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High efficient microwave photonic system on thin-film lithium niobate

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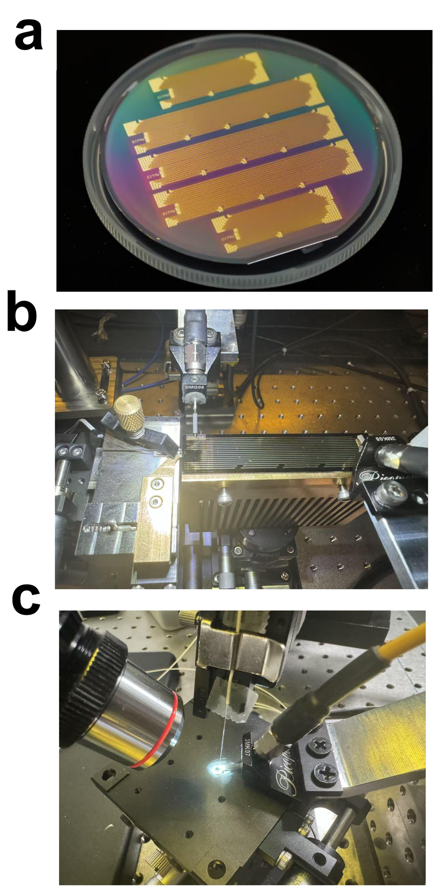
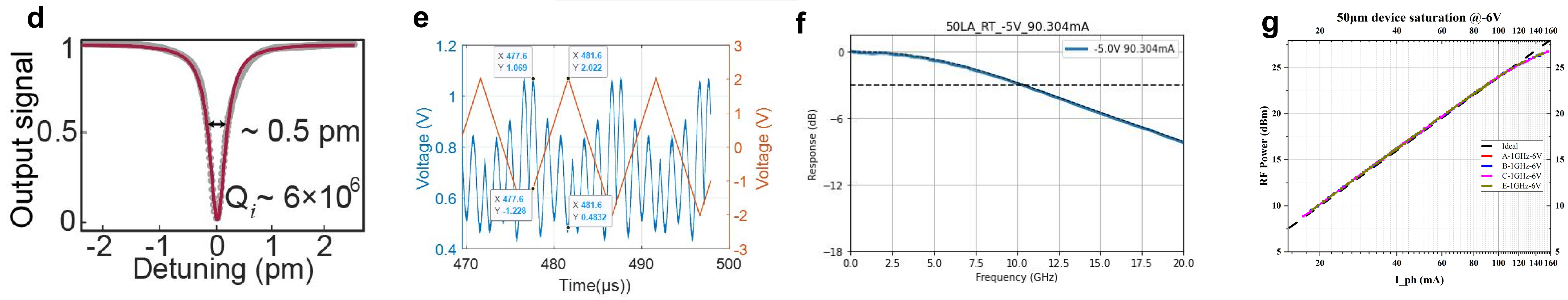
Background:

- Integrated microwave photonics (MWP) is for the generation, transmission, and manipulation of signals on chip.
- Integrated lithium niobate (LN) is a promising platform owing to its unique EO priorities and low optical loss.
- **Existing challenges: high Electrical-Optical-Electrical (EOE) losses, limited bandwidth, low linearity.**
- **Objectives: Improve EOE link gain, reduce losses, enhance linearity and bandwidth.**

Methodology





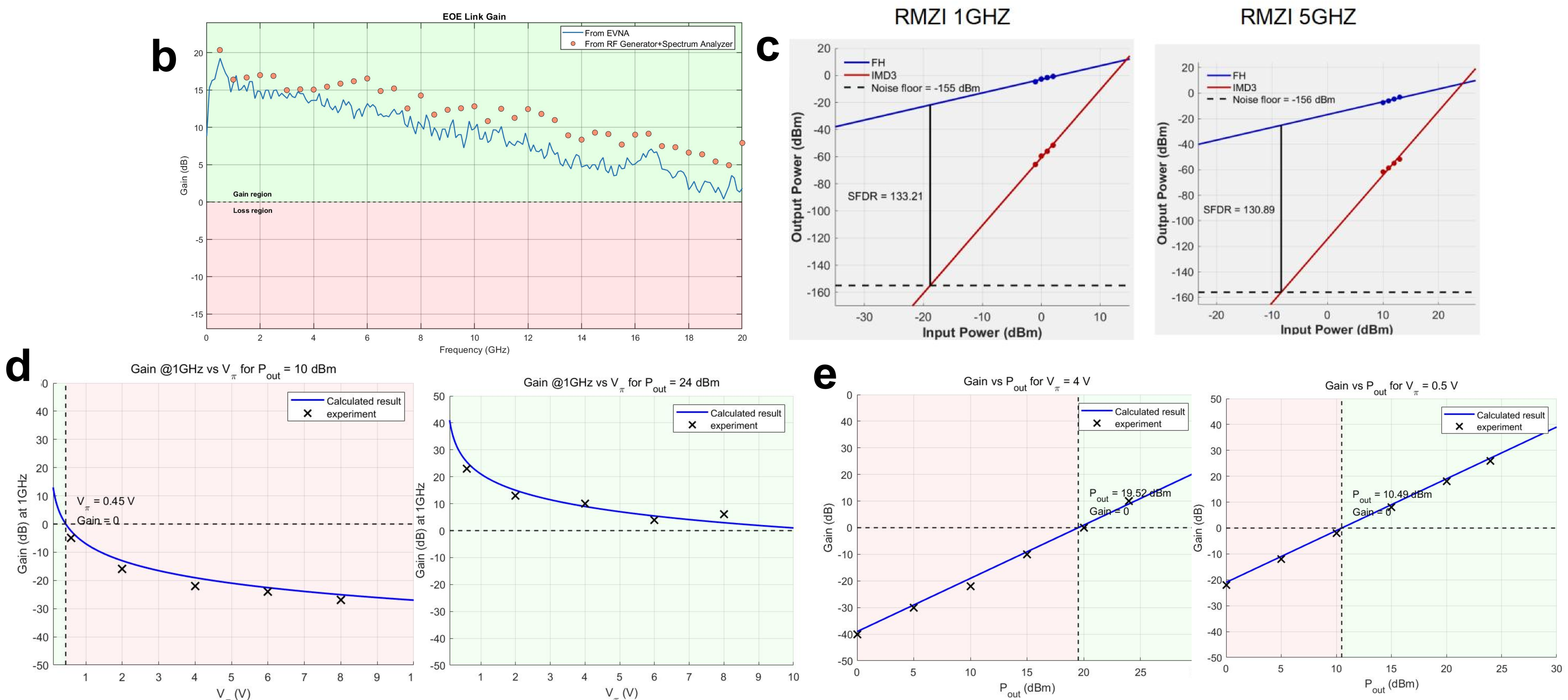
- **Low loss**: Ultra-low-loss LN waveguides with high intrinsic Q-factor. (a,b,d)
- **Low Vpi**: Ring-assisted Mach–Zehnder interferometer (RMZI) modulator, ultra-low Vpi (0.58V).(b,e)
- **High saturation power**: High-power PD, saturation power up to 27 dBm.(c,f,g)

Results

a

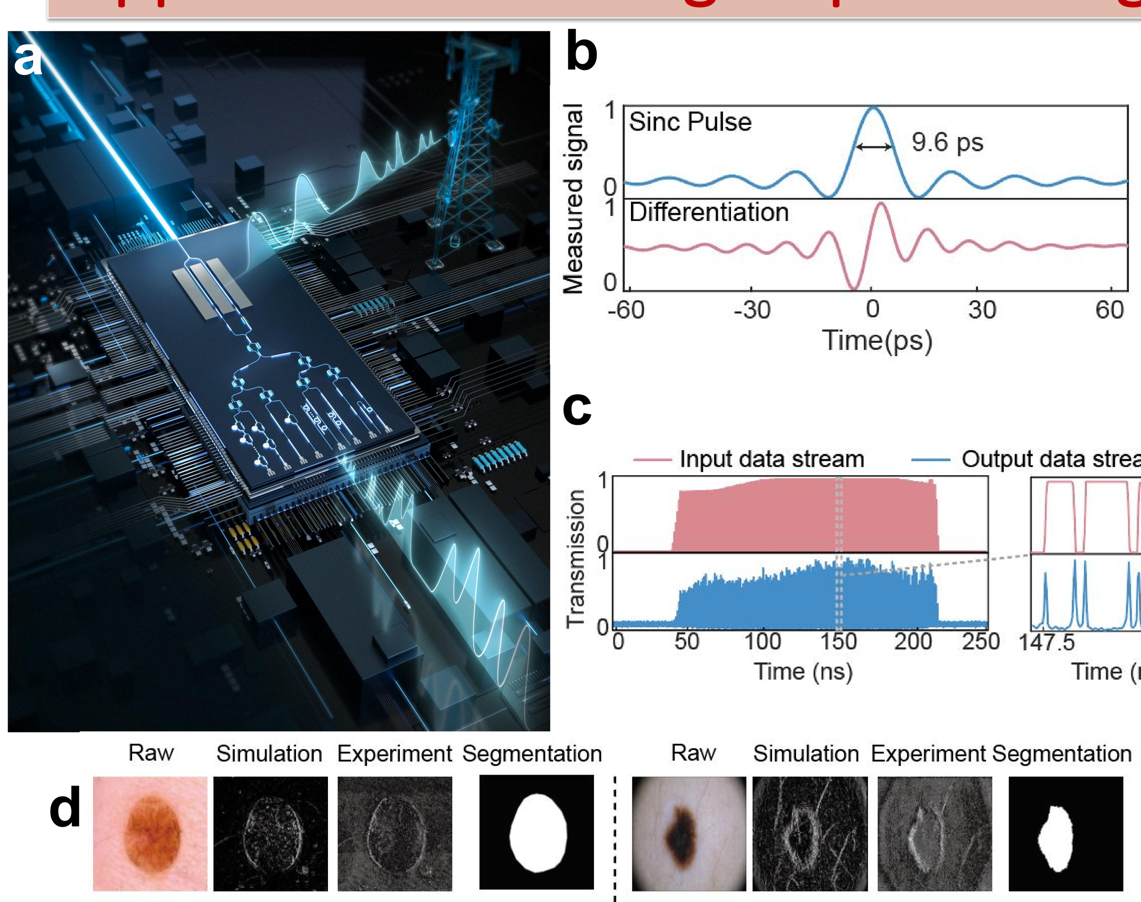
EOE and SFDR Performance Comparison

	Off-chip MZI	Package MZI	MZI	Long MZI	RMZI
Vpi	4.0	4.0	4.0	0.58	8
EOE link gain-1G	11.8	-5.4	3	20.5	-3.0/0.0
EOE link gain-5G	3.5	-10.0	-2	16	-15.5/-6.0
EOE link gain-10G	-5.4	-17.0	-5	13	-32.0/-15.0
SFDR-1G	120.66	112.24	116.19	/	133.2
SFDR-5G	118.11	110.0	114.09	/	130.9
SFDR-10G	115.01	108.0	113.46	/	117.0



- Record-high on-chip **EOE link gain**: **exceeding 20 dB** with 0-20 GHz has net link gain.(a,b)
- Record-high on-chip **SFDR** achieved:**133.2 dB·Hz⁴/⁵** at 1 GHz.(a,c)
- Experimental data closely matched theoretical predictions.(d,e)

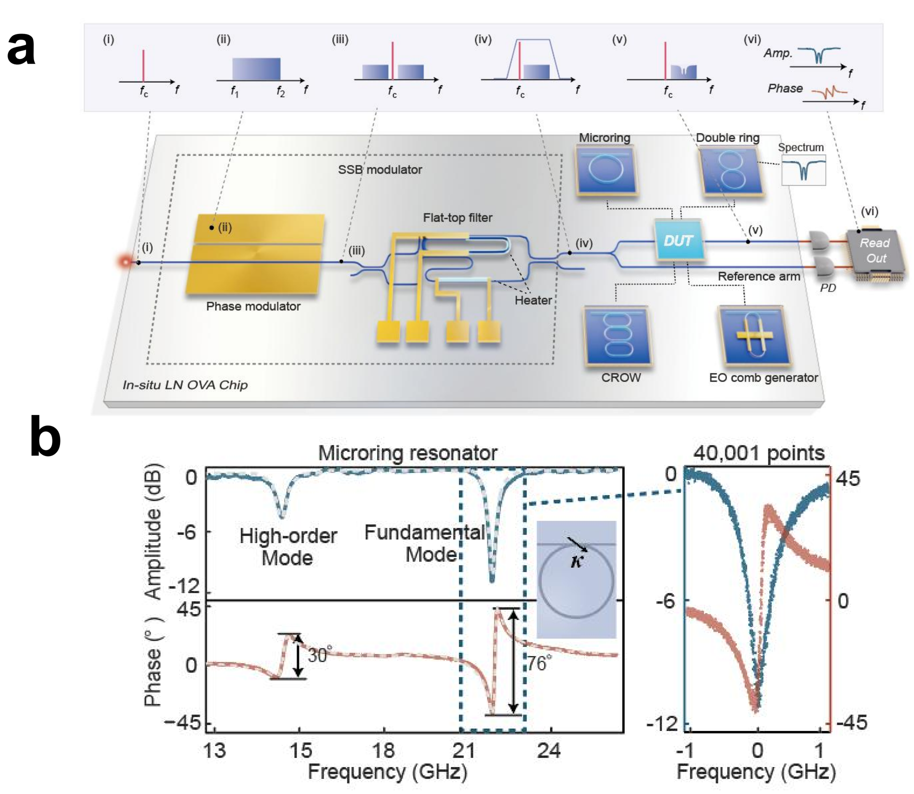
Application: MWP signal processing



- Proces analog signals up to 256 GSa/s (a) including integration, differentiation, and edge detection(b-c).
- Photonic-assisted segmentation in medical diagnostic, achieving 1000 times faster speed than electronic processors (d).

Nature

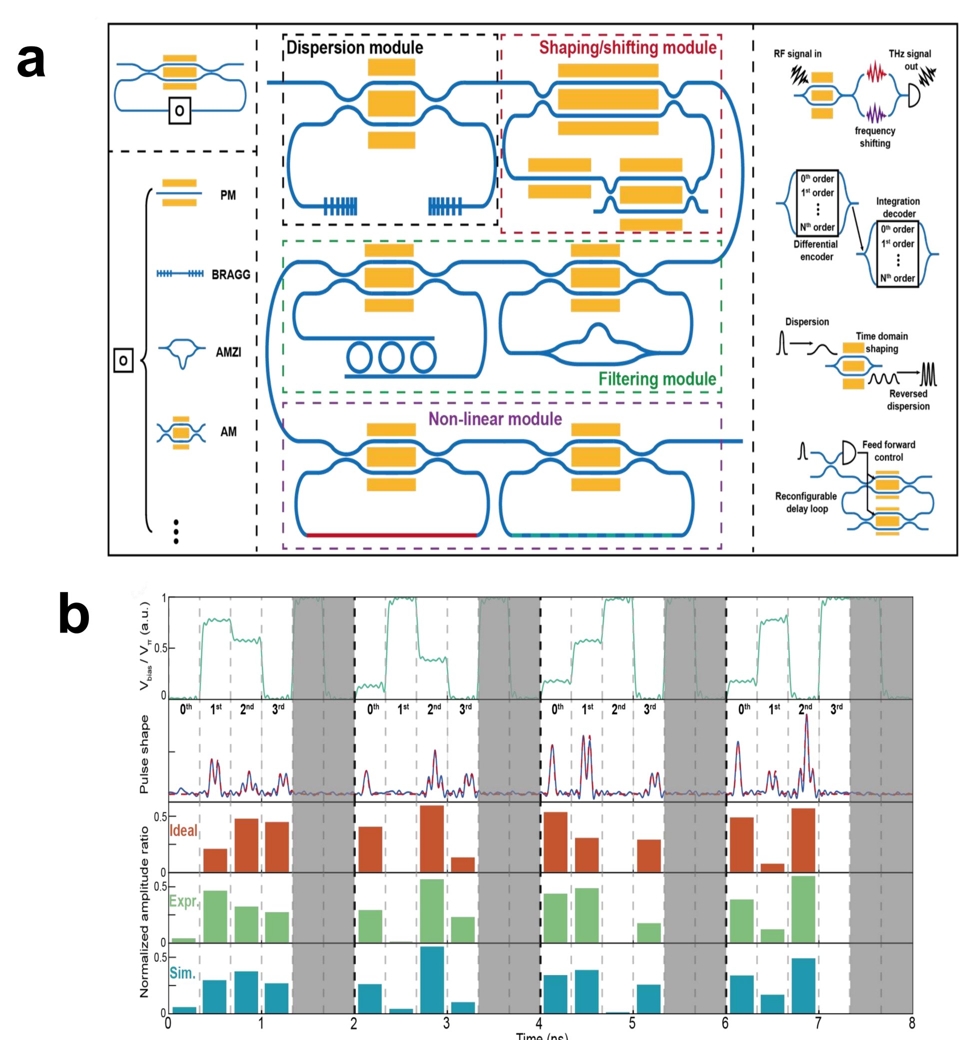
Application: In-situ OVA



- Demonstrate an OVA and fulfill in-situ measurement for integrated devices (a).
- OVA system provide a probe of responses of photonic devices with kHz resolution and tens of terahertz bandwidth (b).

Advanced Photonics

Application: Recycling processor



- Frequency shifting up to 400GHz with a 3GHz sinewave drive;(a)
- Dispersion, 28ps/nm group delay over a bandwidth of 30nm; (a)
- 0-5 orders Configurable on-chip high-order differentiaton (a,b).