Instituto de Microelectrónica de Barcelona. Centro Nacional de Microelectrónica IMB-CNM (CSIC)

IMB-CNM Presentation

Centro Nacional de Microelectrónica

Belongs to CSIC

- (Spanish Council for Scientific Research)

Devoted to Nano and Microelectronics

Departments:

- Micro and Nano Systems
- System Integration
- Micro Nano Fabrication Facility (Clean Room)

Clean room operated by D+T Microelectrónica

- Association of Economic Interest (AIE)

170 people

- 50 researchers
- 40 students
- 30 Clean room engineers

Annual budget 7.5 M€

63% external funding

IMB-CNM facilities

Clean Room
- 1.500 m^2, class 100 to 10.000
- 200 m^2, class 100
- Two lines:
  - Pure (CMOS)
  - Noble metals

Processes
- 4'' complete
- 6'' partial

Available technologies:
- CMOS, BiCMOS
- MCM-D
- MEMS
- Radiation detectors
- MCM packaging

Laboratories
- Packaging
- Characterization and test
- Reverse Engineering
- Silicon Micromachining
- Simulation
- CAD
- Mechanical Workshop
- Chemical sensors
- Bio-sensors
- Radiation sensors
- Optical sensors

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

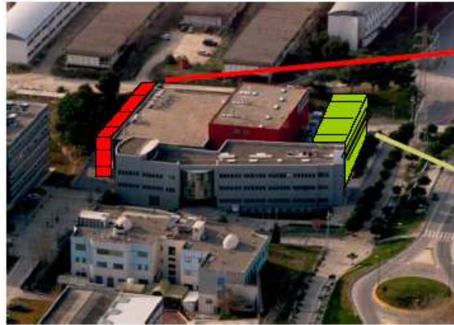
Packaging
- die bonding, wire bonding, SMD

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



Coming equipment:

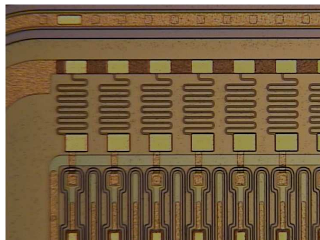
- CMP
- Wafer grinder
- Electron gun evaporation system
- Atomic layer deposition

Operative by beginning of 2008

Radiation Detectors group

People

- 4 permanent doctors
- 2 contracted doctors
- 4 PhD students



Collaborations with other groups

- IFIC (Valencia)
- IFAE (Barcelona)
- Univ. Santiago
- LNPHE from IN2P3 (Paris)
- Univ. Liverpool
- Univ. Glasgow

Experiments

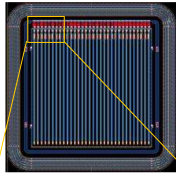
- CERN ATLAS, RD50, sLHC
- SILC

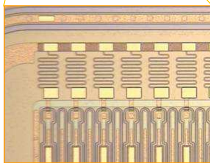
Radiation detectors

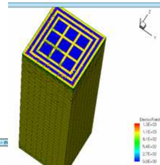
Silicon radiation detectors

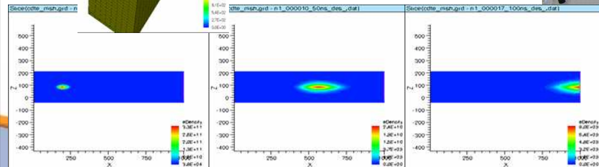
- **Design**
- **Simulation**
- **Fabrication**
- **Characterization**

- Pad, strip and pixel designs
- P-in-N, N-in-P and N-in-N technologies developed
- Silicon oxigenation to increase radiation hardness







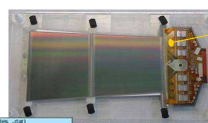


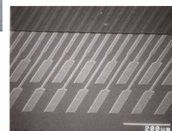
Radiation effects on devices and materials

- Thin oxides for submicronic technologies
- Silicon radiation detectors
- MOS and bipolar devices
- Members of RD50 CERN Collaboration

Pad pitch adaptors for detector modules

- ATLAS-SCT Forward Modules





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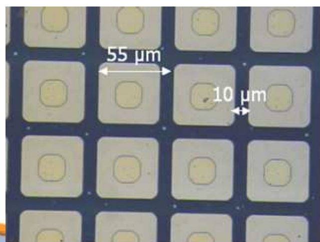
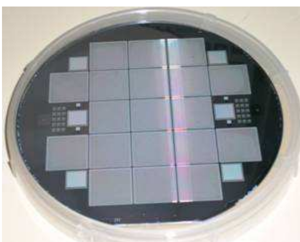
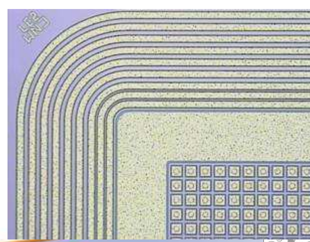
Detectors for x-ray imaging

In collaboration with IFAE (Barcelona)
DearMama project: digital mammography system
Pixel silicon detectors fabricated at CNM
We also used CdTe from Acrorad.
Use of Medipix2 chip

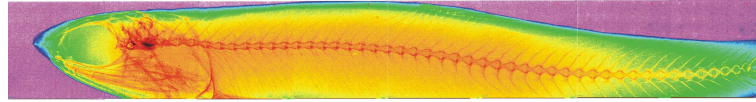






CSIC

Medical imaging systems



In collaboration with IFAE (Barcelona)

Complete system

Backend electronics

Pre-industrialization phase

Evaluation test bench

- High speed: 500 fps, 2sec buffer depth

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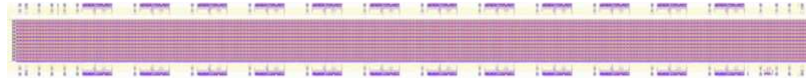
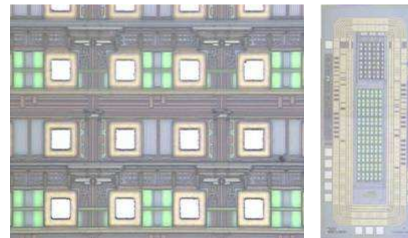
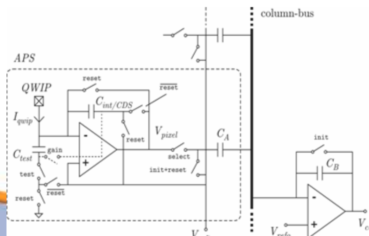
Circuit design for pixel systems



Read-Out IC for large arrays of photon IR sensors at cryogenic temp.

- 6000 (500×12) QWIPs
- true IR video (e.g. 500×640@100fps)
- 215mW@3.3V
- 77K cryogenic operation
- 50mm2 (25mm×2mm)





APS functionality:

- TDI, CDS, built-in test, charge multiplexing
- 50µm×100µm pix size
- 60ns mux time/pix
- 6µA consumption/pix

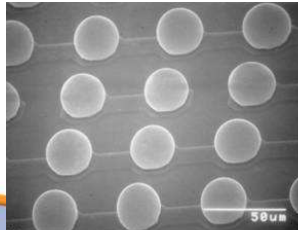
Indra

CSIC

Packaging

SMD
Wirebonding
Bumping pitch
- 400µm. Screen printing
- 50µm. Solder electroplating

Flipchip
- Standard Temperatures (Sn/Pb)
- High temperatures: 280ºC
- Under development: low T

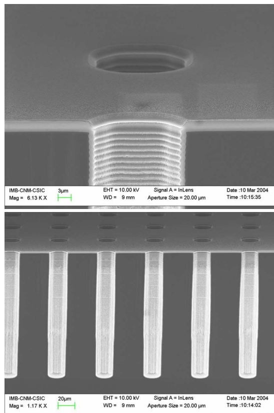


Dek248 Screen printer
ATV reflow oven with vacuum
Manual Pick&Place machine
Datacon 2200 PPS for fine pitch

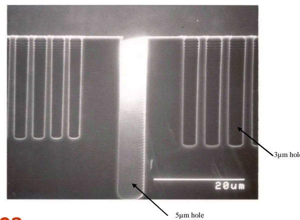
Süss Microtec FC150

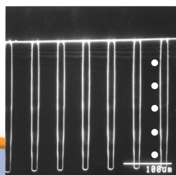
Collaboration with IFAE (Barcelona)

Silicon etching with ICP RIE

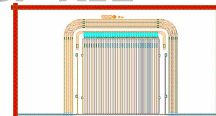


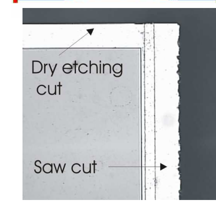
Alcatel 601-E
Aspect ratio 25:1
Minimum diameter tested 3 µm
3D detectors
Edgeless detectors

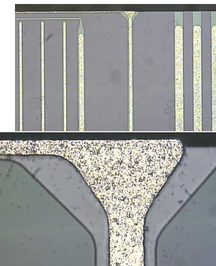




- **10 µm holes**
- **55µm pitch**
- **90 minutes etching**
- **300 µm thick wafer**
- **Aspect ratio 24:1**







3D detector layout and simulation

A collaboration between CNM and Glasgow University

1um
0.4um
Passivation
Oxide
Metal
P-stop p+
5um
n+ doped
50-0um
TEOS 2um
10um
Poly 3um
p- type substrate
300-250um
p+ doped
p+ doped
50-0um
Oxide
Metal
55um pitch

Seperate contact to each n+ column
Oxide layer
n+ column (250um depth, 10um diameter)
p-stop
p+ column (250um depth,10um diameter)
p- substrate (300um thick, doping 7e11cm-3)
55um pitch
Oxide layer covered with metal, all p+ columns
300um substrate (default)
280um substrate
260um substrate
Electric field (V/cm)

ISETcad 3D Simulation

G. Pellegrini Presented at the 2nd Trento Workshop on Advanced Silicon Radiation Detectors, Trento, 2006. Available online at: http://tredi.itc.it

D. Pennicard, **"Simulation Results from Double-Sided 3D Detectors"**, IEEE Transactions on Nuclear Science Volume 54, Issue 4, Part 3, Aug. 2007 Page(s):1435 - 1443

CSIC

Polysilicon hole filling

Poly etched with RIE
Standard resist mask

Polysilicon
Thickness=3µm

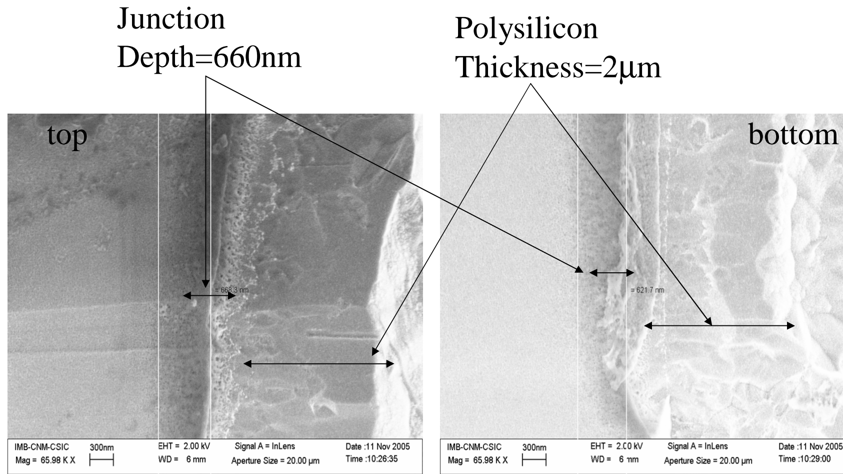
0.4µm

4µm
5.7µm

2.9µm

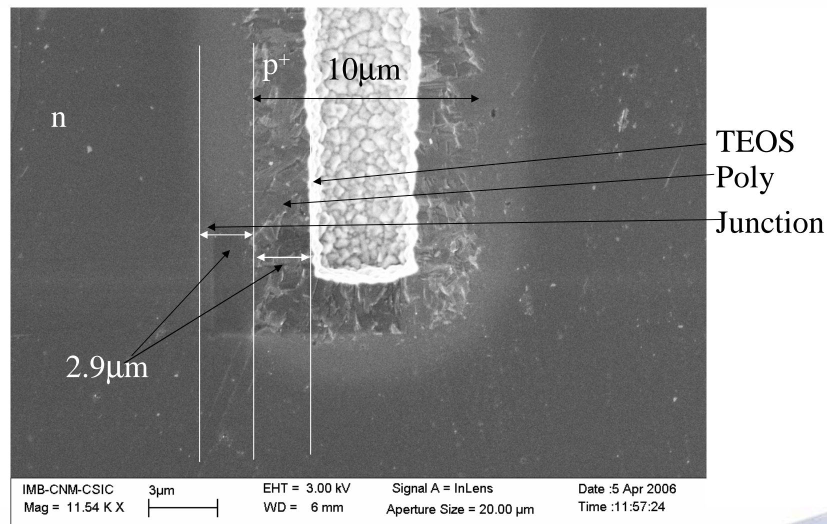
CSIC

Doping diffusion, Phosphorus



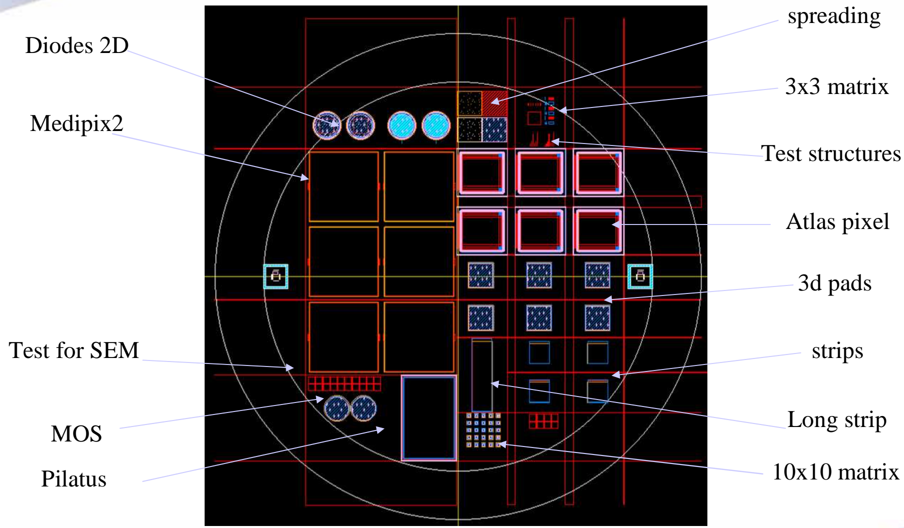
Phosphorus diffusion
Temp.=1050ºC

Doping diffusion, Boron



Boron diffusion
Wafer 3

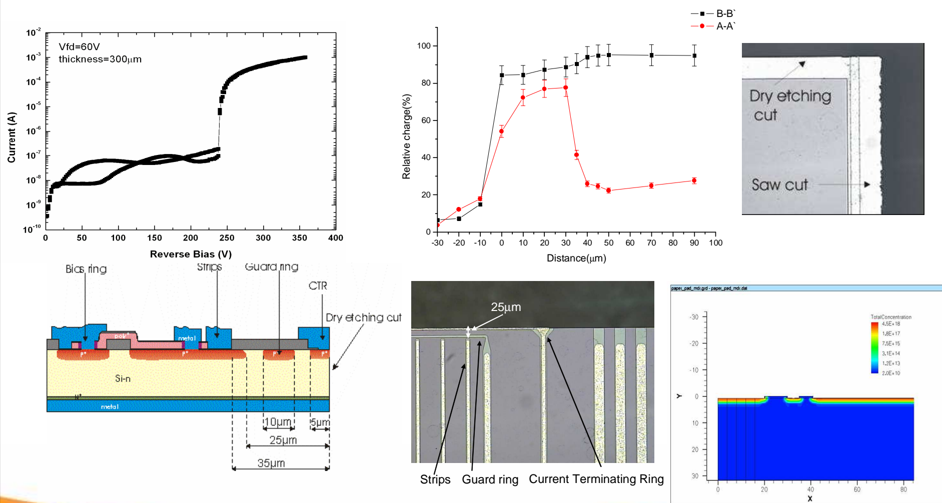
3D detector mask design



Fabrication run in progress, delayed due to refurnishing of our clean room facilities.
End: october 2007

Edgeless detectors

INTAS project with CERN for the fabrication of next TOTEM detectors.

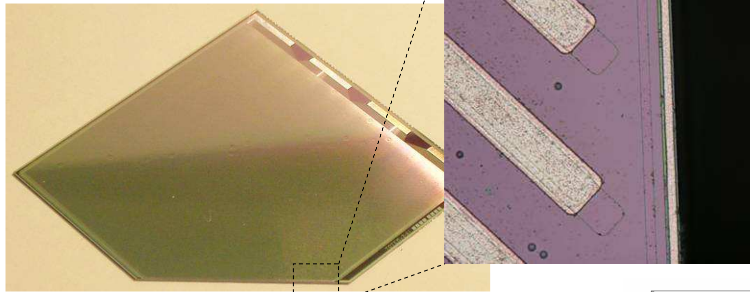


G.Pellegrini et al., **Characterization of Edgeless detectors fabricated by dry etching process**
Nuclear Instruments and Methods A Volume 576, Issue 1, 11 June 2007, Pages 95-97

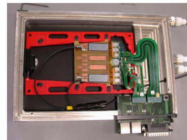
Edgeless detectors

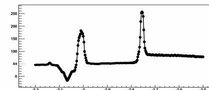
Post processing of detectors fabricated outside CNM

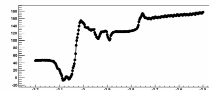
30 minutes per wafer.
Protected with photoresist



Illuminating the edge region with a near infrared laser beam and collecting the correspondent signal through the binary ABCD3T read-out electronic.
Preliminary results confirm the sensitive edge.







G. Ruggiero et al., "**Planar Edgeless Silicon Detectors for the TOTEM Experiment**", Nuclear Science Symposium Conference Record, 2004 IEEE Volume 2, 16-22 Oct. 2004 Page(s):922 - 924.