§2. Development of Arc Detector System

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

ECH system for LHD have been operated with 6 transmission lines during LHD third cycle experimental campaign. The total distance of the transmission line ranges from 90 to 110m between the window of each gyrotron and LHD. Number of miter bends used on a transmission line is about 15 for each line. Once arcing occurs in this long transmission line during the experiment, a decrease in the threshold level of arcing may be due to the remaining ozone and dusts blown up by the shock wave of the arcing in the waveguide. In the worst case, the system is forced to be stopped until the termination of cleansing of the inside of the waveguide. So far, the arc detectors have been installed on the both end of transmission line, mainly to protect the gyrotron and vacuum windows. It is urgently required to identify the position of arcing in the transmission lines and immediately shut down the microwave power to minimize the after effect of the arcing. Arc detector system is under development for the use of multi-point monitoring and fast interlock capability. In order to fulfil the first requirement, each sensor should be compact and be connected to the point of monitor with optical fibers. The cut-off holes on the miter bend mirrors with would be the best place for monitoring the arcing, since the miter bend is the most critical component for the arcing in the transmission line. By setting the line of sight along the axis of the waveguide, the arcing at the miter bend or at the waveguide in between would be detectable from the miter bend on the opposite side of the waveguide. Fig.1 shows the block diagram of arc detector system. Arc detector system consists of 2 parts. One is the detector circuit of arc. The other one discriminates the time of detection of the arcing. The light of arcing is transmitted by optical fiber from waveguide to arc detector. Arc detector receives the light by photodiode. When quantity of light exceeds a threshold level, arc detector outputs a signal of 12V. This signal is sent to discriminator system. This discriminator system has receive the output signal from each detector and turns on the LEDs corresponding to all the points where arcing are detected and discriminates fastest detection point by flashing.

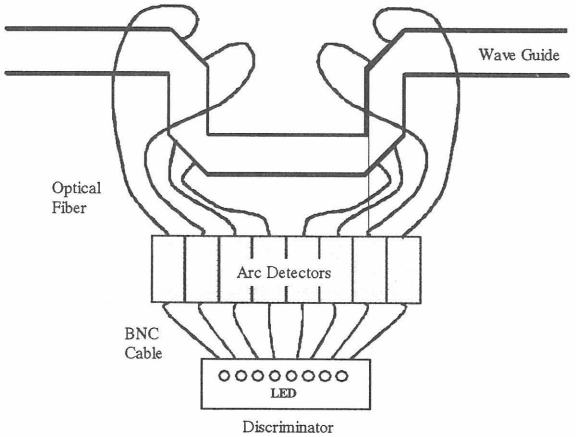

Fig.1: Block diagram of arc detector system

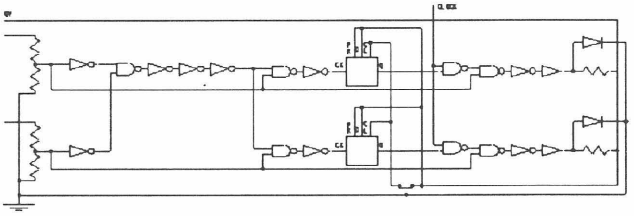

Fig.2: Logic circuit of prototype discriminator.

The prototype circuit of this discriminator with 2 inputs is produced and tested. Fig.2 shows the logic circuit of the prototype. Signals are put from left side of Fig.2. An input signal is divided into two. One passes through several inverters to make short positive edge trigger pulse with the length of delay time through inverters. This pulse length determines the resolution of the time discrimination. This short pulse from each channel is compared with each input signal. The LED corresponding to the fastest channel is flashed and other ones corresponding to the channel which detected arcing are kept just turned on. In a prototype circuit the delay time is about 30 ns. This corresponds to the spatial resolution of 9 meters. As a benchmark test, one signal is branched into two channels with different length of coaxial cables. The result indicates that this prototype circuit is capable to discriminate the difference of 5.5m in the length of coaxial cable. This length is equivalent to the 7.7 meters of light propagation and should be sufficient for identifying the position of arcing in the transmission line. The upgrading to 8 channels for the real use on LHD transmission line is planned. Modifying the circuit itself should be straight forward, but on the actual installation, the length of the optical cables and coaxial cables should be identical to keep this resolution. The delay time in each element in the circuit should also be carefully controlled.