

Multiple Plasmoid Formation and Ejection in TS-3U and TS-4U Merging Tokamaks Experiments

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ABSTRACT

- Multiple plasmoid/ blob structures were measured for the first time in current sheet of merging tokamak plasmas TS-3U and TS-4U, using high-resolution and high-accuracy print circuit board (PCB) type magnetic probe array.

BACKGROUND

- Plasma heating is caused by rapid energy conversion.
 - Faster reconnection \rightarrow more heating.
 - Plasmoid ejection plays a key role in triggering fast reconnection
- In order to promote fast reconnection in ST merging experiment, understanding CS dynamics is important

Features of reconnection in ST merging

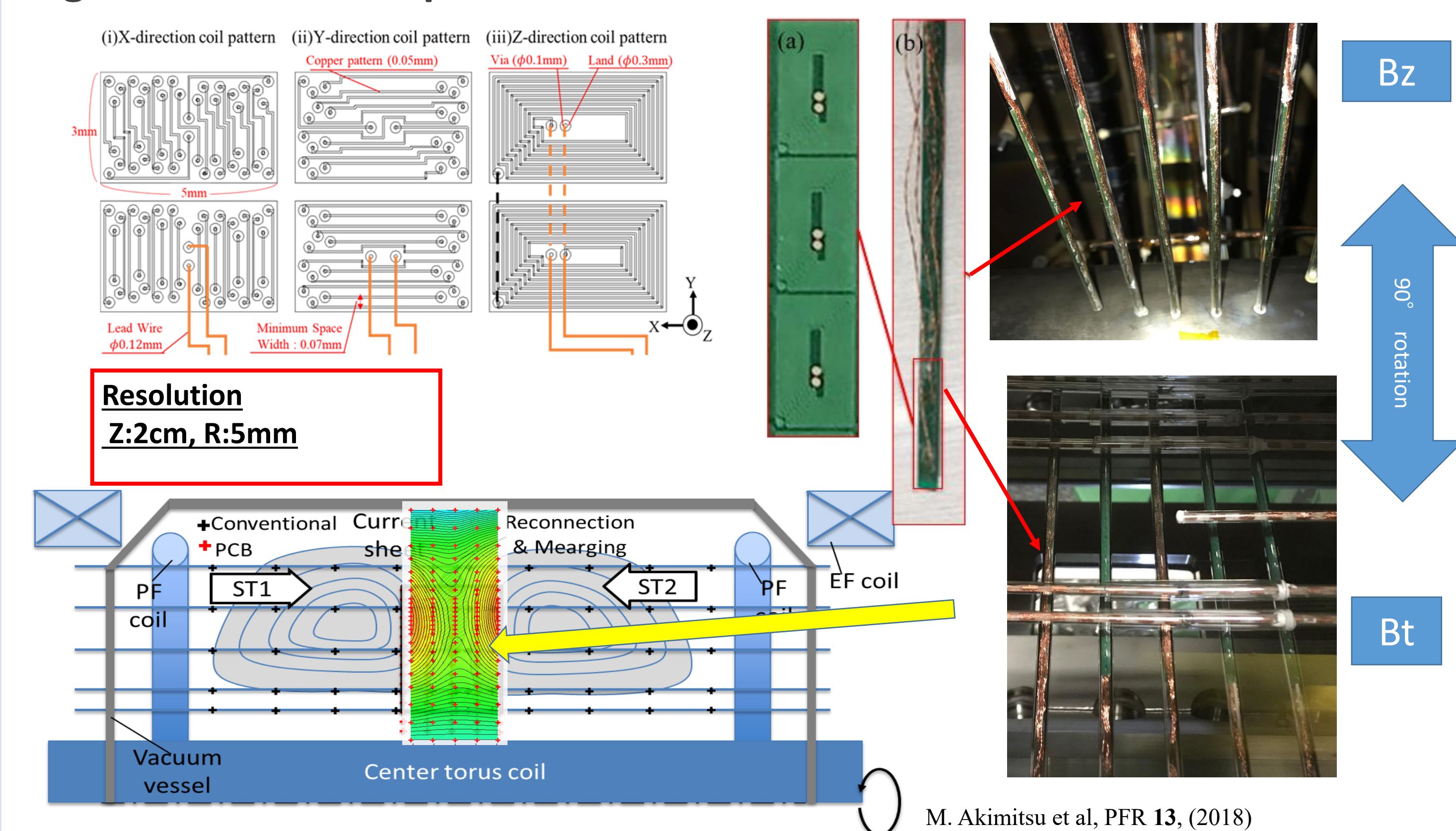
- High guide field ($B_t \sim 0.10\text{--}0.3\text{[T]}$, $B_{rec} \sim 0.05\text{[T]}$, $B_t/B_{rec} \sim 2\text{--}6$)
- current sheet tilting ($J_{Hall} \times B_t$ force) \leftarrow two fluid scale
- asymmetry E_t , E_z
- driven reconnection \Rightarrow Strong inflow, E_t
- pileup \Rightarrow plasmoid formation in CS \leftarrow ion larmor scale (10mm)
- collisionless

- Ion larmor scale measurement and investigate following :

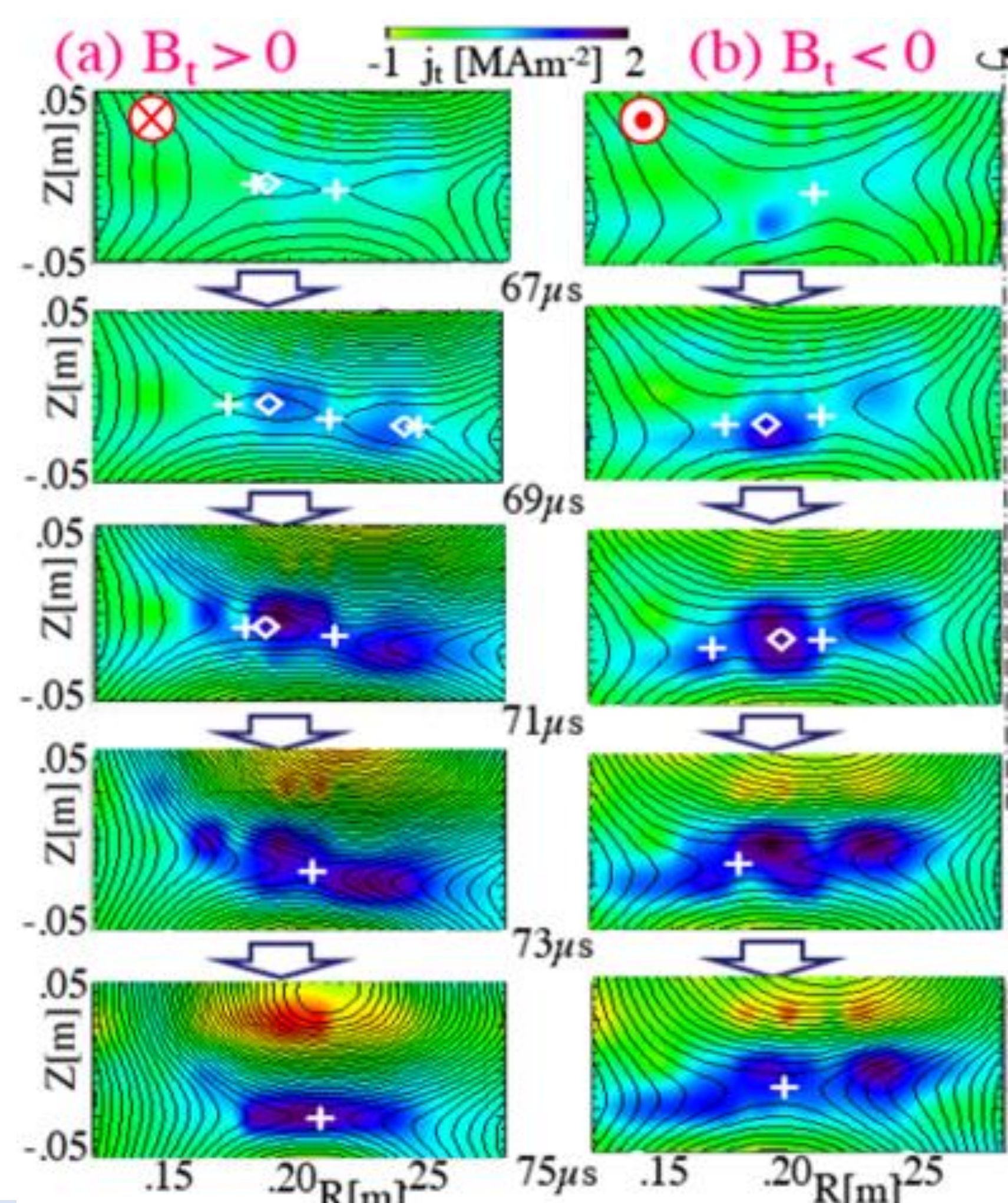
- How is plasmoid formed in current sheet of merging STs?
- How does plasmoid affect to fast reconnection?

EXPERIMENTAL SETUP

High resolution PCB probe



OBSERVATION

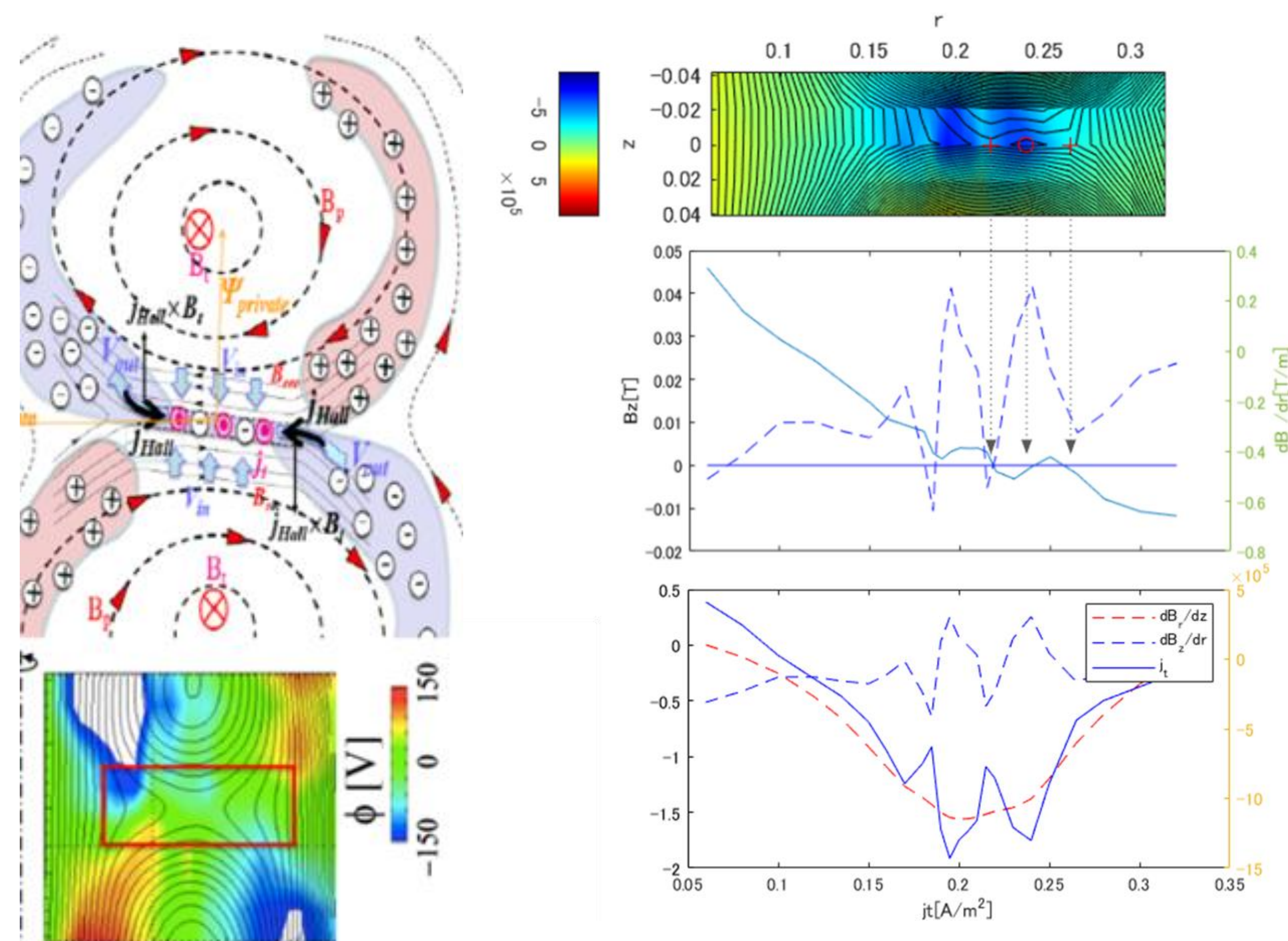


- current sheet is not uniform but there are formation of a single plasmoid and multiple blobs
- some of those blobs have close flux inside but others especially the edge of a continuous blobs don't have closed flux.
- If there are closed flux inside blobs the size of closed flux tend to be 1/2-1/5 of the blob size.
- The current sheet rotates by guide field effect.

RESULT

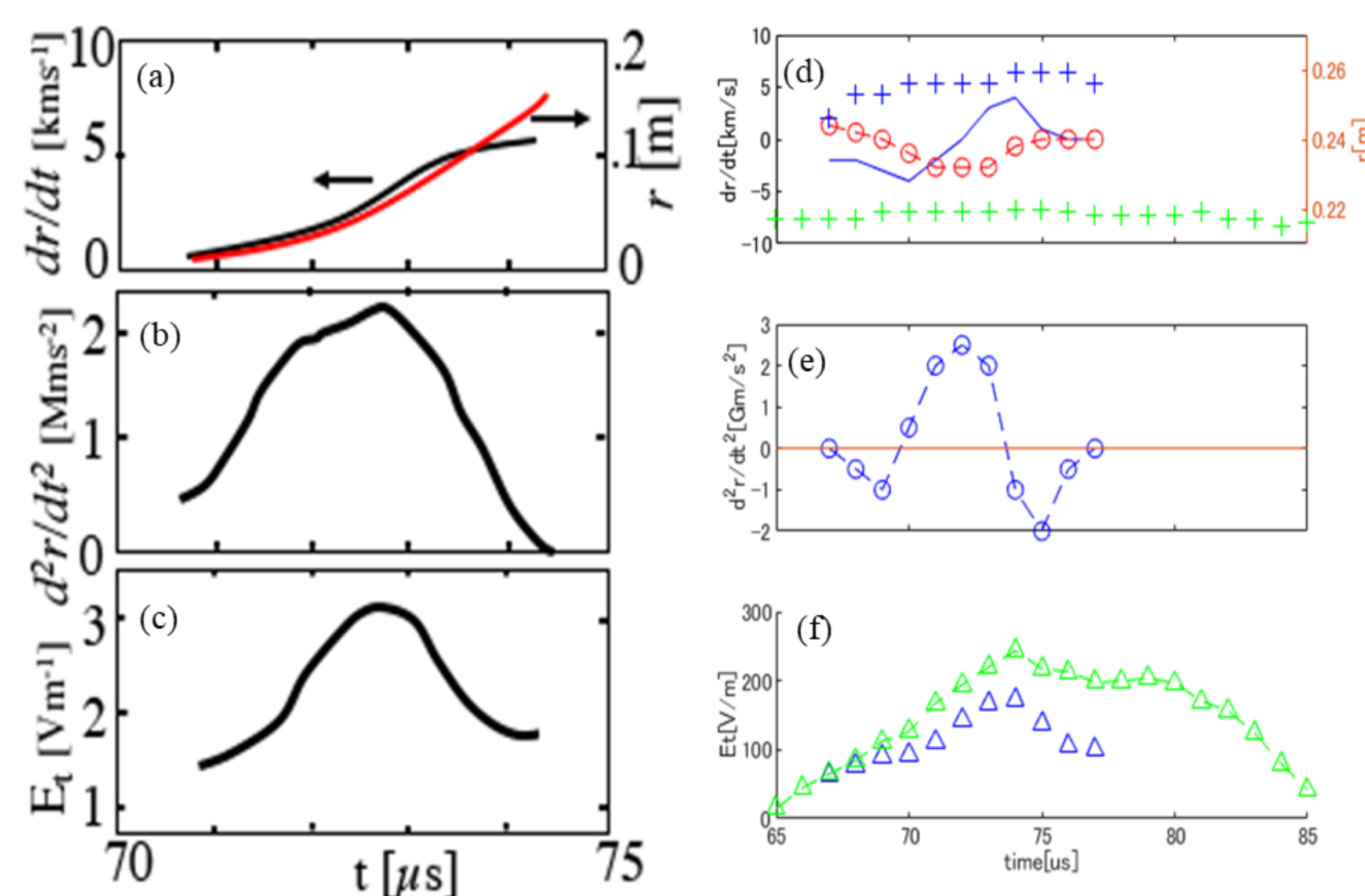
Mechanism of multiple blobs formation

- current sheet split by $j_{Hall} \times B_t$ force caused by quadrupole electrostatic potential ϕ
- fluctuations in magnetic field z-component B_z due to plasmoid or some other reason

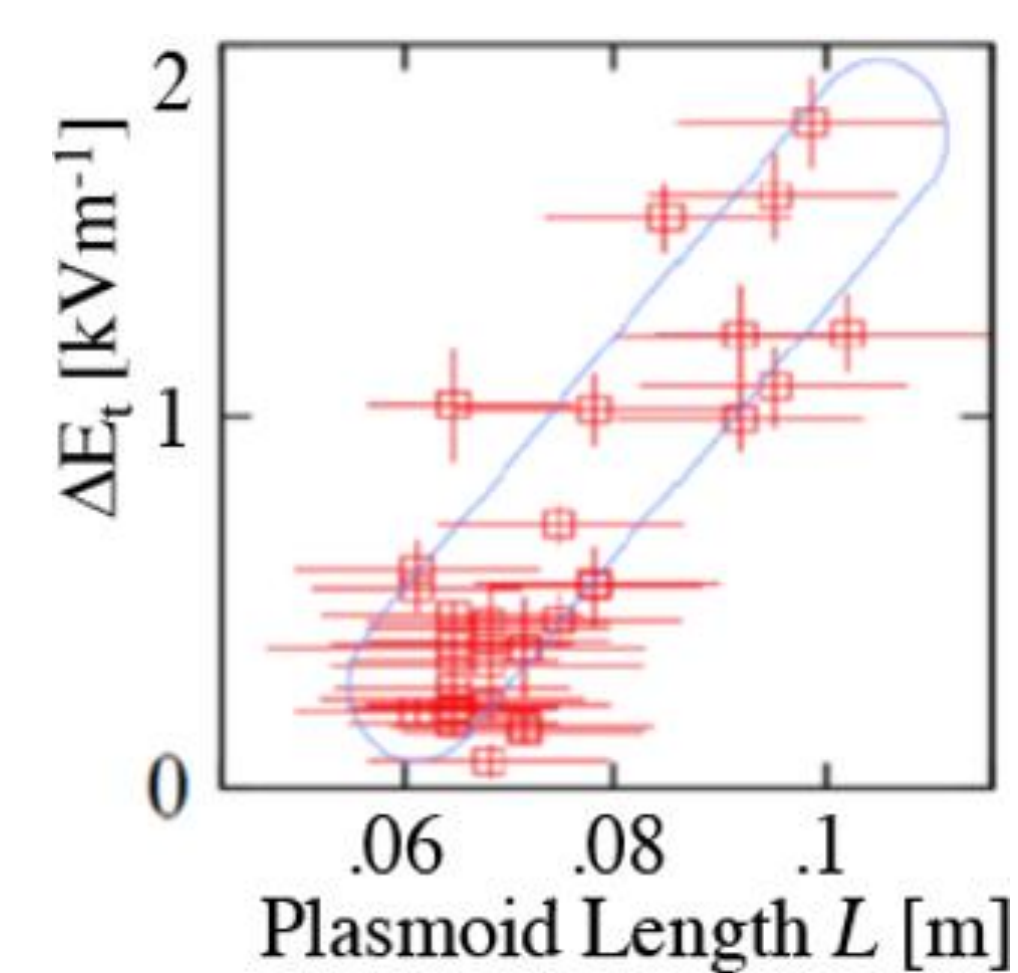


Plasmoid ejection

- dynamics of plasmoid ejection depends on magnetic pressure of downstream.



Correlation between ΔE_t and plasmoid size



CONCLUSION

- We conducted high-resolution 2D measurement of current sheet structure using PCB probe. Plasmoid and multiple blobs are observed in the current sheet of merging ST. Some of those blobs have close flux inside and the size of closed flux tend to be 1/2-1/5 of the blob size. The current sheet rotates by guide field effect. There are two main possible mechanism of multiple blob formation, (i) current sheet split by $j_{Hall} \times B_t$ force caused by quadrupole electrostatic potential ϕ , (ii) fluctuations in magnetic field z-component B_z due to plasmoid or some other reason. The motion of plasmoid ejection affect E_t , and the downstream configuration determines the motion. We demonstrate two different ejection pattern of TS-4U and TS-3U.