Experimental Investigation Of High Voltage Nanosecond Generators Of Injection System For SIBERIA-2 Storage Ring

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Abstract

The injection system for SIBERIA-2 storage ring (Kurchatov Institute, Moscow) has been put into commissioning. The high voltage impulse generators with double coaxial forming lines and three electrode nitrogen filled spark gaps are intended for linac electron gun and fast full-aperture kickers supply. The output impulses are up to 60 kV in amplitude, 15 - 20 ns in duration with front about 3 ns. A root-mean-square dispersion of time delay of gaps is 0.7-0.8 ns. The experimental results of operation of the generators are presented.

I. INTRODUCTION

The dedicated SR source SIBERIA-2 [1] consists of linac (80 - 100 MeV), booster (450 MeV) and main ring (1.5 - 2.5 GeV). The one turn injection system [2] uses full-aperture kickers for injection into booster and from booster to main ring. This scheme requires impulses for kickers with 7 -- 60 kV amplitude, 15 --20 ns time length and very short edges. For high efficiency an essential time stability is needed (about 1--2 ns). Linac electron gun needs 40 kV impulse.

II. HIGH VOLTAGE GENERATORS

The high voltage nanosecond generators were developed for kickers and electron gun supply. Figure 1 presents a simplified scheme of the generator.

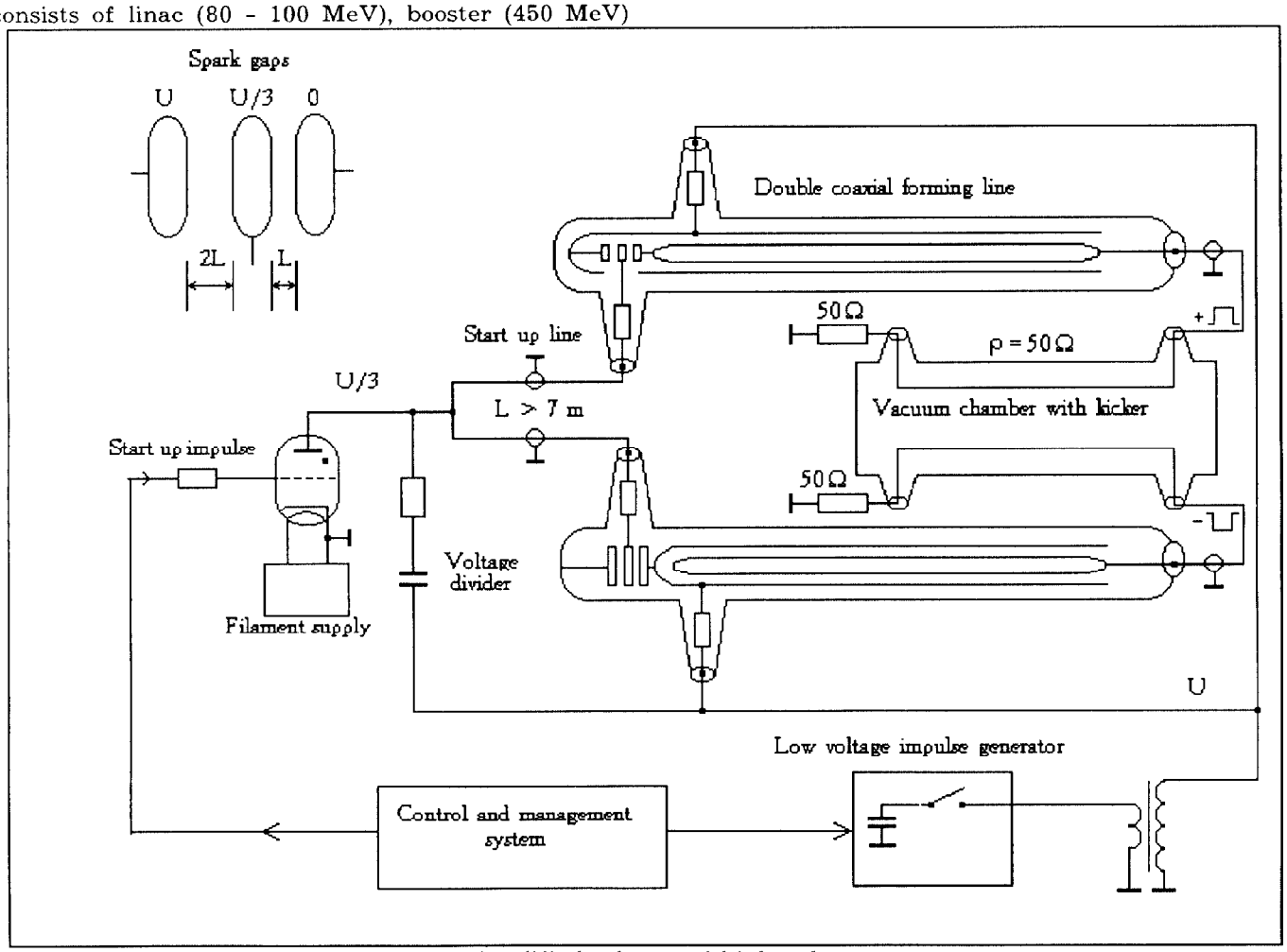

Figure 1: The simplified scheme of high voltage generator.

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Double coaxial lines produce output impulses of electrical power with time interval equaling double passing time of electromagnetic wave through line. In each double forming line, two spark's gaps with three electrodes are used for fast commutation of electrical power. Polarity of output impulses depends on how gaps are connected up between lines. The electrodes are made of duralumin, because it is just this material that provides necessary time stability. We can tune electrical characteristics of the spark by changing pressure of nitrogen (5 - 20 atmospheres) in the gap.

An impulse hydrogen thyratron is used to start up spark gaps. All elements of generator, transport lines and kickers have wave resistance 50 ohms. An impulse transformer with coefficient of transformation about 100 charges forming lines to output voltage. Start up circuit is charged to one third output voltage due to capacity divider.

A low voltage (800 V) impulse generator supplies a primary winding of the transformer. SF_6 gas fills cables and lead-ins at a pressure 5 atmospheres to increase electrical strength.

Resistance's and capacity's dividers (not shown in picture 1) allow us measure voltage and examine shape of impulses.

A control system uses electronics in CAMAC standard: microcomputer, ADC unit, etc. For time measurements we use time-digit converter unit with 0.6 ns per bit resolution. Software can measure average time delay, root-mean-square dispersion and changes of these values during long time.

III. EXPERIMENTAL RESULTS

An oscillogram of output positive impulse with amplitude 60 kV is shown in figure 2. The spark gaps provide enough abrupt impulse's edges. The leading edge is about 3 ns, an impulse's plate is 13 ns, and trailing edge is 5 ns.

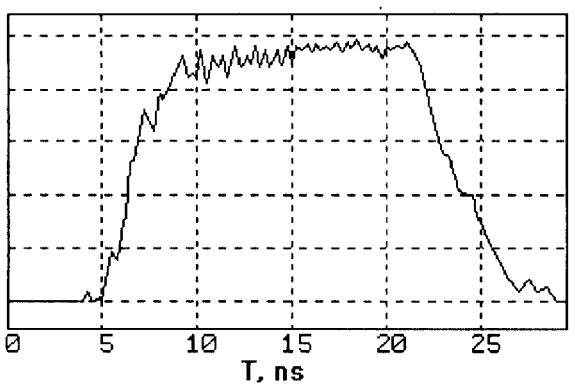

Figure 2: Oscillogram of output impulse 60 kV in amplitude.

A negative impulse has roughly the same characteristics. We have gotten 0.7--0.8 ns root-mean-square dispersion of time delay of the output impulses after careful tuning and training of the spark gaps. The results of examining of time stability of the thyratron, the spark gaps and whole generator during working day are shown in figures 3, 4.

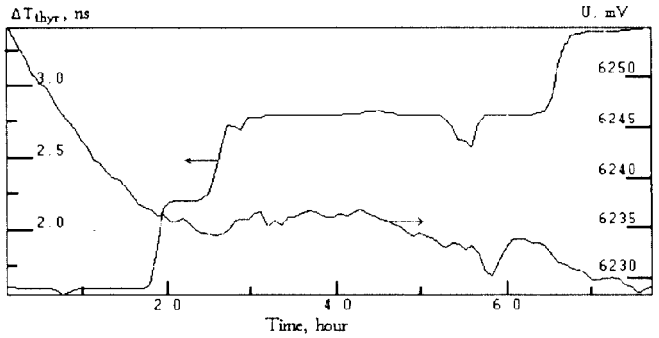

Figure 3: Changes of filament voltage and time delay of thyratron during working time.

The permanent thyratron's time delay needs stabilization of filament voltage not worse then 0.1%. After training during 2 hours, spark gaps show sufficient time stability.

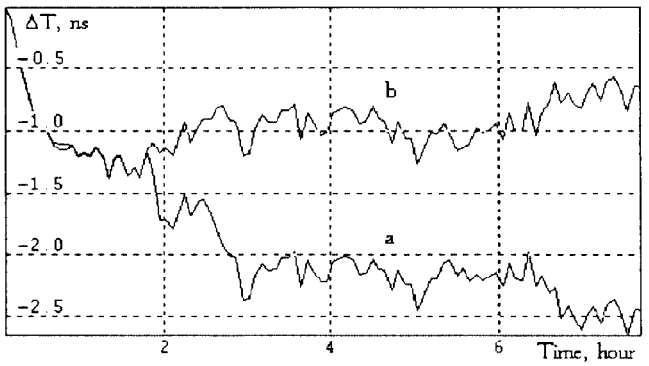

Figure 4: Changes of time delay of spark gaps (a) and whole generator (b).

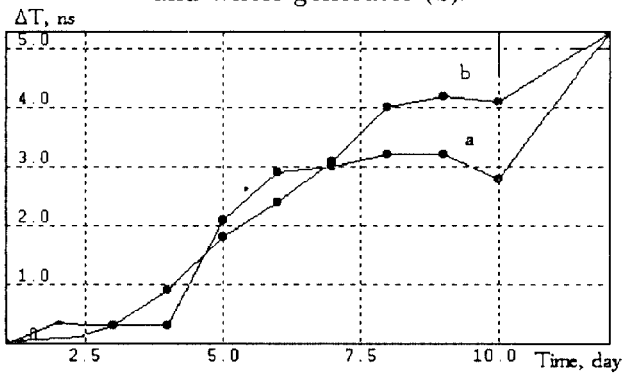

Figure 5: Time delay's increasing of positive (a) and negative (b) spark gaps due to wear and tear of electrodes during 12 days. Total number of impulses about 700,000.

With long operation time, erosion of electrodes occurs that leads to increase of gaps. First it results

in increase time of gaps and then leads to decrease of operation's stability of generator.

Figure 5 shows increasing of time delay of spark gaps due to wear and tear of electrodes during 12 days. Total number of impulses about 700,000.

The obtained results let us make a conclusion that these high voltage generators suit for power supply of injection system for SIBERIA-2 storage ring.

For more detailed information on the subject, please contact us by the addresses given under the headline, or use e-mail **kuzn@ksrs.msk.su.**

IV. REFERENCES

[1] V.Anashin, A.Valentinov et al, "The dedicated SR source SIBERIA-2", The Proceedings of the 11-th Russian Particle Conference, Dubna 1989, p.277-280 (in Russian)

[2] G.Erg et al. "Injection system for the SIBERIA-2 storage ring", these proceedings.