The Correlated Photon PAirs Superconducting Camera (CoPPaSC)

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Abstract: The CoPPaSC project develops an infrared camera exploiting temporal photon correlations in thermal light. Using SNSPDs' picosecond resolution, it filters correlated pairs to enhance contrast and retrieve spectral information under ultra-low-light conditions.

Infrared imaging under passive or low-light conditions remains an open challenge due to the poor signal-to-noise ratio inherent to conventional detection techniques. This limitation is especially critical in applications such as thermography and remote sensing, where active illumination is often impractical. Thermal radiation, however, exhibits intrinsic temporal correlations arising from the classical effect of photon bunching [1]. Although well established in quantum optics, these correlations have yet to be harnessed for imaging thermal sources, largely due to technological constraints in detecting correlated events at extremely low photon fluxes.

The Correlated Photon PAirs Superconducting Camera (CoPPaSC) project presented as part of the National Quantum Science and Technology Institute (NQSTI) cascade projects, introduces an infrared imaging method that leverages temporal photon correlations in thermal light to enhance contrast and retrieve spectral information. The approach combines wavelength-dependent dispersive delays in optical fiber with the picosecond timing resolution of superconducting nanowire single-photon detectors (SNSPDs). In fact, these devices offer high quantum efficiency, low dark counts, and sub-100 ps timing jitter, making them ideally suited for ultra-low-light applications.

The operating principle relies on time-correlated analysis by selecting only temporally correlated pairs, the distribution of measured delays encodes the spectral signature of the source, while uncorrelated background noise is efficiently rejected. This correlation-based discrimination enables enhanced image contrast and spectral sensitivity even in noise-dominated environments or under extremely faint illumination.

CoPPaSC's research program is structured into five Work Packages encompassing a total of 15 tasks. The project aims to assess the feasibility of this approach and conduct preliminary tests toward the development of an ultra-sensitive, high-resolution infrared camera, in preparation for a patent application.

References

[1] Brown, R. H., & Twiss, R. Q. (1956). Correlation between photons in two coherent beams of light. *Nature*, *177*(4497), 27-29.