NSTX

Supported by

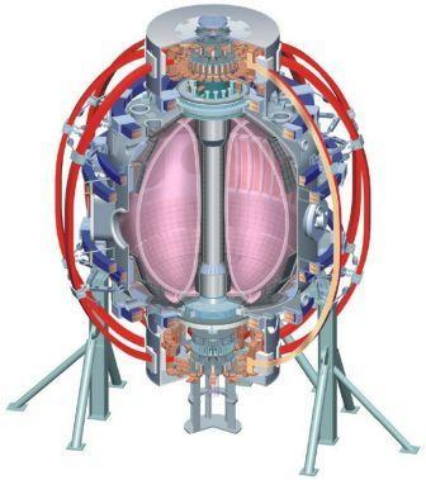
U.S. DEPARTMENT OF ENERGY | Office of Science

Simulation of microtearing turbulence in NSTX and scaling with collisionality

Walter Guttenfelder[1], J. Candy[2], S.M. Kaye[1], W.M. Nevins[3], E. Wang[3], R.E. Bell[1], B.P. LeBlanc[1], G.W. Hammett[1], D.R. Mikkelsen[1], H. Yuh[4]

[1]PPPL
[2]General Atomics
[3]LLNL
[4]Nova Photonics Inc.

College W&M
Colorado Sch Mines
Columbia U
CompX
General Atomics
INEL
Johns Hopkins U
LANL
LLNL
Lodestar
MIT
Nova Photonics
New York U
Old Dominion U
ORNL
PPPL
PSI
Princeton U
Purdue U
SNL
Think Tank, Inc.
UC Davis
UC Irvine
UCLA
UCSD
U Colorado
U Illinois
U Maryland
U Rochester
U Washington
U Wisconsin



Culham Sci Ctr
U St. Andrews
York U
Chubu U
Fukui U
Hiroshima U
Hyogo U
Kyoto U
Kyushu U
Kyushu Tokai U
NIFS
Niigata U
U Tokyo
JAEA
Hebrew U
Ioffe Inst
RRC Kurchatov Inst
TRINITI
KBSI
KAIST
POSTECH
ASIPP
ENEA, Frascati
CEA, Cadarache
IPP, Jülich
IPP, Garching
ASCR, Czech Rep
U Quebec

Simulation of microtearing turbulence in NSTX and scaling with collisionality

- Experimental motivation: favourable $\Omega_i \tau_{E,th} \sim \nu_*^{-0.95}$ dependence in NSTX
  - Cause of anomalous χ_e in high-β discharges unknown, scaling to future devices uncertain
  - Microtearing modes robustly unstable in high ν_* discharges (outer half-radius)
  - Linear stability scaling $\gamma_{lin} \sim \nu_e$ qualitatively consistent with experimental trend → motivates non-linear simulations using realistic experimental parameters

- First non-linear gyrokinetic microtearing simulations for an ST (PRL, 2011)

  New and unique physics
  - Simulations require relatively fine radial grid to resolve resonant current layers ($\Delta_j \sim 0.3\rho_s$)
  - Transport dominated (~98%) by magnetic flutter ($\delta B_r/B \sim 0.15\%$)
  - Perturbed field lines are globally stochastic ($w_{island} > \delta r_{rat}$), test particle stochastic transport model ($\chi_{st} \approx v_{Te} \cdot D_M$) agrees to within 25% of simulations

  Transport scaling relevant to experiment
  - **Predicted $\chi_{e,sim}/\chi_{GB} \sim \nu_{*e}^{1.1}$ close to experimental scaling**
  - "Stiff" with ∇T_e , instability threshold important (and non-linearly upshifted)
  - Suppressible by experimental levels of E×B shear

  Measurement opportunities
  - BES ($k_\theta \rho_s < 1$), high-k scattering (δn, $k_r >> k_\theta$), polarimetry (δB_r strong, broad & ballooning)
  - New data prior to APS (XP1164) would be great, but not critical to invited talk