# EMITTANCE MEASUREMENT OF 16.5 GHz ECR ION SOURCE

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Abstract

The emittance of a low energy ($\sim$ 5 keV) $H^+$ ion beam from a 16.5 GHz ECR ion source was measured. The 16.5 GHz ECR ion source was used for an optical pumping type polarized ion source.

Since 1980, a new 750 keV preinjector has been under construction for the acceleration of a polarized proton beam at KEK. A new polarized ion source which aims to produce an intense polarized $H^-$ ion beam has been developed. Fig. 1 shows a schematic arrangement of the polarized ion source. This polarized ion source uses electron pick-up reactions of a low energy ($\sim$ 5 keV) $H^+$ ion beam from optically pumped sodium atoms. In order to increase the beam intensity, it is necessary to produce an intense and small emittance $H^+$ ion beam. Recently, a 16.5 GHz ECR (Electron Cyclotron Resonance) ion source was developed for this purpose. The microwave power of 1 $\sim$ 2 KW is generated by a coaxial magnetron (JRC.M 1408) and introduced into a discharge chamber transversely or longitudinally with respect to the magnetic field through a thin microwave window. The beam was extracted in a homogeneous magnetic field of 0.9 T and a beam current of 40 $\sim$ 50 mA was obtained at the exit of the sodium charge-exchange cell. The emittance measurement system is schematically shown in Fig. 2. The measurements were performed at the distance of 18 cm from the edge of the magnetic field. The detector head consists of a ceramic plate with thirty two gold segments and the beam current detected by the each segment is integrated and multiplexed. Data are digitized by a transient recorder (Viomation 8100) and averaged for 128 beam pulses by a data processer (Iwatsu SM1330) and then, sent to a micro computer (HP-85).

Typical emittance configuratons are shown in Fig. 3. The value of the emittance shown in the figure is normalized (Area $\times$ $\beta\gamma$). The beam emittance was strongly affected by the beam extraction system. Figs. 3-(a) and (b) show the measured beam emittance configurations in the cases of using multi-slit electrodes and single-hole electrodes respectively. The nomalized beam emittance for the multi-slit case was 1.3 $\pi$ mm•mrad. This value was about a half that of the case with single-hole electrodes and the aberrations also disappeared. We found that the 16.5 GHz ECR ion source was very useful for the optical pumping type polarized ion source.

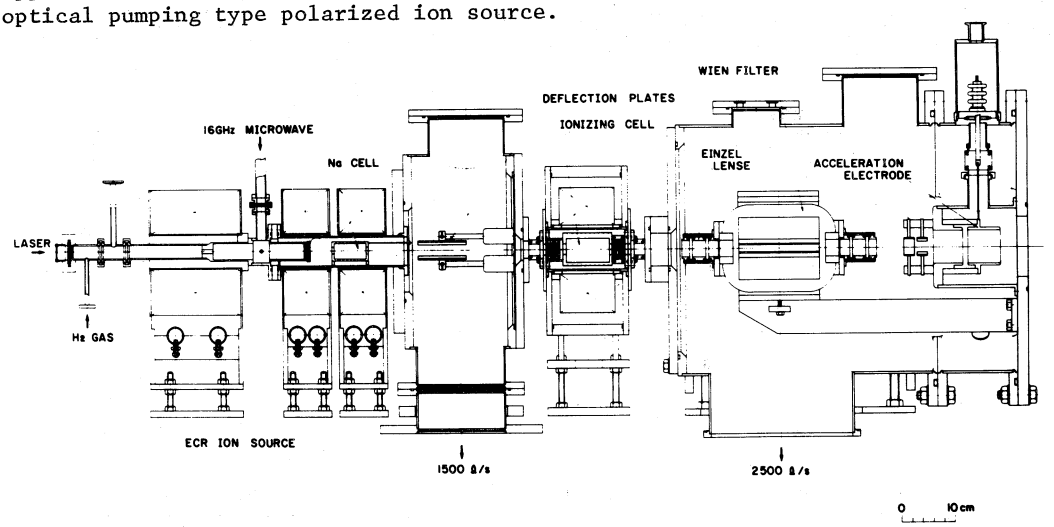


Fig.1 Schematic arrangement of optical pumping type polarized ion source.

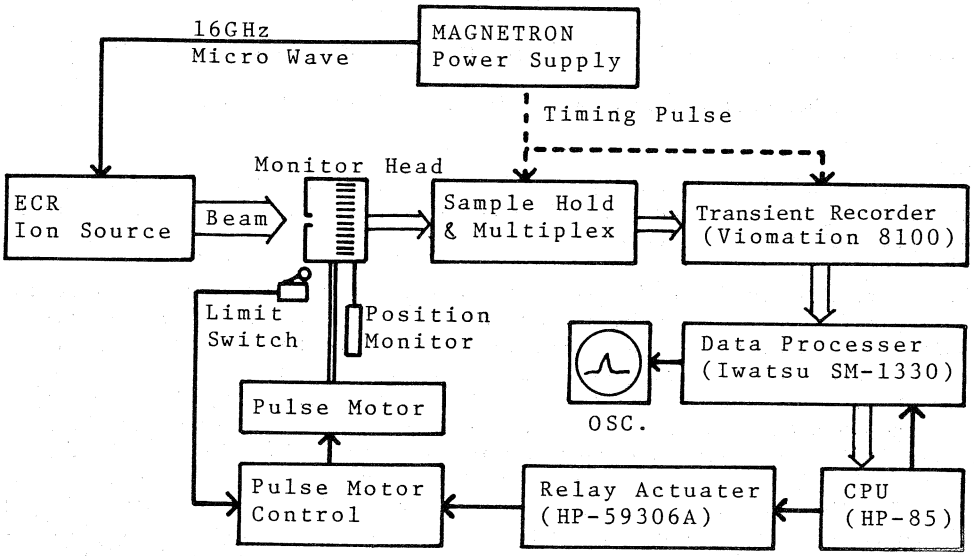


Fig.2 Block diagram of emittance measurement system.

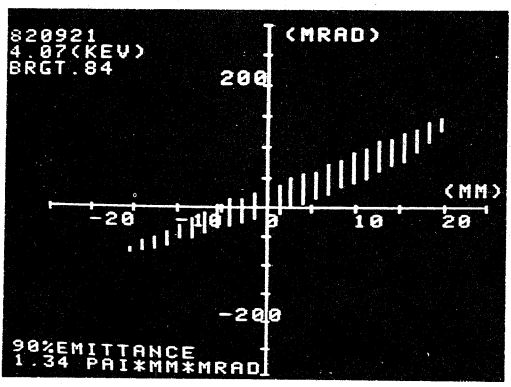


Fig.3 (a)
Beam emittance for the case with multi-slit electrodes.

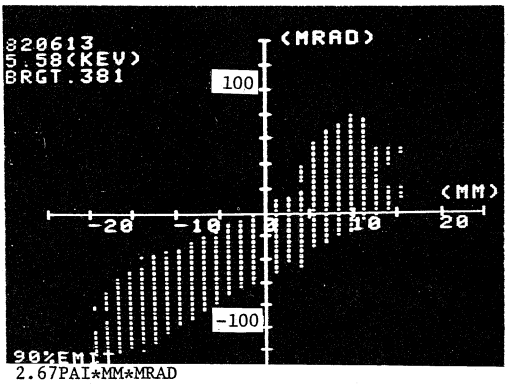


Fig.3 (b)
Beam emittance for the case with single-hole electrodes.