Draft Chapter: "The Practice of Continuous Air Monitoring for Alpha-emitting Radionuclides"

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Principles of Continuous Monitoring

Continuous Monitoring

inlet design for ‘representative’ sampling

i.e., (0.1 $<d_p<$15μm AED)

real-time **alpha-detection** and **flow** measurement

automated background correction

alarm capability w/o unacceptable FAR

Sampling

open face filter holder – all particle sizes

provides sample of record for **dosimetry**

no detection or flow measures

Application

With proper design & placement, provide reliable early detection to optimize worker protection

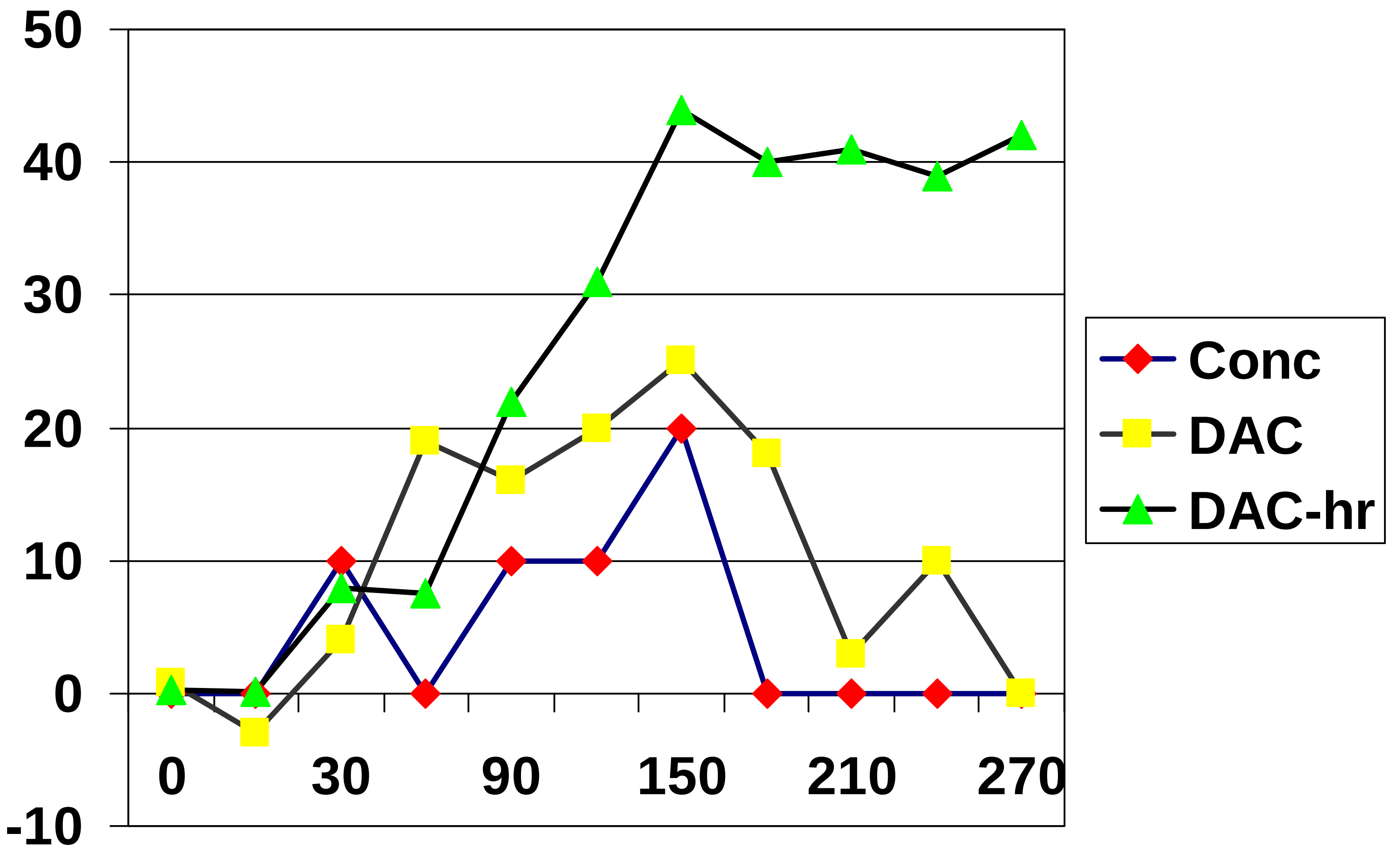
Real-time net TRU concentration (DAC)

Integrated Potential Exposure (DAC-hr)

DAC = ALI / 2400   ($\mu Ci/m^3$)

DAC-hr = DAC * Filter sample time

Concentration/DAC/DAC-hr



Sensitivity

…A function of sampling rate, background, correction method, dust loading, count integration time, …

Decision Level = 1.65 * $(N_s + 2*N_b)^{1/2}$

MDA = 4.65 * σ_b where σ_b is determined from procedure blank data

Expectation ~ 8 DAC-hr (under lab conditins ?)

…. but at what False Alarm rate?

Precision, Accuracy, Bias

Precision refers to the degree of agreement in a series of measurements of the same quantity (cluster about avg.)

(precision is desirable but does not guarantee accuracy !)

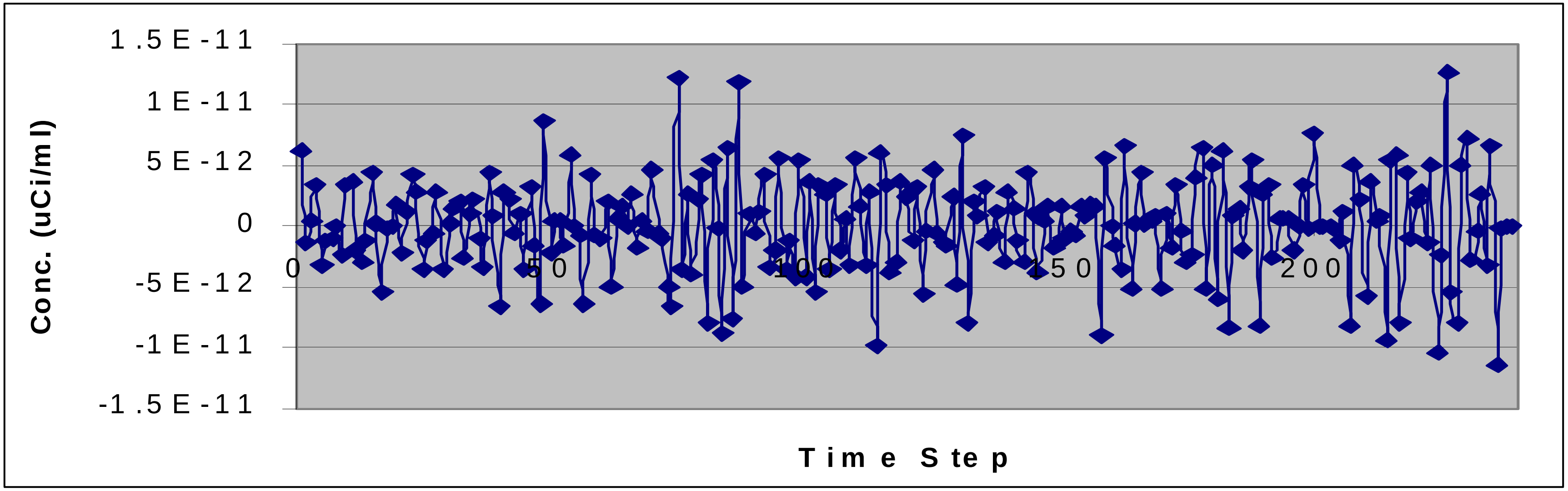
Accuracy is the closeness of measurements to a conventionally true value (…. not often determined using TRU aerosols)

Bias is clustering of measurements that systematically deviate (larger /smaller) from a conventionally true value (… shows up when calibration and setup are different from applied conditions)

All of these factors can depend on sampling conditions (Rn background, dust loading) as well as instrument design, calibration, and use

Alpha CAM data: Concentration

$$C_{pu}(T_i) = T_i * [A(T_i) - A(T_{i-1})] / [T_c^{\,2} * eff * K * V]$$



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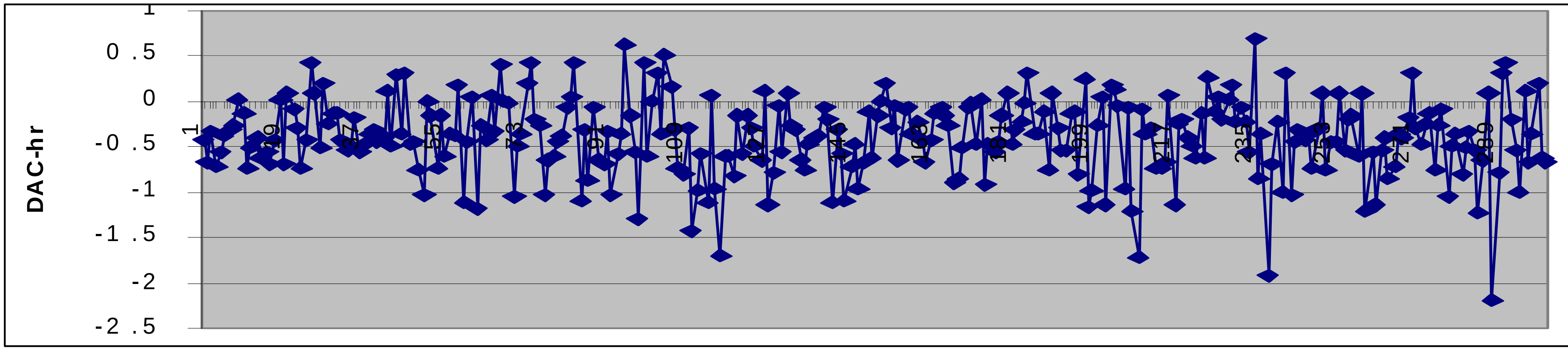
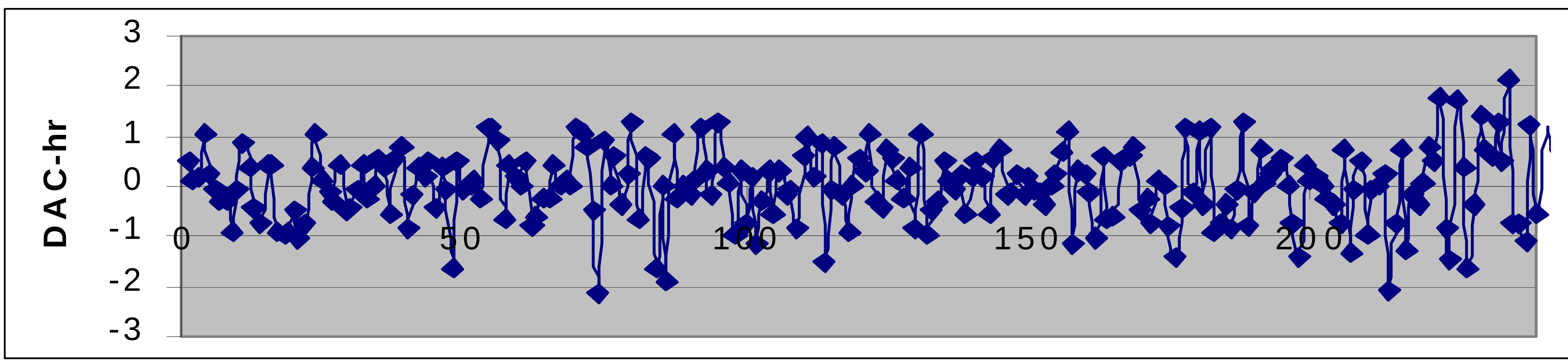
Alpha CAM data: DAC-hr

$$DAC\text{-}hr = T_i * A(T_i) / [T_c * K * V * eff * ZDAC]$$



10 min integration time/ cycle: Avg. = -0.39 DAC-hr



30 min integration time / cycle : Avg = 0.005 DAC-hr

(procedure blank)

Interference control: Background Correction

Peak centroid + channel ROI count ratios:

Pu (ROI-1) = (ROI-2)* K * (ROI-3)/(ROI-4) , ROI()= counts, K = cal. Const.

Peak centroid + valley channels + exponential tail fit overlap into Pu-ROI

$Pu = Y1 – T_{8.78} – T_{7.68} – T_{6.05}$, Ti = exponential tail count in Pu ROI

Y1 = Gross count in Pu ROI

Peak centroid + Peak function fits

$Peak_{k} = A_k * \Sigma\, t_i *[t_i * \exp(f1) * \mathrm{erfc}(f2)]$,

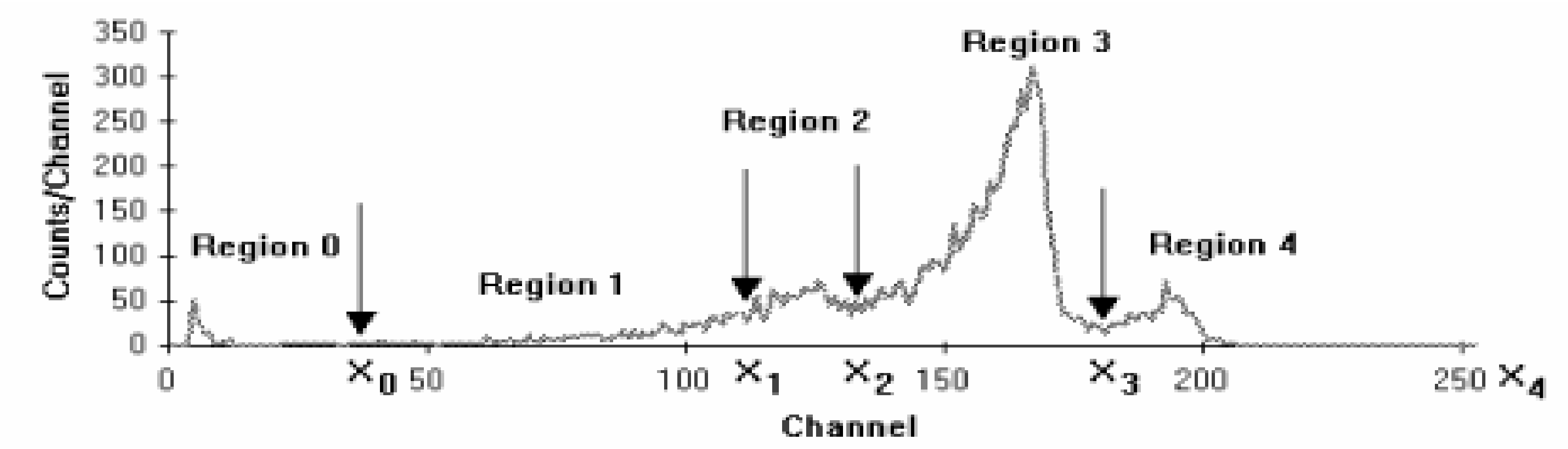
f1= f(x, t_i, μ, …), f2 = f(x, t_i , μ, …), x = channel no.,

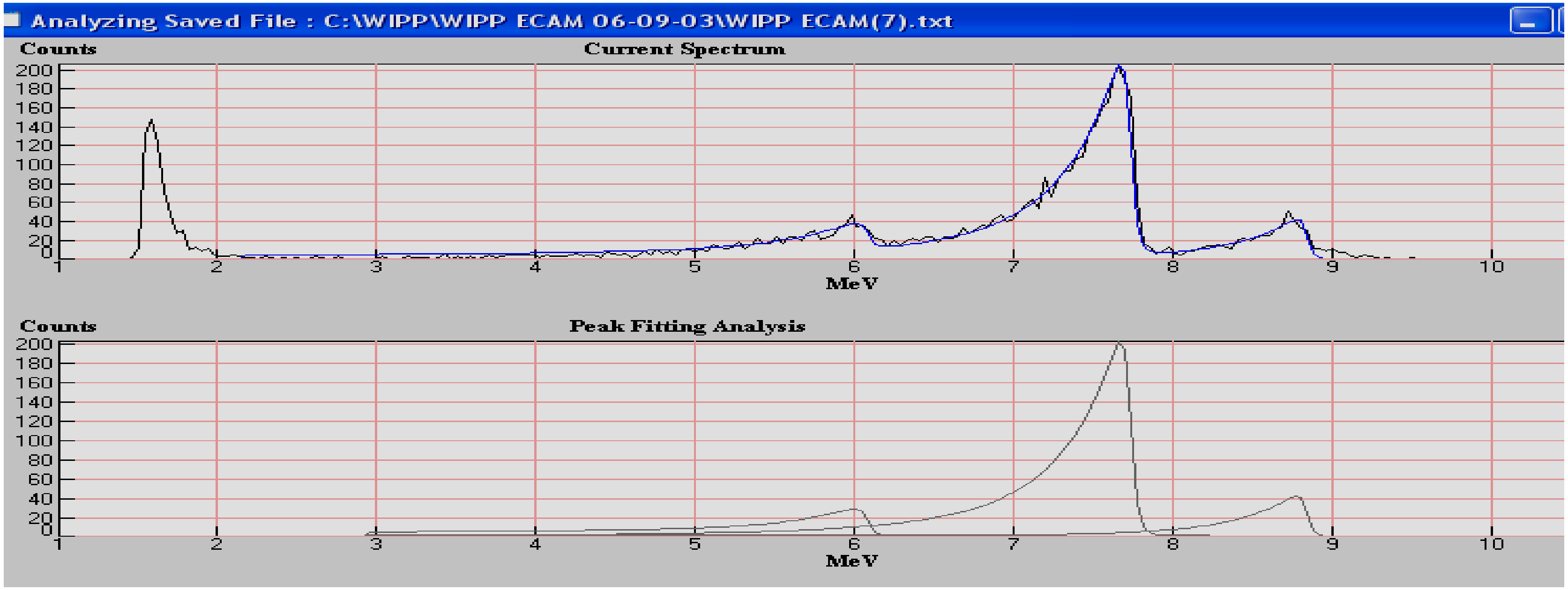
t = fitting parameter, μ= peak centroid channel no,

A= peak amplitude, erfc[] = complementary error function

Other methods ?? Gaussian + exponential tail …. ?

Background correction spectra





CAM design & utilization

CAM inlet design to efficiently capture larger particles significantly improves performance

But CAM performance compromised by poor placement in the work environment

Use of sample extraction/ transport lines further diminishes performance due to line losses

Choice of filter media impacts spectrum analysis

Maintaining adequate sample flow rate a factor

A final thought …

"Radiological air monitoring is not for dabblers…"

George Newton