

## §8. Studies on History of Fusion Energy Conference and International Exchange of Nuclear Fusion Research in Japan

Amemiya, T., Uematsu, E. (CST, Nihon Univ.), Matsuoka, K., Namba, C., Iguchi, H., Kimura, K., Obayashi, H., Kuroda, T.

We report the results of our research on history of nuclear fusion research carried out by the cooperative research “Archival Studies on History of IAEA Fusion Energy Conference”. These results were based on the historical documents that are kept in NIFS Fusion Science Archives and so on. In this fiscal year, we studied 1) History of Tihiro Ohkawa’s nuclear fusion research in 1960s II; 2) On the comments of Japanese attendee to the Third International Conference on Plasma Physics and Controlled Nuclear Fusion Research and its effect on the research in Japan.

### 1. History of Tihiro Ohkawa’s nuclear fusion research in 1960s II

Tihiro Ohkawa is the most famous researcher among Japanese nuclear fusion researchers. We investigated nuclear fusion research on multipole devices by Ohkawa and General Atomic multipole group from 1965 to 1970.

In 1965, Ohkawa announced the effectiveness of average minimum B by the Toroidal octopole experiment at the Second Conference on Plasma Physics and Controlled Nuclear Fusion Research (IAEA Conference). After the conference, he and GA multipole group started a comparative study of octopole and quadrupole systems. They made tabletop (small) toroidal devices with eight current rings and compared the behavior of plasma in quadrupole and octopole configurations. Unfortunately, the stability boundary in the quadrupole configuration couldn’t be found because fluctuations were observed throughout the plasma discharge. Based on the experimental results of tabletop devices, toroidal octopole was converted to quadrupole configuration to compare the instabilities and the confinement time with those of octopole. The comparison between the configurations in large devices was presented at the Third IAEA Conference in 1968 by Ohkawa, Masaji Yoshikawa and Arther A. Schupp, Jr. During this conference, Ohkawa intimated a framework of “hybrid of Tokamak and multipole (Doublet)” at the informal meeting of low beta plasma.

At the above meeting, Ohkawa was concerned about the basic problem of plasma physics for nuclear fusion research. The reason why he converted the device configuration from octopole to quadrupole was discussed in

his paper as follows: “A quadrupole has the advantage that the rings are in principle force-free. Thus a quadrupole can be designed with very small supports just sufficient to hold the ring against gravity when there is no magnetic field.” Ohkawa had thought that the purpose of multipole devices was to understand their fundamental limitation and to see if it could be removed. He came to the conclusion that the multipole device didn’t become a practical fusion reactor, and therefore proposed to change multipole internal rings into toroidal plasma current.

### 2. On the comments of Japanese attendee to Third International Conference on Plasma Physics and Controlled Nuclear Fusion Research and its effect on the research in Japan

The Third International Conference on Plasma Physics and Controlled Nuclear Fusion Research was held at Novosibirsk in U.S.S.R in 1968. In Japan, Six papers were accepted by paper selection committee of this Conference. Participants were Shingo Imatsu(Niigata Univ.), Ryohei Itatani(Kyoto Univ.), Akira Miyahara(IPP Nagoya Univ.), Shigeo Nagao (Tohoku Univ.), Sadao Nakai (Osaka Univ.), Haruyuki Ohnishi(Nihon Univ.), Takami Okuda (Nagoya Univ.), Kosuke Okamoto (The Institute of Physical and Chemical Research), Koji Uo(Kyoto Univ.), Masatoshi Tanaka(JAERI), Masatomo Sato(Nihon Univ.), Kazuo Takayama (IPP Nagoya Univ.), Taijiro Uchida(IPP Nagoya Univ.), Chiyoe Yamanaka (Osaka Univ.), Masayoshi Umeno (Nagoya Univ.), and Yukio Sakagami (the Technical college of Nara).

Special mention of this conference by Japanese attendee is as follows:

- (1) All Japanese reported that multipole devices were concluded to not arrive at practical nuclear fusion reactor and torus device (especially, Tokamak T-3 in U.S.S.R) exceeded the Bohm diffusion limit.
- (2) C.Yamanaka made mention of laser plasma researches presented at the informal meeting.
- (3) Based on results of this conference, T.Okuda suggested that a research structure of Japan had to be changed from research of fundamental plasma physics into that aiming at nuclear fusion reactor.
- (4) M.Tanaka compared the policies of nuclear fusion research between USA and U.S.S.R. His conclusion was as follows: USA was in a position that basic research of plasma physics by multipole was regarded more important than research of comprehensive approach. On the other hand, U.S.S.R executed the comprehensive approach by the use of Tokamak.

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