IRRAD Facility Infrastructure Upgrade

Blerina Gkotse, Maurice Glaser, Georgi Gorine, Isidre Mateu, Emanuele Matli, Giuseppe Pezzullo, Federico Ravotti

CERN EP-DT, BE-OP

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

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 -40ºC 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)

M12

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

Focus of this presentation

See the talk of Prof. Juozas Vaitkus

D15.7: Radiation Hard Facility Instrumentation ready & installed **M44**

See the talk of Michalis Benakis

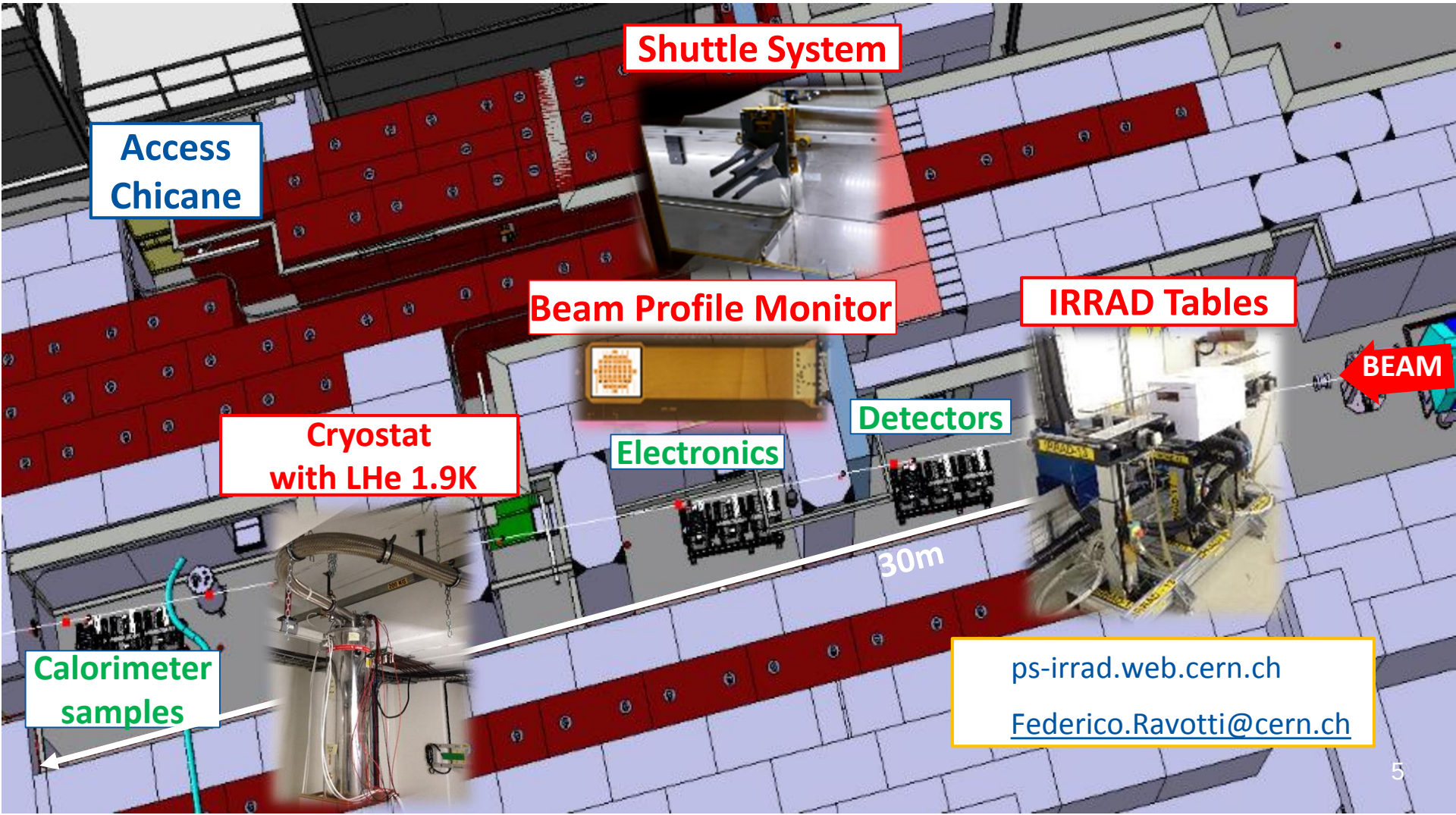
See the talk of Roberto Guida

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 Proton irradiation Facility (IRRAD)

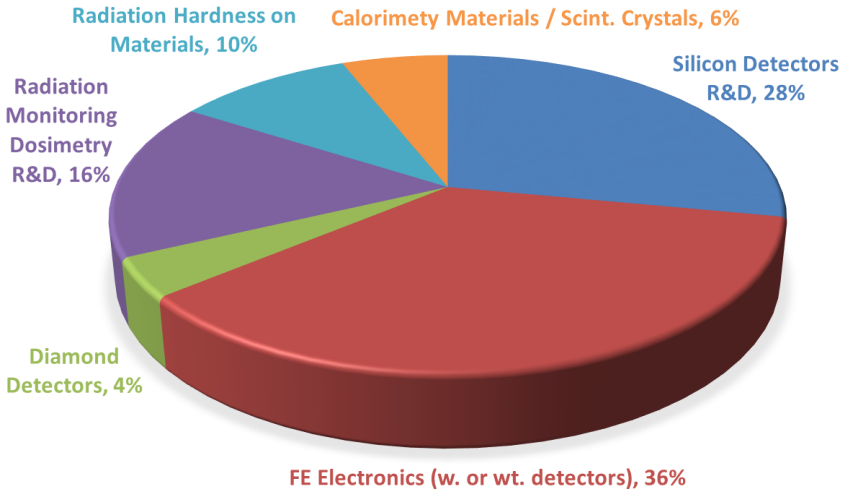
- **Testing components of the HEP experiments**
- Beam of **24 GeV/c** and size of **12×12 mm²**
- Spills of **400msec** every **~10sec**
- Fluence of **1×10¹⁶ p/cm² in 14 days**
- Scanning also in dimensions of 10×10cm²
- Low temperature irradiation (-25°C)



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**



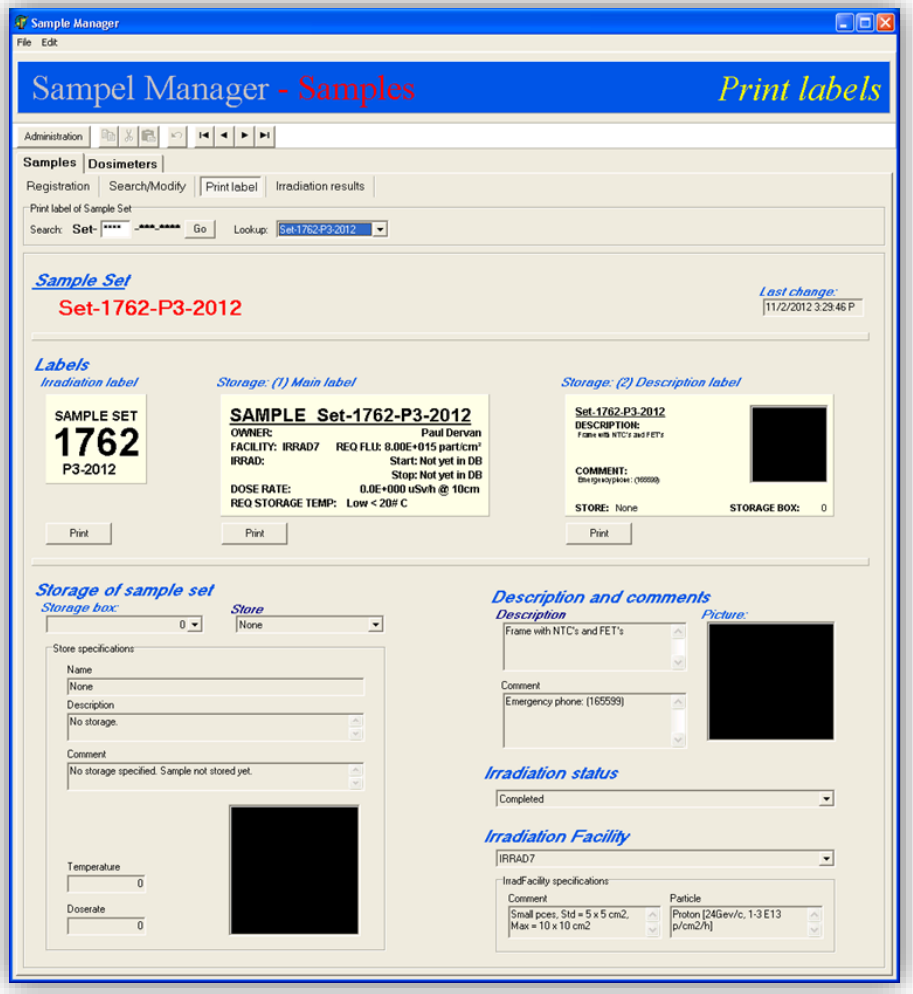
Registered Experiments (web)	52	49 executed (94%)
Number of users / user teams	28	~70% LHC experiments
Number of samples / irradiated objects	**416**	246 "SET" numbers
Samples size (MIN/MAX)	2mm × 2mm	250cm × 13cm × 4cm
MAX target proton fluence per experiment	1×10^{17} p/cm^2 (5×5mm^2 FWHM)	~27MGy in 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

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

Samples Manager

Old system



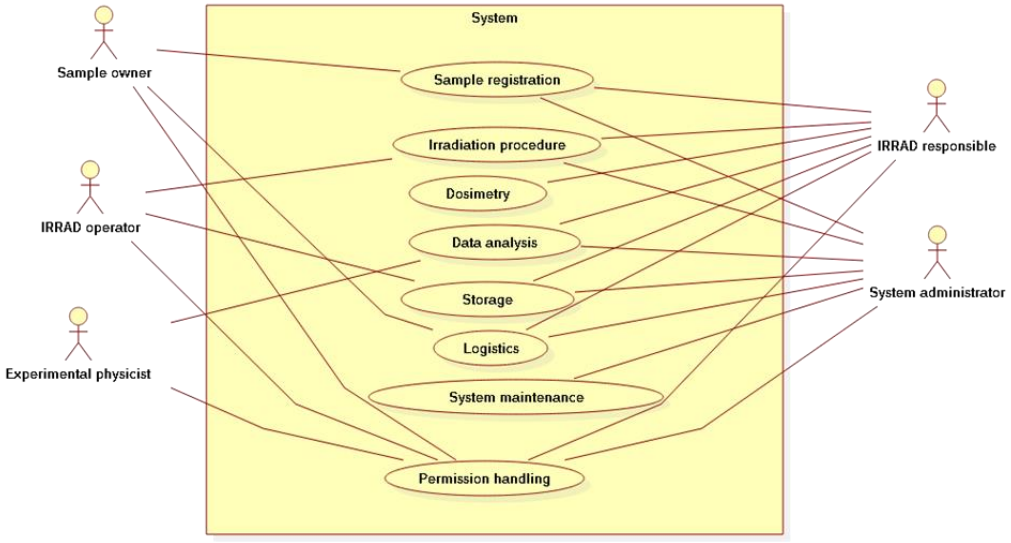
New system

Samples Manager Progress

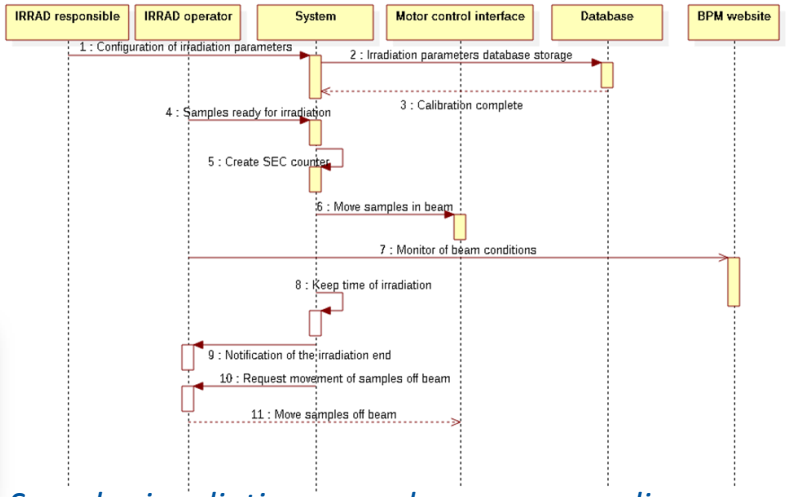
- ✓ Current state of the art
  - Irradiation facilities technology research
  - Contacting facility owners
- ✓ Specifications defined
  - ✓ User communities
  - ✓ Features
  - ✓ Use cases

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

- ✓ First design approach



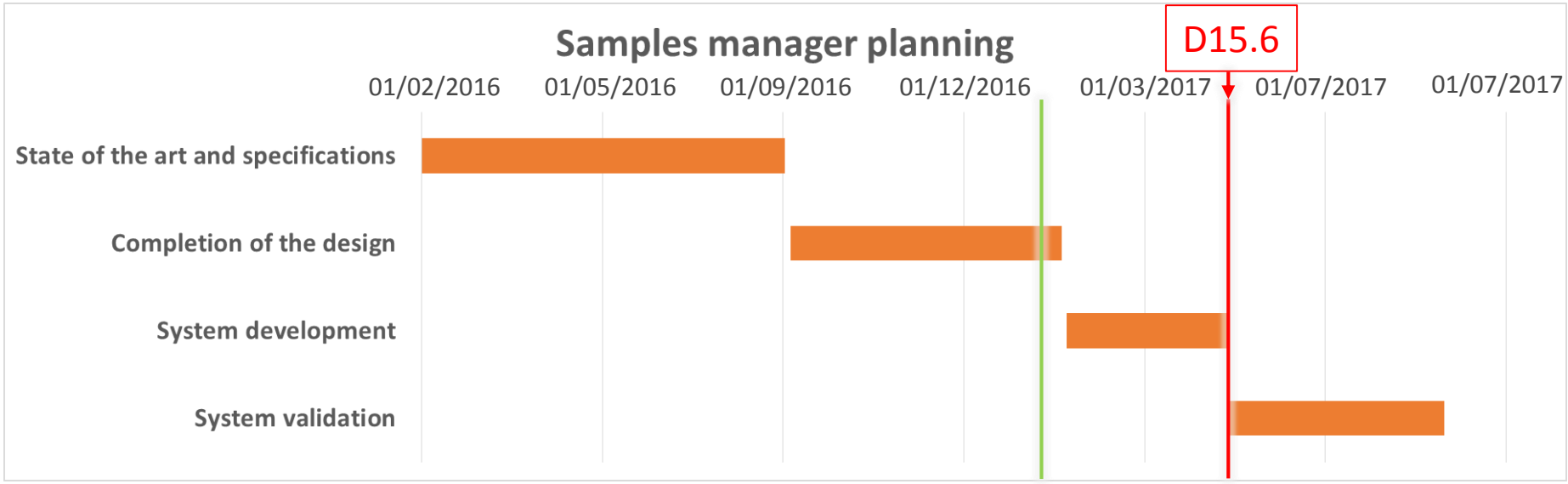
Samples manager use case model



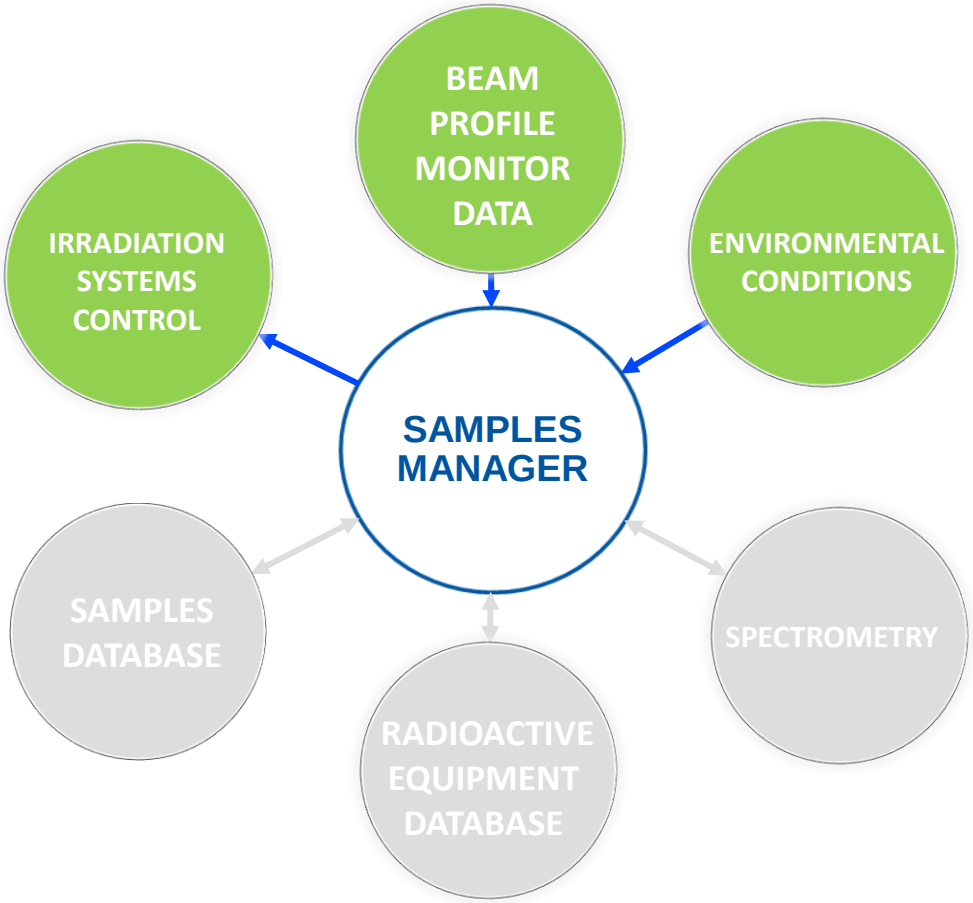
Samples irradiation procedure sequence diagram

Samples Manager Planning

- Completion of the design
- System development
- System validation



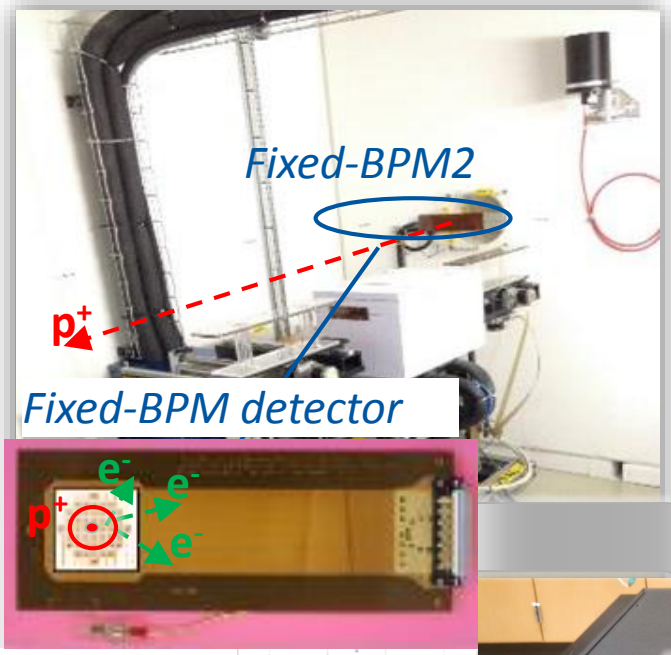
Samples Manager



BPM Detectors and DAQ Unit

Fixed BPM

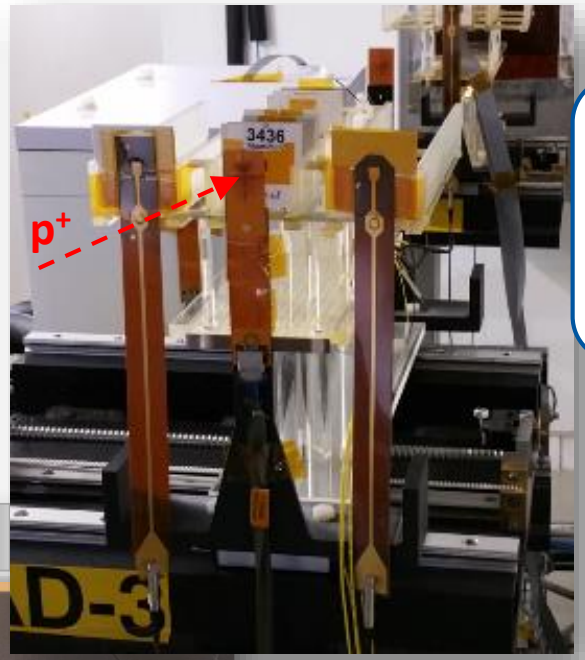
For the beam alignment



Transversal beam profile

Mini and single-pad BPMs

IRRAD tables alignment purpose and “in-beam” detection

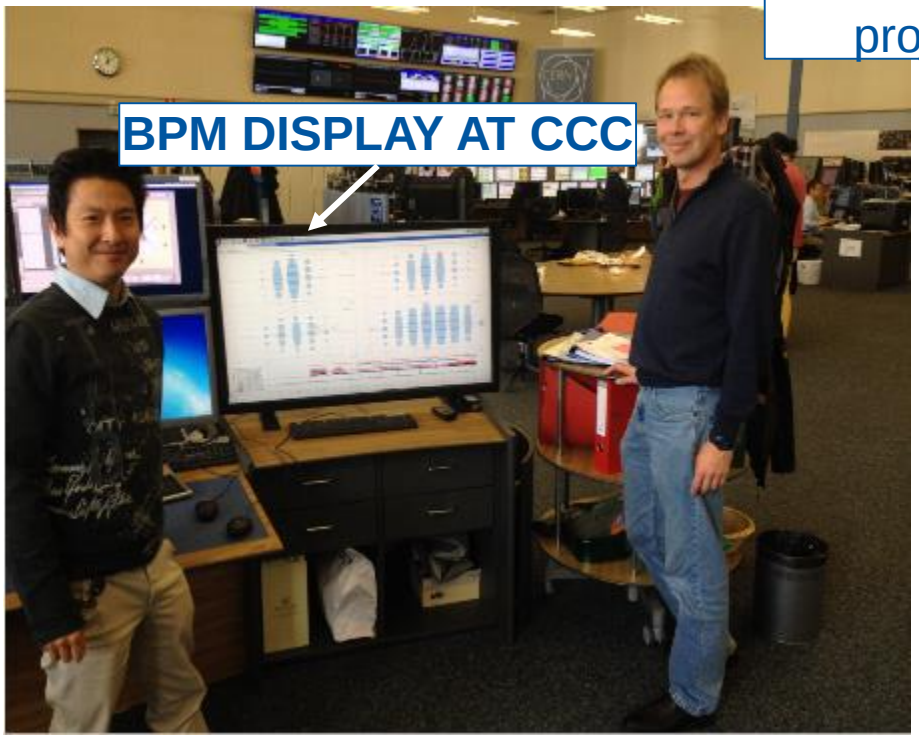


D15.7: Radiation Hard Facility Instrumentation ready & installed

M44

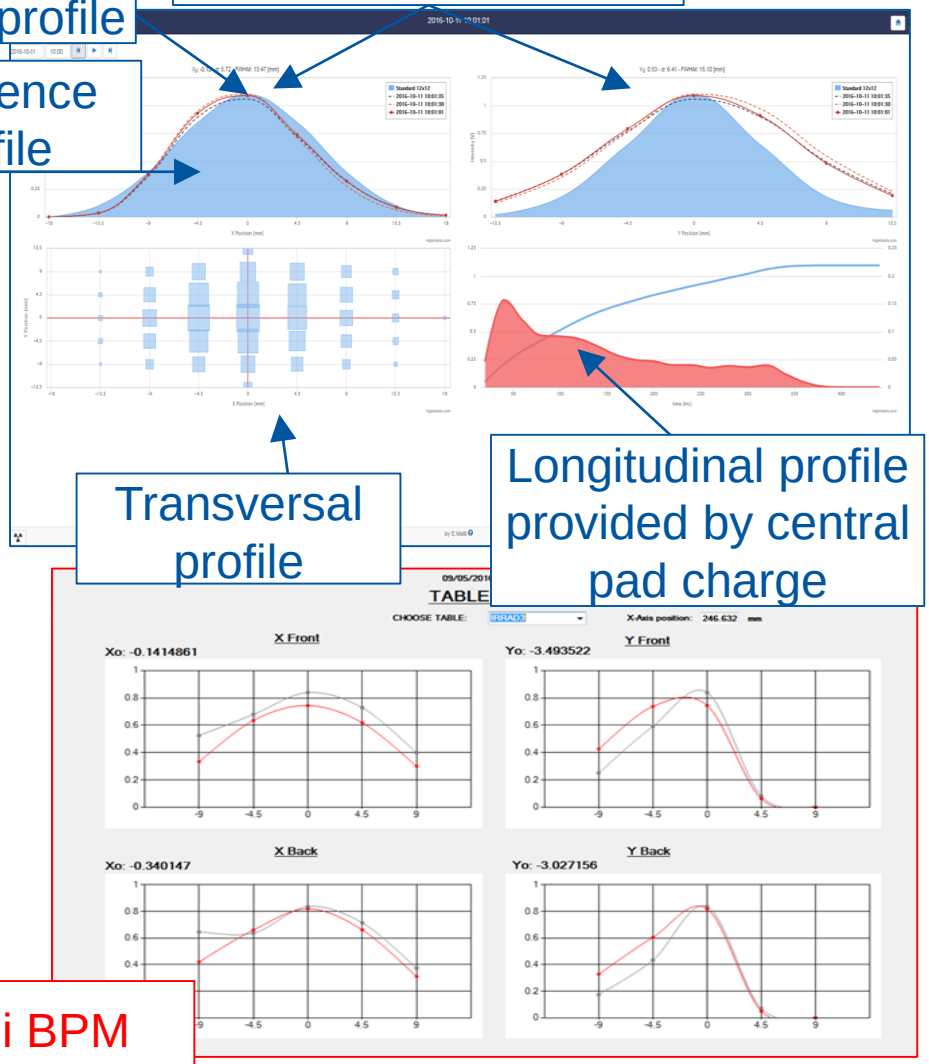
BPM DAQ unit 25-35m away from fixed-BPM device.

Beam Profile Monitors (BPMs)



Beam monitoring at CERN Control Center (CCC)

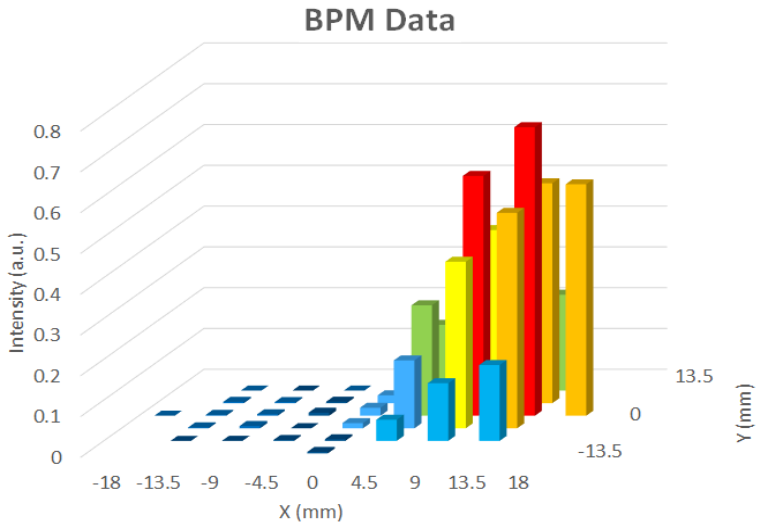
https://op-webtools.web.cern.ch/irrad/index.php

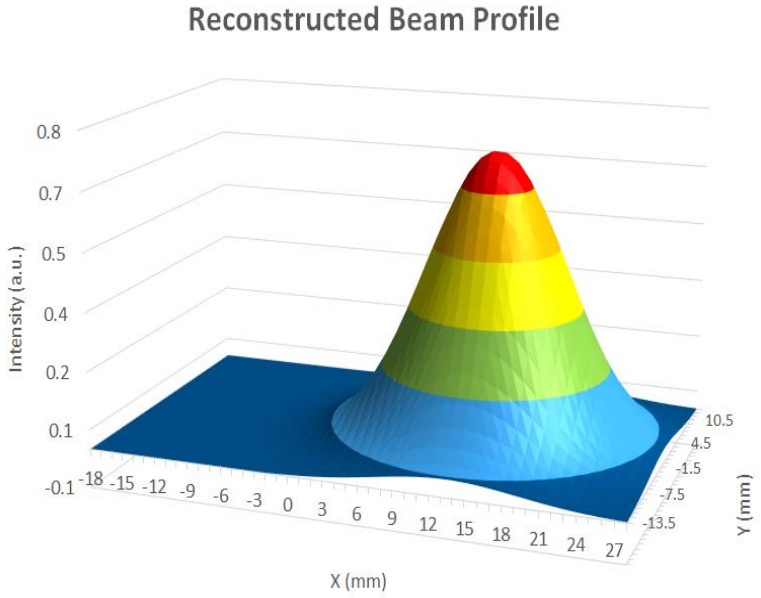


Upgrade: New 3D Fitting Tool Validation

- 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



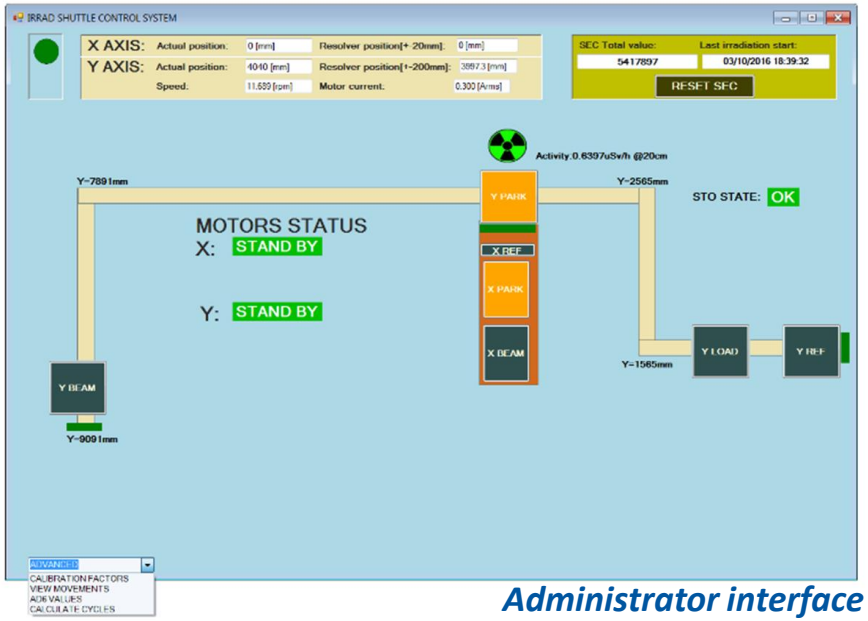


Shuttle-IRRAD1 Description

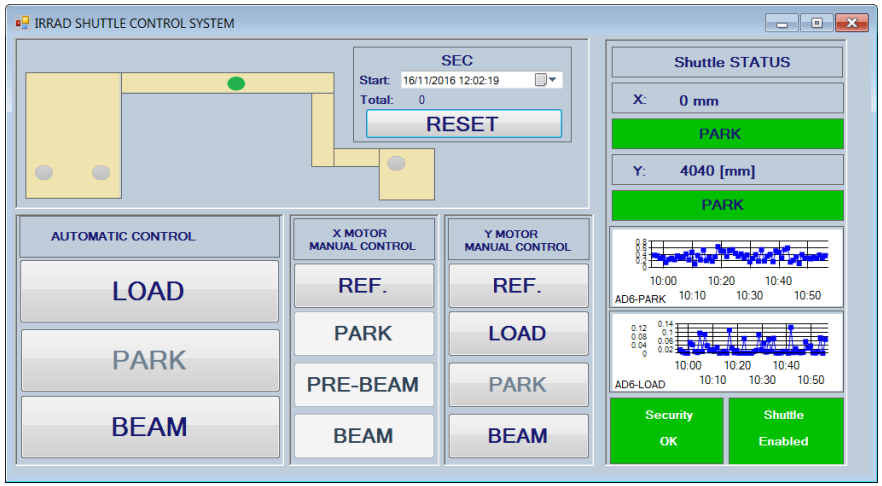
- System to place samples in beam without accessing the area.
- No need to stop the beam
- Manual control
- Software control
- Dose rate monitoring
- Safe handling of samples as priority

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



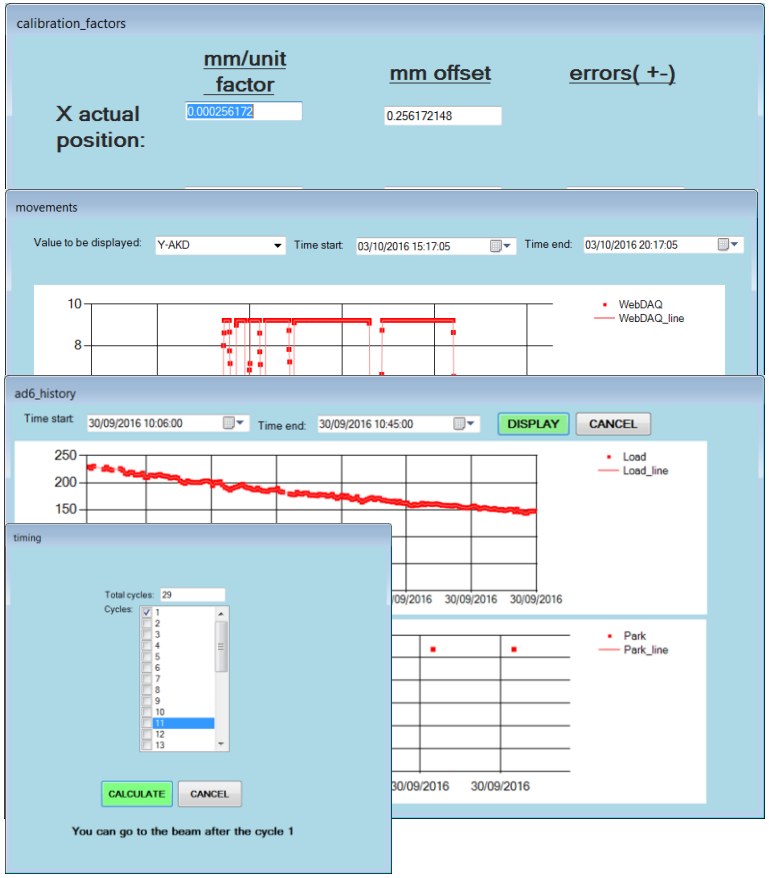
Administrator interface



User interface

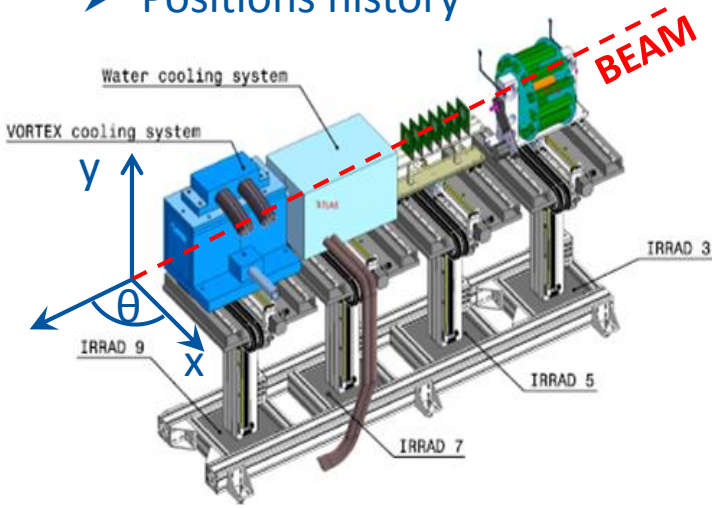
DAQ and Shuttle Monitoring

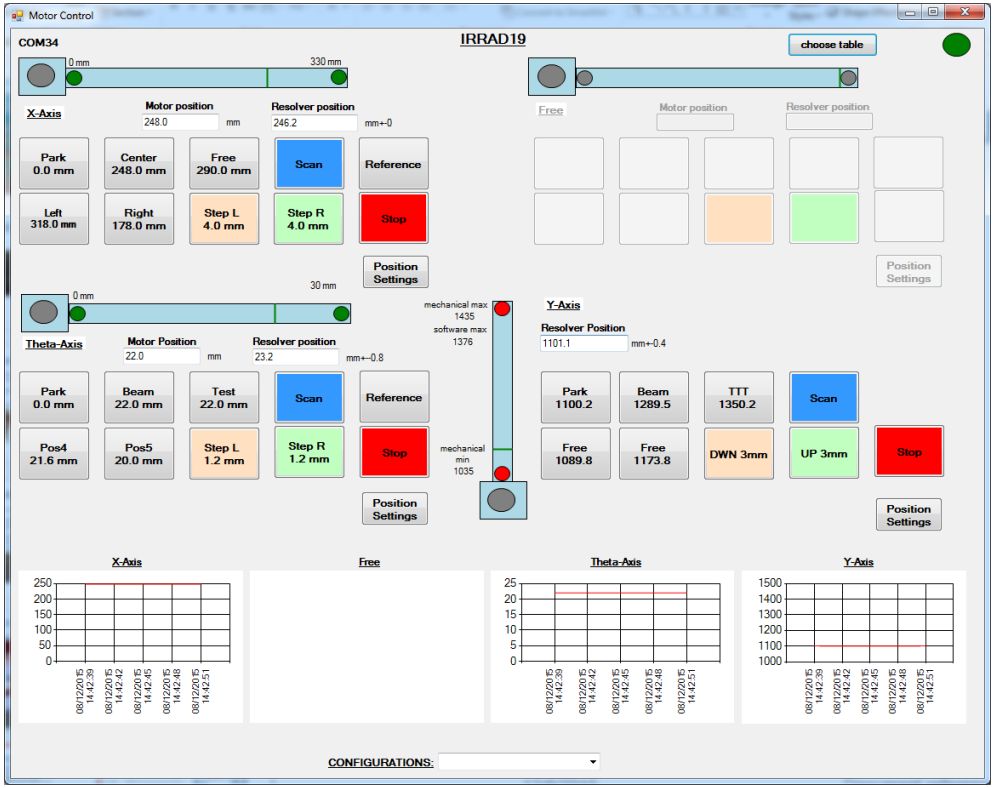
- ✓ Calibration factors
- ✓ Shuttle positions monitoring (both axis)
- ✓ Dose rate monitoring (samples radioactivity)
- ✓ Calculation of the proper timing to place the samples in beam (for short time irradiations)



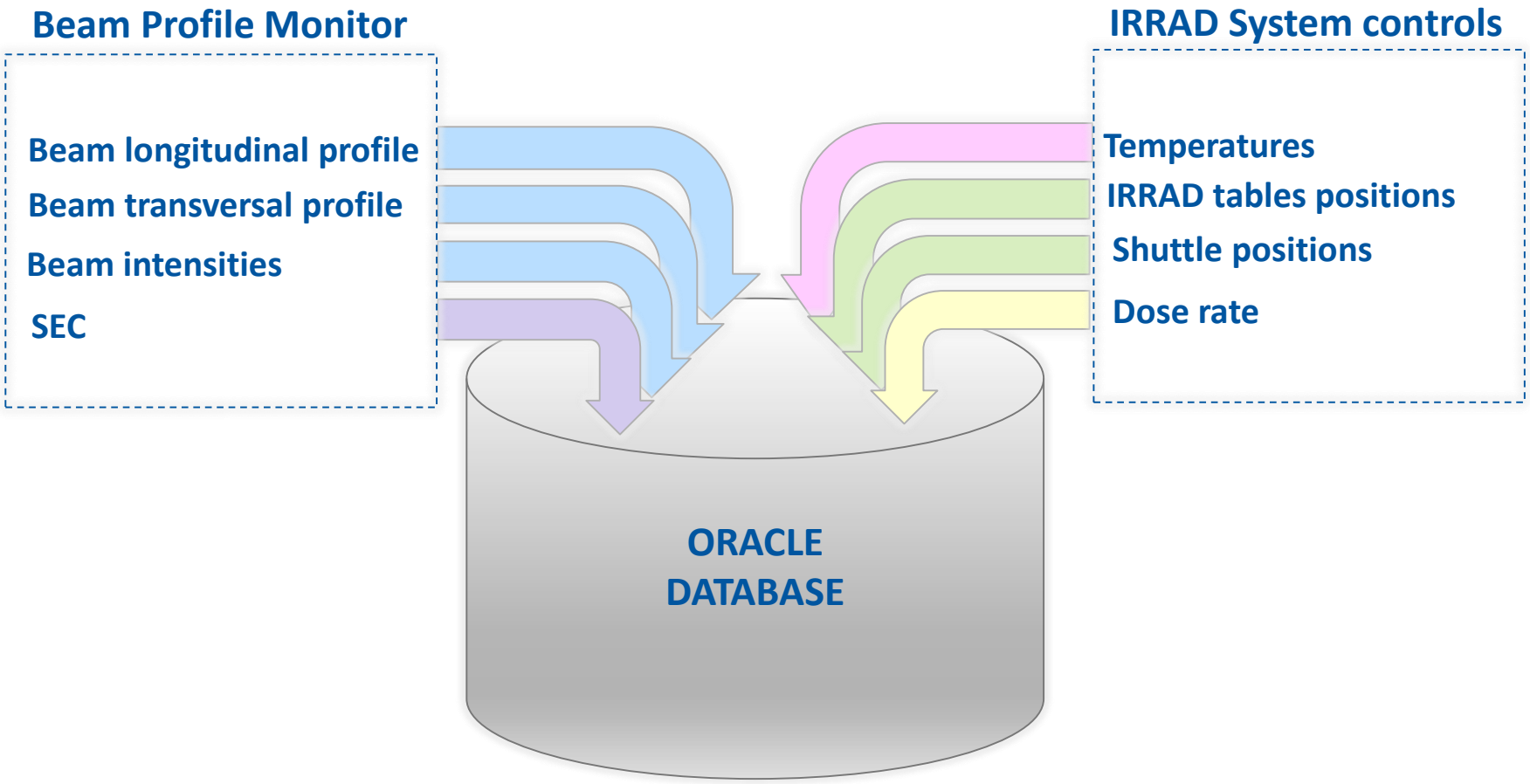
IRRAD Tables Control

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





Samples Manager Dataflow

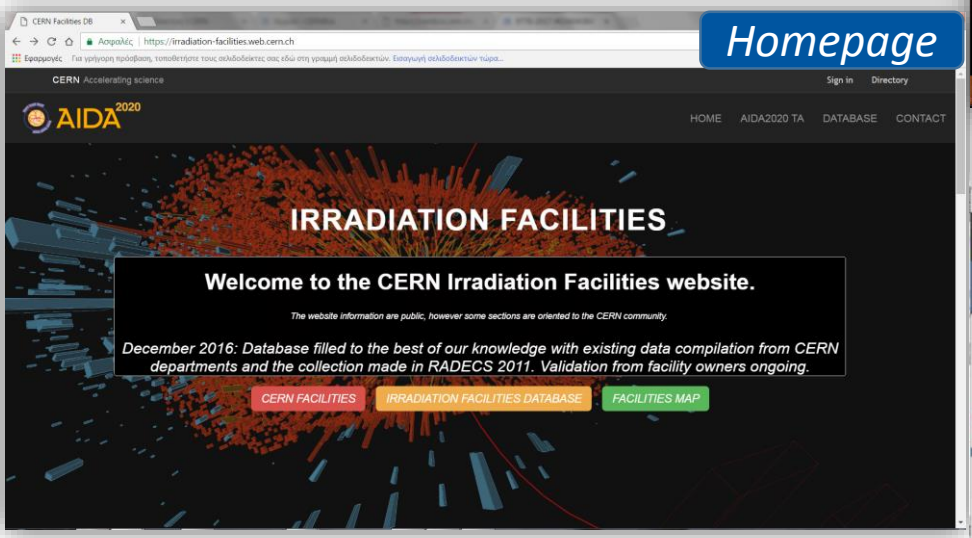


Outline

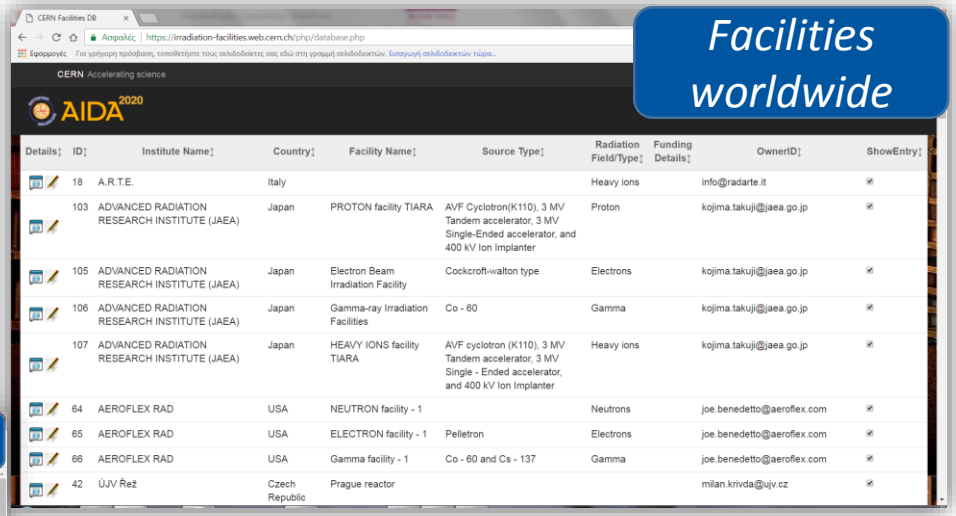
- CERN Milestones & Deliverables
- CERN Proton irradiation Facility (IRRAD)
- Samples manager
  - Samples manager progress
  - Samples manager planning
  - Mini-BPM & single-pad BPM detectors
  - Beam Profile Monitors (BPM)
  - Control systems
  - Samples Manager Dataflow
- **Irradiation facilities database**
- Conclusion

Irradiation Facilities Database

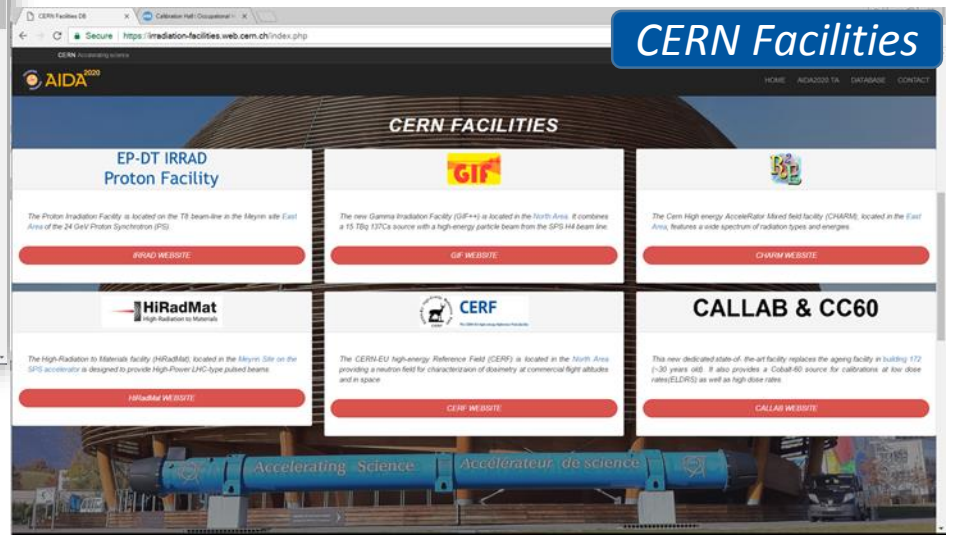
- Unified entry point for irradiation facilities at **CERN** and **worldwide**
- Essential (but exhaustive) collection of information
- 165 entries so far
- Validation of the data in progress



irradiation-facilities.web.cern.ch

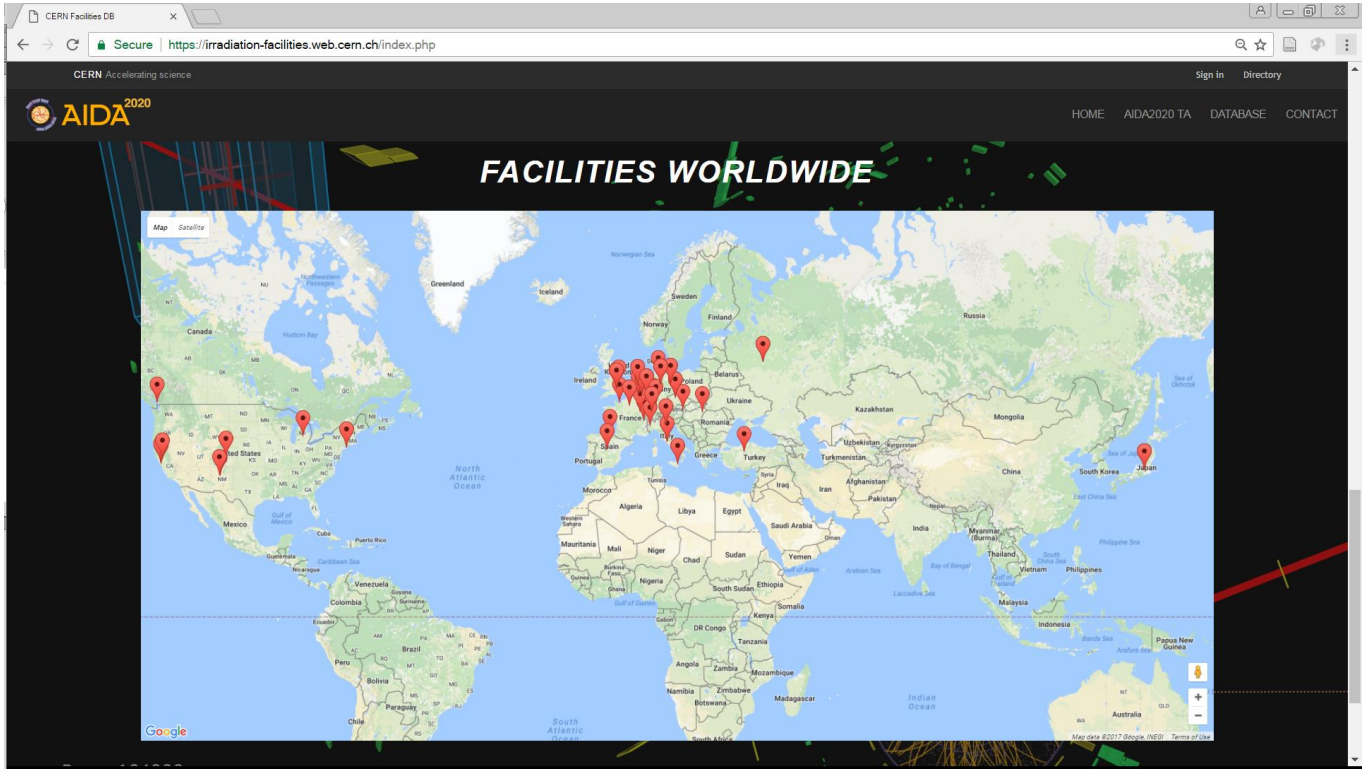


Details	ID	Institute Name	Country	Facility Name	Source Type	Radiation Field/Type	Funding Details	OwnerID	ShowEntry
	18	A.R.T.E.	Italy			Heavy ions		info@radarte.it	
	103	ADVANCED RADIATION RESEARCH INSTITUTE (JAEA)	Japan	PROTON facility TIARA	AVF Cyclotron(K110), 3 MV Tandem accelerator, 3 MV Single-Ended 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 Řež	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!