Reducing the Numbers of Ray Tubes used in Cavity Backscatter Studies

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Backscattered EM fields from large cavities can be studied by using a geometrical optics aperture integration scheme (GO-AI). In the GO-AI approach, the incident field is collimated into tubes of equal cross section and traced through the cavity back to the inlet by shooting and bouncing (SBR). The number of tubes used depends on the size of the aperture. The SBR requires about 350 tubes or more per square wavelength (for a 2-D structure, this is roughly equivalent to 20 per wavelength). There is a drastic increase in the numbers of rays traced with growing aperture size. This paper concerns itself with alleviating the computational efficiency in a GO-AI scheme.

A GO-AI investigation revealed that a 2-D offset bend with an 8.7 λ opening produces a nearly similar RCS for different numbers of tubes (50 - 300) traced. One may conclude, from this numerical experiment that the offset bend is a simple structure and therefore 10 tubes per wavelength maybe enough to have a fairly accurate picture of the backscatter. But how can we quantify this complexity (or simplicity) from a ray tracing perspective? One answer is to shoot a small number of tubes through the cavity opening at randomly spaced intervals and to measure the divergence of the exiting rays that bind a tube. Two cavities, one with a single offset bend, and the other with a double offset bend were tested for this complexity as stated. It was found that the double offset bend produced more divergence of exiting rays on average. Furthermore, when the GO-AI approach was applied to both cavities, the solution for the double bend required more tubes per wavelength to stabilize. It may be concluded that for the cavities under consideration, there exits a good correlation between total tubes required and the average divergence computed for each case. All GO-AI RCS data has been verified by comparing the results with those obtained from a hybrid-modal scheme.