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Technical hands-on courses (TC) – TC3

Bright Photonics Training

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Abstract
In addition to the scientific-based training, EDIFY offers to all ESR specific short-term hand-on training which can provide the ESRs with skills in highly experienced organizations, receiving cutting-edge technological knowledge and skills. These hands-on training will be provided at the same time the ESRs are seconded to Partner Organizations providing the courses, i.e. PBV, PDesign and BP, and are aimed to explore knowledge in circuit simulation and packaging.

Keywords: Photonics, Physics, Solid-state physics, Robotics, Training, Automation

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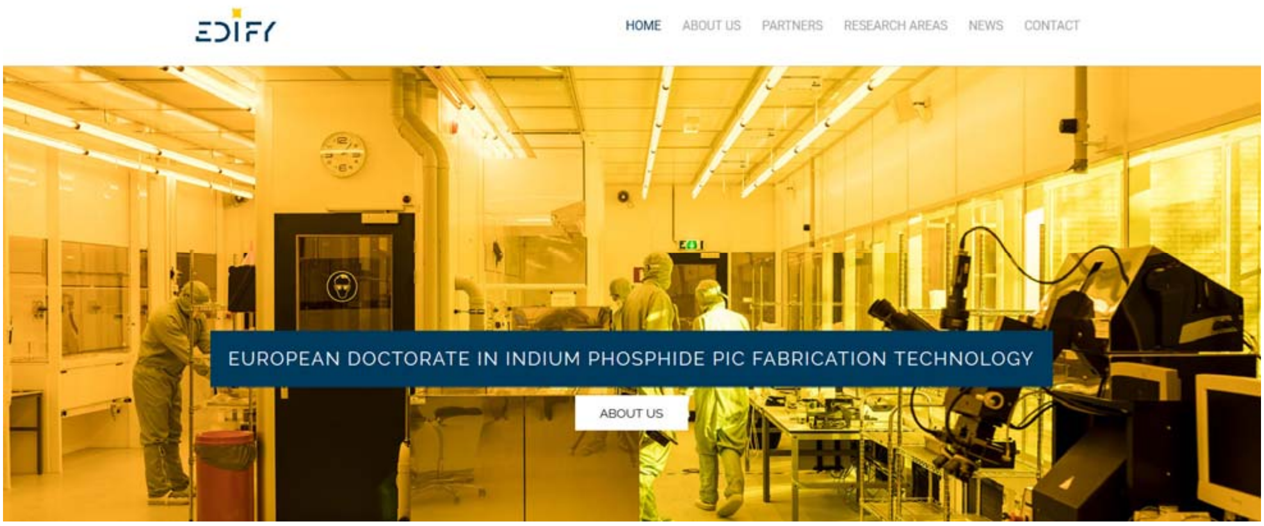
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1. INTRODUCTION

The aim of this report is to provide a brief overview of the third **Technical Hands-On-Course (TC3) – Bright Photonics training**, organized in the framework of the project EDIFY. As a general introduction, the challenge for the EDIFY Training Network is to develop new fundamental skills on simulation, design, measurement automation, fabrication and validation, and organization in an integrated photonics foundry. These skills will help to develop a new generation of technology advances in material and semiconductor properties aimed for low loss waveguides, more efficient passive devices as well as aluminium containing quantum wells for active devices like semiconductor optical amplifiers, saturable absorbers, modulators and lasers. To achieve this, EDIFY training strategy aims to combine scientific advanced training (Scientific Courses 1-5), technical hands-on courses (TC1-3), Winter School and regular EID meetings and networking events. Furthermore, all ESRs will be equipped with a range of transferable skills, as defined in the proposal.

The following specific training objectives (TOs) are defined to fulfill these goals:

- TO1: To enhance the attractiveness of a career in the front-line area of research in integrated photonics InP design, fabrication, characterization and modeling. To provide the opportunity for the fellows to be involved in the creation of a new line of industrial automation and organization of tasks in the InP foundry.
- TO2: To provide academic and industrial sector employers with researchers skilled in a wide range of techniques and methods, and direct experience of interaction across disciplines and sectors.
- TO3: To produce researchers with excellent transferable skills and the ability to transform abstract and challenging ideas into influential and practical outcomes.
- TO4: To create an active, long-term network of young researchers whose personal contacts, support and expertise will help Europe shape the future of research in active/passive devices and enhance/optimize the process of automated integrated photonics fabrication to enable the future of photonics industry in Europe in the next years.
- TO5: To cascade expertise and spread good practice throughout Europe by personnel exchange, and delivering European researchers able to become leaders in the fields of integrated photonics design, fabrication and characterization and industrial organization and automation in photonics industry in the near and mid-term future.

The four ESRs have been enrolled in the PhD program from the UVigo (Doc-TIC). Doc-TIC is the PhD Program promoted by the School of Telecommunications Engineering and atlanTTic. Its mission is to train the best professionals and researchers to generate quality research with international impact and to provide the industry with professionals with advanced knowledge to improve its competitiveness at global level. Doc-TIC involves the merging and expansion of the previous PhD Programmes in Signal Theory and Communications (TSC) and Telematics Engineering, both with Mention of Excellence awarded by the Spanish Ministry of Education.

Each ESR will be required to accumulate at least 30 ECTS (European Credit Transfer and Accumulation System) credits, among the pool of scientific- and transferable skills-based courses at UVigo and TUe to obtain their PhD title.

Through the Doc-TIC PhD Programme the UVigo offers a number of course modules in areas related to photonics (active and passive devices), quantum mechanics, solid-state physics, all of which are given in English. Between them, a group of Scientific-based courses (SC) offered to each ESR will allow them to obtain ten ECTS (60 lecturing hours and 40 hours of homework).

In addition to the scientific-based training, EDIFY offers to all ESR specific short-term hand-on training which can provide the ESRs with skills in highly experienced organizations, receiving cutting-edge technological knowledge and skills. These hands-on training will be provided at the same time the ESRs are seconded to Partner Organizations providing the courses, i.e. PBV, PDesign and BP, and are aimed to explore knowledge in circuit simulation and packaging. This group of Technical-based courses (TC) offered to each ESR, will allow them to obtain six ECTS (30 lecturing hours and 10 hours of homework).

1.1 TECHNICAL HANDS-ON COURSES (TC)

In the following Table we describe the fundamentals of these technical hands-on courses and corresponding skills to be acquired by the ESRs.

Title	*Hands-on Optodesigner training (TC1)*	Month: 22	Duration: 1 Week
Lead	PBV		
Contents: To get an overview of the latest status of the integrated photonics eco-system for the three major photonics technologies: InP, silicon photonics and TriPleX (SiN). This overview will include the available design tools today and the importance of considering test and packaging in an early stage. The unique combination of lectures and hands- on training exercises will teach how to perform circuit simulations, including fabrication tolerances, how to use and develop a design library (PDK) and how to set-up libraries in a structured way. PhoeniX Software tools will be used for this purpose.			
Skills for ESRs: Get introduced to Integrated Photonics Design Flow Automation. Learn the use of photonic integrated circuit simulation tools. Obtain in-depth knowledge of integrated design from mask to photonic and process flow simulations. Exchange experiences and ideas with other participants.			
Title	*Hands-on Fimmwave, PICWave and Harold (TC2)*	Month: 23	Duration: 2 Weeks
Lead	PDesign		
Contents: To learn a suite of robust and fully vectorial mode solvers for 2D+Z waveguide structures. It supports a large number of complementary algorithms which allows it to solve a large variety of waveguides which may be made of any material and of almost any geometry.			
Skills for ESRs: to learn how to model InP related waveguides; buried, etched (rib, ridge) and geometries commonly used in opto-electronics; , slanted-wall and graded structures; and waveguides; simulation of gain and absorption spectra of active material.			
Title	*Bright Photonics (TC3)*	Month: 22	Duration: 1 Week
Lead	BP		
Contents: PIC design flow and design training; How to develop a PIC from user specification to packaging. This reaches across PIC technologies (SOI, InP, SiN, glass) and across multiple packages. The training will be hands-on on the newly in-house developed open source Nazca design flow tool, covering mode solving, foundry and technology definition, layout design and verification, and data processing.			
Skills for ESRs: An introduction towards becoming an all-round PIC engineer and exposure to the latest software developments in the open source Python language to empower the engineer to customize a design flow to evolving needs.			

1.2 TC 2 – BRIGHT PHOTONICS TRAINING

The third of these **Technical courses, TC3 – Bright Photonics Training**, has been held between 20-23 Oct 2020 in a virtual mode (15:00-18:00). This course should have been developed in a secondment in one of the partners, Bright Photonics BV. However, all secondments, due to the current pandemia, has been postponed and we had to reorganize it and the course was moved to an online version. However, this unfortunate circumstance did not imply a considerable change in the contents or in the extension of the training. Since the complementary training included in the TC courses is fundamentally oriented to software and programming (circuit design, simulation and layout), this type of course is the most suitable to be taught online.
Topics covered in the TC3: PIC layout design, cells and layer, interconnect, building block and PDK creation, GDS introduction and advanced manipulation, connection DRC, circuit level path-tracing and compact models.

Technical Hands-on Course TC3: Bright Photonics Training (Dr. Katarzyna Lawniczuk)

1. **Introduction**: PIC requirements and specifications depending on the specific application. Technology selection.
2. **PIC technologies (SOI, InP, SiN, glass).** PIC design constraints related to technology and across multiple packages. How the PIC specifications and technology selection influence the circuit design. How to carefully design your PIC to accommodate the circuit into the mask layout.
3. To learn to use **PIC design with Nazca Design in Python**:
    a. To **get started and directions** into the more advanted features of circuit integrity validation, GDS manipulation and PDK development.
    b. **The role of Nazca** in the PIC development chain and how an open source design tool with community and commercial support provide long term security, flexibility and innovation.
4. **Hands-on through an example: A PIC transceiver**. Design flow tool. Foundry and technology definition. Layout design and verification. Mode solving. Data processing.

1.3 SKILLS, OUTCOMES AND METHODOLOGY

With these contents, the ESRs have acquired a set of **competences**:

- Capacity for mathematical modeling, calculation and simulation in engineering companies, particularly in research, development and innovation tasks in areas related to photonics and associated multidisciplinary fields.
- Ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
- Ability to apply advanced knowledge of photonics, optoelectronics and high-frequency electronics.

The **methodology** applied was based in:

Lectures: The lecturer introduced the main contents of each chapter to the students. These lectures did not cover all the contents of each subject. For that reason, the students had to review the supplementary notes provided in the Nazca Design manuals. It is also expected that the ESRs reviewed the concepts introduced in the webinars and expand on their contents using the guide of each chapter, together with the recommended bibliography, as a reference.
Laboratory: The lectures included some exercises in the lab involving different optical devices and optical communication systems.