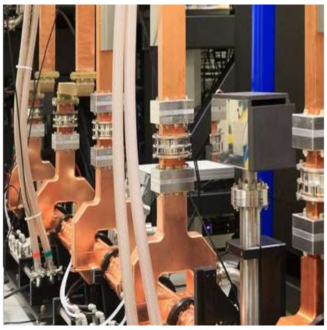
Better CT Scans Improve Disease Insight



Compact light source (CLS), a commercial x-ray source developed only recently, enables computer tomography (CT) scans that reveal more detail than routine scans performed at hospitals today, a new study has shown. The new x-ray technology could soon be used in preclinical studies and help researchers better understand cancer and other diseases.

"Our work demonstrates that we can achieve better results with the compact light source," says Franz Pfeiffer, professor for biomedical physics of the Technical University of Munich in Germany, who led the new study published in *PNAS*. "The CLS allows us to do multimodal tomography scans — a more advanced approach to X-ray imaging."

Conventional CT scans are very detailed when it comes to bones and other dense body parts that strongly absorb x-rays. However, the technique does not do as well with imaging of "soft tissues" such as organs, which are more transparent to x-rays.

According to researchers, the amount of detail in a CT scan depends on the difference in brightness ("contrast"), which makes one type of tissue distinguishable from another. The absorption of x-rays is only one way to create contrast. Alternatively, contrast can be generated from differences in how tissues change the direction of incoming x-rays, either through bending or scattering X-ray light. These methods are known as phase-contrast and dark-field CT, respectively.

"Organs and other soft tissues don't have a large absorption contrast, but they become visible in phase-contrast tomography," explains Elena Eggl, a researcher at TUM and the study's lead author. "The dark-field method, on the other hand, is particularly sensitive to structures like vertebrae and the lung's alveoli."

These methods, however, require x-ray light with a well-defined wavelength aligned in a particular way — properties that standard CT scanners in hospitals do not deliver sufficiently.

For high-quality phase-contrast and dark-field imaging, researchers can use synchrotrons -- dedicated facilities where electrons run laps in football-stadium-sized storage rings to produce the desired radiation. Since these are machines are large and expensive, synchrotrons cannot simply be implemented at every research institute and clinic.

The CLS serves as a miniature version of a synchrotron that produces suitable x-rays by colliding laser light with electrons circulating in a desk-sized storage ring. With its small footprint and lower cost, the CLS could be operated in almost any location.

Prof. Pfeiffer's study reported the first "multimodal" CT scan with the CLS, using the three imaging modes (absorption, phase contrast and dark field) simultaneously. The team generated cross-section images of an infant mouse by using a total of 361 two-dimensional x-ray images of the animal taken from different directions.

"The absorption images only show bones and air-filled organs," says Eggl. "However, the phase-contrast and dark-field images reveal much more detail, showing different organs such as the heart and liver. We can even distinguish different types of fat tissue, which is not possible with absorption-based CT scans."

The success of this research, which was done on a CLS prototype, has led to the commissioning of the first commercial device.

The researchers also plan to use the CLS for phase-contrast and dark-field CT in preclinical studies, an approach that could help visualise cancer. According to Eggl, "We work closely together with two clinics to study tumours. One of our plans is to image breast tissue samples and also entire breasts after mastectomy to better understand the clinical picture of breast cancer."

Source: SLAC National Accelerator Laboratory
Image credit: Klaus Achterhold/TUM

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