



Internal Dosimetry: A comparison of bioassay, PAS and nose-blow measurements

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Internal Dosimetry for actinides

- We are required to measure components of dose of 1 mSv or more
- Bioassay regimes are important—but it is difficult to get down to 1 mSv per year
- Personal air sampling can be used to achieve this limit
- Nose-blows are important in establishing whether intakes have occurred
- How do these various methods compare?

Reliability (sensitivity) of monitoring programmes

Example: ^{239}Pu (inhalation; AMAD 5 μm ; lung type M)

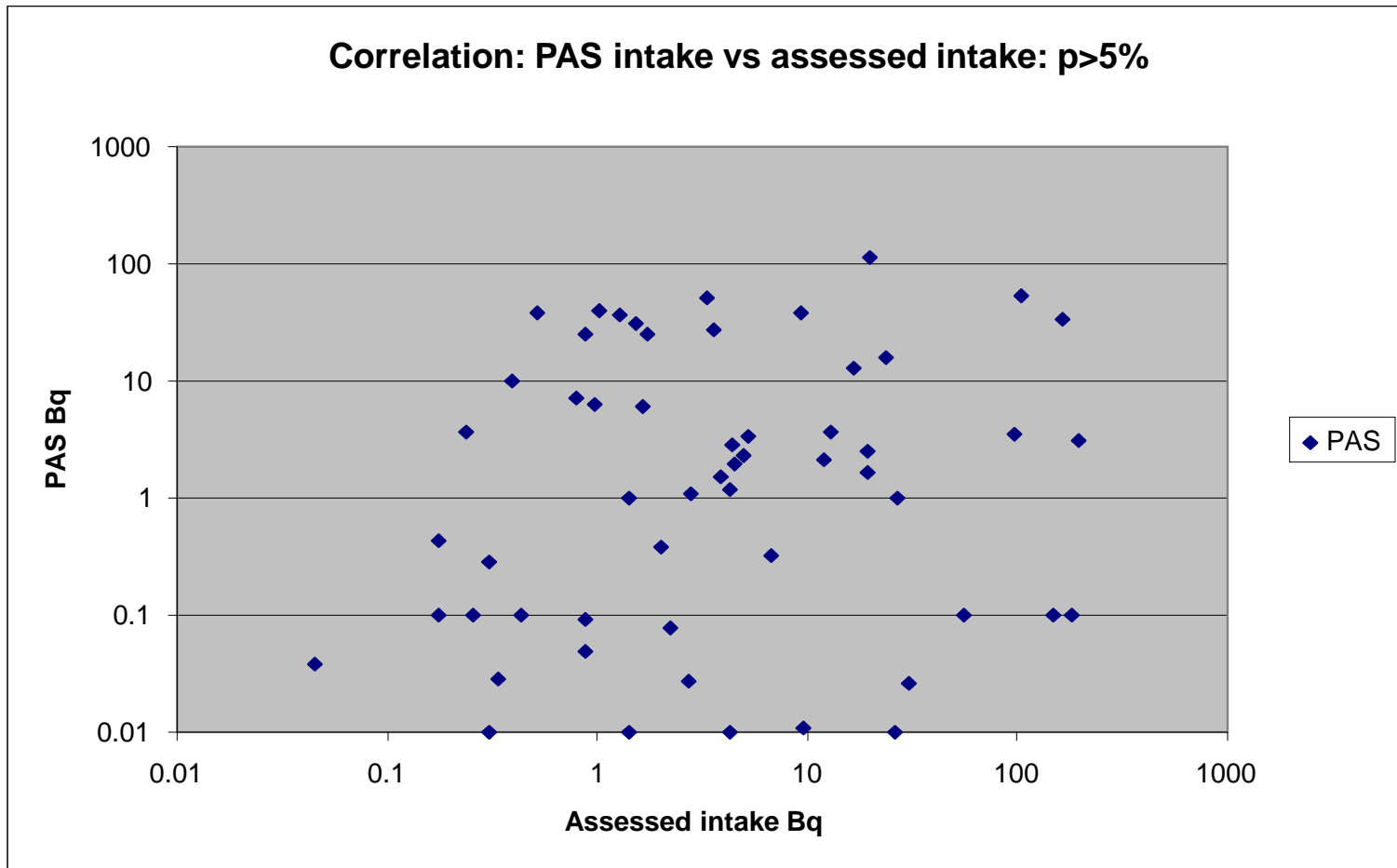
Measurement	Programme	Sensitivity (mSv y^{-1})	Comment
Lung	annual	2,700	Assumes 1kBq LOD
Urine	annual	1.2	Based on reporting level (0.2 mBq/day)*
Urine	quarterly	1.3	Based on reporting level* 4 intakes per year
Faeces	annual	3.8	Based on reporting level (2.0 mBq)
PAS	Daily (200 per year)	0.4	or 0.16 mSv if assume samples are from coherent distribution

* The reporting levels \approx LOD; risk of false positives

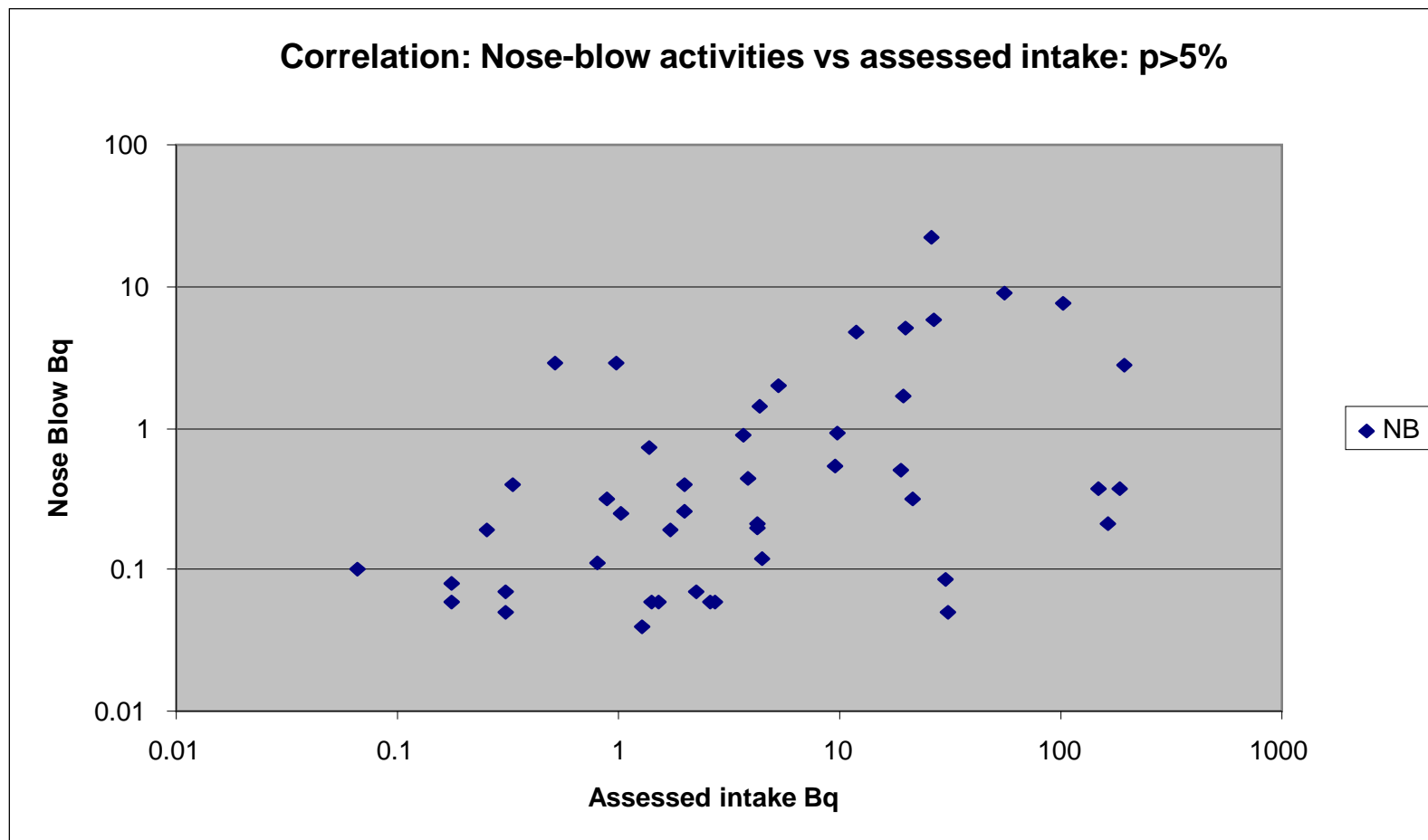
Well-defined intake cases

- **Provide a means of comparing assessed intakes with PAS & nose-blow**
- **Fit bioassay results using biokinetic models: vary the mixture of lung solubilities to optimise the fit.**
- **Select only those cases with $p > 5\%$**

Intakes from PAS vs Intakes assessed from bioassay



Nose-blow activities vs assessed intake



Correlations?

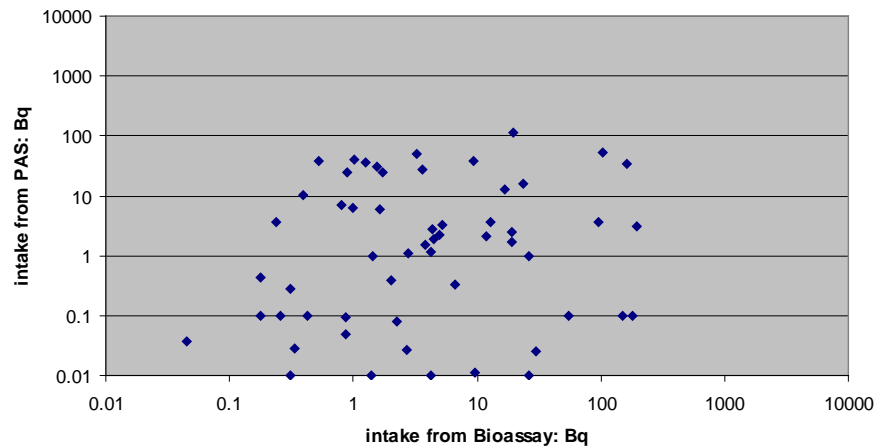
- Visually, it is clear there is little or no correlation
- Calculation of correlation coefficients confirms that there is no correlation between **PAS** and **bioassay**
- At best, there is a very weak correlation between **nose-blow** & **bioassay**

Theoretical approach

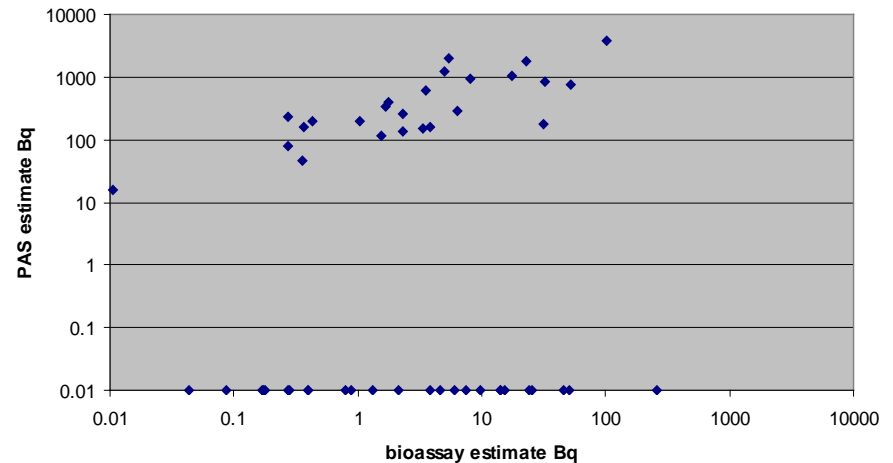
- Should we expect to see correlations?
- Select intakes I at random.
- Use conditional probabilities $p(\text{PAS}|I)$ & $p(\text{Assess}|I)$ to select values of PAS and Assess for a given I .
- Repeat this many times—generate a simulated correlation plot
- Does it look like the real plot?

Simulated correlation: $\sigma_g=2.5$; $\sigma_{bio}=2$; $\text{corr}=0.7$

Observed: PAS vs assessed intake: $p>5\%$



Theoretical

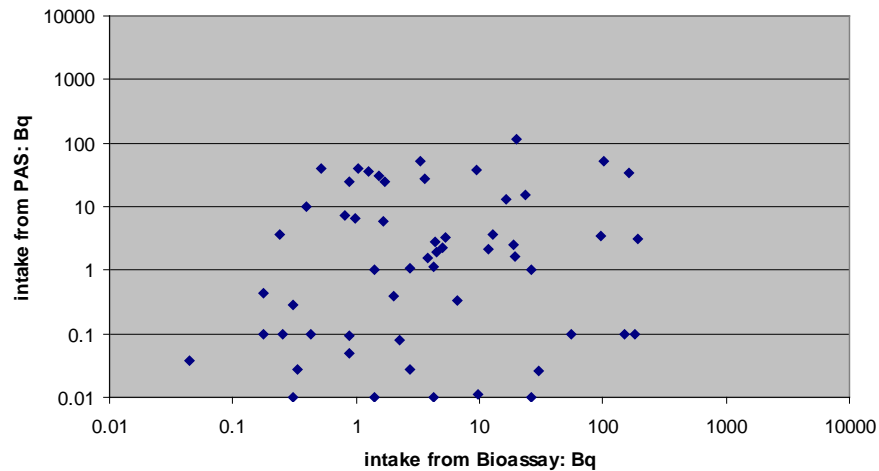


Simulation results

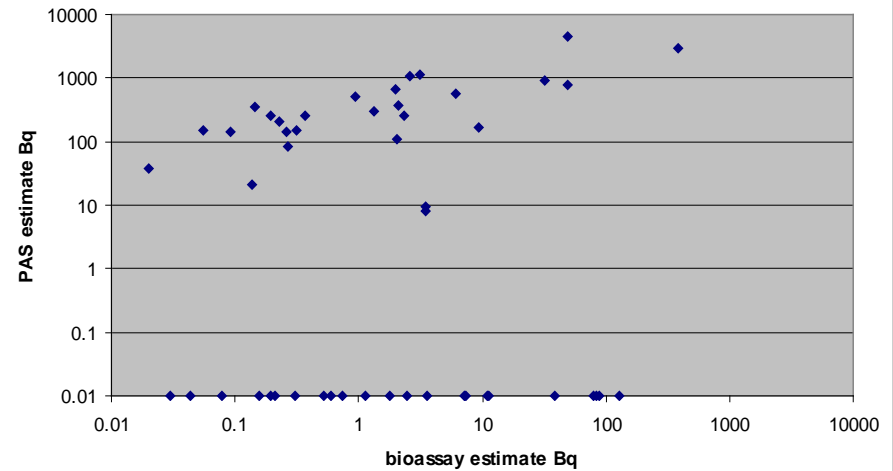
- **Simulation produces far better results than we observe BUT:**
- **For the PAS we have only considered counting stats—there are other sources of uncertainty**
- **Turbulent dispersion—Bull et al (1987) showed that even when particle numbers are vast (counting stats unimportant) intakes measured via air sampling show a lognormal distribution**
- **Orientation of the sampling head wrt release**
- **Can speculate on effects of larger uncertainties**

Simulated correlation 2: $\sigma_g = \sigma_{bio} = 4$; $\text{corr} = 0.5$

Observed: PAS vs assessed intake: $p > 5\%$



Theoretical



Is correlation the whole story?

- **Correlations are poor**
- **However, a survey of 91 intake cases showed that 37 were detected via a PAS result**
- **Most would not have been detected via the routine bioassay program**
- **PAS still has an important role in actinide dosimetry!**

Conclusions

- **The various measures of intake—bioassay, PAS, nose-blow—are poorly correlated**
- **This is not too surprising, given the uncertainties in each—though more work needs to be done to establish this theoretically**
- **This does NOT mean that any of these methods should be abandoned**
- **But we should treat all bioassay and air-sampling measurements with caution!**
- **Further work is needed to investigate the uncertainties in all monitoring methods for small intakes**