FONDAZIONE BRUNO KESSLER

Fondazione Bruno Kessler

…. "Focused Research to push Innovation" ….

P. Bellutti – MicroTechnologies Lab

FBK: Scientific & Technological Research Center

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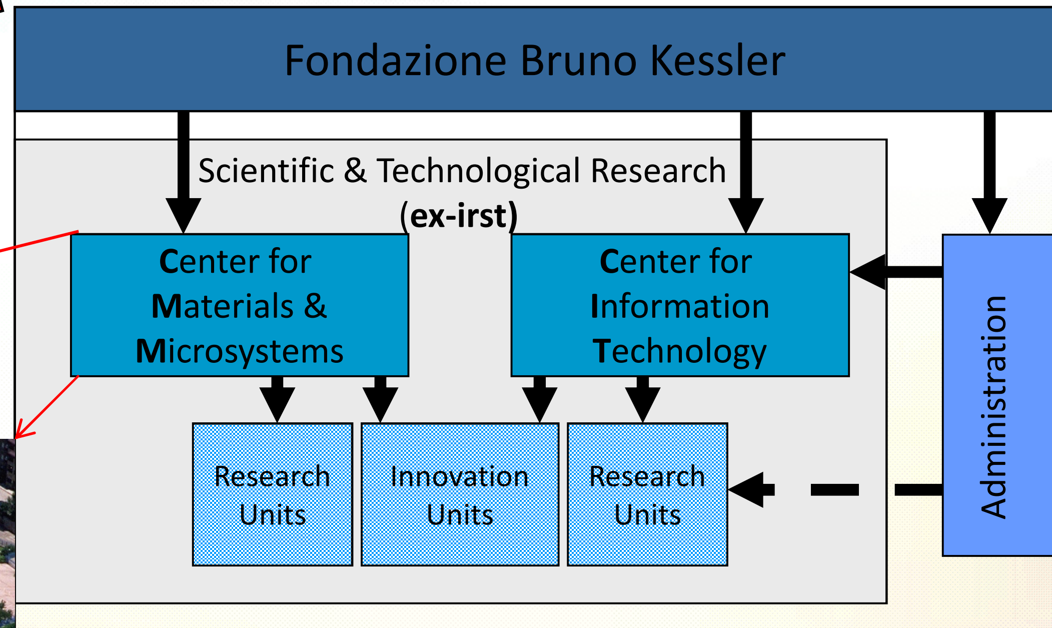

Center for Materials & Microsystems (CMM-irst)

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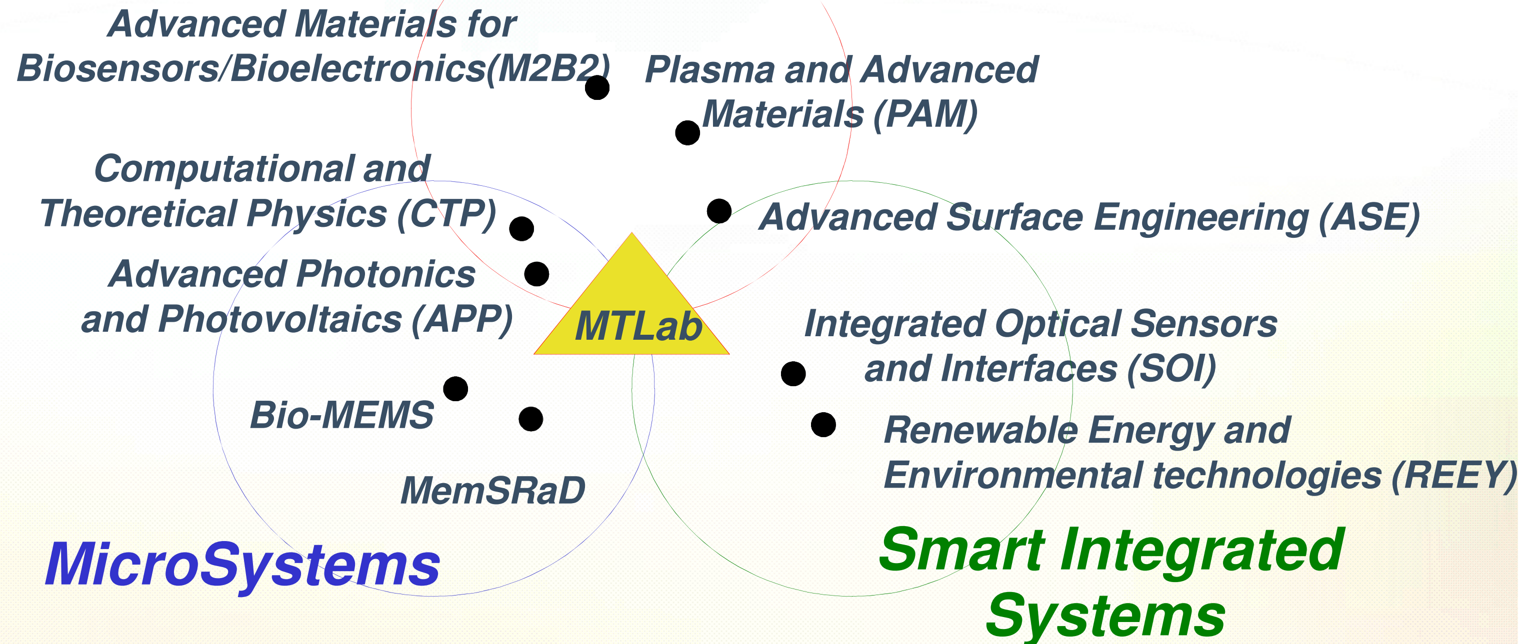
Focused Research: 3 synergic areas



People

- 67 researchers
- 27 technicians and technologists
- 14 PhD students
- 8 research collaborators
- 2 visiting professors

CMM-irst: Areas of interest

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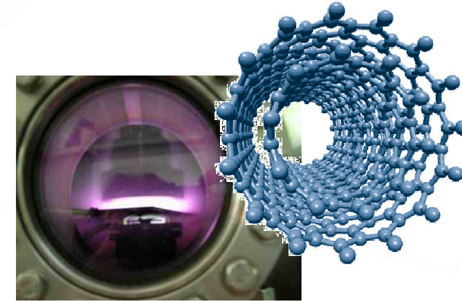
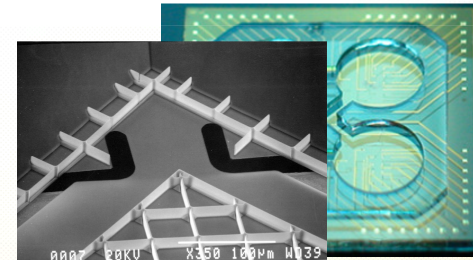
Advanced Materials.

Study and development of innovative materials, both organic and inorganic, with particular emphasis on the study of thin films, nanostructures, and surfaces



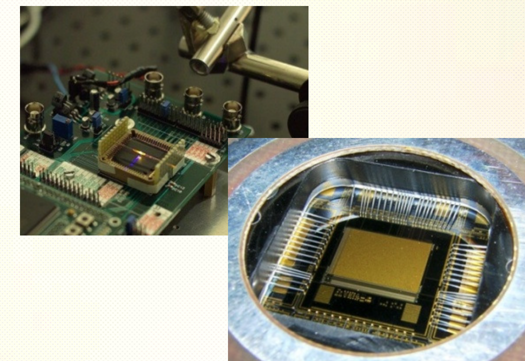
MicroSystems

Development of technological platforms aimed at the Microfabrication of both sensor and actuator systems



Smart Integrated Systems

Development of integrated intelligent sensors and systems capable of local signal processing as well as communication to the real world



CMM-irst: Silicon Facility Expertise

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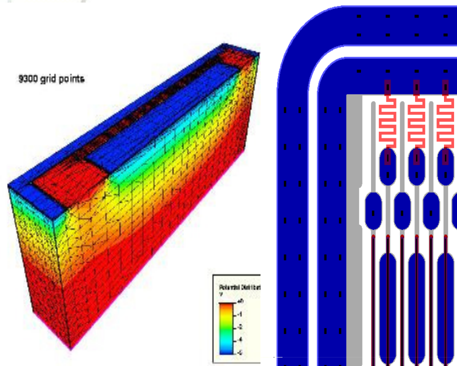
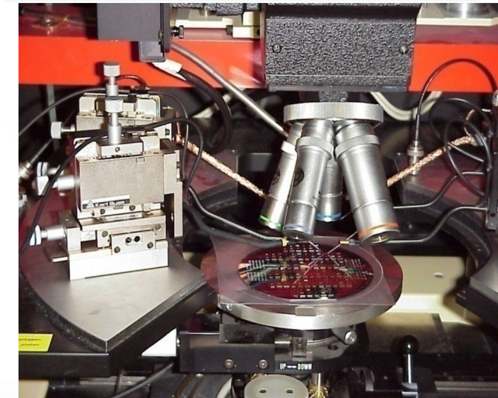
TCAD simulation
CAD design



Fabrication

Device testing

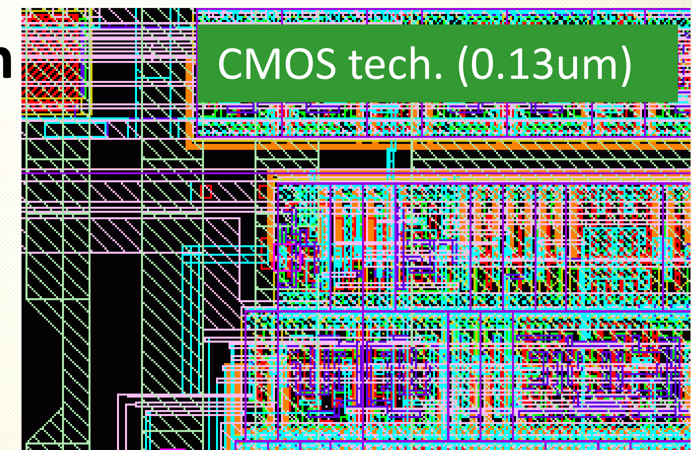


Technologies:

- Radiation detectors
- MEMS
- Photovoltaics
- Optical sensors

Custom CMOS design

Development of ROIC by exploiting state of the art CMOS tech (external services)



CMOS tech. (0.13um)

CMM-irst: Material Characterization Facility Expertise

	XPS	SEM	SIMS	ToF-SIMS	AFM	TXRF
MAIN FEATURE	**Information on chemical bond**	**High spatial resolution**	**High sensitivity to elements**	**Information on surface chemistry**	**Surface Topography**	**Elemental analysis**
SOURCE	X-Ray (Al)	Electrons	Ions	Ions	Mechanical Taping	X-Ray
SENSITIVITY	0.1 % at.	0.1 % at.	10^{-4}÷10^{-7} % at.	10^{-4}÷10^{-6} % at.	=	1E11 at/cm^2.
DEPTH RESOLUTION	2-20 nm (Depth Profile) 10 nm (Surface Analysis)	(Surface Analysis)	1.5-20 nm	1-3 monolayers (static mode)	monolayer	=
SAMPLING DEPTH	2÷20 atomic- layers	2÷20 atomic- layers	2÷3 atomic- layers	1÷3 atomic- layers	=	1nm-1µm
INSTRUMENT AT CMM-irst	**Scienta 200**	**Jeol JSM 7401F**	**CAMECA IMS 4f CAMECA SC-Ultra**	**CAMECA ION TOF IV**	**Solver P47H Solver Pro SPM NT-MDT**	**Atomika 8010W**

CMM: Focus on Micro Technologies Lab

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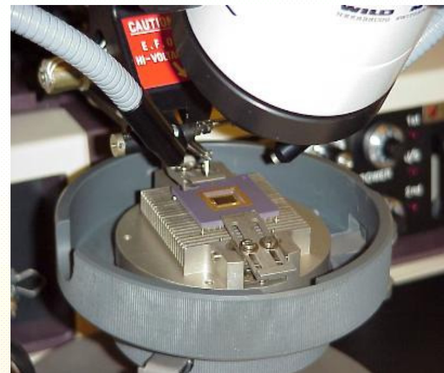
MTLab a flexible, reliable and a technological updated facility for:

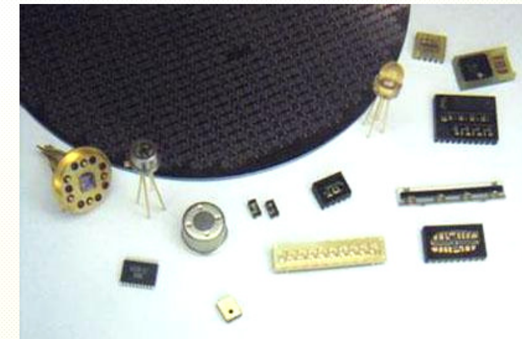
- R&D
- primary-stage product development
- product manufacturing activities

in the area of MEMS, micro and nano technologies.

Microfabrication Lab
carrying out silicon wafer processing and related technologies;



Testing Lab
parametric and functional testing



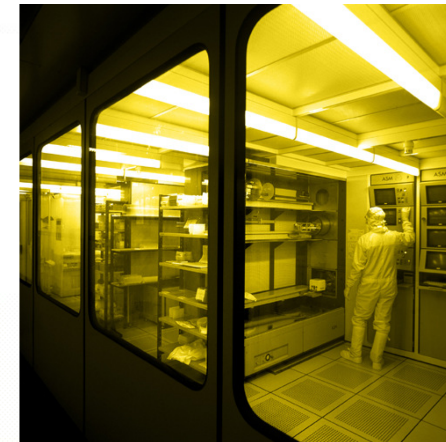
Microsystems Integration Lab
developing solutions for advanced packaging and system engineering

MicroFabrication Lab

Two separate clean room

- 500m^2 of clean room (class 10-100)
- 150m^2 of clean area (class 100-1000) equipped for MEMS technology

4 inch wafers (Si, Quartz, Glass)



Employees

7 Researchers

9 Technicians

Planar processing capacity is 3000 4-inch wafers/year on one shift, 5 mask process

MF Lab: main equipments

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LITHOGRAPHIC EQUIPMENT
Mask aligner (front to back-side alignement)
Stepper (operative early 2010)

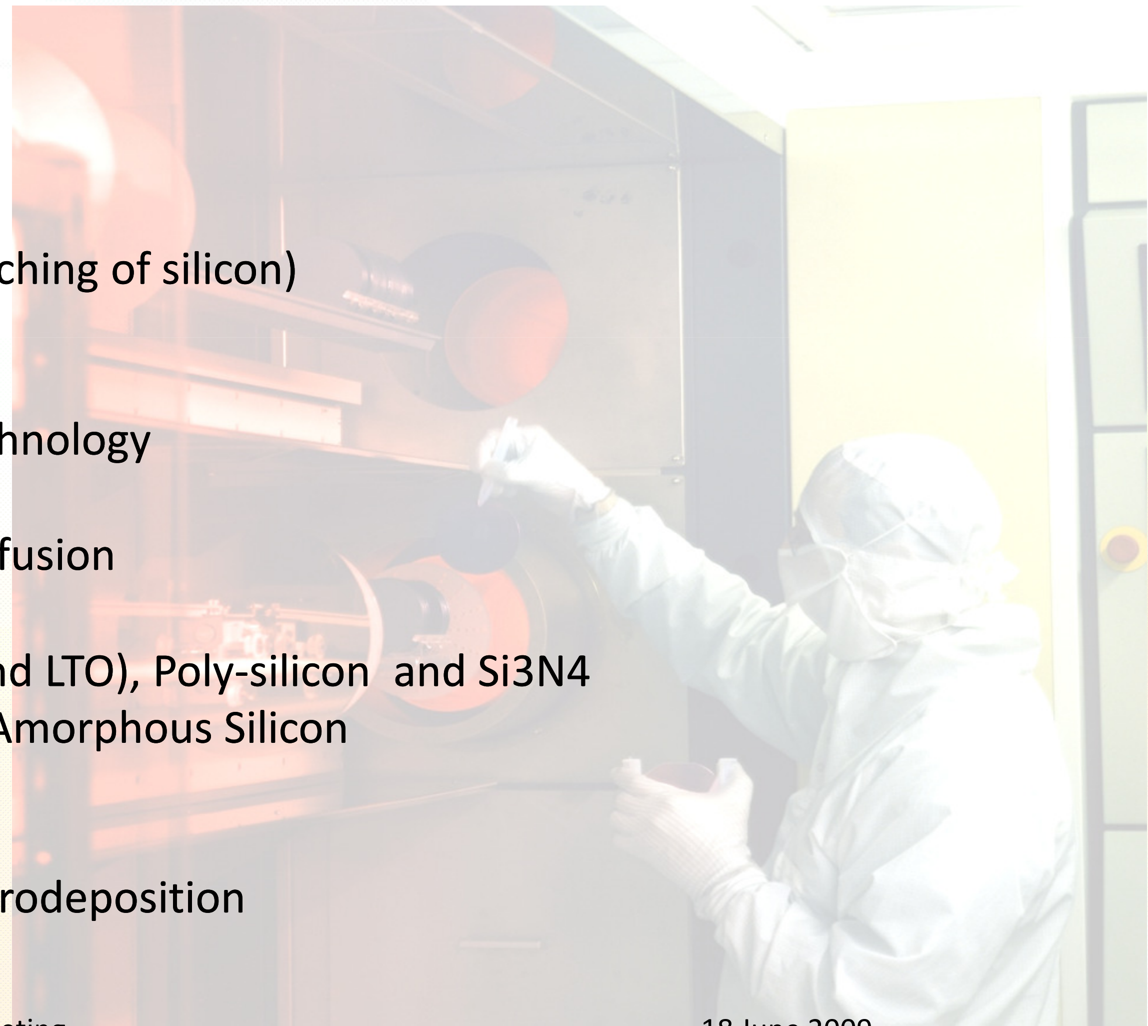
ETCHING
Deep RIE (AMS 2000)
3 Tegal systems for dry etching
Wet etching (including TMAH etching of silicon)

DOPING
Ion Implanter & solid source technology

4 FURNACES for oxidation and diffusion

LPCVD Deposition SiO2 (TEOS and LTO), Poly-silicon and Si3N4
PECVD Deposition SiO2, Si3N4, Amorphous Silicon

METALLIZATION
Sputtering, Evaporator and Elettrodeposition



Available detector technologies

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strip detectors

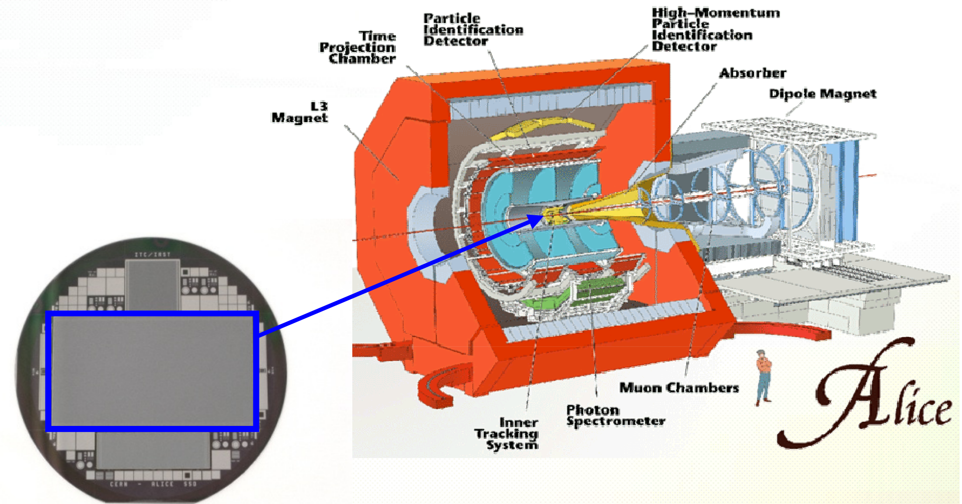
AMS experiment (@ISS)

Detector characteristics:

- Area: 7.2x4.2cm^2
- double-sided with orthogonal strips

700 in spec detectors produced (2002-2004).

ALICE experiment (@CERN)



Detector characteristics:

- Area:7.5x4.2cm^2
- double-sided with strips slightly tilted
- AC coupled

600 in spec detectors were fabricated (2003-2005).

ALICE Industrial Awards in 2006

Available detector technologies
pixel detectors

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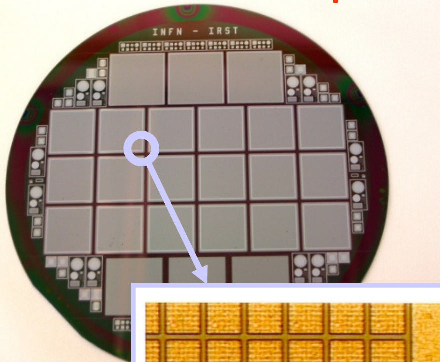
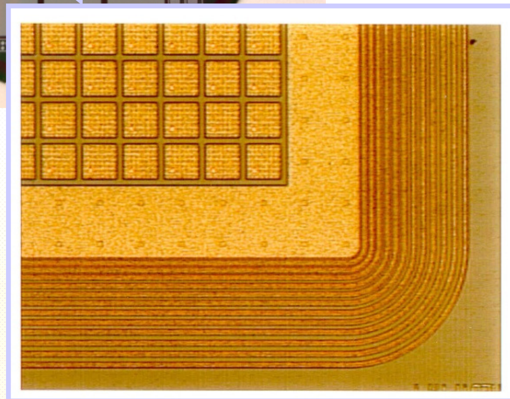
Medipix 1&2



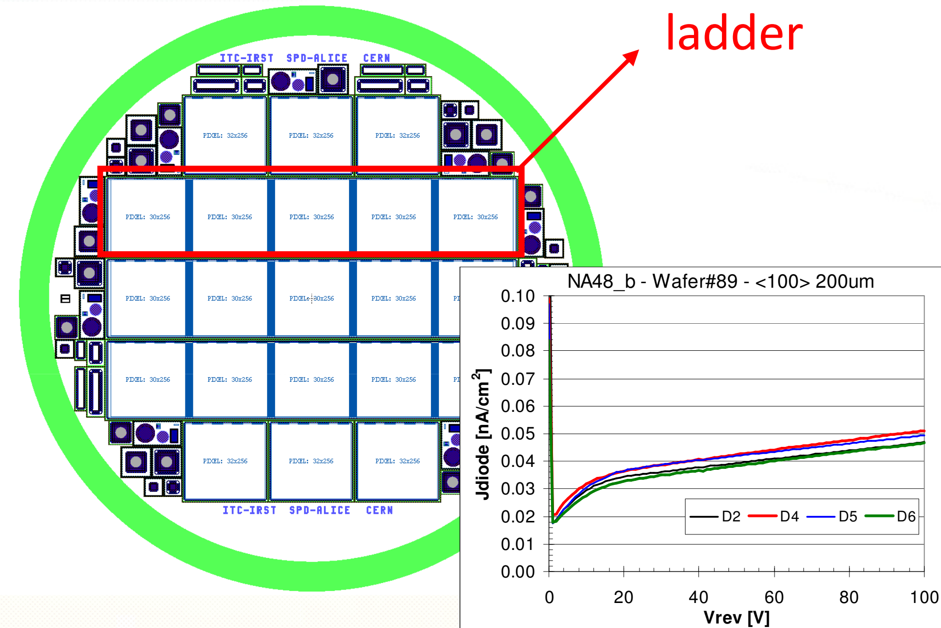


- Medipix1: pixel size 170x170um²
- Medipix2: pixel size 55x55um²

Substrate thick.: up to 1.5mm

NA48/ALICE experiment

ladder



- ALICE SPD layout
- pixel size 50x400um²

Substrate thickness: 200um

300 ladder produced

(2006-2007).

Other major activities on detectors

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MICROSTRIP Detectors

- ❖ SLIM INFN project: double sided strip detector (± 45° oriented strips) on 200 um thick Si
- ❖ SiliPET project (A Small Animal PET Scanner based on stacks of silicon detectors) double sided strip detectors on 1.5mm silicon thickness;
- ❖ Single sided microstrip detectors for industrial application (International Company)

Pixel

❖Hybrid pixel on n type epi-material (75, 100, 150 um) for PANDA experiments

PAD

❖Dosimetry for Intensity Modulated Radiation Therapy (IMRT) based on PAD detectors (matrix of 21x21 diodes) realized on p-type epi-silicon substrate (MAESTRO Projetc)

Others detectors within the CERN RD50 collaboration on **non-standard silicon** :

- ❖ oxygen-rich substrates (DOFZ and Cz/MCz substrates)
- ❖ Epitaxial substrates
- ❖ P-type substrate

….

Detectors technology: main on going research

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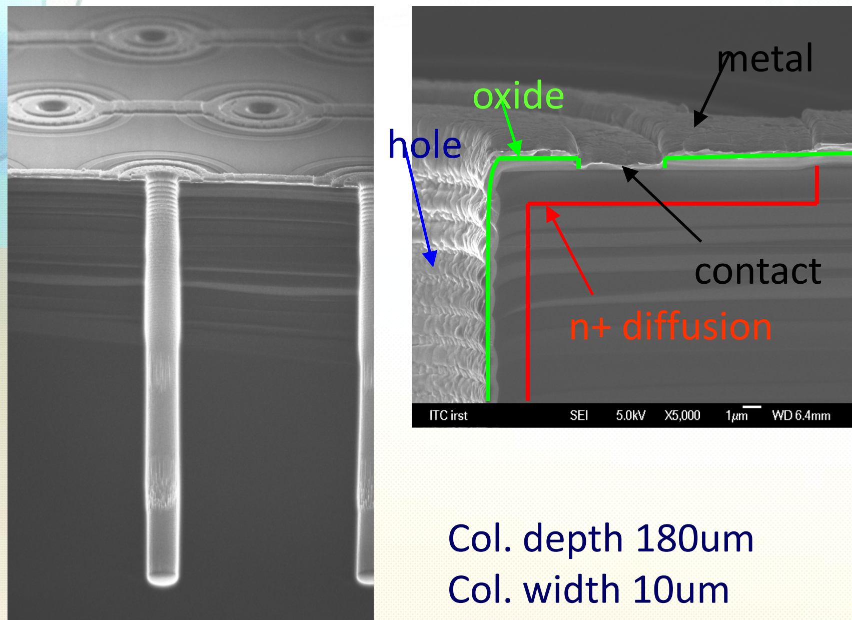
R&D: 3D detectors

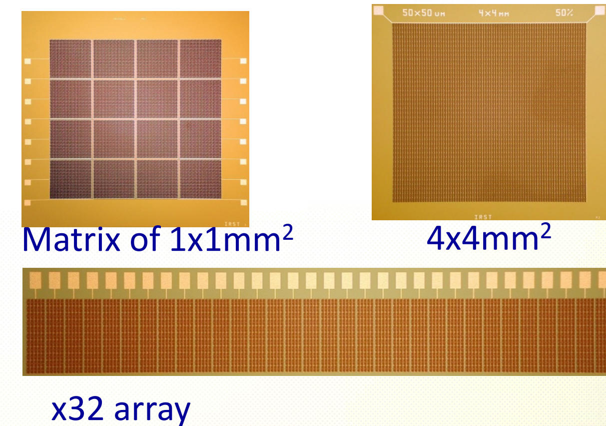


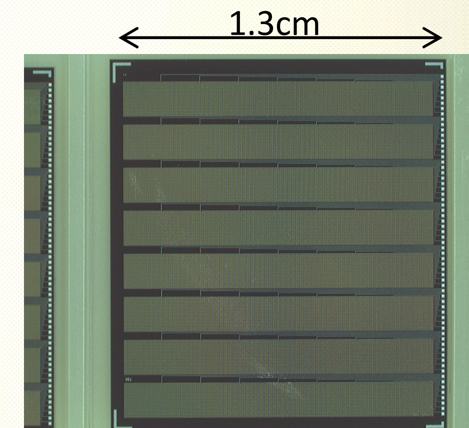
Col. depth 180um
Col. width 10um

Our Si3D detectors are under beam test @CERN

Silicon Photomultiplier

IEEE NSS 2007





FBK conclusive summary

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Our strength:

- More than 15 years of experience on Si detectors technology
- Documented capabilities to develop technologies from scratch
- Strong and strategic long lasting collaboration with INFN
- Reliable contacts with CERN researchers
- Dedicated and separated lines for detectors and MEMS activities

Our weakness

- No equipment redundancy/ back up

Our limitation

- 4 inch pilot line

Solutions:

- Agreement with 4-Labs in order to include their technological capability in FBK offer

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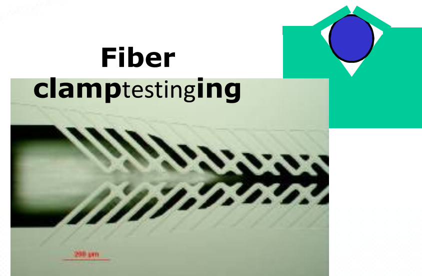
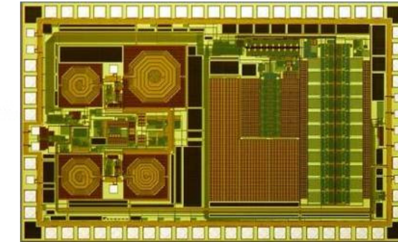
Manufacturing facility: from 150 through 300 mm lines

Substrates: Si, Diamond, III-V and SiC substrates

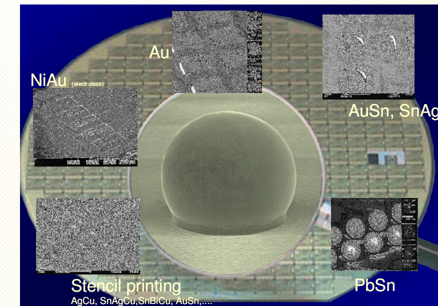
MEMS-MOEMS:
design-development
manufacturing



ASIC's:
design, prototyping,
industrialization,
testing and production



Assembly:
Flip-chip, Wafer level, Chip in polymer,
Flexible systems, Electro-optical packaging
MEMS packaging



Subsystems:
Electromechanical devices, Optical systems

Represented by 4 LABS