Status update

WG5.1 Status report

Summary of results obtained in the first year of the project

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High Energy Physics and Instrumentation Center at USP

Schedule

4. Instrumentation Research and Development: MPGD					
4.1 MPGD R&D					
Construction of the beamline for tests of MPGDs	X	X	X		
Studies of ion backflow using ion probes			X	X	X
Implementation of DRS as a diagnostic tool for the ALICE TPC	X	X	X		
Use of gas analyzer for gas degradation studies		X	X	X	X
4.2 MPGD Simulations					
Training	X	X			
Ion flux studies		X	X	X	X
Integration of Garfield++ and Geant4	X	X			
Simulation of ion probes in MPGDs			X	X	
4.3 MPGD Electronics					
Hardware integration of SAMPA in the SRS ecosystem	X				
Development of dedicated software and drivers for SAMPA in the SRS system	X	X			
Development of a compact standalone acquisition system based on SAMPA (HW)	X	X			
Development of acquisition software and drivers for the standalone acquisition	X	X	X		
Development and optimization of reconstruction routines	X	X	X	X	
Studies for a next generation electronics for MPGD		X	X	X	X
4.4 MPGD Applications					
Study and optimization of single layer ^{10}B converter associated to GEM-based amplification and readout (thermal neutron beam monitor)	X	X			
Validation of beam monitor for thermal neutrons		X			
Study and optimization of multilayer, ^{10}B coated ThickGEM based, converter for thermal	X	X	X		
neutron (detection efficiency optimization)					
Developing and validation of a big-area, efficient, position sensitive, thermal neutron detector		X	X	X	
Study and development of customized application for neutron detector (e.g. RMB)		X	X	X	X
Development of a prototype for monitoring of runaway electrons in a fusion reactor		X	X		
Validation and accreditation of data using monochromatic electron beam				X	
Development of a prototype for monitoring of runaway electrons in a fusion reactor		X	X		
Validation and accreditation of data using monochromatic electron beam				X	

Schedule

7. ALICE Upgrade Activities					
Construction of a degradation chamber	X				
Development of DRS as a tool for the ALICE TPC diagnostics		X	X	X	
Studies of gaseous chemical reactions and outgassing triggered by radiation			X	X	X
Studies of the HGCROC performance	X				
Contribution to the design of PAD readout; validation of prototypes; TDR	X	X	X		
Production and test of PAD readout front-end electronics			X	X	
Contribution to FoCal construction				X	X

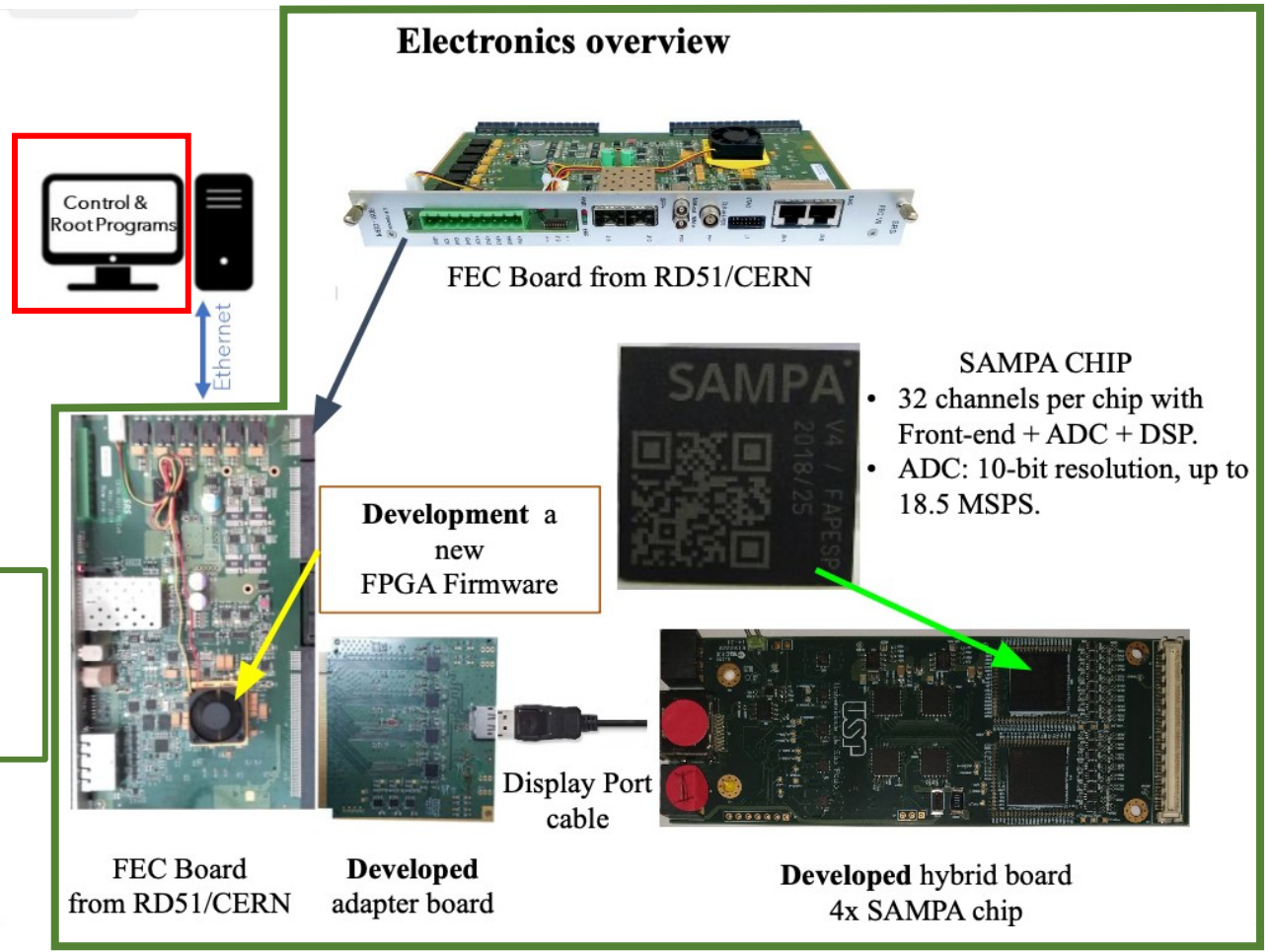
MPGD Electronics

SAMPA-SRS

Status >6 months ago

SW&controle: control (configurations) done with command line or scripts. Acquisition done saving on disk the flux of network date (via WireShark software). Then offline convertion/decoding

All HW parts: almost final prototype, being tested extensively.



SAMPASRS Software (©Thiago for the 0nline part)

sampa_control
slow control cfg

interface to operate and configure the system

sampa_acquisition
DAQ

network package capture (via dedicated fast library). Streaming to disk, sustains 1GBps ethernet data flow

sampa_gui
DAQ visualization

Interface for acquisition/data monitor. fraction of the data is sampled and used for QA histograms

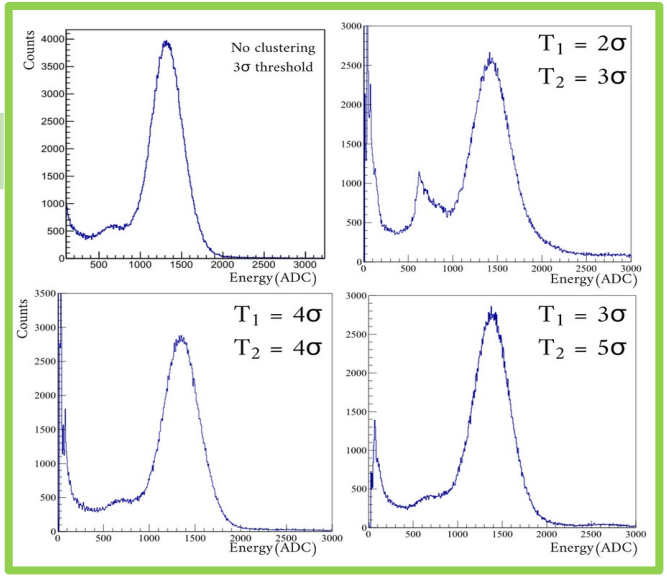
On-line

QA histos

sampa_decoder
data interpretation

De-coding the FEC data flow
Create root-files

Off-line



create_pedestal
pedestal files for ZS

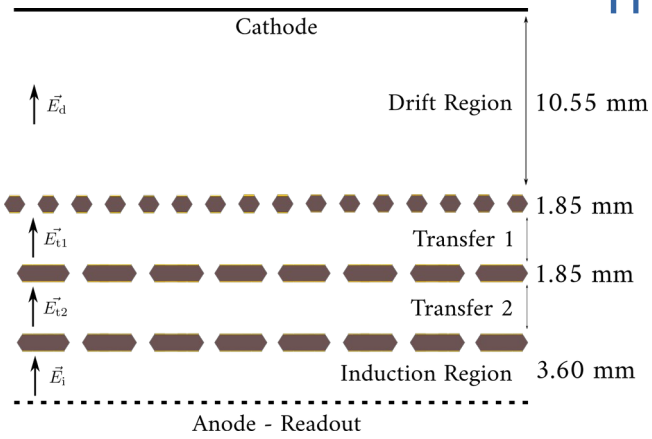
pedestal can be used either off-line, or to criate thresholds to be upload on the SAMPA. (on-line ZS)

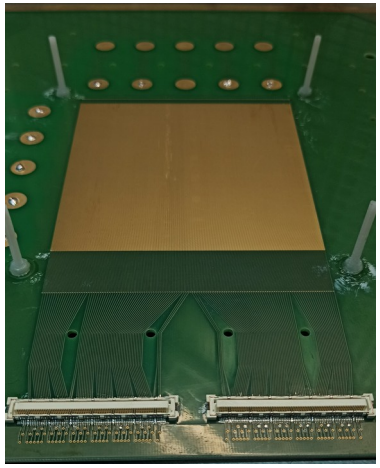
clustering
data tree for analysis

clustering + analysis

Testing SAMPA-SRS with a detector

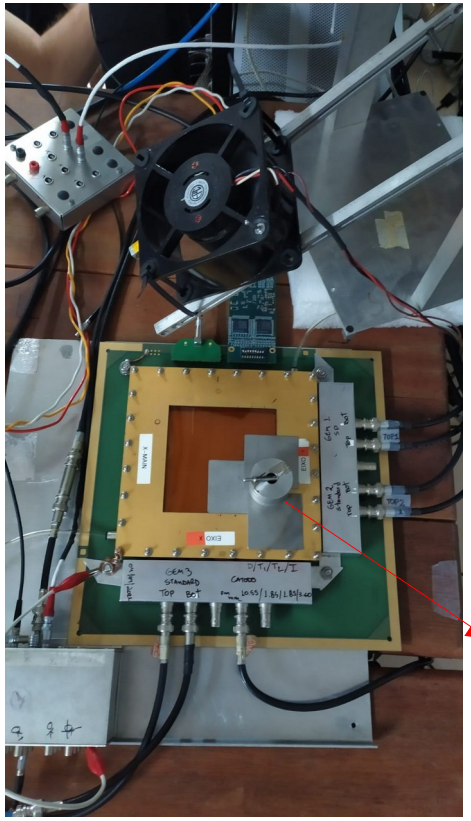
Triplo GEM Ar/CO_2



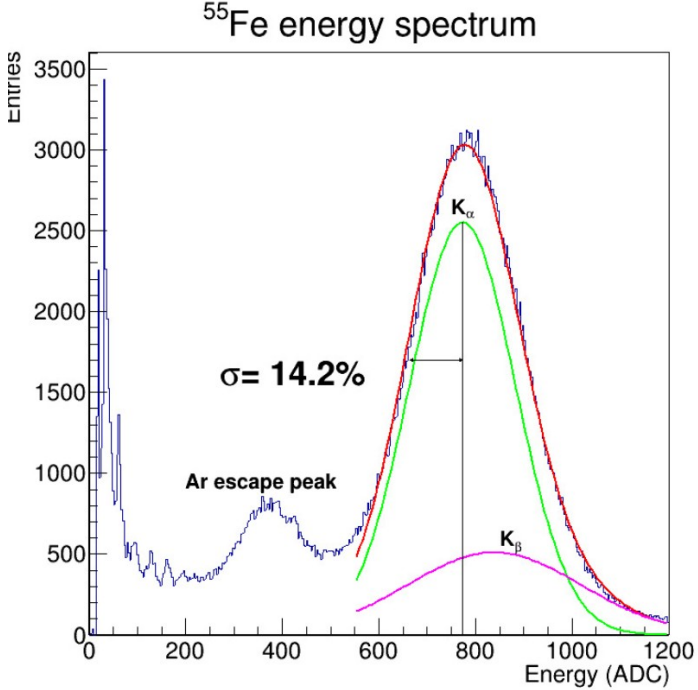


Designed by T. Abelha HEPIC@IFUSP

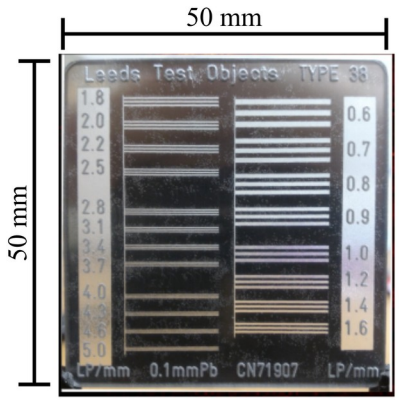
Strip Readout 1D (0.4 mm pitch)

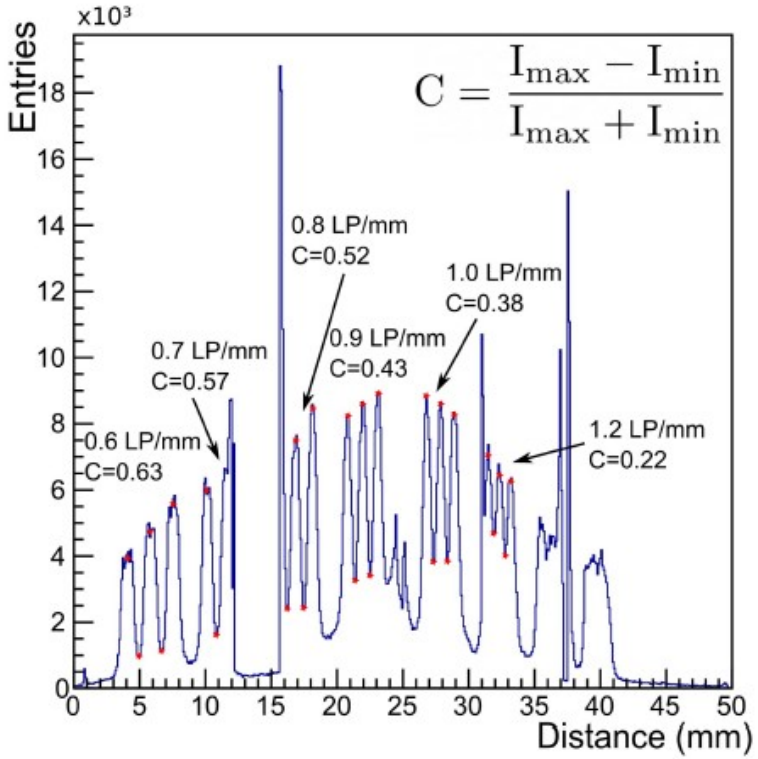


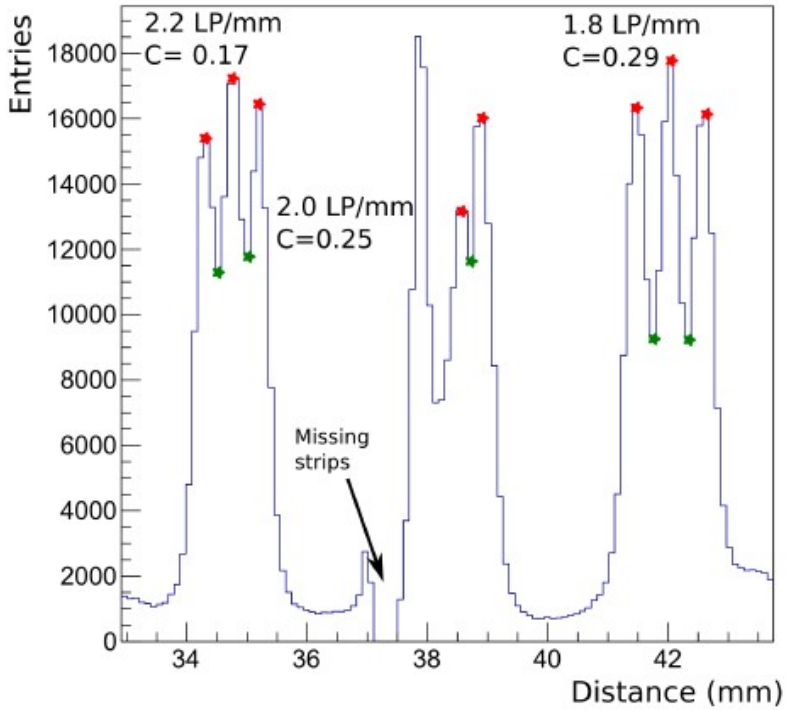
^{55}Fe source



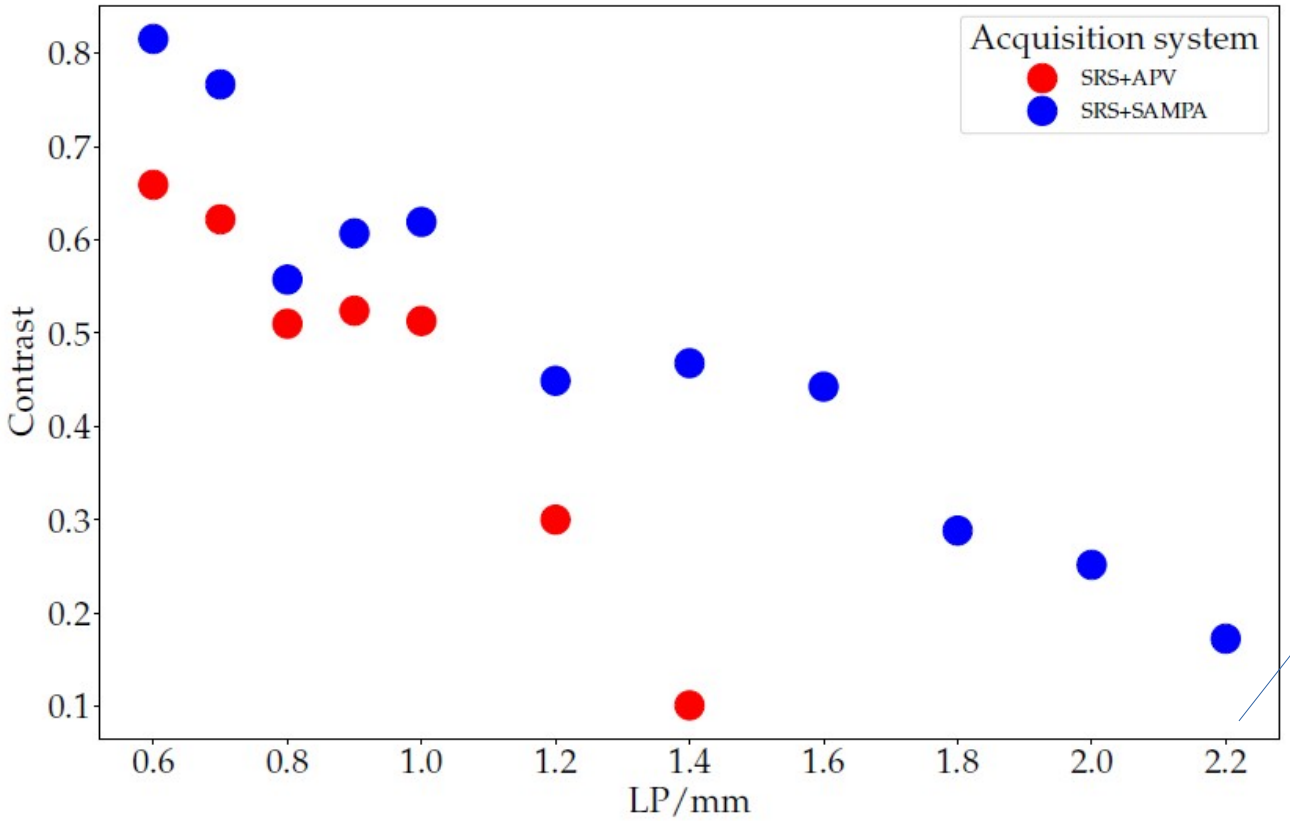
Spatial resolutions







Spatial resolution (preliminary)



That means better than 450µm

From RD51 to RD1

Following the "recommendations of the ECFA CERN will re-organize the projects acting in the R&D of detectors, "new (code)name: DRDs (Detector R&D)

Current groups ("RD##") will be closed, and, if applicable, become part of the new DRDs

- Thus, RD51 is in its last year of activity.
- Now (2023) is being outlined the new "DRD1: gaseous detectors"
- The current RD51 community is being a key player and leader in the "molding" of this new DRD1
- Lots of discussion about how to keep everything you've given, and are continuing to give, right from the current RD51
- Our group is interested in being kept in this communication and entering the new DRD1
- The new DRD1 includes all the R&D on gas detectors, we have already established contacts with other groups (=Rio) that work with gas detectors to have a joint "Brazilian" action in this new DRD1

  First “DRD1 kickoff meeting” at CERN in March, one of us managed to attend in person
  A second meeting will happen end of June, we will attend via Zoom.

MPGD Electronics, Status

- *Hardware integration of SAMPA in the SRS ecosystem*
  - *First prototype of hybrid and interface-card tested and validated. Updated hybrid being mounted in the forthcoming weeks*
- Development of dedicated software and drivers for SAMPA in the SRS system
  - *First version of acquisition software developed and working*
- Development of a compact standalone acquisition system based on SAMPA (HW)
  - *Proof of principle using and adapter cared and a SoCKit CycloneV*
- Development of acquisition software and drivers for the standalone acquisition
  - *Proof of principle modifying the software used during SAMPA test/validation*
- Development and optimization of reconstruction routines
  - *Studies on clustering (Thais' article), data selection, tracking, etc. in the Geovane's theses*
- Studies for a next generation electronics for MPGD
  - *Under discussion "next SRS". Next generation ASIC (Salsa project) outside Tematico.*

MPGD Applications, Status

- Study and optimization of single layer 10B converter associated to GEM-based amplification and readout (thermal neutron beam monitor)
- Validation of beam monitor for thermal neutrons
- Study and optimization of multilayer, 10B coated ThickGEM based, converter for thermal neutron (detection efficiency optimization)

  We had the first prototype in the Lucas' Master (before Tematico). Extensive simulation study in the Renan's Master.

- Developing and validation of a big-area, efficient, position sensitive, thermal neutron detector
- Study and development of customized application for neutron detector (e.g. RMB)

  Lack of manpower. We need to be more aggressive in searching students…

- Development of a prototype for monitoring of runaway electrons in a fusion reactor
- Validation and accreditation of data using monochromatic electron beam
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  Local Tokamak in maintenance since before pandemic… we need some boost on these lines

Schedule overview

MPGD Electronics	1y	2y	3y	4y	5y	
Hardware integration of SAMPA in the SRS ecosystem	X					85%
Development of dedicated software and drivers for SAMPA in the SRS system	X	X				65%
Development of a compact standalone acquisition system based on SAMPA (HW)	X	X				35%
Development of acquisition software and drivers for the standalone acquisition	X	X	X			10%
Development and optimization of reconstruction routines	X	X	X	X		40%
Studies for a next generation electronics for MPGD		X	X	X	X	10%
MPGD Applications						
Study and optimization of single layer ^{10}B converter associated to GEM-based amplification and readout (thermal neutron beam monitor)	X	X				50%
Validation of beam monitor for thermal neutrons		X				0%
Study and optimization of multilayer, ^{10}B coated ThickGEM based, converter for thermal neutron (detection efficiency optimization)	X	X	X			10%
Developing and validation of a big-area, efficient, position sensitive, thermal neutron detector		X	X	X		0%
Study and development of customized application for neutron detector (e.g. RMB)		X	X	X	X	0%
Development of a prototype for monitoring of runaway electrons in a fusion reactor		X	X			0%
Validation and accreditation of data using monochromatic electron beam				X		0%
Development of a prototype for monitoring of runaway electrons in a fusion reactor		X	X			0%
Validation and accreditation of data using monochromatic electron beam				X		0%

MPGD R&D

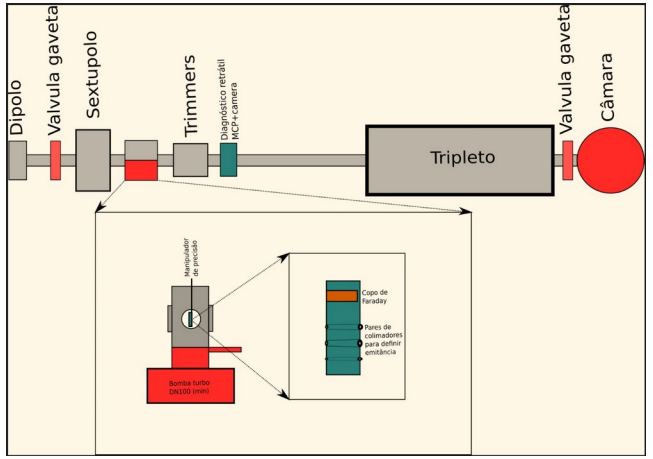
New developments on GEM

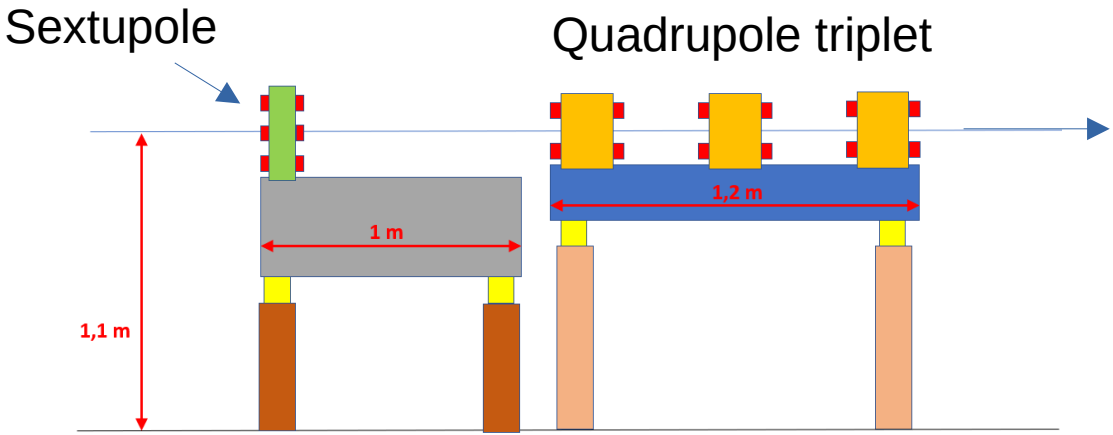
GEM (and LGAD) test facility: proton beams

- Collaboration with CNPEM
- 1 sextupole and 3 quadrupole lenses
  - *From the UVX storage ring*
- Mechanical support and vacuum chambers
  - *Mechanical support being adapted*
- Cooperation agreement under discussion
  - *Documents are necessary for magnets transfer*

GEM (and LGAD) test facility: proton beams

- Collaboration with CNPEM
  - Magnets, supports and beam scanner
- Target of a compact solution for a optical beam line
  - ~10 um beam spot
  - ~1 mm scanning area
  - Imaging with PIXE and RBS
- Supports and magnets will be shipped by next month





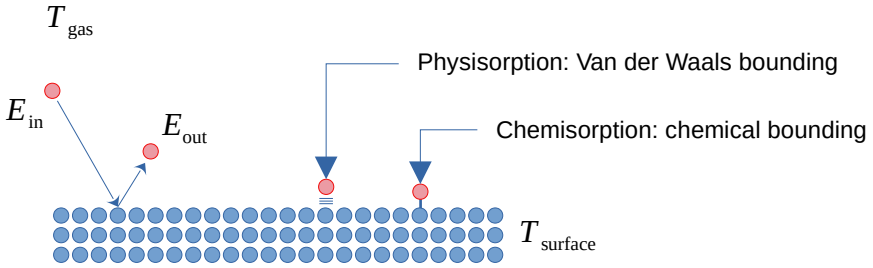
MPGD Simulations

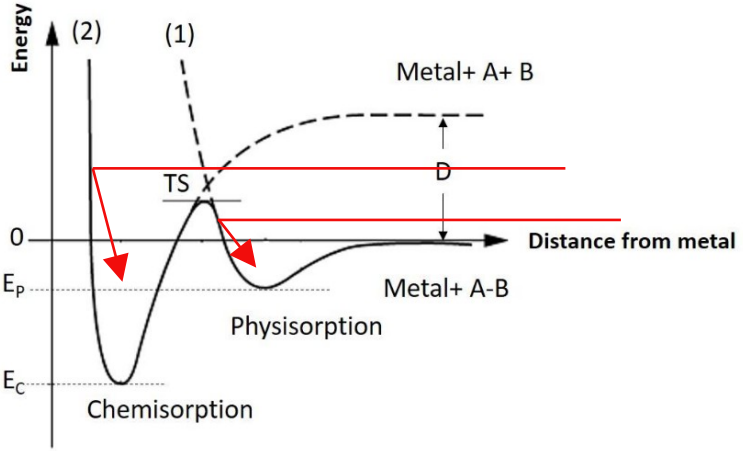
GEM degradation

Simulations

$$E_{out} = E_{in} + A_{th}\left(E_{in} - E_{surface}\right)$$

- Kinetic Monte-Carlo (KMC)
  - Markov chain
  - Boltzmann distribution
    - *gas and surface*
  - Mean field approximation
    - *Physical adsorption*
    - *Chemical adsorption*
    - *Conversion*
    - *Desorption*
    - *To be implemented:* Reduction
  - Parameters: Gas and surface temperatures, binding energies, threshold, pressure





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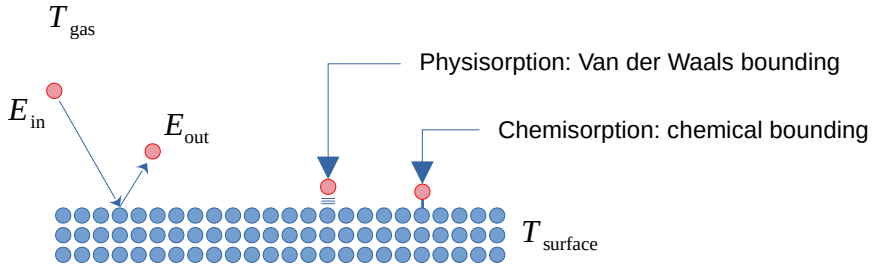

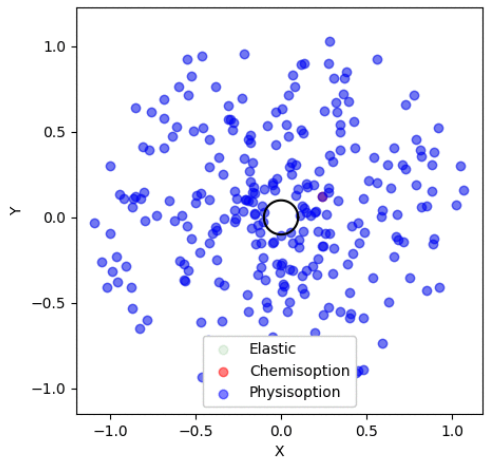

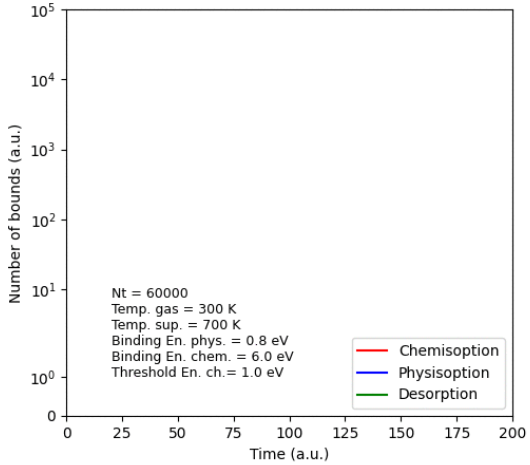

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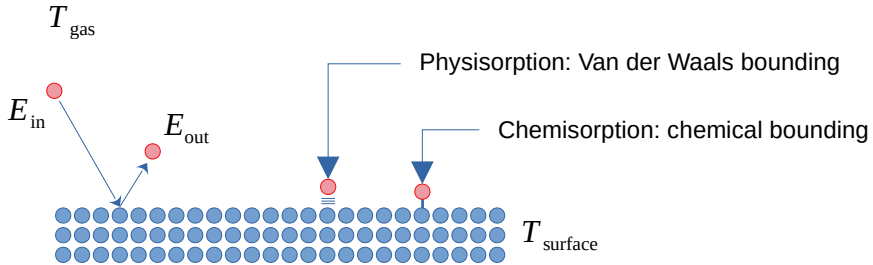

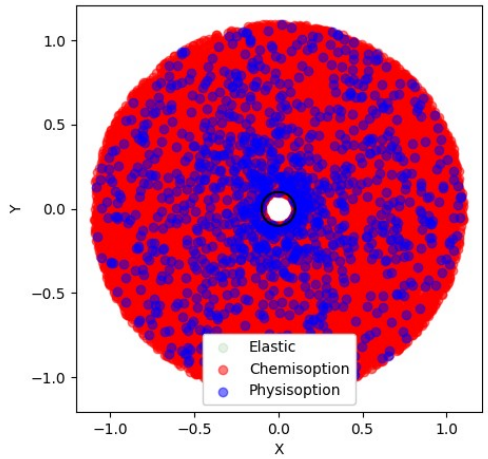

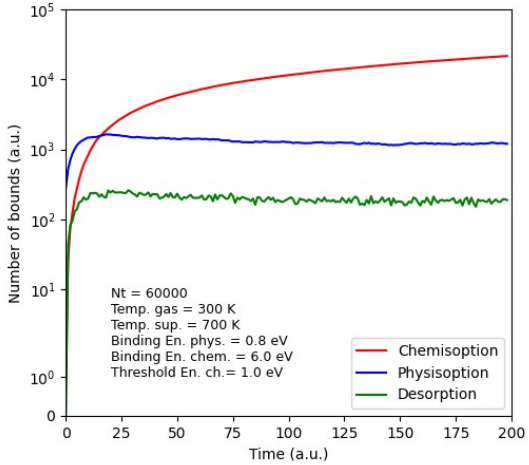

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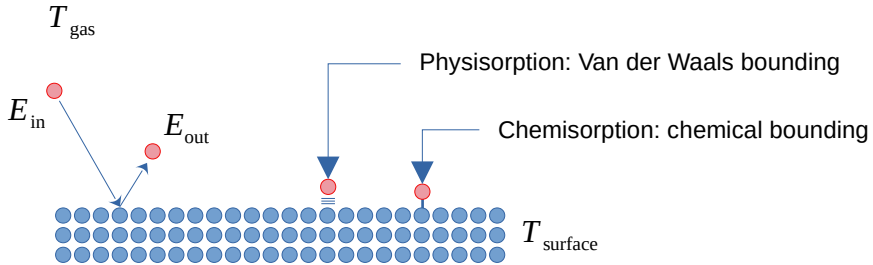
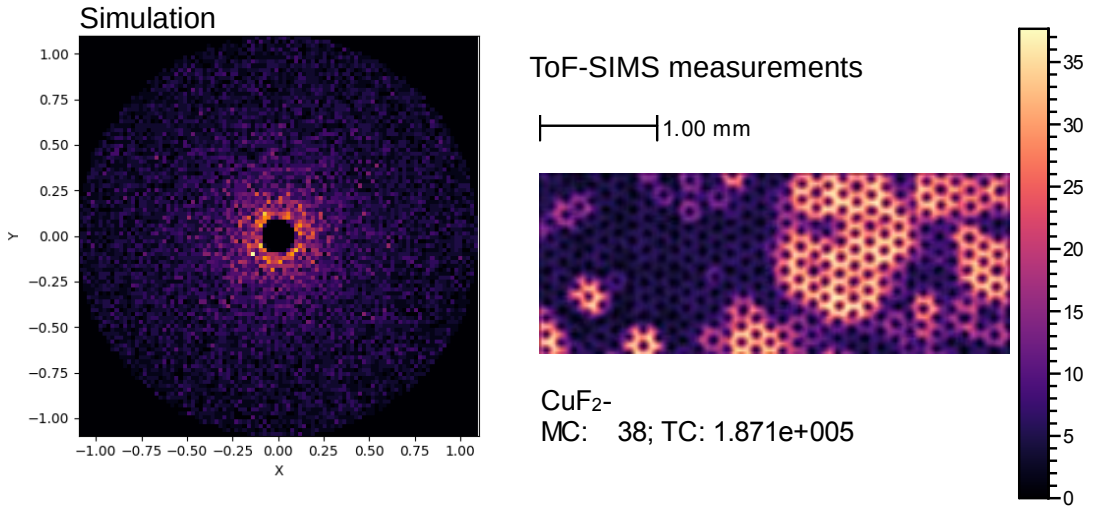
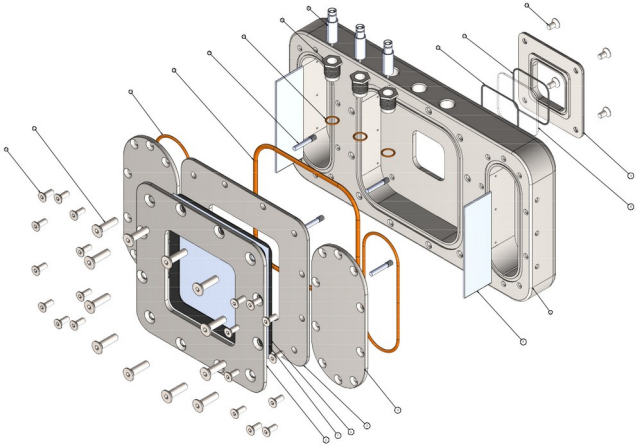
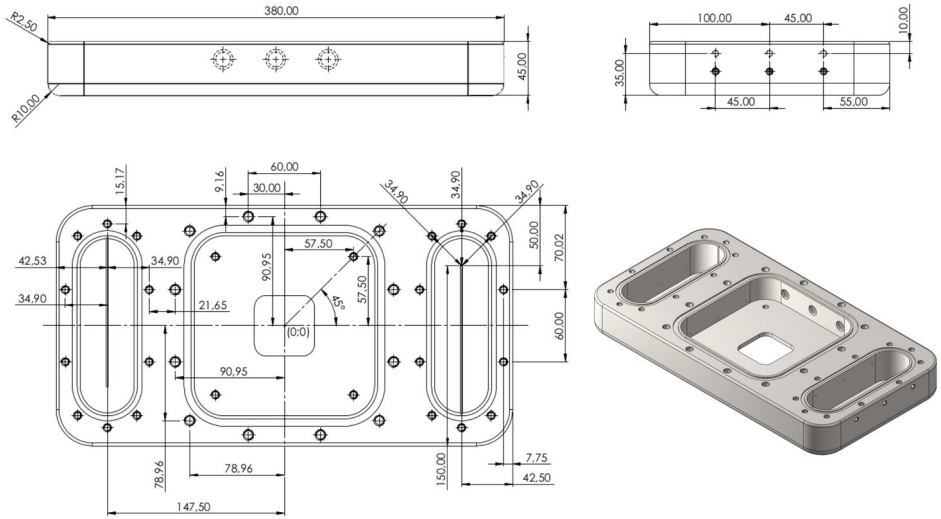


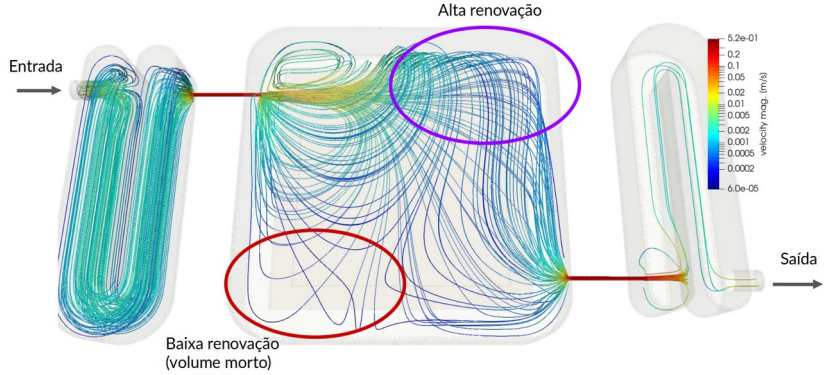


GEM degradation chamber

- Design oriented to cleanness and monitoring requirements
  - Gas flow simulation for dead volume and residence time determination
  - Mechanical design in a single stainless steel block



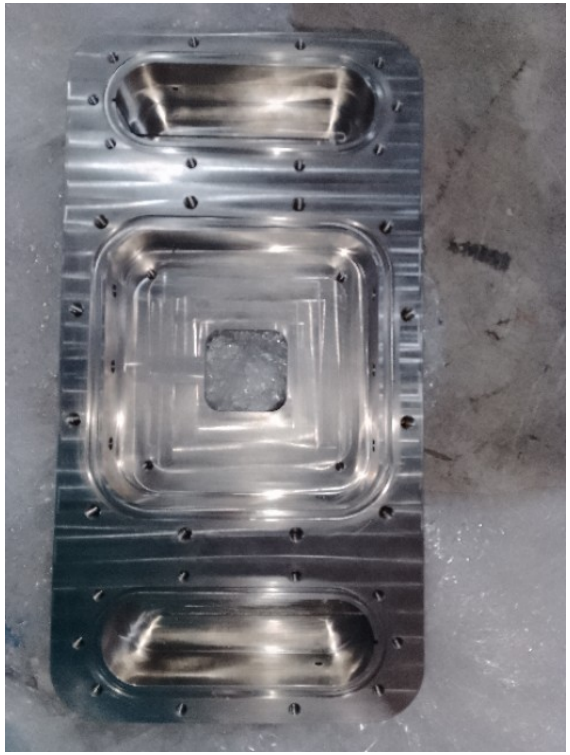




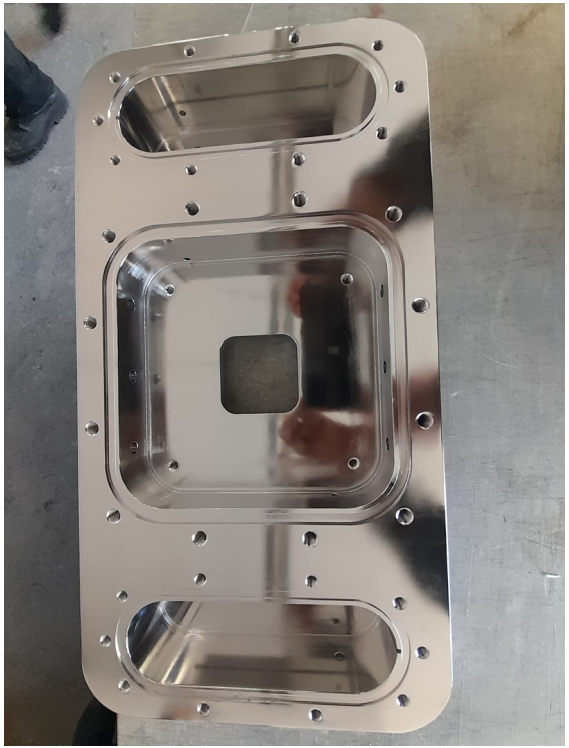
GEM degradation chamber

- Production in the IFUSP mechanical workshop using CNC
  (precision ~ 0,005 mm)

Before surface treatment

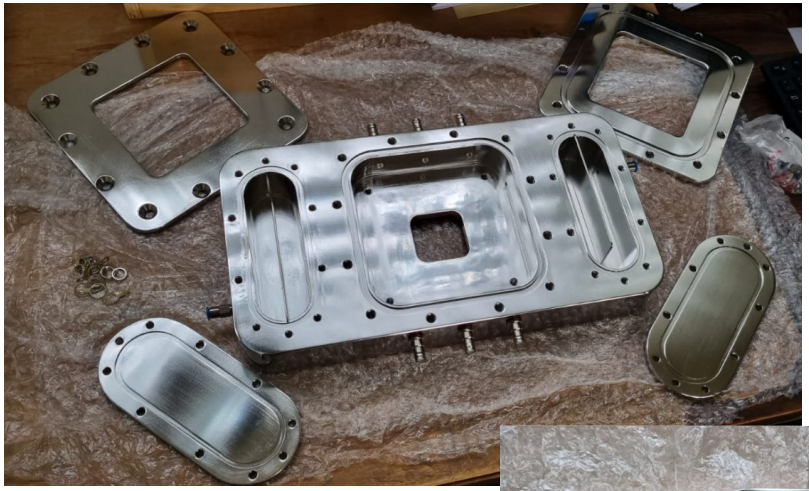


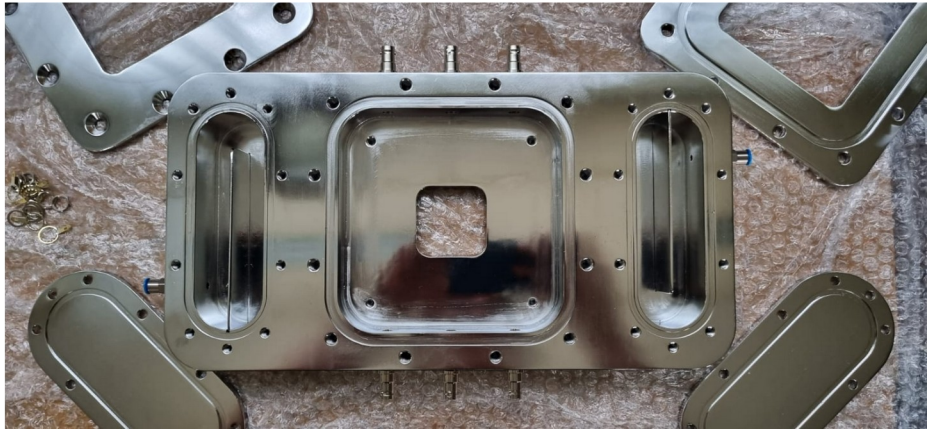
After surface treatment

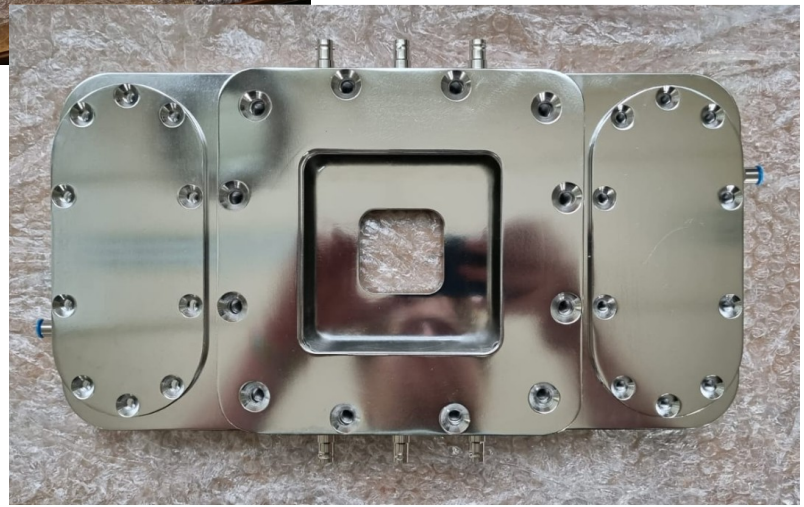


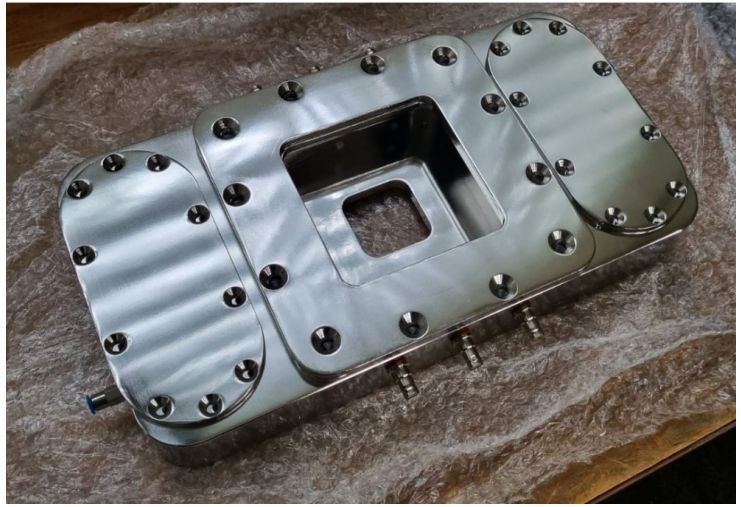
GEM degradation chamber

- Assembly



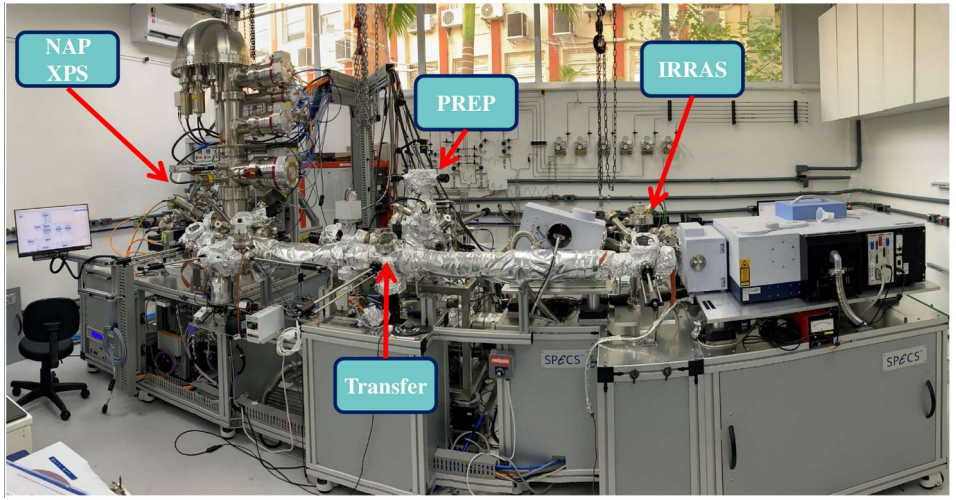






GEM degradation studies

- CBPF collaboration: NAP-XPS measurements
  - *Surface and Interface Phenomena Laboratory*
  - *Dr. Camilla de Sá Codeço*
- NAP mode out of operation :-/
  - *On line surface reaction analysis*
- Offline mode performed



ALICE GEM samples

Analysis procedure (CO_2 adsorption on copper surface):

- **Preparation:** clean the surface with argon sputtering (~1keV)
- **Exposure:** Expose the samples to different CO_2 pressures
- **Analysis:** Evaluate the carbon concentration at the surface with XPS

Data analysis is still preliminary

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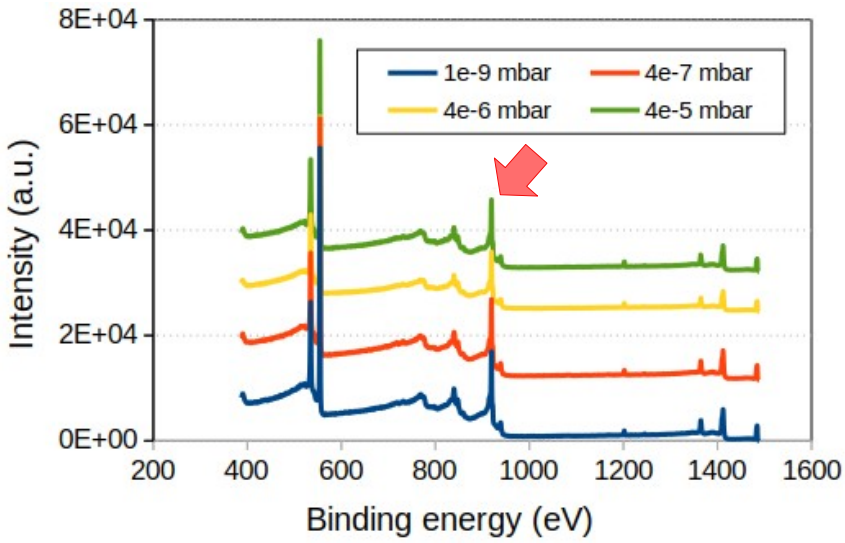

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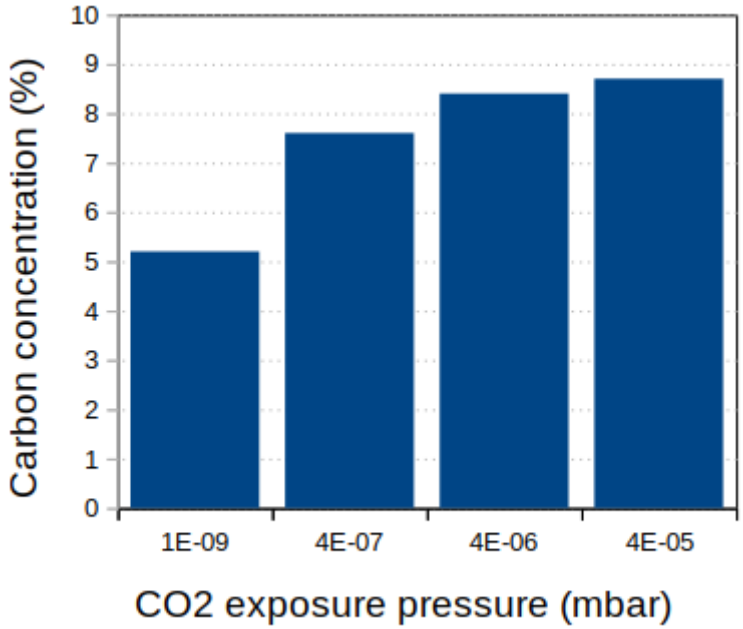

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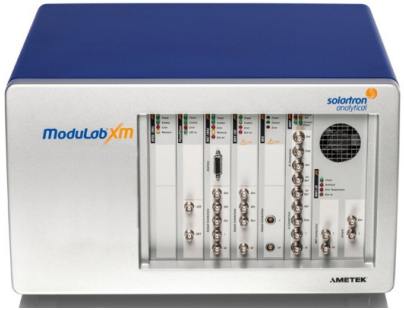
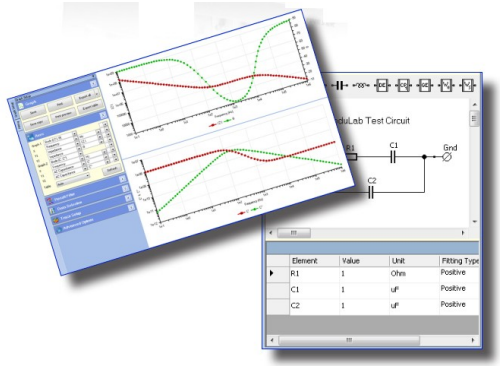
Perspectives to the next year: new equipment

- **ModuLab XM**
  (Solartron Analytical/AMETEK)
  - With high-voltage module (2023-2024)
  - Simulation software license (used to interpret the data and compensate for additional circuitry)
  - Upgrade:
    Femto Ammter module (2025)
- Multiuser documentation

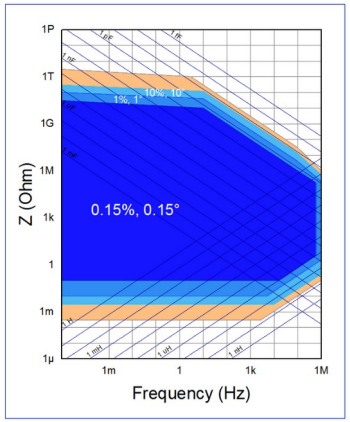




By 2024:

MAT Impedance Accuracy

Impedance accuracy for MAT operating stand alone

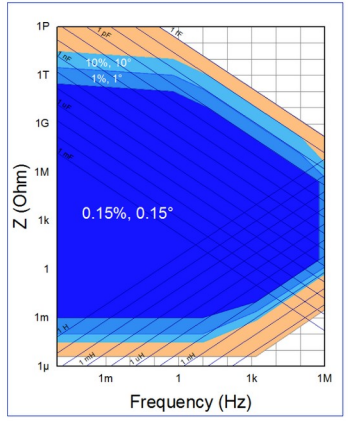


*High Voltage option module provides up to 10X higher impedance than shown
*MREF is used for dielectrics (1 pF to 10 nF) and high impedance measurements
*Faraday cage is recommended for dielectric and high impedance measurements

By 2025(1):

System Impedance Accuracy

Impedance accuracy specification for MAT, Femto Ammeter, 2A booster and MREF



*High Voltage option module provides up to 10X higher impedance than shown
*Femto ammeter and MREF is used for dielectrics (1 pF to 10 nF) and for high impedance
*2A booster is used for very low impedance measurements (sub 100 mohm)
*Faraday cage is recommended for dielectric and high impedance measurements

Perspective to the next year:
GEM degradation studies: new facilities at LAMFI

- Sensitive ToF-SIMS measurements revealed the degradation pattern of GEM by the kapton erosion and deposition
- Auriga FEG with FIG (liquid Ga ion source)
  - *3 nm resolution for precise cut*
  - *EDS and WDS*

ToF-SIMS4 / iontof

Auriga FEG / Zeiss
CrossBeam Workstations (FIB-SEM)