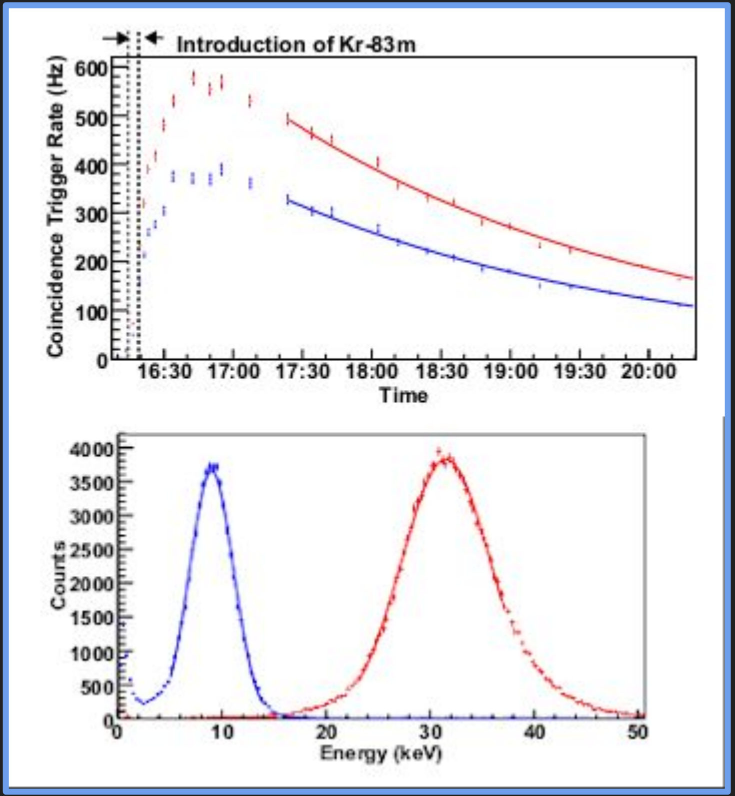
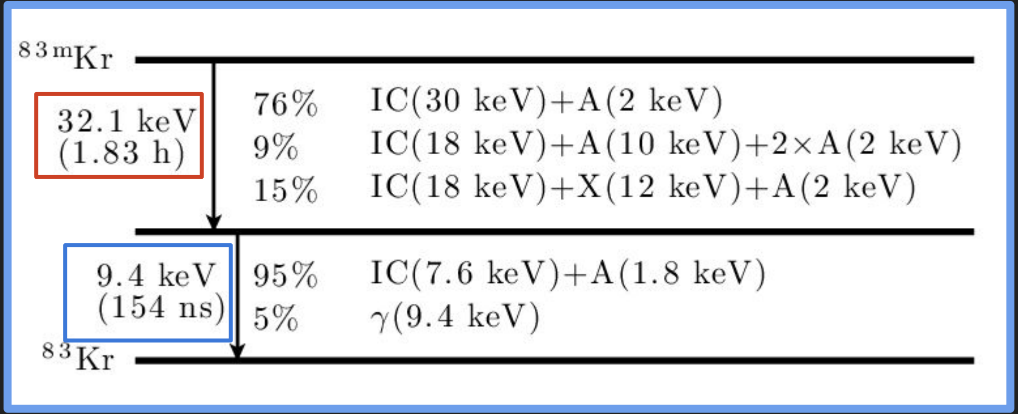
Calibration Sources for CYGNO

Flavio Di Clemente
Giulia D'Imperio
Gianluca Cavoto

23 / 3 / 20

83m Krypton

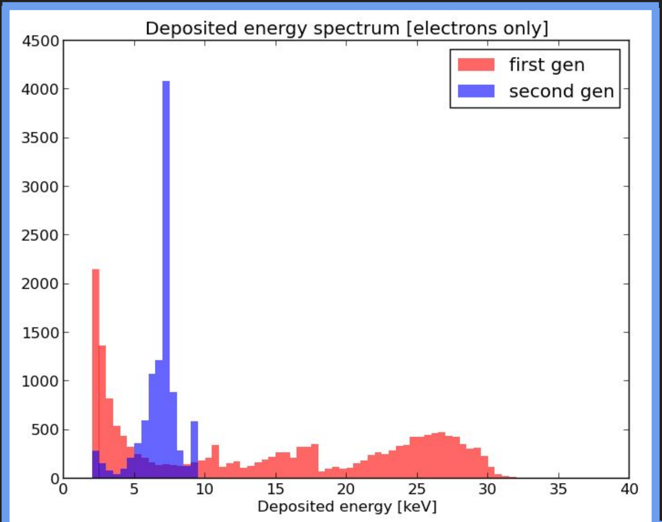


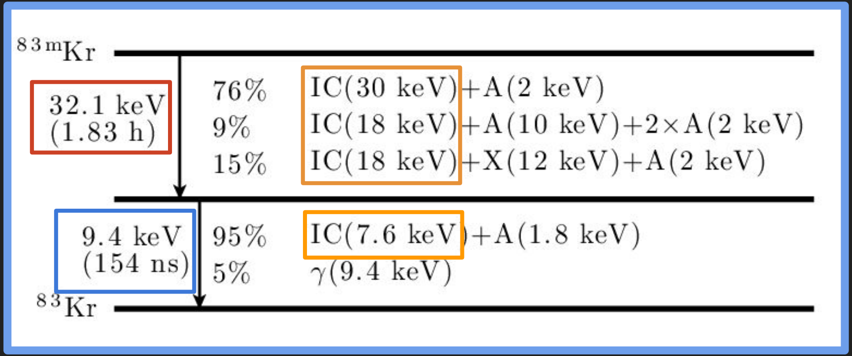


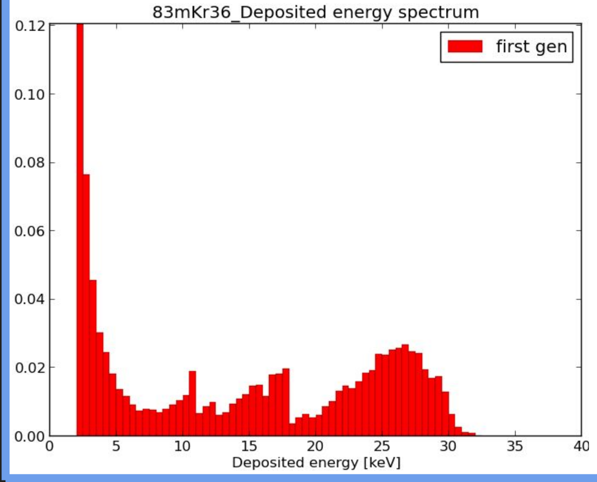
https://arxiv.org/abs/0905.1766v2

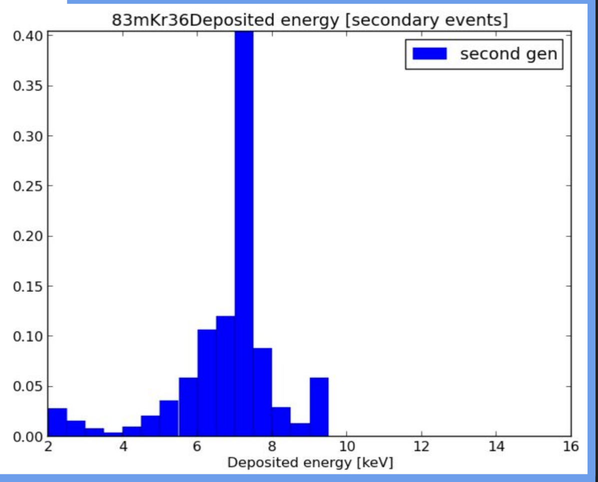
Calibration of a Liquid Xenon Detector with ^{83}Kr^{m}

L. W. Kastens, S. B. Cahn, A. Manzur, and D. N. McKinsey
Department of Physics, Yale University, P.O. Box 208120, New Haven, CT 06520



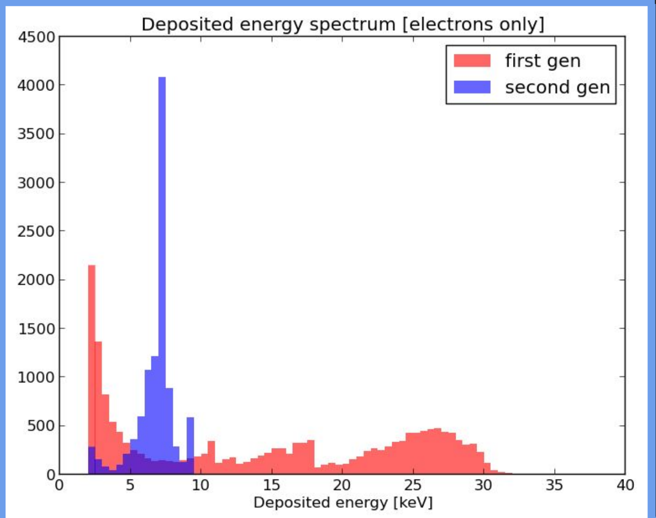


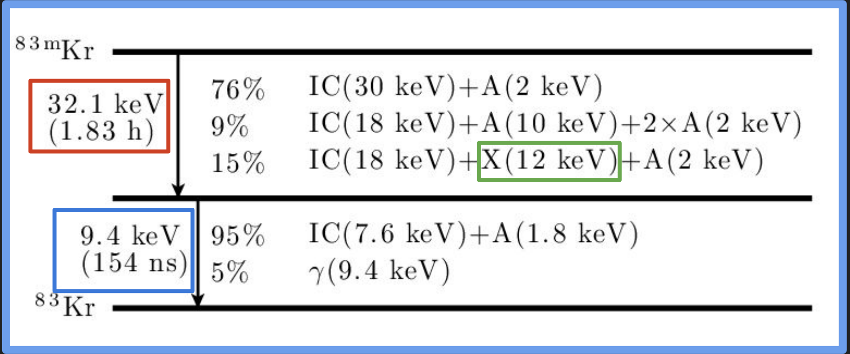


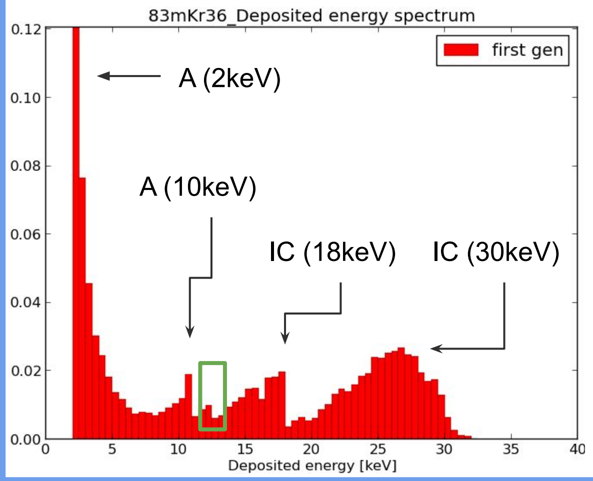


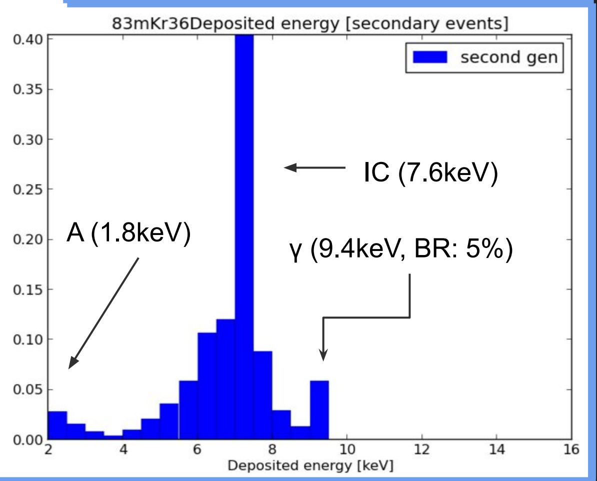
Internal conversion (IC) in the inner shells leaves a hole behind. This produce a chain of electrons filling lower levels consequently.

This chain reaction produces a number of **X-rays (X)** and **Auger Electrons (A)**.



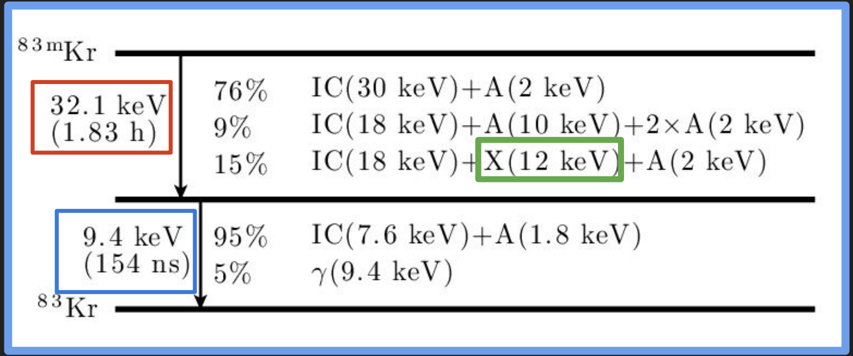


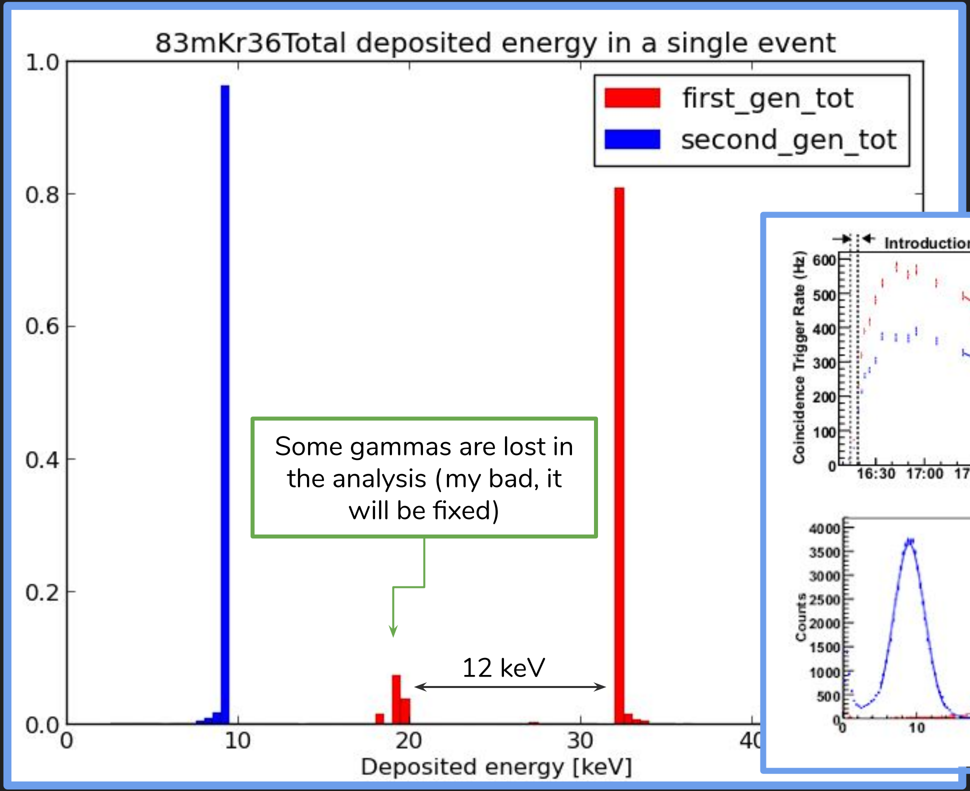


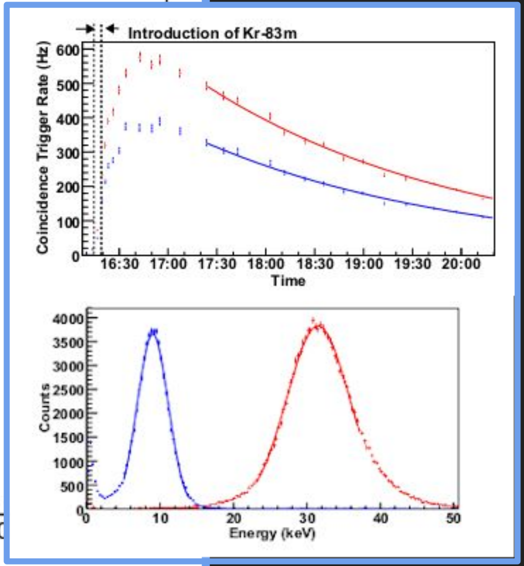


The two phases of the de-excitation can be seen as two independent processes, resulting in two different source of calibration at once.

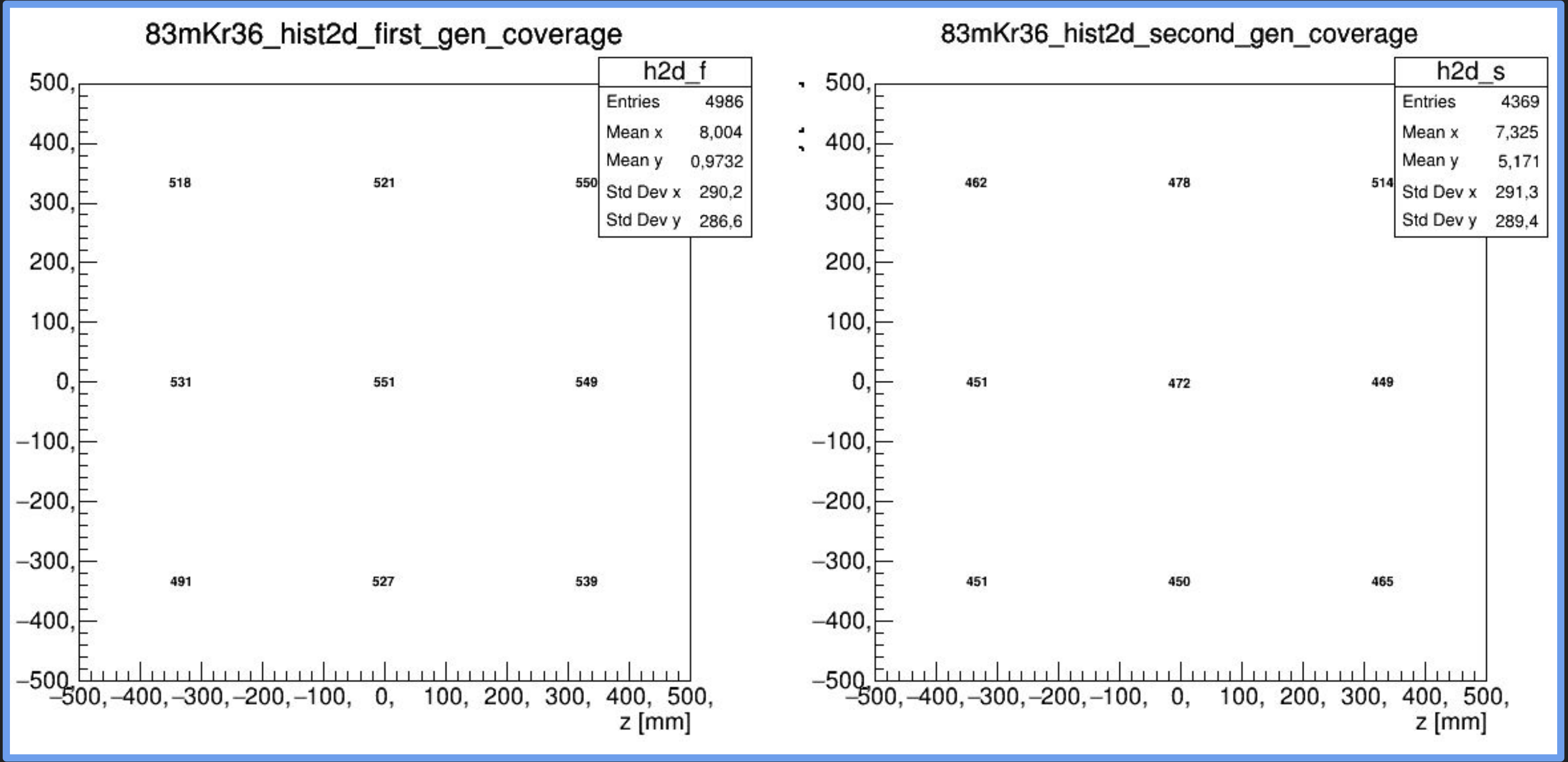
The histogram is filled with the sum of the energies of all the particles resulting from the de-excitation of a single event (dividing the two steps)







Since this is a MC-truth-level simulation, we don't see gaussians as presented in the article listed before (no digitization added, no smearing effect)



We are working on 10^4 events. Events which are fully contained in a single camera represent ~40-50% of the sample. The source is in a gaseous form, thus it can evenly cover all the cameras. Each camera contains ~5% of the entire sample.

Specific Activity of the 83mKr

$$A_{83mKr} = \frac{\ln(2)\, N_A}{T_{1/2}\, m_w}$$

$T_{1/2} = 1.83h = 6588s$

$m_w = 83.8\ g\ mol^{-1}$

→ $A_{83mKr} = 7.6 \times 10^{20}$ Bq/kg

But 83mKr comes from 83Rb, which has $T_{1/2} = 86$ days! → $A_{83Rb} = 6.7 \times 10^{17}$ Bq/kg

83Rb, again, is not a natural nuclide...

Conclusions

83mKr would be a great calibration source for CYGNO, but it needs to be produce in some way.

A gaseous source will perfectly satisfy the need for a uniform coverage.

The 83mKr half-life is short enough to make the source easily removed from the sensitive region, but long enough to make a calibration run possible.

Also the energy spectrum has a well-resolved double peak at low energy.