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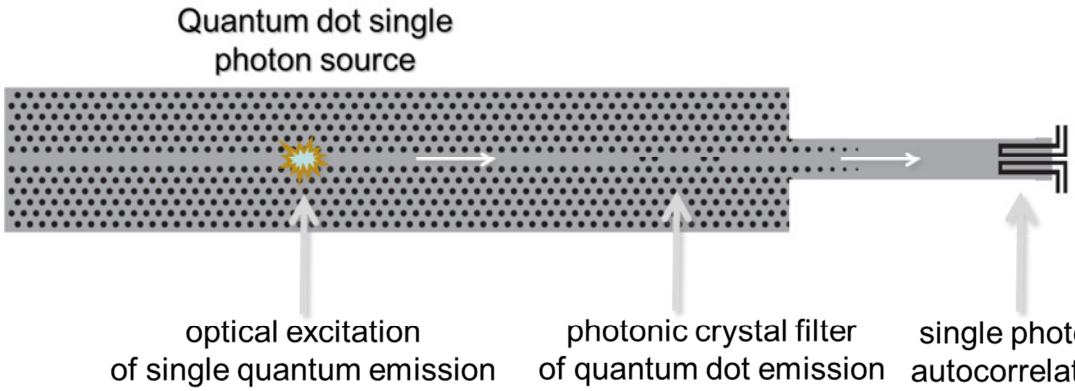
600 YEARS
1413 – 2013

School of Physics and Astronomy
Quantum Physics and Quantum Engineering Group

PhD thesis
Semiconductor Integrated Quantum Photonics

Quantum information processing is a rapidly developing research field. Exploiting quantum bits instead of classical bits, offers key advantages for future technologies such as secure communication and ultra-fast computation. While breakthrough lab-size experiments have proven the validity of these quantum technology concepts, any wide spread utilization will require dense integration of functionalities. Semiconductor integrated quantum photonic circuits with on-chip single photon sources [1] and detectors [2] are a very promising route for full on-chip integration. Utilizing photonic crystals, structures with periodic variations of refractive indices, enable the guiding of the emission and propagation of photons. Single quantum dots embedded in photonic crystals are efficient single photon sources. After traveling along a waveguide, these single photons can be detected by on-chip auto-correlators [3], based on superconducting single photon detectors to probe quantum correlations. Such building blocks are key components of a quantum information processing platform.



Electron micrograph of an example integrated quantum photonic device comprised of a on-chip quantum dot single photon source, a photonic crystal filter and an on-chip auto-correlation detector.

Within this project you will learn, under supervision of Prof Höfling and Dr Liam O'Faolain, how to fabricate photonic crystal waveguide single photon sources, splitters, ridge waveguides, combiners and filters in St Andrews based on quantum dot substrates. Furthermore, Prof Robert Hadfield at the University of Glasgow will provide expertise in fabrication of on-chip superconducting single photon detectors and you will participate in low temperature device characterization at the University of Glasgow. This challenging project will put you at the forefront of an important developing field: integrated quantum photonics for quantum information processing.

[1] T. B. Hoang *et al.*, Appl. Phys. Lett. **100**, 061122 (2012)
[2] J. P. Sprengers *et al.*, Appl. Phys. Lett. **99**, 181110 (2011)
[3] D. Sahin *et al.*, Opt. Express **21**, 11162 (2013)

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or Prof Robert H Hadfield (robert.hadfield@glasgow.ac.uk)