Modern X-ray technology

Another look inside

Jul 30th 2009
From The Economist print edition

The way medical X-rays are generated is over 100 years old. Time to update it

Kobal Collection

WHEN Wilhelm Röntgen, a German physicist, was carrying out some experiments in 1895, he stumbled across a type of radiation which he labelled simply as X, because he did not know what it was. His X-rays did not remain unknown for long, however. Doctors seized on them to look inside living bodies and, later, engineers used them to examine the interiors of mechanical components. What has not changed much since Röntgen's day, though, is how they are made.

Most electronic devices have moved into the era of silicon chips and other solid-state technology. Not X-rays. The machines used to generate them still rely resolutely on vacuum tubes. But that will change shortly if Otto Zhou of the University of North Carolina has his way. Dr Zhou and his colleagues are bringing X-radiography into the world of modern electronics. In doing so they hope to create X-ray machines that are smaller, simpler and able to produce more detailed pictures. These could be used to enhance security screening at airports, to allow engineers to check the structure of materials more easily and, especially, to enhance medical images in a way that would improve cancer therapy.

At the moment, X-rays are produced by heating a negatively charged metal filament to a temperature of around 1,000ºC inside a vacuum tube. The combination of heat and charge releases electrons, which accelerate through the tube and strike a positively charged electrode at the other end. The rays are created by the energy of the impact. X-ray machines of this type have progressed over the years (the computed tomography, or CT, scanners used in hospitals collect hundreds of X-ray images taken from different angles and convert them into a three-dimensional picture of a patient's internal anatomy). But they are still, fundamentally, a century old.

Fields of endeavour

Dr Zhou's method, by contrast, employs a process called electron-field emission. This dispenses with the heat. Also, instead of having a single metal filament release the electrons, it relies on myriad carbon nanotubes to do the same thing. The result is a compact source of X-rays that can be controlled with great precision.

Such sources can then be built into an array, each element of which is programmed to fire whenever required. That will allow for more accurate CT scans. Existing scanners usually have but a single X-ray tube. This is rotated around the patient, taking pictures as it goes. Though the rotation takes only a few seconds, the overall image will be blurred if the patient moves. An array of field-emission devices, however, will take their exposures simultaneously, so the resulting image should always be pin sharp.

Dr Zhou has set up a joint venture with Siemens, a German company that builds CT scanners, to develop his technology for diagnostic imaging. A prototype machine, which has 52 field-emission X-ray sources arranged in a ring, is due to begin trials later this year. It was described to the annual meeting of the American Association of Physicists in Medicine, held this week in Anaheim, California. The new machine will be attached to a linear accelerator, a device used for radiation therapy, to allow simultaneous imaging and treatment, according to Sha Chang, who will lead the team that tests it.

Conventional CT scans are used to work out the shape of the place where a dose of radiation needs to be concentrated in order to attack a tumour without damaging nearby healthy tissue. But the scan and the treatment cannot usually be done at the same time, because they interfere with each other. There are, however, no interference problems with field-emission X-ray sources, so these can be used to take high-resolution pictures while treatment is proceeding. This means those administering the treatment will know with precision when to continue and when to stop.

And the precision of the new technology is remarkable. Dr Zhou's colleagues have, for example, built tiny scanners that can X-ray a mouse's heart and lungs by taking a series of exposures at exactly the same point in the heartbeat. They are even trying to produce beams so precise that they can be aimed at individual cells. That would allow a tumour to be destroyed cell by cell—probably not a practical anti-cancer therapy, but something which would allow researchers to learn more about how cancer cells interact with one another, and thus reveal their vulnerabilities in a way that was previously unimaginable.

Copyright © 2009 The Economist Newspaper and The Economist Group. All rights reserved.