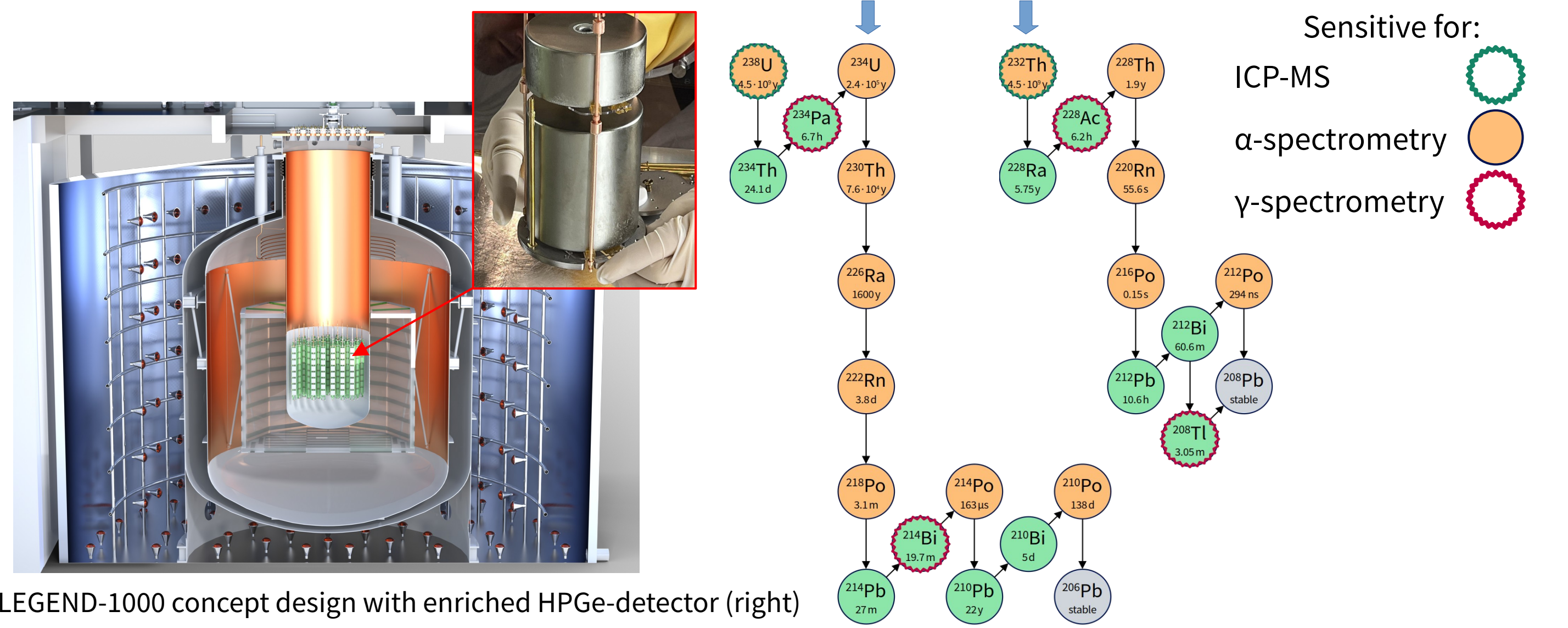


Motivation for alpha screening

- **LEGEND:** Large Enriched Germanium Experiment for Neutrinoless $\beta\beta$ -Decay
- Sensitivity goal: $T_{1/2}^{0\nu\beta\beta}({}^{76}\text{Ge}) = 10^{28} \text{ y} \rightarrow$ requires background of $10^{-5} \text{ cts}/(\text{keV kg y})$ at $Q_{\beta\beta}[1]$
- Material screening required to classify all components
- **Surface alpha screening:**
 - $\rightarrow$ Determine surface vs bulk contaminations
 - $\rightarrow$ Sensitive to multiple radioisotopes of the ${}^{238}\text{U}$ and ${}^{232}\text{Th}$ chains



The background of the alpha detector

Run duration: 30 days, 22 hours

Count rates (1-9 MeV):

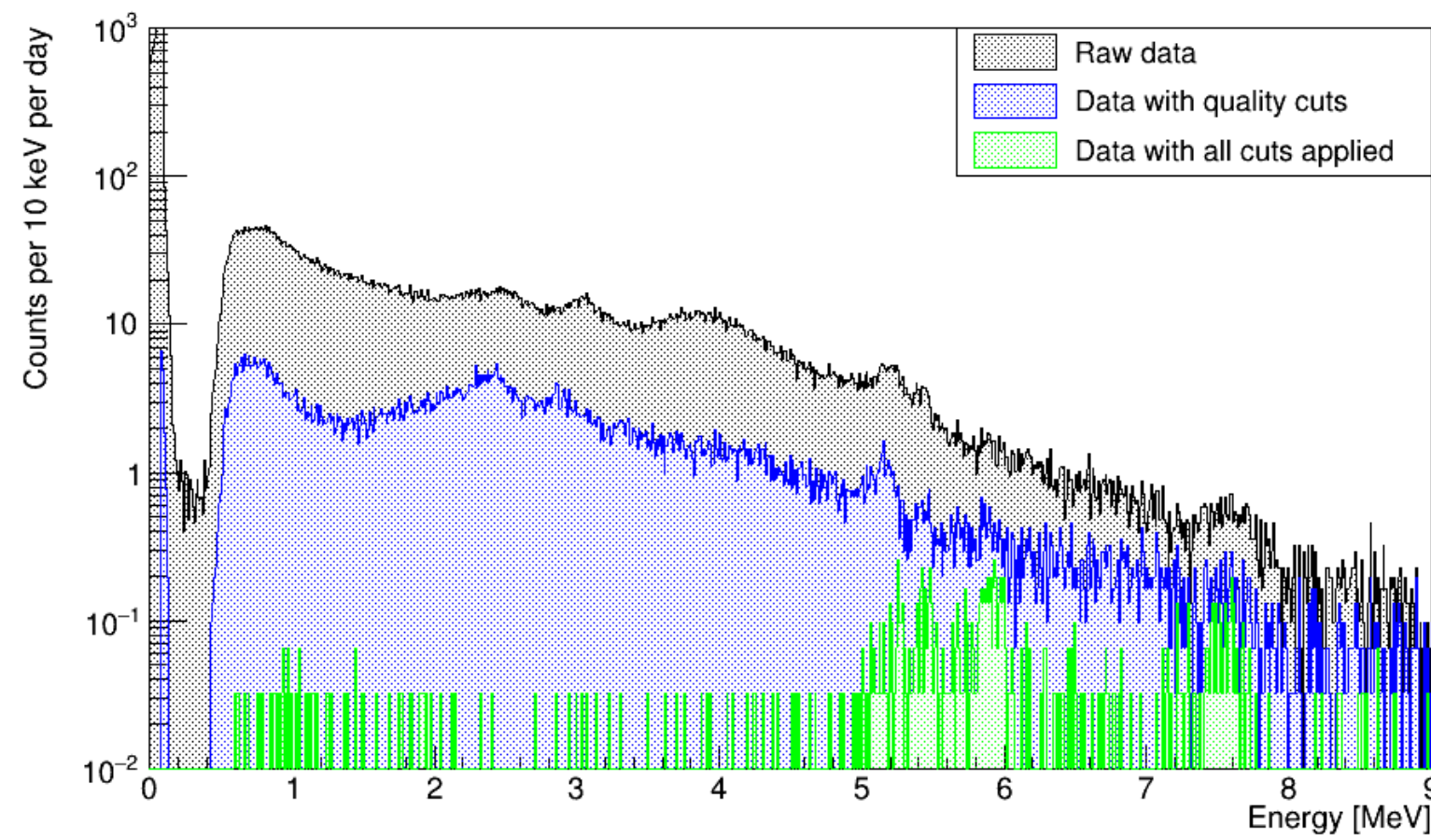
With quality cuts: $975 \pm 6 \text{ cts/d}$

Adding physical cuts: $15.5 \pm 0.7 \text{ cts/d}$

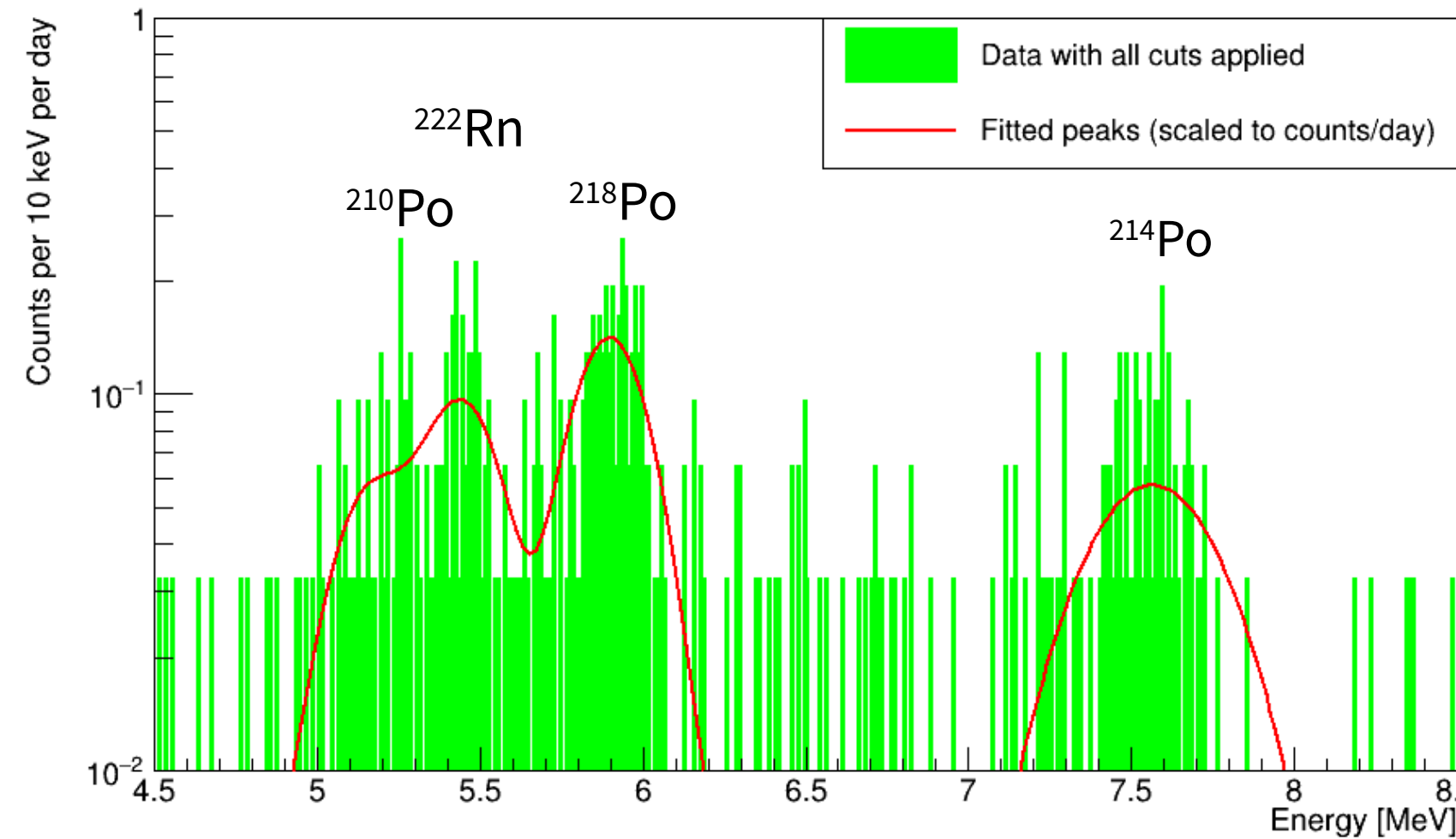
Previous measurement [2]:

$10.9 \pm 0.6 \text{ cts/d} \rightarrow 30\% \text{ lower bg}$

Next step: cleaning of components to remove potential contaminations



${}^{222}\text{Rn}$ induced background:



Nuclide	Rate [cts/d]
${}^{222}\text{Rn}$	2.8 ± 0.4
${}^{218}\text{Po}$	4.2 ± 0.5
${}^{214}\text{Po}$	3.1 ± 0.3
${}^{210}\text{Po}$	1.5 ± 0.4

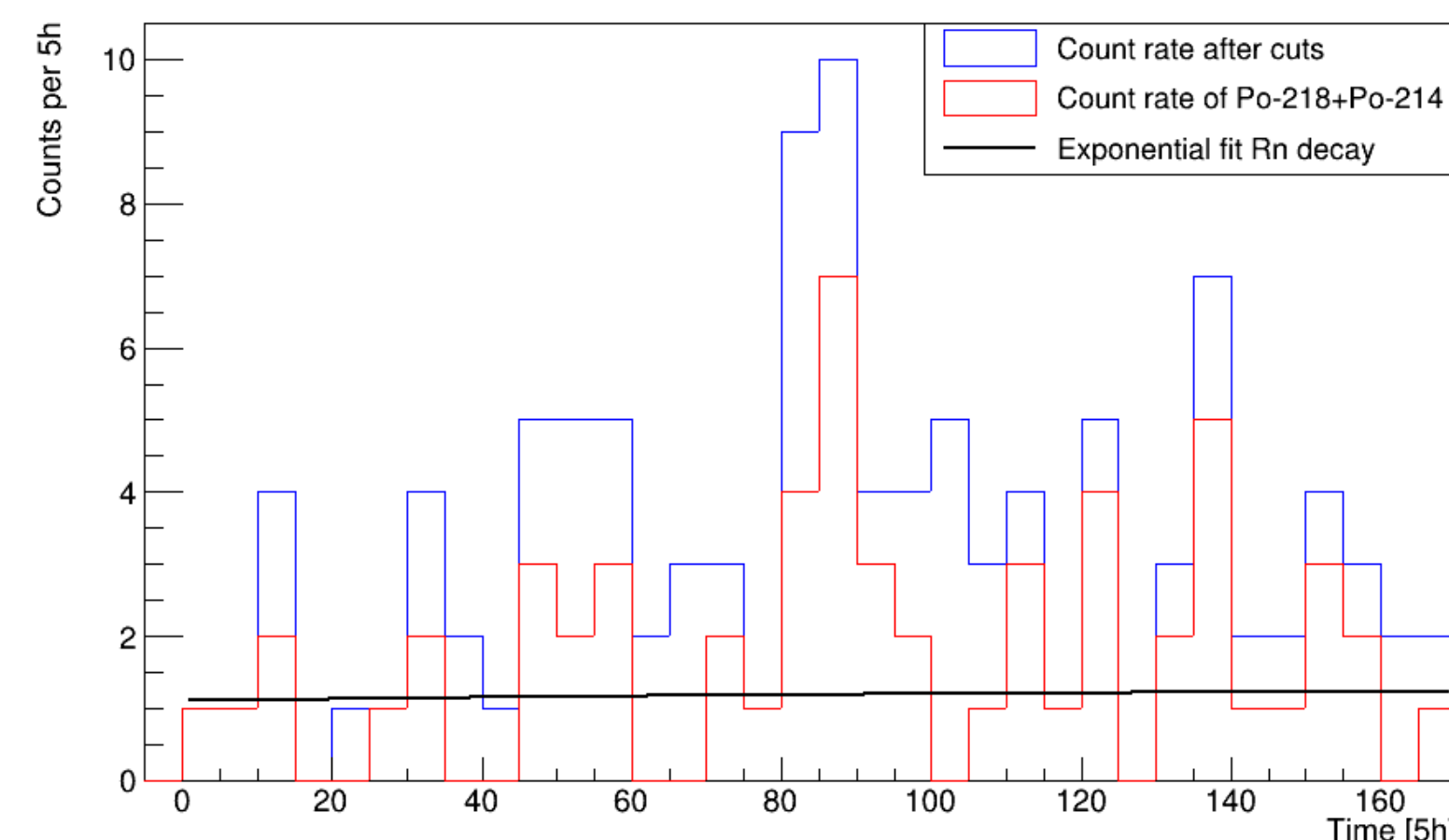
Remaining bg: $3.9 \pm 1.1 \text{ cts/d}$

Various origins: ${}^{220}\text{Rn}$ (6.3-8.8 MeV)

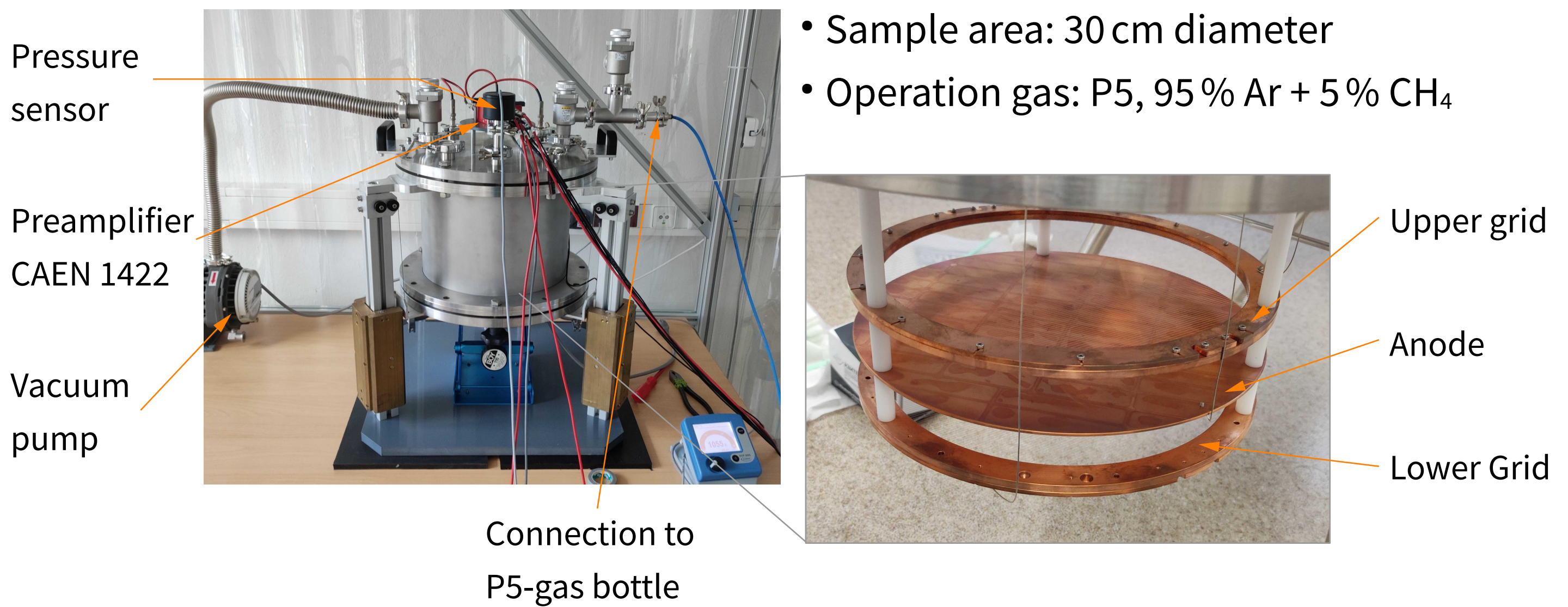
${}^{238}\text{U}$ chain or ${}^{232}\text{Th}$ chain in detector bulk material

Background over time:

- Where does the radon background come from?
- Fitting ${}^{222}\text{Rn}$ decay reveals no contribution from the gas filling
 - $\rightarrow$ Outgassing happens during the measurement
 - $\rightarrow$ ${}^{238}\text{U}$ traces in the detector components



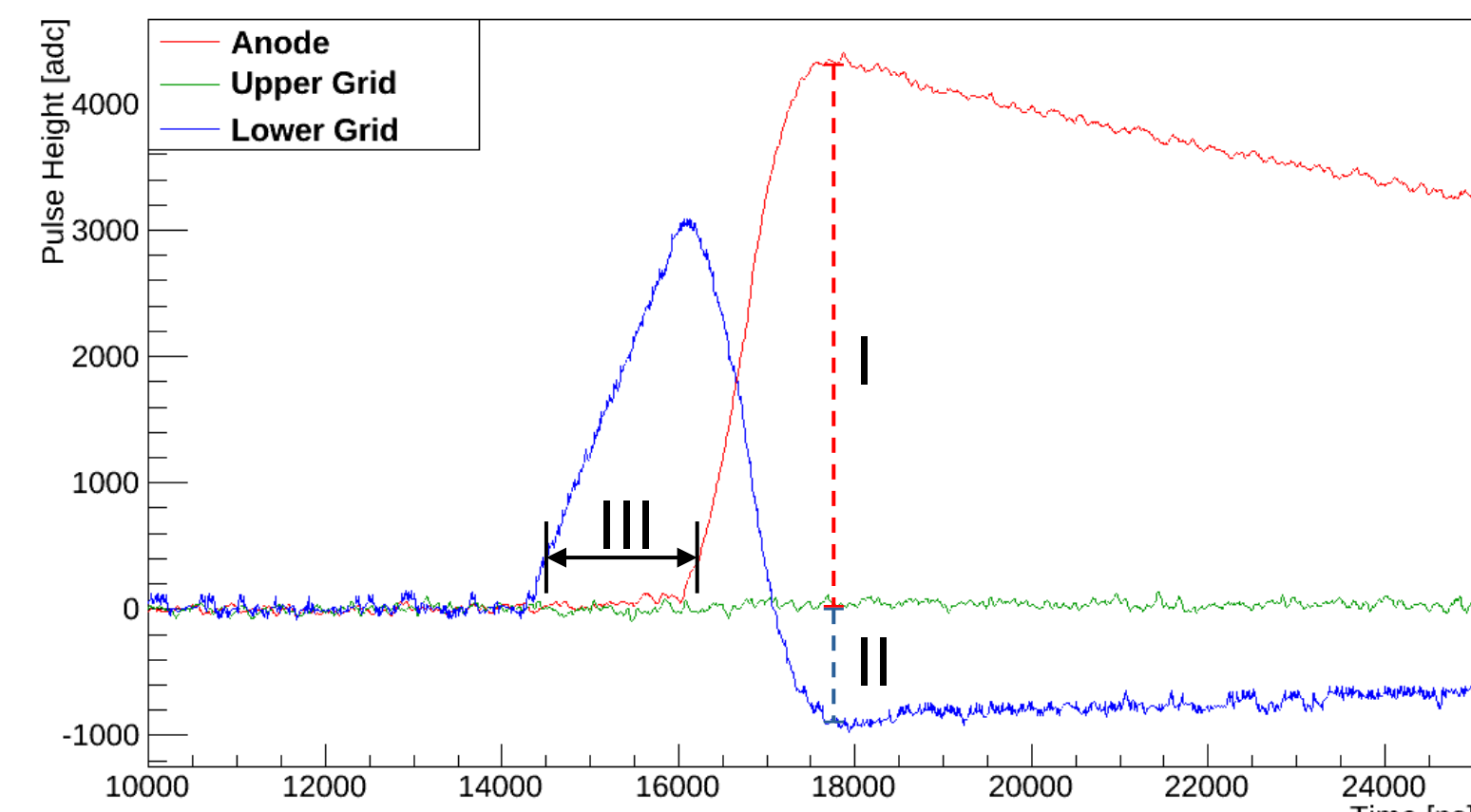
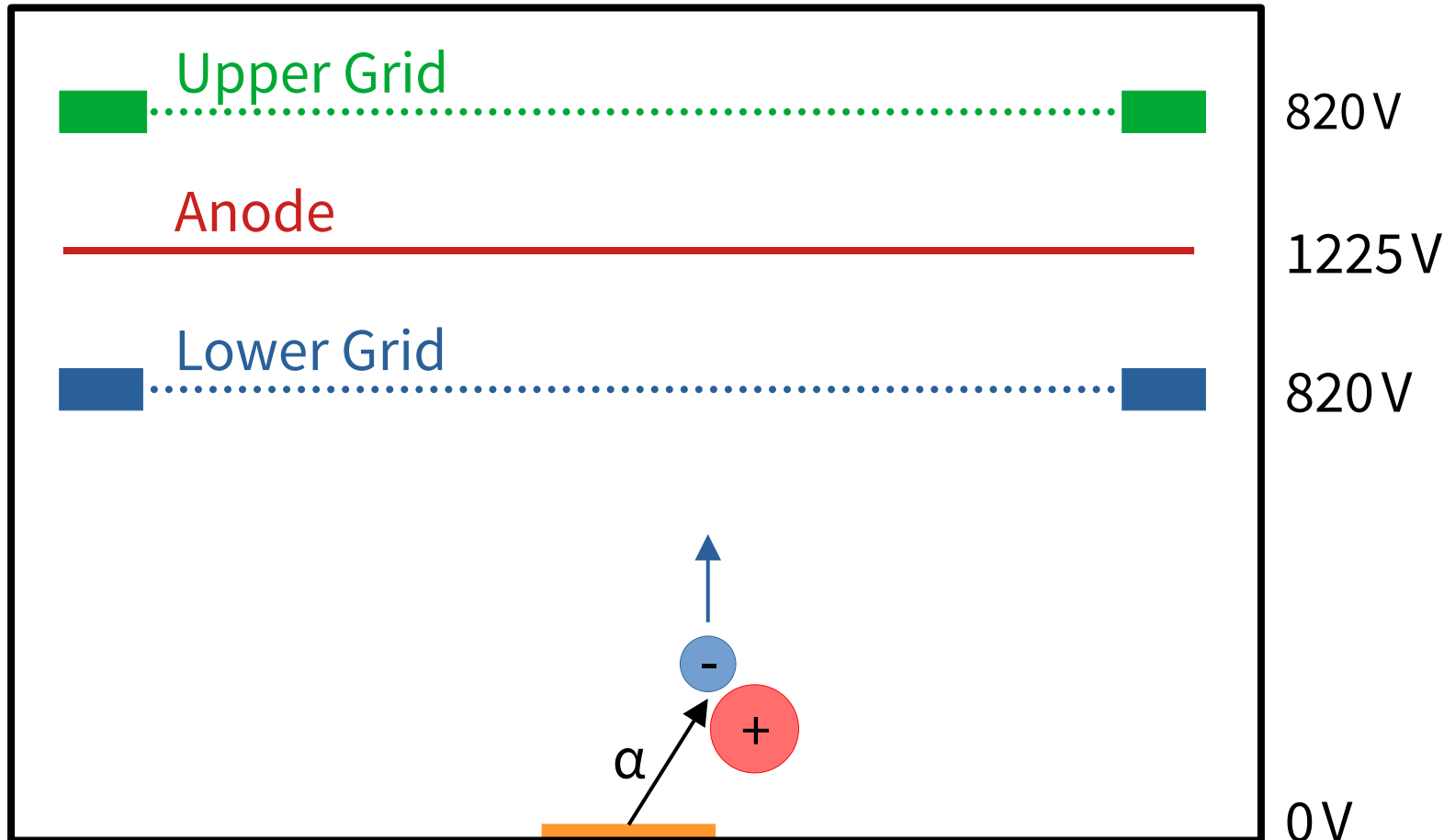
Setup: Frisch-grid ionization chamber



- Sample area: 30 cm diameter
- Operation gas: P5, 95 % Ar + 5 % CH_4

Working principle

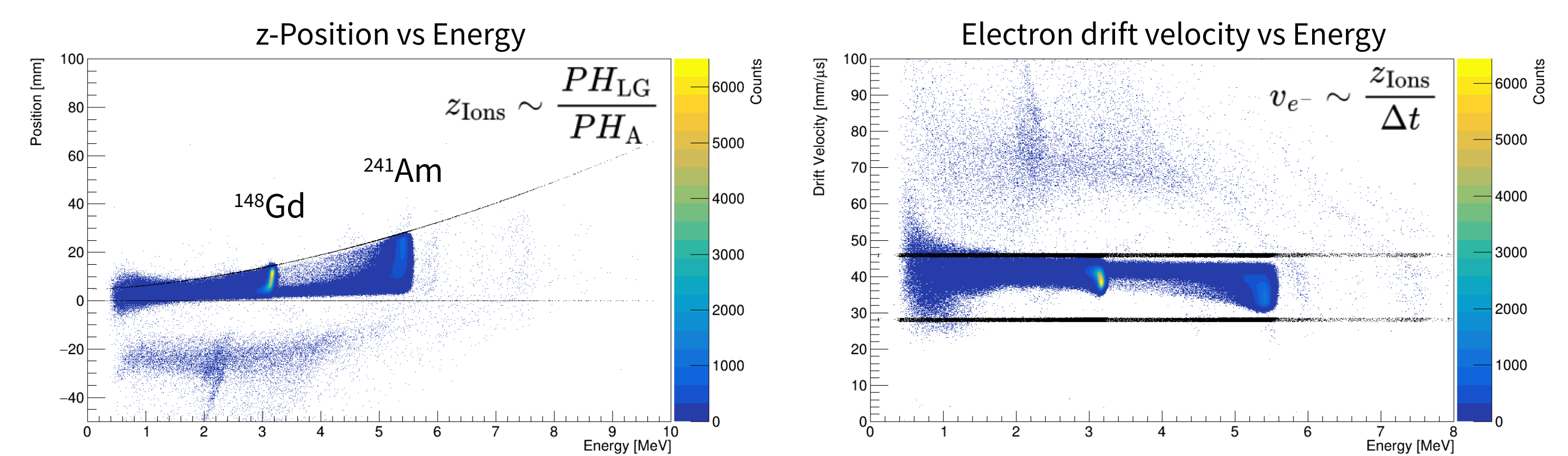
- α -particles decelerate in the P5-gas via ionization
- Electron and ion charge clouds are created
- Positive bias voltages:
 - $\rightarrow$ Electrons drift through the grid toward the anode
 - $\rightarrow$ Anode and grid signal used for evaluation



- Anode pulse height (PH_A) corresponds to the energy of the α -particle
- Lower grid shields anode from slow-drifting ions, grid pulse PH_{LG} depends on z-position of the ions
- Time difference Δt between both pulses depends on the electron drift velocity v_e

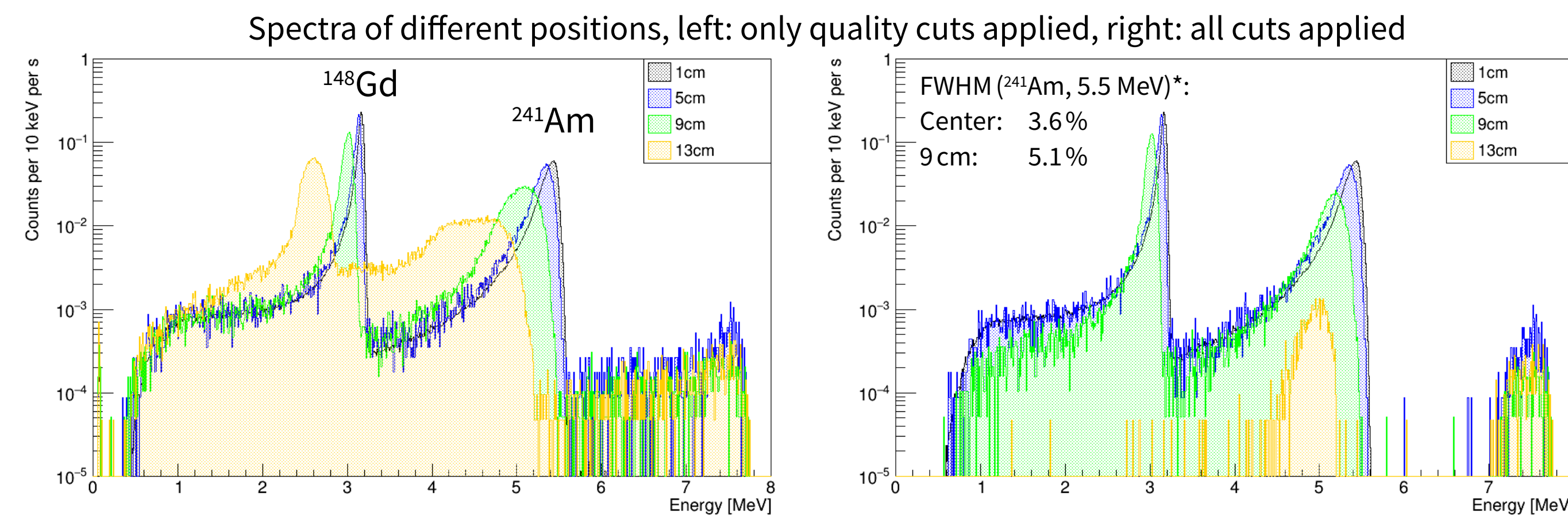
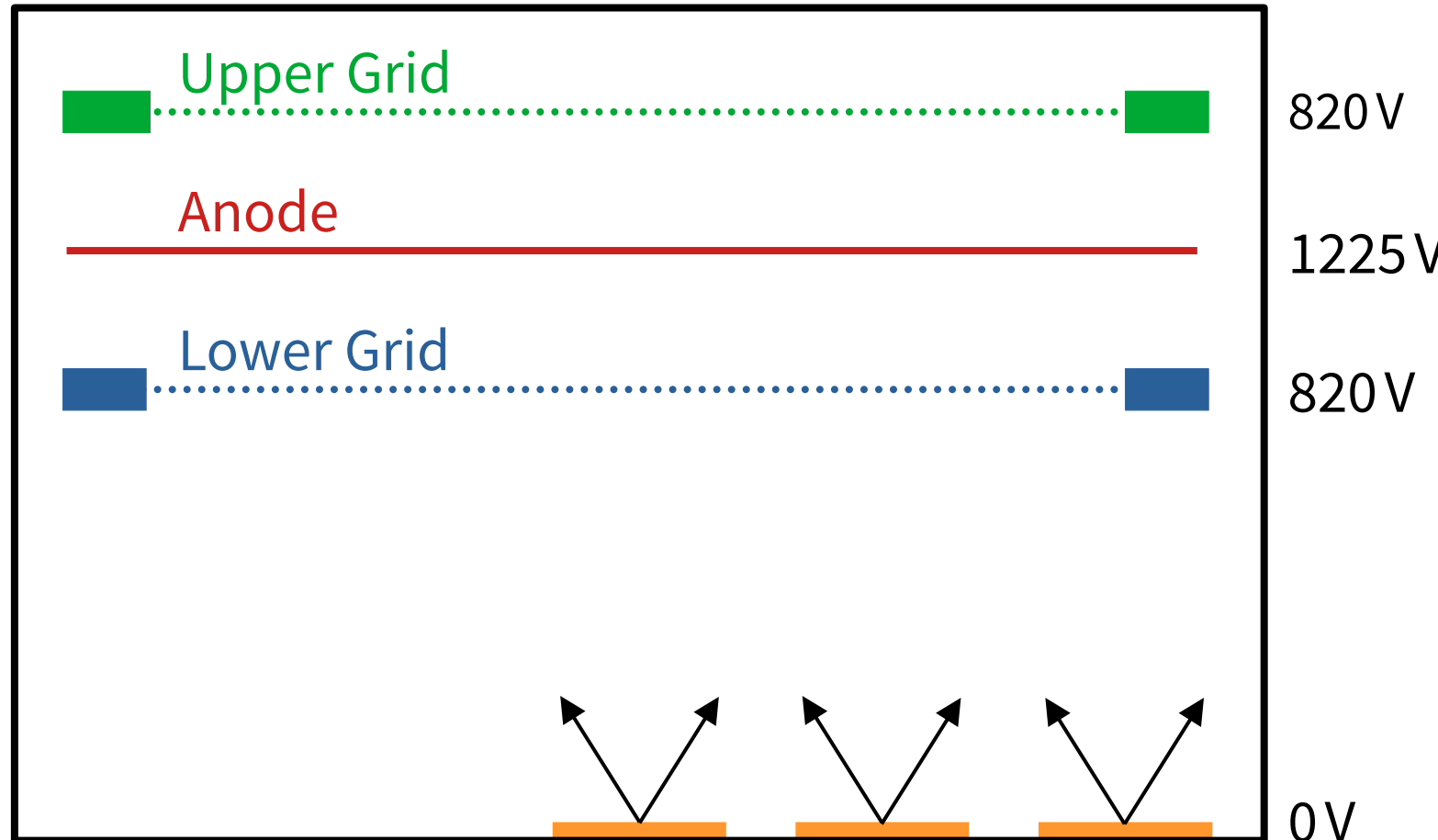
Energy calibration, quality and physical cuts determined with ${}^{148}\text{Gd}$ and ${}^{241}\text{Am}$

- Quality cuts: Only keep events in the detection region below the lower grid
- Physical cuts: Determine event position and electron drift velocity using I to III

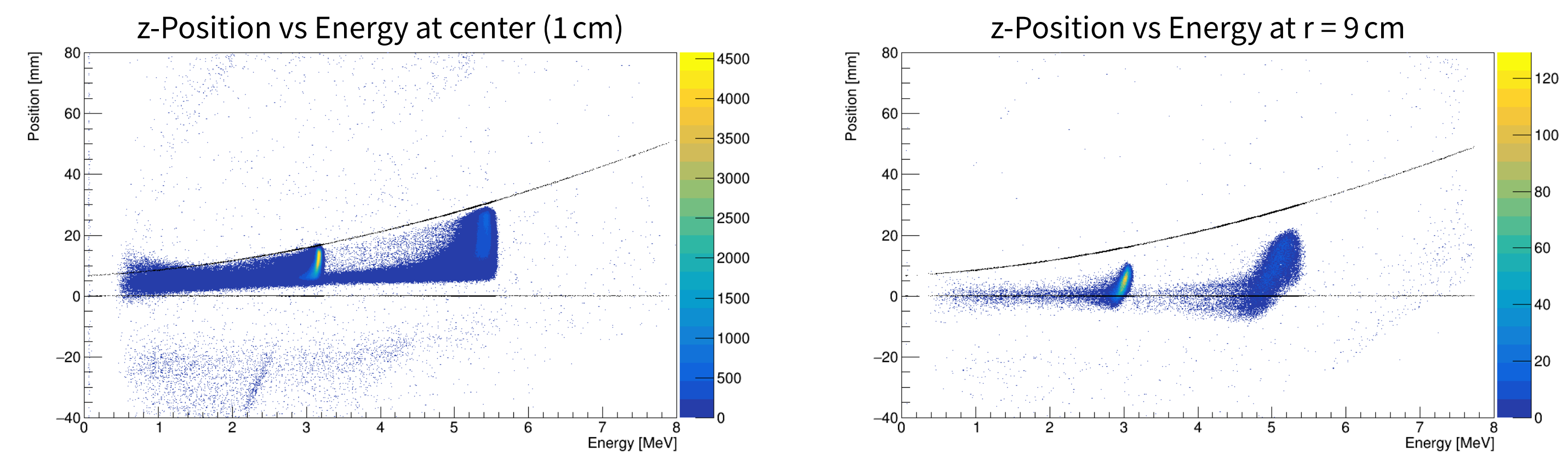


Testing the radial position of sources

- Detector was previously used for small samples [3]
- Investigating the detector response to extended samples necessary
- ${}^{148}\text{Gd}$ and ${}^{241}\text{Am}$ sources placed at different radii, from center ($r = 1 \text{ cm}$) to $r = 13 \text{ cm}$



- Mean energy decreases with increasing distance to center, energy resolution gets worse
- Physical cuts reduce the detection efficiency for sources placed at a high radius



- **Potential reason:** electrons are absorbed on the rings holding the lower grid
 - $\rightarrow$ grid pulse higher, anode pulse lower $\rightarrow$ lower energy and z-position reconstructed!
- **Possible solutions:**
 - New energy reconstruction and cut conditions, using more parameters of the pulses
 - Guard ring with ground/negative potential to drift the electrons through the grid
 - **Any suggestions or help is welcome :)**