# Collaborazioni Camera Pulita

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(CE)

Moscatelli Francesco, Maria Ionica e Sauro Bizzaglia

### Perugia Clean room





#### Semi-automatic PA 200 Karl Suss Perugia



### New instruments: probe station

MPI TS2000 SE New probe station semi-automatic. Installed in September

Triaxial thermal chuck -60°C ÷ +200°C V up to 1.5 kV. Microchamber. Probe card adapter. 6 probes.





### Instruments



1 SMU Keithley 237

- 1 SMU Keithley 236
- 2 SMU HP 4210
- 1 CV Meter Keithley 595
- 1 HF CV Meter Keithley 590
- 1 LCR Meter 4284A
- 1 Switching Matrix 707 (6 card 8x12, 1 of them HV 1000 V)

Parametric System Keithley 4200 con 4 SMU (200 V) e 1 CV SMU





# Esperimento CMS





### Attività Sensori PQC

- Perugia sta effettuando misure di Process Quality Control, dovrà caratterizzare circa 2000 lunette.
- Misurate le strutture di test (C-V, I-V diodes; capacitor; VdP strip/poly/pstop; MOS, FET, dielectric breakdown...) di 5 batches di pre-produzione.



S. Bizzaglia, V. Marian, F. Moscatelli i



## Attività sui moduli







	Rotation (µrad)	Shift 丄 (μm)	Shift 🛛 (µm)
Mean±σ	167±100	11.5±7.8	56±23
Min ÷ Max	10÷320	2 ÷ 26	23 ÷ 90



#### Activity

- End of may: bonding machine update (large head)
- · Infrastructure almost complete now
- Big steps forward in the definition of the PS
  module production procedures

#### • 10 mechanical modules produced

- 200 mm thick AI plates used for fake PS-s, PS-p and MaPSA
- 3D-printed AI and Ti spacers
- Unfolded FEH flex
- Overall good alignment precision (dominated by precision of

mechanical components)

• All jigs produced in PG workshop

### Assemblaggio di 1000 moduli entro il 2024



#### <u>S. Bizzaglia, M. Caprai, L. Fanò, M. Ionica, V. Mariani, A. Rossi,</u> C. Turrioni.

### TCAD Simulations dal 1996

 $\sqrt{20}$  floating node licenses (Advanced TCAD suite)

 $\sqrt{4 PC} - 1$  Workstation





### Technology Computer Aided Design (TCAD)

Simulation of semiconductor processing, device operation and interconnect characterization for technology development and manufacturing.

#### Process and Device Simulation Tools to Accelerate Innovation

Technology Computer-Aided Design (TCAD) refers to the use of computer simulations to develop and optimize semiconductor processing technologies and devices. Synopsys TCAD offers a comprehensive suite of products that includes industry leading process and device simulation tools, as well as a powerful GUI-driven simulation environment for managing simulation tasks and analyzing simulation results. The TCAD process and device simulation tools support a broad range of applications such as CMOS power



### New "University of Perugia" model

- From C-V measurements of MOS capacitors:
  - $\checkmark$  D<sub>IT</sub> assessed by using the C-V High-Low method.
  - ✓ HF measurements at 100 kHz with a small signal amplitude of 25 mV.
  - ✓ QS characteristics measured with delay times of 0.5 s using a voltage step of 100 mV.
  - ✓ N<sub>EFF</sub> obtained from V<sub>FB</sub> measurements.



- ✓ From I-V measurements of MOSFETS:
  - ✓ After X-rays irradiation →  $\Delta V_{th} = \Delta V_{N_{it}} + \Delta V_{N_{ox}}$
  - ✓  $\Delta V_{th}$  is separated into a contribution due to N<sub>IT</sub> and N<sub>OX</sub> from I<sub>DS</sub>-V<sub>GS</sub> of MOSFET (method proposed in McWorther Applied Physics Letters 48, 133 (1986))

- $\checkmark$  D<sub>IT</sub> interface trap density
- $\checkmark$  N<sub>IT</sub> integrated interface trap density
- $\checkmark$  N<sub>OX</sub> oxide charge density
- N<sub>EFF</sub> effective oxide charge density

### HPK test structures

- ✓ Same modeling scheme to simulate C-V of MOS and R<sub>interstrip</sub>.
- ✓ Good agreement between simulations and measurements using the same model used to simulate MOS capacitors.

Measurements



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Simulazioni effettuate da Arianna Morozzi

# PRIN 4DInSiDe: Innovative Silicon Detectors for particle tracking in 4Dimensions activity

Università di Perugia Dipartimento di Ingegneria e CNR-IOM di Perugia







Standard vs Low Gain Avalanche Diodes



E field Traditional Silicon detector



#### Ultra fast Silicon detector E field

#### The LGAD sensors, as proposed and manufactured by CNM

(National Center for Micro-electronics, Barcelona):

High field obtained by adding an extra doping layer

E ~ 300 kV/cm, closed to breakdown voltage



i o m Istituto Officina dei Materiali Simulazioni effettuate da Tommaso Croci





F. Moscatelli, G. Bilei, D. Passeri

#### Calibration/extension of the previously developed simulation models

• Calibration/extension of the previously developed models ("Perugia model" and its recent upgrade) by comparing the simulation findings with measurements carried out on dedicated test structures as well on different classes of 3D and LGAD detectors.

Study the effect of surface and bulk radiation damage with reference to 4D (tracking+timing) detectors toward more radiation resistance solutions.

• The proposed activity will focus specifically on disentangling the effects of the two main radiation damage mechanisms, e.g. the surface damage due to ionizing effect and the bulk damage due to atomic displacement, with reference to 4D detectors toward more radiation resistance solutions.

#### **Deliverables:**

- Simulation of timing performance of 3D and LGAD detectors after irradiation.
- TCAD Radiation damage modelling handbook

