Design Status of the High Energy Ring of the PEP-II B Factory*

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Abstract

Ongoing studies of the design and construction of the High Energy Ring (HER) of the SLAC/LBL/LLNL PEP-II B-Factory are discussed. These studies include (1) magnet refurbishing and measurement, (2) finalizing the lattice, (3) chromatic corrections, (4) copper vacuum system design, (5) vacuum requirements, (6) dust issues, and (7) goals for the initial commissioning periods. Initial commissioning is planned for the Spring of 1997. Full RF and high current studies are envisioned for Fall 1997.

I. INTRODUCTION

The PEP II electron-positron collider with a design luminosity of 3 x 10^{33} $cm^{-2}s^{-1}$ has been approved for construction by SLAC, LBL, and LLNL to study CP violation. The high energy ring (HER) of PEP II will operate with an energy of 7 to 12 GeV, nominally 9.0 GeV. A schematic overview of the layout of the HER is shown in Fig. 1 and the technical parameters are given in Table 1. The HER will be made of, by in large, refurbished and reworked magnets from the original PEP, a new copper vacuum system, and a new RF system operating at 476 MHz. The HER is supported below the low energy ring as shown in Fig. 3.

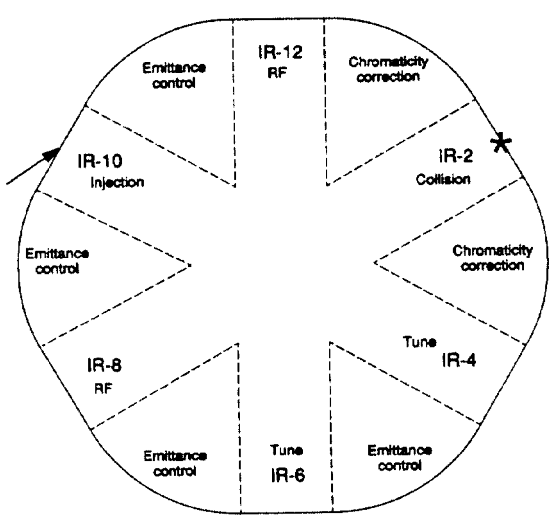

Fig. 1 Schematic overview of the PEP II HER.

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Table 1 Parameters of the PEP II HER

Parameter	Units	Nominal	Range
Energy	GeV	9.0	7 - 12
Circumference	m	2200	------
Emittance x,y	nm-rad	50./2.0	38-60/ 1%-50%
β^*_y	cm	2.0	1.5 - 6
β^*_x	cm	50	33 - 100
Beam-beam tune shift	---	0.03	0.02-0.05
IP spot size	x/y (μm)	155./6.2	Variable
Crossing angle	deg	0	------
Number of bunches		1658	1 - 1746
Ion gap size	%	5	Variable
Charge / bunch	10^{10}	2.7	1 - 10
Beam current	A	1.0	0.3 - 3.0
Synch Rad. Loss	MeV/turn	3.58	1.3-11.3
RF Voltage	MV	18.5	Variable
Number of klystrons		6	------
Number of cavities		24	------
Bunch length	cm	1.0	1.0 - 2.0
Damping time	τx (msec)	37.	81.-16.
Betatron tunes	x/y	24.57/23.65	+/- 1.5
Sych. tune	----	0.052	Variable

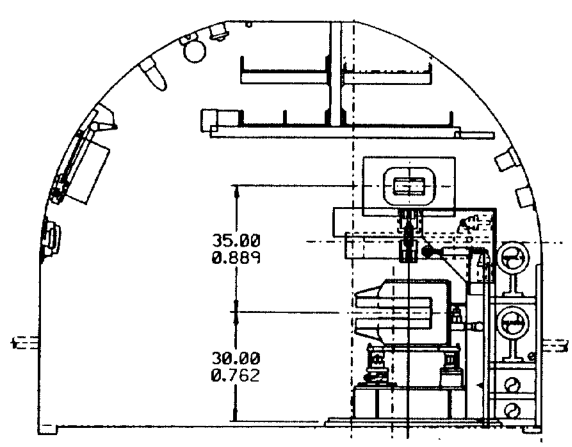

Fig. 3 Cross section view of the PEP II tunnel showing the LER above and HER below. The tunnels and utilities are being reused. The old PEP is now 60% removed, to be complete in the fall 1994. The beams bend to the right.

2. VACUUM SYSTEM

An extruded copper vacuum chamber has been chosen for the HER [1,2]. The cross section of one chamber is shown in Fig. 4. There are four extruded pieces which will be e-beam welded, along with flanges. Copper was chosen because of its good radiation shielding, good heat conductivity, good heat capacity, and ease of welding. Many short test lengths have been produced and full length bend and quadrupole chambers will be ready for the tunnel prototype in early fall 1994. The present design of the sliding joint, allowing 0.625 inch expansion, is shown in Fig. 5. Be-Cu fingers are used.

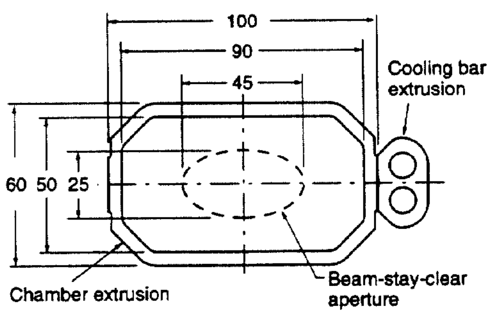

Fig. 4 The copper quadrupole chamber cross section.

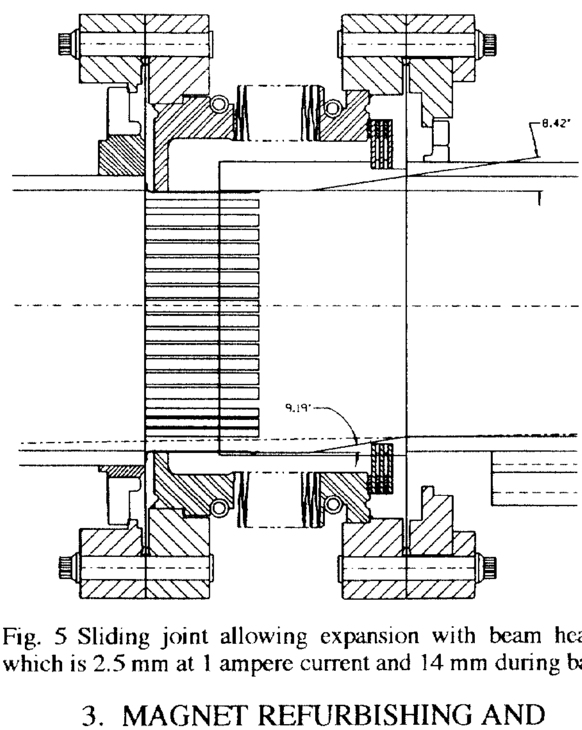

Fig. 5 Sliding joint allowing expansion with beam heating which is 2.5 mm at 1 ampere current and 14 mm during bake.

3. MAGNET REFURBISHING AND REWORKING

The HER will reuse the main bending dipoles of the original PEP as well as the short sextupoles. Two thirds of the old quadrupoles will be reused. The refurbishing of these magnets has started. The first magnetic measurements of refurbished dipoles are shown in Figs. 6 and 7. The remaining arc quadrupoles from PEP which are two long to use, will be cut apart and restacked into shorter magnets with a 560 mm length. New coils will be made. Dipole correctors numbering about 200 will most likely be made new. The raft assembly of these components is shown in Fig. 8.

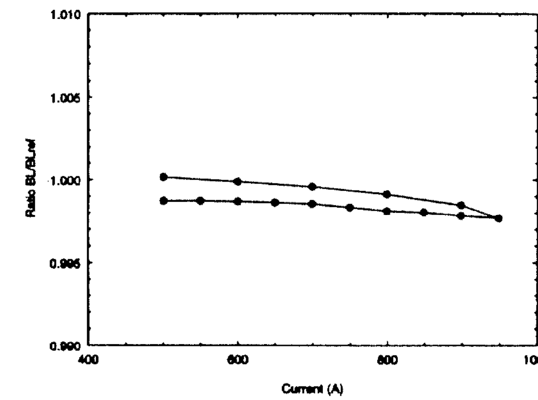

Fig. 6 Relative integrated field measurement of a refurbished dipole compared to the reference magnet.

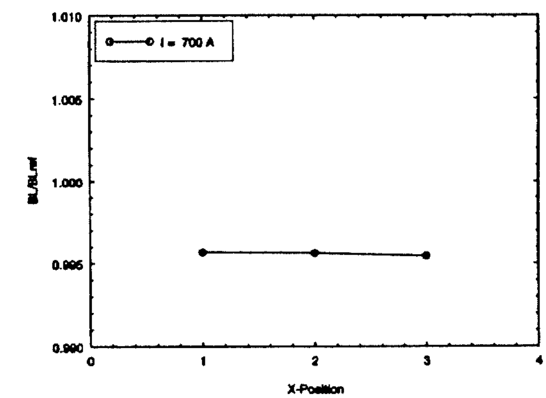

Fig. 7 Measurements showing the negligibly small quadrupole and sextupole multipoles in the dipole magnets.

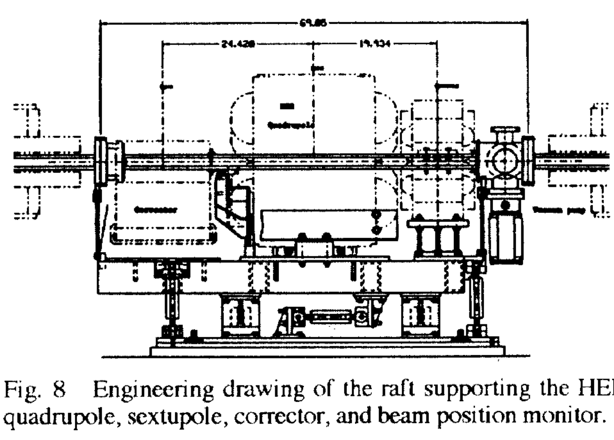

Fig. 8 Engineering drawing of the raft supporting the HER quadrupole, sextupole, corrector, and beam position monitor.

4. LATTICE AND DYNAMIC APERTURE

Over the past year much work on the lattice has produced a sound design. The allowed alignment errors have more than doubled while the dynamic aperture has increased. New sextupole settings and correction procedures have helped. A 1.5 cm βy^* lattice has been studied [3] and an acceptable aperture has been obtained. Thus, a reasonable range in operating conditions is allowed. The 2 cm βy* lattice is shown in Fig. 9 and 10. The tune change with energy offset is shown in Fig. 11 which is quite good. The calculated dynamic aperture for this lattice is shown in Fig. 12 and is excellent.

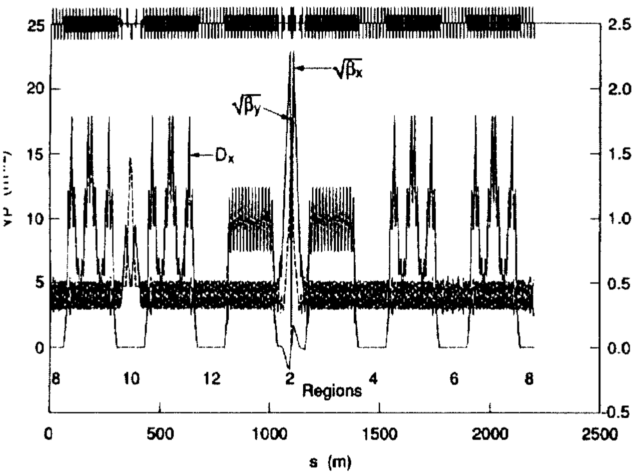

Fig. 9 Betatron and dispersive functions for the HER. The single interaction region is in the center.

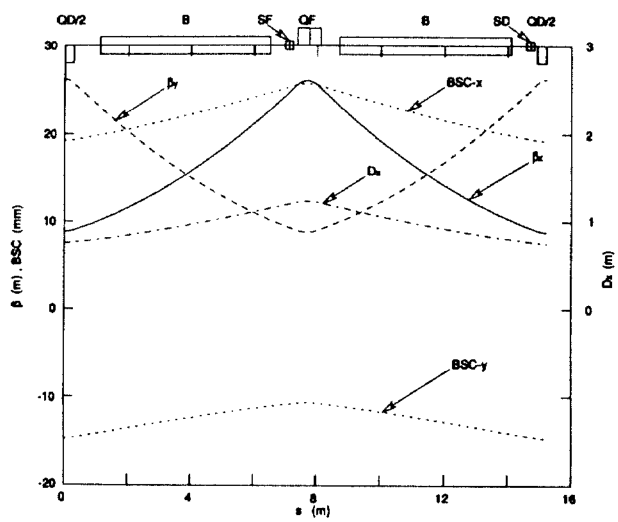

Fig. 10 Lattice functions in a standard arc cell of the HER.

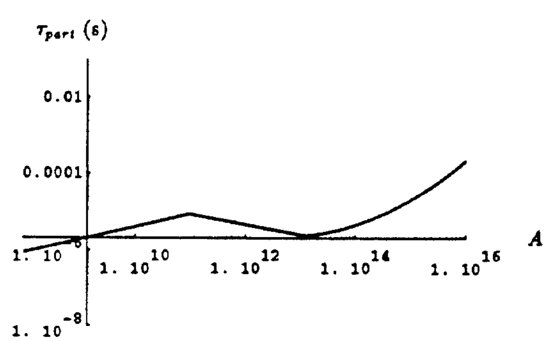

Fig. 13 Calculated lifetime of dust particles in the HER as a function of the particle mass A.

5. RF SYSTEM AND FEEDBACK

There are 6 klystrons and 24 cavities in the HER with full power recirculators and a full low level feedback system [3]. A full longitudinal and transverse bunch-by-bunch feedback (4.2 ns) is being constructed for the HER [4].

6. MACROPARTICLES

Capturing dust by the electron beam is a concern in the HER because of the high current. A study has shown that the anticipated dust will have a low lifetime [<70 μsec] due to the very high temperatures of these macroparticles in the beam [5]. A lifetime plot of macroparticles is shown in Fig. 13.

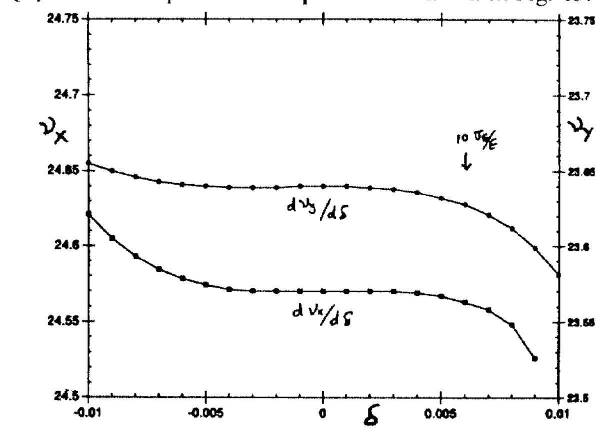

Fig. 11 The change in tunes with energy (βy*=2 cm).

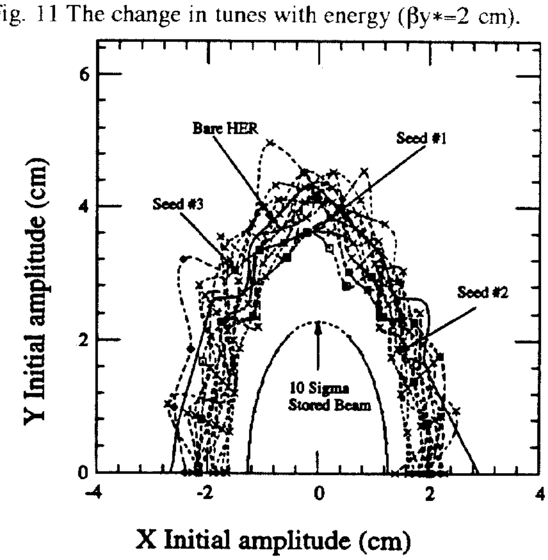

Fig. 12 Dynamic aperture for βy* = 2 cm, 20 seeds, full alignment errors, 10 σ_E/E offset, and with full coupling for y. The required aperture is the dotted line with good clearance.

8. REFERENCES

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