

# Voltage scans on germanium detectors

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Virtual DPG Spring Meeting  
March 21<sup>st</sup>, 2022

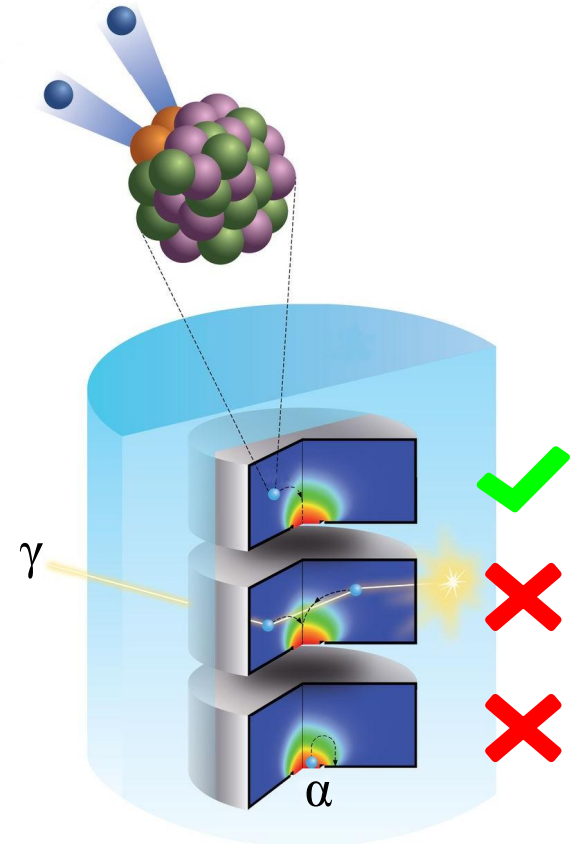
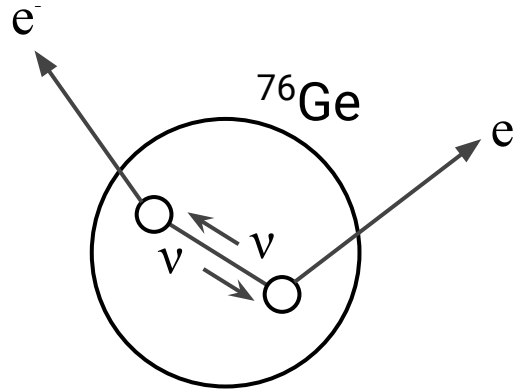
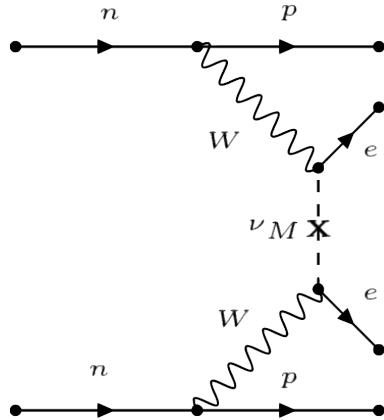


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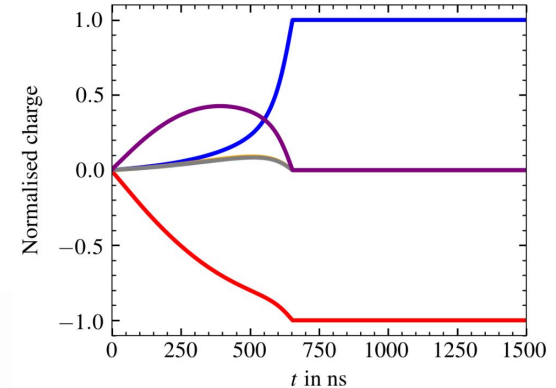
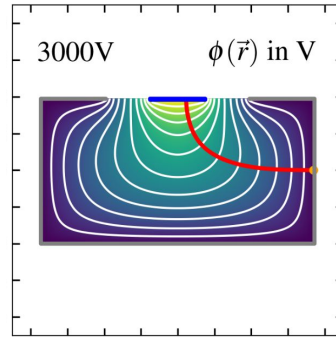
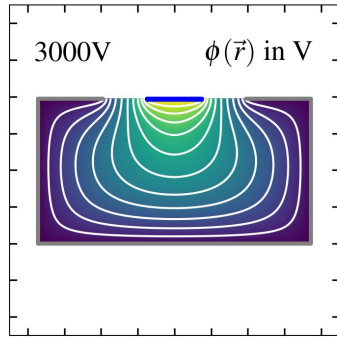
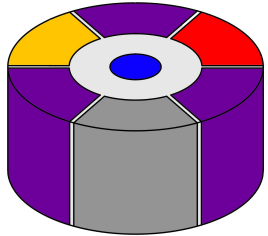
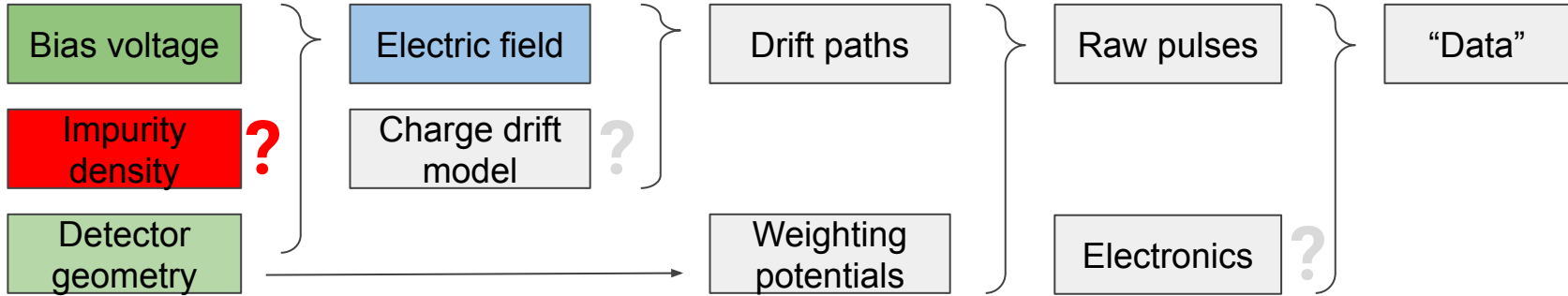
# Motivation

# LEGEND

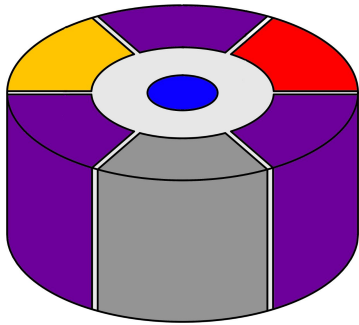
Large Enriched Germanium Experiment for Neutrinoless  $\beta\beta$  Decay



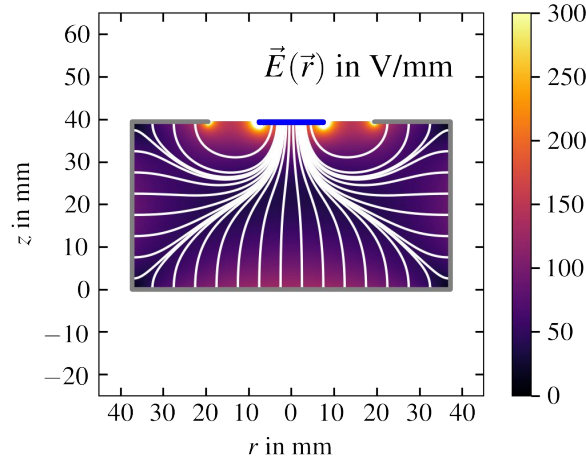
# Pulse Shape Simulation



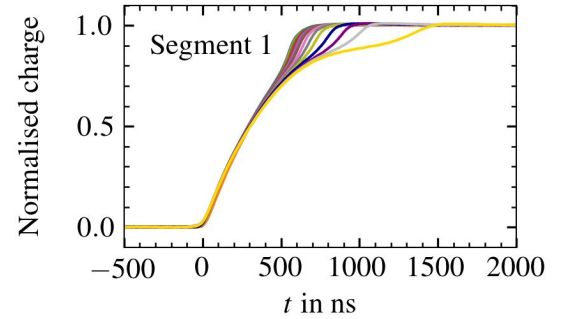
# Outline



Segmented Broad Energy germanium detector



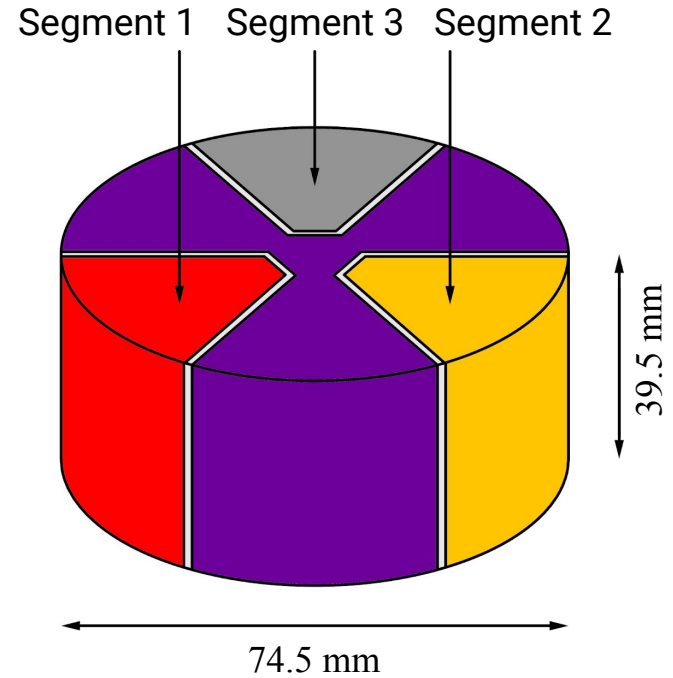
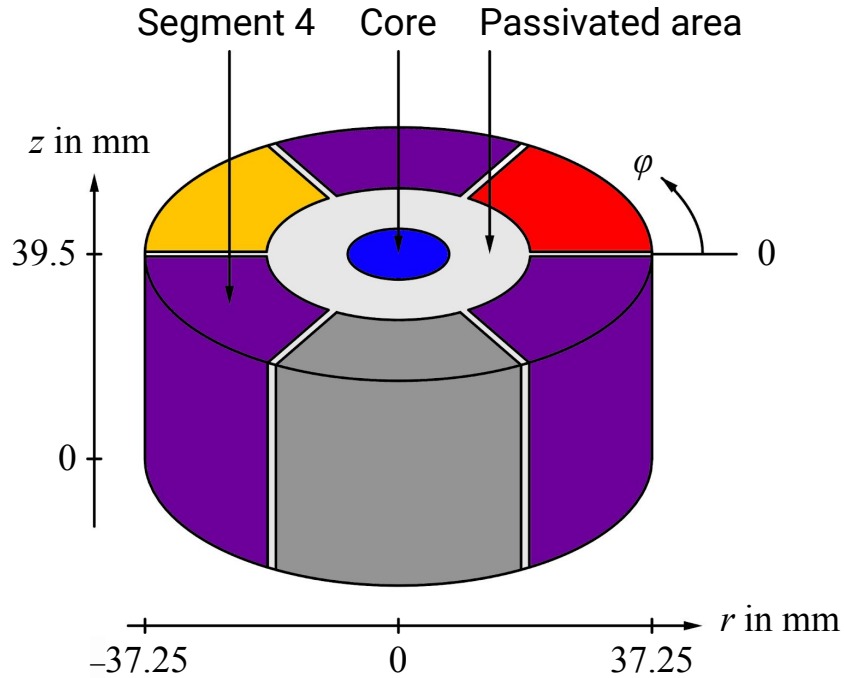
General concept of voltage scans



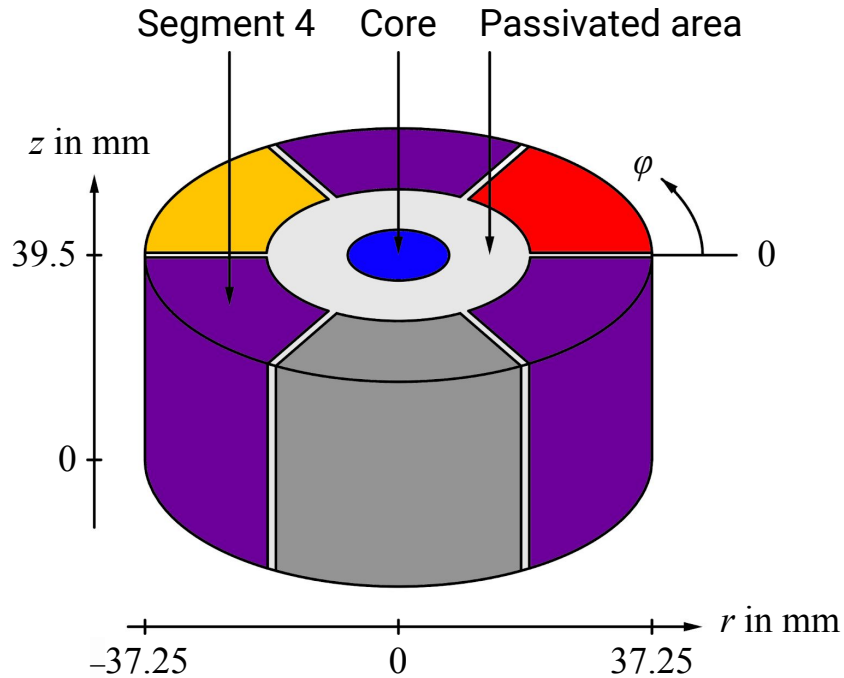
First results: simulation & data



# Segmented Broad Energy Germanium Detector



# Segmented Broad Energy Germanium Detector



Values in the specification sheet of the detector:

Net carrier concentration:

- Top surface:  $0.65 \cdot 10^{10} \text{ cm}^{-3}$
- Bottom surface:  $0.58 \cdot 10^{10} \text{ cm}^{-3}$

Note: The net impurity concentration is given by the crystal grower and could be different than the values calculated from depletion measurements.



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# Contributions to the Electric Potential

$$\nabla^2 \phi(\vec{r}) = -\frac{\rho(\vec{r})}{\epsilon} \quad \phi(\vec{r})|_{S_i} = V_{B,i}$$

$$\phi_\rho(\vec{r}) + \phi_V(\vec{r}) = \phi(\vec{r})$$

$$\begin{aligned} \nabla^2 \phi_\rho(\vec{r}) &= -\frac{\rho(\vec{r})}{\epsilon} & \nabla^2 \phi_V(\vec{r}) &= 0 \\ \phi_\rho(\vec{r})|_{S_i} &= 0 & \phi_V(\vec{r})|_{S_i} &= V_{B,i} \end{aligned}$$



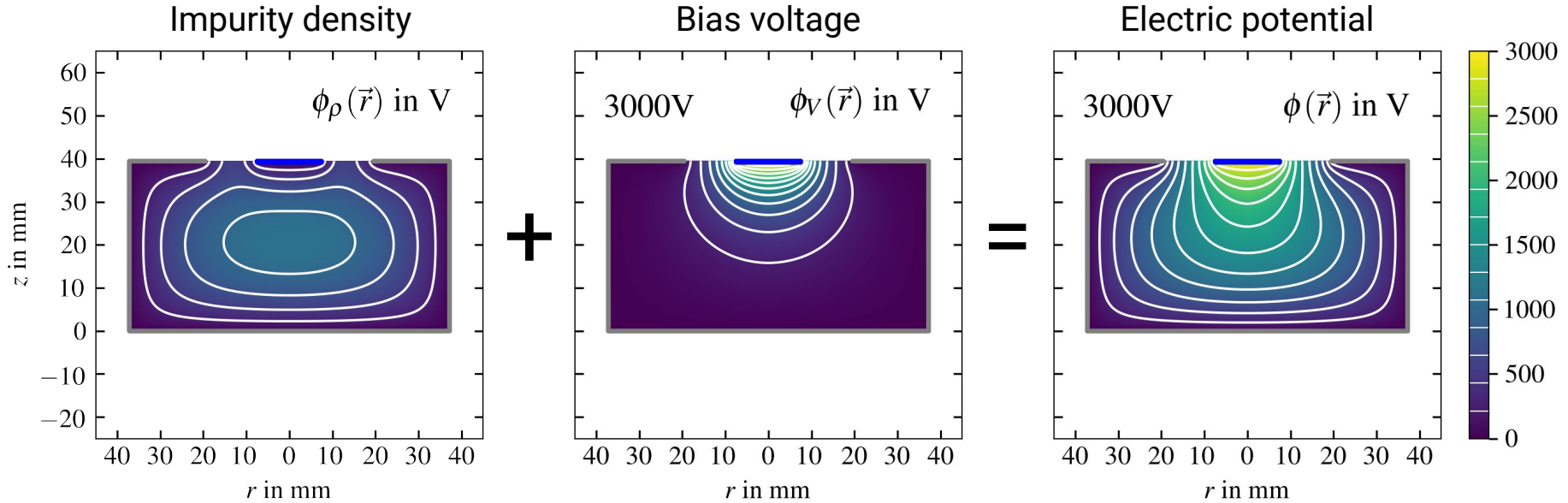
# Contributions to the Electric Potential

$$\text{Impurity density} + \text{Bias voltage} = \text{Electric potential}$$

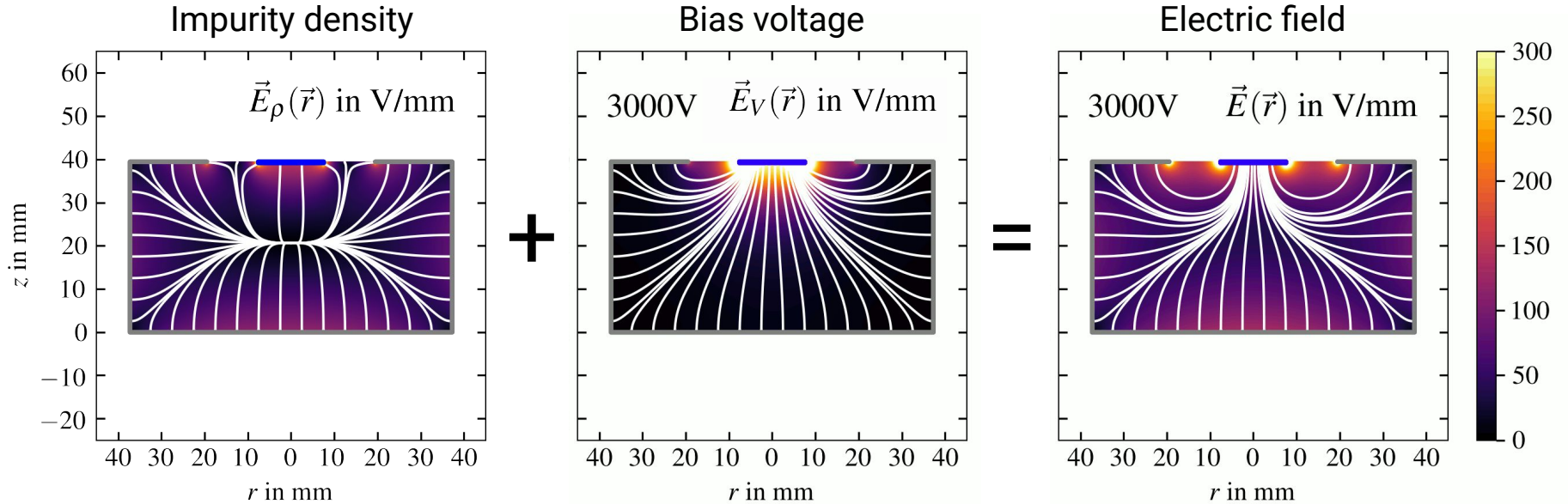




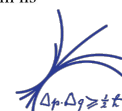
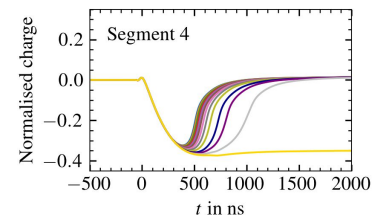
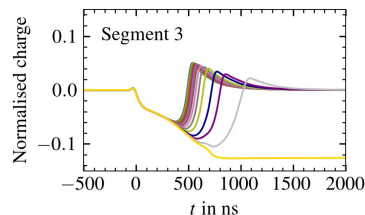
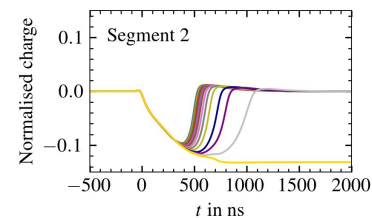
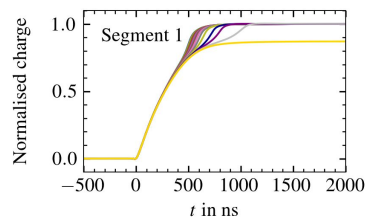
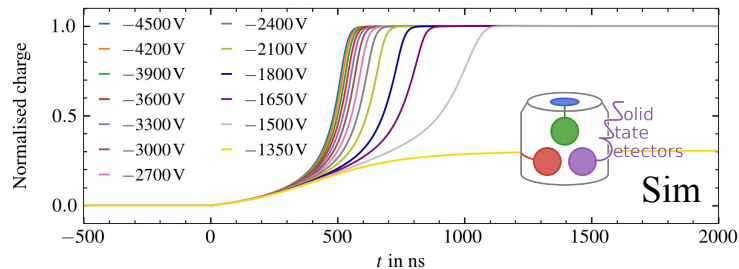
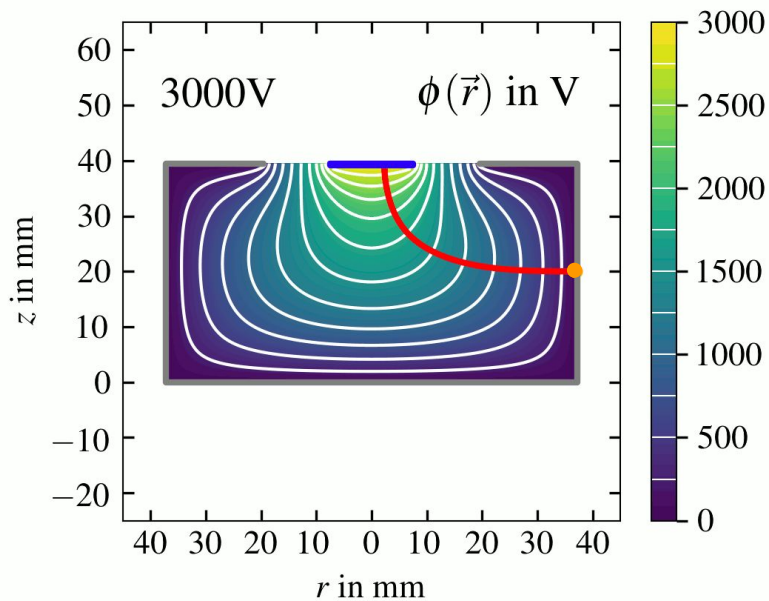
# Concept of Voltage Scans



# Concept of Voltage Scans



# Voltage Scan Simulation Results



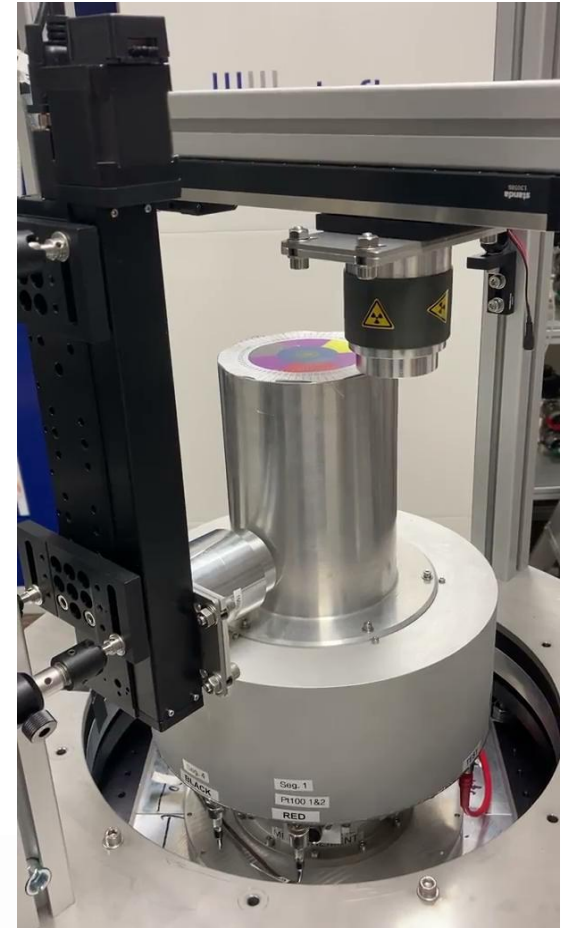
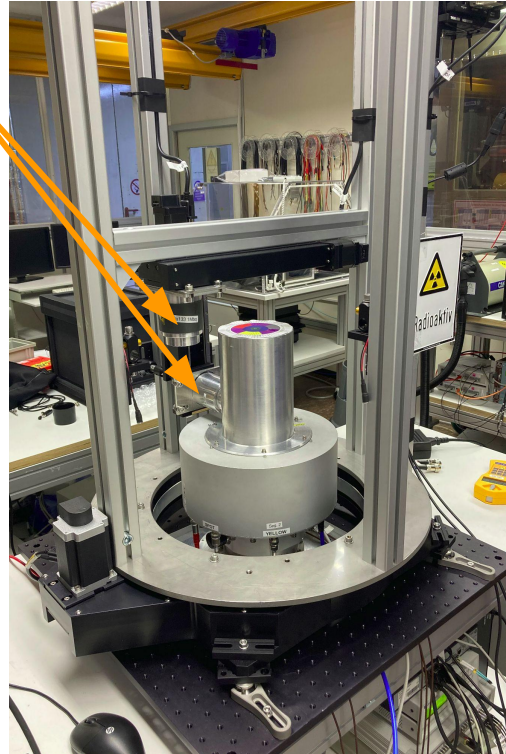
# $^{133}\text{Ba}$ Surface Scanner

Two  $^{133}\text{Ba}$  sources (1 MBq each)

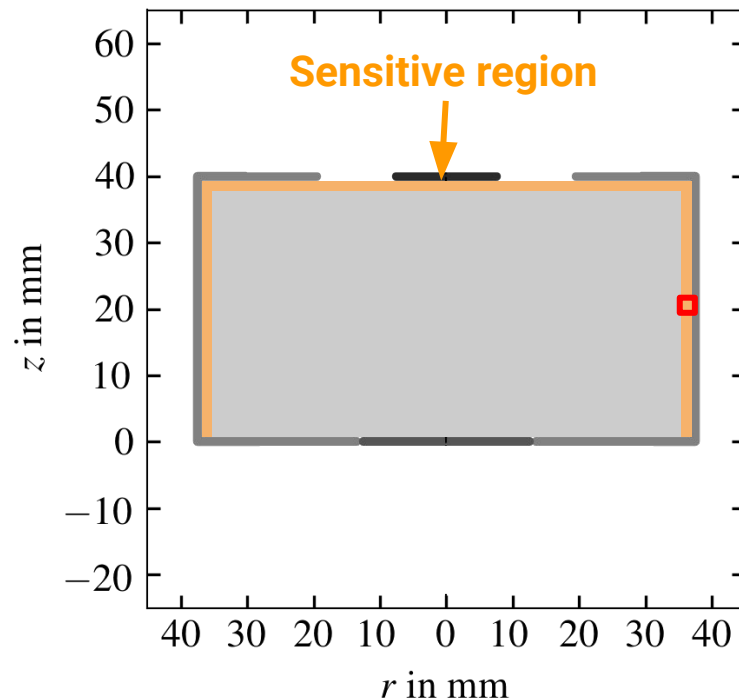
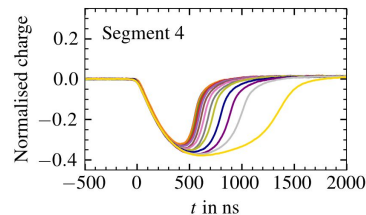
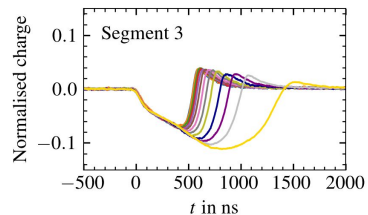
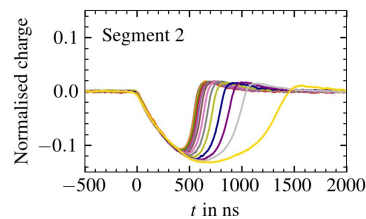
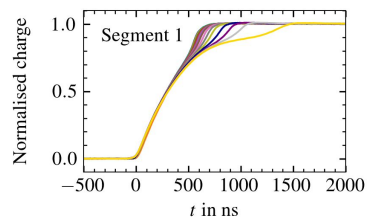
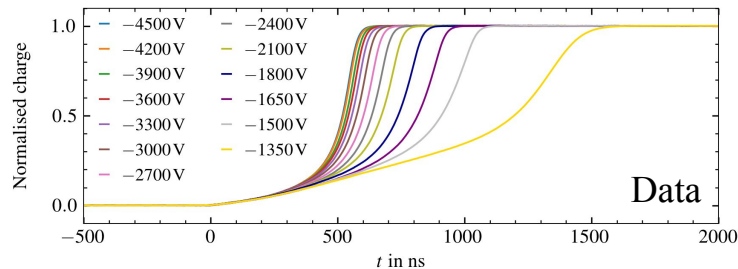
- 30.973 keV
- 80.997 keV
- 276.398 keV
- 302.853 keV
- 356.017 keV
- 383.851 keV

4cm Tungsten collimator  
with  $\varnothing$  1.5mm borehole

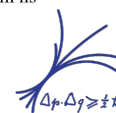
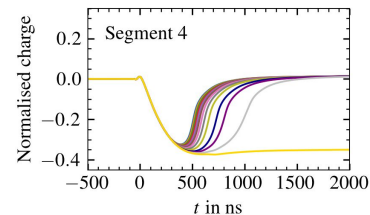
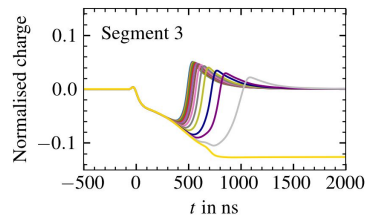
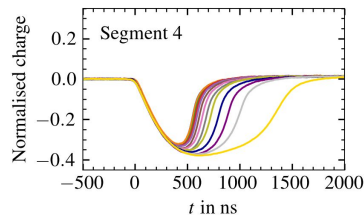
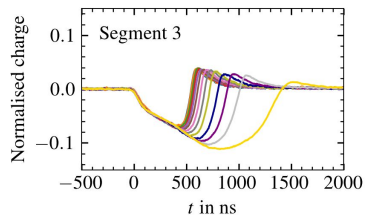
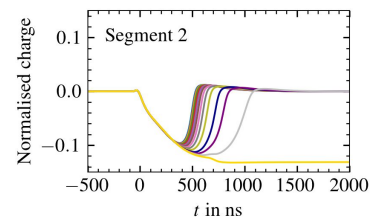
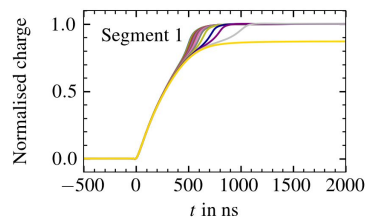
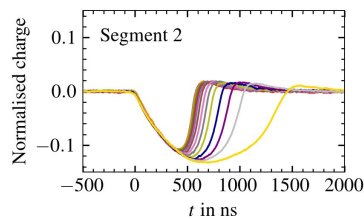
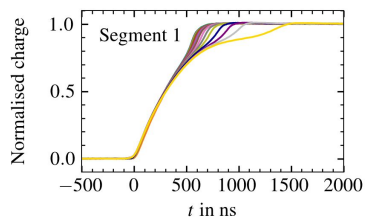
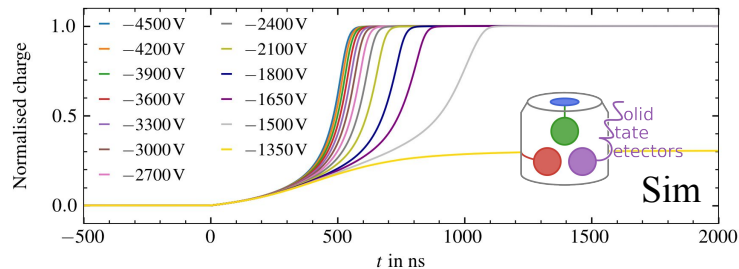
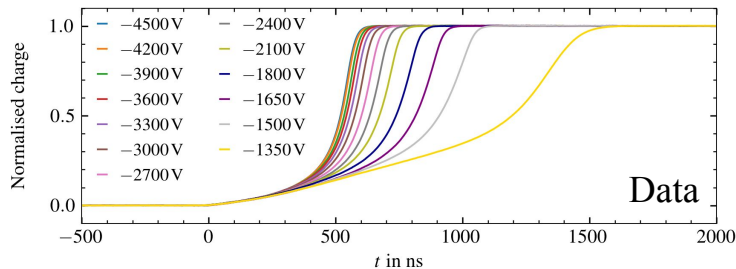
Energy deposited via photoelectric  
effect close to the surface



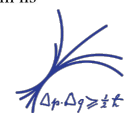
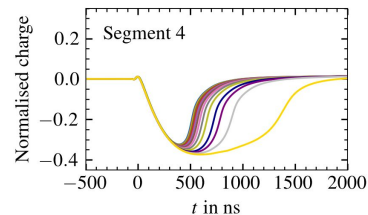
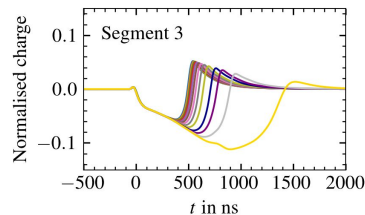
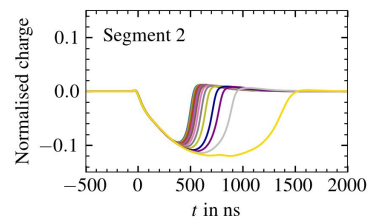
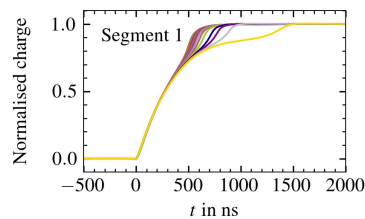
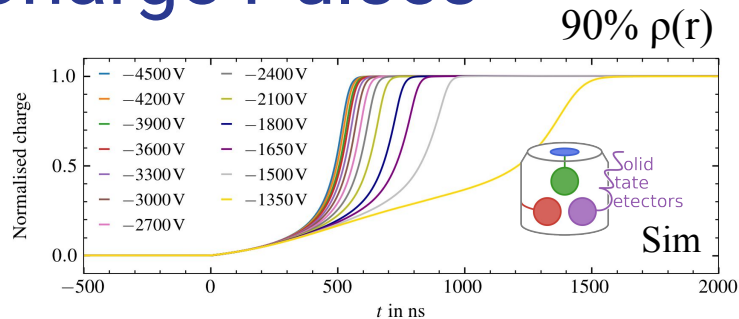
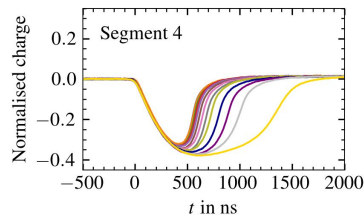
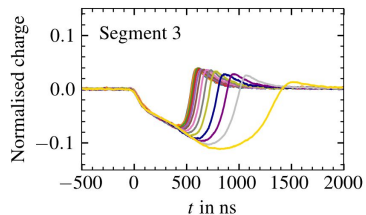
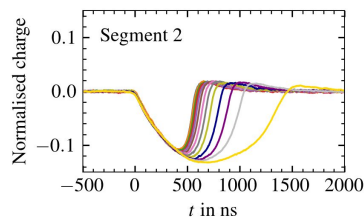
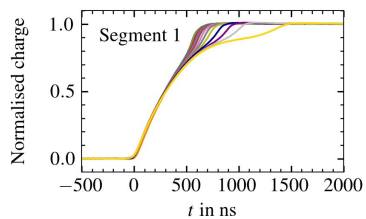
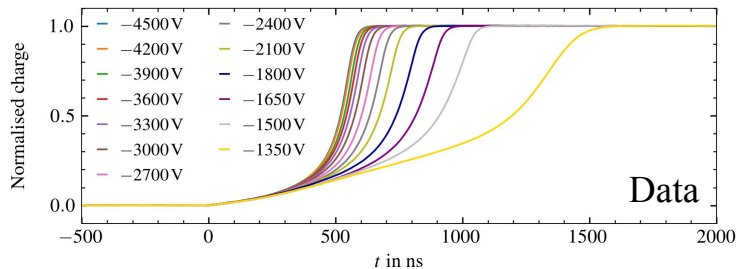
# Voltage Dependence of Charge Pulses



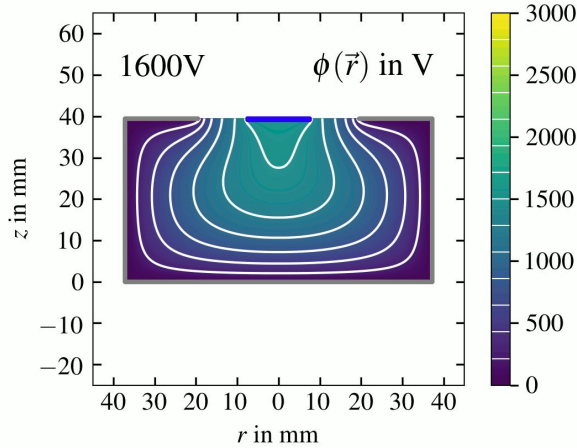
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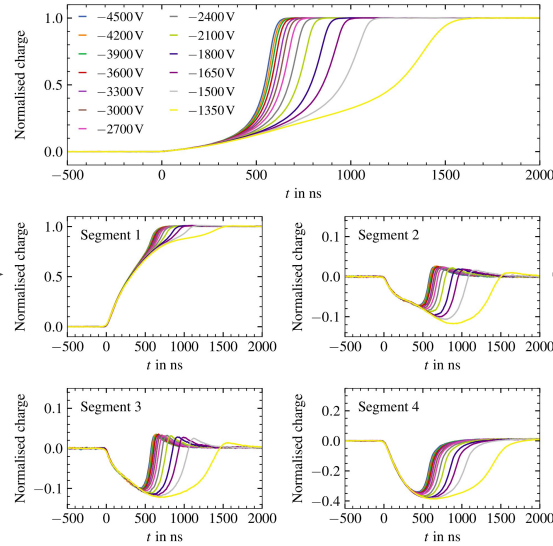
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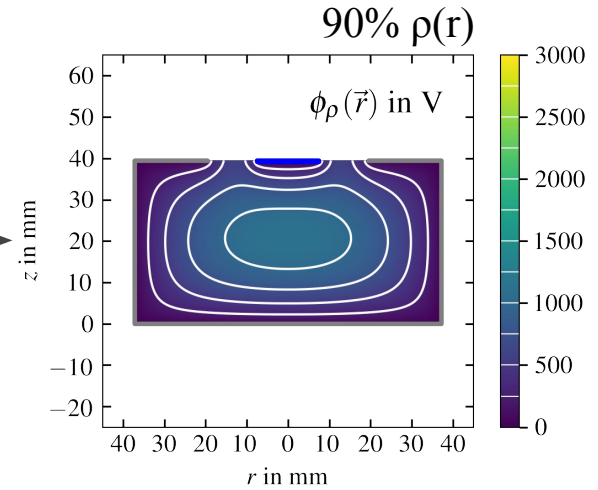
# Summary



General concept of voltage scans



Voltage scans data and simulation



Estimation of the impurity density