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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 → more heating .
- Plasmoid ejection plays a key role in triggering fast reconnection

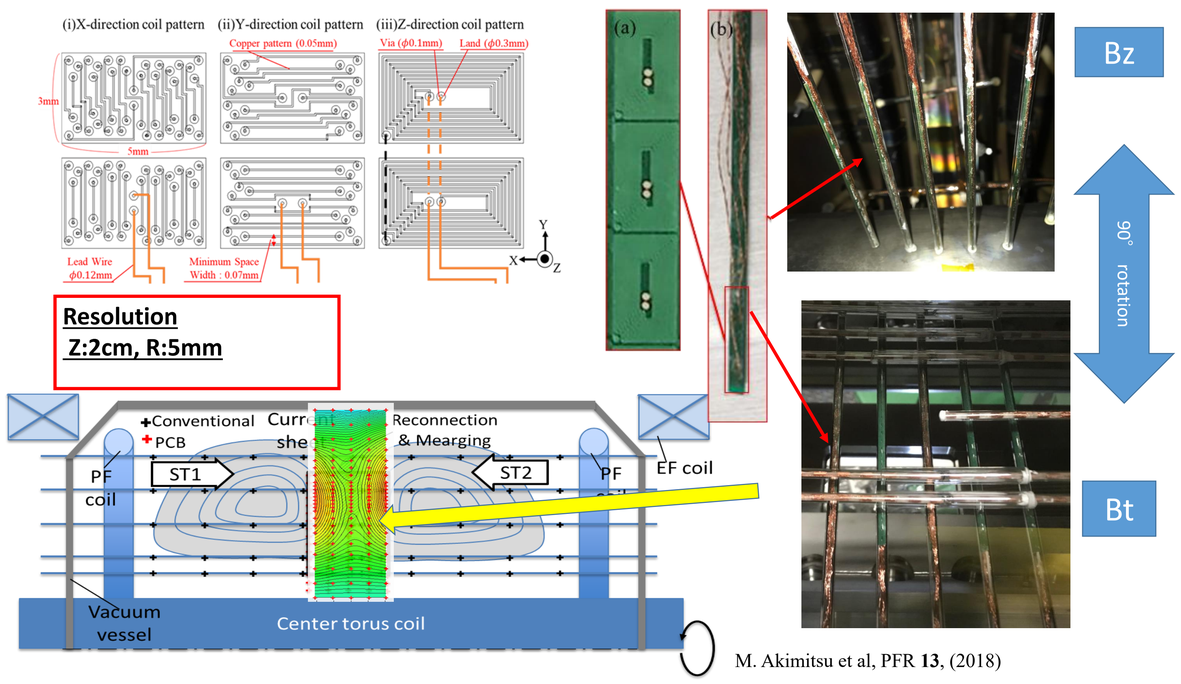
•In order to promote fast reconnection in ST merging experiment, understanding CS dynamics is important

➢Features of reconnection in ST merging
- ➢High guide field (B_t ~ 0.10-0.3[T], B_{rec} ~ 0.05[T], B_t/B_{rec} ~2-6)
  - ➢ current sheet tilting ($J_{Hall} \times B_t$ force) ← two fluid scale
  - ➢ asymmetry Et, Ez
- ➢driven reconnection ⇒ Strong inflow , Et
  - ➢pileup ⇒plasmoid formation in CS←ion larmor scale (10mm)
- ➢collisionless

•Ion larmor scale measurement and investigate following :
1. How is plasmoid formed in current sheet of merging STs?
2. How does plasmoid affect to fast reconnection?

EXPERIMENTAL SETUP

High resolution PCB probe



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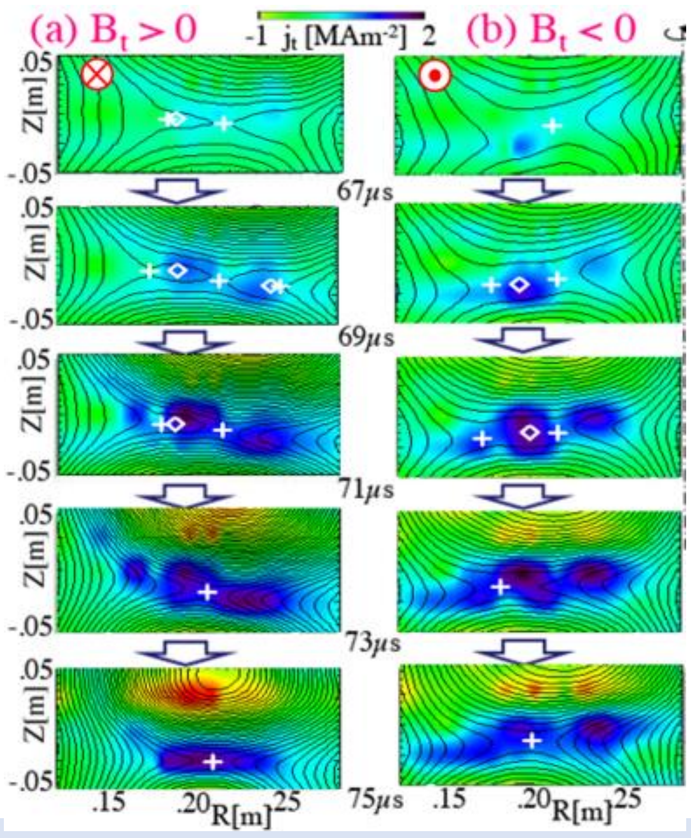
OBSERVATION

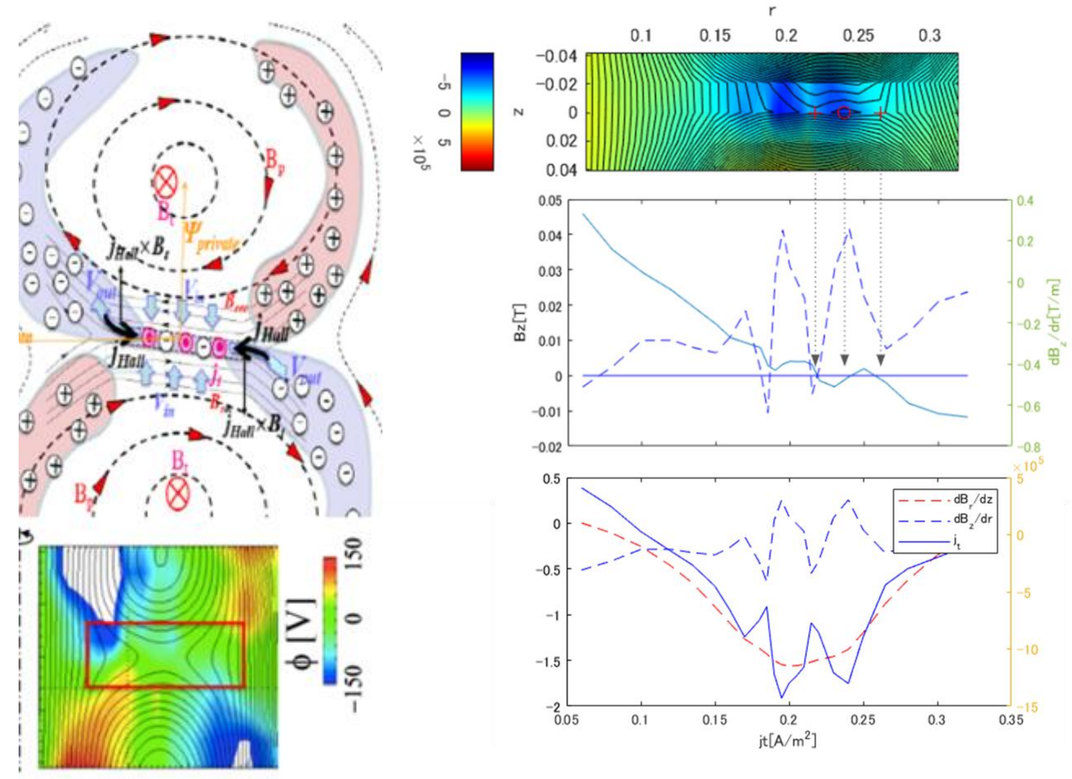


(1)current sheet is not uniform but there are formation of a single plasmoid and multiple blobs
(2)some of those blobs have close flux inside but others especially the edge of a continuous blobs don't have closed flux.
(3)If there are closed flux inside blobs the size of closed flux tend to be 1/2-1/5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

RESULT

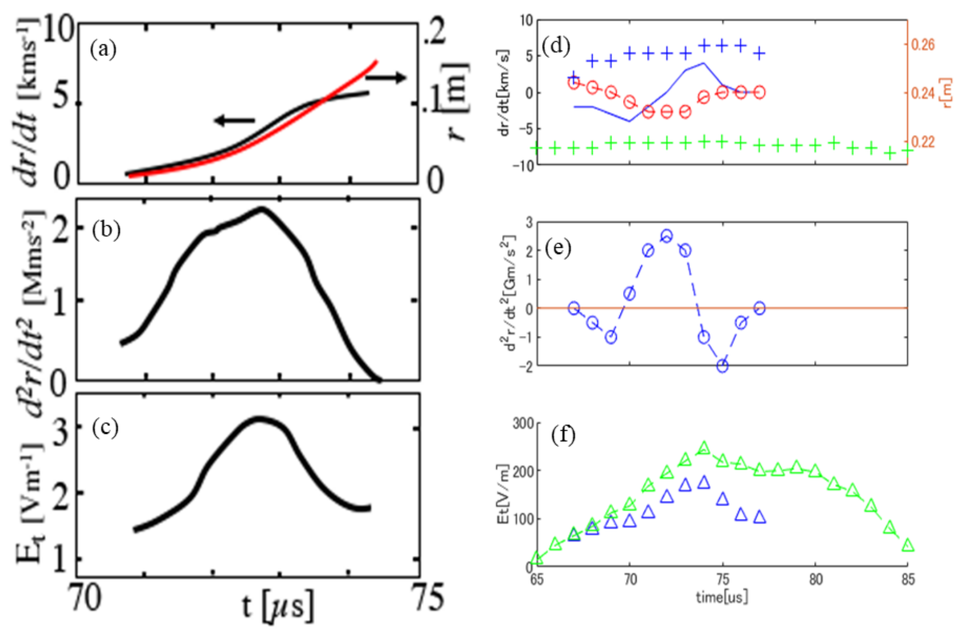
Mechanism of multiple blobs formation

(1) current sheet split by jHall × Bt force caused by quadrapole electrostatic potential φ
(2) fluctuations in magnetic field z-component Bz due to plasmoid or some other reason

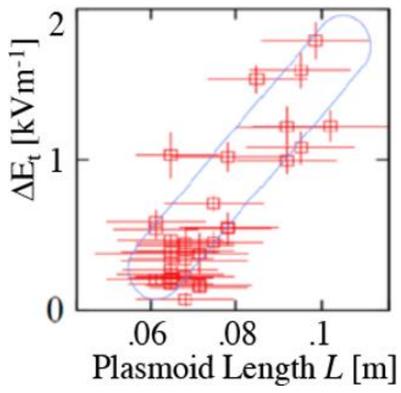


Plasmoid ejection

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



Correration between ΔEt and plasmoid size



CONCLUSION

• We conducted high-resolution 2D measurement of current sheet structure using PCB probe. Plasmoid and multiple blobs are obserbed 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}×Bt force caused by quadrapole electrostatic potential ϕ, (ii) fluctuations in magnetic field z-component Bz due to plasmoid or some othe reason. The motion of plasmoid ejection affect Et, and the downstream configuration determines the motion. We demonstrate two different ejection pattern of TS-4U and TS-3U.