PRESENT STATUS OF KEK PREINEJCTOR

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Most proton and ion synchrotrons have more than one preinjector. However, there is only one preinjector in the KEK synchrotorn. Thus it should be reliable enough. It ran more than 1,700 hours from November 1, 1977 to March 4, 1978. The proton beam stopped 5 times by the preinejctor trouble in the period and total loss time was 97 minutes. 57 minutes were lost by burn of high voltage resistors in an electrostatic chopper power supply. A trouble of a Q-magnet power supply was responsible for loss of 22 minutes. Others were due to temperature rise of cooling water which flowed out of the first focusing quadruplet. They were recovered soon.

The Cockcroft-Walton generator was built about 10 years ago at the Institute for Nuclear Study, Tokyo University, and moved to KEK at Tsukuba in 1971. Its rating voltage and current are 800 kV and 5 mA. As pulsed beam of 700 mA is delivered, beam loading is compensated by a bouncer with a capacitor column of 1000 pF. A loading of 15 kV is reduced to ± 1 kV. When 9 beam pulses are injected successively in 0.4 s followed by a rest of about 1.8 s, another beam loading appeared. A voltage drop of 2 kV occurred between the first pulse and the last pulse in 9 beam pulses. It was already found that ± 0.5 % of the injection energy affected neither the intensity nor the momentum spectrum of the linac beam.[1] However, to ensure more stable operation, a new control circuit, which was made in 1977, is equipped with a forcing circuit.[2] The voltage drop is reduced to 1 kV and stability of the high voltage is also improved. A drift of 0.01 % was observed for 24 hours at the output of the voltage divider. Thus the voltage drift is mainly due to temperature change of the divider resistances. Even if each resistor has a coefficient of ± 300 ppm/°C, the drift is less than ± 0.1 % for ± 3°C change of the room temperature.

The ion source is a duoplasmatron.[1] It works steadily. Its oxide cathode lasted 1,767 hours in this period of operation. A high gradient accelerating column has overall accelerating gap length of 18 cm now.[2,3] Since the length was shortened from 22 cm to 18 cm in October 1976, the column was not disassembled and its inside was not inspected. Arcing is prevented by regulating pressure in the column. Although gas load of the duoplasmatron is heavy, a 650 1/s turbomolecular pump evacuates the system too fast to keep a pressure of 2.3×10^{-4} Torr. Thus hydrogen gas is introduced with an automatic pressure controller near the pump. A 1000 1/s sputter-ion pump was used for differential pumping between the preinjector and the linac. As the pressure was high, it was stalled often. Then it was replaced by a 1000 1/s turbomolecular pump in last summer. One arcing occurred at most for 100 hour run.

As beams were reproducible, exciting currents of focusing Q-mangets were not so different for the optimum intensity in every run. Emittance monitors were set at the entrance of the linac.[5] Measured emittances were displayed on a GDP in the central control room.[6] Typical 90 % emittances are 0.22 π cmmrad. horizontally and 0.36 π cmmrad. vertically. Beam currents are monitored at seven points along the low energy transport.[7] A result is shown in Fig.2. It is noticed that transmission of the beam is not good in the transport and this is mainly due to a decrease from CM-1 to CM-2. CM-1 increases rapidly with the column pressure, whereas CM-3 decreases slightly as shown in Fig.3. By estimating inoization cross sections, it is concluded that H_2^+ ions are produced in the plasma cup where energetic electrons ionize hydrogen molecules.[4] H_2^+ ions contribute to the CM-1 current, however, they are diverged by the matching quadruplet so that small portion of them reaches to CM-2. Although higher content of H_2^+ ions is a drawback of operating the column at the higher pressure, the high current proton beam is neutralized in 1 μs in the low energy transport, so that emittance blow up due to space charge is avoided.

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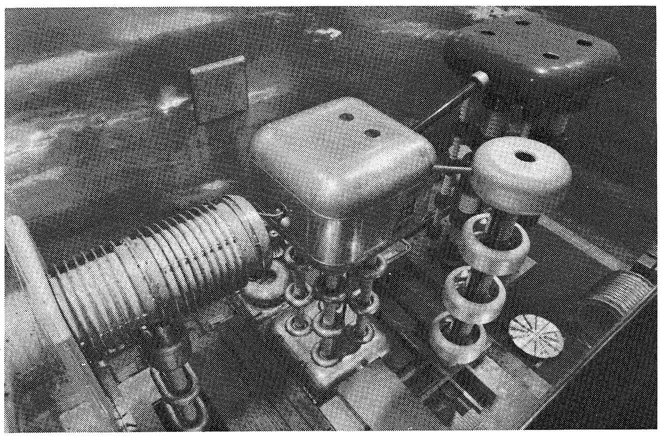

Fig.1. Bird's-eye view of KEK preinjector.

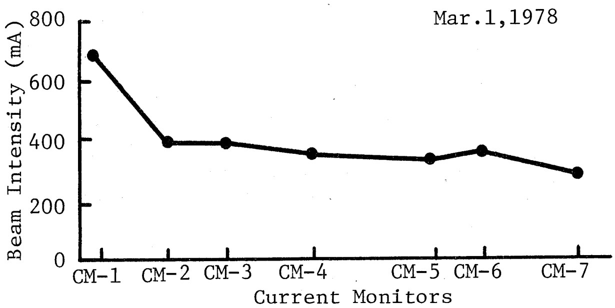

Fig.2. Beam intensities of current monitors CM-1 through CM-7 along the low energy beam transport.

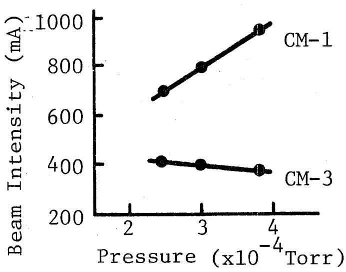

Fig.3. Column pressure vs. beam intensities of CM-1 and CM-3.