

Impact of probe on image quality.

As in the case of image resolution, it is expected that the image quality of the probe-and-ring system will also vary with position relative to the probe. As the amount of probe-ring LORs passing through a single image pixel reduces with distance from the Si detector, it is expected that their effect on image quality will also reduce. In this study we investigate the probe's contribution to two figures of merit, contrast and spill-over ratio (SOR), using a phantom with cold and hot regions at varying distances from the Si detector. The phantom consists of an $80 \times 144 \times 80 \text{ mm}^3$ box at the center for the FOV, containing 1 mCi of activity, which serves as a warm background for the contrast and SOR studies. Four empty (cold) spheres, with diameter of 16 mm, are placed at distances of 27, 59, 91 and 123 mm away from the probe surface, and offset by 16 mm relative to its centre. Equally offset but in the opposite direction, at the same distances from the probe, are hot spheres of 16 mm diameter, whose activity concentration is four times that of the background. Each hot sphere is separated from its corresponding cold one by a distance of 32 mm (centre to centre), which is also the distance that separates successive hot-cold pairs. Figure 1 shows the phantom positioned relative to the probe.

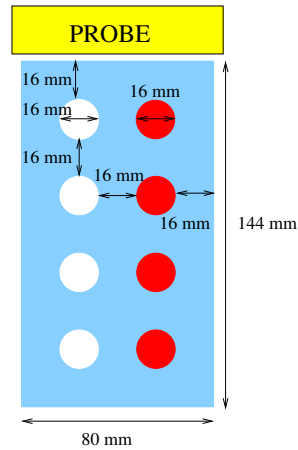


Figure 1. The phantom used for the image quality study and its relative position to the probe. The phantom is at the center of the FOV.

Spherical ROIs with diameter of 14 mm were chosen centered on each hot and cold spot as well as exactly between each of these belonging to one pair, for the warm ROIs. The SOR, hot-warm contrast ($C_{hot/warm}$) and warm-cold contrast ($C_{warm/cold}$) were calculated using the following definitions:

$$SOR = \frac{\mu_{cold}}{\mu_{warm}},$$

$$C_{hot/warm} = \frac{\mu_{hot} - \mu_{warm}}{\mu_{warm}},$$

$$C_{warm/cold} = \frac{\mu_{warm} - \mu_{cold}}{\mu_{warm}},$$

where μ is the mean value of the corresponding ROI in the reconstructed images. The results were plotted as a function of iteration number. Figure 2 shows preliminary results.

There appears to be a large improvement in $C_{hot/warm}$ close to the probe. This is evident in row 1, 27 mm away from the probe and in the region of improved resolution. Here the reconstructed value of the probe

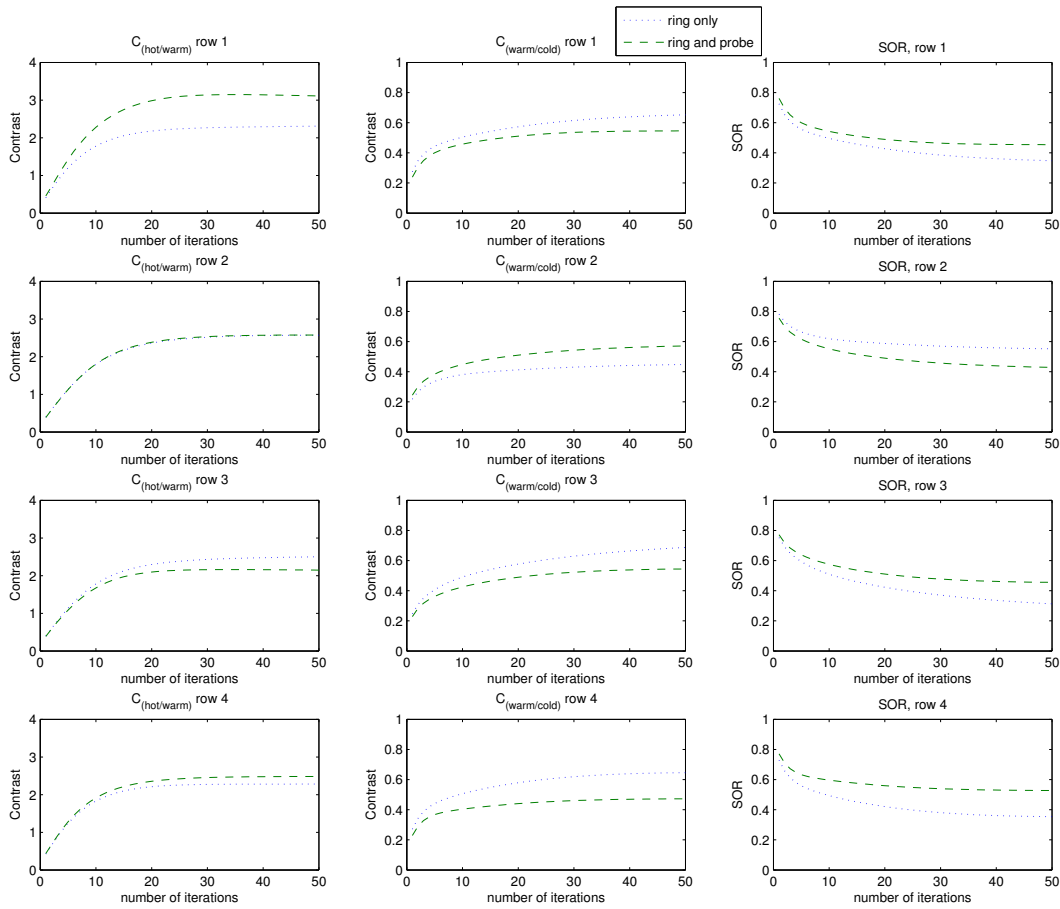


Figure 2. Plots showing $C_{hot/warm}$, $C_{warm/cold}$ and SOR at different distances from the probe. Rows 1, 2, 3, 4 correspond to distances of 27, 59, 91 and 123 mm respectively.

system is very close to the simulated value of 3, while the ring-only system value converges to 2. In the next two rows the ring-only value converges just above 2 while the probe-and-ring value just below. In the last row the probe-and-ring contrast rises slightly while the ring-only value slightly falls below it. In the $C_{warm/cold}$ and SOR measurements, the addition of the probe has a degrading effect. An exception to this seems to be in row 2, but this is likely an error. The ring-ring SOR in row 2 abruptly rises ($C_{warm/cold}$ abruptly falls), inexplicably breaking symmetry with row 3.

The study is still inconclusive. While the $C_{hot/warm}$ plots show a possible improvement in hot-region visualization in the area close to the probe, $C_{warm/cold}$ and SOR measures indicate that there may be an error in the experiment. This is most obvious if one looks at the behavior of these measures in row 2.