On the calculation of output power and X-ray spectrum of Z- pinches based on multiwire arrays

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We present the output power and X-ray spectrum values calculated with the use of a three-dimensional RMGD models describing a Z- pinch implosion. A Z-pinch is formed by an imploding array of thin tungsten wires. In our calculations we take into account a discrete structure of the array and a time-extended plasma formation during evaporation of a wire material under the action of an electric pulse. By means of numerical simulation of a wire-array Z-pinch dynamics we obtained the Z-pinch density, velosity, electron and ion temperatures, ionization degree, and the power output integrated over the pinch volume. We also calculated the characteristics of the Z- pinch X-ray spectrum depending on a photon energy at different moments with respect to the start of the discharge current. Considering the radiation in the pinch radial direction we demonstrate the effect of trailing masses distributed at the pinch periphery on a radiation intensity of a central part or Z-pinch ‘kernel”. This can be explained by absorption of radiation in the peripheral plasma layers. We have done the verification of the assumptions concerning the used RMGD model of a Z- pinch implosion by means of comparisons with such experimental implosion indicators as (i) the time profile of the radiation power integral over the pinch volume and (ii) the spectral distribution of the photon energy. It is established that the calculated data are in good qualitative agreement with the experimental results [1].

Pursuing the aim to study thoroughly the pinch radiation properties we have developed a a detailed model of the pinch kernel, resulting in the electric current implosion of multiwire tungsten array. The model allows the calculation of the soft X-ray radiation intensity with resolution of temporal, spatial, angular and spectral radiation characteristics. The results of calculations are represented for the specific conditions pertinent to experiments with the cylindrical multi-wire arrays carried out at the Angara -5-1 facility. The calculations are justified by the fact that the considered experimental series provided a sufficiently complete information on the temporal profiles of the absolute radiation intensity in the soft X-ray band. We obtained the following numerical results that can be directly compared with the experiment:

* + Integrated over space and time radiation spectra as functions of a polar angle at which they are registered;
  + Time-integrated image of the pinch, which can be prepared by pinhole cameras for different filters;
  + Time-dependence of the pinch spectrum.

This work was supported by grants RFBR 11 -02- 01027 -a, 13 -02- 00013 -a.

The computations were performed using the supercomputers Lomonosov ( SRCC MSU) , MVS-100K ( JSCC ) and K -100 ( IPM RAS).

References

1. Bolkhovitinov EA Volkov, GS, Vitchev I. Yu , E. Grabowski et al , " Studies of the emission spectra of fast z- pinches , resulting in compression stranded assemblies in the Angara -5- 1", Physics of Plasmas (Rus), 38 ( 10) , 894 ( 2012).