

Compensation for Radon Decay Products in Air Monitoring Applications Using Alpha Peak-Shape Fitting



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The Background Challenge

- While geographically dependent, radon is naturally occurring virtually everywhere
- Even in HEPA filtered areas, air sampling with filter papers inevitably results in the accumulation of radon progeny
- The resulting alpha count rates are typically many times the level of interest for transuranic regulations

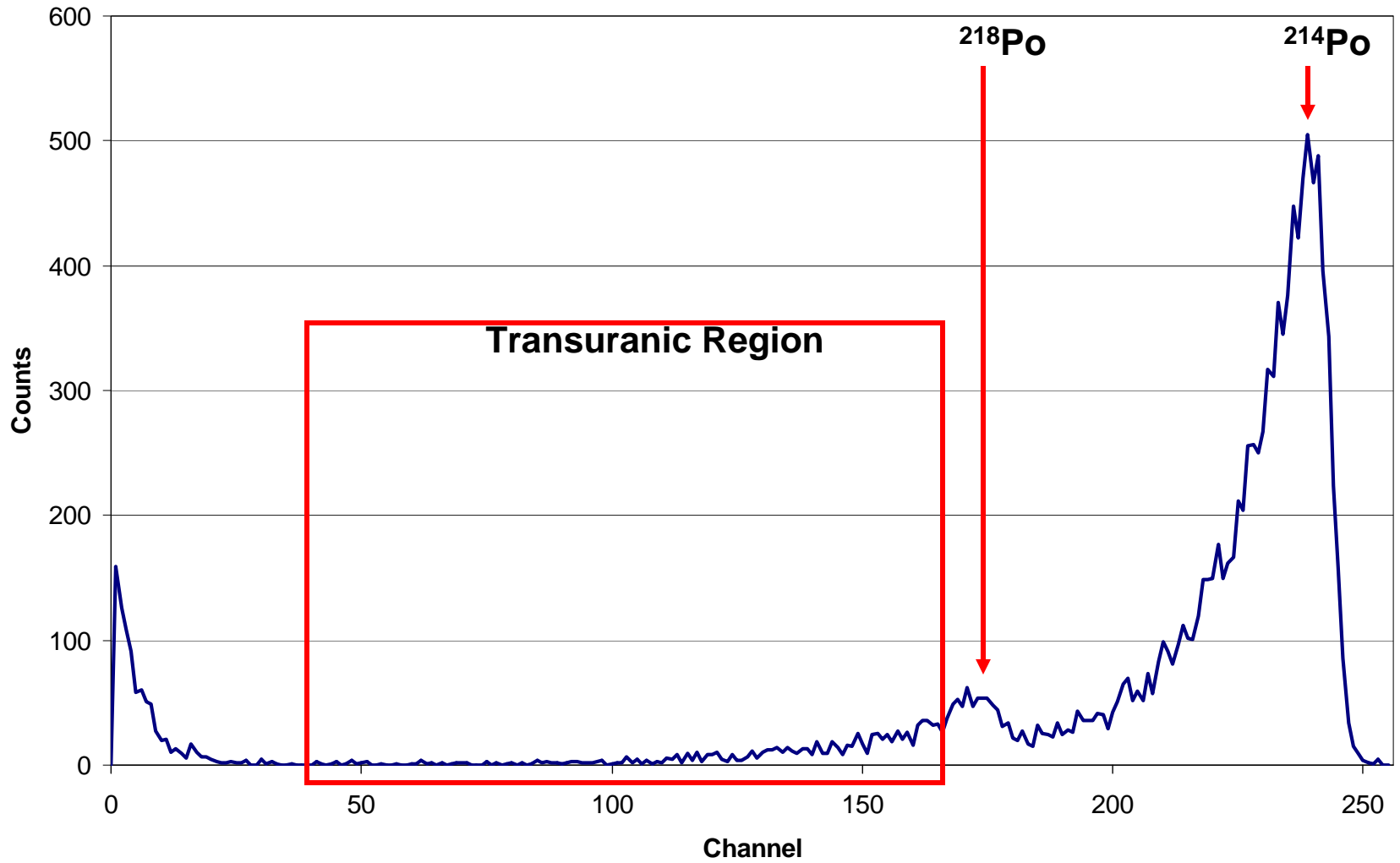
The Alpha Spectrum Problem

- Real-time, continuous monitoring of transuranics prohibits the use of vacuum spectroscopy.
- Measurement of transuranic radioisotopes under ambient pressure conditions is hampered by interference by higher energy alphas from Radon progeny.

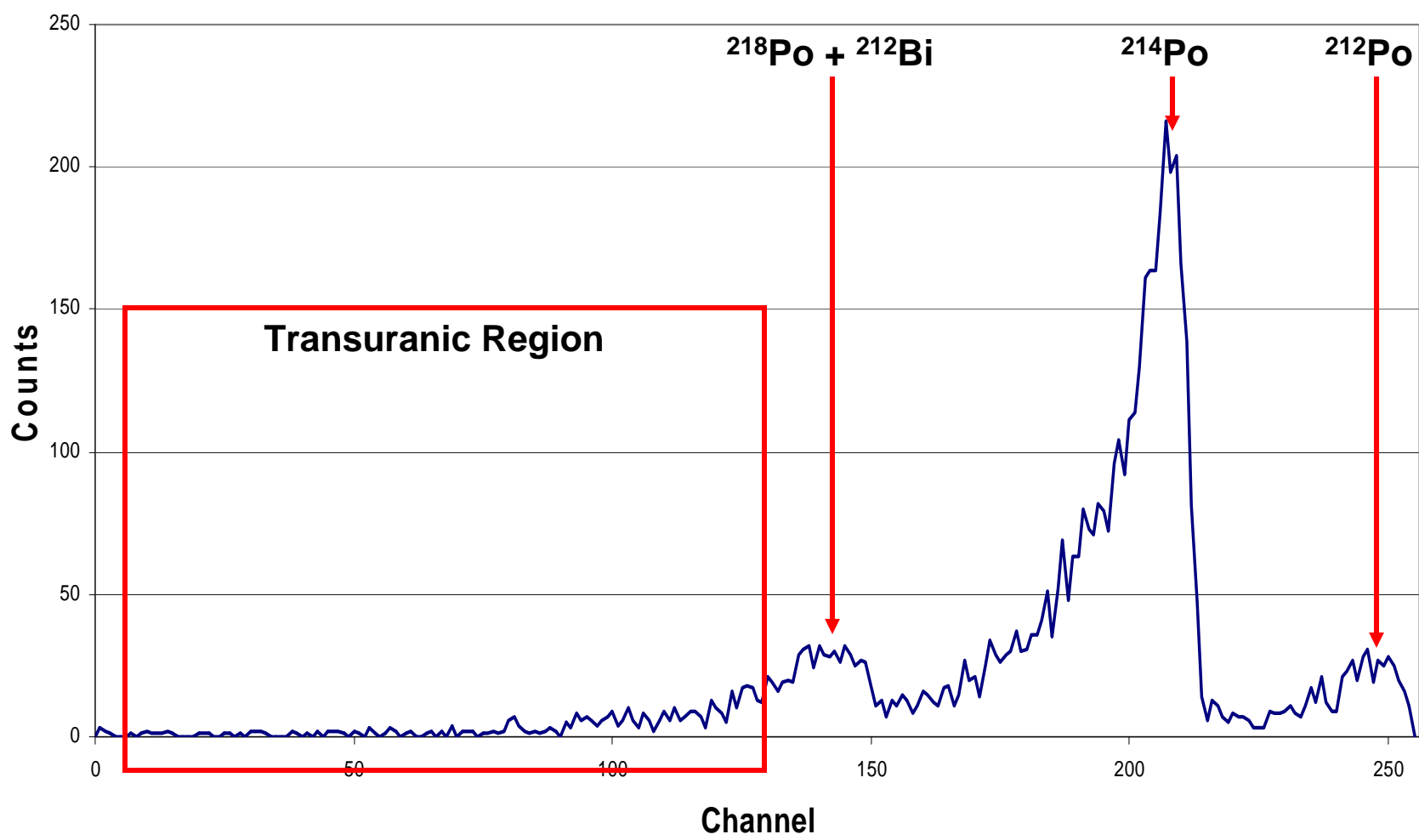
The Radon/Thoron Interferents

- Alpha-emitters from ^{222}Rn chain
 - ^{218}Po @ 6.00 MeV
 - ^{214}Po @ 7.69 MeV
 - ^{210}Po @ 5.30 MeV
- Alpha-emitters from ^{220}Rn (thoron) chain
 - ^{212}Bi @ 6.05 MeV (36% yield)
 - ^{212}Po @ 8.78 MeV (64% yield)

Radon Background Spectrum



Radon/Thoron Background Spectrum



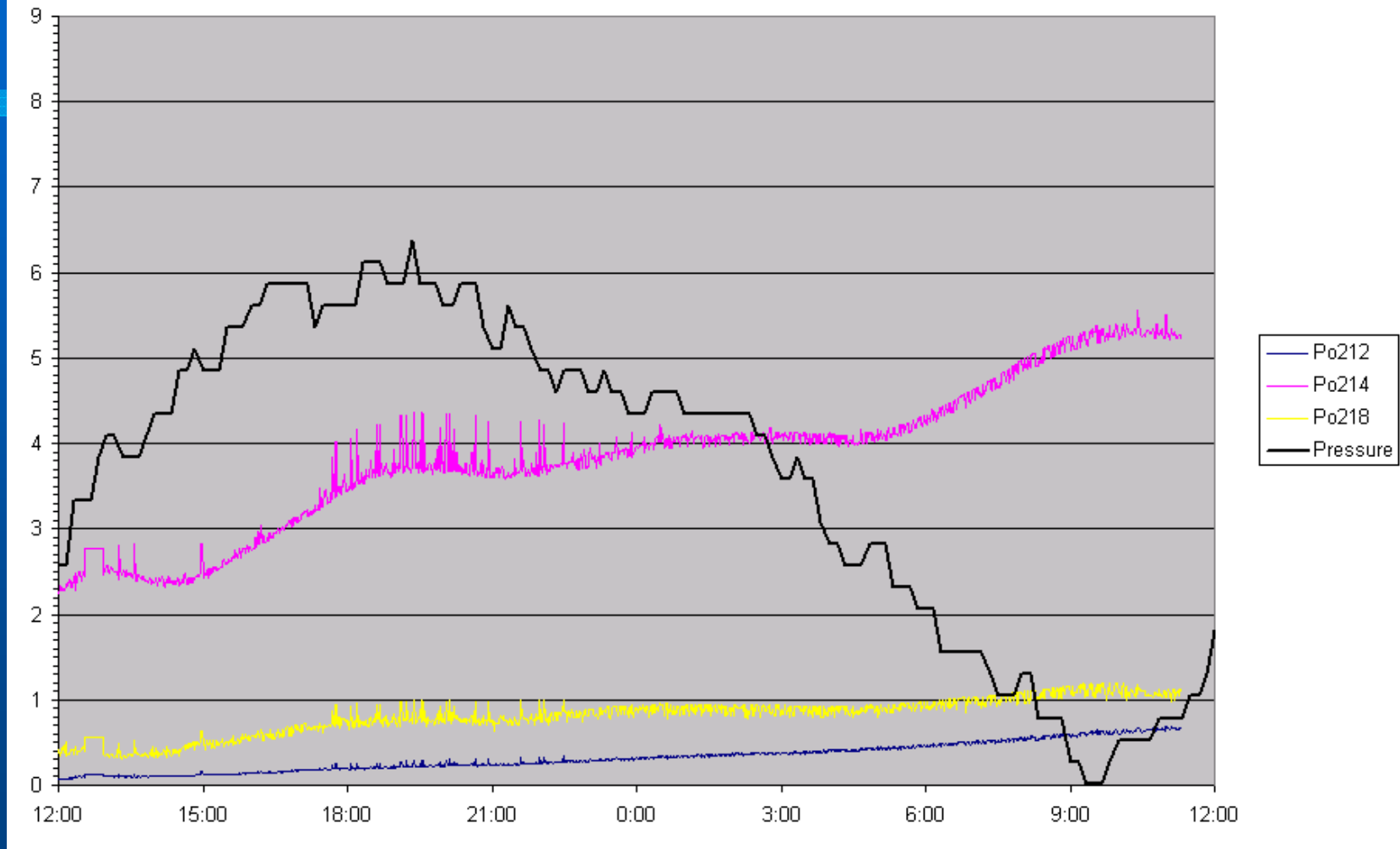
Resolving Isotopes of Interest

- **Counts from the $^{218}\text{Po}/^{212}\text{Bi}$ and ^{214}Po tails interfere with measurements in the transuranic region.**
- **Several factors affect tail interference**
 - Air gap
 - Filter type
 - Dust loading
 - Detector resolution
 - Pressure/temperature changes

Radon Concentration Variability

- Radon levels can vary dramatically with weather conditions
- Radon levels can vary dramatically during the day

Typical Radon Fluctuations



Historical Solutions

Historically, several methods have been employed to compensate for radon interference:

- **Age samples to allow for interferences to decay**
- **Fixed background subtraction**
- **Regions of Interest and fixed ratio subtraction**
- **Exponential tail-fitting**
- **Radon reduction**

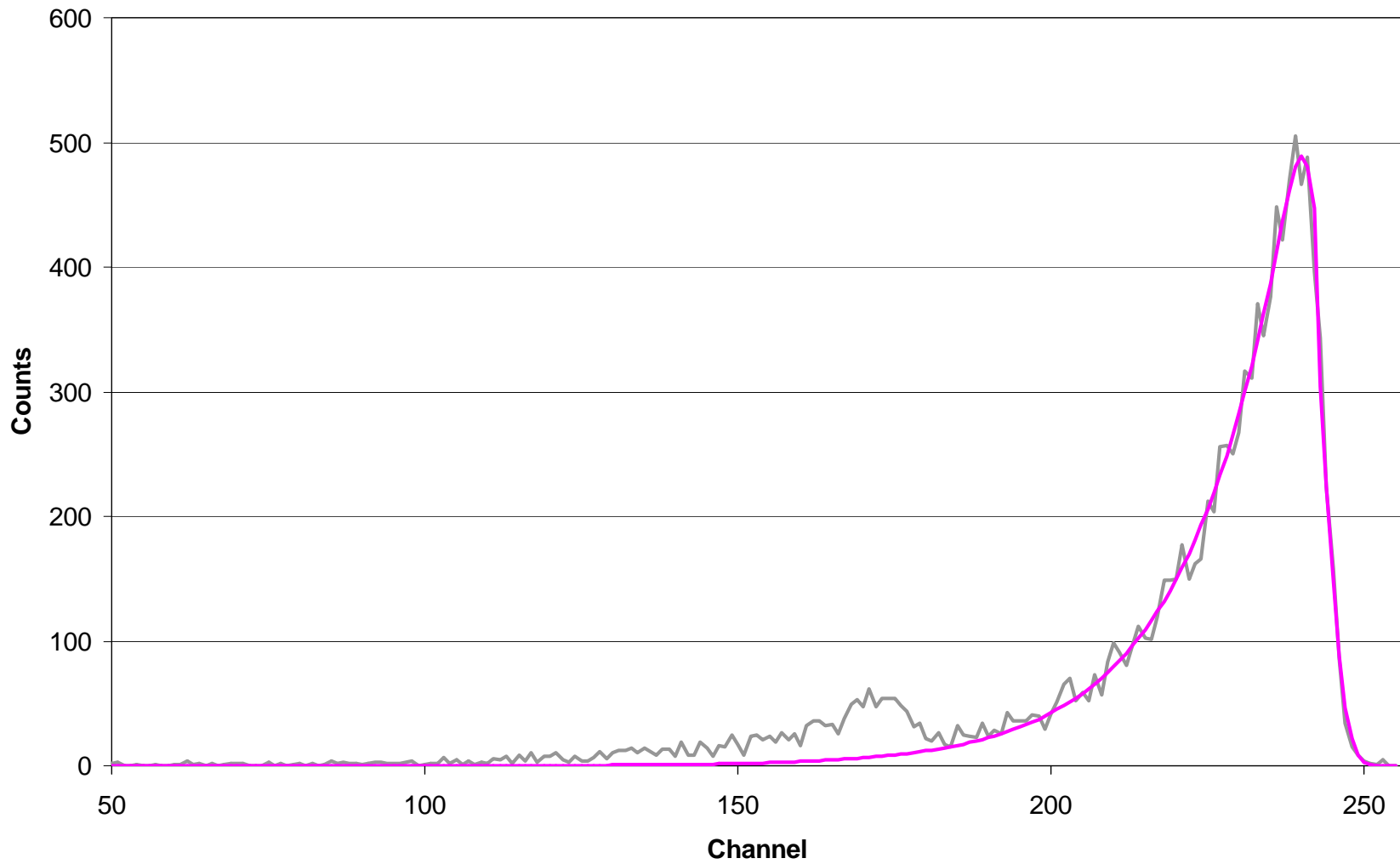
A New Advance In Radon Compensation

Due to advances in microprocessors and miniaturization, peak-shape fitting—a technique used for years in laboratory alpha spectroscopy instruments—is now practical in portable and real-time instruments.

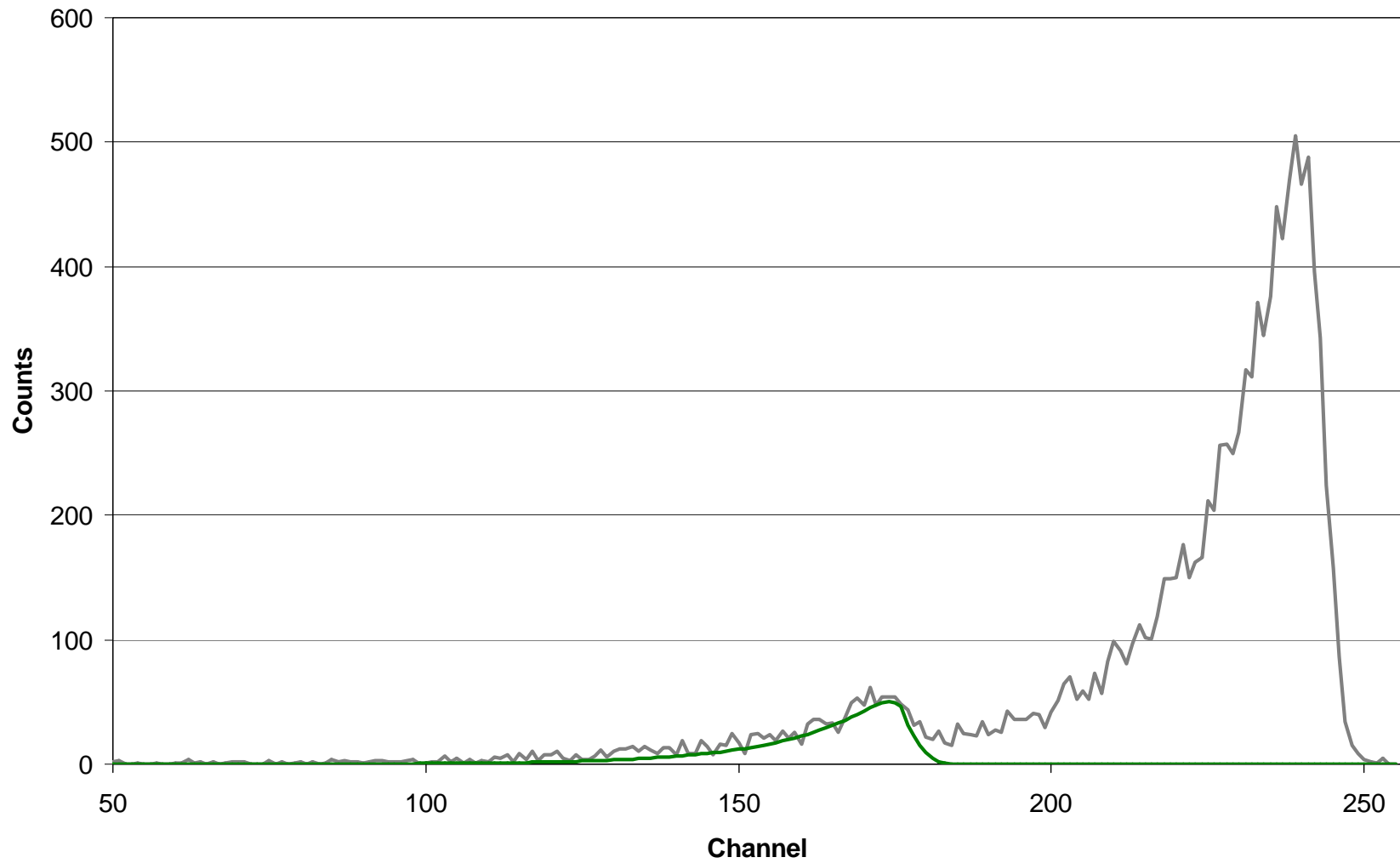
Peak-Shape Fitting Definition

- **Peak-Shape Fitting (PSF) consists of using a mathematical model to represent the spectrum counts for each alpha-emitting isotope so that when the individual models are summed, the result closely approximates the spectrum accumulated from multiple isotopes.**

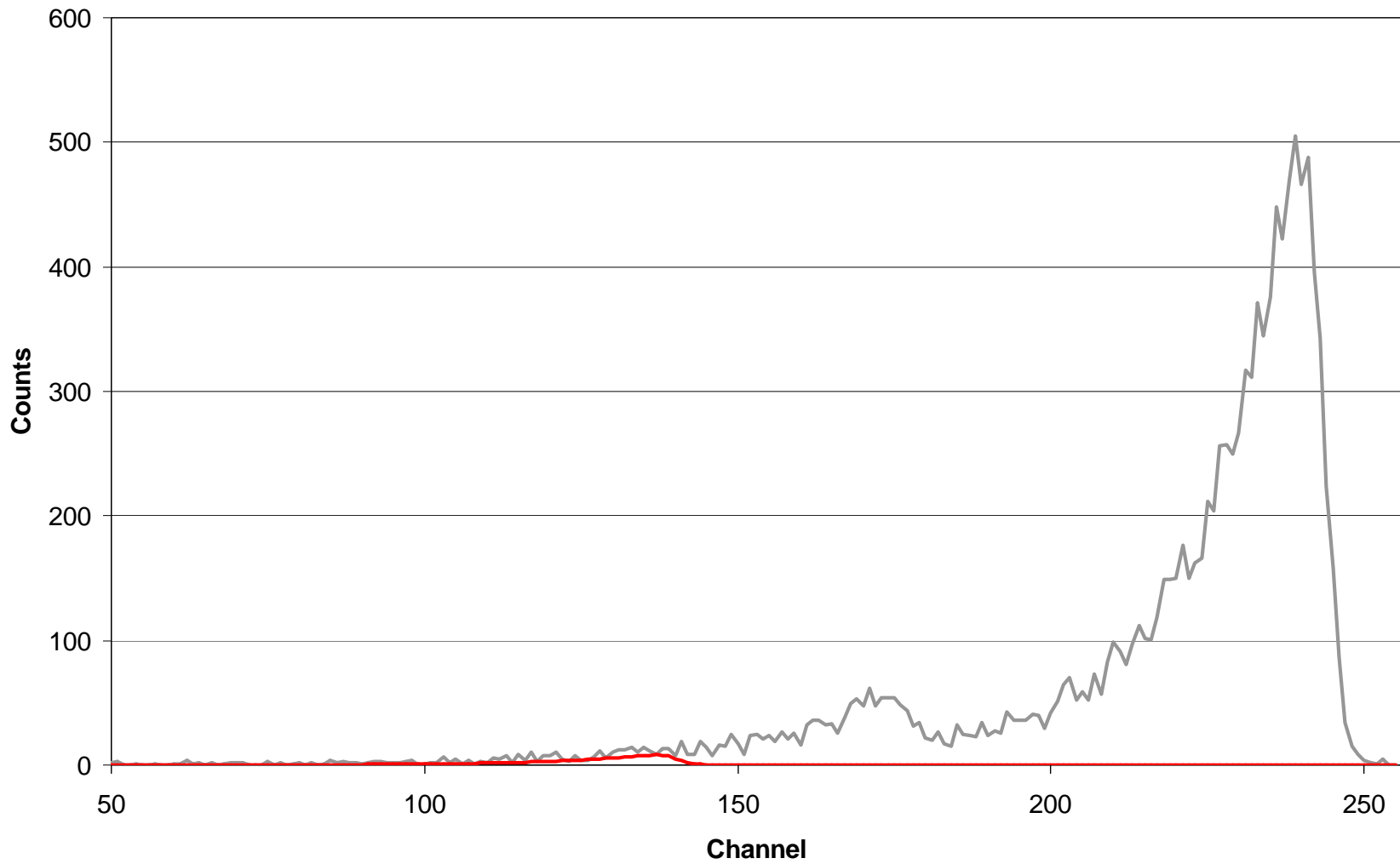
^{214}Po Fit



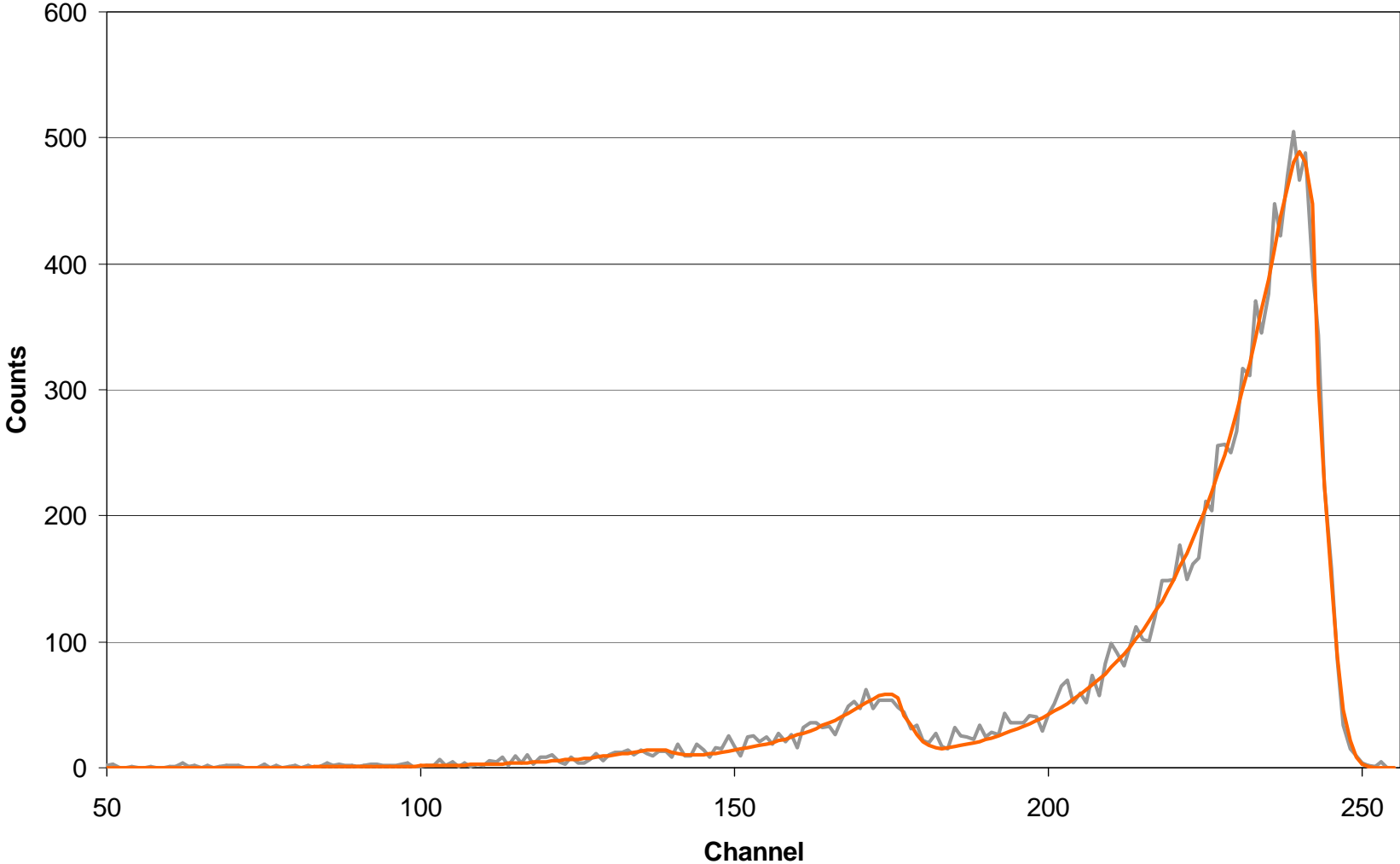
^{218}Po Fit



^{239}Pu Fit



Fitted Spectrum



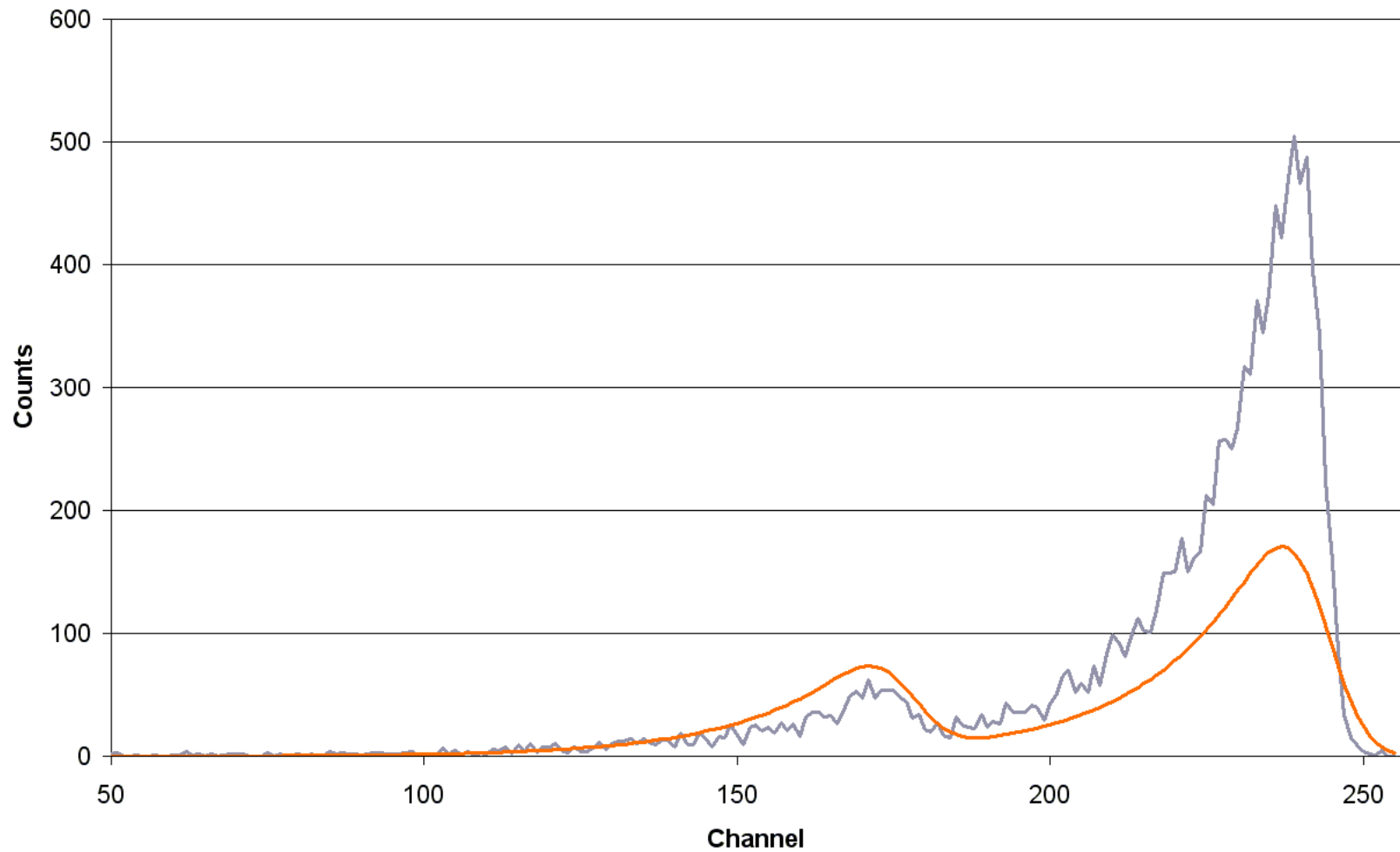
Peak Fit Results

- **After solving for the optimum fit:**
 - **^{214}Po area is 10185 \pm 216 counts**
 - **^{218}Po area is 1051 \pm 147 counts**
 - **^{239}Pu area is 169 \pm 96 counts**

Successive Approximations

- **Begin with initial estimates for peak shape, peak channels and peak areas.**
- **Solve for “best fit” by refining the estimates and comparing the square of individual channel errors.**
- **End when fit error stops improving.**

Peak-Fit Iterations



Peak Fit Method Benefits

- **More accurate radon subtraction**
- **Peak area variances include compensation for interfering peaks**
- **Automatically adjusts to spectrum changes due to:**
 - **Peak shifts**
 - **Dust loading**
 - **Disequilibrium conditions**
- **Ignores most counts resulting from RFI noise**
- **Unusual spectrums produce *Poor Fit* warning**



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Visit Bladewerx on the internet at:

www.bladewerx.com

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