World Federation of NDE Centers

2009 RADIOGRAPHY BENCHMARKS

Overview and Participation in the 2009 Benchmark Session

Attached is a detailed description of the 2009 benchmark for radiography, which is a comparison of RT scattering models. We would like to invite papers on this topic for the benchmark session at the 36th Annual Review of Progress in Quantitative Nondestructive Evaluation (RPQNDE) meeting. This meeting will be held July 26-31, 2009 at the University of Rhode Island, Kingston, Rhode Island. To present a paper at that session, please note that the deadline for submitting an abstract is May 1, 2009 (mark on your abstract that it is for the benchmark session) . Also, please note that the advance registration deadline for the conference is July 3, 2009. For more details of the conference, visit the website at www.cnde.iastate.edu/qnde/qnde.html.

For any technical questions, please e-mail Dr. Gerd-Rüdiger Jaenisch at Gerd-Ruediger.Jaenisch@bam.de For other questions, please contact Prof. Schmerr at lschmerr@cnde.iastate.edu .

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Comparison of RT Scatter Models – Benchmark 2009

Background:

The purpose of this benchmark study is to compare simulation results predicted by various models of radiographic testing, in particular those that are capable to separately predict primary and scatter radiation for specimen of arbitrary geometry. The general background/motivation is presented in the description of the 2008 RT Benchmark problem.

Objective:

The purpose is to compare predictions of various models of radiographic techniques, in particular those that predict the contribution of scattered radiation.

Problem Definition:

The next problem to be considered will have two parts.

PART I

The Part I problem is a generalization of the 2008 benchmark problem. Fig. 1 shows the geometry setup.

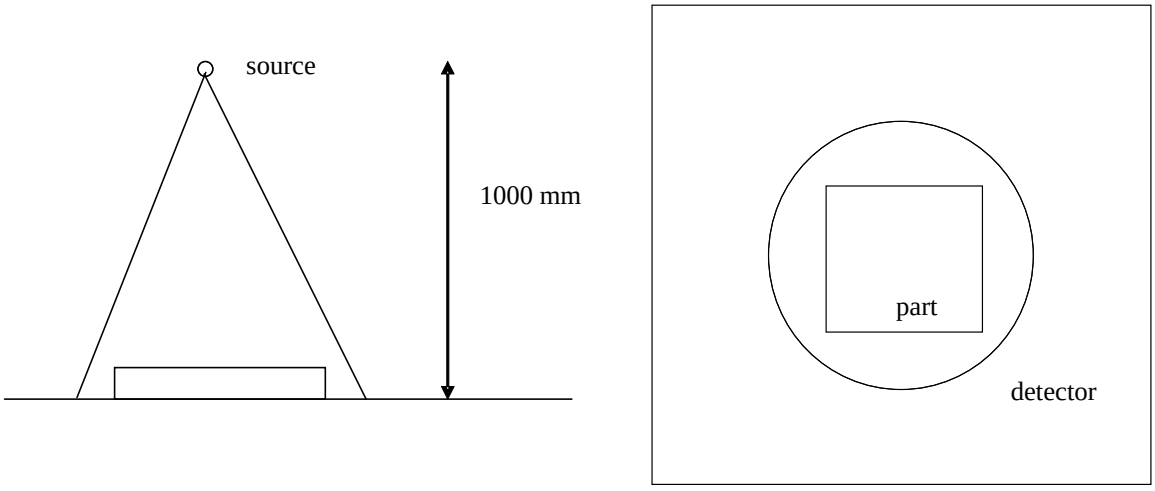

Fig. 1: Geometry setup.

The monochromatic point source is centered over the detector plane with a distance of 1000 mm. To cover a wide application range the energy of the source includes those from the 2008 benchmark: 100, 300, 500, 700, 900, 1100, and 1300 keV. To investigate the

influence of the form factor and the scattering function, i.e. scattering at bound electrons, the lower energy region is extended by 60 and 80 keV. Additionally the high energy region is extended to study the contribution of pair production to the flux of radiation registered by the detector: 1.5, 2, 5, and 10 MeV.

As detector an ideal photon counting detector of size 150 x 150 mm (300 x 300 pixels) is used. Primary and scatter radiation are recorded separately. The primary intensity is normalized to 1 in the free beam in the center of the detector.

The specimen, a steel plate of size 50 x 50 mm, is positioned at the center of the detector. The thickness of the plate varies: 10 mm, 30 mm, and 50 mm. As add-on to the 2008 benchmark a thickness of 100 mm and 150 mm is investigated to address high energy applications.

The calculations include the best physics approach available considering electron binding effects. To ensure the convergence of the scatter flux predicted by the models up to 20 scatter events have been considered in the Monte Carlo calculations. For the comparison primary and scatter intensity are averaged within a window of 10 x 10 pixels at the center of the detector, i.e. an area of 5 mm by 5 mm is considered. The predictions of the models are compared to MCNP code [1] assumed to be the standard reference.

The following values are subject of the comparison:

1. primary radiation (attenuation law as reference)
2. total scattered radiation
3. relative contribution of scattered radiation separated by order of scatter events (1^{st}, 2^{nd}, …, 20^{th})
4. spectrum of scattered radiation
5. variance of total scattered radiation

PART II

The part II problem investigates the influence of discontinuities on the distribution of the scattered radiation. For this purpose a notch simulating planar-like flaws is introduced into the plate considered in the Part I benchmark while restricting to plate thickness of 10 mm:

- length: 50 mm
- width: 10 mm; 5 mm; 2 mm; 1 mm; 0.5 mm; 0.05 mm
- depth: 5 mm; 2 mm; 1 mm

The following values are subject of the comparison:

1. primary radiation contrast
2. scatter radiation contrast
3. total contrast
4. scatter unsharpness

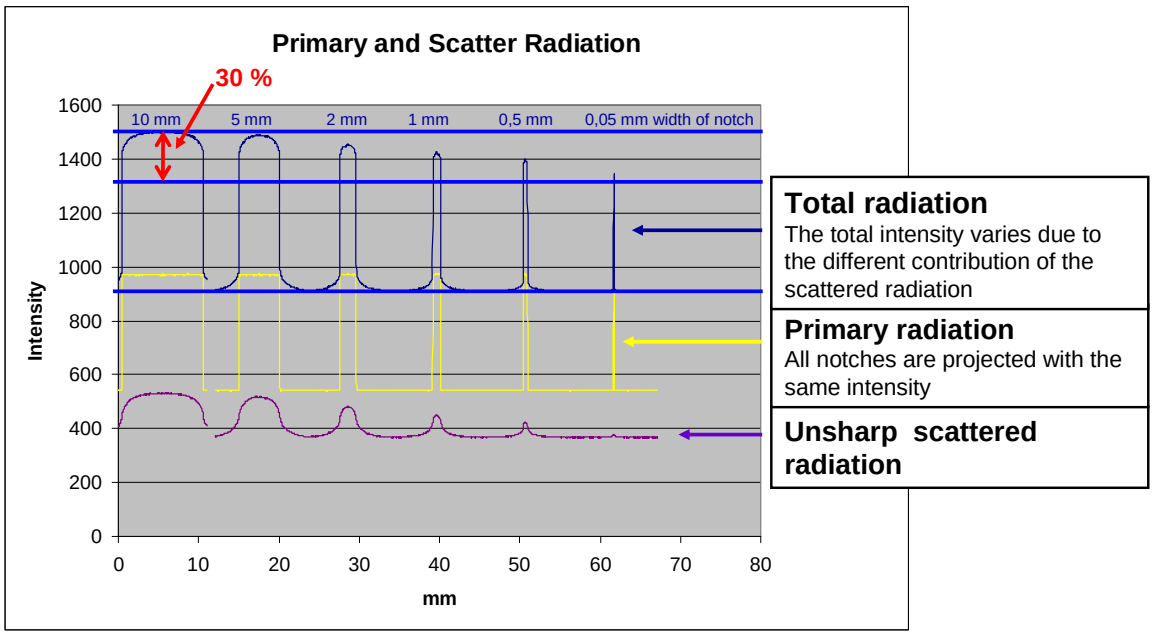

Fig. 2: Calculation example.

REFERENCES

1. J. F. Briesmeister (ed.). “MCNP–A General Monte Carlo N–Particle Transport Code”. LANL Report LA–13709–M. Los Alamos. 2000