Single-Photon Source based on Room-Temperature Atomic Vapour with intrinsic Near-Millisecond Memory

Rebecca Schmieg[1], Michael Zugenmaier[1], Karsten B. Dideriksen[1] and Eugene S. Polzik [1]

[1] *Niels Bohr Institute*, University of Copenhagen, Blegdamsvej 17, Copenhagen, Denmark

Here we present our advances [1] in an atomic vapour single-photon source based on the pioneering DLCZ protocol for quantum repeaters [2]. In a two-step scheme, we first create a collective excitation via a spontaneous Raman scattering process, the created photon heralds the collective excitation. Upon detection of the scattered photon, the collective excitation can be retrieved after a variable delay in form of a deterministic single-photon. To overcome limitations arising due to wall collisions, atomic motion and excess readout noise, we exploit an anti-relaxation coating, motional averaging and four-wave mixing suppression. We observe non-classical cross-correlations between heralding and retrieval photons over a duration of $\tau_{NC} = 0.68 \pm 0.08$ ms. The single photon character of the retrieved single-photons is verified through the conditional auto-correlation of the retrieval light field of $g^{(2)}_{RR|W=1} = 0.20 \pm 0.07$. At the same time we observe cross-correlations of up to 10 (figure 1).

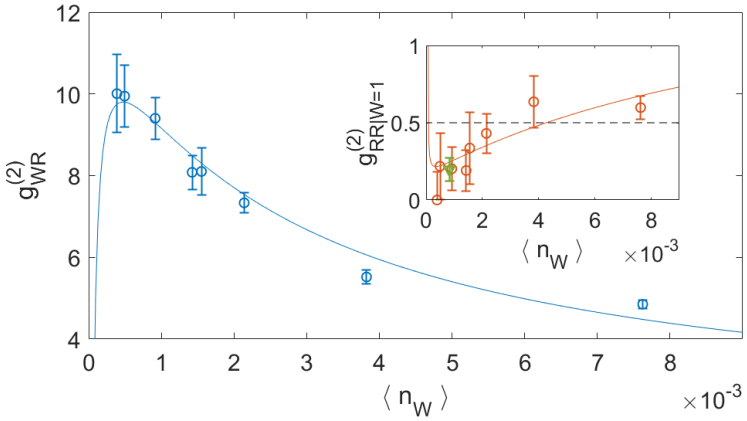

Figure 1. Cross- and conditional auto-correlation of heralding and retrieval photons versus heralding probability. The green triangle is the combined conditional auto-correlation for the lowest heralding probability for improved statistics. In addition, expected model lines are shown.

[1] K. B. Dideriksen, R. Schmieg, M. Zugenmaier and E. S. Polzik:
Room-temperature single-photon source with near-millisecond built-in memory,
arXiv:2010.06875 (2020).
[2] L. M. Duan, M. D. Lukin, J. I. Cirac and P. Zoller:
Long-distance quantum communication with atomic ensembles and linear optics,
Nature **414**, 6862 (2001).