Okazaki, Nucl. Fusion 39, 2001 (1999)) and by driving current with rotating magnetic fields (RMF) (see e.g. I. R. Jones, Phys. Plasmas 6, 1950 (1999)) which also provides additional stability.

[0004] The collision-merging technique proposed long ago (see e.g. D. R. Wells, Phys. Fluids 9, 1010 (1966)) has been significantly developed further: two separate theta-pinches at opposite ends of a confinement chamber simultaneously generate two plasmoids and accelerate the plasmoids toward each other at high speed; they then collide at the center of the confinement chamber and merge to form a compound FRC. In the construction and successful operation of one of the largest FRC experiments to date, the conventional collision-merging method was shown to produce stable, long-lived, high-flux, high temperature FRCs (see, e.g., M. Binderbauer, *et al.*, Phys. Rev. Lett. 105, 045003 (2010)). Most recently, major progress was accomplished using the collision-merging technique in beam-driven FRC experiments that produce relatively high temperature FRCs for a long time (typical plasma parameters: T_e ~250 eV, T_i ~1 keV, $\langle n_e \rangle$ ~2-3×10^{13} cm^{-3}, B_e ~1 kG, plasma lifetime ~30 ms) using high-power neutral-beam (NB) injection (NBI) and effective edge biasing. (see, e.g., Gota, H. *et al.*, Nucl. Fusion 57, 116021 (2017); Gota, H. *et al.*, Nucl. Fusion 59, 112009 (2019); and Gota, H. *et al.*, Bull. Am. Phys. Soc. 64, UP10.00123 (2019)). In such experiments, a target plasma for NBI is produced by the collision and merging of two FRC plasmas using the field-reversed theta-pinch (FRTP) dynamic formation technique (Binderbauer, Phys. Rev. Lett. 105) in which the trapped magnetic flux of the merged FRC is initially ~5 mWb based on rigid-rotor model with external magnetic field of ~1 kG in the confinement section. By injecting high-power NB of >13 MW (increased up to ~21 MW by tuning beam energy during a shot) into the target plasma, the injected fast particles get trapped and travel inside and outside of the separatrix with a large orbit to heat primarily electrons as well as for current drive, in which the fast ions are almost classically confined. This high power NBI has not been attained in any other CT experiment, and was a very important demonstration of the validity of the beam-driven FRC concept and its technical readiness. (Gota, Nucl. Fusion 59; Gota, Bull. Am. Phys. Soc. 64).

[0005] Improved systems, devices, and methods to generate high flux target FRC plasma.

SUMMARY

[0006] Examples of systems, devices, and methods are provided herein for generating and maintaining a magnetic field with a field reversed configuration (FRC). In an aspect, a method for generating and maintaining a magnetic field with a field reversed configuration (FRC) comprises forming a

mirror plasma within a confinement chamber, injecting beams of fast neutral atoms from a plurality of neutral beam injectors into the mirror plasma at an angle towards the mid-plane of the confinement chamber to transition the mirror plasma to a FRC plasma, and maintaining the FRC plasma at or about a constant value without decay by injecting beams of fast neutral atoms from the plurality of neutral beam injectors into the FRC plasma at an angle towards the mid-plane of the confinement chamber.

[0007] In an example, the neutral beam injectors are adjustable from an initial power level to and an increased power level.

[0008] In an aspect, a system for generating and maintaining a magnetic field with a field reversed configuration (FRC) comprising: a confinement chamber; first and second divertors coupled to the confinement chamber; a plurality of biasing electrodes and first and second mirror plugs, one or more biasing electrodes of the plurality of biasing electrodes being positioned within one or more of the confinement chamber and the first and second divertors, and the first and second mirror plugs being positioned between the confinement chamber and the first and second divertors, a gettering system coupled to the confinement chamber and the first and second divertors, a plurality of neutral atom beam injectors coupled to the confinement chamber and oriented at an angle towards the mid-plane of the confinement chamber; a magnetic system comprising a plurality of quasi-dc coils positioned around the confinement chamber and the first and second divertors; first and second sets of quasi-dc mirror coils positioned between the confinement chamber and the first and second divertors; wherein the system is configured to form a mirror plasma within the confinement chamber and inject beams of fast neutral atoms from the plurality of neutral beam injectors into the mirror plasma at an angle towards the mid-plane of the confinement chamber to transition the mirror plasma to a FRC plasma and maintain the FRC plasma without decay while the neutral beams are injected into the FRC plasma.

[0009] Other systems, devices, methods, features and advantages of the subject matter described herein will be or will become apparent to one with skill in the art upon examination of the following figures and detailed description. It is intended that all such additional systems, methods, features and advantages be included within this description, be within the scope of the subject matter described herein, and be protected by the accompanying claims. In no way should the features of the example embodiments be construed as limiting the appended claims, absent express recitation of those features in the claims.

BRIEF DESCRIPTION OF THE FIGURES

[0010] The accompanying drawings, which are included as part of the present specification, illustrate the presently example embodiments and, together with the general description given above and the detailed description of the example embodiments given below, serve to explain and teach the principles of the present invention.