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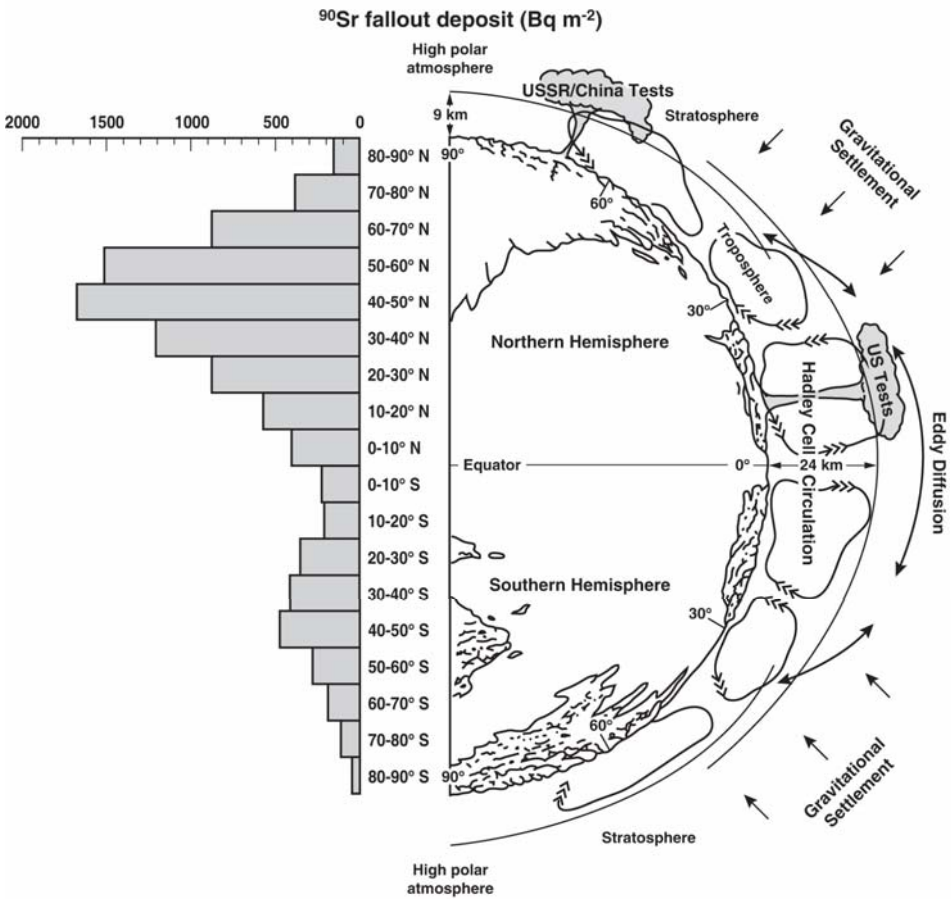
http://eed.llnl.gov/mi/

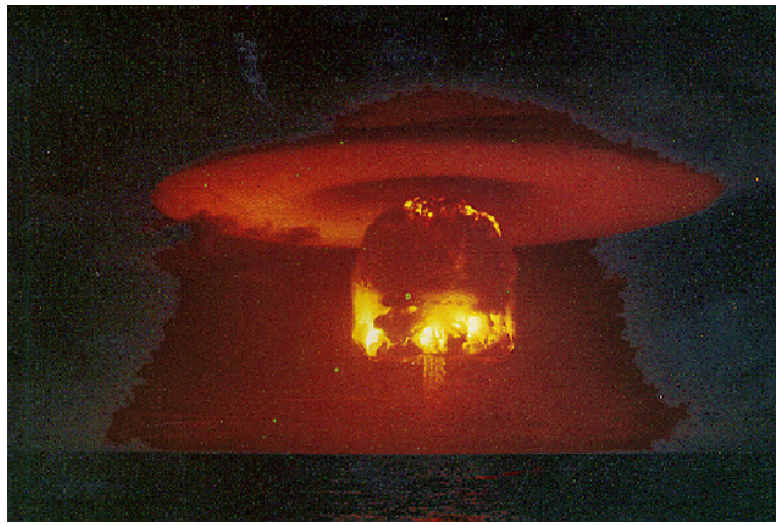
What can low-level plutonium bioassay measurements do for you?

CIEMAT Briefing

This work was performed under the auspices of the U.S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under Contract No. W-7504-ENG-48.

Atmospheric nuclear weapons testing in the Marshall Islands





[Nuclear Weapons Testing in the Marshall Islands]

- **Significant contribution to world-wide fallout (some 11 tests > 4 Mt)**
- **At the same time, most of the tests were conducted in the near surface environment where as much as 50% of the debris was deposited on a local or regional scale**

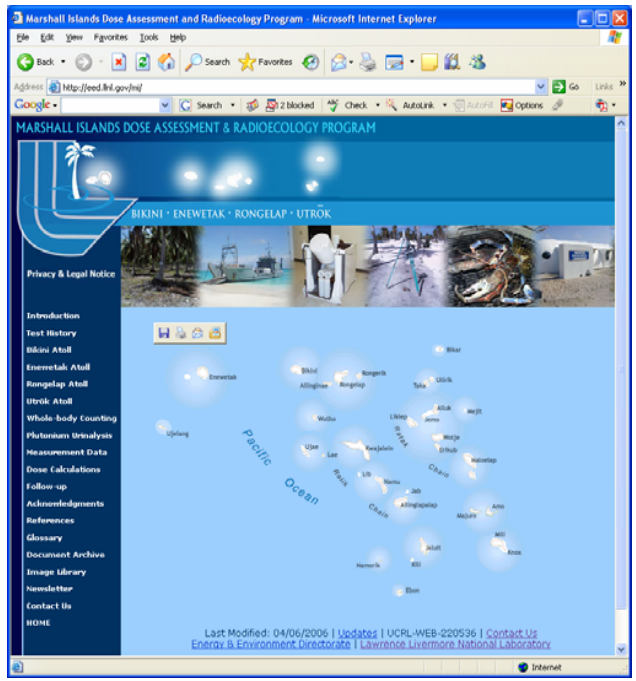
Marshall Islands Dose Assessment & Radioecology Program

Strategic Directives of the Marshall Islands Program

1. To provide technical support services and oversight in establishing radiological surveillance monitoring programs in the Marshall Islands

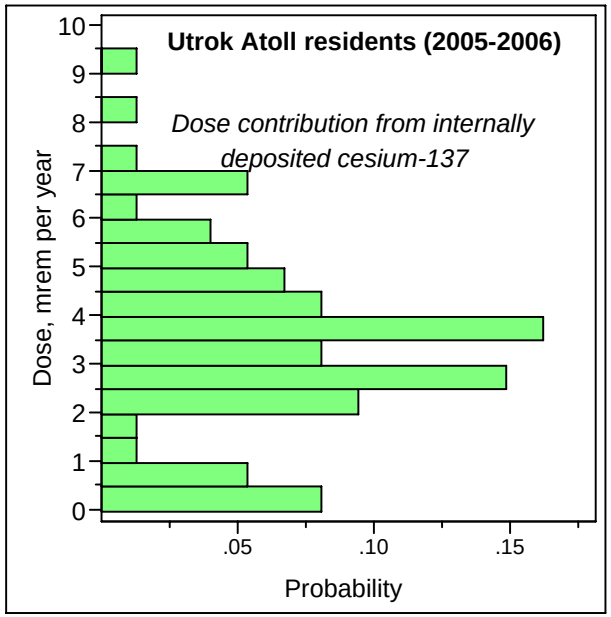
2. To develop comprehensive assessments of current (and potential changing) radiological conditions, and

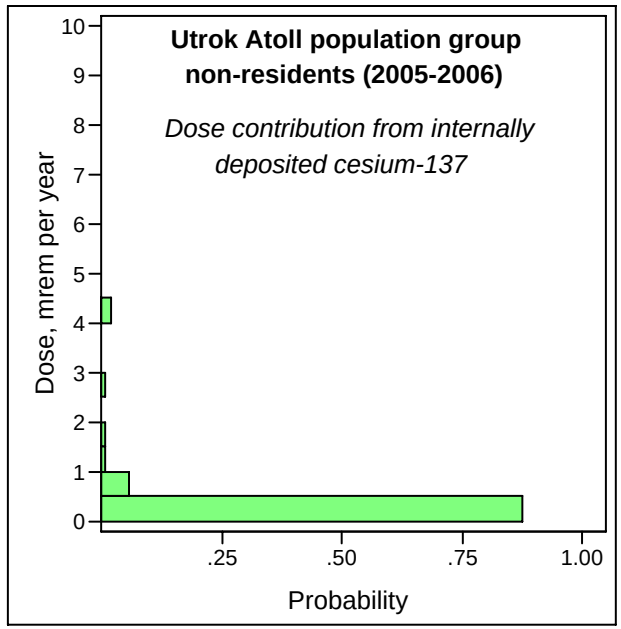
3. To provide recommendations for remediation of contaminated sites and verify the effects of any actions taken



(http://eed.llnl.gov/mi/)

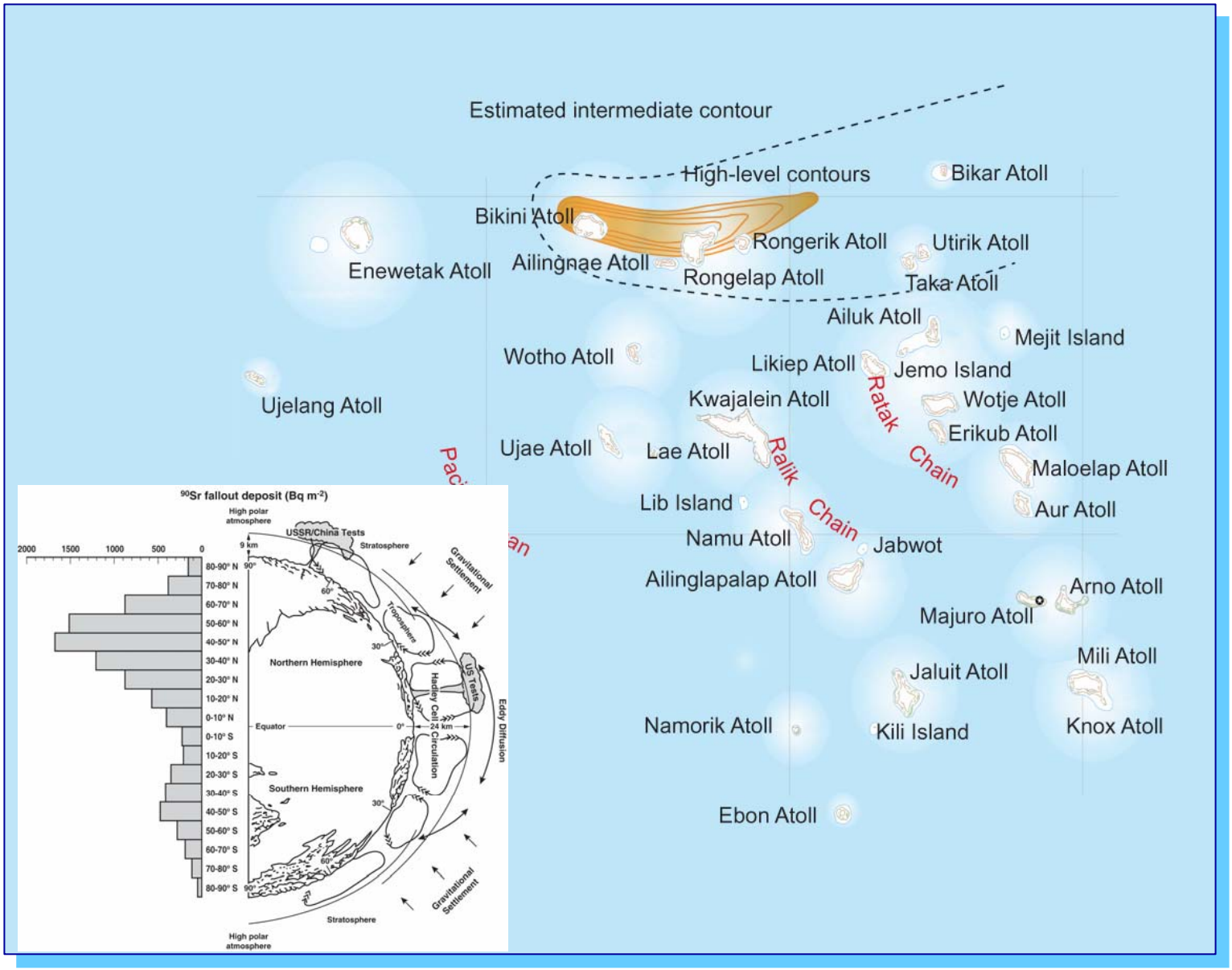
Marshall Islands Whole Body Counting Program Update



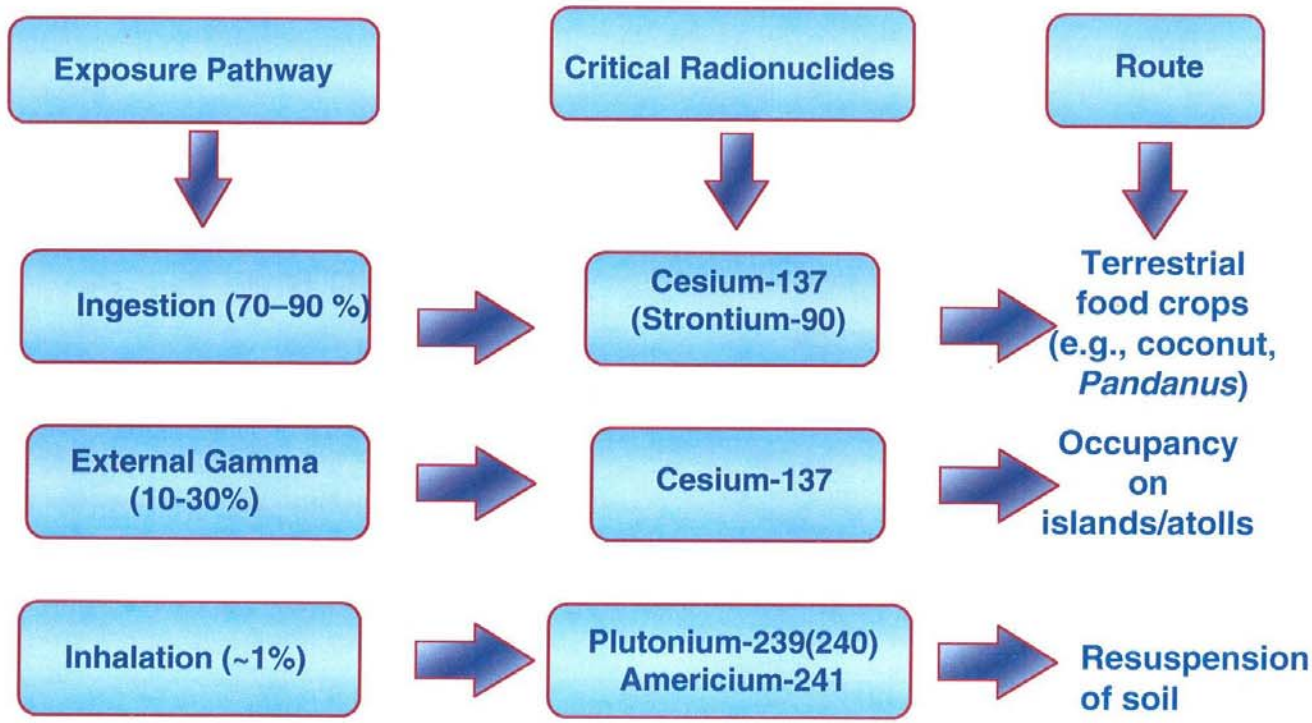


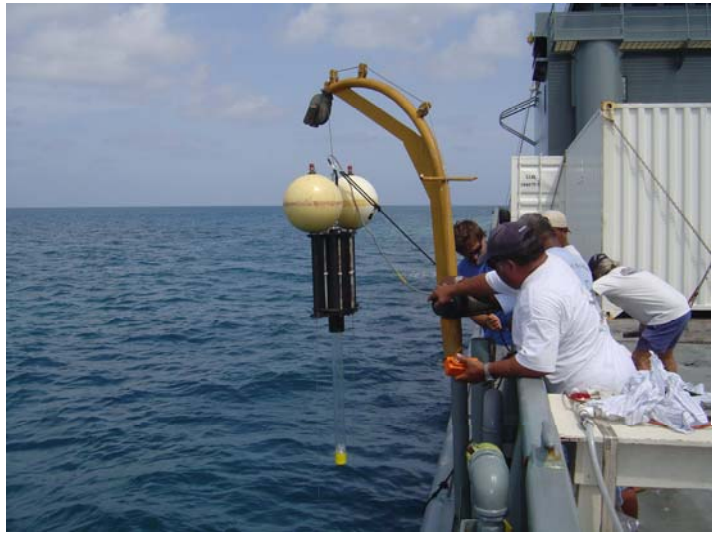
Moments: Mean = 3.5; Median = 3.5; Std. Dev. = 2.0; Std. Err. Mean = 0.23; Upper Confidence Interval Mean = 3.9; Lower Confidence Interval = 3.0; N = 74

Moments: Mean = 0.2; Median = 0.0; Std. Dev. = 0.8; Std. Err. Mean = 0.08; Upper Confidence Interval Mean = 0.38; Lower Confidence Interval = 0.05; N = 82


Estimated intermediate contour
High-level contours
Bikar Atoll
Bikini Atoll
Rongerik Atoll
Utirik Atoll
Enewetak Atoll
Ailingnae Atoll
Rongelap Atoll
Taka Atoll
Ailuk Atoll
Mejit Island
Wotho Atoll
Likiep Atoll
Jemo Island
Ujelang Atoll
Kwajalein Atoll
Wotje Atoll
Ratak Chain
Erikub Atoll
Ujae Atoll
Lae Atoll
Ralik Chain
Maloelap Atoll
Lib Island
Aur Atoll
Namu Atoll
Jabwot
Ailinglapalap Atoll
Arno Atoll
Majuro Atoll
Mili Atoll
Jaluit Atoll
Namorik Atoll
Kili Island
Knox Atoll
Ebon Atoll
^{90}Sr fallout deposit (Bq m^{-2})
2000
1500
1000
500
0
80-90° N
70-80° N
60-70° N
50-60° N
40-50° N
30-40° N
20-30° N
10-20° N
0-10° N
0-10° S
10-20° S
20-30° S
30-40° S
40-50° S
50-60° S
60-70° S
70-80° S
80-90° S
High polar atmosphere
USSR/China Tests
Stratosphere
9 km
90°
60°
30°
0°
Gravitational Settlement
Troposphere
Northern Hemisphere
US Tests
Hadley Cell
24 km
Eddy Diffusion
Equator
Southern Hemisphere
Stratosphere
High polar atmosphere

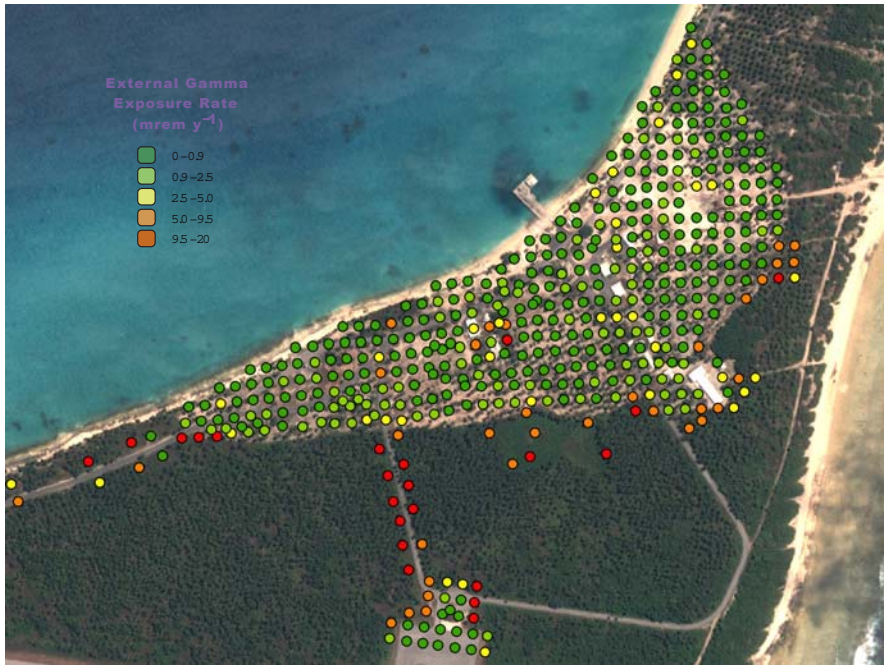
Exposure pathways and critical radionuclides






MITSUBISHI
ROAD-USE-OK

Cleanup Verification Monitoring in Support of Resettlement Programs



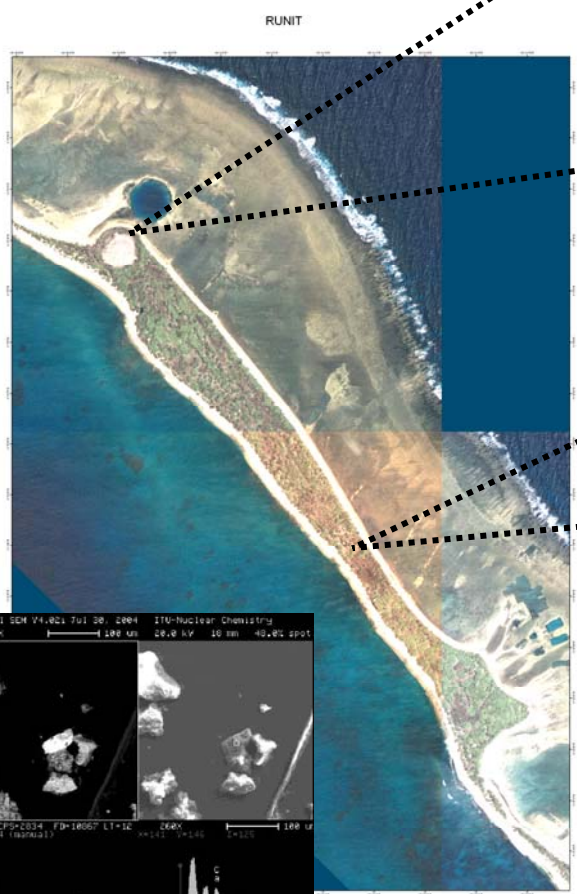
Rongelap external gamma dose rates

Location	N	Cesium-137 External Gamma Dose Rate (mrem per year)	
		range	average
Inside Houses	17	<0.5 – 1.1	0.7
Around Houses	81	<0.5 – 3.3	1.1
Lagoon[#]	63	<0.5 – 28	8.5

[#]**excludes one point (53 mrem per year)**

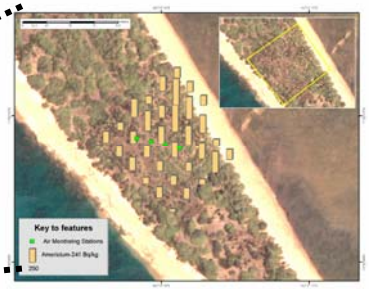
Site Characterization Studies

Site specific environmental surveys –Runit Island



Runit Dome

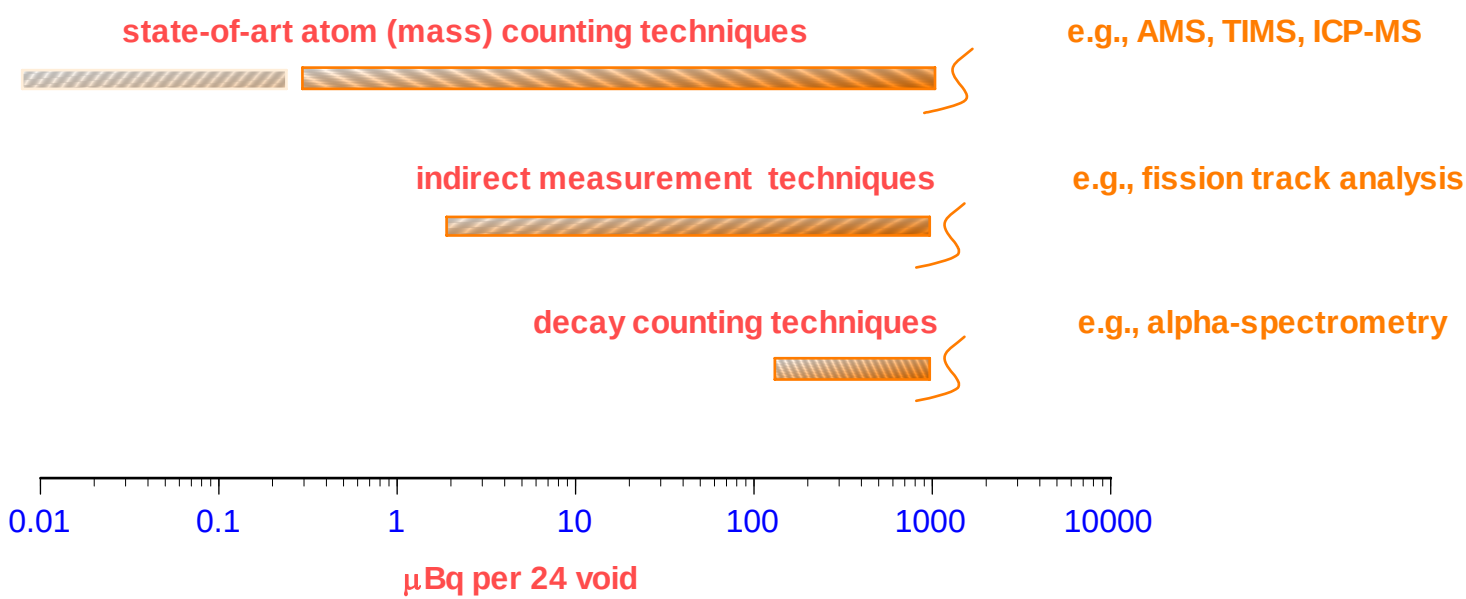
Fig/Quince GZ



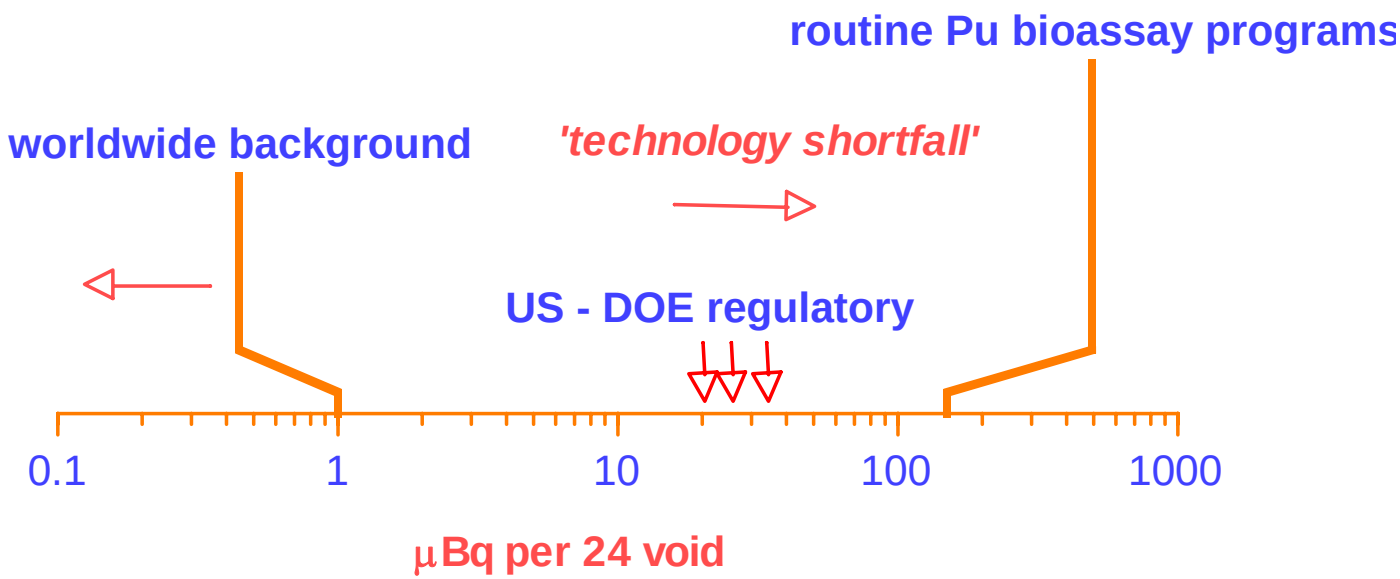
Pu isotopes in surface soil on Runit Island

Site	$^{239+240}$Pu (Bq kg^{-1})		^{240}Pu/^{239}Pu atom ratio
	mean	range	
Runit Dome (berm area)	1600 ± 4600	70 – 18,800	0.075 ± 0.009
Fig/Quince Test Site	1440 ± 590	490 – 3060	0.062 ± 0.008

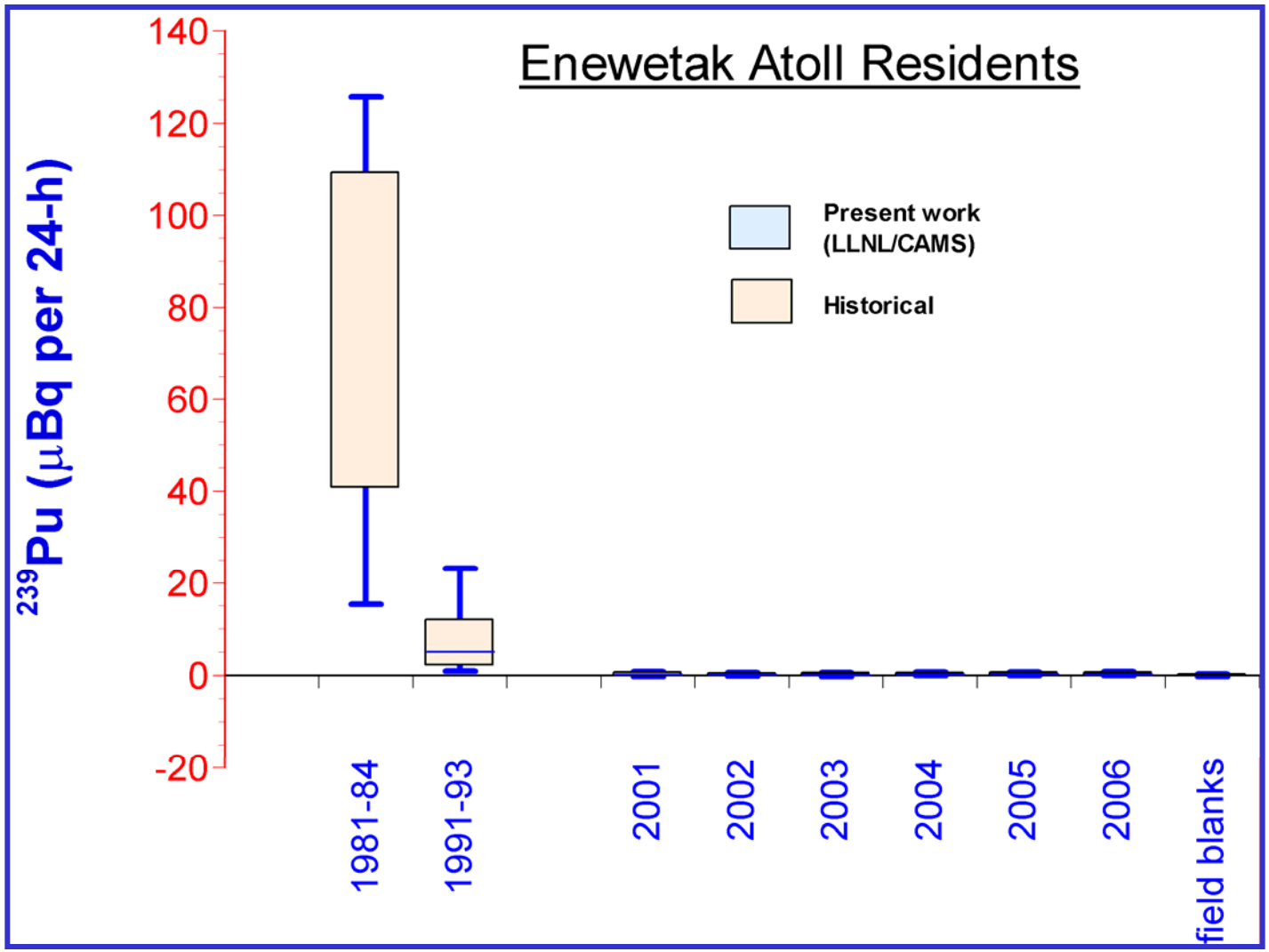
Detection and Measurement of Plutonium Isotopes in Bioassay Samples



U.S. Regulatory Guidance on Occupational Monitoring Programs



Plutonium bioassay measurements on Enewetak Atoll (2001-2005)



Marshall Islands Plutonium Bioassay Program

SUMMARY PLUTONIUM BIOASSAY DATA (2001-2007)

Atoll	error-weighted mean (μBq per 24 h void)			
	field blank	all	male	female
Enewetak	0.01	0.14	0.16	0.11
Rongelap	0.00	0.11		
Utrok #	-0.01	0.11		
#available data through April 2007				

Findings

- Very low levels of urinary excretion of plutonium from Marshall Islanders
- Establishing a more accurate and reliable baseline

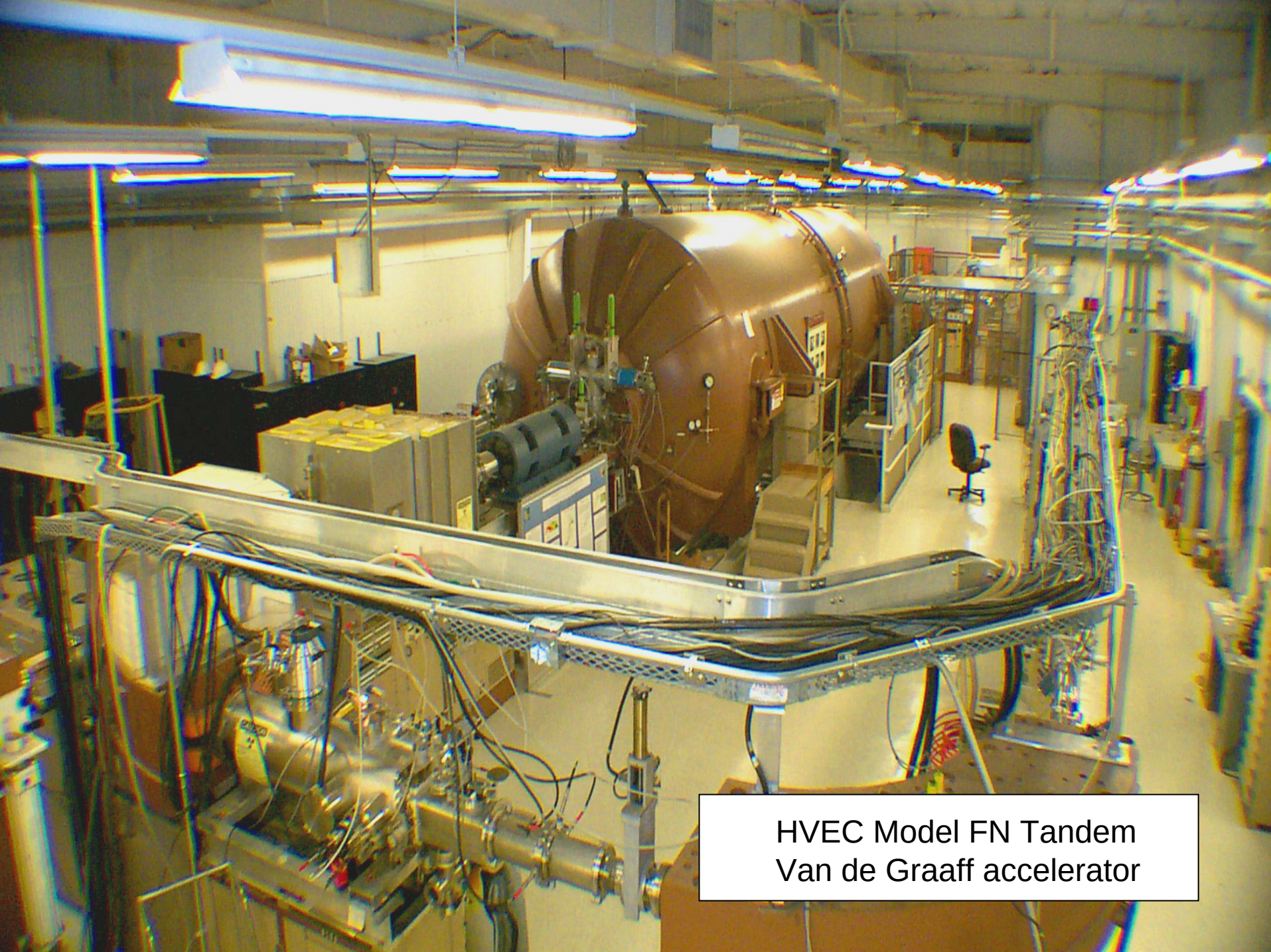
(how clean is clean enough?)


ENEWETAK
RADIOLOGICAL
LABORATORY

Low-level Plutonium Bioassay Measurements at LLNL

- Good house keeping and contamination control
- Rigid collection protocols & oversight

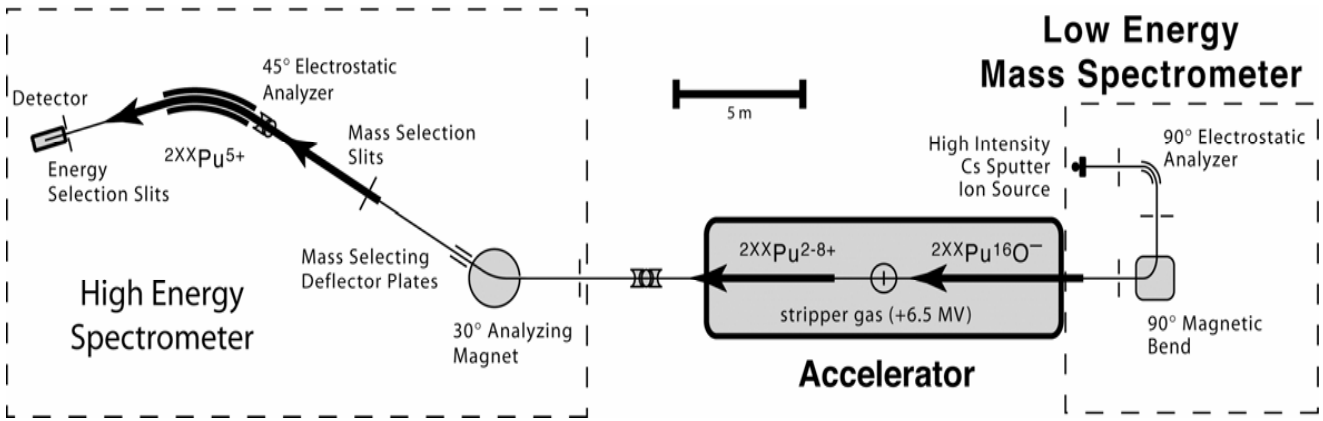
- Utilizing a very high quality detection and measurement capability


HVEC Model FN Tandem
Van de Graaff accelerator

Low-level plutonium Bioassay Measurements at LLNL

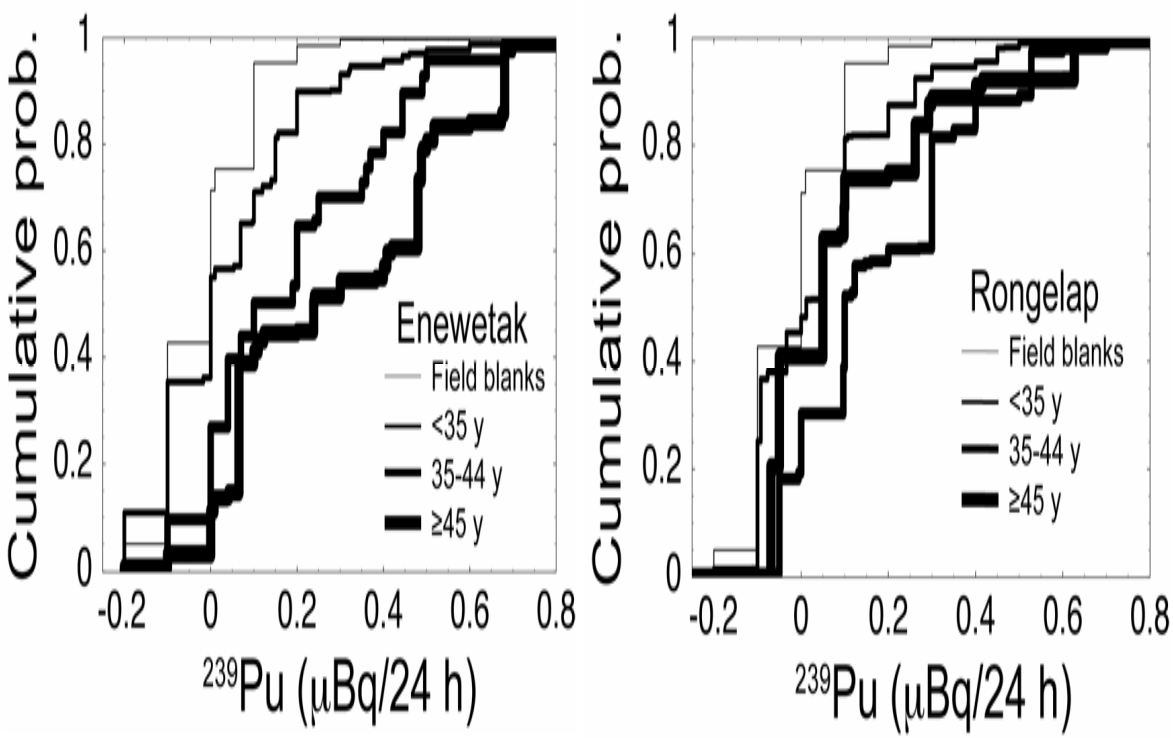
- AMS system offers advantages in terms of sensitivity and is less susceptible to interferences than many other competing mass spectrometric spectrometric technologies.

- The use of AMS for low-level bioassay measurements of plutonium plutonium isotopes has been independently validated by the National National Institute of Science and Technology (NIST) and the Oak Ridge Ridge National Laboratory.



Low-Level Plutonium Bioassay Measurements at LLNL

One interesting observation – a significant positive correlation between urinary excretion of plutonium and volunteer age



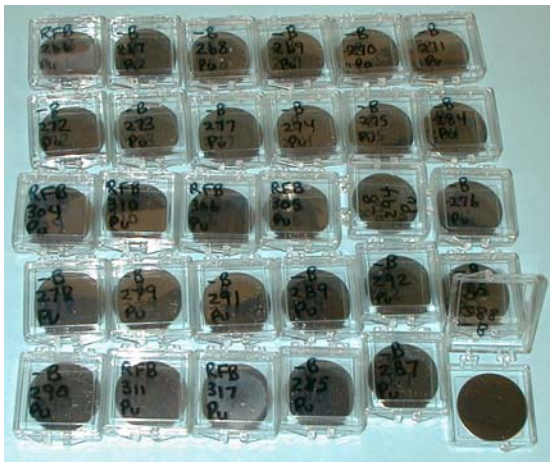
Low-level Plutonium Bioassay Measurements at LLNL

Atoll	Sample group	N	% >0.35 μBq per 24-h void
Enewetak Atoll (median age = 36.1)	field blank	39	5%
	<35 y	129	22%
	35<45 y	57	39%
	> 45y	83	53%

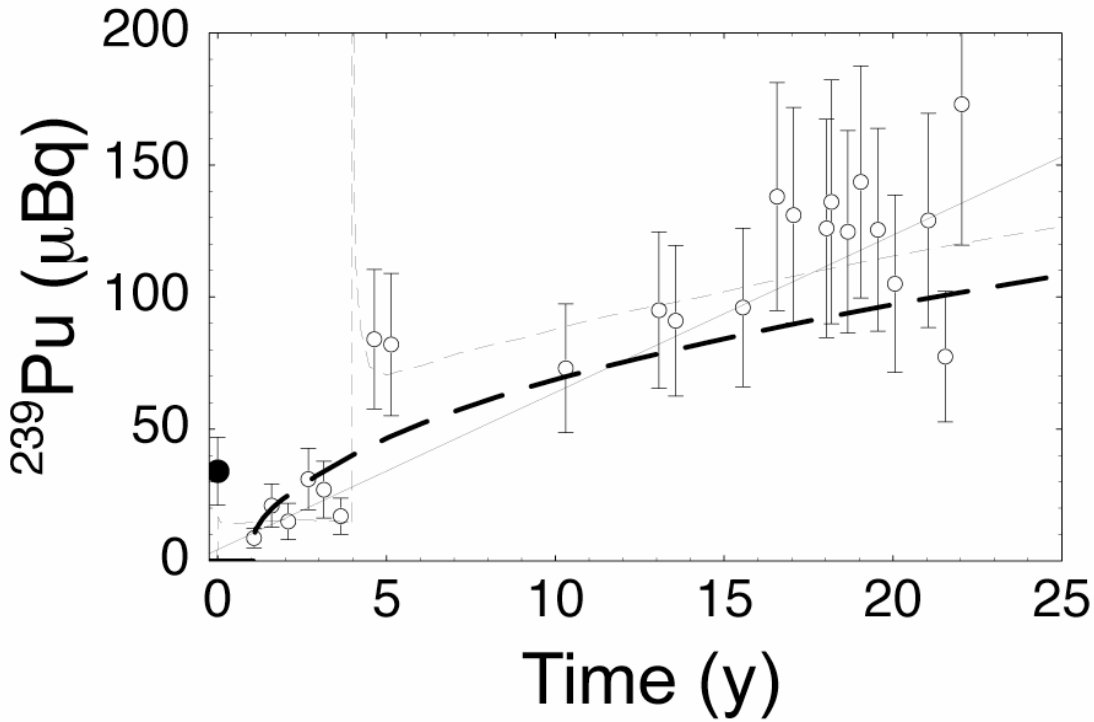
‘Trend may be indicative of low-level chronic buildup of plutonium that could have been easily overlooked with the use of inferior analytical measurement techniques’

‘Similar findings at other settings may have important implications for cleanup, e.g., Palomares (Spain)

AMS Measurements of Residual Activity on Archived Bioassay Alpha-spectrometry Plates

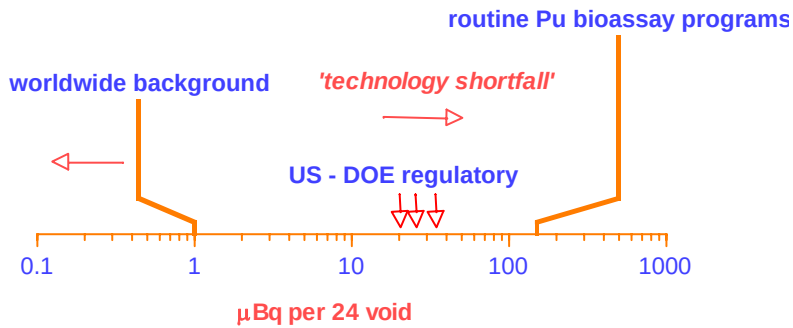


Archived alpha-spectrometry plates



Low-level Plutonium Bioassay Measurements at LLNL

- AMS provides more accurate and reliable measurements at or near anticipated worldwide background concentrations
- AMS is 200 to 1000 times more sensitive compared to alpha-spectrometry
- The measurement technique is capable of monitoring down to a 50y CEDE of < 0.01 mSv based on sub ~μBq level urinary excretion rates of plutonium, far exceeding the requirements established under the latest U.S. Department Energy regulation 10CFR 835 for occupational monitoring of ^{239}Pu
- Isotopic characterization, e.g., $^{240}Pu/^{239}Pu$ atom ratio, may be a useful source-term indicator
- AMS requires a relatively simple preparative chemistry and is an extremely robust technique for measuring low-levels of plutonium



"What can low-level plutonium bioassay measurements do for you?"

1. Helps define the boundary conditions for exposure and uptake (Do you really have a problem? What is the magnitude and extent of the problem?).
2. Better able to quantify and track low-level chronic exposure and uptake within population groups
3. Better able to define the need for and extent of cleanup requirements
4. Better able to manage public perception and provide effective community outreach

Measure-Model-Predict (Verify)