

## § 16. Development of a Heavy Ion Beam Probe for LHD

Ido, T., Nishizawa, A., Kawasumi, Y., Tsukada, K., Kato, S., Yokota, M., Ogawa, H., Inoue, T., Hamada, Y.

A heavy ion beam probe (HIBP) is being developed to measure potential and density fluctuation in plasmas. The LHD-HIBP system is composed of a negative ion source, a tandem accelerator, beam lines, and an energy analyzer. We progressed the development of all components, but we could not attain the potential measurement in this campaign. The progress of each component is described below.

### *Accelerator*

At the end of August, the operation of 3 MV tandem accelerator was finally permitted by the authorities concerned. Then, we started the check of its performance in high voltage range. The accelerator was installed in the LHD Building in 2000 after it had been tested in the Diagnostics Building. At this time, the pressure vessel made from iron was remade with stainless steel so that it does not affect the magnetic field of LHD. Thus, the performance check is for the first time after the reconstruction.

The aging of the accelerator was continued for a few weeks and the output voltage reached to 2MV. However, the load current of the Schenckel-circuit increases extraordinarily in the output voltage range of 1 MV or more. The anomaly in the load current is reciprocable, so the accelerator can not reach to its rated voltage in present.

Moreover, SF<sub>6</sub> gas leaks from the gas cell into the beam line, so the vacuum of the beam line is not good and a part of the injected beam damps in the accelerator.

It needed to be repaired, but it was operated in the voltage range of 2 MV or less in this campaign of LHD because of no time. We must repair it in next year.

### *Ion Source*

In LHD-HIBP, a spatter type Au<sup>-</sup> ion source is used for the tandem accelerator. It had been developed in NIFS and the energy spread is under 10 eV for HIBP. The output current of Au<sup>-</sup> is 3.6 μA, that is small for the plasma diagnostics but enough for the beam trajectory trace.

It is operated with a remote control system developed by using PLC and COACK (Component Oriented Advanced Control Kernel), that is a kind of programming language developed to control various hardware in the

High Energy Accelerator Research Organization (KEK).

The ion source system works substantially, but we should improve the ion source itself to obtain more output current for plasma diagnostics.

### *Beam Line*

The performance of the beam line was continued to be checked.

The stray field of LHD affects beam line components as well as the beam trajectory. In an electrostatic deflector (7.8CD), which is located about 5 m apart from the center of LHD, the breakdown was enhanced by stray field of LHD. Although the deflector can be applied the voltage of 38 kV without the stray field of LHD, its breakdown voltage becomes a few kV in the stray field.

We persistently continued the aging of the deflector in the stray field. We use other power supplies because they can work even in the overcurrent by the control of the output voltage. As the result, the break down voltage increased little by little and reached to 20 kV, which is limited by the performance of power supplies. The aging in the stray field is necessary because the path of the free electron should be affected by the field. We need new 40 kV power supplies and we will check the breakdown voltage in next year.

We tried to trace the beam trajectory with detectors in the LHD vacuum vessel. Unfortunately, the controller of the electrostatic steerer, which was used to compensate the deflection of the beam trajectory due to the stray field, had something wrong, so we could not inject the beam into the LHD vacuum vessel. It has been already fixed, so the trajectory trace will be carried out in next campaign.

### *Energy analyzer*

A new type of energy analyzer is being developed in the Diagnostics Building. It has two anodes so as to reduce the required voltages; the voltages of 56.5 kV and 113.6 kV for 6 MeV beam are applied on the 1st and 2nd anode respectively.

It has been already constructed and the performance is being examined.