Determination of a neutron beam divergence after the Rocking Curve concept using Richardson-Lucy's unfolding algorithm

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Due to the complex scattering along a reactor channel, neutrons seem to be emitted by a source of size D at a shorter distance L to the detector, than the actual one. So, it is usual to express its divergence as the inverse of an effective *L/D ratio*, which is lower than the geometric one [1]. This work proposes a novel approach to determine the L/D based on the concept of *Rocking Curve - RC* [2], which does not require expensive test-objects [3]. This is done by a visual inspection of images of an experimental radiograph unfolded with Richardson-Lucy algorithm [4-5] under several Point Spread Function (PSF) widths s, and selection of the better quality amidst them. This experimental radiograph is acquired with a neutron-opaque blade. Its blurred edge cast on the detector defines an Edge Response Function - ERF, which derivative furnishes the Line Spread Function – LSF, as shown in Figure 1 using a synthetic radiograph of a shielding blade. Its width may be used for the PSF, much more cumbersome and hard to obtain, The width s of the PSF degrading a radiograph is ruled by the beam divergence, and the object-detector gap g. Hence, a certain PSF width s_x and the object-detector gap g_0 used to get it define the coordinates [g_0, s_x] from which the searched PSF width w_0 tied to the beam divergence is inferred. To accomplish this task, a family of *synthetic* curves $s(w,g)$ is generated and the curve $s(w_0, g)$ hit by [g_0, s_x] is assigned as that related to the divergence. The procedure is schematized in Figure 2. The beam divergence determined in this work shows a good agreement with earlier works, an outcome which indicates the soundness and robustness of the presented method. All procedures are carried out by an *ad hoc* written Fortran 90 program, embedding an ancillary RL algorithm. Further details can be found elsewhere [6]

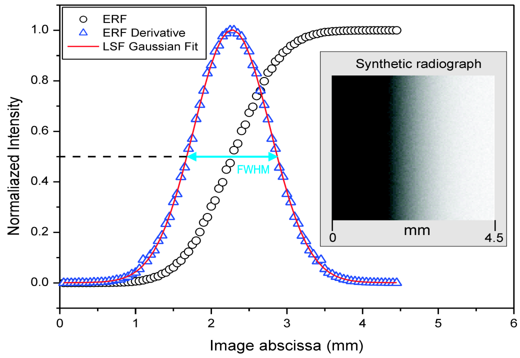

Figure 1. Synthetic radiograph of a shielding blade and its related *Edge Response Function - ERF*. Its derivative yields the *Line Spread Function - LSF* fitted with a Gaussian which FWHM is assigned as the PSF width.

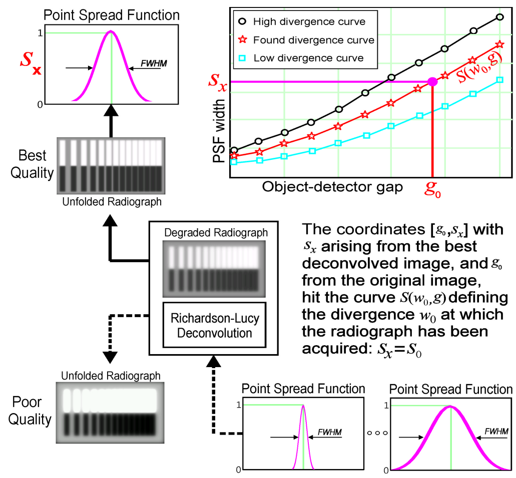

Fig. 2. Determination of the beam divergence. The degraded radiograph is unfolded with several PSF widths. That s_x yielding the best image is assigned as correct one. The point [g_0,s_x] hitting the curve $s(w_0, g)$ defines w_0.

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