Aerogel Čerenkov Requirements for the SHMS ($e,e'K^+$) Program

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SHMS ($e,e'K^+$) Program

So far, three SHMS experiments require good K^+ identification:

Experiment	Physics Motivation	SHMS Momenta (GeV/c)	Worst Fore/Bkd Rate Ratio
Color Transparency (E12-06-107)	• vanishing of *h-N* interaction at high *Q*. • exclusive π, *K* production from nuclei.	5.1-9.6	1(K):10(p)
SIDIS p_T (E12-09-017)	• extract mean k_T of u,d,s quarks in proton. • SIDIS $\pi^{\pm}$, $K^{\pm}$ production.	1.5-5.0	
K Factorization (E12-09-011)	• study of soft-hard factorization in exclusive K^+ production. • L/T separations vs. Q^2, *t*.	2.6-7.1	1(K):3(p)

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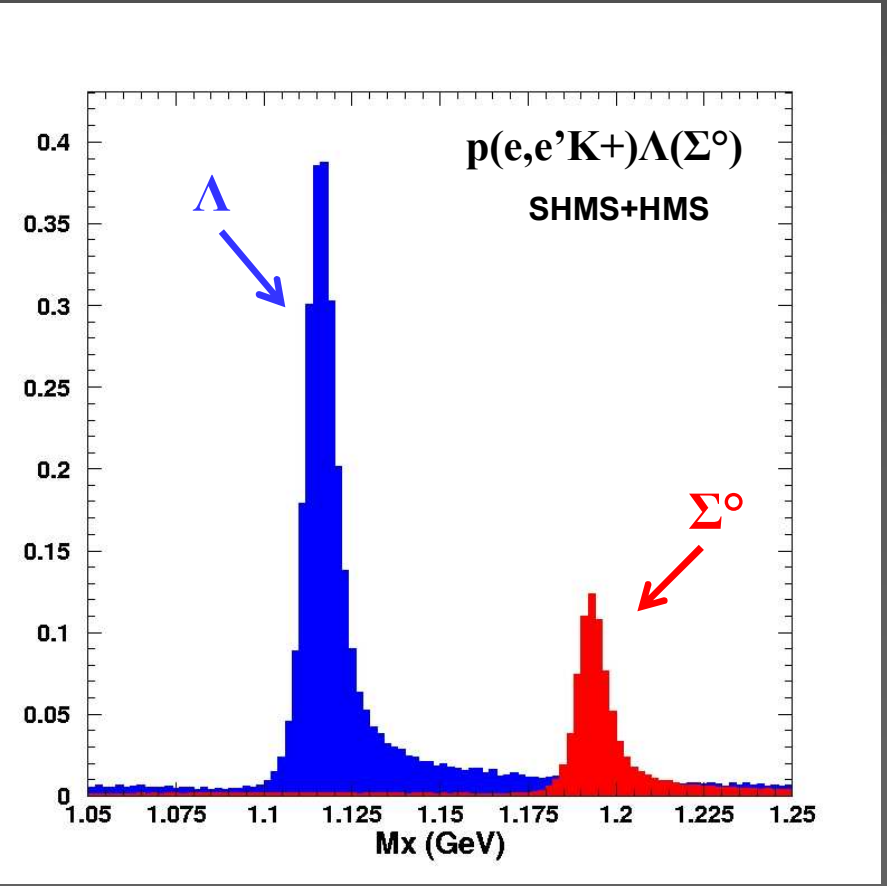
$p(e,e'K^+)$ Missing Mass Resolution

- Example from K^+ Factorization Proposal.
- SHMS+HMS missing mass resolution (~30 MeV) clearly sufficient to separate Λ and Σ° final states
- Good π^+/K^+ (p/K^+) separation using heavy gas (aerogel) Cerenkov is absolutely required.



Simulation at Q^2=2.0 GeV^2 , W=3.0 and high ε.

non-TOF Particle ID @ 1-11 GeV/c

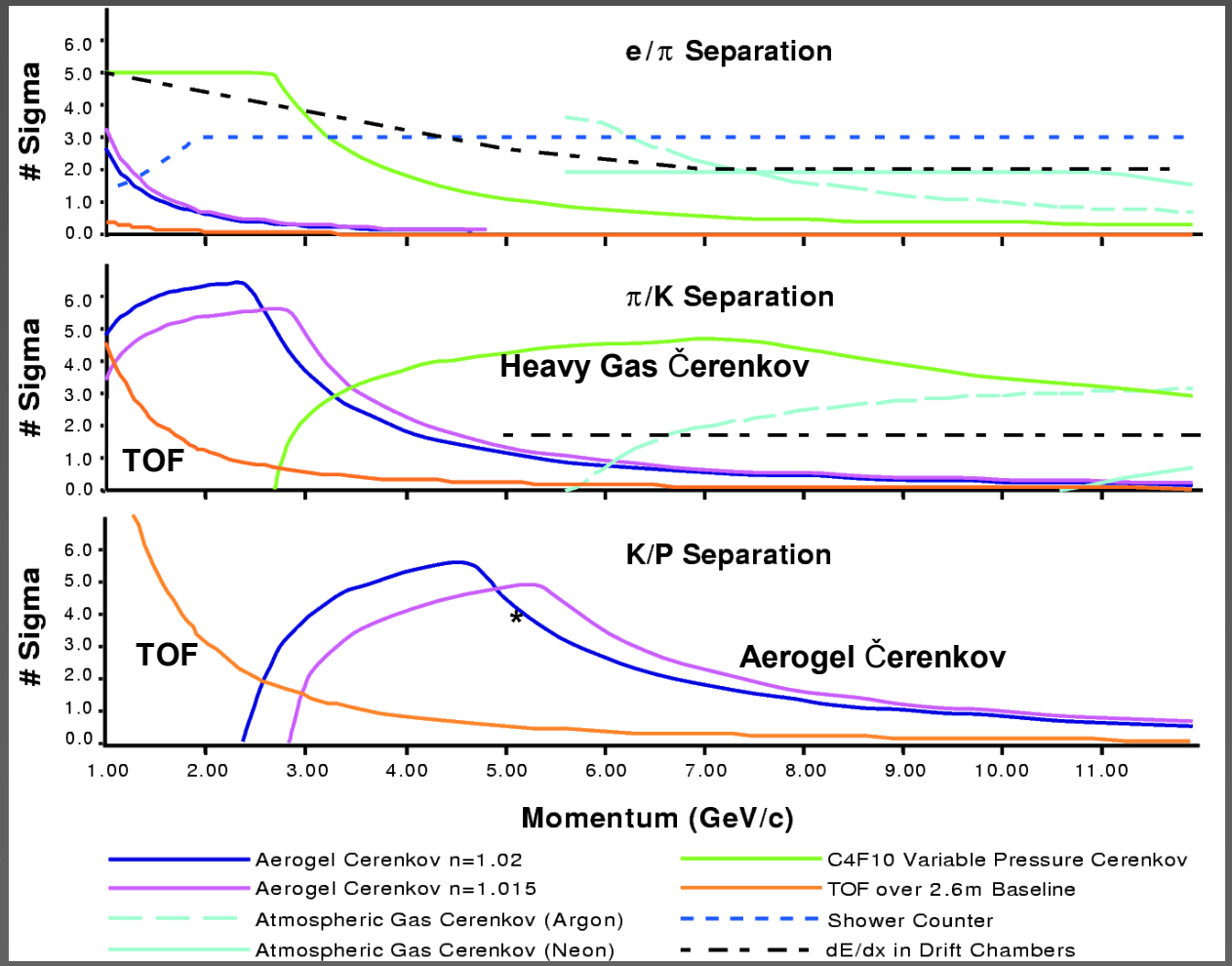
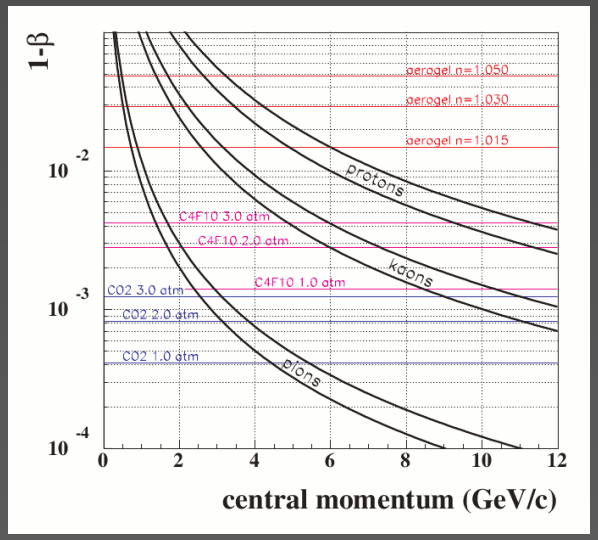


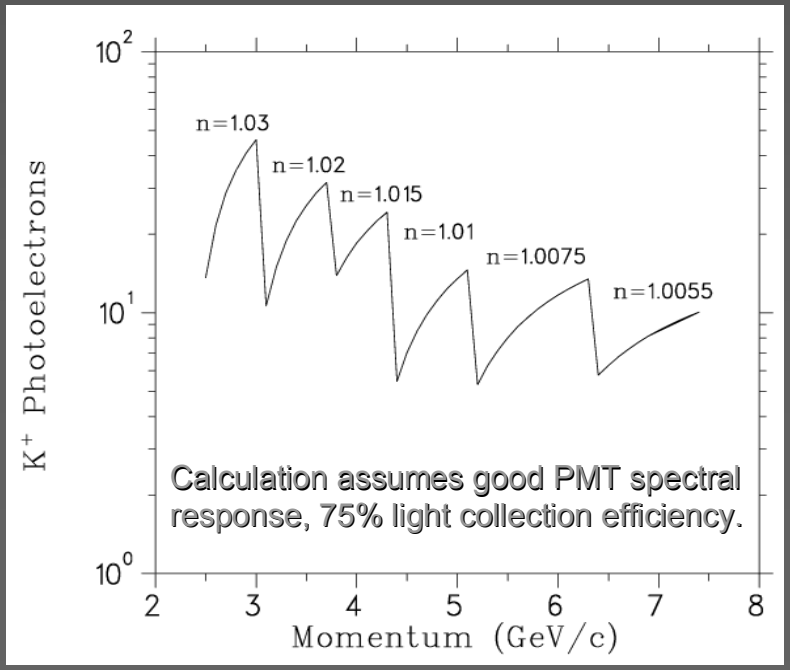
Diagram from SHMS CDR

Note: *n*=1.02,1.015 leads to poor *K/p* separation at higher momenta.

Aerogel Indices of Refraction (*n*)

- ***K/p* separation progressively more difficult at higher momenta.**
- **To maintain reliable *K/p* separation over a wide momentum range aerogels with variety of *n* are required.**





p_{SHMS} (GeV/c)	*n* (10cm)	*K* N_{pe}	*p* N_{pe}
2.5-3.0	1.030	13-46	<0.5
3.1-3.7	1.020	12-31	<0.5
3.8-4.3	1.015	13-24	<0.5
4.4-5.1	1.010	5.5-	<0.5
5.2-6.2	1.0075	5.5-13	<1
6.4-7.3	1.0055	6-9	<1

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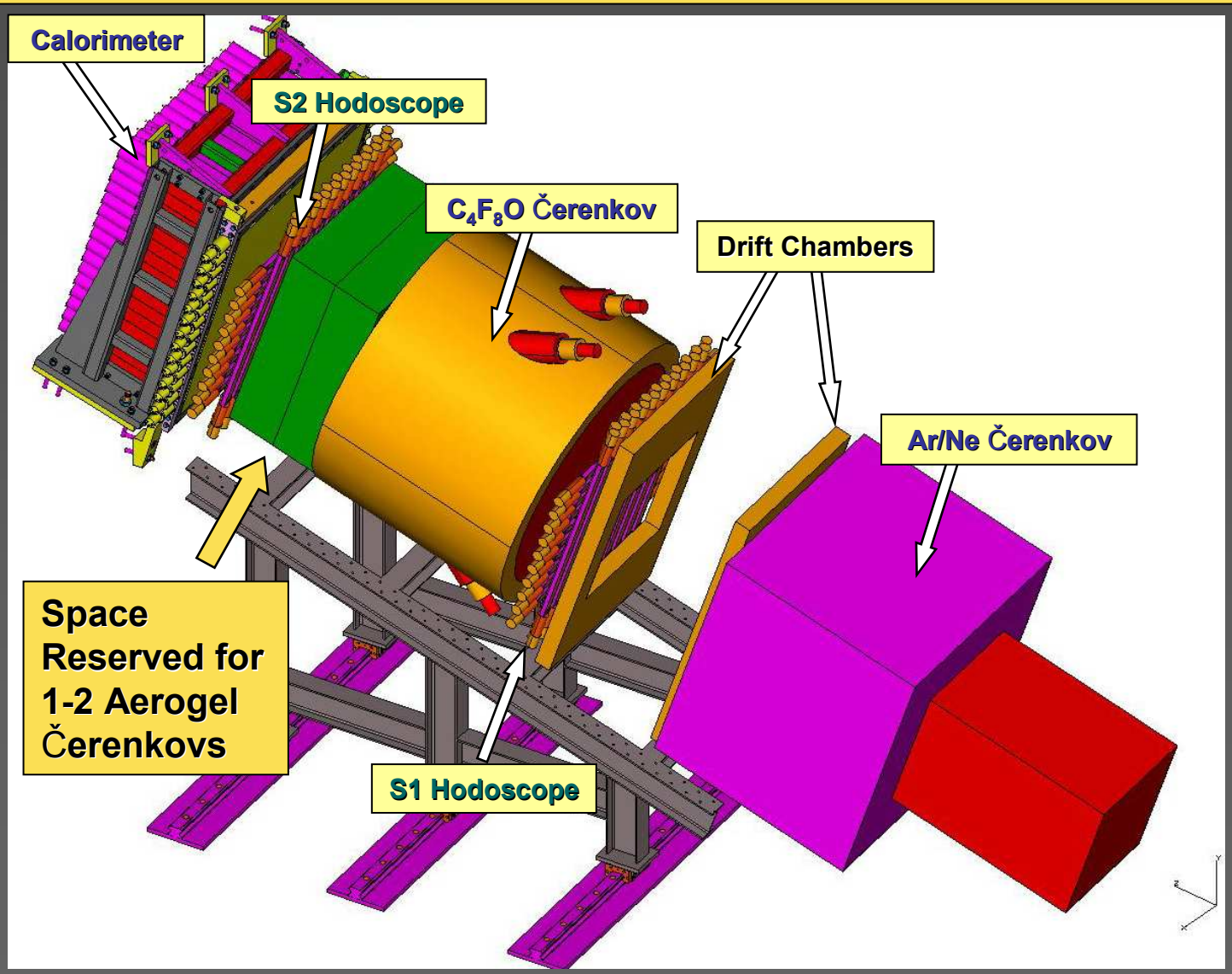
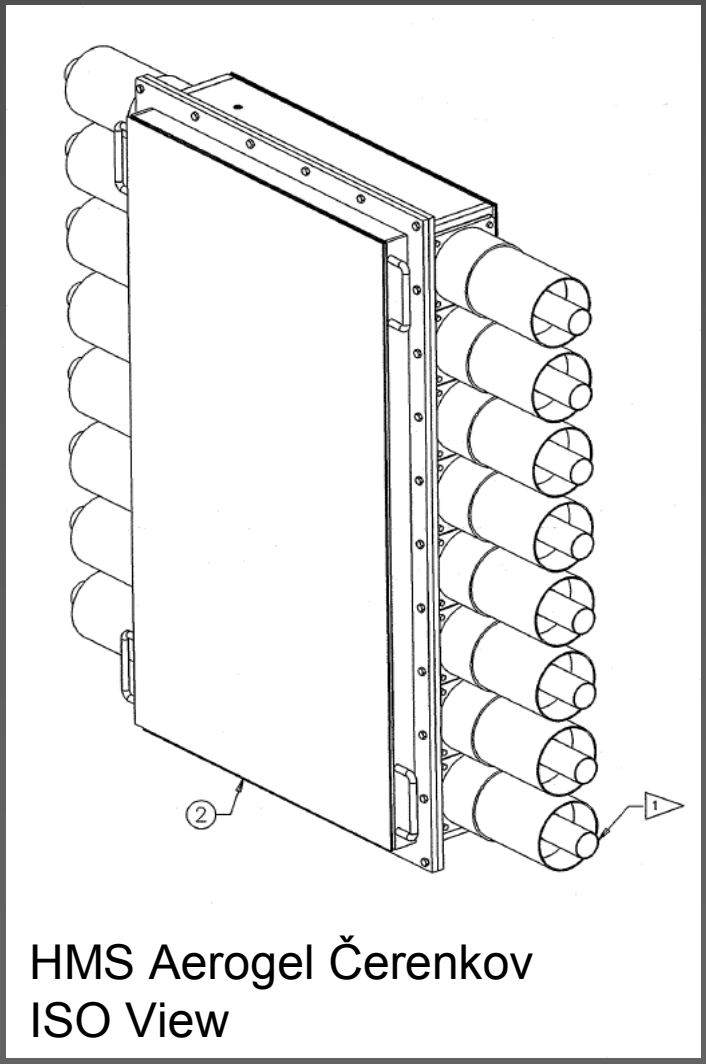
SHMS Detector Stack



Aerogel Čerenkov Design Considerations

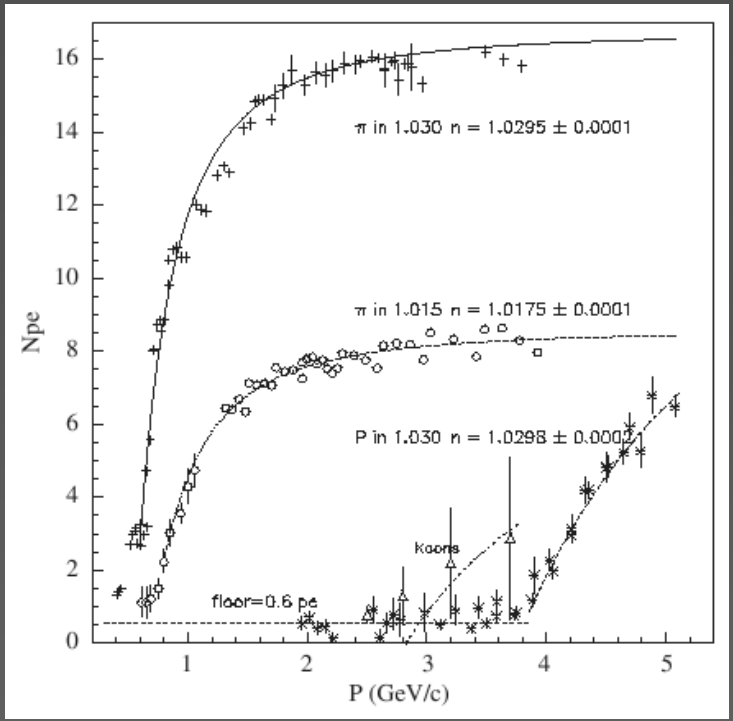
Requirements:

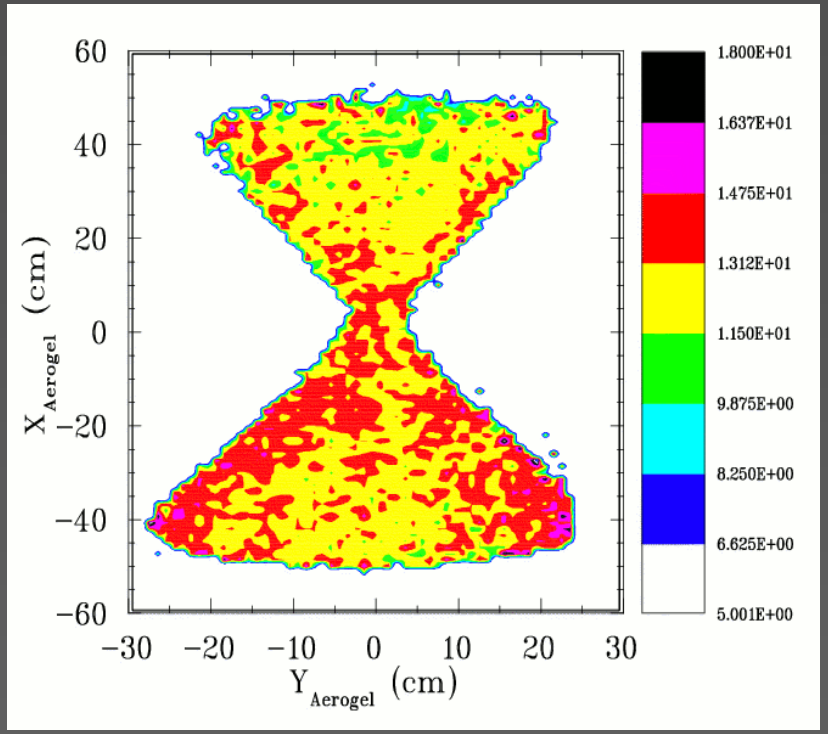
- Easy and fast exchange of Aerogel tray is essential.
- Although only one Aerogel Čerenkov is required at any P_{SHMS}, two detectors would reduce accesses to swap Aerogel when changing momentum.
  - Detector must be slender.
  - HMS Aerogel is 25cm thick.
- Minimum active area: 110x130cm^2.
  - Compare to 70x120cm^2 for HMS.
  - Division into optically isolated segments could enhance high rate capability.



HMS Aerogel Čerenkov
ISO View

HMS Aerogel Čerenkov Performance





R. Asaturyan, et al., NIM A548 (2005) 364.

- **Baseline of 0.6 photoelectrons for sub-threshold particles.**
- **π detection efficiency in n=1.030 aerogel >99% with N_{pe}>4 cut applied.**
- **Variation in total light detected varies by up to 20% across focal plane due to varying path of light through aerogel to PMT and other factors.**

Summary

- Currently, there are three approved SHMS experiments requiring K^+ identification.
  - Anticipate more experiments with this requirement in future.
- Threshold Aerogel Čerenkov detector is simplest and most economical way to satisfy K/p separation requirement.
  - ~6 sets of aerogel with different *n* would enable excellent K/p separation over a wide momentum range.
  - Also helpful to supplement $\pi^{\pm}$ identification below 3.4 GeV/c.
- Design considerations:
  - Helpful if aerogel tray can be changed relatively easily.
  - Very attractive to have 2 Aerogel Čerenkovs in detector stack.
    - Need to watch space requirements very carefully!
  - SHMS beam envelope more square than HMS.
    - Need to avoid efficiency drop in center of detector.