NSTX-U

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Critical gradient model for fast-ion transport by Alfvén Eigenmodes (AE)

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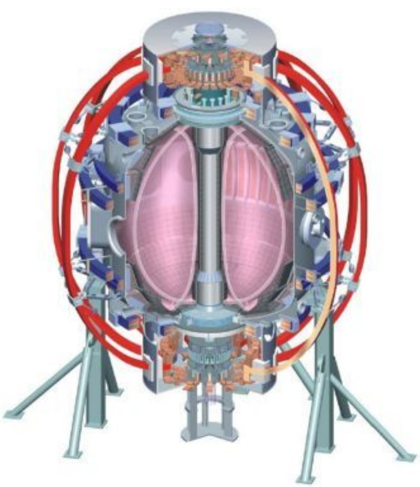
W. Heidbrink, E. Fredrickson, D. Liu, M. Podestà et al.

June 17, 2015



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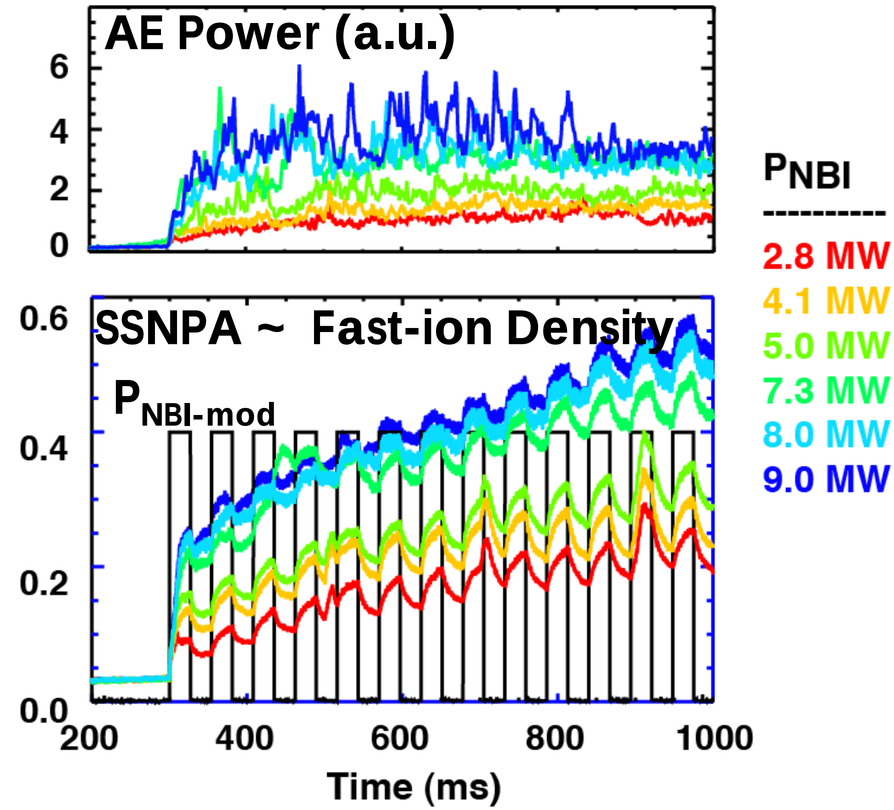
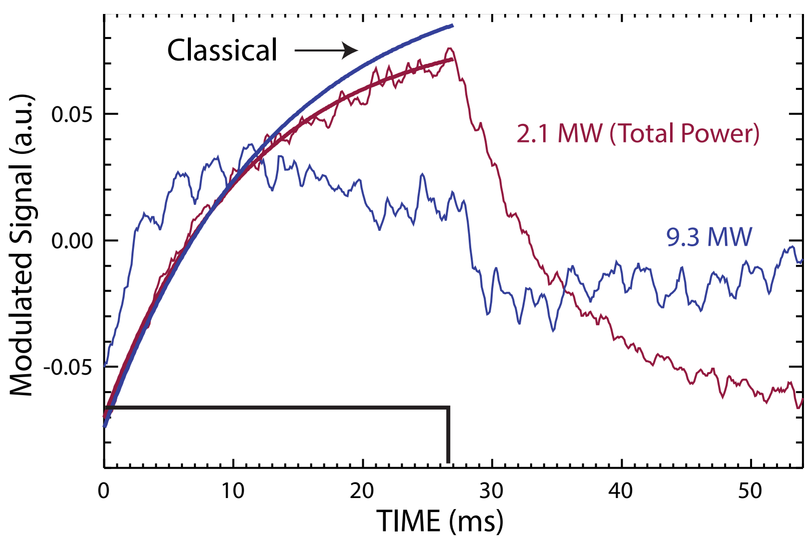
The experiment is inspired by a successful DIII-D experiment

- **Beam power scan varies AE amplitude**
- **Modulated off-axis beam allows measurement of incremental fast-ion flux**
- **Local fast-ion density ceases to rise above certain input power/ AE amplitudes**
  - SSNPA Neutral particle analyzer -> fast-ion density localized in phase space



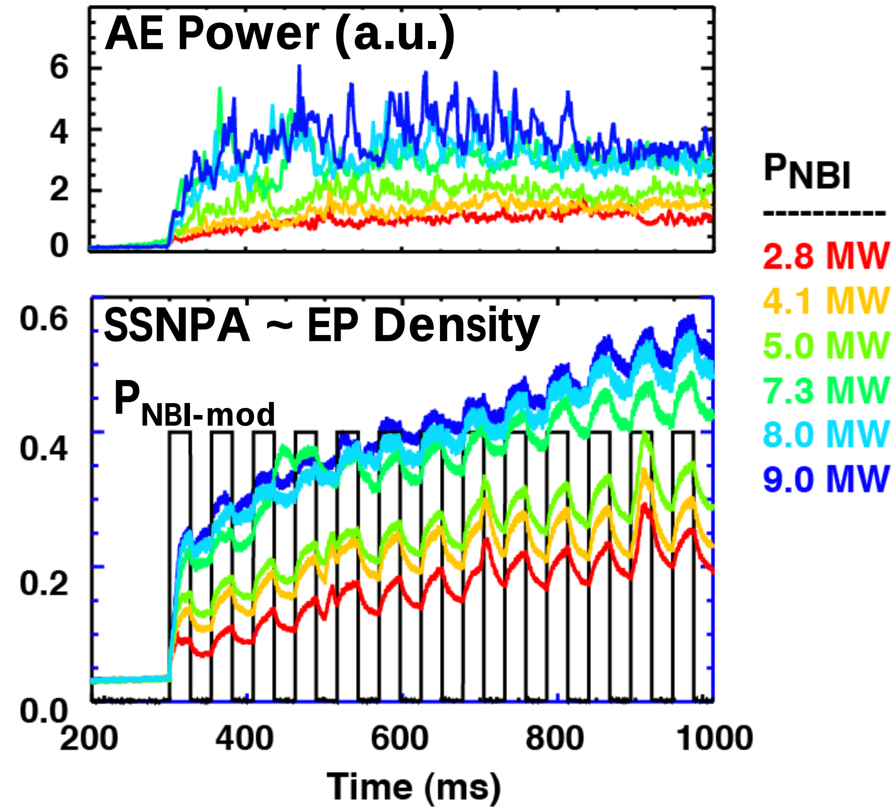


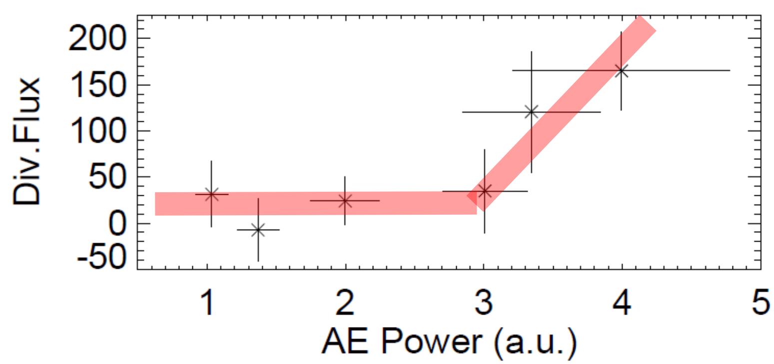
- **Conditionally average the modulated signal**
- **Above threshold, the signal is strongly distorted by transport.**

DIII-D NATIONAL FUSION FACILITY

Recent Data Supports Critical Gradient Model of Alfven Eigenmode (AE) Induced Fast Ion Transport

- **Beam power scan varied AE amplitude**
- **Modulated off-axis beam allowed measurement of EP pulse propagation and flux**
- **Local EP density ceases to rise above certain input power/ AE amplitudes**
  - SSNPA Neutral particle analyzer -> EP density localized in phase space
- **By fitting modulated waveforms, divergence of EP flux is obtained**
- **Divergence of flux shows abrupt change as AE power increases – *indicative of critical gradient behavior***





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Implementation on NSTX-U

Active Beam (for SSNPA & FIDA): On constantly, must be either Source 1A or 1B.

Modulated Beam: Not in SSNPA/FIDA sightlines → either 2A, 2B, or 2C

Plasma Reproducible density across power scan desired → H-mode

Fine Power Steps Run one or more beams at lowered voltage

Runplan

1. Baseline condition
   a) Power level #3
   - ◇ Good H-mode? (Adjust conditions)

   b) Try 1A/2B as low-power case
   - ◇ AEs? (Choose FIDA/SSNPA beam)
2. Complete power scan
3. Power scan with different modulated source
4. Finer power scan near threshold

Power Scan

1. 1B/2B
2. 1B/2B/2C
3. 1B/2B/1A
4. 1B/2B/1A/2C
5. 1B/2B/1A/2A
6. 1B/2B/1A/2A/2C
7. 1B/2B/1A/2A/1C
8. 1B/2B/1A/2A/1C/2C

Diagnostics

Fast ion

SSNPA, FIDA, neutrons, SLIP

Plasma

MSE, Thomson

AEs

Magnetics, reflectometer