IPBMA_6: Projection Radiography

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1 Experiment 1

In this experiment we addressed the visualization of microcalcifications with detectors of different resolutions. Observing the results shown in "Fig. 1", we can conclude that:

1. When the resolution of the detector is equal to the resolution of the quamtum image, microcalcifications are perfectly distinguishable.
2. When the resolution of the detector is higher than the resolution of the quamtum image, a photon beam ends up being captured by different detector cells dividing the total number and diluting the microcalcification peaks.
3. When the resolution of the detector is lower than the resolution of the quamtum image, different photon beams are captured by the same detector cell, summing up the results and losing the microcalcification peak.

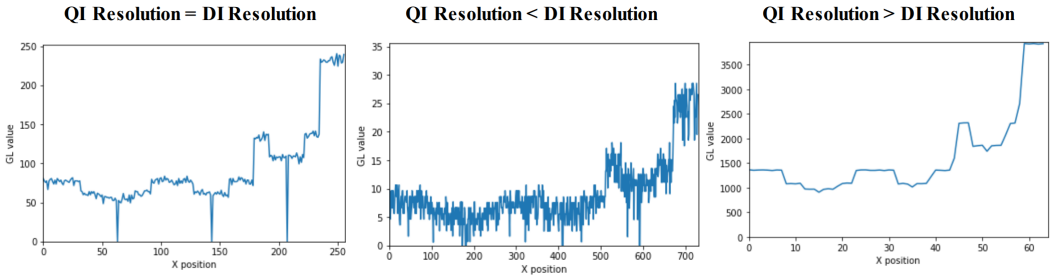

Figure 1: Experiments 1 results.

To understand these results, it is necessary to know how photon detection occurs. This procedure is explained visually in "Fig. 2". Once the X-ray beam passes through the phantom and part of the photons are absorbed, a quantum image is generated that can be captured by the detector. When the ratio between the resolution of the quantum image and the resolution of the detector is 1:1 (i.e., the cells are the same size), each projected beam is captured by one cell. Moreover, the microcalcifications can be clearly identified as each of the deep picks observed on the left plot in "Fig. 3".

However, when the detector resolution is lower, and consequently the cell size is larger, different photon beams are captured by the same cell, summing the results and losing information. This means that if one of these beams arising from the quantum image represents the pick from a microcalcification, its values will be integrated with the neighboring beams and the

information will be lost. On the other side, when the detector resolution is higher (i.e., the cell are smaller), a beam of photons will be captured by different neighboring cells, dividing the total number of photons in each. This also leads to a loss of information.

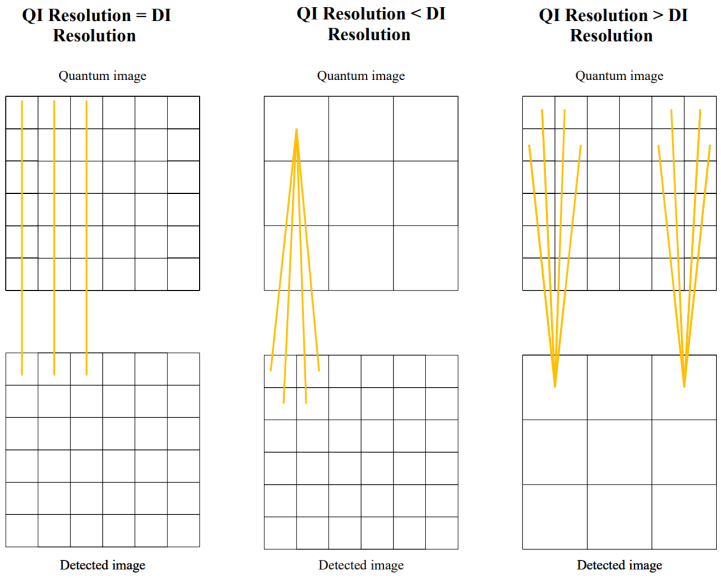

Figure 2: Photon detection.

2 Experiment 2

In this experiment we analyse the impact of the detector size on the image detection without a microcalcification. In table "1" the scale factor of the detector and a quantitative measurement of the noise are given.

1. Here, the size of the detector is the same as in the quantum image. In Fig."3" *left* the detected noisy signal does not allow us to distinguish the gray level values on the frontal face of the breast phantom. Note that the SNR value is more four times higher than the case of experiment 2.1 where resolution is duplicated.

2. In this part of the experiment, the detector size is duplicated. It could be expected *a priori* that the increment of the detector's resolution improved the image quality. However, the results clearly show an opposite effect. Since the energy captured by each cell follows the Poisson distribution, the energy values are distributed over the correspondent detector cells, as well as, the effect produced by the increment of resolution which amplifies the noise. Therefore, the gray level values are hardly distinguishable. A more detailed explanation was given in experiment 1.

3. Finally, the scale factor of the detector is divided by four. Note that the reduction of the detector's cells sizes significantly reduced the noise. As a result, we can identify the projected components of the phantom breast on the frontal face.

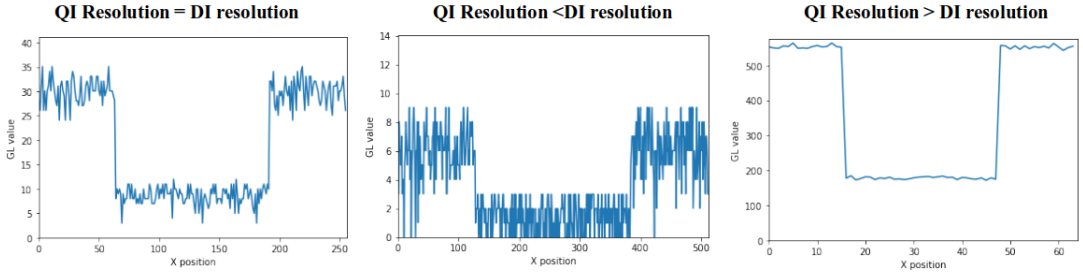

Figure 3: Experiment 2. From left to right scale factor 1, 0.5, 4.

Table 1: Results experiment 2

Experiment	Scale factor	SNR
2.1	1	4.494
2.2	0.5	0.946
2.3	4	48.447