A1: Overview of Merging Formation of High Beta Compact Tori and Spherical Tokamaks in TS-3 and TS-4 Machines at University of Tokyo.

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ABSTRACT: For the past fifteen years, the TS-3 device at the University of tokyo has been utilized to study a great variety of Compact Tori and Spherical Tokamaks (CT/STs) particularly in association with their merging formations. The studies have included the magnetic reconnection experiments, the merging formations of the Field Reversed Configurations (FRC), and the merging formations of ultra high beta spherical tokamaks with the assistance of an external application of the toroidal field to the FRC. The successful operations of these experiments have enabled us to construct an up-scaled merging device, namely, the TS-4 device. The new device TS-4 contains a pair of internal poloidal flux cores of the S-1 type (major radius ~ 0.5m) for the inductive plasma formation, a center coil assembly (containing both of the external toroidal field coils and the OH coils) for the q value control and for the plasma sustain. The initial operations of the TS-4 (since 2001) have demonstrated successfully the cohelicity and the counter helicity merging of two spheromaks as had been observed in the TS-3 machine in the past. Particularly, the counter helicity merging without the external toroidal field revealed the rapid annihilation of the internal toroidal magnetic field, resulting in the formation of a very high beta FRC. The magnetic field measurements have shown that the counter helicity merging plasma has a significant magnetic field deformation in the reconnection region, suggesting its contribution to the generation of the toroidal plasma flow during the relaxation to its equilibrium configuration of the FRC type. The counter helicity merging in a weak external toroidal field, namely, the low q ST and RFP merging, makes merged compact toroids relax transiently to low q spherical tokamaks with a very high beta value. However, the counter helicity merging in a strong external toroidal field has not yet been successfully operated. It has been observed that when the external toroidal field is increased above the certain critical value, the RFP side becomes quite unstable during the production phase. The stabilization of the compact RFP in a strong external toroidal field is an issue to be solved for the production of an ultra high beta ST by the conter helicity merging method.