

Status of SBS GEMs:

Production and Preparation for the Cosmic Tests

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SBS Weekly Meeting 05/31/2017

Outline

- Status of Front Tracker modules (INFN)
- Status of Back Tracker modules (UVA)
- Preparation for the Cosmic Tests @ JLab

GEM Chambers for GMn

Back Tracker GEM chamber

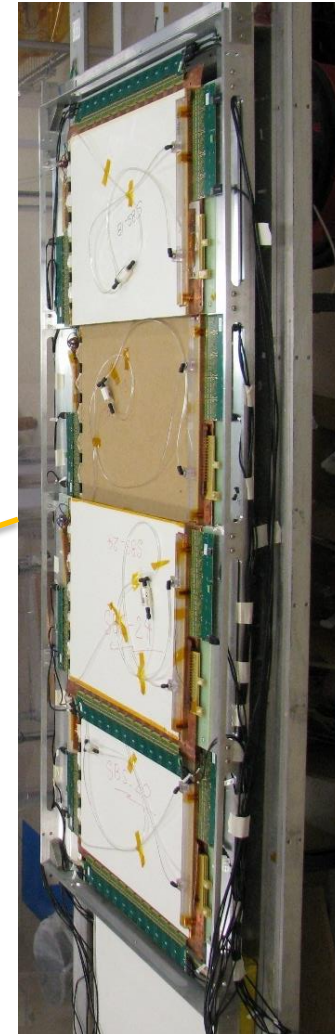
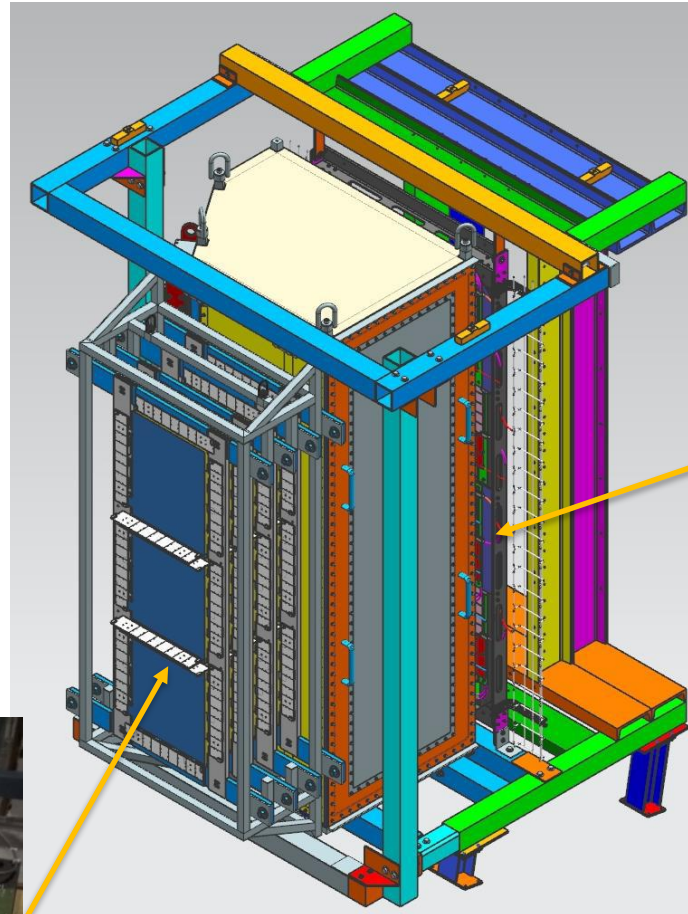
GMn GEM Tracker: 4 layers (INFN GEM modules)

- INFN groups at Roma, Catania, Genoa and Bari
- Required a total 12 modules, each layer (150 cm x 40 cm) made of 3 INFN modules. (16 already built)
- 2 chambers already delivered @ JLab
- Other 2 remaining chambers on their way

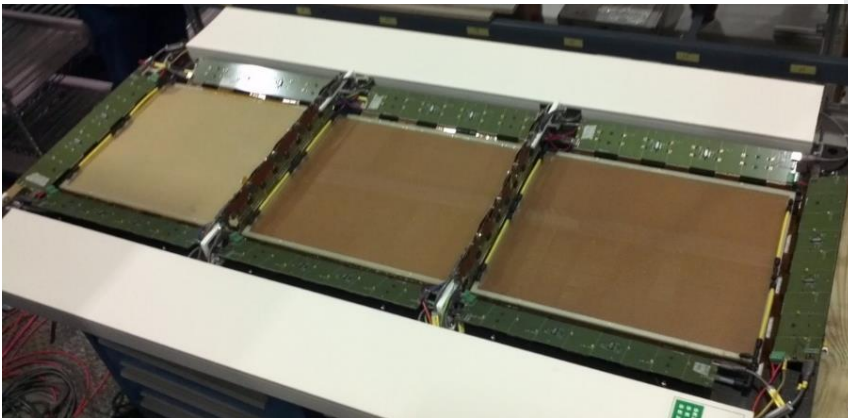
One additional layer behind the GRINCH detector:

- Back layer (200 cm x 50 cm) made of 4 UVa modules
- More than 40 UVa modules available
- Module migration to JLab to start after May 15°
- Aluminum frame has been built and tested @ UVA

Bigbite Spectrometer for the GMn experiment



Front Tracker GEM chamber

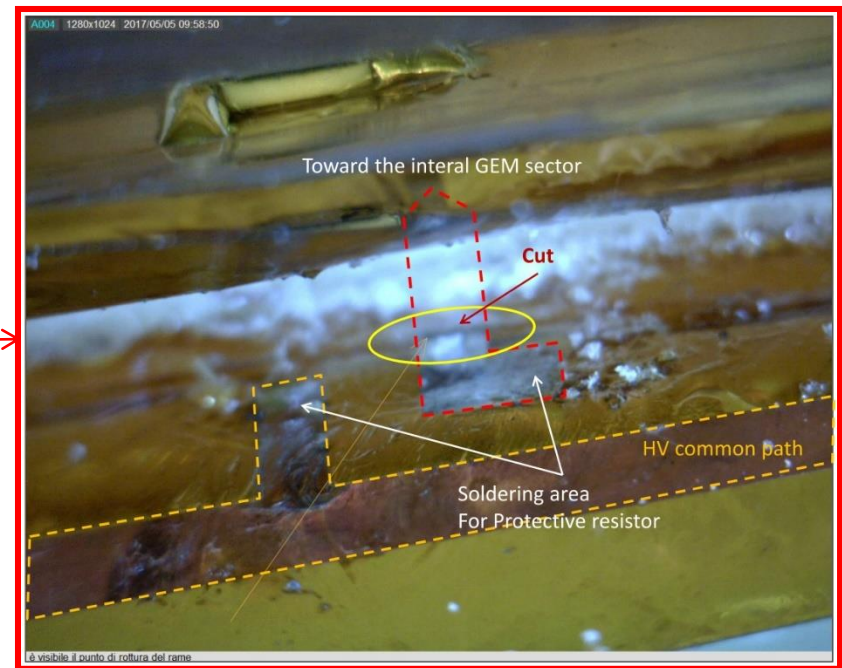
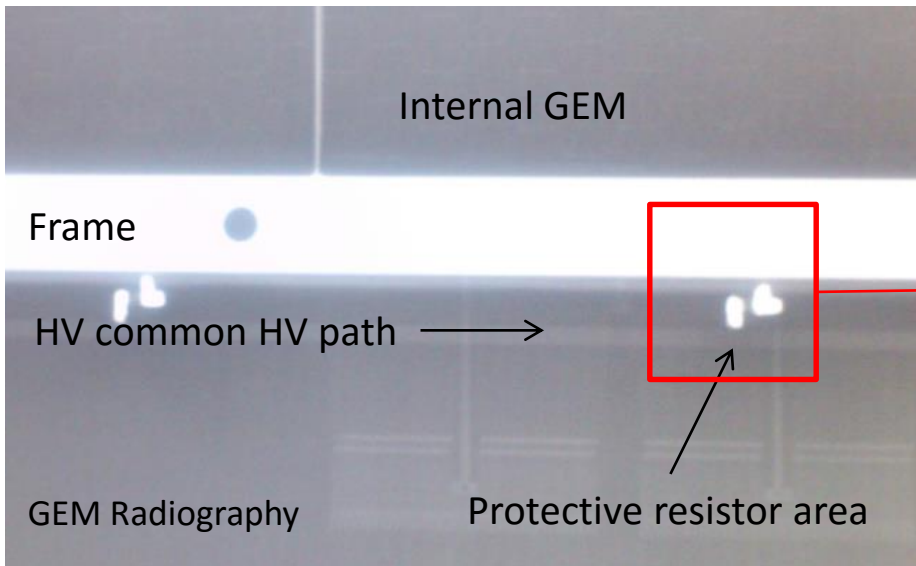


Setting the cosmic stand for characterization and commissioning of the GMn tracker

Front Tracker GEMs: Cause of inefficient sectors

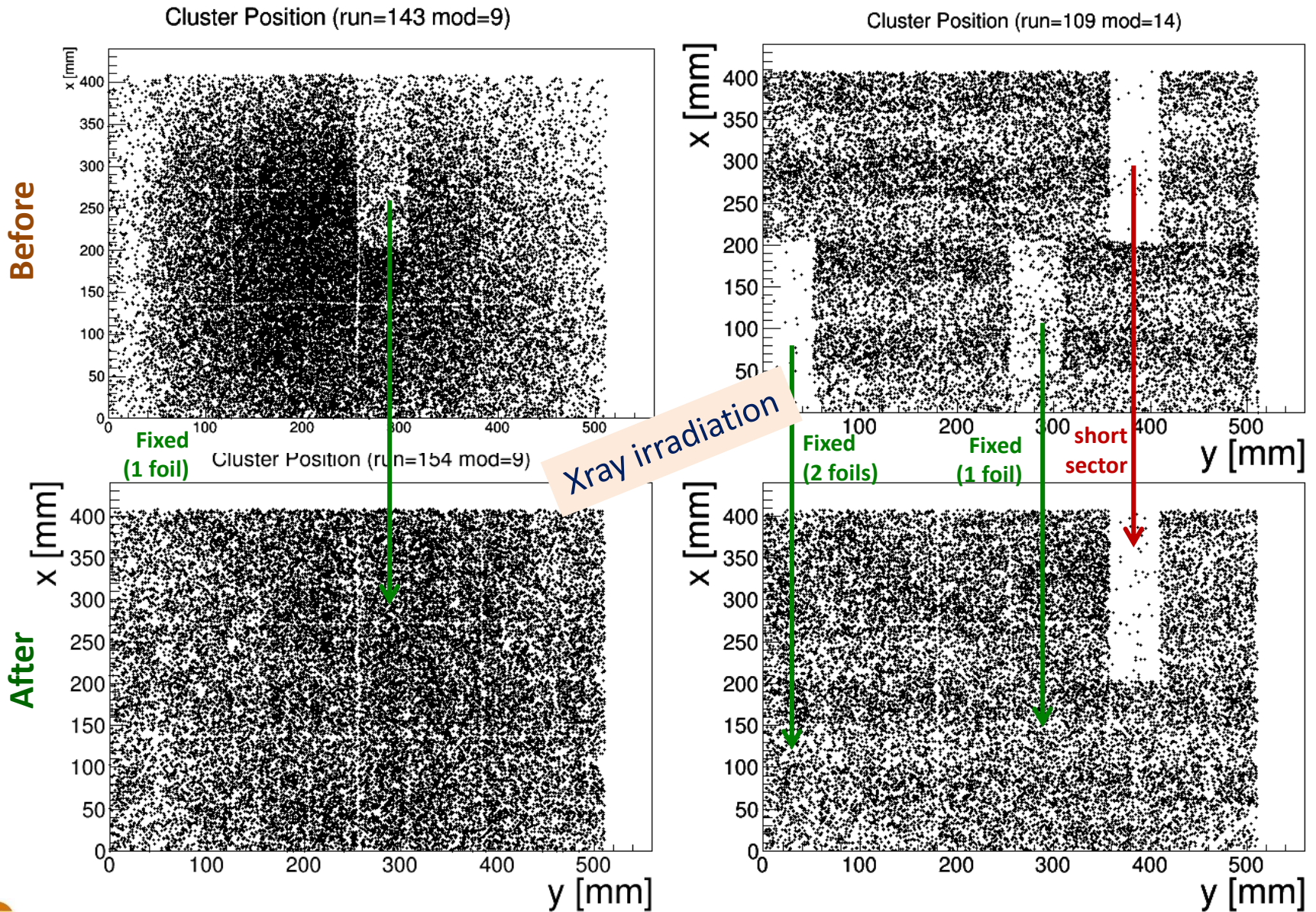
The HV distribution line is interrupted between the protective resistor and the border of the GEM frame – the sector does not get HV.

Cut is likely due to excessive soldering of the protective resistor which extends beyond the expected pads (see GEM radiography) combined to bending of the kapton foil due to module handling (and/or transportation):
the extra soldered border acts as blade for the HV line



Courtesy E. Cisbani

Front Tracker GEMs: Fix of the inefficient sectors



Front Tracker GEMs: Fix of the inefficient sectors

- **Inefficient sectors can be recovered by soldering a thin wire jumper across the HV line cut**
- All inefficient sectors fixed so far (5 on 2 modules) work well
- **We expect to recover all inefficient sectors (13)**
- We are adopting some precautions:
 - Solder the resistor on the designed small pads (do not extend soldering on the HV path)
 - Handle GEM foils with extra care
 - GEM packing for transportation to be revised
- **Work is in progress for the short sectors (9)**

Front Tracker GEMs: Production Status

GEM modules

- 6 modules at JLab: 3 of them need inefficient sector fixing,
 - 1 looks completely dead, **but expected to be recovered** (
 - probably same issue with broken HV line ⇒ Fix planned in **mid July 2017**
- 9 modules in Rome: 3 fully tested, 4 on queue for x-ray testing and fix if needed, 2 ready for HV training
 - 6 of them to be shipped to JLab then assembled into chambers **mid to end July** (if test/rework are fine).
- 3 modules in Catania waiting completion:
 - 2 almost completed (missing readout window FR4 frames → ordered), 1 in the queue for assembling
- 3 additional modules planned (material ordered at CERN, ready in June)

Chamber Carbon Frame

- First complete frame tested on May/15th (couple of details need minor rework); expected delivery of all frames (6 chambers) to JLab from company (RIBA composites) **within mid July**

Electronics/DAQ

- Hardware: all seems to be on hands, except optical fiber transceivers and proper length (10 m?) HDMI cables
- Firmware: SSP-MPD integration largely completed; work in progress in bug fixing and performances improvement

Back Tracker GEMs

Production status

- 42 modules built and tested so far
 - ⇒ 40 modules 100% operational
 - ⇒ 2 modules have one bad sector ⇒ (97% active area operational)
 - ⇒ **Six spare modules in the queue for assembly, Expected by Aug 2017**
- UVa Comic stand with full MPD electronics for 4 modules
 - ⇒ Use to test newly built modules
 - ⇒ Additional test of the modules before shipment to JLab to define working HV
- Prototype of mounting frame for BT GEM layers assembled and tested

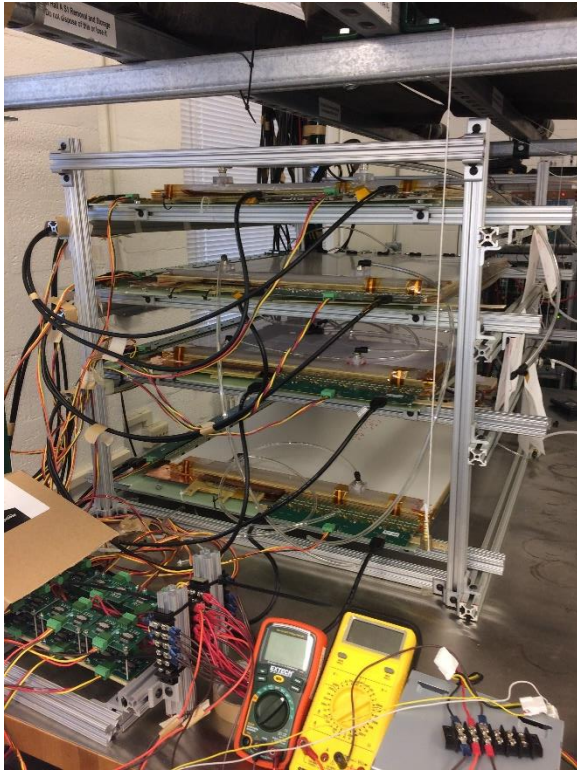
[H. Nguyen's Talk @ MPGD2017:](#)

https://indico.cern.ch/event/581417/contributions/2556718/attachments/1464747/2263931/HuongNguyen_MPGD2017.pdf

Migration of UVa modules to JLab

- 5 modules currently at JLab since 2016
 - ⇒ Danning's high rate tests in Hall A
 - ⇒ Probably for another high rate test team this fall in Hall C for
- Planning to move 4 more modules in June 2017
 - ⇒ Test the chamber on the cosmic stand in June-July
- Migration of all modules to JLab will start June 2017
 - ⇒ Modules will stored at in the GEM clean room space

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GEM Readout and Data Acquisition



APV-25 FEC

SBS requirements: 2-4kHz
Data injecting rate on each SSP at 2 kHz: 1000 MB/s

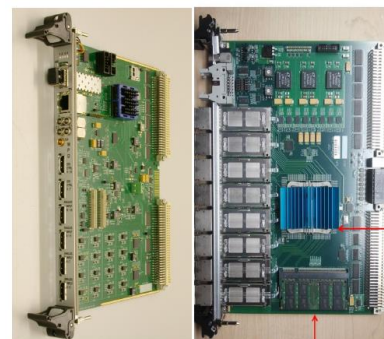
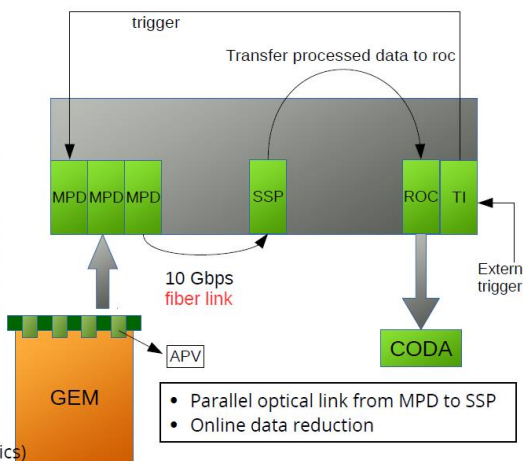


APV-25 FEC

Case of 16bit word each channel reading 6 sample:
 $2\text{Byte} * 128(\text{channels}) * 6(\text{time sample}) = 1536 \text{ Bytes/APV-25}$
 in case of 4kHz trigger rate:
 Volume going out from MPD to SSP: **92 MBytes/s**
 Volume injected into SSP: 24 MPD each ssp:
 $92\text{MB} * 10 + 74\text{MB} * 14 = 2\text{GB/s}$ (where bottle neck sits right now)



FPGA based digitizer MPD(INFN, Paolo)
Subsystem processor (JLab customized electronics)



FPGA based digitizer MPD(INFN, Paolo)
Subsystem processor



- Parallel optical link from MPD to SSP
- Online data reduction

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- Online data reduction

Issues with SSP under investigation

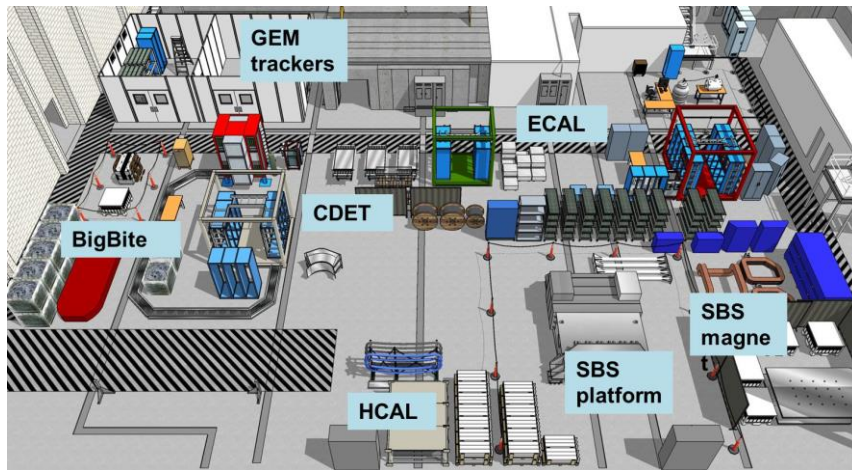
- The MPD (firmware version 4) and SSP setup seems okay for small event sizes (~ 4 APVs on MPD)
- With 12 APVs per MPD, various issues **not related to trigger rate** (observed very low rate)
- Two main issues
 - ⇒ Unexpected extra small data frame with one 32 bits word which comes right after a normal event frame. It appears to be a duplication of the last word of the previous event
 - ⇒ Sometimes the SOF(start of frame) is missing. The data frame looks fine though

Courtesy D. Di

Commissioning of GEM Trackers

Status of the construction of Clean Room space

- Space allocated in the test lab for the storage of the GEMs modules and the cosmic stand
- Bulk of the construction and electrical work completed
- Last step: floor painting and final check up / inspection by the end of next week **(05/09)**
- Clean room expected to be **ready by 05/12**



Tentative plan and timeline for the cosmic test setup

- Mid June: Week of June 12th, I will be at JLab to start setting the cosmic stand (with Siyu and Danning)
- Mid July: Evaristo and his crew are coming mid July will all the modules and frames for the front tracker GEM
- Mid July – End July: will setup the full stand with 4 INFN layers

Setting of the cosmic stand for GEM trackers

- Full characterisation of the GEM modules with cosmics
 - ⇒ Evaluate the dead area (disabled HV sector), study efficiency,
 - ⇒ Define the optimal working HV and gas flow for each module
 - ⇒ Full readout performance DAQ
- Setup of the stand **(05/15 – 06/15/2017)**
 - ⇒ Setup of trigger with 1.6 m long scintillators / PMTs (get it from Bogdan)
 - ⇒ UVa GEM layer (4 modules) will be used for testing the setup
- Have 4 FT GEM layers on the cosmic stand **(06/15 -06/30/2017)**
 - ⇒ Expect all modules and frames for the 4 layer at JLab
 - ⇒ Assembly and connection to HV, gas, electronics
 - ⇒ We should start cosmic data taking by **07/01/2017**
- One VME crate for the readout will be used

Manpower and Resources for the Cosmic test this summer

Commissioning of GEM trackers on the cosmic stand

- UVa team this summer (Kondo, Siyu, Danning)
- Evaristo's team will provide support during the setting of the cosmic test and commissioning phase
- We will have one undergrad student from HU this summer (M. Kohl)

GEM readout electronics and DAQ

- Danning, Alex and DAQ group
- Support from Evaristo and Paolo
- Full scale test on cosmic stand (Kondo, Siyu)

Backup

GEM Readout Electronics & DAQ

2 VME crates for all 4 + 1 GEM layers

Front Tracker crate

16 MPDs (v4.0)
1 SSP
1 Trigger Supervisor
1 VME CPU or Controller
2 slots for HV PS

Back Tracker crate

7 MPDs (v.40)
1 SSP
1 Trigger Supervisor
1 VME CPU or Controller
1 slots for HV PS (or not)

Electronics Hut & Shielding for GMn/Gen GEM electronics

Shielding and dose simulations study done

http://hallaweb.ilab.org/12GeV/SuperBigBite/SBS-minutes/2017/obrecht_GMn_hut.pdf

Progress on the DAQ and rate capability

- MPD4.0 with the implementation of the SSP module and optical link
- The system is under test (Danning, Alex, Paolo and the DAQ group).
- Ongoing debugging of the data transfer with optical link

