DIAGNOSTIC TECHNIQUES AND EXPERIMENTs ON THE ACCELERATION OF IONS IN THE REB GENERATOR «KALMAR»

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There is the phenomenon of ion acceleration under the action of the resulting ambipolar field [1, 2] in pulsed generators of relativistic electron beams (REB), acting on a transparent load for them. In the ambipolar acceleration mode, the ion energy can be several times higher than the applied voltage of the pulse generator multiplied by the ion charge. Ambipolar acceleration technology can have significant advantages over traditional methods, such as cyclic charged particle accelerators. Experiments on the acceleration of ions in the ambipolar field were carried out on a Kalmar generator (voltage per pulse ~250 kV, current ~40 kA, pulse duration ~150 ns).

The following diagnostic methods were used to study the efficiency of ion beam generation in the mega-electron-volt interval of energy. The energy of individual ions was determined by the time-of-flight method by measuring the speed of their movement on a known base. The calorimetric method was used to measure the total energy of charged particle beams and the distribution of energy density in the cross section. The pin-hole camera allowed to measure the current density of electrons on the anode foil, which is affected by the electron beam.

It has been established by the speed of the ions and their penetrating ability, that conditions to accelerate the ions of all sorts of atoms that make up the anode film are created in the high-voltage diode of the generator. These conditions can be created both at the leading edge of the main impulse of the generator power, and at any other moment of the working half-period, depending on the presence of a prepulse. It was found that the maximum energy of 6.1 MeV in the experiment is acquired by the heaviest particles present - aluminum ions. Protons gained maximum energy ~800 keV. The individual ions acquire in the direction of ~20º the energy that turned out to be less by about 15% than the energy of axial ions.

The value of the energy transferred by the ions and measured by the thermal imaging device was from 0.07 to 0.35 J, and the angular divergence was from 1.2 to 2.2°. Efficiency coefficient of energy transfer to ions in the acceleration phase reaches 10% of the electrical energy in the diode of the generator. The total number of accelerated ions in terms of 1 MeV was ~1012 particles in the shot.

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References

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