Possible NSTX contributions to ITPA in boundary physics

R. Maingi

Boundary Physics Topical Group Meeting

Sept 23, 2008

UT-BATTELLE
Management Contractor for DOE's
Oak Ridge National Laboratory

OAK RIDGE
National Laboratory

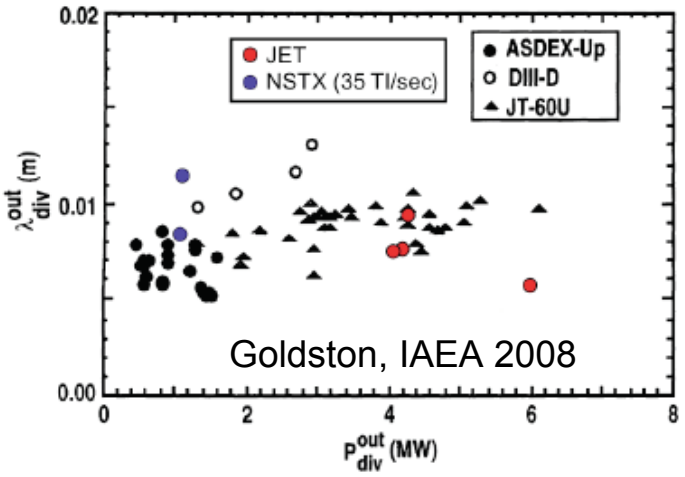
NSTX can contribute steady and ELM heat flux profile analysis for DSOL group

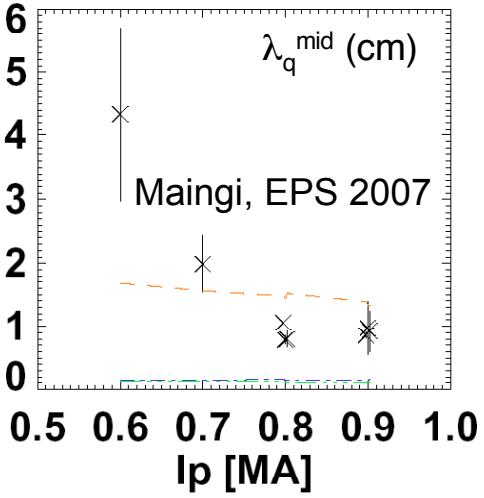
Understand the effect of ELMs, disruptions on divertor and first wall structures

- Exploration of the effect on the SOL and power loadings of ELM mitigation (ongoing)
  - ITER IO wording: An improved assessment of SOL width and local power deposition during disruptions/ VDEs, including limiter plasmas *(RM note: this doesn't mention ELMs)*
  - NSTX can contribute SOL power loadings during disruptions, ELMs, during 3-d field application with new fast camera
- Study runaway effects in disruptions and how to nullify them (new)
- New question (RM): how is heat flux carried across separatrix, i.e. split between electron and ion channels, steady vs. transient, LFS vs. HFS?

ST steady heat flux patterns show similarities and differences with higher R/a devices

- NSTX λ_q^{mid} comparable to higher R/a devices when computed with Loarte's formulation
  - Caution: other devices have little/no gas puff during H-mode phase, whereas NSTX is using ~ 35 torr-l/s (HFS)
  - Gas puff rate itself not important parameters - maybe SOL ν^* better?
- NSTX λ_q^{mid} large compared with high R/a collisional scalings from Counsell, Connor
  - Large ion gyro-radius -> min. SOL λ_q^{mid}?
  - How does turbulence impact λ_q^{mid}?
- New fast camera (1.675 kHz full frame, 10 kHz with reduced FoV) will be installed in FY 09 (new ORNL postdoc: T. Gray)
  - Mostly piggyback - lots of analysis





OAK RIDGE National Laboratory

NSTX participating in 4 existing PEP joint experiments

- PEP-6: dependence of L-H threshold and ELMs on drsep
  - Status: L-H data obtained in 2005 in XP 505 (EPS 2006 paper), and ELMs data obtained in XP 609 in 2008 (no writeup yet)
  - Additional data not needed, although XP 609 had confusing results in power balance are which could be clarified
- PEP-9: dependence of pedestal structure on R/a
  - Status: data obtained on DIII-D, MAST, and NSTX (IAEA 2006 paper)
  - No evidence of higher P' in STs at pedestal ν_e^* ~ 0.5; analysis of NSTX needs a little more resolution; no new data needed
- PEP-16: comparison of small ELM regimes
  - Status: data obtained on C-Mod, MAST, and NSTX (IAEA 2008 paper)
  - Stability analysis about to commence; no new data needed yet
- PEP-22: structure of Type II ELMs
  - Status: no participation yet

NSTX should focus ITPA PEP group contributions on ELM mitigation physics

- 1-1: Test pedestal β_{pol} and ν^* scaling of pedestal width across devices and parameter regimes; develop the theoretical basis for this scaling
- 1-2: Establish pedestal conditions required for L-H transition through cross machine experiments and theory
- 1-4: Determine compatibility of divertor detachment and robust pedestal pressure
- ✓ 2-3: Validate physics basis for ELM control by Resonant Magnetic Perturbations (RMP); i) collisionality threshold, ii) rotation dependence, iii) magnetic mode spectrum optimization, iv) plasma response and v) effect on pedestal stability
- 2-4: Compatibility of RMP ELM control with ITER operation; i) pedestal degradation, ii) pellet fueling, iii) divertor heat flux control, and iv) L-H transition power threshold
- 2-5: Develop physics of ELM dependence on toroidal field ripple and rotation
- ✓ 2-6: Assess applicability of low collisionality small ELM regimes [high δ, κ] in NSTX]; Grassy ELMs and QH-mode [compare similarities with lithium enhanced H-mode and QH-mode?]
- 2-7: Develop and test nonlinear MHD and turbulence models of ELM evolution

NSTX will need new data to contribute to PEP ELM task in areas of Lithium suppression of ELMs and n=3 de-stabilization of ELMs

- Collisionality threshold
  - A collisionality threshold may be present in our ELM stabilization with lithium coating
  - Haven't checked if collisionality threshold present in ELM de-stabilization
- Rotation dependence
  - Rotation can be varied dramatically with 3-d field amplitude
- Magnetic mode spectrum optimization
  - Present capability: can use n=2, n=3, or n=2+3
- Plasma response
  - May be able to image edge island evolution with SXR
- Effect on pedestal stability
  - Analysis in progress, both for ELM stabilization and de-stabilization results