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The Radiopurity.org Material Database

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Abstract. The database at `http://www.radiopurity.org` is the world's largest public database of material radio-purity measurements. These measurements are used by members of the low-background physics community to build experiments that search for neutrinos, neutrinoless double-beta decay, WIMP dark matter, and other exciting physics. This paper summarizes the current status and the future plan of this database.

INTRODUCTION

Over the last few decades, low-background physics experiments have accumulated a tremendous amount of data from their material assay programs. These experiments have either shared their results privately with those who requested the information or simply published the data in refereed journals. For the future development of ever-sensitive low-background experiments, it is desirable to have a searchable, central repository of these measurements. Previous efforts (for example, the public material assay database by the ILIAS collaboration [1]) have been invaluable to the low-background physics community, but issues such as data portability and querying have limited their potentials.

The `radiopurity.org` database is an attempt to address these limitations. The project began in 2010 as an in-house database of the Berkeley Low Background Facility [2]. In 2012, a coalition was formed with the Assay and Acquisition of Radiopure Materials (AARM) Collaboration [3] to develop a community-wide database. The current version of the open-source software has been in use by the community since 2014.

The details of the material assay data format (MADF), software for data manipulation, and its public installation at `http://www.radiopurity.org` can be found in a previous proceedings of this conference series [4], as well as in Ref. [5]. In the following, a brief description of the three elements and their status are provided.

THE MATERIAL ASSAY DATA FORMAT

The Material Assay Data Format (MADF) is intended as a standard data format for codifying assays of material radiopurity. The aim of MADF is to capture the essence of a material assay, including information on the sample and the measurements performed on the sample. The guiding principles behind its design are as follows:

Simple The data format is flat, consisting of a single record for each assay and there are no relationships between records. This has the benefit of making the data highly portable in that any set of measurements can be trivially output to independent text files. In MADF many fields can store extended, descriptive information and only a small number of fields are mandatory. In this way it is more similar to a structured experimental report than, for example, a line in a spreadsheet.

Inclusive MADF tries to minimize constraints on what can be entered in particular fields. For example, there are no requirements that measured values have uncertainties or that limits have confidence levels. The premise is that more information is usually better and that users of the database will be sufficiently qualified to judge what is useful for their purpose. A measured value without an error is not necessarily meaningless. Key to this

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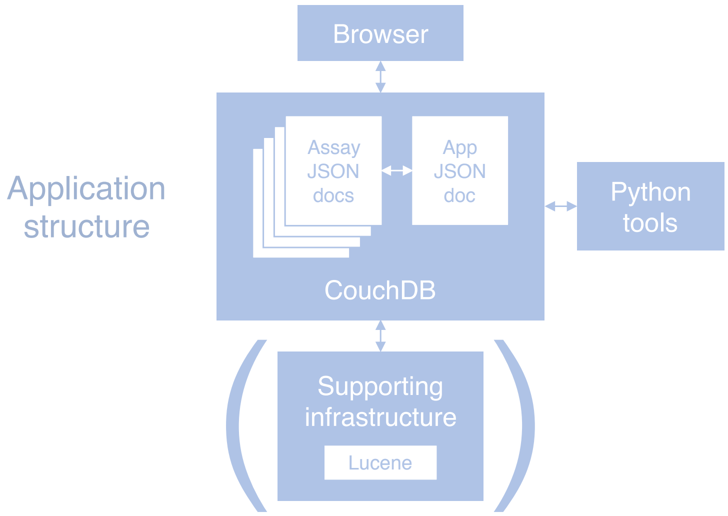

FIGURE 1. The Persephone structure.

working in practice is that the user should be able to understand where the data originated and any assumptions or simplifications made during data entry. The lack of such information has been a principle shortcoming of previous systems and has been addressed in MADF with fields for contact details of individuals involved in the measurement and data entry, and for notes on the data entry.

Flexible The core of MADF is a simple, compact structure, but it can be extended arbitrarily to accommodate specific needs. A typical use case might involve extra fields for information that is important to people who perform assays, but less so to those who use the results. Examples might be file names, calibration data, images, energy spectra or even analysis code.

The data format is expressed in JavaScript Object Notation (JSON), a text-based open standard for data interchange that is widely used by internet applications. The format is language-independent and parsers are available for all major programming languages. Further technical details of MADF can be found in Ref. [5].

PERSEPHONE

Persephone [6] is an open-source software package for storing, displaying and manipulating assays encoded in MADF. It is a JavaScript-based web application stored within, and served by, an Apache CouchDB database [7]. The architecture is illustrated in Figure 1. This software consists of a client-side web application that respects the MADF specification and is served by CouchDB. The application allows powerful search of the information contained within the database and flexible display of the output. It also provides an input form to facilitate data entry. Persephone is accompanied by a set of python tools that provide command line functionality for submitting, downloading, editing and validating documents. These tools allow data to be downloaded into text files and uploaded from them, and provide an alternative way to edit existing data and submit new data. The scripts can be incorporated into larger codes to assist automatic conversion of data from other sources. Thus, the application can be run in a number of use cases: locally by private individuals, by institutions who perform material assays, by experimental collaborations and also as a central public database of community data with regional mirrors. It has been designed to allow straightforward transfer of data between these instances and therefore all public data to be effectively held in common.

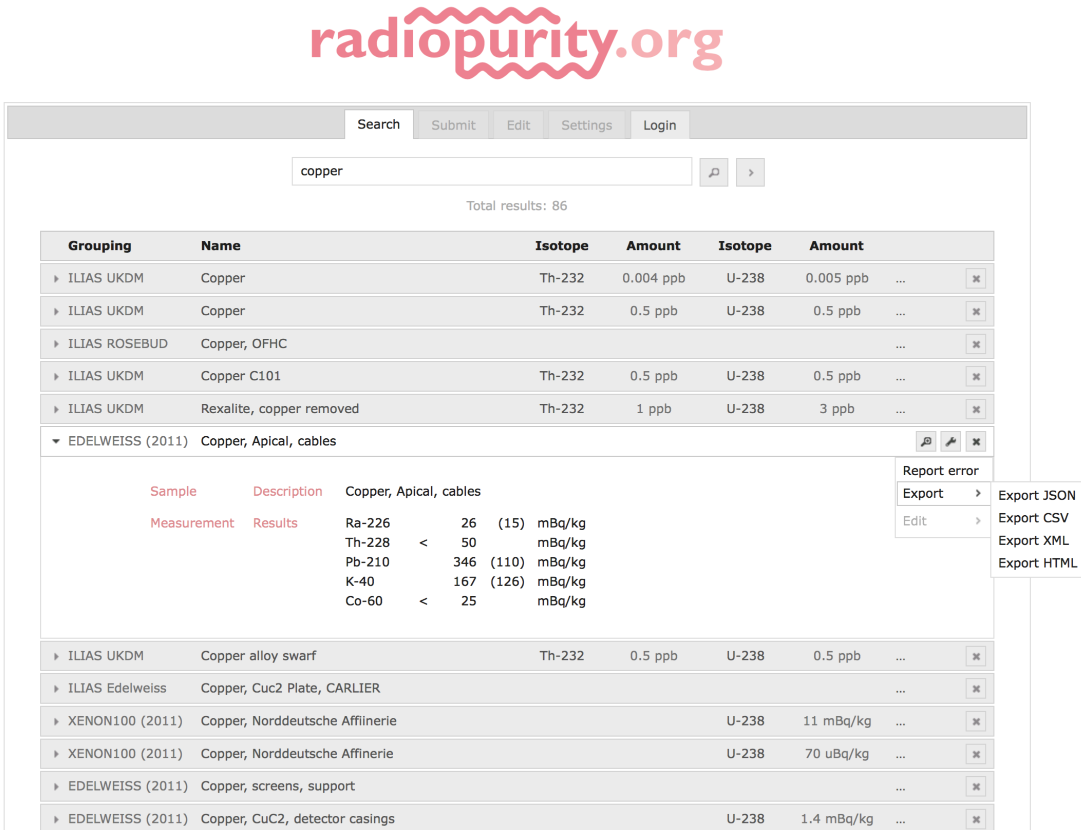

FIGURE 2. An example output of a search for the radioassay results for copper.

THE COMMUNITY DATABASE

A public instance of Persephone exists at `http://www.radiopurity.org`. This database is hosted and managed by SNOLAB and is intended to be a long-term repository for the community's assay data. Figure 2 shows an example of the search output at `radiopurity.org`.

The `radiopurity.org` database has been serving the low-background physics community since 2014. At the time of the conference, users can search for material assay measurements from the ILIAS database, as well as published results from Rau [8], BOREXINO [9], EXO [10], XENON100 [11], EDELWEISS [12], BetaCage [13], SuperCDMS [14], LUX [15], and Majorana [16] experiments. New results from the PandaX and XENON-1T will be incorporated in the near future. For this database to reach its full potential, it is desirable to import historical data from counting facilities and experiments. However, such undertaking would require additional resources from the community, and we encourage the community to support this valuable activity.

There are planned enhancements for the application. These include switching to a modern JavaScript framework; effectuation of new python tools; making institutional deployment of the software easier; and improving the documentation. These refinements will be implemented this year.

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