Social Aspects of Japanese High Energy Accelerators

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Abstract

Japanese research to build accelerators for high energy physics started with Electron Synchrotron at Institute of Nuclear Study, Univ. Tokyo (INS). The development was slow in the beginning, in particular before the construction of KEK-PS. After the experience of TRISTAN, KEKB, one of the best colliders in the world, was eventually constructed. We will review the history of high energy accelerators in Japan from physics, technological and particularly social points of view referring to documents at KEK and other archives. This is the first of a series of papers and will outline the over-all view.

INTRODUCTION

For a big-science laboratory to succeed, the scientific ability is no doubt necessary, but not enough. It needs human resources including scientists, engineers, and technicians, industrial support nearby, acceptance by the neighboring inhabitants, suitable organization and above all the financial support usually from the government. All these are related to the social aspects of the sciences.

In this paper, we review the history of the high energy accelerators (HEAs) in Japan from the historical and social points of view.

INS

By the end of World War II, Japan had a research group of "Nuclear Physicists", including the theorists and experimentalists of cosmic ray physics (CRP) and nuclear (low energy) physics (LEP). In particular, four cyclotrons were constructed in Japan for LEP. General Headquarters destroyed all of them in late 1945, and any experimental research on LEP was forbidden. The nuclear physicists and the "cyclotroneers", however, were kept well. After the occupation, physicists re-started the studies and the three cyclotrons were easily re-constructed in the original institutes. Nuclear physicists, with their national network, became a strong and organized group in the academic society in Japan.

Establishment of INS

INS started in 1955. Its foundation was proposed by the Science Council of Japan (*Gakujyutsu Kaigi*)(SCJ) in 1953. It was accepted by the Government as the joint-use institute attached to Univ. Tokyo, a National University. The "joint-use institute" was thought to be a "property" of the society of the researchers from the SCJ point of view. This contradicted the autonomy of the university, if INS was controlled by the researchers all around Japan. The president of Univ. Tokyo (T.〜Yanaihara) claimed a condition (Yanaihara Discipline) to keep the autonomy of the university. Eventually, the both sides agreed with a solution that ensured the virtual autonomy of the researchers and the nominal one for the university.

The local people (Tanashi town) were against the construction of the laboratory related to "nuclei". It was natural after several related incidents; nuclear attacks to Hiroshima and Nagasaki, the cold war, sacrifice of fishermen in Dai-5-Fukuryumaru (1954) and the abrupt emergence of the nuclear budget (1954). The conflict with local people was settled partly by sincere dialogue between physicists and local people[2] and partly by the establishment of the local committee to watch INS. The issues raised by the "lay-people" in the dialogue were documented by S. Tomonaga[3]. Some are still meaningful today.

Electron Synchrotron (ES)

The primary target of INS was the construction of a (synchro) cyclotron for LEP, to that the human resources were available from the group inherited from before the World War II. For the synchrotron, however, very few experiences were accumulated. Some physicists came from the laboratory of G. Miyamoto, who pioneered the AG-synchrotron in Univ. Tokyo[4]. Some came from the laboratory of T. Kitagaki, who pioneered the separated function synchrotron[5]. Except for H. Kumagai, the leader of ES, few cyclotroneer in INS joined ES[6].

ES succeeded the acceleration of electron to 600 MeV in 1961, and was up-graded to 1.3 GeV later. ES produced the community of the high energy physics (HEP) in Japan. In particular, the group "synchrotroneers" was newly born. A number of graduate students from various universities joined the experiments and got doctoral degrees[8] . They formed main clues of KEK construction.

INS then had facilities and researchers of LEP, CRP and HEP

POST-INS "FUTURE PLANS FOR NUCLEAR RESEARCH"

Nuclear Study Special Committee (*Kakutokui*) (NSSC) of SCJ was almost as early as SCJ . It was influential in the early stage. From human point of view, it was a continuation of the Nuclear Physics group in the pre-war stage. Though failed in getting the control of the research of nuclear power, NSSC has succeeded the construction of cyclotrons and the foundation of INS. Powered by the successful result of ES, NSSC then proposed the Future Plans

for Nuclear Research (FPNR), which included HEP with a new Institute for Particle Physics (*Soryusi Kenkyujyo*)(IPP) as its center. The scope was still wider. The important issue was the management system. All the related laboratories in the universities, joint-use institutes and IPP are governed by the "Research Organization of Physics" (ROP) that was managed by the representatives of the researchers. The hope was the perfect autonomy of the researchers against the government.

The history from FPNR to KEK is complicated[9, 10]. The government was favorable to the proposal, at least in appearance, but did not have the budget. The discussion was put to the newly founded Science Council of the Ministry of Education (*Gakujutsu Shingikai*)(SCM) . There, only the HEP part of IPP was discussed separately from the whole ROP idea and still the criticism for the huge budget arose from other fields. SCM concluded that HEP part of IPP could be accepted with the budget reduced to 1/4. It brought a big dispute within the Nuclear Physics community. The HEP community accepted it because it was the only possibility to survive, but it implied that the HEP abandoned the "trinity" of CRP, LEP and HEP. NSSC eventually accepted it after the government provided the budget of the new institute.

Acceptance of 1/4-Reduction made several things clear. 1) the autonomy of the scientists as pursuit by FPNR became unrealistic. 2) the conflict within the science society cannot be resolved by the democracy as assumed in NSSC and SCJ, 3) Hence the SCM became to play more important role in the science policy from then. Actually, the discussion for TRISTAN was done only through SCM. Big science projects contradict democracy and the conflict can be settled only by the government leadership. From the facility point of view, however, most of the claims appeared in FPNR were realized eventually, RCNP in Osaka Univ. (1971) for LEP and ICRR in Univ. Tokyo (1976) for CRP etc. The autonomy in each group was kept to some extent, too.

KEK

KEK, National Laboratory for High Energy Physics, started in 1971. It was the first *Inter University Research Institute* (IURI), which is independent from a particular university. Physicists of the universities could come to KEK to do their experimental researches and KEK provided the travel expenses and the necessary facilities, too. The management was similar to INS, basically based on the opinion of the researcher community.

Even though there were no (proper) students of KEK, the researchers had educational positions such as professors and so on, quite identical with the universities. This allowed the researchers certain academic freedom as in the universities. The academic freedom of KEK researchers worked well. There were several bottom-up activities at KEK. One example was the voluntary activity for the data compilation of the world-wide high energy experiments[11]. In addition, KEK was entitled for the education to the graduate course students. It resulted in the rapid and effective growth of the HEP laboratories in the universities. Professors of the university could send their students to KEK and they did their Ph.D. researches there. This was also the basis for the foundation of the graduate university for advanced studies (Sokendai) in 1988. KEK created the budget for the travel of students. It was not so in INS[12].

KEK established the technology division where technicians can stay long and be promoted appropriately.

KEK Proton Synchrotron (PS)

A 12-Gev proton synchrotron, KEK-PS, was the first HEP accelerator in Japan. Physicists were not experienced enough yet. The number was not enough, neither. Lee Teng, the head of FNAL Accelerator Division then, visited KEK in 1972. He felt that the researchers at KEK accelerator did not do research actually but supervising the industries constructing PS[13].

Neighbors of KEK was not strongly against the construction and operation of KEK. Nevertheless, the leaders of KEK paid a lot of attention to the public relationship. K. Takahashi became well acquainted with the local leaders (mostly rich farmers) and visited them frequently[12]. KEK started the Open Campus to make good relations to local people as early as April 1976[14] in the year of the first joint-use of PS .

Within KEK and HEP community, the "democracy" was kept. By the proposal of HEP society, the participation of the physicists of non-national universities became possible. Physicists felt the management of KEK democratic[15]

TRISTAN

The consideration of the next-PS project TRISTAN started as early as 1973. An e^+e^- collider with 60 GeV CMS energy, the highest in the world then. The economic growth of Japan became remarkable in that period. It was supported by the SCM in 1977 and approved in 1981.

The ideological bases for TRISTAN were 1) the backwardness in the fundamental science in Japan became remarkable and was thought to be unsuitable for developed country, 2) in the US-Japan economical conflict, Japan was accused as a free rider of the fundamental science, and 3) the fundamental science could promote the industrial growth, inheriting the Bush point of view[16], though it was already to be discarded in US. It was expected that several Nobel prizes could be obtained by TRISTAN experiment.

The number of accelerator physicists increased rapidly. The core members were supplied by the PS projects, while the new and young physicists were supplied by the already-grownup HEP institutes in the universities. They were young Ph.D holders majored in HEP and elementary particle theory. Very few came from engineering.

Besides the construction and the operation, accelerator physicists could participate in several bottom-up projects. The computer program SAD (Strategic Accelerator Design) was one of the remarkable outcomes of the academic freedom. TRISTAN accelerator was designed using several imported codes (with some modification). Some theorists felt it uncomfortable and decided to make their own code, including many new ideas[17]. It provided an essential tool for the design, operation and improvement of KEKB. R&D of the linear collider started also at this period as a bottom-up activity.

TRISTAN was a great success from accelerator point of view but not so when seen from outside. It did not find the top quark or anything remarkable. Thus HEP society met a serious difficulty. There was a possibility that KEK participated in SSC around 1990. KEK could avoid it because it could show B factory as its future plan[18] .

KEKB

KEKB started also as a bottom-up activity and later became an authorized activity.

After its authorization, the parameter committee was established which governed all the decision on its design, quite different from the earlier projects. KEK-PS shows the evidence that it was an assembly of parts designed independently. Design of TRISTAN was more centralized but still some parts were made independently. The parameter committee could make use of the experience of TRISTAN, added new ideas, and decided all the details of the accelerators. The committee was supported and respected because of the confidence gained through TRISTAN project.

DISCUSSION AND SUMMARY

The six variables were proposed in the introduction; scientific expertise, human resources, industrial support, acceptance of neighbors, suitable organization, and financial support. Through the discussion above, it might be concluded that HEA community has successfully assembled those six necessary resources.

Manpower for HEAs has been supplied by HEP society largely, which was empowered by the joint-use of accelerators in turn. This made a loop of positive feedback. Qualitative and quantitative improvement of the industries of Japan enabled the economical growth in 1960's. This no doubt enabled the foundation of KEK from budgetary and technology points of view. The further growth of the economy in 1970's favored the planning of TRISTAN and large-devices of other fields, Subaru telescope[19], LHD for fusion science[20], etc. TRISTAN, with the huge enlargement of the accelerator physicists, made Japanese HEA society one of the leading groups in the world. In 90's, though with the economical depression, KEKB could be constructed on the bases of all the previous investments, becoming the best outcome of HEAs in Japan. It could not be realized without TRISTAN, KEK-PS and INS-ES. The HEA society has grown continuously, accumulating the experiences and transferring the knowledge to the next generations. In transmitting the experience, the continuity of the group played the essential role. It might be the characteristic point of the HEA society in Japan[21]. The mobility of researchers is not always productive. The bottom-up activities allowed by the academic freedom were quite important and even indispensable[22].

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