[0009] The systems and methods described herein advantageously provide: feedback control of the FRC plasma axial position by acting on the voltages applied to a set of external coils concentric with the plasma; feedback control of the FRC axial position using a non-linear control technique; and, feedback control of the FRC axial position independently of the stability properties of the plasma equilibrium. This is independence is advantageous because the equilibrium may have to transit between an axially stable and unstable equilibria on different phases of the FRC discharge, for instance if the axial instability scenario is temporarily lost and recovered during the plasma discharge.

[0010] The systems, methods, features and advantages of the example embodiments 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 methods, features and advantages be included within this description, and be protected by the accompanying claims. It is also intended that the claims are not limited to require the details of the example embodiments.

[0010a] According to a first aspect, there is provided a method for stabilizing a field reversed configuration (FRC) plasma comprising the steps of: forming an FRC magnetic field about a rotating plasma in a confinement chamber to form an FRC plasma positioned along a longitudinal axis the confinement chamber adjacent a mid-plane of the confinement chamber, and stabilizing the FRC plasma in a radial direction normal to the longitudinal axis to position the FRC plasma axisymmetric about the longitudinal axis and in an axial direction along the longitudinal axis to position the FRC plasma axisymmetric about the mid-plane.

[0010b] According to a second aspect, there is provided a system for generating and stabilizing a magnetic field with a field reversed configuration (FRC) comprising a confinement chamber, first and second diametrically opposed FRC formation sections coupled to the confinement chamber, the formation section comprising modularized formation systems for generating an FRC and translating the FRC toward a midplane of the confinement chamber, first and second divertors coupled to the first and second formation sections, first and second axial plasma guns operably coupled to the first and second divertors, the first and second formation sections and the confinement chamber, a plurality of neutral atom beam injectors coupled to the confinement chamber and oriented to inject neutral atom beams toward a mid-plane of the confinement chamber at an angle less than normal to a longitudinal axis of the confinement chamber, a magnetic system comprising a plurality of quasi-dc coils positioned around the confinement chamber, the first and second formation sections, and the first and second divertors, first and second set of quasi-dc mirror coils positioned between the confinement chamber and the first and second formation sections, and first and second mirror plugs position between the first and second formation sections and the first and second divertors, a

gettering system coupled to the confinement chamber and the first and second divertors, first and second set of radial magnetic field coils configured to generate first and second radial magnetic fields within chamber, and a control system operably coupled to the quasi-dc coils and the first and second radial magnetic field coils, the control system including a processor coupled to a non-transitory memory comprising a plurality of instruction that when executed causes the processor to tune the magnetic field generated by the plurality of quasi-dc coils and the first and second radial field coils to stabilize an FRC plasma in a radial direction normal to a longitudinal axis of the chamber to position the FRC plasma axisymmetric about the longitudinal axis and in an axial direction along the longitudinal axis to position the FRC plasma axisymmetric about the mid-plane.

BRIEF DESCRIPTION OF THE FIGURES

[0011] 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.

[0012] **Figure 1** illustrates particle confinement in the present FRC system under a high performance FRC regime (HPF) versus under a conventional FRC regime (CR), and versus other conventional FRC experiments.

[0013] **Figure 2** illustrates the components of the present FRC system and the magnetic topology of an FRC producible in the present FRC system.

[0014] **Figure 3A** illustrates the basic layout of the present FRC system as viewed from the top, including the preferred arrangement of neutral beams, electrodes, plasma guns, mirror plugs and pellet injector.

[0015] **Figure 3B** illustrates the central confinement vessel as viewed from the top and showing the neutral beams arranged at an angle normal to the major axis of symmetry in the central confinement vessel.

[0016] **Figure 3C** illustrates the central confinement vessel as viewed from the top and showing the neutral beams arranged at an angle less than normal to the major axis of symmetry in the central confinement vessel and directed to inject particles toward the mid-plane of the central confinement vessel.