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Ion Runaway Due to Magnetic Reconnection in the MST RFP
J.A. REUSCH, J.K. ANDERSON, W. CAPECCHI, S. EILERMAN, J. KIM, J.J. KOLINER, M.D. NORNBERG, UW - Madison, Y. TSIDULKO, BINP - Novosibirsk, Russia — Non-collisional heating and energization of ions is a powerful process in reversed-field pinch plasmas and in many astrophysical settings. The energization mechanism is connected to magnetic reconnection, but it is still not well understood. Neutral beam injection in MST reveals ion runaway could be important to this energization process. During reconnection events (i.e. sawteeth), measurements of the fast ion distribution using a neutral particle analyzer show substantial energy gain. This is due to a large, transient inductive electric field that overwhelms friction forces on the ions, allowing unrestricted acceleration during the sawtooth ($\sim 200\mu$s). The energy gain is larger for higher initial ion energy, and deceleration is observed with reversed electric field (counter-current injection). Full orbit test particle tracing in the 3D time evolving **E** and **B** fields from visco-resistive MHD simulations of sawteeth in MST shows that beam ions are well confined and experience parallel acceleration during the sawtooth, despite the presence of magnetic stochasticity from a broad spectrum of large-amplitude tearing modes. While parallel runaway energization affects fast ions, it cannot explain the dominantly perpendicular heating observed in the bulk majority and impurity ions. However, transport and pitch-angle scattering are likely important processes that may weakly affect the relatively high-energy NBI ions. This work supported by the US DOE and the NSF.

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