Commercial-ready particle detector technologies at IMB-CNM (CSIC)

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Centro Nacional de Microelectrónica IMB

CSIC Consejo Superior de Investigaciones Científicas

UNIÓN EUROPEA
Fondo Europeo de Desarrollo Regional
Una manera de hacer Europa

AIDA innova

MICRO nano FABS

Major renewal of Clean Room equipment

- 14 M€ FEDER + CSIC
- Upgrade to complete 150 mm wafer fabrication line
- Most of the equipments doubled to avoid contamination
  - CMOS-like line
  - Noble Metal allowed
- Nanofabrication line

We have now the capability to fabricate particle detectors in 150 mm both in Silicon and Silicon Carbide

New furnaces, 12 tubes, atmospheric and low pressure

ISO9011:2015 certification

- We obtained (May 2023) the ISO900:2015 certification
- The scope is restricted to commercial contracts, either from CSIC or D+T
- Research and self-service accesses are not considered

AENOR
GESTIÓN DE LA CALIDAD
ISO 9001

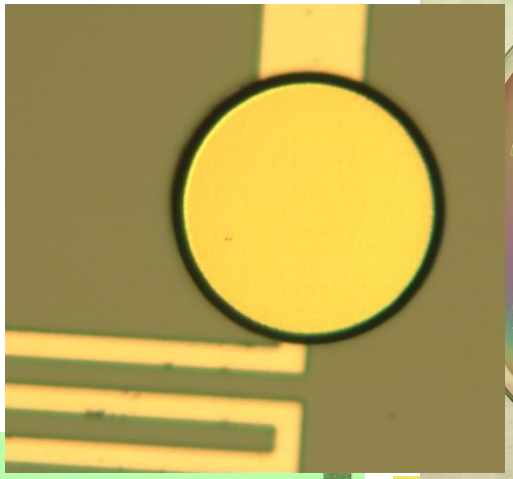
This is a new level of quality in IMB-CNM fabricated detectors and we will be able to reach new more demanding customers

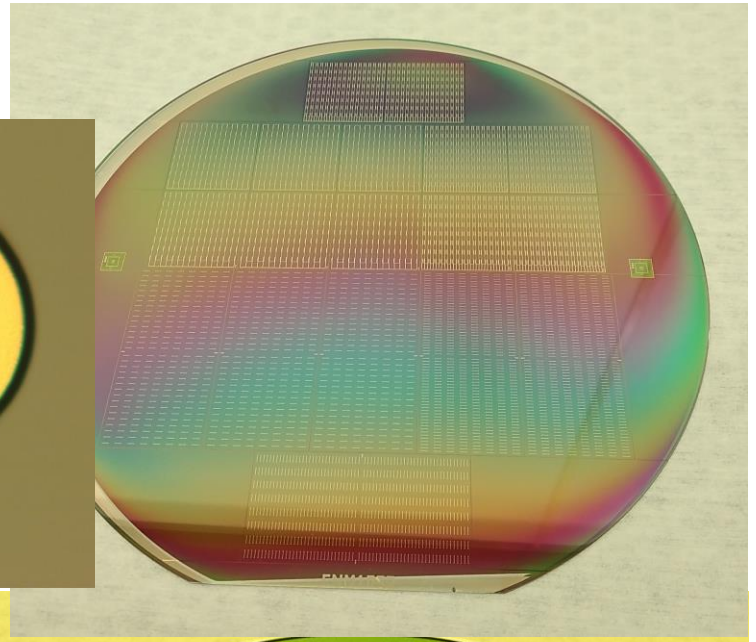
Scope:

1) Design and development oriented towards the production of devices based on nano- and microelectronic technologies manufactured in the micro and nano-manufacturing facilities of the IMB-CNM within the framework of commercial contracts.
2) Production of devices based on nano- and microelectronic technologies in the IMB-CNM micro- and nano-manufacturing facilities within the framework of commercial contracts

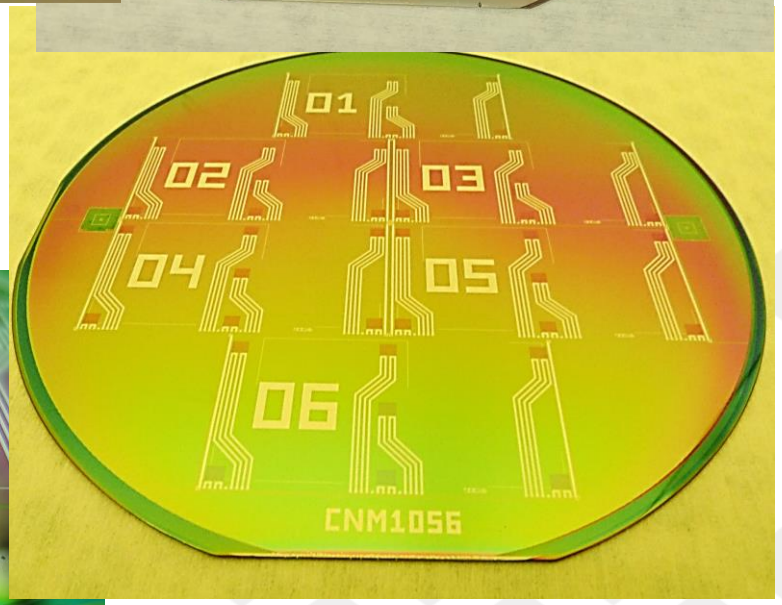
Dummy detectors & pitch adaptors

- Dummy structures to the reliability of flip-chip connections with the readout electronics at CMS
- Manufactured in 150 mm wafers



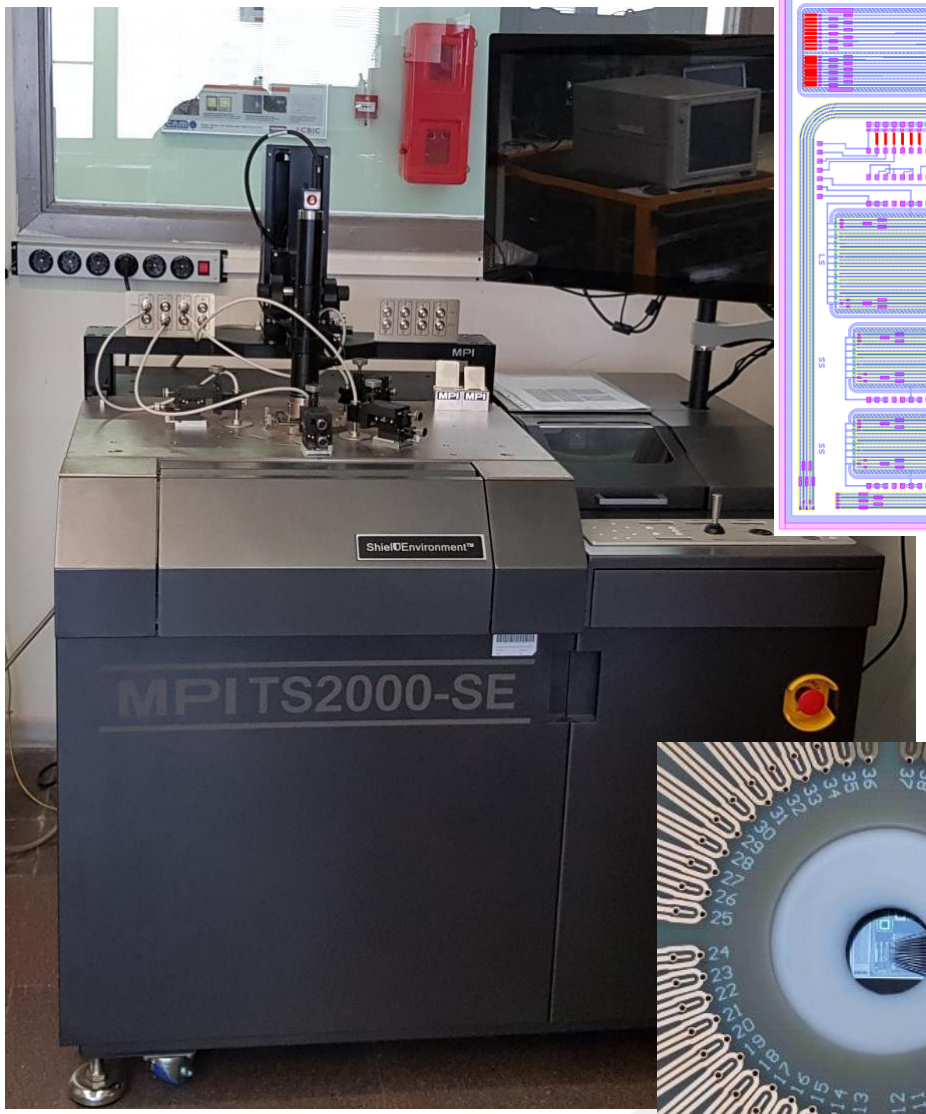


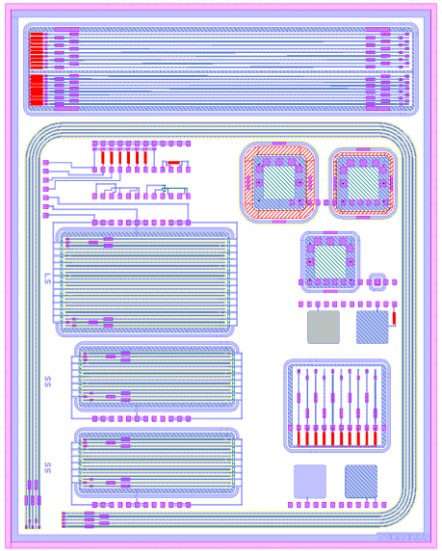
- Dummy structures for the study of thermal dissipation of the ATLAS HGTD system detectors
- They include resistors with a value dependent on temperature.

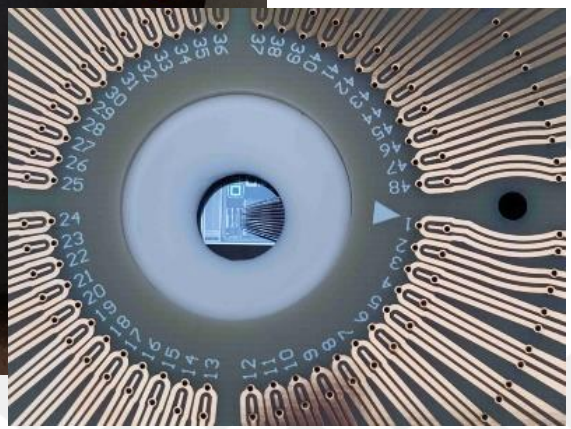


Microstrip sensors

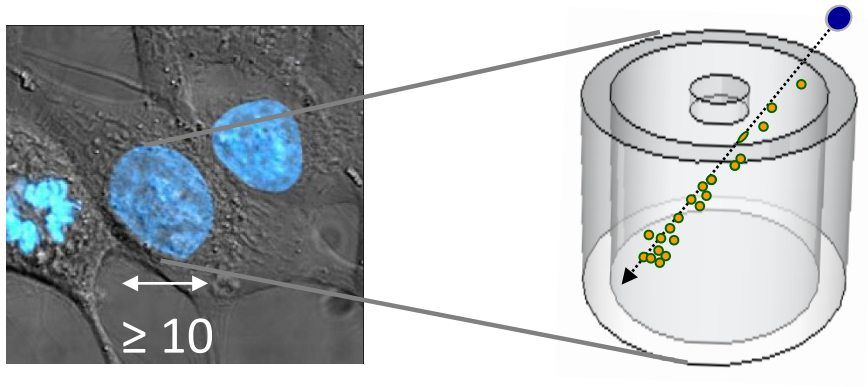
- Particle Physics and Nuclear experiments
- Optimized, production-ready, large area, strip sensor technology on 150 mm substrates with advanced technological options of interest in future Physics experiments
- Currently 2 metal levels, working for a 3rd metal level
- Fully automatic technology and device quality assurance (QA) testing using specific test structures and automatic characterization and analysis methods

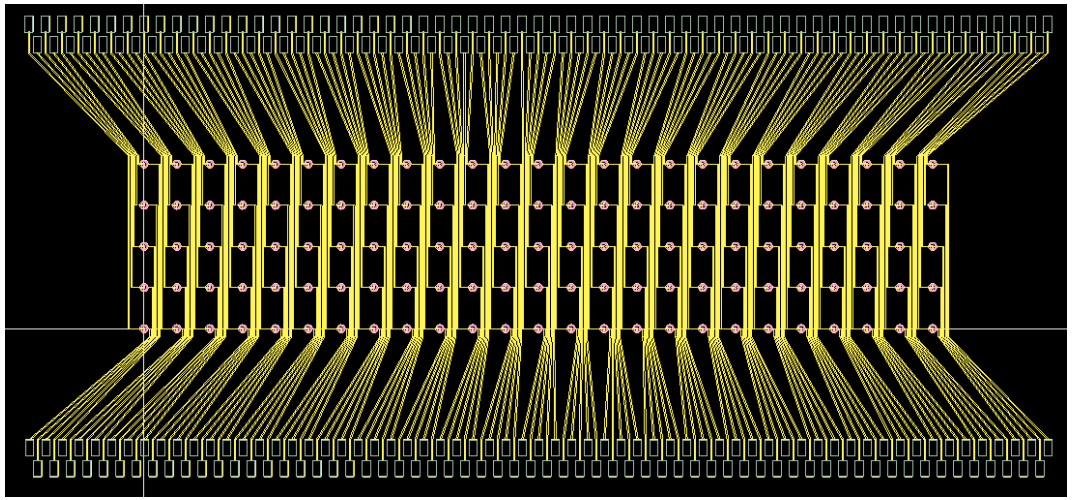


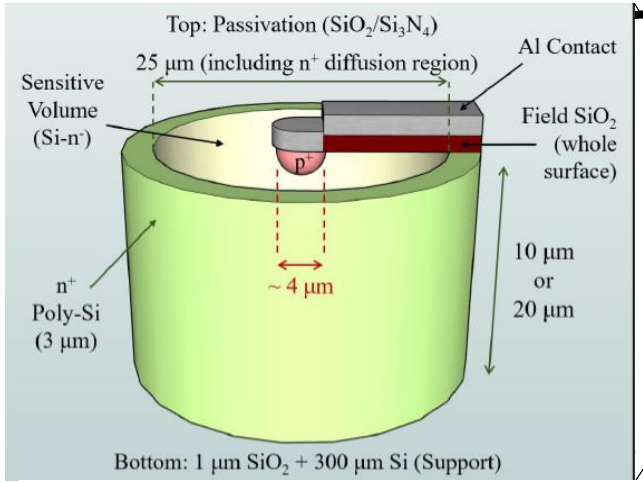


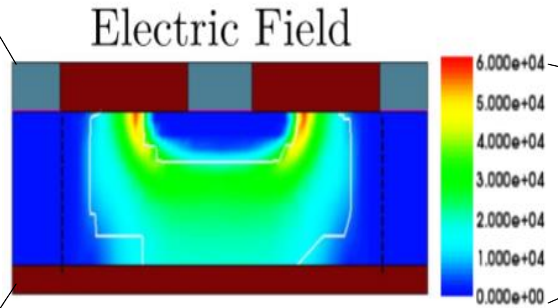


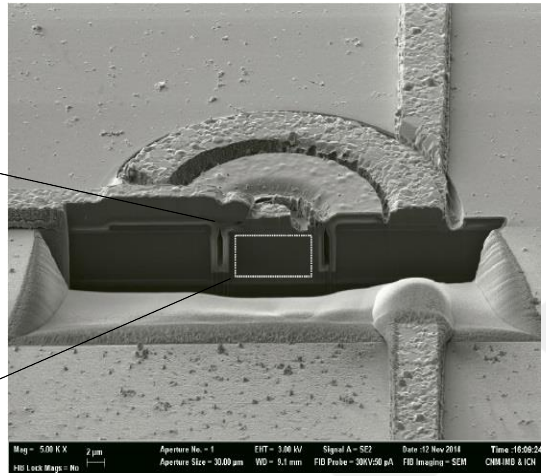
Microdosimeters











C. Guardiola et al.,
Brevet ref: PCT/ES2015/070056

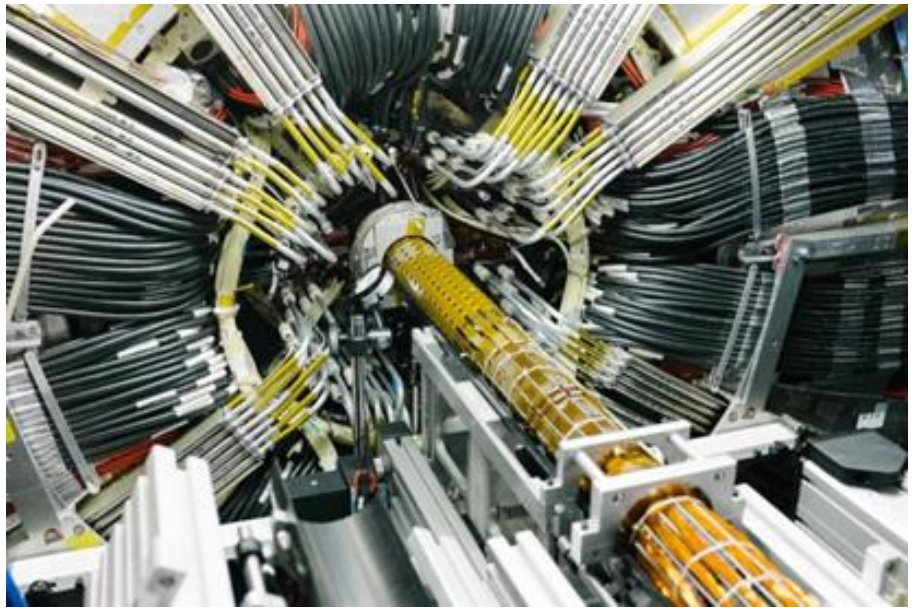
Diameters: 9, 10, 15, 20, 25 µm
Thickness: 5, 10, 20 µm

3D Detectors

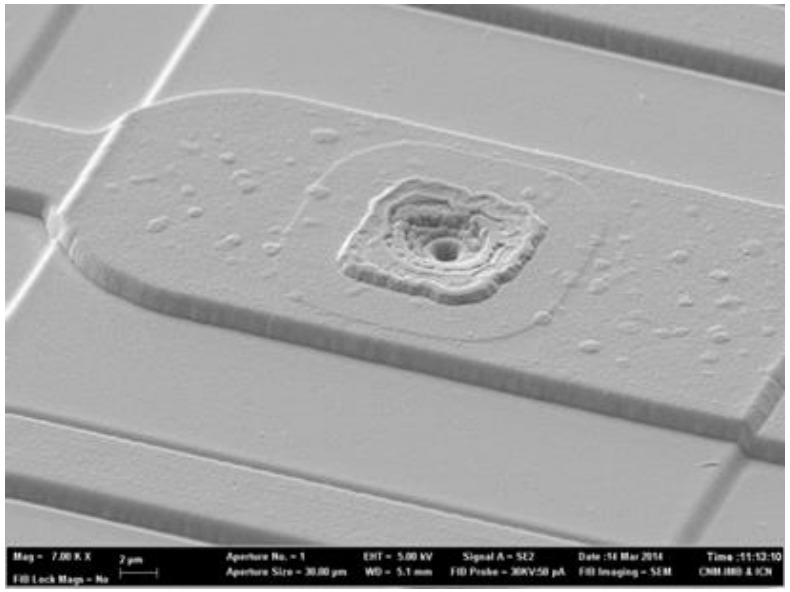
Working to adapt 3D technology to SiC

Installed at CERN experiments:

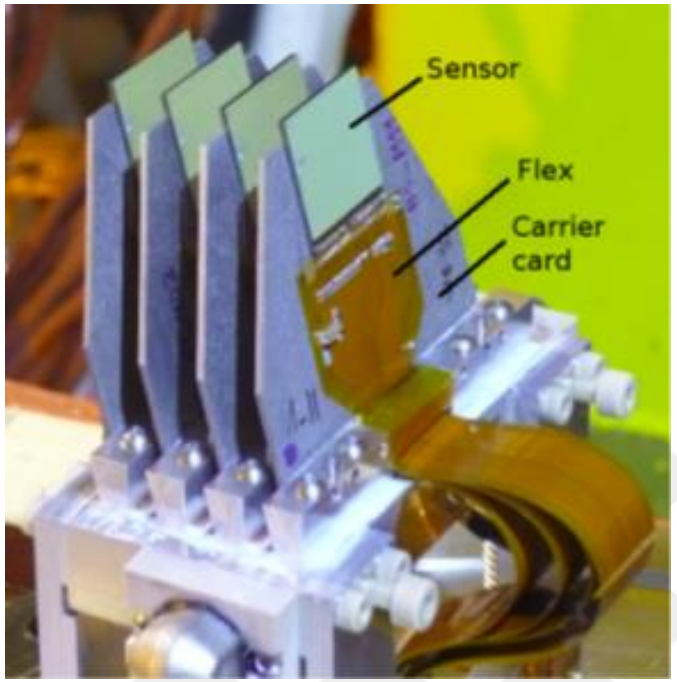
- Atlas IBL (Insertable b-Layer, 50% fabricated at CNM)
- AFP (ATLAS Forward Proton, 100% fabricated at CNM)
- CT-PPS (CMS-TOTEM Precision Proton Spectrometer, 100% fabricated at CNM)



ATLAS IBL

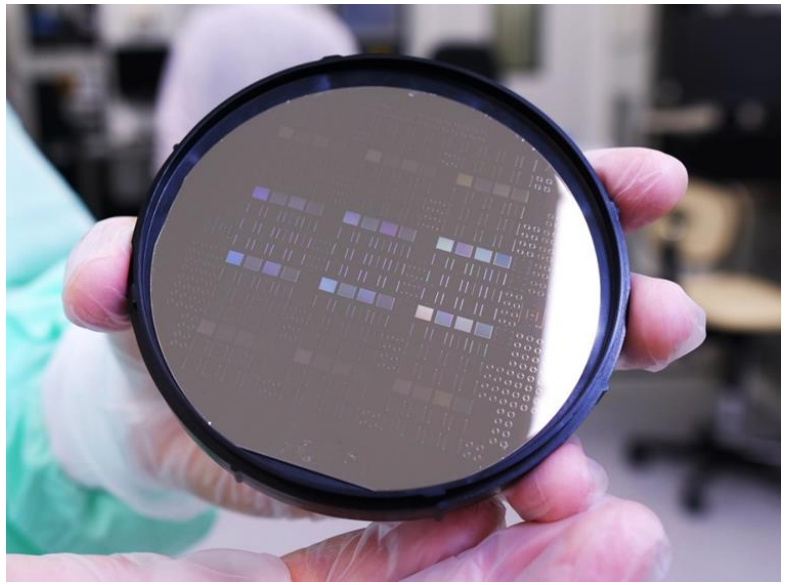


CMS CT-PPS Detectors



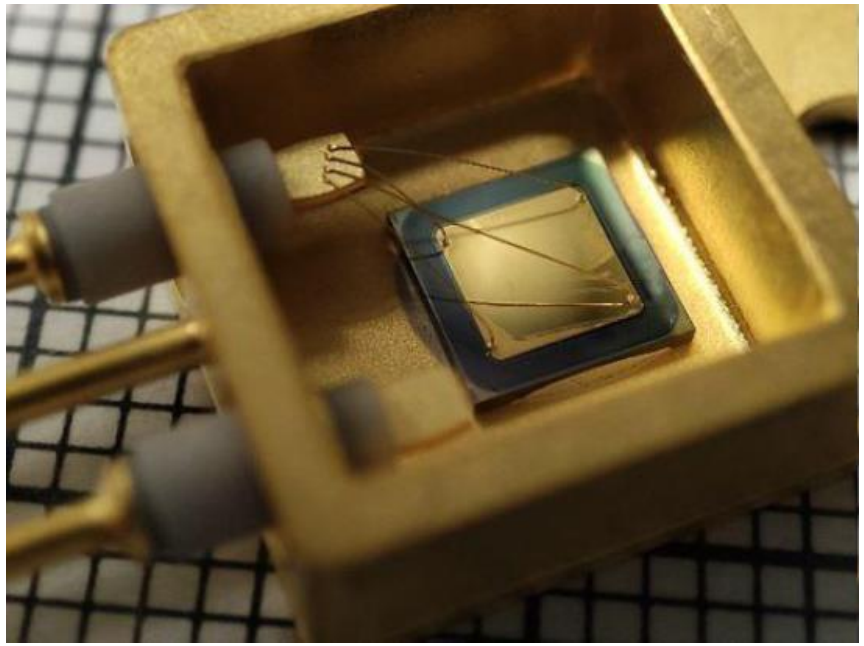
AFP detectors with slim edges

SiC radiation detectors & blocking diodes



Detectors and package optimized to work up to 500ºC

150 mm wafers



- **Space**: deep UV detectors (ESA) and blocking diodes
- **Dosimetry**: solid state ionisation chambers detecting x-raysor hadrons (FLASH)
- **Synchrotrons**: solid state ionisation chambers and fluorescence detectors
- **Heavy Ions**: start detectors and spectroscopy (e.g. GSI and the Nordhia)
- **Neutron detection**: nuclear industry, research and dosimetry
    - Thermal neutrons: fluence and profile monitoring
    - Fission neutrons: nuclear
    - Fusion: Tokamaks

ALTER TECHNOLOGY

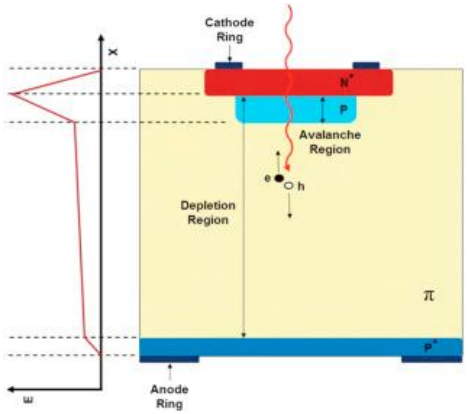
CNA Centro Nacional de Aceleradores

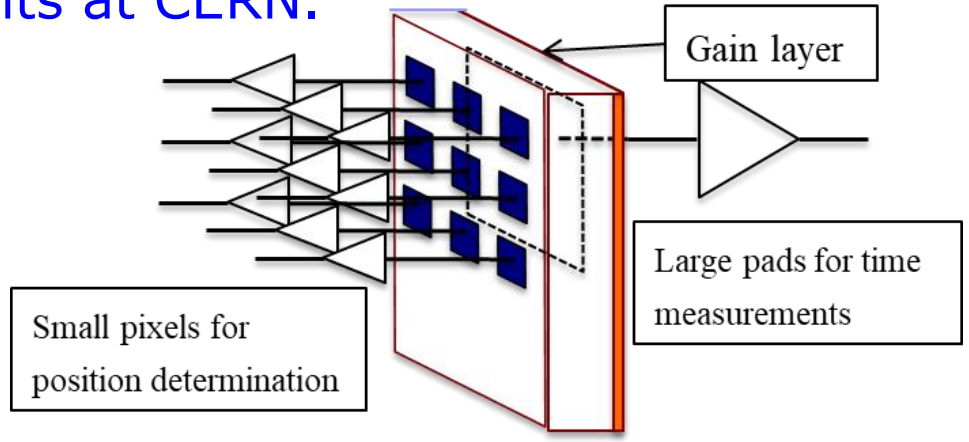
Infraestructuras Científicas y Técnicas Singulares

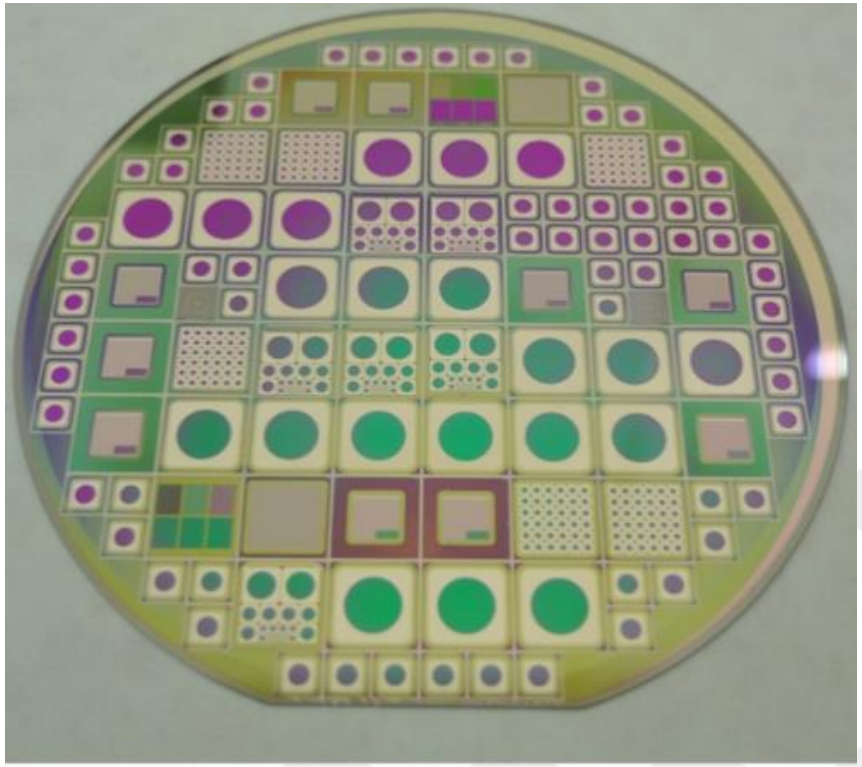
Low Gain Avalanche Detectors (LGAD)

- Featuring an **internal moderate gain**
- Optimized for excellent **time (≈20ps) and spatial resolutions (≈ 50um)**
- Could lead to the **detection of single ions** and to count the number of beam particles with high precision, improving the indirect measure provided by ionization chambers.
- Technology developed at CNM and now the baseline for different experiments at CERN.

Working to adapt 3D technology to SiC

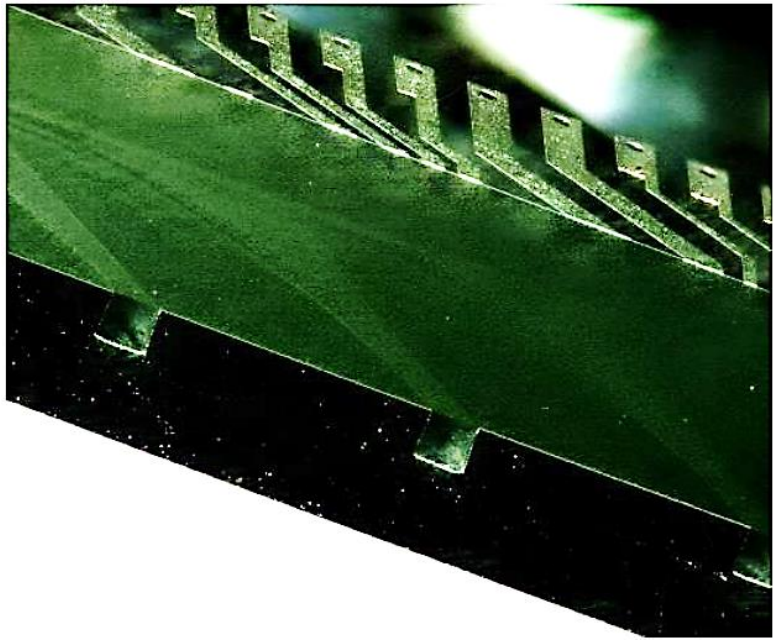


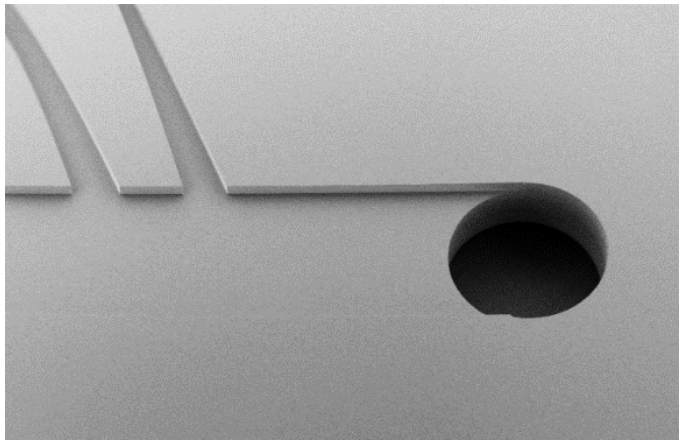


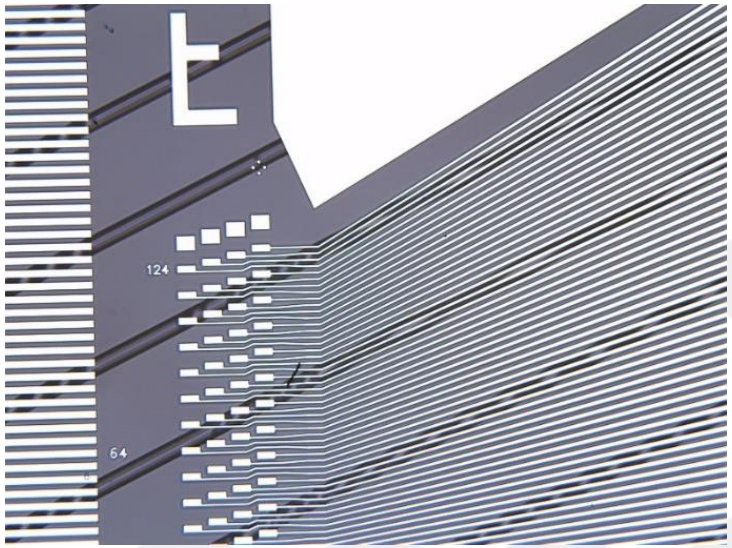


Microchannel cooling for radiation detectors

- Creation of silicon "interposers" which integrate microchannels for efficient heat dissipation in detector systems with high thermal demands together with metal layers for signal and power redistribution
- Applications in photonic science (synchrotrons and free-electron lasers) and in particle physics

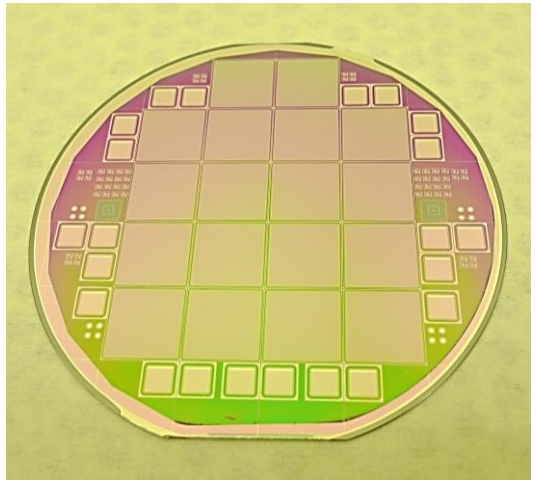


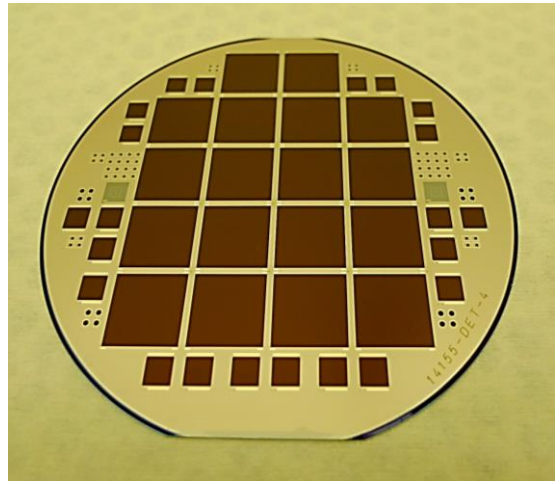




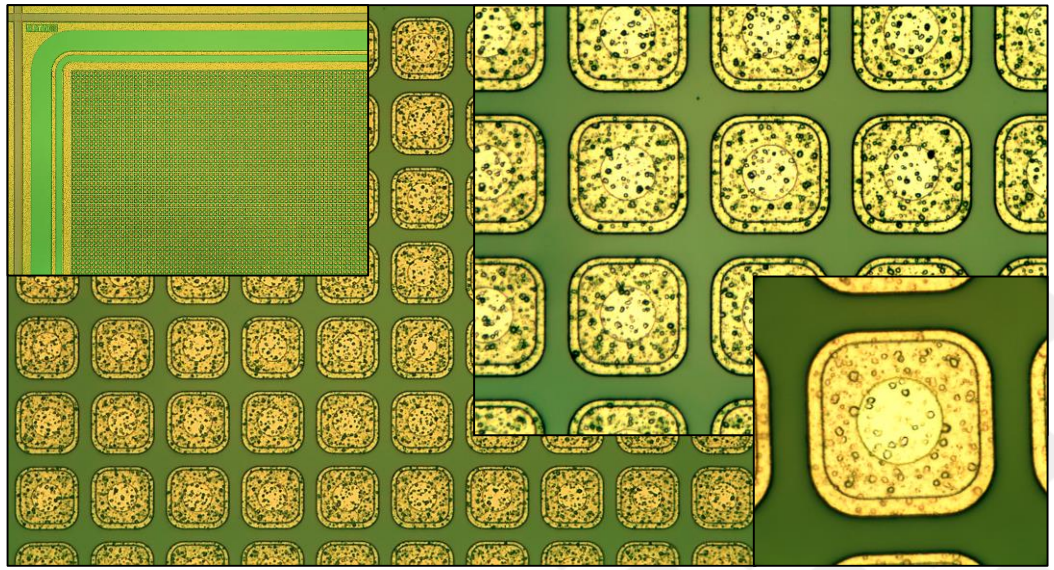
Ultra thin entrance window pixel detectors

- Ultra thin entrance window
- Pixel detectors for Medipix TPX chips
- For very low energy electron detection





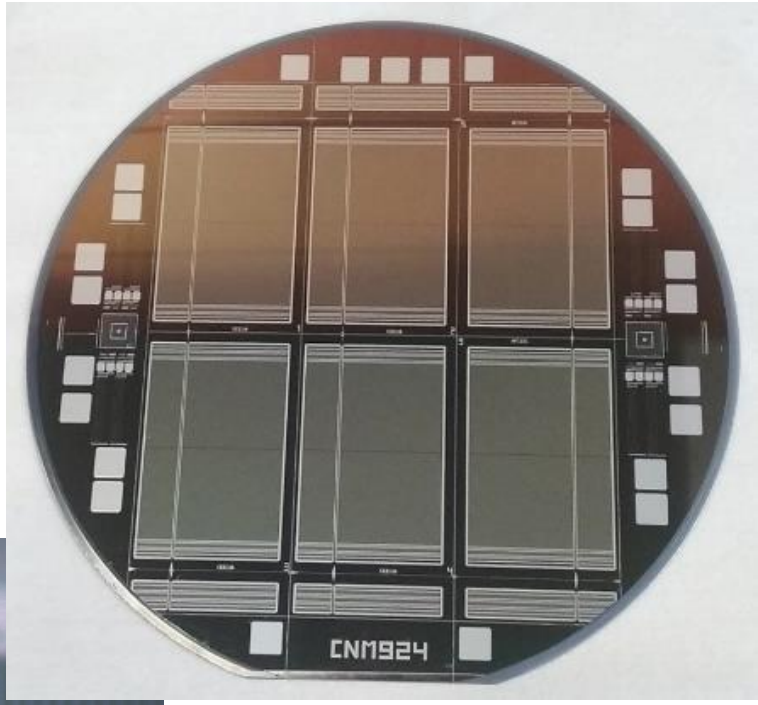
AMSTERDAM SCIENTIFIC INSTRUMENTS

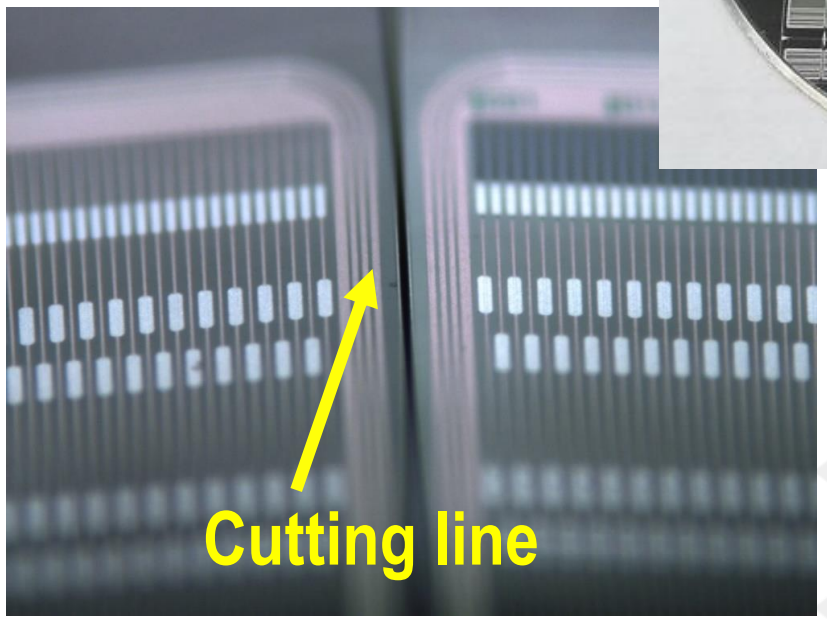


Amsterdam Scientific Instrumentation (NL)

Thin edge microstrip detectors

- Microstrip detectors
- Thin edge microstrip detectors for HPS (Heavy Proton Search)
- Coupling capacitor improved technology
- Cleaving





SLAC National Accelerator Laboratory (USA)