Signal Injection To Exercise The Entire CTBT Monitoring Regime - An Idea For Future Consideration

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T4.1-O121

ORAL PRESENTATION

1 Lawrence Livermore National Laboratory
2 ARGON™

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LLNL-PRES-822316

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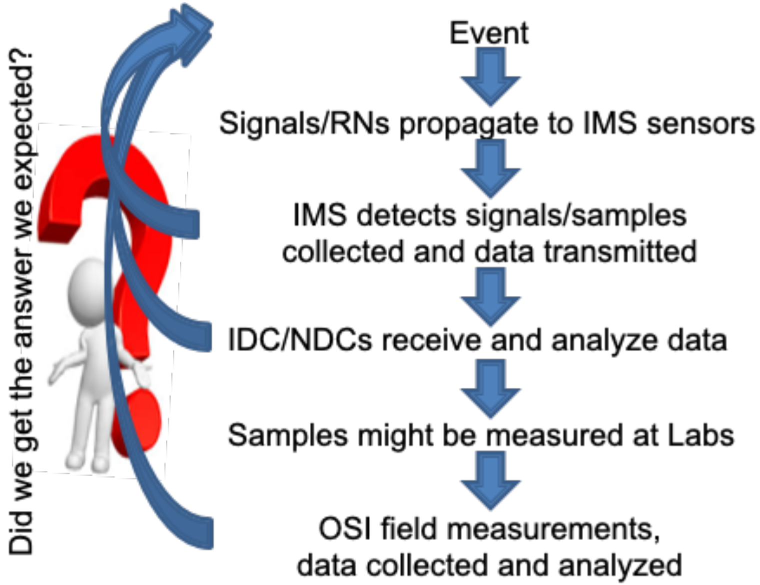
Steven Kreek et al., Lawrence Livermore National Laboratory, kreek1@llnl.gov

Goal: Routinely exercise all people, equipment, and processes against the most realistic and relevant scenarios and signatures

- IMS sensors including signal collection/processing hardware
- IDC data receipt, analysis and interpretation (including NDCs)…
- OSI measurement systems…

Q: Can we exercise the system of systems to include all components?



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Currently, we exercise components of the system


Analysis of IMS Data

> Appl Radiat Isot. 2018 Apr;134:35-39. doi: 10.1016/j.apradiso.2017.07.034. Epub 2017 Jul 28.

Proficiency test exercises for particulate systems at CTBT radionuclide laboratories

Naoko Nakashima [1], Emerenciana B Duran [2]

Affiliations + expand

PMID: 28784355 DOI: 10.1016/j.apradiso.2017.07.034

Abstract

The Provisional Technical Secretariat (PTS) of the Comprehensive Nuclear-Test-Ban Treaty (CTBT)

Exercising the lab network

World events test the IMS, but are unplanned, episodic, only touch some parts, and aren't the focus

Field Exercises

Field exercises are expensive, infrequent and only somewhat realistic; Can't replicate nuclear explosion phenomena/scales

CTBTO | COMPREHENSIVE NUCLEAR-TEST-BAN TREATY ORGANIZATION

Testing the Synthetic Event Generator with Automatic Event Detectors

Noriyuki Kushida, Ronan Le Bras, and Megan Slinkard

Synthetic event generation is being tested in some arenas

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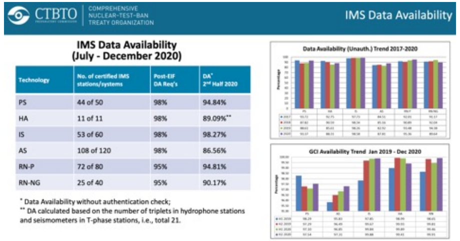
Complemented by performance monitoring

- We know when stations are up/down and background is present all the time
- Occasional failures are examined
- Calibrations and O&M workshops help maintain operations
- But…
  - We don't often exercise the integrated suite of sensors, their hardware, and processes together
  - Where the signatures are consistent with a nuclear test explosion
  - And we think we "know" the answer



IMS Data Availability
(July - December 2020)

Technology	No. of certified IMS stations/systems	Post-EIF DA Req's	DA* 2nd Half 2020
PS	44 of 50	98%	94.84%
HA	11 of 11	98%	89.09%**
IS	53 of 60	98%	98.27%
AS	108 of 120	98%	86.56%
RN-P	72 of 80	95%	94.81%
RN-NG	25 of 40	95%	90.17%

* Data Availability without authentication check;
** DA calculated based on the number of triplets in hydrophone stations and seismometers in T-phase stations, i.e., total 21.

Trending performance

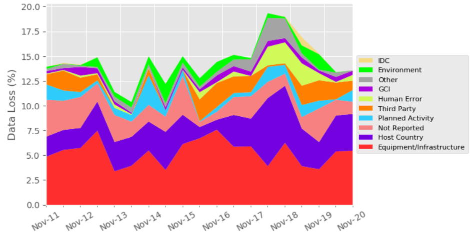


Figure 21. *AS stations historical trends of DL by failure cause*

Failure analysis

Calibrations

Workshops on O&M

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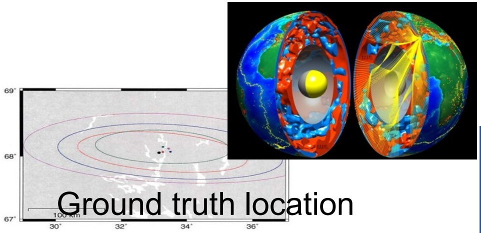
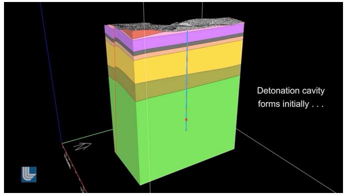
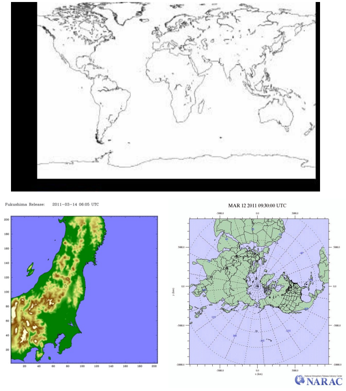
Models could calculate the signals expected for each instrument type/location

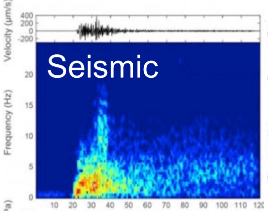


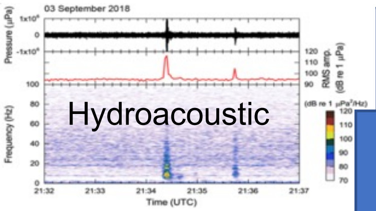


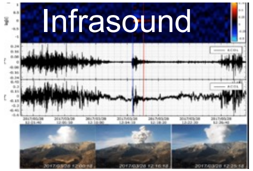
Source term models

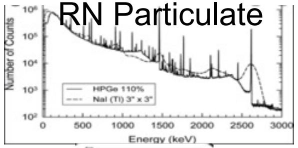


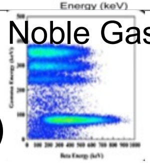
Signal & RN transport











Detector responses (IMS)

Detector responses (OSI)

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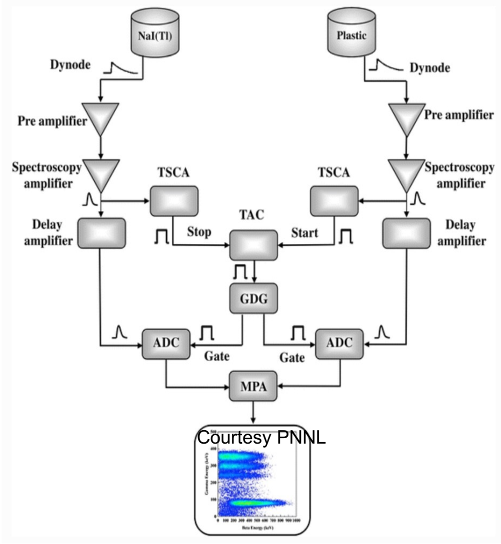
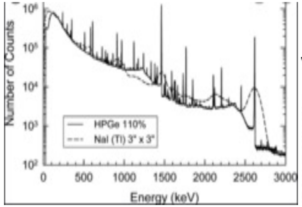
This is possible because detectors, for all their differences, are similar in many ways

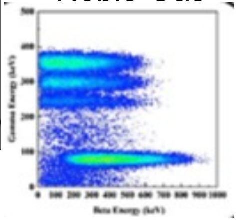


RN Particulate

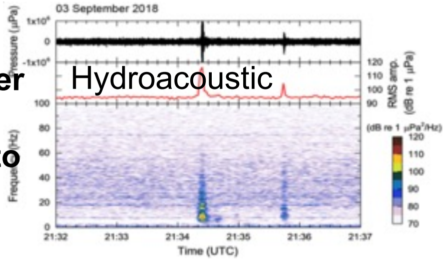
Converts photons & electrons to voltages



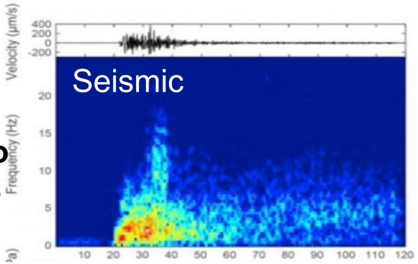
Noble Gas



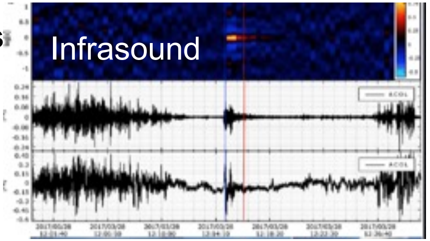
Converts underwater pressure changes to a voltage



Converts ground motion to a voltage



Converts sound waves in air to a voltage



Detectors convert signals to another form (a transducer), all get amplified, and digitized

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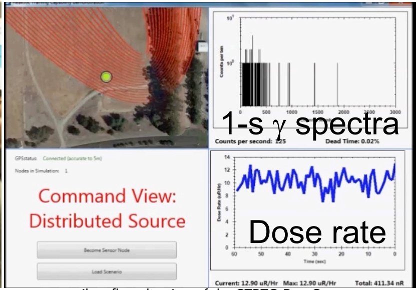
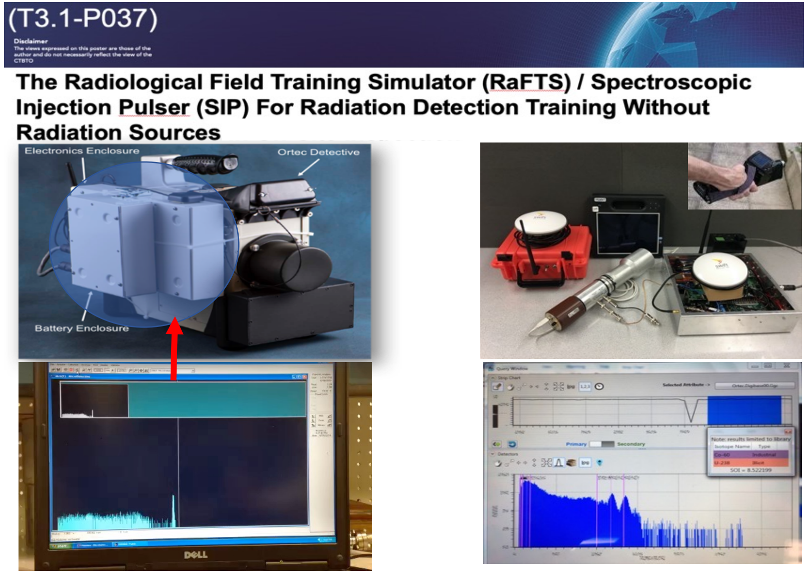
Technologies are emerging that artificially create and even inject relevant signals

- Space between real and virtual world is shrinking...
- Injection into detection hardware is possible
  - With signatures that are hard to replicate otherwise (ex: rad consistent w/ a recent nuclear explosion combined w/ seismic)
- Other communities are demanding ability to replicate signatures to avoid cost/risk of hazard-level sources

Future is becoming more virtual

SnT2017 contribution



Signals are fed directly into electronics, replicating rad source spectra and encounter physics (e.g., $1/r^2$...)

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There are pros and cons to this approach

Pros:

- Demonstrates whole system against "knowns"
  - Tests signal collection, processing, transmission … analysis/interpretation
- Fosters system/data integration across methods
- Transmitting scenarios to stations could enable other things (like pushing software updates)
- Enables sensitivity studies
  - Could demonstrate value of varying collection times
- Leverages existing equipment trends
  - Can be integrated through upgrade of existing hardware or during replacement

Cons:

- Complex to execute
  - Timing, each IMS station would have to respond accordingly and at varying times – GPS coordinated?
  - Transmitting scenarios/control to stations (in addition to data from)
  - OSI instruments would need integration
- Would this impact confidence?
  - For example, are the models good enough?
- Haven't really considered this yet
  - Equipment specs don't consider injection

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While it’s still early…

- Signal injection technology, combined with advances in modeling accuracy and speed, will likely make it possible…
    - …and in the relatively near future
- There are many implementation options
- Starting technical consideration early could help inform future decisions
    - Equipment specifications, for example

LLNL AND ARGON ELECTRONICS MAKE RADIATION FIELD TRAINING FOR FRONT-LINE WORKERS MORE REALISTIC

Department of Energy
Lawrence Livermore National Laboratory

The Lawrence Livermore National Laboratory (LLNL) and Argon Electronics (U.K.) Ltd. have partnered to commercialize the Radiation Field Training Simulator (RaFTS), an ultra-realistic radiation simulator for training emergency responders.

Responders to a suspected act of nuclear or radiological terrorism or accident rely on radiation detectors to assess the threat and respond appropriately. However, interpretation of data collected is nuanced and requires clear understanding of equipment and the impact of different scenarios on performance. For example, some detectors show only the magnitude of the hazard or the presence of contamination. Others identify the radioactive isotope. All are affected by the details of the scenario.

Because radiation is invisible, realistic detector-specific training is critical. Previously, training with high-hazard radioactive materials was accomplished only

Above: Researchers from LLNL and Argon Electronics conduct a test with the Radiation Field Training Simulator (RaFTS). From left: Dave Trombino, Erik Swanberg and Josh Oakgrove, all from LLNL; Philip Dunn of Argon Electronics; Greg White of LLNL; and Steven Pike of Argon Electronics.

2017 R&D 100 WINNER

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THANK YOU!

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