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MILESTONE REPORT

EXTEND IDM FOR NEW FACILITIES AND DATA COMMUNICATION WITH CAEN DIGIWASTE AND CANBERRA APEX- GAMMA LAB PLATFORMS

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Abstract:

This milestone report details the extension, generalisation, and deployment of the IRRAD Data Manager (IDM) to other CERN and external facilities. A complete workflow has been tested for the data integration of the CAEN DigiWaste platform with IDM. Moreover, new functionalities have been developed for importing and using gamma-spectrometry data in IDM.



**EXTEND IDM FOR NEW FACILITIES AND DATA
COMMUNICATION WITH CAEN
DIGIWASTE AND CANBERRA APEX-
GAMMA LAB PLATFORMS**

Milestone: MS14

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Executive summary

This report describes the customisation and deployment of the IRRAD Data Manager (IDM) to other CERN and external facilities. New features have been developed for integrating data to IDM from CAEN DigiWaste and the CANBERRA gamma spectrometry platforms.

1. INTRODUCTION

In the previous AIDAInnova Milestone report MS13 achieved in M18 (October 2022), the requirements, global architecture, and software design changes for enabling the extension of the IRRAD Data Manager (IDM) have been detailed [1]. In this report, we instead discuss the first deployment of IDM prototypes in other irradiation facilities as well as new functionalities related to the handling and analysis of gamma-spectrometry data and the CAEN API data integration.

While a first prototype of IDM for the Gamma Irradiation Facility at CERN (CERN-GIF++) [2] has been developed and successfully deployed (see section 2), the departure of the staff leading the AIDAInnova task at the ENEA Frascati Neutron generator, ENEA-FNG (associated partner to the Italian INFN-RM1, beneficiary in AIDAInnova) [3] de facto stopped the software deployment work ongoing at ENEA-FNG. Since the contribution of ENEA-FNG aimed to prove that the IDM software tool (originally developed for the CERN Proton Irradiation Facility, IRRAD [4]) could be generalized and deployed in facility infrastructures other than the CERN one, in agreement with the EU Project Office, a change of the target facility for the software deployment from ENEA-FNG to the Fermilab Irradiation Test Area (ITA) in the USA was decided [5]. At Fermilab-ITA the deployment of an extended version of the original IDM tool is also currently ongoing with the support of the CERN team involved in Task 4.3. The requested change of target facility infrastructure does not change the scope of the work and still demonstrates the technical feasibility of the task.

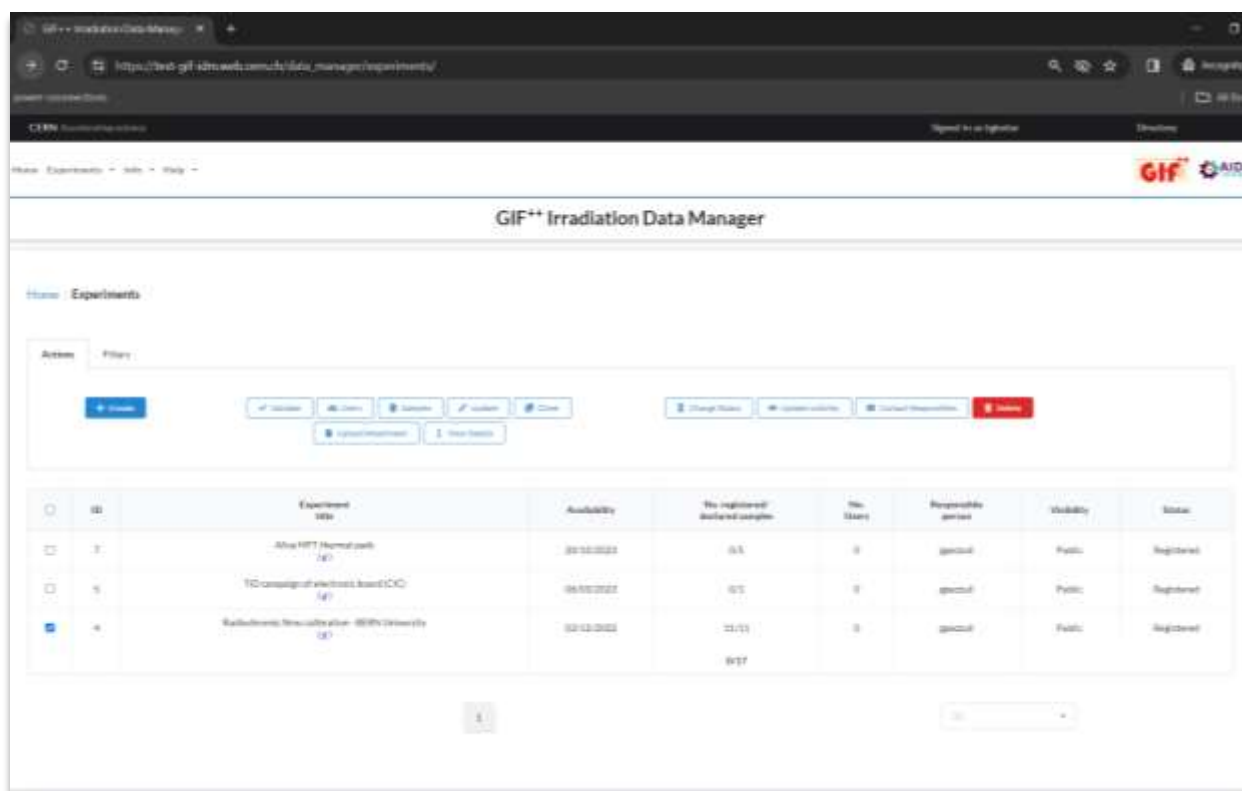
Furthermore, this document describes the tested workflow performed in IRRAD using CAEN RFID tags and the commercial CAEN RadHAND tool for tagging radioactive materials while measuring their dose-rate and detecting the type of radionuclides contained in the material itself. By the integration of the CAEN API data with IDM, these measurements can now be also included in IDM providing a user-friendly and fully integrated interface for the final IDM users.

Finally, this milestone report also includes a new IDM feature related to importing the metal-foil samples gamma-spectrometry data to IDM (from the CANBERRA APEX-gamma platform) and implementing the functionalities for calculating the proton fluence-related values.

2. CERN GIF++ DEPLOYMENT

Following the core requirements and design described in MS13, an IDM instance has been adapted and customised for the CERN Gamma Irradiation Facility (GIF++). The source code is available in a GitLab repository https://gitlab.cern.ch/irrad/gif_idm.git. This instance has been deployed and is currently running on OpenShift, a Platform as a Service (PaaS) provided by the CERN IT infrastructure [6]. The application is accessible under this URL <https://test-gif-idm.web.cern.ch> within the CERN network and has been tested by the GIF++ operators.

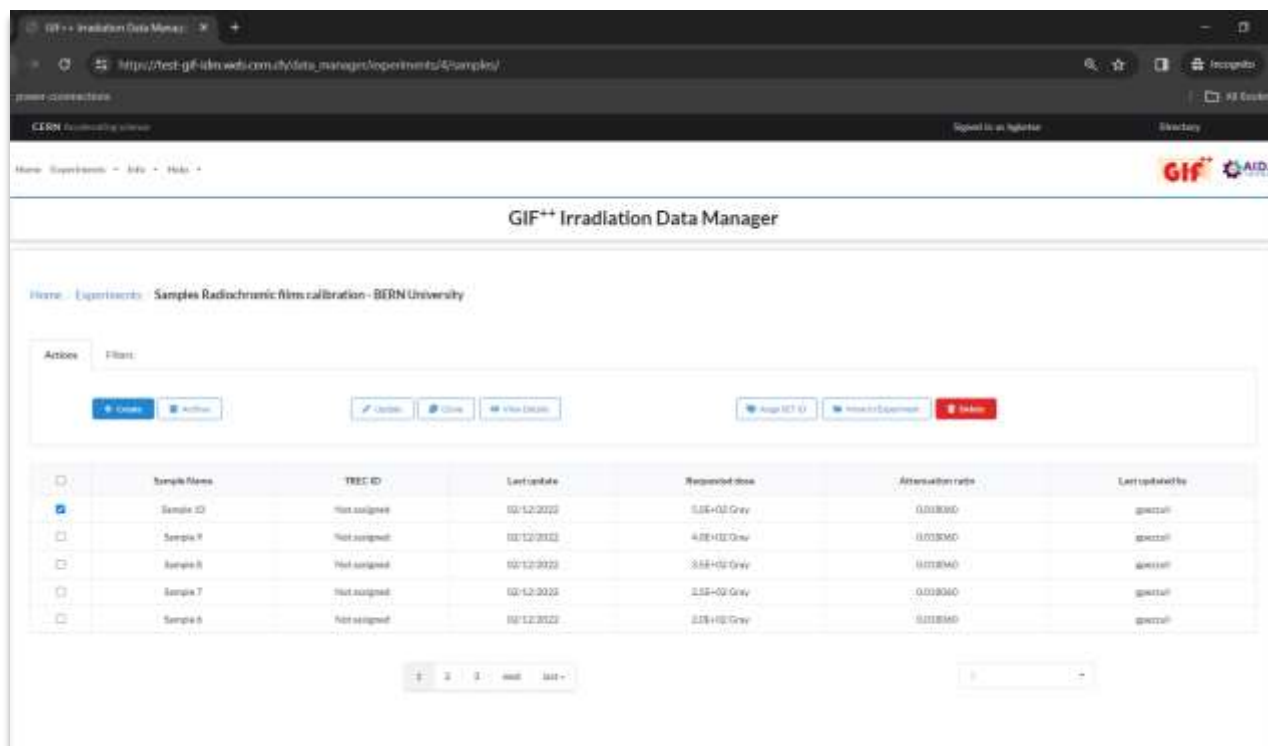
Some of the core functionalities are registering experiments, samples and users' data, calculating useful quantities such as the gamma photon attenuation ratio, following-up the experiments and keeping track of past experiments and irradiated material. Figure 1 shows the experiments' page. Through this view, IDM users can create, update, validate, clone or delete experiments. They can also access the samples or users' pages. Moreover, they can view the details of the experiments, change their status, update their visibility, upload an attachment, or contact the responsible person of the experiment.



ID	Experiment name	Availability	No. registered/assigned samples	No. Users	Responsible person	Visibility	Status
3	Alfa HTT (Normal path) (4)	2012-2022	0/5	0	person	Public	Registered
5	TC conversion via (normal) based (CIC) (4)	06/02/2022	0/5	0	person	Public	Registered
4	Radionuclide transmutation - WIPP University (3)	02/12/2022	11/11	0	person	Public	Registered

Fig. 1 - Experiments' view on the GIF++ Irradiation Data Manager.

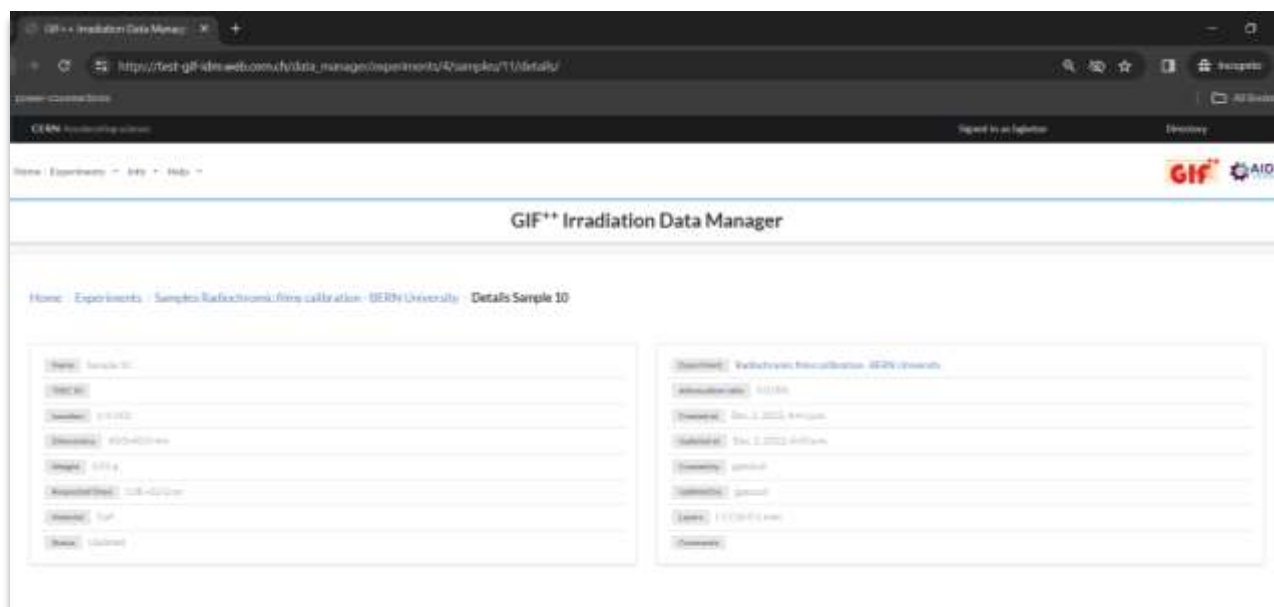
As demonstrated in Figure 2, the samples belonging to specific experiment can be also visualised. Users can create, update, clone, view details or delete sample entries. They can also move samples from one experiment to another one. In that case the samples history belonging to this experiment is kept in the *Archive* accessible from this page. Unique identifiers for traceability can be also provided by assigning SET-IDs.



Sample Name	TREC ID	Last update	Measured dose	Activation ratio	Last updated by
Sample 10	Not assigned	00-12-2022	0.0E+00 Gray	0.000000	gmetzall
Sample 9	Not assigned	00-12-2022	4.0E+02 Gray	0.000000	gmetzall
Sample 8	Not assigned	00-12-2022	3.5E+02 Gray	0.000000	gmetzall
Sample 7	Not assigned	00-12-2022	2.0E+02 Gray	0.000000	gmetzall
Sample 6	Not assigned	00-12-2022	2.0E+02 Gray	0.000000	gmetzall

Fig. 2 - Samples' view on the GIF++ Irradiation Data Manager.

Figure 3 shows the details' page of a specific sample.



Sample Name	TREC ID	Last update	Measured dose	Activation ratio	Last updated by
Sample 10	Not assigned	00-12-2022	0.0E+00 Gray	0.000000	gmetzall

Fig. 3 - Sample details' view on the GIF++ Irradiation Data Manager.

3. FERMILAB ITA DEPLOYMENT

The team of FERMILAB Irradiation Test Area (ITA) proton irradiation facility, with the support of the CERN IRRAD team, took over the customisation and adaptation of IDM according to their in-house facility's requirements, their laboratory IT infrastructure needs and nomenclature. Despite these changes, the core functionalities, such as registering and handling experiments, samples and users' data, have remained the same as the specifications required for ENEA-FNG and described in MS13. A first prototype has been installed and deployed on the FERMILAB IT infrastructure and is going to be tested by ITA users during the run 2024 of the facility.

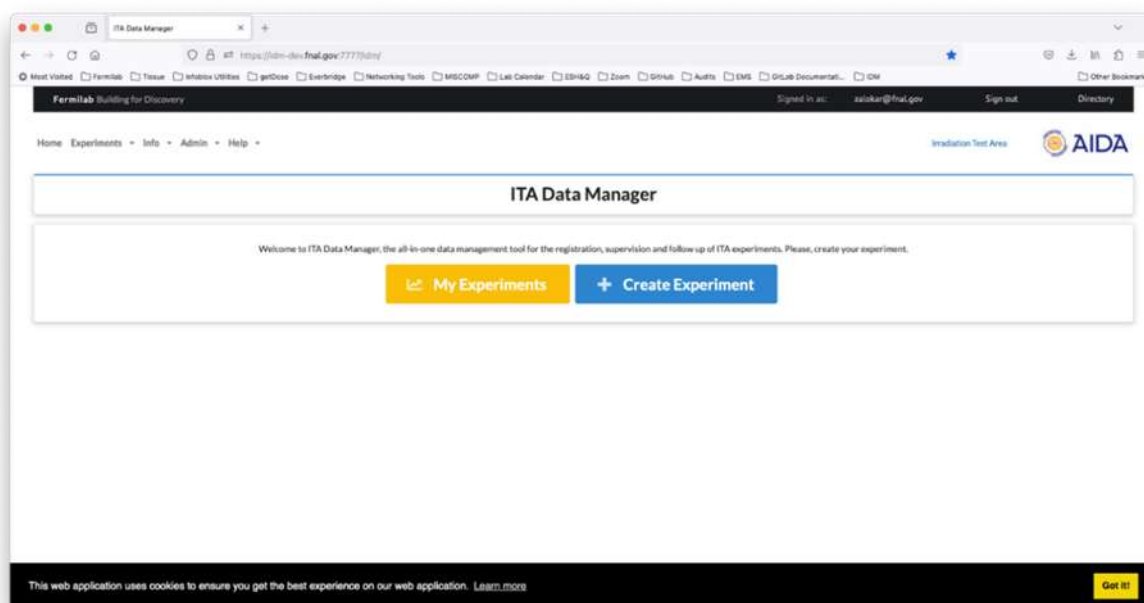


Fig. 4 - FERMILAB-ITA Data Manager homepage.

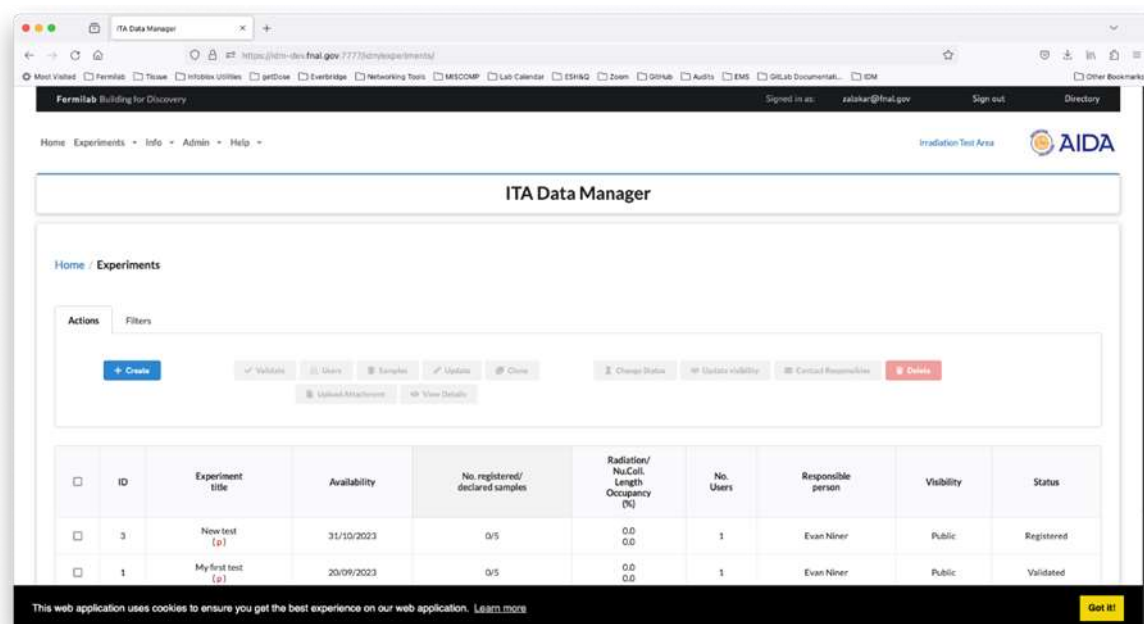


Fig. 5 - FERMILAB-ITA Data Manager experiments' view.

The further development and testing of the ITA data manager will be detailed in the final deliverable D4.3. Figure 4 and Figure 5 illustrate the home and experiments pages. The source code is available under this link: <https://gitlab.cern.ch/irrad1/irrad-data-manager>

4. CAEN RADHAND WORKFLOW AND API INTEGRATION WITH IDM

Within AIDAInnova, CAEN RFID tags have been tested for their use in irradiation facilities for traceability purposes [7,8]. Moreover, CAEN RadHAND, a portable device shown in Figure 6 used for measuring dose rate and detecting radionuclides by means of in-situ gamma spectrometry measurements, has been delivered by CAEN to the IRRAD facility team to test the full operational workflow in real operational conditions.

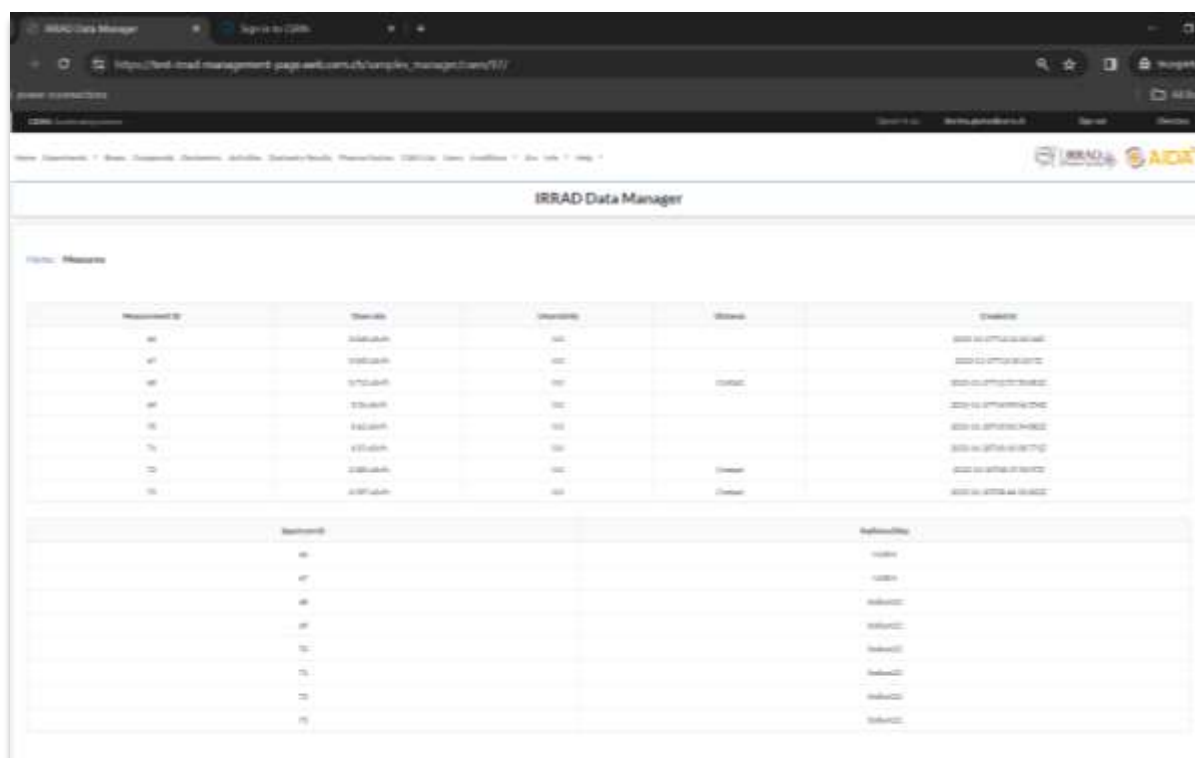


Fig. 6 - CAEN RadHAND device, RFID and radioactive material while performing a measurement.

Following the IRRAD use case and for demonstration purposes, a radioactive material sample (metal foil containing a small amount of Na-22) located in a storage box was tagged using a CAEN RFID as shown in Figure 6. Using the RadHAND, it was possible to read, record and store the RFID number and simultaneously perform measurements of the sample dose-rate and detecting the corresponding emitting radionuclides. A picture was also taken as well as information about the geographic location of the sample were input in the RadHAND device. All measurements' data and related information could be finally associated to the specific RFID and were stored in the CAEN RadBASE database. A video demonstrating the full operational workflow is joint to this report in the [Zenodo repository](#).

Another goal achieved was to develop the necessary software functionalities in IDM for integrating these measurements' data in IDM using the CAEN API. Figure 7 demonstrates this: one newly

developed IDM page includes the results from all the measurements performed with the CAEN RadHAND while testing the workflow for specific RFID and radioactive materials described in this section.



The screenshot shows the IRRAD Data Manager web application. The main table displays measurement data with columns for Measurement ID, Sample, Quantity, Status, and Comments. Below this, there is a section for 'Radionuclide' and 'Half-life'.

Measurement ID	Sample	Quantity	Status	Comments
45	Aluminum	100		2023-02-01 10:00:00
46	Aluminum	100		2023-02-01 10:00:00
47	Aluminum	100	Failed	2023-02-01 10:00:00
48	Aluminum	100		2023-02-01 10:00:00
49	Aluminum	100		2023-02-01 10:00:00
50	Aluminum	100	Failed	2023-02-01 10:00:00
51	Aluminum	100		2023-02-01 10:00:00
52	Aluminum	100	Failed	2023-02-01 10:00:00
53	Aluminum	100	Failed	2023-02-01 10:00:00

Radionuclide	Half-life
45	1000
46	1000
47	1000
48	1000
49	1000
50	1000
51	1000
52	1000
53	1000

Fig. 7 - CAEN RadHAND measurements data in IDM.

5. APEX-GAMMA SPECTROMETRY INTEGRATION WITH IDM

In the IRRAD facility, activation dosimeters (typically thin aluminium foils) are usually placed in line with the irradiated samples, allowing for measuring and validating the final accumulated proton fluence delivered to the sample w.r.t. the estimated fluence from the beam instrumentation [9]. This is accomplished by performing gamma-spectrometry measurements, where the activity values of specific radionuclides can be determined, and by using these values, in turn, to compute the accumulated proton fluence.

In the past, this proton fluence calculation was done manually using a custom software interface and inputting the necessary information by hand to get the corresponding results as illustrated in Figure 8. Similar gamma-spectrometry measurements (often on radioactive samples containing mixtures of unknown radionuclides) are also performed by the Radiation Protection (RP) team of CERN. For this reason, similar IT infrastructure and a common normalised data model for the spectrometry data representation (called ARAMIS) was also developed and formalized in collaboration with the CERN RP team [10].

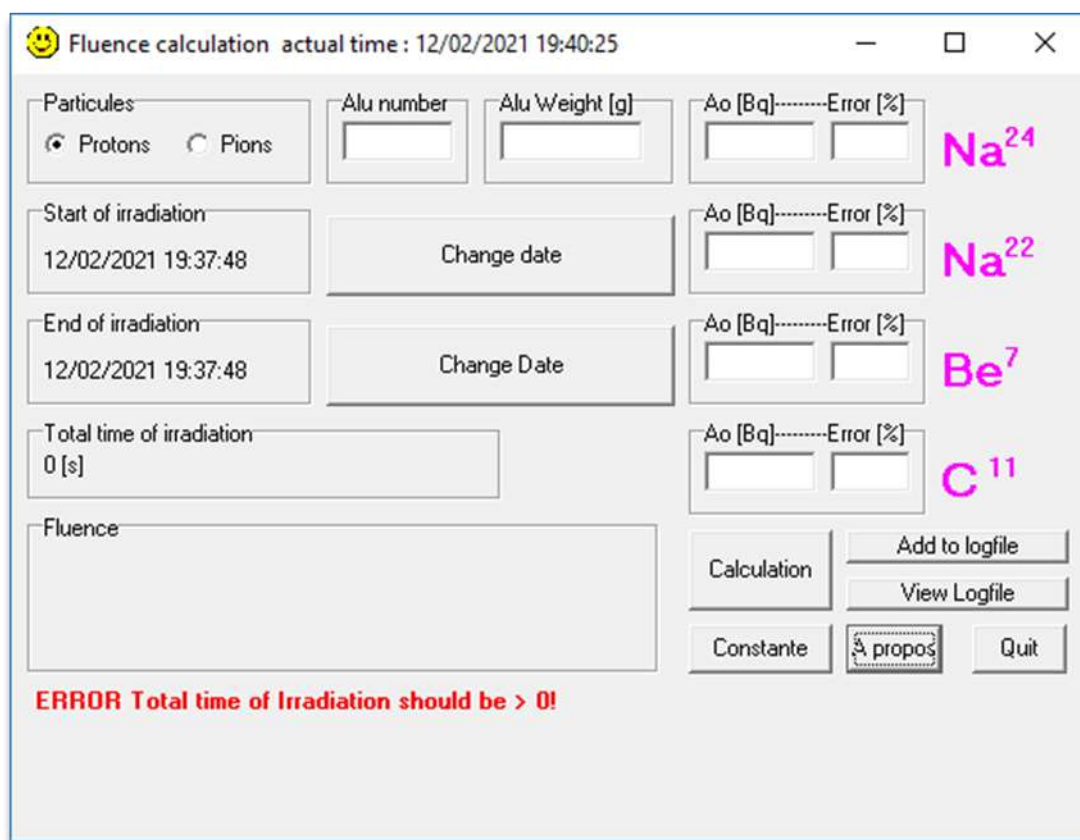
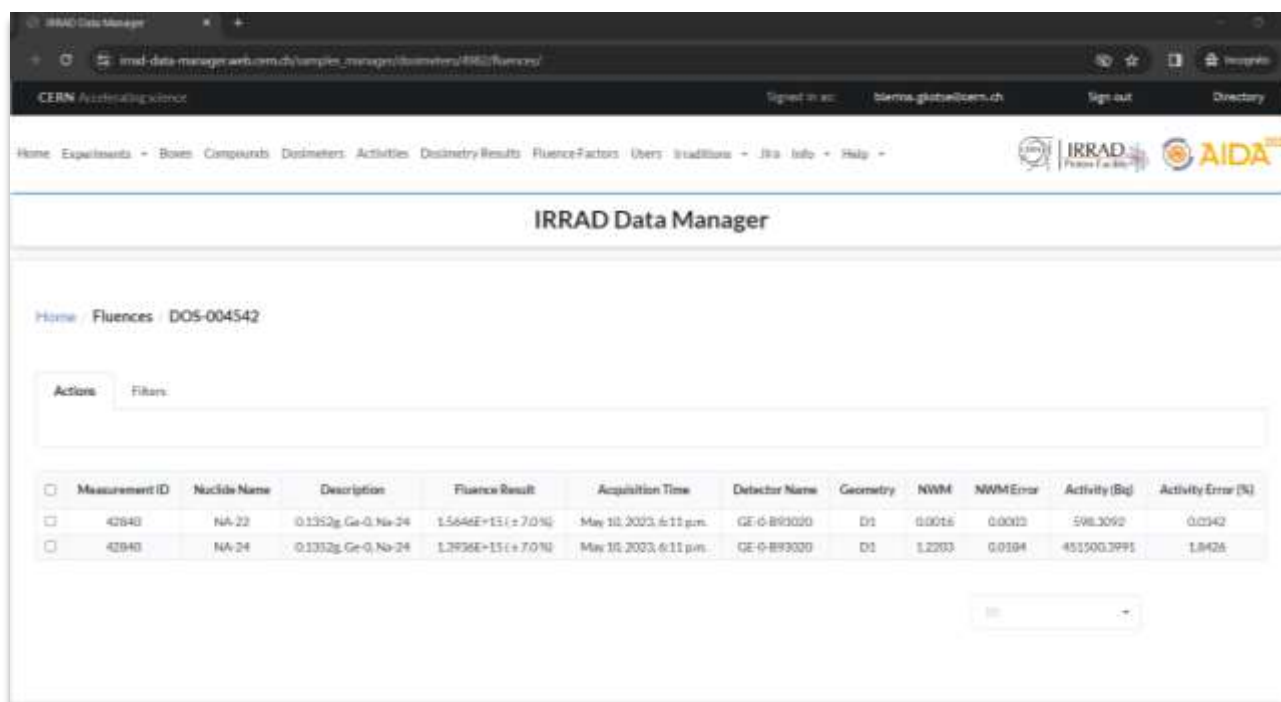


Fig. 8 - Old User Interface for fluence calculations.



Measurement ID	Nuclide Name	Description	Fluence Result	Acquisition Time	Detector Name	Geometry	NWM	NWMError	Activity (Bq)	Activity Error (%)
42943	NA-24	0.1352g, Ge-0, Na-24	1.564E+15 (+ 7.0 %)	May 10, 2023, 6:11 p.m.	GE-0-B93030	D1	0.0016	0.0013	598.3092	0.0342
42943	NA-24	0.1332g, Ge-0, Na-24	1.2936E+15 (+ 7.0 %)	May 10, 2023, 6:11 p.m.	GE-0-B93030	D1	1.2203	0.0104	453500.3995	1.8426

Fig. 9 - Fluence results automatically calculated from gamma spectrometry activities displayed in IDM.

For the IRRAD facility use-case, a CANBERRA apex-gamma server and database were deployed on two separate OpenStack Virtual Machines and two computer clients (operating two HPGe detectors) for performing gamma spectrometry measurements were installed. Based on the conceived ARAMIS data model, the core classes of it were then introduced in IDM so that it was possible to integrate the data from apex gamma spectrometry database. Relevant data such as the activity could be then used for the automatic fluence calculation within IDM as demonstrated in Figure 9.

6. CONCLUSIONS

In conclusion, this milestone report demonstrates that, following the specification given in MS13, two IDM prototypes have been customized for two additional irradiation facilities, the CERN GIF++ and the FERMILAB ITA facility. While the Data Manager for CERN-GIF++ is already used in the facility operation, the deployment of the customized version for FERMILAB-ITA is ongoing and its testing will be described in the deliverable report for this task (D4.3).

The CAEN RadHAND device has been tested in the IRRAD facility and a full workflow for tagging an irradiated sample using the RadHAND and CAEN RFIDs has been conducted successfully at CERN. Additional functionalities have been also developed to allow for smooth integration of the CAEN RadHAND measurement data platform with IDM using the CAEN API. In addition, a new scalable gamma spectrometry system has been put in place for the IRRAD facility: spectrometry measurements acquired with the CANBERRA apex-gamma system can now be directly imported in IDM and used to automatically compute the proton fluence-related values.

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