Proposal for the calibrations of CYGNO04

Distributed events: Kripton

Xenon /Darkside experiments uses gaseous 83mKr decay for calibration

Kr is produced in ^{83}Rb decay. Kr is diffusing into the experimental volume

Kr decays by gamma and Internal Conversion

Monochromatic gamma and **electrons** from the sources.

Increase of monochromatics electrons (30 keV and 9 keV) (on top of Compton electrons) compared to same energy gamma ray source.

Half life of Kr is about 2hours (it disappears quickly)

Can be procured from **Nuclear Physics Institute of the Czech Academy of Sciences**

(20 kBq costs about 6k euro, can be shared with Ptolemy)

Ptolemy RF antenna setup at LNGS

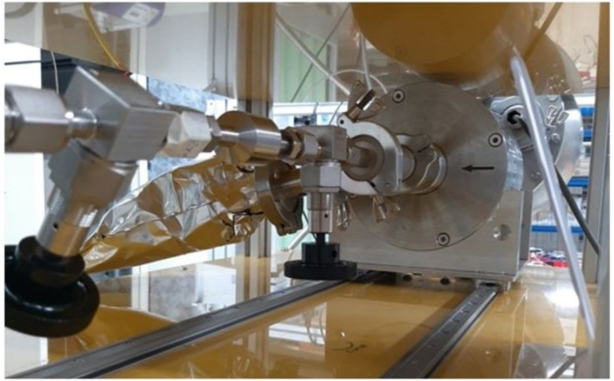


Figure 3.3. Photo of the Krypton source. The second valve opens a tap permitting the injection of the ^{83m}Kr gas. In the background the magnet is visible, too. The black arrow indicates the direction of the magnetic field inside the permanent magnet.

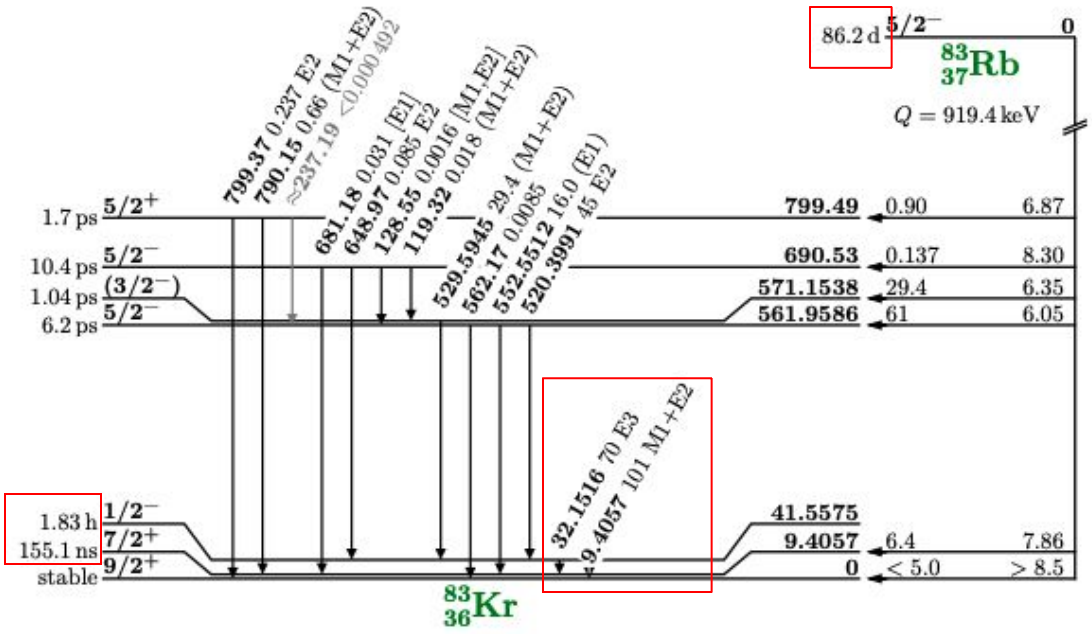
Distributed events: Kripton

Rb has an half life of 3 months

Produces 83Kr that emits 32 keV and 9.4 keV

photons 155 ns apart with an half life

of about 2 hours



Distributed events: Kripton

Rb has an half life of 3 months

Produces 83Kr that emits 32 keV and 9.4 keV

photons 155 ns apart with an half life

of about 2 hours

By Internal Conversion, these will produce electrons

The 9.4 keV photon provides mainly a 7.5 electron (90%) and electrons of 9.1 keV (10%), while the other makes 17.8 keV (25%) and around 30 keV (75%)

Line	Energy E_{ce} (eV)	ICC,[a]	Intensity I_{ce},[b] per decay (%)	Natural line width Γ (eV) [32]	[33]
γ 9405.7					
L_1	7481.1(10)	12.1(1)	66.8(13)	3.75(93)	3.72(19)
L_2	7673.7(6)	1.34(1)	7.47(15)	1.25(25)	1.29(14)
L_3	7726.4(6)	1.03(1)	5.70(11)	1.19(24)	1.58(16)
M_1	9112.9(7)	2.00(2)	10.8(3)	3.5(4)	3.123(4)
M_2	9183.5(6)	0.220(2)	1.19(3)	1.6(2)	0.63(39)
M_3	9191.1(6)	0.166(2)	0.897(21)	1.1(1)	1.1(4)
M_4	9310.6(6)	0.00324(3)	0.0175(4)	0.07(2)	—
M_5	9311.9(6)	0.00290(3)	0.0156(4)	0.07(2)	—
N_1	9378.1(6)	0.247(2)	1.11(3)	0.40(4)	0.288(93)
N_2	9391.0(6)	0.0197(2)	0.0881(21)	—	0,[c]
N_3	9391.6(6)	0.0146(1)	0.0655(16)	—	0,[c]
γ 32151.6					
K	17824.2(5)	478.0(50)	24.8(5)	2.71(20)	2.70(6)
L_1	30226.8(9)	31.7(3)	1.56(2)	3.75(93)	—
L_2	30419.5(5)	492.0(50)	24.3(3)	1.25(25)	1.165(69)
L_3	30472.2(5)	766.0(77)	37.8(5)	1.19(24)	1.108(13)
M_1	31858.7(6)	5.19(5)	0.249(4)	3.5(4)	—
M_2	31929.3(5)	83.7(8)	4.02(6)	1.6(2)	1.230(61)
M_3	31936.9(5)	130.0(13)	6.24(9)	1.1(1)	1.322(18)
M_4	32056.4(5)	1.31(1)	0.0628(9)	0.07(2)	—
M_5	32057.6(5)	1.84(2)	0.0884(12)	0.07(2)	—
N_1	32123.9(5)	0.643(6)	0.0255(4)	0.40(4)	4.0,[c]
N_2	32136.7(5)	7.54(8)	0.300(4)	0.03,[d]	0,[c]
N_3	32137.4(5)	11.5(1)	0.457(6)	0.03,[d]	0,[c]

Distributed events: Kripton

The use of a source producing diffused interactions will allow to make a “tomography” of the response of CYGNO-04 and produce a cumulative mask to correct the response of the detector for disomogeneities in:

- Drift Field
- GEM gain
- Transfer field
- Sensor and lens

A corrective map that can then be used to correct the images of each camera;

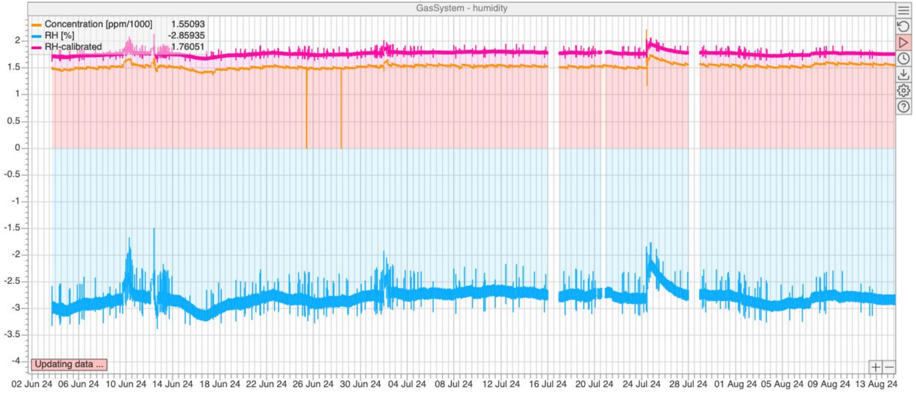
These tests can be performed once for ever or once every long intervals, to cross check their stability;

Technically they require an inlet in the gas system to connect the Ru source;

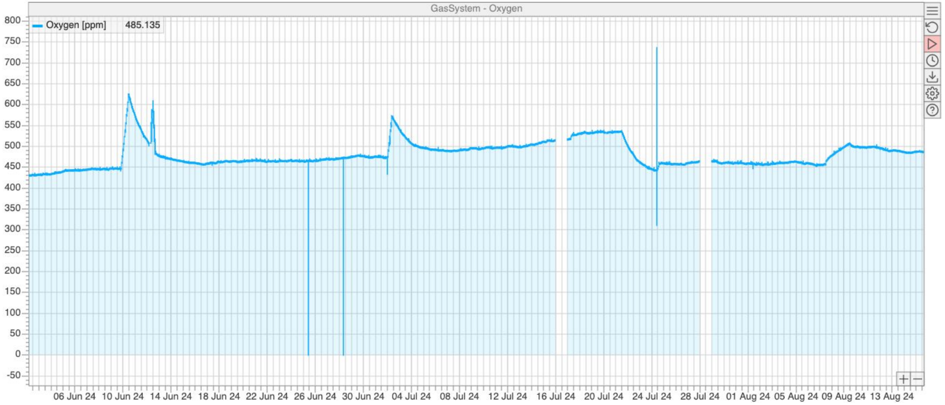
What about a movable ^{55}Fe source?

RUN5 was a stable one

No gas accident and no major issues happened



Humidity between 1.5 and 2.0 ppk

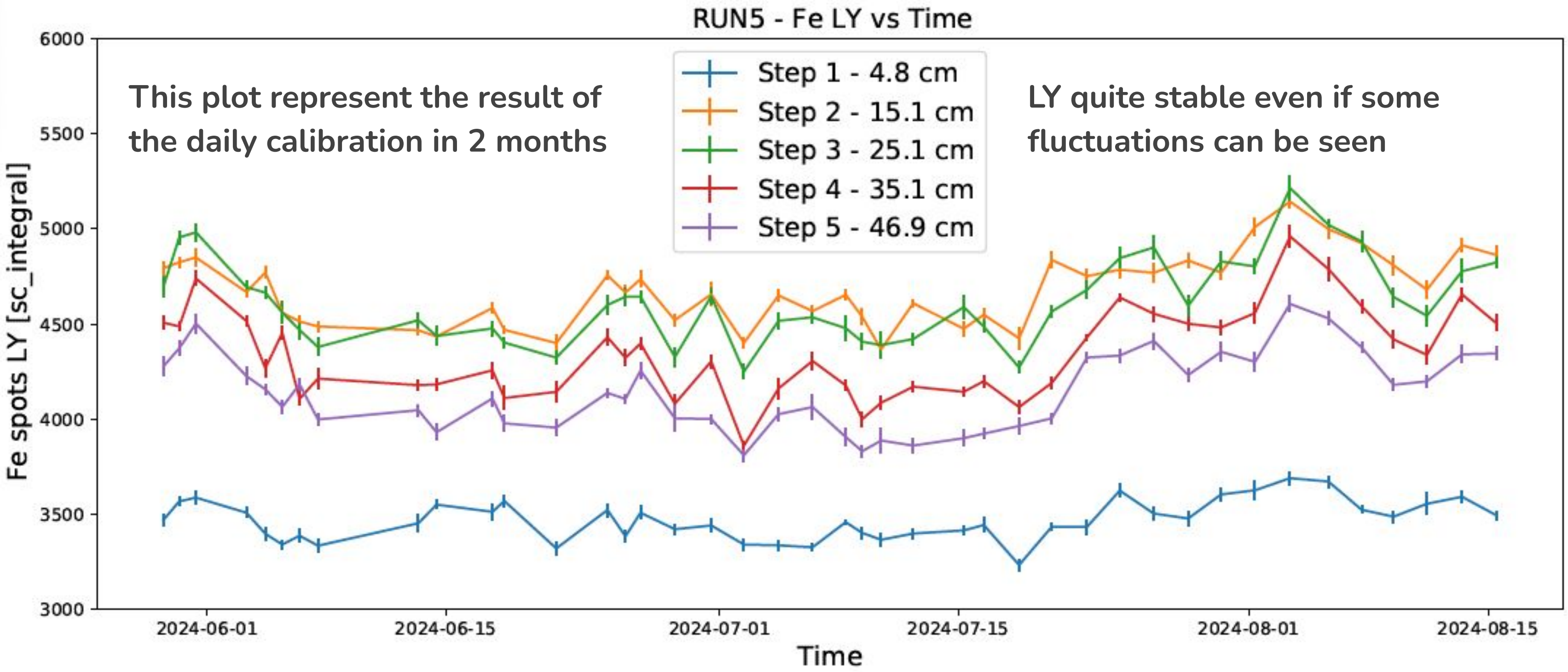


Oxygen between 450 and 530 ppm

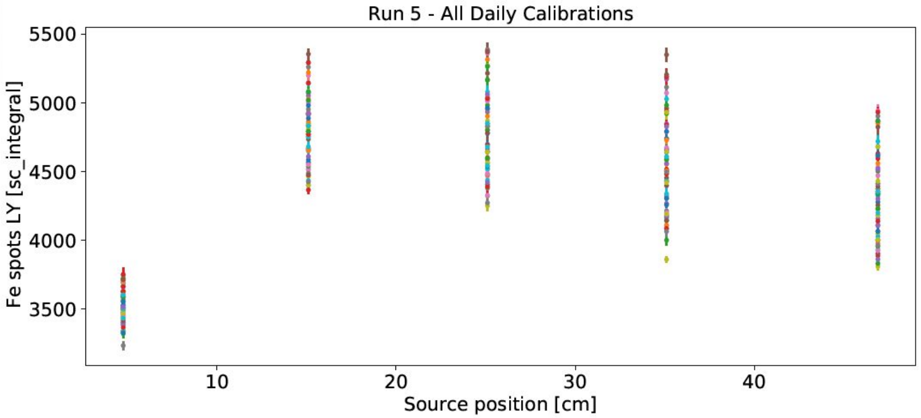
What about a movable ^{55}Fe source?

This plot represent the result of the daily calibration in 2 months

LY quite stable even if some fluctuations can be seen

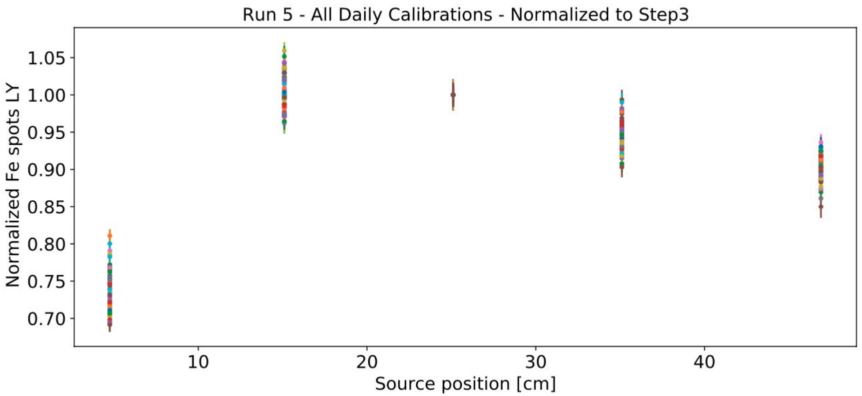


What about a movable ^{55}Fe source?



The fluctuation of the mean values in each steps are of order of ± 10%-15% in months

If we normalise to the central value fluctuations are ± 5%



These are the behavior of the central values of the fit, that will sum up to the energy resolution

What about a movable ^{55}Fe source?

To conclude:

- Even in a quite ideal run, we observed fluctuations not only of the “calibration curve” up and down, but also inversion in its shape that cannot be assumed as constant;
- These are not easily correlated with the monitored environmental parameters;
- In the commissioning phase, we think that the possibility of knowing where events are in 3D is crucial to spot any issue of the very large drift gap;
- The MC should be “trained” with the 3D response map;
- We therefore think that a 55Fe source that can be placed at different z will be needed;
- We can have one that can be moved or more (e.g. 3 per side) in different z that can be “opened and closed” from remote;