SLAC–PUB–8630
06/2000

PEP-II New High Power Low Impedance Movable Collimator*

John Seeman
Stanford Linear Accelerator Center

2575 Sand Hill Road

Menlo Park, Ca 94025

Invited talk presented at 7th European Particle Accelerator Conference

Vienna, Austria , June 26-30, 2000

* Work supported by Department of Energy contract DE–AC03–76SF00515.

PEP-II New High Power Low Impedance Movable Collimator*

PEP-II AP Note 2000.03

J. Seeman, S. DeBarger, S. Metcalfe, M. Nordby, C. Ng#
Stanford Linear Accelerator Center, Stanford, CA 94309, USA

Abstract

A new class of collimators has been designed and built for the PEP-II collider which has opposing movable jaws. These collimators are designed to reduce backgrounds in the BaBar detector. They can support several kW of synchrotron radiation power striking the jaws or the impedance matching ramps. There are no longitudinal nor transverse higher–order-modes. The jaws and collimator body are made of Glidcop.

1 INTRODUCTION

PEP-II [1-3] is a two ring asymmetric electron-positron collider at 3.1 x 9.0 GeV being built in the PEP tunnel at the Stanford Linear Accelerator Center SLAC. See Figure 1. The HER of PEP-II started commissioning in July 1997 and the LER of PEP-II in July 1998. The HER has stored 920 mA at 9 GeV and the LER has stored 1721 mA at 3.1 GeV both in 1658 bunches. A luminosity of 2.08x10**33/cm**2/s was achieved in PEP-II in June 2000 with 665 bunches and 700 mA x 1100 mA (HER x LER). Backgrounds from these high currents come mainly from beam-gas interactions resulting in lost particles immediately upstream or inside the BaBar detector.

Fixed position collimators in the HER have been previously installed in Region 12 and fixed collimators in the LER were installed in Region 4. These collimators help with globally generated lost particles but are not effective against lost particles locally generated just upstream of BaBar. A new class of collimators with movable jaws was designed allowing operation in heavy synchrotron radiation for the areas just upstream of the detector.

2 COLLIMATOR DESIGN

A top view of the collimator is show in Figure 2 and an end view in Figure 3. The design parameters of the collimator are listed in Table 1. The collimator is designed to connect to the extruded copper vacuum chambers of PEP-II with inner dimension of 90 by 50 mm. The jaw is

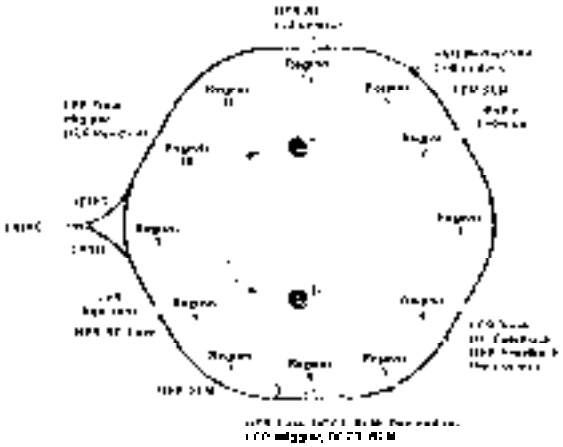

Figure 1: PEP-II B-Factory Overview

shaped to have the same taper angle as the low impedance ramps. In the “in” position the jaws and the ramps form a smooth gentle complete taper. In the “out” position the jaws generates what looks like a mode trapping volume. However, modes are not trapped as the ramp length is short and the ramp inward volume is slightly larger than the outward volume made by the retracted jaw. Thus, no TM or TE modes are trapped.

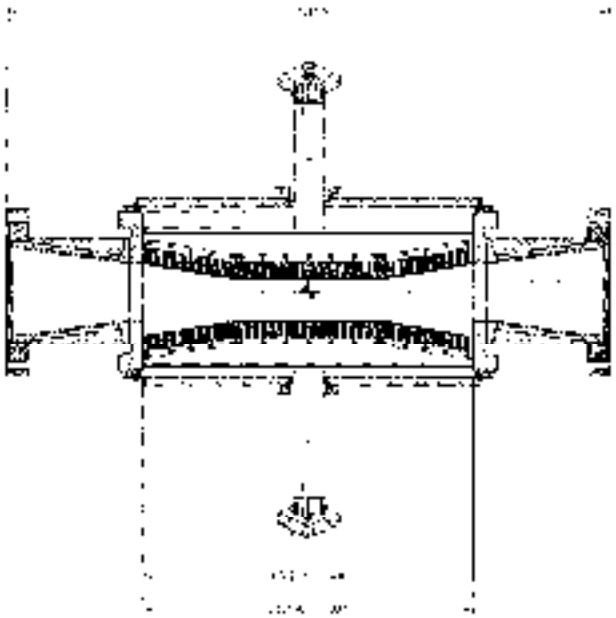

Figure 2 Top view of the high power collimator with two movable jaws and an impedance matching ramp.

*Work supported in Department of Energy contract number DE-AC03-76SF00515.
Email: SEEMAN@slac.stanford.edu

All the ramp and jaw surfaces are water cooled using a design similar to the photon design in the LER arc vacuum chambers. A passage is machined on the opposite side from the beam surface which receives power from synchrotron radiation or lost particles. The passage is grooved to facilitate heat removal. The passage is closed by a brazed-on plate. The geometry is such that there are no vacuum-to-water brazes. There is an air guard passage which enters the stem of the collimator which provides this function internally for both jaws.

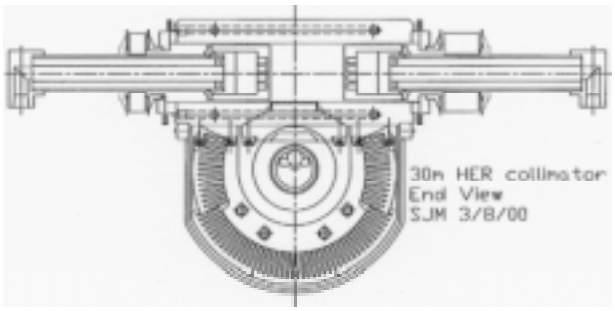

Figure 3 Beam's eye view of the collimator showing the rf fingers which completely surround the jaw.

Table 1 Collimator Parameters

Parameter	LER Value (HER if different)
Beam energy	3.1 (9.0 GeV)
Plane of the jaw	Horizontal
Number of jaws	Two
Chamber and jaw material	Glidcop
Inner bore horizontal	90 mm (125 mm)
Inner bore vertical	50 mm
Jaw stroke	16.5 mm (20.8mm)
Fixed ramp height	16.5 mm (20.8 mm)
Fixed ramp length	113.5 mm (205.8mm)
Jaw radius of curvature	2 m
Jar curved length	154 mm (122.7 mm)
Jaw ramp length	91 mm (208 mm)
Total jaw length	336 mm (540 mm)
Total collimator length	613 mm (1000 mm)
Jaw height	47 mm
Finger clearance	1.9 mm
Min jaw clearance to chamber	1.5 mm
Chamber to jaw out position	16.5 mm (20.8 mm)
Chamber to jaw in position	33 mm (41.6 mm)
Water cooling	All beam surfaces
Beam horizontal beta function	60 m (190 m)
Beam horizontal emittance	50 nm
Beam energy spread	0.077% (0.061 %)
Beam dispersion	0.22 m and 1 m (0.12 m)
Total beam sigma	1.74 and 1.9 mm (3.1 mm)
Jaw allowed power	150 to 200 W per linear cm
Ramp allowed power	75 to 150 W per linear cm

The synchrotron radiation power which is allowed to strike the ramp is up to 150 W per cm and up to 200 W per cm for the jaw. Each surface will have about 0.2 gpm water flow in four circuits for a total of about 0.8 gpm per collimator. The jaw is curved along the beam line to relax the tolerance on alignment which is about 1 mrad. The rf seal around the jaws are made of Glidcop fingers coated with rhodium. The body surface which touches the fingers is coated with silver. The motion of the jaws is transmitted through the vacuum wall via a welded bellows.

The jaws are moved by industrial ball bearing slide mechanisms which can take high off-axis torques. The slide is driven by a stepping motor controlled via a local microcomputer. The position of each jaw is measured with a TLD. Thermocouples are mounted near the heated surfaces for protection using the beam abort.

The power lost on these collimators will make the local vacuum pressure rise. The LER units will have extra vacuum pumping added in adjacent chambers. The HER unit will have a TSP pump installed in the collimator unit as seen in Figure 3. The effective vacuum pumping is about 400 l/s.

Two of these collimators are being built for the Low Energy Ring and one for the High Energy Ring. All will be installed about December 2000.

3 BEAM IMPEDANCE

The impedance of these collimators was studied using MAFIA. The modes of operation studied are shown in Figure 4. All these modes were modeled. The transient TM and TE longitudinal modes are shown in Figure 5. None of these modes was trapped. However, if a small 1.5 mm gap is included above and below the collimator

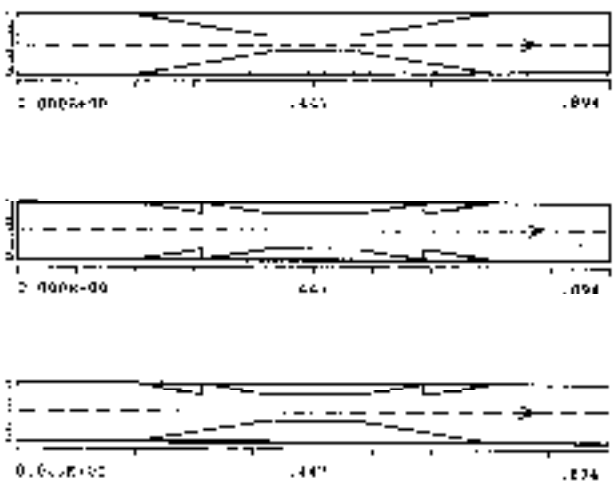

Figure 4 Modes of operation of the collimators for analysis of impedances: fully closed, fully open, and only one jaw inserted.

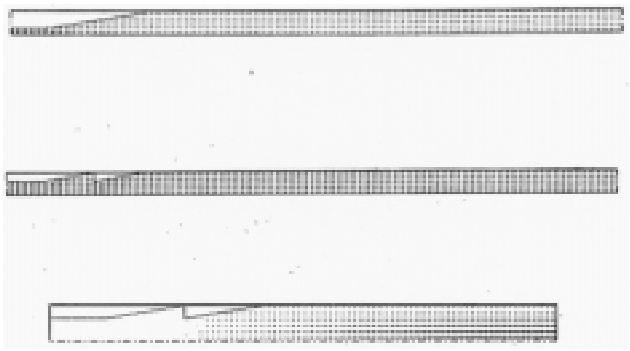

Figure 5 TM modes (upper two plots) for fully inserted and fully retracted jaws and TE longitudinal mode (lower) for the fully retracted case are not trapped by this collimator as the fields “leak” out along the beam chamber. The TE10 mode is about 2.997 GHz and the TM11 mode about 3.430 GHz. The

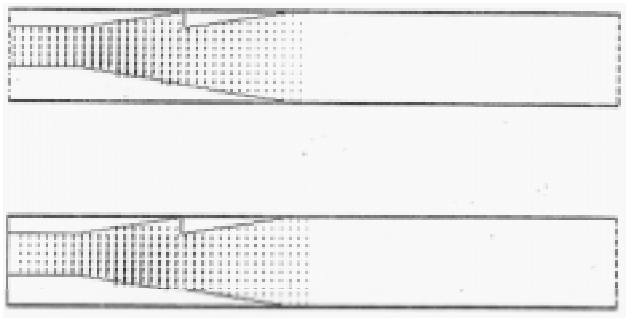

Figure 6 TE modes which are trapped within the structure if a top and bottom gap (1.5 mm) is left between the jaw and its housing. The above modes have frequencies about 2.851 and 2.861 GHz. These modes are not expected to be present nor affect beam operation as this gap has been filled with sliding rf fingers.

jaws in the model, then a TE mode is trapped as shown in Figure 6. The Qo of these potential modes is about 1200 and the Zx is about 60 to 120 kohm/m at a frequency of about 2.773 GHz. The installation of rf fingers removes these modes.

The local energy losses of the beams will be studied during beam operation to verify these impedances.

4 BEAM OPERATION

The collimators will be operated during BaBar data taking to reduce the lost particle backgrounds. The expected number of lost particles per second hitting the jaws is about 10^9. The jaws are designed to be able to intercept an ever larger fraction of the beam if it’s position is too close to the beam core. The backgrounds will measured as a function of position to determine the optimum jaw location.

5 REFERENCES

[1] "PEP-II Conceptual Design Report", SLAC Report 418, LBL-PUB-5379, June (1993).

[2] J. Seeman, “KEKB and PEP-II B Factories,” Proceedings of Flavor Physics Conference, Nuc. Phys. B 59 (1997), p. 51.

[3] J. Seeman, et al, “Status of the PEP-II e+e- Collider”, Proceedings of EPAC2000, Vienna, Austria, June 2000.