



## Status of the new irradiation facilities in the CERN EAST HALL (& GIF++)

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*Note: The presented works in the East and North Areas involves many other CERN groups,  
in particular from PH-EN (see references for more details); EN holds the overall project leadership*

### OUTLINE:

- **CERN PS East Area Irradiation Facilities**
  - Overview: past & future CERN irradiation facilities
  - Status of works in the EAST AREA
  - Planning towards commissioning and operation
- ***GIF++ (A short introduction)***
  - *A gamma irradiation facility (for gaseous detectors) in the North Area*
- **Summary**



## □ CERN Facilities

<http://www.cern.ch/irradiation-facilities/>

- existent infrastructures (from 90's) tailored on specific needs
- assessment in view of LHC/injectors upgrade (2008-2009):
  - **High-energy proton irradiations at high intensity** (slow extraction)
  - **Mixed particle field irradiations** (slow extraction)
  - **Proton/ion irradiations at high energy/density** (fast extraction)
  - **Gamma irradiations in the presence of a particle beam**

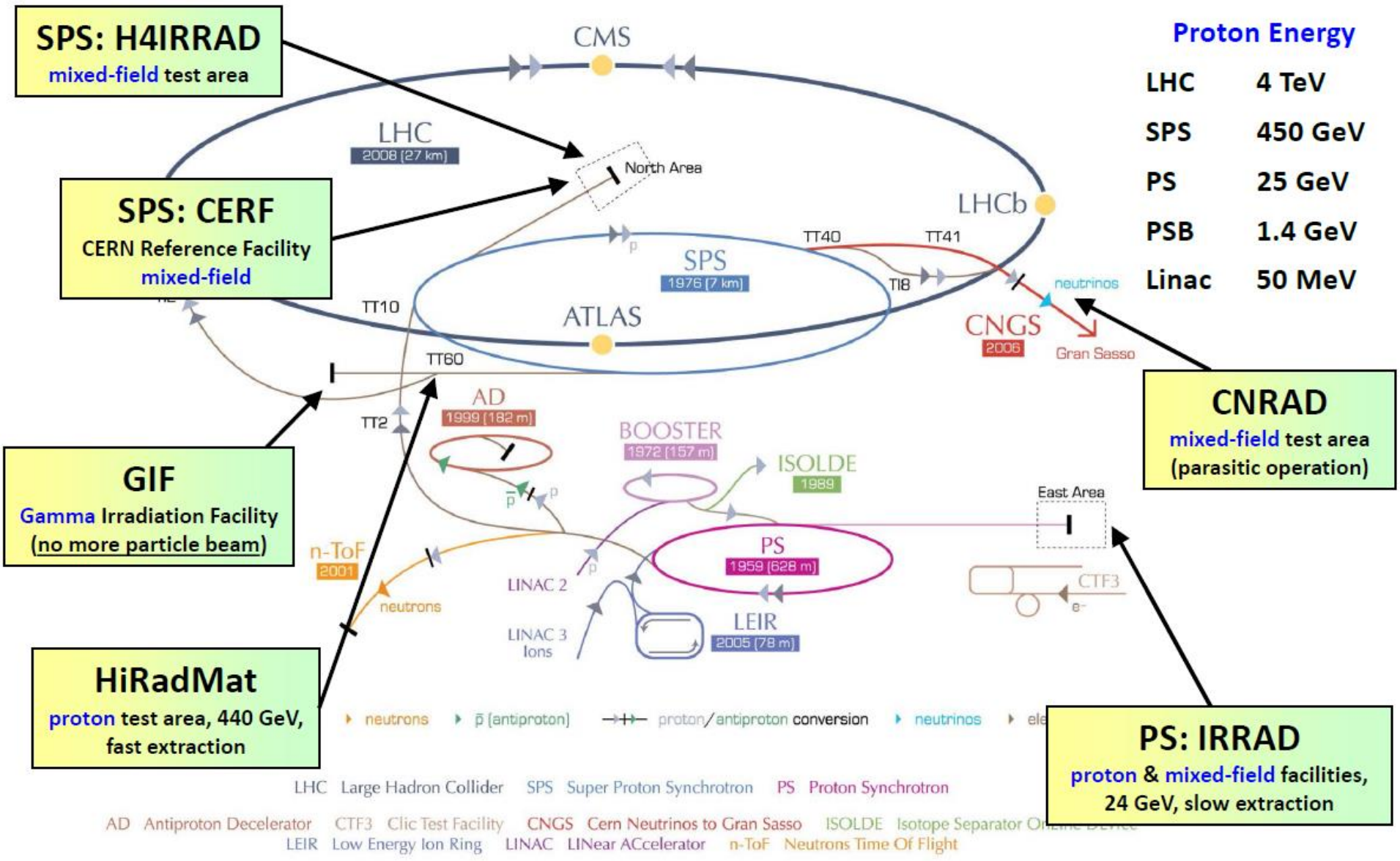
July 2014

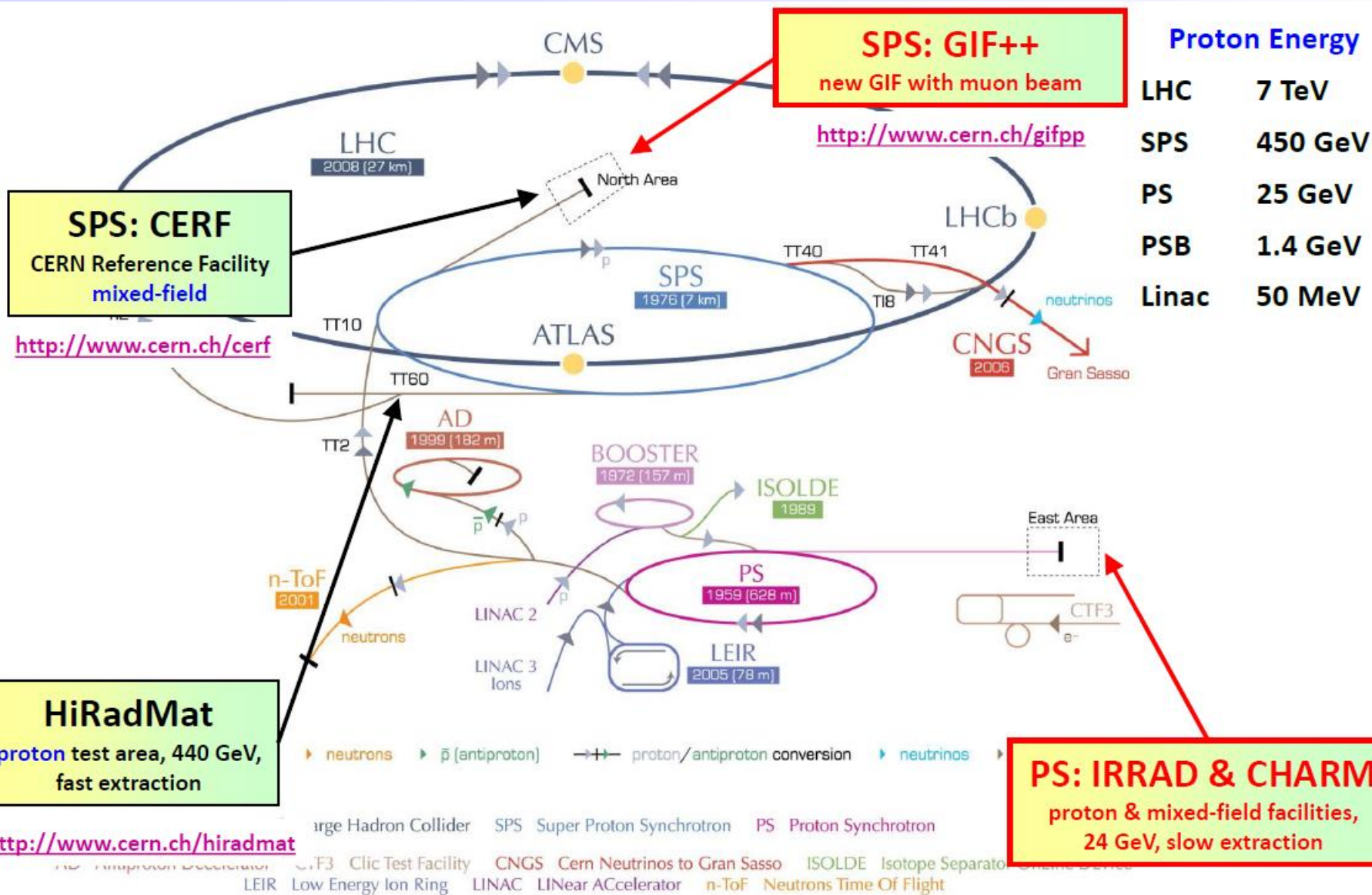
Since 2012

End 2014

## □ External Facilities

- **complementary to CERN facilities** (higher intensities / lower energies)
- **study of basic mechanisms**
  - **$n^0$**  (thermal/MeV)
  - **$p^+$**  (MeV),  **$\pi$**  (MeV)
  - **Heavy Ions** (High LET)
  - **strong  $\gamma$  sources** ( $^{60}\text{Co}$  –  $^{137}\text{Cs}$ )









# AIDA Proton Irradiation Facility (2012)



## IRRAD1:

Shuttle system (max. ~1 Kg)

## IRRAD3 & IRRAD7:

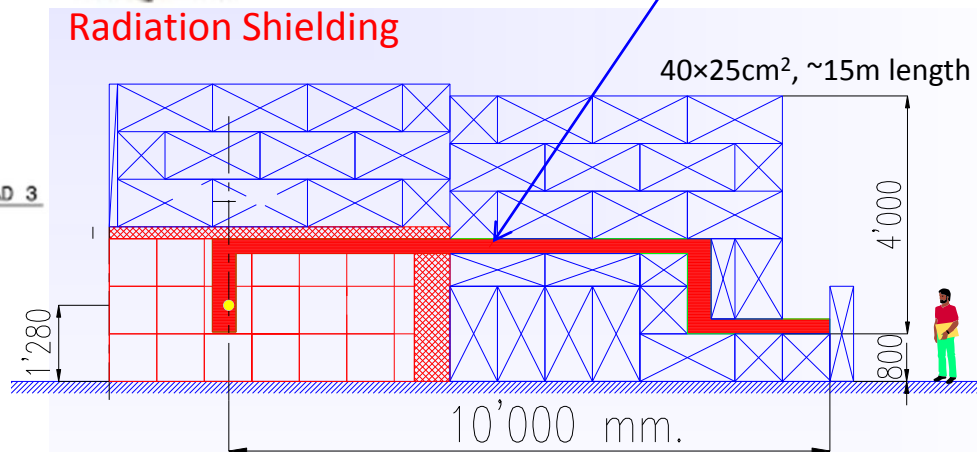
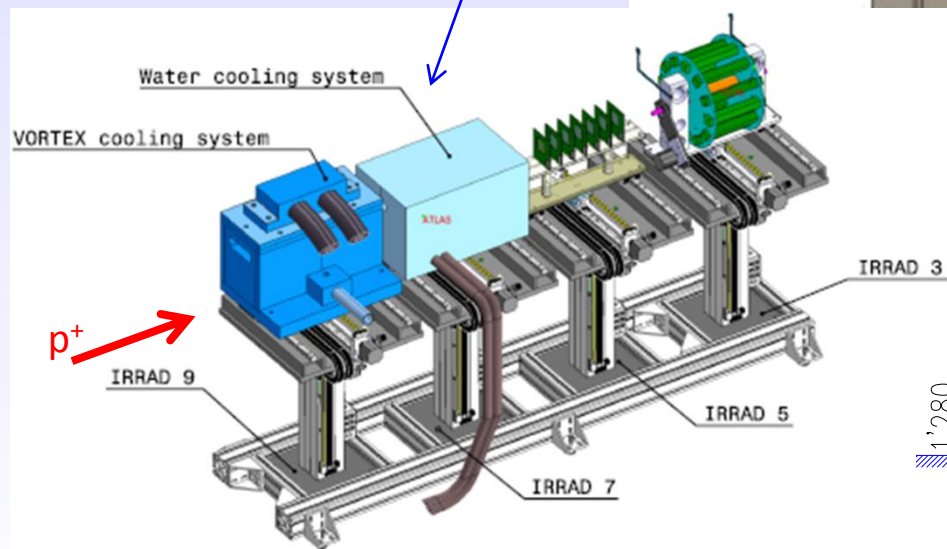
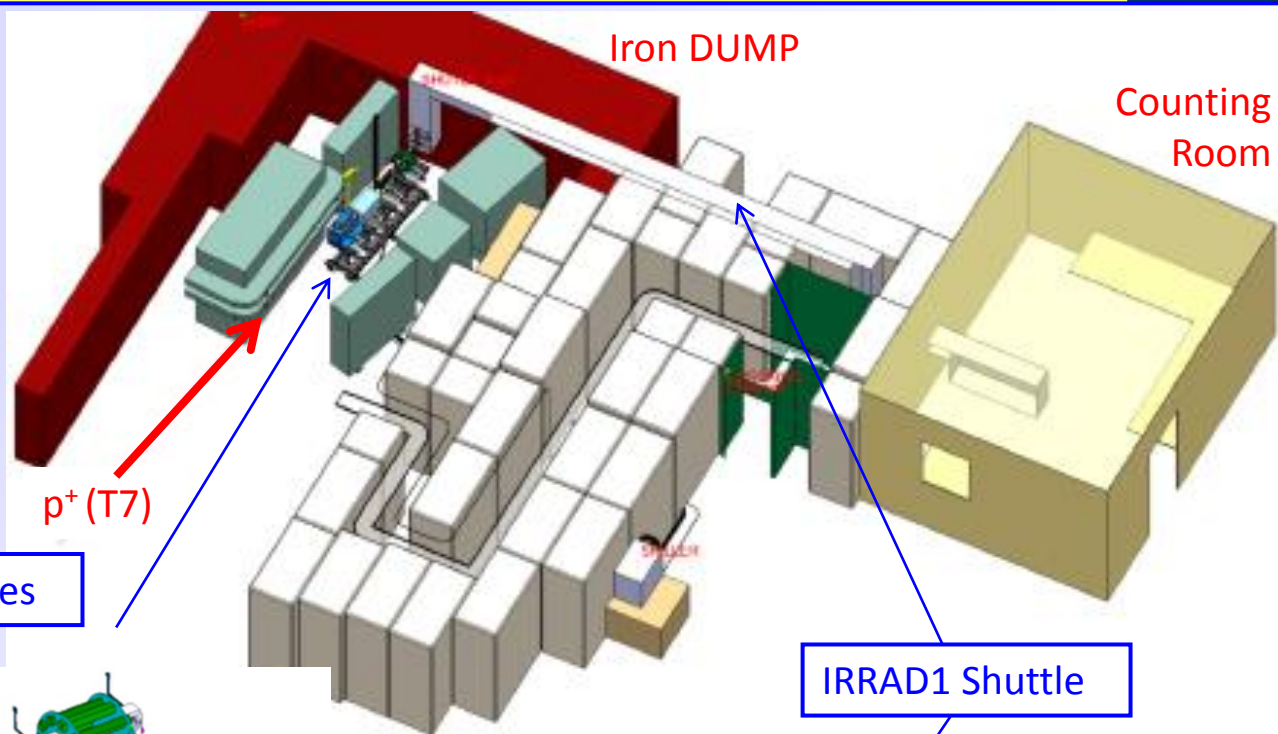
X,Y, $\theta$  remote controlled tables (max. ~50 Kg)

Proton flux:

$\sim 1 \times 10^{16} \text{ p cm}^{-2} \text{ 20days}^{-1}$  (year average)

Beam spot (FWHM):

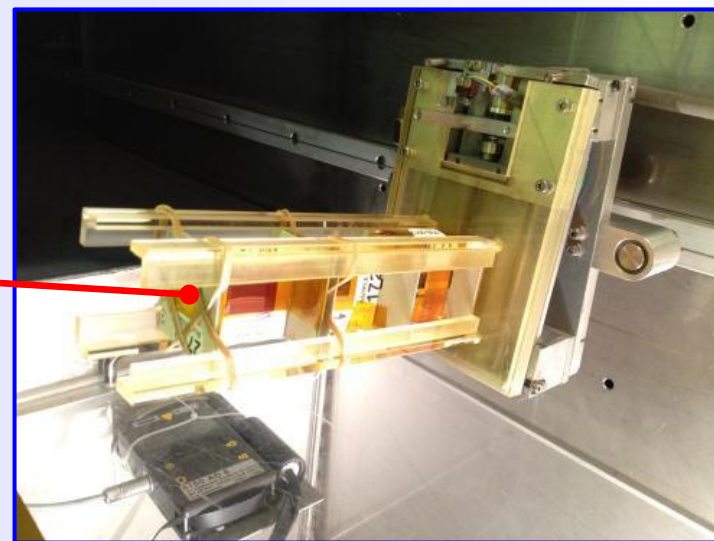
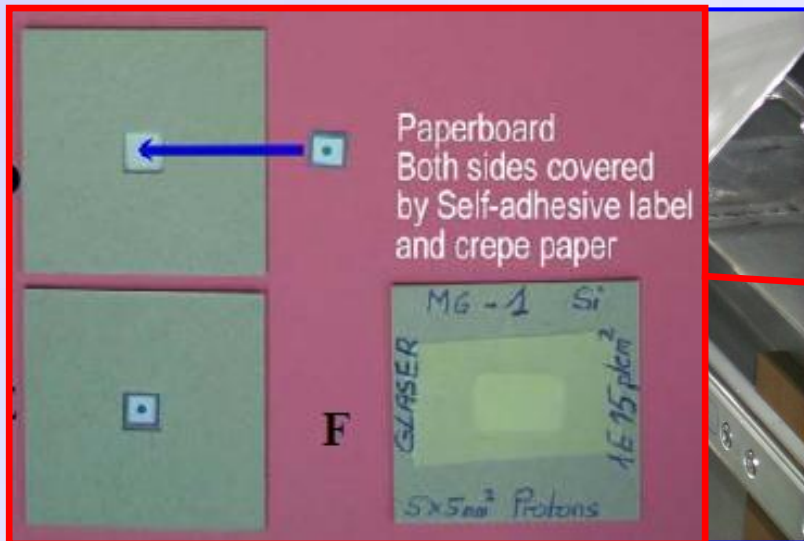
15x15 mm<sup>2</sup>





IRRAD1 Shuttle

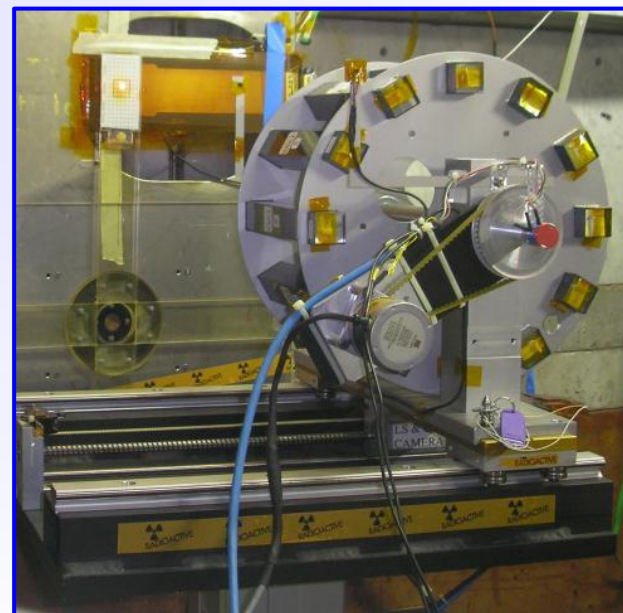
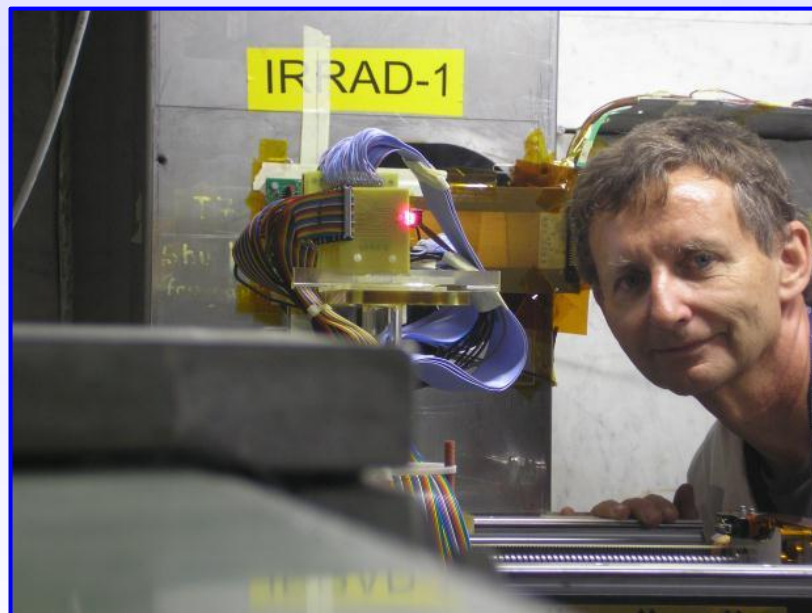
$V_{max} = 5 \times 5 \times 15 \text{ cm}^3$



IRRAD3 & IRRAD7 Tables

$V_{max} = 20 \times 20 \times 50 \text{ cm}^3$

scanning over surface

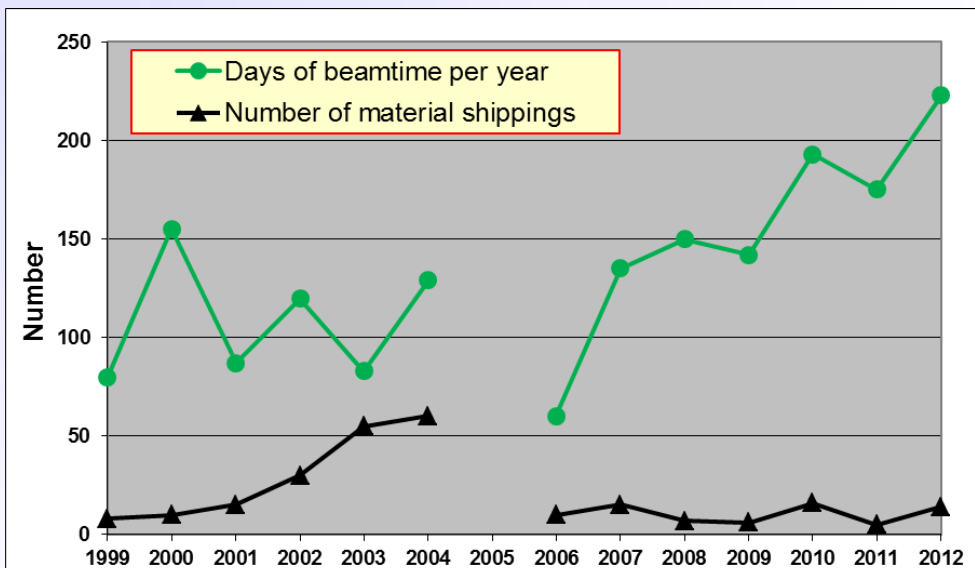
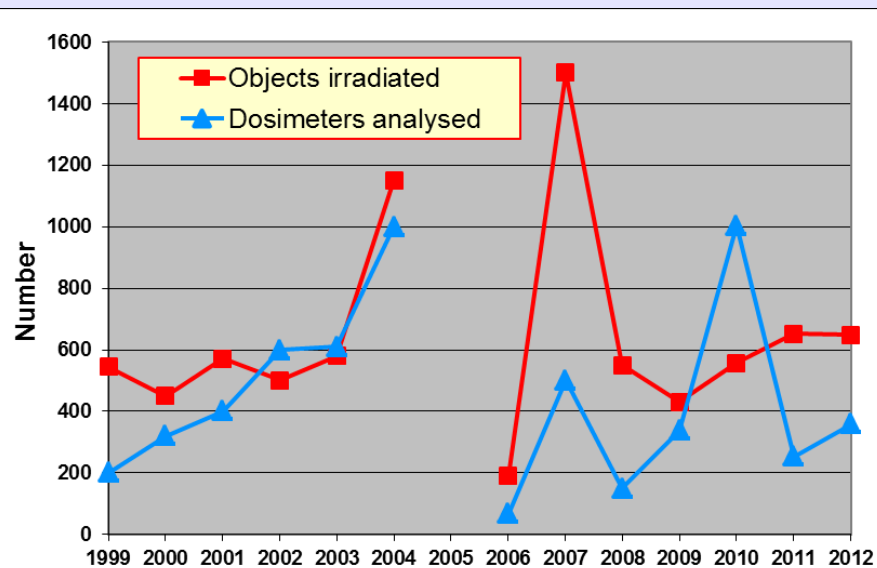


## ☐ Main users of the facilities:

- **LHC Experiments** (in particular innermost detector components – silicon tracking detectors)
- Increasing requests linked to **detector developments for LHC-upgrades** (up to  $2 \times 10^{16}$  p/cm<sup>2</sup>)

## ☐ Irradiations in 2012:

- **40** users from **20** institutes belonging to several experiments/projects
- Main users: ATLAS, CMS, LHCb, ALICE, RD39, RD50, LHC (BE and TE departments)
- **649** objects irradiated, **358** dosimeters measured, **223** days of beam time





(of the present 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!

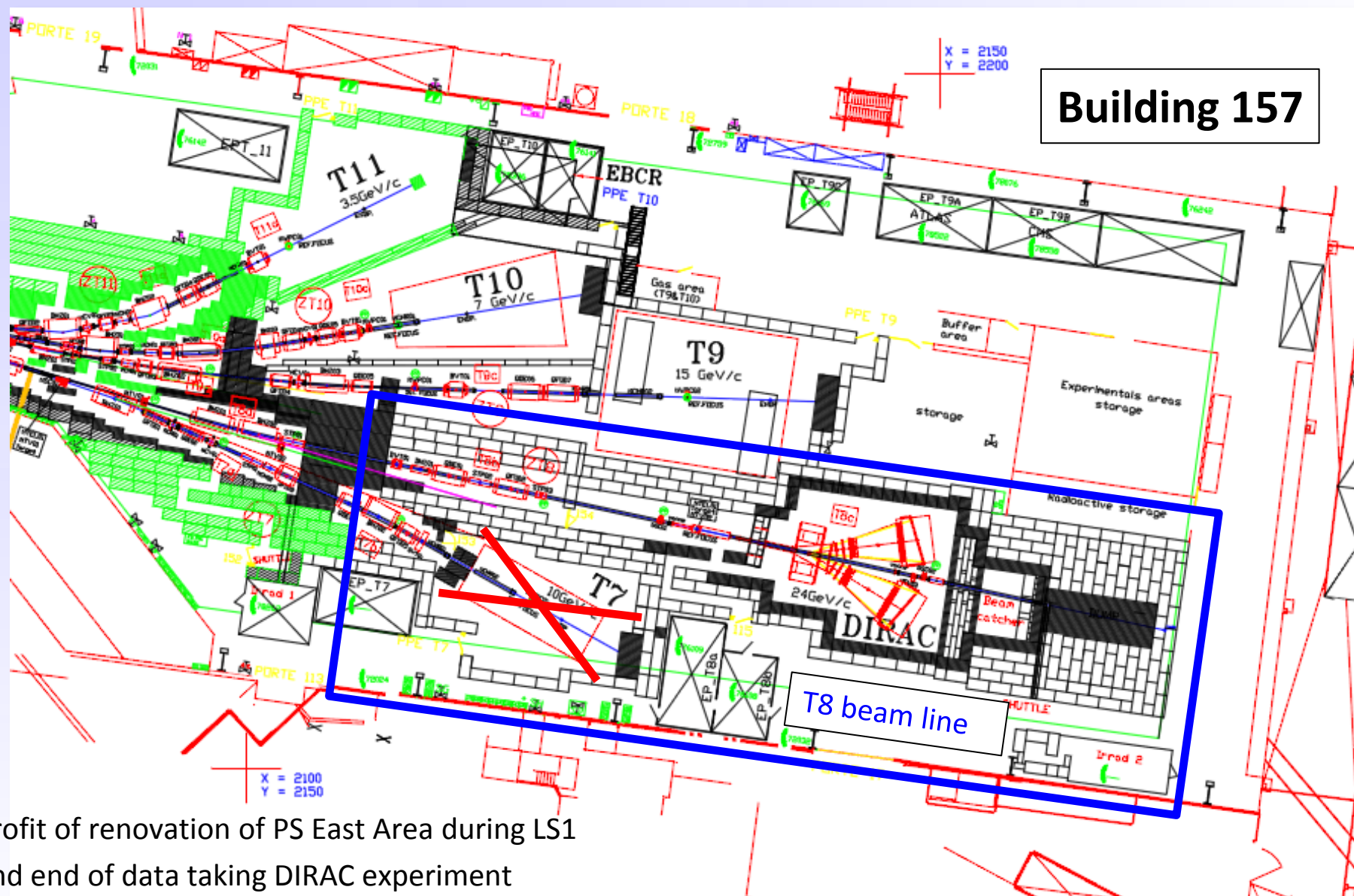
## ❑ Mixed-field IRRAD Facility (behind DIRAC)

- 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 are located in different beam lines: competing for beam!

## ❑ H4IRRAD and CNRAD Test Areas

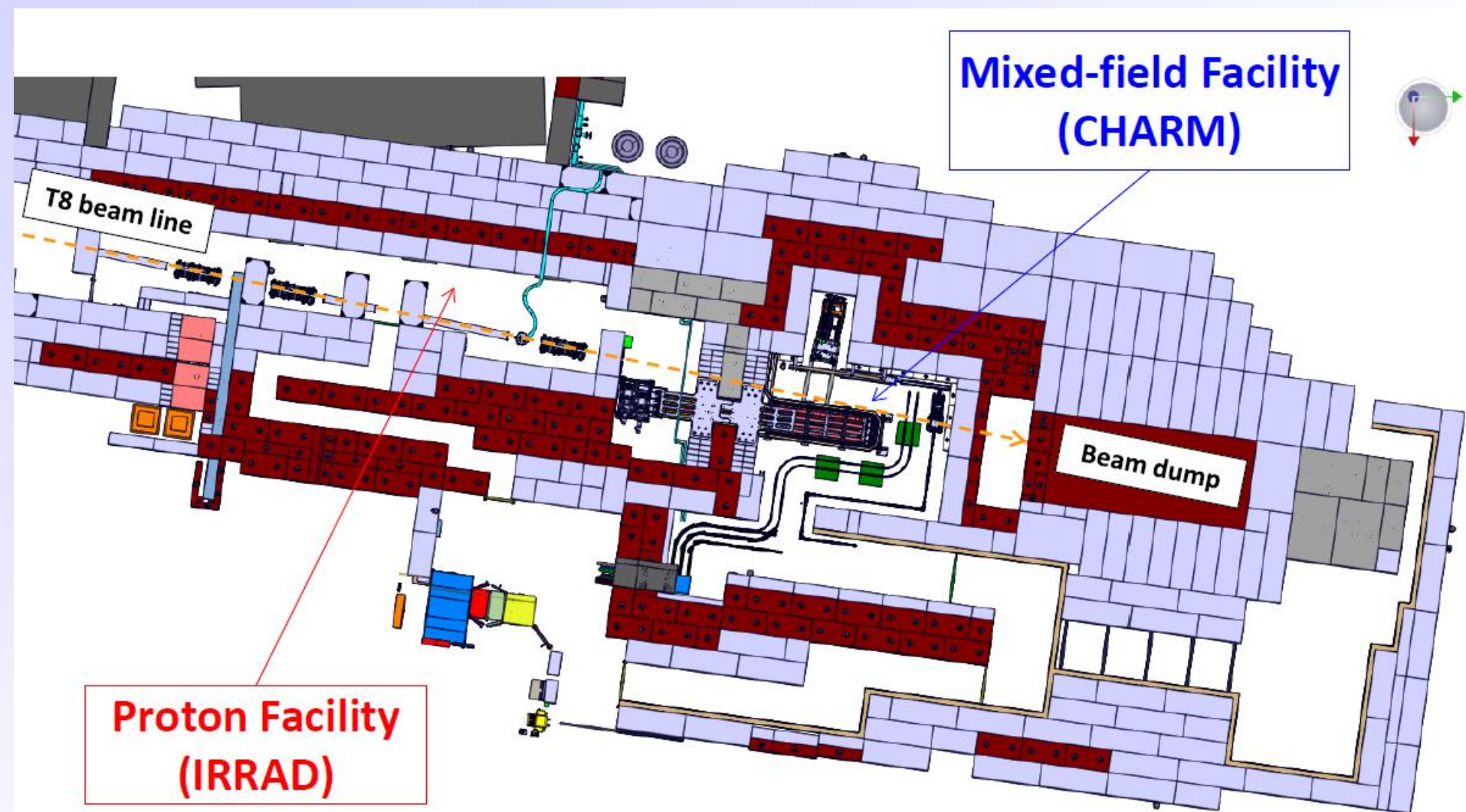
- Not operational after 2012
- **Limited access** (“ad-hoc installations”, lack of flexibility, access requires shielding removal)
- Limited control on beam intensity



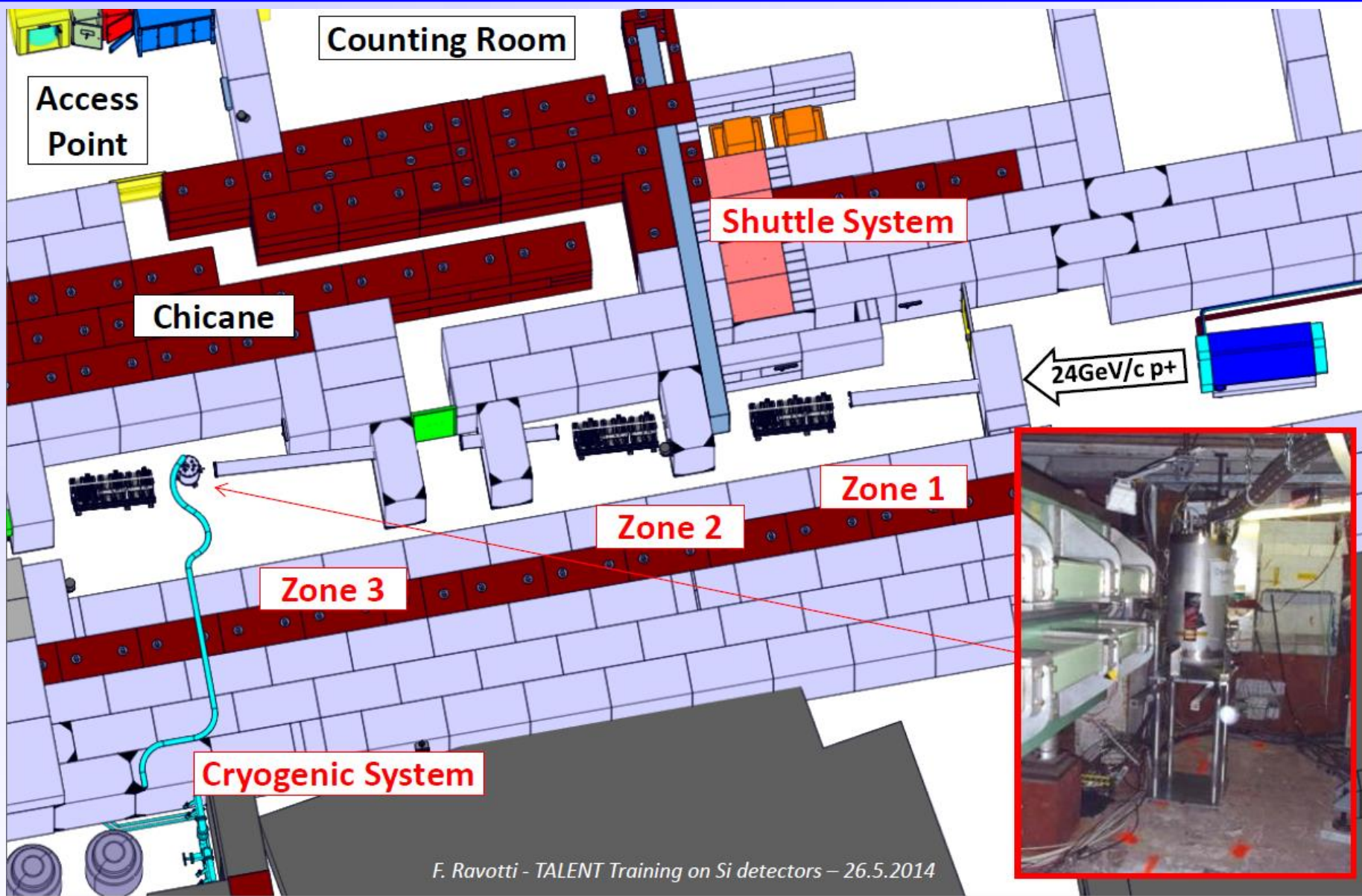
Building 157

T8 beam line

Profit of renovation of PS East Area during LS1 and end of data taking DIRAC experiment



M. Lazzaroni, D. Brethoux (EN-MEF)



F. Ravotti - TALENT Training on Si detectors - 26.5.2014

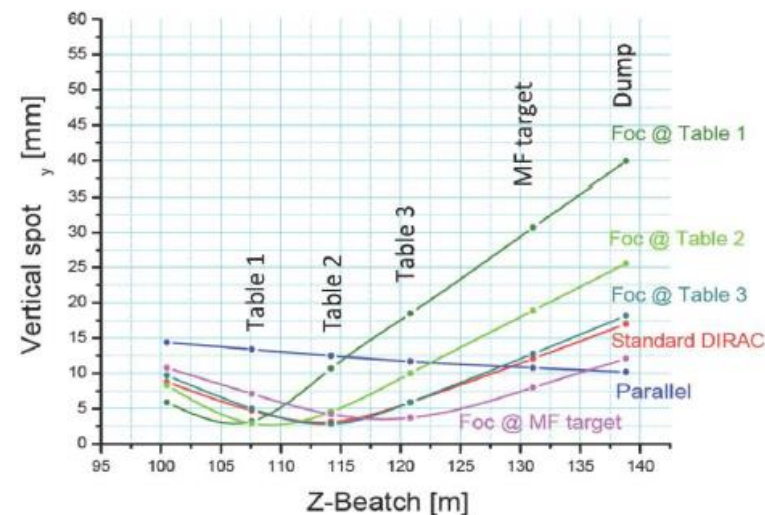
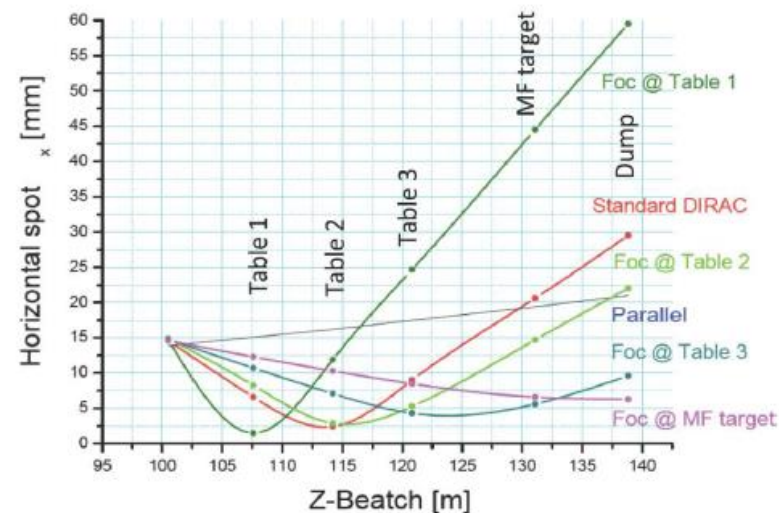


## □ Beam Dimensions

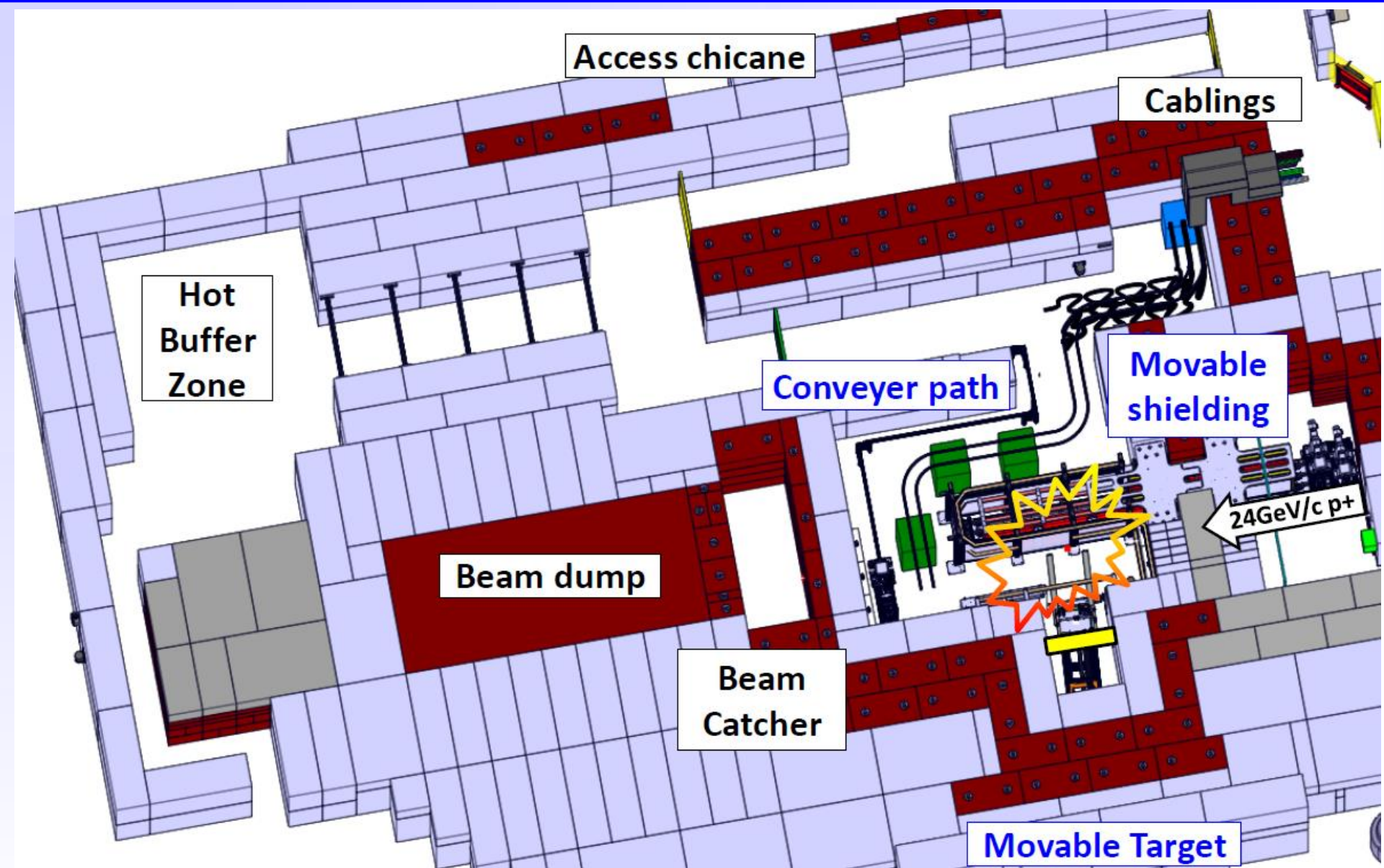
- Several optic variants possible on T8
- Standard size: **15x15 mm<sup>2</sup> (FWHM)**
- Spot size from **5x5 mm<sup>2</sup>** to **20x20 mm<sup>2</sup>**

## □ Beam Intensity

- 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>** (15x15 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)





T7b area dismantled



T7 roof open

Dismantling  
T8 beam-line

(March)

Removal of DIRAC experiment  
(April)





## ❑ Dismantling of IRRAD2 C/Fe/Pb target

Handling of the less radioactive Pb/Fe bricks with hands.



Target behind shielding wall before intervention



Handling of most radioactive Pb/Fe bricks with dedicated tool

A total of 16 pallets of Fe and Pb prepared and sent for elimination as radioactive wastes



- Intervention performed over 3 days (20-22 November 2013)
- 18 people involved (IRRAD team + 14 from Transport, HSE and RP)
- Contamination & chemical risk due to LEAD dust
- External exposure limited thanks to detailed work procedure and dose planning (ALARA Level 1)





## □ New EA-IRRAD Proton Shuttle System



View on the shuttle conduit



Proton shuttle conduit as seen inside the new irradiation area



Proton shuttle loading station

- Photos: December 2013
- Shuttle mechanics & FE controls ready
- Shuttle meanwhile installed

- **Installation ongoing**
  - IRRAD: Cabling, Tables, Spectrometer lab...
  - Several users requested already beam 😊

## Installation salles de contrôle



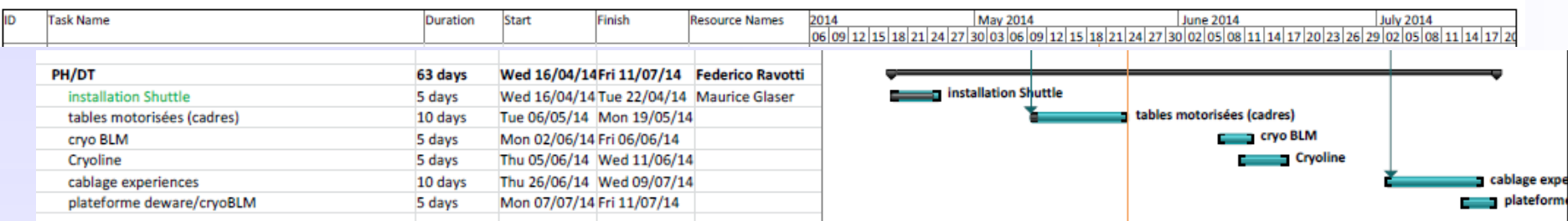
## Installation Marbre



Pictures:20.5. & 26.5.2014

- EAST AREA Proton Facility – Schedule (Status June 2014)**

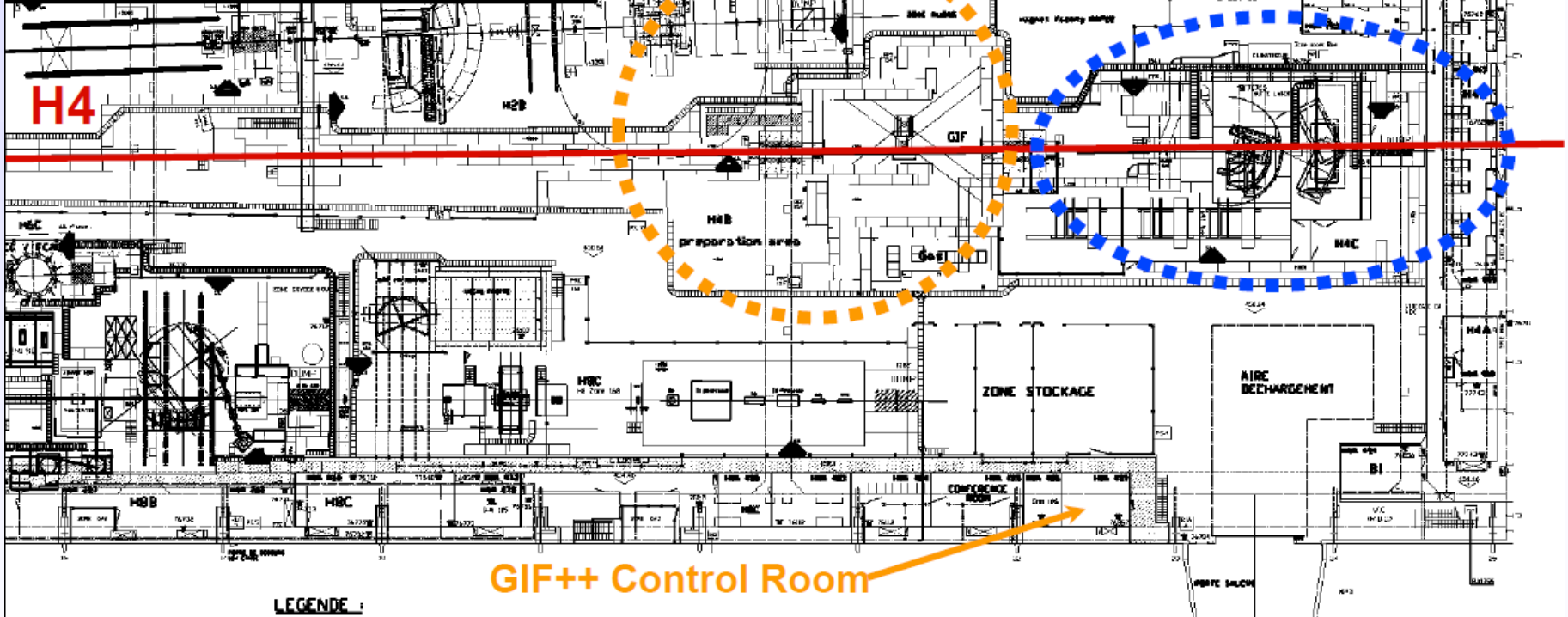
- Shuttle system is installed
- Tables are about to be installed
- Commissioning with beam will start after summer
- First users expected for end of the year  
[will be announced on irradiad & RD50 mailing list]



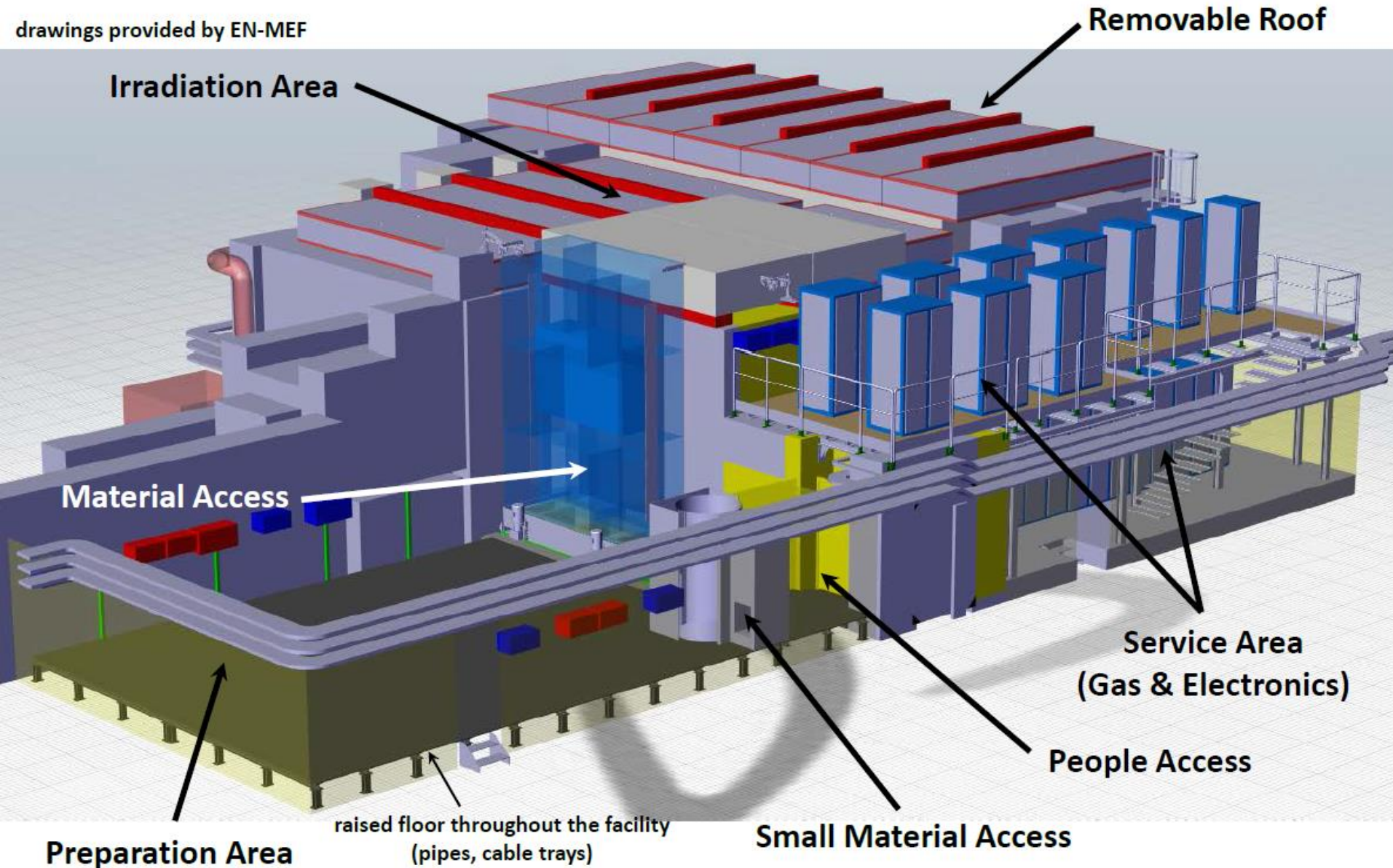
- Pion irradiation campaign at PSI: 12.5. -13.6 .2014 (191 MeV / 300 MeV/c)**

- **Common RD50, ATLAS, CMS irradiation campaign**
- Federico, Maurice, Blerina, Tilman, Michael, Esteban, Hendrik, Christian, Elena,...
- Approx: 100 samples to be irradiated
- ... needed 8 days to set up the beam correctly
- .... irradiations running smoothly until 5.June when water leak in magnet forced to stop
- max reached  $7e14\text{cm}^{-2}$

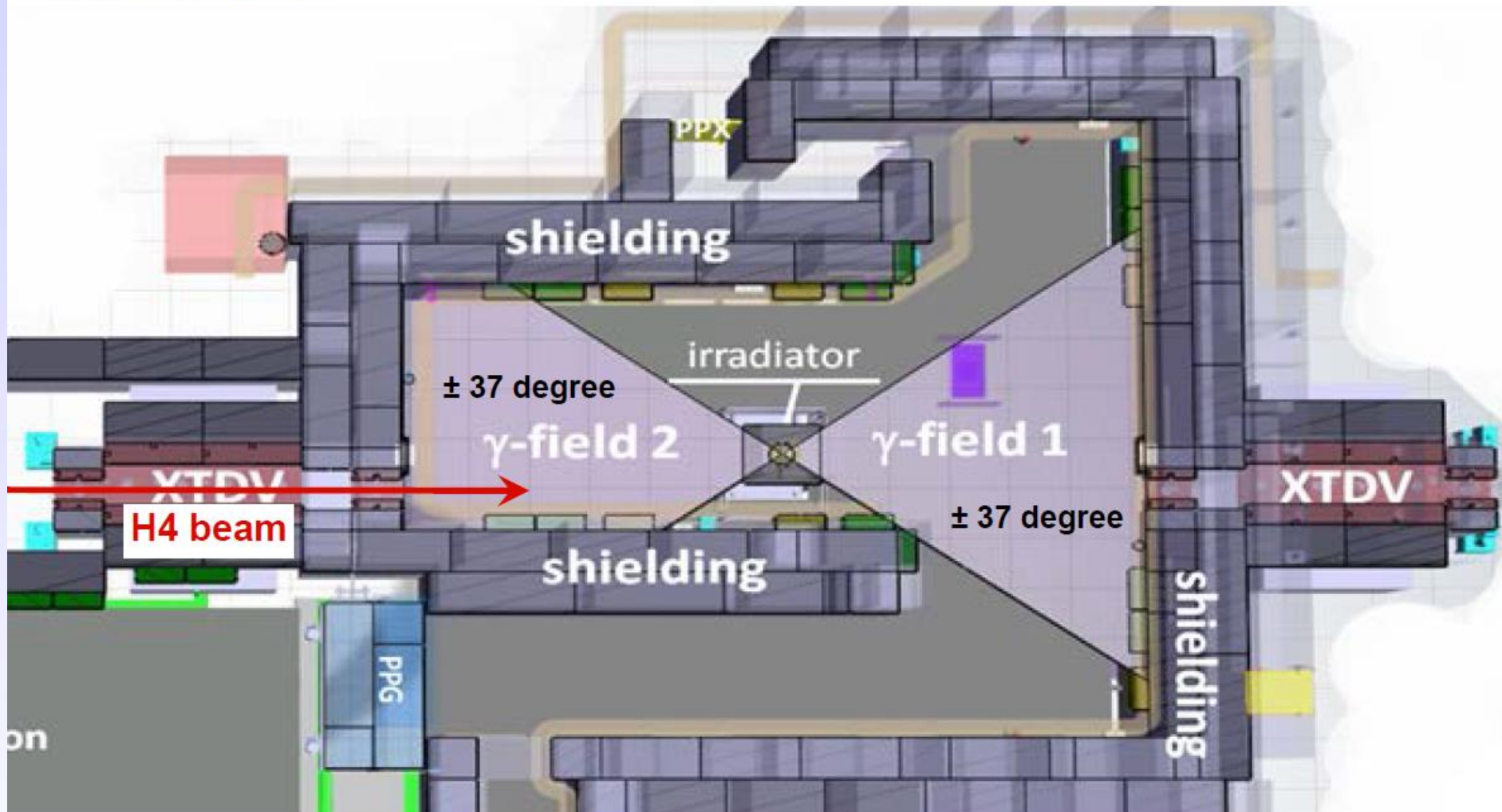
# **GIF++ Facility**



drawings provided by EN-MEF



drawings provided by EN-MEF

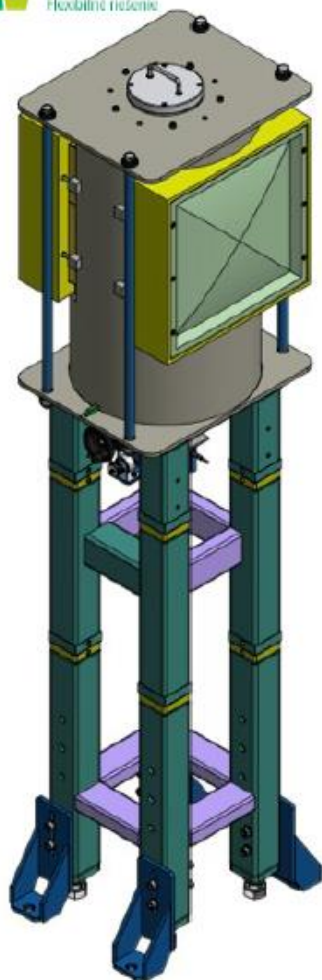


TIPP 2014

11




## GIF++ - The Source

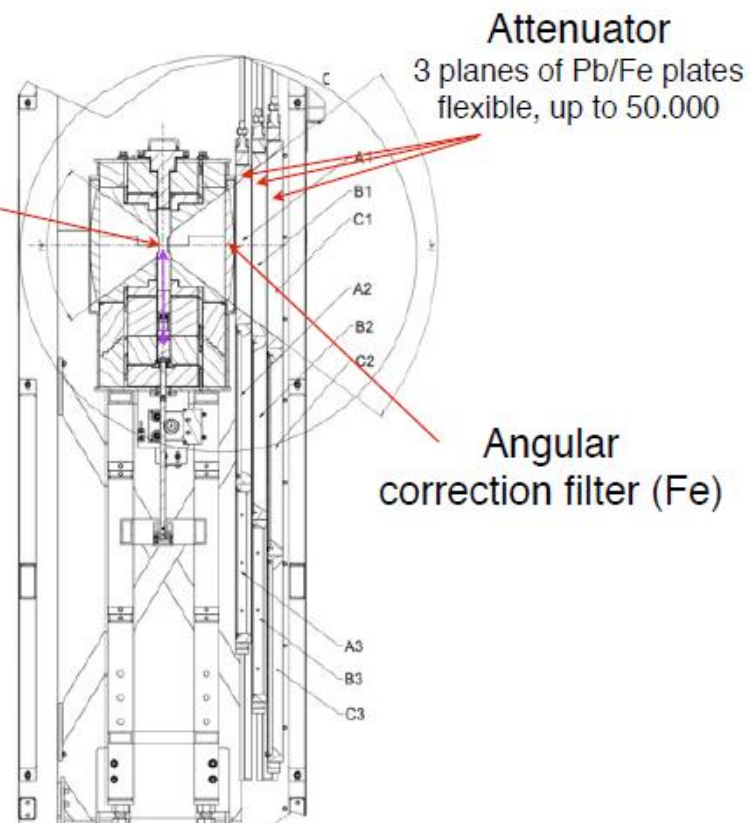


14 TBq  $\text{Cs}^{137}$

1.Nov.2011 = 14.91 TBq  
260  $\mu\text{Gy/s}$  at 1 meter

Source available in Prague  
hot-cell, certificate received.

 Source stacked with  
two cylinders of  $^{74}\text{W}$   
inside irradiator

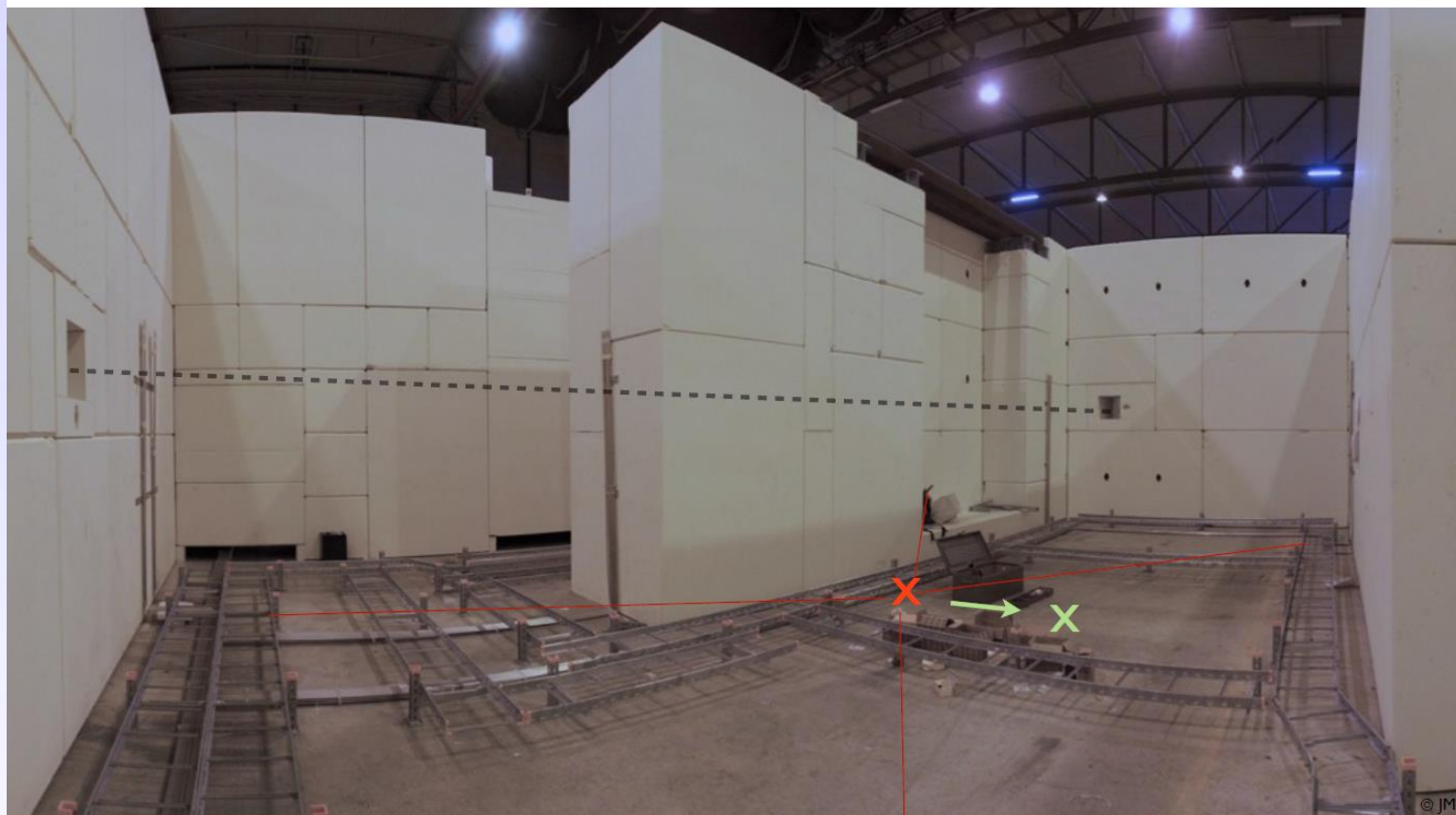


M.R. Jäkel / 5.6.2014



# Status of Construction / Inside Bunker

28.05.214



TIPP 2014

PH-DT  
Detector Technologies

## GIF++ - Schedule Highlights

- 📌 Late September : Arrival of new irradiator  
(Stop of old facility bld. 190 expected in mid-September)
- 📌 Early October : Begin of commissioning  
(Irradiator & attenuator controls, access system, safety systems, gas system...)
- 📌 29. October- 12. November : No access  
(CMS-ECAL beamtime)
- 📌 1-2. Dec. : First dedicated beam time  
(Commissioning of Trigger system, DAQ...)
- 📌 Early 2015 : User operation

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PH-DT  
Detector Technologies

## GIF++ - Gas Mixing Zone

28.05.2014



to  
preparation  
zone

Supply  
lines

to bunker zone

M.R. Jäkel / 5.6.2014

- **Summary: Two new facilities under construction at CERN – Operational in 2015**
  - **New proton and mixed field facility in the CERN EAST HALL**
    - unique in very high energy proton flux and service infrastructure
    - 24 GeV/c protons (up to about  $10^{17}$  p/cm<sup>2</sup>/week)
  - **New gamma irradiation facility with muon beam (GIF++) in North Area**
    - Unique in terms of combining a gamma source with a particle beam  
(*Gamma source too weak from RD50 point of view*)
- **Reference Material for the two facilities**
  - Seminar on CERN irradiation facilities: F.Ravotti, 24 June 2014 <http://indico.cern.ch/event/267436/>
  - GIF++ at TIPP conference: M.Jaekel, 5.6.2014, <http://indico.cern.ch/event/192695/session/7/contribution/274>
  - G.Spiezia, 2013, Radiatin Tests A&T sector <http://indico.cern.ch/event/51128/>
- **Some interesting links**
  - Radiation Facilities Working Group: <http://irradiation-facilities.web.cern.ch/irradiation-facilities/>
  - PH Irradiation Facilities: <https://irradiation.web.cern.ch/irradiation/>
  - GIF++ facility: <https://espace.cern.ch/sba-workspace/gifpp/SitePages/Home.aspx>
  - CHARM facility: <http://charm.web.cern.ch/CHARM/>
  - Irradiation facilities around the world: <http://www.cern.ch/rd50> and <http://radwg.web.cern.ch/>