SHMS Aerogel Construction Details

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Hall C Winter Workshop

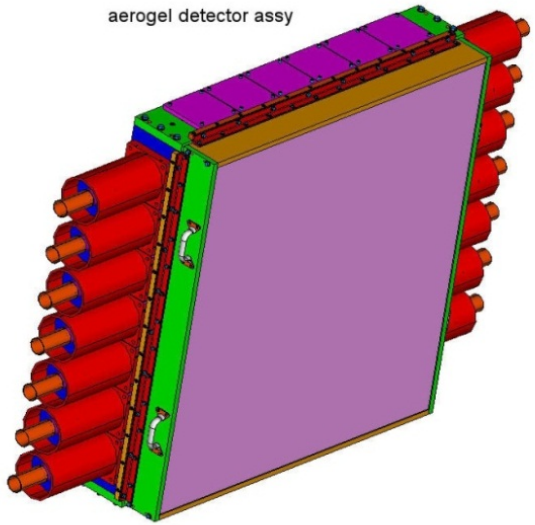
January 13, 2012

Outline

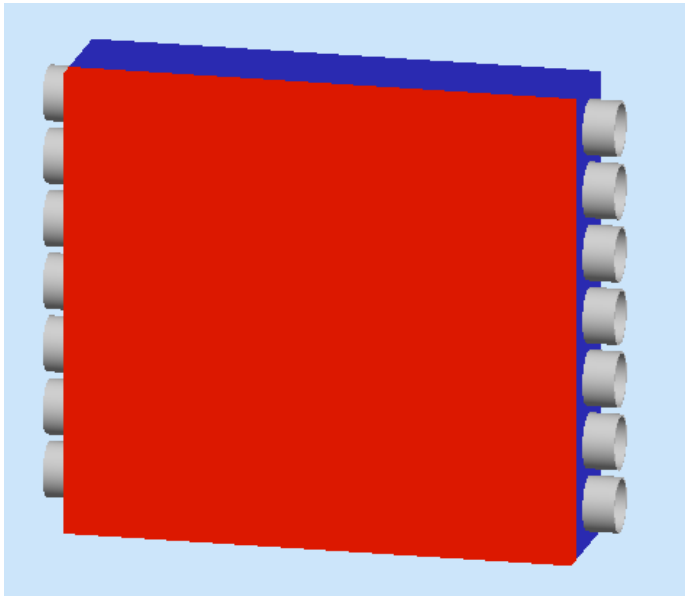
- Simulations
  - SimCherenkov
  - GEANT4/GEMC
- Simulation Verification—Prototypes
- Data Acquisition System
- PMT and Aerogel Studies
  - Uniform Sensitivity
  - Gain Testing
  - Aerogel Index Verification

GEANT4 Monte-Carlo
of the Kaon Aerogel Detector

- In fall 2011 started modeling detector in GEANT4
- GEMC is a framework based on GEANT4 libraries to simulate the passage of particles through matter



Design drawing
[Bert Metzger]

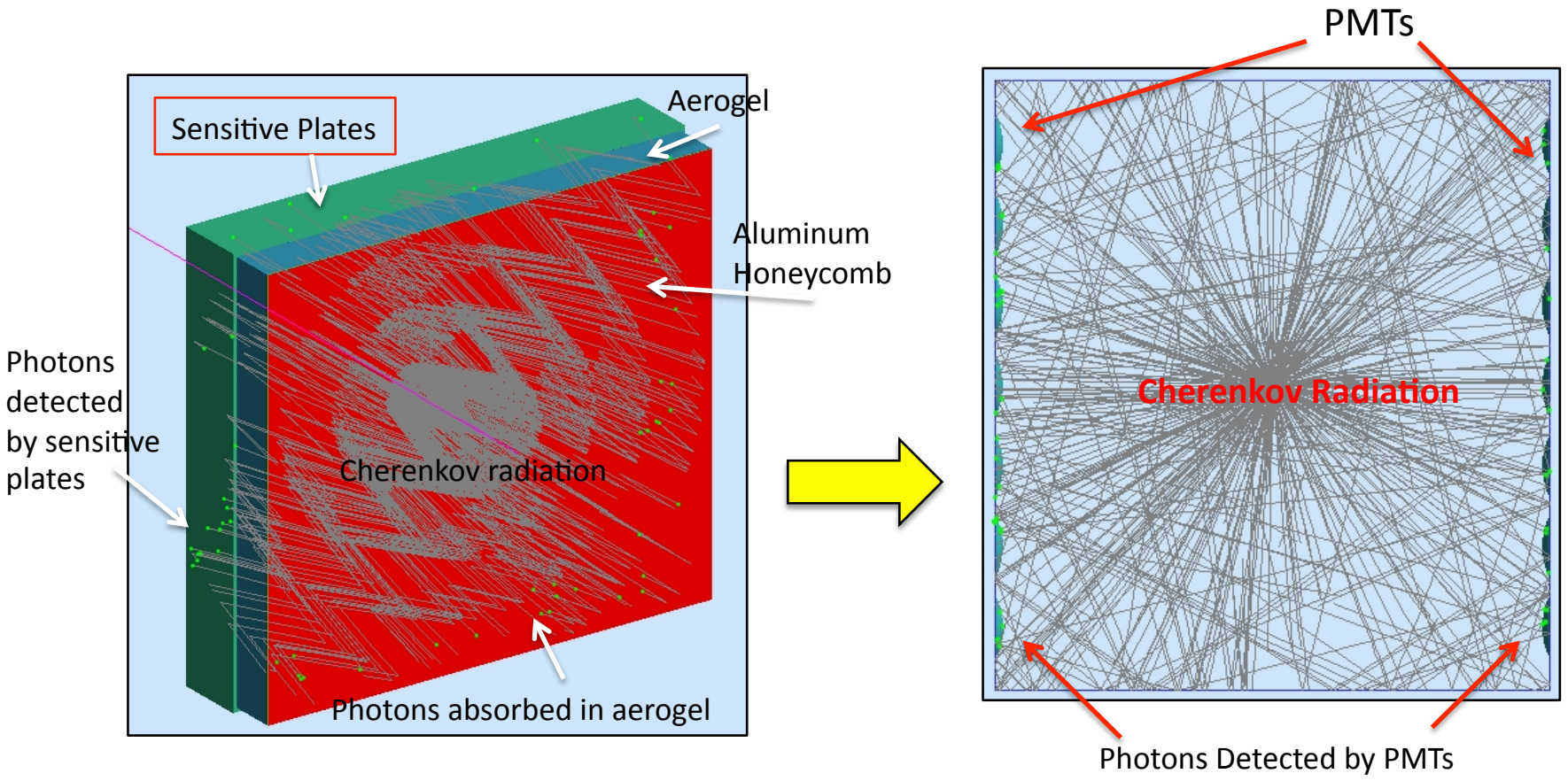


Initial GEMC model

GEMC: https://gemc.jlab.org/gemc/Home.html

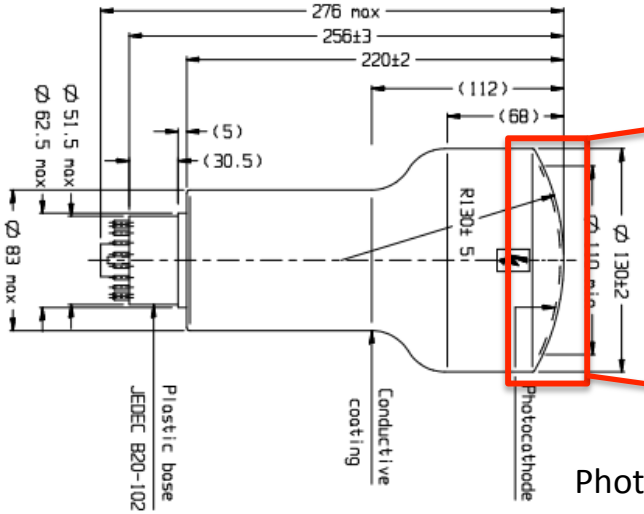
GEANT4/GEMC

Sensitive Materials

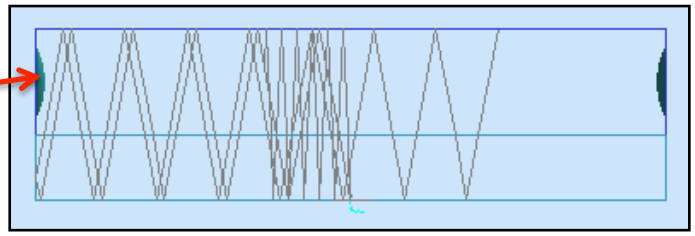


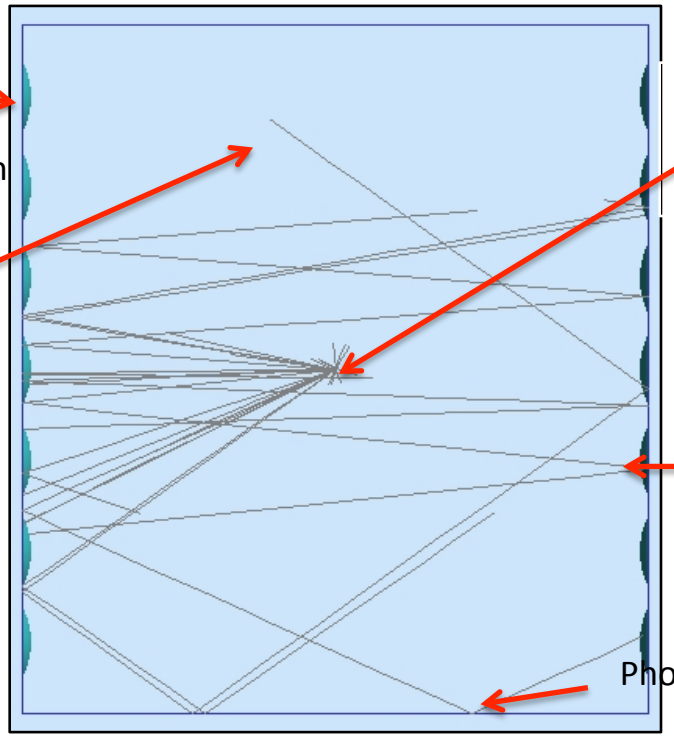
GEANT4/ GEMC – Sensitive Materials (continued)

Simulated PMTs: 5-inch diameter



Top view of KACD





Photon absorbed in aerogel or by Millipore paper

Incident particle passing through the detector

Photon detected by this PMT

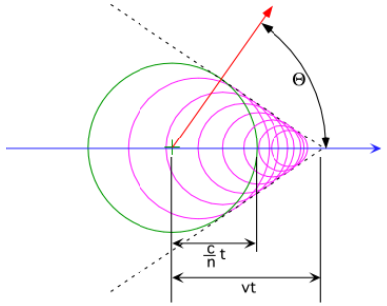
Photon reflection off the walls

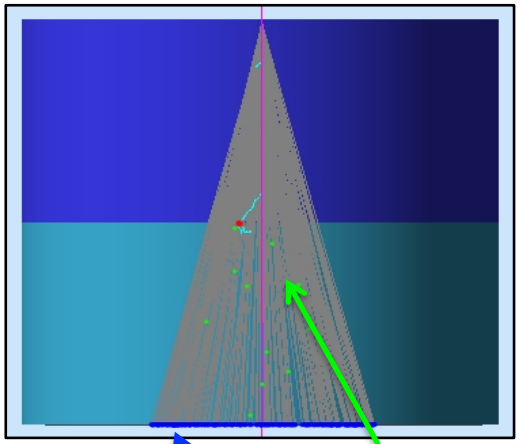
Sensitive materials written for PMT window faces and Millipore lining of the light diffusion box

GEANT4/GEMC - Efficiency

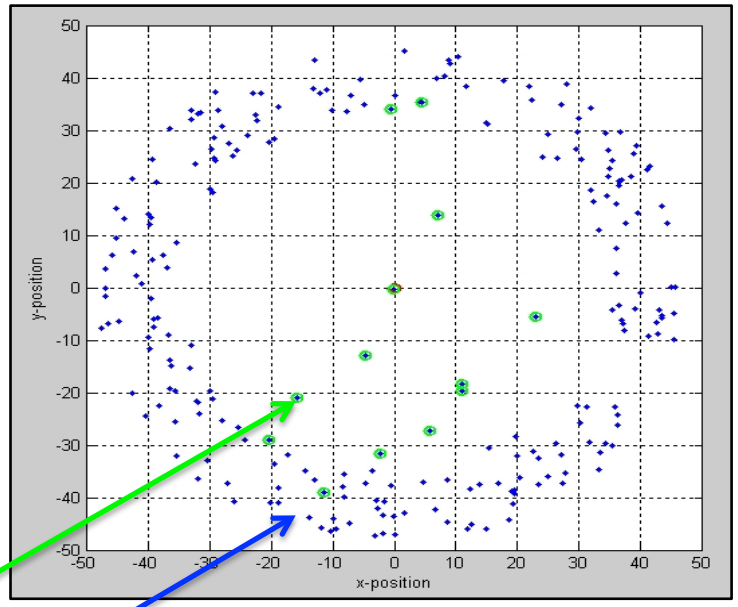
Cerenkov Effect in GEMC!

Cerenkov Effect





Detected Photons

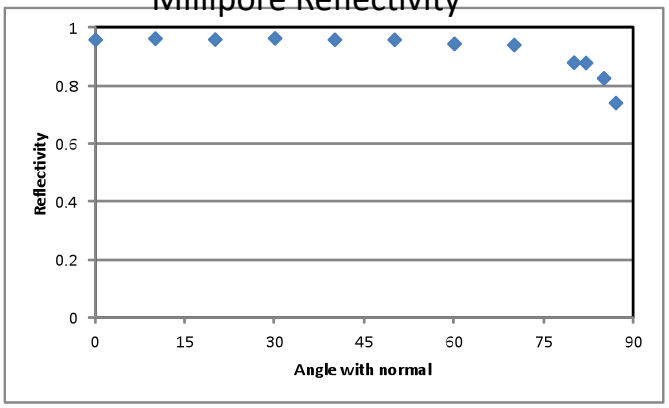


Absorbed by aerogel

Passed though aerogel

Mirrors and Reflective Surfaces

Millipore Reflectivity

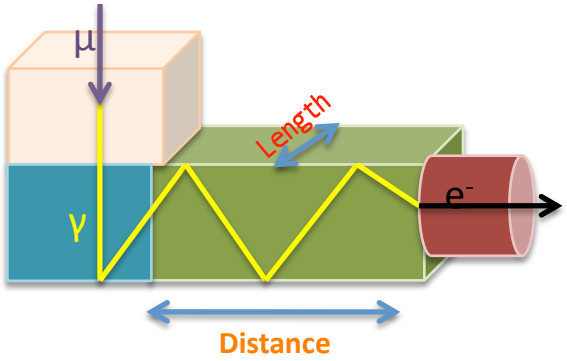


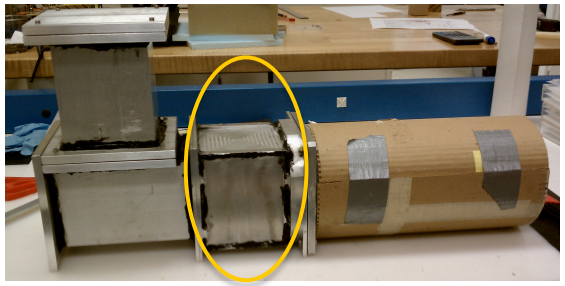
Absorption Inefficiency Ratio:

$$\frac{13}{232} = 5.6\%$$

SimCherenkov - Light Collection Efficiency

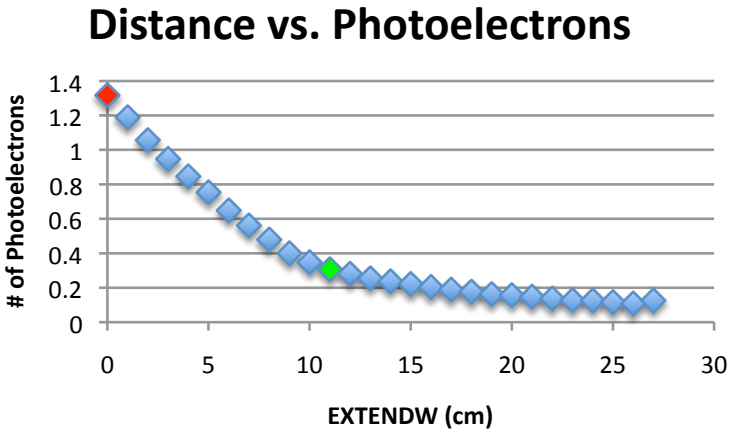
A FORTRAN Monte Carlo simulation was written to model the KACD, allowing for manipulating the detector geometry to simulate the effects of light guides on the detection efficiency.



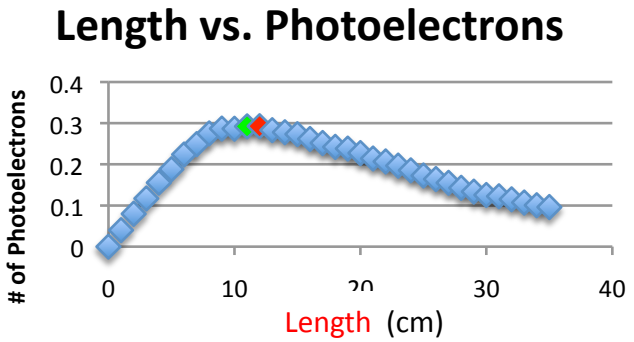


The prototype extension volume simulates the light guide in the full detector. Preliminary tests with a 8x8 cm cube gave a 23% detection efficiency.

Conclusion: for aerogel quality tests use a prototype without extension volume



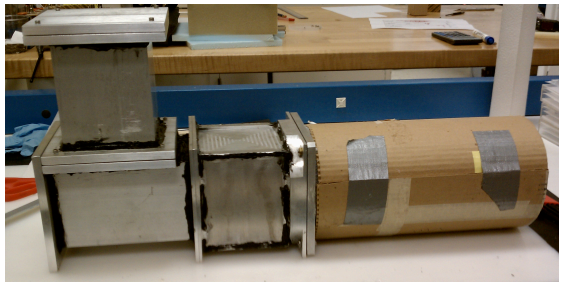
Efficiency decreases as distance between PMT window and Aerogel increases.



Efficiency increases as PMT window is exposed, and decreases as length of light guide exceeds dimensions of PMT window.

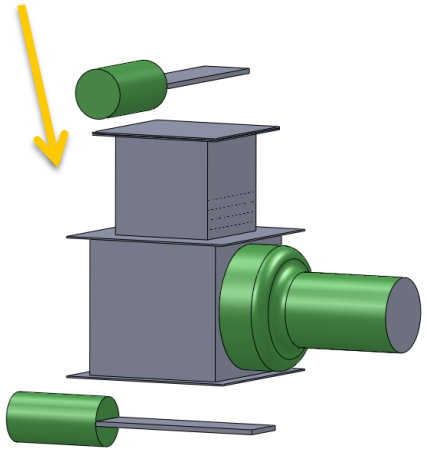
Simulation Verification: Prototypes

- Initial prototype could be used to study effect of light guides on detector efficiency, but had limitations to carry out the aerogel quality tests
- New prototypes built at CUA and JLab is closer representation of slice of the KACD

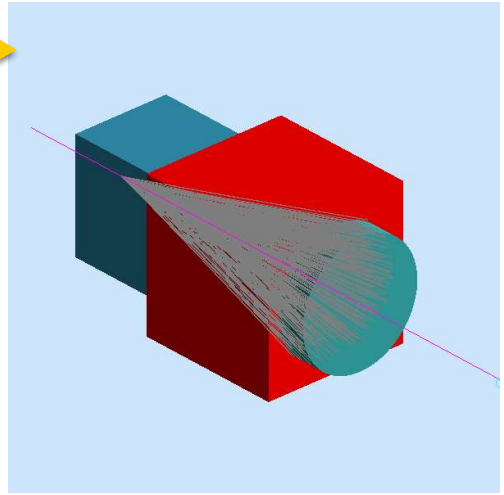


Prototype summer 2011

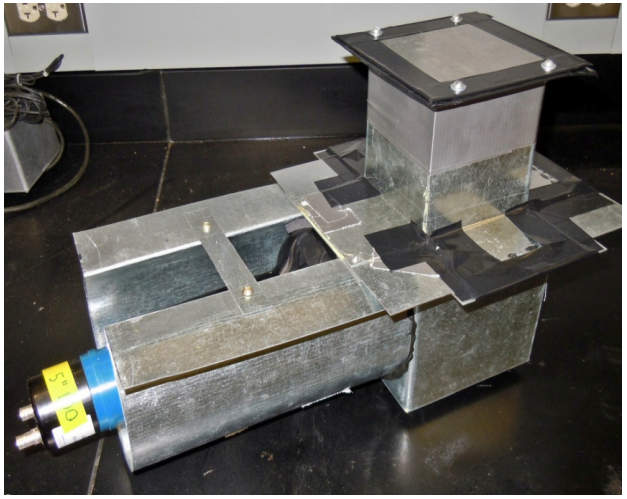
- Modeled in GEMC
- Use for aerogel testing at CUA starting this spring semester



Model of our test setup



GEANT4 simulation

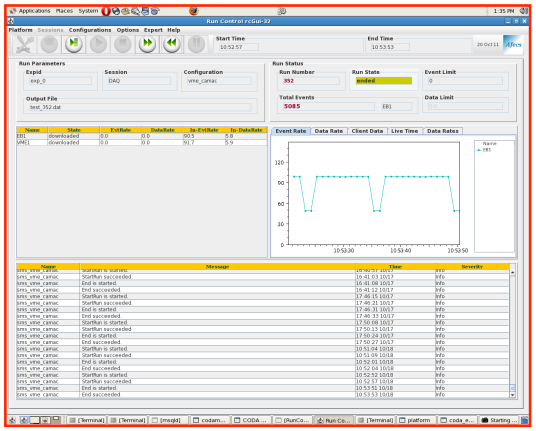


CUA prototype built by student Mike Metz

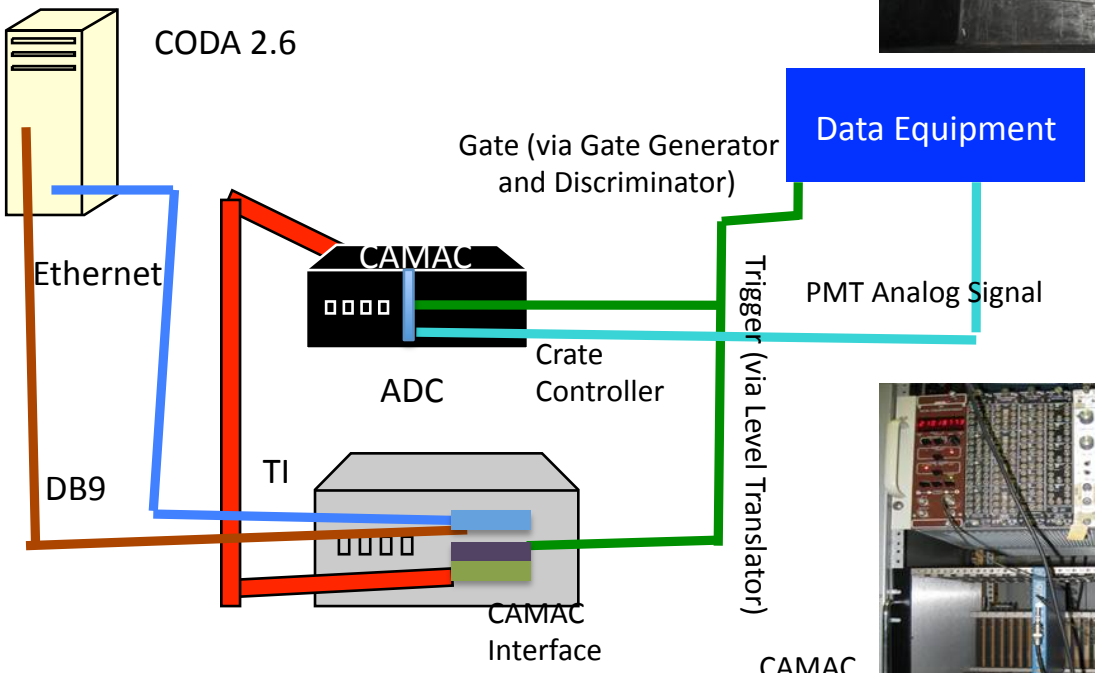
[see A. Mkrtchyan talk for new Jlab/Yerevan prototype and test results]

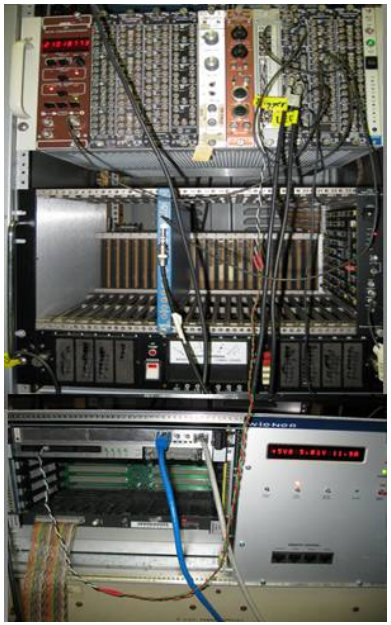
Data Acquisition System

Built a data acquisition system at CUA in summer/fall 2011 for PMT and aerogel tests [NH, MM, MAPC,…]



Run Control GUI

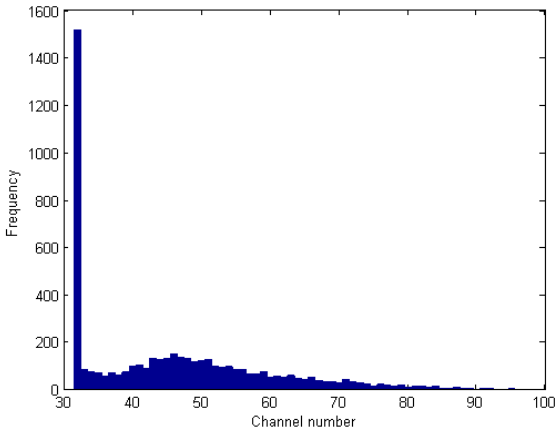


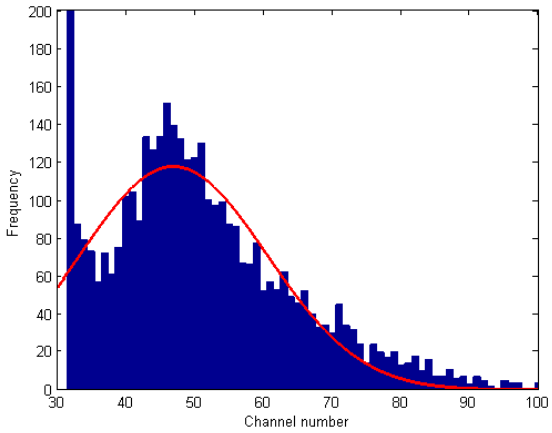


Ready to take data!

PMT Testing: Gain Studies

- PMT gain studies of the 5-inch PMTs from Bates





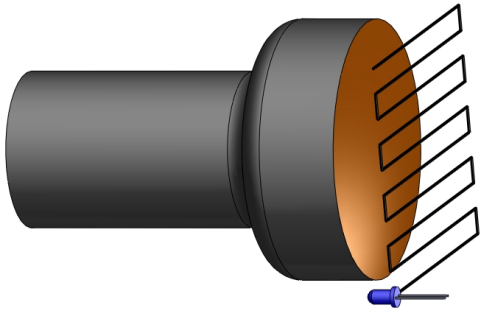
- Initial studies were done at JLab in summer 2011 and are documented in our Wiki http://www.vsl.cua.edu/cua_phy/index.php/MainPage:Nuclear:KaonDetector

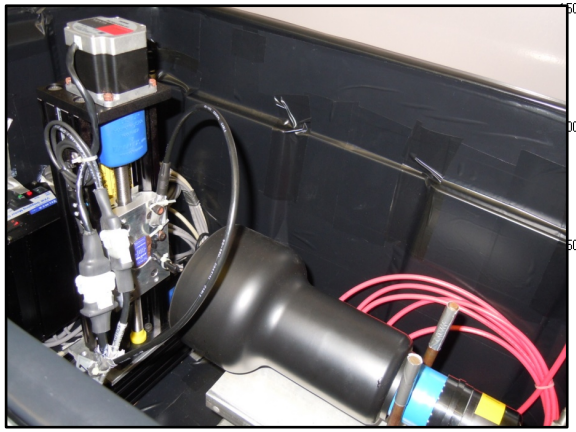
Initial results using our setup at CUA are consistent with those data

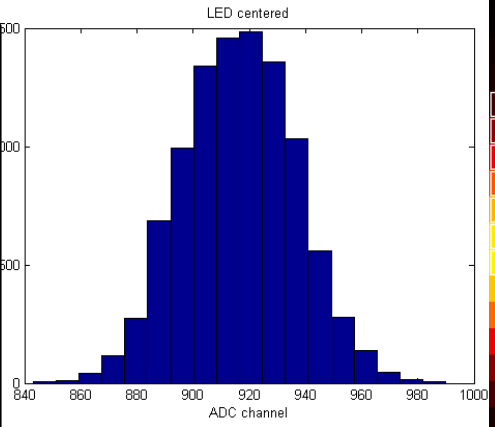
PMT Testing: Uniform Sensitivity

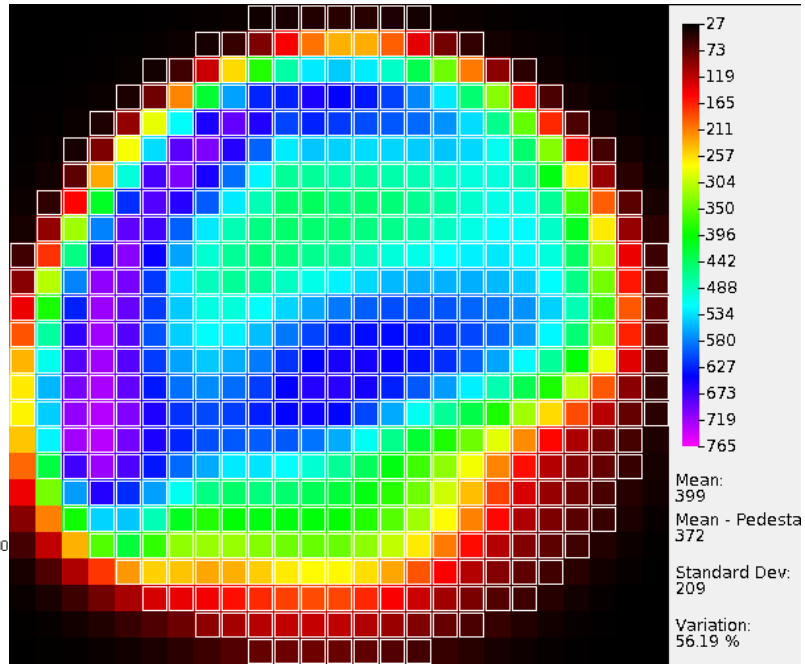
- Test to analyze the uniformity of the response across the PMT photocathode window

  - Blue color, to be close to the Cherenkov radiation wavelength
  - Flashed by a TTL pulse, with 40 ns of width.
  - We can also control the intensity using a potentiometer.
  - The PMT face was divided in a matrix of 25 x 25 positions (spaced by 5mm)
  - Position scanning: the LED was flashed 500 times in each position
  - High voltage in PMT of -1.9kV

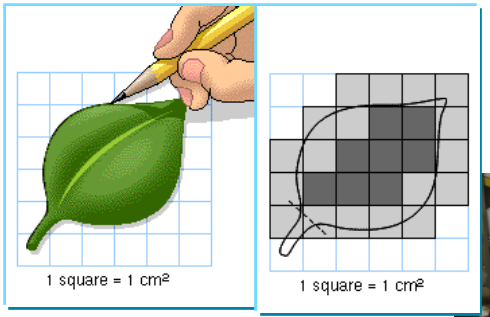








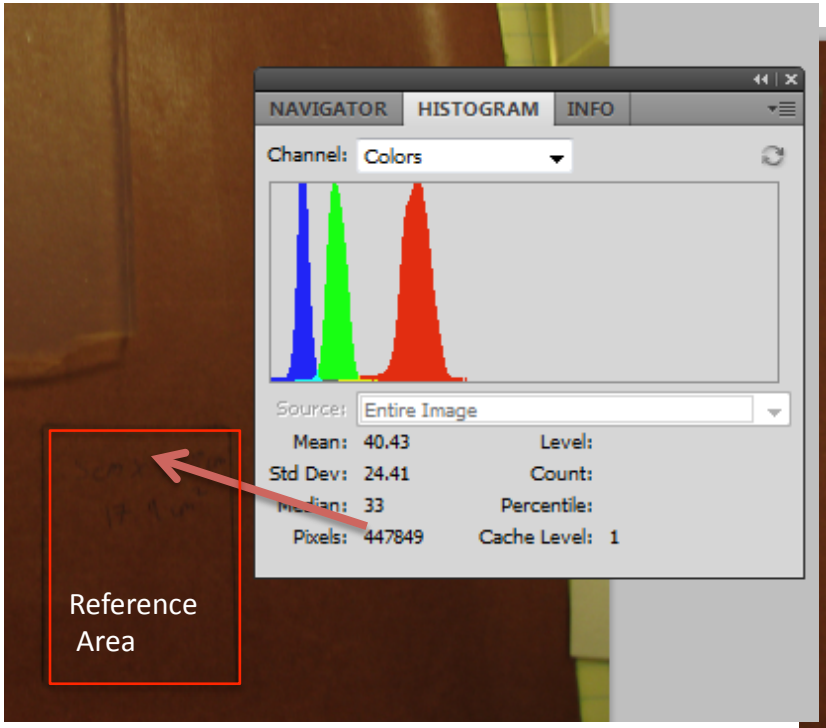
Aerogel Testing—Refractive Index

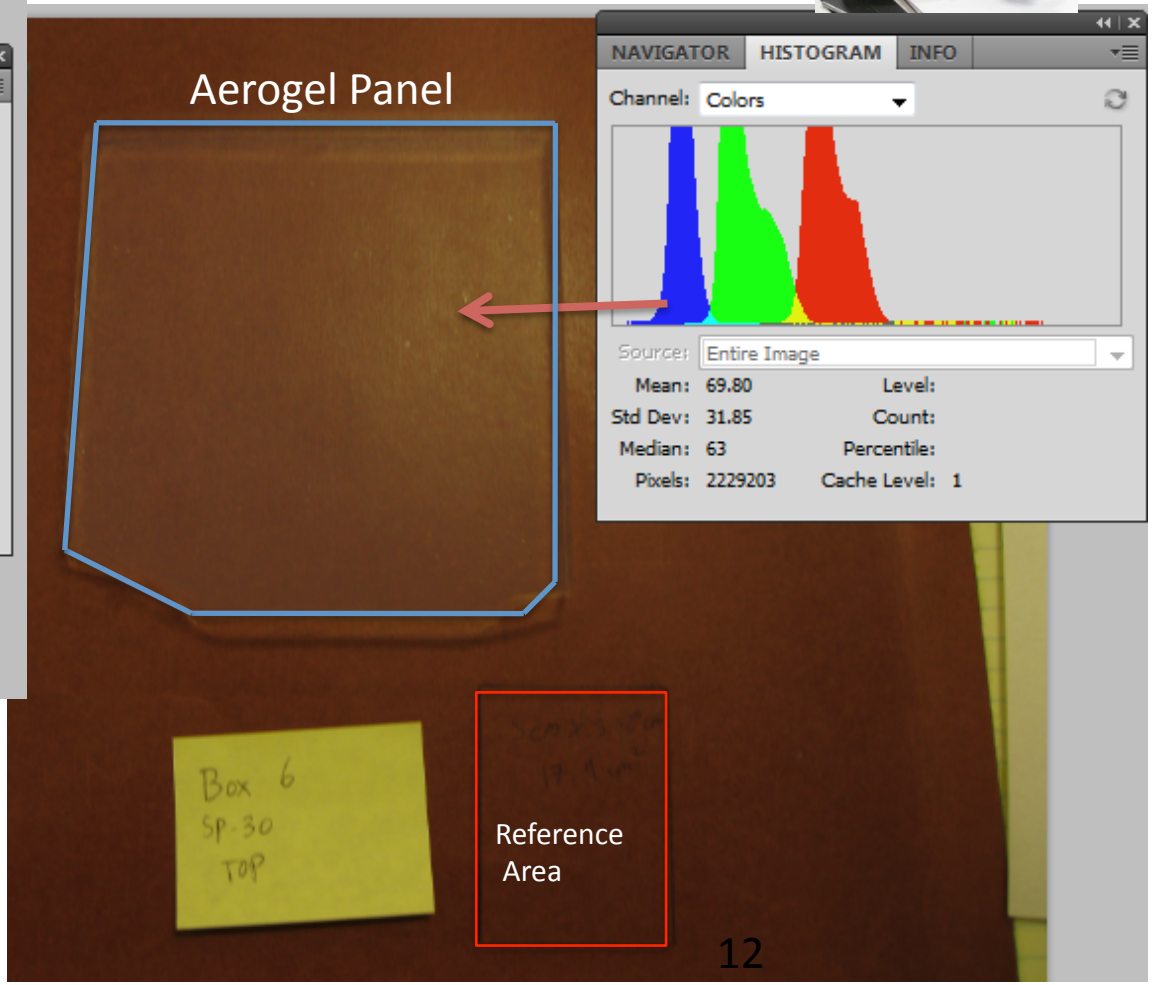


Katya Gilbo

- Photoshop Statistic Application

For Accurate Volume Measurement (applying a biological technique)



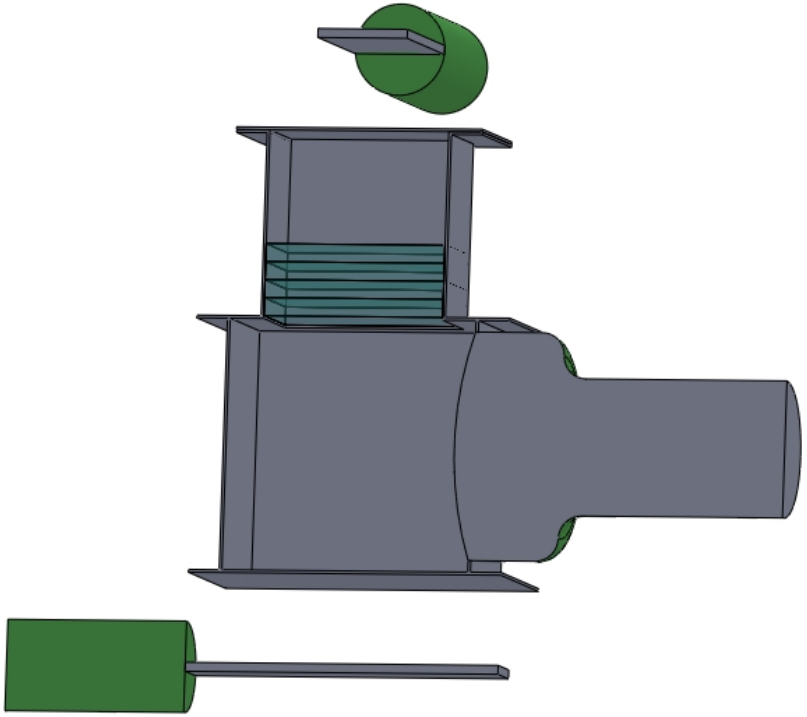


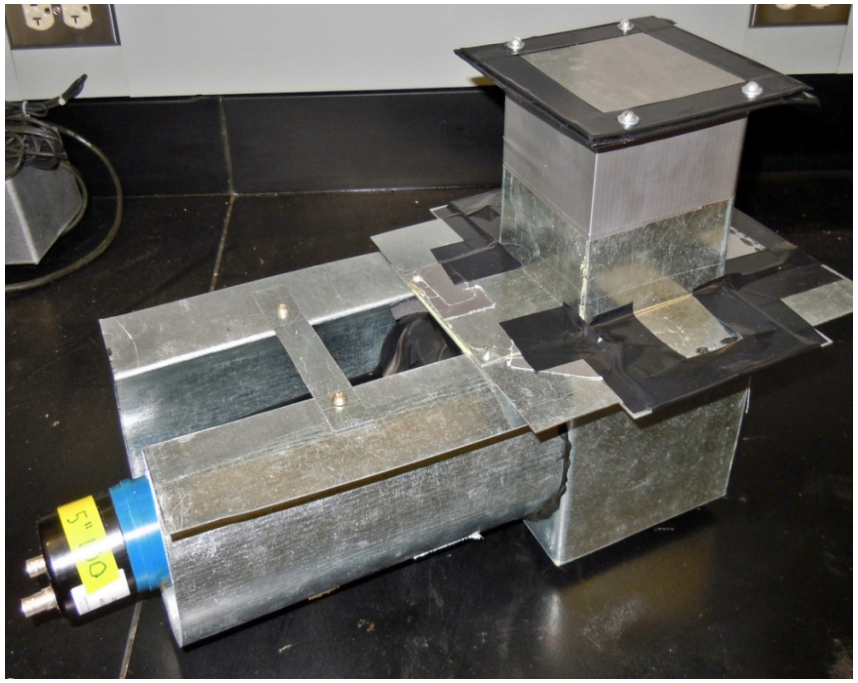
n=1+0.21(p),

where n is the index, p is density

Aerogel Testing: Quality

Will use new prototype built at CUA by Mike Metz to test aerogel quality. This prototype has also been modeled in GEANT4/GEMC.





Tests will start spring 2012 at CUA [NH, MM, MAPC,…]

[see A. Mkrtchyan talk for new Jlab/Yerevan prototype and test results]

Summary

- Kaon aerogel Cerenkov detector and its prototypes modeled using GEANT4/GEMC and SimCherenkov MonteCarlo programs
- Data Acquisition System built and operational
- PMT and aerogel testing underway
  - PMT uniform sensitivity
  - Gain testing
  - Aerogel index and quality

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- Marco Carmignotto, Michael Metz, Nathaniel Hlavin, Kevin Wood, Katya Gilbo

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