Radon activity from leaks: predictions for CYGNO-04

Francesco Renga
INFN Roma

Radon concentration model

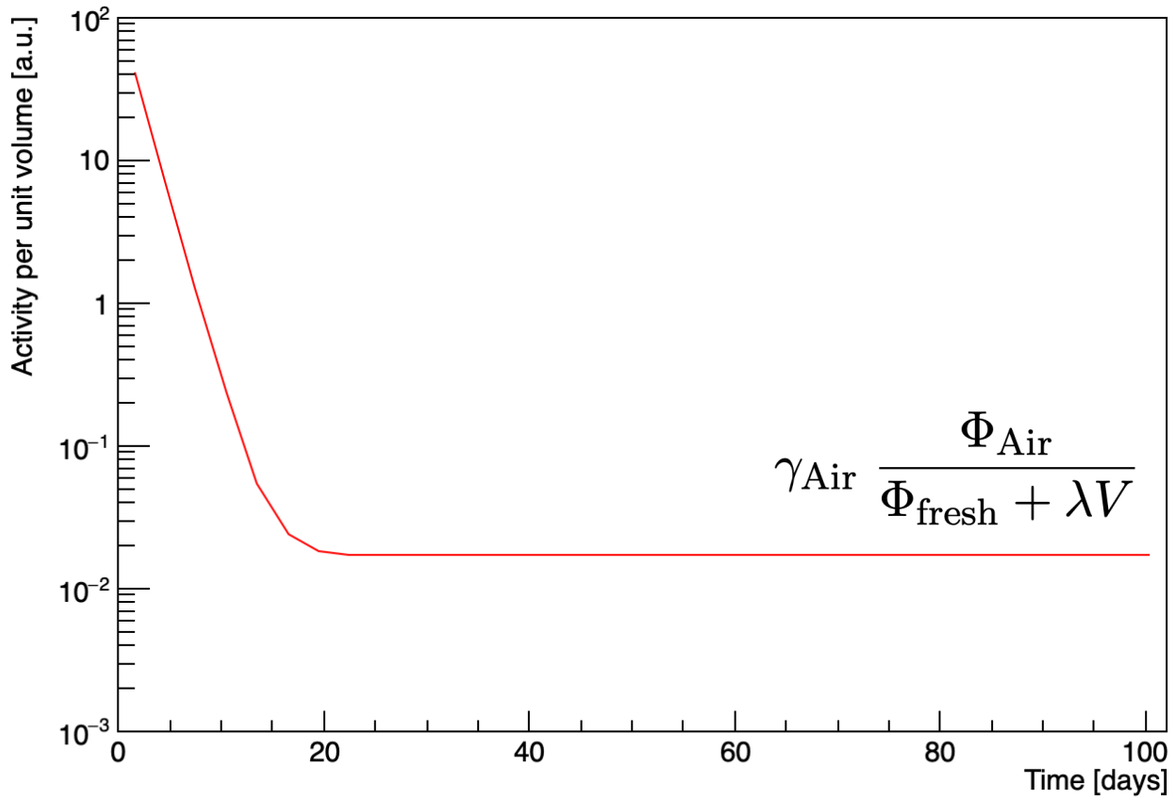
- We tried developing a model for the radon concentration in CYGNO-04, taking into account leaks, fresh/recirculated flow and decays

Incoming Decays

$$n_{\mathrm{Rn}}(t) = n_{\mathrm{Rn}}(0) + \Gamma_{\mathrm{Rn}} t - \int_0^t \Gamma_{\mathrm{tot}} \frac{n_{\mathrm{Rn}}(s)}{n_{\mathrm{tot}}} ds - \int_0^t \lambda n_{\mathrm{Rn}}(s) ds$$

Molar density

Outgoing



$$\gamma_{\mathrm{Air}} \sim 10 \ \mathrm{Bq/m^3}$$

In case of recirculation with Radon filter efficiency ϵ, replace Φ_{fresh} with $\Phi_{\mathrm{fresh}} + \epsilon\Phi_{\mathrm{rec}}$

Leaks vs. incoming flow

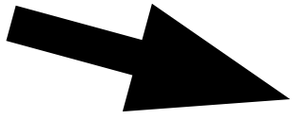
- The incoming Radon flow is assumed to be the product of the incoming air flow and the radon concentration in air

- The incoming air flow depends on the leaks, but it is not equal to the leak rate

  - the ratio between the incoming air rate and the leak rate depends on the origin of the leak, the differential pressure, etc.

  - as a benchmark, we can consider the situation in LIME:

Leak rate ~ 0.4 l/h
Fresh rate ~ 20 l/h (5 l/h)
Oxygen concentration in air ~ 21%
Oxygen concentration in LIME ~ 80 ppm (400 ppm)



Incoming air / leak ~ 0.020 (0.024)

Predictions for CYGNO-04

- Assuming:
  - the same ratio of incoming air rate over leak rate as in LIME
  - a fresh flow of 10 l/h
  - a recirculation flow of 90 l/h with 100% efficiency in removing Radon
  - a total CYGNO-04 volume of 2 m^3

$$\frac{\gamma_{\mathrm{det}}}{\Phi_{\mathrm{leak}}} \sim 1.0 \times 10^{-4} \ \frac{\mathrm{Bq}}{\mathrm{sccm} \cdot \mathrm{m}^3} \sim 3300 \ \frac{\mathrm{events}}{\mathrm{year} \cdot \mathrm{sccm} \cdot \mathrm{m}^3}$$

corresponding to ~ 1300 events/year in the active volume for a leak rate of 1 sccm