
# Nanophotonics for new space technologies

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MICRO nano FABS
Red Española de Salas Blancas de Micro y Nano Fabricación

UNIVERSITAT POLITÈCNICA DE VALÈNCIA

Nanophotonics Technology Center

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- ❑ **~ 80 personal (10 profesores, 9 posdocs, PhDs, 15 personal técnico y administración, 25 PhD)**
- ❑ **Nanofotónica: desde investigación fundamental hasta dispositivos y redes**
- ❑ **Oferta de servicios de Nanofabricación en Sala limpia**

**(250m² clase 10-100-10.000)**

- ❑ **Financiación pública y privada: UE y proyectos nacionales (ESA, EDA, etc.)**
- ❑ **Creación de compañías *Spinoff:* DAS Photonics** (espacio, aeronautica, defensa), **Fibernova** (telecom) and **Lumensia** (biosensores)

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# Introducción NTC

• El Centro de Tecnología Nanofotónica (NTC) es un **centro de I+D+I con capacidades únicas en España** para la micro-nanofabricación de circuitos/estructuras fotónicos integrados en Silicio → Infraestructura Científico-Técnica Singular (ICTS)

•NTC es **multidisciplinar**: materiales y dispositivos fotónicos, procesos de micro-nanofabricación, sistemas y redes ópticas.

•**Aplicaciones en diversos sectores industriales**: TIC, biomedicina, defensa y seguridad, energías renovables, aeroespacial y medio ambiente.

• Configurado como un **centro de servicios de micro-nanofabricación** de estructuras (semiconductores, polímeros, etc) y encapsulado → NTC como **soporte de nanociencia y nanotecnología** para I+D y empresas

• **Clara vocación industrial:** atracción de empresas, creación de nuevas empresas, reconversión de líneas de negocio, etc

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# Spin-off companies

DAS Photonics

http://www.dasphotonics.com/en/
Starting in 2005, photonics for applications in **Defence**, **Avionics** and **Space**
88 employees → 125 by the end of the year

fibernova

2009, Telecom, wireless access, p2p links
http://www.fibernova.com/index-es.html
5-6 employees

LUMENSIA sensors

2013, Photonics for bio-sensing
https://www.lumensia.com/
12 employees

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# Nanofabricación y Caracterización

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# Nanofabricación

## 6-inch silicon processing equipment:

- Electron-beam lithography (30keV and 100keV)
- Photolithography (i-line)
- Reactive Ion Etching (RIE)
- Lift-off, wet etch and chemical cleans
- PECVD deposition ($SiO_2$, a-Si, $Si_3N_4$…)
- DC sputtering (Metals, ITO)
- Physical vapor deposition (Metals)
- Oxidation and doping furnace


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# ÁREA de MICRO/NANO-FABRICACIÓN

## Sala Limpia

**(500 m$^2$) Clase 10-100-10.000**

**Línea completa de micro/nano fabricación de dispositivos fotónicos en tecnología de silicio (compatible CMOS):** cañón de electrones, litografía UV, implantador de iones, ataque de gases, deposición de metales, microscopios electrónico y de fuerzas atómicas, SNOM, RAMAN, elipsometría, perfilometría, FTIR, etc.

# Micro-nanoestructuras fabricadas en NTC

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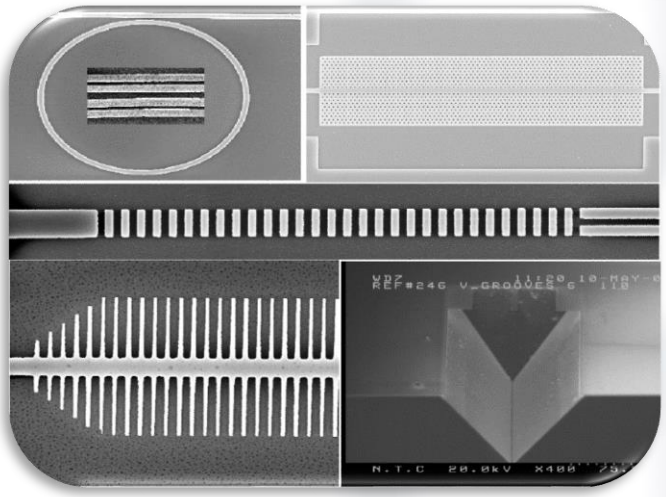
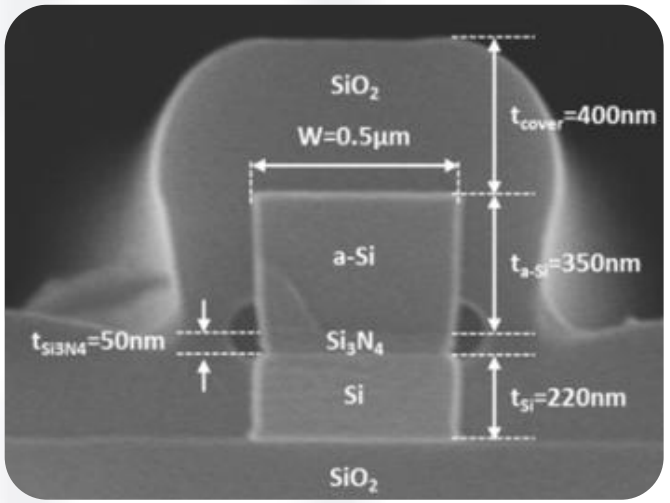
## Silicon photonics circuits

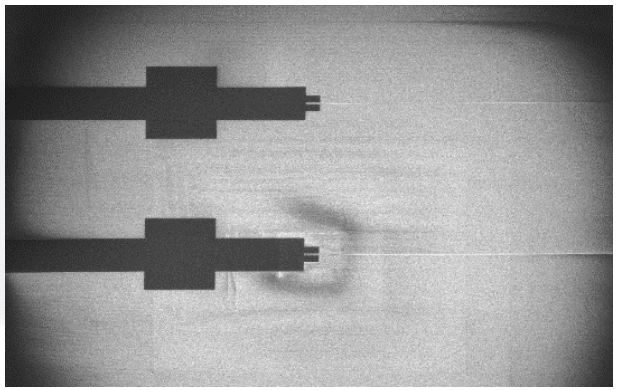


## Advanced photonics circuits




## Photonic crystals and metamaterials

## Light Coupling



# Micro-nanoestructuras fabricadas en NTC

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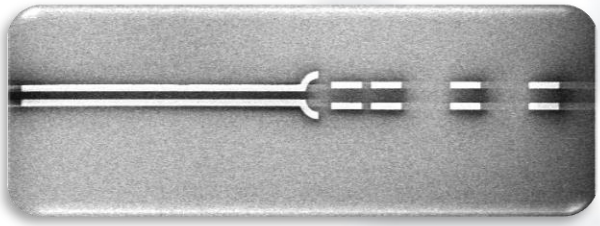
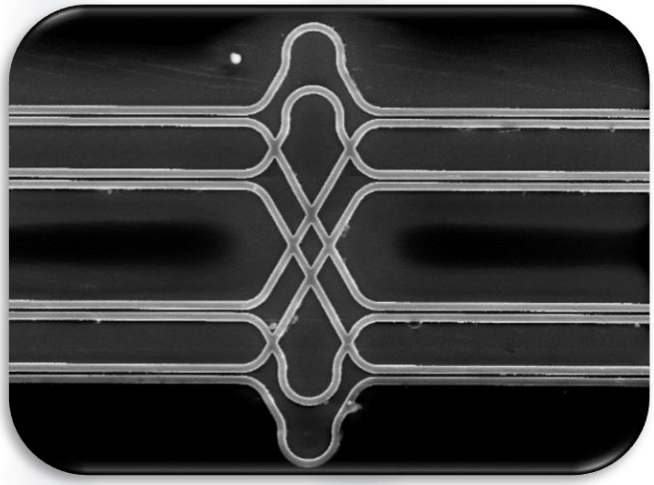
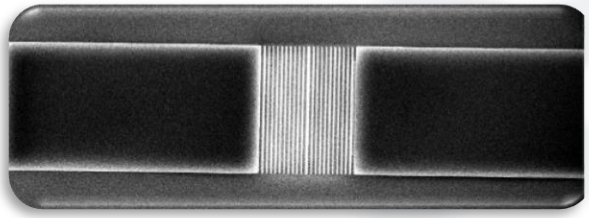
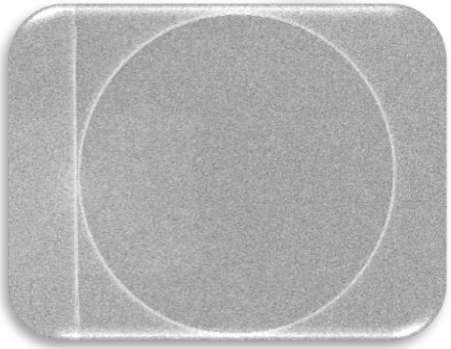
## Integrated optics



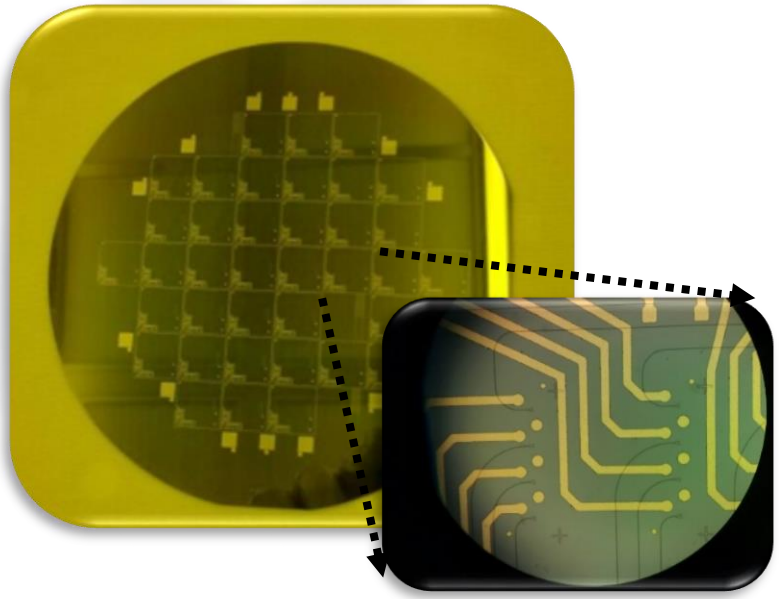


## Sensors





## Wafer Scale



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# Laboratorio de encapsulado

Assembly & Packaging Laboratory
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# Assembly & Packaging Laboratory

## Nanophotonics Technology Center

- Dicing
- Die Bonding, Flip-Chip Bonding
- Tacking, In situ reflow, Eutetic bonding
- Thermocompression
- Single-Step solder ball placement
- Flux less / solder paste / void free soldering
- Thermo compression wafer bonding
- Wafer bump reflow
- Wire bonding: Ball, Wedge Bonding, Stud Bump
- Vertical and horizontal alignment and pigtailing
- Package lid sealing

# ¿Qué ofrecemos?

- ✓ FLEXIBILIDAD PARA DESARROLLO DE PROYECTOS I+D
- ✓ PROTOTIPADO RÁPIDO
- ✓ SERVICIOS PARA EMPRESAS: Solicitud de presupuestos para trabajos determinados

**Contacto: Rafael Bueno (rabuebar@ntc.upv.es)**

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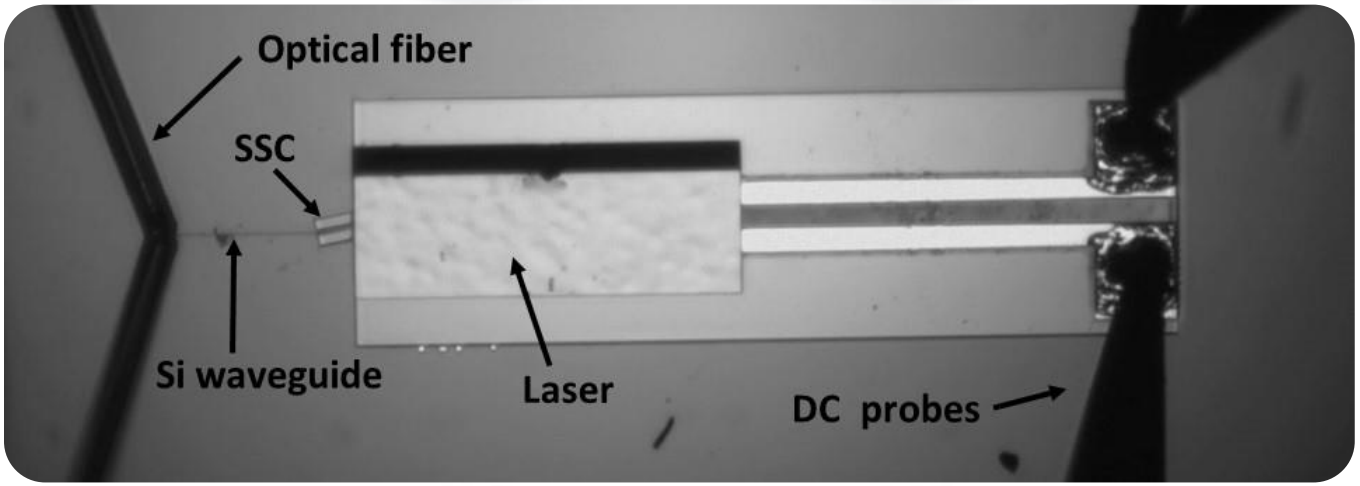
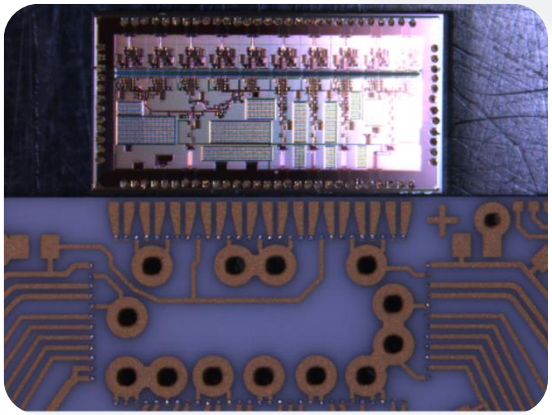
# Flip-chip bonding, bump deposition and wire bonding



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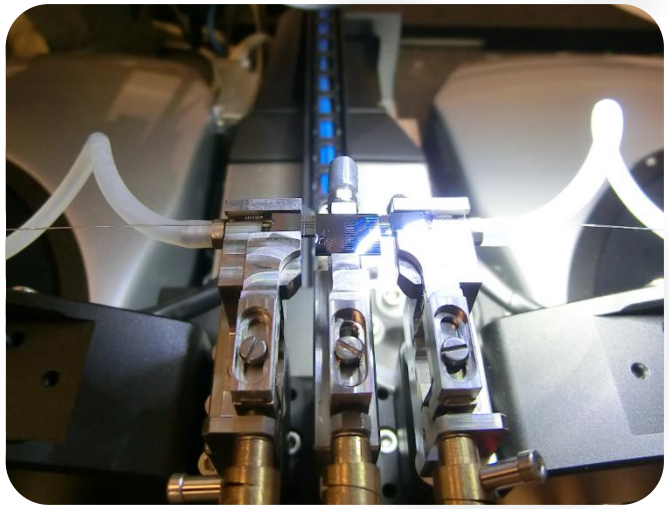
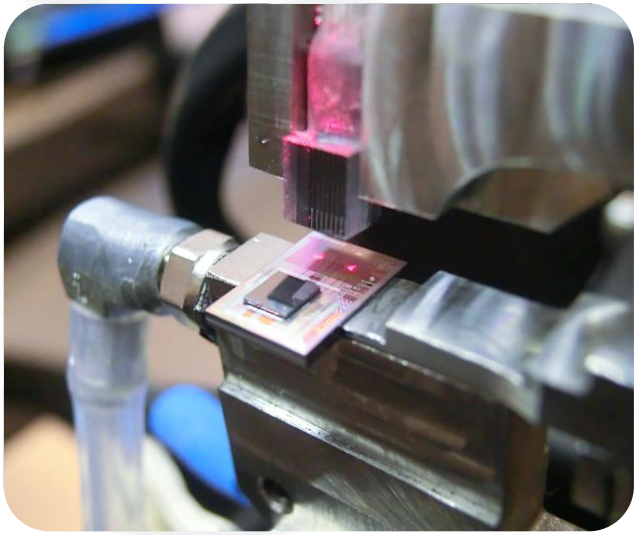
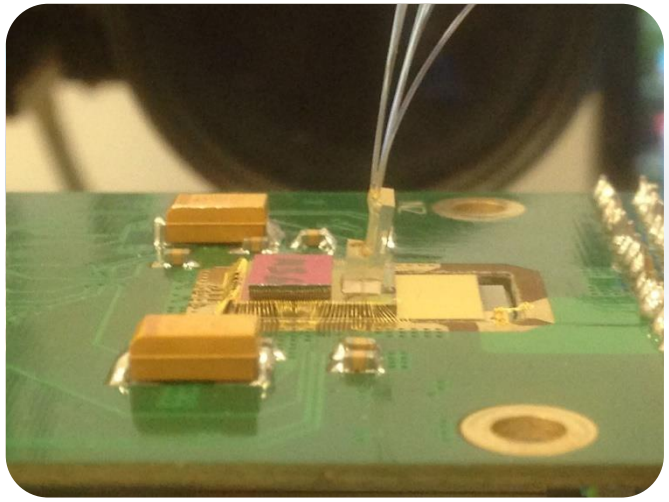
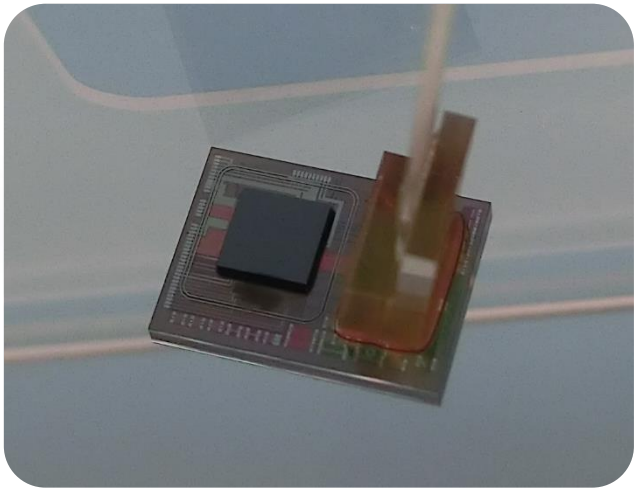
# Fiber array assembling and die-attach









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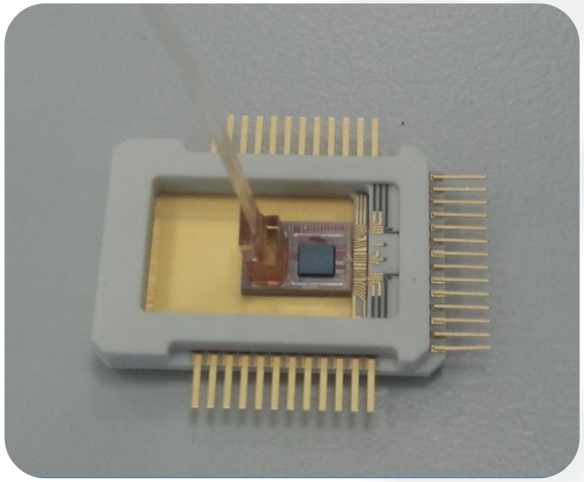
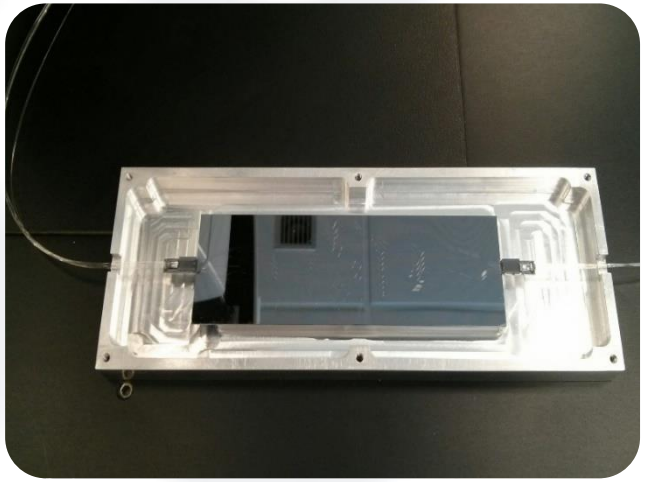
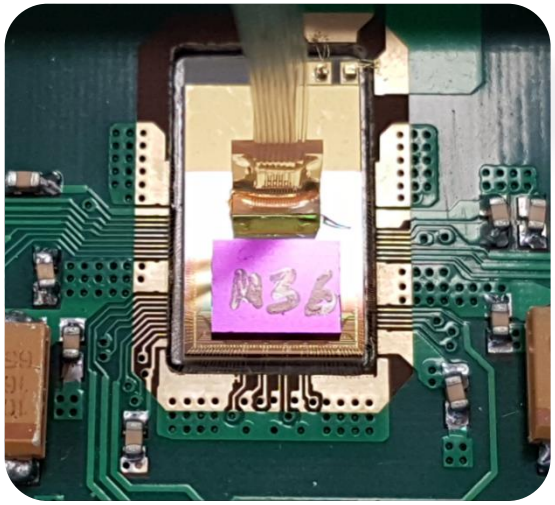
# Housing, sealing and PCB integration





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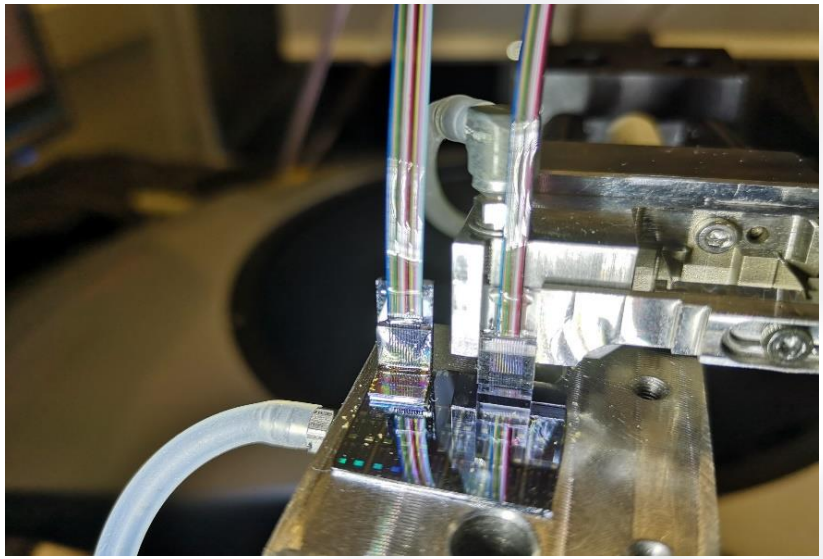
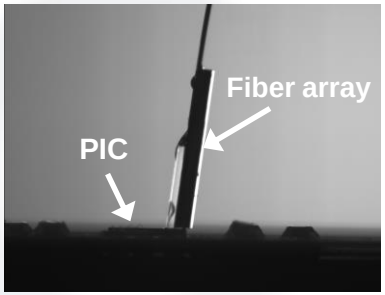
# Nanophotonics for new space technologies

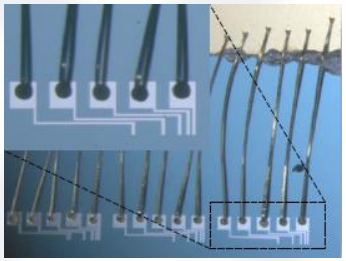
# H2020-RETINA project (2018-2021): Miniaturised Photonics Enabled Next Generation Scanning Aperture Radar

www.retinah2020.eu/

**OBJETIVO PRINCIPAL**: Desarrollo de un conformador fotónico de haces multiples reconfigurable para satélites



- **Desarrollo del encapsulado de un circuito fotónico integrado (PIC) apto para un entorno especial. Alineamiento masivo de fibra óptica – circuito integrado**
- **Array de fibras (128 puertos)**
- **PIC wire-bonding (conexiones eléctricas)**

**Contact: Antoine Brimont (abrimont@ntc.upv.es)**

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# Photonic transceivers

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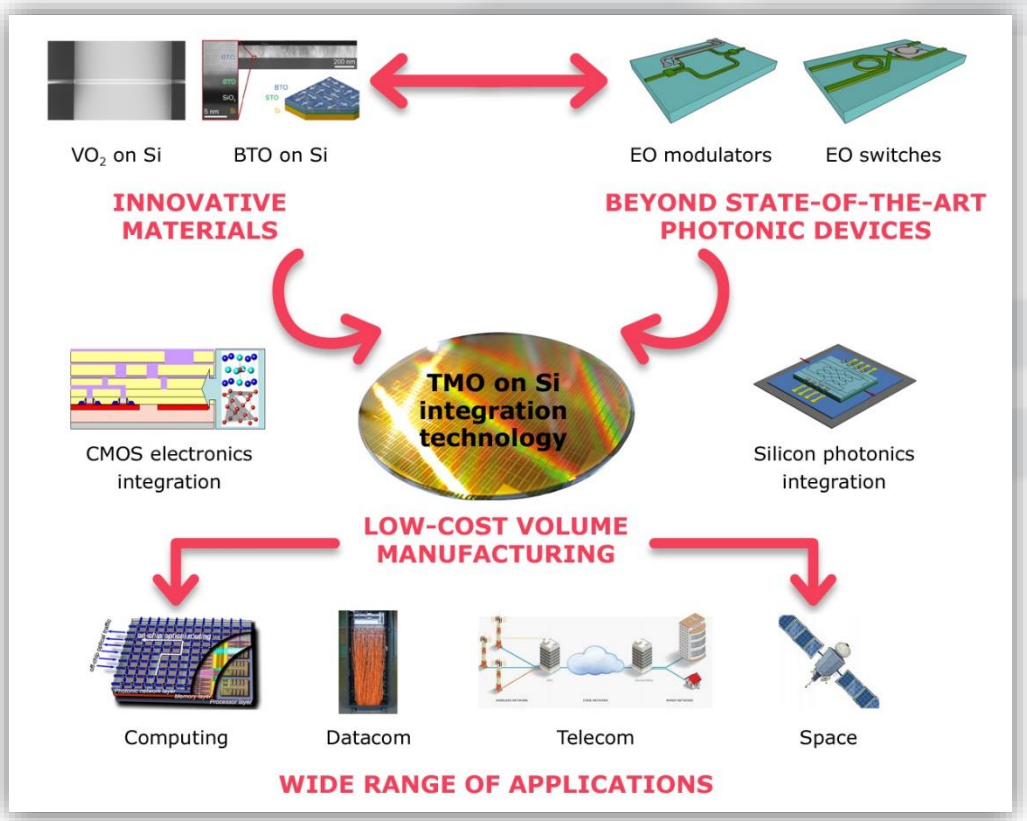
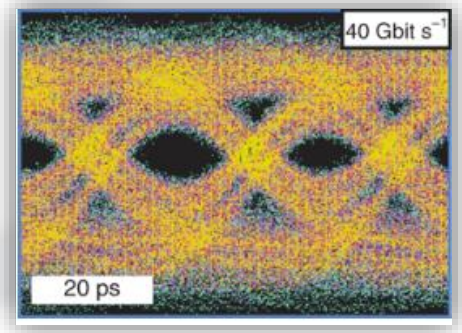
**Development of novel electro-optical modulators and switches**

nature materials

Article | Published: 12 November 2018

Large Pockels effect in micro- and nanostructured barium titanate integrated on silicon




Sitoga

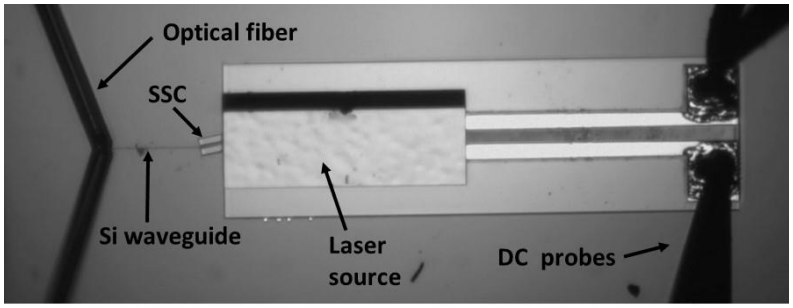
**FP7-ICT-Project**

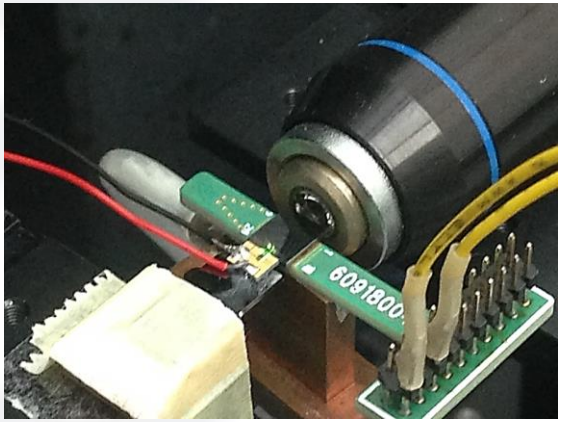
www.sitoga.eu

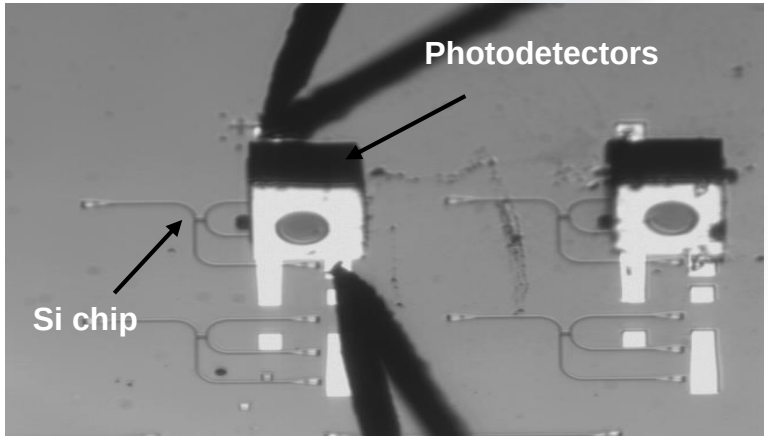
**Contact: Pablo Sanchis (pabsanki@ntc.upv.es)**

# Photonic transceivers

## Integration of laser sources and photodetectors in PIC






- Fabrication and characterization of PIC
- Flip chip bonding of laser in PIC
- Flip chip bonding of photodetector in PIC

Contact: Pablo Sanchis (pabsanki@ntc.upv.es)

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HUAWEI

# Photonic transceivers

## Si Photonics integration for efficient interconnects in data centers

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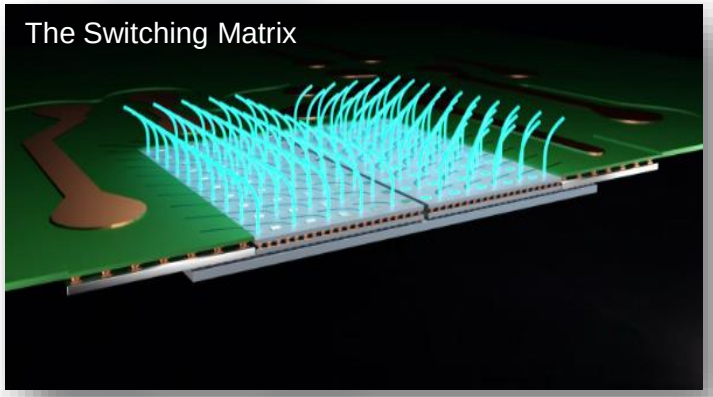
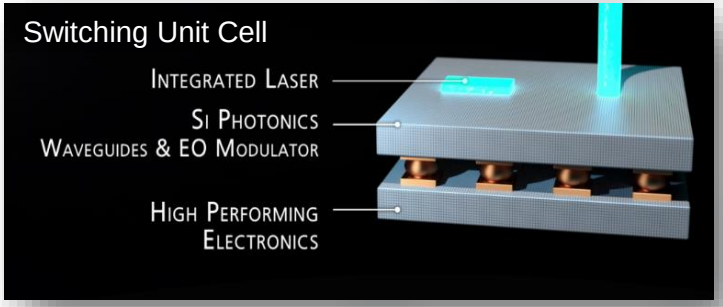




- **Large-Scale** – High density of channels connected to one ASIC
- **Low-Power** –Integration with Lasers and EO modulators
- **Low-Cost** – CMOS foundry / low cost assembly

**Contact: Antoine Brimont (abrimont@ntc.upv.es)**

L3MATRIX
LARGE, LOW POWER AND LOW COST DATA CENTRES

http://l3matrix.eu/

# Nanophotonics polarimeters

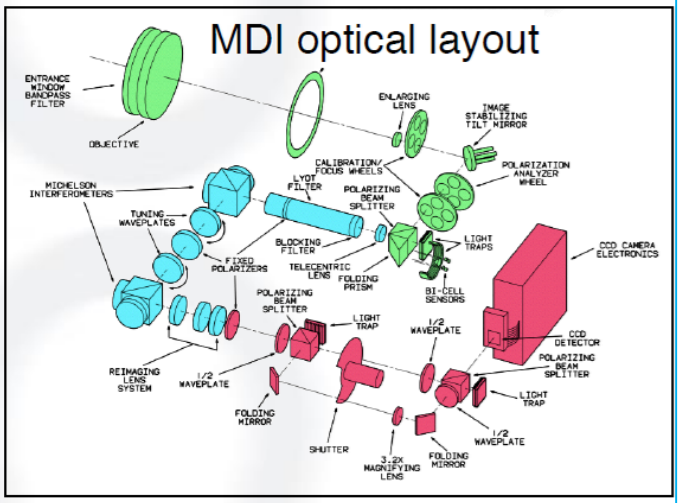
## Polarimeters are key tools in space observation

Example: observation of solar events by measuring magnetic activity using the splitting (Zeeman effect) of the Fe I absorption line at 617.3nm needs a polarimeter, but current implementations are bulky!

**Space-based magnetographs:**

- MDI/SOHO (Lyot filter, Michelson interferometer, **56.5kg**, 1k x 1k CCD, 38W)
- HMI/SDO (MDI heritage, **73kg**, 4k x 4k CCD, 72W, Fe I line at 617.3 nm)
- *Phi/Solar Orbiter (Michelson interferometer, two telescopes, **35kg**, [30 x 40 x 80 cm], 2k x 2k APS, 28W) - to be launched in 2019*
- SOT/Hinode (Filtergraph and spectropolarimeter, **150 kg)**

*Image courtesy of the SOHO/MDI consortium*



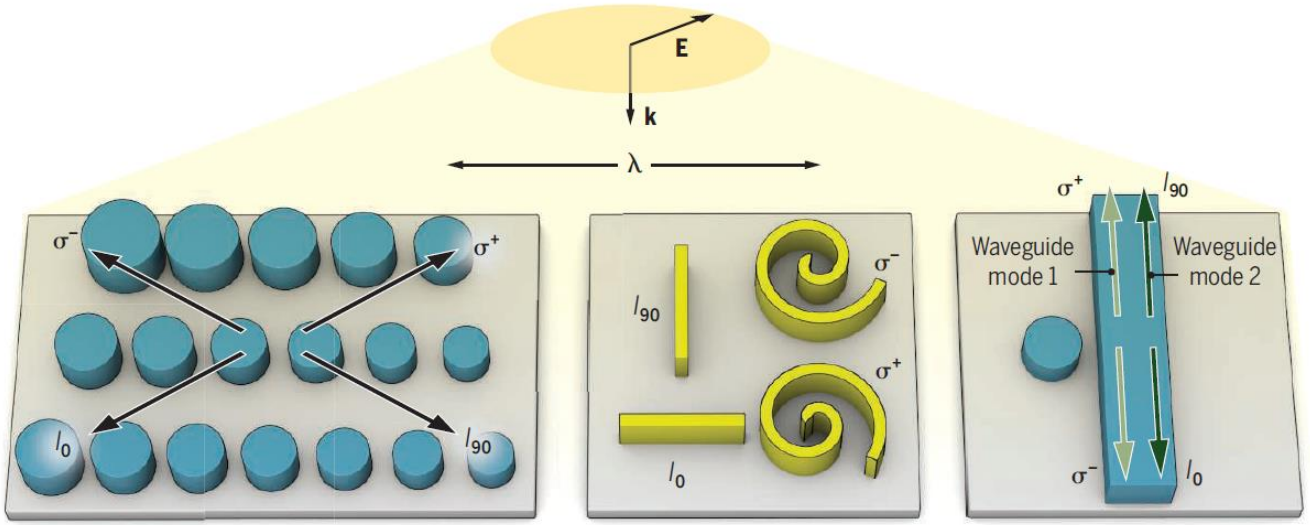
# Nanophotonics polarimeters

Now, nanophotonics enables lightweight, cheap, on-chip polarimeters at any wavelength regime to be in tegrated in space missions

**(Alejandro Martínez, Perspective in *Science*, 362, 751, 2018)**

## Nanoscale polarimeters

Transverse light, with an electric field **E**, wave vector **k**, and wavelength λ, illuminates a set of nanostructures. In all cases, measuring at least four outputs enables the retrieval of the state of polarization. Dielectric and metallic nanostructures are depicted in blue and yellow, respectively.




**Scattered output**
A metasurface consisting of a set of nanoantennas scatters different polarization states into well-defined spatial pathways.

**Absorbed output**
Plasmonic nanoantennas can be fabricated in shapes designed to absorb light of a certain polarization.

**Guided radiation**
Spin-orbit interactions help scatter different input polarizations into different directions and modes of a waveguide.

**Contact: Alejandro Martínez (amartinez@ntc.upv.es)**

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**Más información en la Web: www.ntc.upv.es**

**Interesados enviar correo a**

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