# PULSE GENERATOR FOR THE BEAM INJECTION SYSTEM OF NICA COLLIDER

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*Abstract*

The new scheme of injection kicker elements distribution is described. Parameters of the circuit main elements are estimated. The system allows producing flat top of the injection pulse with high evenness. The suggested design allows building reliable and cost effective injection system satisfying the project parameters.

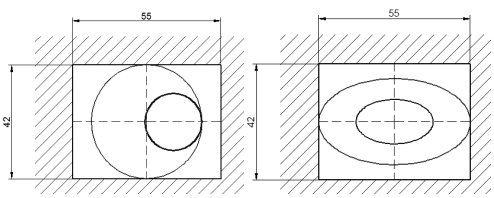
## MAIN CHARACTERISTICS OF BUMP MAGNET

To provide one-turn injection of the ion beam in the collider NICA [1] there are two bump magnets (one piece for each ring). Bump magnet can be composed of several modules. Main requirements for the parameters of bump magnet are shown in table 1.

Table 1:. Kicker Parameters

| | |
|---|---|
| Effective length , mm | 3000 |
| Aperture, mm × mm | 55×42 |
| Pulse duration, nsec | <900 |
| Pulse flat top duration , nsec | ≥100 |
| Field integral, T·m | 0,3 |
| Spatial inhomogeneity of the magnetic field in the beam area,% | <5 |
| Deviation of the field through the bunch length,% | <5 |

Figure 1 shows the operating aperture of the bump magnet, the envelope of the circulating beam (red), the envelope of the injected beam (blue). Blue area is the required area of "good" field.




a) the kicker beginning area b) the kicker end area

Figure 1: The bump magnet aperture, the envelope of the circulating beam (outer curve), the envelope of the injected beam (inner curve).

## PROJECT OF BUMP MAGNET

Several different types of magnets have been considered. The “iron-free" version of the kicker was chosen. It consists of two forward and two reverse conductors in a relatively wide-aperture vacuum chamber. Figures 2 and 3 show the position of the conductors and the distribution of magnetic fields that are optimized for the design parameters of the beam. It should be noted that the selected option almost as good as traditional ferromagnetic one in terms of energy performance, but it is much easier and cheaper to implement.

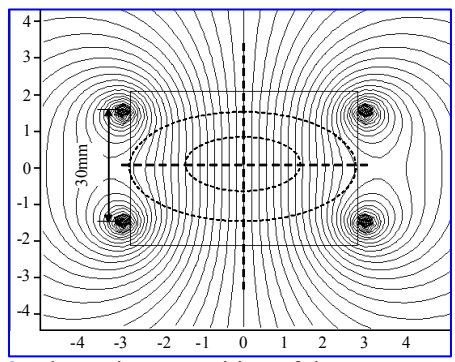



Figure 2: The optimum position of the current-carrying conductors relative to injected and circulating beams at the kicker end area .

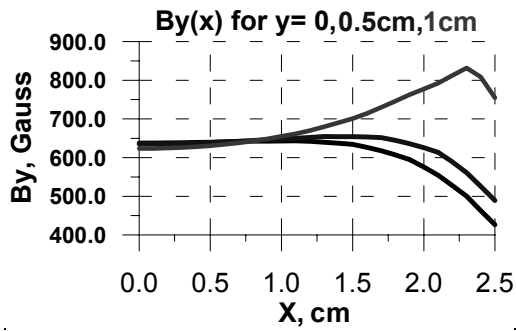



Figure 3: The distribution of the magnetic field.

## PULSED POWER SUPPLY SYSTEM

Pulsed power supply is based on an capacity aperiodic discharge with the inductive load. This scheme allows to form a bell-shaped pulse. For forming the flat top of the acting impulse it is proposed to establish in the area of transportation (the best location - in the middle of the main kicker split into modules) the correcting module with a bell-shaped magnetic pulse with shorter duration, less amplitude and with opposite direction of magnetic field. Power supply circuits for main and correction magnets are shown in Figure 4. The total effect a pair of magnets is illustrated in Fig.5. To facilitate visualization the magnetic fields integrals are expressed in the normalized currents. Flatness at the top of the resulting pulse can be achieved very high, but require high precision timing switches. Besides the amplitude of

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impact (the angle of deflection of the beam) is significantly reduced.

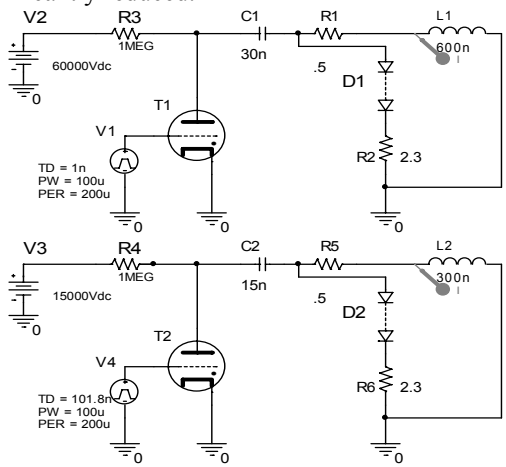


Figure 4: Kicker power supply circuits : main kicker (upper) and correcting kicker (bottom).

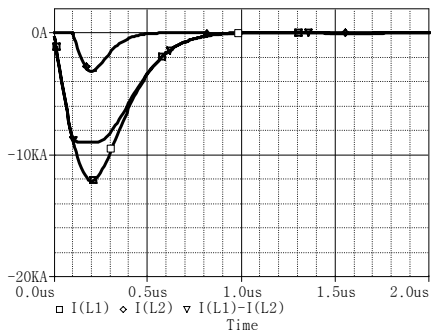


Figure 5: Normalized currents in the magnets: main, correcting and difference

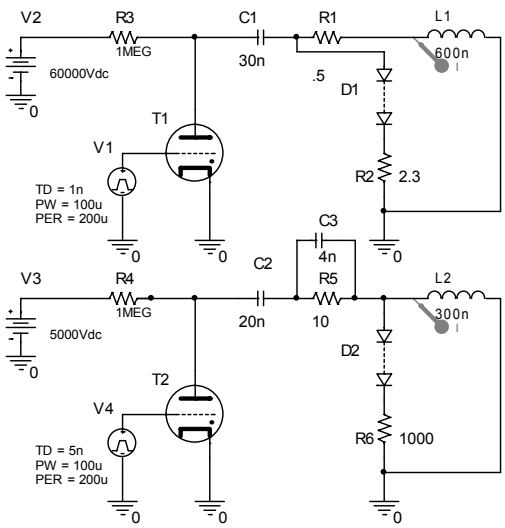


Figure6: Kicker power supply circuits for unipolar powering: main kicker (upper) and correcting kicker (bottom).

Significantly better results in the angle of deviation can be achieved by using an correcting kicker with the same direction of the field, but shifted in time. In this case, the flatness of the top will be a bit worse. One of the variants of such circuits is shown in Figure 6. The total effect a pair of magnets is illustrated in Fig.7.

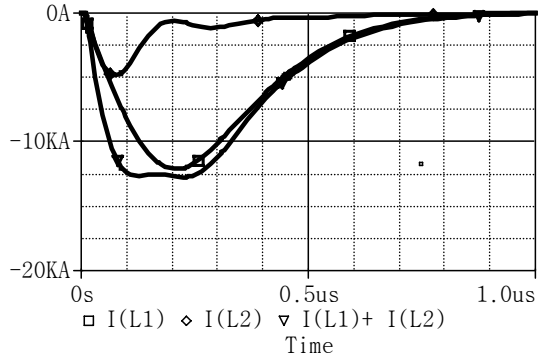


Figure 7: Normalized currents in the magnets: main, correcting and summary

## BUMP MAGNET DESIGN

. The design of an experimental prototype "ironless" bump magnet module is shown in Figure 8. Bushings are located on both sides of the module, which allows using different polarities and thus reducing the voltage on external screen.

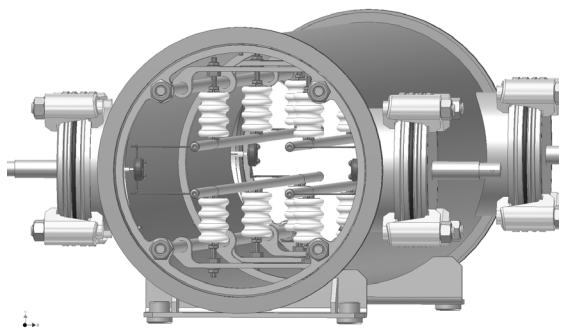

Figure 8: The design of an experimental prototype "ironless" version of bump magnet of Collider NICA

## CONCLUSIONS

The proposed construction of the "ironless" bump magnet and kicker power supply circuits for the NICA Collider satisfy all the requirements of the project and efficiently use the peculiar properties of the structure and dynamics of the beam. Ease of implementation makes them preferable to traditional approaches.

## ACKNOWLEDGMENT

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## REFERENCES

[1] Accelerating-storage complex NICA (Nuclotron-based Ion Collider fAcility). Technical design, under editing I.N. Meshkov and A.O. Sidorin. 2009. http://nucloweb.jinr.ru/nica/index1.htm



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