



FLIR thermal imaging camera helps prevent accidents in the laser room

Operating lasers can be dangerous, as some lasers can produce invisible infrared beams that can potentially harm researchers or start a fire. In the laser room of the University of Glasgow researchers use a FLIR i7 thermal imaging camera to ensure their own safety when they work with their terahertz laser research setup.

"The laser systems in our lab generate invisible high power infrared laser radiation", explains Yong Ma, Research Assistant at the Microsystem Technology Group, School of Engineering, at the University of Glasgow. "I probably do not need to explain that these invisible beams might be dangerous to the researchers. We wear goggles to prevent damage to our eyes, but if the invisible beam would hit our clothing or skin it might cause serious accidents. That's why we need safety equipment in order to spot these invisible beams, which is where the FLIR thermal imaging camera comes into play."

Ensuring researcher safety

"Before I start to work with our terahertz laser research setup I always scan the entire area with the FLIR i7 thermal imaging camera to detect infrared laser beams that are projected in the wrong direction, to make sure that it

is safe", Ma explains. "But that is not the only application I use it for. I also use it to monitor overheating electrical equipment and gas valves, tubes and tanks."

The invisible terahertz laser beam is produced in two steps, Ma explains. "The first step is the CO₂ mid-infrared laser system. This produces an infrared laser beam of 50 Watt at a wavelength frequency of 10.6 micrometer. This regular infrared laser beam is transformed into a terahertz laser beam by channeling it through pressured methanol. The resulting terahertz laser has a power of 150 milli-watt and a wavelength frequency of 119 micrometer."

Visualizing invisible infrared beams

The resulting terahertz infrared laser beam is considered to be a Class IV laser with regard to safety procedures, which requires the lab



The heat from invisible infrared laser beams clearly shows up in the thermal images.



Using the FLIR i7 thermal imaging camera Ma aligns the optics in his research setup.



operator to wear safety goggles. Being able to visualize the invisible laser is therefore very important to ensure the safety of the setup. "We use the FLIR i7 thermal imaging camera for this purpose because it has a good balance in affordability and performance," says Ma. "The microbolometer detector of the FLIR i7 thermal imaging camera is not especially designed to detect infrared radiation in the terahertz wavelength frequency. The terahertz laser produces infrared beams at a wavelength frequency of 119 micrometer while the FLIR i7 thermal imaging camera has a spectral range of 7.5 to 13 micrometer."

"This means that the FLIR i7 thermal imaging camera does not detect the beam directly", Ma continues. "But if the infrared beam produced by the terahertz laser hits an object or surface it will cause it to heat up. This rise in temperature can quite easily be detected using the FLIR i7 thermal imaging camera. It is that principle that I use to make sure there are no stray infrared beams leaking from the setup."

Aligning optical equipment

To channel the invisible terahertz infrared laser beam towards specific targets Ma uses a variety of different infrared lenses and mirrors. But aiming an invisible laser beam can be challenging. That is another reason for using the FLIR i7 thermal imaging camera, Ma explains. "Before I had the FLIR i7 thermal imaging camera I used thermal paper, which discolors when it becomes warm, to detect the terahertz infrared beam and align the optical components, but this method is inaccurate and slow. With the FLIR i7 thermal imaging camera I can much more accurately detect the infrared beam and align the optical components of the setup."

The aim of the research project is to develop a terahertz imaging system which can be used for a multitude of applications,



Research assistant Yong Ma demonstrates the use of the FLIR i7 thermal imaging camera in the laser room.



By visualizing the heat from invisible infrared laser beams the FLIR i7 helps to guarantee the researchers' safety.

according to Ma. "The terahertz region of the electromagnetic spectrum sits between the microwave and the mid infrared region, which is usually defined by the frequency range of 0.1 – 10 THz. It is one of the least explored ranges of the electromagnetic spectrum, but it shows great potential for applications in the fields of science, security and medicine."

Safer than x-ray or ultrasound

"Terahertz infrared radiation penetrates farther in most materials than other types of infrared radiation", Ma continues. "It can penetrate many dielectric materials, such as clothes, paper boxes, plastic bags and even human tissue. But even though it penetrates deeply in the human body it is a non-ionizing type of radiation and is therefore safer to use in medical scans than conventional methods such as x-ray and ultrasound."

Ma thinks there is a multitude of possible applications. "The non-invasive nature of terahertz radiation makes it ideal for medical applications, but it can also be applied in the fields of spectroscopic analysis, security and high speed communications. Terahertz spectroscopy could provide novel information in chemistry and biochemistry, while medical scans using terahertz infrared imaging can be used to non-invasively identify lesion location of certain types of disease, such as skin cancer."

Finding explosives or drugs

"It might also be used to enhance security checks at airports", Ma says. "Terahertz imaging can be used to see hidden objects under clothes, paper boxes and plastics bags, such

as explosives or weapons. Many chemical or biological materials such as explosives or illegal drugs have characteristic fingerprint spectral absorption in the terahertz region. Therefore we can identify explosives or illegal drugs with help of their THz spectral fingerprints."

In modern communication systems terahertz radiation might also be useful, Ma claims. "Terahertz communications systems have the potential to provide a much broader bandwidth, more directional transmission, which is useful to reduce the size of the antenna, and more secure information communication due to the short transmission distance."

At the moment terahertz imaging is a relatively unexplored part of the electromagnetic spectrum. "The terahertz research at our lab is focused on fabrication of terahertz optical components and on system integration. We aim to deliver a terahertz imaging system with improved performance and reduced cost for use in medical and security applications. The FLIR i7 thermal imaging camera helps us to do that safely and accurately."

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