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Field-Circuit Coupling Simulation of Petawatt-class Z-Pinch Accelerator

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Most of the previous studies of petawatt-class Z-pinch accelerator are performing the circuit simulation based on a full circuit model. This model may cause non-ignorable error because it is under the assumption of TEM modes transmission along the MRTLs. In this paper, a method for field-circuit coupling simulation of petawatt-class Z-pinch accelerator was developed, which considered the non-TEM modes in the MRTLs. A 3-D electromagnetic simulation of the MRTLs was conducted and MRTLs'equivalent circuit was created based on the scattering transfer parameters drawn from the electromagnetic simulation. By inserting the MRTLs'equivalent circuit into the pulsed generators and Z-pinch load, a field-circuit coupling model of the whole petawatt-class Z-pinch accelerator was obtained. This method was used in the simulation of Z800 accelerator, a petawatt-class Z-pinch accelerator, and the load was a wire-array for Z-pinch. Compared to the previous circuit model, the load current obtained with the field-circuit coupling model was lower and thus the load-implosion time was longer. Then we compared the load current of accelerators using exponential, hyperbolic and linear MRTLs respectively and recommended the linear one. The relation between the energy transmission efficiency and load parameters were also investigated.

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