MUSIS

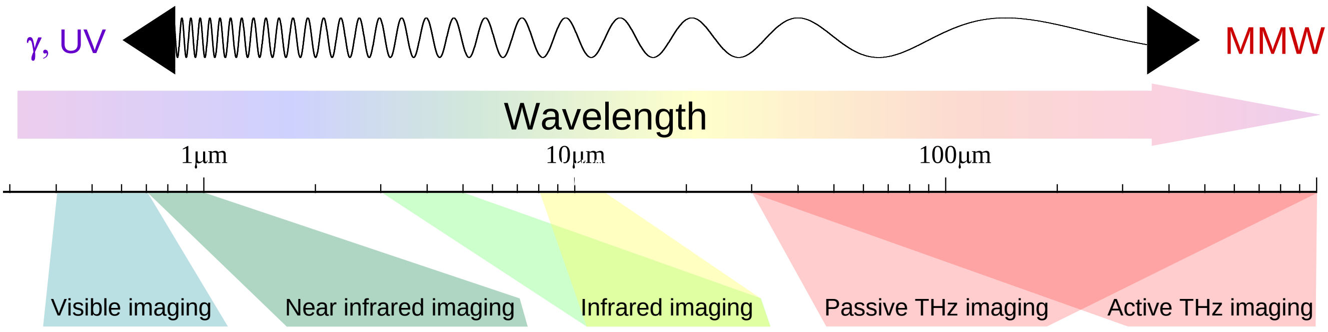
Multispectral terahertz, infrared, visible imaging and spectroscopy

A specifically targeted research project funded by the European Commission under FP7

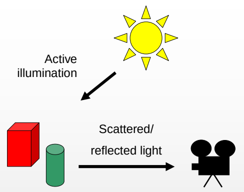
MUSIS is a specific targeted research project (STREP), which started in May 2008, co-funded by the European Commission under the strategic objective “Photonic Components and Subsystems” of the framework 7 ICT program. MUSIS will develop photonic components for multispectral imaging applications in security, safety, medical, and production technology.

Background and basics

Imaging in different parts of the electromagnetic spectrum

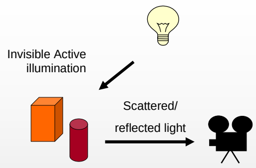


Visible imaging



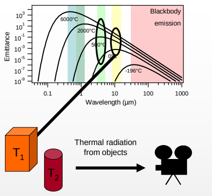
Imaging in the visible spectral range uses light coming from a light source (sun, light bulb, etc.) which is reflected or diffused by objects. The light coming from these objects is then imaged by an optical system onto a sensor and sent to a display unit (monitor, television, print supply). Images in the visible light domain are easy to handle since the human eye and brain are used interpretate them.

Near infrared imaging



Near infrared imagig uses light with a wavelength from 0.7 to 1.1 μm. It works in a similar way to visible imaging: a source shines on the objects and the reflected or diffused light is detected. Near infrared light is not visible to the human eye. In general it is used for surveillance in CCTV systems at night conditions such that a potential intruder does not get aware of the surveillance.

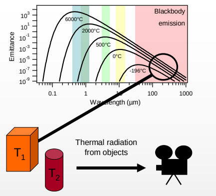
Infrared imaging



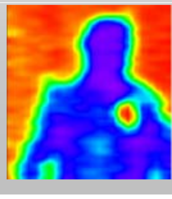
All bodies radiate light related to the energy they contain due to the fact that they have a certain temperature. This light is – for objects around room temperature – mainly in the infrared band around 10 μm. The hotter an object the more light it emits. Using special optical systems and an infrared sensor, pictures of the different temperatures in a scene can be obtained and imaged on a monitor.

Image from ULIS-IR.

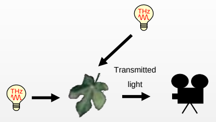
Passive THz imaging



Passive terahertz imaging works in a similar way as infrared imaging using the blackbody radiation of the detected object. The blackbody radiation is much weaker at these frequencies than at infrared frequencies and the image sensitivity of such systems is in general inferior to the sensitivity of an IR system. The strength of terahertz imaging is that it permits to see hidden objects under fabrics as shown on the image.



Active THz imaging



Active terahertz imaging uses instead of the inherent blackbody radiation of the objects themselves a terahertz source. The source shines onto a sample and the terahertz radiation is reflected or diffused (a) or it shines through the sample and the transmitted light is recorded (b). In addition to getting an image of samples using tunable or broadband terahertz sources, spatially resolved terahertz spectra can be obtained.

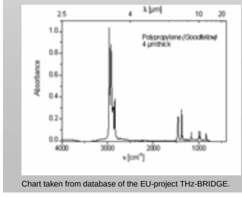
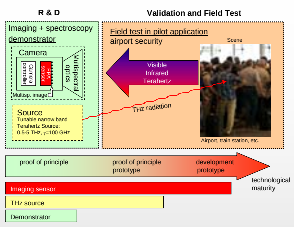


Chart taken from database of the EU-project THz-BRIDGE.

Challenges



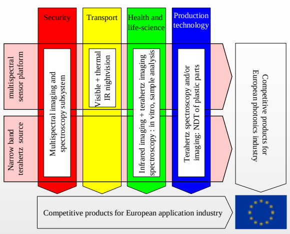
Key information on the MUSIS project:

- MUSIS will develop photonic components for multispectral imaging applications in security, safety, medical, and production technology.
- Benefit by combining the advantages of different spectral detection bands in a unique system.
- Pilot application will be in airport security with use of classic CCTV detection combined with scanning persons for hidden objects as weapons and explosives (terahertz part) and body temperature detection for detecting infectious diseases or excitement (IR part)

MUSIS will address the following challenges:

- Development of a monolithic multispectral terahertz, infrared, and visible focal plane array detector based on a CMOS substrate working at room-temperature. This objective is the most challenging of the project since it includes two world premieres: on the one hand to date no two-dimensional terahertz detection array exists and a tri spectral monolithic detector has never been demonstrated before.
- Development of a room temperature high power, small band tunable terahertz source. The terahertz source to be developed has a very small band and is tunable over a wide range of frequencies from 0.5-5 THz.
- Design of a subsystem capable of doing passive visible, infrared, and terahertz imaging as well as active stand off terahertz spectroscopy. To date no such system exists in the market or in research labs.

Applications



The following new photonics based applications are conceivable using the components developed during the project:

- Security technology:
  - Security check in at airports
  - Monitoring in railway or underground stations
  - Access control to mass events
  - Access control to sensitive infrastructure (nuclear power plants, etc.)
- Safety:
  - Combination of near infrared (NIR, 0.7-1μm) and long-wave infrared (LWIR, 8-12μm) for advanced night vision systems: detection of living objects using LWIR and of non-living objects as lost load with active NIR imaging.
- Health and life-science:
  - Skin cancer detection using terahertz and infrared detection
  - Mapping of biological activity through spectral mapping in terahertz frequency range and infrared imaging
- Production technology:
  - Online production monitoring of plastic parts (air inclusion/cracks)
  - Chemical composition and packaging monitoring in pharmaceutics industry

Consortium

The MUSIS consortium involves six partners from academia, industry and end users from France, Germany, Italy and Switzerland:

- CEA-LETI in Grenoble – France will be in charge of the detector design and the detector fabrication
- FBK in Trento – Italy will design the read out electronic circuit of the multispectral detector
- Rainbow Photonics and ETHZ, both in Zurich – Switzerland will make the design of the terahertz source and build up the demonstrator prototype of the source.
- Robert Bosch GmbH - Germany will design the multispectral optics and build up the system demonstrator. Bosch will furthermore coordinate the consortium work.
- Zurich airport will coordinate the field test of the demonstrator system and its evaluation.

Further administrative project data:

- Project started on May 1, 2008 and will have duration of 40 months (ending August 2011)
- Cost of the project is 4.64 M€ with an EU contribution of 3.2 M€