"Large-volume flux closure during forced and spontaneous magnetic reconnection in simulations of Coaxial Helicity Injection in NSTX-U"

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The issue you propose to cover and why it is important

- Solenoid free non-inductive techniques to form a startup plasma enable lower aspect ratio configurations and simplify tokamak design.
- In NSTX-U, transient CHI is the primary method for current generation without reliance on the solenoid.
- To correctly model current generation and to better understand the physics of CHI start-up, comprehensive resistive MHD NIMROD simulations have been conducted for the NSTX and NSTX-U geometries.
- Understanding the physics of magnetic reconnection during CHI is of great importance for the viability of this concept, therefore realistic MHD simulations by including all the MHD time-scales scales are critical.

The data that is relevant to the issue

We report two new major findings from these CHI simulations:

1. formation of an elongated Sweet Parker (S-P) current sheet and a transition to plasmoid instability has for the first time been demonstrated by simulations of CHI experiments [1]
2. first documentation of plasmoid formation in a laboratory (NSTX) predicted by realistic MHD simulations [1].
3. a large-volume flux closure, and large fraction conversion of injected open flux to closed flux in the NSTX-U geometry have also now been demonstrated for the first time [2].

The explanation of the data

1. As a result of the improved location of injector flux and shaping coils in NSTX-U, which allow a better shaping of the initial flux and attainment of narrower injector-flux footprints, major improvements and differences are elucidated in the NSTX-U simulations [2]:
2. The volume of flux closure is large and nearly all of the CHI-generated current is closed-flux current.
3. Simulations show that reconnection could occur at every stage of the helicity injection, but the final resulting state is a large volume of closed flux surfaces at equilibrium with a large CHI generated current.

"The results from all this work is summarized in these two recent papers"

References:

[1] F. Ebrahimi, R. Raman, Physical Review Letters **114**, 205003 (2015).
[2] F. Ebrahimi, et al. Nuclear Fusion Letters **56,** 044002 (2016).