

## Presentation

# System Architecture and Data Processing Capabilities of the Beam Profile Monitor for the CERN IRRAD Facility

Blerina Gkotse (CERN) *et al*

29 October 2016



The AIDA-2020 Advanced European Infrastructures for Detectors at Accelerators project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement no. 654168.

This work is part of AIDA-2020 Work Package 15: **Upgrade of beam and irradiation test infrastructure.**

The electronic version of this AIDA-2020 Publication is available via the AIDA-2020 web site <http://aida2020.web.cern.ch> or on the CERN Document Server at the following URL: <http://cds.cern.ch/search?p=AIDA-2020-SLIDE-2016-018>

# System architecture and data processing capabilities of the Beam Profile Monitor for the CERN Proton IRRADIATION Facility

Blerina Gkotse<sup>1,2</sup>, Maurice Glaser<sup>1</sup>, Emanuele Matli<sup>3</sup>, Federico Ravotti<sup>1</sup>

<sup>1</sup>CERN, EP-DT Group

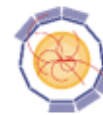
<sup>2</sup>IMT - TELECOM Bretagne

<sup>3</sup>CERN, BE-OP Group

[blerina.gkotse@cern.ch](mailto:blerina.gkotse@cern.ch)



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

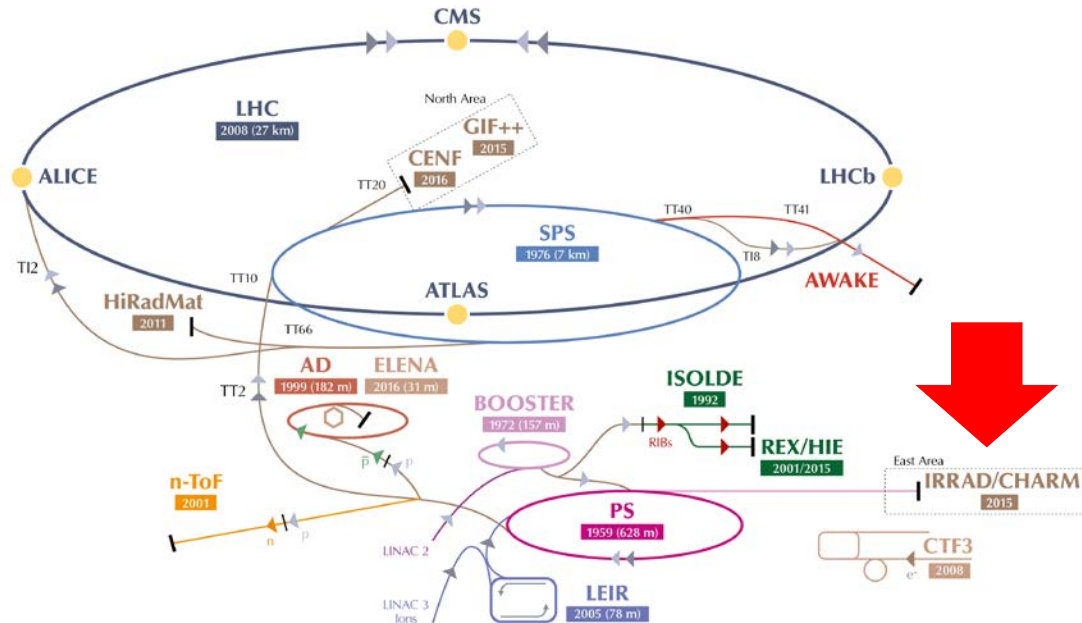


**AIDA** 2020



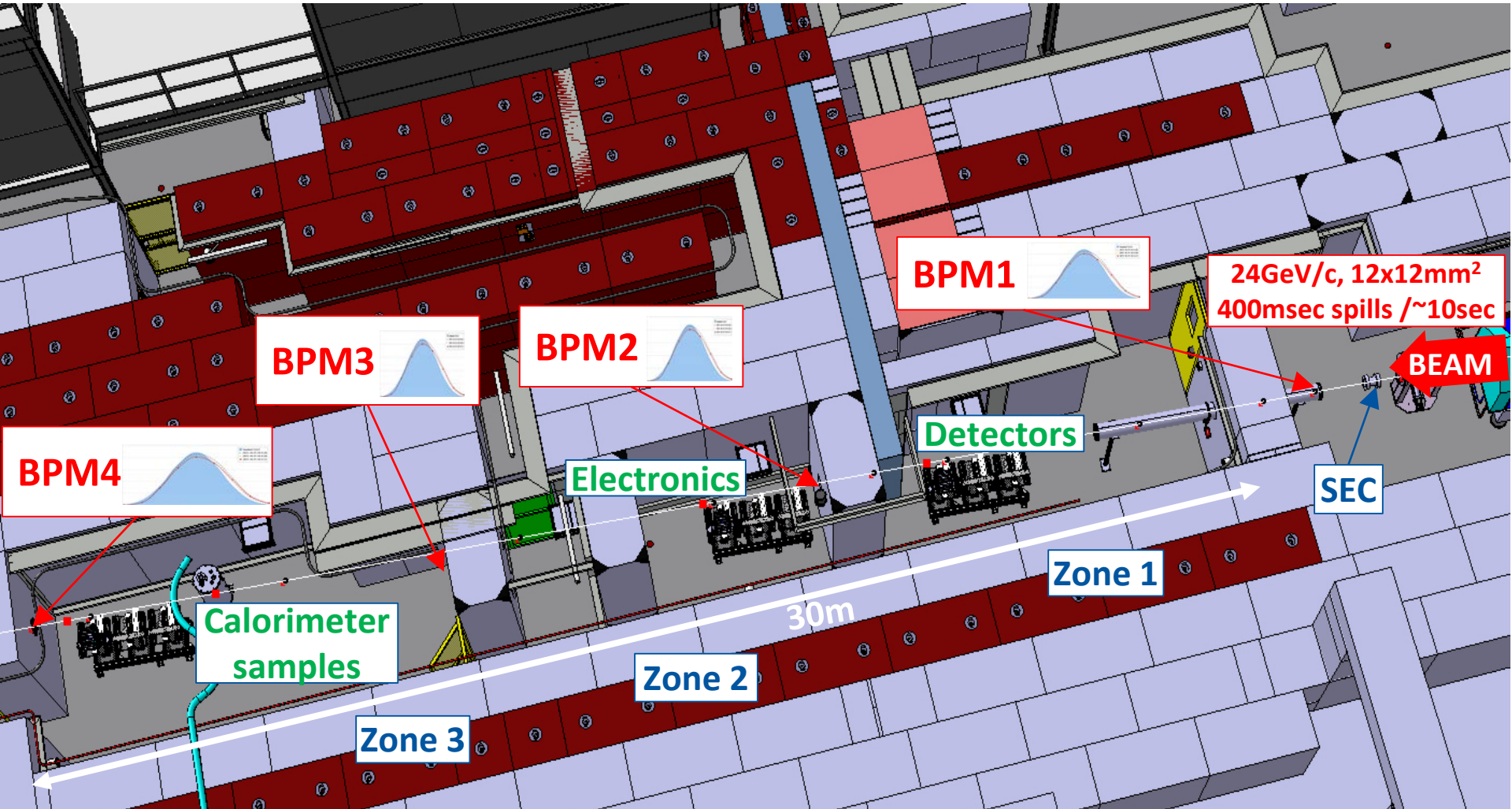
# OUTLINE

- Proton Irradiation Facility (IRRAD)
- Beam Profile Monitor (BPM) hardware
- System architecture
- Processing capabilities
- Recent upgrades
- Conclusion

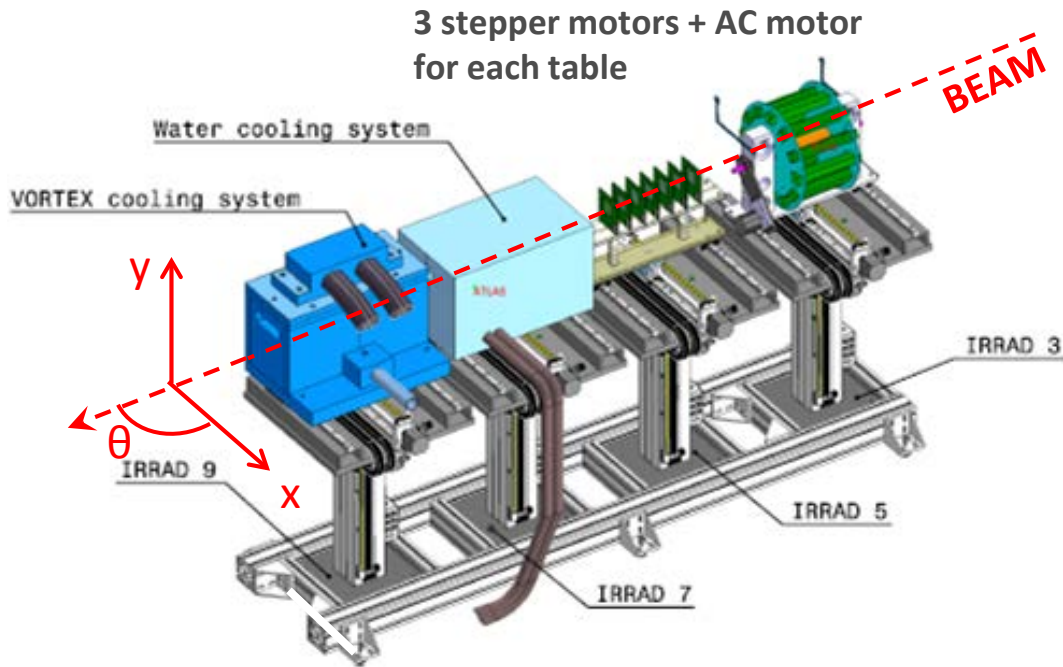


2016 IEEE NSS/MIC

# PROTON IRRADIATION FACILITY (IRRAD)



# IRRAD TABLES AND SAMPLES



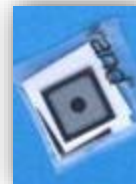
IRRAD Zone1



Silicon detector hybrid



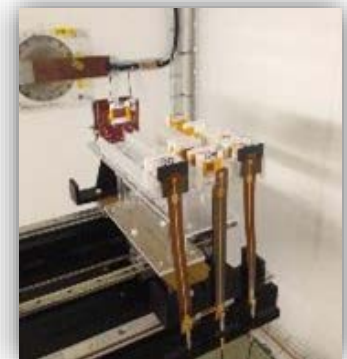
CMS ECAL Crystal



Silicon diode

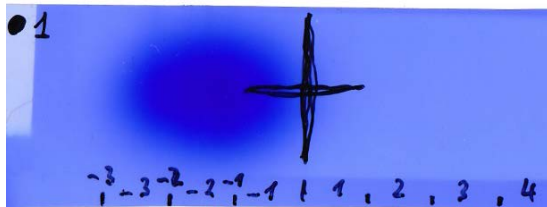
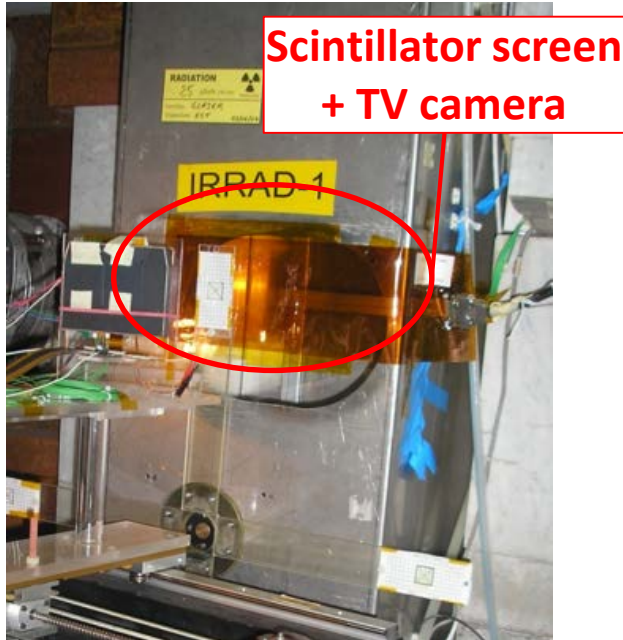


Sample holders & samples



# BEAM ALIGNMENT TECHNIQUES

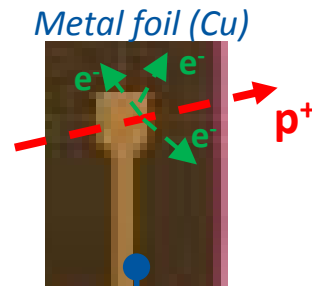
## Past



Proton beam spot as displayed on a Gafchromic film

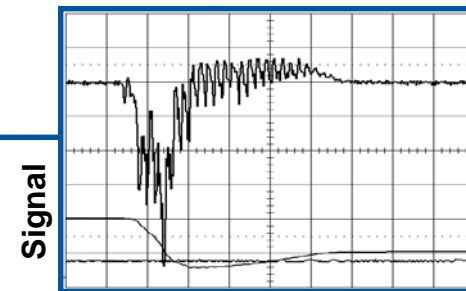
## Present

- Online beam monitoring system
  - Relatively short radioactivity lifetime material
  - Thin to avoid scattering of the beam
  - Thick enough for easy handling
- Secondary Electron Emission (SEE)



**Beam Profile Monitor  
operation principle**

Oscilloscope screen



Time

# Fixed-BPM DETECTOR & DAQ UNIT

➤ For beam alignment purpose

➤ Fixed-BPM device:

- 39 Cu Pads of 4×4 mm<sup>2</sup>,
- 4 layers,
- Baseline ~0.5 mV/spill

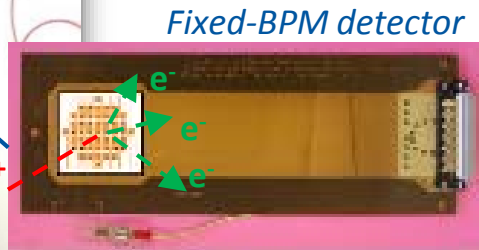
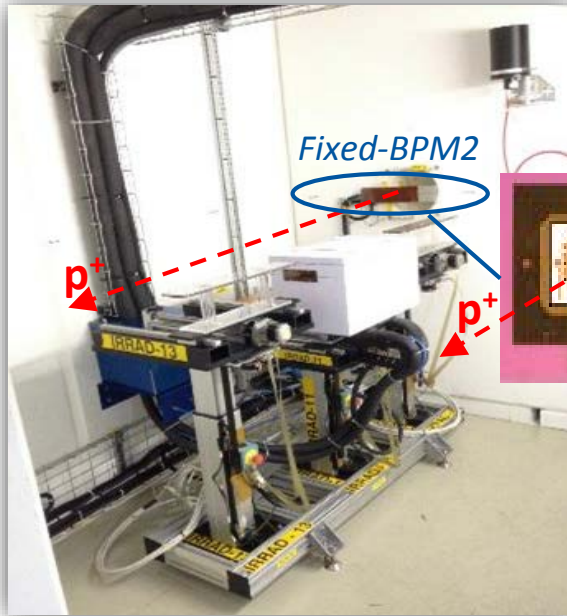
➤ Different dimensions:

- 36×27 mm<sup>2</sup> or 52×39 mm<sup>2</sup>

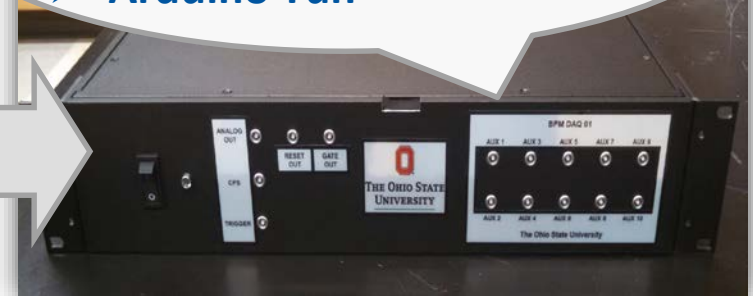
➤ Sensitivity:

- Minimum intensity tested in IRRAD:  
1.14×10<sup>11</sup>p/spill
- Minimum flux calculated:  
1 ×10<sup>10</sup>MIPs/spill (s/n 50)

- 50 ACF2101 integrators
- Analog to digital converter, ADC 16bit
- Arduino Yún



Transversal beam profile



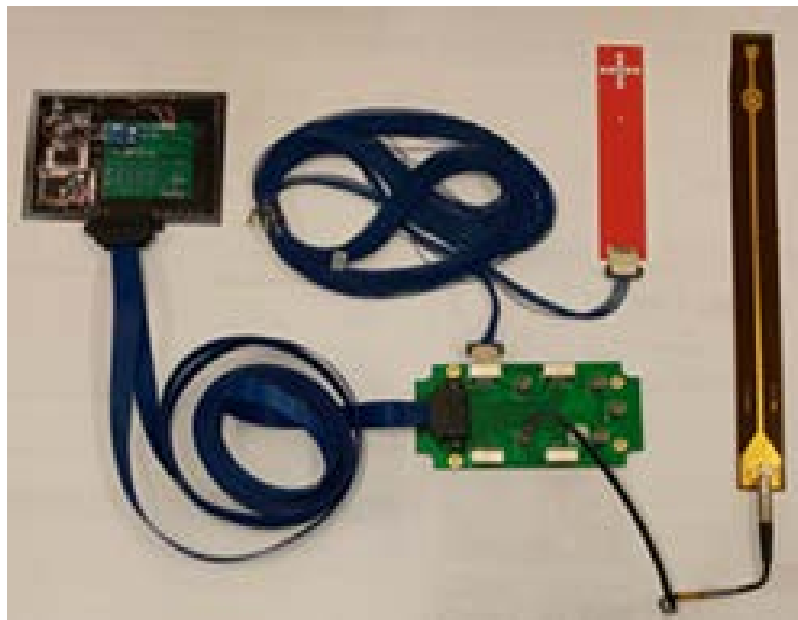
BPM DAQ unit 25-35m away from fixed-BPM device.

Electronics built by:

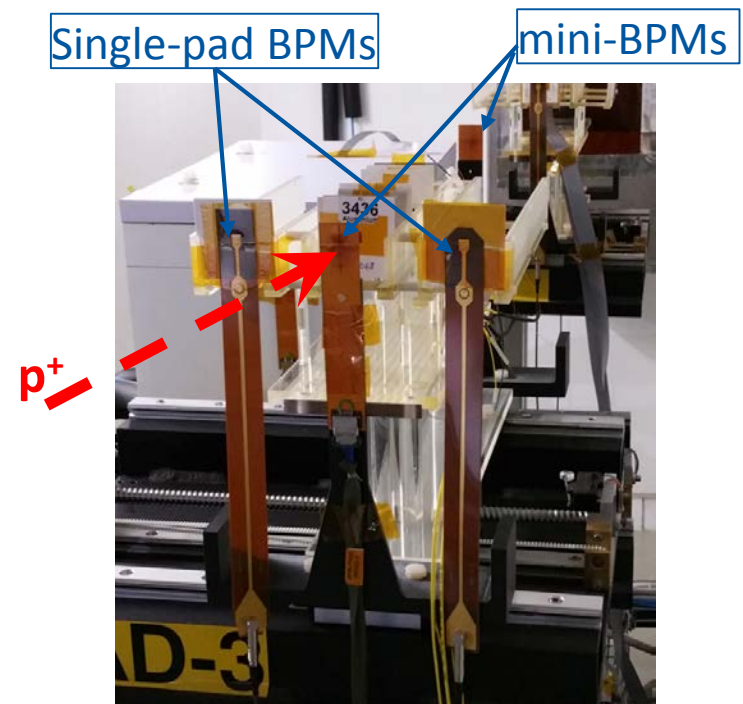


# Mini-BPM & single-pad BPM DETECTORS

- IRRAD tables alignment purpose and “in-beam” detection
- Mini-BPM: 9 Cu Pads of 4x4 mm<sup>2</sup> in a cross shape
- 2 mini-BPMs and 2 single-pad BPMs for each table
- Same DAQ unit type of the fixed-BPM (1 DAQ unit for 2 tables)



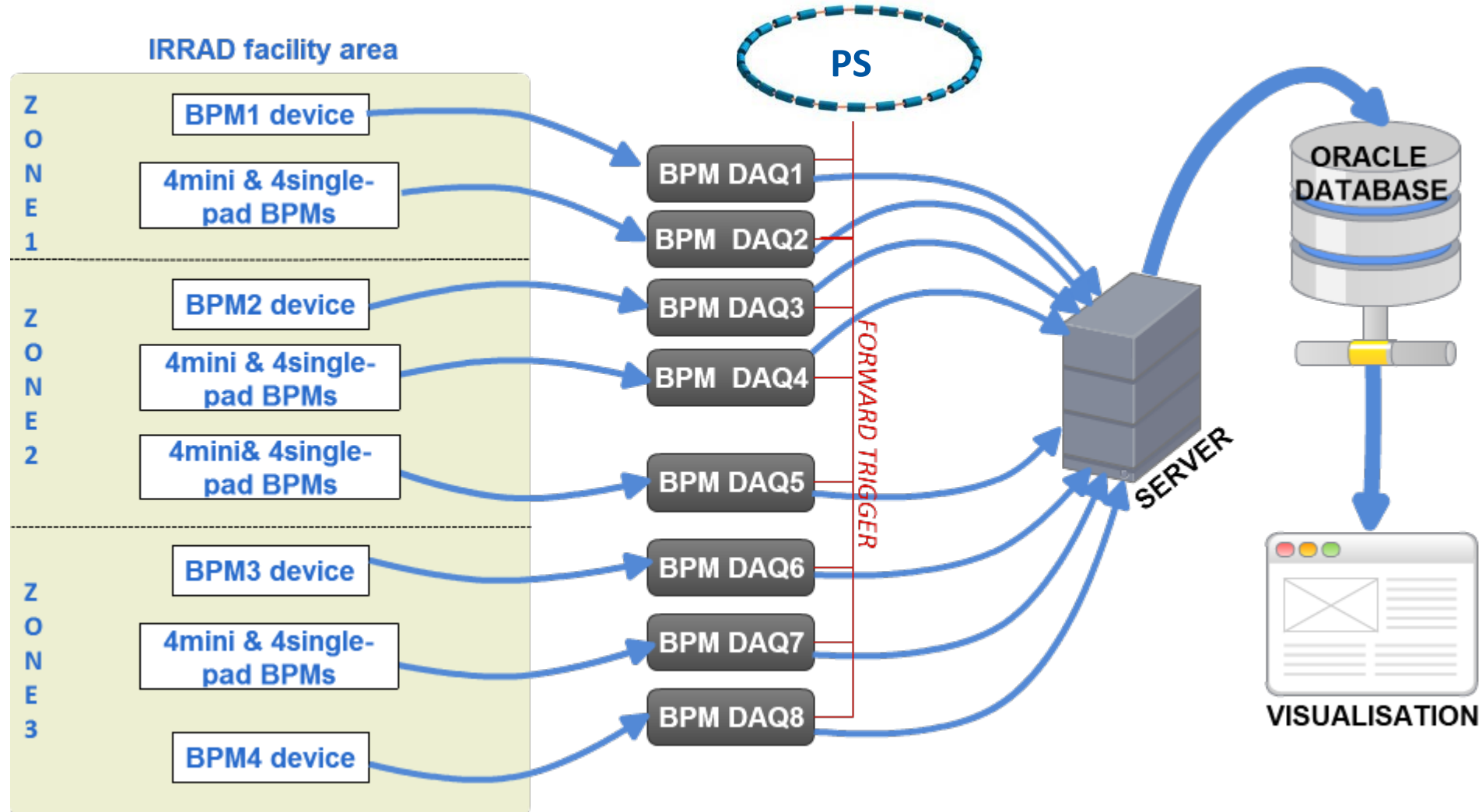
*Mini-BPM and single-pad BPMs system*



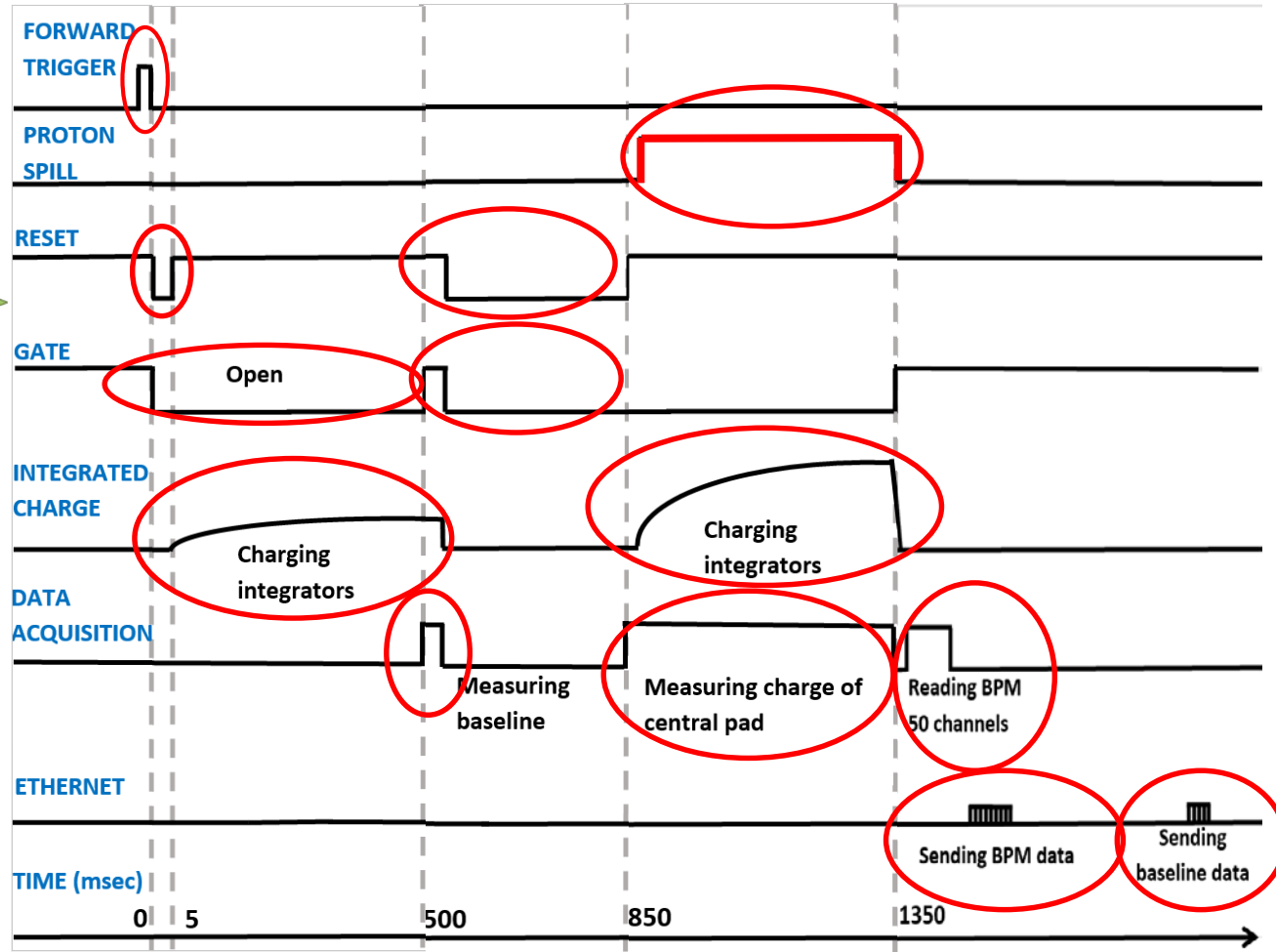
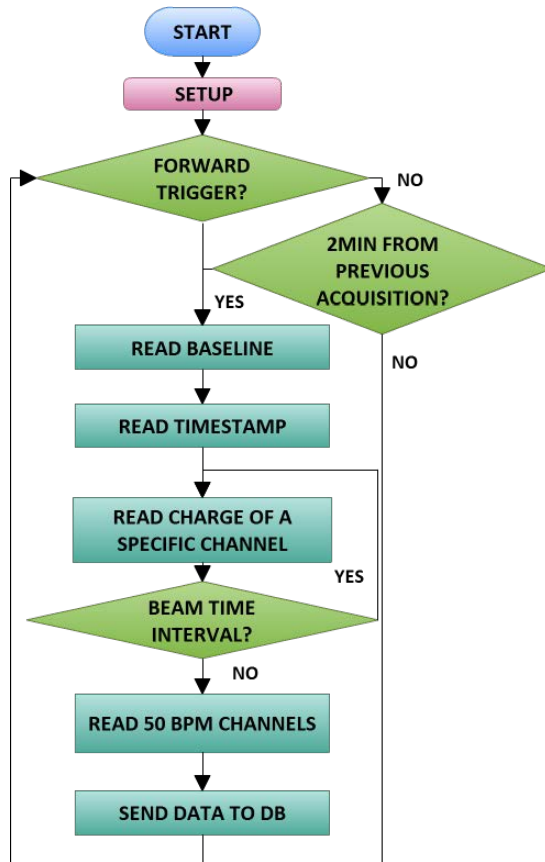
*Installation on IRRAD3 table*



# BPM SYSTEM ARCHITECTURE AND COMMUNICATION



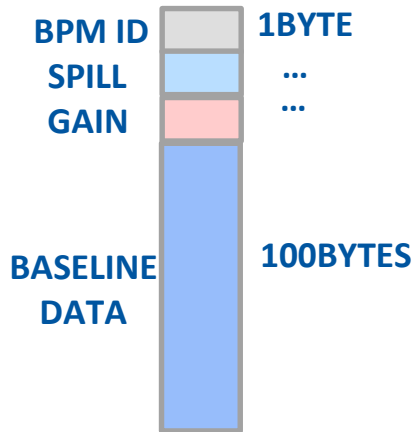
# ACQUISITION PROCESS



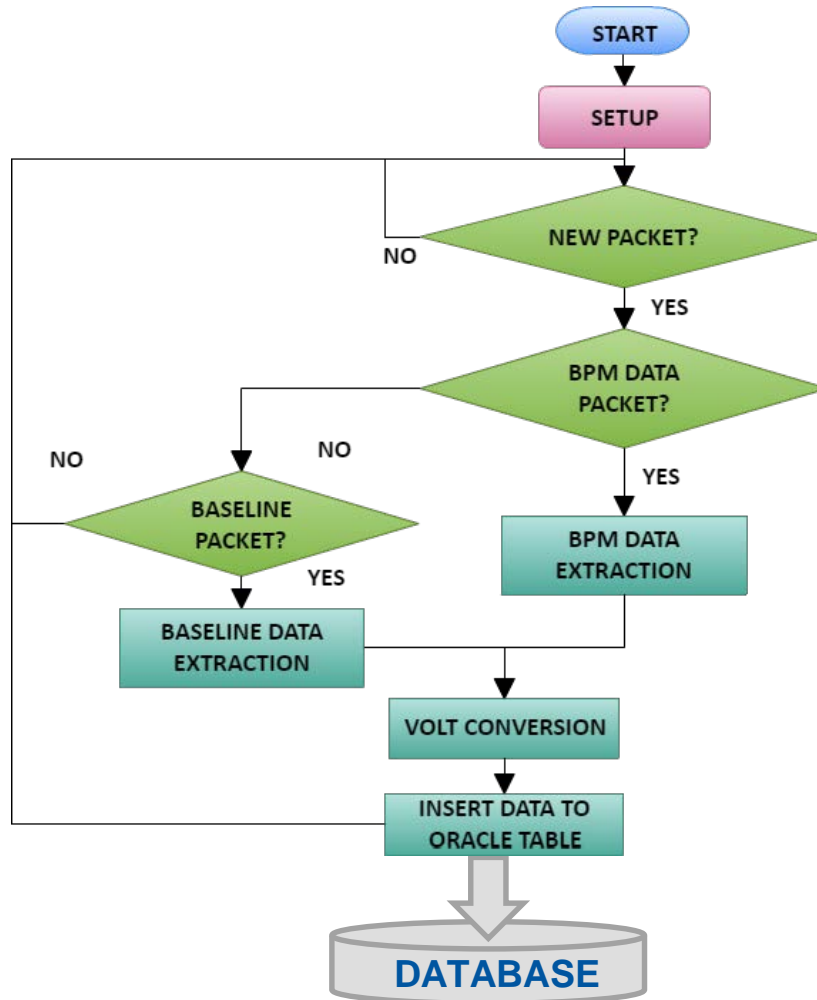
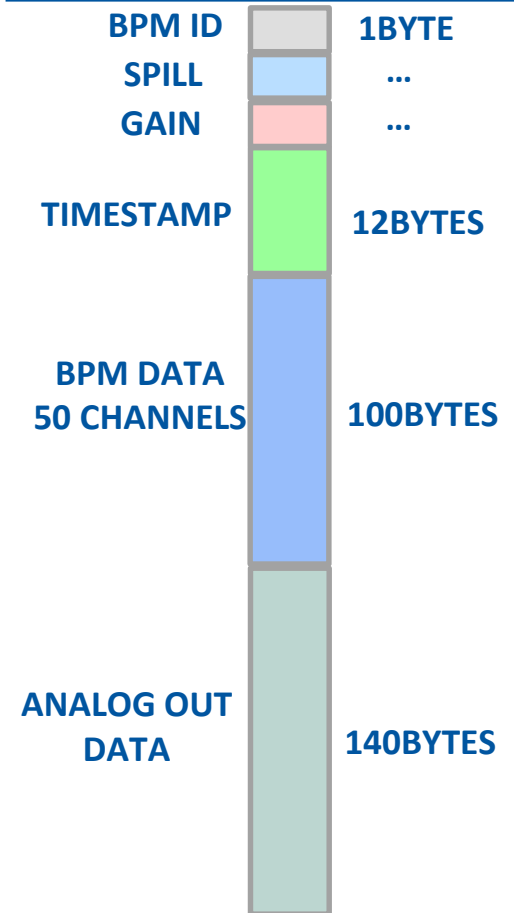
Minimum time between two consecutive spills: 2.4 sec

# SERVER

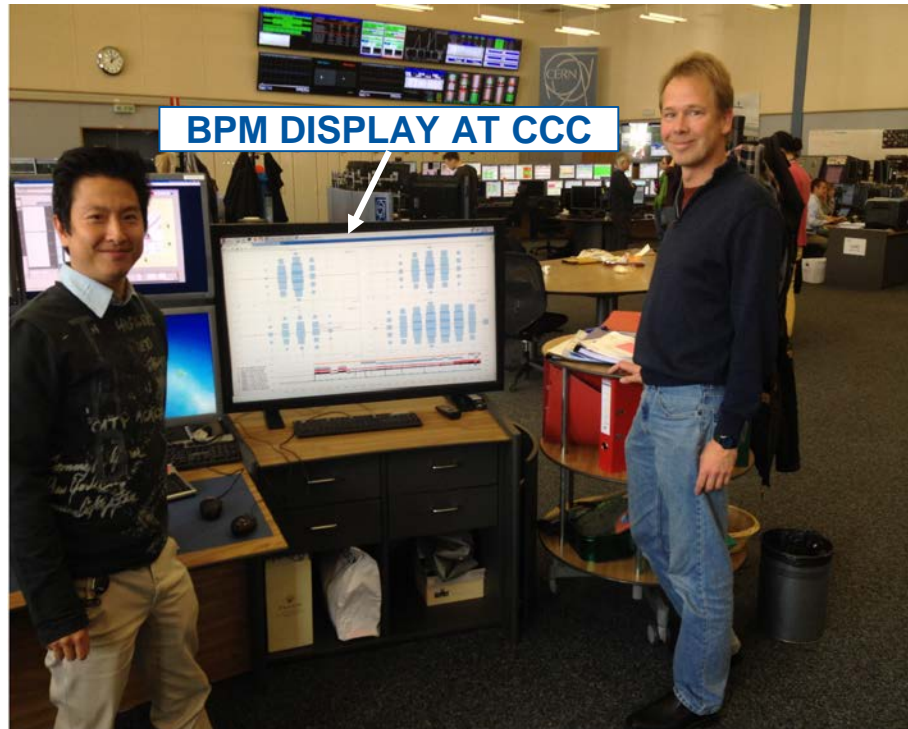
## BASELINE PACKET STRUCTURE



## BPM PACKET STRUCTURE



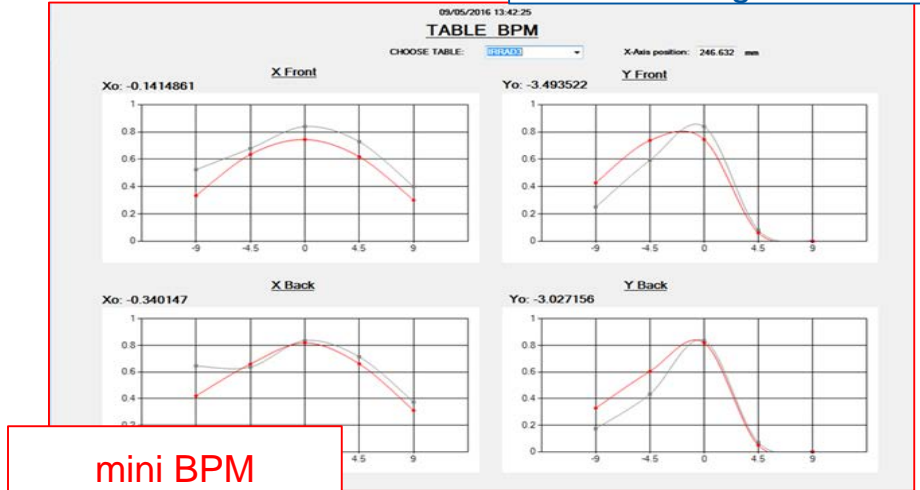
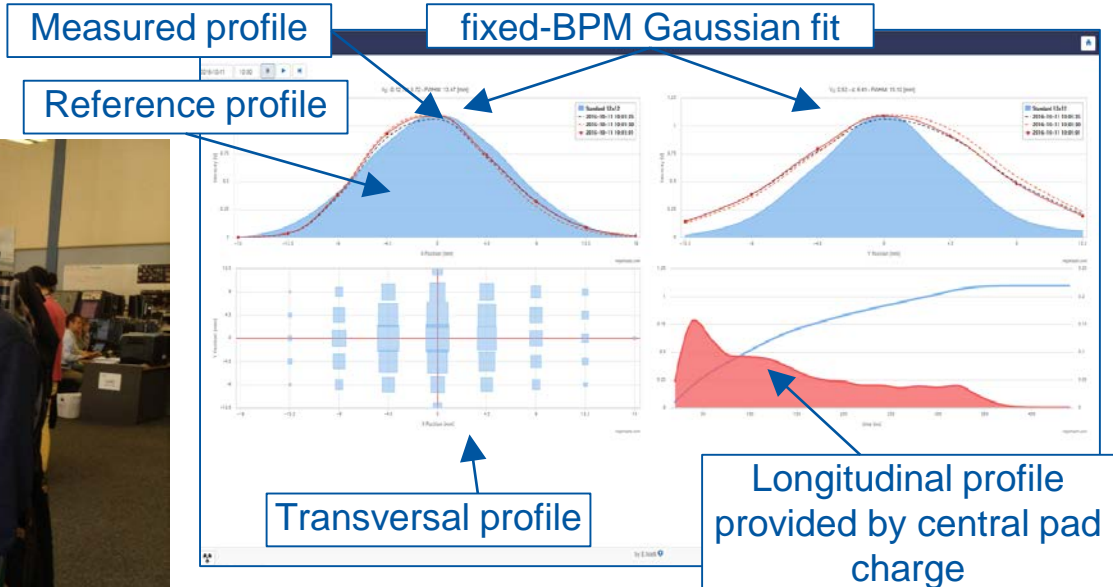
# VISUALISATION



**BPM DISPLAY AT CCC**

Beam monitoring at CERN Control Center (CCC)

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



**mini BPM  
Gaussian fit**

# 2D GAUSSIAN FIT

➤ Weighted mean value

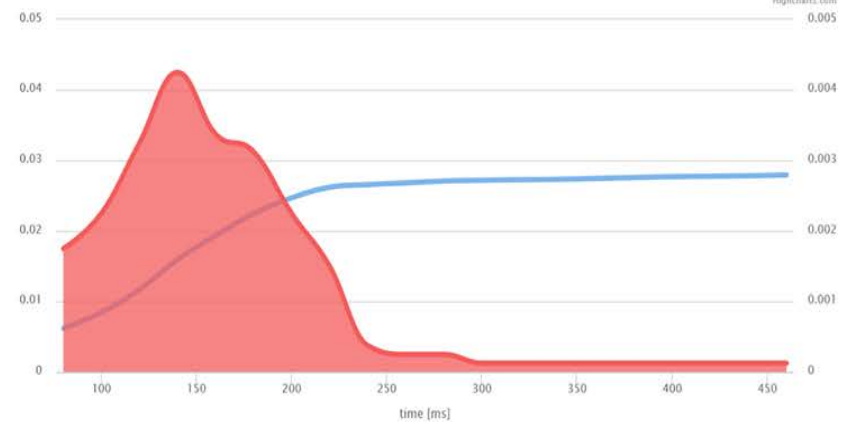
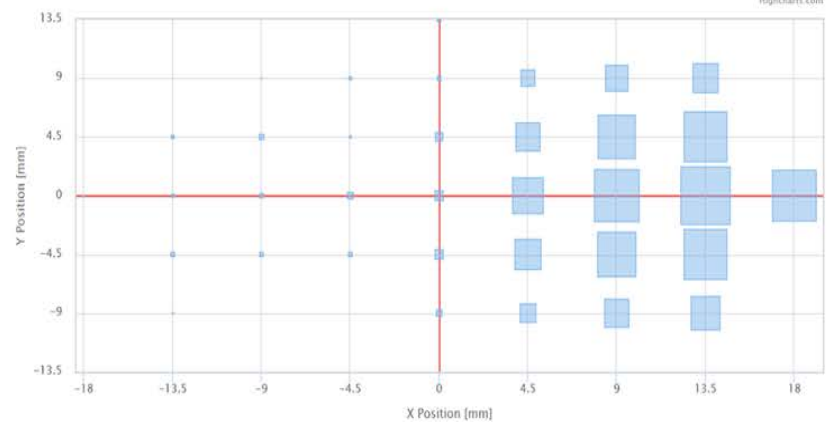
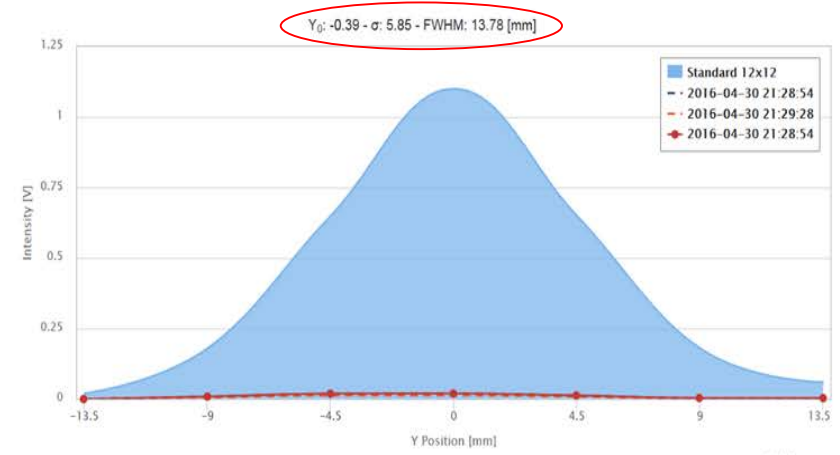
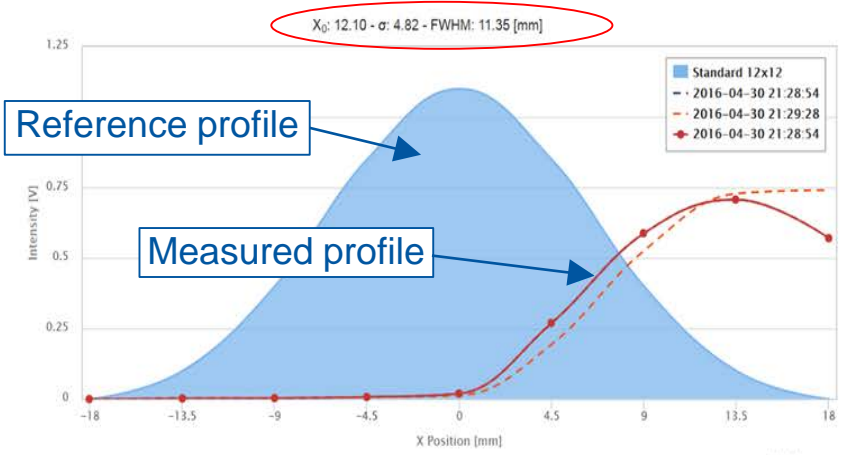
➤ Data taken only by the XY axis

**EXTREME CASE**

BPM 2 | 2016-04-30 21:28:54

$X_0: 12.10 - \sigma: 4.82 - \text{FWHM}: 11.35[\text{mm}]$

$Y_0: -0.39 - \sigma: 5.85 - \text{FWHM}: 13.78[\text{mm}]$

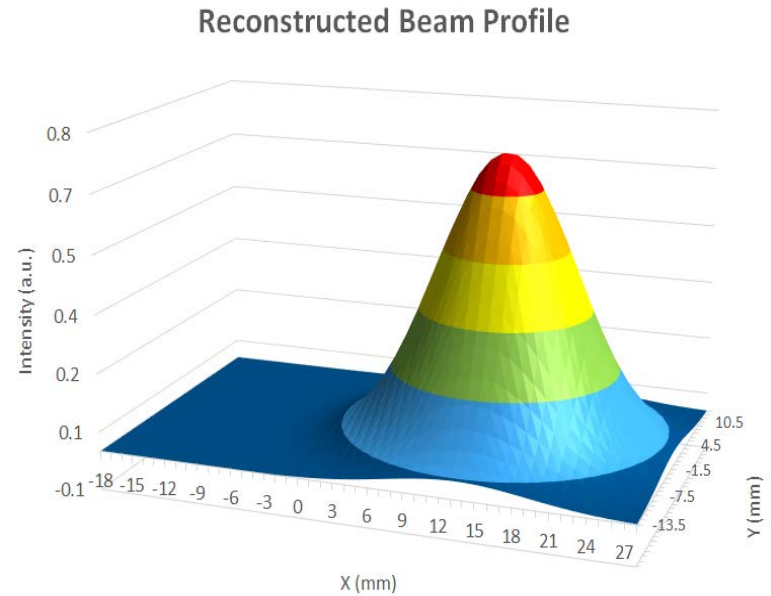
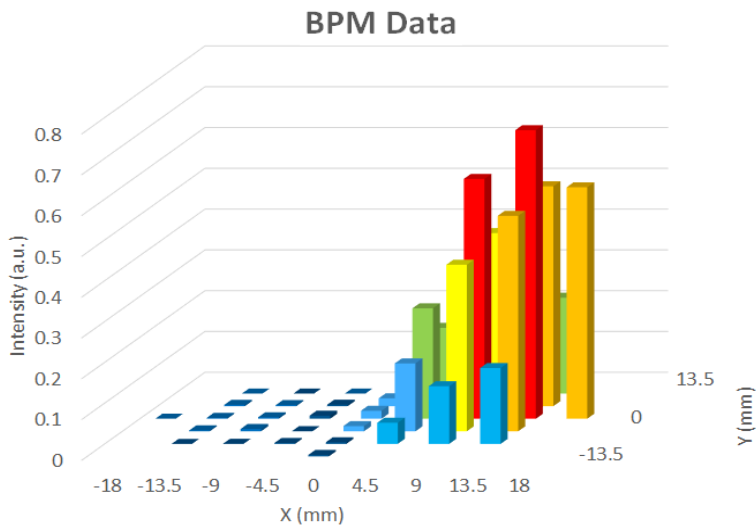


**AIDA** 2020

# UPGRADE: NEW 3D FITTING TOOL

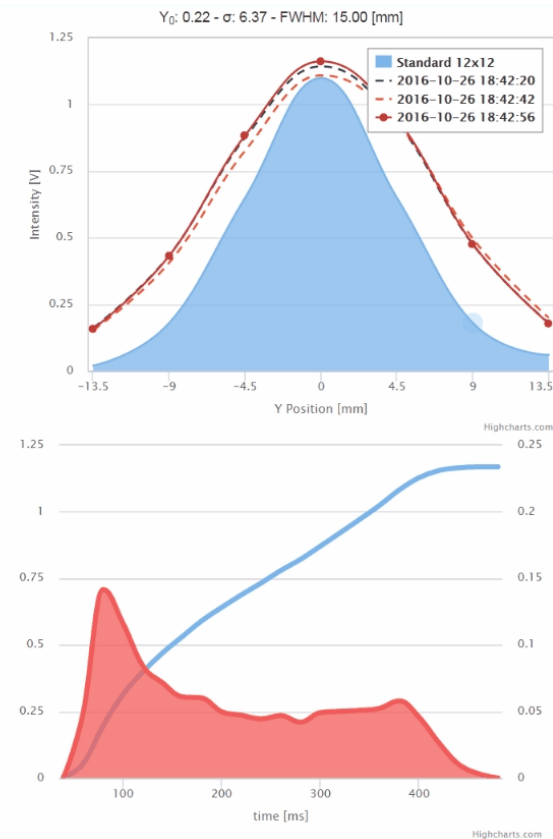
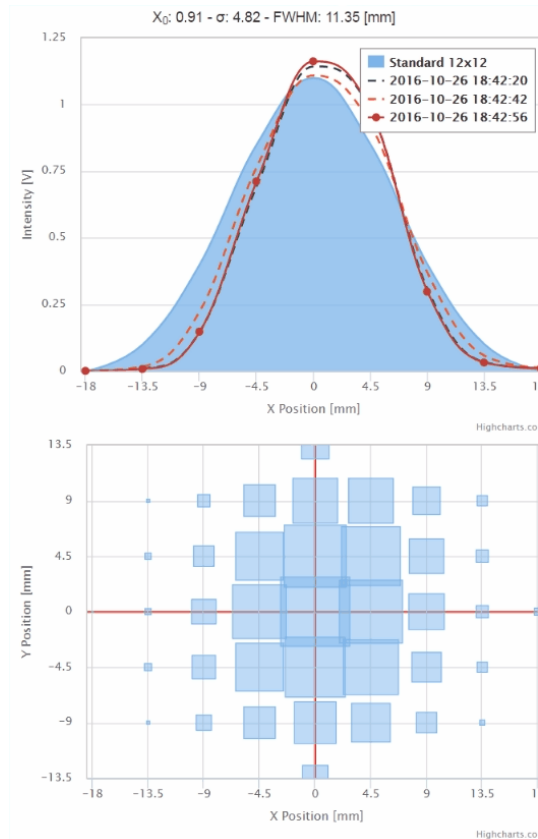
## VALIDATION

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



# CONCLUSION

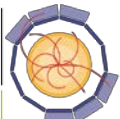
- Beam Profile Monitor system **operational** since IRRAD commissioning (end of 2014)
- Data available **online** and **in real-time**
- Hardware and system architecture in IRRAD
- New fitting tool now available
- Future step: A stand-alone and portable BPM system



Webpage: [op-webtools.web.cern.ch/irrad/bpm.php](http://op-webtools.web.cern.ch/irrad/bpm.php)

Website: [ps-irrad.web.cern.ch](http://ps-irrad.web.cern.ch)

E-mail: [Irradiation.Facilities@cern.ch](mailto:Irradiation.Facilities@cern.ch)



AIDA<sup>2020</sup>

# THANK YOU!

