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Proceedings of the First Annual Teleconference on the Intercomparison of In Vivo Measurement Facilities

M. L. Lobaugh, D. P. Hickman, K. L. Jeffers, L. J. Collins, V. A. Sundsmo, D. G. Alba, O. Aviv, C. Li, H. B. Spitz, R. P. Reese, T. P. Lynch

January 6, 2015

1st Annual Teleconference on the Intercomparison of In vivo Measurement Facilities
Livermore, CA, United States
July 31, 2014 through July 31, 2014

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Letter from the Editor

December 18, 2014

Dear Colleagues,

Thank you for participating in the 1st Annual Teleconference on the Intercomparison of In vivo Measurement Facilities on July 31, 2014. It was a successful and inexpensive way to discuss, collaborate, commiserate, and provide feedback to one another on issues and topics of interest to our community. Enclosed you will find the conference proceedings. To those of you who missed the conference, unfortunately, the written procedures don't completely convey the thoughtful and lively discussions we had, but I know you will find useful and thought-provoking information in the presentations and hope you can join us next year.

LLNL plans to host the 2nd annual conference in May 2015; an official announcement will be sent in early 2015. If you know of others who did not receive this year's information and are interested in participating, please email me their contact information.

Thank you,

Megan Lobaugh
lobaugh1@llnl.gov
LLNL Internal Dosimetry

1st Annual Teleconference on the Intercomparison of In vivo Measurement Facilities
Thursday, July 31, 2014

Page	Title	Presenter	Organization
iii to vii	Fix connection issues, Welcome, and Introductions	Megan Lobaugh	Lawrence Livermore National Laboratory, Radiation Protection Functional Area
1 to 13	Characterization of Soreq Whole Body Counter	Ofer Aviv	Soreq Nuclear Research Centre, Israel
14 to 30	Human Monitoring Laboratory- Capabilities and Current Research	Chunsheng Li	Health Canada, Radiation Protection Bureau, Human Monitoring Laboratory
31 to 43	"Pump and Bake" your way to Improved Resolution	Henry Spitz	Nuclear and Radiological Engineering Program, University of Cincinnati
44 to 64	In-vivo Capabilities	Robert Reese	Sandia National Laboratories, Radiation Protection and Sample Diagnostics Program
65 to 73	Hanford In Vivo Monitoring Program	Tim Lynch	Hanford, Mission Support Alliance
74 to 94	Overview of the In vivo Measurement Capabilities at LLNL	Karen Jeffers	Lawrence Livermore National Laboratory, Radiation Protection Functional Area
95 to 101	The LLNL Thyroid Radioiodine Intercomparison Program	Lori Collins Megan Lobaugh	Lawrence Livermore National Laboratory, Quality Assurance
102	Discussion of EFCOG In Vivo Measurements Facilities Survey Data	Michele Sundsmo	Lawrence Livermore National Laboratory, Radiation Protection Functional Area
103 to 111	To Rib or de-Rib, that is the question	Darrin Alba	U.S. Military Academy at West Point, MARA program at LLNL
112 to 118	Efficiency Errors When Directly Measuring Lung Deposited Radionuclides	Dave Hickman	Lawrence Livermore National Laboratory, Radiation Protection Functional Area

Welcome to the 1st Annual Video Teleconference on the Intercomparison of In vivo Measurement Facilities

- Problems connecting?
  - Call: +001-925-424-8000 ext 8030
- Prepare for Introduction of your facility and the participants present.
  - Facility Information
    - Name
    - Affiliation
    - Location
  - Individual's Information
    - Name
    - Title
    - Organization

Agenda

Start Time	Presenter	Presentation Title
7:30AM PDT	Ofer Aviv (Soreq Nuclear Research Centre, Israel)	Chracterization of Soreq Whole Body Counter
7:50AM PDT	Chunsheng Li (Health Canada, Radiation Protection Bureau, Human Monitoring Laboratory)	Human Monitoring Laboratory-Capabilities and Current Research
8:10AM PDT	Henry Spitz (Nuclear and Radiological Engineering Program, University of Cincinnati)	“Pump and Bake” your way to improved Resolution

Agenda

Start Time	Presenter	Presentation Title
8:45AM PDT	Robert Reese (Sandia National Laboratories, Radiation Protection and Sample Diagnostics Program)	In-vivo Capabilities
9:05AM PDT	Tim Lynch (Hanford, Mission Support Alliance)	Hanford In Vivo Monitoring Program
9:25AM PDT	Karen Jeffers (Lawrence Livermore National Laboratory, Radiation Protection Functional Area)	Overview of the In vivo Measurement Capabilities at LLNL
9:45AM PDT	Megan Lobaugh (Lawrence Livermore National Laboratory, Radiation Protection Functional Area)	The LLNL Thyroid Radioiodine Intercomparison Program

Agenda

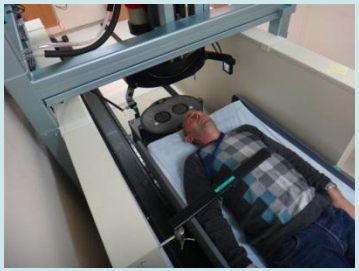
Start Time	Presenter	Presentation Title
10:10AM PDT	Michele Sundsmo (Lawrence Livermore National Laboratory, Radiation Protection Functional Area)	Discussion of EFCOG In Vivo Measurements Facilities Survey
10:20AM PDT	Darrin Alba (U.S. Military Academy at West Point and LLNL MARA Program)	To Rib or de-Rib, that is the question
10:40AM PDT	Dave Hickman (Lawrence Livermore National Laboratory, Radiation Protection Functional Area)	Efficiency Errors When Directly Measuring Lung Deposited Radionuclides
11:00 AM PDT	Open Discussion • ANSI 13.30-2011 • Apex In Vivo	

Thank you for participating!

- Please share any comments or suggestions with Megan at lobaugh1@llnl.gov
- We will share presentation slides and the participant list in the next week or two.

Lawrence Livermore
National Laboratory

Characterization of Soreq Whole Body Counter



O. Aviv, E. Daniely, S. Moskovici, Z. Yungrais, H. Datz, Y. Shamai, G. Haquin

Soreq Nuclear Research Centre, Israel

Teleconference on the Inter-comparison of In Vivo Measurement Facilities

July 31, 2014

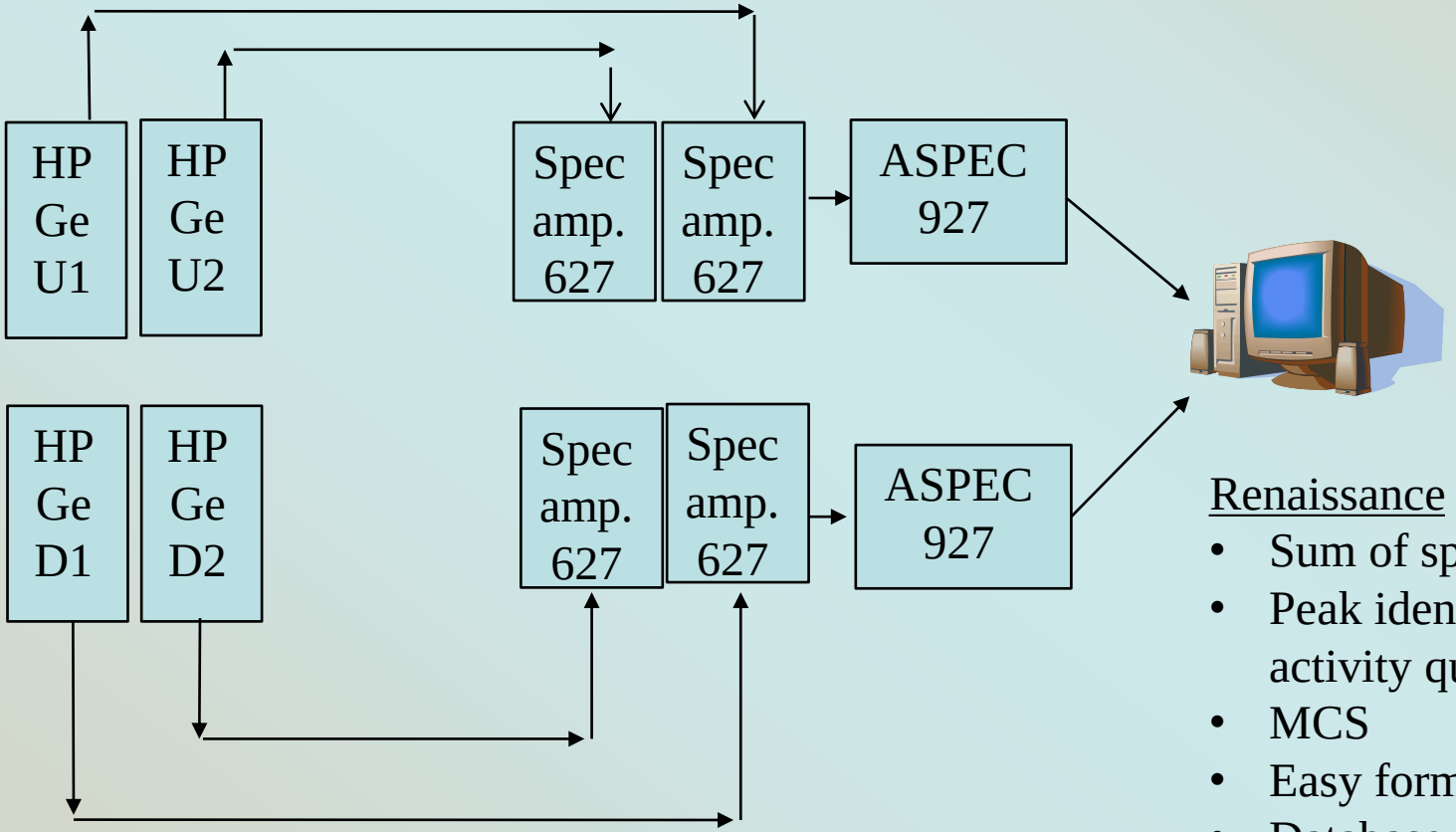
Introduction

- Widely used technique for determination of intake of radionuclides gamma\X-ray
- Complementary to other dosimetric methods
- Non-intrusive procedure
- Rapid (minutes-hour) and direct assessment of the level of contamination in the body
- Counting efficiency is usually obtained either by realistic or computerized (voxel) phantoms

WBC Apparatus (1)

- 4 HPGe detectors (ORTEC) 50% relative efficiency,~1.9 keV resolution at 1332.5 keV gamma ray.
- γ-energy range 12-3000 keV
- 2 detectors above and 2 below a mobile bed
- Adjustable positioning for the top detectors
- Detectors are surrounded by old lead of 8.5 cm and two lead walls (10 cm x 100 cm x 200 cm)

WBC Apparatus (2)

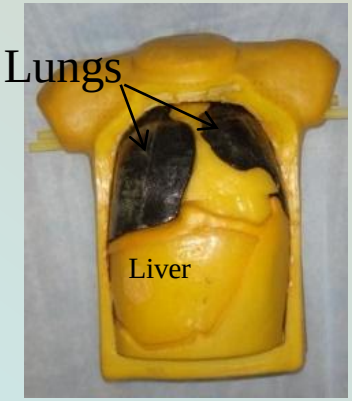


Renaissance

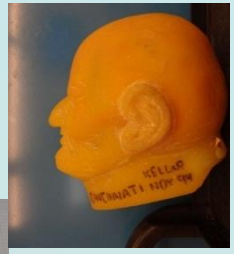
- Sum of spectra
- Peak identification and activity quantification
- MCS
- Easy format report
- Database

WBC characterization Method

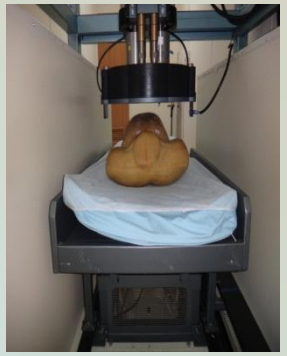
Efficiency, background, resolution → *MDA*



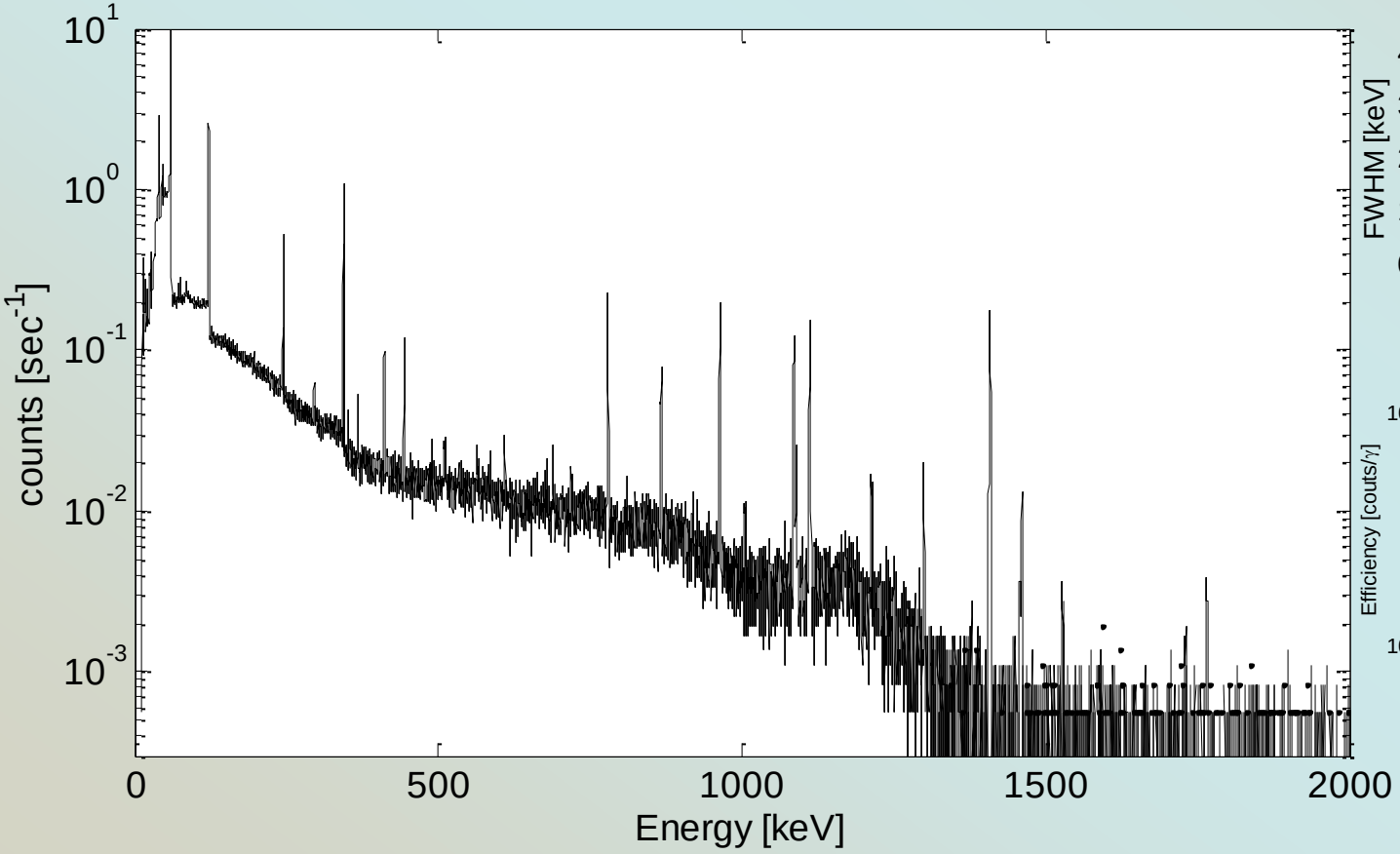
- Set of certified point sources (17-1836 keV)
- LLNL Torso Phantom with removable sets of spiked lungs (^{152}Eu + ^{241}Am) & Liver (^{241}Am)
- Varying sizes of chest wall overlays
- Spiked Skull (^{152}Eu + ^{241}Am)
- Knee (^{152}Eu + ^{241}Am)

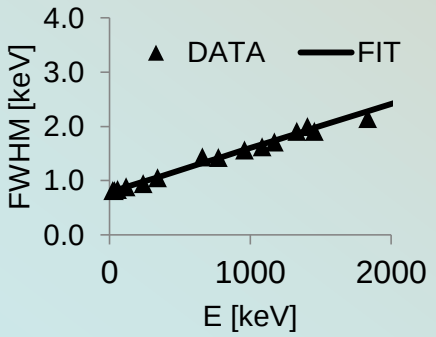


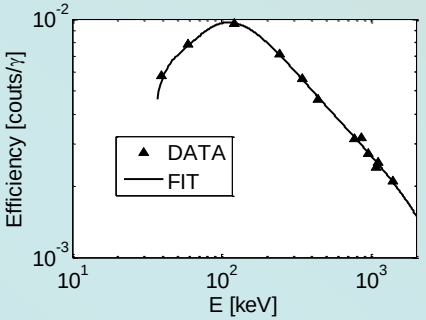
Response to Lung Torso phantom with ^{152}Eu+^{241}Am, stationary bed



Acquisition time: 1 h

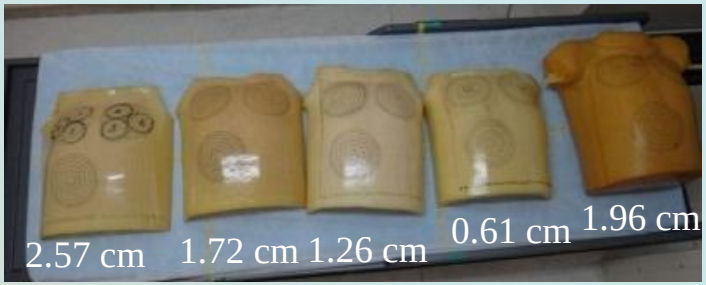


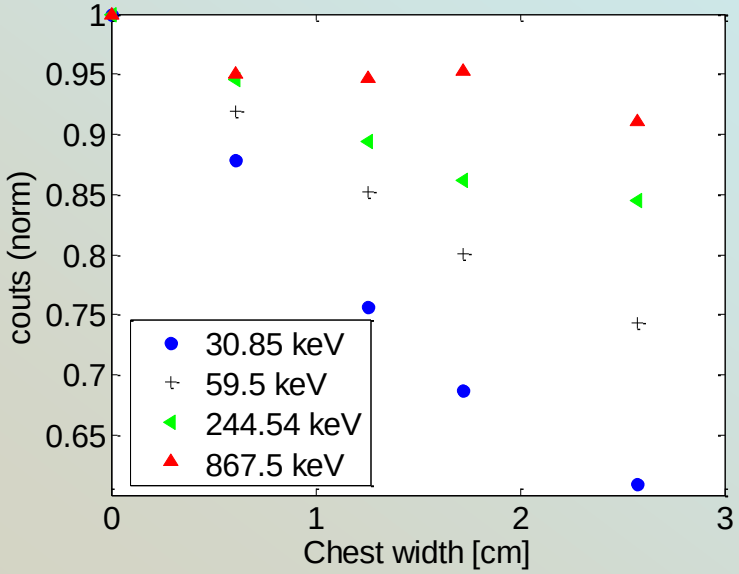


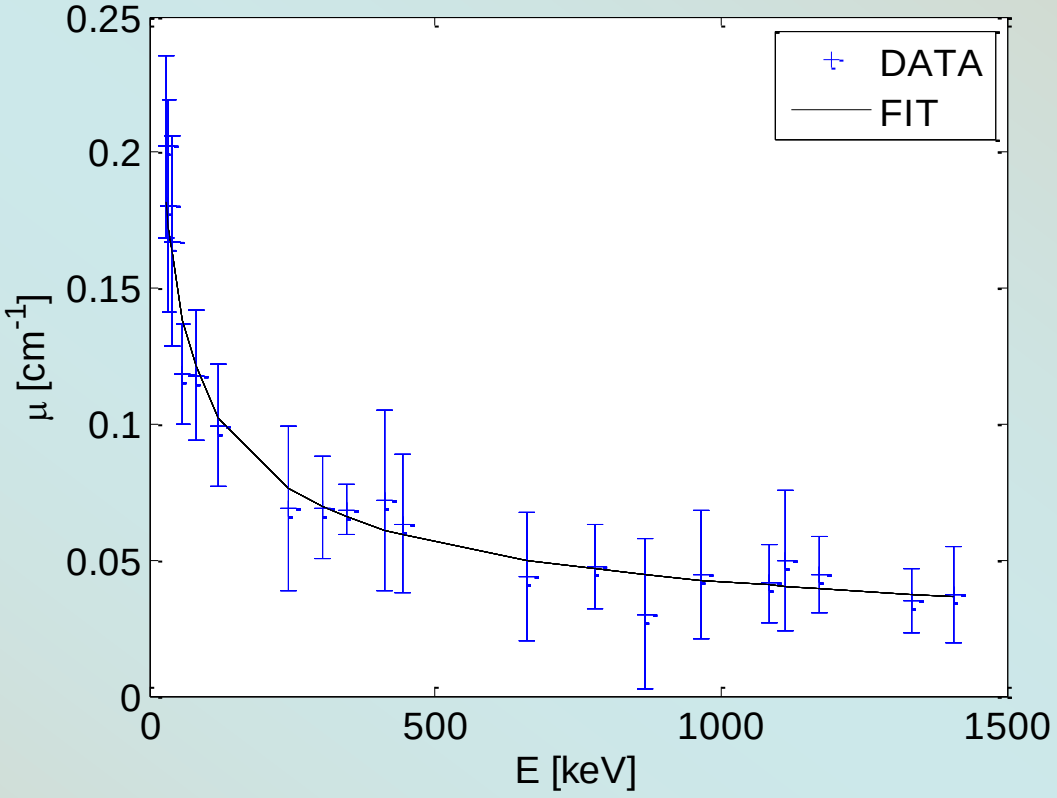


FIT: $\varepsilon(E) = \exp(\sum_i a_i E^{2-i})$

Effective attenuation co-efficient using varying chest wall overlays



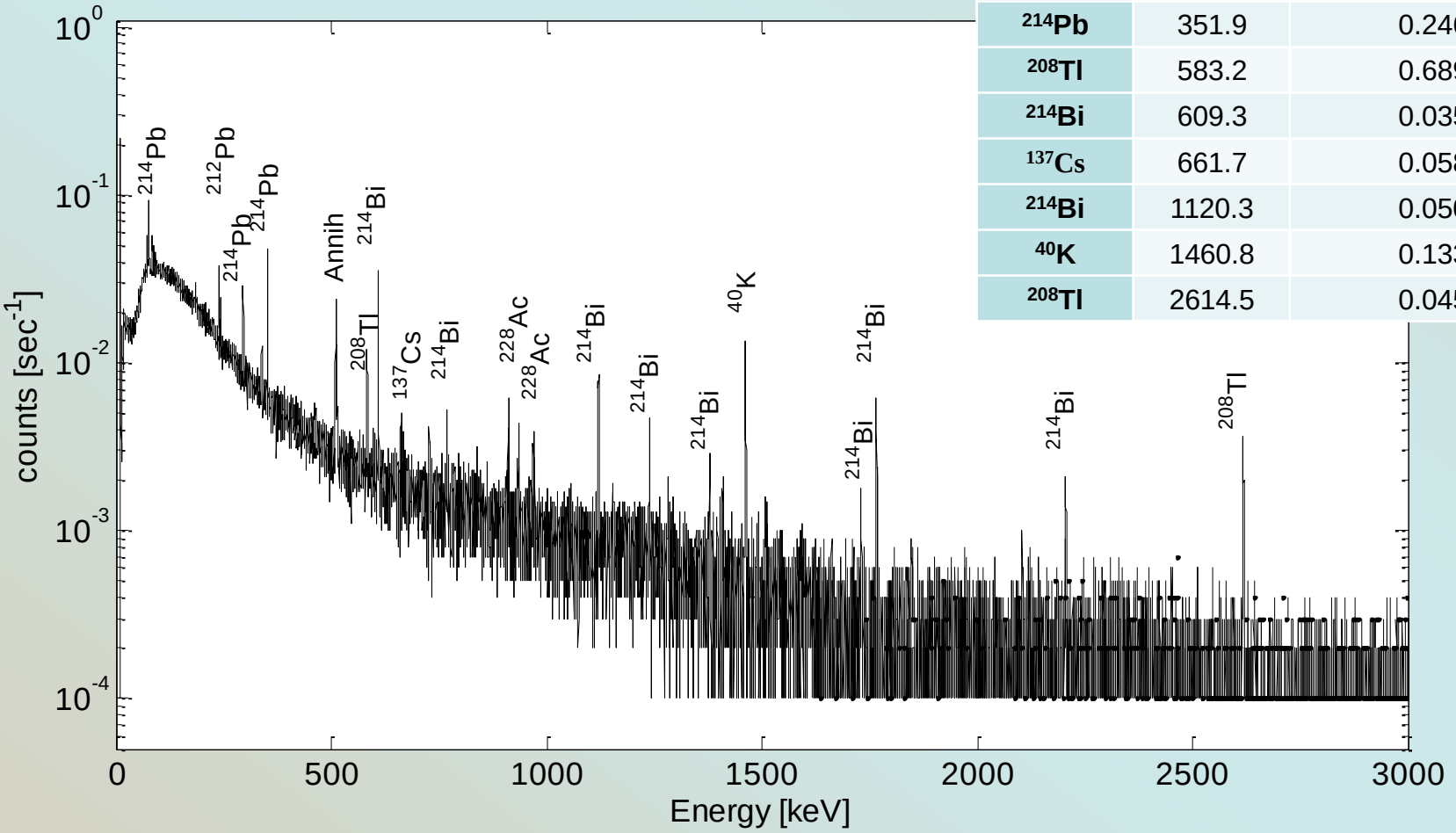




Background counts

Acquisition time: ~3 h

Nuclide	Energy [keV]	Count rate in ROI [counts/sec]
$^{212\backslash214}$Pb	74.8	1.030
^{226}Ra	186.1	0.055
^{214}Pb	351.9	0.246
^{208}Tl	583.2	0.689
^{214}Bi	609.3	0.035
^{137}Cs	661.7	0.058
^{214}Bi	1120.3	0.050
^{40}K	1460.8	0.133
^{208}Tl	2614.5	0.045



Minimum Detection Activities (1)

- Currie MDA:

$$MDA = \frac{2.71 + 4.65\sqrt{B}}{\varepsilon \cdot T \cdot P_\gamma \cdot K}$$

- T=30 minutes
- ε =Lung counting efficiency
  Mobile\Stationary bed
  Distance of 40 cm between the top\bottom detectors*
- K=Decay corrected to measurement start time
- Chest Width Thickness ~2 cm**
- MDA decreases by ~5 of stationary bed mode versus mobile bed mode

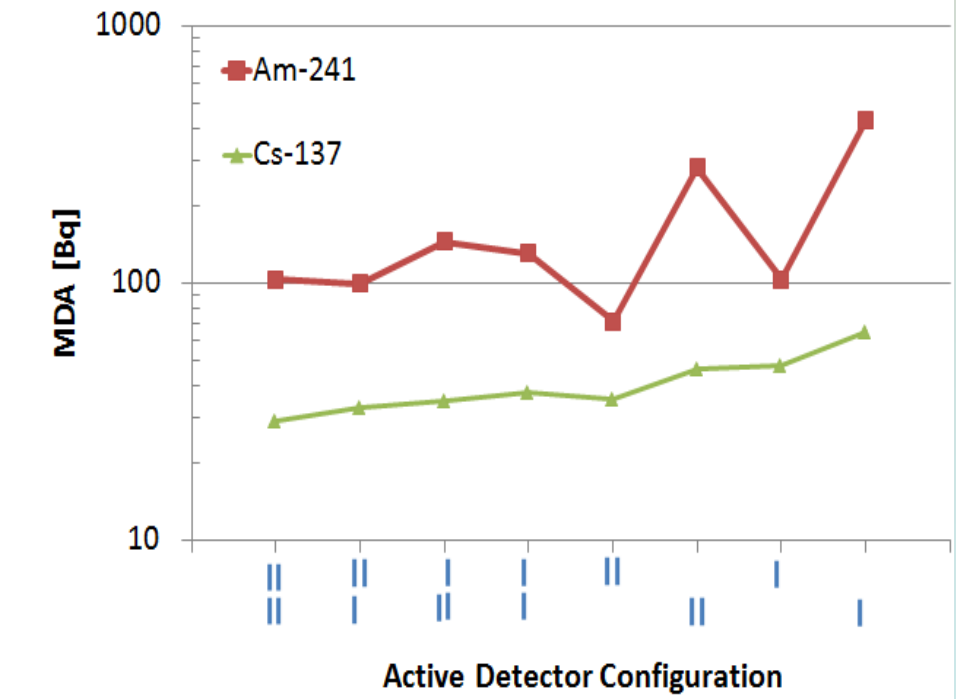
Nuclide	MDA Mobile bed [Bq]	MDA Stationary bed [Bq]
Am-241	109	23
Tl-201	85	18
Ra-223	152	33
Ga-67	92	21
Tc-99m	37	9
Tl-201	297	73
Lu-177	269	68
Pb-212	82	21
Ga-68	41	11
Tl-208	38	10
Cs-134	21	6
Cs-137	32	9
Mo-99	181	49

* For the maximal distance of 48 cm, MDA increases by ~30% for most γ-energies.
**For thicker chest widths, MDA increases by ~15% for the low γ-energies.

Minimum Detection Activities (2)

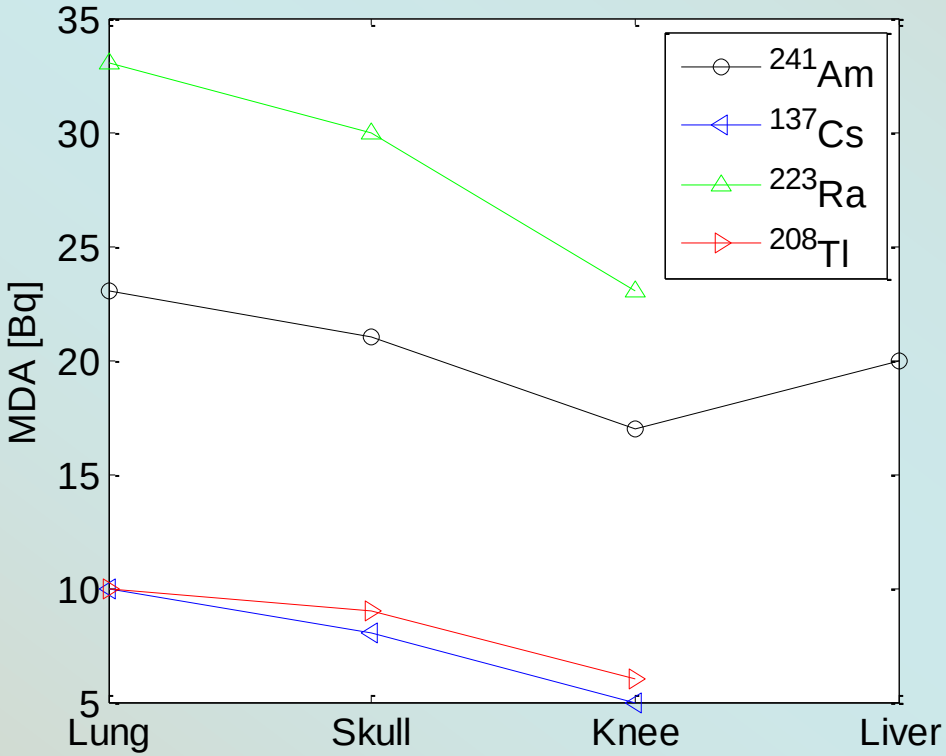
Dependence of MDA values on WBC detector configuration

- Trade-off between the overall detection efficiency and background counts in the region of interest.
- ^{137}Cs should be measured with sum of the four detectors
- ^{241}Am should be measured with sum of the two top detectors

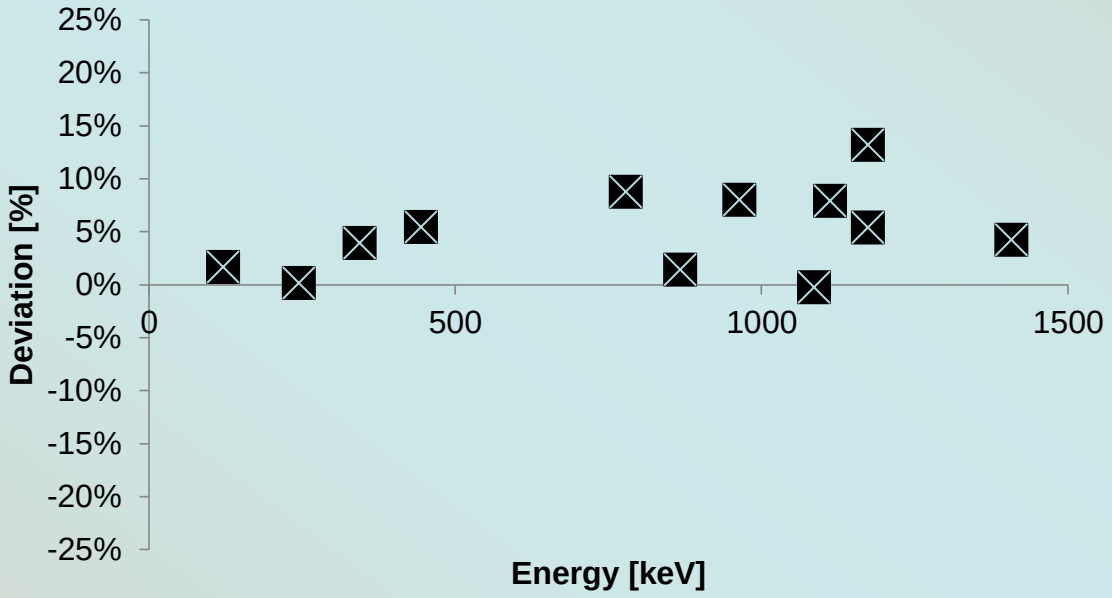


Minimum Detection Activities (3)

Dependence of MDA values on phantom geometry



Comparison between the response to NRCN and Cincinnati Uni. LLNL



An average discrepancy of ~5% is observed, possibly caused by minor difference in source positioning

Summary

- An extensive characterization of SNRC's WBC was carried out using various phantoms.
- Efficiencies calibration and radionuclides MDA were calculated for several WBC configurations. MDA values are similar in magnitude to other state of the art WBC systems.

Acknowledgements

- Prof. Henry Spitz, University of Cincinnati, USA.

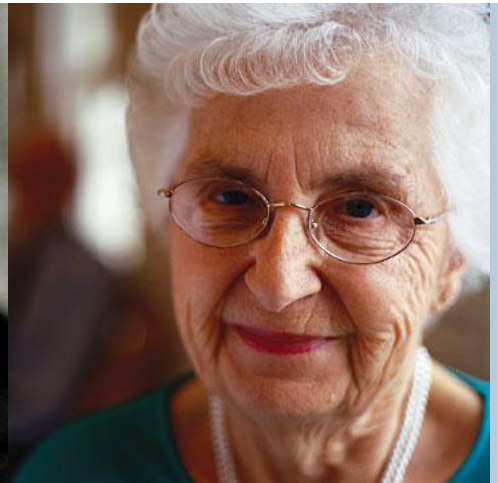
Thank you for your attention!

HUMAN MONITORING LABORATORY:

AN OVERVIEW OF *IN-VIVO* CAPABILITIES & CURRENT RESEARCH

Barry Hauck, Chunsheng Li
Radiation Protection Bureau, Health Canada

LLNL 1st Annual Teleconference on the Intercomparison of *In Vivo* Measurement Facilities
31 July 2014



Canada

MANDATE

HML within the Radiation Protection Bureau - Health Canada

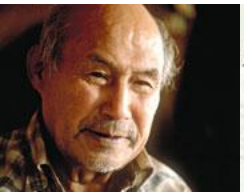
- **Four Business lines:**
  - ***In Vivo* performance testing on behalf of nuclear regulator**
  - **Emergency response**
  - **Research**
  - **Advice and assistance**

  - **Not an operational counting facility**
    -usually count 20-30 persons/yr

In Vivo COUNTING SYSTEMS

Two fixed counting systems- Lung & Whole Body

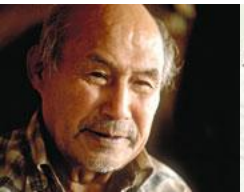
Mobile WB counter for emergency response



WHOLE BODY COUNTER

- Installed in low background counting chamber in 2005
- Consists of four Ortec GEM series HPGe detectors in a single 68L dewar (150% efficiency-nominal 90mm diameter x 105 mm length)
- Detectors on scanning device which moves under counting subject
- Normal (non-emergency)count time 1800 s
- Typical array (four detector) MDA's:
  - Cs-137 = 16 Bq
  - Co-60 = 11 Bq
  - Am-241 = 475 Bq

WHOLE BODY COUNTER



EMERGENCY COUNTING

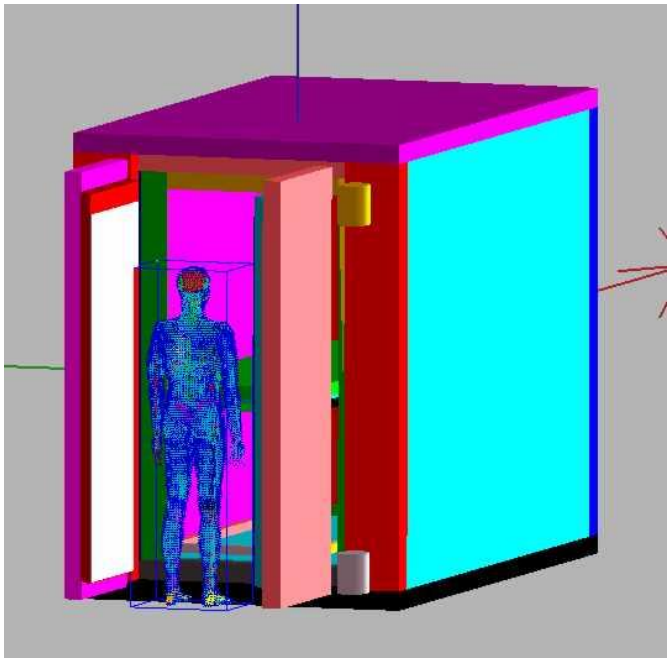
WB counter calibrated using MCNP to count highly contaminated individuals in standing position outside chamber

Can use any of four detectors

Count time = 60 s

MDA range: Cs-137= 3.9 to 120 kBq

Co-60 = 3.1 to 86 kBq



LUNG COUNTER

Installed in graded low background counting chamber in 2004

Consists of four individual Ortec GEM series P-type germanium detectors (85mm diameter x 30 mm thickness) with 17.5 L LN dewars and carbon fibre end caps

Detectors suspended from mounting track which allows independent movement for positioning

Normal (non-emergency) count time 3600 s

Typical array (four detector) MDA's for a 4 cm chest wall thickness:

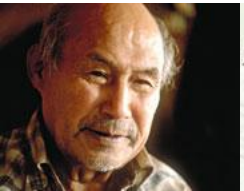
Pu-239 = 24000 Bq

U-235 = 9 mg Nat U

Am-241 = 8.7 Bq

Co-57 = 2.9 Bq

LUNG COUNTER



PORTABLE WHOLE BODY COUNTER

Have calibrated Ortec Detective® (Ge crystal 50mm diameter and 30 mm thickness) for use as a portable WB counter using MCNP and benchmarked model with a BOMAB phantom

Counting geometry: Subject seated in front of detector placed 86 cm above ground with subject's back against wall 100 cm from detector

Normal count time 300 s

Typical MDA's: Cs-137 = 2.4 kBq

Co-60 = 6.5 kBq

Am-241 = 12.1 kBq

INTERESTING CASE

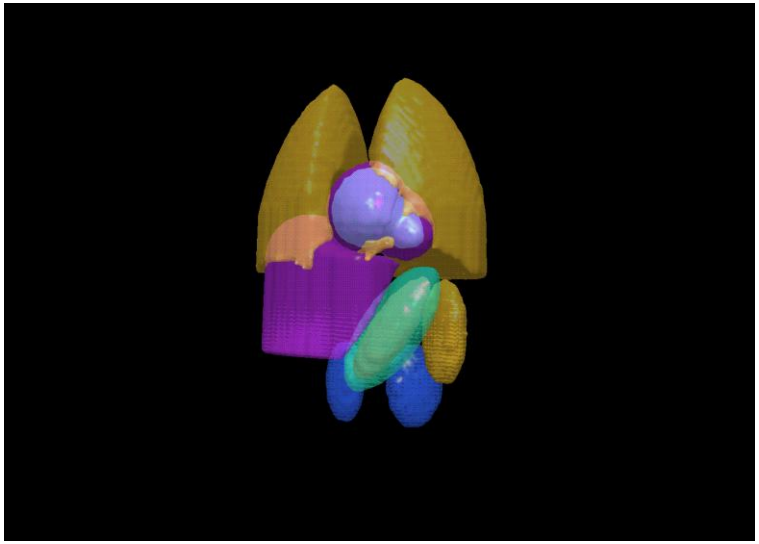
Counted individual with Ra-226 uptake
from chronic exposures that occurred
>70 years ago
Counted both skull and below knee cap bone
Excellent agreement between
two geometries (<10% difference)

RECENT WORK

Collaborative study with U of North Carolina to investigate effect of subject breathing on lung measurement using 4D NURBS-based Cardiac-Torso (NCAT) phantom

Simulated HML lung detector array and NCAT phantom in MCNPX

Conclusion- breathing makes small negligible contribution to the overall uncertainty in lung counting and introduces a systematic bias where all lung burdens are underestimated by a few percent

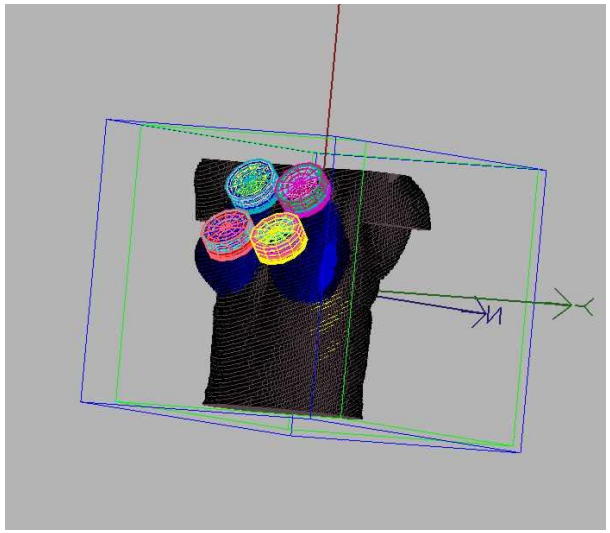


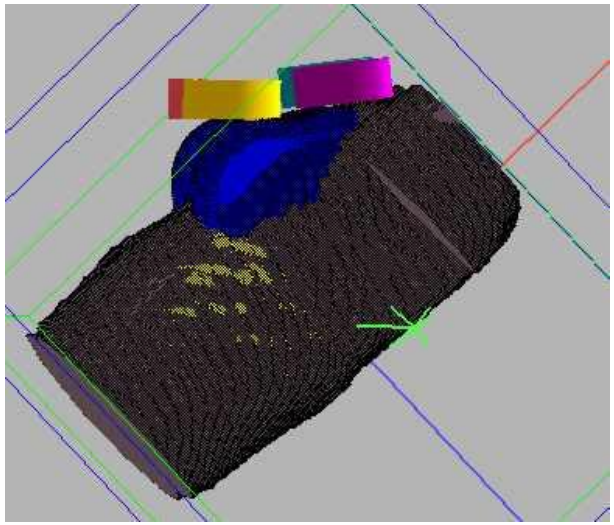
RECENT WORK

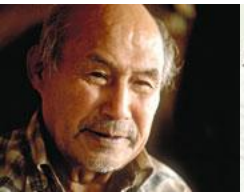
Used MCNP to derive counting efficiencies for female counting subject corresponding to the four standard breast sizes (A to D) for HML lung detectors using phantom created from IRSN female torso library

Assumed average North American female torso girth size of 90 cm

Derived individual detector and four detector array efficiencies



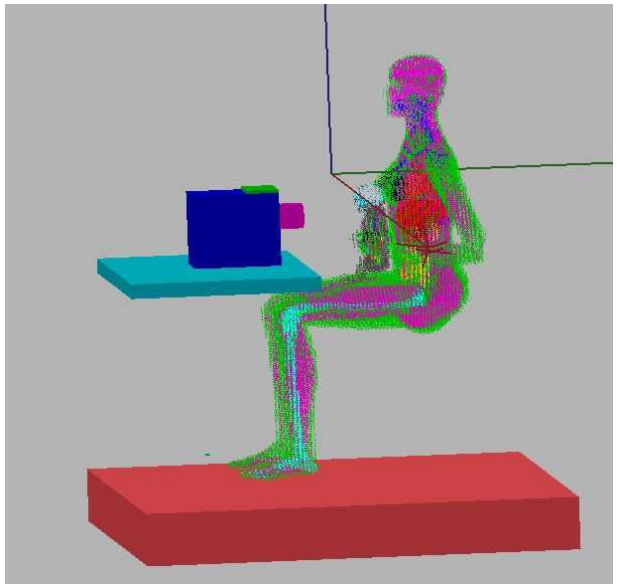


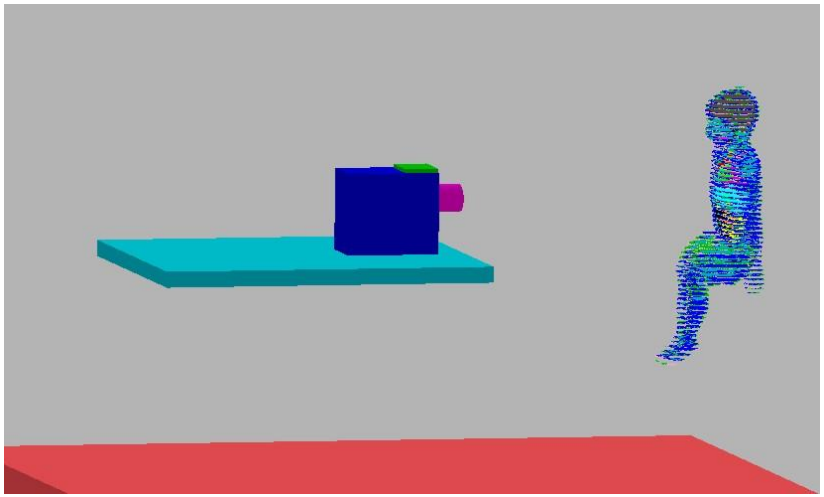


RECENT WORK

Used MCNP to derive calibrations for paediatric subjects using portable WB counter during a nuclear emergency

Created various voxel phantoms calibrations (mother & newborn, 9 month infant, 4, 8, 11 and 14 year old)





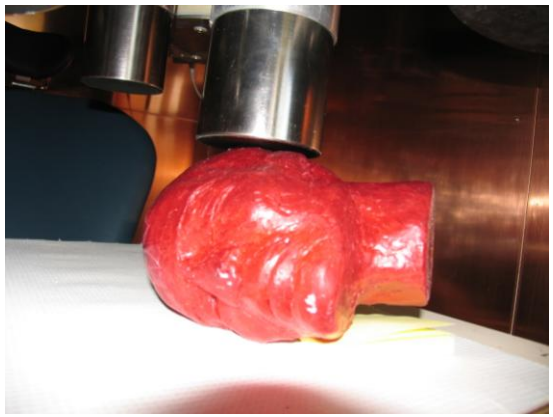
RECENT WORK

Recently participated in EURADOS skull intercomparison

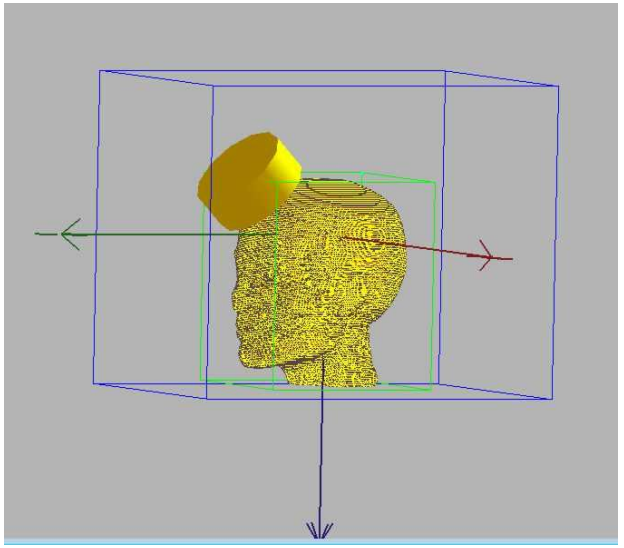
Measured three different skull phantoms- BPAM-001,BFS and CSR- in various positions and derived counting efficiencies

Performed series of simulations involving real and theoretical detectors with various skull phantoms

BPAM-001



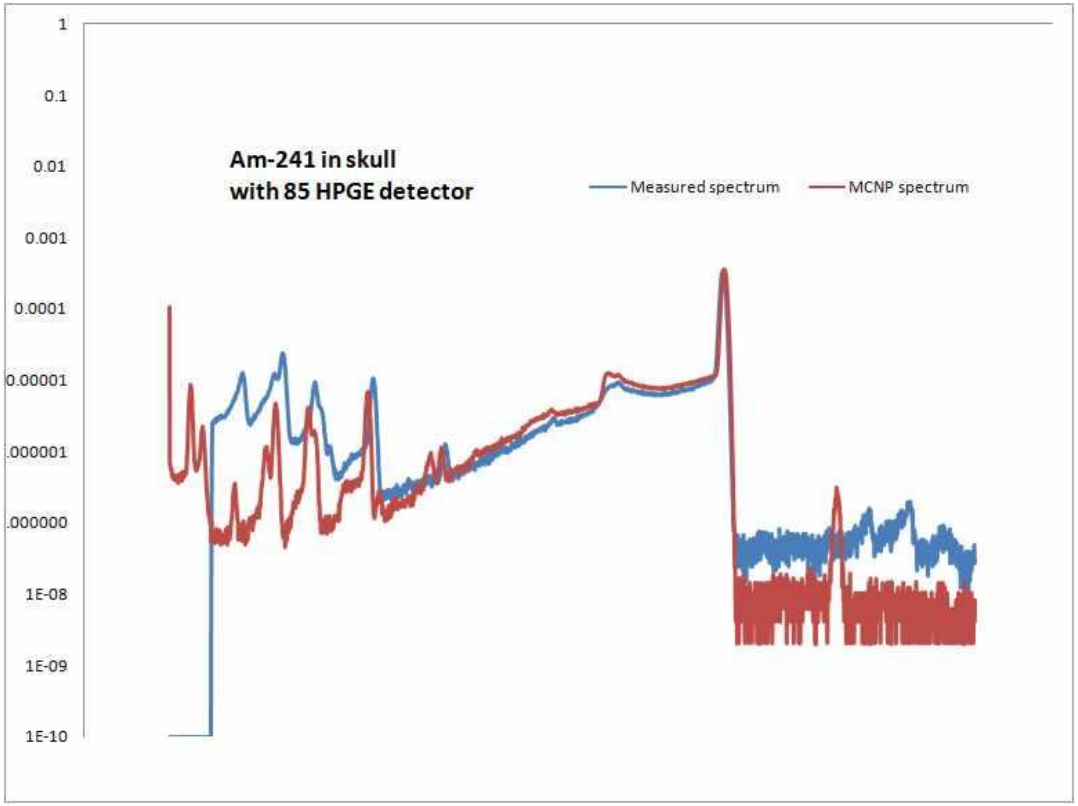
BFS



RECENT WORK

Simulated one counting geometry for BFS phantom and compared actual spectrum versus MCNP derived spectra

Reasonable agreement!

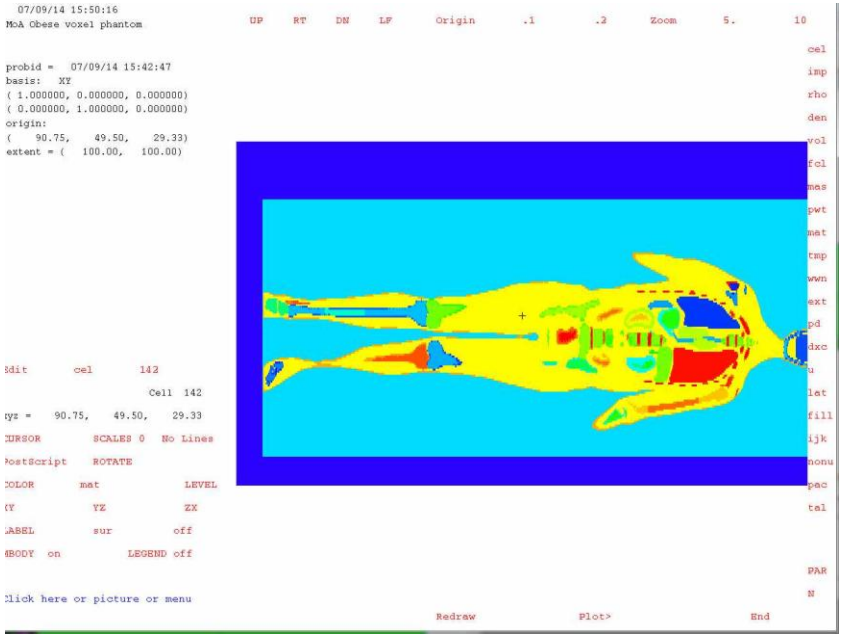


FUTURE WORK

Will investigate the effect of subject size of counting efficiency of WB counter using MCNP

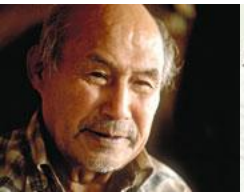
Have created voxel phantoms of various sizes

- from infant to obese adult



ANY QUESTIONS?

THANK YOU!



Pump and Bake Your Way to Improved Resolution

Saves Liquid Nitrogen, Too

Henry Spitz
University of Cincinnati
College of Engineering
Laboratory for Radiological Assessment & Measurement

UNIVERSITY OF Cincinnati

UC Laboratory for In Vivo Measurement

- Two graded-Z, steel rooms
  - ✓ 8’x8’x8’ Fe 6” thick
  - ✓ 12’x8’x8’ Fe 5” thick
- Eight 2800 mm^2 Carbon-Window GL2820RS Canberra detectors for lung counting
- 8”x4” NaI(Tl)
- 6” Square Phoswich
- Other scintillators for special counting

UNIVERSITY OF Cincinnati

Phantoms

- Livermore Thorax with Axillary Lymph Nodes
- Livermore/RSD Whole body
- UC Knee w trabecular bone
- UC Head (Am^{241}/Eu^{152})
- NYU Skulls (Am^{241}, Pu^{210})
- NYU Thoracic Skeleton (Am^{241})

UNIVERSITY OF Cincinnati

Fabrication of Phantoms

- UC fabricates a wide range of phantoms for all types of direct gamma spectrometry measurements.
  - Lungs, liver, thyroid, knee, head (skull)
  - Tissue substitute materials for muscle, trabecular and cortical bone

Open and Blind Measurements

- UC loans phantoms for internal QC Tests
  - Open - activity disclosed
  - Blind – activity undisclosed until results reported to UC
  - High and low activity

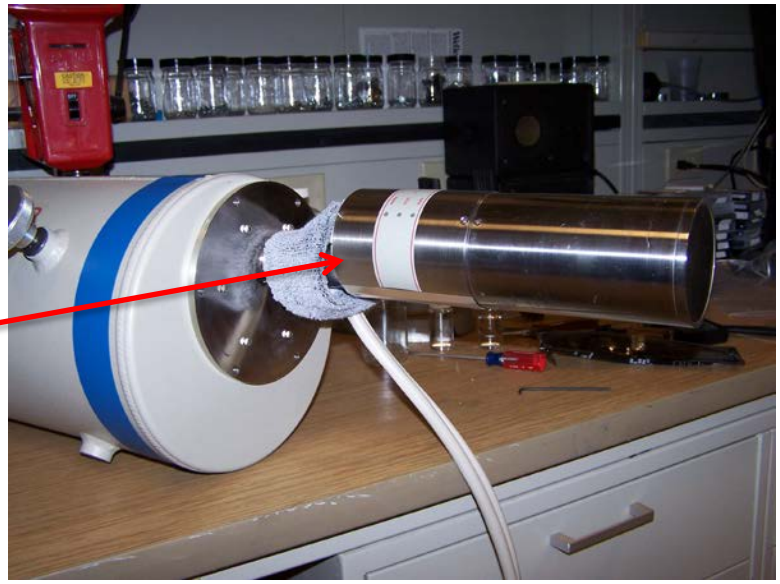
UC Lung Counter

Shielded room with 4 all-attitude detectors for site-specific measurements

UNIVERSITY OF Cincinnati

Service Required

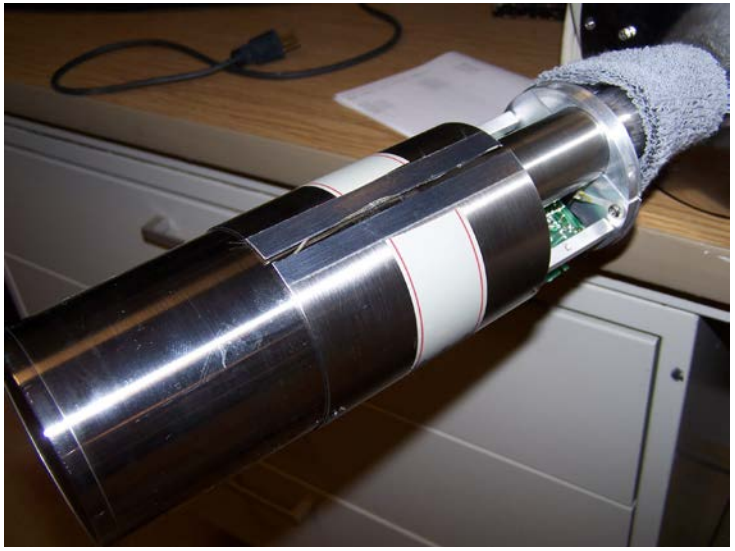
- Resolution at 59.5 keV degraded from 320 eV to 570 eV, but otherwise OK
- Repair quoted at $5k
- *Do It Yourself*, but risk damage?



UNIVERSITY OF Cincinnati

Remove Preamp Cover

Slice the metallic tape

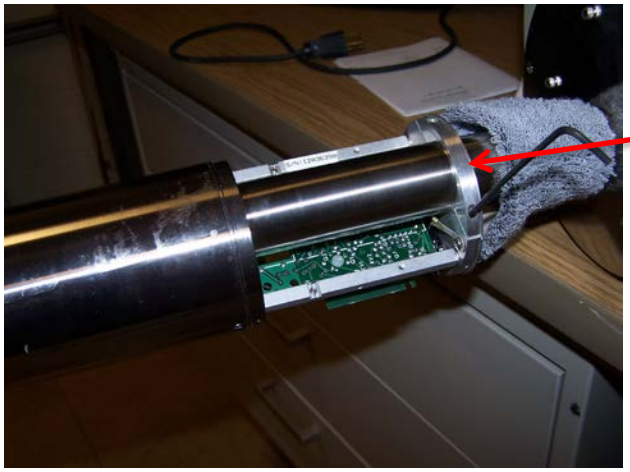


Slide cover down over detector end cap to reveal preamp and vacuum port

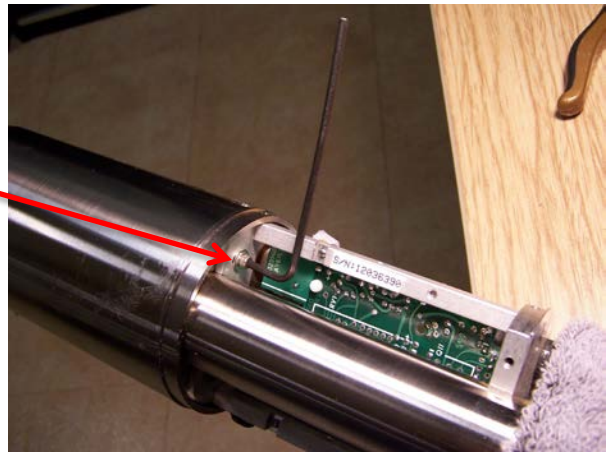
UNIVERSITY OF Cincinnati

Remove Preamp

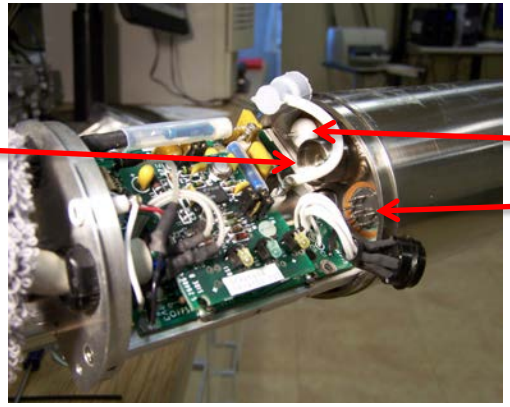
Remove preamp to access vacuum port.



Preamp is attached by a clamp and two screws



Note how vacuum port is obscured by preamp



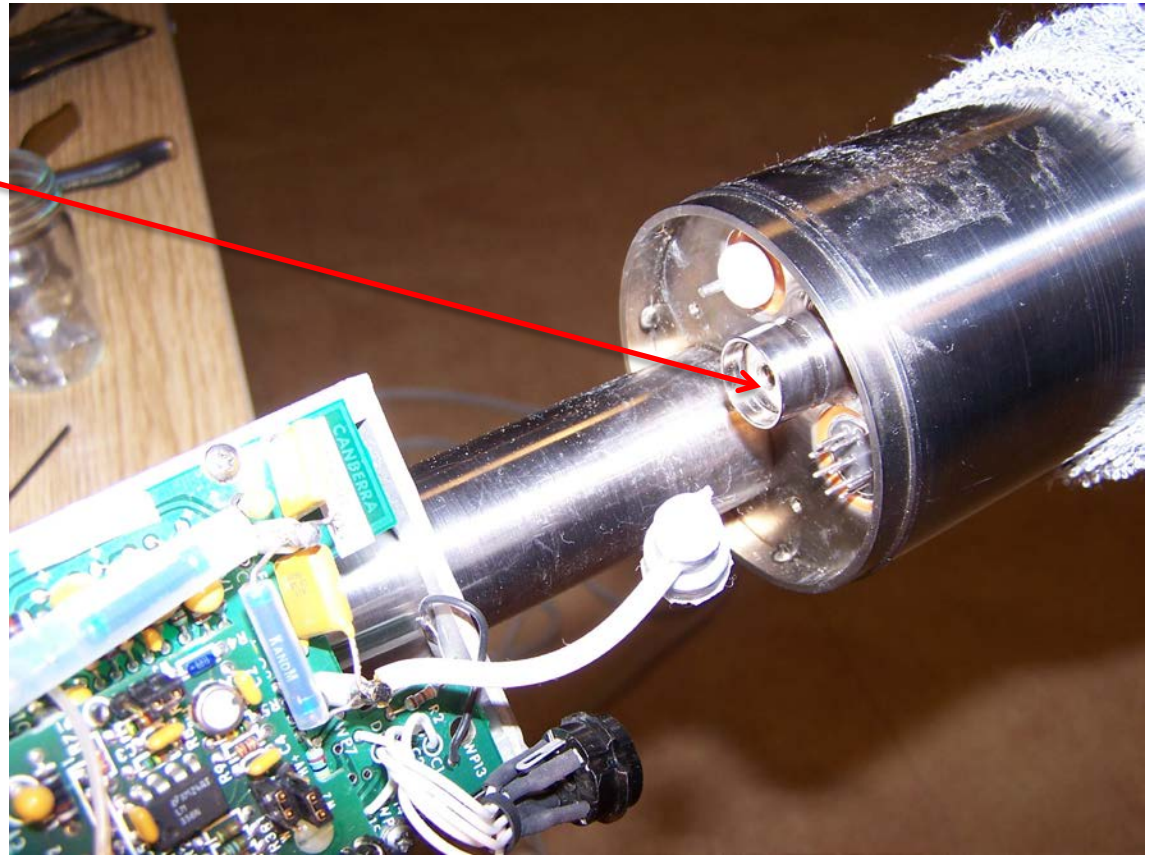
Disconnect 2 plugs for high voltage and signals

UNIVERSITY OF Cincinnati

Vacuum Port

Vacuum plug is removed using a special tool

Cryolab Valve Operator
V08-084-5L1
CPC-Cryolab, Tampa, FL.



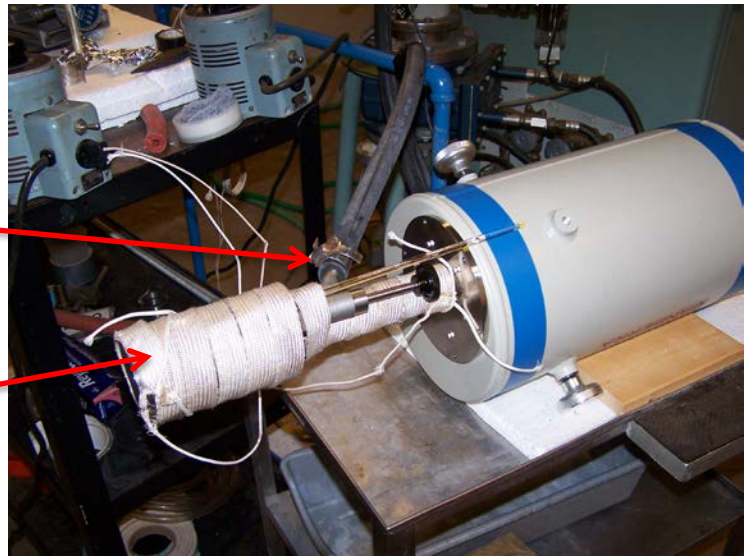
UNIVERSITY OF Cincinnati

Pump & Bake

- Warm detector with heating tape (T≈60^{o}C)
- Withdraw plug and evacuate to ≈ 10^{-6} Torr

Valve operator connected to vacuum

Heating tape



- Close valve and check for leaks before disconnecting vacuum.
- Disconnect heating tape

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Reinstallation

- Allow detector to reach room temperature before reconnecting preamp
- Clean both connectors before reattaching preamp
- Recover preamp and re-seal seam with metal tape.

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The End

UNIVERSITY OF Cincinnati

Exceptional service in the national interest

Sandia National Laboratories

In-Vivo Capabilities

Robert P. Reese

Sandia National Laboratories

Radiation Protection and Sample Diagnostics Program

SAND 2014-16173PE

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

U.S. DEPARTMENT OF ENERGY | NNSA National Nuclear Security Administration

Overview

- Equipment
  - History
  - Purpose
  - Contingency
- Quality Control
  - In-house
  - Inter-comparison
  - Accreditation
- Questions

Equipment

Sandia National Laboratories

Canberra Accuscan II

Equipment: History

Sandia National Laboratories

Purchased MCMXCII

60 patients per year

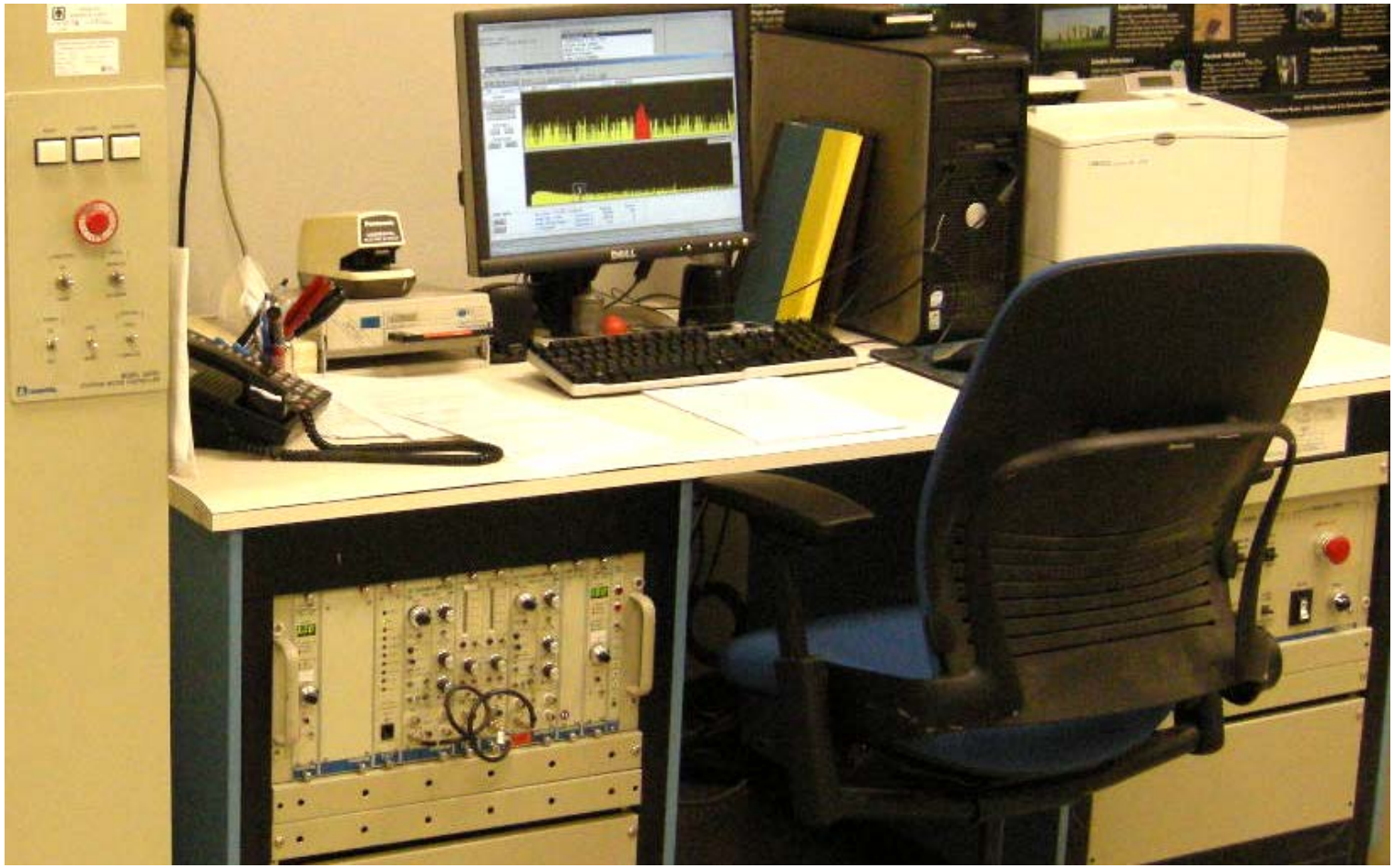
Equipment

Array of two LN-cooled 40% HPGe (P-type)

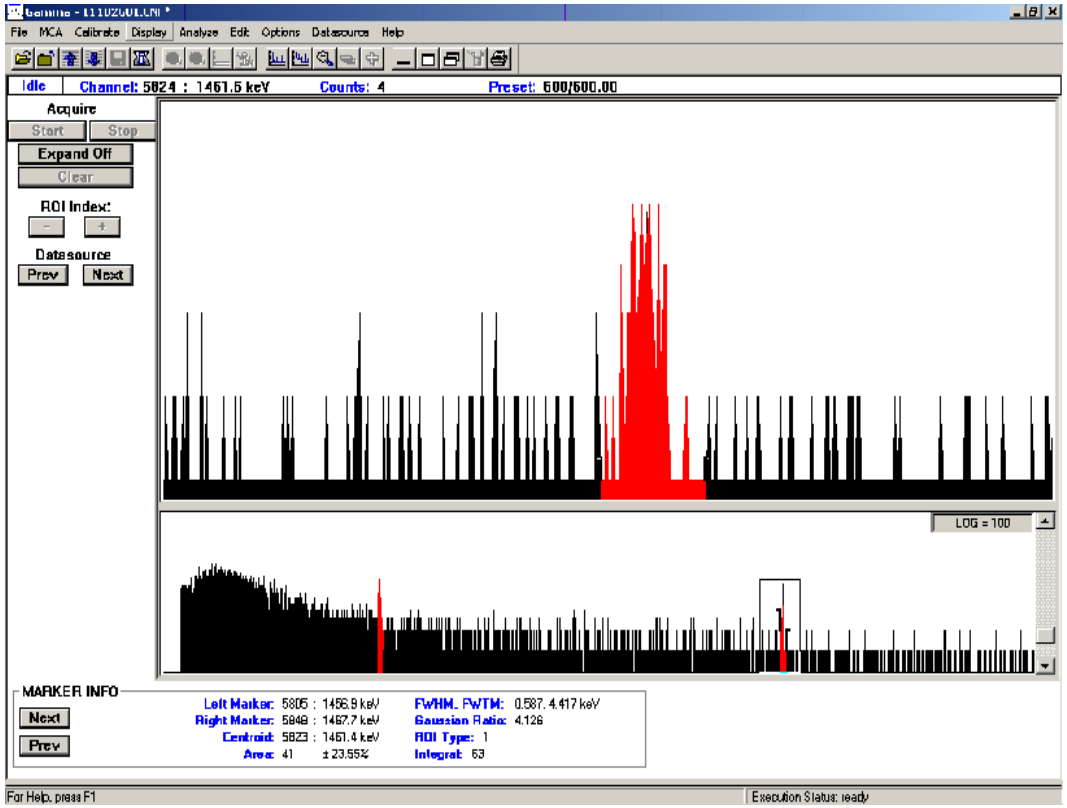
Equipment

Sandia National Laboratories

Original Analog Amps, ADCs, AIM

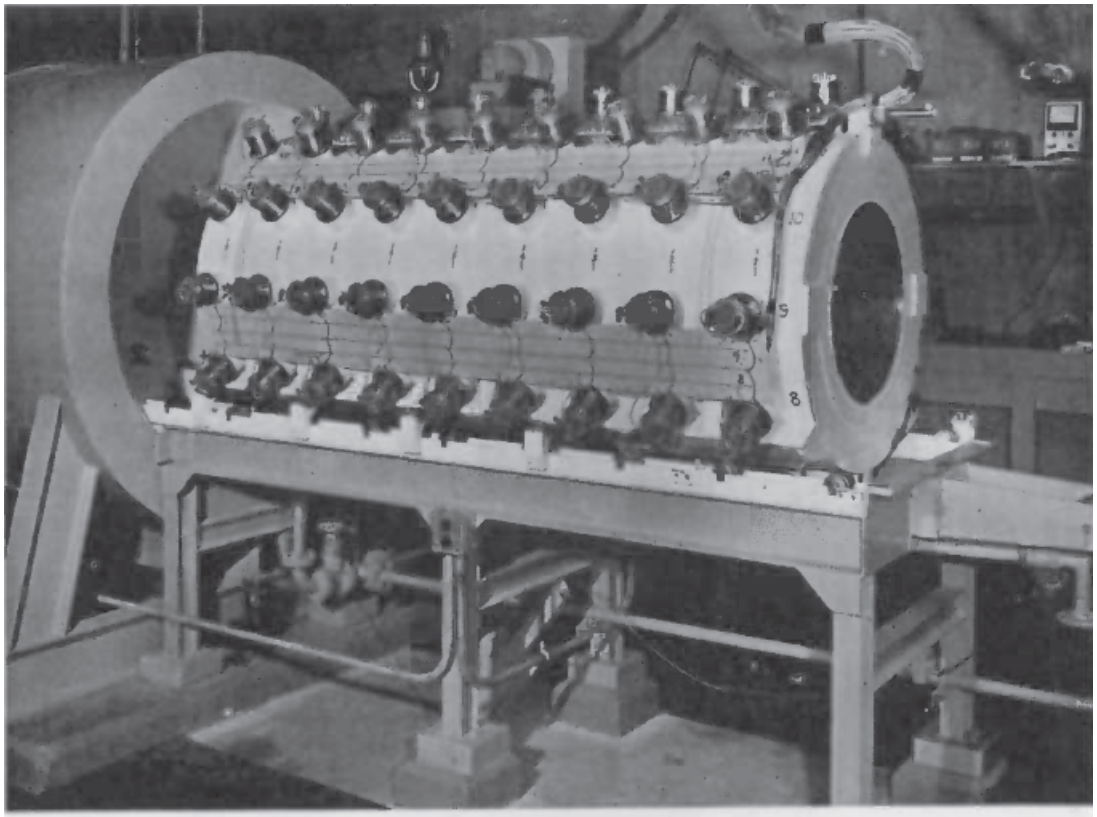


Equipment: Purpose



- Detect and quantify energetic photons from internal sources.
- Quick: High resolution and efficiency give results in ten minutes.
- Little concern about transuranics at SNL

Equipment: Contingency



THE LOS ALAMOS HUMAN COUNTER

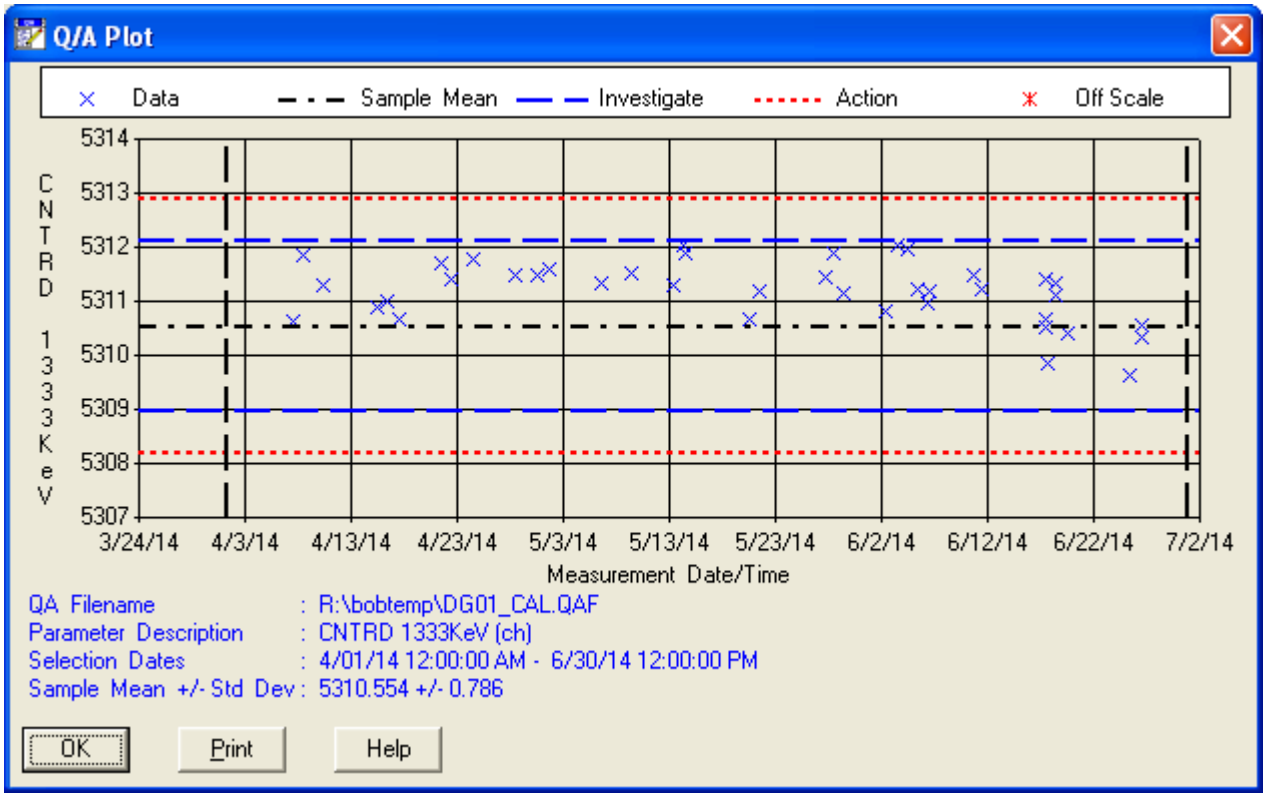
LANL PHOTO ca. 1957

lsc1957_211.pdf

We have assistance agreement with LANL if TRUs are a concern or if we are inoperable.

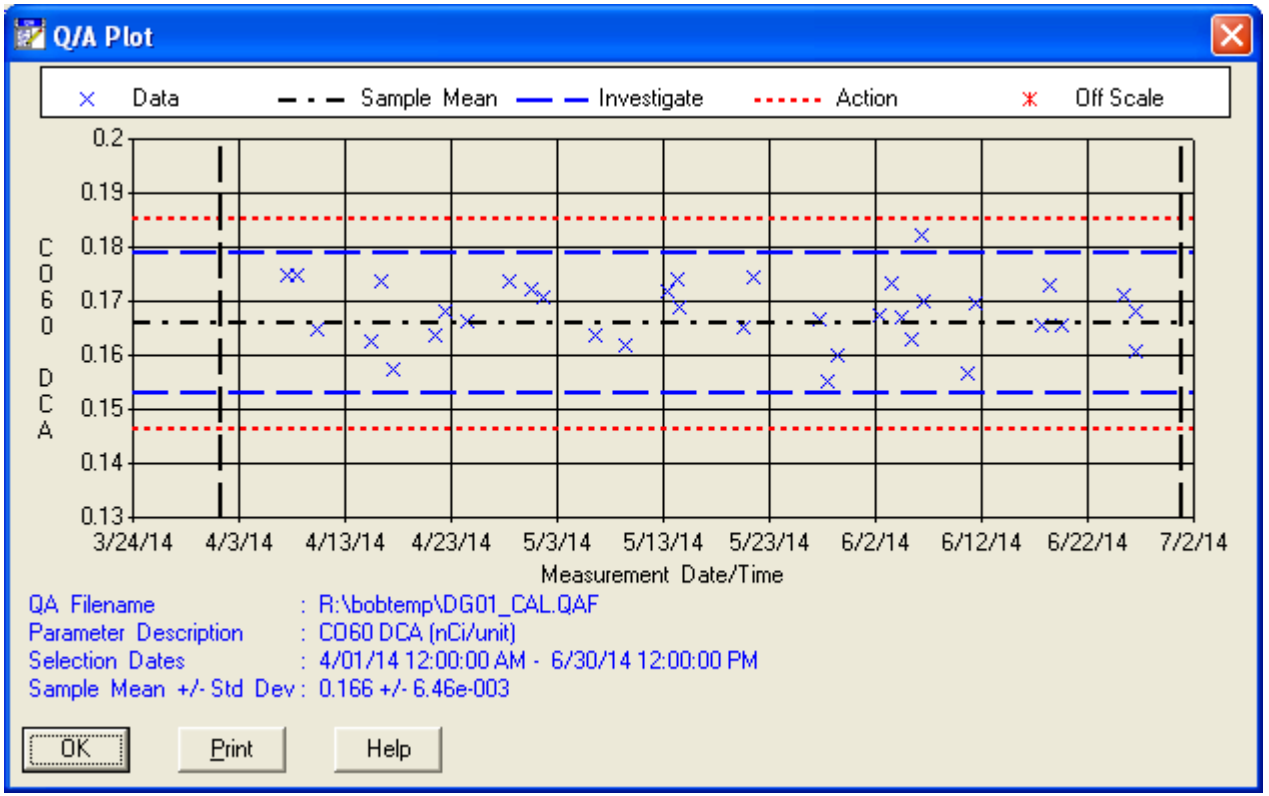
Quality Control: In House

We track amplifier gain,



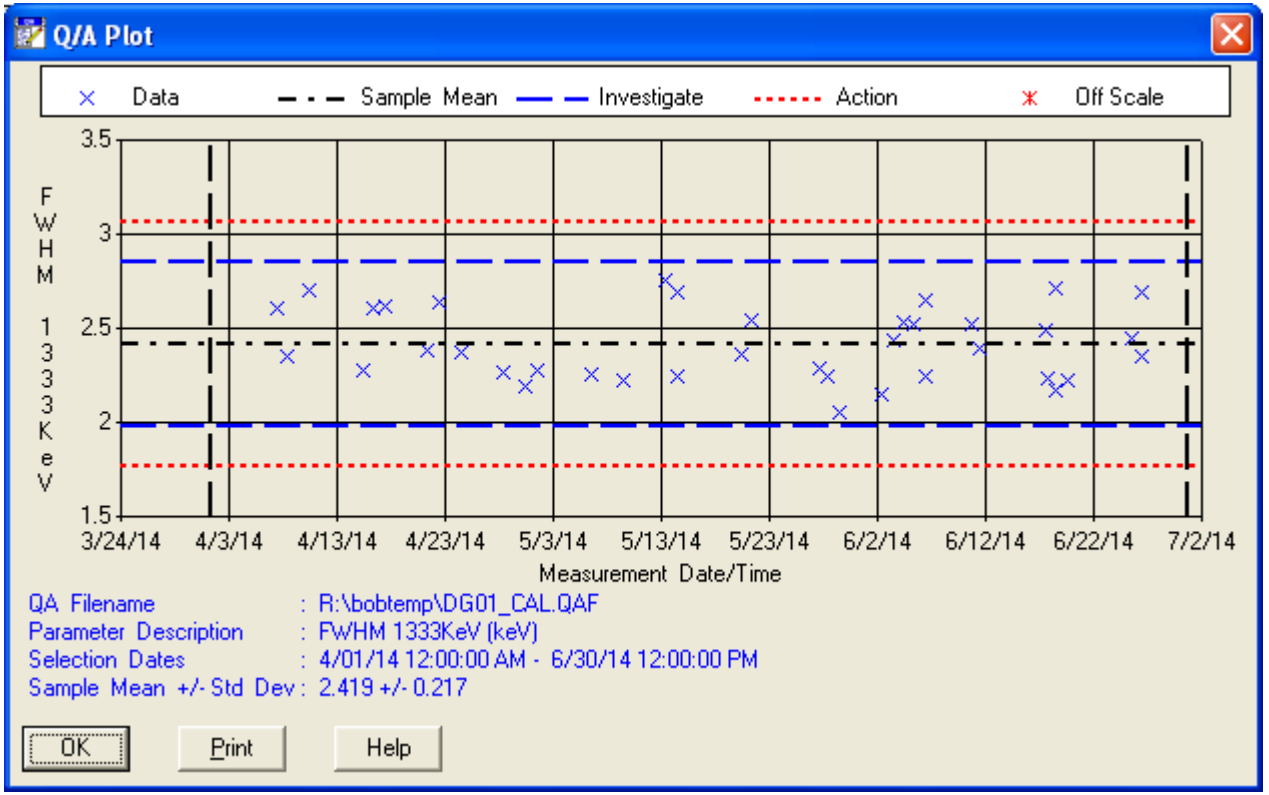
Quality Control: In House

detector efficiency,



Quality Control: In House

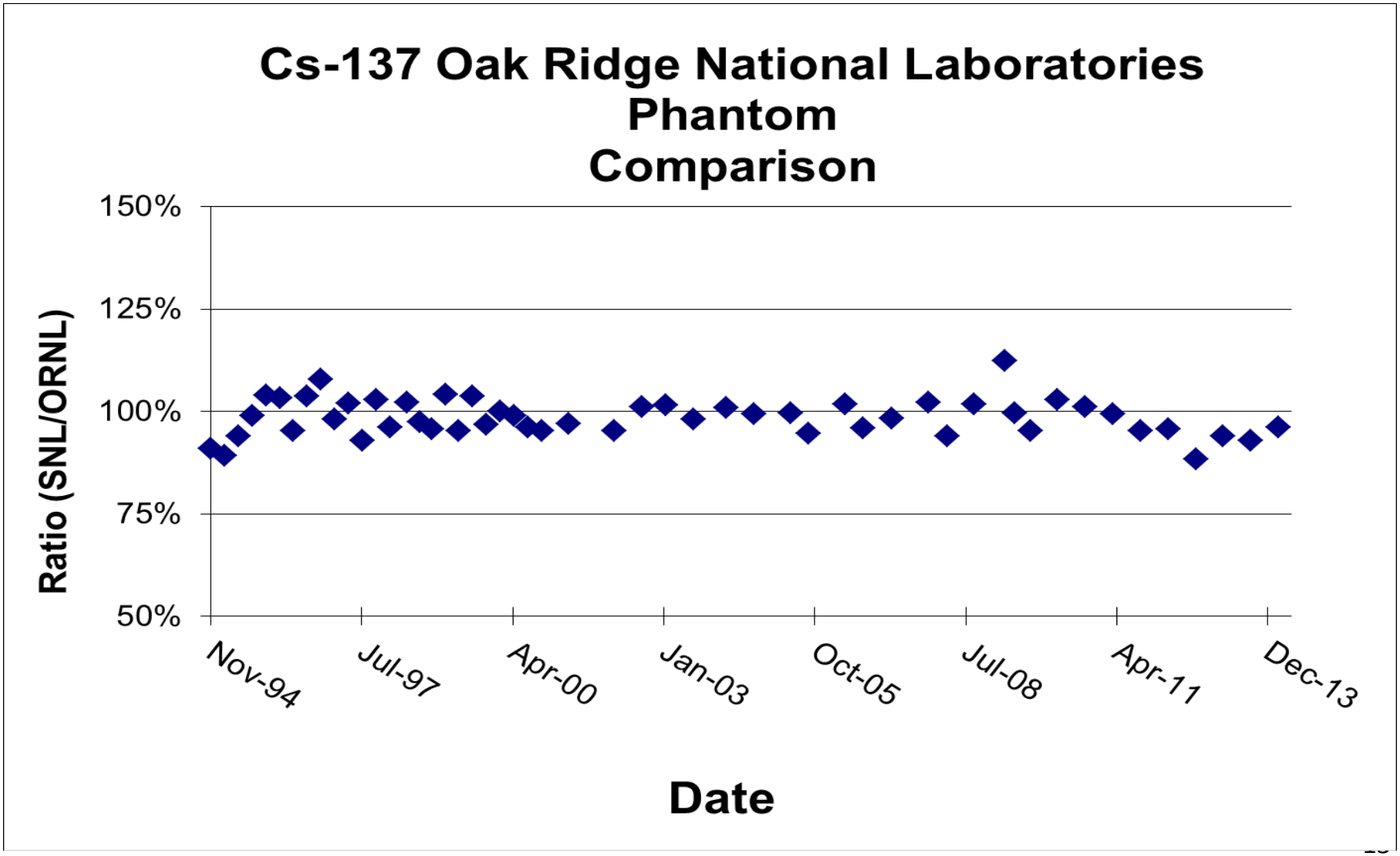
and system resolution.



Quality Control: Inter-comparison

- ORNL Whole-body blind test
- Occasional “round-robin” phantom sharing from INL
- DOELAP phantom

Quality Control: Inter-comparison



Quality Control: Accreditation

Tri-annual exam of SNL Internal Dosimetry Program earns DOELAP accreditation.

Other In-Vivo: PCM

External contamination frisker– thin plastic scintillators – required for accreditation.

Other In-Vivo: PGE

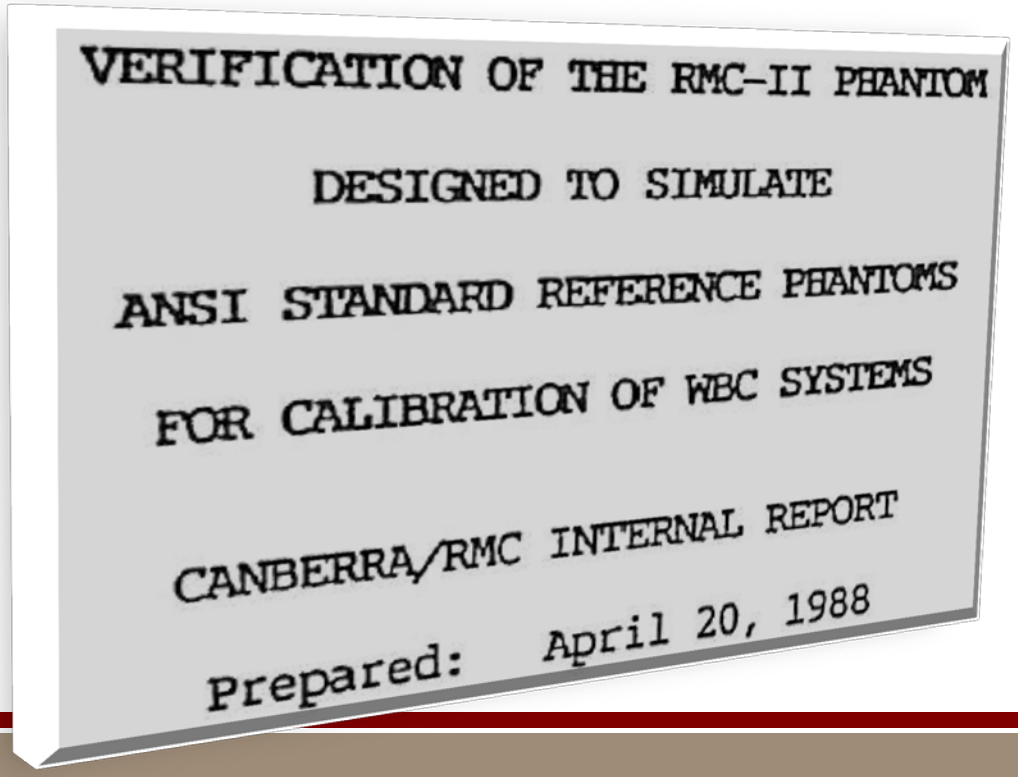
Used for iodine in thyroid and wound counting.

Other In-Vivo: PGE

Just joined Thyroid Radioiodine Inter-comparison Program (TRIP) from LLNL.

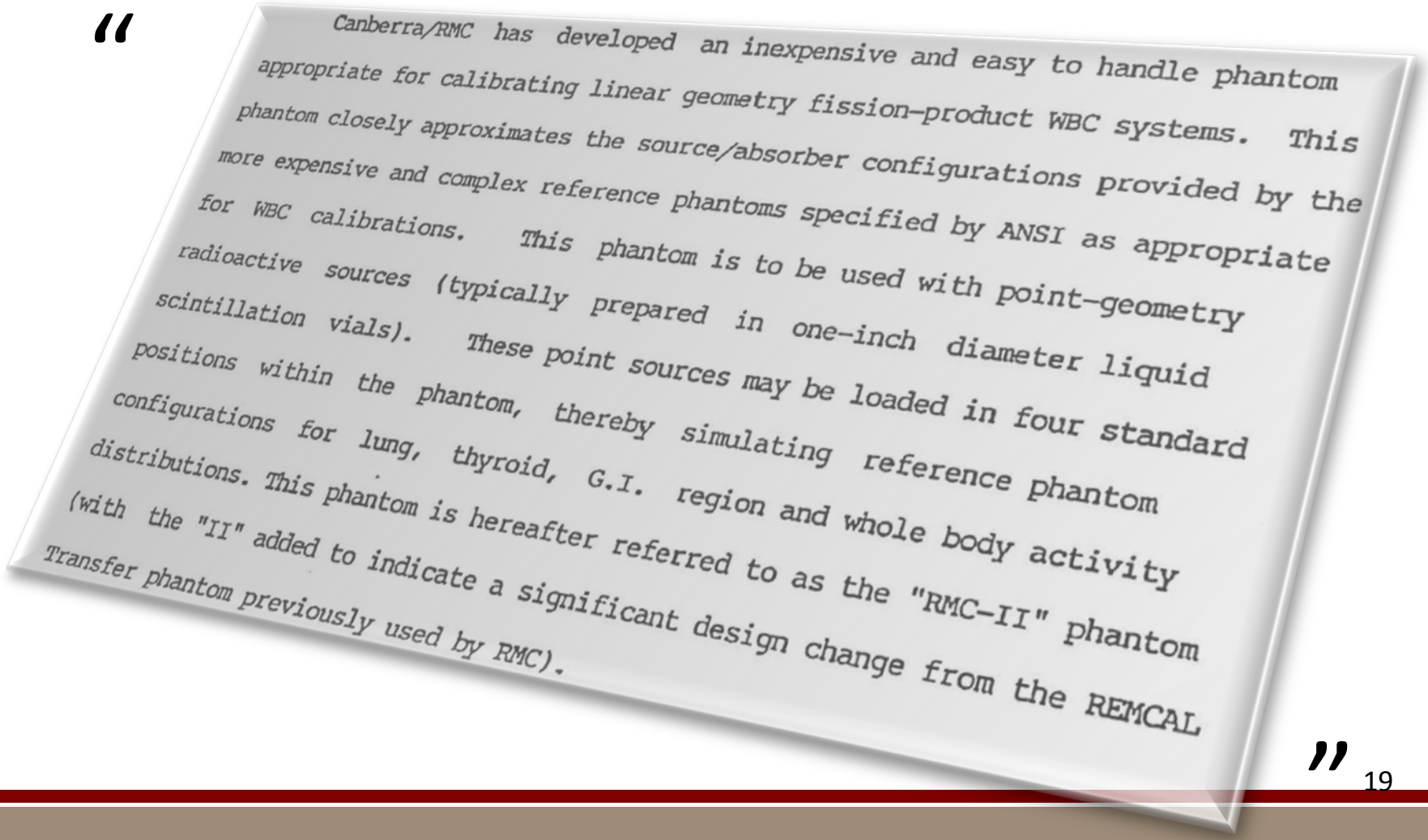
Other In-Vivo: RMC-II

- Canberra/RMC-II phantom has capability for WB, GI, thyroid and lung, validated in 1988.



Other In-Vivo: RMC-II

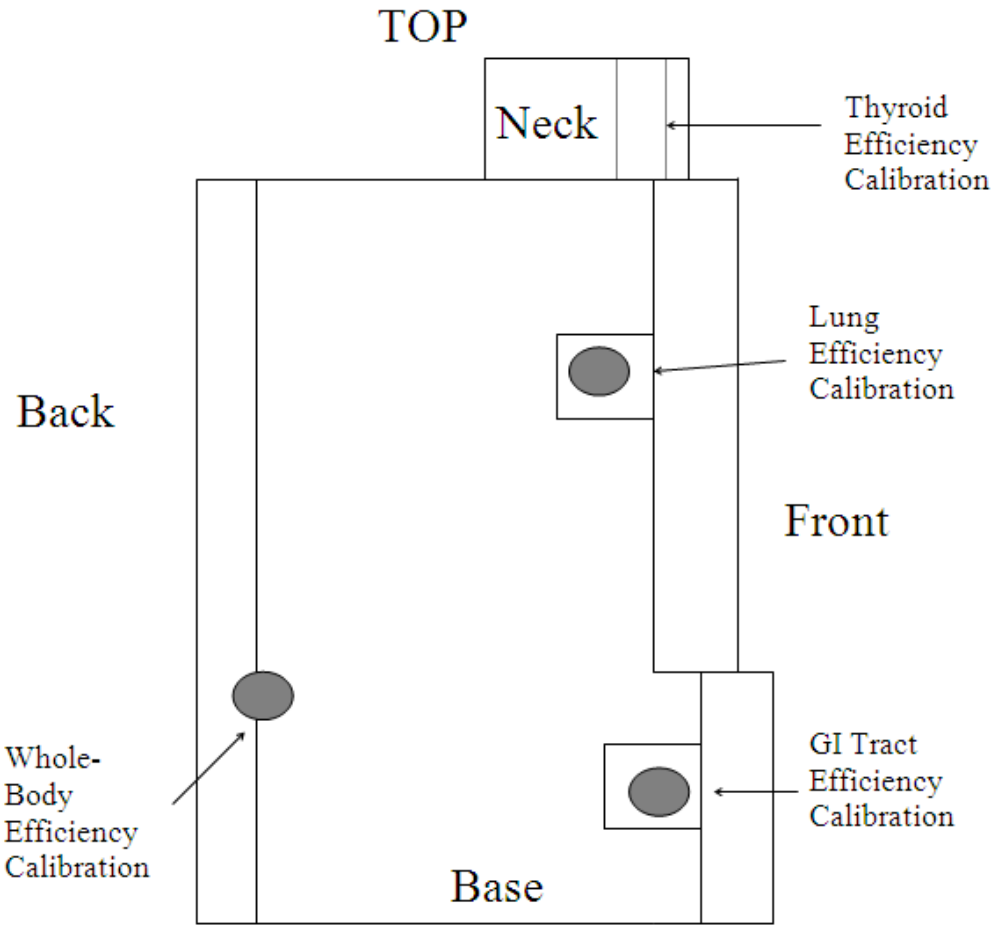
"



Canberra/RMC has developed an inexpensive and easy to handle phantom appropriate for calibrating linear geometry fission-product WBC systems. This phantom closely approximates the source/absorber configurations provided by the more expensive and complex reference phantoms specified by ANSI as appropriate for WBC calibrations. This phantom is to be used with point-geometry radioactive sources (typically prepared in one-inch diameter liquid scintillation vials). These point sources may be loaded in four standard positions within the phantom, thereby simulating reference phantom configurations for lung, thyroid, G.I. region and whole body activity distributions. This phantom is hereafter referred to as the "RMC-II" phantom (with the "II" added to indicate a significant design change from the REMCAL Transfer phantom previously used by RMC).

"

Other In-Vivo: RMC-II



Sandia National Laboratories

Questions?

Overview of Hanford Site Radiological Support Services

Presentation developed by RSS Staff

EH Carbaugh
RL Hill
SL Kon
CL Antonio
TP Lynch

Programs Include

- Technical basis documents
- Procedures
- Quality assurance
- Qualified, trained staff
- Accreditation by DOELAP* for dosimeters and radiobioassay measurements

  (*Department of Energy Laboratory Accreditation Program)

In Vivo (Direct) Radiobioassay

Technical Lead: Tim Lynch

- Measures radionuclides in people

  In 2012:
  3,900 whole body exams
  2,600 lung exams

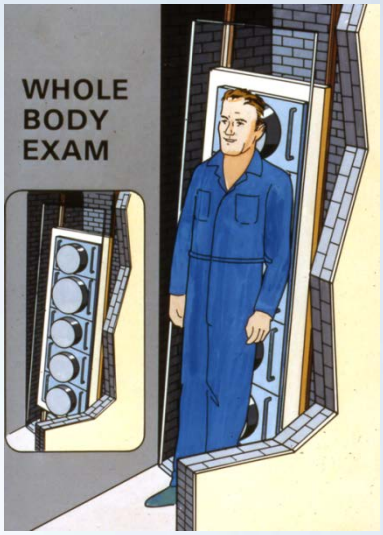
- 4 shielded counting rooms
- 1 shadow-shield counter
- Gamma analysis using Canberra ABACOS software, moving to Canberra APEX software in 2013-2014.

In Vivo (Direct) Radiobioassay

Whole Body Counting

High-energy photons (200 keV to 3 MeV)

Coaxial Ge detectors
Supine position
Scanning detector, 600 s



NaI detectors
Standing position
Stationary, 200 s

In Vivo (Direct) Radiobioassay

Whole Body Counting

- Count workers in street clothes
- Recount if activity is detected
- Minimum detectable activity (MDA)

^{137}Cs	40 Bq	(1 nCi)
^{60}Co	40 Bq	(1 nCi)
^{154}Eu	75 Bq	(2 nCi)

In Vivo (Direct) Radiobioassay

Lung Counting

- Low-energy photons (10 keV to 500 keV)
- 3 similar systems using planar Ge detectors

In Vivo (Direct) Radiobioassay

Lung Counting

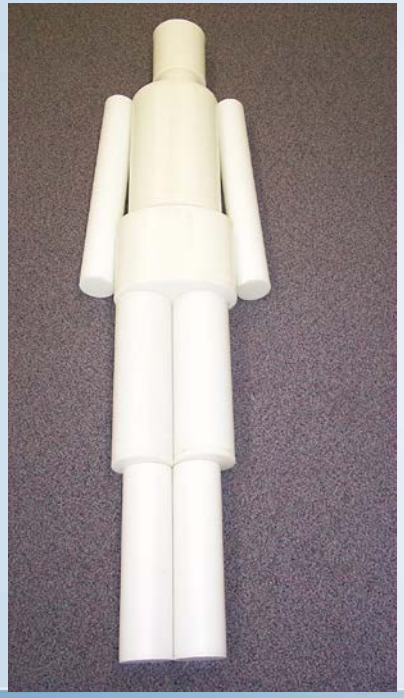
- Workers counted in clean coveralls
- 3,000 to 4,000 second count
- Recount if activity detected
- Minimum detectable activity (MDA)

^{241}Am	7 Bq	(0.16 nCi)
^{235}U	4 Bq	(0.08 nCi)
^{234}Th	57 Bq	(1.5 nCi)

In Vivo (Direct) Radiobioassay

- Calibration and checks using phantoms with NIST-traceable sources

BOMAB Phantom



Lawrence Livermore

Torso Phantom

In Vivo (Direct) Radiobioassay

- Wound counting using planar Ge detector or NaI detector

In Vivo Measurement Facilities and Capabilities at LLNL

1st Annual Teleconference on the Intercomparison of In Vivo Measurement Facilities

July, 31, 2014

Karen Jeffers, Scientific Associate

Lawrence Livermore National Laboratory

LLNL-PRES-657750

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344. Lawrence Livermore National Security, LLC

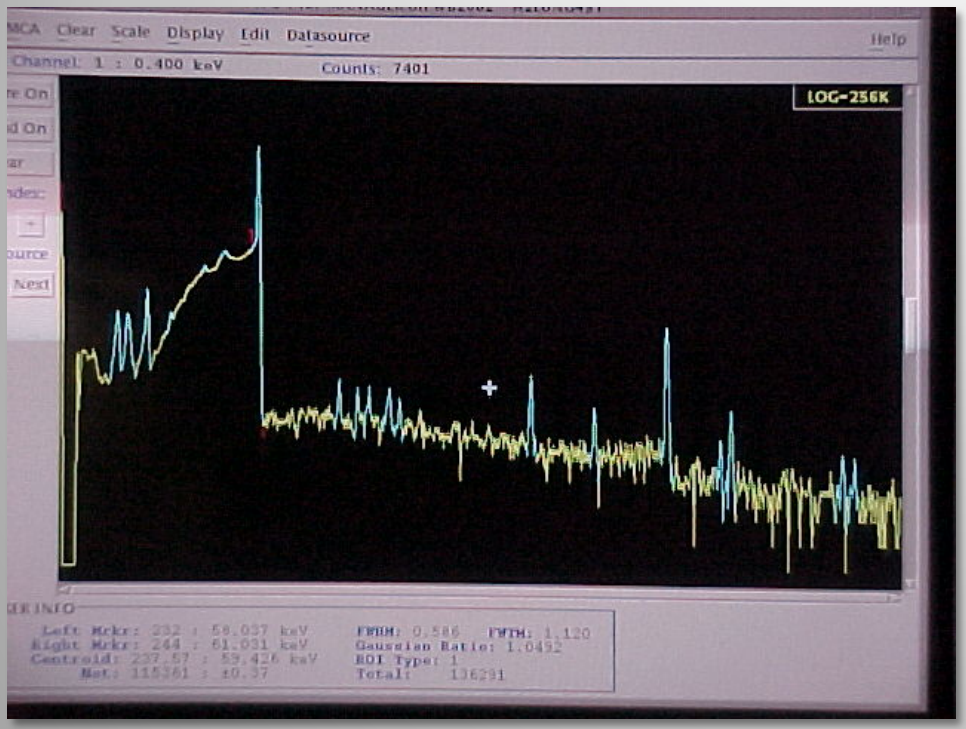
Whole Body Counter Facility

- Consists of two main rooms:
  - Control Room
  - Shielded Counting Room

Control Room

- Houses the following:
  - Portable wound counting system
  - Control and safety systems used in WBC facility
    - LabView System
    - Oxygen Monitors
    - Temperature readout
    - Camera functions
    - Programmable Logic Controller
    - Real-time LN liquid level monitor

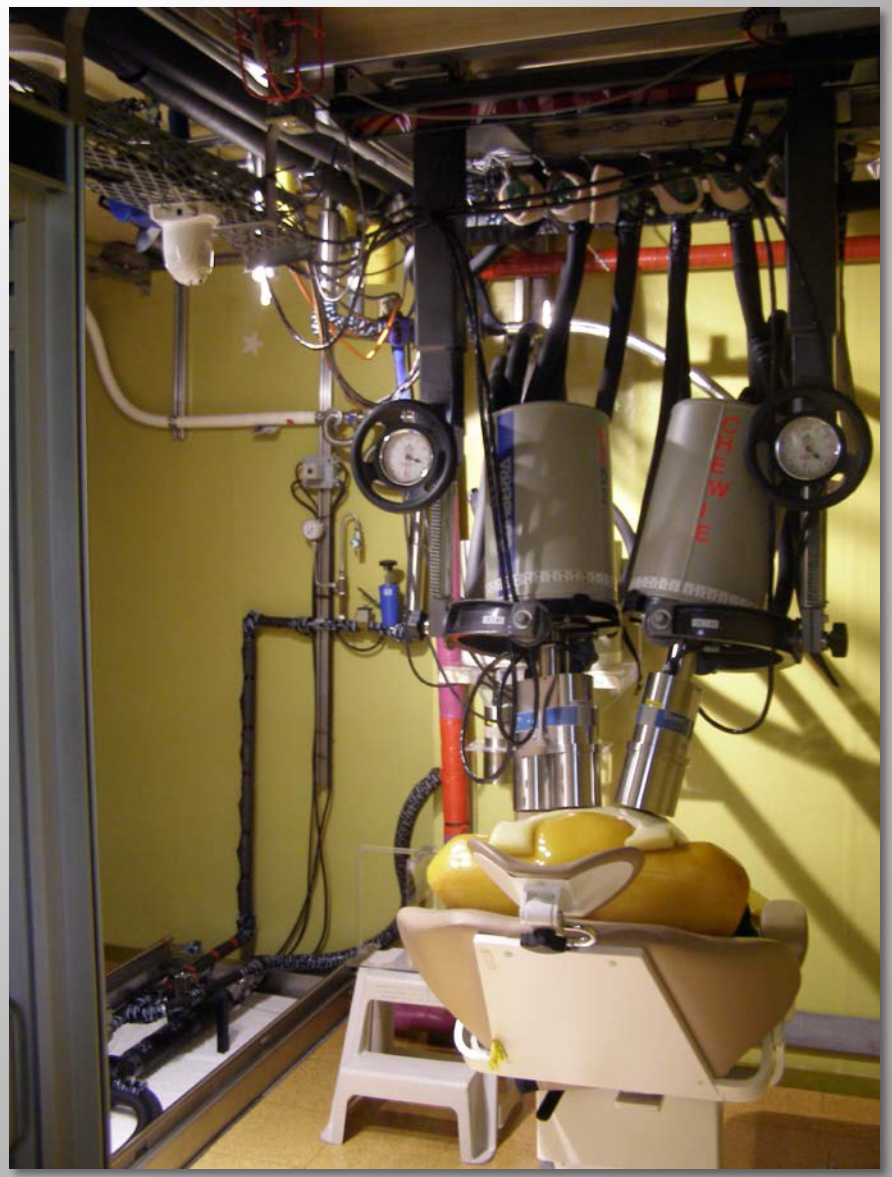
Control Room cont'd



- Computer System
  - VMS based Canberra ABACOS/Genie software
  - Enhanced Analysis
    - Master Library
      - Lowest MDA peak
      - Decay chain progeny

Counting Room

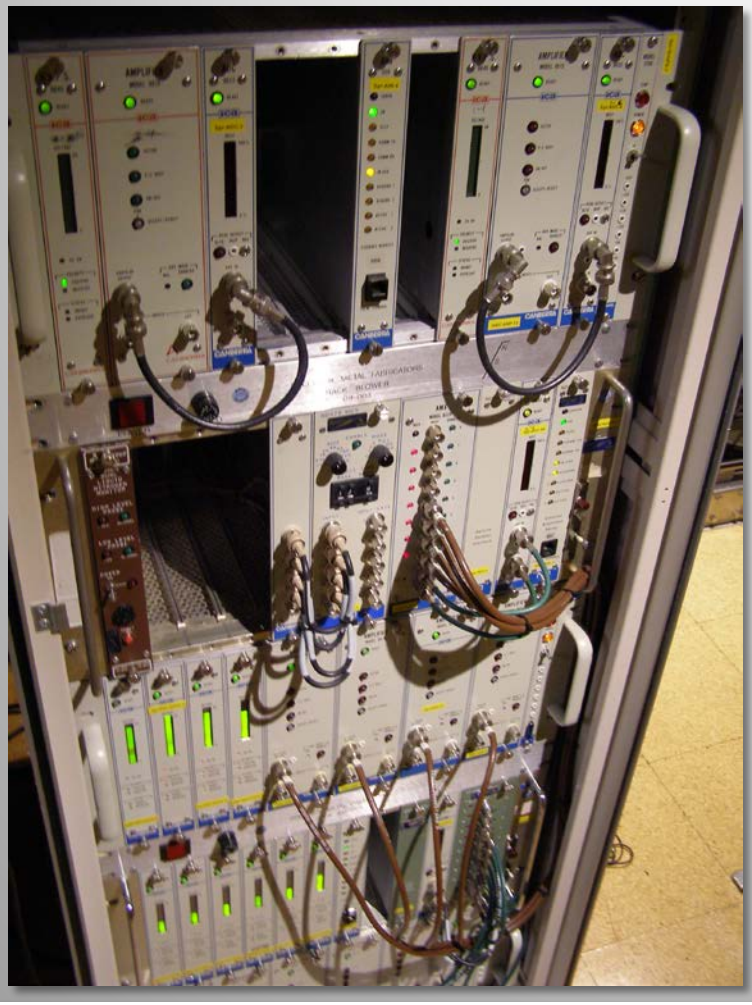
- Located ~20 feet underground
- Shielded with Pb, Cd, and Cu
- Backfilled with 5 feet of serpentine rock
- All steel used is Pre-WWII



Counting Room (cont'd)

- HEPA filters to control airborne radioactivity
- Radon reduced by venting to outside using exhaust fan
- Background reduced by a factor of 50 to 100 depending on energy of radiation

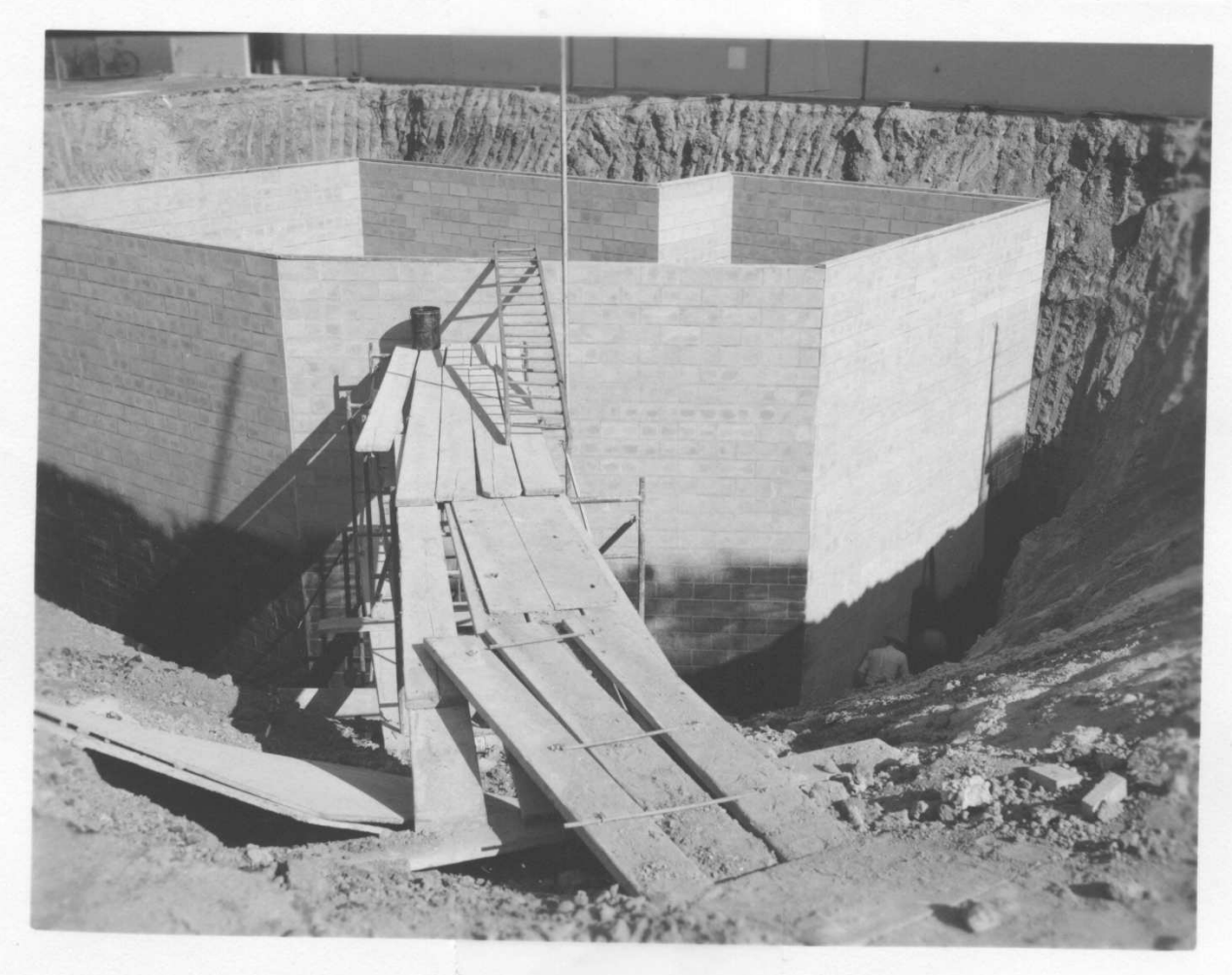
Counting Room Electronics



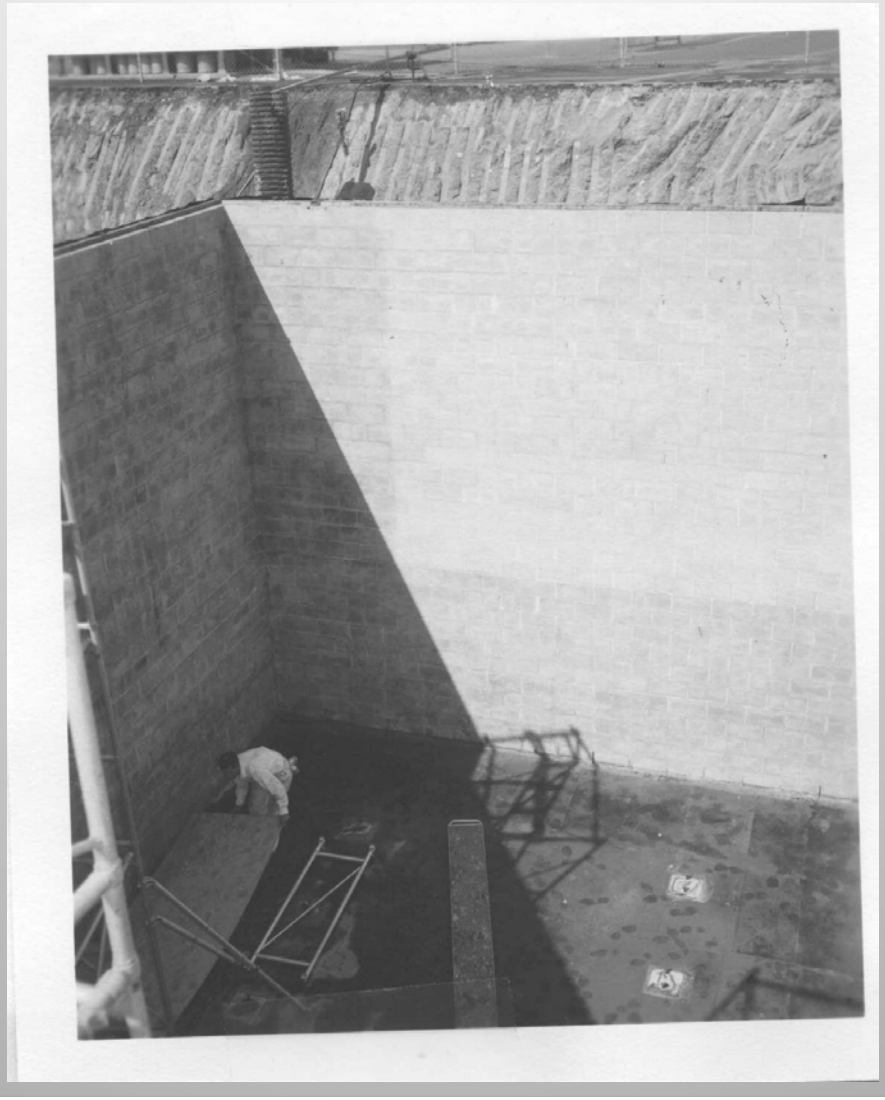
- AIM Model 556
- ADC Model 9633
- Amplifier Model 9615
- HVPS Model 9645

Construction started in 1967

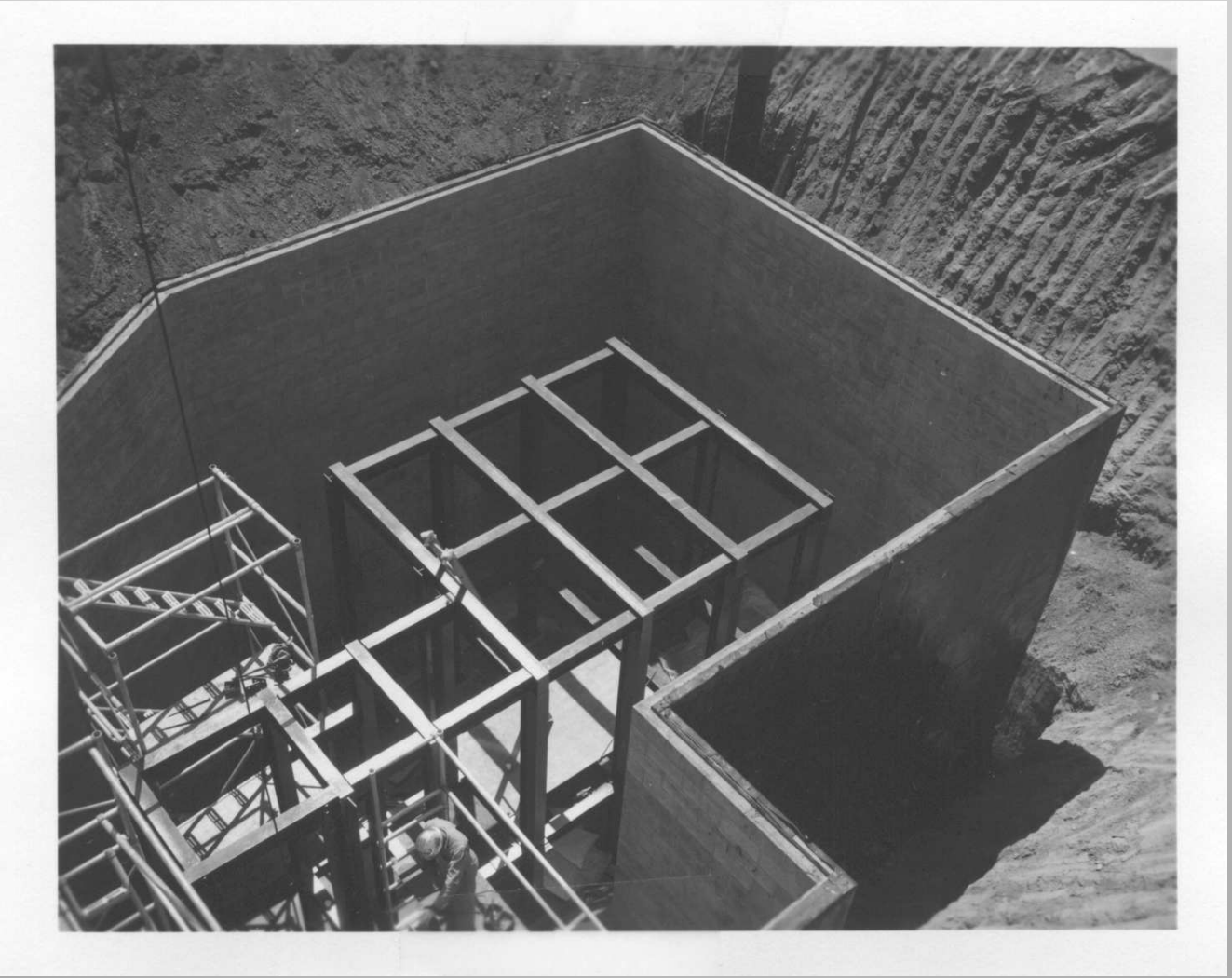
Concrete block wall completed



Painting of inside walls



Counting room frame in place



Serpentine rock distribution

Serpentine rock completed

Counting room wall shielding

Capabilities

- At LLNL lung and whole body counts are routinely performed

Capabilities (cont'd)

- We ocassionally perform many other types of counts including:
  - Liver
  - Kidney
  - Bone (Knee/Skull)
  - Wound
  - Thyroid

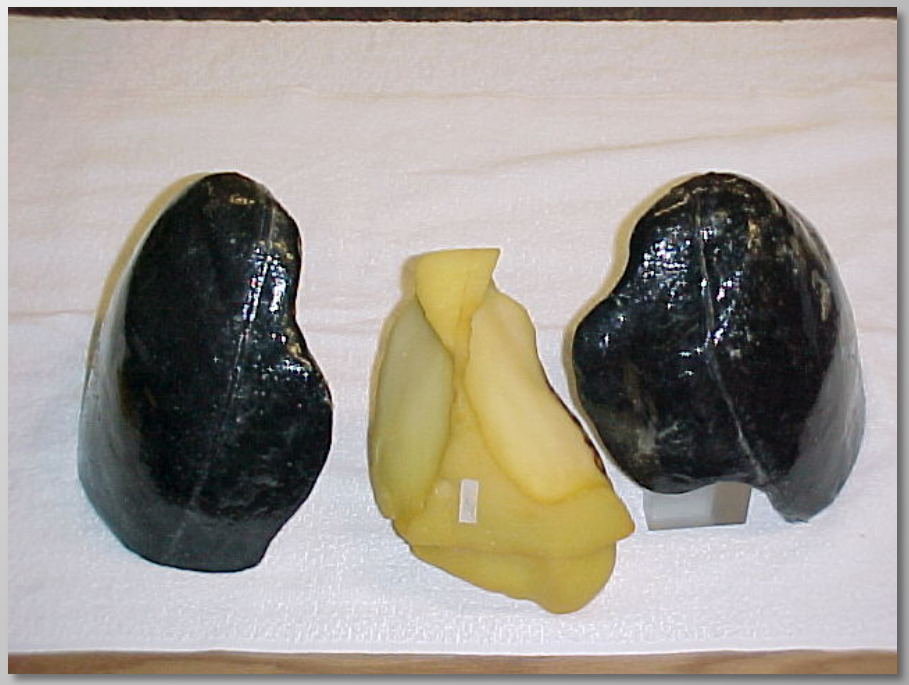
Phantoms

- LLNL Realistic Torso Phantom

- Seamless Bottle Manakin Absorption (BOMAB) Phantom

Phantom Organ Sets

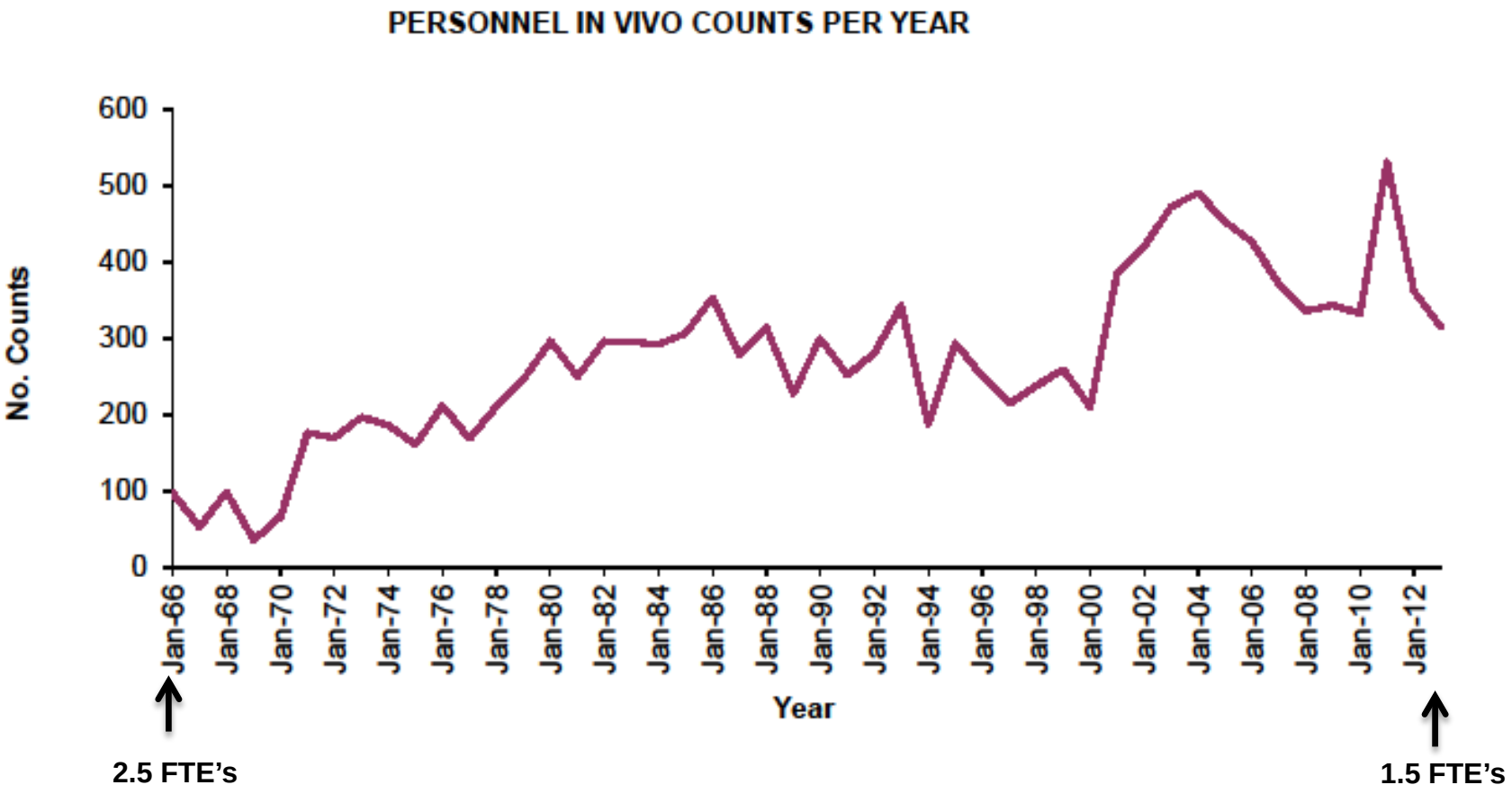
- Lung, liver, and lymph node phantoms
  - Cs-137
  - Eu-152
  - Am-241
  - Pu-238
  - Pu-239
  - Th-232
  - Uranium (U-Nat, D-38, U-235 various enrichments up to 97%)
  - Cm-244



Age of Equipment

- ACTII Detectors - 16 years old
- Scanning Bed Detectors - 12 years old
- Measurement Electronics - 22 years old
- Computer - 3 years old
- In Vivo Software - ~24 years old
- Ultrasound systems - 29 years old
- UPS system - 2 years old

Doing More with Less!



Questions?

Lawrence Livermore
National Laboratory

The LLNL Thyroid Radioiodine Intercomparison Program

1st Annual Teleconference on the Intercomparison of In Vivo Measurement Facilities

July 31, 2014

Megan Lobaugh and Lori Collins

Lawrence Livermore National Laboratory

LLNL-PRES-657858

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract DE-AC52-07NA27344. Lawrence Livermore National Security, LLC

What is TRIP?

TRIP provides participating facilities with an independent means of evaluating in vivo thyroid radioiodine measurements and comparing results with other thyroid counting facilities across the country.

What Does TRIP Give You?

TRIP Sample Bottles containing NIST-traceable isotopes for ^{125}I and ^{131}I

The IAEA/ANSI thyroid calibration neck phantom

What Do We Do?

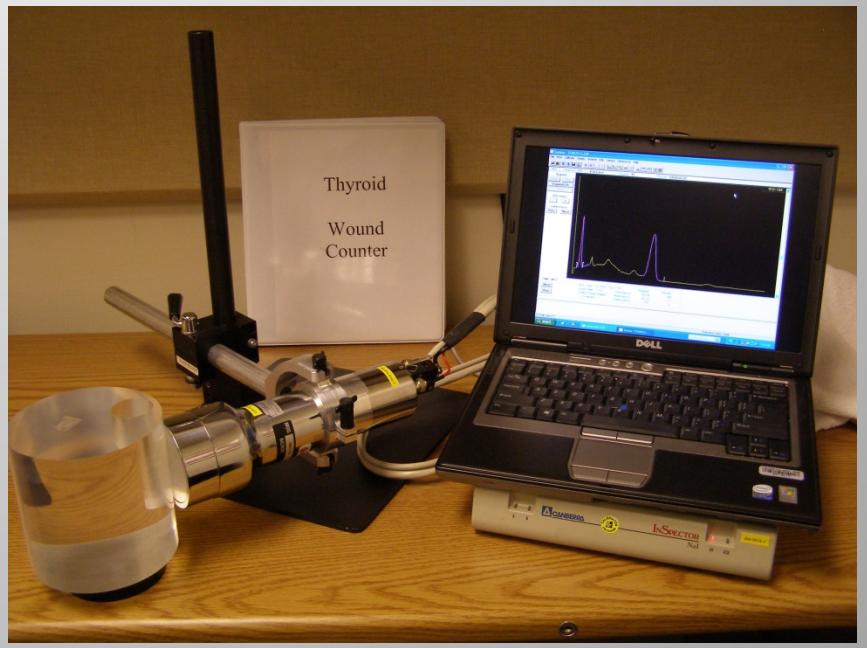
Verify samples before shipping

I-131 intercomparison sample results						
Posting Date:	6/9/2014					
Activities Were Decay Corrected to 12:00 PST on 04/18/2014						
				ANSI 13.30 acceptance criteria		
	Sample activity in Bq	Uncertainty in Bq		Bq Lowest Value -25%	Bq Highest Value +50%	Root Mean Square Error of relative bias and relative precision
Certified value	3.03E+04	9.20E+02		2.27E+04	4.55E+04	< 0.25
Facility Code	Facility Average Result in Bq	Facility Average Uncertainty in Bq	ANSI 13.30 1996 Calculated Bias	ANSI N13.30 2011 RMSE*	Meets ANSI 13.30 - 1996 acceptance criteria -25% to +50%	Meets ANSI 13.30 - 2011 acceptance criteria RMSE <0.25*
5	3.18E+04	3.67E+02	0.05	0.05	yes	yes
15	3.32E+04	3.92E+02	0.10	0.10	yes	yes

Compile and post results. Compare to: ANSI 13.30 & all TRIP participants.

What Do You Do?

1. **Count the TRIP bottles in the TRIP phantom**
2. **Send TRIP the measurement results**



For More Information

Contact the TRIP Coordinator

Lori Johnson Collins
LLNL

P.O. Box 808, L-383

Livermore, CA 94551
phone: (925) 423-3268
loricollins@llnl.gov

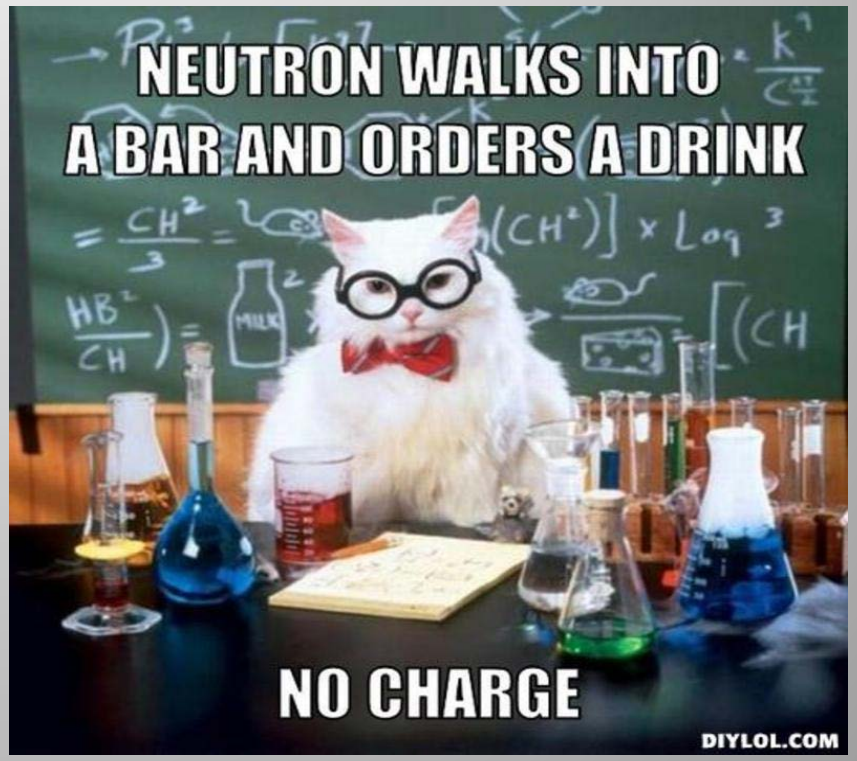
OR

Go to the TRIP web site

https://trip.llnl.gov/information.html

Currently available to US Facilities only

The #1 question people ask about TRIP



Lawrence Livermore
National Laboratory

Energy Facilities Contractors Group (EFCOG)

In Vivo Measurements Facilities Survey Data

- Thank you to those who've submitted information!
- If you are a U.S. DOE Facility and haven't provided information, please contact Michele at sundsmo1@llnl.gov
- Final survey data will be disseminated through EFCOG.

To Rib or de-Rib, That is The Question

1st Annual Teleconference on the Intercomparison of In Vivo Measurement Facilities

July 31, 2014

Darrin G. Alba
Cadet, U.S. Military Academy at West Point

Lawrence Livermore National Laboratory

LLNL-PRES-657863

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344. Lawrence Livermore National Security, LLC

Purpose

- Determine the effect of ribcage on the efficiency for lung detectors

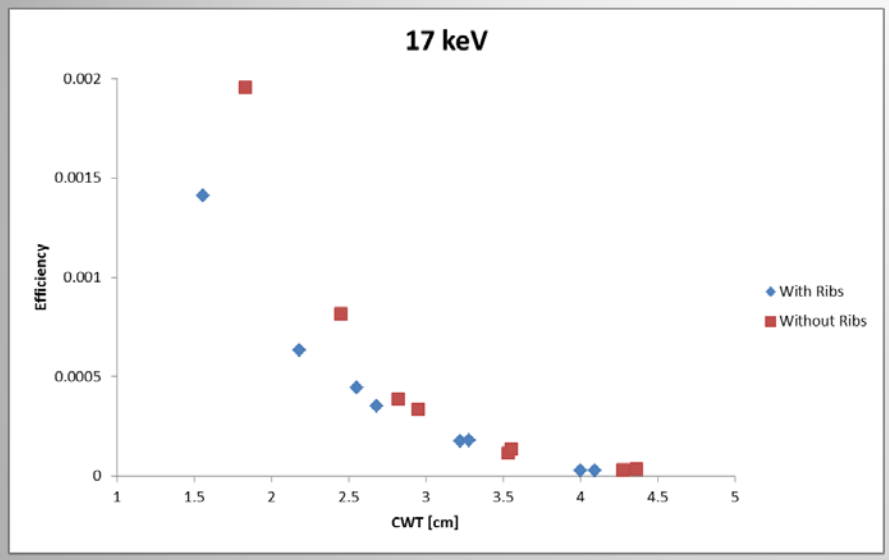
Method

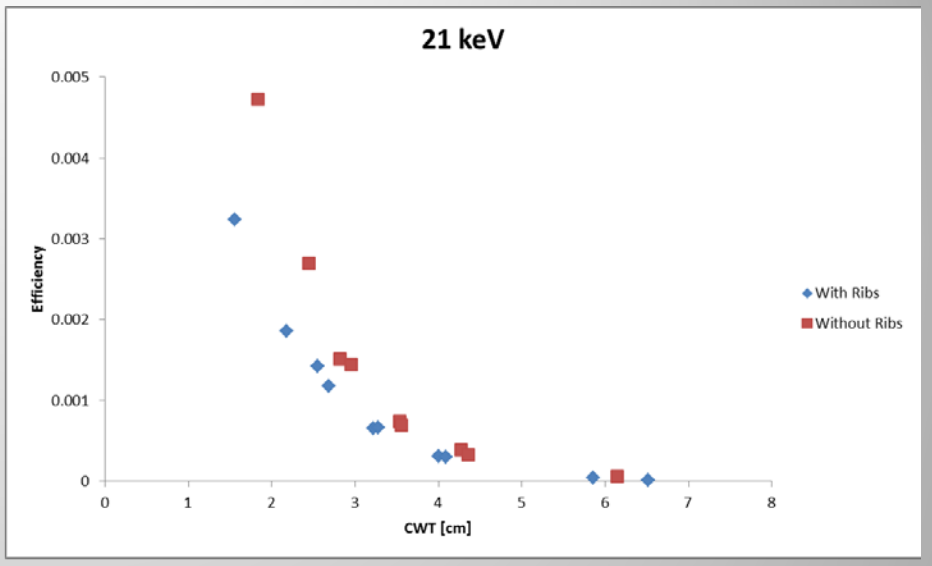
- Used:
  - Eu-152/Am-241 Lung Set
  - Boneless Phantom
  - Overlays of various thicknesses
  - ACT II Lung Detector

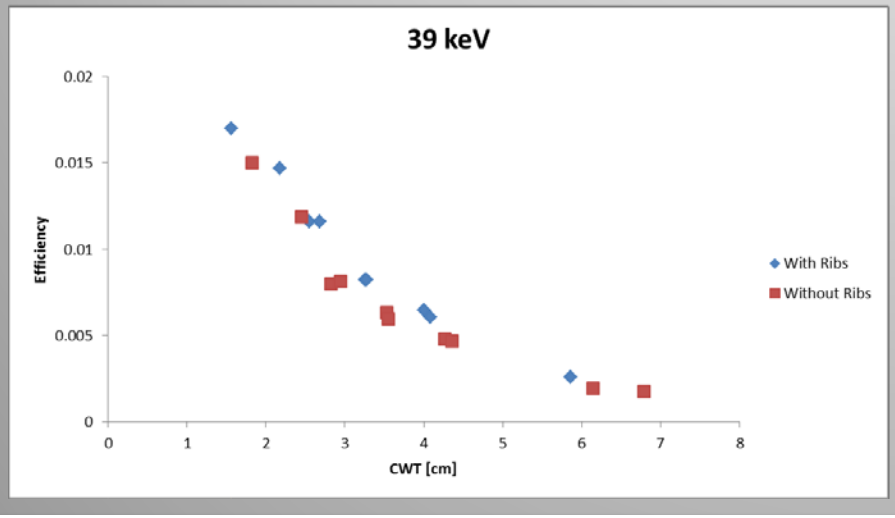
Method

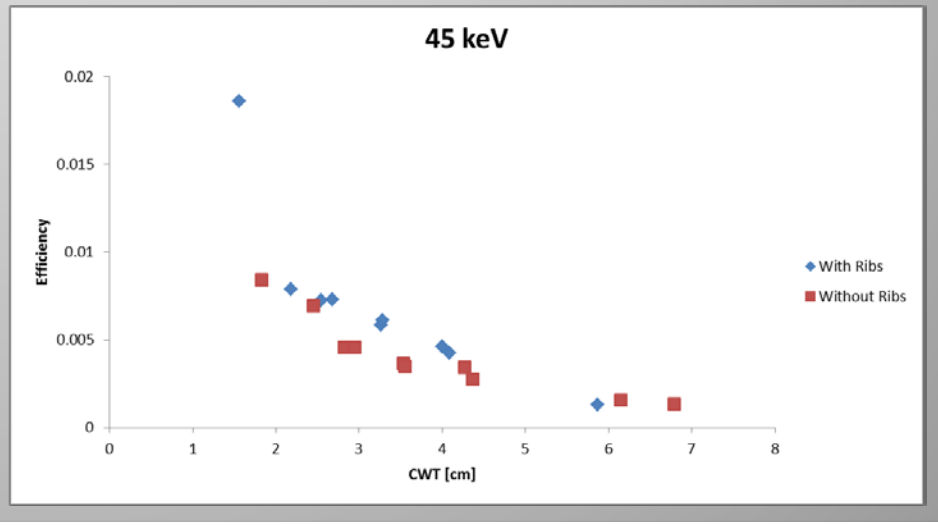
- Conducted count using the ACT II detector
- Determined efficiency = $\frac{\frac{Counts}{time}}{Activity * Abundance}$
- Continued counts with overlays of various thicknesses

ACT II Detector (2012 - Blue,2014 - Red)









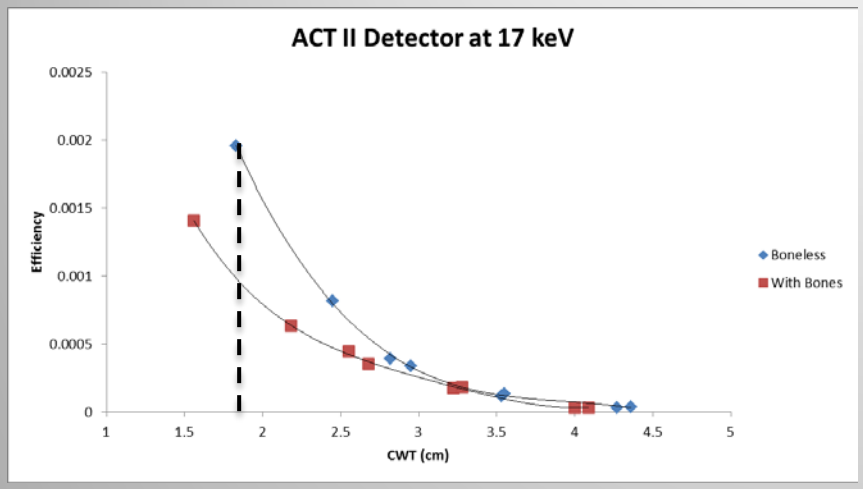
Additional Phantom Data

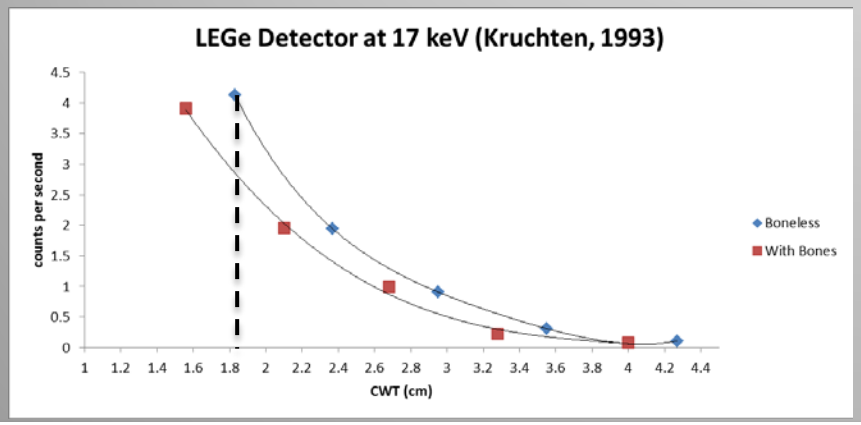
- LLNL, Feb 2012
  - Phantom with bones
  - CWT and measured efficiency
  - ACT II Lung Detector
- Deborah Kruchten, LLNL – Sep 1993
  - Boneless phantom and phantom with bones
  - CWT and counts per second
  - LEGe detector
- LLNL Historical File, ~1980
  - CWT and efficiency
  - Phoswich detector

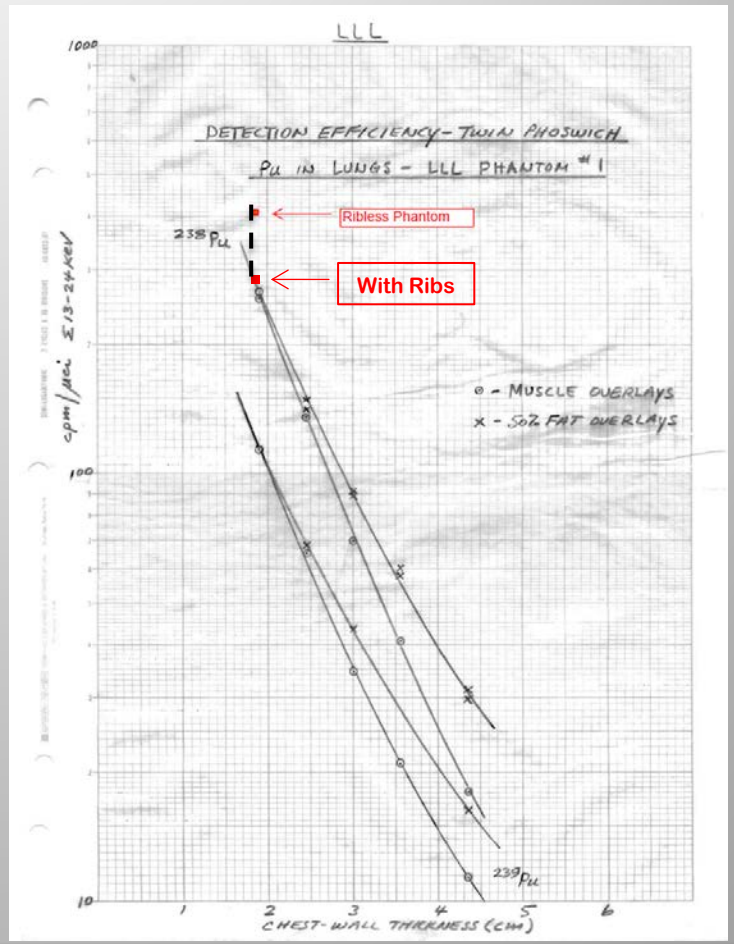
Boneless Phantom to With Bones Phantom measurement ratios

(At CWT = 1.83 cm, 17 keV)

Detector:	Phoswich	ACT II	LEGe
Ratio:	~1.45	~1.72	~1.46







Takeaways

- Efficiencies are similar for energies 39 keV and greater

- Efficiencies are similar for CWTs greater than 3 cm

To Rib or de-Rib, That is The Question

1st Annual Teleconference on the Intercomparison of In Vivo Measurement Facilities

July 31, 2014

Darrin G. Alba
Cadet, U.S. Military Academy at West Point

Lawrence Livermore National Laboratory

LLNL-PRES-657863

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344. Lawrence Livermore National Security, LLC

Efficiency Errors When Directly Measuring Lung Deposited Radionuclides

1st Annual Teleconference on the Intercomparison of In Vivo Measurement Facilities

July, 31, 2014

David P. Hickman, Ph.D.

Lawrence Livermore National Laboratory

LLNL-Pres-657751

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344. Lawrence Livermore National Security, LLC

Previous DOE In Vivo Committee Estimates of Errors (1976)

Subject Background	50%
Counting Statistics	50%
Chest Wall Thickness	40%
Nonuniform Distribution	70%
Calibration Error	5%

Tomlinson – 1976 Workshop on Measurement of Heavy Metals In Vivo

CALIBRATION OF LUNG COUNTING EFFICIENCIES FOR LOW ENERGY PHOTON EMITTERS

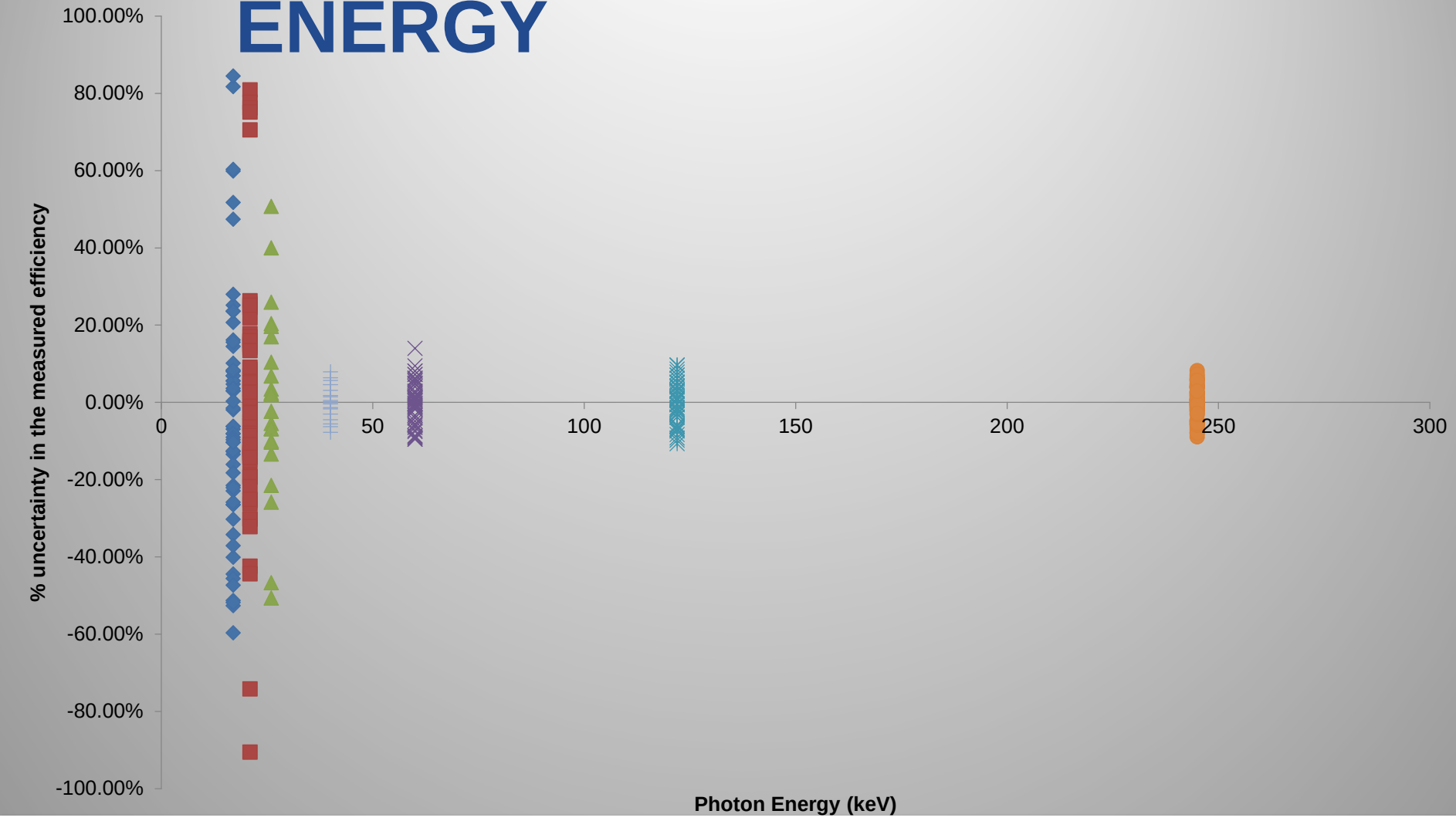
- LLNL Realistic Torso Phantom
- Same Am-241/Eu-152 lung set used since August 2000
- Multiple MEQ-CWTs
- Energies ranging from 17 keV to 245 keV
- Same phantom-to detector orientation and angle
- Over 400 measurements of efficiency

DEVIATION SCORE METHOD

$$\Delta = (x - \bar{x})$$

- X = the measured efficiency for a given energy and CWT.
- $\bar{X}$ = the average efficiency for a given energy and CWT.
- The deviation score is also sometimes called the error (of the measurement).
- % error is computed by dividing by the average efficiency and multiplying by 100.

VARIATION OF LUNG EFFICIENCY AS A FUNCTION OF PHOTON ENERGY



CONCLUSIONS

- Efficiency errors in determining the efficiency increase significantly below about 40 keV.
- Efficiency errors above 40 keV appear to be constant at approximately 10 - 15%.
- Efficiency errors as high as approx. 100% exist for lower energy photons.
- ANSI 13.30-2011 RMS limitation of 25% is too restrictive for photon energies below 40 keV.

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