

# The new CERN IRRAD Facility and its user infrastructure

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CERN PH/DT, IRRAD Facility Team

*... presenting the work of many contributors to the **East Area Upgrade** construction project at CERN  
EN holds the overall projects leadership*

*Core teams:*                    **EA Upgrade Project:** D. Brethoux, R. Froeschl, L. Gatignon, M. Lazzaroni, et al.  
                                      **R2E Project:** M. Brugger & J. Mekki, et al.

*CERN groups:*

***EN-MEF** and **EN-STI** (core teams), **HSE** and **EN-HDO** (Projects Safety), **DGS-RP**, **EN-CV** (EA-IRRAD ventilation), **EN-HE** (exp. areas transports), **GS-ASE** (access control), **BE-BI** and **TE-CRG** (EA-IRRAD cryogenic system), ...*

- ❑ Overview (and evolution) of Irradiation Facilities at CERN
- ❑ PS East Area Irradiation Facilities until 2012
- ❑ New PS East Area Irradiation Facilities (EA-IRRAD)
  - IRRAD Proton Facility
  - CHARM Mixed-Field Facility
- ❑ IRRAD Proton Facility Layout
- ❑ Conclusion

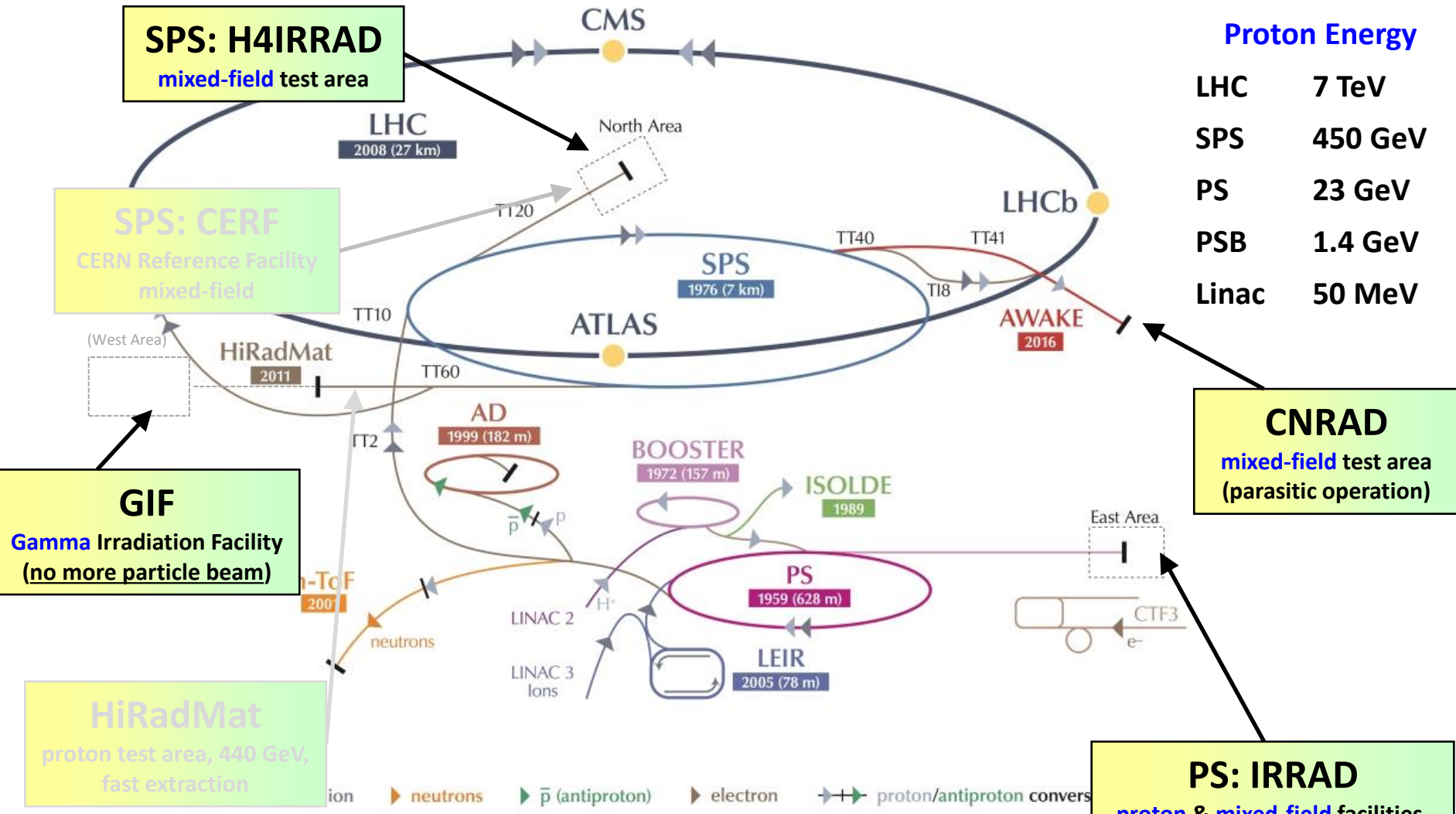


# CERN Irradiation Facilities until 2012



## Proton Energy

LHC	7 TeV
SPS	450 GeV
PS	23 GeV
PSB	1.4 GeV
Linac	50 MeV



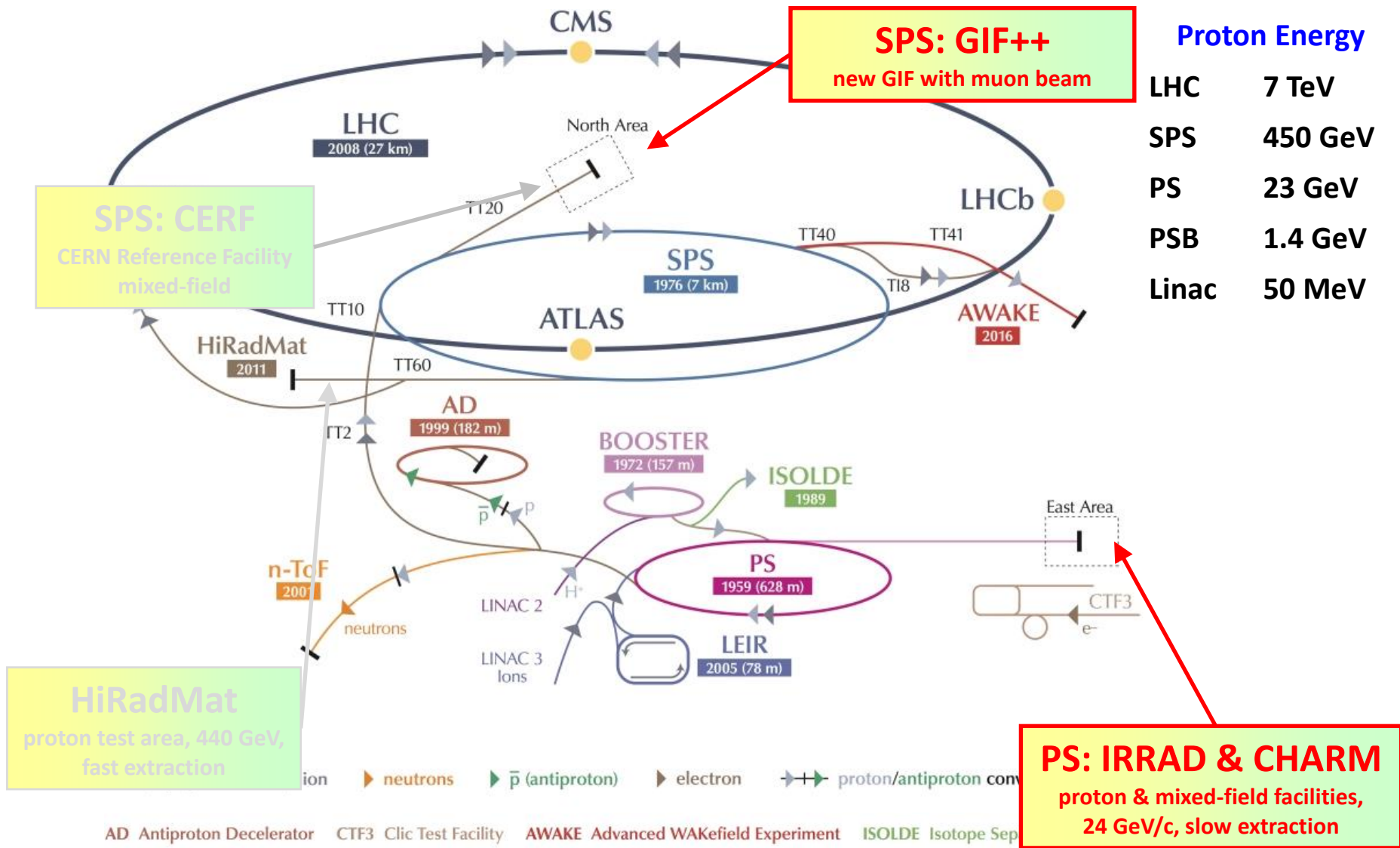
**GIF**  
Gamma Irradiation Facility  
(no more particle beam)

**HiRadMat**  
proton test area, 440 GeV,  
fast extraction

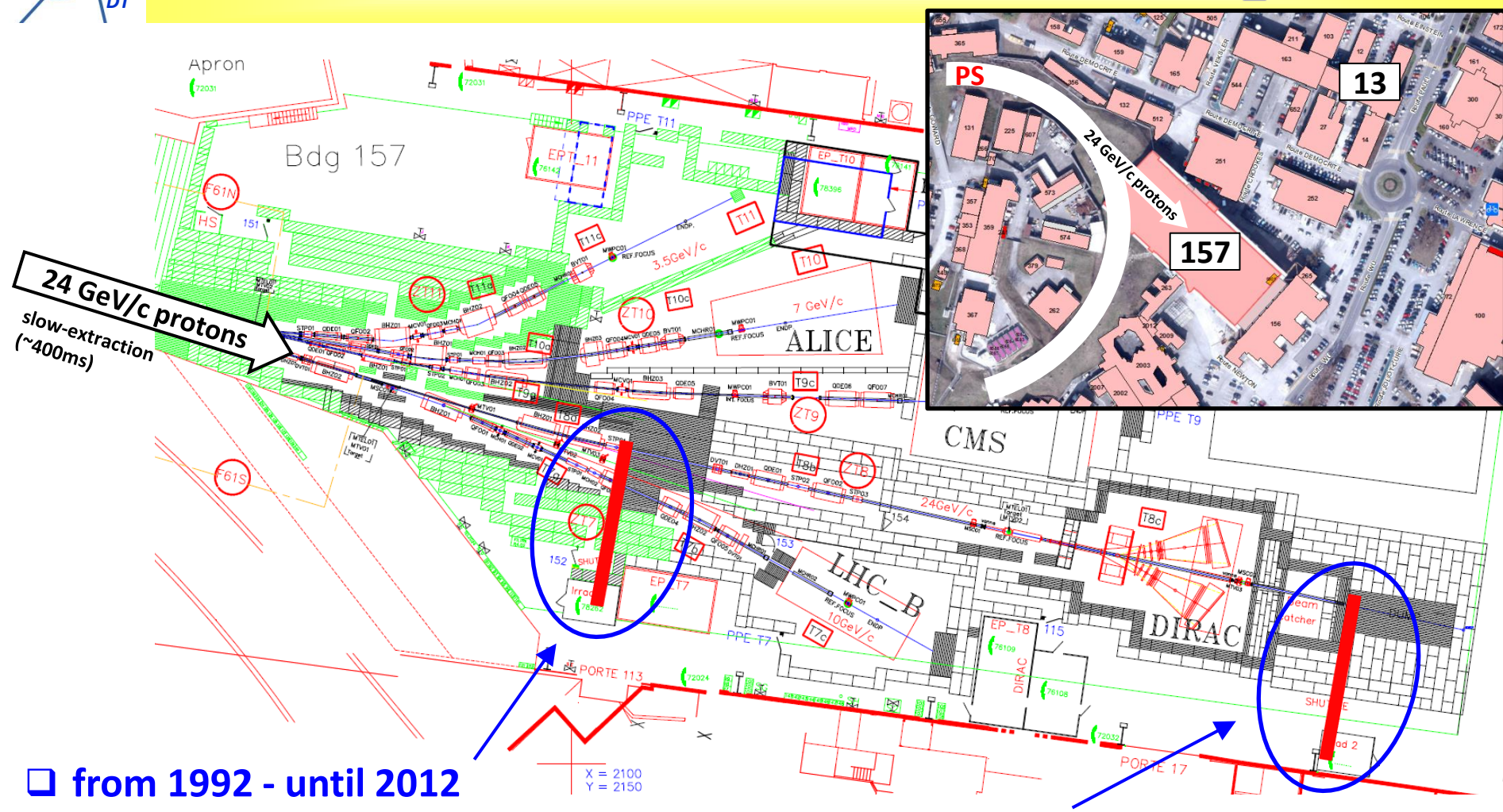
**PS: IRRAD**  
proton & mixed-field facilities,  
24 GeV/c, slow extraction

**CNRAD**  
mixed-field test area  
(parasitic operation)

AD Antiproton Decelerator CTF3 Clic Test Facility AWAKE Advanced WAKEfield Experiment ISOLDE Isotope Separation  
LEIR Low Energy Ion Ring LINAC LINear ACcelerator n-ToF Neutrons Time Of Flight HiRadMat High-Radiation to Materials



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❑ Proton irradiations (T7)

❑ Mixed-field irradiations (T8)

- Primary 24 GeV/c proton beam (IRRAD1, IRRAD3, IRRAD5, ...)
- Mixed field produced in cavity after C (50cm) - Fe (30cm) - Pb (5cm) 'target' (IRRAD2)

# Past Irradiation Experiments



v - 09.

## ❑ IRRAD facilities in numbers ...

- from **1999** to **2012** (no beam in 2005)
- more than **8300** “pieces” irradiated (~650 per year)!
- about **5800** dosimeters (Al foils) measured!

## ❑ Statistics for 2012 ...

- **40** users
- from **20** institutes belonging to several experiments/projects
- main users: **ATLAS, CMS, LHCb, ALICE, RD39, RD50, LHC** (BE and TE)
- **649** objects irradiated
- **358** dosimeters measured
- **223** days of beam time (~ $8.5 \times 10^{16}$  protons delivered to IRRAD)

(of the old facilities / test areas with respect to future needs)

## ❑ Proton IRRAD Facility

- Located in primary radiation area (limited access: stop all beam lines of East Area for access)
- **Limited space** (ALARA, difficult to scan beam over big objects, backscattered particles)
- **Limited flux** of primary protons (weakness of the shielding)
- Safety standards to be improved!

## ❑ Mixed-field IRRAD Facility (behind DIRAC)

- No irradiation positions lateral to target (missing an important 'particle mix' component)
- **Limited intensity** (present flux not interesting for inner detector community)
- Too little space and limited accessibility (access only via shuttle system!)
- Parasitic to DIRAC operation

➤ IRRAD Facilities were located in different beam lines: **competing for beam!**

## ❑ Mixed-field H4IRRAD/CNRAD Test Areas

- CNRAD **not operational** after 2012
- **Limited accessibility** ("ad-hoc installations", lack of flexibility, access required **shielding removal**)
- **Limited** control on **beam intensity**



## □ 2012: CERN management agrees on EA facilities upgrade

- CERN-EN is charged and funded to design and construct the irradiation beam line in the framework of the **EA renovation plan during LS1** (PL: *Lau Gatignon*)
- CERN-PH through AIDA EU FP7-funded project (Task 8.3)



## □ 19 Nov. 2012: first technical meeting on upgrade

- **R2E project (LHC machine): Mixed-field facility & infrastructure design**
- **CERN-PH & AIDA: Proton facility & infrastructure design**



## □ 26 Nov. 2012: last day of operation for the DIRAC experiment

## □ July 2013: dismantling DIRAC & old IRRAD1 and IRRAD2 Facilities

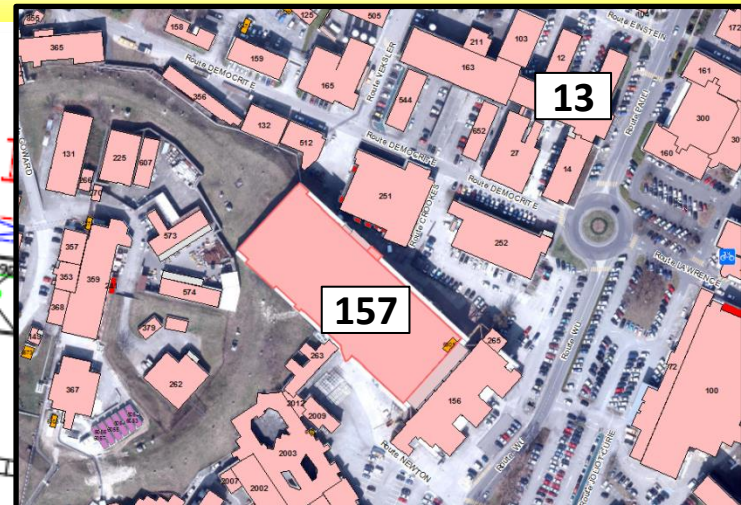
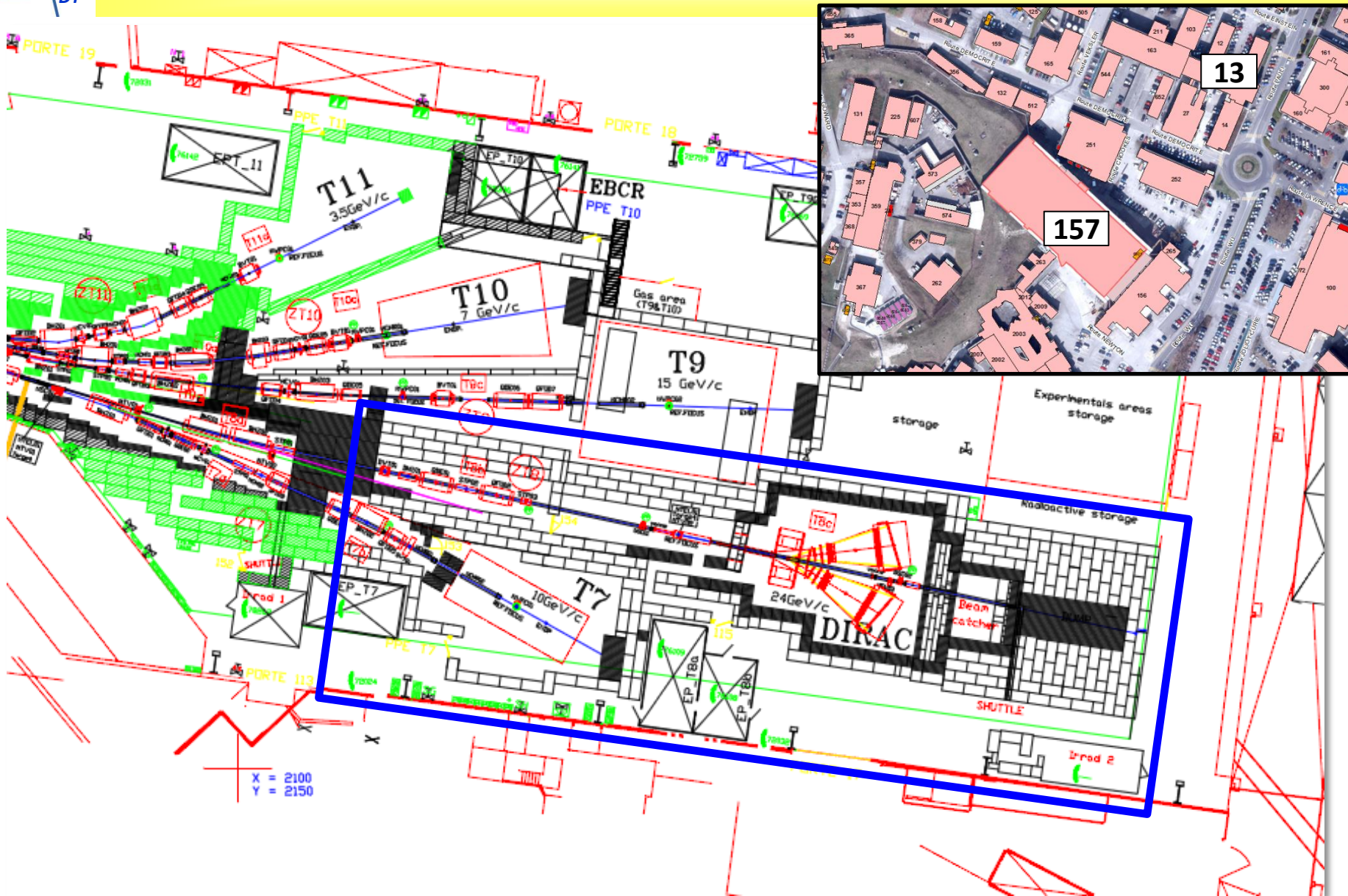
## □ Nov. 2013: removal of IRRAD2 target & beginning of construction

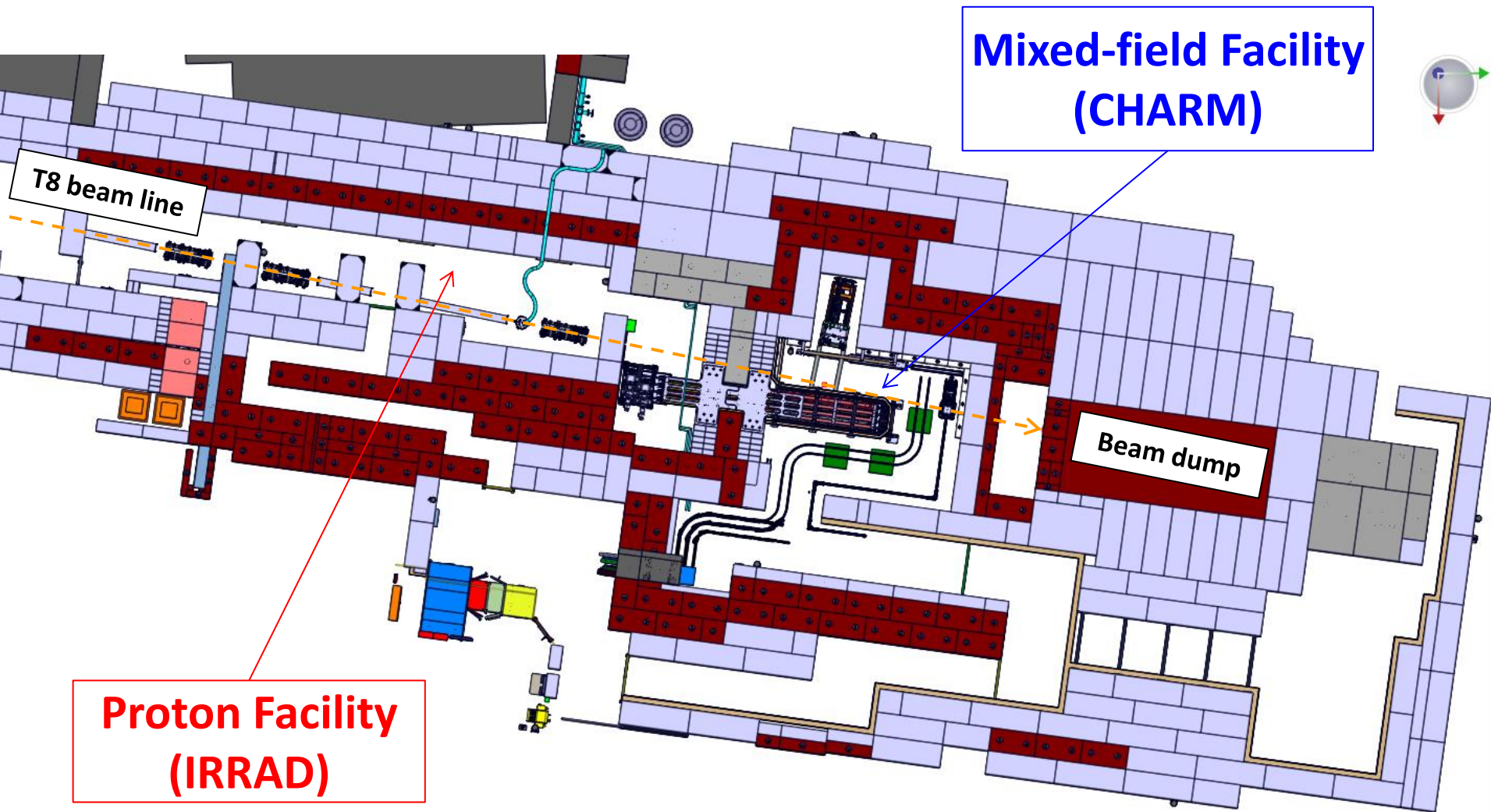
- R2E project: Cern High-energy Accelerator Mixed-field facility (CHARM)
- **CERN-PH & AIDA: proton IRRADiation facility (IRRAD)**

## □ 10 Oct. 2014: first pilot beam in the new EA-IRRAD facility for commissioning

## □ 17 Nov. 2014: first irradiation experiments

# OLD East Area Layout





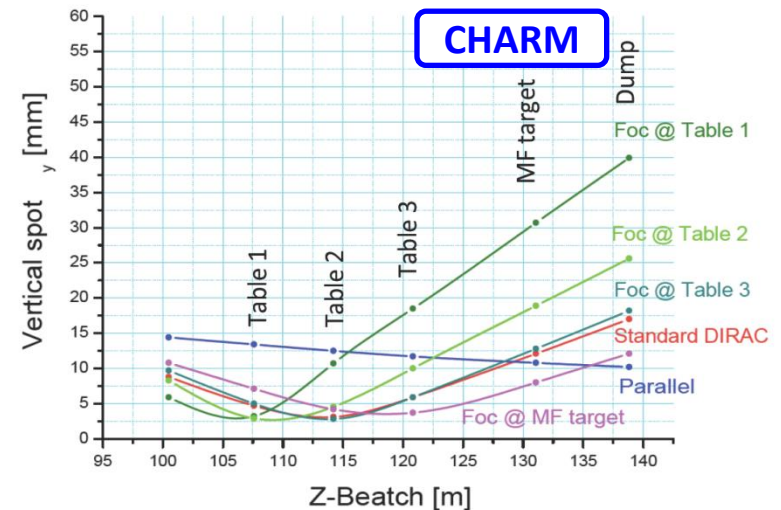
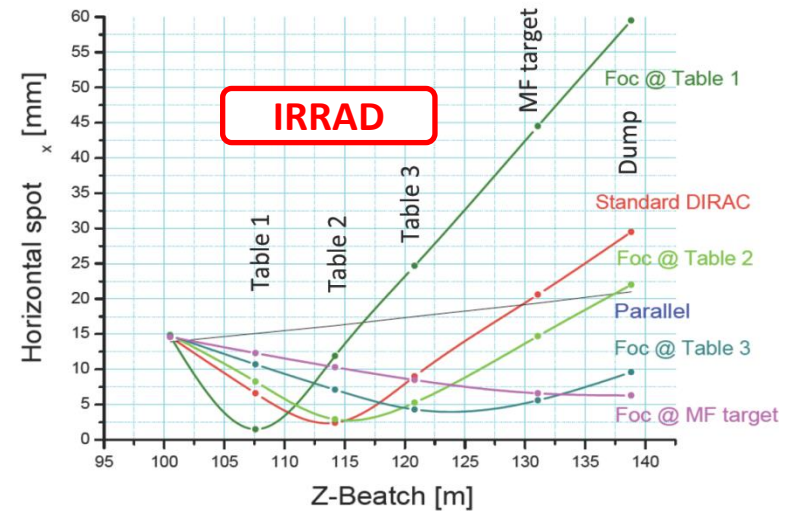
© drawings provided by EN-MEF

## □ Beam dimensions

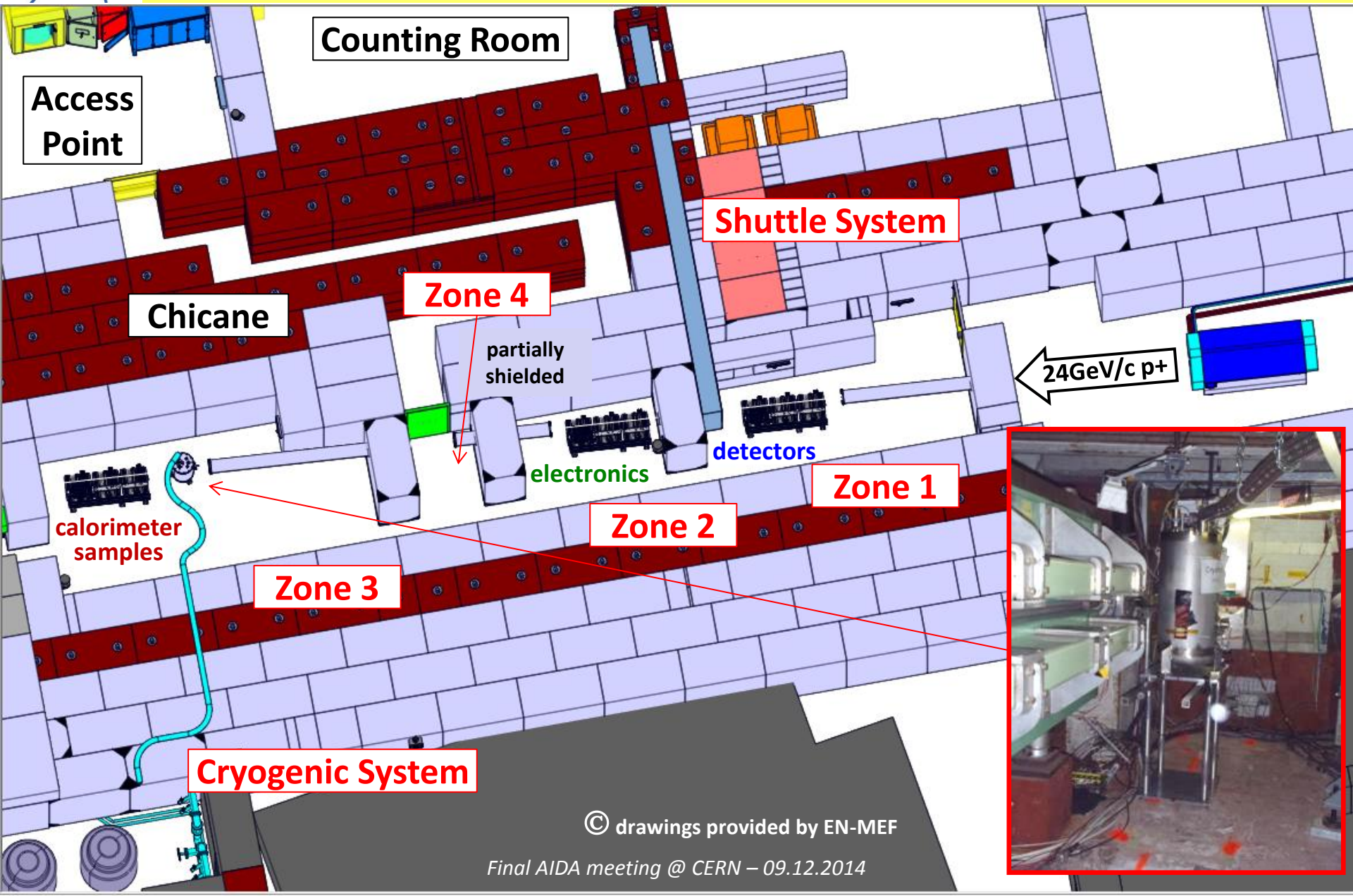
- **several optic variants possible on T8**
- standard size: **12x12 mm<sup>2</sup> (FWHM)**
- spot size from **5x5 mm<sup>2</sup> to 20x20 mm<sup>2</sup> (FWHM)**

## □ Beam intensity (estimations)

- p<sup>+</sup> are delivered in “spills” of  $\sim 5 \times 10^{11}$  p
- number of spills/frequency depends on CPS
- **Typical CPS from 2014: 30s**
- **Typical figures (High Intensity): 3 spills per CPS**
  - **$\sim 1 \times 10^{16}$  p cm<sup>-2</sup> 5days<sup>-1</sup> (12x12 mm<sup>2</sup> FWHM)**
  - **$\sim 4x$  more than the old facilities**
- **Design figures (maximum): 6 spills per CPS**
  - **$\sim 1 \times 10^{17}$  p cm<sup>-2</sup> 4days<sup>-1</sup> (5x5 mm<sup>2</sup> FWHM)**



© L. Gatignon, preliminary calculations (EDMS 1270807)  
Here dimensions are mm (RMS)

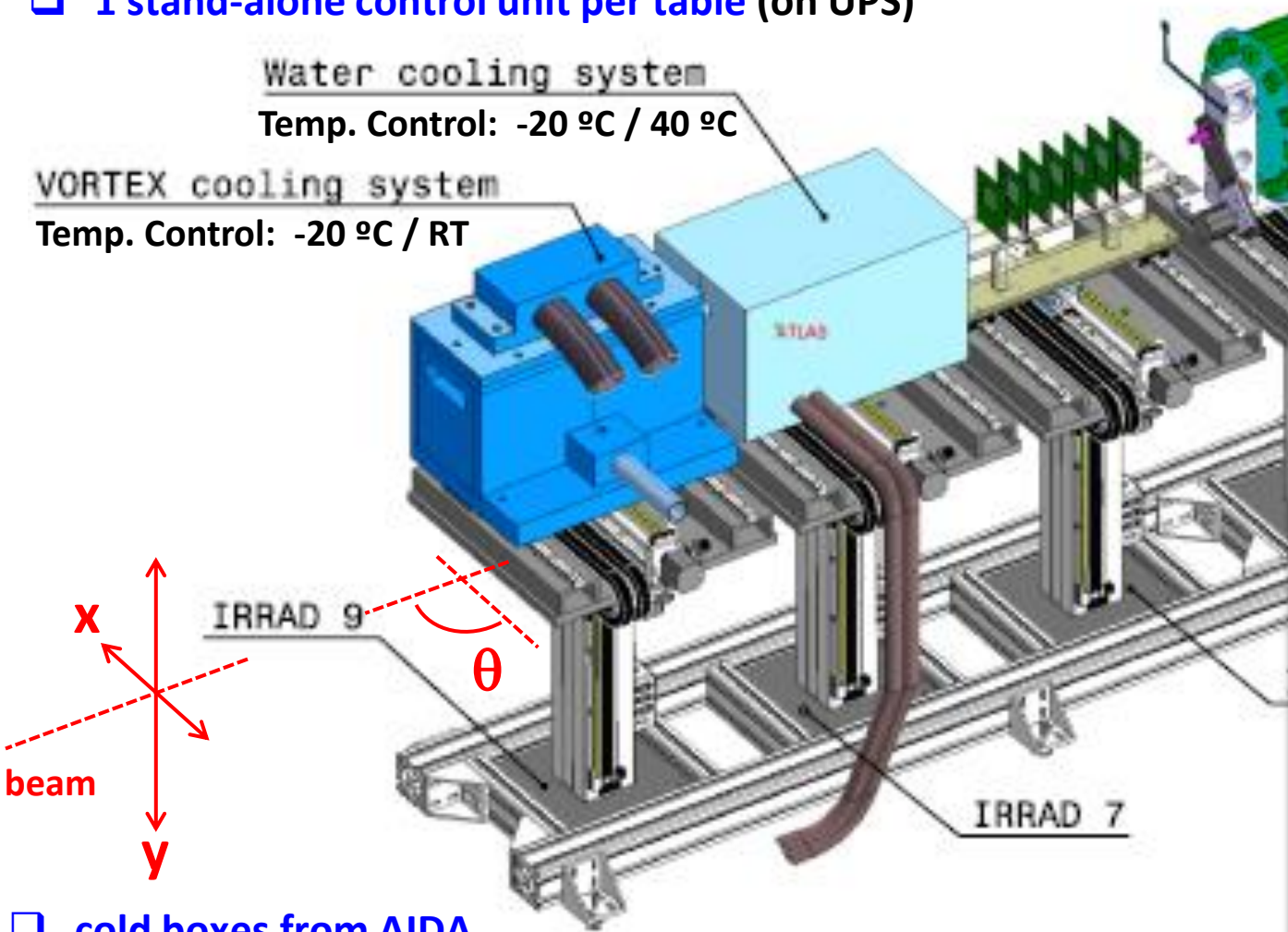


- ❑ mainly “passive” samples
- ❑ possibility to irradiate samples under bias

- ❑ 3 tables per IRRAD zone; DUTs powered and cooled
- ❑ 1 stand-alone control unit per table (on UPS)

Water cooling system  
Temp. Control:  $-20\text{ }^{\circ}\text{C}$  /  $40\text{ }^{\circ}\text{C}$

VORTEX cooling system  
Temp. Control:  $-20\text{ }^{\circ}\text{C}$  / RT



IRRAD 3



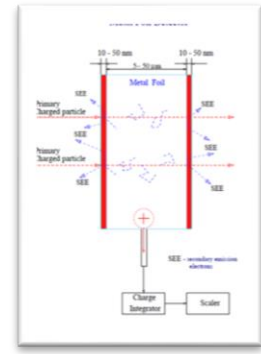
- ❑ cold boxes from AIDA (WP8.3.2 QMUL/Sheffield)

- ❑ prototype (AIDA MS31)

❑ New Beam Position Monitors (Metal Foil Detectors)

❑ New Web-application

- display **Beam Profile Monitor** data (for IRRAD users and CERN CCC)
- new database for data storage (ORACLE); can display multiple BPM devices
- flexible display also for other IRRAD data: **SEC counters, table/shuttle positions, T., ...**



BPM Shuttle | 3 Spills | Last Spill
07-10-2012 23:57:14

BPM Display

© E. Matli (BE-OP)

$X_0: -0.70 - \sigma^2: \text{NaN}$

$Y_0: 0.36 - \sigma^2: 21.00$

Mobile
Final AIDA meeting @ CERN - 09.12.2014

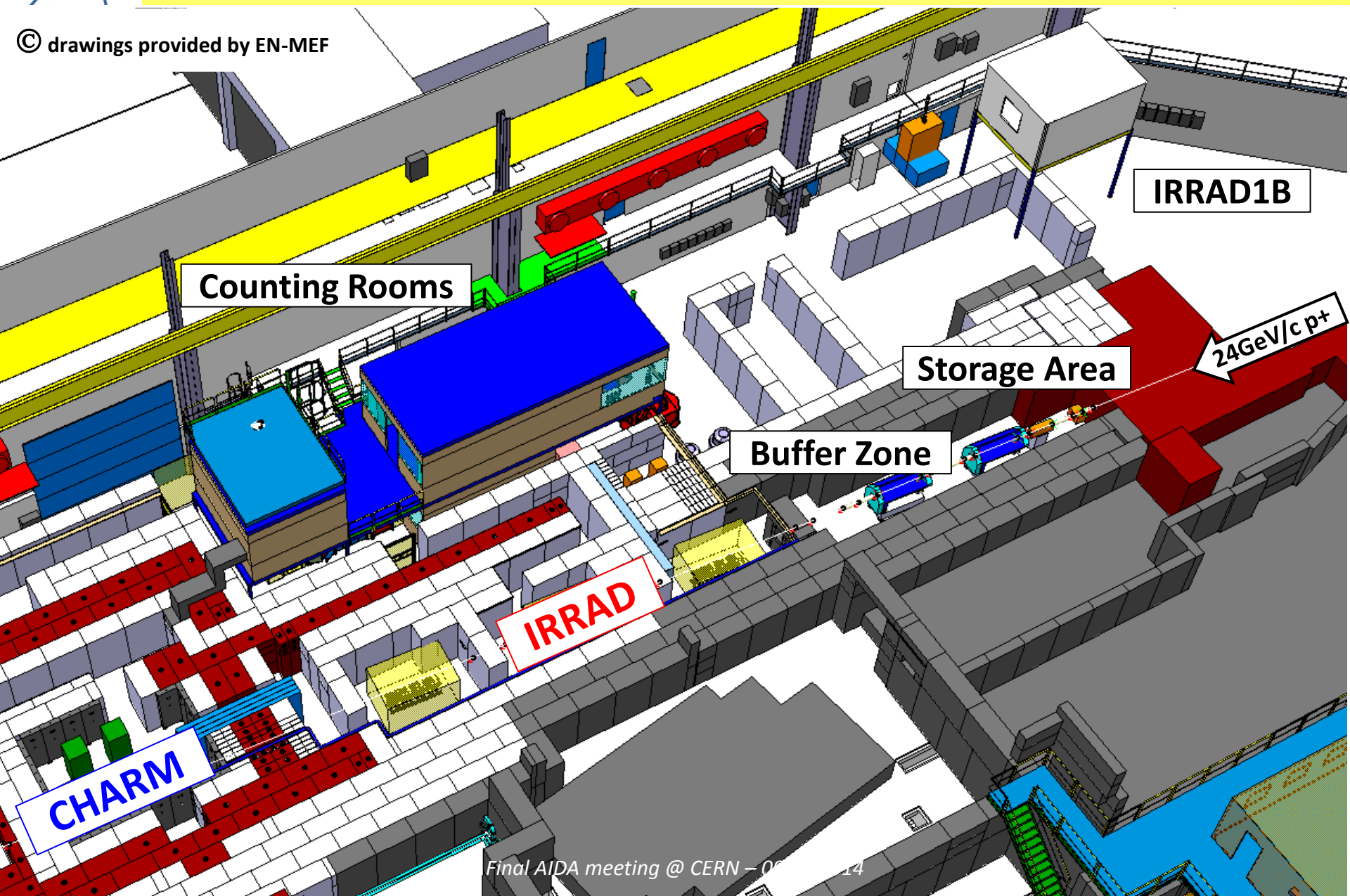




Counting Room

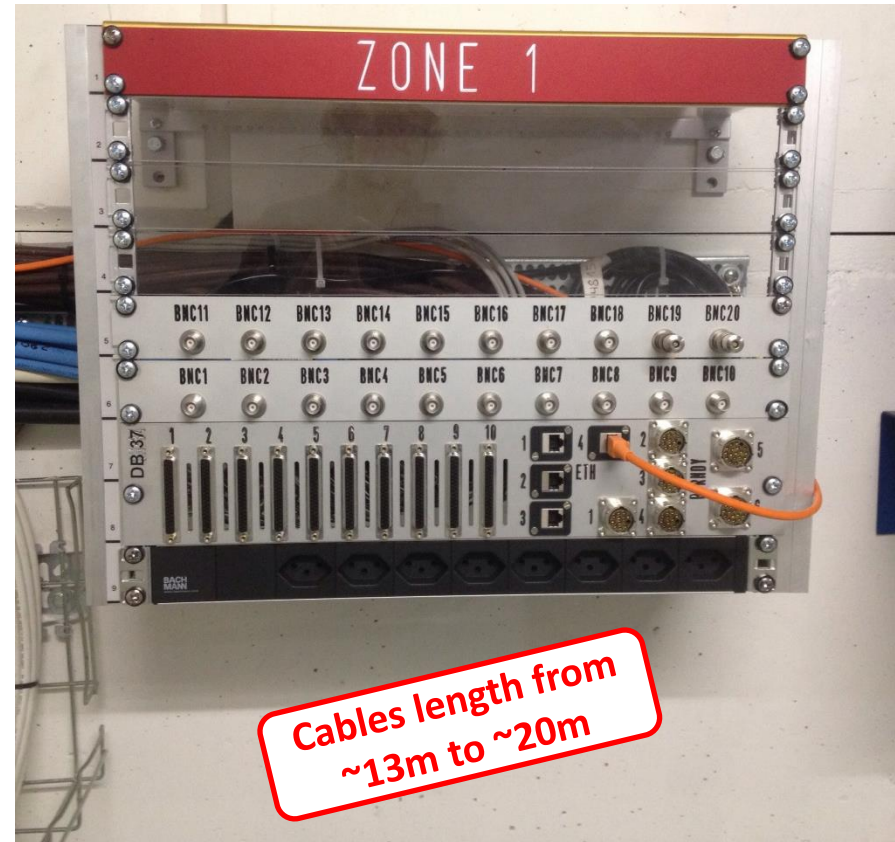
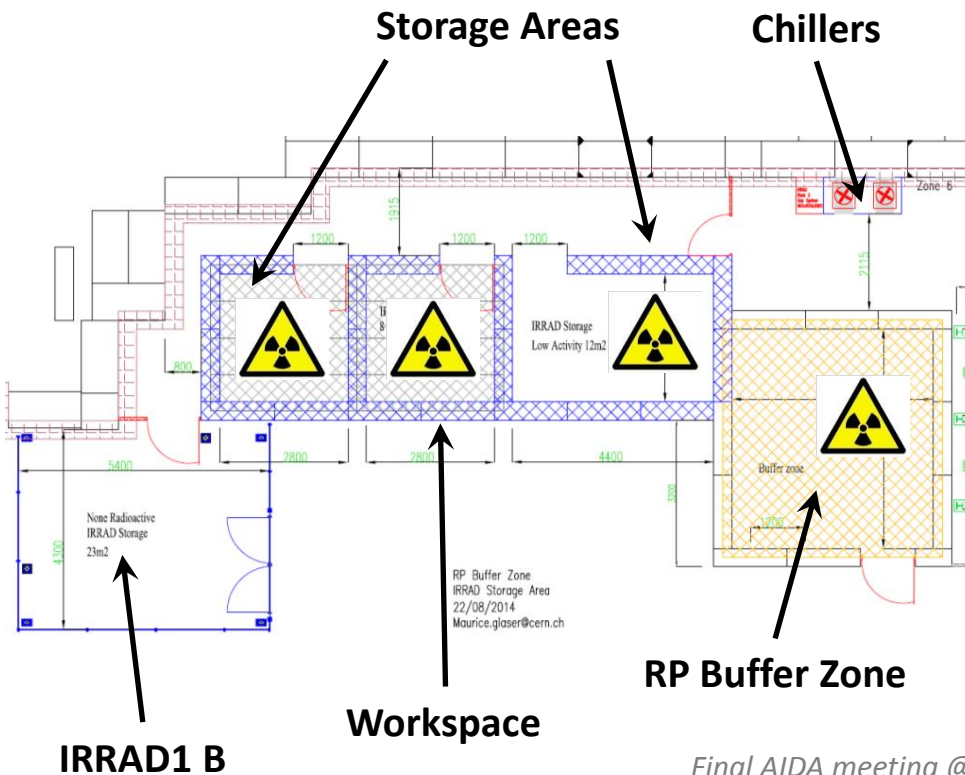


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## Storage area

- shielded zones for **cool-down** and **storage at room and low temperature** of IRRAD (and CHARM) irradiated equipment
- workspace to handle and **perform (setup) measurements** on irradiated equipment

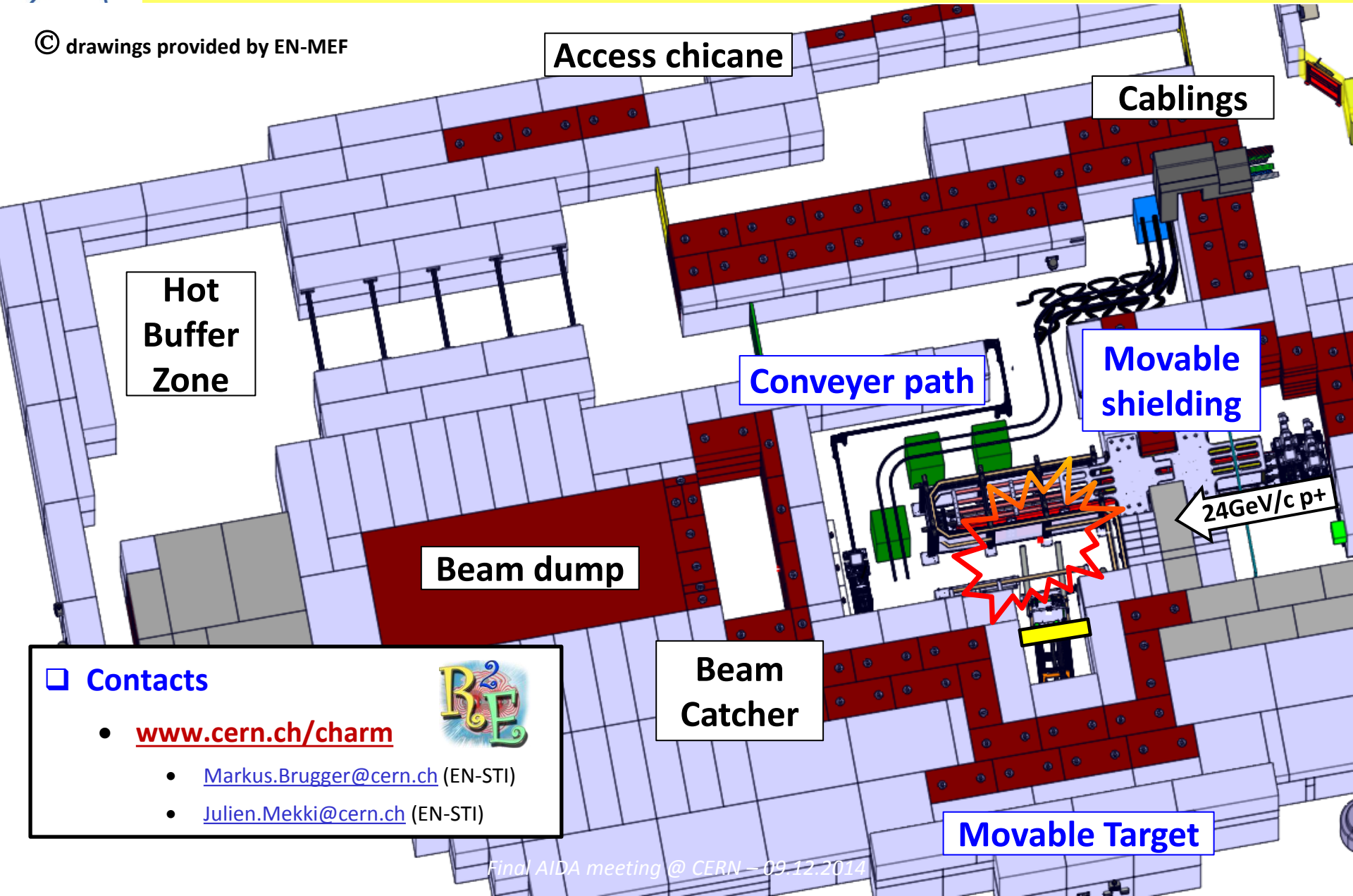


**Cables length from ~13m to ~20m**

## Fixed cabling/piping infrastructure

- **4 Patch-Panels** installed along IRRAD
- twisted-pairs, coaxial, power HV/LV, ...
- space for **custom users-cabling** (optical fibers, etc..)

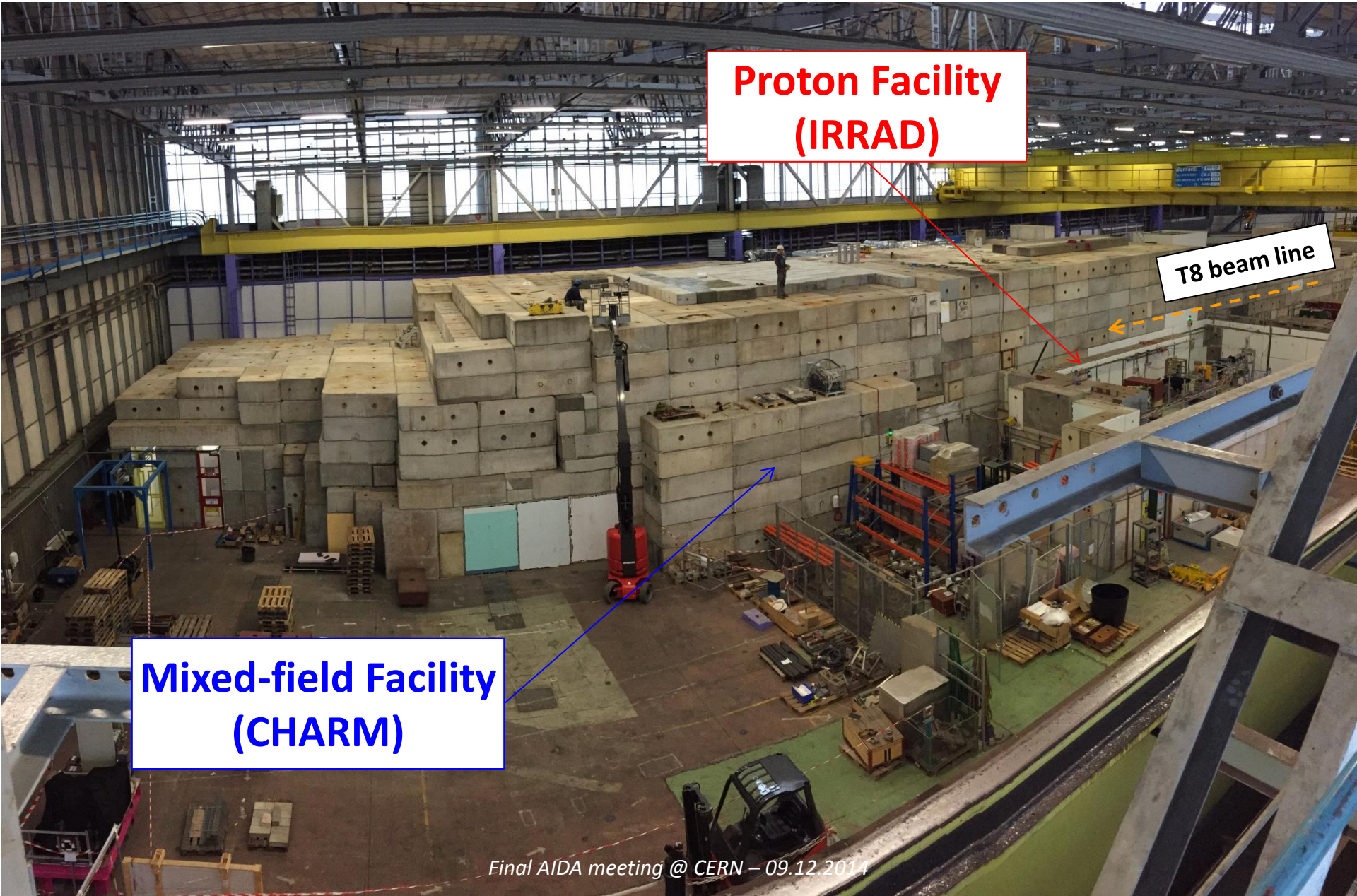
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## Contacts

- [www.cern.ch/charm](http://www.cern.ch/charm)
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- [Julien.Mekki@cern.ch](mailto:Julien.Mekki@cern.ch) (EN-STI)





**Proton Facility  
(IRRAD)**

**T8 beam line**

**Mixed-field Facility  
(CHARM)**

## ❑ New EA-IRRAD facility is now being commissioned (fully operational in 2015)

- Experimental community (PH): **Proton** facility (**IRRAD**)
- Accelerator community (EN): **Mixed-field** facility (**CHARM**)

## ❑ IRRAD Proton Facility in 2014

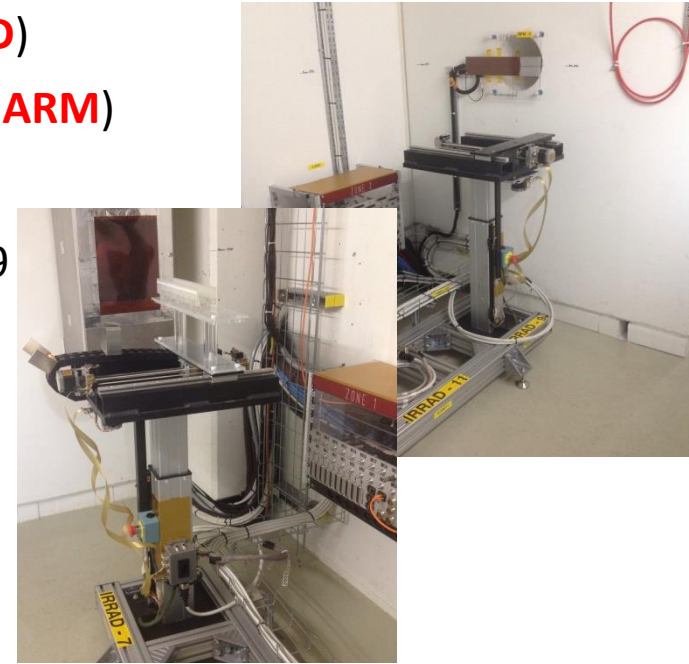
- 2 Tables operational (no cooling): IRRAD 7 & IRRAD 9
- Limited time/space (16 experiments registered!)

## ❑ More to come in 2015

- IRRAD1 Shuttle System
- Additional tables, cooling systems
- Users space for testing irradiated samples
- Storage area being assembled
- ...

## ❑ New web-site

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



IRRAD Proton Facility

HOME FACILITY USERS IRRADIATION OPERATION SAMPLES SAFETY CONTACTS

Directory

PH-DT  
Detector Technologies

**Contacts**

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Maurice Glaser	164276
irradiation.Facilities@cern.ch	
IRRAD Control Room	43344
CCC PS	74677

**Useful Links**

- Visit CERN
- Visit EAST Area
- Beam Profile Monitor (BPM)
- ELOG PS OP
- TRES (usage of buffer zones)

[irrad-ps-users@cern.ch](mailto:irrad-ps-users@cern.ch)  
e-group (subscribe)

- Secondary Beams & Areas
- PH/DT Irradiation Service
- Gamma Irradiation Facility
- PH-RADMON Sensors Database

**Latest News**

**IRRAD Home**

The IRRAD proton facility is located on the T8 beam-line at the CERN PS East Hall (building 157) where the primary proton beam with a momentum of 24GeV/c is extracted from the PS ring. As shown in the figure below, the space allocated for irradiation tests in the East Hall is shared between two irradiation facilities: the IRRAD proton facility is located upstream while the CHARM mixed-field facility implemented downstream. Since most of the protons pass through the IRRAD facility without interacting, the mixed-field facility can profit from the same protons used by IRRAD. Inside CHARM, these protons impinge on a target surrounded by a well calculated shielding configuration.

The IRRAD proton irradiation facility at the PS East Area is maintained and operated by the irradiation team within the PH-DT-DD section at CERN.

Location of the IRRAD proton area within the EA-IRRAD Facility in the CERN East Hall (building 157)

**Mixed-field Facility (CHARM)**

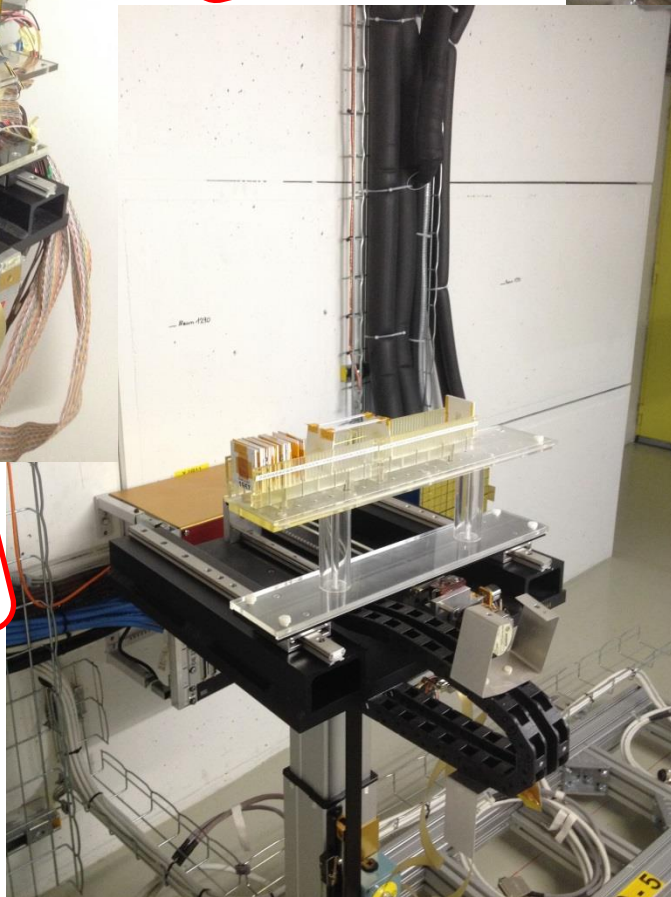
T8 beam line

Beam dump



**Detector Prototypes  
(IRRAD9)**

**Small samples  
(IRRAD7)**



**CryoBLM experiment  
(IRRAD15)**