

## Free-Space Quantum Key Bit Transfer Over A 26 Km Urban Path

**P. J. Edwards, A. Blake, C. Cochran, G. Gleeson, H. B. O’Keeffe and D. Woodgate**

Centre for Advanced Telecommunications and Quantum Electronics Research,

Division of Business Law and Information Sciences, University of Canberra, ACT 2601

Australia., Email: Paule@ise.canberra.edu.au

### **Abstract**

We have successfully demonstrated the transmission of quasi single-photon quantum key bits at a rate exceeding 100 bps over a 26 km free-space urban path with bit error rates within the limits required by the commonly used B92 and BB84 quantum key distribution protocols.

Linearly polarised photons were fibre coupled from an 830 nm laser diode to a photon launcher consisting of a fibre collimator and 40 mm optical beam expander. The laser was pulsed at 1MHz with mean photon occupancies per pulse below unity.

Unlike recent claims of fibre–optic quantum key distribution over a distance of 100 km, the error rates in our trial were sufficiently low to ensure non-zero information content of random keys exchanged under the conditions of the trial. We believe that our results represent a significant step forward towards quantum key exchanges over global distances using earth satellites as key couriers, since atmospheric turbulence is generally recognised to be the limiting factor in such exchanges. The demonstrations were conducted at lower altitudes, over longer paths and under more difficult propagation conditions than similar atmospheric trials in Europe and the USA. They were supported by comprehensive monitoring of optical wave-front distortion and intensity fluctuations due to turbulence. This showed that the effects of turbulence in our trials were more pronounced than expected for realistic optical links between ground stations and low earth orbit satellites. We observed effective image diameters exceeding 5 arc seconds and mean square scintillation indices of order unity, averaged over our 250 mm receiving aperture.

We therefore believe that we have realistically simulated the worst case effects of atmospheric turbulence expected over practical ground to earth orbit single-photon qubit links and that consequently we have demonstrated the feasibility of exchanging secure quantum keys over continental and global distances by earth satellite.