NUCLIDE SPECIFIC ANALYSES OF ACTINIDES

IN SUMP WATER USING PERALS™

Brookhaven Graphite Research Reactor
SUMP TREATMENT PROJECT
December 1997

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ABSTRACT

A rapid (one day) method to simultaneously determine ' total' Plutonium, Uranium, Thorium and Americium in β–contaminated environmental water samples was developed and tested at Brookhaven National Laboratory (BNL) using the PERALS™ (Photon-Electron-Rejecting-Alpha-Liquid Scintillation) system. The PERALS™, with a 99% α–detection efficiency, can electronically filter out unwanted β/γ signals present in a sample. Water is processed using a six step procedure designed to sequentially extract 4 actinides (Pu, Am, U and Th) from a single 400 mL sample. Three commercially avialable organic-based scintillating solutions, compatible with the PERALS™, were used to extract the 4 actinides from water. Specifically, two successive 2 mL extractions, using ALPHAEX™, separate Pu from Am under different chemical conditions. The uranium/thorium rich aqueous fraction was then processed using two successive 4 mL amounts of THOREX™ and URAEX™ extractive scintillators which extract Th and U, respectively.

The method was first tested using individually spiked tap-waters containing α-emitting Th-230, Pu-236, Am-243 and U-232. Recoveries for each of the 4 added tracers were > 95% under pre-defined chemical conditions. The Minimum Detectable Level (MDL) for a 400 mL sample counted 30 minutes in a PERALS spectrometer was < 1 pCi/L, based on separate 'method blank' measurements. Actual BNL sump water samples were collected in 400 mL glass bottles from the decommissioned Brookhaven Graphite Research Reactor (BGRR). The samples were filtered, acidified and spiked with about 100 dpm each of Th-230, Pu-236, Am-243 and U-232 yield- tracers and processed using the tested BNL method.

Because the PERALS™ cannot resolve α energies < 250 keV, some isotopes of uranium, Pu or thorium could not be individually quantified. The algorithm used to determine total Pu, Th and U activites in each extracted fraction was to integrate the total number of counts (cpm) aquired under the combined 'tracer + actinide-of interest peaks'. This count-rate was assumed to be representative of the total number of disintegrations per minute (dpm) in the spiked sample because the PERALS α-detection effciency is > 99%. For each counted fraction, the amount of spike added to the original sample (dpm), multiplied by the method recovery, was subracted from the measured total activity, yielding the net ' total' activity of the actinide-of-interest. Method recoveries for each of the 4 actinides were determined from a separate spiked tap-water sample. Data with 2σ uncertainties are presented for 6 BNL/BGRR water samples measured for total U (i.e., U-234,U-235,U-238), total Pu (i.e., Pu-238, Pu-239/240), total Th (Th-224, Th228) and Am using the PERALS method.

Plan for Sequential Extraction of Ra-226 and Actinides from BGRR Sump Water

Alpha specific nuclide analyses, performed by EPI/GEL Laboratory, Charleston SC in October 1997, indicated that 3 actinides (^{241}Am, $^{238,239,240}Pu$, $^{234,235,238}U$) as well as ^{226}Ra, were present in the BGRR sump water with maximum concentrations less than 200 pCi/L (see below)

Both tri-valent actinides ^{244}Cm and ^{237}Np were not found in the BGRR sump water (which simplifies the sequential extraction scheme)

The levels of $^{90}Sr/Y$ and ^{137}Cs were **10.9 uCi/L and 4.35 uCi/L**, respectively.

The presence of beta-emitting $^{90}Sr/Y$ and beta/gamma emitting ^{137}Cs in the BGRR water poses no problem because the PERALS can reject the unwanted signals from these radionuclides that may co-extract into the extractive scintillators.

Radionuclides in BNL/BGRR Sump Water

Nuclide	Concentration (pCi/L) 9/18/97	Concentration (pCi/L) 10/3/97
Am-241	30.2 ± 15.2	24.5 ± 3.3
Pu-239/40	44.2 ± 14.1	164.0 ± 21.6
Pu-238	22.4 ± 12.2	4.6 ± 1.7
U-235	11.0 ± 7.2	14.3 ± 2.6
U-234	47.0 ± 15.6	69.1 ± 8.1
U-238	56.8 ± 16.5	72.4 ± 8.4
Ra-226	27.5 ± 20.7	ND
Sr-90	10,900,000 ± ?	ND
Y-90	"	
Cs-137	4,354,000 ± 62,700	ND
Tc-99	14,600 ± 1,860	ND
H3	41,600 ± 18,900	ND

Analyses performed by EPI/GEL using HASL-300 or equivalent methods.

METHOD

A sequential extraction scheme was proposed and tested at BNL on matrix-free water samples that were spiked with 50-100 dpm amounts of:

Th-230, Pu-236, U-232, Am-243.

These NIST (National Institute of Standards Tehnology) traceable radionuclides were obtained from Dr. Isabel Fisenne of the Environmental Measurements Laboratory (EML) and were later used as yield determinants when performing actual analyses on BNL's BGRR sump water samples known to contain ^{241}Am, ^{238,239,240}Pu, ^{234,235,238}U.

The EML tracers that were used as yield determinants ***(i.e., Th-230, Pu-236, U-232, Am-243)*** were chosen because their alpha energies were significantly different than those of the nuclides of interest (See Alpha Energy Table).

The PERALS has the capability of resolving alpha peak energies that are separated by at least 0.250 Mev; LSC cannot. Uranium 233,234,235,236 cannot be resolved by PERALS.

However, as can be seen from the Alpha Energy Table , the difference between a nuclide of interest and it's "yield tracer " alpha energy are suffiently different (except for Am-213 and 243).

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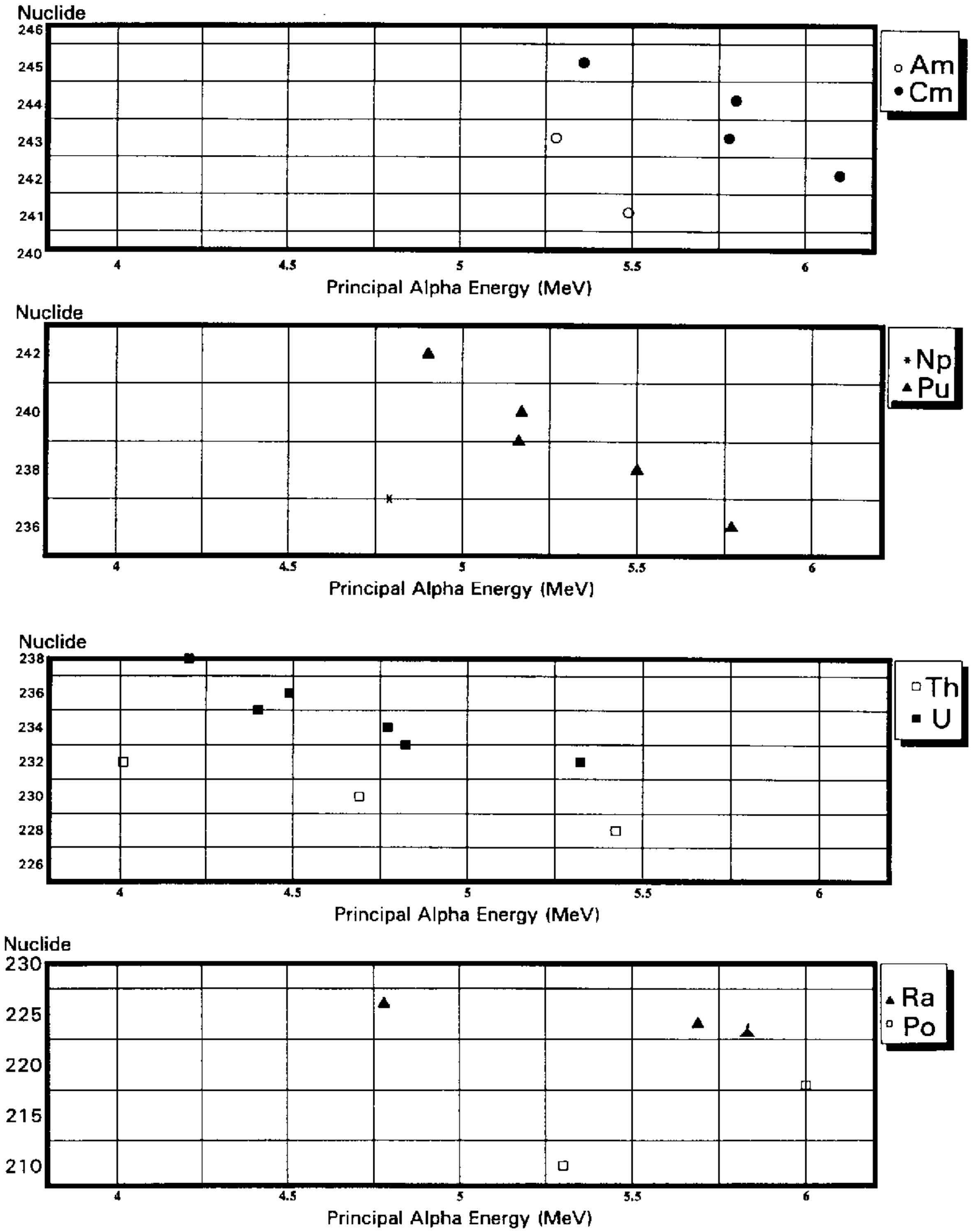
Figure 1

Principal Alpha Energies for Radium and Actinide Series Elements



Extraction Efficiencies of Ra, U, Th, Pu, Am, Cm, and Np

in 3 Commercially Available Extractive Scintillators

by PERALS Spectrometry

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New York, NY 10014

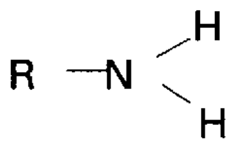
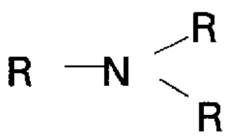
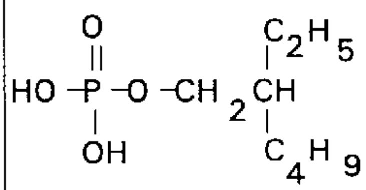
RADIOCHEMISTRY LABORATORY WASTE MANAGEMENT WORKSHOP

41st BIOASSAY CONFERENCE
November 13, 1995
Boston, MA

From McDowell, J.K. and McDowell, B.L., Liquid Scintillation Alpha Spectrometry, CRC Press, Boca Raton, FL, 1994.
ETRAC is East Tennessee Radiometric and Analytical Chemicals, Inc.

Summary of ETRAC Extractive Scintillators

(Toluene Based with Napthalene and PBBO)

	Extractant	Structure	Recommended Conditions
THOREX	Branch Primary Amine		SO4; pH 1
URAEX	Tertiary Amine		SO4; pH 1
ALPHAEX	HDEHP		NO3; pH 2-3

HDEHP = bis-2-ethyl-hexyl phosphoric acid
PBBO = 2-(4'-biphenyl)-6-phenyl benzoxazole

Tracers

Ac	Th	Pa	U	Np	Pu	Am	Cm
AW	230	X	232	237	242	243	244
MeV	4.7	Beta	5.3	4.8	4.9	5.3	5.8

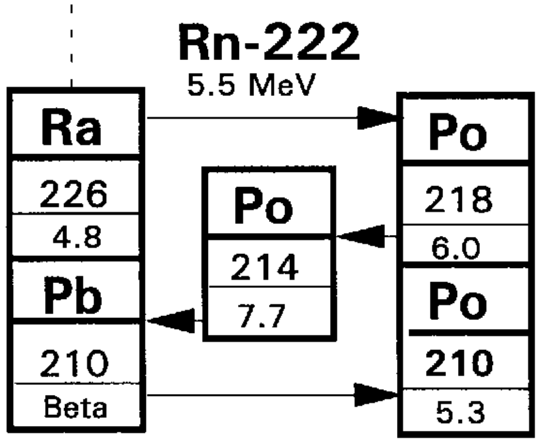


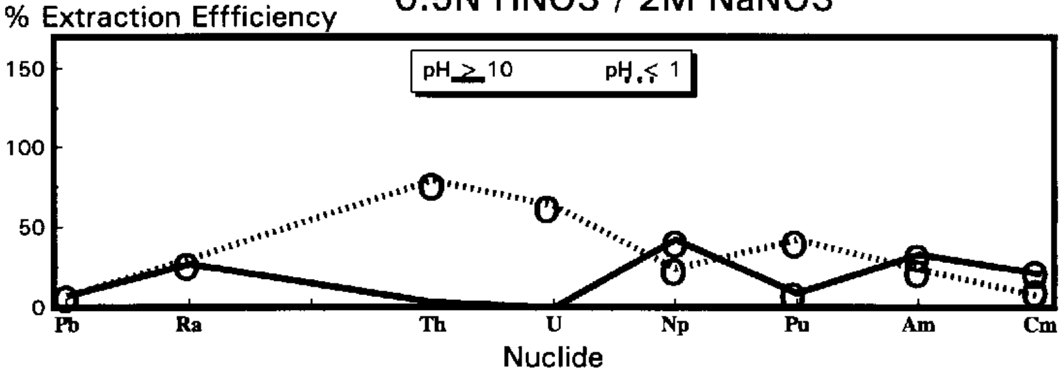
Figure 4

Extraction Efficiencies for Ra, Pb and Actinides At Extreme pH's

(1 Sigma Counting Error = 2-4%)

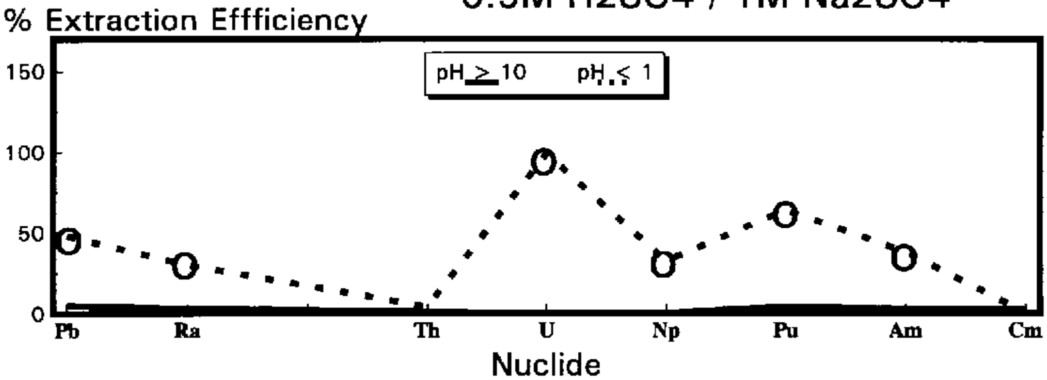
ALPHAEX

0.5N HNO3 / 2M NaNO3



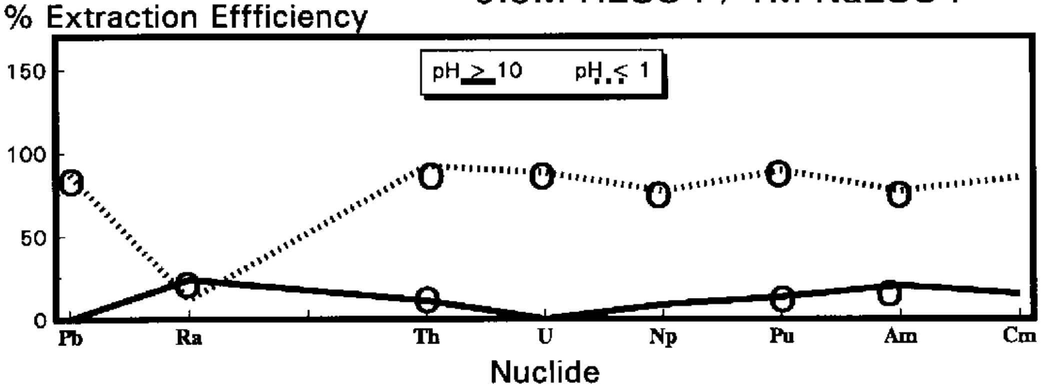
URAEX

0.5M H2SO4 / 1M Na2SO4



THOREX

0.5M H2SO4 / 1M Na2SO4



The BNL Sequential Extraction Scheme

Based on the work of Scarpitta (1995) and Dacheux (1997) , an extraction scheme was devised (and tested) to sequentially extract Pu, Am, Th, U from a single 400 mL aqueous sample using each of 4 ETRAC™ extractive scintillators by varying the conditions of pH and/or acid concentration.

The six step sequential extraction procedure is outlined in Figure 2 and is as follows:

a). Add 50 - 100 dpm of each yield determinant tracer to a Filtered Sample Pu(IV), Th(IV), U(VI), Am(III).

b). Reduce Pu(IV) to Pu(III) using 1 g/L Ascorbic acid.

Keeping Pu in the (III) oxidation state will not allow it to extract into the organic phase of the next step.

c). Acidify the solution to 0.7N with con. HNO_3.
Adjust pH to 1.0 and add 2 mL of ALPHAEX and $NaNO_3$ salt. .

The Thorium and Uranuim will extract into the **organic** phase leaving Pu(III) and Am(III) in the **aqueous** phase.

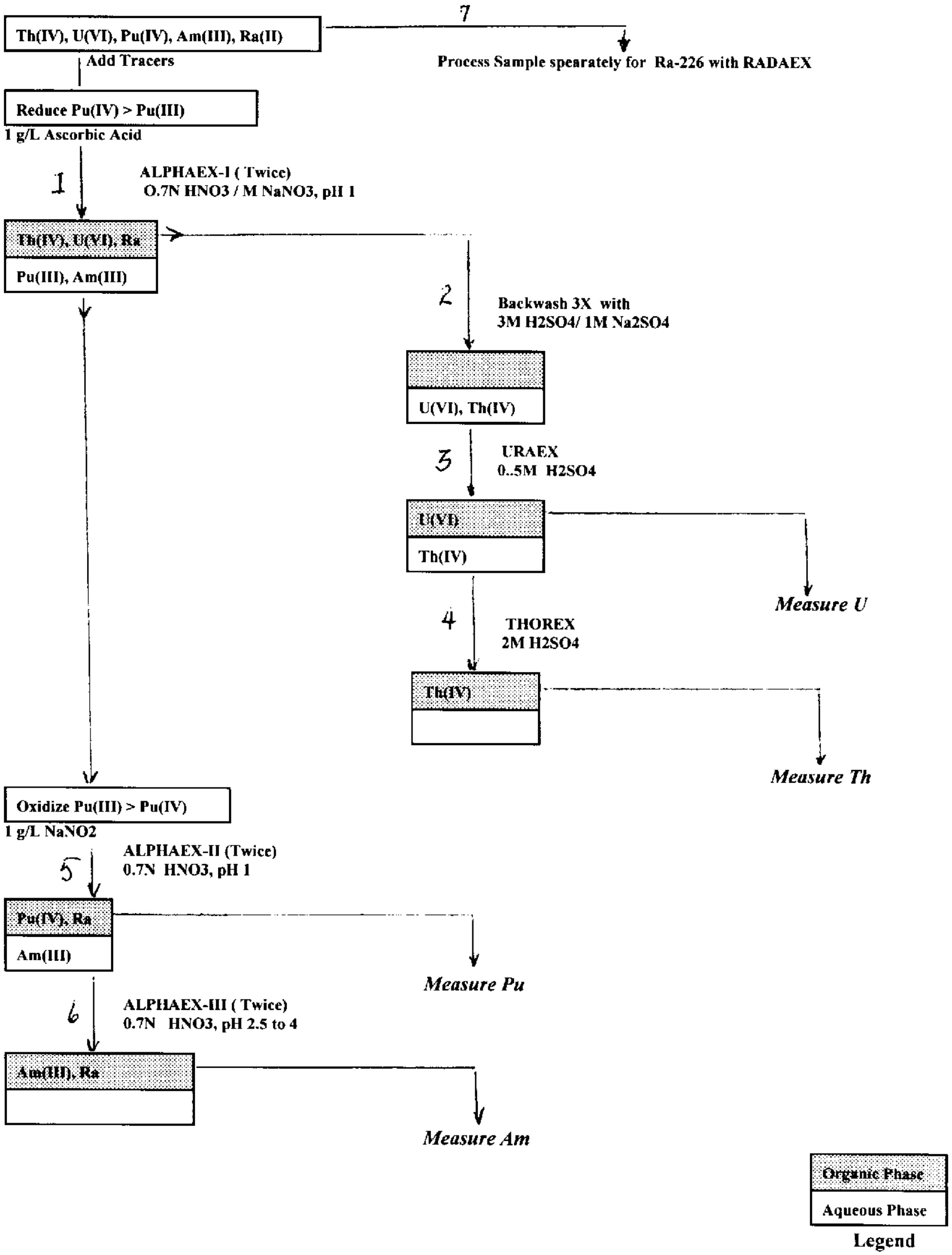
(d) The **aqueous** phase is treated separately to separate Pu from Am (See Fig. 2, Steps 5 and 6) .

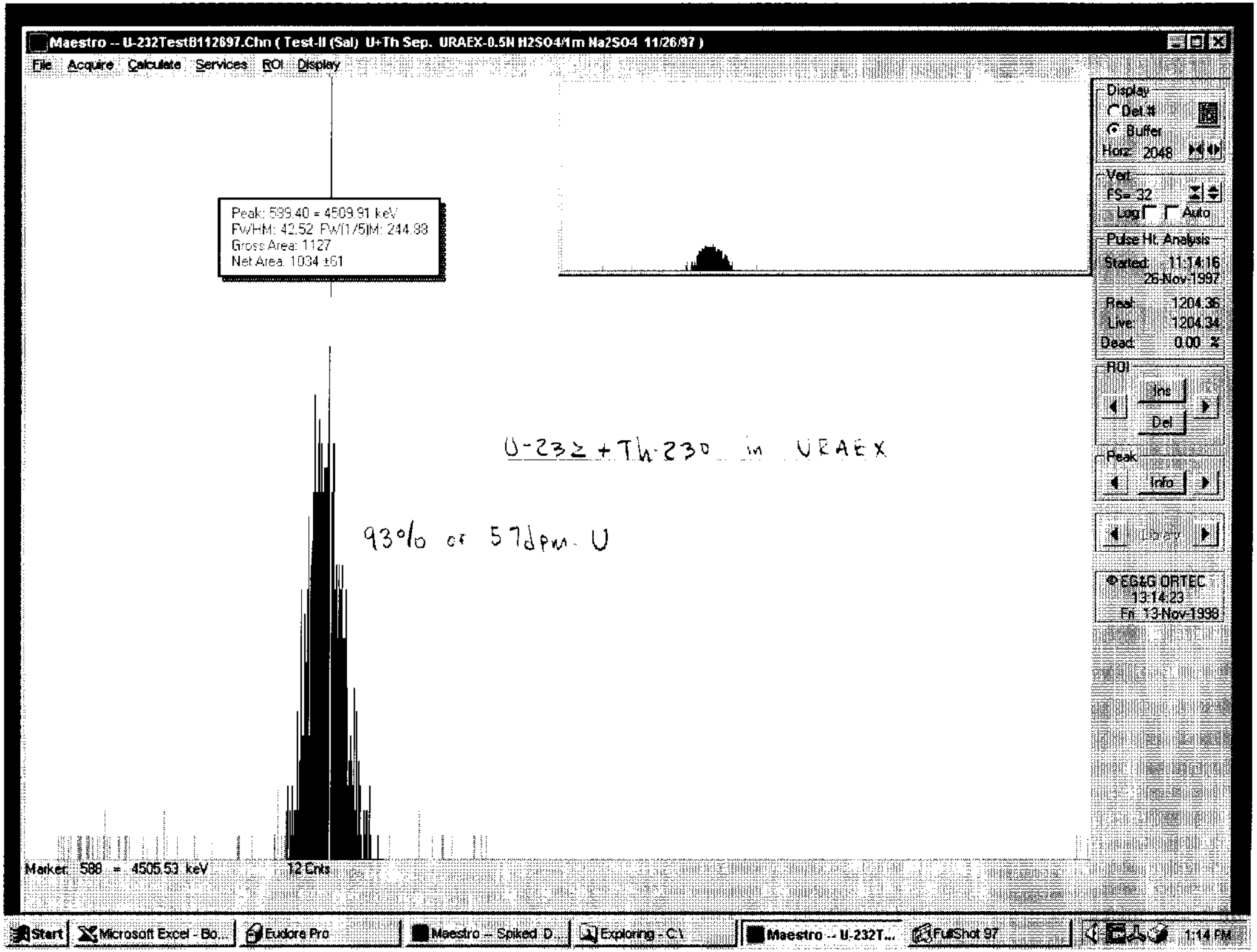
At this point, the **organic** phase is treated separately to sequentially extract both Thorium and Uranium as shown in Fig. 2, Steps 3 and 4.

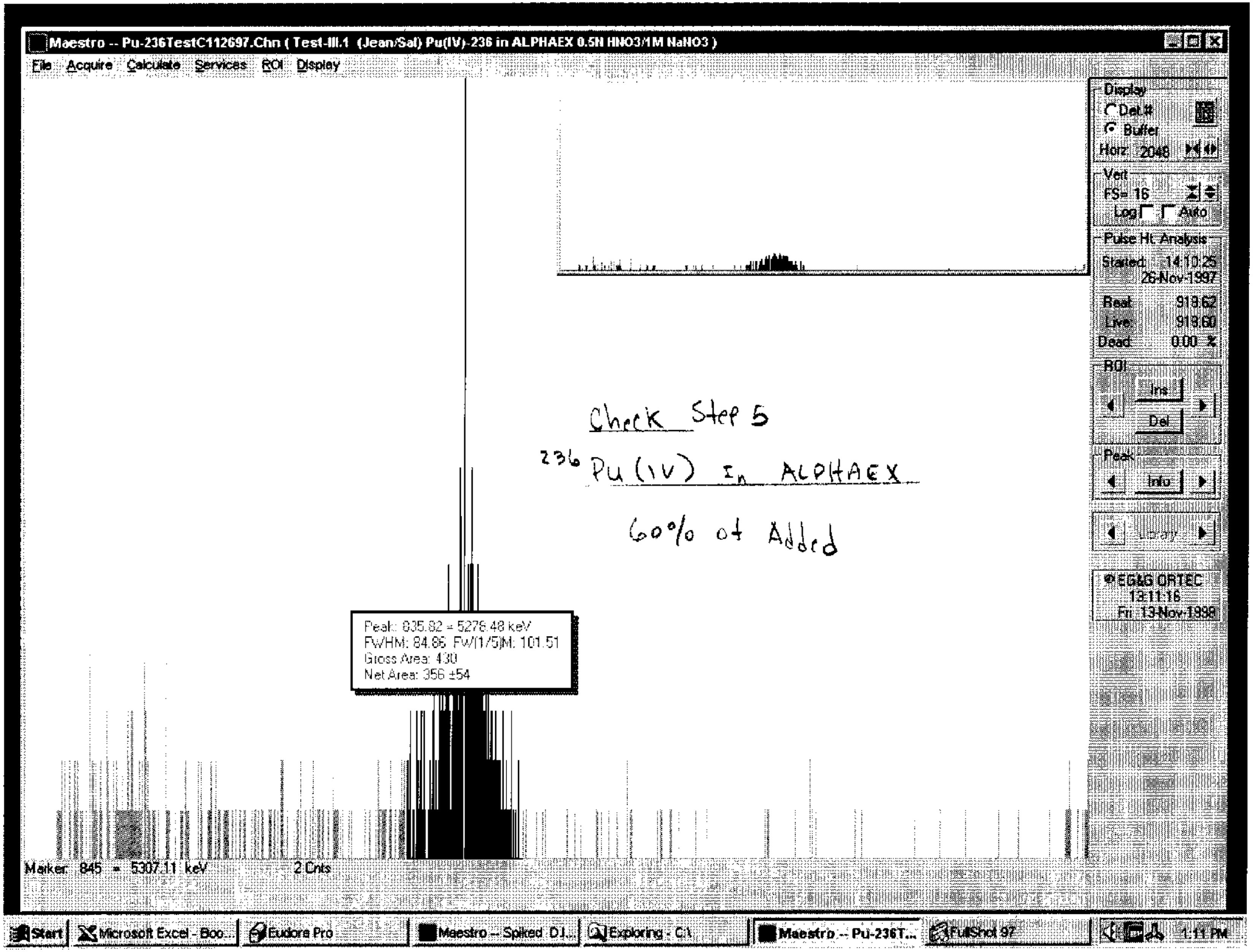
Scarpitta, S.C. and N. Krikorian. *Extraction Efficiencies of Ra, Pb, U, Th, Pu, Am, Cm and Np in Five Commercially Available Extractive Scintillators Using PERALS™*, Proceedings of the 41st Annual Conference of Bioassay, Environmental and Analytical Radiochemistry, Boston, 1995.

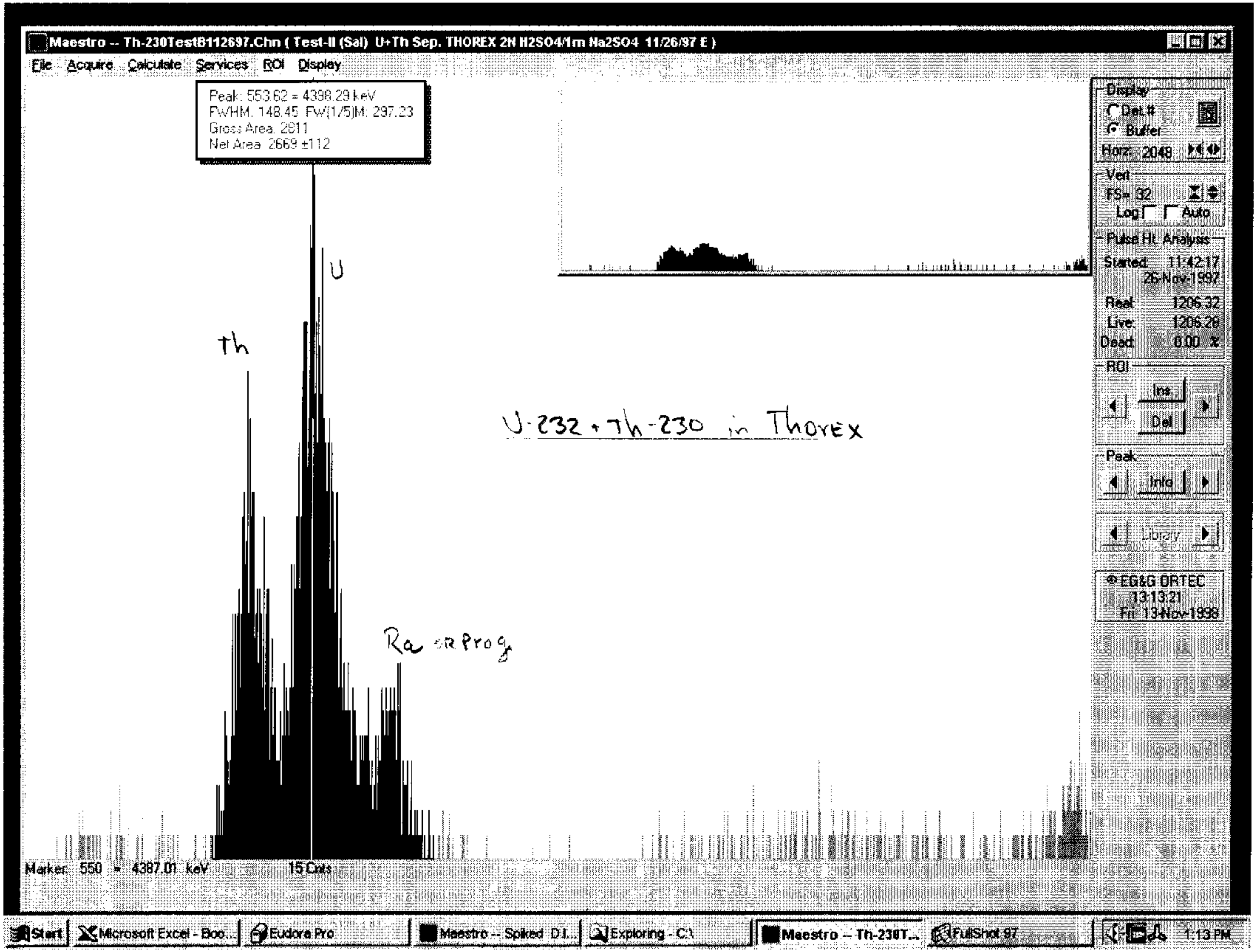
Dacheux, N and J. Auipas. *Determination of Uranium, Thorium, Plutonium, Americium and Curium Ultratraces by PERALS.* Anal. Chem. 69:2275-2282;1997.

Figure 2: Sequential BNL Actinide Separation Scheme

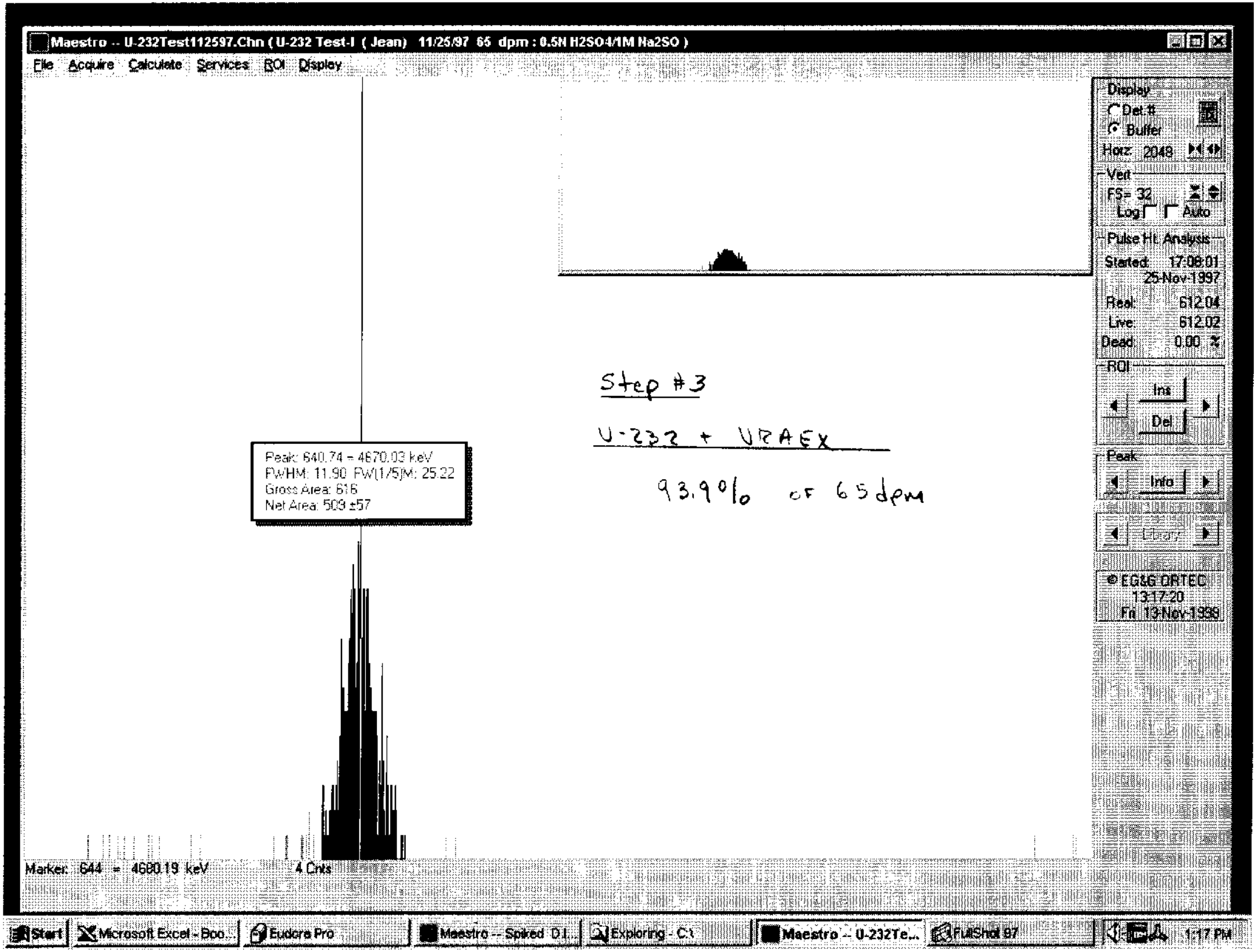


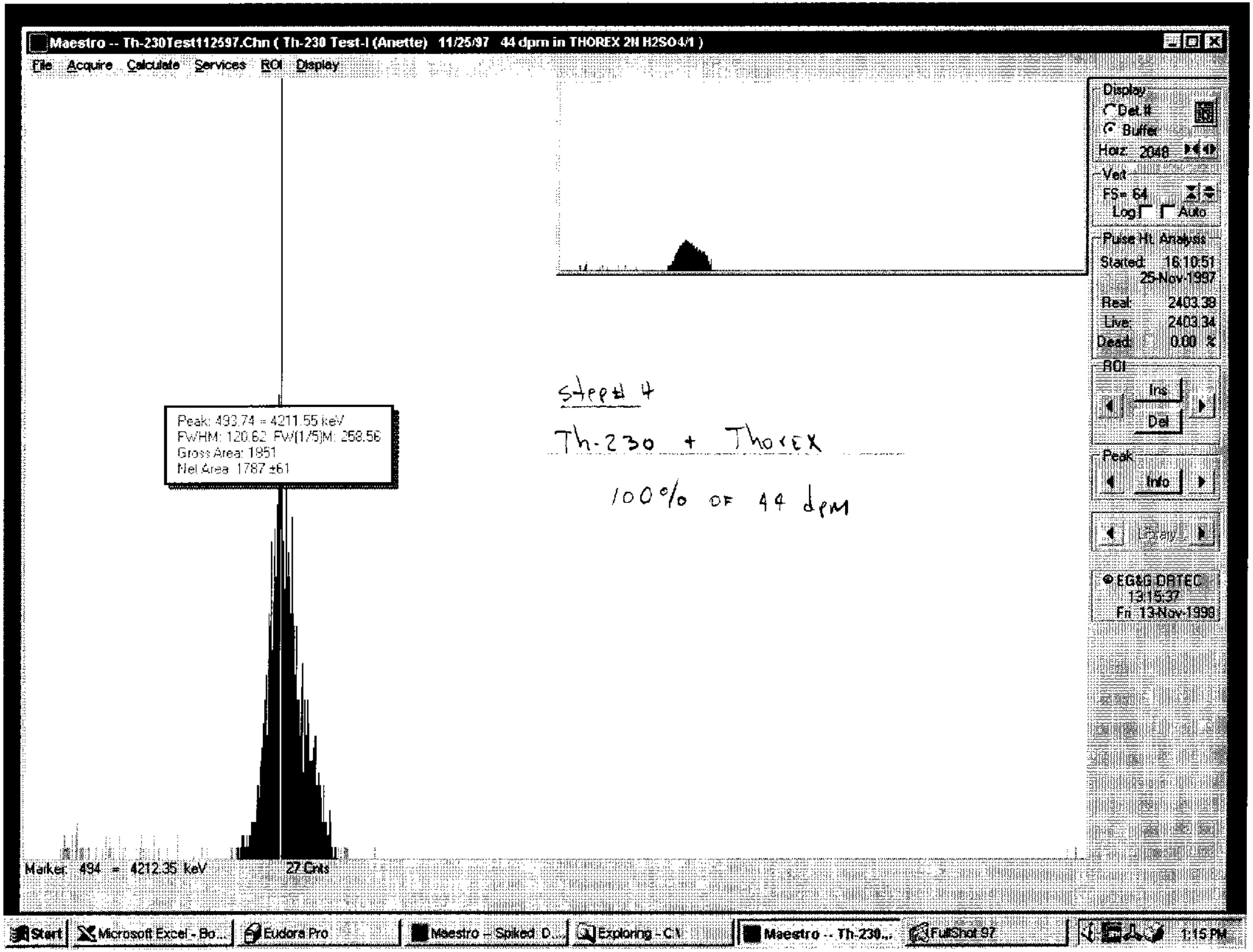

Maestro -- U-232TestB112697.Chn (Test-II (Sal) U+Th Sep. URAEX-0.5N H2SO4/1m Na2SO4 11/26/97)
File Acquire Calculate Services ROI Display
Peak: 589.40 = 4509.91 keV
FWHM: 42.52 FW(1/5)M: 244.88
Gross Area: 1127
Net Area: 1034 ±61
U-232 + Th-230 in URAEX
93% of 57dpm. U
Display
Det #
Buffer
Horz 2048
Vert
FS= 32
Log Auto
Pulse Ht. Analysis
Started: 11:14:16
26-Nov-1997
Real: 1204.36
Live: 1204.34
Dead: 0.00 %
ROI
Ins
Del
Peak
Info
EG&G ORTEC
13:14:23
Fri 13-Nov-1998
Marker: 588 = 4505.53 keV 12 Cnts
Start
Microsoft Excel - Bo...
Eudora Pro
Maestro -- Spiked D...
Exploring - C:\
Maestro -- U-232T...
FullShot 97
1:14 PM


Maestro -- Pu-236TestC112697.Chn (Test-III.1 (Jean/Sal) Pu(IV)-236 in ALPHAEX 0.5N HNO3/1M NaNO3)
File Acquire Calculate Services ROI Display
Peak: 835.82 = 5276.48 keV
FWHM: 84.86 FW(1/5)M: 101.51
Gross Area: 430
Net Area: 356 ±54
Marker: 845 = 5307.11 keV 2 Cnts
Check Step 5
236 Pu (IV) In ALPHAEX
60% of Added
Display
Det #
Buffer
Horz 2048
Vert
FS= 16
Log Auto
Pulse Ht Analysis
Started: 14:10:25
26-Nov-1997
Real: 918.62
Live: 918.60
Dead: 0.00 %
ROI
Ins
Del
Peak
Info
EG&G ORTEC
13:11:16
Fri 13-Nov-1998
Start
Microsoft Excel - Boo...
Eudora Pro
Maestro -- Spiked DI...
Exploring - C:\
Maestro -- Pu-236T...
FullShot 97
1:11 PM

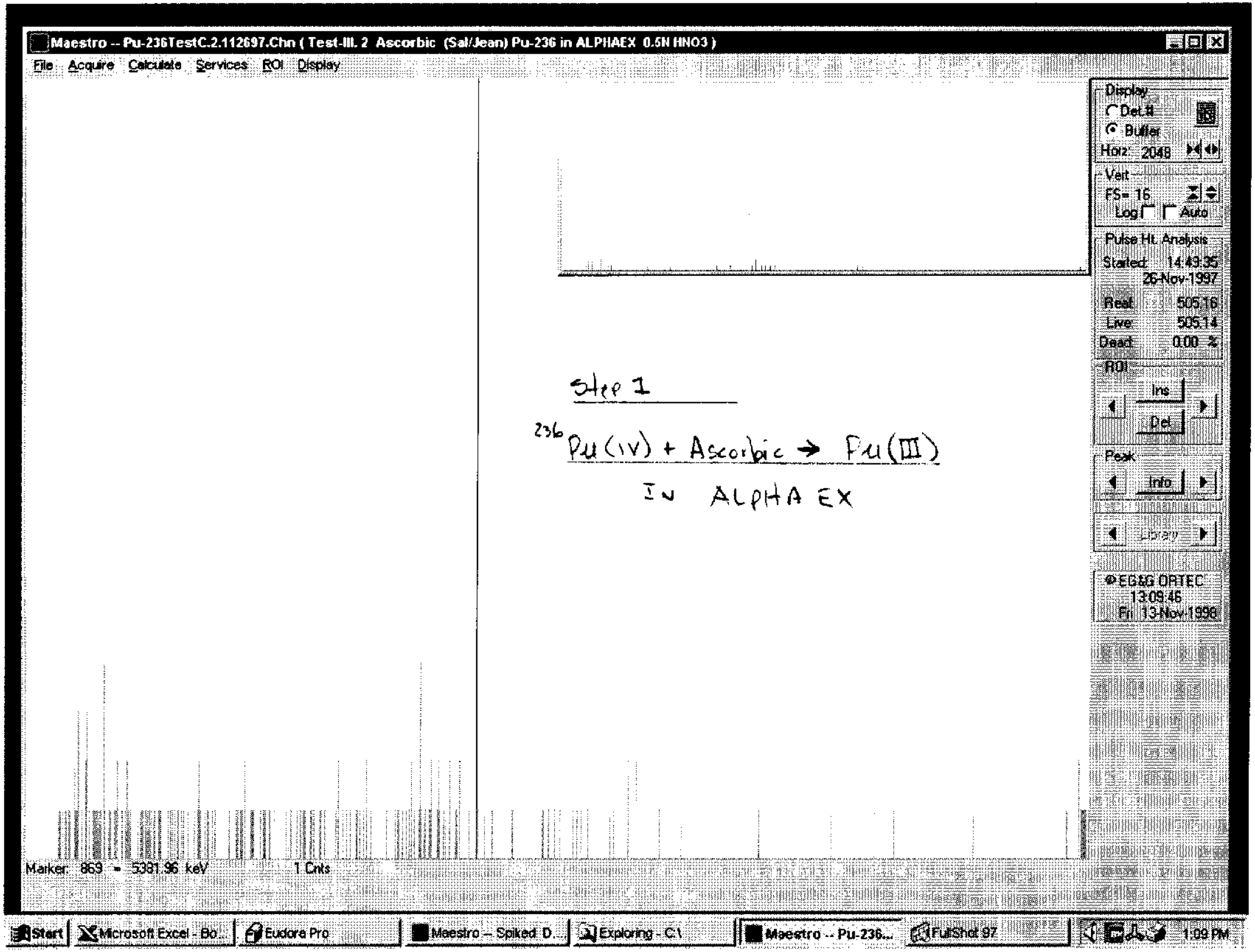


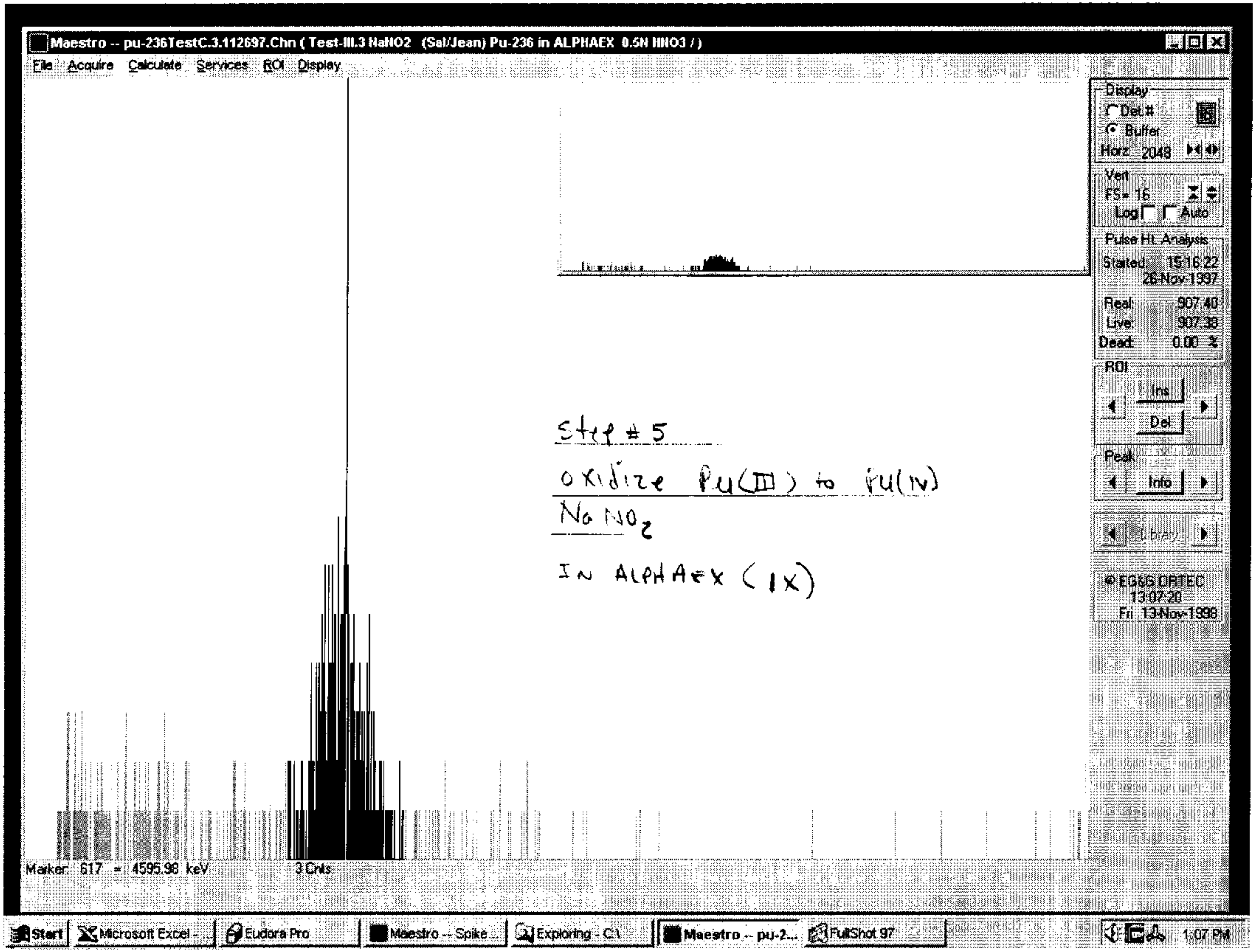
Maestro -- Th-230TestB112697.Chn (Test-II (Sal) U+Th Sep. THOREX 2N H2SO4/1m Na2SO4 11/26/97 E)
File Acquire Calculate Services ROI Display
Peak: 553.62 = 4398.29 keV
FWHM: 148.45 FW(1/5)M: 297.23
Gross Area: 2811
Net Area: 2669 ±112
Th
U
Ra or Prog
U-232 + Th-230 in Thorex
Marker: 550 = 4387.01 keV
15 Cnts
Display
Det #
Buffer
Horz: 2048
Vert
FS= 32
Log
Auto
Pulse Ht. Analysis
Started: 11:42:17
26-Nov-1997
Real: 1206.32
Live: 1206.28
Dead: 0.00 %
ROI
Ins
Del
Peak
Info
Library
EG&G ORTEC
13:13:21
Fri 13-Nov-1998
Start
Microsoft Excel - Boo...
Eudora Pro
Maestro -- Spiked D.I...
Exploring - C:\
Maestro -- Th-230T...
FullShot 97
1:13 PM


Maestro -- U-232Test112597.Chn (U-232 Test-I (Jean) 11/25/97 65 dpm : 0.5N H2SO4/1M Na2SO)
File Acquire Calculate Services ROI Display
Peak: 640.74 = 4670.03 keV
FWHM: 11.90 FW(1/5)M: 25.22
Gross Area: 616
Net Area: 503 ±57
Step #3
U-232 + URAEX
93.9% of 65 dpm
Display
Det #
Buffer
Horz: 2048
Vert
FS= 32
Log
Auto
Pulse Ht. Analysis
Started: 17:08:01
25-Nov-1997
Real: 612.04
Live: 612.02
Dead: 0.00 %
ROI
Ins
Del
Peak
Info
Library
© EG&G ORTEC
13:17:20
Fri 13-Nov-1998
Marker: 644 = 4680.19 keV
4 Cnts
Start
Microsoft Excel - Boo...
Eudora Pro
Maestro -- Spiked D.I...
Exploring - C:\
Maestro -- U-232Te...
FullShot 97
1:17 PM



Maestro -- Th-230Test112597.Chn (Th-230 Test-I (Anette) 11/25/97 44 dpm in THOREX 2N H2SO4/1)
File Acquire Calculate Services ROI Display
Peak: 493.74 = 4211.55 keV
FWHM: 120.62 FW(1/5)M: 258.56
Gross Area: 1851
Net Area: 1787 ±61
Marker: 494 = 4212.35 keV 27 Cnts
steed 4
Th-230 + Thorex
100% of 44 dpm
Display
Det #
Buffer
Horz: 2048
Vert
FS= 64
Log Auto
Pulse Ht. Analysis
Started: 16:10:51
25-Nov-1997
Real: 2403.38
Live: 2403.34
Dead: 0.00 %
ROI
Ins
Del
Peak
Info
Library
EG&G ORTEC
13:15:37
Fri 13-Nov-1998
Start
Microsoft Excel - Bo...
Eudora Pro
Maestro -- Spiked D...
Exploring - C:\
Maestro -- Th-230...
FullShot 97
1:15 PM


Maestro -- Pu-236TestC.2.112697.Chn (Test-III. 2 Ascorbic (Sal/Jean) Pu-236 in ALPHAEX 0.5N HNO3)
File Acquire Calculate Services ROI Display
Display
Det.#
Buffer
Horz 2048
Vert
FS= 16
Log
Auto
Pulse Ht. Analysis
Started 14:43:35
26-Nov-1997
Real 505.16
Live 505.14
Dead 0.00 %
ROI
Ins
Del
Peak
Info
Library
EG&G ORTEC
13:09:46
Fri 13-Nov-1998
Step 1
236 Pu(IV) + Ascorbic → Pu(III)
IN ALPHA EX
Marker: 869 = 5381.96 keV 1 Cnts
Start
Microsoft Excel - Bo...
Eudora Pro
Maestro -- Spiked D...
Exploring - C:\
Maestro -- Pu-236...
FullShot 97
1:09 PM



Screen Capture, 1:07:21pm - Friday, 11/13/98, 1024w x 768h

Test of Sequential BNL Separation (Refer to Fig. 2)

Test #	**BNL Sep'n Step**	**Nuclide and dpm Added**	**PERLAS dpm observed**	**% Yield**
Test I.1 (Jean) 11/25/97	3 URAEX	U-232 + Progeny 65 dpm	Single Peak 61.0	93.9%
Test I.2 (Anette) 11/25/97	4 THOREX	Th-230 (No Prog) 44 dpm	46.5	100%
Test II Sal/Jean 11/26/97	3,4 URAEX and THOREX	Mix of 61 dpm U-232 58 dpm Th-230	56.8 (U-232) 140.5 (Th-230 + Th-228)	93.1%
Test III (Pu)	ALPHAEX	41 dpm		
III.1 Pu(IV)	1,Ascor	Pu(IV)236	30.3	74%
III.2 Pu(III)	5,NaNO2	Pu(III)236	5.4	13%
III.3 Pu(IV)		Pu(IV)236	24.4	60%

Calculation of Results, Uncertainties and MDL

The general equation to calculate the activity concentration (pCi/L) of a nuclide, using the PERALS combined with solvent extraction techniques is:

$$\mathbf{A_i\ (pCi/L)} = \left[\frac{CR_i \times V_{OT} \times 1000}{V_{oc} \times V_s \times Y_i} \right] + \left[\frac{CR_i}{V_{oc}\, V_s \times D_i} \right] \times V_{aq} \qquad (1)$$

where,

A_i = Activity of nuclide, pCi/L
C_i = Net count-rate for nuclide, i, of interest (cpm)
1000 = multiplication factor to convert mL to L
D_i = Distribution coefficient of nuclide, i
V_{aq} = Volume of aqueous phase, mL
V_{OT} = Volume of total extractive scintillator used, mL
V_{OC} = Volume of extractive scintillator counted, mL
V_s = Volume of Original Sample, mL
Y_J = Yield factor for tracer used (unitless).

In most cases $D_i > 1000$ so that the amount of radionuclide remaining in the aqueosus phase is negligible. Equation 1 then reduces to:

$$\mathbf{A_i\ (pCi/L)} = \left[\frac{C_i \times V_{OT} \times 1000}{2.22 \times V_{oc} \times V_s \times Y_J} \right] \qquad (2)$$

The yield (Recovery) , Y_J, is determined from:

$$Y_J = \left[\frac{C_i \times V_{OT} \times 1000}{V_{oc} \times V_s \times T_a} \right] \qquad (3)$$

where T_a = Activity of added tracer, dpm and C_J = count-rate of tracer

The uncertainty, **U(pCi/L)** in the reported value is:

$$\mathbf{U_i\ (pCi/L)} = \left[\frac{V_{OT} \times 1000}{2.22 \times V_{oc} \times V_s \times Y_J} \right] \times \left[s^2_G + s^2_B \right]^{1/2} \qquad (4)$$

where,

s_G = standard deviation of the gross count rate, cpm
s_B = standard deviation of the background count rate, cpm

The MDL is estimated from the following equation:

$$\mathbf{MDL\ (pCi/L)} = \frac{[\ 2.71\ +\ 4.65\ s_B\ ]\ \times 1000\ V_{OT}}{2.22 \times V_{oc} \times V_s \times T \times Y_J} \qquad (5)$$

where,

T = counting time of the sample, min
s_B = standard deviation of the background count rate (cpm) when counted for T minutes

Example of MDL

Assuming a single extraction, a count-time of 30 min, a PERALS alpha-background of 0.01 cpm,

then an MDL (see Eq. 5) of **0.2 pCi/L** can be achieved when:

V_{OT}/V_{OC} = 2/1.5 = 1.33
V_s = 500 mL and
Y_J = 0.99

C.O.C. Number ____________

ALPHA STECTROSCOPY
by
PERALS

Sample I.D.: ____________ Volume (mL): 400 pH: ______

Actinide	Total Volume Organic Used (mL)	Total Volume Organic Counted (mL)	Gross Counts	Count Time (sec)	Counts per Minute (cpm)	Total Activity (dpm)	Net Tracer (dpm)	Net Sample (dpm)	pCi / l
Ra - 226									
Pu - 238; 239 / 240	4	2					72		
Am - 241	4	2					77		
U - 234; 235; 238	5	2					89		
Th - 232; 228	5	2					116		

Spiked Blank ____________ Volume (mL): 400 pH: ______

Actinide	Total Volume Organic Used (mL)	Total Volume Organic Counted (mL)	Gross Counts	Count Time (sec)	Counts per Minute (cpm)	Total Activity (dpm)	Net Tracer (dpm)	Net Sample (dpm)	
Ra - 226							0		
Pu - 238; 239 / 240	4	2					72		
Am - 241	4	2					77		
U - 234; 235; 238	5	2					89		
Th - 232; 228	5	2					116		

1 pCi = 2.22 dpm

____
Sample Preparer

____
Sample Analyst

____
Data Reviewer

PERALS™ DATA SUMMARY - I

Gross-Alpha (Ra + Actinide) Results of BGRR Sump-Water

A. Gross-Alpha Results (Samples were Not spiked with yield tracers)

ASL Sample ID	Analysis Date	Gross Alpha Result(*) (pCi/L)	U
C97-12-10-09/01 (First Sample)	12/2/97	Th(IV)+Ra(II)+U(VI)+Pu(IV) = 238 Pu(III) = NA Σ = 238 pCi/L	± 10% ± 10%
C97-12-02-11/02 (Neutron Alarm)	12/2/97	Th(IV)+Ra(II)+U(VI)+Pu(IV) = 172 Pu(III) = 90 Σ = 262 pCi/L	± 10% ± 10% ± 10%
Spiked Blank(#)	12/2/97	Composite Yield = 86.5% Using Th230 +U232 +Pu236	± 3%

*Samples Analyzed using ALPHAEX without Added Tracer. The reported Results were adjusted by the yield recovery of the Spiked Blank sample.
#Pu-236, Th-230 and U-232 Tracers added to D.I. water and processed separately for Yield and QA purposes.
Pu(III) was determined by re-extracting aqueous sample using ALPHAEX under different chemical conditions
NA means Not Analyzed. U is the estimated Uncertainty in reported result.

B. Gross-Alpha Results : Glass vs Plastic Bottles (L-Dups)

ASL Sample ID	Analysis Date	Gross Alpha Result(*) (pCi/L)	U
C97-12-03-16/01P	12/3/97	Th(IV)+Ra(II)+U(VI)+Pu(IV) = 93 Pu(III) = 23 Σ = 116 pCi/L	± 10% ± 10% ± 10%
C97-12-03-16/01G	12/3/97	Th(IV)+Ra(II)+U(VI)+Pu(IV) = 83 Pu(III) = 18 Σ = 101 pCi/L	± 10% ± 10% ± 10%
Spiked Blank (#)	12/4/97	Composite Yield = 87.7% Using Th230 +U232 +Pu236	± 3%

*BGRR Samples Analyzed using ALPHAEX without Added Tracer. The reported Results were adjusted by the yield recovery of the Spiked-Blank sample.
#Pu-236, Th-230 and U-232 Tracers added to D.I. water and processed separately for Yield and QA purposes.
Pu(III) was determined by re-extracting aqueous sample with ALPHAEX under different chemical conditions.
U is the estimated Uncertainty in reported result.

PERALS™ DATA SUMMARY - II

Nuclide-Specific Actinide Results of BGRR Sump-Water

(All Samples Spiked with 100 dpm each of Pu-236, Am-243, U-232 and Th-230)

A. Base-Line Sump Sample (Beginning of Pumping)

ASL Sample ID	Analysis Date	Result (pCi/L)	Uncertainty
C97-12-02-08/02	12/8/97	Pu_{Tot} = 140	± 25%
"	"	Am/Ra = 126	± 25%
"	"	U_{Tot} = 3	± 25%
"	"	Th_{Tot} = 5	± 25%
"	"	Σ = 274	± 25%

B. Neutron-Alarm Sump Sample (Pumping Stopped)

ASL Sample ID	Analysis Date	Result (pCi/L)	Uncertainty
C97-12-02-11/01	12/8/97	Pu_{Tot} = 160	± 25%
"	"	Am/Ra = 84	± 25%
"	"	U_{Tot} = 6	± 25%
"	"	Th_{Tot} = 33	± 25%
"	"	Σ = 283	± 25%

C. Restart of Pumping Sump Sample

ASL Sample ID	Analysis Date	Result (pCi/L)	Uncertainty
C97-12-10-09/01	12/11/97	Pu_{Tot} = 164	± 25%
"	"	Am/Ra = <2*	± 25%
"	"	U_{Tot} = 48	± 25%
"	"	Th_{Tot} = 26	± 25%
"	"	Σ = 238	± 25%

(*) means Am was not effectively extracted and result was MDL.

D. Spiked D.I. Blank

Sample ID	Analysis Date	% Recovery of Added Tracer	MDL (pCi/L)
Spiked Blank	12/12/97	Pu-236 = 88.3 ± 3%	2.0
"	"	Am-243 = 96.7 ± 3%	2.0
"	"	U-232 = 92.4 ± 3%	3.0
"	"	Th-230 = 82.0 ± 3%	3.0

Tracers added to D.I. water and processed separately for QA and Yield purposes.

MDLs for U and Th are 3.0 because of larger volume of extractive scintillator used.

Author Biography

Dr. Scarpitta was for 4 years one of the 2 coordinators of the U.S. DOE's Environmental Measurements Lab (EML) Quality Assessment Program (QAP) while he was Supervisor of the Radioanalytical Chemistry Division in 1991-1995. Besides 15 other publications, he is the principal author of 2 recent studies performed and published while at EML, New York. They are : (a) "Calibration of a Liquid Scintillation Counter for Alpha, Beta and Cerenkov Counting", Report EML-583, July, 1996 and (b) "Cerenkov Counting as a Complement to Liquid Scintillation Counting", Appl. Radiat. Iso. 47(8):795-800:1996. He first presented his work with the PERALS spectrometer at the 41st Annual Conference of Bioassay, Environmnetal and Radioanalytical Chemistry in Boston (1995). For the past 2 years he has been a full-time member of the Environmental Safety and Health Division and head of the BNL Analytical Services Lab.