



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

**SBS Meeting  
March 27, 2013**

Todd Averett

Department of Physics

The College of William and Mary

Williamsburg, VA USA

**In collaboration with:**

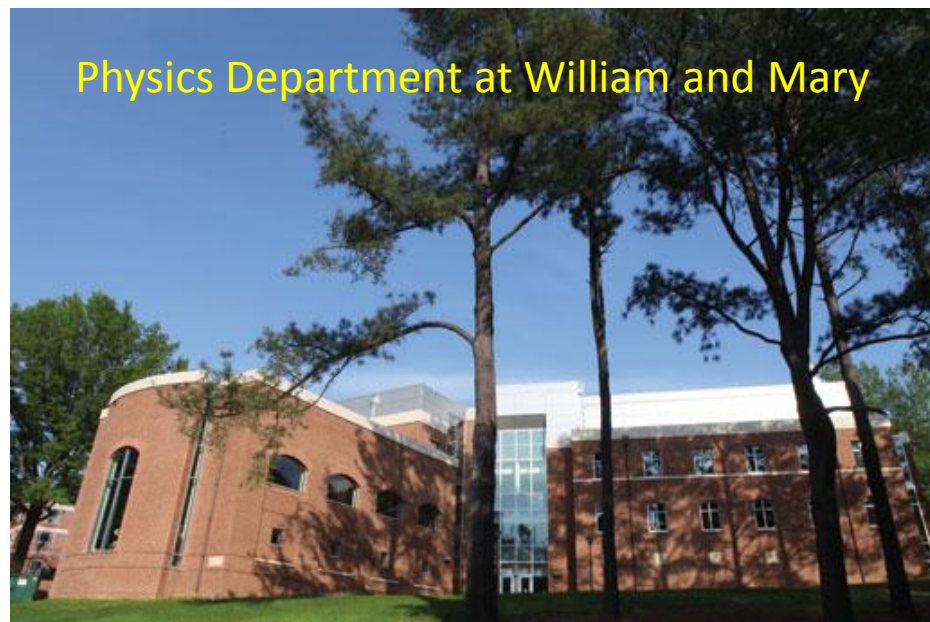
H. Yao, William and Mary

B. Wojtsekhowski, S. Esp, Jefferson Lab

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

K. Aniol, Cal. State LA

J. Annand, Glasgow



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)

Email: [hyao@wm.edu](mailto:hyao@wm.edu), [tdaver@wm.edu](mailto:tdaver@wm.edu)



# Motivation: High Rate Running

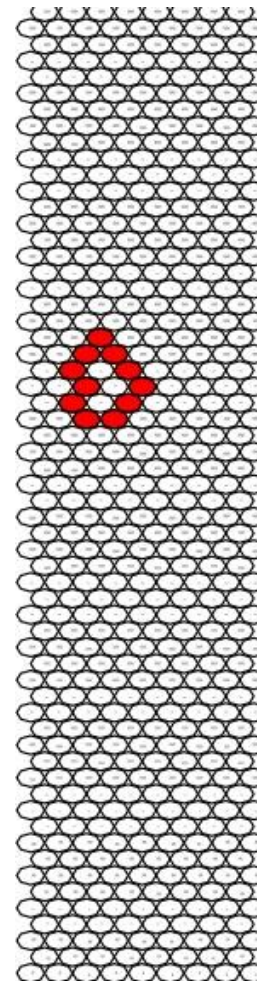
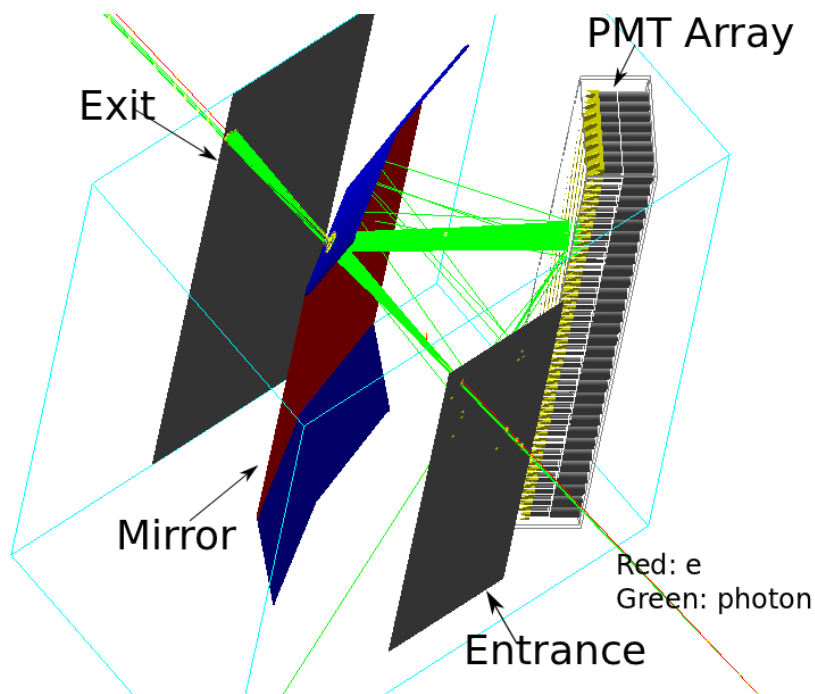
- Expect 4-5x increase in total luminosity over previous BigBite running.
- Assume 4-5x background rate.
- 30 degree scattering angle
- Segmented PMT array (29mm tubes), 9(8) x 60 tubes
- Search for timing clusters in 5-10 ns window.
- Magnetic shielding between rows.
- Locate PMT array on large angle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



# Simulation and Design

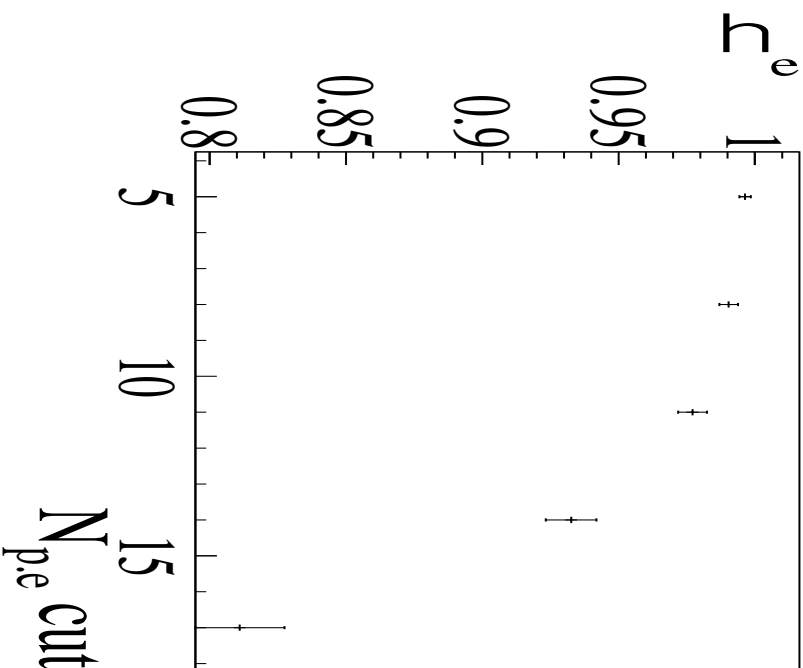
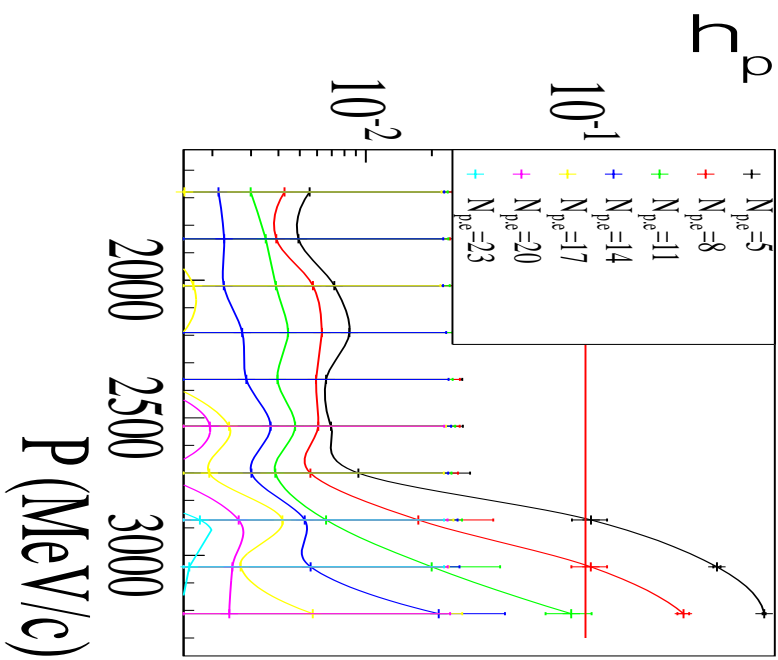


- Design based on GEANT 4 simulation and geometric constraints from BigBite detector package
- 65 cm path length, 85 cm keep out
- Single reflection from cylindrical mirrors. Not focusing on specific PMT's, not sensitive to precise mirror geometry/alignment
- Clusters with avg 10 PMT's/event and 1.7 p.e.'s/tube





# Electron and $\pi$ efficiencies

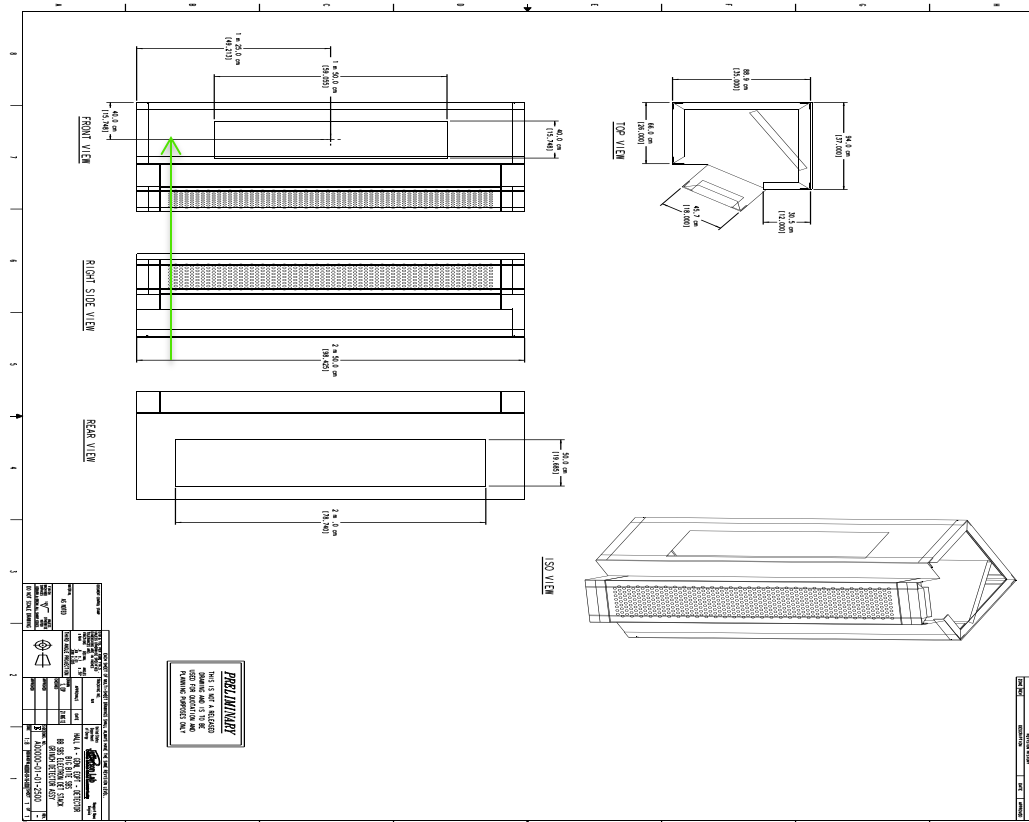
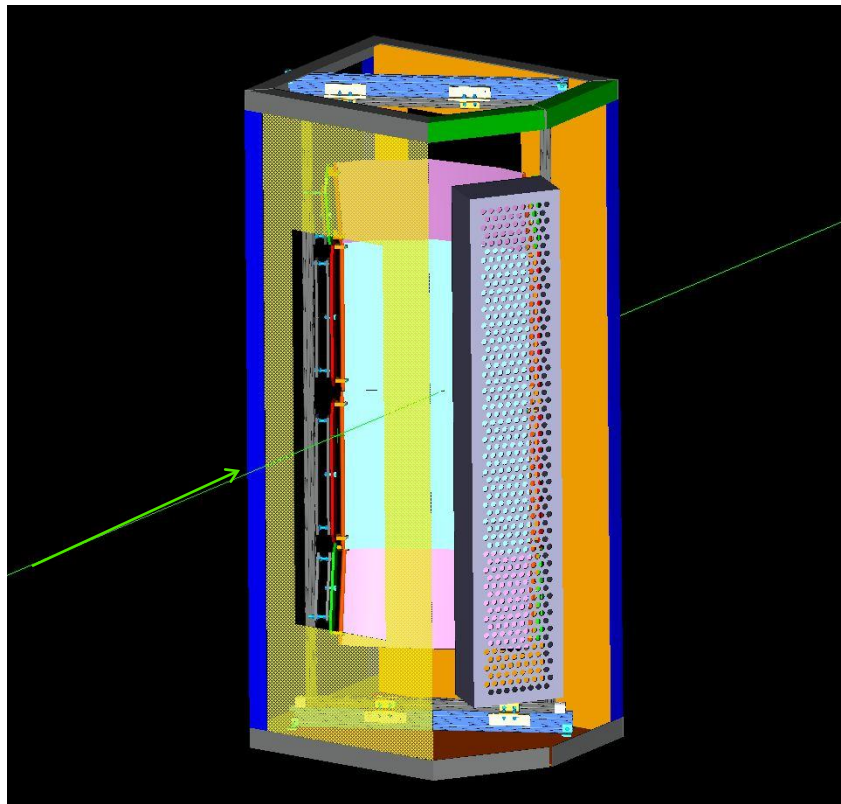




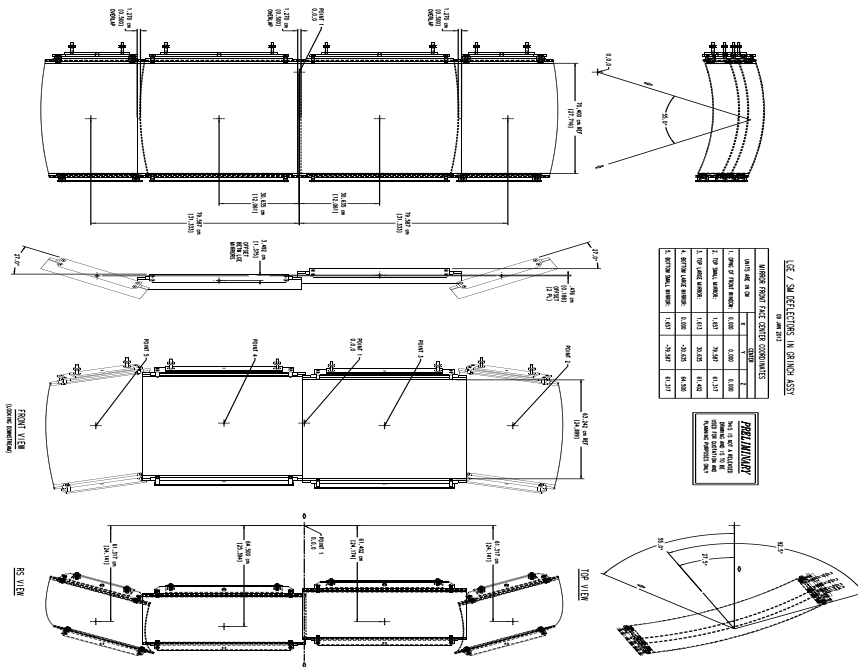
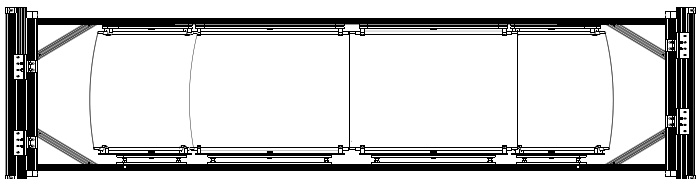
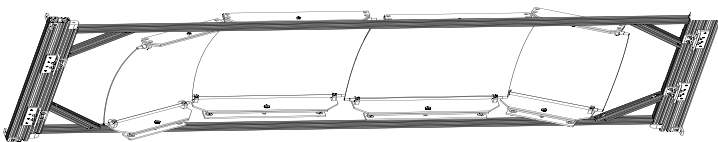
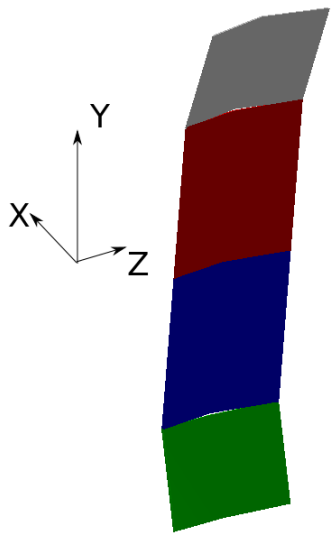
# Design Update

- First draft of design complete.
- Approval granted (Thia) to complete full production drawings to solicit bids
- Detector vessel made from frame of angled aluminum with sheet aluminum sides JLab
- 9 (8) x 60 array of PMT's in iron box, with mu metal and iron strips/bars between rows. Attach to vessel, removable. NC A&T
- Removable mirror frame, adjustable mirror mounting system. W&M

# Design



# Mirror Frame





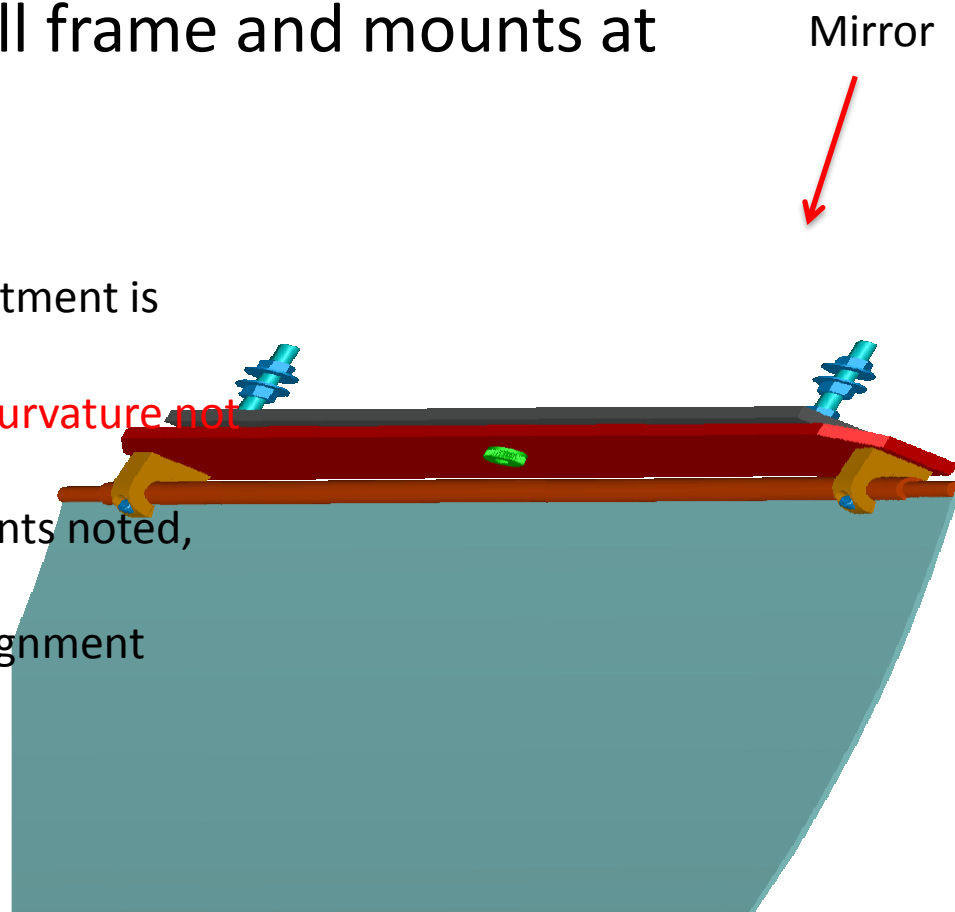
# Mirror alignment tests



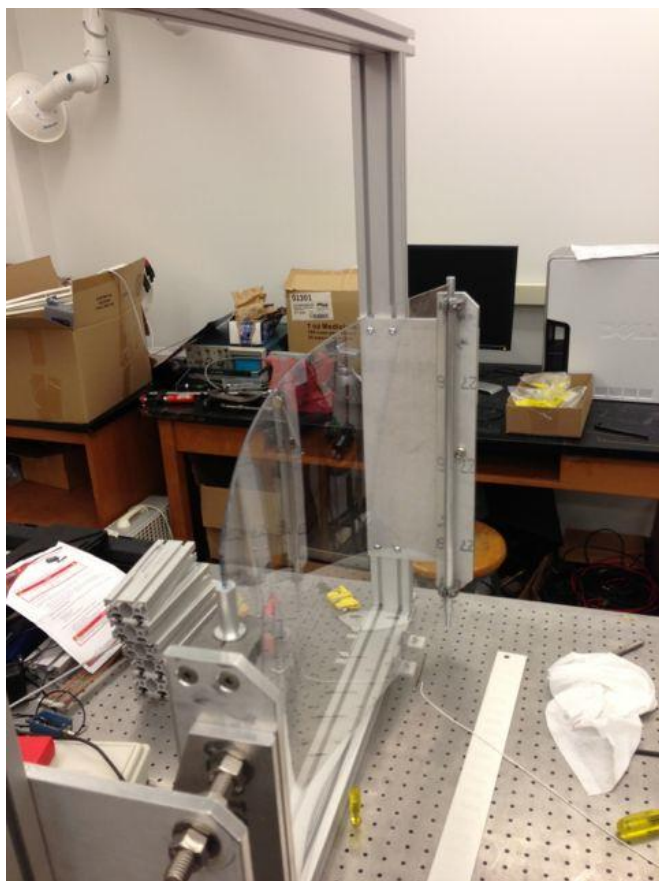
- Alignment of mirrors accomplished through multi-axis mount. Used for flat or curved mirror.
- Full scale prototype built and tested at W&M
- Cost estimate to make full frame and mounts at W&M is \$3-5k.

## Results:

- Functionality of mount and adjustment is good.
- Lexan sheet is still very flexible; curvature not uniform (1/8" thickness).
- Several minor design improvements noted, mostly with vertical rod
- Concurrently developing laser alignment system.





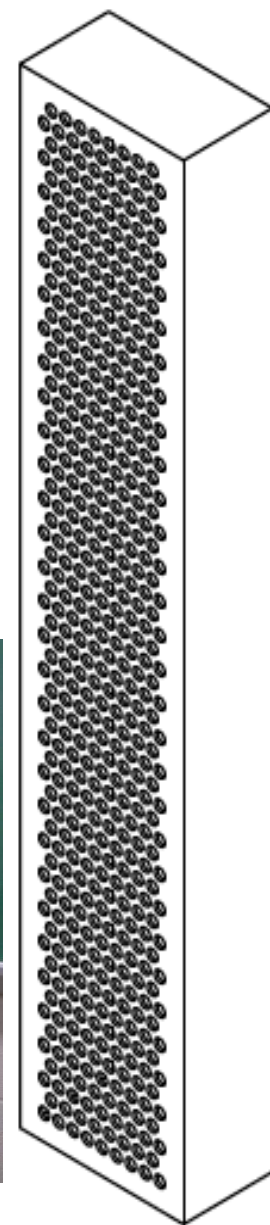
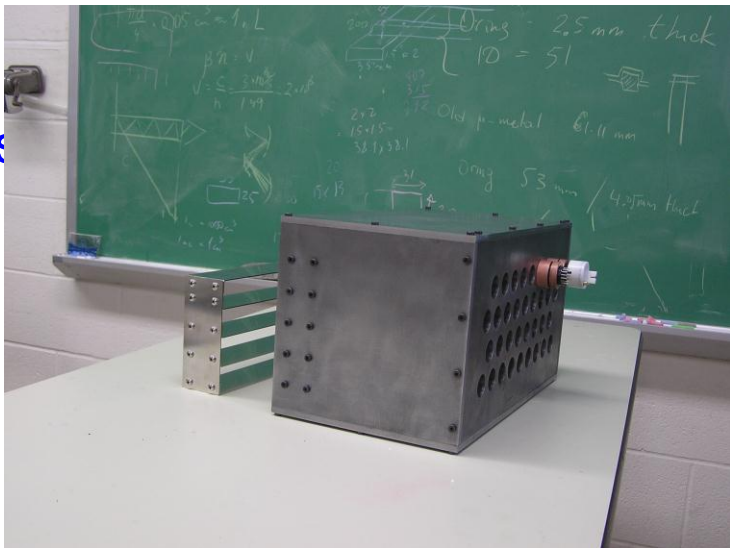




# Photon Detector Array

NC A&T

- ❑ Array of 9x60 29-mm PMTs
- ❑ Housed in an iron magnetic shielding box
- ❑ Each row is shielded at the front  
by two adj. 1-mm thick plates  
( $\mu$ -metal and iron)
- ❑ Mirrorized plastic cones for  
light  
collection

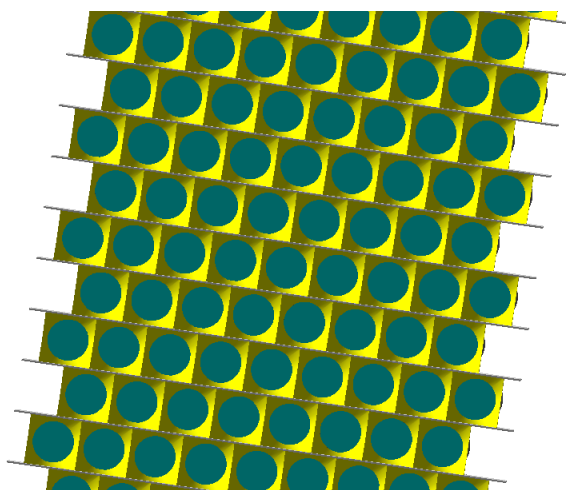
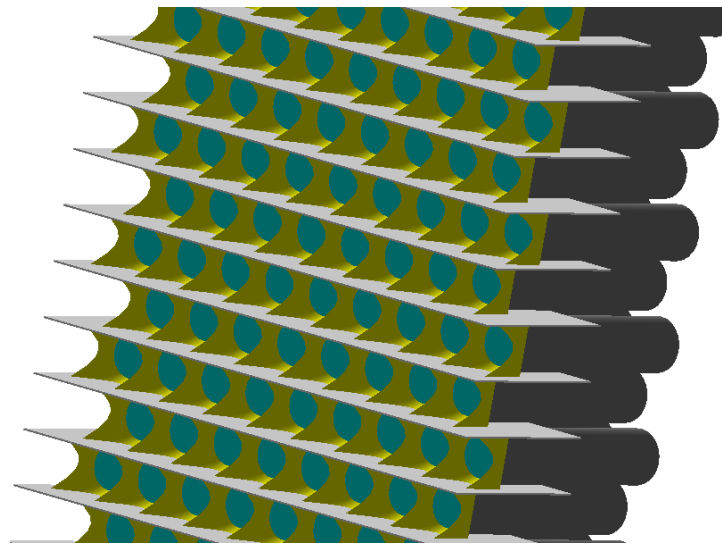
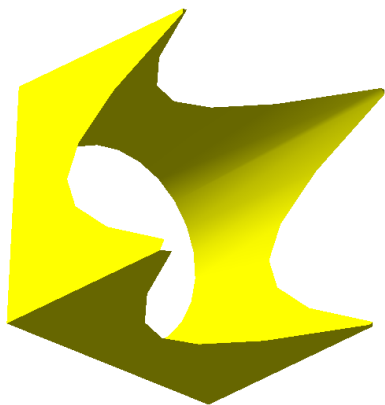


Prototype: row of 9 PMTs + reflectors + Mag. Shi  
→ in progress, testing → June 2013



# Light Cones

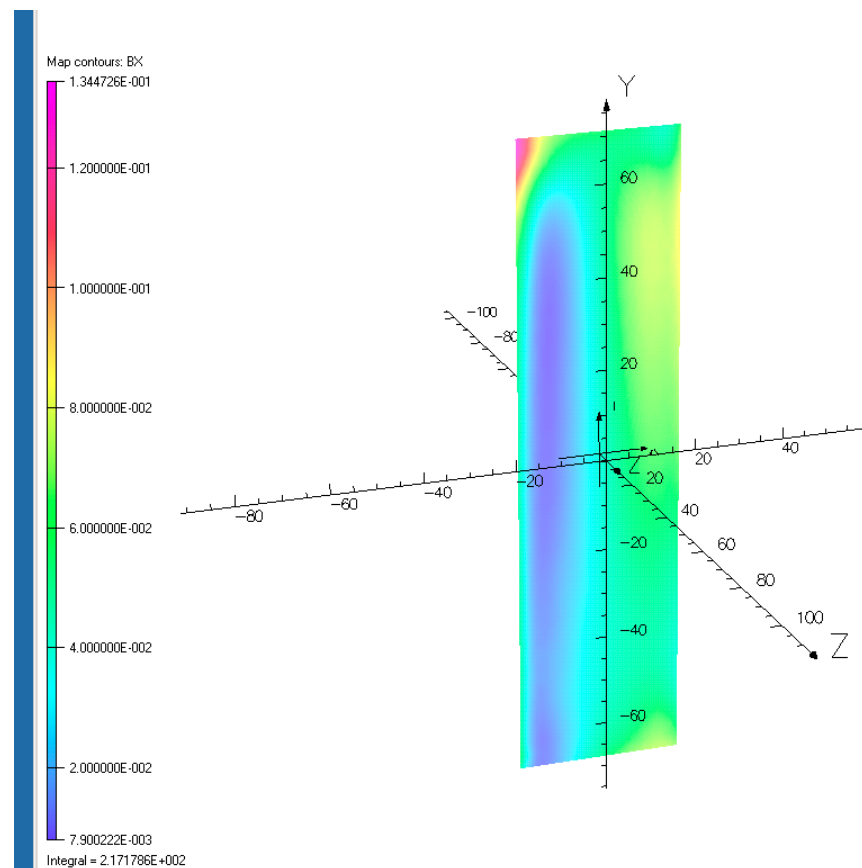
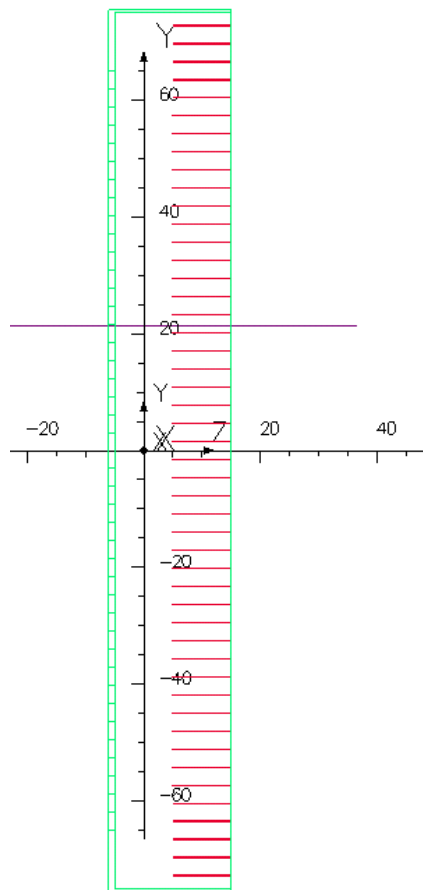
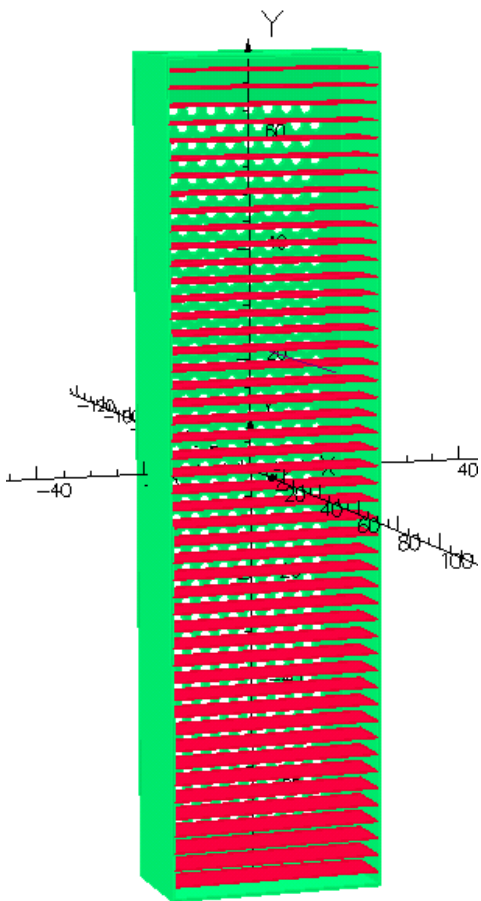
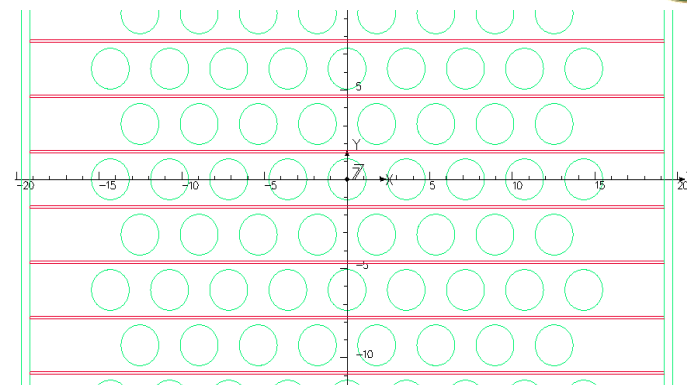
- Aluminized plastic cones





# Magnetic Shielding

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

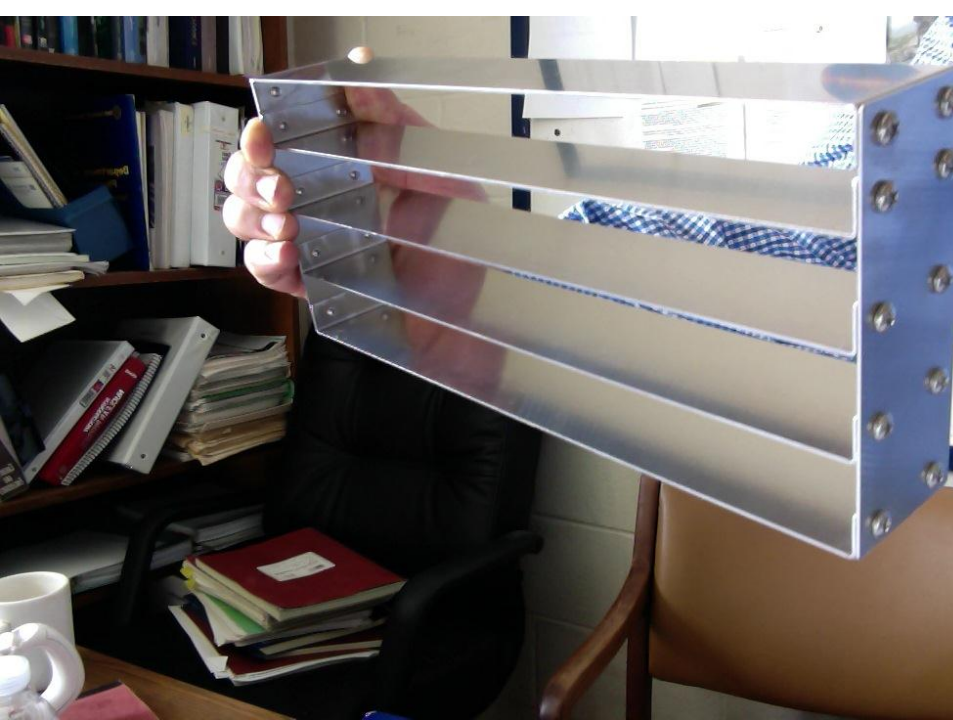




## Prototype (cont.)



1. Light reflector
2.  $\mu$ -metal box
3. Prototype box with 1 mm bars





## Prototype status (cont.)

PDA final design → September 2013

PDA Assembly → December 2013

Test of the PDA → January – March 2014 (?)

Parts ready:

a) magnetic shielding box and

b) 1 mm steel bars, made of steel-1008

c)  $\mu$ -metal shielding box

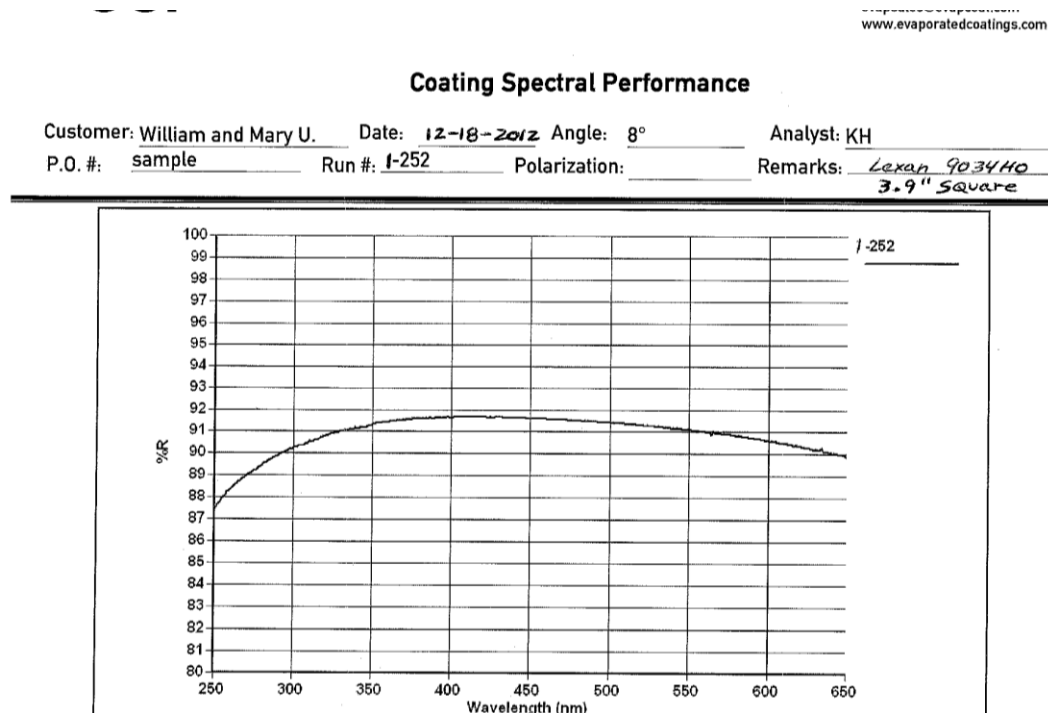
d) Light reflectors of correct size will arrive soon.

The reflectors and 1 mm steel bars will be sent for mirror deposition.



# Mirror Reflectivity Tests

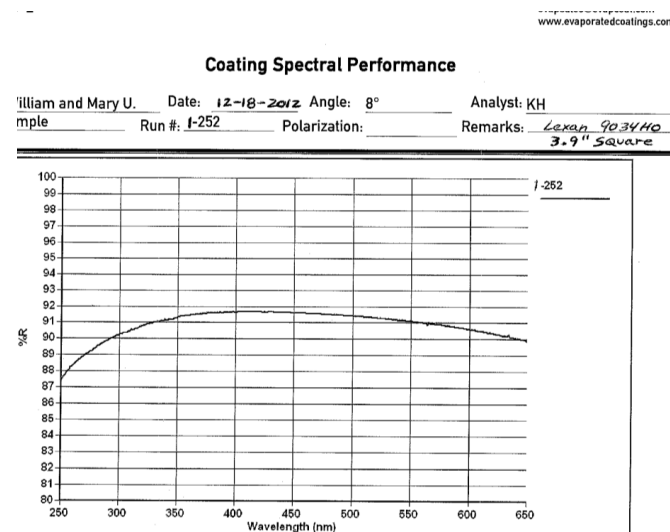
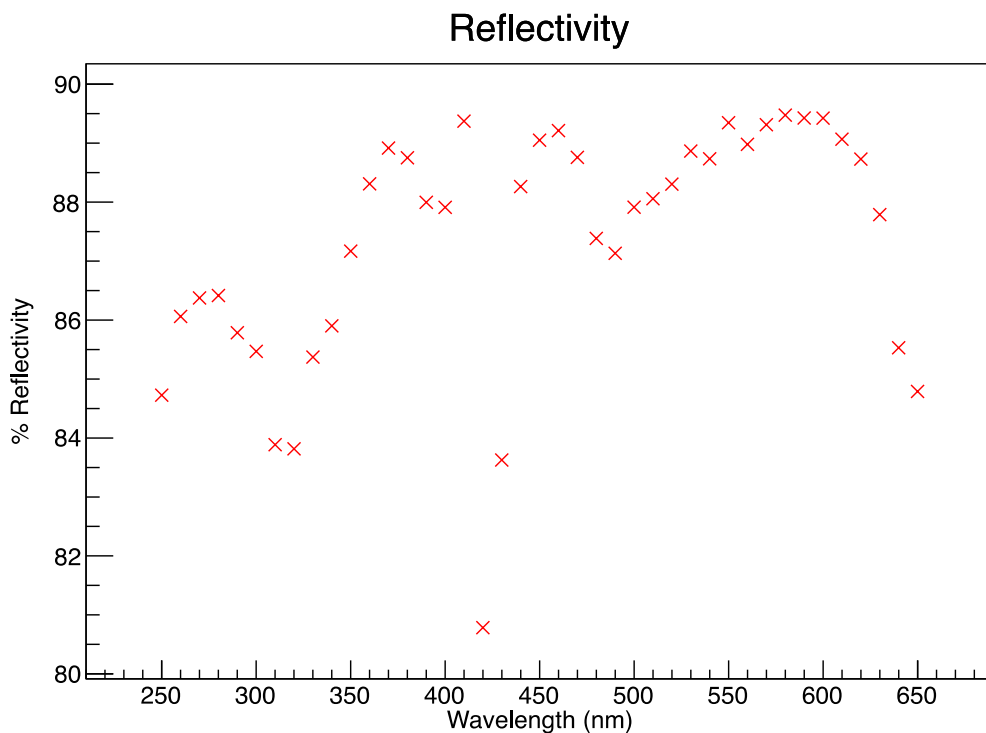
- Received sample of Al-coated Lexan, flat pieces, from ECI coatings.
- H. Yao measured reflectivity in test stand in FEL building.





# Reflectivity Results

- Results not clean because:
  - System designed for mirrors that focus all reflected light onto a photodiode.
  - Doesn't work geometrically for flat mirror. Realignment of PD required during scans.



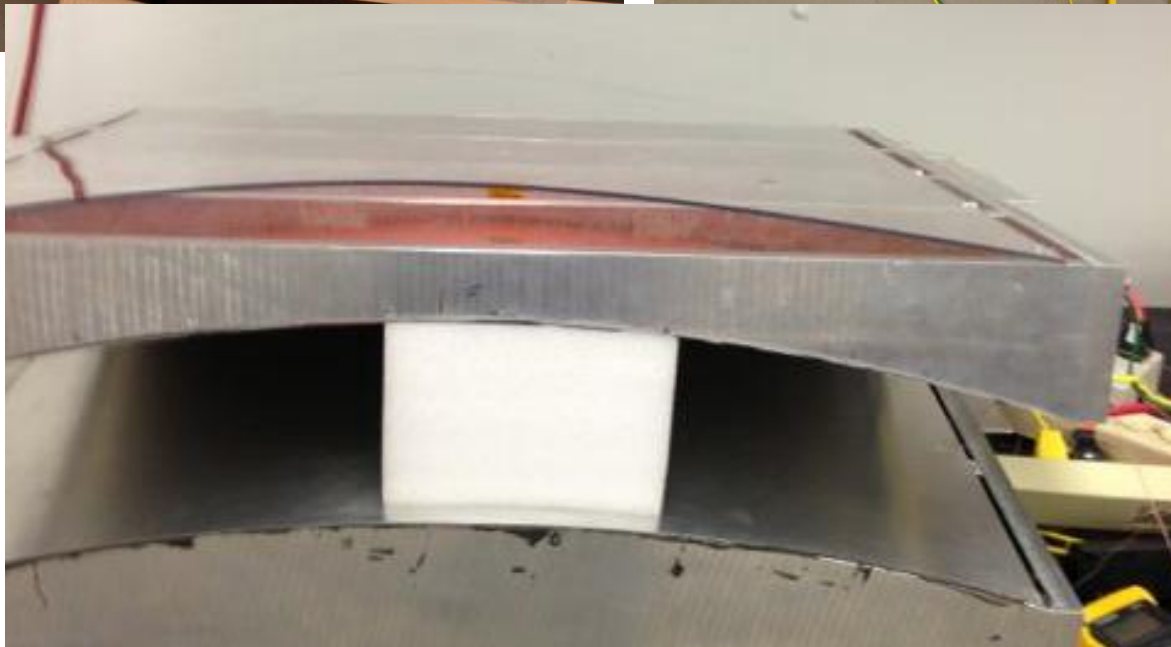




# Continued Mirror Tests



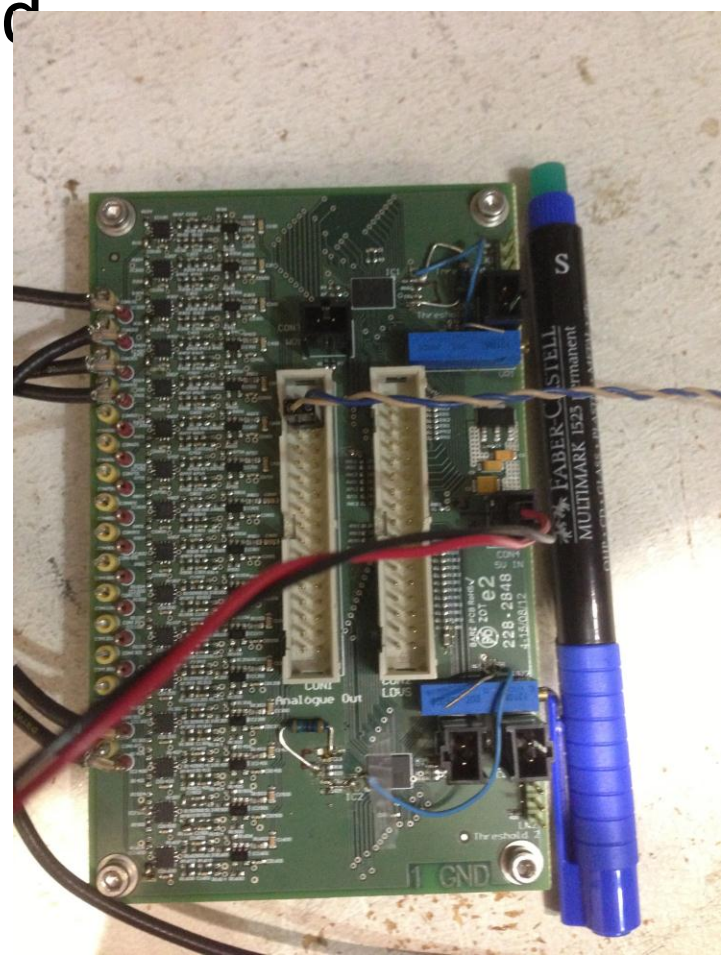
- Will measure relative loss of reflectivity at several fixed wavelengths for a flat mirror that is then curved (flexed) to the proper radius. (W&M laser lab)
- Successful formed Lexan using custom made heated moulds. Not optical quality.
- Constructing a 1' x 1' mirror with honeycomb and Lexan backing (similar to Hall A design).





# Front end Electronics

- J. Annand has produced phase II prototype of NINO front-end card.
- Successfully tested phase I card using signals similar to expected small-amplitude single PE signals from GRINCH.
- K. Aniol recently completed purchase for all NINO cards.





# Plans

- Finish production drawings for vessel, mirror mounting, May 31<sup>st</sup>, 2013
  - Send drawings for quotes
  - Fabrication, Summer 2013 (need Jlab approval)
  - Assembly, Fall 2013
  - Testing, late 2013
- Finalize mirror design studies by April 30<sup>th</sup>
  - Order mirrors in summer.
- Other summer projects
  - Gas system
  - Mirror alignment system
  - Cables
  - Gain matching studies using rates/timing??
  - HV distribution system