

# Photonic Integration for Satellite Applications



antwerpspace

An OHB Company

“EPIC Meeting on Photonics” at European Space Agency (ESA)

13-14 Sep 2022

Hakimeh Mohammadhosseini



# What you will see in this presentation

- ▶ How Photonic Integration Technology (PIC) could contribute to Satellite applications?

***At Antwerp Space we focus on leveraging PIC technology for:***

- ▶ Telecom Payloads (EPFCV2)
- ▶ Radar Payloads (Spacebeam)
- ▶ Laser Communication (Photonic Lantern)
- ▶ Quantum Key Distribution (QKD) (QRNG)

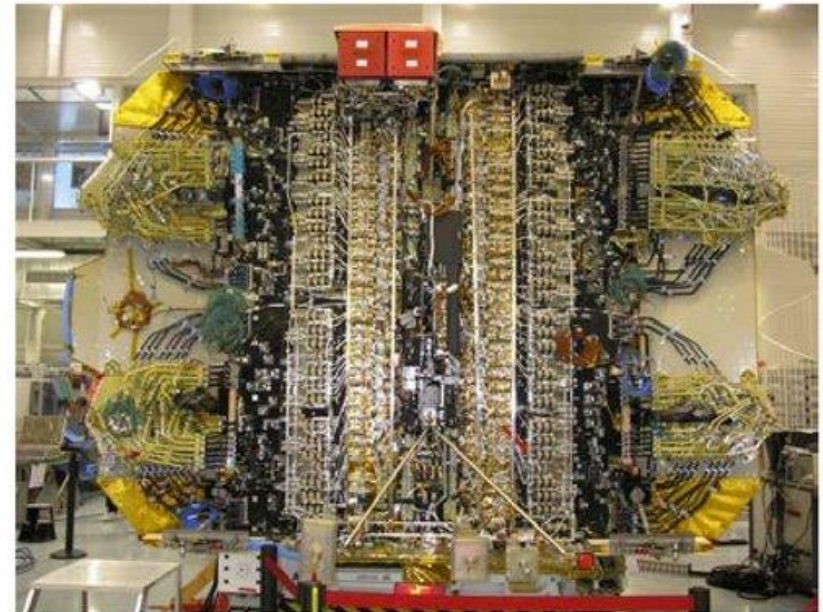


*First Woman Graphic Novels*

# Why Photonics for Telecom Payloads?

- ▶ COMSAT Payloads can be huge!

*Replacement of conventional RF payload equipment with their photonic counterparts and using fiber optic cables in place of coaxial cables and waveguides can enable dramatic reduction of mass for the terabit/s **satellite***



*Typical Payload Panel Equipment Layout using Conventional RF Equipment*

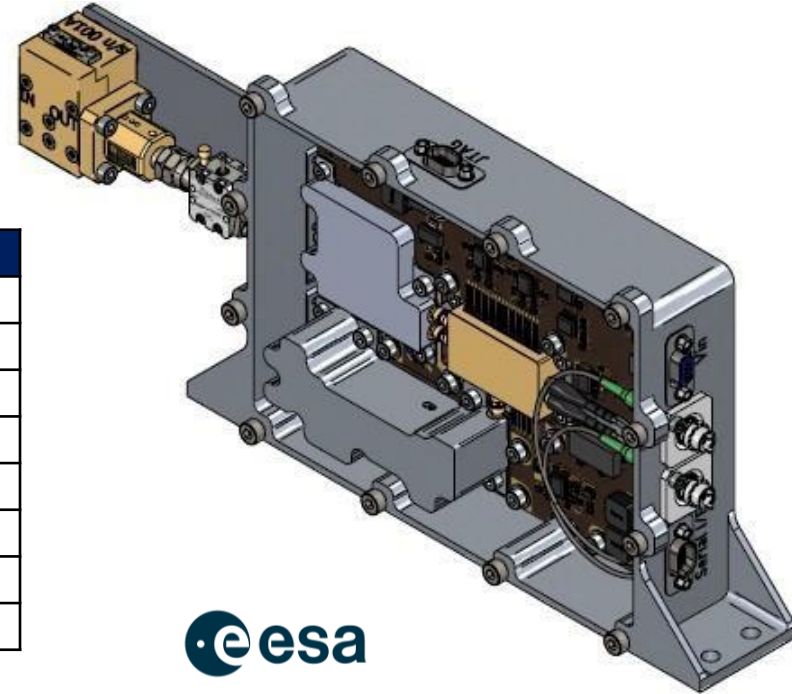
*Applications of photonics in next generation telecommunication satellites payloads*

*J. Anzalchi, et al. Airbus Defense & Space, ICSO2014*

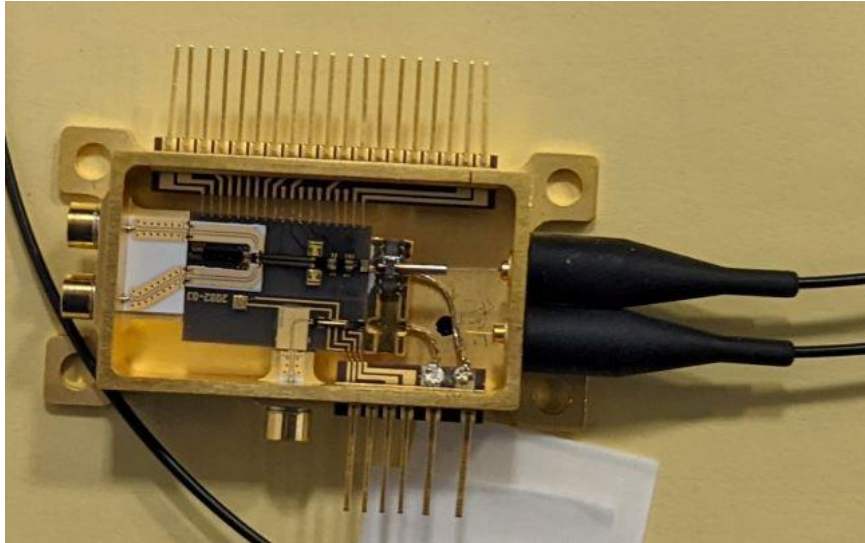
# Antwerp Space EPFCV2

## A PIC-based Electro-Photonic Frequency Converter

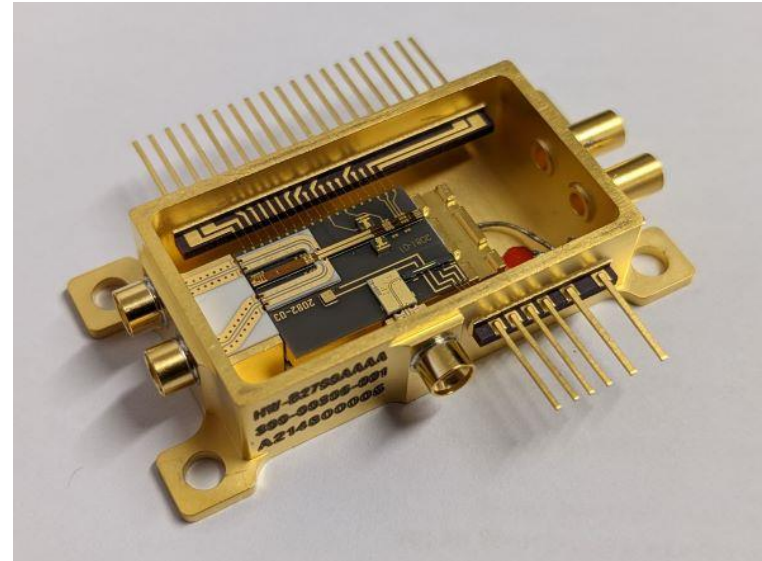
Specification	Value	Unit
Operational RF Frequency Range	47.2 to 50.2	GHz
LO Frequency	30	GHz
IF Frequency	17.2 to 20.2	GHz
F-conversion Technology	Photonic Integration	NA
Operational optical wavelength	C-band	nm
Optical Interface	Mini AVIM	NA
RF, LO, and IF inputs	Feedthrough pins	NA
RF input power range	-60 to -35	dBm



# Packaged Photonic Integrated Circuit (PPIC)

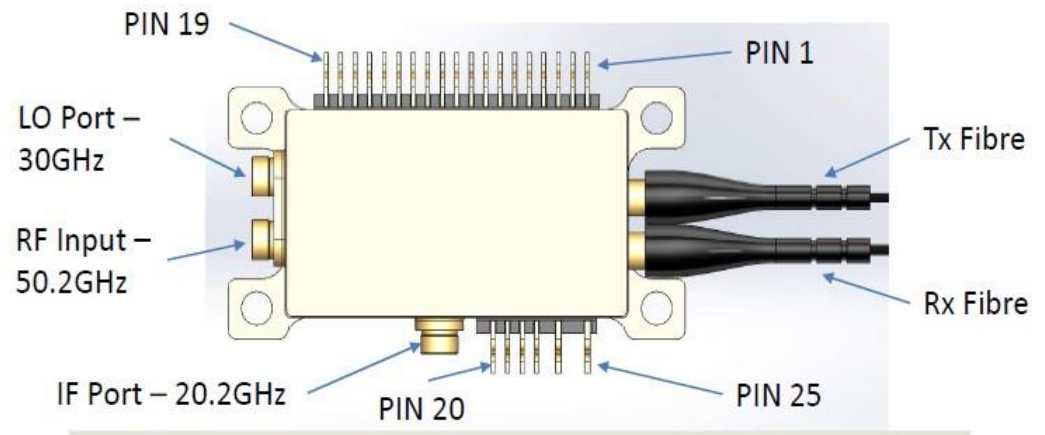


*Designed and fabricated by Alter UK.*



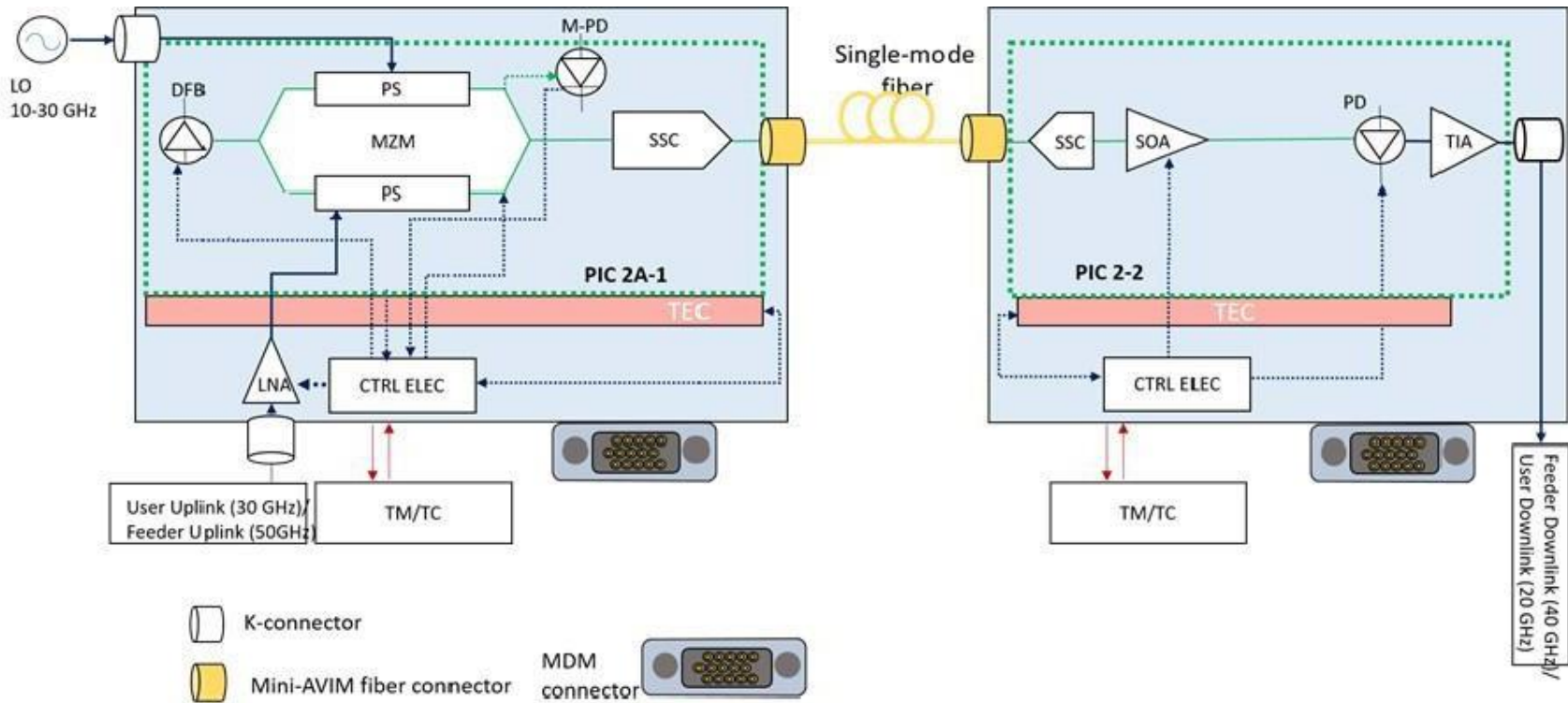
*Designed and fabricated by Alter UK.*

# Hermetically sealed PPIC

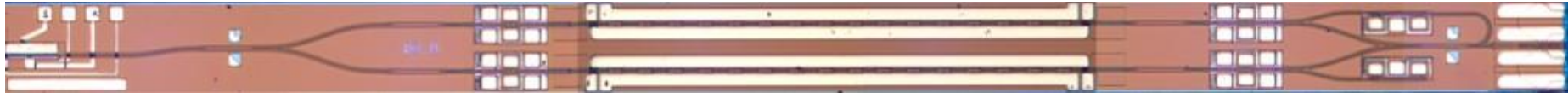


Specification	Value	Unit
PPIC size2	40 × 26 × 16	mm3
PPIC mass	<40	grams
PPIC components	Thermal, Optical, and RF parts	NA
Material and Processes of PPIC are in accordance with ECSS-Q-ST-70C		

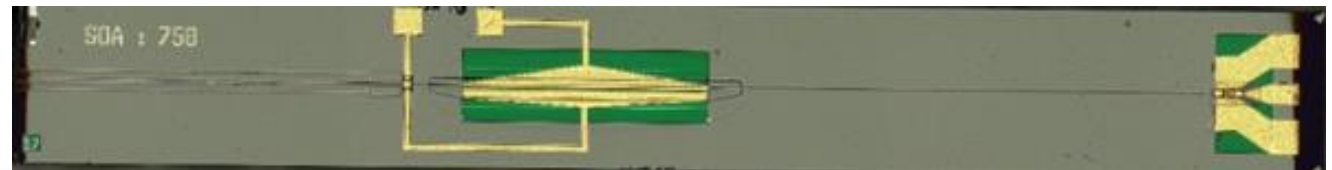
# EPFCV2 integrated microwave photonic link



# Fabricated Transmitter & Receiver chips

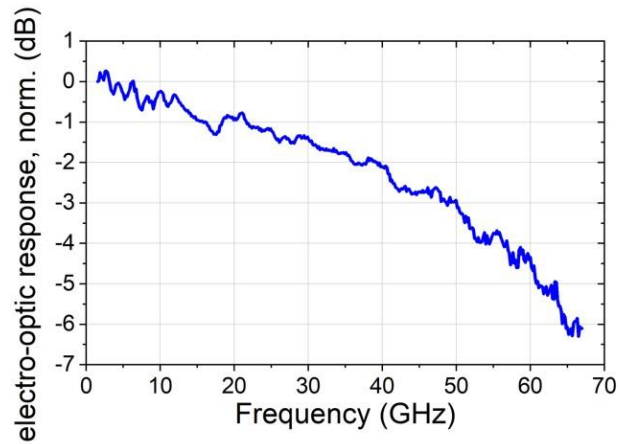
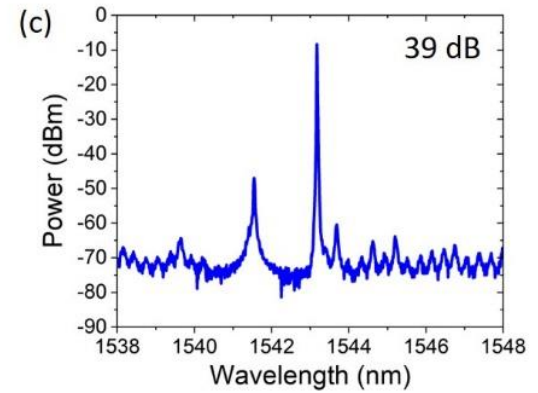
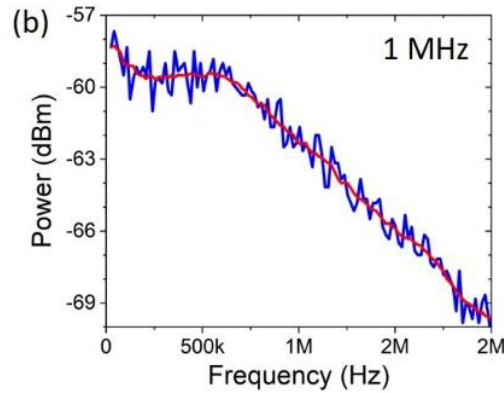
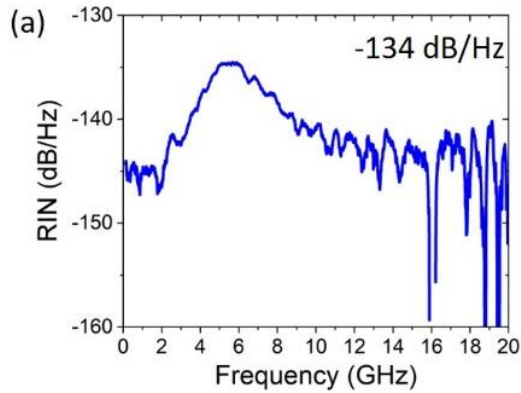


Metric	Value	Unit
IQM modulator 3dB Bandwidth	50	GHz
Wavelength range	C-band	nm
Laser type	DFB	NA
Laser RIN	<140	dB/Hz
Laser linewidth	< 3	MHz
SMSR	40	dB
PD 3dB BW	<20	GHz
PD responsivity	0.8	A/W
SOA Gain	20	dB

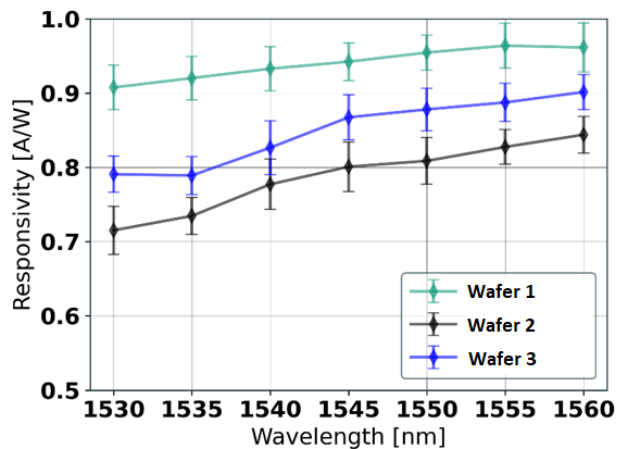
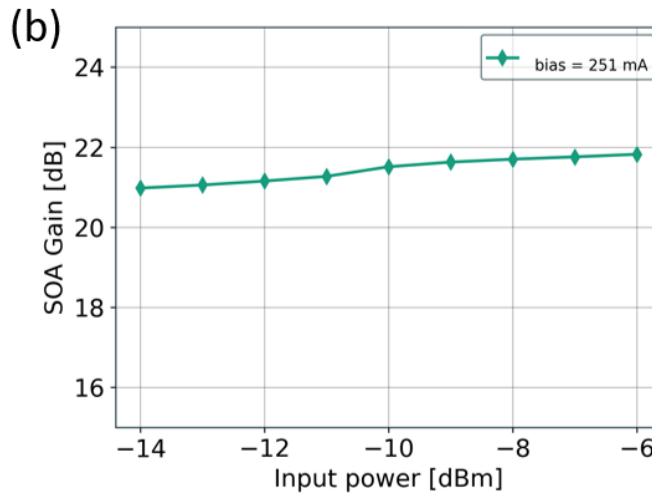
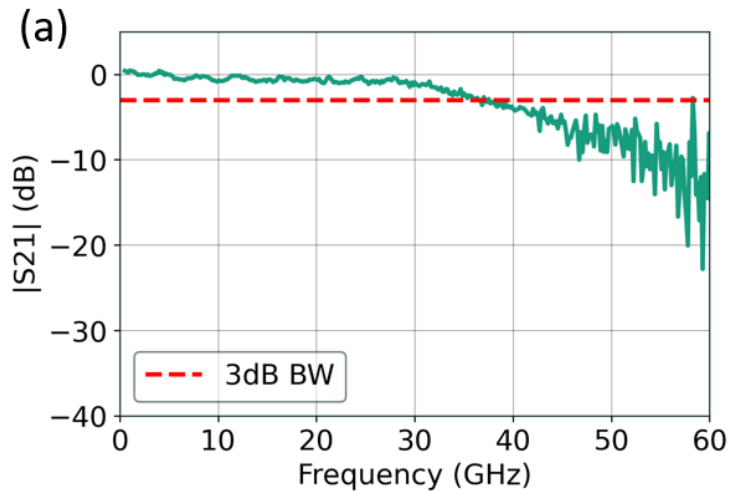




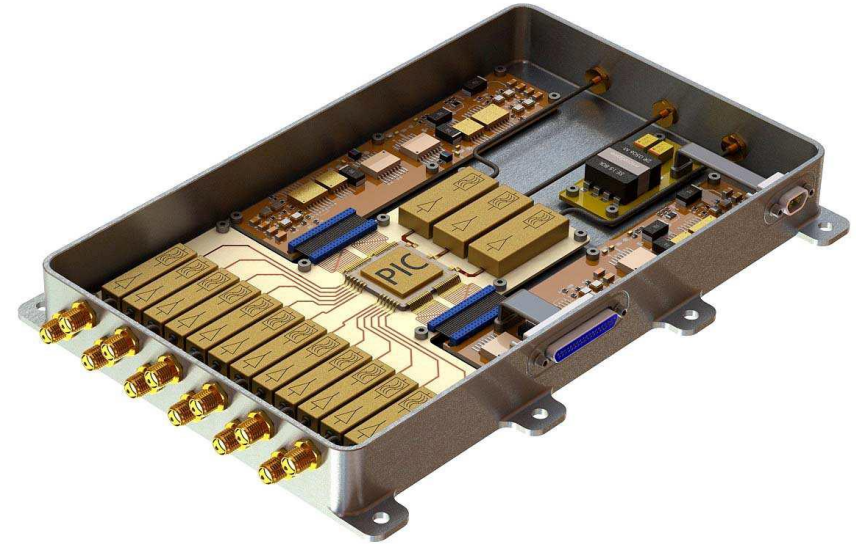
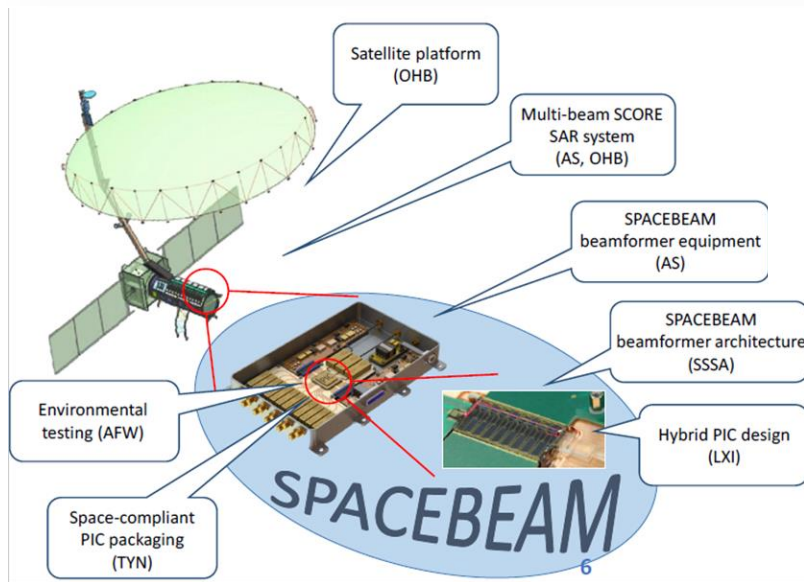
# Measurement results on Tx-side: RIN, line



# Measurement results on Rx-side



# Spacebeam: A reconfigurable multi-beam Scan-on-Receive Synthetic Aperture Radar



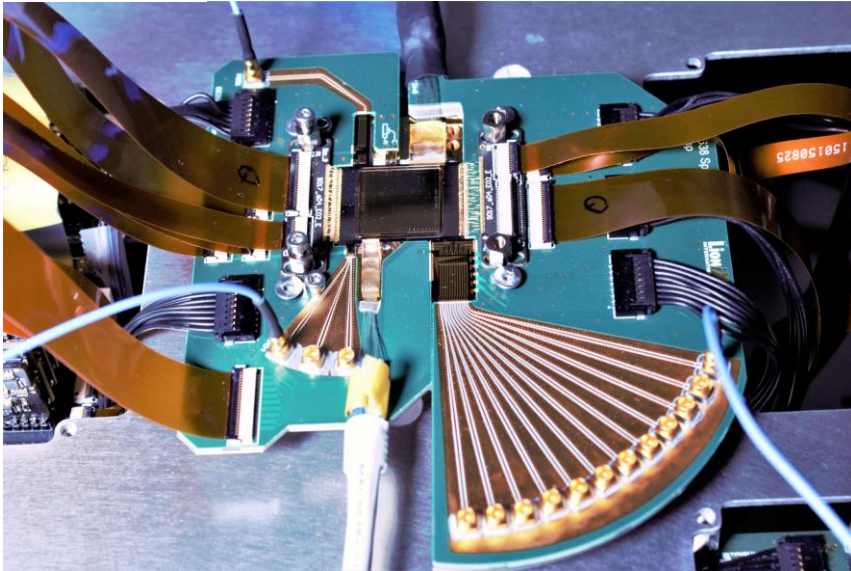
*SPACEBEAM develops a reconfigurable multi-beam Scan-on-Receive SAR for Earth observation*



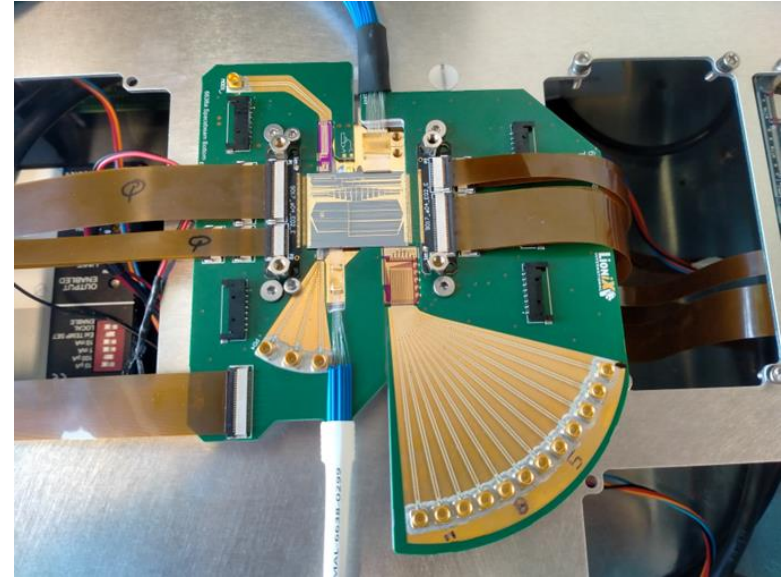
Parameter	Value
Frequency band	X-band
Bandwidth	390 MHz
Ground resolution	1.5-by-1.5 m
Swath	30 x 30 km
Dynamic range	30 dB
Beamshaping	PIC-based
Control	PZT

Photonic Integ

# Spacebeam latest updates ...

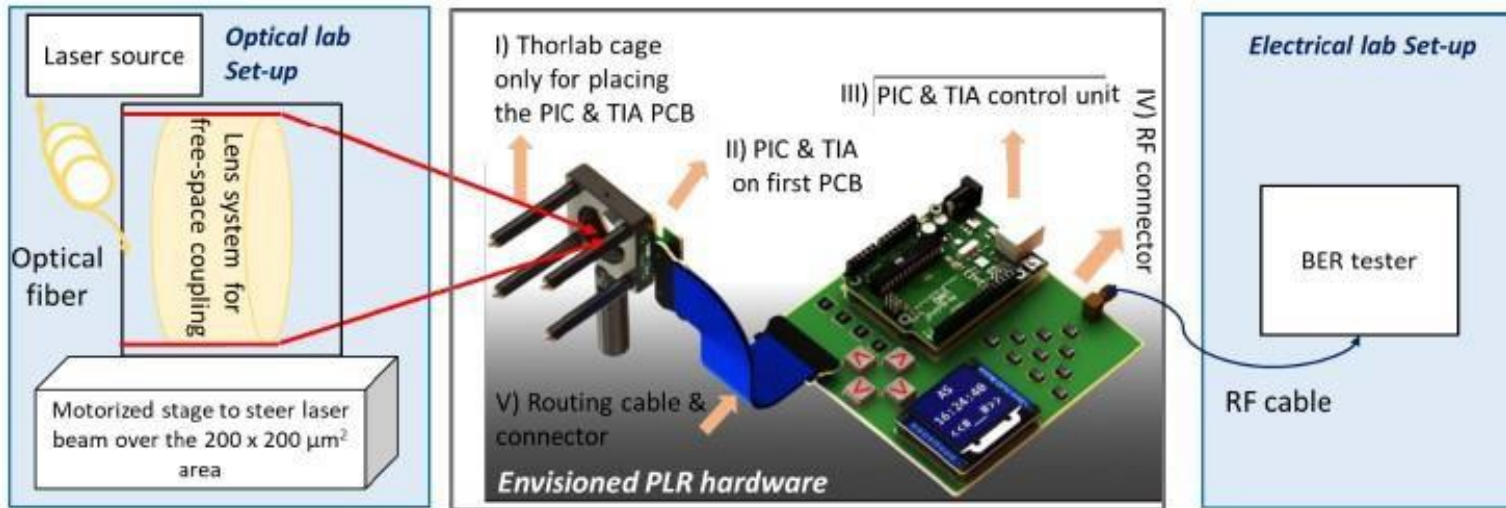


*A PZT-based beamformer*



*A heater-based beamformer*

# Photonic Lantern Receiver: Hardware & Test Strategy



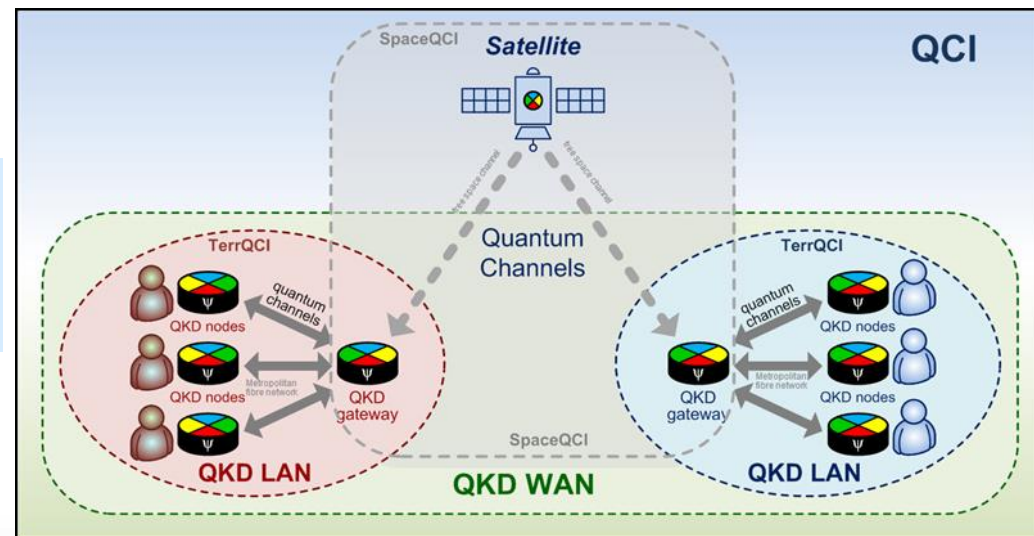
Metric	Value	Unit
Receiving area	$200 \times 200$	$\mu\text{m}^2$
Optical insertion losses	-10.5	dB
Operating wavelength	1550	Nm
Data rate	1.2	Gbps
PD responsivity	0.8	A/W
Rx input requirement	Single Optical input	NA
Rx output channel	Single signal output	NA
Features	Non-mechanical, with an integrated PD, 4Q sensor, extendable surface area	



# QRNG

- ▶ EU is planning a Quantum Key Distribution network to make the European communication structure secure against hacking by quantum computers: EuroQCI
- ▶ EU: Program EURO QCI
  - Space segment called Space QCI – Development is handled by ESA under SAGA
  - Ground segment called Terra QCI - Development lead by Airbus

*Antwerp Space is working on QRNG for SAGA*



# Thank you !

Is there any Questions ?

Contact:

[hakimeh.Mohammadhosseini@antwersp.space](mailto:hakimeh.Mohammadhosseini@antwersp.space)

[stephan.roemer@antwersp.space](mailto:stephan.roemer@antwersp.space)



**antwersp.space**

An OHB Company

