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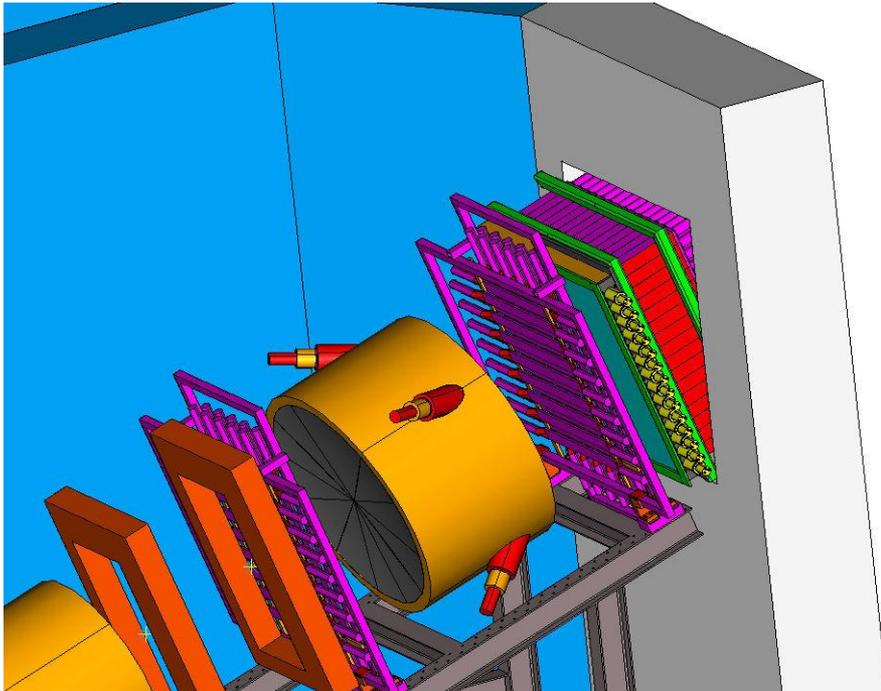
# SHMS Calorimeter Status Update

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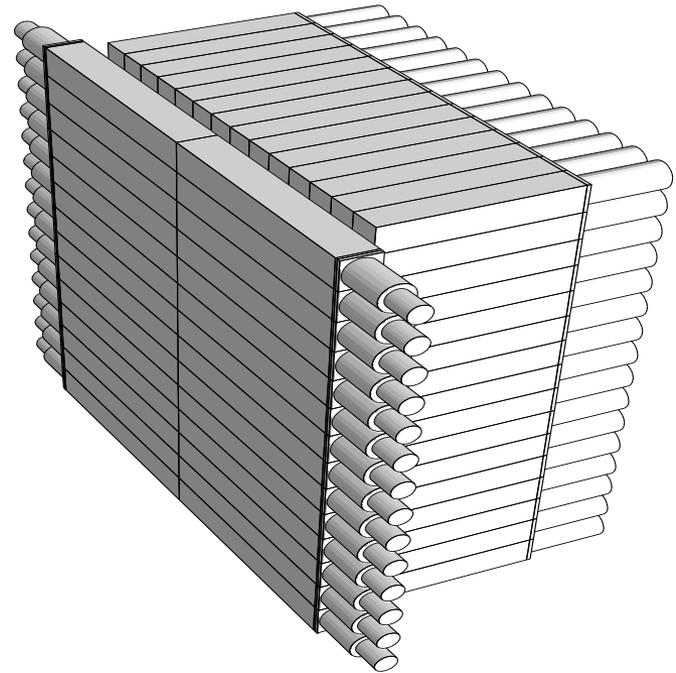
 **Jefferson Lab**

 **YEREVAN PHYSICS INSTITUTE**  
AFTER A. ALIKHANIAN

## Detector Hut



## Calorimeter



- Calorimeter is situated at the very end of SHMS detector stack
- With effective area 120cm x 140cm, it will cover SHMS acceptance
- Higher energy leads to thicker calorimeter than in HMS/SOS
- Energy resolution better than 7% (at 1 GeV energy) is expected
- $\pi/e$  rejection 200:1 with Preshower & Shower (at 99.5%  $e^-$  efficiency)
- Preshower consists of 28 modules (TF-1) from the SOS calorimeter stacked back to back
- Shower part consists of 224 modules (F-101) from decommissioned HERMES detector

# Calorimeter blocks revision and test

**232 blocks for Shower part**



**Best 224 (+8) out of 250 available are selected & ready for installation.**

**Preshower part assembling**



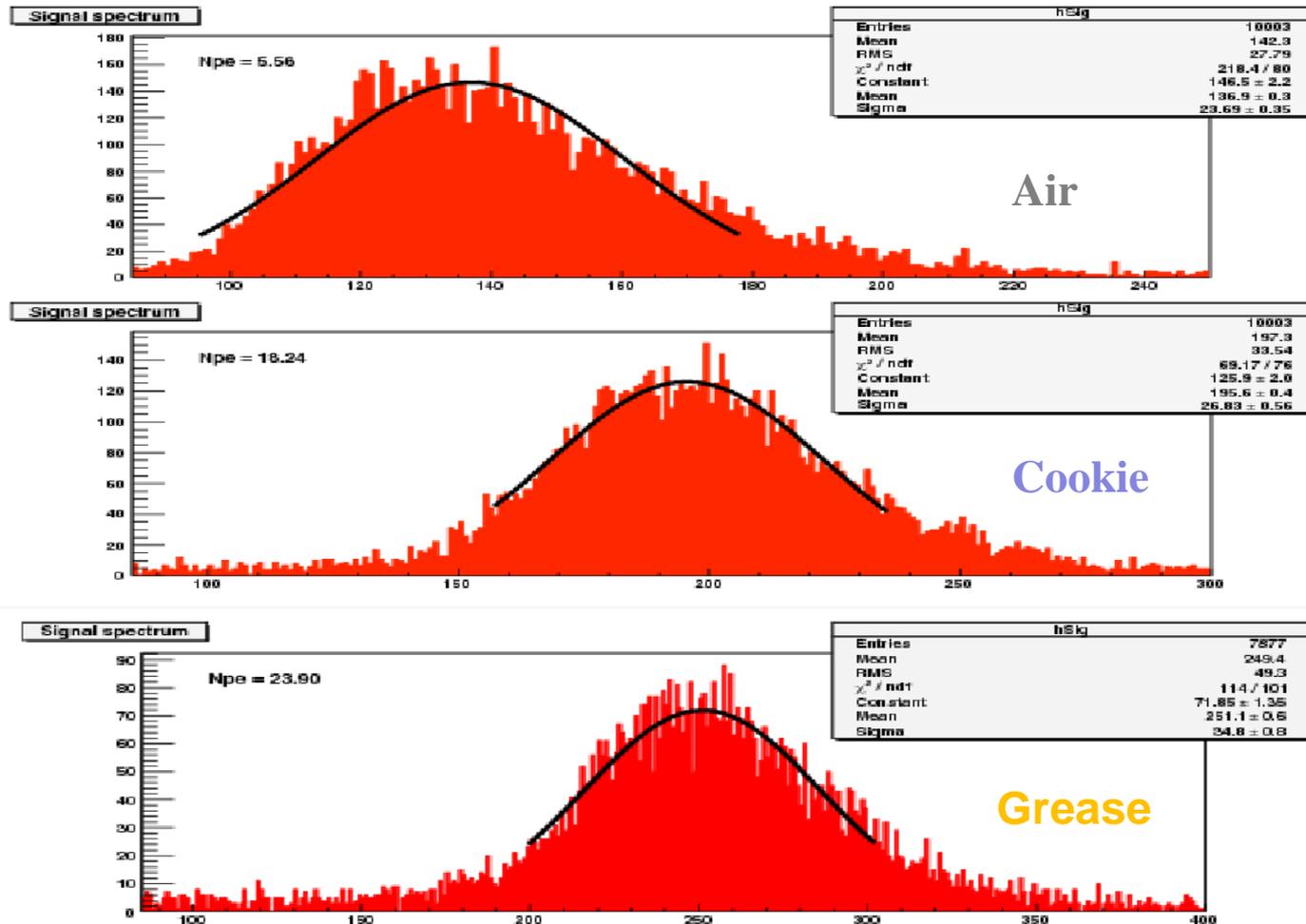
**28 blocks & PMTs from SOS calorimeter have been used for Preshower**

# SHMS Preshower



- **Preshower is assembled and tested for light leaks**
- **Full-scale cosmic tests will start as soon as will have all electronics**

# Effect of Optical contact between block and PMT



- Three versions of optical contact between PMT and LG blocks are tested
- Best results (maximum transmission from block to PMT) with optical grease
- Signal ratio is 0.33/0.67/1.00 for versions: air/cookie/grease respectively

# GEANT4 Simulation of SHMS Calorimeter

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- Calorimeter is situated at the very end of detector stack of SHMS
- Material before the calorimeter smears energy & coordinates of the particles
- The functional form of energy dependence of the calorimeter resolution is:

$$\sigma = A/\sqrt{E} \oplus B \oplus C/E$$

- term “A” is purely of stochastic origin
- term “B” reflects the detector non-uniformity & calibration uncertainty
- term “C” comes from electronic noise

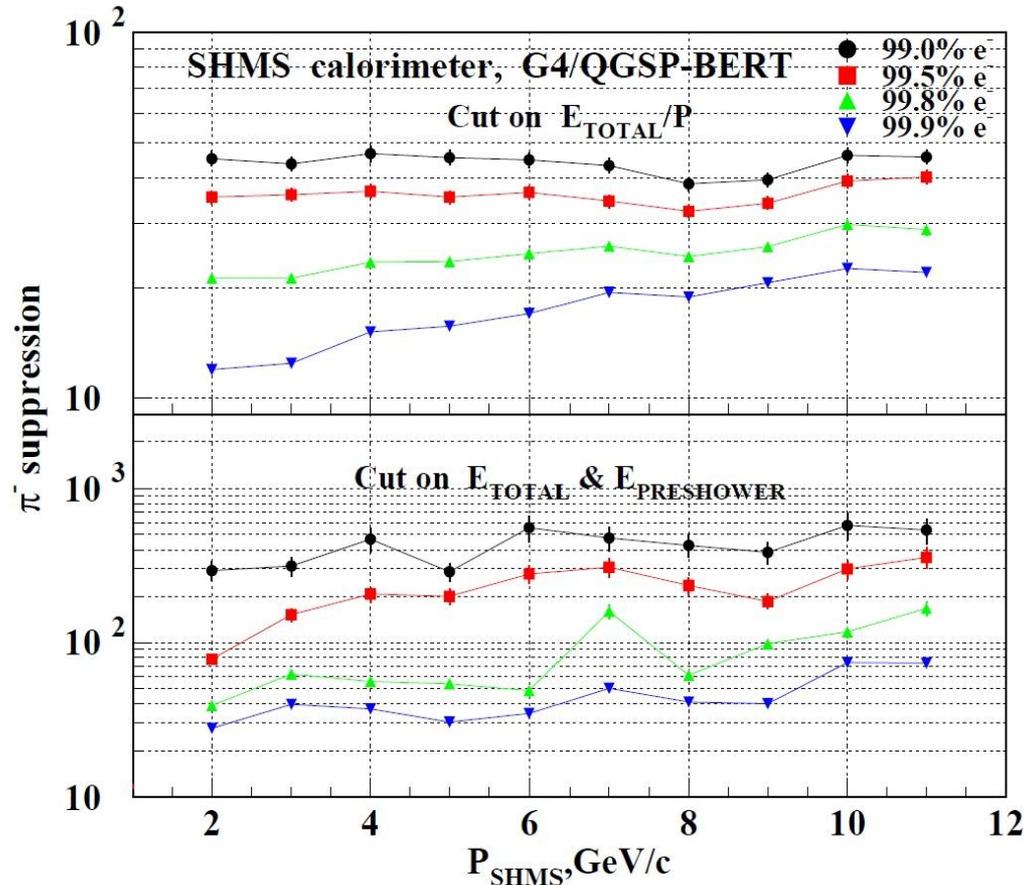
- More material between the focal plane and the calorimeter in SHMS than in HMS (~0.38 & ~0.16 rad. length), and less transparent F-101 than TF-1 reduces photoelectron statistics and lead to poorer energy resolution of SHMS calorimeter.

$$\text{HMS} \rightarrow \sigma = 3.75/\sqrt{E} \oplus 1.64 \oplus 1.96/E$$

$$\text{SHMS} \rightarrow \sigma = 5.52/\sqrt{E} \oplus 1.65 \oplus 3.30/E$$

- Nevertheless, Good  $e/\pi$  separation can be achieved by using Preshower & Shower

# GEANT4 Simulation of SHMS Calorimeter



Only total energy deposition

Combination of Total energy deposition and energy deposition in preshower

- GEANT4 simulations for calorimeter within full momentum range of SHMS
- Simulation closely follows geometry and parameters of calorimeter components
- Energy resolution better than 7% (at 1 GeV energy) are predicted
- $\pi/e$  rejection 200:1 with Preshower & Shower (at 99.5%  $e^-$  efficiency) is expected

# SUMMARY

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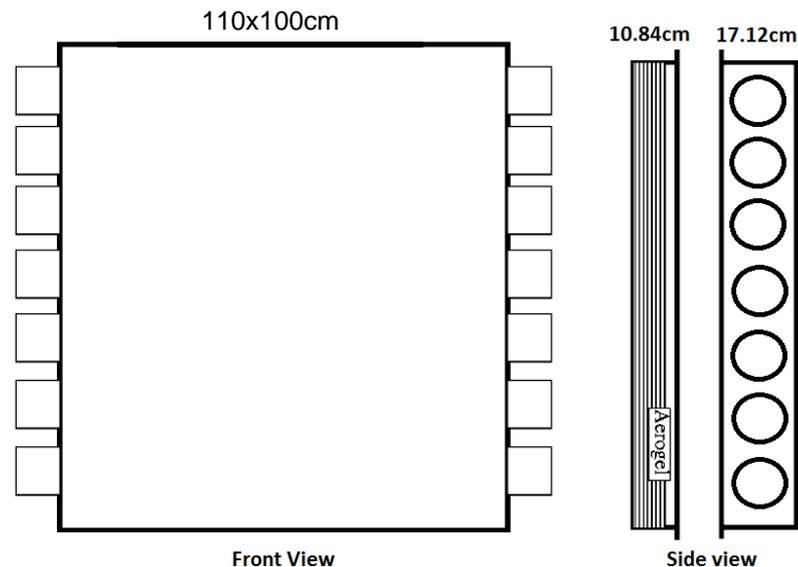
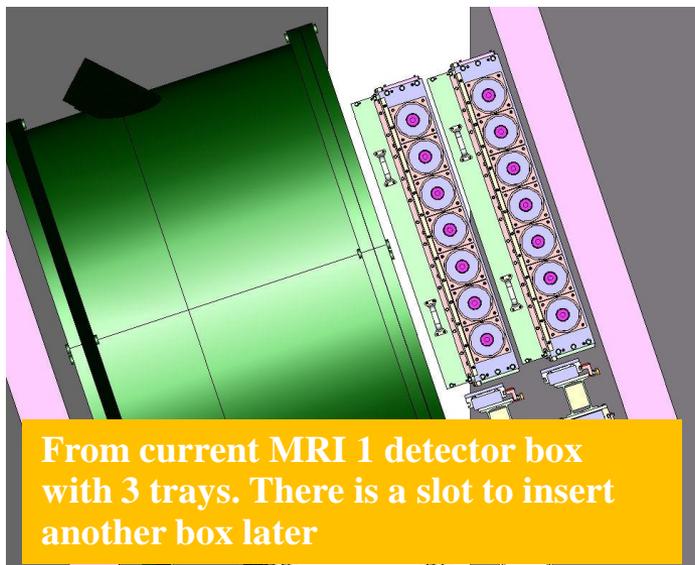
- **Preshower part is fully assembled and light leak tested.**
- **Different optical couplings between block and PMT have been studied**
- **Effect of detector material before the calorimeter on performance of the counter have been studied.**
- **$\pi/e$  rejection 200:1 with Preshower and Shower (at 99.5%  $e^-$  efficiency) is expected.**

## Upcoming

- **Preparation and configuration of electronics for Preshower cosmic tests (ADC, computer, HV power supply, delay lines, splitter, ...)**
- **Build or refresh pair of scintillators from SOS hodoscopes for cosmic tests.**
- **Development of the strategy of calorimeter electronics.**
- **Crosstalk test between adjacent Preshower blocks.**
- **More work on calorimeter software (calibration and analysis code).**

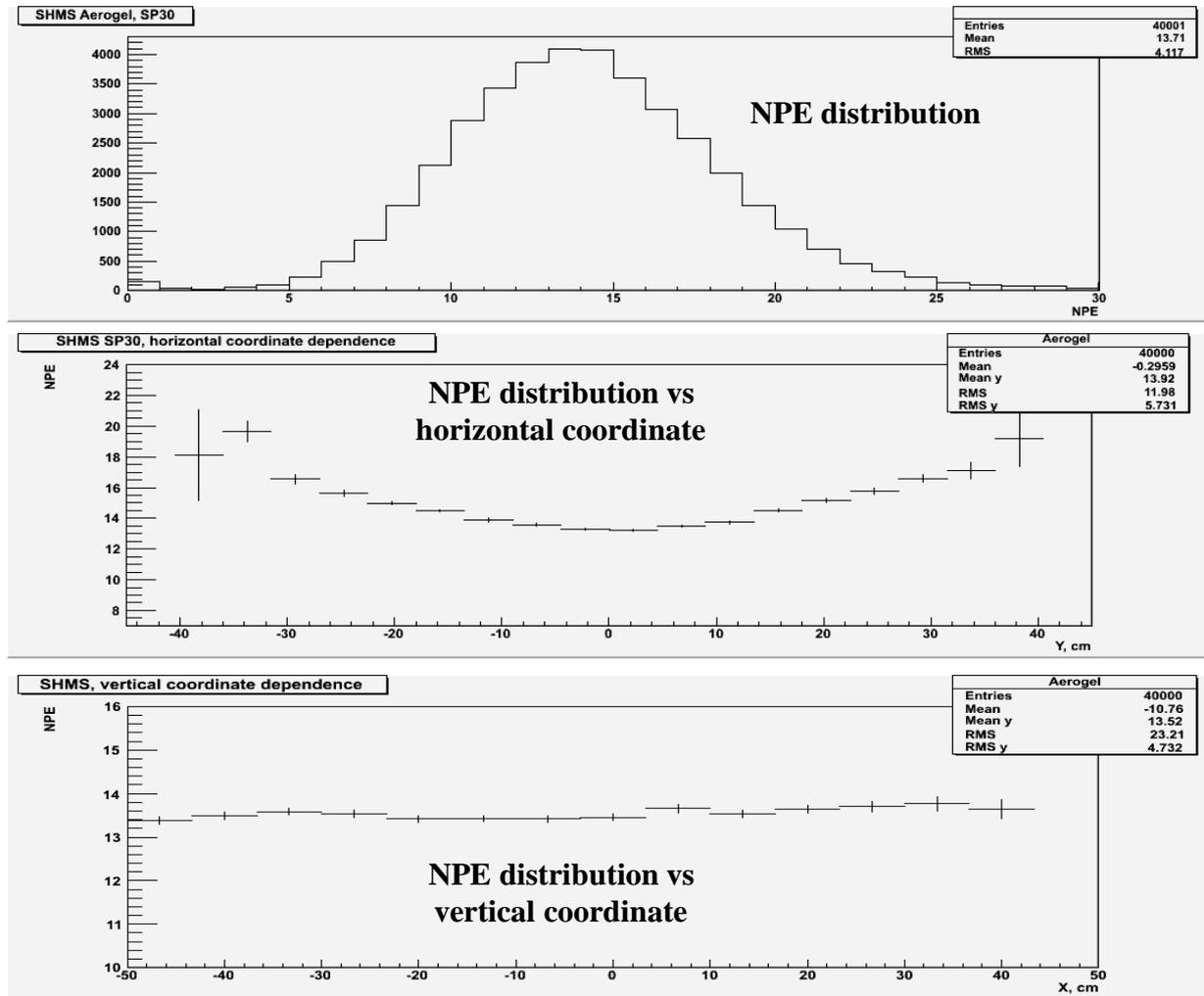
# SHMS Aerogel detector

- **Effective area 110cm x 100 cm**
- **7 Phototubes will be mounted from each side of the box (optional: install 6 additional PMTs from the top)**
- **Diffusion box will be covered with Millipore paper inside**



- **Aerogel materials and PMTs from BLAST detector will be used**
- **MC studies and revision of PMTs and Aerogel materials (in collaboration with CUA)**
- **Kaon identification system will consist of Aerogel detectors with  $n=1.03$ ,  $1.02$ , and either  $1.015$  or  $1.010$**
- **Similar to HMS detector, but with larger effective area 110cm x 100cm**
- **All characteristics of the materials and PMTs are taken into account in the simulation code**

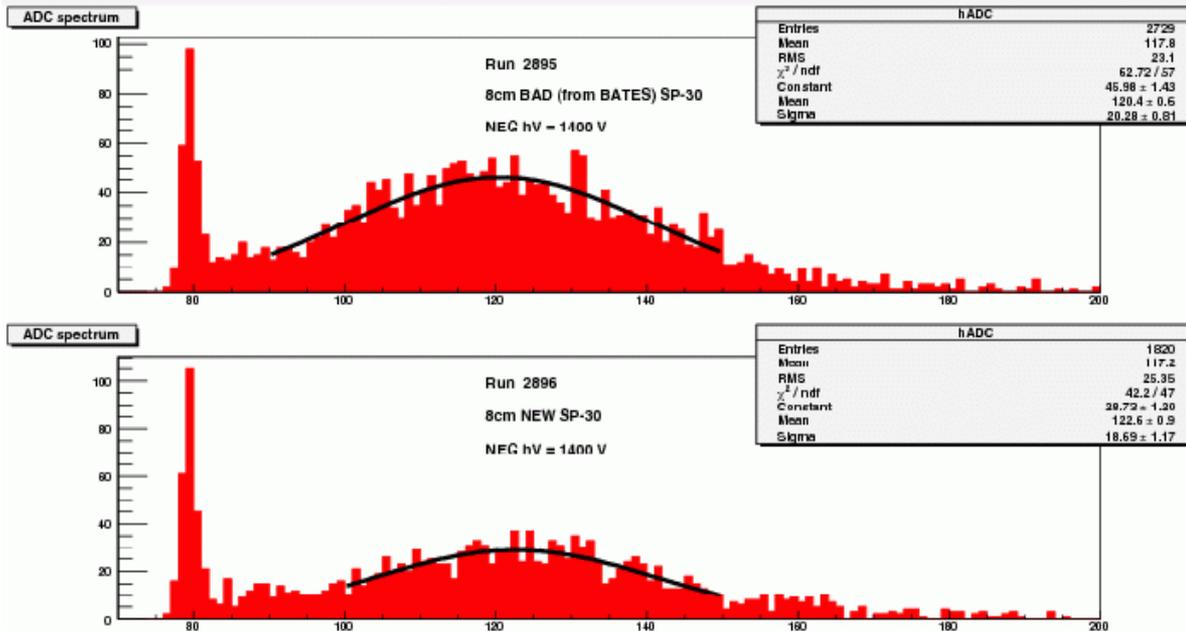
# GEANT4 Simulation of Aerogel Detector for SHMS



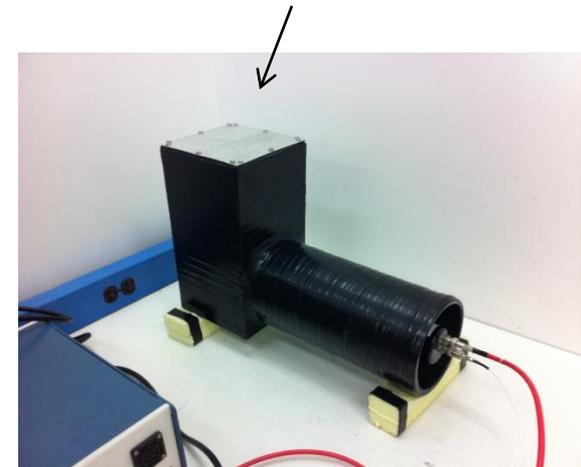
- Simulation of HMS aerogel shows good agreement with experimental data
- For SHMS aerogel, with 9 cm  $n=1.030$  radiator ~14 photoelectrons are expected
- Detector response is expected to be uniform in vertical direction and within 30% over horizontal

# Aerogel Material Quality Studies

## Relative signal from cosmic for 8 cm n=1.030 aerogel



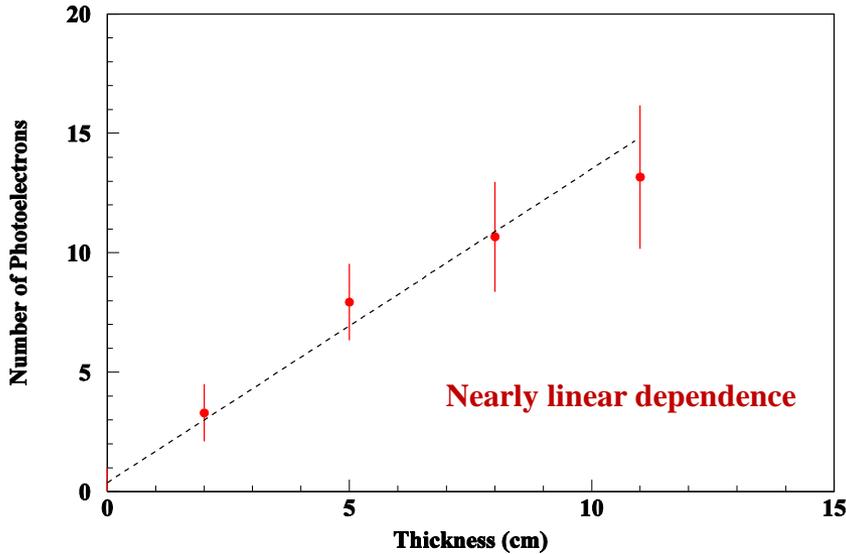
Prototype has been constructed to test relative quality of aerogel materials



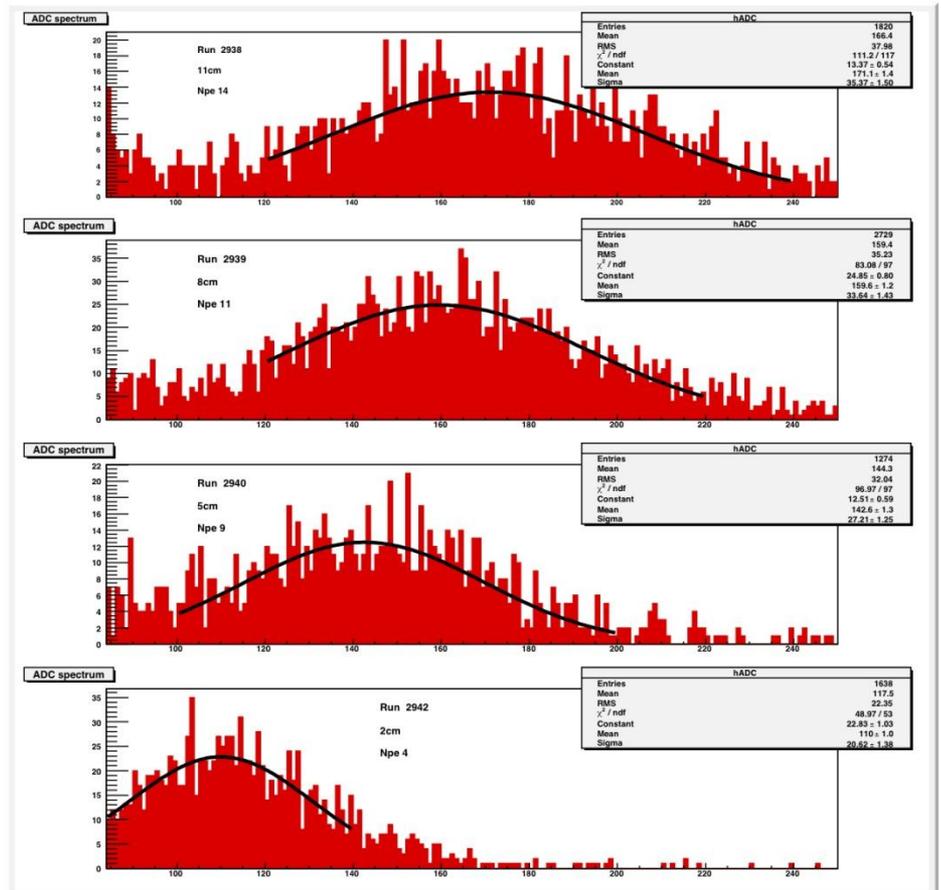
- **Top: Signal distribution (ADC chan.) for 8 aerogel stack from BLAST detector**
- **Bottom: Amplitude distribution for 8 cm new unused aerogel**
- **No significant degradation effect (<5%) for BATES aerogel material have been found !**

# Aerogel Material Studies

## Number of photoelectrons from cosmic for aerogel $n=1.030$



Number of detected photoelectrons versus the aerogel thickness



Amplitude distribution and Npe for aerogel with thickness 11, 8, 5 and 2cm

# SUMMARY

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- **Aerogel materials & PMTs from the BLAST detector are on site.**
- **New test setup (prototype) for aerogel material tests have been built.**
- **Revision and quality tests of aerogel materials and PMT's started.**
- **Preliminary tests don't find any significant (<5%) degradation of BATES aerogel.**
- **MC studies of SHMS aerogel detector have been started .**

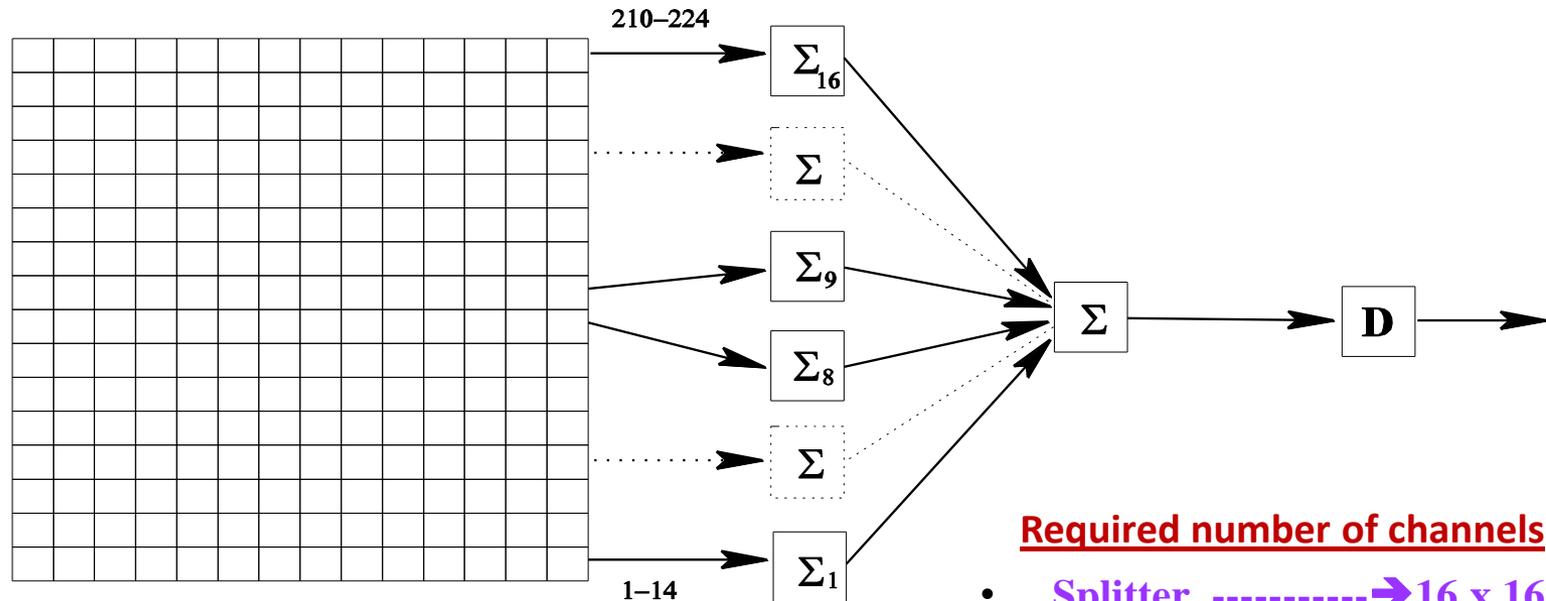
## Upcoming

- **Continue revision and quality test of aerogel materials and PMT's**
- **Modification of HV bases for SHMS Aerogel detector (change from negative to positive HV and add amplifier in HV base).**

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# Back-up slides

# Shower Electronics (minimal)



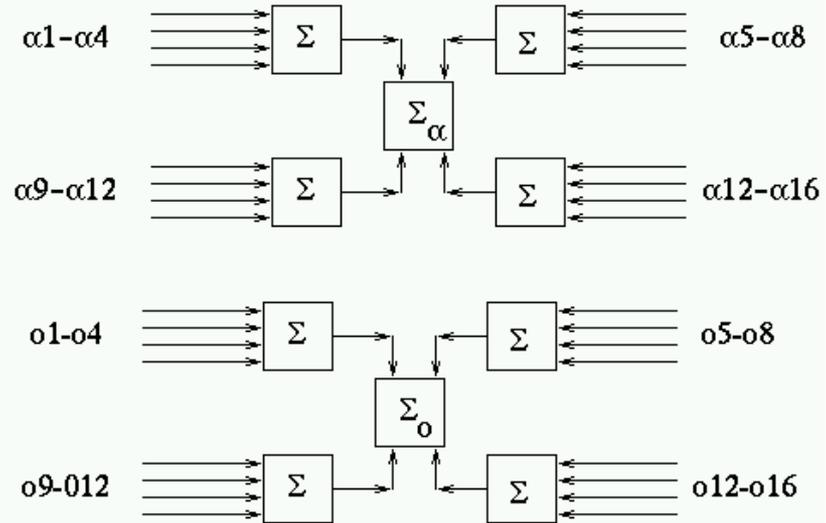
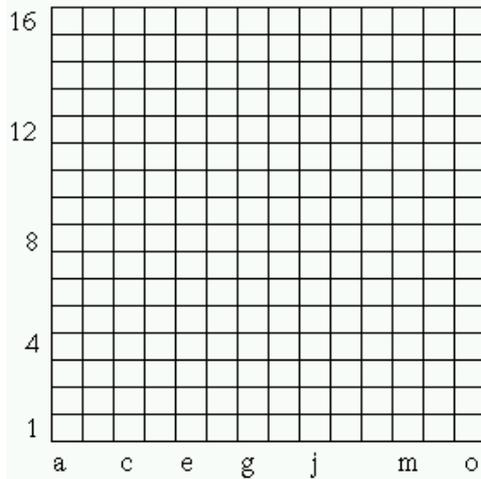
## Simple but with problems

- Not good to have sum of 224 PMTs
- No any flexibility to organize trigger
- Offsets and noise will be very high

## Required number of channels

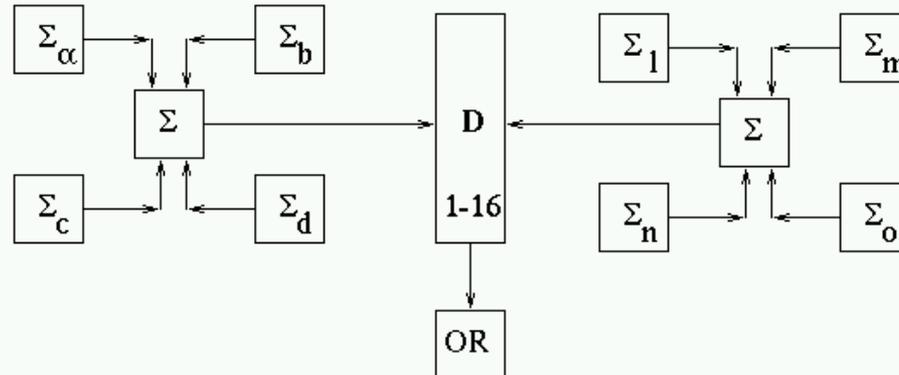
- Splitter -----→ 16 x 16
- Cable delay -----→ 224
- FB ADC -----→ 224
- Lin. Fun-In -----→ 17 x 16
- Discriminator ---→ 1
- Electronic delay -→ 1
- FB (F1 ?) TDC --→ 1
- Scaler -----→ 1

# Shower Electronics (more preferable)



Make all combination of sums and discrimination in detector hut.

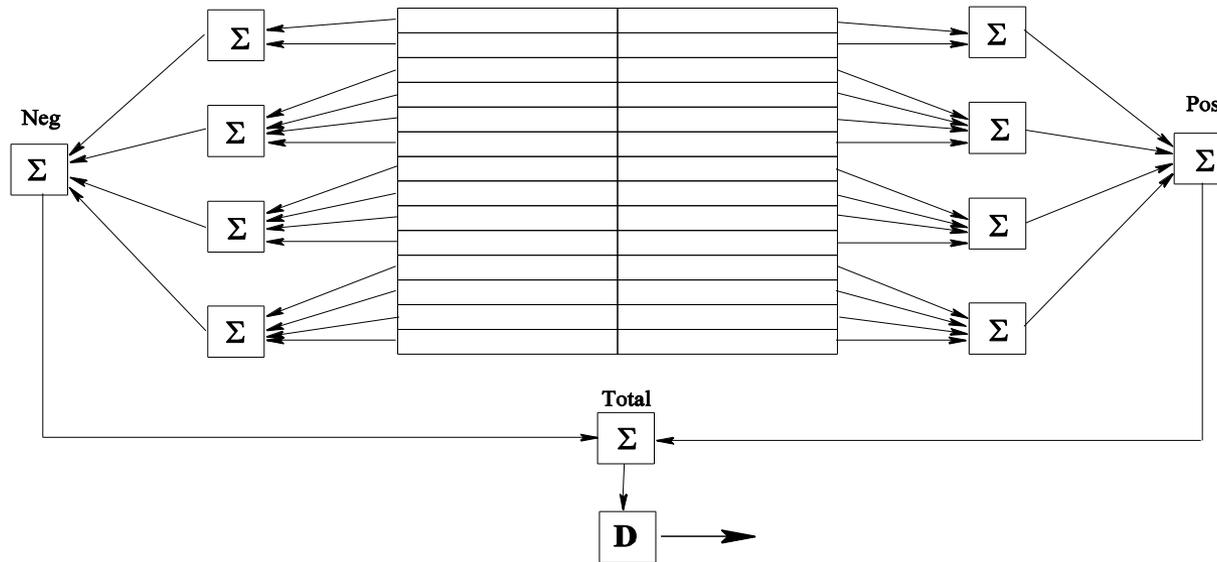
Radiation problem ?



- **Lin. Fun-In** -----> ~20 (4 x 4 “Phillips 740”)
- **Discriminator** ---> 1 x 16 + 4 (1x4)

Required more blocks

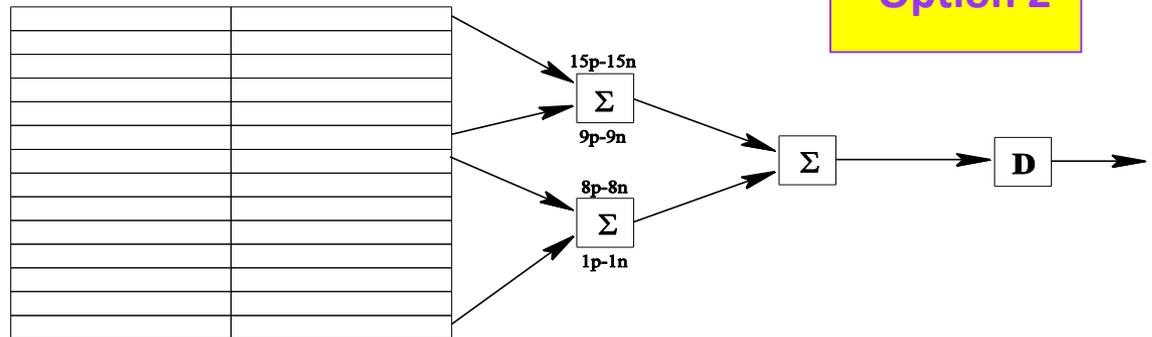
# Preshower Electronics (minimal)



Option 1

## Required number of channels

- Splitter → 2 x 16
- Cable delay → 28
- FB ADC → 28
- Lin. Fun-In → 11 x 4 (opt. 1)
- Lin. Fun-In → (2 x 16 + 1 x 4)
- Discriminator → 1
- Electronic delay → 1
- FB (F1 ?) TDC → 1
- Scaler → 1



Option 2

Option 3 → Similar to shower electronic