CMS Instrumentation and Spin Off Applications

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Director of Researcher

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CMS DETECTOR PHASE 2 UPGRADES

Trigger/DAQ

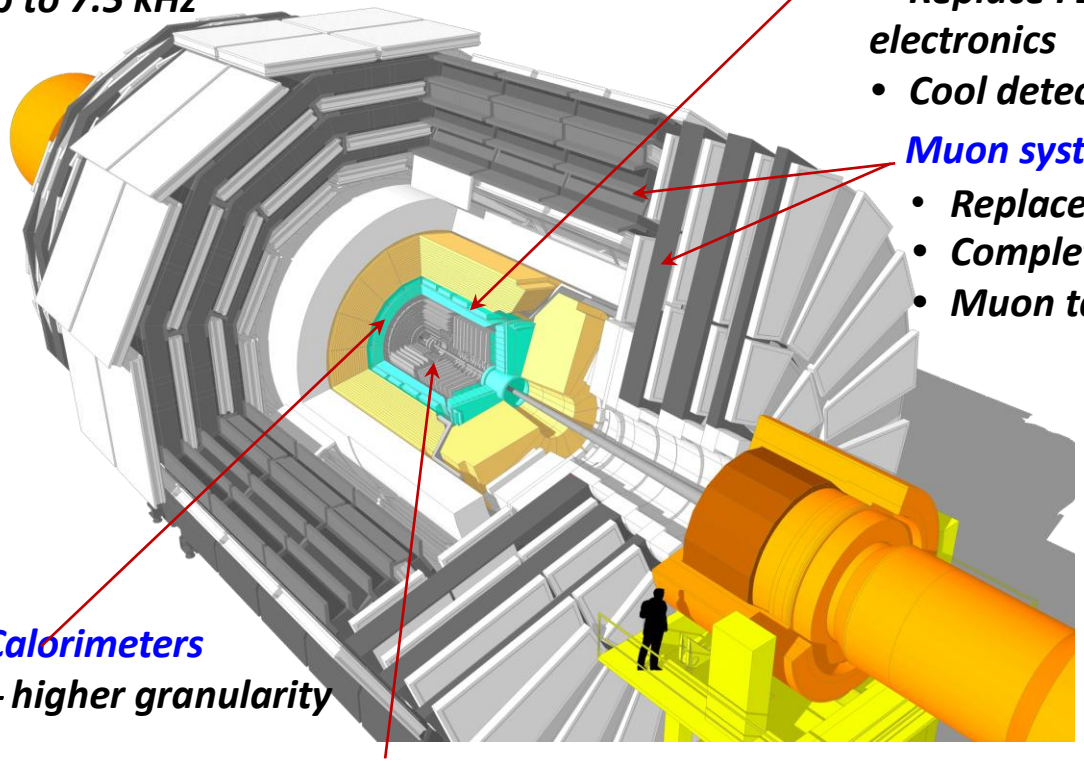
- *L1 with track up to 750 kHz - 12.5 μs latency*
- *HLT output up to 7.5 kHz*

Barrel EM calorimeter

- *Replace FE electronics*
- *Cool detector APDs*

Muon systems

- *Replace DT & CSC FE electronics*
- *Complete RPC coverage*
- *Muon tagging 2.4 < η < 3*



Replace Endcap Calorimeters

- *Rad. Tolerant - higher granularity*

Replace Tracker

- *High granularity – less material- b eff- p_T resolution*
- *Selective readout of outer tracker at 40 MHz for L1 trigger*
- *Extend η coverage to 4*

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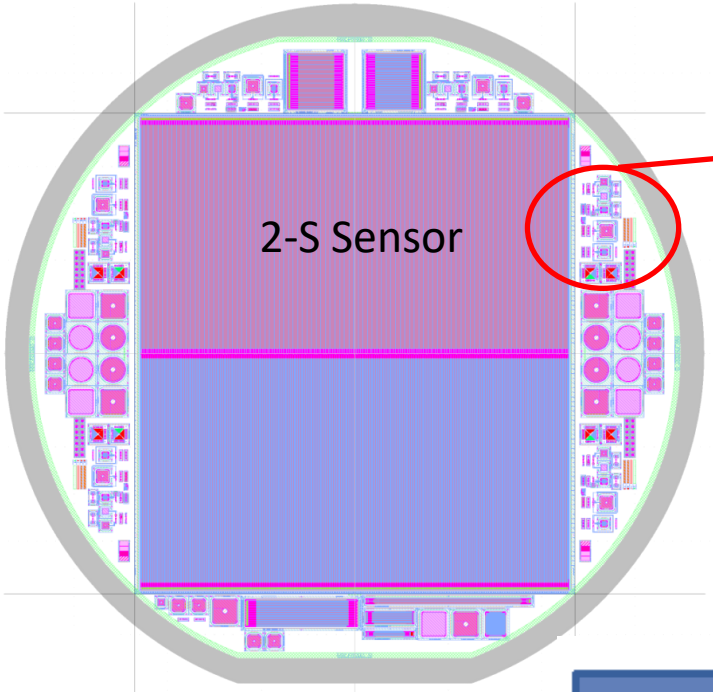
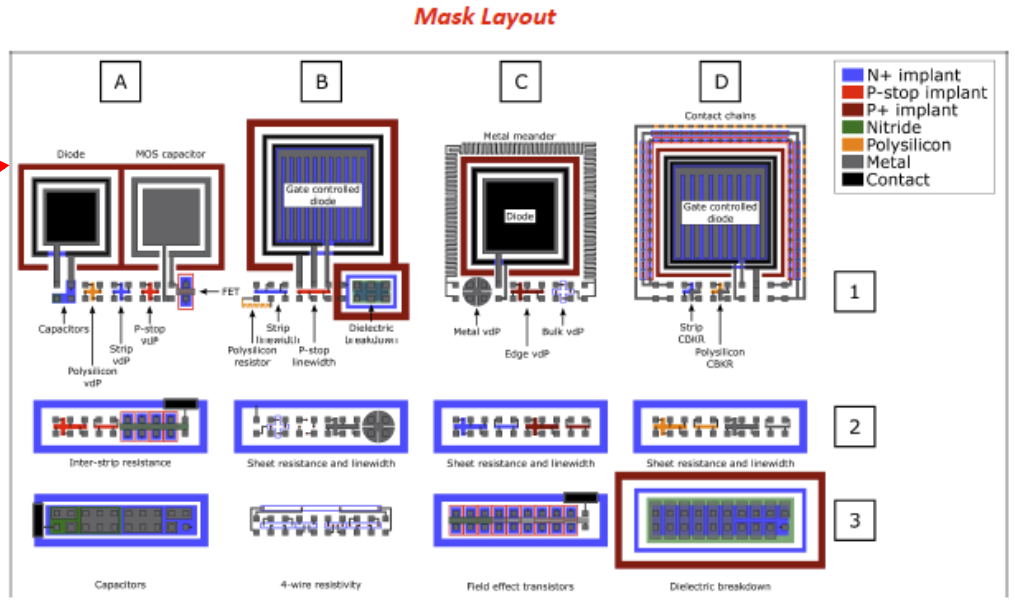
CMS DETECTOR PHASE 2 UPGRADES



p-type (111) Si



Measurement on Test Structures → Extract useful information about the sensor itself

Bulk resistivity	Diode, van-der-Pauw, 4-wire
Oxide quality	MOS, GCD, capacitors with implant
Interstrip resistance	FET, van-der-Pauw
Sheet resistances	Meander, van-der-Pauw, linewidth

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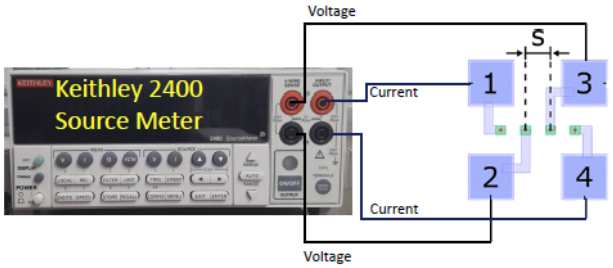
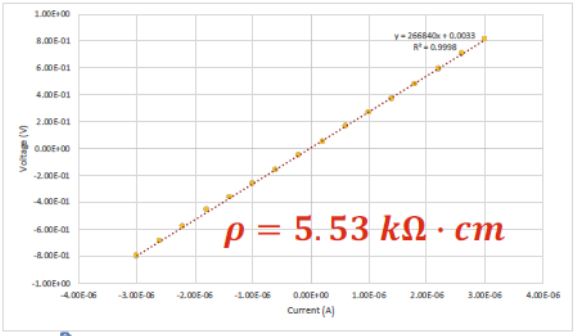
Subject 1: Test Structure Measurements

4-Point Resistivity Measurements

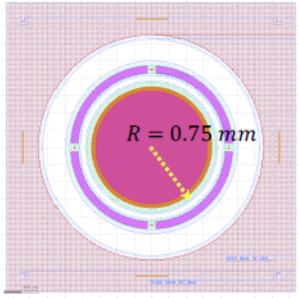
(Infineon VE711408_08_16)

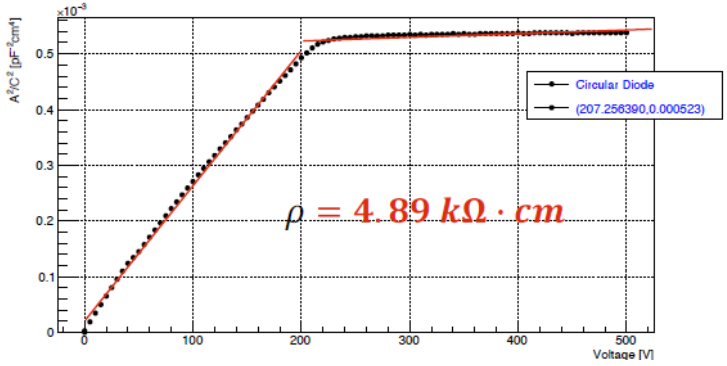




CV Measurement

Round Diode: $2R = 1.5\ mm$





Candidate Profile:
1)Physicist/Engineer
2) Programming skills->
C++/ROOT/python

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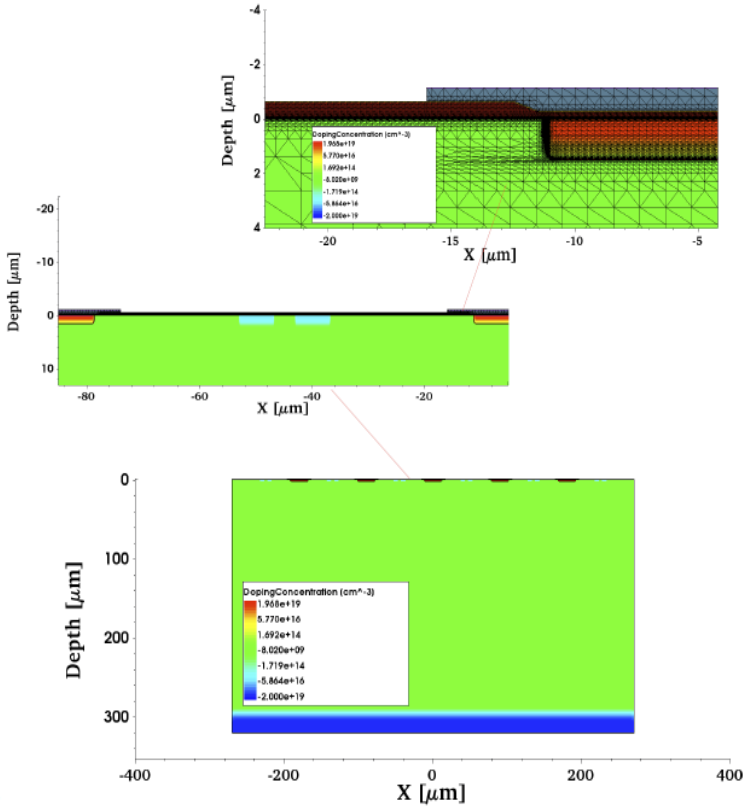
Subject 2: TCAD Test Structure Simulations

- 2D structure with 5 strips
  - Pitch: 90 um
  - Width: 22 um
- The capacitance between two neighboring strips i,j according to [2] is calculated by :

$$C_{int} = C_{I_j - I_i} + C_{M_j - M_i} + C_{I_i - M_j} + C_{I_j - M_i}$$

Geometrical characteristics and doping concentrations used for the TCAD simulations

Bulk doping concentration [cm^{-3}]	4.0×10^{12}
Strip doping concentration [cm^{-3}]	1.0×10^{9}
Backplane doping concentration [cm^{-3}]	1.0×10^{19}
p-stop doping concentration [cm^{-3}]	1.0×10^{16}
SiO_2 thickness between strips [μm]	0.65
SiO_2 thickness between metal-strip [μm]	0.25
SiN_4 thickness [μm]	0.05
Aluminum thickness [μm]	0.5
Strip implant thickness [μm]	1.5



[2] S. Chatterji, A. Bhardwaj, K. Ranjan, Namrata, A. K. Srivastava and R. Shivpuri, Analysis of interstrip capacitance of si microstrip detector using simulation approach, Solid-State Electronics 47 (2003) 1491

Candidate Profile:
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2) Programming skills-> TCAD

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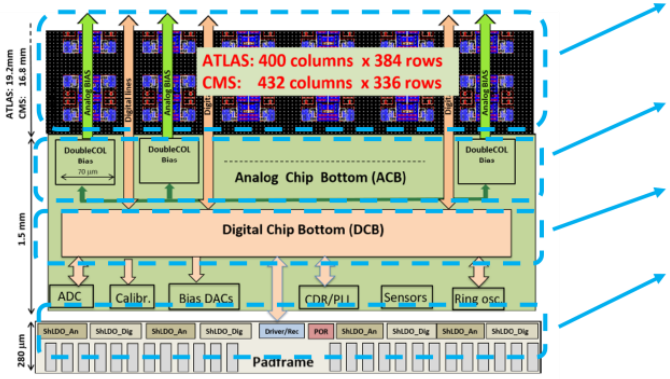
Subject 3: CMS Inner Tracker DAQ and System Tests

- New generation of Pixel Readout Chips are being developed for the Phase-2 Upgrade of the Inner Tracker and INPP of NCSR "Demokritos" has undertaken the following responsibilities:
  - Development of the Data Acquisition System for the Control and Readout of the prototype chips

Software Suite + **Firmware Suite** +

Hardware
FC7 Board,
Developed by CERN

  - Coordinatization of the testing and characterization campaign for the chips
    - Functional validation, performance evaluation, temperature studies, irradiation campaigns etc.



Pixel Matrix & Analog Front End:
CERN + Demokritos
(A. Papadopoulos)

Analog Chip Bottom:
University of Zurich

Digital Chip Bottom:
Demokritos (Y. Kazas)

Power Supply Circuits:
Universita e INFN, Firenze

Coordinating the team:
Demokritos (Y. Kazas)

Candidate Profile:
1)Physicist/Engineer
2) Programming skills-> Python/C++, FPGA programming (VHDL)

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Radioactive Source Localization Lab (AILAB)

More Information can be found at site: http://ailab.inp.demokritos.gr

or at the educational video:
https://www.youtube.com/watch?v=Xo-LDNK9yQ4&list=PLcNicqge3dtPV1C_FG2Ea7qhzbzyt7rEA&index=3

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1) Radioactive Source Localization by a Network of CZT Sensors

Main task: Localization of light shielded and/or moving sources

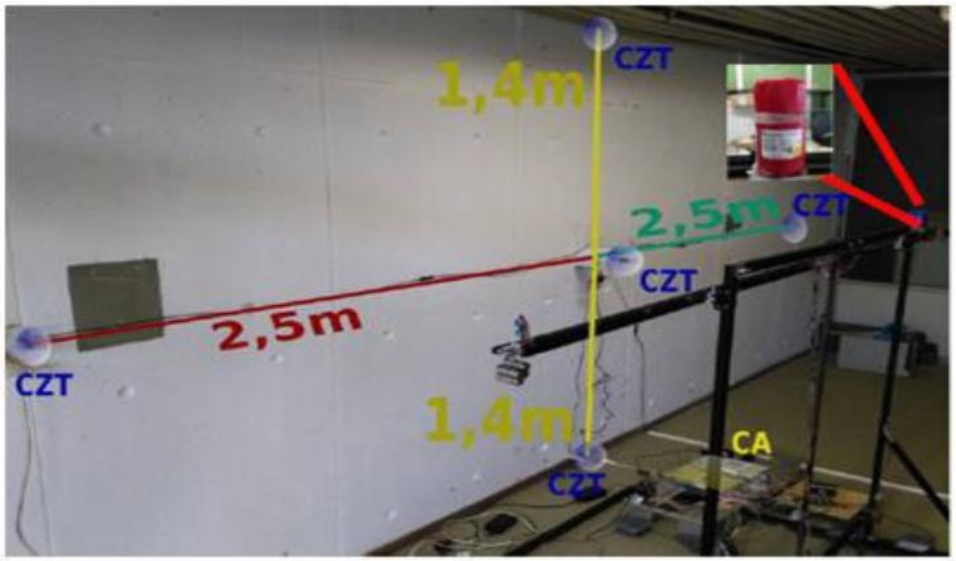

Figure 2 : Network of five radiation detectors in cruciform configuration and the light shielded (1cm of Pb surrounding the source) ^{137}Cs source used for test bed of the localization algorithms

Using Planar spectroscopic CZT sensor topology study the capability to localize Radioactive Sources in an open area using MVA techniques.

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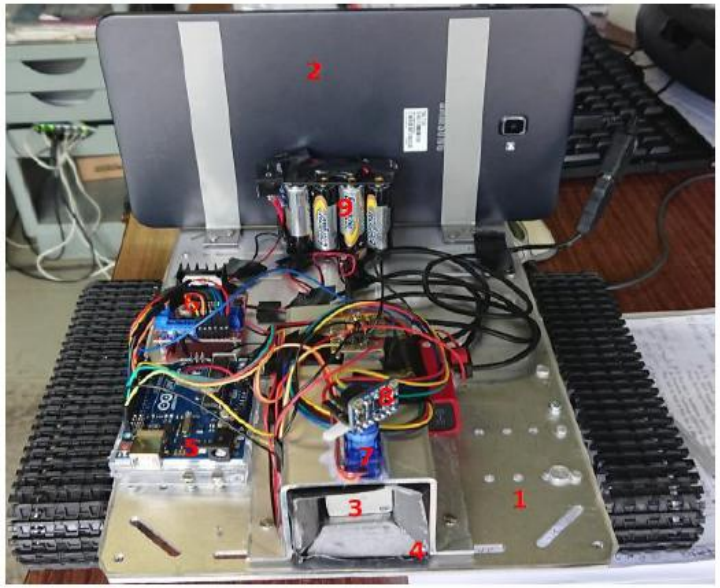
2)Radioactive Source Localization by an autonomous rover equipped with CZT Sensors

Main task: write a stand alone software in python to retrieve data from CZT sensor and analyze them



1. Rover Body
2. Tablet
3. Radio Sensor
4. Pb shield
5. Adruino Controller
6. Motor Driver
7. Servo Radar
8. LIDAR
9. Battery source

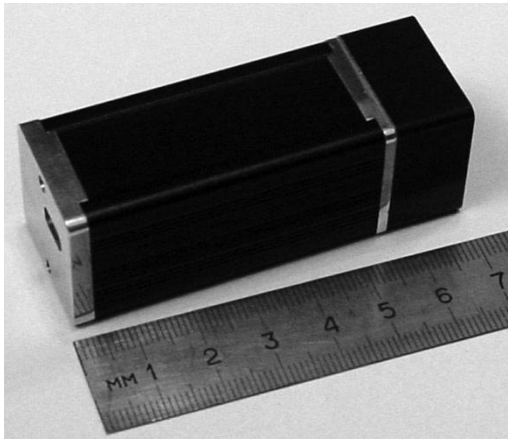


Figure 3: Semi-Autonomous rover platform equipped with radiation sensor

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2) Programming skills->
C++/ Java /python

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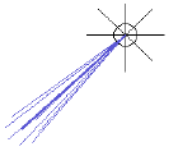
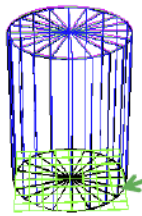
3) Simulation studies of Radioactive Source Localization by an Anger type camera.

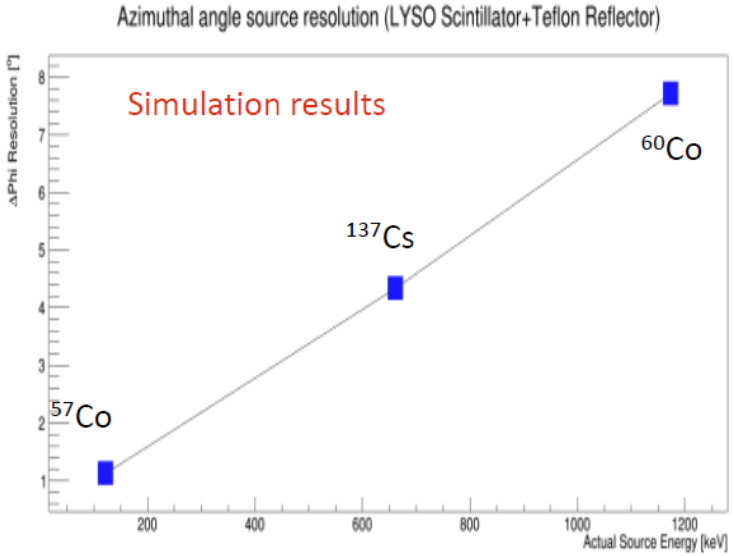
Main task: Analyze simulated events of a Anger type camera with analytical and MVA techniques (Deep Neural Networks) to find the direction of the radioactive source

An Anger type gamma ray detection system based on a 2" x 3" LYSO scintillator crystal and read out by an array of 8x8 SiPM. The system can detect a wide range of sparse radioactive sources with energies from a few tens of keV to 1.5MeV ideal for homeland security

Simulation layout







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2) Programming skills-> C++/Geant4/ROOT/python

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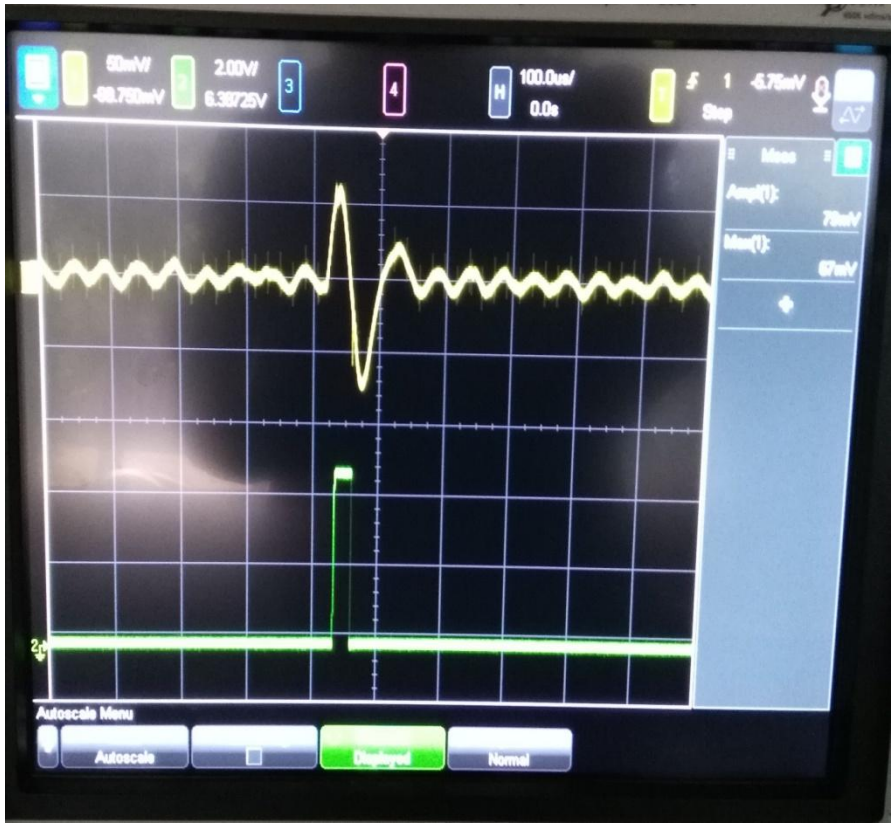
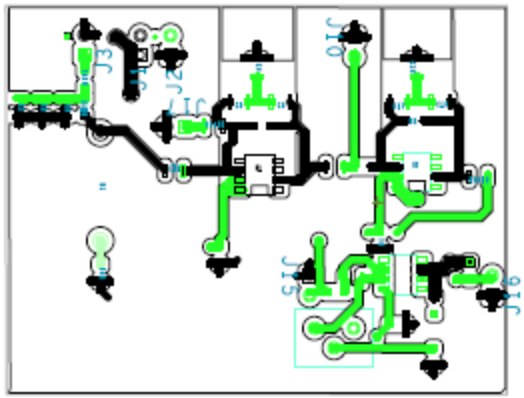
4) Low-Cost Radiation detectors

Main Task: Design Low noise board + evaluation software





Candidate Profile:
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