ISBN: 978-3-95450-197-7 doi:10.18429/JACoW-RUPAC2018-WEPSB19

A PROTOTYPE OF PULSED SEPTUM MAGNET FOR NICA COLLIDER INJECTION

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Abstract

The development and creation of the ion collider NICA continues at the Joint Institute for nuclear research. A scheme of beam injection into the NICA Collider using a pulsed septum magnet is presented. The duration of the pulse magnetic field is about 10 μsec, the amplitude of the field is about 0.5 Tesla. The conceptual design of the septum prototype and the power supply scheme are given. The power supply provides a current of about 50 kA in a current loop with an inductance of 1 μH.

MAIN CHARACTERISTICS OF SEPTUM MAGNET

To provide the injection of the ion beam in the collider NICA [1] there are two septum magnets (one piece for each ring).Main requirements for the parameters of septum magnet are shown in Table 1.

Table 1Septum Magnet Parameters

Effective length , mm	2500
Aperture, mm × mm	35×35
Pulse duration, nsec	>200
Pulse flat top duration , nsec	≥200
Field , T	0,5
Spatial inhomogeneity of the magnetic field in the beam area,%	<5
Deviation of the field through the bunch length,%	<5

Figure 1 shows the arrangement of the main elements at the injection site.

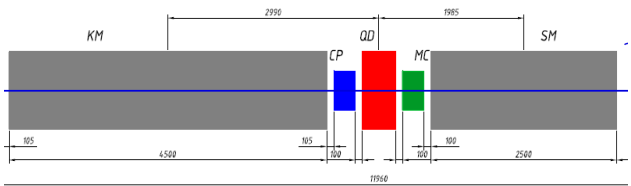

Figure 1: The arrangement of the main elements at the injection site. KM-kiker magnet, SM-septum magnet, QD- quadrupole lens

PROJECT OF SEPTUM MAGNET

When choosing the type of septum magnet we took into account the large duty cycle of procedure. Therefore, preference was given to a pulsed magnetic septum.

Several different types of magnets have been considered. The “iron-free" version of the septum was chosen [2].

The conceptual design of the" iron-free " septum magnet is shown in Fig. 2.

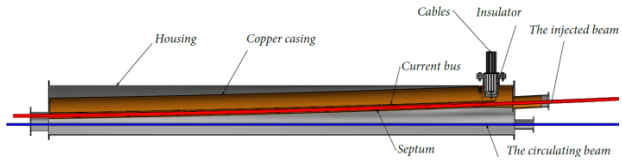

Figure 2: The conceptual design of the "iron-free" septum magnet.

In this design, the deflecting magnetic field is formed in the space between the current-carrying strip bus and a wide septum partition, which is both a reverse current conductor and a part of the common conducting screen, inside which all magnetic fields are concentrated – both working and scattered.

OPTIONS FOR TECHNICAL IMPLEMENTATION

The NICA Collider consists of a large number of superconducting elements. Groups of such elements are connected in series by current and cryogenic lines. Groups of such elements are connected in series by current and cryogenic lines.

Therefore, three variants of the technical implementation of the septum magnet are considered: “warm” (with bypass lines), “cold” (septum is inside the cryogenic volume) and “mixed” (septum magnet and bypass lines are inside general vacuum box).

PULSED POWER SUPPLY SYSTEM

Pulsed power supply is based on a capacity aperiodic discharge with the inductive load. This scheme (Fig. 3) allows forming a bell-shaped pulse.

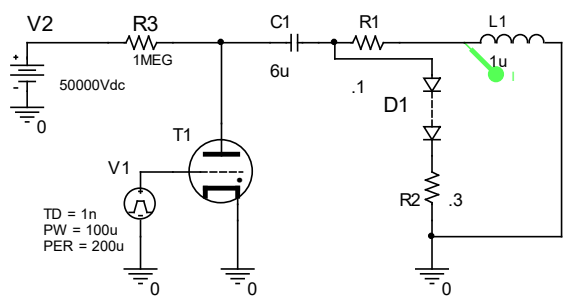

Figure 3: Scheme of pulsed power of the septum. L1 is the total equivalent inductance of the circuit, C1 is the storage capacitance and R1 is the equivalent resistance of ohmic and dielectric losses.

The D1-R2 circuit allows energy to be dissipated, what may be important for the cryogenic option. For switching it is assumed to use the hydrogen thyratron of the type of

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TDI. In the design scheme, it is modeled as a switch with an internal resistance of 0.01 Ohms. The pulse duration (~10 μsec) was chosen as the minimum possible to provide the required time inhomogeneity of the magnetic field. The skin layer will be ~0.3 mm. Calculated current pulse shape is shown in Fig. 4.

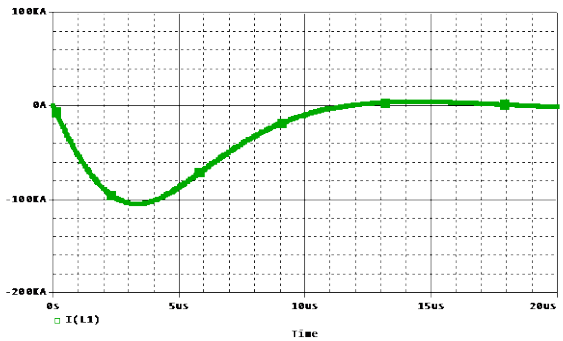

Figure 4: The calculated shape of the current pulse.

THE PROTOTYPE OF SEPTUM MAGNET

It was decided to manufacture a prototype of the septum magnet to test the main technical solutions and test the power supply.

The design of an experimental prototype "ironless" septum magnet module is shown in Figs. 5 - 7.

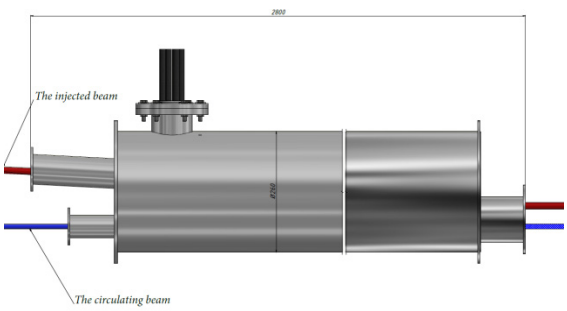

Figure 5: External view of the magnet.

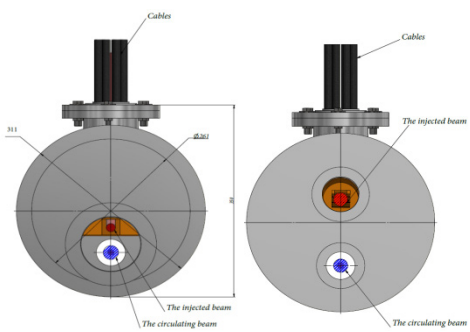

Figure 6: Front and rear views of the magnet.

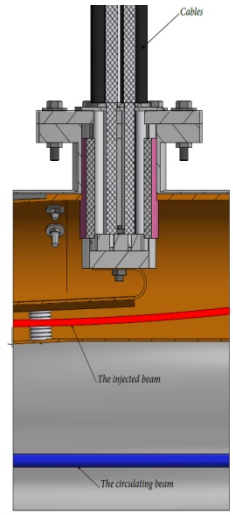

Figure 7: Low-inductive connection of the pulse generator to the current loop.

CONCLUSIONS

The proposed construction of the "ironless" septum magnet and septum pulsed power supply circuit for the NICA Collider satisfy all the requirements of the project. Relative ease of implementation makes them preferable to traditional approaches. Currently, JINR is developing full-scale prototypes of the design and power supply scheme.

ACKNOWLEDGMENT

Authors express thanks Lebedev NikolayIvanovichfor assistance in the simulation of electronic.

REFERENCES

[1] G.Trubnikov et al., "NICA Project at JINR", Proc. of IPAC'13, Shanghai, China, 2013. P. 1343-1345.

[2] V. A. Bulanov, E. V. Gorbachev, A. V. Tuzikov, and A. A. Fateev, "Pulsed Ironfree Inflectors for Particle Injection and Extractionin Cyclic Accelerators", Physics of Particles and Nuclei Letters, 2016, Vol. 13, No. 7, pp. 1527–1532.