Fast Ion Transport Studies in the Large Plasma Device*

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The LArge Plasma Device (LAPD) at UCLA is an 18-m long linear device that produces highly reproducible ~10-ms duration plasmas with $n_e>10^{12}$ cm^{-3}, $T_e>1$ eV, and B~1 kG every second. Its large size and excellent diagnostic access accommodate detailed studies of fast-ion physics at reduced parameters. The first fast-ion experiments were conducted with a modified 100-1000 eV argon processing source that was inserted into the plasma.[1] Measurements of fast-ion transport are performed with a ~300 eV ribbon beam in the quiet afterglow plasma.[2] The parallel energy of the beam is measured by a two-grid energy analyzer at two axial locations (z = 0.32 m and z =6.4 m) from the ion gun. The calculated ion beam slowing-down time is consistent to within 10% with the prediction of classical Coulomb collision theory. To measure cross-field transport, the beam is launched at 15° with respect to the magnetic field. The beam "spot" is periodically focused by the magnetic field due to geometrical effects. Radial beam profile measurements are performed at different axial locations where the ion beam is periodically focused. The measured cross-field transport is in agreement to within 15% with analytical classical collision theory and the solution to the Fokker-Planck kinetic equation. Collisions with neutrals have a negligible effect on the beam transport but do attenuate the beam current. In a preliminary study of the effect of fluctuations on fast-ion transport, a biased disk with the same diameter as the helical fast-ion orbit is inserted into the plasma; initial results indicate that large fluctuations affect the fast-ion transport. To study fast ion interaction with shear Alfven waves,[3] a lithium source that emits ~1 mA of Li^+ ions up to ~3000 eV was developed. With this source, the speed of the fast ions can match the parallel phase speed of the ~10 G Alfven waves that are launched by loop antennas; the $\omega - k_z v_z = \Omega$ cyclotron resonance is also accessible. Calculations indicate that resonant fast ions will experience measurable deflections in upcoming experiments.

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1 H. Boehmer *et al.,* Rev. Sci. Instrum. **75** (2004) 1013.
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