# Ghost-microscopy: Visible light imaging using infrared illumination

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*We use parametric down-conversion as the illumination source in a microscope system. The down-conversion produces position-correlated photon pairs at 460 nm and 1550 nm. The infrared light probes the sample and the transmitted photons trigger a time-gated camera to record the position of the paired visible photon (the latter not interacting with the sample). Hence, we record an image formed from visible light even though the sample has only been subject to infrared illumination. The microscope is an example of a Ghost Imaging system.*

Ghost imaging using entangled photons to obtain images with light that has never interacted with the object has been a topic of research for 20 years [1, 2]. Recently we have improved the efficiency of this approach by replacing the conventional use of a scanning detector with a time-gated camera [3]. This use of a camera improves the intrinsic collection efficiency by a factor equal to the number of pixels in the image. In this present work we take advantage of the fact that the correlated photons need not be at the same wavelength thereby allowing us to illuminate the object at 1550 nm while the correlated photons at 460 nm remain within the detection spectral window of the highly-efficient camera. The short gate time of the camera means that the resulting images are virtually background free and the ability to resolve individual photons means that the anticipated Poissonian distribution of photon number is valid. Even when the images contain an average of fewer than one photon per pixel, an additional assumption of a diffraction-limited smoothness of true image, means that a high-quality imaging result can still be inferred.

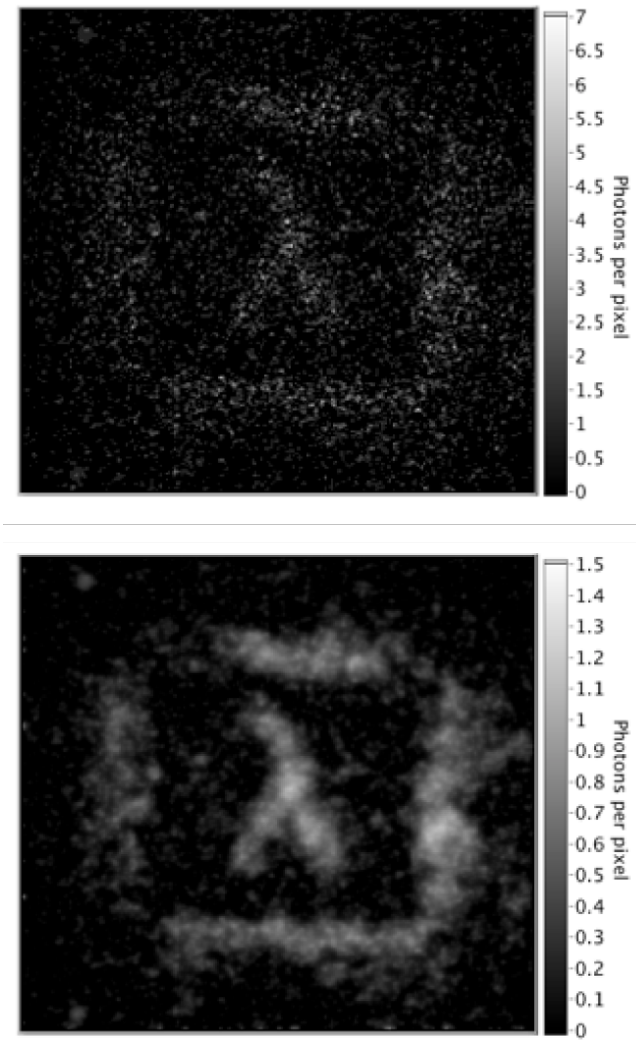


FIG. 1. Image of a etched gold pattern on a silicon wafer. The 120 micron high character is illuminated, in transmission, at 1550 nm and the image is recorded using position-correlated photons at 460 nm. The total number of photons in the image is 20,000. The sparse, integer data (top) is processed under the assumptions of Poissonian noise and a total-variation squared regulariser to give a better estimate of the object (bottom).

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