# Mechanical Engineering of Accelerators

When promoting accelerator science, it is very important for scientific development to advance the elucidation of a real proof and a physical law for new theory. "The purpose of many of experiments is to verify a theoretical model, and theory builds the new model which describes a nature based on the knowledge acquired in the experiment." is declared in the KEK road map (2013).

On our activity, based on the idea of a scientist or a researcher, an engineer will develop an experimental device jointly. In this case it is important that the experimental devices and technologies which matched the needs are developed. For the purpose, first of all, joint development by the teamwork of an engineer and a researcher, i.e., the development by engineering and a science, is an indispensable condition. I have the opportunity to prepare and build an experimental device and prototype machine, and cavity fabrication facility in KEK.

How should we manufacture the craftsmanship of the scientific-experiments field of which large-sized R&D equipment recently? It is difficult for our team to maintain enlargement of an experimental device, and the highest level technology. Therefore, the development of the machine element, the evaluation test and accumulation of experimental data expected to be related to large-sized equipment development are developed usually as an important issue. I think that the technique of integrating such basic technology should be taken at the time which needs a large-sized institution and equipment as development.

And also these fundamental technical development research activities are asked for participation of the young man who will play an active part in five years and ten years. And technical tradition is performed to them.

In this session the development of technology and the status of the highest level engineering technology in KEK are explained based on actual activity.

About the scenario of developing and evaluation for facility and equipment

Cavity Fabrication Facility (CFF)

In the development of the superconducting cavity for accelerator that is the main composition equipment of International Linear Collider (ILC), electron beam welding (EBW) becomes an important process on the cavity of which the Nb material is used. The technology of EBW influences the cavity performance that is cavity gradient. Because of EBW in the equator part of cavities and large amount of process is needed for cavity manufacturing process. In KEK we constructs the pilot

plant where the superconducting cavity processing technology by EBW. A clean room was completed as of March of 2010. The main process equipment, that is Servo Press Machine, EBW machine and the Chemical Polishing (CP) processor and so on were installed in a clean room.

The purpose of this facility is to establish manufacturing technology for cavities, reduce production costs, and promote manufacturing technology of the cavity. For example, we take a specific approach to provide work space for joint development on cavity manufacturing. We also want to collaborate on the R&D activities with others aiming at the industrialization of cavity manufacturing in the future. In other words, the purpose is development of human resources and handing down (continuation) of the technology which we have created. We want to proactively work on establishing cavity manufacturing technology.

If the optimum procedure is established through this activity, by using our process as the basis for validation of the cavity manufacturing process, we expect that the facility will be used not only by KEK but also by private companies, and relevant research institutions.

Electro Polishing (EP) facility for superconducting cavity

In the high energy physics the ILC is investigated and designed by many scientists in the world. As the main technology for the ILC super conducting technology is selected in 2004. A surface treatment by the Electro Polishing (EP) for a superconducting cavity is very important process. In KEK according to the back ground we constructed the EP system at the Superconducting Test Facility (STF) building in KEK. We tried to evaluate the performance of tanks and each facility to continue the practical use. On this EP performance for superconducting cavity the basic result of KEK is the top level of the world. We research the best performance of EP for cavities that are developed the good recipe on EP process.

Assembly clean room for superconducting Nb cavity

In order to assemble the parts in high cleanness condition, a clean room is one of the necessary facility, Here is a clean room of double room type that large room in class ISO 6 has small room in class ISO 4. Mechanical Engineering Center (MEC) and Accelerator Laboratory (ACCL) collaborates to develop this clean room at STF building. For superconducting cavities as ILC that need the highest clean room any time, it is expected for researchers to assemble the good performance cavities in this clean room.

T0 chopper for neutron beam line

To utilize 2 eV neutrons, we designed and assembled a To chopper running at 100 Hz for the beam cross section of 80mm×80mm. The chopper blade (Shielding part) is 82mm×82mm×300mm (300mm is the length along the beam) with a margin of ±1mm with respect to the beam size. This margin corresponds to the phase control accuracy of ±5μs. The rotating radius of the rotor is 300mm. The rotor material was chosen to be Inconel X750 from the mechanical properties at room temperature as well as the activation properties. The fluctuations of the rotational phase were within 1.5μs(Peak to peak). This is well satisfied with our specification for the phase control accuracy of ±5μs. The level of vibrations in this system was also reasonably good. Then, we started a continuous running test in order to evaluate the life time as well as to examine the auto stop system in case of emergency. The first model of the 100Hz T0 chopper, second model of the 50Hz T0 chopper and others were installed into neutron beam line at J-PARC.

Fermi chopper for neutron beam line

We developed a Fermi chopper which has function of high rotation speed as 600Hz and high accurate phase control of rotor by using a rotation system similar to turbo molecular pump with magnetic bearing system. For the realization of the 600Hz Fermi chopper, we developed on several items that are the fundamental condition, slit materials, rotor, and the control circuit. The speed control performance of the prototype was investigated. Further investigations are required for slit materials, but we confirmed a good phase control performance of the magnetic bearing rotation system with the outside. We succeeded in the Fermi chopper that accuracy is 600Hz±0.001Hz.

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Ultra-precision machining for structure

X-band (11.424GHz) is a method which provides high gradient to accelerator structure, and accelerators high speed particles (Electron, positron) passing through the structure. It is important for the X-band accelerator structure to achieve stable electric field performance under a condition of the high gradient over 65MV/m. Therefore, an accelerator structure of high degree of precision is required. In order to meet this requirement we have worked on developing high precision machining applied to disks for the accelerator structure. The key points of machining of the disks are described.