DATA PROCESSING OF EMITTANCE MEASUREMENT

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In the KEK preinjector, beam emittance is measured as a background job in multi-computer system.[1] As the control system of the emittance monitor and data processing program have been improved, the measurement is performed remotely from the center control room of the accelerator and results are quickly shown on a graphic display (GDP).

The hardware system is shown in Fig.1. The central computer processes data and displays the results on the GDP, whereas a satellite computer takes data and controls a monitor head. Emittance measurement is started by a command signal as shown in Fig.2. A pulse motor moves the emittance monitor. When it reaches a point, the computer begins to take data. Angle divergence of the protons which pass through a slit of 0.1 mm wide, is measured with a 32 segment detector at 62 different locations.[2] When data taking is completed, the monitor returns to its home.

The computer program is divided into 10 subprograms as shown in Fig.3. Each of them has its own functions and runs successively in chaining mode because 8 K words are available for the background job. Subprogram P1 sets standard preset parameters. In P2 we can modify the preset parameters to change the mode of measurement, if necessary, from the GDP keyboard. After that the measurement can be started by the operator's command. Also the commands are fed to the monitor hardware through the satellite computer in P2. P3 modifies data of the satellite computer and prints out them with a line printer. P4 interpolates the obtained data with parabola along the direction of angle so that number of the data are doubled. It also calculates percent emittances, which contain corresponding percents of the total beam at 5 % step and prints them out. P5 displays the emittance with subroutines P6 through P10 on the GDP as shown in Fig.4.

An error occurs at analog-to-digital conversion. If digital data are summed up to calculate the beam intensity, the calculated intensity may be somewhat smaller than the real intensity, because analog signals of less than 1 LSD might be lost in A-D conversion. Assuming Gaussian distribution of the beam intensity in both directions of position and angle, the total intensity is evaluated to be (1 + 0.5/digital peak intensity) times the calculated intensity above mentioned.

An 62 beam pulses are used for a single emittance measurement, the beam should be stable enough. The stability is evaluated by seven successive measurements. Standard deviations are summarized for the precent emittances and for the relative beam intensity in Table 1.

Table 1

Beam Intensity included	Emittance(mean) [π cm mrad]	Standard Deviation Emittance(mean)
99.43 %	0.591	2.4 %
90.0 %	0.226	1.4 %
80.0 %	0.155	0.73 %
Relative Beam Intensity	5509	Standard Deviation R.B. Intensity(mean) 0.72 %

References
1) H. Ishimaru, T. Sakaue, K. Itoh, K. Muto and S. Fukumoto, Proc. 1976 Proton Linear Accelerator Conf., p.202, 1976.
T. Katoh, K. Uchino, T. Kamei, M. Tejima, T. Takashima, K. Ishii, S. Ninomiya and E. Kadokura, IEEE Trans. NS-24, 1989, 1977.
2) K. Ito, T. Sakaue, H. Ishimaru and S. Fukumoto, Proc. 2nd Symposium on Ion Sources and Application Technology p.71, 1978.

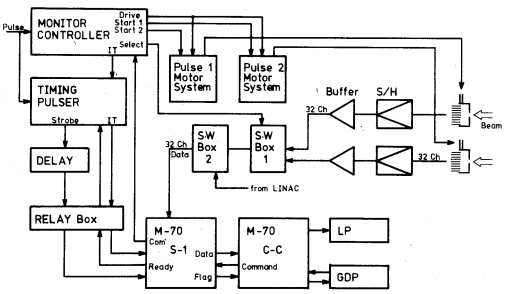

Fig.1 Block diagram of hardware system

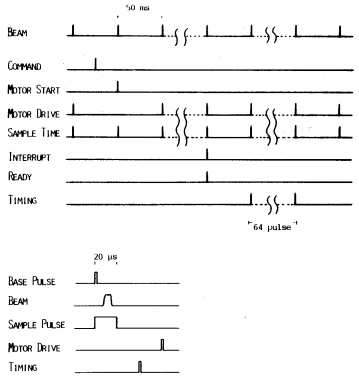

Fig.2 Timing chart of hardware system

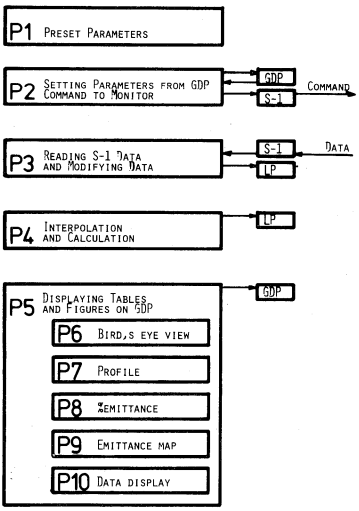

Fig.3 Block diagram of computer program

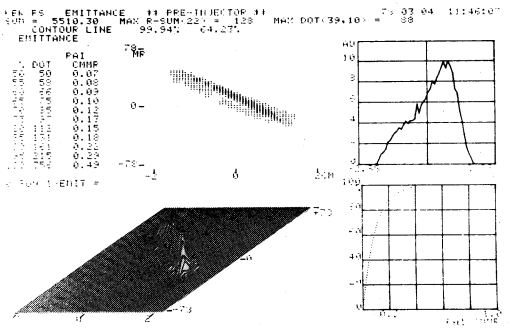

Fig.4 Emittance display on GDP