Forward Tracking Hodoscope

M. Khandaker

SANE Readiness Review

July 2, 2007

Goals and Requirements of the Tracker

Goals:

- *Provide redundant and efficient electron detection with limited tracking resolution to suppress background.*
- *Reject non-target related backgrounds.*
- *Determination of particle charge sign – discriminate low momentum positrons from electrons.*
- *Measure positron asymmetry for transverse field configuration.*
- *Partially reduce positron contamination of electron sample.*

Requirements:

- *Locate detector as close to target as possible to reduce knock-ons.*
- *Detector as thin as possible.*
- *Operate in high magnetic field ($\sim$2 kG) region.*
- *For p=1 GeV/c particle, need position resolution of $\sigma_y \sim$1–2 mm to determine particle charge sign (from simulation studies).*

Tracking Hodoscope Design

Location and Size:

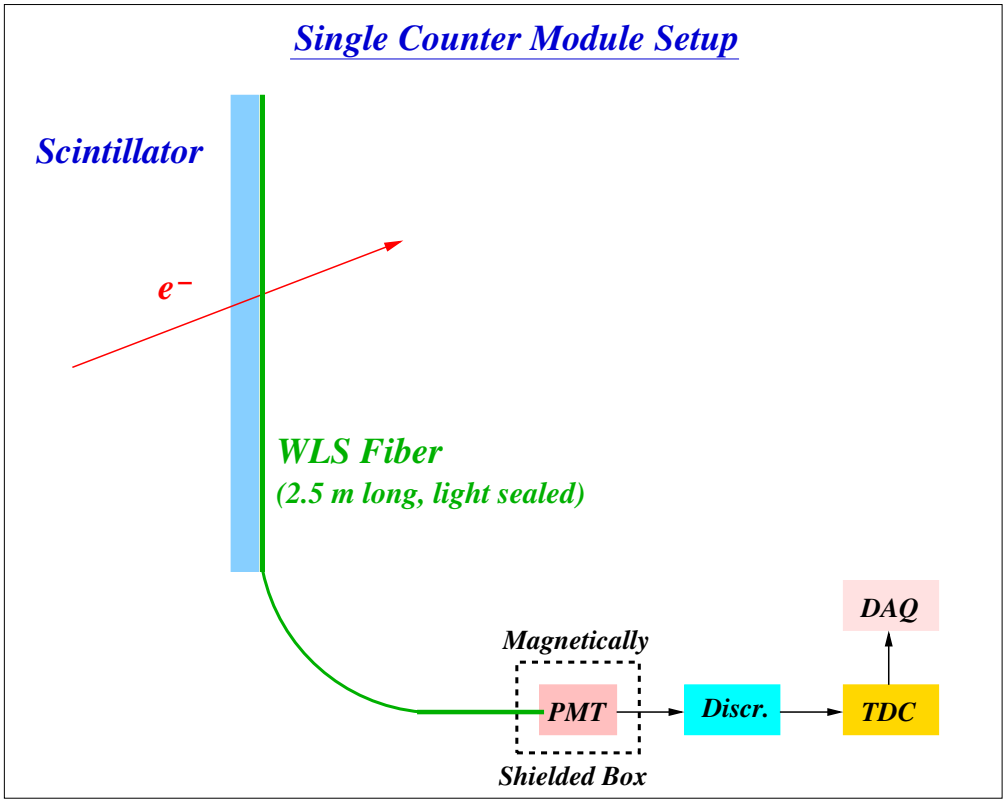
- *Located 50 cm downstream of target directly in front of gas Čerenkov.*
- *Active area: 40 cm (vertical) $\times$ 22 cm (horizontal).*
- *133 bars along vertical and 73 along horizontal.*
- *Two Y planes, offset by 1.5 mm for redundancy, and one X plane.*
- *Expected position resolution: $\sigma_y \sim 0.9$ mm.*

Material:

- *Bicron BC-408 Plastic Scintillator (3 mm $\times$ 3 mm square).*
- *Bicron BCF-92MC multi-clad blue-green WLS Fiber (1.2 mm $\varnothing$, 2.5 m long).*
- *Fiber glued on to scintillator surface along length of bar.*
- *Scintillator/Fiber unit wrapped with Teflon for reflectivity.*

Tracker Readout System

- ***Single-ended readout with multianode PMT.***
- ***Discriminator plus TDC per channel.***



- ***Hodoscope not included in event trigger.***
- ***Offset Y-planes' coincidence (in software) for reliability.***

Event Rates and Dose

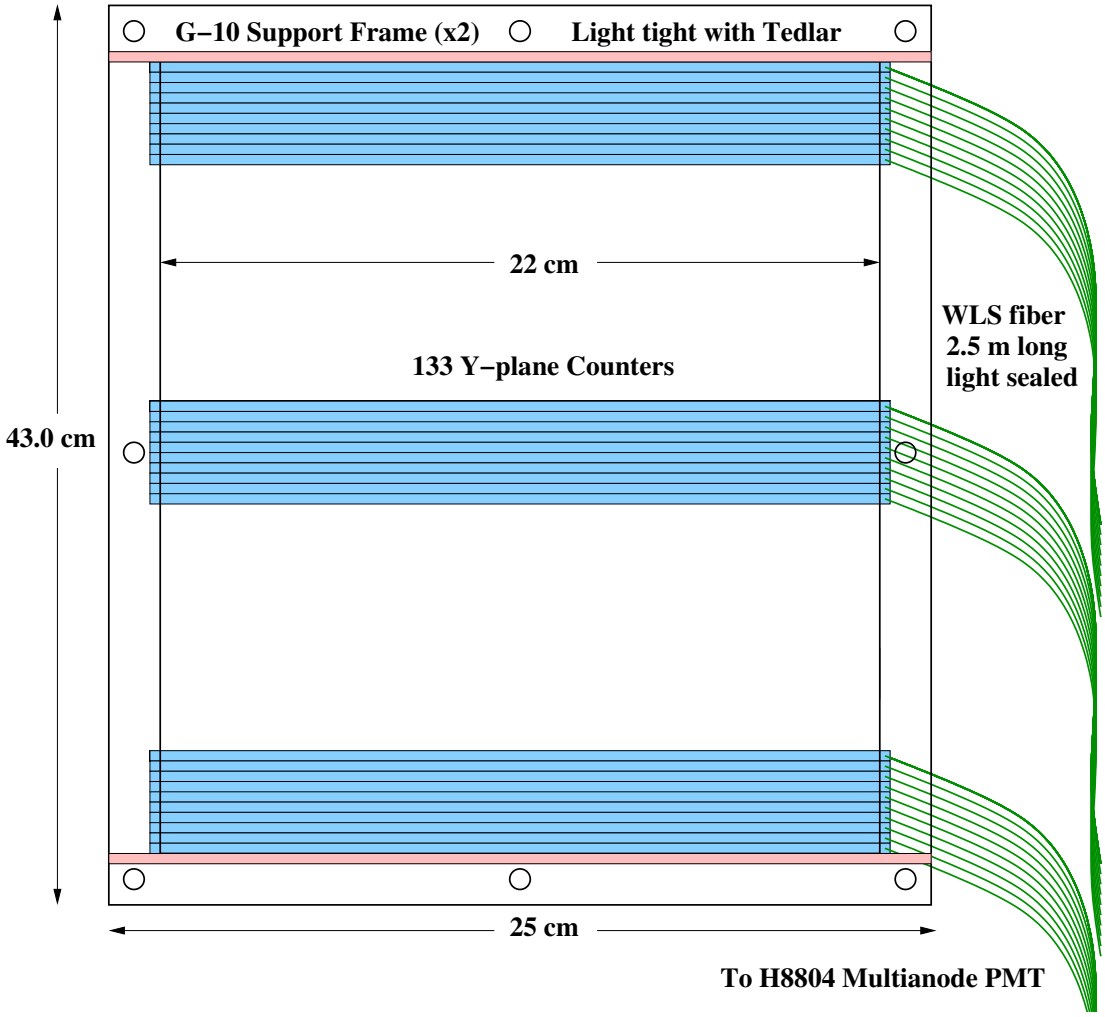
- ***Expected total rate from (events + bgnd.) $\sim$ 3–4 MHz; $\sim$ 24 kHz per counter in Y-plane ($\sim$ 44 kHz in X-plane).***

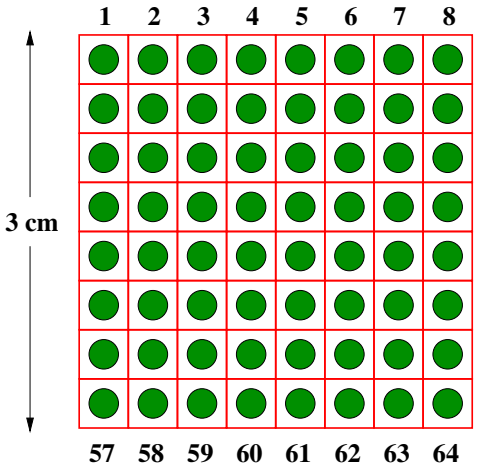
- ***Assuming a total e^- rate of 5 MHz for 1000 hrs of beam on target, expected total dose over active area is $\sim$650 rads.***

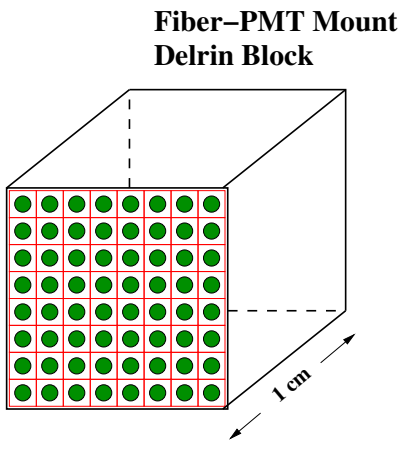
Tracker Mount Support Frame

- *Individual counter module stacked next to each other in each plane.*
- *Tedlar separator between counters to prevent light crosstalk.*
- *Counters held in place between two G-10 frames per plane.*
- *WLS fibers coupled to PMT with Delrin block adapter and optical grease.*
- *All three planes mounted to Čerenkov's front support frame.*
- *Shielded box with PMTs mounted on to Čerenkov's back support frame far away from target magnetic field.*

Tracker Mount Support Frame



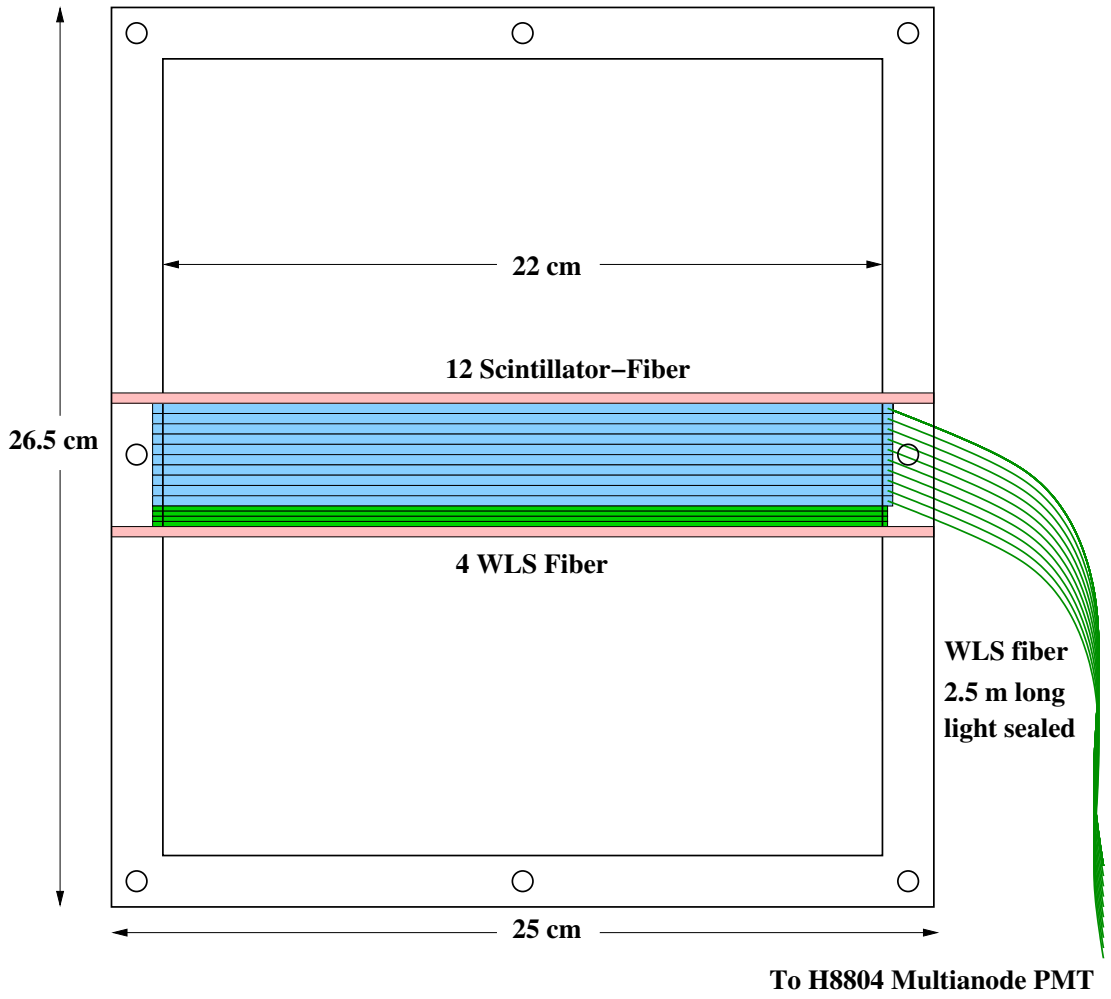




Acquisition of Hardware and Electronics

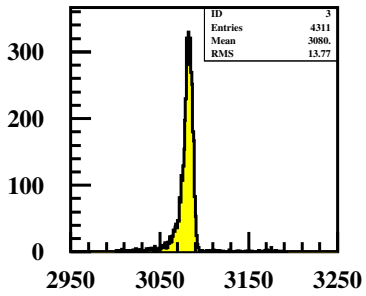
Item	Status
• Hamamatsu H8804 64-channel PMT	all units acquired
• BC-408 scintillators	all units acquired
• Multi-clad WLS fibers	all units acquired
• LeCroy 1877 96-chnl Multihit TDCs	Hall C (all chnls)
• LeCroy 4413 16-chnl Discriminators	LEGS/BNL (all chnls)
• CAMAC Crate and Controller	LEGS/BNL (2)
• 64-channel PMT signal cables	orders placed
• Ribbon Cables from Discr. to TDC	Hall C (all chnls)
• Fiber-PMT Mounting Adapter	JLab Workshop order

Tracking Hodoscope Prototype Tests

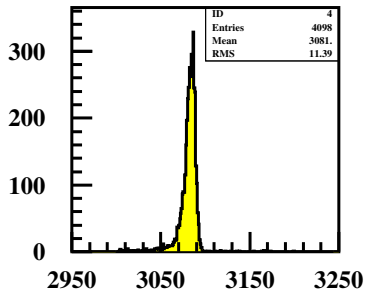


- *12 scintillator-fiber units and 4 only WLS fibers units.*
- *Tracker mounted on Minerνa test frame in SOS hut.*
- *z-distance 83 cm from SOS focal plane.*
- *SOS set at θ=147°, p=300 MeV/c negative particles.*
- *Beam tests during E05-017, E06-009, May-June, 2007.*

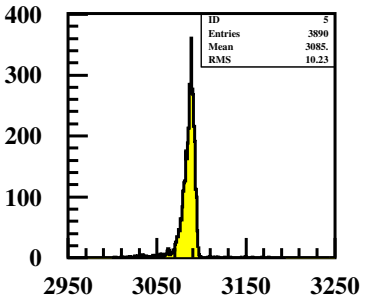
Prototype's Timing Response



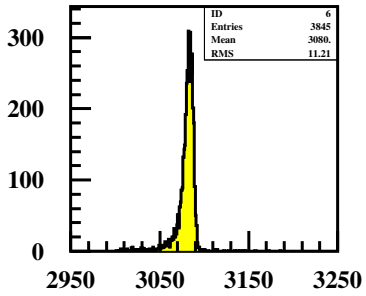
Counter 3 TDC (chnl)



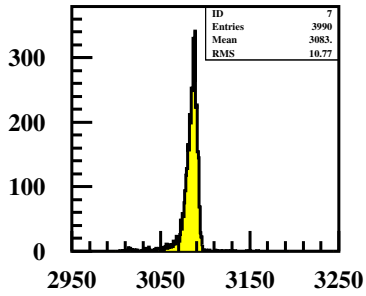
Counter 4 TDC (chnl)



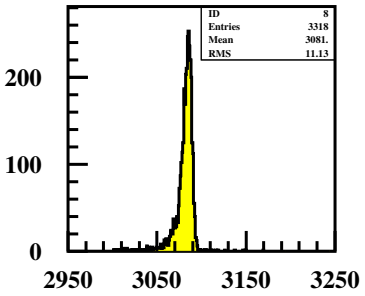
Counter 5 TDC (chnl)



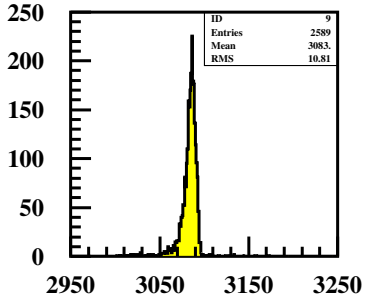
Counter 6 TDC (chnl)



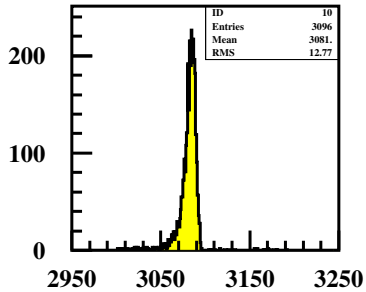
Counter 7 TDC (chnl)



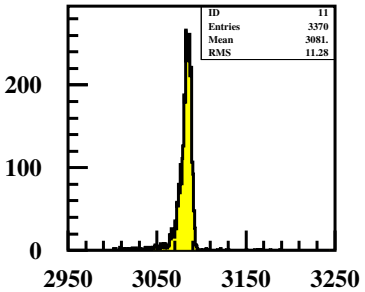
Counter 8 TDC (chnl)



Counter 9 TDC (chnl)



Counter 10 TDC (chnl)



Counter 11 TDC (chnl)

Prototype Test Results

- ***Very clean timing response observed for all counters w/ $\sigma \sim 5$ ns.***
- ***Reconstructed separation distance between counters ~ 3.2 mm.***
- ***Observed position resolution ($\sigma_y \sim 3$ mm) mostly accounted for by multiple scattering in S1Y counters in SOS.***
- ***Crosstalk between adjacent PMT channels in same row or in consecutive rows $\sim 15\%$.***
- ***Tracker's measured detection efficiency $\sim 80\%$.***

Tracking Hodoscope Personnel

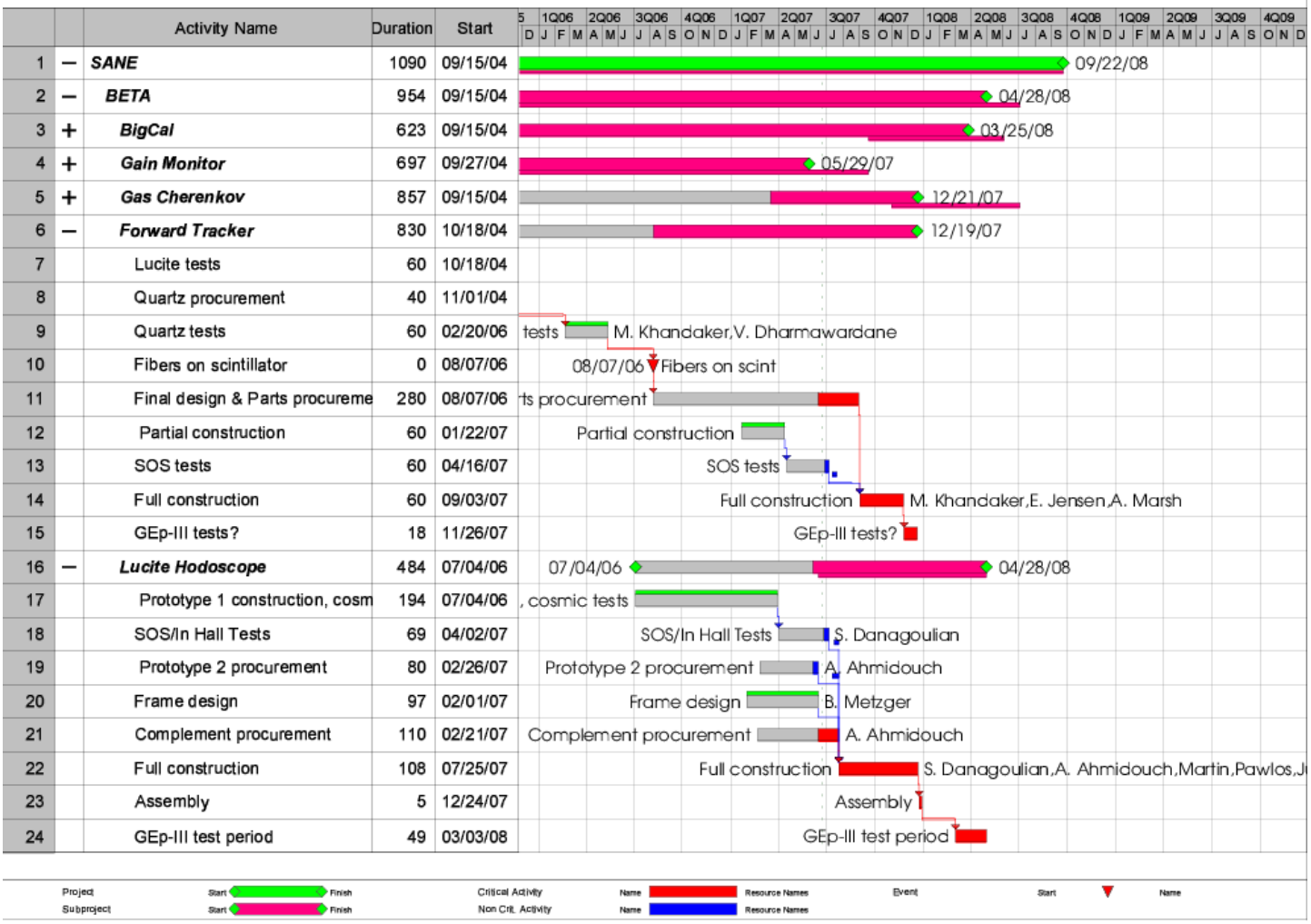
- ***Production of full tracker construction underway.***
- ***Two CNU undergraduate students (part-time):***
  - ***Eric Jensen***
  - ***Amber Marsh***
- ***One U of Regina postdoc (part-time):***
  - ***Cornel Butuceanu***
- ***One NSU faculty (M.K.)***
- ***JLab Hall C Staff support:***
  - ***Peter Bosted***
  - ***Vipuli Dharmawardane***
  - ***Mark Jones***
  - ***Hamlet Mkrtchyan***

Tracking Hodoscope Timelines

Start: 09/15/04
Finish: 09/23/08
Today:06/24/07

SANE

Page #1



- ***Construction of all three planes ready for integration into Čerenkov's frame by November, 2007.***
- ***Beam tests during G_E^p-III in late fall–early spring.***