Fast ion physics in the C-2U beam driven FRC

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In the C-2U experiment, a high beta field-reversed configuration (FRC) plasma with closed flux surfaces is embedded in a low beta, open-field line magnetic mirror plasma. Fast ions born from tangential neutral beam injection execute betatron-like orbits, sampling both regions of plasma as they orbit the magnetic axis. These large orbit particles sustain[1] and stabilize[2] the plasma and suppress turbulence.

Experimental evidence indicates that the fast ions in the FRC slow down classically via collisions with electrons. These fast ions accumulate in the core as they slow and exert a pressure on the mirror plasma comparable to the thermal plasma.

Measurements of magnetic fluctuations at the edge of the plasma, however, reveal the presence of multiple beam driven modes, indicating a non-classical interaction between the beam and the open field line plasma. These modes include a low frequency chirping mode, an Ion Bernstein-like mode, and a high frequency, compressional Alfven mode. Remarkably, none of these modes are observed to have a deleterious effect on global plasma confinement. In fact, the Bernstein mode has the beneficial effect of dramatically enhancing the DD fusion reaction rate by drawing a trail from the plasma ion energy distribution.

In this presentation, we experimentally characterize the fast ions in the C-2U FRC with data from multiple diagnostics including magnetics, spectroscopy, neutral particle analyzers and fusion product diagnostics. Results are compared to a particle-in-cell simulation in a simplified geometry.

[1] M. W. Binderbauer *et al*., AIP Conference Proceedings **1721**, 030003 (2016).
[2] M. Tuszewski *et al*., Phys. Rev. Lett **108**, 255008 (2012).