ON-LINE DATA ANALYSIS OF THE BEAM EMITTANCE FOR THE INS SF CYCLOTRON

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1. Introduction

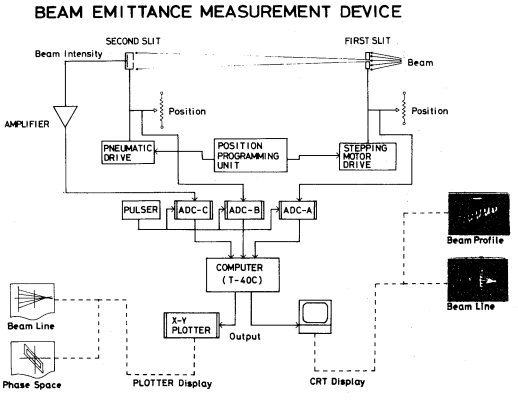
A device for beam emittance measurement has been installed and used for the INS SF cyclotron. It consists of a first slit with 0.5 mm width and an ionization chamber with a second slit of the same width. The two slits are separated by a distance of two meters. The device is located just outside the cyclotron.

The beam density distribution was presented on a XY recorder. However, the response of the XY recorder was rather slow and acquisition of the whole data took about 4 min.. Furthermore, the phase space contour and the beam paths were drawn by hand afterward from the raw data. These works took a long time and were troublesome. In order to obtain the informations on the extracted beam more quickly, a data processing system has been added to the device by using an on-line computer TOSBAC-40C。 The system is described in this report.

2. On-line computer system

Fig. 1 shows a block diagram of the system. The measuring procedure is as follows for one of the two directions, horizontal and vertical. At a given position of the first slit, the ionization chamber sweeps automatically across the beam pipe and measures the beam current through the second slit. Then the position of the first slit is shifted also automatically to the next position, and the above measurement is repeated. These procedures come to an end after the beam currents have been measured at the 16 positions of the first slit, yielding a set of the raw data. The automatic cycling is controlled by a hardware in the emittance measuring device. It is shown as the position programing unit in Fig. 1.

Three signals are produced in the device; two analog voltages proportional to the positions of the first and second slits, and an analog voltage proportional to the current measured by the ionization chamber.



Fig。 1 Block diagram of the system

The three signals are fed into three AD converters, which sample the three voltages according to the given gating signals produced by a pulse generator. The digitized data are stored in the memories of the computer. At a position of the first slit, 256 data are sampled, corresponding to 256 positions of the second slit. After this data acquisition process is completed, the operator can select one of the display modes through the TTY key-in. The display can be made on either one of the two output peripherals of the computer, the CRT and the digital XY plotter. The following display modes are available:

CRT display ; 1) Profile of the current distribution
2) Beam paths
XY plotter display ; 1) Beam paths
2) Phase space contour

The raw data may be punched out on paper tapes for later use. For another measurement the memories of the computer must be cleared.

3. Results

The on-line computer system enables us to make a quick measurement of the characters of the extracted beams. A set of the whole raw data can be taken within a minute. An example of the two-dimensional CRT display of the beam profile measured by this system is shown in Fig. 2. The 16 horizontal lines correspond to each of the 16 positions of the first slit. The second slit sweeps along these lines. When the ionization chamber detects the beam, it produces the signals proportional to the current. The signals are displayed as peaks in the figure and give us informations on the position of the beam center, the direction of the beam and the spatial distribution of the beam current. These raw data are treated in the computer and are used to produce the phase space contour and the beam paths. An example of the phase space contour is shown in Fig. 3. This device is playing an important role in the diagnostics of the cyclotron and is expected to help the user for efficient beam transport to the target.

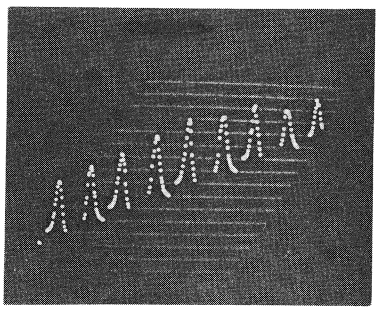


Fig. 2 CRT display of the current distribution

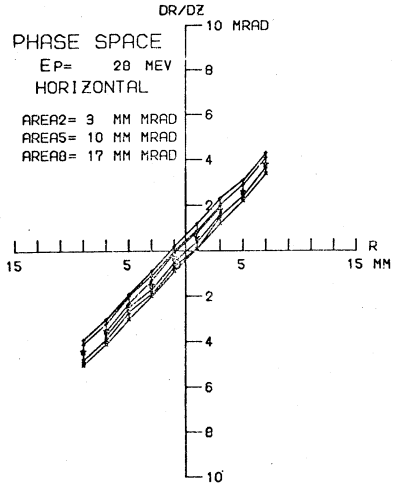


Fig. 3 XY plotter display of the phase space contour