THE POWER SUPPLY SYSTEM OF ELECTROSTATIC DEFLECTING PLATES FOR ACCELERATING COMPLEX NICA.

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Abstract

Three pairs of electrostatic deflecting plates will be placed in the booster ring. They will provide injection of heavy ion beam into the Booster. The power supply system for one plate providing all necessary parameters including suppression of the afterpulses is described in the report. The calculated and experimental results are also presented.

INTRODUCTION

Development and construction of the NICA ion collider [1] is underway at the Joint Institute for Nuclear Research. The booster in which the ion beam is preaccelerated and cooled is one of the main facilities of the complex.

The booster injection system presupposes the use of the electrostatic septum and of three deflecting devices [2]. Electric plates are expected to be used as the actuating elements. Hydrogen thyratrons are used as a switches.

CHARACTERISTICS OF ELECTRIC PULSES

All electrical plates are fed with identical pulses that differ only by the amplitude of the applied voltage. Main characteristics of electric pulse with maximum amplitude are shown in Table 1.

Table 1: Main characteristics of electric pulse.

Maximum electrical potential on the plate	60 kV
Charging time	< 50 ms
Duration of pulse plateau at least	30 us
Nonuniformity of voltage on the plateau	≤ 1%
The discharge time	≤ 0,1 us
Residual voltage	≤ 0,5 kV
The number of pulses in a row	1 ÷ 3
The pulse repetition frequency	10 Hz

The parameter values given in Table 1 are generally achieved without major difficulties, but the residual voltage value stands out as an exception to this generalization.

This issue was given special attention. The measurements showed that the voltage at the thyratron (and, consequently, at the plate) nears zero by the time the thyratron is switched off and starts increasing after that. This may be attributed to the response of multiplication and filter circuits of the controlled power supply and the relaxational polarization of dielectrics (e.g., in the lead cables). One possible solution to this problem consists in implementing the “afterburning” (i.e., maintaining the discharge current through the thyratron with the use of an additional low voltage power supply). Such a system is presently used at the Nuclotron accelerator. The arc-burning voltage naturally depends on the thyratron model and operating regime and usually falls within the range from 100 V to several hundred volts.

THE SUPPLY SCHEME

To reduce residual voltage and improve reliability of high voltage components, it was decided to use a pulse charging.

The PSPICE model of the power supply circuit is presented in Fig.1.

The initial pulse of the thyristor generator is applied to the primary winding of the step-up transformer. We use industrial measuring transformer GE-36. Near the top of the pulse when the current in the primary winding of the transformer crosses zero value thyratron is triggered.

The discharge chain C_2, R_3, R_4 maintains the discharge current through the thyratron in a few tens of microseconds, thereby preventing fast afterpulses. Slow processes are suppressed by leakage of charges through the secondary winding of transformer.

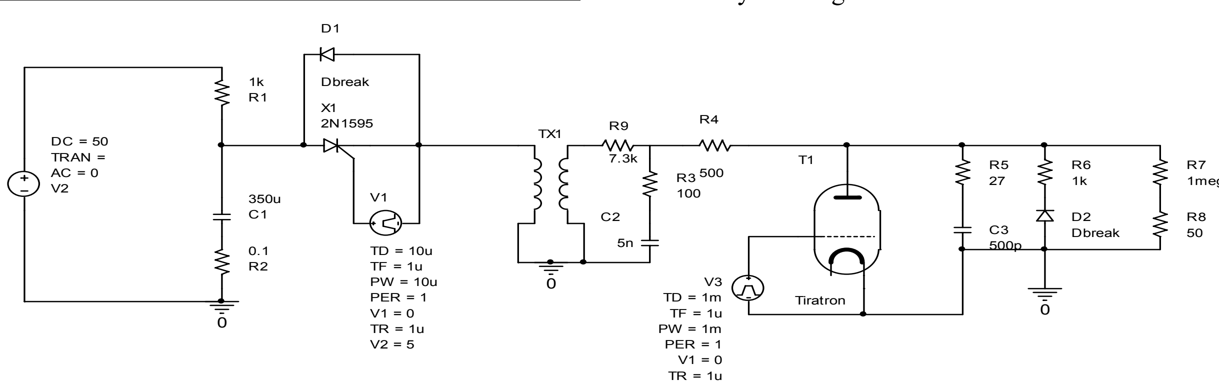

Figure1: PSPICE model of the power supply circuit.

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The result of calculation with program SPICE is presented in Fig.2. Voltage scale is reduced. Prototyping measurement results are presented in Fig.3.

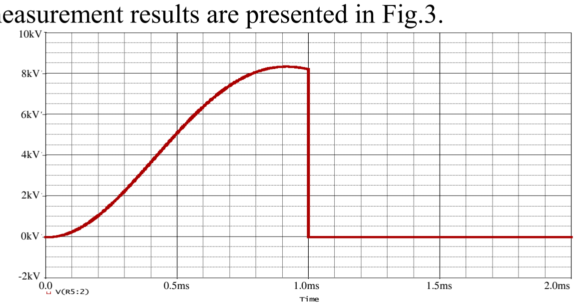

Figure 2: Shape of the voltage pulse on the plate simulated with PSPICE.

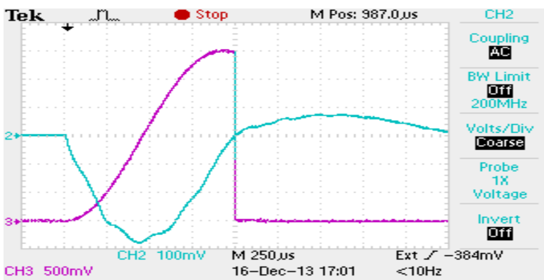

Figure 3: Prototyping measurement results. Voltage (10 kV/div) at the equivalent capacitance and input current (40 A/div) of the transformer.

CONCLUSIONS

Selected approach and scheme of the power supply for deflecting plates were simulated with PSPICE and compared with experimental results on equivalent load. The test results allow to take this scheme as a prototype for booster injection system.

ACKNOWLEDGMENT

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