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Python based detector simulation software - RASER

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Outline

- Introduction of RASER
- Published research based on RASER
- Framework
- Function under development
- Summary

Introduction of RASER

<https://pypi.org/project/raser/>

- Fast simulation software for semi-conductor detectors: RAdiation SEmiconductorR



- DEVSIM for solving electric and weighting field:

$$\nabla^2 \vec{U}(r) = -\frac{\rho}{\epsilon}, \quad \nabla^2 \vec{U}_w(r) = 0$$

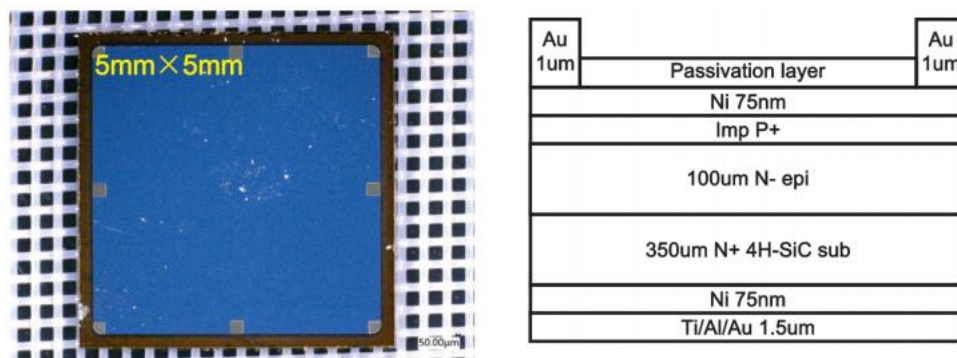


- Geant4 for non-uniform charge deposition solution:

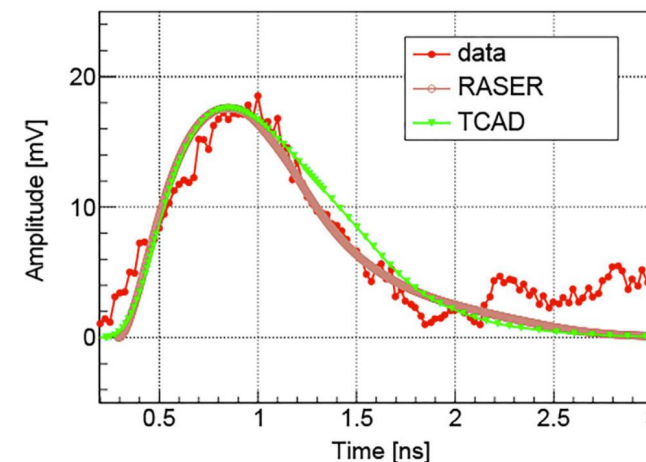
$$I_{e,h}(t) = Ae_0 N_{e,h} \vec{v}_{e,h}(t) \cdot \vec{E}_w$$



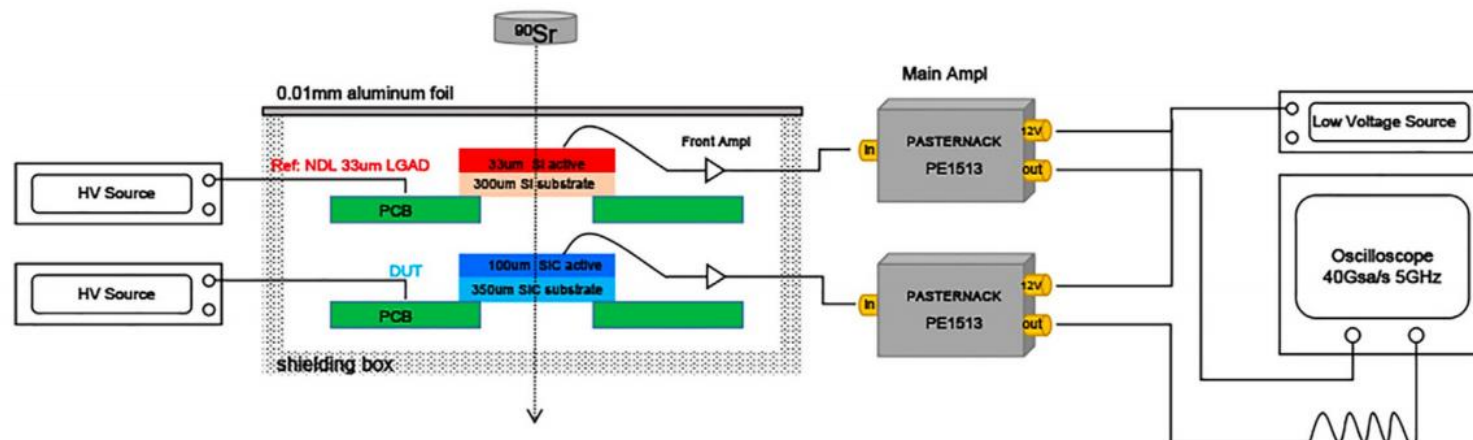
- Timing resolution study of SiC planar detector



SiC planar detector fabricated by Nanjing University



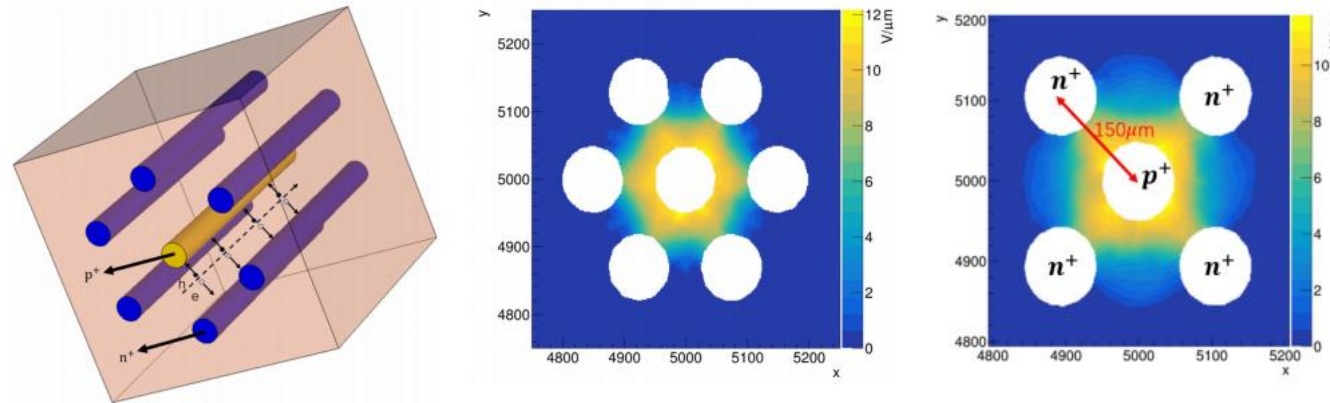
Data and RASER simulation.



Experimental set-up of timing resolution system

- Epitaxial layer 100um SiC
- Si LGAD as reference
- BB amplifier

- Timing resolution study of SiC 3D detector



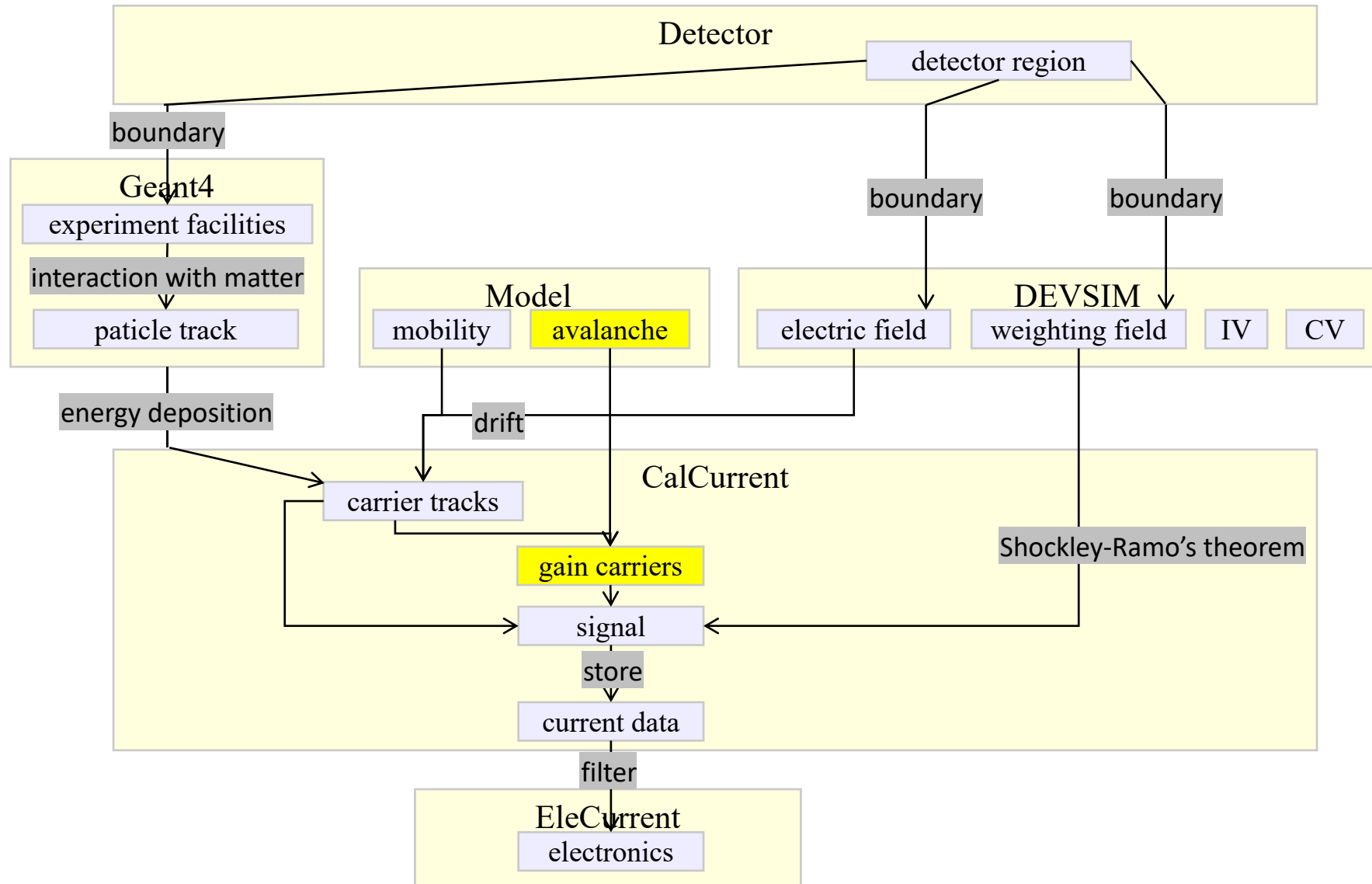
Schematic diagram of SiC 3D detector(7 electrodes and 5 electrodes)

- 3D electrode structure
- shorten the distance between electrodes
- improve charge collection and amplitude
- better timing resolution

SiC Detector Type	Column Spacing [μm]	Thickness [μm]	Rise Time [ns]	Pulse Height [mV]	Time Resolution [ps]
Planar	100	100	0.38	13	77
3D-4H-SiC-7E	50	350	0.29	48	34
3D-4H-SiC-5E	50	350	0.32	53	25

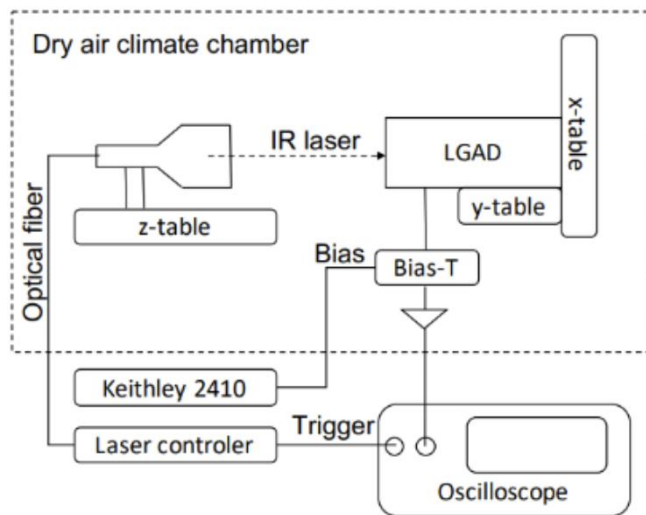
Timing resolution from 3D SiC detectro with 7 or 5 electrodes

Framework

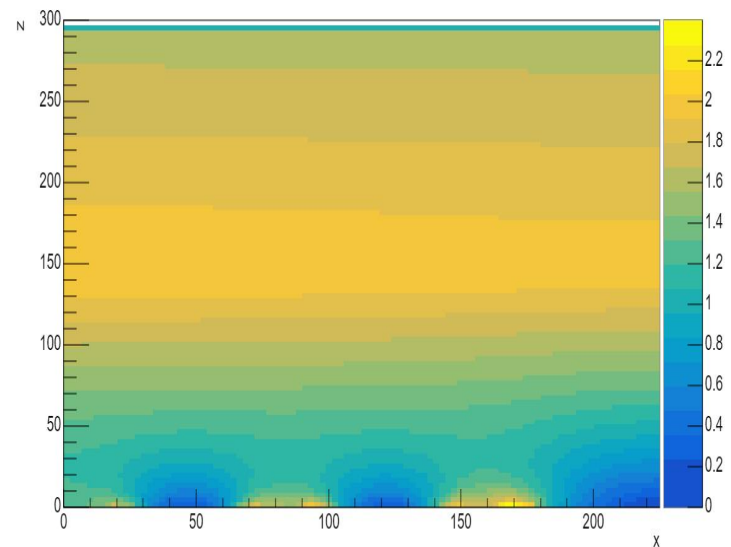


Function under development

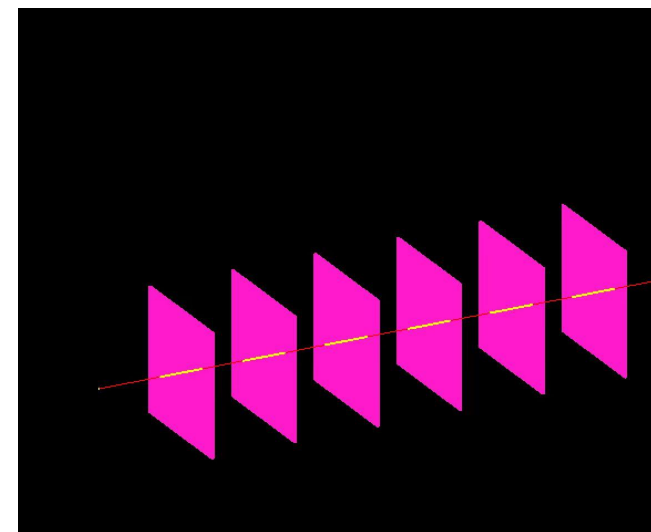
- Electric field estimation by edge-TCT of detector with gain layer
- Spatial resolution of strip detector without/with gain layer, irradiation damage
- Spatial and timing resolution of pixel detector without/with gain layer, usage in telescope



Schematic view of LGAD edge-TCT set-up



Electric field of Si strip detector



Telescope(pixel detector) on beam

Summary

- RASER, a simulation software for semi-conductor detectors containing multiple functions
- Based on Geant4, DEVSIM and other simulation tools, good agreement with data
- Flexible probability for electric readout
- Capable for more detector and system, including irradiation defect

Thanks for your attention.