



National Nuclear  
Forensics Library  
Virtual Table Top Exercise  
“Galaxy Serpent”



***Galaxy Serpent: A Web-Based Table-Top Exercise  
for National Nuclear Forensics Libraries***

Jim Borgardt (US-Department of State);  
Frank Wong (US-Department of Homeland Security)

IAEA CN-218; Vienna  
Session 2F  
08 July 2014

# What is Galaxy Serpent?



- First of its kind, entirely web-based, virtual table-top exercise using national nuclear forensics libraries (NNFLs)
- Conducted under the auspices of ITWG; co-led by US State Dept and Dept of Homeland Security
- Designed to address technical aspects of NNFLs
- 16 countries initially volunteered at ITWG-17 to participate

# A Framework for Cooperation



National nuclear forensics libraries (NNFLs):

- Provides an organizational knowledge framework for States investigating illicit uses of nuclear material
- Consists of information pertaining to the inventory of nuclear or other radioactive material produced, used, or stored by a State
- Allows a State to quickly assess the question “Is it consistent with our material?”

# Galaxy Serpent: Purpose



- Raises awareness about the technical aspects of creating and using NNFLs
  - *Teams create their NNFL from provided, existing data (public domain)*
  - *Teams then use their NNFL to determine if seized material is or is not consistent with their material in their NNFL*
- Teams encouraged to communicate, share approaches or methods, as needed

# Galaxy Serpent: Conduct



- 3-4 teams, each from a different State or organization (i.e. “Galaxy”) play in each Round
- Five rounds were conducted; each about 8 weeks in duration (Feb 2013 – April 2014)
- Teams receive information and post progress on a dedicated web portal (provided and managed by State Dept)



# Galaxy Serpent: Participants



Round 1 (Feb-Apr '13)	Round 2 (May-July '13)	Round 3 (Aug-Oct '13)	Round 4 (Feb-Apr '14)	Round 5 (Feb-Apr '14)
Australia/ANSTO	<i>Japan</i>	<i>Hungary</i>	"Pisces"	<i>JRC/ITU</i>
Brazil	South Africa/ NECSA	Sweden	<i>"Aquarius"</i>	"Pegasus"
<i>Canada</i>	UK/AWE	"Shapley"	"Seyfert"	"Sagittarius"
"Cygnus"	"Hydra"	"Carina"		

Italicized text indicates the team in each round which was assigned the reactor that was the source of the hypothetical seizure.

# Galaxy Serpent: Web Portal



frank.wong@hq.dhs.gov Sign Out

Account Help

Workspaces

Search Advanced

VIRGO Galaxy Calendar People Documents Discussions Settings Properties + Add Tab

VIRGO Galaxy Files

Options

Upload New

Files by Folder

Items not in Folders

- All Items
- Seized source data (1)
- VIRGO Reactor Data (7)
- Trash

Items not in Folders

Name	Status	Modified	
130322 2nd report phase 2.doc	-	Mar 25 by	<input type="checkbox"/>
130315 1st report phase 2.doc	-	Mar 18 by	<input type="checkbox"/>
130308 4th (final) report phase 1.doc	-	Mar 11 by	<input type="checkbox"/>
130301 3rd report phase 1.doc	-	Mar 4 by	<input type="checkbox"/>
130222 2nd report phase 1.doc	-	Feb 25 by	<input type="checkbox"/>
130215 1st report phase 1.doc	-	Feb 18 by	<input type="checkbox"/>
Template for weekly Galaxy Serpent Phase 1 reports.doc	-	Feb 15 by James Berggren	<input type="checkbox"/>
Seized source data (1)			<input type="checkbox"/>
VIRGO Reactor Data (7)			<input type="checkbox"/>

## Team Virgo Sample Home Page

- ✓ Progress Reports
- ✓ Phase I Injects: Reactor Data
- ✓ Phase II Injects: Seized Material Data



# Galaxy Serpent: Artificialities



- Uncertainties were developed, and not part of the original SFCOMPO data
- The “universe” of data sets were intentionally constrained to low-enriched uranium (LEU) reactors to help bound the problem
- Model NNFLs were composed of just three reactors; a combination of BWR and PWRs.



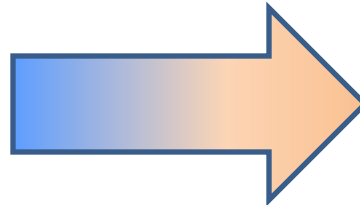
# Galaxy Serpent: Scenario



- Public domain spent fuel compositions are used (SFCOMPO; 14 nuclear reactors)
- Each Galaxy is provided data from ~3 reactors (i.e. “moons of Saturn”)

## **Phase I**

*Create an NNFL from the data provided*



## **Phase II**

*A dirty bomb with spent fuel was seized. Determine if this spent fuel is or is not consistent with spent fuel in your NNFL*

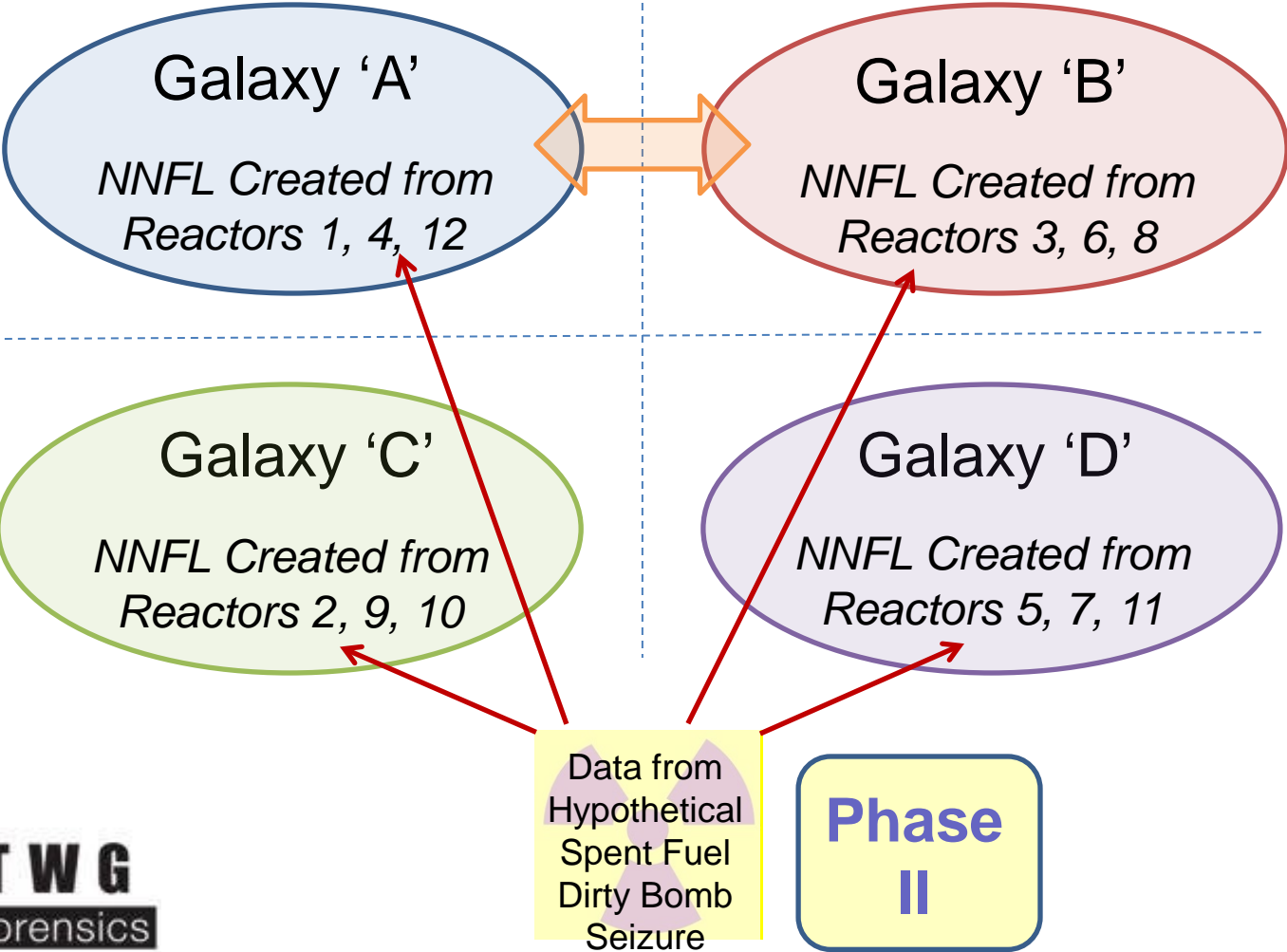
# Galaxy Serpent: Scenario Example



**Phase I**



Create NNFL from provided public domain data



# Galaxy Serpent: Progress Posting



◀ Back to Items not in Folders

Options ▾

130301 3rd report phase 1.doc 135 KB  
Weekly report 3 - Phase 1

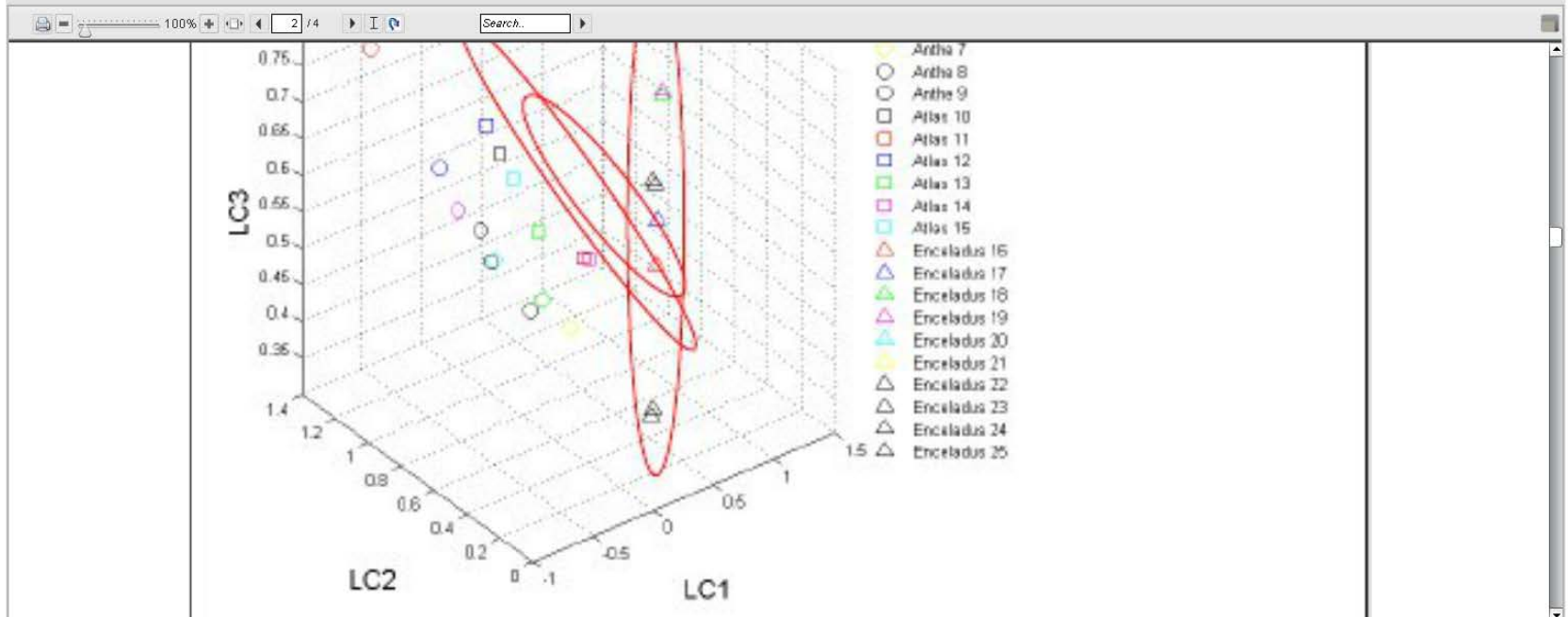
Download ▾

Upload New Version

Share ▾

Tags: report [edit tags](#)

Last edited by is Mar 4 No Status



Audit Log

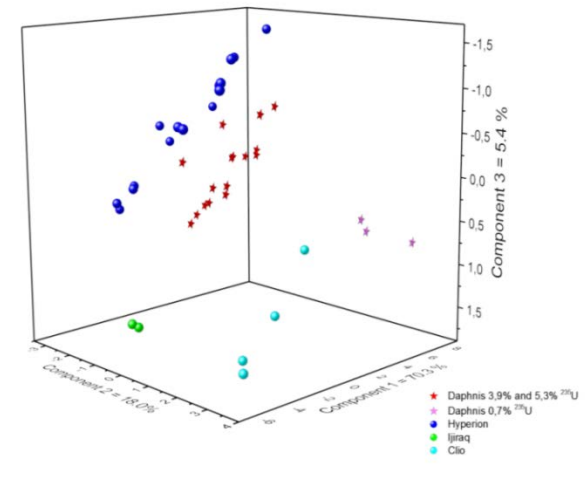
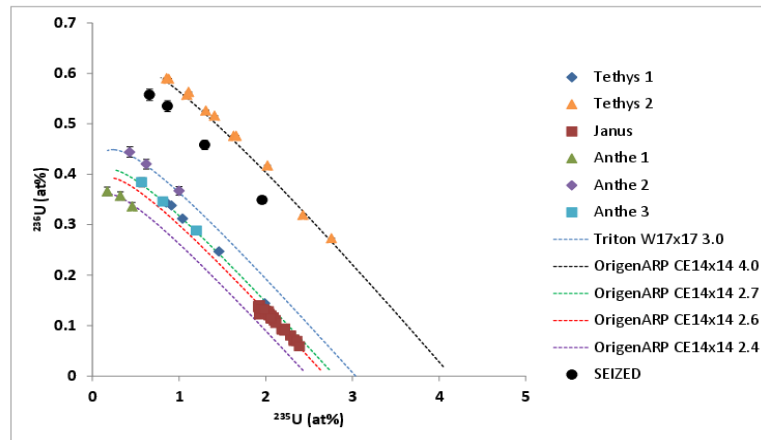
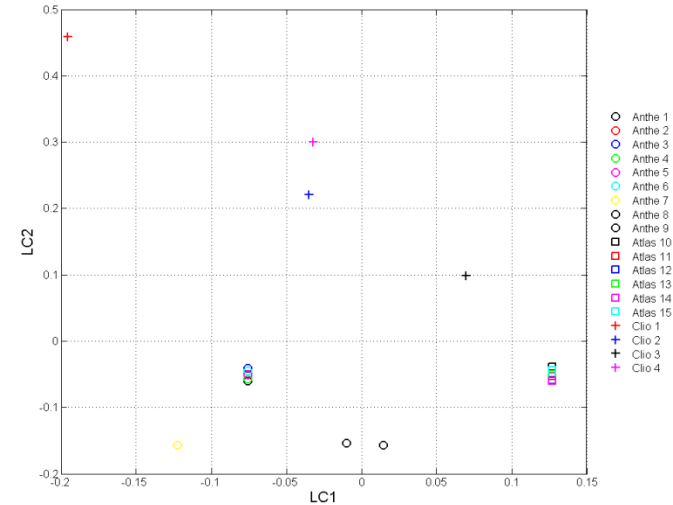
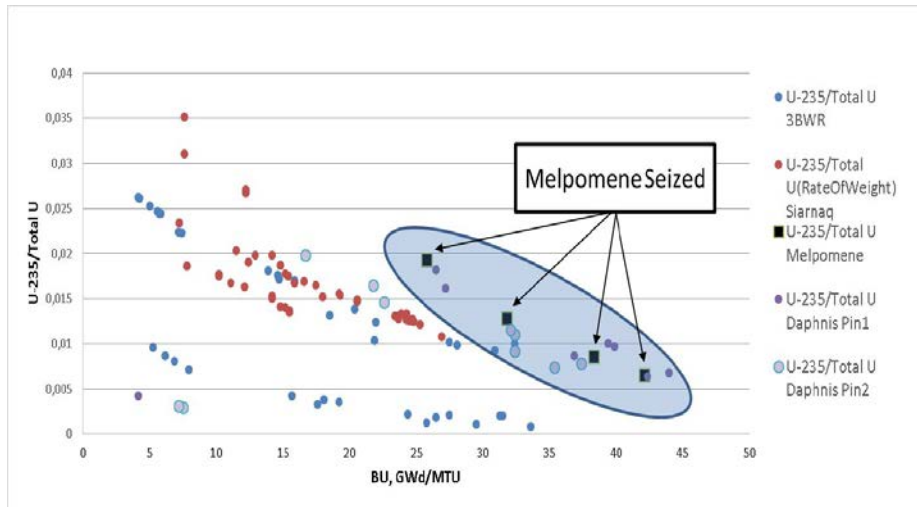


*Team Virgo: Excerpt from Phase I progress; their NNFL is complete and PCA is used to cluster reactors*

# Galaxy Serpent: Evaluation



## Examples: Technical assessment of results



# Galaxy Serpent: Results



All teams benefited from the exercise

- All teams that completed the exercise correctly answered “Is it consistent with our material?”
- All gained valuable insights into procedural issues, gaps in expertise, and similar critical infrastructure
- Contributions for variety of professional expertise
- Assignment of confidence levels

# Lessons Learned



- Cost effective international collaboration of scientists
- Multiple analytical methodologies, with confirmed findings
- Community of experts aware of NF and NNFLs expanded
- Wide-ranging expertise provided valuable contributions
- Demonstrated efficacy of NNFLs in drawing inferences of the origins of a hypothetical seizure of spent nuclear fuel
- NNFLs provided critical insights: especially about organizing existing data, re-purposed for an NNFL
- NNFLs can play a vital role in the investigative effort involving nuclear or other radioactive material

# Future Efforts



## Journal of Nuclear Materials Management (JNMM)

- Partnered with JNMM to arrange a special issue, summer 2014, dedicated to the Galaxy Serpent TTX
- 10 articles, including 9 early round participants teams and 1 from organizers
- Electronic release date: late July 2014

## Galaxy Serpent v2.0 – tentative outline

- Planning phase: Q3, Q4 2014
- Exercise: To begin Q1 2015
- Similar web-based, virtual format
- Anticipate feedstock as material of interest



Fall 2013	Winter 2014	Spring 2014	Summer 2014	Volume XXII, Number 4
<b>JNMM</b> Journal of Nuclear Materials Management				
Galaxy Serpent A: Web-based Table-Top Exercise Using the Concept of National Nuclear Forensics Libraries J. D. Bergardt, F. H. G. Wong 4				
Australia's Experiences in the Galaxy Serpent Virtual Tabletop Exercise Grant Griffiths, Brian Lee, David Beaumont, David Hill, and Katherine L. Smith 12				
The Use of a National Nuclear Forensic Library in Order to Identify Unknown Seized Nuclear Material: Brazil's Participation in the Galaxy Serpent Exercise Jorge Eduardo Souza Sirlis, Isabella Cristina Antunes Costa Bordon, Rafael Cardoso Baptista Pereira, and Rafael Coelho Martins 24				
Galaxy Serpent Virtual Tabletop Exercise: Canada's Approach, Findings, and Lessons Learned Alli Slaten Rick, Kenneth Francis, Doucet, Ivo Dimovski, Geoff Edwards, Duncan Barber, Stavros Corbett, and Daniel Wojtowicz 31				
Lessons Learned from the International Tabletop Exercise of National Nuclear Forensics Library at JAEA Yoshie, Kenzou, Nobuo, Shinohara, and Yoichi Furutake 41				
South Africa's Experiences in the Galaxy Serpent National Nuclear Forensics Library Tabletop Exercise Audrey M. Nkwawamaso, Albert M. Bopape, James H. Bahloko, and Kenneth R. Nduna 47				
The UK's Contribution to the Galaxy Serpent Tabletop Exercise Andrew J. Hayden, Christopher A. Cooper, Paul Thompson, Philip G. Turner, Robert Gregg, Kevin W. Hedderly, Andrew E. Jones, and John V. Goulemas 57				
The Hungarian Experience in the Galaxy Serpent Tabletop Exercise on National Nuclear Forensics Libraries Eva Kovács-Székely, Sándor Szabó, Tamás Csörgő, and György Némethy 67				
U and Pu Isotopic Correlations to Check Consistency of Seized Nuclear Material Against a Known Inventory: Team Sweden Effort to Create and Use a Virtual National Nuclear Forensics Library (VNNFL) in the Galaxy Serpent Tabletop Exercise Anders Axelsson, Henrik Ramneback, and Björn Sandström 72				
The Galaxy Serpent Exercise: Methodology, Experience, and Findings of the Institute for Transmutation Elements Marta Wallenius, Zsófia Varga, and Klaus Mayer 78				