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GFA and SwissFEL Accelerator Seminar

Compact accelerators and radiation sources based on relativistic plasma waves produced by intense laser beams

Tuesday, 14 June 2011, 16.00 h, WBGB/019

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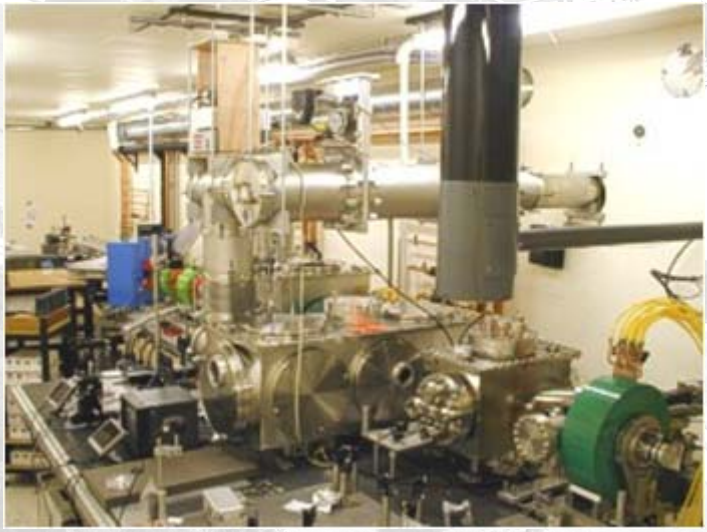
Focussing an intense and ultra-short duration laser pulse into plasma can produce high amplitude plasma waves. The huge electrostatic forces of these density waves, which follow in the wake of the laser pulse, can be used to accelerate charge participles with gradients that are 3-4 orders of magnitude higher than available in conventional accelerators, shrinking a 1 GeV accelerator from 100's of metres to 1 cm. We will show that these accelerators can now produce electron beams with 10's to 100's of picoCoulombs of charge, energy spreads much less than 1% and emittances of the order of 1 π mm-mrad. Furthermore, we also present measurements that show that the electron bunch length is of the order of 1 fs, determined by the accelerating "structure" of the plasma bubble. This implies a peak current in excess of 1 kA. These parameters make the laser driven plasma wakefield accelerator (LWFA) a suitable ultra-compact candidate for driving a free-electron laser. However, the plasma bubble also has huge transverse forces, which allows the structure to act as a very strong wiggler and betatron radiator, which gives rise to the emission of x-ray photons with energies stretching to several MeV. In this talk, we will present the results of a 10 year campaign to develop laser plasma wakefield accelerators at the University of Strathclyde towards producing a compact free-electron laser. This programme of research, the Advanced Laser Plasma High-energy Accelerators towards X-rays, ALPHA-X, has involved a consortium of scientists and has produced several of the major results in the field, such as the first demonstration of controlled acceleration in a LWFA, the first demonstration of acceleration to 1 GeV, the first demonstration of a compact synchrotron source based on a LWFA, the first demonstration of beams with 1 pi mm mrad emittances and energy spread of 0.3%, and the production of gamma rays from a LWFA betatron radiator. The experimental measurements from a campaign to observe coherent radiation from a LWFA driven FEL will be presented.



ALPHA-X beam-line at Strathclyde

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