# Photon-Number Resolution with SNSPDs: Single-Pixel Rise-Time Analysis vs. Multi-Pixel Architectures

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Superconducting nanowire single-photon detectors (SNSPDs) offer high System Detection Efficiencies (SDE), sub-20-ps timing jitter, and ultralow noise at high rates [1, 2], enabling advanced quantum photonics experiments. Here we experimentally compare photon-number-resolution (PNR) capabilities obtained with (i) IDQ's single-pixel SNSPDs and (ii) IDQ's parallel SNSPDs (P-SNSPDs) architecture with 8 or 28 interleaved pixels. We used arrival-time analysis with Swabian Instruments's Time Tagger Ultra to record and timestamp the time-of-arrival between illuminating laser pulse and recorded photon click for both SNSPD architectures to be able to compare their respective PNR capabilities. For all datasets, assignment probabilities are computed by fitting exponentially modified Gaussian (EMG) to the distribution of the time-of-arrival histogram, where each peak corresponds to a distinct n-photon state [3]. Under our measurement conditions, the single-pixel modality yields ~90% assignment for 1- and 2-photon states due to peak overlap. In contrast, P-SNSPDs exhibit well-separated peaks for each n-photon event and thus enabling near-unity (>99.9%) assignment probabilities, which is especially relevant for applications such as photonic quantum computing [4] or quantum communications [5].

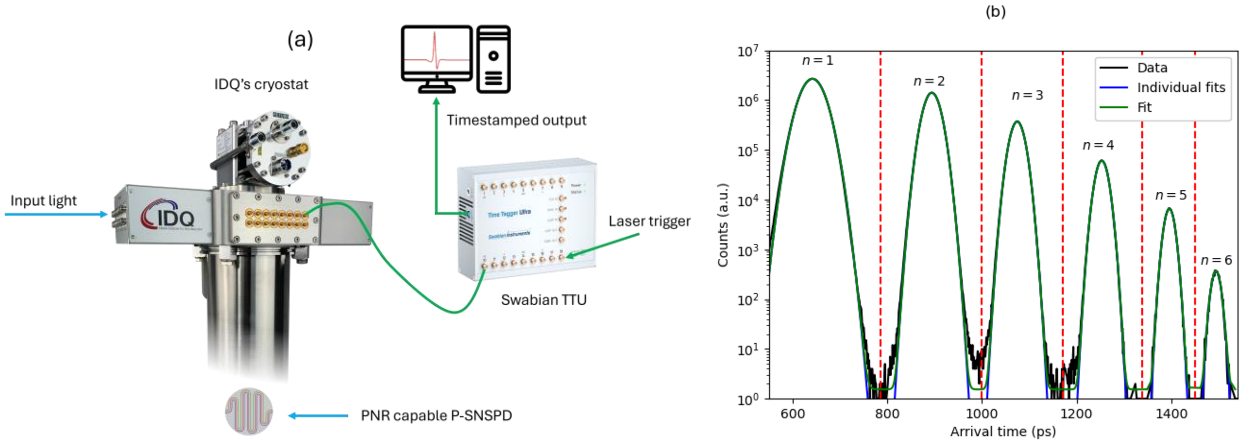


**Fig. 1: (a, left)** Scheme of the experimental setup **(b, right)** Log-scaled time-of-arrival histogram for an 8px P-SNSPD showcasing the different n-photon state and their respective difference in timestamped signal, allowing to differentiate between all states. The average photon number of this dataset was $\mu = 3$. The overlap between EMG-shaped peaks limits ultimately the assignment probabilities. The red vertical lines represent the transition threshold for best n-state discrimination as each peak corresponds to a distinct n-photon state.

## References

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