THE NEW INJECTION SYSTEM OF THE HLS II

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Abstract

The 0.8GeV storage ring is being rebuilt at NSRL. The design and construction of the new injection system of the ring is presented. Kicker magnet, septum magnet and the pulsed power supplies are described. Test results are given. The ceramic chambers, vacuum tank of the septum magnet, and local pulsed power control are also described. The installation and commissioning of the new system are undergoing

INTRODUCTION

Currently the HLS II project is in progress at NSRL [1]. The new storage ring which has more insertion devices and a lower emittance will soon be filled with 0.8GeV electron beam from the newly built, full energy Linac. Injection of electron beam into the storage ring is accomplished by four kicker magnets and a septum magnet. The septum magnet is at the cross point of the ring and the transfer line. Two kickers are located in the straight section and the other two are inside the DBA structure near B12 and B1 as shown in Figure 1 [2].

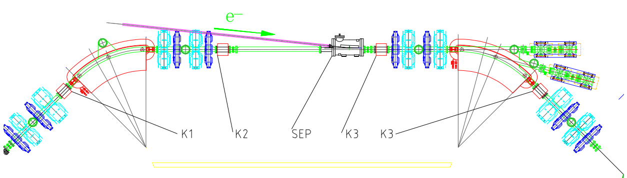

Figure 1: Pulsed Magnets in the storage ring.

The septum magnet deflects the beam from transfer line by a 105mrad and makes the injected beam to be parallel to the stored beam. The kickers move the stored beam orbit horizontally by an offset of 24 mm and close to the septum and bring the injected beam within the storage ring acceptance aperture as shown in Figure 2.

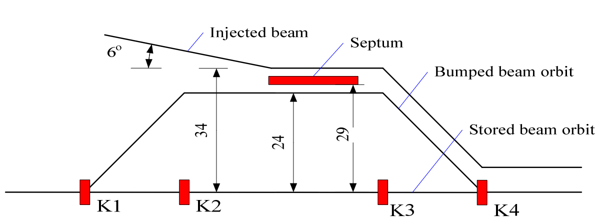

Figure 2: Critical parameters.

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PULSED MAGNETS

The designed parameters of the pulsed magnets are listed in Table 1.

Table 1: Specifications of Pulsed Magnets

Magnet	kicker	septum
Beam Energy (GeV)	0.8	0.8
Deflection (mrad)	105	8
Integrated field (Tm)	0.35	0.027
Peak field (Gs)	8495	1154
Core length (mm)	400	180
Size of aperture (mm)	33*12	98*54
Inductance (μH)	1.73	0.52
Peak current (A)	8112	4961
Pulse width (μs)	60	1.3

Septum

The septum magnet is of eddy current type. The septum screen shields the magnetic field leakage by the eddy current effect which is caused by fast variation of the pulsed magnetic field. The magnet core is C shaped, 0.1mm laminations. It is 400mm long and is housed in a vacuum tank as shown in Figure 3.

Beside the core an OFC dummy tube is placed in the path of the stored beam to lower beam impedance. A magnetic screen is wrapped around the dummy tube to further attenuate the septum leakage field.

An injection beam profile monitor is integrated into the body of the tank. Under the stainless steel tank, a 200l/s NEG pump is employed to obtain required vacuum.

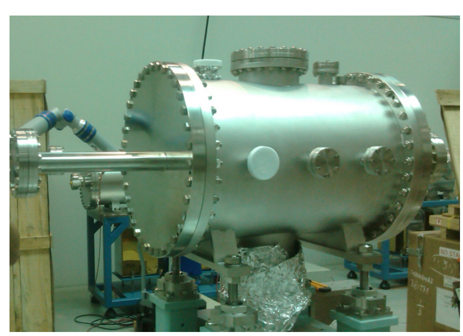

Figure 3: Septum magnet.

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Kickers

The kickers are window frame magnets with a free aperture of 98 mm wide and 54 mm high as shown in Figure 4. The magnet core is made by Mn-Zn ferrite which is able to provide the required 0.12T, 1.3 μs duration, half sine wave magnetic field. The top of the case can be moved and the coil can be taken out without moving ceramic chamber. This makes the replacement and maintenance of the coil is easier.

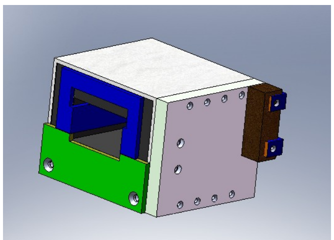

Figure 4: Kicker magnet.

Ceramic Chamber

Inside the kicker magnet, a ceramic vacuum chamber is provided. The chamber including flange is a 300 mm long, 90 mm wide and 54 mm high with a thickness of 5 mm.

The inner surface of the ceramic chamber is coated with a titanium layer. The thickness of the coating is carefully chosen to keep the deformation of the field within the error allowance and in the meantime minimize the contribution to the beam coupling impedance. The final DC resistance is 1.2 ohm and the value is very close without much difference from each other.

At one end of the chamber there is a welded bellow to protect the ceramic. A RF contact is inserted inside the bellow for the continuity of the inner shape.

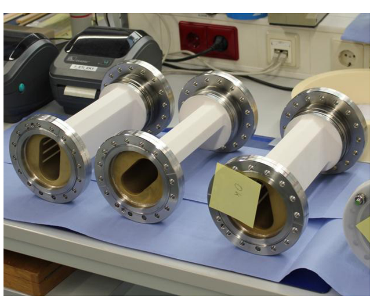

Figure 5: Ceramic chambers.

Pulsed Powers and Local Control

The kickers are driven by four pulsed power individually. In the kicker power, PFN is a simple RLC resonant discharging circuit. The thyratron CX1154C, damping R and the high voltage capacitor are placed inside a coaxial structure to reduce the stray inductance. Suitable damping R reduces the reversal voltage and noise. The septum power uses a similar RLC resonant discharge circuit but uses a thyristor switch. And the size of cabinet is much smaller than the kicker's as shown in Figure 6.

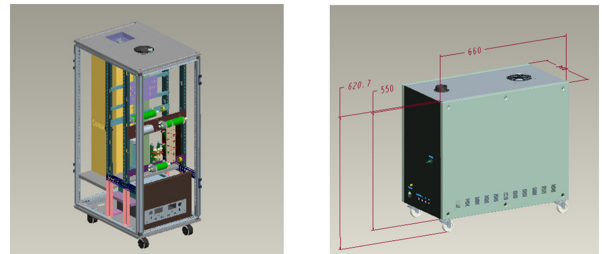

Figure 6: Kicker and septum magnet pulsed powers.

Four kicker powers and one septum power share a common 19' control cabinet. Four 30kV rated and one 3kV rated charging powers are all placed in the cabinet. A PLC based controller achieves command control, status-monitoring, safety interlock and real-time communication with the IOC as shown in Figure 7.

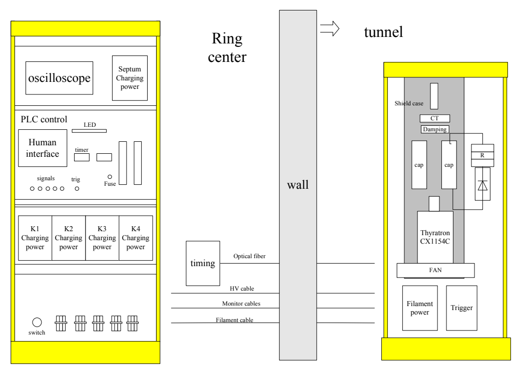

Figure 7: Pulsed power control.

TESTING AND MEASUREMENT

Extensive tests have been performed on the magnets and pulsed powers.

Magnetic field strength and excitation current is in good linear relation as shown in Figure 8 and 9 for kicker and septum respectively. The magnet shows no sign of saturation at designed field strength.

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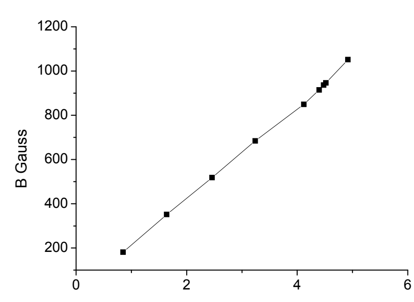

Figure 8: B-I relation of kicker magnet.

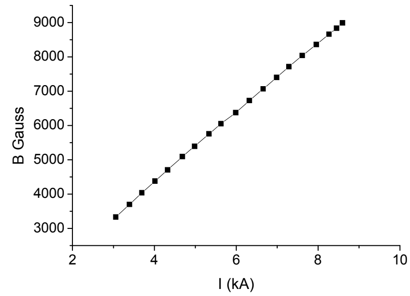

Figure 9: B-I relation of septum magnet.

For magnetic field profile measurement, a dot probe sensor is used. It is a multi-turn coil with total area of 367mm^2, while for kicker the area is 111mm^2. Long probe sensor is also made which is 1.6mm wide and 400mm-600mm long. Long probe is convenient to measure the integrated field along the z-axis and is quick to find the field homogeneity at different horizontal position in the window.

The coil signals are integrated by either an integration circuit or the digital integration function provided by oscilloscope. After integration the waveforms from sensor become identical to the pulsed magnetic field.

Figure 10 is the profile of septum magnetic field along z-axis at different x position. At the bumped beam position which is 24mm away from the stored beam center, the leakage field was measured to be 66 μT·m which is only 0.02% of the main field strength.

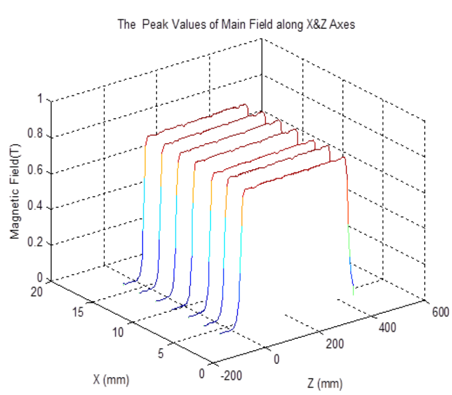

Figure 10: Field profile along z-axis of the septum magnet.

For kicker magnet, measurement results show that field homogeneity is better than ±1.0% in the region ±30mm relative to the center.

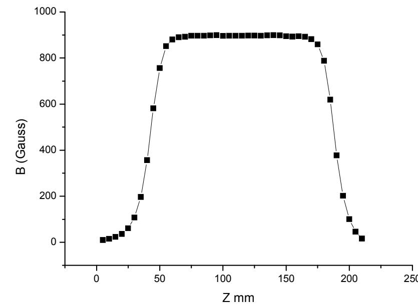

Figure 11: Field profile along z-axis of the of kicker.

The pulsed powers are also tested. They are stable, reliable and can generated enough current for the magnetic field excitation. The current amplitude stability proved to be better than 0.2%, and jitter is less than 5ns. The pulse width mismatch between kicker powers is adjusted to be less than 6ns.

CONCLUSION

The pulsed magnets and the pulsed powers for HLS II storage ring were fabricated, tested and are under installation. The test results show that the magnets and powers have good performance and can meet the requirement the new project. The whole system is scheduled to finish its installation and commissioning before Sep. 2013.

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