Developing Sample Management Tools for the Irradiation Test Area (ITA)

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03 August 2020

Background: Radiation Testing

- As beam intensities increase, we need stronger and more radiation-hard detectors and electronic components

- Testing radiation hardness of samples increases effectiveness and safety of experiments

- Outside facilities offer this testing, but with limited availability
  - LANL, CERN

- Irradiation Test Area (ITA) under construction to offer onsite radiation testing

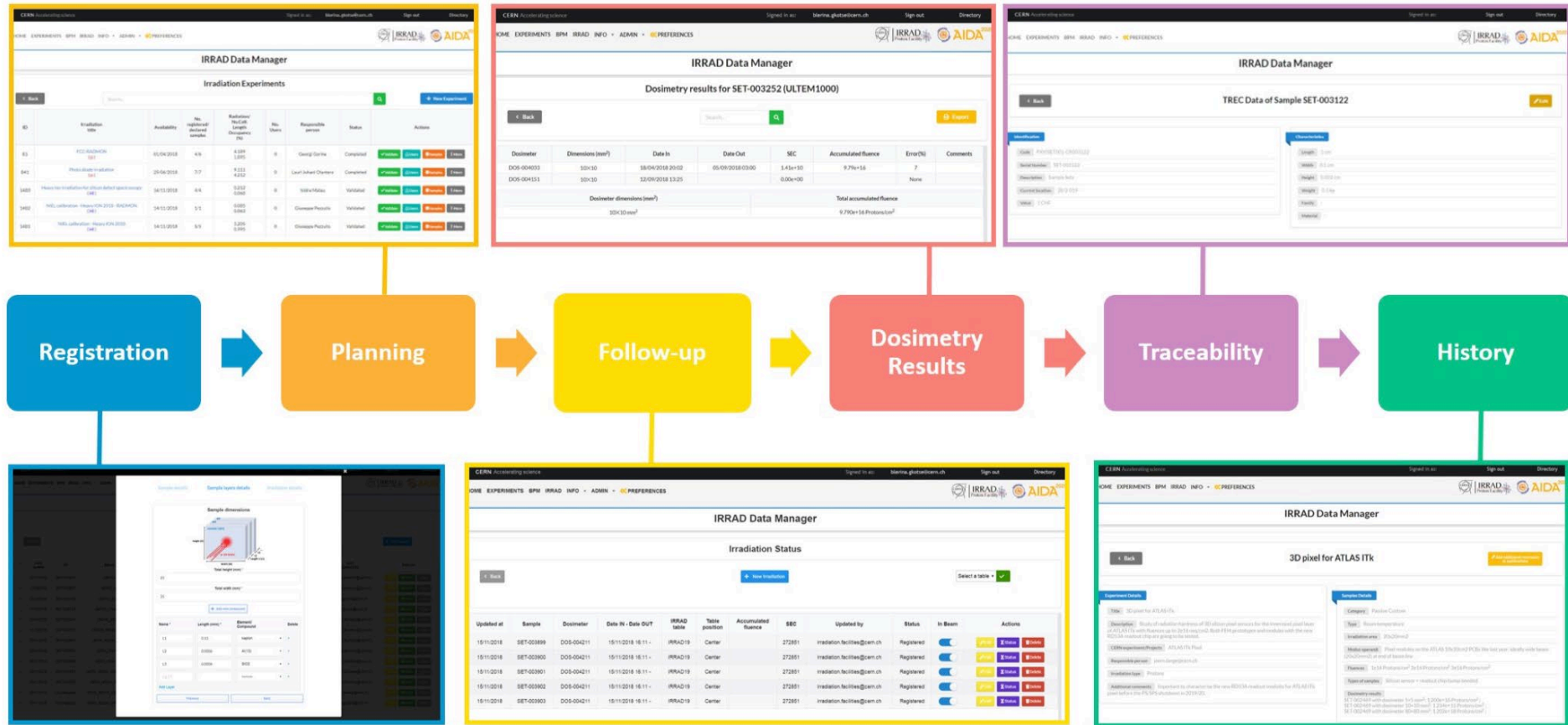🟣 **Fermilab**

In Progress: the ITA

Photo from ITA Beam Line Installation

- Beam line directs a 400 MeV proton beam to sample

- Concrete cave provides radiation shielding

- Blue tracks guide samples for easy remote access

- (As of Summer 2020) New data management tool regulates the ITA's testing process and user access

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CERN's IRRAD Data Manager (IDM)

For more information about IDM: http://icalepcs2019.vrws.de/papers/mopha048.pdf
(image source)

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Original Project Goals

In collaboration with CERN and members of the Test Beam group, to bring a version of the IDM to Fermilab for use at the ITA.

Gather information about ITA processes and use of IDM

Identify which IDM components are useful for Fermilab science

Develop or document additional features as necessary

Interview users so that the database tool fits Fermilab needs

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Project Implementation

Phase I   Familiarize with IDM code and ITA processes

Phase II   Modify IDM to reflect ITA needs

Phase III   Correct IDM database for accurate calculations

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Phase I: Familiarization with IDM Code

Components and Tasks

- Exploration of the IDM code (Python, HTML)

- Introduction to Django framework

- Initial improvements

Code Catalogue

- Categorization of IDM files in Python and HTML

- Emphasis of important functions

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Phase I: Outcomes

Phase I: Code Catalogue

samples_manager/templates

filename		description
base		pre-login screen
		contains information about general title, toolbar and associated dropdown menus
fluence_conversion		manually written text of fluence conversions with links to sources
home		extension of base.html, includes formatting and Home-screen 'welcome' text. Includes modal in use
		still includes information about IRRAD, but much has to do with login and security.
terms_conditions		IRRAD-specific information about IRRAD availability
		(such as: responsibilities of users, training needs, IRRAD contacts, financial support information)

samples_manager/templates/samples_manager

filename		description
base		post-login screen
		logo information and links, toolbar, titles

The files in this folder contain the bulk of the .html code for the entire IDM site

samples_manager/ (.py files)

filename	imported IDM .py files	description
admin.py	from .models import Experimen	mostly empty file
		imports Experiments and registers this model
compound_views.py	.models, .forms, .views	9 functions, including those to save a compound form, add a new compound, update a compound, etc.
dosimeter_views.py	.models, .forms, .views	8 functions, including to assign_dosimeters, clone/update dosimeters, etc.
		essentially contains the functions of the dosimeters page and its buttons
experiment_views.py	.models, .forms, .views	15 functions:
		get_experiment_data a longer function detailing fluence additions, 'data' (experiment, materials, dosimeter area, object and experiment categories
		admin_experiments_user_view
		experiments_list
		admin_experiments_list
		experiment_new
		experiment_status_update

Phase II: IDM Modifications

Components and Tasks

- Edits to forms, tables, general IDM content
  - Python

- Addition of comments to code

IDM Development Log

- Documentation of IDM functions

- Running log of all changes made

- Compilation of necessary changes

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Phase II: Outcomes

```python
IRRAD_TABLES = ( # Optionality unnecessary for ITA. Allows specification of table in IRRAD; ITA has one table.
            # ("", "Select table"),
            # ("Shuttle", "Shuttle"),
            # ("IRRAD3", "IRRAD3"),
            # ("IRRAD5", "IRRAD5"),
            # ("IRRAD7", "IRRAD7"),
            # ("IRRAD9", "IRRAD9"),
            # ("IRRAD11", "IRRAD11"),
            # ("IRRAD13", "IRRAD13"),
            # ("IRRAD15", "IRRAD15"),
            # ("IRRAD17", "IRRAD17"),
            ("Test", "Test"), # Under 'Irradiation': changes 'New Irradiation' form table specification, does not change dropdown menu to filter by table
            )

TABLE_POSITIONS = (
            ("", "Select sample placement"), # MEL: changed wording slightly
            ("Front Porch", "Front Porch"),
            ("Cave Trolley", "Cave Trolley"), # MEL: changed 'center' and 'left' positions to 'Front Porch' and 'Cave Trolley'
            #("Right", "Right"), # MEL: commented out this line; not necessary for ITA.
            )


class ExperimentsForm1(forms.ModelForm): # 'New Experiment' form, page 1
    cern_experiment = forms.CharField(required=True)
    def __init__(self, *args, **kwargs): # field titles within the form and specification of which fields are required
        _cern_experiment_list = kwargs.pop('data_list', None)
        super(ExperimentsForm1, self).__init__(*args, **kwargs)
        self.fields['responsible'].empty_label = None
        self.fields['title'].label='Irradiation experiment title *'
        self.fields['description'].label='Description *'
        self.fields['cern_experiment'].widget = ListTextWidget(data_list=_cern_experiment_list, name='cern_experimen
        self.fields['cern_experiment'].label='Fermilab experiment/Projects *' # MEL: Changed CERN to Fermilab
        self.fields['responsible'].label='Responsible person *'
        self.fields['emergency_phone'].label = 'Emergency telephone number*'
        self.fields['emergency_phone'].required = True
        self.fields['constraints'].required = False
        self.fields['availability'] = forms.DateField(('%d/%m/%Y',),widget=forms.DateInput(format='%d/%m/%Y',attrs={'placeholder': 'When your samples will be
        # ^ Availability dates. Ideally this would allow more than one, currently only allows 1 entry.
        self.fields['availability'].label= 'Availability *'

    class Meta:# models.py contains the 'Experiments' model, which contains more detailed specifications of formatting and options for fields in the form.
```

Removal of IRRAD-specific code

Form edits for ITA context

Notes for clarification and needed changes

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Phase II: Outcomes

8/3/2020   Logsdon | Developing Sample Management Tools for the Irradiation Test Area (ITA)
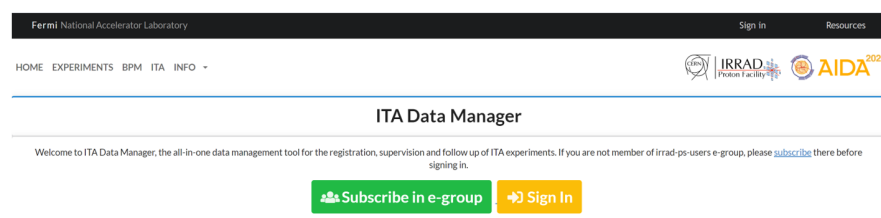
Phase II: IDM Documentation

Current IDM functions and capabilities

Outlined on 6/19. Updates to the IDM since then are included under Updates (beginning with section 5) and/or have been [noted] in the descriptions below.

1 PRE-SIGN IN

Description: Toolbar and Header have been modified to reflect Fermilab facilities rather than CERN's, though the 'Subscribe in e-group' button still links to CERN's SSO, JIRA. The BPM button links to IRRAD data and monitoring, and General Terms and Fluence Conversions menus under INFO both reflect IRRAD terms and fluence information.

The 'Resources' button in the header now links to Fermilab's Resources page (closest equivalent to CERN's resources page) found at https://www.fnal.gov/pub/resources/index.html, and the Fermi National Accelerator Lab button links to Fermilab's homepage https://www.fnal.gov/. Both of these have been updated on the pre- and post-sign in pages.

7 COMPILATION OF ALL 'NEEDED CHANGES' FROM SECTIONS 1-6: 7/13

Description: All unfinished tasks from sections 1-6.

Notable changes to be made:

- (header) Acknowledgements and logos with their respective links
- (pre-sign in center box) Welcome message mentions IRRAD and e-group subscription
- (pre-sign in center box) e-group subscription link in message and the green e-group button link to CERN's SSO
- (toolbar) The BPM button is IRRAD-specific and contains IRRAD data
    - o Change to something else that's ITA-helpful or get rid of it
- **all pre-login changes must be updated on the post-login screen**
- (toolbar) the JIRA tab needs to be connected to the Fermi SSO
    - o Or commented out, if unnecessary
- 'New Experiments' form needs to be updated:
    - o Category field—these options aren't relevant to the ITA
        - ▪ Passive Standard, Active, Passive Custom
        - ▪ Some of these individually also have particular settings that may be unnecessary (such as set beam size options)
    - o Availability field—only allows for 1 date to be added
    - o Experiment sharing opt-in—mentions IRRAD in the check box
        - ▪ Also need to figure out where these opted-in experiments go. It may be that as an admin I can see all experiments
- 'My Experiments' table still doesn't show the Radiation/Nu.Coll… values from the table
- Fermi SSO needs to be integrated throughout the site
- A 'SET-ID'-like system is needed for the sample ID numbers
- The 'New Compound' form shows only a blank box

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Phase III: Correction of IDM Database

Components and Tasks

- Research on stopping power
  - Fermilab report TM-1834
  - *Atoms, Radiation, and Radiation Protection* (James E. Turner)
  - NIST Stopping-Power and Range Tables for Protons
  - Mentor Dr. Michael Geelhoed's assistance

Stopping Power Updates

- New Mathematica notebook for calculations

- Transfer of updated values to IDM database

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Phase III: Outcomes

	A	B	C	D	E	F	G	H	I	J	K
1	atomic_nu	atomic_sy	atomic_ma	density	min_ionization	nu_coll_ler	nu_int_len	pi_coll_len	pi_int_leng	radiation_length	
2	1	H	1.007975	8.37E-05	6.238	42.8	52	70.4	80.3	63.05	
3	2	He	4.002602	0.000166	2.85572	51.8	71	79.5	103.6	94.32	
4	3	Li	6.9675	0.543	2.38503	52.2	71.3	79.1	103.3	82.77	
5	4	Be	9.012183	1.848	2.39817	55.3	77.8	82.4	109.9	65.19	
6	5	B	10.8135	2.34	2.44704	58	83.3	85.2	115.5	52.68	
7	6	C	12.0106	2.25	2.59696	59.2	85.8	86.5	117.8	42.7	

$$-\frac{dE}{dx} = 0.3071 z^2 \frac{Z}{A} \frac{1}{\beta^2} \log \frac{(1.022 \times 10^6)\gamma^2\beta^2}{I} - \beta^2 - \log\gamma$$

Z, A, I represent the atomic number, atomic mass, and excitation energy of the element.

z, β, γ represent the atomic number, the ratio of the particle velocity to the speed of light, and relativistic constant $\frac{1}{\sqrt{1-\beta^2}}$, respectively, of the beam particles.

Equation from Fermilab Report TM-1834, Rev. 14

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Conclusion: Next Steps

Deployment of the IDM alongside the ITA this Fall

Transfer of my work to the Test Beam Facility team

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Acknowledgements

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