Measurements of global and localized ion heating during impulsive reconnection in MST

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In the MST reversed field pinch, impulsive reconnection occurs at (a) sawtooth crashes in standard plasmas, in which many large tearing modes are present, and (b) bursts of edge-resonant tearing modes with poloidal mode number $m = 0$ in enhanced confinement plasmas. In both cases, magnetic energy decreases while ion thermal energy increases. Fast, localized measurements of the impurity ion temperature ($T_i$) are made using charge exchange recombination spectroscopy. Ion heating is observed to be limited to the outer half of the plasma for an $m = 0$ burst, and is strongest near the $m = 0$ resonant surface. Conversely, ion heating occurs at all radii during a sawtooth crash, as $T_i$ more than doubles over $\sim 100 \, \mu s$. The results suggest that ions are heated primarily near the reconnection layer, and that global heating during a crash arises from activity at multiple reconnection sites throughout the plasma. Both the heating profile and degree of heating during a crash vary strongly with plasma current, density, the reversal parameter, and ion species. At high plasma current (0.5 MA), the large $T_i$ (> 1 keV on-axis) generated during a crash can be sustained by reduction of magnetic fluctuations using auxiliary current drive. Work supported by U.S.D.O.E. and N.S.F.

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