# Ultra-low power all-optical switch using a single quantum dot embedded in a photonic wire

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# Ultra-low power all-optical switch using a single quantum dot embedded in a photonic wire

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We present experimental results on two-mode optical giant non-linearity of a single InAs quantum dot (QD) embedded in a GaAs tapered photonic wire (fig. 1a). This system, in which the QD is efficiently coupled to a single guided mode, has been exploited to realize ultrabright single-photon sources [1,2]. We exploit here its broad operation bandwidth (>100 nm around 950 nm) to efficiently address two different transitions of the QD with two cw laser beams (fig. 1b). The laser coupled to the upper transition leads to a Rabi splitting of the intermediate state (Autler-Townes effect), affecting the resonant reflectivity of the laser coupled to the lower transition (see fig. 1c).

By performing reflectivity experiment, we show that a coupling laser of 10 nW (50 photons per emitter lifetime) can modify the transmission of the probe laser, realizing an ultra-low power all-optical switch.

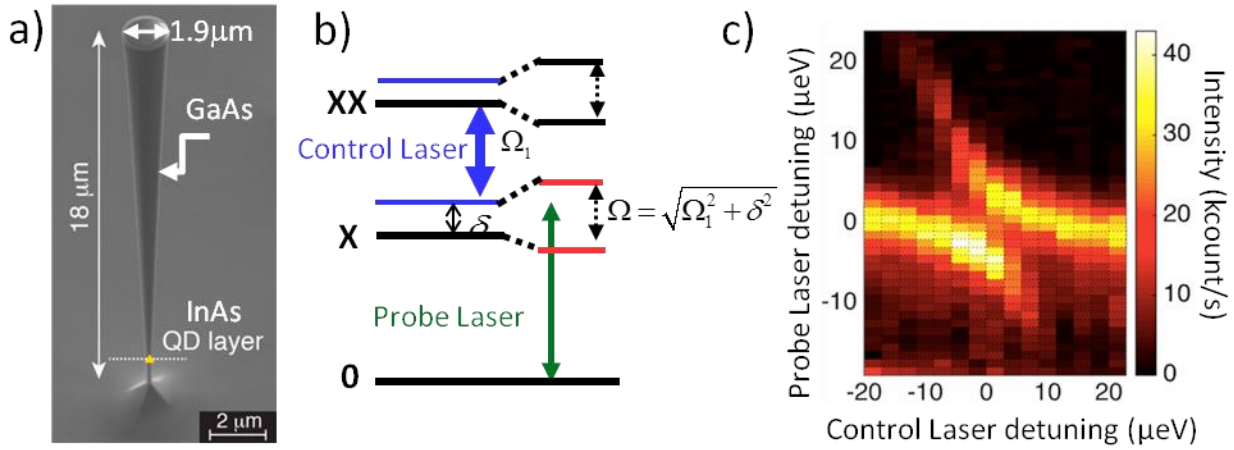


*Figure 1. (a) Scanning electron microscope image of a trumpet like photonic wire. (b) Energy scheme for a quantum dot three-level system with two lasers on resonance with two transitions. Here, on the exciton level, we observed the fine structure splitting (FSS). When the coupling laser is on resonance with the state $X_v$, two new dressed states are formed . The FSS is large so that we can neglect the influence of the coupling laser on the state $X_H$. (c) Color plot of the reflection intensity as a function of the probe laser detuning $\Delta_p$ (horizontal axis) and coupling laser detuning $\Delta_c$ (vertical axis). For $\Delta_c$=0, the splitting experienced by the probe laser is equal to the Rabi frequency of the coupling laser.*

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[2] M. Munsch et al, *"Dielectric GaAs Antenna Ensuring an Efficient Broadband Coupling between an InAs Quantum Dot and a Gaussian Optical Beam"*, Phys. Rev. Lett. **110**, 177402 (2013).