Magnetic fluctuation measurements in HSX and its impact on transport

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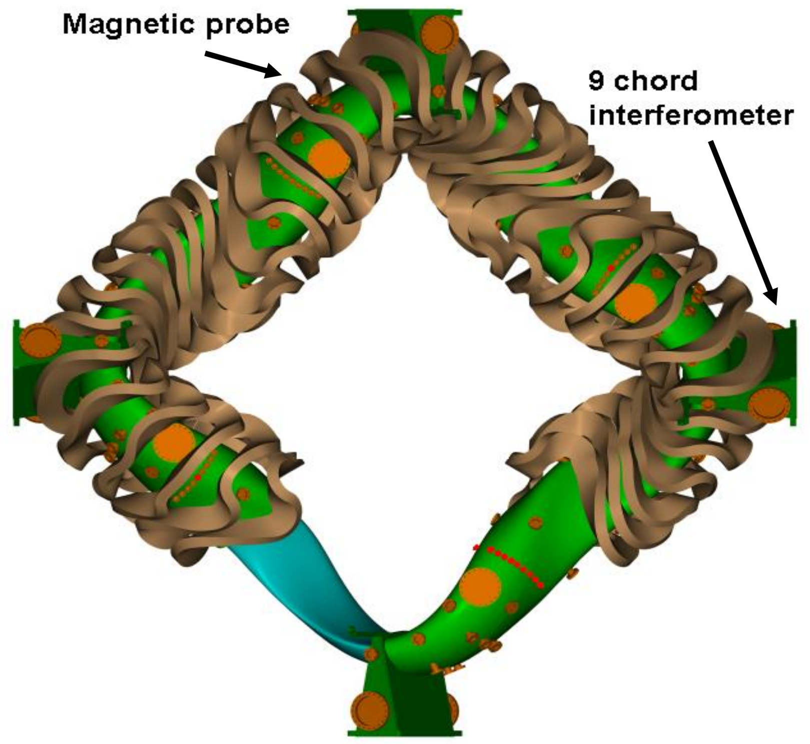
Overview

- **Magnetic Probe Experimental Setup**
  - Probe has 2 sets of 3 perpendicular components; perpendicular (poloidal), parallel (toroidal), and radial in HSX geometry.
  - Perpendicular component is 2 ~ 3 Gauss which is 20 ~ 100 times higher than the other two have.
- **In QHS mode operation, there exist 3 different magnetic fluctuations**
  - Broadband fluctuations have up to 200 kHz frequency limit.
  - Coherent magnetic oscillations have strong coherence with line averaged plasma electron density fluctuations, but have no impact on the plasma parameters.
  - Bursty fluctuations at low plasma density (less than 5.0 x 10^{11} cm^{-3}) have strong impact on the plasma parameters.
  - Two different regions of Coherent and Bursty fluctuation modes in plasma density vs ECRH location.
  - Coherent and Bursty fluctuations in QHS mode contain most of the magnetic fluctuation power.

Probe Design



Probe Design

•Effective area
- •8.4 cm^2 for parallel
- •6.6 cm^2 for perpendicular
- •11.5 cm^2 for radial

•Boron-Nitride housing as a particle shield.

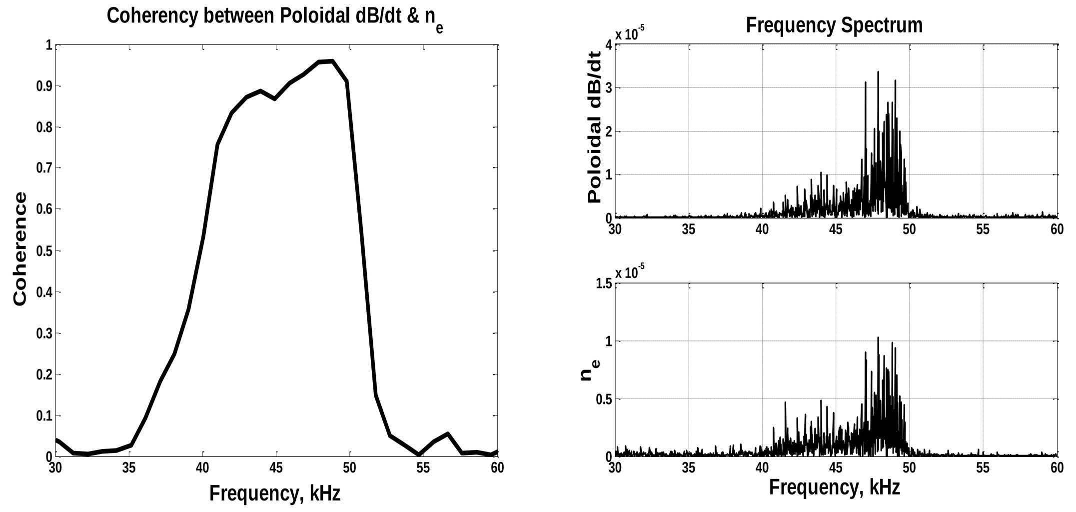
•This movable probe is currently located at the wall.

•High gain dB/dt amplifier with 250 kHz bandwidth.

Magnetic Fluctuations in QHS

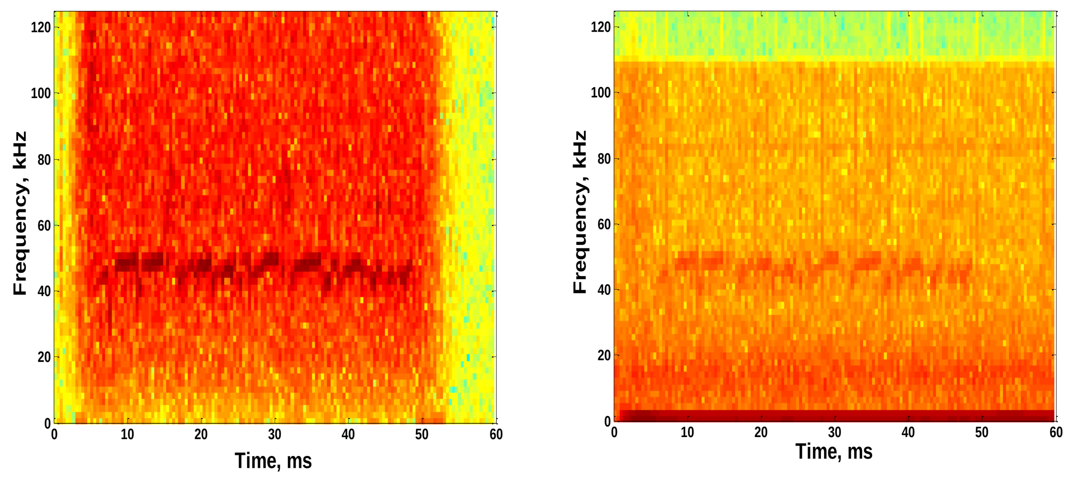
Coherence between dB/dt and n_e

•Plasma density range is 0.1 ~ 2.0 x 10^{12} cm^{-3}
•Frequency range is 40 ~ 120 kHz
•Coherence is 0.9 ~ 1.0



•Frequency vs time wavelet analysis demonstrates that dB/dt & n_e are strongly correlated.

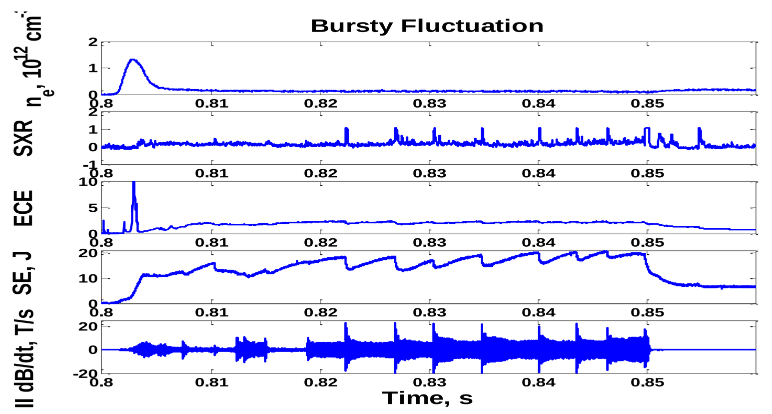
•Maybe related to GAE mode.



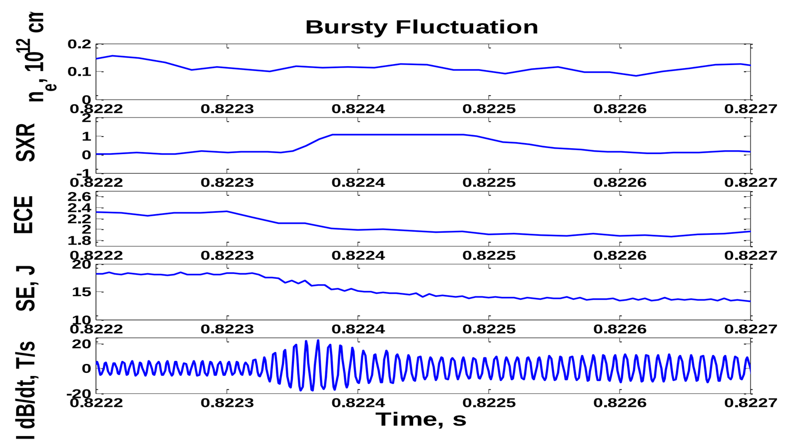
Bursty Fluctuations

•Plasma density range is less than 0.5 x 10^{12} cm^{-3}.

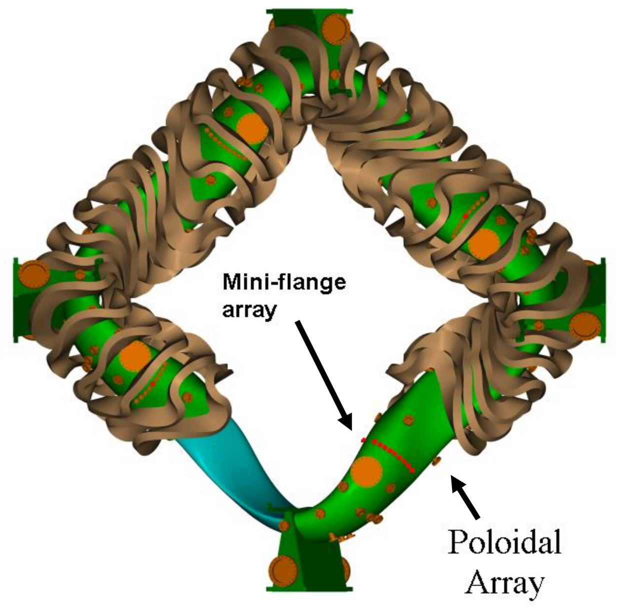
•Frequency range is 90 ~ 180 kHz.

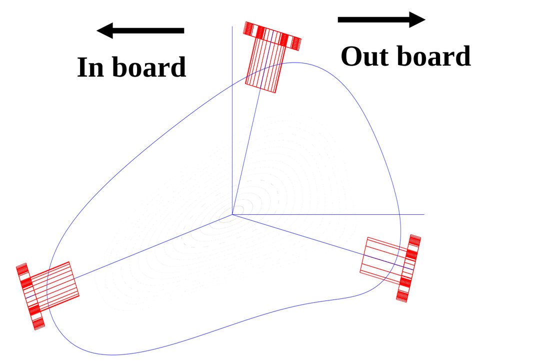


•Bursty fluctuations have large impact on the plasma parameters.
- •We observe large sawteeth like crashes in the stored energy and ECE.
- •Indicates that bursty oscillations maybe correlated to the super-thermal electrons.



m & n mode spectrum





•Using the results of coherent and bursty fluctuation measurements, 3 rotatable magnetic probes will be used to measure the poloidal mode spectrum up to m = 1.

•Poloidal mini flange arrays and toroidal edge arrays will be used to specify the higher m and n mode spectrum.

Conclusion & Future work

Summary

•Magnetic fluctuations consist of broadband, coherent, and bursty fluctuations.

•Coherent fluctuations are strongly correlated with the plasma density, and have no impact on the plasma parameters.

•Bursty fluctuations have significant impact on plasma parameters, such as stored energy measured by diamagnetic loop, ECE, and SXR.

Future work

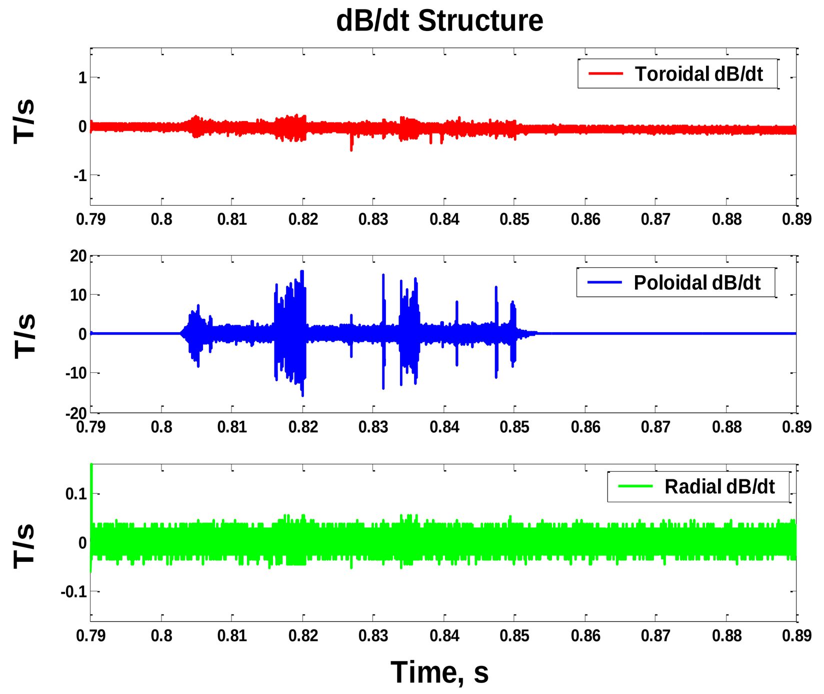
Measure magnetic fluctuations and their toroidal and poloidal mode spectrum.
- •Edge arrays of magnetic pickup coils to figure out the m & n mode structure of these coherent and bursty fluctuations.
- •Poloidal and toroidal arrays of magnetic probes are being built.
- •This will help to study the helical nature of the Pfirsh-Schluter current.

Insertable current probes to measure magnitude of Pfirsh-Schluter current.

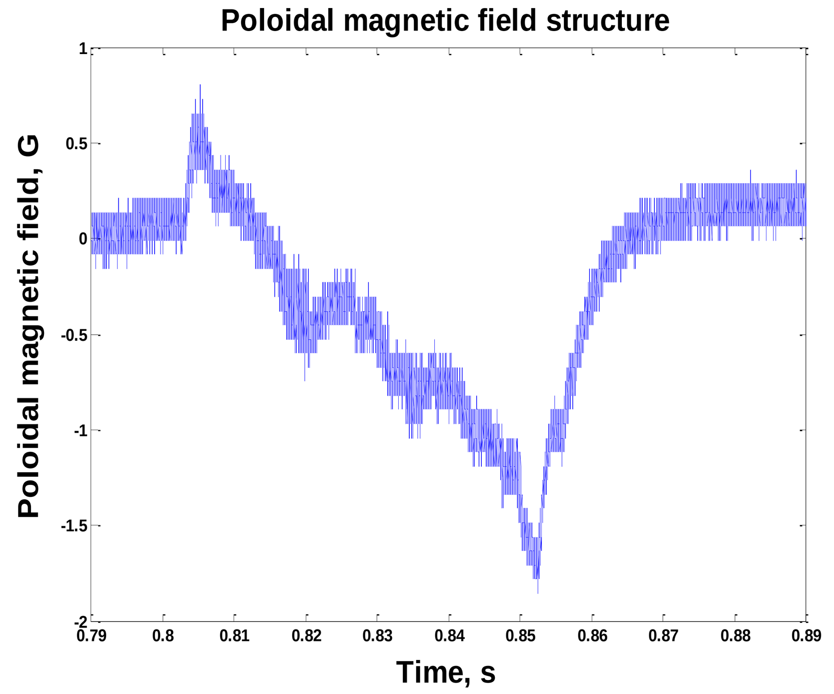
Correlate magnetic fluctuations with density & temperature fluctuations to understand the role that magnetic fluctuations play in particle, energy, and momentum transport.

Fluctuation Level

Perpendicular fluctuation level is 20 ~ 100 times higher than parallel and radial components are.

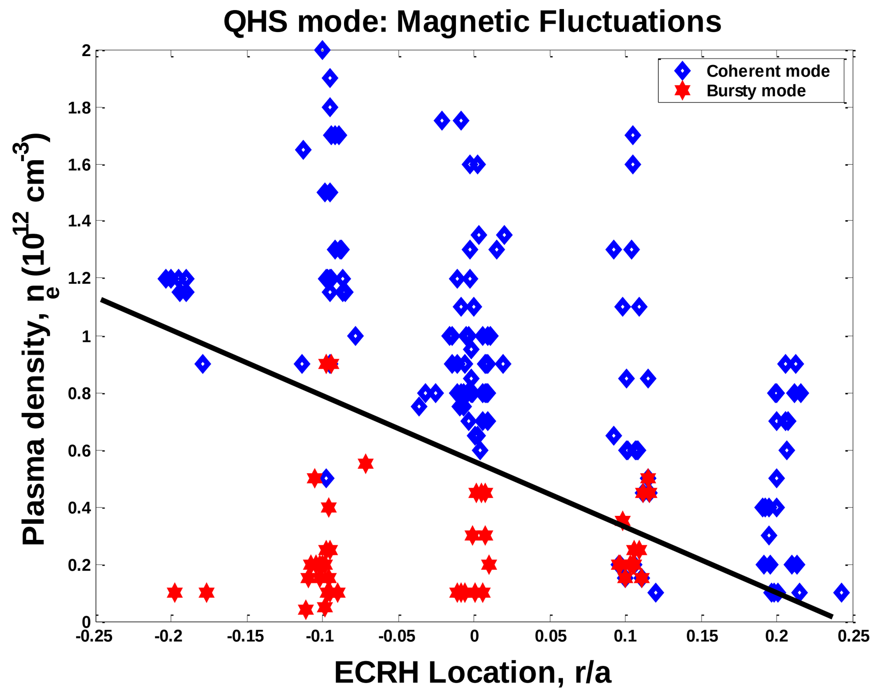


Poloidal magnetic field level is about 3 gauss.



Fluctuation Modes and Power in QHS

Fluctuations in QHS strongly depend on the plasma electron density and ECR Heating location.



Plasma density is 1.0 x 10^{11} cm^{-3}

Peak of the power is not at the plasma center.