



## 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:  $^{239}\text{Pu}$  (inhalation; AMAD 5  $\mu\text{m}$ ; lung type M)**

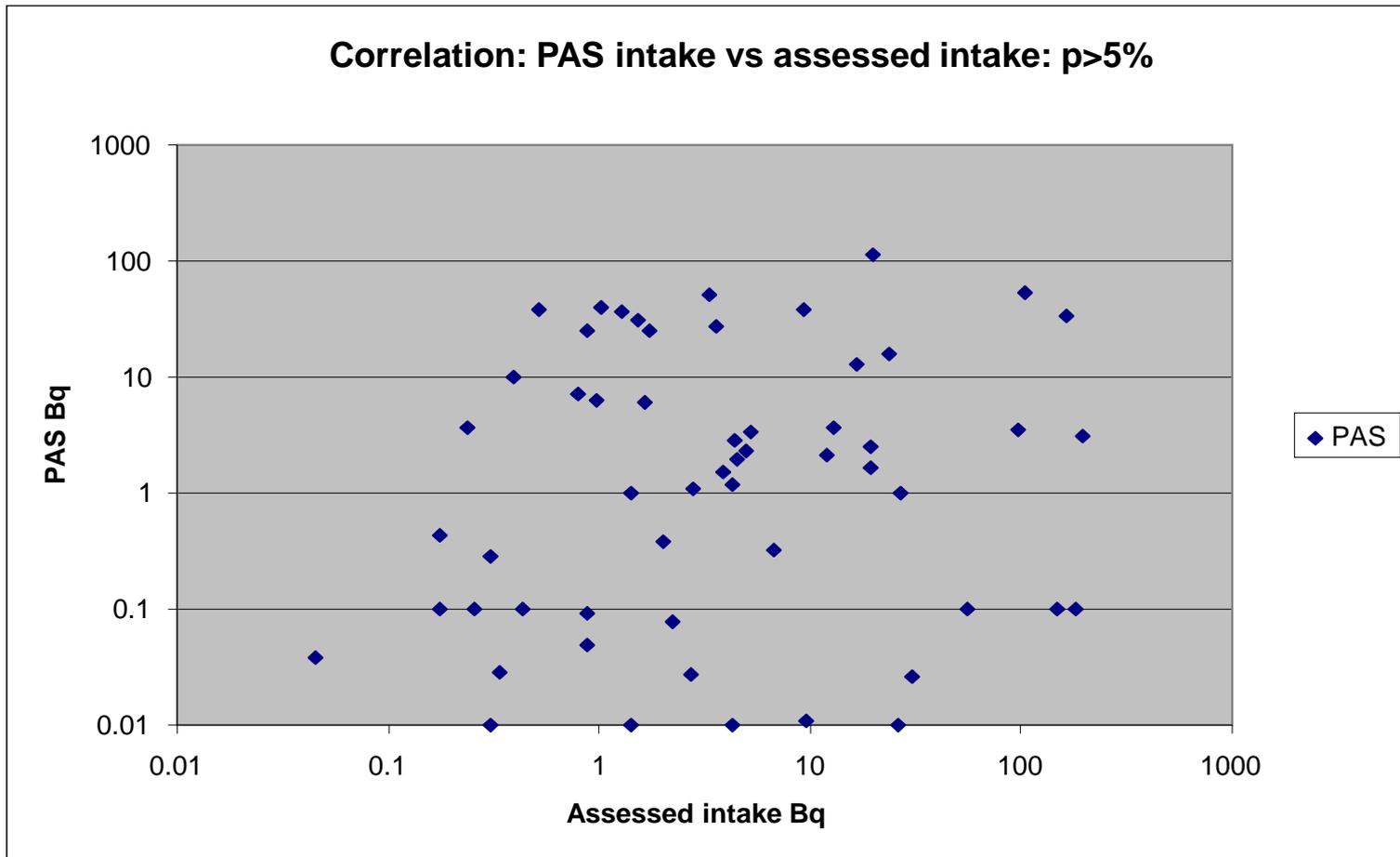
Measurement	Programme	Sensitivity (mSv $\text{y}^{-1}$ )	Comment
Lung	annual	<b>2,700</b>	Assumes 1kBq LOD
Urine	annual	<b>1.2</b>	Based on reporting level (0.2 mBq/day)*
Urine	quarterly	<b>1.3</b>	Based on reporting level* 4 intakes per year
Faeces	annual	<b>3.8</b>	Based on reporting level (2.0 mBq)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

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

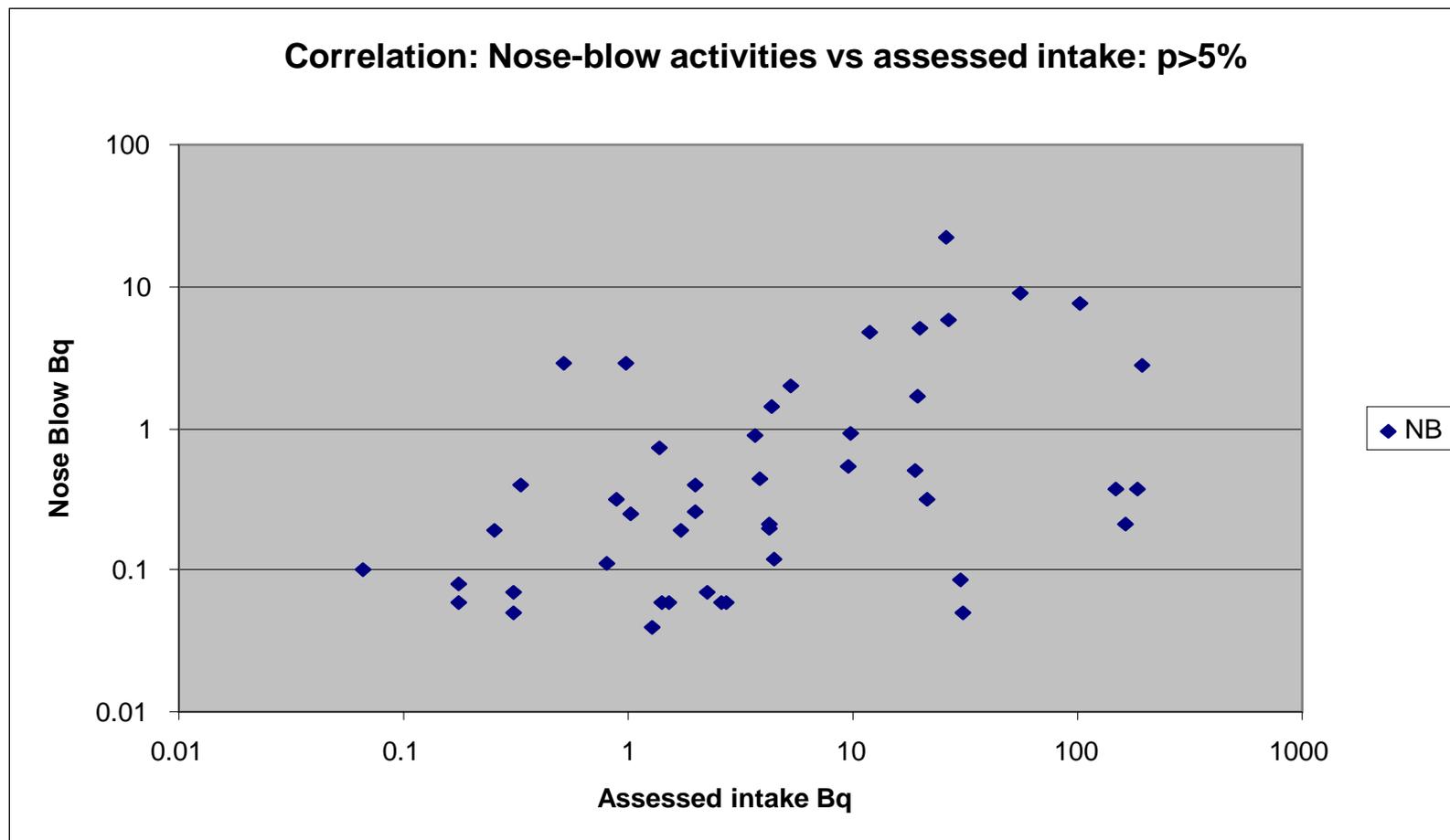
# Well-defined intake cases

- **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?

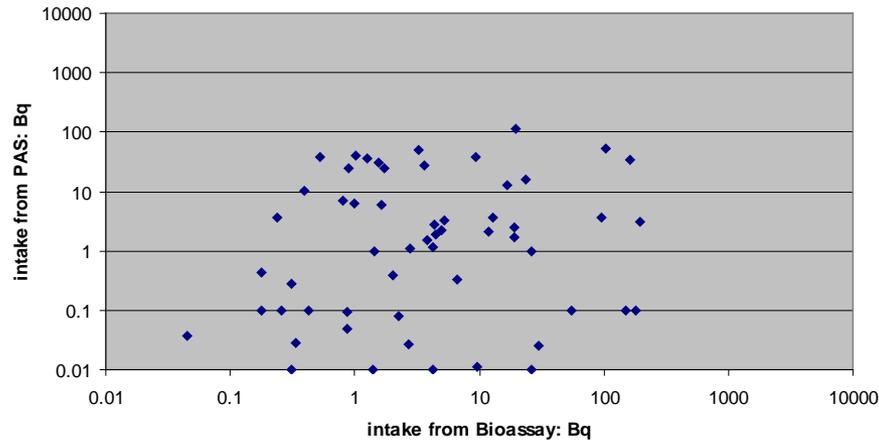
- Visually, it is clear there is little or no correlation
- Calculation of correlation coefficients confirms that there is no correlation between **PAS** and **bioassay**
- At best, there is a very weak correlation between **nose-blow** & **bioassay**

# Theoretical approach

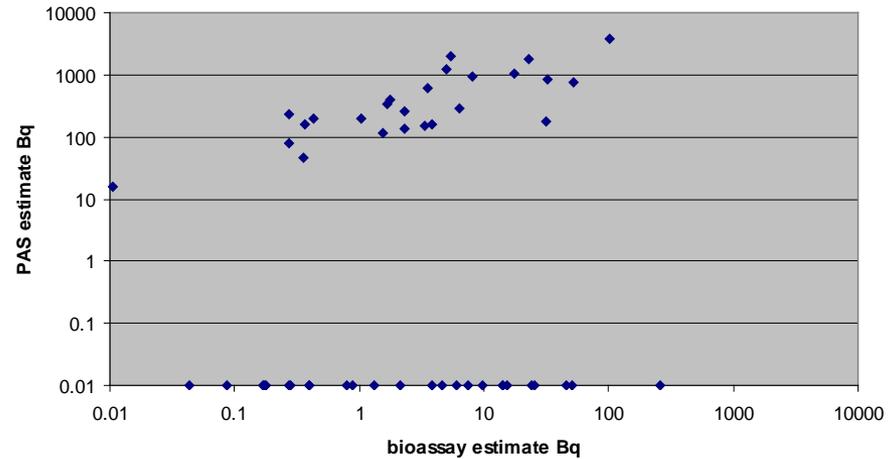
- **Should we expect to see correlations?**
- **Select intakes  $I$  at random.**
- **Use conditional probabilities  $p(\text{PAS}|I)$  &  $p(\text{Assess}|I)$  to select values of PAS and Assess for a given  $I$ .**
- **Repeat this many times—generate a simulated correlation plot**
- **Does it look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

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

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



Theoretical

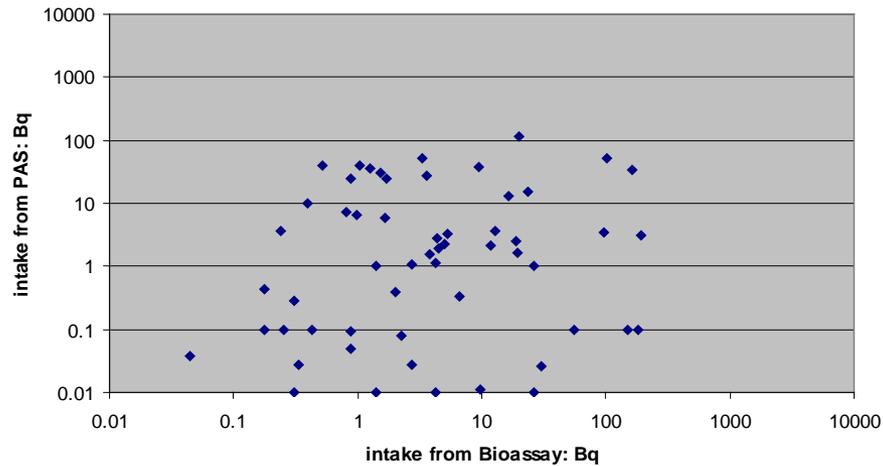


# Simulation results

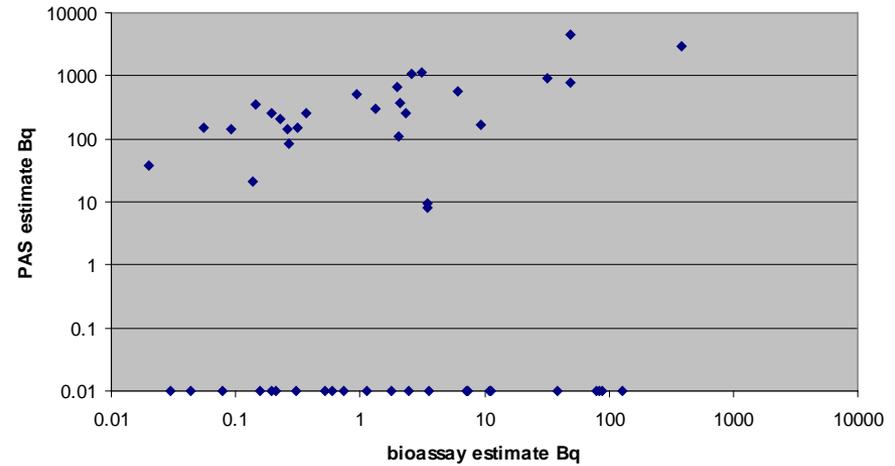
- **Simulation produces far better results than we observe BUT:**
- **For the PAS we have only considered counting stats—there are other sources of uncertainty**
- **Turbulent dispersion—Bull et al (1987) showed that even when particle numbers are vast (counting stats unimportant) intakes measured via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

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

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**