DESIGN OF A 10 GEV ELECTRON ACCUMULATOR RING

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A conceptual design of an electron-nucleus collider was performed in order to extend the present RCNP activities to quark nuclear physics. [1] In the design, beam energy is 5 GeV for both electrons and protons. For this combination of energies, the luminosity was found to be limited to 10^{31} $cm^{-2}s^{-1}$. The limitation comes from the space charge effect in the proton accelerator. An asymmetric collider geometry can provide the luminosity of 10^{33} $cm^{-2}s^{-1}$ for the collision of a few GeV electrons and and a few tens GeV(/u) protons(ions).

As the first stage, an action program was started to design an electron accumulator ring at 8-10 GeV proposed as the Photon Electron Accumulator Ring Laboratory (PEARL). The non-perturbative regime of QCD is current challenging task on the border line between nuclear and particle physics. Outstanding questions are the quark-gluon structure of baryons and mesons, the existence or non-existence of glueballs which are predicted by QCD and the origin of the confinement which prevents colored objects propagating freely in space. The PEARL project will give the opportunity to investigate these subjects.

General features of the electron accumulator ring are summarized below.

1. Maximum energy is 10 GeV.
2. Expected beam current is 0.5 A and will be increased to 1 A in future.
3. Polarized photons are produced by the Compton backscattering of Laser lights.
4. Electrons are polarized and internal gas targets are used.
5. Circumference is around 600 m in order to accommodate the ring in a proper area.

Figure 1 shows kinematic regions of the electron energy loss, ν, and the squared electron four momentum transfer, Q^2, accessible with 10 GeV beam. It enables

1. the access to high momentum transfers, implying fine spatial resolution.
2. the broad access to the deep inelastic scattering (DIS) regime.
3. the access to baryons up to 4 GeV mass, and mesons up to 3 GeV mass. For both baryons and mesona, a large fraction of the spectrum is missing. [2]

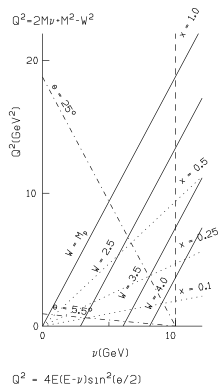

Figure 1: Kinematic regions of the 10 GeV accumulator ring.

The general parameters of the accumulator ring are listed in Table 1 and the optical functions for the arc section are shown in Fig.2. The injection energy is 8 GeV, and the maximum energy 10 GeV. Arcs are composed of simple FODO arrays and bending radius is 27.5 m. Dispersion suppressors ensure the transition between arcs and the straight sections where the dispersion is zero. Length of a long and a short straight section is 100 m and 40 m, respectivelly.

Table 1: Parameters of a 10 GeV Accumulator Ring.

Circumference	586	m
Injection energy	8	GeV
Maximum energy	10	GeV
Lattice type	FODO	
Bending radius	27.52	m
Number of dipole magnets	48	
Number of normal cells	20	
Number of dispersion suppression cells	8	
Super periodicity	2	
Momentum spread	1.5×10^{-3}	
Nominal tune (ν_x/ν_y)	17.9/12.7	
Natural chromaticity	-26.3/-18.5	
Dispersion in straight cells (D_x)	0.0	
Long straight section (100 m)	2	
Short straight section (40 m)	2	
Radiation loss	32	MeV/turn
Harmonic number	994	
Damping time τ_x	2.0	ms
τ_y	2.0	ms
τ_s	1.0	ms

The RF paramerters of the ring are listed in Tabe 2. Radio frequency is 508.58 MHz, which is same as that of SPring-8. Shunt impedance of a cavity is assumed 6 MΩ. There are 4 stations in the ring, and 6 units per station. 4 cavities are installed at each unit. In total, 96 cavities are used to supply 42 MV and 16 MW continuously to a beam of 0.5 A. Power dissipated in the cavities is 3.4 MW assuming 10 % shunt impedance drop. Total power is 21 MW assuming 10 % loss in transmission lines. Input power per cavity is 200 kW, and power dissipated per cavity is 35 kW. There is a limit of 300 kW for the power that can be carried by each input coupler.

Table 2: RF parameters of a 10 GeV Accumulator Ring.

Radio frequency	508.58	MHz
Maximum RF voltage	42	MV
Number of RF stations	4	
Number of units/station	6	
Number of cavities/unit	4	
Total number of cavities	96	
Power transferred to the beam at 0.5 A	16	MW
Power Dissipated in the cavities*	3.4	MW
Total Power**	21	MW
Shunt impedance of a cavity	6	MΩ
Input power per cavity	200	kW
Power dissipated per cavity	35	kW

* Assuming 10 % shunt impeddance drop. ** Assuming 10 % loss in transmission lines.

References

[1] K. Hatanaka *et al*, RCNP Annual Report (1997) 312.

[2] A. Hosaka, H. Toki and H. Ejiri, Nucl. Phys. **A629** (1998) 160c.