

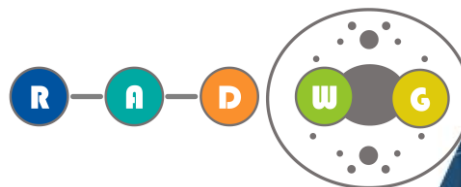


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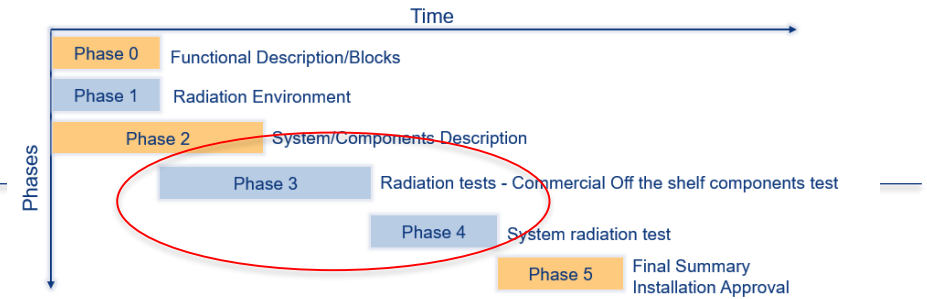
R2E Annual Meeting 2022



Controls
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RHA Process



- We have the RHA guidelines
- Phase 3 and Phase 4 depends on the availability of **suitable** and **relevant** radiation test **facilities**
- Suitable for :
 - Component testing (Phase 3)
 - System level testing (Phase 4)
- Relevant
 - Adapted to test up to the expected radiation design margins (RHA)
 - Meaningful results for the expected radiation environment

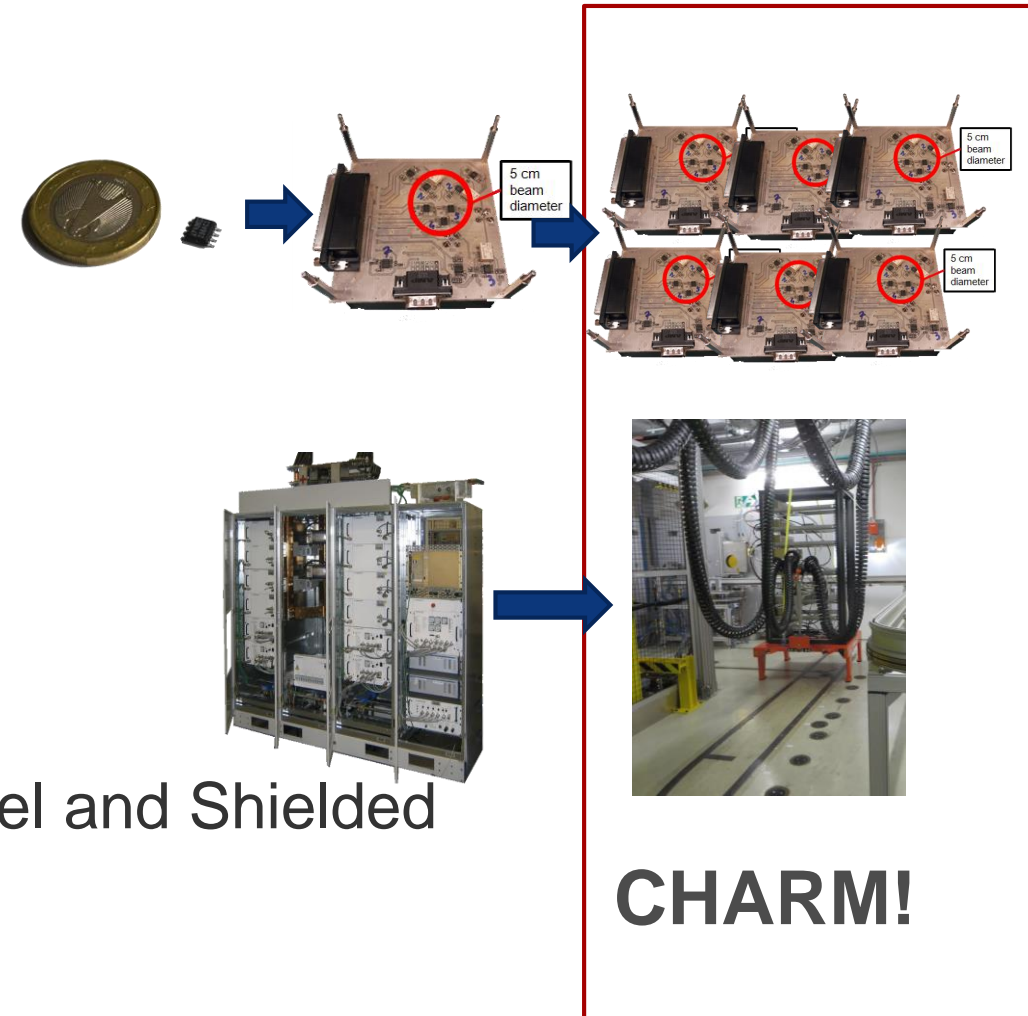
Use of CHARM

- It is necessary to test:

- Full electronic systems
- Large volumes electronic equipment
- High number of single components
- In representative radiation fields

- CHARM offers:

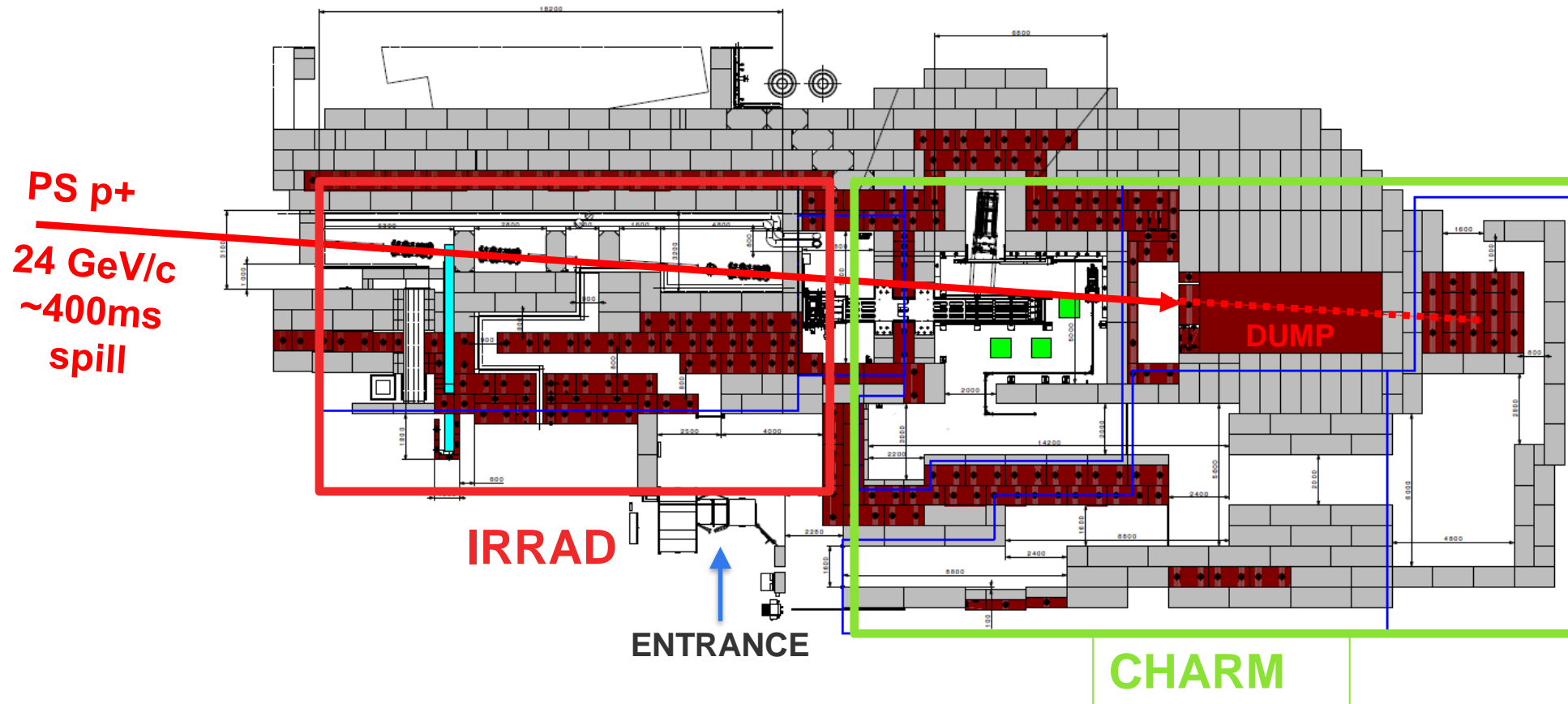
- Large dimension of the irradiation room
- Mixed-Particle-Energy radiation fields : Tunnel and Shielded areas



East Area Irradiation Facility

Primary beam line from PS (T08): 24 GeV/c proton beam

CHARM irradiation area is placed downstream to **IRRAD** on the T8 line



Irradiation Room

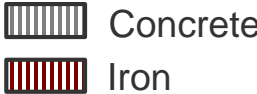
PRIMARY PROTONS IMPINGE THE TARGET: A SECONDARY RADIATION FIELD IS CREATED

3 KEY ELEMENTS:

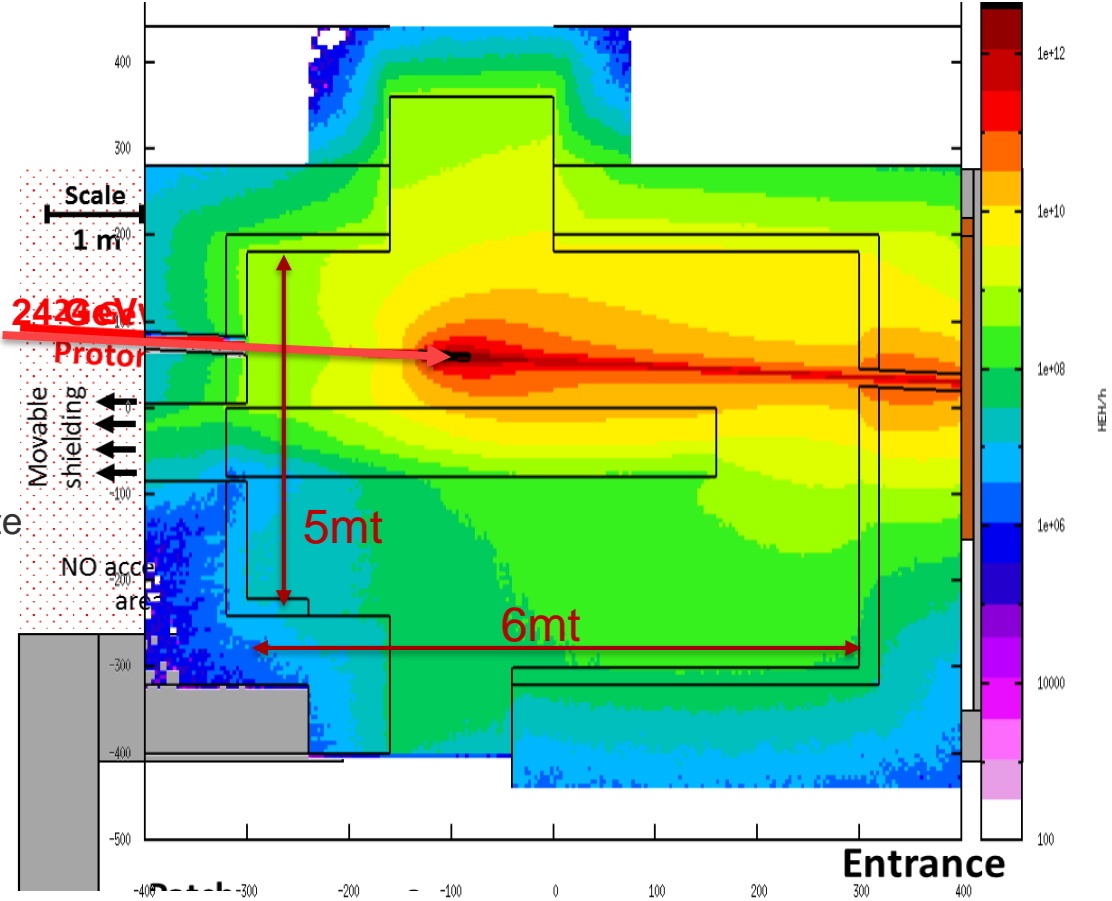
1. Target



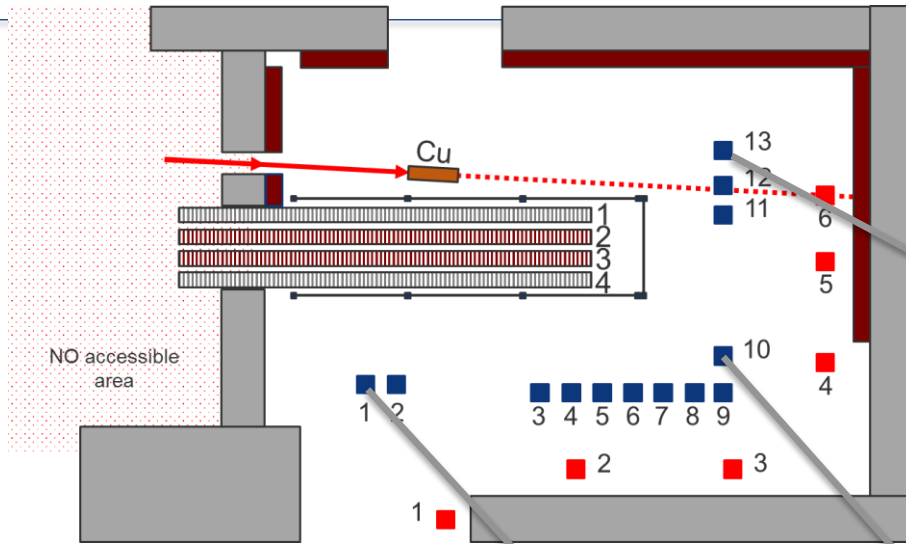
2. Movable Shielding



3. Positions

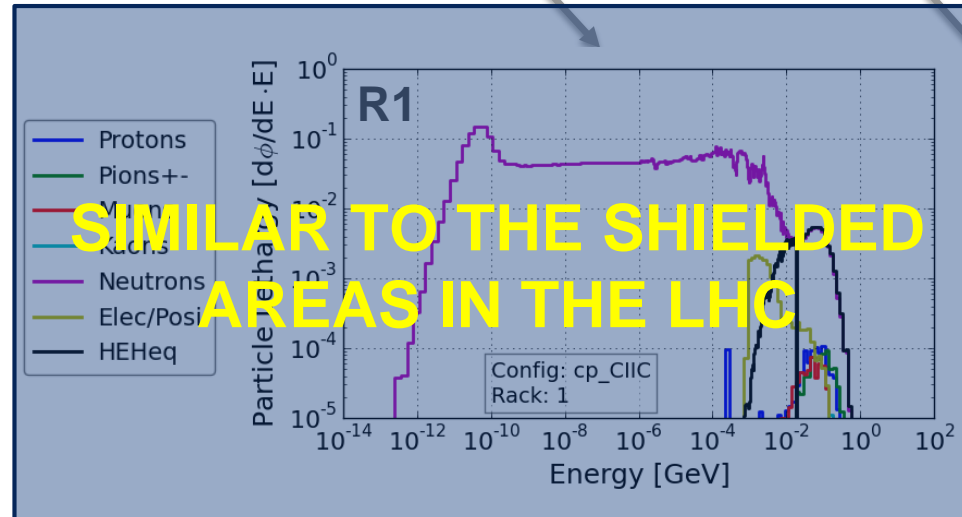
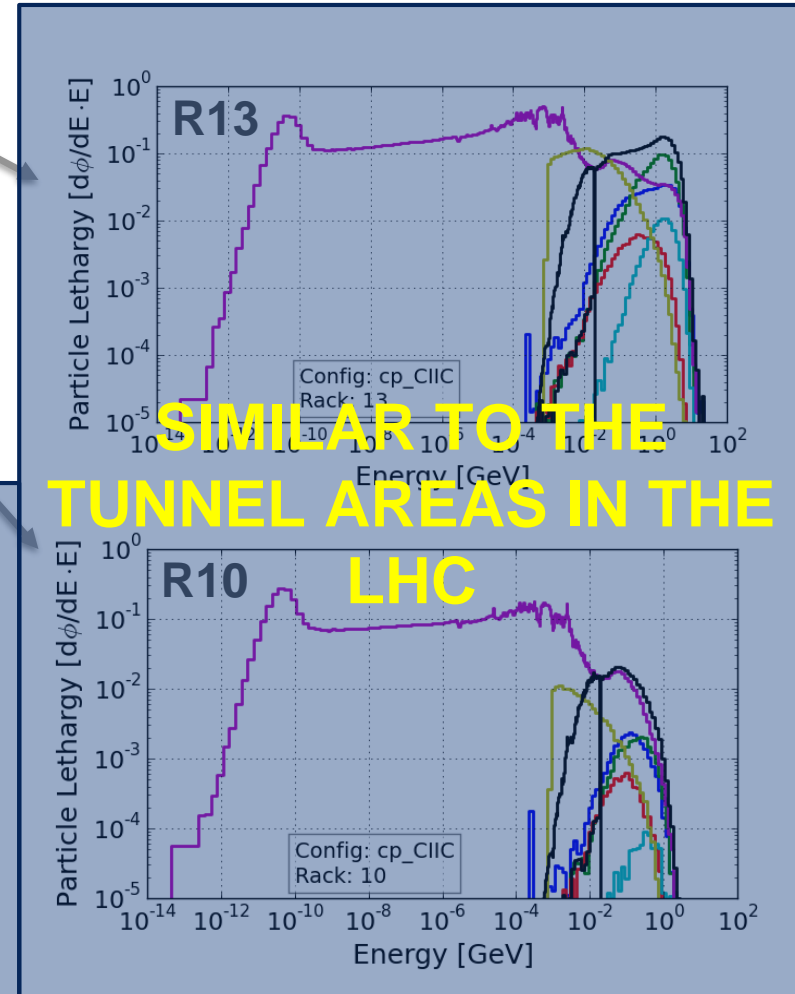


Spectra vs position



CHARM configuration: Cu CIIC

Data from FLUKA simulations



CHARM Virtual Tours



Cern High Energy Accelerator Mixed-field



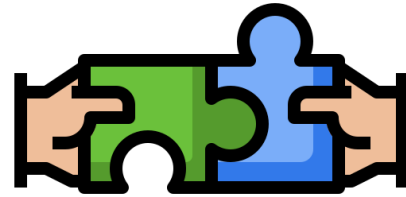
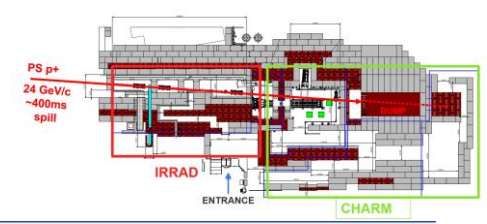
Radiation test Facilities : Services



Planning and Coordination of CHARM facility

- Is a tasks that takes in consideration:
 - The user requests
 - The user cabling needs
 - The user system size
 - Understanding the user aim and objectives in terms of radiation testing
 - Knowledge of the radiation field and parameter of the facility
 - Coordination with IRRAD facility

CHARM/IRRAD Operation

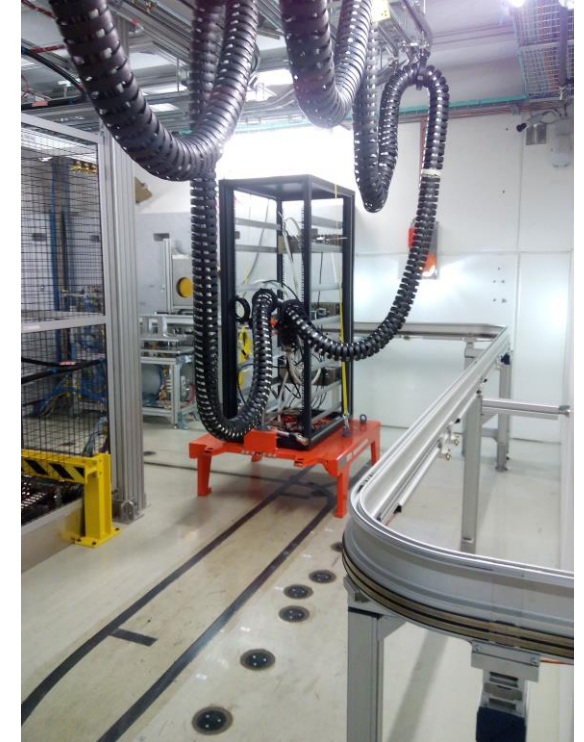
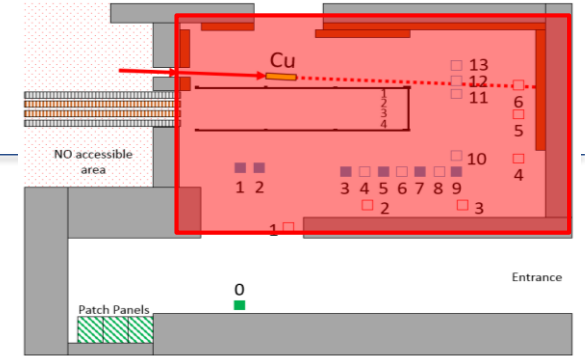


- Accesses are planned on both facility to reduce the overhead of the personnel and minimize the radiation doses
- Weekly Planning take into account special requests of users in both areas
- Users are redirected to the proper facility according to their requirements
- Contacts with OP and RP are carried out in a coordinated way using dedicated e-group
- Joint weekly report to the PS/SPS coordinator
- Joint follow-up of all the upgrades concerning the irradiation areas and the associated beam line



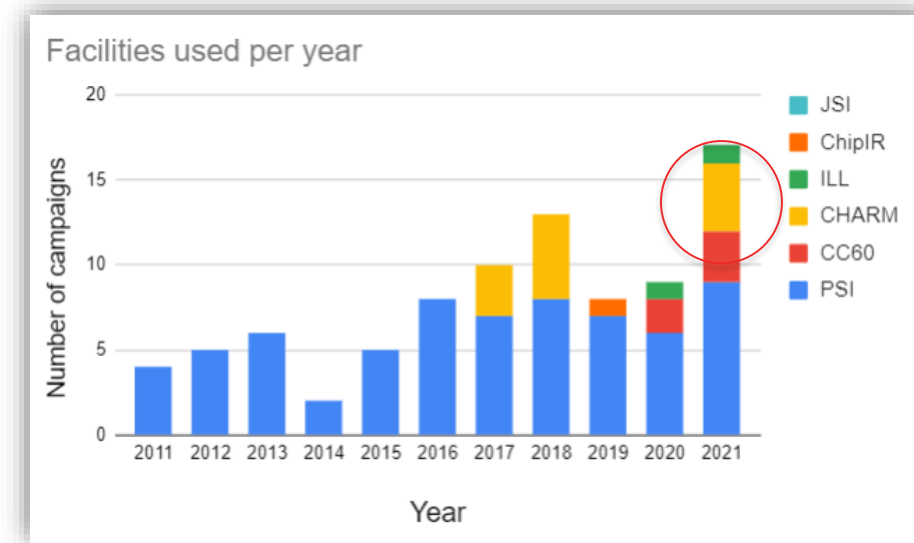
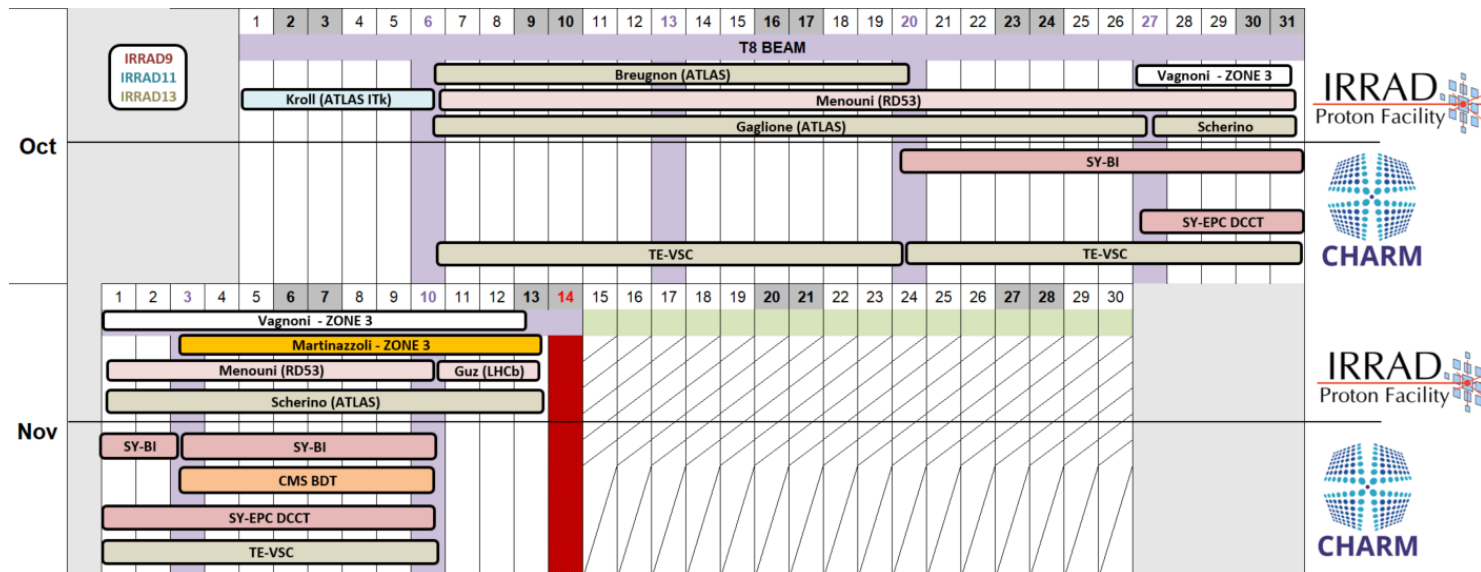
CHARM Operation

- The access is every Wednesday
- A run/slot lasts **one week**
- The rack can fit **several users**
- It is brought inside by a **robotic conveyer**
- It automatically leaves the rack in position
- It reduces the **time of exposure** of the working people in the activated area
- The users have to demonstrate that the test work one week before the access (dry run)
- The user has only one-shot (Wednesday) to make the installation of his test
- The chain and the rack are provided by us in advance



2021 Planning

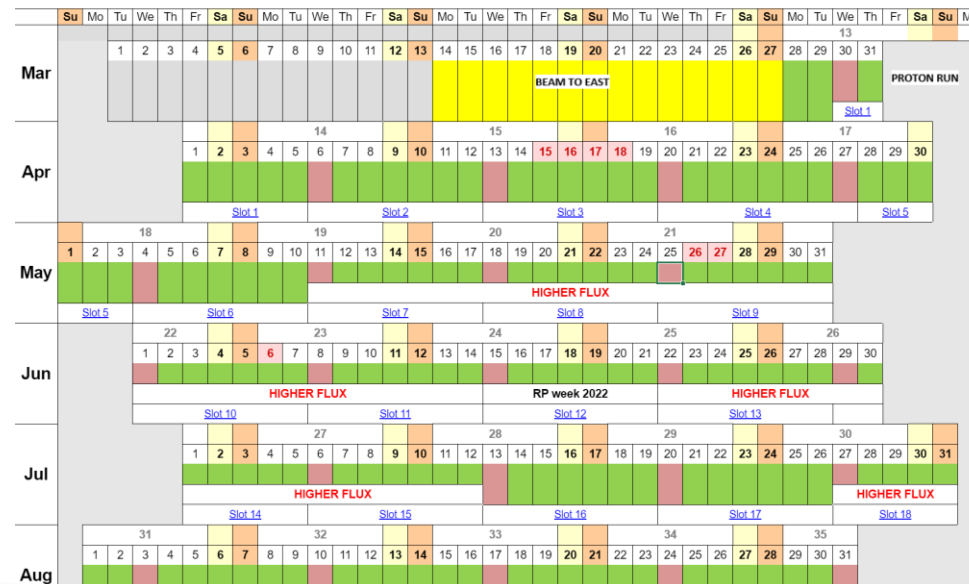
- **6 weeks** of operations
- **2 days** of commissioning
- 6 users scheduled; **15 system level tests**
- ATS (TE-VSC, SY-EPC, SY-BI, SY-BMI, BE-CEM)
- RCS (CMS)
- External Users from space company SkyLab
- Several components testing by BE-CEM-EPR
- Three days given for the ions beam preparation for CHIMERA projects



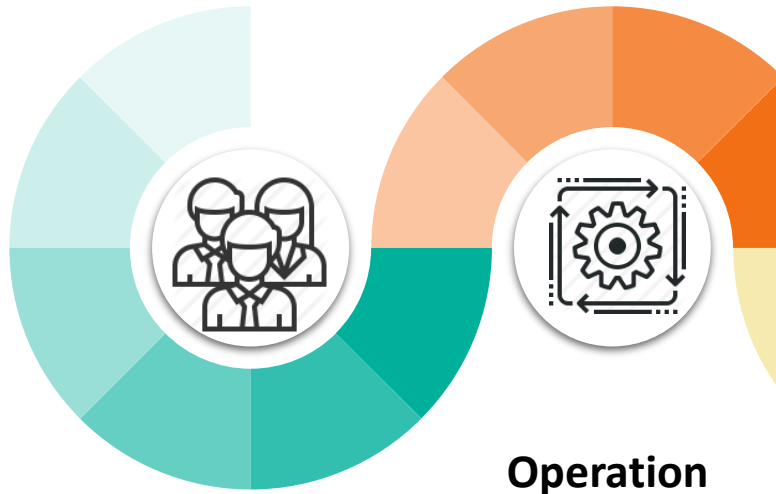
2022 Planning

- **35 weeks** of operations
- 1 week of commissioning to face the very different radiation requests
- **33 Requests** already received
- 8 users : 13 system level tests **already scheduled** in 9 weeks
- Thanks to the PS User coordination we can have more spills during some slots

2022 Calendar



Radiation test Facilities : Services



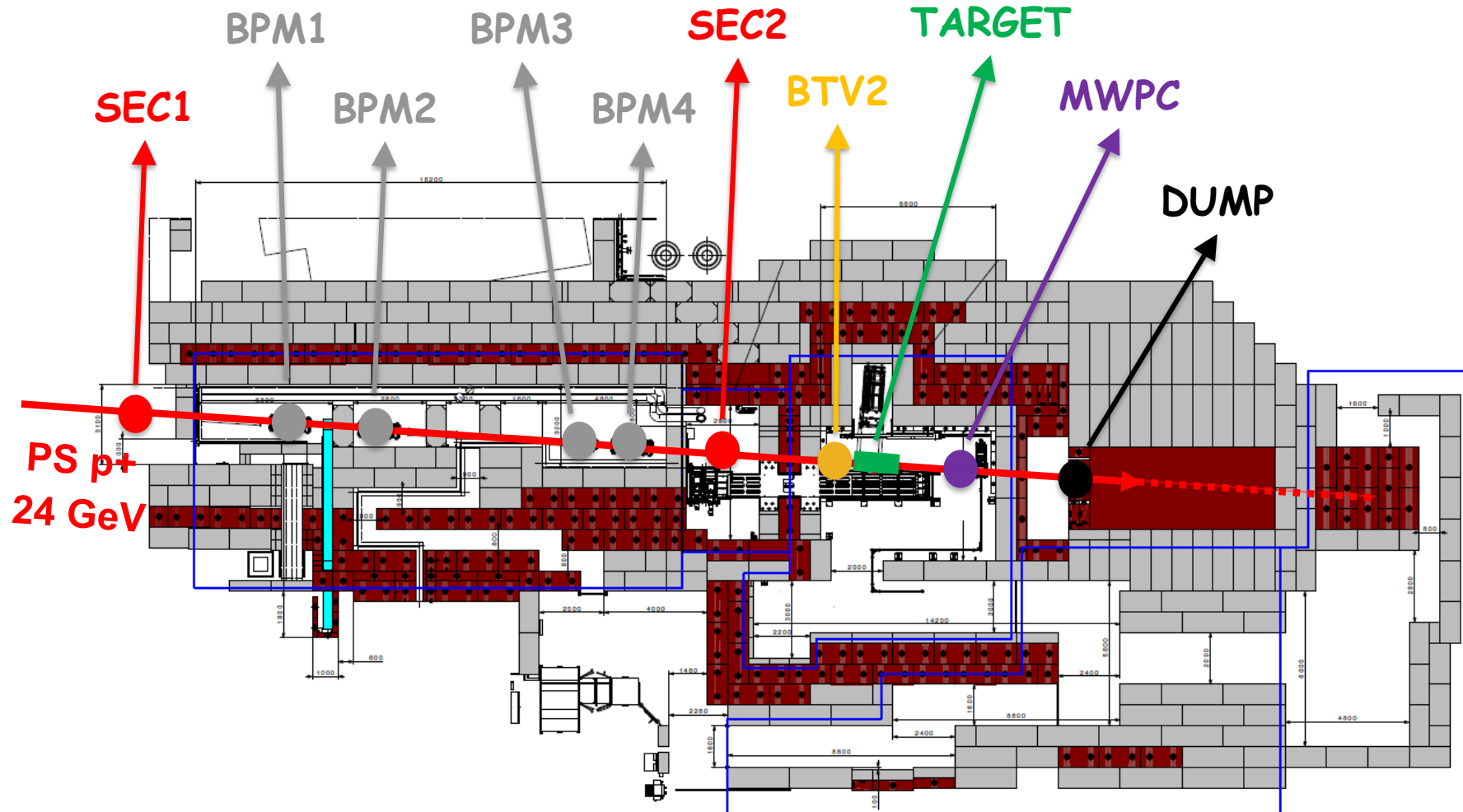
Coordination

The user requests are collected and processed reserving the most suitable slots in the facilities. Multiple requests are accommodated in the same slot to be more effective

Operation

The facility operation includes the preparation the installation and the removal of the setup. Big part of the operation is also the beam steering, verification and follow-up.

Detectors at CHARM



Scaling/Calibration factors

- The intensity of the radiation field in CHARM is proportional to the Protons on Target (POT)
- Dose and HEH Fluence are directly proportional to the cumulated POT

$$Dose(p, c) = POT \cdot K_{dose}(p, c)$$

$$Fluence_{HEH}(p, c) = POT \cdot K_{HEH}(p, c)$$

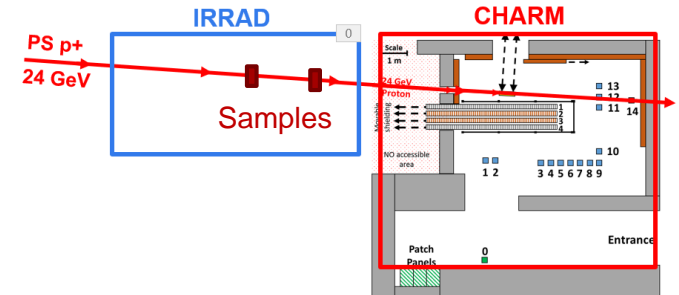
$$\frac{Dose(p, c)}{POT} = K_{dose}(p, c) \text{ [Gy/POT]}$$

$$\frac{Fluence_{HEH}(p, c)}{POT} = K_{HEH}(p, c) \text{ [cm}^{-2}\text{/POT]}$$

- During the calibration we measure the Dose and the Fluence
- We measure the POT from the SEC1
- Each position 'p' and configuration 'c' can be calibrated with two factors K_{dose} and K_{HEH}
- More than 150 configurations calibrated up to now
- Continuous benchmarking with FLUKA simulation thanks to BE-STI Team
- Using calibration factors measured in the initial calibration is not enough

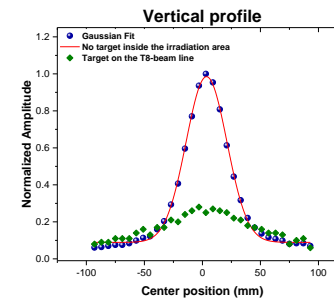
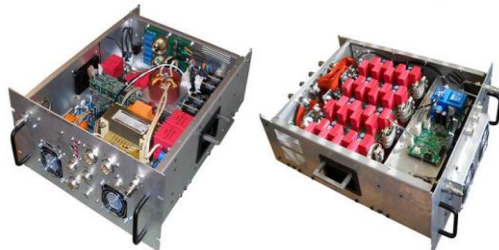
Challenges in CHARM dosimetry

- Insertion of heavy samples upstream
- Beam position
- Self shielding effect
- Solution: online monitoring of the radiation levels at the equipment location



	Percentage difference RadMon
No Sample Run	-
1.5 cm copper	-8%
3 cm copper	-19%
6 cm copper	-37%

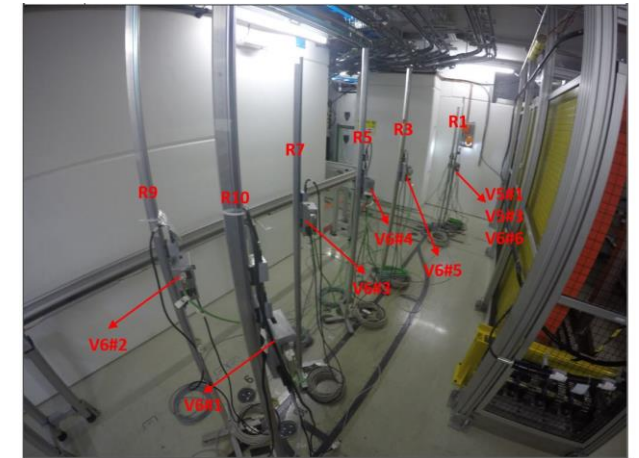
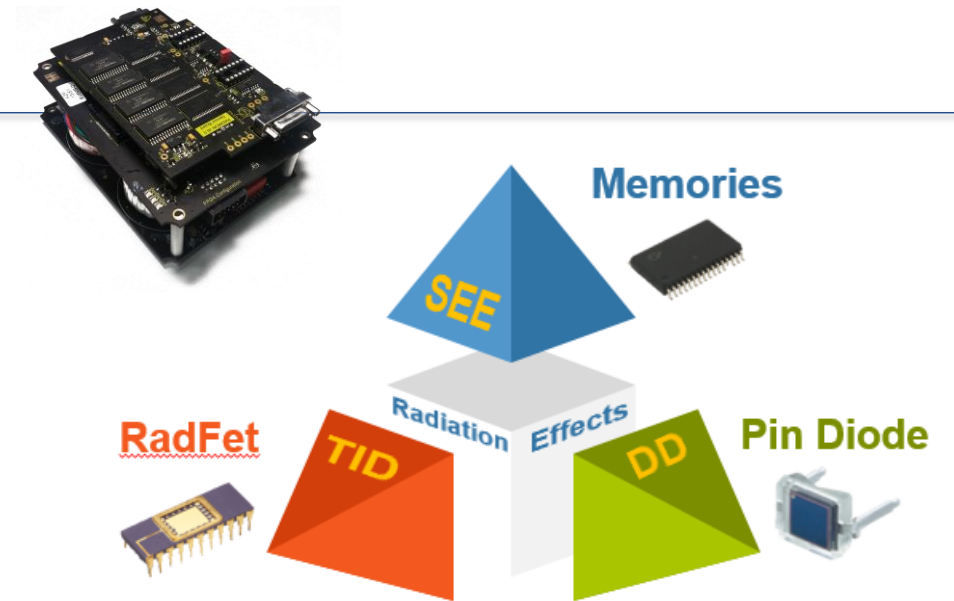
Test Location R10	
Side B vs Side A	
Diff. DOSE	-34%



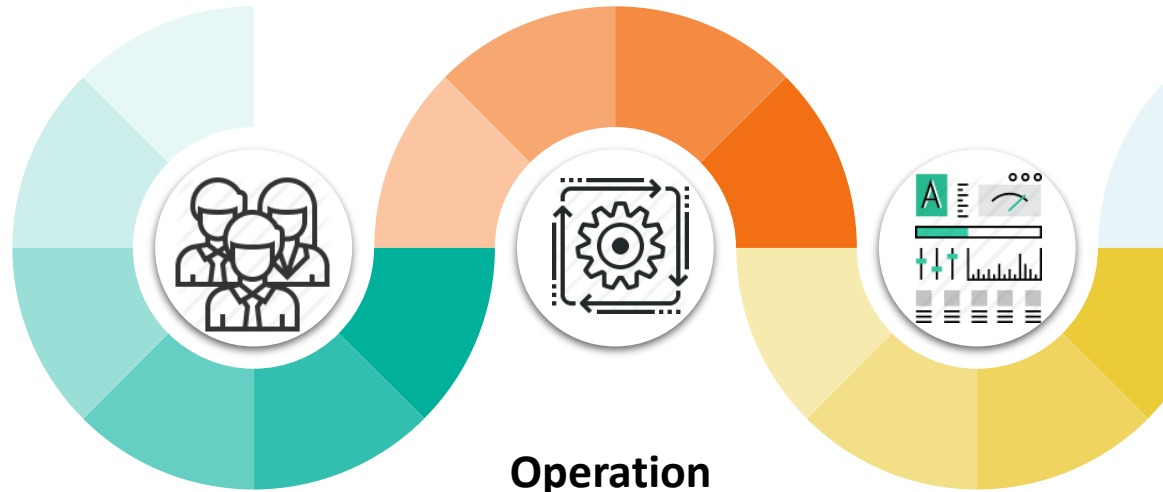
Test Location R13	
Horizontal axis (mm)	Diff (%)
48.7	59%
23	27%
center	-
-33.5	-43%

Online radiation monitoring

- **RadMon system**
- All the users have dedicated measurements close to their equipment
- Every user provided with dedicated dosimetry assessment
 - User dosimetry document (UDD)
 - <https://edms.cern.ch/ui/#!master/navigator/project?P:1640664133:1640664133:subDocs>



Radiation test Facilities : Services



Coordination

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Operation

The facility operation includes the preparation the installation and the removal of the setup. Big part of the operation is also the beam steering, verification and follow-up.

Dosimetry

Continuous monitoring is essential to provide the users with reliable measurements. The users receive the dosimetry document for their tests

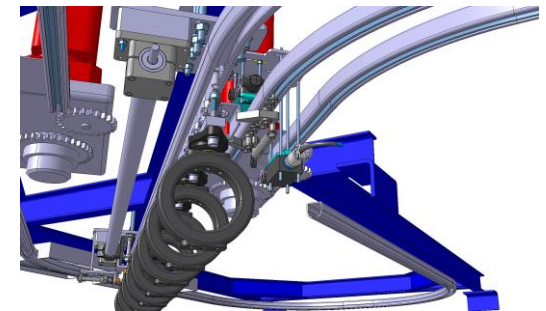
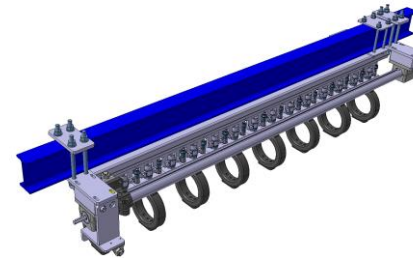
Upgrade



- Extension of the CHARM control room
- Optical fibers in the overhead conveyer
- Movable Diamond detector BLM for in-spill dosimetry (with SY-BI)
- New Beam instrumentation in the T8 (with IRRAD, BE-EA and BE-BI)
- Telescopic feet and controls for new T8 instrumentation (with CEM-MRO)
- AGV conveyer maintenance
- New Website: charm.web.cern.ch

- On going: Automatic cable chain insertion system collaboration with BE-EA

- Every year the facility improves with the feedbacks from operation



Conclusions

- CHARM is a complex irradiation facility built in the East Area at CERN
- Several configurations of the facility permits to emulate different type of radiation fields
- Services provided by the CEM-EPR through R2E resources:
 - Users coordination
 - Operation
 - Dosimetry
 - Upgrades
- High users demand implies high coordination and operational efforts
- The facility dosimetry is very challenging and the RadMon system is the main tool that allows us a real-time measurements.
- CHARM is in continuous upgrade to face the increasing number of user and requests that book the facility for long periods of time
 - Restart week 13 for **35 weeks operation** and already **33 requests received**

Thank you for
your attention!



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Mechatronics**