

FAST MAGNETS FOR THE NSLS-II INJECTION

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Abstract

Third generation light sources require top-off operation in order to provide high stability of the photon beam. In this paper we present a conceptual design of the fast pulsed magnets used for injection into the 3 GeV storage ring. Because the NSLS-II project is in the design stage possible variants of the injection straight section are also discussed.

INTRODUCTION

The NSLS-II light source [1, 2] should provide ultra-bright light for users. Full utilization of the light source capabilities requires the top-off operation mode [3]. In such mode electron beam will be injected into the storage ring [4], while the shutters remain open. Such mode requires precise operation of kicker magnets in order to minimize disturbance of the stored beam.

INJECTION HARDWARE

Present design [2] provides 6.8 m long straight sections. Such distance between the end quadrupoles is sufficient to organize injection with four fast bumps (see Fig. 1). The first two kickers bring the electron beam towards the septum edge while keeping it parallel to the equilibrium orbit. The other pair brings the stored beam with incoming beam back to the equilibrium orbit. Each kicker will be fed by an individual power supply in order to be able to compensate for the inevitable deviations of the kickers strength from each other.

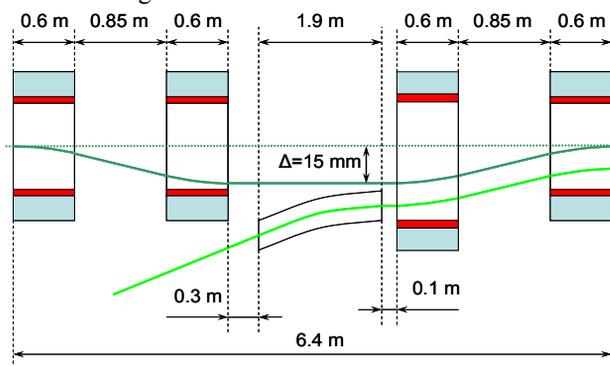


Figure 1: Injection straight for NSLS-II 3 GeV ring

Septum

For the purpose of analysis we have chosen the septum design of the DIAMOND storage ring [5], which has parameters similar with NSLS-II. The injected and stored beams are separated by a septum with 3 mm thick wall. The center of the injected beam, optimally matched for injection, is 2 mm away from the septum wall (see Fig. 2). The stored beam with much smaller size is brought to

about 1 mm to the wall from the other side.

The magnetic length of the septum is equal to 1.67 m. With magnetic field amplitude of 0.9 T the bending angle is 8.5°. Assuming 10×20 mm² vacuum chamber it is easy to obtain that the energy stored in the magnet is about 100 J. Single turn winding provides for 4.2 μH inductance and 7 kA peak current. For 100 μs pulse duration capacitor bank of 240 μF is required and charging voltage is about 1 kV.

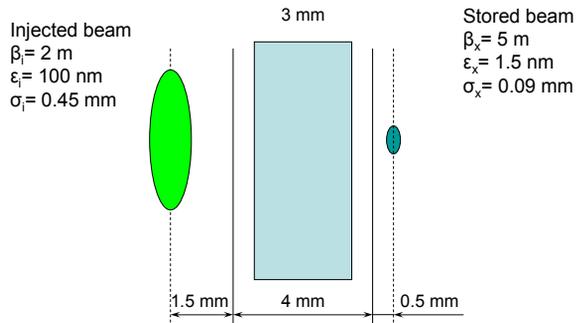


Figure 2: Septum cross section.

As it is mentioned before, the stored electron beam returns to the equilibrium orbit, while the injected bunch oscillates around it. In order to provide lossless injection the dynamic aperture in horizontal direction should exceed 10 mm.

Kicker Design

The cross section of the kicker magnet is shown in Figure 3. Its internal dimensions are defined by a vacuum chamber, which is proposed to have elliptical shape with internal axes 60 by 30 mm. The kickers' ceramic vacuum vessel will have the same profile. It will allow to avoid transitions and associated with them instabilities of the circulating electron beam. For the estimation of power supply ratings we assume that the gap between kicker poles will be 40 mm and width will be 70 mm. The winding will be done of single copper sheet with 3 mm thickness.

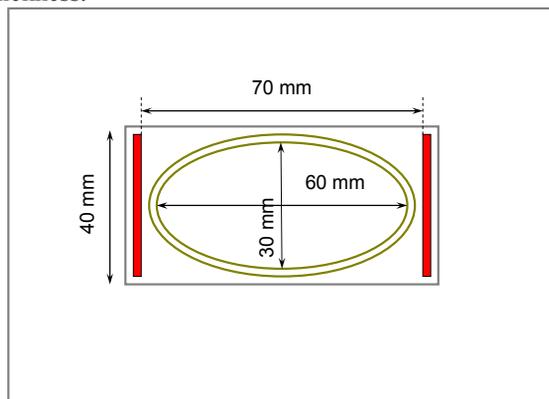


Figure 3: Kicker cross section.

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For the kicker length of 50 cm estimated magnetic length will be 60 cm. Magnetic field of 0.142 T deflects 3 GeV electron beam to the required 15 mm. Such field should not create significant problems with saturation of the ferrite core. The peak current in a winding will be 5.2 kA and estimated inductance of the kicker is 1.4 μ H.

The kicker will be fed by half sine-wave current pulse. Its width at the base will be equal to 4 μ s (slightly less than two revolution periods). From the kicker inductance one can easily obtain that capacitor of 1.2 μ F is required. The power supply should provide charging voltage of 5.7 kV with charging rate of 0.2 kJ/s.

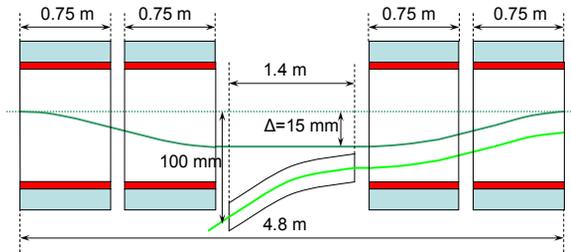


Figure 4: Short injection straight.

As it is mentioned before, the design of the NSLS-II storage ring can be modified. Therefore, we provided analysis how possible changes may affect the design of injection straight. It was found, that the reduction of available space to 6 m still leaves sufficient space for the four bumps. The kicker length will increase to 0.8 m and strength of the magnetic field will increase to 0.2 T. The critical length of the straight section would be 5.0 meters when 0.75 m long kickers will have 0.22 T magnetic field, which is close to the saturation level in the ferrite (see Fig. 4). In order to provide clearance for the one of the

kickers the field in the septum also needs to be increased to 1.2 T.

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