SnT 2025
8 SEPTEMBER
ONLINE DAY
9 TO 12 SEPTEMBER
AT HOFBURG PALACE, VIENNA & ONLINE
CTBT: SCIENCE AND TECHNOLOGY CONFERENCE

P3.6-831

Comparison of Approaches for Memory Effect Correction and Background Measurement in a Radioxenon Detector

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INTRODUCTION AND MAIN RESULTS

In this study, alternative methods for gas background accounting in the calculation of radioactive xenon isotope activities were investigated. These methods provide a more accurate determination of the gas background spectra.

It was found that the gas background spectrum of a selected isotope can differ from the spectrum of a sample containing the same isotope, necessitating careful consideration during activity calculations. A series of calculations was performed based on measurements of radioactive spikes and other samples using MIKS. A comparison of different approaches was conducted.

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Introduction

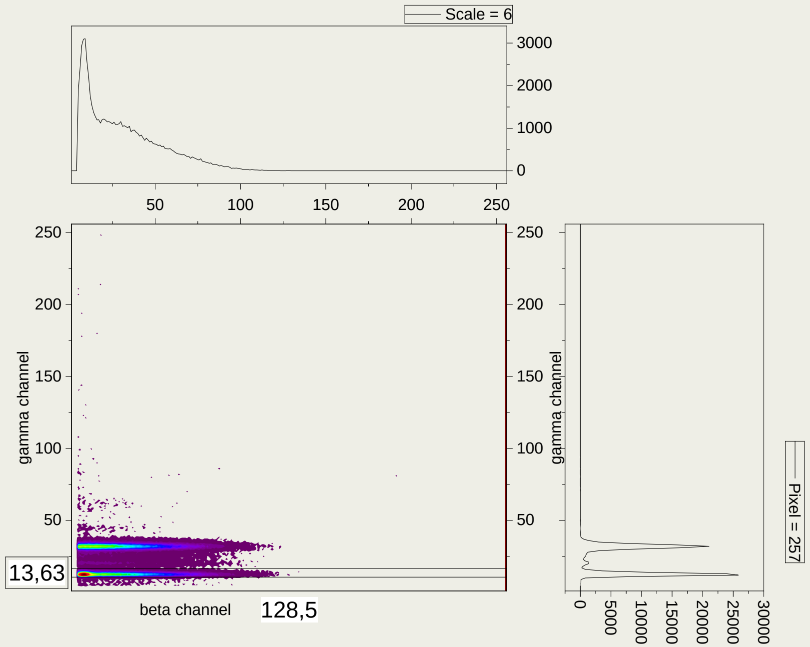
Modern radioxenon detection systems exhibit a low memory effect. For example, the MIKS plastic detector cell has a memory effect coefficient of less than 5%. However, even low levels of memory effect can affect measurement results. To account for this, the gas background is measured separately and incorporated into the calculation of sample activity.

Accurate accounting for the gas background is important to ensure precise activity measurements. The standard approach, the Net Count Calculation method, applies the same region-of-interest (ROI) ratios for both the sample and the gas background.

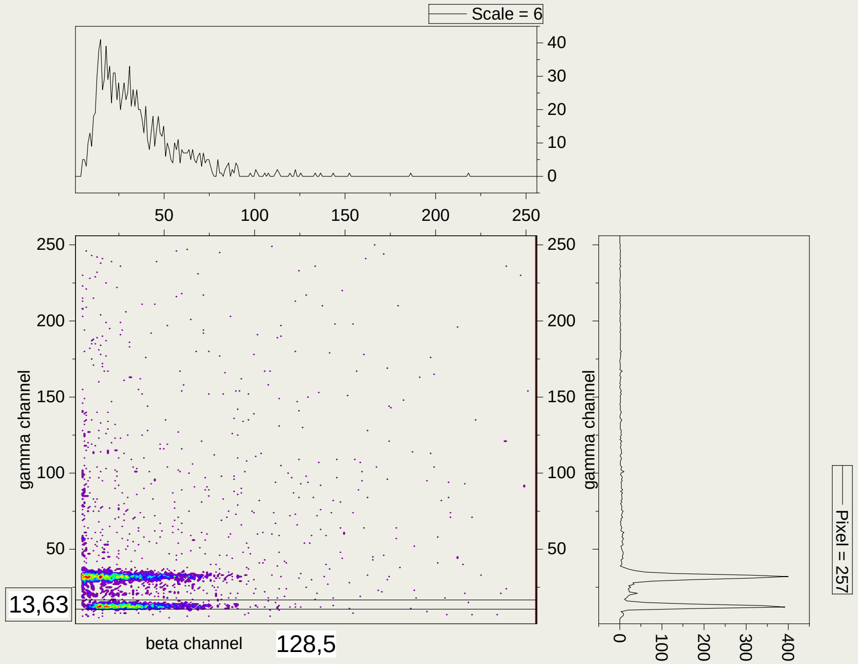
It was found that the gas background spectrum of a selected isotope can differ from the spectrum of a sample containing the same isotope, necessitating careful consideration during activity calculations.

Methods/Data

β-γ spectra from a sample



β-γ spectra from a gas background



The figures above show the sample spectra and the gas background spectra (measured using ^{133}Xe) acquired after the sample measurement.

A distinct difference in the shape of the coincidence spectra is evident. This is particularly noticeable in the ratio of counts between ROI3 and ROI4.

The observed difference in the spectral shapes from the sample and the gas background is attributed to the different measurement geometries.

The standard NCC method cannot account for this difference.

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Taking into account the gas background in the regression equation

DETBK spectrum

SAMPLE spectrum

GASBK spectrum

$$\overset{\vec{\mathbf{x}}}{\begin{bmatrix}\vec{\mathbf{c}}\\ \vec{\mathbf{d}}\end{bmatrix}} - \begin{bmatrix}k_s\vec{\mathbf{b}}\\ k_g\vec{\mathbf{b}}\end{bmatrix} \approx \overbrace{\begin{bmatrix}\mathbf{R}_s & \mathbf{R}_{g1}\mathbf{F}\\ 0 & \mathbf{R}_{g2}\end{bmatrix}}^{\mathbf{R}_F} \overset{\vec{\theta}}{\begin{bmatrix}\vec{\beta}\\ \vec{\gamma}\end{bmatrix}}$$

Net signal: exceeding the total background

Amount of memory activity in GASBK

Matrix of corrections for accounting for the gas background in the sample measurement

$$\vec{\mathrm{x}} - \vec{\mathrm{b}}_k \approx \mathbf{R}_F\vec{\theta}$$

Results

We believe that in order to correctly take into account the detector's gas background, it is necessary to perform additional calibration for the gas background. The difference in spectra can be significant.

To account for the gas background, it is necessary to introduce extended spectrum vectors, which consist of the sample spectrum and the gas background. The regression matrix is also transformed. Thus, the problem of taking into account the gas background is also reduced to a linear regression.

Usually the sensitivity matrices of the gas background and samples are equal; however, in general it is possible to take into account the difference. Only the method of simultaneous fitting can give a correct result. We must fit the spectrum of the sample and the gas background simultaneously with different calibration matrices $\mathbf{R}_s \neq \mathbf{R}_g$

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