§11. Development of a Detector System for High-energy and Heavy lons

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In LHD, the heavy ion beam probe (HIBP) works, and the electrostatic potential can be measured in the core region of LHD plasmas. However, since attenuation of the probe beam inside of the plasma is severe, under the present circumstances, the accurate measurement of the potential profiles in plasmas with the electron density of 1×10^{19} m⁻³ or more is difficult. Moreover, turbulence measurement, which requires high signal-to-noise ratio and temporal resolution, is performed only in quite low density plasmas (~ 0.1 x 10^{19} m⁻³). In order to study the plasma confinement of LHD, the further high precision measurement is required. In this study, the new detector equipped with high detection efficiency and a high multiplication factor for heavy ion beams is developed, and it aims at the high performance HIBP.

Since the last fiscal year, broadband general-purpose operational amplifier AD8065 of Analog Devices Inc. has been selected for a new detector system, and the basic composition of an amplifier circuit has been designed for the high temporal resolution. Current fiscal year, the proto-type NIM module of the circuits was designed and fabricated. The current amplification circuits for 16 channels are carried in this NIM module, as shown in Figure 1.

We carried out quantitative measurements on the current amplifiers. The amplification factor at $1 \ge 10^7$ [V/A] was measured and the linearity held to an accurate at a level of integral nonlinearity of less than 0.002 %, as shown in Figure 2. The cut-off frequency of the amplifier was measured to be 3.3 MHz at -3 dB, as shown in Figure 3.

Although the circuit had satisfied the performance, it also had the problems shown below; (1) Noise superimposed on the input line of the circuit board is with the output about 100 mV at the high frequency domain, (2) Ringing occurs to the output larger than 3.5 V, (3) Peak of the frequency characteristic at 1.2 MHz (It is not flat.). These problems are due to be solved after next fiscal year. Such as an impedance matching in wiring of the circuit board inside the NIM module is due to be improved. A flatting of the frequency characteristic and a reduction of the high frequency noise are due to be carried out by adding the low-pass filter or the pole-zero cancelation. Furthermore, it is connected to a proto-type detector after reconstruction of this amplifier circuit, and the beam test using an accelerator is planned.



Figure 1. HIBP proto-type amplifier circuits on NIM module







Figure 3. Frequency characteristic of the current amplifier