High Frequency Electron Temperature Fluctuations in MST

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Abstract

High frequency electron temperature fluctuations are present in the plasma of tokamaks. In the past, measurements at low frequency (<0.5%) at frequencies of 100s of kHz, have shown that these fluctuations can be related to tearing mode structures. In this work, we report on the measurement of electron temperature fluctuations at frequencies above the tearing mode frequencies. A large ensemble of electron temperature fluctuations were measured in different ranges of the frequency spectrum, using the MST Thomson scattering diagnostic. From these measurements, we were able to determine the frequency spectrum of the fluctuations over a wide range of frequencies. This work is supported by the U.S. Department of Energy.

Motivation

- Correlated Electron Cyclotron Emission diagnostics can resolve temperature fluctuations in tokamaks with low noise (<0.5%) at frequencies of 100s of kHz, but correlated RFP plasmas prevent the use of such diagnostics.
- Previous studies with the Thomson scattering diagnostic on MST have mapped electron temperature fluctuations to tearing mode structures, but little is known about the high frequency behavior.

Outline

- Description of the Madison Symmetric Torus (MST) and the MST Thomson scattering diagnostic.
- Two-time point measurements:
  - Uncorrelated measurements at low frequency consistent with previous measurements of temperature fluctuations associated with dominant tearing modes.
  - Uncorrelated measurements at high frequency are surprisingly large.
- Future work:
  - Correlation with high m,n number magnetic modes.
  - Measurement of relative density fluctuations.

MST Thomson scattering setup

- Basic capabilities:
  - Electron temperature from 10 eV to 10 keV (not yet calibrated for absolute density).
  - 21 radial locations with 2 cm resolution.
- Multiple modes of operation:
  - 2 kHz continuous operation to 12.5 kHz pulse burst operation.

Summary

- Significant fluctuation amplitudes are observed at low frequencies (ΔTe ∼ 80 eV).
- Fluctuations in improved confinement plasmas are larger in absolute magnitude, but are approximately 15-19% relative to the average temperature, while in standard plasmas the relative fluctuations are approximately 20-30%.
- Consistent with previous results showing relative fluctuation amplitudes correlated with dominant tearing modes are lower in improved confinement plasmas.

Future work:

- Correlating high frequency temperature fluctuations with magnetic modes.
- Magnetic spectra show measurable power at frequencies above the tearing modes.
- Substantial scattering of power is present in both standard and improved confinement plasmas.
- Magnetic field monitors and Thomson data taken between sawteeth (t > 1.5 ms after crash).
- Future goals include correlation with high m,n number magnetic modes.