FLUCTUATION STUDIES IN THE ALFVÉN WAVE RANGE OF FREQUENCIES IN THE TOKAPOLE II TOKAMAK

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Abstract (modified)

Fluctuation Studies in the Alfvèn wave range of frequencies in the Tokapole II Tokamak* M. A. LaPointe, R. N. Dexter, E. J. Haines, D Kortbawi, S. C. Prager, J. C. Sprott, University of Wisconsin - Madison -- Magnetic fluctuation measurements in the frequency range of 200 kHz to 8 Mhz have been made. There exists some enhanced fluctuation levels between 1.0 and 1.3 MHz for the $q < 1$ discharges. Radial profiles of the transverse fluctuation spectra are presented at low and high q for the frequency range from 500 kHz to 2.0 Mhz. The q dependance of the fluctuation levels is also presented.

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Purpose

Initial magnetic measurements were taken to determine the characteristics of the high frequency fluctuations in various plasma regimes. The questions to be addressed by this experiment consist of

1) Measure the turbulent fluctuations in the Alfvèn wave range of frequencies (500kHz < f < 5 MHz)

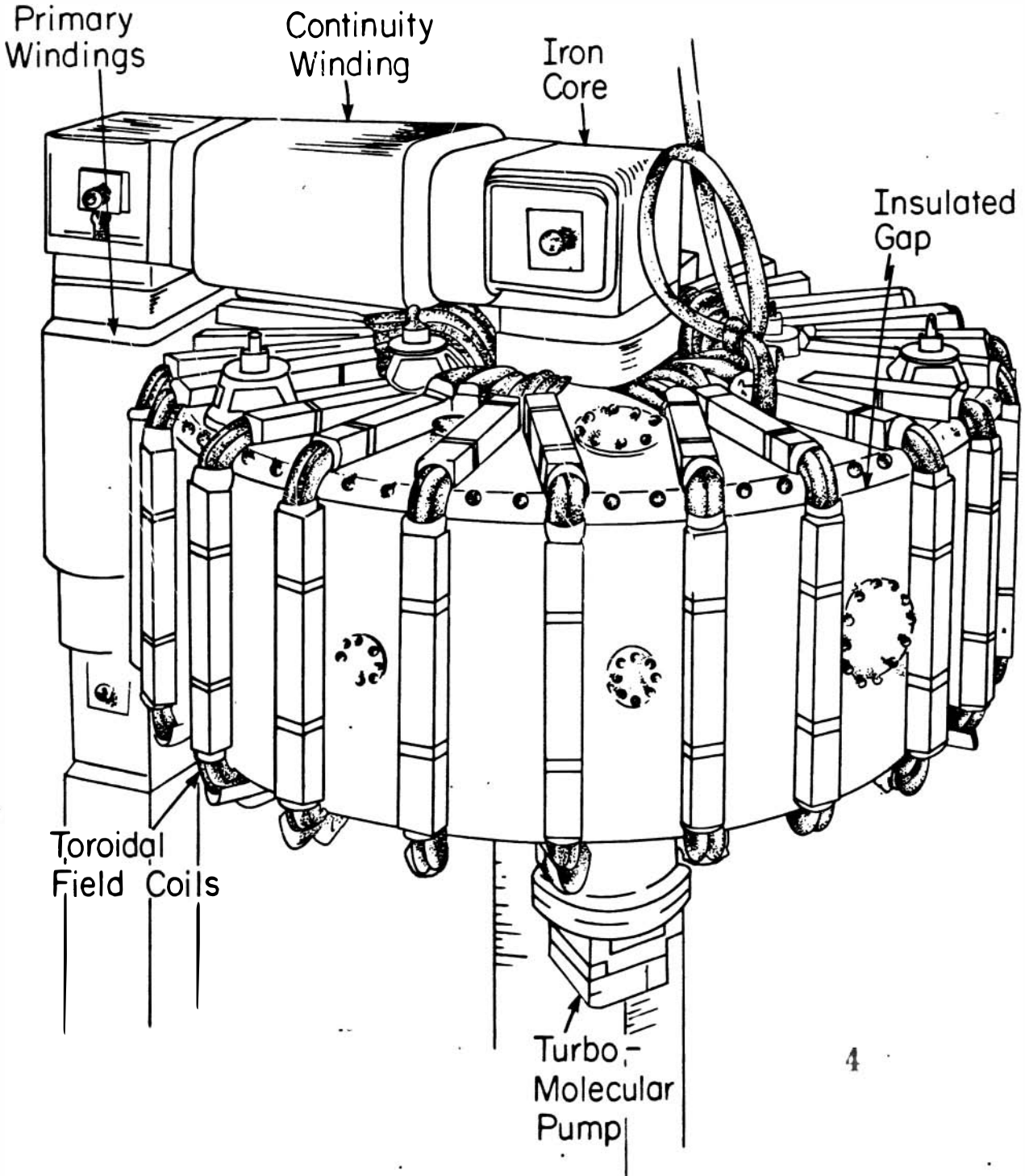
2) Compare the fluctuation characteristics at high frequencies with the low frequency results

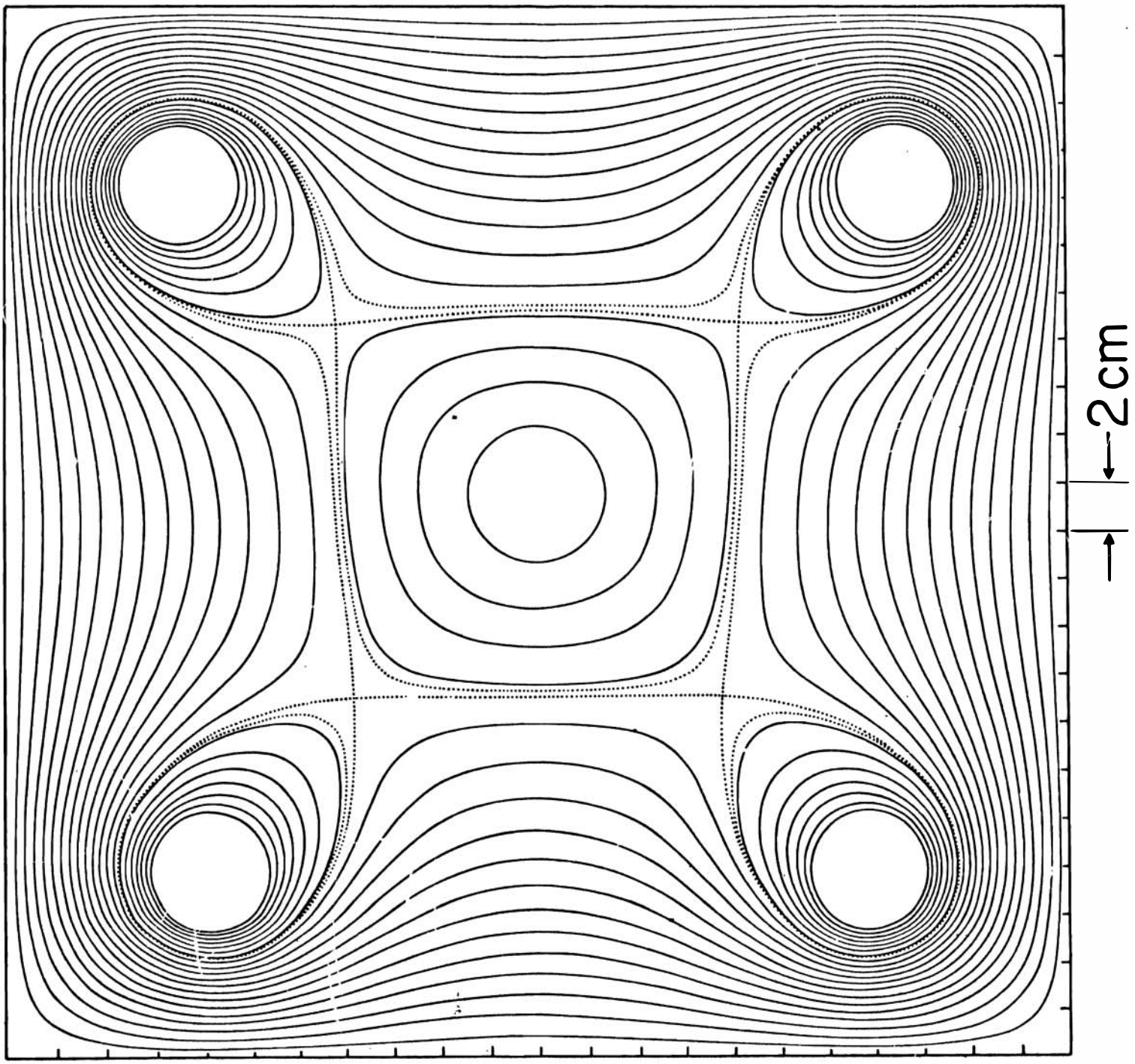
3) Examine features of the spontaneous Alfvèn wave spectrum

4) Compare results with calculations of the fluctuations due to thermal noise.

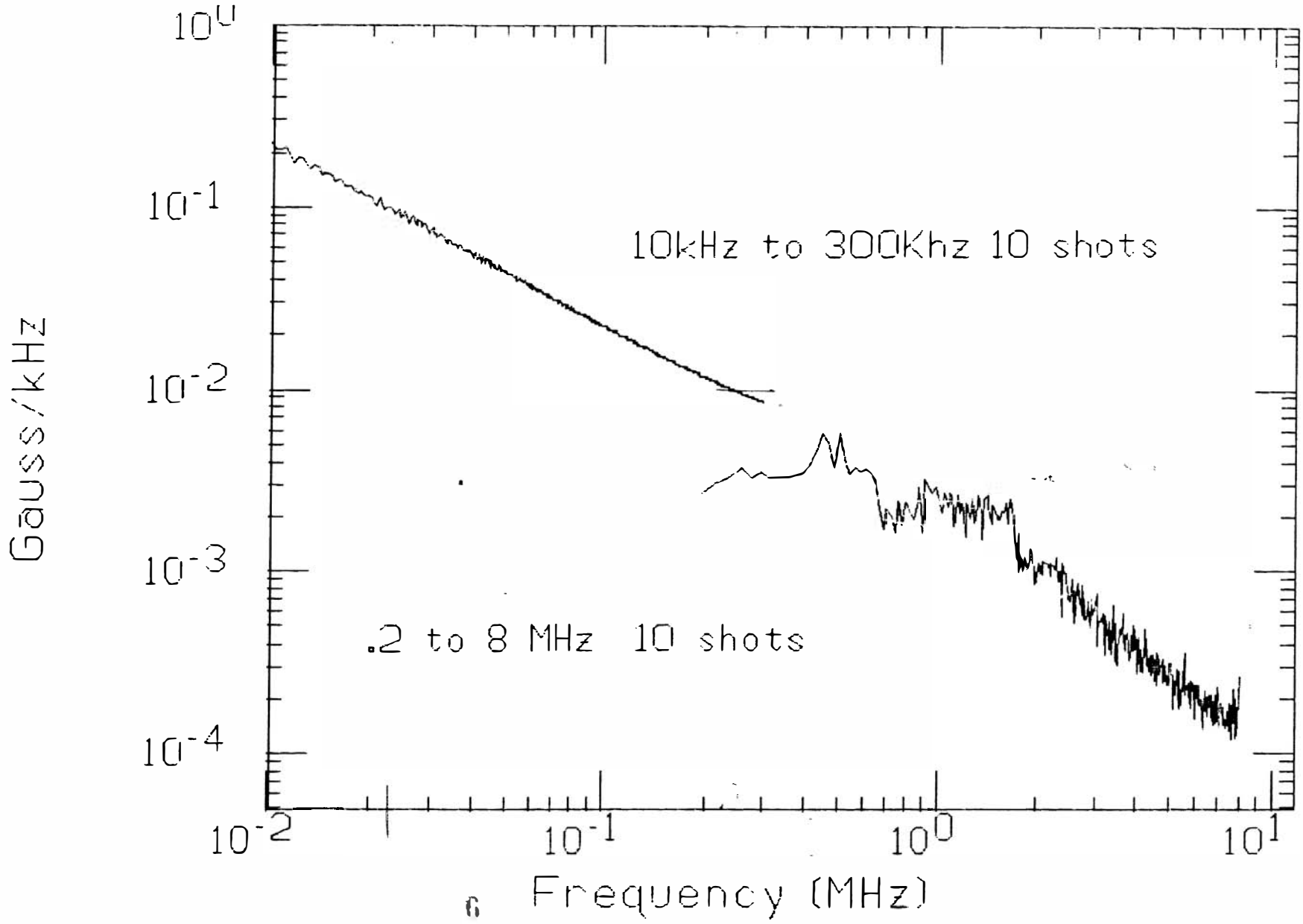
Tokapole II Parameters

Four node poloidal divertor	
Major radius	50 cm
Minor radius	8 - 10 cm typical
Toroidal field	2.5 - 5.5 kGauss
Plasma current	15 - 80 kAmps
Line averaged density	2 - 10 x 10^{12} cm^{-3}
Electron temperature	~ 100 ev
Ion temperature	~ 20 ev
Discharge length	3 - 7+ msec
Base vacuum	4 x 10^{-7} torr


Primary Windings
Continuity Winding
Iron Core
Insulated Gap
Toroidal Field Coils
Turbo-Molecular Pump

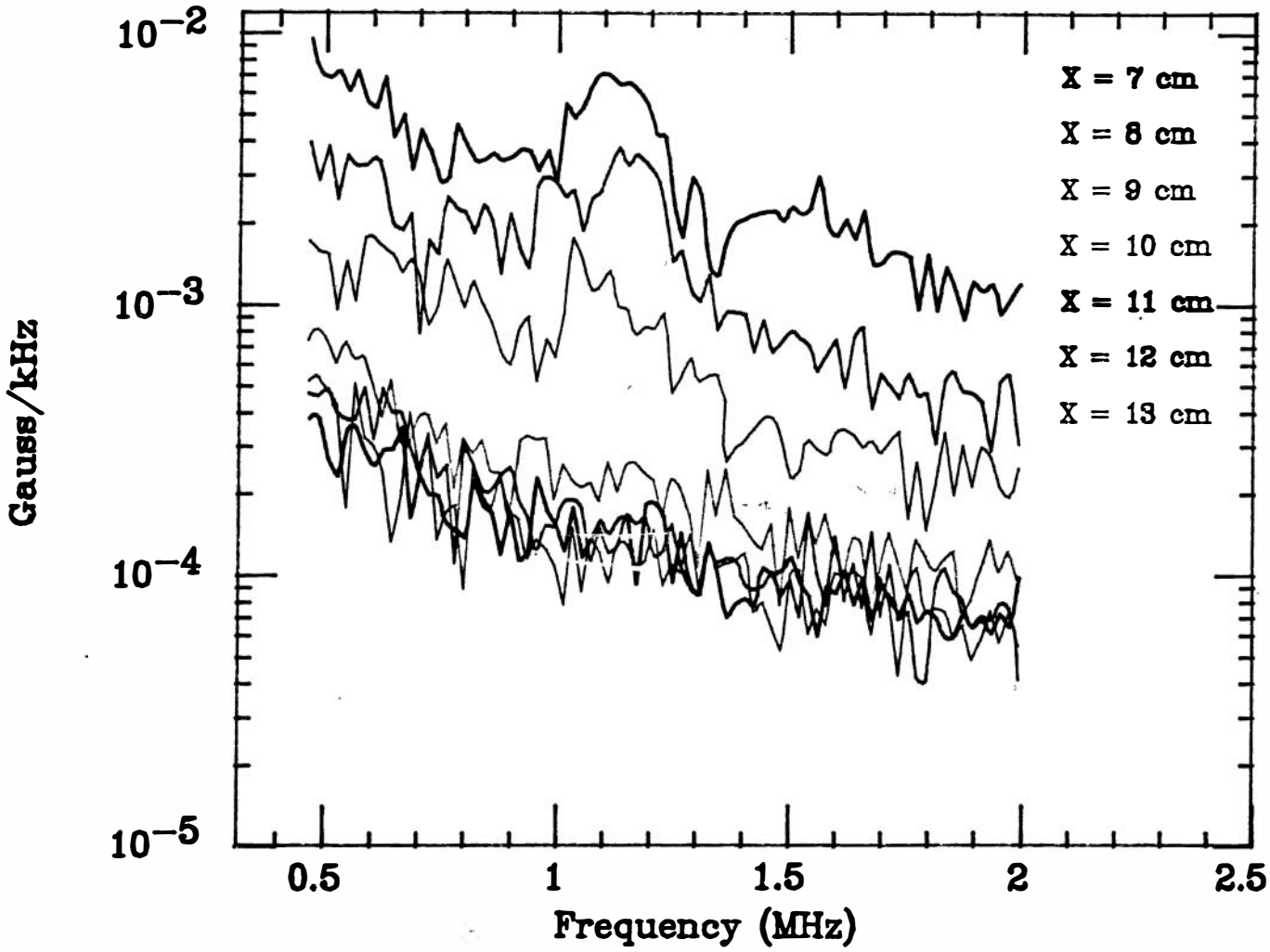

2cm

The fluctuation spectrum at the higher frequencies is a continuation from the low frequency results

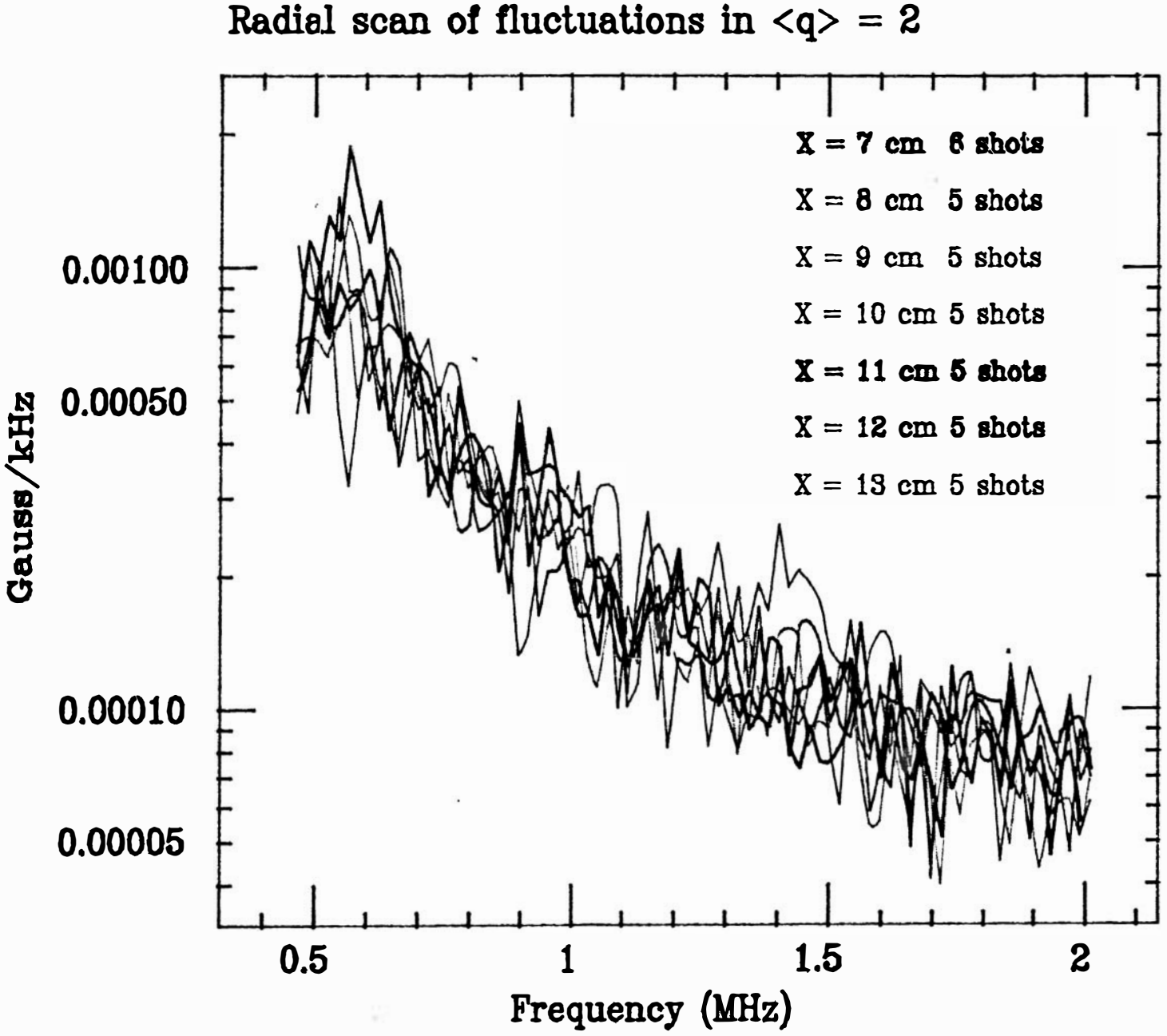


Calculations of the fluctuations due to the thermal noise in a plasma put an upper bound of $\tilde{B}/B \sim 10^{-7}$ on the fluctuation level (Z. Agim, poster 6S24, this conference). Measured fluctuation levels are larger those predicted by the thermal noise calculations for all cases studied to date.

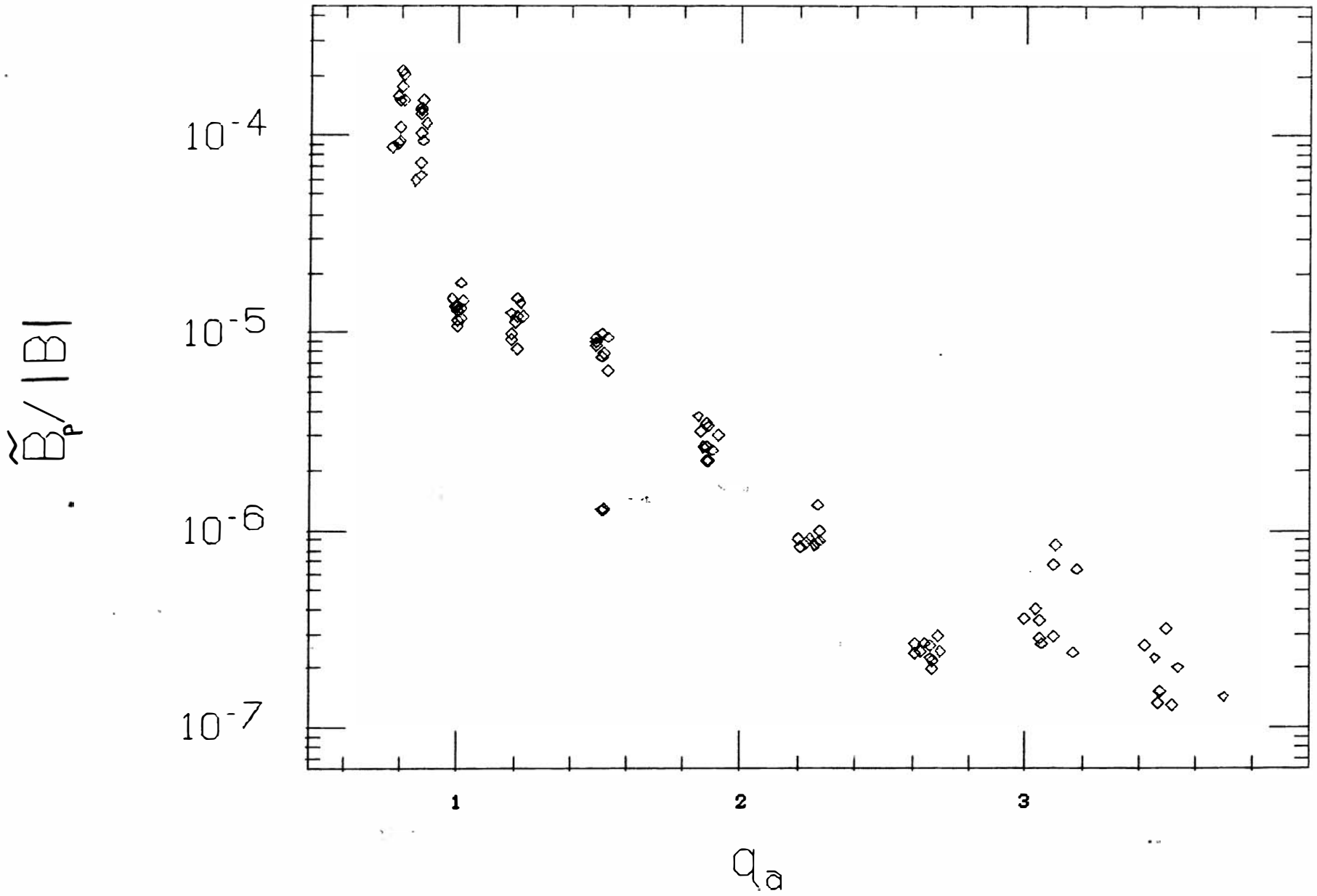
The poloidal fluctuations at low q (~0.7) in the frequency range of 500 kHz to 2 MHz have a radial profile that is peaked inside the separatrix. The fluctuation level has a 1/f frequency dependance.



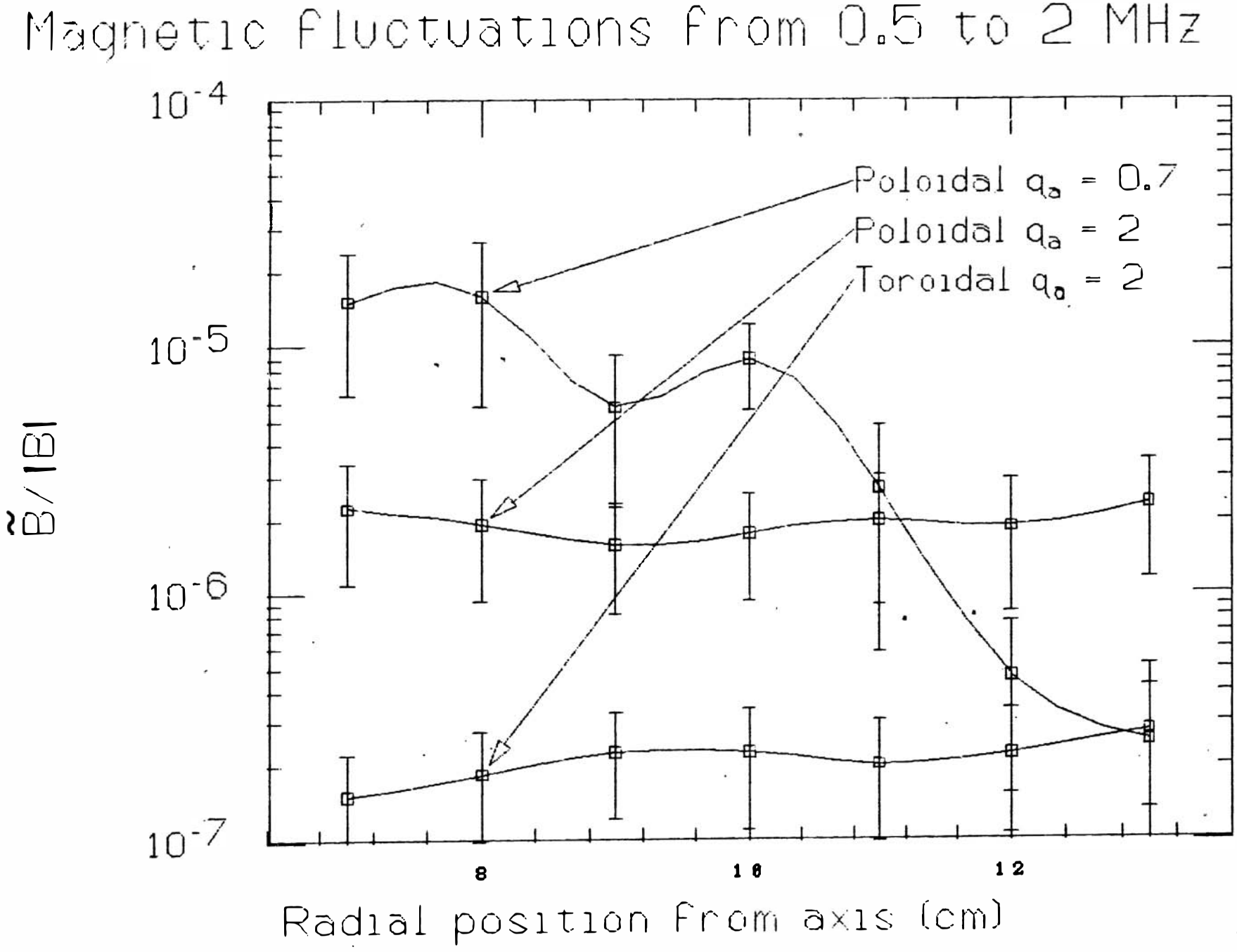
The poloidal fluctuations at high q (~2) in the frequency range of 500 kHz to 2 MHz show a relatively featureless radial profile. The fluctuation level is constant across the profile. The fluctuation level seems to have about a 1/f dependance at all radial positions.


Radial scan of fluctuations in <q> = 2
X = 7 cm 6 shots
X = 8 cm 5 shots
X = 9 cm 5 shots
X = 10 cm 5 shots
X = 11 cm 5 shots
X = 12 cm 5 shots
X = 13 cm 5 shots
0.00100
0.00050
0.00010
0.00005
Gauss/kHz
0.5
1
1.5
2
Frequency (MHz)

The total fluctuation level in the frequency range from 500 kHz to 2 MHz inside the separatrix (x=7 cm from axis) increases as the q is decreased.



At $q_a \sim 2$ the toroidal fluctuation level is an order of magnitude smaller than the poloidal fluctuations. The fluctuation level at $q_a \sim 0.7$ inside the separatrix is a factor of 5 to 10 larger than the poloidal fluctuations at $q_a \sim 2$. Outside the separatrix, the fluctuations at $q_a \sim 0.7$ fall off to a level below that of the $q_a \sim 2$.


Magnetic Fluctuations from 0.5 to 2 MHz
10^{-4}
10^{-5}
10^{-6}
10^{-7}
$\tilde{B}/|B|$
Poloidal q_a = 0.7
Poloidal q_a = 2
Toroidal q_a = 2
8
10
12
Radial position from axis (cm)

Summary

The high frequency fluctuations show similar characteristics to the low frequency fluctuations

$\tilde{B}_p$ and $\tilde{B}_t$ fluctuation levels for the high q_a (~2) plasmas are constant with radius.

$\tilde{B}_p$ fluctuations are about an order of magnitude greater than B_t fluctuations.

$\tilde{B}_p$ fluctuation levels in low q_a (~0.7) plasmas show profile that is peaked toward the center.

Flucuation levels in the range 500 kHz to 2 MHz increase by three orders of magnitude as the effective edge q is lowered from q_a ~3.5 to ~0.7.

All fluctuation levels measured are greater than those expected from thermal noise.

Future Work

Continue investigations of the fluctuation spectra in the higher frequency regimes at various q values

Investigate the radial fluctuation spectra at the various q values in the higher frequency range

Start correlation studies in these frequency regimes

Begin driven wave studies in this frequency range