

IRRAD Facility Infrastructure Upgrade

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AIDA²⁰²⁰

AIDA-2020 WP15

Outline

❖ CERN Milestones & Deliverables

❖ CERN Proton irradiation Facility (IRRAD)

❖ Samples manager

- Samples manager progress
- Samples manager planning
- Mini-BPM & single-pad BPM detectors
- Beam Profile Monitors (BPM)
- Control systems
- Samples Manager Dataflow

❖ Irradiation facilities database

❖ Conclusion

CERN Milestones & Deliverables

❖ 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)

M24

D15.6: CERN Proton Facility Upgrade (all items operational)

Focus of this presentation

M12

MS16: specification for management system and online DB ready & documented



See the talk of Prof. Juozas Vaitkus

D15.7: Radiation Hard Facility Instrumentation ready & installed

M44

See the talk of Michalis Benakis

See the talk of Roberto Guida

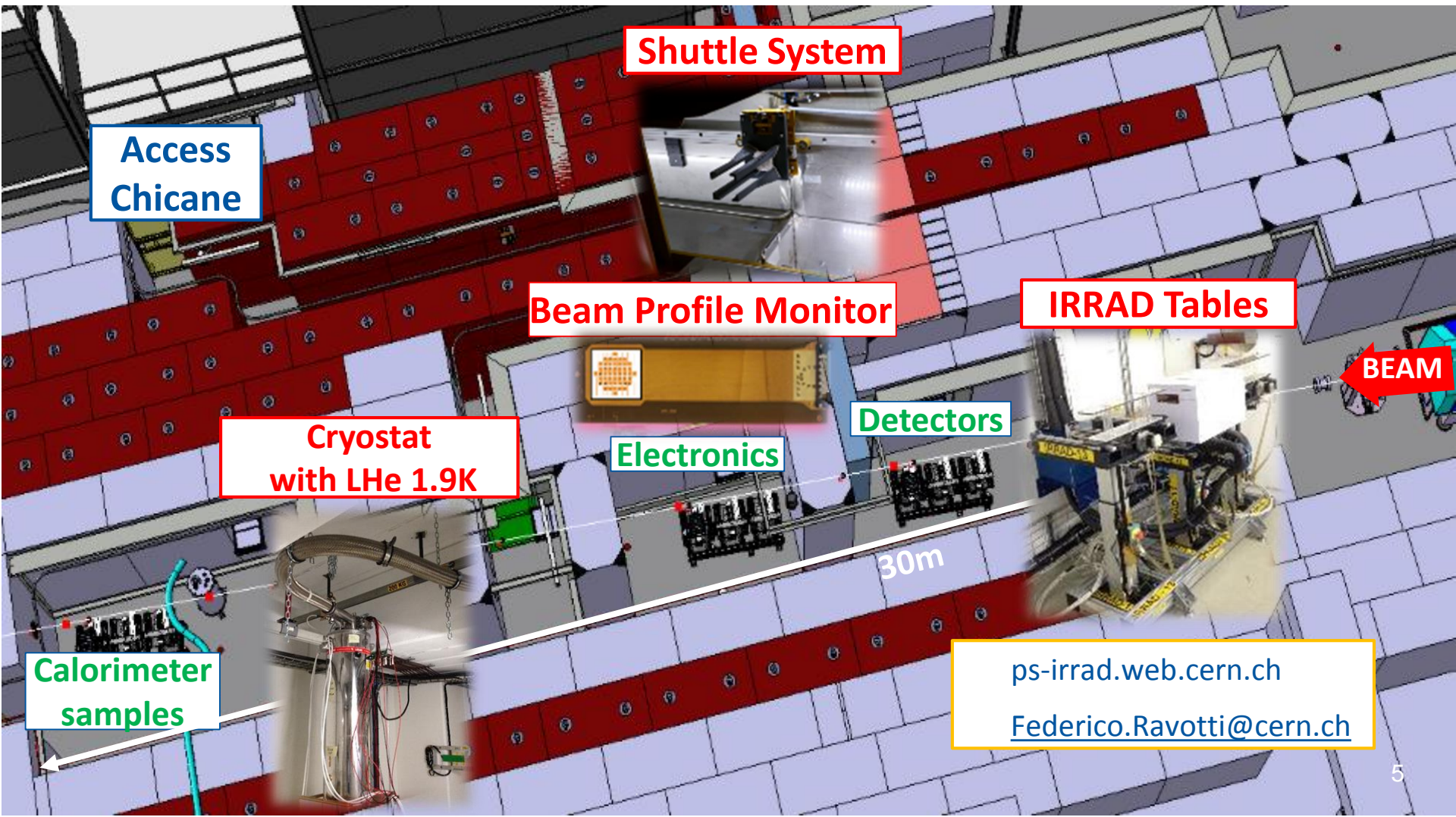
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CERN Proton irradiation Facility (IRRAD)

- 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 10×10 cm²
- Spills of 400 msec every ~10 sec
- Low temperature irradiation (-25°C)

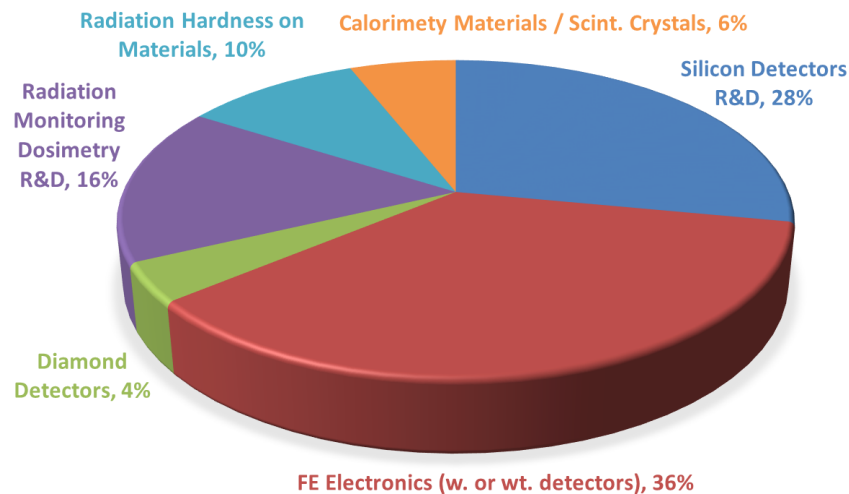


ps-irrad.web.cern.ch

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

New system

The screenshot shows the 'Sample Manager - Samples' web application. It features a navigation bar with 'Administration', 'Samples', and 'Dosimeters' tabs. The 'Samples' tab is active, showing a 'Registration' section with 'Search/Modify', 'Print label', and 'Irradiation results' buttons. Below this is a 'Print label of Sample Set' section with a search field containing 'Set-1762-P3-2012' and a 'Go' button. The main content area displays 'Sample Set: Set-1762-P3-2012' with a 'Last change' timestamp of '11/2/2012 3:29:46 P'. There are three label preview sections: 'Irradiation label' showing 'SAMPLE SET 1762 P3-2012', 'Storage: (1) Main label' showing detailed sample information like 'OWNER: Paul Dervan' and 'FACILITY: IRRAD7', and 'Storage: (2) Description label' showing 'Set-1762-P3-2012' and 'DESCRIPTION: Frame with NTC's and FET's'. Each label has a 'Print' button. Below the labels is a 'Storage of sample set' section with a 'Storage box' dropdown set to '0' and a 'Store' dropdown set to 'None'. It includes a 'Store specifications' form with fields for Name, Description, Comment, Temperature, and Doserate. To the right is a 'Description and comments' section with a 'Description' field containing 'Frame with NTC's and FET's', a 'Comment' field with 'Emergency phone: (165559)', and a 'Picture' field. At the bottom right is an 'Irradiation status' dropdown set to 'Completed' and an 'Irradiation Facility' dropdown set to 'IRRAD7', which includes a table for 'IrradFacility specifications' with columns for Comment and Particle.



Samples Manager Progress

- ✓ Current state of the art
 - Irradiation facilities technology research
 - Contacting facility owners
- ✓ Specifications defined
 - ✓ User communities
 - ✓ Features
 - ✓ Use cases

(cds.cern.ch/record/2159521/files/AIDA-2020-MS16.pdf)

- ✓ First design approach

TREC Traceability of Radioactive Equipment at CERN

SEARCH **EQUIPMENT** LOCATION

PXXISET001-CR002200 - Equipment details

Identifier **PXXISET001-CR002200**

Other identifier **SET-002200**

*Description **Sample Sets**

*Responsible

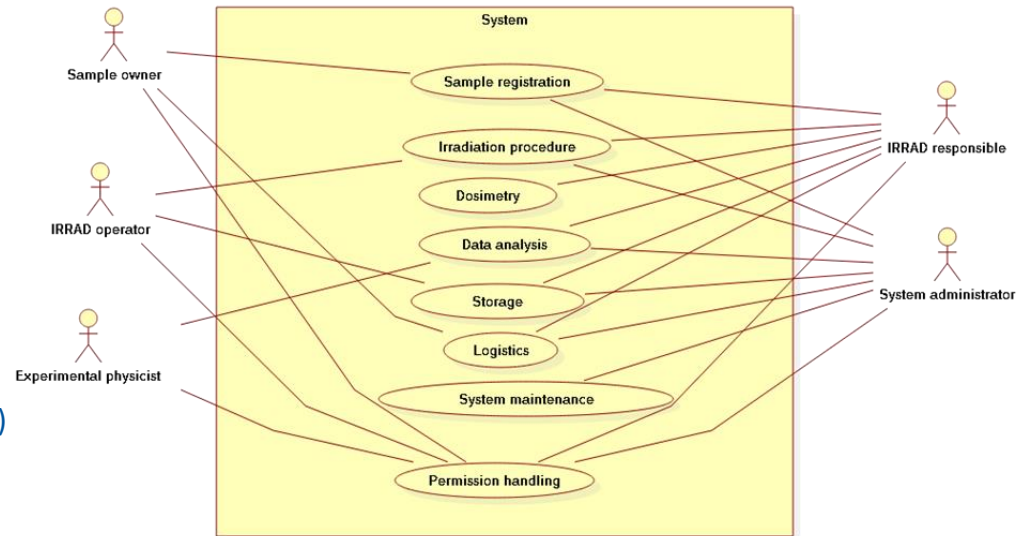
Comments

Cancel Previous Next

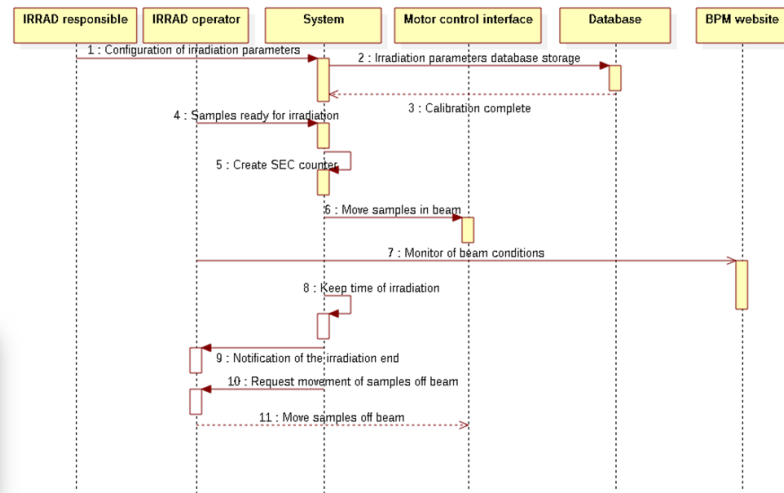
PXXISET001-CR002147

PS-IRRAD Facility
www.cern.ch/ps-irrad

SET-002147



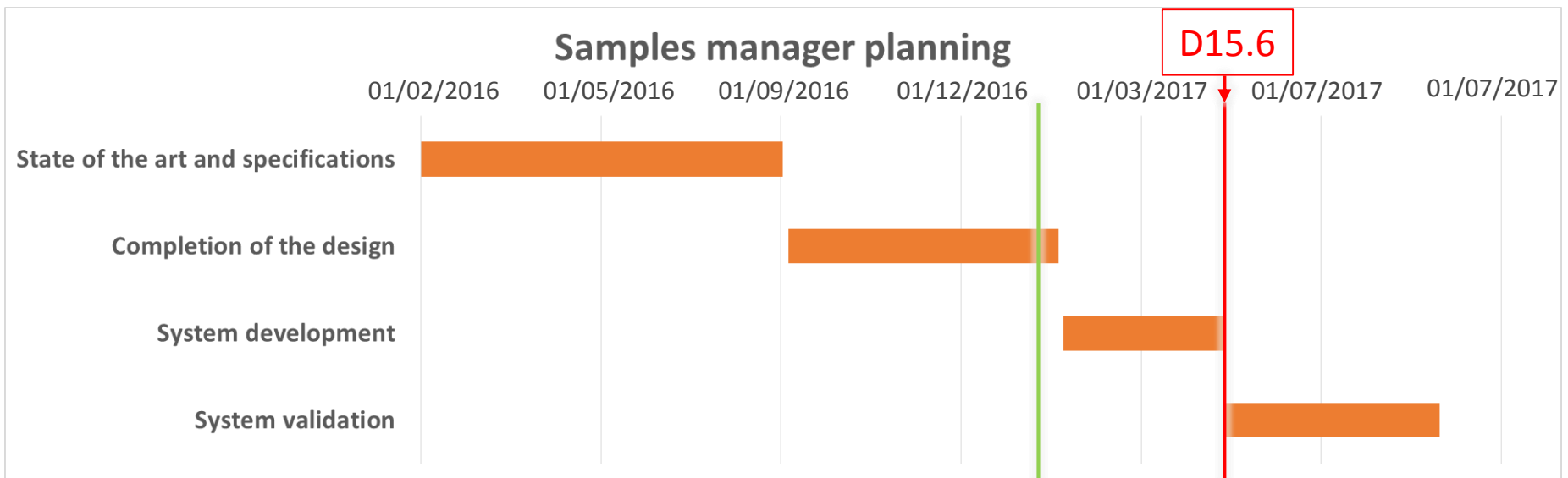
Samples manager use case model



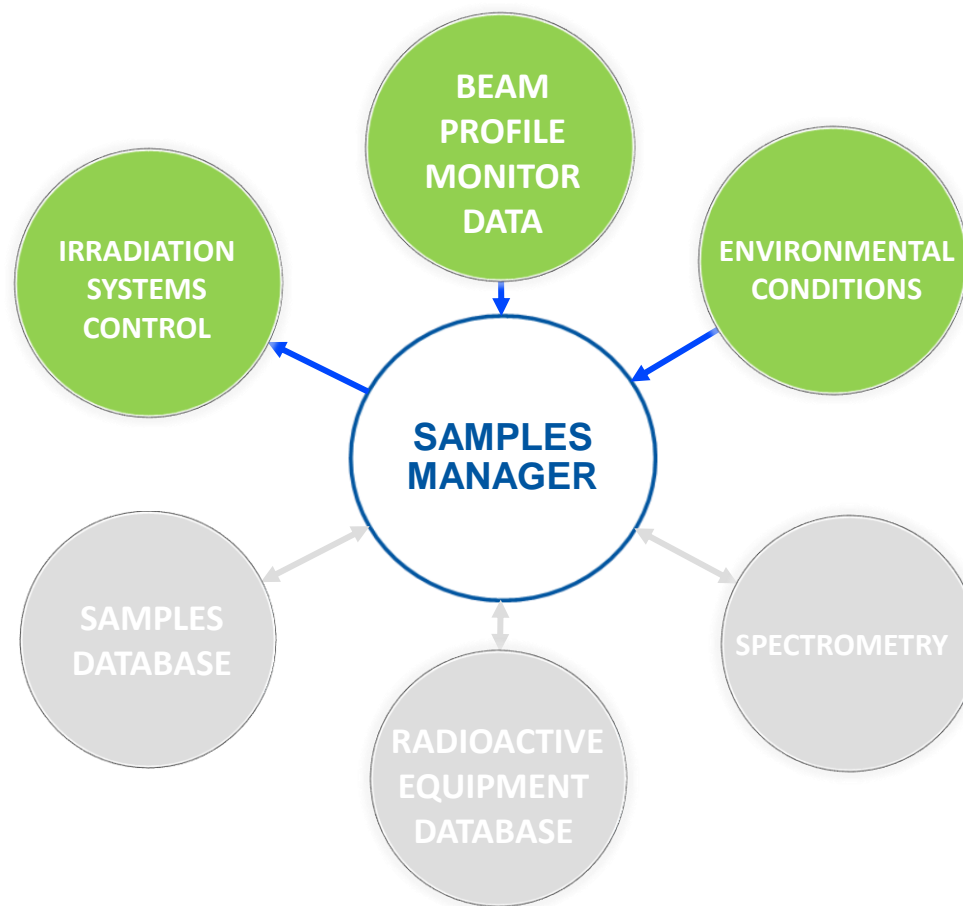
Samples irradiation procedure sequence diagram

Samples Manager Planning

- ❑ Completion of the design
- ❑ System development
- ❑ System validation



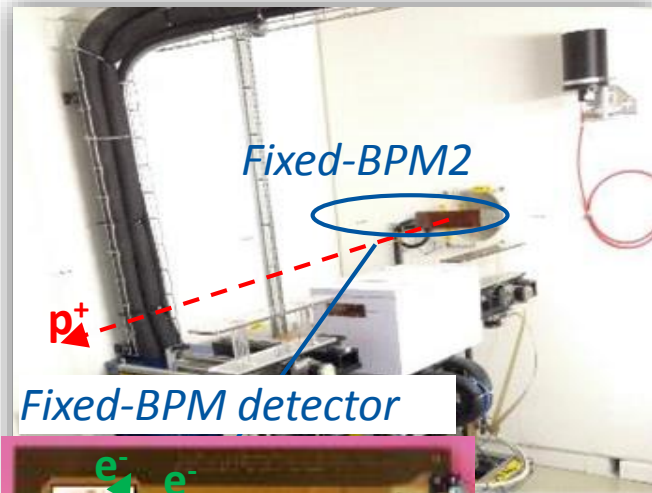
Samples Manager



BPM Detectors and DAQ Unit

Fixed BPM

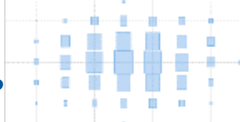
For the beam alignment



Fixed-BPM detector

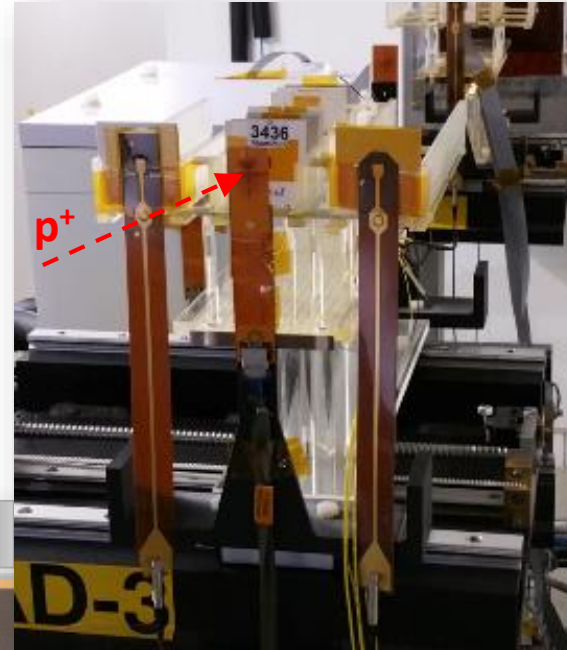


Transversal beam profile



Mini and single-pad BPMs

IRRAD tables alignment purpose and "in-beam" detection



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

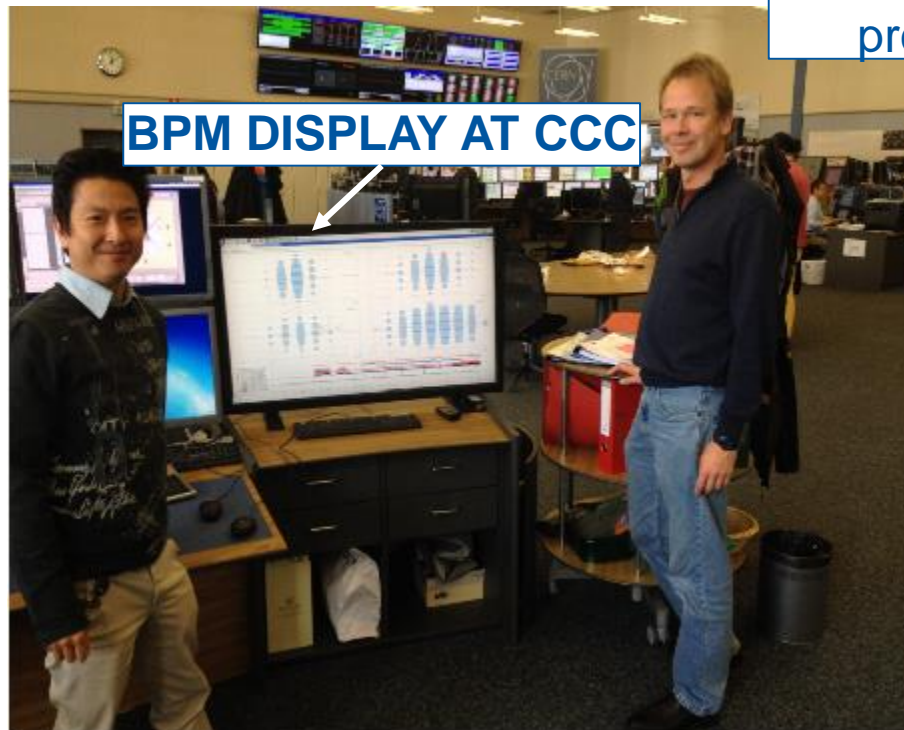
M44



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



Beam Profile Monitors (BPMs)



BPM DISPLAY AT CCC

Beam monitoring at CERN Control Center (CCC)

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

Measured profile

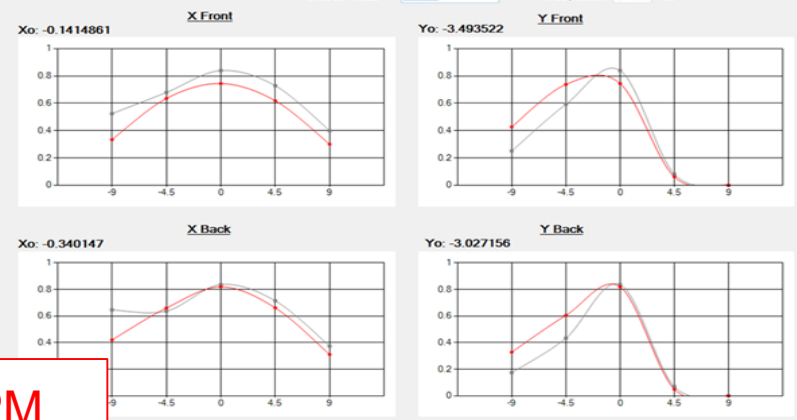
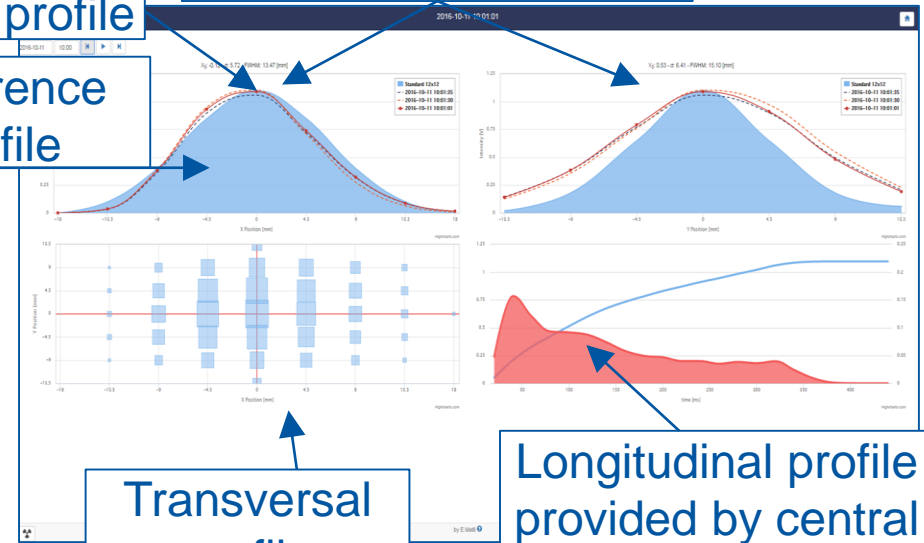
Reference profile

fixed-BPM Gaussian fit

Transversal profile

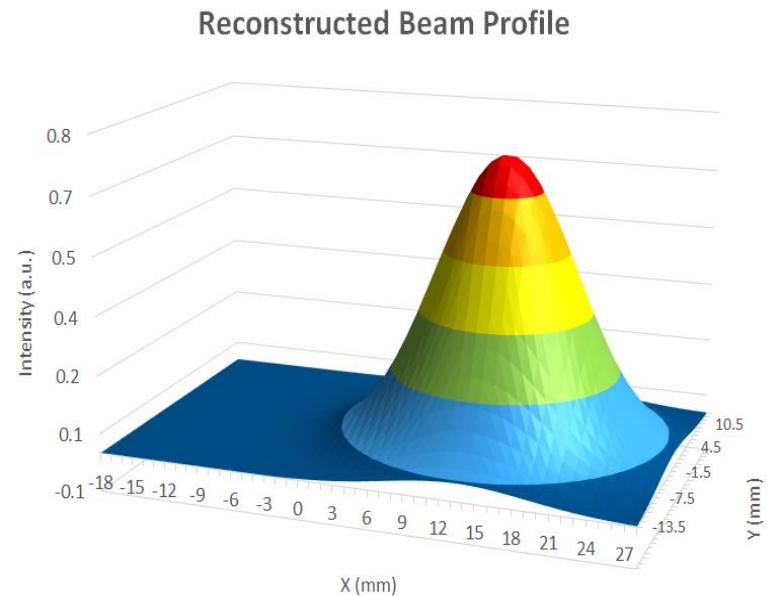
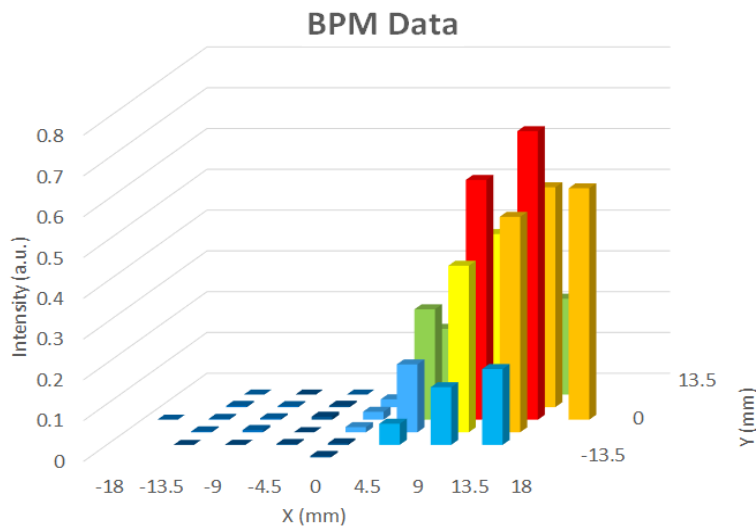
Longitudinal profile provided by central pad charge

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



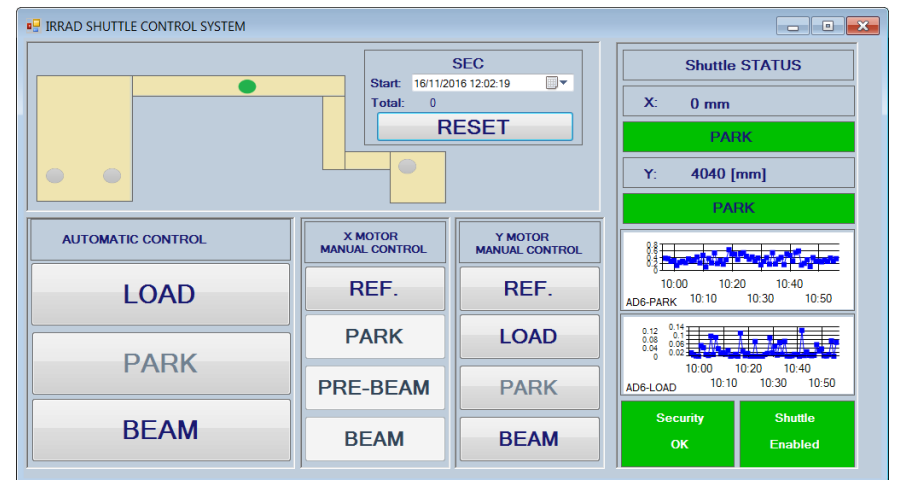
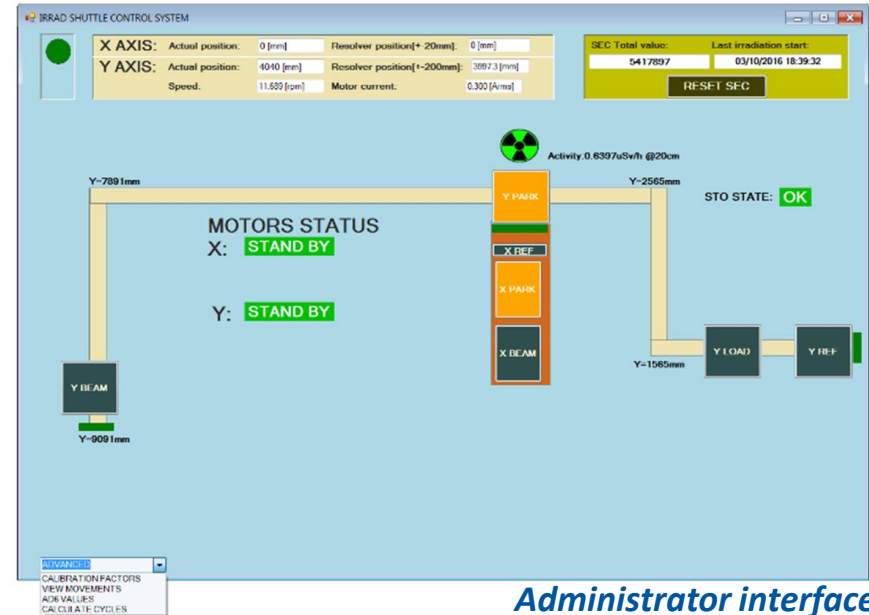
Shuttle-IRRAD1 Description

- 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



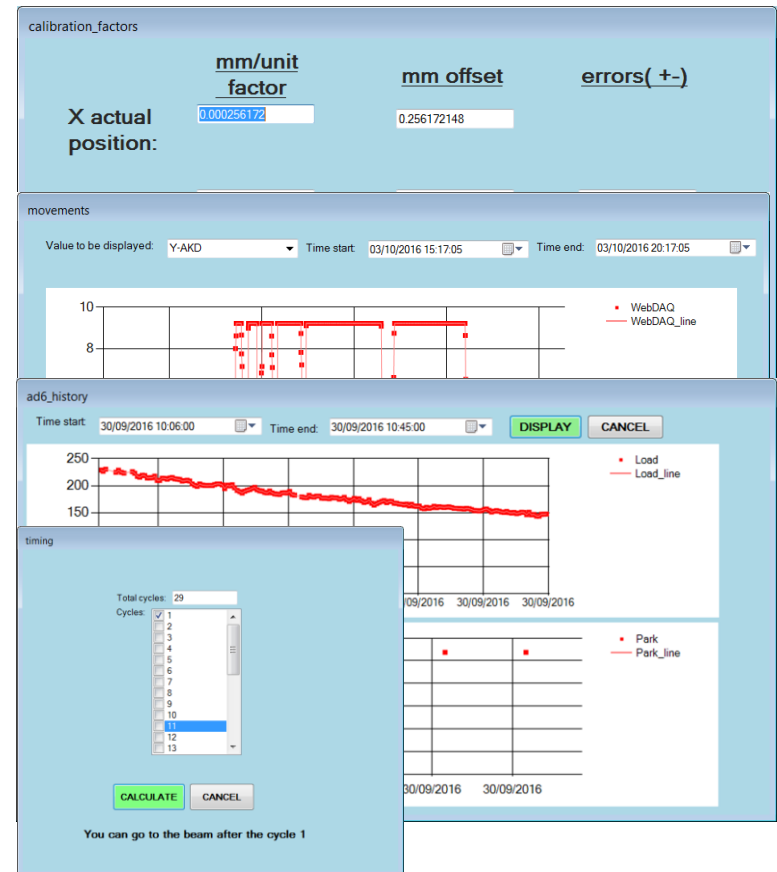
Shuttle-IRRAD1 Control Interfaces

- 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



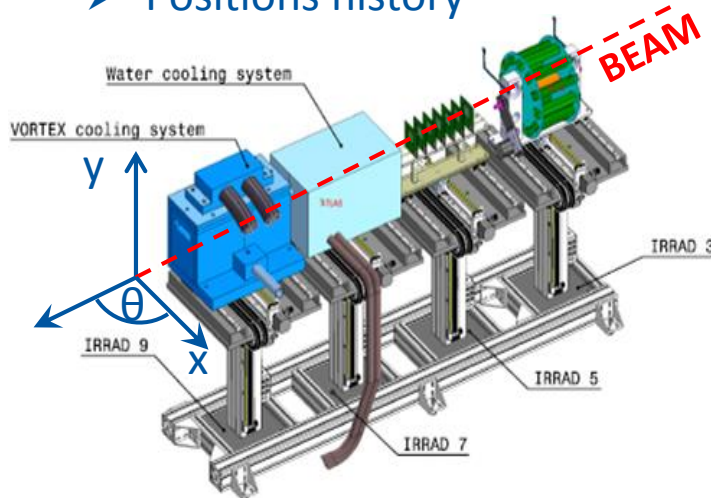
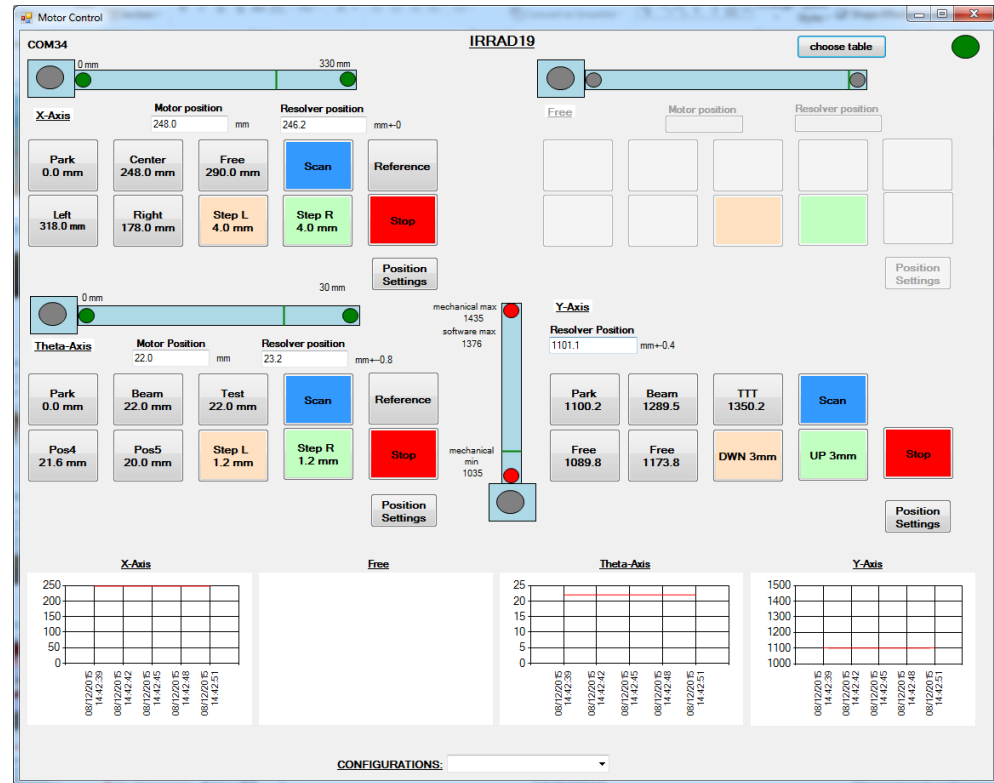
DAQ and Shuttle Monitoring

- ✓ 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)

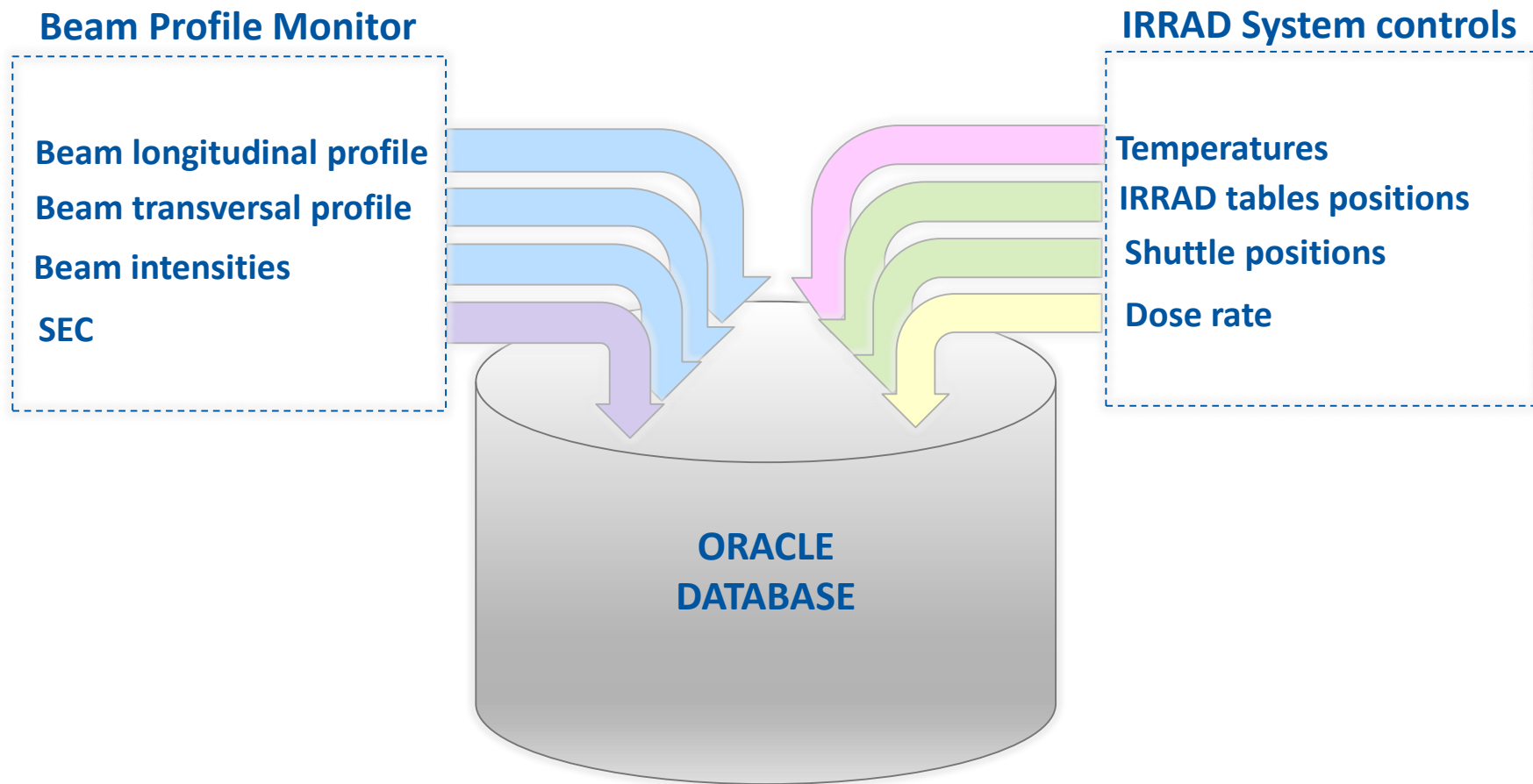


IRRAD Tables Control

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



Samples Manager Dataflow

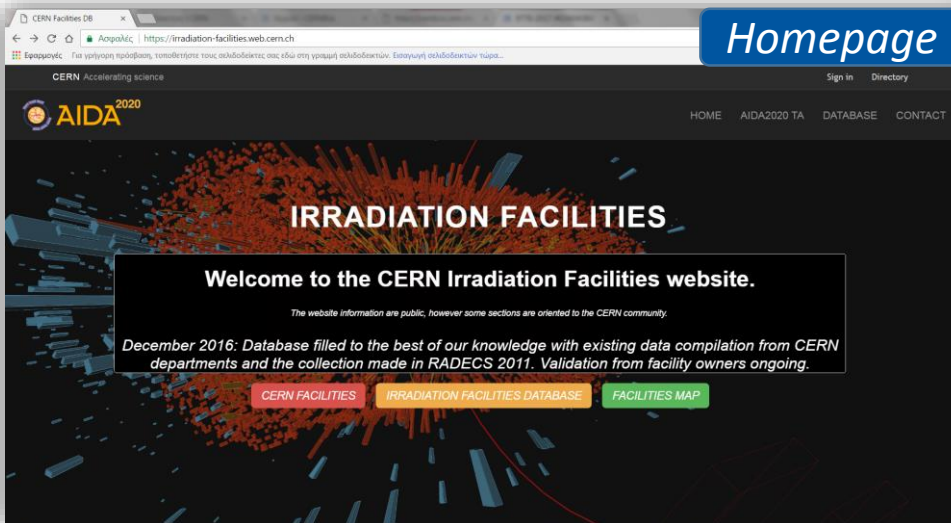


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Irradiation Facilities Database

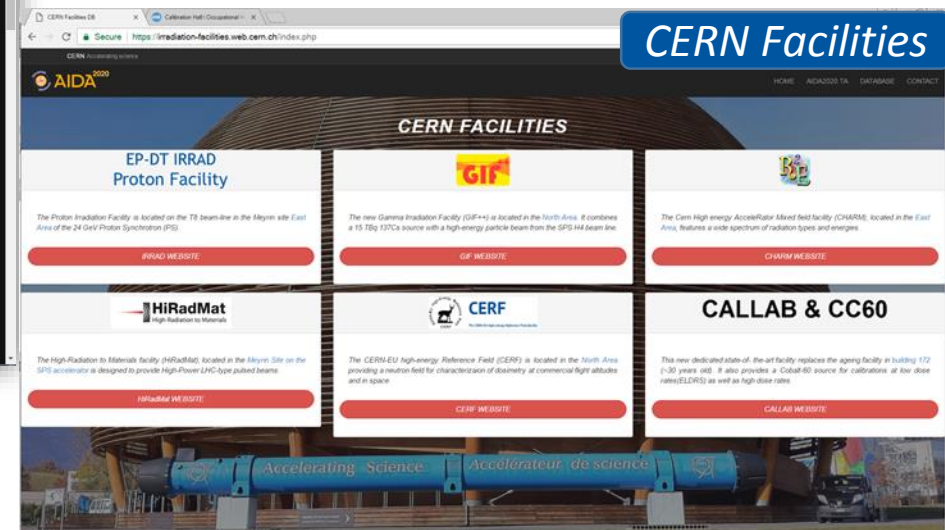
- Unified entry point for irradiation facilities at **CERN** and **worldwide**
- Essential (but exhaustive) collection of information
- 165 entries so far
- Validation of the data in progress



irradiation-facilities.web.cern.ch

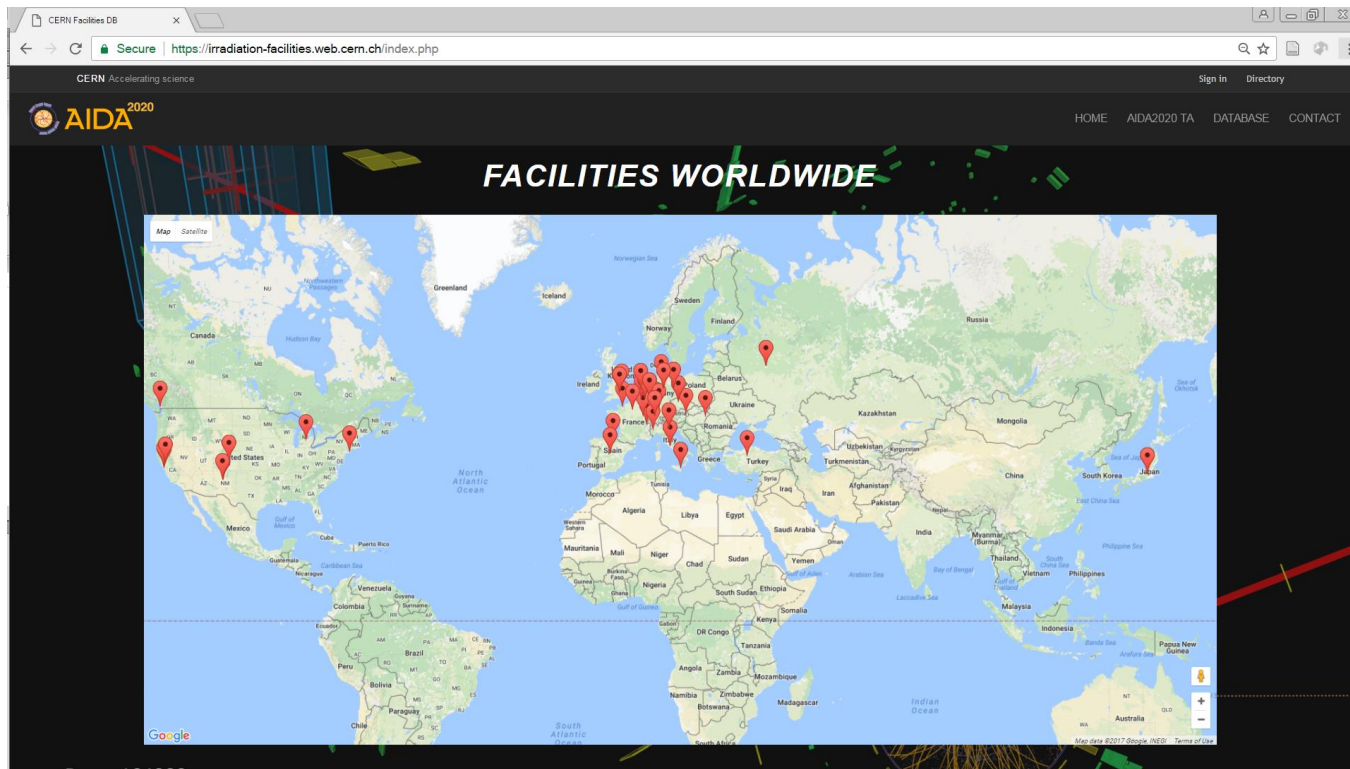
Facilities worldwide

Details	ID	Institute Name	Country	Facility Name	Source Type	Radiation Field/Type	Funding Details	OwnerID	ShowEntry
	18	A.R.T.E.	Italy			Heavy ions	info@radarte.it		
	103	ADVANCED RADIATION RESEARCH INSTITUTE (JAEA)	Japan	PROTON facility TIARA	AVF Cyclotron(K110), 3 MV Tandem accelerator, 3 MV Single-Ended accelerator, and 400 kV Ion Implanter	Proton	kojima.takuji@jaea.go.jp		
	105	ADVANCED RADIATION RESEARCH INSTITUTE (JAEA)	Japan	Electron Beam Irradiation Facility	Cockcroft-walton type	Electrons	kojima.takuji@jaea.go.jp		
	106	ADVANCED RADIATION RESEARCH INSTITUTE (JAEA)	Japan	Gamma-ray Irradiation Facilities	Co - 60	Gamma	kojima.takuji@jaea.go.jp		
	107	ADVANCED RADIATION RESEARCH INSTITUTE (JAEA)	Japan	HEAVY IONS facility TIARA	AVF cyclotron (K110), 3 MV Tandem accelerator, 3 MV Single - Ended accelerator, and 400 kV Ion Implanter	Heavy ions	kojima.takuji@jaea.go.jp		
	64	AEROFLEX RAD	USA	NEUTRON facility - 1		Neutrons	joe.benedetto@aeroflex.com		
	65	AEROFLEX RAD	USA	ELECTRON facility - 1	Pelletron	Electrons	joe.benedetto@aeroflex.com		
	66	AEROFLEX RAD	USA	Gamma facility - 1	Co - 60 and Cs - 137	Gamma	joe.benedetto@aeroflex.com		
	42	ÚJV Rež	Czech Republic	Prague reactor			milan.krivda@ujv.cz		



Irradiation Facilities Database Features

- Possibility to create and edit new facilities by the facility owners
- Search filters by country, source or radiation field
- Irradiation facilities worldwide map
- Auto-maintenance (regular reminders)
- **Open-access** data but secured with the CERN authentication system (SSO)



Conclusion

- Samples manager is on track
- The development of the core software has started and expected to be finished by M24
- Irradiation facilities database completed ahead of schedule and data are being validated
- Once D15.6 completed, the CERN team will further progress on D15.7

Contact: Irradiation.Facilities@cern.ch

THANK YOU!

