

A semi-empirical model for surface contamination monitoring

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- To clarify the nomenclature to avoid errors in future publications
- To clarify 'p-factors'
- To propose a simple approach to assaying radionuclides with complex decay schemes

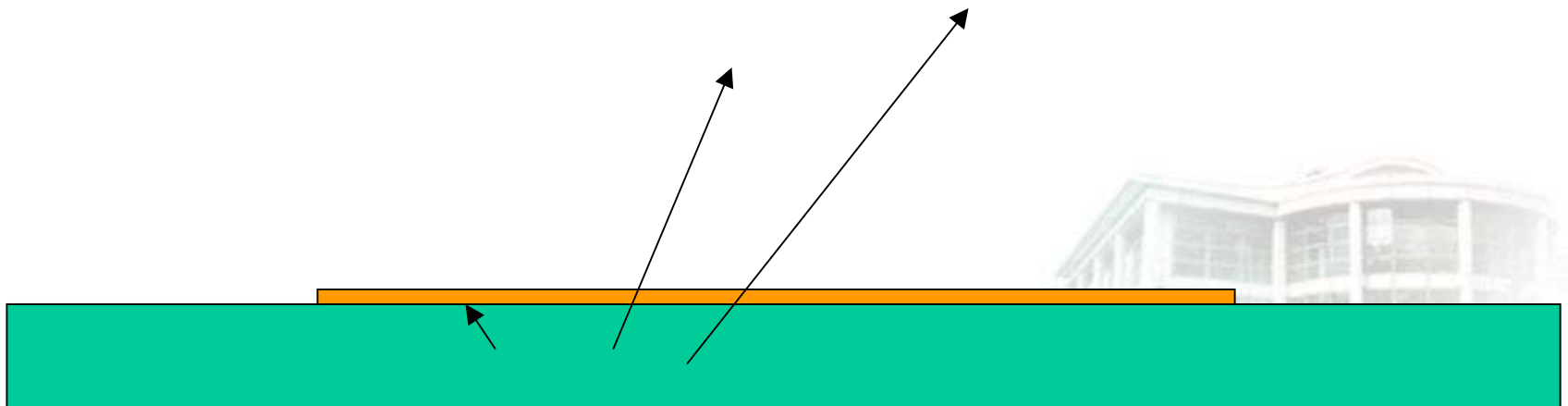


First stage – an ideal surface contamination monitor

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- An infinitely thin detector
- In contact with the surface
- Each particle that crosses the detector is detected with a fixed probability



- The activity per unit area on the surface is given by:

$$N' \frac{1}{\epsilon'} \left(\frac{A_c}{S_c} \right) \left(\frac{\epsilon_c}{N_c} \right)$$

The equation reflects what is done in practice – measuring the ratio between the observed counts from a reference source and those from the surface.

The calibration factor, the instrument response factor, the p-factor etc can all be expressed as parts of the above equation, hopefully helping to avoid errors in future publications.



Second stage – towards the real instrument

- Assume: infinitely thin detector in contact with the surface
- Assume: detection probability varies with particle energy
- The observed count rate from a surface (or reference source) will have the form:

$$N = \varepsilon_0 A_0 W \int_E \varepsilon(E) k(E) dE$$

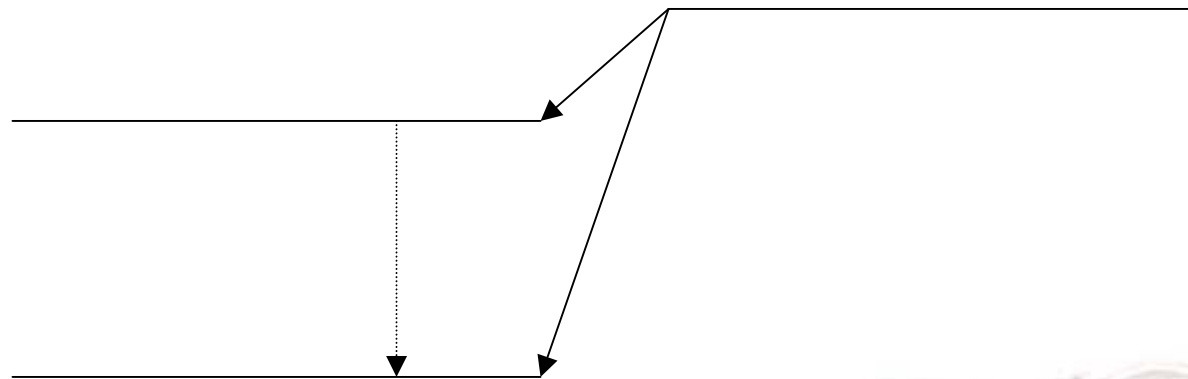


Third stage – further towards a real detector

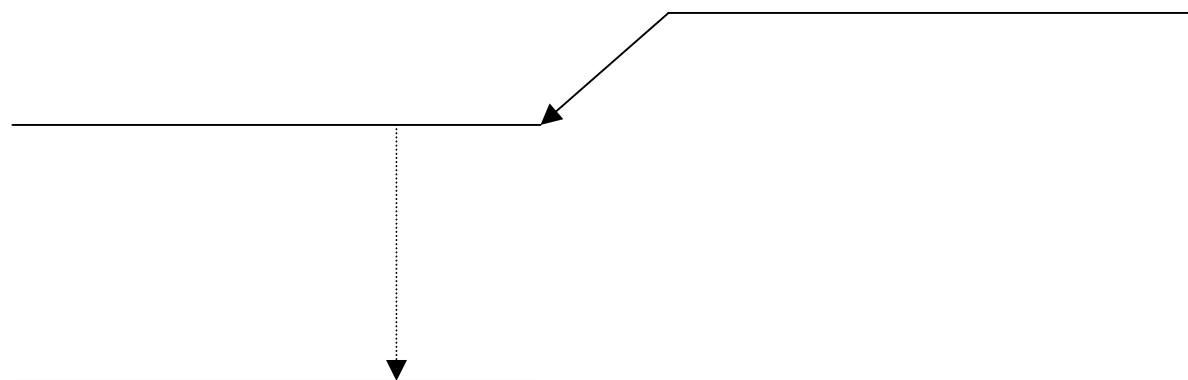
- Dropping the assumption of an infinitely thin detector in contact with the surface makes the equations very complex
- The gain is probably not worth the pain
- ...so use experimental data (eg count rate versus distance above the surface) to get some idea of the error introduced by the assumption...



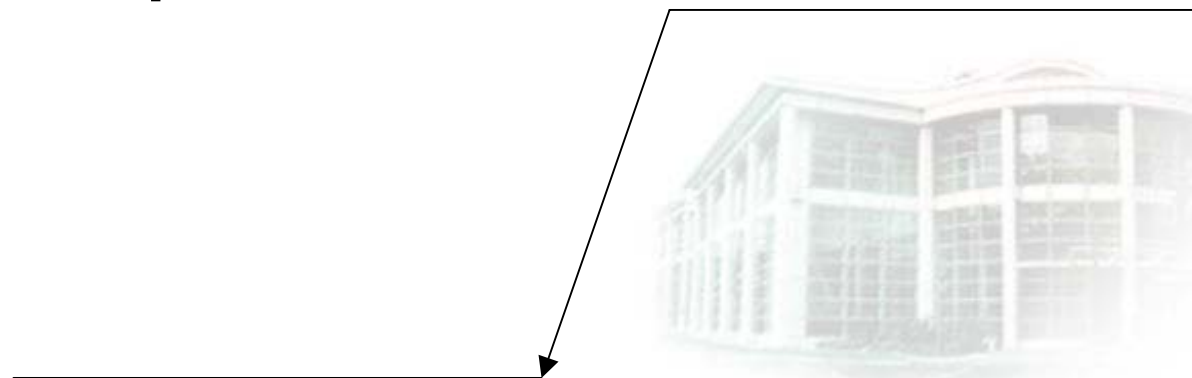
- Split a complex decay scheme up into ‘cascades’



- Becomes...



plus



So the approach is...

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- Divide the decay scheme up into cascades
- For each cascade, list the radiations emitted (betas / gammas / conversion electrons etc)
- Identify which radiation is detected 'the best' in the cascade
- Calculate the observed count rate
- Then add the results from all the cascades
- This errs on the side of caution



- The probability of detecting the radionuclide is given by an expression of the form

$$\sum_j p_j (1 - \prod_i (1 - \varepsilon_{ij}))$$



- We're making progress on developing a mathematical model of surface contamination monitoring
- The aim is to simplify the results for practical applications
- A complete model is very difficult so experimental data will be used to justify assumptions

