A photonics-based Terahertz frequency synthesizer.

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Electromagnetic waves with a frequency between 0.3 and 3 THz are often referred to as terahertz waves or T-rays. These waves are of great importance for security and spectroscopic applications, but also in high capacity wireless networks. For example, THz rays penetrate clothes and can be used to visualize metal objects underneath, a property used in body-scanners at airports. Also, the specific and strong absorption of a range of gasses such as HCl, CO,… allows for their sensitive detection with the help of T-Rays. Lastly, T-rays are expected to provide a solution for the quest for bandwidth in wireless networks. Nowadays, there is already an evolution to use carriers frequencies of 60 GHz instead of carriers at a few GHz, to boost the capacity of a link. However, it is expected that by 2020 the radio-bands at 0.3 THz and 0.6 THz will need to be used to fulfill the needs at that time. So, there is an urgent need for THz sources.

For all these applications, the THz sources should be broadly tunable and produce a narrow linewidth terahertz line. Furthermore, these sources should be cheap, mass manufacturable and have a small form factor to truly unlock the potential of the terahertz radio band. This remains an issue for current approaches: they are bulky and expensive. Although there are solutions based on electronics, these are limited in bandwidth and are not easily tunable.

It has been shown, however, that optical approaches, relying on the fast beat-notes that are generated by two lasers on a photodiode could provide a solution here. Because the lasers operate at much higher frequencies (hunderds of THz), they can easily provide a widely tunable terahertz signal with a narrow line-width.

The Photonics Research Group at Ghent University has recently shown that even integrated lasers on a small form factor silicon chip can be used to generate T-rays. Although these designs did not allow tuning the frequency of the T-ray, and while its linewidth was not small enough to be used in high capacity networks it shows that chip-scale photonic circuits could be used for Terahertz frequency synthesis. By exploiting newly integrated laser technologies it is envisioned that broadly tunable ultra-wideband T-ray sources can be integrated on a small (~1 mm2) chip. If successful, this source could be readily employed in high-capacity terahertz wireless networks or used as a low cost source for detecting poisonous gasses.

The goal of the PhD project is to demonstrate a widely tunable, narrow line width source. The project will involve both the design, fabrication and characterization of the chip scale lasers at optical frequencies as well as the characterization of the generated T-Rays at terahertz frequencies. When successful the chip-will be used in a proof-of-concept demonstrator, for generating T-ray carriers for high capacity wireless links.

Application:

Apply by filling in the **application form***.

More information:

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About Photonics Research Group

The Photonics Research Group (about 85 people) is associated with IMEC, and is part of the Department of Information Technology of Ghent University. The group is headed by Prof. R. Baets and has been active in photonics device research for many years. The other professors in the group are P. Bienstman, W. Bogaerts, B. Kuyken, N. Le Thomas, G. Morthier, G. Roelkens and D. Van Thourhout. The main applications under study are silicon nanophotonics, heterogeneous integration, optical interconnect, WDM optical communication, silicon photonics biosensors and photonic integrated circuits for biomedical applications in the near-infrared and mid-infrared wavelength range. More in particular, the silicon nanophotonics work focuses on the design and fabrication of SOI-based photonic devices using standard lithographic techniques compatible with CMOS-processing. The group is also strongly involved in the development of heterogeneous technologies, whereby the silicon photonics platform is combined with other materials such as III-V semiconductors for efficient sources, nanocrystals and polymers.

The Photonics Research Group has been coordinating the network of excellence ePIXnet and is involved in a number of EU-projects, including the FP7 projects ActPhast, PLAT4M, Cando, and Pocket and the H2020 projects TOPHIT, TeraBoard, PIX4Life, MIRPHAB and Phresco. Furthermore, the group is partner of the Center for Nano- and Biophotonics of Ghent University and the group has been awarded three ERC Independent Researcher Starting Grants and one ERC Advanced Investigator Grant.