Time of Flight for E907

Tim Bergfeld
U. of S. Carolina

- Prototype Time Resolution
- A Couple of Designs
- Cost & Funding

University of South Carolina
High Energy Physics Group

Test Materials on Hand

We have obtained the following:

Test Scintillator:

- Test Block − 5cm cube
- Two 5cm x 6.3cm x 300cm Bars
- One 6.3cm x 10cm x 300cm Bar

Phototubes:

Three fast Hamamatsu 5.1cm Assemblies

Three Hamamatsu R5900U tubes (2.7cm x2.7cm)

These materials have long lead times.

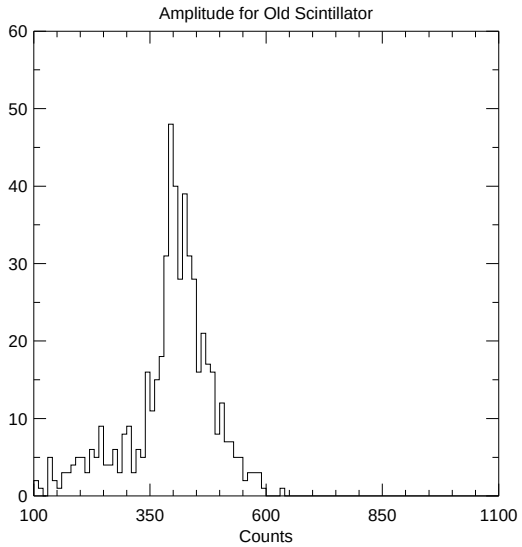
Scintillator takes 3 months

Phototubes take 3months then 25/month

or for small tubes 100 in 5 months.

Old vs New Scintillator

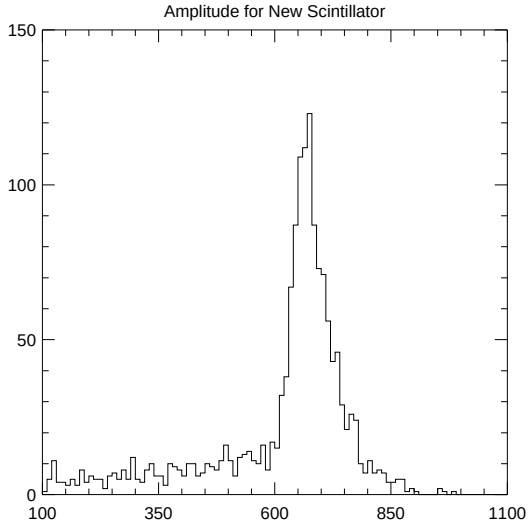
Old bar from the CLEO experiment was polished by BICRON.
New block from Saint−Gobain 5cm cube. One side blacked out.



Old Bar

Tested with same tube, voltage, electronics. In both cases the cosmics were 2−3cm from the phototube.

Minimize attenuation effects



New Block

Results: New block gives 1.7 times more light than the old CLEO bar.

Recall we also have a factor of two shorter attenuation length for the CLEO bars as measured by the CDF collaboration.

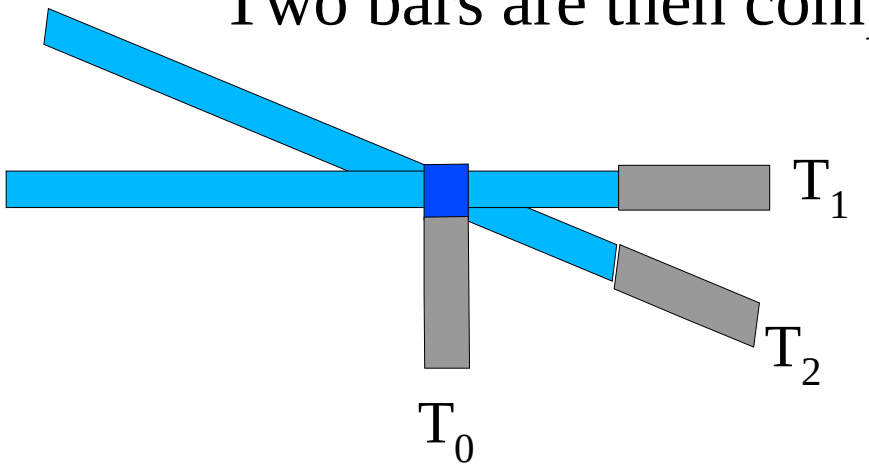
Tim Bergfeld
907 Meeting

USC HEP
University of South Carolina
High Energy Physics Group

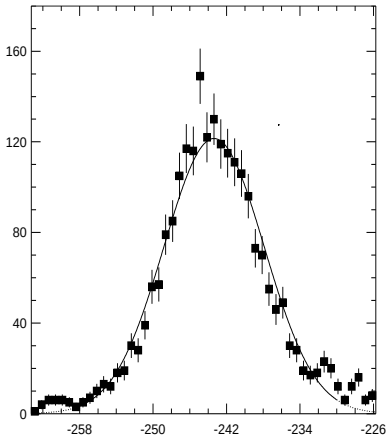
Time Resolution

Use the two new bars with 51 mm tubes:

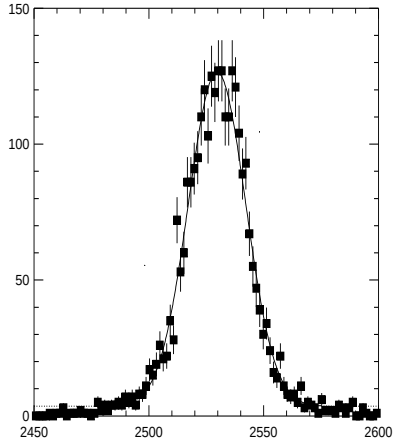
- Use the new block and another tube as the trigger
- Two bars are then compared with each other.



Look at $T_1 - T_2$ and avoid the T_0 resolutions.



Time (at 30cm)



Time (at 150cm)

	Resolution of Bar	Estimated System Res.
30cm from phototubes	≈100ps	≈100ps
150cm from phototubes	≈212ps	≈150ps
270cm from phototubes	≈250ps	≈100ps

USC HEP
University of South Carolina
High Energy Physics Group

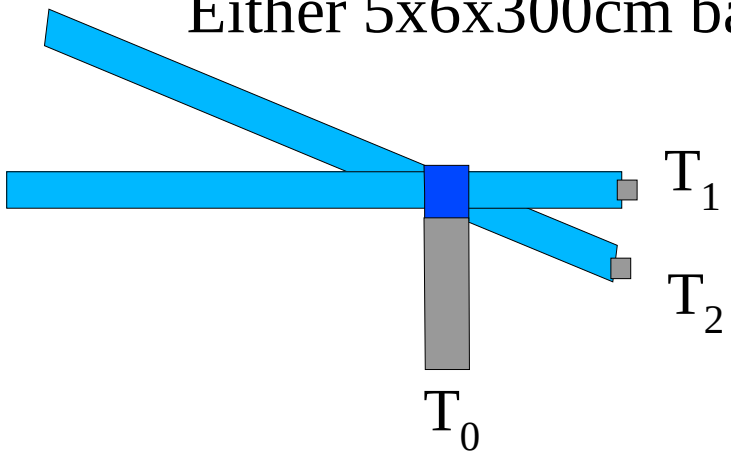
Time Resolution

Use the two new bars with small tubes:

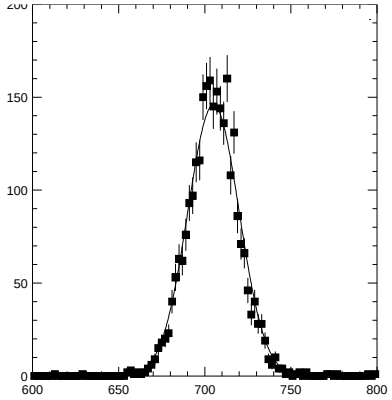
Use the new block and another tube as the trigger

Two bars are then compared with each other.

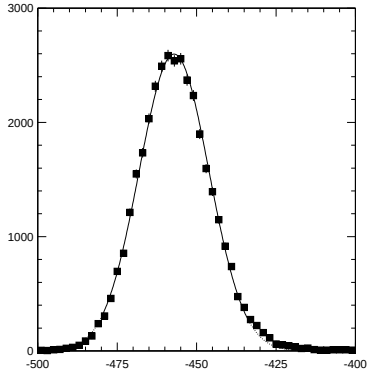
Either 5x6x300cm bar or 1x5x100cm bar



Look at $T_1 - T_2$ and avoid the T_0 resolutions.



Time (at 150cm)



Time (at 50cm)

	Resolution of Bar	Estimated System Res.
150cm from phototubes	≈254ps	≈180p
Thin Scintillator 50cm from end of bar	≈185ps	≈130ps

USC HEP
University of South Carolina
High Energy Physics Group

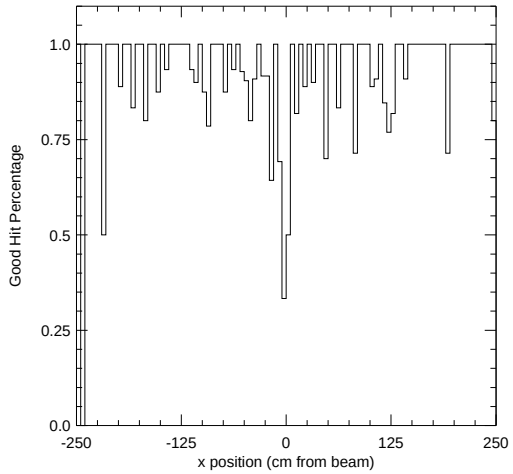
Overlapping Hit Efficiency

To evaluate the differences in the segmetation for the two designs we use the Monte Carlo. We restrict ourselves to tracks we want the TOF to identify:

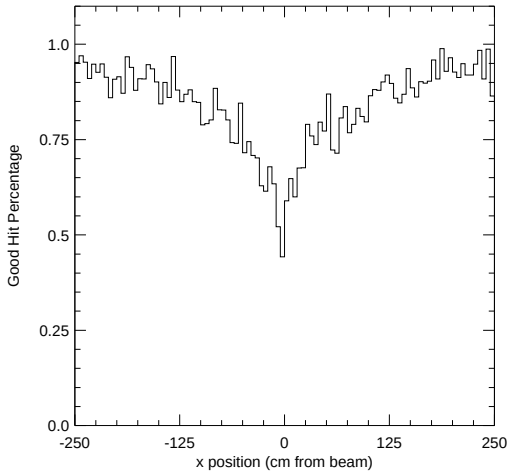
- primary tracks
- momentum between 0.7 and 2.7 GeV/c

We then look at those hits in the TOF wall which are the only hit in a counter and divide by all of the hits

PP Interactions



Numi Target



Conceptual Designs: 1

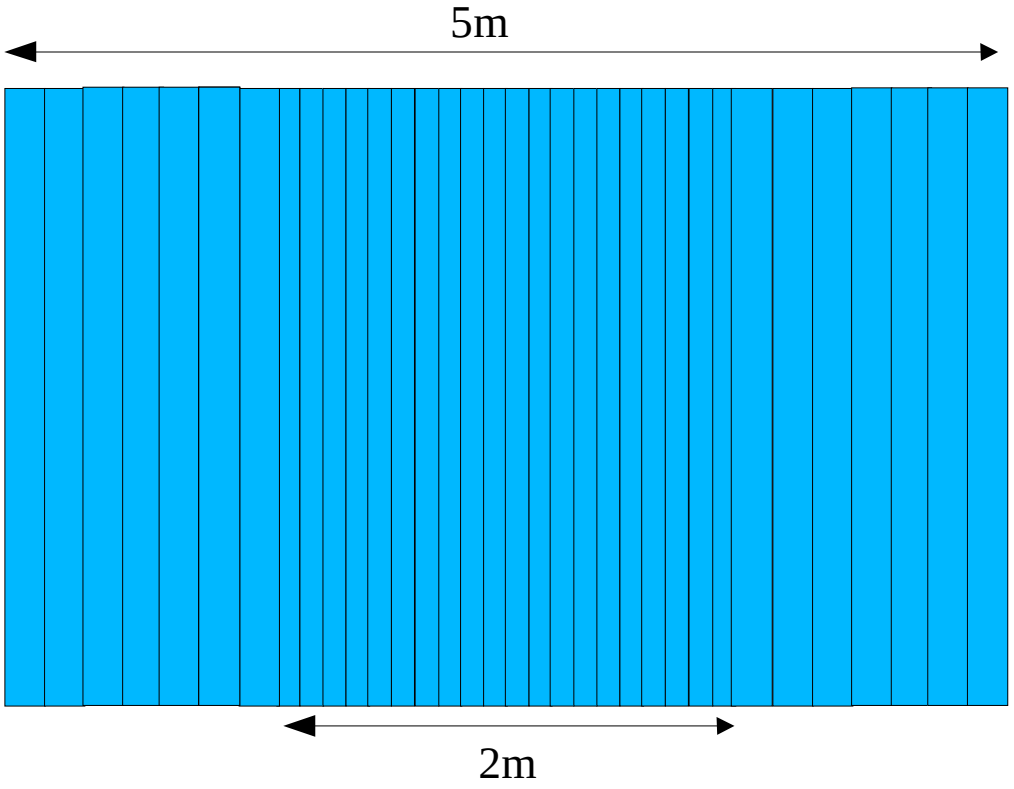
10 cm wide bars on the outside

5cm wide bars on the inside segment.

Lowers phototube count than all 5cm wide scintillator saves 60 tubes from 200.

Good Hits: 83%

All 5cm : 87%



Choice: Use 5.1cm phototubes
150ps
$332K

or use small square tubes
180ps
$255K

Conceptual Designs 2

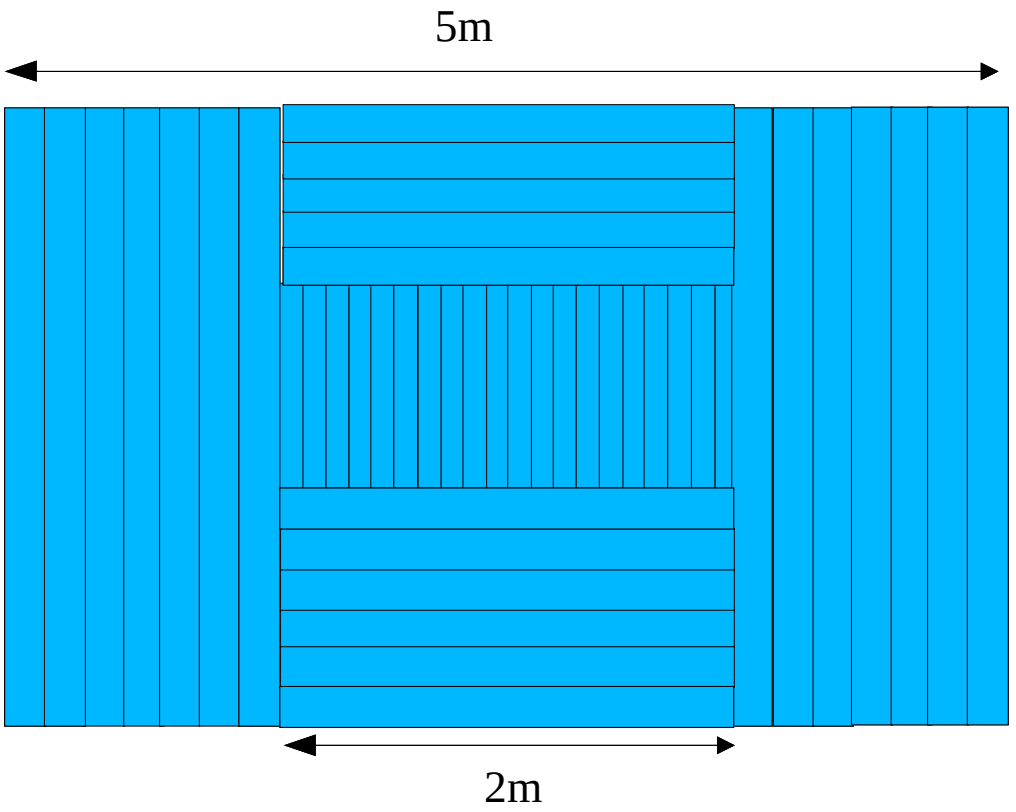
10 cm wide bars on the outside, top and bottom

5cm wide bars on the inner segment, but they are thin −1cm thick Less scattering.

≈25% of hits are in center.

Good Hits: 84%

All 5cm : 87%



Choice: Use 5.1cm phototubes or use small square tubes

150ps	180ps
$339K	$284K

Will always use small tubes on inner segment.

Time of Flight Cost

Scintillator bars:

5x5x300	bar	$820/bar
5x10x300	bar	$1325/bar
1x5x100	bar	$136/bar

Phototubes:

51mm tubes from Hamamatsu:

Assemblies H6156	$1650 each
Include homemade bases	about $1400 each
Without bases R5496	$1100 each

27mm Square tubes from Hamamatsu:

Only the tube	R5900U	$700 each
Tube with base		$850 each

Comparison of Phototubes

Hamamatsu R5496

- 5.1 cm Tube
- Better Time Resolution
- Longer Lead Times

Hamamatsu R5900U

- 2.7 x 2.7cm square
- Worse Time Resolution
- Lower cost
- Better Lead Times
- Better in Magnetic Fields

Funding

Electronics should be obtainable from PREP

USC has a application in for:

- SSAAP (Stockpile Stewardship) money from DOE
  Should hear in September Denied
- Preapp in for EPSCOR
  Should hear soon on preapplication with application decision in the fall. Denied

USC may be able to get $40K from DOE

MIPP proposal included $160,000

Other Contributions: _____

Summary

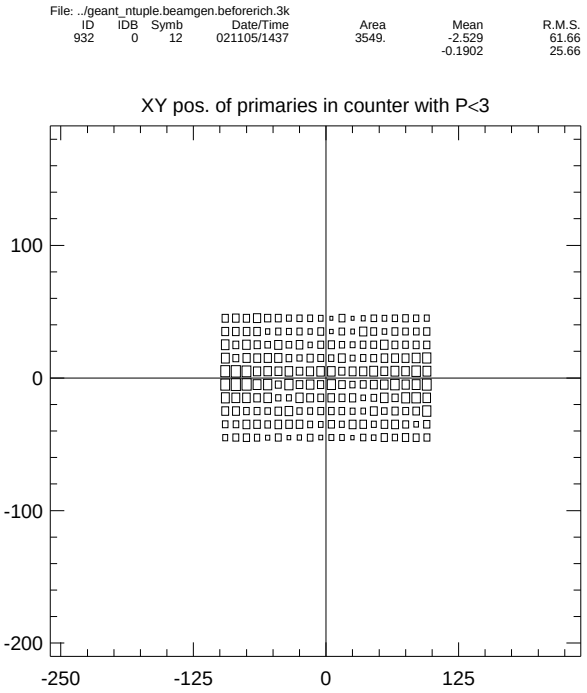
- We have no funding yet.
- Multiple Designs

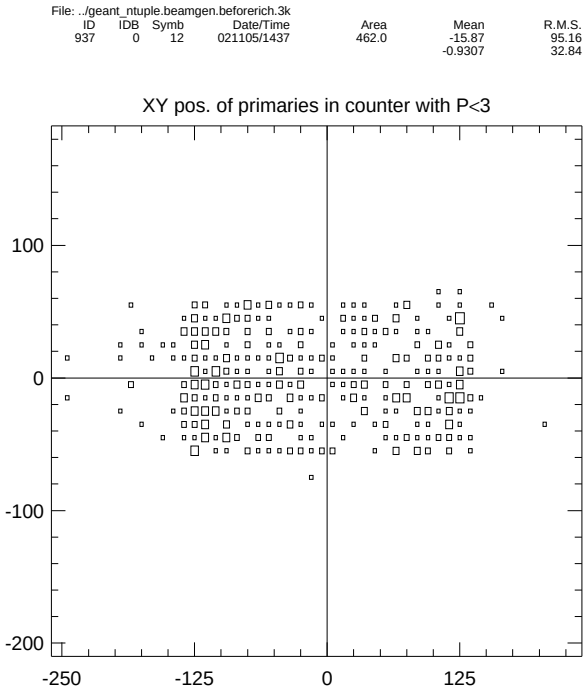
Shape	5.1cm Tubes	2.7x2.7cm Tubes
All Verticle	$332K	$255K
With Thin Section	$339K	$285K
Resolution	150ps	180ps

- Time is Running Out

USC HEP
University of South Carolina
High Energy Physics Group

Open Center Efficency





Hits before Magnet in Apperature

Hits before Rich

Primary Tracks with P<3

Efficiency for these hits is 13%

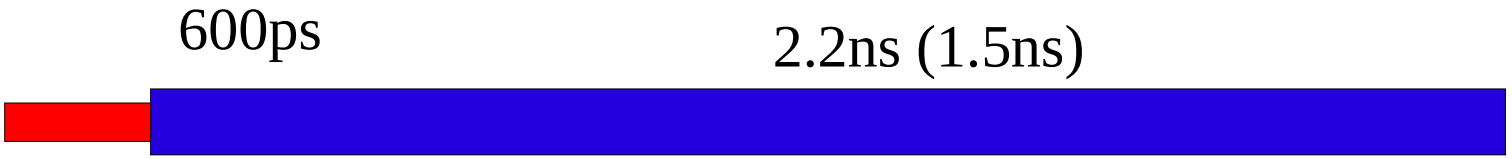
Tim Bergfeld
907 Meeting

USC HEP
University of South Carolina
High Energy Physics Group

Time Resolution

Using old Scintillator and Phototubes

FNAL polished bar with 31mm tube at one end:



600ps 1.45ns (1ns)

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

Magnetic Fields

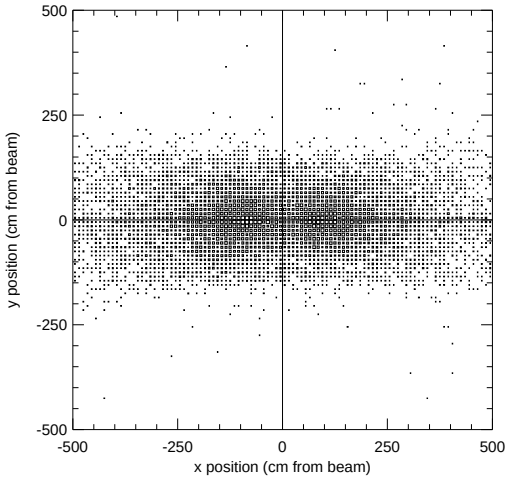
What sort of frindge fields will be present at the phototubes from ROSY's magnetic field?

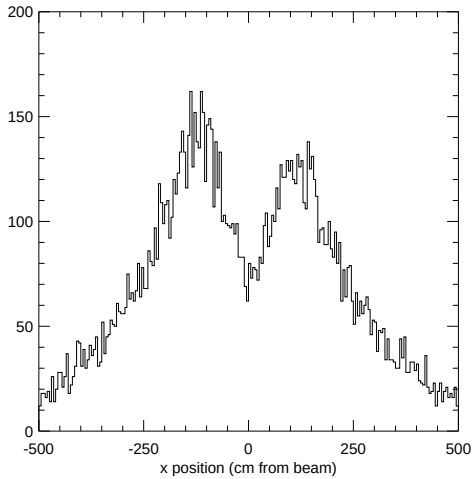
Bob Wands calculated fringe fields at 5 cm increments in Gauss

10 cm From Magnet	*X=0*	*X=100*	*X=250*
55cm up	147	28	
160cm up	8	7	3
	Y=50	*Y=100*	*Y=150*
110cm in X	19	15	7
20 cm From Magnet	*X=0*	*X=100*	*X=250*
55cm up	83	23	
160cm up	8	6	3
	Y=50	*Y=100*	*Y=150*
110cm in X	16	12	7
30 cm From Magnet	*X=0*	*X=100*	*X=250*
55cm up	54	17	
160cm up	7	6	3
	Y=50	*Y=100*	*Y=150*
110cm in X	13	10	6

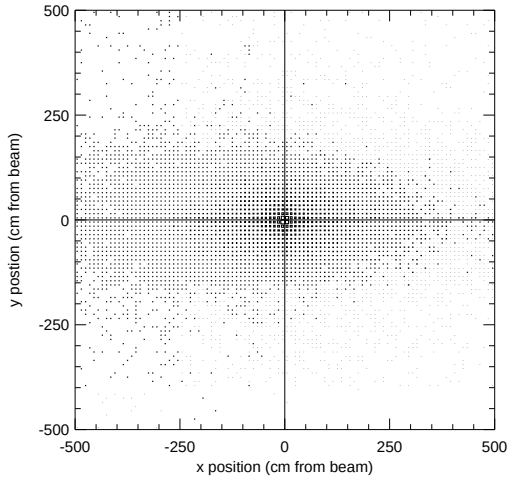
Hit Distributions with NUMI Target

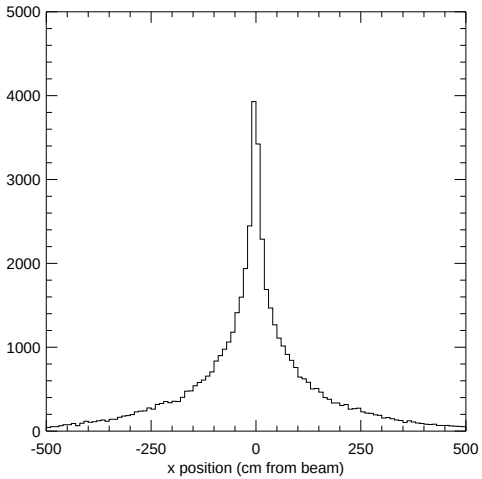
Primary Tracks with P<3





All Tracks





Tim Bergfeld
907 Meeting

University of South Carolina
High Energy Physics Group