Merging-compression formation

M. Gryaznevich and Tokamak Energy Ltd team

Tokamak Energy Ltd, Culham Science Centre, Abingdon, OX143DB, UK

Lead-author e-mail: mikhail.gryaznevich@tokamakenergy.co.uk

Merging-compression plasma formation is a solenoid-free plasma formation method used in STs. Two plasma rings are formed and merged via magnetic reconnection into one plasma ring that then is radially compressed to form ST configuration. Plasma currents of several hundred kA and plasma ion and electron thermal temperatures of keV-range have been produced on START and MAST tokamaks using this method, however full understanding of the physics of all three stages of m/c formation has been obtained only recently, and will be presented here in detail for the first time. Plasma rings formation and adiabatic compression can be explained and modelled using physics well-known in tokamak research and experimental data from MAST and START can be used to justify predictions of the values of achievable plasma currents in future devices. The reconnection process can be described by resistive MHD and two fluid models, using slow shock and current sheet models [D.Biscamp, Phys Lett, 105A 1984 124], however only recently these models have been benchmarked with the experimental data. All models predict strong ion and electron heating at increased toroidal (guide) and poloidal (reconnection) fields.

This method will be used to create ST plasmas in a compact (R~0.4-0.5m) high field (3T) ST40 tokamak which is under construction, expecting operations in 2016. Main parameters, physics and engineering issues will be discussed in detail as well as update on the construction status. Moderate extrapolation from MAST/START data suggests achievement of plasma current of ~2MA. Using theoretical predictions benchmarked on experimental data from TS-3, TS-4, USTX, MAST and START, 10keV range temperatures should be achieved at densities ~ 0.5-1.0x10^20 m^-3, bringing ST40 plasmas into burning regime conditions straight from the plasma formation, assuming that the energy confinement in ST has strong favorable dependence on TF.