Some Mundane Details

1. Getting help: see Aspasia (Rm 213) or Henry (Rm320) for help with lodging, transportation (e.g. cabs), food, .. Mary Heintz for computer/wireless/etc.
2. Wireless is HEPWAP4- runs on timer
3. Building is open Friday-we will have to prop open the HEP side door Sat.
4. Please do not take the Red Line or Green Line CTA- use cabs or Metra or the CTA #6 bus (ask Ossy about the Green Line);
5. Lunch will be brought in today and Sat; Friday dinner is at Cedars on 53rd St.

Goals of the Workshop

Henry Frisch
Enrico Fermi Institute, Univ. of Chicago

Outline

1. Context
2. What Do We Need?
3. The Goals for the 1st Workshop (Klaus)
4. Some Motivation (pictures)
5. Goals of This Workshop

Context

Phototube technology is being stressed by the lure of SiPMT's, shrinking scientific markets, and market forces- and yet there are areas in which PMT's and MCP-PMT's are unsurpassed:

1. Large-area (> or >>m^2--whole-body PET, neutrons, animal PET,neutrinos, colliders, fixed-target);
2. Gain- (> 10^7)
3. Noise (<0.1 counts/cm^2 from MCP pair)
4. Gain x bandwidth x area/cost

(New Figure of Merit ~10^{18} $cm^2 sec^{-1} \$^{-1}$)

(can we define a new unit?- the ? Need 1/resolution too..)

What Do We Need?

1. Higher efficiency (form factor x QE …)
2. New Assembly methods for large-areas
3. High and tight yields
4. Integrated systems optimized for specific applications
5. Extension into new areas in parameter space (time, space, rate, hardness, wavelength,…)
6. `The pull of the customer' (Michael M)

All these lead to lower cost; but the PC drives

It would be a tragedy to lose the knowledge and a healthy competitive environment for vacuum photodevices

The goals of the 1st workshop:

Klaus slide from 1st Cathode Workshop:

What is Our Goals?

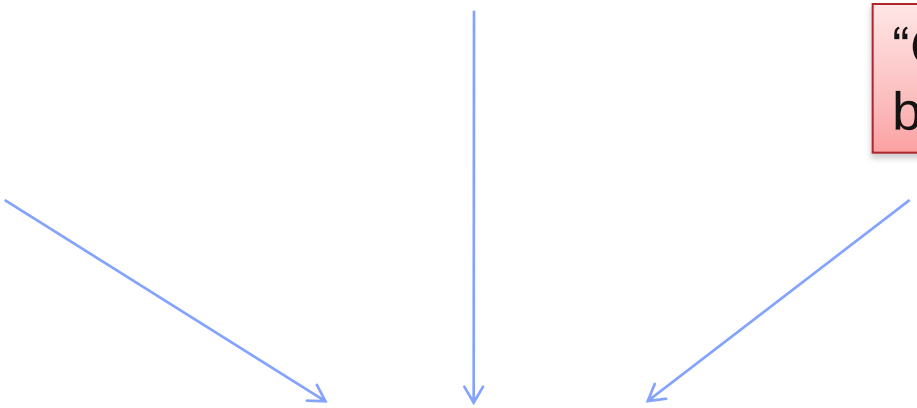
1. Discuss and agree on the basic underlying physics processes (Finding a common Language)	**Yes**
2. Bring up and explore new directions, materials, techniques, and geometries	**Yes**
3. Elucidate the trade –offs between conventional choices: transparent/reflective, bialkali/III-V, etc.	**?**
4. Clarify the requirements for large-area photo-cathodes (Vacuum, fabrication, lifetime, mechanical & chemical)	**Yes**
5. Identify the most promising conventional materials for high-QE, low-noise cathodes in the 300-500nm range	**Yes**
6. Identify additional resources, facilities, and (possibly) collaborative efforts	**Yes**
7. Contribute to narrowing the possibilities for this year's work on photo-cathodes to a few most promising paths	**Yes**

The Three Criteria: *

Long lifetime of the device & easy to assembly

High efficiency & bandwidth optimization

"Good" noise behavior

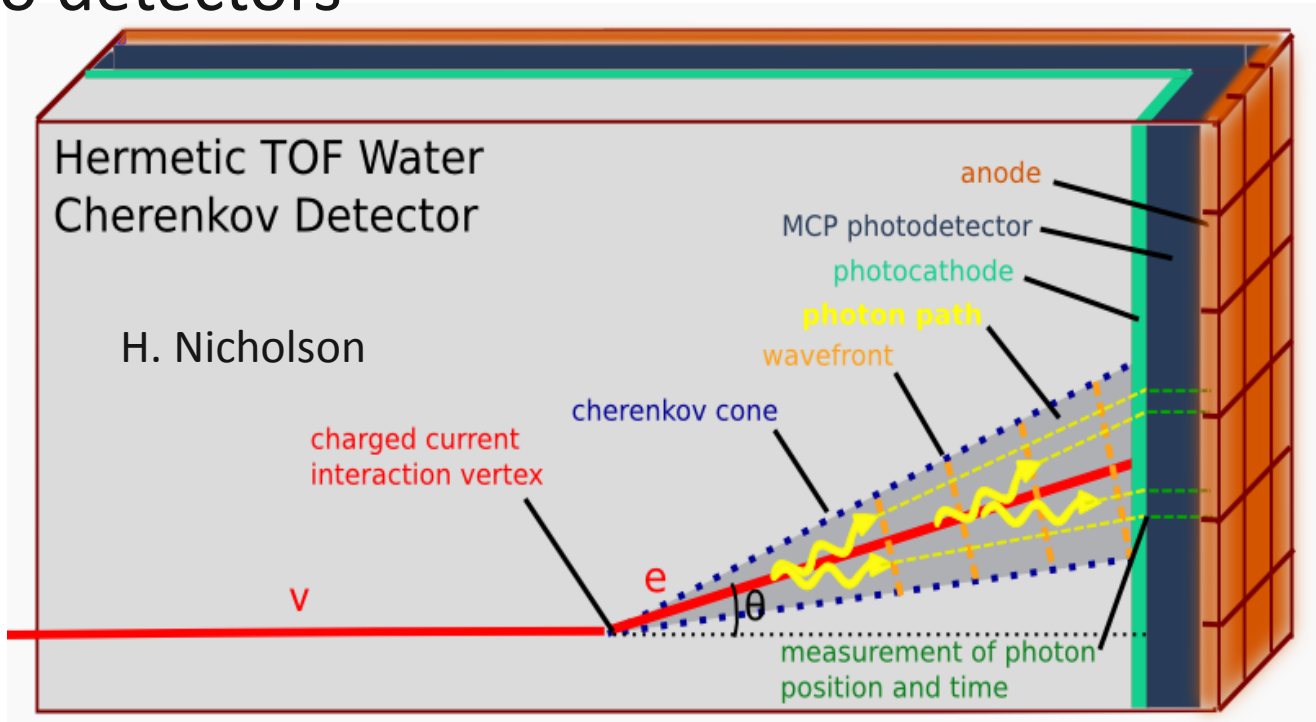


What is the best structure for a good and cost-efficient Photocathode?

* **Klaus slide from 1st Workshop on Photo-cathodes: 300-500nm July 20-21, 2009: University of Chicago**

Neutrino Physics

Need: lower the cost and extend the reach of large neutrino detectors



Approach: measure the arrival times and positions of photons and reconstruct tracks in water

Benefit: Factor of 5 less volume needed, cost.

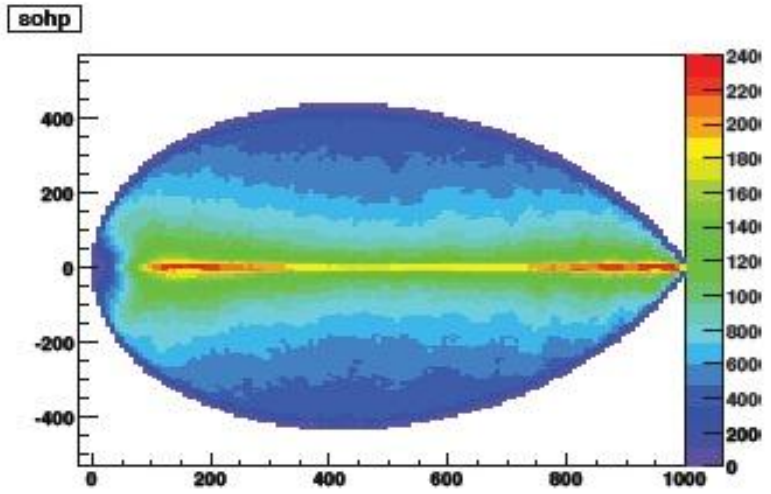
Competition- large PMT's, Liquid Argon

Can we build a photon TPC?

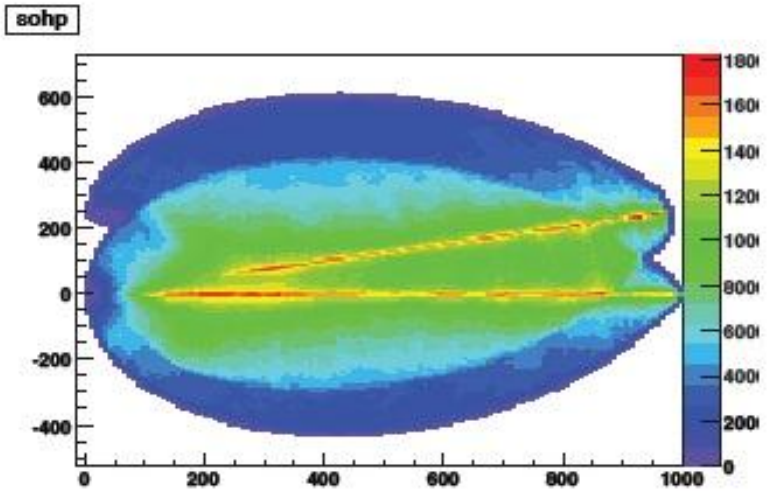
Track Reconstruction Using an "Isochron Transform"

Results of a toy Monte Carlo with perfect resolution

Color scale shows the likelihood that light on the Cherenkov ring came from a particular point in space. Concentration of red and yellow pixels cluster around likely tracks



Single track



Two tracks displaced from a common vertex

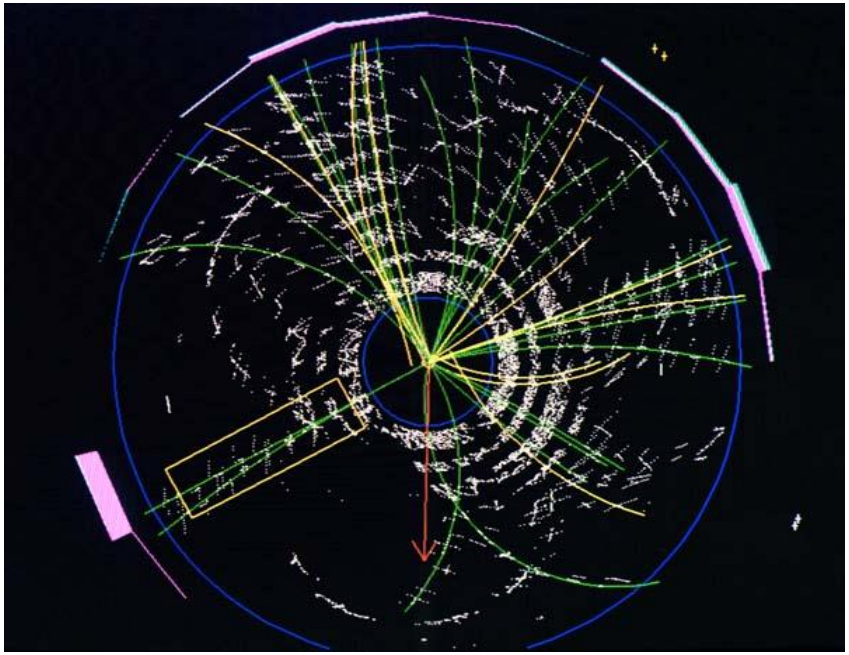
Work of Matt Wetstein (Argonne,&Chicago) in his spare time (sic)

Colliders:

Need: 1) identify the quark content of charged particles

2) vertex photons

Extract *all* the information in each event (4-vectors) – only spins remain…

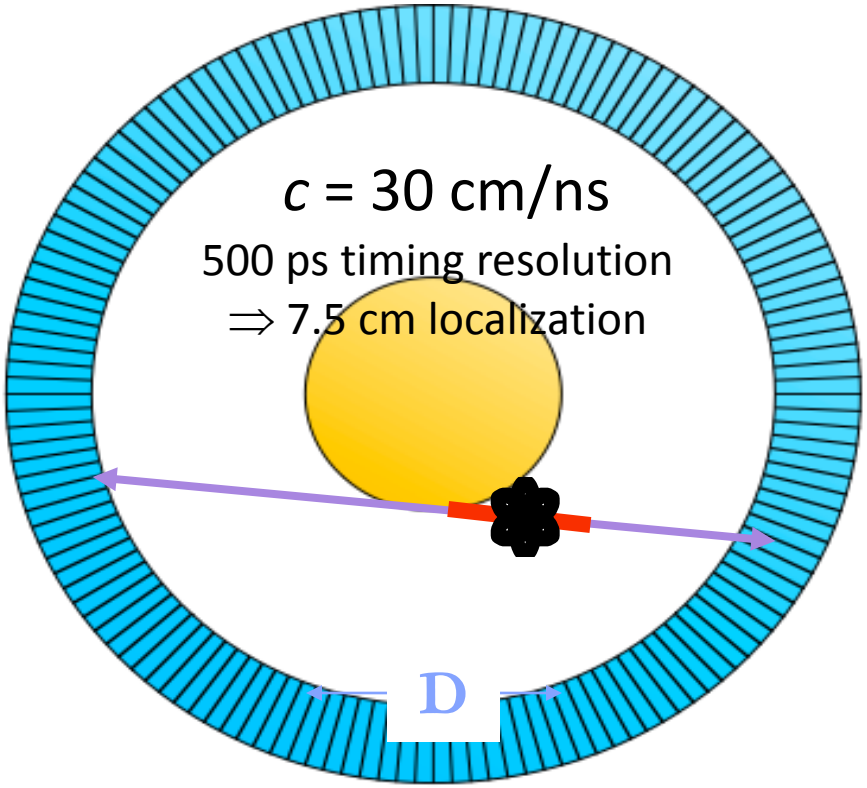


Approach: measure the difference in arrival times of photons and charged particles which arrive a few psec later. Light source is Cherenkov light in the window/radiator.

Benefit: Discoveries in signatures not possible now

(Note: conventional TOF resolution is 100 psec -factor of 100 worse than our goal= 1” is 100 psec, so need a small scale-length).

Application 3- Medical Imaging (PET)



Bill Moses Slide (Lyon)

Can localize source along line of flight.

Time of flight information reduces noise in images.

Variance reduction given by $2D/c\Delta t$.

500 ps timing resolution
⇒ 5x reduction in variance!

Time of Flight Provides a *Huge* Performance Increase!
Largest Improvement in Large Patients

Goals of the Workshop

The proposed goals of the workshop are to:

1. Understand deeply the chemistry and physics of alkali photocathodes.
2. Discuss/propose experiments, measurements and theory that would answer remaining questions;
3. Foster collaborative efforts to bring a broad and powerful variety of photodetectors with high QE into the application areas.