§6. ECE Diagnostics on LHD: the Michelson Spectrometer

England, A. and Nagayama, Y.

A fast scanning Michelson spectrometer, operating in the Martin-Puplett mode, is in use on LHD. This is one of a set of three instruments installed for ECE diagnostics. A roof-top mirror of the interferometer is driven by a 3-phase synchronous motor with a variable frequency power supply. The effective scan length is 46 mm. The Michelson has a frequency resolution of about 4 GHz and an adjustable scan time of between 10 and 40 milliseconds. Each scan produces an interferogram which can be Fourier transformed to produce a spectrum of the ECE signal from approximately 60 GHz to 600 GHz.

The instrument has two hot-electron InSb bolometer detectors cooled to liquid Helium temperature. A Moire sensor monitors the mirror position. Every 40 μ m, the sensor produces a pulse to sample the data. The radiometer data are sampled by the use of Aurora 14 digitizers in a Camac crate, which is controlled by a personal computer with a Pentium-pro (200MHz) processor and the Windows NT system.

The Michelson system is also controlled by the use of Camac and the Windows NT personal computer. The scanning frequency is 20 Hz in LHD experiments. The 3-phase AC power is simulated by a 4 kHz rectangular wave. This rectangular wave produces a great deal of electromagnetic interference (EMI). With all other ground connections removed, L(10 mH)-C(0.01 μ F) low-pass filters on the output of the motor-driver and a 100 kHz active low-pass filter on the output of the detector reduce the EMI significantly. Further reduction is needed and the best method for doing this is under investigation.

In spite of the large attenuation from the notch filters, there is still a large ECH signal from the plasma that renders it impossible to make measurements with the Michelson during the ECH phase of the discharge.

However, after the ECH terminates, a clear ECE second-harmonic signal is present. This signal decays on successive scans of the spectrometer. However, no other harmonics have been unambiguously observed. This may be due to the low density and low temperature of the discharges produced in the first operating cycle of LHD.

Calculations have shown that the plasma is optically thin above 90 GHz. Hence the temperature must be determined by the ratio of two harmonics.

Figure 1 shows the raw data from the interferometer from a scan during the ECH phase of shot 744 when both an 84 GHz and a 168 GHz gyrotron were being used. When the 168 GHz gyrotron turns on at about 6800 on the x-axis, the frequency doubles.

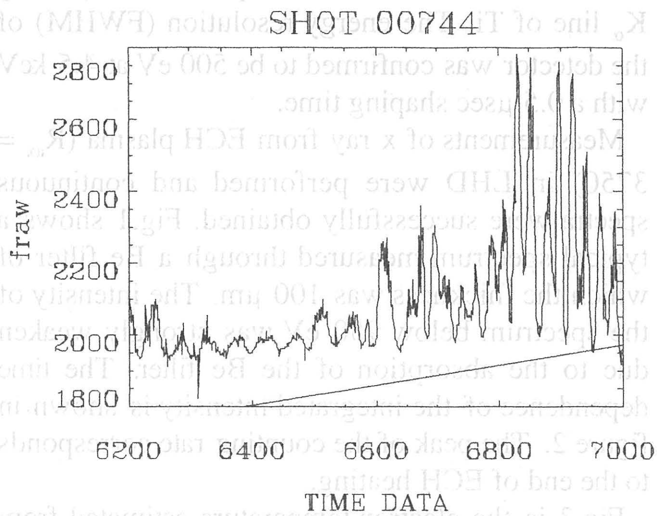

Fig. 1. Raw data for scan of shot 744. Gyrotrons at 84 GHz and 168 GHz were being operated. The observed frequency doubles after the 168 GHz gyrotron turns on.