A Scintillating Hodoscope for the SHMS

D. J. Mack
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Why Do We Need a Scintillating Hodoscope?

- Forms the basic trigger:

  need $\geq$ 99.9% efficiency for min.ion. particles,

  robust with respect to loss of a few channels,

  need good background rejection.

- Helps measure the wire chamber efficiency:

  need enough separation between arrays to make a telescope,

  need fine enough pitch to define a beam.

- Permits rejection of accidental coincidences:

  need enough coincidence time resolution to separate RF bursts.

- Provides PID by TOF below 6 GeV/c:

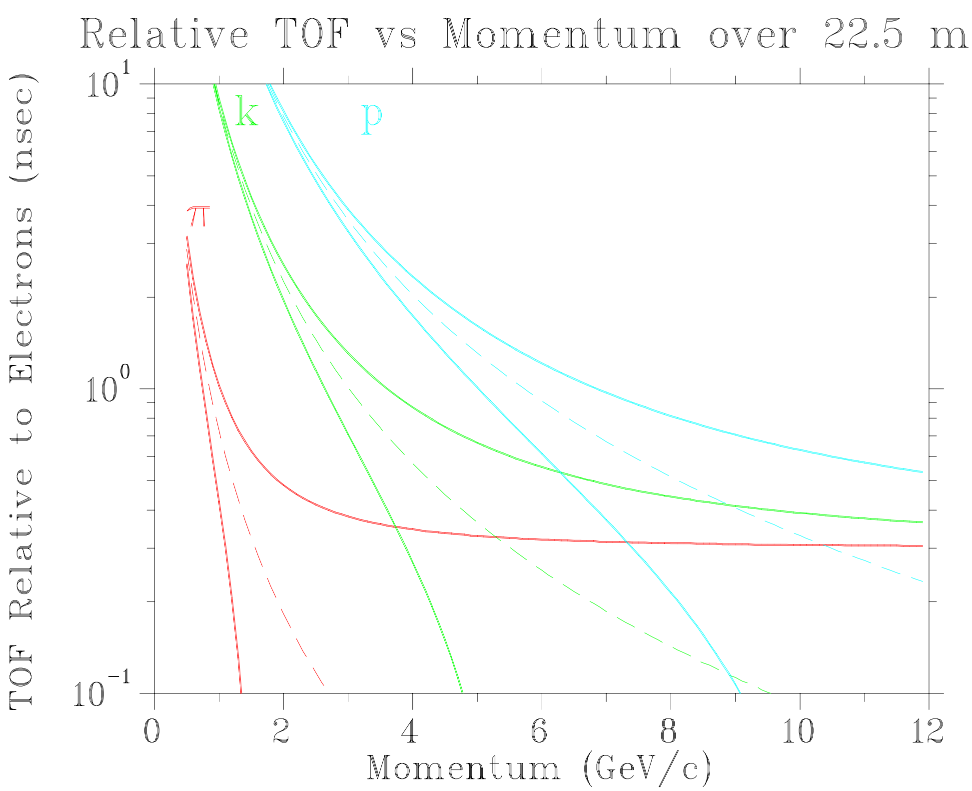
  need at least 200 ps (rms) coincidence time resolution.

I am assuming we will do no PID by TOF inside the detector stack. This is not a bad thing, because it allows us to do other things well.

Particle Identification at 12 GeV

Presently at JLab, many experiments still discriminate hadrons by Time of Flight. Much of this capability will be lost at 12 GeV.

Assuming a conservative 200 ps time resolution (rms) and the criterion that separation should be at least 3σ:

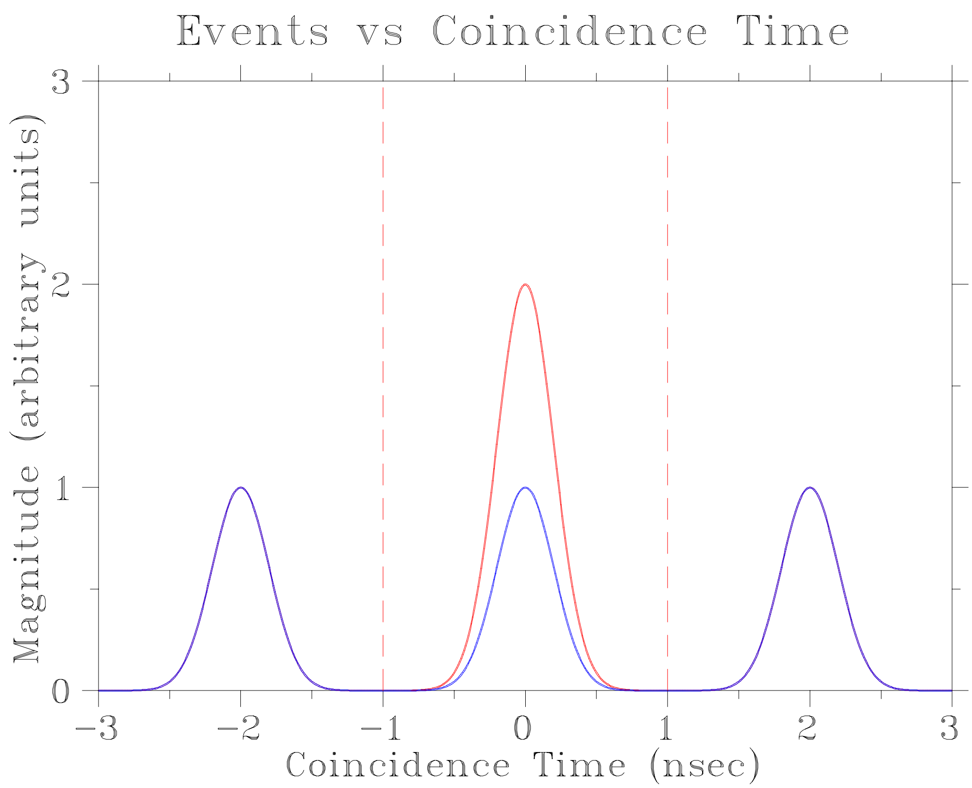


By about 6 GeV/c, TOF won't generally be useful for PID.

Threshold Cerekov detectors will be much more important at 12 GeV.

Rejecting Accidental Coincidences

A coincidence time resolution of 200 ps in principle provides the ability to make a clean, 5σ cut on the real coincidence peak.



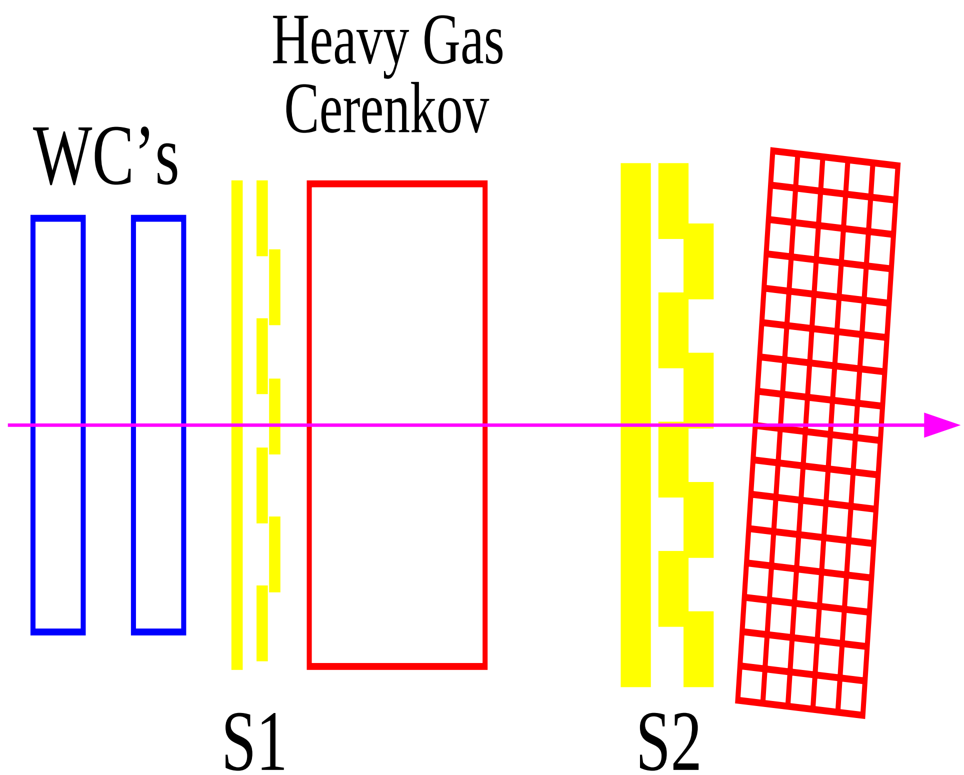
An SHMS focal plane time resolution of 100 ps will easily allow us to achieve this.

Performance Specifications

- **SHMS focal plane time resolution of $\leq$ 100 ps**
- **Downstream detectors should be minimally impacted.**[1]
- **Good pulse height uniformity versus position**
  for better efficiency, to simplify calibration interpretation of histograms.
- **10 year lifetime before major overhaul**

[1] Significant impacts need to be resolved by optimizing the performance of the detector stack rather than a single detector.

The Modest Proposal



- Two X-Y scintillating hodoscope arrays: S1X,Y and S2X,Y
- 2 m separation, with S2 against the Calorimeter.
- "Standard" hodoscope trigger would remain "3/4".
- S1 will be "thin" (eg, 5mm) to minimize knock-on electrons.
- S2 will be "thick" (eg, 1cm-2.5cm) for good time resolution.
- Long attenuation length scintillator like BC408
- PMT: 12-stage like the XP2262B
  operated at low anode current for long lifetime,
  probably need a preamplifier.

The Immodest Proposal

Several things that have bothered me about the traditional JLab detector stack:

1. Scintillator is sensitive to low energy backgrounds (especially nice, *thick* scintillators). In low signal/noise conditions even a 3/4 trigger can be very dirty.

2. Detection of heavy hadrons (protons, deuterons) has been done without the benefit of a Cerenkov detector which could have suppressed low energy backgrounds.

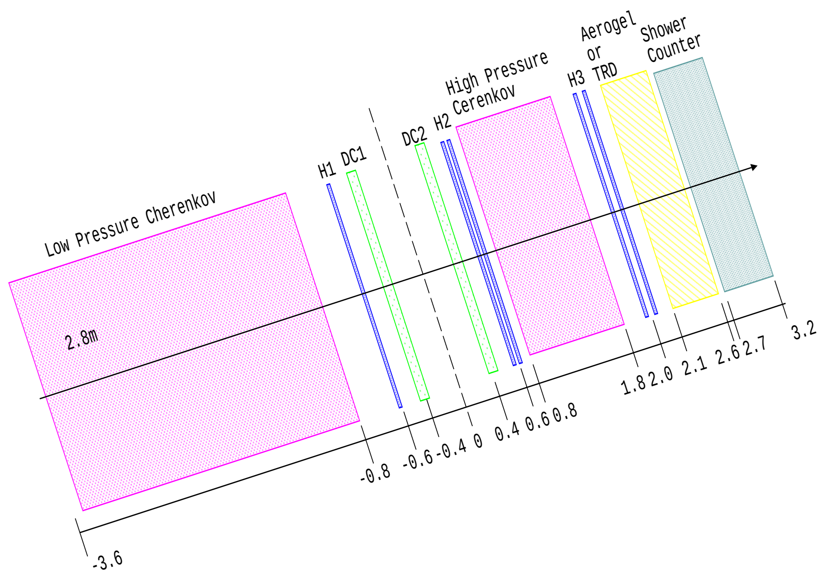
It may be possible to solve both problems, without requiring a new detector[2], by using a quartz Cerenkov hodoscope for the rear array.

This question will be answered in the next few years as a result of R&D for the Qweak experiment.

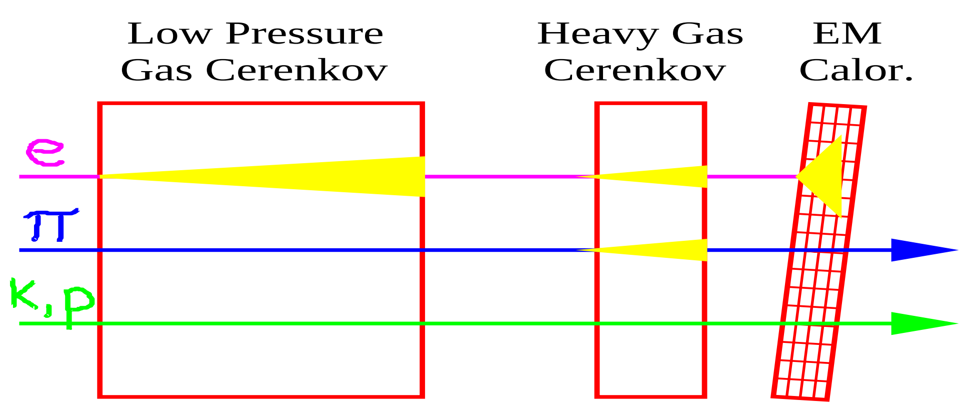
[2]One could argue that the first layer of the Lead Glass calorimeter has always given us this capability, but the probability of absorbing the hadron is high.

SHMS Detectors

The SHMS detectors will be broadly similar to the present HMS detectors, with several critical modifications for PID at large momenta:



- $e-hadron$ discrimination will require a longer, lower pressure gas Cerenkov.
- $\pi-k$ discrimination will require a heavy gas Cerenkov.



Summary

The Modest Proposal is to make the SHMS hodoscopes a slightly improved version of the HMS hodoscopes, with one fundamental change in that the forward array would be relatively thin.

In the Immodest Proposal we would seriously consider making the rear array out of quartz.

I plan to let modelling and prototyping answer the question.