



Courses on

Photonic Integrated Circuits Design, Fabrication & Packaging

The **Integrated Photonic Technologies Center INPHOTEC**, part of the **TeCIP Institute** of the **Scuola Superiore Sant'Anna**, in collaboration with **CNIT** (National Inter-University Consortium for Telecommunications), announces a **comprehensive training program on photonic integrated circuits design and fabrication**, and on **photonic/electronic packaging and characterization**.

INPHOTEC makes available during the courses to the enrolled trainees its **700 sqm highly professional fabrication facility and technology platforms for clean room live sessions**.

Target candidates are coming from the academia and the industry with a master of science in the area of Electronic or Telecommunication Engineering or Physics, or professionals with adequate background who want to pursue intensive specialization courses with practical sessions in the complete line of design, fabrication, packaging and characterization.

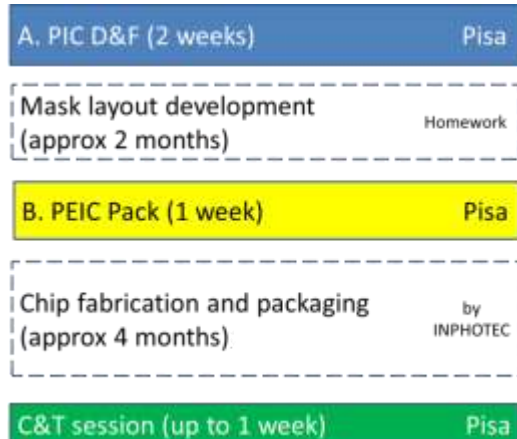
The number of admitted trainees is limited to 20 units.

A certificate of attendance will be released to participants.

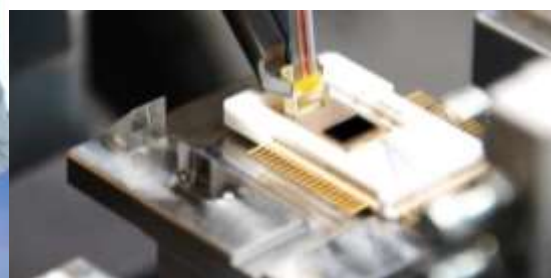
Courses

- A. Photonic Integrated Circuit Design and Fabrication (PIC D&F)** [2 weeks]
- B. Photonic and Electronic Integrated Circuit Packaging (PEIC Pack)** [1 week]

A **Characterization and Testing (C&T) session** [up to 1 week] is offered to trainees after realization of the chip by INPHOTEC.



The two courses A and B can be taken as stand-alone or in combination according to the organization aside



Course timing for edition 1

September edition

	Morning	Afternoon
5/9	SSSA (Class)	SSSA (Class)
6/9	SSSA (Class)	SSSA (Class)
7/9	PHX_General (OptoDesigner)	PHX_General (OptoDesigner)
8/9	PHX_General (OptoDesigner)	PHX_PDK (PDK user)
9/9	PHX_PDK (PDK user)	PHX_PDK (PDK user)
12/9	SSSA (Class)	SSSA (Class)
13/9	SSSA (Class)	SSSA (Lab)
14/9	SSSA (Lab/Design)	SSSA (Lab/Design)
15/9	SSSA (Design)	SSSA (Design) if needed

PIC D&F

Day	Morning (4 hours, e.g. 9-13)	Afternoon (4 hours, e.g. 14-18)
5 SEPT	<p>Introduction to PICs; waveguides and passive devices FARALLI / P. VELHA</p> <ul style="list-style-type: none"> - Theory of guided modes in waveguides: Silicon and Nitrides - Single- and multimode waveguides - Waveguide crossings - Waveguide transitions - Y-junctions - Multi mode interference couplers/splitters (MMIs) 	<p>Passive devices SORIANELLO</p> <ul style="list-style-type: none"> - Silicon In/Out - Grating couplers - Edge couplers and tapers - Micro ring resonators (MRR)
6 SEPT	<p>Active devices (modulators & photodetectors) CONTESTABILE / PORZI</p> <p>Laser basics and integration technologies:</p> <ul style="list-style-type: none"> - Luxtera "LAMP" approach - Hybrid integration approach: Evanescent coupling and metal bonding (UC Santa Barbara-Aurion, Skorprios, BCB-Ghent), III-V direct growth on Silicon, Ge Laser <p>Silicon Photonics modulators:</p> <ul style="list-style-type: none"> - Si-Ge p-n and p-i-n junctions for Mach-Zehnder and Microring-based intensity modulators - Electro- absorption modulators - Siscap configuration for capacitive low power consumption modulators - Silicon slot organic modulators 	<p>Active devices (modulators & photodetectors) CONTESTABILE / PORZI</p> <p>Ge photodetectors:</p> <ul style="list-style-type: none"> - p-i n - avalanche photodetectors <hr style="border-top: 1px dashed black;"/> <p>Introduction to mask design: design rules and PDK overview (2 hours) ANDRIOLLI/FARALLI</p> <p>Process Design Kit</p> <ul style="list-style-type: none"> - Fabrication process parameters <ul style="list-style-type: none"> * Silicon thickness and etch * Mask layers * Introduction to design rules - Library - Design rule checking - Examples based on the available mask design software (to be discussed also with the software supplier) <ul style="list-style-type: none"> - Mask layout guidelines: Components, Layout for electrical and optical testing, Approaches for space-efficient GDS layout, Additional examples <hr style="border-top: 1px dashed black;"/> <p>Software installation; introduction to mode solver and propagator PHOENIX Licensed software PHOENIX Teaching,</p>

PIC D&F – cont'ed

Day	Morning (4 hours, e.g. 9-13)	Afternoon (4 hours, e.g. 14-18)
7 SEPT	PHOENIX OPTODESIGNER simulation	PHOENIX OPTODESIGNER simulation
8 SEPT	PHOENIX OPTODESIGNER simulation	PHOENIX PDK user
9 SEPT	PHOENIX PDK user	PHOENIX PDK user
12 SEPT	PIC fabrication & technology steps (photolithography, e-beam lithography, etching, depositions, metallizations, planarization) ROMAGNOLI	INPHOTEC fabrication platforms (Class) DONEDA (30'), Introduction FARALLI: Substrate and cladding deposition (30') NOTTOLA: Litography (45') TIRELLI: Plasma Etching (45') ROTTA: Metal deposition (20') Characterization and metrology, reliability (Class) BONTEMPI Topics: FilmTek, SEM, Profilometro, 4probes-measurement, metricon (45')
13 SEPT	PIC packaging techniques and design constraints [Class] PREVE, OTON, Timing (2.5h + 1.5h) 1° part (classroom): basic concepts of packaging and mask design for packaging 1° part (classroom): introduction to fiber optics and devices necessary for chip characterization	PIC Packaging and Characterization (Lab) TOCCAFONDO, CHIESA, ROTTA, VELHA (3 groups)* - live packaging show session - part: live characterization session (how to align and measure the response).

* 3 groups (5-6 people): robot packaging 1 + big room packaging 2 + characterization

PIC D&F – cont'ed

Day	Morning (4 hours, e.g. 9-13)	Afternoon (4 hours, e.g. 14-18)
14 SEPT	Mask design with a tutor (2 hours)** PORZI, OTON, SORIANELLO, PINNA, ANDRIOLLI, VELHA Develop mask with Phoenix / Clean Room live session, 1° group (2 hours) DONEDA and collaborators	Mask design with a tutor** PORZI, OTON, SORIANELLO, PINNA, ANDRIOLLI, VELHA Develop mask with Phoenix / Clean Room live session 2° group (2 hours) DONEDA and collaborators
15 SEPT	Mask design with a tutor** PORZI, OTON, SORIANELLO, PINNA, ANDRIOLLI, VELHA Develop mask with Phoenix	Mask design with a tutor (optional) ** PORZI, OTON, SORIANELLO, PINNA, ANDRIOLLI, VELHA Develop mask with Phoenix

** Project definition: Beginners/intermediate: building blocks (bidirectional couplers, MZI, MMI, ring resonators, other to be defined), interconnection of building blocks; Advanced: from home project