# RASA Detector Calibrations – Field Automation and Factory Calibrations

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## OVERVIEW

General Dynamics Mission Systems operates the United States Radionuclide Stations (RASA and SAUNA) in CTBTO International Monitoring System. As the RASA manufacturer, General Dynamics provides the control software for the system.
General Dynamics engineers perform scheduled and unscheduled maintenance visits to RASA stations, including detector replacements.

## PROBLEM

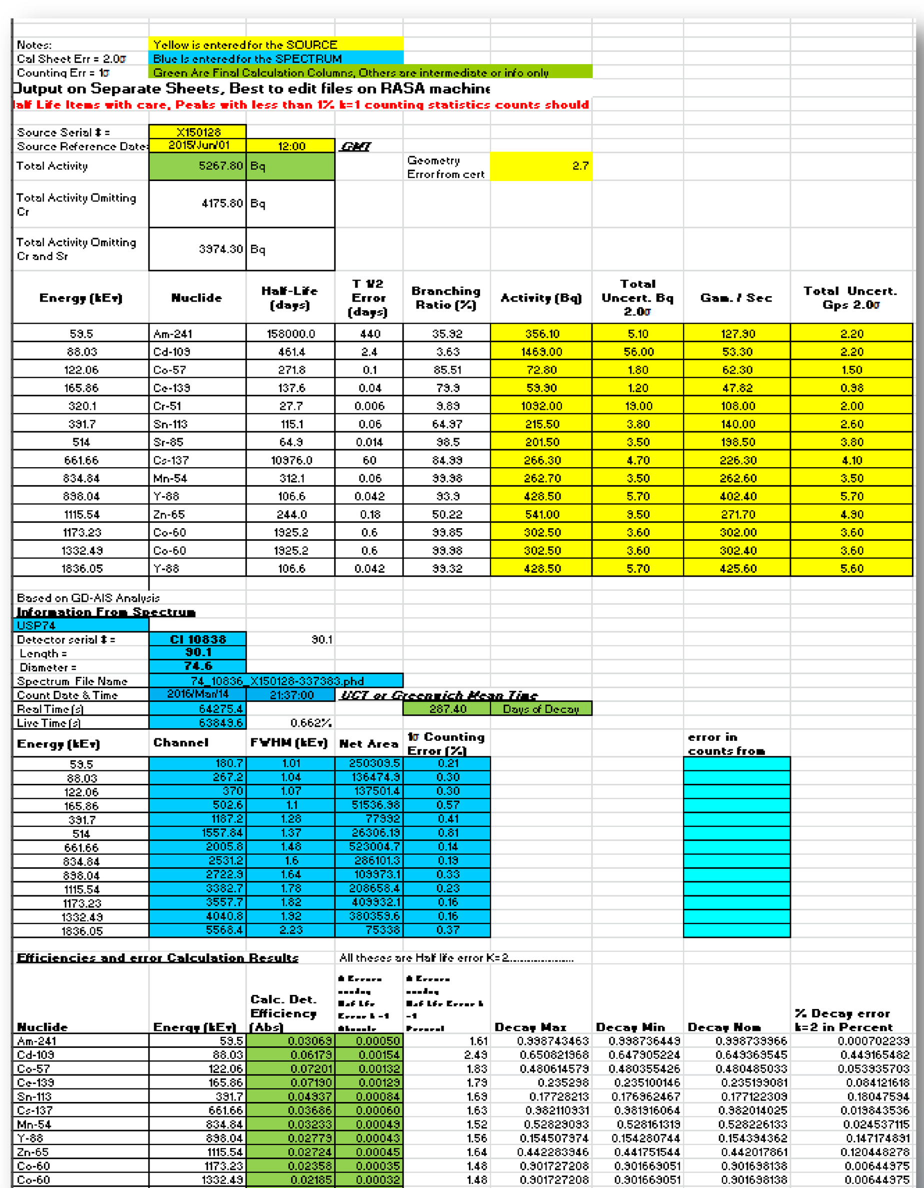
The current RASA detector calibration process is a labor-intensive task with potential for human error. Mistakes and delays in this process can result in reduced data availability of RASA systems during and after a detector replacement.

## CURRENT PROCESS

**Labor intensive**
- Requires engineer to intervene and perform manual tasks to continue, often at odd hours

**Dependent on remote data analysis**
- Communications/schedule issues result in delays and increased downtime

**Manual data entry**
- Errors result in delayed returns to operations and prolonged downtime



Notes: Yellow is entered for the SOURCE
Cal Sheet Err = 2.0σ Blue is entered for the SPECTRUM
Counting Err = 1σ Green Are Final Calculation Columns, Others are intermediate or info only
Output on Separate Sheets, Best to edit files on RASA machine
Half Life Items with care, Peaks with less than 1% k=1 counting statistics counts should

Source Serial # = X150128
Source Reference Date 2015/Jun/01 12:00 GMT
Total Activity 5267.80 Bq — Geometry Error from cert 2.7
Total Activity Omitting Cr 4175.80 Bq
Total Activity Omitting Cr and Sr 3974.30 Bq

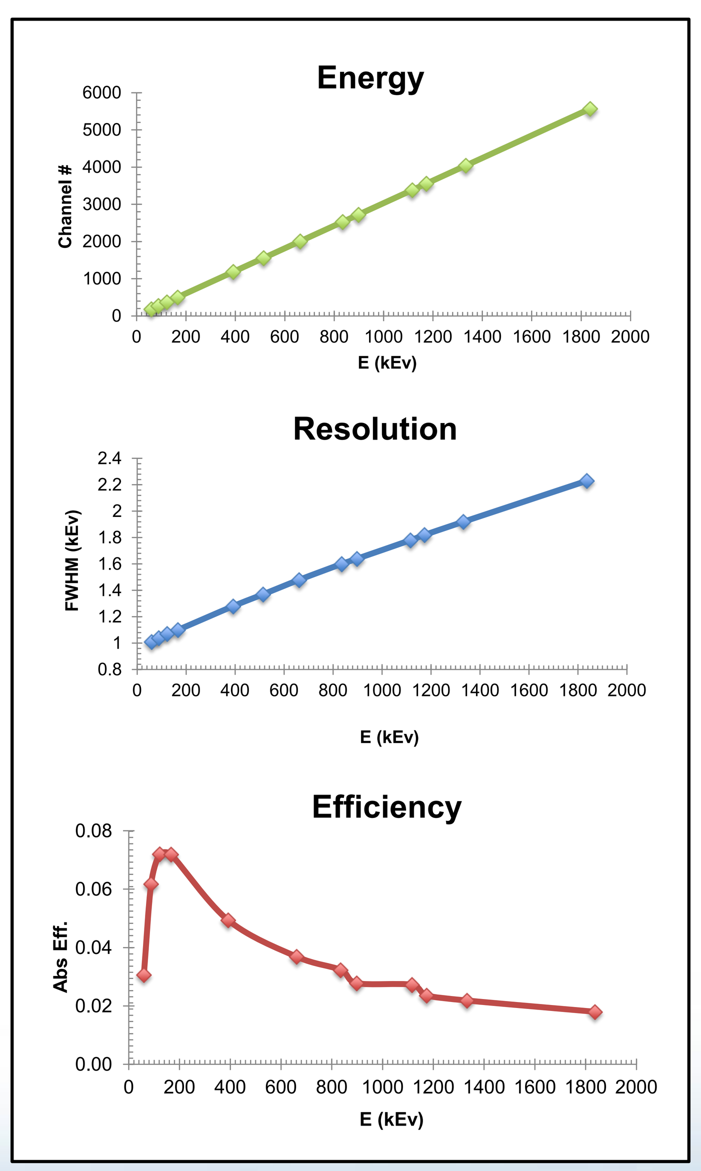
| Energy (kEv) | Nuclide | Half-Life (days) | T 1/2 Error (days) | Branching Ratio (%) | Activity (Bq) | Total Uncert. Bq 2.0σ | Gam. / Sec | Total Uncert. Gps 2.0σ |
|---|---|---|---|---|---|---|---|---|
| 59.5 | Am-241 | 158000.0 | 440 | 35.92 | 356.10 | 5.10 | 127.90 | 2.20 |
| 88.03 | Cd-109 | 461.4 | 2.4 | 3.63 | 1469.00 | 56.00 | 53.30 | 2.20 |
| 122.06 | Co-57 | 271.8 | 0.1 | 85.51 | 72.80 | 1.80 | 62.30 | 1.50 |
| 165.86 | Ce-139 | 137.6 | 0.04 | 79.9 | 59.90 | 1.20 | 47.82 | 0.98 |
| 320.1 | Cr-51 | 27.7 | 0.006 | 9.89 | 1092.00 | 19.00 | 108.00 | 2.00 |
| 391.7 | Sn-113 | 115.1 | 0.06 | 64.97 | 215.50 | 3.80 | 140.00 | 2.60 |
| 514 | Sr-85 | 64.9 | 0.014 | 98.5 | 201.50 | 3.50 | 198.50 | 3.80 |
| 661.66 | Cs-137 | 10976.0 | 60 | 84.99 | 266.30 | 4.70 | 226.30 | 4.10 |
| 834.84 | Mn-54 | 312.1 | 0.06 | 99.98 | 262.70 | 3.50 | 262.60 | 3.50 |
| 898.04 | Y-88 | 106.6 | 0.042 | 93.9 | 428.50 | 5.70 | 402.40 | 5.70 |
| 1115.54 | Zn-65 | 244.0 | 0.18 | 50.22 | 541.00 | 9.50 | 271.70 | 4.90 |
| 1173.23 | Co-60 | 1925.2 | 0.6 | 99.85 | 302.50 | 3.60 | 302.00 | 3.60 |
| 1332.49 | Co-60 | 1925.2 | 0.6 | 99.98 | 302.50 | 3.60 | 302.40 | 3.60 |
| 1836.05 | Y-88 | 106.6 | 0.042 | 99.32 | 428.50 | 5.70 | 425.60 | 5.60 |

Based on GD-AIS Analysis
Information From Spectrum
USP74
Detector serial # = CI 10838 90.1
Length = 90.1
Diameter = 74.6
Spectrum File Name 74_10836_X150128-337383.phd
Count Date & Time 2016/Mar/14 21:37:00 UCT or Greenwich Mean Time
Real Time (s) 64275.4 287.40 Days of Decay
Live Time (s) 63843.6 0.662%

| Energy (kEv) | Channel | FWHM (kEv) | Net Area | 1σ Counting Error (%) | error in counts from |
|---|---|---|---|---|---|
| 59.5 | 180.7 | 1.01 | 250309.5 | 0.21 | |
| 88.03 | 267.2 | 1.04 | 136474.9 | 0.30 | |
| 122.06 | 370 | 1.07 | 137501.4 | 0.30 | |
| 165.86 | 502.6 | 1.1 | 51536.98 | 0.57 | |
| 391.7 | 1187.2 | 1.28 | 77392 | 0.41 | |
| 514 | 1557.84 | 1.37 | 26306.19 | 0.81 | |
| 661.66 | 2005.8 | 1.48 | 523004.7 | 0.14 | |
| 834.84 | 2531.2 | 1.6 | 286101.3 | 0.19 | |
| 898.04 | 2722.9 | 1.64 | 109973.1 | 0.33 | |
| 1115.54 | 3382.7 | 1.78 | 208658.4 | 0.23 | |
| 1173.23 | 3557.7 | 1.82 | 409932.1 | 0.16 | |
| 1332.49 | 4040.8 | 1.92 | 380359.6 | 0.16 | |
| 1836.05 | 5568.4 | 2.23 | 75338 | 0.37 | |

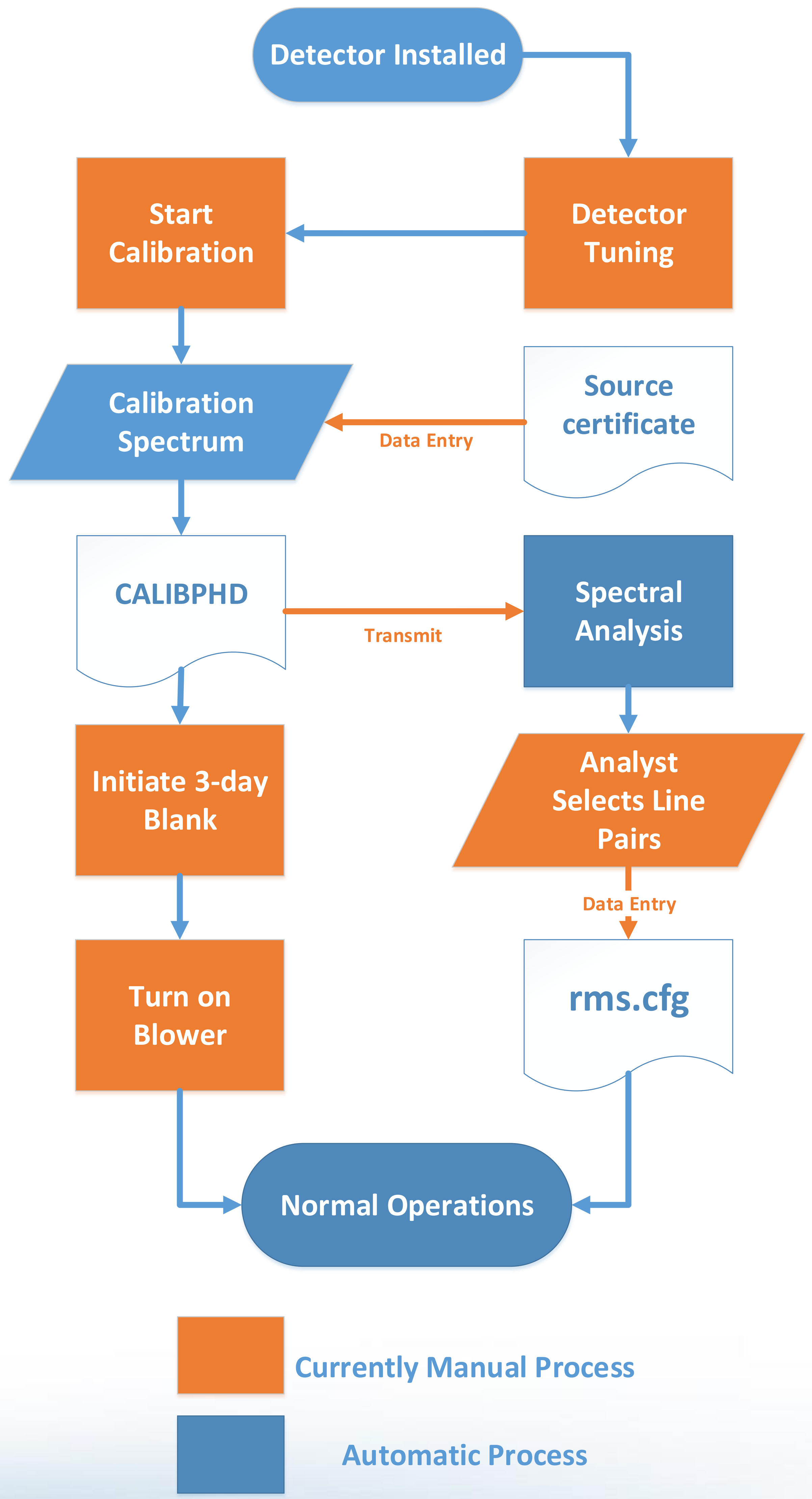
Efficiencies and error Calculation Results — All theses are Half life error K=2

| Nuclide | Energy (kEv) | Calc. Det. Efficiency (Abs) | [illegible] | [illegible] | Decay Max | Decay Min | Decay Nom | % Decay error k=2 in Percent |
|---|---|---|---|---|---|---|---|---|
| Am-241 | 59.5 | 0.03069 | 0.00050 | 1.61 | 0.998743463 | 0.998739449 | 0.998739966 | 0.000702239 |
| Cd-109 | 88.03 | 0.06179 | 0.00154 | 2.49 | 0.650821968 | 0.647905224 | 0.649369545 | 0.449165482 |
| Co-57 | 122.06 | 0.07201 | 0.00132 | 1.83 | 0.480614579 | 0.480355426 | 0.480485033 | 0.053935703 |
| Ce-139 | 165.86 | 0.07190 | 0.00129 | 1.79 | 0.235298 | 0.235100146 | 0.235199081 | 0.084121618 |
| Sn-113 | 391.7 | 0.04937 | 0.00084 | 1.69 | 0.17728213 | 0.176962467 | 0.177122309 | 0.18047594 |
| Cs-137 | 661.66 | 0.03686 | 0.00060 | 1.63 | 0.982110931 | 0.981916064 | 0.982014025 | 0.019843536 |
| Mn-54 | 834.84 | 0.03233 | 0.00049 | 1.52 | 0.52829093 | 0.528161319 | 0.528226133 | 0.024537115 |
| Y-88 | 898.04 | 0.02779 | 0.00043 | 1.56 | 0.154507974 | 0.154280744 | 0.154394362 | 0.147174891 |
| Zn-65 | 1115.54 | 0.02724 | 0.00045 | 1.64 | 0.442283946 | 0.441751544 | 0.442017861 | 0.120448278 |
| Co-60 | 1173.23 | 0.02358 | 0.00035 | 1.48 | 0.901727208 | 0.901669051 | 0.901698138 | 0.00644975 |
| Co-60 | 1332.49 | 0.02185 | 0.00032 | 1.48 | 0.901727208 | 0.901669051 | 0.901698138 | 0.00644975 |
| Y-88 | 1836.05 | 0.01800 | 0.00028 | 1.55 | 0.154507974 | 0.154280744 | 0.154394362 | 0.147174891 |




## AUTOMATED SOLUTION

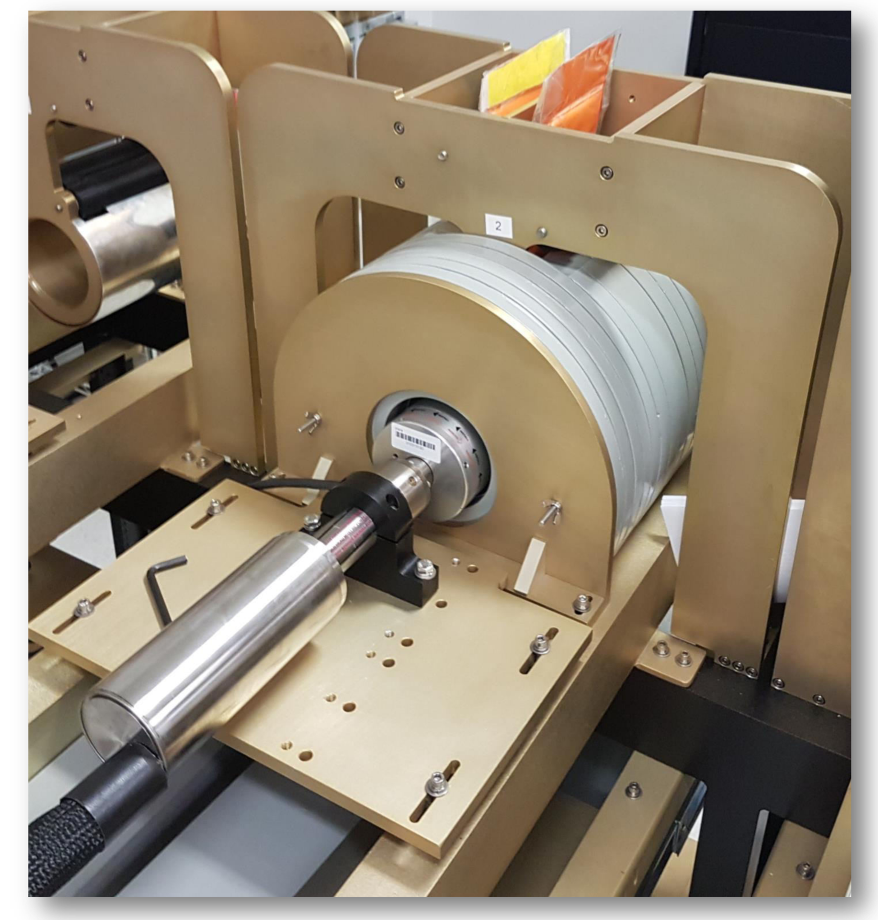
General Dynamics continues to develop an onboard software calibration module to remove the manual steps and delays involved in the current process. This will result in fewer errors and faster time to restored operations
- Fully local, not dependent on remote resources
- Leverage the CTBTO NDC-in-a-Box virtual appliance for local spectral analysis to match IDC results
- Automated tool, requiring minimal user interaction - only when expert analysis is required



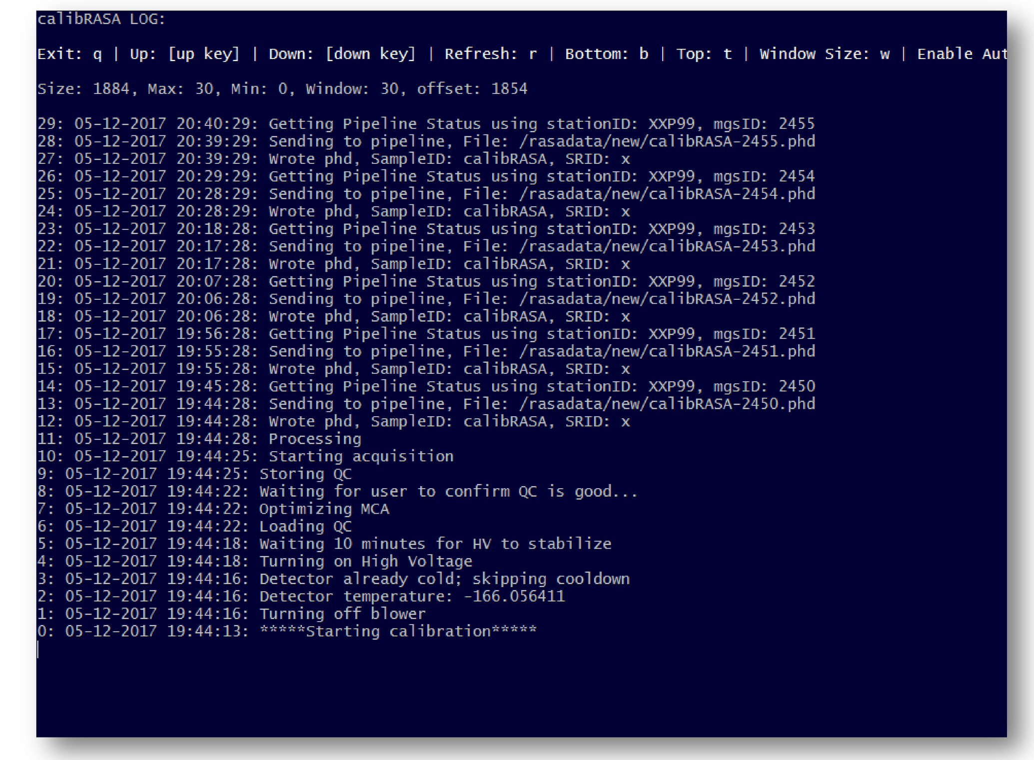

## FACTORY CALIBRATIONS

In collaboration with the CTBTO, General Dynamics is researching the viability of one-time calibrations performed in a factory or laboratory setting, rather than a full calibration at every new installation.

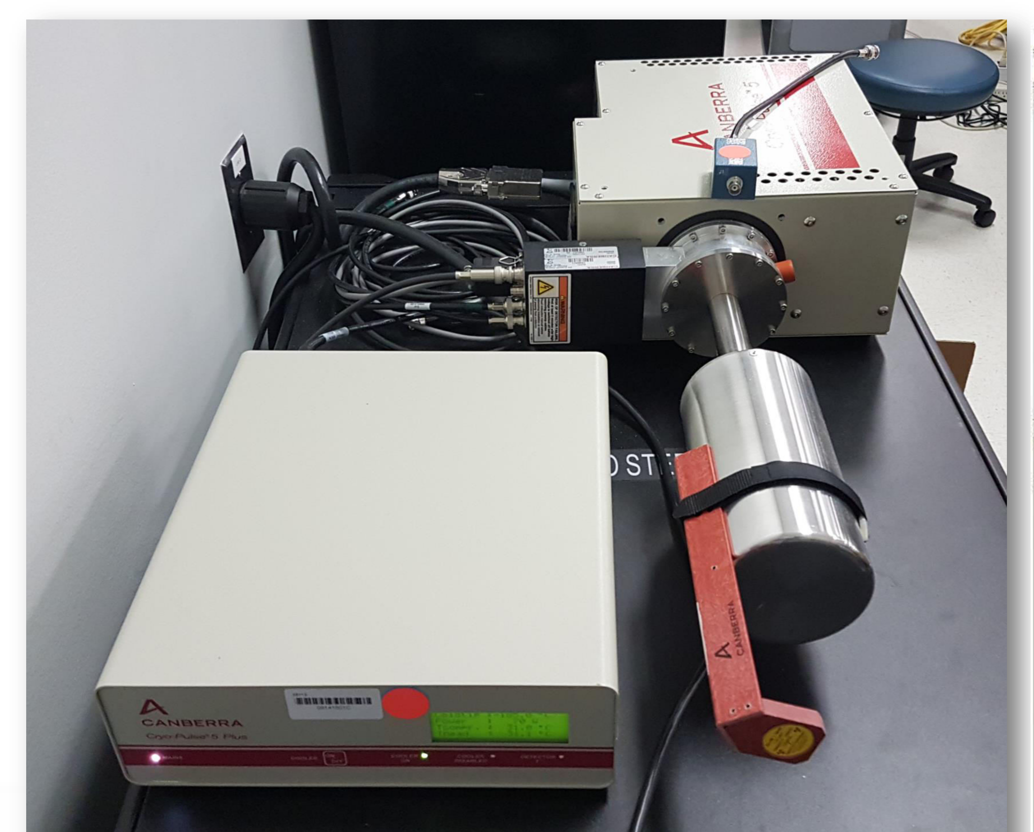
If factory calibrations are proven viable and approved by the PTS, in-field calibrations may be reduced and replaced with quick checks to validate the existing data. The Canberra ISOCS / LabSOCS factory detector characterization and modeling software is a promising solution that continues to be evaluated.

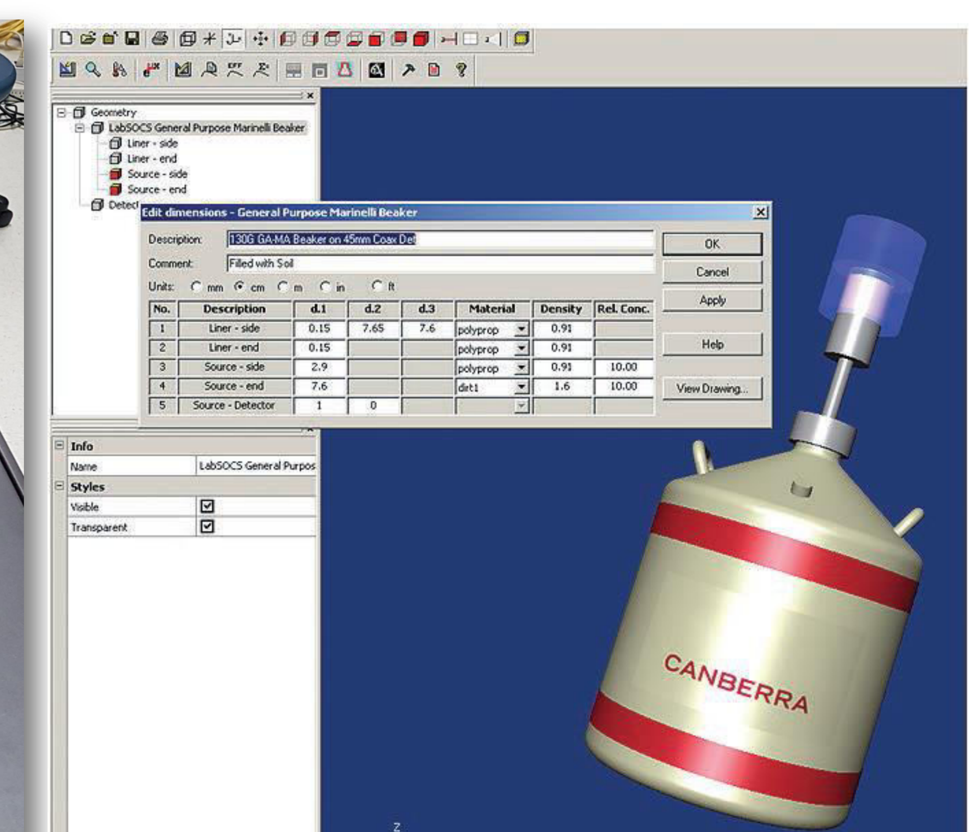


GDMS Testbed - Detector Test Stand




Testing RASA Software Calibration Script




GDMS Testbed – Evaluation of Canberra LabSOCS / ISOCS

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