**Physics Post Graduate Conference**

**Wednesday 23rd August 2018**

**McGougan Room**

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| **Time** | **Student** | **Primary Supervisor** |
| **09:15-09:30** | **Ryan McDermott**  | **Trager-Cowan** |
|  | **Title:** EBSD Analysis Applied to the Characterisation of AlGaN/GaN Heterostructures and Tungsten Carbide Hard Metals**Abstract:** From our Tungsten Carbide-Cobalt hard metal alloy orientated in both the [0001] and [11-20] directions, the ECCI images show distinct sub-grain structure in the crystallite. Using the EBSD data set we were able to map the intragranular misorientation of the grain to understand why these sub-grains are forming. The same technique is used in the AlGaN/GaN sample to verify faint cracks or misfits seen in the ECCI image running along the [10-10] direction. |  |
| **09:30 – 09:45** | **Timothy Frazer** | **McKenna** |
|  | **Title:** On the role of laser focal spot distribution on laser-solid interactions**Abstract:** The ability of high-power lasers to generate a source of high energy ions through interaction with a dense plasma has the potential to realise a variety of novel applications, such as laser-driven isotope production or proton oncology. Before such applications can be moved from the research laboratory into the public sphere however, a significant degree of control over laser-solid interactions must be demonstrated. In this talk, progress towards improving such control through manipulation of the laser focal spot is presented, and the implications for future work in the field are discussed.. |  |
| **09:45 – 10:00** | **Garviil Chatzitheodoridis** | **Ronald** |
|  | **Title:** Measuring Multiple Coulomb Scattering of Muons in Liquid Hydrogen**Abstract:** The Muon Ionisation Cooling Experiment (MICE) aims to demonstrate ionisation cooling as a viable option for producing low emittance muon beams, a requirement for muon colliders and neutrino factories. The method relies on momentum loss in all directions through the means of Coulomb ionising collisions with the atoms of an absorber material, and restoration of paraxial momentum by RF-accelerators. Collisions however also result in scattering. In this talk, the principles of ionisation cooling and MICE will be presented, along with an initial analysis of Multiple Coulomb Scattering (MCS) in the liquid hydrogen MICE absorber. |  |

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| **10:00– 10:15** | **Pavlos Bozinakis** | **Martin** |
|  | **Title**: Cathodoluminescence from cubic GaN, and semi-polar wurtzite GaN formed after GaN regrowth on nanotubes**Abstract:** Strong polarization and piezoelectric fields manifest in wurtzite GaN, due to the asymmetry of the crystal structure and the ionic character of the bonding in III-IV semiconductors. These inherent electric fields undermine the performance of GaN-based LEDs. The accumulation of polarization charge at the interfaces of MQWs (active region of LEDs) is minimized when wurtzite GaN is grown in semi-polar orientations. Devices which utilize non-polar orientations of wurtzite GaN or cubic GaN are polarization-free. Photoluminescence (PL) and cathodoluminescence (CL) spectroscopy are used to analyze the optical properties of cubic GaN and semi-polar wurtzite GaN materials. |  |
| **10:15 – 10:30** | **Gemma Quinn** | **Strain** |
|  | **Title:** Diamond Membrane Devices For Efficient Coupling to Vacancy Centres**Abstract:** This project aims to maximise the efficiency of the coupling between optical modes and diamond defect centres. Efficient coupling is crucial to the performance of diamond as a platform for networked quantum technologies. The design and build of a confocal microscope system is presented. This nanometric accuracy system for high-speed micro-photoluminescence mapping of the defect centres can find, characterise and spatially register the diamond emitters. Combined with an automated pick-and-place system using the same registration structures to locate the pre-defined emitters and transfer them with nanoscale accuracy to host cavities. Finally, these devices will be used to realise cavities with high efficiency coupling between nanoscale emitters and optical modes. |  |
| **Coffee Break 10:30-11:00** |
| **11:00 – 11:15** | **Lucas Inigo Gamiz** | **Jaroszynski** |
|  | **Title:** Streaming Instabilities in Laser Wakefield Acceleration**Abstract:** Recent laser wakefield acceleration simulations have demonstrated electrons to counterstream in the back of the bubble suggesting the presence of streaming instabilities which furthermore possibly influence self-injection. Dispersion relations for the two-stream and current filamentation instabilities have been derived where the two-stream instability dispersion instability effects. Analysis of the current filamentation instability is ongoing. Suitable initial setups for the instabilities are still being developed. |  |

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| **11:15-11:30** | **Pedro Alvez** | **Dawson** |
|  | **Title:** Chalcogenide and inorganic perovskite colloidal semiconductor nanocrystals for smart lighting**Abstract:** This work focuses on studying colloidal semiconductor nanocrystals to fabricate innovative light sources. The aim is to pioneer the application of these nanomaterials in smart lightning, which impact a broad spectrum of nowadays technologies, such as visible light communication, biomedical instrumentation, lighting and flexible display systems, sensing, monitoring, and the potential to assist quantum technologies. To achieve this, our approach combines the high-performance of blue or UV gallium-nitride optoelectronics with the attractive photoluminescence and manufacturing properties of colloidal quantum dots as colour converters or laser gain materials, to deliver novel formats of hybrid visible light sources. |  |
| **11:30-11:45** | **Gavin Kirwan** | **Hidding** |
|  | **Title:** Stabilisation and control of quality-boosted laser-plasma generated electron bunches using a plasma photocathode**Abstract:** Many laser-based acceleration techniques suffer from large shot-to-shot variations of outputted electron bunch parameters, stemming from the vulnerability of typical electron injection processes to jitter. The so-called "Trojan Horse" (TH) plasma photocathode method (PWFA) decouples the in-plasma bunch generation from the plasma wakefield excitation process and constitutes a beam brightness transformer capable of producing beams of beyond state-of-the-art emittance and brightness. Here, we show that a near nC-class laser-wakefield produced driver beam (LWFA) with substantial shot-to-shot variations in key parameters can be converted into stable, high quality witness beams using an attached TH accelerator stage. |  |
| **11:45-12:00** | **Georgia Adam** | **Cross** |
|  | **Title:** Modulated electron beam produced by a thermionic cathode electron gun for a particle accelerator**Abstract:** A Pierce-type thermionic cathode electron gun for a linear particle accelerator was designed and modelled using the FEM method (TRAK). The parameters for the simulation were identified using Rodney’s and Vaughan approach. Information about the Current, the Electric and Magnetic field along with the Beam Waist Radius were obtained. Moreover, the electron trajectory was calculated using certain features of TRAK. Investigation into a high duty cycle operation in the 1.5GHz to 3GHz range will be carried out using the same type of electron gun in the future years. |  |
| **Lunch 12:00-13:30** |

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| **13:30 – 13:45** | **Jack Smith** | **Strain** |
|  | **Title:** Towards a tuneable optical resonator in gallium nitride for coupling to diamond colour centre defects**Abstract:** Diamond is host to hundreds of optically active point defects, some of which have electron spin and optical properties that make them highly suited to applications in metrology, nano-scale magnetometry, and quantum information processing. However, in order to fully utilise these properties, it is necessary to couple the defects to tuneable optical cavity so that their usually weak emissions can be enhanced with the Purcell effect. Here we present work towards a hybrid diamond-on-GaN photonic architecture, beginning with the fabrication of GaN waveguides. GaN is a promising material because of its transparency, second order-nonlinearity, and similar refractive index to that of diamond. |  |
| **13:45-14:00** | **Laurence Nix** | **He** |
|  | **Title:** Design of a Gyroklystron Amplifier for Accelerator Applications**Abstract:** During electron bunch compression in accelerators, curvature is imposed on the bunch by the fundamental microwave radiation. Harmonic linearization methods can correct for this. A gyroklystron to be designed during this project will provide 48GHz microwaves to drive a harmonic linearizing structure as the 4th harmonic of a 12GHz X-band system. To date, work has focused on studying the functionality of the Magic simulation package and performing simulations to verify its accuracy in preparation for gyroklystron design. Study of a 36GHz 3rd harmonic model is in progress with the results forming the groundwork for the design of the 48GHz gyroklystron. |  |
| **14:15 – 14:30** | **Emma Le Francois** | **Dawson** |
|  | **Title:** High Speed, ultra-low photon flux imaging**Abstract:** The aim of this PhD project is to investigate the potential of spatio-temporal illumination sources further targeting their operation at ultra-low light levels in the single photon range. By using SPAD arrays, we will be able to create correlations of generated and detected photons in both space and time. This ability will allow the capture of images with extremely few photons, combined with sparse image processing techniques (compressive sensing). Research has been done on self-positioning and free space optical data transfer at the few photon level. Many applications such as low flux biological system, underwater data communication and navigation, quantum imaging and robotic control are related to this project. |  |
| **Coffee Break 14:30-15:00** |

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| **15:00-15:15** | **Andrzej Kornaszewski** | **Jaroszynski** |
|  | **Title:** Attosecond electron and radiation pulse generation in the ion channel free-electron laser, based on the laser wakefield accelerators**Abstract:** Attosecond electron bunches are useful as source of attosecond X-rays for ultrafast imaging of electron motion in biological and physical processes. Recent theoretical research has shown that the laser-plasma wakefield accelerator can generate attosecond duration electron bunches and that control of the plasma density ramp is required to achieve injection of attosecond electron bunches. Progress on studying several ways of achieving the required down-ramp density characteristic are presented. |  |
| **15:15-15:30** | **George Chappell** | **Hastie** |
|  | **Title:** Progress on II-VI semiconductor disk lasers to target green/yellow fundamental emission**Abstract:** II-VI semiconductor multi-quantum wells (MQWs) can be designed to have a radiative ground state transition with wavelength throughout the visible spectrum, and are proposed for use in the gain structures of novel green/yellow emitting semiconductor disk lasers (SDLs). As preliminary work, a blue diode-pumped *III-V* SDL was built, tested and found to have a maximum output power an order of magnitude higher than literature values for similar SDLs, with half the laser threshold. II-VI QW gain structures were designed for 580 nm emission and grown by collaborators at the City College of New York. The initial QW characterizations are presented. |  |
| **15:30-15:45** | **Joshua Robertson** | **Hurtado** |
|  | **Title:** Neuromorphic Photonic Systems of Lasers**Abstract:** In this talk we investigate various laser systems in an effort to realise their neuromorphic potential towards large scale brain-inspired processing networks. Photonic neuromorphic systems promise massive improvements to operation speeds by emulating the neural spiking signals of the brain at over 7 orders of magnitude faster than biological neurons. Semiconductor lasers such as vertical-cavity surface-emitting lasers (VCSELs) offer important neuronal attributes such as non-linear dynamics and excitability as well as laser scalability and O/C-band operation. By testing these devices we unveil their neuromorphic applications and their potential role in photonic neural processing networks. |  |