CLAIMS

What is claimed is:

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

forming an FRC about a plasma in a confinement chamber,

injecting a plurality of neutral beams into the FRC plasma at an angle toward the mid-plane of the confinement chamber, and

heating electrons of the FRC plasma with high harmonic fast waves propagating into the FRC plasma, wherein the high harmonic fast waves are fast waves in radio frequency ranges.

2. The method of claim 1, wherein the step of heating electrons includes launching a plurality of high harmonic fast waves from one or more antennas into the confinement chamber.

3. The method of claim 1, wherein the step of heating electrons includes launching a plurality of high harmonic fast waves from one or more antennas into the FRC plasma in the confinement chamber at a launch angle from the mid-plane of the confinement chamber.

4. The method of claim 3, wherein the launch angle is in a range of 15° to 25° from the mid-plane of the confinement chamber.

5. The method of claim 3, wherein the launch angle is near but less than normal to a longitudinal axis of the confinement chamber.

6. The method of claims 2 through 5, wherein the one or more antennas is a phased array antenna with a plurality of straps.

7. The method of claims 1 through 5, wherein the radio frequency of the high harmonic fast waves are in radio frequency ranges of 15-25Mhz.

8. The method of claim 6, wherein the high harmonic fast waves are fast waves in radio frequency ranges.

9. The method of claims 1 through 5 and 8, wherein the step of heating the electrons including heating the electrons from a first temperature to a second temperature that is at least seven (7) greater than the first temperature.

10. The method of claims 1 through 5 and 8, wherein the step of heating the electrons including heating the electrons from 150 eV to above 1 keV.

11. The method of claims 1 through 5 and 8, further includes maintaining the FRC at or about a constant value without decay while injecting beams of fast neutral atoms into the FRC plasma in the confinement chamber and elevating the plasma electron temperatures to above 1.0 keV.

12. The method of claims 1 through 5 and 8, further comprising the step of generating a magnetic field within the confinement chamber with quasi dc coils extending about the confinement chamber and a mirror magnetic field within opposing ends of the confinement chamber with quasi dc mirror coils extending about the opposing ends of the confinement chamber.

13. The method of claim 11, further comprising the step of generating a magnetic field within the confinement chamber with quasi dc coils extending about the confinement chamber and a mirror magnetic field within opposing ends of the confinement chamber with quasi dc mirror coils extending about the opposing ends of the confinement chamber.

14. The method of claim 12, wherein the step of the forming the FRC includes forming a formation FRC in opposing first and second formation sections coupled to the confinement chamber and accelerating the formation FRC from the first and second formation sections towards the mid through plane of the confinement chamber where the two formation FRCs merge to form the FRC.

15. The method of claim 13, wherein the step of the forming the FRC includes forming a formation FRC in opposing first and second formation sections coupled to the confinement chamber and accelerating the formation FRC from the first and second formation sections towards the mid through plane of the confinement chamber where the two formation FRCs merge to form the FRC.

16. The method of claims 14 and 15, wherein the step of forming the FRC includes one of forming a formation FRC while accelerating the formation FRC towards the mid through plane of

the confinement chamber and forming a formation FRC then accelerating the formation FRC towards the mid through plane of the confinement chamber.

17. The method of claims 14 and 15, wherein the step of accelerating the formation FRC from the first and second formation sections towards the mid through plane of the confinement chamber includes passing the formation FRC from the first and second formation sections through first and second inner divertors coupled to opposite ends of the confinement chamber interposing the confinement chamber and the first and second formation sections.

18. The method of claim 17, wherein the step of passing the formation FRC from the first and second formation sections through first and second inner divertors includes inactivating the first and second inner divertors as the formation FRC from the first and second formation sections passes through the first and second inner divertors.

19. The method of claim 17, further comprising the step of guiding magnetic flux surfaces of the FRC into the first and second inner divertors.

20. The method of claim 16, further comprising the step of guiding magnetic flux surfaces of the FRC into first and second outer divertors coupled to the ends of the formation sections.

21. The method of claim 20, further comprising the step of generating a magnetic field within the formation sections and the first and second outer divertors with quasi-dc coils extending about the formation sections and divertors.

22. The method of claim 19, further comprising the step of generating a magnetic field within the formation sections and first and second inner divertors with quasi-dc coils extending about the formation sections and divertors.

23. The method of claim 21, further comprising the step of generating a mirror magnetic field between the first and second formation sections and the first and second outer divertors with quasi-dc mirror coils.

24. The method of claim 21, further comprising step of generating a mirror plug magnetic field within a constriction between the first and second formation sections and the first and second

outer divertors with quasi-dc mirror plug coils extending about the constriction between the formation sections and the divertors.

25. The method of claim 22, further comprising the steps of generating a mirror magnetic field between the confinement chamber and the first and second inner divertors with quasi-dc mirror coils and generating a necking magnetic field between the first and second formation sections and the first and second inner divertors with quasi-dc low profile necking coils.

26. The method of claim 11, further comprising the step of generating one of a magnetic dipole field and a magnetic quadrupole field within the chamber with saddle coils coupled to the chamber.

27. The method of claim 12, further comprising the step of generating one of a magnetic dipole field and a magnetic quadrupole field within the chamber with saddle coils coupled to the chamber.

28. The method of claims 26 and 27, further comprising the step of conditioning the internal surfaces of the chamber and the internal surfaces of first and second formation sections, first and second divertors interposing the confinement chamber and the first and second formation sections, and first and second outer divertors coupled to the first and second formation sections with a gettering system.

29. The method of claim 28, wherein the gettering system includes one of a Titanium deposition system and a Lithium deposition system.

30. The method of claims 11 and 12 further comprising the step of axially injecting plasma into the FRC from axially mounted plasma guns.

31. The method of claims 11 and 12 further comprising the step of controlling the radial electric field profile in an edge layer of the FRC.

32. The method of claim 31, 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.

33. The method of claims 1 through 5 and 8, further comprising injecting compact toroid (CT) plasmas from first and second CT injectors into the FRC plasma at an angle towards the mid-plane of the confinement chamber, wherein the first and second CT injectors are diametrically opposed on opposing sides of the mid-plane of the confinement chamber.

34. The method of claim 11, further comprising injecting compact toroid (CT) plasmas from first and second CT injectors into the FRC plasma at an angle towards the mid-plane of the confinement chamber, wherein the first and second CT injectors are diametrically opposed on opposing sides of the mid-plane of the confinement chamber.

35. The method of claim 12, further comprising injecting compact toroid (CT) plasmas from first and second CT injectors into the FRC plasma at an angle towards the mid-plane of the confinement chamber, wherein the first and second CT injectors are diametrically opposed on opposing sides of the mid-plane of the confinement chamber.

36. A system for generating and maintaining 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,

first and second divertors coupled to the first and second formation sections,

one or more of a plurality of plasma guns, one or more biasing electrodes and first and second mirror plugs, wherein the plurality of plasma guns includes first and second axial plasma guns operably coupled to the first and second divertors, the first and second formation sections and the confinement chamber, wherein 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, and wherein the first and second mirror plugs being 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,

a plurality of neutral atom beam injectors coupled to the confinement chamber and angled toward a mid-plane 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, and first and

second set of quasi-dc mirror coils positioned between the first and second formation sections and the first and second divertors, and

an antenna system positioned around the confinement chamber, wherein the antenna system is configured to launch high harmonic fast waves into the FRC plasma to heat plasma electrons, wherein the high harmonic fast waves are fast waves in radio frequency ranges.

37. The system of claim 36, wherein the antenna system includes one or more antennas positioned to launch the high harmonic fast waves at a launch angle from the mid-plane of the confinement chamber into the FRC plasma.

38. The system of claim 37, wherein the launch angle is in a range of 15° to 25° from the mid-plane of the confinement chamber.

39. The system of claim 37, wherein the launch angle is near but less than normal to a longitudinal axis of the confinement chamber.

40. The system of claims 36 through 39, wherein the antenna system includes phased array antennas with a plurality of straps.

41. The system of claims 36 through 39, wherein the radio frequency of the high harmonic fast waves are in radio frequency ranges of 15-25Mhz.

42. The system of claims 36 through 39, wherein the system is configured to heat FRC plasma electrons from 150 eV to above 1 keV.

43. The system of claims 36 through 39, wherein the system is configured to heat FRC plasma electrons from a first temperature to a second temperature that is at least seven (7) greater than the first temperature.

44. The system of claims 36 through 43, wherein the system is configured to generate an FRC and maintain the FRC without decay while the neutral beams are injected into the plasma.

45. The system of claim 44, wherein the system is configured to elevate FRC plasma electron temperature above 1 keV.

46. The system of claims 36 through 45, wherein the first and second divertors comprise first and second inner divertors interposing the first and second formation sections and the confinement chamber, and further comprising first and second outer divertors coupled to the first and second formation sections, wherein the first and second formation sections interposing the first and second inner divertors and the first and second outer divertors.

47. The system of claim 46, further comprising first and second axial plasma guns operably coupled to the first and second inner and outer divertors, the first and second formation sections and the confinement chamber.

48. The system of claim 47, further comprising two or more saddle coils coupled to the confinement chamber.

49. The system of claim 36, wherein the formation section comprises modularized formation systems for generating an FRC and translating it toward the mid-plane of the confinement chamber.

50. The system of claim 36, wherein biasing electrodes includes one or more of one or more point electrodes positioned within the containment chamber to contact open field lines, a set of annular electrodes between the confinement chamber and the first and second formation sections to charge far-edge flux layers in an azimuthally symmetric fashion, a plurality of concentric stacked electrodes positioned in the first and second divertors to charge multiple concentric flux layers, and anodes of the plasma guns to intercept open flux.

51. The system of claim 50, 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.

52. The system of claim 51, wherein first and second radial magnetic fields are antisymmetric about the mid-plane.

53. The system of claims 36 through 52, further comprising first and second compact toroid (CT) injectors coupled to the confinement chamber at an angle towards the mid-plane of the

confinement chamber, wherein the first and second CT injectors are diametrically opposed on opposing sides of the mid-plane of the confinement chamber.