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PD/P8-21: Theoretical Research and Numerical Simulation of the Fast Z-pinch Plasma Characteristics on the Low Current (<5MA) Facilities

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To develop reliable numerical simulation tools is very important for the theoretical research, experimental analysis and load designing of Z-pinch implosions. A dedicated Z-pinch implosion physical scheme of the two-dimensional numerical simulation of three-temperature radiation magneto- hydrodynamics code (MARED) is introduced. The results of its 1D test demonstrate that the MARED code is suitable for simulating implosions on different devices and with a wide range of load parameters. Combination of the wire-array Z-pinch experiment simulation and analysis shows that under the same load conditions, the X-ray radiation power produced by the tungsten wire-array implosion is much greater than the power generated by the aluminum wire array. With the same load current, the greater load mass gains the lower X-ray power. However, the X-ray radiation power increases as the load current. The MARED code is found able to reproduce the primary dynamic characteristics of the Z-pinch implosions, and the development of the instability qualitatively agrees with the simplified instability theoretical analysis and experimental results. It is also used to simulate the radiation field formation of the wire-array with foam column filled at the axis, and its preliminary results are qualitative consistent with the simulation results from the Sandia laboratory.

In this paper the processes of radiation production of aluminum wire-array Z-pinch implosion are discussed by analyzing a typical Sino-Russia joint Z-pinch experiment on S-300 facility in 2006. Generally, radiation is produced by free-free, free-bound and bound-bound transitions, and which process plays the most important role in producing radiation depends on a lot of factors. the processes and mechanisms of radiation production are discussed by investigating numerically a typical aluminum wire array Z-pinch implosion on S-300 facility. It is shown that line emission provides over 70 percent and continuum including free-free and free-bound transitions occupies less 30 percent of the total radiation. And in the line emissions most photons are generated from L-shell transitions which can take place everywhere, but high energy K-shell photons are much less and mainly produced in the interior region where electron temperature is relatively high.

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