SHMS Aerogel Detector status

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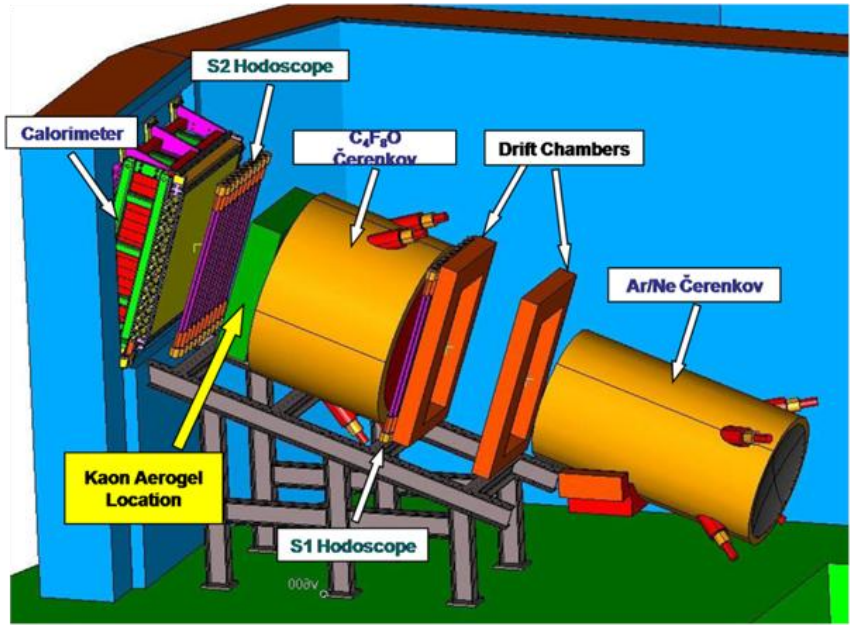
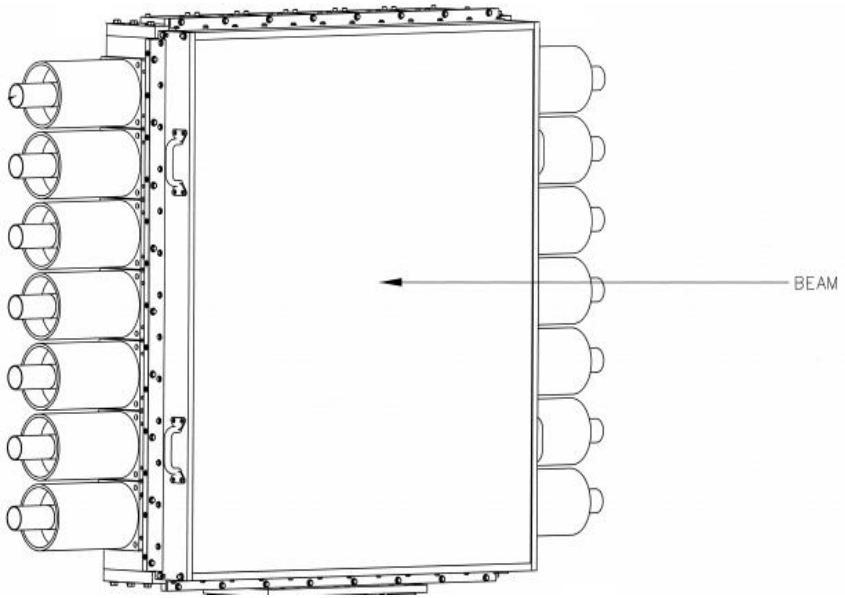
SUPER HIGH MOMENTUM SPECTROMETER

Detector Hut



Aerogel Detector



- **Aerogel detector is situated between heavy gas (C_4F_2O) Čerenkov detector and S2 Hodoscopes**
- **Dimensions: 110x100x25cm, covers SHMS acceptance**
- **Possible to install 2 detectors**
- **Consists of diffusion box with 14 PMTs (plus optional 6 on top) and replaceable tray for 4 different indexes of aerogel**

Particle identification in SHMS

- Noble gas Cerenkov detector: e/π
- Heavy gas Cerenkov detector: π/K
- Lead glass Calorimeter: e/π

➢ **The Aerogel Čerenkov detector will provide Kaon-Proton separation**

n	π_{thr} (GeV/c)	K_{thr} (GeV/c)	P_{thr} (GeV/c)
1.030	0.57	2.00	3.80
1.020	0.67	2.46	4.67
1.015	0.81	2.84	5.40
1.011	0.94	3.32	6.31

Using 4 trays with different refractive indexes allows K/P separation in 2 - 6 GeV/c range

12 GeV Approved Experiments where the Aerogel Čerenkov detector is important:

- E12-06-107 The Search for Color Transparency at 12 GeV

- E12-09-011 Studies of the L-T Separated Kaon Electroproduction Cross Section from 5-11 GeV

12 GeV Approved Experiments where the Aerogel Čerenkov detector may be beneficial:

- E12-06-104 Measurement of the Ratio $R=\sigma_L/\sigma_T$ in Semi-Inclusive Deep-Inelastic Scattering

- E12-06-101 Measurement of the Charged Pion Form Factor to High Q^2

- E12-07-105 Scaling Study of the L-T Separated Pion Electroproduction Cross Section at 11 GeV

Current Status

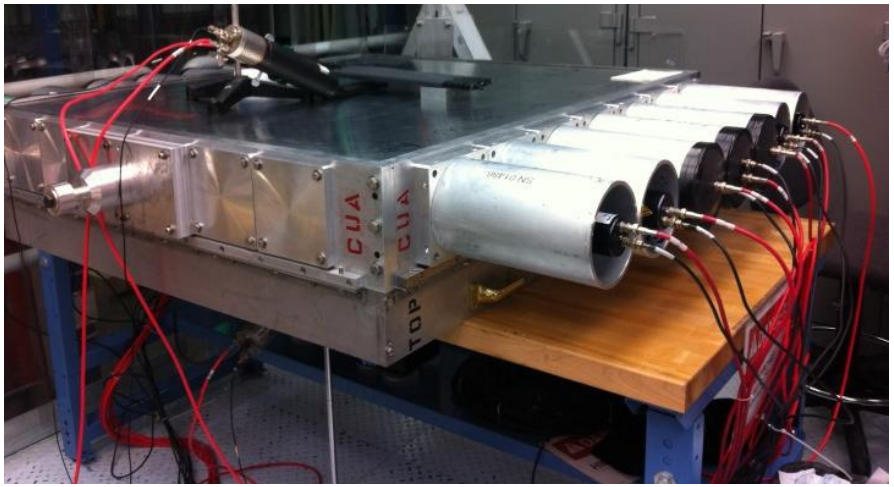
✓ Diffusion box currently covered with Millipore

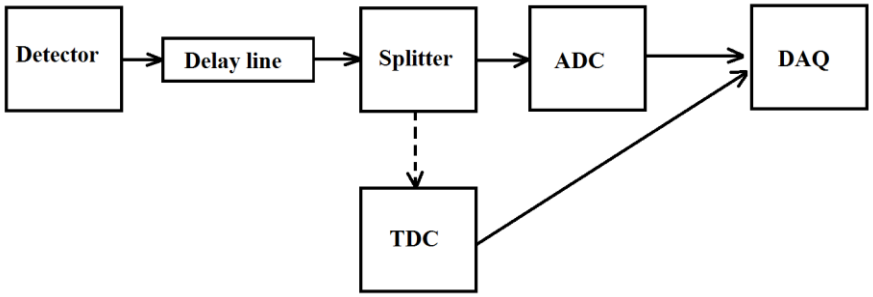
✓Electronics has been set up in EEL (will need similar configuration for installing in the SHMS)

✓SP30 (n = 1.03) and SP20 (n = 1.02) trays filled with 8 layers of aerogel and have been tested with cosmics

✓ SP-30 material has also been tested in P349 experiment at CERN

✓ 14 Photonis XP 4572 PMTs are assembled in separate set of cylinders for comparative tests with 14 XP 4500 PMTs (previously used in BLAST)

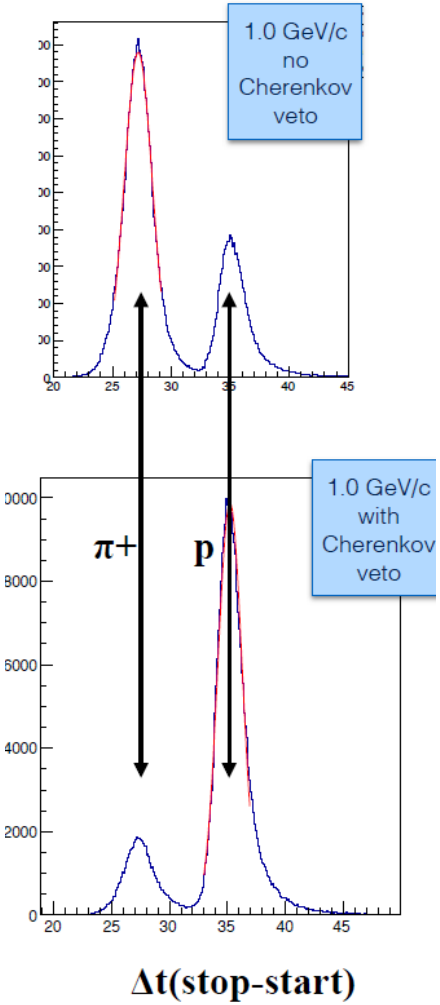


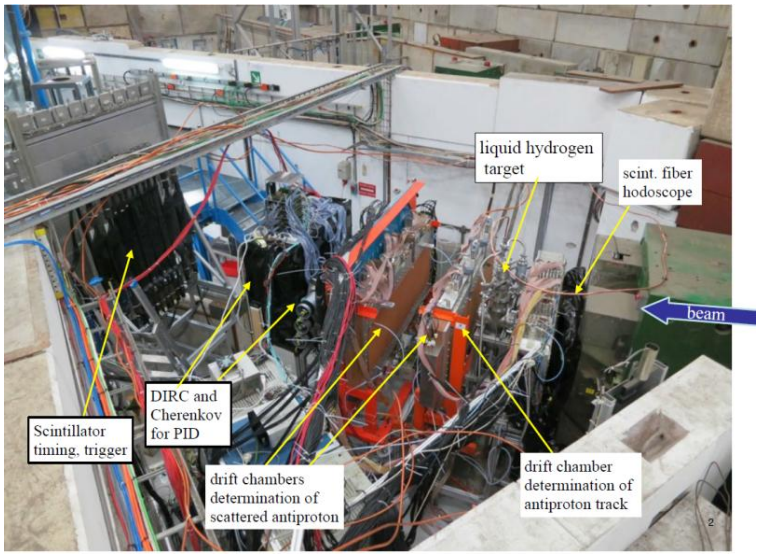


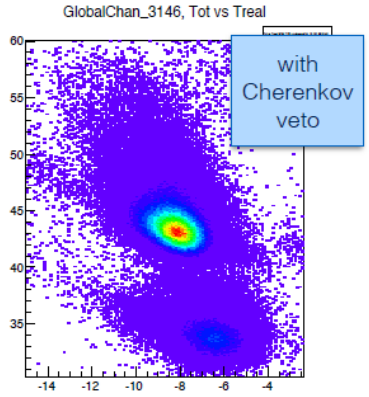
✓ Lower index aerogel trays (n = 1.015 and n = 1.01) are subject to optimize light collection, e.g., PMTs, reflector etc.

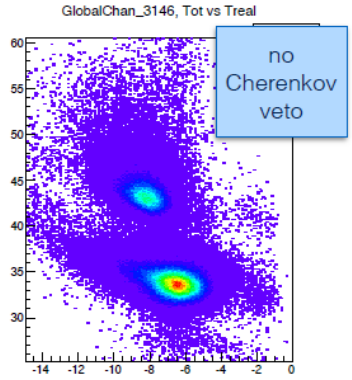
SP 30 in P349 experiment at CERN

Slightly modified BLAST detector with SP 30 aerogel was sent to CERN and worked as a part of PID. Detector has provided good π+/p separation

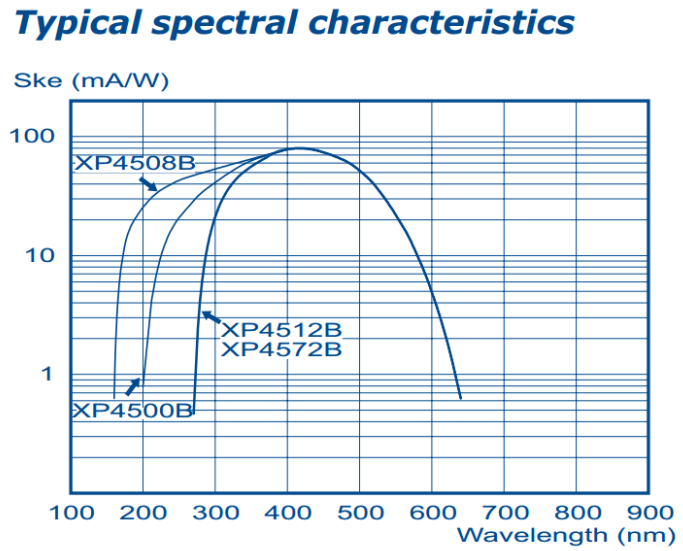


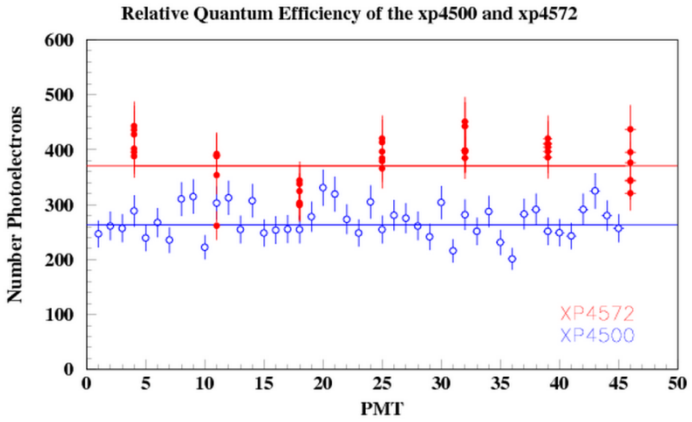






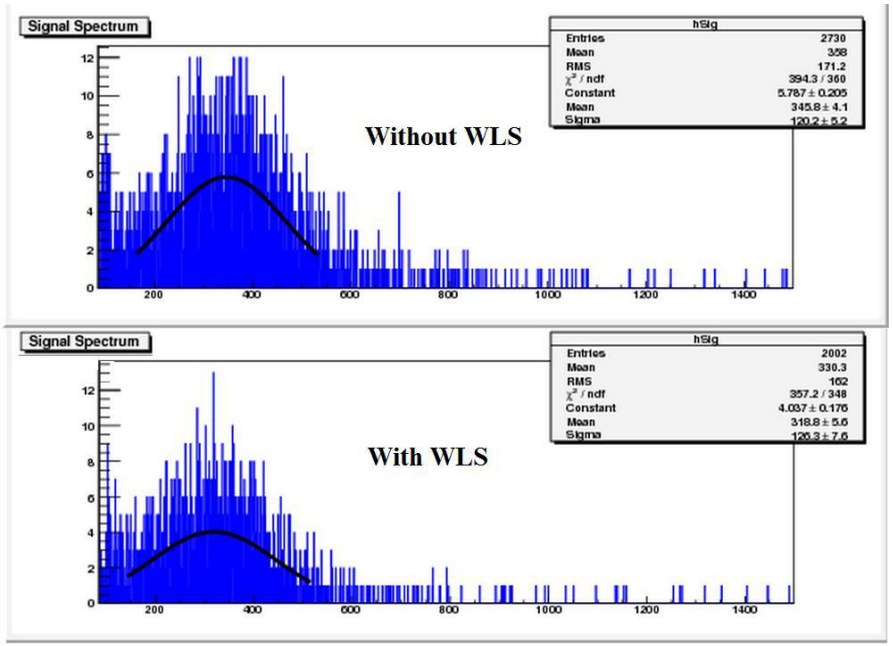
PMT Quantum efficiency





Test with 400nm LED

Prototype test with wave length shifter didn't show any improvement in XP 4500 response



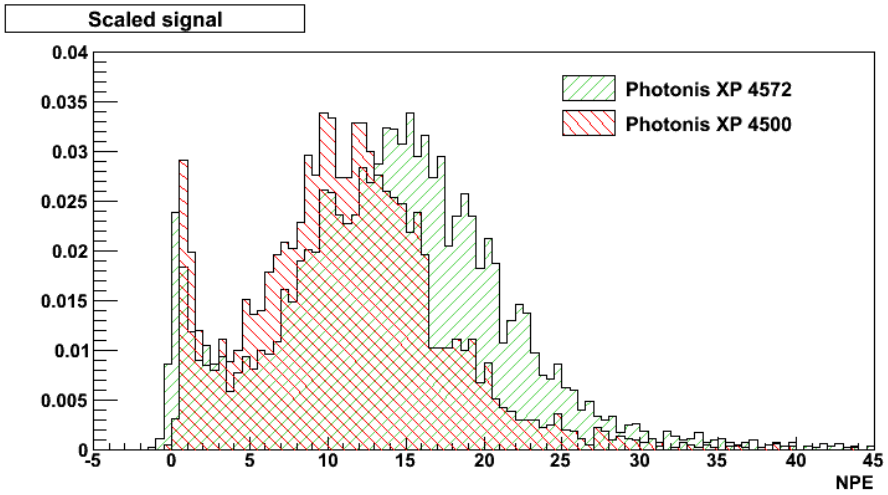
Optimization of the detector performance: XP 4500 or XP 4572?

The obtained set of 14 **XP 4572** PMTs was installed instead of **XP 4500's** to see if we can improve the detector response

Cosmic tests were carried out with one stack of SP30 aerogel (n = 1.03) placed at the center of the tray

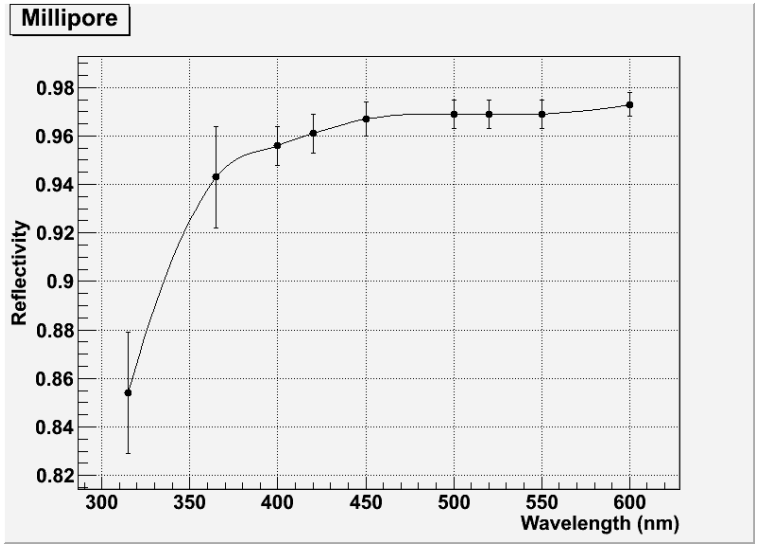
LED source was used for SPE calibration

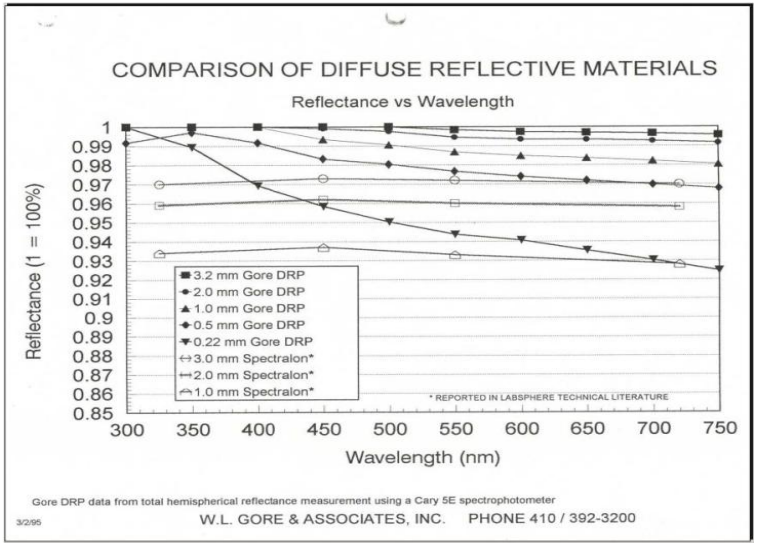
HVs are optimized to keep SPE peaks at ~30 channels for all PMTs



Using XP 4572 PMTs increased signal by 25-30%, which is in agreement with our estimations and measurements of quantum efficiences

Optimization of the detector performance: Reflector choice





According to simulation, using Gore instead of Millipore may increase the detector response by another 25-30%

We obtained 24 sheets of 1mm thick and 4 sheets of 3mm thick Gore reflector (12x30 inch)

Will cover the diffusion box with Gore. If we see good results, the 2 low index trays will be assembled with Gore

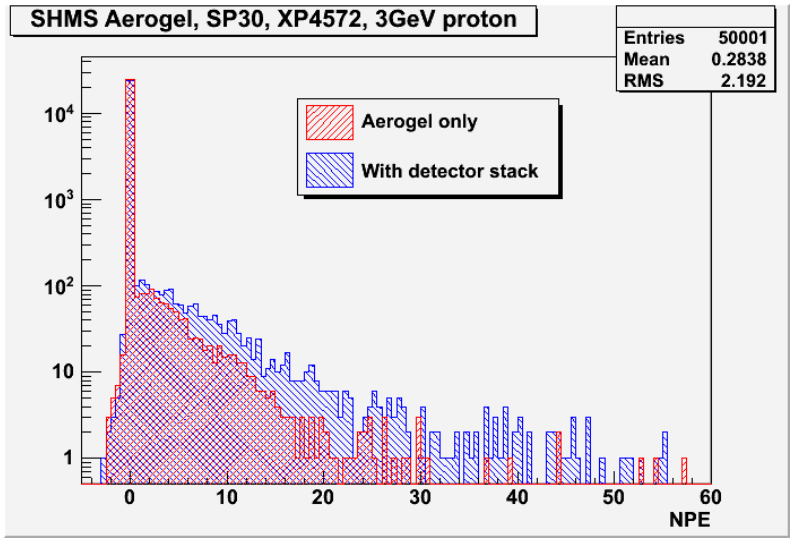
MC Simulation

Electronics effects were added to the MC code for more accurate estimations of the rejection

The main factor deteriorating rejection is the impact of δ-rays produced by the underthreshold particles passing through material

Detectors before the Aerogel counter in the SHMS:
Heavy gas Cherenkov, Drift chambers, Hodoscope, Noble Gas Cherenkov

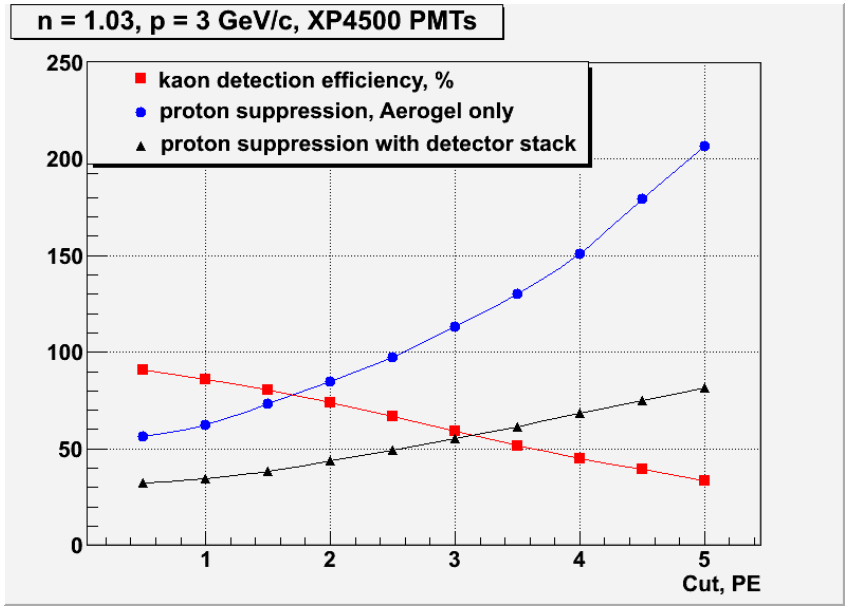
Rejection (suppression) is calculated for two cases – with and without the detector stack material before the Aerogel

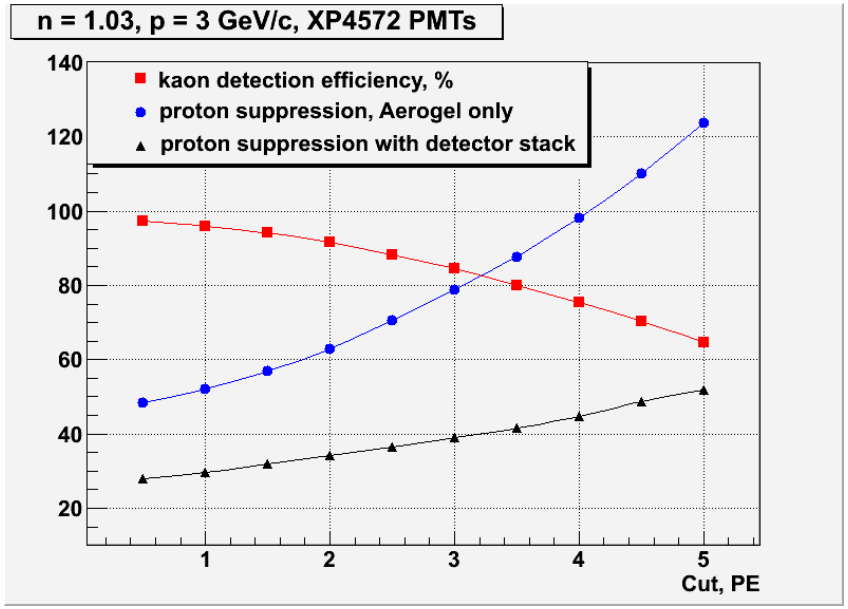


Example of the detector signal induced by the underthreshold proton

MC Simulation: Kaon/Proton rejection and Kaon detection efficiency

SP30 (n = 1.03)

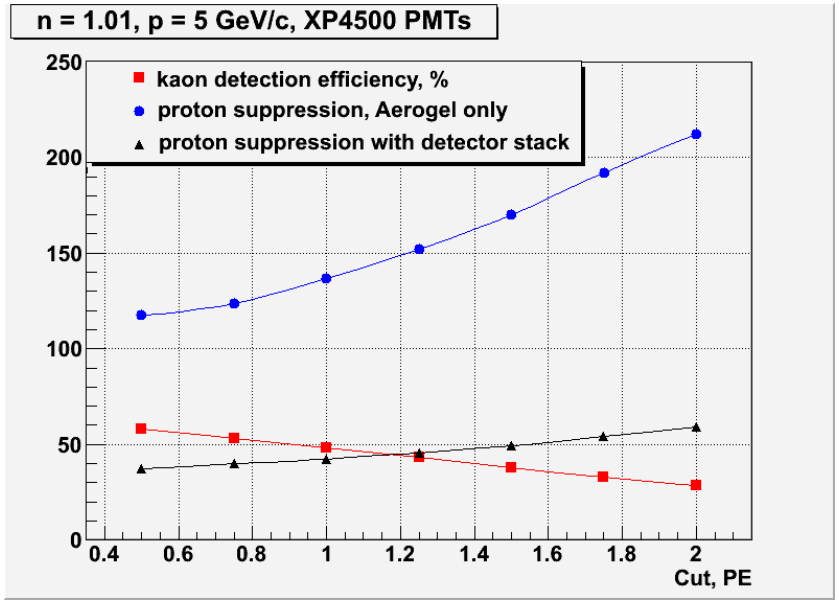


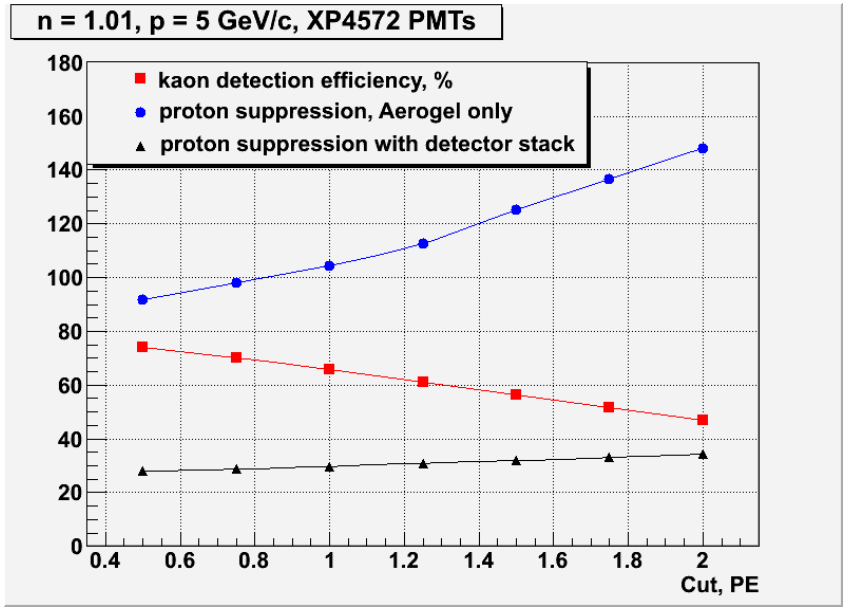


Cut (PE)	XP 4500 Eff (%)	XP 4572 Eff (%)
0.5	91	97
1	86	96

MC Simulation: Kaon/Proton rejection and Kaon detection efficiency

SP11 (n = 1.011)





Cut (PE)	XP 4500 Eff (%)	XP 4572 Eff (%)
0.5	58	74
1	48	66

Summary

- *Diffusion box (with Millipore reflector) and two trays with n=1.030 and 1.020 aerogel are assembled and have been tested with cosmics*
- *Two lower index trays are being optimized to improve light collection*
- *Optimizations include: tests of the PMTs, simulations, and reflectors studies*
- *Materials for publication are being prepared*

Upcoming

- Finalize optimization studies for lower index trays, e.g., make final decision about the PMTs and reflector
- Assemble and test the optimized SP-15 and SP-11 trays