

Test Results of SRRC Pulsed Magnets for 1.5 GeV Injection

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ABSTRACT

The SRRC pulsed magnets were designed for 1.3 GeV electron beam injection. It is proposed to operate the storage ring at 1.5 GeV in order to improve beam lifetime and its stability. Therefore, 1.5 GeV full energy injection is planned. The kickers, septum magnets and the associated power supplies were modified to meet 1.5 GeV operation requirements. Test results is presented in this report.

1 INTRODUCTION

The injection of the electron beam into the storage ring takes place in one of the straight section in the horizontal plane from the inner side of the ring, figure 1 [1]. The injection system composed of five pulsed magnets; they are four kickers and one septum. Each pulsed magnet is equipped with a capacitive discharged pulser capable of producing half-sine current pulse with 1.5 μ s base width, 7 kA peak for the kicker and 300 μ s base width, 8 kA peak for the septum, respectively.

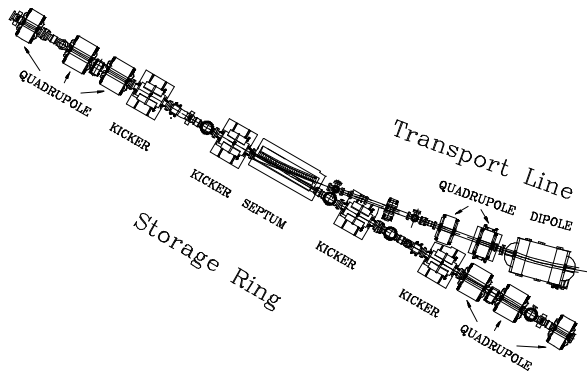


Fig. 1 Layout of SRRC Storage Ring Injection Section

The kicker magnet is a window frame ferrite magnet. Each 40 cm long kicker produces 12 mrad kick to fulfill the injection dynamics requirement. Over 90 % of the kicker pulsed magnetic field is able to penetrate the metal coated ceramic chamber without distortion. The septum magnet is made of laminated Si steel with

length of 90 cm which produces 10° bend of the injected beam in parallel with the injection straight centerline, and is basically a modified version of super ACO design.

Triggering of the pulsed magnets is provided by the timing system of the storage ring control system. The delay of each pulsed magnet can be individually adjusted to provide tuning flexibility.

2 KICKER AND SEPTUM MAGNETS

Functional block diagram of the kicker pulser is shown in figure 2. The pulser is capacitively charged before the thyatron switch is triggered to fire the circuit. The diode switch is activated during the drive in order to eliminate reversed field produced in the kicker as well as for thyatron protection. Calibrated current transformer (CT) and dB/dt probe are used to monitor the driving pulse. Some modification of the injection system have been carried out to improve its performance according to previous operation experience. It was constructed that the AC power supplies were used for the thyatron tube filament heaters of the kicker pulsers. The effort of reducing the current jitters was found to be limited by the AC power source. The jitters could be improved by using DC power supplies instead. Table I gives the specification of kicker and septum for 1.5 GeV operation

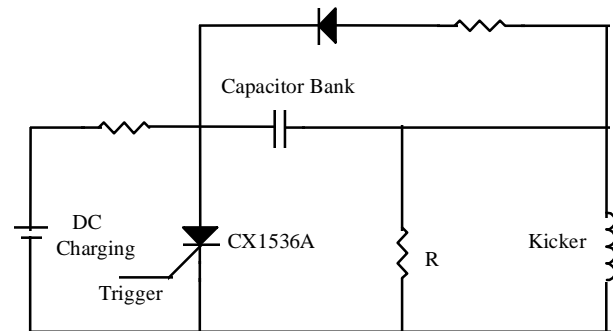


Fig. 2 Functional block diagram of kicker pulser

The conductor carrying excitation current from the septum pulser to the magnet was enforced with a larger conduction cross section. Because the septum coil carries larger current and dissipates more heat for the 1.5 GeV case, the cooling with forced air is required so as to keep the septum coil temperature below 40 °C. Figure

3 gives the functional block diagram of the septum pulser. A circuit was added to recover the residual energy and also protect the power supplies. The SCR can provide pulse with jitters better than 10 ns.

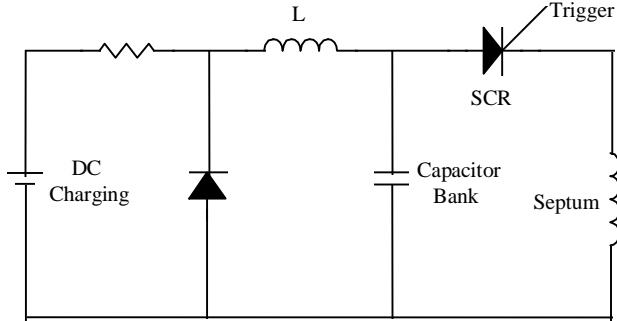


Fig. 3 Functional block diagram of septum pulser

	kicker	septum
length	40 cm	90 cm
gap	54 mm	12 mm
bend angle	12 mrad	10°
peak magnetic field	1.5 KG	9.7 KG
pulse length (half sine, base width)	1.5 μ s	300 μ s
peak currents	7 KA	8 KA
magnet inductance	1.2 μ H	1.5 μ H
amplitude stability (peak to peak)	0.5 %	0.2 %
jitters (peak to peak)	4 ns	5 ns

Table I Major parameters of kicker and septum for 1.5 GeV operation

3 SYSTEM PERFORMANCE

Four kicker circuits were also trimmed so that pulser shapes matched with one another. With the replaced DC power supply for thyatron filament heater, the kicker pulse jitters were reduced from 20 ns (peak to peak) to better than 4 ns. Figure 4 shows the linear relation between the applied DC charging voltage and the peak driving pulse monitored by current transformer. Relation between the dB/dt probe and the DC charging voltage of the pulser is also given in the figure. A straight line fit of the data indicates that no saturation of the kicker magnet was observed even when it was driven at 20 % higher current than the 1.5 GeV injection required. Four kickers were then tested with field

strength 20 % higher than the 1.5 GeV requirement for 8 hours nonstop run under 10 Hz operation. The performance of the kickers remained the same throughout the test duration. Since the duty cycle was relatively low for the kicker pulse, no observable thermal effect was detected for the kicker magnet.

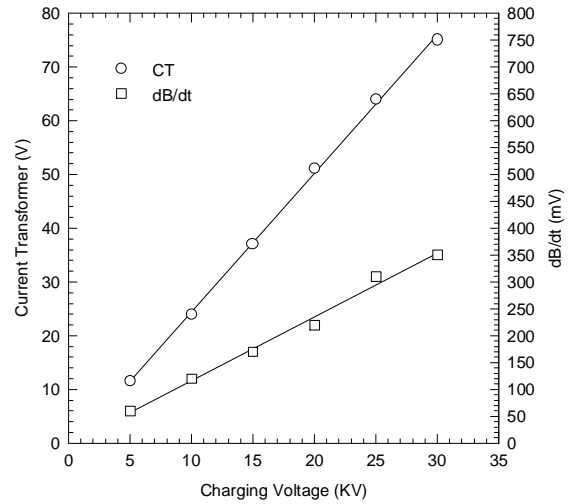


Fig. 4 Current transformer and dB/dT probe reading with respect to kicker charging voltage.

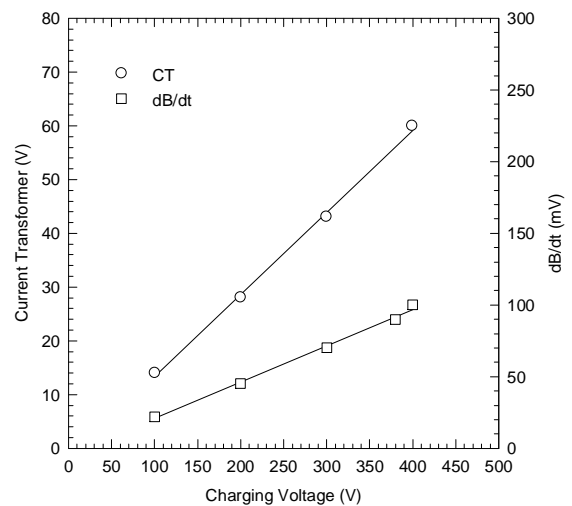


Fig. 5 Current transformer and dB/dT probe reading with respect to septum charging voltage.

The septum magnet was tested at field strength 20% higher than what 1.5 GeV required. Figure 5 shows relation between septum pulser charging voltage and the driving current peak value monitored by current transformer. A dB/dt probe has also been used to verify

that no saturation effect was observed in the septum magnet under the operation condition described above. During the 8 hours test period, both pulse shape and jitters were monitored and the performance kept the same.

4 CONCLUSION

From the test results given by kickers and septum, it indicates that the modified injection system is capable of operating for 1.5 GeV full energy injection. The test run was given at the condition that both kicker and septum field strengths were 20% higher than the 1.5 GeV required. This modification of injection system also

provides more comfortable beam injection for present 1.3 GeV injection.

5 ACKNOWLEDGMENT

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REFERENCE

- [1] M. H. Wang, C. C. Kuo, C. S. Hsue, Proceedings of the 1991 Particle Accelerator Conference, 2697 (1991)