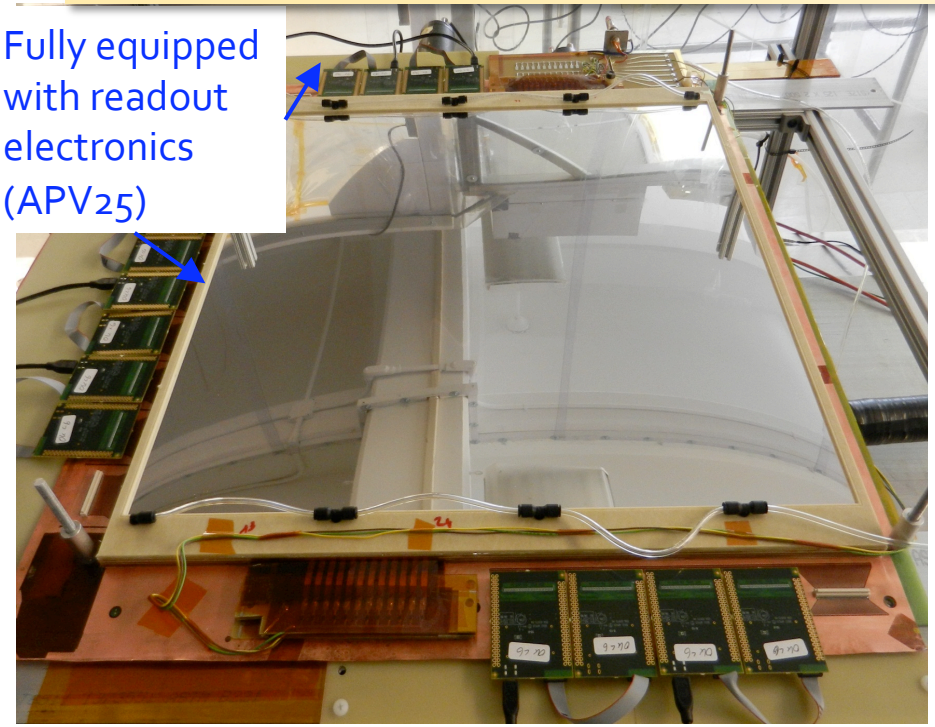
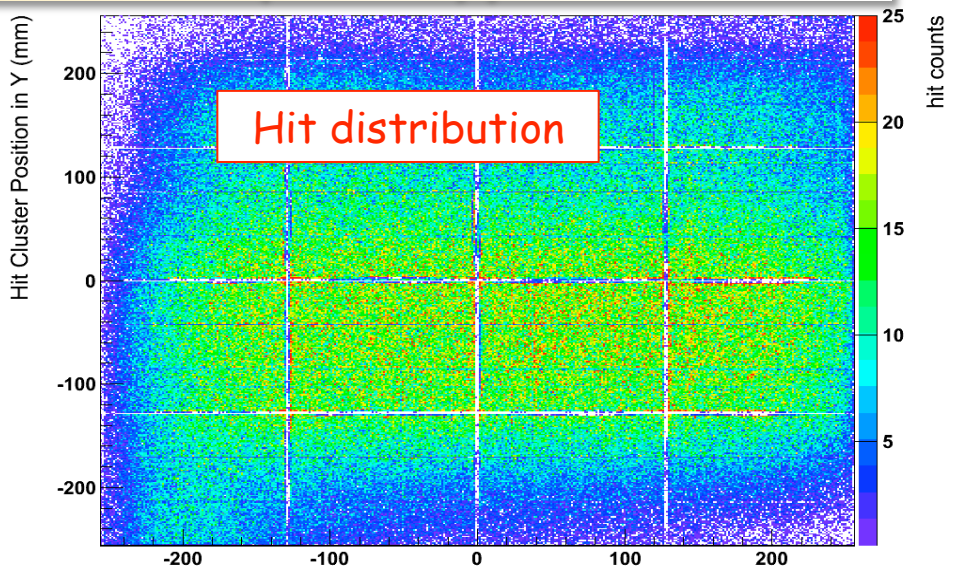
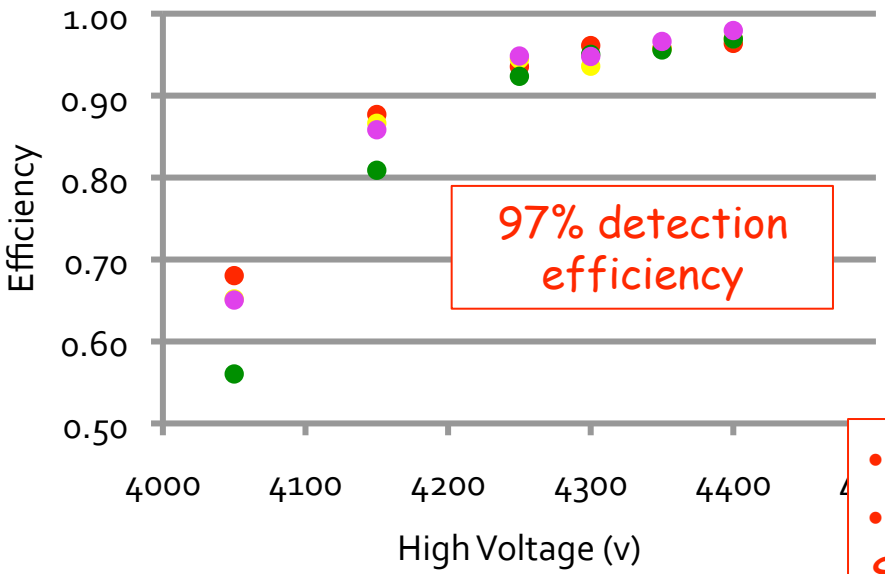
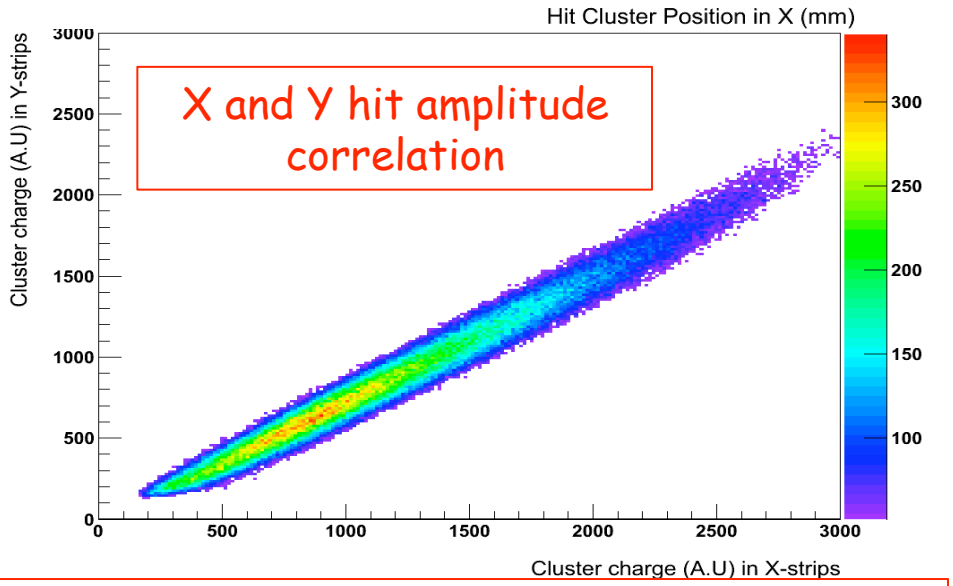
SBS GEM module full-size prototype

Fully equipped with readout electronics (APV25)









- Prototype meets SBS design requirements
- Starting production of 40 modules in September

SBS GEM pre R&D at UVa

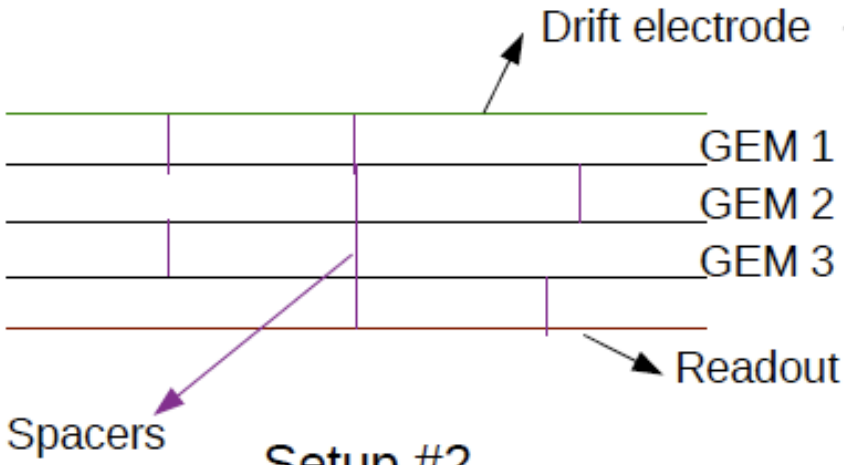
- Duration : August 2011 - August 2013
- Funding received: Total: $ 270 k (3 contracts - $ 45 k, $ 98 k and $ 127 k.)
- Other funding for UVa GEM R&D: UVa internal funds - $ 60 k, EIC detector R&D - $ 150 k and all team members except Dr. Nelyubin paid by Liyanage DOE grant)
- UVa GEM team: Liyanage (PI), Nelyubin and Gnanvo (Research scientists), Saenboonruang , Gu, Bai, and Sacher (students)
- SBS GEM prototypes produced:
  - 2011-2012- two SBS prototype modules
    - prototype # 1: operational, with 4 out of 20 sectors disabled.
    - prototype # 2: operational, with 1 out of 20 sectors disabled.
    - conclusion: basic design works, but needs many design improvements to facilitate fabrication and operation.
  - 2012 – An improved new design prepared addressing the noted issues.
  - 2012-2013 – two SBS prototype modules
    - fabrication considerably improved with the new design.
    - All sectors operational with all characterization results meeting SBS design criteria.
    - SBS GEM module design and fabrication methods established.
  - 2013 – Two GEM modules currently under fabrication based on the established design and procedure: several minor improvements will be tested using these two final pre R&D modules.
- Two APV25 based readout systems capable of reading 10,000 channels was setup and characterized.

Conclusion: the SBS GEM module design and fabrication procedure established with Full size prototypes meeting design goals

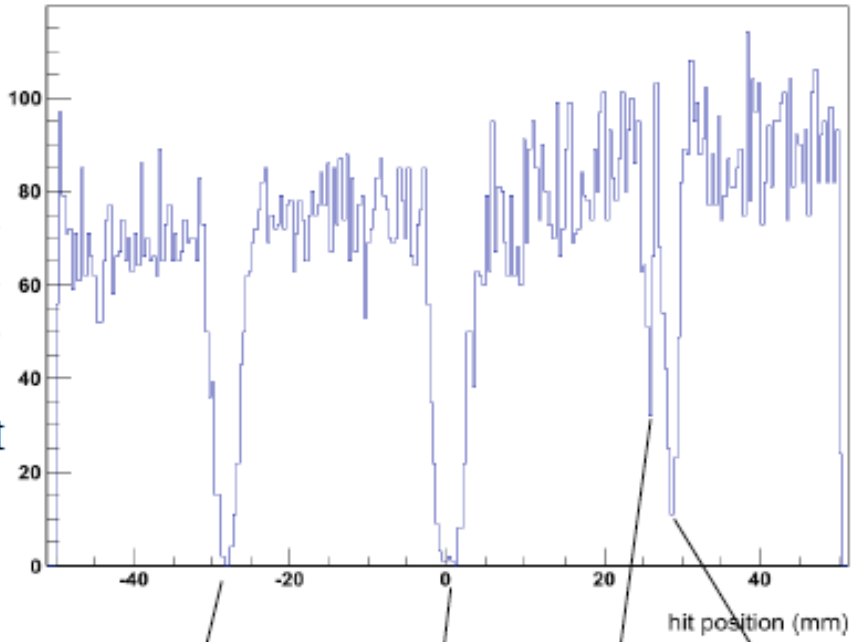
SBS production plan

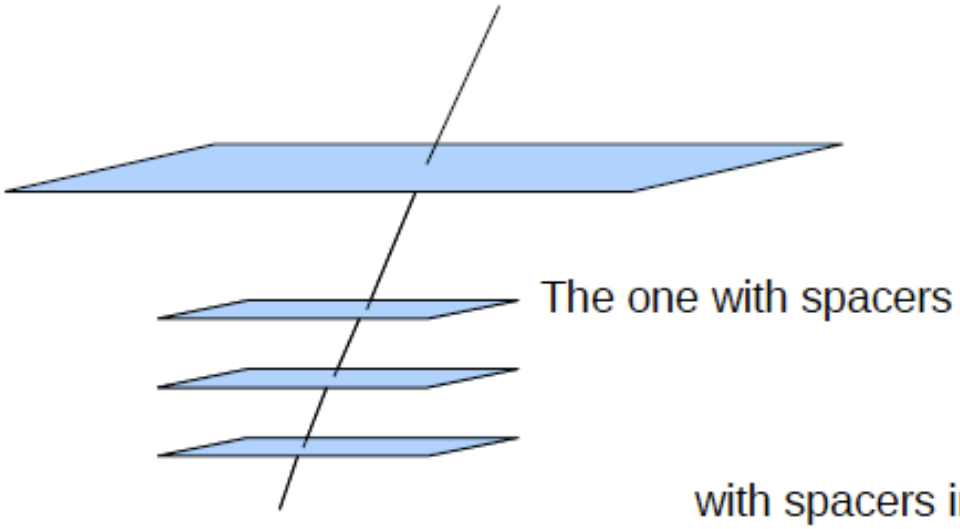
- It is divided to WBS 2 and WBS3. However: the actual schedule is mostly driven by foil availability, man power consideration etc.
- Per PMP we need to get GEM components for both WBS 2 and 3 in next two years.
- So, I would like to go by the number of modules.
  - Fabricate 40 modules + 8 spares in three years: (as PMP plan for all polarimeter trackers.)
  - Need to order components (GEM foils, readout planes and frames) for 48 chambers now.
  - GEM foils and readout planes are the most urgent
  - Setup a manpower + other expenses contract by this Fall.
  - CERN has agreed to deliver the foils over one year.
  - UVa will assemble ~ 16 modules per year for the next 3 years.
  - Plan to have 48 modules assembled, instrumented and tested by the end of 2016. At least 40 modules should meet the spec.

Study of Spacers in GEM module



Setup #2





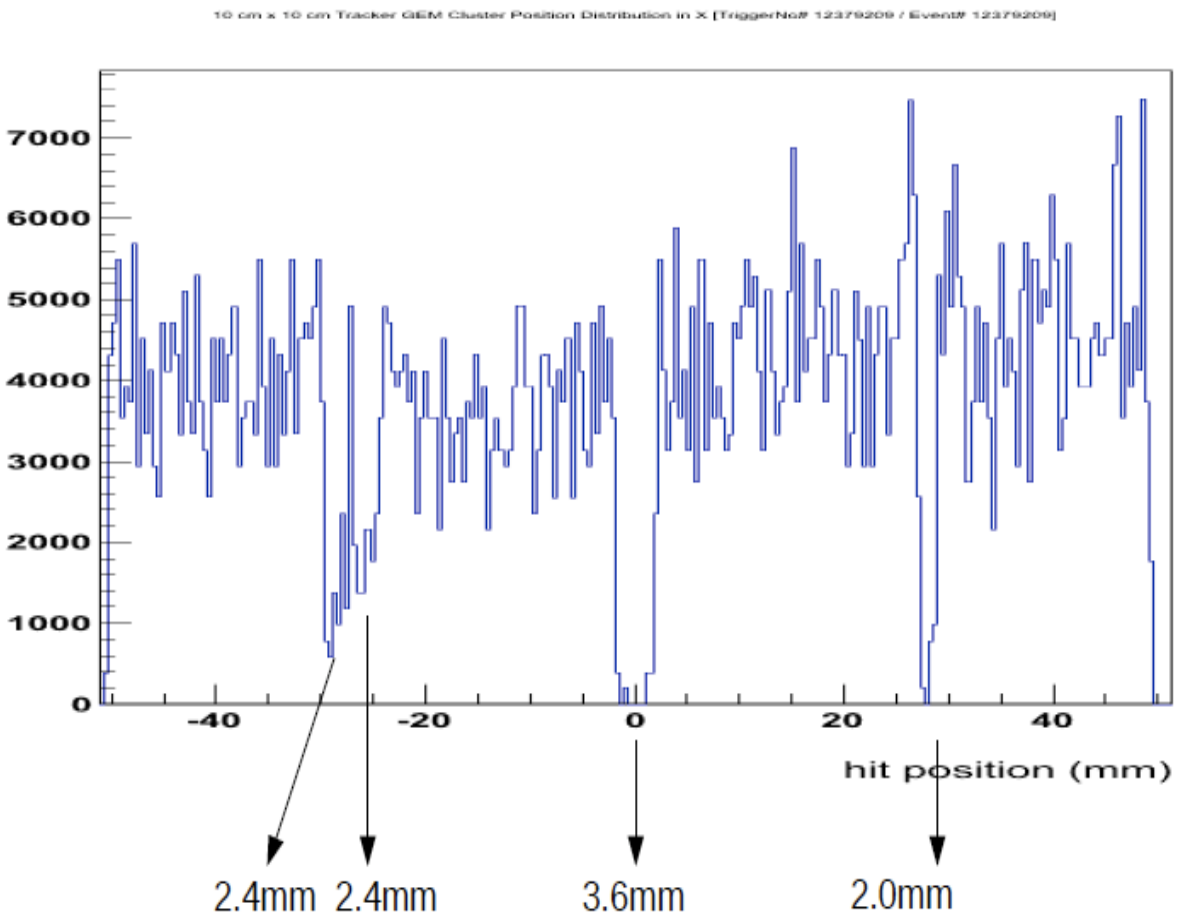
The one with spacers

3.2mm 5.6mm 2.0mm 2.4 mm

with spacers in drift area

No spacers in drift area

Study of Spacers in GEM module



Conclusions:

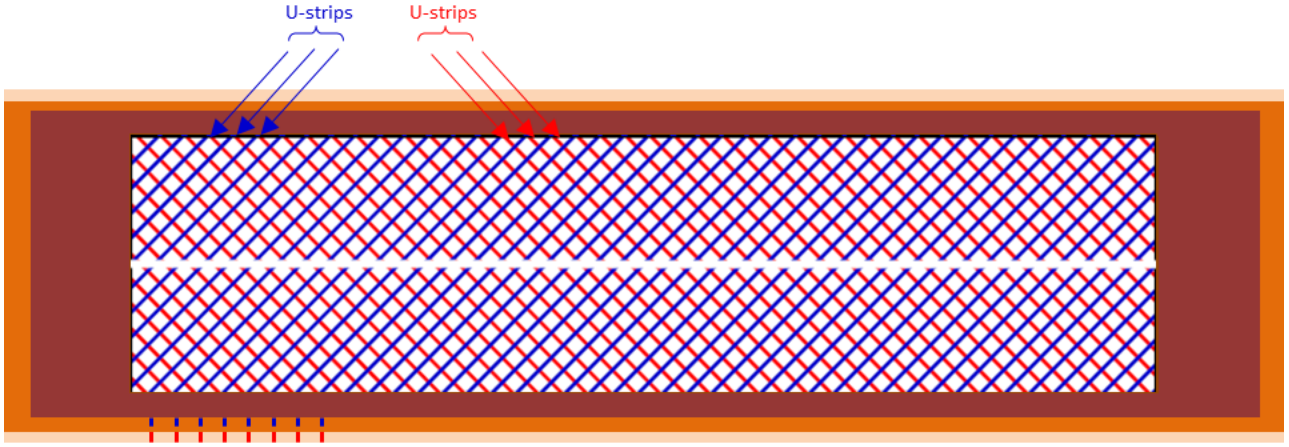
- Each GEM/readout spacer (2 mm tall), seems to contribute ~ 2.4 mm.
- Drift spacer (3 mm tall) contributes ~ 3.5 mm.
- Add Roughly quadratically.
- Little or no dependence on track angle.
- Might depend on the particle rate: check at Fermilab

Proposed Large Area GEM chamber

- Rui de Oliveira's group at CERN has offered to collaborate with us to build a 50 cm x 200 cm GEM chamber.
- Jefferson lab-UVa collaboration has the expertise, infra-structure and capability to build such a GEM chamber
- Would be a breakthrough in large area tracking technology.
- Size ideally matched for Jlab large detectors: Huge boost to future experiments.
    - Cover large areas with no dead zones.
- Link to industrial applications beyond nuclear physics: National security, Radiation detection, Medical Physics .....

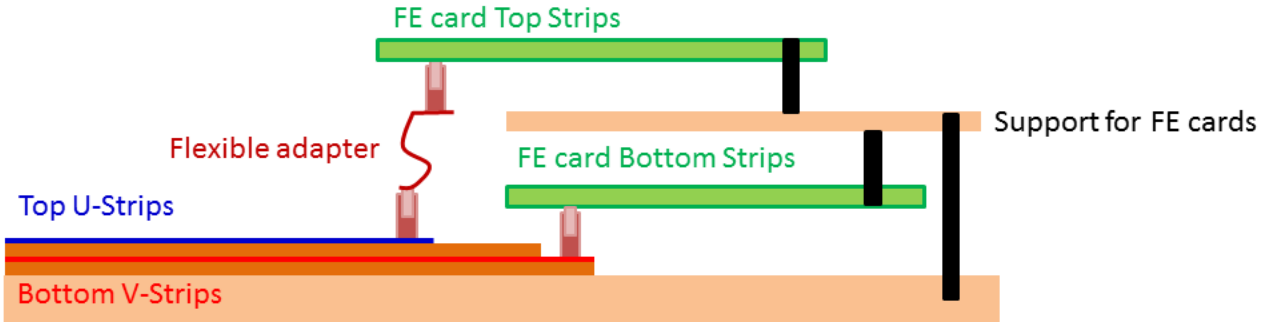
Proposed Large Area GEM chamber

Top view of the 2d 45° readout



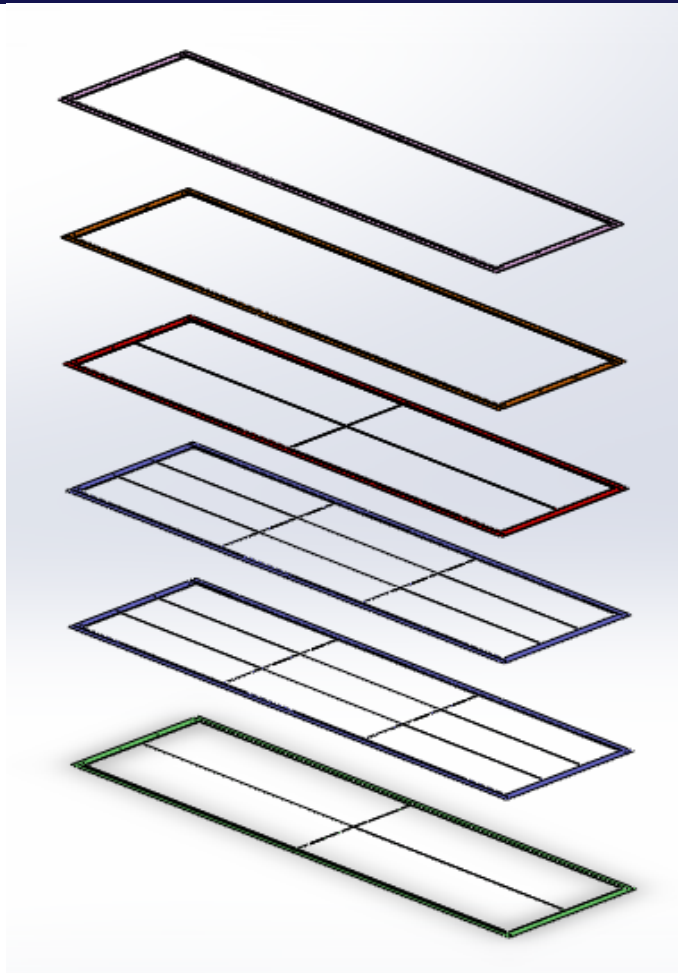
- 200 cm x 50 cm active area.
- Base frame with wide sides
- U-V readout from both sides
- 400 micron strip pitch.
- longest strip is ~ 35 cm

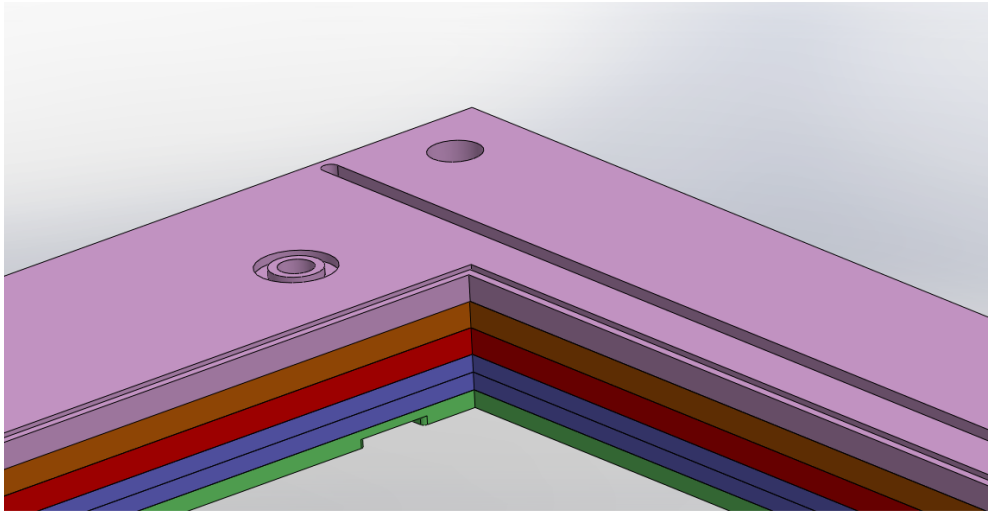
Cross section view with FE cards

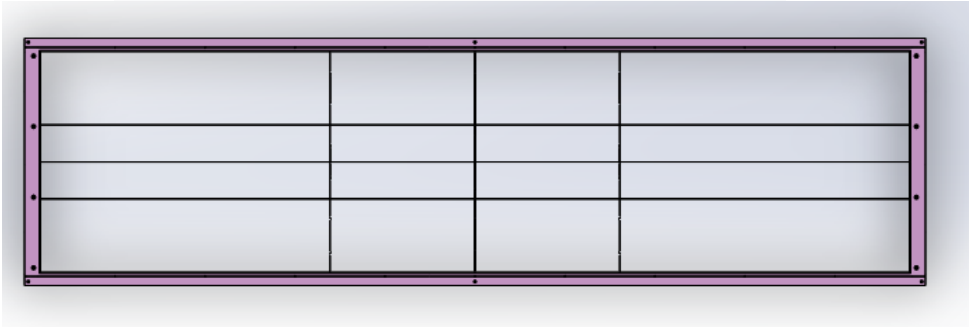


- Readout cards in two layers.
- Readout: 18 k of APV-25 based SRS electronic channels

Frame design underway







- Design/mechanical studies underway within Solidworks to evaluate:
- Evaluate stress on frames
- Foil deformations
- Gas flow.
- Frame assembly techniques

Proposed Plan

- Year 1 :
  - GEM chamber and assembly fixtures design – 3 months { $ 25,500}
  - GEM components and assembly fixture fabrication – 6 months .
    - GEM foils readout plane at CERN { $ 28,000}
    - GEM frames at RESARM in Belgium { $ 20,000}
    - Assembly fixtures at UVa. { $ 10,000}
  - Chamber assembly and initial testing – 3 months { $ 25,500}
- Year 2:
  - Instrument chamber with electronics.
  - Test and characterize the chamber.

Personnel

- Bogdan Wojtsekhowski - Jefferson Lab.
- Nilanga Liyanage, Kondo Gnanvo, Vladimir Nelyubin, Chao Gu, Xinzhan Bai, and Danning Di and Seth Sacher - UVa