§23. High Efficiency Current Drive in FBX Spherical Plasma

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The next generation fusion device, the ITER tokamak, is expected to have a Q value much larger than one, requires few billion dollars and more than ten years to construct. However, the world political and economical situation seems not healthy enough to start construction of this device at least within few years. The alternative concept devices such as LHD type helical devices and so called Laser Fusion type devices have a great chance to catch up tokamaks in this time duration.

The tokamak researchers in UK and USA pay a great attention to the low aspect ratio tokamaks: spherical tokamaks (ST) similar to the device FBX-II developed in WASEDA UNIVERSITY in 1986. This device had been transferred to NIFS in 1998 (shown in the right column).

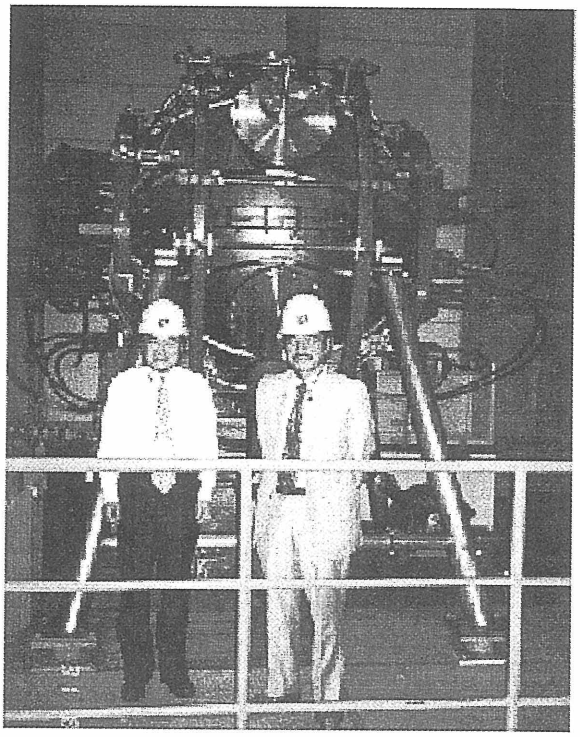

Fig.1. FBX-II in NIFS (1998.9)

(http://faculty.web.waseda.ac.jp/fbx3/fusion.html)

FBX-II is followed by the British device START and established this scheme in the world. The ST is expected to be one of the new plasma confinement schemes span out from the side of the standard tokamaks. Two main world fusion research laboratories, UKAEA Fusion at Culham, UK (device called MAST) and Princeton Plasma Physics Laboratory at Princeton USA (device named NSTX) put main efforts to grade up this scheme.

These laboratories selected this scheme because it has a large advantage over Tokamaks. The main features are:

1. High tolerance against the major plasma disruption,
2. Nearly an order of magnitude higher plasma beta

However because of the basic design principle, the total poloidal magnetic flux seen by the plasma is about an order of magnitude smaller than the conventional tokamaks. This limits a plasma startup scenario in the startup phase.

This project aims to develop a technique to drive toroidal plasma current with optimal efficiency. In this year, the regulation and the design standard difference between Waseda and NIFS, especially the floor loading and the safety standard interfered the re-installation of the FBX-II device.

In order to solve these problems, minor modification of the FBX current supply is designed, which utilizes 100 ms 100 kA chemical capacitor banks and the 900 MHz magnetron RF generator. This had failed to obtain an agreement inside the project. After this, a new coil system and a new vacuum vessel are designed to match the available NIFS current source. This project is planned to carry axial plasma / helicity injector systems as well as the Neutral Beam Injectors to obtain high beta plasmas. But this scheme was not granted by the NIFS committee in July.

After then, this project merged into the SPICA: CT injection group in LHD project. Here, even though the spherical torus / spheromak is produced by the sub-ms fast current start up scheme, it has the same current drive problems as FBX. Moreover, we should launch plasma for about 7 m from the injector throat to the LHD plasma center without tilting. The main part of the current grant is spent on the preparation of fundamental diagnostics for this SPICA.