

Research at the University of Queensland (UQ) is based in the Nano-optics and Quantum Technology Laboratories. In addition, there is access to a cleanroom and three laboratories (Chemical Fabrication, Diagnostics, and Microresonator Fabrication) shared with other groups. All of these laboratories are located either in the Parnell building or the Physics Annex at the Saint Lucia Campus. The UQ Node also has offices, a seminar room and visitors' rooms in the Parnell building with computer, internet and colour laser printing resources. A \$3.6M refurbishment of the basement of the Parnell building began in late 2006, and was completed in 2008. The refurbishment provides a new expanded laboratory space for both the Nano-optics and Quantum Technology programs, as well as access to extensive new cleanrooms, and new laboratories in Chemistry, Materials, and Quantum Devices.

### Nano-Optics Laboratory

The quantum dot quantum computing group has a state-of-the-art capability to resolve and coherently probe single quantum structures over a wide range of wavelengths and temperatures. A Tsunami Titanium Sapphire laser (average power 2.6 W, pulse duration 60 fs) is used in combination with an optical parametric oscillator (Opal) with doubling unit, providing electromagnetic radiation from 350 nm to 3.5  $\mu\text{m}$ . The laboratory is also equipped with a modular confocal/multiphoton optical microscope with a cryogenic, fully automated, high precision stage. Detection of the signal is achieved using a high-resolution spectrometer with a state-of-the-art Peltier-cooled electron multiplying CCD array (Andor Ixon) and/or a high resolution Fabry-Perot etalon coupled to a second cooled EMCCD. A time-correlated single photon counting fluorescence lifetime spectrometer (PicoQuant) is also available for further diagnosis of the fluorescence. Finally, precision automated translation stages and vibration isolation equipment



**FIGURE 1**  
Quantum Technology Laboratory at UQ.

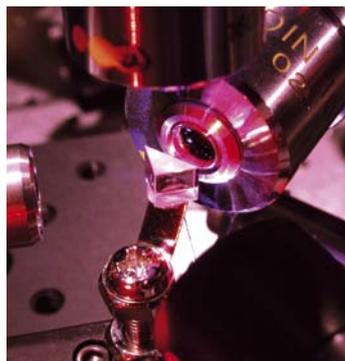
are available for assembling a Michelson interferometer for use as an autocorrelator or to prepare phase coherent pulse pairs.

### Quantum Technology Laboratory

The Quantum Technology (QT) Laboratory is a custom built (200 m<sup>2</sup>) HEPA-filtered optics facility which was built for experimental quantum optics. It is the base of the Linear Optics Quantum Computing program, which investigates quantum computer architectures where the quantum information is encoded into optical degrees of freedom. The laboratory can be divided into three light-proof sections via moveable walls, facilitating parallel low-light operation. Each section contains a vibration-isolated optical table, with one or more optical downconversion sources. These are pumped by either: an ultra-violet Argon-ion laser (> 1.3 W at 351.1 nm), a mode-locked Ti:Sapphire laser (60 fs pulses at 780–820 nm with an average power of 2.6 W), or compact ultra-violet diode lasers (~30 mW at 410 nm). A range of high-precision opto-mechanics and optics are used including: precision translation and rotation stages in both manual and automated configurations, single mode fibre launchers, a range of nonlinear downconversion crystals and custom polarisation elements. Single photon detectors (free-space and fibre-coupled), a photon counting CCD camera, fast counting electronics, and automated quantum tomography systems are used for gate set-up and analysis. The QT Lab is shared with research efforts in Quantum Communication, Quantum Control and Quantum Metrology.

### Chemical Fabrication Laboratory

All of the equipment for fabricating quantum dots is available in the wet chemistry laboratory. It includes a fume hood for safe usage of the toxic chemicals (such as H<sub>2</sub>S gas) used in their preparation. The laboratory is also used for other processes, such as purification of the quantum dots and is also shared with the Soft Condensed Matter group.



**FIGURE 2**  
Microsphere testing setup.

### Diagnostics Laboratory

The Diagnostics Laboratory is located in the Physics Annex and is equipped with a second ultra-fast femtosecond laser system, a confocal/multiphoton optical microscope as well as a fluorescence spectrometer. This laboratory is used for preliminary diagnostics and characterisation of quantum dot systems in bulk solutions and in polymer films.

### Microresonator Fabrication Laboratory

Also located in the Physics Annex is the Microresonator Fabrication Laboratory. This laboratory was completely refurbished in 2005/2006, and is now fully HEPA-filtered for cleanliness, and partitioned into six workspaces with independent lighting, air conditioning and light barriers. This space is shared with the Atom Optics group. A computer controlled CO<sub>2</sub> laser and computer controlled translation stages are available to fabricate microsphere resonators and fibre taper couplers. There is also an external cavity diode laser used for testing the microcavities. A room temperature spectroscopic fluorescence microscope with a liquid nitrogen cooled CCD camera detector is also available for testing various fluorophores and coupled fluorophore/microcavities and other structures.

### Other Facilities available to the Centre

A cleanroom laboratory shared with Dr Paul Meredith, who leads a soft condensed matter group within the Department of Physics, is also available for clean sample preparation (such as quantum dots in polymer films) and assembly of components of the single dot microscope system. This laboratory is a class 350 cleanroom and has a class 3.5 laminar flow hood, a spin coater and an absorption spectrophotometer.

The Centre also has access to other facilities and resources at the Centre for Biophotonics and Laser Science at the University of Queensland including the high power, tuneable pulsed laser systems of the Laser Diagnostics Laboratory and laser stabilisation equipment.

### Theoretical Groups

The theory groups at the University of Queensland aim to further develop the field of quantum information and develop optical quantum computation circuits for near term demonstration as well as long term applications. This group is served by office space and computer resources housed in the Parnell building.