

## PHD POSITION ON PHOTONIC ISING MACHINES - INTEGRATED OPTICS IMPLEMENTATIONS

Ghent University – IMEC, Photonics Research Group  
Tech Lane Ghent Science Park – Campus A  
Technologiepark – Zwijnaarde 126, B-9052 Gent, Belgium

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### JOB DESCRIPTION:

Three Belgium teams at Vrije Universiteit Brussel (VUB), Université libre de Bruxelles (ULB), Ghent University (UGENT) have united their expertise to develop a new type of optical computing devices that can solve hard combinatorial problems.

Such combinatorial problems are commonplace in our society, for instance in logistics, finance or pharmaceutical research. However, for many real-world applications, finding a solution requires high-performance computer clusters that consume large amounts of energy and run for a long time. Our project aims to create a radically new platform of analogue hardware accelerators, so-called Ising machines, that efficiently speed up these computationally difficult tasks in a way unlike any current digital computer. These Ising machines are a newly emerging computational concept and have shown great promise. They are based on the idea that the lowest energy state of a well-constructed dynamical system will encode the solution to the combinatorial problem. However, their implementation is highly challenging due to limited bandwidth, scalability and stability issues. A breakthrough is needed to make them practical for real-world applications. Photonics presents an ideal way to achieve this breakthrough due to its inherent parallelism and high speed. We aim to create accelerators for a broad set of problems, that are orders of magnitude faster and more energy efficient than digital computer and previous experimental implementations.

Our three teams will work on different aspects of this challenge:

ULB will focus on the underlying theory, leading to a deeper understanding of Ising machines and improving their performance. The general approach will be extended to other applications such as mixed integer programming, sampling from the thermal distribution over solutions to be studied, and solving real world problems. From the fundamental point of view, we will study the relation between classical and quantum Ising machines, and with other computational models such as adiabatic quantum computing.

VUB will focus on tabletop Ising machines with up to 100.000 spins and orders of magnitude speed up with respect to digital implementations.

UGENT will focus on building integrated versions of photonic Ising machines that contain fewer nodes than the tabletop implementations, but have the potential for much higher speeds and, when produced using volume fabrication, would be cheaper as well.

The researchers will work in close collaboration between the different groups. The selected candidates will carry out their PhD in “cotutelle”, i.e. they will be jointly supervised by two of the groups, will have to carry out part of their research at (at least) two institutions, and will receive a diploma from two institutions. This will

ensure efficient flow of ideas, and put the researchers in contact with all aspects of the project. Researchers will be encouraged to work on several aspects of the present project (for instance a specific experimental implementation and the underlying theory).

## PROFILE

A Master degree in Physics or Engineering.

Depending on the topic of the PhD, different backgrounds and expertise's are required. These can include skills in experimental physics and in particular optics/photonics; in computational physics; in theoretical physics and analytical calculations.

You possess strong verbal and written English communication skills.

## OUR OFFER

In exchange for your talent, passion and expertise, you will get an interesting position in a multicultural and high-tech institute, with challenges for the taking. This is your opportunity to contribute to the technology that will determine the society of tomorrow.

The candidates will receive a PhD grant which allows one to live comfortably in Belgium. Social security (medical insurance) is fully covered.

## APPLICATION:

Candidates should submit a CV and a transcript of records, as well as the names of 3 people that can be contacted for recommendations.

The application should be sent to  
Peter.Bienstman@ugent.be (for those most interested in integrated optics)

After a preselection based on the written application, candidates will be interviewed.

Please note that for administrative reasons a similar job offer will be posted by the three teams, but that the applications will be evaluated jointly by the 3 teams involved in this project.

Deadline for applications is 15 June, although late applications may be considered if the positions are not filled.

Starting date is by common agreement, for instance 1st September of 1st October 2022.

## ABOUT THE 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. Dries Van Thourhout and has been active in photonics device research for many years. The other professors in the group are Roel Baets, Peter Bienstman, Wim Bogaerts, Stephane Clemmen, Bart Kuyken, Nicolas Le Thomas, Yanlu Li, Geert Morthier, Gunther Roelkens and Kasper Van Gasse. The main research directions are silicon nanophotonics, heterogeneous integration, optical communication, neuromorphic computing, photonic (bio)sensors and photonic integrated circuits for biomedical applications in the near-infrared and mid-infrared wavelength range.

The Photonics Research Group has been coordinating the network of excellence ePIXnet and is involved in a number of EU-projects, including the H2020 projects ActPhast4R, AQUARIUS, CALADAN, FUN-Comp, Hydroptics, InSiDe, INSPIRE, MedPhab Pilot Line, MIRPHAB Pilot Line, PIX4Life Pilot Line, MORPHIC, NEBULA, Neoteric, TopHit and PhotonHub. The group also host two EOS Research projects, INTERREG projects and several ITNs (MICROCOMB, OMT, WON, Phonsi). Furthermore, the group is partner of the Center for Nano- and Biophotonics of Ghent University and leads ePIXfab, the European Silicon Photonics Alliance.

The group has been awarded five ERC Independent Researcher Starting Grants, one ERC Consolidator Grant and two ERC Advanced Investigator Grants.