Update on **G**as **R**ing **I**magi**N**g **CH**erenkov (GRINCH) Detector

SBS Weekly Meeting

Huan Yao[1] for GRINCH Collaboration

[1]College of William and Mary

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

Outline

Basic Simulation and Design

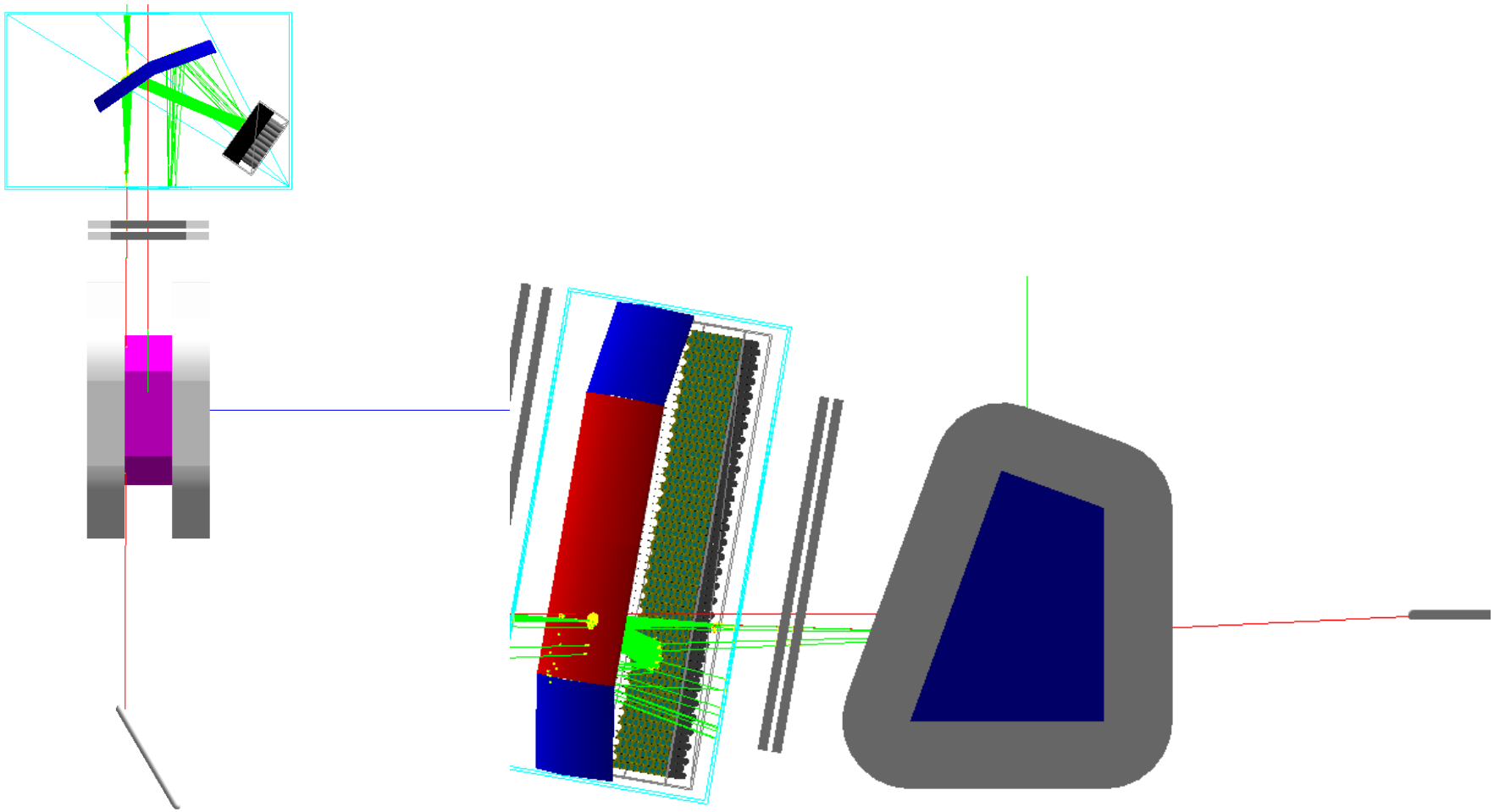
Advanced Simulation and Design

CAD Design

Test

Plan

GEANT4 Simulation



(a) Top view

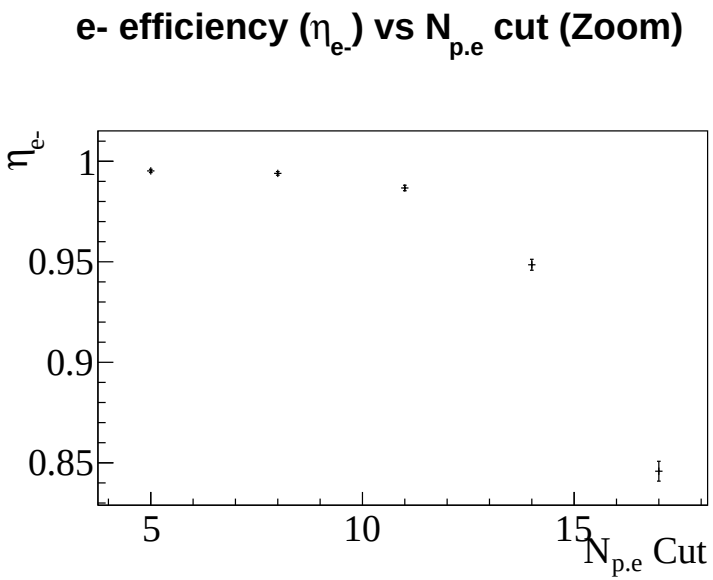
(b) Side view

Figure: GEANT4 GRINCH Simulation

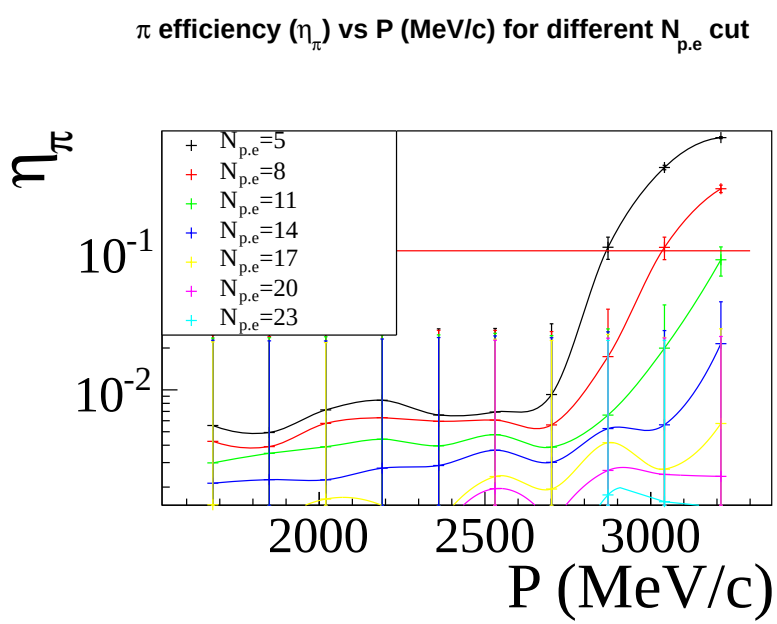
Simulation Basic Features

- Uniform distribution event generator.
- Add uniform magnetic field (1.2 T) for BigBite magnet.
- GC Tank with entrance window and exit window.
- Four cylindrical mirrors.
- 9x60 PMT array with glass surface on PMTs, light-catcher and 61 mu-metal magnetic shielding bars.

η_e and η_π



(a) η_e for different $N_{p.e}$ cut.



(b) η_π for P for different $N_{p.e}$ cut.

Figure: Efficiency

Mirror Center Position from Susan Esp's Design

MIRROR FRONT FACE CENTER COORDINATES			
UNITS ARE IN CM	CENTER		
	X	Y	Z
1. OPNG OF FRONT WINDOW:	0.000	0.000	0.000
2. TOP SMALL MIRROR:	0.049	81.560	-65.906
3. TOP LARGE MIRROR:	0.000	30.635	-66.000
4. BOTTOM LARGE MIRROR:	1.613	-30.635	-62.902
5. BOTTOM SMALL MIRROR:	0.049	-81.560	-65.906

Figure: Mirror front face center coordinates from Susan Esp's design.

σ weighted event generator

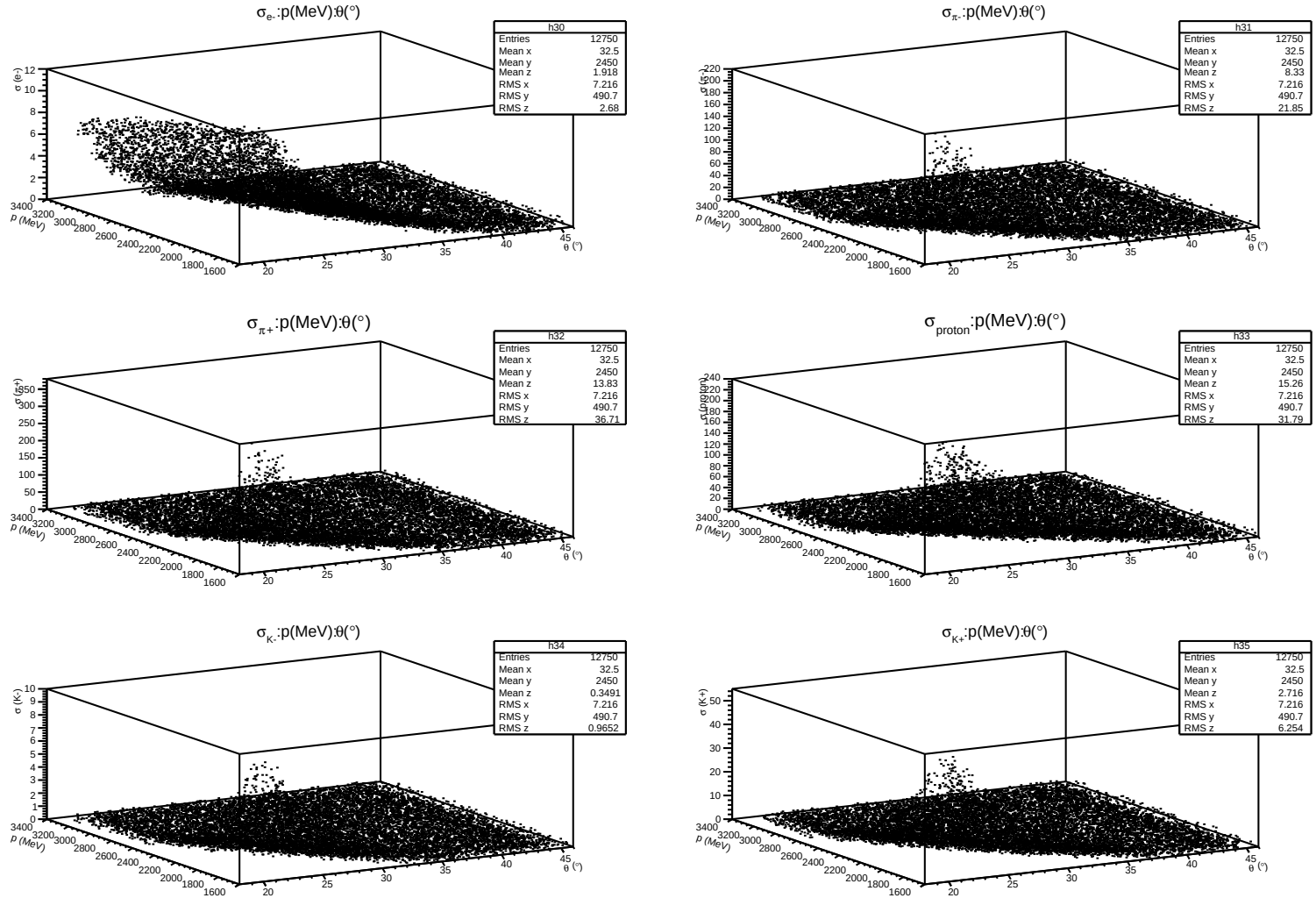
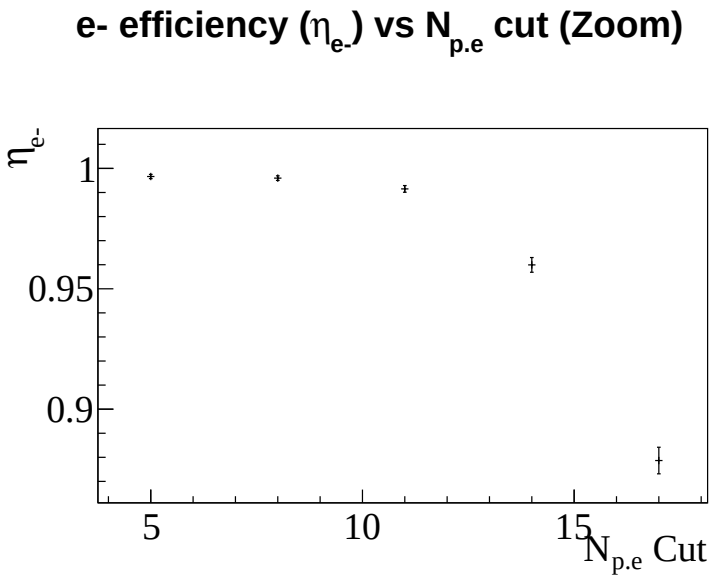
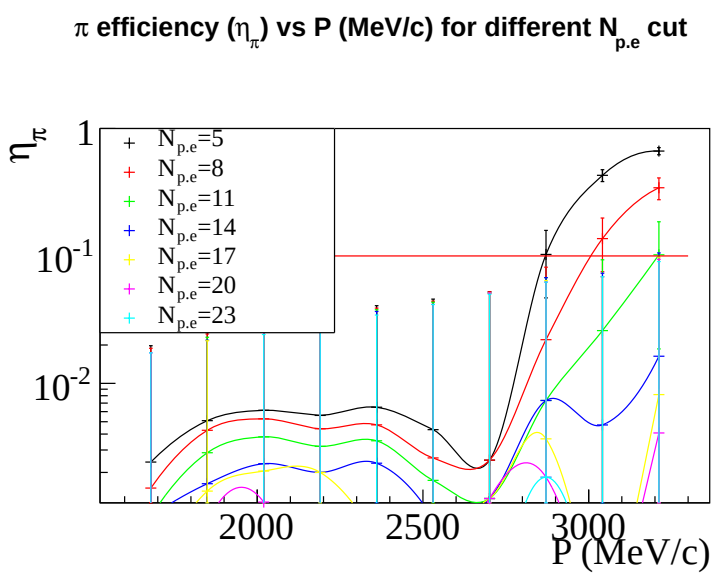


Figure: σ distribution for 6.6 GeV

η_e



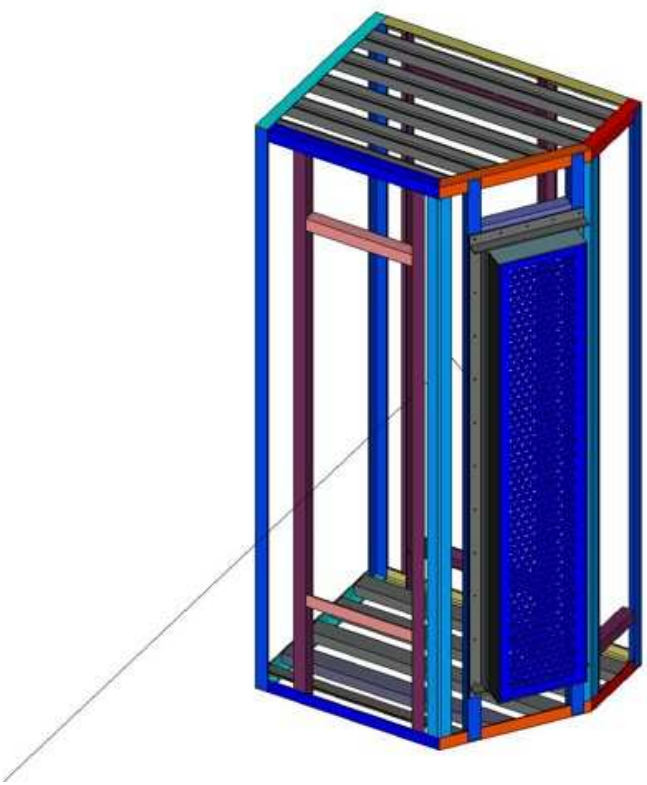
(a) η_e for different $N_{p.e}$ cut.



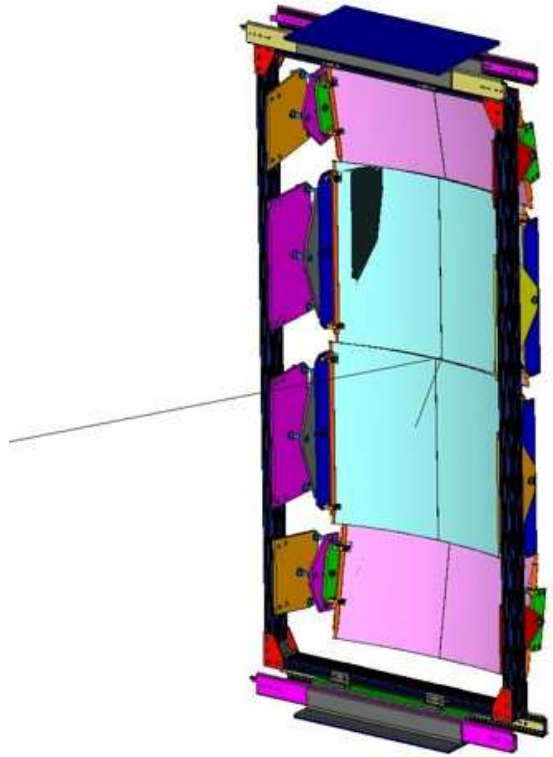
(b) η_π for P for different $N_{p.e}$ cut.

Figure: Efficiency with new mirror center provide by JLab design group, real BigBite magnetic field and σ weighted event generator.

GRINCH CAD (Jlab Design Group: Susan Esp)



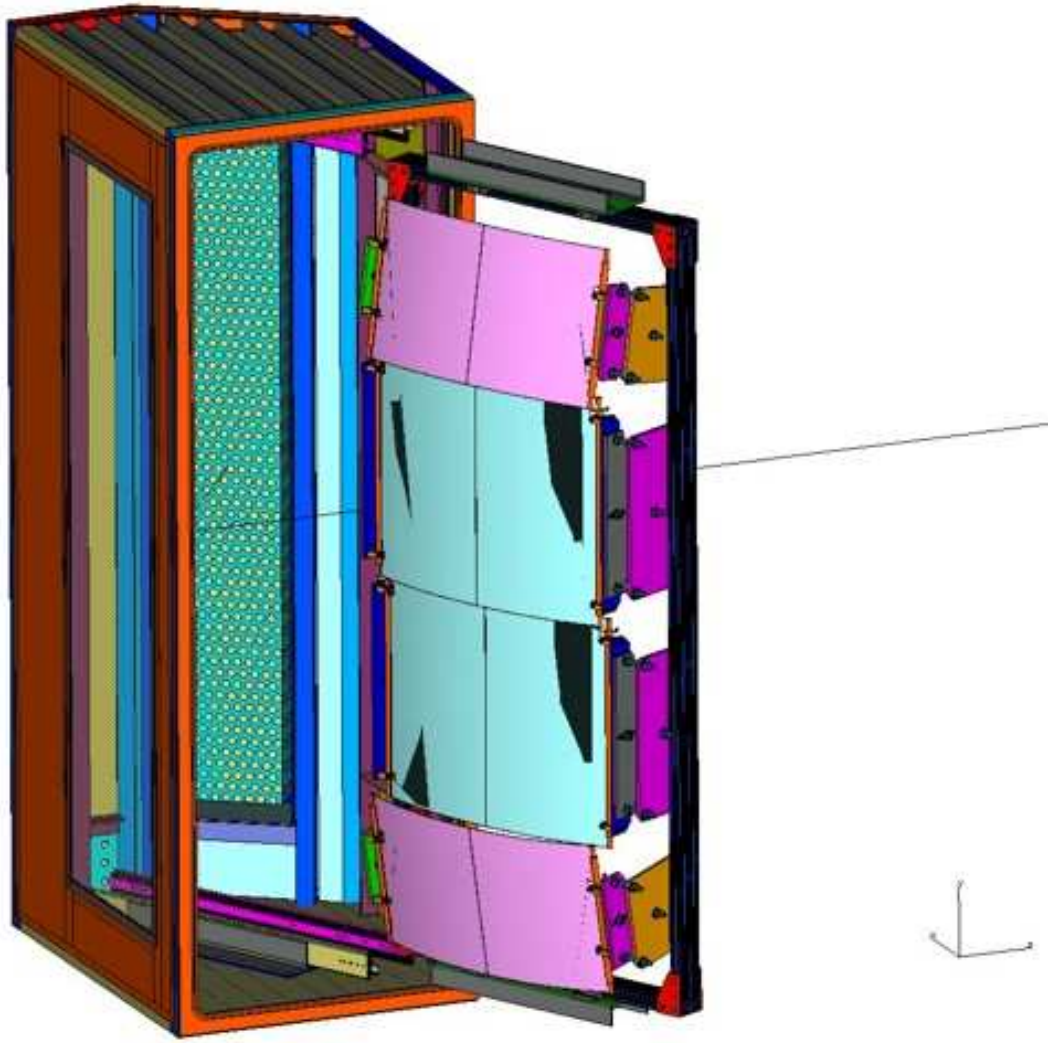
(a) GRINCH weldment with magnetic shield.



(b) GRINCH mirror with rails.

Figure: GRINCH CAD Drawing.

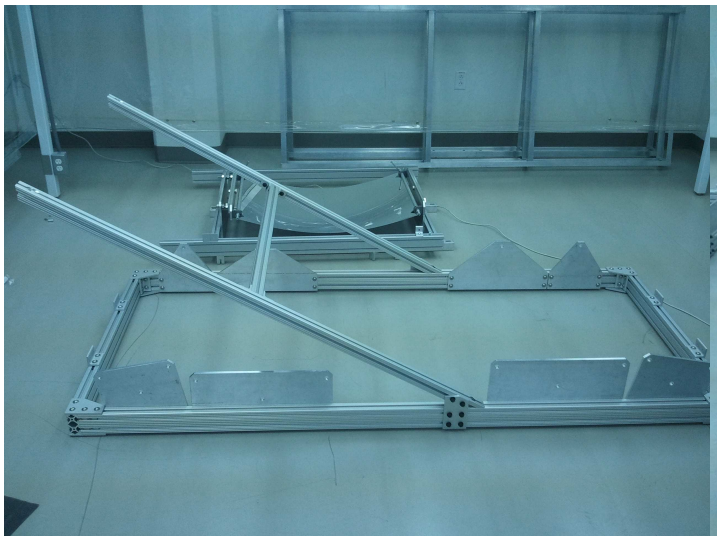
GRINCH CAD (cont..)



(a) GRINCH with mirror out 40 inches.

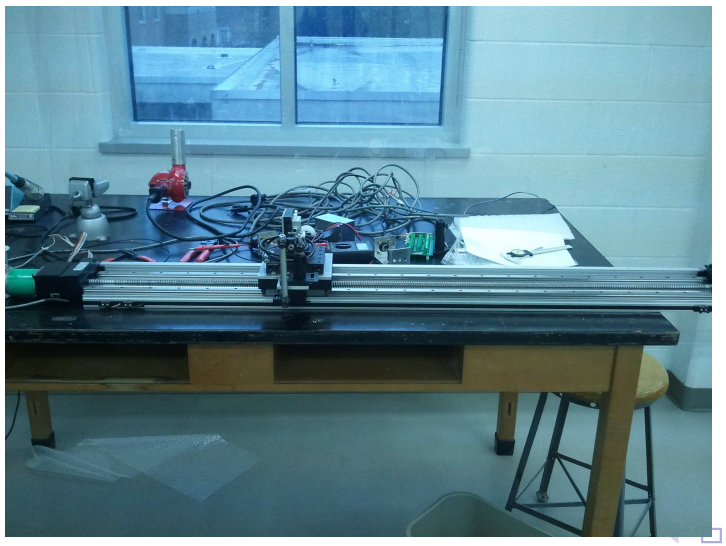
Figure: GRINCH CAD Drawing.

Mirror System Parts



(a) Mirror Mount System and Mirror

(b) Alignment Mount System



(c) Translation Stage and Laser

Mirror Test Preliminary Result

Result of first test (Scott)

The light is on the PMTs for all of the mirror length.

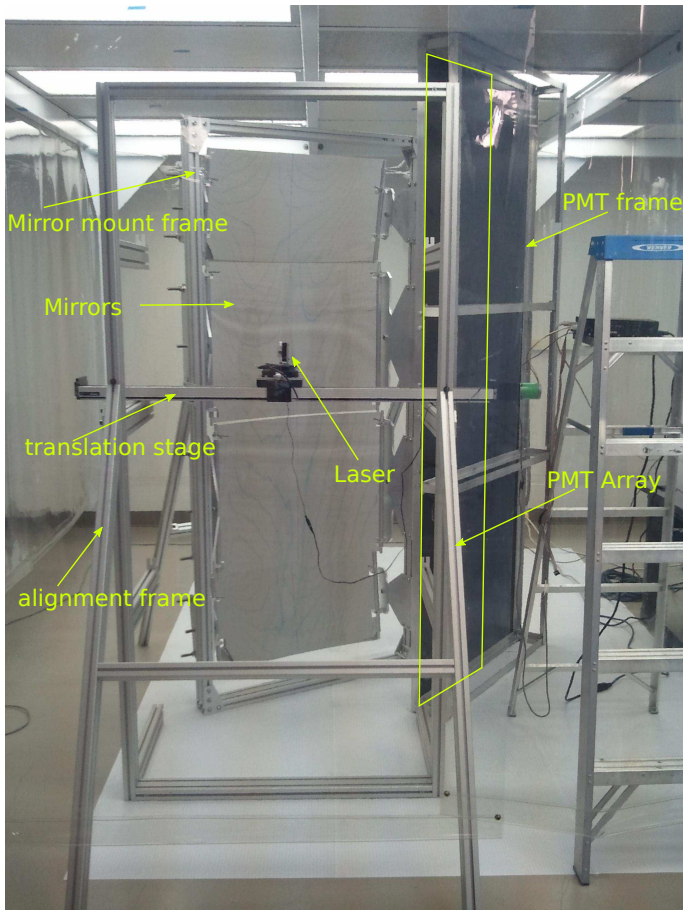


Figure: Mirror test system. All are bolted on the ground. The center of the system is at the center of the laser.

Photon Detector Array Prototyping and Test

NC A&T University

Built and tested prototype photon detector array.

- 4 rows of 9(8) PMTs
- prototype box
- 1 mm steel bars, made of steel-1005, 5cm height, 33.7cm long.
- μ-metal shielding shelf, 5cm height.
- Light catchers (reflectors), size is 2.97x3.1cm, outer diameter is 4.29cm, and titled angle is 19°.

Photon Detector Array Parts

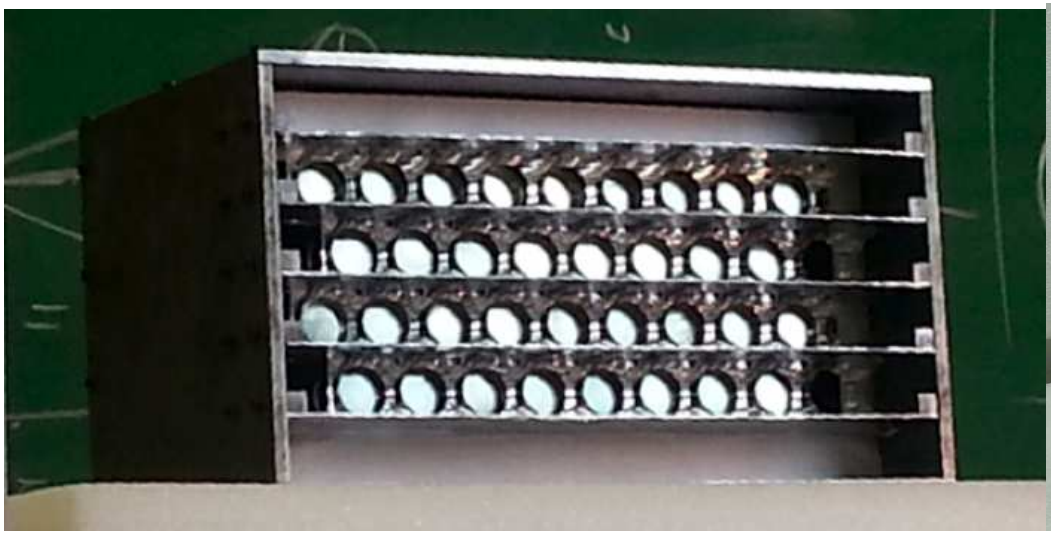
(a) A raw of 9 Light catchers

(b) μ-metal shelf

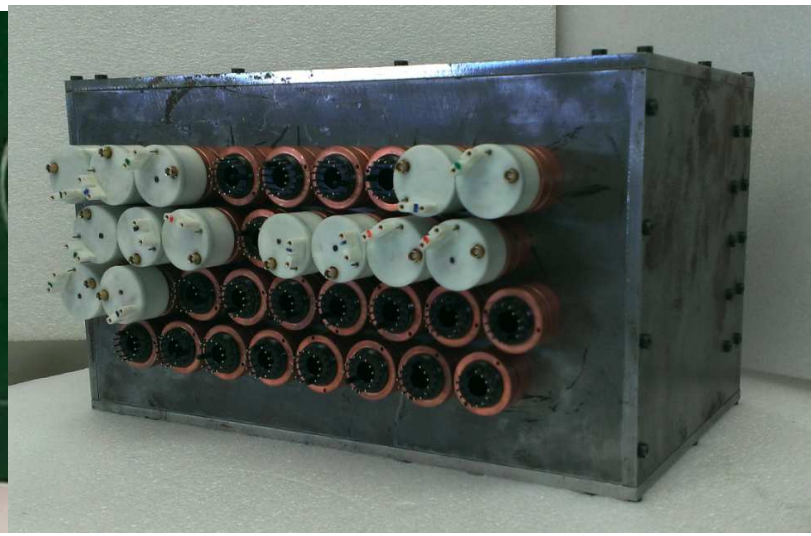
(c) prototype box with steel bars and μ-metal shelf

Figure: Photon detector array prototyping

Photon Detector Array

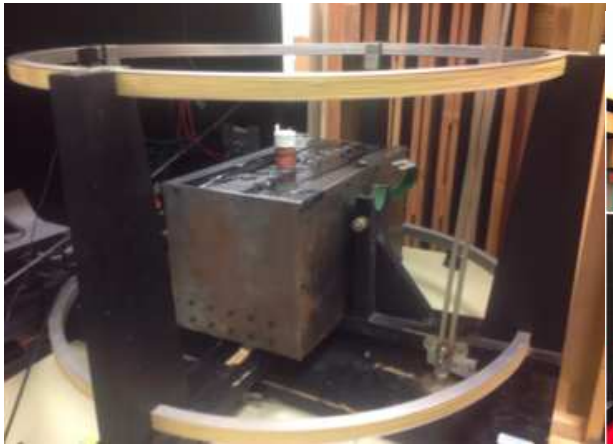


(a) Front view

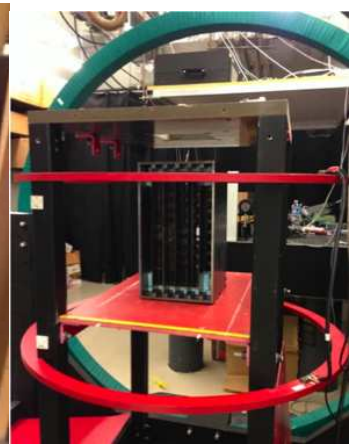


(b) Back view

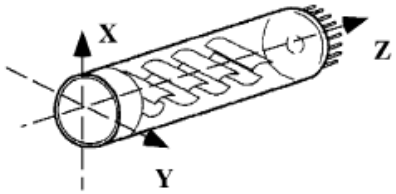
PDA Magnetic Test



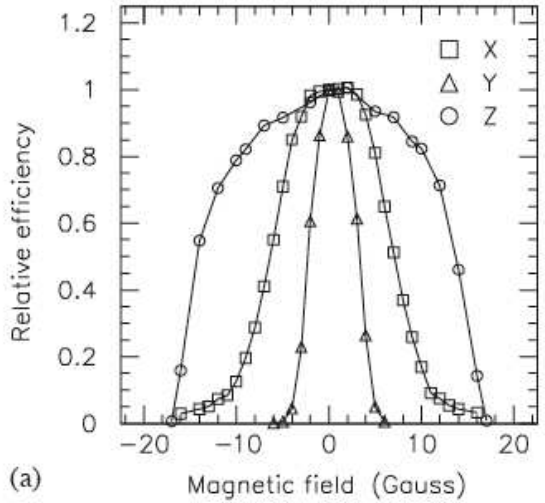
(c) Test with 15G field.



(d) Test with 30G field.



(e) Coordinate in



(f) PMT efficiency w.r.t

PDA Magnetic Test Result

Requirement

The relative efficiency of the PMT remains above 90% if the field strength in Z direction is kept within $\pm$7 G. In X direction (perpendicular to dynodes) - within $\pm$4 G, in Y direction - $\pm$1.5 G.

Applied B(Gauss)			B(Gauss) at ph-cathode		
Bx	By	Bz	Bx	By	Bz
0	0	15	0	0	3.5
0	15	0	1.6	0	0
15	0	0	0	0	0

Table: Result from the test with 15G field.

Applied B(Gauss)			B(Gauss) at ph-cathode		
Bx	By	Bz	Bx	By	Bz
0	0	30.5	0.9	0.4	7
30.5	0	0	0	2	1.2

Table: Result from the test with 30G field.

To do list

- W&M
  - Calibrate the mirror's radii and test with nonzero angles of laser light in W&M.→ 02/2014.
  - Work with machine shop to finish gas panel.→ 03/2014.
- JLab
  - Finish engineering drawing. → 04/2014
- Glasgow
  - Refine NINO design.→ 02/2014.
  - Production.→ 04/2014.
- JMU
  - PMT test. → 04/2014.
- NC A&T
  - Start to bid for PDA.→ Now.
  - Test NINO cards with LabView based DAQ.→ 02/2014.
  - PDA fabrication.→ 03/2014
  - PDA Assembly.→ 04/2014
  - PDA Test.→ 06/2014
- Construction completed.→ 07/2014
- Full detector test.→ Fall 2014