Instabilities and Transport of Fast Ions on MAST (Topic: EX/P4-34)

S.E.Sharapov[1] *et al.*

[1]*CCFE, Culham Science Centre, Abingdon, UK;*

The final experimental campaign on MAST preceding MAST Upgrade operation resulted in a progress in physics and diagnostics issues:

- Fast ion re-distribution caused by beam-driven fishbones and causing a significant deficit in beam-plasma neutron yield was investigated in a series of MAST discharges with varying density and NBI power. It was found that amplitude of fishbone perturbations decreases at higher density/ low NBI power and access to an MHD quiescent domain with classical fast ion transport is found above a critical density;
- The effect of bursting frequency-sweeping TAEs at the early current ramp-up phase of the discharges was found to cause a re-distribution of the beam ions with effective diffusion estimated as D_{an}~2.5 m^2s^{-1} (found from matching the measured and TRANSP neutron yields);
- A prototype proton detector measuring 3 MeV protons and 1 MeV tritons born in DD fusion was successfully tested on MAST. Proton rates of up to 200 kHz were recorded, and measurements were made of the fusion profiles before and after sawtooth crashes;
- Beam-driven Alfvén cyclotron instabilities were studied in MAST plasmas consisting of two ion species, deuterium and hydrogen. It was found that at increasing H/D concentration CAEs are suppressed as Figs1-3 show. The suppression effect on CAE is especially strong (CAE disappear) in the frequency range, $\omega_{BD} \leq \omega \leq \omega_{BH}$, where the ion-ion hybrid resonance provide a strong damping.

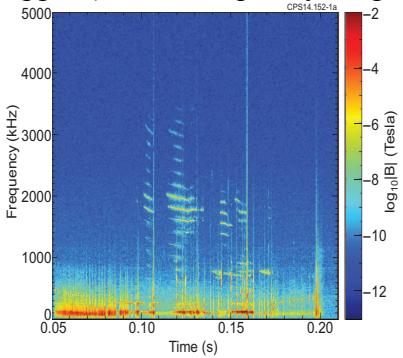

***Figure 1**. Beam-driven ACI observed in pure D plasma (MAST #30457).*

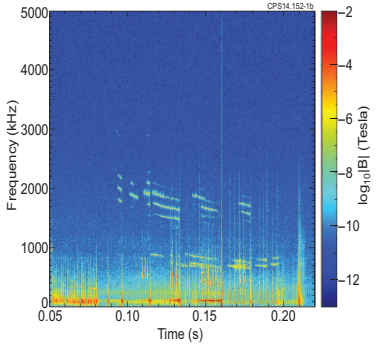

***Figure 2.** Beam-driven ACI observed in discharge with 60 ms H puff giving $n_H/n_D \approx 33\%$ (MAST discharge #30464).*

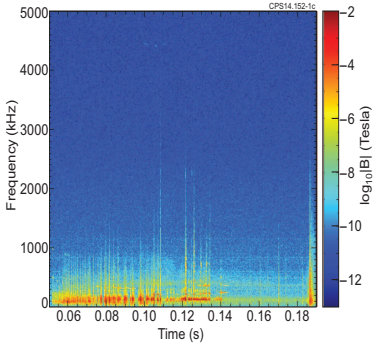

***Figure 3.** ACI are suppressed in discharge with longest H puff giving $n_H/n_D \approx$ 60-80 % (#30471).*

- Effect of RMP on beam losses was investigated using the orbit-following codes LOCUST. A significant increase in beam power loss was found for a single null MAST plasma equilibrium, from (5-10)% in the axisymmetric limit to as much as 50% when RMPs are applied.