PREX/CREX Software, Optics, Tracking

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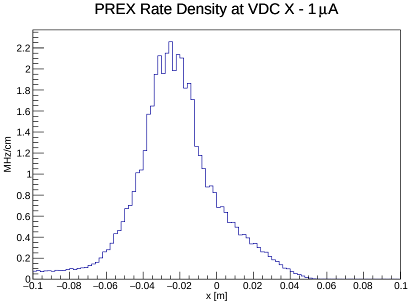
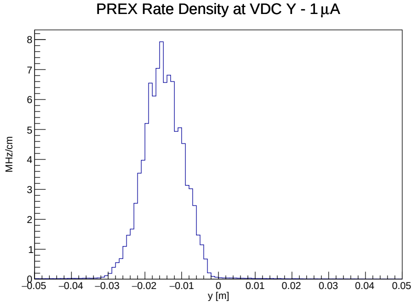
Overview

- Tracking Requirements and Software
- Optics MC
- AT Detector Configuration Modification

Requirements

- We have a track rate of ~ 10 MHz/μA
  - Need 1 μA to use standard beam monitors
  - Max ~ 2 kHz/mm^2 at VDC and quartz
- VDC's with standard electronics can operate at 20 kHz/wire (1 cm spacing), APEX goes to 75 kHz/wire (this could be left in?)
- GEMs demonstrated to work at 25 kHz/mm^2





Requirements

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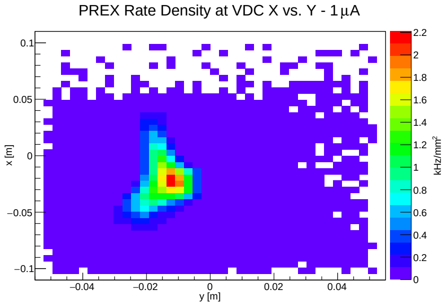
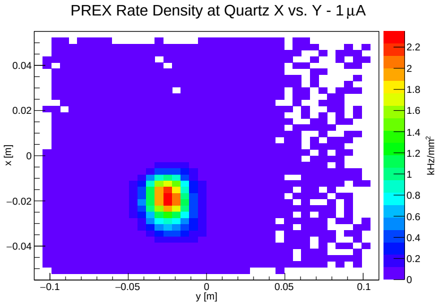
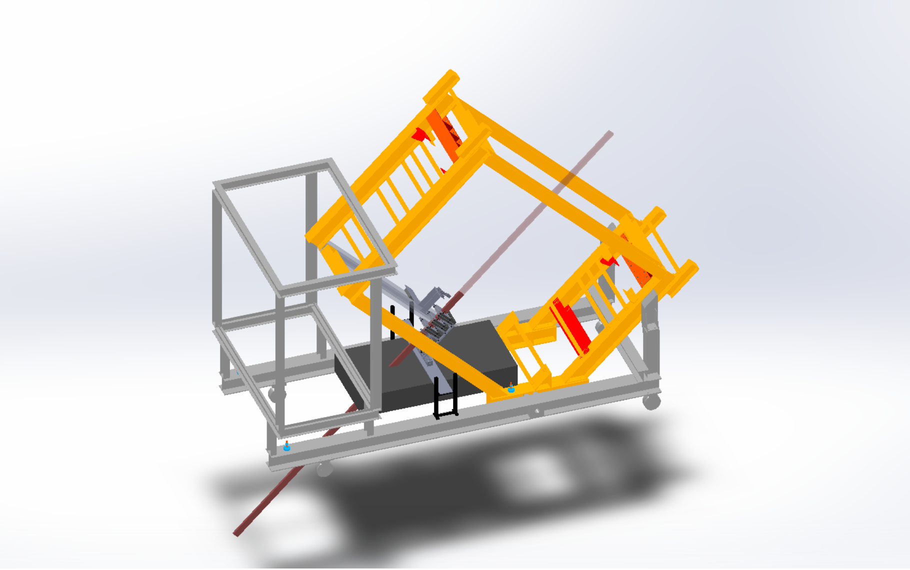




PREX Original GEM Layout



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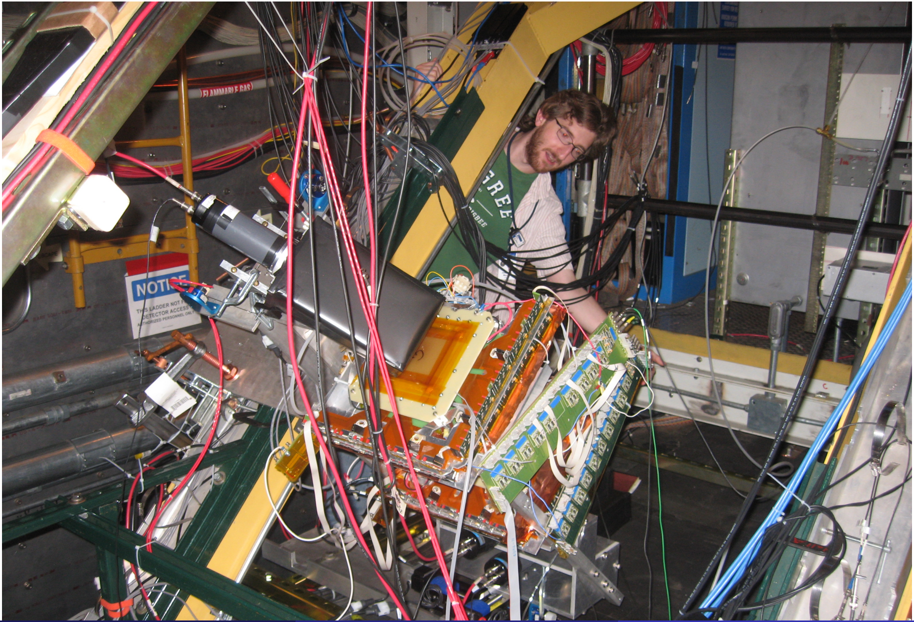
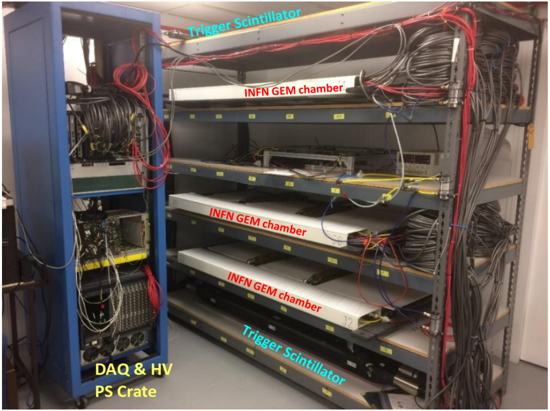
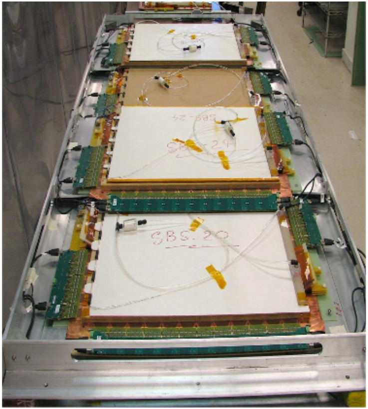


SBS GEM Production





- UVA produced 48 $50{\times}60$ cm^2 modules for SBS
- Testing has been ongoing with beam and cosmics with setup at JLab
  - "Terabytes of data" collected to be analyzed
- New frame will have to be designed - will do at ANL

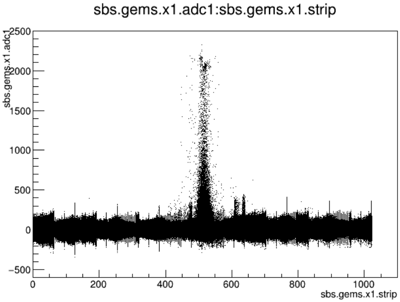
Plans Readout

- Have 3 10×20 cm (in det stand) and 3 SBS GEMs in each arm (hard mounted to HRS)
- CODA APV25 readout systems are being deployed for GEMs in JLab-related development activities
  - MPD - will be employed by SBS, VME based (1 module = 2048 channels)
- Will have two working systems

- Have MPD decoder integrated into analyzer that works but not integrated with higher level analysis yet

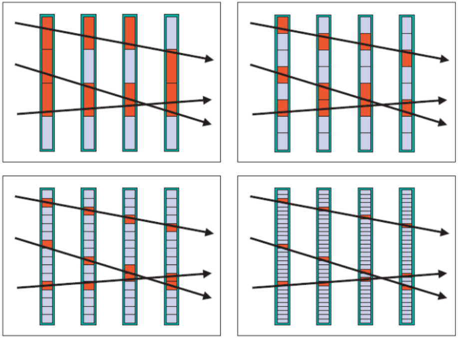
`https://github.com/JeffersonLab/SBS-Offline`

- Done basic work with SBU students



Tracking

- Tracking for GEMs can be solved using standard Hall A Tree Search Alogrithm by Ole
- Has been integrated in with analyzer by Ole (TreeSearch-GEM library exists) - still needs to be worked into our replay
- SBS and SoLID need to produce GEM pseudodata to test tracking software - this is a good addition



- UConn (Fuchey) and UVA (Di) has been actively working on doing pseudodata simulation for SBS
  - Not trivial to reproduce for PREX case
  - Resources on this would be useful

Tracking (cont)

- Analysis of test GEM data should continue with SBU and ISU
  - Worked out fitting time structures
  - Have method to do zero suppression, common mode noise
  - Needs to be integrated into replay
- Clustering algorithm needs to be included - simple fits probably OK for low rate
- Tracking needs to be set up for configuration
- Really need operational experience in collaboration - test stands eventually with CODA important
- ISU and SBU cosmic stand data should have regular meetings to bring online

Tracking Summary

- Sufficient GEMs will exist for PREX/CREX running for our tracking purposes
- Frame design needs to be considered for SBS inclusion
- DAQ electronics exist and will need to be incorporated into our system - already integrated into CODA
- Counting mode decoder and software libraries need to be updated to handle tree search with GEMs

Optics Software

- Produced second order transport code a while ago

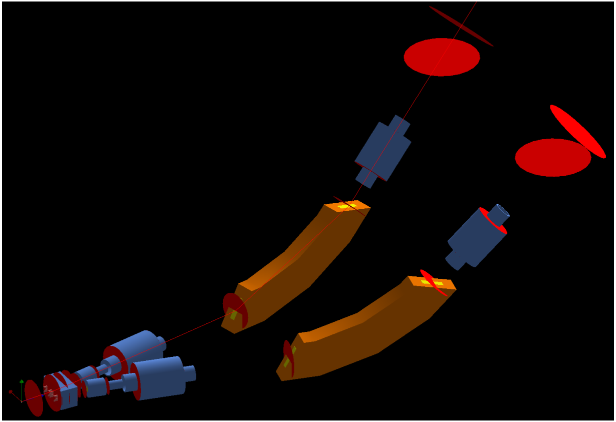
  `https://github.com/sbujlab/hrstrans`

- Uses basic matrices using elements calculated here

  `https://cds.cern.ch/record/283218/files/SLAC-75.pdf`

- Nickie validated with his G4MC transport and SNAKE
- Have PREX and standard tune configurations
- Example code on optimizing matrix elements and acceptance for tunes
- Main tool from Ryan as we explore data

g4hrs: GEANT4 simulation of HRS optics is functional and producing results



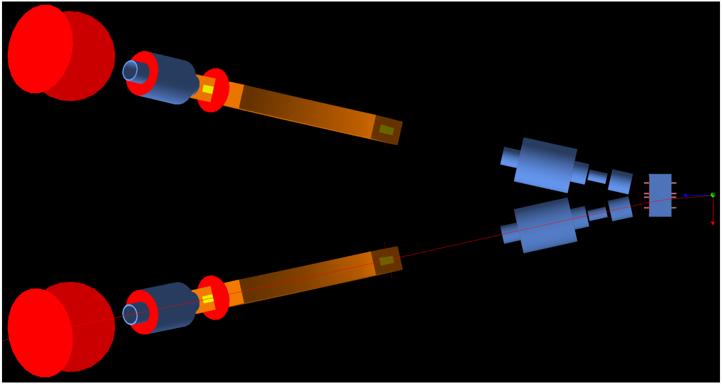
electron propagated along central trajectory

Progress

- Overhauled code based on `remoll` structure and generators
- Vastly reduced and simplified input files necessary to run the simulation or change running conditions
- Added ParallelWorld geometry containing virtual detectors to measure position and angle at key planes
- Built SNAKE FORTRAN functions directly into simulation for event-by-event comparison
- Included most up-to-date septum field map
- Implemented easily adjustable field settings able to set individual magnets or specify an overall tune
- Verified central trajectory ray

Next steps

- Tune matrix elements
- Reproduce data and hamc distributions
- Begin looking at engineering impact on acceptance and FOM

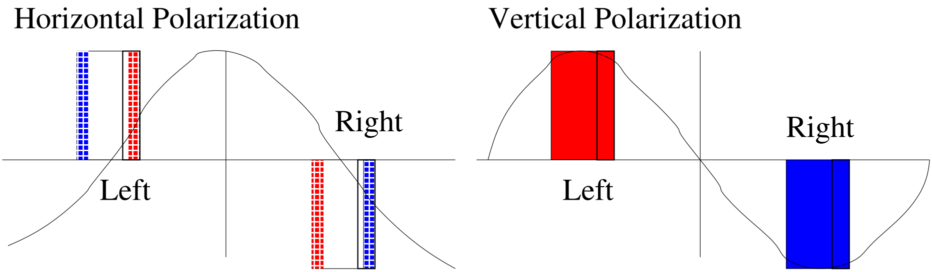


Questions and Work

More in Ryan's talk

- Is A_T sensitivity real, predictable, and controllable in optics?
- Is our tune appropriately optimized?
  - What does the raster do to us?
  - Better way to do A_T?
- Optimal detector placement w/ GEMs

Two A_T Detector Weakness



- A_T contribs monitored by A_T detector (left arm - right arm)
- Horizontal polarization hurts A_{PV} for acceptance asymmetries
- If transverse polarization lies the A_T det plane you measure 0
- Correlary: Vertical polarization will easily overwhelm A_T detectors - must be guaranteed to be supressed
- Propose 4 A_T detectors to do linear separation

BACKUP

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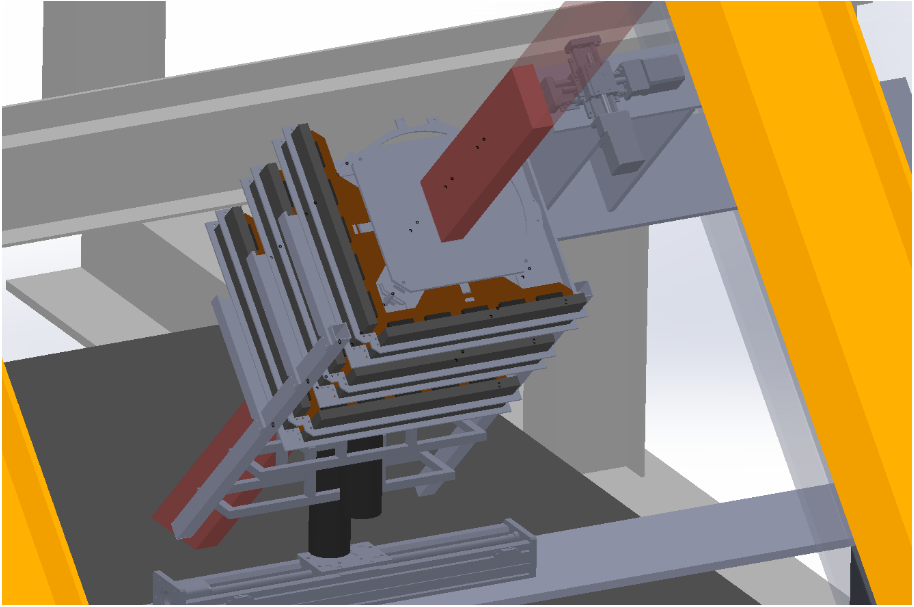

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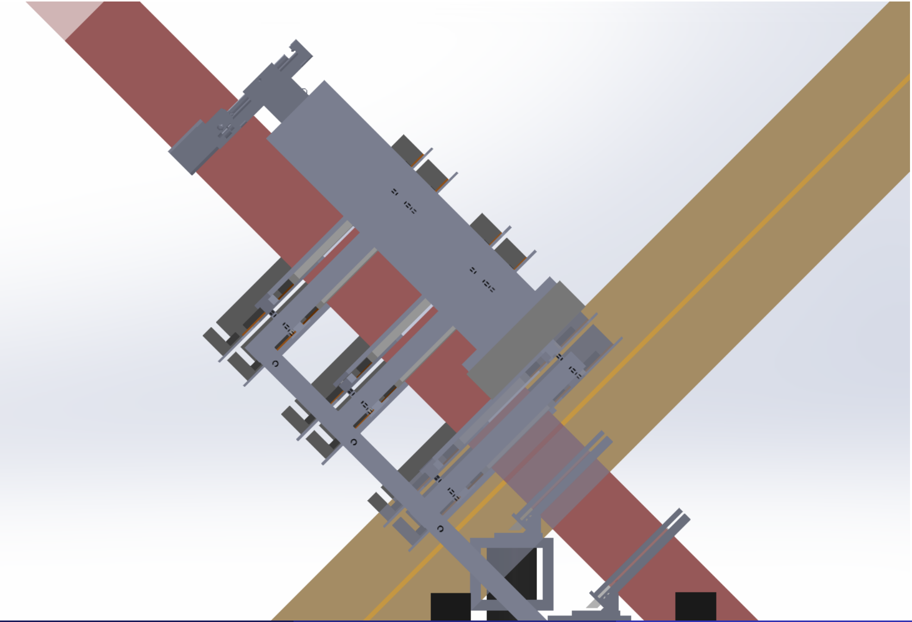

A_T Evaluation

- A_T detector was oriented in one direction of azimuth
- More robust system would have pair of detectors in each arm
- For symmetric system, out of plane polarization cancels
- Contribution to A_{PV} for azimuthal shift $\phi \to \phi + \delta$ and bite $\Delta\phi$

$$\begin{aligned} A_{\mathrm{V}} &= \frac{A_0}{\Delta\phi} \sin\Delta\phi \left(\cos\delta_{\mathrm{L}} - \cos\delta_{\mathrm{R}}\right) \\ A_{\mathrm{H}} &= \frac{A_0}{\Delta\phi} \sin\Delta\phi \left(\sin\delta_{\mathrm{L}} - \sin\delta_{\mathrm{R}}\right) \end{aligned}$$

- A_T detectors at δ measure the SUM of these

$$\begin{aligned} A_{\mathrm{V}}^{AT} &= \frac{A_0}{\Delta\phi_{AT}} \sin\Delta\phi_{AT} \cos\delta \\ A_{\mathrm{H}}^{AT} &= \frac{A_0}{\Delta\phi_{AT}} \sin\Delta\phi_{AT} \sin\delta \end{aligned}$$

- A_T detectors will be overwhelmed by vertical polarization, but horizontal hurts A_{PV} linearly in ϕ
- top-bottom asymmetry in same arm can help deconvolute