PROTON SYNCHROTRON FOR INTENSE NEUTRON AND MESON BEAM

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Design studies of a proton synchrotron, which is the generator of the meson-intense and neutron-intense beam, GEMINI, are in progress. This 800 MeV synchrotron aims to deliver an intense proton beam, e.g. 500 μA in time average. Such a beam intensity, for instance, will be achieved by accelerating 6 x 10^{13} protons per pulse with a repetition rate of 50 Hz. This machine also should play the role of the injector to the present KEK 12 GeV proton synchrotron on behalf of the 500 MeV booster synchrotron. The circumference of the machine, therefore, is determined to be a half of that in the 12 GeV synchrotron. It should be guaranteed that a single bunched beam is always supplied to each of the neutron and meson experimental facility. This leads uniquely to the harmonic number of RF acceleration system of 2. The machine parameters are listed in Table 1. The accelerator will consist of an H^- ion source, preaccelerator including RFQ, 100 MeV Alvarez-type linac, and 800 MeV rapid-cycling synchrotron.

The beam loading on the linac with a 30 mA H^- ion beam is relatively small. To simplify the RF power system, 400 MHz klystrons of 2MW will be used, which drive five tank structures. The rapid-cycling 800 MeV synchrotron of 54 m in diameter consists of 24 FBDO cell-structures. In order to attain high space-charge limit, the horizontal and vertical tunes are chosen to be relatively high, i.e. 6.8 and 7.3 respectively. The synchrotron ring magnet is excited by 50 Hz, dc-biased sine-wave current. To reduce the RF accelerating voltage, the magnet system would be excited by a bi-resonant frequency system with the frequencies of 33 and 100 Hz as originally proposed by M. Foss and W. Praeg at ANL[1)2)]. The radiation protection is a serious problem in such a high intensity accelerator. The beam loss at injection, which causes the radiation damage of the accelerator components and produces a large amount of residual radio-activities, will be considerably reduced by chopping the preinjector output H^- ion beam synchronously with the RF acceleration voltage.

The design study of this machine is only on the start point. Some aspects of the designs may be changed in the process of the design work.

Reference

1) M. Foss and W. Praeg, "Shaped Excitation Current for Synchrotron Magnet", Proc. IEEE Trans. on Nuclear Science, NS-28 (1981) 2856.
2) H. Someya, et al., "Bi-Resonant Circuit for Excitation of Synchrotron Magnet", in this symposium.

Table 1. A New Pulsed Neutron and Meson Source GEMINI

Maximum kinetic energy	800 MeV
Maximum intensity	6×10^{13} p/p
Repetition rate	50 Hz (100/3 Hz & 100 Hz)
Average beam current	500 μA
Injection energy	100 MeV
Injection beam current	30 mA
Number of turns of injected beam	>240
Beam pulse width of injected beam	>330 μs
Magnet radius	7.00 m
Average radius	27.00 m
Number of period	24
Length of straight section	3.008 m
Structure	FBDO
Betatron frequency	
Horizontal	6.8
Vertical	7.3
Revolution frequency	0.757 - 1.489 MHz
Maximum beta-function	
Horizontal	12.4 m
Vertical	12.9 m
Momentum compaction factor	2.71×10^{-2}
Transistion energy/rest energy	6.07
Beam emittance	
800 MeV	0.29×0.16 (mm rad)^2
100 MeV	0.97×0.52 (mm rad)^2
Number of bending magnets	24
Length of bending magnets	1.833 m
Length of quadrupole magnets	
Focussing magnet	0.525 m
Defocussing magnet	0.565 m
Bending magnet field	
800 MeV	0.697 T
100 MeV	0.212 T
Quadrupole magnet peak field gradient	4.18 T/m
Peak energy gain per turn	90.6 keV (60.4 keV)
Harmonic number	2
RF frequency	1.513 - 2.978 MHz
Maximum RF voltage	240 kV (185 kV)
RF bucket area	1.89 eV•sec
Number of RF stations	8
Incoherent space charge limit	7.2×10^{13} protons