Control of sawtooth oscillation dynamics using externally applied stellarator transform

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The control of sawtooth oscillations is an active area of tokamak research. Large sawtooth oscillations need to be avoided in ITER, since these large sawteeth couple to neoclassical tearing modes and edge localized modes resulting in serious confinement degradation. Small sawtooth oscillations, however, may be beneficial in preventing impurity and helium ash accumulation in the center of the plasma.[1] Sawtooth oscillations are observed in the Compact Toroidal Hybrid (CTH), a current-carrying stellarator/tokamak hybrid device. CTH has the unique ability to change the relative amount of vacuum transform from stellarator coils to that generated by plasma current to change sawtooth oscillation dynamics. The fractional transform, defined as the ratio of imposed vacuum transform to the total transform was systematically varied from 0.04 to 0.43 to observe changes in CTH sawtooth oscillation behavior. We observe that the normalized inversion surface radius is proportional to the total transform as is found in tokamaks.[2] We also observe that the measured sawtooth period and amplitude decrease with increasing levels of 3D field, as quantified by the amount of vacuum transform imposed. In tokamaks, decrease in the observed sawtooth period has been attributed to a decrease in core electron temperature.[3] The decrease in sawtooth period observed on CTH appears to have no associated decrease in core electron temperature. Finally, the measured crash time of the sawtooth oscillation is independent of the amount of vacuum transform applied, indicating that the final reconnection dynamics of the $m = 1$ and $n = 1$ mode are not significantly affected by the 3D stellarator fields.

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