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

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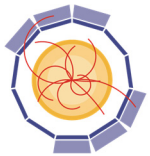
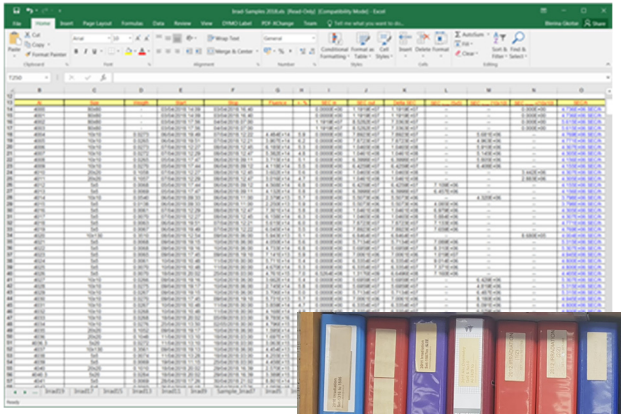


Goal

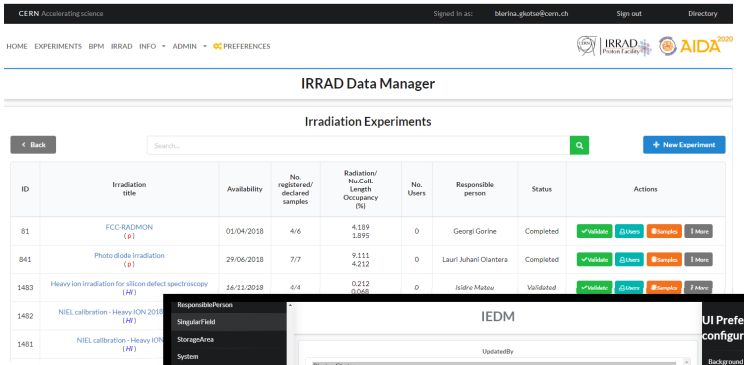
Challenges:

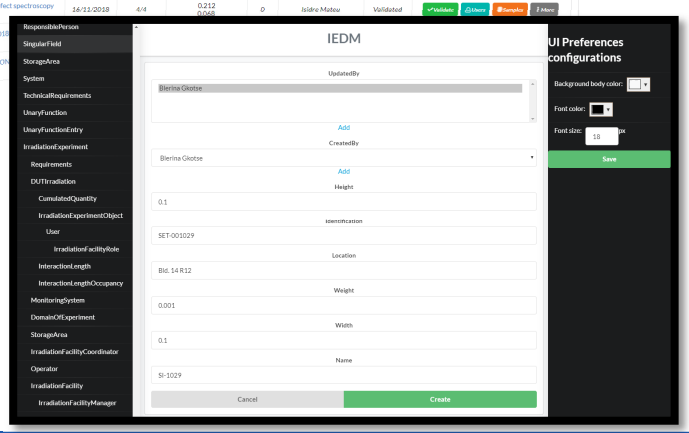
- Data management, a crucial issue in HEP
- Small experimental facilities, no strong IT support
- Knowledge sharing among communities



Solutions:

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





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)

Outline

- **Ontologies, Knowledge Bases and Knowledge Graphs**
- State of the Art & Methodology
- The Use Case of the IEDM Domain Ontology
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Ontology: Origin

Deriving from ancient Greek:

Ontology = On (ὄν) + logos (λόγος)

Aristotle

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

In computer science:
formal description and classification of "what exists",
what can be represented as knowledge

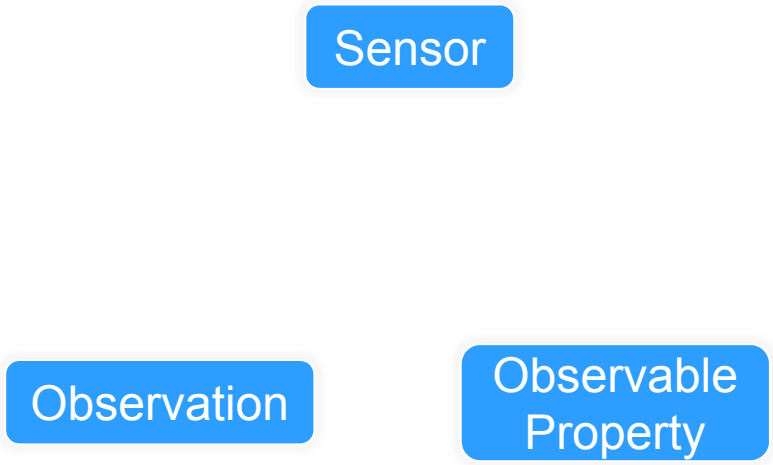
Ontology: Problem

Computers don't understand semantic meaning

E.g., *"I lost my mouse…"*

Ontology: Structure

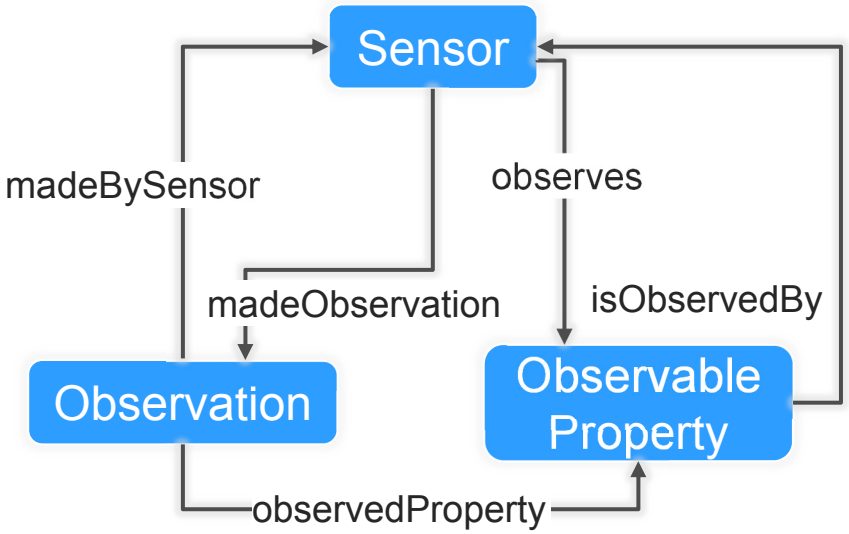
- **Class**: a set of entities of a specific domain



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

Ontology: Structure

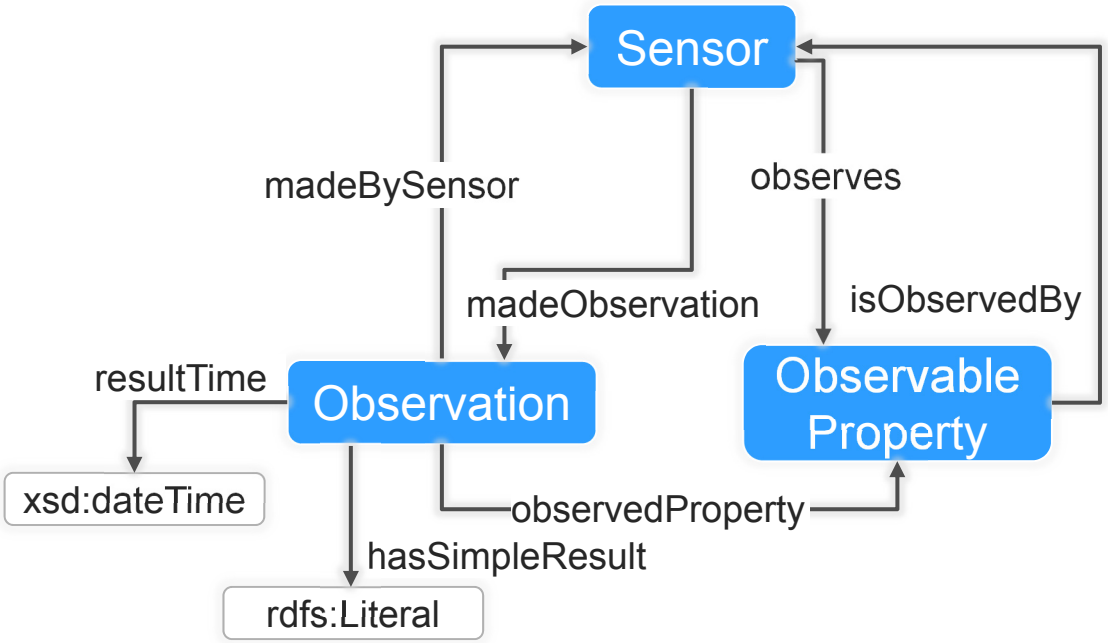
- **Class**: a set of entities of a specific domain
- **Relation**: a semantic link among classes, also called **object property**



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**



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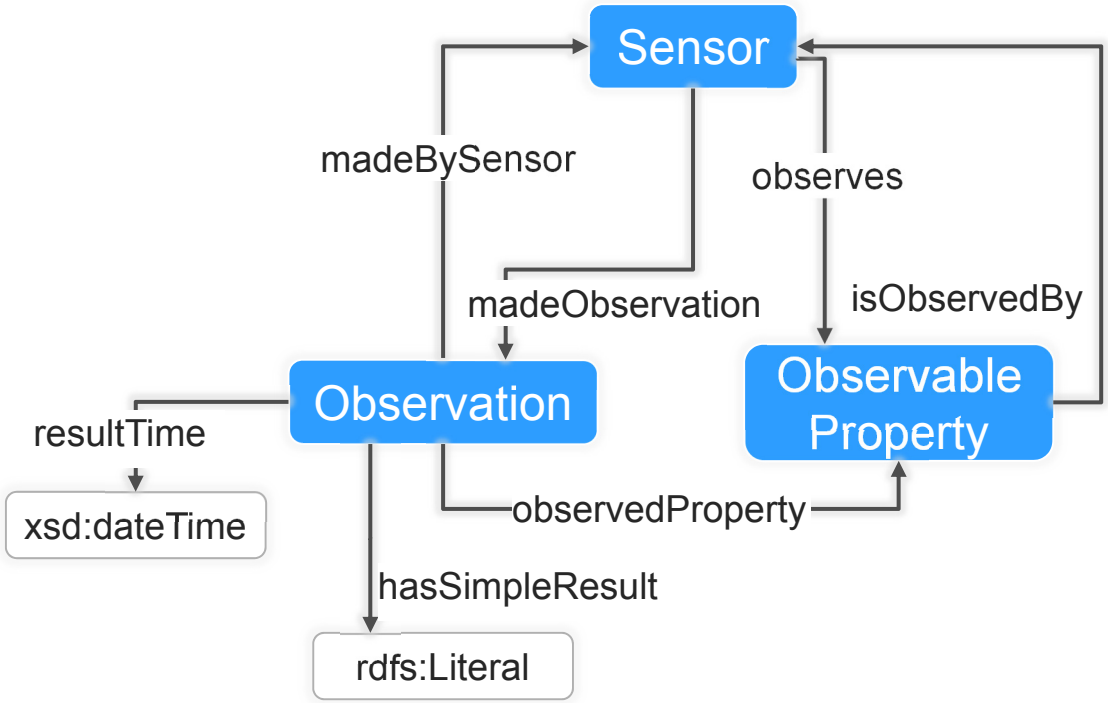
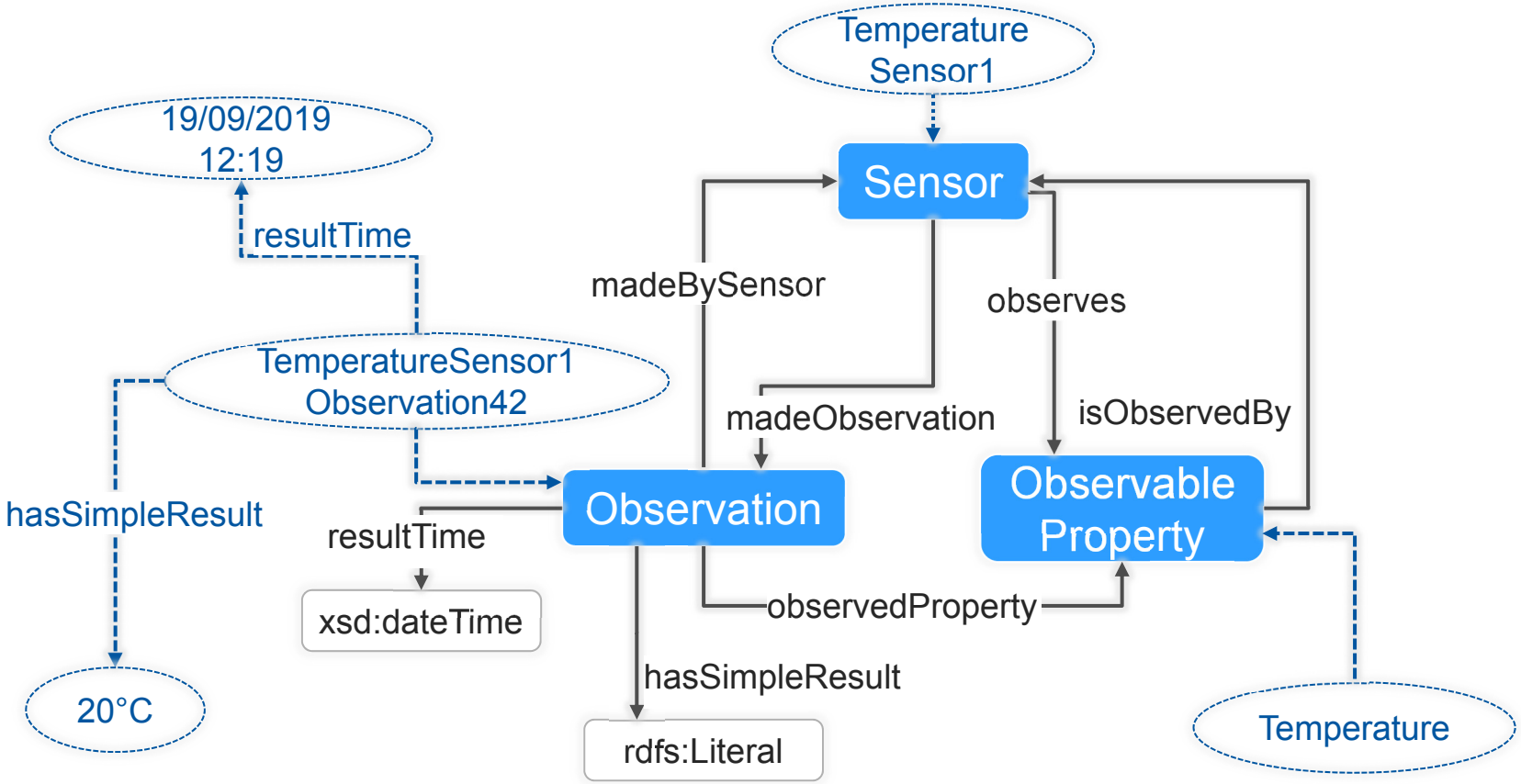
Knowledge Base (KB)



Excerpt from SOSA ontology and instances

Knowledge Base (KB)

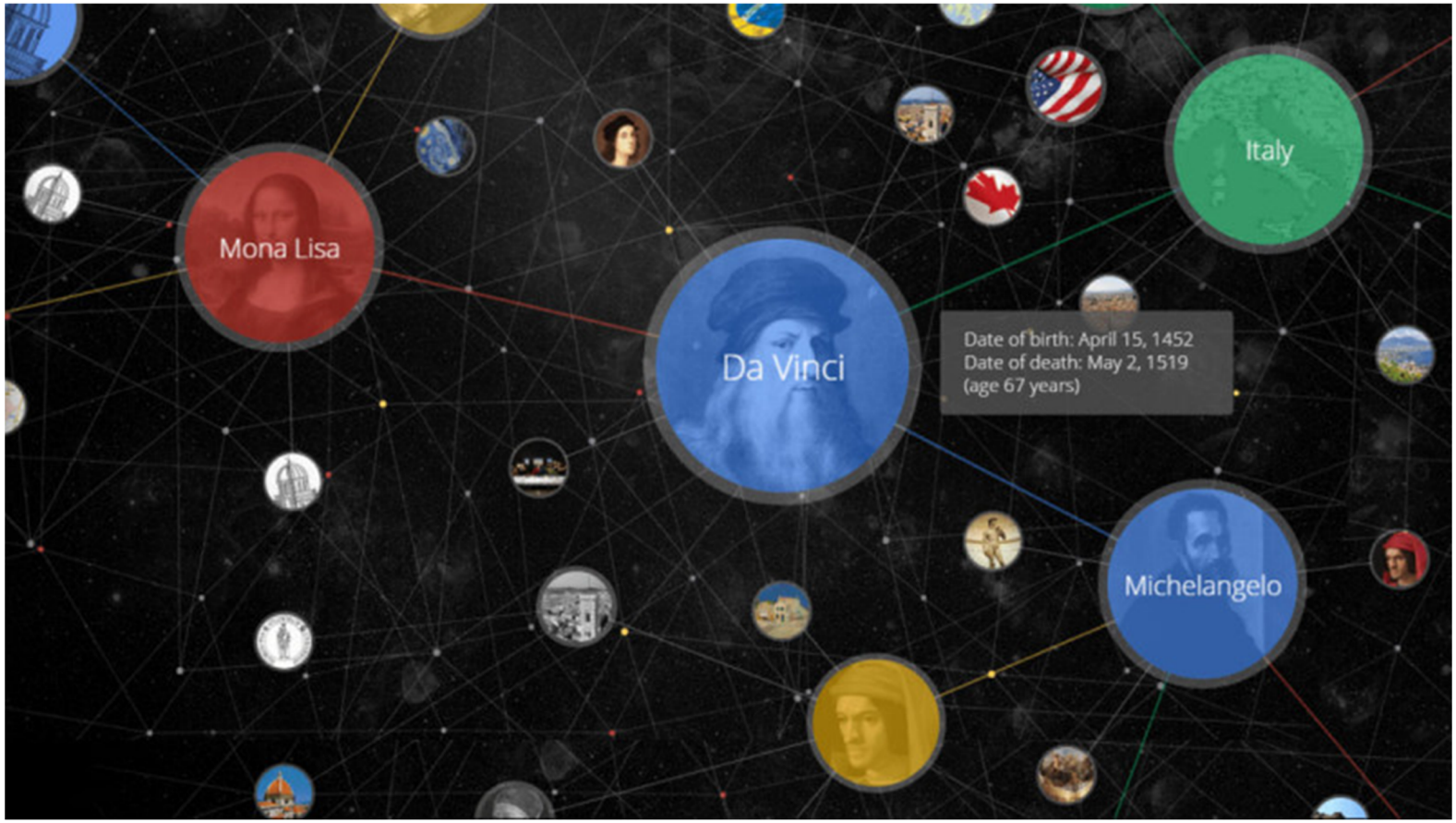
Individual instances of domain's classes and properties



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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- **State of the Art & Methodology**
- The Use Case of the IEDM Domain Ontology
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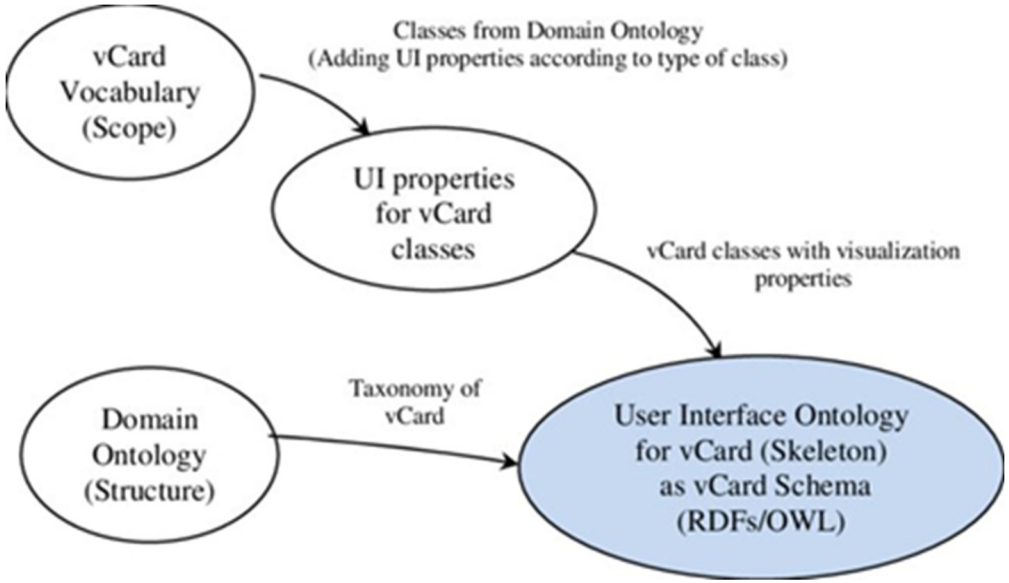
Ontology-based UI Development

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

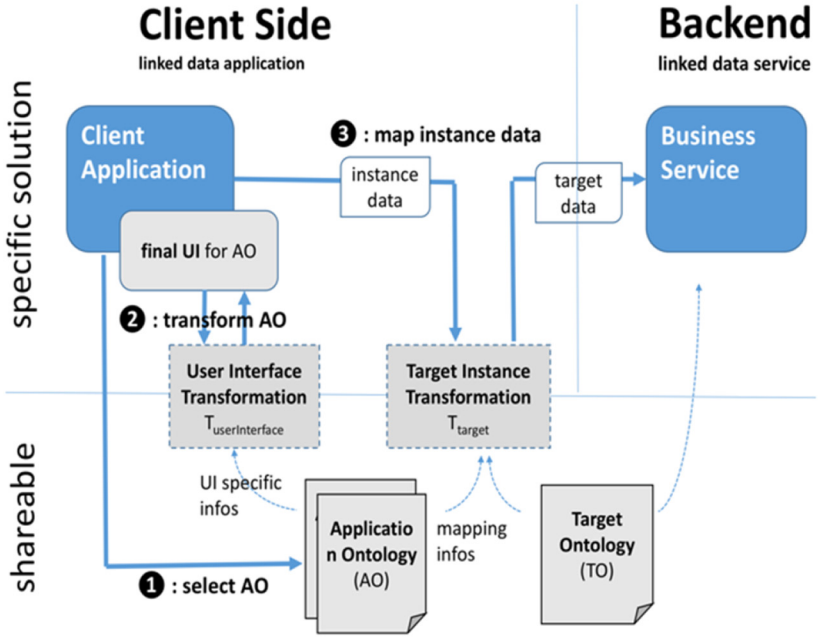


*S. K. Shahzad, "Ontology-based User Interface Development: User Experience Elements Pattern", Journal of Universal Computer Science, 17, 7, 2011, pp. 1078-108

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	×			

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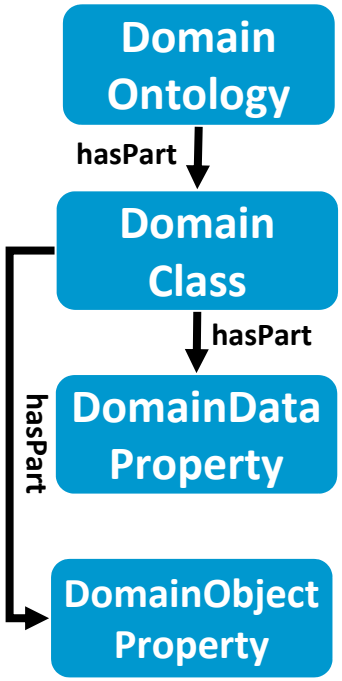
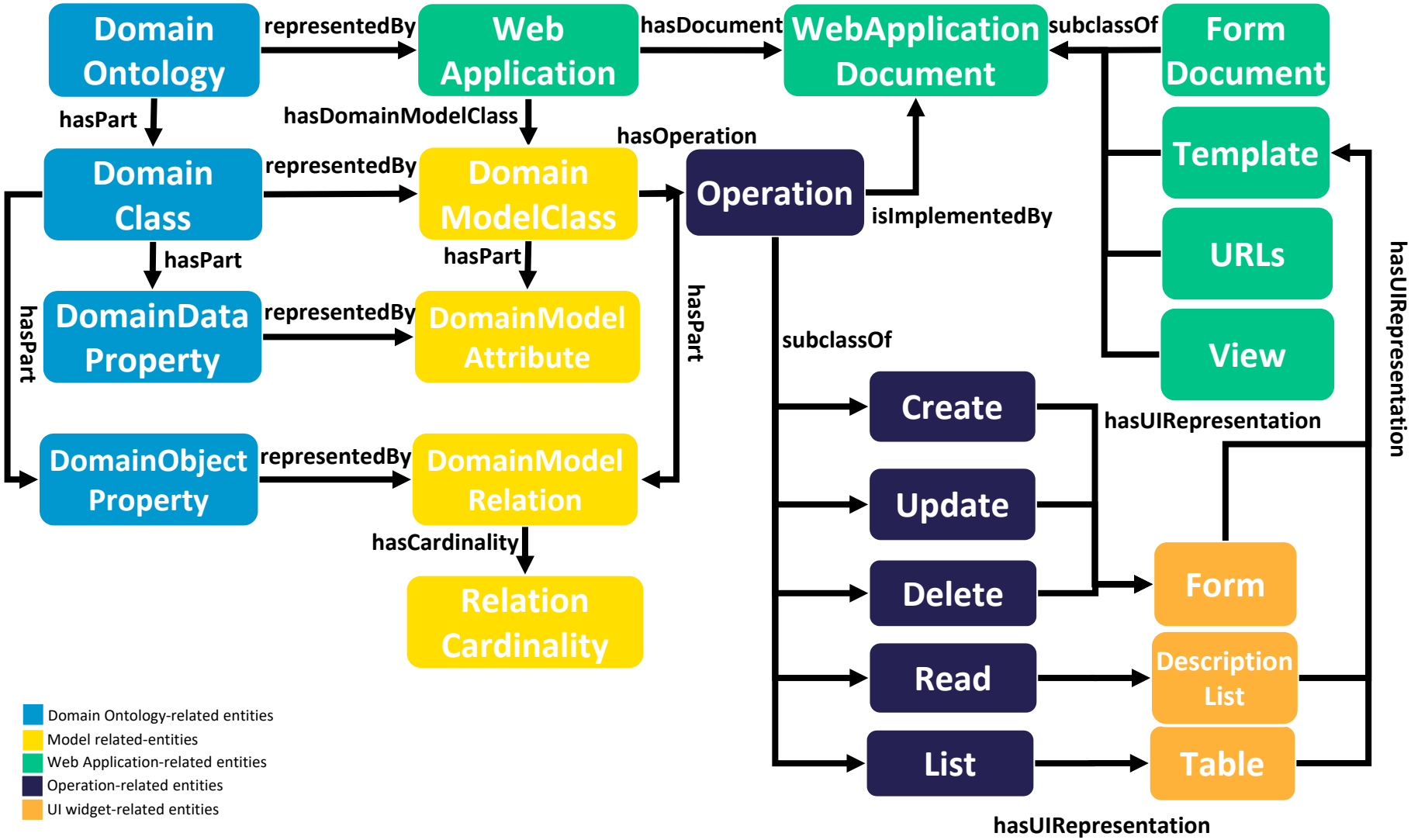
Ontology-based Web Application Ontology (OWAO)



Domain Ontology-related entities

Ontology-based Web Application Ontology (OWAO)



Web Application Generator (GenAppi)

Loading domain and OWAO ontologies

Domain Ontology (DO)

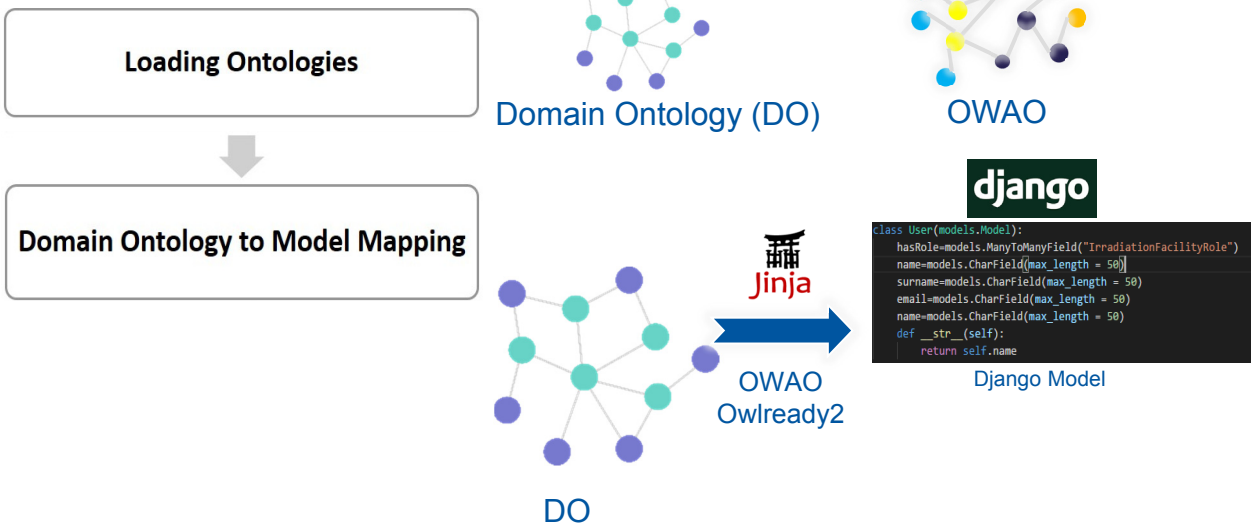
OWAO

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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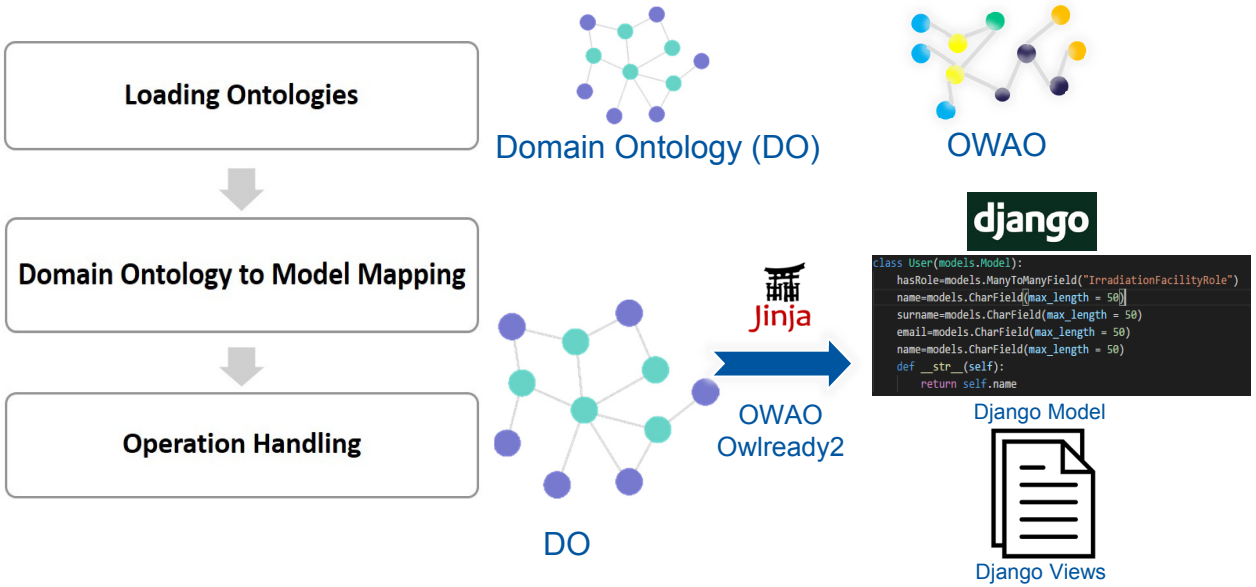
Generating Django view files for data operations (CRUD)



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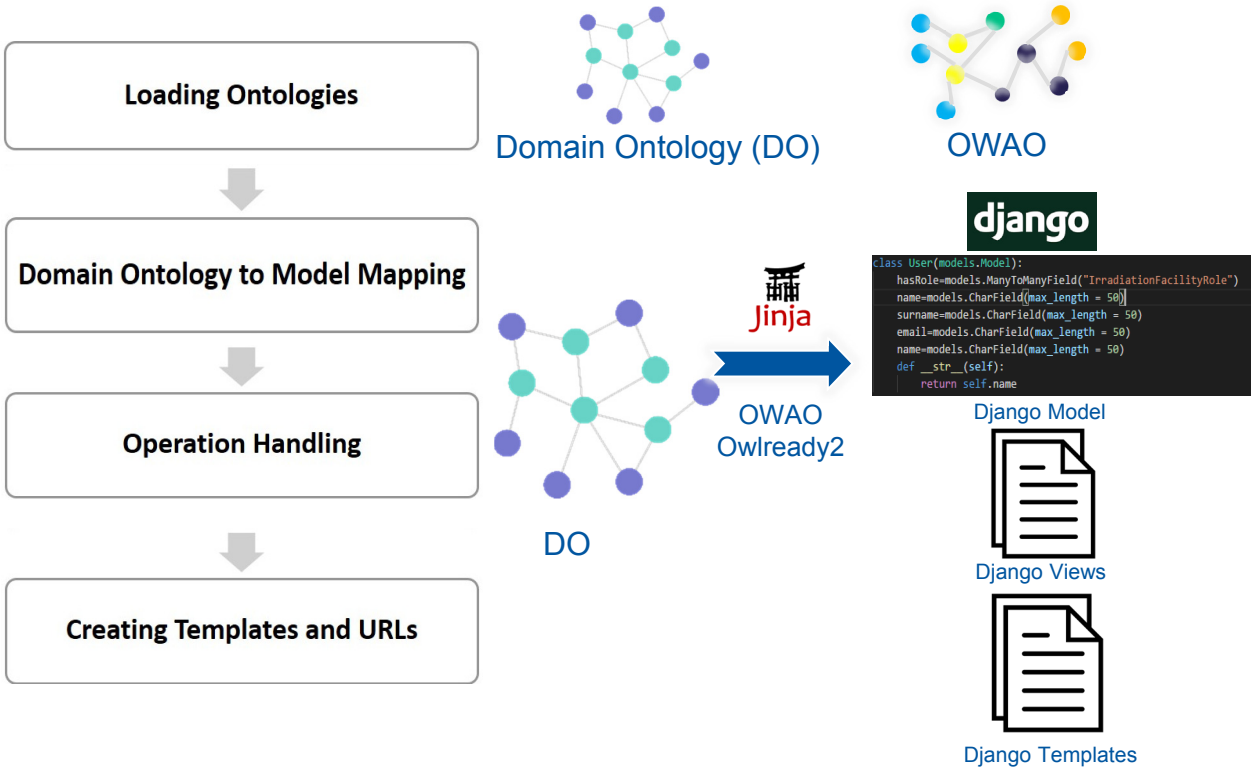

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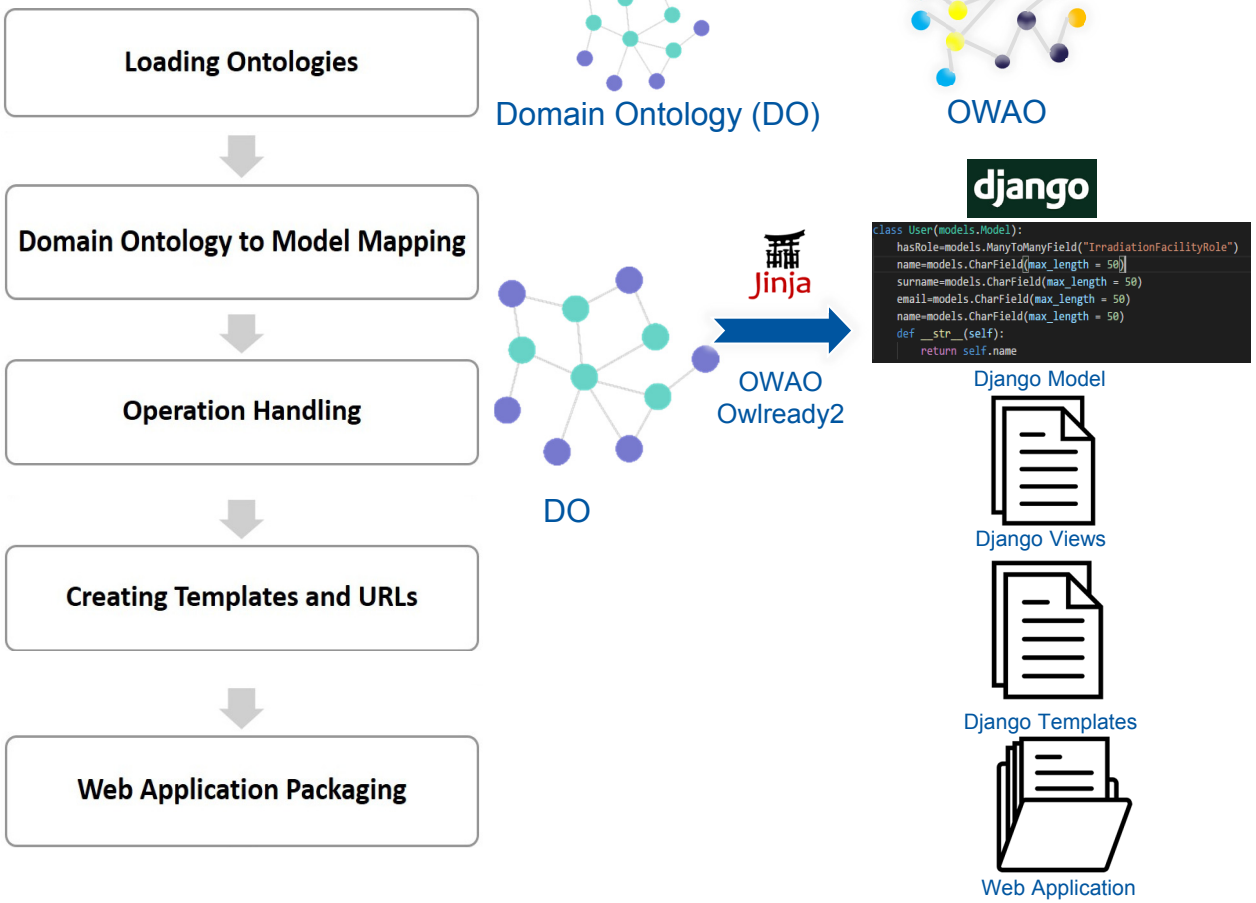
Grouping files in specific directories



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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)

Creating Django Template and URLs files for the UI

Grouping files in specific directories

Migrating model and server starting

Loading Ontologies

Domain Ontology to Model Mapping

Operation Handling

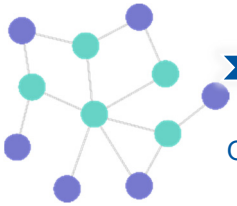
Creating Templates and URLs

Web Application Packaging

Migration and Server Settings

Domain Ontology (DO)

OWAO



DO

Jinja

OWAO
Owlready2

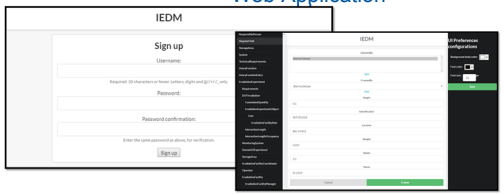
Django Model

Django Views

Django Templates

Web Application

DB or Triple Store



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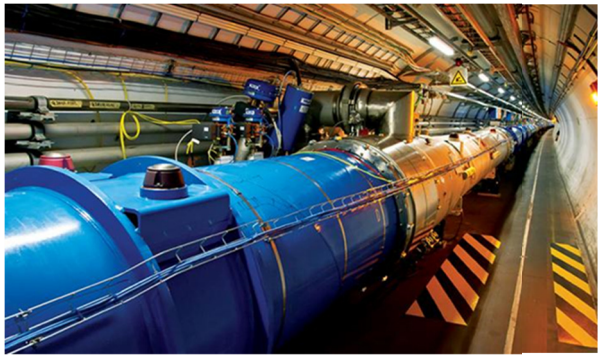
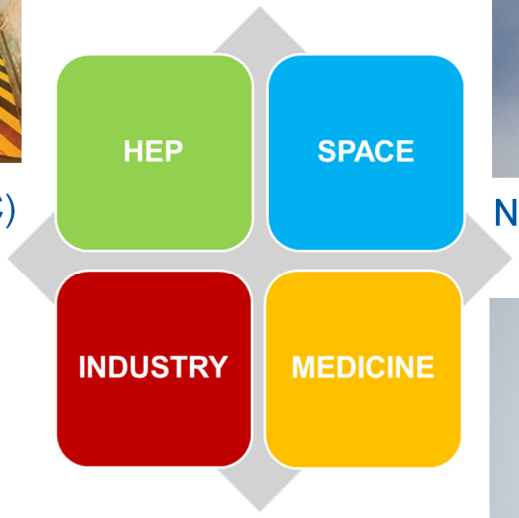
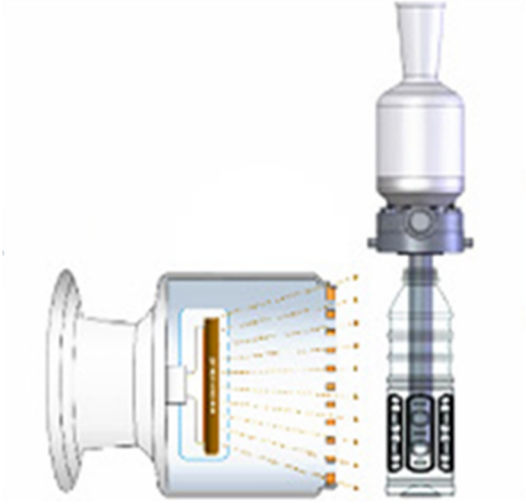
Irradiation Experiment Domain



CERN Large Hadron Collider (LHC)

NASA spacecraft



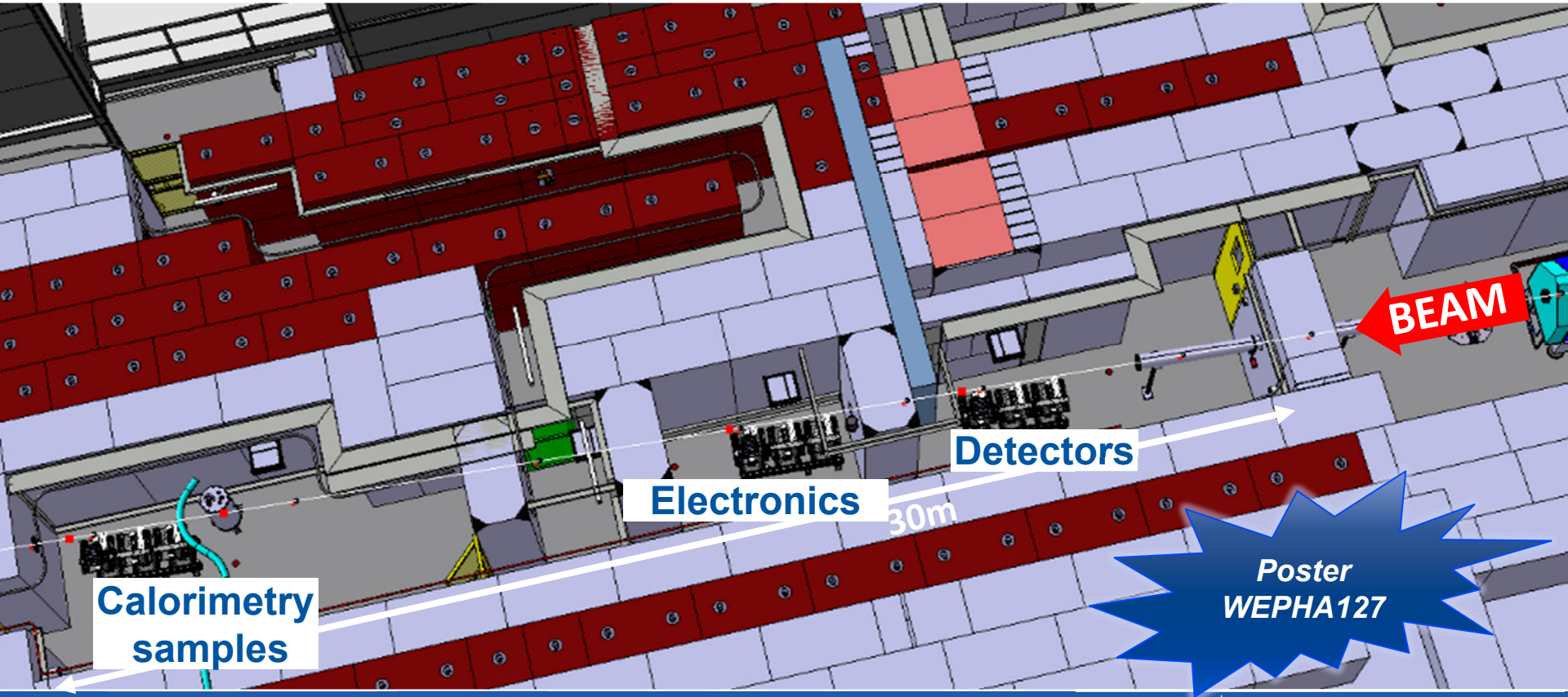


Bottle sterilization by electron beam irradiation

Clinac® iX System linear accelerator

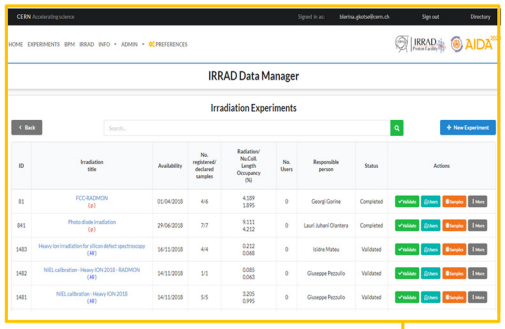
CERN Proton Irradiation Facility (IRRAD)

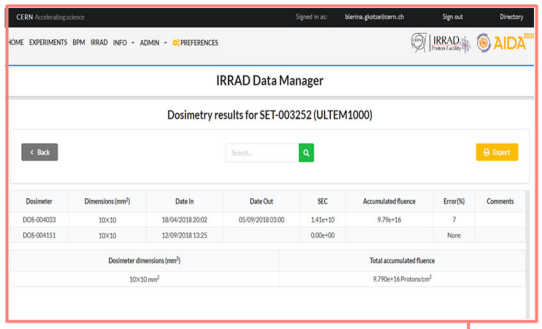
- A **reference facility** for **proton irradiation experiments**
- **Testing of components** of the HEP experiments
- In 2018: 81 irradiation experiments, 97 users, 792 samples, 405 dosimeters and 2056 dosimetry measurements

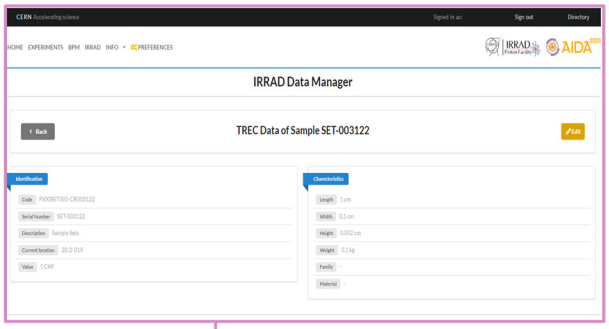


IRRAD Data Manager (IDM)

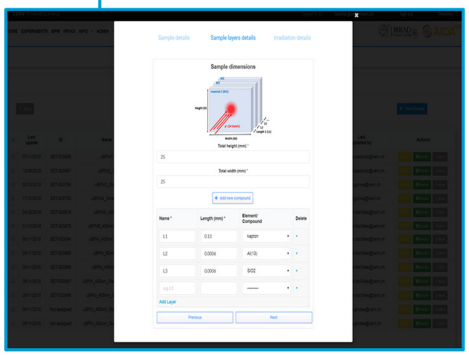
Custom-made web application for the data management of IRRAD

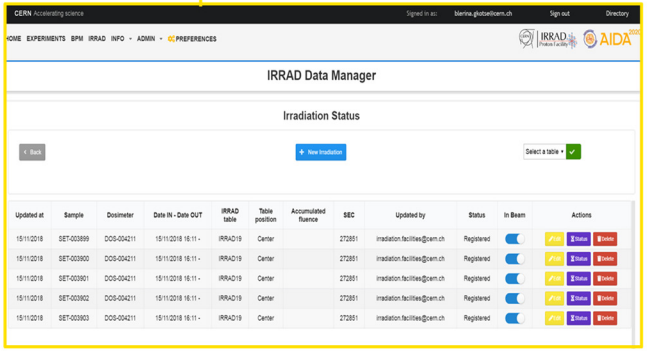


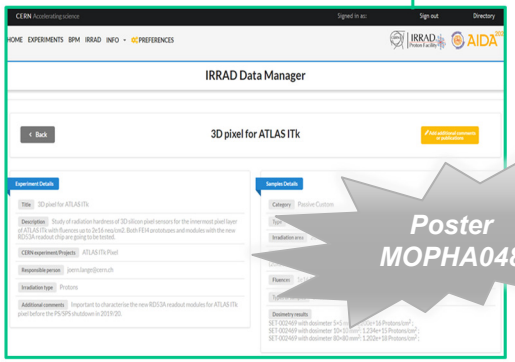




Registration → **Planning** → **Follow-up** → **Dosimetry Results** → **Traceability** → **History**



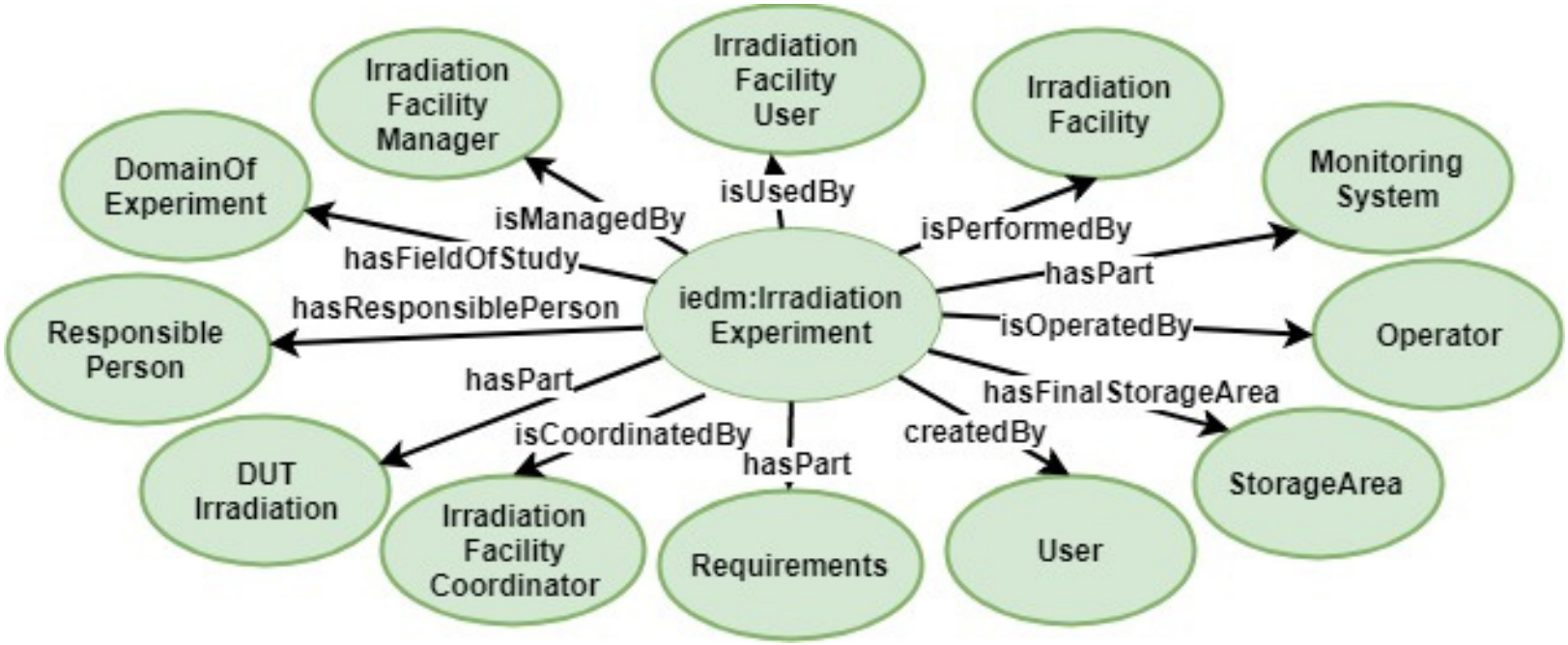




Poster MOPHA048

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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- Ontologies, Knowledge Bases and Knowledge Graphs
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- **Generated Web Application**
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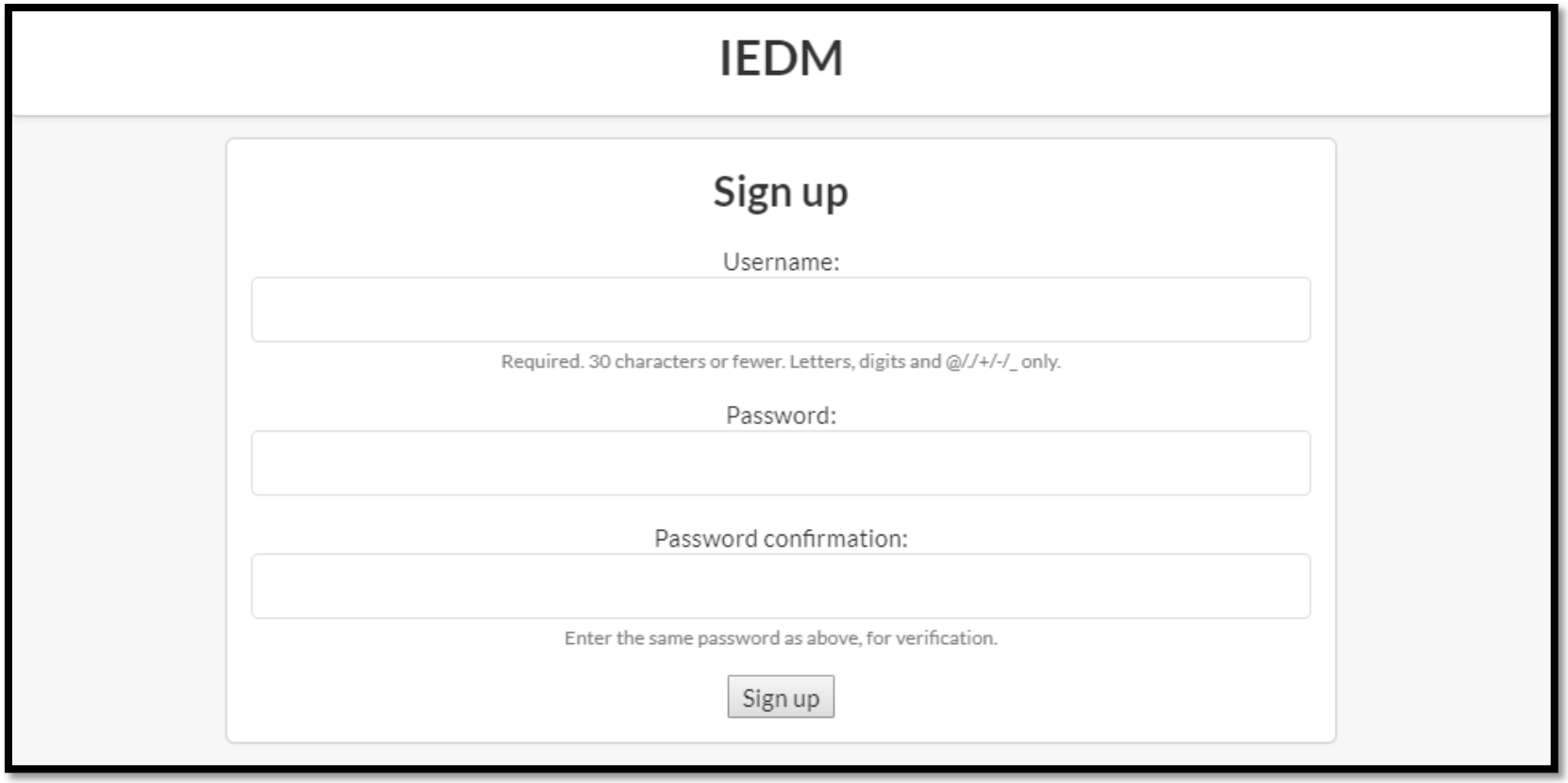
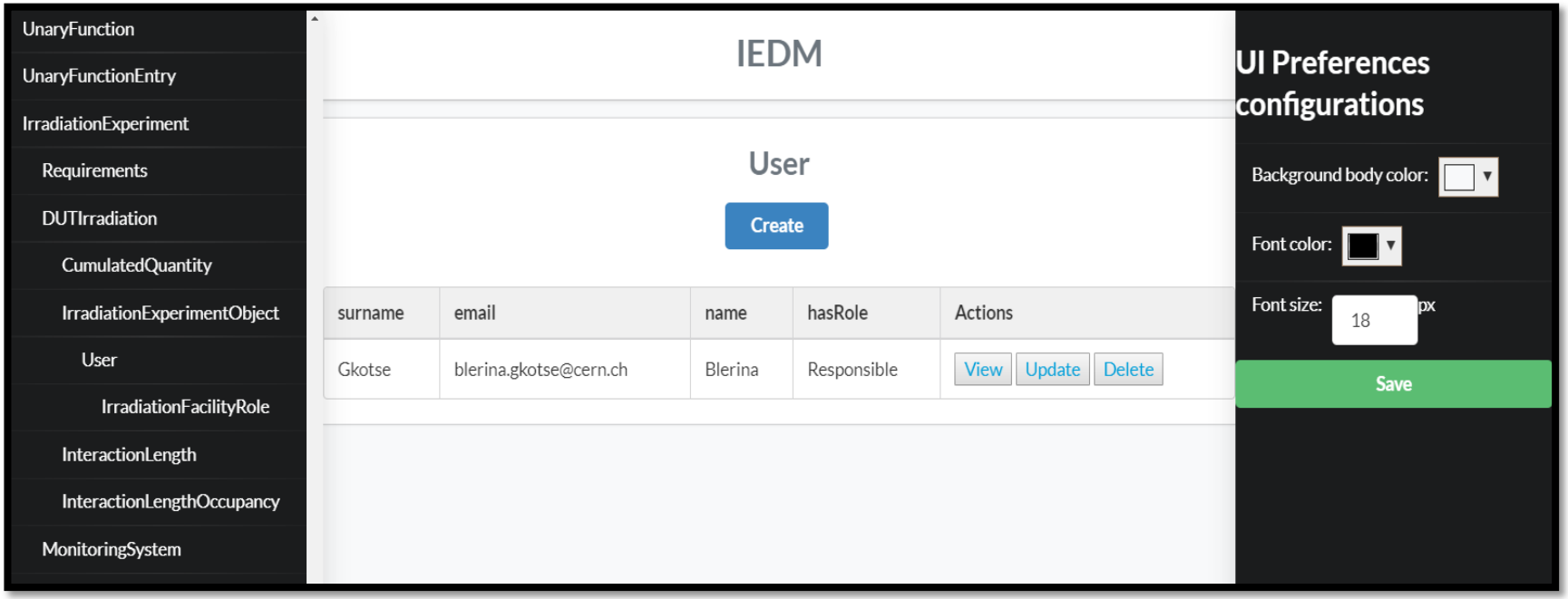
Generated Application: Authentication

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



Generated Application: List

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



Users' list

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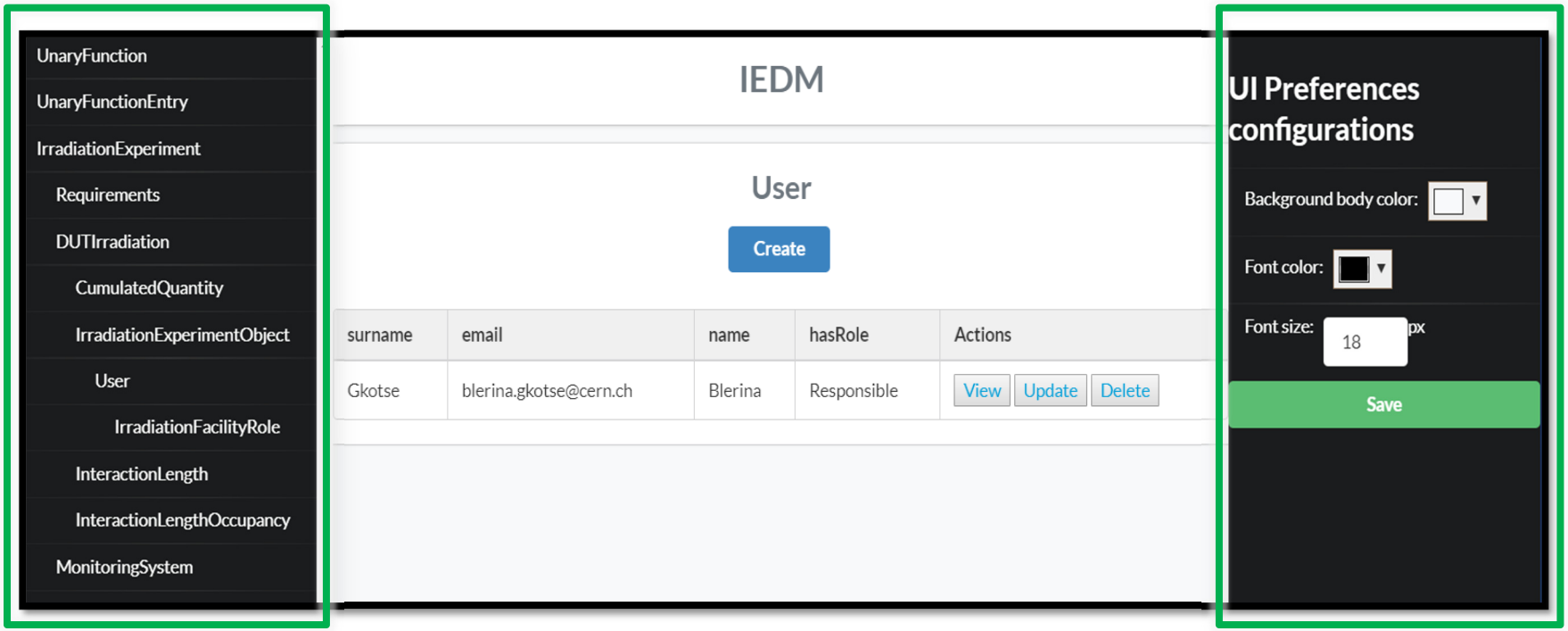
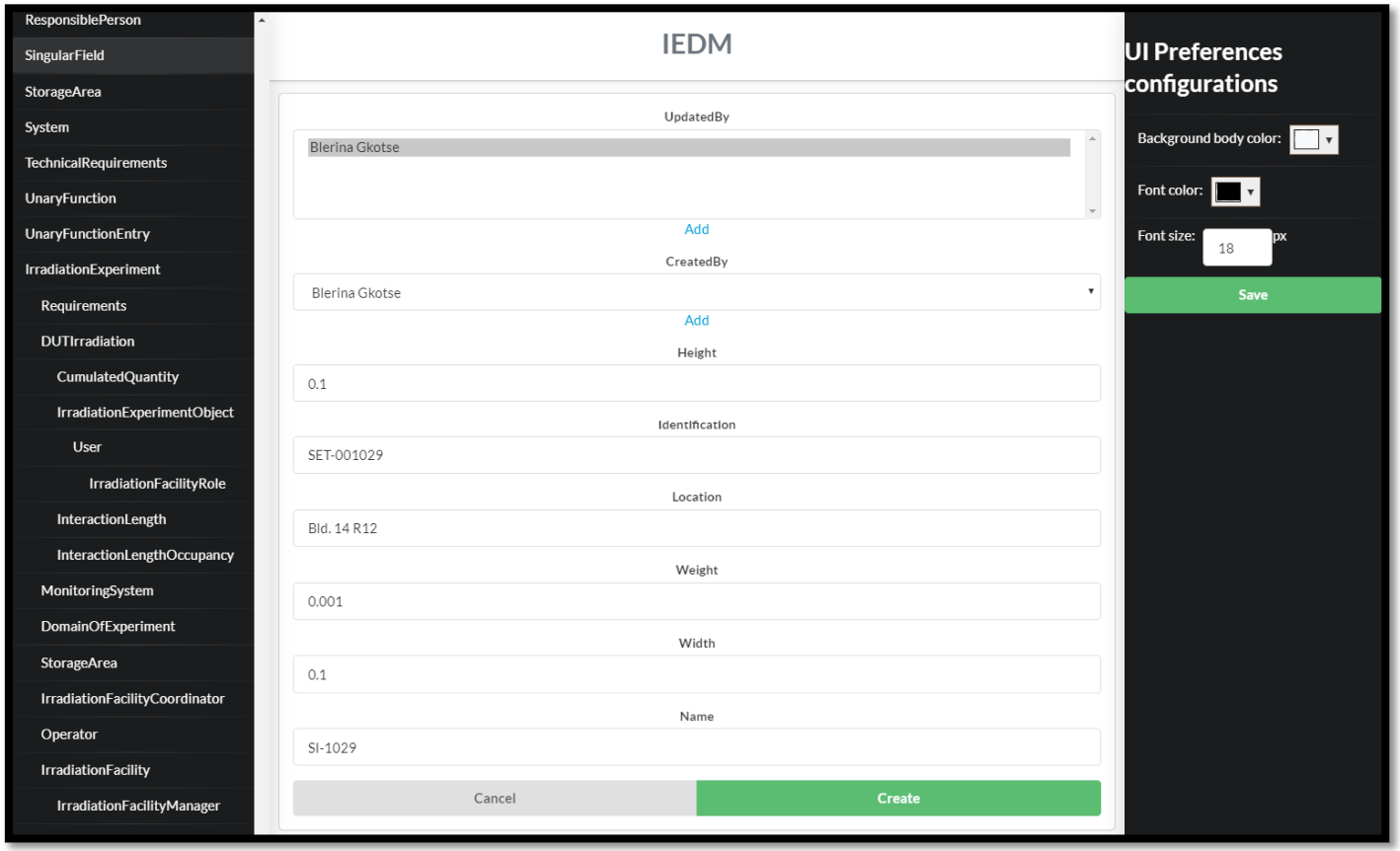


Users' list

Generated Application: Create Instance Form

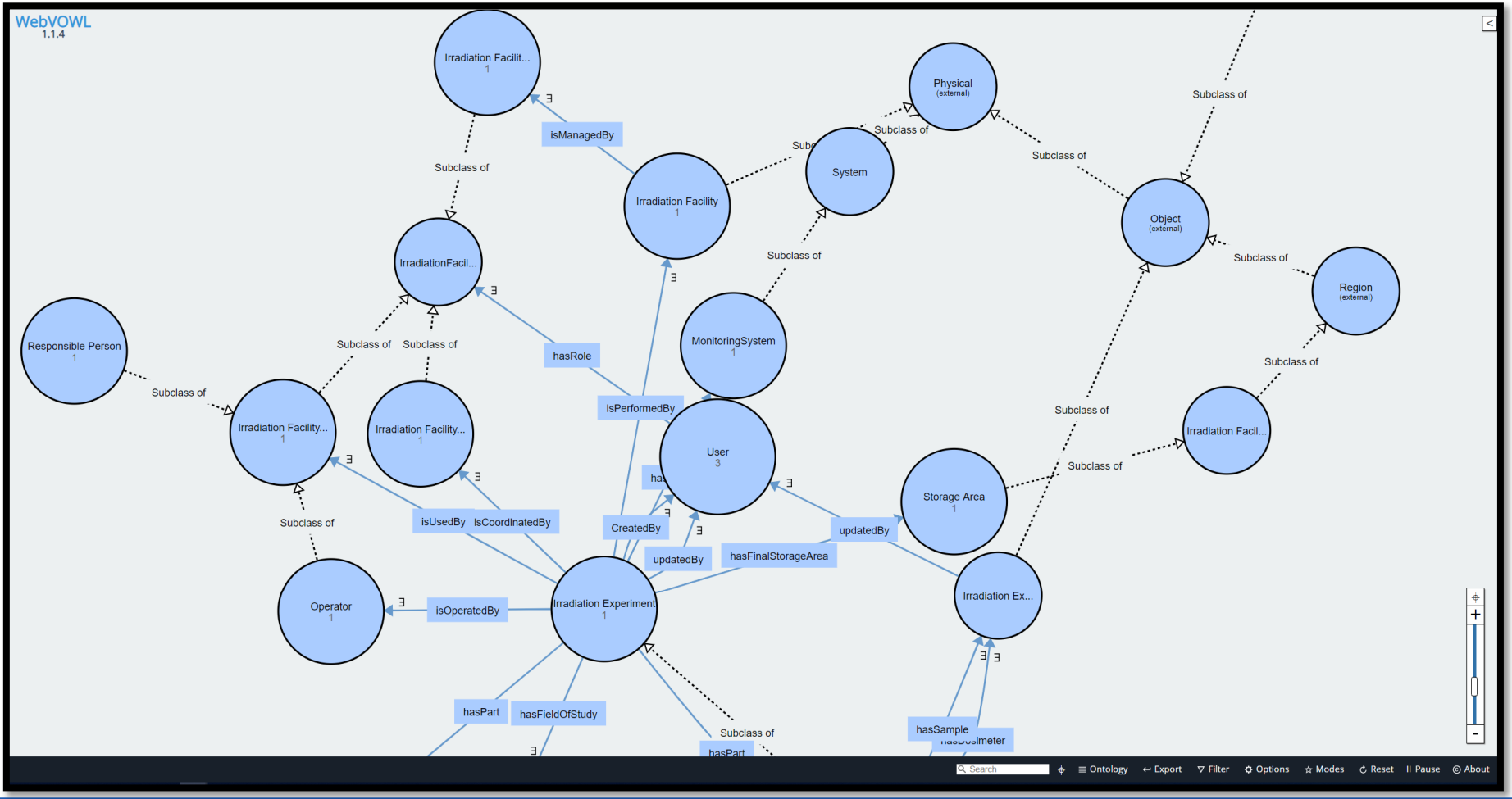
- Input form for each domain ontology class instance
- **Data properties = input fields**
- **Object properties = selection fields** and **links** to the corresponding **class forms**



Registering an Irradiation Experiment Object

Generated Application: Ontology Visualisation

Domain ontology (IEDM) visualized using **WebVOWL**



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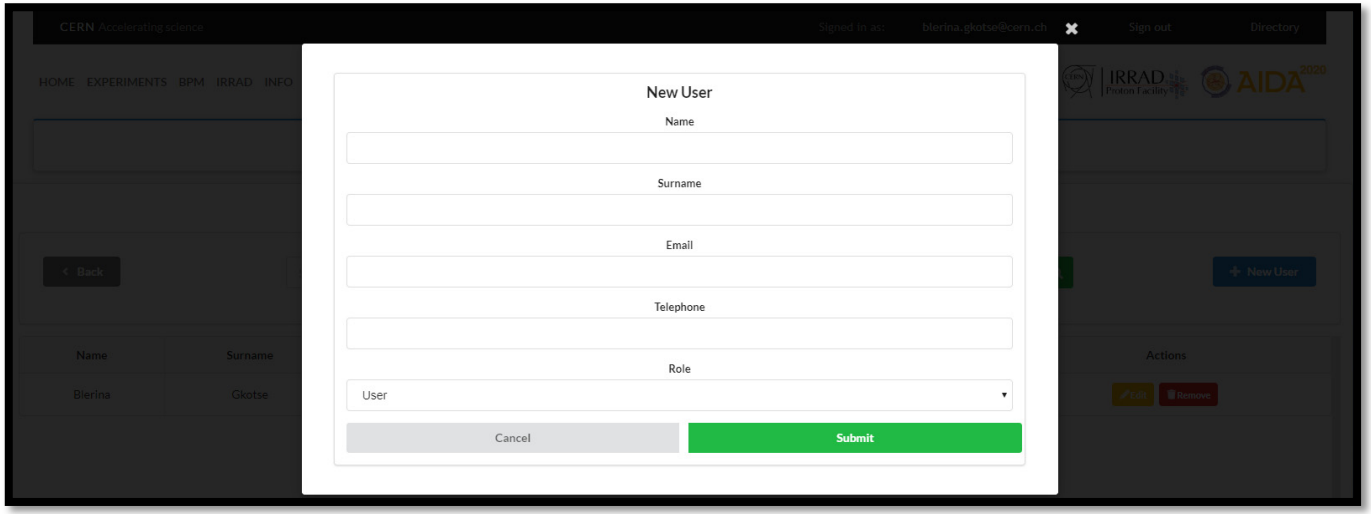
Generated Web Application vs. IDM

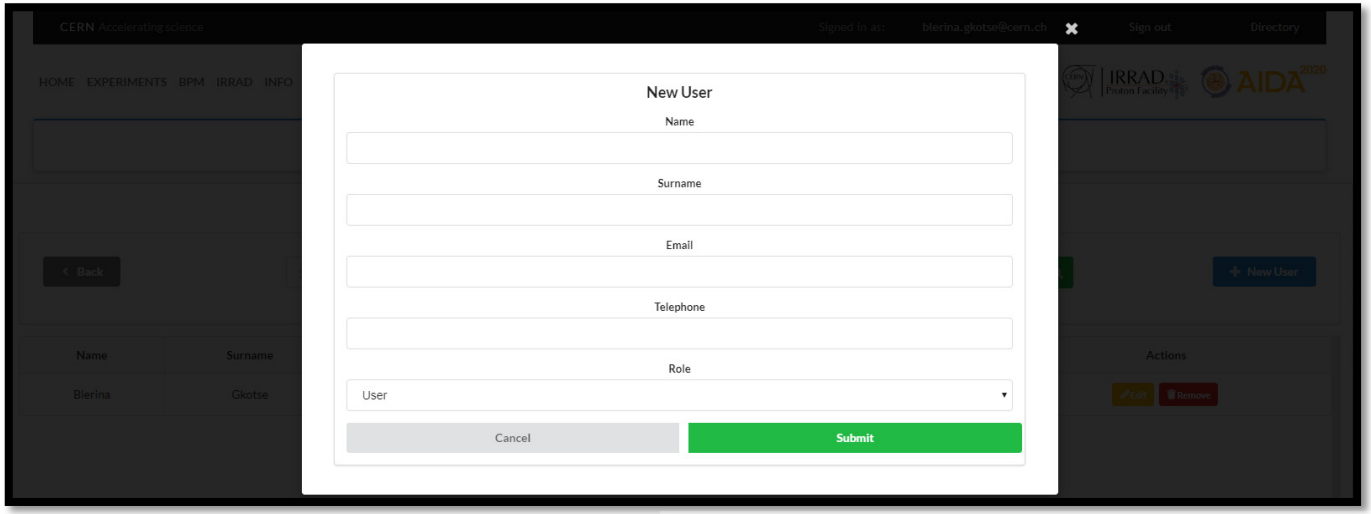
	IDM	Generated Web Application
Purpose	IRRAD facility data management	any domain
Software infrastructure	CERN	free and open-source
Storage	Oracle database	any relational database, ontology or triple store
Web Semantic technologies	no	yes, allowing for data integration
Functionalities	more advanced (e.g.,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

User Interfaces Comparison: Create Form



IDM create instance form

User Interfaces Comparison: Create Form



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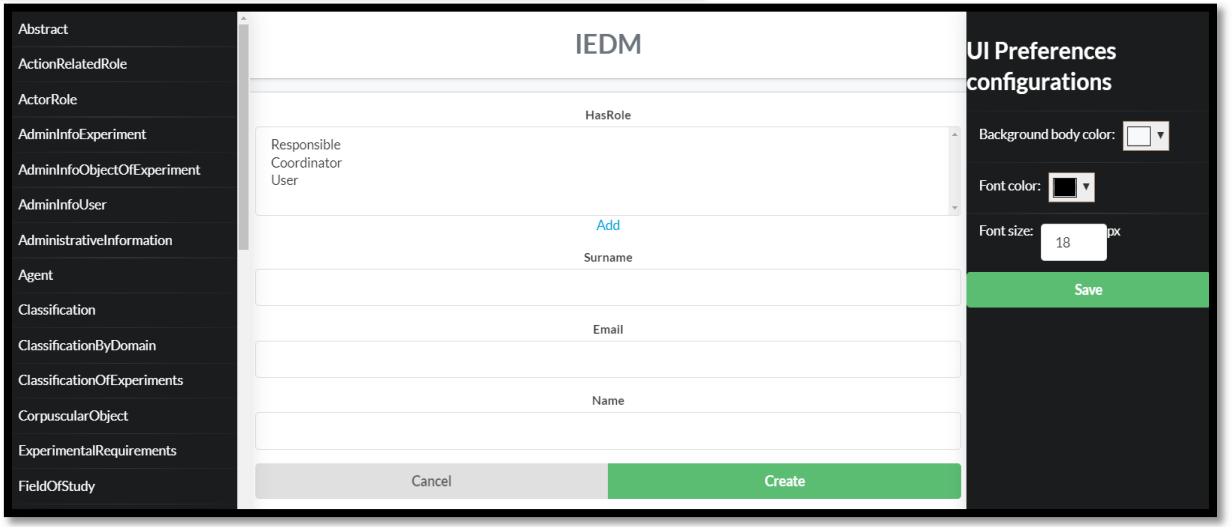
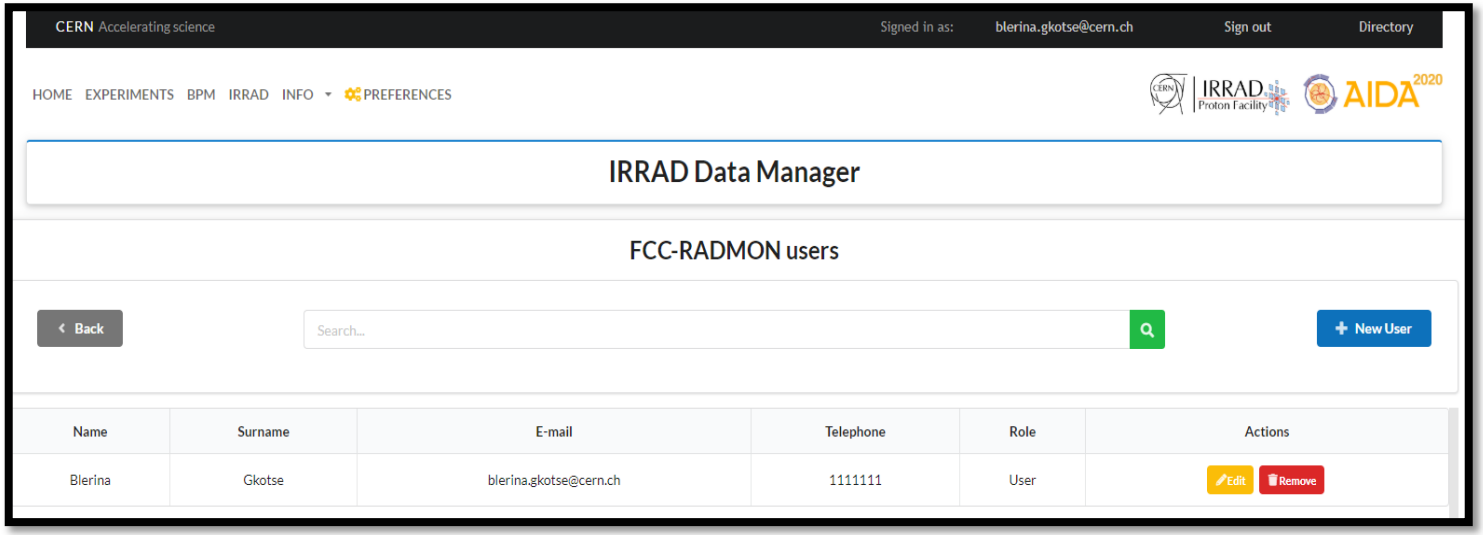


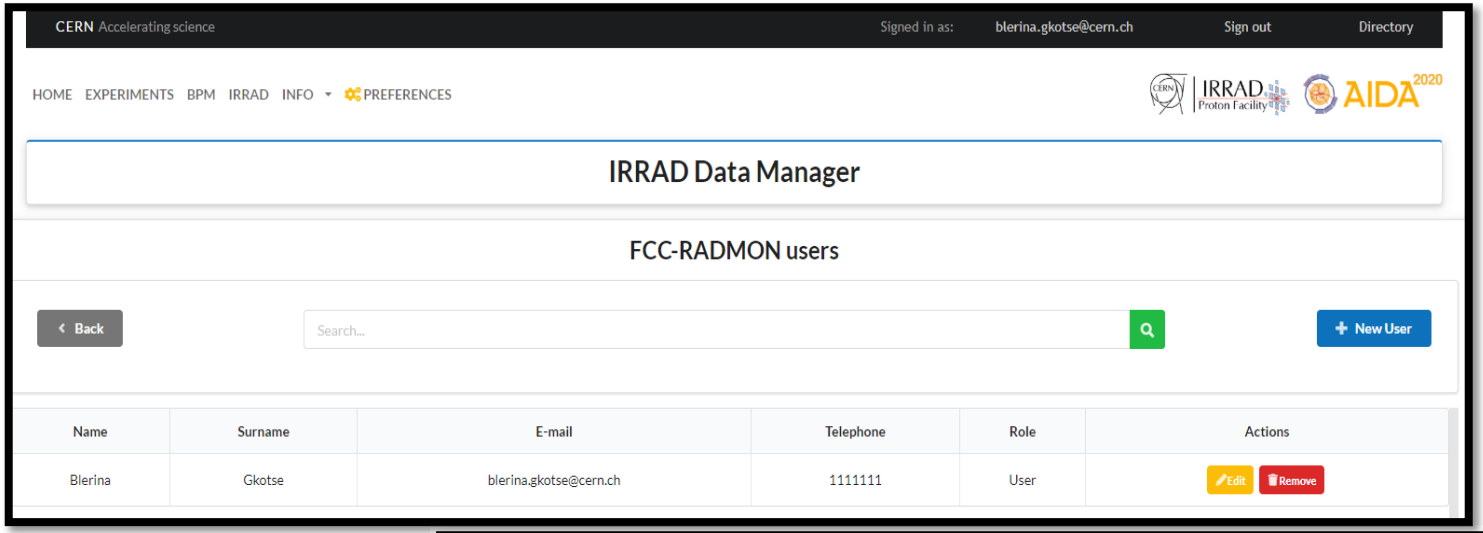
Generated application create instance form

User Interfaces Comparison: List Table

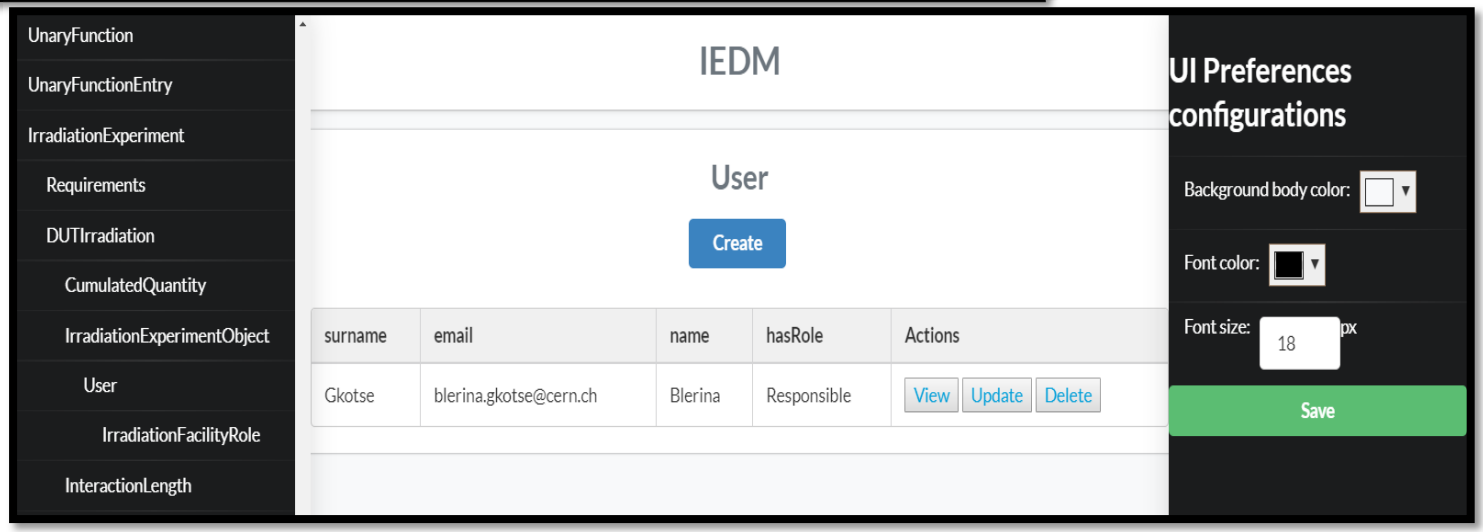


IDM list table

User Interfaces Comparison: List Table



IDM list table



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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