4. JSPS A3 (China, Japan and Korea) Foresight Program

I. Project title

Study on critical physics issues specific to steady state sustainment of high-performance plasmas

II. Period of cooperation

August 2012 - July 2017

III. A3 foresight program in the field of plasma physics

The three countries, China, Japan and Korea (C-J-K), have recently built large toroidal devices called EAST, LHD and KSTAR having superconducting magnetic coils, respectively, and have successfully started the academic research aimed at the steady-state operation of high-performance plasma, which is an inevitable subject for the realization of fusion reactor. The EAST tokamak is characterized by a long pulse discharge with successful current drive and edge plasma physics research using high-Z plasma-facing components such as molybdenum and tungsten with high melting point. The KSTAR tokamak is characterized by the transport study on high-performance plasmas represented by H-mode discharge with edge transport barrier and the study for heat load mitigation of ELM activity in H-mode using various methods, e.g., pellet injection and stochastic magnetic field excited by RMP coils and so on. On the other hand, LHD is the largest HELICAL-type device, which confines the high-temperature plasma with the helical magnetic field generated by external helical coils alone. It is characterized by the steady state operation without the necessity of toroidal plasma current unlike tokamaks. Therefore, the properties of the LHD plasma are very distinctive and different from those of tokamak plasmas, e.g., the characteristic transport of high-energy particles based on three-dimensional magnetic configuration, the edge heat and particle transports based on inherently-equipped stochastic magnetic field and the disruption-free sustainment of long pulse plasma. By conducting joint research using the three world-class superconducting toroidal devices with entirely unique features, various advanced researches on critical physics issues to be resolved are possible toward the steady state operation of high-performance plasma. The proposed joint project will be certainly able to promote further development of plasma physics studies and fusion researches conducted by the three countries of C-J-K.

IV. Significant cooperative activities

When a discharge is longer, the handling of high heat load over the divertor and the first wall surrounding high-temperature plasma becomes a vital issue because it creates an entirely different situation from what has been studied in normal conducting toroidal devices with the discharge length strictly limited. The issue is a common and challenging subject among the three different devices in the three countries of C-J-K. The study of critical physics for the steady state operation of high-performance plasma is made possible only by superconducting devices and will produce important results for the first time with the three superconducting devices of C-J-K. Then, as the study focusing only on the critical physics that will be revealed for the first time by the steady state discharge of high-performance plasmas, the following three critical physics issues are listed up for the joint research among C-J-K as shown in Fig.1.

(I) Steady state sustainment of magnetic configuration
(II) Edge and divertor plasma control
(III) Confinement of alpha particles

The three issues still remain as open questions for the steady state discharge of high-performance plasma, i.e., 'Critical physics issues for steady state operation' in the steady state operation as shown in Fig.1. The issues involved three unresolved subjects, which have to be studied through the present Joint Research. Individual studies should be along with the planned 'Collaboration programs' (also see Fig.1), which consider the characteristics of each of the devices.

V. Activities in FY 2012

The first meeting was held in Jeju island of Korea on 22th August 2012 as the coordinators' meeting for A3 foresight program. The basic direction of A3 research collaboration has been agreed by director-generals among three institutes of ASIPP, NFRI and NIFS. The second meeting was held in Hokkaido of Japan during 22th - 25th January 2013 as the scientific seminar to discuss the detailed schedule of the collaboration in addition to the practical collaboration plan and young scientist education. The statistical summary for personal exchange between Japan and China and between Japan and Korea is listed in Table 1.

Table 1 Statistical Summary of A3 collaboration in FY2012

(including scientific collaboration, coordinator meeting in Korea and seminar in Japan)

J→C person (person-day)	C→J person (person-day)	J→K person (per.-day)	K→J person (person-day)
2(23)	15 (106)	6 (17)	14(143)

(Morita, S.)

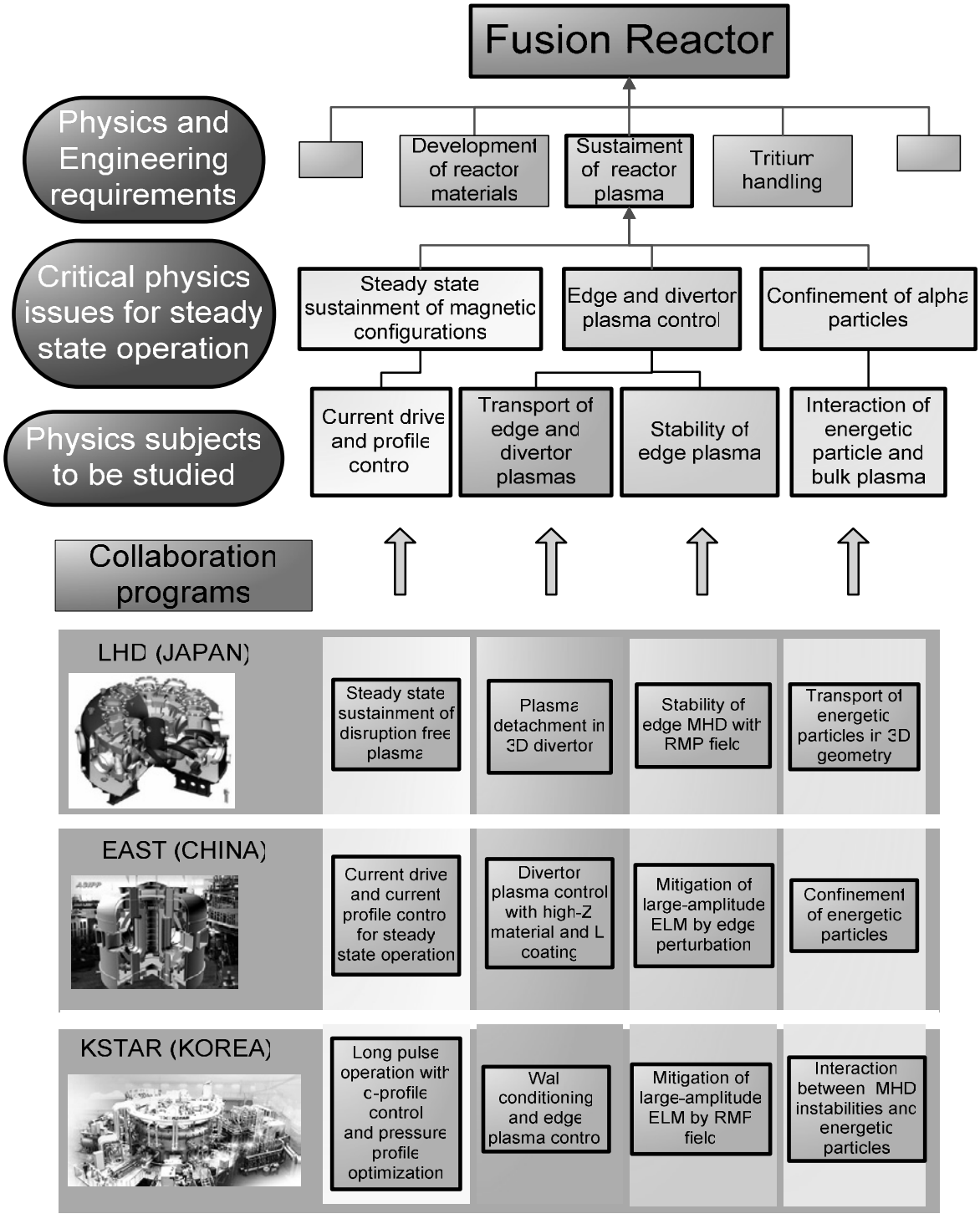

Fig.1 Schematic drawing on Joint Research Project among LHD (NIFS: Japan), EAST (ASIPP: China) and KSTAR (NFRI: Korea). Engineering requirements for the reactor can be reduced through the collaborative studies on critical physics issues specific to steady state sustainment of high-performance plasma. This Joint Research Project quests three 'Critical physics issues' for the steady state operation and these issues consist of four key 'Physics subjects' to be studied. The collaborative research is coordinated among 'Collaboration programs' by considering the characteristics and capability of three devices.