SAND2020-1480C

# Sandia support to DMAMC Mission

Belkis Cabrera-Palmer

Sandia National Laboratories

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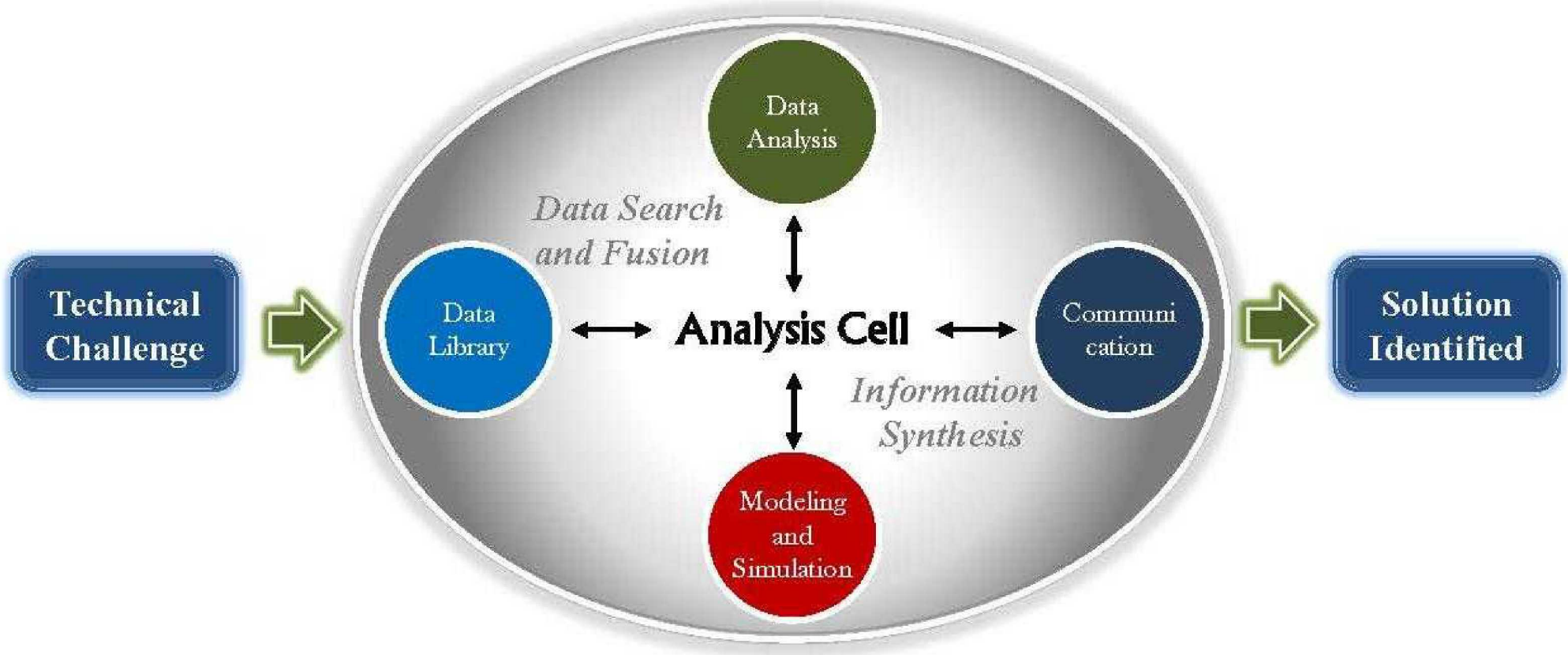
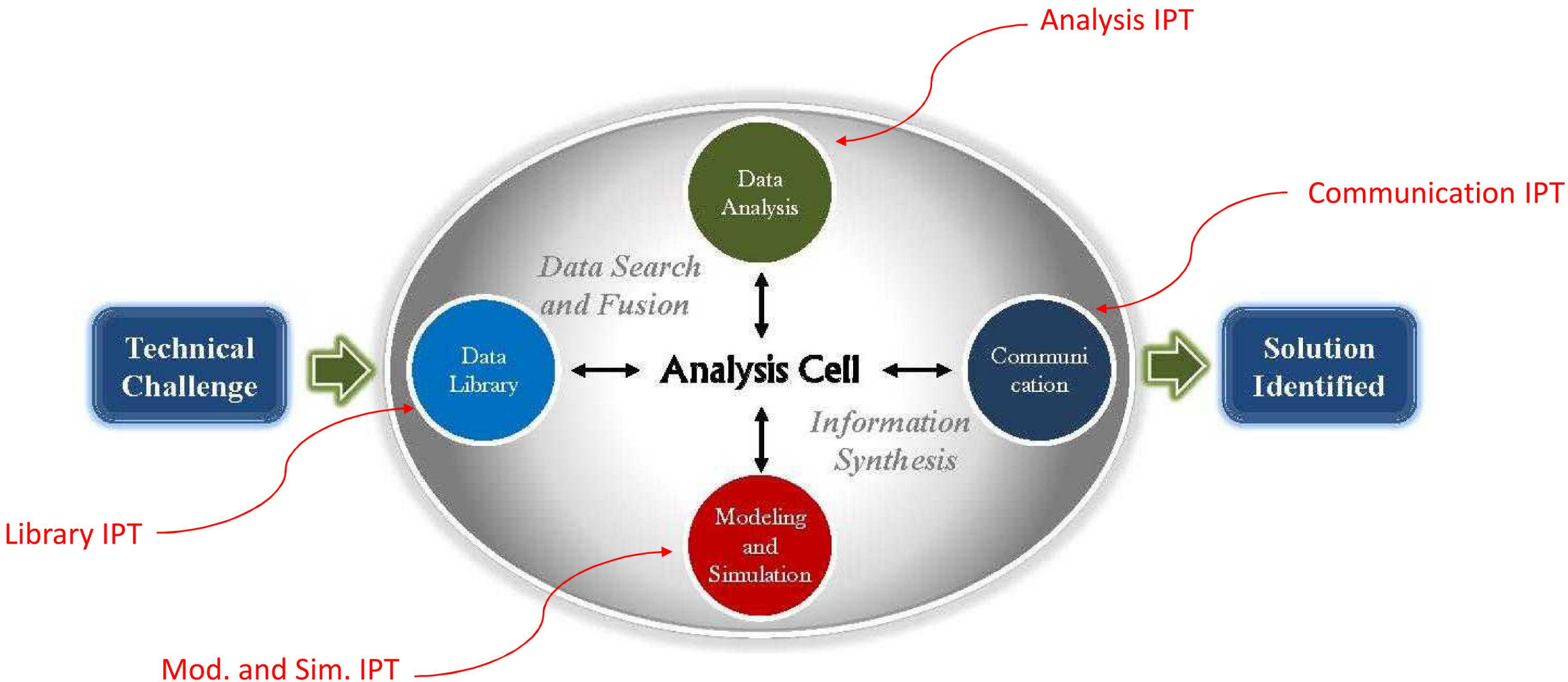
# What is the DMAMC?

**Data Mining, Analysis, and Modeling Cell:** A matrix organization comprised of subject matter experts from the radiation and nuclear detection community, who leverage access to existing test data, reports, models, analysis and communications tools to respond to scientific and technical questions posed by CWMD stakeholders.

# How does DMAMC Work?



# How does DMAMC Work?



# SNL-supported DMAMC tasks

DMAMC
Data Mining Analysis and Modeling Cell

- Management Integrated Product Team (IPT) member.
  - Sandia POC: Belkis Cabrera-Palmer
- **For Library IPT:**
  - **Lead the Characterization Catalog working group (also an Analysis IPT task)**
  - **Execute design and development of the Characterization Catalog Web Application.**
- For Analysis IPT:
  - Member of the SME* working group (currently inactive). *Subject Matter Expert
  - Available to respond to stakeholder inquires and requests for peer-review
- Proposals for long/short-term studies: goals, task breakdown and cost estimate.

# Chem/Bio mission?

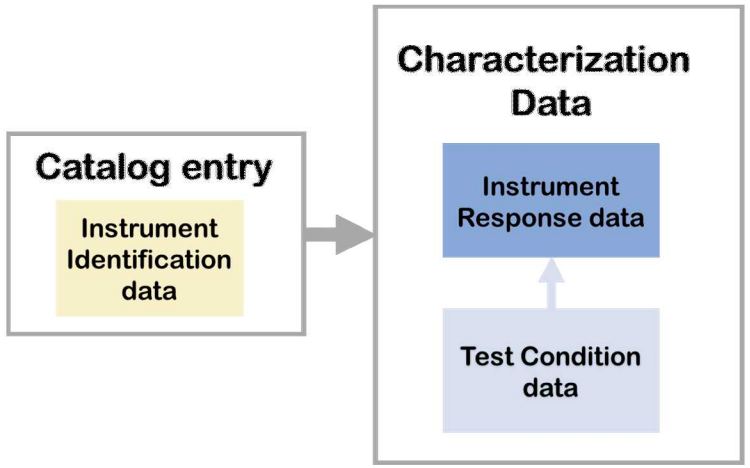
- Preparing to support DMAMC if/when expanding knowledge base into  Chem/Bio threat detection
- SNL Chem/Bio SMEs with strong expertise in:
  - Plume modeling
  - Bio testing
  - Bio aerosol science
  - Commercial bio-detection equipment survey
  - …?
- Currently, no scope in our task to cover Chem/Bio work.

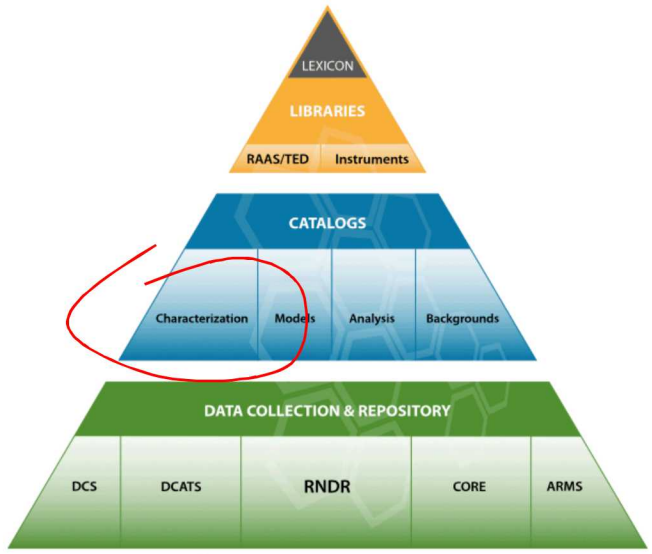
# Instrument Characterization Catalog "CharCat"

**Definition**: Online catalog containing characterization data of radiation detection instruments used and tested at CWMD test events.

The catalog contents are specific to each detector unit identified by serial number, and will include characterization data pertaining to Normalization Test Ground Truth detectors, Reference detectors and SUTs, collected during CWMD test events and projects, including legacy DNDO test events and projects.

As such, this catalog aims to support test scientists and analysts at CWMD and CWMD partner organizations.

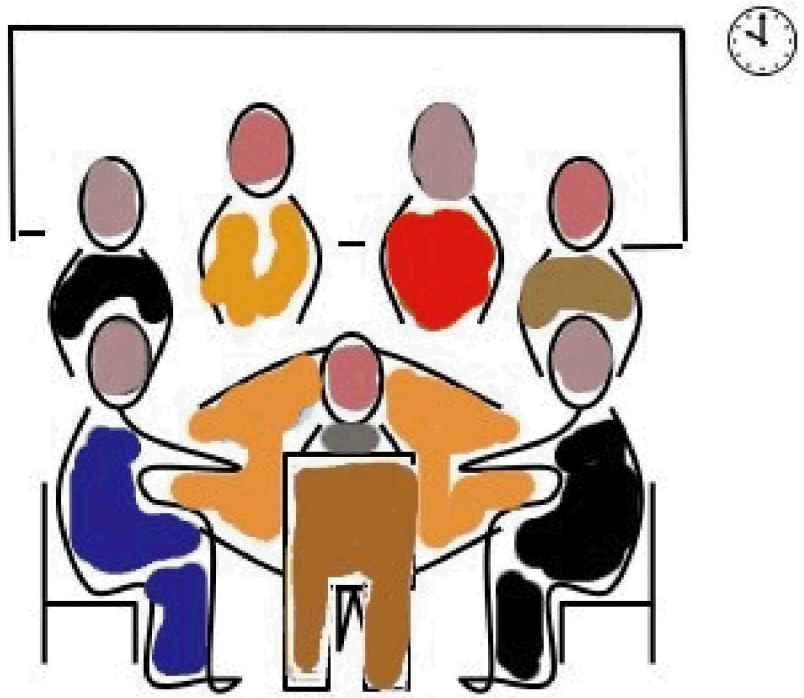


# CharCat multi-institutional Working Group

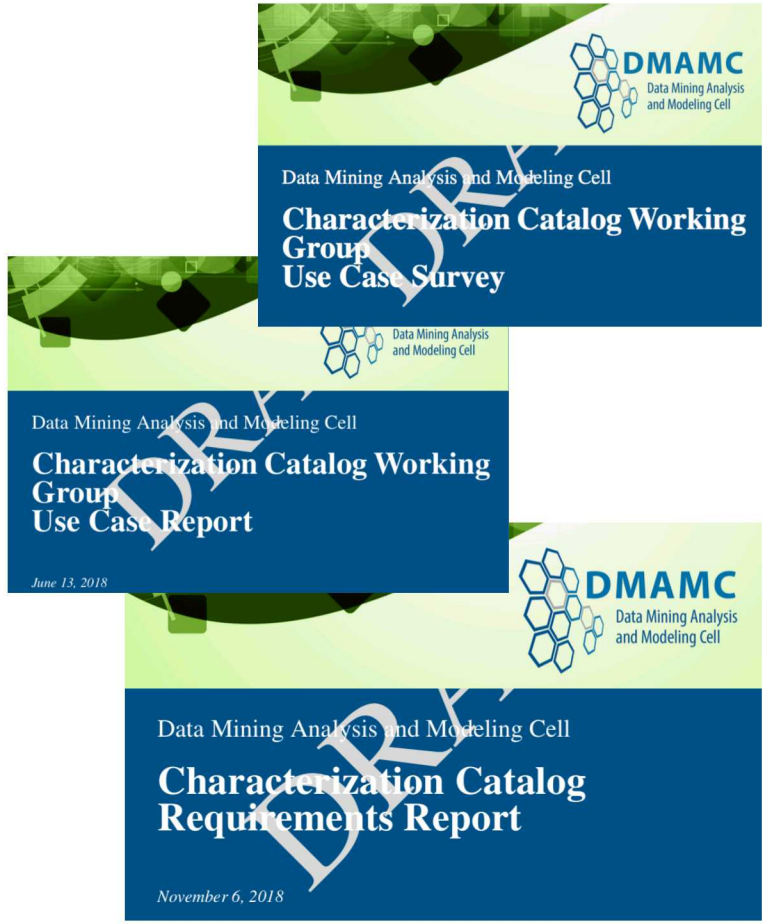
- Active from Jan 2018 to Sept 2019
- Members as of Sep 2019:

1. CWMD: Daniel Weidinger
2. NIST: Miles McCord
3. NRL: Lee Mitchell
4. PNNL: Emily Mace, Gariann Gelston, Heather Orr, Juan Barajas
5. **SNL (lead):** Development Team of 3 staff and 6 student interns



# CharCat Working Group products

- Use Case survey:
  - 8 written responses
  - 9 phone interviews
  - 1 CWMD Brown Bag
- Use Case Report submitted on June 2018.
- Requirements Report submitted on November 2018.
- Review and feedback on the CharCat prototype (2018) and application (2019) being developed by SNL.



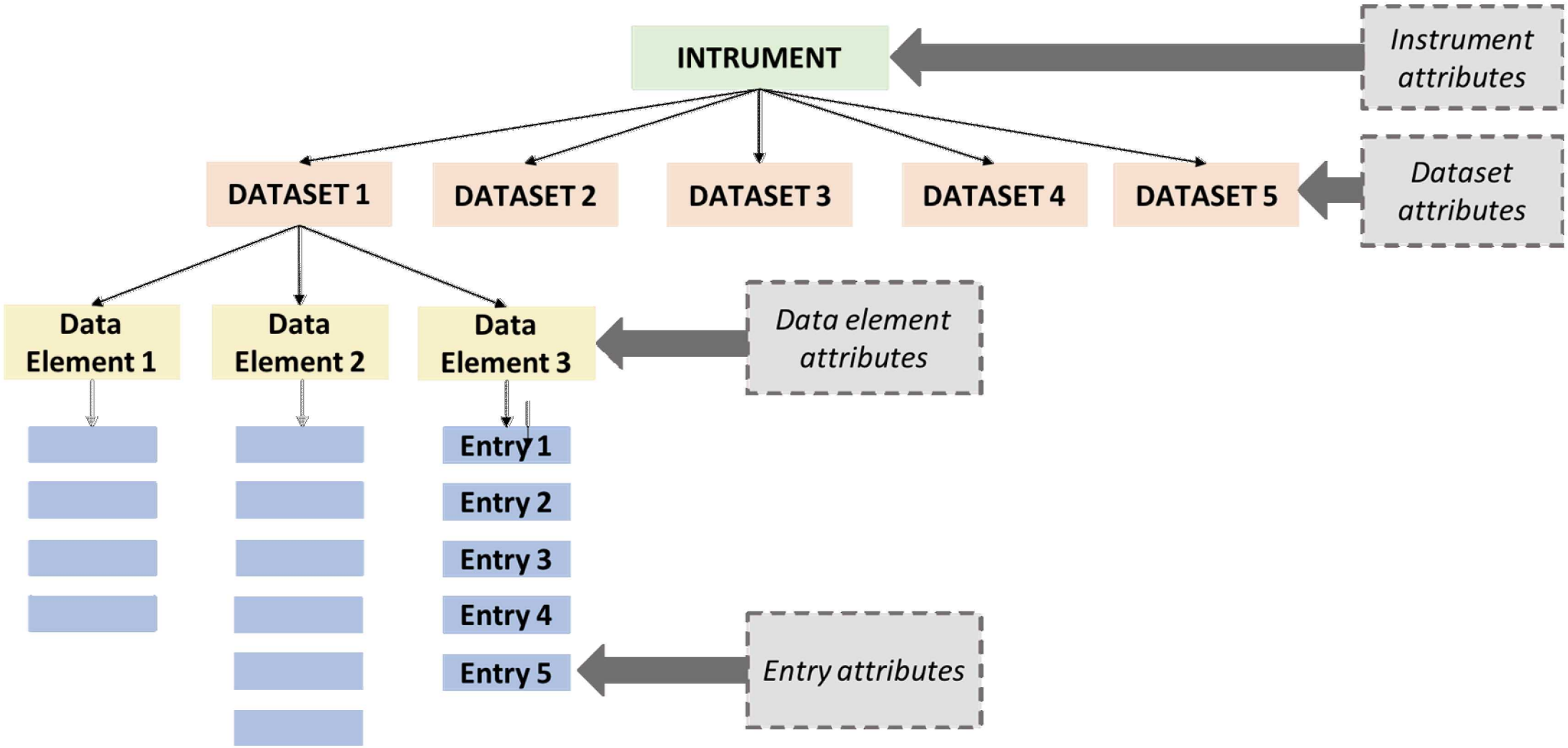
# SNL CharCat FY19 Development Team

- Full Application development activities started on Feb 2019
- Products completed by Oct 2019:
  - CharCat Application Package v1.0,
  - Users and Developer Guides

**Development Team members:**

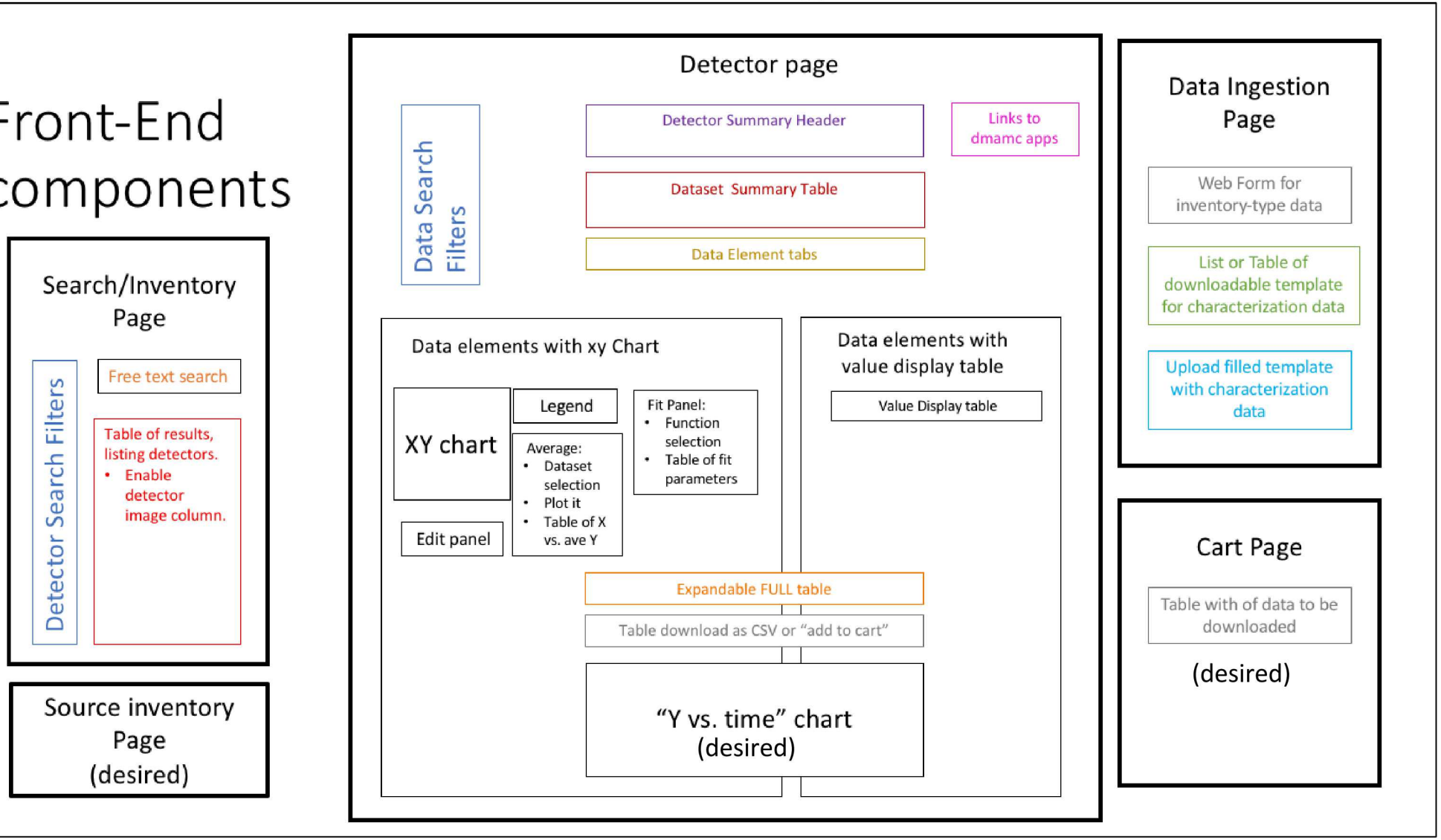
1. Belkis Cabrera-Palmer (PI)
2. Matthew Wong
3. Charlie Gieseler
4. Kousuke Tachida (intern)
5. Justin Cheon (intern)
6. Arthur Zhang (intern)
7. Boris Kudryavtsev (intern)
8. Marton Demeter (intern)
9. Adam Jensen (intern)

# CharCat Data Organization



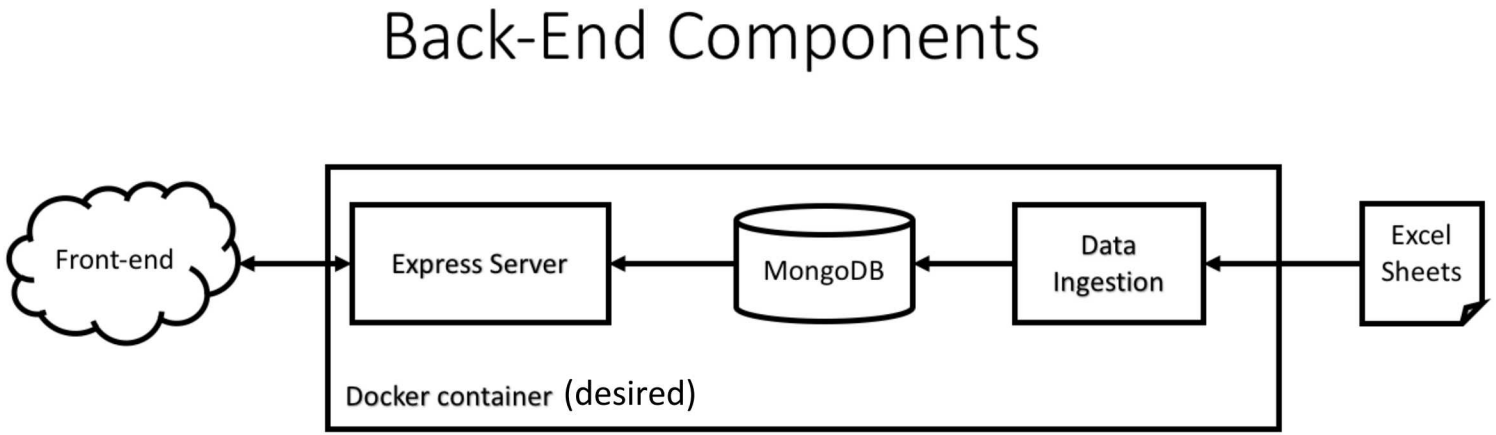
# CharCat Front-End Design

## Front-End components




By the end of FY19, most front-end components have been implemented.

# CharCat Back-End Design




- By the end FY19, most back-end components have been implemented.
- Currently hosted in a SNL externally facing server at https://hekili.ca.sandia.gov/dmamc/
- CharCat WG members have accounts and provided regular and direct feedback on newly developed features during development.

# CharCat development: Recommended Next Steps

Complete list in Section 4 of the User and Developer guide:

- **Expand content**: add Ion chamber page, add background page, add linkages to DMAMC catalogs.
- **Enhance functionality**: fix known issues or make existing functionality more robust.
- **Add Functionality**:
  - Enhance application cybersecurity and data protection
  - Track user activity, for example, file upload and removal.
  - Implement OAUTH for common login into DMAMC portal
  - Understanding requirements for future deployment. Ex: implement and test Docker container to facilitate delivery and deployment.
- **Test**

# Current CharCat Dev tasks

As of January 2020, green light to continue CharCat development activities.

We are assembling the development team to:

1. **Deploy and Maintain** CharCat_v1.0 “as is” at SNL Outrage (hekili) server.
2. **Security**: implement security recommendations for deployment at hekili
3. **User access level:** develop access control and activity tracking
4. **Testing and Stabilization**
5. **Inventory catalog expansion**: make inventory data ingestion more robust, implement backup.

# CharCat live demo.

https://hekili.ca.sandia.gov/dmamc/

# Backup slides if live demo does not work

Inventory search enabled by by free text typing and by filters.

# Instrument Characterization Catalog

Inventory

CLEAR FILTERS

Detector Class

Detector Type

Detector Subtype

- [ ] High sensitivity ion chamber
- [ ] BF3
- [ ] Coaxial HPGe
- [ ] He3
- [x] HPGe
- [ ] NaI

Manufacturer

- [ ] Reuter Stokes
- [ ] LANL
- [x] ORTEC
- [ ] Health Physics Instruments
- [ ] Ortec

Detector Use

Owner

SAVE CSV

Search

| Serial Number | Description | Use | Owner | Location | Number of Available Characterizations | Last Characterization | Test Participation | Last Test Participation | Last Known Operat |
|---|---|---|---|---|---|---|---|---|---|
| 51-TP50885A | Name: GEM100P4-108-HE-S<br>Manufacturer: ORTEC<br>Model: GEM100P4-108-HE-S<br>Type: Gamma / Coaxial HPGe<br>Class: Spectrometer | --- | NRL | --- | 1 | --- | --- | --- | --- |
| 50-TP50751A | Name: GEM100P4-108-HE-S<br>Manufacturer: ORTEC<br>Model: GEM100P4-108-HE-S<br>Type: Gamma / Coaxial HPGe<br>Class: Spectrometer | --- | NRL | --- | 1 | --- | --- | --- | --- |
| 51-TP32852A | Name: GEM100P4-108-HE-S<br>Manufacturer: ORTEC<br>Model: GEM100P4-108-HE-S<br>Type: Gamma / Coaxial HPGe<br>Class: Spectrometer | --- | NRL | --- | 1 | --- | --- | --- | --- |
| 121457818 | Name: IDM-200<br>Manufacturer: ORTEC<br>Model: IDM-200<br>Type: Gamma / HPGe<br>Class: Spectrometer | Reference Detector | ORNL | --- | --- | --- | 5 | Test name: RASE handheld<br>Date: 2015-11-01T07:00:00.000Z | --- |
| 52-TP51027A | Name: GEM100P4-108-HE-S<br>Manufacturer: ORTEC<br>Model: GEM100P4-108-HE-S<br>Type: Gamma / Coaxial HPGe<br>Class: Spectrometer | --- | NRL | --- | 1 | --- | --- | --- | --- |
| 52-TP50986A | Name: GEM100P4-108-HE-S<br>Manufacturer: ORTEC<br>Model: GEM100P4-108-HE-S<br>Type: Gamma / Coaxial HPGe<br>Class: Spectrometer | --- | NRL | --- | 1 | --- | --- | --- | --- |
| | Name: Micro-Detective HPGe<br>Manufacturer: ORTEC | | | | | | | | |

- Hovering over cell opens tool-tip with date of last update and person
- Enabled CSV file download of the whole table

# Instrument Characterization Catalog

Inventory

CLEAR FILTERS

Detector Class

Detector Type

Detector Subtype

Manufacturer

Detector Use

Owner

SAVE CSV

Search

| Serial Number | Description | Use | Owner | Location | Number of Available Characterizations | Last Characterization | Test Participation | Last Test |
|---|---|---|---|---|---|---|---|---|
| 10000254 | Name: Reuter Stokes Ion Chamber<br>Manufacturer: Reuter Stokes<br>Model: RS-S131-200-ER0000<br>Type: gamma / High sensitivity ion chamber<br>Class: Health Physics<br>Cooler Run hours: not applicable | Measure background at test events | ORNL | Current location: ORNL<br>Regular location: ORNL | --- | --- | 5 | Test nam<br>Date: 197 |
| 1 | Name: BF3 NRDS neutron detector<br>Manufacturer: LANL<br>Model: NRDS<br>Type: Neutron / BF3<br>Class: Coarse Neutron Spectrometer<br>Cooler Run hours: not applicable | Normlization Test Ground Truth; Reference Detector | LANL | Current location: not available<br>Regular location: LANL | 1 | Date: 2012<br>Scientist: Travis Grove, Cheslan Simpson<br>Scientist institution: LANL | Lots | Test nam |
| 2 | Name: BF3 NRDS neutron detector<br>Manufacturer: LANL<br>Model: NRDS<br>Type: Neutron / BF3<br>Class: Coarse Neutron Spectrometer<br>Cooler Run hours: not applicable | Normlization Test Ground Truth; Reference Detector | LANL | Current location: not available<br>Regular location: LANL | 1 | Date: 2012<br>Scientist: Travis Grove, Cheslan Simpson<br>Scientist institution: LANL | Lots | Test nam |
| 51-TP50885A | Name: GEM100P4-108-HE-S<br>Manufacturer: ORTEC<br>Model: GEM100P4-108-HE-S<br>Type: Gamma / Coaxial HPGe<br>Class: Spectrometer | --- | NRL | --- | 1 | --- | --- | --- |
| 585216 | Name: Meridian Neutron Survey Meter<br>Manufacturer: Health Physics Instruments<br>Model: 5085<br>Type: Neutron / He3<br>Class: Health Physics<br>Cooler Run hours: not applicable | Normlization Test Ground Truth | CWMD | --- | --- | --- | --- | --- |
| | Name: NRDS neutron detector | | | | | | | |

Updated on 5/3/2019 by David West

# Instrument Characterization Catalog

Inventory


**Micro-Detective HPGe, SN 103217545**

Use: Normlization Test Ground Truth
Manufacturer: ORTEC
Model: HPRDS3
Revision: 5085
Class: Spectrometer
Type: Gamma
Owner: CWMD

Report errors in data

- Click on an inventory detector opens the unit's characterization data page, showing:
  - Header with general detector information
  - Linkage to other DMAMC catalogs with related data
  - Table of available Characterization datasets
- Linkage to other DMAMC catalogs:
  - Instrument library with general detector specifications
  - ModCat if there is an existing model
  - RNDR for raw data
  - RAAS for related documents and reports
- User can select which dataset to inspect.
- Dataset table can be downloaded as csv file

DMAMC Linkages

- Backgrounds Catalog
- Report Analysis and Archive System (RAAS)
- Instrument Library
- Modcat
- Lexicon
- Characterization Catalog
- RNDR

Characterization Datasets

| Dataset Name | Measured data elements | Start Date | End Date | Measurement Location | Test Scientist Institution | Measurement Purpose | Test Event |
|---|---|---|---|---|---|---|---|
| 2016/07/28, Routine | Absolute Peak Efficiency | 7/28/2016 | 7/29/2016 | NIST | NIST | Routine characterization | --- |
| 2016/08/01, pre-ERNIE | Absolute Peak Efficiency | 8/1/2016 | 8/1/2016 | NIST | NIST | Normalization Test, ERNIE | 2016/08/10 ERNIE |
| 2016/08/15, post-ERNIE | Absolute Peak Efficiency | 8/15/2016 | 8/15/2016 | NIST | NIST | Normalization Test, ERNIE | 2016/08/10 ERNIE |
| 2016/07/29, Routine background | Background spectrum | 7/29/2016 | 7/29/2016 | NIST | NIST | Routine characterization | --- |
| 2016/08/02, pre-ERNIE background | Background spectrum | 8/2/2016 | 8/2/2016 | NIST | NIST | Normalization Test, ERNIE | 2016/08/10 ERNIE |
| 2016/08/15, post-ERNIE background | Background spectrum | 8/15/2016 | 8/15/2016 | Virginia International Gateway (VIG) Port of Virginia | NIST | Normalization Test, ERNIE | 2016/08/10 ERNIE |
| 2016/07/28, Routine 1 | Absolute Peak Efficiency | 2/6/2017 | 2/6/2017 | NIST | NIST | Routine characterization | --- |

SAVE CSV

- The displayed data elements depend on the dataset. In this example, all the selected datasets report Absolute Peak Efficiency.
- Plot displaying Efficiency vs. Energy values of all selected datasets
- User can further select which dataset to plot.
- Plot formatting: zoom in and out, display x and y grid, display error bars, draw connecting line.

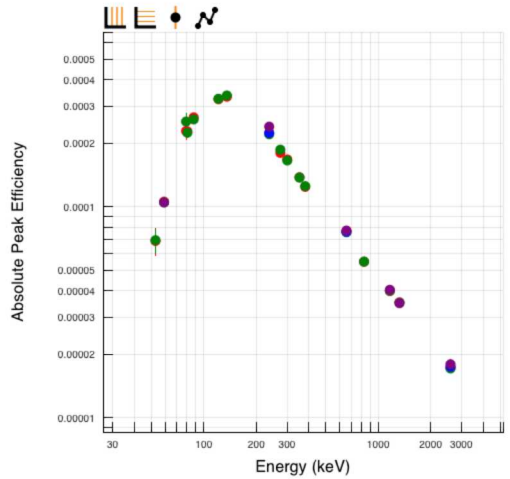
Test Case Filters

- Test Event
- Dataset Date
- Radionuclide
- Source ID
- Location
- Weather
- Distance

Measured Data Elements

Absolute Peak Efficiency

Absolute peak efficiency ($\epsilon_{abs\ peak}$):
Number of pulses recorded within the full energy peak area of the spectrum divided by the number of radiation quanta emitted by the source.




Fit Panel

Type: $p_0 + \ldots + p_n x^n$ Distance: All

X Axis: Log Y Axis: Log

Degree: 5

UPDATE | FIT | RESET

Average of selected datasets

| Data Legend | Marker | Source Detector distance (cm) |
|---|---|---|
| 2016/07/28, Routine | | 50 |
| 2016/08/01, pre-ERNIE | | 50 |
| 2016/08/15, post-ERNIE | | 50 |
| 2016/07/28, Routine 1 | | 50 |

- Fit panel with several available functions
- Fit selected datasets
- Table displaying fit coefficient values and errors.
- Evaluated fit function also plotted.
- Axis can be fitted in log or linear scale.
- User gets a warning when fitting datasets with different detector-source distance (important for Absolute Peak efficiency data).

Test Case Filters

Test Event

Dataset Date

Radionuclide

Source ID

Location

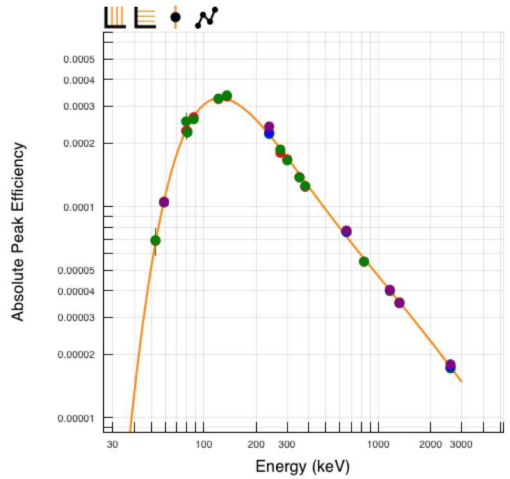
Weather

Distance

Measured Data Elements

Absolute Peak Efficiency

Absolute peak efficiency ($\epsilon_{abs\ peak}$):
Number of pulses recorded within the full energy peak area of the spectrum divided by the number of radiation quanta emitted by the source.




Fit Panel

Type: $p_0 + ... + p_n x^n$ Distance: All

X Axis: Log Y Axis: Log

Degree: 5

UPDATE | FIT | RESET

| Coefficients | Values | Errors |
|---|---|---|
| $p_0$ | -121.21 | 1.410574e+1 |
| $p_1$ | 203.5908 | 2.913759e+1 |
| $p_2$ | -138.4822 | 2.375327e+1 |
| $p_3$ | 46.50743 | 9.551872e+0 |
| $p_4$ | -7.75336 | 1.894907e+0 |
| $p_5$ | 0.5134636 | 1.483921e-1 |

Average of selected datasets

| Data Legend | Marker | Source Detector distance (cm) |
|---|---|---|
| 2016/07/28, Routine | | 50 |
| 2016/08/01, pre-ERNIE | | 50 |
| 2016/08/15, post-ERNIE | | 50 |
| 2016/07/28, Routine 1 | | 50 |

Round values

- Table displaying average of selected dataset
- Average values also display (orange diamonds with black border)
- If data errors are provided, they are considered in the average calculation.

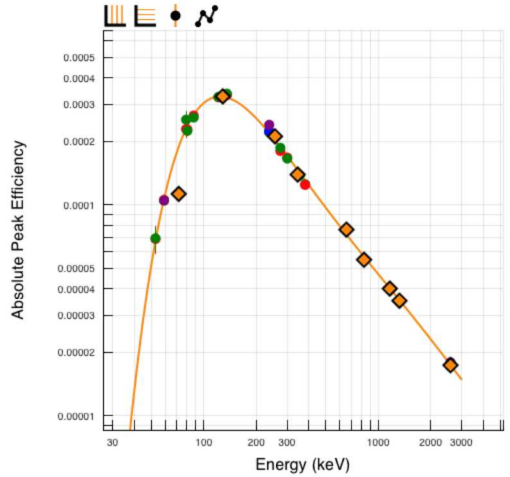
Test Case Filters

- Test Event
- Dataset Date
- Radionuclide
- Source ID
- Location
- Weather
- Distance

Measured Data Elements

Absolute Peak Efficiency

Absolute peak efficiency ($\epsilon_{abs\ peak}$):
Number of pulses recorded within the full energy peak area of the spectrum divided by the number of radiation quanta emitted by the source.




Fit Panel

Type: $p_0 + ... + p_n x^n$ Distance: All

X Axis: Log Y Axis: Log

Degree: 5

| UPDATE | FIT | RESET |
|---|---|---|

| Coefficients | Values | Errors |
|---|---|---|
| $p_0$ | -121.21 | 1.410574e+1 |
| $p_1$ | 203.5908 | 2.913759e+1 |
| $p_2$ | -138.4822 | 2.375327e+1 |
| $p_3$ | 46.50743 | 9.551872e+0 |
| $p_4$ | -7.75336 | 1.894907e+0 |
| $p_5$ | 0.5134636 | 1.483921e-1 |

Average of selected datasets

Round values

| Energy (keV)† | Energy Error† | AbsolutePeakEfficiency () | AbsolutePeakEfficiency Error |
|---|---|---|---|
| 72.26976 | 15.047779 | 0.000112 | 8.136e-7 |
| 129.267105 | 10.191466 | 0.000325 | 3.276e-6 |
| 257.51545 | 26.705231 | 0.00021 | 3.878e-6 |
| 347.570733 | 41.153487 | 0.000139 | 2.891e-6 |

† Individual measurement errors not used in calculation.

| Data Legend | Marker | Source Detector distance (cm) |
|---|---|---|
| 2016/07/28, Routine | | 50 |
| 2016/08/01, pre-ERNIE | | 50 |
| 2016/08/15, post-ERNIE | | 50 |
| 2016/07/28, Routine 1 | | 50 |

- Test case filters to further select data
- Plot, average and fits are updated according to new selection
- Hovering over plotted data point shows tool-tip with test case data

Test Case Filters

Test Event

Dataset Date

Radionuclide

- [ ] Am241 (3)
- [x] Ba133 (14)
- [ ] Cd-109 (2)
- [ ] Co57 (4)
- [ ] Co60 (6)
- [ ] Cs137 (4)
- [ ] Mn-54 (2)
- [ ] U232 (8)

Source ID

Location

Weather

Distance

Measured Data Elements

Absolute Peak Efficiency

Absolute peak efficiency ($\epsilon_{abs\ peak}$):
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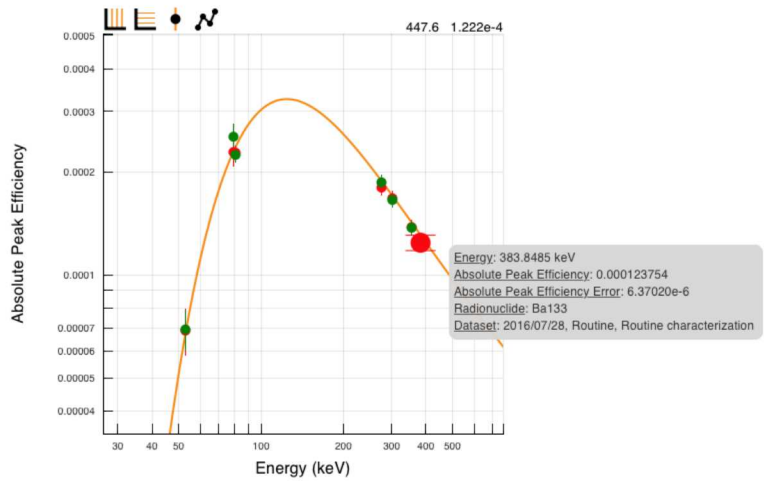


Fit Panel

Type: $p_0 + \ldots + p_n x^n$ Distance: All

X Axis: Log Y Axis: Log

Degree: 5

UPDATE | FIT | RESET

| Coefficients | Values | Errors |
|---|---|---|
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Average of selected datasets

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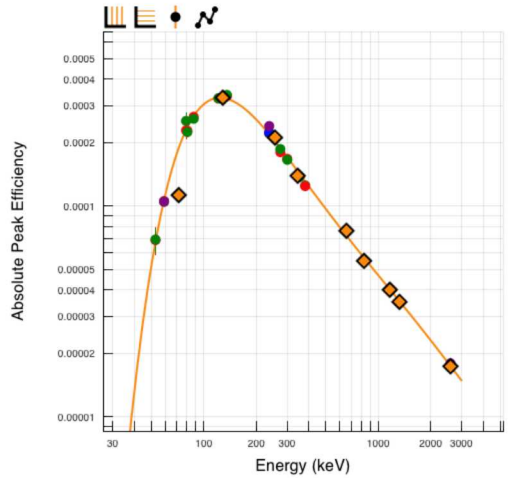
|---|---|---|
| 2016/07/28, Routine | | 50 |
| 2016/08/01, pre-ERNIE | | 50 |
| 2016/08/15, post-ERNIE | | --- |
| 2016/07/28, Routine 1 | | --- |

Weather

Distance




Fit Panel

Type: $p_0 + \ldots + p_n x^n$ Distance: All

X Axis: Log Y Axis: Log

Degree: 5

| UPDATE | FIT | RESET |
|---|---|---|

| Coefficients | Values | Errors |
|---|---|---|
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Average of selected datasets

Round values

| Energy (keV)† | Energy Error† | AbsolutePeakEfficiency () | AbsolutePeakEfficiency Error |
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| 2016/08/01, pre-ERNIE | | 50 |
| 2016/08/15, post-ERNIE | | 50 |
| 2016/07/28, Routine 1 | | 50 |

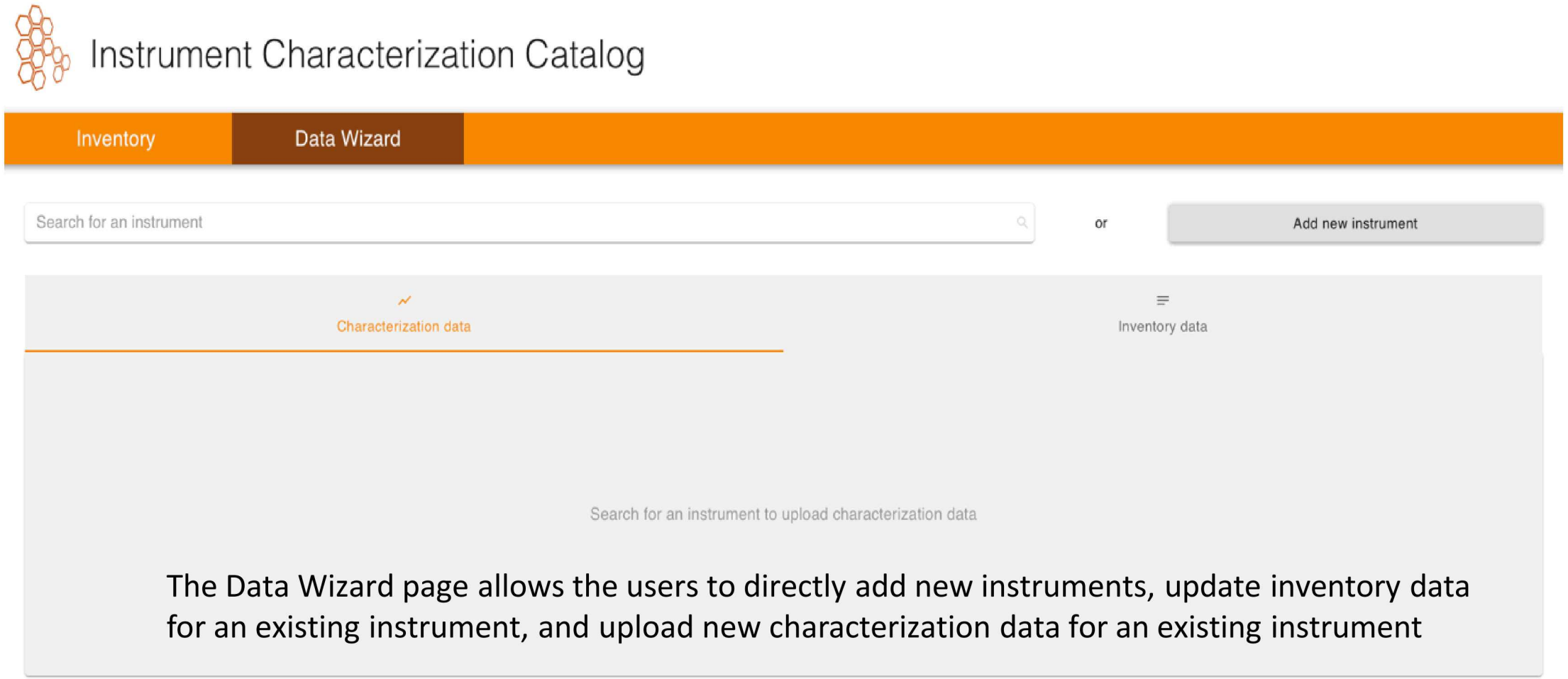
Round values

| Dataset | Energy | Absolute Peak Efficiency | Absolute Peak Efficiency Uncertainty | Source ID/Serial number | Radionuclide | Net Peak Counts | Net Peak Counts Uncertainty | Life |
|---|---|---|---|---|---|---|---|---|
| 2016/07/28, Routine, Routine characterization | 53.1622 | 0.000069 | 0.000011 | 133-A | Ba133 | 1029.04 | 149.2108 | 2 |
| 2016/07/28, Routine, Routine characterization | 79.6142 | 0.000228 | 0.000021 | 133-A | Ba133 | 5141.88 | 105.922728 | 2 |
| 2016/07/28, Routine, Routine characterization | 80.9979 | 0.000227 | 0.000012 | 133-A | Ba133 | 65162.36 | 273.681912 | 2 |
| 2016/07/28, Routine, Routine characterization | 276.3989 | 0.000179 | 9.296e-6 | 133-A | Ba133 | 12099.33 | 130.672764 | 2 |
| 2016/07/28, Routine, Routine characterization | 302.8508 | 0.000167 | 8.460e-6 | 133-A | Ba133 | 28938.77 | 173.63262 | 2 |
| 2016/07/28, Routine, Routine characterization | 356.0129 | 0.000137 | 6.901e-6 | 133-A | Ba133 | 80939.31 | 283.287585 | 2 |
| 2016/07/28, Routine, Routine characterization | 383.8485 | 0.000124 | 6.370e-6 | 133-A | Ba133 | 10509.42 | 107.196084 | 2 |

SAVE CSV

- Full data table displayed at the bottom of each detector page
- Download as CSV file
- Toggle to display rounded or unrounded values.

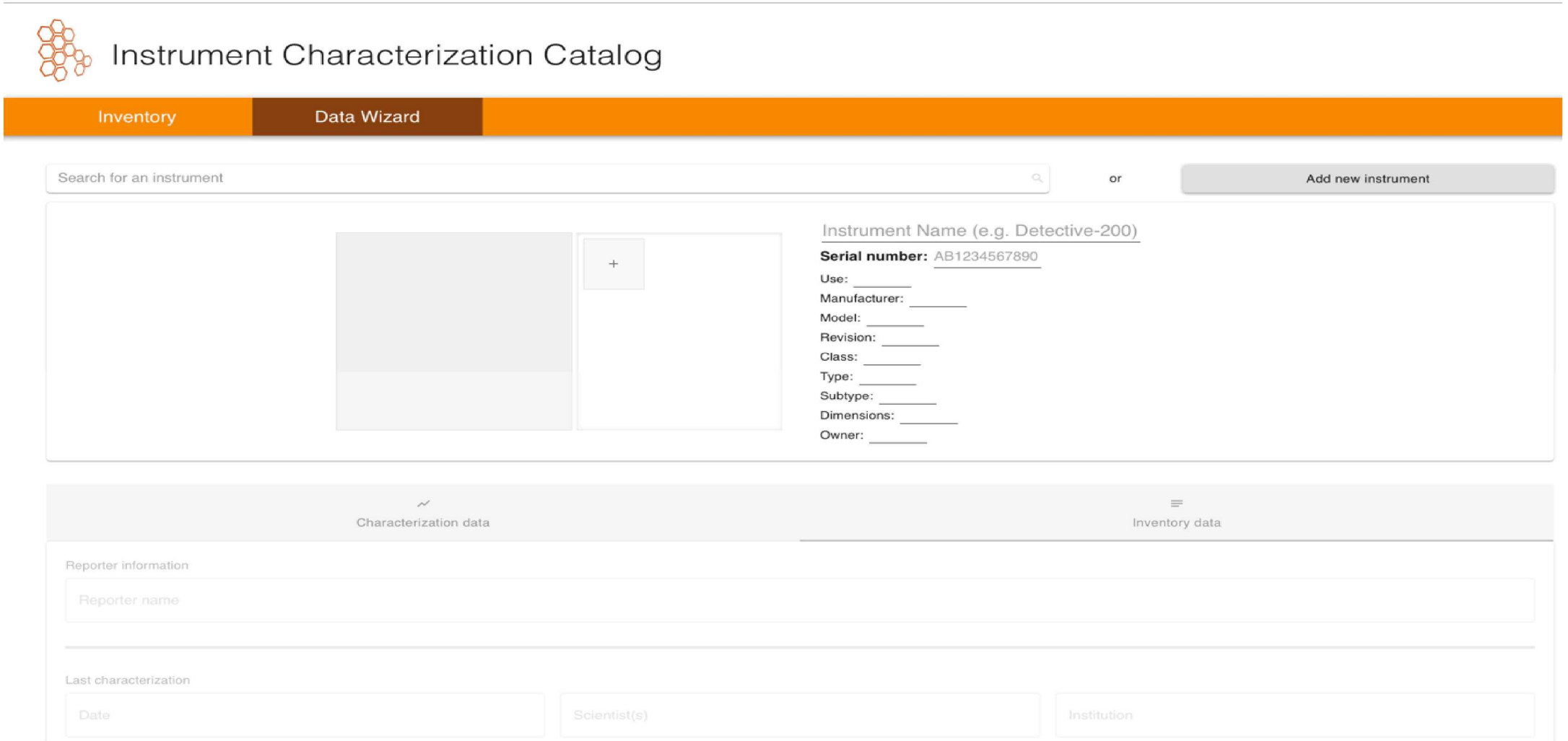
The Data Wizard page allows the users to directly add new instruments, update inventory data for an existing instrument, and upload new characterization data for an existing instrument.




The Data Wizard page allows the users to directly add new instruments, update inventory data for an existing instrument, and upload new characterization data for an existing instrument

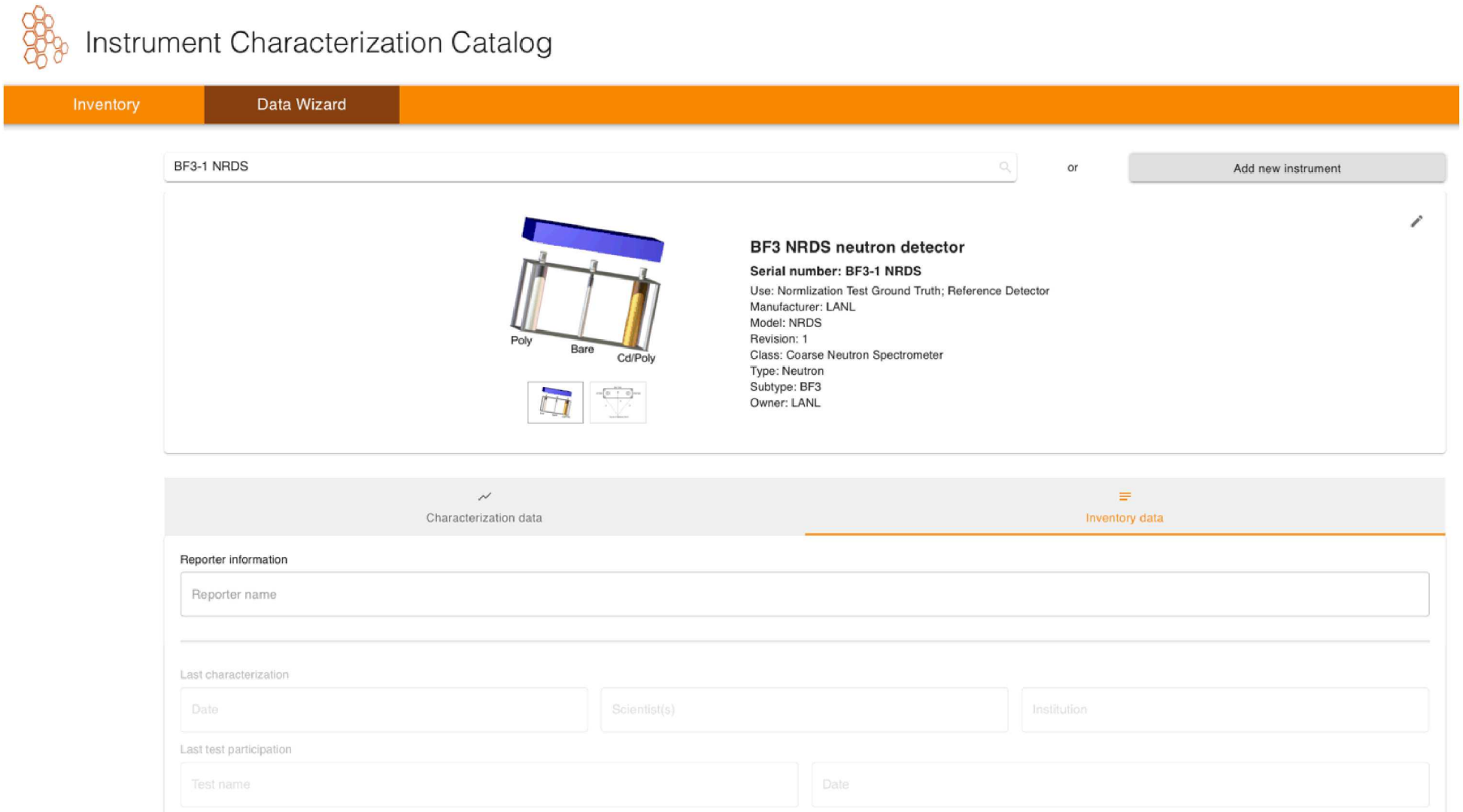
New instruments can be added by clicking on “Add new instrument”. A fillable web form opens for the user to enter new instrument information, where:

- Instrument name and serial number are required fields,
- Instrument image files can be added by folder browsing or drag-and-drop



To update inventory data of an existing instrument, search for the instrument, and click on the “Inventory data” tab:

- Enter the updated inventory data and click “Submit” at the bottom of the page.
- The inventory data table should contain the updated data.
- The inventory log in the instrument page should have one more entry corresponding to this update.



To add characterization data of an existing instrument, search for the instrument, and click on the "Characterization data" tab. The user has to follow two steps:

- Download the current Excel template corresponding to the specific instrument
- Upload the Excel template filled with the new data, either by browsing or by drag-and-drop