§2. A Two Colour MM-Wave Interferometer for the Measurement of the Line Electron Density on LHD

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A two colour mm-wave interferometer has been developed for the measurement of line integral electron density on the horizontal midplane of the LHD. To overcome the effects of the change in the transmission path length (approx 100 m) during long pulse plasmas (10-1800 sec), we have applied two colour interferometry at 140 and 285 GHz.

We have used Quasi-optical techniques to overcome losses associated with waveguide components at these frequencies. The dynamic range of the system has been measured to be more than 70dB and the loss in the HE11 corrugated wave guide and the low gain antennas coupling through the vacuum vessel has been measured to be about 21 dB. The difference between signal and Local Oscillators at both 140 and 285 GHz is accurately/ fixed at 1 GHz to eliminate the phase changes as a result of frequency changes and the heterodyne beat signals are downconverted into 1 MHz before being fed to fringe counters.

Figure 1 shows the block diagram of the system. Phase locked solid state sources generate free space Gaussian beams at both 140 and 285 GHz on the transmit side of the instrument. These are overlaid in a Martin-Pupplet diplexer with a common polarization and fed into an HE11 corrugated wave guide which transports the copolarized beams to antennas which in turn pass the radiation across the plasma and back to the receive side of the instrument. Mechanical movements and changes in electron density alter the effective path length traversed by the probing beams and therefore their phase when they return to the instrument. When the signal returns to the instrument a second M-P diplexer separates the beams into their two frequencies and passes them to mixers. Phase locked Local Oscillator beams, set exactly 1 GHz away from the source frequencies at 139 GHz and 284 GHz respectively are also presented to each mixer, which allow down-conversion of the primary signal containing the phase information to 1 GHz. A two colour interferometer measures line electron density by measuring changes in effective path length of one arm of an interferometer, which passes through the plasma. It does so by measuring the phase of the returning signal from a signal arm and comparing that with phase in the second reference arm.

The interferometer has been succssfully operated in the initial experimental campain of theLHD as is shown in Fig.2, which shows the time behavior of the line integral density of the first plasma.

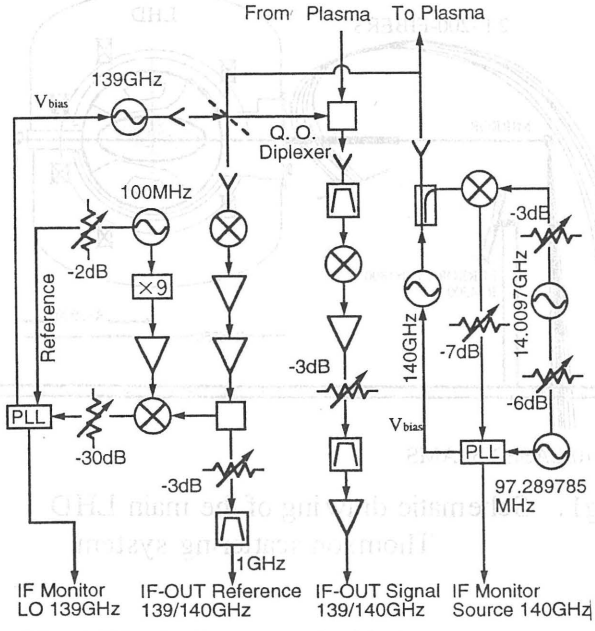

Fig.1 Block diagram of 140 GHz channel.

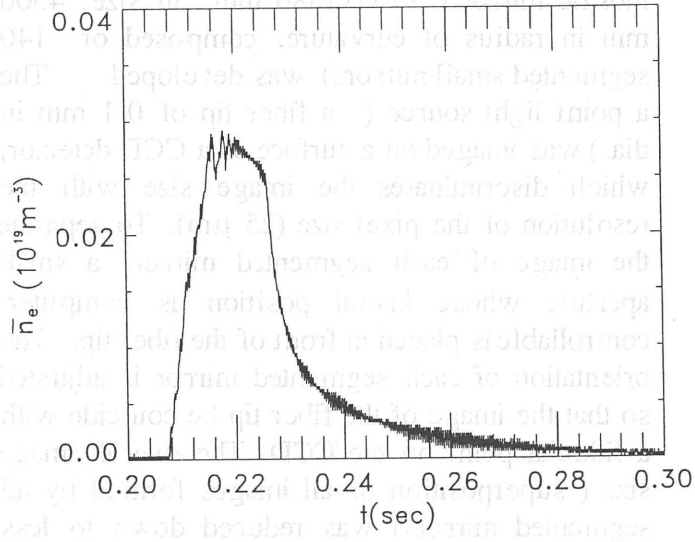

Fig.2 Time behavior of the line integral density of the first plasma.