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XP1046: Effect of externally applied 3-D fields on divertor profiles

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NSTX Team Review
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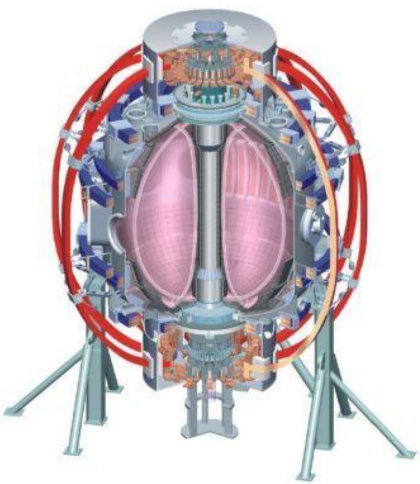

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Summary of results in FY09

- Applied 3-D fields induce strike point splitting and the vacuum field line tracing provides good agreement with measured striations in divertor profiles

- The expected periodicity of measured divertor profiles for imposed 3-D fields was confirmed experimentally

- Inclusion of plasma response does not affect the structure of split strike point significantly

- 3-D field triggered ELM heat flux appears to largely follow split strike point channels

Understanding of how divertor profiles are modified in the presence of 3-D fields is important for projection to ITER

Collisionality scan

- Data in FY09 were obtained from limited plasma conditions, *ie* ν^*_e~1, q95~11, highly shaped (δ~0.8, κ=2.4)
  → We need a wide parameter scan to see how divertor profiles are affected by the plasma conditions

- Pedestal collisionality is a parameter revealed important for the observation of the strike point splitting in other tokamaks
  → In DIII-D, no footprint striation was observed for $\nu^*_e < 0.5$
  → NSTX clearly showed strike point splitting at $\nu^*_e \sim 1$
  → Use natural density rise for collisionality scan
  → Target range of scan: $0.3 \le \nu^*_e \le 3\text{-}4$ (135182)
  → Comparison of data with field line tracing

- At ν^*_e~1, 3-D fields did not significantly change the heat and particle flux distribution despite local peaks in the profile
  → Any possibility of more beneficial deposition at different ν^*_e?

q95 scan

- q95 is a parameter playing an important role in determining locations of resonant surfaces

  → Investigate effect of resonant contributions to the divertor profile modification, ie how well the rational surface locations are aligned with the peaks in the applied perturbation.

- Target range of scan: High, q95=6-7 (Ip=1.2MA), and low, q95=11 (Ip=0.8MA), points

Ip scan at constant q95

- The striations observed at the divertor surface theoretically attributed to the long and short connection lengths originated from the pedestal region
- Ip is a well known knob to change the SOL width at the divertor surface
- By changing Ip at constant q95, we will be able to change the SOL plasma conditions with pedestal conditions unchanged
- If the observed divertor striations change with Ip, this may indicate that SOL plasma also plays a role in determining heat and particle flux profile splitting
- Two Ip points: high (Ip=1.2MA) and low (Ip=0.8MA)

Plasma shapes

- All strike point splitting discharges in FY09 were highly shaped (δ~0.8, κ=2.4), no data yet for low δ plasmas
- Shape parameter is important for the strike point splitting?
- Take data in a low δ plasma (δ~0.6) with outer strike point at the outer divertor surface (outside CHI gap)

  → take advange of dense LP array to measure particle flux profile

Toroidal rotation of n=1 field

- Only n=3 perturbation data have been taken so far

  → Apply n=1 perturbation to see the effect on divertor profiles

- Possibility of toroidally asymmetric heat and particle deposition with the imposed 3-D fields

  → n=3 not possible to rotate

  → Application of toroidally propagating n=1 fields, frequency of up to 100Hz, I_{3D}=1.5-2kA OK to avoid disruption

Shot plan

- Reference shot:

  135184 (Ip=800kA, Bt=0.4T, I_{3D}=-500A, No ELMs triggered)

- Use square-wave 3-D coil current waveform to limit 3-D effect to the edge of the plasma

  → duration of 35ms to cover two TS profiles with freq of 10Hz

- 2 points each for Bt (0.33, 0.5T), Ip (0.8MA, 1.2MA), and P_{NBI} (3MW, 5MW) scan: total of 8 shots

- n=3 field application to a low δ discharge (reference: 137605, δ=0.6): 2 shots

- n=1 field rotation, frequency of 10Hz and 100Hz, Maximum $I_{3D,peak}$=1.5-2kA to avoid locking: 2 shots

Total of 12 good shots needed