



PhD student: Mohamed Mammeri

Integrated Photonic Circuits for Passive Optical Networks

Tutor:

Prof. DELLA CORTE
Francesco Giuseppe

co-Tutor:

PARASECOLO Francesca
GRADASSI Fabrizio

Cycle: XXXIX

Year: Second

My background

- **Master Degree:** Applied Physics (University of Algiers 1)
- **Research Group:** Electronics
- **PhD start date –end date:** November 2023-November 2026
- **Scholarship type:** PNRR co-funded (ex DM 117/2023)
- **Partner company:** Open Fiber

Summary of study activities

- **Courses**

- *Power devices and circuits.*
- *Using Deep Learning Properly*
- *AI at the deep edge*

- **PhD School**

- *Italian Society of Electronics (SIE)*

- **Events attended**

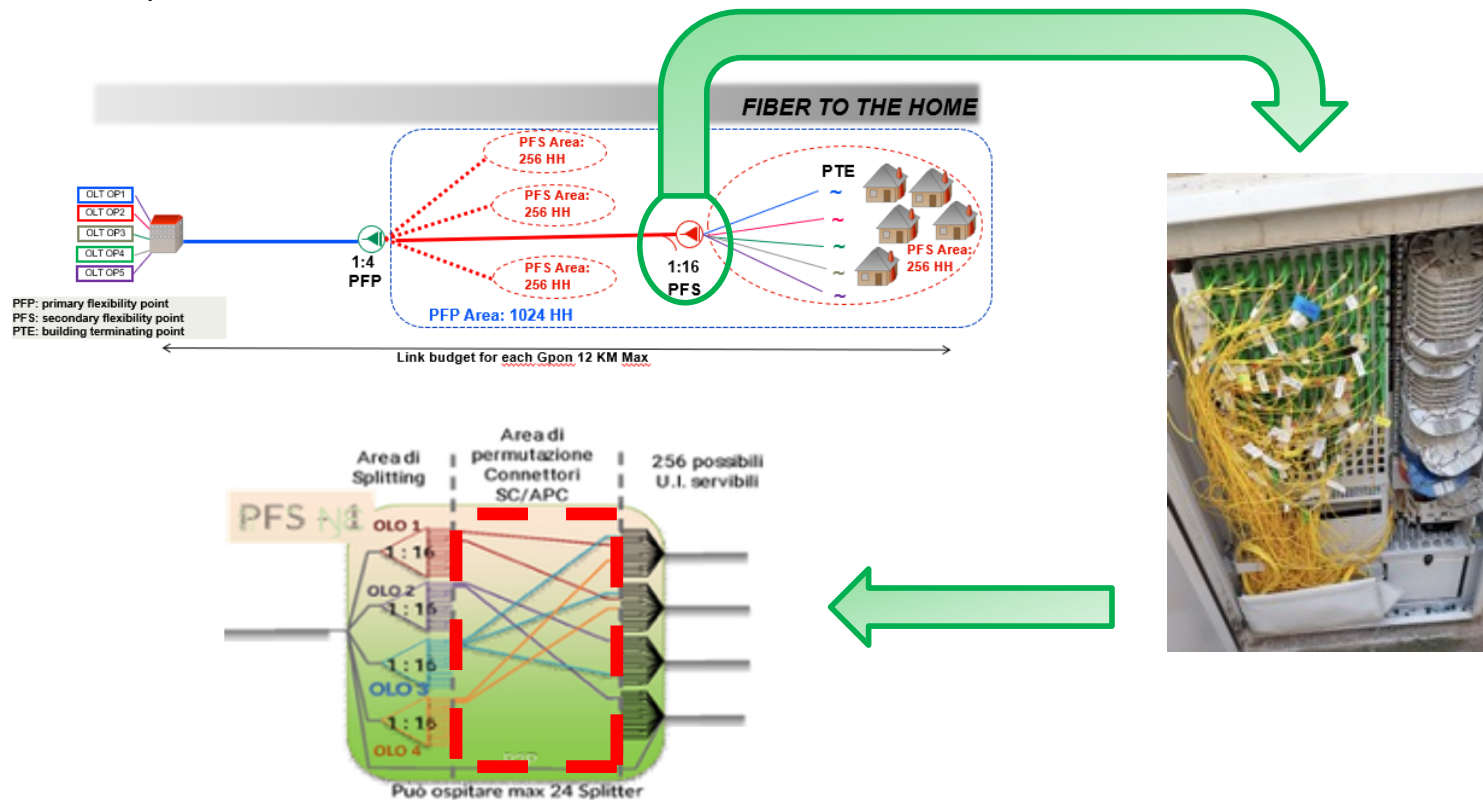
- *LVI Annual Meeting of the Italian Society of Electronics (SIE)*
- *RESTART Plenary Dissemination Workshop – Hands-On with the Future of Telecommunications.*
- *RESTART workshop at Rome Future Week, organized in collaboration with Open Fiber's "Re-thinking Innovation" initiative*

- **Laboratory activities**

- *Training on facilities related to characterization of optoelectronic devices.*
- *Design, simulation and experimental tests of different types of photonic switches.*
- *Clean room experiments for fabricating integrated optical switches (activity performed at CNR-ISASI)*

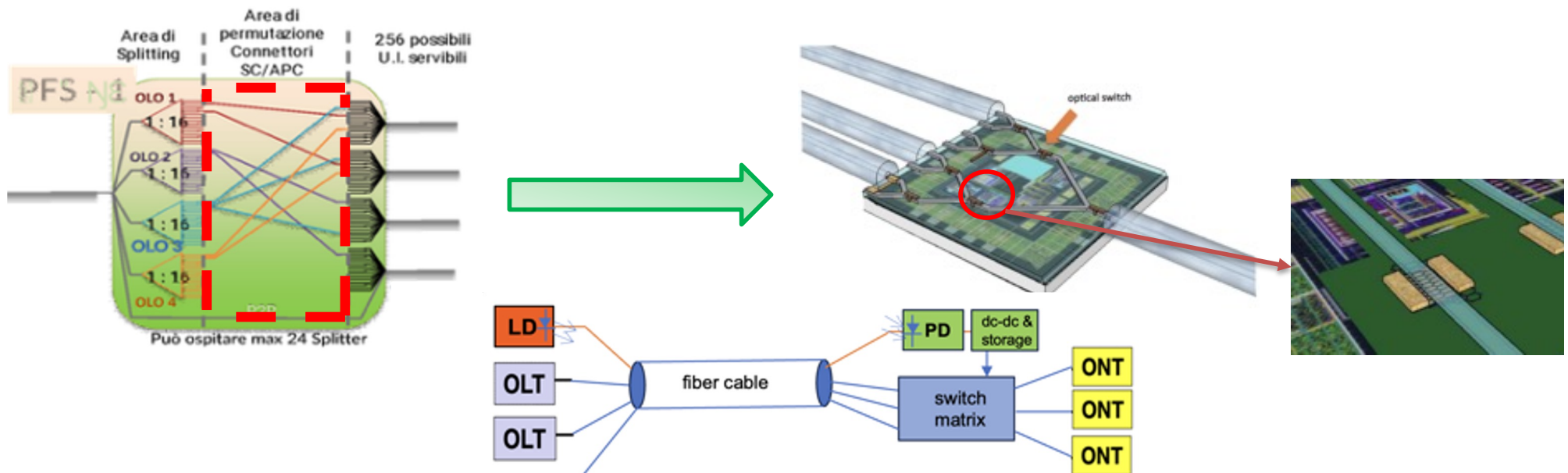
Research area

- Problem:** When a new subscriber line is to be activated (or an existing one switched), a staff member is assigned to physically connect the optical fibers in the permutation area of the patch cabinet to ensure that the optical link is established.



Research area

- **Objective:** Developing an innovative compact, low cost, low power, broadband, remotely reconfigurable, low-power active optical switch able to replace the permutation area to connect any Optical Line Terminal to any ONT.



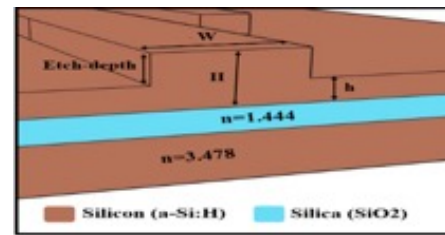
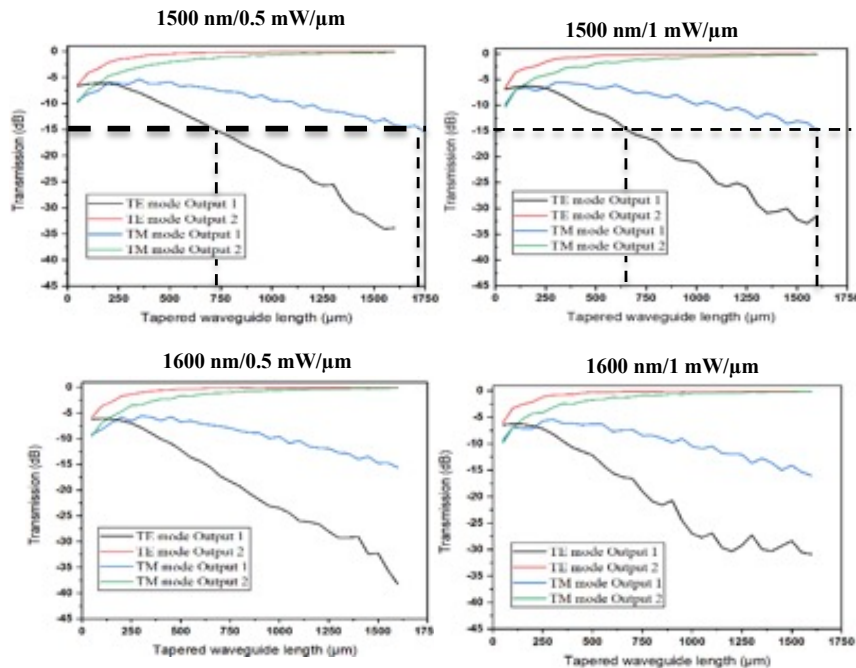
Switches must be single mode, polarization independent and wavelength independent in the range 1310-1620 nm. They should be low-power, too.

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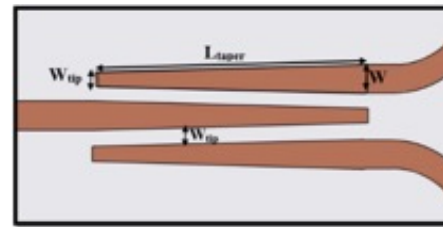
Research results (1st year)

switch based on **adiabatic structures**
(large cross-section) :

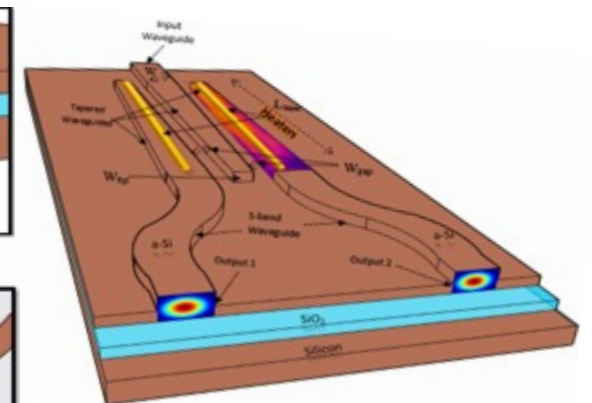
Waveguides: large cross-section, single mode, polarization independent



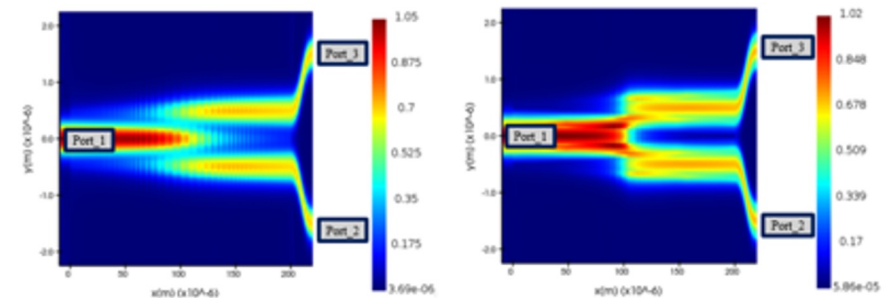
(a)



(b)



(c)



COMPONENTS	HEIGHT	WIDTH	LENGTH
SLAB	1 μm	15 μm	Along the device
INPUT WAVEGUIDE RIB	1 μm	2 μm	10 μm
TAPERS	1 μm	2 μm gradually decreasing to 1 μm	Varying from 100 μm to 1500 μm
S-BEND WAVEGUIDES	1 μm	2 μm	30 μm

Research results (2nd year)

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Adiabatic optical Switch Manufacturing:

Established Technology



ISASI-CNR cleanroom



Laser Writing System
1 μ m res – 385 nm
wavelength



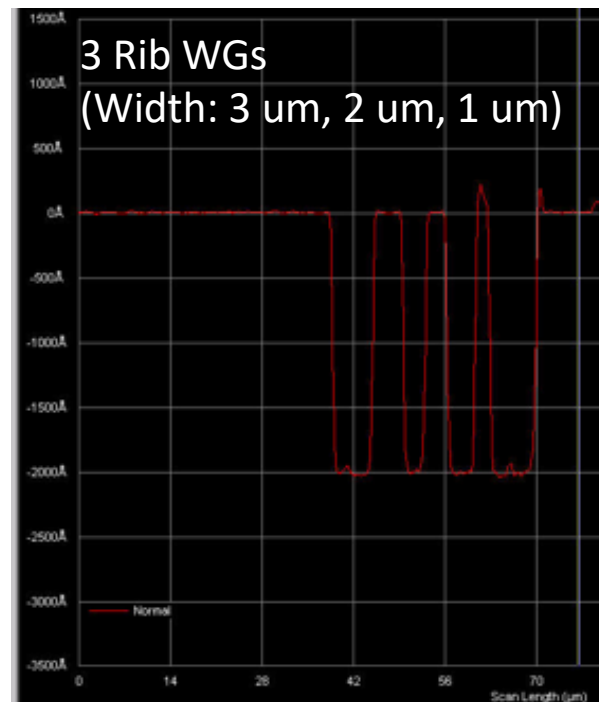
Thermal evaporator



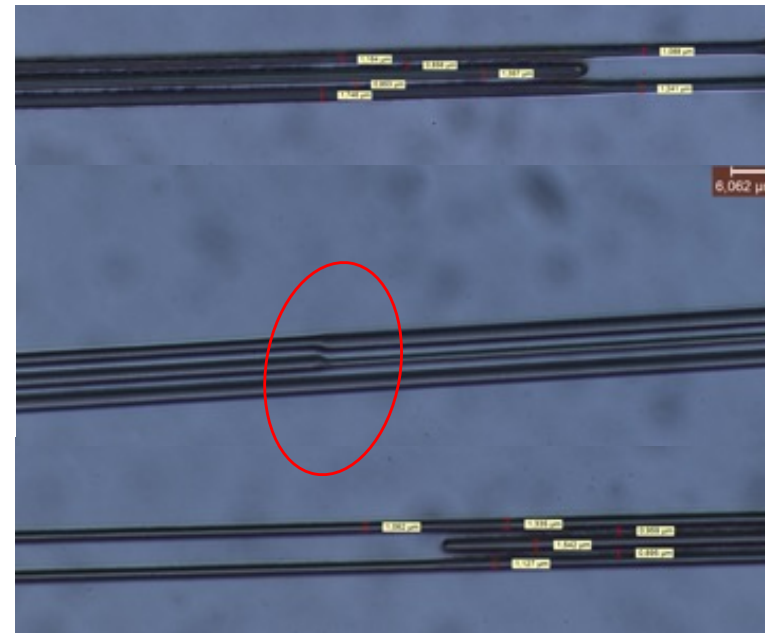
Plasma Lab 80+ Oxford
ICP Etching;
Deep Si Cryo and Bosch Etching

Research results (2nd year)

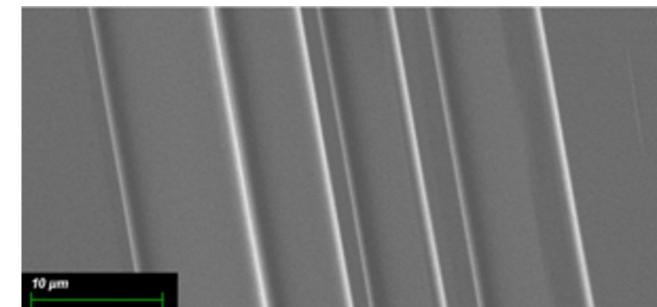
Profilometer measurements



Microscope figures



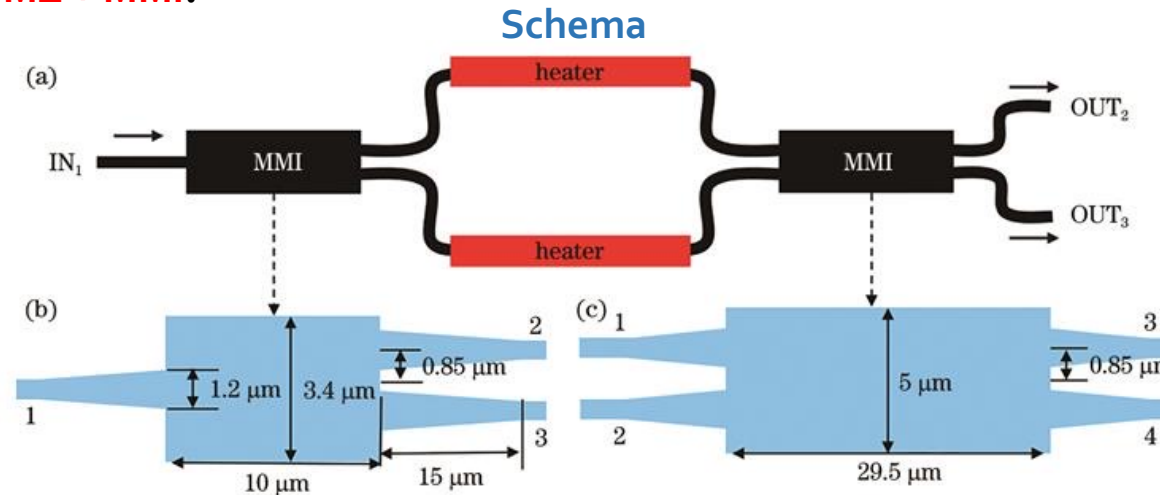
SEM images



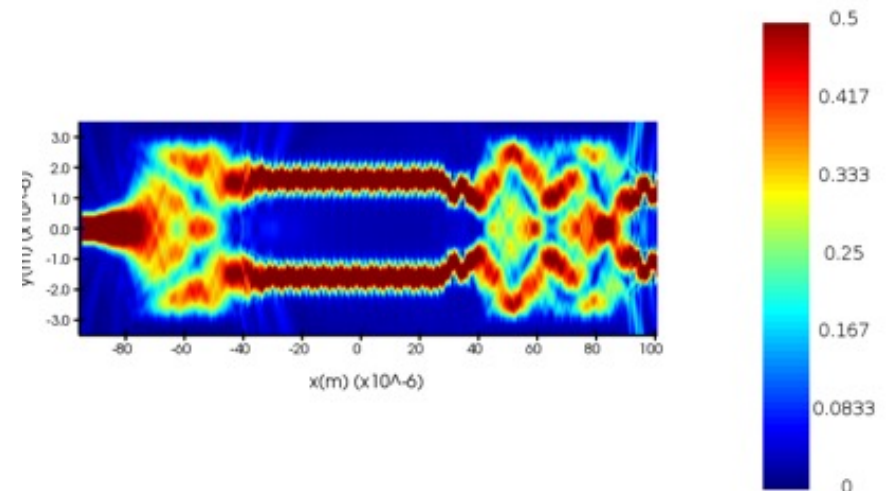
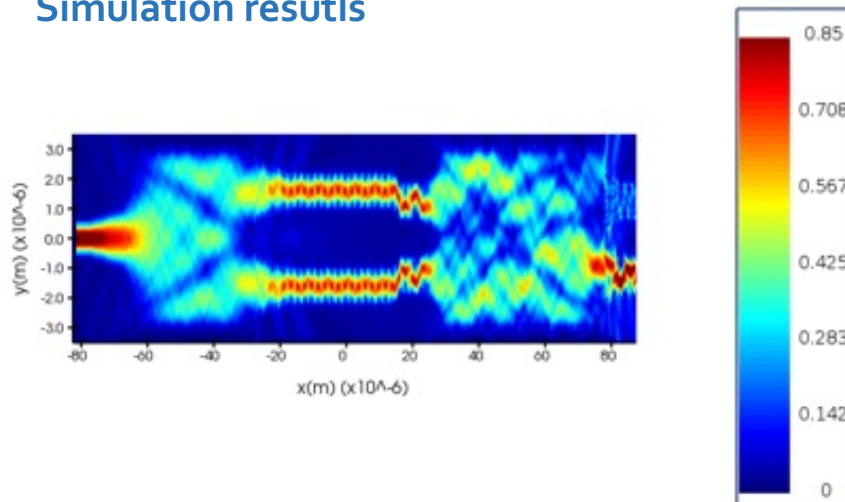
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Research results (2nd year)

switch based on **MMI + MZ + MMI**:



Simulation results



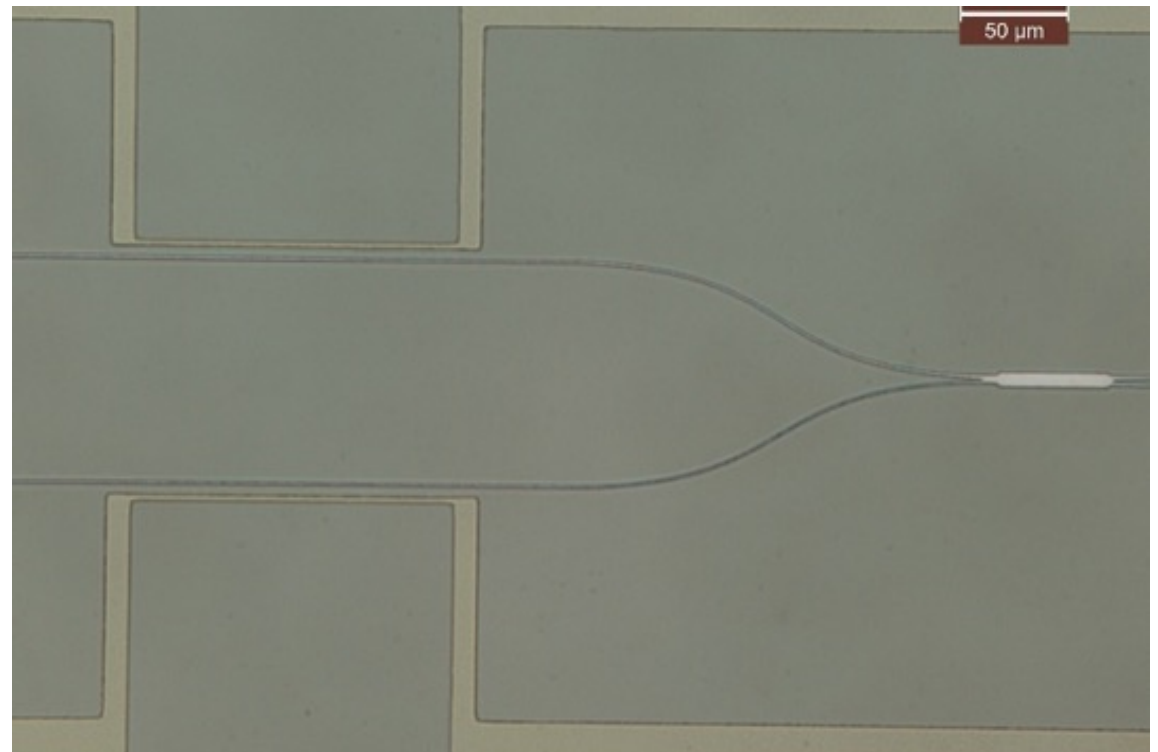
Research results (2nd year)

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MMI+MZI optical Switch Manufacturing results:



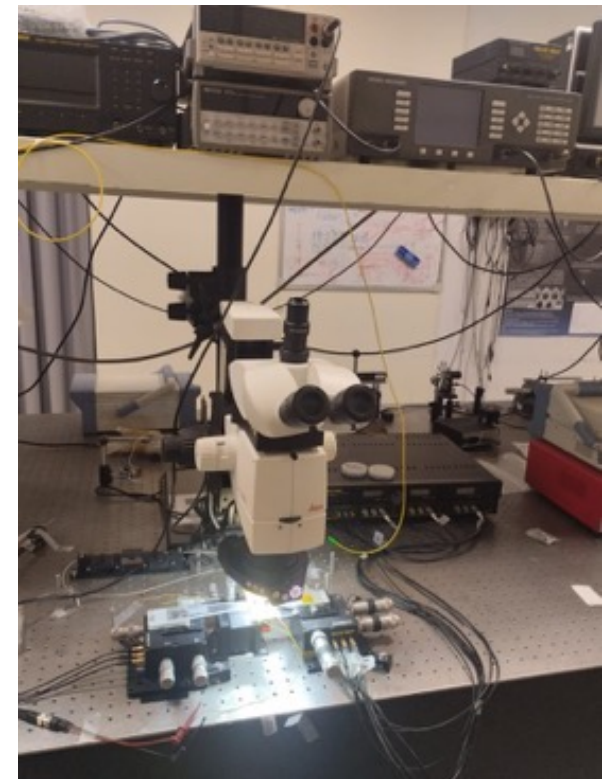
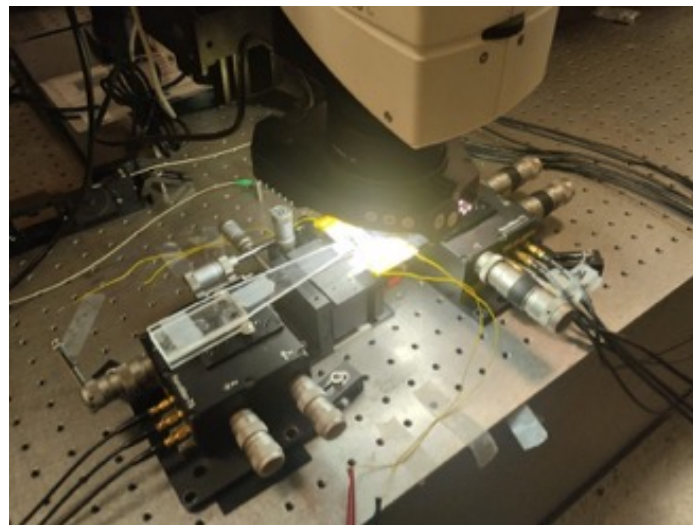
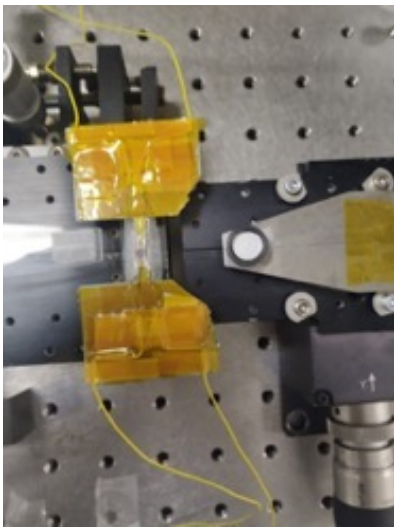
A new fabrication run is in progress,
in collaboration with PoliMi.



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Research results

Characterisation of switch based on **MMI + MZ + MMI**:



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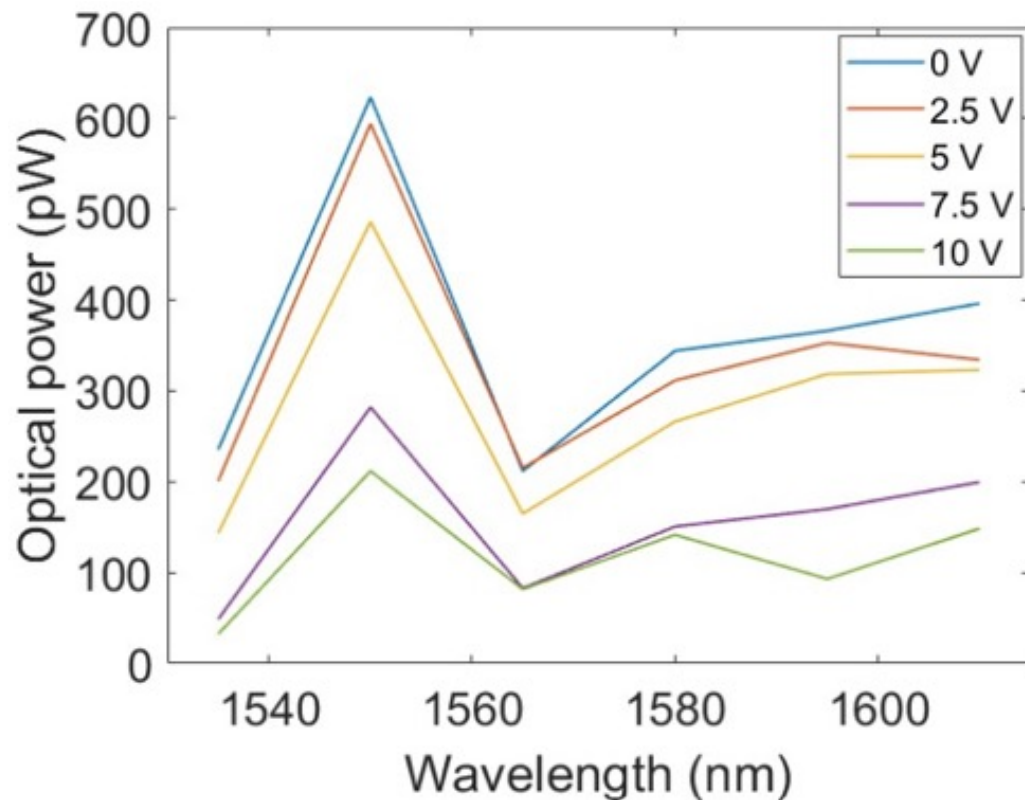
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Research results

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Characterisation of switch based on **MMI + MZ + MMI**:

lock-in amplifier

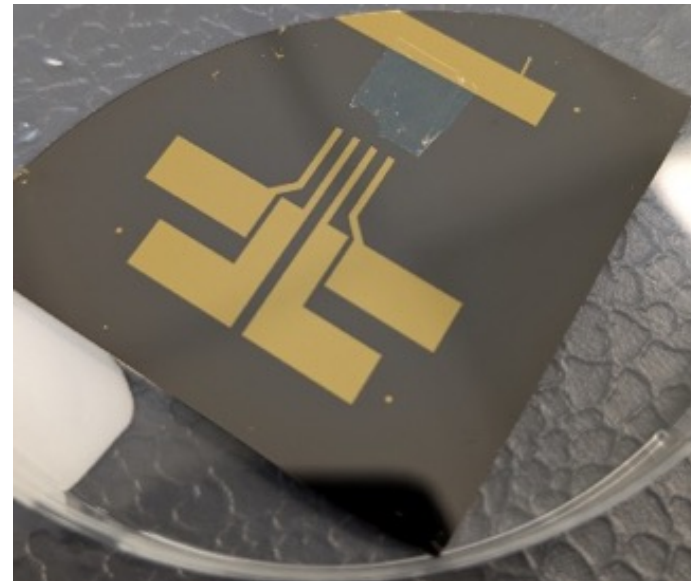
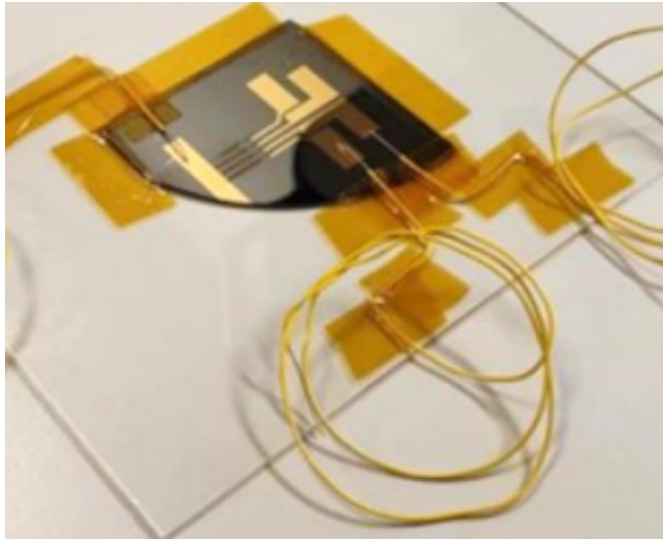


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Research results

Fabrication of a **Graphene/Insulator/Graphene** capacitor

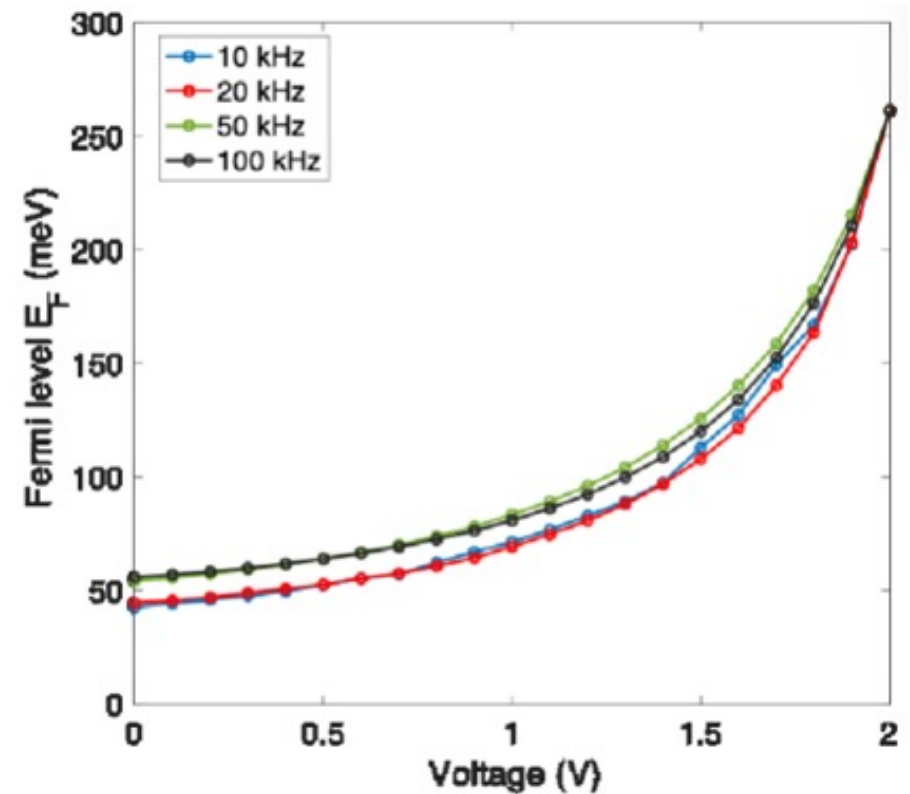
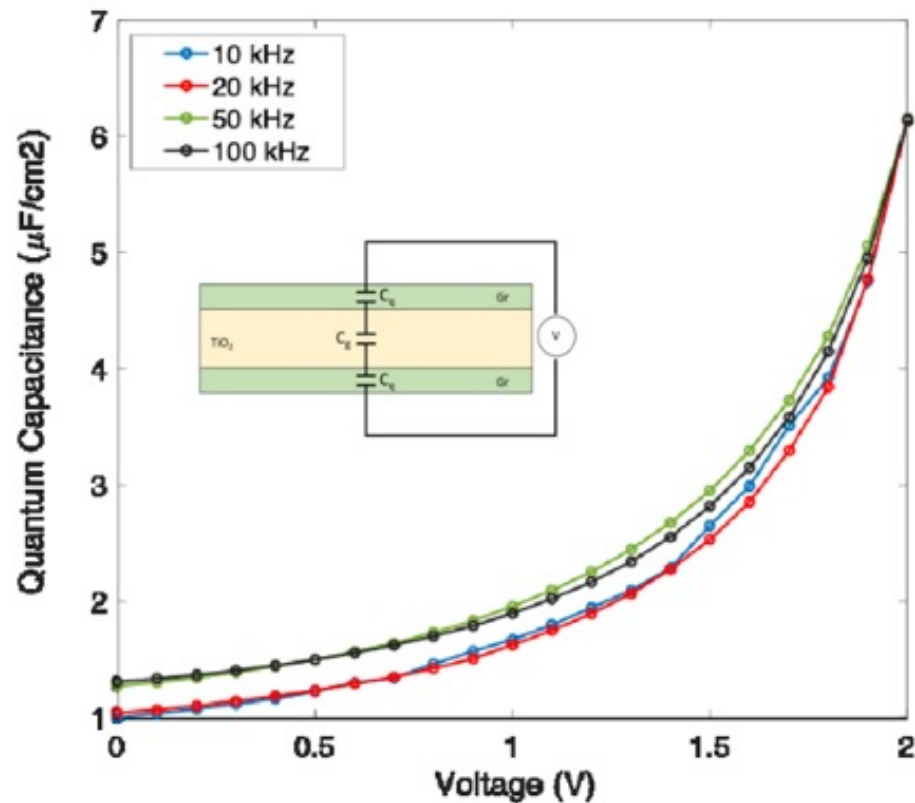


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Research results

characterization of a Graphene/Insulator/Graphene capacitor



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Research Product

Mohamed Mammeri, Teresa Crisci, Stefano Vergari, Babak Hashemi, Francesco Giuseppe Della Corte, Maurizio Casalino, Lakhdar Dehimi “Machine Learning-Assisted Design and Optimization of a Broadband, Low-Loss Adiabatic Optical Switch”. Electronics (MDPI), Published: 24-03-2025, Vol:14, P:1276. <https://doi.org/10.3390/electronics14071276>. **Published journal paper**

Babak Hashemi, Maurizio Casalino, Teresa Crisci, Mohamed Mammeri, Francesco G. Della Corte. Broadband Thermo-Optic Photonic Switch for TE and TM Modes with Adiabatic Design, Photonics 2024, 11(12), 1177. **Published journal paper**

Teresa Crisci, Luigi Moretti, Mariano Gioffrè, Babak Hashemi, Mohamed Mammeri, Francesco Giuseppe Della Corte, Maurizio Casalino. “1.3 Micron Photodetectors Enabled by the SPARK Effect”, Micromachines (MDPI), Published: 08-04-2025, Vol:16, P:440. **Published journal paper.**

[P1] Mohamed Mammeri, Babak Hashemi, Teresa Crisci, Maurizio Casalino and Francesco Giuseppe Della Corte, “Optimizing machine learning techniques for precise prediction of optical properties in silicon waveguides”. LVI Annual Meeting of the Italian Society of Electronics (SIE) 2025 **Conference paper**

- Babak Hashemi, Mohamed Mammeri, Maurizio Casalino, Teresa Crisci, Francesco G. Della Corte. “2x2 switch matrix using an adiabatic design”. LVI Annual Meeting of the Italian Society of Electronics (SIE) 2025. **Conference paper**

- Teresa Crisci, Luigi Moretti, Piera Maccagnani, Caterina Summonte, Rita Rizzoli, Francesco Giuseppe Della Corte, Babak Hashemi, Mohammed Mammeri, Stefano Vergari, Mariano Gioffre, Mario Iodice, Giuseppe Coppola, Maurizio Casalino. “Revealing the Potential of Buried Graphene in Silicon-Based Telecom Photodetectors”. LVI Annual Meeting of the Italian Society of Electronics (SIE) 2025. **Conference paper**

Submitting a conference paper at “2026 IEEE 23rd Mediterranean Electrotechnical Conference (MELECON)”

Next Year

- Final optimization and testing of the designed optical switches and splitters, improving their performances and fabrication reproducibility.
- Design, simulation and fabrication of new switching device by implementing graphene capacitor.
- A six-month research training period is planned at the Universitat Politècnica de València, Spain. The stay will focus on conducting experiments and exploring new optical switching approaches