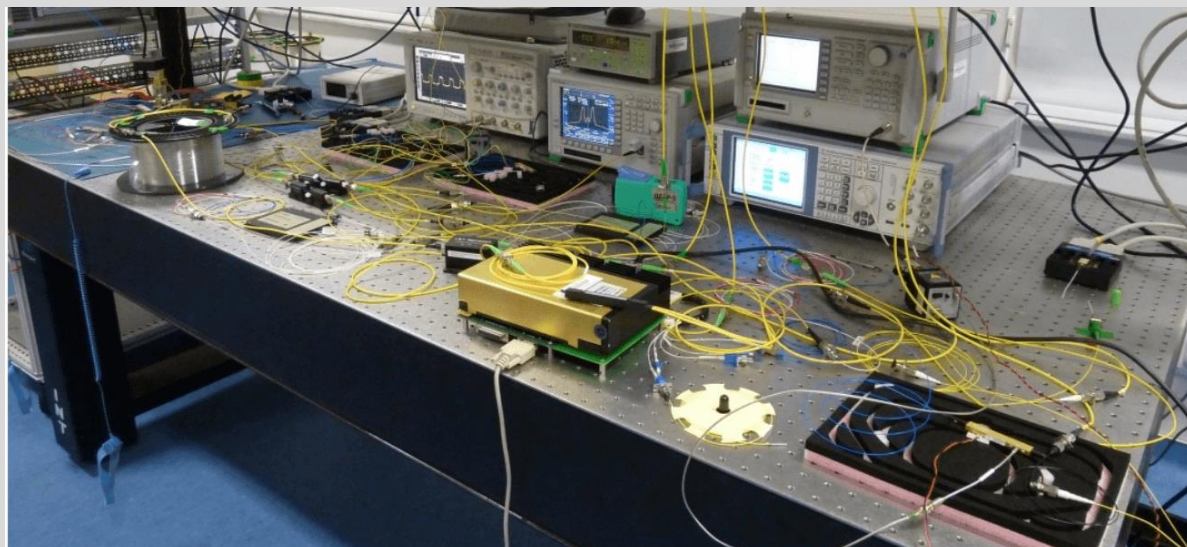
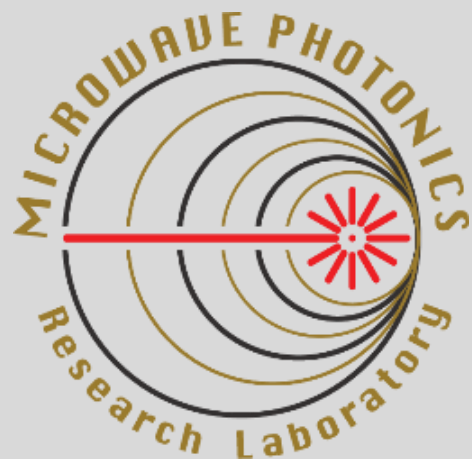


Cyprus Space Info Day 2022

PECS Activities in the Microwave Photonics Research Laboratory (MPRL) at the University of Cyprus

Stavros Iezekiel
iezekiel@ucy.ac.cy



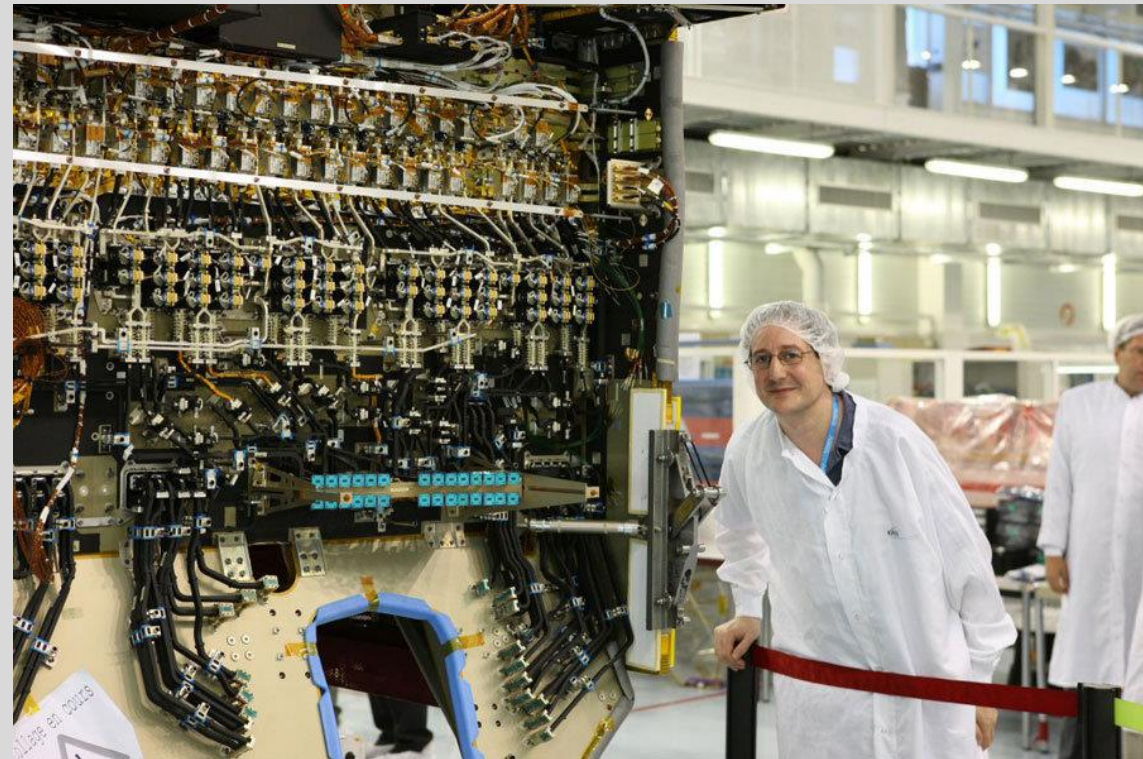
Mission:

To use photonic technologies and techniques to enhance the performance and functionality of microwave systems. Examples include the photonic generation and control of microwave and mm-wave signals for satellite payloads and 5G systems.

Eutelsat's Ka-Sat carries almost 1100 radio-frequency waveguide filters

Trends/requirements:

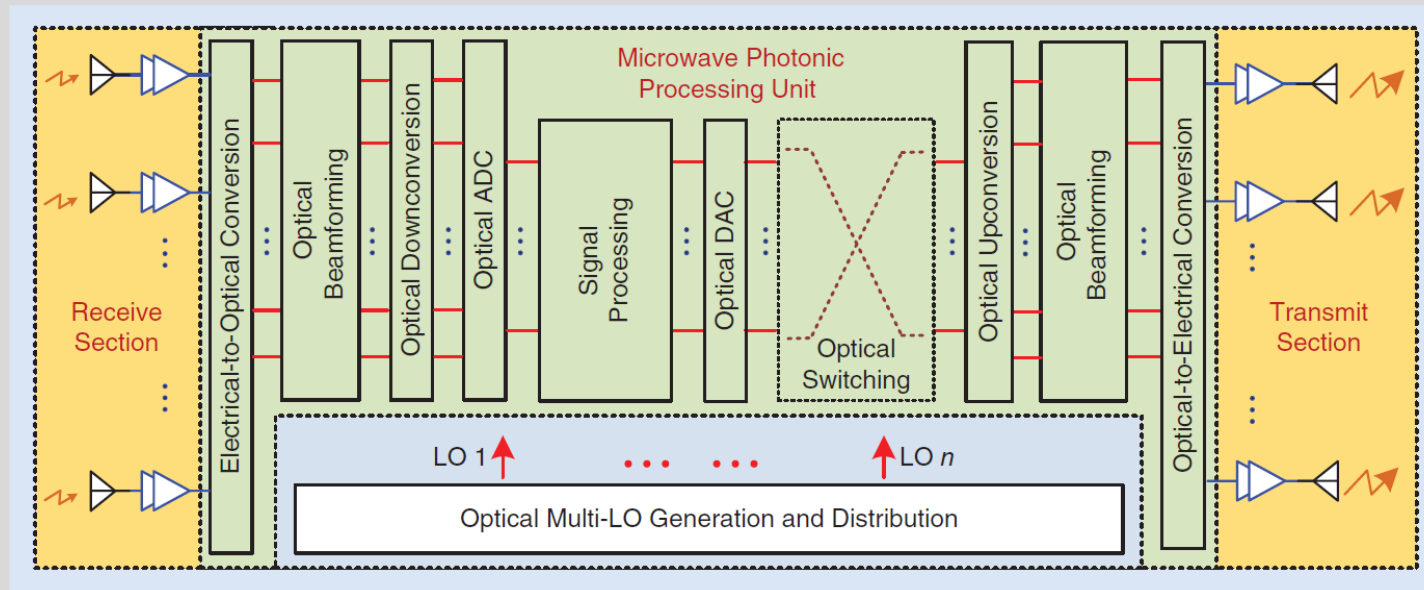
- Evolution to higher carrier frequencies
- Reconfigurability
- SWaP



https://www.esa.int/ESA_Multimedia/Images/2017/08/RF_filters_in_telecom_satellite

Concept of integrated microwave photonic payload:

Our work is focused on microwave photonic (MWP) techniques for implementation of frequency generation units (FGU). Integrated microwave photonics is especially attractive for addressing both bandwidth and SWaP requirements, in addition to offering high levels of functionality. A key advantage of MWP is the capability of producing microwave and mm-wave signals with low phase noise



Increasing integration

Main Portfolio: Projects in microwave photonic frequency generation units (microwaves through to mm-waves)

- PECS3: From 2023 {235 k€}
- MIPHOSAT-3
- Continuation of MIPHOSAT-2 {to progress to TRL4}

- PECS2: 2019 – 2023 {194 k€}
- MIPHOSAT-2
- Integrated Photonics Implementation of 30 GHz and 60 GHz FGU based on Optical Combs
- TRL 2 ⇒ TRL 3

- PECS1: 2018 -2021 {197 k€; subcontractor: Avanti Hylas}
- MIPHOSAT-1
- Ka-band FGU/FCU based on conventional OEO
- TRL 2 ⇒ TRL 3

- PECS4: 2022 – 2024 {249 k€; subcontractor ETHZ}
- OEO-THz
- Development of sub-THz optoelectronic oscillator
- TRL 2 ⇒ TRL 3

Increasing LO frequency

Title: Photonic Integrated Circuit-based Micro-LIDAR (PICSAR).

Prime Contractor: University of Cyprus

PECS Budget:

99 k€

Co-funded Budget:

0 k€

Contract No.: 4000135259/21/NL/SC / Proposal ID: CY_16

Year of Contract: 2021

Proj. Mgr.: Stavros Iezekiel

Email PoC: iezekiel@ucy.ac.cy

TRL

Initial: 2

Achieved: TBD

Target: 3

Date: Sep 2022

Background and justification:

In this project we will investigate the feasibility of PIC technology for micro-LIDARs for space applications focused on small satellite navigation, celestial body approach & landing, space debris identification and rendezvous and docking.

Objective(s): Our aim is to develop a fully integrated LIDAR operating up to 100 km range based on the hybrid integration of PIC in the InP and SiN platforms. The laser beam will be transmitted through a 1D OPA based on waveguide grating antennas.

Achievements and status: To May 2022

We performed a link budget analysis and we obtained that the PIC microlidar can operate up to 100 km when using 1 W CW telecom-wavelength source with ultra-narrow Lorentzian linewidth of 1 kHz and internally-frequency-swept 1D OPA. These results are very promising for ranging or landing applications.

Benefits: LIDAR system with low SWaP (size, weight and power) and high resolution/accuracy can be realized by replacing the existing discrete optical and optoelectronic components with one or more PICs co-integrated with the associated electronics and micro-optics.

Next steps:

The most critical component of our system is the OPA. Therefore, simulations using FDTD software must be performed to define the performance parameters (e.g. FoV, beam divergence, coupling efficiency) of the OPA.

Our experience, lessons learned, best practice & tips

ESA-PECS Projects are Challenging

- For the academics: do **NOT** think of them as a substitute for EU Horizon or national funding schemes.

ESA-PECS Projects are Rewarding

- As a group that is relatively new to space science & technology, the interaction with ESA has accelerated our knowledge of the field and created new links with key players both in Cyprus but also in Europe & Canada.

Our experience, lessons learned, best practice & tips

ESA Technical Officers are worth their weight in gold

- Technical officers are a key element of the contract, providing not only technical advice and guidance, but also helping to keep the project on track and helping create new contacts with companies.
- Keep them in the loop.
- ESA as a whole is a **proactive** partner (unlike funding agencies) – they want to help!

Our experience, lessons learned, best practice & tips

Learn to do things the ESA way

- PECS is an excellent mechanism for learning:
 - How to write tenders (proposals)
 - How to manage and report on a successful contract (project)
 - How ESA does business.
- Attendance at ESA Briefing events is **invaluable**, especially if you **listen** to the advice given by ESA personnel!
- Teaming up with companies/universities that have experience of working with ESA is an excellent way for newcomers to gain experience of their own.

Our experience, lessons learned, best practice & tips

Obtaining funding

- Ensure your proposal is **relevant and is a good idea** (not just wishful thinking).
- Use the appropriate scheme, e.g. feasibility study for very low TRL.
- Follow the template – most of it is self-explanatory.
- The project implementation part (e.g. work flow/WBS) is just as important as the technical case.
- Give yourself enough time!

The Way Forward

Investment in Infrastructure is **CRITICAL**

- In order for Cypriot companies & universities to fully exploit the opportunities in the space sector, additional investment from government is needed. (ESA will not fund this.)
- Suggestion: National Core Facilities (e.g. hosted by universities but accessible to industry).
- Examples:
 - Antenna Test Facility
 - Microwave and Photonics Test Facility
 - Clean Room

The Way Forward

It should be easier for spin-out companies to be created

- For ESA, the value chain is critical.
- Cyprus has the potential for a significant space cluster.
- BUT: Current legislation does NOT provide incentives for academics to form spin-out companies.
- Ideally in the future Cyprus should host an ESA Business Incubation Centre.