'T-rays' to shed light on nuclear fusion

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In the race to secure clean energy in the future, Lancaster University Engineers are reinventing a piece of technology which so far has only been used in labs to diagnose cancer, detect explosives, and even analyse grand artistic masterpieces.

Working with world-leaders in their field, researchers will employ modern microfabrication processes to bring vacuum tubes - born at the beginning of the electronics era - up to Terahertz frequencies (hundreds of GHz), which they hope will bring about a breakthrough in the understanding of the mechanisms of nuclear fusion.

Nuclear fusion, considered to be a potential future option for a clean and inexhaustible energy supply, requires extremely high temperatures (more than 100 million°C) for the fuel, a hot plasma that has to be confined by a proper magnetic field. Unfortunately, this plasma can suffer from undesired turbulence that, if too intense, can block the fusion reaction, resulting in energy loss or, in a worst case scenario, melt the metal wall of the reactor. Only Terahertz radiation can provide an accurate insight into plasma behaviour without perturbing this extremely delicate material.

Terahertz waves (or T-rays) have unique properties as they can penetrate many materials without damaging them. In recent years, Terahertz radiation has been put to use in fields as diverse as cancer early diagnosis, airport security and fine art restoration. But until now, Terahertz technology has been largely confined to the laboratory because of the lack of compact and powerful sources.

Funded by the Engineering and Physical Sciences Research Council, the £450,000 research project brings together an international team of researchers including the University of Leeds, the University of California Davis, US, and the Beijing Vacuum Electronics Research Institute, China.

Once built, the device will be the core of the plasma diagnostic, led by Professor Neville C. Luhmann, University of California Davis, US, to be installed at the National Spherical Torus Experiment (NSTX), a nuclear fusion test facility at Princeton US.

Lancaster University's Professor Claudio Paoloni said: "Considering that 60 kg of fuel for nuclear fusion can produce an energy equivalent to 250,000 tons of oil, it is a very important technology for the future provision of clean, reliable energy. However, to do this efficiently and safely, a reliable new way of monitoring plasma turbulence is needed.

"The device developed by this project will result in a novel plasma diagnostic system which is fundamental for the future development of nuclear fusion reactors, potentially leading to a breakthrough in nuclear fusion techniques.

"Ultimately, by developing a compact, affordable and powerful Terahertz vacuum electron device we will demonstrate that it can have a formidable impact at a commercial level. By taking Terahertz technology out of the laboratory and into the real world, we will finally enable many other fundamental applications to take a step forward in fields from healthcare and security to food analysis and even art."

Provided by Lancaster University