H^- INJECTOR FOR MOSCOW MESON FACTORY LINAC

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Status report is presented for an H^- injector being now under construction. The injector parameters are as follows: energy – 400 keV; average beam current – 400 μA; beam pulse duration – up to 200 μs; pulse repetition rate – 50 Hz. A pulsed high-voltage generator and a surface-plasma ion source power supply have been developed and manufactured.

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1. INTRODUCTION

The development of an H^- injector is aimed at a solution of a fundamental problem of obtaining intensive accelerated beams of negative hydrogen ions in linear accelerators.

The experience of construction and exploitation of the proton injector has been taken into account while developing and fabricating the H^- injector equipment. The efforts for maximum unification of the equipment of both injectors have been applied. The general layout of the high-voltage equipment of the H^- injector and the proton injector is similar to [1] except for the ion source (IS) high-voltage screen. The length of the screen has been increased up to 150 cm to place inside it the surface-plasma IS vacuum chamber and the equipment for differential pumping. The injectors are located in the identical high-voltage side by side rooms [2]. The injector parameters are:

energy of H^- ions ……..400 keV;
pulse beam current……40 mA;
average beam current ……...up to 400 μA;
pulse repetition rate (PRR)……...2…50 Hz;
macro-pulse beam current duration..60…200 μs;
normalized emittance……< 0.35 π·cm·mrad.

2. GENERATOR OF ACCELERATING PULSE VOLTAGE

The generator of accelerating pulse voltage units providing pulses with amplitude of -400 kV, duration of 210 μs and PRR of up to 50 Hz has been developed, fabricated, and mounted.

An artificial line (AL) consists of 10 sections. 11 coils with inductance of 2.54 mH have been reeled-up with PEV-2 copper wire of 2.5 mm diameter. The frame is a noncombustible glass-cloth-base laminate pipe with an external diameter of 322 mm and a length of 850 mm. Every coil has 150 turns. The first AL section contains two coils, the rest nine sections consists of one coil each. Each of 10 capacities (capacitor assemblies of 0.05 μF; 25 kV) are composed of five connected in a parallel PKGI pulse capacitors of 0.01 μF; 25 kV.

A diode stabilizer rack (DSR) represents a capacity-diode voltage multi-cascade discriminator (Fig.1,2) [3]. The serial connection of identical DSR cascades allows stabilizing the high voltage. In regular continuous operation DSR along with the system of compensation of pulse plateau inclination provides stability of voltage along pulse within the range of ±0.2%. The rack consists of 32 cascades placed inside four insulation material barrels and filled by transformer oil. The chokes of 4.2 H for pulse voltage up to 25 kV have been used while DSR cascades manufacturing. The choke coil consists of two parts and contains 3300 turns of PEV-2 wire with a diameter of 0.5 mm. Such a wire cross-section allows reducing thermal losses and makes it possible for DSR to operate long time with PRR up to 100 Hz.

Fig.1. The equipment inside the injector high-voltage room: DSR, pulse transformer and high-voltage shield of IS power supply

A thyratron switch rack (TSR) contains three identical TGI1-2500/50 water-cooling thyratrons. Every thyratron forms its "own" part of high-voltage pulse: rising edge, pulse plateau and falling edge.

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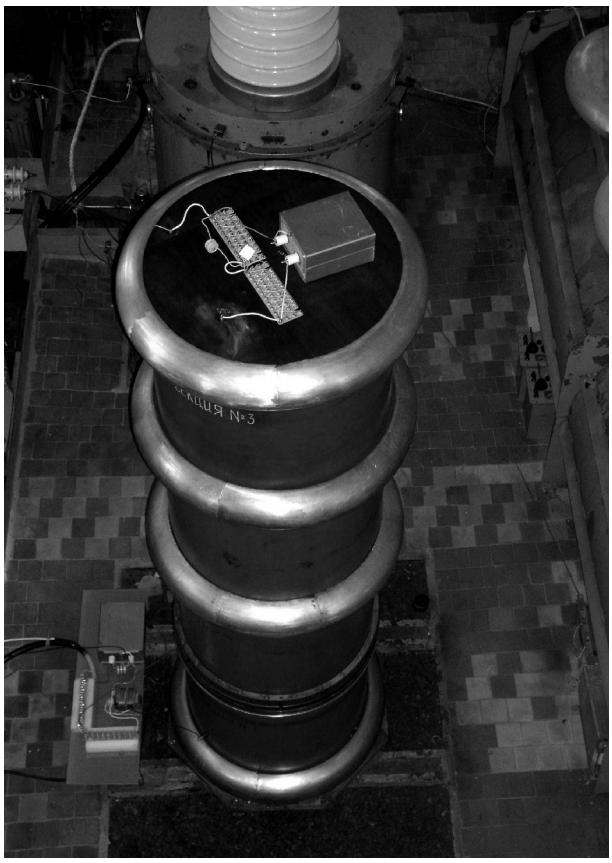

Fig.2. The diode stabilizer rack

A rectifier for 6.5 kV circuit supplies responsible for edges and a rectifier for 12 kV as well as AL are used in circuits responsible for pulse plateau. The presence of diodes for 25 kV (assemblies of KD203 diodes) in TSR chains allows preventing possible overvoltages and increasing the operation reliability of the accelerating voltage generator.

An accelerating tube (AT) with water divider is mounted at the injector vacuum chamber (Fig.3). Mechanical strains for the AT which is suspended as a console, are reduced by the unloading appliance.

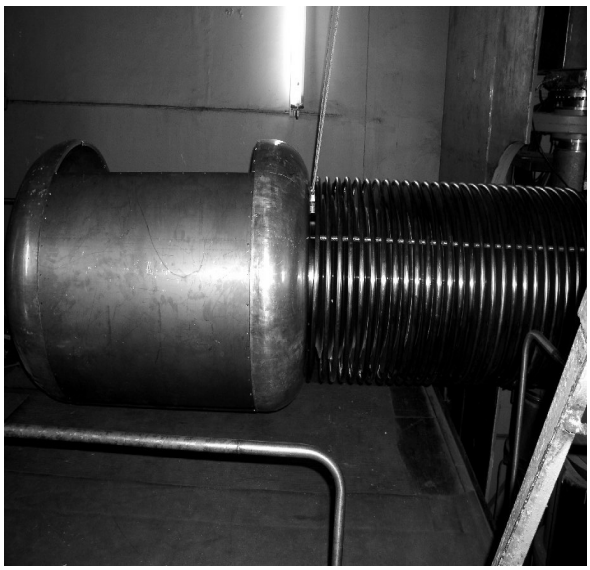

Fig.3. The accelerating tube with the IS high-voltage screen

3. POWER SUPPLY OF A SURFACE – PLASMA SOURCE OF H-IONS

The devices of IS power supply have been developed, fabricated, and tested. They were installed in three standard racks located in the high-voltage shield (Figs.1,4). The connection cables allow disconnecting the devices at the elevating maintenance platform for tuning and repair.

The parameters of all power supply devices are stabilized and can be changed in accordance with reference signals.

A discharge current generator (DCG) consists of a charger, a thyristor switch unit and AL. DCG forms stable pulse of discharge current in ion source. The DCG parameters are:

short circuit current……up to 130A;
wave resistance of 10-section AL…..11.6 Ohms;
charge voltage stability ……..±0.2%;
idling voltage ……0…1800 V;
pulse current duration…….60…200 μs;
PRR ……up to 50 Hz;
accuracy of the voltage setting ……..±1%.

DCG charger is a transformer-free regulated and stabilized converter of voltage. It consists of an inverter, a controller, a step-up transformer, and a high-voltage rectifier. DCG has been tested using 12 Ohms load equivalent; the current of 100 A has been obtained for the pulse current duration of 200 μsec and PRR of 50 Hz as well as the short circuit current of 130A.

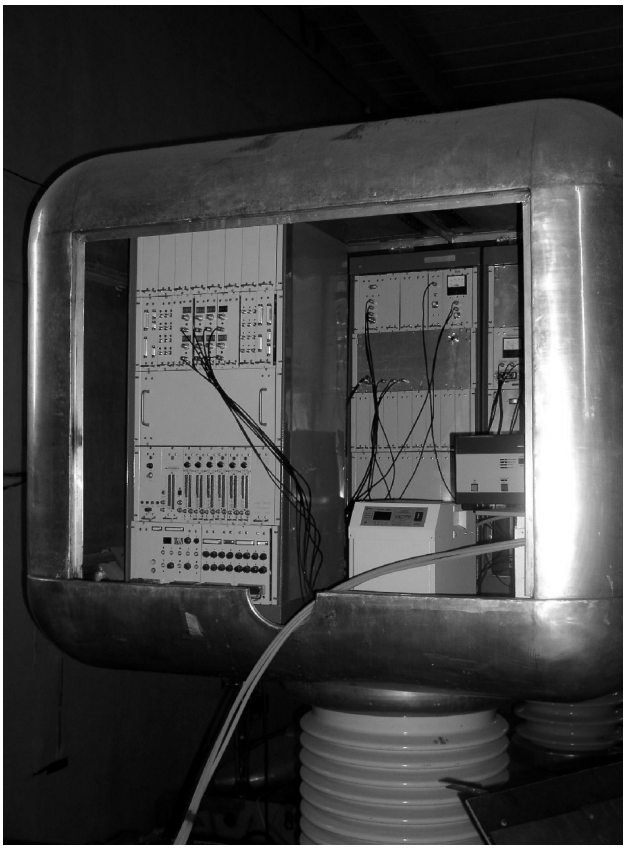

Fig.4. The devices of the IS power supply inside the high-voltage shield

An extracting voltage generator (EVG) forms positive polarity pulses of high voltage. The generator parameters are:
pulse amplitude……up to 20 kV;
stability of voltage along pulse …...±0.5%;
pulse current ……..up to 1A;
PRR…….up to 50 Hz;
pulse duration (plateau) ……..200 μs.

EVG scheme is identical to those of the generators of accelerating pulse voltage we used in both injectors: a modulator with a pulse transformer and a capacity-diode amplitude discriminator at an exit. The advantage of such an approach is the possibility to avoid using of a high-voltage lamp. EVG provides the mentioned above stability of voltage along the pulse. The EVG charger is approximately of the same type, as DCG.

A magnet power supply unit, a power supply unit of the hydrogen pulsed feed valve and a unit of cesium heater are developed with the following regulated parameters:
magnet current ……up to 6 A;
pulse current of a gas feed valve…..up to 30 A;
cesium heater current ……..up to 6 A.

ACKNOWLEDGEMENTS

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ИНЖЕКТОР ИОНОВ H^- ДЛЯ ЛИНЕЙНОГО УСКОРИТЕЛЯ МОСКОВСКОЙ МЕЗОННОЙ ФАБРИКИ

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Представлено состоянии работ по созданию инжектора отрицательных ионов водорода с энергией 400 кВ, который должен обеспечить средний ток пучка ионов до 400 мкА при длительности импульса тока до 200 мкс и частоте повторения импульсов 50 Гц. Разработаны, изготовлены и смонтированы генератор ускоряющего импульсного напряжения и система питания поверхностно-плазменного ионного источника.

ІНЖЕКТОР ІОНІВ H^- ДЛЯ ЛІНІЙНОГО ПРИСКОРЮВАЧА МОСКОВСЬКОЇ МЕЗОННОЇ ФАБРИКИ

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Представлено звіт про стан робіт зі створення інжектора негативних іонів водню з енергією 400 кВ, що повинен забезпечити середній струм пучка іонів до 400 мкА при тривалості імпульсу струму пучка до 200 мкс і частоті повторення імпульсів 50 Гц. Розроблено, виготовлені і змонтовані генератор прискорювальної імпульсної напруги і система живлення поверхнево-плазмового іонного джерела.