§10. A Study of History of Nuclear Fusion Research on the Basis of Historical Documents

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The reason why scientists should learn history, at least, of their own field is as follows. History is a dialogue between past and present, according to E.H.Carr. Generally speaking, to know history is useful and sometimes inevitable for future research. Especially in big sciences like nuclear fusion, scientists are sometimes involved in big projects. The project is to be planned on the basis of the "present" situation including academic significance, finance, manpower and so on. Recommendations and opinions on big projects are released by high-ranking committees like Science Council of Japan (SCJ) in response to present domestic environment surrounding science by taking account of world situation. Of ultimate importance is how we can make the project successful. Historical documents that are "evidence" of the "past" contain information on how projects were planned and carried out, and can give us valuable lessons. NIFS Fusion Science Archives can provide us with more than 22,000 historical documents. Scientists making plans on future project should avoid failures experienced in the past, if any, by studying the history.

SCJ initiated to discuss the program on big science projects in 2009. In the road map issued by SCJ in October of 2010 the plasma physics project to which one of the authors is related was nominated as one of 18 projects recommended to forward. This collaborative work on the study of history has gotten a boost from the plasma physics project that is being planned.

Importance of studying history has been recognized in some organizations including NIFS and KEK that are inter-university research institutes. Especially Sokendai (The Graduate University for Advanced Studies) that is composed of inter-university research institutes organized the project "History of Inter-university Research Institutes" and archival activities have been actively continued among inter-university research institutes. In this framework, the history of nuclear fusion research was studied from the predawn period of fusion research in the world to the inauguration of NIFS along with that of other inter-university research institutes. [1)]

Based on the activity in the Sokendai framework the collaborative work started to aim at describing more detailed history of experimental projects, i.e., JIPP T-II and Reacting plasma project (R-project), which were planned and/or carried out at Institute of Plasma Physics (IPP), Nagoya University. Once the project approved after sincere discussion at committee meetings the details are usually left up to staff of the project. In that context it is important to examine how the project was carried out on site on the basis of documents. Both of the authors were involved in the projects, which is advantageous to supplement information from documents.

JIPP T-II that started operation in 1976 was the hybrid machine of tokamak and stellarator. The main purpose was to produce plasmas with electron temperature of keV-range and to compare plasma confinement characteristics of tokamak and stellarator in the same vacuum vessel. At that time the plasma current was thought to be the key parameter of confinement. One of main subjects of tokamak was to maintain the equilibrium by feedback control in a resistive shell. The toroidal magnetic field was 3 Tesla for tokamak operation of which magnitude was the highest in Japan at that time. Looking back at history the remarkable point was the later decision of installing shear panels. This was to protect the over-turning moment on TF coil. Shear panels resulted in strong limitation to heating and diagnostics. If the shear panels were not installed good accessibility was kept although it should be operated at reduced magnetic field. This symbolized that JIPP T-II was the engineering machine rather than the machine aiming at elucidating physics mechanisms. Unfortunately profile measurements of plasma parameters were under development, which means transport study was not ready. The feedback control of the plasma position was successfully demonstrated. In the current-carrying stellarator operation it was shown that the plasma disruption did not occur at the iota of more than 0.14 due to the strong positional stability inherent of external helical fields. However, currentless operation was not realized because this subject was not taken into consideration at the planning phase. Because IPP was the inter-university research institute its mission should be to promote academic studies rather than development ones that should be covered by JAERI. More discussion should be needed in advance what is to be done in JIPP T-II experiments.

In the R-project the same thing happened. The confinement study of burning plasma was important from academic viewpoint, however constructing the tokamak where tritium was to introduced was not the task of IPP. It is apparent that to cover tritium handling, remote handling, radiation damage to diagnostics and so on by limited manpower was beyond the ability of IPP. From the academic viewpoint of elucidating physics mechanisms diagnostics were limited. Some of neighboring citizen were against the introduction of tritium from radiation safety viewpoint. The approval by citizen was the necessary condition for MOE to approve the project. Finally the project was not approved.

In summary the research in inter-university institutes should be based not on development aspect but on academic aspect within a reasonable budget. The achievement was reported at the 8th Joint Meeting on Fusion Energy in June 2010 at Takayama-city. The number of the collaborative research is NIFS08KVXJ012.

1) Matsuoka, K., et al.: "History of Interuniversity Research Institutes" issued by Sokendai (2010).