

Proposal for the calibrations of CYGN004





Distributed events: Krypton

Xenon /Darkside experiments uses gaseous ^{83m}Kr 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 monochromatic 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

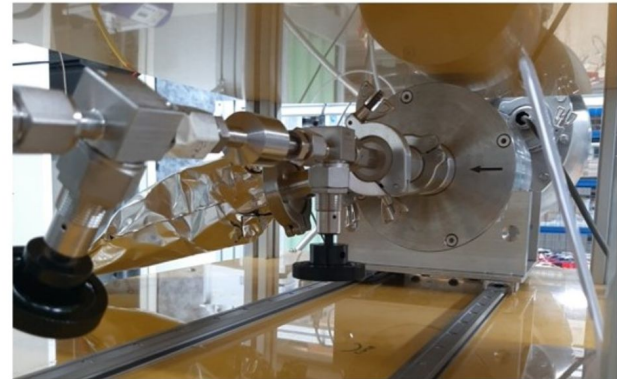


Figure 3.3. Photo of the Krypton source. The second valve opens a tap permitting the injection of the ^{83m}Kr gas. In the background the magnet is visible, too. The black arrow indicates the direction of the magnetic field inside the permanent magnet.



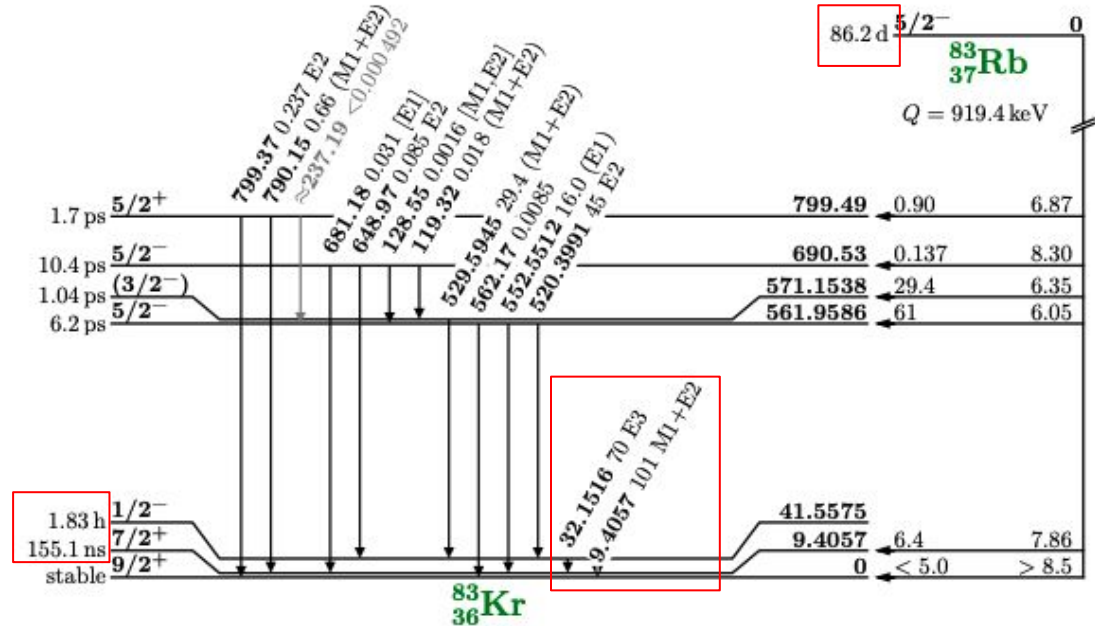
Distributed events: Krypton

Rb has an half life of 3 months

Produces ^{83}Kr that emits 32 keV and 9.4 keV

photons 155 ns apart with an half life

of about 2 hours





Distributed events: Krypton

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: Krypton

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;

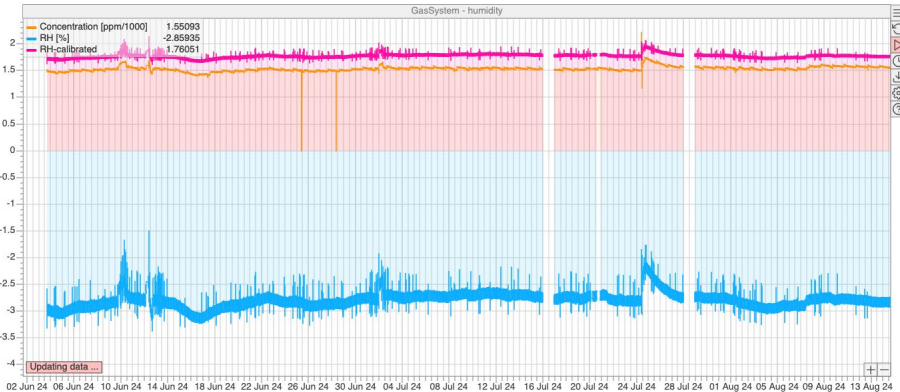
These tests can be performed once for ever or once every long intervals, to cross check their stability;

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

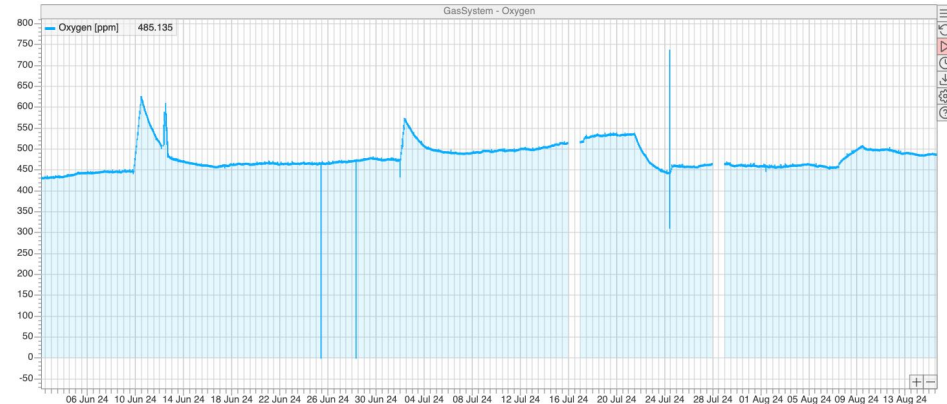
What about a movable ^{55}Fe source?

RUN5 was a stable one

No gas accident and no major issues happened

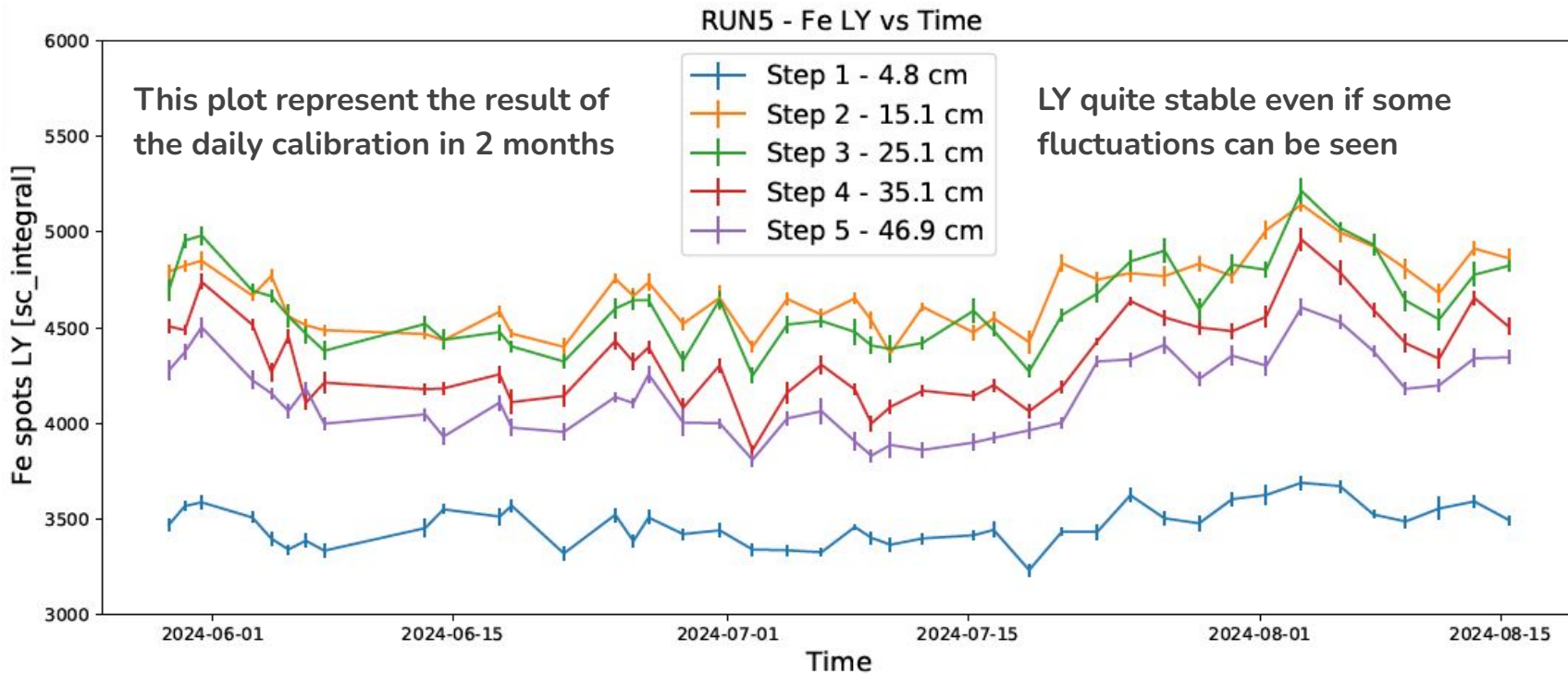


Humidity between 1.5 and 2.0 ppk



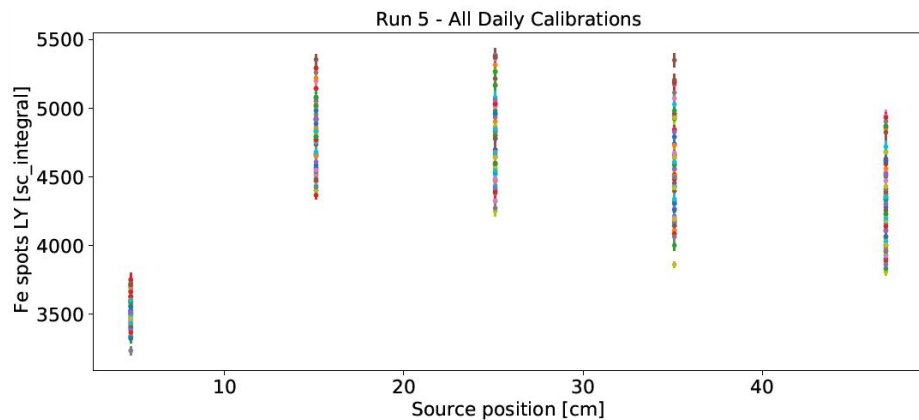
Oxygen between 450 and 530 ppm

What about a movable ^{55}Fe source?





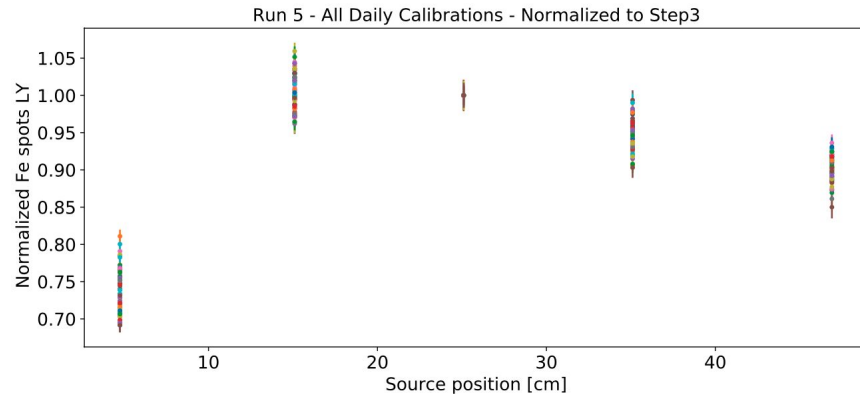
What about a movable ^{55}Fe source?



If we normalise to the central value
fluctuations are $\pm 5\%$

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

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





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;
- We therefore think that a ^{55}Fe 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;