SURFING A WAVE TO COMPACT LASER TECHNOLOGY

December 10 2007

New laser-based technology could be opened up to health services by collaborative research, led by scientists at the University of Strathclyde, which aims to make diagnostic equipment much smaller and less expensive.

The research, also involving teams at the Friedrich-Schiller-Universität, Jena, Germany, and Stellenbosch University in South Africa, is exploring ways to make powerful devices accessible to hospitals and medical research centres in a way which has not been possible before.

The machines, synchrotrons and free-electron lasers, can be used in lung and breast screening but are currently huge and expensive, covering areas equivalent to several football pitches and costing hundreds of millions of pounds in construction alone.

Governments are prepared to meet the costs of this equipment but the new research could help to reduce their cost dramatically and to shrink their size so that they could fit in a room, in the same way that computers, mobile phones and synthesisers have become much more compact and affordable.

A huge range of applications across the scientific spectrum could be opened up by the new X-ray techniques used in the devices. These could include improved cancer tumour detection, high-contrast x-ray imaging and a form of ultrafast photography which could enable scientists to capture events which happen too quickly for the human eye to discern, such as a chemical bond breaking in a cell protein.

Until now, light sources have been driven by accelerators based on microwave cavities but this ‘conventional’ technology is not the only way to accelerate particles. Intense laser pulses can be fired into plasma to create a wake and its huge electric fields can be harnessed to drive electrons to very high energies extremely rapidly. The wake the laser pulse generates is similar to waves trailing behind a moving boat and small bunches of electrons can gather energy from the wave, in much the same way as a surfer would catch a wave and use it to move forward.

This ‘wake-field’ technique could make devices far smaller, potentially reduced to about the size of a pool table, at a fraction of the current costs.

As a first step towards the project’s goal, experiments devised by Strathclyde and carried out in Jena, in collaboration with teams from Jena and Stellenbosch, have led to a breakthrough in light pulse production driven by a laser-plasma accelerator. This work is published in the Nature Physics journal this week.

Professor Dino Jaroszynski, Director of the TOPS (Electron and Terahertz to Optical Pulse Source) laboratory at Strathclyde, said: “Table-top plasma wake-field accelerators herald a revolution in the way science is done, by making available compact sources at a fraction of the cost of large facilities.

“This technology reduces the size of these light sources by 1,000, and gives you a powerful scientific tool for the price of a laser.”

The project to develop compact light sources is part of the Strathclyde-led ALPHA-X (Advanced Laser Plasma High-energy Accelerators towards X-rays) programme, which has been supported by the Research Councils UK Basic Technology programme. The experimental work at Jena has been supported by Laserlab Europe.

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NOTES FOR EDITORS:

The project for developing compact laser-based radiation sources for industrial and academic research is led by the University of Strathclyde. The developments will provide knowledge exchange both directly, by providing Scottish-based facilities, and through the development and commercialization of the sources, which could be installed in university-sized institutions