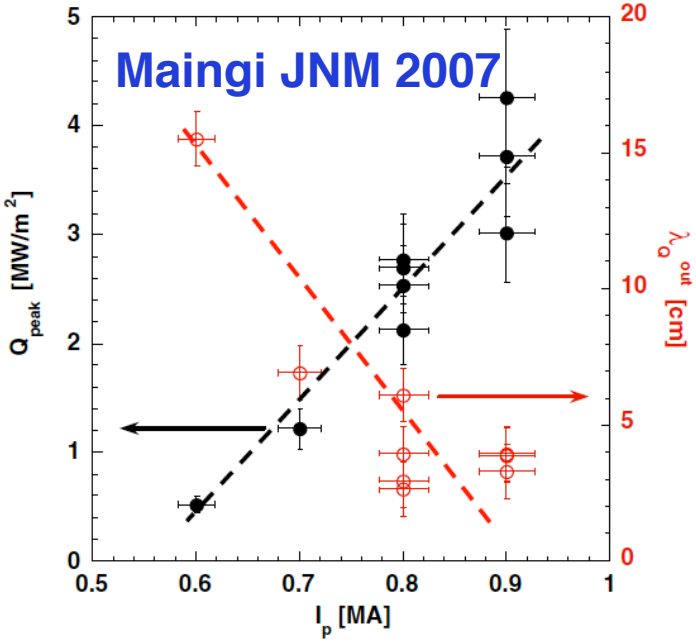
Much data from past experiments

- Power accounting and heat flux scaling with fine P_{NBI}, I_P scans in δ=0.5, κ=2, LSN discharges
  - 4 channels divertor bolometry, slow IR cameras



- Heat flux scaling with coarse P_{NBI}, I_P scans in δ=0.8, κ=2.2, LSN discharges (XP 816)





Desired data for FY2009-2010

- P_{NBI} scan to vary ν_e^* (flux -> sheath limited)
- I_p scan to vary cross-field transport rate
  - Profiles get steeper with I_p, does turbulence change also?
  - Will naturally vary q95
    - Should we do some discharges at fixed q95 to separate SOL connection length from this variation?
    - Or do an explicit B_t scan to vary SOL connection length?
- n_e scan to vary ν_e^*, divertor radiated power
  - Should we include a partial detachment comparison?
- Outer strike point scan over nearest divertor Langmuir probes: R=0.8m (low δ), R=0.5 m (hi δ)
- RF vs. NBI comparison
- Ohmic + L-mode power scan (reversed B_t? Or USN?)

Proposal for 2009: focus on low δ data because it may be difficult to get next year

- ✓ P_{NBI} scan in 1 MW increments: 0-6 MW (0.8 MA) 12
- ✓ I_p scan in 0.1 MA increments: 0.6-1.0 MA 18
  - 4 MW, 5MW or 6 MW as baseline?
  - Also do the end points at fixed B_t/I_p=0.5625 T/MA
  - Still need to determine what q* needed to match C-Mod, DIII-D
- ✓ n_e scan with natural density rise, + small fueling variation? 5
- ✓ Outer strike point scan over nearest divertor Langmuir probes: R=0.8m (build in)
- X RF vs. NBI comparison
  - Not possible pre-Lithium because of RF availability schedule?
- Ohmic + L-mode power scan (reversed B_t? Or USN?)
  - Reversed B only possible at end of run, ie not pre-Lithium
- Are repeat shots needed for filter variations, etc?