Knowledge-Graph-based Graphical User Interface Generation for the CERN Proton Irradiation Facility

DATA SCIENCE SUMMER SCHOOL

B. Gkotse[1,2], M. Glaser[1], P. Jouvelot[2], E. Matli[1], G. Pezzullo[1], F. Ravotti[1]

[1] European Organization for Nuclear Research, CERN EP-DT-DD, Geneva, Switzerland
[2] MINES ParisTech, PSL University, Paris, France

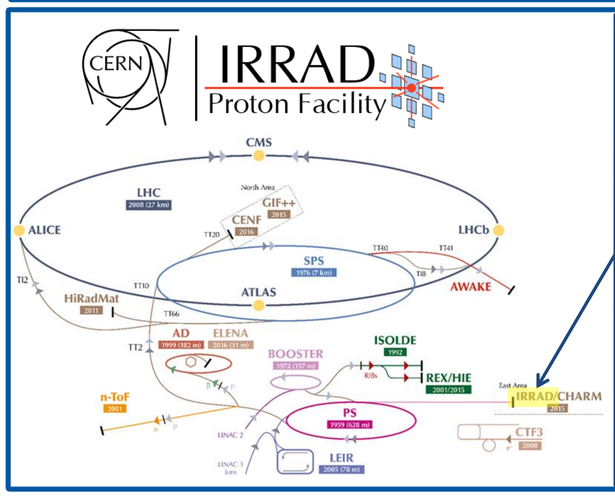
Blerina.Gkotse@cern.ch

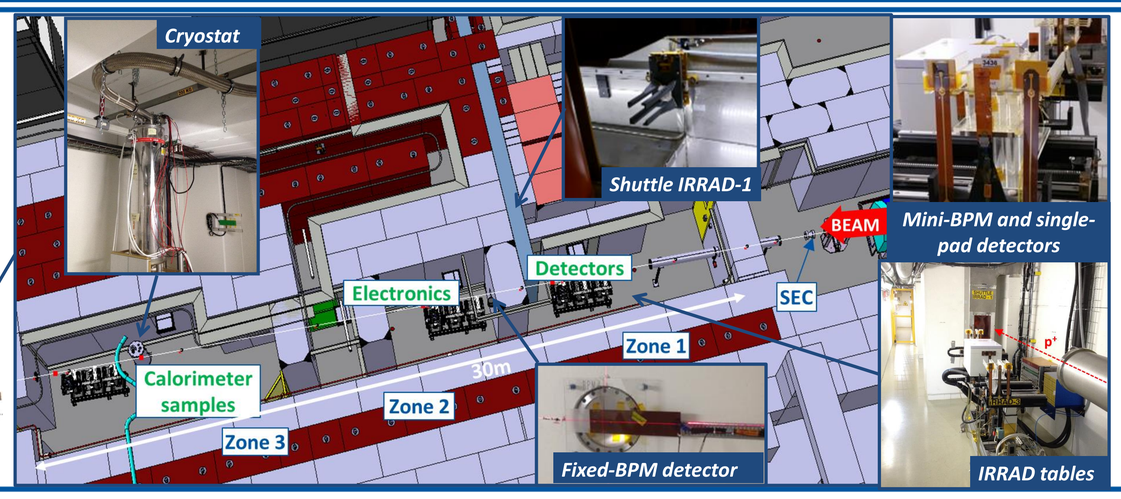
Abstract

At CERN physicist and engineers probe the fundamental structure of the universe. They develop and use particle accelerators for high-energy physics experiments to study the basic constituents of matter, the fundamental particles. Most of the electronic components and systems as well as materials used in these scientific instruments have to be qualified for their radiation resistance before being installed in the CERN accelerators. Irradiation facilities are used to perform these qualifications.

After performing a thorough survey on irradiation facilities characteristics and information systems, we are developing an Irradiation Facility knowledge graph, to be used for the automatic generation of adaptive graphical user interfaces (GUI) for the control of such infrastructures. Since actual instances of GUIs are not initially available in our framework, this knowledge graph will be used for generating the HTML and CSS code of (plausible) instances of different types of facilities GUIs. These instances will be then fed as input to a Neural Network with the aim of training it to generate automatically dedicated GUI code. This system will be later tested and validated within the development of the Proton Irradiation Facility (IRRAD) Data Manager (PrIMa) at CERN , which is a reference facility for the qualification of components for high-energy physics.

IRRAD Proton Irradiation Facility





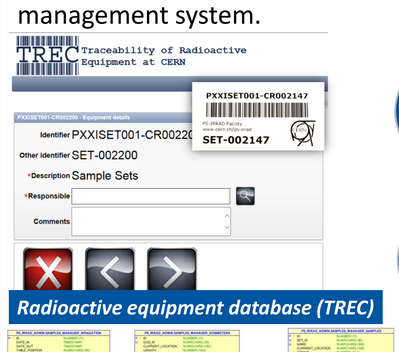
Testing components for HEP experiments

- Proton beam of 24 GeV/c momentum and 12×12 mm^2 size
- Spill of 400 ms length, repeated every ~10 s
- Total 1×10^{16} cm^{-2} proton fluence in 14 days
- Samples scanned across the beam (10×10 cm^2)
- Irradiation at low temperature (-25 °C)
- LHe-filled cryostat (1.9 K)

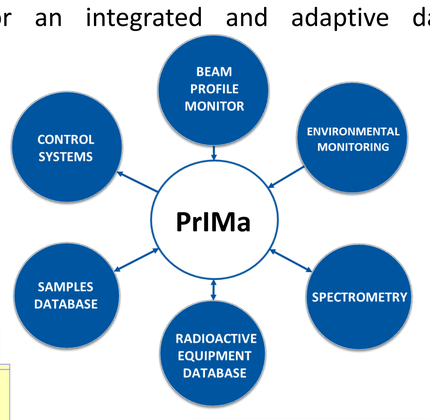
cern.ch/ps-irrad

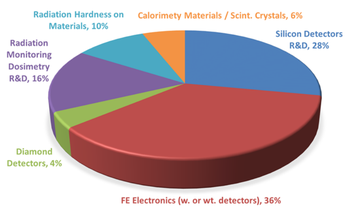
PrIMa, the IRRAD Data Manager

More than 800 samples were irradiated in 2017 and this number is increasing year by year. The amount of data to be processed (samples and users data and additional information from spectrometry and for samples traceability) calls for an integrated and adaptive data management system.

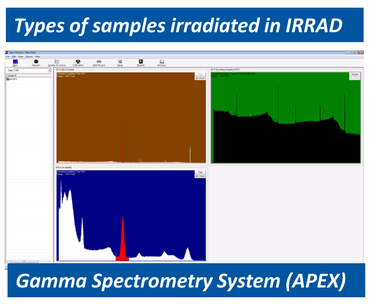


Radioactive equipment database (TREC)

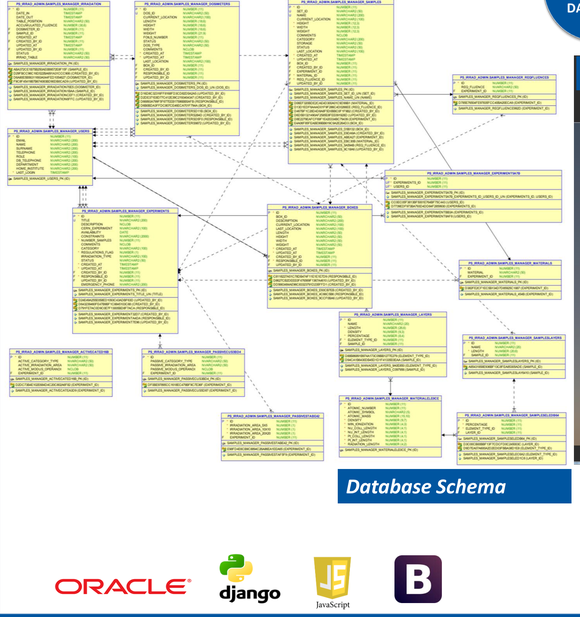




Types of samples irradiated in IRRAD

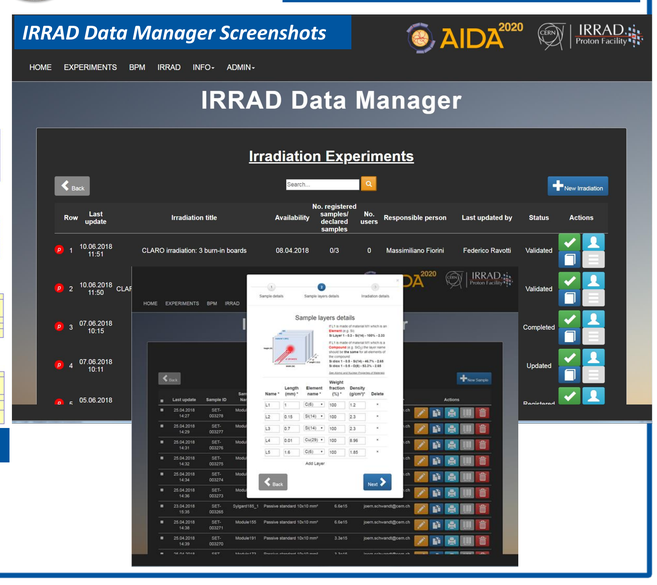


Gamma Spectrometry System (APEX)



Database Schema

IRRAD Data Manager Screenshots

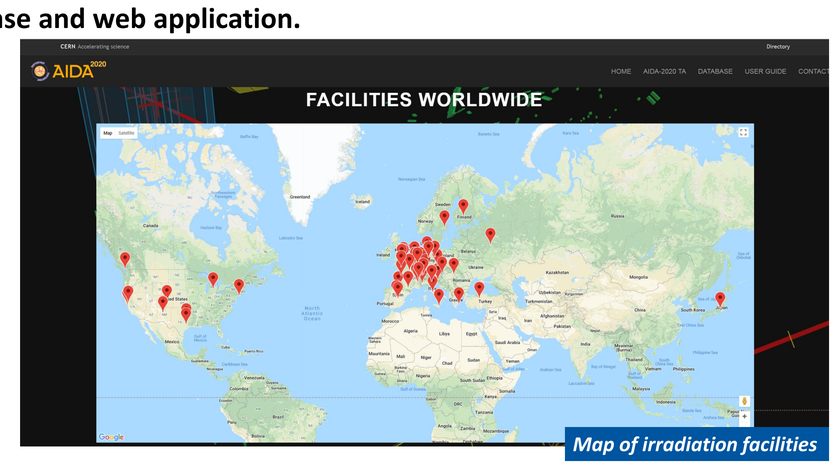


Irradiation Facilities Survey

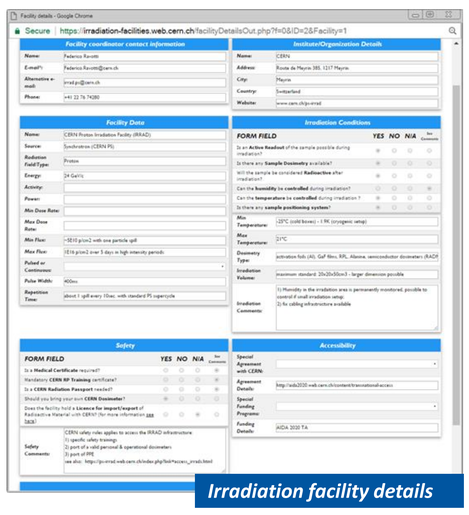
We conducted an extensive survey on the irradiation facilities existing worldwide in order to find the **important semantic entity domains. With the data collected we developed and populated an irradiation facilities database and web application.**

Entity domain examples:

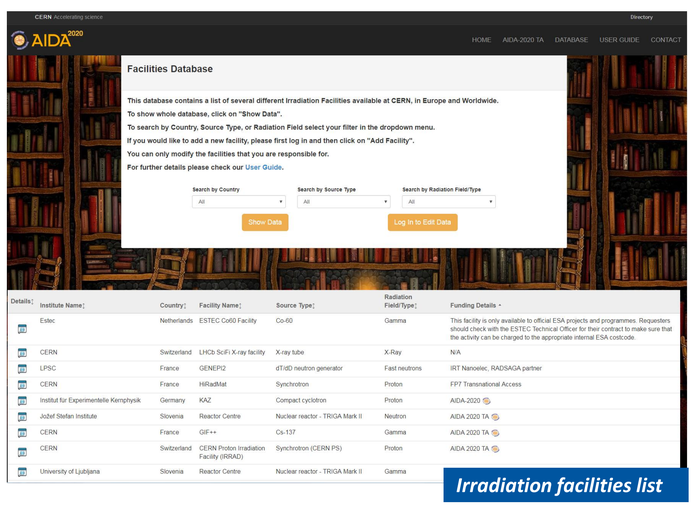
- Contact information
- Institute
- Facility data
- Safety
- Accessibility



Map of irradiation facilities



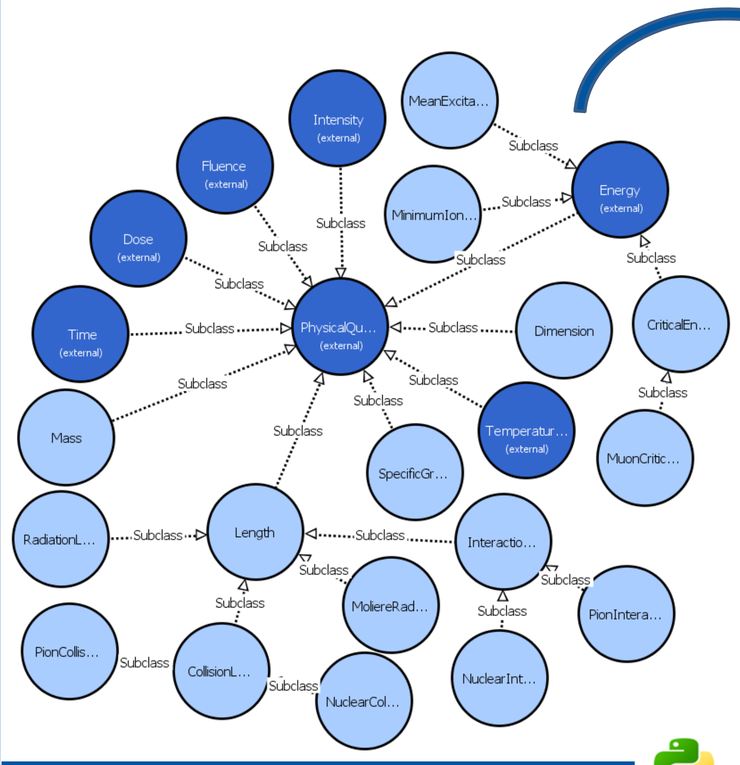
Irradiation facility details



Irradiation facilities list

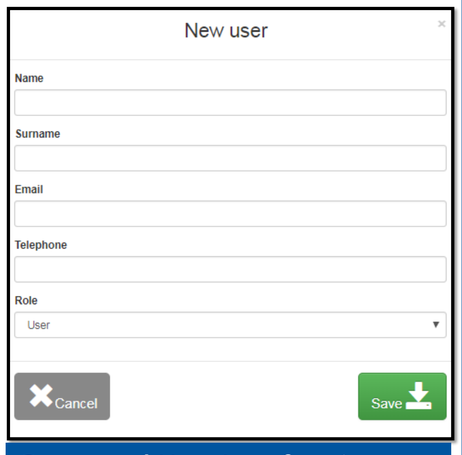
Automatic UI Generation from Knowledge Graphs

By combining the Irradiation Facility, User Interface and Interaction knowledge graphs, Django user interfaces are generated, using the Owlready2, Semantic UI and Jinja2 template tools.



Irradiation Facility and Semantic UI knowledge graphs

KG-to-Django UI code generation

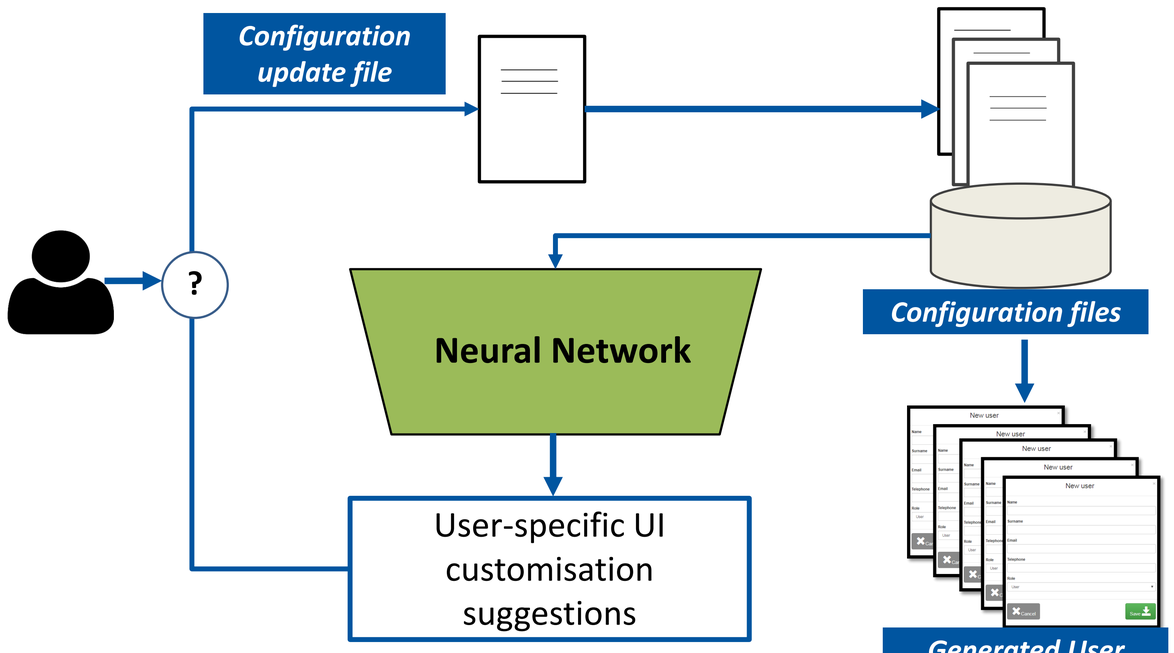


Generated User Interface instance

Lamy JB. *Owlready: Ontology-oriented programming in Python with automatic classification and high level constructs for biomedical ontologies*.. Artificial Intelligence In Medicine 2017;80:11-28

Future work: UI Adaptation

Using generated Django User Interface instances, we intend to perform machine-learning-based classification on the different user configuration files set by the scientists who use the automatically generated data manager. This classification will then enable an semi-automatic UI display customisation in order to adapt the data manager to the users' needs and preferences.



This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement no. 654168.