online version

Einfluss von grossen passivierten Oberflächen auf BEGe Detektoren

Influence of Big Passivated Surfaces on BEGe Detectors

DPG - Frühjahrstagung Dortmund
Dienstag, 16.03.21
Martin Schuster

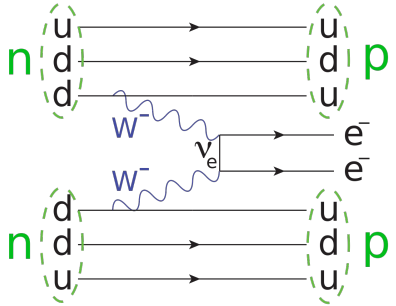
MAX-PLANCK-INSTITUT
FÜR PHYSIK

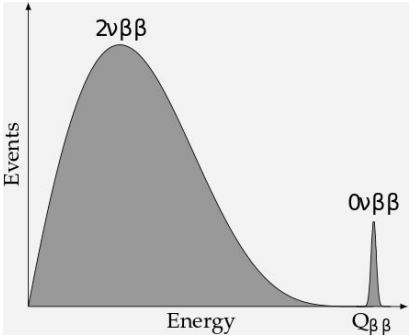
Outline

- Physics Motivation
- Detector design
- Experimental Setup and Data
- Effects of the passivated area on the energy spectra for different temperatures
- Pulses and Simulation
- Summary and outlook

Germanium Detectors – Physics Motivation

Search for **Neutrinoless double beta decay**





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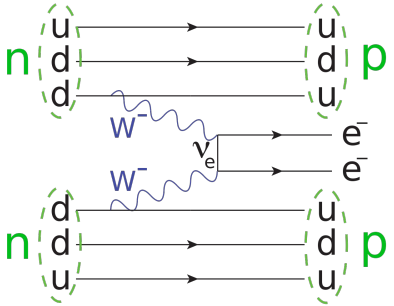

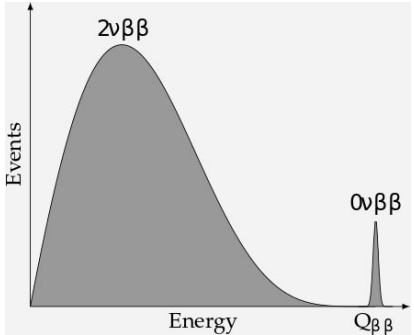

e.g. with ^{76}Ge

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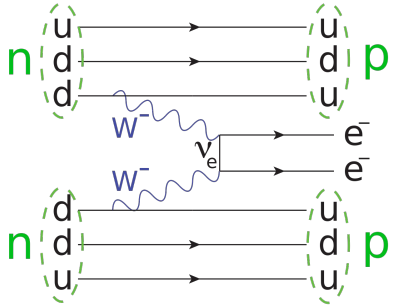
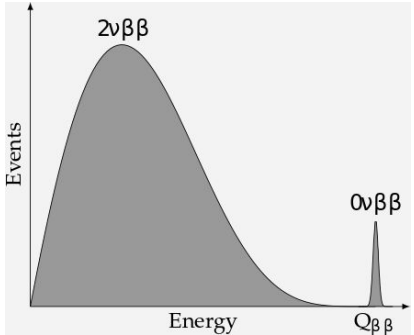




e.g. with ^{76}Ge

LEGEND
Large Enriched Germanium Experiment for Neutrinoless ββ Decay

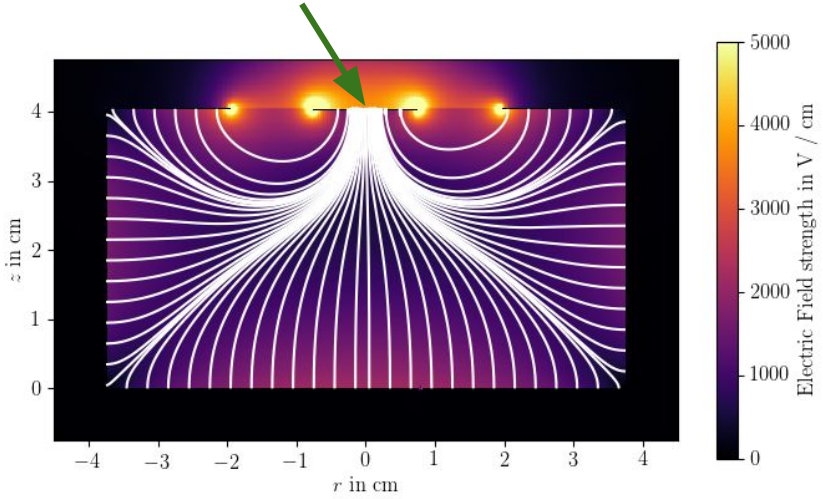
(enriched) Germanium Semiconductor Detectors

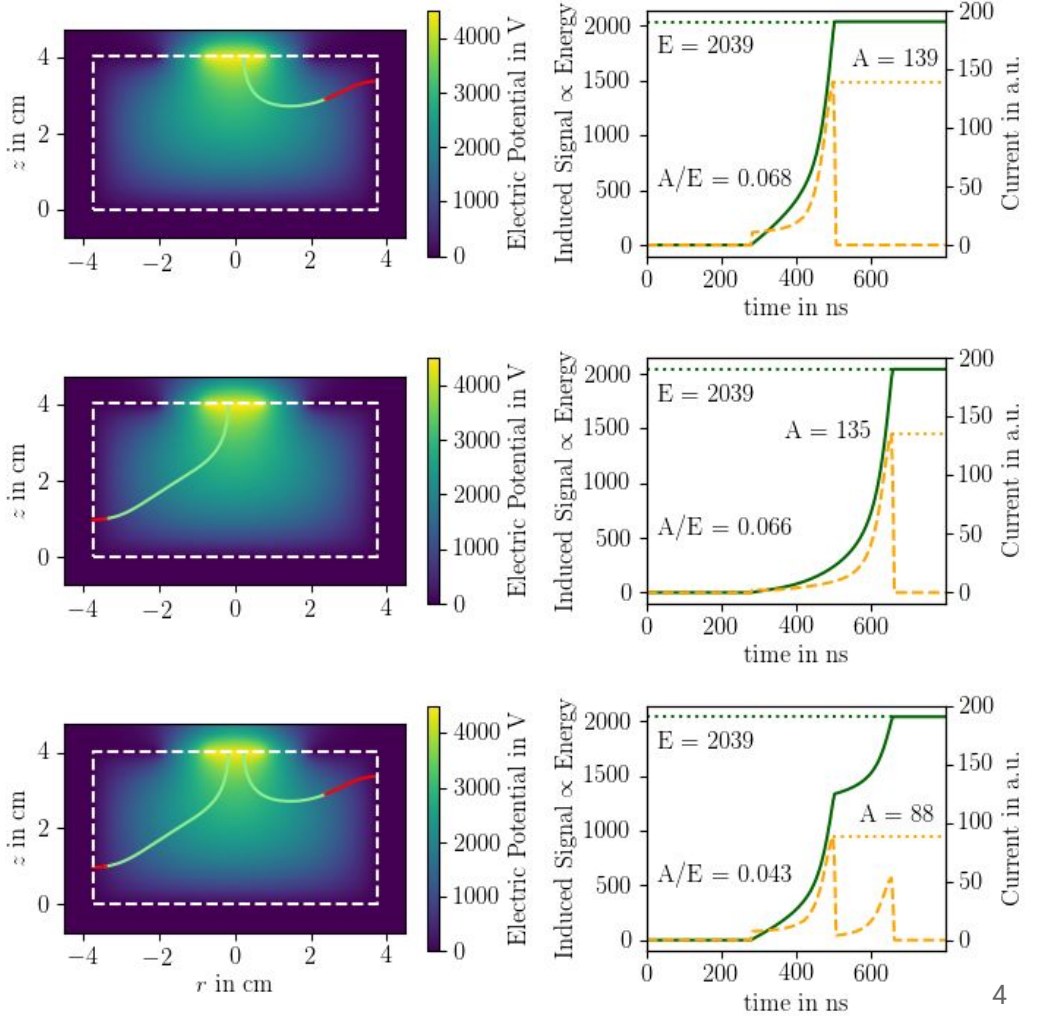
Source == Detector -> High Detection efficiency

Excellent Energy Resolution -> good sensitivity and background discrimination

BEGe – Design

Point Contact, here +4500V





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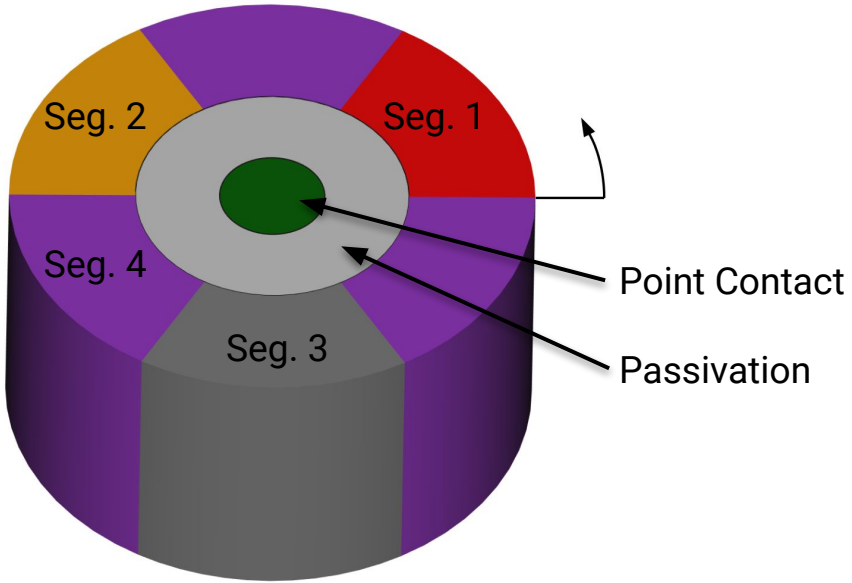
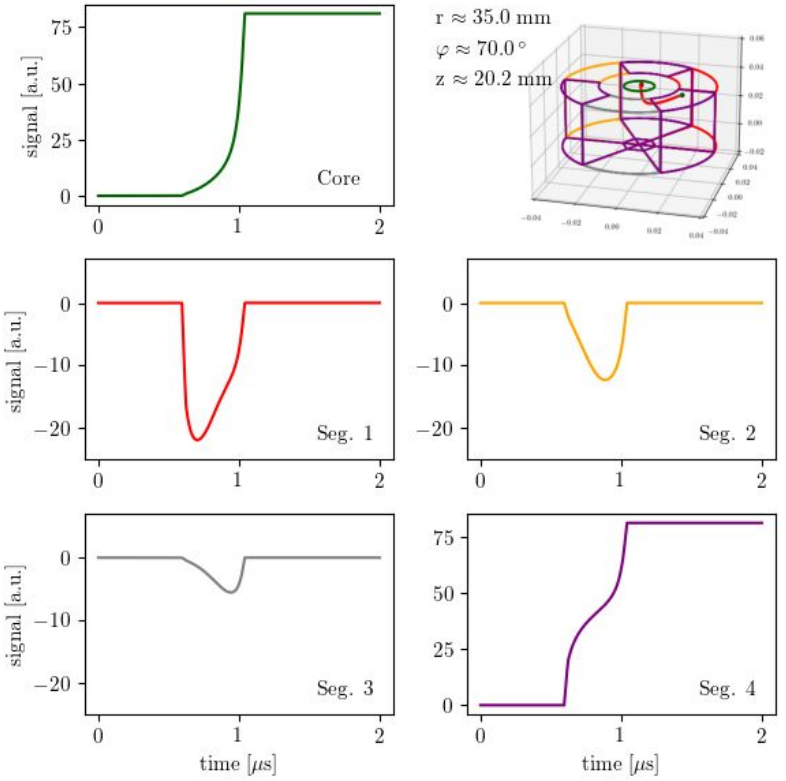
Solid State Detectors

Segmented BEGe – Detector Design





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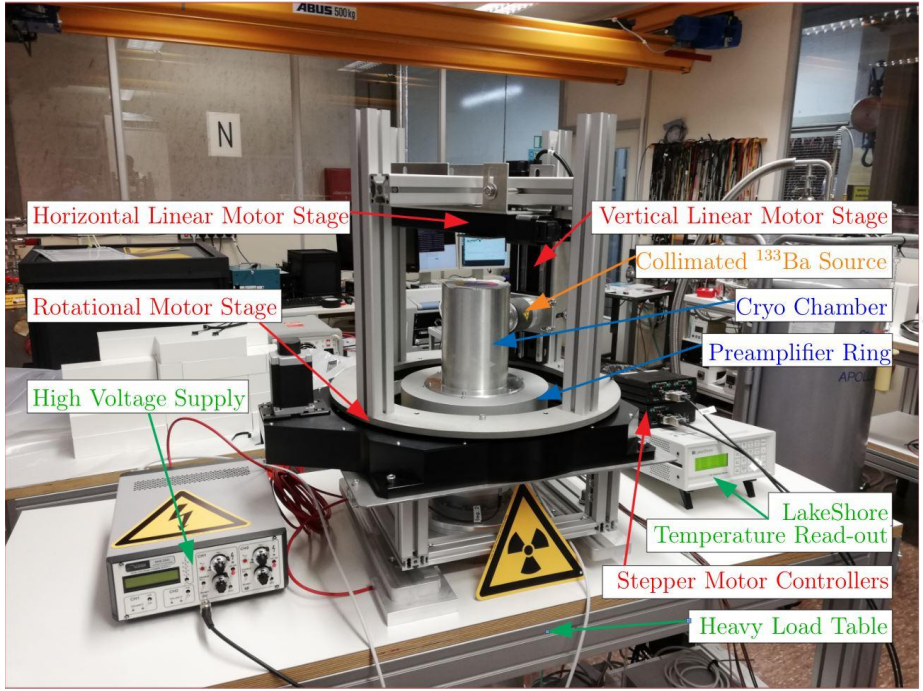
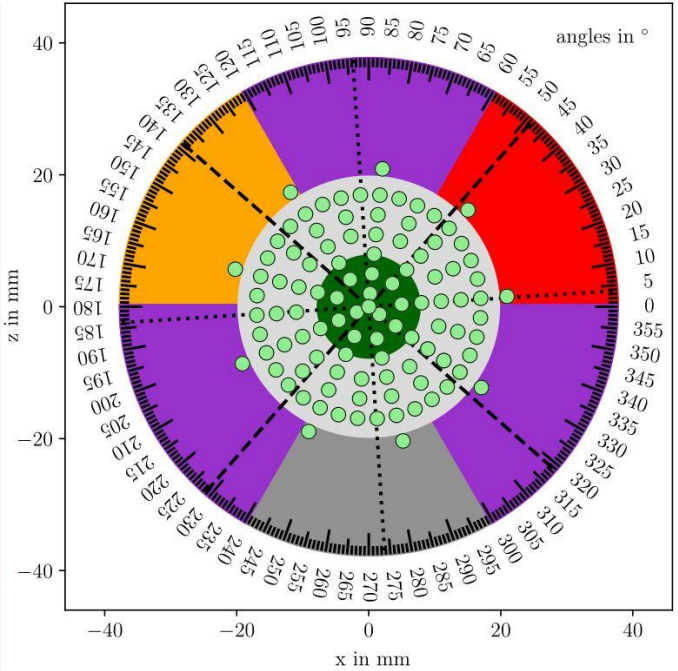
Solid State Detectors

Experimental Setup and Acquired Data





Temperatures in K
73.3
74.5
76.9
79.4
81.5
84.8
87.2
89.6
94.3
98.4
103.2
106.9
110.7
114.0
117.7

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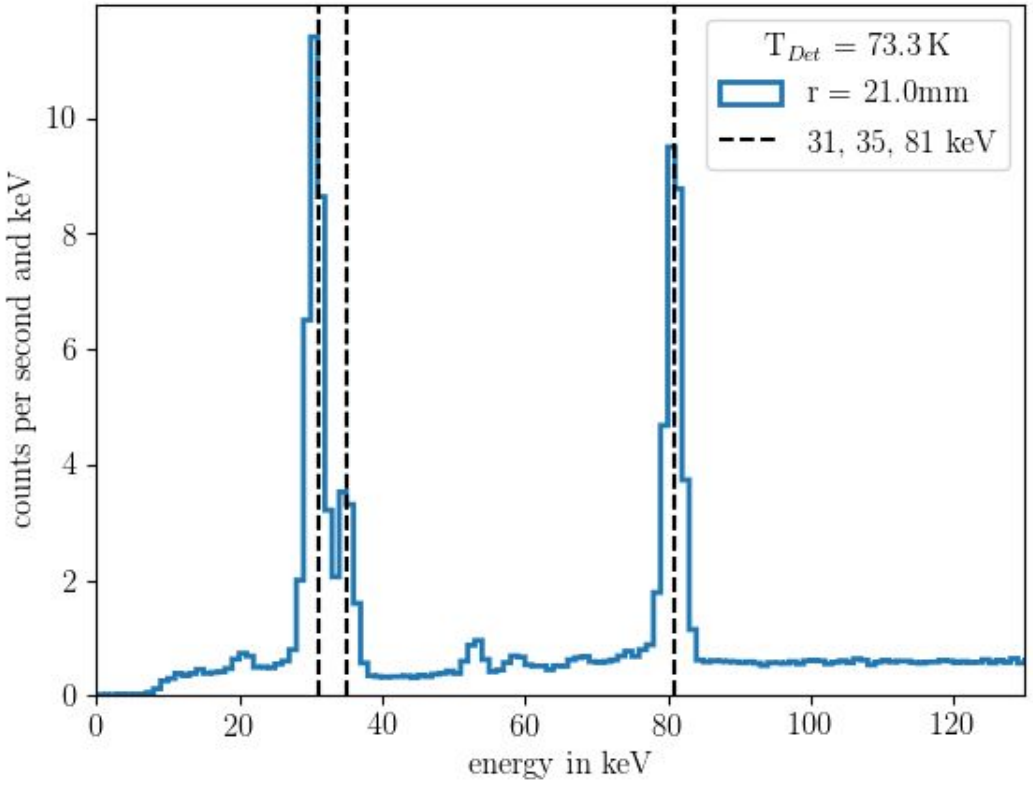
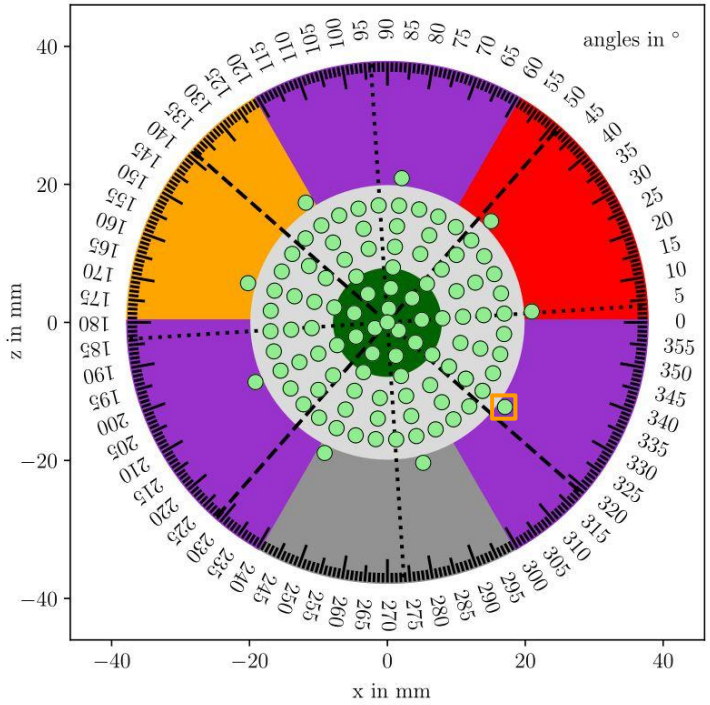
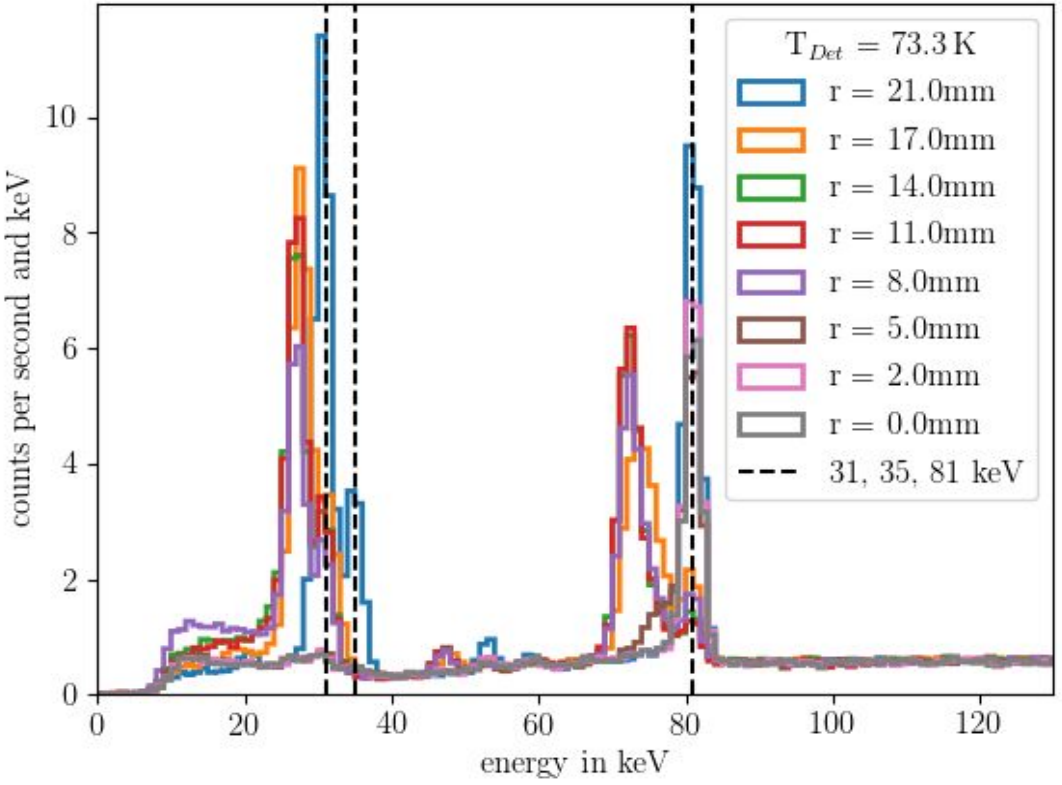
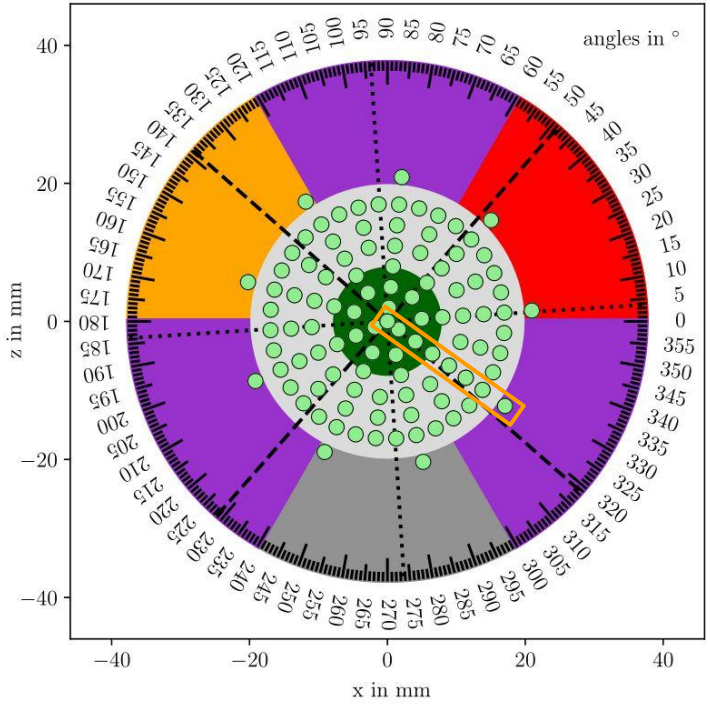
Energy Spectrum



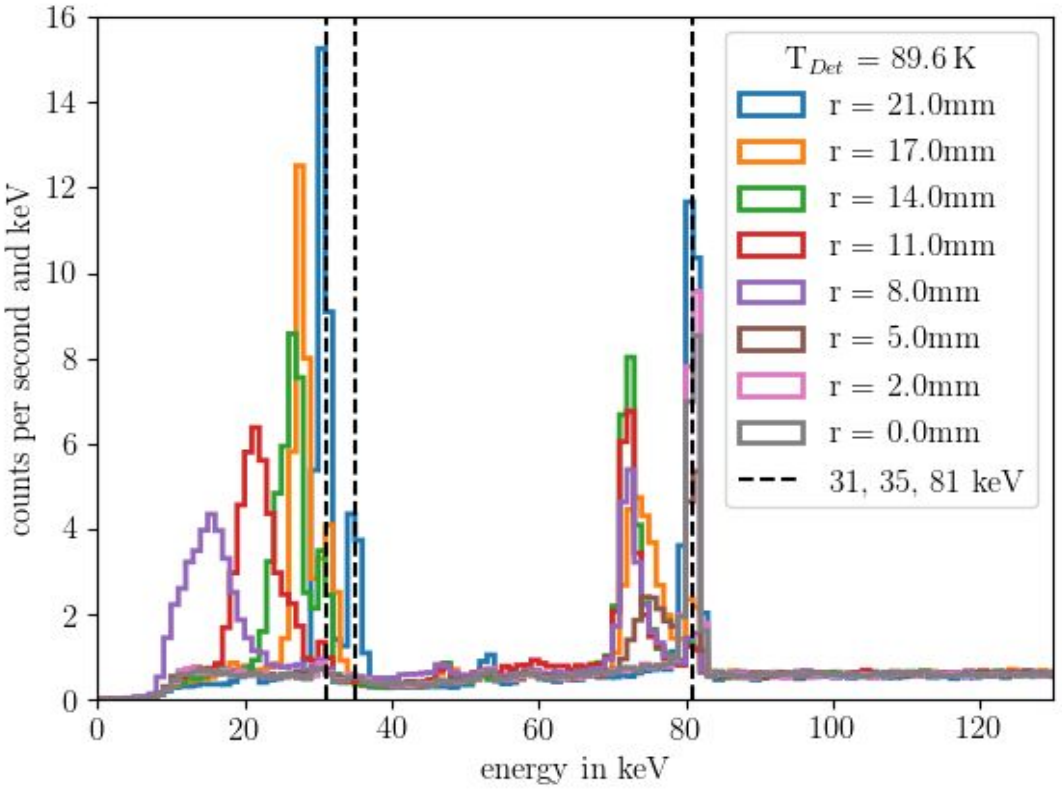


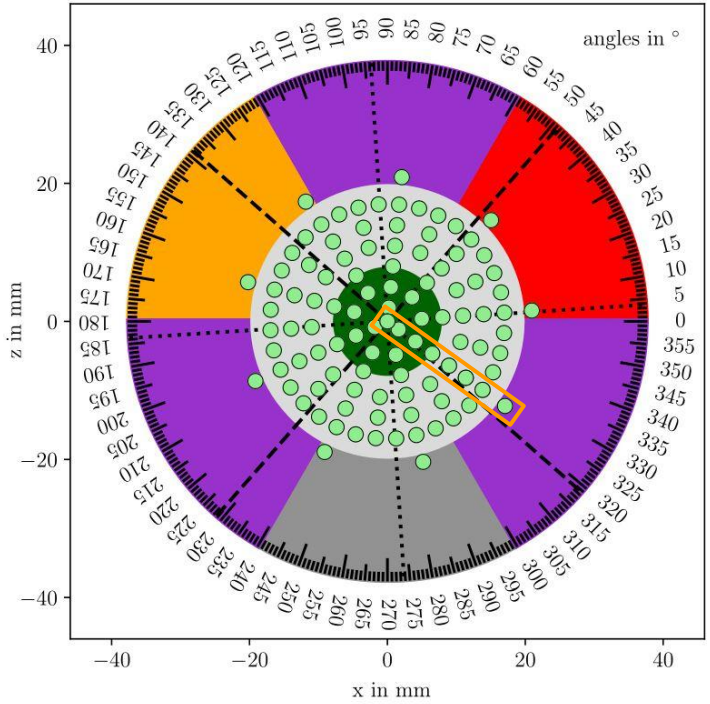
Energy Spectrum





T-dependence





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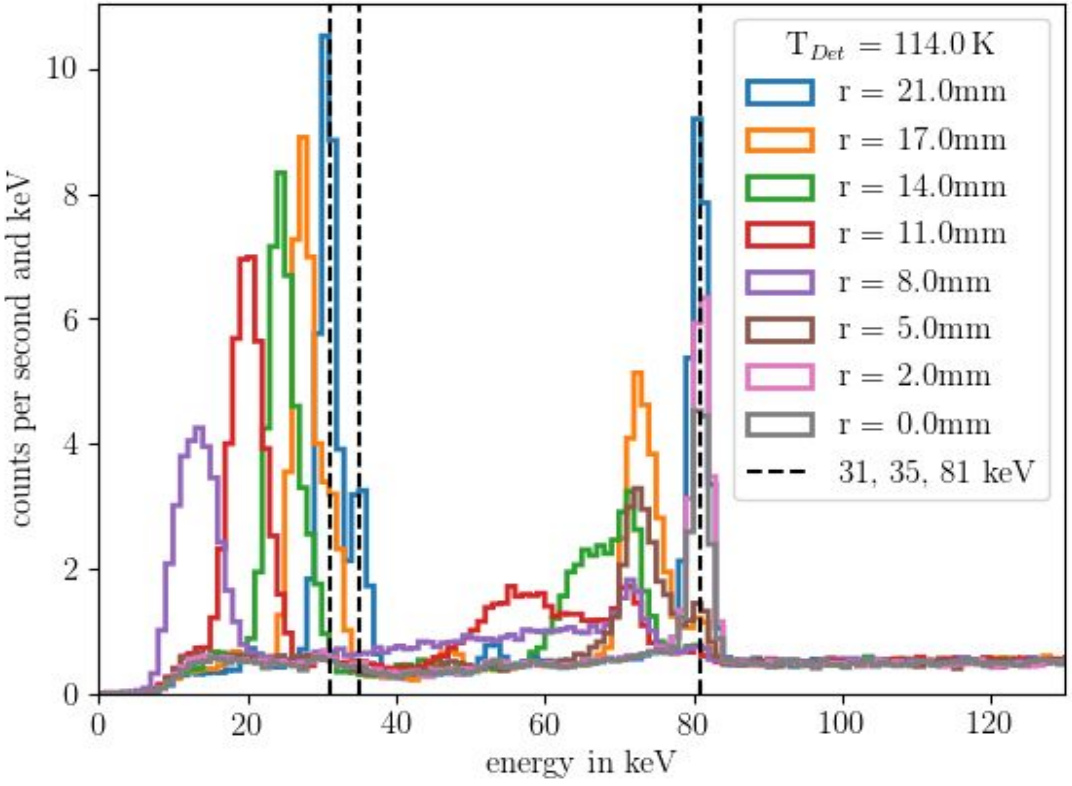
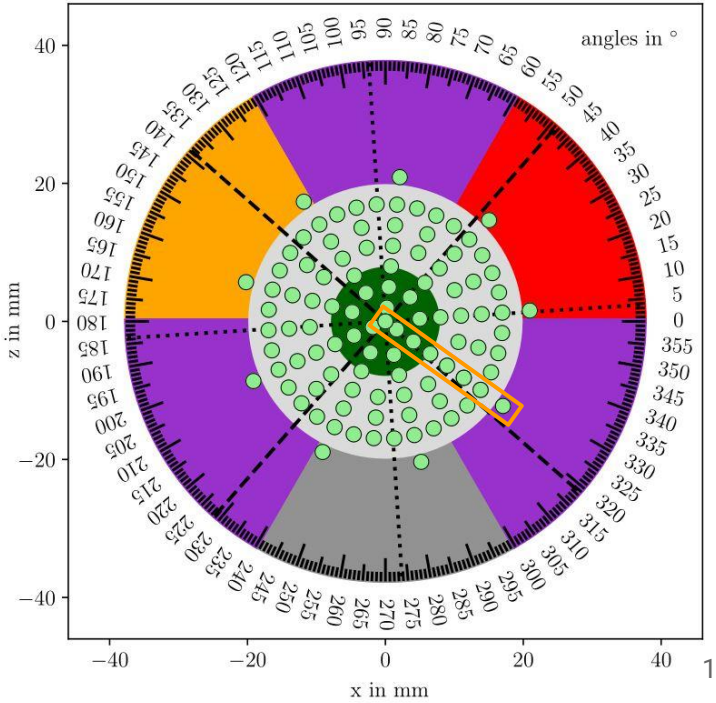
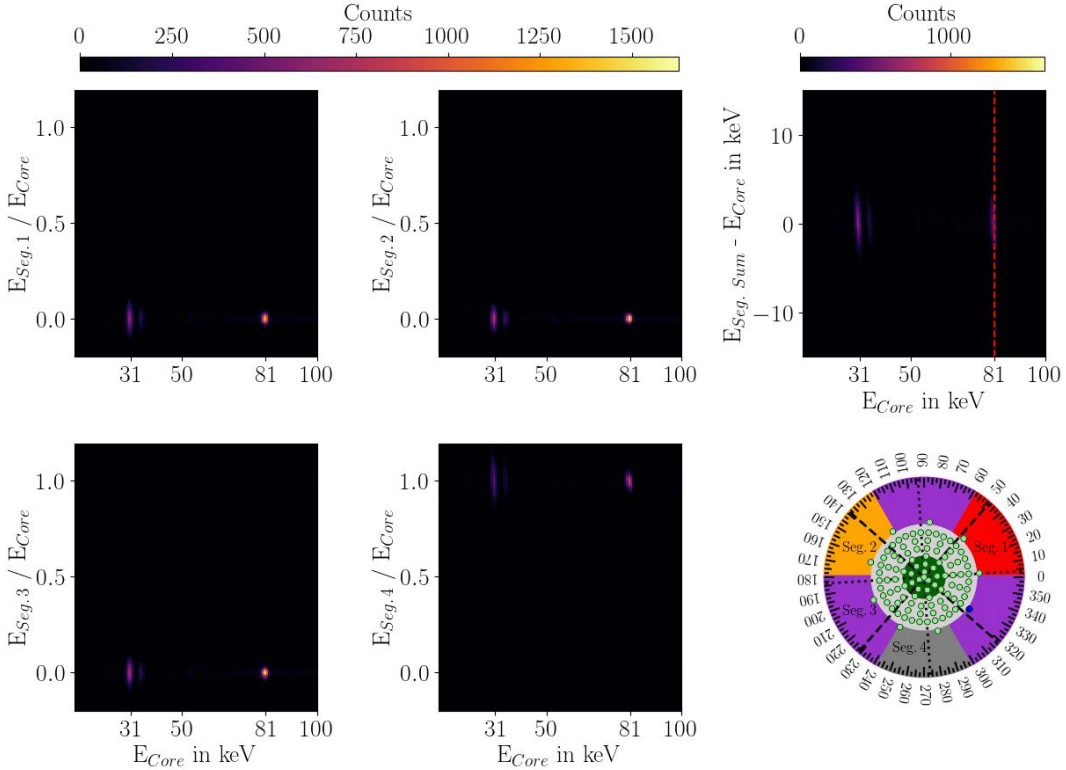
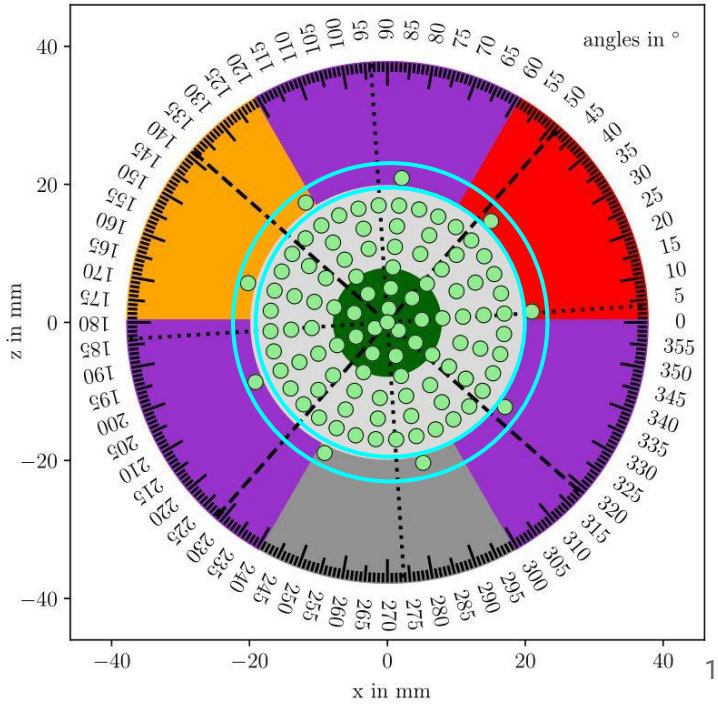




Look at Segments
Phi- and r- Dependence



$T_{Detector}$ = 89.6 K



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Phi- and r- Dependence

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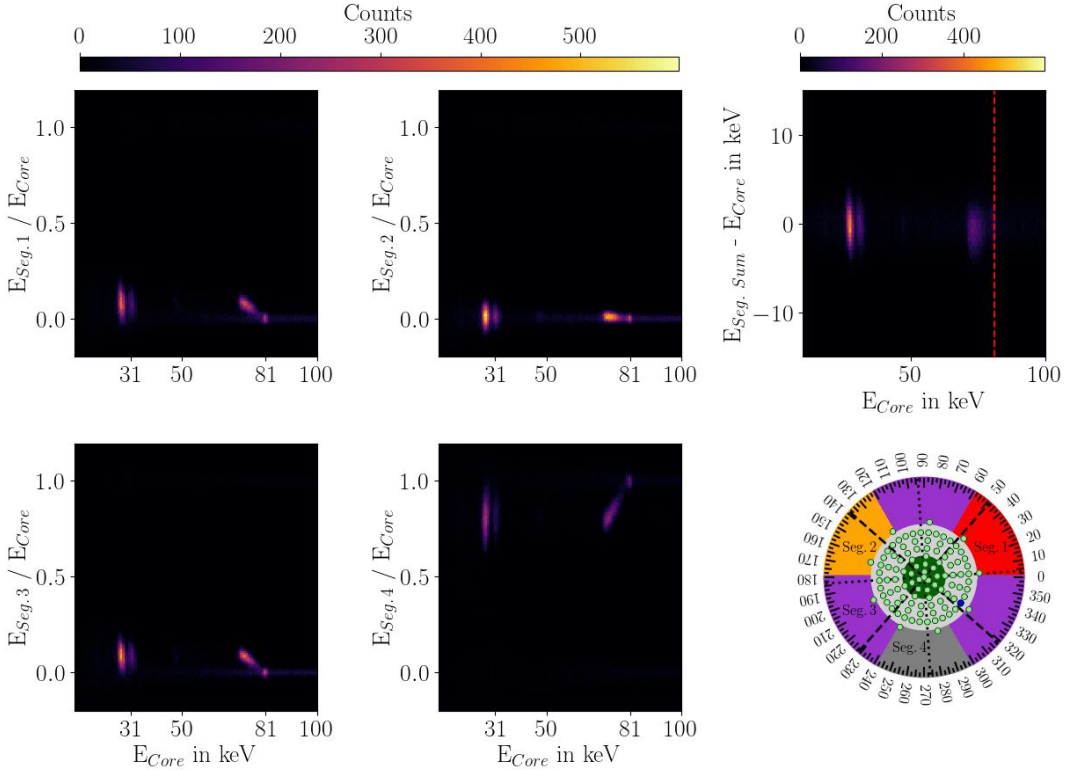

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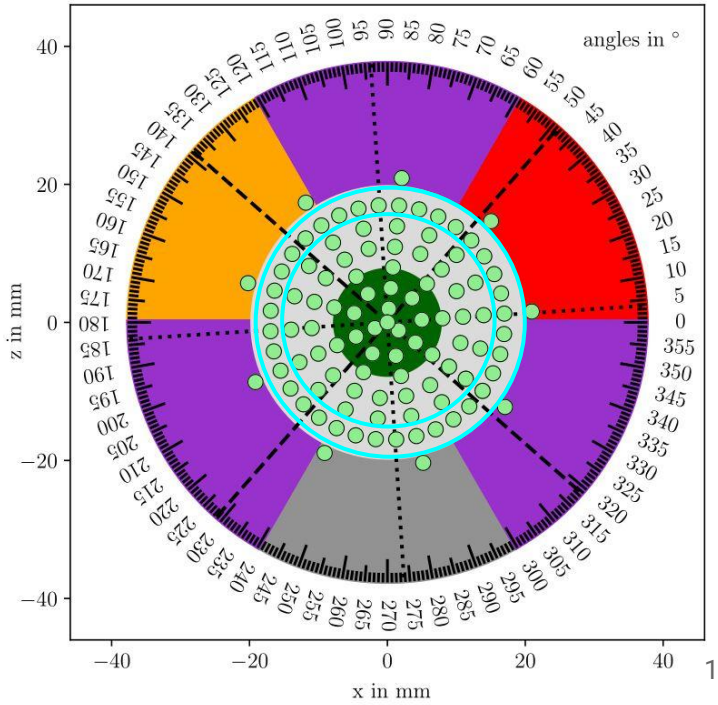

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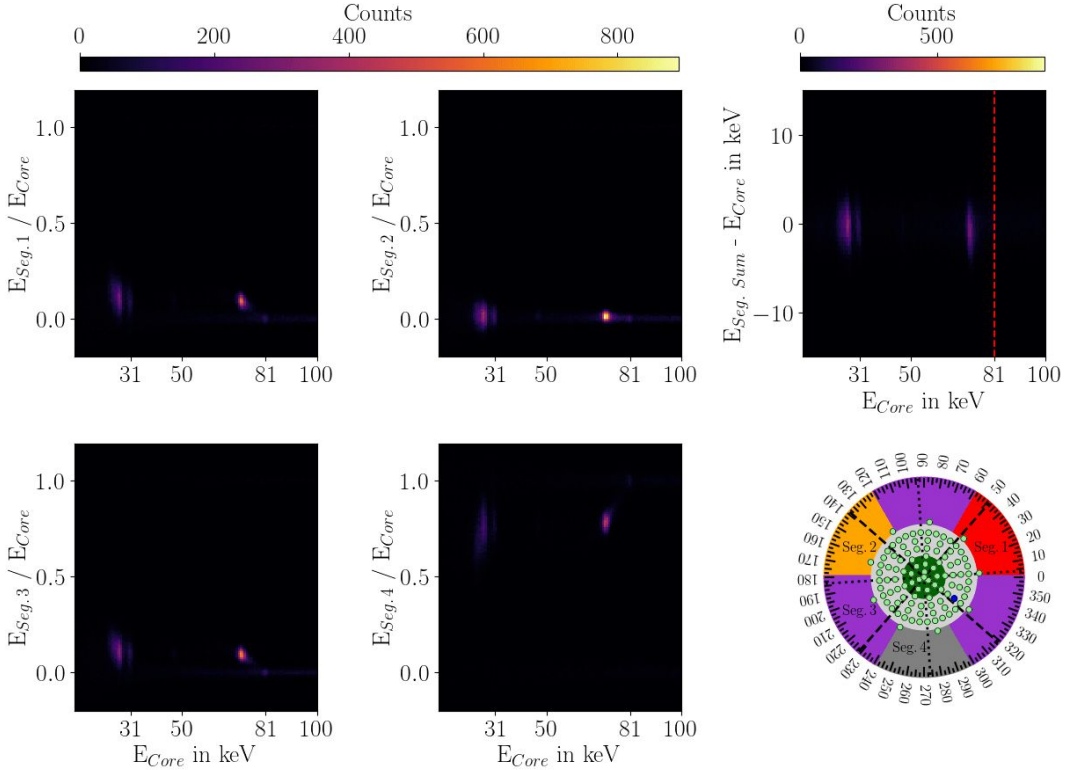

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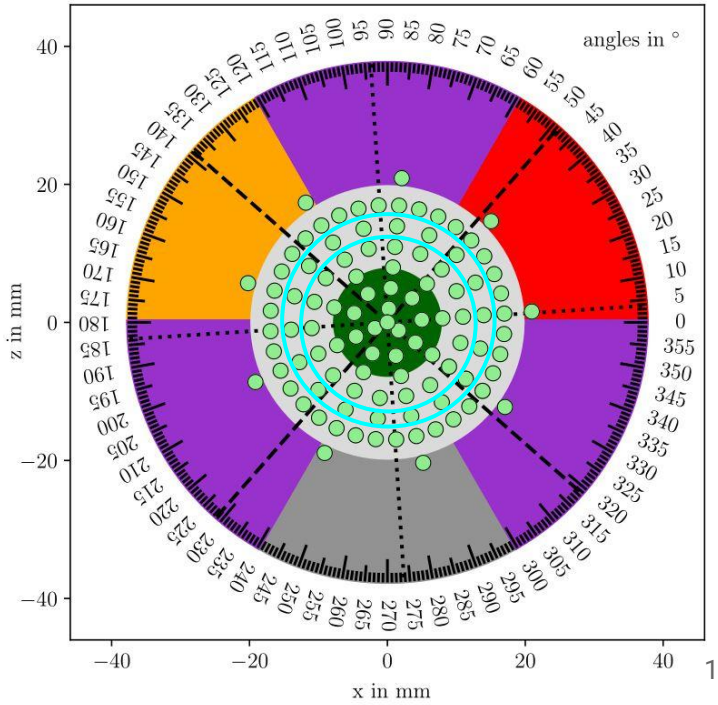

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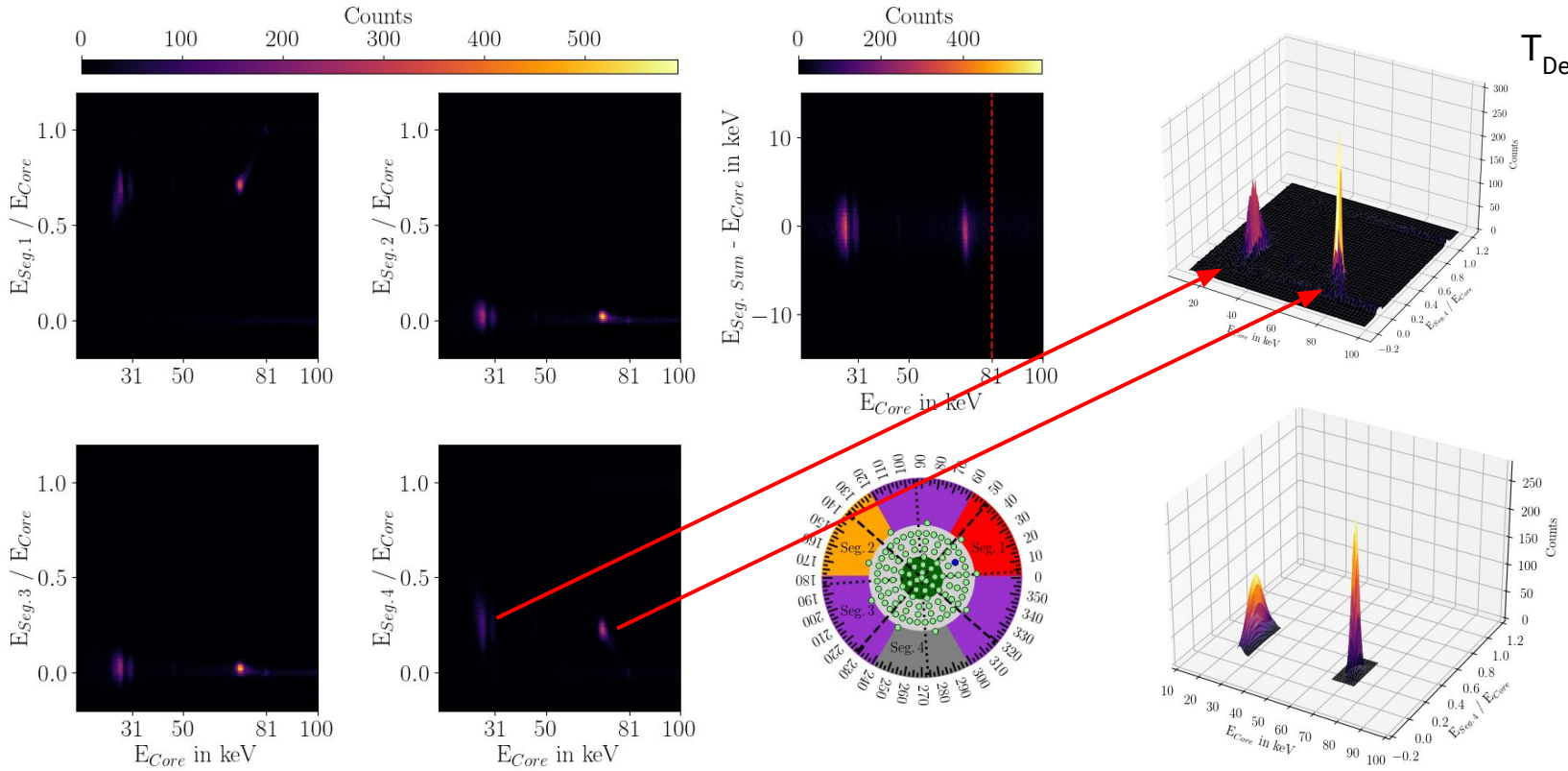

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Fit with 2D-Gaussian

Look at Segments
Phi- and r- Dependence

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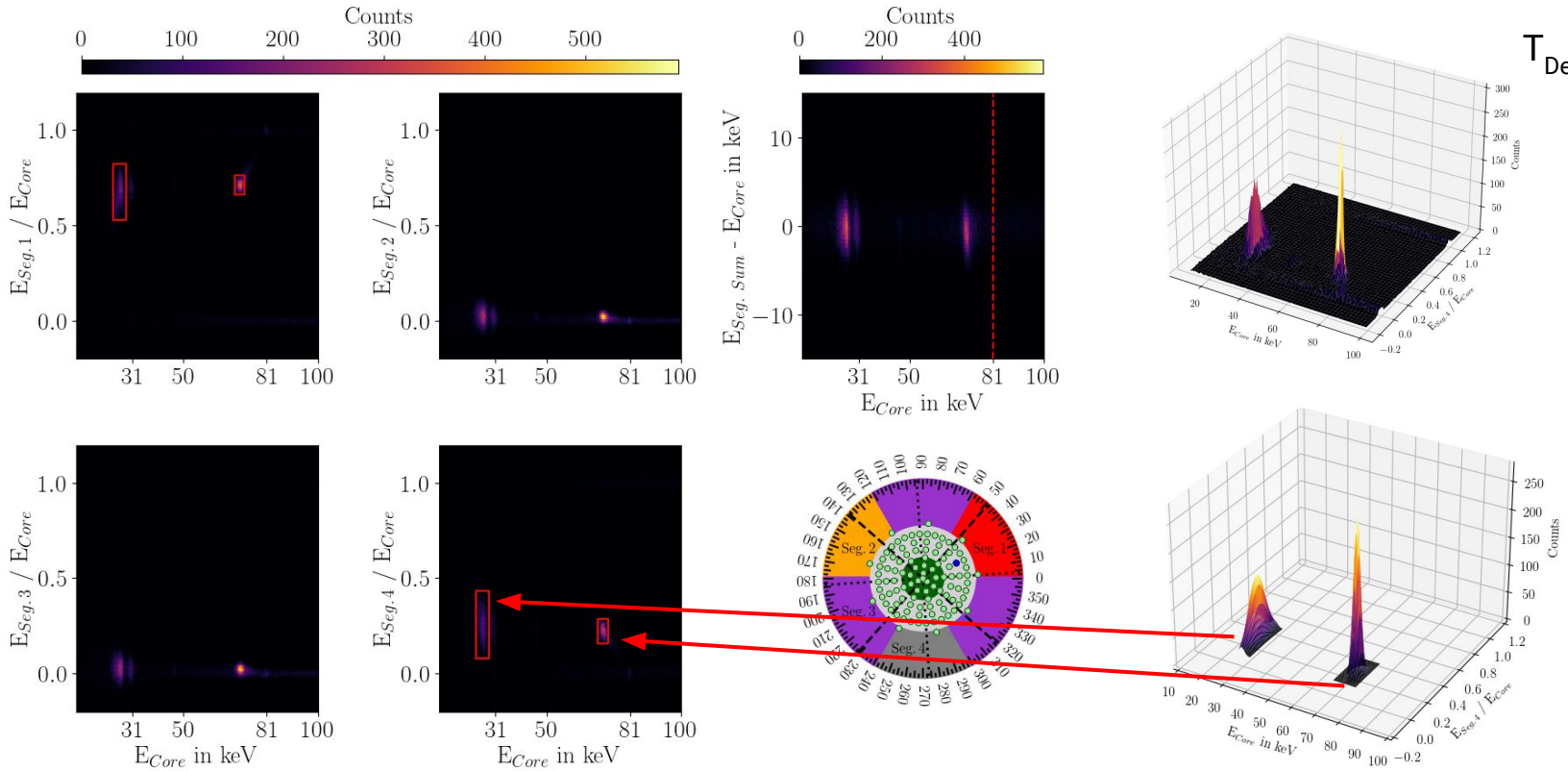


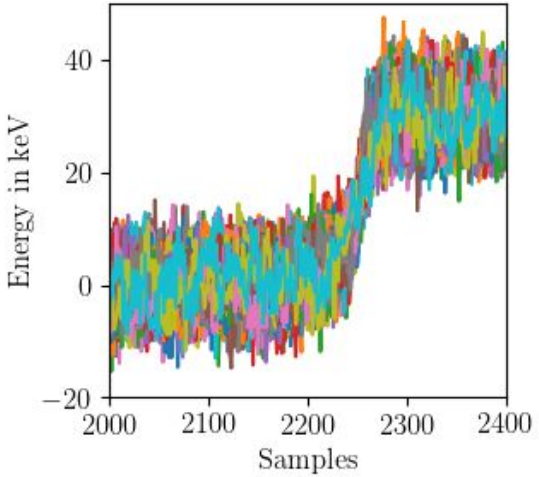
$T_{Detector}$ = 89.6 K

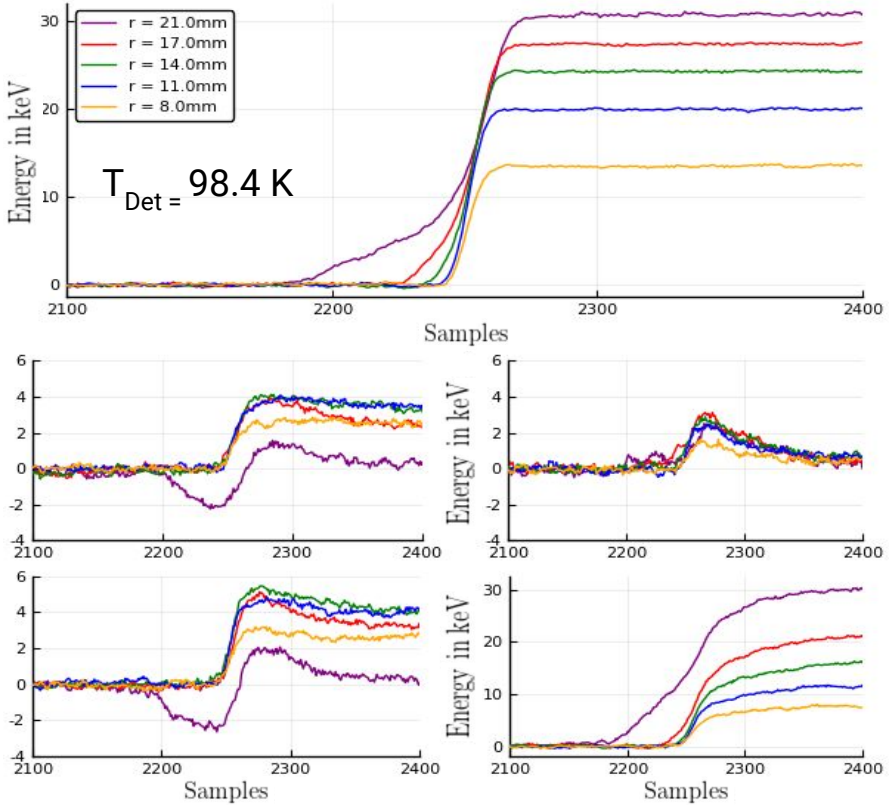
Fit with 2D-Gaussian

Look at Pulses

MAX-PLANCK-INSTITUT FÜR PHYSIK

Averaging selected pulses to form “Superpulses”





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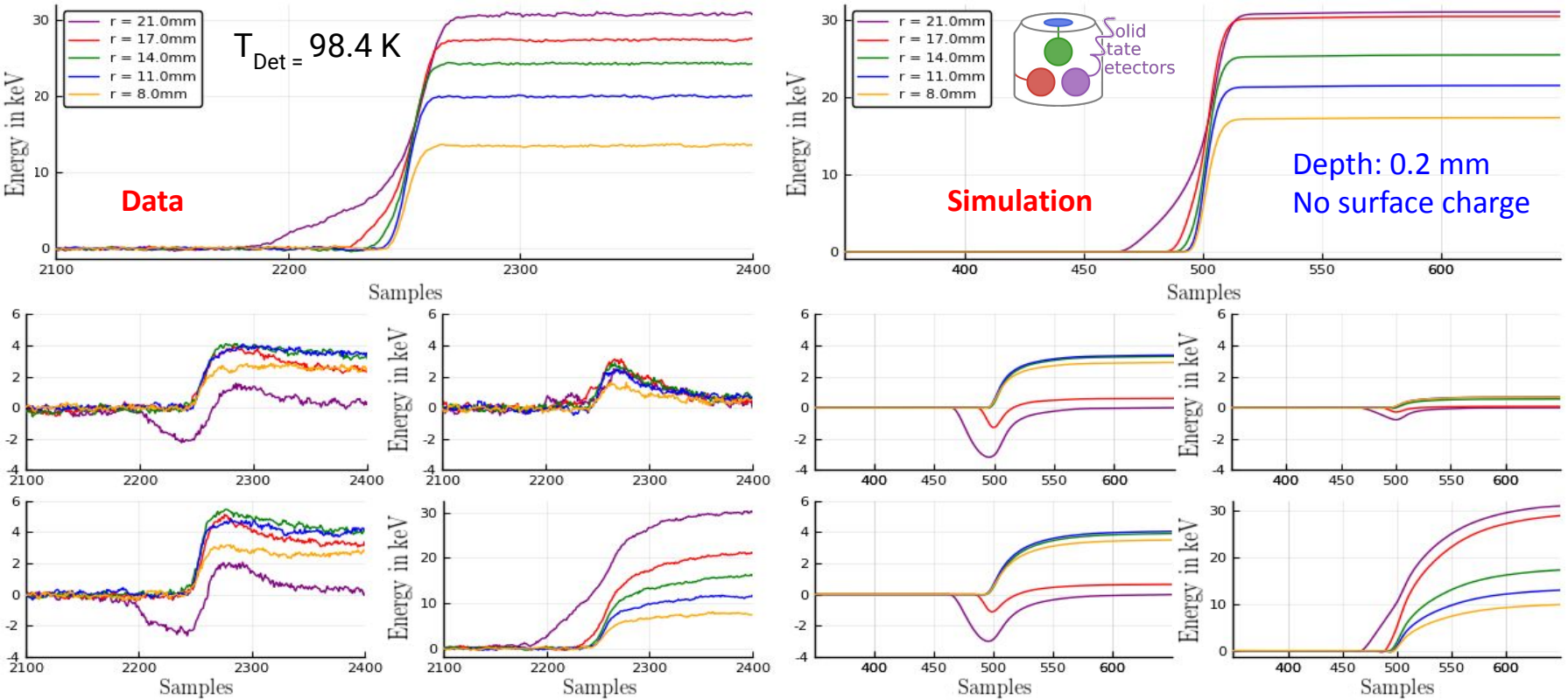

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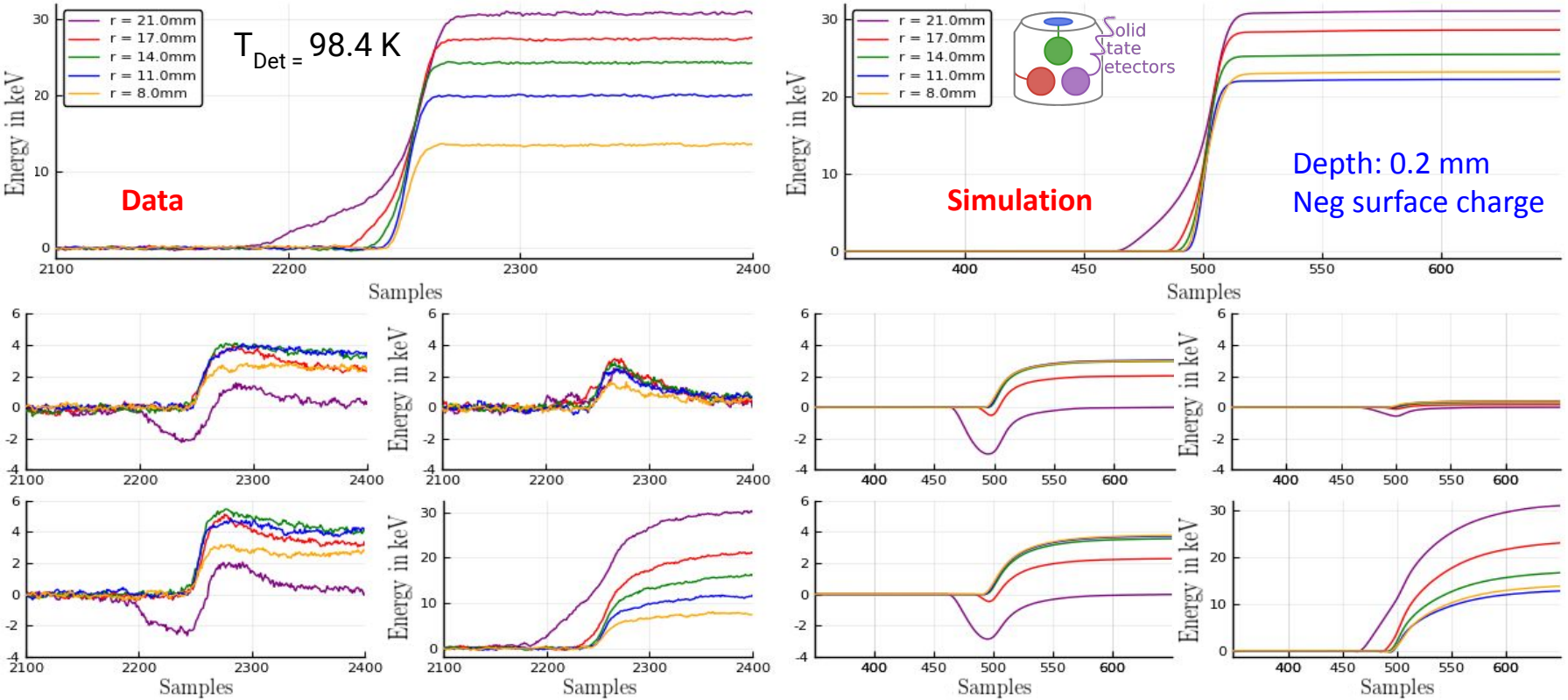

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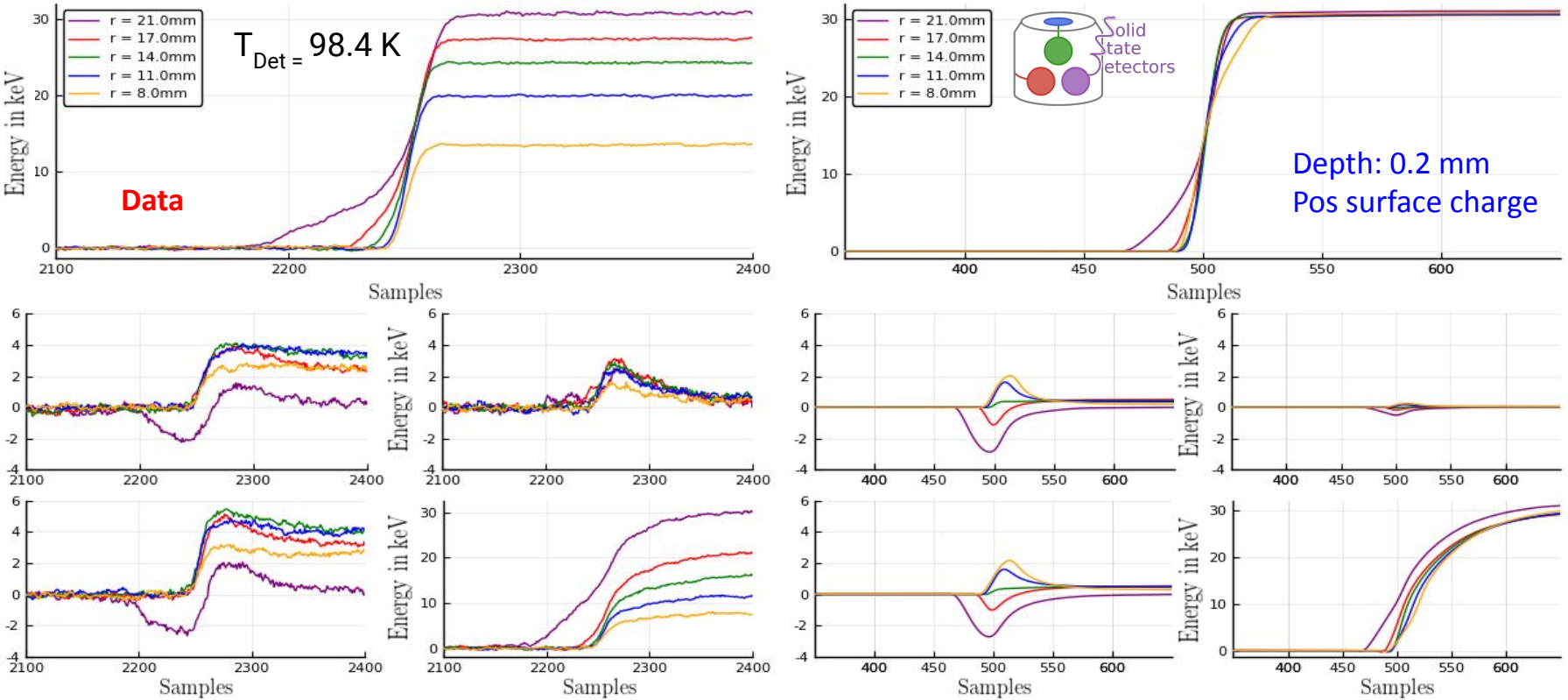


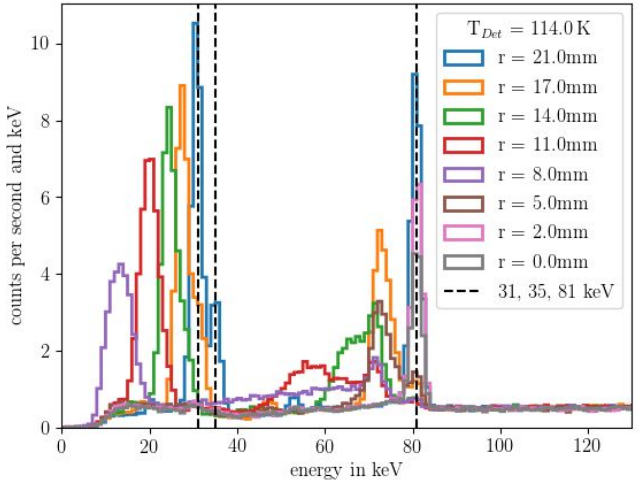
Summary and Outlook

MAX-PLANCK-INSTITUT FÜR PHYSIK

Behaviour right beneath the passivation layer:

- Low-energy peaks shift towards lower energy
  - r- dependence seems to increase for higher temperatures
  - affected zone grows with temperature

- Energy is shared between neighboring segments
  - charge (hole) trapping / charge diffusion



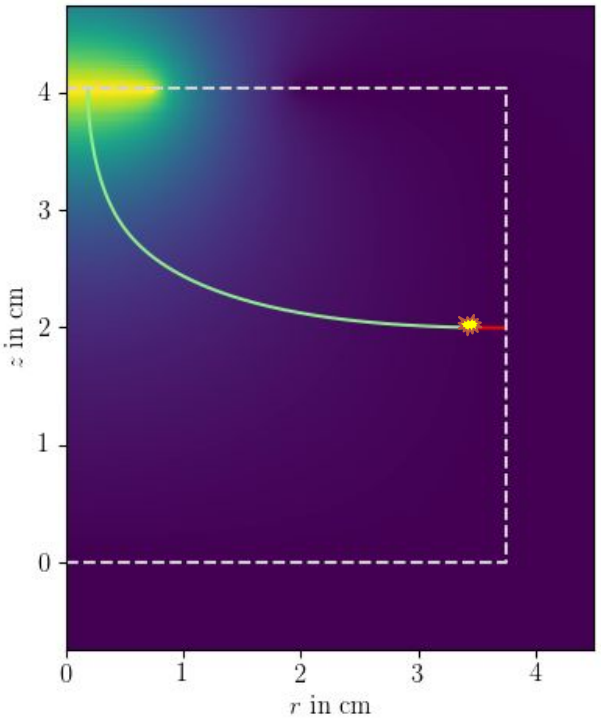
Next Steps:

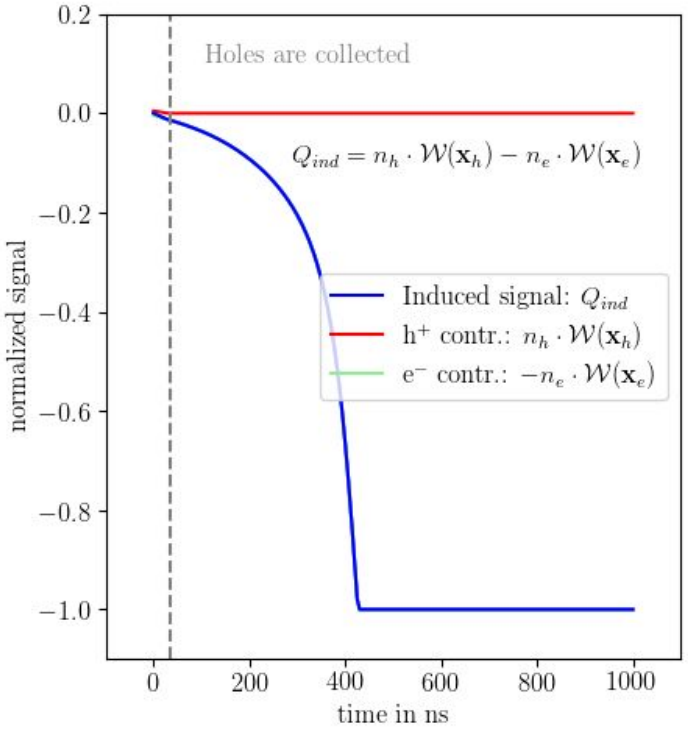
- Explore surface charge up scenarios with simulations

- Study the effects with a geometrically identical p-type detector

BACKUP

Signal Formation





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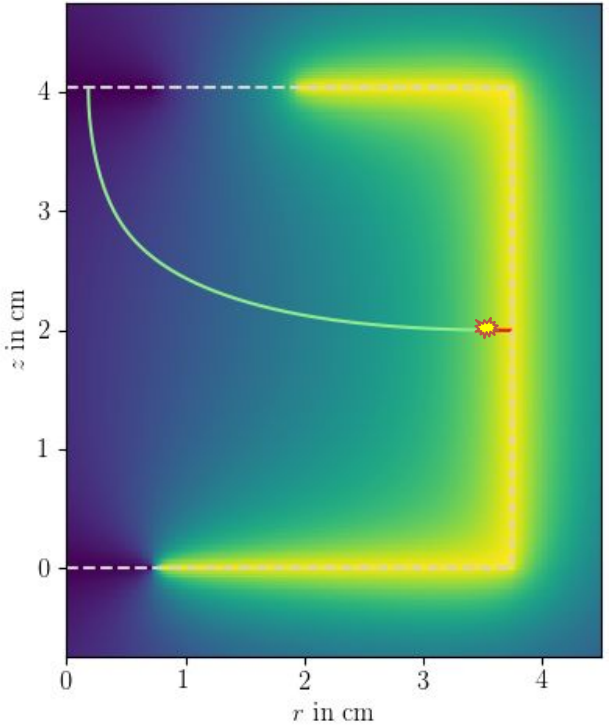
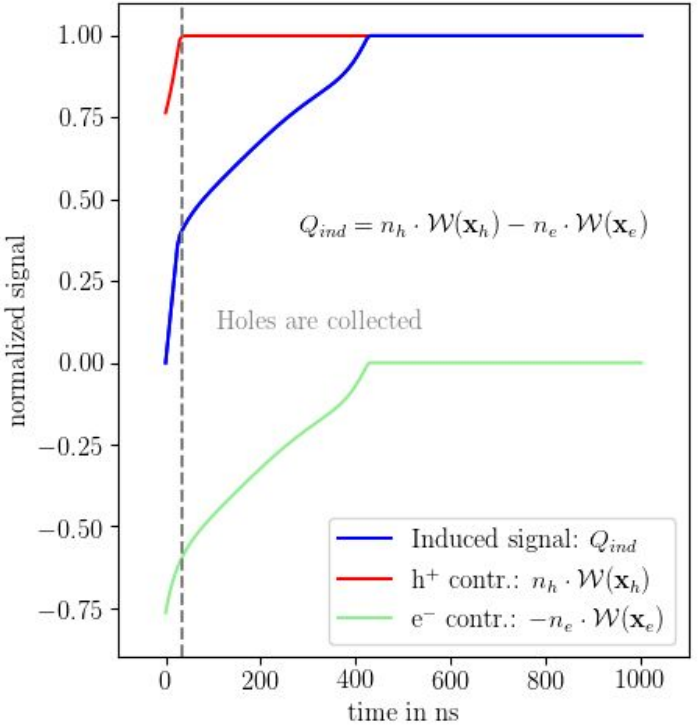
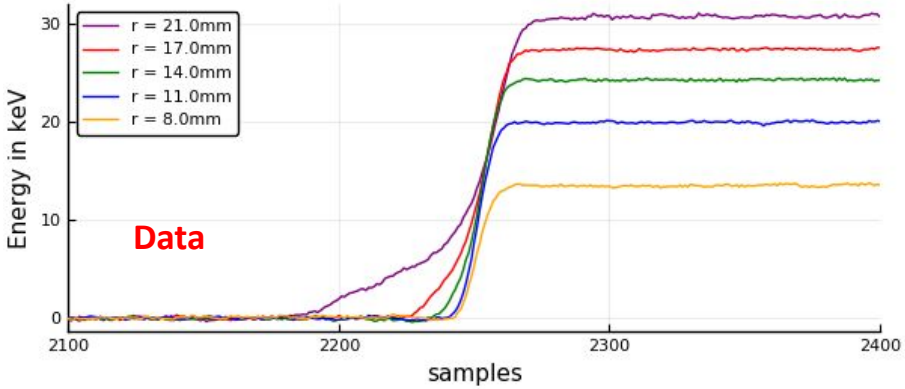




Solid State Detectors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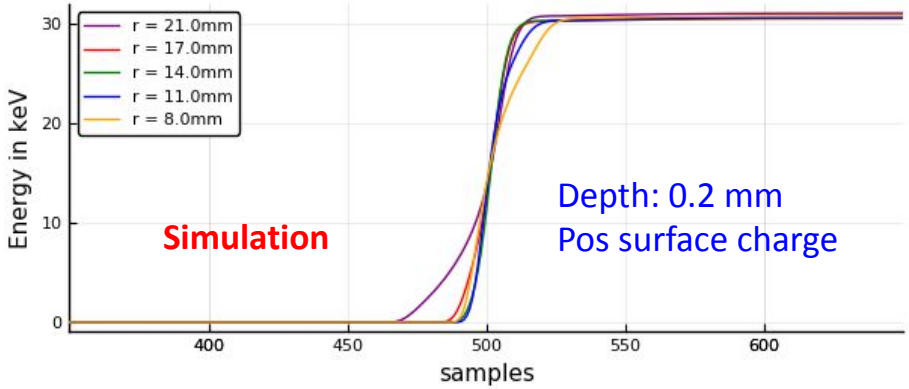
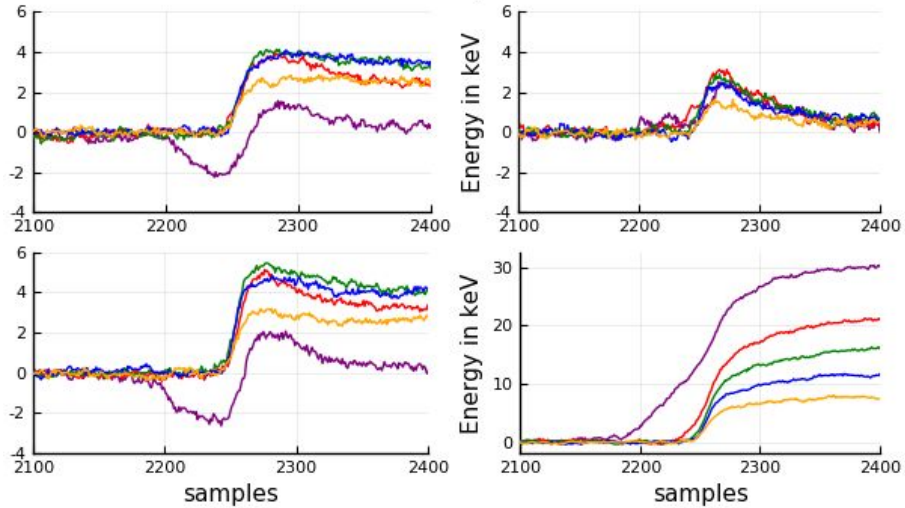
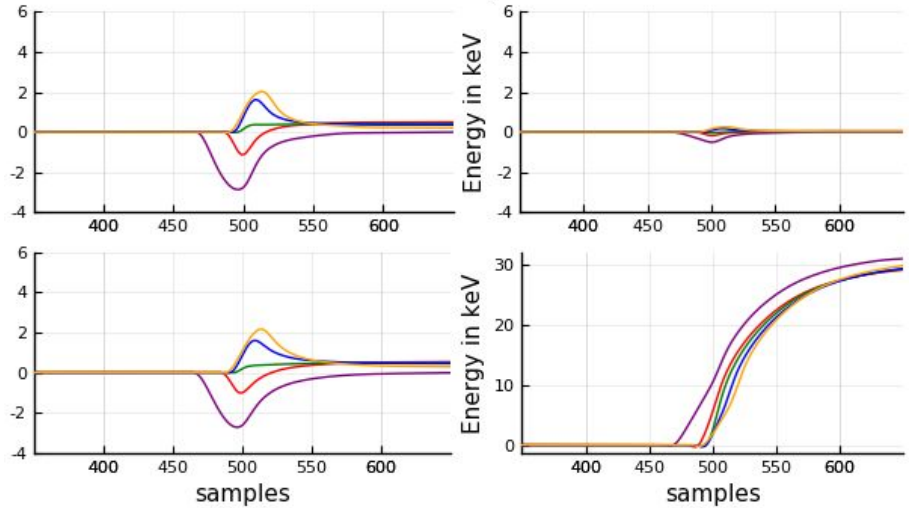
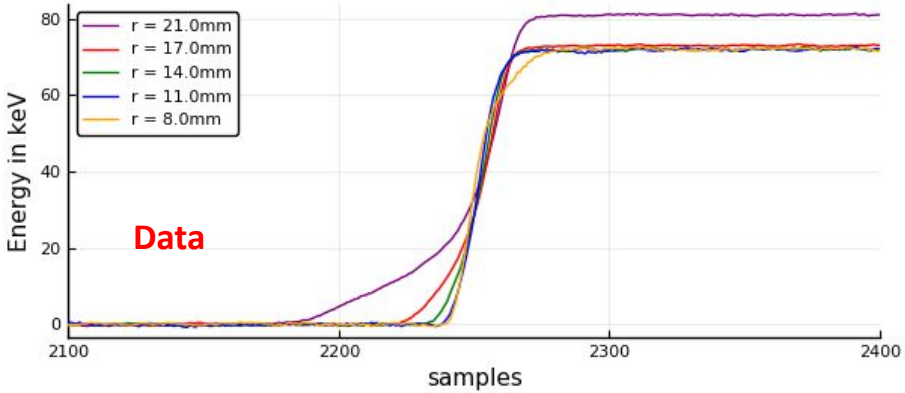
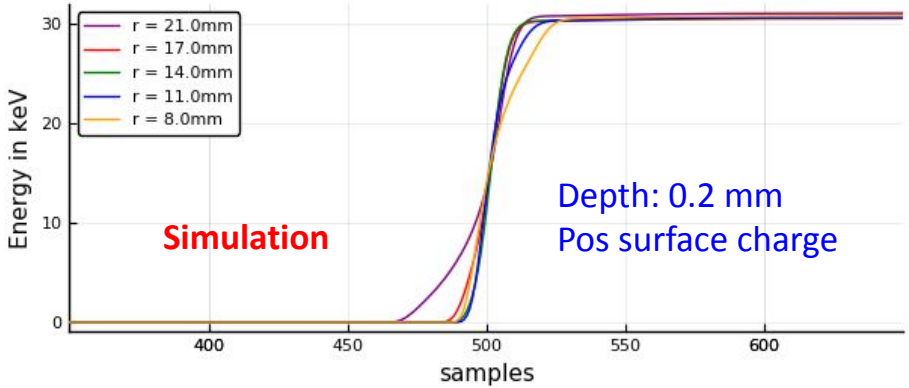
r = 17.0mm
r = 14.0mm
r = 11.0mm
r = 8.0mm
Energy in keV
Data
samples

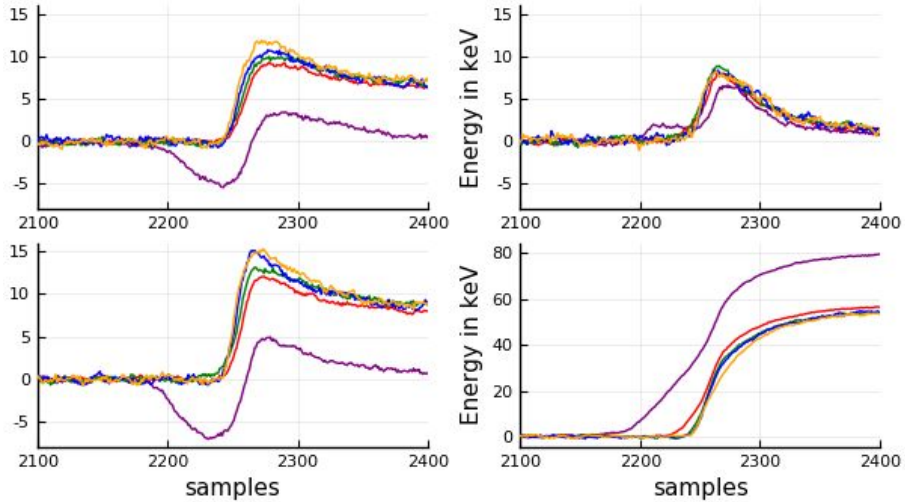

r = 21.0mm
r = 17.0mm
r = 14.0mm
r = 11.0mm
r = 8.0mm
Energy in keV
Simulation
Depth: 0.2 mm
Pos surface charge
samples

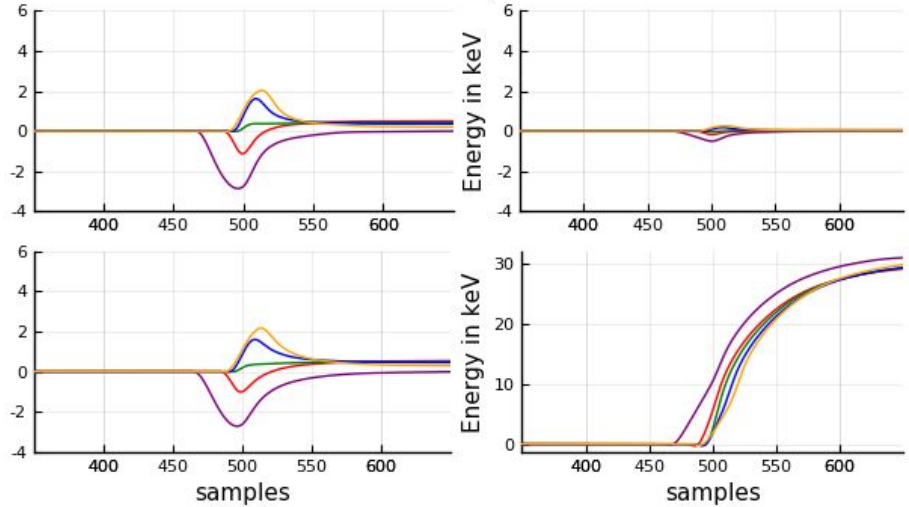

Energy in keV
samples

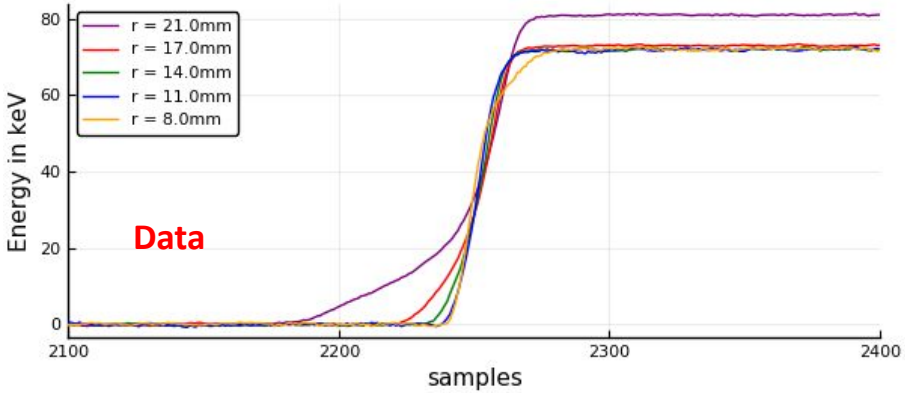

Energy in keV
samples

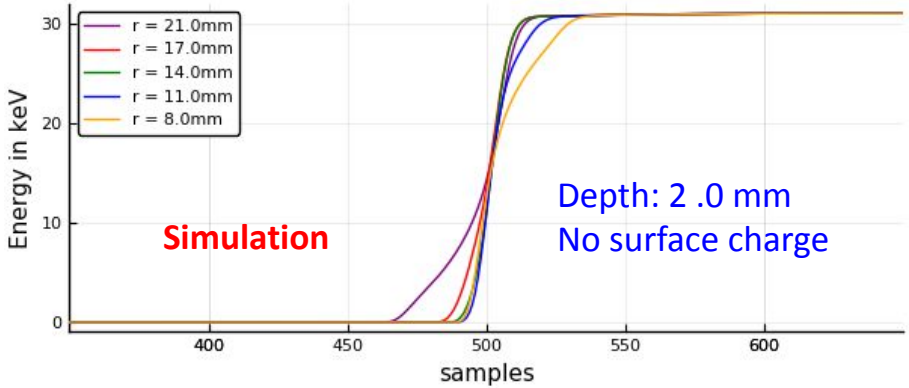

r = 21.0mm
r = 17.0mm
r = 14.0mm
r = 11.0mm
r = 8.0mm
Energy in keV
Data
samples


r = 21.0mm
r = 17.0mm
r = 14.0mm
r = 11.0mm
r = 8.0mm
Energy in keV
Simulation
Depth: 0.2 mm
Pos surface charge
samples


Energy in keV
samples


Energy in keV
samples


r = 21.0mm
r = 17.0mm
r = 14.0mm
r = 11.0mm
r = 8.0mm
Energy in keV
Data
samples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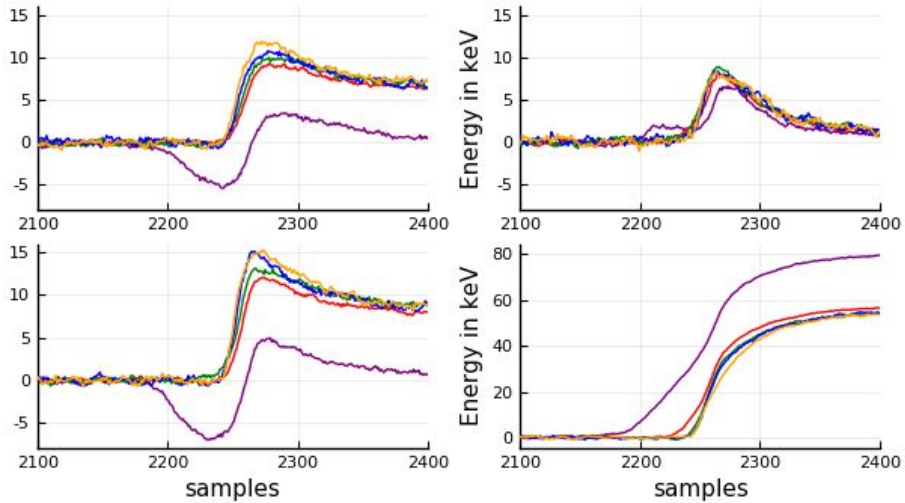
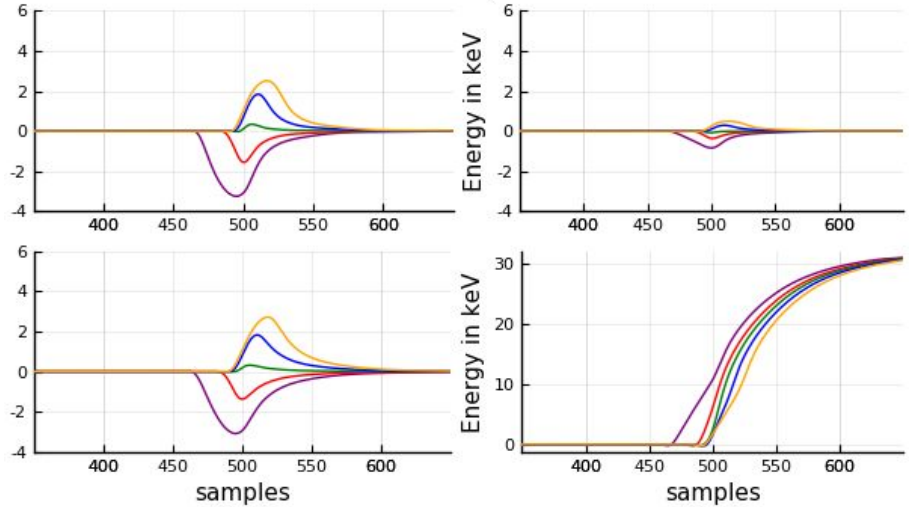
r = 17.0mm
r = 14.0mm
r = 11.0mm
r = 8.0mm
Energy in keV
Simulation
Depth: 2 .0 mm
No surface charge
samples


Energy in keV
samples


Energy in keV
samples