



AIDA WP8.4

Materials and components irradiation and database progress

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WP8.4 Members

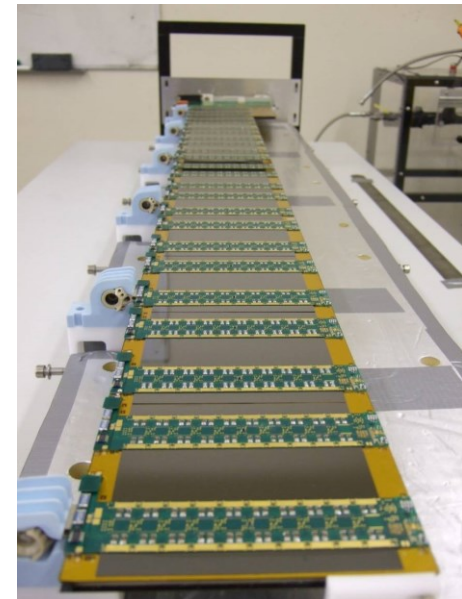
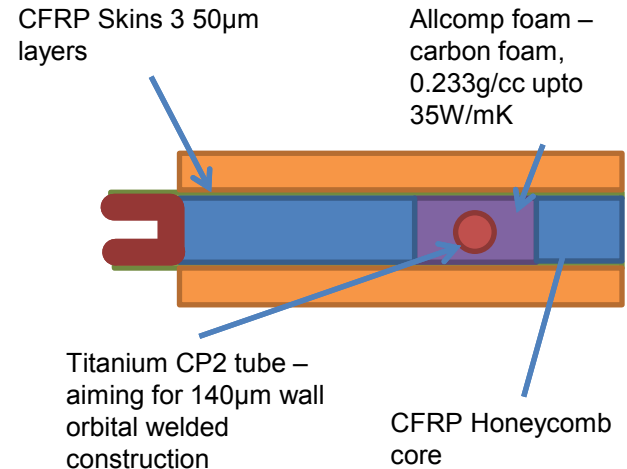
- Partners and interests:
 - INFN-Milan; electronic components and circuits
 - INFN Perugia; silicon pixel detectors (APS)
 - STFC-RAL; polymers and composite structures
 - Associate ETHZ; scintillator crystals

Materials irradiation

- Thermoset polymers are widely used in detector structures in HEP, eg ATLAS detectors
 - Main structure as composite matrix eg CFRP
 - Other adhesives for assembly
- High stiffness, Low Z materials
- Properties of the organic matrix change as a result of doses present in current LHC detectors
 - Typically crosslink density increases, modulus (stiffness) increases
 - State of cure increases
 - Pendant groups knocked off >gas evolution

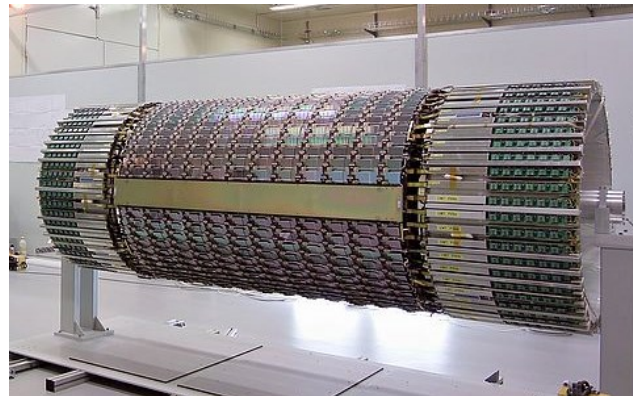
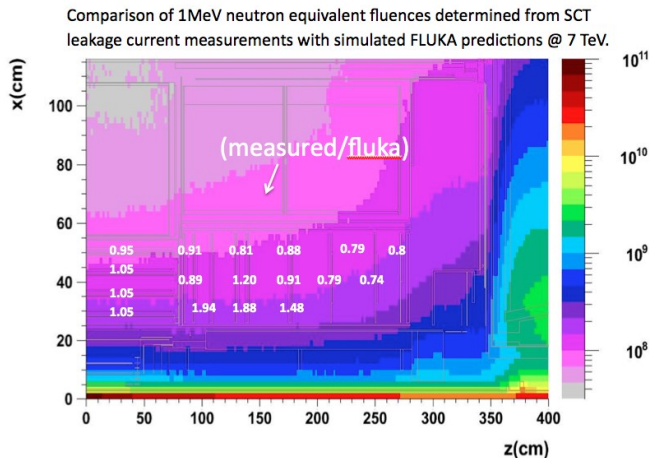
Application Example: ATLAS stave

- Stave components rely on adhesive bonding
- Flexible materials are desirable but these are considered to be more prone to radiation damage than stiffer, more highly crosslinked polymers
- Anecdotal evidence suggests this isn't always true
- How do material properties change with radiation dose?
- If stiffness increases (as expected) then stress states within stave also change



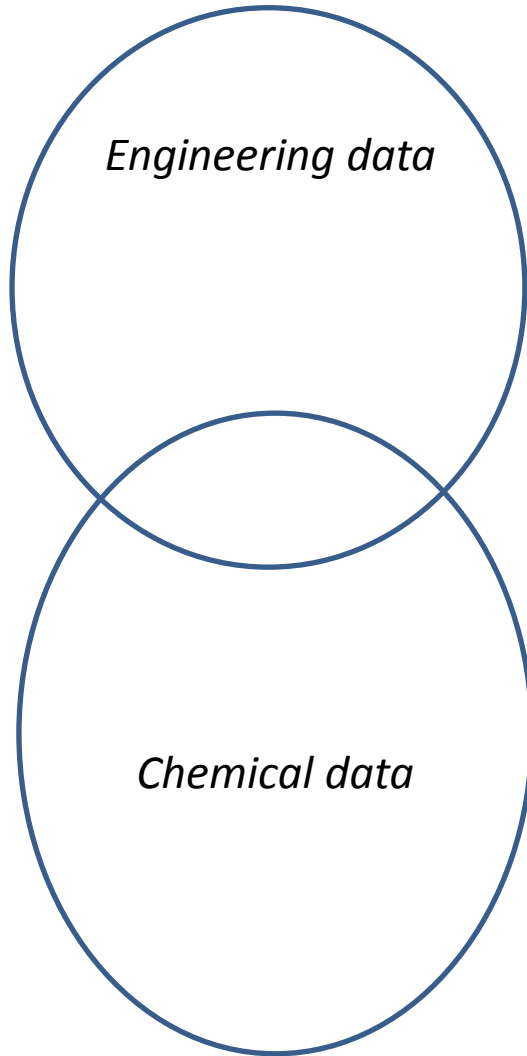
AIDA TA

- Opportunities within AIDA to use irradiation facilities
- Need to understand how doses available via AIDA-TA compare to doses required
- Need to consider activation issues and how to mitigate (eg by testing unfilled adhesives only, to remove metals)



Existing ATLAS tracker

Test methods for characterising radiation damage in polymers

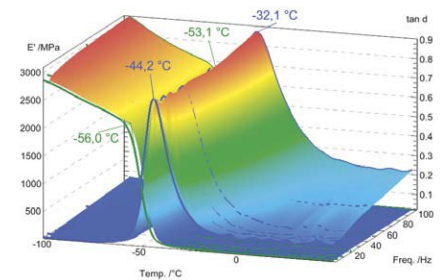
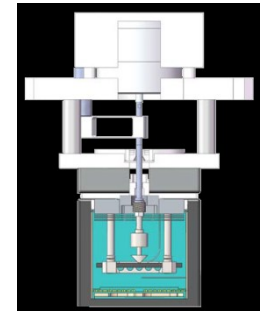


- Macro-Mechanical
 - Tensile
 - Bond strength eg lap shear
- Micro-mechanical
 - DMA, modulus, transitions, molecular mobility
- FTIR analysis
 - Chemical bond changes
- Thermal
 - DSC, state of cure
 - TGA, thermal stability

Specimen size increasing ↑

Flexible adhesives test plan

- Data exists on rigid, rad-hard epoxies which tend to be highly crosslinked, high modulus and brittle.
- Focus on characterising the rad-hardness of more flexible epoxies and silicones
- A chemical structure-property relationship approach
- Test a range of chemistries to understand what changes occur after irradiation
- FTIR-ATR to detect chemical bond changes (non-destructive), then
- DMA to measure modulus, detect thermal transitions (also non-destructive)
- Can extend to TGA and DSC for example



DMA results of an elastomer showing tan-delta and modulus as a function of temperature and frequency (Netzsch)

Database Status

- “User Case Analysis” phase now finalised
- Mockups created
- We have a detailed specification to make the database implementation phase as efficient as possible, given resource constraints

Servers

- The new server has arrived but is not yet installed. This is Aonyx, which will be the backup for the Lutra server inside the firewall.
- Very robust system:
 - All data entry will be done on Lutra (backed up by Aonyx), and then exported nightly across the firewall to Tarka (backed up by Mijbil) on which the query system will run. Aonyx will be in a different building to Lutra (probably in the ATLAS centre at RAL).
 - The urls can be swapped between the pairs of machines to allow for power outages, patching and other similar occurrences; this process will be invisible to users.



Database specification

- Spreadsheet table of fields with example data
- Mockups were iterated with the steering group Oct-Nov 2012 Different query pages for “passive materials” and “detector materials”
- How to handle dose and fluences measured in different ways
- Discussed conversion between radiation dose and fluence?
 - Decided to report fluences only, as dose conversion is material-dependent
- Database expert availability delayed to end of May

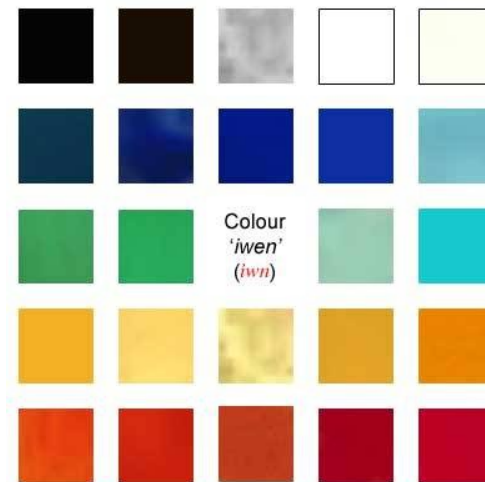
Spreadsheet to identify fields

- Drop-down boxes are preferred in the DB implementation
- The database will contain references to the detailed data via DOI and also include functionality for holding PDF files (where copyright allows).
- Comprehensive description of the radiation environment.
- To give a flavour of the results, a “headline” results figure will be included, to save users always looking for data in attachments.

Field name	sample material/identifier	Grade	sample geometry or test type	sample dimensions	sample properties reference or datasheet	particle type	particle energy MeV	particle flux [/cm2/h]	particle fluence [cm2]	Dose [Mgy]	non-ionizing dose [Mgy]	irradiation temperature [K]	additional irradiation conditions	observable	value	measurement conditions	related experiment	reference DOI	main citations	comments	time after irradiation [hours]
data type	drop-down	drop-down	drop-down		freetext	drop-down	number	number	number	number	number	positive number	freetext	drop-down		freetext	drop-down	DOI	DOI	freetext	number
drop-down choices	epoxy	RAL71	tensile	n/a	n/a	N	n/a	n/a	n/a	n/a	n/a	n/a	n/a	stress at break	n/a	n/a	ATLAS	n/a	n/a	n/a	
	epoxy/glass	RAL237	compression			P								elongation at break			CMS				
	epoxy/carbon	Araldite2015	flexural			Gamma								breakdown voltage			LHCb				
	CE/carbon	Stycast2850FT	high voltage			electron											ALICE				
	CE/glass	epoxy-anhydride															LHCmachine				
	lead tungstate	epoxy-amine																			
		epoxy-aromaticamine																			
		epoxy-toughened																			

Database name

- Many acronyms were generated and this one chosen:
- IMhoTEP Irradiated MaTErials Properties – this one does carry on the Egyptian theme of AIDA as in the opera
- Database W3C accessibility compliant
- Colour scheme:



Front end and query page

The screenshot shows the IMHOTEP website interface. At the top left is the IMHOTEP logo with the tagline 'Properties of Materials under Irradiation'. To the right is the AIDA logo. Below the logos is a navigation bar with links for 'AIDA HOME', 'IMHOTEP', 'FAQ', 'ABOUT US', and 'CONTACT'. The main heading is 'Welcome to IMHOTEP'. Below this is a brief description of the database and a search instruction. The search form includes several sections: 'Scope of Search' with a dropdown for 'Passive Materials'; 'Material or Component' with a text input; 'Particle Type' with a dropdown for 'Choose Particle Type'; 'Radiation Parameters' with radio buttons for 'Particle Energy (MeV) and Fluence (cm²)' and 'Dose (MGy)', each with 'More than' and 'Less than' options and dropdowns for limits; 'Irradiation Temperature (K)' with 'More than' and 'Less than' options and dropdowns for limits; 'Related Experiment' with a dropdown for 'Choose experiment'; and 'Record contains these words:' with a text input. A red 'SEARCH' button is at the bottom of the form. The footer contains the European Union flag, copyright information for STFC (2012-2017), and the AIDA logo.

- Version 6

URL with mock-ups:

<http://imhotep.rl.ac.uk/Mock-Ups/IMH000.html>

Data entry

[AIDA](#) >> [IMHOTEP](#) >> [Submit Information](#)

IMHOTEP - Submit Data

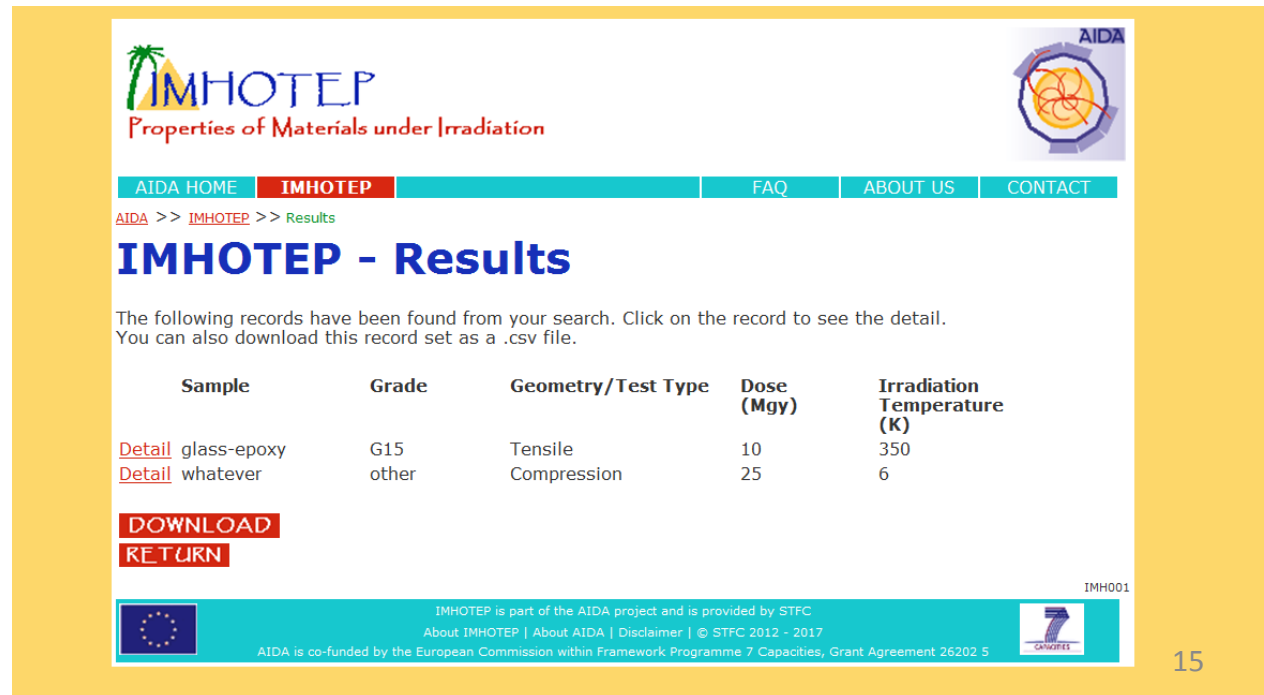
This database contains summary data from tests to quantify materials and components for LHC detector upgrades. If you would like to submit data to IMHOTEP, you can do so here. It will be sent to the IMHOTEP Data Manager for consideration.

Material or Component? <i>Mandatory</i>	Passive Material
Sample Material / Identifier <i>Mandatory</i>	epoxy
Grade	RAL71
Sample Geometry or Test Type <i>Mandatory</i>	Tensile
Sample Dimensions	
Particle Type	Neutron
Particle Energy (MeV)	
Particle Flux (/cm²/h)	
Particle Fluence (cm²)[*]	
Dose (Mgy)[*]	<small>eg 10</small>
<small><i>Either fluence or dose must be given</i></small>	
Non-Ionizing Dose (Mgy)	
Irradiation Temperature (K) <i>Mandatory</i>	<small>eg 300</small>
Additional Irradiation Conditions	
Time of measurement after Irradiation (hours)	
Observable	strength Mpa
Value	<small>eg 40</small>
Measurement Conditions	<small>eg inert atmosphere</small>
Related Experiment	ATLAS CMS
Sample Properties Reference or Data Sheet	Choose document to upload <small>Upload document</small>
Publication Date <i>Mandatory</i>	dd/mm/yyyy
Reference DOI <i>Mandatory</i>	<small>eg 123456</small>
Main Citations	
Publication Date	<small>eg 01/10/2010</small>

SUBMIT

Output

- Because of the large number of fields, results are summarised, with a link to a detailed page
- Exportable in CSV format
- Mockup:



The screenshot displays the IMHOTEP website interface. At the top, there is a navigation bar with links for AIDA HOME, IMHOTEP, FAQ, ABOUT US, and CONTACT. Below the navigation bar, the breadcrumb trail reads "AIDA >> IMHOTEP >> Results". The main heading is "IMHOTEP - Results". A text block states: "The following records have been found from your search. Click on the record to see the detail. You can also download this record set as a .csv file." Below this is a table with the following data:

Sample	Grade	Geometry/Test Type	Dose (Mgy)	Irradiation Temperature (K)
Detail glass-epoxy	G15	Tensile	10	350
Detail whatever	other	Compression	25	6

Below the table are two buttons: "DOWNLOAD" and "RETURN". At the bottom of the page, there is a footer containing the European Union flag, the text "IMHOTEP is part of the AIDA project and is provided by STFC. About IMHOTEP | About AIDA | Disclaimer | © STFC 2012 - 2017", and the AIDA logo. The page number "15" is located in the bottom right corner.

Detailed output page



[AIDA HOME](#)

IMHOTEP

[FAQ](#)

[ABOUT US](#)

[CONTACT](#)

[AIDA](#) >> [IMHOTEP](#) >> [Results](#) >> [Detail for xxxx](#)

IMHOTEP - Detailed Results

The detail for the chosen record will appear here.

Sample glass-epoxy

Material / Identifier

Grade G15

Sample Tensile

Geometry or Test Type

Dose (Mgy) 10

Irradiation 350

Temperature (K)

Observable strength Mpa

Value 40

Related CMS

Experiment

Reference DOI 123456

Documentation

[This could be eg](#)

http://www.iucnosg.org/Bulletin/Volume28A/Kanchanasaka_Duplaix_2011.html

or

[Kanchanasaka, B. and Duplaix, N. \(2011\). Food Habits of the Hairy-nosed otter \(*Lutra sumatrana*\) and the Small-clawed otter \(*Aonyx cinereus*\) in Pru Toa Daeng Peat Swamp Forest, Southern Thailand. Proceedings of Xth International Otter Colloquium, IUCN Otter Spec. Group Bull. 28A: 139 - 161](#)

or some other kind of link presentation to the source document. Which do you want?

RETURN

IMH002



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AIDA is co-funded by the European Commission within Framework Programme 7 Capacities, Grant Agreement 262025



Deliverables

- D4.1 Experience at LHC: delivered
 - Definition of test programme: drafted and ongoing
- MS30 First results: in progress, see today's presentations
- *Thank you to our partners INFN and ETHZ for their work*

Thank you for your attention

Old slides

Front-end mockups 1

The query page style and content has been iterated: “spot the difference!”

The screenshot shows a web page for AIDA (Advanced European Infrastructures for Detectors at Accelerators). The header features the AIDA logo and navigation links: HOME, ABOUT AIDA, NEWS, EVENTS, NETWORKS, TRANSNATIONAL ACCESS, IMHOTEP (highlighted in red), and RESULTS. The main content area is titled "Home" and "Welcome to IMHOTEP". It includes a search section with the following fields and options:

- Material:
- Particle Type: Choose Particle Type (dropdown)
- Particle Energy (MeV): Choose Particle Energy (dropdown)
- Dose (MgY): More than: Choose lower limit (dropdown); Less than: Choose upper limit (dropdown)
- Irradiation Temperature (K): Choose temperature (dropdown)
- Related Experiment: Choose experiment (dropdown)
- Record contains these words:
- Search button

On the right side, there are two sections: "ACTIVITIES" with links for Common software tools, Microelectronics, Relations with industry, Transnational access to test beams and irradiation facilities, Irradiation and beam line R&D, and Detector infrastructures R&D; and "FOR PROJECT MEMBERS" with links for FAQs and Intranet.

The footer contains a yellow bar with the text: "AIDA is co-funded by the European Commission within Framework Programme 7 Capacities, Grant Agreement 262025. Design based on Ezekiel | Webmaster Kate Kahle | Glossary | Jobs | Sitemap | Contact us".

Front-end mockups 2

IMHOTEP
Properties of Materials under Irradiation

[AIDA HOME](#) | **IMHOTEP** | [FAQ](#) | [CONTACT](#)

[AIDA](#) >> [Imhotep](#)

Welcome to IMHOTEP

You could have a few sentences here to describe what it is for

To find more about the properties of materials under various radiation regimes, please use the search options below

Material

Particle Type

Particle Energy (MeV)

Dose (MgY) More than Less than

Or is it more sensible to let them enter a lower and higher limit rather than choose from a menu?

Irradiation Temperature (K)

Related Experiment

Record contains these words:

SEARCH

Links to eg STFC, ASD, whatever plus copyright, disclaimer

IMH000

Front-end mockups 3



IMHOTEP
Properties of Materials under Irradiation

AIDA Welcome to IMHOTEP
Home
Search *You could have a few sentences here to describe what it's for*
FAQ
Contact To find more about the properties of materials under various radiation regimes, please use the search options below
Not sure what links are sensible here

Material

Particle Type Choose Particle Type ▾

Particle Energy (MeV) Choose Particle Energy ▾

Dose (MgY) More than Choose lower limit ▾
Less than Choose upper limit ▾
Or is it more sensible to let them enter a lower and higher limit rather than choose from a menu?

Irradiation Temperature (K) Choose temperature ▾

Related Experiment Choose experiment ▾

Record contains these words:

SEARCH

Links to eg STFC, ASD, whatever plus copyright, disclaimer

IMH000

Front-end mockups 4

The screenshot displays the front-end of the IMHOTEP web application. At the top left is the IMHOTEP logo with the tagline "Properties of Materials under Irradiation". To its right is the Science & Technology Facilities Council logo, and further right is the AIDA logo. A navigation bar contains links for AIDA HOME, IMHOTEP, FAQ, ABOUT US, and CONTACT. Below the navigation bar, the text "AIDA >> Imhotep" is followed by a large blue heading "Welcome to IMHOTEP". A short instruction reads: "You could have a few sentences here to describe what it is for. Keep it short!". Below this, a paragraph states: "To find more about the properties of materials under various radiation regimes, please use the search options below". The search interface includes several input fields: "Material or Component" (text box), "Particle Type" (dropdown menu), "Radiation Parameters" (radio buttons for "Particle Energy (MeV) and Fluence (cm²)" and "Dose (MgY)", with associated dropdowns and text boxes), "Irradiation Temperature (K)" (dropdown menu), "Related Experiment" (dropdown menu), and "Record contains these words:" (text box). A red "SEARCH" button is positioned below the text box. The footer contains the text "IMHOTEP is part of the AIDA project and is provided by STFC", a "Disclaimer" link, and the copyright notice "© STFC 2012 - 2017".

Front-end mockups 5

IMHOTEP
Properties of Materials under Irradiation

AIDA HOME **IMHOTEP** FAQ ABOUT US CONTACT

AIDA >> Imhotep

Welcome to IMHOTEP

This database contains summary data from tests to quantify materials and components for LHC detector upgrades. If you would like to submit data to IMHOTEP, you can do so [here](#)

To search the IMHOTEP database, please use the options below

Material or Component

Particle Type Choose Particle Type ▾

Radiation Parameters

Please choose either
Particle Energy/Fluence
OR
Dose

Particle Energy (MeV) and Fluence (cm²) Choose Particle Energy ▾

More than Choose lower limit ▾
Less than Choose upper limit ▾

OR

Dose (MGy)

More than Choose lower limit ▾
Less than Choose upper limit ▾

Irradiation Temperature (K)

More than Choose temperature ▾
Less than Choose upper limit ▾

Related Experiment Choose experiment ▾



Record contains these words:

SEARCH

IMH000

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- **System Design**

- The system will hold local copies of source PDFs wherever copyright allows. All other sources will be represented by URLs. The Data Manager (Simon) will have to check that these links are still valid, probably as an annual housekeeping task. It will be possible to have more than one document per record.
 - We will not be converting between dose and fluence – the Data Manager will enter whatever is supplied in the source document
- Certain fields will be mandatory in the records – every record entered must contain at least these fields. Which fields are vital has to be **decided by the Steering Group**. Later during design we will decide on the validation needed during input to ensure consistency.