A novel methodology to determine the divergence of a neutron beam

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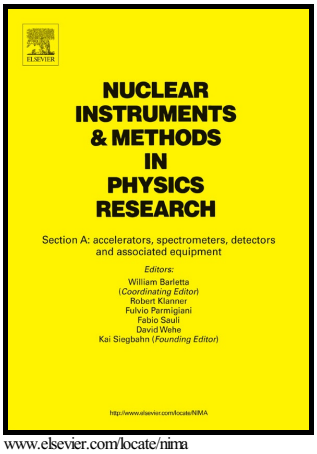

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A novel methodology to determine the divergence of a neutron beam

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ABSTRACT

This work posits a novel approach to characterize the divergence of a neutron beam emerging from a reactor port. Unlike the usual inverse of the *L/D* ratio, the term *divergence* as employed here refers to the deviation from an ideal parallel beam emitted from a surface source. Within this concept, an ideal point source in spite of its conical beam would not exhibit any divergence. Hence, the beam divergence of a surface source is more adequately characterized adopting the notion of *Rocking Curve* - *RC*, a term borrowed from the X-ray diffraction field. After this idea, every point of the surface source emits neutrons in all directions but with different intensities following a bell-shaped profile. Once the *RC* semi-width is determined, it is possible to assess its effect upon the quality of an acquired neutron radiograph, since it incorporates degrading agents such as geometrical unsharpness, neutron scattering, noise and statistical dispersion. In this work an inverse procedure is applied, i.e., to use an actual neutron radiograph to find the *RC* semi-width. To accomplish this task, synthetic images - generated with defined *RC* semi-widths and object-detector gaps - are compared with experimental ones acquired with the same gaps in order to find the most resemblance between them. The angular semi-width of the *best* synthetic image is assigned to that of the experimental one, defining thus the aimed beam divergence, which has been compared with a different method with a fair agreement. An equivalent procedure embedded in the algorithm has been employed to evaluate the *L/D* using the same radiographic images. The outcome fairly agrees with the value inferred from the neutron flux ratio at different locations. Both approaches *RC* semi-width and *L/D ratio* yielded consistent results with other utterly different methods. Yet, the *rocking curve* approach forecasts more precisely the neutron pattern hitting the detector and does not need a precisely machined test-object as required by the *L/D* conventional technique, but only a shielding foil provided with a straight edge.

Key words: L/D ratio, neutron beam divergence, rocking curve

1. Introduction