§12. Development of ECE Diagnostics on LHD

Nagayama, Y., Sugito, S., Kawahata, K.,

The electron cycrotoron emission (ECE) diagnostics has been developed on LHD. Since the intensity of the ECE is proportional to the electron temperature and the frequency is proportional to the magnetic field, the ECE diagnostics has an unique capability of measuring the local electron temperature continuously.

Block diagram of the LHD ECE diagnostic system is shown in Fig. 1. The ECE from the LHD plasma is collected by a big antenna and transferred through the corrugated waveguide system to the diagnostics room (2), where the ECE is divided to the heterodyne radiometer and other by the use of a wire mesh polarizer. The other polarized ECE is also divided to the fast scanning Michelson interferometer (FMI) and Grating polychromator (GPC) by the use of a rotatable polarizer. The ECH heating frequency (84GHz and 168GHz) is eliminated by an interference notch filter, which is made of 170 parallel plastic films in the corrugated waveguide.

The corrugated waveguide has an extremely low loss transmission system. In FY1996, the corrugated waveguide is installed by Kuriharant Co. in the basement of the LHD building. The rest of the waveguide is to be installed after the middle stage in the LHD hall is established. The corrugated waveguide and the most components (filters, polarizers, etc.) are made of General Atomics (GA).

The big ECE antenna is developed in Princeton Plasma Physics Laboratory (PPPL) under the US-Japan collaboration program in FY1996. On the antenna, a large concave mirror collects the ECE microwave and a small convex mirror injects the ECE into the corrugated waveguide. The effective diameter of the main mirror is 40cm and the distance from the plasma is 280cm. The spatial resolution is 6cm. The main mirror is made of copper and is cooled by the water in order to work under the continuous high power (10MW) LHD operation. The main mirror is rotatable in order to look at a calibration source, which is set opposite side of the plasma. Therefore the ECE calibration in LHD is as easy as in TFTR. The bearing of the main mirror is a critical part. The first bearing material was macor, but it was broken easily. At NIFS, the vespor (polyamide) bearing was installed and it works very well.

A vacuum test chamber for the ECE antenna is built at the diagnostics building. Helicoflex type metal O-ring, which is made by Usui Kokusai Sangyo Co., is used for the ECE racetrack shaped flange. The performance of this O-ring is satisfactory. The helium leak is undetectable, when the antenna port is covered by the plastic bag which is filled by the helium.

The vibration of FMI is a serious noise source. In FY 1996, an anti-vibration structure was developed by the machinery group of the engineering division at NIFS. This is a heavy plate which is floated by air springs. Since the position of the 1 ton lead weight is low, this floating structure is stable. The noise sound level decreases significantly, and the vibration at the detector is undetectable by a human finger.

The calibration source is a hot source, which is made by Graseby Specac Ltd. in England. Since this is portable, this source can be used in the LHD vacuum vessel when it is open. The shutter of the hot source is under development in the diagnostic engineering section in the engineering division at NIFS.

The development of ECE diagnostics is continued in order to be one of the diagnostics of the first LHD plasma.

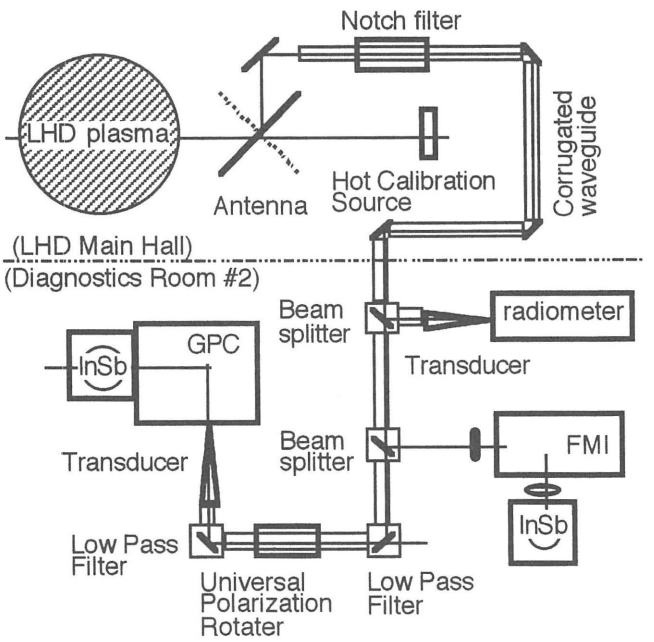

Fig. 1 The LHD ECE diagnostic system.