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GEn-RP Status Update

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Contents

Experimental Technique/Design

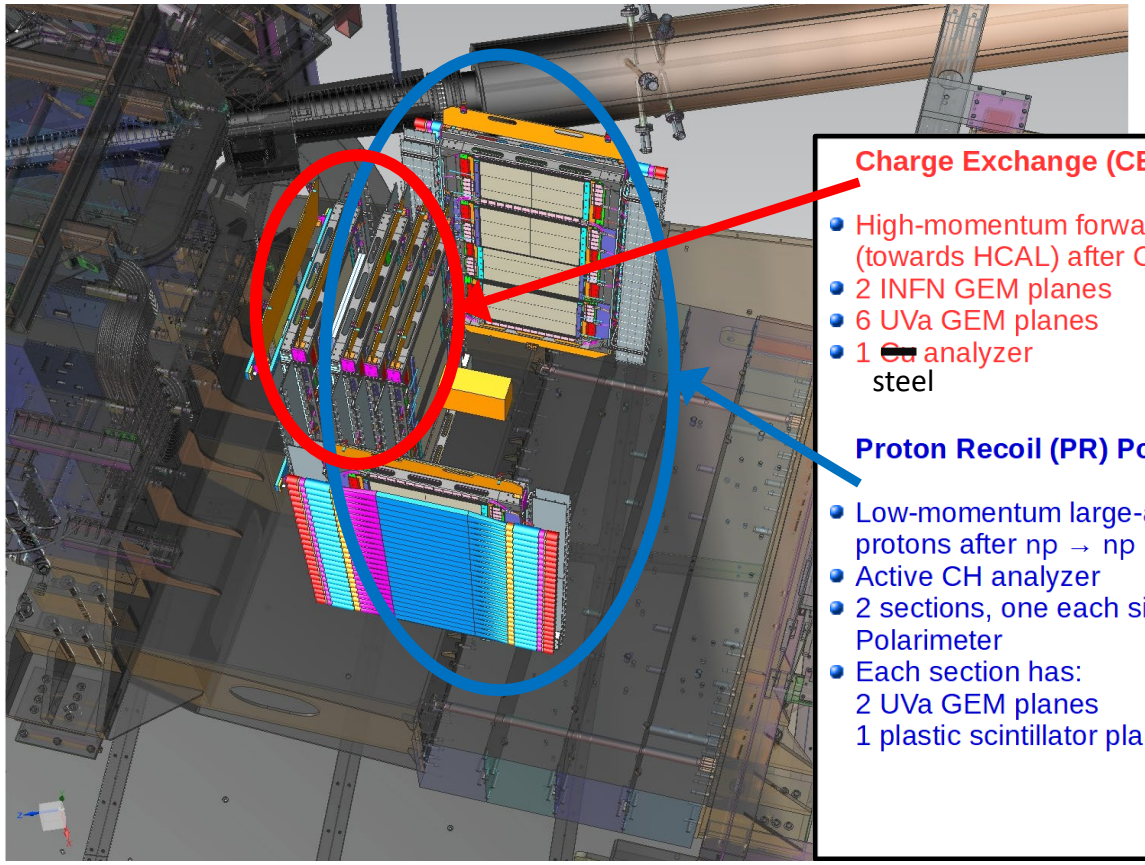
E12-17-004 will measure ratio of GEn/GMn using two recoil polarimetry techniques at 4.5 $(GeV/c)^2$ via the $\left({}^2H(\vec{e}, e'\vec{n})p\right)$ reaction

- ✓ "GMn" beam, beamline, target, BB
- ✓ Beam: ~11 GeV/c, ~40 μA, P_{beam} = ~80%
- ✓ Target: 10cm LD_2 (unpolarized)

(A) Main goal: Charge-Exchange np → pn channel
- ✓ Steel analyzer (passive)
- ✓ GEM tracking + HCAL measure forward protons

(B) Secondary goal: Conventional np → np
- ✓ Plastic analyzer (active)
- ✓ Large-angle recoil protons →Side detectors
- ✓ (GEM + hodoscope)
- ✓ Forward neutron → HCAL

Approved for 120 PAC hours
- ✓ ~ 10 Calendar days



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Status of Polarimeter Preparations

- Active CH analyzer
  - On site from Glasgow
  - Existing 4x8 array of 40x40x250 mm EJ200
  - Will be checked out summer 2020
- Large angle recoil proton detectors
  - Hodoscope detectors
    - Check out proceeding (CNU students and Brad)
  - UVa GEM detectors under construction and testing
- CE Polarimeter
  - INFN and UVa GEM detectors under construction and testing
  - Steel analyzer in procurement
- With exception of lead wall, all design work done and procurement started (Chris S. and Robin W.)
  - Lead wall work to continue next week (Brad, Chris)

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Status of Other Equipment
(as reported at weekly SBS meetings)

- HCAL
  - Good progress is being made
  - Currently debugging cabling, completing PMT coupling grease work
  - Work on discriminator thresholds
  - Setting up cosmic triggers with larger scintillators
- BigBite Spectrometer
  - Work is ongoing
  - More details in Mark Jones talk later today
- Moller Polarimeter
  - Reported as ready to go
  - Will run a detailed simulation before experiment
  - Each run takes ~1 shift to complete

ERR Recommendation #1

1) Outline a plan and schedule to pursue realistic simulations of high-rate tracking performance in the presence of anticipated backgrounds, and to take advantage of any opportunities to validate the simulations using real data.

- Tracking algorithms being implemented
- Direct validation of simulations to experimental data in progress (PRad, UVa x-ray tests, etc.)
- Discussed existing simulations in more detail
  - G4SBS, Glasgow version G4SBS, and NMU GEn background sim

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Link to GEn-RP ERR here → E12-17-004 ERR Page

ERR Recommendation #2

2) Update simulation geometries to the latest CAD model of the final installation and include fringe magnetic fields.

- Geometry updates completed (cross checked with CAD model)
  - No major changes simulation geometry
  - No major changes in results
- Updates to magnetic field models
  - Looking into field clamp impacts (GEn-RP in particular)
  - Fringe field effects
  - Impact on scintillator PMTs being evaluated

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ERR Recommendation #3

3) Obtain a written agreement with E12-09-019 which includes a high-level schedule showing how installation and deinstallation of all experiment hardware interleave with the run plans of the two experiments.

- Extensive document has been drafted between Brian Q., Brad S., and Bogdan W.
- Still a work in progress
- Will summarize GEn-RP portion here

GEn-RP Installation Summary (with GMn)

- GEn-RP specific hardware needs to be installed with sufficient time for cosmic checkout
- GEn-RP specific hardware will remain installed until after GEn-RP run is complete, with the exception of analyzers
- Installation of GEn-RP hardware prior to beam time
  - GEn-RP requires the use of the Moller Polarimeter
  - SBS rear field clamp
  - Recoil polarimeter detector assemblies (1 hodoscope array, 2 UVa GEM planes)
  - “Inline” SBS frame which supports GEMs, Steel analyzer, and CH analyzer
  - GEMs for inline assembly (2x INFN + 6x UVa GEMs)
  - Shield wall between SBS and beamline
  - Lead bricks inside dipole gap
  - Steel and CH analyzers will be test fitted then removed for beamline/BB/HCAL commissioning

GEn-RP DAQ and Analysis Software Summary

- Front end VME-based readout hardware to be placed in bunker on large angle side of SBS
- DAQ software needs to be implemented for
  - GEn-RP GEM detectors (identical to GMn BB readout)
  - GEn-RP scintillator detectors (standard/existing FADC + v1190)
- GEn-RP physics modules for SBS analysis software
  - GEn-RP physics modules for SBS analysis software
    - Gain settings, Timing checks, PID, Yields, Asymmetries
      - straight-forward implementation in PODD framework
    - Displays for PMT-based hodoscopes and analyzes
      - existing/standard online display GUI
    - GEM tracking support for SBS GEMs
      - clone (with minor config. changes) of GMn BB GEM software

GEn-RP Run Plan as Integrated with GMn

- GMn / GEn-RP will spend 5 days on equipment commissioning
  - Beamline, HCAL at 14-m, and BB
  - GEn-RP will take one shift to commission specific equipment
- HCAL will be moved to 8.5-m (~4 hours)
- GEn-RP will then take over with
  - Installation of analyzers, cabling
  - Additional shielding for GEn-RP not previous installed
  - Nominal 1 calendar shift
- GEn-RP production running (~108 hours)
  - Selected to match GMn running to minimize overhead
    - SBS at 24.7 degrees and 2.25-m from pivot
    - Beam energy 4.4 GeV
    - Beam Polarization assumed to be 80% (GMn doesn't require polarization)

GEn-RP Data Collection Run Plan

Item #	Q^2 $(\mathrm{GeV/c})^2$	Beam GeV/c	Target	Beam μA	Time hour	BB ang/dist deg./meter	SBS ang/dist deg./meter	SBS BdL T·m	HCAL dist. m
M1	*Møller Meas.*	4.4	–	< 5	8				
1	4.5	4.4	LD2	30	22	41.9/1.55	24.7/2.25	+1.71	8.5
2	4.5	4.4	–	–	2	Verify beam tune after polarity flip			
3	4.5	4.4	LD2	30	22	41.9/1.55	24.7/2.25	−1.71	8.5
4	4.5	4.4	–	–	1	Polarity flip to positive			
5	4.5	4.4	LD2	30	22	41.9/1.55	24.7/2.25	+1.71	8.5
4	4.5	4.4	–	–	1	Polarity flip to negative			
6	4.5	4.4	LD2	30	22	41.9/1.55	24.7/2.25	−1.71	8.5
M2	*Møller Meas.*	4.4	–	< 5	8	*Optional / As needed.*			

Table 5: The beam time and other parameters of the GEn-RP 4.5 GeV^2 run (Sect. 3.6). Total 108 hours of beam on target (out of 120 PAC hours). 8 of the remaining 12 PAC hours (nominal 2 calendar shifts) are used for backing-in and backing-out of the GEn configuration. One additional calendar shift is used for overhead during production running. Note that (existing) E12-09-019 BB optics and SBS momentum calibrations for the 4.5 GeV^2 kinematic setting will be used and will not be remeasured.

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GEn-RP de-installation plan

- De-installation of GEn-RP components (nominal 1 shift)
  - Remove SBS rear field clamp
  - Remove CH and steel analyzers
  - Remove lead shielding on beamline side and dipole gap as needed
  - Remove shielding around SBS GEM crates
  - De-cable and remove beamline side Proton Recoil detector
  - Right-side Proton Recoil detector can be left in place or removed as desired

ERR Recommendation #4

4) Provide an evaluation of the expected INFN GEM performance ***or present a plan for using alternate detectors.***

- Two fallback options have been identified
- (1) Evaluate veto efficiency of "as-is" 3 layer (INFN + INFN + UVa) upstream triplet
  - Do not need tracks, just a charged veto for GEn
- (2) Shuffle a single GEM plane from the paired GEM planes in the RP assemblies into upstream triplet
  - CH analyzer + hodoscope position/time information provides track
  - Tracking GEMs for CE process are unchanged

ERR Recommendation #5

5) Provide updated reports and expected performance evaluations for both UVa and INFN GEM detectors based on the most recent test results. Present a plan that assures the availability of detectors having suitable performance for the experiment.

- Following updates provided by Kondo Gnanvo

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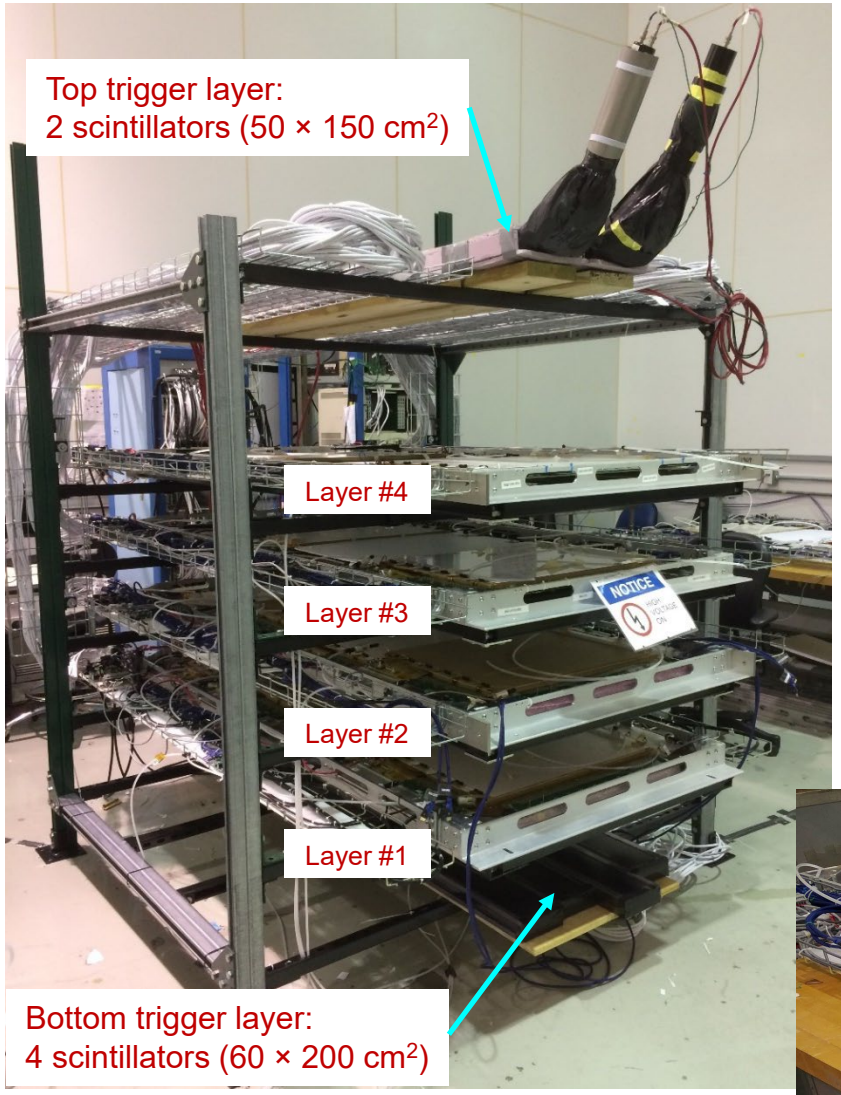
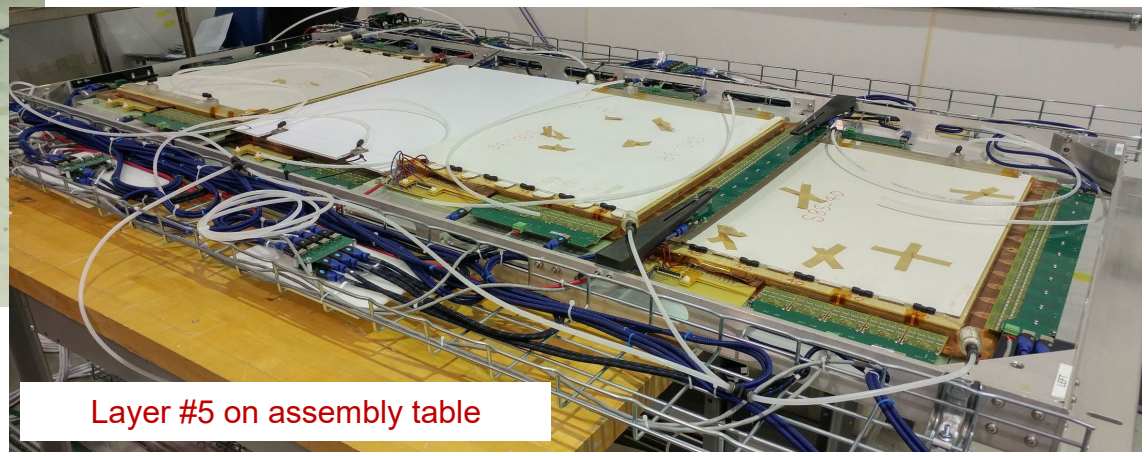
Status of UVa GEM layers assembly in EEL124



- ⇨ **11 large GEM layers needed for GEn-RP: one going to Bigbite and 10 to SBS side polarimeter.**
- ⇨ **5 UVa GEM layers have been assembled, tested and validated: All modules hole HV and stable.**
- ⇨ **4 layers are on the cosmic stand 5th layer will be moved there in the next couple of weeks**
- ⇨ **DAQ is now ready for taking cosmic data with all assembled layers. Expect to start next week with 4 layers.**
- ⇨ **From now on assemble the remaining 6 layers @ ~ 1 layer per month.**
- ⇨ **Continue cosmic data taking, extract resolutions, efficiencies etc. (Andrew Puckett)**


Layer #5 on assembly table

GEMs with U-V readout to supplement front tracker

Motivation:

⇨ The U-V GEM: to complement the INFN GEM Layers which use COMPASS 2D straight strip.

⇨ The addition of U-V geometry enhances and complements the X-Y strips and will help with tracking in the high rate environment.

Key Features: active area: 150 × 40 cm^2, U-V strips readout (60°) stereo angle

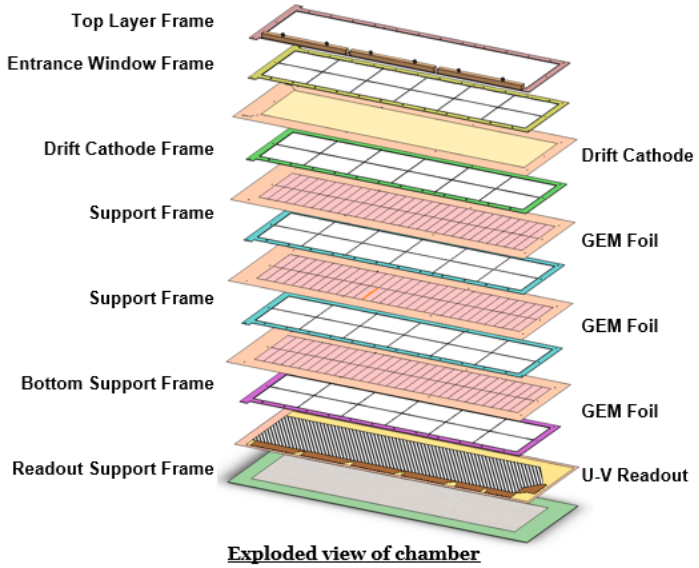
⇨ New GEM foil production allows for the FT U-V GEM layer to be **one single large module**

⇨ **No dead area** from support frames or electronics (Other than for spacers and HV sector)

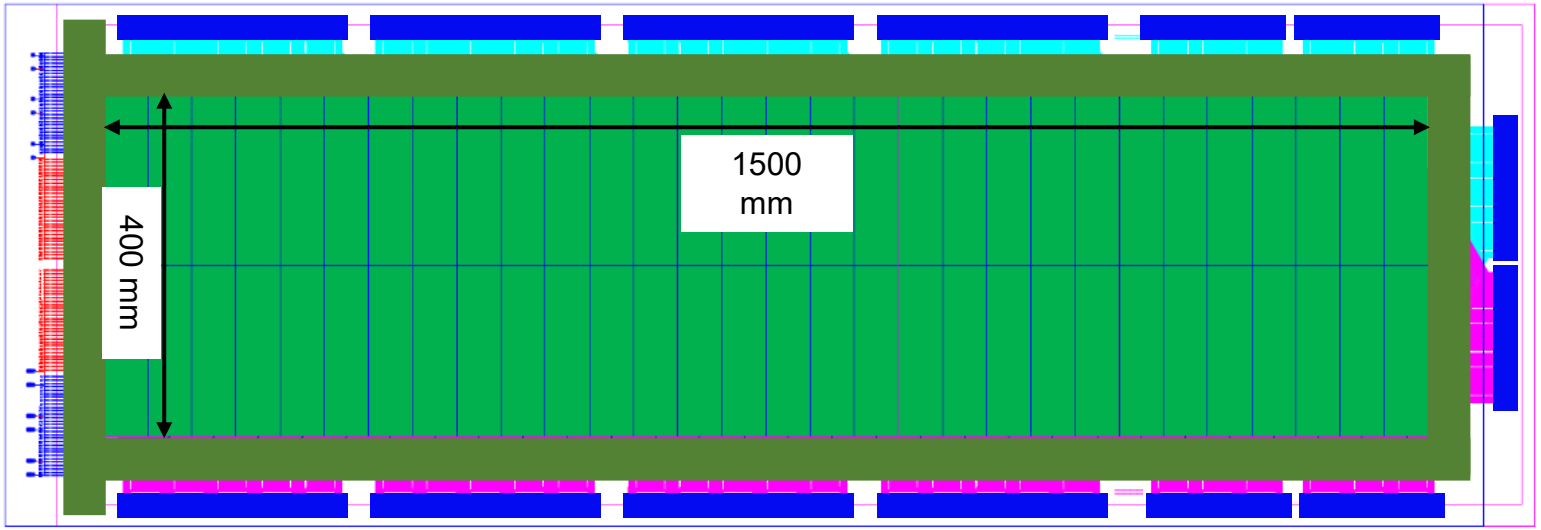
⇨ The INFN-built MPD readouts for these GEMs will be the same as for all SBS GEMs

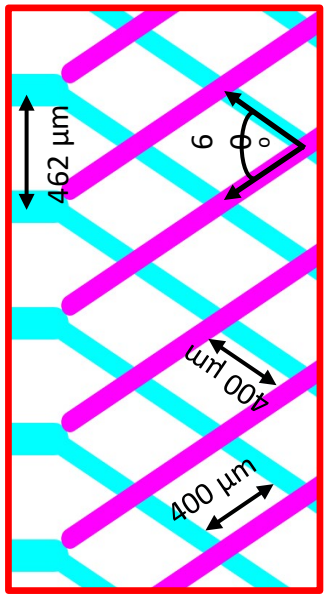
⇨ **The design is finalized, GEM foil components under fabrication at CERN now, expect all parts at UVa by early March.**

⇨ **On track to complete fabrication of 2 UV GEMs by July, 3rd one to follow.**



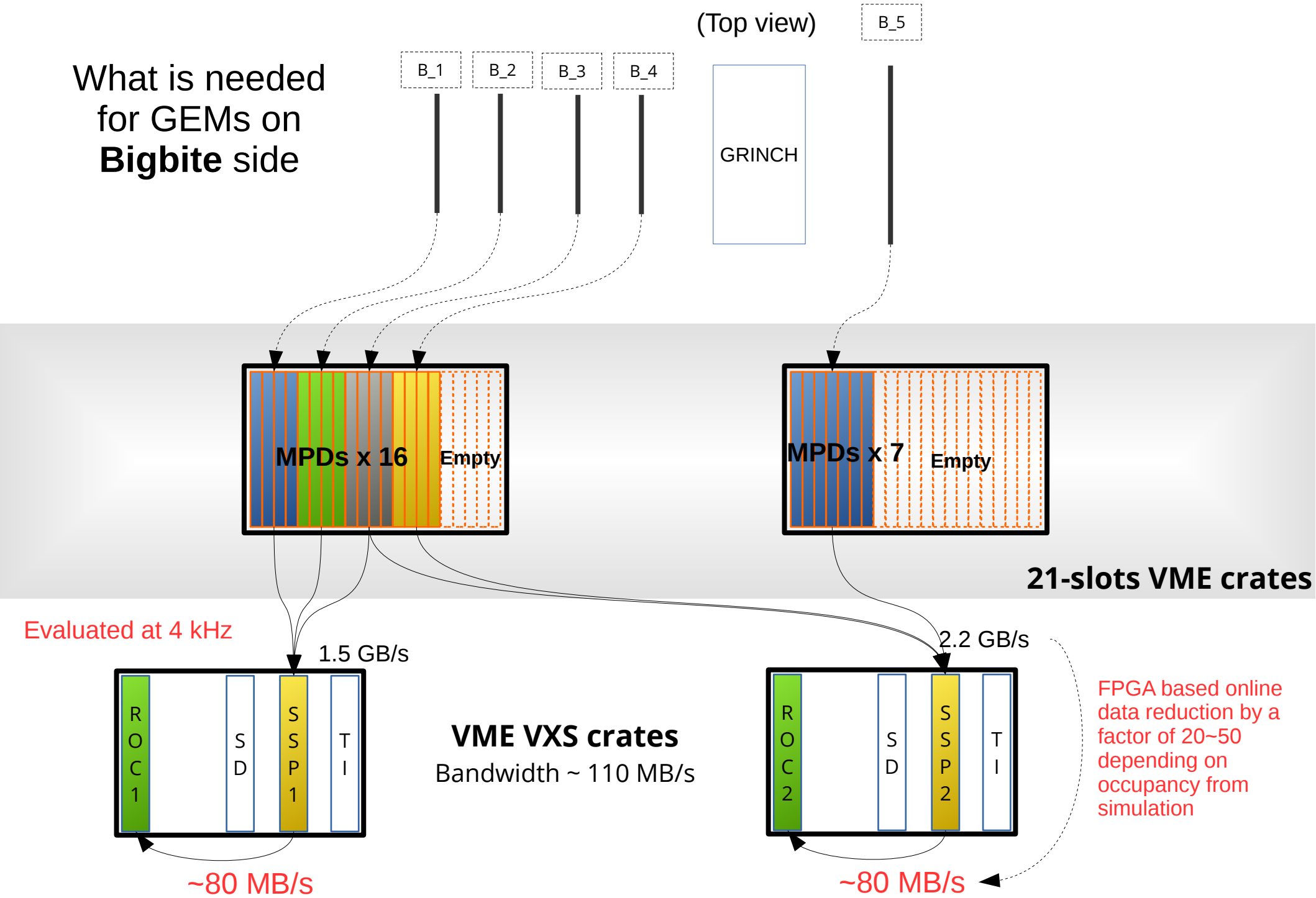
Exploded view of chamber



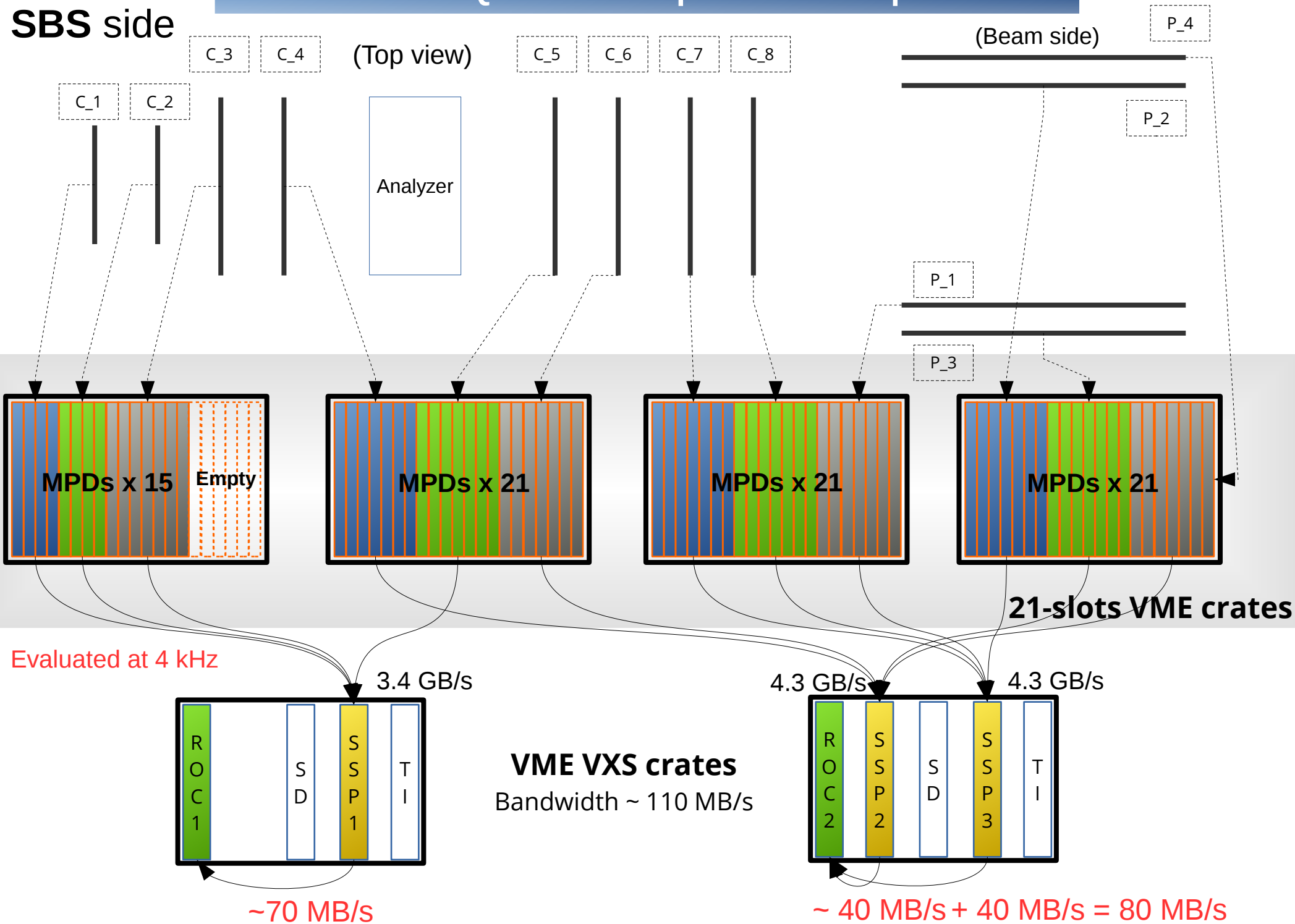


GEM DAQ test and implementation plan

What is needed for GEMs on **Bigbite** side



GEM DAQ test and implementation plan



Plan of GEM DAQ

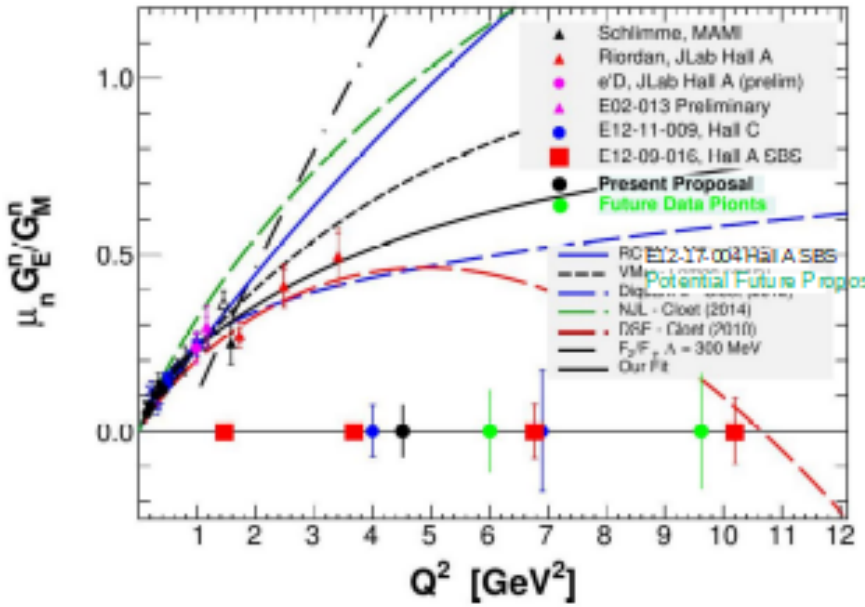
- SSP based online data reduction has been implemented on small scale and tested with cosmic data.
- Currently working with DAQ group(Ben) on going to large scale --- by March 2020
  - The large scale setup will be tested with 4 layers of UVa GEM chamber in EEL.
- High occupancy test with X-ray --- by May 2020
- Installation of final setup starts from this summer.

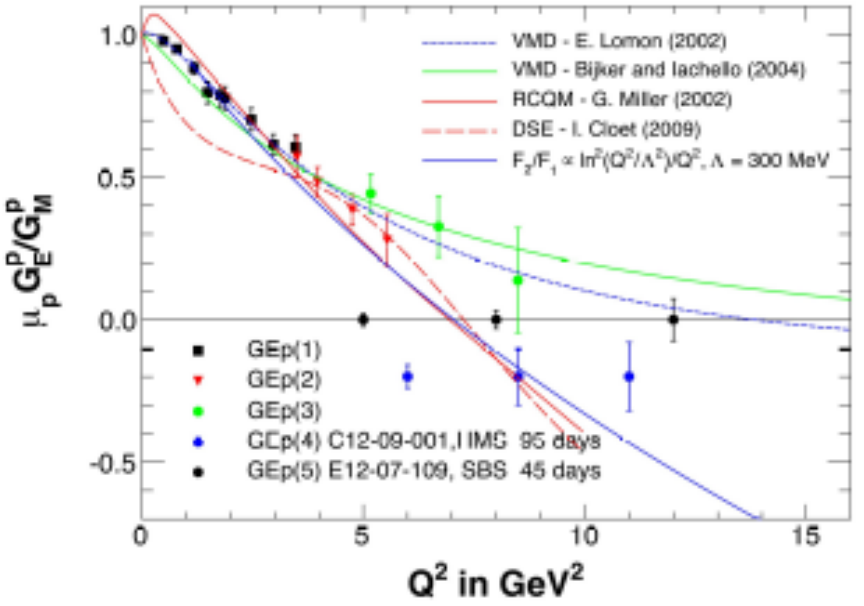
Summary

- GEn-RP specific detector frame/support designs complete and procurement started
- RP side detector hodoscopes refurbishment on track
- RP CH analyzer complete, on-site and ready for final checkout
- DAQ hardware, cabling, and software for PMT systems in-hand
- GEM system construction and checkout in progress
- Readout systems/software identical to that needed for GMn BigBite arm (GMn collaboration taking the lead on this)
- ERR was left in a ‘pending’ state, we must satisfy the committee regarding the tracking and GEM related issues they identified
- Plan to have ERR formally cleared by May at the latest

Backup slides … land of the forgotten

Run Plan





G_E^n/G_M^n 17004 Hydrogen/Deuterium

Experimental Points — 10cm Hydrogen/Deuterium

Q^2 [GeV^2]	θ_{BB} [deg]	d_{BB} [m]	θ_{4SD4S} [deg]	d_{4SD4S} [m]	d_{HCAL} [m]	Beam Line Configuration #
4.5	41.9	1.55	24.7	2.25	8.5	3

With 5 days (120 hours) beamtime with a 4.4 GeV polarized electron beam on a deuterium target, E12-17-004 will measure:

- G_{En}/G_{Mn} via charge exchange polarimetry;
- G_{En}/G_{Mn} via large angle recoil proton polarimetry;
- G_{Ep}/G_{Mp} via standard (forward) recoil polarimetry;
- G_{Ep}/G_{Mp} via charge exchange polarimetry.

It is anticipated that these measurements will have a large impact on future Halls A and C recoil polarization experiments.