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CTBTO generation of synthetic radionuclide spectra to support the NDC Preparedness Exercise NPE15

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Introduction

As part of the 2015 NDC Preparedness Exercise (NPE15), the production of a large number of synthetic spectra was required both for Noble Gas and particulates technologies.

The NPE15 control team requested the CTBTO to generate the largest portion of the particulate spectra with specified nuclides of interest and activity concentrations. Some spectra contain a very large number of radionuclides (up to 80) and with very high activities. The beta-gamma Noble Gas spectra for NPE15 were generated by the Pacific Northwest National Laboratory (PNNL), USA.

Input nuclides and activities for the simulation were provided by the control team (FOI) in line with the exercise scenario.

This poster describes the key methodological aspects and tools used by the CTBTO to meet these high requirements:

(a) optimization of the Monte Carlo model of VGSL (Virtual Gamma Spectroscopy Laboratory) tool with detailed simulation parameters (specific IMS detector, shielding and source geometry),

(b) simulation of spectra matching the high activities of the CTBT relevant nuclides as provided by the control team and

(c) combination with actual sample spectra as sent by IMS stations, which represents the station background conditions

(d) creation of SPHD files in IMS 2.0 format (e) test of samples with NDC-in-a-box automatic processing and interactive analysis software.

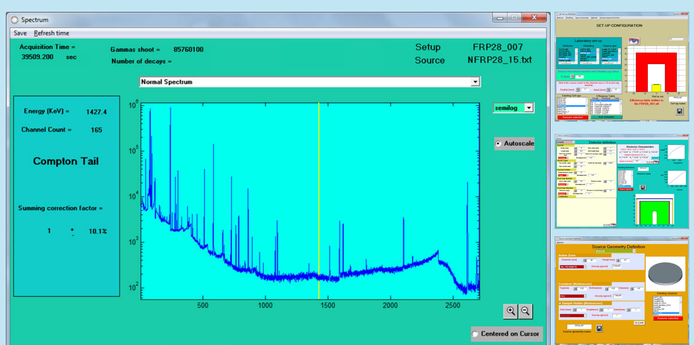
The result is a set of 21 spectra that were used by the participants of the NPE15 and that can in future be used for training and testing purposes.

VGSL simulation

A total of 21 particulate spectra have been simulated using the CTBTO software Virtual Gamma Spectroscopy Laboratory, VGSL, (Plenteda, 2002).

- DEP33: 11 samples;
- FRP28: 3 samples;
- RUP61: 5 spectra;
- SEP63: 2 spectra

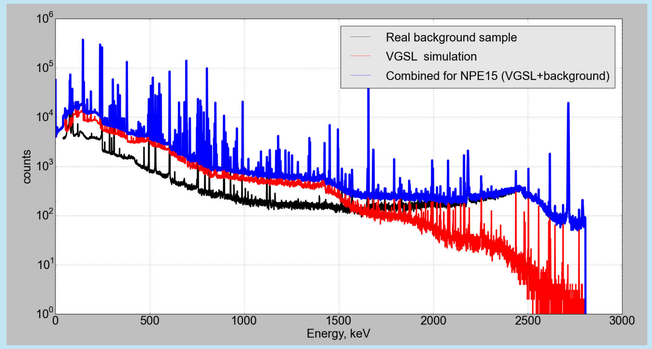
VGSL simulation is based on optimized detector models (distance crystal to end-cup; thickness of dead layer). VGSL simulation includes Compton component. Coincidence summing effects are also reflected.



Combination with actual background

Add-hoc software tool was written for combining VGSL simulated component with actual sample spectra, with the following key features:

- Updated energy calibrations are used (to compensate for gain shift at station level).
- VGSL simulated spectra used real/live acquisition time of 92000/78000 sec.
- Timestamps from the NPE15 scenario are used for #Collection and
- #Acquisition in the final combined spectra.
- Combined #g_Spectrum block is generated in IMS2.0 format.



Testing for consistency against IMS 2.0 format

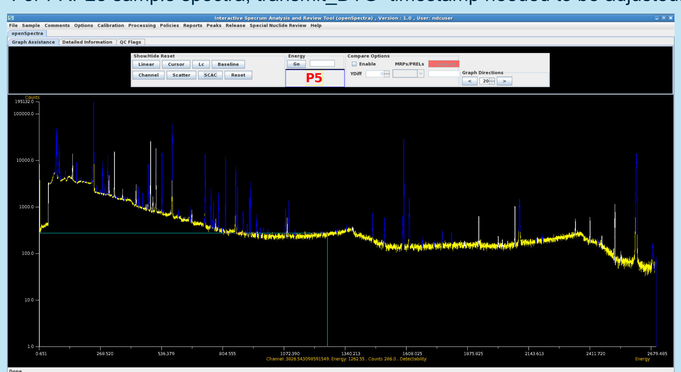
The testing is performed using NDC-in-a-Box software:

- Autosaint and OpenSectra for particulates
- Bg_analyse and norfy for beta-gamma based Noble Gas

(a) CTBTO particulate spectra

All produced spectra have been tested for processing.

Outcome:
The processing was successful for DEP33, RUP61 and SEP63 (autoSaint automatically updates energy calibration).
For FRP28 sample spectra, transmit_DTG timestamp needed to be adjusted.



(b) PNNL Noble Gas spectra

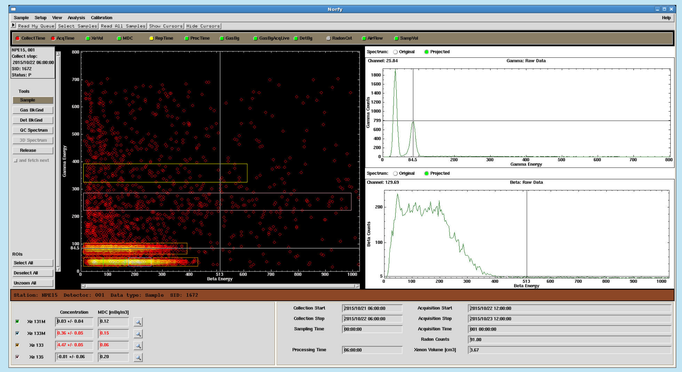
All produced spectra for DEX33 (detector background, 11 gas background spectra and 11 sample spectra) have been tested for processing.
* *QC spectra were missing.*

***Outcome**:*

- A configuration issue was fixed (DEX33_001 already exists as SPALAX detector).
- One gas background (201510251200_DEX33_001-G0001F12788) and one sample (201510261200_DEX33_001-S0001F56002) failed the initial processing.

Required corrections are applied (Formats related) .

- Additional implemented corrections: #collection and #Processing blocks are taken out from detector and gas background spectra.
- Slight energy shift noticed in gamma energy calibration but ROI limits match well the counts distribution of detected xenon isotopes.



Lessons learned

- ✓ Accommodated timeline should have been allocated on this activity due to the high complexity of the exercise in order to have proper and deeper control of the final product.
- ✓ Consider the use of QC spectra in the analysis, as part of NPE data.
- ✓ Appropriate station/detector coding for anticipating configuration issues.
- ✓ Robustness of calibration algorithms is highly important when dealing with the analysis of complex spectra.
- ✓ Importance of using updated calibration energy and resolution parameters for correcting potential gain shifts.

References

R. Plenteda, 2002. A Monte Carlo Based Virtual Gamma Spectroscopy Laboratory, PhD dissertation, Atominstitut der Österreichischen Universitäten.