Reflectometry measurements of turbulence in Alcator C-Mod plasmas

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Outline:

• Reflectometer
• Discharges
• Analysis
• Conclusions

45th APS-DPP conference, October 27-31, 2003
Albuquerque, New Mexico, USA
Reflectometer

Off-axis ICRF internal transport barrier (ITB).

Grey: MIT system (5 channels), light blue: PPPL system (2 channels).

Pellet enhanced performance (PEP) mode.

Grey: MIT system (5 channels), light blue: PPPL system (2 channels).

• Low frequency (50-110 GHz) system: Amplitude modulated, O-mode. The upper and lower sidebands are separately detected for the 88 GHz channel.
• High frequency (132-140 GHz) system: Dedicated fluctuation channels, have been brought into operation from May to July 2003.
Discharge waveforms

Li-pellet injection

Black: H-mode (1030709022)
Red: L-mode (1030709027)

\[ I_p \ \text{[MA]} \]

\[ 2.6 \times 10^{20} \ \text{n}_e \ \text{[m}^{-3}] \]

\[ P_{RF} \ \text{[MW]} \]

\[ D_\alpha \ \text{[a.u.]} \]

0.0 \hspace{2cm} 0.6

Time [s]
Thomson density profiles
Bremsstrahlung profiles

- Time resolution of profiles is 0.5 ms, spatial resolution is 1 mm.
- Pellet injection is from the low field side, close to the midplane.
- The Li-pellet has a size of 1/2 mm$^3$ and a velocity of 800 m/s.
- Detection of ablation cloud by high-speed gated CCD camera.
The 132 GHz signal disappears when the density decays below cutoff.
Cross correlations

Cross correlation between rms magnetic fluctuations and 132 GHz reflectometer band autopowers for the H-mode shot. Band resolution 50 kHz, time resolution 0.5 ms.

Cross correlation for the L-mode shot.

Positive (negative) time lag: Density fluctuations occur before (after) the magnetic fluctuations.
Conclusions

First turbulence measurements from two new high frequency reflectometer channels have been made in Alcator C-Mod.

We have studied two discharges where Li-pellets were injected:
• Density perturbation decays in roughly 15 ms.
• 132 GHz signals almost identical for the two shots: Core fluctuations low frequency compared to edge fluctuations.
• Correlations with magnetic fluctuations show that density and magnetic fluctuations are strongly (weakly) correlated for the shot initially in H- (L-) mode.

Future analysis and upgrades:
• Non-RF heated plasmas display a stronger density peaking and a slower decay, about 30 ms, in response to pellet injections.
• Correlation analysis will be extended to include phase-contrast imaging, D-alpha, correlations between reflectometry channels et cetera.
• Reflectometer will be upgraded to a 'pure' fluctuation diagnostic (removal of amplitude modulation).