



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

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H. Yao, William and Mary

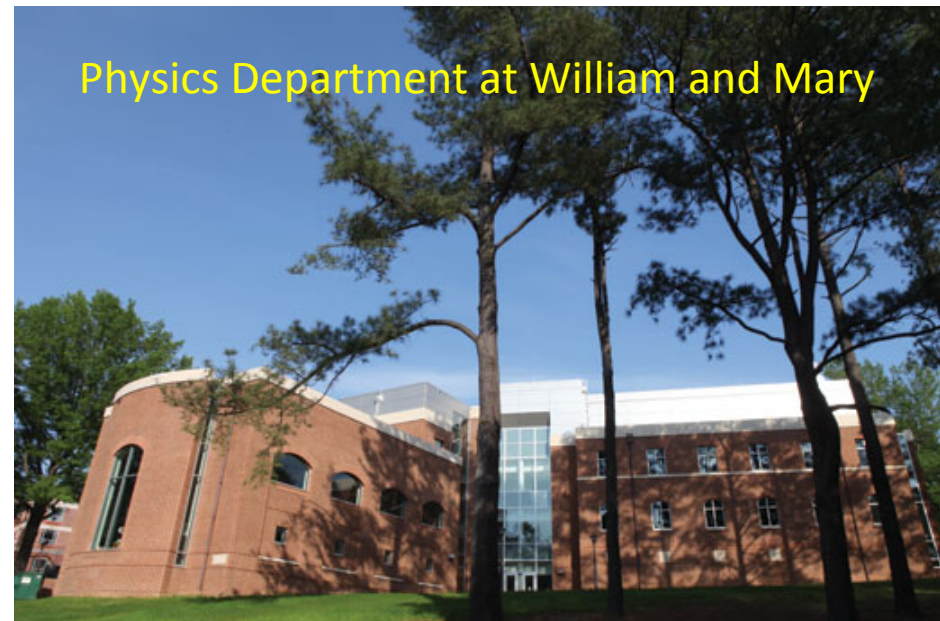
B. Wojtsekhowski, S. Esp, Jefferson Lab

A. Ahmidouch, S. Danagoulian, NC A&T

K. Aniol, Cal. State LA

J. Annand, Glasgow

Ioanna, Gabriel Niculescu, JMU



Wiki: [http://wm-jlab.physics.wm.edu/mediawiki/index.php/Bigbite\\_Gas\\_Cherenkov](http://wm-jlab.physics.wm.edu/mediawiki/index.php/Bigbite_Gas_Cherenkov)

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# Motivation: High Rate Running

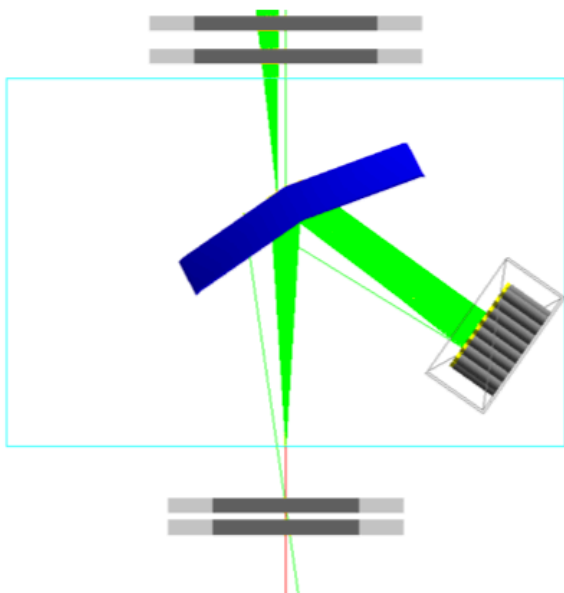
- Expect 4-5x increase in total luminosity over previous BigBite running.
- Assume 4-5x background rate.
- 30 degree scattering angle
- Segmented PMT array (29mm tubes), 9(8) x 60 tubes
- Search for timing clusters in 5-10 ns window.
- Magnetic shielding between rows.
- Locate PMT array on large angle side away from beam line.
- $C_4F_8O$  heavy gas at 1 atm



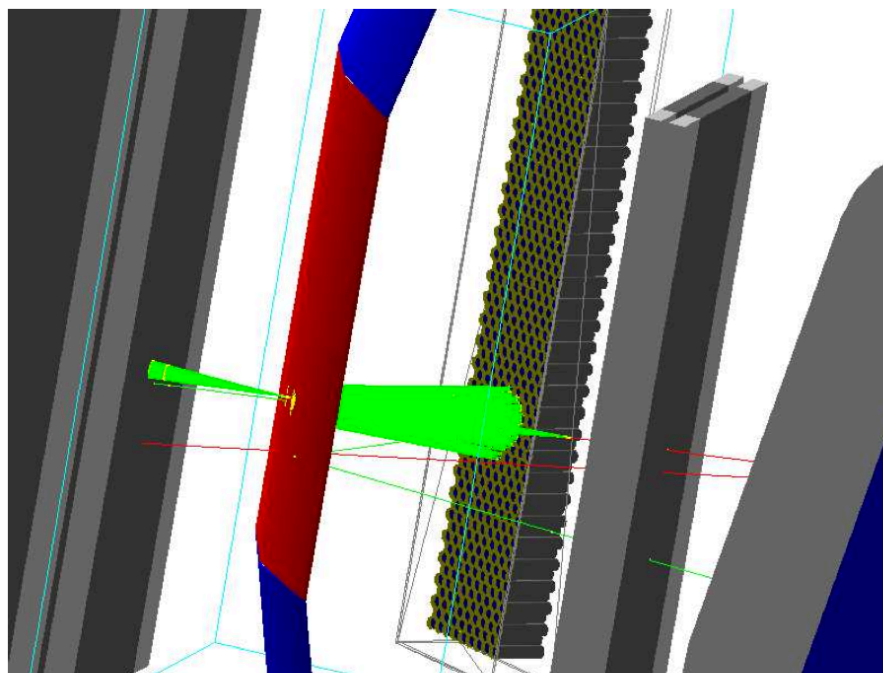
# Simulation Update



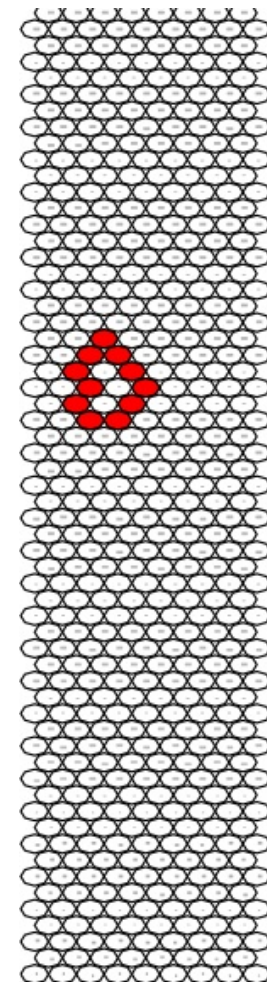
- GEANT4 simulation now includes cross-sections for electrons and pions in event generator. Background not included.
- Efficiencies studied across entire mirror geometry. No issues discovered. Single reflection from cylindrical mirrors. Not focusing on specific PMT's, not sensitive to precise mirror geometry/alignment
- Clusters with avg 10 PMT's/event (.geq. 1 ph.e.) and 1.7 p.e.'s/tube



(a) Top view of gas Cherenkov detector.



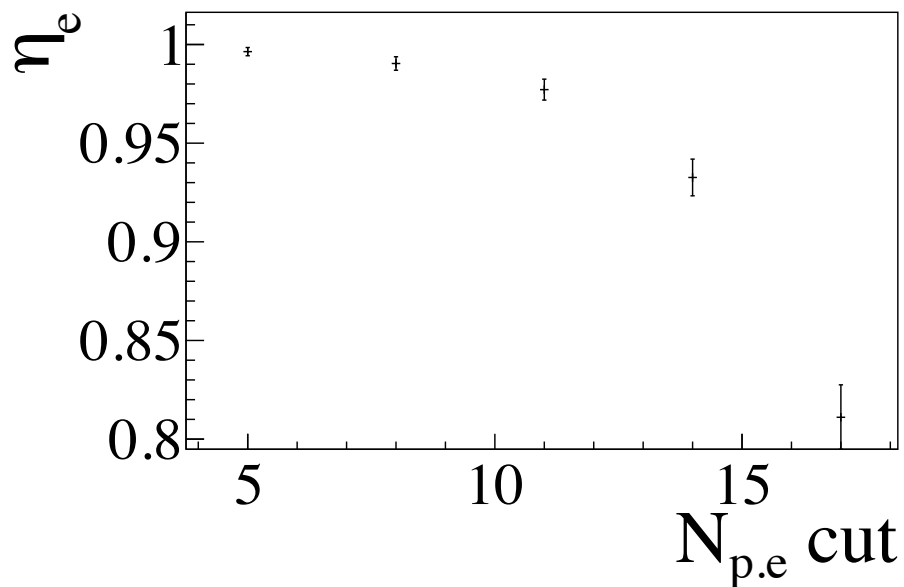
(b) Side view of gas Cherenkov detector.



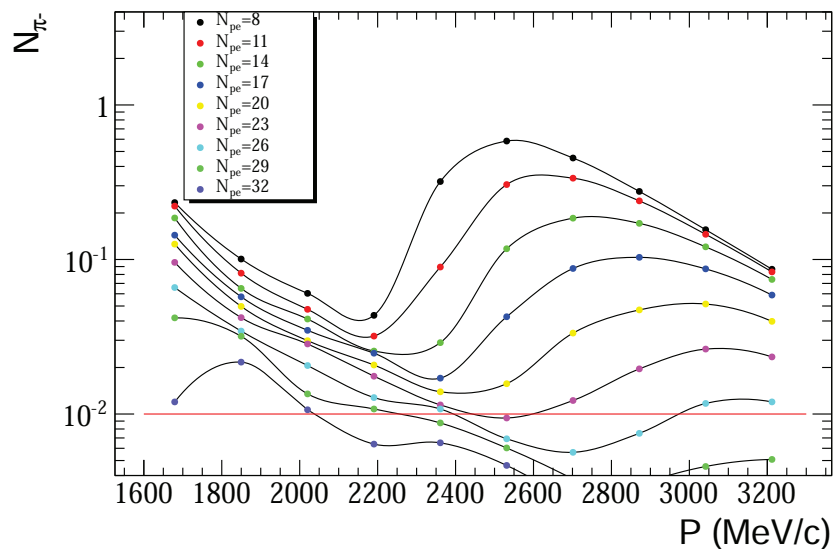


# Electron and $\pi$ efficiencies

e efficiency ( $\eta_e$ ) vs  $N_{p,e}$  cut (Zoom)



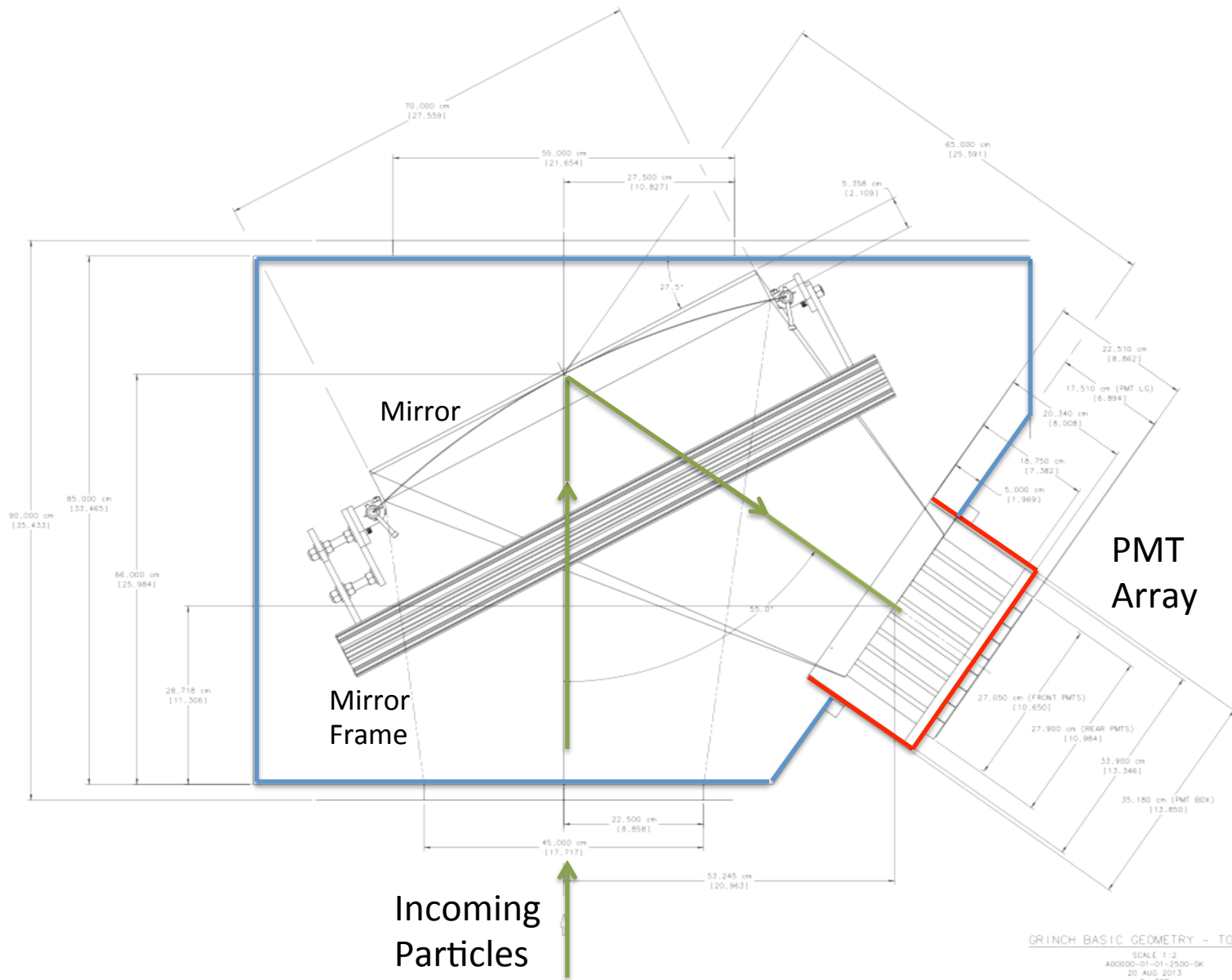
$N_{\pi}$  mis-identified vs P (MeV/c) for 6.6 GeV





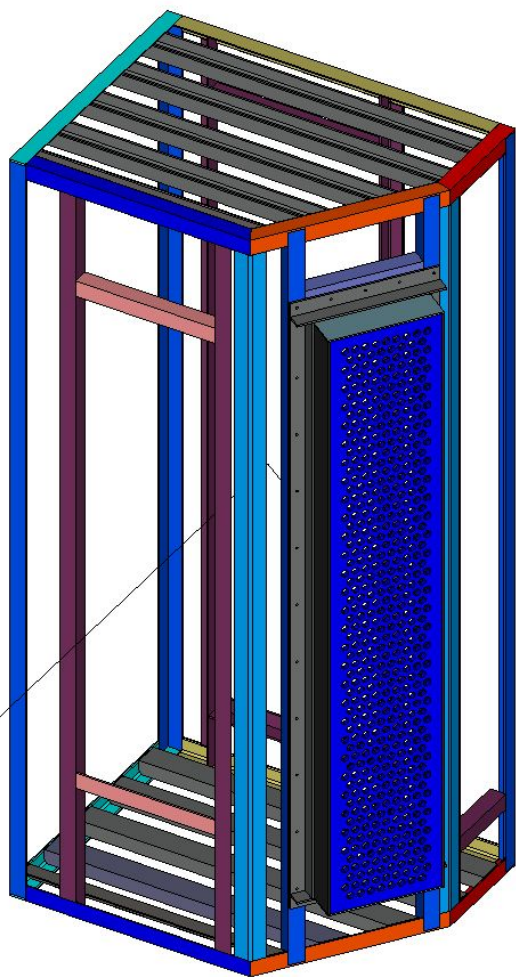
# Design Update

- Weekly meetings with Susan Esp. Full-time focus on GRINCH.
- Detector geometry now frozen.
- Detector vessel made from frame of angled aluminum with sheet aluminum sides. Preliminary design undergoing engineering review.
- Removable mirror frame, adjustable mirror mounting system. Design based on prototype studies at W&M. Shop drawings complete by end of this month. Fabrication to begin immediately at W&M.
- 9 (8) x 60 array of PMT's in iron box, with mu-metal and iron strips between rows. Attach to vessel after assembly, NC A&T

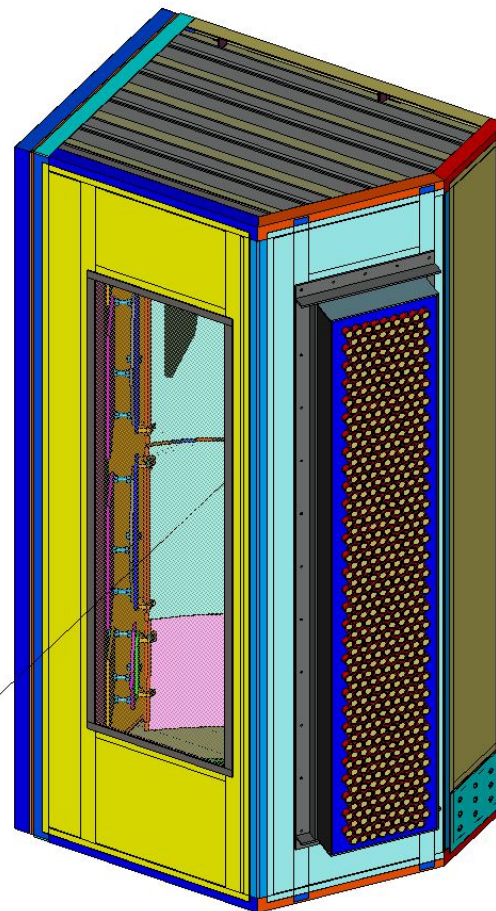




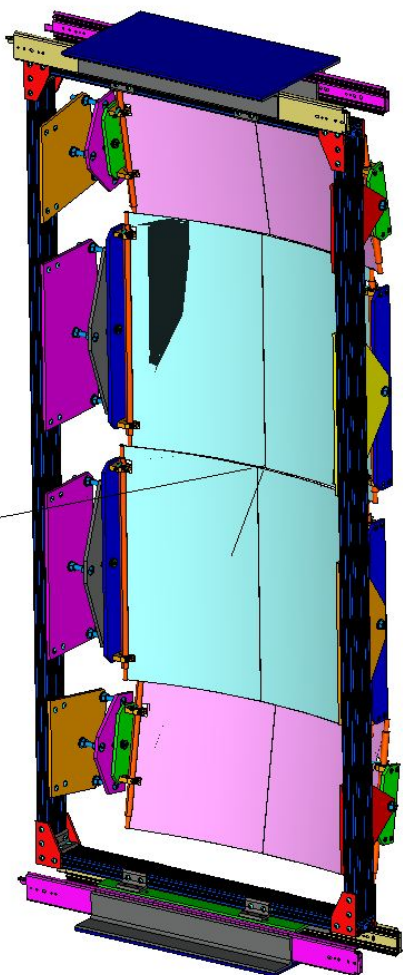
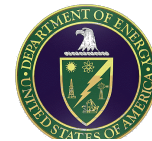
# Design



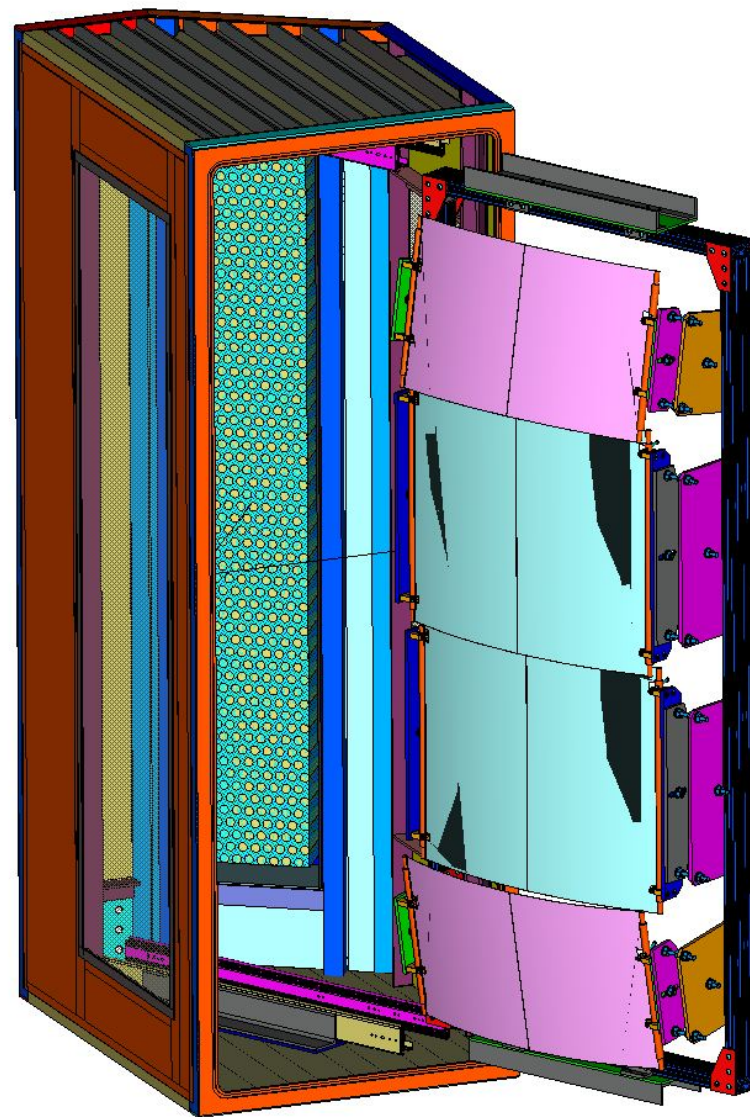
Vessel Weldment  
Front View



Complete Assembly  
Front View



Mirrors and Frame  
Front View



Mirrors Out of Vessel  
Rear View

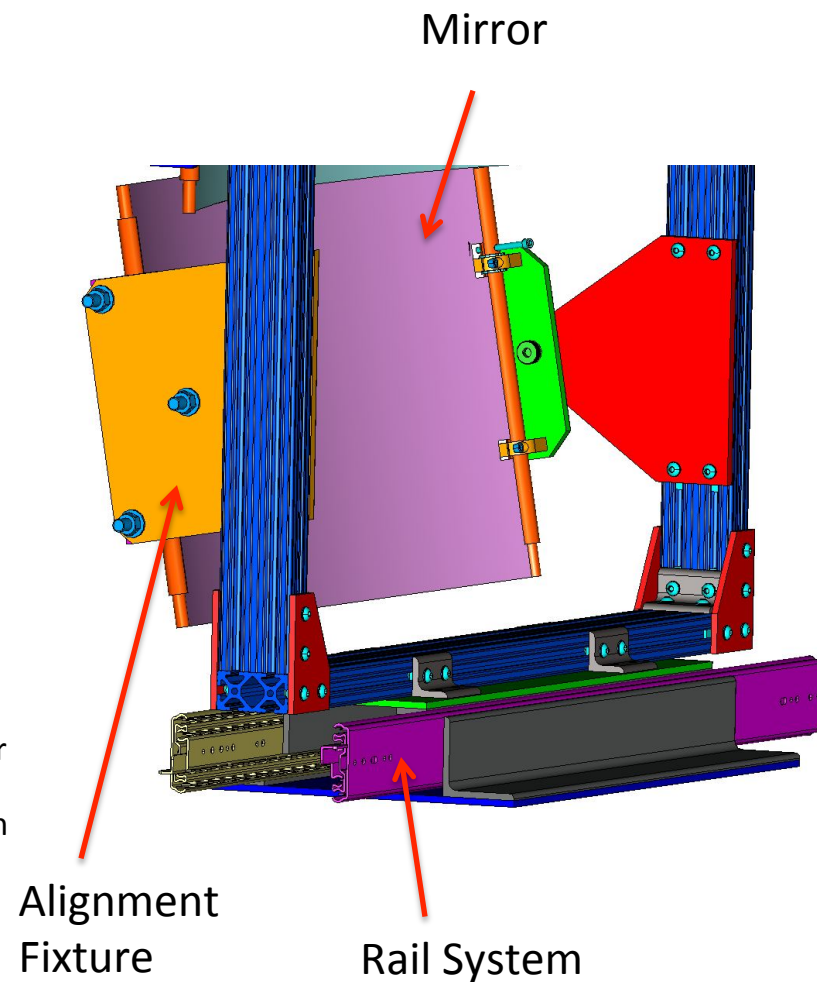




# Mirror Frame and Alignment

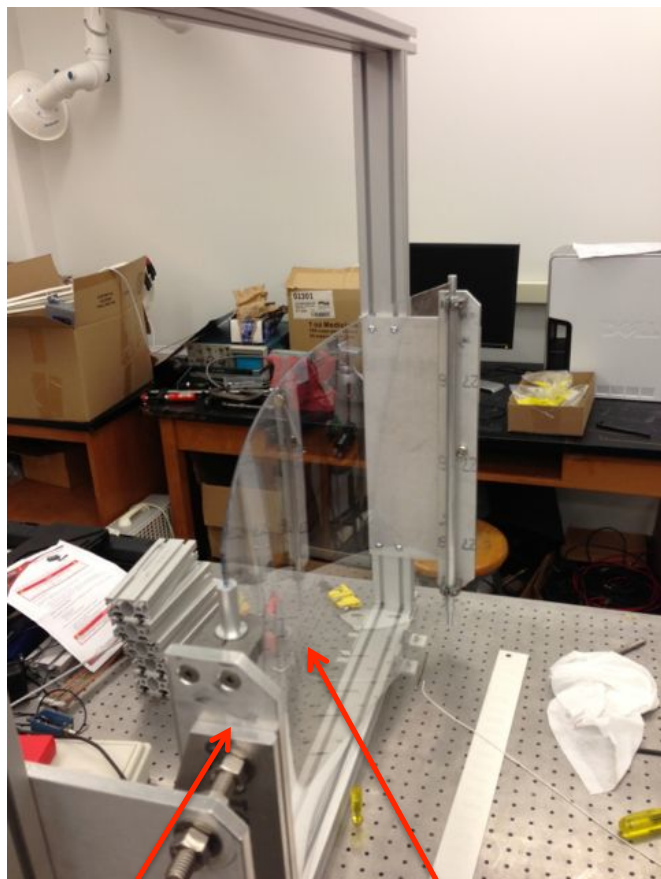


- **PROTOTYPE STUDIES—COMPLETED**
  - JLab design group and W&M machine shop produced a full size prototype of the mirror mounting system.
  - W&M successfully made pre-formed 1/8" Lexan mirror blanks.
  - Also tested forming mirror shape in-situ from flat Lexan.
  - Lexan abandoned due to difficulty forming to desired shape. Non-uniform radius of curvature.
  - Better design is 1/32" thick aluminum sheet, formed in-situ. Better control of geometry.
  - Added additional degree of freedom to facilitate alignment.
- **FULL ASSEMBLY**
  - Cost estimate to make full mirror frame and mounts at W&M is about \$5k. Estimate 1 month machine time.
  - Clean room revived at W&M for construction of full mirror assembly.
  - Cost estimate for 6 mirrors (2 spares) is around \$4k, W&M will purchase. Ready to order pending final mirror frame design.
- **ALIGNMENT SYSTEMS**
  - Concurrently developed alignment system based on linear translation rail and two-axis adjustable diode laser. Effective for tests in laboratory.
  - Developing removable LED-based system for alignment needs in assembled detector.





# W&M Prototype Mirror Assembly



Alignment  
Mechanism

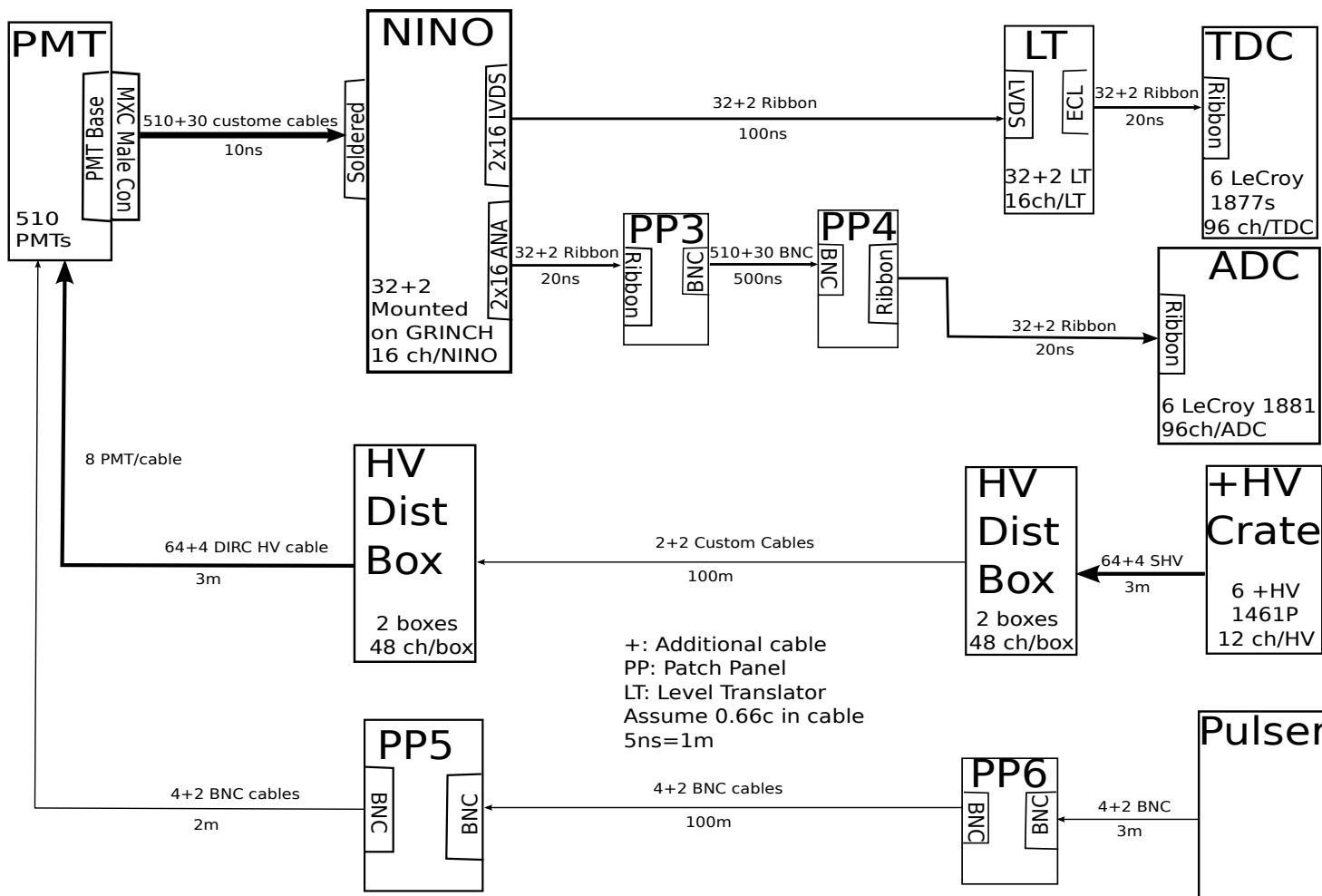
Lexan Mirror Blank





# GRINCH DAQ Scheme

## Gas Cherenkov Electronics





# Plans

- Finish production drawings for entire January 1<sup>st</sup>, 2014
  - Send drawings for quotes
  - Fabrication, Assembly Spring 2014 (need Jlab approval)
  - Testing, Summer 2014
- Other W&M projects
  - Gas system, purification, pressure regulation
  - In-situ Mirror Alignment system
  - Cables
  - Gain matching studies
  - HV distribution system