CLAIMS

1. A method for generating and maintaining a plasma in a magnetic field with a field reversed configuration (FRC) comprising the steps of:

forming an FRC about a plasma in a confinement chamber (100) having a longitudinal mid-plane, and

maintaining the FRC at or about a constant value without decay by injecting beams of fast neutral atoms from neutral beam injectors (600) into the FRC plasma at an angle towards the mid-plane of the confinement chamber and characterised in that the method further comprises: injecting compact toroid (CT) plasmas from first and second CT injectors (720) into the FRC plasma at an angle towards the mid-plane of the confinement chamber, wherein the first and second CT injectors are positioned on opposing sides of the mid-plane of the confinement chamber.

2. The method of claim 1 further comprising one or both the steps of:

a) generating a magnetic field within the chamber with quasi-dc coils (412) extending about the chamber, or b) generating a mirror magnetic field within opposing ends of the chamber with quasi-dc mirror coils (420) extending about the opposing ends of the chamber.

3. The method of claims 1 or 2 wherein the step of forming the FRC includes forming a formation FRC in a formation section (200) coupled to an end of the confinement chamber and accelerating the formation FRC towards the mid-plane of the chamber to form the FRC or includes forming first and second formation FRCs first and second formation sections coupled to first and second ends of the confinement chamber and accelerating the first and second formation FRCs towards the mid-plane of the chamber where the two formation FRCs merge to form the FRC.

4. The method of claim 3 wherein the step of forming the FRC includes one of forming a formation FRC while accelerating the formation FRC towards the mid-plane of the chamber and forming a formation FRC then accelerating the formation FRC towards the mid-plane of the chamber.

5. The method of claim 3 further comprising the step of guiding magnetic flux surfaces of the FRC into diverters (300) coupled to the ends of the formation sections (200).

6. The method of claim 5 further comprising the step of generating a magnetic field within the formation sections (200) and diverters (300) with quasi-dc coils (414, 416) extending about the formation sections and diverters.

7. The method of claim 6, further comprising the step of: generating a mirror magnetic field between the formation sections (200) and the diverters (300) with quasi-dc mirror coils (430).

8. The method of claim 7, further comprising step of generating a mirror plug magnetic field within a constriction between the formation sections (200) and the diverters (300) with quasi-dc mirror plug coils (444) extending about the constriction between the formation sections and the diverters.

9. The method of claims 1 through 7 further comprising one of the following steps:

a) generating one of a magnetic dipole field and a magnetic quadrupole field within the chamber with saddle coils (460) coupled to the chamber;

b) conditioning the internal surfaces of the chamber (100), formation sections (200), and diverters (300) with a gettering system (800);

c) conditioning the internal surfaces of the chamber (100), formation sections (200), and diverters (300) with a gettering system (800) wherein the gettering system (800) includes one of a Titanium deposition system and a Lithium deposition system;

d) axially injecting plasma into the FRC from axially mounted plasma guns (350);

e) controlling the radial electric field profile in an edge layer (456) of the FRC; and

f) controlling the radial electric field profile in an edge layer of the FRC wherein the step of controlling the radial electric field profile in an edge layer of the FRC includes applying a distribution of electric potential to a group of open flux surfaces of the FRC with biasing electrodes.

10. The method of claim 1 wherein the injecting of CT plasmas into the FRC plasma at an angle towards the mid-plane of the confinement chamber includes injecting CT plasmas at an angle of about 15° to 25° with respect to the normal to the longitudinal axis of the confinement chamber and towards the mid-plane of the confinement chamber.

11. The method of claim 1 wherein the injecting of CT plasmas into the FRC plasma at an angle towards the mid-plane of the confinement chamber includes injecting CT plasmas in rep-rate mode.

12. A system (10) for generating and maintaining a plasma in a magnetic field with a field reversed configuration (FRC) comprising

a confinement chamber (100),

first and second diametrically opposed FRC formation sections (200) coupled to the confinement chamber, the formation section comprising modularized formation systems for generating an FRC and translating the FRC toward a longitudinal mid-plane of the confinement chamber,

first and second divertors (300) coupled to the first and second formation sections,

first and second axial plasma guns (350) 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 (600) coupled to the confinement chamber and oriented to inject neutral atom beams toward a mid-plane of the confinement chamber at an angle with respect to the normal to a longitudinal axis of the confinement chamber,

a magnetic system comprising a plurality of quasi-dc coils (412,414,416) positioned around the confinement chamber, the first and second formation sections, and the first and second divertors, a first and second set of quasi-dc mirror coils (420,430) positioned between the confinement chamber and the first and second formation sections, and first and second mirror plugs (440) positioned between the first and second formation sections and the first and second divertors,

a gettering system (800) coupled to the confinement chamber and the first and second divertors,

one or more biasing electrodes (900,905,910,920) for electrically biasing open flux surface of a generated FRC, the one or more biasing electrodes being positioned within one or more of the confinement chamber, the first and second formation sections, and the first and second divertors,

two or more saddle coils (460) coupled to the confinement chamber, and characterised in that the system further comprises:

first and second compact toroid (CT) injectors (720) coupled to the confinement chamber at an angle towards the mid-plane of the confinement chamber, wherein the first and second CT injectors are positioned on opposing sides of the mid-plane of the confinement chamber.

13. The system (10) of claim 12 wherein the system is configured to generate an FRC and maintain the FRC at or about a constant value without decay while neutral atom beams are injected into the FRC.

14. The system (10) of claim 12 or 13, wherein the first and second mirror plugs (440) comprise third and fourth set of mirror coils between each of the first and second formation sections and the first and second divertors or wherein the first and second mirror plugs comprise third and fourth set of mirror coils between each of the first and second formation sections and the first and second divertors and each of the first and second mirror plugs (440) further comprises a set of mirror plug coils wrapped around a constriction in the passageway between each of the first and second formation sections and the first and second divertors.

15. The system (10) of claims 12 through 14 wherein the formation systems comprise a plurality of power and control units coupled to individual ones of a plurality of strap assemblies (230) to energize a set of coils of the individual ones of the plurality of strap assemblies wrapped around the elongate tube of the first and second formation sections

16. The system (10) of claim 15, wherein individual ones of the plurality of power and control units comprising a trigger and control system.

17. The system (10) of claim 16, wherein the trigger and control systems of the individual ones of the plurality of power and control units being synchronizable to enable static FRC formation wherein the FRC is formed and then injected or dynamic FRC formation wherein the FRC is formed and translated simultaneously.

18. The system (10) of claims 12 through 17 wherein the plurality of neutral atom beam injectors comprises one or more RF plasma source neutral atom beam injectors and one or more arc source neutral atom beam injectors.

19. The system (10) of claims 12 through 18 wherein the plurality of neutral atom beam injectors are oriented with an injection path tangential to the FRC with a target trapping zone within separatrix of the FRC.

20. The system (10) of any one of claims 12 through 19 wherein at least one of the following applies:

a) the elongate tube is a quartz tube with a quartz liner;

b) the formation systems are pulsed power;

c) the gettering system comprises one or more of a Titanium deposition system and a Lithium deposition system that are configured to coat the plasma facing surfaces of the confinement chamber and the first and second divertors; and

d) the biasing electrodes include one or more of:

i) at least one point electrode (905) positioned within the containment chamber to contact open field lines,

ii) a set of annular electrodes (900) between the confinement chamber and the first and second formation sections to charge far-edge flux layers in an azimuthally symmetric fashion, and

iii) a plurality of concentric stacked electrodes (910) positioned in the first and second divertors to charge multiple concentric flux layers, and anodes (920) of the plasma guns to intercept open flux.

21. The system of claim 12 wherein the first and second CT injectors are oriented at an angle of about 15° to 25° with respect to the normal to the longitudinal axis of the confinement chamber and towards the mid-plane of the confinement chamber.

22. The system of claim 12 wherein the first and second CT injectors are configured to the inject CT plasmas into the FRC plasma in rep-rate mode.