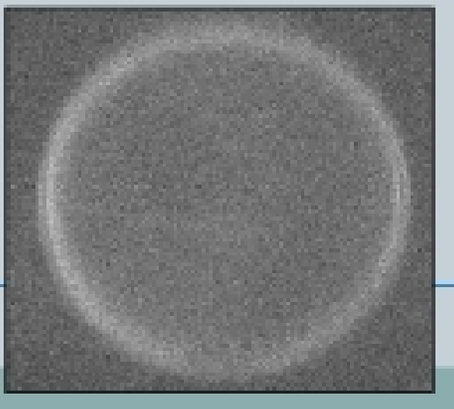
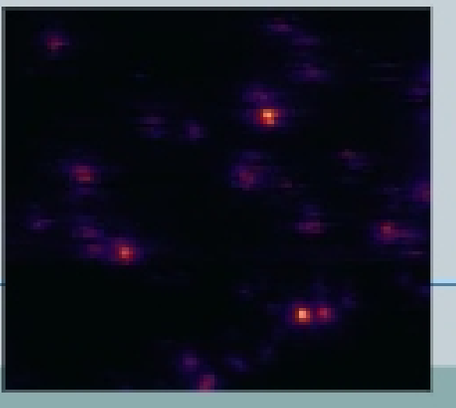
Quantum Optics and Quantum Information Laboratory

- Outline
  - Lab 1 - Bell's Inequalities and Entanglement
  - Lab 2 - Single Photon Interference
  - Lab 3&4 - Confocal Microscope Imaging of Single Emitter Fluorescence and Observing Photon Antibunching Using Hanbury Brown and Twiss Setup

Lab 1 – Bell Inequalities and Entanglement

- Entanglement : the state of an entangled particle cannot be separated into single-particle states.

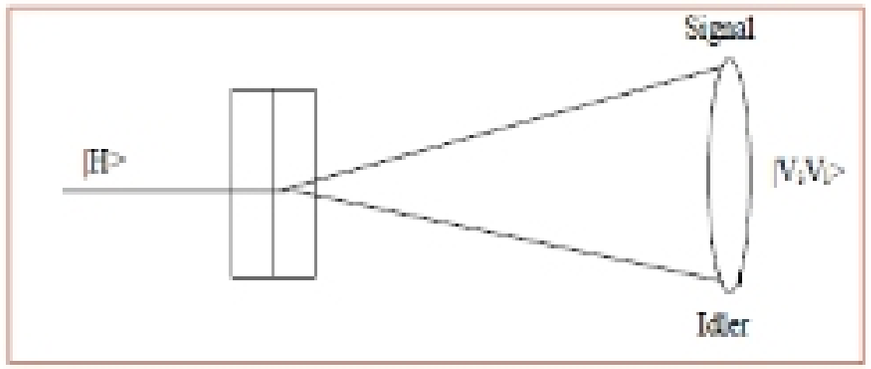
$$|\Psi_{12}\rangle \neq |\Psi_1\rangle \otimes |\Psi_2\rangle$$

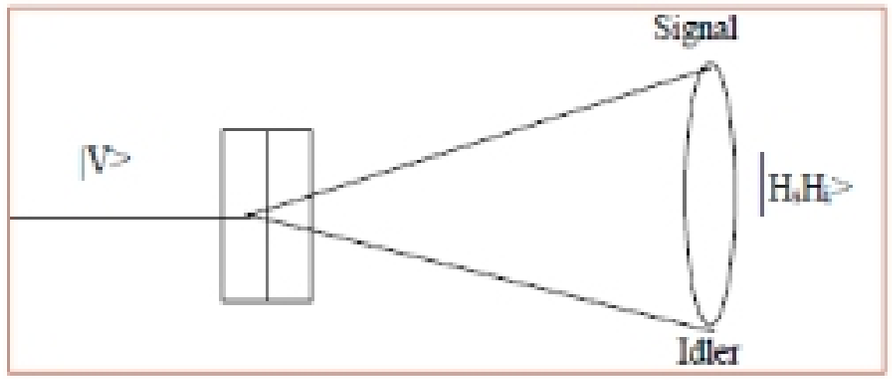
- A measurement on one particle affects the state of the second one, no matter how far apart they are.

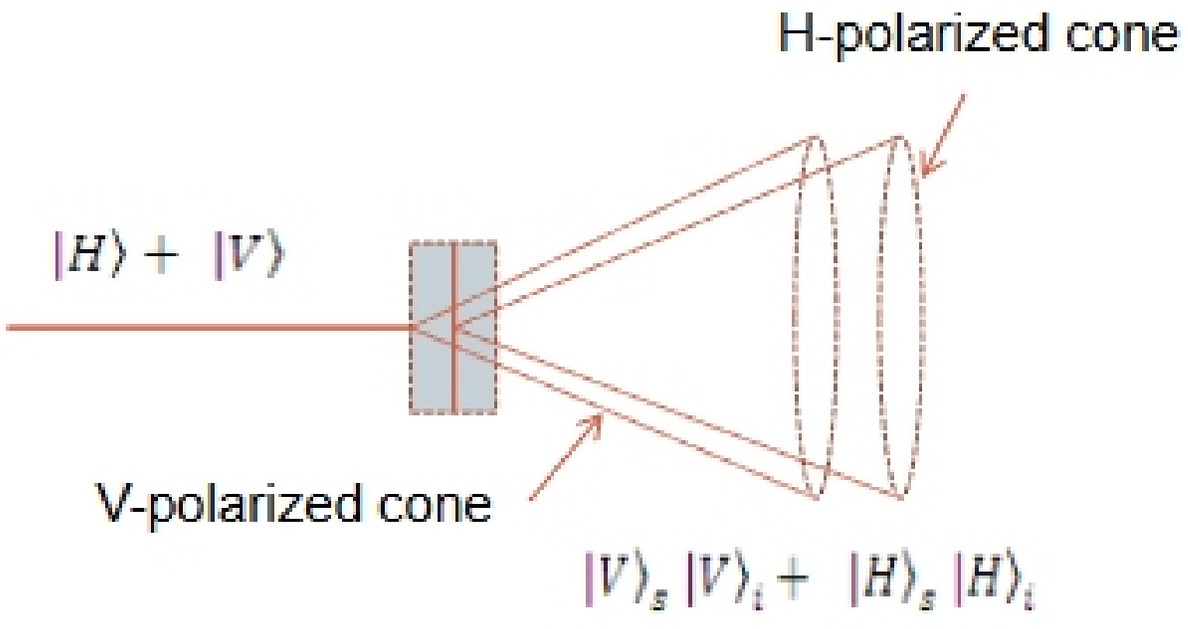
- Examples of entangled states :
  - entangled spin states
  - entangled polarization states

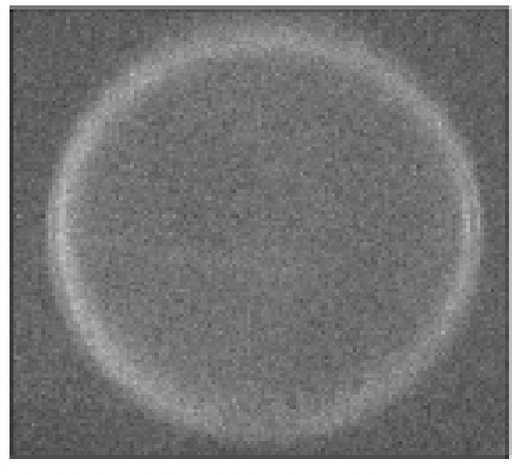
How did we create entangled photons in this lab?

- Polarization states of photons entangled: Laser of 45° polarized light on two orthogonally placed Type 1 BBO crystals
- Spontaneous parametric down-conversion









Down-converted light cone imaged