

# Materials Data Curation System

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Information Technology Laboratory

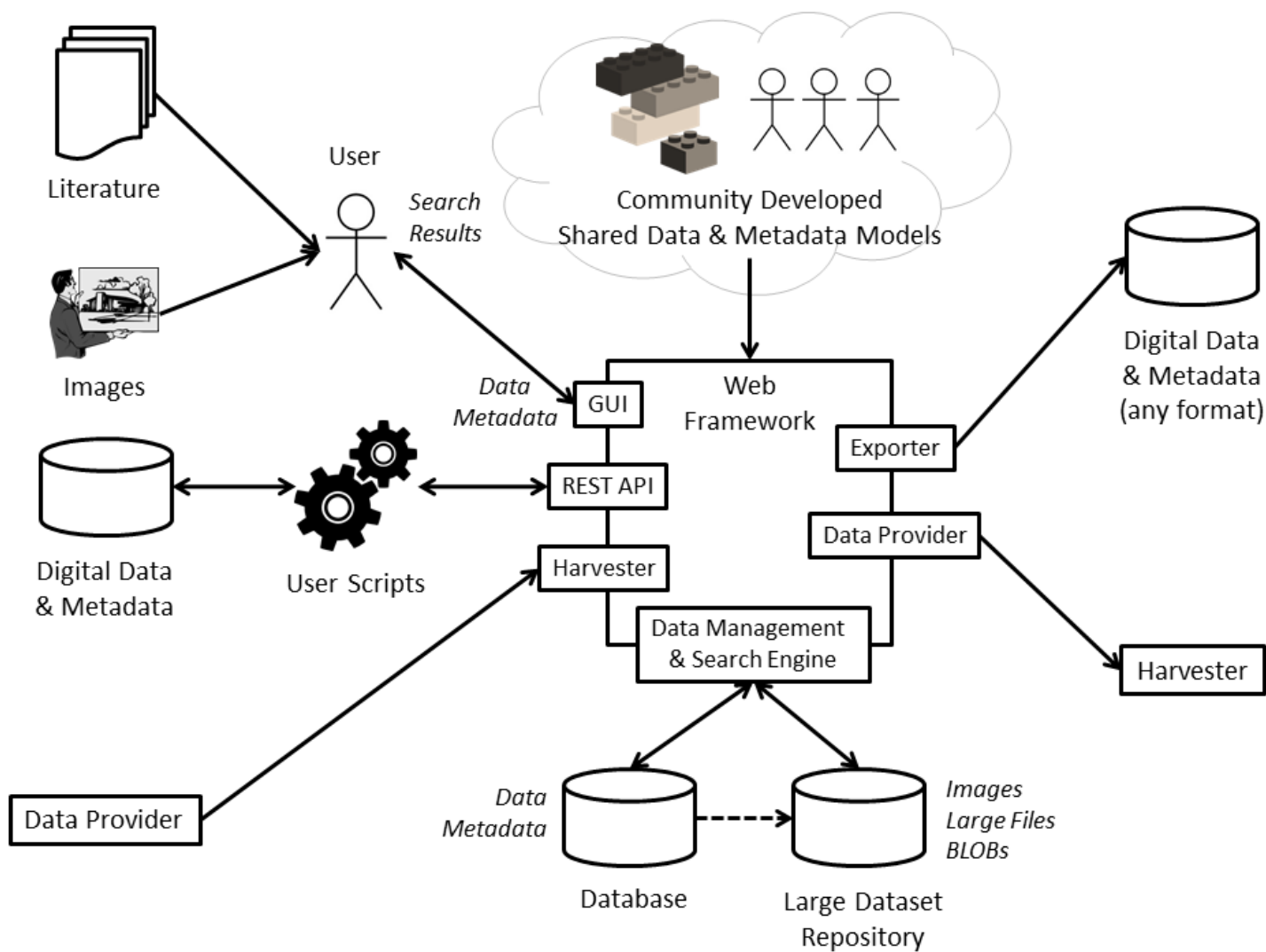
National Institute of Standards and Technology (NIST)

# Materials Data Curation System

## Components and Features:

- Data Curation (data markup)
- Data Exploration (search)
- Composer (Template builder)
- Exporter (any output desired)
- Module System (Rich GUI Widgets)
- RESTful Application Program Interface (API)
- Administrative Dashboard (for admins)
- New Features (1.4 release)

# Materials Data Curation System



# Data Curation

Sample 3?

Summer Undergraduate Researcher



<http://www.jeolusa.com>

• quantity-unit mole fraction

• composition

Select Elements

Element	Quantity
Ni	.75
Al	.25

• quantity-unit mole fraction

• composition

Select Elements

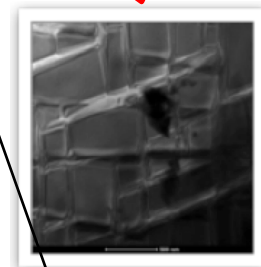
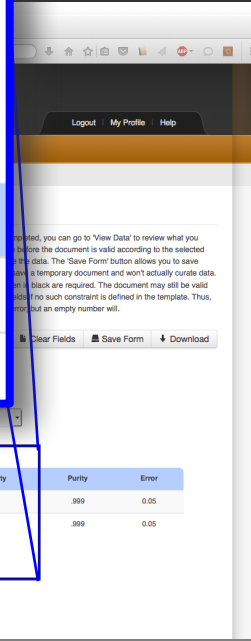
Element	Quantity	Purity	Error
Ni	.75	.999	0.05
Al	.25	.999	0.05

• transmission-electron-microscopy

• sample-id

• user-id

• acquisition-date-time



Sample-3.jpg



# Data Curation

## Three Steps to Curate

### 1. Select Template

- Global Templates
- User Defined Templates

### 2. Enter Data

- HTML Generated
- Based on Template

### 3. View Data

- Requires Validation
- Download in XML Format
- Can save to Repository

The screenshot displays the 'Materials Data Curation System' interface. At the top, it says 'Welcome, admin. Thanks for logging in.' and includes links for 'Logout', 'My Profile', and 'Help'. The main navigation bar contains 'Home', 'Data Curation', 'Data Exploration', and 'Composer'. Below this, there are sub-navigation links: 'Select Template', 'Enter Data', and 'View Data'. The 'Data Curation' sidebar on the left has three items: '1 Select Template' (highlighted), '2 Enter Data', and '3 View Data'. The main content area is titled 'Select Template' and contains a message: 'Select a template from the following table. Once you make your selection, click on "Enter Data" to proceed. It will automatically load the appropriate form and display it on the next page.' Below this is a yellow warning box: 'No template selected. Select one in the table below.' The interface is divided into two sections: 'Global Templates' and 'User Defined Templates'. Each section contains a table with columns for 'Template name', 'File name', and 'Actions'. The 'Global Templates' table lists: Demo-Diffusion (demo.diffusion.xsd), Choice (\_choice.xsd), Restriction (\_restriction.xsd), and Basic-Schema (\_basic\_schema.xsd). The 'User Defined Templates' table lists: My Template. Each row in both tables has a 'Set as current template' button.

Template name	File name	Actions
Demo-Diffusion	demo.diffusion.xsd	Set as current template
Choice	_choice.xsd	Set as current template
Restriction	_restriction.xsd	Set as current template
Basic-Schema	_basic_schema.xsd	Set as current template

Template name	Actions
My Template	Set as current template

# Data Curation

## Three Steps to Curate

### 1. Select Template

- Global Templates
- User Defined Templates

### 2. Enter Data

- HTML Generated
- Based on Template

### 3. View Data

- Requires Validation
- Download in XML Format
- Can save to Repository

The screenshot displays the 'Materials Data Curation System' interface. At the top, there is a navigation bar with 'Home', 'Data Curation', 'Data Exploration', and 'Composer'. Below this is a sub-navigation bar with 'Select Template', 'Enter Data', and 'View Data'. The main content area is titled 'Data Entry' and contains a form for entering material data. The form is organized into a tree structure with expandable sections:

- experiment**
  - experimentType**
    - Choose:
  - tracerDiffusivity**
    - material**
      - materialName:
    - phase**
      - name:
    - crystalStructure**
      - spaceGroup:
      - symbolOrNumber:
      - wyckoffSequence:
      - sequence:
  - Composition**
    - quantityUnit:
    - constituents:
    - materialForm**
      - Choose:
      - singleCrystalline
        - diffusingSpecies
          - element:
  - materialPurity:

At the top of the form, there are buttons for 'Clear fields', 'Load form', 'Save form', and 'Download'. The current selection is 'None'.

# Data Curation

## Three Steps to Curate

### 1. Select Template

- Global Templates
- User Defined Templates

### 2. Enter Data

- HTML Generated
- Based on Template

### 3. View Data

- Requires Validation
- Download in XML Format
- Can save to Repository

> One step when using REST API

The screenshot displays the 'Materials Data Curation System' interface. The top navigation bar includes 'Home', 'Data Curation', 'Data Exploration', and 'Composer'. A secondary bar shows 'Select Template', 'Enter Data', and 'View Data'. The 'View Data' step is active, showing a sidebar with three numbered steps: 1. Select Template, 2. Enter Data, and 3. View Data. The main content area displays a preview of curated data in XML format, with a message: 'This is a preview of the curated data in XML format. As part of this demo, please save your data to the repository so that we can better evaluate our system. You can also click the download button for a copy on your local machine.' Below the message are two buttons: 'Download XML' and 'Save to repository'. The XML data is structured as follows:

```
experiment
├── experimentType
│   └── tracerDiffusivity
│       ├── material
│       │   ├── materialName : Aluminum
│       │   └── phase
│       │       ├── name : FCC
│       │       └── crystalStructure :
│       └── Composition
│           ├── quantityUnit : mass percent
│           └── constituents
│               ├── constituent
│               │   ├── element : Mg
│               │   ├── quantity : 0.31
│               │   ├── purity : 0.8
│               │   └── error : 0.005
│               └── constituent
│                   ├── element : Al
│                   ├── quantity : 0.25
│                   ├── purity : 0.5
│                   └── error : 0.005
└── materialForm
    └── singleCrystalline :
```

# Data Exploration

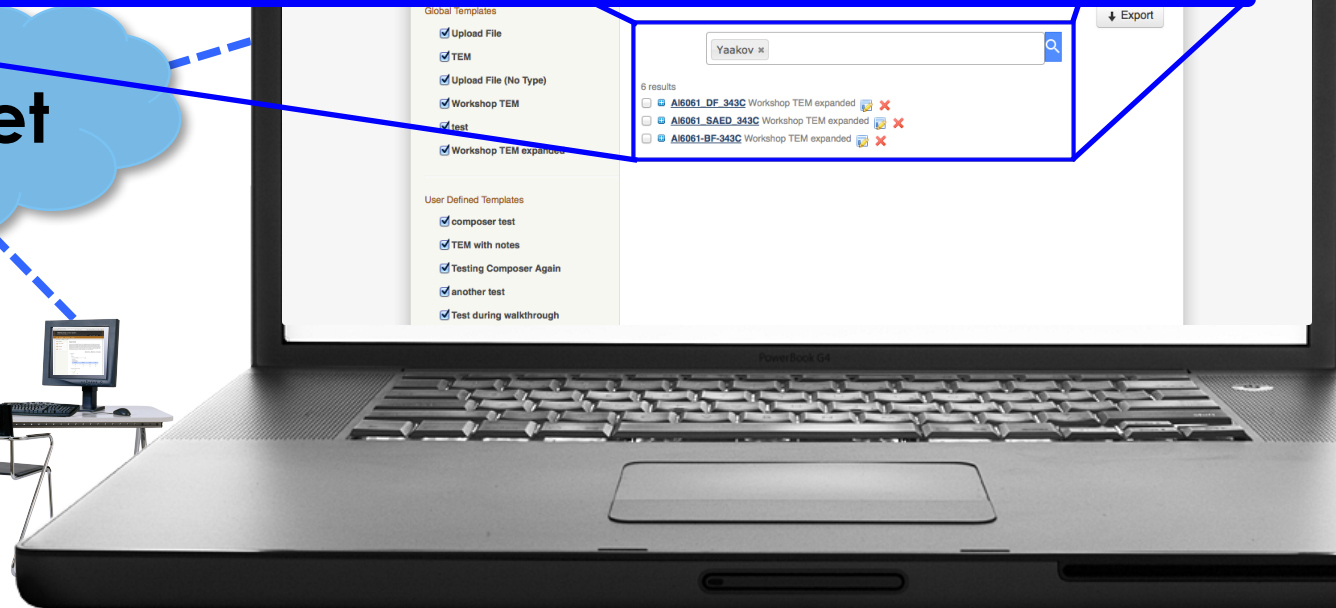
Yaakov ✕



3 results

- AI6061 DF 343C Workshop TEM expanded
- AI6061 SAED 343C Workshop TEM expanded
- AI6061-BF-343C Workshop TEM expanded

Intranet





# Data Exploration

## Three Steps to Explore:

1. Select Template
  - ▣ Global Templates
  - ▣ User Defined Templates
2. Select Fields
  - ▣ Specific fields to search against
3. Perform Search
  - ▣ Query By Example
  - ▣ Search by Keyword

The screenshot displays the 'Materials Data Curation System' interface. The page title is 'Materials Data Curation System' with a welcome message for 'admin'. The navigation bar includes 'Home', 'Data Curation', 'Data Exploration', and 'Composer'. The 'Data Exploration' section is active, showing a sidebar with three steps: '1. Select Template', '2. Select Fields', and '3. Perform Search'. The main content area is titled 'Select Template' and contains instructions: 'Select a template from the following table. Once you make your selection, click on "Select Fields" to proceed. It will automatically load the appropriate form and display it on the next page.' Below the instructions, there are two sections: 'Global Templates' and 'User Defined Templates'. The 'Global Templates' section contains a table with columns for 'Template name', 'File name', and 'Actions'. The 'User Defined Templates' section contains a table with columns for 'Template name' and 'Actions'.

Materials Data Curation System  
Welcome, admin. Thanks for logging in.

Logout My Profile Help

Home Data Curation Data Exploration Composer

Select Template Select Fields Perform Search

Data Exploration

Query by Example SPARQL Endpoint

1 Select Template

2 Select Fields

3 Perform Search

### Select Template

Select a template from the following table. Once you make your selection, click on "Select Fields" to proceed. It will automatically load the appropriate form and display it on the next page.

#### Global Templates

Template name	File name	Actions
Demo-Diffusion	demo.diffusion.xsd	Current template
Choice	_choice.xsd	Set as current template
Restriction	_restriction.xsd	Set as current template
Basic-Schema	_basic_schema.xsd	Set as current template

#### User Defined Templates

Template name	Actions
My Template	Set as current template

Home Data Curation Data Exploration Composer Contact Top ^

# Data Exploration

## Three Steps to Explore:

1. Select Template
  - ▣ Global Templates
  - ▣ User Defined Templates
2. Select Fields
  - ▣ Specific fields to search against
3. Perform Search
  - ▣ Query By Example
  - ▣ Search by Keyword

The screenshot displays the 'Materials Data Curation System' interface. At the top, there is a navigation bar with 'Home', 'Data Curation', 'Data Exploration', and 'Composer'. Below this, a secondary navigation bar shows 'Select Template', 'Select Fields', and 'Perform Search'. The main content area is titled 'Data Exploration' and 'Select Fields'. On the left, a 'Query by Example' sidebar contains three steps: '1. Select Template', '2. Select Fields' (which is highlighted), and '3. Perform Search'. The 'Select Fields' main area includes instructions: 'Select the fields that you want to use in your query by clicking on the checkboxes. Only the checked fields will be available in the query screen. When you are done, please click on Perform Search to access the Query Builder.' A 'Clear fields' button is located in the top right. The field selection tree is as follows: 'experiment' (expanded) contains 'experimentType' (expanded) with a 'Choose' dropdown set to 'tracerDiffusivity'; 'tracerDiffusivity' (expanded) contains 'material' (expanded) with 'materialName' checked, and 'phase' (expanded) with 'name', 'crystalStructure', 'spaceGroup', 'symbolOrNumber', 'wyckoffSequence', and 'sequence' unchecked; 'Composition' (expanded) contains 'quantityUnit', 'constituents' (expanded) with 'constituent' (expanded) containing 'element', 'quantity', 'purity', and 'error' all unchecked.

# Data Exploration

## Three Steps to Explore:

1. Select Template
  - ▣ Global Templates
  - ▣ User Defined Templates
2. Select Fields
  - ▣ Specific fields to search against
3. Perform Search
  - ▣ Query By Example
  - ▣ Search by Keyword

The screenshot displays the Materials Data Curation System interface. The page title is "Materials Data Curation System" with a welcome message for "admin". The navigation bar includes "Home", "Data Curation", "Data Exploration", and "Composer". The "Data Exploration" section is active, showing a "Perform Search" button and a "Query Builder" section. The "Query Builder" section contains a query: "materialName is Aluminum" and "AND quantity < 5". Below the query builder is a "Saved Queries" section with a "Delete All" button and a table of saved queries.

Materials Data Curation System  
Welcome, admin. Thanks for logging in.

Logout | My Profile | Help

Home | Data Curation | Data Exploration | Composer

Select Template | Select Fields | Perform Search

### Data Exploration

Query by Example | SPARQL Endpoint

1 Select Template

2 Select Fields

3 Perform Search

### Perform Search

Click on a field of the Query Builder to add an element to your query. The custom tree defined in Step 2 will appear and you will be able to select one of the highlighted elements. Click on plus/minus icons to add/remove criteria. You can save queries to build more complex queries and you will retrieve them on your next connection. When your query is done, please click on Submit Query to get XML documents that match the criterias.

### Query Builder

materialName is Aluminum

AND quantity < 5

Save Query | Clear | Submit Query

### Saved Queries

Delete All

Add to Builder	Queries	Delete
↑	materialName is Aluminum	×
↑	element is Al	×
↑	quantity < 5	×
↑	(materialName is Aluminum AND quantity < 5)	×

Home | Data Curation | Data Exploration | Composer | Contact

Top ^

# Composer

## Begin with Types

### Available functions for Type Manager:

- Upload Types
- Manage Versions
- Edit Types
- Delete Types

The screenshot shows the 'Materials Data Curation System' interface. At the top, there is a navigation bar with 'Home', 'User Management', 'Templates & Types' (selected), 'Repositories', and 'Website'. Below this is a sub-navigation bar with 'Manage Templates', 'Manage Types' (selected), and 'Manage XSLT'. The main content area is titled 'Type Manager' and features an 'Upload Type' button. A table lists registered types with columns for 'Type name', 'Filename', 'Buckets', 'Status', and 'Actions'. The 'Actions' column includes 'Versions', 'Edit', and 'Delete' options for each type. At the bottom right, there is a 'Manage Buckets' button. The footer contains links for 'Home', 'Data Curation', 'Data Exploration', 'Composer', and 'Contact', along with a 'Top ^' link.

Type name	Filename	Buckets	Status	Actions
remote-file	remote-file.xsd		Registered	✓ Versions Edit Delete
temperature-unit	temperature-unit.xsd		Registered	✓ Versions Edit Delete
time-unit	time-unit.xsd		Registered	✓ Versions Edit Delete
uncertainty	uncertainty.xsd		Registered	✓ Versions Edit Delete
temperature	temperature.xsd		Registered	✓ Versions Edit Delete
time-unit	time-unit.xsd		Registered	✓ Versions Edit Delete

# Composer

## Two Steps to Compose:

1. Start Template
  - ▣ Global Templates
  - ▣ User Defined Templates
2. Compose
  - ▣ Based on Selected Template
  - ▣ Add/Delete Elements and Attributes
  - ▣ Save to a new User Defined Template

The screenshot displays the 'Materials Data Curation System' interface. The page title is 'Start Template'. A navigation bar at the top includes 'Home', 'Data Curation', 'Data Exploration', and 'Composer'. Below the navigation bar, there are tabs for 'Start Template' and 'Compose Template'. The main content area is titled 'Start Template' and contains a message: 'Select a new or existing start template from the following table to start composing. Once you make your selection, click on "Compose Template" to proceed. It will automatically load the appropriate template and display it on the next page.' A yellow warning box states: 'No template selected. Select one in the table below.' Below this, there are two tables: 'Global Templates' and 'User Defined Templates'. The 'Global Templates' table has columns for 'Template name', 'File name', and 'Actions'. The 'User Defined Templates' table has columns for 'Template name' and 'Actions'.

Template name	File name	Actions
New Base Template	new_base_template.xsd	Select as start template
Demo-Diffusion	demo.diffusion.xsd	Set as current template
Choice	_choice.xsd	Set as current template
Restriction	_restriction.xsd	Set as current template
Basic-Schema	_basic_schema.xsd	Set as current template

Template name	Actions
My Template	Set as current template

# Composer

## Two Steps to Compose:

1. Start Template
  - ▣ Global Templates
  - ▣ User Defined Templates
2. Compose
  - ▣ Based on Selected Template
  - ▣ Add/Delete Elements and Attributes
  - ▣ Save to a new User Defined Template

The screenshot displays the Materials Data Curation System interface. At the top, it says "Materials Data Curation System" and "Welcome, admin. Thanks for logging in." with navigation links for "Logout", "My Profile", and "Help". Below this is a navigation bar with "Home", "Data Curation", "Data Exploration", and "Composer". The "Composer" section is active, showing "Start Template" and "Compose Template" options. A "Legend" section on the left defines symbols for "name", "Type", and "(minOccurs, maxOccurs)". The main area, titled "Compose Template", contains a tree view of an XSD schema. The tree structure is as follows:

- xsd:schema
  - xsd:element : experiment Experiment (1, 1)
    - xsd:complexType CatalogNumber
      - xsd:sequence
        - xsd:element : id xsd:string (1, 1)
        - xsd:element : catalogTitle CatalogTitle (1, 1)
    - xsd:complexType CatalogTitle
      - xsd:sequence
        - xsd:element : name xsd:string (1, 1)
    - xsd:simpleType ChemicalElement
    - xsd:restriction
    - xsd:complexType ChemicalSubstance
      - xsd:sequence
        - xsd:element : chemicalFormula xsd:string (1, 1)
        - xsd:element : name xsd:string (1, 1)
        - xsd:element : catalogNumber CatalogNumber (0, \*)
        - xsd:element : elements ChemicalElement (1, \*)
    - xsd:complexType CitationType
      - xsd:choice
        - xsd:element : citation CitationOnlyType (1, 1)
        - xsd:element : DOI DOIOnlyType (1, 1)
    - xsd:complexType CitationOnlyType
      - xsd:sequence
        - xsd:element : citation xsd:string (1, 1)

# Exporter

## Three Steps to Export:

1. Select search result to export from
  - ❑ One search result
  - ❑ Multiple search results
2. Select an Export format to export to
  - ❑ Web based
3. Export data into file type desired
  - ❑ POP, CSV, HTML, Script

The screenshot displays the Materials Data Curation System interface. At the top, the header reads "Materials Data Curation System" with a welcome message "Welcome, admin. Thanks for logging in." and navigation links for "Logout", "My Profile", and "Help". Below the header is a navigation bar with "Home", "Data Curation", "Data Exploration", and "Composer". The main content area is titled "Query Results" and includes a "Query by Example" and "Search by Keyword" section. A sidebar on the left contains three steps: "1 Select Template", "2 Select Fields", and "3 Perform Search". The main area shows a tree view of query results for "sample-1.xml Diffusion". The tree structure is as follows:

- experiment
  - experimentType
    - tracerDiffusivity
      - material
        - materialName : Al
        - phase
          - name : fcc
          - crystalStructure
            - spaceGroup
              - symbolOrNumber : A1
      - Composition
        - quantityUnit : mass fraction
        - constituents
          - constituent
            - element : Al

At the bottom, there are two tabs for "sample-1.xml Diffusion" and "sample-2.xml Diffusion". A "Back to Query" button and an "Export" button are visible in the top right corner of the results area.

# Exporter

## Three Steps to Export:

1. Select search result to export from
  - ❑ One search result
  - ❑ Multiple search results
2. Select an Export format to export to
  - ❑ Web based
3. Export data into file type desired
  - ❑ POP, CSV, HTML, Script

The screenshot displays the Materials Data Curation System interface. At the top, the title "Materials Data Curation System" is shown with a welcome message "Welcome, admin. Thanks for logging in." and navigation links for "Logout", "My Profile", and "Help". Below this is a main navigation bar with "Home", "Data Curation", "Data Exploration", and "Composer". The "Data Exploration" section is active, showing "Query by Example" and "Search by Keyword" options.

The main content area is titled "Query Results" and contains a "Back to Query" button and an "Export" button. A modal window titled "Export" is open, prompting the user to "Please Choose one of the following export format:" with radio buttons for "XML" and "JSON", both of which are selected. The modal also features an "Export" button.

The background of the "Query Results" section shows a tree view of data fields under "From Local:". The tree includes "crystalStructure" (with sub-fields "spaceGroup" and "symbolOrNumber: A1"), "Composition" (with sub-fields "quantityUnit: mass fraction", "constituents", and "constituent" which has a sub-field "element: Al"), and "sample-2.xml" (with sub-fields "Diffusion" and "X").

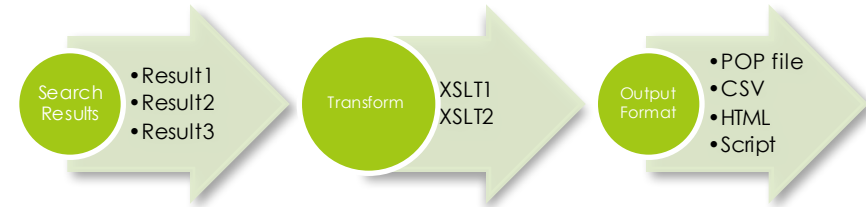
At the bottom of the page, there is a footer with navigation links: "Home", "Data Curation", "Data Exploration", "Composer", and "Contact", along with a "Top ^" link.



# Exporter

## Three Steps to Export:

1. Select search result to export from
  - ❑ One search result
  - ❑ Multiple search results
2. Select an Export format to export to
  - ❑ Web based
3. Export data into file type desired
  - ❑ POP, CSV, HTML, Script

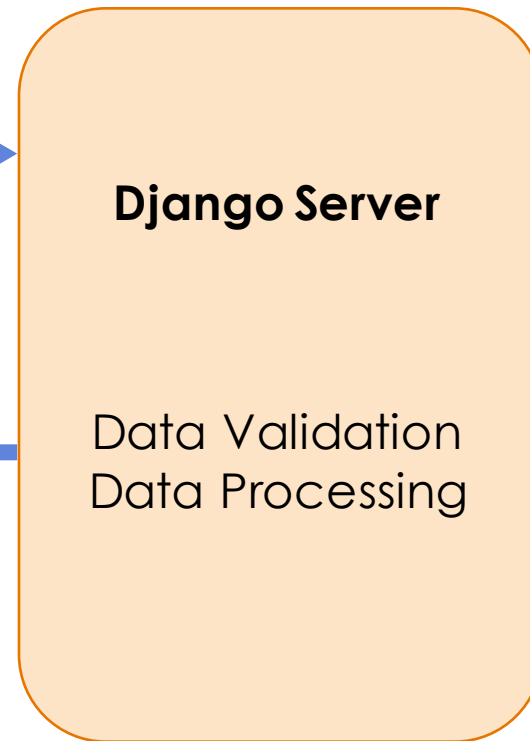
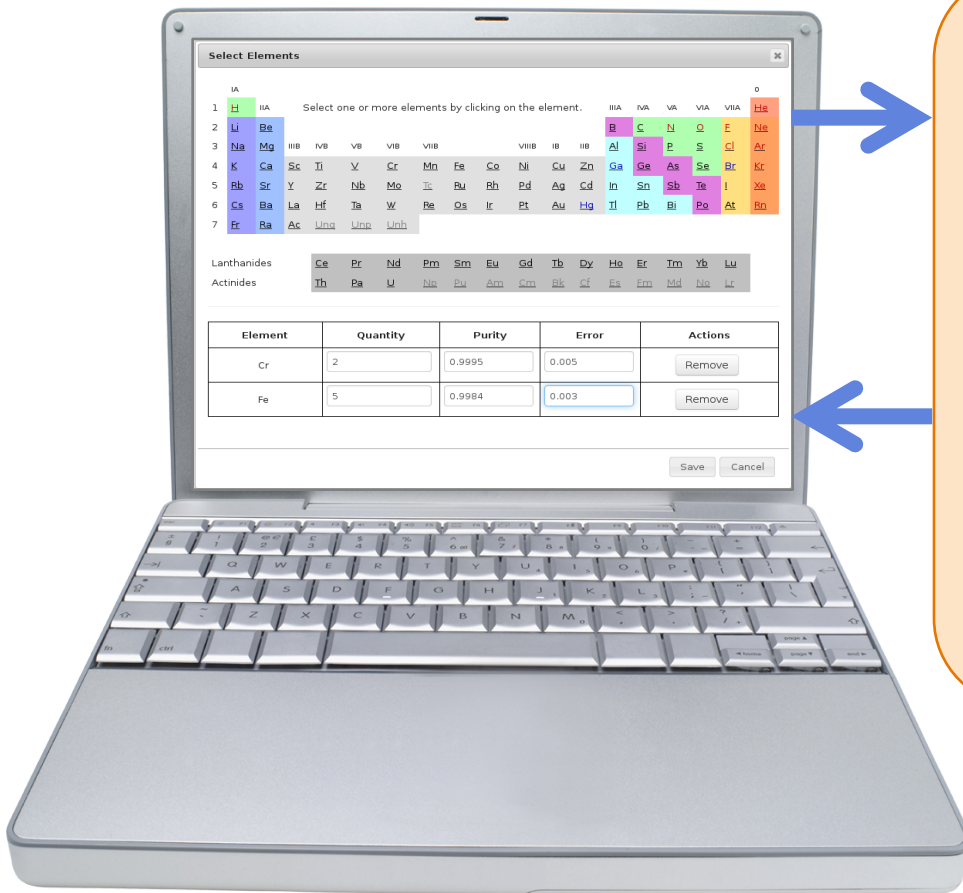


```
$$ POP File
$$ CREATED 10-28-2014
$$
$$

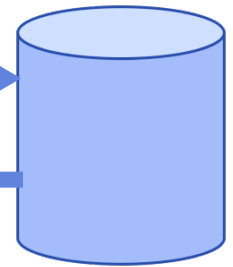
TABLE 10
CREATE_NEW_EQ @@,0
CHANGE_ST COMP A1,MG ENT
CHANGE_STATUS PHASE FCC =ENT 1
S-COND N=1 P=101325
S-COND w(a1)=.1 w(cx)=.12
S-COND T=@1
EXPERIMENT DT (FCC,Mg)=@4
TABLE_VALUES
$$ T ( C) Time (s) D(cm2/s) D(m2/s)
655.1 3564 5.97E-08 5.97E-12
587.6 3390 1.46E-08 1.46E-12
530.5 12702 4.20E-09 4.20E-13
478.7 21342 1.05E-09 1.05E-13
433 67614 2.70E-10 2.70E-14
394 151740 8.12E-11 8.12E-15
TABLE_END
```

# Module System API

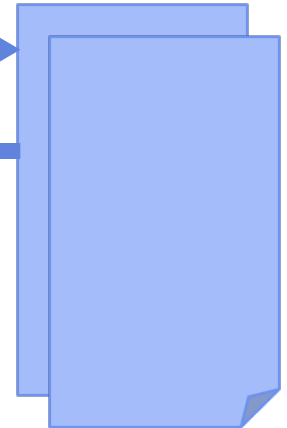
## Periodic Table Module



Remote  
Data  
Source

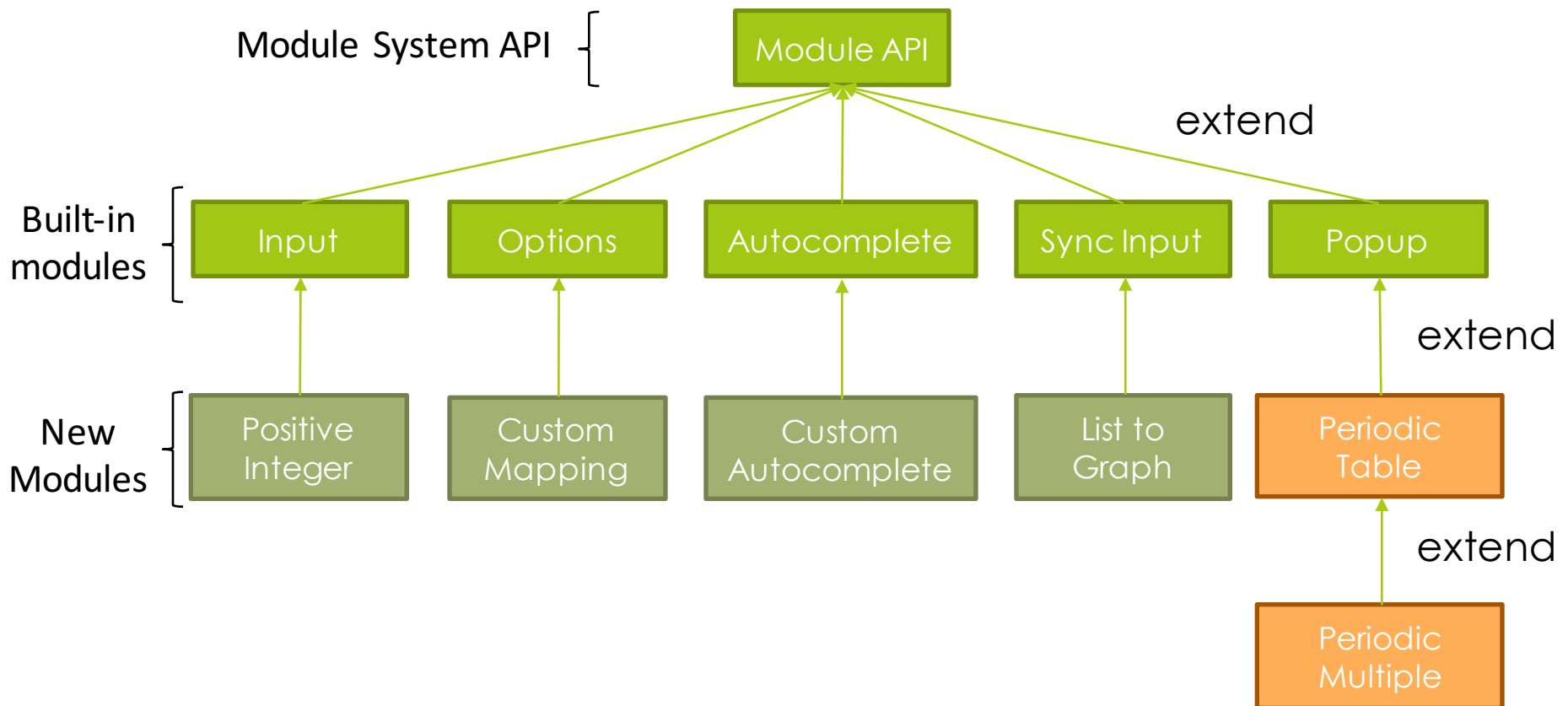


External  
Programs



Direct connection  
to back-end

# Module System



# REST API

## CRUD Operations for: (create, read, update and delete)

- Curate
- Explore
  - Query by Example
  - Search by Keyword
- Templates
- Types
- Saved Queries
- Repositories
- Users and Groups

swagger <http://129.6.0.11:8000/docs/apiapi-docs/> api\_key Explore Django REST Swagger

### curate

Show/Hide | List Operations | Expand Operations | Raw

- POST /rest/curate POST http://localhost/rest/curatePOST data title=title, schema=schemaID, content=root

### explore

Show/Hide | List Operations | Expand Operations | Raw

- GET /rest/explore/select/all GET http://localhost/rest/explore/select/alldataformat: [xml,json]
- GET /rest/explore/select GET http://localhost/rest/explore/selectid: string (ObjectId)schema: string (ObjectId)title: stringdataformat: [xml,json]
- GET /rest/explore/delete GET http://localhost/rest/explore/deleteid: string (ObjectId)
- POST /rest/explore/query-by-example POST http://localhost/rest/explore/query-by-examplePOST data query={elementvalue} repositories=Local.Server1.Server2 dataformat: [xml,json]{query:content
- POST /rest/explore/sparql-query POST http://localhost/rest/explore/sparql-queryPOST data query=SELECT \* WHERE {?s ?p ?o} dataformat=xml repositories=Local.Server1.Server2

### repositories

Show/Hide | List Operations | Expand Operations | Raw

- GET /rest/repositories/select/all GET http://localhost/rest/repositories/select/all
- GET /rest/repositories/select GET http://localhost/rest/repositories/select?param1=value1param2=value2URL parameters: id: string (ObjectId)name: stringprotocol: stringaddress: stringport: integeruser: stringstatus: stringFor string fields, you can use regular expressions: /exp/
- POST /rest/repositories/add POST http://localhost/rest/repositories/addPOST data name=name, protocol=protocol, address=address, port=port, user=user, password=password
- GET /rest/repositories/delete GET http://localhost/rest/repositories/delete?id=IDtodelete
- PUT /rest/repositories/update PUT http://localhost/rest/repositories/update?id=IDtoUpdatePUT data name=name, protocol=protocol, address=address, port=port, user=user, password=password

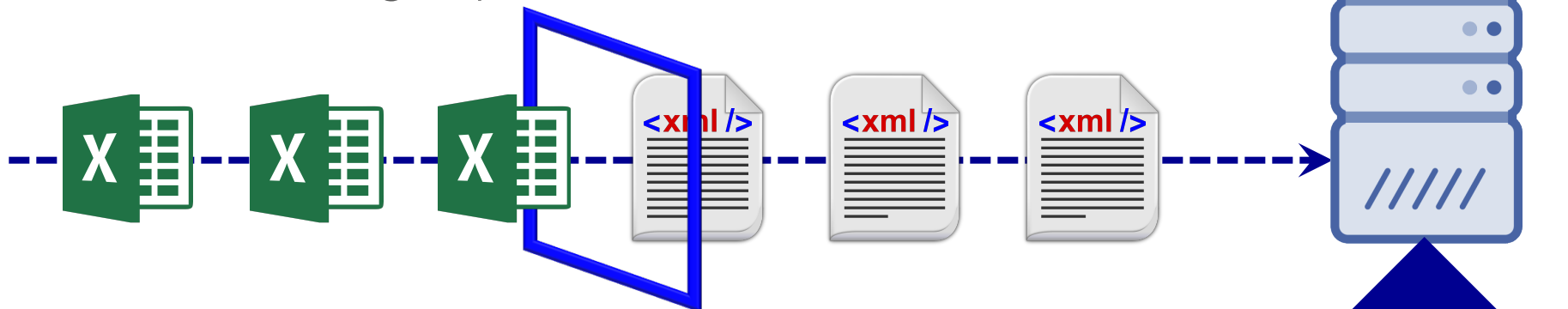
### saved\_queries

Show/Hide | List Operations | Expand Operations | Raw

- GET /rest/saved\_queries/select/all GET http://localhost/rest/saved\_queries/select/all
- GET /rest/saved\_queries/select GET http://localhost/rest/saved\_queries/selectid: string (ObjectId)user: string template: stringquery: stringdisplayedQuery: string
- GET /rest/saved\_queries/delete GET http://localhost/rest/saved\_queries/delete?id=idURL parameters: id: string

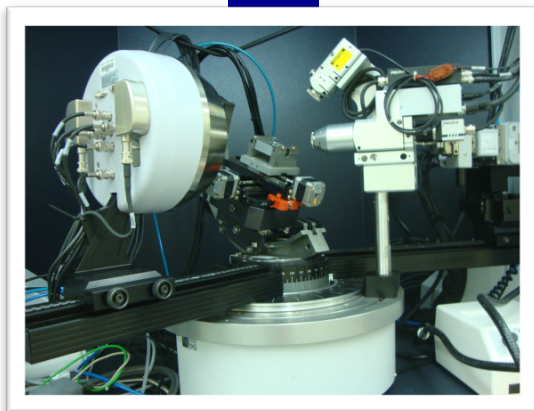
# REST API

- Automating Repetitive tasks



- Integration with equipment and other infrastructure

Automated Capture



# Administrative Dashboard

## Main Features:

- User Management
  - Manage Users
  - Manage Groups
- Templates & Types
  - Manage Templates
  - Manage Types
  - Manage Modules
- Repositories
  - Federated Search
- Website Management

The screenshot displays the 'Materials Data Curation System' administrative dashboard. The page title is 'Materials Data Curation System' with a welcome message: 'Welcome, admin. Thanks for logging in.' The navigation menu includes 'Home', 'User Management', 'Templates & Types', 'Repositories', and 'Website'. The 'User Management' section is active, showing a sub-menu with 'Manage Users', 'Account Requests', and 'Contact Messages'. The main content area is titled 'User Management' and contains a table of links for various system components:

Authentication and Authorization		
<a href="#">Groups</a>	<a href="#">Add</a>	<a href="#">Change</a>
<a href="#">Users</a>	<a href="#">Add</a>	<a href="#">Change</a>
OAuth2 Provider		
<a href="#">Access tokens</a>	<a href="#">Add</a>	<a href="#">Change</a>
<a href="#">Applications</a>	<a href="#">Add</a>	<a href="#">Change</a>
<a href="#">Grants</a>	<a href="#">Add</a>	<a href="#">Change</a>
<a href="#">Refresh tokens</a>	<a href="#">Add</a>	<a href="#">Change</a>

The footer contains navigation links: 'Home | Data Curation | Data Exploration | Composer | Contact' and a 'Top ^' link. Copyright information at the bottom reads: '© 2012 - 2015 Materials Data Curation System | Privacy Policy | Terms of Use | Administration' and 'Website template by Arcsin'.

# MDCS Releases (2015 to Present)

- Release 1.0 – circa February 12, 2015
- Release 1.1 – circa March 3, 2015
- Release 1.1.1 – circa May 7, 2015
- Release 1.2 – circa October 1, 2015
- Release 1.2.1 – circa November 3, 2015
- Release 1.3 – circa January 12, 2016
  - Exporter – using XSLT or Python
  - Access Control of MDCS components via User Permissions
  - Module System Improvements
  - General Improvements
  - More customizable User Interface
  - Search by Keywords and Dynamic Refinements
- Release 1.4 – circa June-July, 2016

# New Features for 1.4

- User Dashboard
- OAI-PMH Support
- XML Schema elements and attributes
  - Extensions
  - Imports
  - Namespaces
  - Key/keyrefs
- Parser Decoupling
- Search by Keyword
- Common code base development



# NIST Materials Resource Registry

## Shares the same technology stack as MDCS

- Django Web Framework
- Python and Modules
- MongoDB and MySQL for persistence
- Support for XML Schemas parsing and rendering
- Module System (Rich GUI widgets)
- Administrative Dashboard
- User Dashboard
- OAI-PMH protocol support for sharing records

# Thank You – Questions?

## Materials Data Curation System

Download on GitHub:

<https://github.com/usnistgov/MDCS>

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