POSSIBILITY OF DEUTERON ACCELERATION BY THE KEK PROTON SYNCHROTRON

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Recently, the many nuclear physicists have had an expectation that the new phase in the high and medium energy ($\leq$5Gev/N) nuclear physics will be developed if the nucleus or the ions are accelerated by use of the proton synchrotron in KEK. To answer this expectation, the possibility of accelerating the deuteron beam was searched as a first step. The search was carried out according to a principle that the introduction of the huge equipments and the new large investiments to realize this plan must be suppressed strictly because of extreme lack of the human and economical resources coming from start of a big project, TRISTAN. In result, an effective and realizable manner of accelerating the deuteron beam without confliction with above principle was found.

The underlying scheme of acceleration is described in the following.

1) Pre-injector and linac

The deuterium gas is put into the present ion source to get the deuteron beam. The deuteron beam from the ion source is accelerated to an energy between 750Kev/2 and 750 Kev (present proton's) with a Cockcroft Walton generator to be injected to the linac[1]. The linac accelerates the deuteron bunchs with 4π mode in r.f. phase and a slightly modified field gradient to eject from the linac with the half velocity of the present proton's[1]. The kinetic energy of the deuteron beam from the linac is almost half of, and the momentum is almost same as the present proton's.

2) Booster synchrotron

The range of the accelerating frequency is kept in the present value (1.6MHz to 6MHz) because the extension of the frequency range brings the large modifications of the r.f. accelerating system and this offends against the openning principle. Consequently, the revolution frequency of the deuteron beam at injection becomes half of the accelerating frequency, that is, the harmonic number is naturally fixed for two. Then the final revolution frequency is 3MHz, which corresponds to 0.38 of β (=v/c), 7.7KGauss of the final guiding magnetic field (11KGauss at present) and 150Mev of the final kinetic energy (500Mev at present). The power for the extraction kicker magnet must be increased because a couple of bunches of the deuterons are extracted instead of a single bunch in the present case. The procedures of beam fransfer to the main ring synchrotron need not be changed from the present status because the accelerating frequency at extraction is same as the present one.

The eighteen bunches are extracted from the booster during 0.45sec and accumulated in the magnetic injection porch of the main ring synchrotron followed by the rising field for acceleration.

(3) Main ring synchrotron

The range of the accelerating frequency also is kept in the present one from the same reason as the booster. This restriction, however, can accelerate the deuteron beam to only 300Mev with a full swing of the accelerating frequency. So the following multi-stage acceleration was thought out. The eighteen bunches are debunched once, and rebunched in the thirteen bunches by returnning the accelerating frequency to near the starting one (~6MHz). During these procedures, the magnet system supplies a flat pass of the magnetic field. After rebunching, the thirteen bunches are accelerated to 740Mev with a second full swing of the accelerating frequency. After the second acceleration, the thirteen bunches are debunched again and rebunched in the nine bunches, and then, the nine bunches are accelerated to the top energy of 11Gev corresponding to the maximum guiding field with the last full swing of the accelerating frequency. The transition energy is 10.5Gev for the deuteron acceleration, which is just before the top energy, so the beam should be extracted at the energy little lower than the transition energy.

The largest investiment for this plan is only introduction of a new high grade control computor because of poor capacity of the present computor to make the pattern of the flat passes in the magnetic field.

The nucleus of $Z/A=1/2$ (Z; atomic number, A; mass number) are accelerated with same manner as one for the deuterons. However, the present ion source for the protons can produce only the deuterons and the α-particles.

Reference

1) T. Katoh et al., presented paper to this simposium.