Calculation and Simulation of Scattering Intensity Distribution in Neutron Pinhole Image in the Presence of Air

Guoguang Li

Department of Engineering Physics, Tsinghua University, Beijing 100084, China

lgg20@mails.tsinghua.edu.cn

The intense pulsed neutron radiation image diagnostic system mainly consists of tungsten pinhole collimator, plastic scintillator and image recording system. In the existing literature, the scattering intensity distribution in neutron pinhole image is considered as a uniform background, and the neutrons attenuation and scattering in air are ignored. In this paper, we propose a novel program for calculating the scattering intensity distribution on the incident plane of plastic scintillation, which takes into account the presence of air. Simulation work is also carried out in Geant4, and the calculation results are compared with the simulation results, which shows that the two methods are consistent. The results show that for the practical pinhole geometry, due to the long distance of pinhole imaging, the attenuation and scattering of neutrons by air not only cannot be ignored, but also becomes the main contribution of scattering intensity. For a 14 MeV point neutron source, the scattering intensity distribution due to pinhole attenuation is basically uniform, which has no negative effect on the image diagnosis. However, the scattering neutron intensity due to air attenuation is not evenly distributed and its shape is similar to the through-view aperture of the point source. In addition, we found that the relative scattering intensity caused by pinhole attenuation was inversely proportional to the square of the image distance, such as changing the image distance from 1m to 16m the scattering intensity is changed from 5.74×10^{-7} to 1.83×10^{-9}, while the relative scattering intensity caused by air attenuation does not change with the image distance and it is almost stable at 3.42×10^{-6}. Further studies indicate that the scattering intensity received by the incident plane of scintillation is almost all from the scattering of air within the first half meter of plastic scintillation. In order to reduce the influence of air scattering on neutron pinhole image diagnosis, one possible method is to put the image diagnosis system in a vacuum chamber. The results of this paper are instructive for the scattering evaluation and shielding of neutron pinhole image.

Keywords: scattering intensity distribution, neutron pinhole image, air attenuation,novel calculation program, Geant4 simulation