Quantum state measurement and control in cavity QED

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Circular Rydberg atoms are very sensitive probes of millimeter-wave quantum fields stored in high quality superconducting cavities. They make it possible to count the number of photons in an ideal Quantum NonDemolition way. This photon counting procedure can be extended to realize a complete reconstruction of the field's quantum state. The procedure has been applied to a variety of quantum fields, including Fock and Schrödinger cat state. The time-resolved state reconstruction makes it possible to follow in real time the fast decoherence of their non-classical features.

We shall discuss these experiments and the perspectives they open, particularly for active quantum feedback. Information extracted from a partial field-intensity QND measurement can be used to react on the cavity with a coherent source and steer its evolution towards a prescribed Fock state. This scheme efficiently prepares Fock states on demand and protects them from decoherence.