New 3D neutron sensors with high detection efficiency, high γ rejection and reduced fabrication complexity

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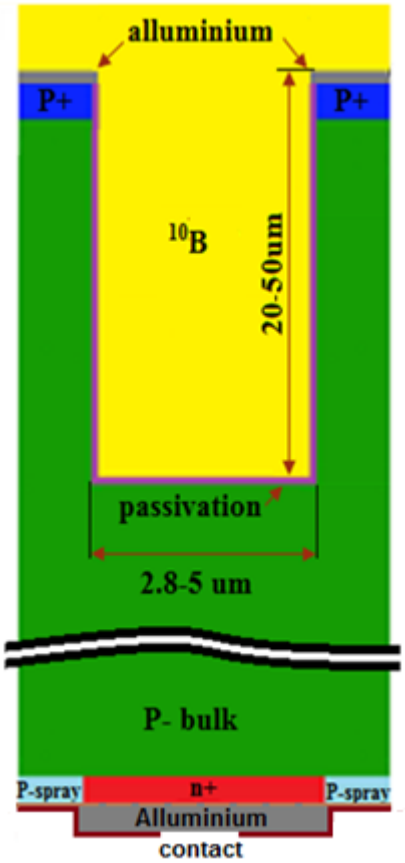
Introduction

Neutron detection and imaging

- Automotive
- Aeronautical
- Fuel cell
- Hydrogen tanks
- Homeland security
- Forensics
- Archaeology
- Archaeometry
- Cultural heritage
- Other fields requiring sensitivity to light elements such as hydrogen, carbon and nitrogen

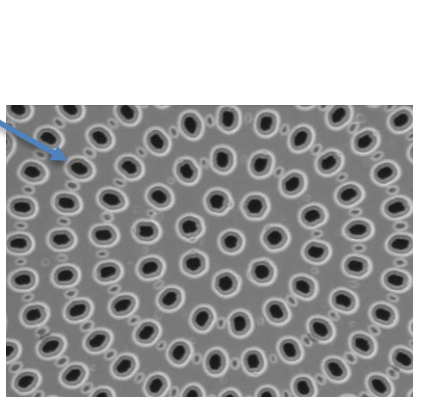
Scientific collaborations:

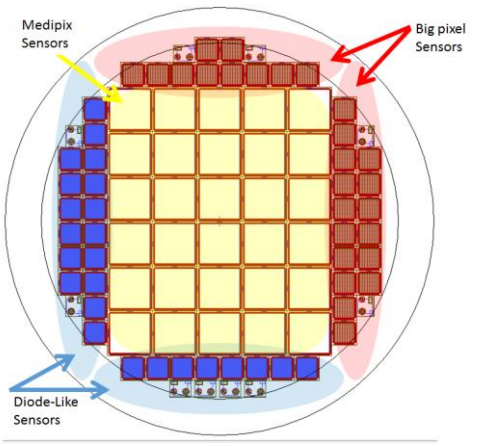
- ✓ Lawrence Livermore National Laboratory (USA)
- ✓ Jozef Stefan Institute (Slovenia)
- ✓ *Czech Technical University in Prague*
- ✓ *Nuclear Physics Institute, Academy of Sciences of the Czech Republic*

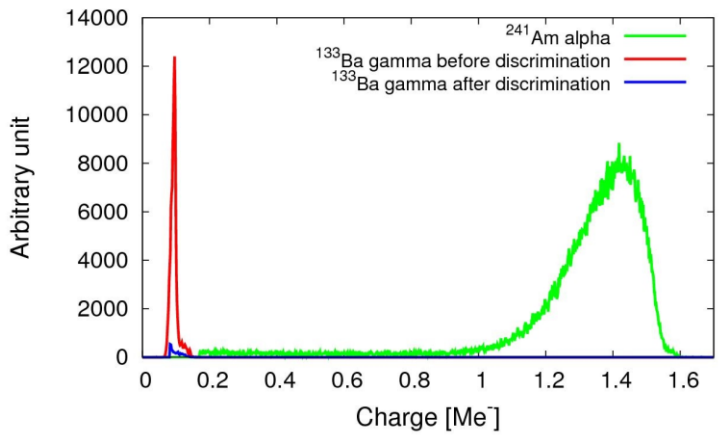


The Idea/Concept

- 3D microstructures can greatly enhance the detection efficiency of thermal neutrons
- The new proposed device has:
  - simple fabrication process
  - web-like structure with different geometries
  - ^{10}Boron as a converter material
- GEANT4 simulations predict ~20% efficiency
- High γ-ray discrimination is obtained using Pulse shape or pixel cluster analysis methods
- ^{10}Boron deposition tests have been successfully completed at LLNL laboratory
- The wafer layout contains diodes and MEDIPIX compatible pixel sensors







- Collected charge spectra obtained from ^{241}Am α and ^{133}Ba γ particles impinging the 3D detector before and after pulse discrimination

Potential Impact

- ❖ Owing to process simplification, suited to volume productions at relatively low cost
- ❖ The proposed sensors can be coupled to MEDIPIX/TIMEPIX family chips for thermal neutron imaging with high time and spatial resolution and high rejection to gamma rays
- ❖ Also suited to portable instruments
- ❖ Considerable performance improvement with respect to the state of the art can be achieved for relatively low neutrons fluxes (less than 10^6 counts/pixel): unlimited dynamic range, ideal linearity and fast imaging