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Study of the fast-ion acceleration by beam-driven wave in C-2W

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In past C-2U experiments, a beam-driven wave was observed to accelerate a tail population of thermal ions [1]. The resulting D-D fusion rate was dramatically enhanced compared to the thermonuclear rate. Since this process transfers beam energy directly to thermal ions, bypassing the electron channel and related loss mechanisms, it would be beneficial to harness this process in a reactor.

The C-2W device has achieved higher plasma parameters than its predecessor (pressure, stored energy) [2]. In experiments with mixed hydrogen and deuterium beam injection, a neutral particle analyzer (NPA) [3] has observed acceleration of beam-injected deuterons well beyond the neutral beam (NB) energy. The effective temperature of the fast deuterium ion tail is strongly dependent on the amplitude of an $n = 2$ bursting mode, suggesting that the deuterons are accelerated by the beam-driven wave. Focusing on a single burst by the conditional averaging technique, it was revealed that the fast deuterium ions increase during the burst. The next burst occurred before the fast deuterium ions decayed, thus sustaining a high fast ion tail effective temperature.

A recent machine configuration change in which the beam injection angle relative to the machine axis was decreased has created the opportunity to study the effect of injection angle on the acceleration process and to elucidate the resonance condition(s) of the wave-particle interaction. The wave-particle interactions of the two different fast ion populations were analyzed. These data can guide reduced models for the fast ion acceleration process.

References

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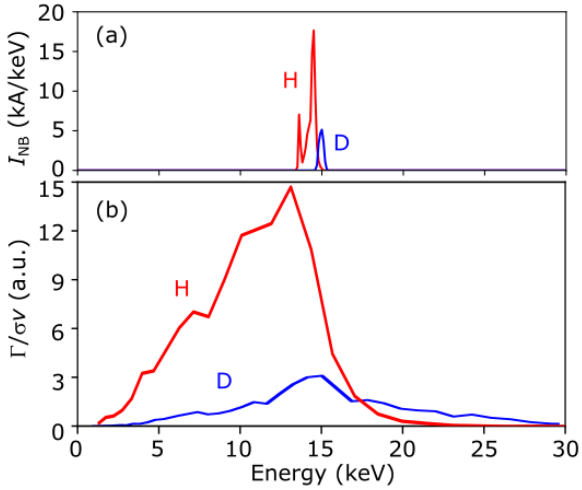

Figure 1: Energy spectra of the (a) current of the injection NBs and (b) energetic particle flux observed by NPA.