Person: Szumila-Vance, Holly (hszumila@jlab.org)
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Jefferson Lab
Thomas Jefferson National Accelerator Facility

Operational Safety Procedure Review and Approval Form # 113037
(See ES&H Manual Chapter 3310 Appendix T1 Operational Safety Procedure (OSP) and Temporary OSP Procedure for Instructions)

Type:	*OSP* Click for OSP/TOSP Procedure Form Click for LOSP Procedure Form Click for LOTO-COMPLEX Information Click for LOTO-GROUP Information
Serial Number:	***ENP-21-113037-OSP***
Issue Date:	*3/8/2021*
Expiration Date:	*2/8/2024*
Title:	***GEM detectors for the SBS experiment***
Location: (where work is being performed) Building Floor Plans	***101 - Experimental Hall A*** — Location Detail: (specifics about where in the selected location(s) the work is being performed): ***BigBite and SBS detector stacks***
Risk Classification: (See ES&H Manual Chapter 3210 Appendix T3 Risk Code Assignment)	Without mitigation measures (3 or 4): ***3*** With mitigation measures in place (N, 1, or 2): ***1***
Reason:	This document is written to mitigate hazard issues that are : ***Determined to have an unmitigated Risk code of 3 or 4***
Owning Organization:	***PHALLA***
Document Owner(s):	***Szumila-Vance, Holly (hszumila@jlab.org)*** Primary

Supplemental Technical Validations

50V or Greater: De-energized Work (Phillip Stanley, Tim Fitzgerald)
Mode 1: Class 1, 2, and 3 Electrical Equipment (Phillip Stanley, Tim Fitzgerald)
ODH 0 and 1 (Imani Burton, Jennifer Williams)
Portable Hand Tools (Bert Manzlak, Paul Collins)
Pressurized Tanks, Containers, and Vacuum Vessels (Dave Meekins, Kelly Dixon, Timothy Whitlatch, Will Oren)
Ladders (Bert Manzlak, George Perry)
ESH&Q Liasion (Bert Manzlak)

Document History

Revision	Reason for revision or update	Serial number of superseded document

2	***Included SAF130A and 130C training, and relieve valve after regulator***	

Lessons Learned	Lessons Learned relating to the hazard issues noted above have been reviewed.
Comments for reviewers/approvers:	

Attachments

Procedure: ***GEM-OSP-SBS.pdf***
THA: ***THA_GEM_SBS.pdf***
Additional Files: ***front_tracker_gem_manual.pdf***

Review Signatures

Subject Matter Expert : Electricity->50V or Greater: De-energized Work	**Signed** on 3/3/2021 1:43:13 PM by Phillip Stanley (pstanley@jlab.org)
Subject Matter Expert : Electricity->Mode 1: Class 1-> 2-> and 3 Electrical Equipment	**Signed** on 3/3/2021 1:43:18 PM by Phillip Stanley (pstanley@jlab.org)
Subject Matter Expert : Oxygen Deficiency Hazards (ODH)->ODH 0 and 1	**Signed** on 3/3/2021 11:00:07 AM by Jennifer Williams (jennifer@jlab.org)
Subject Matter Expert : Portable Hand Tools	**Signed** on 3/3/2021 1:12:06 PM by Bert Manzlak (manzlak@jlab.org)
Subject Matter Expert : Pressure Systems->Pressurized Tanks-> Containers-> and Vacuum Vessels	**Signed** on 3/4/2021 6:34:39 AM by Timothy Whitlatch (whitey@jlab.org)
Subject Matter Expert : Working at Elevations->Ladders	**Signed** on 3/3/2021 1:12:16 PM by Bert Manzlak (manzlak@jlab.org)

Approval Signatures

Division Safety Officer : PHALLA	**Signed** on 3/4/2021 7:41:01 AM by Ed Folts (folts@jlab.org)
ESH&Q Division Liasion : PHALLA	**Signed** on 3/8/2021 10:36:21 AM by Bert Manzlak (manzlak@jlab.org)
Org Manager : PHALLA	**Signed** on 3/8/2021 10:23:27 AM by Cynthia (Thia) Keppel (keppel@jlab.org)
Safety Warden : Experimental Hall A	**Signed** on 3/4/2021 8:07:20 AM by Jessie Butler (jbutler@jlab.org)

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Jefferson Lab
Thomas Jefferson National Accelerator Facility

Operational Safety Procedure Form

(See ES&H Manual Chapter 3310 Appendix T1 Operational Safety Procedure (OSP) and Temporary OSP Procedure for instructions.)

Click

Title:	GEM detectors for the SBS experiments		
Location:	Hall A on SBS and BigBite detector stacks	**Type:**	☒ **OSP** ☐ **TOSP**
Risk Classification (per Task Hazard Analysis attached) (See *ESH&Q Manual Chapter 3210 Appendix T3 Risk Code Assignment*.)		**Highest Risk Code Before Mitigation**	3
		Highest Risk Code after Mitigation (N, 1, or 2):	1
Owning Organization:	Hall A	**Date:**	24 Feb 2021
Document Owner(s):	Holly Szumila-Vance		

DEFINE THE SCOPE OF WORK

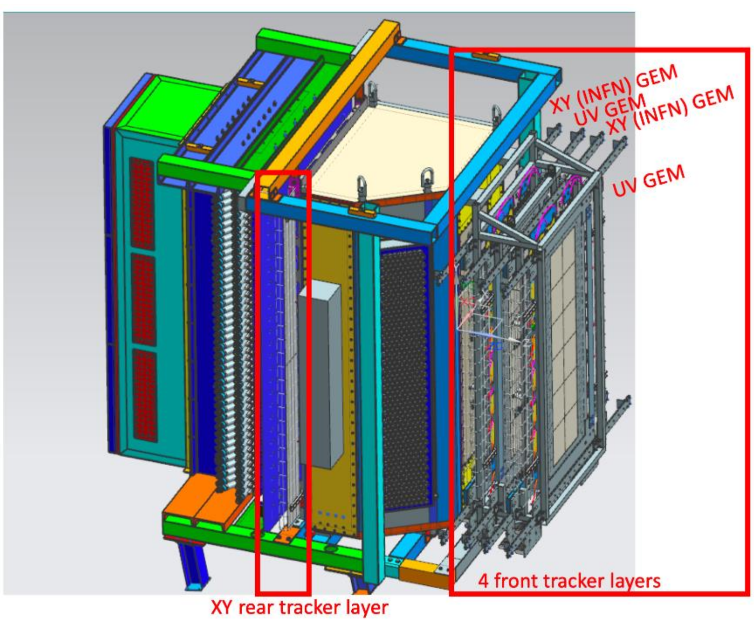
1. Purpose of the Procedure – Describe in detail the reason for the procedure (what is being done and why).

This document describes the GEM detectors that will be used in the SBS experiments in Hall A. These GEMs will be installed around both the BigBite and SBS detector stacks and are produced from both UVa and INFN.

2. Scope – include all operations, people, and/or areas that the procedure will affect.

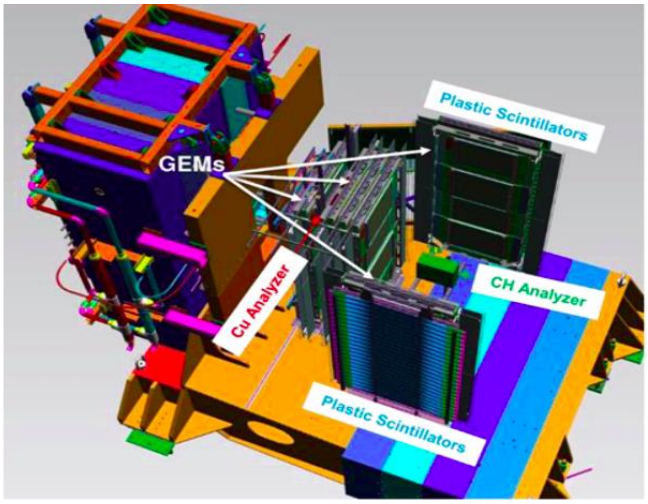
Operation of the GEMs in the Hall A SBS experiment. The scope of this OSP encompasses electrical issues associated with the GEM detector, the use of Ar/CO2 gas flowing in the detectors, work conducted under Covid-19 elevated MEDCON levels, and access to the detector by use of a ladder.

3. Description of the Facility – include building, floor plans and layout of the experiment or operation.



The GEM detectors for the SBS experiments will be installed on both the BigBite and SBS detector arms. The BigBite assembly will have 4 front tracker layers with a UVa-produced UV layer (60 deg stereo angle) in the front, followed by an INFN-produced XY layer and this pattern repeated. The front tracker INFN layers are composed of 3 modules that in total produce an active area of 40 cm in the horizontal direction by 150 cm in the vertical direction. These INFN layers readout via 54 APVs per chamber. The front tracker UV layers are composed of a singular larger module with the same active area. Downstream of the GRINCH detector, a larger UVa-produced XY layer is installed as the rear tracker. This rear tracker is composed of 4 GEM modules tacked in a layer so that the total active layer is 60 cm in the horizontal direction by 200 cm in the vertical direction and is readout by 88 APVs in total.

For the GEN-RP experiment, there will be 2 INFN GEM planes and 6 UVa GEM planes in line with the CH analyzer (Charge Exchange polarimeter). Two sets of two additional UVa-produced GEMs will be on the Proton Recoil Polarimeter stacks located to the sides of the CH analyzer.



The GEMs are readout by APV25s that are connected to backplanes supplied with low voltage on the sides of the GEM plane. These APV25 readout is connected by HDMI cables to MPDs for readout. The MPDs are housed in crates to the left of BigBite and the right of SBS for each detector's GEMs, respectively. These "forward" electronics crates will house the MPDs and will be shielded with lead bricks. The output signals from the MPDs in the forward electronics will be carried by optical fibers to the DAQ for trigger processing. The DAQ computer will be located in the weldment for BigBite. The HV supplies for the GEMs will be located in the weldment.

The GEMs will be supplied with an Ar/CO2 bottle in the gas shed with a pressure regulator located under the pivot to distribute gas to the GEM modules. The gas system will be remotely monitored from the counting house. The flow is <1 ft^3/hour. A relief valve between the regulator and detector is implemented as a backup in the event of regulator failure.

ANALYZE THE HAZARDS and IMPLEMENT CONTROLS

4. Hazards identified on written Task Hazard Analysis

Electrical shock, pressurized gas containers, potential for ladder work, and work under Covid-19 elevated MEDCON

5. Authority and Responsibility:

5.1 Who has authority to implement/terminate

Hall A/C Leader, Hall A Work Coordinator, Holly Szumila-Vance, Kondo Gnanvo, Evaristo Cisbani, Roberto Perrino, Bogdan Wojtsekhowski

5.2 Who is responsible for key tasks

Holly Szumila-Vance, Kondo Gnanvo, Evaristo Cisbani, Roberto Perrino

5.3 Who analyzes the special or unusual hazards including elevated work, chemicals, gases, fire or sparks (See ES&H Manual Chapter 3210 Appendix T1 Work Planning, Control, and Authorization Procedure)

Work Coordinator or designee

6. Personal and Environmental Hazard Controls Including:

6.1 Shielding

Shielding of forward electronics is coordinated with Jack Segal and Kondo Gnanvo

6.2 Barriers (magnetic, hearing, elevated or crane work, etc.)

GEMs may need to be accessed by ladder. Safety training will be adhered and work in pairs will be advisable to assist.

6.3 Interlocks

N/A

6.4 Monitoring systems

Remote monitoring of gas flow system.

6.5 Ventilation

N/A

6.6 Other (Electrical, ODH, Trip, Ladder) (Attach related Temporary Work Permits or Safety Reviews as appropriate.)

Use of current limited high voltage supply at 4kV. Use of shielded HV cables and connectors. Exposed high voltage wrapped with high voltage electrical tape (none in design).

Gas supplied through a pressure regulator attached to the gas bottle with flow limited by a flow meter.

7. List of Safety Equipment:

7.1 List of Safety Equipment:

N/A

7.2 Special Tools:

N/A

8. Associated Administrative Controls

Setup, removal, or changes to the GEM setup may be coordinated through Kondo Gnanvo, Evaristo Cisbani, Roberto Perrino, Bogdan Wojtsekhowski, Holly Szumila-Vance, Chuck Mahon, members of the Work Coordinator's staff, members of Hall A/C staff, and others designated by Kondo, Evaristo, Roberto, or Holly. Signs and labels will be posted at the gas assembly, HV, and LV junctions.

9. Training

9.1 What are the Training Requirements (See List of Training Skills)

Hall A walk through, Radiation Worker I, ODH training, Ladder safety training if requiring access by ladder, Pressure system training SAF130A, SAF 130C, addition of current electrical training with subject to change as the new training is taking hold at the lab, equipment specific training

DEVELOP THE PROCEDURE

10. Operating Guidelines

See Operations manual for the INFN and UVa GEMs. Do not operate the system unless authorized by an individual in Section 5 and with training as noted above.

11. Notification of Affected Personnel (who, how, and when include building manager, safety warden, and area coordinator)

Contact Hall Work Coordinate prior to start of work, daily.

12. List the Steps Required to Execute the Procedure: from start to finish.

1. GEM installation prior to start of experiments on the GEM holders of the BB and SBS detector stacks.
2. GEM forward electronics will be placed approximately 10m to the outside of the BB and SBS detectors at pre-designated Hall clock positions and will be shielded. This electronics will be connected to the DAQ by fiber optics.
3. Connect the gas system to the GEMs.
4. Install GEM HV units and PC in the weldment, far electronics locale.
5. Connect the electronics, data acquisition, high voltage, and gas.

For detailed operation of detector operation, refer to INFN/UVa GEM manual.

13. Back Out Procedure(s) i.e. steps necessary to restore the equipment/area to a safe level.

1. Turn off high voltage
2. Stop gas flow
3. Reassess the job before turning power and gas back on

14. Special environmental control requirements:

14.1 List materials, chemicals, gasses that could impact the environment (ensure these are considered when choosing Subject Mater Experts) and explore EMP-04 Project/Activity/Experiment Environmental Review below

N/A

14.2 Environmental impacts (See EMP-04 Project/Activity/Experiment Environmental Review)

N/A

14.3 Abatement steps (secondary containment or special packaging requirements)

N/A

15. Unusual/Emergency Procedures (e.g., loss of power, spills, injury, fire, etc.)

In the event of injury, or an immediate emergency exists, call **911** and also notify:

- Guards (**x5822**)
- Occupational Medicine (**x7539**)
- Crew Chief (**x7045**) (if inside the fence)

In case of an injury follow standard JLAB procedures. Initial response cards are located with each phone for appropriate emergency phone numbers. Additional information can be found at https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-24400/*.pdf.

16. Instrument Calibration Requirements (e.g., safety system/device recertification, RF probe calibration)

None

17. Inspection Schedules

None

18. References/Associated/Relevant Documentation

Operator manual for INFN/UVa GEMs and THA

19. List of Records Generated (Include Location / Review and Approved procedure)

Submit Procedure for Review and Approval (See ES&H Manual Chapter 3310 Appendix T1 OSP & TOSP Instructions – Section 4.2 Submit Draft Procedure for Initial Review):

- Convert this document to .pdf
- Open electronic cover sheet: https://mis.jlab.org/mis/apps/mis_forms/operational_safety_procedure_form.cfm
- Complete the form
- Upload the pdf document and associated Task Hazard Analysis (also in .pdf format)

Distribution: Copies to Affected Area, Authors, Division Safety Officer
Expiration: Forward to ES&H Document Control

Form Revision Summary

Revision 1.6 – 06/23/2020 – Update section 15 to reflect guard number, what to do in an emergency, crew chief numbers, etc. approved by H. Fanning
Revision 1.5 – 04/11/18 – Training section moved from section 5 Authority and Responsibility to section 9 Training
Revision 1.4 – 06/20/16 – Repositioned "Scope of Work" to clarify processes
Qualifying Periodic Review – 02/19/14 – No substantive changes required
Revision 1.3 – 11/27/13 – Added "Owning Organization" to more accurately reflect laboratory operations.
Revision 1.2 – 09/15/12 – Update form to conform to electronic review.
Revision 1.1 – 04/03/12 – Risk Code 0 switched to N to be consistent with 3210 T3 Risk Code Assignment.
Revision 1.0 – 12/01/11 – Added reasoning for OSP to aid in appropriate review determination.
Revision 0.0 – 10/05/09 – Updated to reflect current laboratory operations

ISSUING AUTHORITY	FORM TECHNICAL POINT-OF-CONTACT	APPROVAL DATE	REVIEW DATE	REV.
ES&H Division	Harry Fanning	04/11/18	04/11/21	1.6

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Author:	Holly Szumila-Vance	**Date:**	24 Feb 2021	**Task #:** If applicable	

Complete all information. Use as many sheets as necessary

Task Title:	GEM detectors for Hall A SBS experimets			**Task Location:**	Hall A on SBS and BB sides
Division:	Physics	**Department:**	Hall A	**Frequency of use:**	Daily
Lead Worker:	Kondo Gnanvo				
Mitigation already in place: Standard Protecting Measures Work Control Documents	Use of shielded HV cables and connectors, relief valve between regulator and detectors				

Sequence of Task Steps	Task Steps/Potential Hazards	Consequence Level	Probability Level	Risk Code (before mitigation)	Proposed Mitigation (Required for Risk Code >2)	Safety Procedures/ Practices/Controls/Training	Risk Code (after mitigation)
1	Electrical shock from 4kV high voltage supplying GEM detector	M	L	2	Use of current limited high voltage supply at 4kV Use of shielded HV cables and connectors. Exposed high voltage wrapped with high voltage electrical tape.	High voltage cables are only connected or disconnected to/from the detectors, power supplies, and patch panels when power supply is not energized. ESH Manual Chapter 6200 Electrical Safety Program https://www.jlab.org/ehs/ehsmanual/manual/6200.html / Training: SAF 603A Electrical Safety Awareness Class, Modes, etc. https://www.jlab.org/ehs/ehsmanual/manual/6200.html Electrical safety training for QEW is currently being modified, training is subject to change	1

Task Hazard Analysis (THA) Worksheet

(See ES&H Manual Chapter 3210 Appendix T1 Work Planning, Control, and Authorization Procedure)

Sequence of Task Steps	Task Steps/Potential Hazards	Consequence Level	Probability Level	Risk Code (before mitigation)	Proposed Mitigation (Required for Risk Code >2)	Safety Procedures/ Practices/Controls/Training	Risk Code (after mitigation
2	Use of compressed Ar/CO2 gas	M	L	2	Gas supplied through a pressure regulator attached to the gas bottle with flow limited by a flow meter.	Setup, connection, or disconnection of the gas shall only be done by individuals authorized by this OSP. ESH Manual Chapter 6150 Gas Cylinder Safety - Storage, Movement, and Labeling https://www.jlab.org/ehs/ehsmanual/manual/6150.html, Training for individuals: SAF130A, SAF130C Relief valve between the regulator and detector is implemented as a backup in the event of regulator failure.	N
3	Covid-19 contamination (if at an elevated MEDCON level)	M	M	3	Face covering required. Maintain Social Distancing of 6' or use appropriate PPE if 6' distancing cannot be maintained.	Discuss OSP: ESH-20-102494-OSP. Follow required guidelines	1
4	Use of portable ladder for access to GEM detectors	H	M	3	Use of ladder training and having an observer/assistant.	SAF307 Ladder Safety	1

Highest Risk Code before Mitigation:	3	**Highest Risk Code after Mitigation:**	1

When completed, if the analysis indicates that the Risk Code before mitigation for any steps is "medium" or higher (RC≥3), then a formal Work Control Document (WCD) is developed for the task. Attach this completed Task Hazard Analysis Worksheet. Have the package reviewed and approved prior to beginning work. (See ES&H Manual Chapter 3310 Operational Safety Procedure Program.)

Form Revision Summary

Periodic Review – 08/29/18 – No changes per TPOC
Periodic Review – 08/13/15 – No changes per TPOC
Revision 0.1 – 06/19/12 - Triennial Review. Update to format.
Revision 0.0 – 10/05/09 – Written to document current laboratory operational procedure.

ISSUING AUTHORITY	TECHNICAL POINT-OF-CONTACT	APPROVAL DATE	REVIEW DATE	REV.
ESH&Q Division	Harry Fanning	08/29/18	08/29/21	0.1

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SBS Front Tracker GEM chambers

User manual for integration and cosmic tests in the Test-Lab/clean room

Latest Update: 13 January 2021

Authors: E. Cisbani, P. Musico, L. Re, R. Perrino, … add your name if it is not in the list and you edit this document!

Link to the document: https://pandora.infn.it/public/3b9827

Table of Contents

Changelog

Oct-Nov/2020:

1. New CODA3 readout (instruction shall be extended)
2. Remote control of the DAQ and triton
3. Details on Low Voltage distribution and Voltage Regulators specs

Aug/2019:

1) Directory /home/daq/evaristo in sbsvme20 has been moved to /home/daq/daq.old/evaristo. It affects the HV section mainly. Text updated
2) Cosmics trigger updated [20190825]. Relevant chapter updated
3) Update GEM Gas System section
4) Extended cosmic data analysis a little bit
5) Add MPD configuration masking parameter in histogram test

GEM System

A single GEM module is 40x50 cm2 active area and it represents an independent unit in terms of: Readout Electronics, HV. Each GEM foil is divided in 20 rectangular sectors. The number of readout channels are: 1024 along “x” and 1280 along “y”.

Three GEM modules compose a single GEM chamber. They are adjacent along the “y” (vertical) direction. The chamber mechanical support consists of a frame made of 4 carbon fiber bars.

A single GEM chamber is independent in terms of: HV, Low Voltage, Gas distribution, Readout Electronics.

All the above systems are connected to the “external world” from the bottom of the GEM chamber.

Notation:

each GEM module has a production index (M00, M01, … or MOD00, MOD01 ...).

Similarly the first assembled GEM chamber is numbered “J0”, the second is “J1”, the third is “J2” and so on.

The bottom GEM module in the GEM chamber Jx is named JxM0 (which corresponds to one of the above GEM module production index), the middle module is JxM1, the upper module is JxM2 as shown in the next figure.

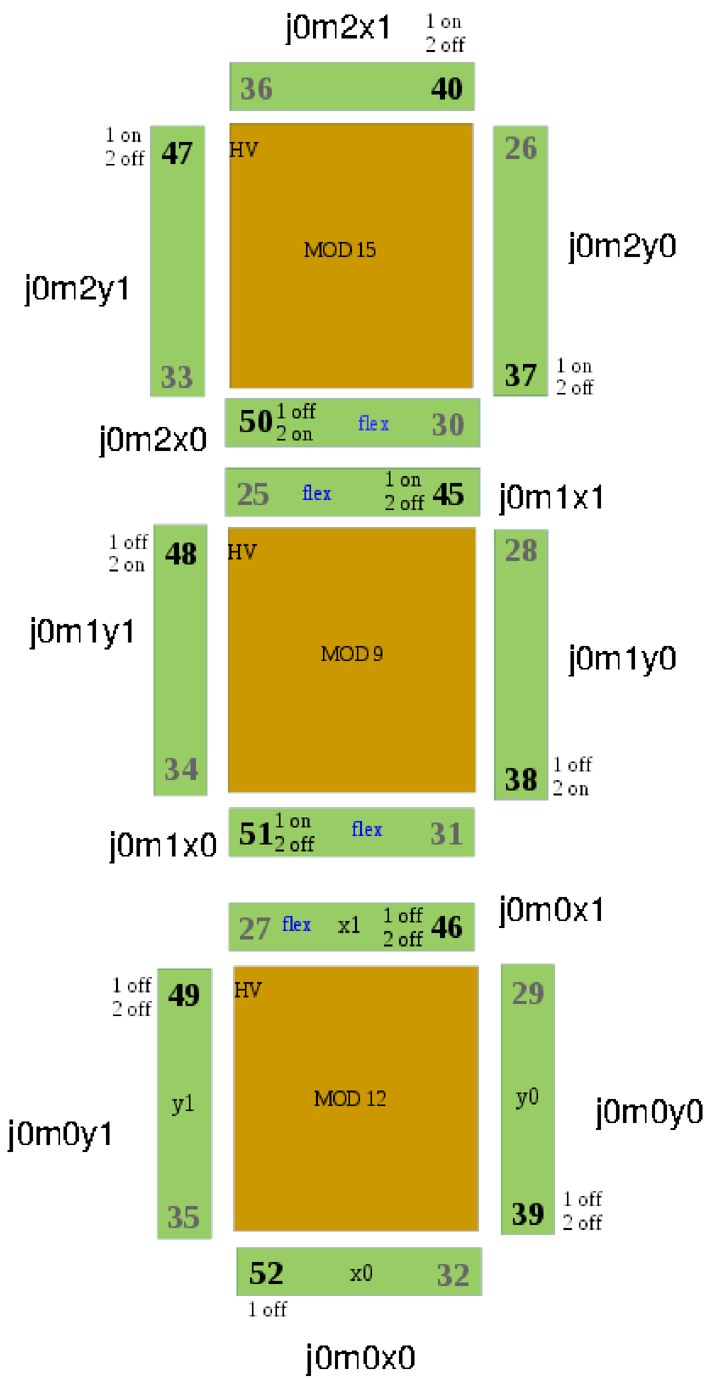


Fig 1: the J0 chamber; backplane switches settings, types, cables numbers; backplane numbering

notation. The cables patch panels and gas valves are on the bottom side. Conventional origin of the axes is the bottom-left vertex.

GEM Readout

The GEM modules are readout by the APV based cards which sit on backplanes. Each backplane may host from 1 to 5 cards. There are three types of backplanes:

1. Rigid backplane (rigid)
2. Flexible backplane version 1 (flex-v1) - inverting
3. Flexible backplane version 2 (flex-v2)

The functionalities of the different backplanes are identical except for voltage regulators that power the APV cards. The voltage regulators are installed on the rigid backplanes only. Therefore, the rigid backplane gets power (nominal voltage 3.3-3.5 V, current 0.5-0.7 A depending on number of cards) from the Low Voltage power supply, while the flex backplane low voltages come from the rigid backplane.

The flex backplanes are installed between two GEM modules, with the surface perpendicular to the GEM surface, as shown in figure 1. The flex backplanes do host 4 cards.

In addition to the low voltage power supply connector, each backplane has 2 HDMI connectors (for analog and digital signals). The HDMI cables connected to these two connectors run in the cable trays of the GEM and end-up into two different patch-panels (analog and digital). Long HDMI cables connect these patch-panel to the VME-MPD modules.

GEM Gas System

The gas system of the three GEM modules of a GEM chamber is connected in parallel to each GEM module.

The gas inlet pass on one small manual flow-meter control (2 SCFH[1]) then goes to a valve (open/close) and a filter (SMC ZFC200-08B) for particles with diameter above 10 um. After the filter the gas enter the 3 GEM modules almost in parallel. The gas comes out of the 3 GEM modules, and it flows in a single pipe to the outlet valve (open/close).

Inlet and outlet are on the short side, where cabling enter the chamber cable trail;

When gas is not flushed, both valves MUST BE closed.

When gas is flushing both valves must be open.

Operation:

Purge the line (after a long stop or new cylinder):

1. Open the purge valve (blue knob)
2. Remove the green plug at the end of the dark blue purge line (the same used for single module test) behind the racks, near the single module test setup
3. Open the gas cylinder valve

1) Standard Cubic Feet per Hour

4. Open the main black valve (all other valves closed!)
5. Wait a few minutes
6. Close the purge valve and close the dark blue purge line with the green plug
7. Go to next step.

Flush the gas:
1. open the outlet valve
2. open the inlet valve
3. open the gas cylinder valve (if not already open)
4. open the main black valve (if not already open)
5. adjust the manual flowmeter between 0.1 and 0.3

Stop flushing gas:
1. close the manual flowmeters
2. close the inlet valve
3. close the outlet valve
4. close the gas cylinder valve

Currently the gas cylinder contains either N_2 or a mixture of 75 Ar and 25 CO_2.

WARNING: After long stop (>few days) use N_2, purge the line longer (hours) and then flush gas on chambers for 2 or more days with HV OFF (flushing is important to reduce the humidity in the chambers). Then turn HV on, still using N_2, to burn possible dust (?); as suggested by Kondo Ar/CO_2 tends to create ionization instead of burning dust. Take time (1-2 hours at least for each HV level) and increase HV from 1000 to 2000 to 3000. Keep the current limits less than 1000 nA above the normal current values. Monitor the trend of the currents carefully. Once you are satisfied by the chamber HV-I behaviour switch to ArCO_2, keeling HV on (at max 3000 V):
- close the outlet valves of each chamber
- close the inlet valve(s) to the chambers
- close the valve on the pressure control on the N_2 cylinder
- close the N_2 cylinder valve
- unscrew the pressure control from the N_2 cylinder
- move the pressure control to the ArCO_2 mixture cylinder and screw it.
- open the ArCO_2 cylinder valve
- pull the vent valve few seconds to clean the line in the pressure control
- open the pressure control valve
- open the inlet valve(s) to the chambers
- open the outlet valves of each chamber
- verify the manual flow controller

GEM Low Voltage

Each chamber readout electronics is connected to one output of a Low Voltage Power Supply Unit (TTi CPX400DP – 2 channels); voltage and current limits are set to: ~4 V, ~9.5 A and are locked.

Switch on the low voltage

1. press the "POWER" knob on the left of the front panel of the module (it powers the LV module, but not the chamber, if properly switched off in the last operation)
2. press the small button "Output 1" (left panel, or “Output 2” right panel) to power the electronics of the chamber; the red led below "1" (or “2”) shall light.

When the cards are initialized and configured, the current should be around 7.5-7.6 A; during normal acquisition the current is around 8.1 A; if the current is significantly different the cards are not initialized (maybe some of them have been disabled).
NOTE: Each low voltage line supplies 16 LH4913 Voltage Regulators which in turn provide 2.5V and 1.25V to the 54 APV25 cards on 8 rigid and 4 flex backplanes; the LH4913 are deployed on the rigid backplanes only (two LH4913 on a single rigid backplane); the Voltage Regulators of 4 vertical backplanes serve the 4 flex backplanes[2]: these regulators absorb more current and therefore they cause a larger voltage drop along the low voltage lines from power supply to backplane. The nominal drop voltage of the Regulators is 0.5 V at 1A and 1.5 at 3A. Therefore the Regulator input voltage shall not be lower than 3V; a value around 3.5 V should be safe.

Switch off the low voltage

same as before, in reverse order; remember to press the "Output 1" (and/or “Output 2”) button before switching the "POWER" know off; otherwise at the next Power on, the output(s) are enabled.

The power supplies are connected to the jlab network (TO BE CONFIRMED) with the following IPs:

```
00:50:c2:e5:55:0c - sbsftlv0.jlab.org - 129.57.56.68
00:50:C2:E5:55:F4 - sbsftlv1.jlab.org – 129.57.56.69
```

GEM High Voltage

The three GEM modules of a single layer are connected to 3 channels of a VME module (CAEN Model V6521N); in total 2 HV VME modules are used for the 4 layers in the cosmic tower. These modules are operated by a small standalone program hv_main in sbsvme20:/home/daq/daq.old/evaristo/hv (also eeltest has installed the program, same directory of sbsvme20).
All outputs of hv_main are on the standard linux output (the terminal) but you can redirect them into a file and monitor them with the "tail -f" command.

2) Referring to fig 1: m1y1 → m2x0, m0y1 → m1x0, m2y0 → m1x1, m1y0 → m0x1; the mixture between backplanes of different modules is due to the positions of the low voltage connectors and their proximity.

The usual procedure is to run one instance of hv_main in background to monitor every few seconds (typically 5) the voltage and current of the channels of interest; than use another instance of hv_main to change the settings as needed.

Before using it, from sbsvme20 (or eeltest) go in evaristo/ to set the environmental variables:
> cd /home/daq/daq.old/evaristo/ (see above NOTE:Aug/2019)
> source setlinuxvme
then go into evaristo/hv/
> cd hv
the program has quite a few options; to get the list of them with a small description:
./hv_main -h

Power ON and OFF GEM HV

WARNING: use N2 after a long stop, before switching to Ar/CO2 (see above gas section).

The "standard" procedure to power on the HV on the GEM modules is essentially:

1. Start flushing gas (generally we start with N2 after long stop) days before switching on the HV
2. Remove the protective polystyrene (or any other material) covers from each GEM module
3. Start the monitoring instance of hv_main which will run in background; on sbsvme20:
   > cd /home/daq/daq.old/evaristo
   > source setlinuxvme
   > cd hv
   > nohup ./hv_main -loop 0 5 20000000 5 >> monhv_xxx.txt &
   the last command runs a background process that monitors prof HV channels from 0 to 5 for 20000000 sec, every 5 sec. The output is written in monhv_xxx.txt (change xxx with the starting date or any other informative string)
4. Open a new terminal on sbsvme20 and go into /home/daq/daq.old/evaristo/hv, then start looking at the output file of the previous command, which should update every 5 sec:
   > tail -f monhv_xxx.txt
5. Back on the original terminal where you use hv_main, set the main channel limits (if not done before or if you do not know):
   > ./hv_main -rch 0 5 -rup 10 -rdown 50 -trip 5
   (note here -rch 0 5 means that all next options apply to channels from 0 to 5; for a single channel, for example channel=3, use -ch 3 or -rch 3 3)
6. Start ramping up the HV (setting the proper current limits, which is in nA, see table below); for example:

> ./hv_main -rch 0 5 -iset 26000 -vset 1000 -on

7. Look in the other monitor the values of Voltages and Currents; the Currents of different channels shall be similar within +/- few tens of nA (below ~1000 V) and +/- few hundreds nA above ~2000 V. After reaching the target HV, the currents shall stabilize in a few minutes.
8. When stable continue to ramp up HV:

   > ./hv_main -rch 0 5 -iset 51500 -vset 2000

   NOTE: if you decrease the HV, decrease vset first, than reduce max current
9. And so on up to the target HV (4100 V is the maximum we tested); the typical maximum currents shall be ~1000 nA above the expected value at the set HV (see next table)

HV (V)	Set Max Current (nA)	Divider Only Current (nA)
300	7700	7500
500	13500	12500
800	21000	20000
1000	26000	25000
2000	51500	50050
3000	77000	75050
3500	90000	87500
3700	95000	92500
3800	97500	95000
3900	100000	97500
3950	102000	98800
4000	102500	100000
4050	104000	101300
4100	105000	102500
4150	106500	103800

10. To switch OFF the HV:

> ./hv_main -rch 0 5 -vset 0 -off

11. To stop the "tail -f" monitoring on the other terminal press CTRL-C
12. To terminate the background process of hv_main:

> pkill -2 hv_main

Analyse the HV data (in near real-time)

You can visualize the trend of currents and voltages using root on triton: copy monhv_xxx.txt from sbsvme20 on triton (even during acquisition):

On triton (directory evaristo/hv):

```
> scp sbsvme20:evaristo/hv/out/monhv_xxx.txt out/
> root -l
>.L readMon.cpp+
> setStyle()
> readMon("out/monhv_xxx.txt")
```

To plot only from a specific time from start:

```
> readMon("out/monhv_xxx.txt",-1, 0.13, 2) // read and plot all channels, from time
0.13 h for 2 h.
```

NOTE:

The format of monhv_xxx.txt is.

```
      1st column: fraction of time elapsed
      2nd column: absolute time in second;
      3rd is the voltage of the first monitored channel in V;
      4th is the current in nA;
then the last two columns repeat for each monitored channel.
```

Tests GEM readout (card configuration and ADC histograms)

After readout electronics cabling, the first few tests that give information of the status of the cabling and electronics are the cards discovery, cards configuration and the ADC histograms.

on sbsvme20:

edit the DAQ config file (if needed):

> cd /home/daq/ben/mpd/libsrc4.0/test/cfg/

> emacs config_apv_j0-3.txt

when saved, make a link:

> ln -s config_apv_j0-3.txt config_apv.txt

then go one directory up:

> cd ..

and run the card configuration and histo-test standalone program; better to be sure the coda roc server (start_roc) is not running on sbsvme20 on a different terminal; once verified run the standalone program:

> ./mpdLibTest out.txt 4

it produces: out.txt

To analyze the data, go on triton:
> cd evaristo/daq
copy the out.txt file:
> scp sbsvme20:/home/daq/ben/mpd/libsrc4.0/test/out.txt out/out_xxxx.txt

> root -l
> .L readHisto.cpp+
> readHisto("out/out_xxxx.txt")
It will show up the "usual" histograms of each channel that has been scanned.

Cosmics Trigger

Consider to write any information on the run log available at https://pandora.infn.it/public/cd5c37 (download, update and send to Evaristo when finished).

The trigger for cosmics is based on two layers of plastic scintillators located on top and on bottom of the test station. The top scintillators are two long pads, the bottom ones are four thick blocks with square cross section.

[20190826 Update] New cosmics trigger configuration.

The top scintillators were replaced with new ones (TS1, TS2, TS3). TS3 is placed staggered on top of TS1, TS2. High voltage setting is established at -1710 V for TS1+TS2; at -1500 V for TS3 (Bogdan's settings). Signals are moderately amplified (NIM P/S Mod. 776) and a threshold of 50 mV is applied (NIM P/S Mod. 707). The bottom scintillators (BS1,BS2,BS3,BS4) remain the same, now all of them working. Their signals are amplified too.

The trigger logic was simplified. All scintillators are read out from one end only, thus reducing the number of electronics channels. Therefore, the trigger is now:

TRIG_TOP = .or. (TS1,TS2)   TRIG_BOTTOM = .or. (BS1,BS2,BS3,BS4)

TRIG_COSMICS = .and. (TRIG_TOP ,TRIG_BOTTOM)

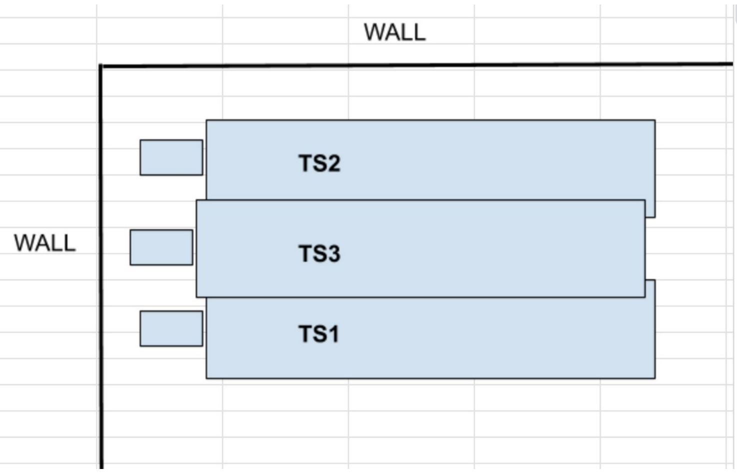
The updated HV and signal mapping from PMTs to NIM logic is displayed in the following sketches.

TRIG_TOP and TRIG_BOTTOM are done in NIM P/S Mod. 755

TRIG_COSMICS is done in NIM LeCroy Mod. 622

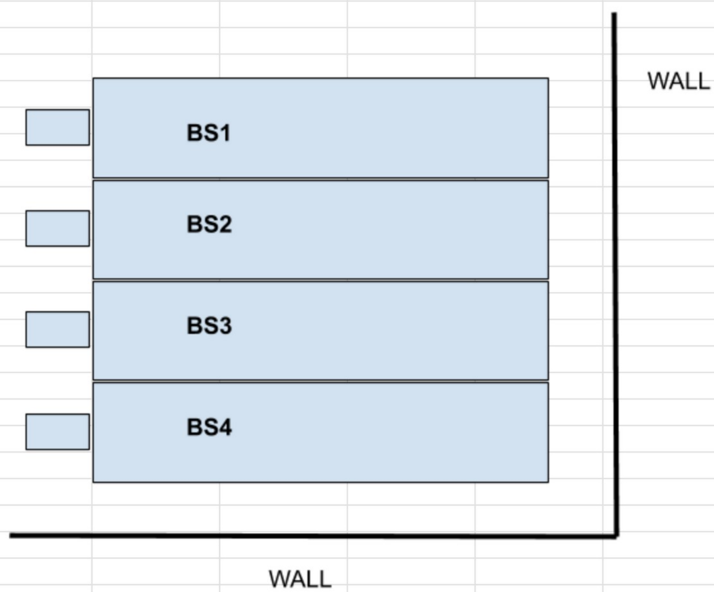
HV			
	Cable	PowerSupplyChan	Power HV [V]
TS1	247	L0.7	-1710
TS2	248	L0.8	-1710
TS3	20	L0.6	-1500

Signal			
	Cable	PatchPanel	FrontEndNIMCable
TS1	LUC-L-08	22	NA-04
TS2	LUC-L-12	23	NA-02
TS3	LUC-L01	5	NA-09



HV			
	Cable	PowerSupplyChan	Power HV [V]
BS1	19	L0.5	-1600
BS2	455	L1.0	-1600
BS3	454	L1.1	-1600
BS4	22	L0.3	-1600

Signal			
	Cable	PatchPanel	FrontEndNIMCable
BS1	LUC-L-29	6	NA-11
BS2	LUC-L-03	7	46-D
BS3	LUC-L-13	8	48-C
BS4	LUC-L30	4	NA-06



Take Cosmic Data ("standard" Acquisition)

If the chamber electronics looks good, you can start taking data (pedestal and cosmic) using coda system and MPD with version 4 firmware.

First you need to check the trigger logic is properly configured (in the NIM crate).

Switch on the PMT Scintillators HV

they are used to form the cosmic trigger:

on a triton terminal:

> ssh pi@rpi5   // need password

> ./start_hv

On a different terminal:

> ~/slowc/hvs rpi5

Load the configuration for cosmic:

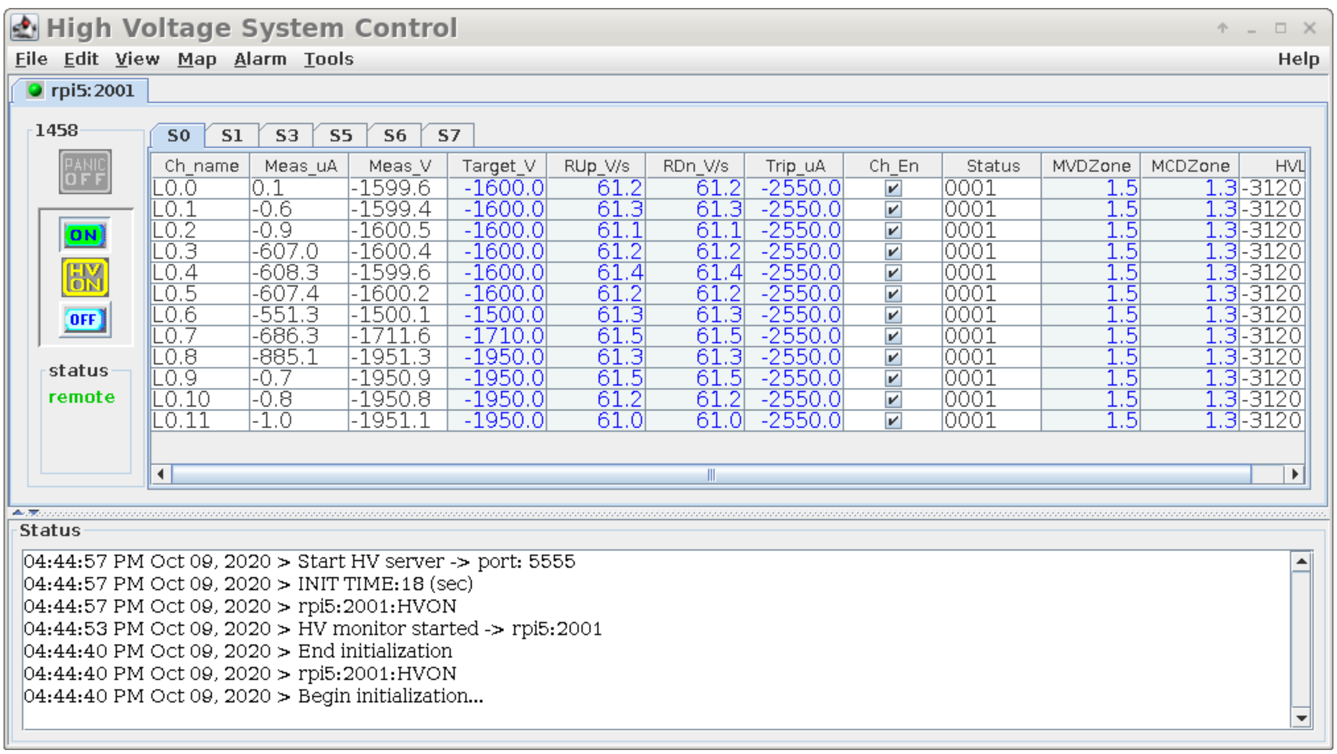
-> File -> Load Settings and choose “cosmic-infn_xxxx.set” (xxxx is the latest date) or set HV on the graphic panel; HV settings must be negative!

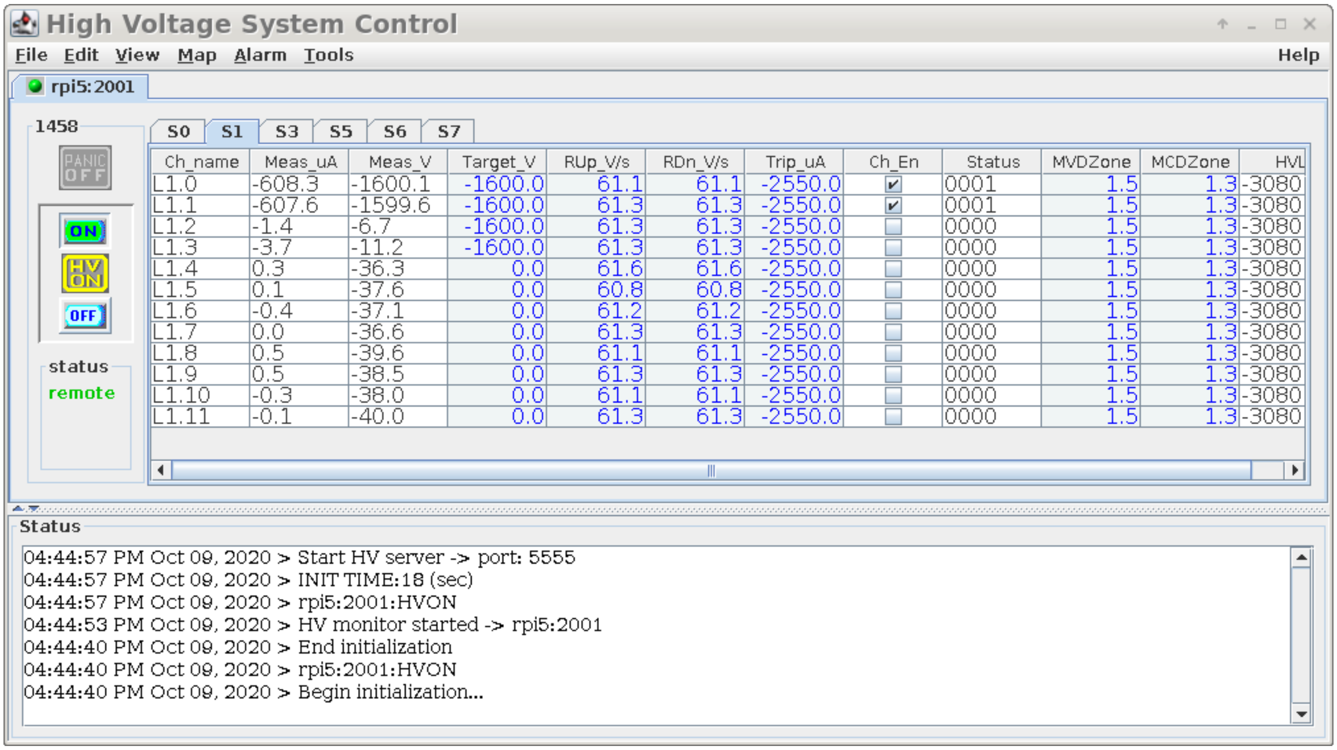
Enable the channel(s) of interest (see the following two screenshots):

-> got the the “S0” tab/module

-> Edit -> Enable Channels -> In selected module

Then push the “ON” button.





Initialize DAQ (coda)

Nov/2020: We are moving to CODA3

CODA3 run on sbs-onl account (on triton); data are collected on /*home*/sbs-onl/data and copied on /bigdata/daq/data_coda3 (to free space on /home/sbs-onl/data)

Configuration files are in: triton:/home/sbs-onl/infn-cfg/newConfigFile/; main file is mod_config.cfg which include single MPD files from infn_crate_1/

Run log are automatically stored on: https://logbooks.jlab.org/ with “INFN-GEM” tag

Start the mSQL database server used by coda: need to be updated to CODA3

on a triton terminal:

> source coda_user_setup # possibly not needed

> msqld

keep it running;

Connect to the VME CPU master and run the roc: need to be updated to CODA3

on a different triton terminal:

> ssh sbsvme20

> ./start_roc   // (coda_roc_rc3.5 -n MPD20 -t ROC)

Now start coda:

on a different triton terminal:

> kcoda (this is to be issued before starting start_roc, in order to kill all processes of previous running coda); NOTE: we noticed that killing coda may discunnect the scintillator HV client from the raspberry; this is probably related to some java issue.

> startcoda

-> platform > connect

-> configurations -> MPDvme

-> "configure" (tools symbol)

-> "download" (floppy symbol) -> this actually configure the APVs

-> "prestart" (play and pause symbol)

-> "go" (play symbol) to start the run

Using CODA from a remote computer
connect to triton and run:

./run_vncviewer

you are in front of the triton desktop; if locked, press ENTER and give the password (or username if none is connected). Proceed as before.

Old CODA2:

From remote you can connect to the CODA controller already running on triton:

connect first to triton, then:

> source coda_user_setup (not sure it is required)

> rcgui

you will get the CODA control panel to start/stop the run (@@ SHALL ASK Alexandre and/or others how to read the message log from remote)

To start from scratch the whole CODA from a remote terminal and keep it running on the local consolle:

connect on triton

> source coda_user_setup

> kcoda

start the roc on sbsvme20 with:

> xterm -display :0.0 -T "roc" -e ssh -t sbsvme20 'source setup_ben; ./start_roc' &

start CODA (note the 0.0 at the end):

> startcoda0.0

all terminal will open on the local consolle (X11 server :0.0); no new windows will show up on your remote terminal

start the gui:

> rcgui

now you get control of the run, but cannot see the output log (@@shall ask Alex or others)

the CODA2 MPD/APV config file is in:
`sbsvme20:/home/daq/ben/mpd/libsrc4.0/rol/cfg/config_apv.txt`
(MPD version 4 firmware)

(As of Nov/2018) the CODA output data files are collected in: /bigdata/daq/data

The backup data are in the tape sylos on: /mss/halla/sbs/prod/GEM_test/INFN_GEM/

or /mss/halla/sbs/GEM/ft_cosmics/

to backup files use:

/site/bin/jput /bigdata/daq/data/mpd_ssp_3857.dat.*.gz /mss/halla/sbs/prod/GEM_test/INFN_GEM/

for further details see: https://scicomp.jlab.org/docs/storage

Analyse the data

The analysis code has been written by Siyu and is based on root and a graphical GUI that permits:

- (Raw) look at the raw data
- (ZeroSub) look at the subtracted data (need a pedestal file)
- (Pedestal) generate the pedestal file

- (Hit) generate the hits map data
- (Analysis) do the analysis
- … more

On triton set the environmental variables:

source MPD4_VME/setLinuxEnv

then launch the GUI:

> cd MPD4_VME/ROOT_GUI/ (or MPD4_VME/ROOT_GUI.siyuOriginal20181025)

> ./ROOT_GUI

The main configuration file is in: cfg/DetConfig.cfg where one can change, for example, the output directories (and file names) or the map file.

The “standard” map file is in: database/gem_map_infn_j0_3.cfg (see above DetConfig.cfg)

Once an analysis procedure is selected from the top left panel (e.g. Pedestal) and the required files are provided, push the “Confirm” button on the bottom left corner.

The typical flow is:

1. Produce the pedestal file:
    a. select “Pedestal”
    b. then provide the raw pedestal file in the upper data input by pushing “Open” change dir to /bigdata/daq/data then select “All files” from the “Files of type” select the specific run file(s).
    c. Finally press “Confirm” in the main window. This produces a root pedestal file in the directory ./PedestalDir (see in the message screen)
2. Generate the hit files:
    a. select “Hit”
    b. then provide the root pedestal file (processed in the previous step, look into the directory ./PedestalDir)
    c. then provide the raw data file(s), in the lower data input looking into /bigdata/daq/data (All files types, and check “Multiple Files”).
    d. press “Confirm”. This produces root files of each input data file, with the common noise removed, pedestal subtracted, noise thresholding 1-dim hits. The root file should be stored by default in /home/daq/MPD4_VME/ROOT_GUI/results/GEMfixNov18/
3. Generate the “analysis” files:
    a. select “Analysis” then proceed as in the previous points; this will generally 2d clustered data, ready for 2D hit maps, tracking, ...

Use “hadd” to combine multiple root files into a single one.

Open root and load the “hadded” file, then “new TBrowser” and finally browse the histograms.

Alternatively to point 3: open a new terminal (in triton) and go into:

> cd MPD4_vme_Decoder

> run root

> .L simprox_new.cpp+

> simpro(0.5, 30, “full path of TRoot hit files”,”another hit file path - optional”, “another hit file path - optional”) where:

0.5 = correlation threshold

30 = max distance (in mm) between reconstructed and measured hit, for efficiency estimation

“full path …”: is the path of the Hit files produced in the point 2. of ROOT_GUI. You ca use “*” or other wildcards for multiple files (and/or the additional 2 optional parameters)

The simprox_new.cpp root script will provide hit maps, some sort of efficiency maps and hopefully more in the future.

To get the x/y charge sharing distribution. in root:

> .L simredo.cpp+

> postdraw()

To get the pedestal in root:

> .L simprox_new.cpp+

> Pedestals(“name of the root file in the ….ROOT_GUI/PedestalDir/ directory”)

Old decoding and 1-D hit generation (<Set/2018)

on triton, go into:

> cd MPD4_vme_Decoder

edit the config file (basically write the proper run number)

> emacs config/gem.cfg

then run:

./mpd4_decoder (or something similar)

NOTE: the old method is useful to check the raw data, just after a new run: set the config file accordingly and look at the 216 raw sampled data in a single window.

2D Hit maps and more

Use Siyu method (ask Siyu)

or the above “simprox.cpp” method. The two methods probably produce slightly different results.

CODA issues

If CODA stops working properly, try first to press the “reset” (rewind) button and then disconnect from the server. Then quit coda. If the graphic panel does not work, go directly to the triton terminal where you start code and digit:

> kcode

> startcode

In the sbsvme20: stop the server (CTRL-C) and restart it as described above.

If the problem persist, you probably need to reboot the sbsvme20 CPU either by “reboot” or power cycling the VME crate. In the latter case REMEMBER TO RAMP DOWN THE LV and HV!

Single Chamber test

Before moving a newly integrated chamber into the cosmic stand, it is important to test the readout (cards, backplanes, cabling, patch panels). This is done (since July/2018) by the minicrate system used for the single module test (see below).
The single chamber test consists of: configuration and histogram test (using the standalone program mpdLibTest), pedestals (using code version 4).
The hardware setup consists essentially of: the VME minicrate with a single MPD, a trigger supervisor and a VME master (eeltest); the NIM modules that provide the trigger signal to the trigger supervisor (in this case a pulsed trigger for the pedestals, provided by the quad gate generator); one Low Voltage channel.
Since we use a single MPD, testing all chamber electronics requires 4 different configuration (cabling from chamber to MPD and relative daq-configuration file).
The acquisition is on eeltest, the analysis is done on triton.

Configuration/Histogram test (use mpdLibTest)

Daq config file in daq@eeltest:ben/mpd/libsrc4.0/test/cfg/config_singlechamber_##.txt
where ## = x0,x1,y0,y1 depending on the backplanes that are connected

From triton connect to eeltest (or sbsvme20) and run:
> ssh eeltest
> source setup_triton

> cd ben
> source setlinuxvme
use the proper configuration file depending on the connected backplanes (example for x1 backplanes)
> cd mpd/libsrc4.0/test/cfg
> ln -s config_apv_singlechamber_x1.txt config_apv.txt   # delete previous link if exist
Now run the histogram test
> cd ../
> ./mpdLibTest out.txt 4

The above command configure the MPDs and cards before doing the histogram test; one can skip configuration of the MPD and related card masking the corresponding bit of the mask parameter with:
> ./mpdLibTest out.txt 4 5 0x2
where:
5 is the gain (5 is the default)
0x2 will mask the second MPD, disabling its configuration. To mask all 16 MPDs use: 0xFFFF

Go on triton:
> cd evaristo/daq
copy the out.txt file:
> scp eeltest:/home/daq/ben/mpd/libsrc4.0/test/out.txt .
Read it
> root -l
> .x readHisto.cpp+
> readHisto("out.txt");
If everything is fine, save the plots on a pdf file and copy on the subdir histo/
Move the out.txt on the subdir out/
If something is wrong, fix it and repeat!

Pedestal test (use coda)

Daq config file in daq@eeltest:ben/mpd/libsrc4.0/rol/cfgtest/config_singlechamber_##.txt
where ## = x0,x1,y0,y1 depending on the backplanes that are connected
It use coda, therefore, on triton start the mSQL if not running (see above)

From triton connect to eeltest and run:
> ssh eeltest
use the proper configuration file depending on the connected backplanes (example for x1 backplanes)
> cd mpd/libsrc4.0/rol/cfgtest
> ln -s config_apv_singlechamber_x1.txt config_apv.txt   # delete previous link if exist
Now start the coda "roc":
> cd

> source setup_triton
> ./start_test

Go on triton to start coda (see above)
connect then select the configuration: MPDtest
download, prestart, start … take 2000 events at least

Stay on triton:
> cd MPD4_vme_Decoder
Edit the config file (config/gem_singlechamber.cfg) changing the run number of the saved pedestal and the input data; eventually link to gem.cfg;
run mpd decoder:
> ./mpd4_decoder
Look at the pedestal:
> root -l
> .L sctest.cpp+
> sctest("Pedestal/pedestal_$$$$.root"); # $$$$ = run number
If everything is fine, save the plot on a pdf file and put in Result/
If something is wrong, fix it

Single Module test

Before integrating the GEM module into a chamber, it is tested in the single module test bed, using a 90Sr radioactive source (0.3 uCi), a scintillator coupled to a PMT (-2000 V) which is powered by one of the Lecroy HV Power supply. See elog at https://lxcis.iss.it/elog/jlab/366 for further information (available only from the iss.it network!).

For data acquisition we use coda, while for histogram test we use the mpdLibTest code.

Procedure to run the single module test

New procedure, using a VME-minicrate and a single MPD; the VME-minicrate is managed by the eeltest master.
The MPD configuration files for coda are in: ben/mpd/libsrc4.0/rol/cfgtest/
the official single module configuration file is: config_apv_singlemodule.txt

Start HV for the Scintillator (need passwords!)

----

on a triton terminal:

> ssh pi@rpi5

> ./start_hv

on a second triton terminal:

> ssh adaq@sbs1

> cd slowc

> ./hvs rpi5

Set HV on the graphic panel; it must be negative! Enable the channel and push the "ON" button.

Initialize DAQ (coda):

----

on triton terminal:

> ssh eeltest   # was: ssh sbsvme20

> cd ben/mpd/libsrc4.0/rol/cfgtest/

> cp config_apv_singlemodule.txt config_apv.txt

> cd

> source setup_triton

> ./start_test # was: ./start_roc   (coda_roc_rc3.5 -n MPD20 -t ROC)

on triton terminal:

> kcoda   (perhaps to be issued before ./start_roc … must check ...)

> startcoda

-> platform > connect

-> configurations -> MPDtest

-> "configure" (tools symbol)

-> "download" (floppy symbol) -> this actually configure the APVs

-> "prestart" (play and pause symbol)

-> "go" (play symbol) to start the run

```
the MPD/APV config file is in:
sbsvme20:/home/daq/ben/mpd/libsrc/rol/cfg/config_apv.txt
```

(MPD version 3 firmware)

Data analysis:

----

on triton terminal:

> cd mpd3_decoder

edit the config file:

> emacs config/gem.cfg

(run number, processing type (RAW, PEDESTAL ...)

> ./main

for pedestal, rename the file if needed; there is a small script runhit.sh that do part of the job

Computing nodes and main directories

All tests use the following computing nodes:

`daq@triton: desktop computer for analysis and coda manager`

evaristo/ data and custom root macro for HV and Histo analysis

mpd3_decoder/ for decoding, raw data display, pedestal, hitmap of data from MPD-version3 firmware

MPD4_vme_Decoder/ as mpd3_decoder, but for MPD-version4 firmware (over VME)

`daq@sbsvme20: Intel Single Unit VME CPU for acquisition and GEM-HV slow control`

evaristo/ library and program for GEM-HV control and some other minor stuff

ben/mpd/ libraries, code and config files for MPD version 3 (libsrc) and version 4 (libsrc4.0) firmware

daq@eeltest clone of sbsvme20 used for single module, single chamber tests and/or HV control

pi@rpi5: raspberry board for Lecroy HV crate and module low level control
adaq@sbs1: for the Lecroy HV control graphic client
Tape backup directory: /mss/halla/sbs/prod/GEM_test/INFN_GEM/

Utils

Backup data, from triton:

/site/bin/jput filee_name1 file_name2 … /mss/halla/sbs/prod/GEM_test/INFN_GEM/
(see: https://scicomp.jlab.org/docs/storage)

Contacts

DAQ: Danning Di: dd9rq@virginia.edu

Siyu:

Alexandre:

Brian:

General and Logistic: Mark Jones: jones@jlab.org

Thermo camera/Gas/Tools/Parts ...: Chuck (Mahlon Long): mlong@jlab.org

90Sr source and radioprotection: Adam Hartberger: adamh@jlab.org

Mechanical workshop and other Hall A needs: Jessie Butler: jbutler@jlab.org

Mechanical design: Robin Wines: wines@jlab.org

Web sites

SBS Wiki:
https://hallaweb.jlab.org/dvcslog/SBS/ (specific components: Electronics, GEM and GEM commissioning)
Weekly GEM Commissioning meeting:
https://hallaweb.jlab.org/wiki/index.php/GMn_GEM_Commissioning_Meeting
runlog: https://pandora.infn.it/public/cd5c37

Compiling libraries and executables

Slow control utilities migrated from the Rome/GEM:

in sbsvme20:
use Ben jvme libraries and ancillaries

in evaristo/ do:
> source setlinuxvme

in director: grmlib are the source of selected methods from the Rome/GEM library, ported on C:
> make; make install
will generate libgrm and copy in include and lib

on directory hv is hv_main the program that control the CAEN V6521N HV modules
> make clean; make
> hv_main -h for help

include and lib link to ben/ relevant files

mpdLib

on sbsvme20 in ben/mpd/libsrc (MPD Version 3) or libsrc4.0 (MPD version 4)

the source files: mpdLib.c (.h) and mpdConfig.c (or similar)
the compile:
> make; make install

mpdTest program

Standalone test program and acquisition

on sbsvme20 in ben/mpd/libsrc/test (MPD Version 3) or libsrc4.0/test (MPD version 4)

the source code is mpdLibTest (or something similar)
to compile:
> make

to run it:
> ./mpdLibTest out_file mode #events gain

The configuration file is cfg/config_apv.txt (check the include inside config_apv.txt point to the correct default file)

coda mpd library

on sbsvme20 in ben/mpd/libsrc/rol (MPD Version 3) or bin/mpd/libsrc4.0/rol (MPD version 4)

main source code (it derives from mpdLibTest): @@@@
to compile:

disconnect code first (if running)
stop the roc: (where start_roc terminal is running)
> make
restart the roc:
> ~/start_roc

reconnect the CODA client (as described above)

The config file is cfg/config_apv.txt (check the include inside config_apv.txt point to the correct default file)

Mapping and addressing

CAEN HV V6521N Base Addresses

J0 and J1: 0xFFD0.0000 (relative ch 0 to 5)
J2: 0xFFE0.0000 (relative ch 0 to 2)

TTI LV CPX400DP Ethernet Addresses

J0 and J1: 00:50:C2:E5:55:0C
J2: 70:B3:D5:E5:BA:48

MPD - APV mapping spaces

APV is connected to one backplane “slot”; the position of the slot participates to determine the IC2 address and the ADC index.
The backplane has 2 HDMI connectors (digital and analog); 2 internal (short) HDMI cables connect the backplane to one digital and one analog patch panels.
Two external (long) HDMI cables connect the patch panels to a single MPD. The analog cable is plugged in one of the 4 analog connectors of the HDMI and the digital to one of the 2 digital connectors.
The APV is mapped in the I2C and ADC space.
The I2C space is used to configure the APV; its mapping is determined by:

- 2 bit switch on the backplane, which set the base address 0, 8, 16 or 24; backplanes connected to the same MPD shall not have the same base address!
- slot of the APV card on the backplane; see table 2.

The ADC space define the physical mapping of the strips into the electronics channels. The mapping is determined by:

- the connector in the MPD (bottom map ADC-channel 0 to 3, next up ADC-channel 4 to 7 and so on up to 15)
- the in and out connectors in the analog patch panel
- the slot of the APV card on the backplane; see table 2. Each slot corresponds to a line (that is twisted-shielded wires) of the HDMI Cable.

Table 1: I2C Backplane Switches settings and corresponding I2C base address

Switch		I2C Base Address	
1	2	Rigid 5 slots rev 2	Flex 5 slots rev 1 and 2
off	off	0	0
off	on	8	16
on	off	16	8
on	on	24	24

Table 2: Card slot in backplane and corresponding I2C and ADC offset.
Backplane Rigid 5 slots v2.0:
I2C: Analog connector - 4 - 3 - 2 - 1 - 0 - LV and Digital connectors
ADC: Analog connector - 4 - 3 - 2 - 1 - 0 - LV and Digital connectors
Backplane Flex rev. 1 - (inverted):
I2C: Analog connector - 4 - 3 - 2 - 1 - 0 - LV and Digital connectors
ADC: Analog connector - 0 - 1 - 2 - 3 - 4 - LV and Digital connectors
Backplane Flex rev. 2:
I2C: Analog connector - 0 - 1 - 2 - 3 - 4 - LV and Digital connectors
ADC: Analog connector - 0 - 1 - 2 - 3 - 4 - LV and Digital connectors

For each chamber, there are:

- 4 MPDs (identified by the slot in the VME crate)
- 4 Analog Patch Panels, 2 on the Right and 2 on the Left cable trays; on each side one Patch Panel is Bottom and the other is Top (depending on their relative positions); they are identified by: R-T, R-B, L-T, L-B
- 4 Digital Patch Panels; 2 sits on the Right and 2 on the Left cable trays; as for analog patch panel, on each side one is Bottom and the other Top; same identification scheme
- 12 backplanes; 6 of them are rigid, 4 are flexible

A single card is therefore identified by:
MPD

- VME slot (1,...20)
- Analog Connector index (0,1,2,3)
- Digital Connector index (0,1)

Analog Patch Panel

- Outer Connector index (7,8,9,10)

- Inner Connector index (1,2,3)

Digital Patch Panel

- Outer Connector index (1,4)
- Inner Connector index (2,3,5,6)

Backplane

- Type and backplane revision (rigid, flex-v1, flex-v2)
- Slot in backplane (0,1,2,3,4)

Note:
digital connectors on MPD and on digital patch panel are interchangeable;
digital and analog lines of a backplane shall be connected to a single MPD

Troubleshooting

Histogram test

Pedestals

Real (cosmic) data

By signing this page, you testify that you have read, understand, and agree to abide by the procedure specified in the above referenced work control document:

Serial Number: ENP-21-113037-OSP

Title: GEM detectors for the SBS experiment

Name	**Signature**	**Date**