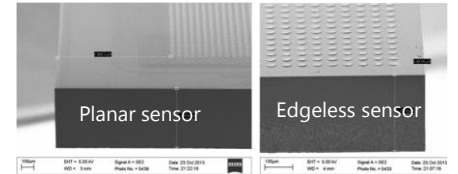




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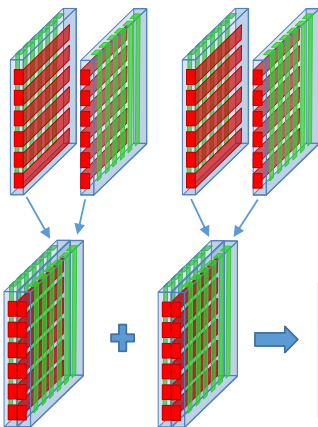
Introduction

The traditional radiation imaging detectors are 2D sensitive only. This 2D approach limits their spatial resolution or sensitivity. The CUBIX is a concept of a radiation imaging/tracking camera with full 3D segmentation and high absorption for common radiation types. The basic hybrid sensor module is of a cube shape of roughly 3 cm³ with 2 Mega voxels. Good absorption for penetrating radiation is achieved by large detector volume (1.5 cm thickness or more, sensitivity of 25-50% for 511 keV gamma can be achieved with silicon). Thanks to the 3D segmentation the detector maintains very good spatial resolution regardless of the total thickness. The whole detector device can be of hand-held size operated at room temperature.

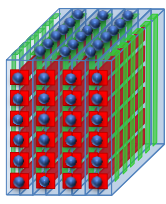
The Idea/Concept

The CUBIX concept is enabled by technology of so called “edgeless” silicon sensors. It allows to bring contacts of the strip detectors to the chip edges. Combining many thin layers of such sensors the single hybrid sensor is created as depicted in the figure below.

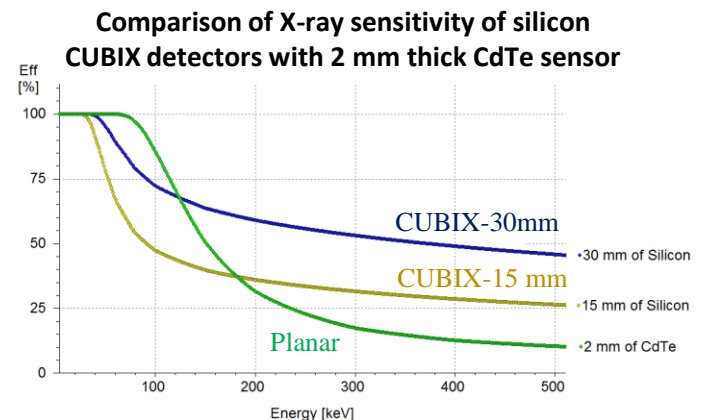
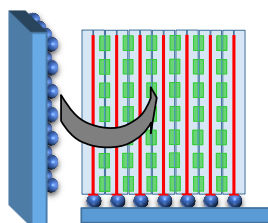
a) Edgeless sensor chips with crossed strips



b) 3D sensor block



c) Sensor block attached to ROC



The proposed detector concept allows recording of up to 80 million hits per second (Timepix3 ASIC). The detector would be operated in list mode providing the 3D coordinates, energy and time-stamp for every hit. The complete information recorded for every event allows for reconstruction of full chain of interactions for every particle (tracking mode). This way the undesired influences of radiation background or e.g Compton scattering can be greatly reduced or even further exploited (directional sensitivity, polarization sensitivity, Compton camera ...). The CUBIX detector unit is 3 sides butttable. The 4 sides buttability could be also achieved with small gap of about 200 microns among modules.

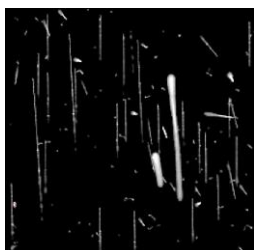
Potential Impact

There are many applications of such ultimate imaging detector and hand-held tracker: Low dose medical imaging (X-ray, scintigraphy, SPECT, PET), Non-destructive-testing with isotopes or low power X-ray sources, radiation monitoring and security, environmental and geological research, exploration and mining, scientific experiments, education etc. Many other applications would be probably enabled by this technology in future. The proposed CUBIX structure presents a next level in 3D integration of sensors. This technology can be a significant technological breakthrough in field of radiation imaging and radiation protection.

Imaging based on particle tracking: Examples taken with multilayer 2D tracker Timepix

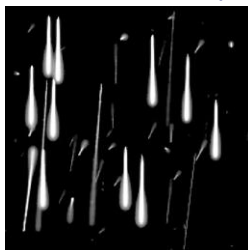
Proton and hadron therapy monitoring

Protons 221 MeV



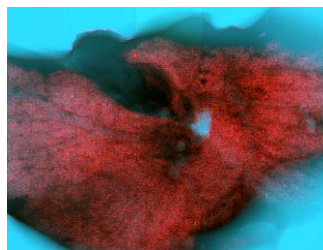
Many secondaries, (delta electrons recoils, fragments).

Carbons 89 MeV/u



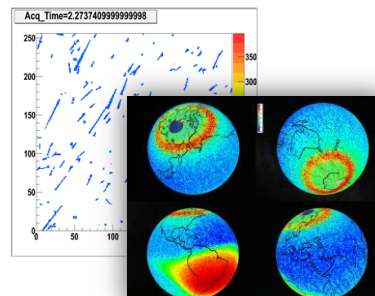
Carbons and protons and their scattering.

Spectroscopic medical imaging (mouse lungs)

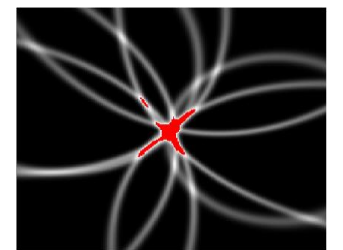


Phase effects are used to visualize alveoli structure

Tracks of particles in space and sky maps



Compton gamma camera for medical SPECT



Measured with 2 layers