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Improved confinement at high current in the MST RFP[1]

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Inductive current profile control has proven to be a robust means of reducing global magnetic tearing fluctuations and improving both particle and energy confinement in MST and other reversed-field pinches. The improved confinement has been maintained as these studies have been extended to higher plasma current. The electron stored energy in these plasmas increases with current; electron temperature increases from 0.6 keV to 2 keV as current increases from 0.2 MA to 0.5 MA. This is the largest T_e yet achieved in the ohmically-heated RFP and is achieved in addition to measurements of sustained 1 keV ion temperatures, indicating that ion confinement is also improved. The global energy confinement time in these plasmas is about 12 ms, a modest improvement over the 10 ms confinement time at low current. The corresponding global thermal diffusivity ($a^2/4\tau_E$) is about 5 m^2/s. Measurement of the x-ray spectrum from 2 keV to 100 keV, combined with Fokker-Planck analysis, indicates that energetic electrons are well-confined in these high current plasmas, with a velocity-independent diffusion coefficient which is inconsistent with transport by magnetic fluctuations. Thus, with current profile control we obtain favorable confinement of thermal electrons, thermal ions, and energetic electrons at 0.5 MA. Past results indicate that energetic ions (produced by neutral beam injection) are also well-confined. The improved confinement at high current occurs simultaneously with a plasma beta (volume-average pressure/surface-average magnetic pressure) of 10%. This is less than the peak beta of 26% achieved in low-current pellet-fueled MST plasmas, but beta is power-limited in these higher temperature, lower density plasmas.

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