EP-DT
Detector Technologies

The gas systems infrastructure for the CERN Gamma Irradiation Facility

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AIDA-2020 Second Annual Meeting, Paris LPNHE, April 4-7, 2017

Outline

- GIF++ overview
- Gas systems infrastructure
  - supply
  - distribution
  - Gas recirculation units
  - Gas analysis modules
- Conclusions

The new CERN - GIF++

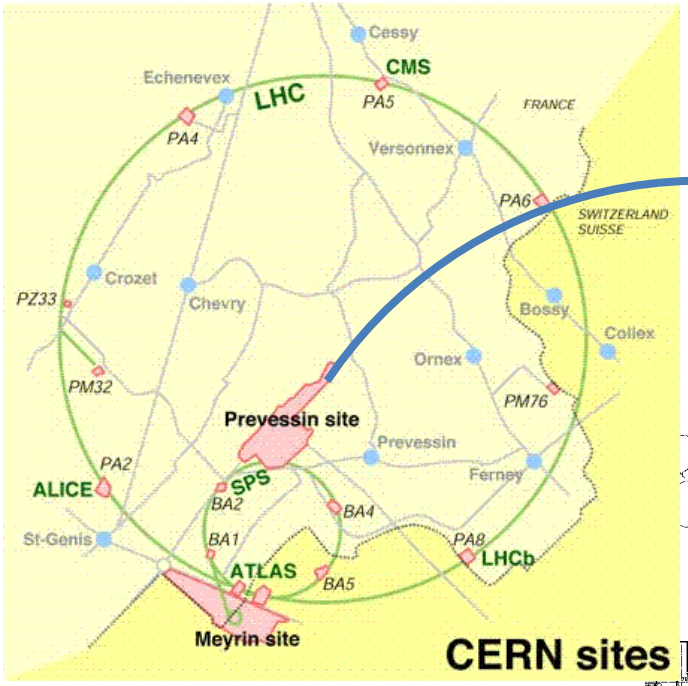
Strong needs from the LHC and HL-LHC detector and accelerator communities

- GIF++ follows up on the very successful GIF facility
- The GIF++ facility presented takes into account the requirements from the users and has been discussed extensively with them.

GIF++ is a unique place for detector R&D tests:

- Strong gamma source
- Particle beam available
- Excellent gas and electronic infrastructures
- Unified control/monitoring system
- Setups for beam & cosmic trigger, radiation monitoring, environmental monitoring, DAQ, …

GIF++ facility: location



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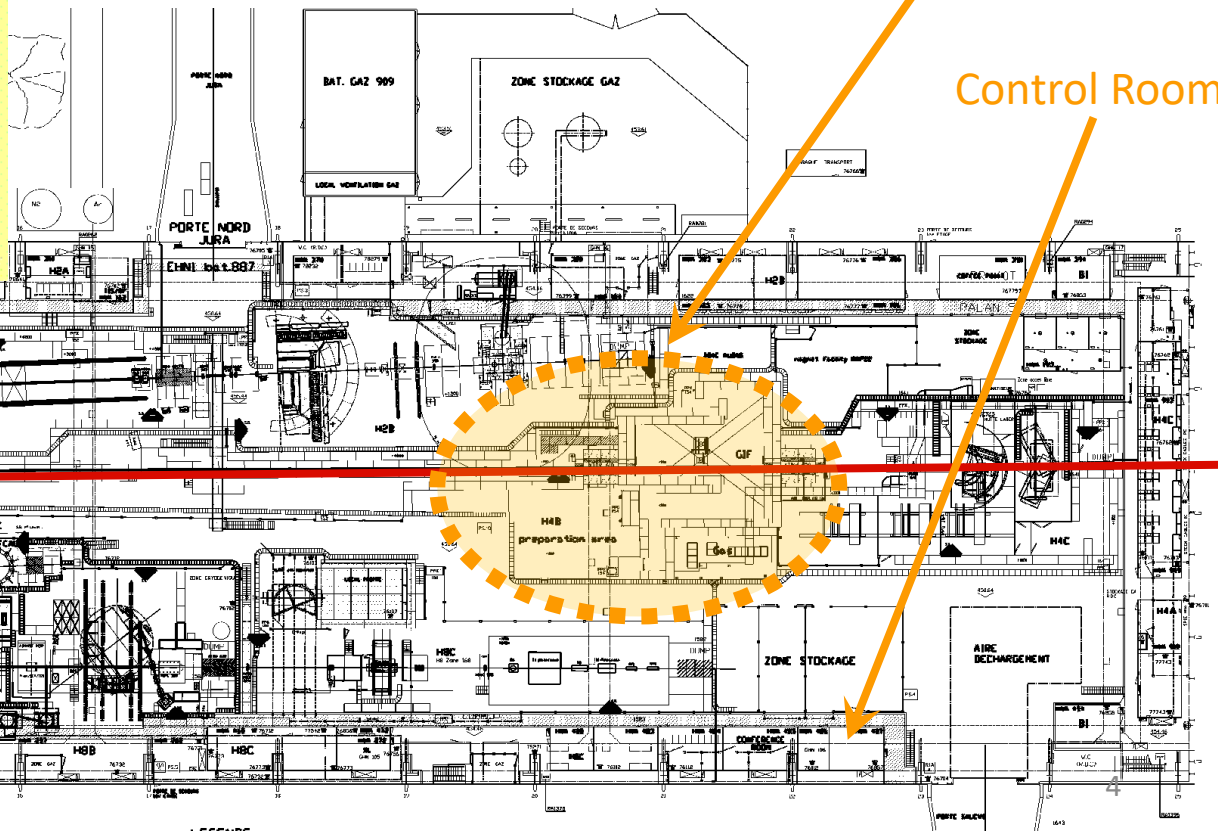


Control Room

H4 beam line

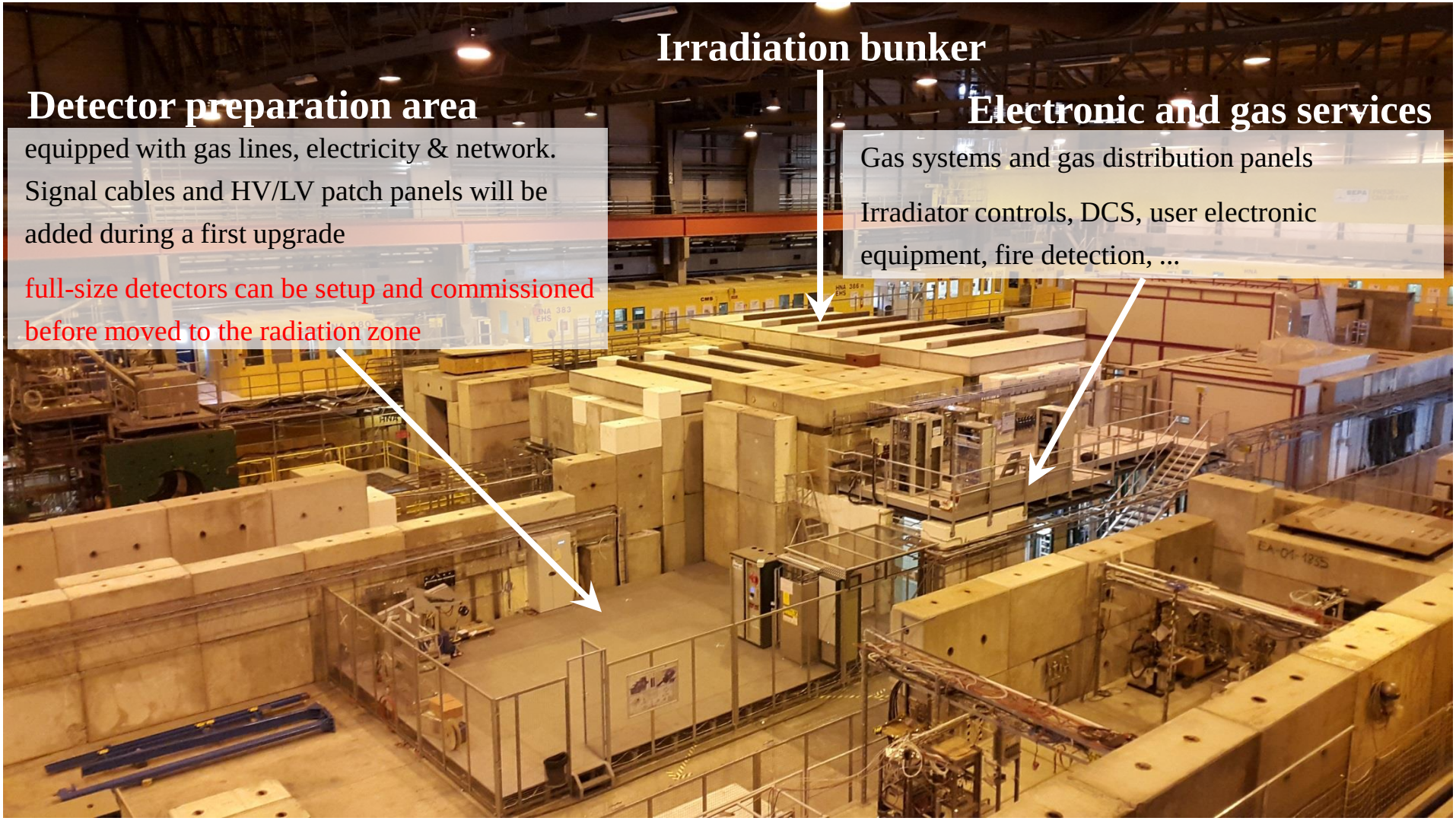
GIF++ collaboration

- The CERN EN-department (EN-MEF)
  - provides the infrastructure for housing the irradiator and detectors: civil engineering components (shielding, false floor …), beam line elements, control room and the supply of general infrastructure (electricity, gas …)
  - provides the gas distribution lines inside the facility (about 5 km)
- The CERN PH-department (EP-DT)
  - provides the irradiator & attenuator, the facility controls (GIF control system), the gas systems, as well as the user management
- The user community
  - providing the detector specific infrastructures (beam trigger, cosmic trigger, …)

GIF++ facility: key numbers

	Details	Dimensions
GIF++ facility	Building 887 - H4 beam line in EHN1	225 m^2
Detector preparation area	Area for detector preparation directly accessible from control room	83 m^2
Services area	Area hosting large part of the peripheral infrastructure and services (gas supplies and systems)	2 x 40 m^2
Bunker	Experimental area: 14 TBq ^{137}Cs source (662 keV gammas)	100 m^2
Control room	Control rooms for services and users close to the preparation area	

GIF++ facility

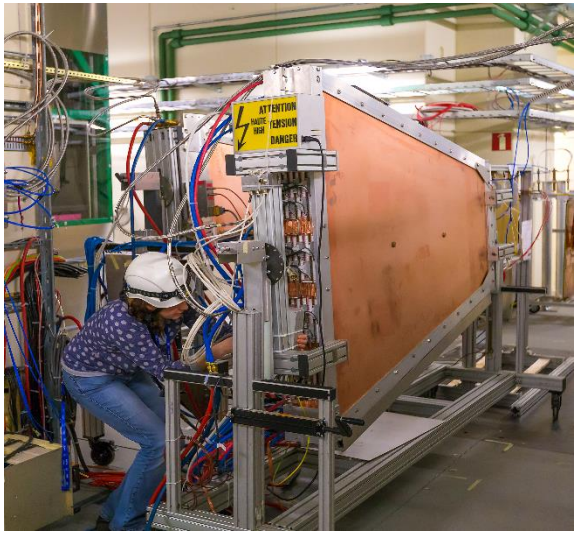


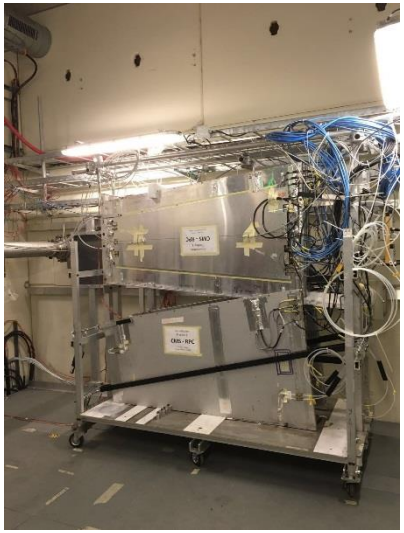
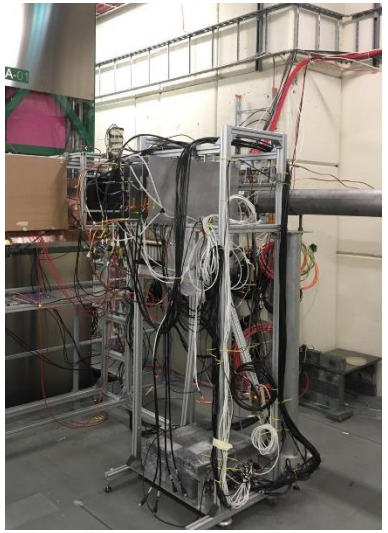
A large variety of tests on gaseous detectors

- Detector validation up to new HL-LHC expected dose
- Detector and electronic development
- Performance of «recent» detector developments
- Test on real size detectors (>> m^2) and prototype
- Studies with new environmentally friendly gases
- New gas systems and operation for new detector upgrades
- Large detector productions at high rate before installation

6 detector technologies:

- DT, MDT
- CSC
- RPC, iRPC, GRPC
- MM
- GEM
- sTGC

GIF++ gas systems infrastructure

The gas systems infrastructure is fundamental for the operation of gaseous detectors at GIF

First floor:

Gas service area

~ 20 gas racks and distribution panels (40 m^2 net area)

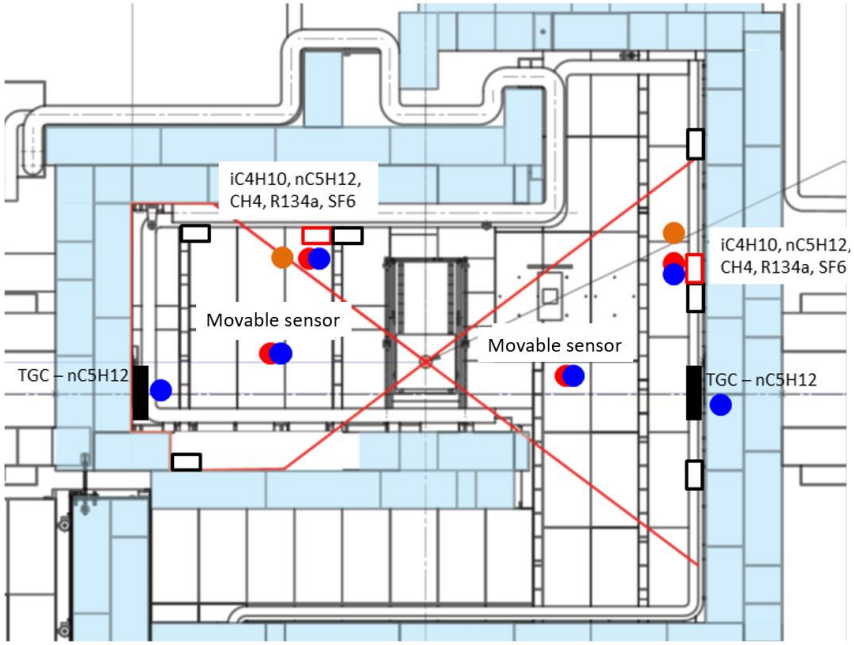
Ground floor:

Electronics area

~ 20 electronic racks hosting the irradiator controls, DCS, user equipment, fire detection, ...

Gas systems infrastructure - overview

- Gas supply
- Gas distribution
- Control rack (basic functionality, i.e. connection to systems, gas systems status, distributions of monitored parameters…)
- Gas mixing racks for fixed installations (beam and cosmic trigger setups).
- 1 IR analysis rack for cosmic trigger
- 1 analysis rack (O_2+H_2O+gas chromatograph).
- New gas recirculation systems developed



Gas supply panels

- neutral gases: Ar, CO2, N2, He, SF6, CF4 and 3 additional gas lines (spare and/or pre-mixed)
- flammable gases or gases with low vapour pressure: iC4H10, CH4, Ar/H2, C2H2F4 and 2 additional (spare and/or pre-mixed)

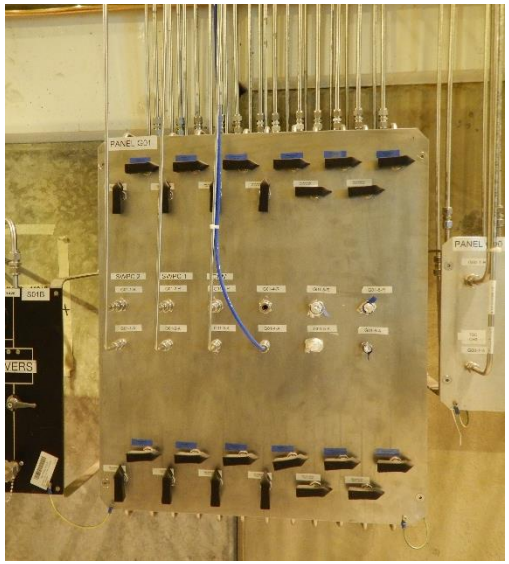
Gas supply and distribution in the service area

Example of neutral gas supply panels

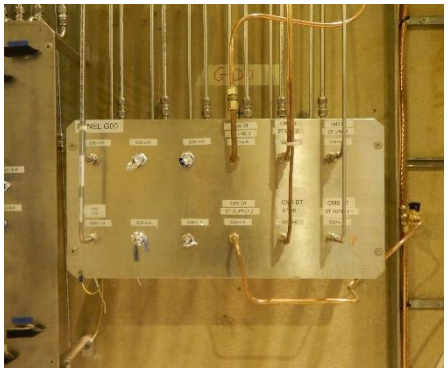
Gas mixture distribution panels

- 21 distribution panels (6 lines each)
  - Two types:

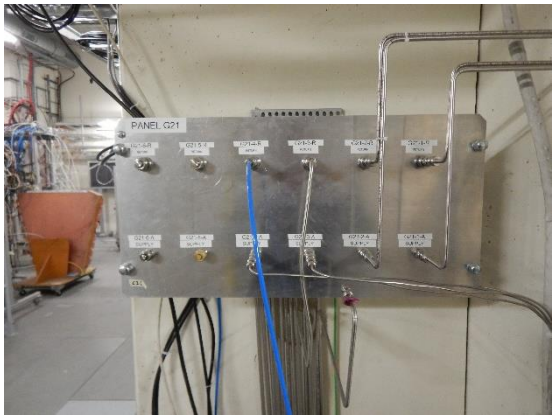
From service area to bunker and preparation area



From service area to bunker only

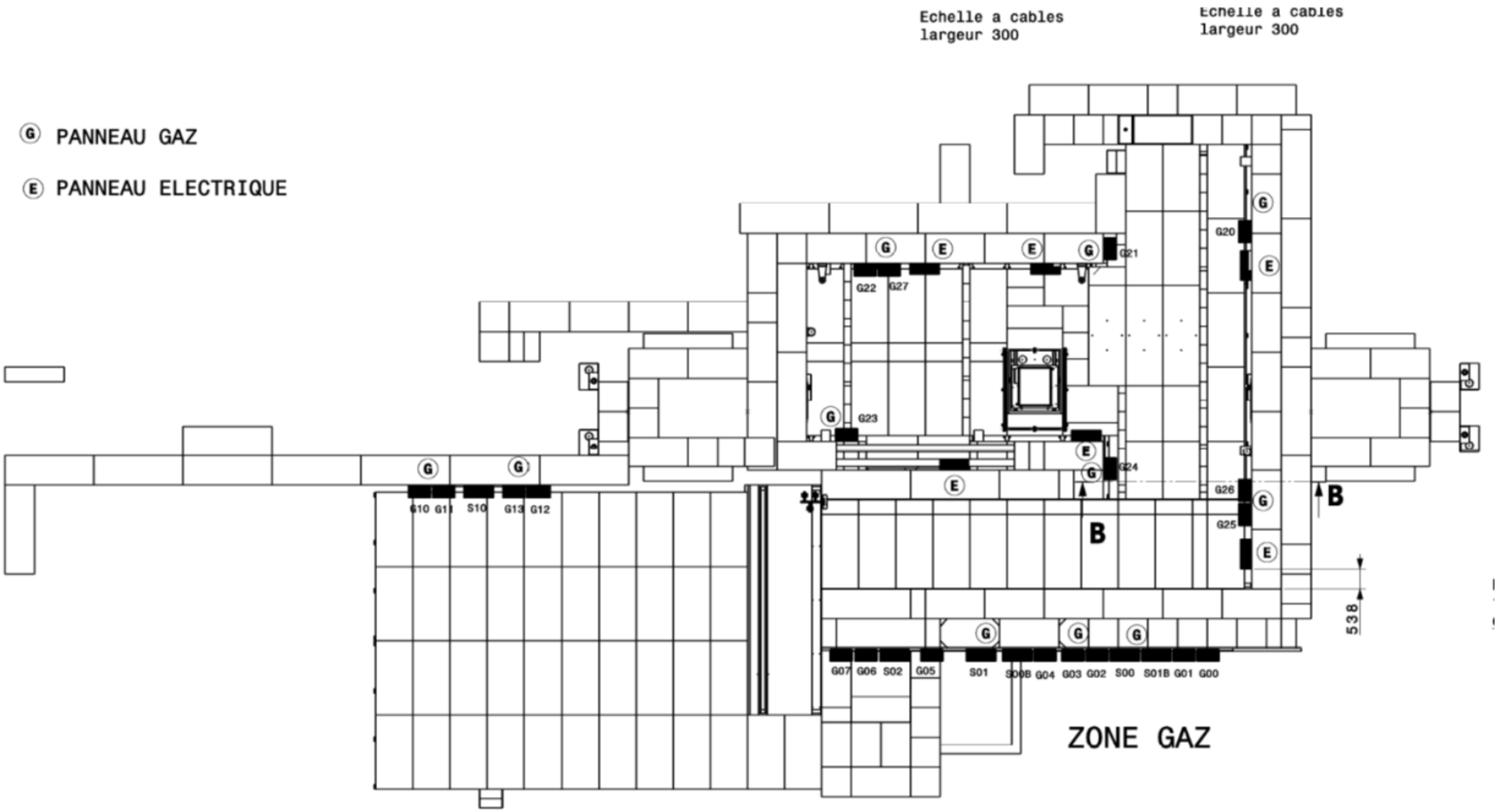


Corresponding gas panels in the GIF bunker



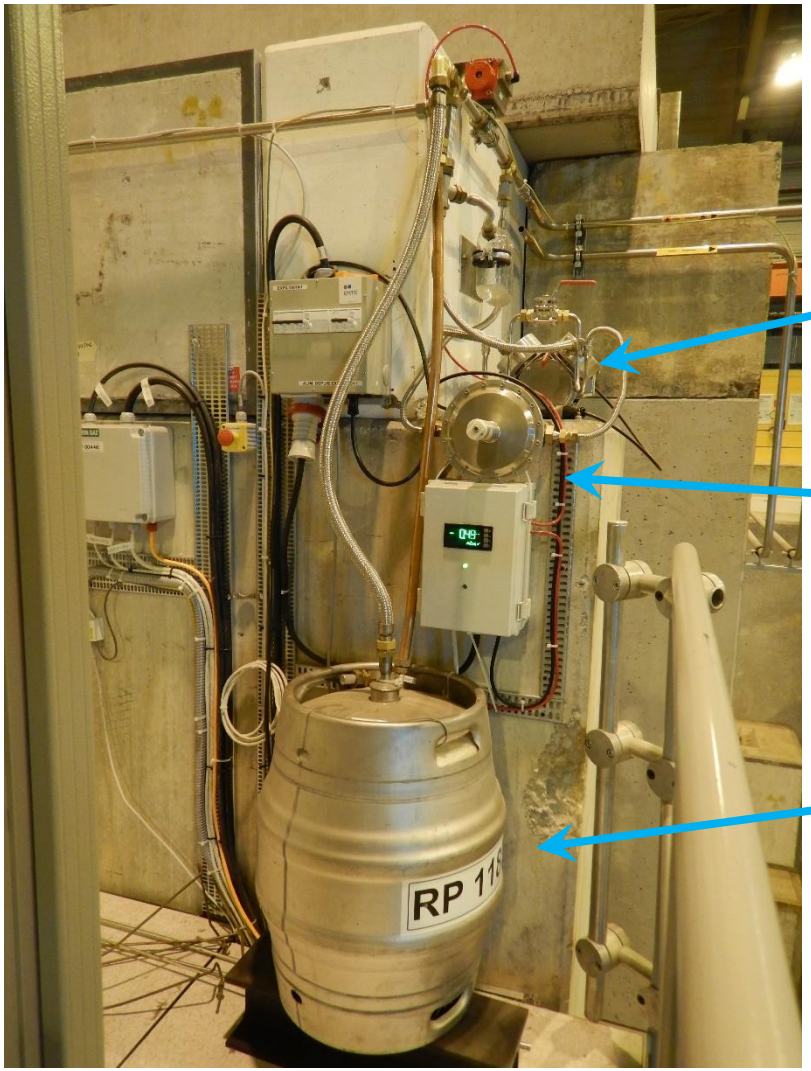
Gas mixture distribution panels

- Location of distribution panels



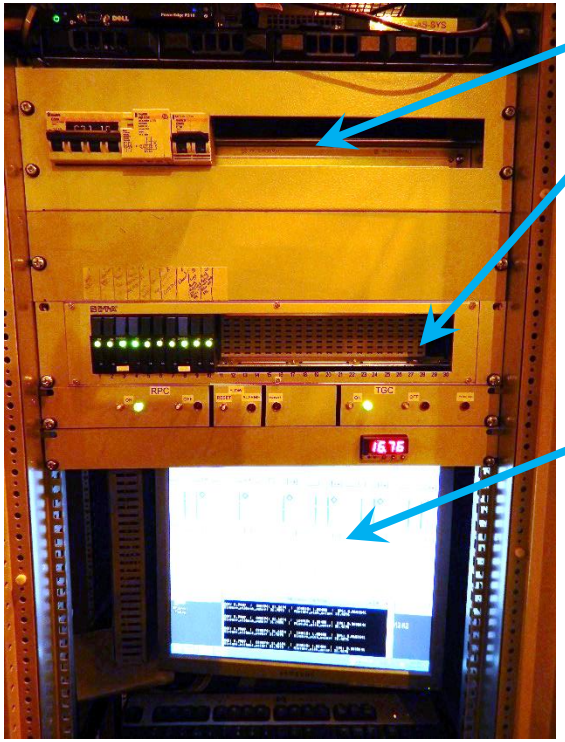
Exhaust pressure regulation

- Extraction systems needed to create slight under-pressure in the exhaust line
- needed to guarantee that gases are really exhausted through the exhaust line out of the building



Gas mixers

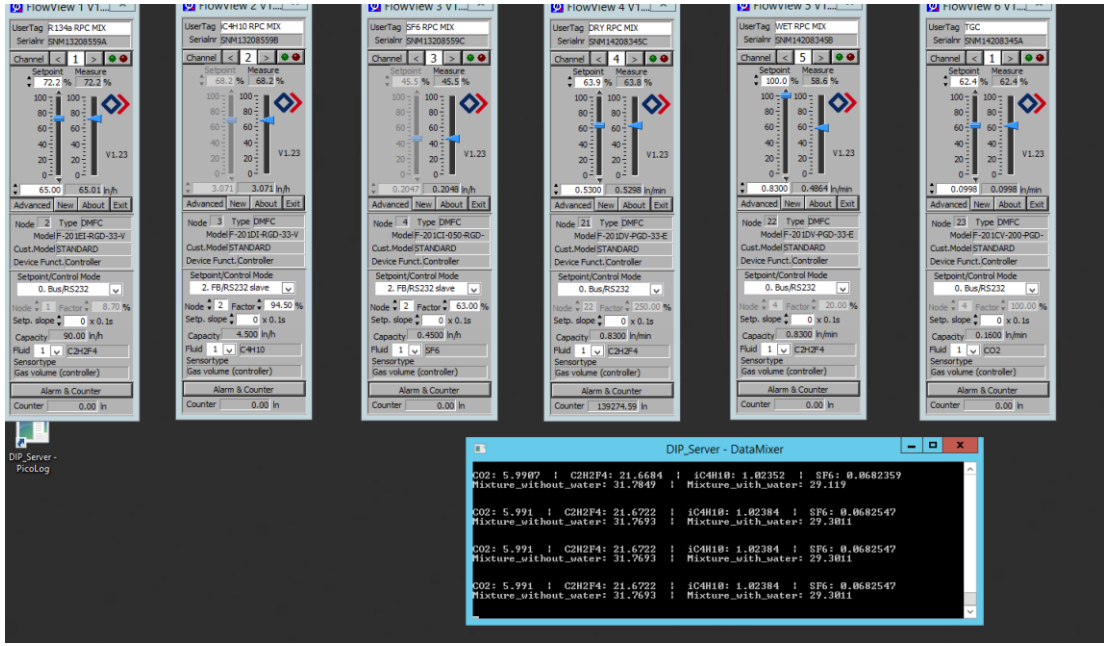
- Beam and cosmic triggers



Power supply

On-site interface and temperature monitoring for nC5H12 thermal bath

Software controls and parameters distribution through DIP protocol

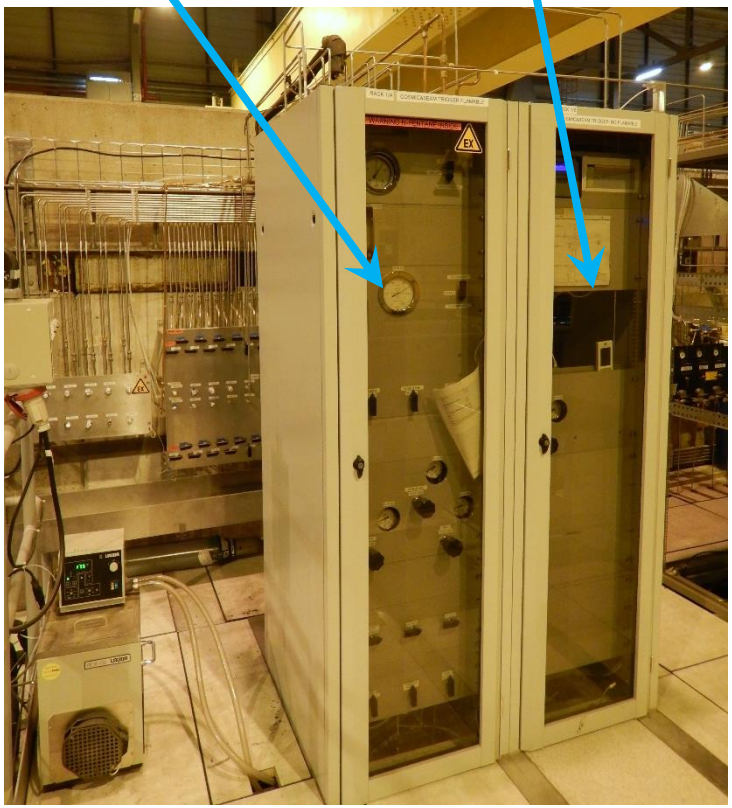


Gas mixers

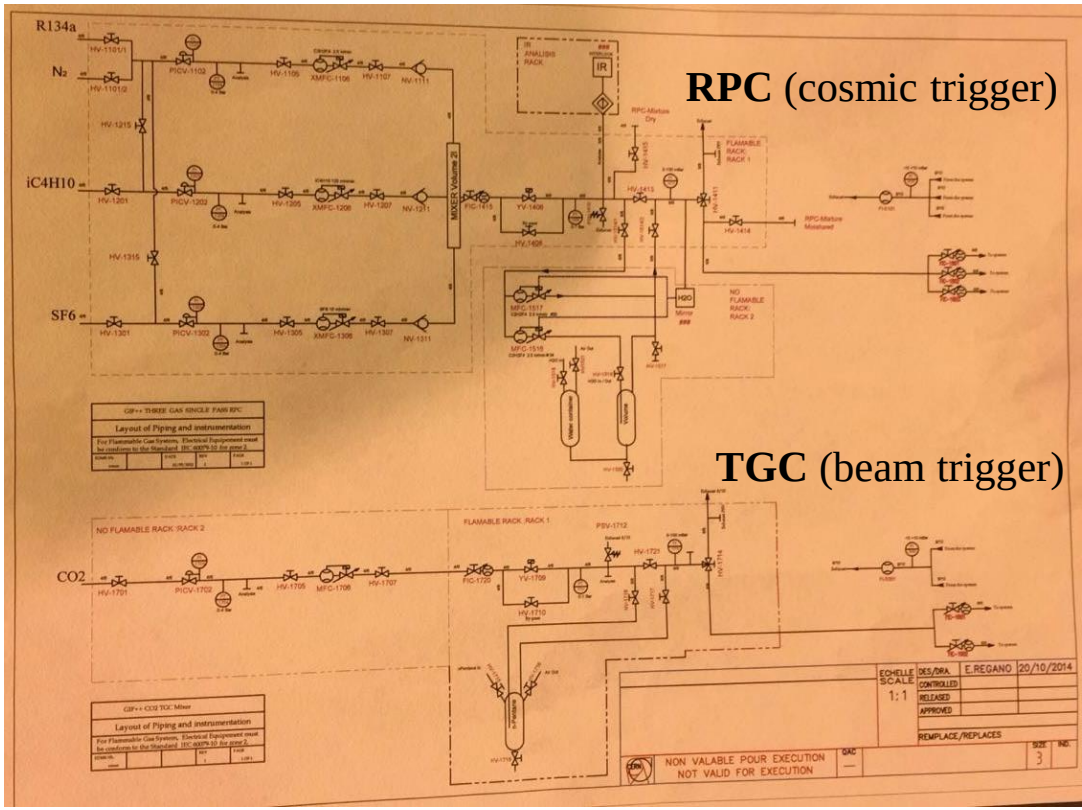
- Beam and cosmic triggers

Beam and cosmic mixers:
ATEX components

Non ATEX components



P&I diagram



Gas mixers

- Beam and cosmic triggers

RPC and TGC mixture distribution

RPC humidifier

IR monitoring and flammability interlock of RPC mixer

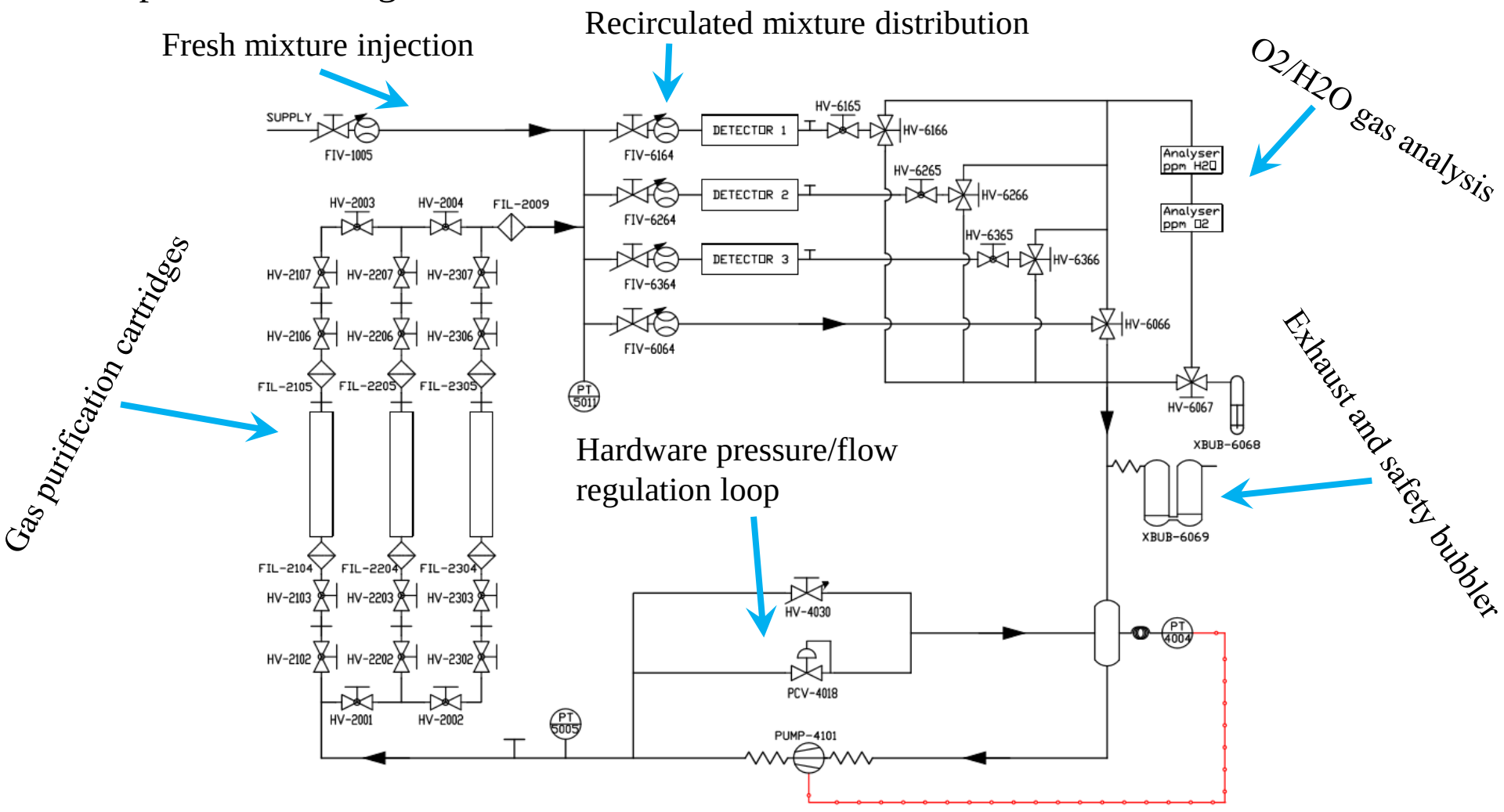
Gas recirculation systems

- In real systems gas mixture is often recirculated (at LHC experiments 90% of gas systems are recirculating the gas mixture)
  - Two main reasons: reducing operational costs and greenhouse gas emission
- As a result of a R&D on gas system we developed a new portable gas recirculation unit
  - advantages: much cheaper of previous version (25 kCHF wrt 90 kCHF) and, most important, much more reliable and easier to operate
- 5 systems produced (2 operational at GIF since almost 2 years)

Gas purification cartridges

Gas recirculation systems

- Simplified P&I diagram



B. Mandelli et al., A new portable gas recirculation unit for gaseous detector R&D, CERN EDMS note 1734199.

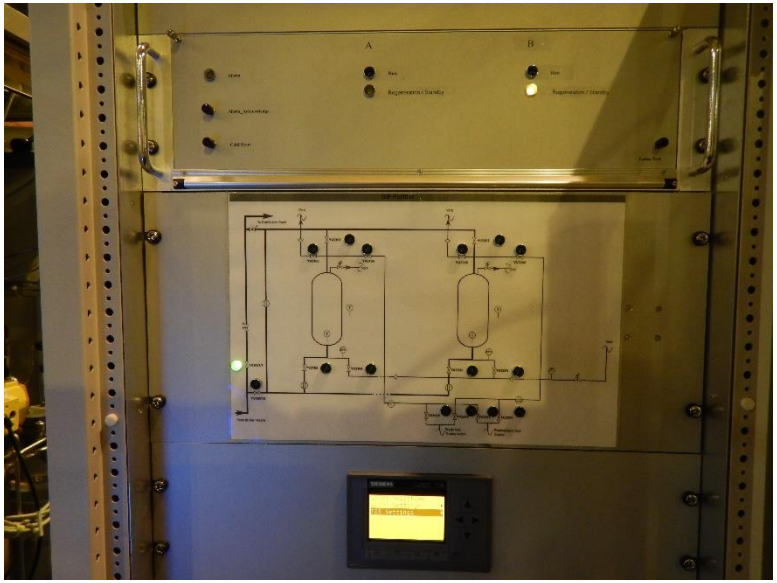
Gas recirculation systems

- Second generation of new gas recirculation system
- It includes a fully automated purifier module (suitable for detectors requiring regeneration of absorber material too often)
- Installation completed; Being commissioned at GIF

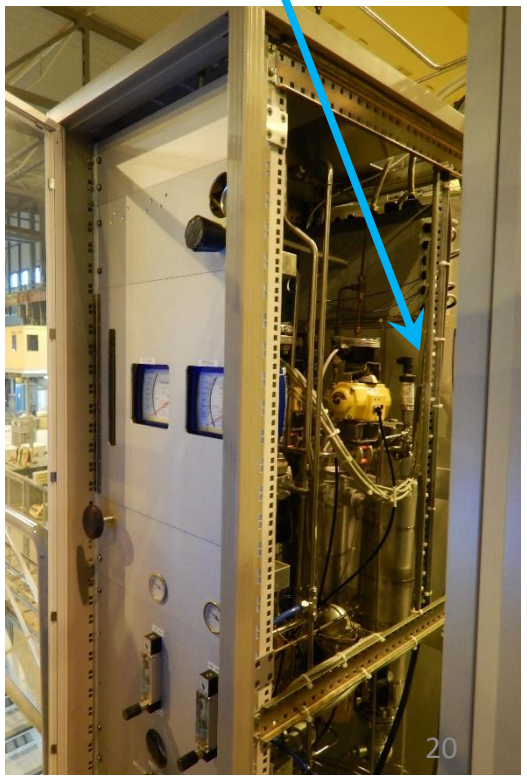
Gas recirculation module

Gas mixture purification module

Monitoring and controls panel



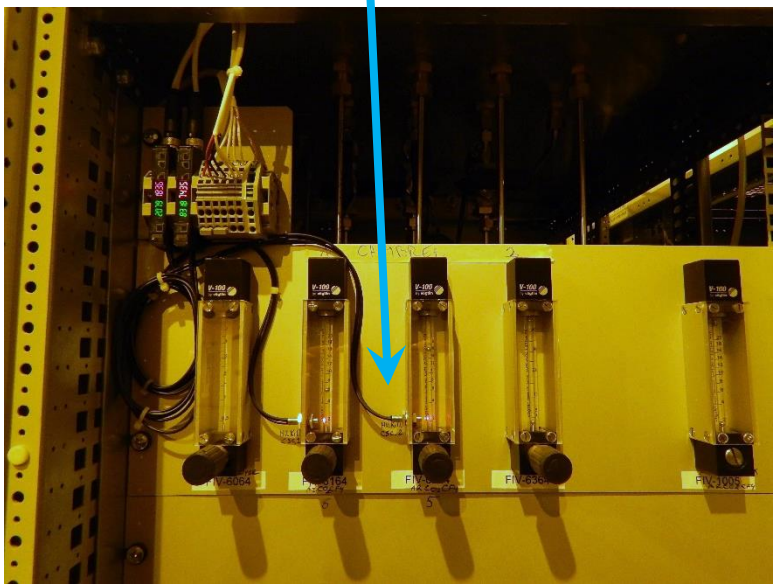
Cartridges with cleaning agents



Gas flow monitoring and alarms

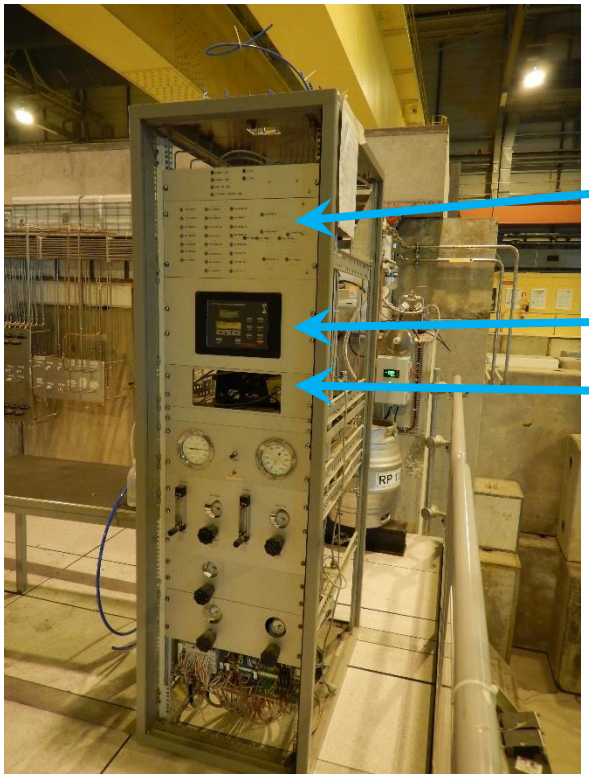
- Developed a system to check if flow in each recirculation loop is according to required values. In case of problems, warning and/or interlock signals are sent to DCS or HV system

Gas flow is verified by means of optical sensors without contact with the gas mixture



Gas analysis

- O2/H2O: standard LHC experiments - like analysis rack



Gas streams connected for analysis and/or calibration

O2 analyser

H2O analyser

Gas analysis

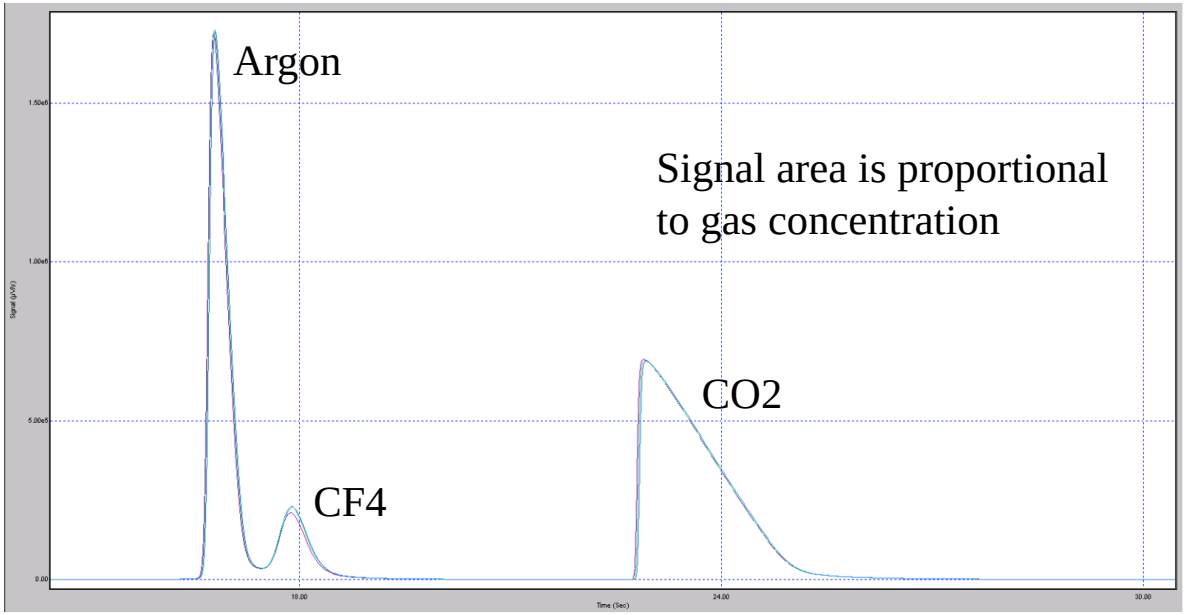
- Gas chromatographic analysis: allows monitoring gas mixture composition and presence of impurities on return from detectors under test

Sampling manifold

PC for GC software controls

GC analyser (3 modules for large spectra gas separation)

Gas chromatogram



Conclusions

- The CERN-GIF++ irradiation facility is operational since 2015:
  - GIF++ is a unique place for detector R&D

- The gas systems infrastructure is a key element of the successful R&D programs performed at GIF++
  - New mixing units and gas recirculation modules have been developed and build for GIF++
  - Further development are ongoing to have systems allowing operation of detectors requiring high gas filtering capacity
  - Design, components and construction procedures follow from experience and development of the gas systems for the LHC experiments
  - Gas analysis and especially gas chromatography are now available to all GIF++ users

Deliverables vs achievements

D15.10 : GIF++ gas system [24]

The gas system has been equipped with additional distribution panels and mixers to allow for more parallel users. An IR analysis system has been installed. (Task 15.5).

All deliverables achieved (in blue). In addition to many other developments/achievements.

- New mixing units have been developed and build for GIF++

  → Installed and operational

- Additional gas distribution panels have been included at supply and in the gas systems

- New gas recirculation modules have been developed and build for GIF++

  → 1 operational since beginning 2015, 1 since 2016 and one recently installed (commissioning will start in about one month)

- Further development are ongoing to have gas recirculation systems allowing operation of detectors requiring high gas filtering capacity

  → New design for an automated purifier for GIF++ (first application for the ATLAS and CMS RPC R&D)

- Gas analysis and especially gas chromatography are available to all GIF++ users

  → GC operational since beginning 2016

  → IR analysers since 2015. A second installed 2016

  → Automated O2/H2O analysis rack will be connected in september 2017

- Design, components and construction procedures follow from experience and development of the gas systems for the LHC experiments