



Washington TRU Solutions LLC

Rapid evaluation of anthropogenic activity on smears and air filters using a portable HPGe spectrometer

Robert B. Hayes, Ph.D., CHP, PE
Principal Engineer
WIPP Site, MS 486-05, PO Box 2078
Carlsbad, NM 88221
AMUG Meeting, May 2011, Las Vegas, NV

Opening WIPP and Beyond...



Washington TRU Solutions LLC

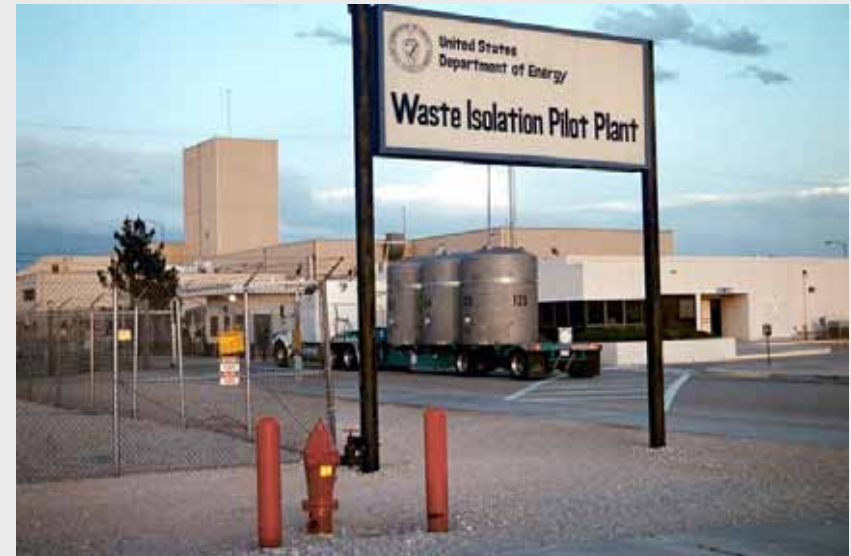
- March 26, 1999 first waste shipment and emplacement in the WIPP underground.
- Because of the intensely dedicated commitment to safety and environmental protection, the WIPP site has continually enjoyed substantial grass roots support from its surrounding communities.
 - Over 2 decades of obtaining the safest mine in the state award
 - Multiple instances of 2 million safe worker hours (4 million 2x)
 - Multiple Department of Energy (DOE) star of star awards, (first of them all including the ISO 140001 and the triple crown)
 - Multiple voluntary protection program (VPP) star among stars awards
 - Continuous VPP certification since 1994
 - A very large number of emergency response team awards (medical and mine rescue), over 7 large trophy cases full!

The WIPP way



Washington TRU Solutions LLC

- Conduct of operations is like gospel
- If it can't be done safely, keep thinking about it until it can
- Safety, Quality and Regulatory Compliance are our main product!
 - If and only if these can be attained, then we work on cost effectiveness (i.e., throughput)



WIPP is a crown jewel of operational excellence



Washington TRU Solutions LLC

- All this while permanently emplacing over 2 million cubic feet of Transuranic waste (including both contact handled and remote handled TRU waste)
 - In a fully operational mine
- The waste arrived in over 9,450 shipments traveling almost 11 million miles (over 22 moon trips) without a single detectable release of radioactivity
- Total waste emplaced is over 74,000 cubic meters



Does WIPP serve National Security?



Washington TRU Solutions LLC

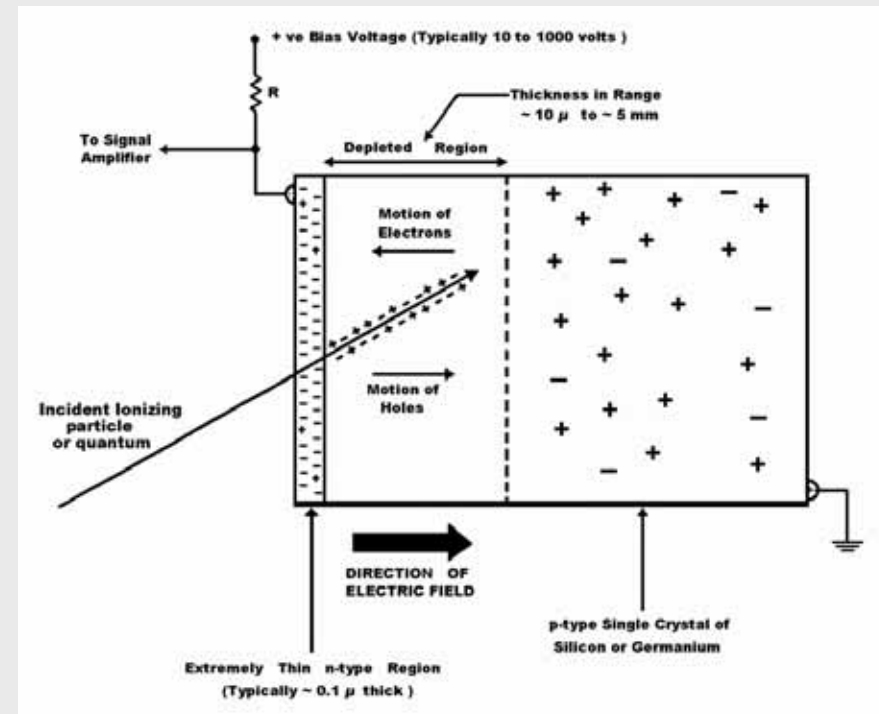
- Almost 2 million curies emplaced in the WIPP underground
- Permanent removal from the biosphere of 5 million curies authorized for WIPP through the Land Withdrawal Act
 - A very wise act of congress in my opinion
- WIPP has cost around 5 billion dollars to date during operations and will cost around 10 billion at end of mission.
 - Yucca mountain has already cost around 5 billion and was estimated to cost around 100 billion by the end of its mission, values keep rising
 - Is WIPP showing a cost effective model for a geological repository?

Gamma spectrometry



Washington TRU Solutions LLC

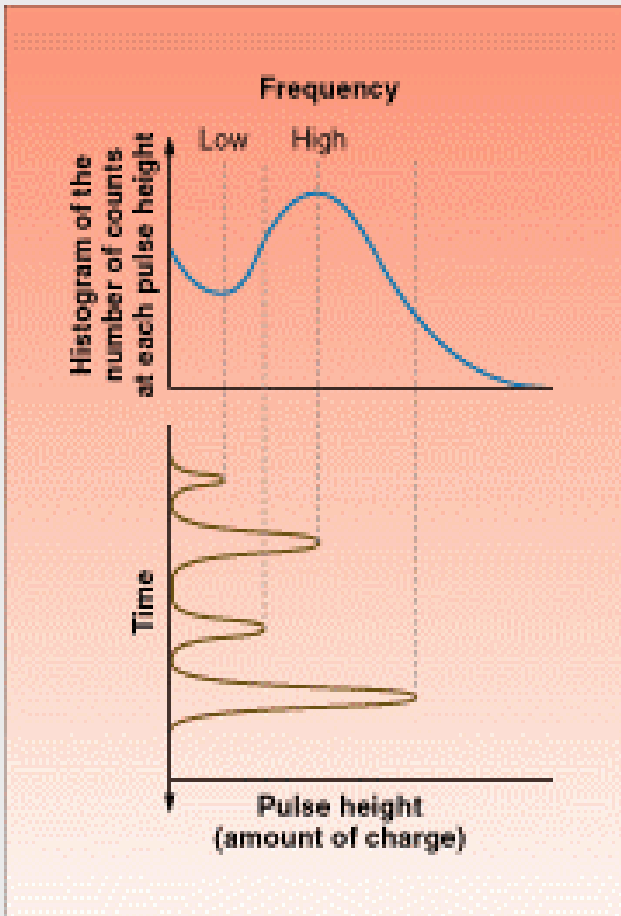
- Requires measuring the energy of each photon detected.
- Typically done with solid state detectors but can be done with ion chambers.
- Solid state detectors include GeLi, SiLi, HPGe
- Total ionization is correlated with incident particle energy



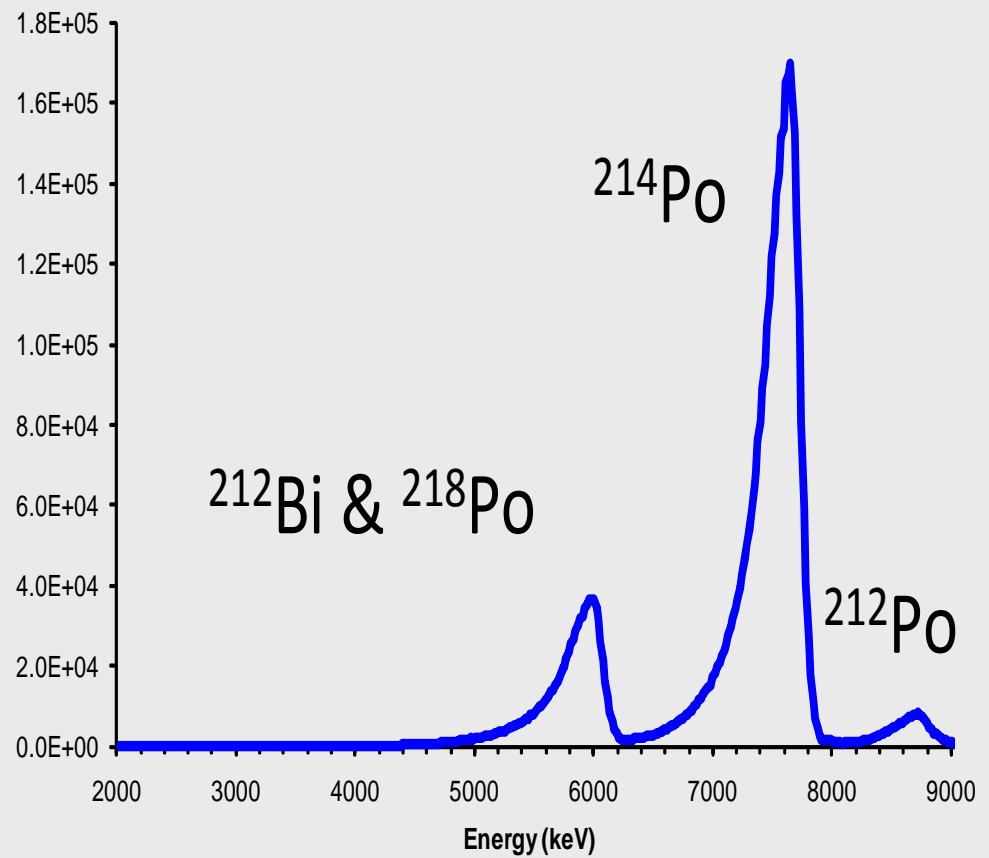
Output histogram



Washington TRU Solutions LLC



11-PEA-4 97 Fig. 2



Ortec Microdetective



Washington TRU Solutions LLC

- Portable High Purity Germanium (HPGe) detector.
 - HPGe is the gold standard for gamma spectrometry
- Designed for Search and interdiction type operations for Homeland Security missions
- Intended to be operated by firemen, police and border protection type users.



SNM Mode 12/08/2006 3:00:40 PM
Storage Space: 1900 Files

Pu-239 Region

U-235 Region

Neutron

SNM may be present. Position Detective to maximize reading, then press Identify to confirm.

Identify Back

ID Mode Elapsed Time: 94 sec
Storage Space: 1973

Neutron Count Rate = 0 cps

γ Dose Rate = 0.72 μ Sv/h

Am241, Count for > 3 minutes
Cs137
Co60
K40

Intense Display Search

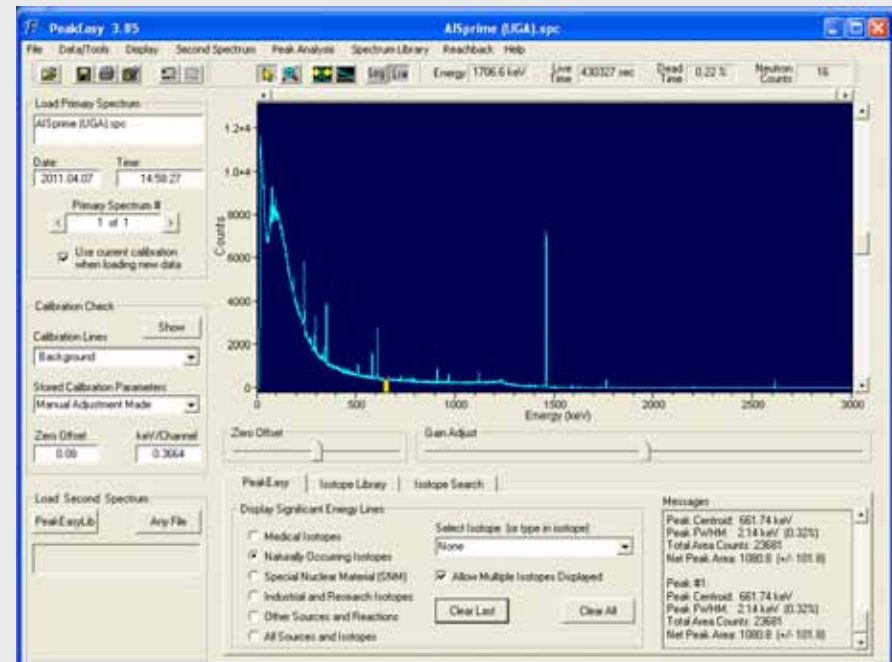
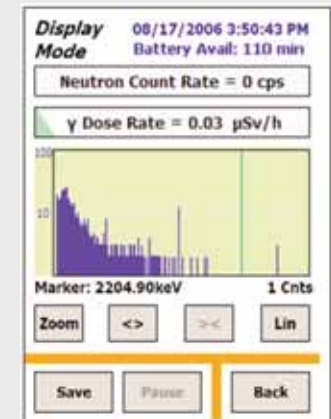
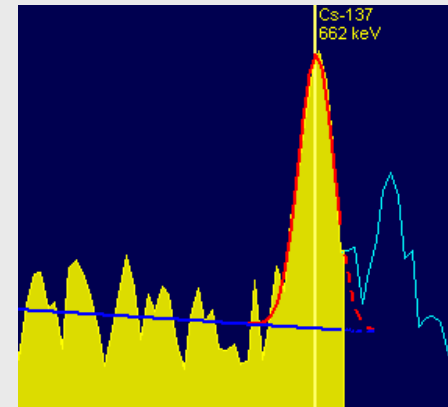
Save Pause Back

It knows TRU nuclides, is that enough?



Washington TRU Solutions LLC

- Sensitive enough to see environmental Cs137 in the WIPP underground after counting for 1 week
 - Equivalent to about 1 nCi at 2 m
- Regularly mistakes natural Ra226 for U235
- Is truly simple enough to insure verbatim compliance.

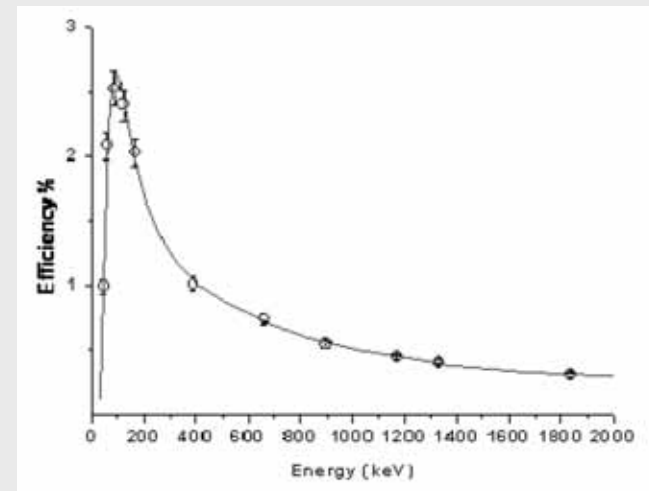


Measuring time to alarm



Washington TRU Solutions LLC

- Single source at fixed incremental distances to simulate varying activity sources.
- Normalization of fluence based on solid angle to approximate multiple activity sources.
- Repetition of source at fixed position to obtain statistics
- Source and detector always colinear
- Only Am^{241} measured at this time
- Efficiency curve not measured, only estimated



Functional dependence on time to alarm



Washington TRU Solutions LLC

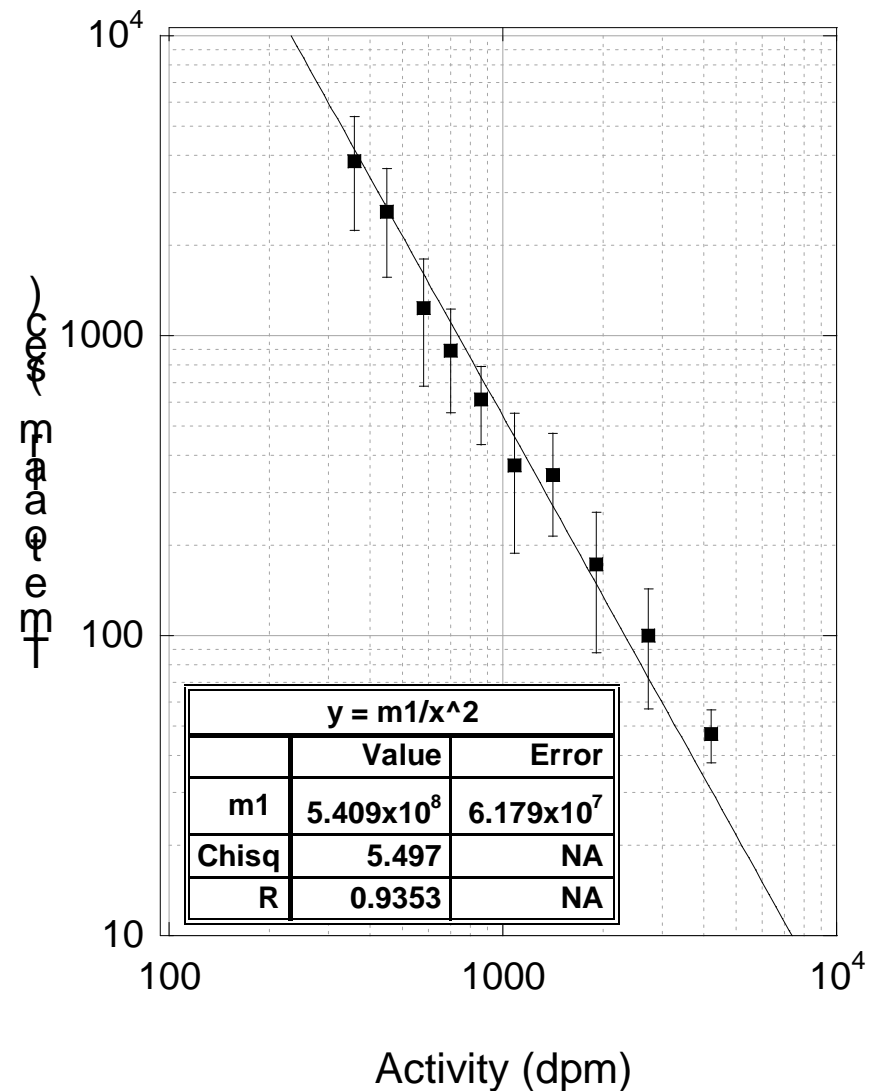
- Signal to noise = S/N
- Alarm occurs at some threshold $S/N = C$
- Signal Rate = S'
- Noise is only Poisson background = $B^{1/2}$
- Background rate = B'
- Time to alarm = t
- $C = S/N = S/B^{1/2} = S' \cdot t / (B' \cdot t)^{1/2} = S' \cdot (t/B')^{1/2}$
- or $C = S' (t / B')^{1/2}$
- Solving for t gives $t = C^2 B' / S'^2$
- Now S' is a measure of the activity of the source so $A = S' / k$ allowing the activity dependence of time to alarm to be found as
- $t = C^2 B' k^2 / A^2$

Minimum detectable activity?



Washington TRU Solutions LLC

- Performance right out of the box for Am^{241}
- High contamination or airborne activity (2000 dpm/100 cm^2) can be seen in a few minutes.
- Contamination area (20 dpm/100 cm^2) wait times are completely out of reach
- How to improve?

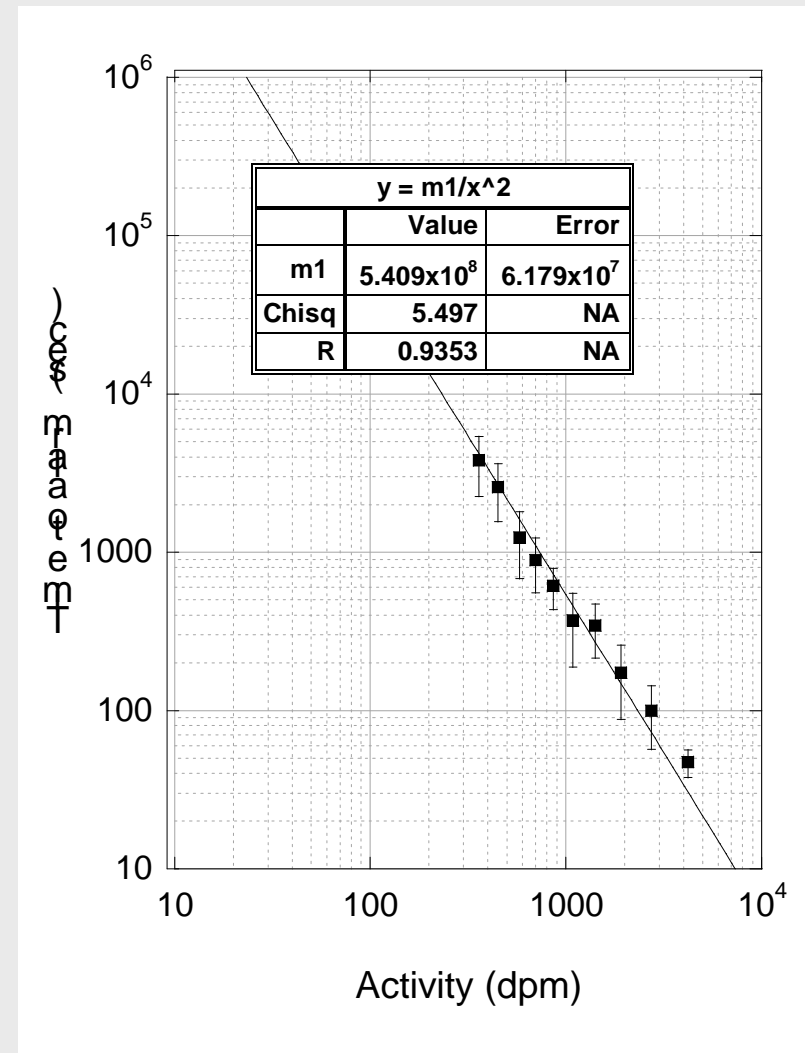


Without custom application changes



Washington TRU Solutions LLC

- The vendor offers an LCX mode which alarms at a 30% lower $S/N=C$
- The vendor offers a tungsten cap to fit over the entire detector nose to lower B'
 - Sufficient clearance is there for a smear
- Quadratic in C and linear in B'
 - $t = C^2 B' k^2 / A^2$

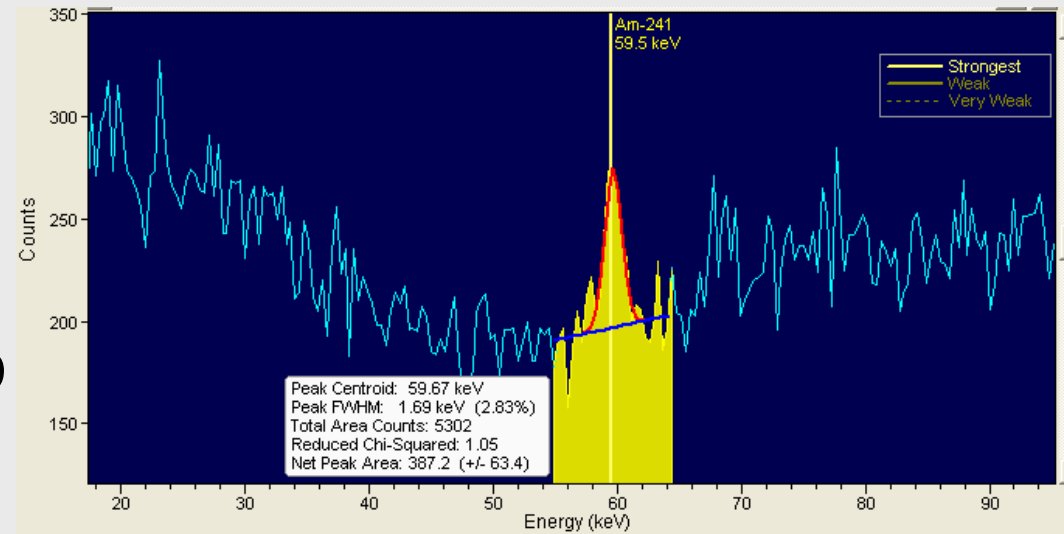


Next steps



Washington TRU Solutions LLC

- Do full multivariable solid angle correction
- Measure for other isotopes in addition to Am241
- Realize this is only a “go, no go” quick check on high contamination and invest time and energy accordingly
- Engineer tripod for counting



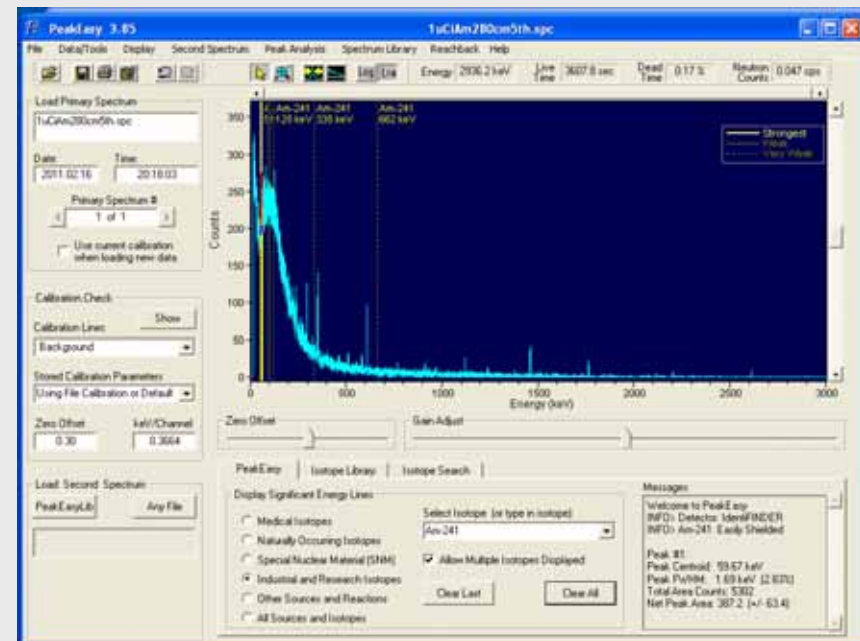
Options and potential

Multiple application uses have been identified

- User friendly for “go, no go” call in high contamination of Am241
- Expected to quickly identify low levels of Cs137 contamination
- Has been shown to be useful in emergency response as a rapid whole body counter
- Background measurements

Formal spectral analysis requires “expert interpretation”

- Not desirable for routine operations



Conclusion



Washington TRU Solutions LLC

- Limited utility of portable HPGe for WIPP has been found.
 - High Am241 contamination, lower levels of other fission products are expected (but not yet measured).
 - Emergency Response and background measurements
- WIPP has enjoyed over 12 years of safe regulatory compliant operations.
- WIPP has demonstrated a commitment to finding science based solutions to technically demanding problems and has enjoyed measureable success in doing so.
- WIPP is committed to the continuing science based operations focused on safety integrated into our regulatory compliant disposal of TRU waste in this, the worlds first licensed geological repository for TRU waste.