POLARIZED H^- PREINJECTOR PROJECT AT KEK

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The construction of a new 750 keV preinjector has been started since April in 1980 for the acceleration of polarized protons in the KEK 12 GeV synchrotron. The keys to the success of the project are the development of intense polarized ion source and the construction of effective transporting system to the 20 MeV linac. We aim to complete this project until the end of the fiscal year of 1983.

Development of Polarized Ion Source (APOLON)

In order to accelerate the polarized protons in the booster synchrotron, the beam intensity of more than 4×10^9 ppp is needed for beam control during acceleration. This intensity means the beam current from the 20 MeV linac should be more than 1 mA. While, for using the H^- injection technique, a 100 turns injection is possible, so that the beam intensity of a 10 μA is usable.[1] Recently, a new idea of polarized ion source has been proposed, in which utilized the charge-exchange reactions between fast protons and electron-spin oriented Na atoms.[2),3),4)] The principle of this new type polarized ion source which is called by the nickname of 'APOLON' (Advanced POLarized source with Oriented Natrium atoms) is schematically shown in Fig.1. There are two ways to produce electron-spin oriented Na atoms; Stern-Gerlach method with using an inhomogeneous magnetic field presented by Witteveen[3] and optical pumping method by a dye laser light proposed by Anderson.[4] We have developed Witteveen's type polarized H^- ion source since last year and obtained about 3 μA of 30 ∿ 40 % polarized H^- ion beam in the preliminary experiment. The waveform of the output polarized beam is shown in Fig.2. We have also started a construction of Anderson's type source recently so as to verify which was the more efficient way to produce an intense polarized H^- ion beam.

Low Energy Polarized Beam Transporting System (LEPBT)

The design of LEPBT should be considered about a spin transportation as well as a beam transportation. In order to accelerate the polarized protons in the synchrotron, the direction of proton spin should be perpendicular to the median plane. While the spin direction of the beam from the polarized source is parallel to the beam direction, it is necessary to change the spin direction. Fig.3 shows the outline of the LEPBT. Total length of this line is about 40 meters. Beam envelopes were calcurated with using the computer program MAGIC and TRANSPORT and results are presented in Fig.4. Assumed emittance is $\varepsilon_x = \varepsilon_y = 100$ π mm·mrad (unnormalized). The beam line consists of 6 bending and 56 quadrupole magnets. After passing the first bending magnet whose bending angle is 23.7°, the spin direction is changed parpendiculary to the beam direction on the median plane and rorates for 90° around the beam axis by the solenoid magnetic field.

Vacuum and beam monitor system is now under consideration. The charge-exchange cross section of H^- ions by the collisions with residual gas atoms is about 10^{-16} cm^2 at 750 keV and the vacuum pressure should be less than 1×10^{-7} Torr. to reduce the beam loss within 1 %. Intensity and profile monitors for a very low beam current have been also developed.

Control System

In this new 750 keV preinjector there are about 100 ∿ 150 power supplies to be controlled and about 25 power supplies among them are used for the polarized ion source which is placed in the insulated high voltage station. We consider the computer control system based on CAMAC and its blockdiagram is shown in Fig.5. Each power supply is controlled through the interface module (PSI) which performs the serial-parallel conversion. Commands from the minicomputer (LSI-11)

are transfered to PSI as a serial data. This system utilized only two buslines between the computer and the PSI module. A serial-parallel conversion device is the 16 bits encoder-decoder IC (HARRIS HD-15530) and another type (HD-1553A) is extended to 32 bits. The hardwire logic for ON-OFF and interlock is also included in this PSI module. Detail desingning of the PSI and some tests for the characteristics of the encoder-decoder IC are now in progress.

References

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3) G.J.Witteveen, Nucl. Inst. Meth., 158 (1979), 57.
4) L.W.Anderson, Nucl. Inst. Meth., 167 (1979), 363.
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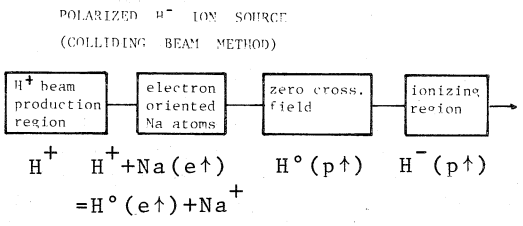

Fig.1 Block diagram of pol. H^- ion source

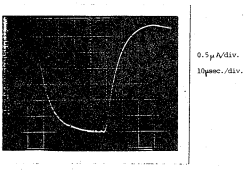

Fig.2 Waveform of pol. H^- ion beam

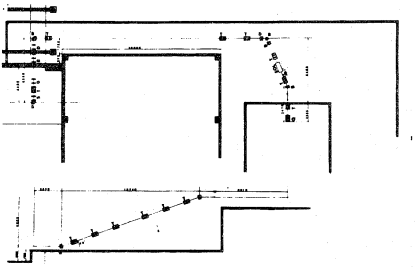

Fig.3 Outline of LEPBT

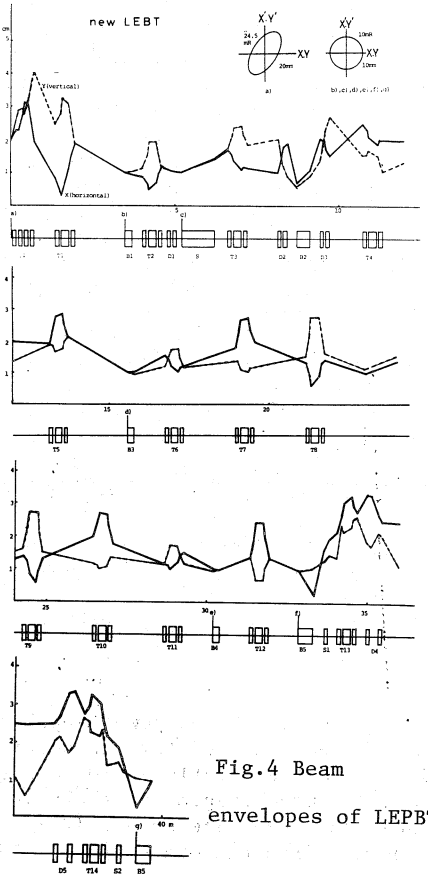

Fig.4 Beam envelopes of LEPBT

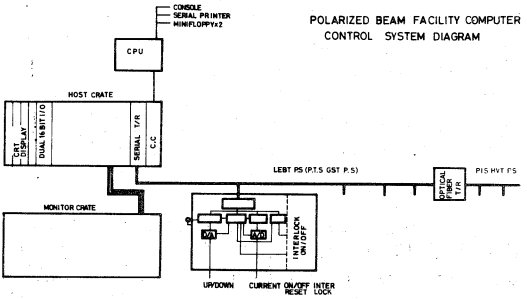

Fig.5 Control system