^{40}K Concentration

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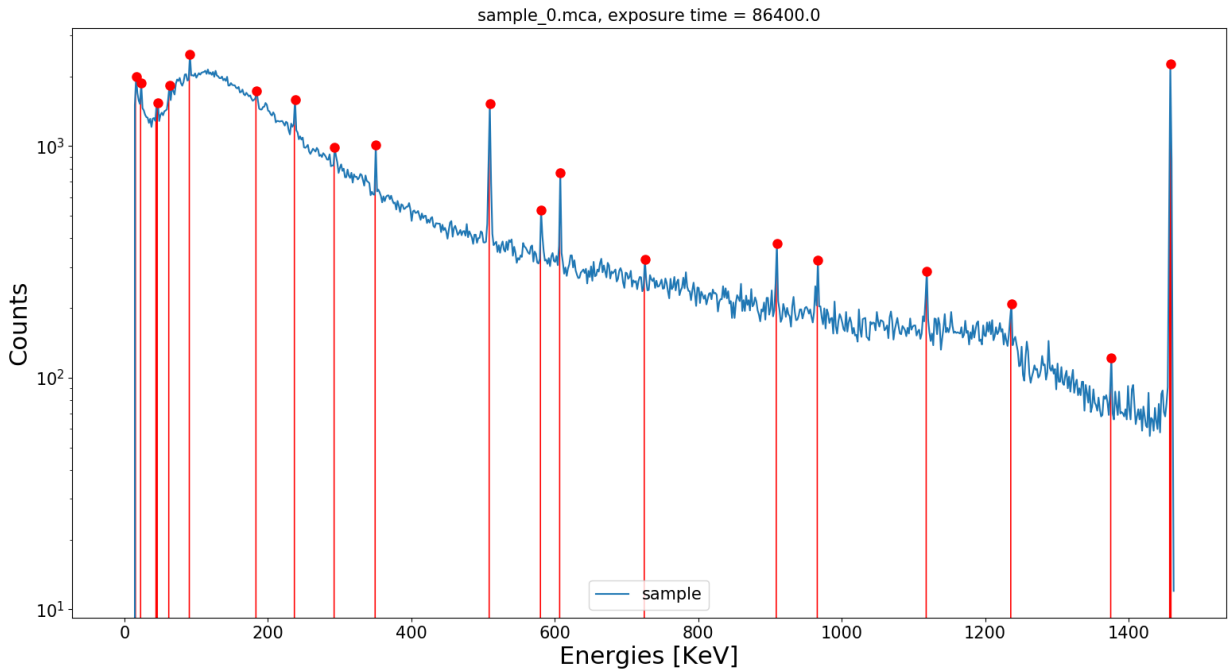
Procedure

A set of solutions of potassium salt were prepared in polypropylene clinical containers. Different concentration levels have been diluted in injectable water solution. The container has a 50 ml. capacity. The maximum concentration was set as 10 g.

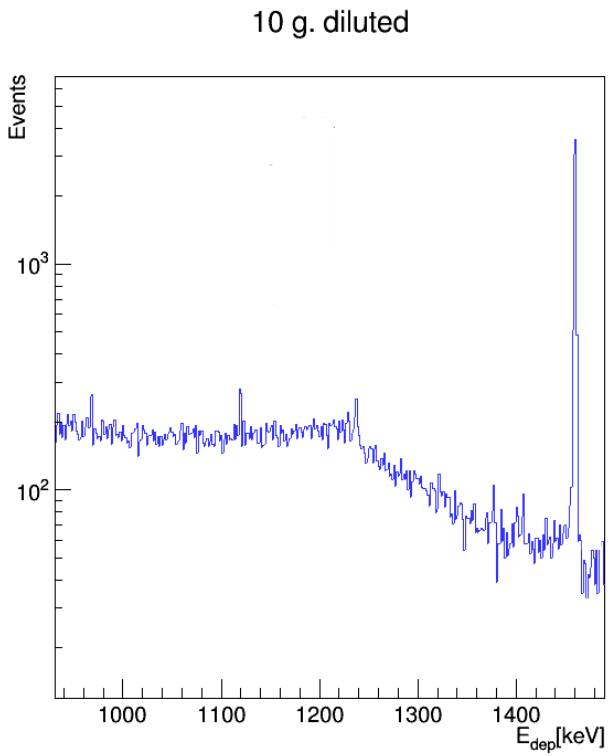
Background

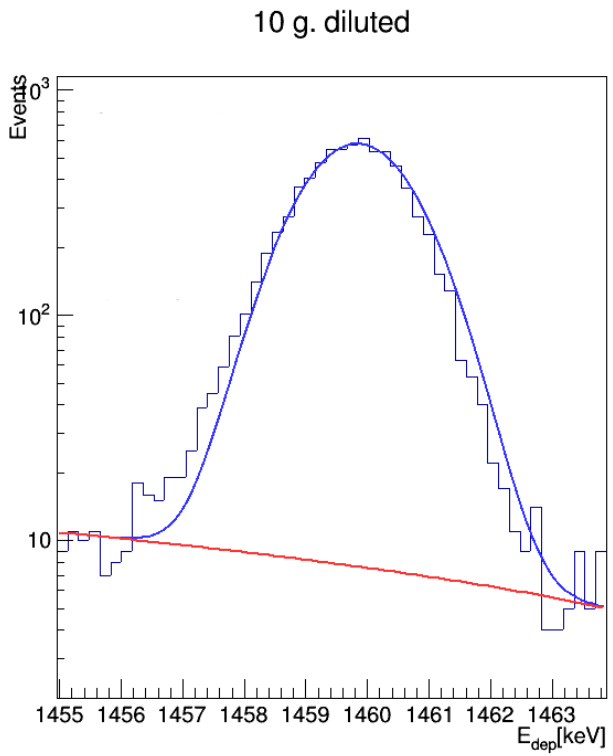
The solution itself already contains a ^{40}K percentage. This has been revealed with the function of autoPeak of the current version of histoGe. Therefore, background subtraction is mandatory.



Peak count

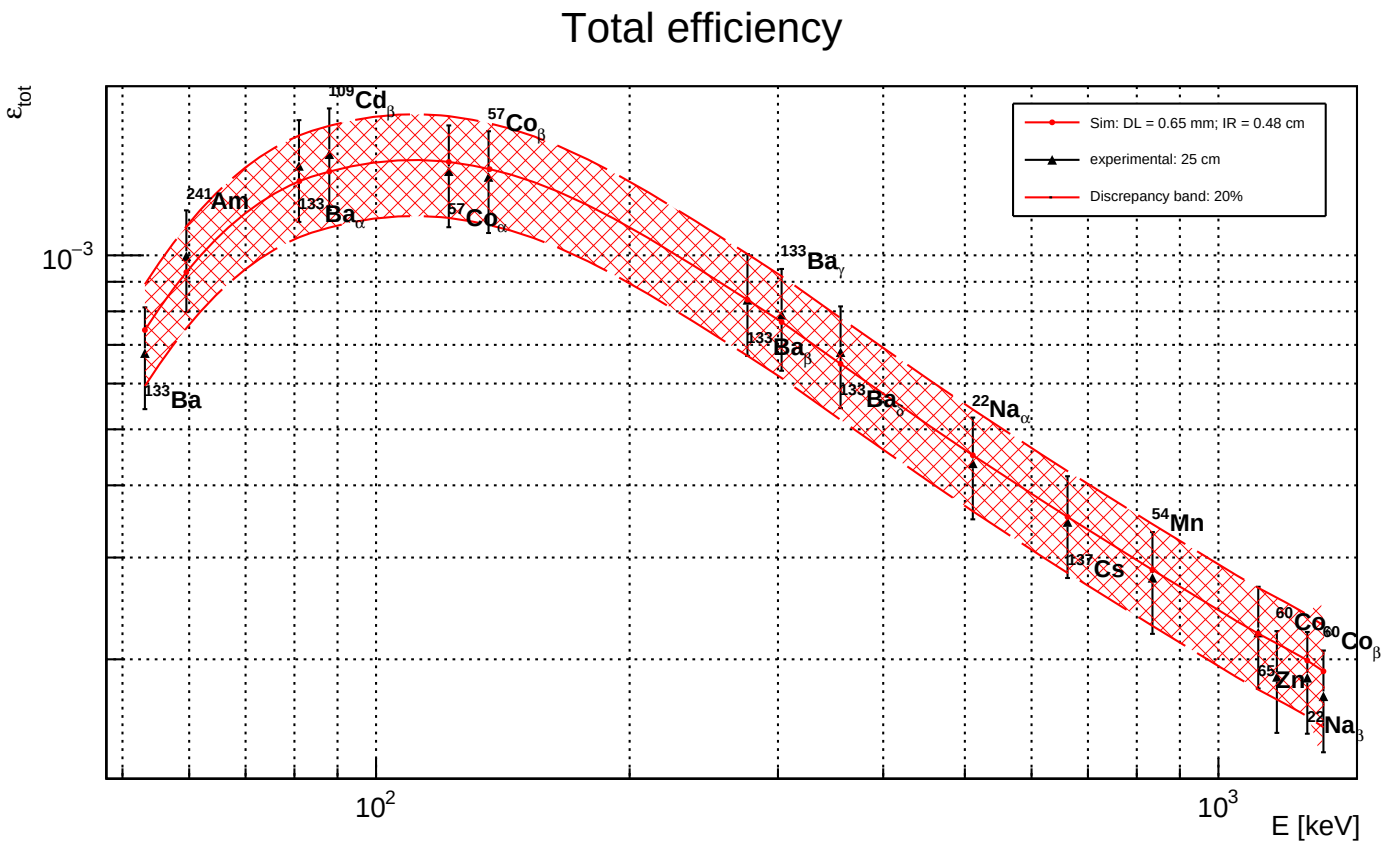
The number of characteristic gamma rays of 1460 keV in full energy photopeak emitted by the sample container is determined as usual, a Gaussian distribution is fitted to the photopeak and baseline is modelled as a straight line.





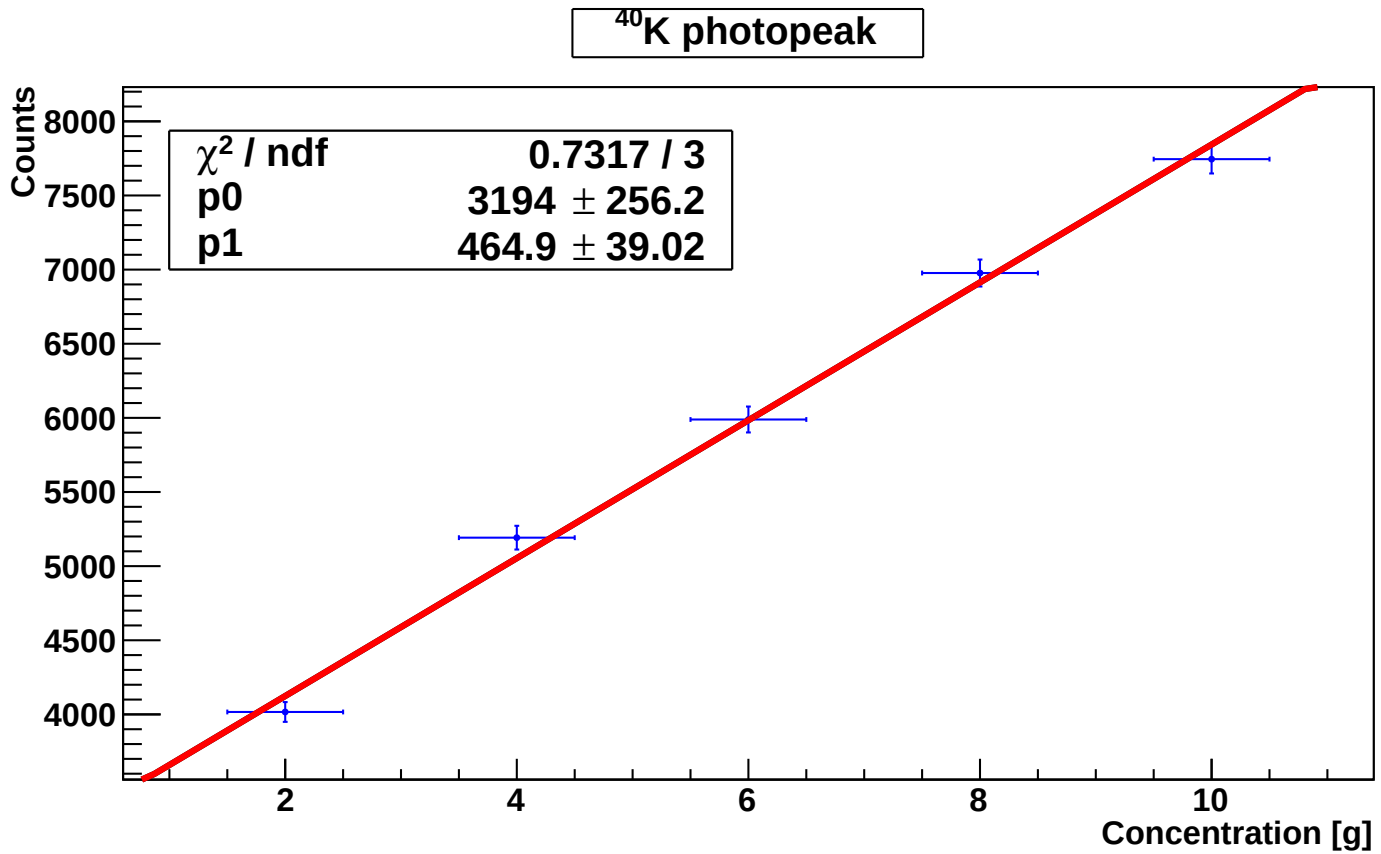
Point source efficiency

The model of HPGe detector geometry, specifically the dead layer width and the inner contact radius.



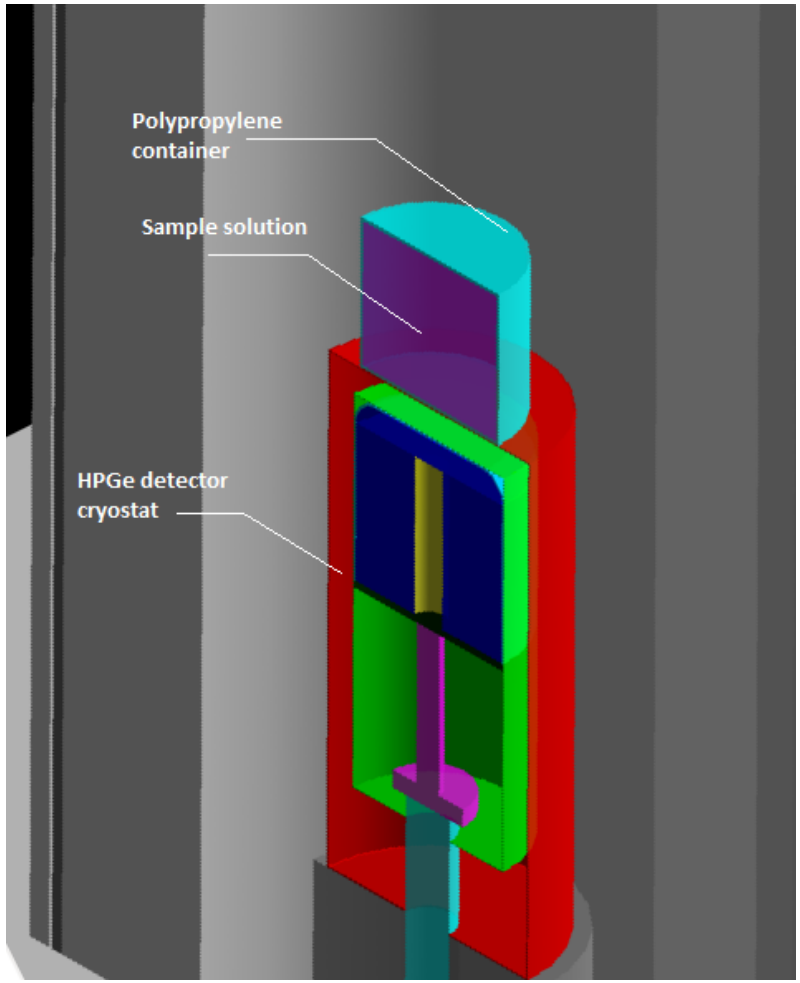
Peak count

The number of counts in ^{40}K photopeak per salt concentration gram follow a linear tendency. Such slope will be modified by efficiency effect once the ^{40}K concentration is calculated.



Simulation

On the other hand the sample container geometry was implemented in the current version of the HPGe simulation. This is performed by considering both its dimensions and the polypropylene material.



Simulation

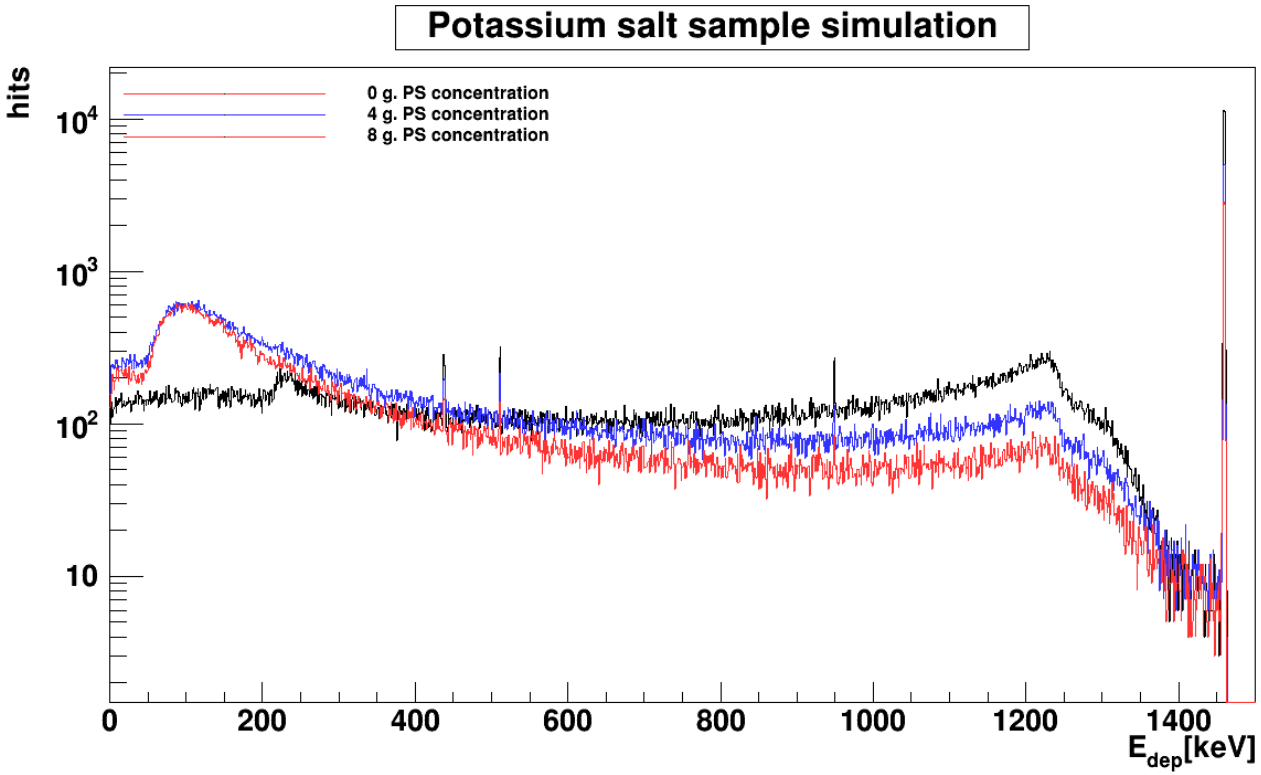
The sample container (SC) is filled with injectable water solution (H_2O with a small concentration of KCl). Also, both the concentration of Potassium salt and its chemical composition must be taken into account when declaring G4Material.

Item	Percentage
KCl	59 %
Iodized Salt	40 %
$NaAlO_2$	1 %

The density of the final solution is established by a weighted average per concentration.

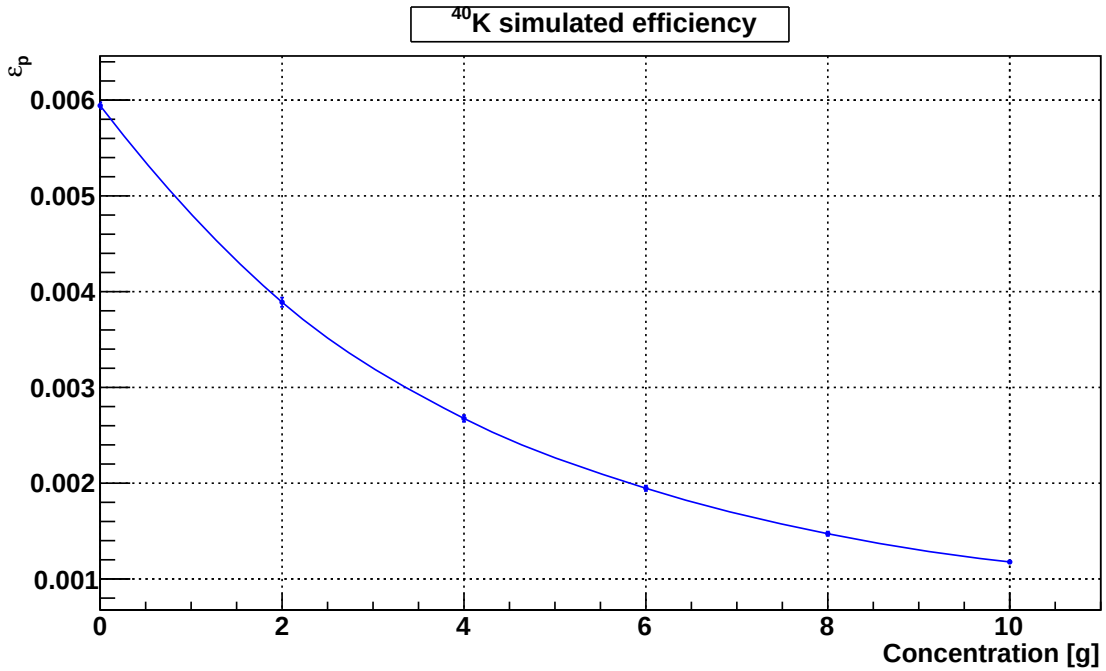
Simulation

Naturally, each point within the volume is set as a radiation emitter. Then, a mono-energetic gamma-ray is sent isotropically. Unlike point sources case, the photon is now able to interact with media and the container itself.



Efficiency

The Potassium salt presence modifies the efficiency value since K nuclei are able to capture the 1460 keV gamma-ray. The higher concentration the less probability of the photon to leave the sample container.



Activity

Once the photopeak efficiency at 1460 keV is obtained, it is possible to compute the total number of emitted photons by the sample in such energy line:

$$\varepsilon_p = \frac{N_p}{N_t} \quad \Rightarrow \quad N_t = \frac{N_p}{\varepsilon_p},$$

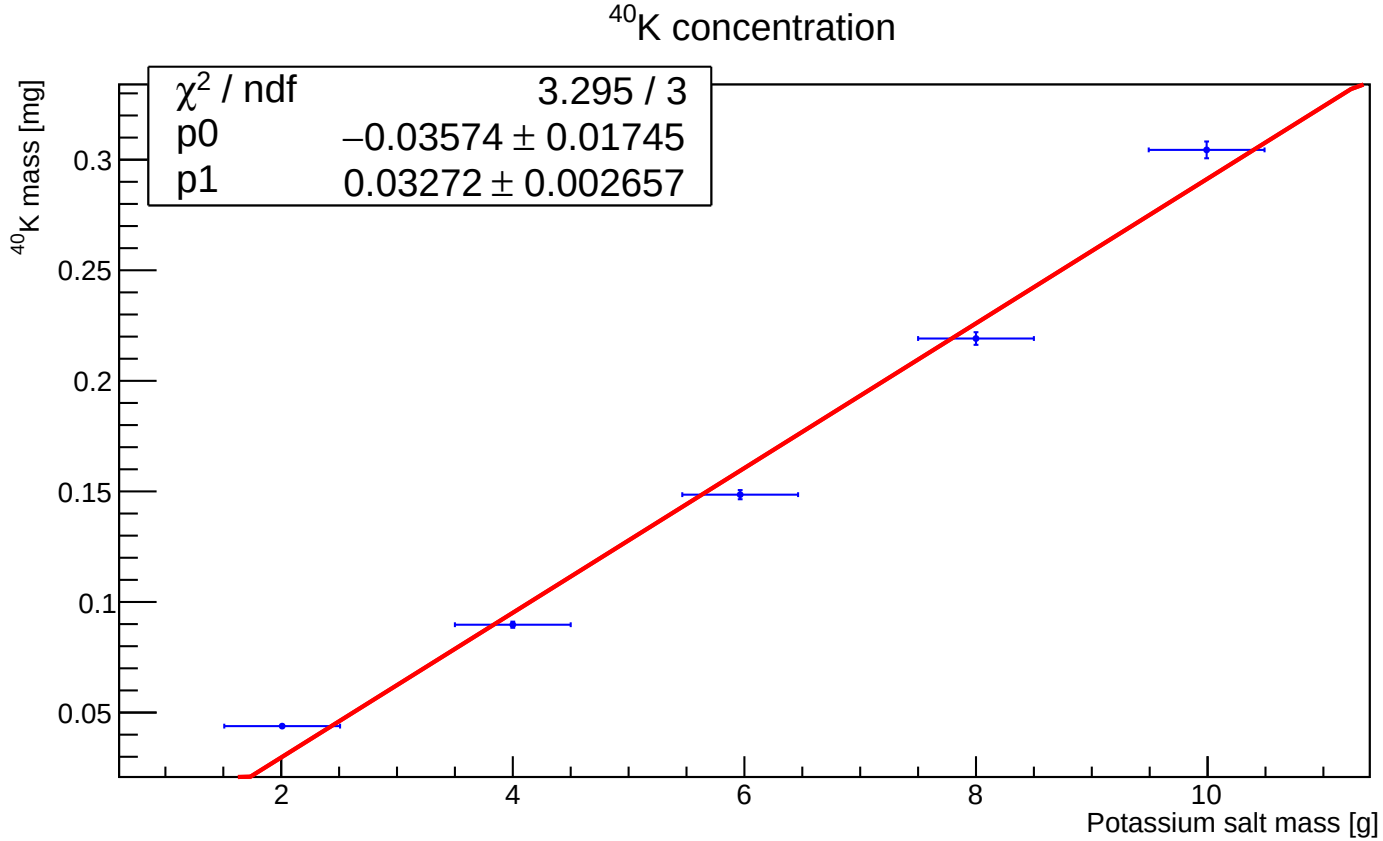
in the same way, the activity is determined by obtaining the disintegration rate:

$$A = \frac{N_t}{T}, \qquad m = \frac{MA\tau}{N_A},$$

with M the molar mass, τ the half-life of ^{40}K and N_A the Avogadro number.

Results

Finally the concentration of ^{40}K per gram of Potasssium salt is obtained.



$$\eta = 0.03272 \pm 0.002657 \text{ mg}[^{40}\text{K}]/\text{g}[\text{PS}]$$

Results

This ratio can also be calculated by considering potassium content per gram of salt indicated on label.

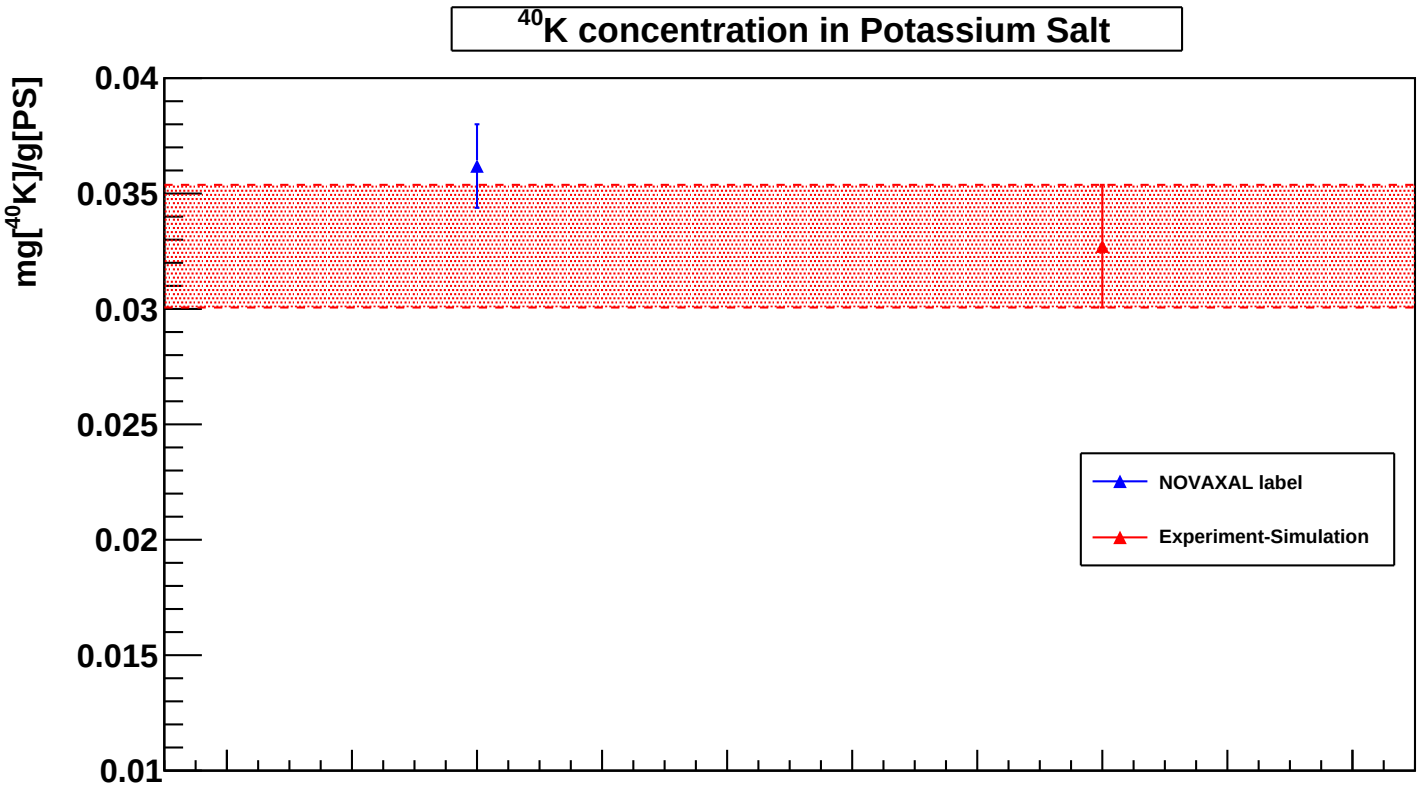
$$464mg[K]/1.5g[PS] = 309.33mg[K]/g[PS]$$

Finally multiplying by the natural abundance of ^{40}K (0.0117%):

$$\eta = 0.0361919 \text{ mg}[^{40}\text{K}]/\text{g}[\text{PS}]$$

Comparison

The agreement between both results depends largely on the uncertainty associated with the process of preparing the potassium salt itself. A uncertainty lower than 5% is estimated.



Conclusions