The CERN Gamma Irradiation Facility
GIF++

http://gif-irrad.web.cern.ch/

M.R. Jäkel

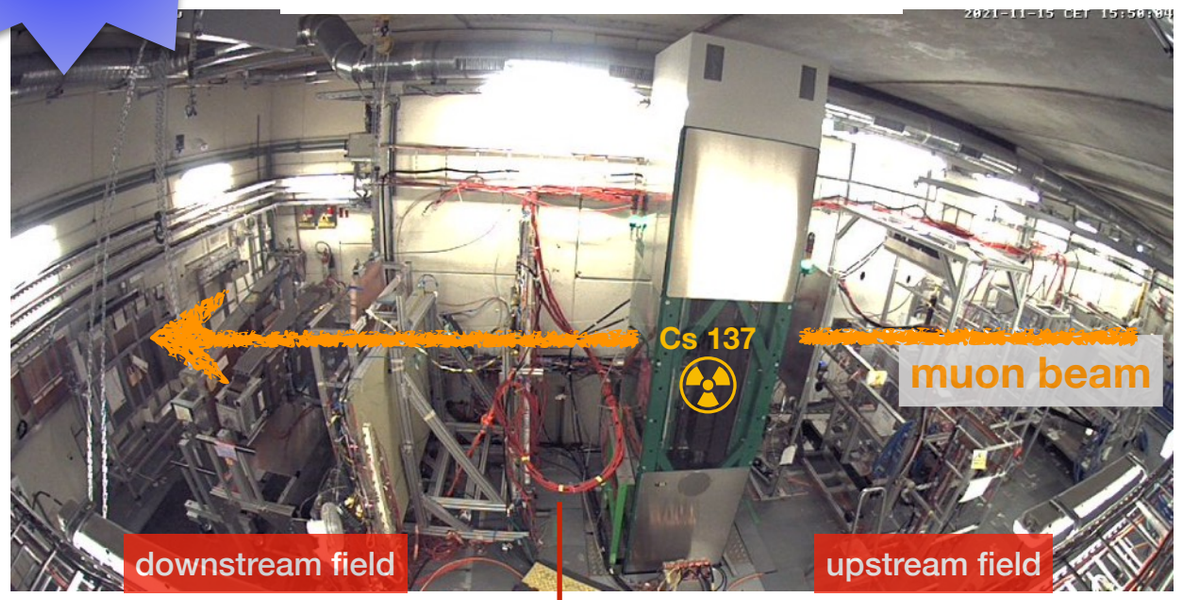
1st DRD1 Collaboration Meeting
01.02.2024

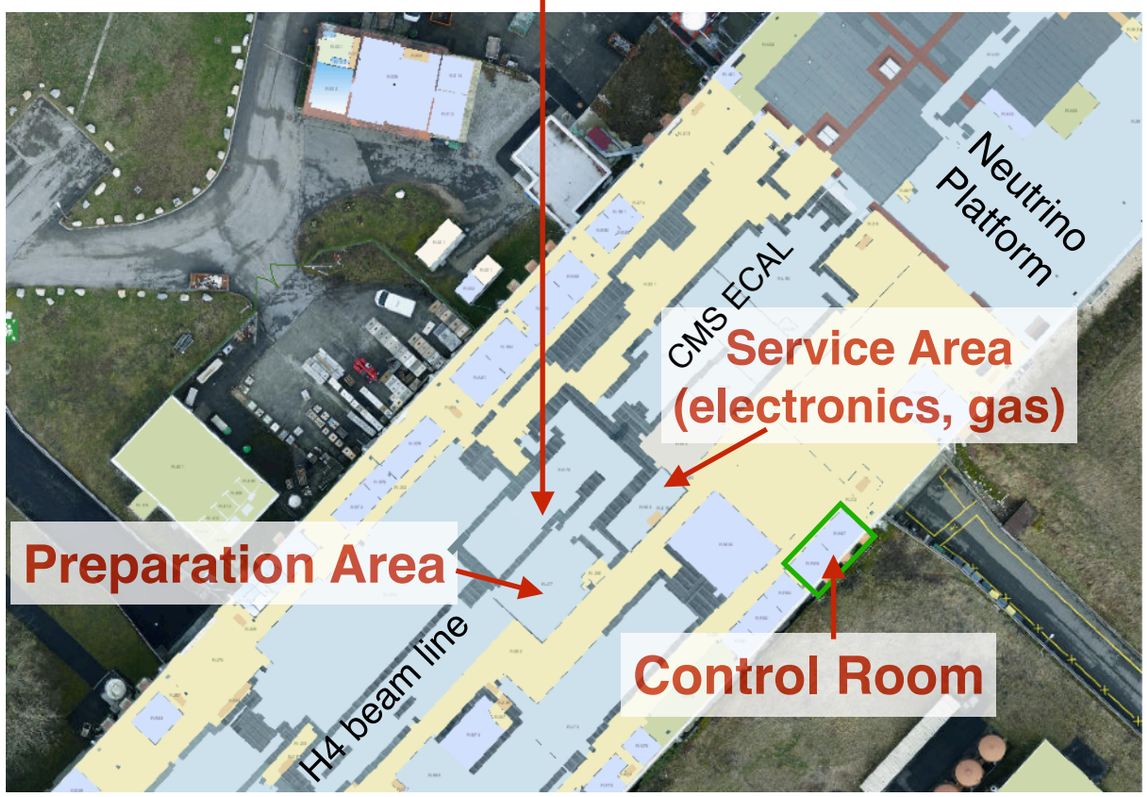
EP-DT
Detector Technologies

GIF++ @ EHN1

Irradiator operation throughout the whole year

Irradiation Bunker





Introduction :

- Unique place, combining a high energy muon beam with a 11.4 TBq* ^{137}Cs gamma source
- Joint EP & BE facility, operated by EP-DT
- Designed for testing real size detectors
- ≈100 m² irradiation fields, 2 irradiation zones with independent attenuation systems
- Central Control System, wide range of available gases (+ custom gases), common DCS…

*) 14TBq as of 2014

Current R&D Program :

- Detector validation tests in presence of high radiation background & muon beam
- Ageing studies under HL-LHC radiation conditions
- Search for eco-friendly gas mixtures
- Mass-production test of muon chambers
- Radiation tests of electronics and optical components

New

GIF++ EP TEAM 2024

GIF Physics Coordinator

- Day-to-day Coordination
- Experiment approval
- Allocation of space and time for setups, beam time coordination….

- Overall facility responsibility
- Future development of the GIF++ facility

GIF User Coordinator

- GIF++ & IRRAD: users supervisor, contact to EN services
- General user support
- Gas system first level support,
- Deputy EXSO

EXSO

- EP-DT Facilities Team Responsible, IRRAD Facility Coordinator
- Irradiation Facilities EXSO

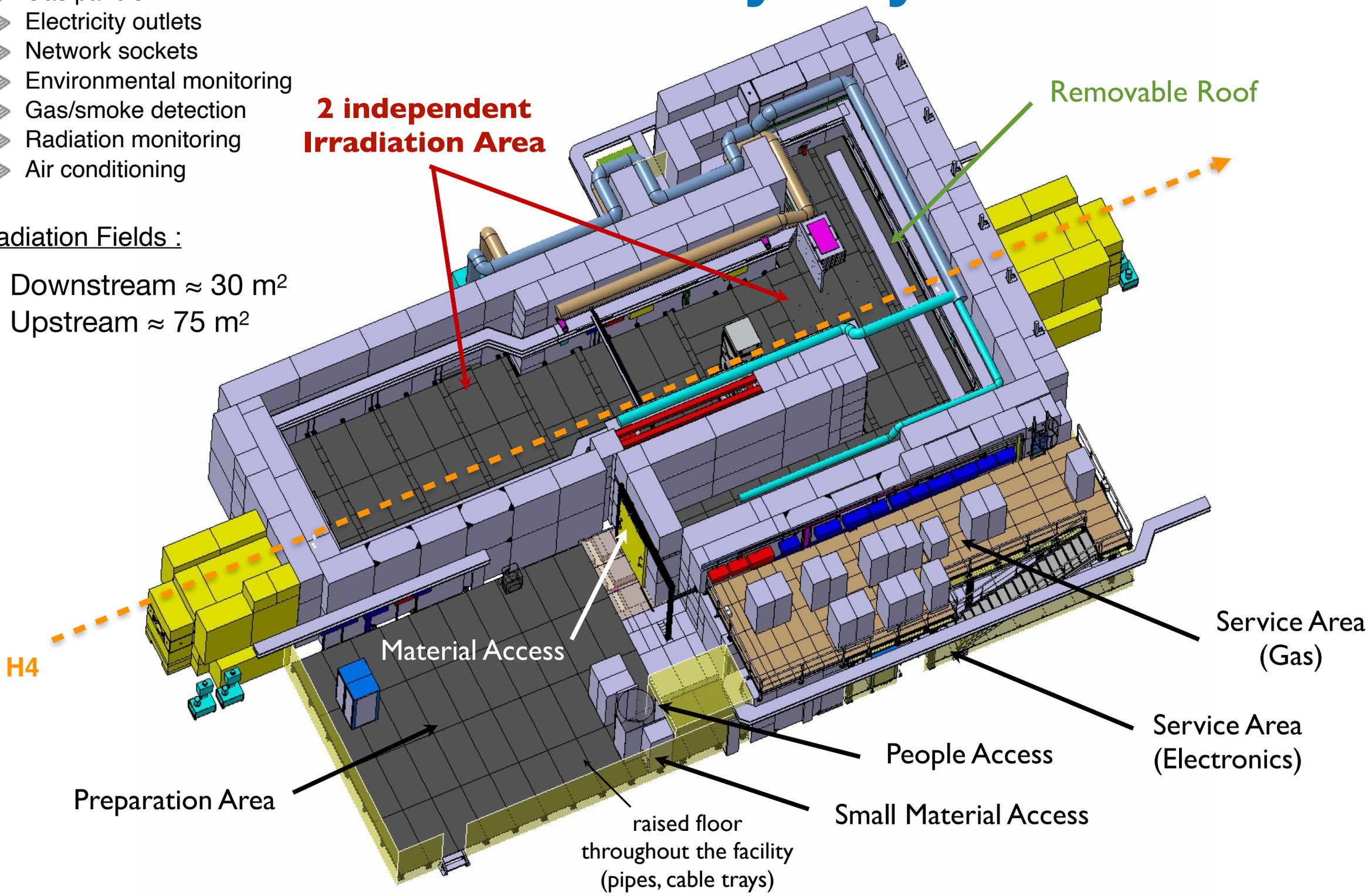
GIF++ Facility Layout

Bunker area contains :

- Gas panels
- Electricity outlets
- Network sockets
- Environmental monitoring
- Gas/smoke detection
- Radiation monitoring
- Air conditioning

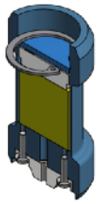
Irradiation Fields :

- Downstream ≈ 30 m²
- Upstream ≈ 75 m²

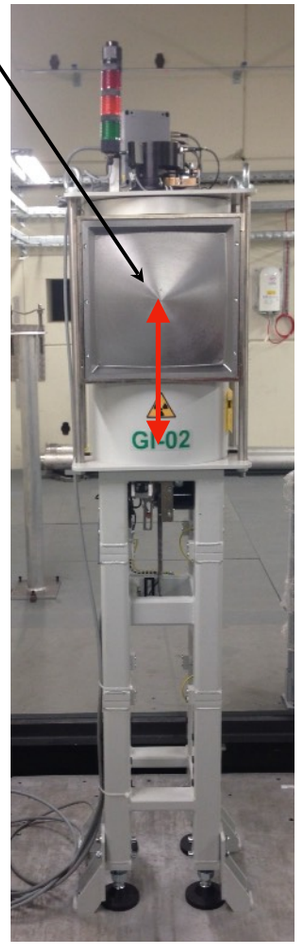


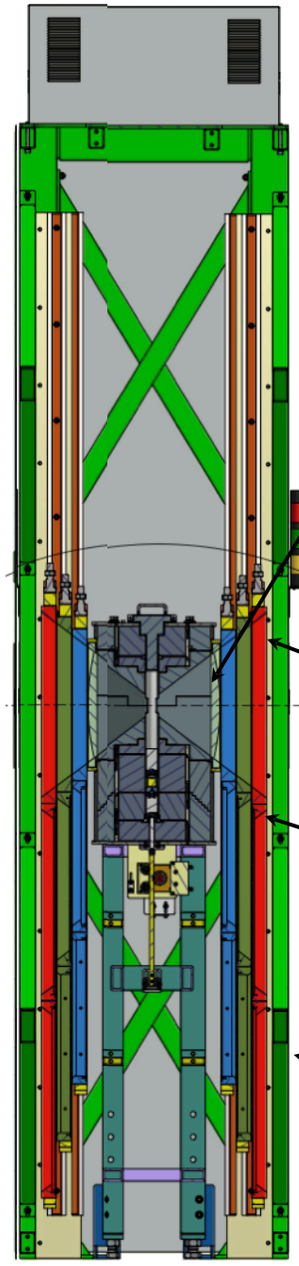
GIF++ Irradiator & Attenuation Filters

One ^{137}Cs source, two identical attenuation systems, each consisting of one angular correction filter (Fe) and 6 absorption filters - a total of 14 custom shaped filters



14 TBq
^{137}Cs
(as of 2014)
≈ 11.5 TBq now





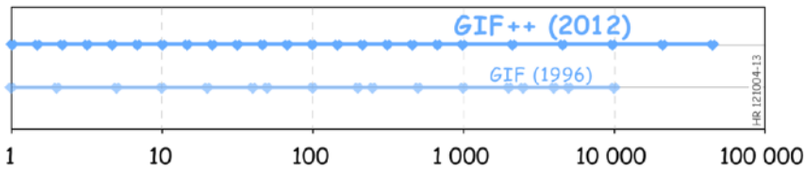
Angular correction filter provides uniform photon distribution for large area detectors

Filter System :

Absorption factor		
0	0	0
10	1.47	2.15
100	100	4.64

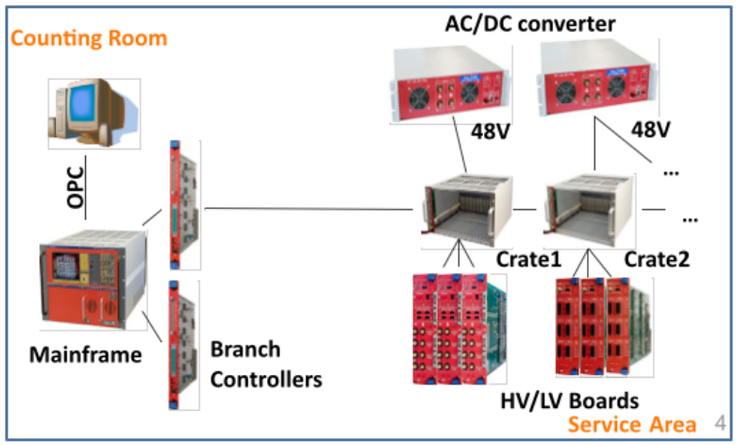
24 possible attenuation factors :

1	21.54	464.2
1.47	31.62	681.3
2.15	46.42	1000
3.16	68.12	2154
4.64	100	4642
6.81	146.8	10000
10	215.4	21544
14.68	316.2	46415



(calculated values for un-scattered gammas)

GIF++ Infrastructure & Safety



Mixture distribution

Monitoring of pressure, O2/H2O, temperature, atmospheric pressure

Additional software controlled pressure regulation for very low flow regimes

Gas mixing unit

Access / Safety / Procedures

GIF ++

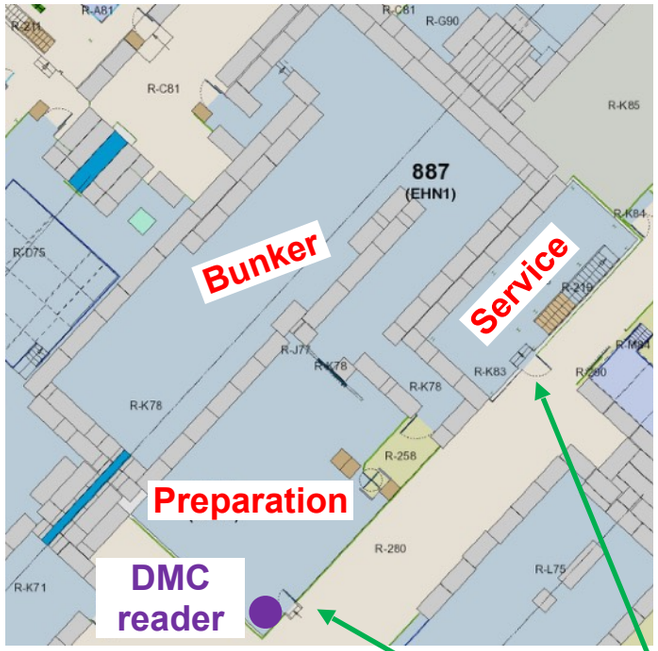
Go back to main frame

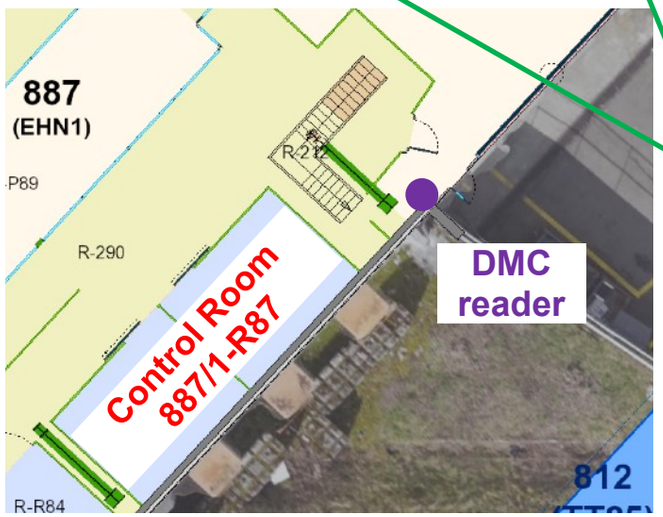
Access Requirements for GIF Areas :

Zone	Access Rights & PPE	
EHN1	• CERN Card • Personal Dosimeter • Personal Protection Equipment	
GIF Control Room	• CERN Card • Personal Dosimeter + "Control Room HNA-487 (0887-1-R87)"	
GIF Service and Preperation Areas	• CERN Card • Personal Dosimeter • Personal Protection Equipment	
GIF Irradiation Bunker	• CERN Card • Personal Dosimeter • Personal Protection Equipment • Activated (!) Operational Dosimeter + ADMAS rights : "GIF++ Zone Turnstile (EHN1-GIF)" + Training Rank : "10800 : CERN - Beam Facilities" +Training Rank : "10350 Radiation Protection - Supervised Area" + Valid IMPACT request	

The dosimeter service (building 55) will hand out personal- and operational dosimeters to you.

Access Requirements & Safety





2 DMC reader stations next to the GIF++ area!

www.cern.ch/gif-irrad

Zone	Access Rights & PPE	
EHN1	• CERN Card • Personal Dosimeter • Personal Protection Equipment	
GIF Control Room	• CERN Card • Personal Dosimeter + ADAMS rights : "Control Room HNA-487 (0887-1-R87)"	
GIF Service and Preparation Areas	• CERN Card • Personal Dosimeter • Personal Protection Equipment + e-group : "GIF-ServiceArea"	
GIF Irradiation Bunker	• CERN Card • Personal Dosimeter • Personal Protection Equipment • Activated (!) Operational Dosimeter + ADAMS rights : "GIF++ Zone Turnstile (EHN1-GIF)" + Training Rank : "10800 : CERN - Beam Facilities" +Training Rank : "10350 Radiation Protection - Supervised Area" + e-group : "GIF-ServiceArea" + Valid IMPACT request	 DMC

+ ADAMS rights: "**Zone Patrol Rights (bldg. 887) - H4 (124, 134, 144, 154,164) (EHN1-H4)**"

GIF++ Storage Areas

Access rights to be requested via ADAMS for the storage areas:

- 0887-R-Q92 - CAGE-GIF++
  - groups CMS and LHCb
- 0887-R-R86 - CAGE-GIF++
  - groups ATLAS and ALICE

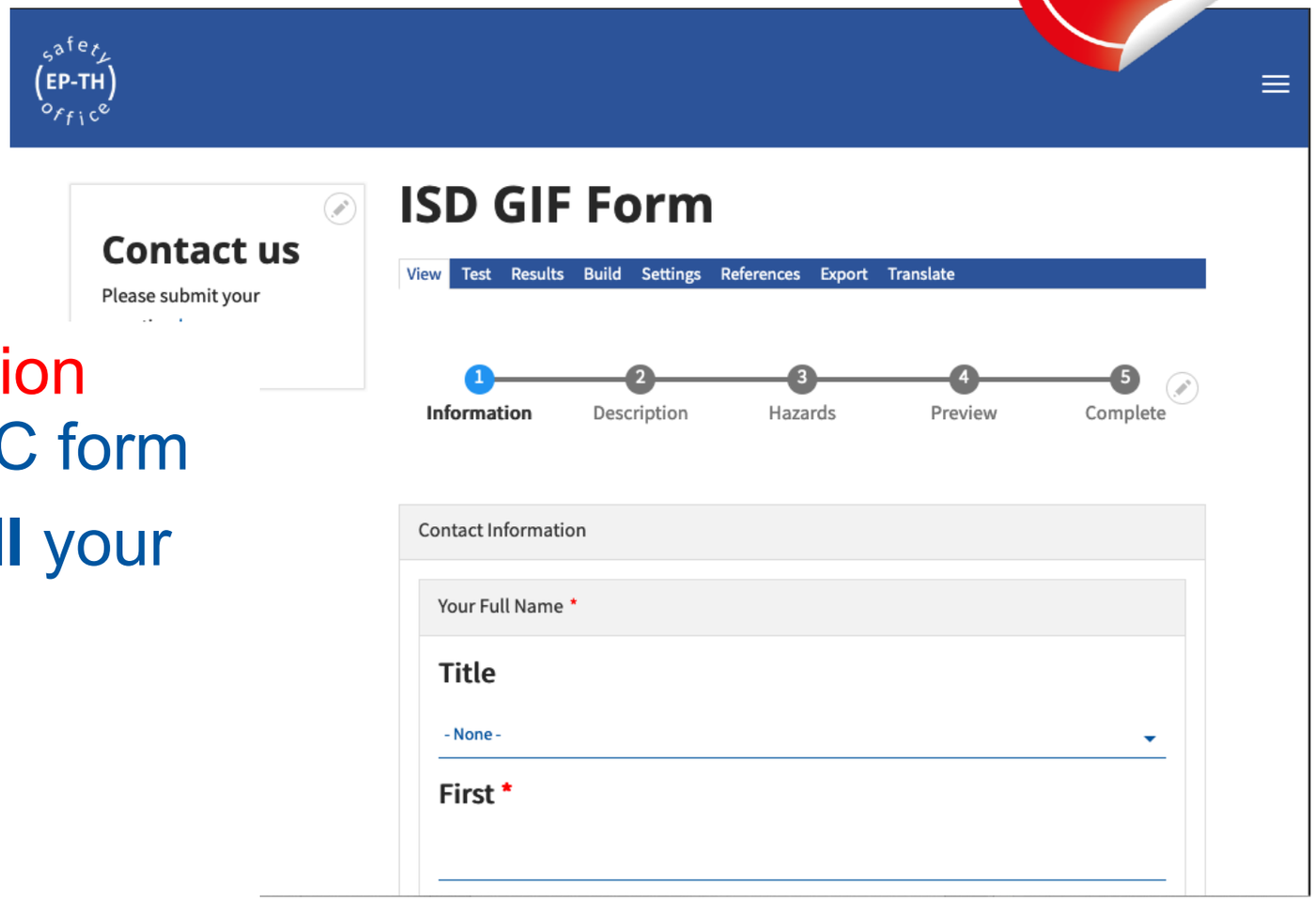
PPE, Radiation Areas & Visits

- Work in beam areas & experimental halls requires the **use of Personal Protective Equipment (PPE):** Helmet, Safety Shoes
  - EDMS 1223620
- It is **forbidden to eat and drink in radiation designated areas**
  - use the cafeteria in EHN1

- Whenever possible, **avoid lone working**. If not possible, refer to:
  - EDMS 1406153

- **private visits are strictly forbidden!**
- **official visits are possible** (outside beam time & upon approval by the EP-DT GIF++ operation team)

Work @ GIF++: ISD (1/2)



- The online **I**nitial **S**afety **D**eclaration **(ISD)** replaces the previous ISIEC form
- To be **filled in before you install** your experimental setup at GIF++

The **IMPACT number is needed for the ISD** – make sure this is generated beforehand!

- ISD is **accessible from EP Safety Office website** (remember to sign-in):
- https://ep-th-safety.web.cern.ch/GIF_ISD

Work @ GIF++: ISD (2/2)

- For **new or modified experimental setup**, a **safety inspection** performed by EP Safety Office is **mandatory before operation**

- The EP **Safety Clearance must be obtained before operation**
  - confirmed by e-mail notification

- For **experimental setups which have not been modified**, at least an **electrical safety inspection** is **to be carried out every year**
  - Safety Clearance renewal coordinated at facility restart in January for all concerned setups

- Contact the EP Safety Office in advance to make sure everything is ready for your clearance!

Work @ GIF++: Safety Instructions

The information contained in EP-SO web pages shall be considered as early as possible in the design of the experimental setup to facilitate the safety validation process.

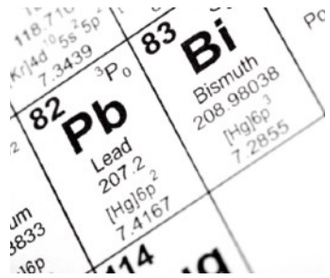
You will find details about:

- ✓ List of **materials allowed and forbidden** at CERN;
- ✓ Instructions and **recommendations to be followed for specific hazards** and risks brought by the experiment to CERN;
- ✓ Best **safety practices for installation and operations of detectors** at CERN;
- ✓ **Safety contacts** for additional questions, etc.

This process should start no later than 1 week prior to the installation of your experiment at CERN.

If your setup introduces hazards or risk implications (including but not limited to the use of flammable gas, mechanical equipment, cryogenics or lasers), **the EP Safety Office (ep-adso@cern.ch) must be contacted as early as possible, before submitting the ISD.**

Work @ GIF++: Lead



- Lead must be **used for radiation shielding purposes only**!
  - small iron/concrete blocks are also available: in case of need, contact Giuseppe
- Bricks at GIF++ are painted, but must be **handled with gloves**:
  - CERN Stores (SCEM 50.43.20.FA)

- see also **Lead Safety Guideline SG-C-0-0-3** (EDMS 1050102)
- old **painted bricks being replaced by new ones**: all replaced by the beginning of 2024

Work @ GIF++: Gas

- **Compulsory Safety Trainings** for all GIF++ users using **Flammable (ATEX)** and / or **Fluorinated greenhouse (F)** gas
- ATEX Habilitation - Level 1 Training:
  - Learning Hub
- F-GAS Training:
  - Learning Hub
- Note: both **classroom trainings!**

- Portable **Gas "sniffer"** available at GIF++
  - stored next to **EHN1 cafeteria** (see slide 9)
  - accessible via e-group: << **TRAKA887-GasDetector** >>

ION GASCHECK Gas "sniffer"

Work @ GIF++: Gas

- Gas bottles/banks **must be transported generating an EDH/SIT**
  - between all CERN sites
  - **self-transport of n-pentane**, procedure available: EDMS 2708714

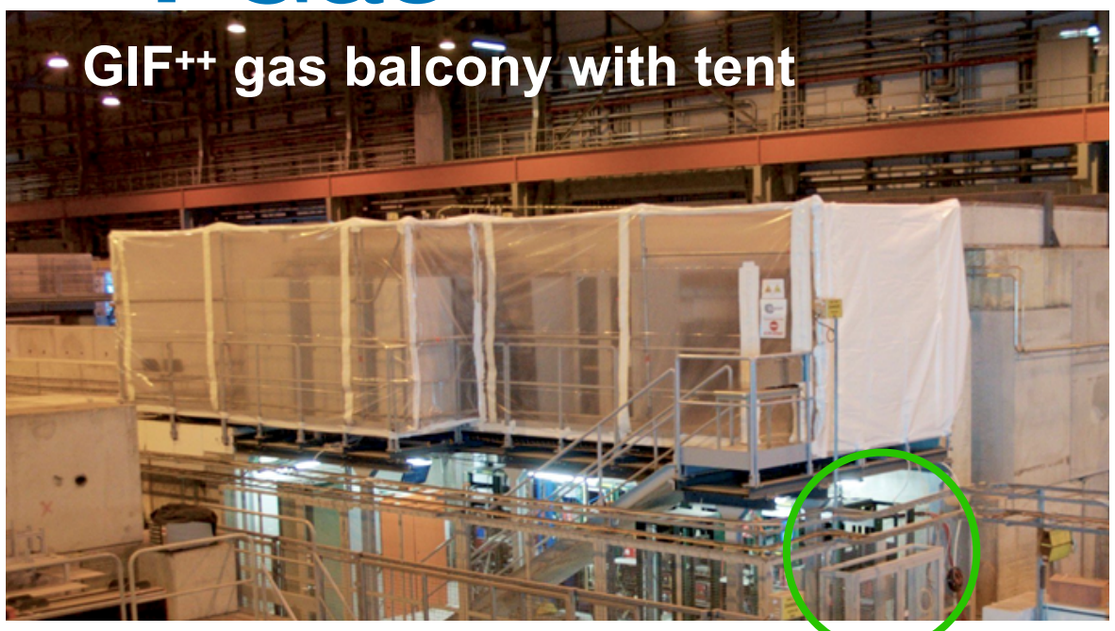
NEW!

- Gas bottles **cannot be installed on the gas balcony**, connect via:
  - **gas point inside EHN1**

(887 NORTH EXPERIMENTAL HALL EHN1 + GT10 TO 17 PREVESSIN)

  - **gas point outside EHN1** (bld. 909)
  - exception: R1234ze, R1233zd

- Gas **detection in the bunker**:
  - 4 fix **ODH sensors**
  - 4 **flammable gas sensors**



- ODH and CO_2 risk under the tent: **portable sensor available on site!**

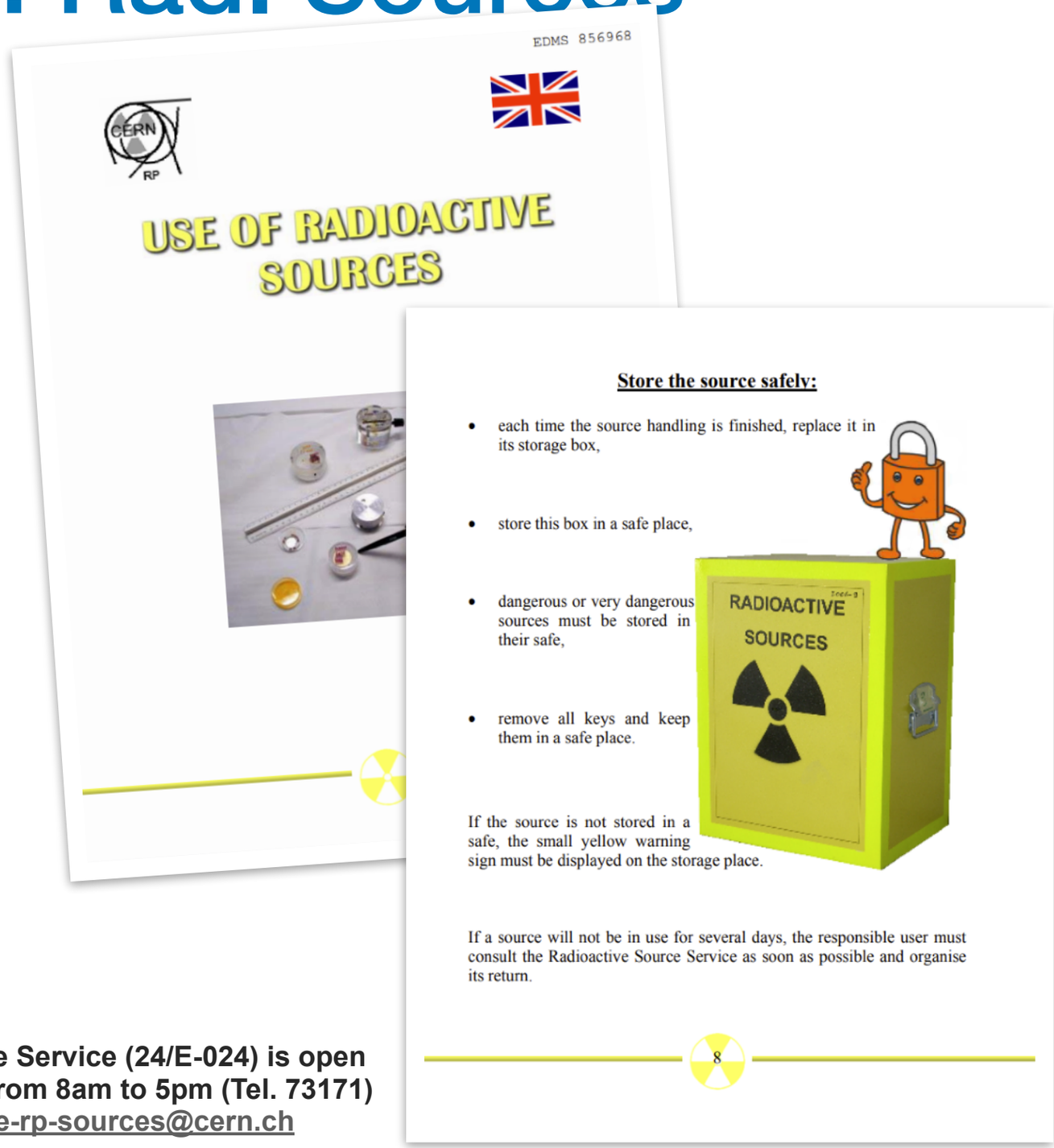
R1234ze

ODH/CO_2 portable sensor

Work @ GIF++: Rad. Sources

- Radioactive Sources often used at GIF++ for testing & calibration of experimental setup / instruments
- **Respect the handling instructions** given by the HSE-RP Source Service and consult:
  - Manual *Use of Radioactive Sources*
- **Ensure the source integrity!**
  - **never dismount or modify the source holder** without authorisation!
  - for special requests, please, contact the Source Service or the EP-RSO

- **Store the source safely!**


EDMS 856968

CERN
RP

USE OF RADIOACTIVE SOURCES

Store the source safely:

- each time the source handling is finished, replace it in its storage box,
- store this box in a safe place,
- dangerous or very dangerous sources must be stored in their safe,
- remove all keys and keep them in a safe place.

RADIOACTIVE SOURCES

If the source is not stored in a safe, the small yellow warning sign must be displayed on the storage place.

If a source will not be in use for several days, the responsible user must consult the Radioactive Source Service as soon as possible and organise its return.

8

Source Service (24/E-024) is open daily from 8am to 5pm (Tel. 73171)
service-rp-sources@cern.ch

Work @ GIF++: Traceability

- **Radiological control** of material leaving beam areas **is a legal obligation**:
  - applicable to equipment inside GIF++ bunker
  - exposed to the **particle beam** and / or to the **^{137}Cs source**

http://cern.ch/trec

TREC

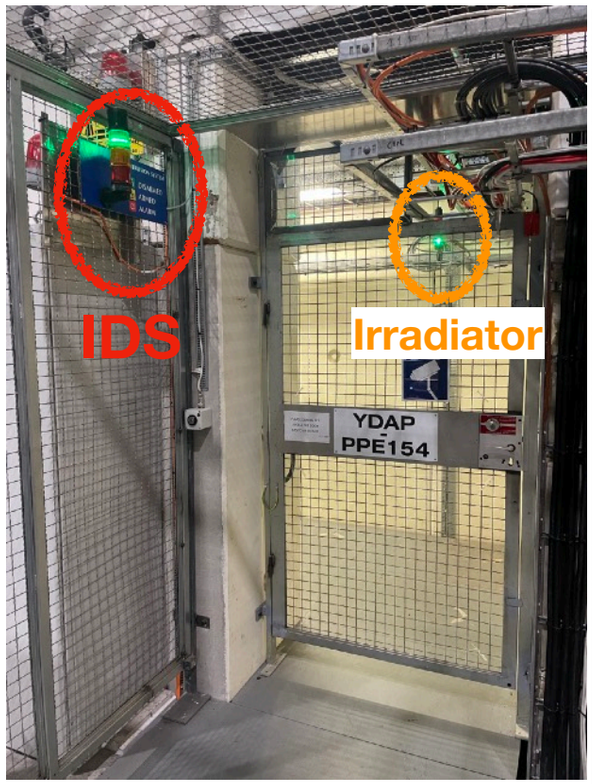
- **Detailed procedure (EDMS 2717760):**
  - **label equipment** and register it in TREC
  - TREC labels (& console) available in the **Buffer Zones 887 R-C37** (*Jura side*) and **887/R-R92** (*Saleve side*)
  - material can be **removed after RP control**
  - **"big" setups can be controlled at GIF++!**

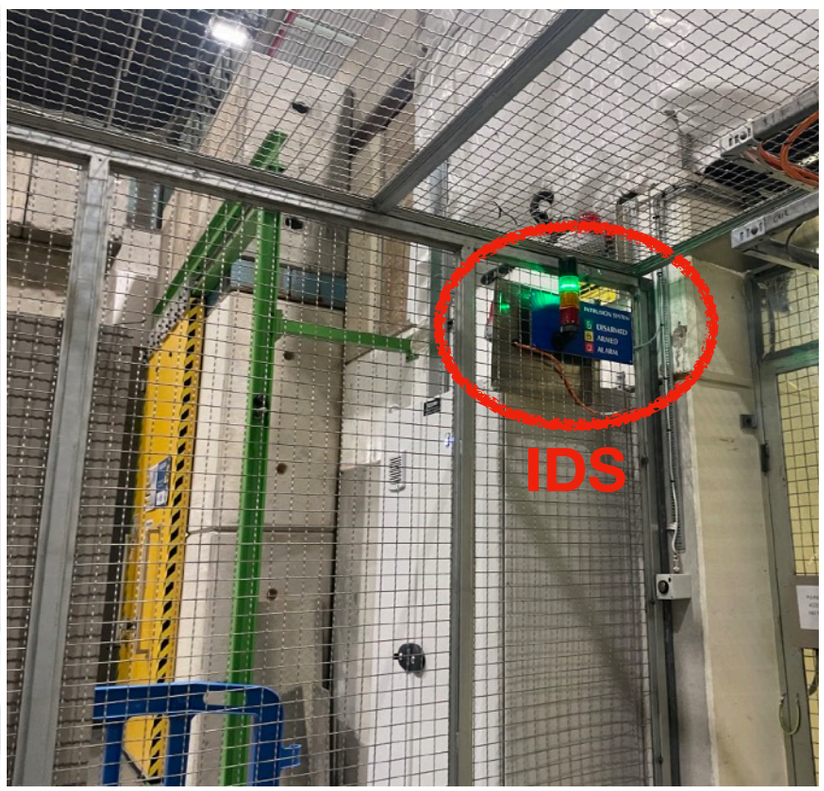
TREC labels

GIF++ Intrusion Detection

- **Intrusion Detection System :**
  - Active during the Christmas Shutdown (will be communicated when turned on)
  - STRICTLY no access when the IDS light is **YELLOW** (Green = Off, Red = Alarm)
  - Works like any burglar alarm. When you open the first door, you will trigger the alarm and CERN security is informed. Depending on their assessment (cameras) the french police will be involved

If you really need access during the CERN closure, you have to contact me or Federico, and we will see what can be done.





Successful 2023 operation :

- **Last year we had 6 weeks of dedicated muon beam in 2023**
  (down from 9 weeks in 2024, due to shortened beam operation)
  Still able to provide ≈ 48 weeks of Gamma irradiation to the wide community
- All 6 weeks of dedicated muon beam shared with RD51
- **Up to 12 set-up scheduled** in parallel during beam weeks, however number was reduced by several cancelations due to test program finished early (MM,DT2), other cancelations caused by manpower issues or detectors not ready

	Set-ups participating	Date of beam period starting: 24.04	3.05	5.07	12.07	23.08	30.08	
Nr.	Setup / Week	17	18	27	28	34	35	Requested
1	ATL-MPI - 1&2	u	u	u	u	u	u	3x2 weeks
2	ATL-NSW MM			d	d	~~d~~	~~d~~	2x2 weeks
3	ATL-RPC -1&2	d	d	d	d	~~d~~	~~d~~	3x2 weeks
4	CMC-CSC -1	d	d	d	d	d	d	3x2 weeks
5	CMC-CSC - 2	d	d	d	d	d	d	3x2 weeks
6	CMC-CSC - 3					~~u~~	~~u~~	3x2 weeks
7	CMS-DT-MB2	u	u					1x2 week
8	CMS-GEM			d	d	~~d~~	~~d~~	2x2 weeks
9	CMS-RPC - 1	u	u	u	u	u	u	4x2 weeks
10	CMS-RPC - 2	u	u	u	u	u	u	4x2 weeks
11	EP-DT2	u	u	u	u	u	~~u~~	4x2 weeks
12	ProToV			~~u~~	~~u~~			3x2 weeks
13	RE21/CBM					d	d	1x2 week
14	RPC Ecogas			u	u	u	u	3x2 weeks
	Upstream	5	5	5	5	6	6	
	Downstream	3	3	5	5	3	3	
	Total	8	8	10	10	9	9	

2023

U = upstream, D = downstream, ~~U~~/~~D~~ = user cancelation

Outlook 2024 :
14 Requests for beam time
Schedule expected soon

ATLAS – sMPI	3 x 2 Weeks
ATLAS – MPI RPC	3 x 2 Weeks
ATLAS – LEGACY	3 x 2 Weeks
ATLAS – PHASE 2	3 x 2 Weeks
ATLAS NSW MM (2x)	1 x 2 Weeks
CMS – CSC (3x)	3 x 2 Weeks
CMS – GEM	2 x 3 Weeks
CMS – RPC (2x)	4 x 2 Weeks
EP-DT2	3 x 2 Weeks
RPC ECOgas	3 x 2 Weeks

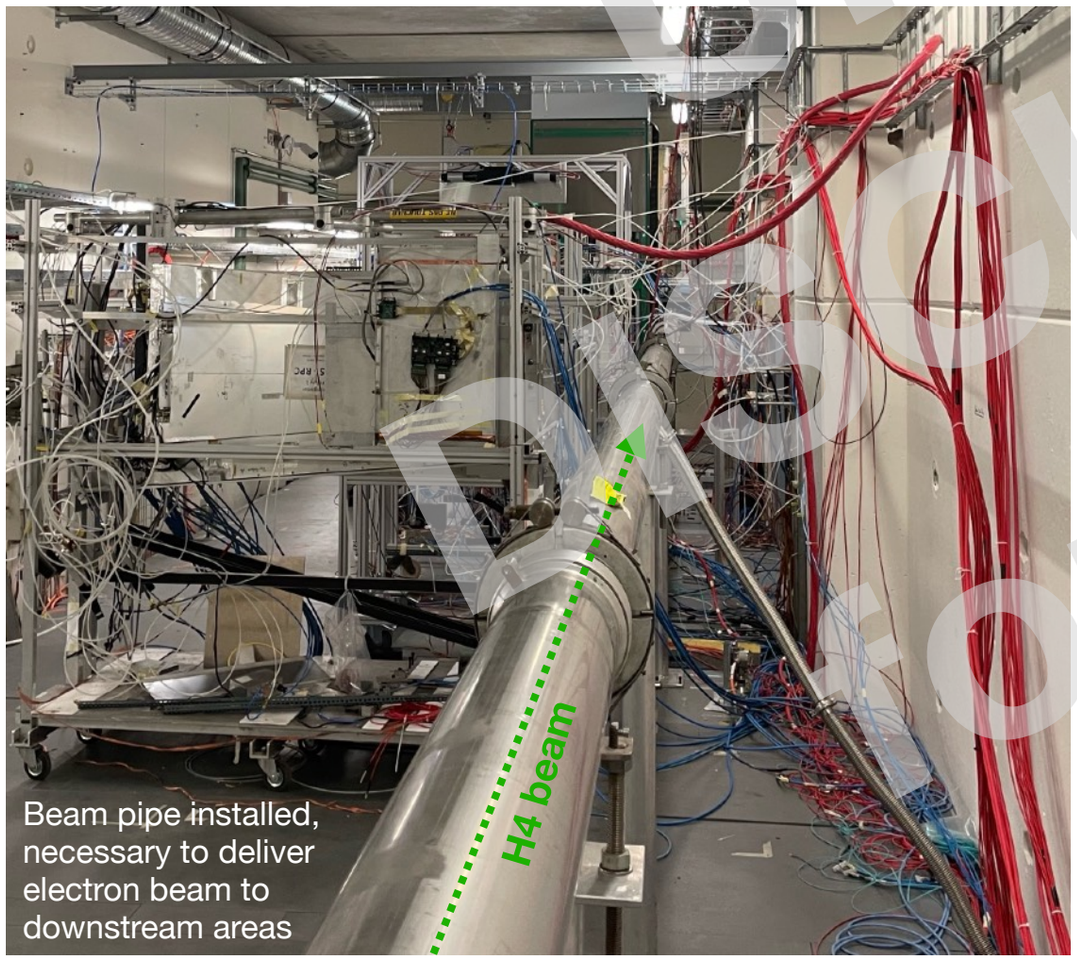
Successful 2023 operation :

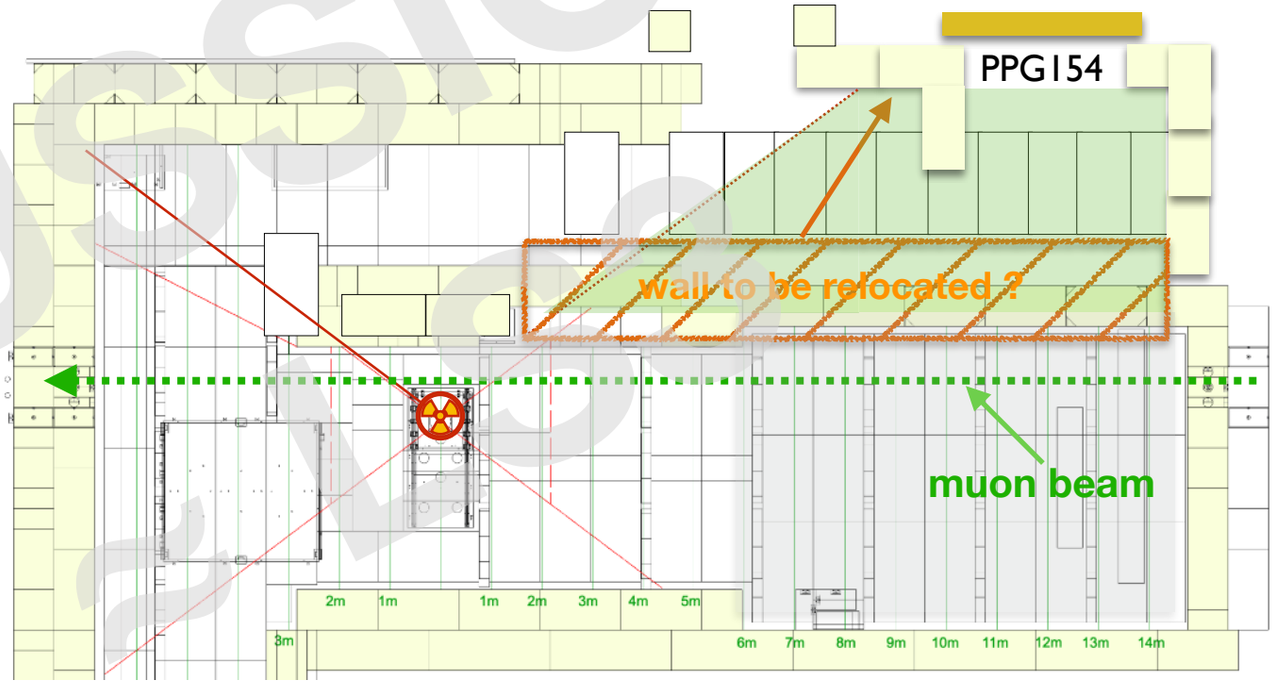
- 22 Active User Groups in 2023, normally staying for several months (years) of irradiation

Activity	Resp.	Facility	Title	Description	Responsible
216465	EP-UAT	GIF	RPC - BI production test	Production test of the BI gas gaps. This will include a setup going in and out from the bunker containing 24 gas gaps. Dimensions 300x100x60, weight 200 kG.	GIULIO AIELLI (538291/EP-UAT)
216137	EP-UAT	GIF	TGC prototype irradiation	TGC irradiation tests 2023	LUCA MOLERI (763487/EP-UAT)
213815	EP-UAT	GIF	Test beam tracking MM detectors with Isobutane/ArCO2	Test beam tracking MM detectors with Isobutane/ArCO2	VALERIO D'AMICO (803500/EP-UAT)
213813	EP-UAT	GIF	Test beam of MM production detectors with Isobutane/ArCO2	Test beam of MM production detectors with Isobutane/ArCO2	VALERIO D'AMICO (803500/EP-UAT)
212816	EP-UCM	GIF	CMS HGCAL dry run at gIF++	Irradiation of HGCAL samples at GIF++	ALEXANDER KAMINSKIY (514197/EP-UCM)
211132	EP-UCM	GIF	Consolidation of CMS RPC : Trolley 1	Operations and Modifications CMS RPC for Consolidation TR1. We are about to complete the program for 2 chambers.. We need to continue the charge accumulation for the other 2 chambers.	MEHAR ALI SHAH (709112/EP-UCM)
210614	EP-ADP	GIF	ProTov	Rate capability and aging test on gaseous detector with small form factors	ALESSANDRO ROCCHI (818582/EP-ADP)
210342	EP-UAT	GIF	ATLAS Legacy RPC Prototype	Setup for ageing test of an RPC detector with 50 cm x 50 cm size and 2 mm gas	SINEM SIMSEK (743236/EP-UAT)
208598	EP-UAT	GIF	Performance studies for sMDT detector prototype - MPI group	Performance studies for sMDT detector prototype - MPI group	ELENA VOEVODINA (803901/EP-UAT)
208569	EP-UAT	GIF	Performance studies for RPC detector prototype - MPI group	Performance studies for RPC detector prototype - MPI group	ELENA VOEVODINA (803901/EP-UAT)
205030	EP-UCM	GIF	CMS CSC longevity studies at GIF++ - ME11	CMS CSC (ME11) test beam and longevity studies at GIF++ (maintenance, measurements).	EKATERINA KUZNETSOVA (566065/EP-UCM)
205028	EP-UCM	GIF	CMS CSC longevity studies at GIF++ - ME21	CMS CSC (ME21) test beam and longevity studies at GIF++ (maintenance, measurements).	EKATERINA KUZNETSOVA (566065/EP-UCM)
204921	EP-UAI	GIF	Eco-friendly gas mixture tests - CMS RPC Trolley 3	Studies for an eco-frendly gas mixture for the RPC's	LUCA QUAGLIA (832884/EP-UAI)
204544	EP-UCM	GIF	CMS-iRPC electronic test	CMS-iRPC chamber and electronics test	MEHAR ALI SHAH (709112/EP-UCM)
204305	EP-UCM	GIF	Rate capability for ME0 CMS GEM	Rate capability of GEM detector heavily irradiated	DAVIDE FIORINA (828894/EP-UCM)
204304	EP-DT-FS	GIF	GIF++ EP-DT R&D 2	Test of RPC gaseous detectors under gas recirculation.	MATTIA VERZEROLI (851185/EP-DT-FS)
204283	EP-CMG	GIF	CMS DT MB2 chamber irradiation upstream	Irradiation and data taking of a DT MB2 chamber + monotubes at GIF++	LISA BORGONOVI (759297/EP-CMG)
204259	EP-UAT	GIF	RPC BIS78 Modul0 and Phase 2 prototype	Performance and ageing test of the ATLAS BIS78 Module 0 and Phase2 prototypes,	GIULIO AIELLI (538291/EP-UAT)
204254	EP-DT-DD	GIF	GIF User - upcoming installations	Allowing access to bunker area for selected user in preparation for upcoming installations.	GIUSEPPE PEZZULLO (749724/EP-DT-DD)
203678	EP-UAT	GIF	Long Term Ageing of MM production detectors with Isobutane/ArCO2	Long Term Ageing of MM production detectors with Isobutane/ArCO2	VALERIO D'AMICO (803500/EP-UAT)
203676	EP-UAT	GIF	Long Term Ageing for ATLAS-NSW MM	Long Term Ageing of MM production detectors with Isobutane/ArCO2	VALERIO D'AMICO (803500/EP-UAT)

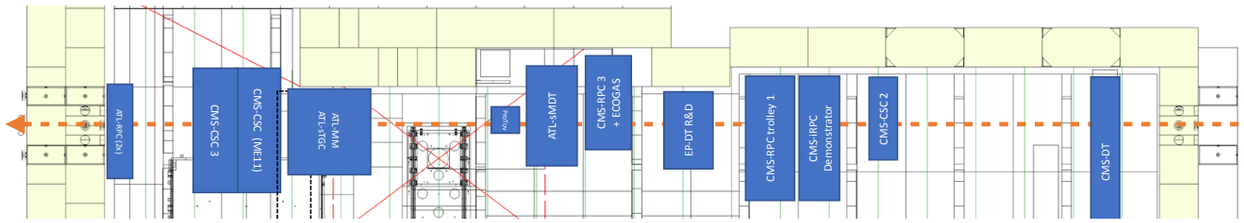
Ongoing Challenges

- **Proposal : Bunker extension to increase space on the Saleve side of the beam line to allow better distributions of detectors, while significantly limiting the shadowing effect on detectors further away from the source**
  - Possibility to place the full width of a detector inside the muon beam
  - No extra floor space in EHN1 needed. Dedicated preparation area converted into irradiation area.
  - Will need dedicated funding





Uneven shadowing for setups :



Mainly from support frames, shielding blocks, etc…

Upgrade to Gas Exhaust System

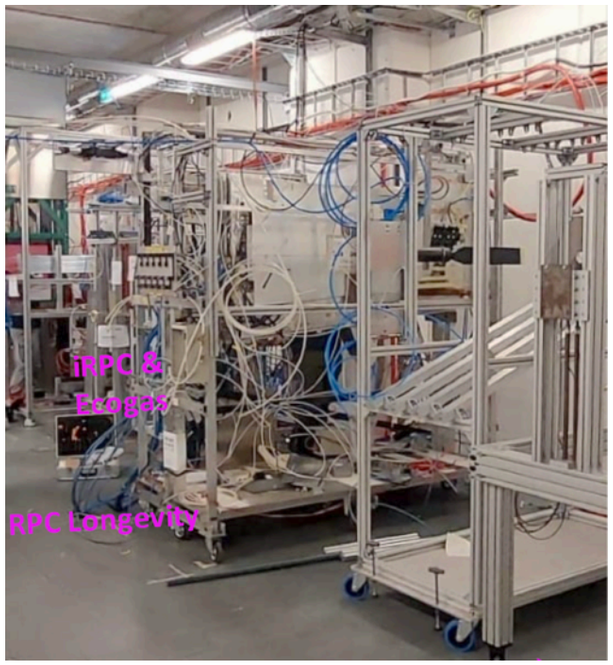
EP-DT-FS
R.Guida et al

The gas system infrastructure is a key element of the successful R&D programs performed at the GIF++

Gas recirculation module

- **2023 showed a significant increase in RPC chambers tested** at GIF++
  - Increase in the overall gas consumption, especially in the RPC mixture
  - **Gas consumption / extraction no longer negligible**
- We currently have one simple exhaust line to the outside, most gas consumption is contributing to the **CERN environmental footprint**

ECO-Gas

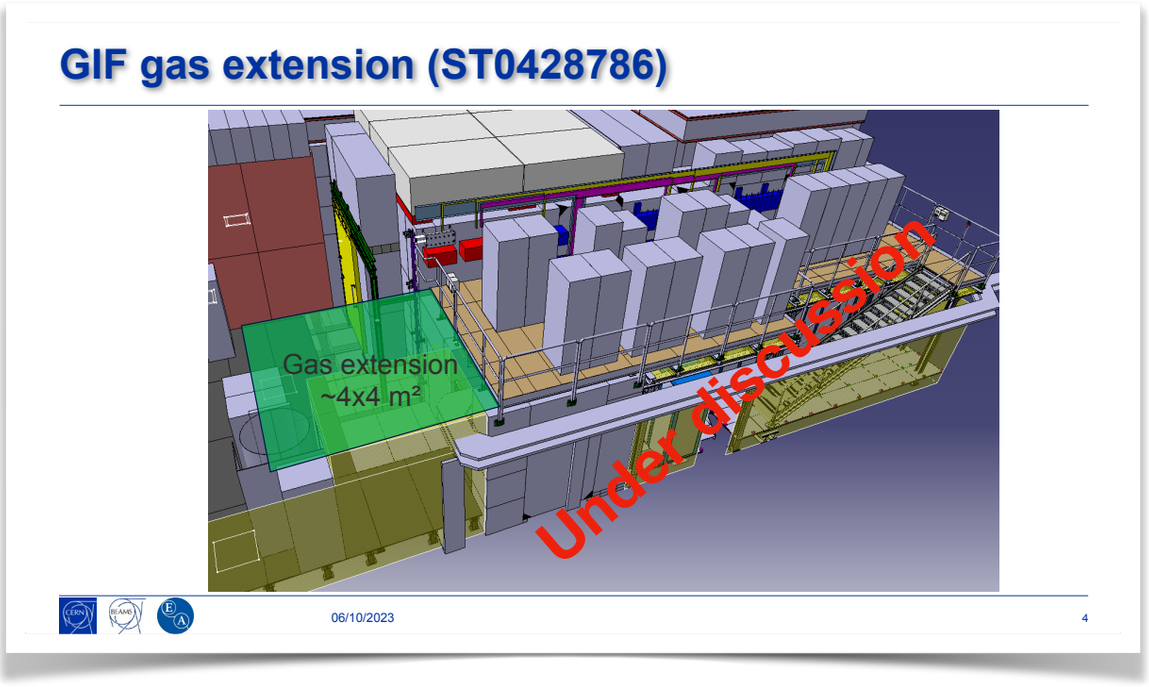


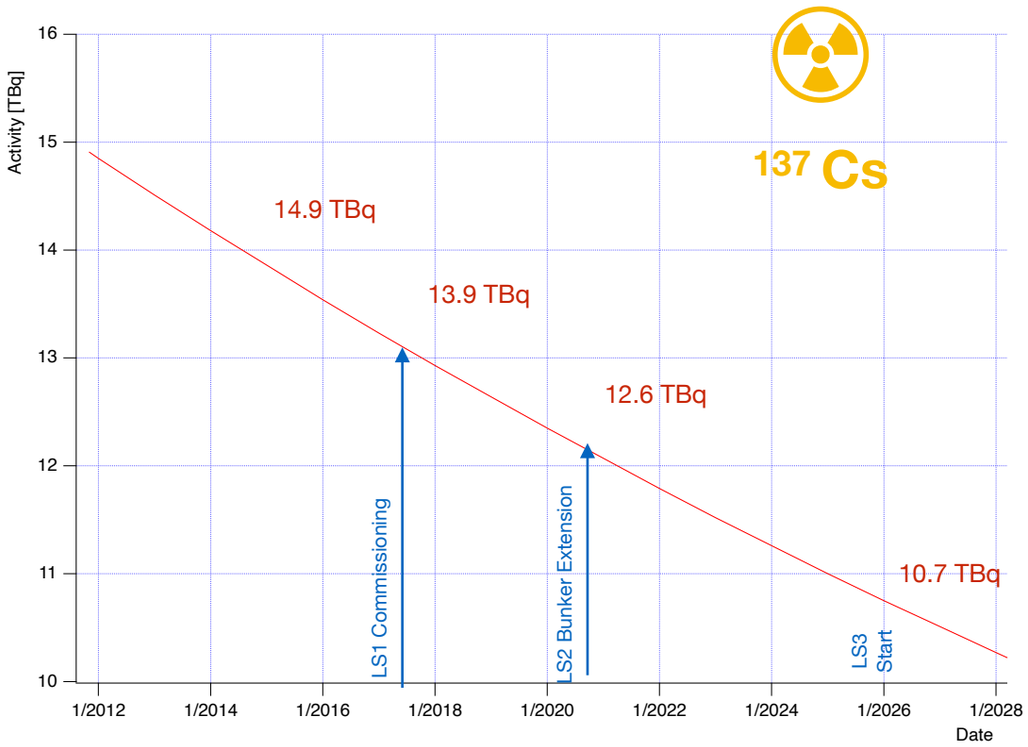
- **Proposal to install an RPC gas-recuperation system at GIF++**
  - Planning in 2024 with installation in 2025/26
- **Discussion on optional recirculation system**.
  - Only feasible to long term stable setups
  - Not possible for systems where chambers get swapped all the time

Gas System

EP-DT-FS
R.Guida et al

- Due to the **increased number of users** at GIF++
  - We have currently run out of space to install new gas rack
  - Some optimisation can be made, and we are working on an extension of the gas rack area
- Primary gases (Ar, CO_2..) are currently provided, but special premixed gases (bottles) can be charged to your budget account
- New Mixer racks need to be provided by the users (with support of EP-DT-FS)
  - At least ≈ 3 month needed for a new mixer rack
  - Location to be agreed with EP-DT-FS
- Gas consumption - especially for green house gases - needs to be defined beforehand





From original 14 TBq (2014), we will be < 11 TBq by LS3

To ensure & improve the efficient operation of the facility beyond LS3, we started to look for a new source !

- Extension of Irradiator maintenance contract ✓ (*)
- Market survey for new source.
  Currently challenging. ✗

- Difficult to plan the replacement of the current Cs source
  - Very few producer of high intensity sources, with biggest manufacturer currently not available
  - Prices of available (existing) sources are extremely high
- Current dimensions of Irradiator capsule can limit the reachable activity
  - Housing and bunker designed for ≤ 100 TB, but capsule dimensions will limit us to ≈ 20 TBq
  - On site loading of new source appears to be technical possible
- A new Irradiator with increased dimension could be envisaged.
  Opens the possibility to add multiple sources in one Irradiator via loading carousel
  - Significant higher costs. Might need a redesign of the attenuator system.
  - Very challenging in current financial situation

*) Contract agreed, needs to be signed.

Important Informations

- Please contact GIFPhysics.Coordinator@cern.ch first, describing your needs/plans.
  The GIF++ Physics coordinator will then analyse your request, and will present it (togetherwith you) in the weekly meeting for discussion and possible space allocation
- The request for irradiation time at the GIF++ is done via IMPACT, and can be valid up to one year
  - Safety clearance has to be renewed once a year or when modifications were done that could impact the safety clearance
- Contact GIF-Tech-Coordination@cern.ch for all technical follow-up questions
- Subscribe to e-group "GIF-active-users" for getting informations about the GIF++
- **Join the weekly meeting** on Thursday 9h https://indico.cern.ch/category/1942/ (Hybrid 892-1B09 & Zoom)
  - **Mandatory** for setups active in the bunker and setups planning to join in the next weeks
- Standard access day is currently Wednesday. Other access (= Irradiator off) needs to be agreed in the weekly meeting
- Filter settings are agreed in the weekly meeting
  - Current standard: Downstream - full field, Upstream = attenuation factor 2
- Final setup will need the approval of the GIF Coordination team before installation
  - Please respect the needs of other users placed further away from the irradiation source.
    Excessive shadowing (e.g. lead blocks) will not be tolerated and the setup will need to be removed
- Setups not currently under test needs to be removed from the bunker at the next access day (Wednesday)
- Requests for Muon Beam time are collected once per year (Nov./Dec.) and submitted to the SPS Physics Coordinator by the GIF++ Physics Coordinator (finished for 2024)