7th Asia-Pacific Conference on Plasma Physics, 12-17 Nov, 2023 at Port Messe Nagoya

# Multiple Blob Formation in Current Sheet of Merging Tokamak Plasmas

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Multiple plasmoid-like structures were observed at the current sheet of merging plasma rings during the merging experiment in TS-6 spherical tokamak using high-resolution print circuit board (PCB) type magnetic probe array[1] and ion Doppler tomography spectroscopic system[2] with spatial resolution of 5 mm and 10 mm in radial direction (less than Ar ion Larmor radius), respectively. In this report, we discuss the multiple plasmoids/ blobs are classified into three types: (1) the central blob (O-point) often with closed flux, (2) the downstream blobs sometimes transformed into magnetic island and (3) current sheet blobs without closed flux which are formed by deformed magnetic field lines.

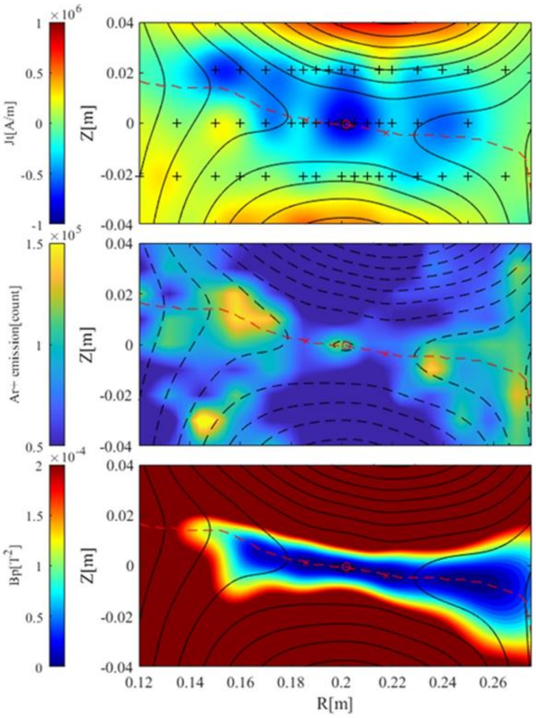


Figure 1. Poloidal flux contours along with (a) toroidal current density, (b) Ar+ emission, and (c) poroidal magnetic field $B_p^2$ at the plasmoid formation moment.

Using the magnetic field measurements, we observed a phenomenon called current sheet blobs, wherein the current sheet divides into multiple distinct blobs. The long current sheet is tilted by the Hall effect under strong guiding magnetic field. The blob arrangement corresponds with the distribution of Ar II emission detected on the poloidal plane that opposes the position of the magnetic field measurement. This alignment implies that the blob structure is approximately axisymmetric over at least half of the toroidal circumference. We found that central one of the multiple blobs often have closed magnetic surfaces (magnetic islands), while others are initially localized current blobs without closed flux. The central current sheet blob is formed by the inflow flux larger than the outflow flux. This plasma pileup forms a peaked pressure profile, often forming a closed flux. In the downstream, the reconnection outflow dumps, forming a fast shock-like structure as well as the current density peaks without closed flux. However, the strong plasma pile-up effect often transforms the current sheet blob into another magnetic island. On the other hand, the Hall effect forms bending magnetic field lines, forming current sheet blobs in the peripheral region. Those blobs have no closed flux.

Additionally, our findings indicate that as the plasmoid relocates, both the effective resistivity and the inflow velocity experience an augmentation at the X point, the very location from which the plasmoid departs, as illustrated in Figure 2. The experimental results compellingly demonstrate that the expulsion of plasmoids triggers an inflow mechanism, thus substantially influencing rapid reconnection within the merging spherical Tokamak (ST) configuration.

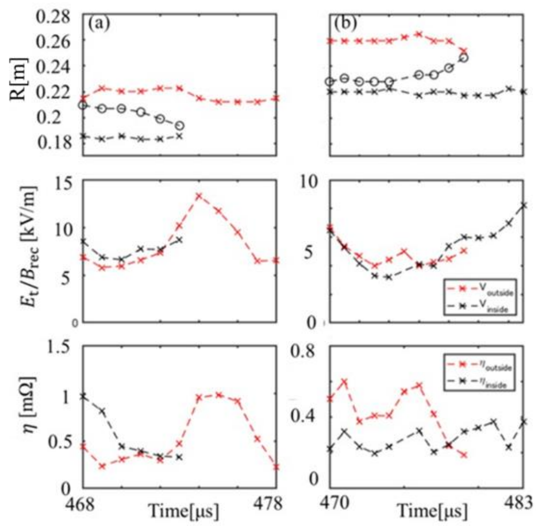


Figure 2. Top: Radial position of X-point and O-point (symbols: x and o, respectively), Middle: inflow velocity, Bottom: effective resistivity of case O-point move (a) inward (High field side), (b) outward (Low field side)

References

[1] M. Akimitsu et al, PFR 13, (2018), 1202108.
[2] H.Tanaka et al., PFR 16, (2021), 2402068