Explanation of the coherence/non-coherence of the experimental results obtained

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Visualization of the images with different spatial resolutions

The first experiments aims to show the visual effects of different cell sizes, in the detection of the quantum image. The first one is a baseline, while the other two shows what happens if the cell size is bigger or smaller than the pixels of the quantum image.

First of all comparison of the first two experiments shows how increasing of a the resolution of the detector more than the one of the quantum image does not lead to any improvement, at least not in a straight forward manner. The image seems to be more noisy. But if we look with details the darker is the area the less noisy, and there is an especial case where the number of photons absorbed is 0 where all the details are retained. Also the overall number of electrical charges produced seems to be reduced by a factor. A deeper explanation of the cause of this effect will be done in the similar case in the following section.

Secondly The comparison of the first and the last experiments show us interesting results. Apparently the decreasing the resolution of the detector reduce significantly the noise, but smaller details seems to be lost. The intensity also seems to be increased by a factor. A deeper explanation of the causes of this effect will be done in the similar experiment in the following section.

Relation between the noise and the spatial resolution

The second experiment is also a comparison of the effect of different spatial resolutions of the detector but in this time it will be done with the signal to noise ratio metric rather than just visual.

In the first two experiment we see again effects that are similar to the one observed in the previous similar comparison. The overall number of photons absorbed by the detector seems to be reduced by a factor, and also the line seems to be more noisy. This effects occurs due cell size reduction, that lead to less photons received by each individual cells. This can be analized more explicity with the following relation. Let n_0 and n_1 be the number of cells we have on a given axis of the detector in the the first and second experiment respectively, and let w_0 and w_1 be the size of the edge of each cell corresponding to that axis in the first and second experiment respectively. Then the following relation is true:

$$n_0 w_0 = n_1 w_1 \tag{1}$$

$$\frac{n_0}{n_1} w_0 = w_1 \tag{2}$$

Then if $n_1 > n_0$ the size in that axis got reduced by a factor $\frac{n_0}{n_1}$. Lets call that factor f_w and in a similar manner we can define f_h for the other axis. Now we can say that the surface area of each cell got reduced by a factor $f_w * f_h$, and therefore the number of photons absorbed for each cells got reduced by the same factor. This has a significant impact in the signal to noise ratio, which as it was explained in the previous report can decrease drastically with the reduction of the number of photons.

There is also another interesting phenomena. Now that each pixel has a different shape and position, it can happen that parts of two pixels of the quantum image that belongs to regions with different intensities falls into the same cell of the detector resulting in a new value of intensity that does not exist in the original image, this does not happen in our experiments but can be observed with other ratios. What is interesting in our case with this phenomena is that smaller spatial resolution helps us to retain smaller details, like the inserted artifact in the first group of experiments.

Finally in the comparison of the first and last experiment a significant reduction of the noise is seen. Now we have all the theoretical frame to know that this is due the cell with bigger sizes that now absorb $f_w * f_h$ more photons which improve the overall signal to noise ratio. There is also other drawbacks with a poor spatial resolution, as it was explained before smaller details are lost, like the inserted artifacts in the first group of experiments.