§32. A Pulse Radar Reflectometry for the CHS Plasmas

Ejiri,A., Pavlichenko,R., Kawahata,K.

One of the methods for profile measurement is a pulse radar reflectometry. The system launches a short microwave pulse (of about 1 nsec) into a plasma, and measures the timing when the pulse returns to a detector. By measuring the round trip time, we can get information on the plasma density profile.

We are now preparing a multi channel pulse radar system. It is a similar system as that developed by S.H.Heijnen et al.[1]. The difference between our system and their system is that we multiplex four frequencies into a pulse, and split the IF signal with four bandpass filters. Figure 1 shows a schematic drawing of the system. Four Gunn oscillators are used as probing sources, and a short pulse is created by a varactor type switch. The pulse is laucnched into the plasma, and the reflected pulses are mixed with a local of 39GHz.
Since the four different probing microwaves have different IFs, we can separate each other by bandpass filters. The merit of this system is simultaneous launching of four different frequencies, and use only one local oscillator, instead of four different local ones.

Since the present ADC cannot measure the shape of this fast pulse, we use a Constant Fraction Discriminator (CFD), which yields the timing of a pulse, and a Time to Amplitude Convertor (TAC). The CFD is not affected by amplitude change in a pulse, which often happens in a real plasma measurement. However, an error arises when the pulse shape is deformed due to a plasma. The pulse deformation depends on the dispersion in a plasma (i.e. density profile), and it is a function of microwave frequency. We did a simulation to estimate the time measurement errors due to pulse deformation. Figure 2 shows the error as a function of pulse width. Two types of errors are shown. One is that due to CFD and the other is that for the timing measurement of the peak of the pulse. The error increases with the decrease of pulse width. A short microwave pulse has a wider frequency spectrum. Thus, the pulse deformation due to the dispersion is serious for shorter pulse, and leads to a larger error. The error in peak timing measurement is always smaller than that in CFD (Fig.2). This is due to the fact the former method is not affected by symmetric pulse broadening, while the latter is affected. When we consider the effect of noise, the pulse width should not be too wide, because a wider pulse has a larger time error due to the noise. Thus, we have to find the optimum pulse width in CHS plasmas. The bandpass filter also causes pulse deformation, however, the effect is fixed, and can be calibrated.

References

1)Heijnen,S.H. et al. Rijnhuizen Report 94-222, (1994).

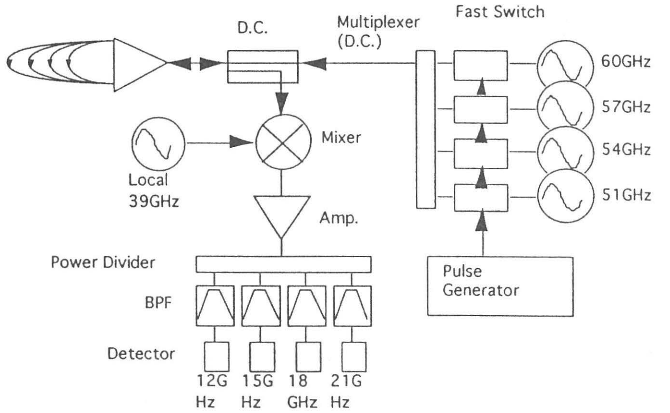

Fig.1. Schematic drawing of the pulse radar system.

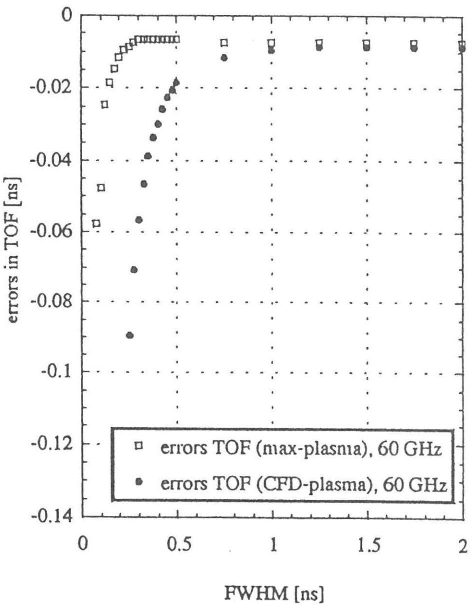

Fig.2 Errors in time as a function of pulse width. Open squares show errors peak points method, and filled circles show those by CFD.