Monte Carlo Work

Seamus Riordan
University of Massachusetts, Amherst
sriordan@physics.umass.edu

June 19, 2013

Outline

- SBS Monte Carlo
- New Generators/Ported Fortran Code

Code Availability

- Be nice to put in a SVN repository if enough people need it
- I apologize for documentation! I've tried to make the headers, etc. commented well enough that you can use them. The full G4 MC is a bit more complicated, but yell at me if you have questions
- Put on my web space here:

`http://www.jlab.org/~riordan/software/`

G_E^n, G_M^n, A_1^n, G_E^p Simulation

Basis:

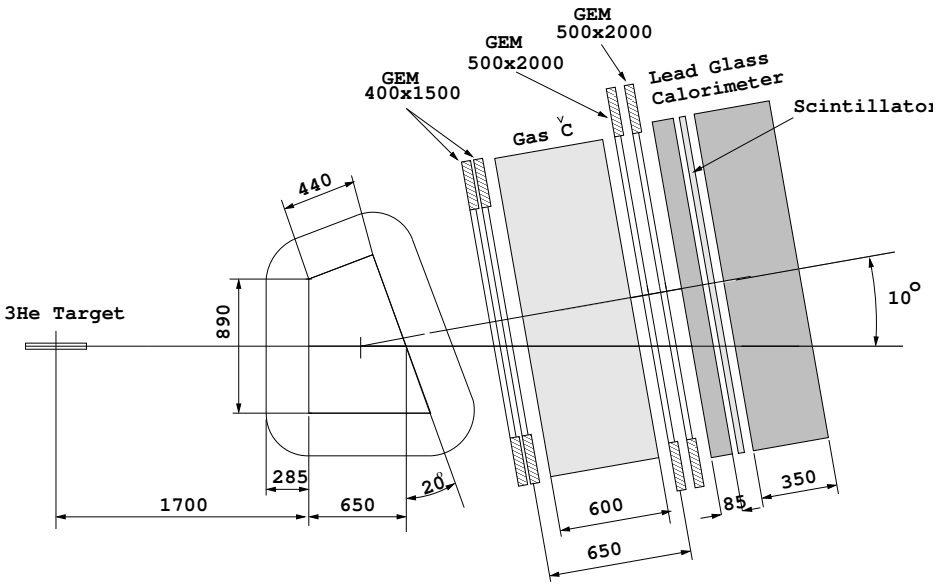
- Both G_E^n, G_M^n, A_1^n have similar hardware configurations
  - BigBite + GEMs + Cerenkov + shower/preshower
  - 48D48 and HCal
- FFs all use elastic or QE nucleon scattering - similar reconstruction needs

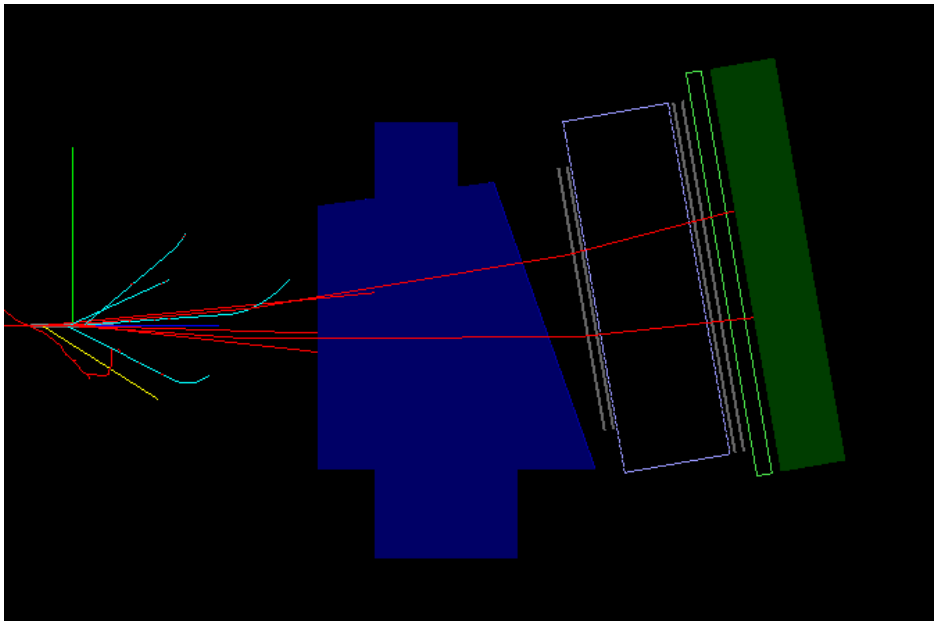
Needs:

- Given a realistic field map - what is the momentum resolution for various configurations?
  - High precision field propagation, multiple scattering effects in detailed geometry
- What is the acceptance given new placement of 48D48 for G_E^n, latest Cerenkov design?
- How do inelastic backgrounds contribute?

GEM Configurations I

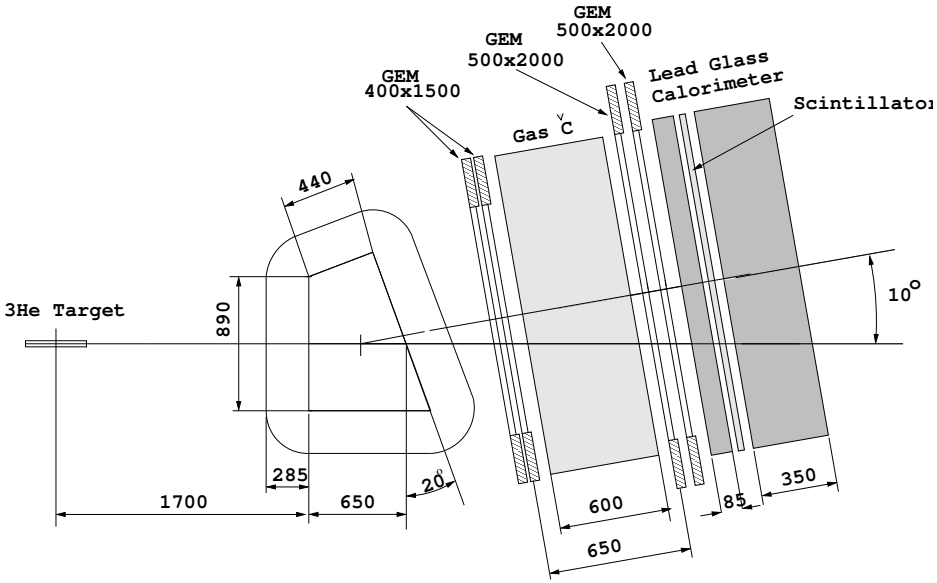
G_E^n/G_M^n, G_M^n, A_1^n Proposal

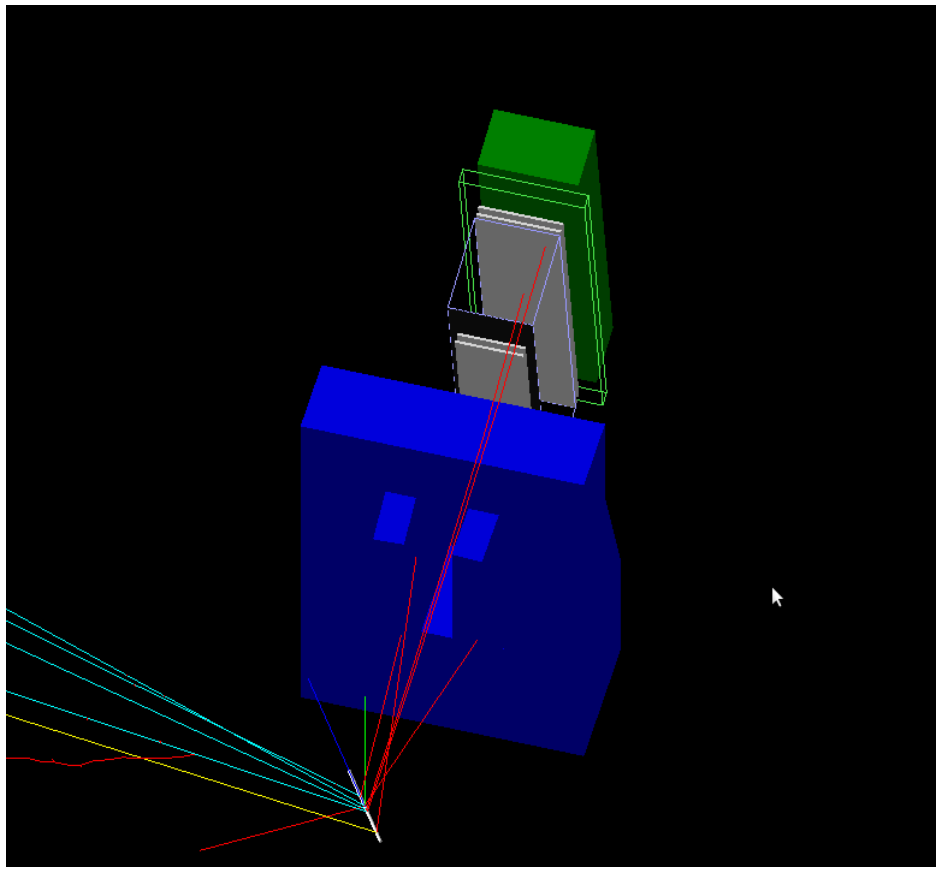




GEM Configurations I

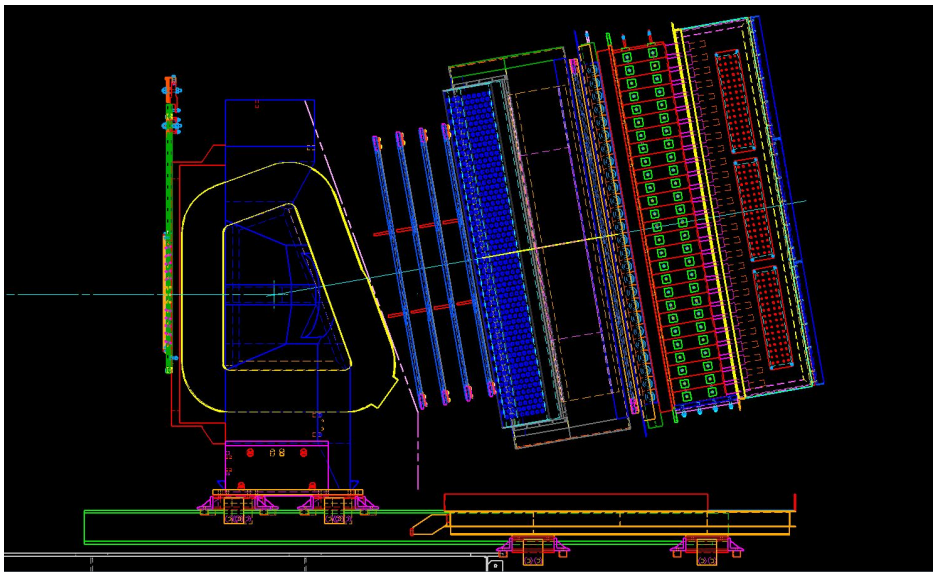
G_E^n/G_M^n, G_M^n, A_1^n Proposal

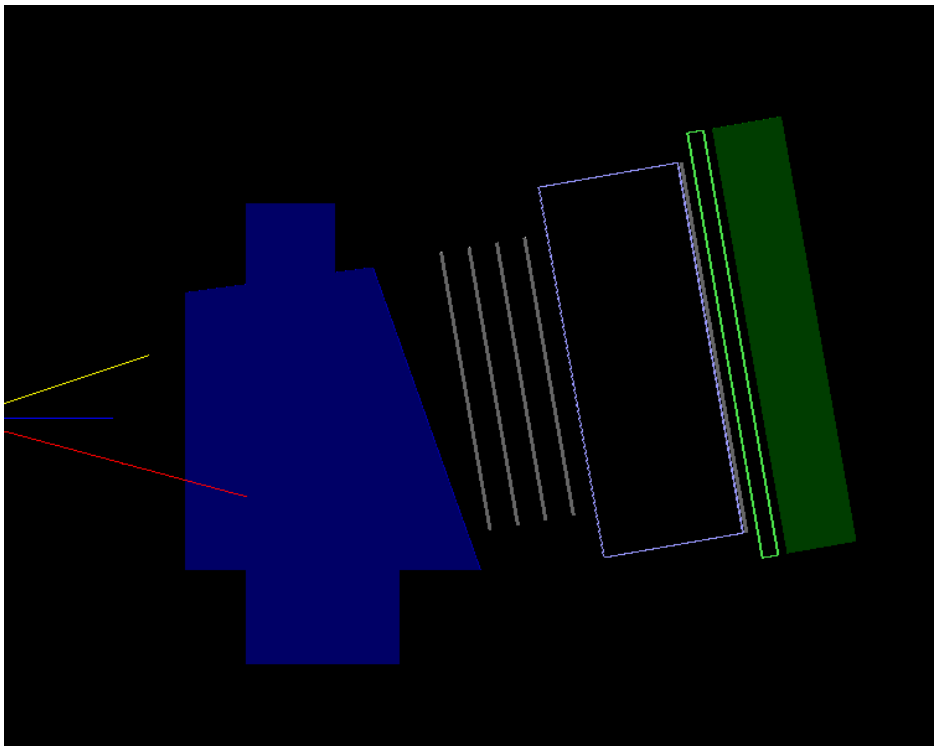




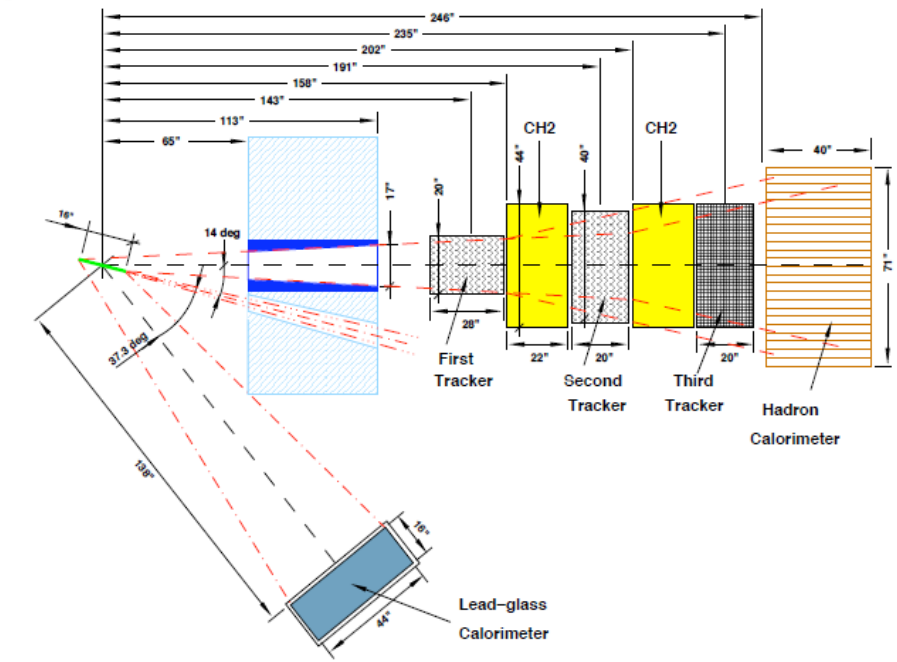
GEM Configurations II

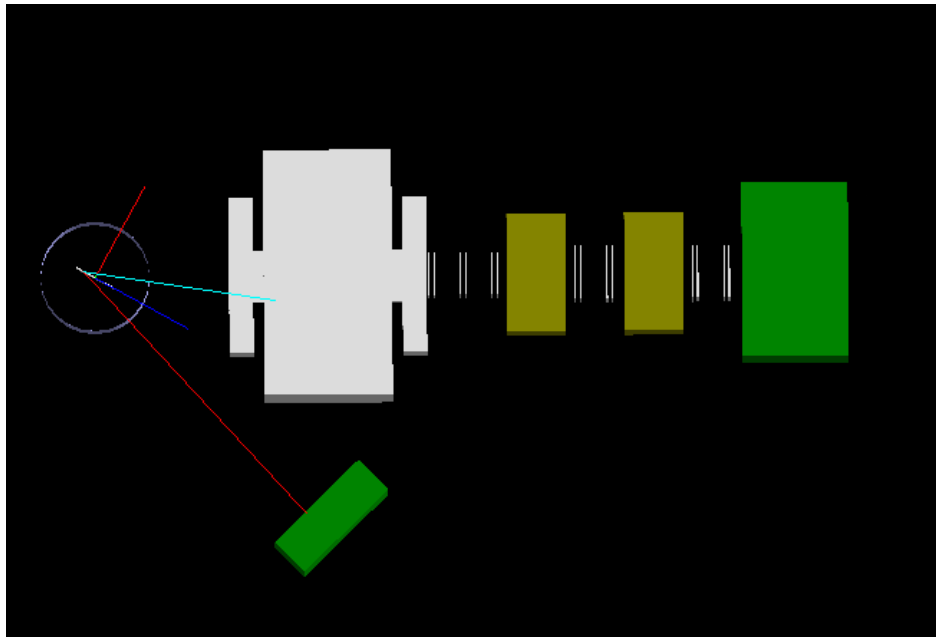
G_E^n/G_M^n New Frame





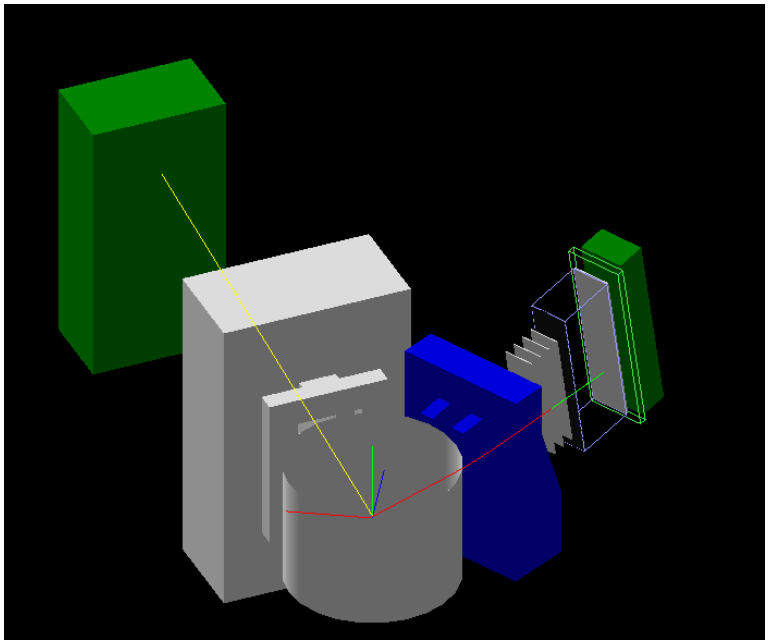
GEp-V Configuration

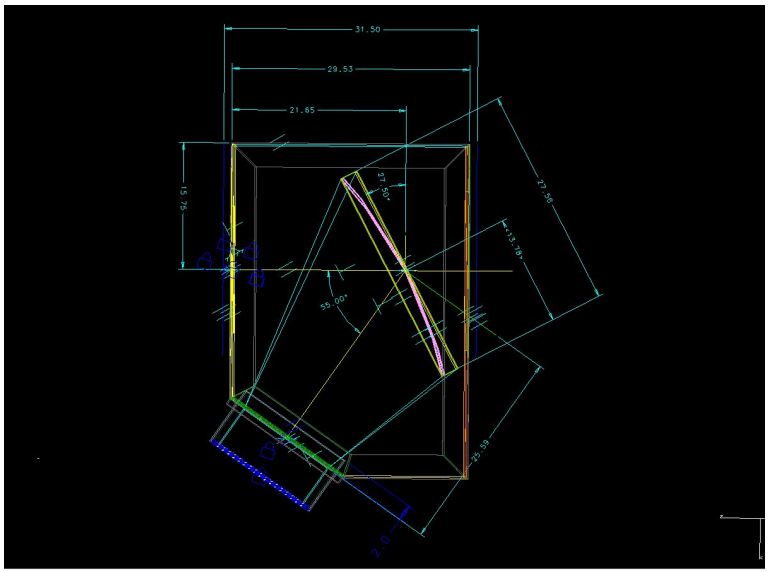




Components Included

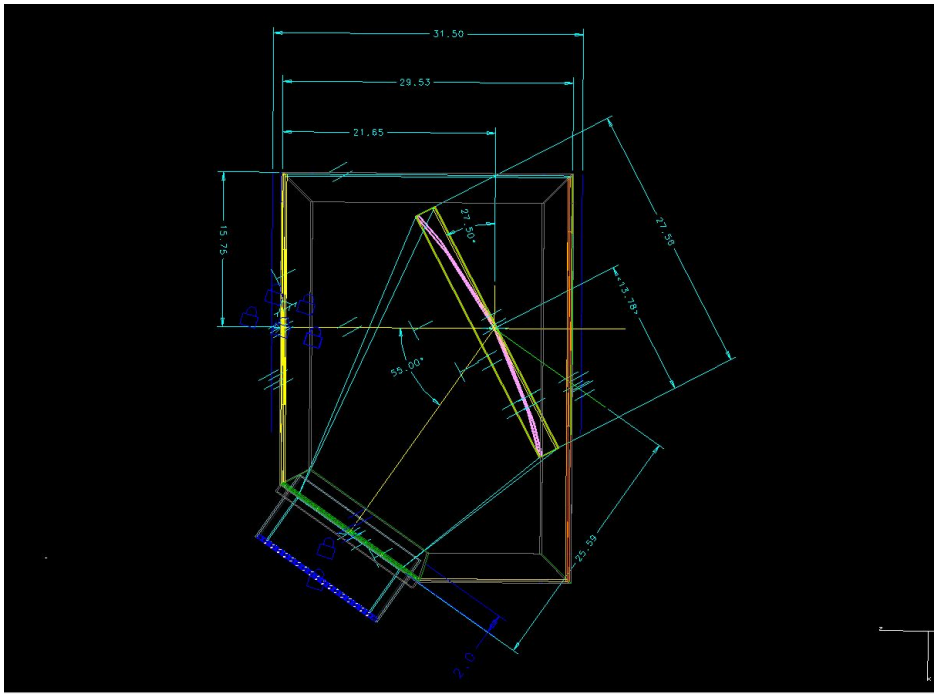
- BigBite and 48D48 Magnet
- Realistic BigBite field
- LH_2/LD_2 cryotargets, ^3He glass cells
- Vacuum scattering chamber
- GEMs
- Calorimeters
- Cerenkov





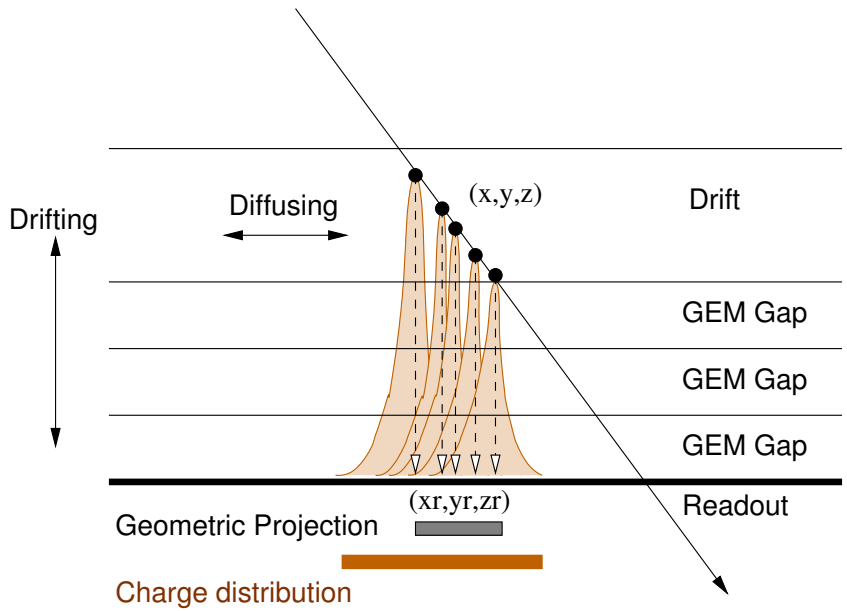
Cerenkov

- Cerenkov just a gas box with flat mirror - no light collection
- Mirror 1 mm acrylic
- Entrance (exit) windows 0.1 (0.2) mm Al
- Gas is C4F8O, 1 atm

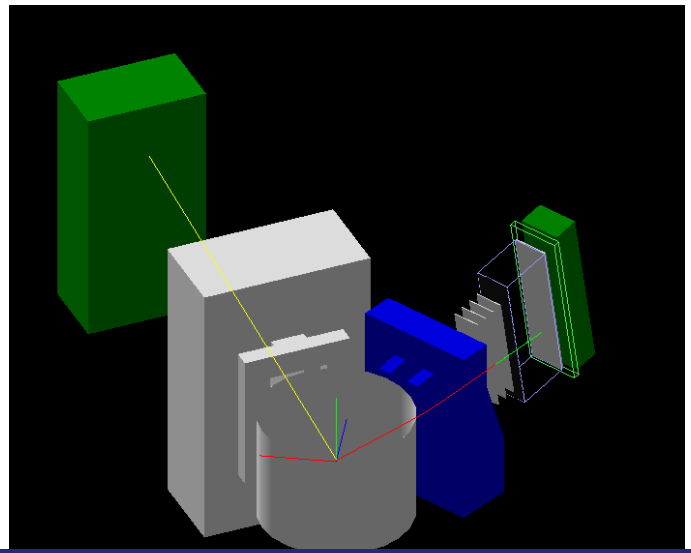


Sensitive Detector Elements

- GEM material/design from SBS GEM tracking sim
- Gas ionization layer sensitive detector for hits
- Hits taken as points - only from primary track, no background
- Assume 70 μm detector res.



- Calorimeters are dead absorbers, no showering, no smearing
- Acts as "trigger" for each arm



Implemented Generators

Wrote:

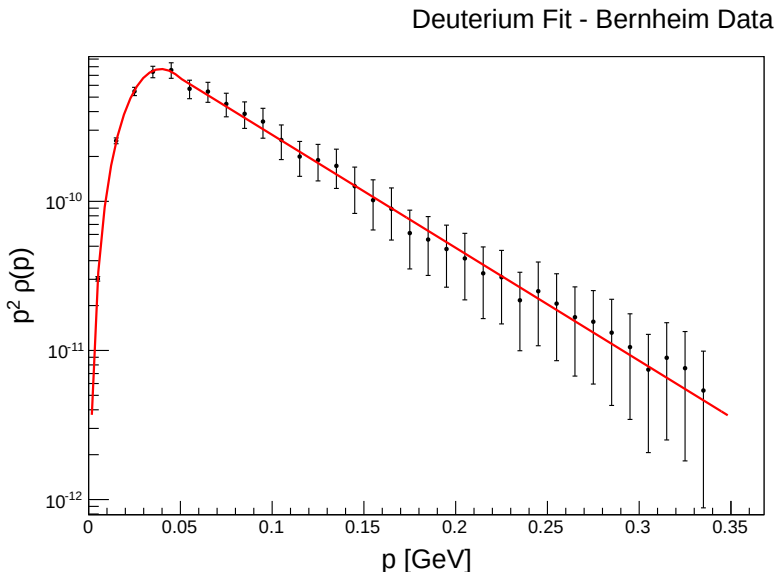
- eN elastic, quasielastic
- Parameterized eN inelastic
- DIS from CTEQ distributions

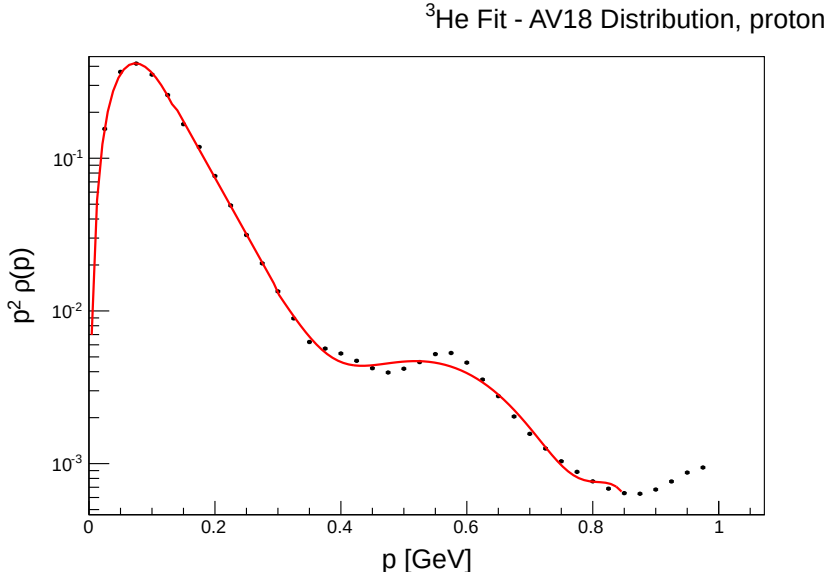
Nice to include someday:

- External radiative effects
- Wiser $\pi^{\pm,0}$ production
- Asymmetries
- Multiple scattering?

QE Generator

- QE rates given by
  - Nucleon momentum distributions - just use simple smearing
  - Kelly parameterization for G_E^p, G_M^p, G_M^n, E02-013 parameterization for G_E^n





- Dumbly sample these distributions
- No offshell effects, could implement DeForest PWIA

Rate Results - G_E^n

Kin	Cut factor	Quoted Rate [Hz]	Prop conf [Hz]
1.5 GeV^2	1.0	29.7	37.9
3.7 GeV^2	2.0	1.01	1.00
6.8 GeV^2	3.0	0.049	0.053
10.2 GeV^2	4.0	0.006	0.007

- Rates agree with outher caculations
- With plausible cuts on data, reproduce rates quoted in plots

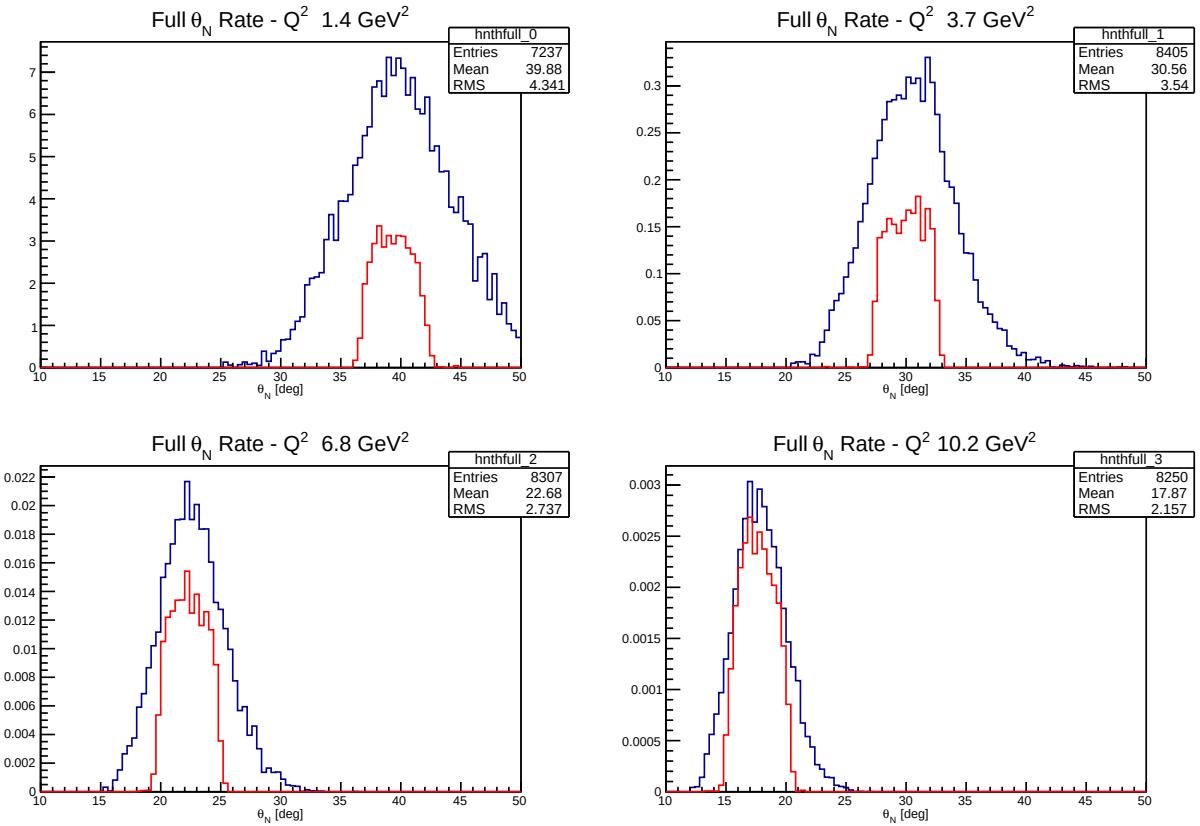
Rate Results - G_M^n

Kin	Quoted Rate [Hz]	MC New conf [Hz]
Kin		
3.5 GeV^2	50.0	56.6
4.5 GeV^2	10.0	10.2
6.0 GeV^2	0.73	0.74
8.5 GeV^2	0.26	0.29
10.0 GeV^2	0.21	0.30
12.0 GeV^2	0.043	0.051
13.5 GeV^2	0.010	0.012
New 13.5 GeV^2	-	0.058

- Rates agree very well with Kelly param. and what was used for the G_M^n proposal

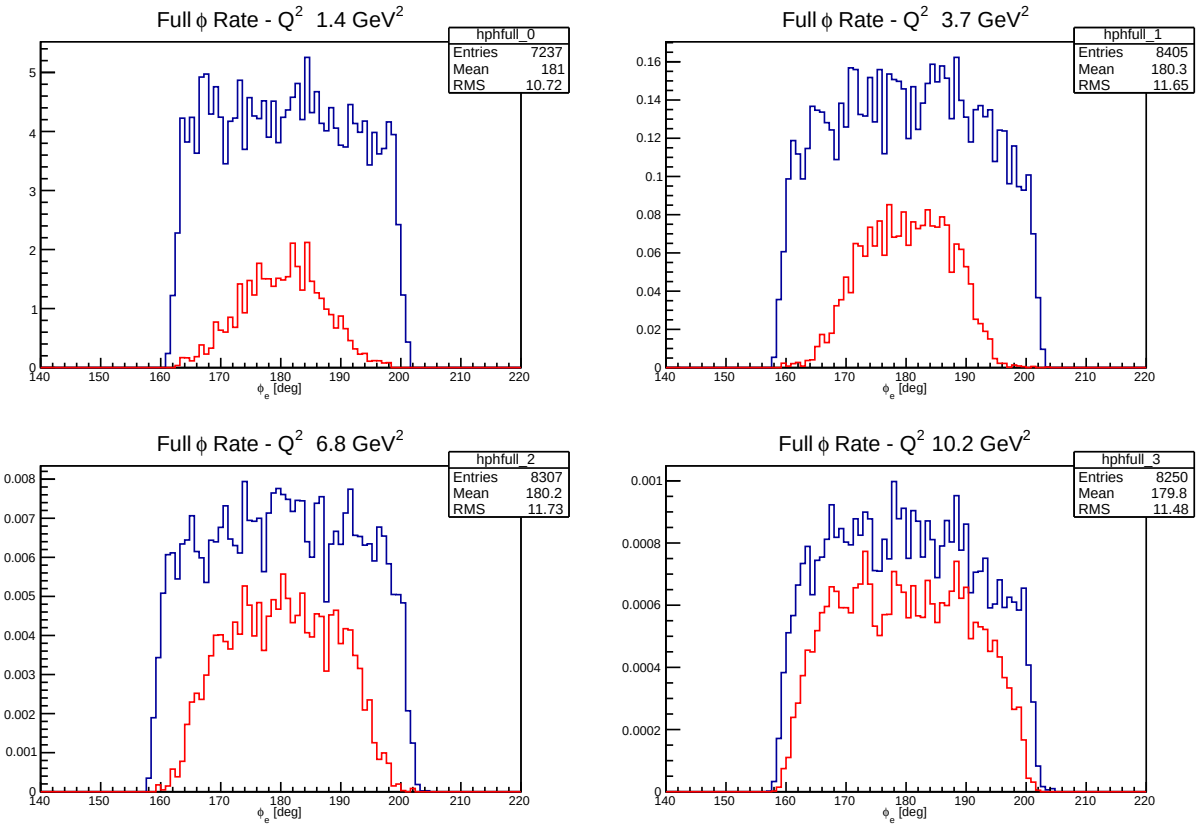
Rate Results - G_E^n Acceptance

- Black is QE neutron inclusive, red is coincidence
- Acceptance not matched well for G_E^n for θ and ϕ - was taken into account in rates
- Maybe some room for tuning?



Rate Results - G_E^n Acceptance

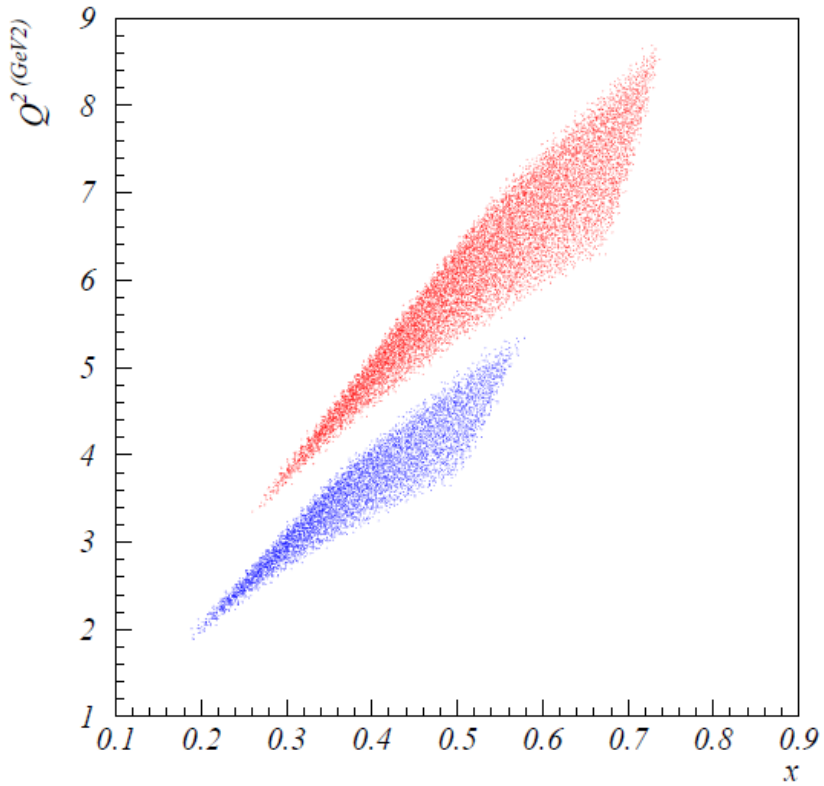
- Black is QE neutron inclusive, red is coincidence
- Acceptance not matched well for G_E^n for θ and ϕ - was taken into account in rates
- Maybe some room for tuning?



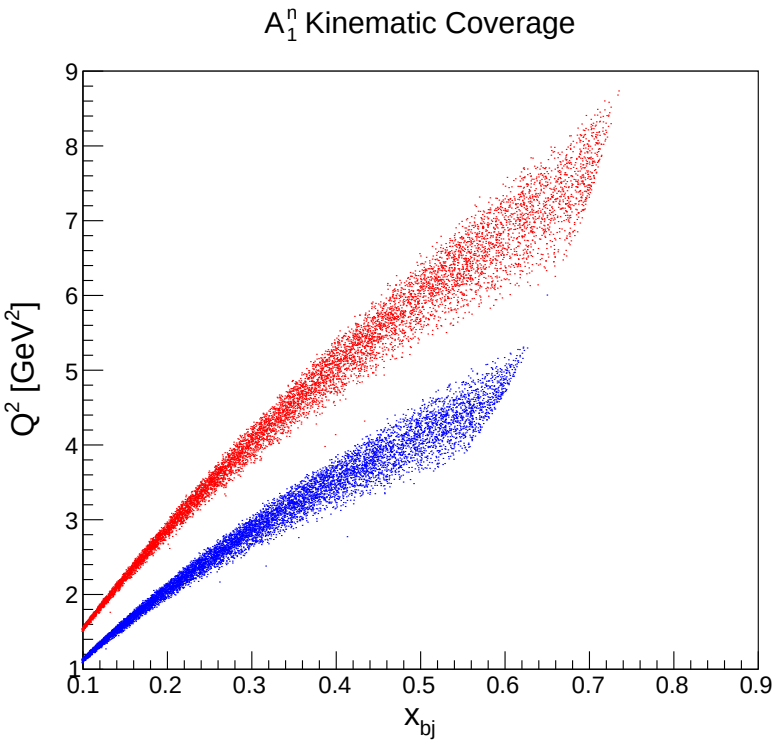
Acceptance for A_1^n

- Just used 1-arm neutron FF setup

Proposal



New MC



Rate Results - A_1^n

$E = 6.6$ GeV

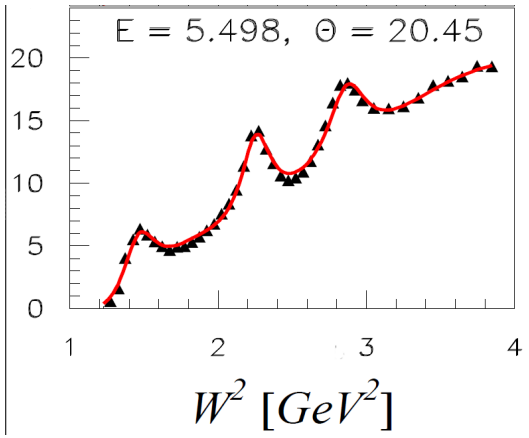
x	Prop [Hz]	CTEQ [Hz]	B/C [Hz]
0.60	1.3	5.9	8.2
0.56	8.0	7.2	9.3
0.52	12.0	10.2	12.3
0.48	17.0	12.8	15.4
0.44	23.0	20.5	19.0
0.40	30.0	24.9	24.4
0.36	30.0	34.3	30.8
0.32	17.0	46.0	35.3

$E = 8.8$ GeV

x	Prop [Hz]	CTEQ [Hz]	B/C [Hz]
0.71	0.5	1.0	1.7
0.67	1.7	1.4	2.2
0.63	2.9	2.2	2.9
0.58	4.1	3.3	4.5
0.54	6.4	5.5	5.9
0.49	8.2	6.8	8.7
0.45	8.8	10.8	11.3
0.40	6.2	15.4	14.3

Inelastic Generators

- Previous inelastic rates were given by MAID parameterization - got both σ and A, but limited in Q^2
- Worked in Christy/Bosted inclusive parameterization of *ep* and *en* data
- Use simple single pion decay model, assume Δ contributes for $\pi^{+/-}$,π^0 rates



- Reproduce plots in the papers well

Further Work

- Momentum resolution into reconstructed variables
- Radiative effects
- Add in Wiser code to SBS
- Shower responses
- Cerenkov responses

Summary

- Rates are near proposal expectations
- G_E^n kinematics might use some tuning to improve acceptance matching
- Inelastic studies need to be done