Update on GEM R&D at UVa

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Outline

- Update on Construction of SBS GEM prototype
- New Design for the SBS GEM
- Toward the Large Area GEM for SoLID

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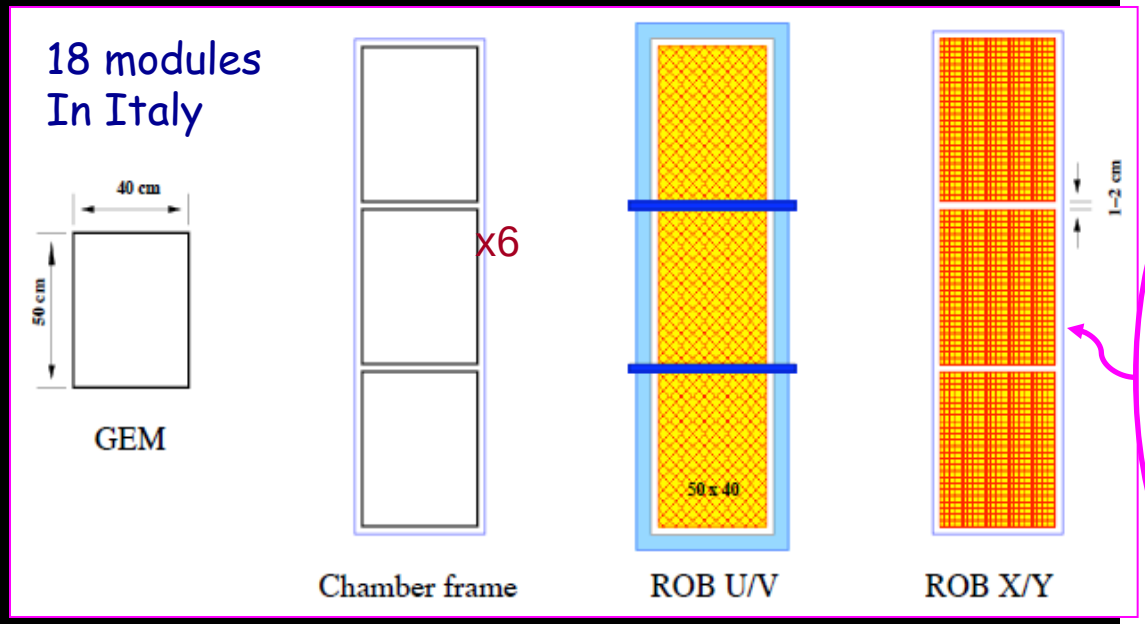
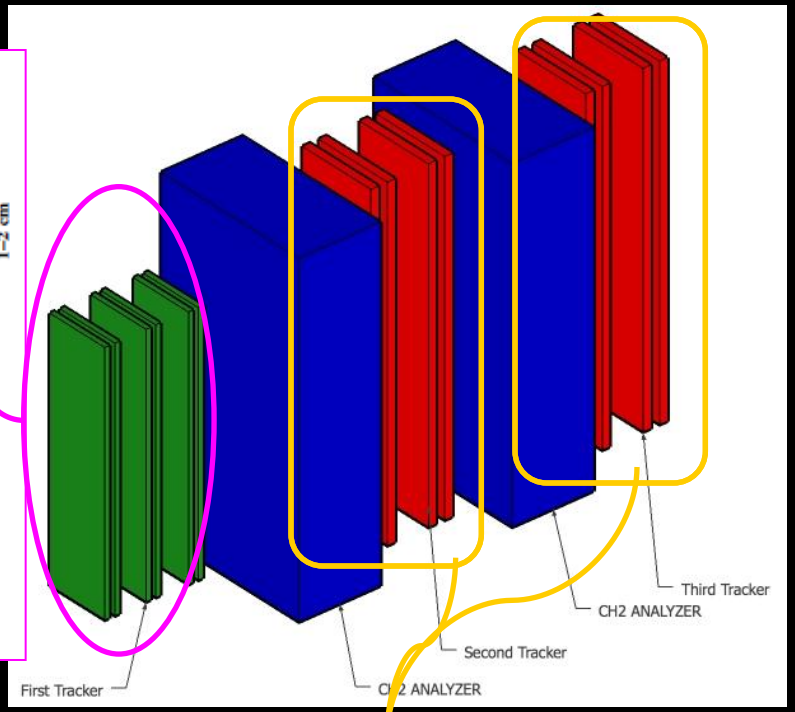
Jefferson Lab SBS Trackers – Front Tracker



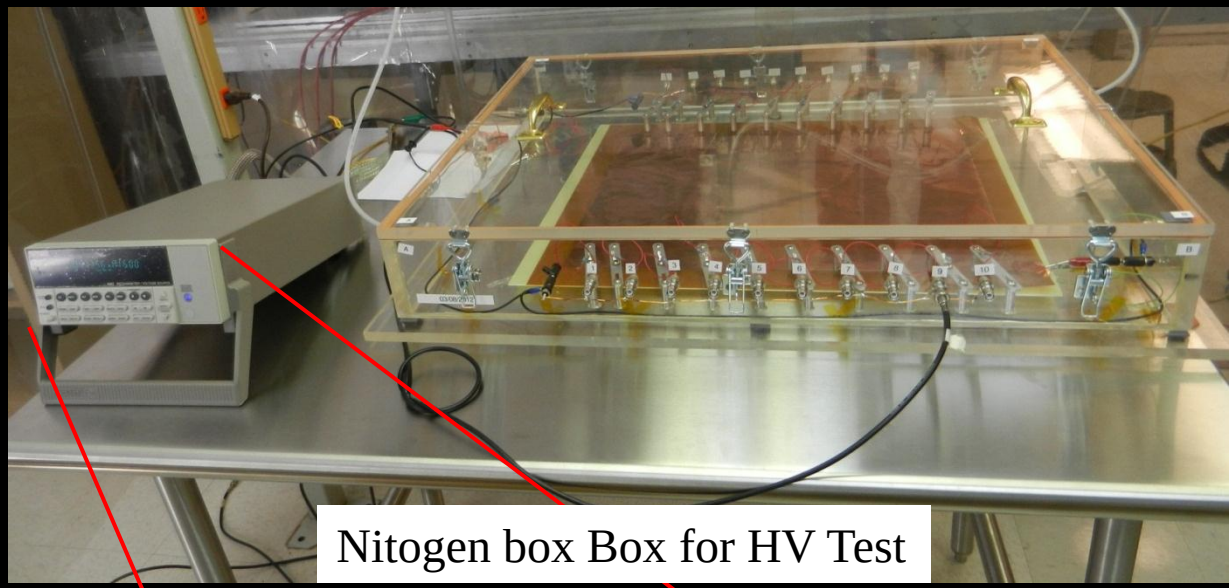


76 modules
In Virginia

- 50 cm x 40 cm Modules are assembled to form larger chambers with different sizes
- Front tracker: Six 40 cm x 150 cm GEM layers
  - INFN Funding: to be built in Italy
- Polarimeter trackers: Eight 50 cm x 200 cm GEM layers
  - to be built in Virginia

HV Test of the GEM foils

- Nitrogen Box with 20 connectors for the HV sectors on the GEM foil
- Keithley Picoammeter 6487
  - Voltage Source 505 V ➔ Ohmmeter
- Criteria for good HV sector on the foil
  - < 5 nA leakage current @ 500 V in Nitrogen



Leakage current 0.7 nA

HV

The Stretcher device for the SBS GEM foils

- UVa Stretcher device upgraded from Benciveni (LNF. Italy) and Cisbani (Roma, Italy)
- Improvement ➔ Easy to handle and fast ➔ a foil is stretched in less than 30 min
- 7 Load cells (max 23 kg over 13 cm, ➔ max 1.78kg/cm)
  - Test foils stretched at 0.25kg/cm, 0.35kg/cm, 0.75kg/cm
- Monitoring displays of the measured tension

Gluing GEM foil to its frame

- Stretched foil glue to the spacer frame
- Glue Epoxy: Araldite 103-1 + Hardener HY 991 (100:40 ratio in weight)
- Recommended by RD51 and used for COMPASS, TOTEM GEMs …
- Main deformation of the frame after gluing in vertical direction
  - agreement with simulations
- We are working to prevent this effect

Dry test on a mylar foil stretched at 0.34kg/cm and glued to a frame

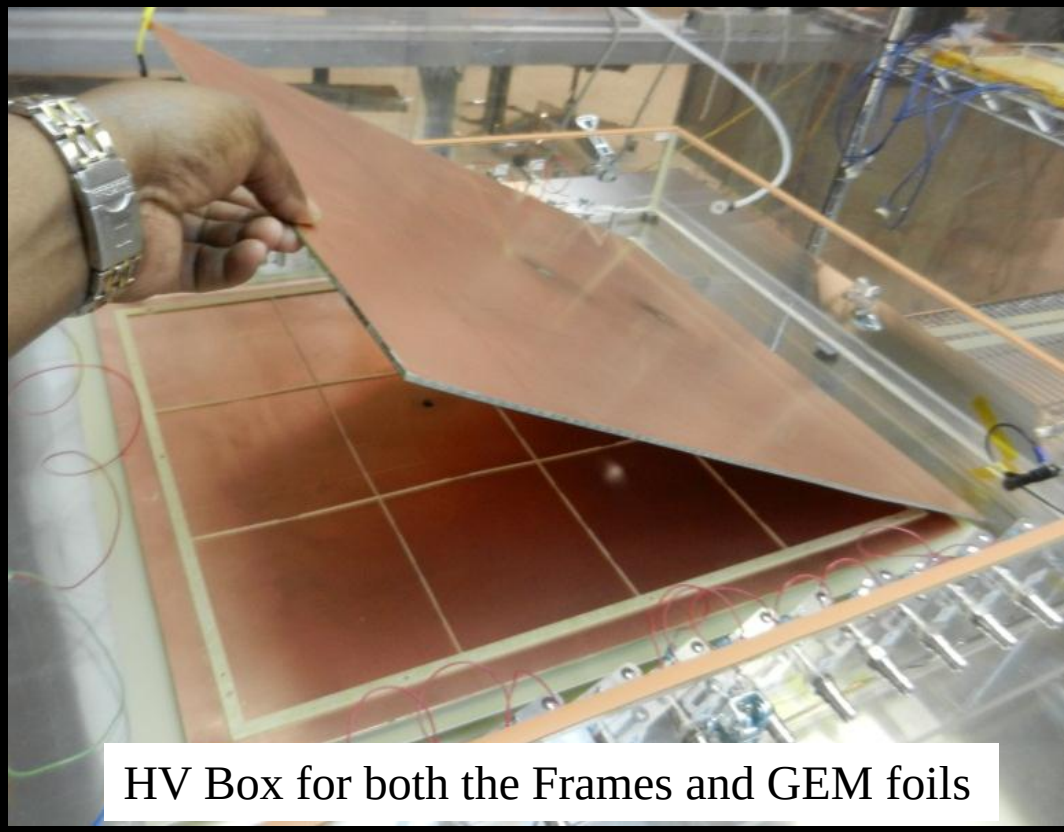
Preparing the frame before gluing …

- Step 1: Polishing of the frame and the inner spacer
- Step 2: Cleaning in Ultra Sonic Bath (USB)
- Step 3: Drying the frame in a storage cabinet with Nitrogen flowing inside

Nitrogen Cabinet for drying and storage

Preparing the frame before gluing …

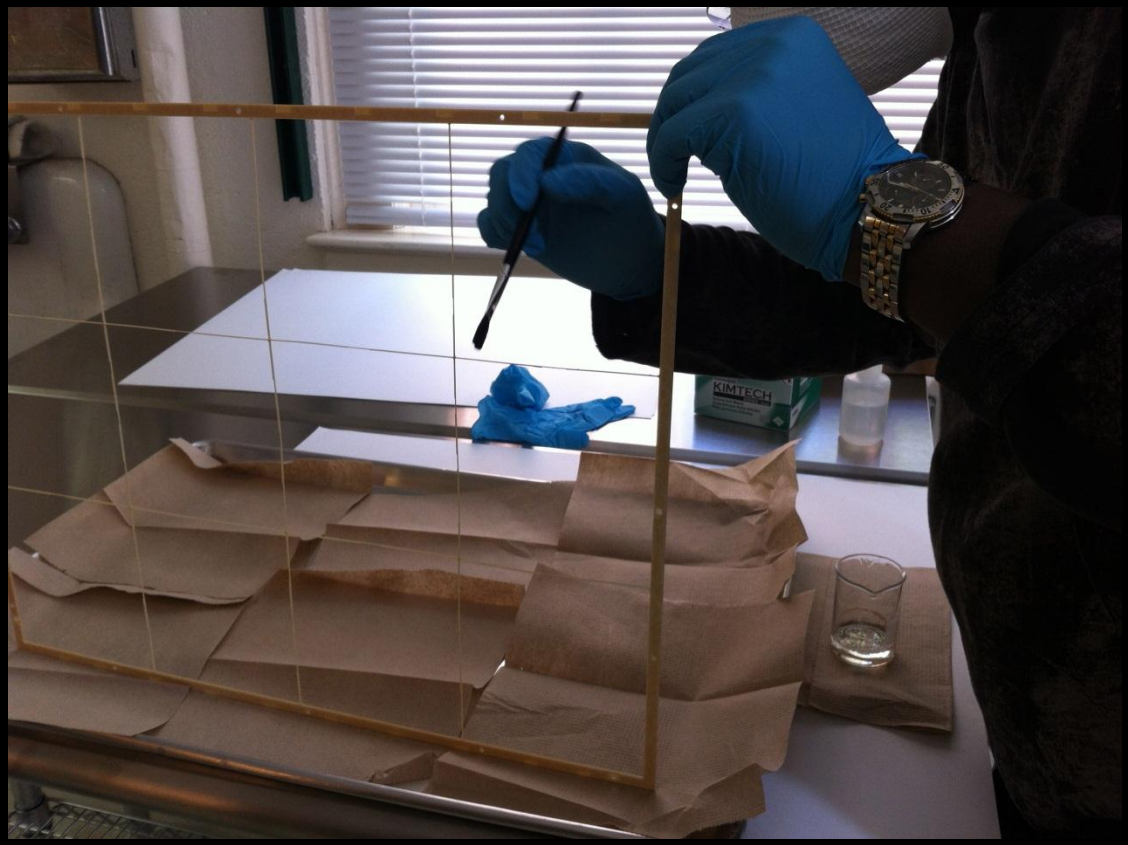
- Step 4: HV test of the dry frame at 4kV
- 12 frames tested ➔ 2 two of them spark ➔not properly dry



HV Box for both the Frames and GEM foils

Preparing the frame before gluing …

- Step 5: Coating of the inner part of the frames
- Varnish: Nurovern LW + hardener
- Supplier: Walter Mader (Switzerland)



Next step: Full assembly of the SBS GEM

- The stretcher for the GEM foils produced and tested
- The full procedure for testing the GEM foil is in place and validated
- We went to all the steps to prepare the spacer frames for the gluing
- Next delicate step: Solder the protection resistors on the foil
- We are just waiting for the readout boards from CERN
  - (At last check it was supposed to be delivered end March …)
- As soon as we get them, we are ready to fully assemble the first SBS prototype

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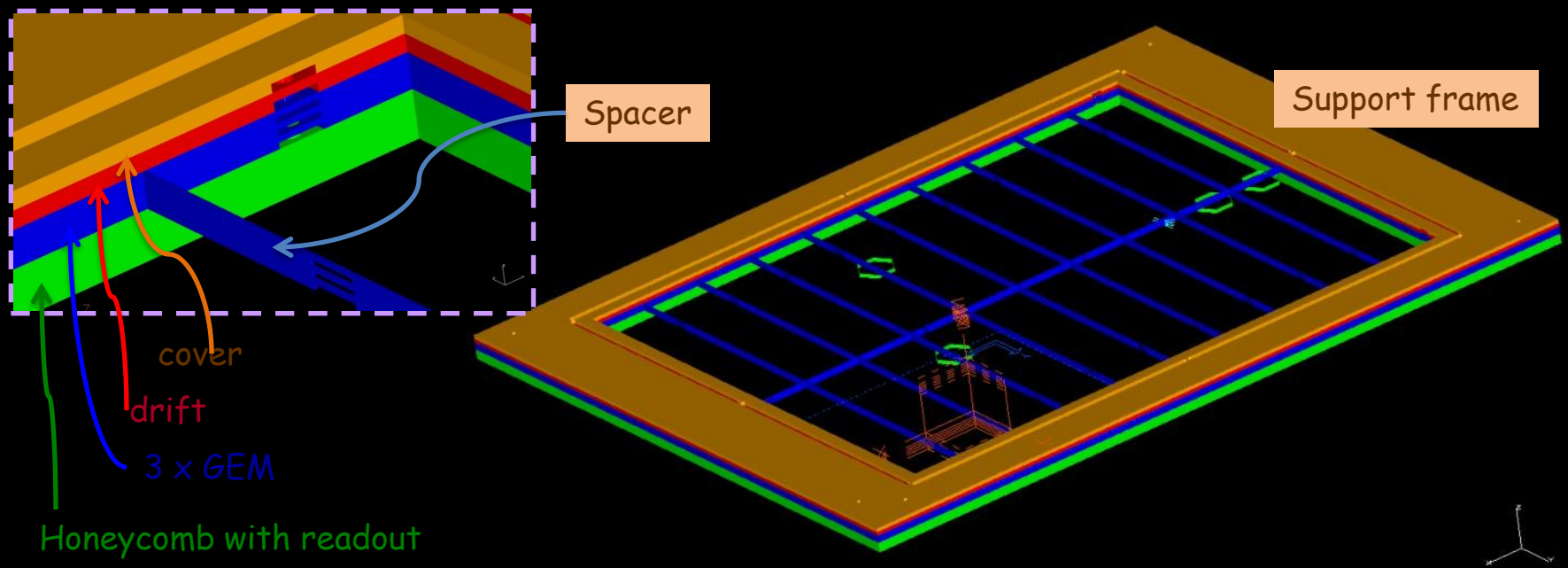
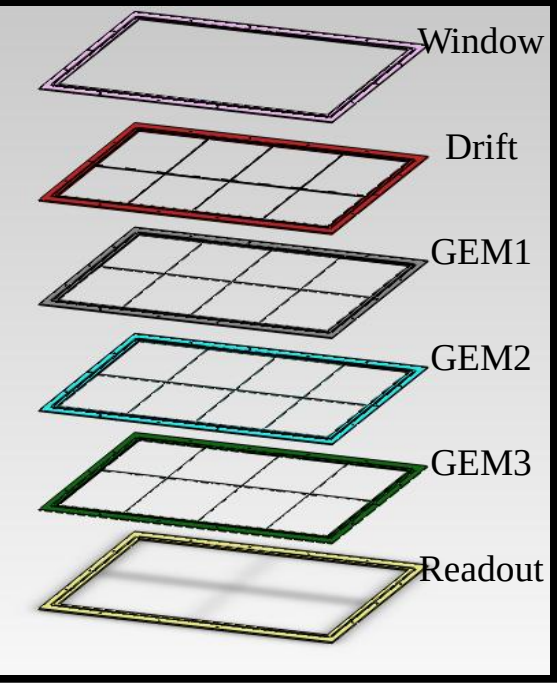
Current frame design with the gas distribution

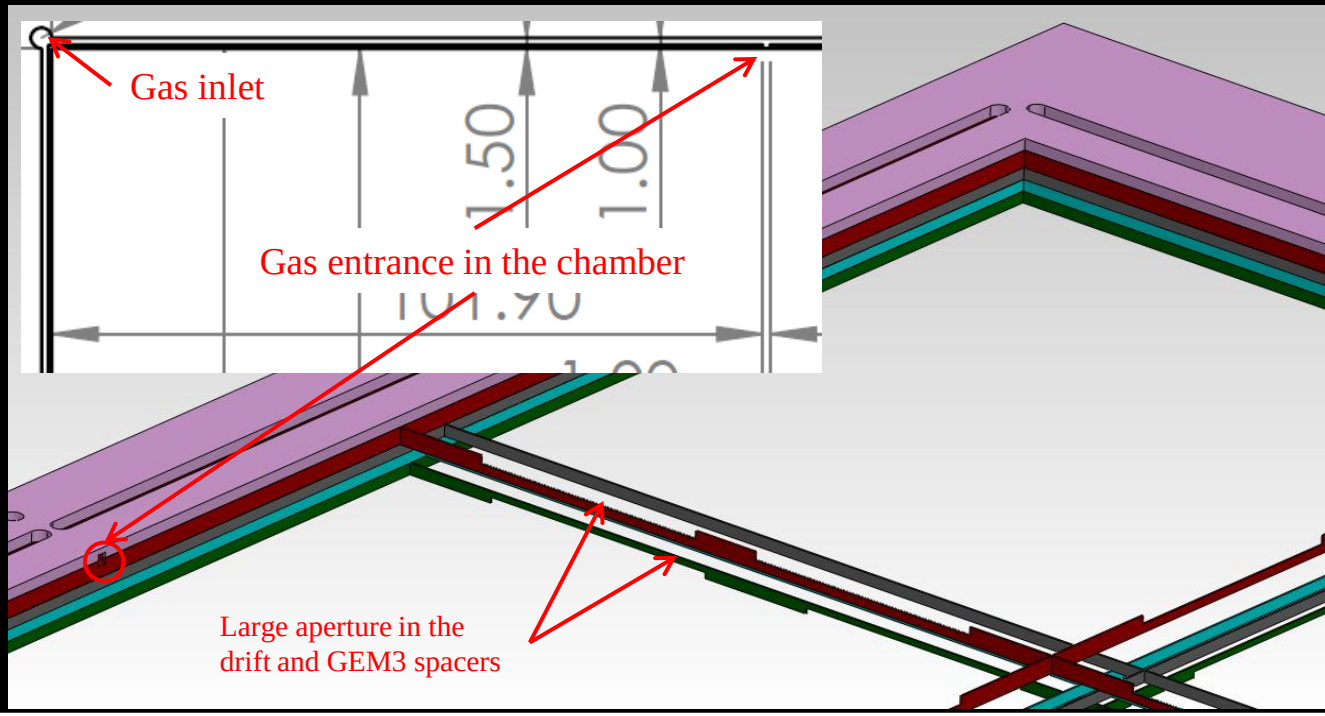


- In the current design, the gas flows laterally in each region of the chamber
- 3 gas inlets and 3 outlets on each frames to allow a uniform distribution (same design for all the frames)
- Aperture in the spacers on each frame to allow the lateral flow
- Concern about the uniform gas distribution in the GEM holes level at high rate

New frame design with gas distribution

- In the new design, the gas flows laterally in drift region and vertically in the GEM transfer regions through the GEM holes (5 different frame designs)
- 1 gas inlet in the window frame and 1 outlet in the readout frame at the opposite corner
- Large aperture in the spacers only in the drift frame and the last GEM3 frame
- We are also making modification to be able to mount the chambers on the external support frames





New design of the GEM foil

- Redesign the HV sectors ➔ No resistors soldered directly on the foils
  - Allow testing the GEM HV sector after frame is glued
  - Allow replacement or disabling of a bad HV sector after assembly
  - Avoid soldering in the clean room
- The new foil will have 20 electrodes strips for the HV sectors coming out of the frames on the smaller side of the chamber
- External PCB with the HV divider and the protection resistors

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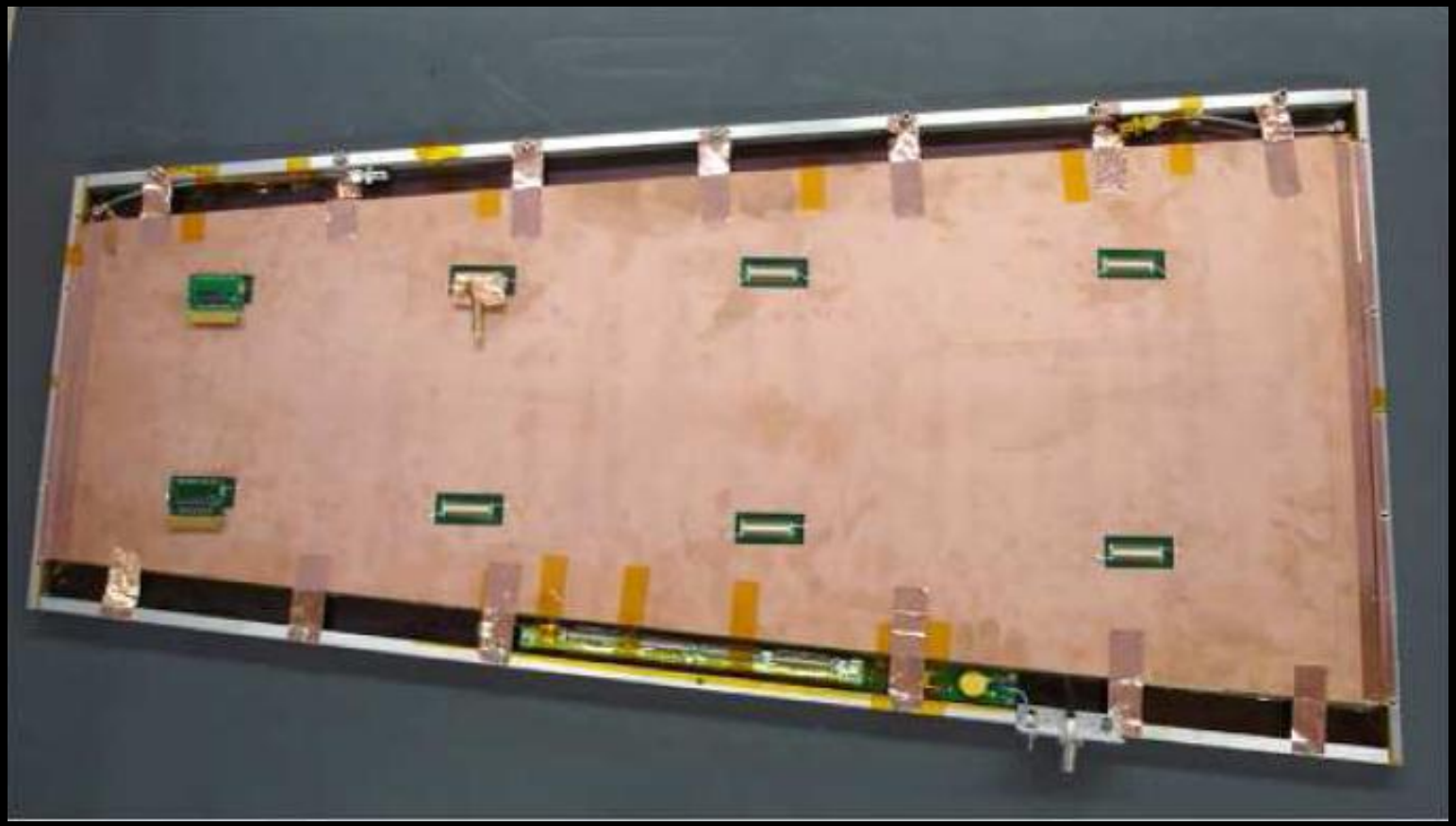
Large Area GEM R&D at UVa

- We are involved in 3 R&D efforts for large area GEM chambers
  - CMS High Eta Muon Chamber Upgrade
  - EIC Forward Tracker
  - SoLID Large GEM Tracker
- All 3 chambers will have similar size GEM foil (~100 cm × 50 cm) and trapezoidal shape chambers
- The readout board is the only major difference between the 3 at this step of prototyping stage
- We expect to be able to build on such large prototype by the end of this

Common development for the 3 Chambers

- Build a larger stretcher for $1 \times 0.5\ m^2$ This is an extension of the SBS stretcher
- Build for the HV test Nitrogen box
- Setup for gain uniformity measurement of large GEM foil
- Setup with IR lamp structure for heating and preparing large spacer frames ➔ replacement of the Nitogen Cabinet

Common development for the 3 Chambers



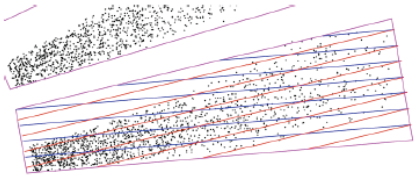
Large prototype GEM module for CMS: 99 cm x (22 – 45.5) cm

Specific Readout and Electronics for SoLID

- Readout board for SoLID
- Need to start the design of the readout
- Establish the contact with Tech Etch to study the single layer 2D readout
- Beyong APV25 electronics, looking at other SRS alternatives
- BNL chip VMM1 for ATLAS Muon Chamber Upgrade might be a good

PVDIS GEM configuration

- Suggested readout scheme:
  - a 2D readout optimized to get high accuracy in the ϕ coordinate, lower but sufficient resolution in the r coordinate.
  - each set of stripes parallel to one of the radial sides of the module: i.e. stripes at a 10-deg stereo angle to each other.
  - strip pitch is 0.6 mm for locations 7 and 8;
  - 0.4 mm for locations 4, 5 and 6.
  - Issues:
    - A full tracking simulation needs to determine that this readout scheme gives the required tracking resolution.
    - How well will the 10-deg stereo angle separated strip layers work ? – need to test with prototypes.



Personnel at UVa

- **Senior Research Scientist:**
  - Prof. Nilanga Liyanage
  - Vladimir Nelyubin
- **Research Scientist:**
  - Kondo Gnanvo
- **Graduate Students:**
  - Kiadtisak Saenboonruang (small GEM tracker, analysis
- **Undergraduate Student**
  - Taylor Sholz (drawngs for the stretcher and new GEM design)
  - Seth Saher (Test and assembly of SBS GEM)