

**Procedure GEM Framing and Testing**  
**sPHENIX Project - Time Projection Chamber**  
**Revision 1.0**  
**May 4, 2020**  
**Procedure No. sP-SE.QAM.012**

**sPHENIX Project DETECTOR-SPECIFIC QUALITY ASSURANCE PLAN**

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**Quality Assurance Plan Version Control**

Revision	Date	Authors	Change Description
1.0	5/04/2020	Oleg Grachov	Initial release

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## **1.0 Purpose and Scope**

These procedures are designed to ensure that the processing of Gas Electron Multiplier (GEM) foils at the sPHENIX TPC “framing centers” is performed safely and correctly.

## **2.0 Definitions**

- GEM: “Gas Electron Multiplier” foil (also referred to as just “foil”)
- TPC: “Time Projection Chamber”
- HV: “High Voltage”

## **3.0 Responsibilities**

This section describes the responsibilities for two roles, “owner” and “operator”.

- Operator: Observance of all rules regarding proper foil handling and safe operation of the fixtures and test equipment used in the clean room, following the documented project-defined procedures, and direct instructions of the “owner,” to frame and test GEM foils, recording and stewardship of the test data obtained for each foil processed in the clean room.
- Owner: leadership of all clean-room operations, ensuring that all “operators” have been properly trained, operate safely, and use only the approved procedures at all times, ensuring that the foil test results are recorded and made available to project management, presentation of project status and foil test results at all appropriate meetings.

## **4.0 Prerequisites**

Qualified operators must be familiar with, and follow at all times, the local ES&H regulations of each framing center’s institution. They must also read, and follow at all times, the documented procedures for foil framing and testing.

## **5.0 Precautions and Limitations**

This document pertains only to the GEM framing and testing (Leakage Current Measurements) operations at the framing centers. Upon successful processing at the framing centers, the framed and tested foils are sent to collaborating institutions for full chamber assembly and testing. These operations are described on separate SOP documents.

## **6.0 Procedures**

In the case of the TPC it is of special importance to ensure that only highest-quality GEM foils enter the readout chambers. The reason is that a TPC has no redundancy for the readout chambers. If any sector in the stack stops operation the TPC volume perpendicular to this sector cannot be read out anymore and is lost. Further, the readout chambers seal the TPC gas volume such that they cannot be exchanged within runs. Concluding a high GEM quality is the key for a successful detector setup.

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The quality of a GEM foil can on first order be divided into optical and electrical quality. One optical quality feature is the number and size of defects on the GEM foil. Defects occur due to problems in the manufacturing process and are visible for example as over etched holes, connected holes or non-etched holes. In a visual inspection by eye and microscope such big defects might be spotted. The inspection is performed at PCB Workshop CERN after GEM production.

In order to reduce the total charge stored in the GEM foil, one side of the foil is segmented into 16 HV sectors. Each HV sector is powered separately through 20 M $\Omega$  SMD loading resistor soldered at PCB Workshop CERN directly onto the foil and connected to a HV distribution line implemented on the boundary of the foil. These resistors should be checked in framing center.

Electrical quality measure is the resistance of the GEM and operational stability regarding electrical breakdown at high voltages. Measuring the resistance of GEM involves a high voltage power supply to apply a potential across the all electrodes and a precise current meter to measure the residual current, determining the resistance by Ohms law. For a higher resistance of the GEM a better performance and stability is expected. The method is performed in room air at PCB Workshop CERN after GEM production.

The threshold conditions for leakage current measurements at which GEM foils are accepted vary slightly in previous experiments around (0.2- 0.5) nA at (500-550) V in nitrogen (or air) environment. Further, the operational stability of the GEM at high voltages is observed.

A sector should not exceed a specific number of electrical discharges or should calm down below a certain discharge rate. Additionally, it is of highest importance that the discharges do not occur at one specific position of the foil.

Due to its small structures the GEM is very vulnerable to dust such that all QA measurements and detector production steps are performed in clean environments. To clean up some contamination inside the GEM holes, the method high voltage (HV) cleaning is used. Here a high voltage is abruptly connected to the GEM electrodes without any voltage ramping process, using special HV splitting box. Further the power supply is allowed to supply a higher current compared to normal QA work. As a result the GEM discharges multiple times after connecting the HV and the high current in the sparks should burn away the contamination inside the holes. Usually the method is performed in room air. The method can also be used to rescue GEMs which are damaged by a high resistance short.

Whereas the optical quality control is only done once, the leakage current measurements are repeated for each production step to continuously ensure the quality of the foil. During the sPhenix TPC chamber production the following quality determining and assuring methods will be applied to GEM foils delivered from CERN, the list corresponds to the baseline solution:

- Visual inspection by eye, or microscope if needed to exclude bigger defects on the GEM foil. The foil is rejected if a certain amount and size of defects is exceeded. Rejected foils should be send back to PCB Workshop CERN.<sup>[1]</sup>
- SMD loading resistors checking. The foil is rejected if resistance outside of range 19 M $\Omega$  – 21 M $\Omega$ . Rejected foils should be send back to PCB Workshop CERN for reprocessing and tested again.<sup>[1]</sup>
- Combined high voltage cleaning and leakage current measurements. The foil is rejected if the leakage current of any sector exceeds 0.3 nA at - 500 V in air. A related issue is the

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GEM stability regarding electrical discharge which is observed in the same test. Sparks occurring in electrical discharges are considered possibly destructive, especially if they accumulate at the same position, showing a weak spot of the foil. Rejected foils might be reprocessed at PCB Workshop CERN and tested again. <sup>[1]</sup><sub>SEP</sub>

The leakage current measurements in dry nitrogen environments are due to the gas flushing process quite time consuming and repeated at every production step. Performing the measurement in ambient clean room air significantly reduces the time consumption. Previous experiments report on the fear of unstable environmental conditions but their magnitude is not significant. One standard method in the quality assurance chain for the sPhenix TPC GEM foils are leakage current measurements in air at all production steps.

To measure the leakage current flowing between the GEM's top and bottom electrode a high potential difference is applied to the electrodes while measuring the electric current. The expectation is that the current decreases fast to a stable value after the GEM capacitance has been charged. This assumption is motivated by the equivalent circuit of a GEM foil which is in first order a capacitance with a parallel resistor. If the capacitance is fully charged only the current through the parasitic resistor remains, which determines the degree of isolation for a GEM foil. At typical QA GEM voltages of - 500V the resulting currents are less than 300 pA in air since the polyimide is a good isolator.

All measurements with GEM foils take place in a cleanroom to protect the foils from dust. The GEMs under test covered with in a polycarbonate hood (enclosure). The humidity level of the air under the hood is measured. The relative humidity, temperature and atmospheric pressure in clean room are logged with 30 min sample.

The used HV power supply is one-channel ISEG (or similar type) power supply. The current is measured using custom multi-channel pico-ammeter initially developed at Zagreb such that the 16 GEM sectors are measured at the same time. The devices measure the current 120 times within ~6s and send out the mean value and standard deviation using a transmitter every ~10s.

The measurement control and data acquisition is implemented in LabVIEW. The voltage is set to - 500V for all sectors and ramping up is instantly, using special HV splitting box. The measurement duration for each GEM sector is 15 min for leakage current measurements.

The following procedures should serve as a baseline to create the instructions in framing centers. All points are obligatory but the framing centers are free to add more, if necessary. All procedures with GEMs should be done in clean room Class 1000 (ISO6), or in a Class 1000 Laboratory space.

## **6.1. GEM Handling, Storage and Packing (Unpacking)**

### **6.1.1. Protection Clothing**

- overall suit (non-sticky fabric)
- shoes (only for clean room)
- protective hood
- fitting rubber gloves
- mask covering mouth and nose
- additional protection for beard is mandatory (please use a dedicated cover or a second face mask)

### **6.1.2. Cleaning Equipment**

- use only lint-free (fiber-free, dust-free) cloths and wipes to clean surfaces and tooling

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- do not use paper wipes and paper lab-books in the clean room: use only materials, which do not give up any fluff, when used
- use tacky rollers to clean surfaces, if needed
- use iso-propanol or ethanol for cleaning. Do not use acetone by any means!
- use ultrasonic bath to clean any kind of mechanical equipment, which enters the clean room
- use only oil-less air or N<sub>2</sub> guns
- use a N<sub>2</sub> or air gun regularly to blow off dust particles from any part of equipment being in close vicinity to GEM

### 6.1.3. Additional Requirements

- in case of accident, please document it in the database
- make sure you do not lean over “naked” GEM foils
- never pass tools over the GEM area
- wipe sweat drops from your face and forehead regularly
- clean all surfaces in close contact with GEM before and after your activity
- clean GEM packing material before putting them into the clean room
- CERN GEM transportation equipment can be use twice for transportation: for transportation from CERN and transportation from framing center to assembling center

### 6.1.4. GEM Storage

- store the GEMs (before and after framing) in dry cabinet (Attachment 1, Fig. 10) with relative humidity less than 30%, or inside clean room Class 1000 (or Class 1000 laboratory space) with relative humidity less than 30%.
- store the GEMs in horizontal, or vertical position between layers of protective papers, or plastic sheets

### 6.1.5. GEM Packing (Unpacking)

#### 6.1.5.1 Unpacking foils received from CERN

1. Clean the transportation box by blowing it off with air, or N<sub>2</sub> outside the clean room (Attachment 1, Fig.1).
2. Remove shipping wrapping paper and bubble wrapping (Attachment 1, Fig.2).
3. Cut wrapping tapes and remove external hard corrugated pads (Attachment 1, Fig.3).
4. Remove single package with GEM foils (normally there are 4 packages with 4 different types of foils) and place it on separate table inside of gowning area of clean room (Attachment 1, Fig.4)
5. Clean single package by blowing it off with air, or N<sub>2</sub>.
6. Move single package into clean room (Attachment 1, Fig.5).
7. Cut green tapes and remove internal upper hard corrugated plate. Single package consist several identical layers, each layer consist of 2 soft corrugated plates and 2 plastic sheets, which protected 2 GEM foils from both sides.
8. Take out single layer with 2 GEM foils and use GEM foils for framing and testing (Attachment 1, Fig.6)

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### 6.1.5.1. Packing Framed GEMs for Shipping

Use CERN packing method and materials for packing of the framed GEMs for shipping to the assembling center.

1. Assemble single layers: put 2 framed GEMs between the 2 soft corrugated plates and 2 plastic protecting sheets (Attachment 1, Fig.6) and fix with tape.
2. Stack single layers between two hard corrugated plates to assemble single package (maximum 5 single layers per one single package). Put tape to fix.
3. Stack single packages, use tape.
4. Stack single packages between 2 hard corrugated plates and fix with tape.
5. Cover stack with bubble wrapping and put inside standard FedEx shipping box. Fill empty spaces with bubble wrapping material.

## 6.2. GEM Framing

**Precaution: Use gloves and mask. Never touch the sensitive area of GEM-foil with anything**

### 6.2.1. GEM Frames Preparation

1. Frames visual inspection. Remove overhanging fibers with sand paper. Document possible damages and reject damaged frames.
2. Check diameter of holes and improve them if needed using the reamers with diameters 0.107" and 0.089".
3. Pre-clean with isopropanol manually.
4. Clean in an ultrasonic bath :
  - bath 1 with isopropanol for final cleaning, 5 minutes and let isopropanol drain;
  - bath 2 with distilled water, 5 minutes and let water drain.
6. Blow-dry with nitrogen, or clean air (Attachment 1, Fig.8).
7. Put frames into the dry cabinet, with relative humidity less than 30%. Leave them (at least) overnight for drying before the gluing with GEMs.

### 6.2.2. GEM and Foil Alignment

1. Clean the tools, the gluing glass jig and table with isopropanol.
2. Take bottom GEM frame (no deepening for resistors) out of dry cabinet and put it into the gluing glass jig. Insert the 4 corner pins and check proper fitting (upper left corner – 0.089" diameter of pin, other corners – 0.107" diameter of pins) (Attachment 1, Fig.9).
3. Remove 2 of 0.107" diameter lower corner pins.
4. Take GEM foil out of CERN package, or dry cabinet (Attachment 1, Fig.10) and blow off with nitrogen (or clean air). Measure the resistance between the HV path and the ground – check for a short in any sector.
5. Put the GEM foil on stretcher frame (resistors down), center it and tape to the frame (Attachment 1,

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Fig.11).

6. Place stretcher frame with GEM foil (resistors up) into gluing glass jig with GEM frame. Insert the 2 of 0.107" diameter lower corner pins and check proper fitting and alignment of the GEM foil (Attachment 1, Fig.12).
7. Take upper GEM frame out of dry cabinet and put it into the gluing glass jig over stretcher frame with GEM foil and check proper alignment and fitting. Take out the pins.
8. Take the upper GEM frame out and place it on glue application table.
9. Take stretcher frame with GEM foil out and place it on table.

### 6.2.3. Frame and Foil Gluing.

1. Make sure that the epoxy isn't past its expiration date before using
2. Prepare DP-460 epoxy applicator gun and install gluing tip. Put an appropriate amount of glue onto mixing plate, mix up the appropriate amount of DP-460 epoxy thinned about 10% with alcohol to reduce the viscosity.
3. Distribute the glue uniformly on the mixing plate with the swab and roller (Attachment 1, Fig.13).
4. Use a roller to apply glue on the bottom GEM frame. Very little epoxy is needed, so care must be taken. Try to avoid glue on the gluing glass jig, if so, remove it immediately with isopropanol and a lint-free cloth (Attachment 1, Fig.14).
5. Check complete coverage with glue of the GEM frame surface. Check for excess glue (e.g. in the corner holes) and if so, remove it with an isopropanol soaked swab.
6. Insert the 2 upper corner pins (left corner - 0.089" diameter and right corner - 0.107" diameter).
7. Place stretcher frame with GEM foil (resistors up) into the gluing glass jig with GEM frame. Be sure it is down all the way. Check again adjustment GEM frame to foil.
8. Use a roller to apply glue on an upper GEM frame. Very little epoxy is needed so care must be taken. Check complete coverage with glue of the frame surface. Check for excess glue (e.g. in the corner holes and HV testing holes) and if so, remove it with an isopropanol soaked swab. Be sure no epoxy gets on the back side of the frame, if some does clean it off with alcohol and a lint-free cloth (Attachment 1, Fig.15).
9. Place GEM frame epoxy side down over the stretcher frame with GEM foil till it is down all the way. Insert 2 of 0.089" diameter lower corner pins. Place the pressure plate over the frame to apply pressure to the combined epoxy joints (Attachment 1, Fig.16).
10. Put 6 of 0.350 pounds stretched weights all around the stretcher frame where the GEM foil is taped on. Place 2 of 3 Pounds weights on the pressure plate. Remove all pins after 1 hour. Put over the hood. Allow the glue to completely dry within 24h.
11. After 24 hours. Remove the hood. Remove the centered weights and stretched weights. Remove compression plate.
12. Remove stretcher frame with GEM foil and place it on separate table. Check gluing quality: missing glue, glue excess. No glue should contaminate GEM holes. Check mounting holes especially! (Attachment 1, Fig.17).
13. Un-tape GEM foil from stretcher frame, put label on inactive area of foil and safe it in clean dry place before leakage current measurements (Attachment 1, Fig. 18).



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### **6.3. GEM Leakage Current Measurements**

**Precaution: Use gloves and mask. Never touch the sensitive area of GEM foil with anything. Never start a new test before the pico-ammeter currents stabilized after the previous test**

#### **6.3.1. Preparations**

1. Clean the tools, the mounting glass plate and table with isopropanol.
2. Blow the GEM foil off with N<sub>2</sub> (or clean air).
3. Make sure that the relay switch is in OFF position.
4. Mount the GEM foil on glass plate using 2 pins with diameter 0.089". Connect common Ground (bottom) and HV Path (upper) strips of GEM foil to pico-ammeter. Cover GEM foil with protective paper.
5. Mount the bar with 16 HV spring probes. Use the same 2 pins with diameter 0.089" and 2 outside screws for mounting and adjusting position of probes. Check that the ends of all probes are inside HV holes of GEM frame.
6. Put washers and nuts on 2 outside screws. Minimum pressure on bar should be applied. Check contact between the HV path and Sector 1 and Sector 16. Use screws with nuts for adjusting contacts (Attachment 2, Fig.1).
7. Remove protected paper. Put the temperature, pressure and relative humidity sensor close to the GEM foil. Put the hood (enclosure) over (Attachment 2, Fig.2). It will provide HV protection: no exposed voltage.
8. Measure the resistance between the HV path and the sectors (19 MΩ – 21 MΩ) – check the contacts (Attachment 2, Fig.2).
9. Measure the resistance between the HV path and the ground – check for a short in any sector.

#### **6.3.2. Leakage Current Measurements**

1. Make sure that the relay switch is in OFF position
2. On the dialog panel of HV power supply (PS), set the voltage to - 500 V.
3. Wait until the PS ramps up to - 500 V.
4. Start data taking by pressing START LOG and Measurement on LabView dialog panel (Attachment 2, Fig.3).
5. Wait 2-3 seconds, then apply the HV putting the relay switch in ON position.
6. In case of some major defects on the GEM foil, a constant sparking will be detected -> stop test immediately (turn relay switch in the OFF position).
7. Look at the currents: small Mean and RMS indicate bad probe contact (Attachment 2, Fig.4)
8. After measurement time reached 15 min, turn relay switch in the OFF position.
9. Wait 2-3 seconds, then stop data taking by pressing STOP LOG and Stop on LabView dialog panel. Make an entry in the database

#### **6.3.3. Removing the GEM-foil**

1. Make sure that the relay switch is in OFF position
2. Remove the hood (enclosure).
3. Remove the connections (HV Path and Ground)
4. Unscrew nuts and unmount the bar with 16 spring probes

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5. Remove 2 pins from GEM frame and glass plate.
6. Remove GEM foil and safe it in clean dry place.

## **7.0 Environment, Safety, Health**

All staff members are responsible for

- becoming knowledgeable of and maintaining awareness of the hazards associated with their work,
- contributing to the formulation and improvement of hazard controls,
- conducting their work safely in accordance with all project and institutional controls,
- exercising stop-work authority in cases of imminent danger to health and safety of workers or the public, or in case of a threat to the environment or property.

Specifically:

- All workers wear appropriate personal protective equipment (gloves, glasses, steel-toed shoes)
- Proper disposal of chemicals (isopropyl for cleaning, glue, etc.), gluing tips, etc.
- Gases used are not flammable: N<sub>2</sub> and CDA @ ~1 L/min during testing.
- Gas bottles secured in racks. Good practices employed for tubing.
- Cabling and grounding appropriate for use of HV (~1 kV max) and LV supplies. No exposed voltage.
- Enclosure will provide HV protection: no exposed voltage.
- Proper cable and tubing routing to eliminate trip hazards.
- Clear hazard labels on entryways and on all equipment. Site-specific procedures clearly documented.
- Fire extinguishers, fire suppression systems inside clean rooms

## **8.0 Documentation**

Each foil received from CERN will be tested versus several documented performance specifications. These include the segments leakage currents at full voltage, as well as making observations regarding foil visual appearance, current spikes, and so on. These quantities are documented for each foil in a database (Attachment 2, Fig.5). Each framing institution enters the same list of test results for each foil and into the same database.

The database is basically a stock list with QA and logistic information for the TPC production.

Purposes of database:

- logistics of material including infrastructure store and evaluate QA for GEMs
- develop acceptance criteria
- QA for completed TPC chamber
- monitor production progress

Decisions on which foils to include in full chambers, to be done at the “chamber assembly and test centers,” will be based on the information from this test results database.

## **9.0 References**

The majority of the procedures needed for this project results from the recent completion of very similar work towards the GEM-upgraded TPC for the ALICE experiment at CERN as well as other GEM-based systems such as the PHENIX Hadron Blind Detector. The procedures used for the ALICE TPC GEM framing and testing may be found at the following links:

- <https://indico.cern.ch/event/645829/>

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- [arXiv:1811.07043](https://arxiv.org/abs/1811.07043)

## **10.0 Attachments**

### **Attachment 1.**

- Fig.1, 2 Transportation package with foils.
- Fig.3 Box from hard corrugated pads.
- Fig.4, 5 Single packages with foils.
- Fig.6 Single layer with 2 GEM foils.
- Fig.7 .Single layer with 2 framed GEMs covered with plastic sheets from both sides.
- Fig.8 Frames blow dry with nitrogen, or clean air.
- Fig.9 Bottom GEM frame installed on the gluing glass plate.
- Fig.10 Dry cabinet with frames and GEMs.
- Fig.11 Installation of the GEM foil on stretching frame.
- Fig.12 Placing of the stretching frame with GEM foil (resistors up) into gluing glass jig with bottom GEM frame.
- Fig.13 Glue distribution on the mixing plate.
- Fig.14 Glue applying on the bottom GEM frame.
- Fig.15 Glue applying on the upper GEM frame.
- Fig.16 Placing of GEM frame epoxy side down over the foil.
- Fig.17 Stretcher frame with framed GEM foil.
- Fig.18 Framed GEMs covered with plastic sheet ready for HV tests.

### **Attachment 2.**

- Fig.1 Setup for leakage current measurements.
- Fig.2 GEM and bar with 16 HV spring pins covered with enclosure, which provided HV protection: no exposed voltage
- Fig.3 Measurements of resistance between the HV path and the sectors – check the contacts.
- Fig.4 LabView dialog panel before starting of data taking.
- Fig.5 LabView dialog panel during data taking.
- Fig.6 Screen shot of computer Database of GEM assembling and testing.

Fig.1 Transportation package with foils



Fig.2 Transportation package with foils



Fig.3 Box from hard corrugated pads



Fig.4 Single packages with foils



Fig.5 Single package with foils in clean room



Fig.6 Single layer with 2 foils in clean room

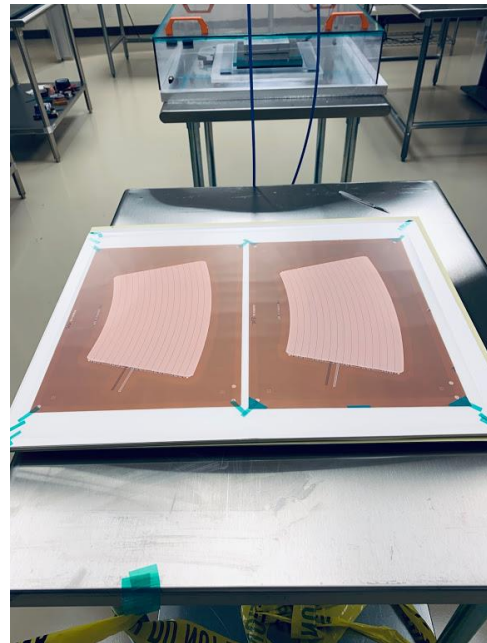


Fig.7 Single layer with 2 framed GEMs covered with plastic sheets from both sides

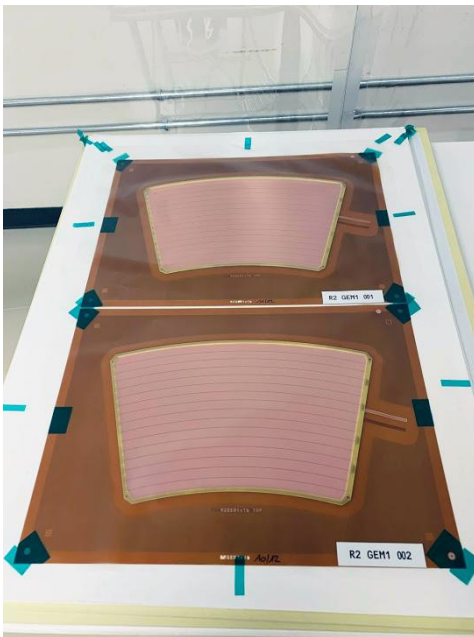


Fig.8 Frames blow dry with nitrogen, or air.

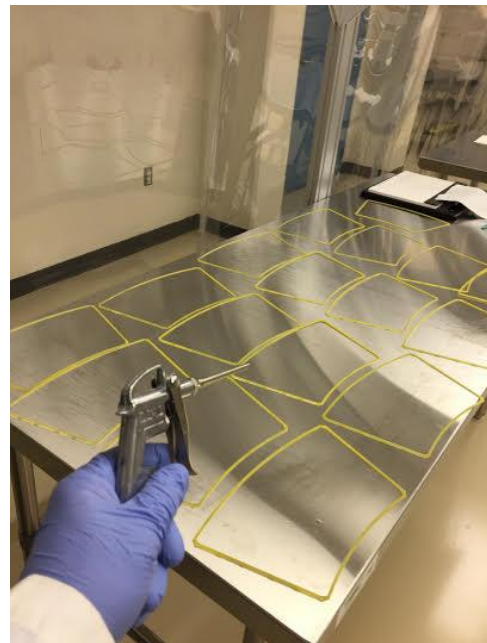


Fig.9 Bottom GEM frame installed on the gluing glass plate

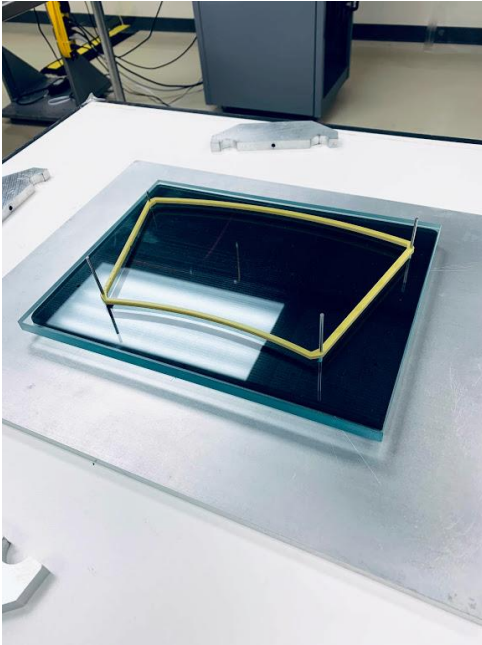


Fig.10 Dry cabinet with GEM foils and frames



Fig.11 Installation of the GEM foil on stretching frame.



Fig.12 Placing of the stretching frame with GEM foil (resistors up) into gluing glass jig with bottom GEM frame.

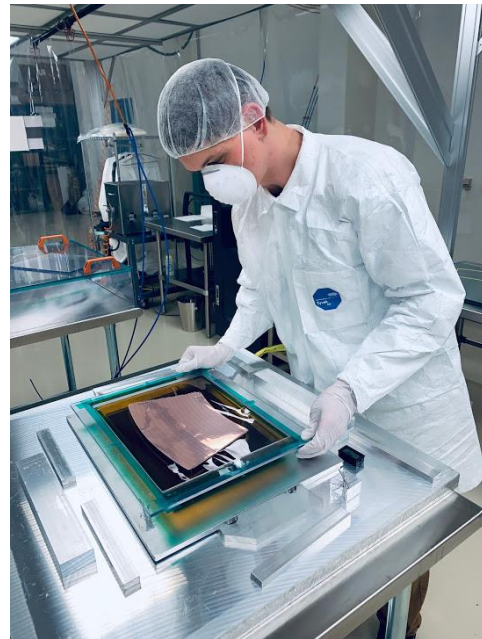


Fig.13 Glue distribution on the mixing plate

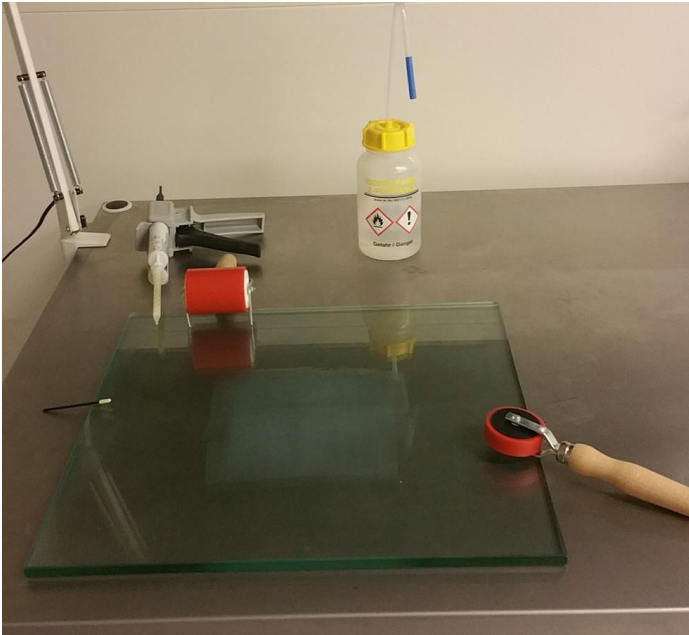


Fig.14 Glue applying on the bottom GEM frame.

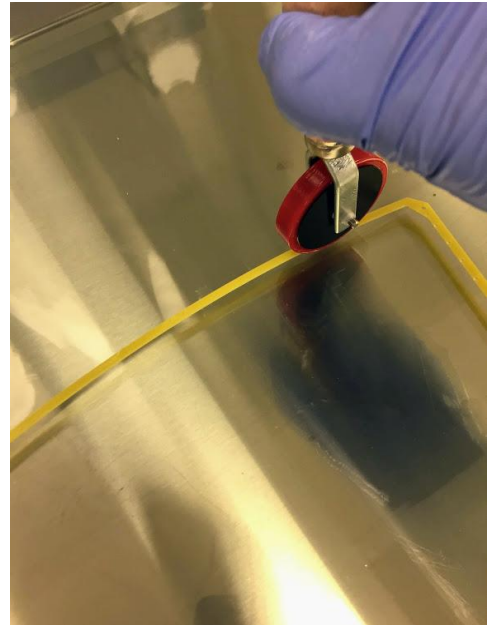


Fig.15 Glue applying on the upper GEM frame.

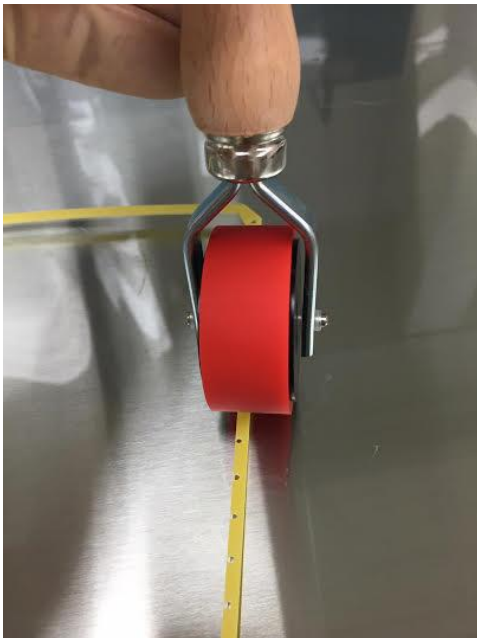


Fig.16 Placing of GEM frame epoxy side down over the foil. Pressure plate placed over the frame.

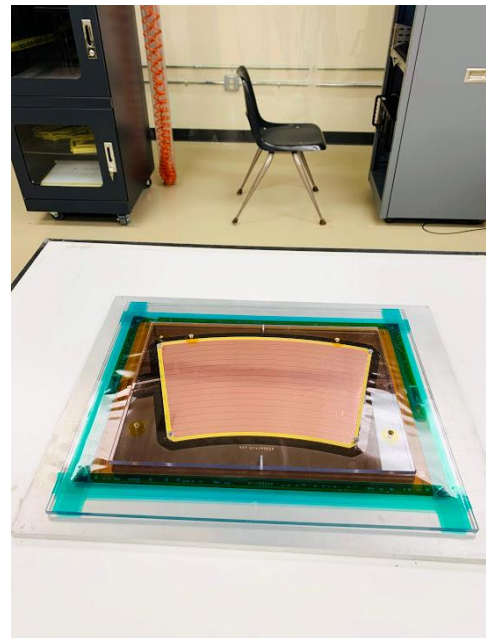


Fig.17 Stretcher frame with framed GEM foil

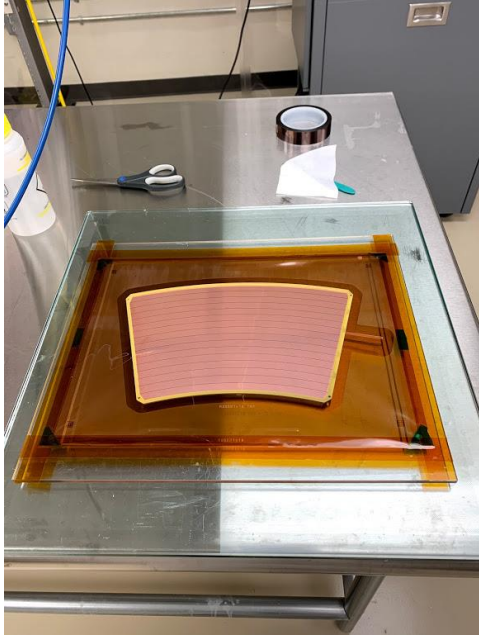


Fig.18 Framed GEMs covered with plastic sheet ready for HV tests

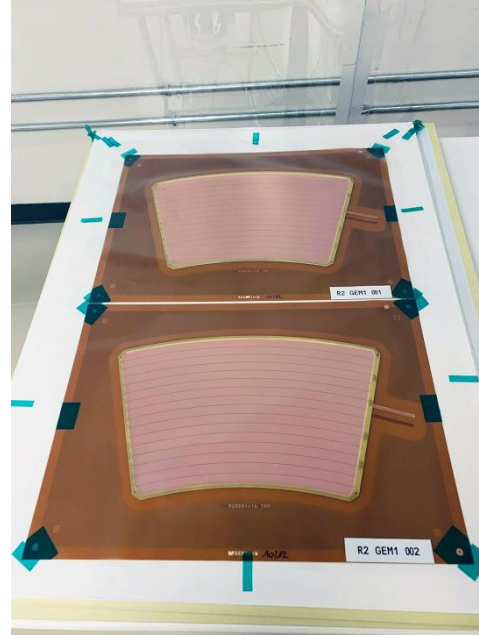




Fig.1 Setup for leakage current measurements.

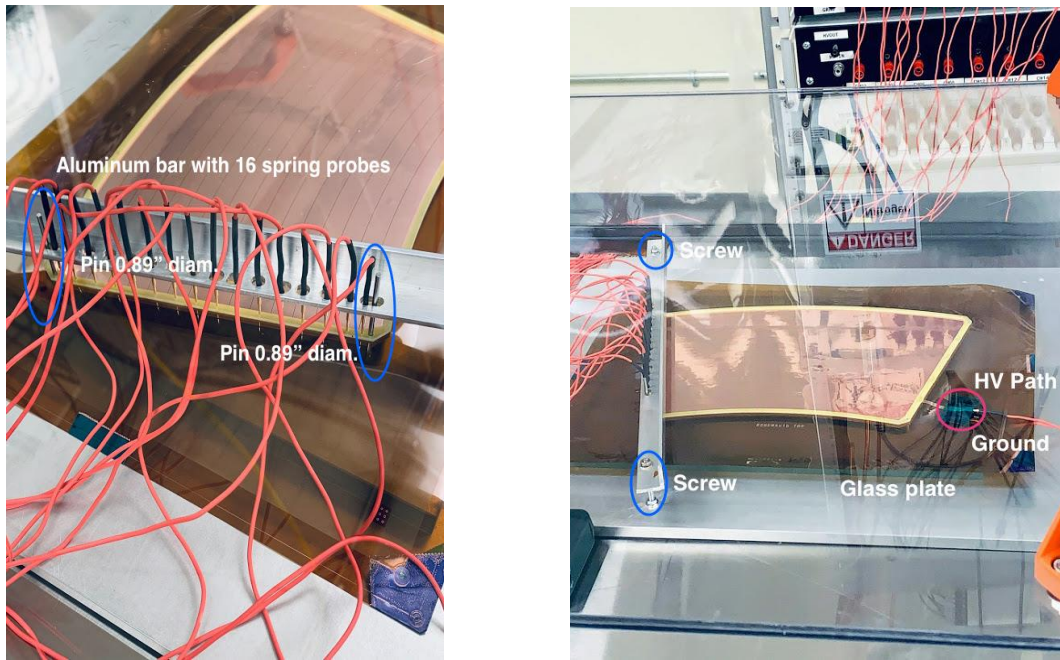


Fig.2 GEM and bar with 16 HV spring pins covered with enclosure, which provided HV protection: no exposed voltage.

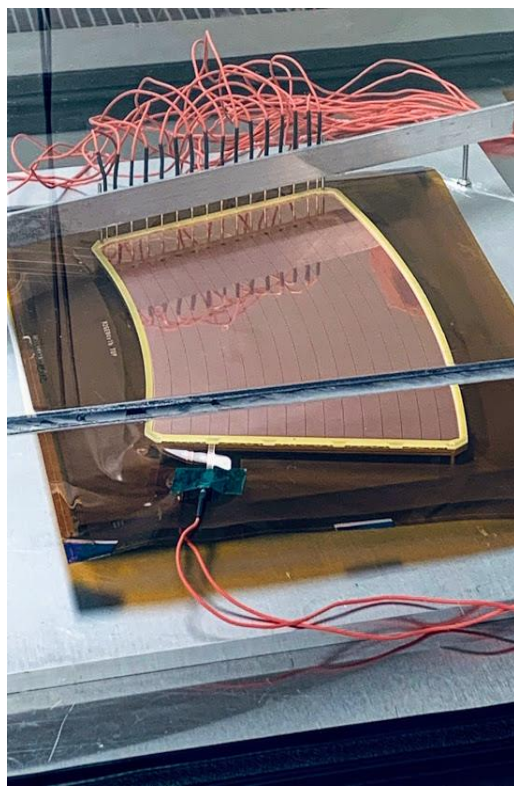


Fig.3 Measurements of resistance between the HV path and the sectors – check the contacts.

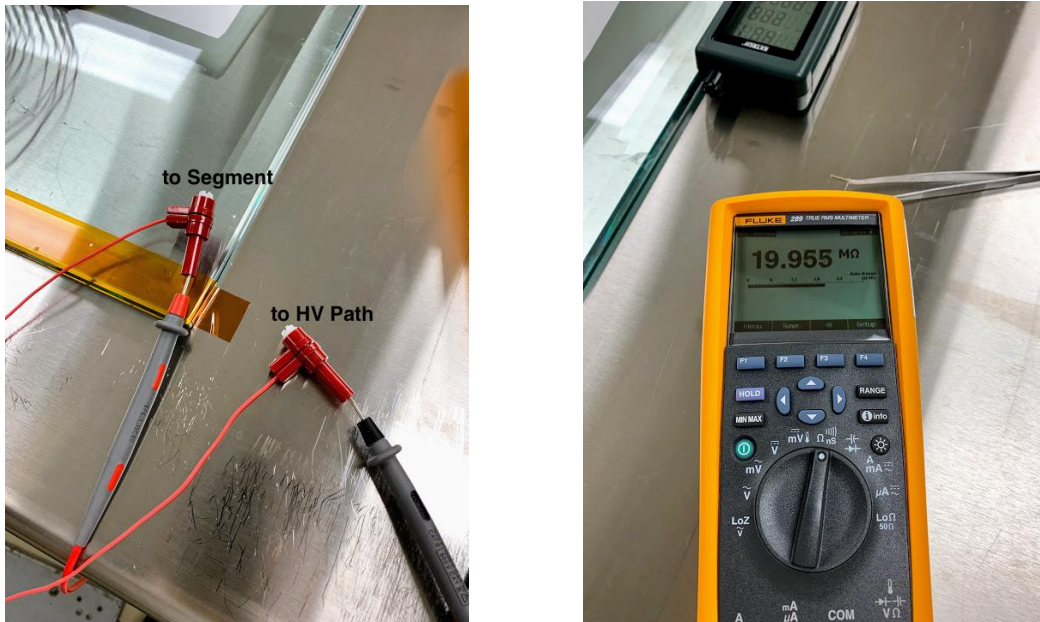


Fig.4 LabView dialog panel before start data taking

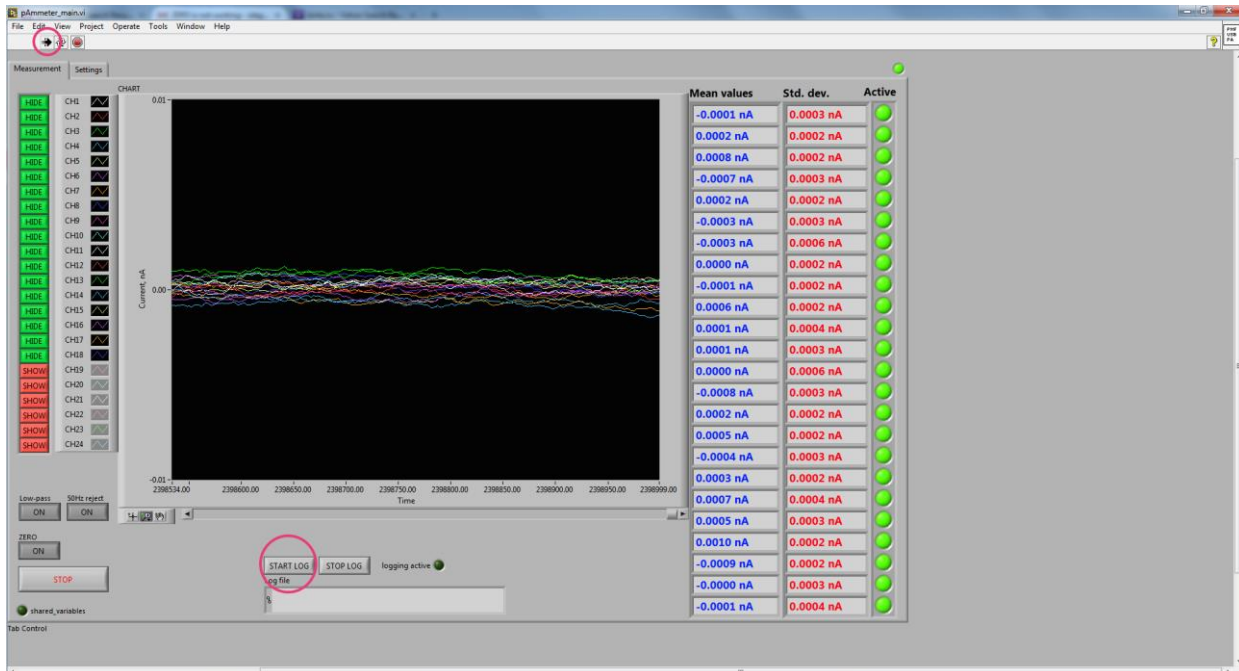


Fig.5 LabView dialog panel during data taking

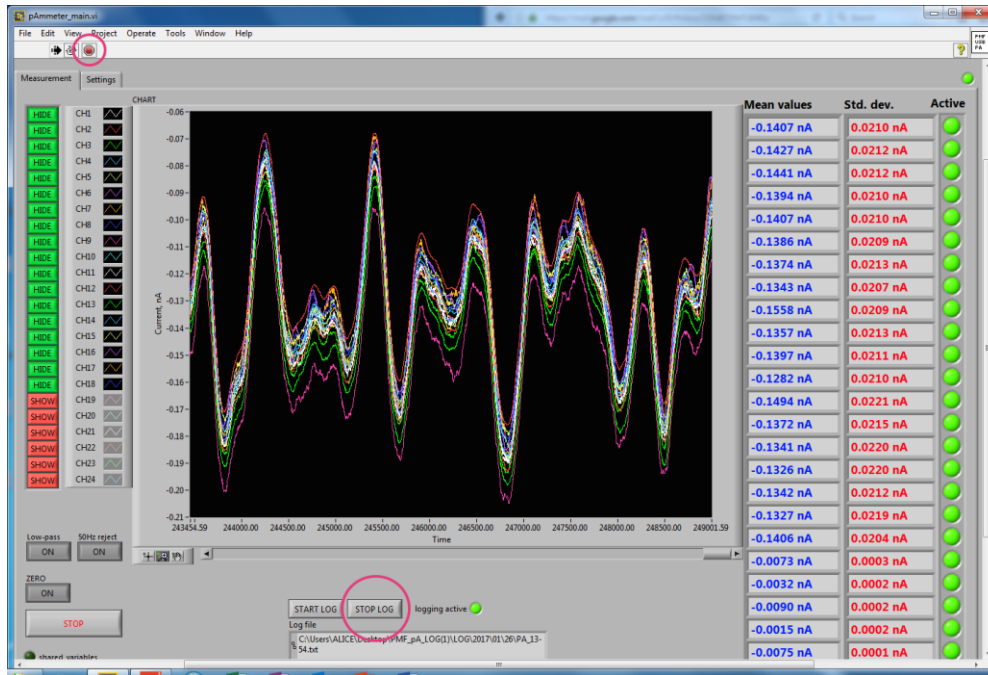


Fig. 6 Screen shot of computer Database of GEM assembling and testing.

step (link)	status	data field (hover cursor for explanations)	value	n	date	QA step/file comment	author	condition	true?
<b>Basic QA</b>									
1	1	quick defect map	<a href="#">dummyDefects.txt</a> <a href="#">show</a>		2017-01-15 15:46:31	ok dummy defects	Peter	file txt	
2	2	HV cleaning	done		2016-10-20 16:25:11		Renato	eq done	
3	3	intersegment test	ok		2016-11-08 12:33:45		Renato	eq ok	
4	4	resistor values [MOhm] segment list, tolerance +0.07	<a href="#">fill values</a>					file txt	
6	6	leakage current [pA] at 500 V	108.9	19	2017-04-19 12:58:35	avg all segments 81.4, sparks: 91	Oleg	<= 167	
7	7	spark map	<a href="#">dummy.txt</a> <a href="#">show</a>		2017-01-14 18:51:35	ok, old value 0 dummy	Renato	file txt	
8	8	absolute humidity [ppmV]	3577	2	2017-01-19 11:19:01	Relative humidity 9.4(%) & temperature 27.2 (Celsius) file - Pressure 956 mbar	Pieter	<= 6000	
10	QA-B	I_leak histo data	<a href="#">I-G1-001-AfterTrim-PA_17-35.txt</a> <a href="#">evaluate</a>	6	2017-03-03 18:22:02	ok   avg all segments 38.6, sparks: 0 Leakage at 500 V After trimming	Dick	file txt	
<b>Framing and assembly</b>									
20	20	frame glueing	ok		2017-02-02 02:09:06	ok there is some wrinkle on CH0 near frame, after frame glueing	Oleg	eq ok	
25	25	quality	B		2017-02-02 02:09:06	Bthere is some wrinkle on CH0 near frame, after frame glueing / Edited by Essi: One long etching defect with a small copper peninsula.	Essi	le C	
26	ROC	assembly in ROC	ok		2017-06-28 21:08:55		Dick	eq ok	

End of Document

