Update on the Gas Ring Imaging Cherenkov (GRINCH) Detector for A_1^n using BigBite

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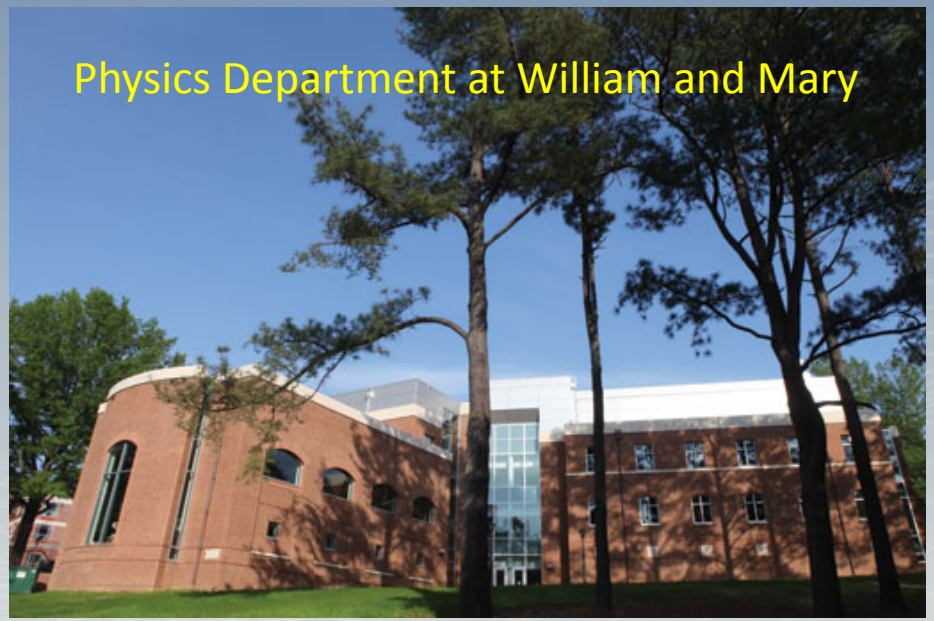

Wiki: http://wm-jlab.physics.wm.edu/mediawiki/index.php/Bigbite_Gas_Cherenkov

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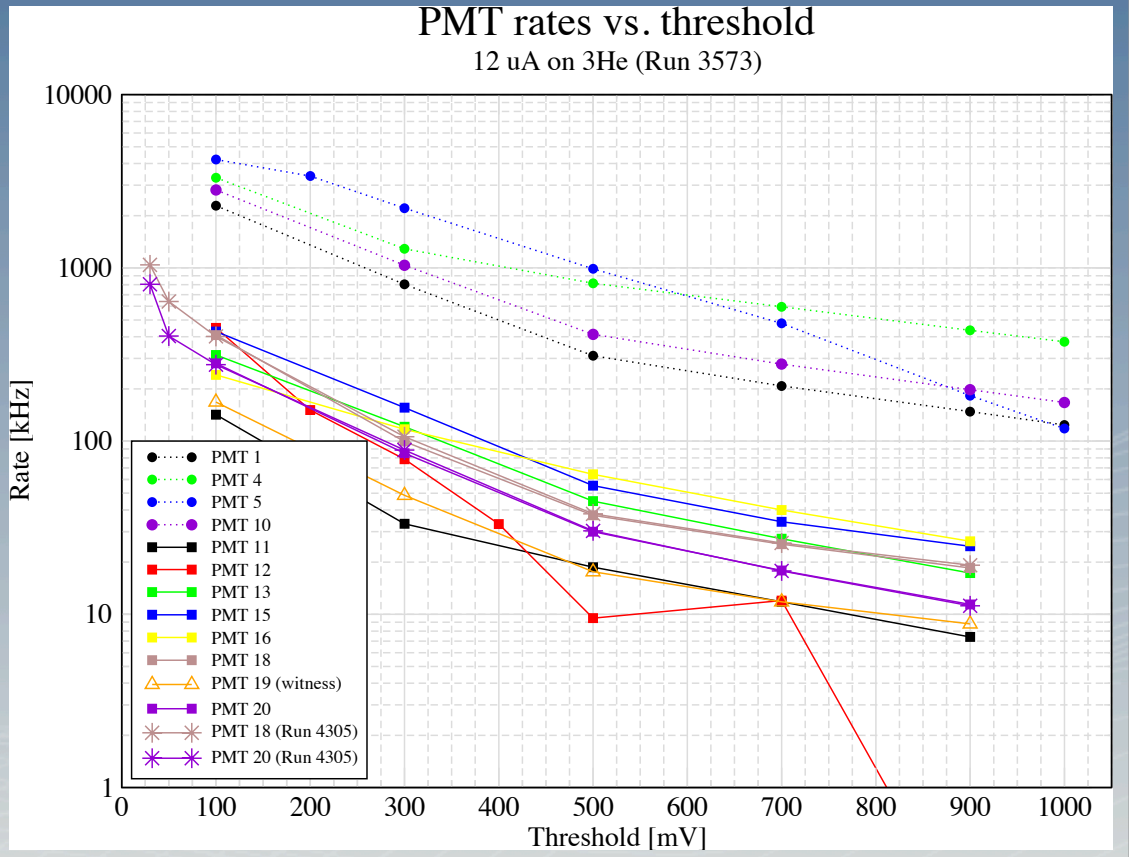
Motivation: High Rate Running

- Expect 4-5x increase in total luminosity over previous BigBite running.
- Assume 4-5x background rate.
- 30 degree scattering angle
- Segmented PMT array (29mm tubes); Area=0.05x smaller than 5" tube; 3x thinner glass face.
- Search for timing clusters in 5-10 ns window.
- ADC for low rate running and gain matching.
- Peak–height sensitivity during high-rate running.
- Locate PMT array on large angle side away from beam line. Shield beamline for EM background.
- C_4F_8O heavy gas
- Clusters with avg 10 PMT's/event and 2.4 p.e.'s/tube

d2n background

- Simulation and lab tests showed that background rates in d2n Cherenkov PMT's was due to background EM particles producing Cherenkov light in PMT glass face.
- Background particles from entire beamline.
- Neutron background insignificant.
- Large angle side 10x lower rates

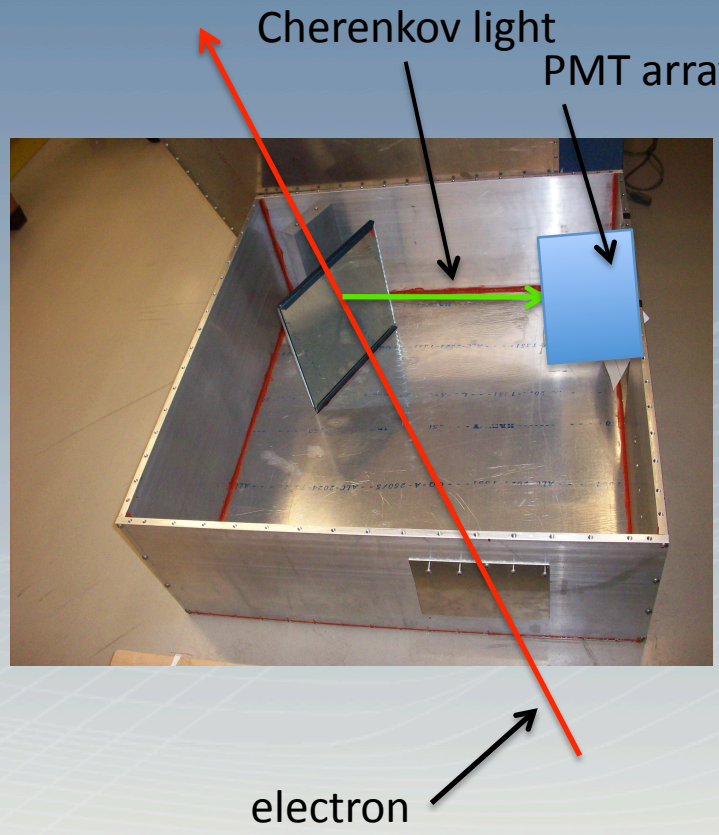


Expected Rates Relative to d2n

- Beam current 11.5→40 uA
- Target length 40→60 cm
- Total material in beam line 0.31→0.36 g/cm^2
- Based on total luminosity, expect background intensity to increase by factor of 4 to <= 16 kHz/cm^2
- Factor of 3 thinner glass PMT face.
- Rate per tube <= 140 kHz
- Beamline/target window shielding simulation shows it is possible to reduce background rate by factor of 3. Rate/PMT <= 50 kHz

Prototype Detector

- Matches geometry of full detector.
- 70 cm active path length
- 9x9 array of 29mm tubes
- Hermetic box
- Flat mirror
- Constructed at W&M
- Tested in Hall A during g_2^p



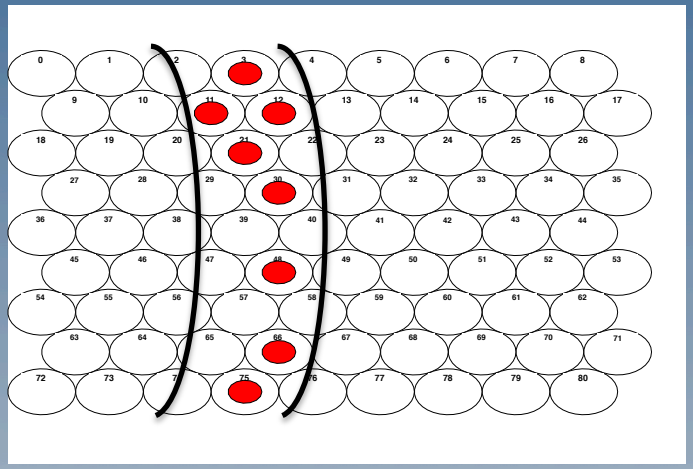
Prototype Tests

- Trigger:
  - Scintillator paddle before and after the detector
  - Lead-glass block for PID

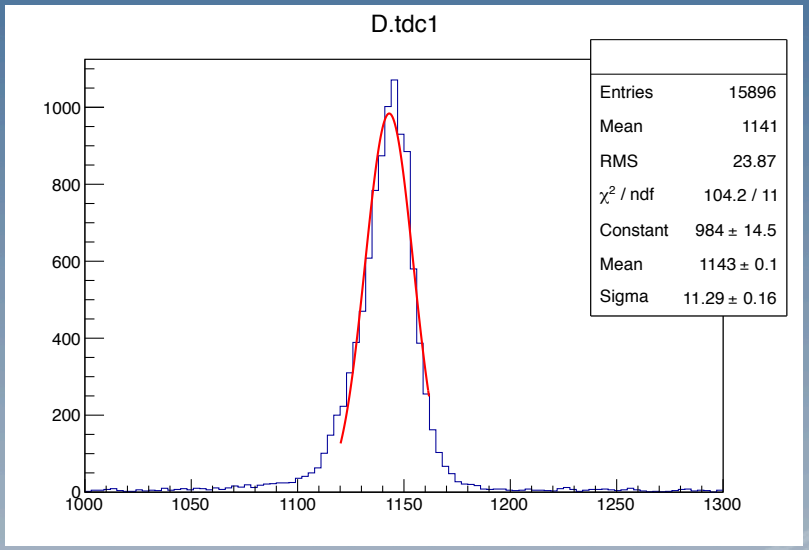
- DAQ: NIM & VME, 10x amplifiers, TDC's, ADC's, scaler
- Location: Beam height, Beam right side, 45 deg, thick scattering chamber
- Discriminator set to detect s.p.e. events in PMT array
- LED pulser system for gain matching

- Problems:
  - Trouble getting C_4F_8O gas, used CO_2 or air.
  - Initially difficult to find clusters in large background.
  - Used ½" lucite to generate large ring, detect partial ring.
  - Many different background conditions during run.

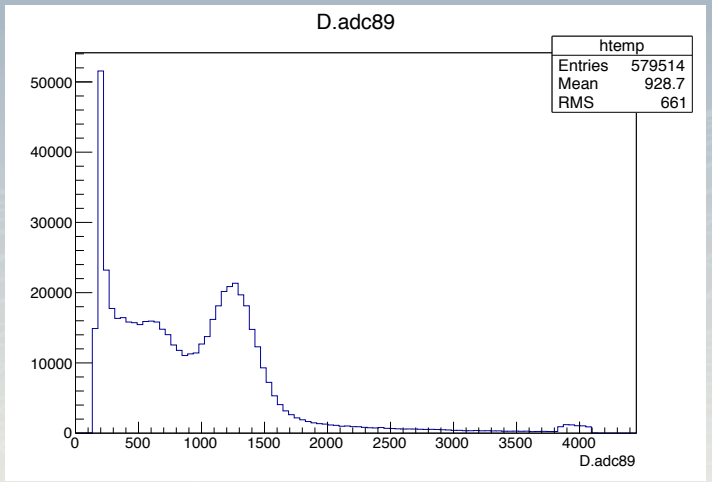
Prototype Results



Large radius ring from lucite



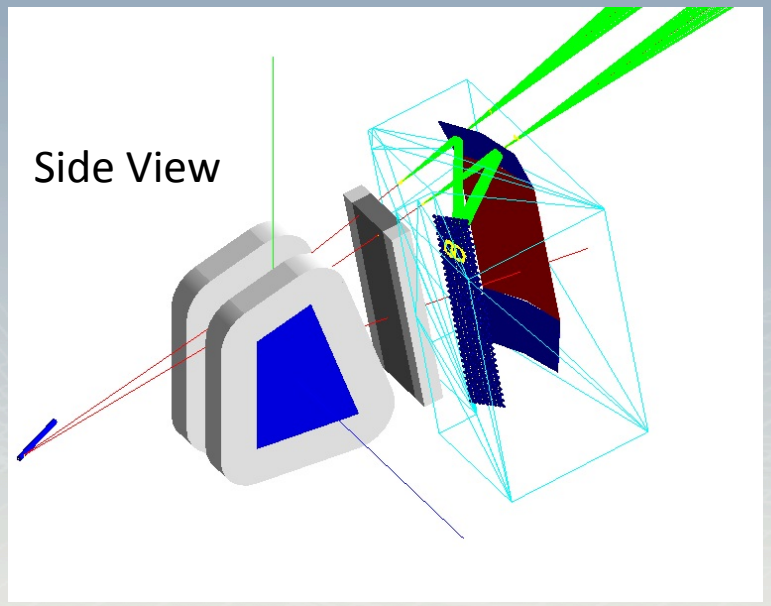
Timing spectra, single tube, σ=3ns

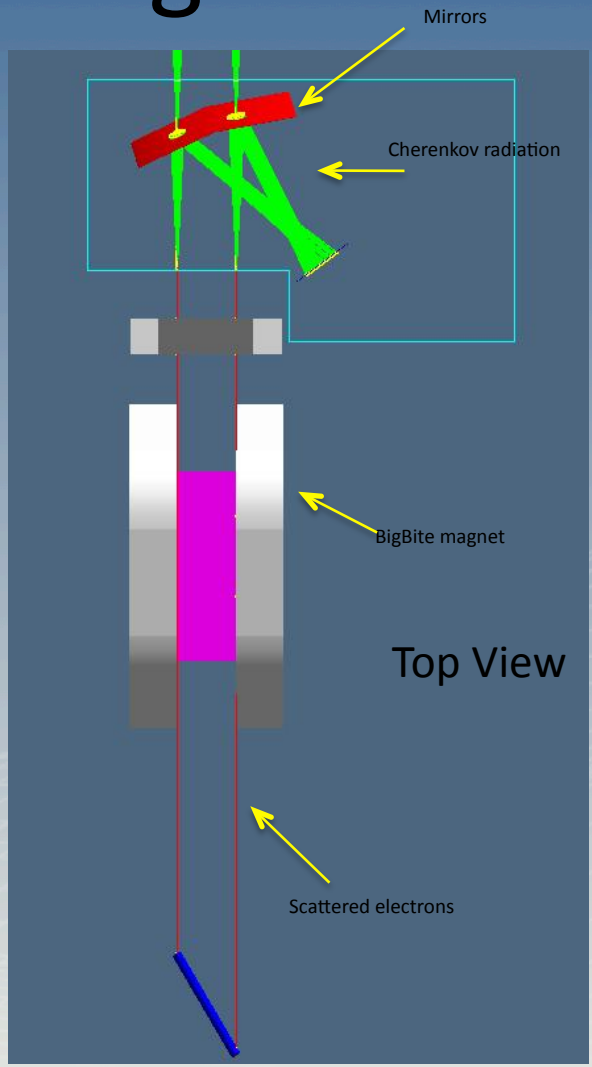


PbGl spectra after timing cut

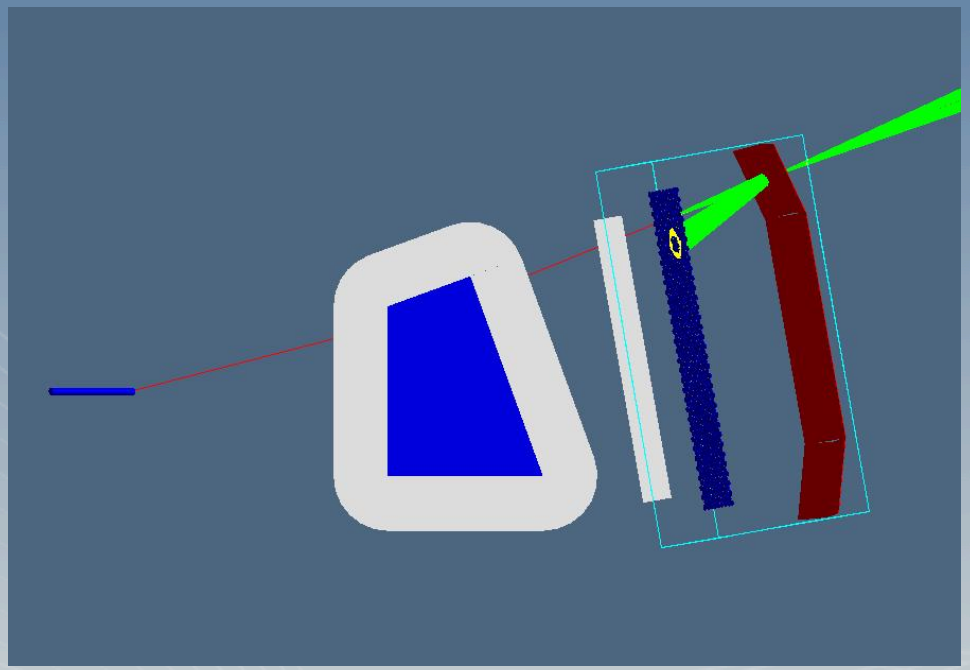
Simulation and Design

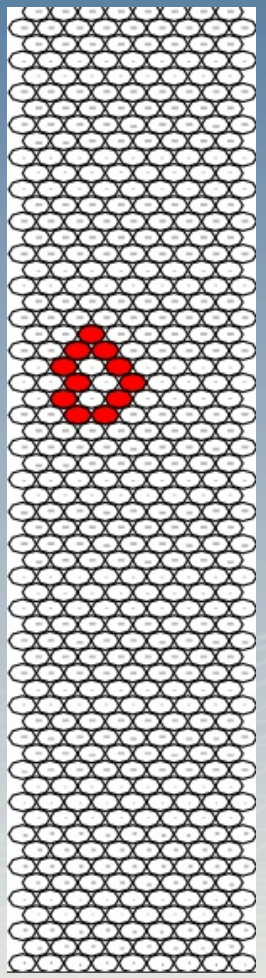
- Preliminary design based on GEANT 4 simulation and geometric constraints from BigBite detector package
- 70 cm path length**
- Single reflection from cylindrical mirrors. No focusing on specific PMT's, not sensitive to precise geometry.

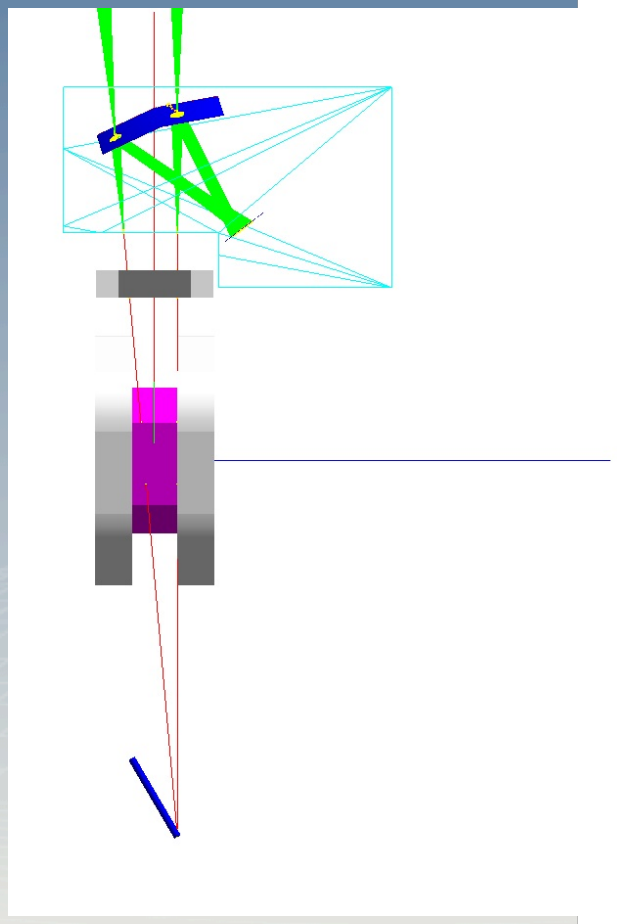




Simulation and Design



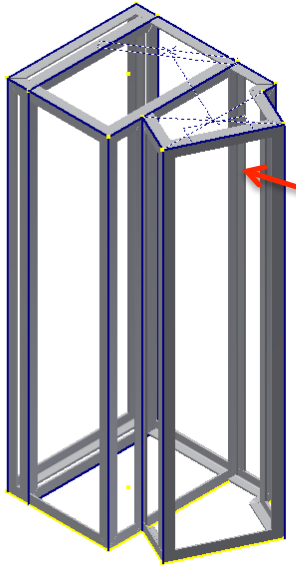


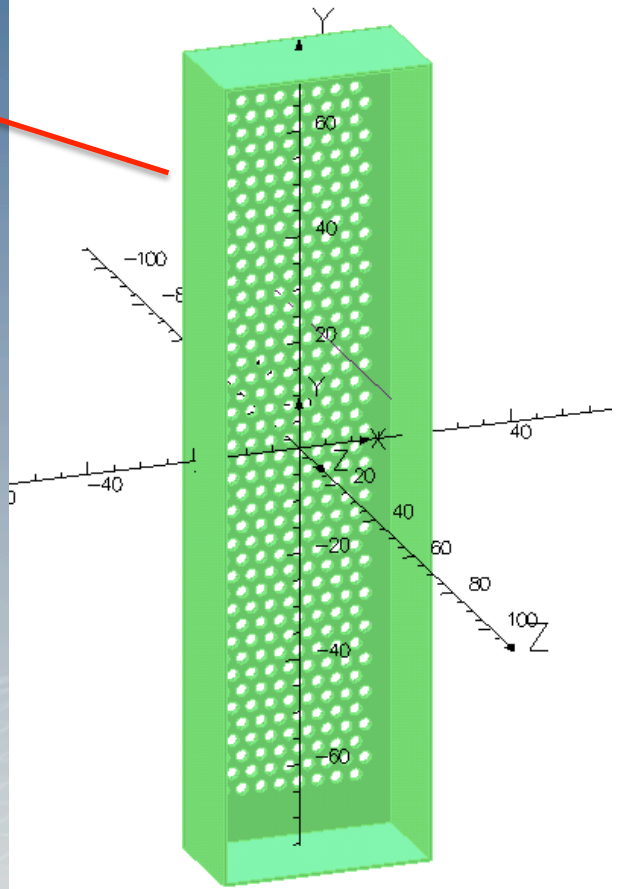


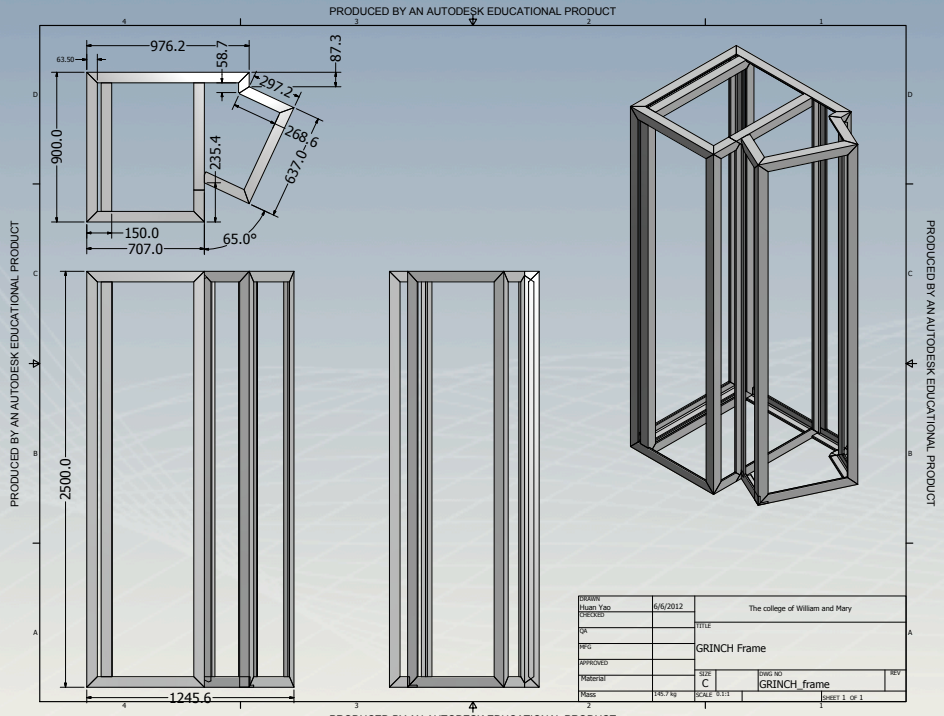
Design

- 9x60 array of PMT's in iron box
- Detector vessel made from frame of angled aluminum or iron.
- Sides covered with thin metal sheet welded to frame.
- Front and rear exit windows.
- Personnel access on side.
- Began working with designer Susan Esp

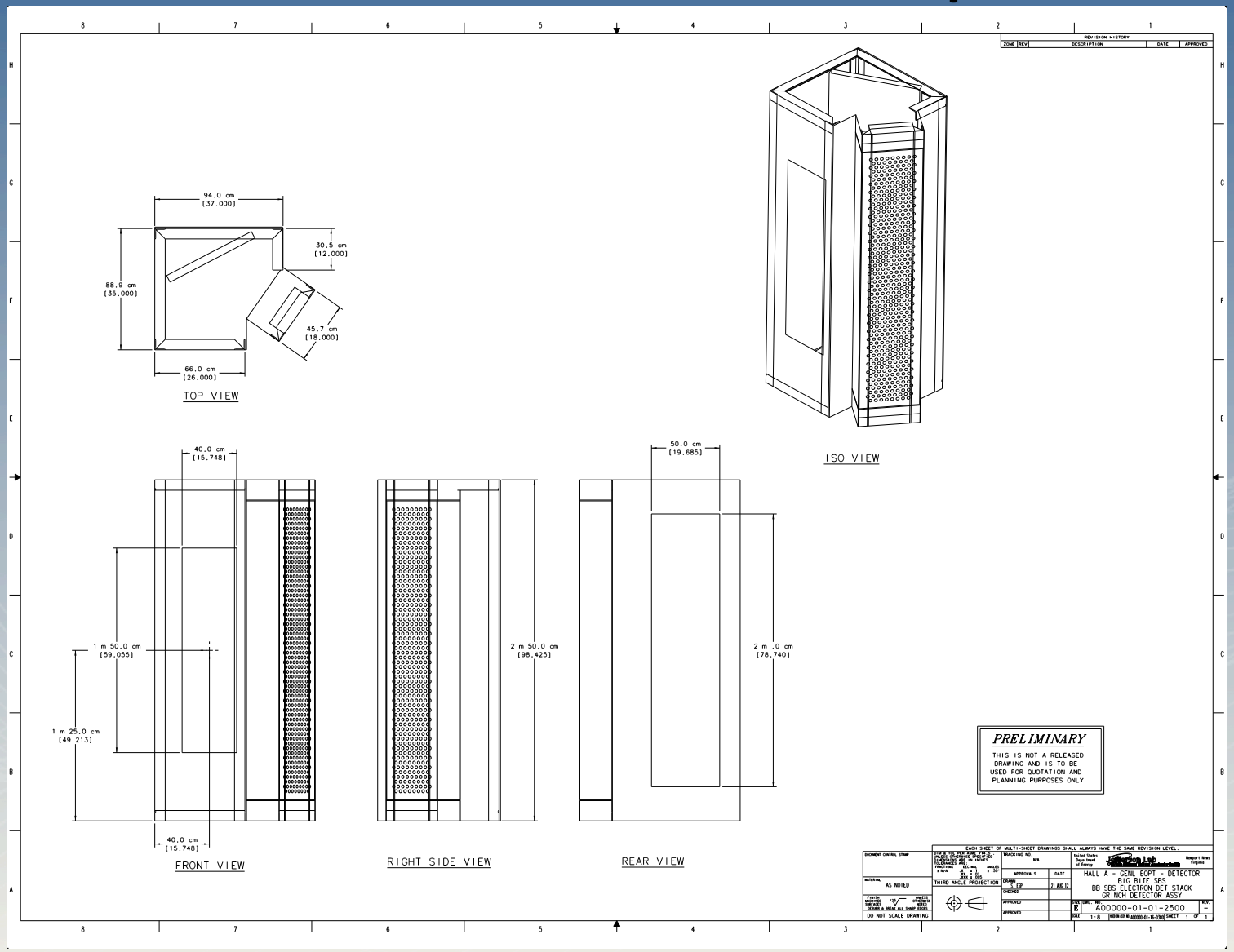
Conceptual Design



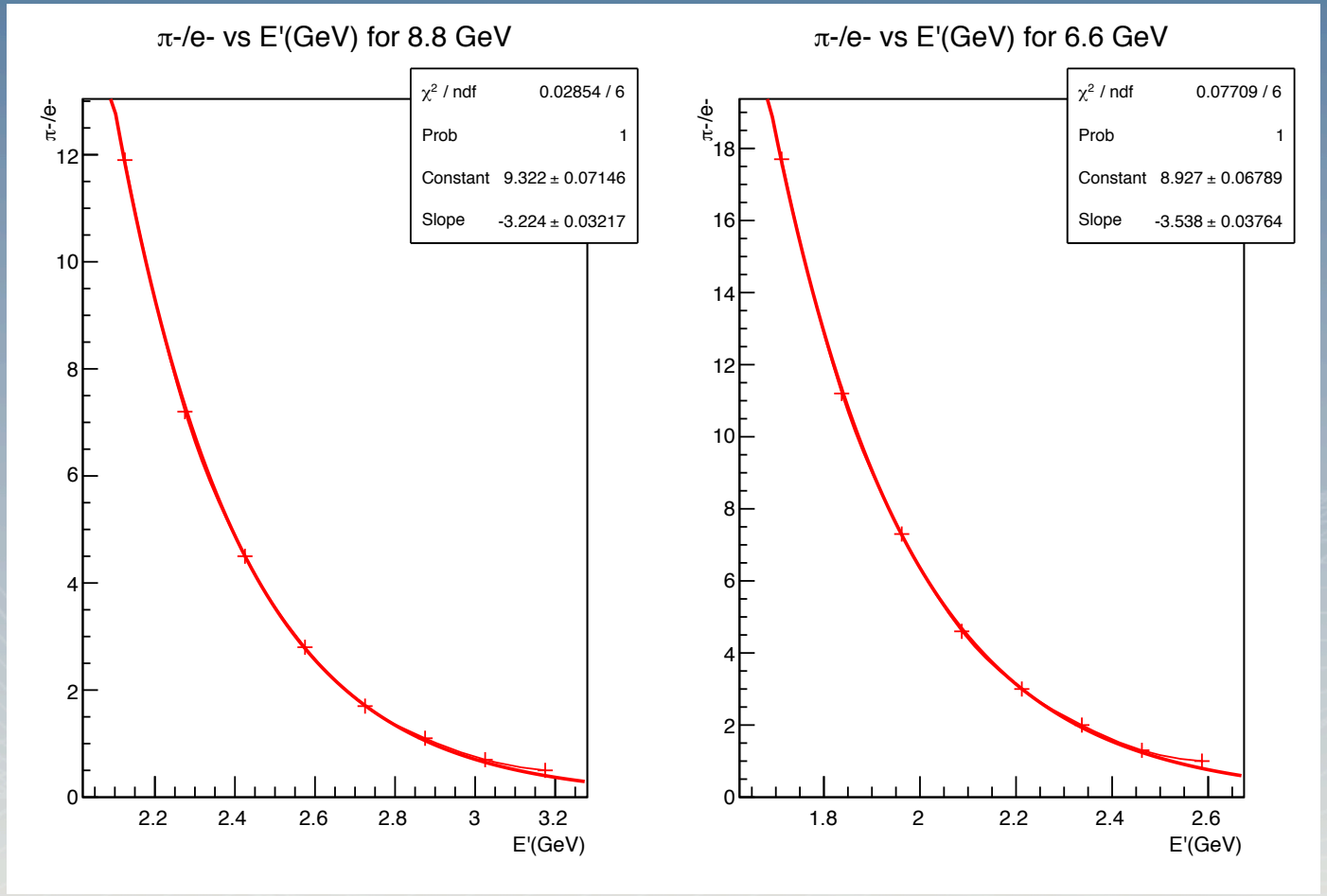




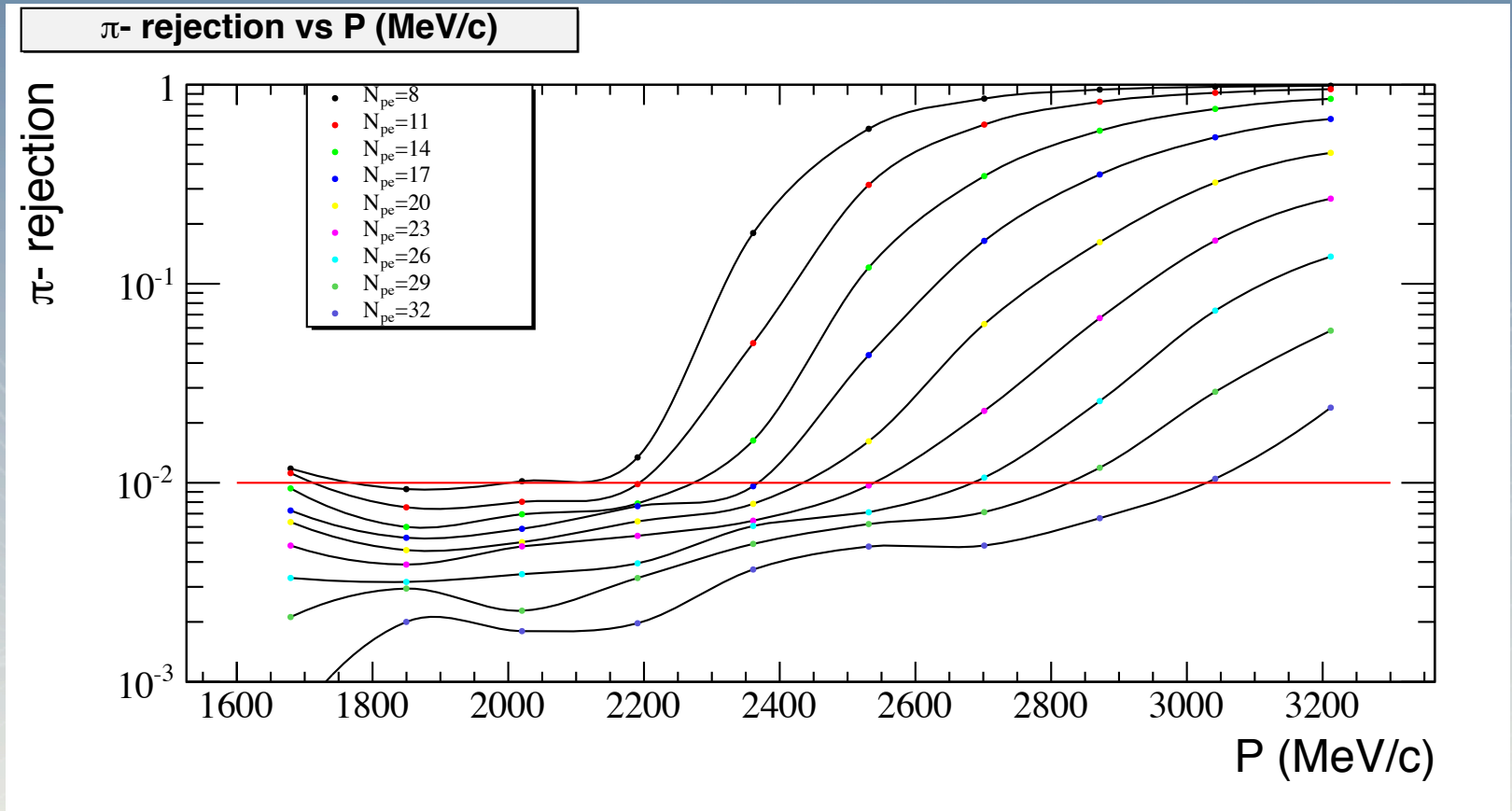
First draft from S. Esp



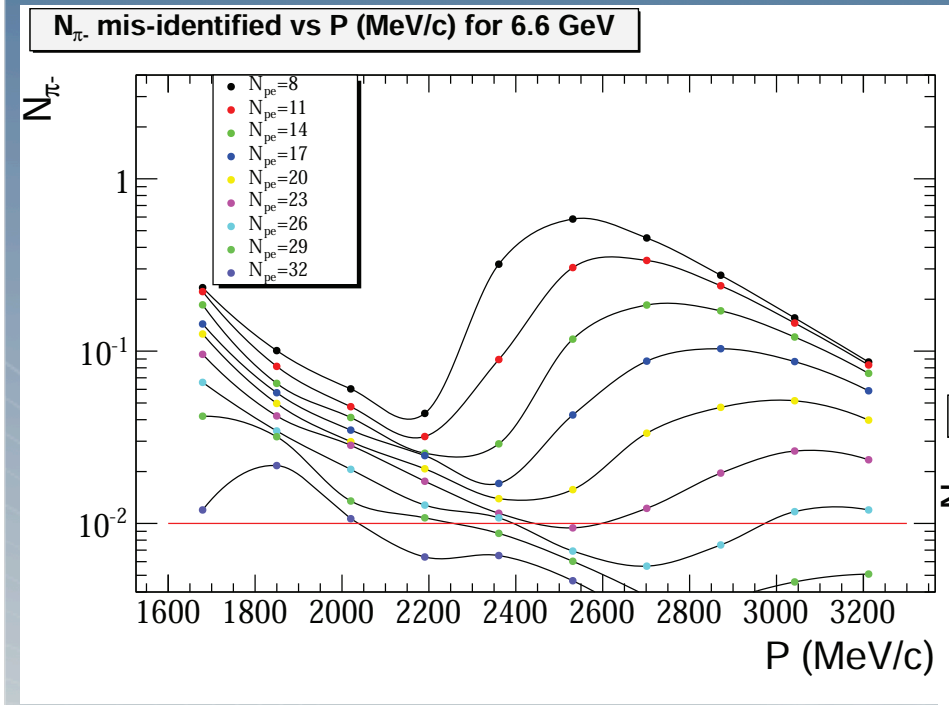
Expected pi^-/e^- ratio

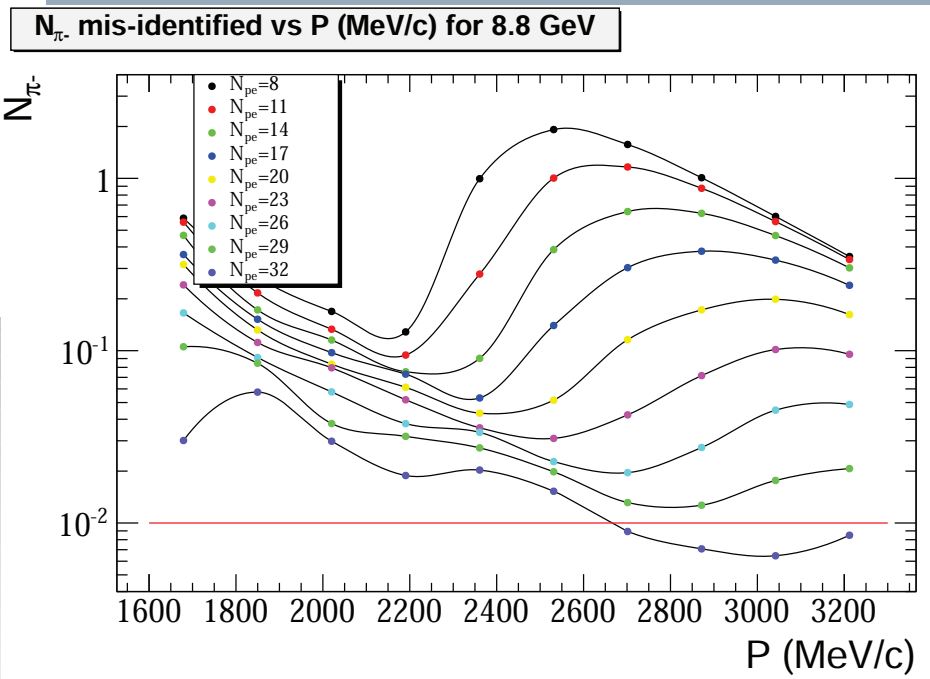


Pion rejection versus momentum, P=1.5 atm



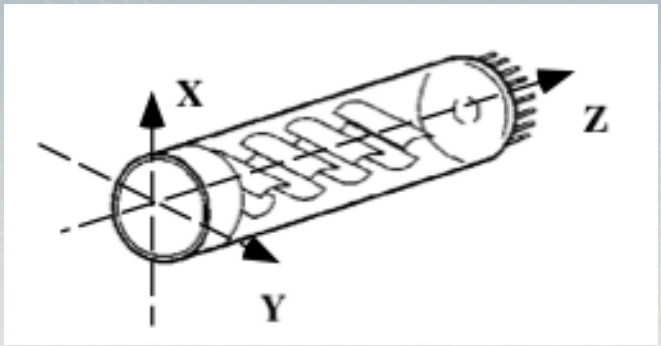
Mis-identified pions per event

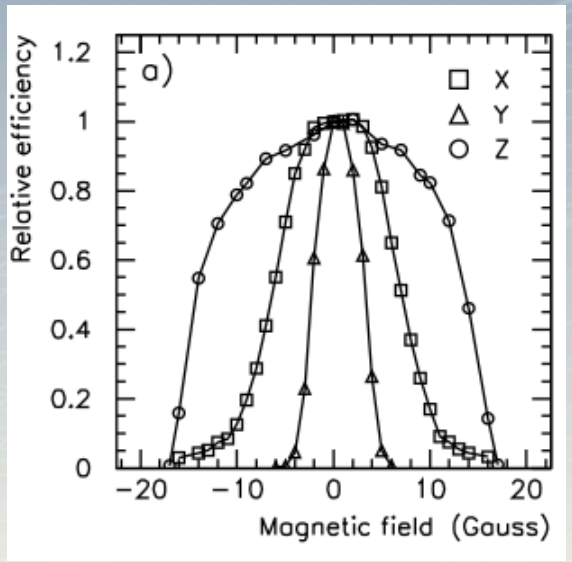




DIRC Magnetic Shielding Studies

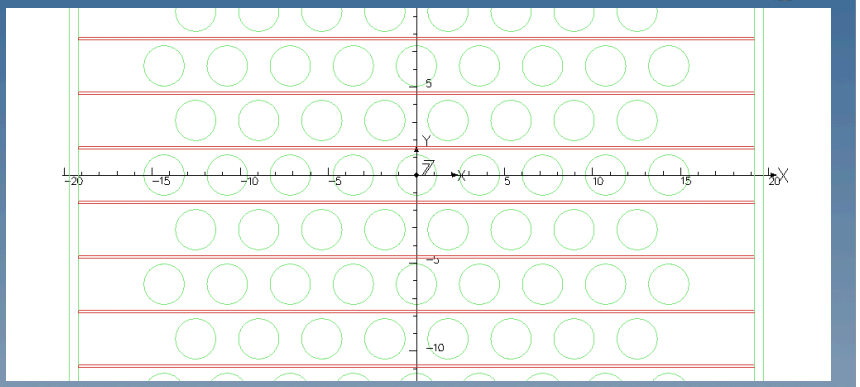
- PMT efficiency (events above threshold) most sensitive to magnetic field in Y direction.
- Orientation of PMT w.r.t BigBite field is critical.

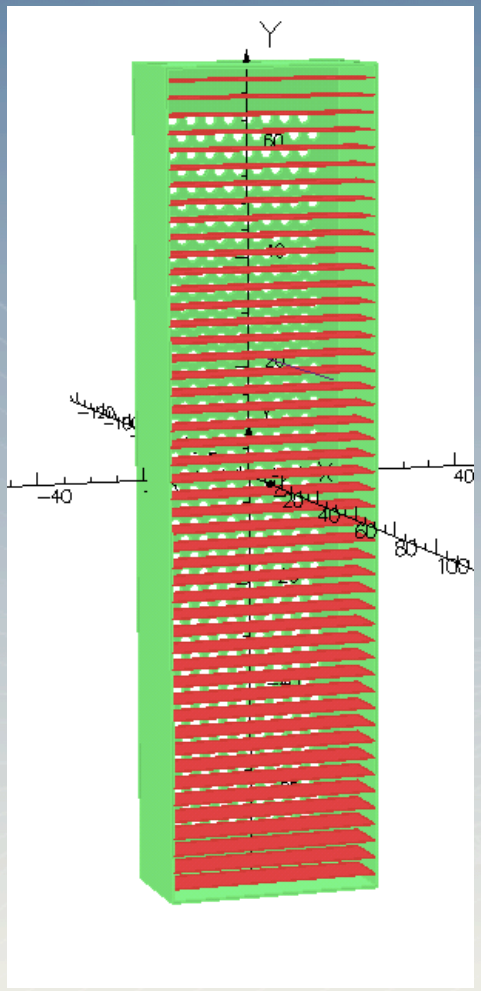


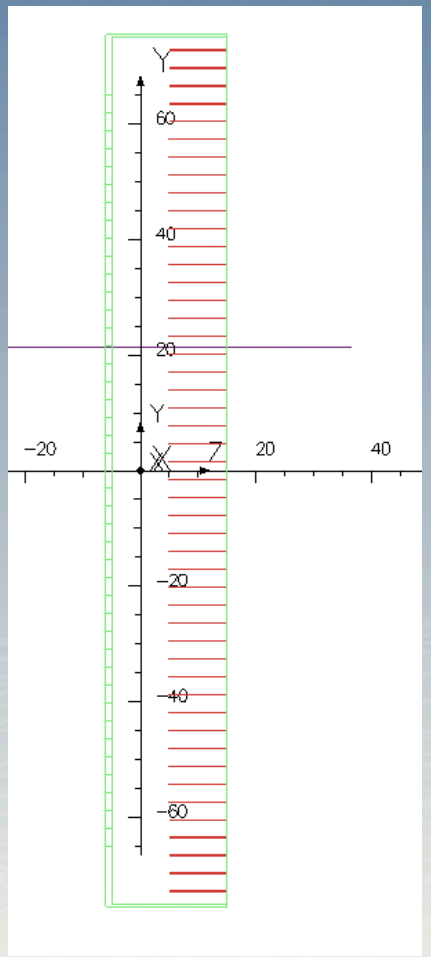


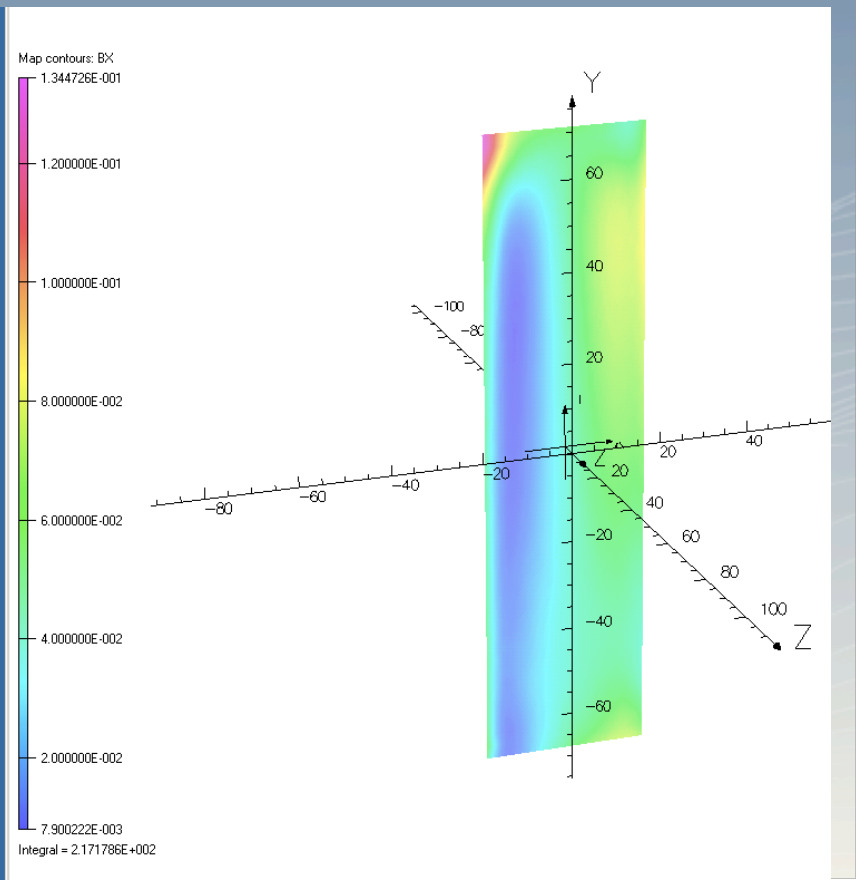
Magnetic Shielding

- TOSCA simulations using mu-metal plates between PMT rows.









Plans

- Finish simulation to optimize geometry, gas pressure, efficiency, pion rejection.
- Focus on design work with Jlab Design Group.
- NC A&T University to build and test PMT array iron box and magnetic shielding. Samuel Danagoulian, Abdellah Amidouch
- Begin mirror design studies.