

Fast and accurate sample screening with XIA's Ultra-Lo 1800

Question: In a given amount of time, what activity level can I detect from a sample with a high degree of confidence (3σ)?

The number of counts coming from the unknown sample (N_s) is defined as the total number of counts detected in a given time period (N_t) less the contribution of the known background of the instrument (N_{Bt}). The uncertainty in the measurement is also shown.

$$N_s \equiv N_t - N_{Bt} \quad (1)$$

$$\sigma_{NS} = \sqrt{(N_t + N_{Bt})} \quad (2)$$

If we demand a 3σ measurement, we require that $N_s \geq 3\sigma$. So setting equation (1) to 3 times equation (2), it can be shown that:

$$N_s = \sqrt{(4.5^2 + 18 \cdot N_{Bt})} + 4.5 \quad (3)$$

This expression allows us to calculate the minimum level of activity which we can detect in time t (with 3σ confidence) given an instrument which produces N_{Bt} background in the same time t .

Now we compare the counting times and “detection limit” of XIA’s Ultra-Lo 1800 (using a stainless steel sample tray with background emissivity of $2.5 \alpha/hr$) and the best commercially available instrument (Alpha Sciences model 1950 - which has a background of $5 \alpha/hr$ with a detector sensitive area of 1000 cm^2) presented with an unknown 1000 cm^2 sample.

Counting time (hours)	Detection Limits			
	Model 1950		Ultra-Lo 1800	
	Counts	Emissivity	Counts	Emissivity
6	4.7 α/hr	0.005 $\alpha/cm^2/hr$	2.9 α/hr	0.003 $\alpha/cm^2/hr$
8	4 α/hr	0.004 $\alpha/cm^2/hr$	2.4 α/hr	0.0024 $\alpha/cm^2/hr$
12	3.1 α/hr	0.003 $\alpha/cm^2/hr$	1.9 α/hr	0.0019 $\alpha/cm^2/hr$
24	2.1 α/hr	0.002 $\alpha/cm^2/hr$	1.2 α/hr	0.0012 $\alpha/cm^2/hr$

It’s important to note here that in above calculations, we are only using a fraction of the detector sensitive area on the Ultra-Lo 1800. Look at the results as the sample size increases:

Counting time (hours)	Counts / Emissivities ($\alpha/cm^2/hr$)				
	Sample size (cm^2)				
	0	450	900	1350	1800
6	3.56 α/hr	0.0072	0.0031	0.0017	0.0008
8	3.0 α/hr	0.0060	0.0026	0.0014	0.0006
12	2.35 α/hr	0.0047	0.0020	0.0010	0.0004
24	1.57 α/hr	0.0031	0.0013	0.0007	0.0002

