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Interactive comment on "Increasing the accuracy and temporal resolution of two-filter radon–222 measurements by correcting for the instrument response" *by* A. D. Griffiths et al.

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Thank-you for the additional comments.

1) The parameters that are included in the equations of the model have a high level of uncertainty . . . the authors could include a section regarding Rn-222 measurement uncertainty, maybe an evaluation of the uncertainty for each parameter and to propagate it in the equations.

Some of the model parameters, we agree, are quite uncertain. Nevertheless, we contend that the instrument response as a whole is quite well constrained by observations.

The large uncertainty in parameters is a result of the model being under-determined. For our purposes, though, the parameter values are irrelevant. Instead, we take care to ensure that the overall response is within the bounds set by measurements.

As a specific example, take the photomultiplier tube (PMT) collection efficiency. We have no direct observations of this, but once we have fixed the other parameters, we know that it must take a value which ensures that the net efficiency of the detector matches the calibration value, known from measurement to within 5%. The net efficiency has been measured roughly once a month, in all operational two-filter radon detectors. It's small coefficient of variability is evidence that the detector has a net efficiency which is stable over a timescale of years.

The uncertainties in parameters are propagated into the results during Monte-Carlo sampling, as described by Eqns. (19–23). The most uncertain of these is the plateout time constant, which is sampled from a log-normal distribution with a geometric standard deviation of 2. The plateout time constant has only a small effect on the net efficiency, though, because the fraction of progeny lost to plateout is small, i.e. a few percent.

In the revised manuscript, we shall summarise the uncertainties at the end of Sect. 2 (Model Validation) and note that the uncertainties are propagated through the deconvolution routine to the output.

2) Regarding the equations [3-5]. . . progeny concentrations in this delay chamber will be different if there is a screen or not (some progeny are collected on the screen). Furthermore, it will be also different for different external flow rates (some progeny go out the system in the exhaust air). Both issues, affects the radon progeny concentration that enters in the internal radon chamber, how are they included in equations [3-5]?.

These process are intentionally not included in Eqs. (3–5). Equations (3–5) describe the rate of change of radon progeny concentration in a slug of air traveling through the delay chamber, a fact that was not clear enough in the manuscript. These equations are

$$\frac{dN_A}{dt} = N_{\mathsf{Rn}}\lambda_{\mathsf{Rn}} - N_A\left(\lambda_A + \lambda_p\right)$$

$$\frac{dN_B}{dt} = N_A\lambda_A - N_B\left(\lambda_B + \lambda_p\right)$$

$$\frac{dN_C}{dt} = N_B\lambda_B - N_C\left(\lambda_C + \lambda_p\right)$$

where N_A is the concentration of polonium–218, N_B lead–214, and N_C bismuth–214. At time $t = 0$, the slug of air enters the delay chamber with $N_A = N_B = N_C = 0$. This is shown schematically in Fig 1.

Production occurs at the parent's rate of decay, and loss occurs because of radioactive decay (λ_A, λ_B, λ_c) and deposition on the walls (plateout, λ_p). After a certain time τ, the slug of air reaches the second filter at the end of the delay chamber. To work out the concentration of radon progeny in the air arriving at the second filter, we solve Eqns. 3–5 at time $t = \tau$.

We can make this assumption ($N_A = N_B = N_C = 0$) because the air entering the delay chamber has either arrived from the outside, after passing through a high efficiency filter, or from the internal filter, with an efficiency of $\gtrsim$95%. As well as passing through the second filter, air from the internal flow loop also passes through a length of pipe, a blower, and a denim screen. The denim screen is intended to homogenize the flow by destabilising any large eddies in the flow field, but has the secondary effect of reducing the progeny concentration further.

The other loss processes, namely collection to the screen and loss from the exhaust, do not apply to the slug of air. Screen loss is taken into account by assuming that

$N_A = N_B = N_C = 0$ in air entering the delay chamber. Exhaust air is assumed to be free of radon progeny.

In the revised manuscript, we shall improve the clarity of the descriptions of Eqs. (3–5) and modify Fig. 1 (in the manuscript) to make the assumption of plug flow more explicit.

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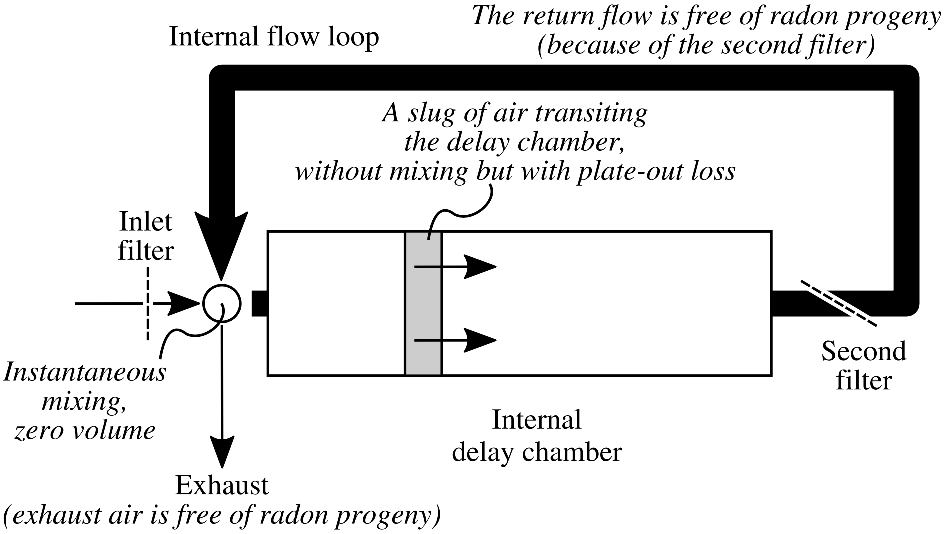

Fig. 1. Simplifed model of the radon detector's internal flow loop.