April 30th, 2024

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Stronger together

2000

EMPLOYEES

320+

MILLIONS EUROS
OF TURNOVER

20+

% OF TURNOVER
INVESTED IN R&D

80%

OF TURNOVER
IN EXPORT

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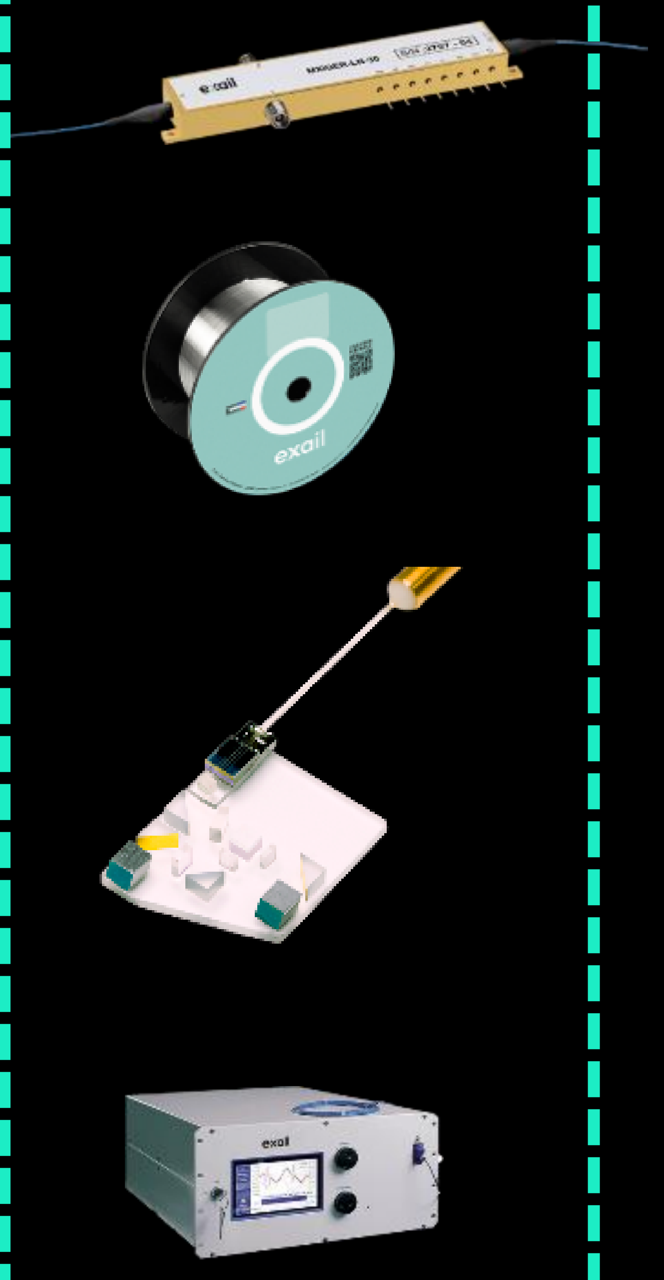
From components to complex systems

Components

Photonics



Equipment

Inertial navigation

Sonars & positioning

Quantum instruments

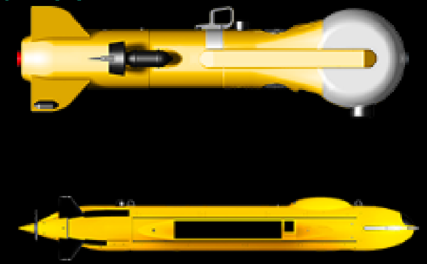
On-board electronic

Simulators

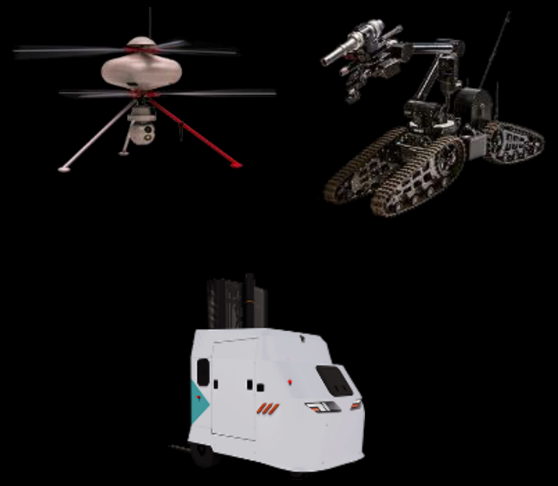
Platforms

Surface drones

Underwater drones

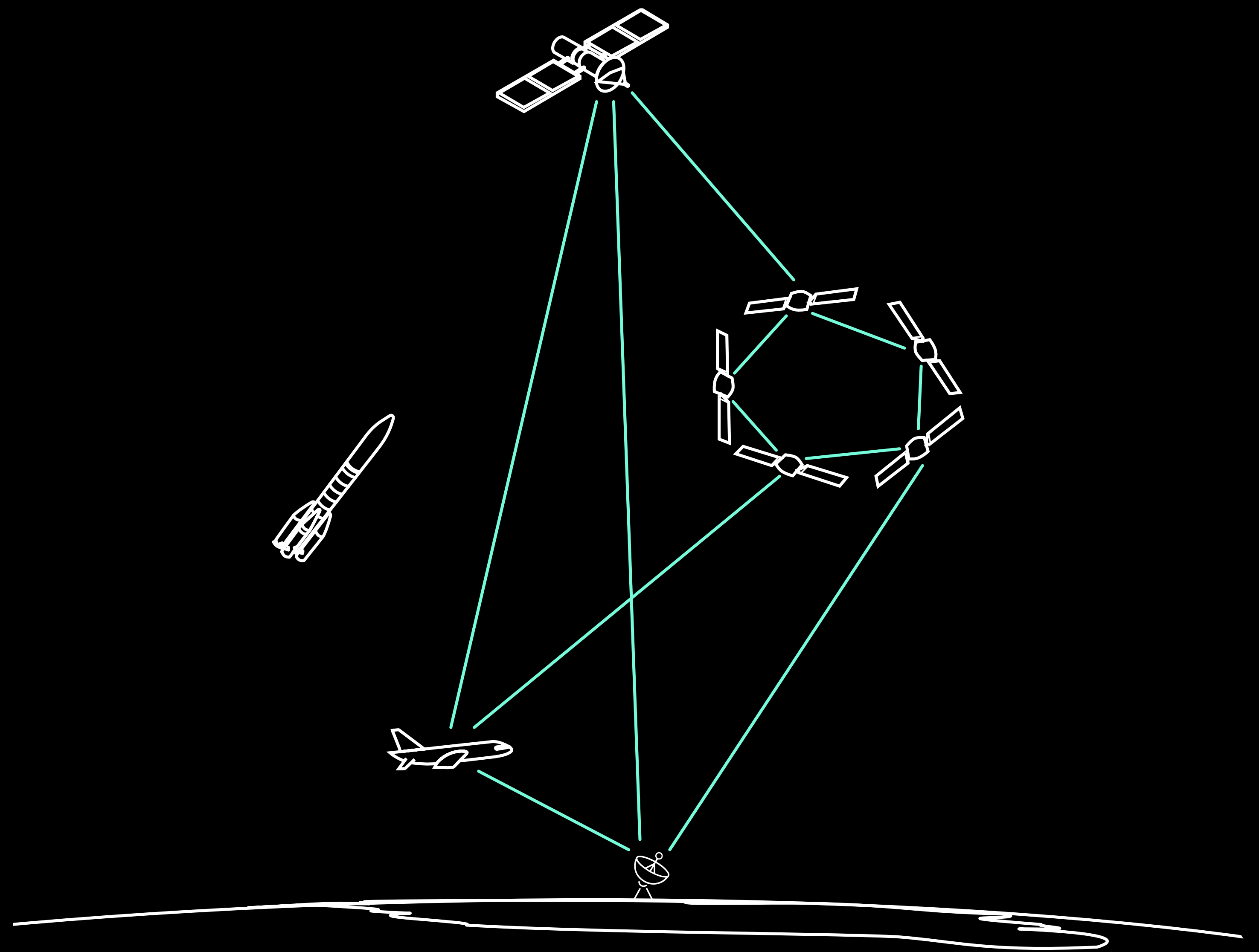


Unmanned ground & aerial vehicles



Complex systems

NAVIGATION + COMMUNICATION



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$LiNbO_3$ Phase modulators dedicated to industrial applications

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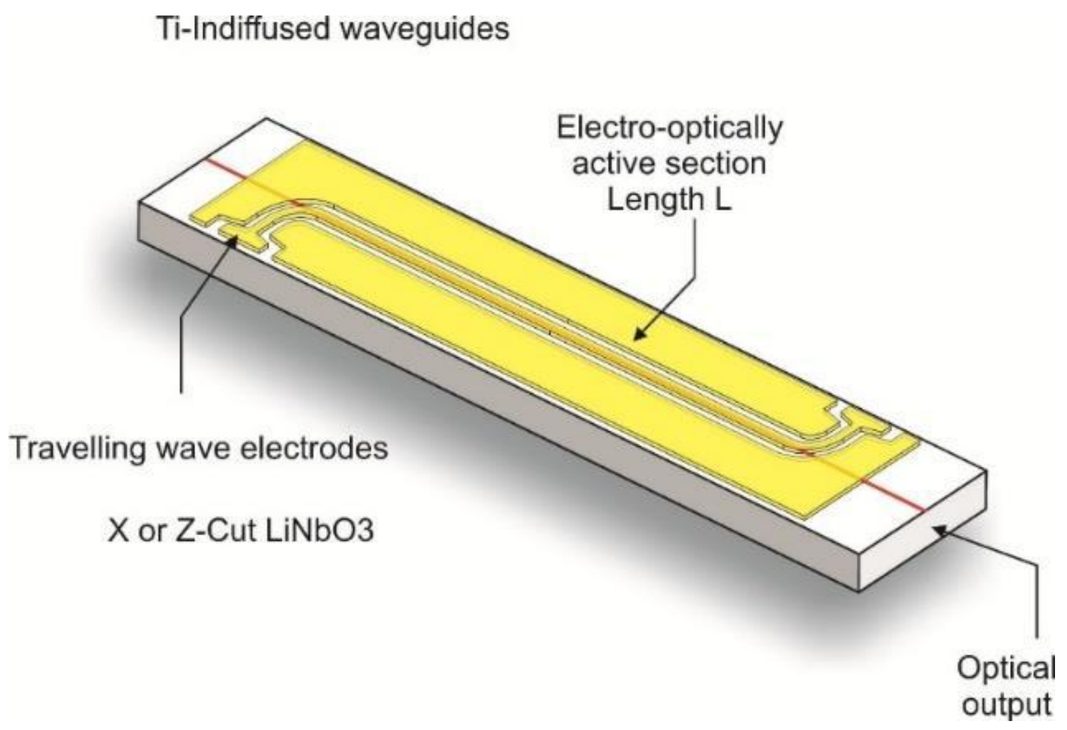
1. The $LiNbO_3$ Phase modulators principle and the application needs

Principle:

- Expression of the optical field modulated by sine voltage $E(t) = E_0 \; e^{j\omega t} e^{j\gamma \sin(\Omega t)}$ with $\gamma = \pi . \frac{V_0}{V_\pi(\Omega)}$: the modulation index.

Applications:

- Spectroscopy and laser cooling experiments
- Fiber lasers for frequency broadening and Brillouin effect suppression
- Fiber Laser based on Coherent Beams Combining
- Fiber Laser based on Spectral Beams Combining
- Frequency stabilization of lasers when using the Pound Drever Hall locking technique
- Terrestrial and space modulation DPSK
- Sensors: lidar, gyroscope



Specifications:

- Optical input power, $V\pi$, Insertion loss
- RAM, PDL, PER, DC Coupled, Resonant, Chip on base plate, High optical or RF input powers, Fibered, Free space, Radiation resistant,…



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2.2
UP TO 20 GHZ EO USABLE BANDWIDTH AND LOW VPI PHASE MODULATOR:

THE NIR-MPZ-LN-10-LVP

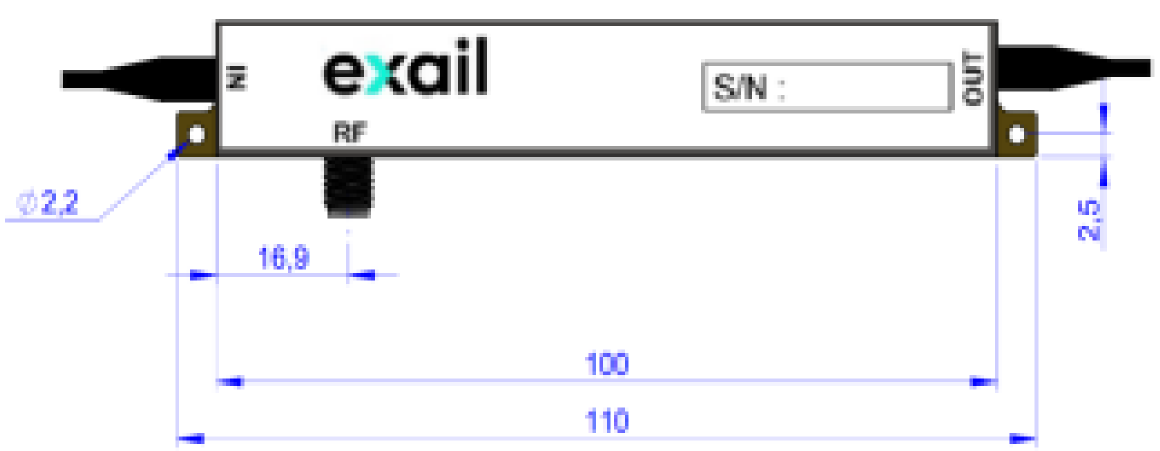
The NIR-MPZ-LN-10-LVP general specification

NIR-MPZ-LN-10-LVP:

- New optical broadband (-3dB@10GHz) phase modulator with a low Vpi characteristic.

Key parameters:

- Usable Electro-Optical Bandwidth up to 20 GHz
- $V\pi$ @ 50kHz = 2 V
- $V\pi$ @ 10 GHz = 3 V
- 2 dB < IL < 4 dB
- Longer mechanical housing (+15mm)



NIR-MPZ-LN-10-LVP

20 GHz Phase Modulator

Electrical Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Electro-optical (EO) bandwidth	S_{21}	-	10	12	-	GHz
Usable EO bandwidth	S_{21}	-	-	20	-	GHz
Ripple S_{21}	ΔS_{21}	-	-	0.5	1	dB
Electrical return loss	S_{11}	-	-	-13	-10	dB
Vπ RF @50 kHz / 1 GHz	$V\pi_{RF\ 50\ kHz/1\ GHz}$	-	-	2 / 2.3	-	V
Vπ RF @10 GHz	$V\pi_{RF\ 10\ GHz}$	-	-	3	-	V
RF input impedance	Z_{in-RF}	-	-	50	-	Ω

Optical Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Crystal	-	-	Lithium Niobate X-Cut Y-Prop			
Waveguide process	-	-	Proton exchange			
Operating wavelength	λ	-	950	1060	1150	nm
Insertion loss	IL	Without connectors [1]	-	3	4	dB
Polarization Extinction ratio	PER	Standard, without connectors [1]	20	-	-	dB
		Optional, w/ or w/o connectors [1]	25	30	-	dB
Optical return loss	ORL	-	-40	-45	-	dB

All specifications given at 25°C, 1060 nm, unless differently specified.
[1] Consider an extra-loss up to 0.4 dB for each FC/APC optical connector

Absolute Maximum Ratings

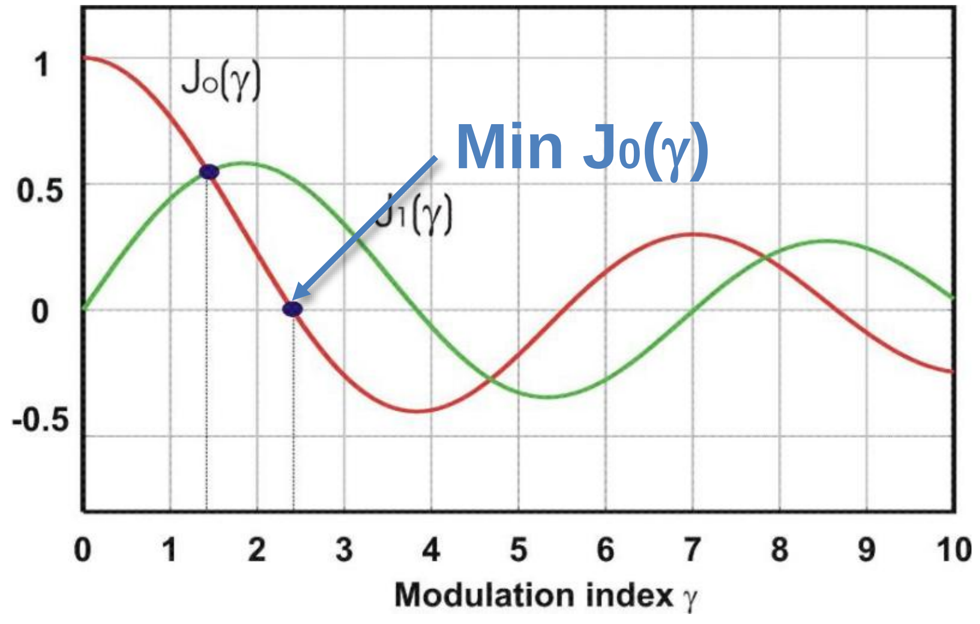
Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. These are absolute stress ratings only. Functional operation of the device is not implied at these or any other conditions in excess of those given in the operational sections of the data sheet. Exposure to absolute maximum ratings for extended periods can adversely affect device reliability.

Parameter	Symbol	Min	Max	Unit
Modulation voltage range	EV_{in}	-	+33	dBm
Optical input power (CW mode)	OP_{in}	-	+25	dBm
Operating temperature	OT	0	+70	°C
Storage temperature	ST	-40	+85	°C

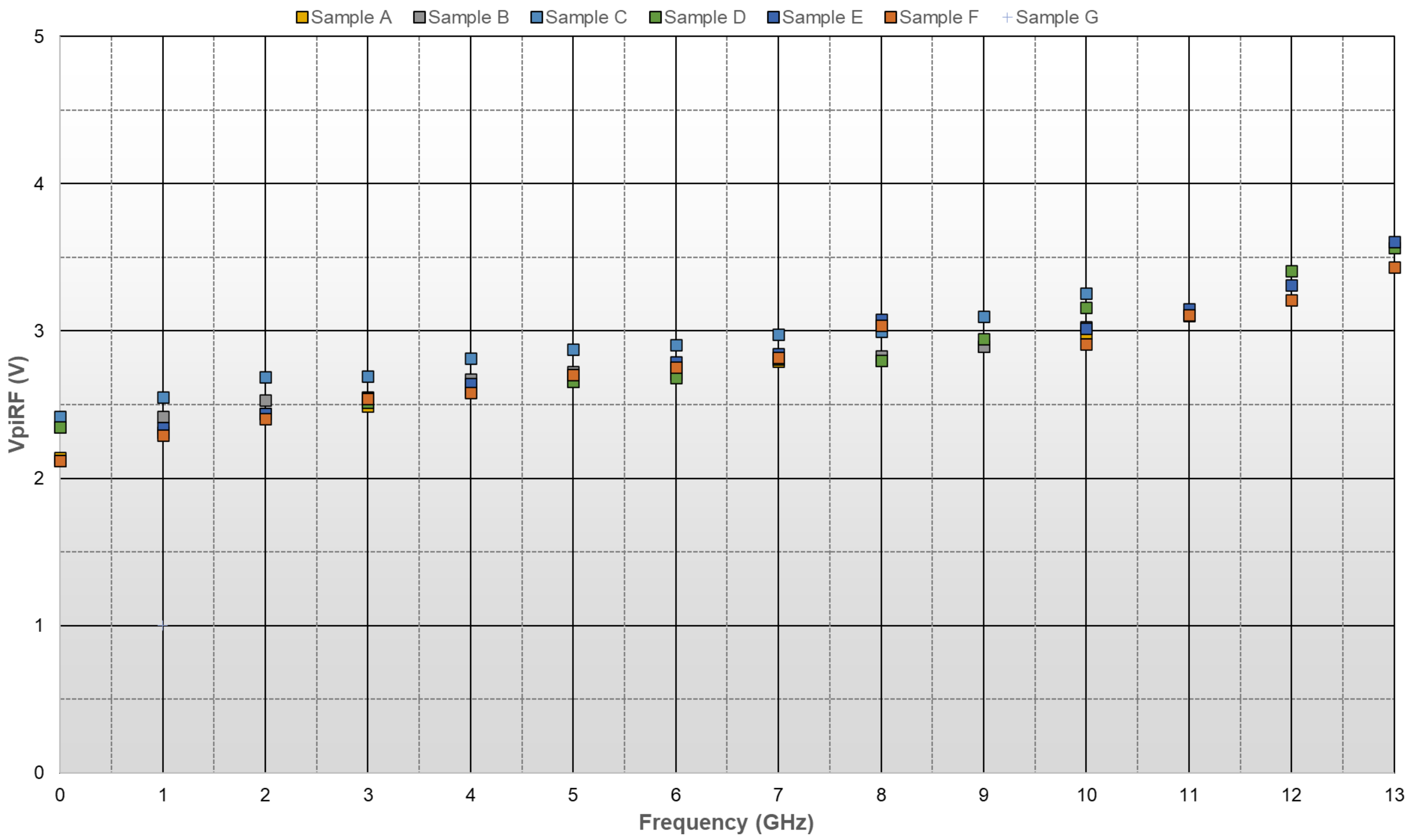
Key improvement: Vπ vs frequency evaluation

Measurement setup:

- λ = 1060nm
- Sinusoidal electrical modulation @ different frequencies
- Vπ (f) deduced from optical spectrum analysis (vanish the optical carrier).



Vπ versus frequency



Results:

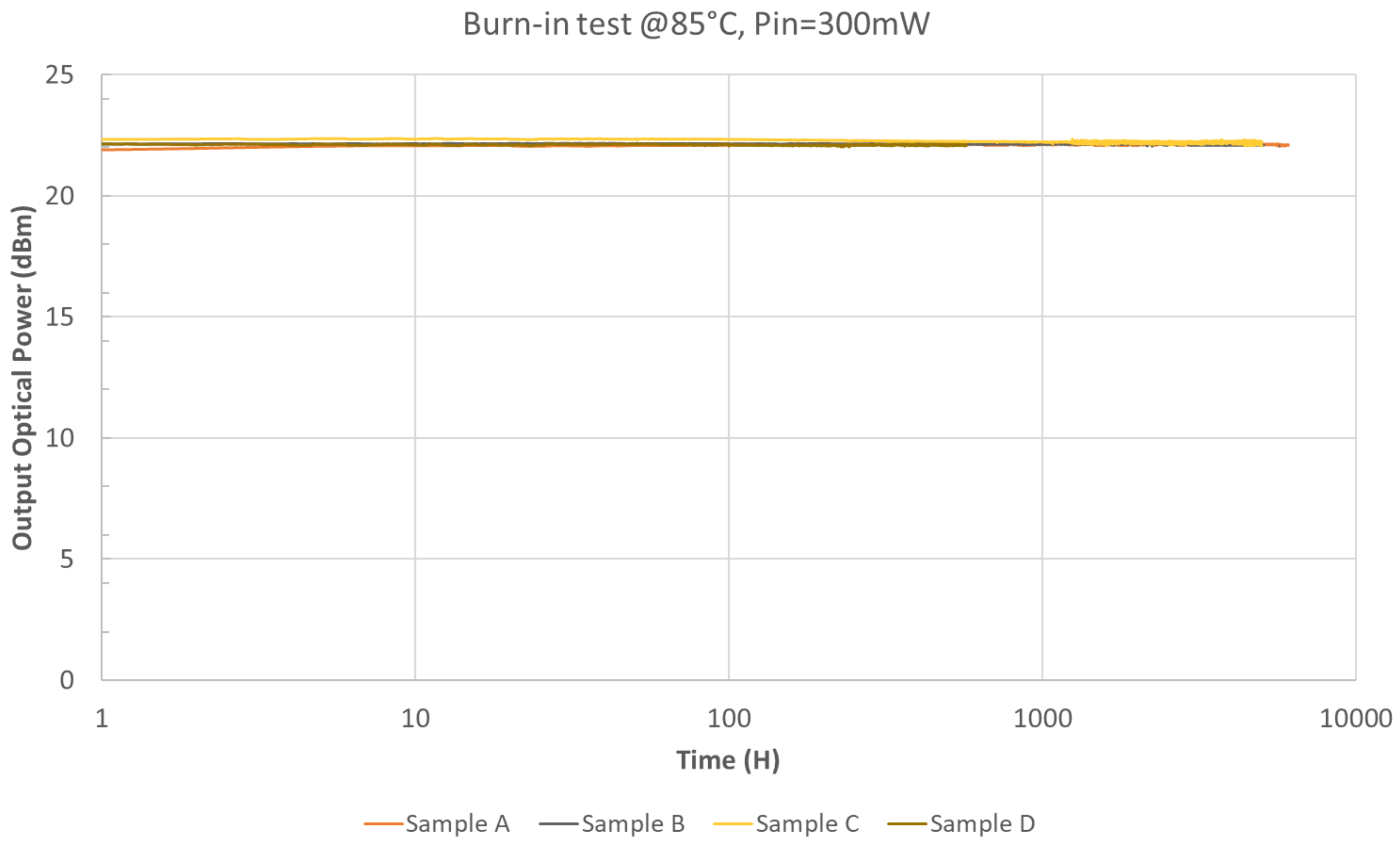
- Vπ @ 1 GHz = 2.3 V
- Vπ @ 10 GHz = 3 V

Accelerated aging test @ high optical input power level

Setup conditions:

- Optical Pin= 300 mW @1064 nm.
- T = 85 °C.
- Optical Pout recorded.

		Initial Test Before Screening (ITBS)	Final Test After Screening (FTAS)
Sample A	**IL (dB)**	2,4	2,3
Sample B		2,8	2,6
Sample C		2,3	2,6



Results:

- No degradation after a cumulated time of 16 500 H.
- Insertion loss variations < 0,3 dB.

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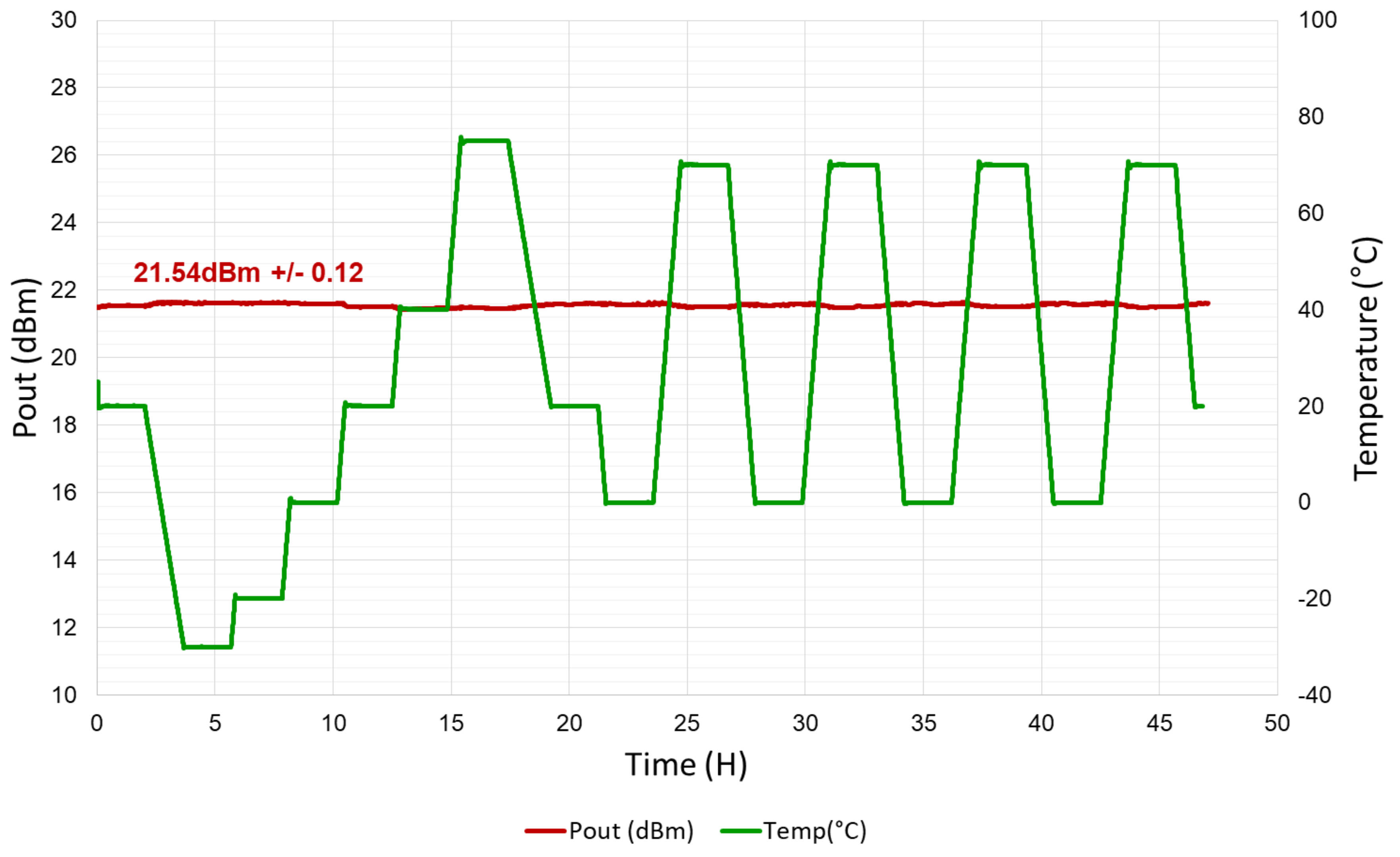
Optical power stability [-30 ; +75] °C

Setup:

- Temperature: [-30 ; +75]°C, ramp < 1°C / min
- Input optical power (CW): 300 mW
- Wavelength: 1064 nm
- RF input Power: +28 dBm @ 2 GHz
- Output optical power measured



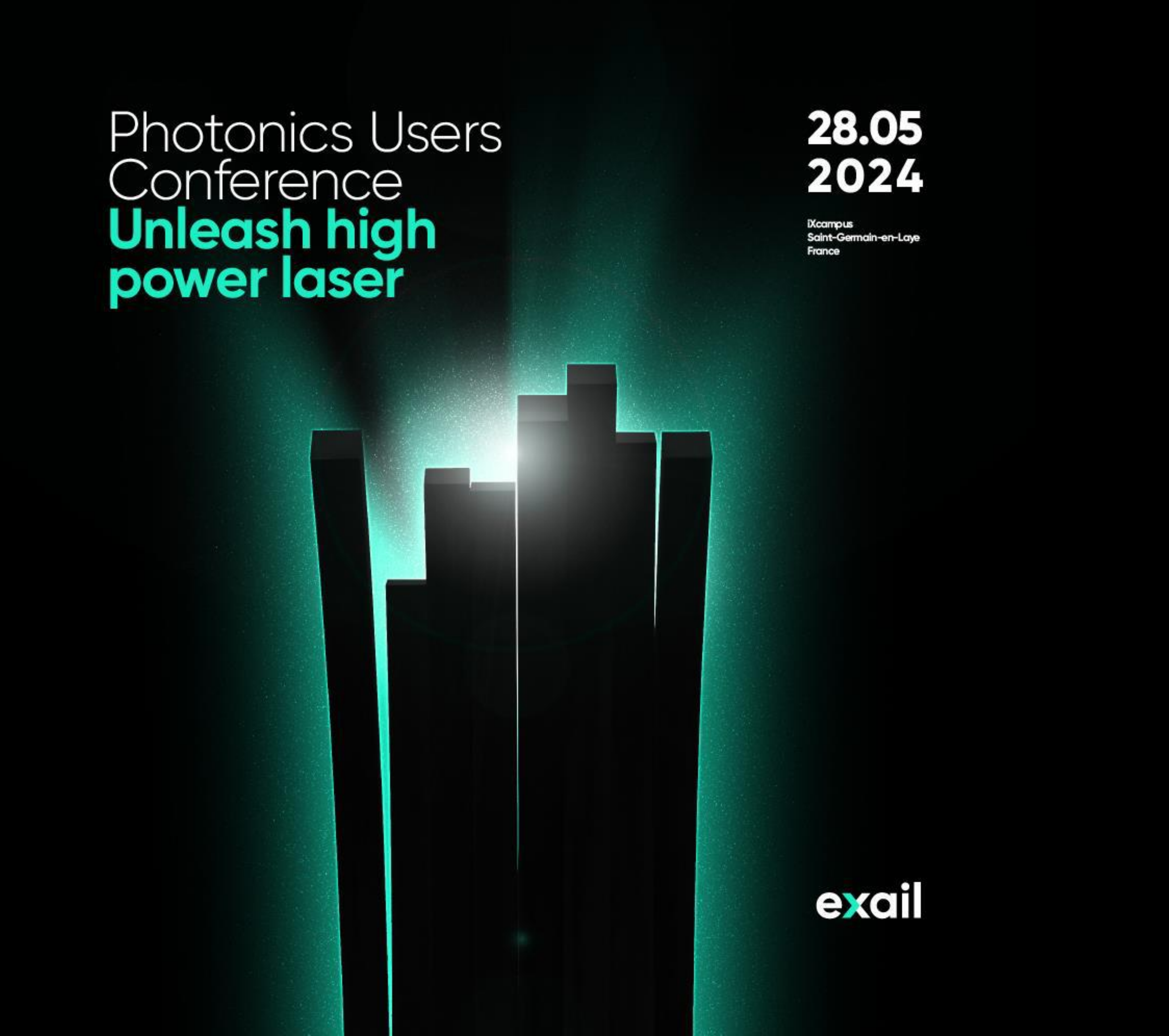
Results:

- Output optical power stable > +20 dBm
- No sharp variations with T°.

Exail Phase Modulator Versus the competition

Manufacturer	Exail	E…..	J…..	T….	O…..	
EO-Bandwidth	Up to 20 GHz	10 GHz	< 10 GHz	> 7 GHz, 10 GHz typ.	> 7 GHz, 10 GHz typ.	> 16 GHz, 20 GHz typ
Vπ@50 kHz	2 V	X	X	X	X	X
Vπ@1 GHz	2,2 V	4 V Max	6 V	6,2 V Typ, 6,8 V Max	6,8 V	5,5 V
Vπ@10 GHz	3 V	X	X	X	10 V	X
Optical input power	300 mW	50 mW	300 mW	50 mW	60 mW	300 mW
Insertion Loss	2 dB < IL < 4 dB	5 dB	4 dB	3 dB – 3,5 dB Max	3 dB – 3,5 dB Max	3 dB – 4 dB Max
RF input power	33 dBm	27 dBm	X	25 dBm	27 dBm	27 dBm

- **Exail offers the Best NIR Phase Modulator available on the market for Spectrum Broadening**


Photonics Users Conference
Unleash high power laser
28.05 2024
iXcampus
Saint-Germain-en-Laye
France
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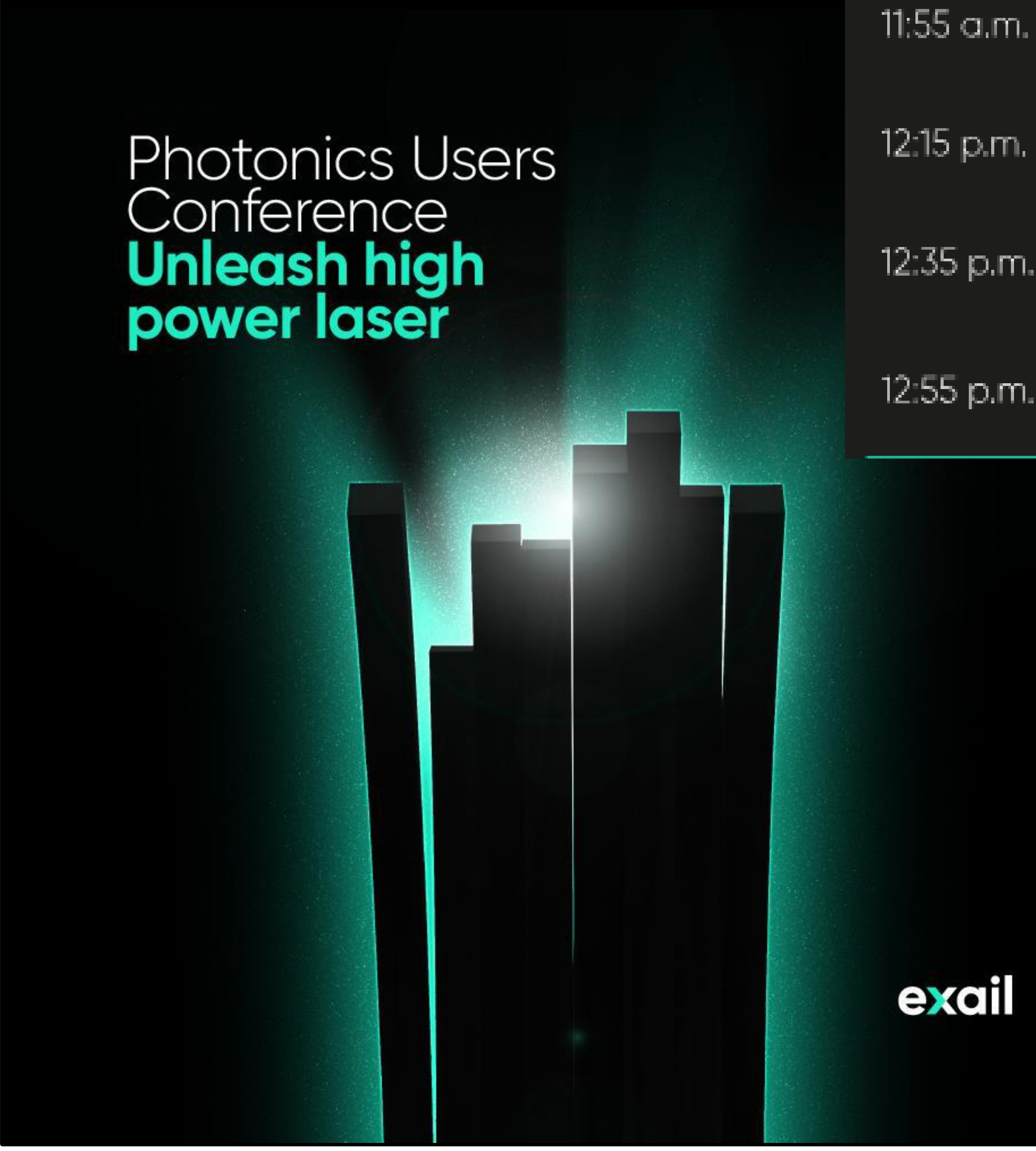
iXtech21
Conception d'un modulateur optimisé

HIGH ENERGY & DIRECTED ENERGY LASER SESSION

09:40 a.m.	**Fiber laser and coherent combining technologies for directed energy laser systems |** ONERA | Pierre Bourdon
10:05 a.m.	**Recent fiber laser results at the Optoelectronics Research Centre, University of Southampton |** The Optoelectronics Research Centre (ORC) | Johan Nilsson
10:30 a.m.	**120kW optical phased array CBC laser and applications |** Civan Lasers | Eyal Shekel
10:50 a.m.	**Recent advances toward high-power 2 µm CBC systems |** Fraunhofer IOSB | Clément Romano
11:10 a.m.	**High power fiber lasers for beam combining |** Fraunhofer IOF | Friedrich Möller
11:30 a.m.	Coffee break
11:55 a.m.	**Recent progress on high-power 2 µm fiber lasers based on single-oscillator all-fibered architectures |** ISL | Anne Dhollande
12:15 p.m.	**Power scaling of 1 µm and 2 µm all-fiber amplifiers via phase modulation |** AFRL | Angel Flores
12:35 p.m.	**Towards synthetic lasers utilizing fully monolithic fiber laser building blocks |** Optical Engines | Donald Sipes
12:55 p.m.	**Trends in high energy short pulse lasers for scientific and societal applications |** Thales | Christophe Simon-Boisson

SCIENTIFICS AND PULSED LASERS SESSION

02:30 p.m.	**From scientific discovery to applications: high intensity laser facilities around the world |** LLNL | Félicie Albert
03:00 p.m.	**Laser performance improvements at the national ignition facility |** LLNL | Larry Pelz
03:25 p.m.	**Dedicated amplitude and phase electro-optical modulators for laser fusion |** Exail/CEA | Aurore Ecarnot
03:45 p.m.	**Fiber front ends for high energy laser at LULI2000 |** LULI | Loïc Meignien
04:05 p.m.	**DiPOLE technology: next steps & new applications |** STFC | Jacob Spear
04:25 p.m.	Coffee break
04:50 p.m.	**High energy and high power laser development at HiLASE and applications |** HiLASE | Martin Divoky
05:10 p.m.	**Nanosecond pulse source at the PHELIX high-energy / high-intensity laser facility |** GSI | Udo Eisenbarth
05:30 p.m.	**High energy adjustable temporal pulse shape lasers |** EKSPLA | Jonas Kalenda
05:50 p.m.	**First demonstration of a 120J phase-conjugate mirror dedicated to self-correction of the wavefront for kJ-class and kW-class average power Lasers |** Amplitude | Stéphane Branly
06:10 p.m.	Closing remarks
06:20 p.m.	Happy hour & networking dinner



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