Injection System for the PLS Storage Ring*

J. E. Milburn, S. H. Hong, S. H. Jeong, B. K. Kang, I. S. Kim,
Y. M. Koo, N. S. Shin and M. Yoon
Pohang Accelerator Laboratory, POSTECH
San 31, Hyoja-Dong, Pohang, Korea 790-784

Abstract

A 2 GeV synchrotron light source is being built in Pohang, Korea. Injection of 2 GeV electrons into the storage ring is accomplished using a four bump kicker arrangement to displace the closed orbit of the storage ring by up to 21 mm horizontally, and using a D.C. Lambertson type septum magnet to bend the injected beam 8^o vertically. The kicker magnets are single turn ferrite core devices excited by a 4 μs half sine wave. They are excited by a single power supply, with two magnets powered in series, and two sets of magnets powered in parallel, so as to minimize timing and waveform errors. All injection elements are designed to fit entirely into one straight section of the storage ring. Diagnostics for the injection system and special vacuum components are also described.

1 INTRODUCTION

The Pohang Light Source (PLS) project consists of a full energy (2 GeV) electron linac and a 285 m circumference storage ring (SR). The linac is placed 6 m below the plane of the storage ring. The beam transfer line (BTL) from the linac to the storage ring transports the beam under the experimental hall, and ramps up to intersect the SR.

The final vertical bend in the BTL is provided by a Lambertson-type septum magnet, which bends the beam 8^o to an orbit in the plane of the SR, and parallel to the stored beam. During injection, the stored beam is moved 21 mm towards the septum by a four bump kicker system. At the exit of the septum magnet, the separation between the centers of the injected beam and the stored beam is 12 mm.

A plan view schematic of the injection scheme is shown in Figure 1. A drawing of the entire system is shown in Figure 2.

2 COMPONENTS

2.1 Septum Magnet

The septum magnet is a Lambertson type magnet, operating at 1.1 T primary field for a 2.0 GeV injected beam. Parameters for the septum magnet are shown in Table 1.

The magnet core is machined from solid pieces of steel. To minimize eddy current effects in the core, and leakage field due to these eddy currents, the magnet is operated in

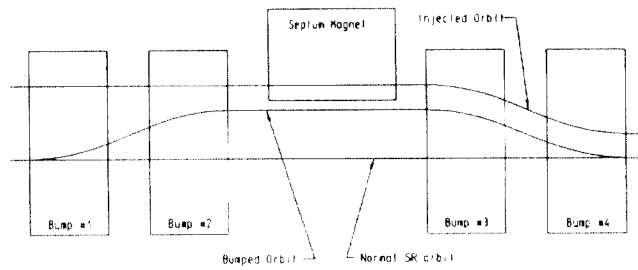

Figure 1: Plan view schematic of the injection scheme

DC mode, with very slow ramp rates during turn on and turn off.

At full excitation, the integrated leakage field on the stored beam path is 2 gauss-m, which results in only a .03 mrad kick to the stored beam.

A cross section of the septum magnet is show in Figure 3.

2.2 Kicker Magnets

The four kicker magnets are ferrite core, single turn devices. They are powered via a pulse transformer, which is placed directly on top of the magnet. The pulse transformer has the effect of reducing the effective inductance of the device, lowering the voltage requirement of the power supply (and increasing the current requirement), and reducing transverse gradients in the magnet. A cross section of a kicker magnet is shown in Figure 4.

Parameters for a single kicker are given in Table 2.

The magnet casing and conductors are made of gold plated copper. The gold plating is added to minimize corrosion and maintain good joint conductivity.

The pulse transformer is a 1:2 transformer, with a center

Table 1: Septum Magnet parameters

Beam Energy	2 GeV
Effective Length	0.869 m
Bend Angle	8^o
Bending Field	1.1 T
Leakage field (at stored beam orbit)	2 gauss-m
Septum Thickness (incl. chambers)	3 mm
Magnet gap	25 mm
Number of turns	144
Current	154 A
Voltage drop	37 V
D.C. Power	5.7 kW

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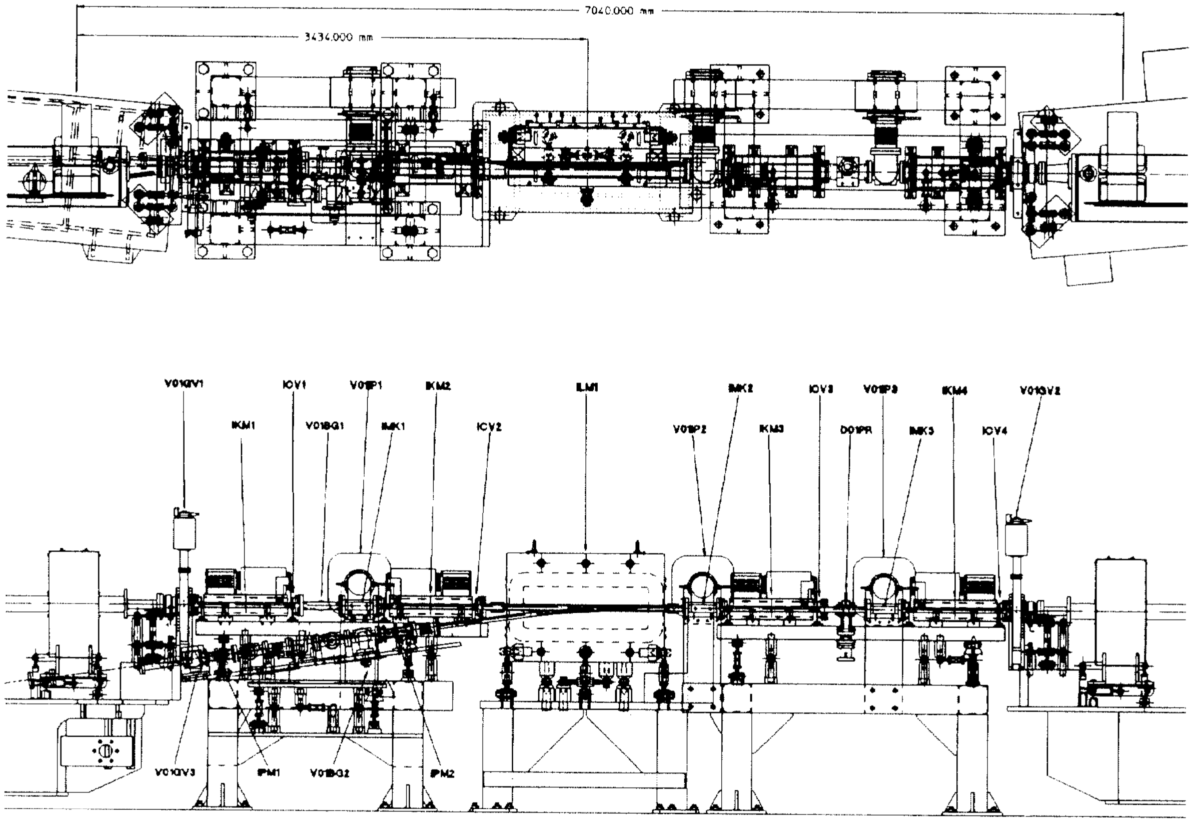

Figure 2: Plan and Elevation views of the injection system

Table 2: Kicker Magnet parameters

Effective length	0.6 m
Bend Angle	16.6 mrad
Bending Field	0.185 T
Vertical aperture	0.040 m
Horizontal Aperture	0.092 m
Peak Current	12 kA
Peak Voltage (excluding cabling)	4.0 kV
Effective Inductance (at transformer input)	0.9 μH
Repetition rate	10 Hz

tapped secondary. The center tap is the common ground, and is connected to the outer case of the magnet. The primary circuit floats, to allow for series connections of magnets.

2.3 *Kicker Power System*

All four bump magnets are powered by a single supply. Two sets of two magnets, powered in series, are powered in parallel. The maximum requirements for the power supply are summarized in Table 3. The primary advantage of using a single supply is that the supply becomes insensitive to minor changes in the waveform of the pulse, *i.e.* all of the magnets track each other.

Table 3: Kicker Supply parameters

Max pulse voltage	16 kV
Max current	24 kA
Repetition rate	10 Hz
waveform	half sine wave
pulse width	4 μs

2.4 *Vacuum System*

To achieve sufficient lifetime of the circulating electron beam, an operating average pressure of 10^{-9} torr is required in the storage ring.

The BTL, as single pass beamline, requires a pressure of only about 10^{-6} torr. Isolation between BTL and SR vacuum is provided in the BTL line, about 1 m upstream of the septum magnet, by a 0.10 mm thick aluminum foil. The foil is thick enough to withstand a catastrophic vacuum accident in the BTL without rupturing.

Inside the bump magnets, a ceramic vacuum chamber is provided. The inner surface of the ceramic chamber is coated with titanium-nitride, to minimize beam chamber impedance. The coating is not uniform, as field errors generated by eddy currents in a complete, uniform coating would adversely affect the field uniformity of the kicker. A pattern is chosen which gives acceptable impedance characteristics, with acceptable disturbance to the magnet field.

Both ends of each ceramic chamber have a ceramic to metal transition, and a welded metal bellows. Inside the bellows, an slip joint type impedance shield is provided.

To protect the ceramic chambers from photon bombardment, photon absorption masks are placed in the injection straight section. A 220 l/s sputtering ion pump is provided at each photon mask.

2.5 *Instrument and Control System*

Two wide band stripline beam position monitors, located about 1 m apart, are provided in the BTL section immediately upstream of the septum magnet. These devices allow monitoring of the injected beam input vector. A scintillating beam profile monitor is installed between bump magnets #3 and #4. The profile monitor allows for calibration of the bump magnet amplitudes and the injected beam profile.

2.6 *Alignment*

Most components are pre-aligned on rigid support plates in the laboratory. The assembled plates are installed and aligned as a unit. There are four sub-assemblies in the injection system; (1) the upstream bump assembly, including two bump magnets, a photon mask, and a spool chamber. (2) the downstream bump assembly, including two bump magnets, a photon mask, and the beam profile monitor, (3) the septum assembly, including the septum magnet, the septum vacuum chamber, and a photon mask, and (4) the BTL assembly, including the thin window, an isolation gate valve, a vacuum roughing port, two stripline monitors, and vacuum diagnostic ports.

3 INSTALLATION STATUS

Injection system components are being installed at this time. Full system testing will begin in July, with operation expected to begin on September 1.

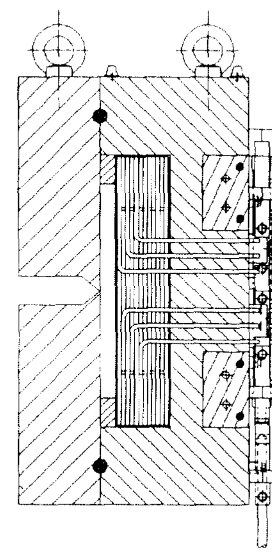

Figure 3: Septum Magnet cross section

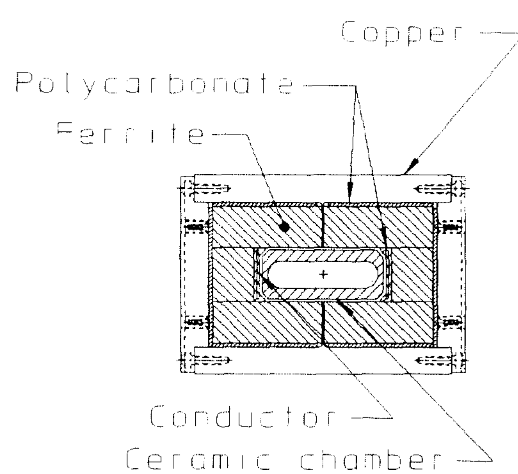

Figure 4: Kicker Magnet cross section