Optimization of Statistical Methods for HpGe Gamma-ray Spectrometer used in Wide Count Rate Ranges

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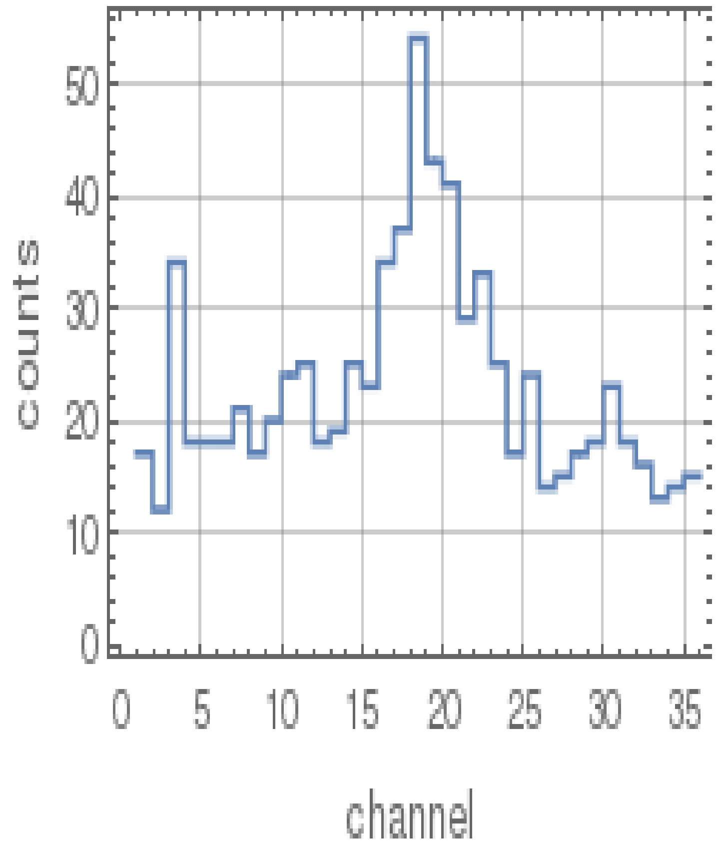
Gamma-ray spectroscopy measurements with HpGe detectors is a common technique in nuclear physics. Our challenge is to obtain the “best'' spectroscopy data possible in every measurement situation. We present the efforts that have been done to optimize the statistical methods applied to HpGe detector outputs.. Advances in computing technology have allowed for the consideration of Bayesian methods as ways to incorporate the model uncertainty into the data analysis and the uncertainty budget. In this framework, we applied Bayesian methods and the Ellipsoidal Nested Sampling to HpGe detectors counting output, in order to explain the experimental data and compare the evidence corresponding to each model.

In order to explain the experimental data shown in Fig., we will consider two different models: “Lorentzian+ offset" and “Gaussian + offset". According to these models the mean values n of the counts are



$$n(ch) = \frac{A}{\pi} \times \frac{\Gamma}{(ch - ch_0) + \Gamma^2} + \alpha + \beta \times ch$$

$$n(ch) = \frac{A}{\sqrt{2\pi\sigma}} \times e^{\frac{(ch-ch_0)^2}{2\sigma^2}} + \alpha + \beta \times ch$$

In our example there are 36 channels, the likelihood is given by the product of 36 Poisson distributions parameterized by A, Γ, α, β, σ and ch_0.

The appeal of the Bayesian approach of the uncertainty in measurements is the quantication of both the sampling and model contributions to the post-data uncertainty.