Lithium niobate empowered silicon nitride platform for fragmentation-free operation in the visible and the NIR

HORIZON-CL4-2021-DIGITAL-EMERGING-01-07
Advanced photonic integrated circuits
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Start Date: 01.09.2022 [M01]
Duration: 42 Months

Funded by the European Union

Deliverable D7.1 - Project announcement (Fact sheet, presentation, press release, social accounts) and website

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1.0	03.11.22	ICCS	ICCS	Version 1.0 of the Deliverable

Copyright Statement

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LOLIPOP: horizon-de-lolipop.eu

Funded by the European Union

Table of Contents

List of abbreviations

EC	European Commission

Executive Summary

The document reports on the preparation of basic material for the announcement of LOLIPOP project to the general public through the official tools of the EC and the dissemination channels of the consortium partners. The document also reports on the preparation of the project website, presenting its structure and initial content, as well as of LOLIPOP accounts in popular social media. Finally, it provides details of the promotion video of the project that will facilitate towards the awareness of the general public on the project's goals and impact.

Keywords: Dissemination, Project presentation, Press release, Factsheet.

1 Introduction

The EU-funded LOLIPOP project builds on TriPleX, a proprietary waveguide technology for photonic integrated circuits developed by Netherlands-based company LioniX International, that satisfies the growing need for bandwidth and capacity in telecommunication and sensing applications. LOLIPOP will focus on equipping TriPleX with new functionalities by exploring materials like lithium niobate on insulator (LNOI), an excellent material for high-speed light modulation; germanium, known for its high-speed and ultra-wide bandwidth detection capabilities; and gallium arsenide, a well-established material for gain chips. To combine LNOI and TriPleX, various hybrid integration methods, such as flip-chipping and micro-transfer printing, will be explored. For the germanium photodiodes, heterogeneous integration will be developed to achieve high detection efficiency in a broad wavelength range (400-1600 nm). The announcement of the project launch to the general public and the scientific and technical community was pursued through the publication of the project factsheet and the project presentation through the cordis website of the EC and through two press-releases from a university and an industrial partner of the consortium. This dissemination material is presented below.

2 Website

LOLIPOP website is launched at the registered web domain: https://horizon-de-lolipop.eu/, advertising the project objectives, vision and summary, as well as proving information about the consortium's background, their contribution to the project, their contact details and links for their websites. Among others, the links for the social media accounts of the project, the latest news and dissemination activities (publications, public deliverables, press releases, conferences & workshops) are included. On the website the project kick-off announcement (M02), the project factsheet, the project presentation and a press release (M02) have been published. A screenshot of the home page of LOLIPOP's website can be found in Appendix I of the present document.

3 Social media accounts

For the communication of project's news and achievements with scientific and public audience LOLIPOP's social media accounts (LinkedIn, Twitter and Facebook) have been created and posts related to LOLIPOP announcement have already been published. The links are included below:

Website - https://horizon-de-lolipop.eu/project-launch-kick-off-meeting/

LinkedIn - https://bit.ly/3sHTB0n

Facebook - https://bit.ly/3sIoLEy

Twitter - https://bit.ly/3SRupPp

4 Project factsheet

The 2-page long project factsheet follows a typical format and provides standard information about the project (call identifier, consortium, timeline, budget, contact persons and project website), a short description about the motivation behind the project, a short description about the main technical concepts and the main objectives, and an overview about the exploitation plans and the expected impact. The factsheet will be made available through the project website (https://horizon-de-lolipop.eu/) and will be also available through the cordis website (http://cordis.europa.eu/projects/home_en.html). The project factsheet is appended to the present report as Appendix II.

5 Project short presentation

The short presentation of the project includes 15 slides that provide the same information as the project factsheet with stronger emphasis, however, on the technical scope and the technical concepts of the project. The short presentation of the project will be made available through the project website (https://horizon-de-lolipop.eu/) and will be also available through the cordis website (http://cordis.europa.eu/projects/home_en.html). This presentation is appended to the present report as Appendix 2.

6 Press release

One press release was prepared in order to announce the project to the general public and the scientific and technical community. This document was prepared by the ICCS in collaboration with all partners and was wired through the News section of the photonics communications research laboratory's website, the social media accounts as well as in the "News" section of the partners websites.

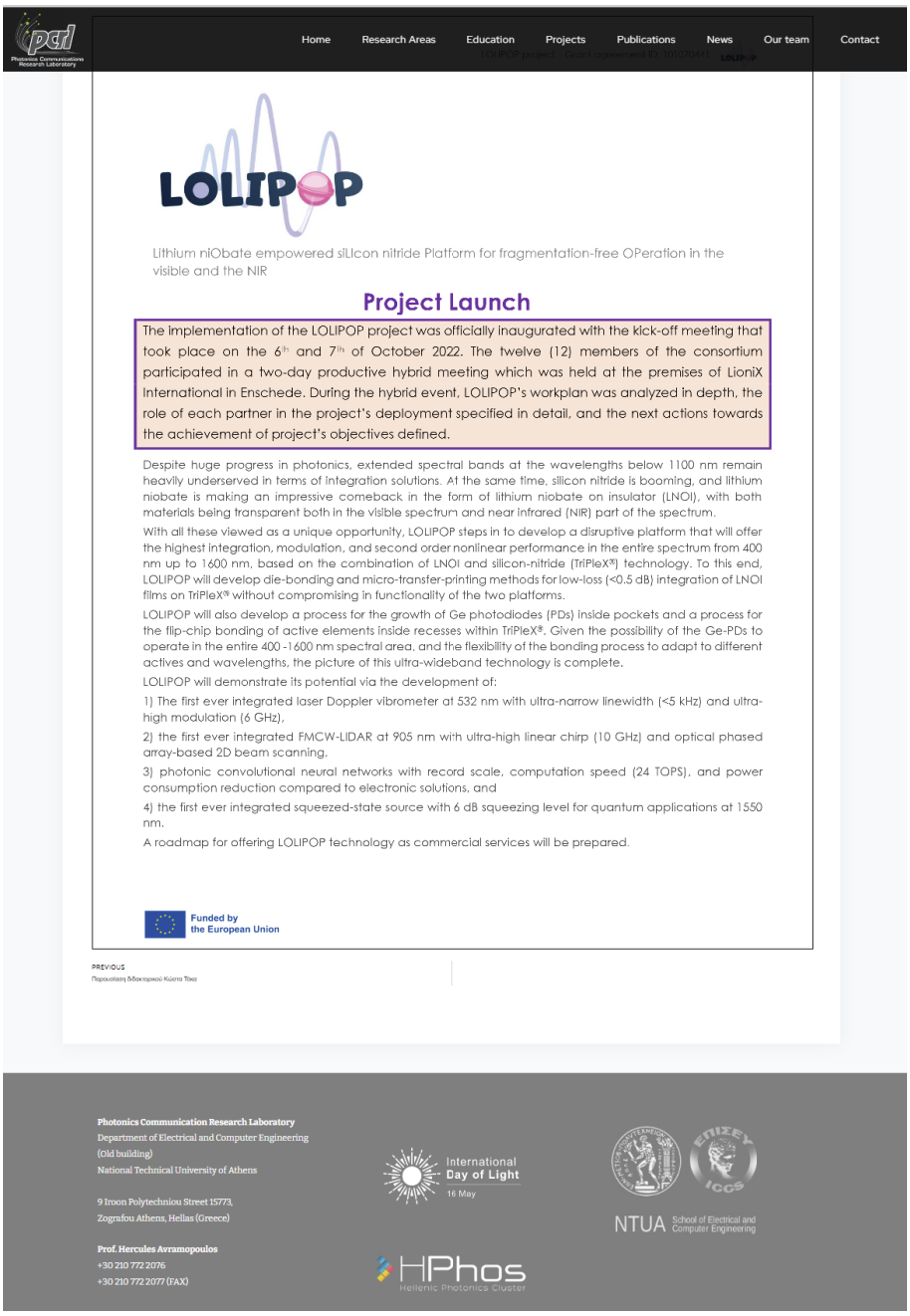
Website - https://horizon-de-lolipop.eu/project-launch-kick-off-meeting/

LinkedIn - https://bit.ly/3sHTB0n

Facebook - https://bit.ly/3sIoLEy

Twitter - https://bit.ly/3SRupPp

Press release published by the partners through News sections of their web sites. Examples can be found below:



pcrl Photonics Communications Research Laboratory

Home Research Areas Education Projects Publications News Our team Contact

LOLIPOP

Lithium niObate empowered siLIcon nitride Platform for fragmentation-free OPeration in the visible and the NIR

Project Launch

The implementation of the LOLIPOP project was officially inaugurated with the kick-off meeting that took place on the 6th and 7th of October 2022. The twelve (12) members of the consortium participated in a two-day productive hybrid meeting which was held at the premises of LioniX International in Enschede. During the hybrid event, LOLIPOP's workplan was analyzed in depth, the role of each partner in the project's deployment specified in detail, and the next actions towards the achievement of project's objectives defined.

Despite huge progress in photonics, extended spectral bands at the wavelengths below 1100 nm remain heavily underserved in terms of integration solutions. At the same time, silicon nitride is booming, and lithium niobate is making an impressive comeback in the form of lithium niobate on insulator (LNOI), with both materials being transparent both in the visible spectrum and near infrared (NIR) part of the spectrum.

With all these viewed as a unique opportunity, LOLIPOP steps in to develop a disruptive platform that will offer the highest integration, modulation, and second order nonlinear performance in the entire spectrum from 400 nm up to 1600 nm, based on the combination of LNOI and silicon-nitride (TriPleX®) technology. To this end, LOLIPOP will develop die-bonding and micro-transfer-printing methods for low-loss (<0.5 dB) integration of LNOI films on TriPleX® without compromising in functionality of the two platforms.

LOLIPOP will also develop a process for the growth of Ge photodiodes (PDs) inside pockets and a process for the flip-chip bonding of active elements inside recesses within TriPleX®. Given the possibility of the Ge-PDs to operate in the entire 400 -1600 nm spectral area, and the flexibility of the bonding process to adapt to different actives and wavelengths, the picture of this ultra-wideband technology is complete.

LOLIPOP will demonstrate its potential via the development of:

1) The first ever integrated laser Doppler vibrometer at 532 nm with ultra-narrow linewidth (<5 kHz) and ultra-high modulation (6 GHz),

2) the first ever integrated FMCW-LIDAR at 905 nm with ultra-high linear chirp (10 GHz) and optical phased array-based 2D beam scanning,

3) photonic convolutional neural networks with record scale, computation speed (24 TOPS), and power consumption reduction compared to electronic solutions, and

4) the first ever integrated squeezed-state source with 6 dB squeezing level for quantum applications at 1550 nm.

A roadmap for offering LOLIPOP technology as commercial services will be prepared.

Funded by the European Union

PREVIOUS

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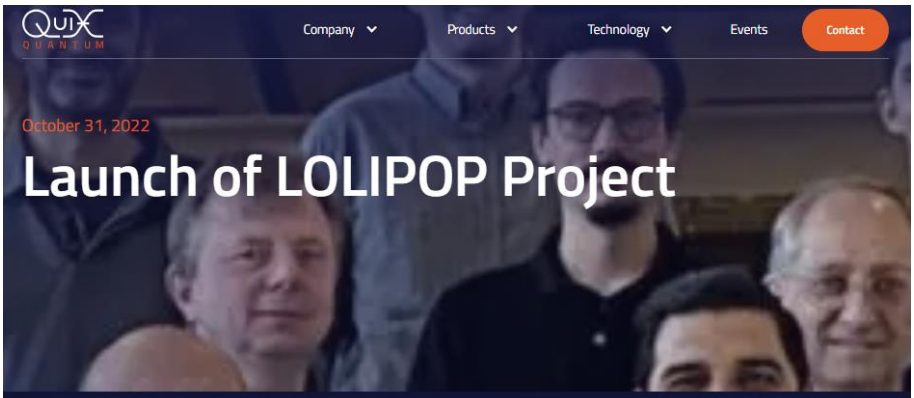
International Day of Light 16 May

HPhos Hellenic Photonics Cluster

NTUA School of Electrical and Computer Engineering



Homepage - **Launch of LOLIPOP Project**

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LOLIPOP: Lithium niObate empowered siLIcon nitride Platform for fragmentation-free OPeration in the visible and the NIR.

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LOLIPOP project – Grant agreement ID: 101070441

Project facts:

Topic: HORIZON-CL4-2021-DIGITAL-EMERGING-01-07 Advanced photonic integrated circuits **Project no:** 101070441
Start date: 1 September 2022
Duration: 42 Months

EU contribution: € 4.996.729,25

Beneficiaries: 12 Partners from 6 count

LOLIPOP project comprises twelve (12) partners from six (6) European countries among which:

2 Large companies: Polytec (DE), and LioniX International BV (NL)

3 world renowned research and technology organizations: imec (BE), University College Cork – National University of Ireland (IE), and CSEM SA1 (CH)

5 SMEs: PHIX Photonics Assembly (NL), Optagon Photonics (EL), Superlum Diodes Limited (IE), QuiX Quantum BV(NL), and Irida Labs (EL)

2 Academic organizations: University of Twente (NL), and the Institute of Communications & Computer Systems (EL) that coordinates the action.

For more info, visit LOLIPOP website

https://horizon-de-lolipop.eu/

LIONIX INTERNATIONAL Home

PROJECT LOLIPOP OFFICIALLY INAUGURATED AT LIONIX INTERNATIONAL

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Consortium members in attendance of the project's kick-off meeting at LioniX International.

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Despite huge progress in photonics, extended spectral bands at wavelengths below 1100 nm remain heavily underserved in terms of integration solutions. At the same time, silicon nitride is booming, and lithium niobate is making an impressive comeback in the form of lithium niobate on insulator (LNOI), with both materials being transparent both in the visible spectrum and near infrared.

With all these viewed as a unique opportunity, LOLIPOP steps in to develop a disruptive platform that will offer the highest integration, modulation, and second order nonlinear performance in the entire spectrum from 400 up to 1600 nm, based on the combination of LNOI and silicon-nitride (TriPleX®) technology. To this end, LOLIPOP will develop die-bonding and micro-transfer-printing methods for low-loss (<0.5 dB) integration of LNOI films on TriPleX® without compromising the functionality of the two platforms.

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Modules Targeted for Development

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Please visit the project website or download the project's press release for more details.

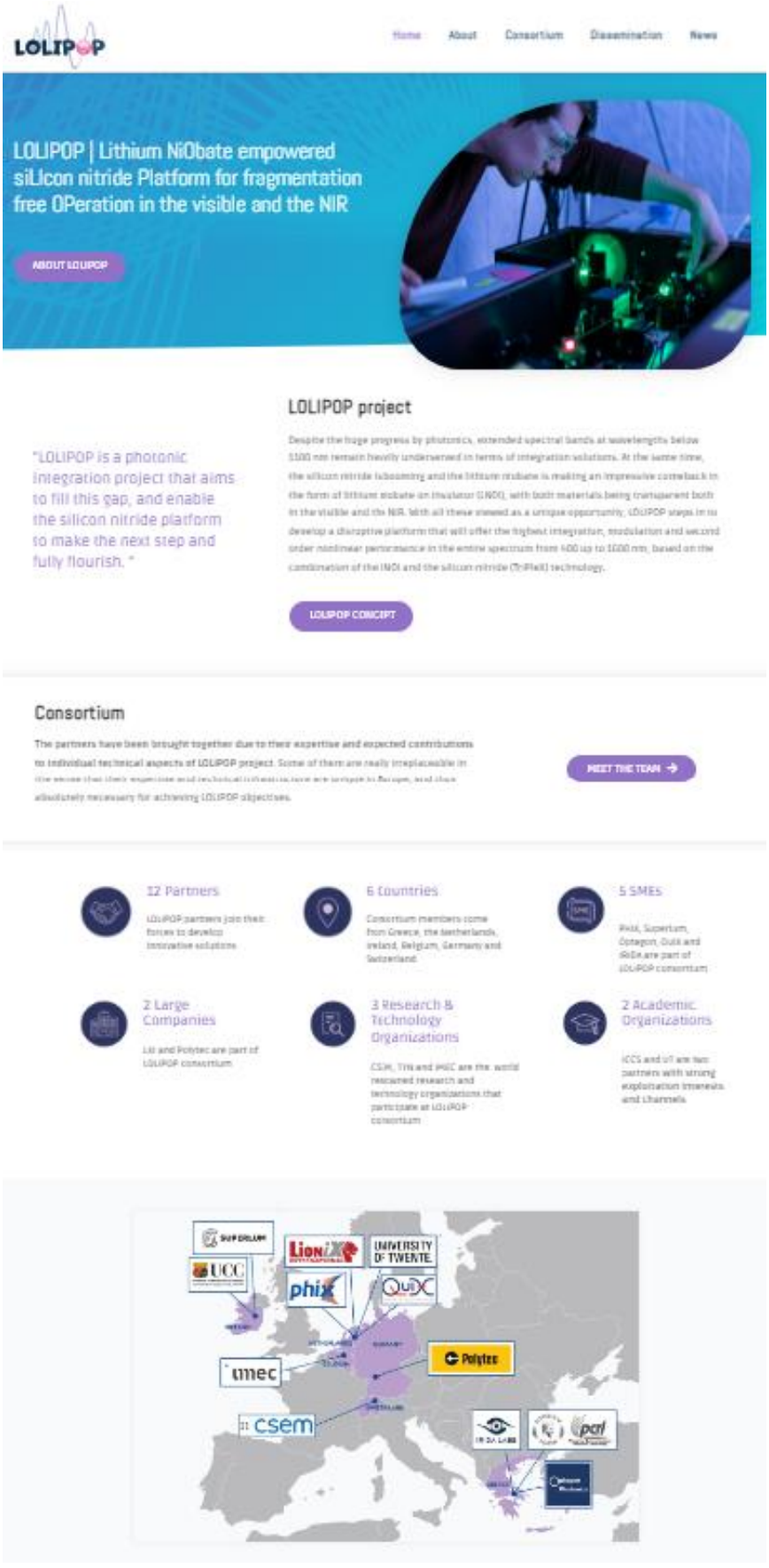
7 Further dissemination channels

Further announcements of LOLIPOP have already been made through the websites of the participating organizations.

8 Conclusions

Dissemination material for the project has been prepared. It is in the form of a 2-page factsheet that contains a brief overview of the motivation of project, its objectives, the exploitation strategy and the expected impact. The content of the factsheet has been elaborated in a short presentation, presenting also in more detail the role of the partners and the underlying technology. The project has been announced through the websites of the organizations participating, through their websites and two press releases have been prepared and issued.

Appendix I: LOLIPOP Website



Appendix II: LOLIPOP Factsheet

LOLIPOP is a Horizon Europe project funded by the European Union aiming to develop a new hybrid platform, based on silicon nitride, empowered with lithium niobate, for operation in the entire spectrum from the visible to NIR.

Motivation

Extended spectral bands with wavelengths below 1100 nm continue to be severely underserved in terms of integration solutions despite significant advancements in photonics. At the same time, lithium niobate is making an impressive comeback in the form of lithium niobate on insulator (LNOI), and silicon nitride is experiencing a boom. Both materials are transparent in both the visible and near infrared (NIR) portions of the spectrum.

Concept - Objectives

Today, silicon nitride in photonics is gaining tremendous speed. The silicon nitride is probable the platform with the highest potential for the development of complex photonic integrated circuits (PICs), which can sense and think with ultra-high sensitivity, precision, and computational resources. This is due to the combination of low propagation loss (below 0.1 dB/cm), high integration density, and ultra-wideband operation that it can offer. This upcoming generation of PICs could increase the use of photonics in already-existing application fields like metrology, sensing, biosensing, and microwave photonics as well as make it possible to adopt photonic solutions in newly-emerging fields with high interest like neuromorphic computing, quantum communications, and quantum computing.

The silicon nitride platform is passive despite these great prospects and its special potential for passive waveguiding performance. On this platform, hybrid solutions for light emission, modulation, nonlinear processing, and detection are currently poor or absent if they are to simultaneously provide high photonic performance, wideband operation, and integration robustness. Thus, the silicon nitride platform has potential, but it is only partially being utilized at this time. A photonic integration effort called LOLIPOP aims to close this gap so that the silicon nitride platform can advance and develop fully.

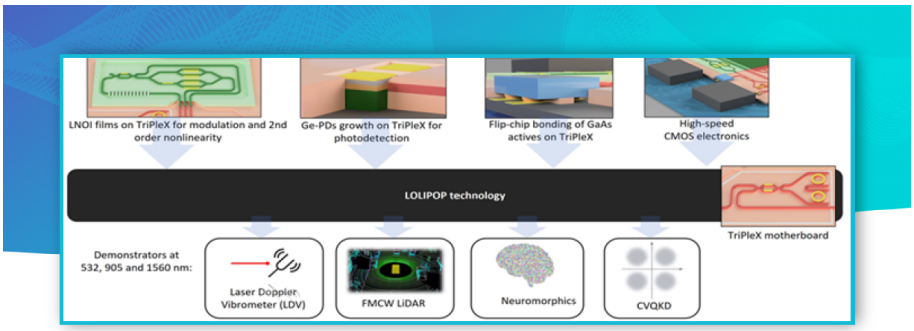
In order to achieve this, LOLIPOP invests in the combination of silicon nitride with the lithium niobate on insulator (LNOI) technology while concurrently utilizing a disruptive set of techniques to integrate semiconducting materials onto the silicon nitride substrate. The motherboard of this new hybrid technology, called LOLIPOP, is made of TriPleX, a silicon nitride variant of LXI.

Factsheet

Call identifier: HORIZON-CL4-DIGITAL-EMERGING-07
Topic: Advanced photonic integrated circuits
Project No: 101070441
Timeline: 1 September 2022 - 28 February 2026
EU contribution: € 4.996.729,25
Project Website: horizon-de-lolipop.eu
Consortium: 12 Partners (6 countries)

Funded by the European Union

LOLIPOP project – Grant agreement ID: 101070441



Concept - Objectives (cont.)

In order to support a vision with three primary axes linked to the optical functionality, the spectral coverage, and the future manufacturing flow of the envisioned platform, both this motherboard, the components that are handled as daughterboards, and their integration techniques have been chosen.

Specific targets in LOLIPOP are:

- High-speed modulation and second order nonlinear processing on silicon nitride
- Cutting-edge performance from the deep blue up to 1600 nm on silicon nitride
- Prospect of wafer-scale integration processes and high-volume production

It is clear that the hybrid integration technology of LOLIPOP will be a general-purpose and implementation technology given the breadth and diversity of the elements, capabilities, and wavelength bands that it can handle. However, the four use cases and corresponding system demonstrators that will be created as part of LOLIPOP have been chosen due to their potential as stand-alone solutions for technological and commercial breakthroughs in application areas and markets that are already thumping or are anticipated to boom in the future, in addition to their suitability to demonstrate the fundamental concepts and building blocks of this technology.

These include the established Laser Doppler Vibrometers (LDV) business, the growing Light Detection and Ranging (LIDAR) system market, and the emerging areas of optical neuromorphics, quantum communications, and quantum computing. A key concept of LOLIPOP at the system level is the simultaneous use of hybrid silicon nitride circuits in imaging units (like LIDAR systems) and in image processing units (like photonic neural networks), which will be integrated and will work closely together. This is in addition to the technical value and innovations of each demonstrator.

To demonstrate the disruptive potential of the LOLIPOP-envisioned technological developments, prototypes of the technology will be cointegrated with the infrastructure of the end users and evaluated in realistic industrial facilities.

Impact

Based on the combination of LNOI and silicon-nitride (TriPleX®) technology, LOLIPOP steps in to develop a disruptive platform that will provide the highest integration, modulation, and second order nonlinear performance in the full spectrum from 400 nm up to 1600 nm. To accomplish this without compromising the functionality of the two platforms, LOLIPOP will implement die-bonding and micro-transfer printing techniques for low-loss (0.5 dB) integration of LNOI films on TriPleX®.

Contact

Institute of Communications & Computer Systems
Photonics Communication Research Laboratory

Prof. H. Avramopoulos
Dr. Lefteris Gounaridis
Mr. Adam Raptakis

Project Website: **horizon-de-lolipop.eu**

Funded by the European Union

LOLIPOP project – Grant agreement ID: 101070441

Appendix III: LOLIPOP Short presentation

LOLIPOP

Lithium niobate empowered silicon nitride platform for fragmentation-free operation in the visible and the NIR

Funded by the European Union

Topic: Advanced photonic integrated circuits

Type: HORIZON-RIA

Call: HORIZON-CL4-2021-DIGITAL-EMERGING-01-07

Project No: 101070441

Start date: 1 September 2022

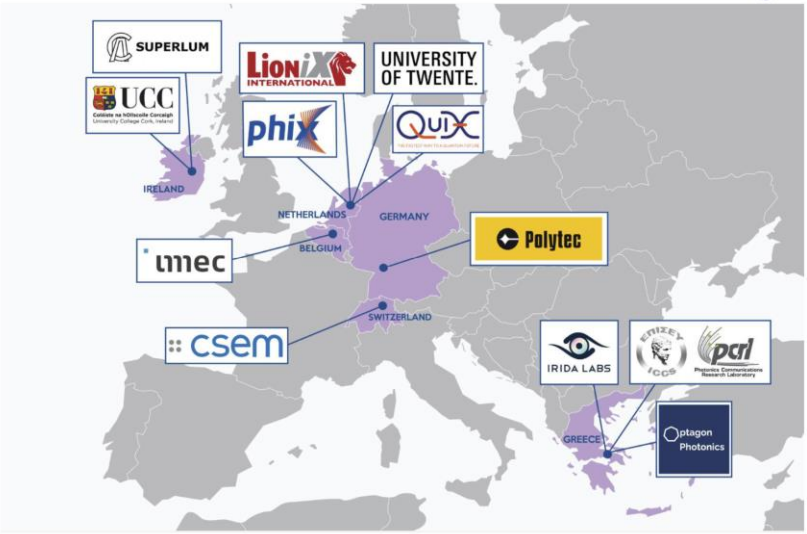
Duration: 42 Months

EC contribution: € 4.996.729,25

LOLIPOP Consortium

12 Partners
6 Countries

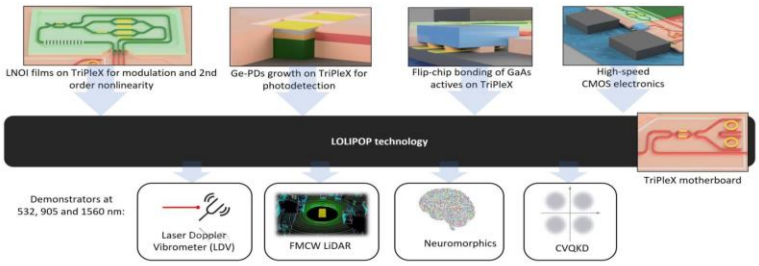
2 Large Companies
5 SMEs
3 World renowned research and technology organizations
2 Academic Organizations



Driving ideas of LOLIPOP initiative

1) High-speed modulation and second order nonlinear processing on silicon nitride

2) Cutting-edge performance from 400 up to 1600 nm on silicon nitride



3) Prospect of wafer-scale integration processes and high-volume production

4) Explore this hybrid integration technology for three different use cases:
- Sensing and ranging applications: Laser Doppler Vibrometer (LDVs), Light Detection and Ranging (LIDAR)
- Image processing units: Photonic Neural Networks
- Quantum computing and communications: Optical Squeezing Source

Driving ideas – in more detail (I)

High-speed modulation and second order nonlinear processing on silicon nitride

Invest on the LNOI films, which is the most recent and promising form of the well-known lithium niobate (LN) material

Work on the transfer of LNOI films on TriPleX aiming at a hybrid LNOI-on-TriPleX platform with highest modulation and passive waveguiding performance

Starting point

Modulation bandwidth of LNOI above 100 GHz, $V\pi$ below 1.5 V and propagation loss below 0.25 dB/cm

Project goal

Transfer of the LNOI films will offer an unmatched potential for fast modulation and second order nonlinear effects

Driving ideas – in more detail (II)

Cutting-edge performance from 400 up to 1600 nm on silicon nitride

Invest on the LN material which can match the ultra-wideband operation capacity of the silicon nitride from 400 nm (Vis) up to 2 μm and above.

Support applications, especially in the Vis, that cannot be efficiently supported today by integrated photonics.

Starting point

Great variety of components have been already developed in both platforms
First steps of integration have been reported

Project goal

Demonstrate systems and applications within a very broad range of wavelength operations from Vis to C-band

Driving ideas – in more detail (III)

Prospect of wafer-scale integration processes and high-volume production

Develop processes for the integration of the various materials and components on the TriPleX platform

Develop integration processes that will be compatible with wafer scale integration, and thus with the prospect of high-volume production

Starting point

Flip-chip bonding
Die bonding
Micro Transfer Printing (μTP)

Project goal

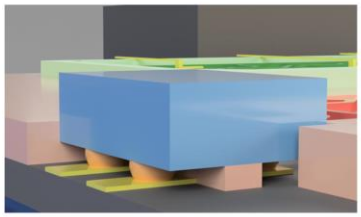
Extend these processes to be incorporated with other processing steps that are part of the TriPleX technology, and be consolidated as a single and cohesive process flow

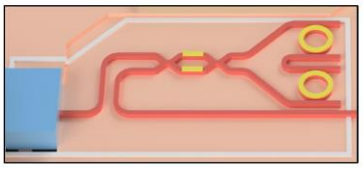
Innovations (I)

Development of active elements, operating in different wavelengths in the range from Vis to C-band and development of ECLs on hybrid TriPleX platform

Development of active GaAs elements for operation at 780, 905 and 1064 nm and >50mW optical power

Development of ECLs with low linewidth (<5kHz) and tuning range around specific wavelengths





Starting point

ECL on TriPleX (butt-end coupling):

- Linewidth <0.5 kHz at 1550 nm
- Linewidth <2.3 kHz at 684 nm

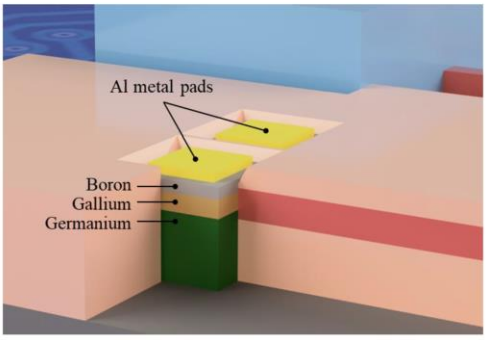
Innovations (II)

Heterogeneous integration of semiconducting layers on TriPleX wafers and growth of Ge-PDs with wideband operation (400-1600 nm) and high bandwidth (up to 30 GHz)

Development of Ge-PDs for different wavelengths from 532 to 1560 nm

Growth of the Ge-PDs on the TriPleX platform

Creation of pockets on the TriPleX wafers



Starting point

Epitaxial growth of Ge islands on silicon substrates
Mostly used for wavelengths longer that 1100 nm

Innovations (III)

Develop CMOS electronics with low power consumption and high bandwidth (up to 30 GHz)

Development of electronic drivers for the operation of the LNOI modulators

Development of TIAs for the operation of the Ge-PDs on the hybrid TriPleX PICs

Starting point

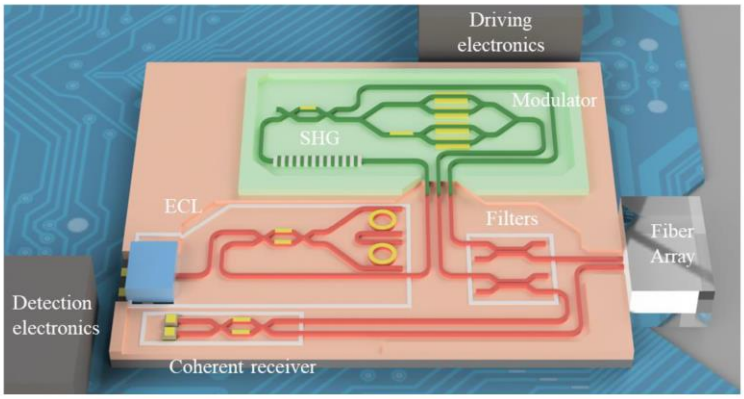
Solutions for high-speed electronic interfaces (drivers and TIAs) have been already demonstrated

Target modules (I)

LDV Modules

System level:

- Modulation frequency:
  - **Module-1 @40 MHz (M18)**
  - **Module-2 @6 GHz (M30)**
- Operation wavelength: 532 nm
- Linewidth: <5 kHz
- Detection distance: ~10 m
- Modulation schemes:
  - Simple serrodyne (Module-1)
  - 4-branch (Module-2)

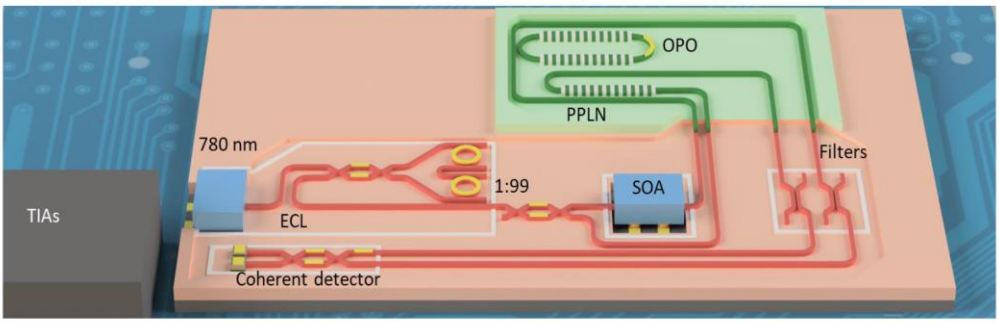


Target modules (II)

Squeezed state engine (Module-3 - M18)

System level:

- Squeezing level: 6 dB
- Operation wavelength: 780 nm
- Spontaneous parametric down-conversion (SPDC) process



Target modules (III)

Optical Phased Array unit (Precursor-4 – M18)

System level:

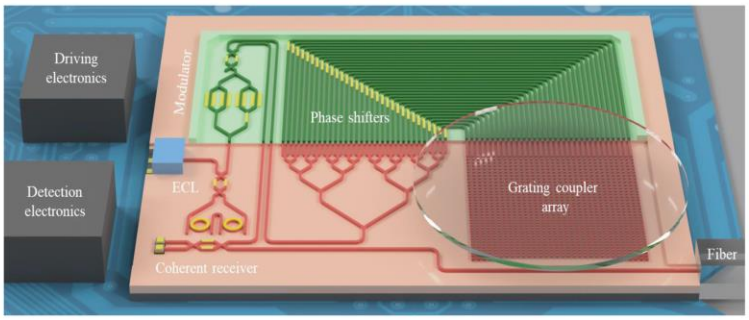
- 32 - 64 grating couplers
- Operation wavelength in a range of 60 nm around 905 nm
- Field of view (FOV): 12°×25° with 0.2° and 0.1° resolution
- Active optical aperture of almost 3 mm × 1.5 mm

Target modules (V)

FMCW-LIDAR (Module-4 – M30)

System level:

- Operation wavelength in a range of 60 nm around 905 nm
- Output power: 20 mW
- FOV: 12°×25° with 0.2° and 0.1° resolution
- Operating range: 100s of meters
- Linear OPA with 512 grating couplers

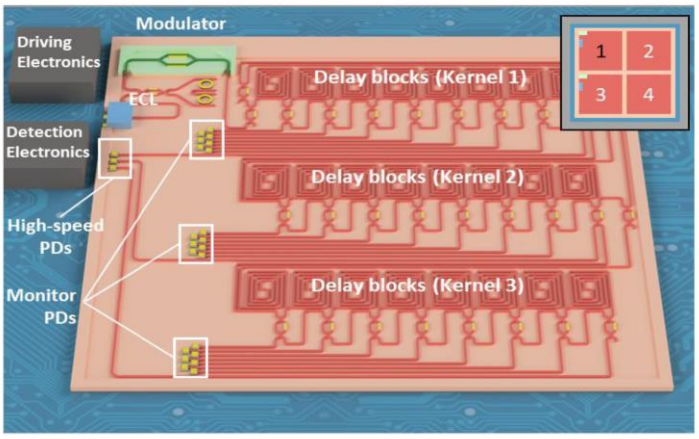


Target modules (VI)

Neuromorphic processors

System level:

- Modulation frequency:
  - Module-5 @10 Gbaud(**M18**)
  - Module-6 @40 Gbaud (**M30**)
- Operation wavelength: 905 nm
- Computation speed:
  - Module-5 6 TOPS
  - Module-6 24 TOPS



Contact

For more info, visit LOLIPOP website
https://horizon-de-lolipop.eu/

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Appendix IV: LOLIPOP Press release

Lithium niObate empowered siLIcon nitride Platform for fragmentation-free OPeration in the visible and the NIR

Project Launch

The implementation of the LOLIPOP project was officially inaugurated with the kick-off meeting that took place on the 6th and 7th of October 2022. The twelve (12) members of the consortium participated in a two-day productive hybrid meeting which was held at the premises of LioniX International in Enschede. During the hybrid event, LOLIPOP's workplan was analyzed in depth, the role of each partner in the project's deployment specified in detail, and the next actions towards the achievement of project's objectives defined.

Despite huge progress in photonics, extended spectral bands at the wavelengths below 1100 nm remain heavily underserved in terms of integration solutions. At the same time, silicon nitride is booming, and lithium niobate is making an impressive comeback in the form of lithium niobate on insulator (LNOI), with both materials being transparent both in the visible spectrum and near infrared (NIR) part of the spectrum.

With all these viewed as a unique opportunity, LOLIPOP steps in to develop a disruptive platform that will offer the highest integration, modulation, and second order nonlinear performance in the entire spectrum from 400 nm up to 1600 nm, based on the combination of LNOI and silicon-nitride (TriPleX®) technology. To this end, LOLIPOP will develop die-bonding and micro-transfer-printing methods for low-loss (<0.5 dB) integration of LNOI films on TriPleX® without compromising in functionality of the two platforms.

LOLIPOP will also develop a process for the growth of Ge photodiodes (PDs) inside pockets and a process for the flip-chip bonding of active elements inside recesses within TriPleX®. Given the possibility of the Ge-PDs to operate in the entire 400 -1600 nm spectral area, and the flexibility of the bonding process to adapt to different actives and wavelengths, the picture of this ultra-wideband technology is complete.

LOLIPOP will demonstrate its potential via the development of:

1) The first ever integrated laser Doppler vibrometer at 532 nm with ultra-narrow linewidth (<5 kHz) and ultra-high modulation (6 GHz),

2) the first ever integrated FMCW-LIDAR at 905 nm with ultra-high linear chirp (10 GHz) and optical phased array-based 2D beam scanning,

3) photonic convolutional neural networks with record scale, computation speed (24 TOPS), and power consumption reduction compared to electronic solutions, and

4) the first ever integrated squeezed-state source with 6 dB squeezing level for quantum applications at 1550 nm.

A roadmap for offering LOLIPOP technology as commercial services will be prepared.

Funded by the European Union

Project facts

Topic: HORIZON-CL4-2021-DIGITAL-EMERGING-01-07 Advanced photonic integrated circuits
Project no: 101070441
Start date: 1 September 2022
Duration: 42 Months
EU contribution: € 4.996.729,25
Beneficiaries: 12 Partners from 6 countries

LOLIPOP project comprises twelve (12) partners from six (6) European countries among which:

2 Large companies: Polytec (DE), and LioniX International BV (NL)

3 world renowned research and technology organizations: imec (BE), University College Cork – National University of Ireland (IE), and CSEM SA[1] (CH)

5 SMEs: PHIX Photonics Assembly (NL), Optagon Photonics (EL), Superlum Diodes Limited (IE), QuiX Quantum BV(NL), and Irida Labs (EL)

2 Academic organizations: University of Twente (NL), and the Institute of Communications & Computer Systems (EL) that coordinates the action.

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[1] Funded by SERI

Funded by the European Union