

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

David K. Baltz  
Chief Technologist  
Bladewerx LLC  
Rio Rancho, NM

# 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

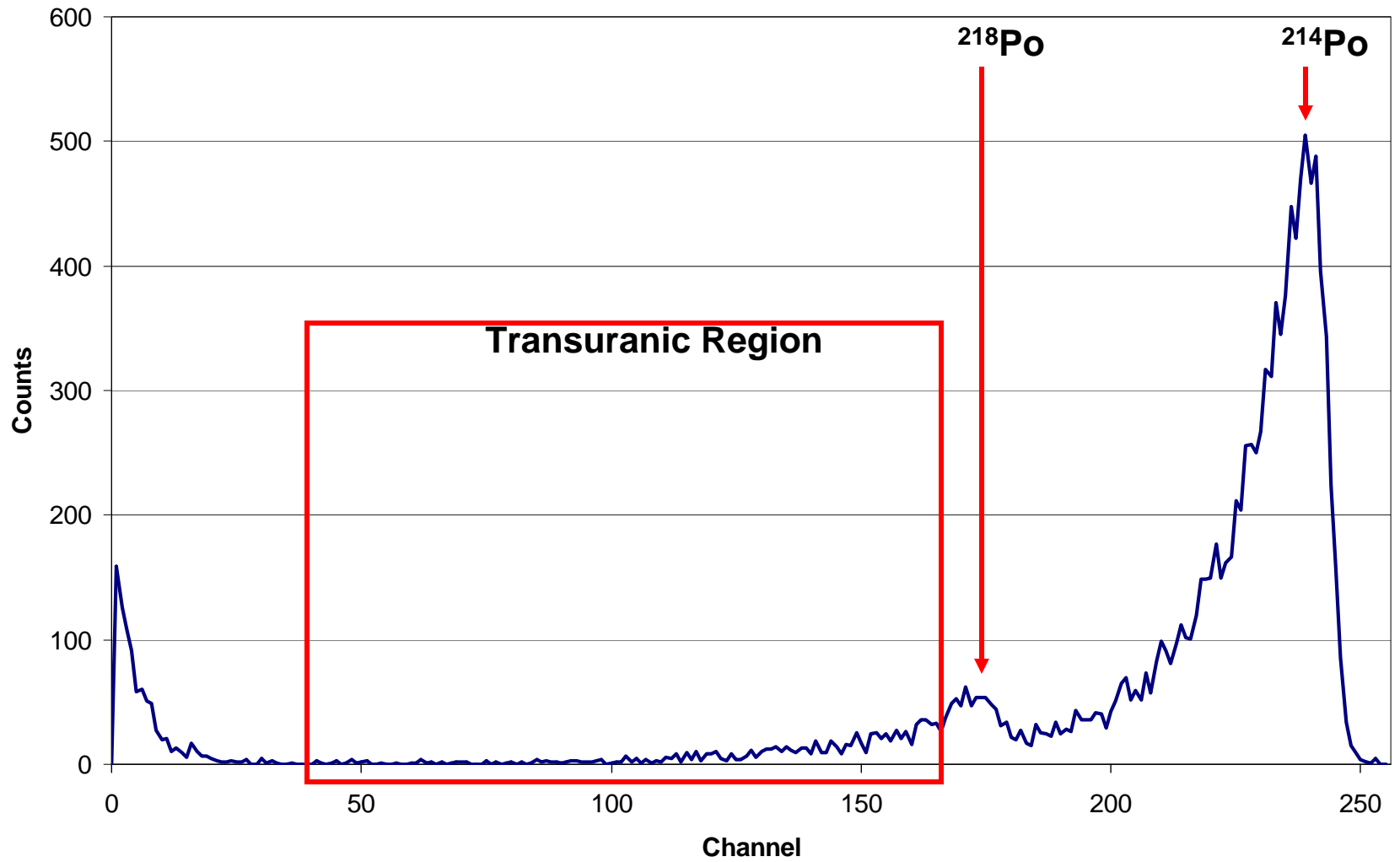
# The Alpha Spectrum Problem

- **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.**

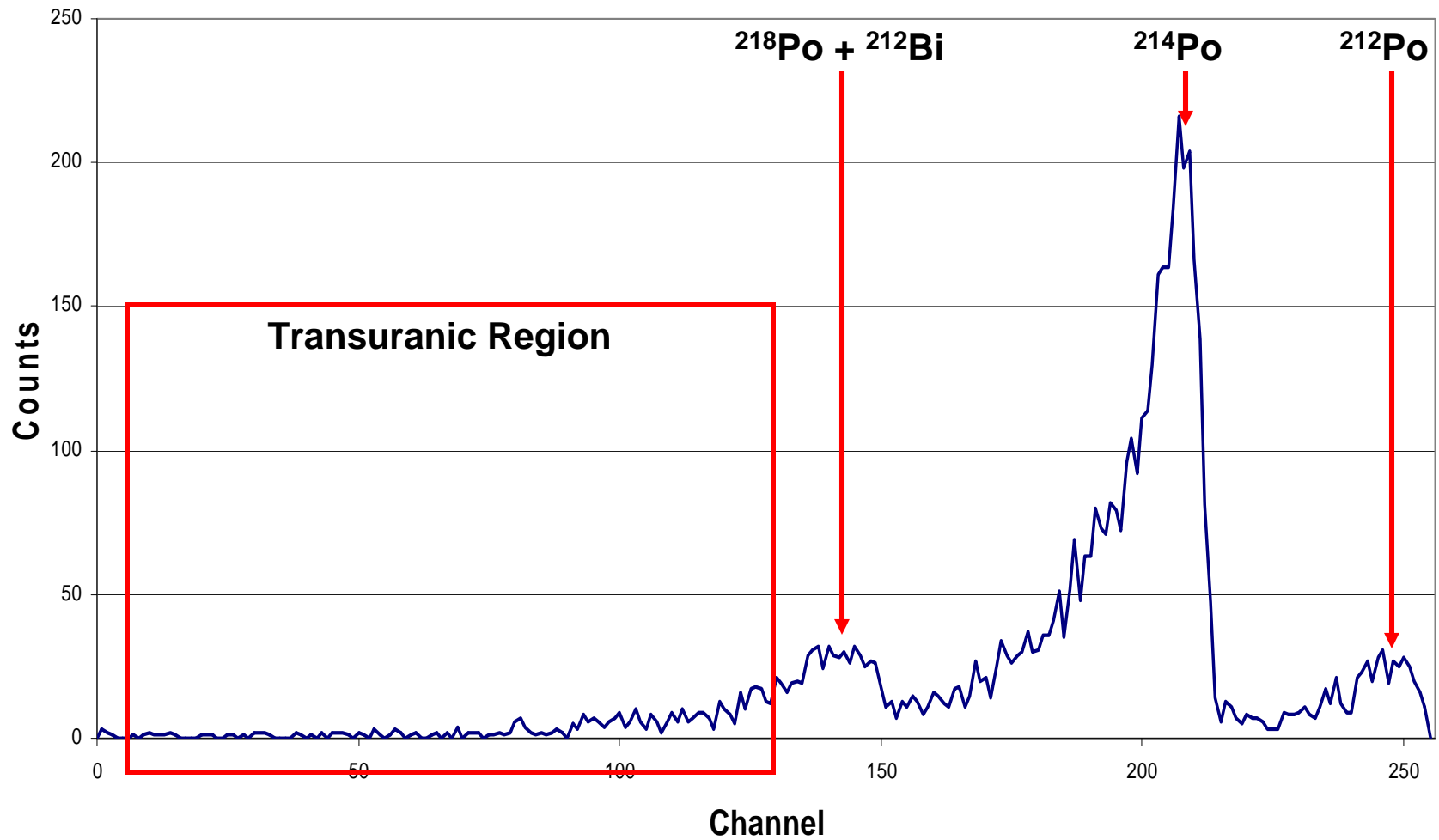
# The Radon/Thoron Interferents

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

# Radon Background Spectrum



# Radon/Thoron Background Spectrum



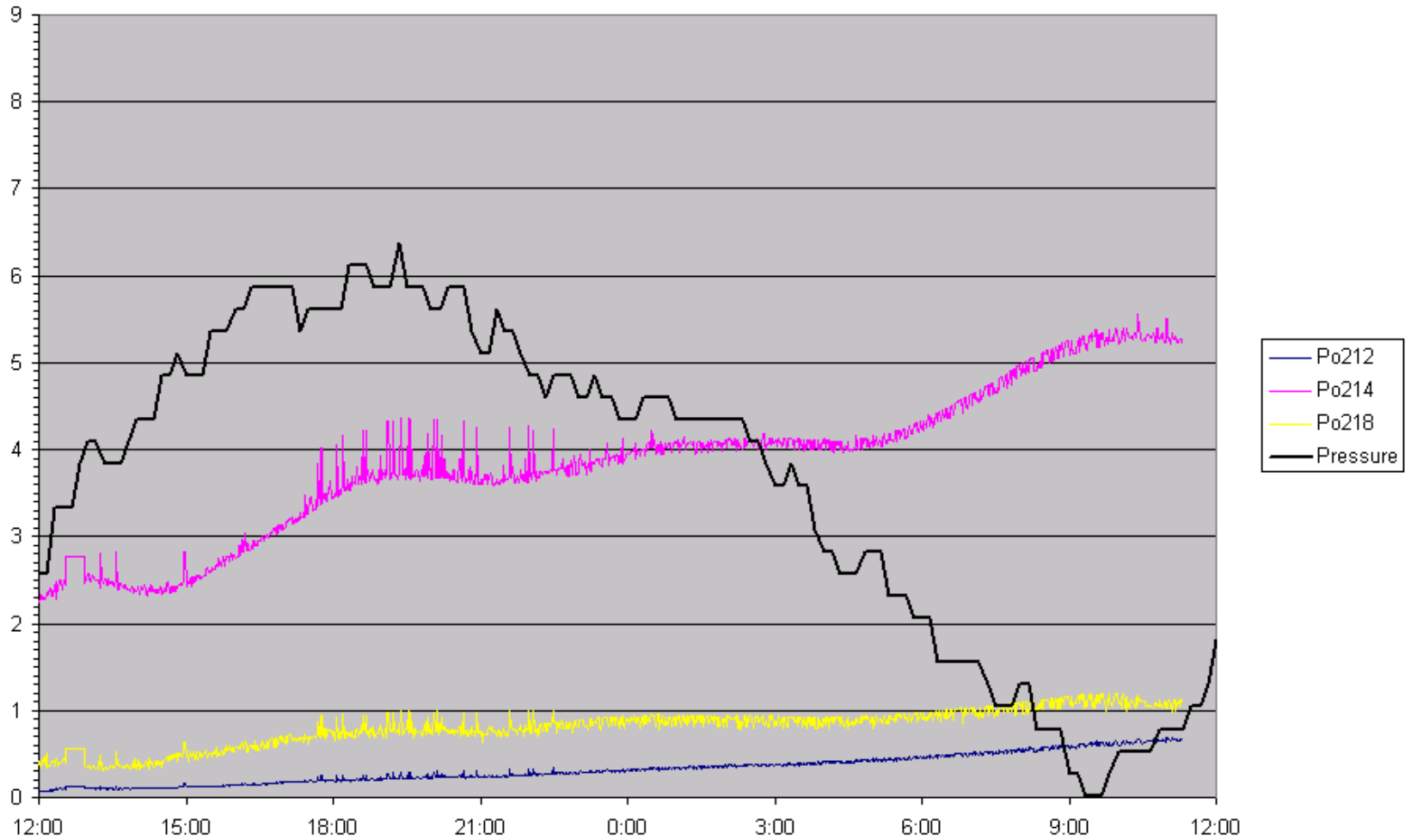
# Resolving Isotopes of Interest

- **Counts from the  $^{218}\text{Po}/^{212}\text{Bi}$  and  $^{214}\text{Po}$  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**

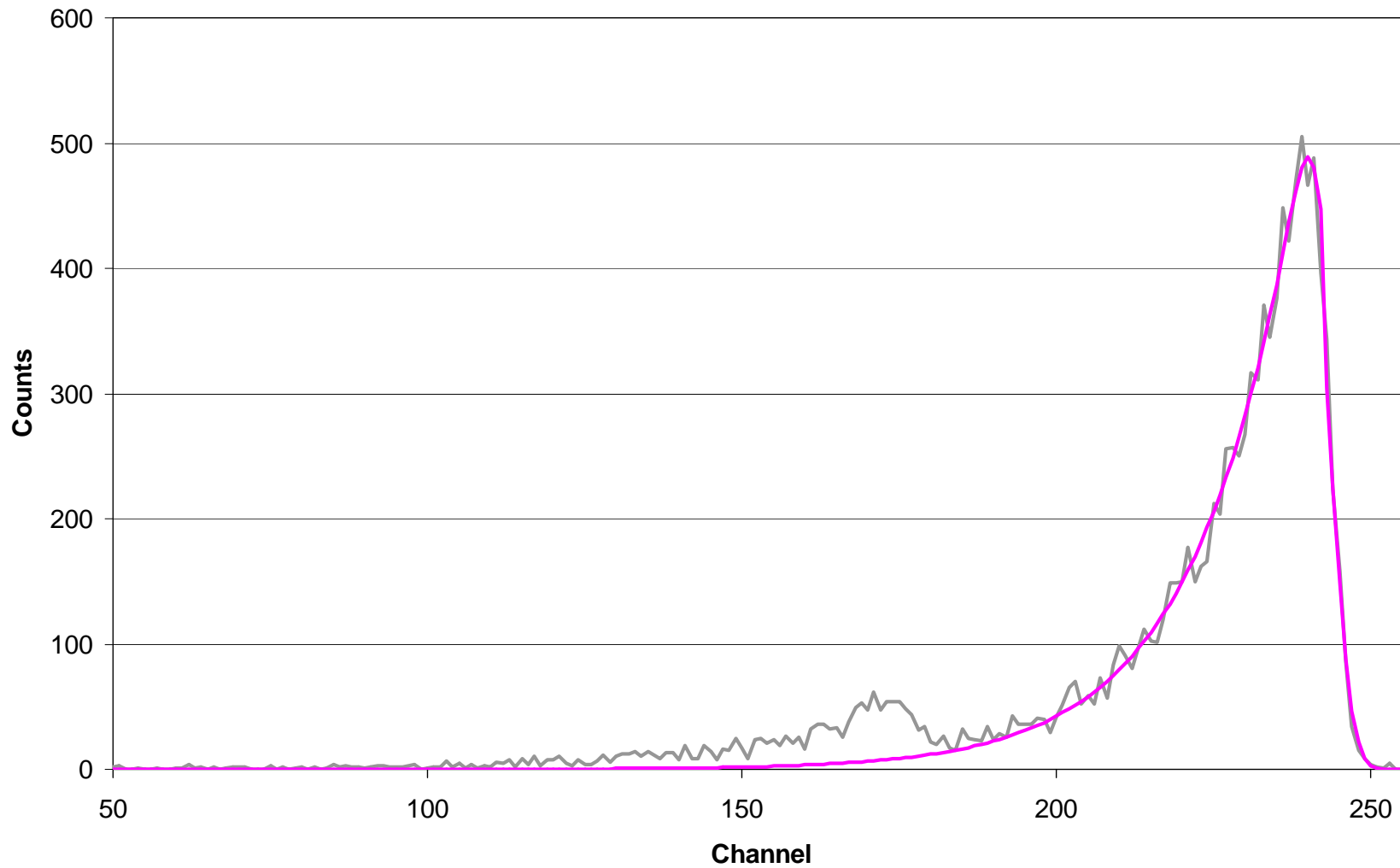
# A New Advance In Radon Compensation

**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.**

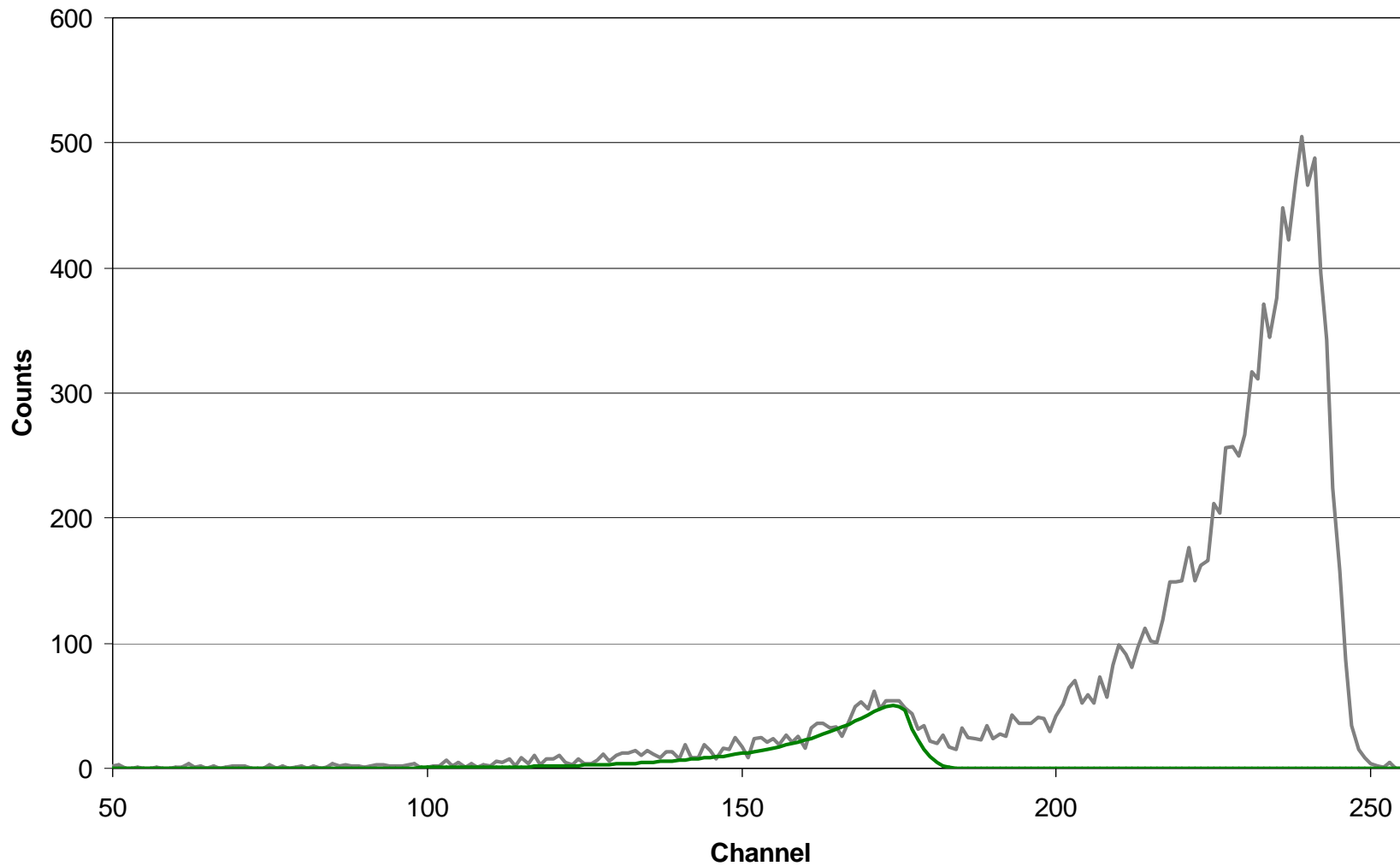
# Peak-Shape Fitting Definition

- **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.**

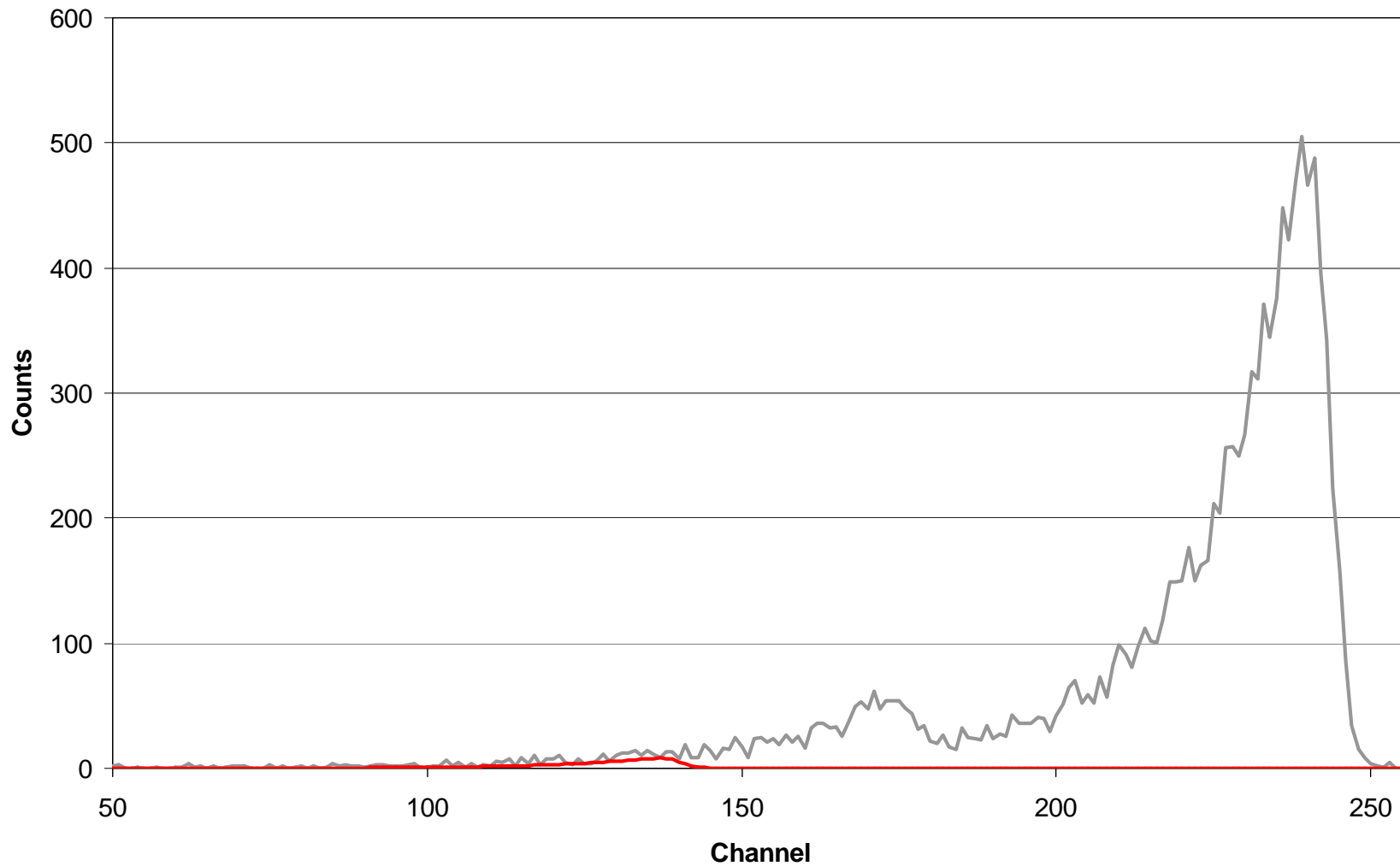
# $^{214}\text{Po}$ Fit



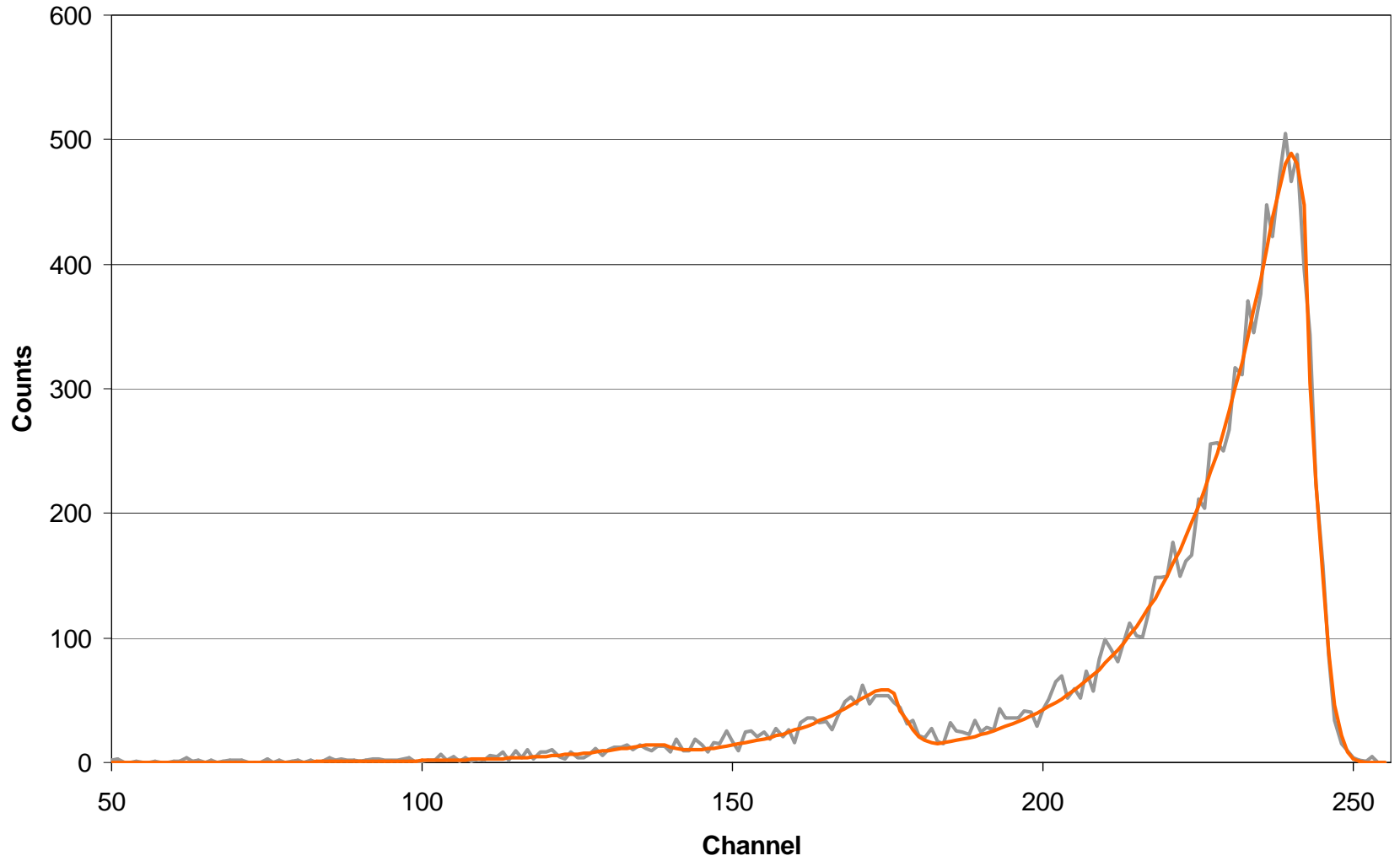
# $^{218}\text{Po}$ Fit



# $^{239}\text{Pu}$ Fit



# Fitted Spectrum



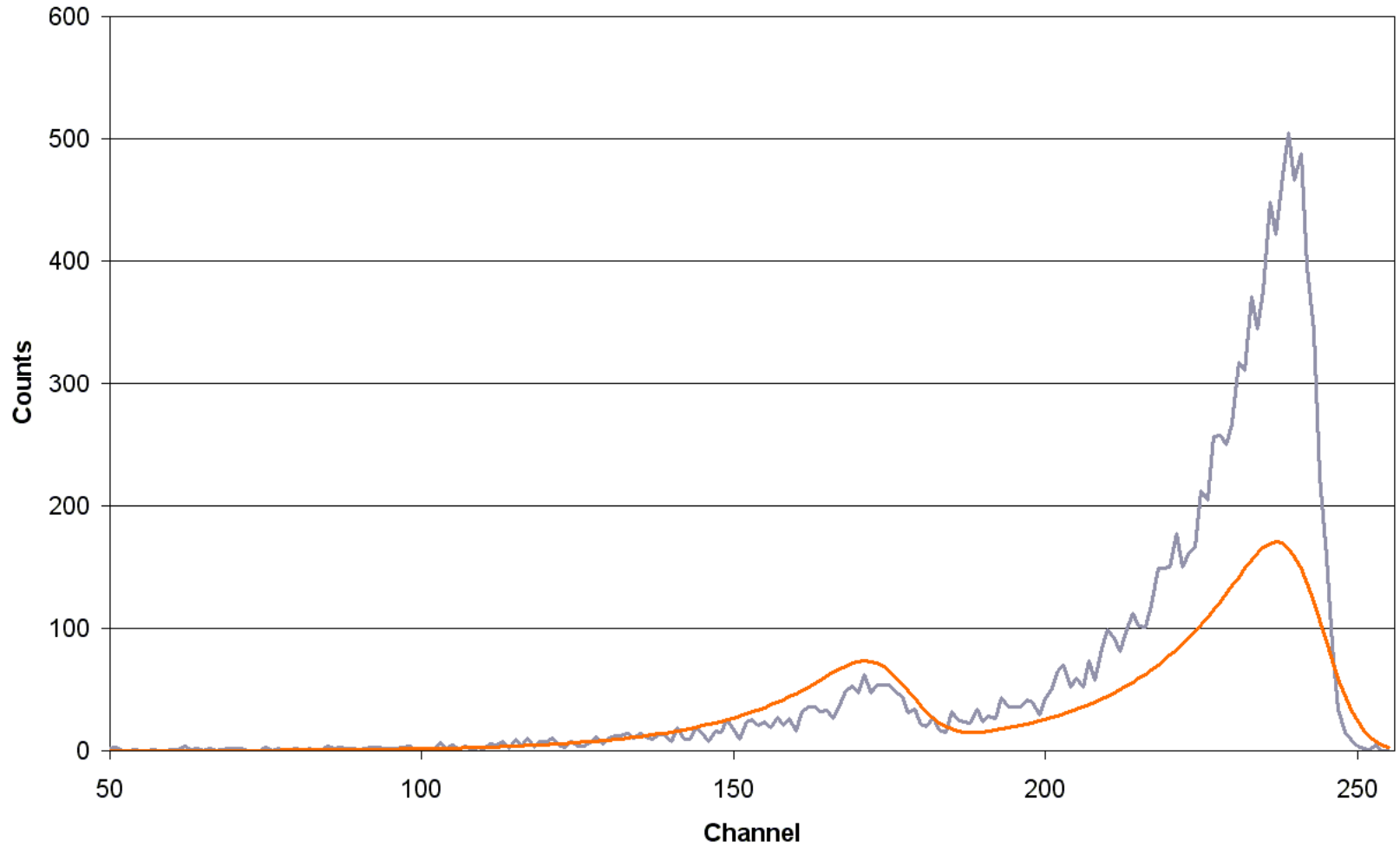
# Peak Fit Results

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

**FOR MORE INFO...**

*Visit Bladewerx on the internet at:*

**[www.bladewerx.com](http://www.bladewerx.com)**

Bladewerx LLC April 2007