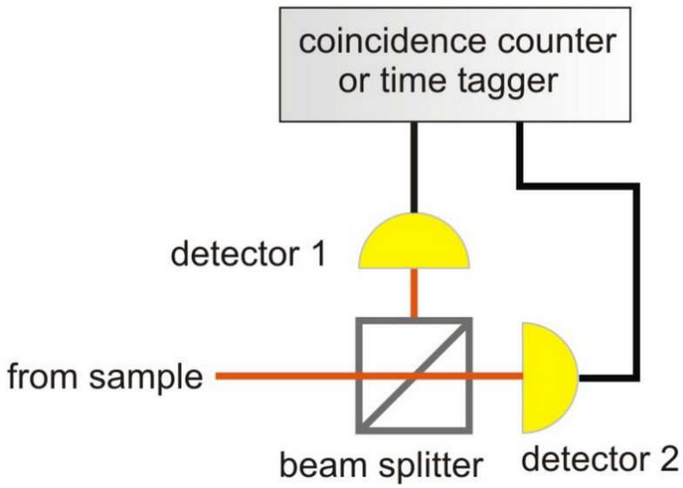
Practical single photon sources

- "Perfect" single photons

- Occasional multi-photon states

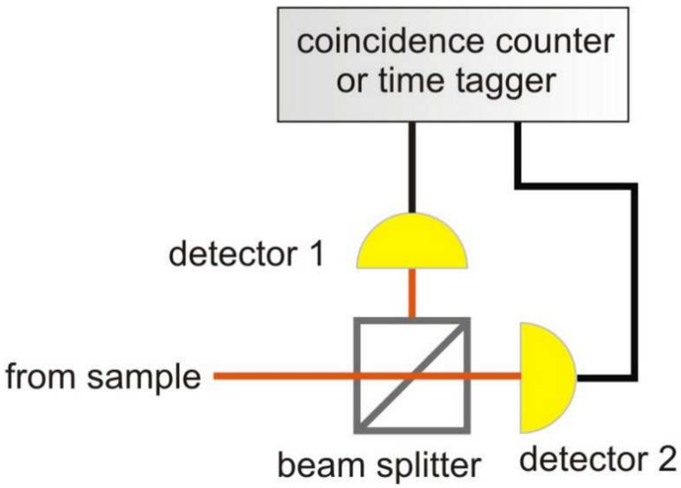
Single photon detection

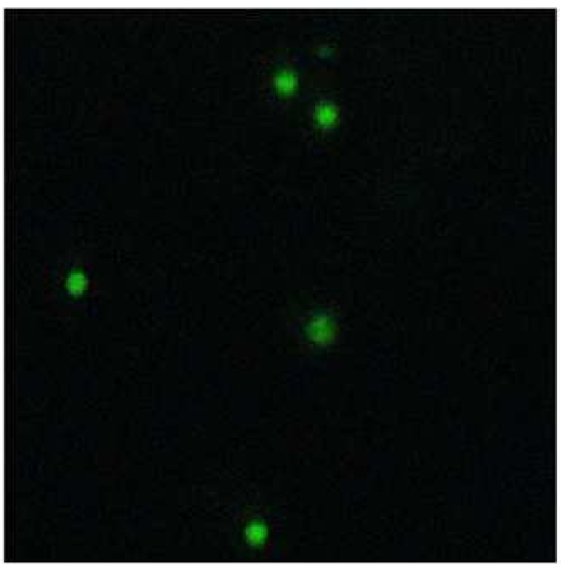


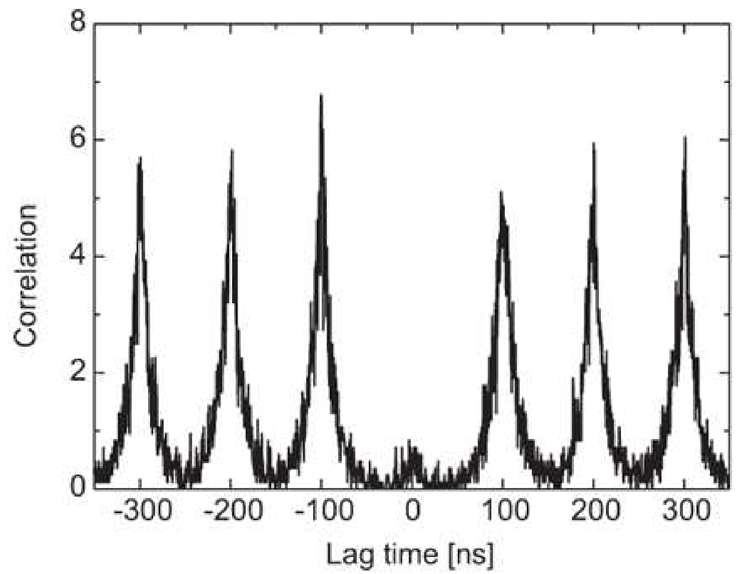
Single photon state = only one detector will click

The absence of coincidences in clicks of the two detectors is the signature of a single-photon state

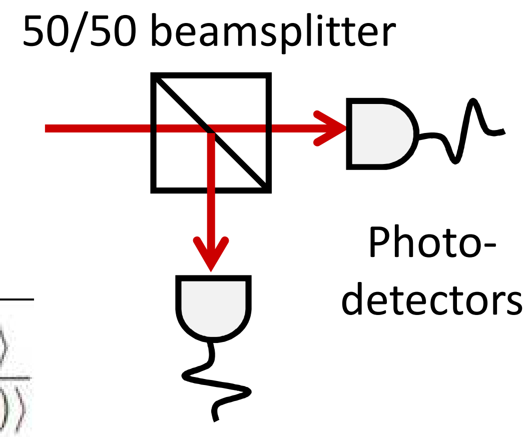
Single photon detection







Correlation functions



- Second-order intensity correlation ($g^{(2)}$) characterizes photon number fluctuations

$$g^{(2)}(\tau) = \frac{\langle \mathcal{E}^*(t)\mathcal{E}^*(t+\tau)\mathcal{E}(t+\tau)\mathcal{E}(t)\rangle}{\langle \mathcal{E}^*(t)\mathcal{E}(t)\rangle\langle \mathcal{E}^*(t+\tau)\mathcal{E}(t+\tau)\rangle} = \frac{\langle I(t)I(t+\tau)\rangle}{\langle I(t)\rangle\langle I(t+\tau)\rangle}$$

- For photon number- resolved measurements

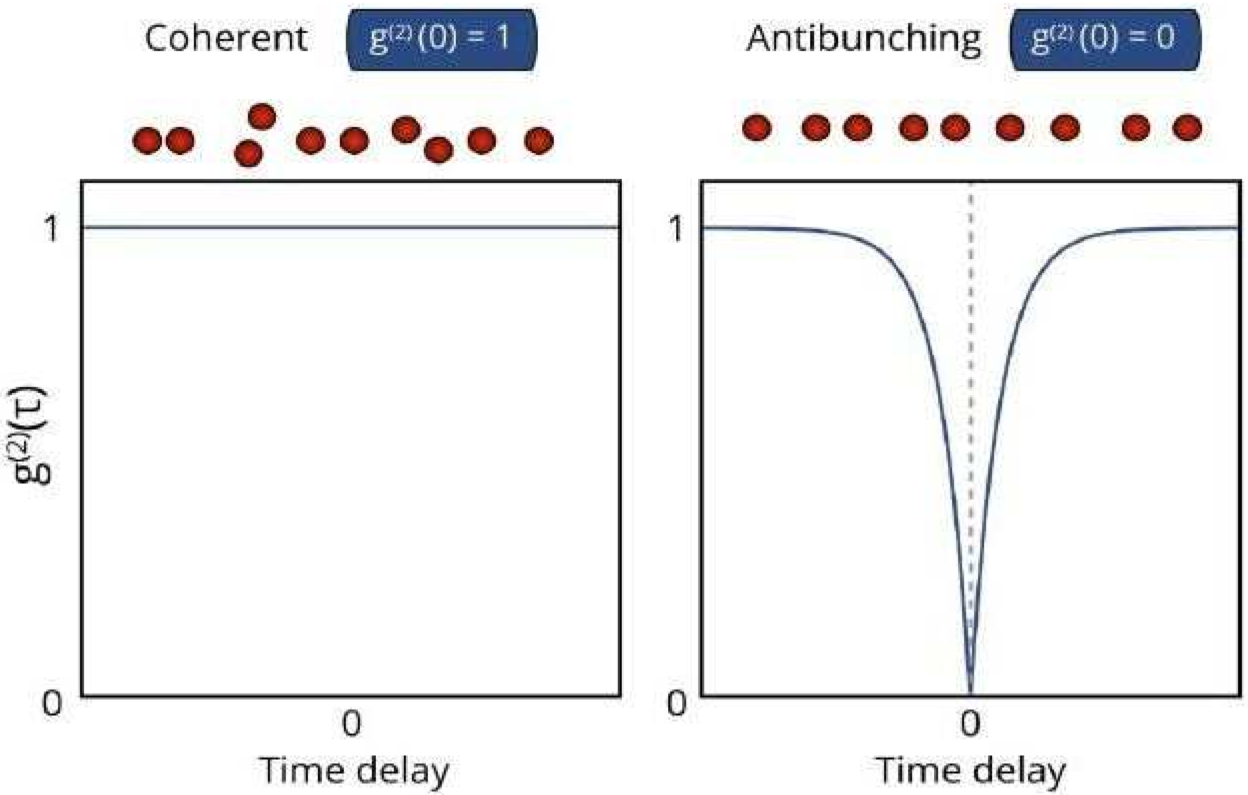
$$g^{(2)}[0] = \frac{\langle \hat{n}(\hat{n}-1)\rangle}{\langle \hat{n}\rangle^2},$$

- $g^{(2)}(0)$ describes the bunching of a field
  - $g^{(2)}(0)=1$ – **random**, no correlation, ex.: poissonian (laser) light

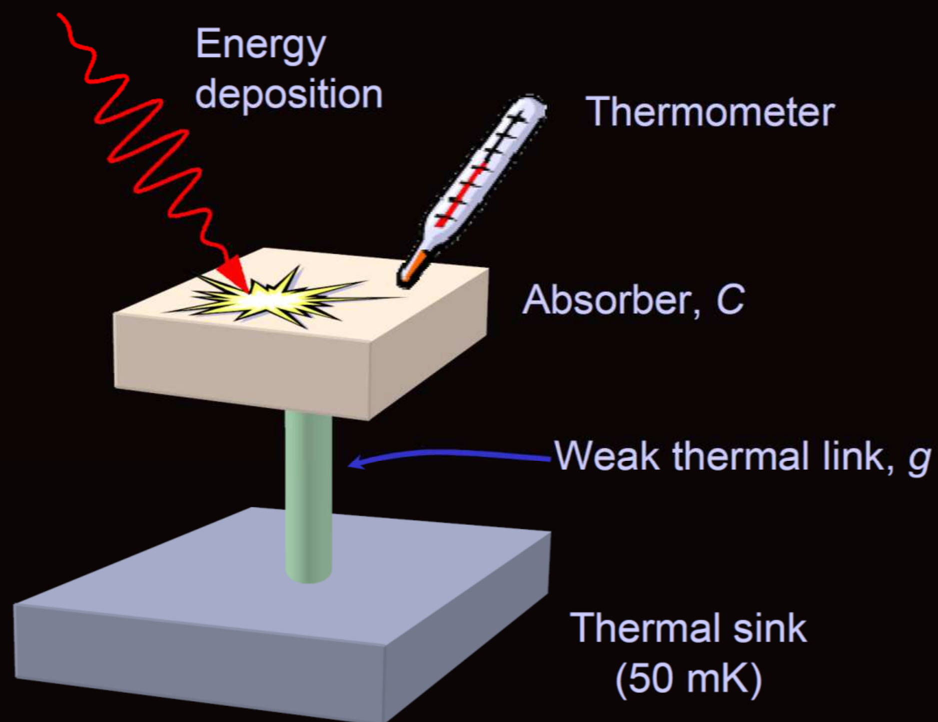
  - $g^{(2)}(0)>1$ – **bunching**, photons tend to arrive together, ex.: thermal light

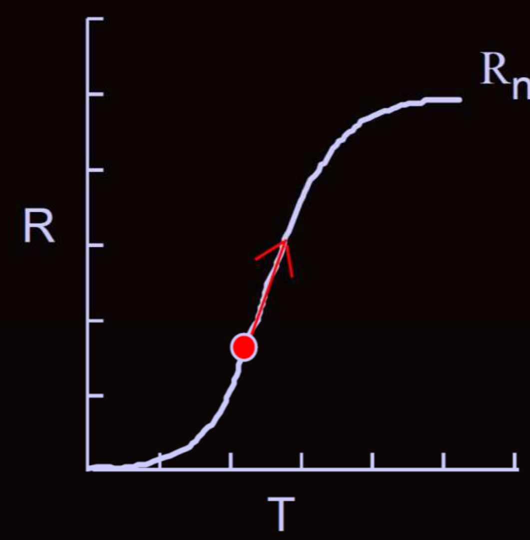
  - $g^{(2)}(0)<1$ – **anti-bunching**, violates classical inequality, ex.: Fock states

Single photon detection



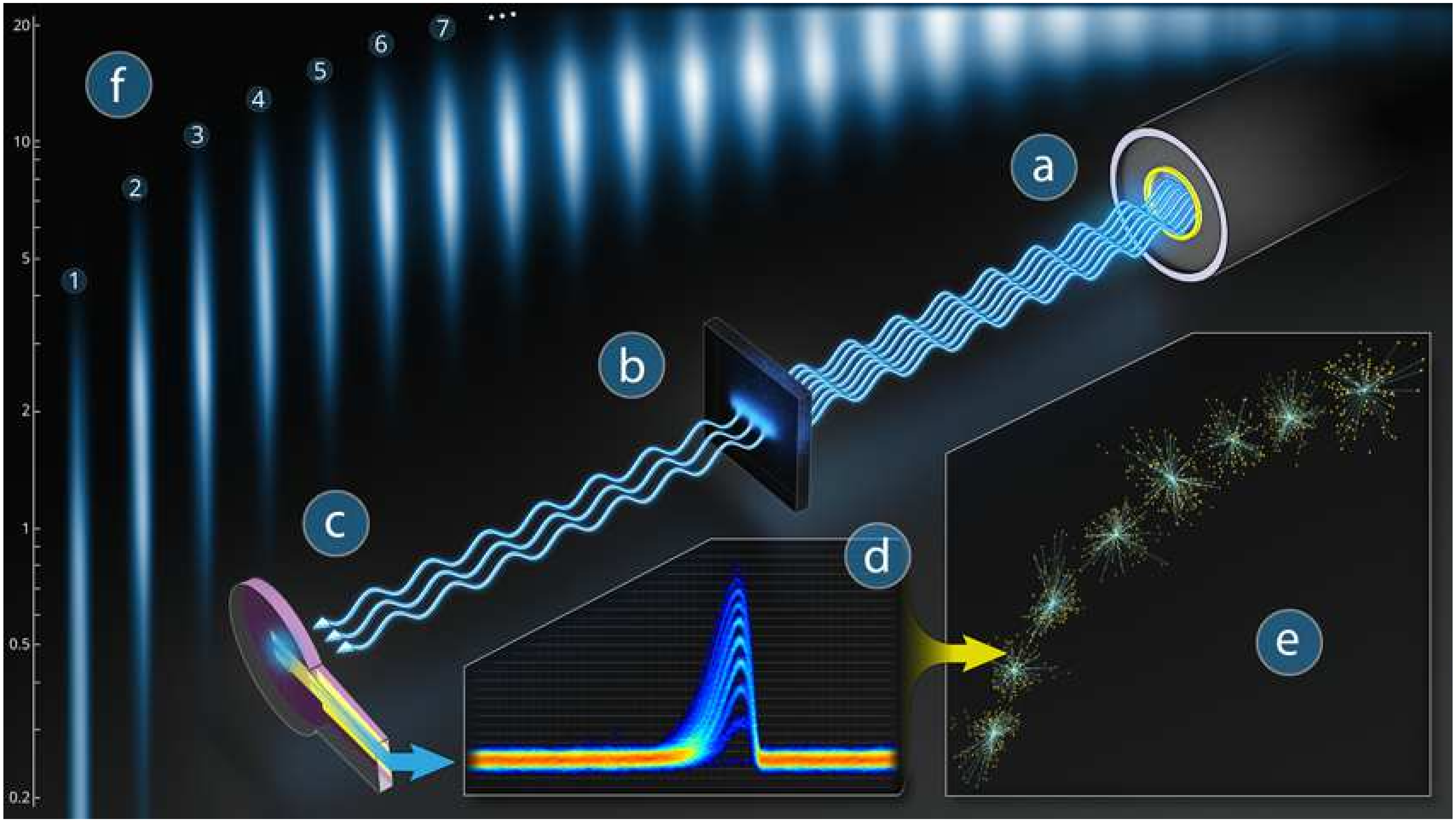
Transition Edge Sensor (TES)





- Calorimetric detection of UV/optical/IR photons:
- Temperatures are ~100 mK to ensure low noise and high sensitivity.
- Absorber and thermometer are the same (superconducting W thin film)
- Microfabrication techniques

Transition edge sensor (TES)



Light from a pulsed laser (a) is directed through a variable attenuator (b) onto a transition edge sensor device (c). The resulting signal (d) is analyzed with a statistical clustering algorithm (e) which returns a nominal photon number (f).

Transition edge sensor (TES)