**Physics Post Graduate Conference**

**Wednesday 16th August 2017**

**Carnegie Room**

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| **Time** | **Student** | **Primary Supervisor** |
| **09:30 – 09:45** | **David Woodward** | **Eliasson** |
|  | **Title:** 3D full wave simulations of tokamak micro instability measurements through cross polarisation Doppler-backscattering  **Abstract:** Control over the pedestal region of the tokamak H-mode fusion plasmas is vital to the viability of a burning plasma in a fusion power plant, but gradient driven micro instabilities within the pedestal region degrade confinement through anomalous heat transport. Cross polarisation Doppler-backscattering (CP-DBS) is designed to measure instability driven magnetic perturbations and is a novel diagnostic technique however as the complex tokamak edge plasma lies beyond the validity limits of conventional scattering theory, the interpretation is non-trivial. Full wave 3D modelling will extend our understanding of the scattering process in this complex, anisotropic and inhomogeneous environment, validating and interpreting measurements.  . |  |
| **09:45 – 10:00** | **Badriah Alotabi** | **McNeil** |
|  | **Title:** Modelling a plasma accelerator driven FEL  **Abstract:** This work provides an introduction to the physics of coherent radiation sources using a relativistic electron beams in a Free Electron Laser (FEL), and makes a comparison with conventional laser sources. We will also look at the principles of plasma acceleration which can drive the FEL. In addition, we will explain the FEL principles, compare them to the conventional systems, in order to demonstrate why FEL can be considered as important sources of increasing number of applications owing to their wide range of tuneability and high brightness. |  |
| **10:00– 10:15** | **James Denholm** | **Hourahine** |
|  | **Title:** Expanding the scale of condensed phase models  **Abstract:** The size of systems that can be simulated is limited by the computational cost of modelling their behaviour and the requirements to numerically represent them. For suitable cases, Renormalization Group methods can be used to exponentially expand the available size of the system that can be studied. This is often used when studying scale free processes such as second order phase transitions. Here we instead aim to use Renormalization Group rescaling techniques to allow the same parameter space to be used to simulate systems on a larger scale. We initially apply this idea to the d = 2 Ising model. |  |

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| **10:15 – 10:30** | **Daljeet Gahle** | **O’Mullane** |
|  | **Title**: Neutral and Ion Transport Effects on Balmer Dδ/ε Ratio Technique for Electron Temperature Diagnosis  **Abstract:** SOLPS simulations of MAST-U with the novel Super-X divertor configurations predict target heat fluxes reduced by a factor of 5 in comparison to the conventional divertor.1 Experimentally the target and divertor chamber will be studied using a range of diagnostics: IR camera, Thompson scattering, Langmuir probes and spectroscopy.2, 3 This presentation describes the technique of inferring electron temperature from synthetic high-n Balmer line ratios and the associated errors due to plasma transport and sight-line integrated effects. These ratios are sensitive to the electron temperature region of detachment (< 1 eV) and can compensate the difficulty of using Langmuir probes in detached plasmas.  References   1. E. Havlickova et al., Plasma Phys. Control. Fusion **57** (2015) 115001 2. J.T. Terry and M.L. Reinke, Plasma Phys. Control. Fusion **59** (2017) 044004 3. K. Verhaegh et al., Nucl. Mater. Ener. (2017) In Press |  |
| **Coffee Break 10:30-11:00** | | |
| **11:00 – 11:15** | **Lukasz Dziechciarczyk** | **Kemp** |
|  | **Title:** Novel use of diamond in lasers  **Abstract:** Diamond is a very attractive laser material due to its thermal conductivity, very wide energy bandgap and high Raman shift. Literature shows advances in very highly efficient and high power Raman diamond lasers operating at the range of wavelengths. This work focuses on Raman lasers operating at the eye-safe wavelength of 1.5 um 2nd Stokes converted from 1 um. Another approach to a diamond laser is making use of the nitrogen related colour centers incorporated in the diamond’s lattice. Gain measurements and photodynamic effects are investigated to understand intrinsic processes in diamond. |  |
| **11:15-11:30** | **Zoe Davidson** | **Gray** |
|  | **Title:** Temporally Resolved Optical Probing of Picosecond Laser Propagation in Underdense Plasmas  **Abstract:** A challenge for many researchers investigating intense laser-plasma interactions experimentally is in making measurements of the plasma dynamics, as they occur on timescales as short as femtoseconds. In order to address this, an experiment was conducted on the Vulcan laser system where we successfully implemented a temporally resolving optical probe which enabled measurements of the laser propagation dynamics in underdense plasma in a single shot. We will describe the development of this novel technique and demonstrate the dynamics of self-focusing and filamentation in an underdense plasma. These insights are important for the development of compact plasma based particle accelerators.  . |  |

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| **11:30-11:45** | **Matat Jablon** | **Trager-Cowan** |
|  | **Title:** Electron Backscattered diffraction (EBSD) and Electron Channelling Contrast Imaging (ECCI) of tungsten carbide  **Abstract:** This study examines the feasibility of using Electron Backscattered Diffraction (EBSD), a fast and minimally destructive technique, as an alternative to Transmission Electron Microscopy and X-Ray Diffraction for examining dislocations in tungsten carbide, a hardmetal. Samples were analysed using Electron channelling contrast imaging (ECCI) in a scanning electron microscope (SEM) to identify dislocations. These images were then compared to a variety of EBSD maps. It was found that by correlating these two techniques, previously unseen dislocation loops in indented WC Cu samples were identified. The implications of these two techniques for understanding wear in WC hardmetals are discussed below. |  |
| **Lunch 12:00-13:30** | | |
| **13:30-13:45** | **Andrew Sutherland** | **Hidding** |
|  | **Title:** Spatial alignment and temporal synchronisation of relativistic electron and laser beams  **Abstract:** The interaction between either or both high-power lasers and relativistic electron beams has become commonplace in state-of-the-art particle accelerators and, as such, requires scrupulous coordination. Presented is a new, minimally-invasive, plasma-based technique capable of exceptional combined spatiotemporal accuracy; discussion is supported by both experimental and analytical investigations as well as 3D PIC simulation. The dynamics of the scheme center on the atomic process of impact ionisation contained by localised plasma oscillations and result in detectable recombination radiation sensitive to both the temporal synchronisation and spatial alignment of the interacting beams. |  |
| **13:45 – 14:00** | **Georgios Arvanitakis** | **Dawson i** |
|  | **Title:** Visible Light Communications for Underwater Applications  **Abstract:** Underwater Wireless Communications are of great interest for industrial, scientific and military applications. However, radio frequency (RF) signals cannot travel any meaningful distance in sea water, while data rates from acoustic communication are very limited. By using LEDs or/and lasers operating in wavelengths between 400-550nm, where water exhibits a window of reduced absorption in the visible spectrum, it is possible to transmit data at high data rates (~Mb/s-Gb/s) for mid-range distances (<200m). Here, we will discuss the importance of implementing Visible Light Communication in underwater environments, the current state of the art, the challenges faced and some preliminary lab-based results. |  |

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| **14:00-14:15** | **Ahmad Habib** | **Hidding** |
|  | **Title:** Ultra-bright electron beams for the next generation FELs  **Abstract:** Plasma-based wakefield accelerators hold great prospects to shrink the footprint of the next generation free-electron lasers. However, a FEL requires high brightness electron beams. The plasma photocathode mechanism (aka Trojan Horse) enables ultrahigh 5D-brightness electron beams with nm-level normalized emittance and kA peak currents. Nevertheless, the GV/m-accelerating gradient leads to large energy chirp and spread. This energy chirp is a major showstopper towards compact FELs. A recently developed technique allows to compensate the energy chirp completely. Ultrahigh 5D-brightness combined with minimized energy spread opens a path towards witness beams with unprecedented ultrahigh 6D-brightness.  [1] Manahan, G.G. and Habib, A.F.et al.Nat.Commun.8,15705(2017) |  |
| **14:15 – 14:30** | **Lucia Spasevski** | **Martin** |
|  | **Title:** Wide bandgap AlGaN semiconductors: doping and polarity  **Abstract:** Two sets of wide bandgap AlxGa1-xN:Si samples with AlN content ranging from 60% up to 85%, grown in a polar and semipolar direction were examined in this study. The samples were produced at the Tyndall Institute by metalorganic vapour phase epitaxy. Different scanning electron microscope techniques were employed to investigate the doping, and the impact of polarity. Wavelength dispersive X-ray spectroscopy (WDX) and cathodoluminescence (CL) hyperspectral imaging are used to correlate the composition and optical properties. Changes introduced by the Si doping will be considered and challenges for doping of high AlN-content AlGaN will be discussed. |  |
| **Coffee Break 14:30-15:00** | | |
| **15:00-15:15** | **Daniel Ullmann** | **Hidding** |
|  | **Title:** Optical density downramp injection for plasma wakefield accelerators  **Abstract:** The application of the first all-optical density downramp as flexible charge injector scheme in the context of under-dense photocathode plasma accelerators, e.g. a plasma wakefield accelerator, is investigated. Therefore, dedicated 3D particle-in-cell simulations and experimental studies at the FACET test facility at SLAC were carried out resulting in superior witness beam quality as compared to hydrodynamic approaches undertaken before. Special emphasis is laid on what is believed to be a new regime of this method, namely igniting a column of plasma prior to the electron bunch arrival. It is not only the accessibility of the optical plasma torch’s density distribution due to the control of the lasers parameters, but also the simplicity of the setup itself which makes this method a great tool for plasma wakefield accelerators. |  |

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| **15:15-15:30** | **Mark Stonehouse** | **Dawson** |
|  | **Title:** Structured Illumination for Visible Light Communications  **Abstract:** As visible light communications become of greater interest for commercial applications, the need for suitable light sources also increases. For this, GaN µLED’s are exceptional candidates due to their high modulation rates and optical output power.    Through the use of measurement techniques, the performance and device characteristics can be obtained, thus allowing for greater understanding of the device and how suitable it is for data transmission. Along with this, the driving electronics behind the device can allow for greater control over the device performance and allow for additional applications to be realized.' |  |