

Automatic Web Application Generation from an Irradiation Experiment Data Management Ontology (IEDM)

Blerina Gkotse^{1&2}, Pierre Jouvelot², Federico Ravotti¹

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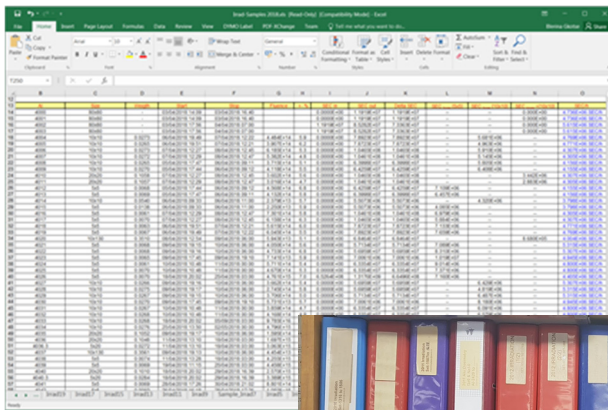
² MINES ParisTech, PSL University, Paris, France



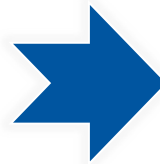
Goal

Challenges:

- Data management, a crucial issue in HEP
- Small experimental facilities, no strong IT support
- Knowledge sharing among communities

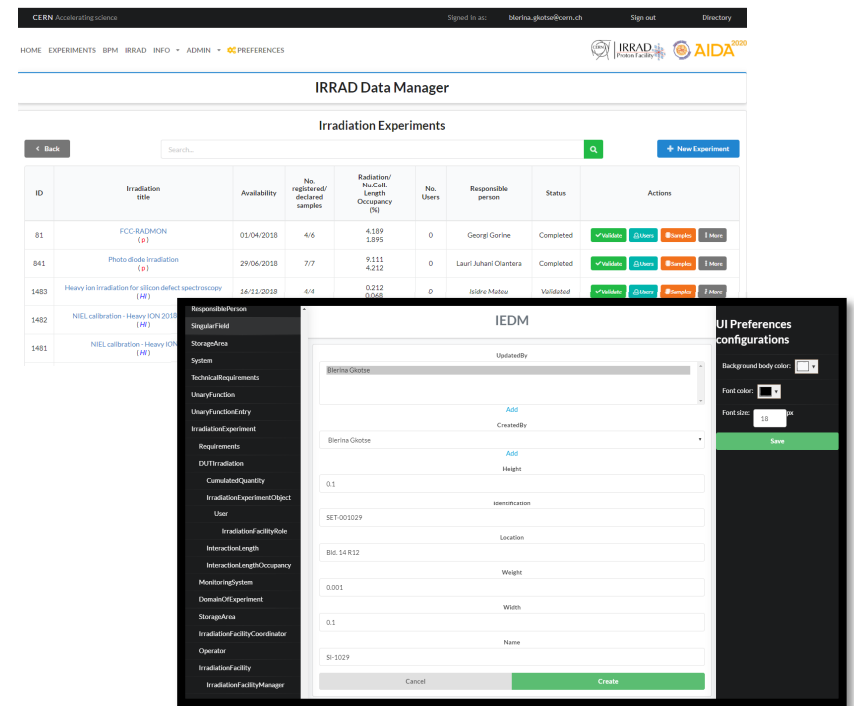


ID	Irradiation title	Availability	No. registered/ declared samples	Radiation* Neutrons Length Occupancy (N)	No. Users	Responsible person	Status	Actions
81	FCC-RADMON (p)	01/04/2018	4/6	4.189 1.895	0	Georgi Gorine	Completed	Viewable Editable Deletable Info
841	Photo-diode Irradiation (p)	29/06/2018	7/7	9.111 4.212	0	Lauri Juhani Ojanpera	Completed	Viewable Editable Deletable Info
1483	Heavy ion irradiation for silicon defect spectroscopy (M)	14/12/2018	6/4	0.212 0.068	0	Isidra Mateo	Validated	Viewable Editable Deletable Info
1482	NIEL calibration - Heavy ION 200kV (M)							
1481	NIEL calibration - Heavy ION 300kV (M)							



Solutions:

- ✓ Web Application for data management
- ✓ Automatic generation
- ✓ Based on Ontologies and Knowledge Graphs



CERN Accelerating science | Signed in as: Marina.Glotse@cern.ch | Sign out | Directory

HOME EXPERIMENTS BPM IRRAD INFO ADMIN PREFERENCES

IRRAD Data Manager

Irradiation Experiments

ID	Irradiation title	Availability	No. registered/ declared samples	Radiation* Neutrons Length Occupancy (N)	No. Users	Responsible person	Status	Actions
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Back | Search | + New Experiment

UI Preferences configurations

Background body color: [dropdown]
Font color: [dropdown]
Font size: 18 px [input]
Save

IEDM

UpdateBy: [dropdown]
Add
CreateBy: [dropdown]
Add
Heights
Identification
SET-001029
Location
BIG 14 R12
Weight
0.003
Width
0.1
Name
SI-1029
Cancel Create

ResponsiblePerson
SingleField
StorageArea
System
TechnicalRequirements
UserFunction
UserFunctionEntry
IrradiationExperiment
Requirements
DUFIrradiation
CumulativeQuantity
IrradiationExperimentObject
User
IrradiationFacilityCode
InteractionLength
InteractionLengthOccupancy
MonitoringSystem
DomainOfExperiment
StorageArea
IrradiationFacilityCoordinator
Operator
IrradiatedFacility
IrradiationFacilityManager

Outline

- **Ontologies, Knowledge Bases and Knowledge Graphs**
- **State of the Art and Methodology**
- **The Use Case of the IEDM Domain Ontology**
- **Generated Web Application**
- **Comparison with the IRRAD Data Manager (IDM)**

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Ontology: Origin

Deriving from ancient Greek:

Ontology = On (ὄν) + logos (λόγος)

In philosophy:

subject of existence, science of being,
"what exists" in the world



Aristotle

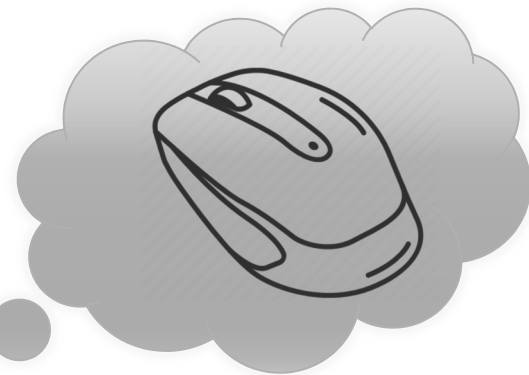
In computer science:

formal description and classification of "what exists",
what can be represented as knowledge

Ontology: Problem

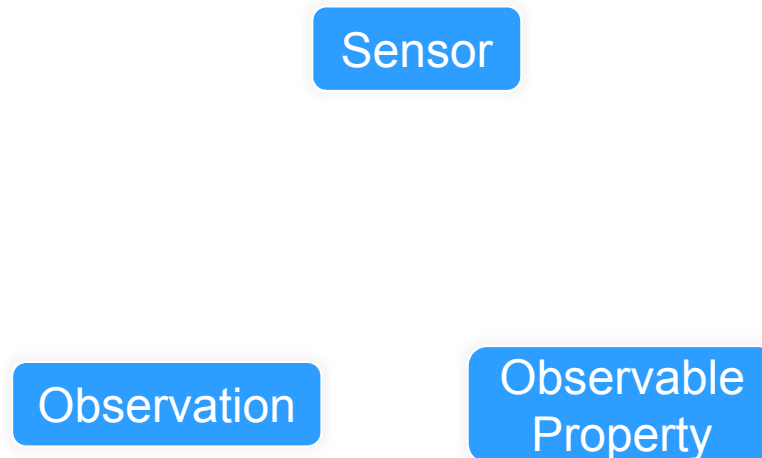
Computers don't understand semantic meaning

E.g., *"I lost my mouse..."*



Ontology: Structure

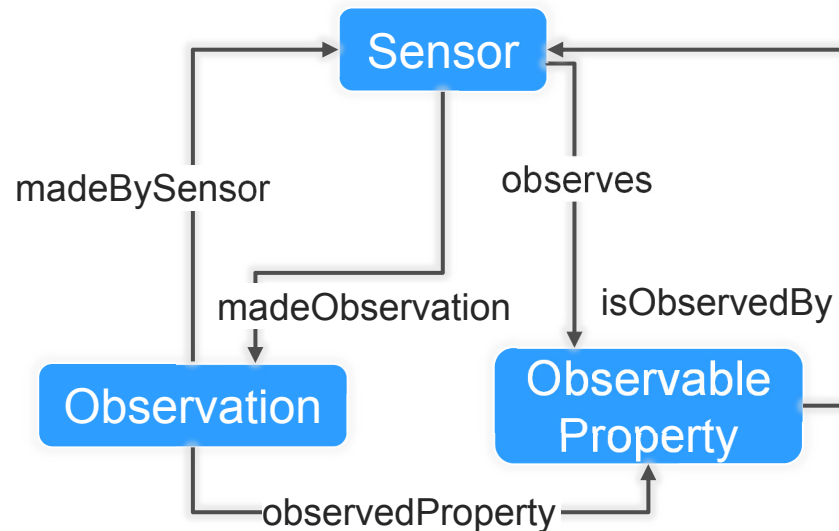
- **Class:** a set of entities of a specific domain



Excerpt from SOSA (Sensors, Observations, Samples and Actuators) ontology

Ontology: Structure

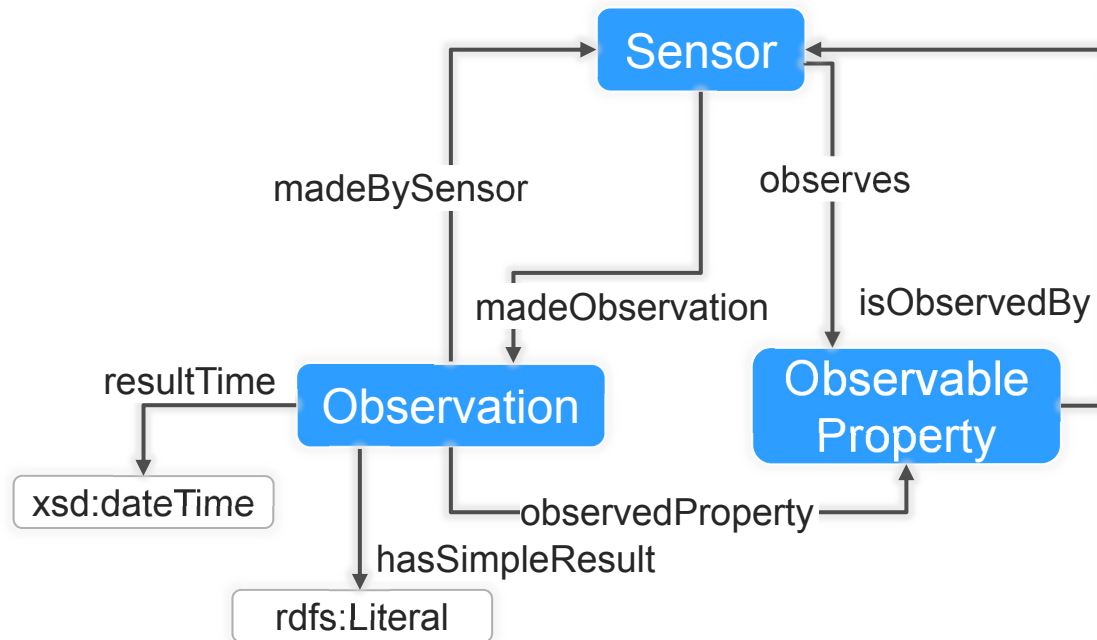
- **Class:** a set of entities of a specific domain
- **Relation:** a semantic link among classes, also called **object property**



Excerpt from SOSA (Sensors, Observations, Samples and Actuators) ontology

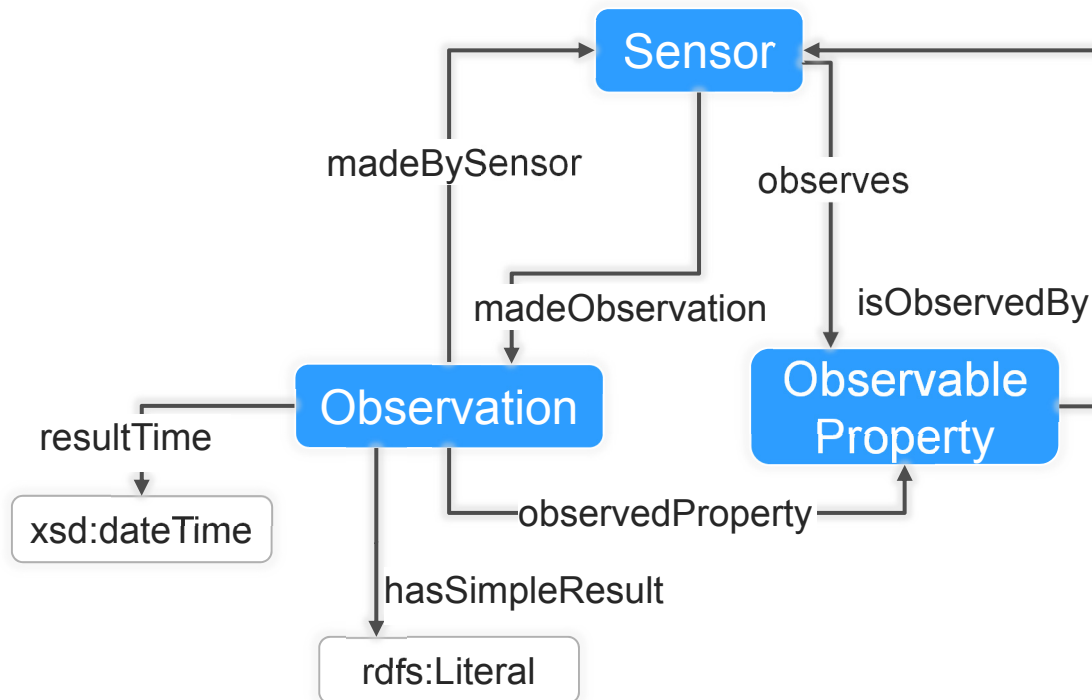
Ontology: Structure

- **Class:** a set of entities of a specific domain
- **Relation:** a semantic link among classes, also called **object property**
- **Property:** attribute of specific type, also called **data property**



Excerpt from SOSA (Sensors, Observations, Samples and Actuators) ontology

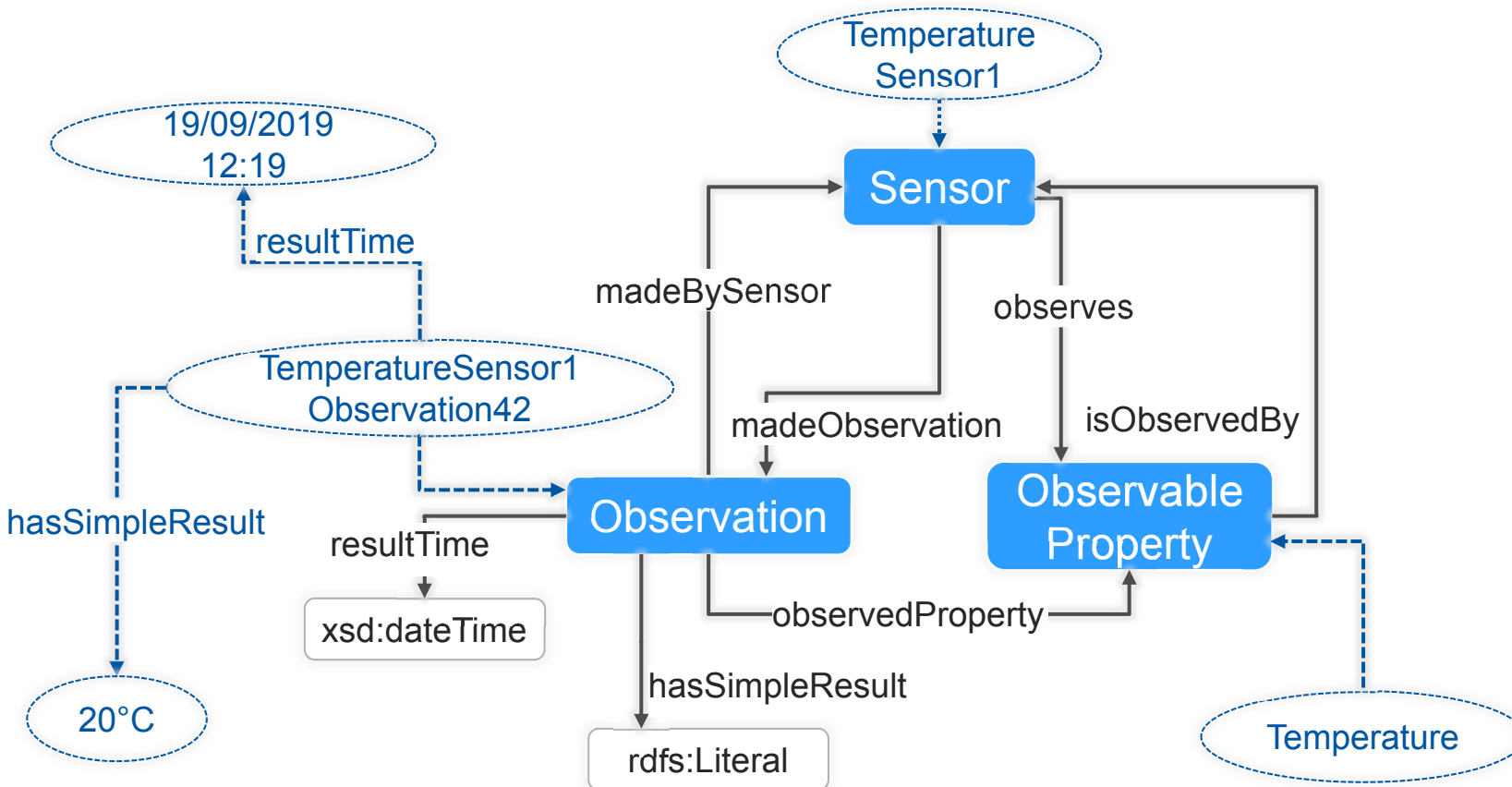
Knowledge Base (KB)



Excerpt from SOSA ontology and instances

Knowledge Base (KB)

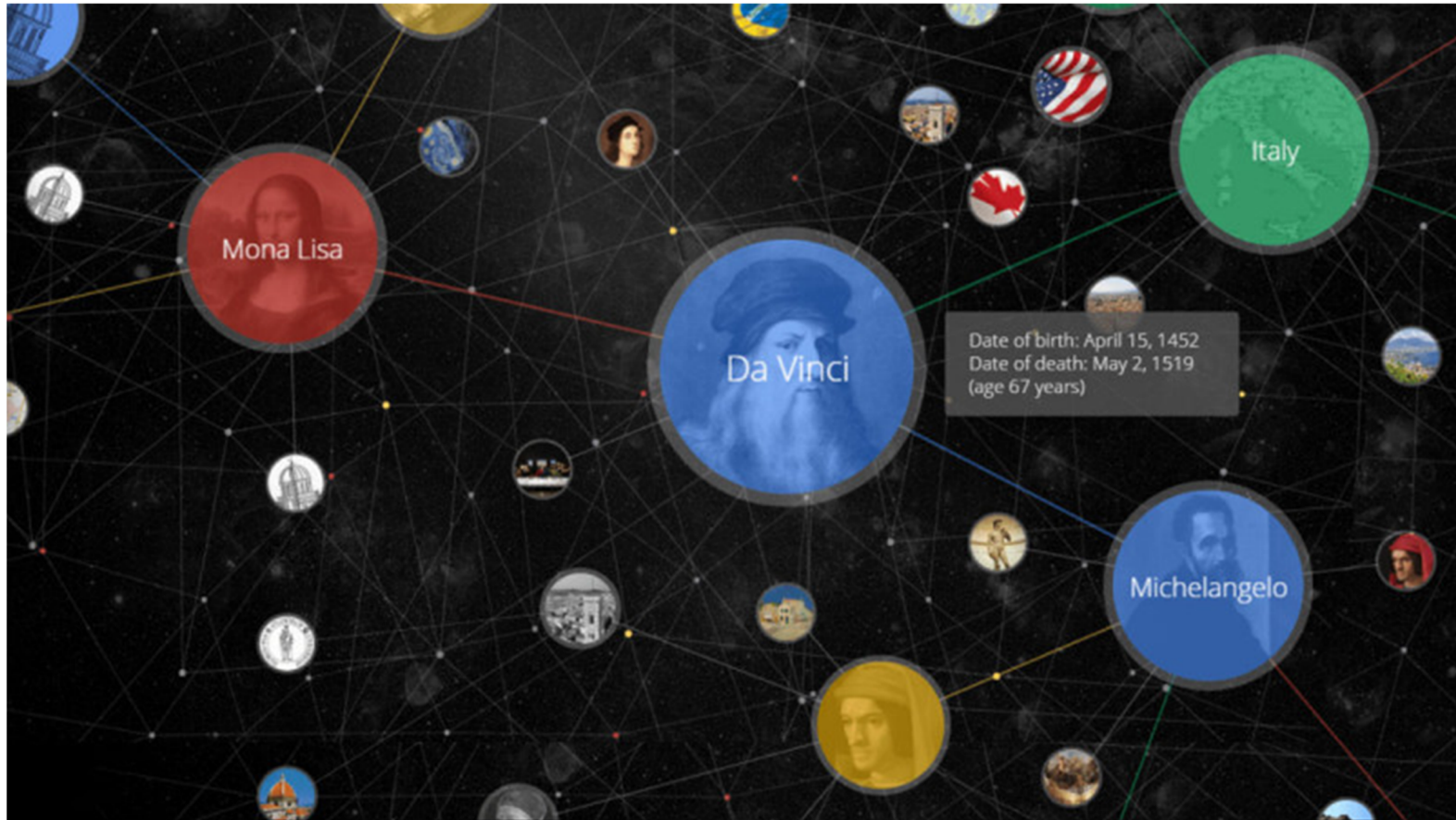
Individual instances of domain's classes and properties



Excerpt from SOSA ontology and instances

Knowledge Graph (KG)

- Term coined by Google (2012)
- Knowledge bases from a variety of sources
- Used in **academia** and **industry**



Google Knowledge Graph

Use of Ontologies, KBs and KGs

- Domain knowledge sharing:
 - Common understanding among software agents and people
 - Analysis and reuse of common knowledge
- Interoperability
- Data integration
- Natural Language Processing (NLP):
 - Inference, link prediction and reasoning
 - Query answering and information extraction
 - Recommender systems

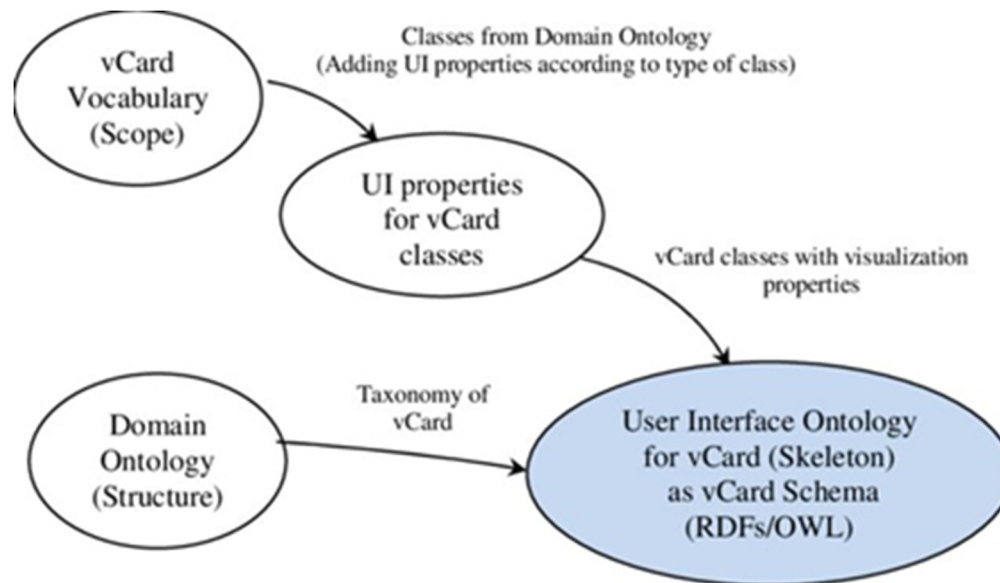
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Ontology-based UI Development

In the work of S.K. Shahzad (2011)*:

- UI ontology (UIO) mapped with a domain ontology (vCards) for aiding UI development
- UIO not documented and thus not reusable

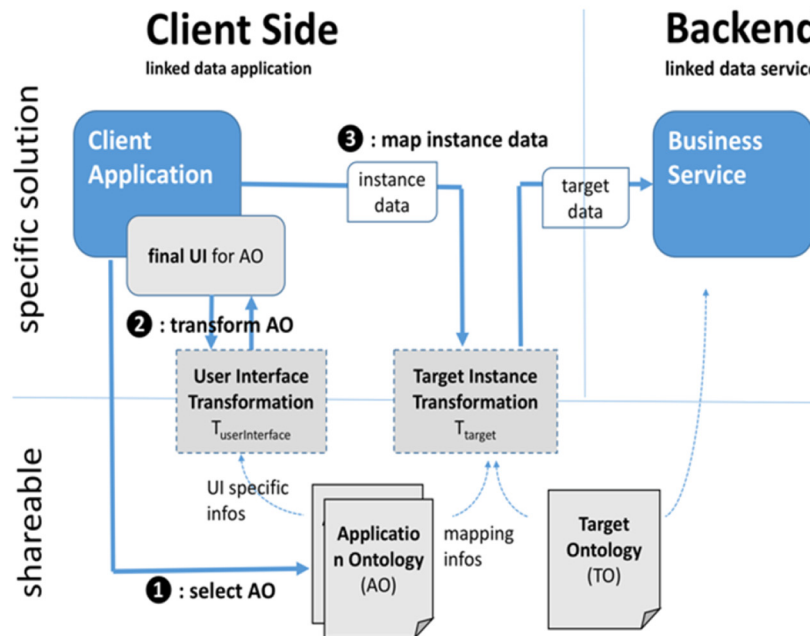


*S. K. Shahzad, "Ontology-based User Interface Development: User Experience Elements Pattern", Journal of Universal Computer Science, 17, 7, 2011, pp. 1078-108

Ontology-based UI Generation

In the work of Hitz *et al.* (2016)*:

- User input as an Application Ontology
- Transformation to a Target Ontology for UI generation
- Proprietary annotations required: limitation to universality



*M. Hitz, T. Kessel and D. Pfisterer, "Towards Sharable Application Ontologies for the Automatic Generation of UIs for Dialog based Linked Data Applications" in Proc. 5th Int. Conf. on Model-Driven Engineering and Software Development (MODELSWARD 2017), Porto, Portugal, Feb. 2017. pp. 567-569. doi:10.5220/0006137600650077

User Interface Ontologies

Ontologies for **formally describing UI components**

Several UI ontologies **investigated** and **integrated in our work**:

- **Semantic UI ontology**: Concepts from the Semantic UI framework
- **LOV UI ontology**: UI concepts (supported by the Linked Open Vocabularies (LOV))
- **RaUL ontology**: RDFa User Interface Language (supported by LOV)
- **HUICA ontology**: Hierarchical User Interface Component Architecture

	UI elements concepts (form, tables, ...)	Style Properties (color, background color, ...)	Data operations	Back end concepts
Semantic UI	×			
LOV UI	×	×		
RaUL	×		×	
HUICA	×			

User Interface Ontologies

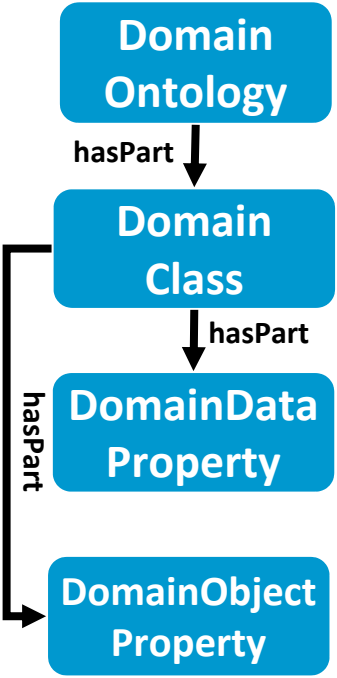
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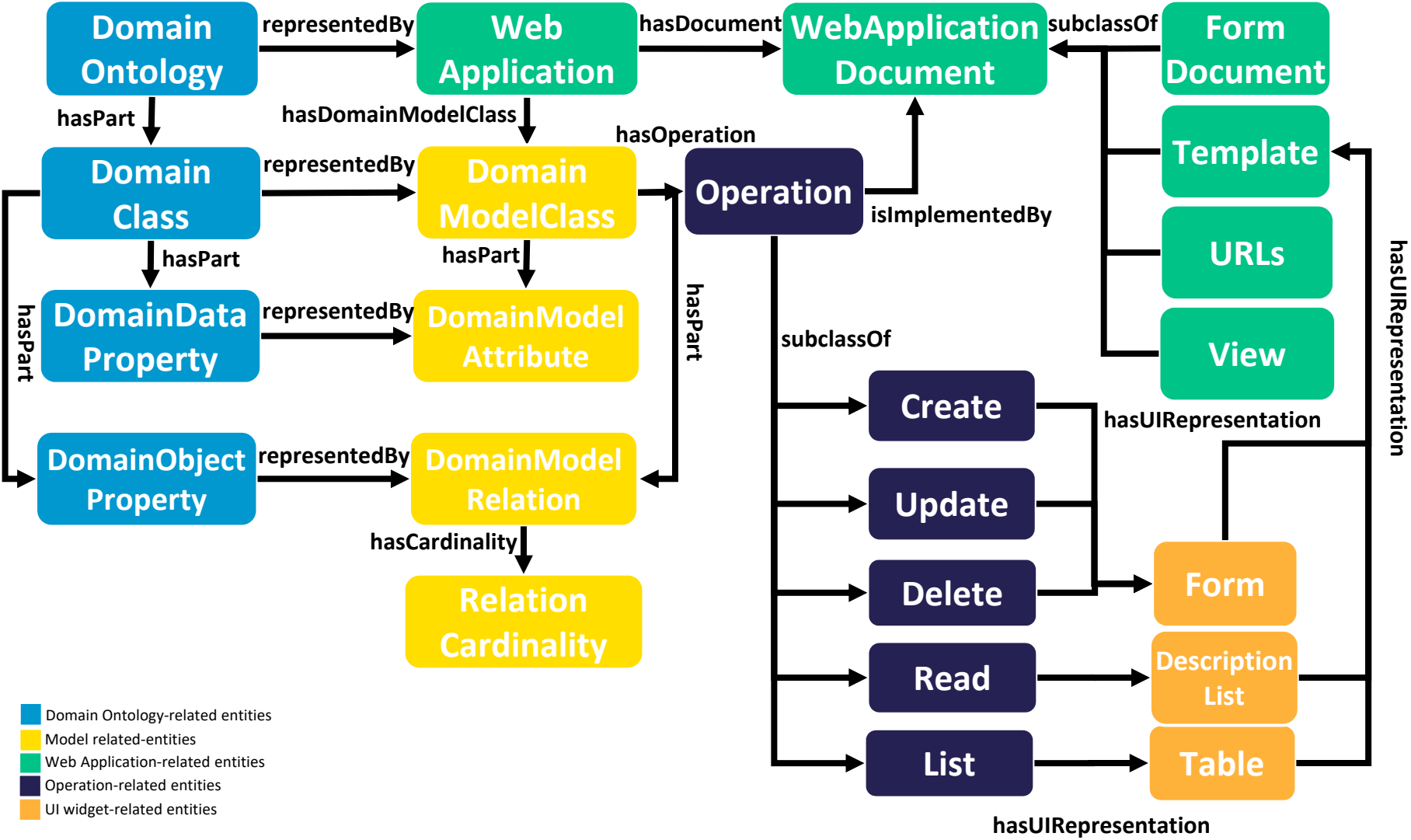
	UI elements concepts (form, tables, ...)	Style Properties (color, background color, ...)	Data operations	Back end concepts
Semantic UI	×			
LOV UI	×	×		
RaUL	×		×	
HUICA	×			

Ontology-based Web Application Ontology (OWAO)



■ Domain Ontology-related entities

Ontology-based Web Application Ontology (OWAO)



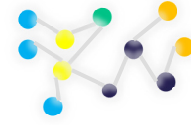
Web Application Generator (GenAppi)

Loading domain and
OWAO ontologies

Loading Ontologies



Domain Ontology (DO)



OWAO

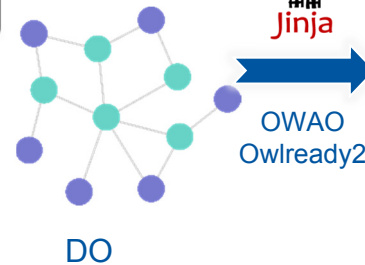
Source code: <https://gitlab.cern.ch/bgkotse/genappi>

Web Application Generator (GenAppi)

Loading domain and OWAO ontologies



Transforming domain classes and object and data properties to Model classes and attributes



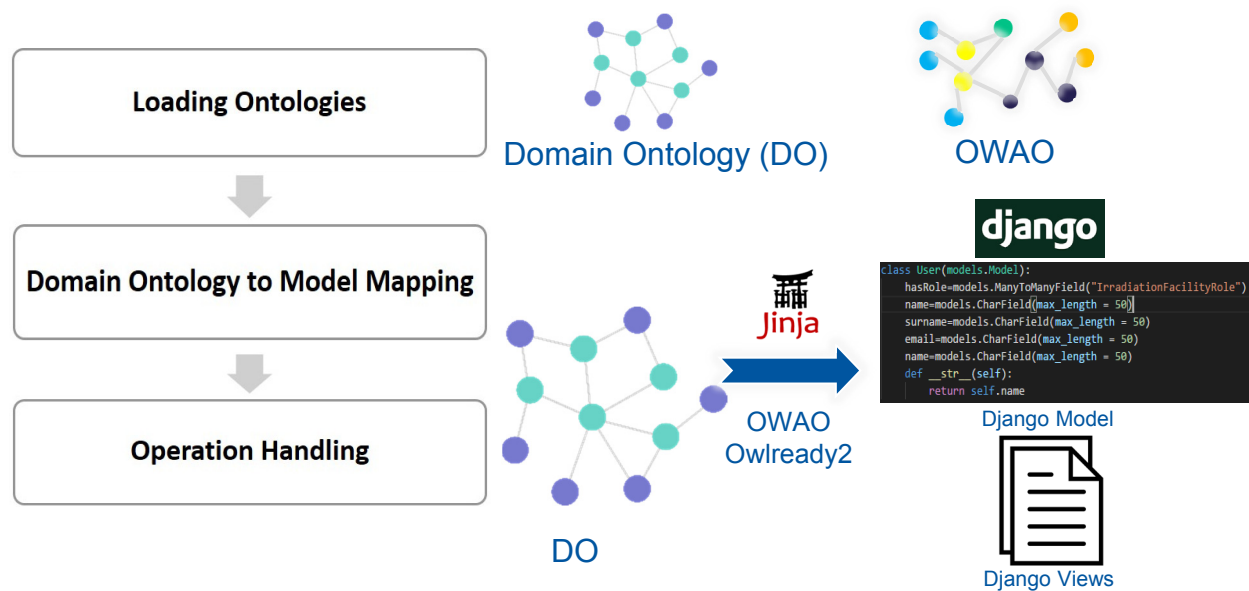
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Web Application Generator (GenAppi)

Loading domain and OWAO ontologies

Transforming domain classes and object and data properties to Model classes and attributes

Generating Django view files for data operations (CRUD)



```
class User(models.Model):
    hasRole=models.ManyToManyField("IrradiationFacilityRole")
    name=models.CharField(max_length = 50)
    surname=models.CharField(max_length = 50)
    email=models.CharField(max_length = 50)
    name=models.CharField(max_length = 50)
    def __str__(self):
        return self.name
```

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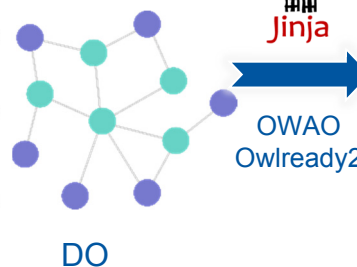
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Creating Django Template and URLs files for the UI



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```



Django Model



Django Views



Django Templates

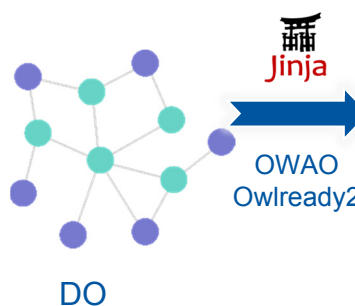
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Generating Django view files for data operations (CRUD)



Creating Django Template and URLs files for the UI



Grouping files in specific directories



Django Model



Django Views



Django Templates



Web Application

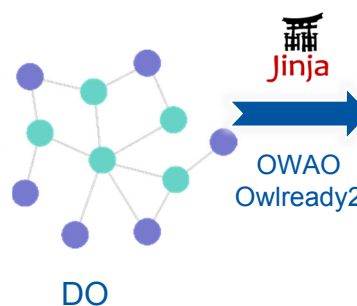
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Django Model

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Django Views

Creating Django Template and URLs files for the UI



Django Templates

Grouping files in specific directories

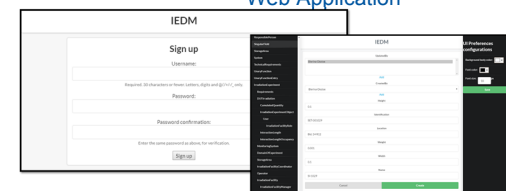


Web Application

Migrating model and server starting



DB or Triple Store

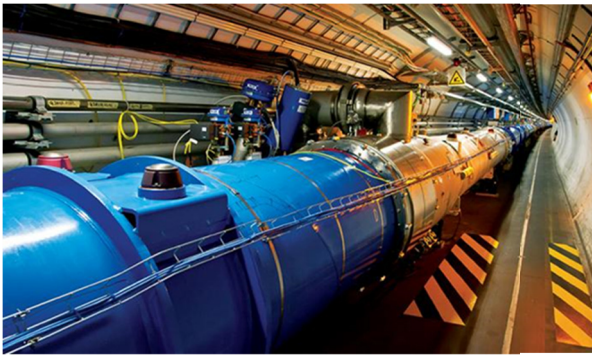


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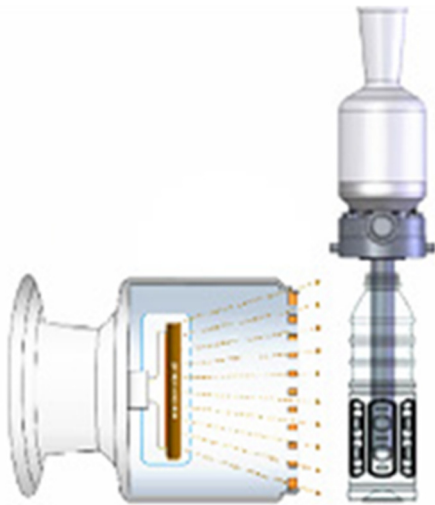
Irradiation Experiment Domain



CERN Large Hadron Collider (LHC)



NASA spacecraft



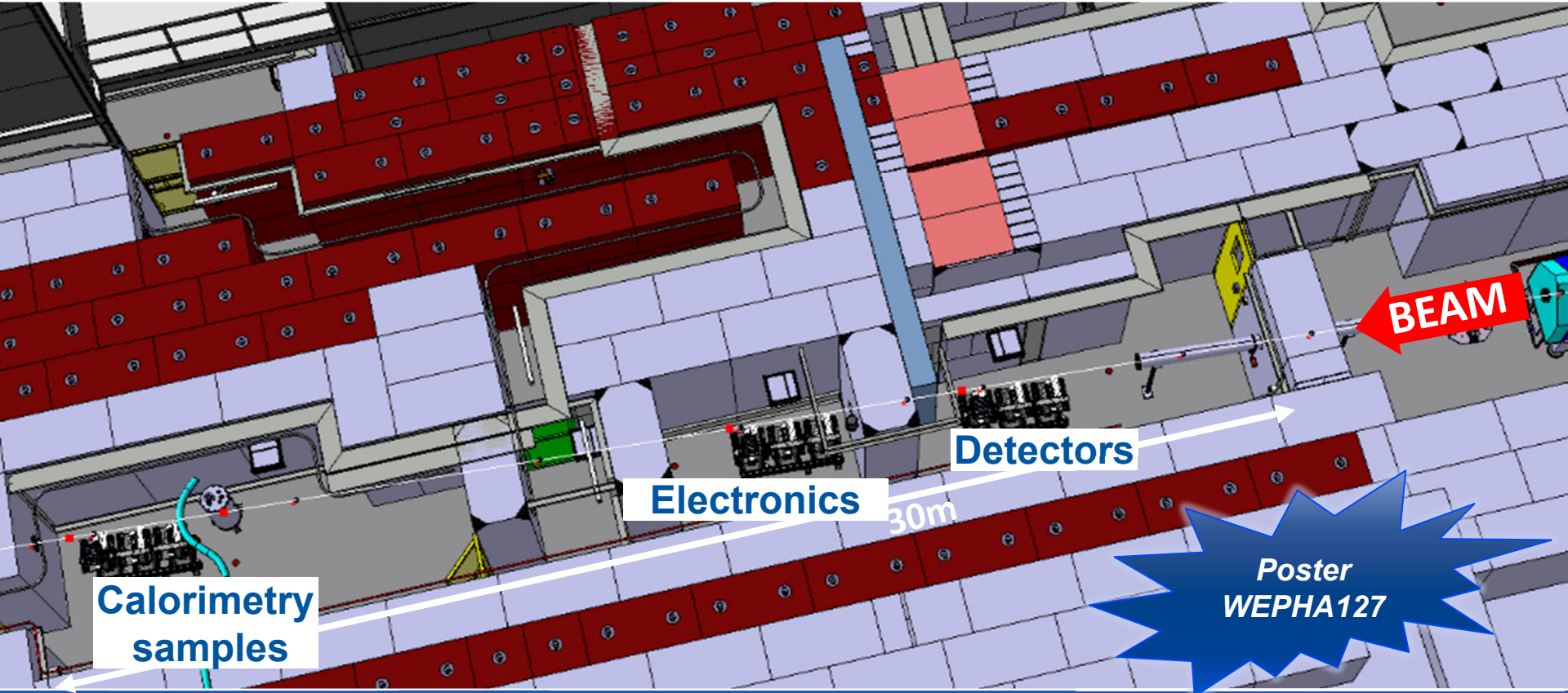
Bottle sterilization by electron beam irradiation



Clinac® iX System linear accelerator

CERN Proton Irradiation Facility (IRRAD)

- A reference facility for proton irradiation experiments
- Testing of components of the HEP experiments
- In 2018: 81 irradiation experiments, 97 users, 792 samples, 405 dosimeters and 2056 dosimetry measurements



IRRAD Data Manager (IDM)

Custom-made web application for the data management of IRRAD

IRRAD Data Manager
Irradiation Experiments

ID	Irradiation site	Availability	No. registered/defined samples	Residual/No. CLN Length Occupancy (%)	No. Hours	Responsible person	Status	Actions
81	FCC-RADIATION (S)	05/04/2018	4/8	4/39 1/95	0	Georg Corina	Completed	View Details View Status View History
841	Photo-diode Irradiation (S)	28/06/2018	3/7	4/111 4/22	0	Laetitia Lohier-Clairier	Completed	View Details View Status View History
1403	Heavy Ion Irradiation for silicon defect spectrometry (M)	16/12/2018	4/6	0/22 0/08	0	Valérie Hane	Validated	View Details View Status View History
1402	NEL Calibration - Heavy Ion (2018 - RADIATION) (M)	14/12/2018	1/1	0/05 0/03	0	Gillesgo Pesticola	Validated	View Details View Status View History
1401	NEL Calibration - Heavy Ion (2018 - M)	14/12/2018	5/5	3/20 0/95	0	Gillesgo Pesticola	Validated	View Details View Status View History

IRRAD Data Manager
Dosimetry results for SET-003252 (ULTEM1000)

Dosimeter	Dimensions (mm ²)	Date In	Date Out	SEC	Accumulated fluence	Error (%)	Comments
DOS-004023	20x20	18/04/2018 20:02	05/09/2018 03:00	1.43e+10	9.79e+16	7	
DOS-004051	20x20	12/09/2018 13:25		0.00e+00			None

Dosimeter dimensions (mm²): 20x20 mm² Total accumulated fluence: 9.790e+16 Protons/cm²

IRRAD Data Manager
TREC Data of Sample SET-003122

Identification: POSEIDON-OR003122

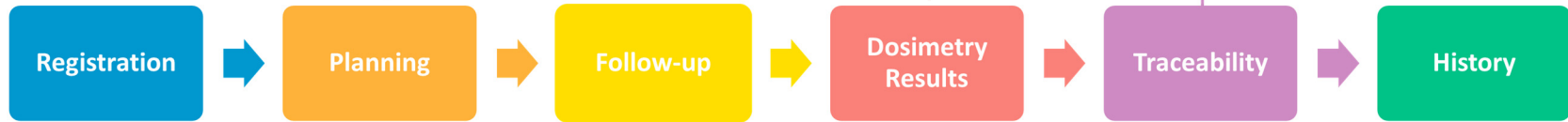
Sample Name: SET-003122

Description: Sample Set

Coordinates: 49.2-059

Material: LCP

Characteristics: Length: 5 cm, Width: 0.2 cm, Thickness: 0.025 cm, Weight: 0.12 g, Density: -



Sample dimensions

Sample Name: [input]

Material: [input]

Length (mm): [input]

Width (mm): [input]

Thickness (mm): [input]

Weight (g): [input]

Volume (cm³): [input]

Surface Area (cm²): [input]

Buttons: [Save] [Cancel]

IRRAD Data Manager
Irradiation Status

Updated at	Sample	Dosimeter	Date In - Date Out	IRRAD table	Table position	Accumulated fluence	SEC	Updated by	Status	In Beam	Actions
15/11/2018	SET-003089	DOS-004211	15/11/2018 18.11 -	IRRAD19	Center		272851	irradiation.facilities@cern.ch	Registered	<input type="checkbox"/>	View Details View Status View History
15/11/2018	SET-003090	DOS-004211	15/11/2018 18.11 -	IRRAD19	Center		272851	irradiation.facilities@cern.ch	Registered	<input type="checkbox"/>	View Details View Status View History
15/11/2018	SET-003091	DOS-004211	15/11/2018 18.11 -	IRRAD19	Center		272851	irradiation.facilities@cern.ch	Registered	<input type="checkbox"/>	View Details View Status View History
15/11/2018	SET-003092	DOS-004211	15/11/2018 18.11 -	IRRAD19	Center		272851	irradiation.facilities@cern.ch	Registered	<input type="checkbox"/>	View Details View Status View History
15/11/2018	SET-003093	DOS-004211	15/11/2018 18.11 -	IRRAD19	Center		272851	irradiation.facilities@cern.ch	Registered	<input type="checkbox"/>	View Details View Status View History

IRRAD Data Manager
3D pixel for ATLAS ITK

Experiment Name: ATLAS ITK

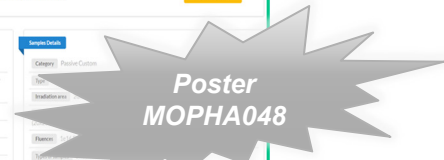
Description: Set of radiation detectors of 2D silicon pixel sensors for the innermost layer of ATLAS ITK with fluence up to 1e16 protons/cm². Both FEM and standard and includes with the new IRRAD module for ATLAS ITK.

Responsible person: jens.schlegel@cern.ch

Material type: Silicon

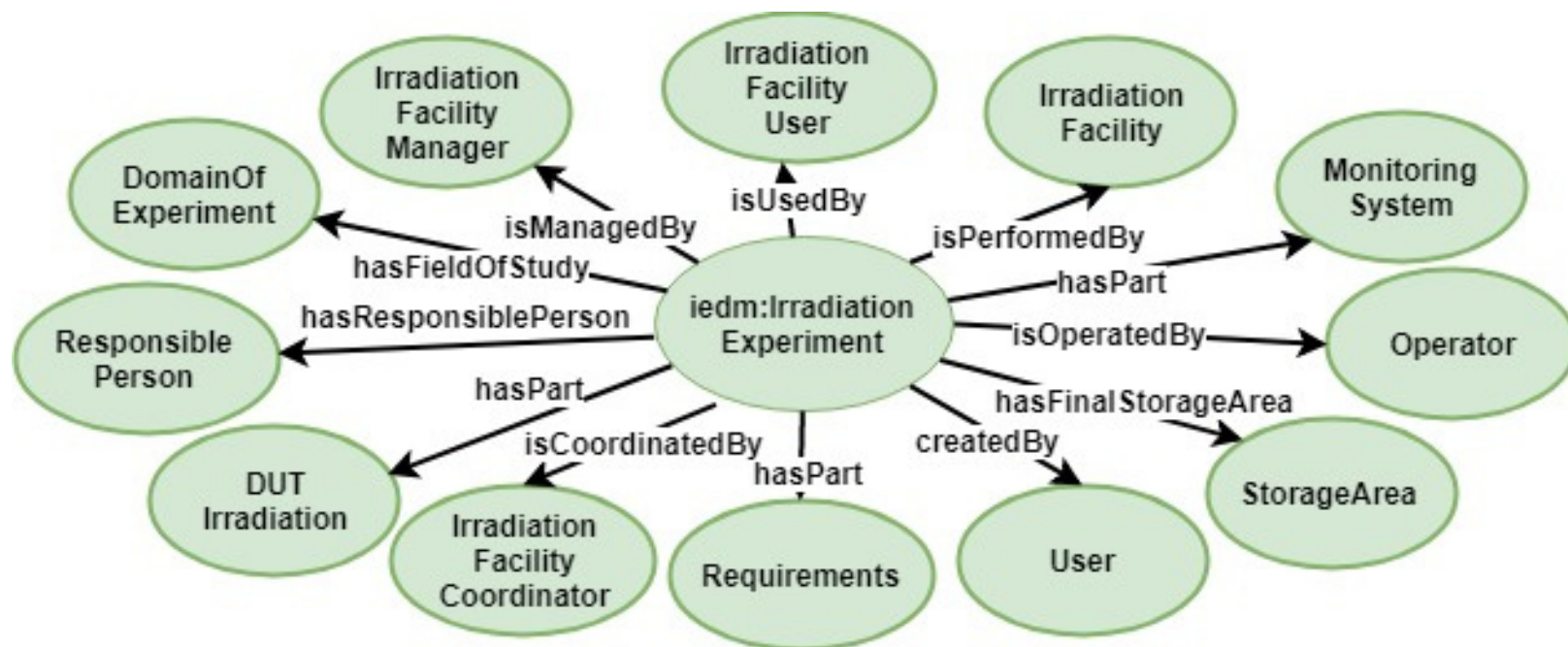
Additional comments: Important to characterize the new IRRAD module for ATLAS ITK prior to the Po-209 irradiation in 2019.

Dosimetry results: SET-002467 with dosimeter DOS-004211 1.224e+16 Protons/cm², SET-002468 with dosimeter DOS-004211 1.202e+16 Protons/cm², SET-002469 with dosimeter DOS-004211 1.202e+16 Protons/cm².



Irradiation Experiment Data Management Ontology (IEDM)*

- Inspired by the **IDM development** and by **research in other irradiation facilities**
- **Concepts of irradiation experiments** focusing on their **data management**
- Used in our work as a **Domain Ontology**



*B. Gkotse, *et al.*, "IEDM: An Ontology for Irradiation Experiments Data Management", presented at ESWC2019, Portoroz, Slovenia, Jun. 2019, in press. Documentation at <http://cern.ch/iedm>

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Generated Application: Authentication

- Django authentication and authorisation system
- Jinja2 template for the interface generation

IEDM

Sign up

Username:

Required. 30 characters or fewer. Letters, digits and @/./+/_ only.

Password:

Password confirmation:

Enter the same password as above, for verification.

Generated Application: List

- List of saved instances per class
- Visualisation of domain ontology classes
- UI display adaptable according to the user's preferences

The screenshot displays the IEDM application interface. On the left is a dark sidebar with a list of ontology classes: UnaryFunction, UnaryFunctionEntry, IrradiationExperiment, Requirements, DUTIrradiation, CumulatedQuantity, IrradiationExperimentObject, User, IrradiationFacilityRole, InteractionLength, InteractionLengthOccupancy, and MonitoringSystem. The main content area is titled 'IEDM' and shows a 'User' section with a blue 'Create' button. Below this is a table with columns: surname, email, name, hasRole, and Actions. The table contains one entry for 'Blerina' with email 'blerina.gkotse@cern.ch' and role 'Responsible'. The Actions column for this entry contains 'View', 'Update', and 'Delete' buttons. On the right side, there is a 'UI Preferences configurations' panel with settings for Background body color, Font color, and Font size (set to 18 px), and a green 'Save' button.

Users' list

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Users' list

Generated Application: Create Instance Form

- Input form for each domain ontology class instance
- **Data properties = input fields**
- **Object properties = selection fields and links to the corresponding class forms**

The screenshot displays the IEDM application interface. On the left, a dark sidebar lists domain ontology classes such as ResponsiblePerson, SingularField, StorageArea, System, TechnicalRequirements, UnaryFunction, and others. The main area shows a form titled 'IEDM' with the following fields:

- UpdatedBy: A selection field with 'Blerina Gkotse' selected.
- CreatedBy: A selection field with 'Blerina Gkotse' selected.
- Height: An input field containing '0.1'.
- Identification: An input field containing 'SET-001029'.
- Location: An input field containing 'Bld. 14 R12'.
- Weight: An input field containing '0.001'.
- Width: An input field containing '0.1'.
- Name: An input field containing 'SI-1029'.

At the bottom of the form are 'Cancel' and 'Create' buttons. On the right, a 'UI Preferences configurations' sidebar shows settings for Background body color, Font color, and Font size (set to 18 px), with a 'Save' button below.

Registering an Irradiation Experiment Object

Outline

- Ontologies, Knowledge Bases and Knowledge Graphs
- State of the Art & Methodology
- The Use Case of the IEDM Domain Ontology
- Generated Web Application
- **Comparison with the IRRAD Data Manager (IDM)**

Generated Web Application vs. IDM

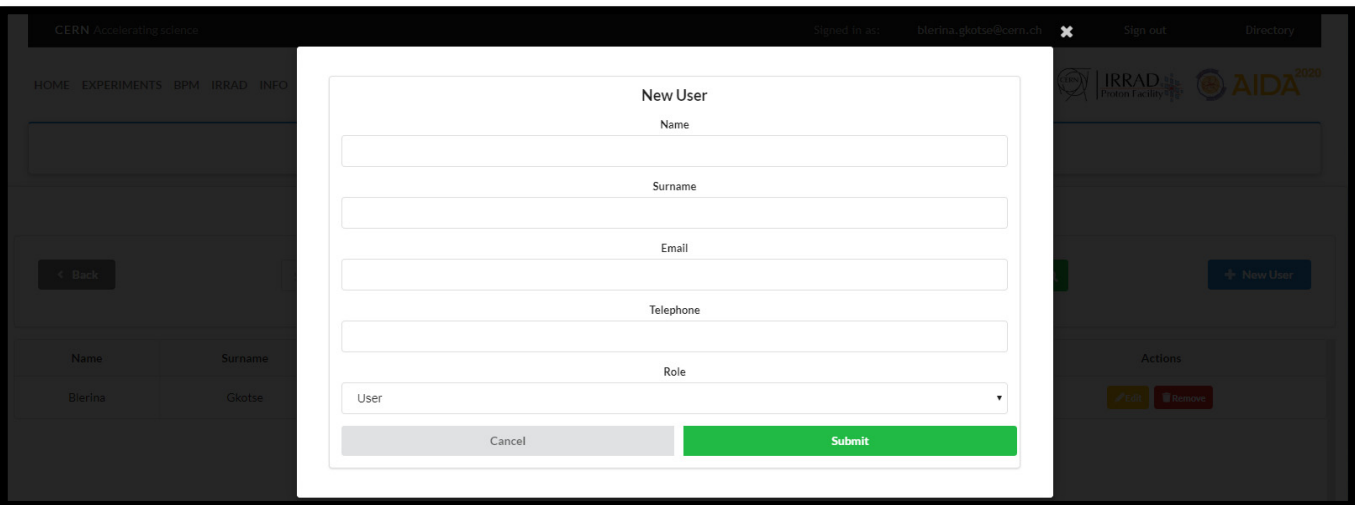
	IDM	Generated Web Application
Purpose	IRRAD facility data management	any domain
Software infrastructure	CERN	free and open-source
Storage	Oracle database	any relational database, ontology or triple store
Web Semantic technologies	no	yes, allowing for data integration
Functionalities	more advanced (e.g., interaction length calculation)	CRUD operations

User Interfaces Comparison: Create Form

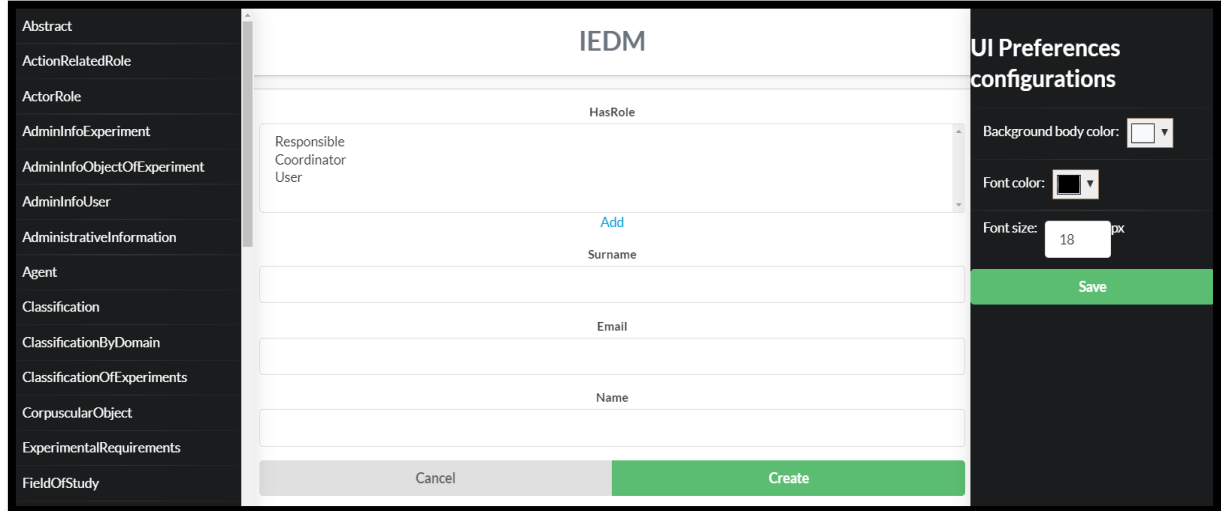
The screenshot shows a web application interface. At the top, there is a navigation bar with the CERN logo and text 'CERN Accelerating science'. Below this is a dark sidebar menu with links for 'HOME', 'EXPERIMENTS', 'SPM', 'IRRAD', and 'INFO'. A 'Back' button is visible in the sidebar. The main content area is dark and contains a 'New User' form overlay. The form has the following fields: 'Name', 'Surname', 'Email', 'Telephone', and 'Role'. The 'Role' field is a dropdown menu with 'User' selected. At the bottom of the form are 'Cancel' and 'Submit' buttons. The background shows a 'New User' button and an 'Actions' section with 'View' and 'Remove' buttons. The user is logged in as 'blerina.gkotse@cern.ch'.

IDM create instance form

User Interfaces Comparison: Create Form



IDM create instance form



Generated application create instance form

User Interfaces Comparison: List Table

The screenshot shows the IRRAD Data Manager web interface. At the top, there is a navigation bar with 'CERN Accelerating science', 'Signed in as: blerina.gkotse@cern.ch', 'Sign out', and 'Directory'. Below this is a secondary navigation bar with 'HOME EXPERIMENTS BPM IRRAD INFO' and a 'PREFERENCES' icon. The main content area is titled 'IRRAD Data Manager' and 'FCC-RADMON users'. It features a search bar with a 'Search...' placeholder, a green search icon, and a '+ New User' button. Below the search bar is a table with the following data:

Name	Surname	E-mail	Telephone	Role	Actions
Blerina	Gkotse	blerina.gkotse@cern.ch	1111111	User	Edit Remove

IDM list table

User Interfaces Comparison: List Table

CERN Accelerating science Signed in as: blerina.gkotse@cern.ch Sign out Directory

HOME EXPERIMENTS BPM IRRAD INFO PREFERENCES

IRRAD Proton Facility AIDA 2020

IRRAD Data Manager

FCC-RADMON users

< Back Search... + New User

Name	Surname	E-mail	Telephone	Role	Actions
Blerina	Gkotse	blerina.gkotse@cern.ch	1111111	User	Edit Remove

IDM list table

- UnaryFunction
- UnaryFunctionEntry
- IrradiationExperiment
- Requirements
- DUTIrradiation
- CumulatedQuantity
- IrradiationExperimentObject
- User
- IrradiationFacilityRole
- InteractionLength

IEDM

User

[Create](#)

surname	email	name	hasRole	Actions
Gkotse	blerina.gkotse@cern.ch	Blerina	Responsible	View Update Delete

UI Preferences configurations

Background body color:

Font color:

Font size: px

[Save](#)

Generated application list table

Conclusion

- **Automatic generation of web applications from ontologies:**
 - Methodology and software tools
 - Use case based on the IEDM ontology
- **Generated web application:**
 - based on **web semantic technologies**, enabling data integration
 - **starting point** for further customization
- **Future work: UI preferences customization**

Automatic Web Application Generation from an Irradiation Experiment Data Management Ontology (IEDM)

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