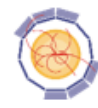




This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement no. 654168.



AIDA 2020

IRRAD Facility Infrastructure Upgrade

**Blerina Gkotse, Maurice Glaser, Georgi Gorine, Isidre Mateu,
Emanuele Matli, Giuseppe Pezzullo, Federico Ravotti
CERN EP-DT, BE-OP**

Outline

- ❖ **CERN Milestones & Deliverables**
- ❖ CERN Proton irradiation Facility (IRRAD)
- ❖ Samples manager
 - Progress
 - Specifications
 - Database structure
 - Design & Software Choice
 - New User Interface
- ❖ Irradiation facilities database
 - Features
 - Database
 - Facility Details
 - Administrator View
 - Statistics & Outlook
- ❖ RadHard Sample Holders for IRRAD
 - Preliminary Results of mechanical tests
- ❖ Conclusion

AIDA-2020 D15.6

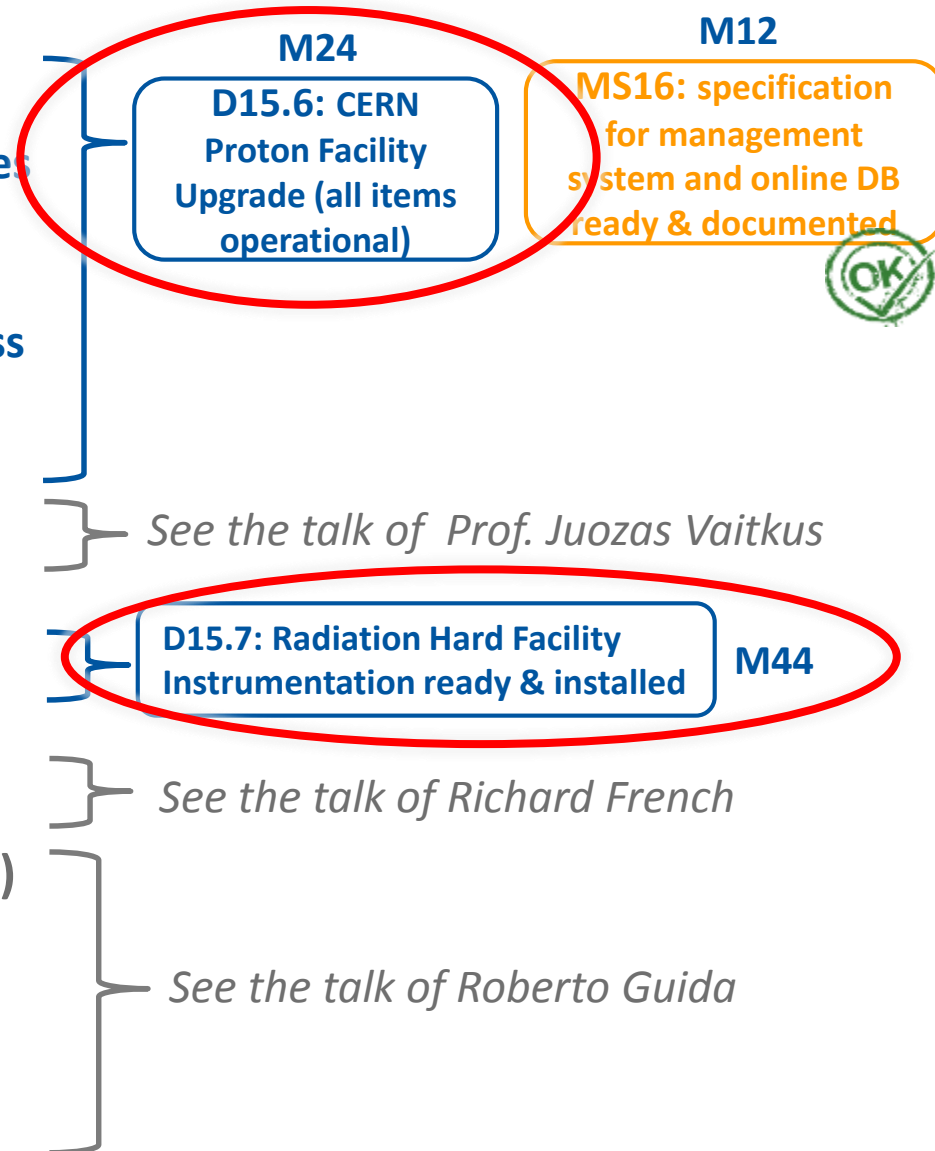
AIDA-2020 D15.7

❖ CERN Proton Facility (IRRAD)

- Online database on EU irradiation facilities of interest for HEP
- Improve IRRAD infrastr. / user friendliness
 - equip area to store/handle activated materials
 - sample and user management software system
 - upgrade contactless fluence monitoring
-Vilnius University
 - high-granularity & fast Beam Profile Monitor
 - test sample holders for extremely-high fluence
 - thermal box to -40°C for CERN & Birmingham
-University of Sheffield

❖ CERN Gamma Irradiation Facility (GIF++)

- Extension / upgrade of GIF++ Gas system
 - New online dose-rate monitor (INRNE)
 - Extension of the cosmic ray tracker on the side walls (INFN)
 - Demonstrator for an augmented reality event display (INFN)

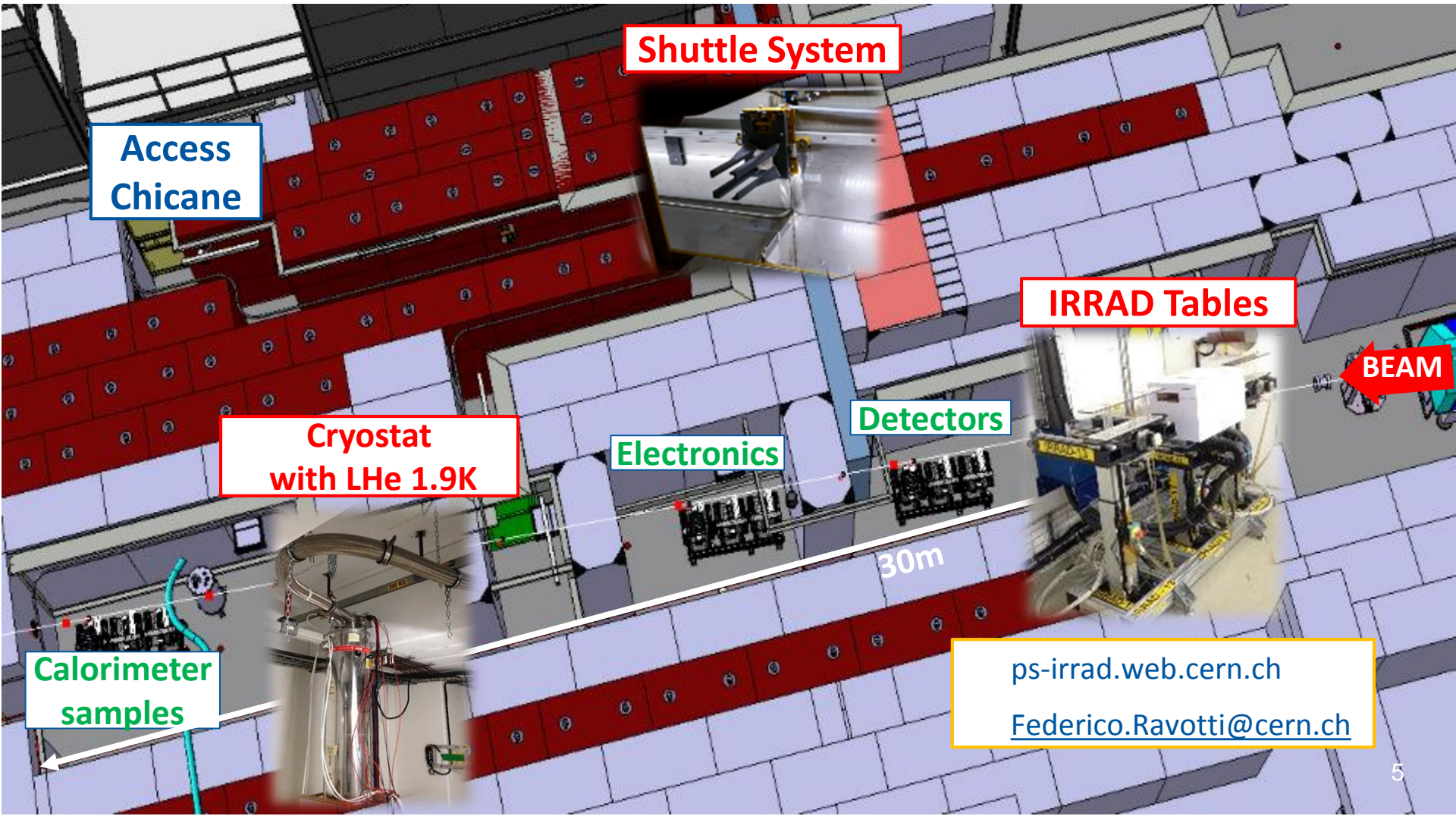


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CERN Proton Irradiation Facility (IRRAD)

- Testing components of the HEP experiments
- Fluence of 1×10^{16} p/cm² in 14 days
- Beam of 24 GeV/c and size of 12×12 mm²
- Scanning also in dimensions of 10×10cm²
- Spills of 400msec every ~10sec
- Low temperature irradiation (-25°C)

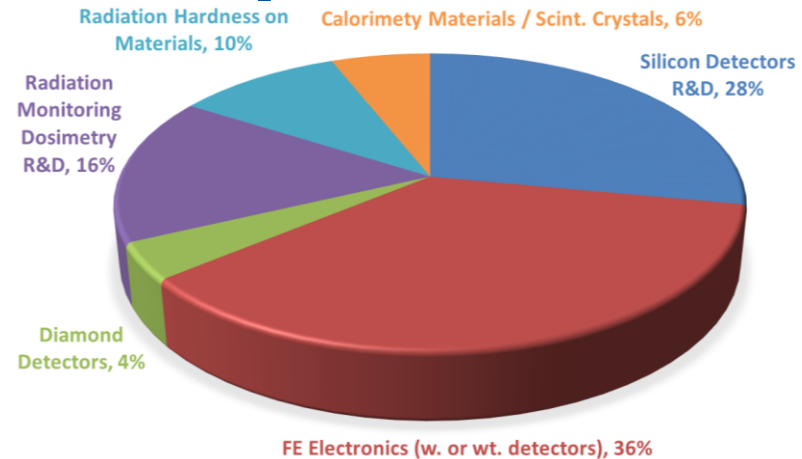


ps-irrad.web.cern.ch

Federico.Ravotti@cern.ch

Proton IRRADiation Facility in 2016

- Radiation damage studies
- Test of prototypes & final assemblies before installation
- Test and calibration of components



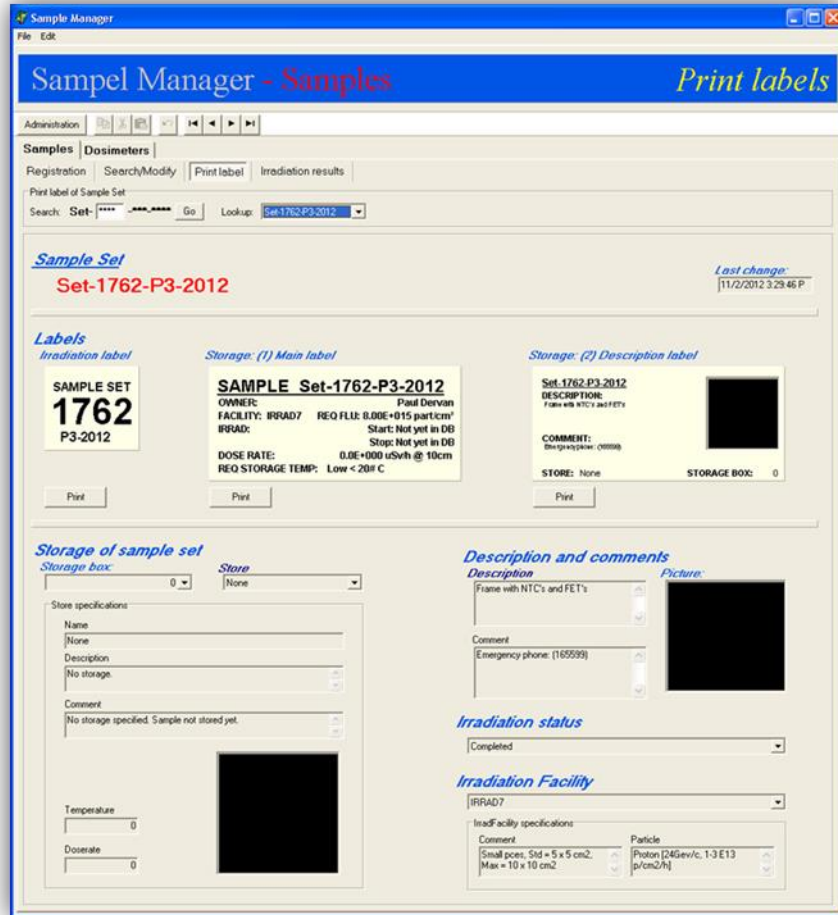
Registered Experiments (web)	52	49 executed (94%)
Number of users / user teams	28	~70% LHC experiments
Number of samples / irradiated objects	416	246 "SET" numbers
Samples size (MIN/MAX)	2mm × 2mm	250cm × 13cm × 4cm
MAX target proton fluence per experiment	1×10^{17} p/cm ² (5×5mm ² FWHM)	~27MGy in silicon
Delivered proton (typical MIN/MAX)	~ 2×10^{11} p/cm ² (1 spill)	~ 4.2×10^{16} p/cm ² (5×5mm ² FWHM) ~ 1.6×10^{16} p/cm ² (20×20mm ² FWHM)
Irradiation time (typical MIN/MAX)	400 ms	~60 days ~76 days

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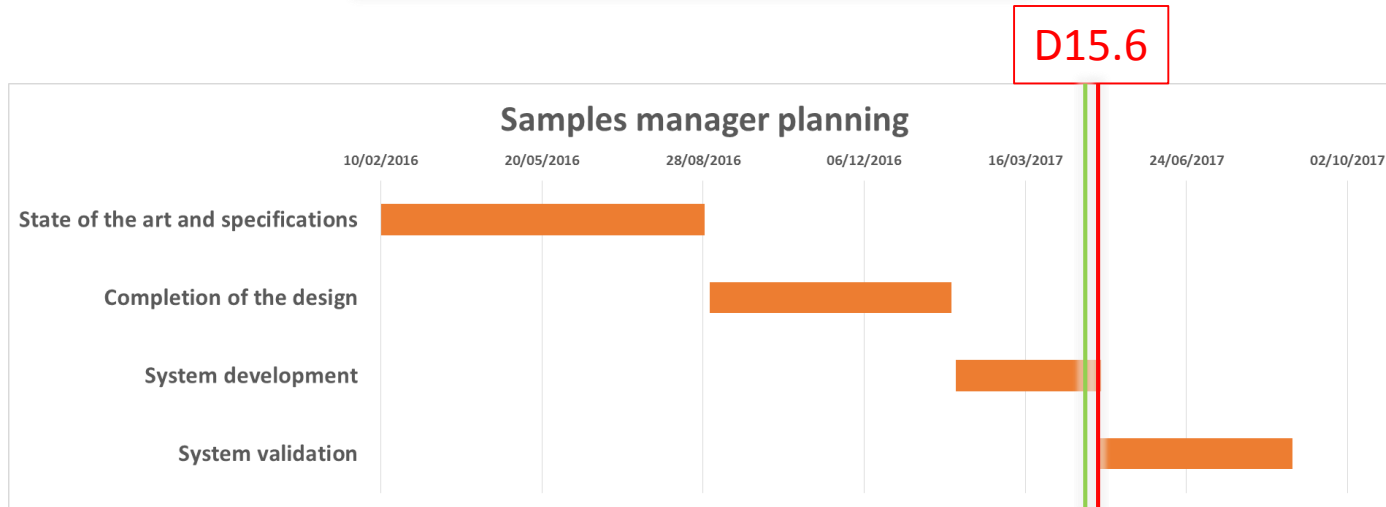
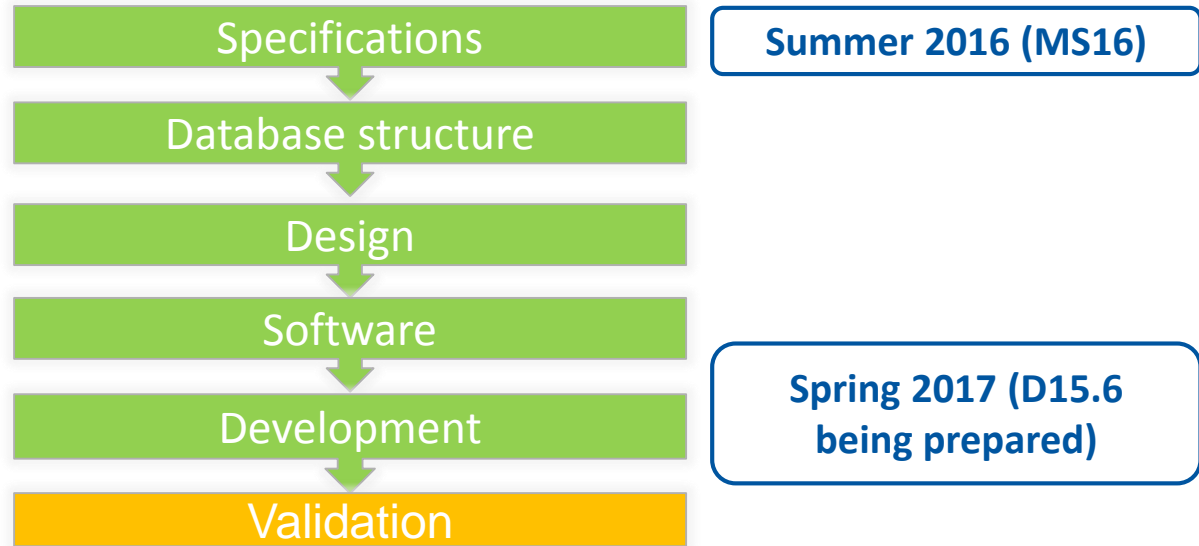
Samples Manager

Old system

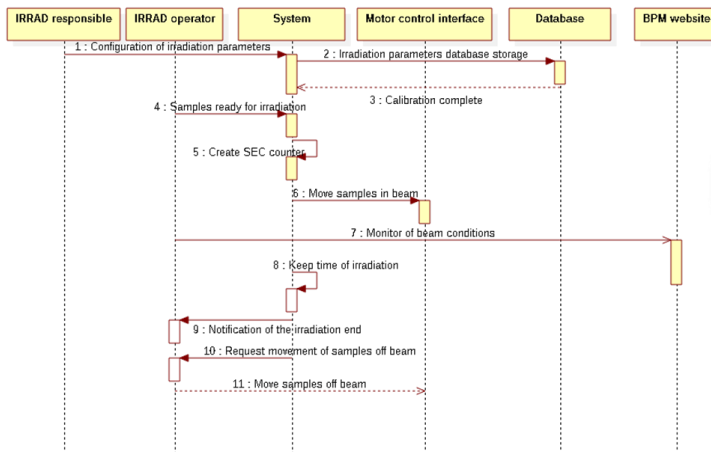
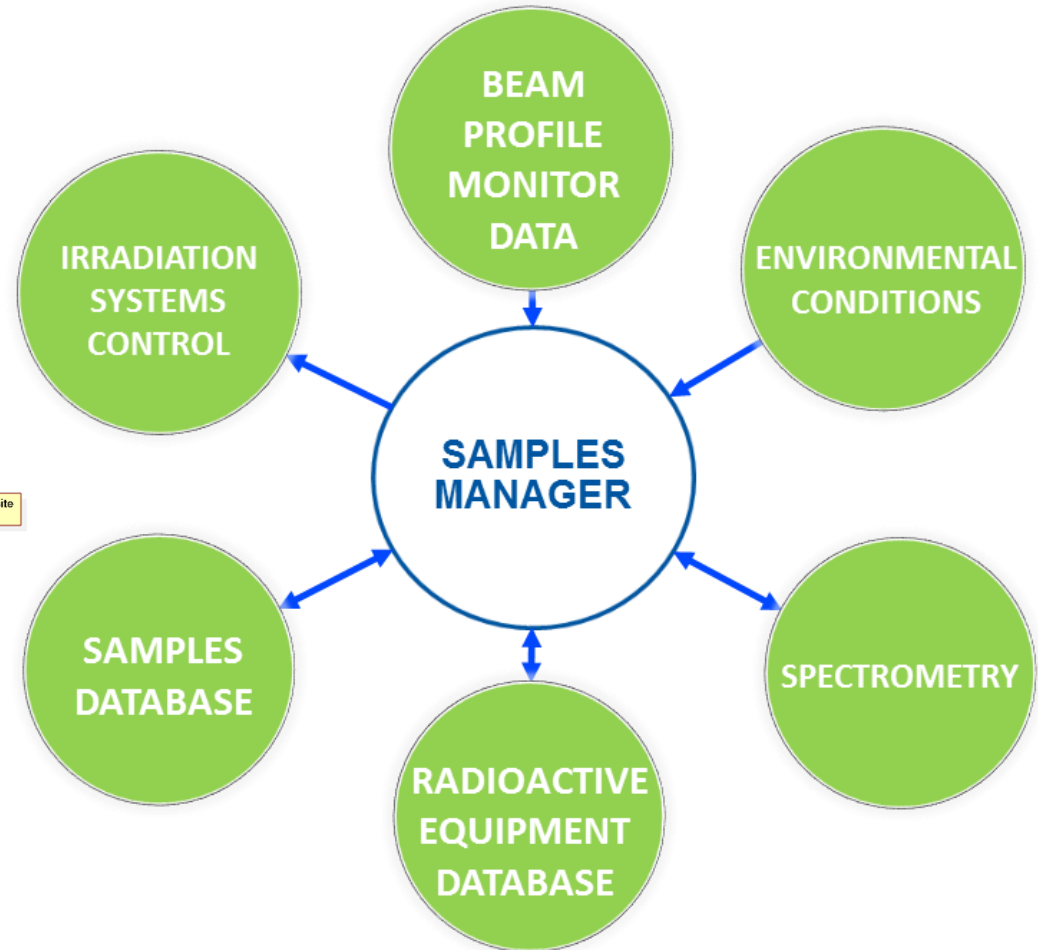
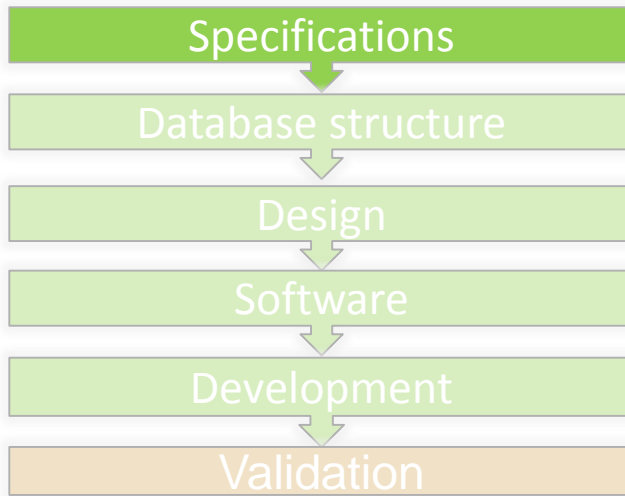


- **Outdated system**
 - Facility renewed in 2014
 - Evolution of CERN technologies
 - New CERN procedures
- Increasing amount of data
- Lack of multiple user profiles
- Need for a new **user friendly** system for **centralized data** management of the IRRAD facility.

Progress



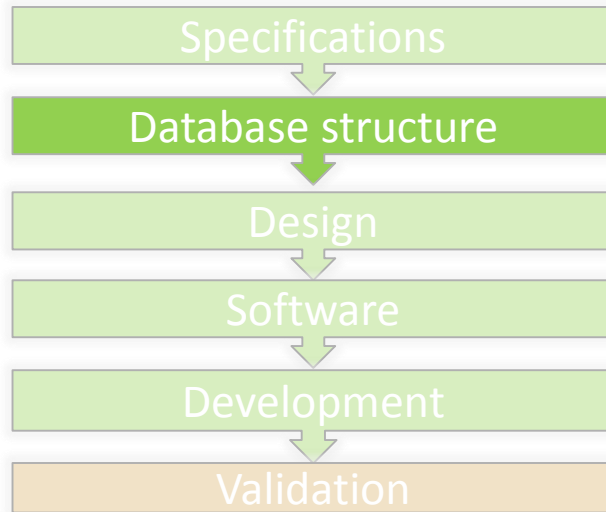
Specifications



Samples irradiation procedure sequence diagram

Specifications on cds.cern.ch/record/2159521/files/AIDA-2020-MS16.pdf

Database Structure



Irradiation experiment
<u>ID</u>
Maximum requested fluence
start date
end date
Irradiation planning
Requested space/resources
Storage request
Type of irradiation (Active/Passive)
Category (20x20, 5x5, 7x7, cold irradiation, cryogenic, shuttle, other)
General regulations flag
Comments

Irradiation Experiments Users
<u>User ID</u>
<u>Irradiation_Experiment ID</u>

Irradiations
<u>Samples ID</u>
<u>Dosimeter ID</u>
Date_IN
Date_OUT
Position
SEC IN
SEC OUT

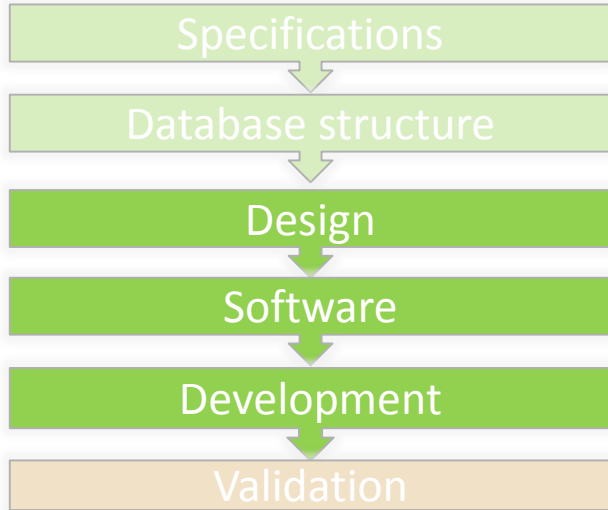
Samples
<u>ID</u>
Size
Weight
Type/material
Requested fluence
Description
Experiment
Location
Status
Comments
<u>Irradiation_Experiment ID</u>

Users
<u>ID</u>
User email
Name
Surname
Telephone
Role

Dosimeter
<u>ID</u>
Size
Weight
Type/material
Number of foils
Density
Description
Location
Status
Category (Profiling, Simple, Calibration)
Comments

Factors
<u>Samples size</u>
<u>Material</u>
<u>Location</u>
Value

Design & Software Choice



- Design of the interfaces according to the specifications and the requirements of the users and the coordinators
- Design with *balsamiq* mockups
- Software development with *Oracle* database, *Django*, *Bootstrap* and *Angular*



SAMPLES #	IRRADIATION TITLE	OWNER	UPDATED BY	DATE OF UPDATE	STATUS
Set-2017	Sintillating fibers irradiation	Georg Gorine	Federico Ravotti	23/2/2017	Registered
Set-2007	Silicon detectors 5x5mm*2 irradiation	Federico Ravotti	Giuseppe Pezzullo	23/2/2017	Edited
Set-2009	Silicon detectors 10x10mm*2 irradiation	Isidre Mateu	Federico Ravotti	23/2/2017	Approved
Set-2003	Silicon detectors 20x20mm*2 irradiation	Georg Gorine	Maurice Glaser	23/2/2017	Ready
Set-2005	Cold irradiation	Georg Gorine	Federico Ravotti	23/2/2017	Loaded
Set-2005	Silicon detectors 10x10mm*2 irradiation	Georg Gorine	Federico Ravotti	23/2/2017	In beam
Set-2005	Cryogenic irradiation	Giuseppe Pezzullo	Federico Ravotti	23/2/2017	Out of beam
Set-2003	Diamond detectors	Georg Gorine	Federico Ravotti	23/2/2017	Completed
Set-2003	Sintillating fibers irradiation	Georg Gorine	Federico Ravotti	23/2/2017	In storage
Set-2003	Sintillating fibers irradiation	Giuseppe Pezzullo	Federico Ravotti	23/2/2017	Out of IRRAD

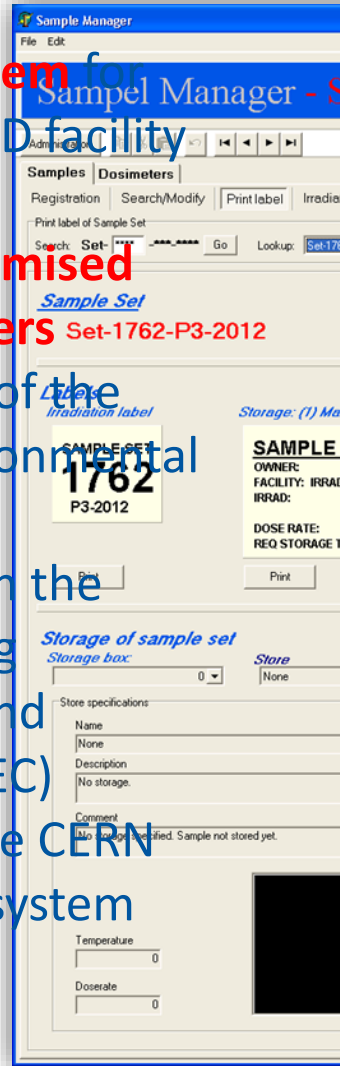
Balsamiq Mockups

New User Interface

Old system

New system

- ✓ Centralised system for the overall IRRAD facility operation
- ✓ Interfaces customised according to users
- ✓ Overall display of the beam and environmental conditions
- ✓ Compatible with the CERN computing infrastructure and procedures (TREC)
- ✓ Secured with the CERN authentication system (SSO)



Outline

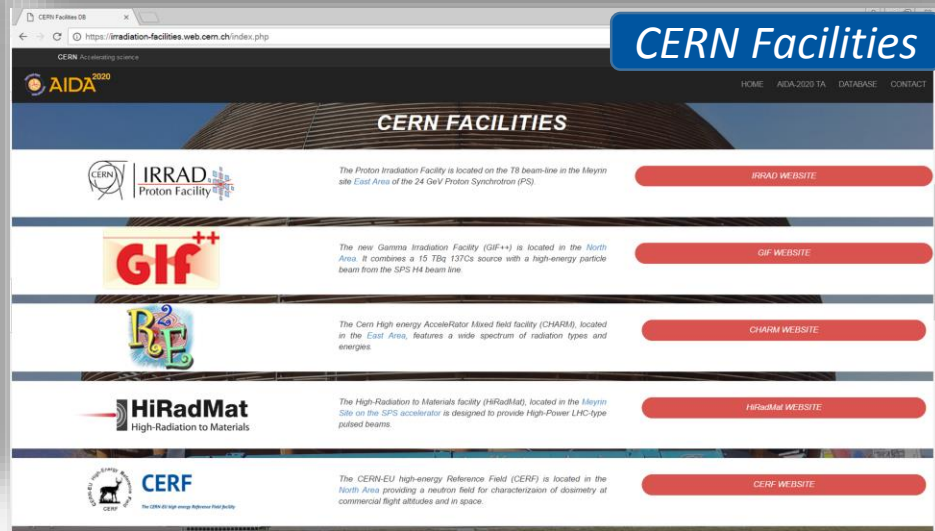
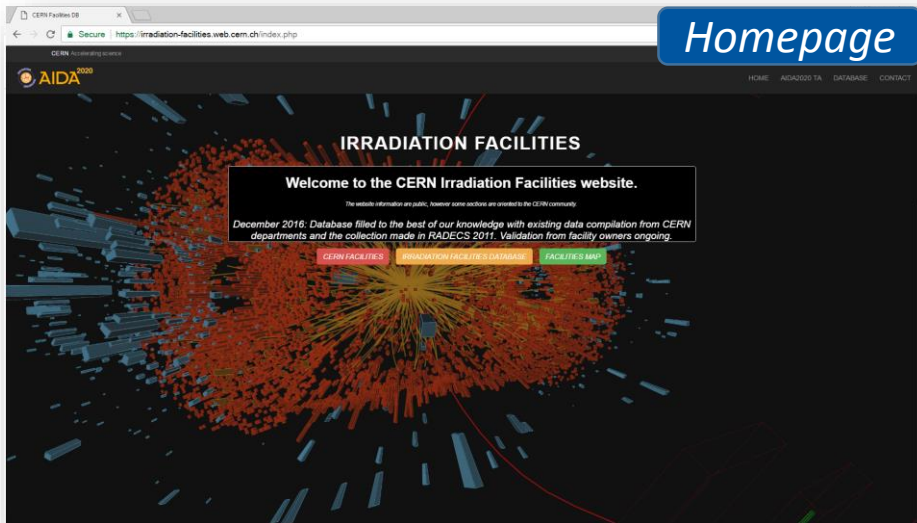
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Irradiation Facilities Database

- Deliverable in EU-project **AIDA-2020**
- Unified entry point for irradiation facilities at **CERN** and **worldwide**
- Essential (but exhaustive) collection of information
- **182 entries** initially loaded
- Data validation in progress since Feb. 8th

Facilities worldwide

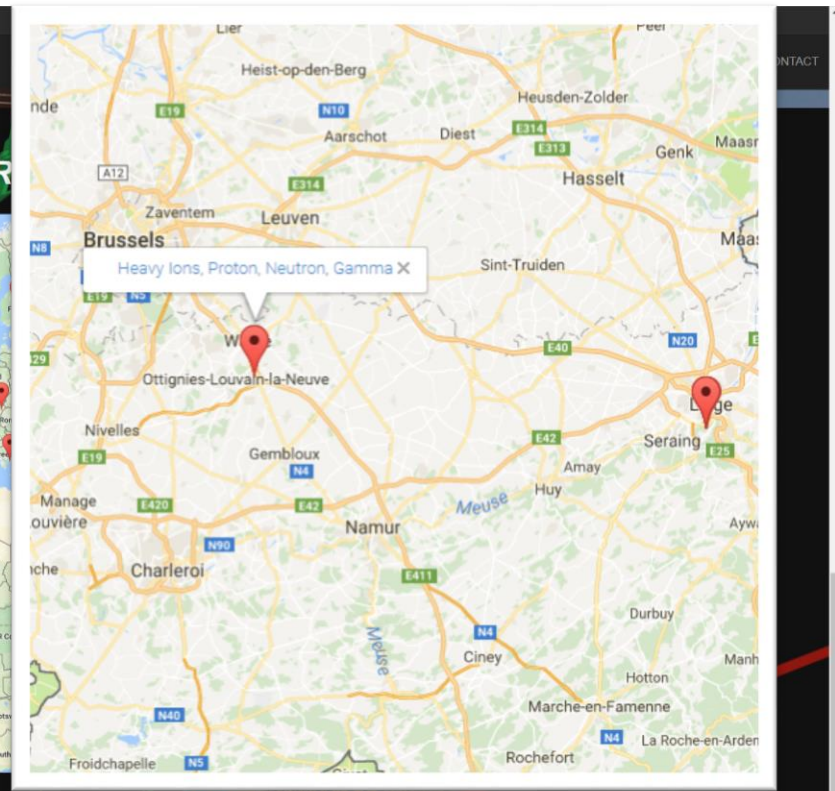
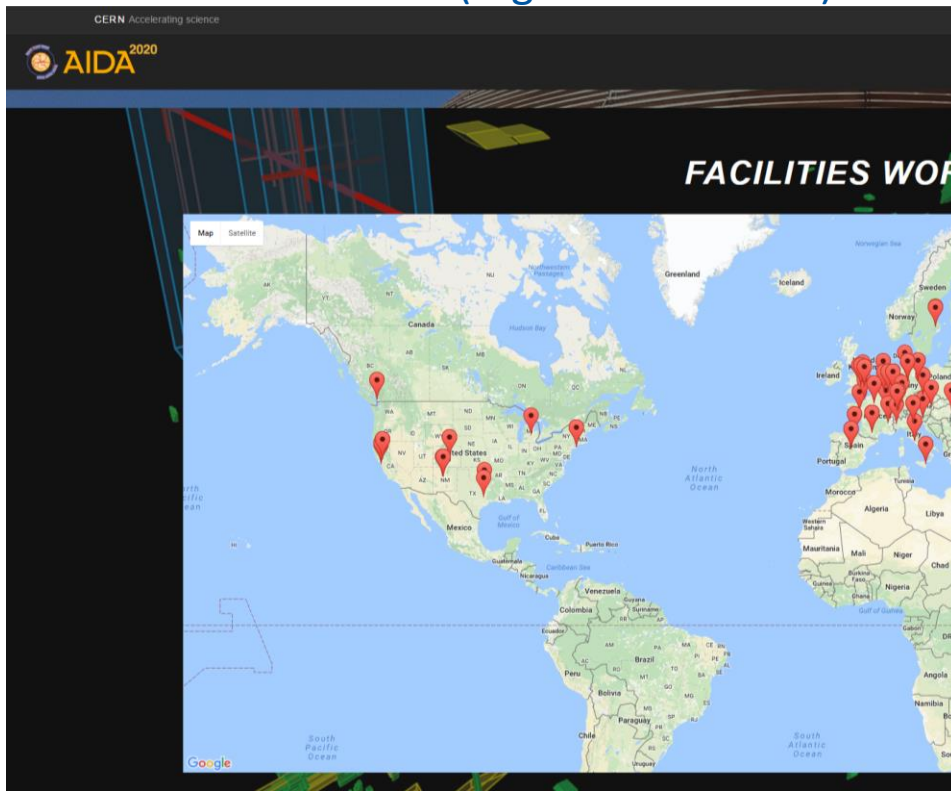
Institution Name	Country	Facility Name	Source Type	Field Type	Details
A R T E	Italy			Heavy ions	
ADVANCED RADIATION RESEARCH INSTITUTE (JAEA)	Japan	PROTON facility TIARA	J/ψ Cyclotron(K110), 3 MV Tandem accelerator, 3 MV Single-Ended accelerator, and 400 kV Ion Implanter	Proton	
ADVANCED RADIATION RESEARCH INSTITUTE (JAEA)	Japan	Electron Beam Irradiation Facility	Clack-coh-walton type	Electrons	
ADVANCED RADIATION RESEARCH INSTITUTE (JAEA)	Japan	Gamma-ray Irradiation Facilities	Co- 60	Gamma	
ADVANCED RADIATION RESEARCH INSTITUTE (JAEA)	Japan	HEAVY IONS facility TIARA	J/ψ cyclotron (K110), 3 MV Tandem accelerator, 3 MV Single-Ended accelerator, and 400 kV Implanter	Heavy ions	
AERIFLEX RAD	USA	NEUTRON facility - 1		Neutrons	
AERIFLEX RAD	USA	ELECTRON facility - 1		Electrons	
AERIFLEX RAD	USA	Gamma facility - 1		Gamma	
UJV Rad	Czech Republic	Phage reactor			
BOEING RADIATION EFFECTS LABORATORY (BREL)	USA	Test facilities		Gamma	
BROOKHAVEN NATIONAL LABORATORY (BNL)	USA	TANDEM VAN DE GRAAFF ACCELERATOR FACILITY (BNL SEU7)		Heavy ions	
Campus Tecnológico e Nuclear - CTN	Portugal	Portuguese reactor			
CEA Saclay	France	LABRA		Co- 60	Gamma
CEA Valduc	France			Neutron	
Centre Spatial de Liège	Belgium	Proton facility - 1		Cyclotron	Proton
Centre Spatial de Liège	Belgium	Electron facility - 1		Accelerator	Electrons
Centre Spatial de Liège	Belgium	Gamma facility - 2		Electromagnetic stopping of electron	Gamma
Centre Spatial de Liège	Belgium	Proton facility - 2		W6G	Proton
Centre Spatial de Liège	Belgium	Neutron facility - 1		BeBe isotopic	Neutron
Centre Spatial de Liège	Belgium	Gamma facility - 1		Co- 60 and Cs- 137	Gamma
CENTRO DE INVESTIGACIONES ENERGÉTICAS, MEDIOAMBIENTALES Y TECNOLÓGICAS (CIEMAT)	Spain	Gamma irradiation facility			Gamma
CENTRO DE MICROANÁLISIS DE MATERIALES (CMAM - UNIVERSIDAD AUTÓNOMA DE	Spain	Gamma facility			Gamma



Address: cern.ch/irradiation-facilities

Features

- **Open access** data, secured with the CERN authentication system (SSO)
- Search filters by country, source or radiation field
- Irradiation facilities worldwide map
- Possibility to **ADD** a new facility and **EDIT** an existent one by the **facility coordinator**
- **Auto-maintenance** (regular reminders)



Database

Facilities Database

This database contains a list of several different Irradiation Facilities available at CERN, in Europe and Worldwide.

To show whole database, click on "Show Data".

To search by Country, Source Type, or Radiation Field select your filter in the dropdown menu.

If you would like to add a new facility, please first log in and then click on "Add Facility".

You can only modify the facilities that you are responsible for.

For further details please check our [User Guide](#).

Search by Country:

Search by Source Type:

Search by Radiation Field/Type:

[Show Data](#) [Log In to Edit Data](#)

Details:	Institute Name:	Country :	Facility Name:	Source Type:	Radiation Field/Type:	Funding Details:
	Seibersdorf Laboratories	Austria	TEC-Laboratory	Co-60	Gamma	
	CSL - University of Liège	Belgium	Cyclotron	Cyclotron	Proton	
	CSL - University of Liège	Belgium	Focal e	4 pure beta- radio-isotopes sources (106Ru,36Cl,147Pm,Y/Sr)	Electron	
	CSL - University of Liège	Belgium	CHU	Bremsstrahlung stopping of electron	Gamma	
	UCL-Universite Catholique de Louvain	Belgium	Gamma Irradiation Facility (GIF)		Gamma	
	UCL-Universite Catholique de Louvain	Belgium	Neutron Lines(NIF)		Neutron	
	UCL-Universite Catholique de Louvain	Belgium	Proton Beam Line(LIF)		Proton	
	UCL-Universite Catholique de Louvain	Belgium	Heavy Ion Irradiation Facility(HIF)		Heavy Ions	
	CSL - University of Liège	Belgium	Gamma facility - 1	Co-60 / Cs-137	Gamma	
	CSL - University of Liège	Belgium	CHU	Accelerator	Electron	
	CSL - University of Liège	Belgium	Neutron facility	Ra-Be isotope	Neutron	
	CSL - University of Liège	Belgium	VdG	Van de Graaff linear accelerator	Proton	
	TRIUMF	Canada	PIF		Proton	
	TRIUMF	Canada	NIF		Neutron	
	Institute of Experimental and Applied Physics (UTEF)	Czech Republic	Laboratory of the VdG accelerator-Light ion beam		Light ions	
	ÚJV Rež	Czech	Prague reactor			

Facility Details

- Coordinator, Institute
- Facility data
- Irradiation conditions
- Safety
- Accessibility
 - AIDA-2020 TA!
- Additional comments

Facility details - Google Chrome
 Secure | <https://irradiation-facilities.web.cern.ch/facilityDetailsOut.php?f=0&ID=2&Facility=1>

Facility coordinator contact information		Institute/Organization Details	
Name:	Federico Ravotti	Name:	CERN
E-mail:	Federico.Ravotti@cern.ch	Address:	Route de Meyrin 385, 1217 Meyrin
Alternative e-mail:	irrad.ps@cern.ch	City:	Meyrin
Phone:	+41 22 76 74280	Country:	Switzerland
		Website:	www.cern.ch/ps-irrad

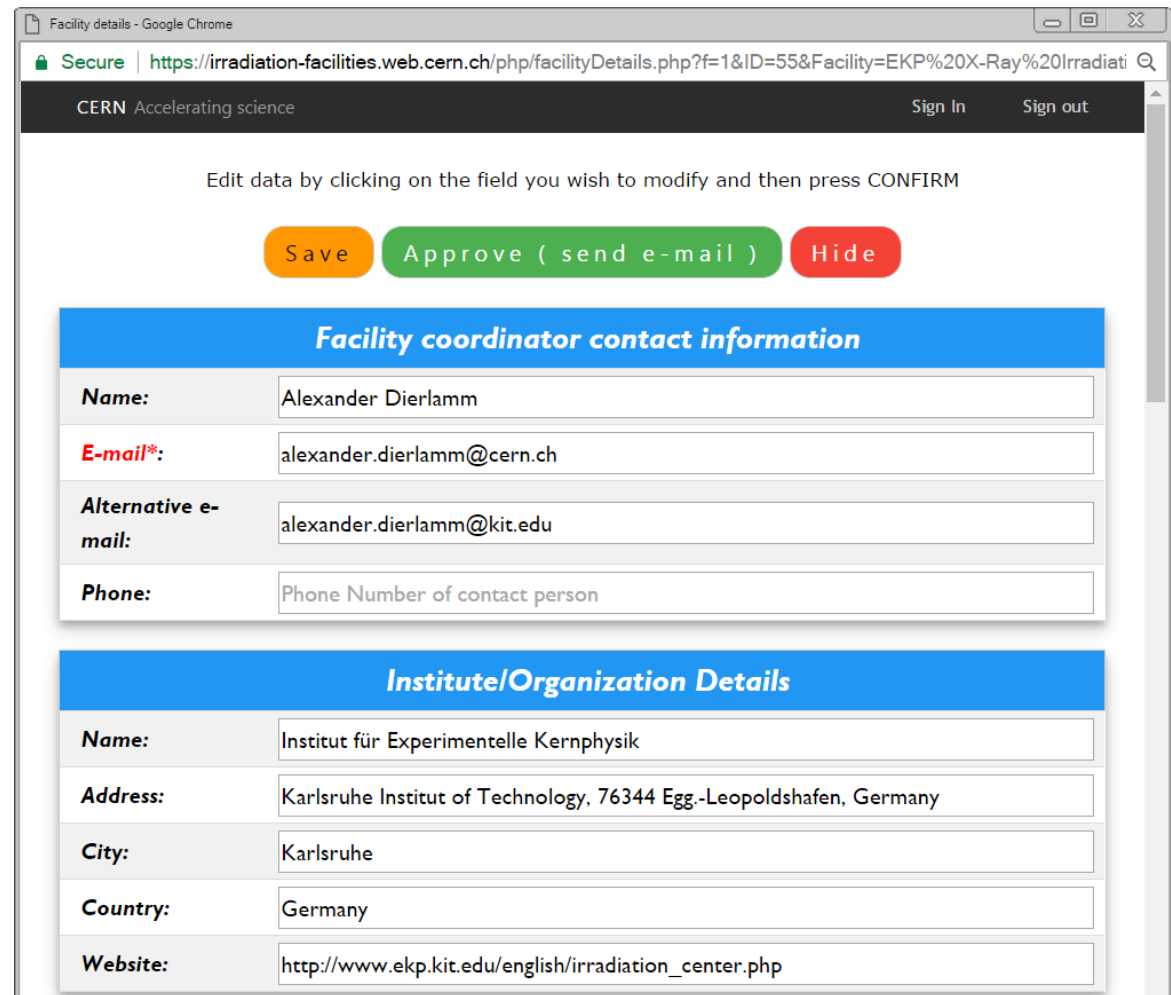
Facility Data		Irradiation Conditions	
Name:	CERN Proton Irradiation Facility (IRRAD)	FORM FIELD	YES NO N/A <small>See Comments</small>
Source:	Synchrotron (CERN PS)	Is an Active Readout of the sample possible during irradiation?	<input checked="" type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
Radiation Field/Type:	Proton	Is there any Sample Dosimetry available?	<input checked="" type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
Energy:	24 GeV/c	Will the sample be considered Radioactive after irradiation?	<input checked="" type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
Activity:		Can the humidity be controlled during irradiation?	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input checked="" type="radio"/>
Power:		Can the temperature be controlled during irradiation ?	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
Min Dose Rate:		Is there any sample positioning system ?	<input checked="" type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
Max Dose Rate:		Min Temperature:	-25°C (cold boxes) - 1.9K (cryogenic setup)
Min Flux:	-5E10 p/cm2 with one particle spill	Max Temperature:	21°C
Max Flux:	1E16 p/cm2 over 5 days in high intensity periods	Dosimetry Type:	activation foils (Al), GaF films, RPL, Alanine, semiconductor dosimeters (RAD)
Pulsed or Continuous:		Irradiation Volume:	maximum standard: 20x20x50cm3 - larger dimension possible
Pulse Width:	400ms	Irradiation Comments:	1) Humidity in the irradiation area is permanently monitored, possible to control if small irradiation setup; 2) fix cabling infrastructure available
Repetition Time:	about 1 spill every 10sec. with standard PS supercycle		

Safety		Accessibility	
FORM FIELD	YES NO N/A <small>See Comments</small>	Special Agreement with CERN:	
Is a Medical Certificate required?	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input checked="" type="radio"/>	Agreement Details:	http://aida2020.web.cern.ch/content/transnational-access
Mandatory CERN RP Training certificate?	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input checked="" type="radio"/>	Special Funding Programs:	
Is a CERN Radiation Passport needed?	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input checked="" type="radio"/>	Funding Details:	AIDA 2020 TA
Should you bring your own CERN Dosimeter ?	<input checked="" type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>		
Does the facility hold a Licence for import/export of Radioactive Material with CERN? (for more information see here)	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input checked="" type="radio"/>		
Safety Comments:	CERN safety rules applies to access the IRRAD infrastructure: 1) specific safety trainings 2) port of a valid personal & operational dosimeters 3) port of PPE see also: https://ps-irrad.web.cern.ch/index.php?link=access_irrad.html		

Additional Comments

Administrator View

- **Modifications or new submissions** are screened by the *Admin* team, corrected (if necessary) and finally **approved**. Data become then available (again) for public view.
- *Facility Coordinators* are informed by e-mail.
- A *Facility Coordinator* can also request to **delete** his Facility: data are still in the database but removed from public view.



Facility details - Google Chrome

Secure | <https://irradiation-facilities.web.cern.ch/php/facilityDetails.php?f=1&ID=55&Facility=EKP%20X-Ray%20Irradiati>

CERN Accelerating science Sign In Sign out

Edit data by clicking on the field you wish to modify and then press CONFIRM

Save Approve (send e-mail) Hide

Facility coordinator contact information

Name:	Alexander Dierlamm
E-mail*:	alexander.dierlamm@cern.ch
Alternative e-mail:	alexander.dierlamm@kit.edu
Phone:	Phone Number of contact person

Institute/Organization Details

Name:	Institut für Experimentelle Kernphysik
Address:	Karlsruhe Institut of Technology, 76344 Egg.-Leopoldshafen, Germany
City:	Karlsruhe
Country:	Germany
Website:	http://www.ekp.kit.edu/english/irradiation_center.php

User Manual: <https://cds.cern.ch/record/2244674/files/AIDA-2020-NOTE-2017-002.pdf>

Statistics & Outlook

- **42** entries have been validated so far by the *Facility Coordinators*
- The website has been visited **~350** times



Follow up:

- Send **second reminder** to the *Facility Coordinators* that did not reply yet
- Article on **AIDA-2020 newsletter** being released
- Send the first **“annual” validation** reminder (test the notification system) by the end of 2017
- Contact CERN colleagues to **remove outdated information** from old CERN websites

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RadHard Sample Holders for IRRAD

- Current material used for the samples holders are from pure cellulose (getting damaged $>10^{17}$ p/cm²)
- Performing irradiation and tests in TRIGA reactor in JSI*



**D15.7: Radiation Hard Facility
Instrumentation ready & installed**

M44

*Many thanks to I. Mandic, V.Cindro and JSI operation team for the support!

Preliminary Results of Mechanical Tests

N.	Material	Thickness [mm]
1	Carbon Veneta	1.40
2	Carbon Veneta	1.54
3	3D	2.75
4	3D	2.20
5	3D	1.66
6	3D	1.12
7	3D	1.00
8	3D	0.80
9	Carbon FAP	1.07
10	Carbon FAP	1.00
11	Carton	1.00

HOLDERS TESTED:

Sample SET	Fluence
1	1.00E+16
2	5.00E+16
3	1.00E+17
4	3.00E+17
5	5.00E+17

- The standard IRRAD holder start failing $> 5 \times 10^{16}$ n/cm²
- The 3D printer material breaks at 1×10^{17} n/cm² and gets activated as much as the cellulose
- The **carbon fibres** has the best results so far

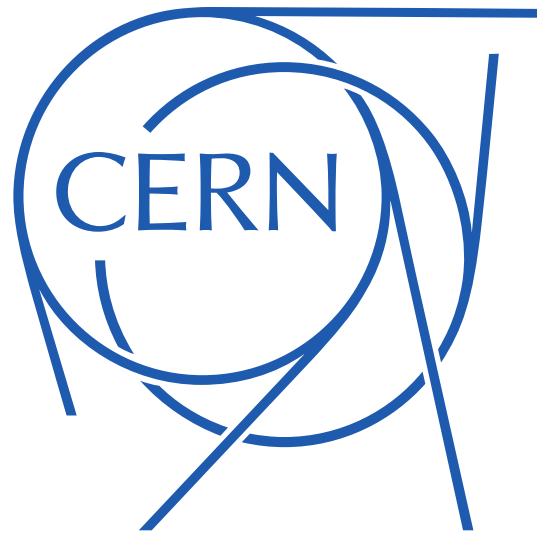
Conclusion

- Samples Manager core application developed and soon under validation
- Irradiation facilities database completed ahead of schedule (February) and data are being validated and maintained
- The deliverable report **D15.6** to be submitted in the end of April (M24)
- First measurements ongoing on new sample holder materials irradiated at JSI in March (**D15.7**)
- Next IRRAD run starting in May 2017. Detailed schedule:
ps-irrad.web.cern.ch/documents/run2017/Schedule_IRRAD_CHARM_2017_v2.pdf

Contact for IRRAD: irrad.ps@cern.ch

Contact for irradiation Facilities database: Irradiation.Facilities@cern.ch

THANK YOU!

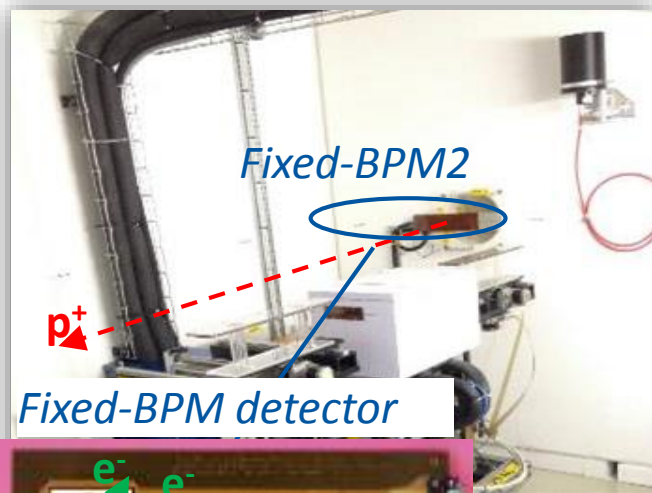


Samples Manager

BPM Detectors and DAQ Unit AIDA ²⁰²⁰

Fixed BPM

For the beam alignment



Fixed-BPM detector



Transversal beam profile



Mini and single-pad BPMs

IRRAD tables alignment purpose and “in-beam” detection



D15.7:
Radiation
Hard Facility
Instrumenta
tion ready &
installed

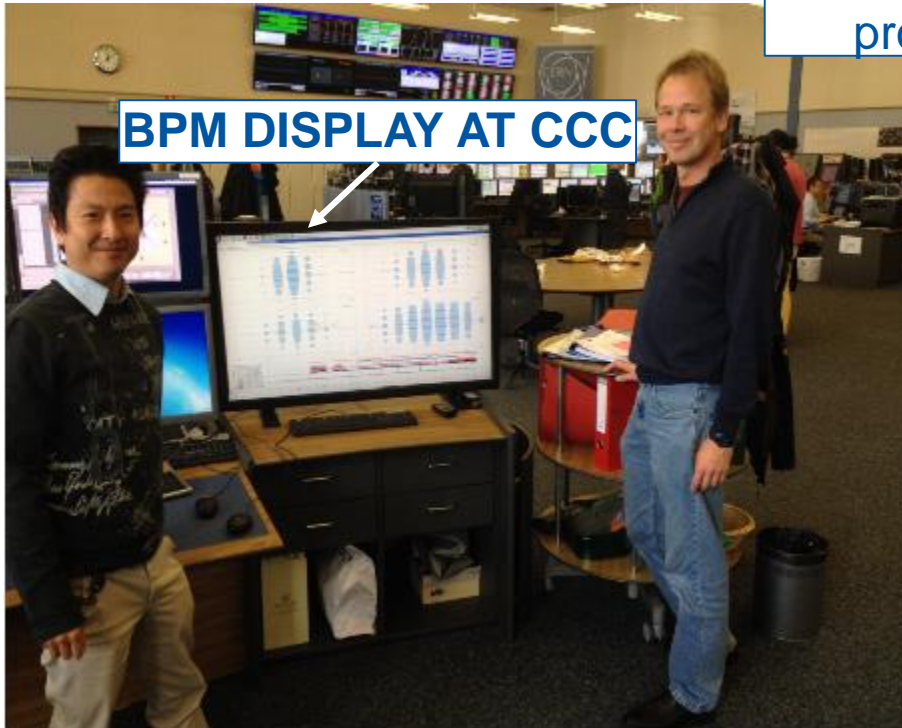
M44



BPM DAQ unit 25-35m away from fixed-BPM device.



Beam Profile Monitors (BPMs) AIDA 2020



BPM DISPLAY AT CCC

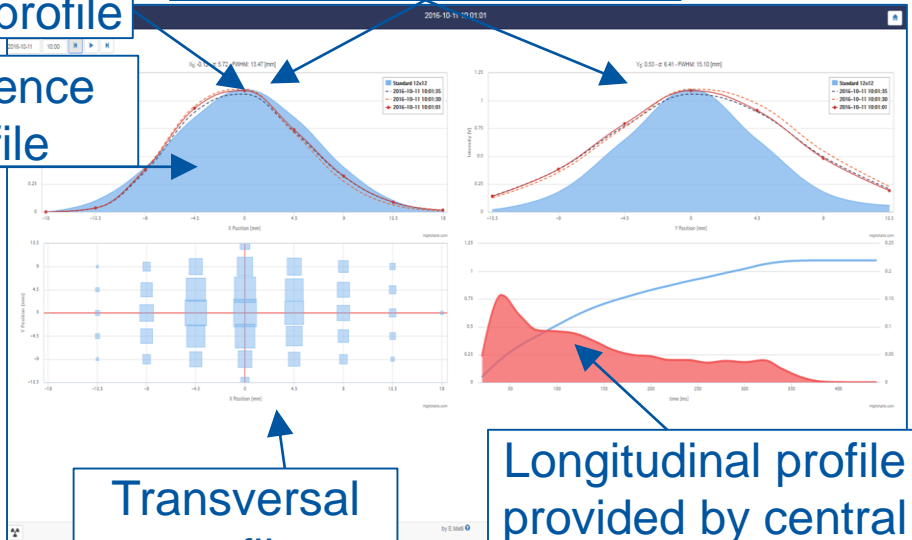
Beam monitoring at CERN Control Center (CCC)

<https://op-webtools.web.cern.ch/irrad/index.php>

Measured profile

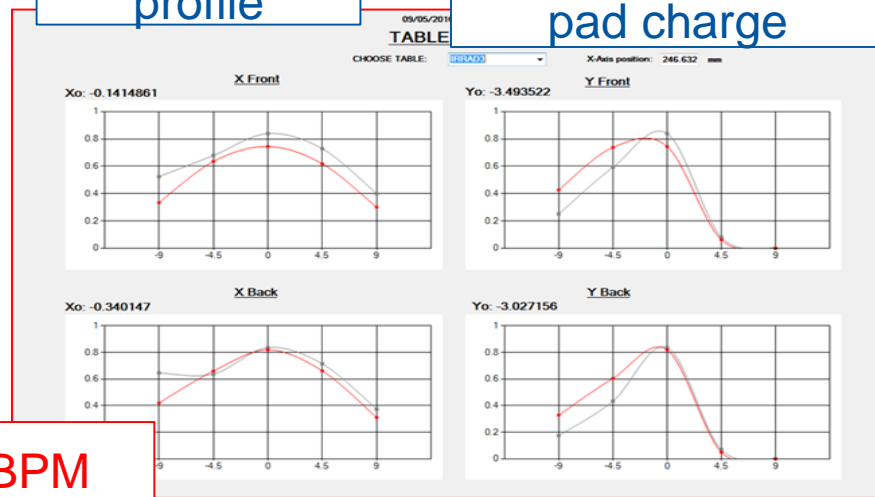
Reference profile

fixed-BPM Gaussian fit



Transversal profile

Longitudinal profile provided by central pad charge

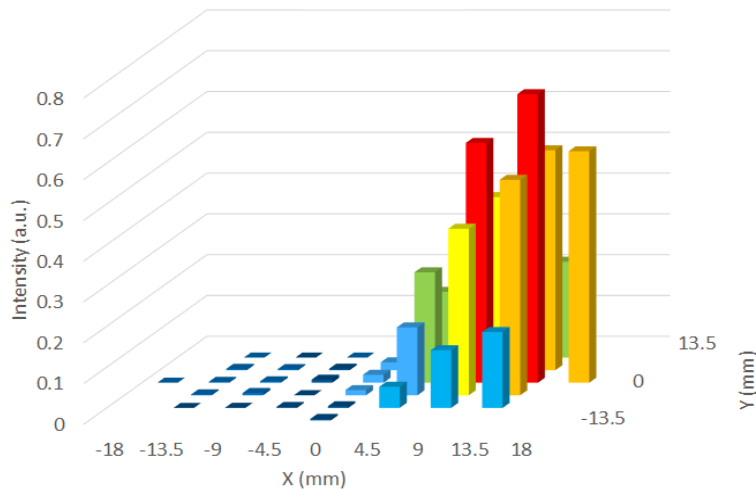


mini BPM
Gaussian fit

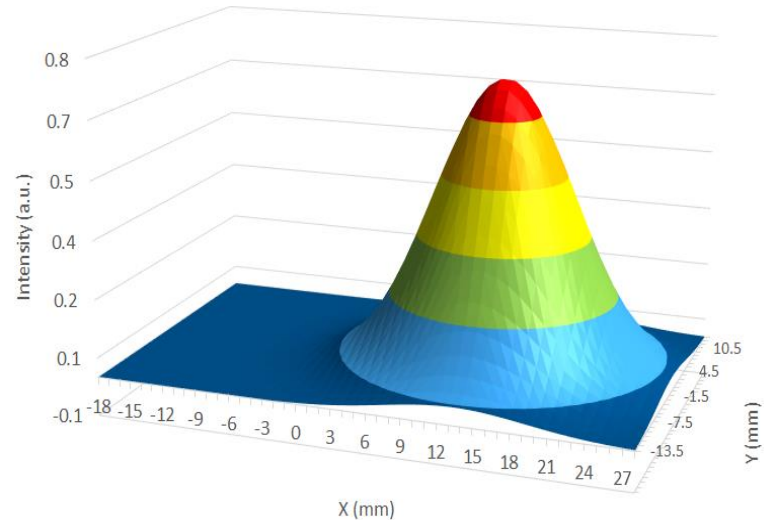
Upgrade: New 3D Fitting Tool Validation

- Better accuracy required by:
 - CERN Control Center (CCC)
 - IRRAD team
 - IRRAD users
- Developed within AIDA-2020, D15.7
- All BPM channel values included
- Initial values for the algorithm: the maximum value and its XY position
- SciPy function for least square minimization
- Validated over hundreds of spills against other fitting methods

BPM Data



Reconstructed Beam Profile



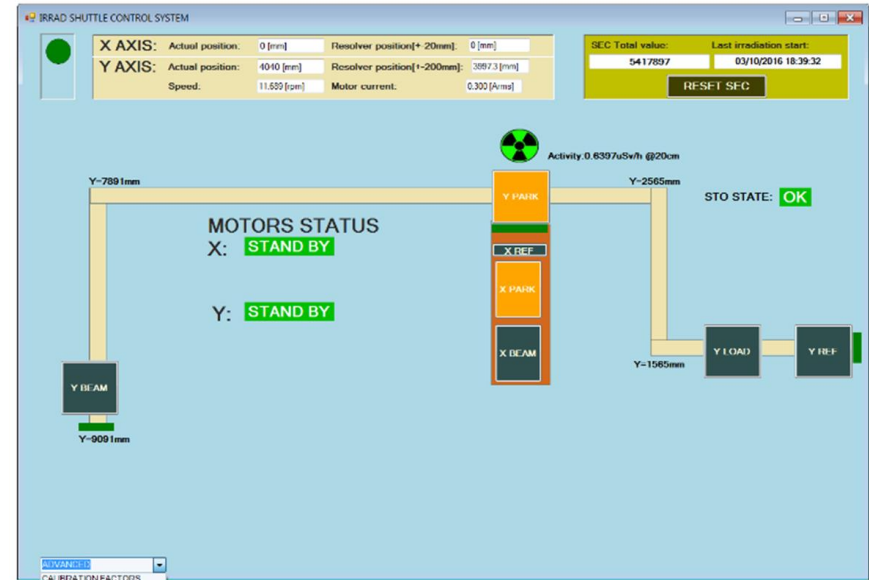
Shuttle-IRRAD1 Description

- System to place samples in beam without accessing the area.
- No need to stop the beam
- Manual control
- Software control
- Dose rate monitoring
- Safe handling of samples as priority

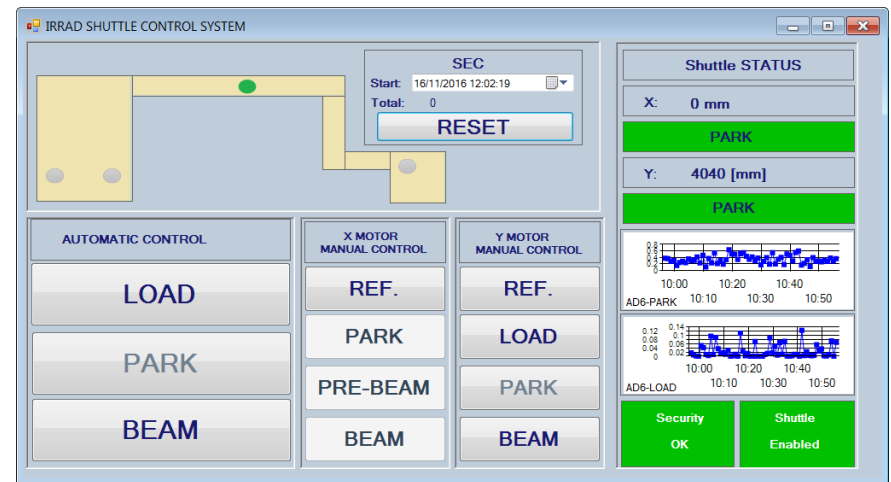


Shuttle-IRRAD1 Control Interfaces

- Remote control of the shuttle via Ethernet
- Two interfaces:
 - Administrators-full control
 - Users-simplified version
- Y- Axis positions: Reference, Load, Park and Beam
- X-Axis positions: Reference, Park, Pre-Beam and Beam
- Counting beam intensity while shuttle in beam
- Software interlock when samples radioactivity is too high



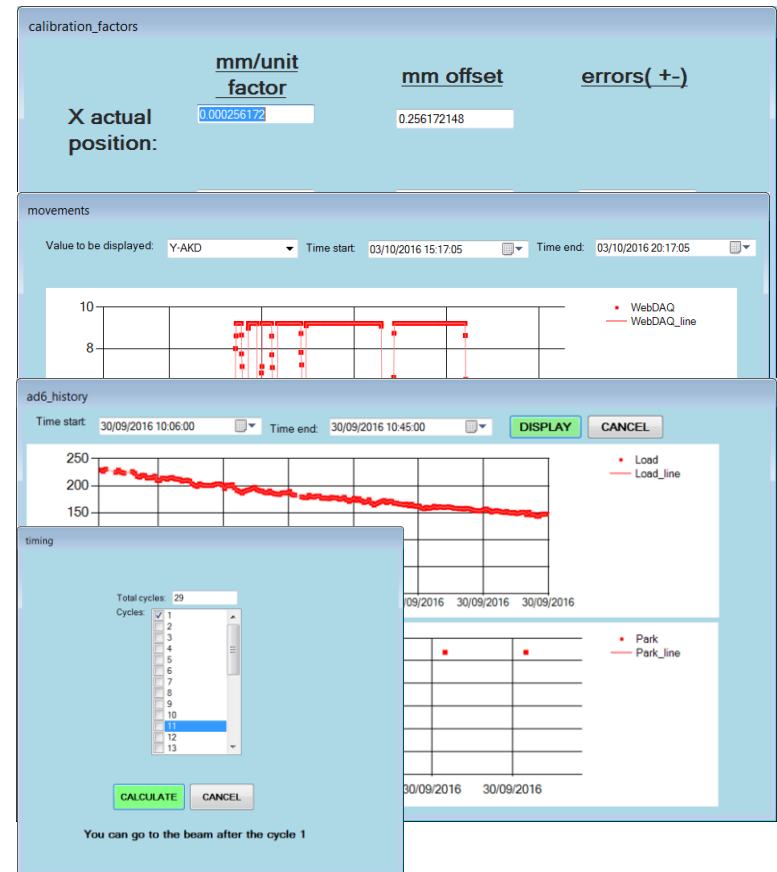
Administrator interface



User interface

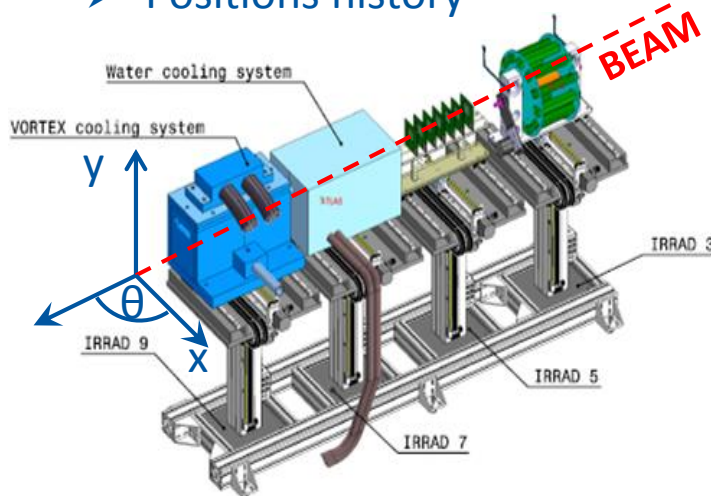
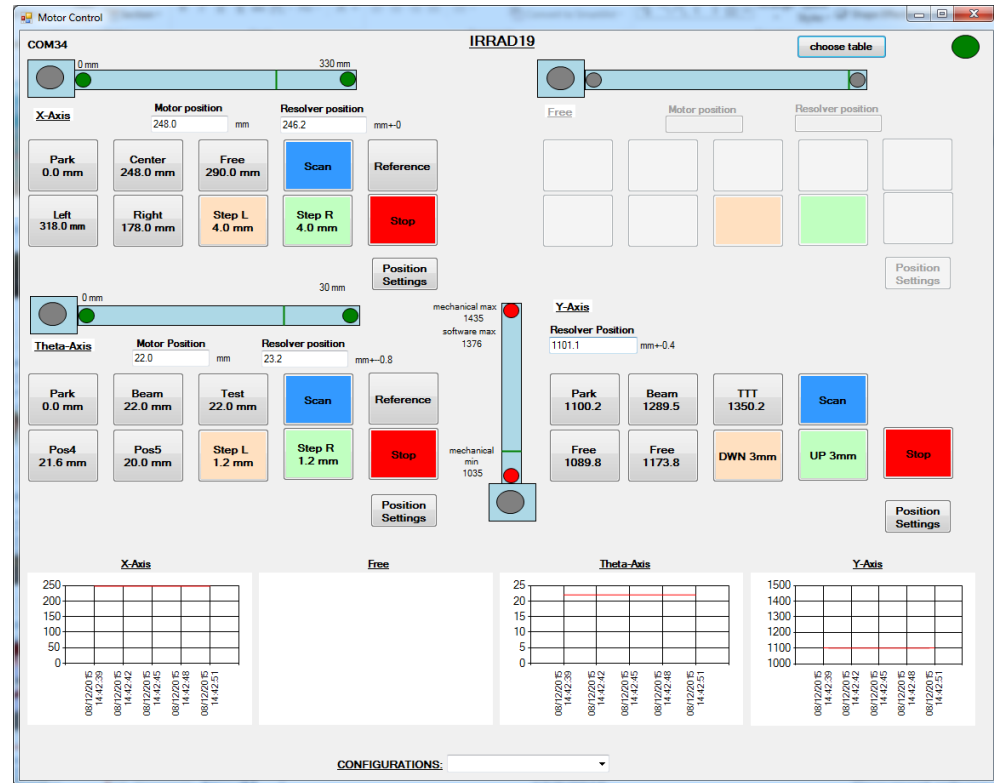
DAQ and Shuttle Monitoring

- ✓ Calibration factors
- ✓ Shuttle positions monitoring (both axis)
- ✓ Dose rate monitoring (samples radioactivity)
- ✓ Calculation of the proper timing to place the samples in beam (for short time irradiations)



IRRAD Tables Control

- XY and theta axis movement
- Positions definition
- Speed definition
- Motors calibration
- Storage of calibration and system configuration parameters
- Positions history



Samples Manager Dataflow

