LIGENTEC

PHOTONIC INTEGRATED CIRCUITS FOR COMMUNICATION IN SPACE

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September 2019

Located in Lausanne, Switzerland

LPCVD SiN→ low loss circuits

Thick film SiN → small footprint

PHOTONIC INTEGRATION OFFERS NEW PATHS FOR OPTCIS

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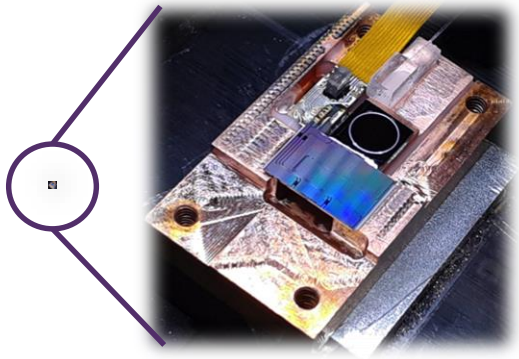
MAX-PLANCK-INSTITUTE OF QUANTUM OPTICS GARCHING MPQ

4 m^3

MenloSystems

1 m^3

CORES
Chip-scale Optical Resonator Enabled Synthesizer



1 cm^3

- ✓ Less complexity
- ✓ Power efficient
- ✓ Small size
- ✓ No movable parts

1998 2008 2019

SILICON PHOTONICS 2.0: THICK FILM SILICON NITRIDE

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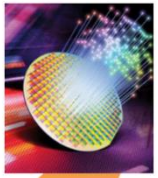
AERONAUTICS
(in-flight entertainment)

SPACE (QKD, comm)

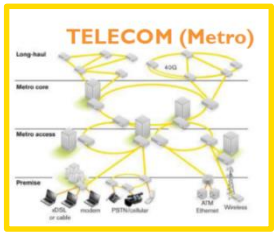
AUTOMOTIVE
(low latency for autonomous cars)

Low volumes



SI PHOTONICS

MEDICAL

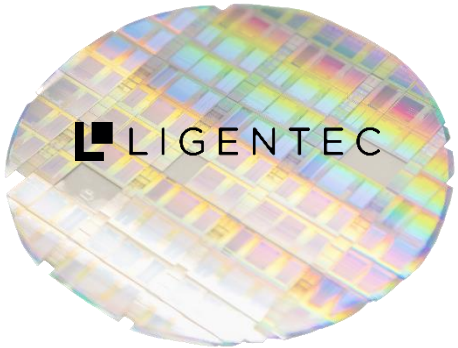


HIGH-PERFORMANCE COMPUTING

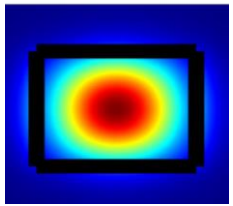
High volumes

- ✓ 100% CMOS compatible
- ✓ < 0.1dB/cm propagation losses
- ✓ optical power handling (Watts)
- ✓ broad transparency window
- ✓ Excellent I/O coupling
- ✓ Space compatible

OUR GAME CHANGER:
THICK FILM SILICON NITRIDE



PROPRIATORY ALL NITRIDE CORE TECHNOLOGY (Patent granted)



90% light confined in SiN waveguide:

- ✓ Low loss
- ✓ Small chip size
- ✓ High Yield

Modules for product integration (patent pending)

- ✓ Cost and power savings in packaging

OUR IP BLOCKS: COMPACT AND LOW LOSS

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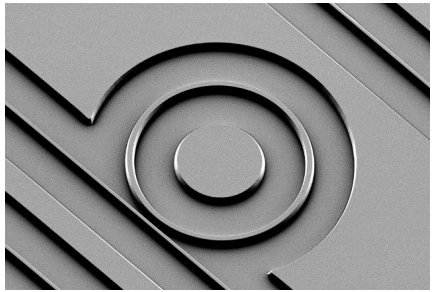
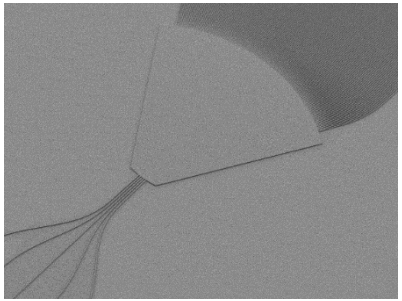
Ring resonator

5 x smaller bend
10 x lower loss
Q up to 30 Million



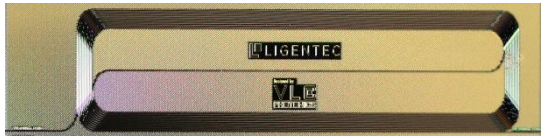
Arrayed Waveguide Grating

10 x smaller



Delay line

5 x lower loss
5 x more compact



Compared to other SiN technology

PDK FOR TELECOM AND VISIBLE λ

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Complete design environment

Verified designs for 1550nm and 900nm wavelengths

PDK includes:

- DRC rules file
- Verified reference designs
- Verified simulation data

Partners:

VLC PHOTONICS

Mentor® A Siemens Business

SYNOPSYS® Silicon to Software™

LUCEDA PHOTONICS

VPIphotonics DESIGN AUTOMATION

LIGENTEC, FABRICATION PARTNER FOR LOW LOSS PICs

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IP BLOCKS

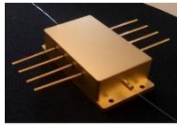
Specs / Layout

FABRICATION

Known good dies

Packaged and tested

TESTING
& ASSEMBLY



CUSTOMER

OEM,
Subsystem
Manufacturer,
etc.

FGU: RF FREQUENCY GENERATION UNIT FOR TELECOMMUNICATION PAYLOADS

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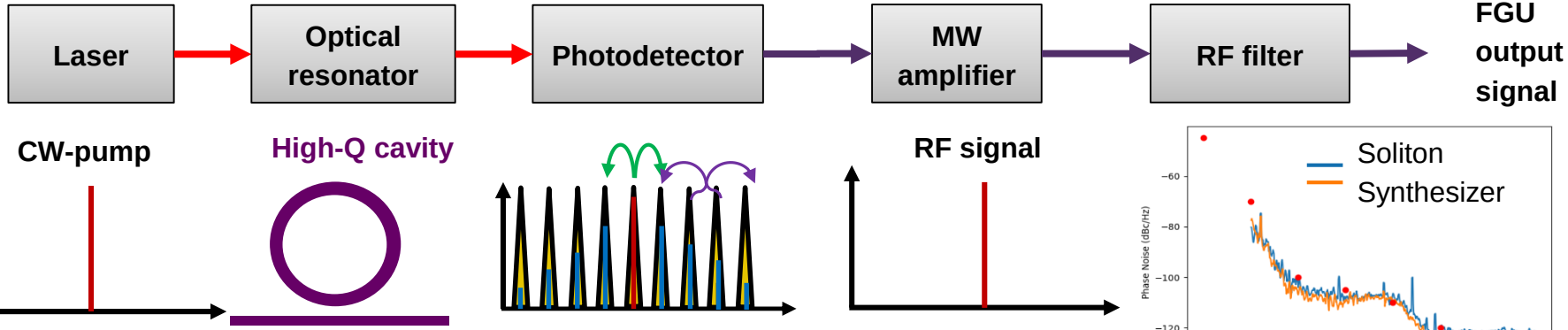
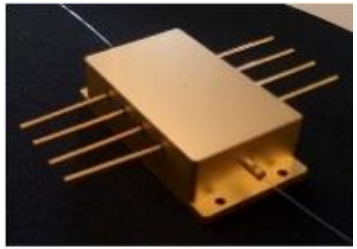
Optical signal

Electrical signal



complex modulation and multiple frequency conversion require:
ultralow phase noise reference LO (8-10GHz)



Pulsed soliton regime:
no excess phase noise

csem EPFL

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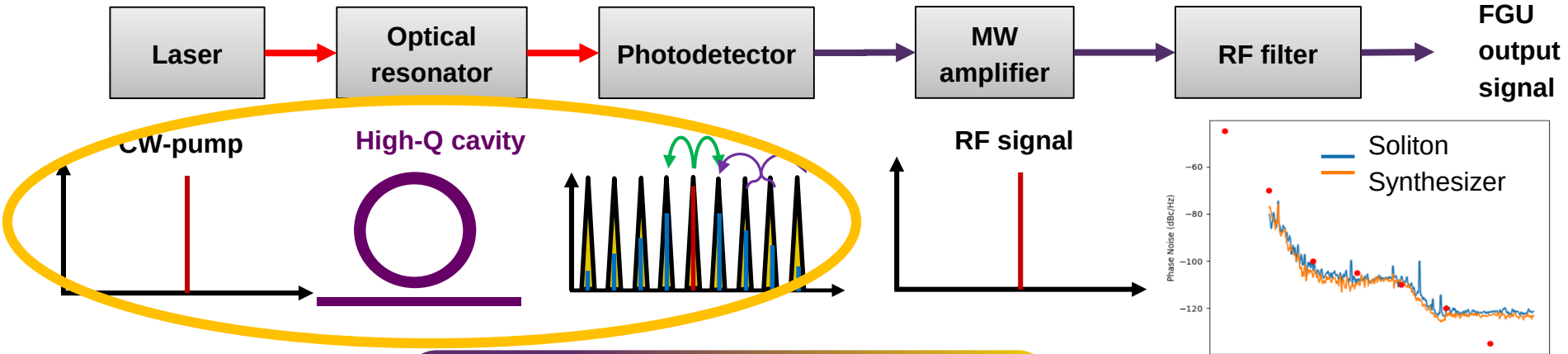
Optical signal

Electrical signal

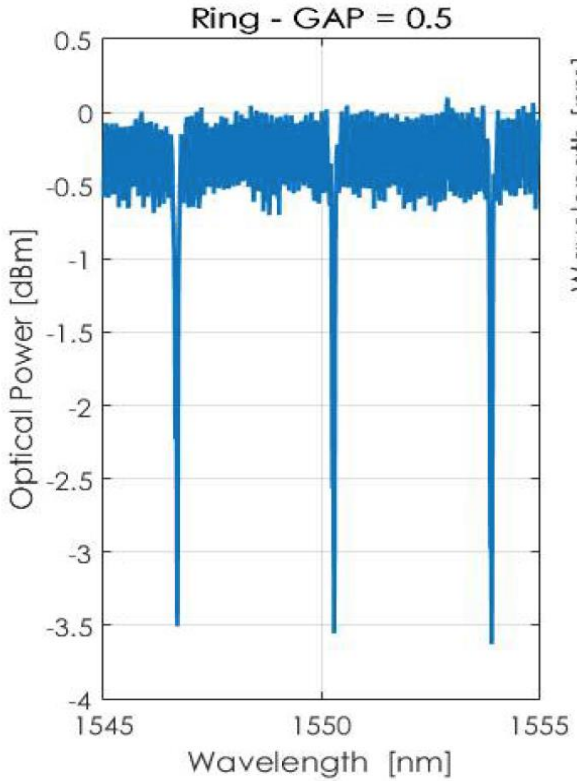


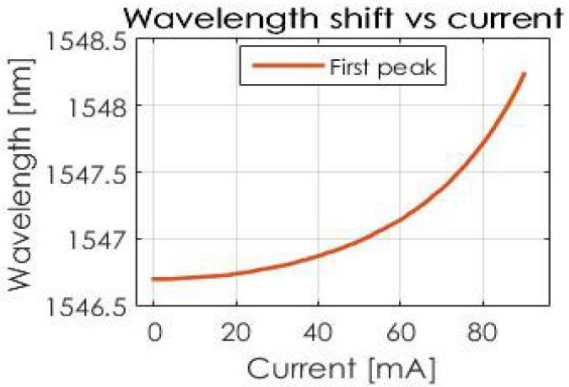
Pulsed soliton regime:
no excess phase noise

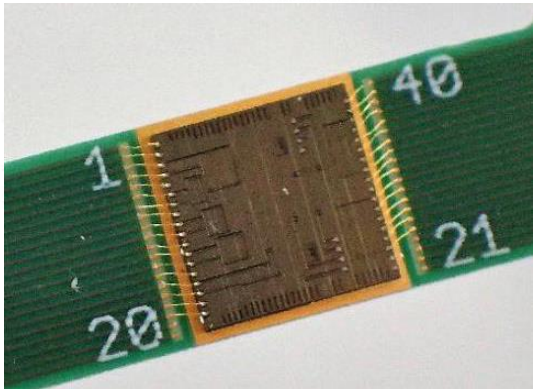
Also useful for other applications
Spectroscopy
Spectrometer calibration
Atomic clocks

csem EPFL

500 GHZ RESONATORS WITH HEATERS







- Shift of 1 FSR possible with <100mW power
- Speed 25kHz
- Power for pi shift 100mW

SAPPHIRE
(Space Adaptive Photonics Phased Array IR Feeder Link)

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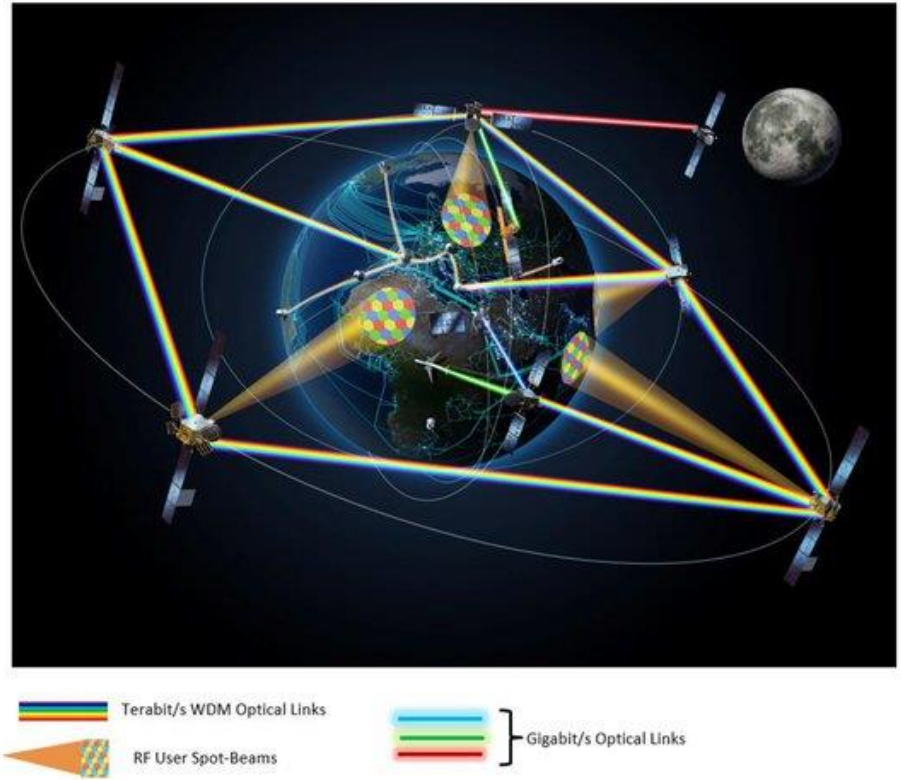
esa European Space Agency

hydron



Artist Impression of HydRON Vision of an all optical space network integrated into terrestrial network infrastructures. **Image credit: ESA**

SAPPHIRE
(Space Adaptive Photonics Phased Array IR Feeder Link)

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Telecom-grade optical phased array antenna with enhanced adaptive optics

- **Tbps teleports to provide backbone feeder-link connectivity (Ground-to-space) for mega-constellations and Extremely High Throughput Satellites (e-HTS)**
- **GEO/MEO/LEO optical feeder link applications**
- **Compatibility with terrestrial fibre networks: wavelength 1550nm**

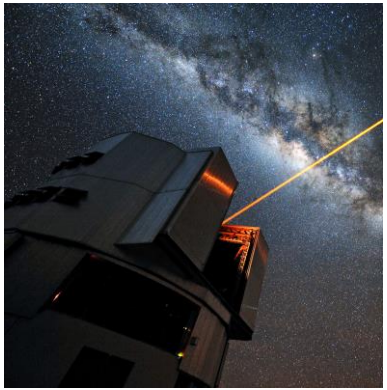
WHY?

- **Next gen satellite systems targeting interoperability with terrestrial networks - such as 5G+, IOT, etc**
- **Increasing traffic -> Lasercom can provide 10x more bandwidth. SAPPHIRE will provide a telecom-grade feeder link solution for future satellite infrastructure needs.**
- **A solution for upcoming architectures, such as the ESA HyDRON High Throughput Optical satellite Network - "Fibre in the Sky"**

Project contact:
mBryonics: John Mackey, john@mbryonics.com
ESA: Clemens Heese, clemens.heese@esa.int

esa European Space Agency scylight SAPPHIRE mbryonics LIGENTEC

SAPPHIRE
(Space Adaptive Photonics Phased Array IR Feeder Link)



As part of Line 1 of the ARTES ScyLight Programme, the SAPPHIRE activity is developing for ESA a next generation, telecom-grade optical phased array antenna with enhanced adaptive optics. This is to enable:

- **Tbps-class teleports to provide backbone feeder-link connectivity (Ground-to-space) for upcoming mega-constellations and Extremely High Throughput Satellites (e-HTS)**
- **GEO/MEO/LEO optical feeder link applications**
- **Compatibility with terrestrial fibre networks: wavelength 1550nm**

The need:

- **Historic key SatCom market segments - such as television - no longer represent a growth area. Next gen satellite systems targeting seamless interoperability with terrestrial networks - such as 5G+ - in order to provide data transport services and target new verticals such as autonomous transport, cloud applications, and industrial IOT.**
- **Like terrestrial networks, the internet in space needs an optical backbone to cope with ever increasing traffic. Lasercom can provide 10x more bandwidth and throughput compared to radio-based solutions. The feeder link represents a bottleneck to future satellite networks and SAPPHIRE will provide a telecom-grade solution for future satellite infrastructure needs.**
- **A solution for upcoming architectures, such as the ESA HyDRON High Throughput Optical satellite Network - “Fibre in the Sky”**

Project contact:

mBryonics: John Mackey, john@mbryonics.com

ESA: Clemens Heese, clemens.heese@esa.int

INTEGRATED OPTICAL PHASED ARRAY FOR COMMUNICATION OR LIDAR

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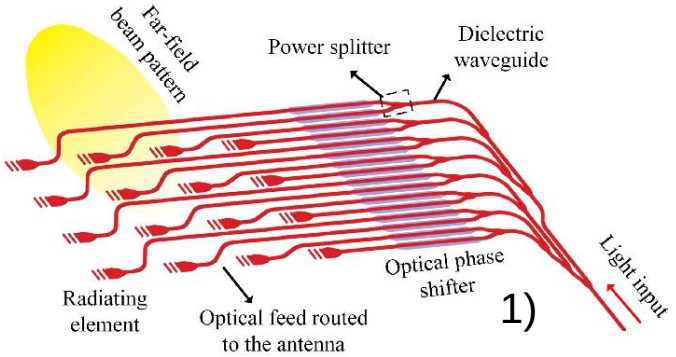
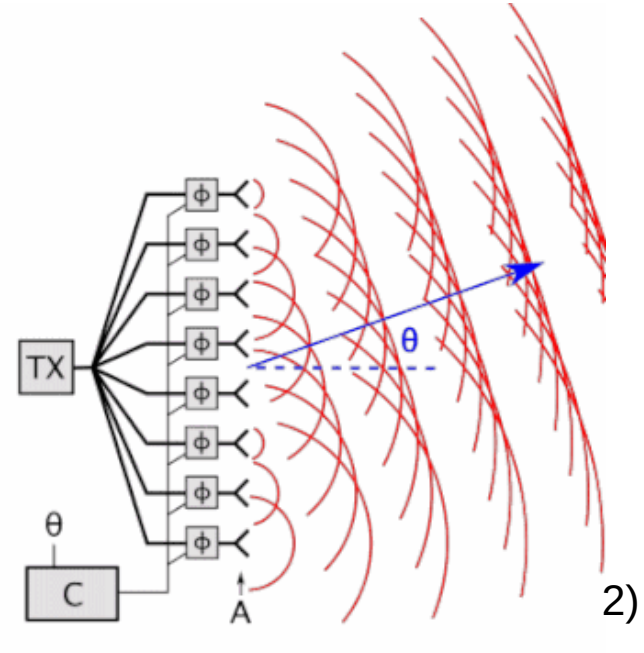
LIGENTEC's SiN

- ✓ Space compatible technology
- ✓ Low loss light propagation
- ✓ High power light propagation
- ✓ Low loss optical phase shifter





1) Reza Fatemi et al., IEEE Journal of Solid-State Circuits 02/2019
2) Wikipedia

HETEROGENOUS PIC INTEGRATION WITH SiN INTERPOSER

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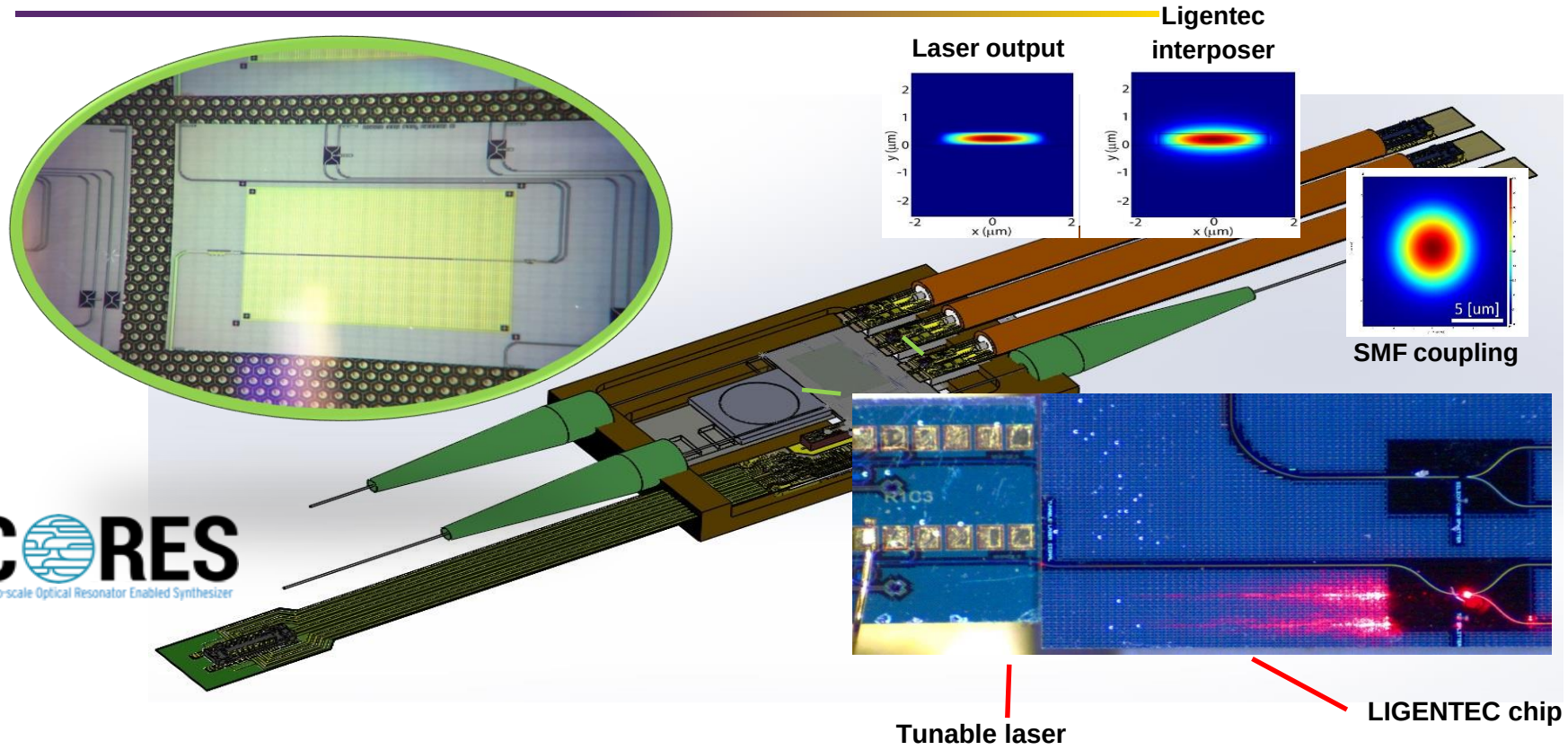

CORES
Chip-scale Optical Resonator Enabled Synthesizer

PIC AWARDS2018

LIGENTEC

WINNER in the PIC Platforms Category

To learn more about LIGENTEC, visit www.ligentec.com

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EPIC
European Photonics Industry Consortium

WE ARE HIRING

- ✓ **Silicon Photonics 2.0: Low loss compact SiN**
- ✓ **Space compatible technology**
- ✓ **High mode confinement**
- ✓ **Application wavelength in visible, telecom and MidIR**
- ✓ **Fast turn-around & MPW**

How can we help you?
How can you help us?

LIGENTEC

LIGENTEC is your manufacturing partner for low loss PICs from prototype to volume.

Supply chain in space for PIC from design to final product often incomplete

- Design
- PIC partners for increased functionality
- PIC testing
- PIC packaging
- OEM integration partners
- Final product vendors

- Communication: Beamforming, OPA, optical RF delay, QKD
- Atomic clocks: Supercontinuum, frequency combs
- Earth Observation

SCAN ME

Webinar
in October

This presentation was presented at EPIC Meeting on New Space 2019

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