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LARGE HADRON COLLIDER
10 years and counting

WISP search gains momentum

Elephants in the gamma-ray sky

IceCube tracks cosmic neutrino source

IMAGING

First human 3D X-ray in colour

New-Zealand company MARS Bioimaging Ltd has used technology developed at CERN to perform the first colour 3D X-ray of a human body, offering more accurate medical diagnoses. Father and son researchers Phil and Anthony Butler from Canterbury and Otago universities in New Zealand spent a decade building their product using Medipix read-out chips, which were initially developed to address the needs of particle tracking in experiments at the Large Hadron Collider.

The CMOS-based Medipix read-out chip works like a camera, detecting and counting each individual particle hitting the pixels when its shutter is open. The resulting high-resolution, high-contrast images make it unique for medical-imaging applications. Successive generations of chips have been developed during the past 20 years with many applications outside high-energy physics. The latest, Medipix3, is the third generation of the technology, developed by a collaboration of more than 20 research institutes – including the University of Canterbury.

MARS Bioimaging Ltd was established in 2007 to commercialise Medipix3 technology. The firm's product combines spectroscopic information generated by a Medipix3-enabled X-ray detector with powerful algorithms to generate 3D images. The colours represent different energy levels of the X-ray photons as recorded by the detector, hence identifying different components of body parts such as fat, water, calcium and disease markers.

MARS Bioimaging Ltd

A 3D colour image of a wrist with a watch on, showing part of the finger bones in white and soft tissue in red.

So far, researchers have been using a small version of the MARS scanner to study cancer, bone and joint health, and vascular diseases that cause heart attacks and strokes. In the coming months, however, orthopaedic and rheumatology patients in New Zealand will be scanned by the new apparatus in a world-first clinical trial. "In all of these studies, promising early results suggest that when spectral imaging is routinely used in clinics it will enable more accurate diagnosis and personalisation of treatment," said Anthony Butler.

Weighing options for better ion-therapy systems

Sixty experts from all over the world met on 19–21 June at the European Scientific Institute (ESI) in Archamps, France, to explore future medical accelerators for treating cancer with ions. The workshop, jointly organised by CERN, ESI and GSI in Darmstadt, Germany, focused on designs for a next-generation medical and research facility for ion therapy in Europe. The event was the second in the series "Ions for cancer therapy, space research and material science", which was initiated by GSI to highlight the increasingly important interface between physics and its applications.

Particle therapy, also known as hadron therapy, is an advanced form of radiotherapy that uses protons, carbon and other ions to precisely target tumour cells while sparing the surrounding healthy tissues. While commercial proton-therapy equipment is now available, there are only a few bespoke facilities providing treatment with heavier ions such as carbon. Ions are effective with tumours that are resistant to photon irradiation, and their action on DNA is fundamentally different, resulting in the release of more complex DNA fragments from destroyed cells. These, in turn, could also trigger the immune system to attack unirradiated metastases across the body, particularly if combined with the right immune-modulating agents. However, the cost, complexity and size of ion-therapy facilities are hampering the widespread adoption of this treatment modality (see *CERN Courier* January 2018 p25 and p32).

Nymus3D

A virtual particle therapy centre.

The availability of technically still-challenging gantry systems for ions is one of the elements that would lead to faster, more efficient and flexible therapy systems for the routine treatment of "big killers" such as lung cancer. Two approaches for a next-generation therapy system were discussed at the Archamps event: one, relying on proven delivery schemes, could be based on a superconducting synchrotron; another involves novel approaches such as linacs with a high pulse-repetition rate.

Compared to the situation for state-of-the-art photon therapy, where 3D imaging is seamlessly integrated in virtually every setup to guide the treatment, new options for image-guided therapy must be accommodated into ion-therapy systems. As pointed out at the conference, the pinnacle of this development could be fast, adaptive particle therapy combined with online magnetic resonance imaging and monitoring of prompt emissions to assess the particle-beam range. This would finally enable the precise elimination of tumours in complex anatomical locations or moving organs.

During the closing discussion session, it was made clear that the community is eager to establish a dedicated collaboration resulting in a proposal to the European Commission for a new European facility for ion therapy and research. Discussions about a possible R&D programme raised the need to compare the linac- and synchrotron-based designs, for example, and a dedicated meeting is proposed in the autumn to define how best to proceed.

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