Summary of Energetic Particles Topical Group (TG5) Session

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with help from
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NSTX Research Forum 2001
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Goals

NSTX

- Review achievements of past year
- Identify current status of theory, codes, & diagnostics
- Propose plans for future
- Define priorities

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Energetic Particle Physics Topics Covered

NSTX

- Orbit confinement: measurement of confinement quality, orbit calculation, collisionaleffects, non-adiabaticity, special orbit shapes

- MHD interactions: MHD transport of fast ions, parallel fishbones, MHz NB-driven MHD, aspect ratio scaling of TAEs, Alfvén mode spectroscopy

- Diagnostics & results: NPA, neutron detectors, fast lost ion probe, thin foil Faraday cups, diamond detectors

- HHFW-fast ion interactions: damping of HHFW on thermal & NB ions

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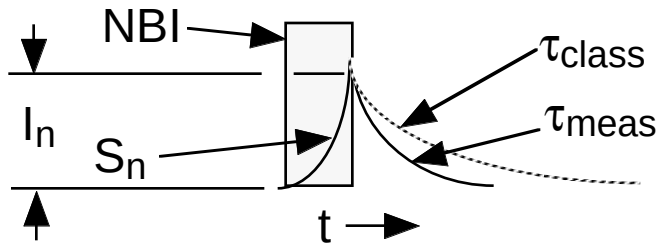
Energetic Particle Orbit Physics (1)

NSTX

Heidbrink (UC Irvine)

- Inject beam blips to measure global beam ion confinement. Emphasize low B_T to look for non-adiabaticity. Also do with HHFW to look for NBI acceleration.



$$\tau_{meas}^{-1} = \tau_{class}^{-1} + \tau_{conf}^{-1}$$

C. S. Chang (NYU)

- Thermal & fast ion drift orbits near X-point are lost. Loss can cause E_r & H-mode transition.

Egedal (MIT)

- Constants-of-Motion (COM) approach to guiding center beam orbits could allow very rapid calculation of loss fraction. Try it & compare against other codes. Infer f(v) from NPA data? Other possible applications also.

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Energetic Particle Orbit Physics (2)

NSTX

Akers (Culham)

- LOCUST code developed to model NB dist'n in MAST. Monte Carlo, parallelised to follow many NB orbits. Includes collisions, CX, power deposition profile in plasma, loss, etc. Modify to read NSTX data. Incorporate in TRANSP?

Redi (PPPL)

- Check collisional NB ion loss with GC Orbit. Use results to benchmark TRANSP collisional loss calculation.

Yavorskij (KINR)

- Use analytical methods to study radial & pitch angle transport induced by nonadiabaticity. Incorporated analytical diffusion coefficient into GC Orbit to compute enhanced loss fraction that arises from nonadiabaticity

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Energetic Particle Orbit Physics (3)

NSTX

<u>Belikov (KINR)</u>

- Study orbit shapes analytically at high β. Check to see whether special orbit classes (teardrops, dumbbells) alter loss distribution on wall.

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MHD Interactions with Energetic Particles (1)

NSTX

White (PPPL) • Derive fast ion transport from IREs; assess fishbone stability at high β; predict effects of fast ion orbit squeezing on NTMs

Kolesnichenko (KINR) • Compute fishbone stability at high β, including circulating ion effects.

Fredrickson (PPPL) • Beam-driven MHD observed, including MHz modes & TAEs (~100 kHz). Mode frequency scales weakly with B & n_e. Many modes seen simultaneously

Gorelenkov (PPPL) • MHz modes in NSTX are CAEs, localized near plasma edge. Theory allows many modes at single m, sensitive dependence on f(v). May heat electrons locally.

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MHD Interactions with Energetic Particles (2)

NSTX

<u>Heidbrink (UC Irvine)</u>

- Do aspect ratio scaling of TAE gap structure by measuring TAEs in NSTX & DIII-D at same B, I_p. Check n scaling with ρ_{fast}/R.

<u>Fasoli (MIT)</u>

- Do Alfvén mode spectroscopy in NSTX with multi-turn coils inside vessel. May be able to implement “bucket transport” or otherwise affect fast ion distribution with applied wave.

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Energetic Particle Diagnostics (1)

NSTX

Medley (PPPL)

- NPA now working on fixed sightline (R_{tan}=70 cm). Drop in neutral flux seen at IRE & H-mode trans'n. Working on noise reduction & 2D scanning.

Roquemore (PPPL)

- Stored energy & neutron rises greater with NB source B than C; in accord with orbit loss model. Rise for A equal to B. IREs cause large (70%), irrecoverable drop in neutron rate.

Darrow (PPPL)

- Fast lost ion probe now working, no energy resolution. Sees loss ~10x smaller than expected. Yet, antenna thermocouples see ≥ expected loss.

Cecil (CSM)

- Propose use of multilayer thin foil Faraday cups to resolve energy & pitch angle distribution of lost fast ions.

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Energetic Particle Diagnostics (2)

NSTX

Krasilnikov (TRINITI)

- Use NDDs as NPA, fusion source profile, & beam ion loss diagnostic. NDDs are very compact & rugged.

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HHFW-fast ion interactions

NSTX

Rosenberg (PPPL)

- Use NPA, FLIP, neutrons, CHERS to look for ion heating & tail formation by HHFW. Also look for NB acceleration.

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Priorities

NSTX

Diagnostics:
1. NPA horizontal & vertical scanning
2. Energy & pitch angle resolving fast ion loss diagnostic
3. NDD NPAs
4. Alfvén spectroscopy system
5. Fusion source profile monitor

Modeling:
1. Accurate beam loss & power deposition model for TRANSP
2. LOCUST
3. COM-based beam loss
4. Collisional & ripple loss

Theory:
1. CAEs
2. Diffusion rate due to nonadiabaticity
3. MHD-induced fast ion transport
4. Fishbone stability in ST

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