Progress on Single Photon Detector Efficiency Calibrations at NIST

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We report on our progress towards implementing a measurement service aimed at the calibration of single-photon detectors. We present how our calibration is tied to the calibration of our transfer standard optical fiber power meters. We also developed and built a superconducting nanowire single photon detector system for use as an in-house reference for single photon detection efficiency measurements. This system can also be utilized in comparisons among NIST and other NMIs.

CALIBRATION OF SINGLE-PHOTON DETECTOR EFFCIENCY

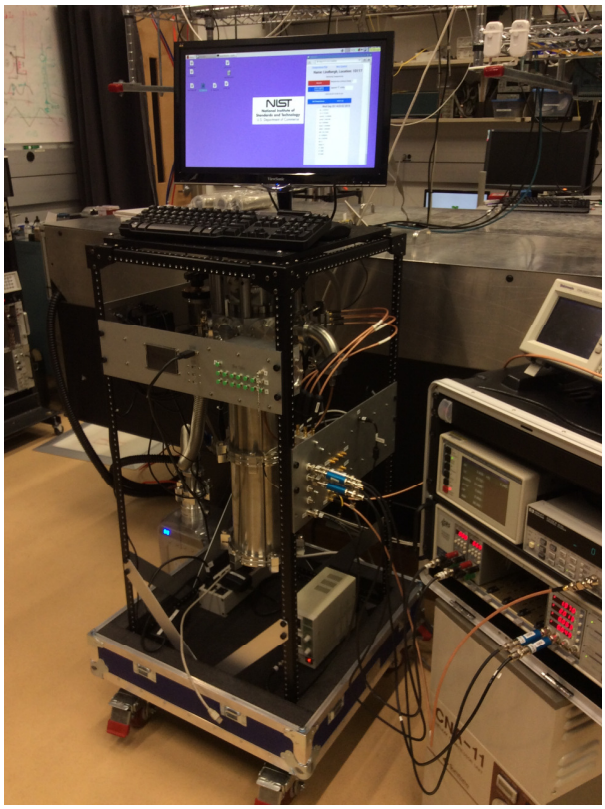
Our measurement of single-photon detector efficiencies is based on a simple beamsplitter method, where an attenuator is used to attenuate from light levels that allow high-accuracy absolute-power measurements to levels compatible with photon-counting detectors. First, the transmittance of the beamsplitter is measured at optical powers that allow both its input and output powers to be accurately measured with optical power meters, then its input power is reduced such that the output is in the range of the device under test (DUT). Using this measured transmittance and the measured input power, the low level optical power on the DUT can be determined, thus allowing the calibration of a transfer standard optical power meter, *e.g.* Si trap detector, to be transferred to the DUT.

We have implemented a fiber-coupled and free-space measurement system. In both cases we were able to achieve a measured detection efficiency with an extended relative uncertainty of less than 1 %.

SUPERCONDUCTING NANOWIRE SINGLE PHOTON DETECTOR SYSTEM

For use as in-house reference and comparisons between NIST and other NMIs, we have built a superconducting nanowire single-photon detector (SNSPD) system. The system is based on a 1K cryostat design, capable of operating our WSi SNSPDs [1]. Currently, the system hosts two SNSPDs, optimized for 1550 nm. The compact and robust detector packaging [2] allows shipping of the SNSPDs inside the cryostat without noticeable degradation of the SNSPD performance over many temperature cycles. In the future, we will equip the cryostat with SNSPDs optimized for ≈850 nm, 1064 nm and ≈1310 nm. The system is fully automated and turn-key and as such, the operator does not need extensive cryogenic experience or knowledge.

Figure 1. 1K SNSPD system used as in-house reference.



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