中国科学技术大学
University of Science and Technology of China

Quantum Physics & Quantum Information

Experimental Feasibility Test of Measurement-Device-Independent Quantum Key Distribution on Free-space Channel

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Introduction

- *QKD provides unconditional security.*
- *Various QKD devices and networks have been built.*
- *Detection loopholes exist in practical QKD systems.*
- *Measurement-device-independent (MDI)-QKD is proposed.*
- *Hong-Ou-Mandel (HOM) interferometer is a key part.*
- **We report a demonstration of free-space HOM intererometer.**
- **The length of the free-space channel is 220 meter.**

Previous attempts

- *HOM interferometer is demonstrated at laboratory.*
- *HOM interferometer is demonstrated with fiber channels.*
- In previous free-space quantum experiments,
  quantum operation was implemented at the transmitter, and then the photons are transmitted to the receiver.
- In free space, to the best of our knowledge,
  no HOM interference has been observed before.

The goal

Long distance free-space HOM interference

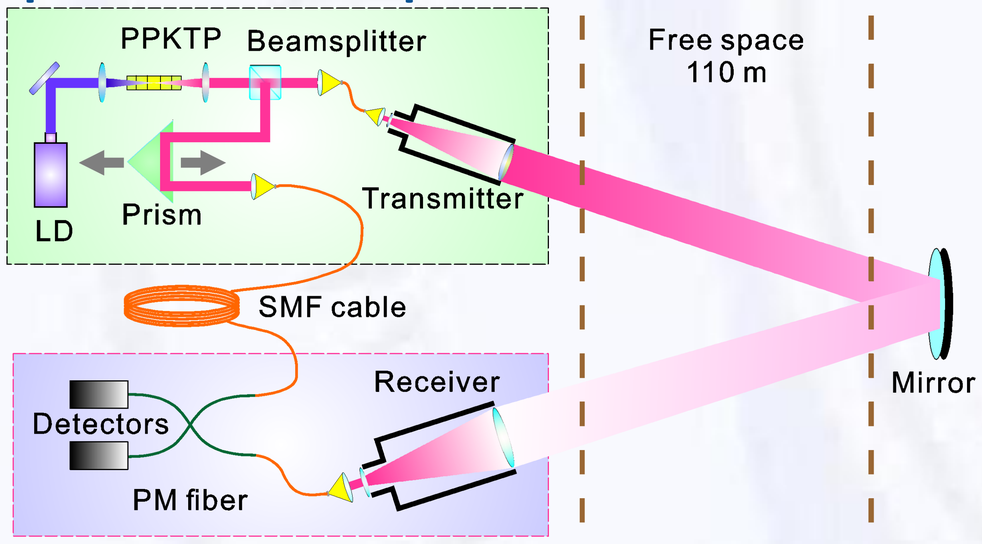
Challenges and solutions

Two photons	→	SPDC source
Frequency	→	Wavelength degenerate Single longitudinal mode pumping Temperature control for PPKTP
Polarization	→	Polarization control
Temporal mode	→	Scan for optical length
Spatial mode	→	Optical fiber beam splitter (2 inputs & 2 outputs) (Polarization maintain)

Other techniques:

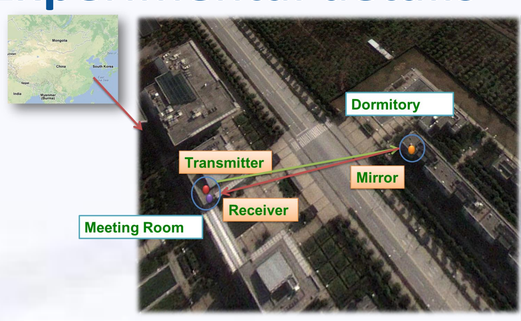
SMF coupling, fine tracking, optical length scanning…

Experimental setup

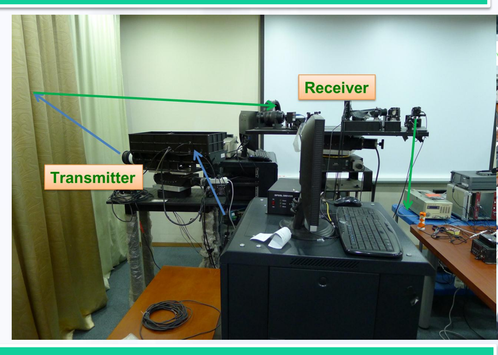


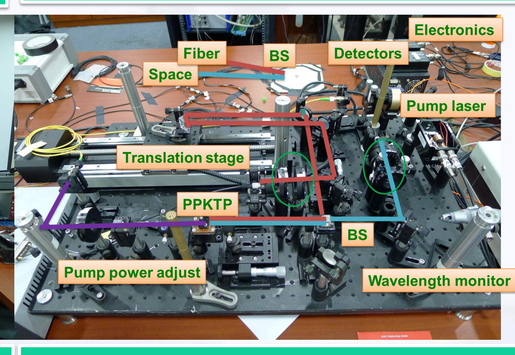
Signal photons and idle photons are generated through PDC process. After flying over 110 m free space to reach the mirror, one of each twin-photon pair is reflected back and coupled into the fiber of the receiver. At the same time, the other photon is delayed in a SMF cable with same optical path length. Using a motorized linear translation stage, difference of optical length of the two channel is fine adjusted on the fiber link at the transmitter. The number of coincidence events varies to HOM dip while optical length difference vanishes.

Experimental details



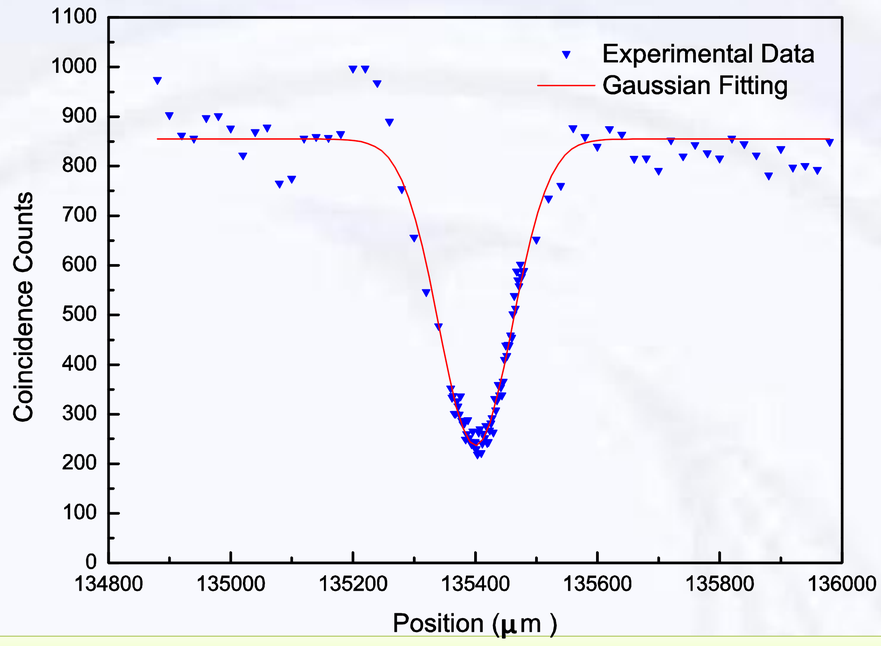
Location | General view of the lab



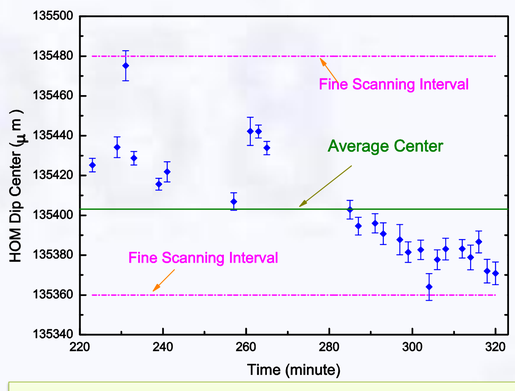


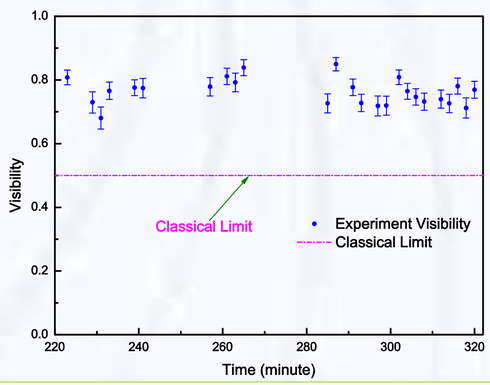
The transmitter and the receiver | The source and the interferometer

Results



Interferometer: HOM dip of coincidence counts in 100 minutes





Drifting: the center of the dip | **Stability: the visibility of the dip**

Discussion

- *Our experiment represents*
  a long-distance free-space HOM interferometer
  a feasibility test of MDI-QKD via free space channel
  a first step of BSM based protocols in free space
- *Future works*
  MDI-QKD, entanglement swapping, dense coding…

Comments are welcome!

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