IMB-CNM (CSIC)

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IMB-CNM Presentation

- **Centro Nacional de Microelectrónica**
- **Is a Public Research Organism that belongs to the Spanish Council for Scientific Research (CSIC)**
- **Located in Bellaterra, close to Barcelona (Spain)**
- **Devoted to Nano and Microelectronics**
- **Micro Nano Fabrication Facility (Clean Room)**

- **Departments:**
  - **Micro and Nano Systems**
    - Silicon sensors and actuators
    - Nanotechnologies
  - **Systems Integration**
    - Power devices
    - Circuits and systems design
    - Biomedical applications

Some figures

- **2008 Year budget: 14.7 M€**
  - **3.3€ Clean Room budget**
  - **8.0 M€ Extraordinary budget for the expansion**
  - **3.4 M€ Non Clean Room budget**
- **2008 external funding:**
  - **3.8 M€ Research projects**
  - **0.8 M€ Industrial contracts**

- **IMB-CNM staff**
  - **175 people**
  - **55 researchers**
  - **50 Phd Students**
  - **70 Admin & technical**

From them

- **38 people Clean Room**
  - **12 Process Engineers**
  - **1 Maintenance Eng.**
  - **13 Process Tech.**
  - **11 Maintenance Tech.**
  - **1 Admin**

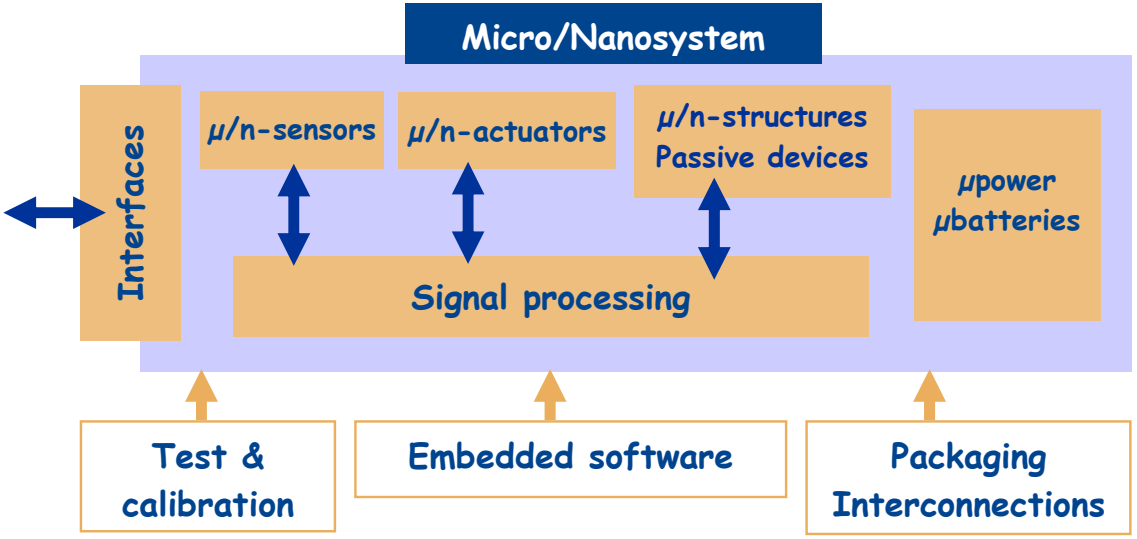
IMB-CNM Research focus

A steering & driving line :
MICRO & NANOSYSTEMS

The complexity and extension of Microelectronics

Micro-Nanosystems Department
- Radiation detectors
- Gas sensors and fuel cells
- Micro-nano tools
- Electrochemical transducers
- Silicon photonics
- Nanofabrication and functional properties of nanostructures
- Bio MEMS

Systems Integration Department
- Biomedical applications
- Integrated circuits and systems
- Integration of power devices and systems
- Reverse engineering in microelectronic devices



IMB-CNM facilities

- **Clean Room**
  - **1.500 m², class 100 to 10.000**
  - **Micro and nano fabrication technologies**
  - **Three areas:**
    - Pure (CMOS)
    - Noble metals allowed
    - Nanoelectronics
- **Processes**
  - **4'' complete**
  - **6'' partial (no thermal processes)**
- **Available technologies:**
  - **CMOS, BiCMOS, MCM-D, MEMS / NEMS, power devices**
  - **Bump bonding packaging**
- **Silicon micromachining**
- **Packaging**
  - **200 m², class 100**

- **Laboratories**
  - **Characterization and test**
    - DC and RF (up to 8 GHz)
    - Wafer testing
    - Thermography
    - Radiation testing
  - **Reverse Engineering**
  - **Simulation**
  - **CAD**
  - **Mechanical Workshop**
  - **Chemical sensors**
  - **Bio-sensors**
  - **Radiation sensors**
  - **Optical sensors**

Clean Room Equipment (more than 150 units)

- Thermal processes and CVD
- Ion Implantation
- PVD and Metallisation
- Lithography (proximity and stepper)
- Nano-lithography (electron beam, AFM and nano-imprint)
- Direct laser writing
- Dry etching
- Wet and dry micromachining
- Wet etching and cleaning
- In line test
- Wafer grinding and CMP

See full list at:
http://www.imb-cnm.csic.es/

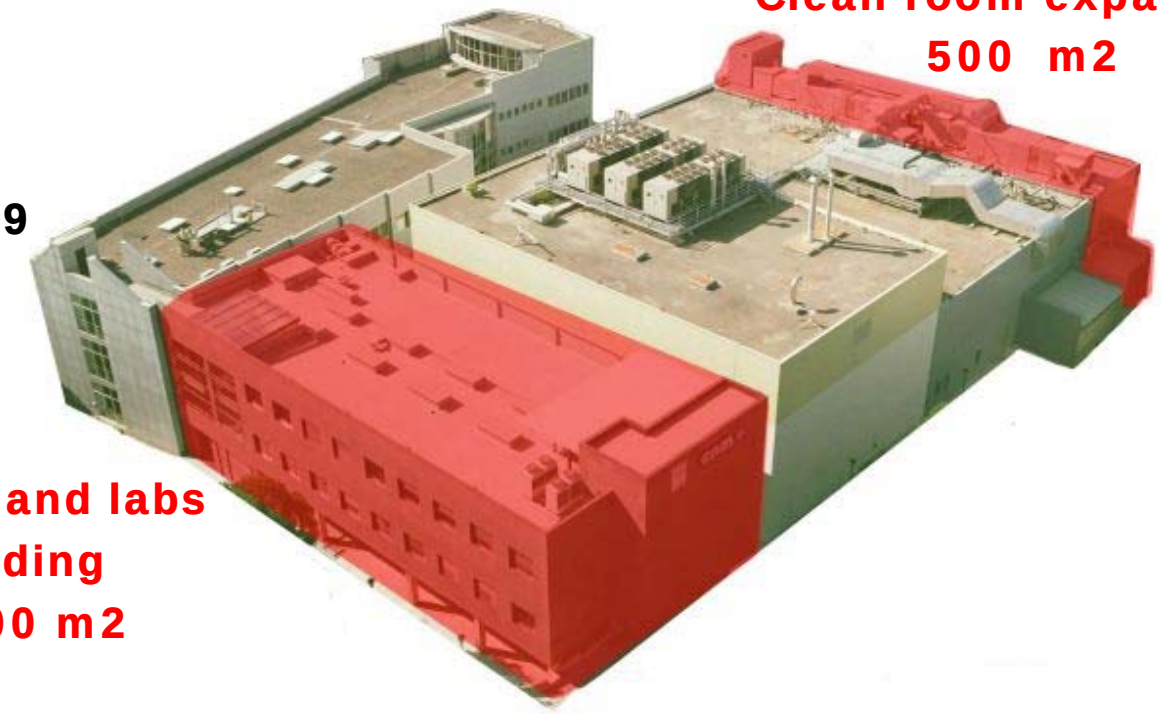
Some Views of the ICTS' main Clean Room

Clean room main processes

- Wet and dry oxidations.
- Ion implantation
  - B, P, As, N and Ar.
- Diffusion
- CVD
  - Si3N4, polysilicon, SiO2, BPSG
- Metallization
  - Al/Si, Al/Cu, Al/Cu/Si, TaSi, Ti, Ni, Au, Pt, Cr, Ag, a-Si, and Ge.
- Wet and dry etching
- Surface and bulk silicon micromechanization
- Anodic bonding
- Packaging
  - die bonding, wire bonding, SMD
- In line test
  - Ellipsometry, interferometry, profilemetry, four-point probes
- Photolithography
  - contact/proximity, step and repeat, double side
- Nanotechnology
  - AFM
  - Electron beam
  - Nano-imprint
  - FIB (Focused Ion Beam)

IMB-CNM Expansion

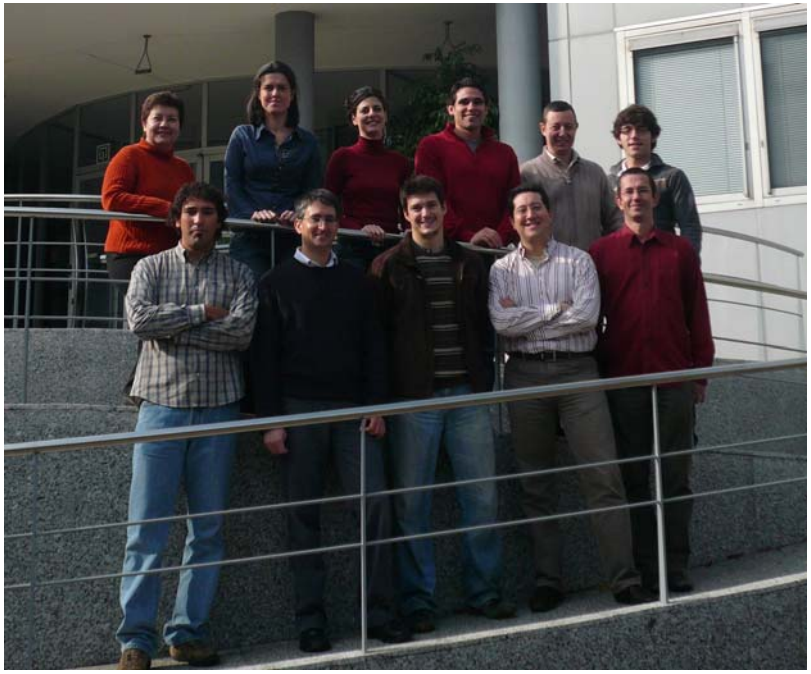
- Civil work finished
- Installation will be finished by end 2009



- New equipment and processes not yet ready:
  - Wafer bonding
  - CMP
  - Wafer grinder
  - Electron gun evaporation system
  - Atomic layer deposition

Radiation Detectors group

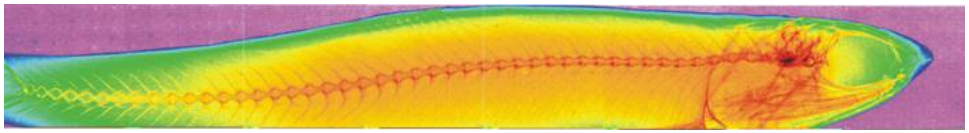
- **People**
  - 3 permanent doctors
  - 5 contracted doctors
  - 4 PhD students
  - 1 Engineer



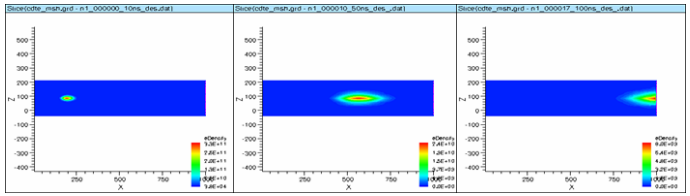
- **Activities started in 1996**

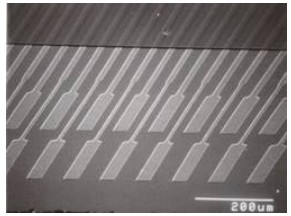
- **Experiments**
  - Members of the RD50 CERN Collaboration
  - ATLAS, ATLAS upgrade (sLHC)
  - SILC
  - GRI (Gamma Radiation Imager)

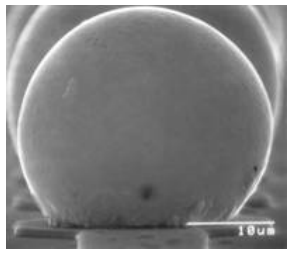
Activities in Radiation Detectors

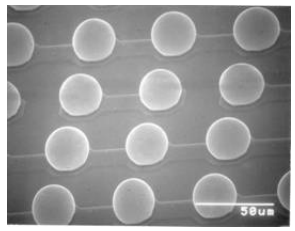


- **Silicon radiation detectors**
  - Layout design, simulation, fabrication, characterization
  - Pad, strip and pixel designs
  - P-in-N, N-in-P and N-in-N technologies developed
  - Silicon oxigenation









- **3D detectors**
  - Electrodes deep into silicon bulk
  - Low full depletion voltage
- **Pad pitch adaptors for detector modules**
  - ATLAS-SCT Forward Modules

- **Medical imaging**
  - X-ray radiation pixel detectors
  - DEAR-MAMA European Project
  - Real time stereotactic biopsy
  - Complete pre-industrial system
    - Hardware, software, and chip design
- **Radiation effects on devices and materials**
  - Thin dielectrics for submicronic technologies
  - Silicon radiation detectors
  - MOS, BiCMOS and bipolar devices
- **High density bump bonding**
  - Fine pitch by electrodeposition
  - For image devices

D+T Microelectronics

- **Association of Economic Interest (AIE) funded by CSIC**
  - **To commercially exploit IMB-CNM Clean Room**
- **CNM-IMB has an industrial side through D+T**
- **Partners**
  - **CSIC (**75% participation ⇔ Public Company)
  - **Alcatel Standard Eléctrica, S.A.**
  - **Biosystems S.A.**
  - **Componentes De Electrodomésticos Y Electrónicos S. Coop. Ltda (MCC Grupo - Mondragón Corporación Cooperativa)**
  - **Tecdis Display Iberica S.A.**

Limitations

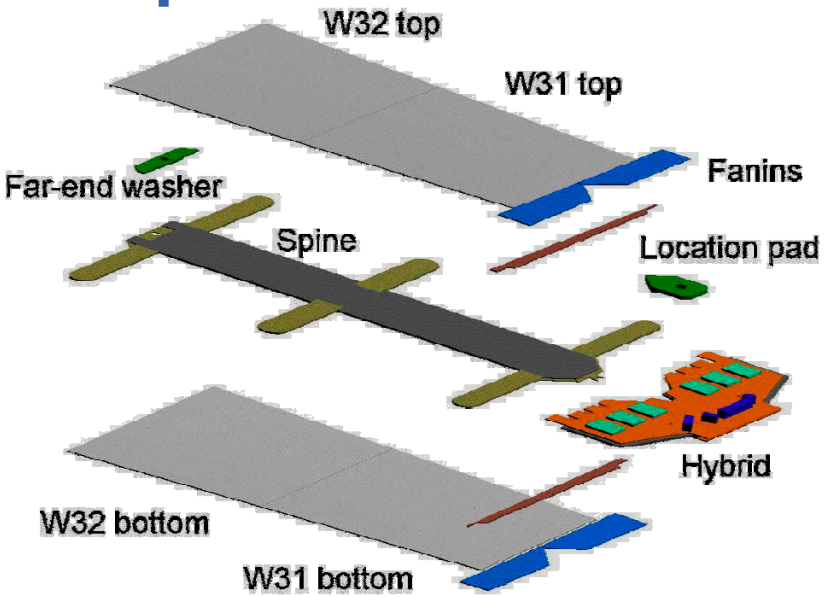
- Clean room only fully equiped for 10cm (4'') wafers
- Only partially equiped for 15 cm (6'')
  - No thermal processing
- Clean Room used most of the time for scientific projects
- No focused in commercial activities
  - This philosophy can be changed
- IMB-CNM is not prepared for mass production
  - No adequate for thousands of large strip detectors
- No ISO9001

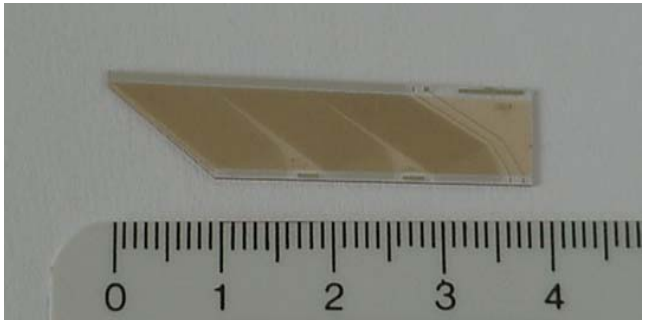
Advantages

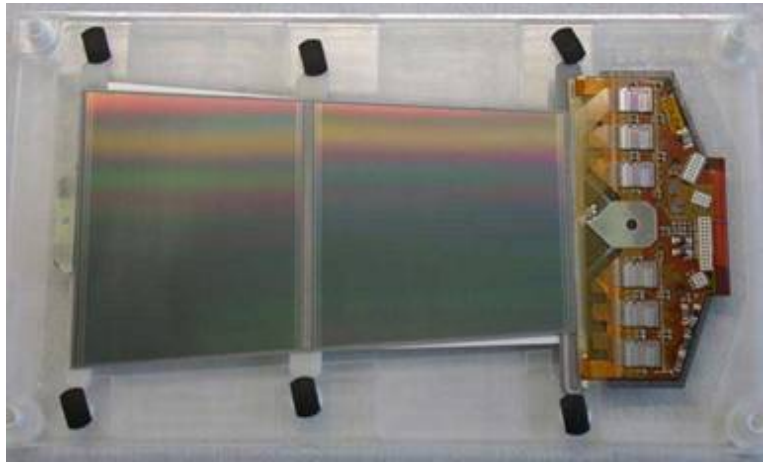
- Clean room operated by dedicated, very specialized team
  - 50 people staff (including maintenance)
  - Working in 2 daily shifts. Room for a third one
  - No direct access of researchers or students
- Complete equipment for silicon micro and nano technology
  - Not so common in other University Clean Room
  - Example: we have complete 3D processing (ion implant, deep etching, p- and n-type polysilicon, two side alignment, ...)
- Very well suited for low series of very specific technologies
  - Several hundred wafers per year (< 1,000)
  - 3D, double side, thin, slim edge, ...
- IMB-CNM Clean Room could place a role in devices that are not attractive to large companies
- Packaging solutions (bump bonding) available soon

Past examples: ATLAS pitch adaptors

- **Pitch adaptor production**
  - **10,000 pieces for ATLAS Inner Detector Endcaps in three years**
  - **The biggest commercial contract of IMB-CNM/D+T**
  - **WE contracted new technicians working only for this production**
  - **Good experience**







Current example: 3D pixel detectors

- Double sided 3D technology developed at CNM-Barcelona
  - Holes are etched from both sides
  - Reduction of stress
  - Simplification of fabrication process
- Not compatible with thin wafers
  - Support wafer ca not be used
- Complete process at our Clean Room
  - Second demonstration of 3D feasibility after Stanford
- 3D pixel detectors for Insertable B-layer for ATLAS
- Current manufacturers: (Stanford+Sintef), FBK, CNM
- Good results proved with Medipix2 chips
- Atlas chips under study