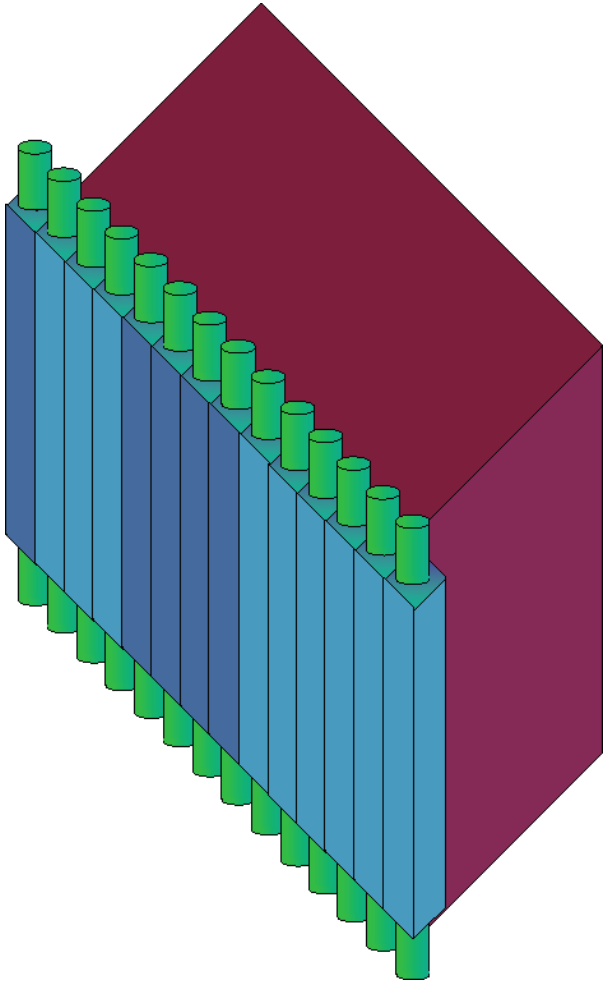
Time of Flight for E907

Tim Bergfeld
U. of S. Carolina



- Introduction
- Current Design
- Time Resolution
- Physics Issues

University of South Carolina
High Energy Physics Group

The Justification for TOF

The dE/dx measurements of tracks from the TPC will give Particle ID up to about 0.9 GeV/c

The Cherenkov detector thresholds are 2.5 GeV/c for pions, 7.5 GeV/c for Kaons and 17.5 GeV/c for protons

Leaves a range of momentum between 0.7 GeV/c and 2.7 GeV/c with no Particle ID

This is the job for the TOF detector

Pion/Kaon separation for tracks between 0.7 GeV/c and 2.7 GeV/c, and Kaon/proton separation at higher momenta

University of South Carolina
High Energy Physics Group

Previously Built TOF Systems

Experiment	Size of Scintillator	Time Resolution
CLEO	2.8m x 5cm x 10cm	150ps
CDF	3m x 4cm x 4cm	~100ps
OBELIX	3m x 9cm x 4cm	170ps
E813	3m x 8.5cm x 5cm	110ps
CLAS	4.5m x 5cm x 15cm	160ps

Now we want a good system using avaialable materials.

Our goal is 200ps −− better would be nice.

This gives give 2.4 σ separation for K/π at 2.0 GeV/c

University of South Carolina
High Energy Physics Group

Current Design

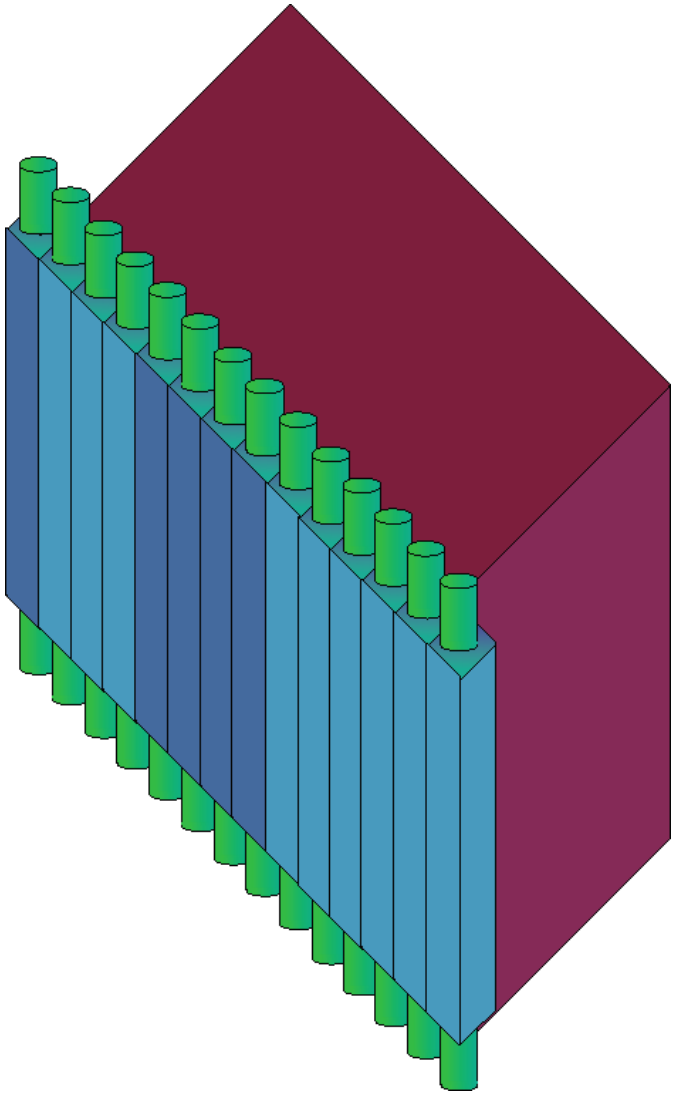
One Plane

88 Bars of 5cm x 5cm x 2.8m
2.8m x 4.4m coverage

Vertically placed right before ROSY

One photo tube on each end

Currently we are prototyping the bars at U. of S. Carolina



University of South Carolina
High Energy Physics Group

Available Parts

The 88 bars are from the CLEO experiment and are at FNAL.

These have one sawed face from a CDF attempt to use them

Will have to be polished and wrapped.

However these are old, circa 1990, and at 7% light reduction per year, we have only 40% light output of the original bar. Thus we should expect a time resolution of 150ps / $\sqrt{0.4}$ = 237ps in the best case.

Phototubes:

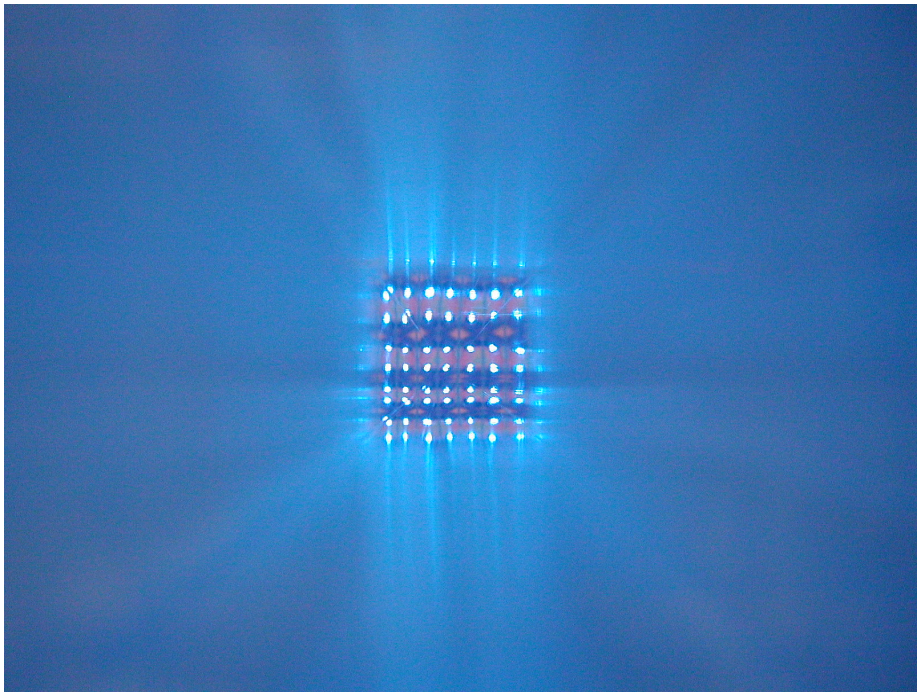
A stash of 31mm 10stage phototubes (XP2008's) are in Lab 6.

These tubes need bases. We have 4 at USC.

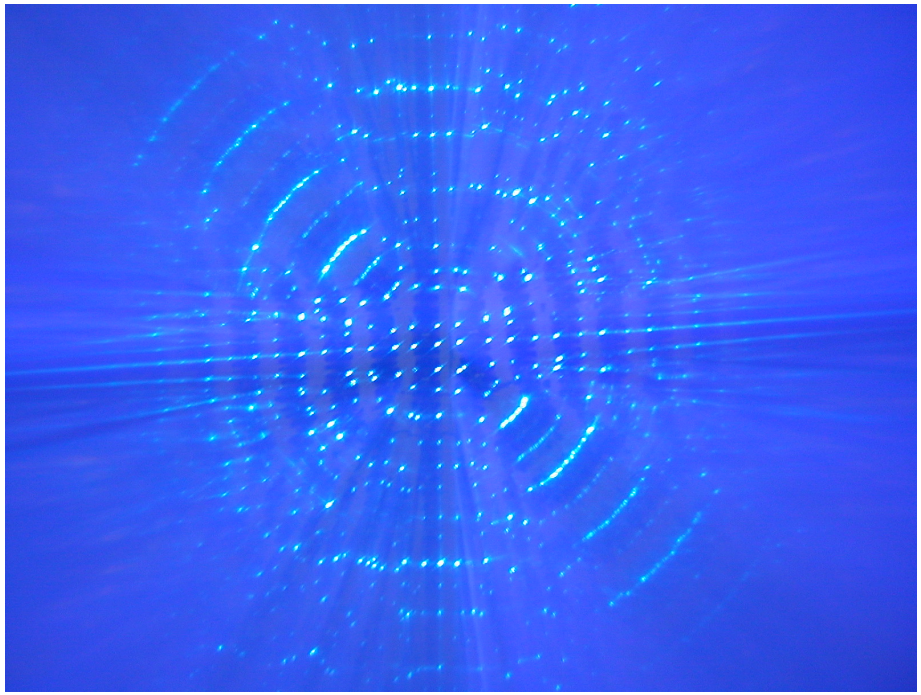
Other tubes of various kinds are in Lab 6

Polishing the Bars

Compare light transmission through the bars from a blue LED at the center of the far end. Now we look at how well the bars reflect the light.



Fermilab Polished



Diamond Mill Polishing at Saint−Gobain (BICRON)

University of South Carolina
High Energy Physics Group

Time Resolution

FNAL polished bar with 31mm tube at one end:

600ps 2.2ns

600ps 1.45ns

370ps

S−G polished bar with 31mm tube at one end:

Signal has about twice the amplitude as with FNAL bar

FNAL polished bar with 51mm tube at one end:

Resolution follows $T/\sqrt{N}$ or simple photo statistics

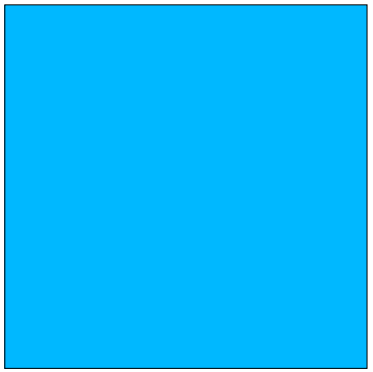
More photons == Better resolution

The resolution for the whole system will be about $\sqrt{2}$ lower in the center of the bar with the second phototube

University of South Carolina
High Energy Physics Group

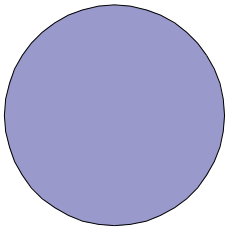
Phototubes

End of Scintillator

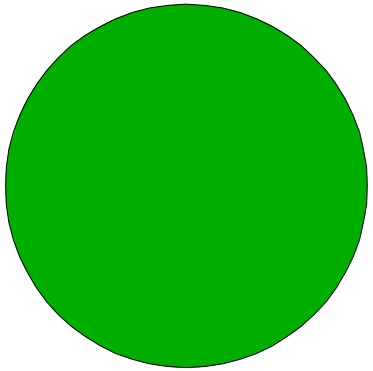


5cm square

31mm Tube



51mm Tube



31mm tubes are what is available in Lab 6

If we need to collect more light, the larger 2" tubes have a better match the the size at the end of the scintillator. Thus more photons.

- 4 tubes ordered from Hamamatsu tubes will arrive end of March
- We have a few from around USC
- 4 tubes from Livermore have arrived.

Will try using a light guide to collect the photons and improve the phototube scintillator coupling.

University of South Carolina
High Energy Physics Group

Time of Flight

Proposal was for a fictitious $160,000 −− Know to be low at the time and assumed using only available parts.

Polishing the bars:

Saint−Gobain charges $450/bar for polishing	$39,600
Saint−Gobain for new bar $820/bar	$72,160
FNAL??	
USC?? Can somewhere else polish the bars?	

Phototubes:

31mm tubes from FNAL	$0
Bases for tubes (about $300 each)	$52,800
51mm tubes from Hamamatsu, H6156	
Includes the bases (about 1400each)	$246,400
Without bases (R5496 −− 1100 each)	$193,600

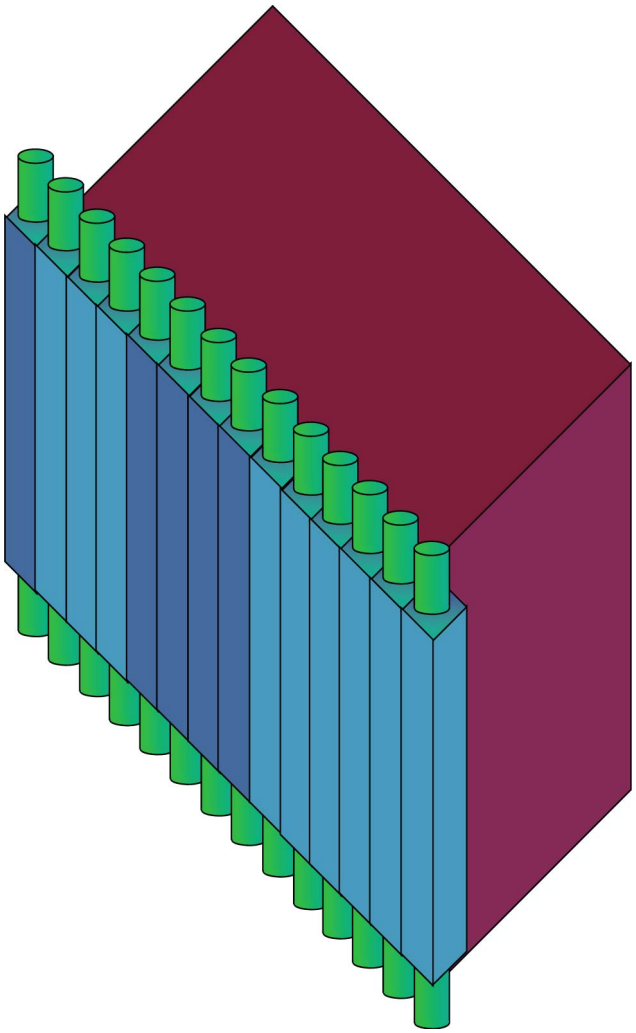
USC has a preapplication in for SSAAP money from DOE

University of South Carolina
High Energy Physics Group

Physics Issues

With placement in front of ROSY we have 5cm or 0.12 radiation lengths in the beam. Is this a problem for tracking resolution?

What sort of frindge fields will be present at the phototubes from ROSY's magnetic field? How much sheilding will be required for the phototubes?



Monte Carlo: will get the right geometry and readout into Geant.

Mostly being done at USC may need extra help when assembly time comes.

University of South Carolina
High Energy Physics Group