The International Workshop on Basic Nuclear Forensic Methodologies for Practitioners

2013 International Nuclear Atlantic Conference – INAC 2013
11th Meeting on Nuclear Applications – XI ENAN
Recife, PE, Brazil, November 24-29, 2013

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Pacific Northwest
NATIONAL LABORATORY

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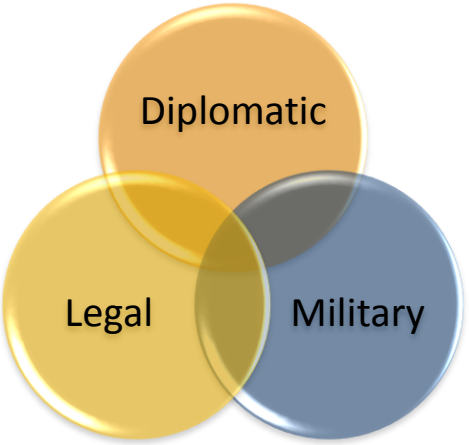
PNNL-SA-96240

nu·cle·ar fo·ren·sics

[noo-klee-er fuh-ren-siks]



…the application of nuclear physics and technologies to the study of nuclear material or problems in cases where findings may be presented as technical evidence in a court of law *or in a national security setting.*"

Nuclear Forensics Terms Handbook, PNNL-15484, Nov. 2005

…involves ***"…the analysis of intercepted illicit nuclear or radioactive material and any associated material to provide evidence for nuclear attribution…"*** with the goal of identifying forensic indicators in interdicted nuclear and radiological samples or the surrounding environment (e.g., the container or transport vehicle). These indicators provide important clues to the process history and ultimate origin of the material.

International Atomic Energy Agency, Nuclear Security Series No. 2, IAEA, Vienna (2006).

Basic Processes in Nuclear Forensics

Civil or Criminal Prosecution

Nuclear Nonproliferation & Antiterrorism

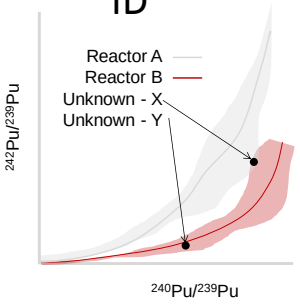
Collection → Categorization → Characterization → Evaluation

Interdictions, border security and detection, International cooperation, Post-det. collections, DoS lead internationally, FBI lead within the U.S.

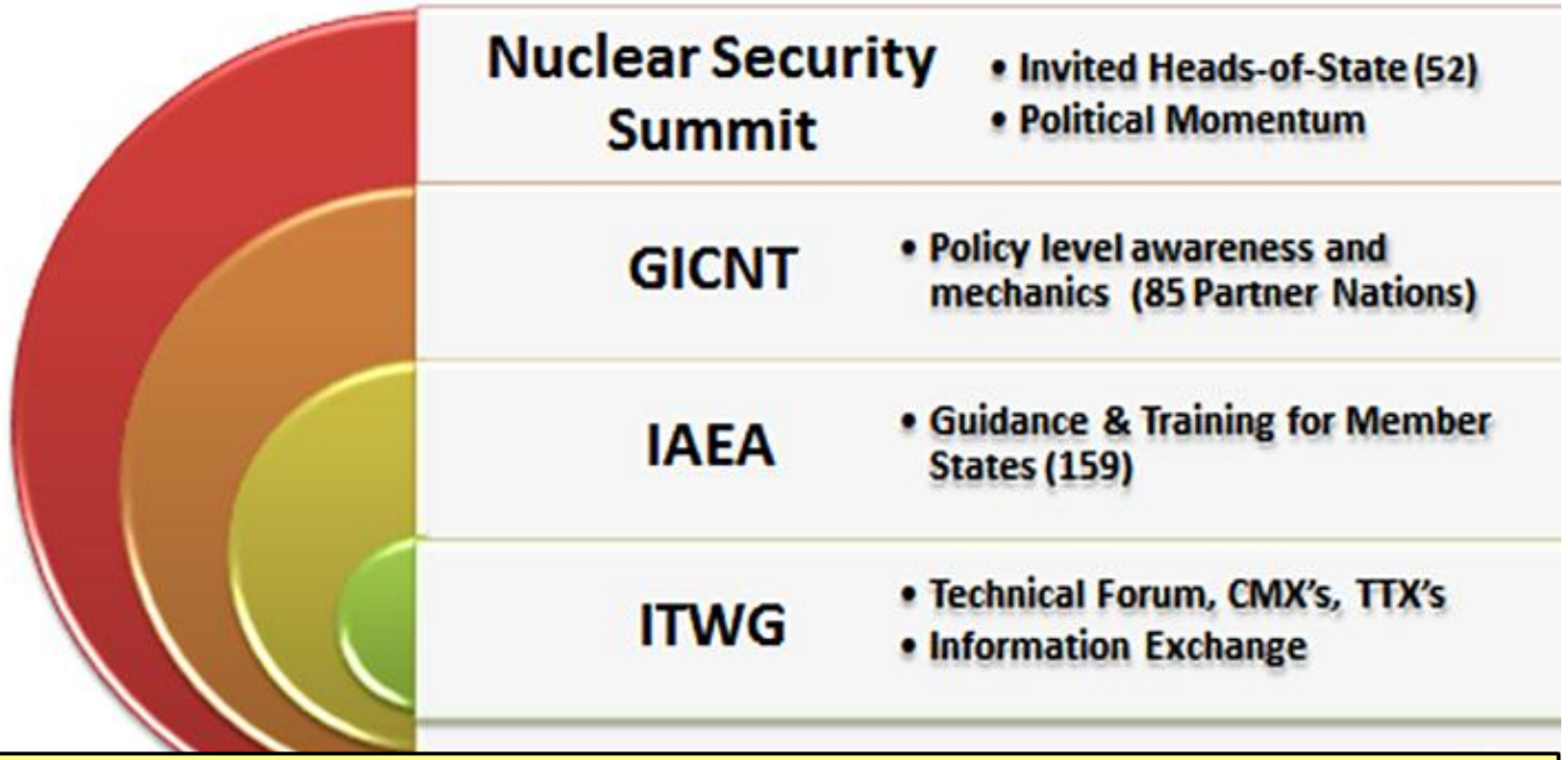
Is the material radioactive? Is the material dangerous? …natural, low-enriched, or WUNM?

Major actinide isotopics, Minor activation and fission products, trace contam., morphology, physical characteristics, etc.

Unravel pre-det. isotopics if post-det. scenario, device class, originating fuel cycle type and class, reactor class, process class, source ID



International Organizations and Efforts



ITWG was founded upon initiative of the G8 in 1996 as a global gathering of official Nuclear Forensics practitioners

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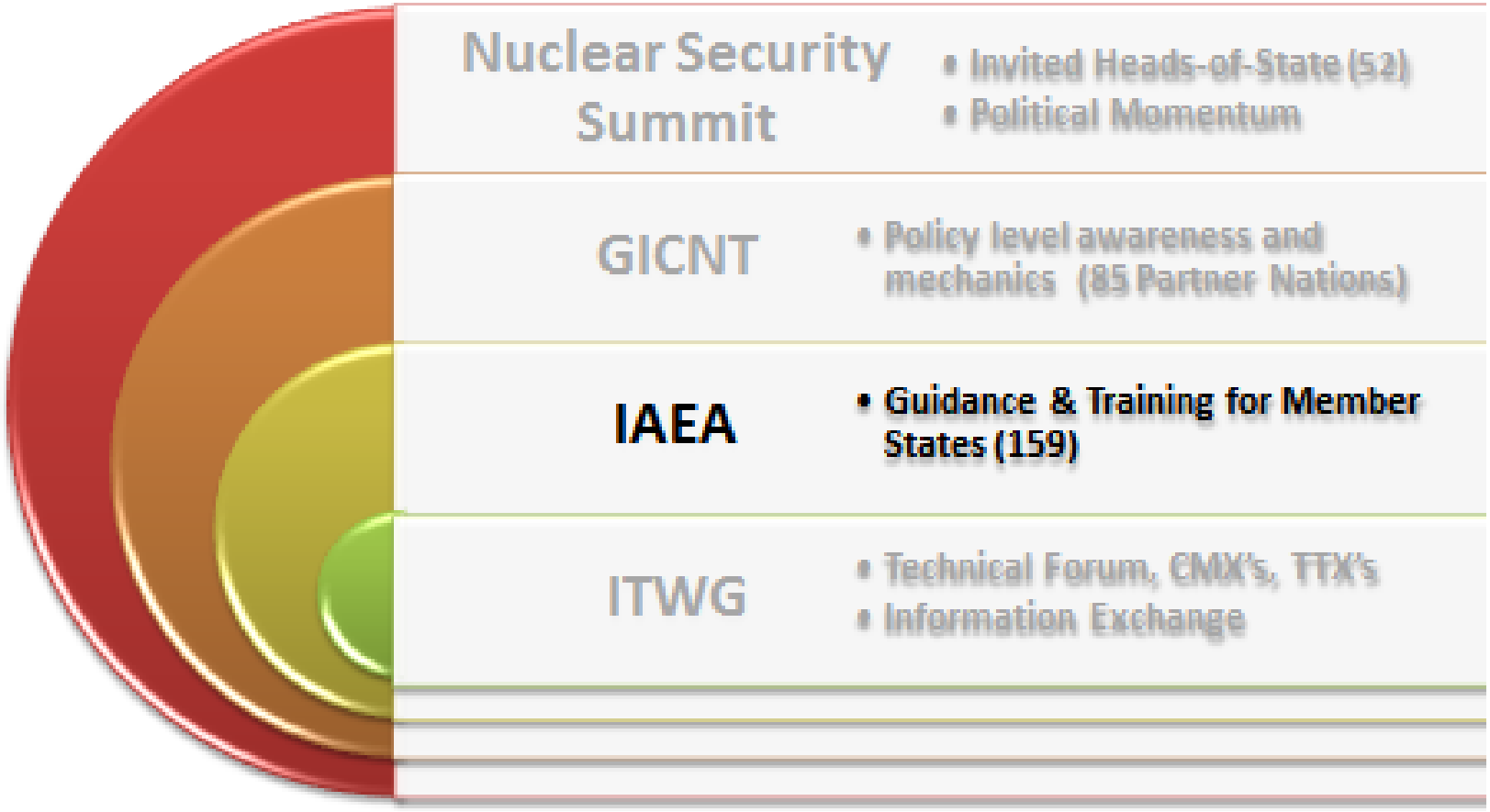
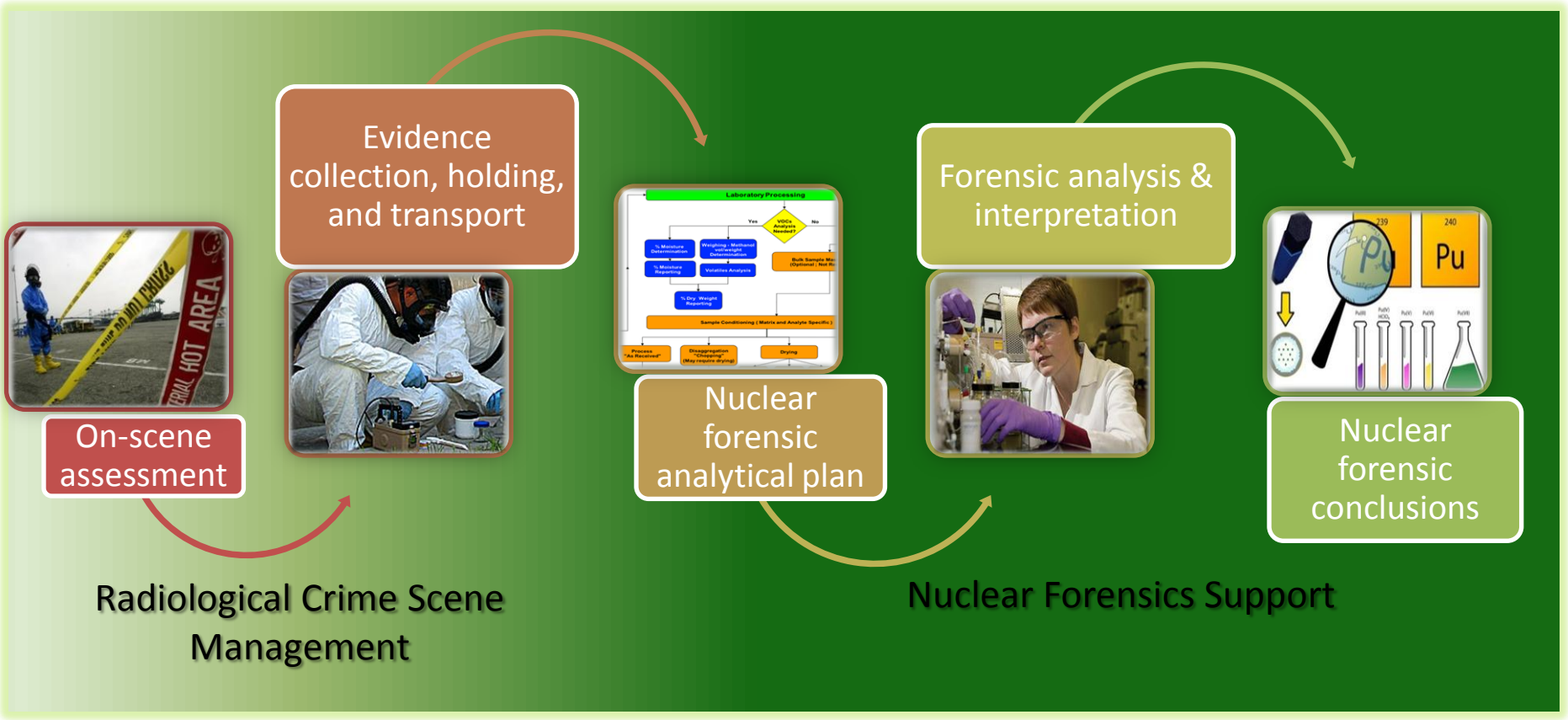


Background of Workshop

- Jointly sponsored by the IAEA and NNSA, hosted by PNNL
- Basic nuclear forensics methodologies for IAEA Member States
  - In depth training on basic techniques (e.g., gamma and alpha spectrometry)
  - Introduction to advanced techniques (e.g., mass spectrometry)
- 1st workshop: February 27 - March 6, 2012
  - 24 participants from 12 IAEA Member states: Argentina, Brazil, Georgia, China, Hungary, Japan, Republic of Korea, Russia, South Africa, Spain, Turkey, and Uzbekistan
- 2nd workshop: October 28 – November 8, 2013
  - 26 participants from 10 IAEA Member states: Algeria, Bulgaria, Czech Republic, Indonesia, Malaysia, Mexico, Pakistan, Singapore, Thailand, and Vietnam

Anatomy of a Nuclear Forensics Investigation



Course Outline

Scenario Based Exercises

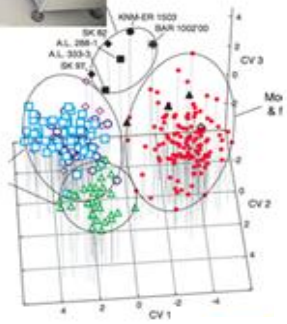




Introduction to Nuclear Forensics → Sample receipt / evidence inventory → Basic Physical Measurements → Developing an Analytical Plan → High Resolution Gamma Spectroscopy → High Resolution Alpha Spectroscopy → Advanced Analysis → Evaluation







Supporting Training Modules

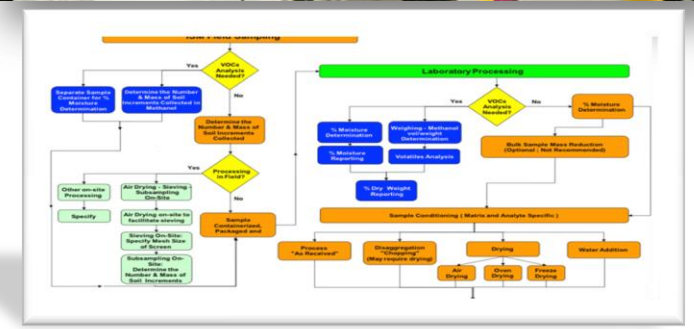
Sample Receipt and Evidence Inventory

- Managing potentially dispersible laboratory
  - Donning and doffing PPE, operation of handheld radiation detectors
  - Managing dose

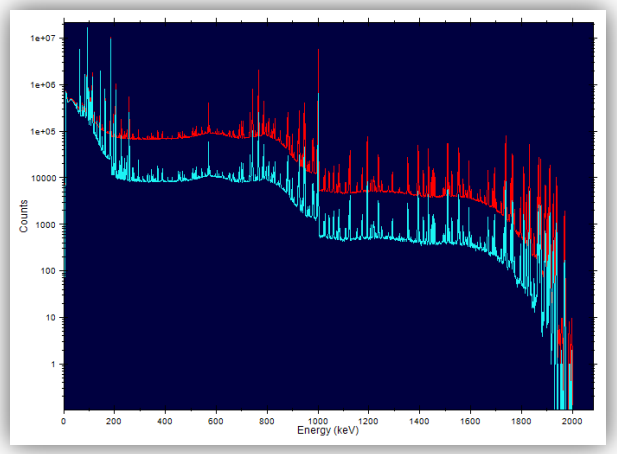
- Evidence inventory & chain of custody
- Preserving traditional and nuclear forensic evidence

Basic Physical Measurements and Developing an Analytical Plan

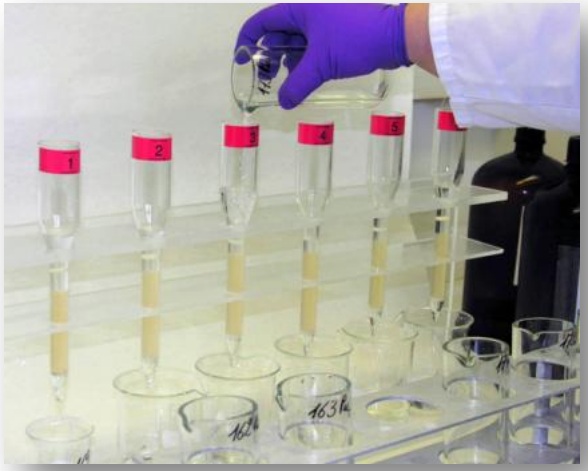
- **Within the confines of a radiological lab:**
  - Measure masses, dimensions, and densities
  - Photograph evidence
  - Optical microscopy
  - Separation of comingled evidence
- **Translate legal requirements into an analysis plan**



High-Resolution Gamma Spectroscopy



- Classroom instruction on the theory of nuclear detection and gamma spectroscopy
- Hands-on instruction:
  - Instrument operation
  - Calibration
  - Collecting spectra
  - Analysis and evaluation of spectra
    - Basic analysis
    - Identifying unknowns, estimating enrichment of uranium

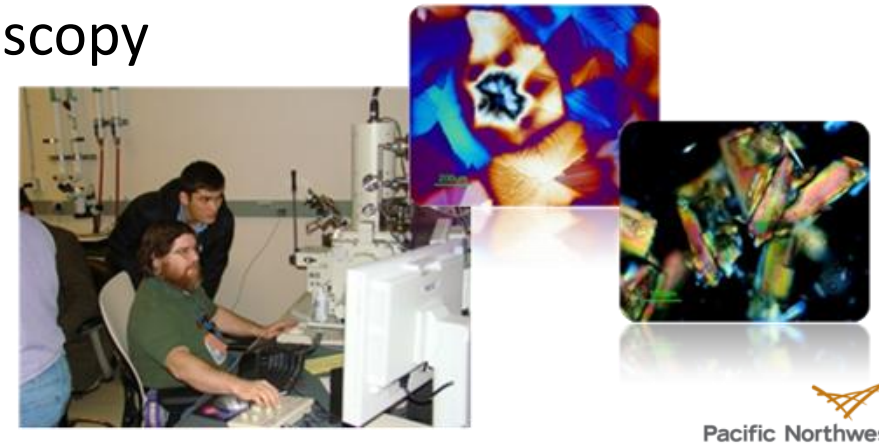


High-Resolution Alpha Spectroscopy

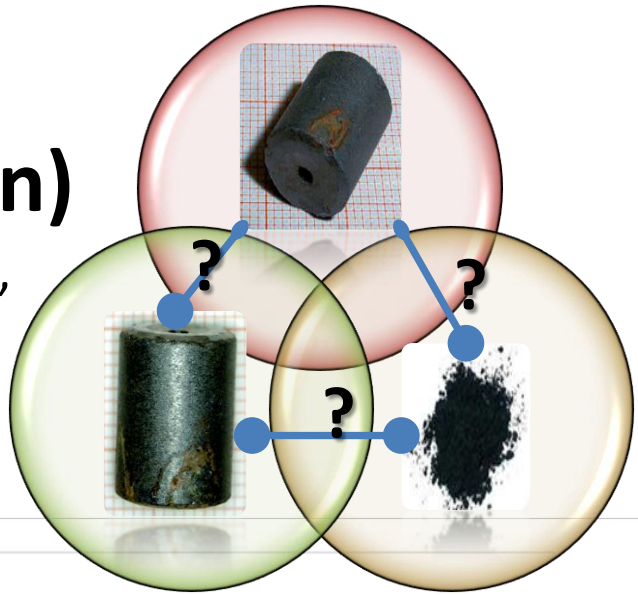
- Theory of high-resolution alpha spectroscopy
- Sample preparation
  - Dissolution
  - Separation
  - Electro-deposition/Vapor-deposition
- Demonstration on Instrumentation & Counting

Introduction to Advanced Analyses

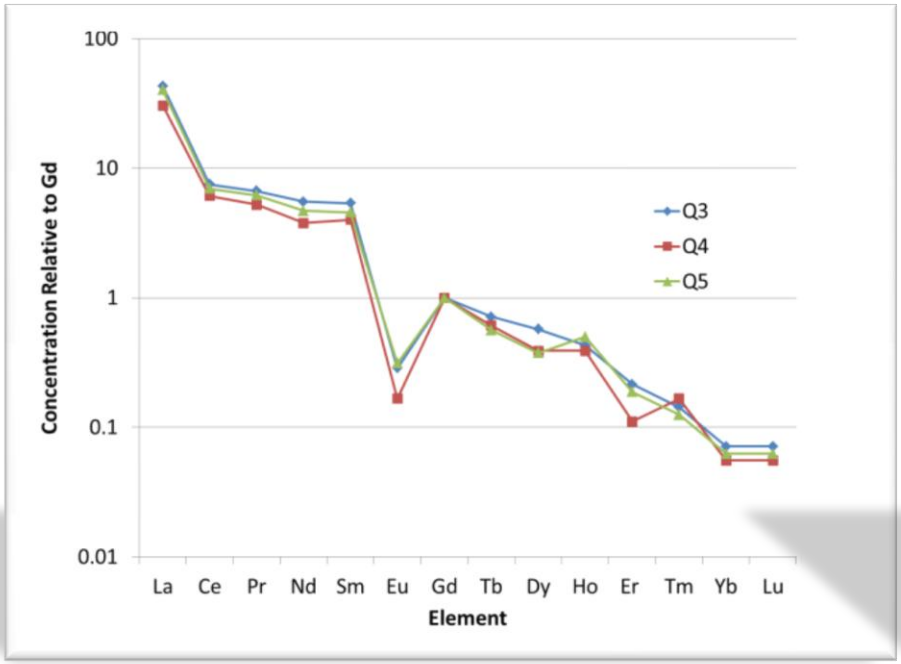
- **Tours of laboratories housing advanced instrumentation**
  - MC-ICP-MS
  - TOF-SIMS
  - Nano-SIMS
  - ICP-MS
  - ICP-OES
  - Optical microscopy
  - XRF microscopy
  - SEM
  - TEM

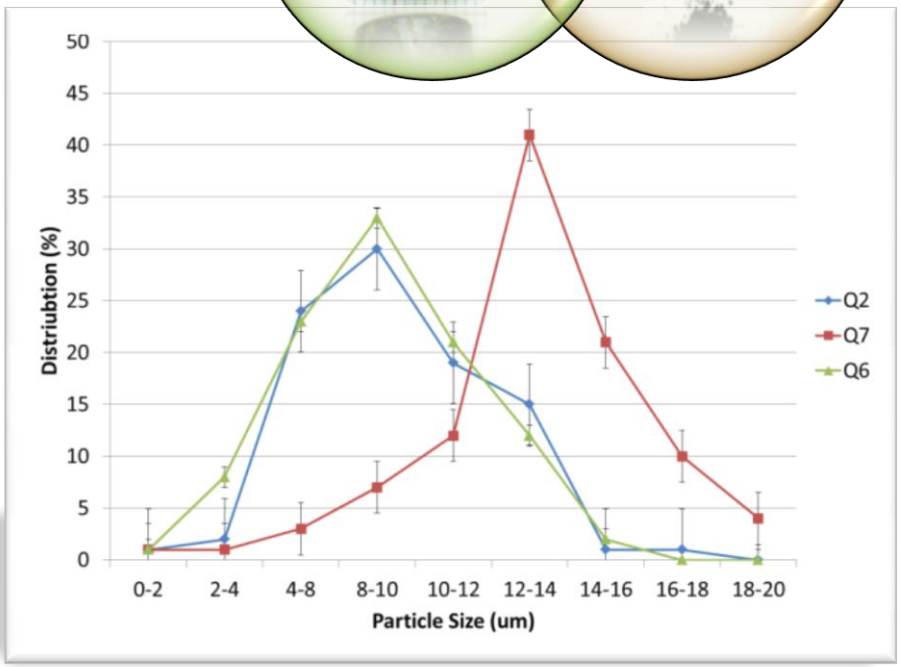


Scenario-based Exercises and Data Evaluation (Interpretation)



- Participants assist authorities in “Categorizing” and “Characterizing” evidence in a mock nuclear forensics investigation
  - Has a law been broken?



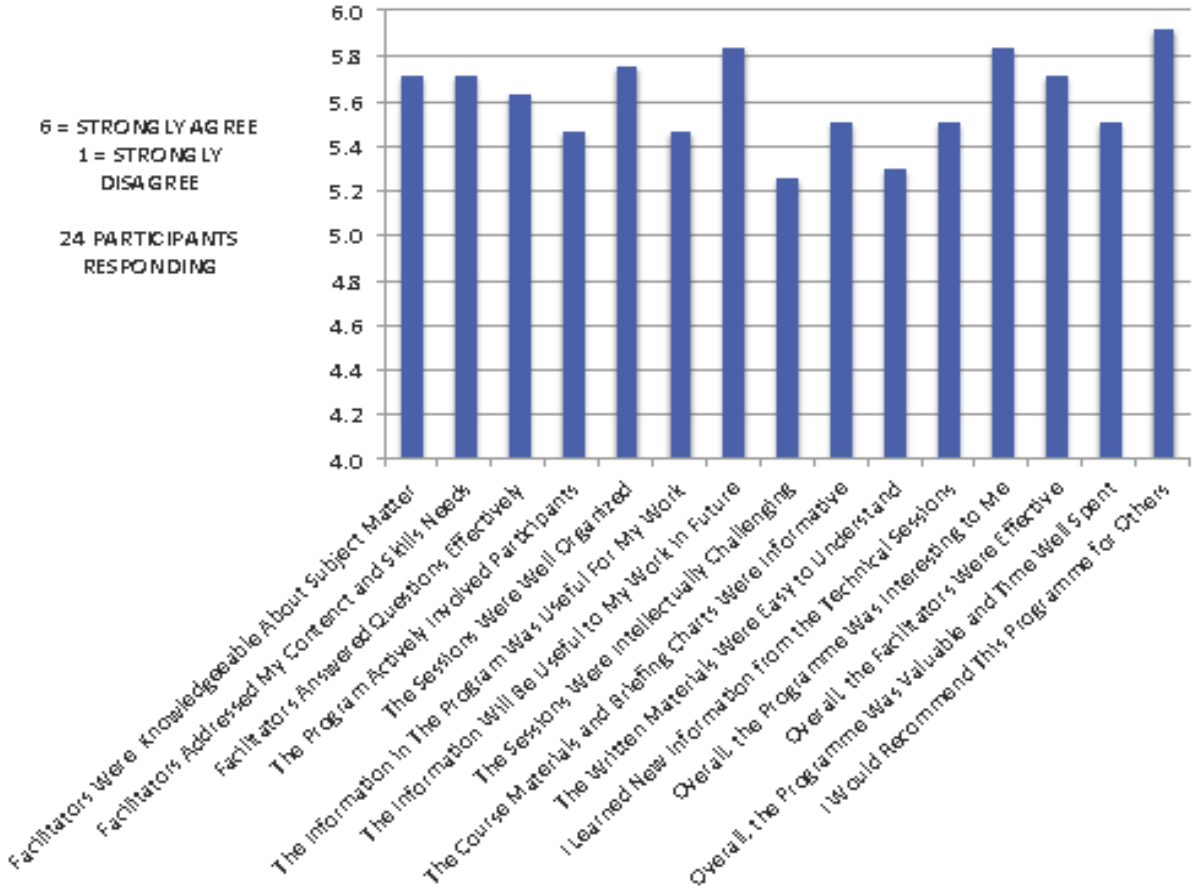


  - Identifying linkages, inclusion/exclusion decisions

Summary

6 = STRONGLY AGREE
1 = STRONGLY DISAGREE

24 PARTICIPANTS RESPONDING



- **First of its kind training - a success!**
- **Future Recommendations**
  - Transition more of the training to hands-on instruction
  - Better utilize instructors from outside of host facility
  - Extend the duration of the course

Acknowledgements

In loving memory of Jeff Hammack

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