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SYMMETRIC LOW-VOLTAGE POWERING SYSTEM FOR RELATIVISTIC ELECTRONIC DEVICES

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A special driver for double-sided powering of relativistic magnetrons and several methods of localized electron flow forming in the interaction region of relativistic magnetrons are proposed and discussed. Two experimental installations are presented and discussed. One of them is designed for laboratory research and demonstration experiments at rather low voltage. The other one is a prototype of a full-scale installation for an experimental research at relativistic levels of voltages on the microwave generation in the new integrated system consisting of a relativistic magnetron and symmetrical induction driver.

Рассмотрены возможности формирования локализованного электронного потока в области взаимодействия релятивистского магнетрона в предложенной ранее схеме симметричного питания. Приведено описание установок, рассчитанных на проведение демонстрационных исследований на невысоком уровне напряжения и прототипа полномасштабной установки для проведения исследований по генерации СВЧ-излучения при релятивистских напряжениях.

INTRODUCTION

The high efficiency of «ordinary» classic magnetrons has been achieved as a result of intense experimental and theoretical investigations [1]. Relativistic magnetrons, in spite of a 30-year history of development, are in an «initial» stage. The main purpose of experimental investigations was the demonstration of achievement of extremely high RF power [2, 3]. Most results were obtained using high-current accelerators in existence as drivers, but not specialized drivers. Actually RM generators were adapted for use with those drivers and looked like an additional part to alien drivers. However, the efficiency of RM is low as compared with low-voltage classic magnetrons. It appears that one way of increasing the efficiency of RM is symmetric powering of RM that suppresses parasitic beam current in the longitudinal direction, i.e., the construction of a specialized driver for this purpose.

DRIVER

In our opinion a symmetric induction driver corresponds to a certain extent to the idea of two-sided powering of RM. Figure 1 shows the scheme of such a driver integrated with a magnetron. The driver consists of two identical sections of LIA (Linear Induction Accelerator) (areas *1* and *2* in Fig. 1) placed symmetrically relative to the magnetron (area *3*) and connected with a magnetron by a common central electrode — the voltage adder. Both ends of the central electrode join to flanges which are at ground potential. The central part of the electrode performs as the RM cathode. Merits of the driver are the merits of LIA with a voltage adder. Such a scheme is broadly used in modern high-current accelerators (HERMES-III, COBRA, etc.).

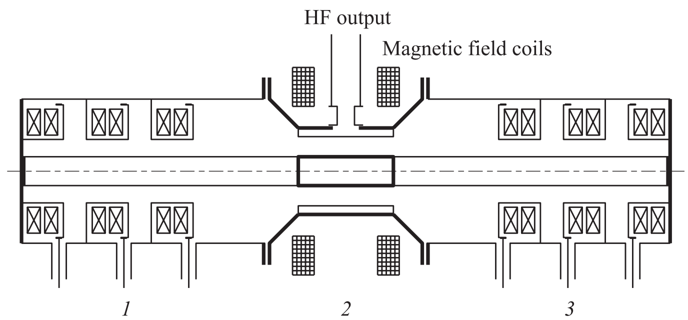

Fig. 1. Schematic of a driver with a magnetron

RF power is led out through slots in resonators of the magnetron to radial waveguides followed by short matching sections — transformers of impedance. This scheme has been successfully used in experiments with pulsed high-power RM [2, 3].

To realize the idea of two-sided powering of RM, we have developed a project of an experimental laboratory facility with the following parameters:

- maximum voltage of 250 kV on a load of 25–50 Ω;
- pulse duration of 80 ns;
- five induction cells per section;
- maximum voltage of 50 kV for exciting induction cell.

Sections of LIA. Figure 2 shows the design of a LIA section. The section consists of five induction cells, a short transition section to a magnetron region and a mechanism for fastening and aligning the voltage adder.

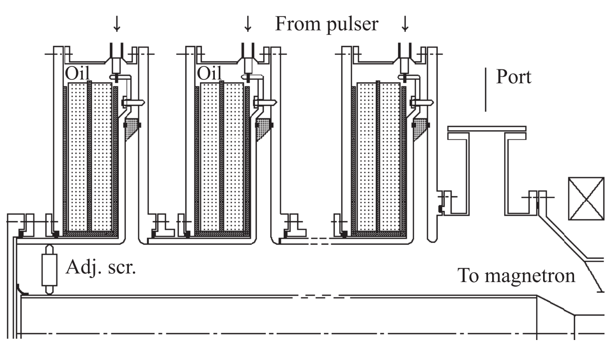

Fig. 2. Section of LIA

Each inductor cell contains two high-quality magnetic cores made of metglass with a polymer interlayer insulation of 12-cm inner diameter, 22-cm external diameter and 2-cm thickness. With the project parameters given above, maximum alteration of magnetic induction is as little as 2.4 T.

Cores and high-voltage inputs are embedded in transformer oil. All metallic parts of the inductor cell are made of aluminium. Parts of the transition section to the magnetron region are made of stainless steel to reduce distortion of pulsed magnetic field.

High-Voltage Generator. As the first step we plan to modify one of the existing modulators on the basis of a water-insulated, coaxial pulse-forming line with a gas switch.

Later we are going to use a new compact high-voltage generator with a repetition rate of several Hz. The key elements of the generator are fast capacitors with internal circuits forming quasi-rectangular pulses of nanosecond duration. We have chosen the following parameters of industrially produced capacitor-shaper:

- 80-kV charge voltage;
- 1.7-Ω impedance;
- 80-ns duration of output pulse;
- 28-nF overall capacitance.

Figure 3 shows the scheme of the generator. This approach simplifies the construction of the generator and decreases its dimensions. Successful operation of a compact 400-kV generator was reported in [**?**].

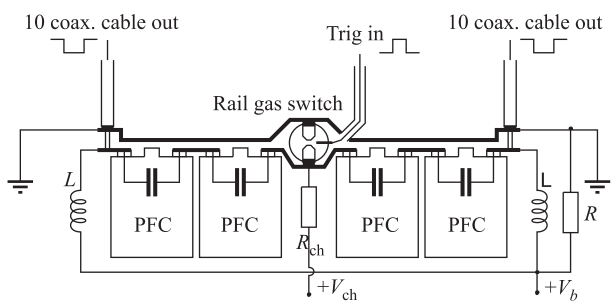

Fig. 3. Scheme of high-voltage generator

CONCLUSIONS

To realize the idea of two-sided powering of RM, we have developed two experimental installations. One of them is designed for laboratory research and demonstration experiments at rather low voltage. The other one is a prototype of a full-scale installation for an experimental research at relativistic levels of voltages on the microwave generation in the new integrated system consisting of a relativistic magnetron and symmetrical induction driver. The choice is based on our wishes to build a facility consisting of several modules with flexible transmission lines between a pulsed generator and the induction cavities made from standard low-voltage coaxial cables. The number of the cavities, type and parameters of the pulsed power generator may be easily changed depending on the current experimental programme.

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