§11. Study on Standardization for Fusion Reactor Designs and Construction of an Unified System Design Code

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In designing a fusion reactor, a huge number of plasma-physics and fusion-engineering parameters must be evaluated with taking into account relations among them. By incorporating these issues, system design code FUSAC[1] has been developed, and design/operation windows for tokamak fusion reactors have been studied.

Apart from the development and applications of system design code, a number of numerical simulation codes have been developed for diverse areas of plasma physics and fusion engineering. Integration of these detailed physics/engineering codes into system design code will bring refinement of design and performance evaluation of fusion power plants, and will bridge the gap between the huge number of operational parameter scans by system design codes and a final engineering design of each reactor component.

For quickness of such integration, an integrated system design code should have a 'robust' structure, that is, the integration can be completed without large change of a basic system design code and detailed physics/engineering calculation codes. Here we report current status of the development of the integrated system design code. We use Fortran 90/95 as a programming language. For efficiency of the integrated design code development, we have established the following programming rules;

1. Physics constants and input parameters are allocated to a private module, and referred in the main frame of the integrated code.
2. Variables interfacing with the main frame and detailed design modules are allocated to a private module and this module is referred in the main frame and these design modules.
3. These variables are interfaced with the main frame and detailed design modules via 'execution subroutines.'

As shown in Fig. 1, the detailed system component design modules are mediated by the 'switching module.' The role of the switching module is an interface for design parameters between FUSAC and the detailed design modules. Some detailed design modules are selected and executed via the switching modules; the others are not used according to analysts' design philosophy.

At first, we have integrated the plasma equilibrium calculation code TOSCA[2] into this integrated system design code. In the previous reactor design studies, two-dimensional analyses such as plasma equilibrium were performed *offline* based on a one-dimensional reactor configuration determined by system design code.

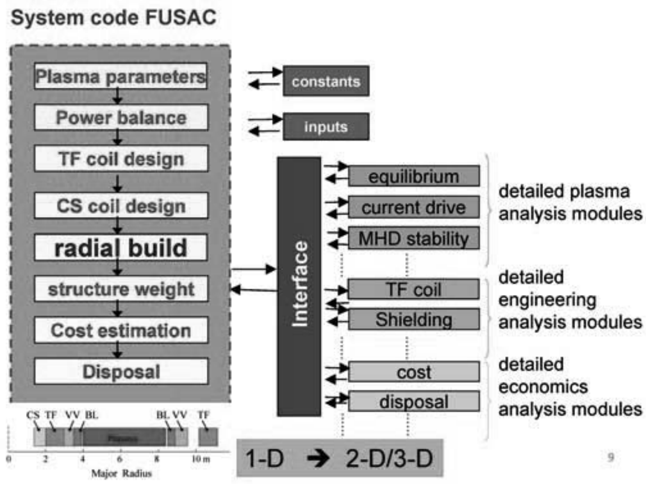

Fig. 1 Framework of Integrated Design Code.

Generally such an offline design studies include a lot of tedious trials and errors. The present development of the integrated system design code can demonstrate reactor design in which zero-, one- and two-dimensional analyses are integrated consistently and *online*. The FUSAC-equilibrium integration enables to *online* evaluate and optimize the position and current of each PF coil automatically.

As shown in Fig. 2, the number of PFC was assumed to be six as well as that of ITER. The position of two outer PFC (vertical field coil) are decided from the viewpoint of the opening for access ports, and two inner PFC (divertor coil) are automatically fixed at the top/bottom of the TF coil. While, optimization is carried out for two other PFC located between divertor and vertical field coils.

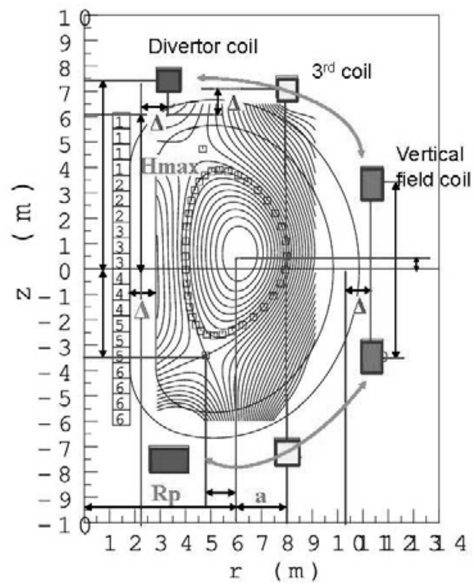

Fig. 2 PF coil positions for TOSCA equilibrium code.

[1] R.Hiwatari et al., Nuclear Fusion 44 (2004) 106-116
[2] H. Fujieda, et al., JAERI-memo 08-256 (1996)