§5. Arc Sensor System

Mizuno, Y., Kubo, S., Shimozuma, T., Idei, H., Yoshimura, Y., Haba, K., Takita, Y., Kobayashi, S., Ito, S., Sato, M., Ohkubo, K.

The 88.9 mm ϕ corrugated waveguide system is used to transmit the high power millimeter waves from a gyrotron to the LHD. Sometimes, arcing occurs inside the waveguide system during high power transmission. Such arcing may give a fatal damage on a gyrotron by a high power microwave reflected back to the gyrotron. The fast detection of the arcing and fast response interlock system to shut down the power supply system for the protection of the gyrotron are necessary. The arc sensor system consists of the sensor units and discriminator units. The sensor units detect light from the arcing. The discriminator unit distinguishes which sensor worked and furthermore, which detects at first among connected sensors. A detailed description about these units is found in Ref.[1]. These systems were prototype and demonstrated that similar system is applicable to the real high power transmission system by a commercial flash lamp of a camera. In this fiscal year, we started the manufacturing and the installation of the arc sensor system in the existing transmission line. The light of the arcing inside the waveguide is guided to the sensor unit by a optical fiber with the core diameter of 200 μm through a small hole drilled in the mirror of the mitterbend. Eight sensors are installed in each transmission lines. One of them is installed on Matching Optics Unit (MOU) of the gyrotron mainly to monitor the arcing on a gyrotron window. The others are installed on the mirror of miter bend. The holes in the miter bend mirror are drilled so as to collimate and distinguish the lights from forward and backward in the waveguide. Fig. 1 shows the total waveguide transmission system for LHD with the positions where the arc detectors are installed. The unit that detected an arc sends a signal to a discriminator unit. Each arc sensor unit has an optical status output. The status is sent by an optical fiber to prevent the miss operation due to the electromagnetic noises. Each discrimination unit sends a stop signal to a high voltage power supply connected to each relevant gyrotron. The response time of each discrimination unit is about 20 μs. In order to define the position where the arcing occurs, the sensor unit that operated first for one event should be discriminated. It is necessary to adjust the time lag between the light detection for each sensor and the receipt of the status for the discrimination unit for this purpose. There are about 60 meters difference in the distances between the sensor units and the discriminator unit. There are two methods to compensate this difference. One is to use the optical fibers of the same length to send the status of each sensor unit to a discriminator unit. It is relatively easy but costs much. Furthermore, it is necessary to manage lengthy optical fibers. Another method is to compensate these time lags by electric circuit. We realized these compensations by the delay line utilizing the response delay of the TTL. The circuit is designed so that the delay time can be adjusted form 0 to 350 ns by 5ns step. The behavior of this delay circuit is confirmed using the flash lamp. The manufacturing of this system has been completed the fourth cycle experimental campaign of LHD. Therefore, it is not used for the operating transmission system yet. Main concerns for the real system are the adjustments of the sensitivity of each sensor and the time lag. The sensitivity of the sensor is set at the maximum now. It might be necessary to replace optical fiber to guide the light from the hole of the mirror to the detector. The compensation of the time lag is completed assuming the same intensity at each sensor, but in reality, it might be necessary to readjust the sensitivity or time lag. The system will be operational from the beginning of the fifth cycle experimental campaign of LHD.

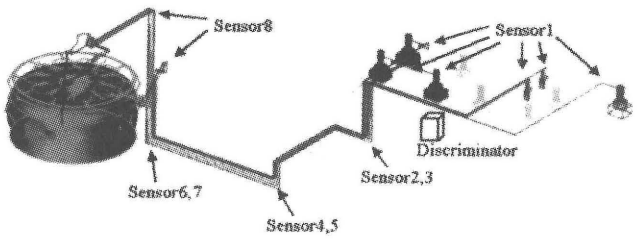

Fig.1: total waveguide transmission system for LHD with the points where the arc detectors are installed.

Reference

1) Mizuno, Y. et al. NIFS Annual Report FY1999, p122.