BeamTest2006 – Positron Annilation in Flight

Premlinary Look
Aug 30, 2006

Does the GLAST Monte Carlo successfully model real positron data?

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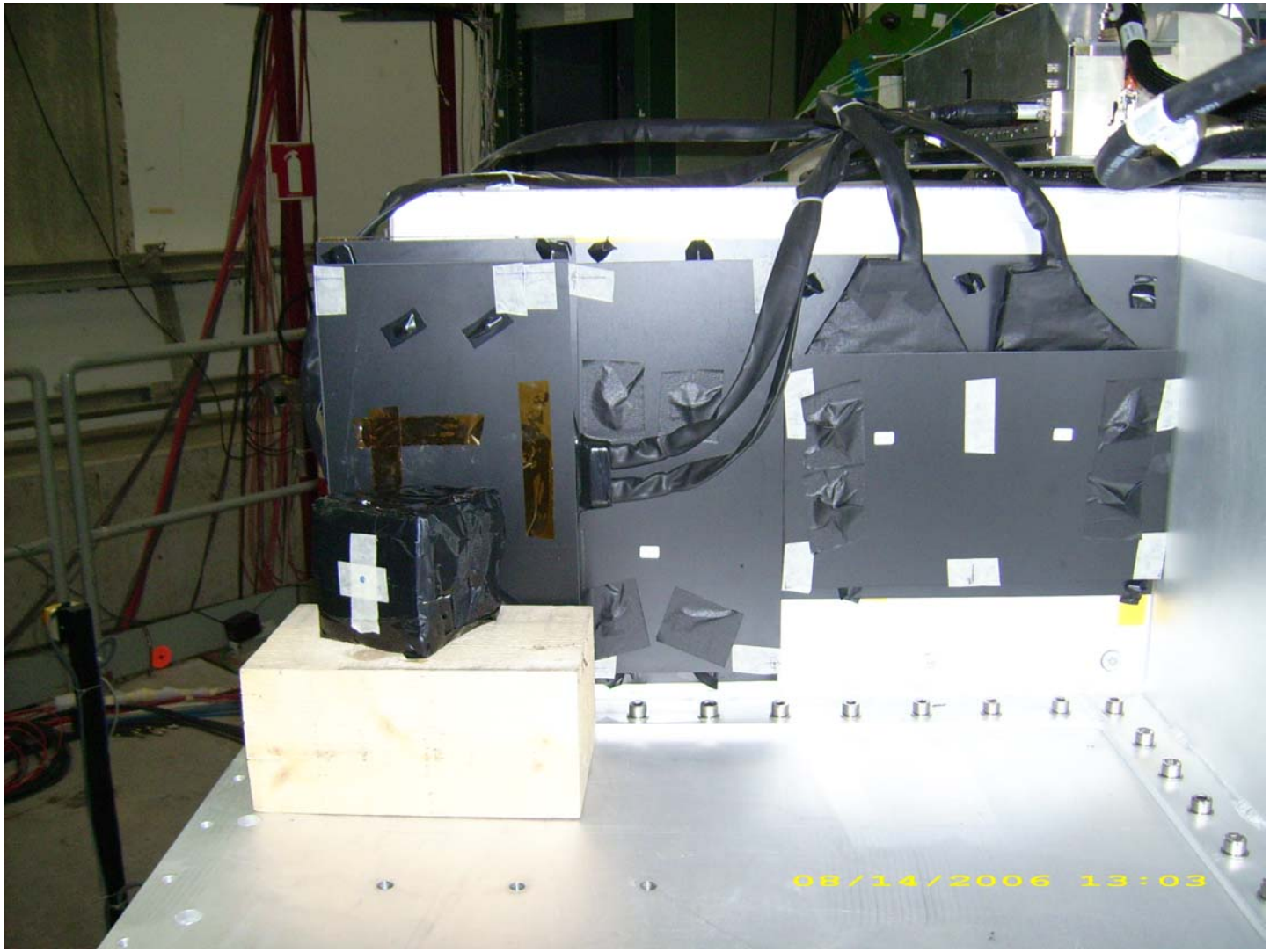
08/14/2006 13:00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Positron Runs at CERN PS

1) Positron (and Electron) Beam Energy=1.0 GeV

2) 4 Thicknesses of actual GLAST MLI (from Alex Mosieev) (MLI face perpendicular to beam). Aligned by first seeing the shadow of a PB block placed where the MLI was to go. Then Pb block was replaced with MLI.

3) Spect Mag ON to bend positrons away from straight ahead brems.

4) Dump is stacked on the beam axis to block straight ahead brems

5) Ext triggered CU = S0*S2*C1*C2*!SH*!S3*!(delayed 20 usec wide S0) (S3 was vetoing on the light guide of S2)

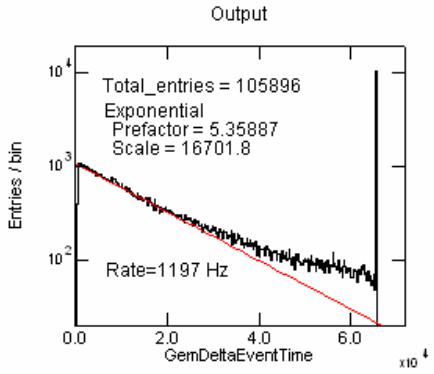
6) Beam is ~50% positrons (50% pions)

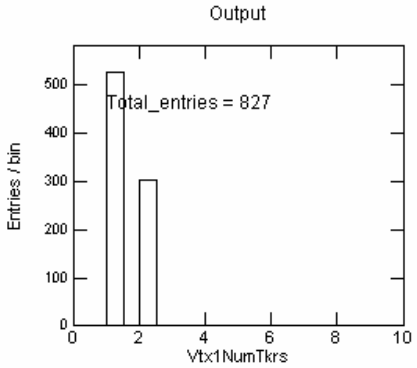
7) Beam ~50 deg into top of the side of Tower 3 (through ACD tile)

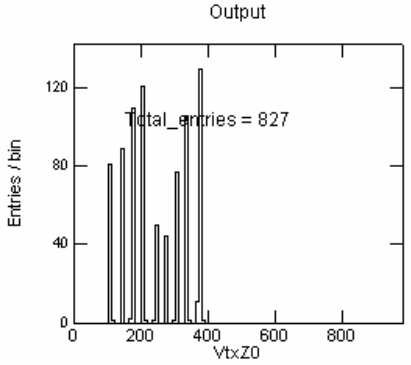
8) Positrons 4 x 250 K runs (700001356, 58, 59, 60)
Electrons 4 x 250 K runs (700001361, 62, 63, 64) (Spect unchanged)

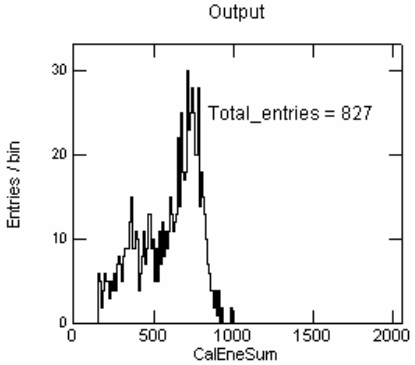
9) Need MC data !

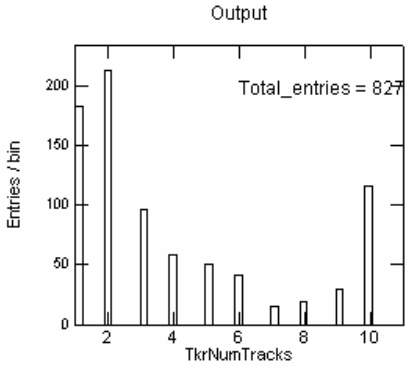
Positron Runs at CERN PS

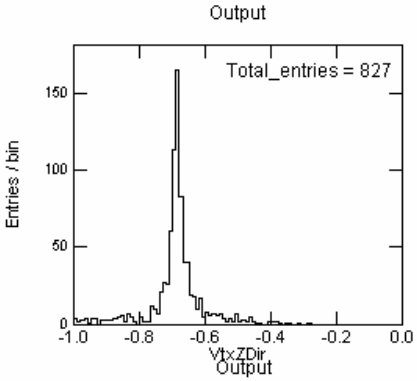


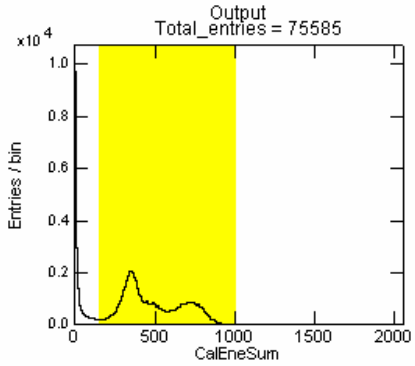


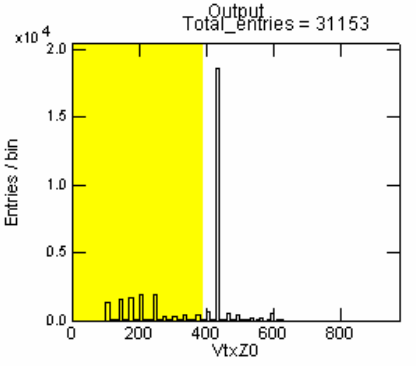


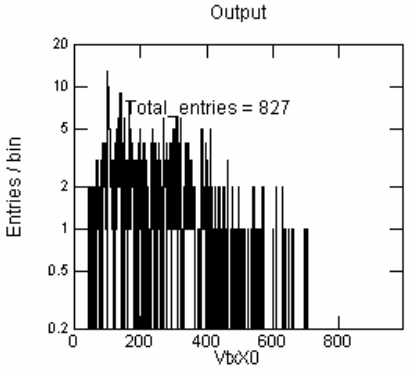


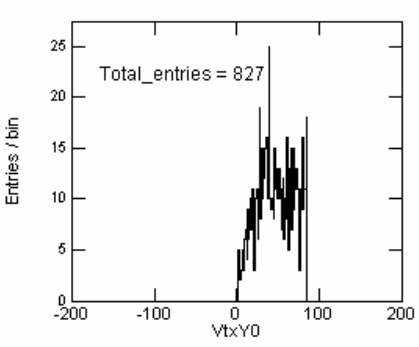


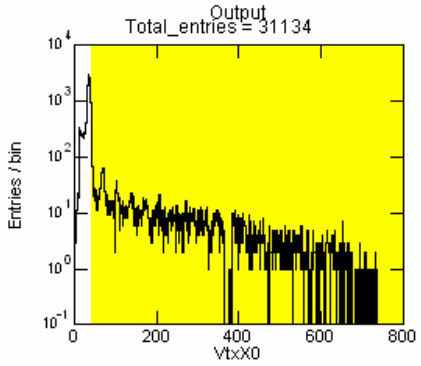


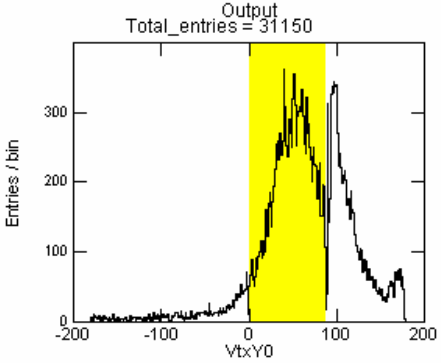




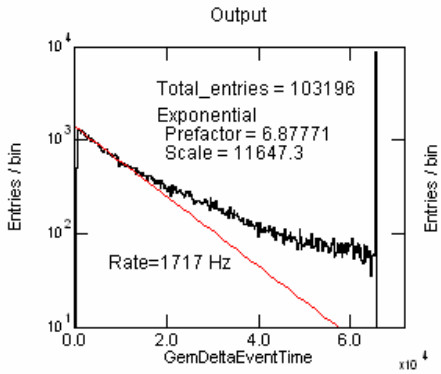


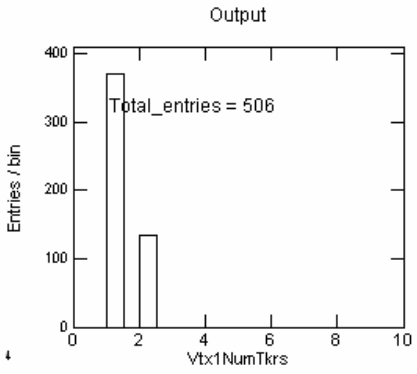


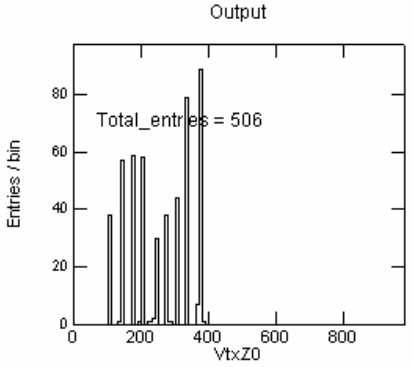


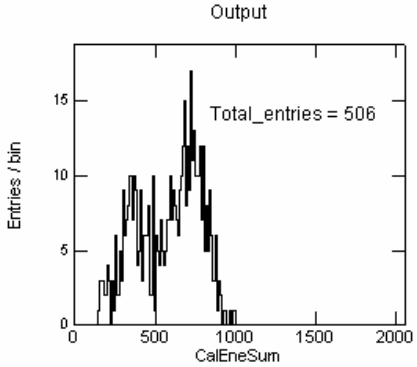


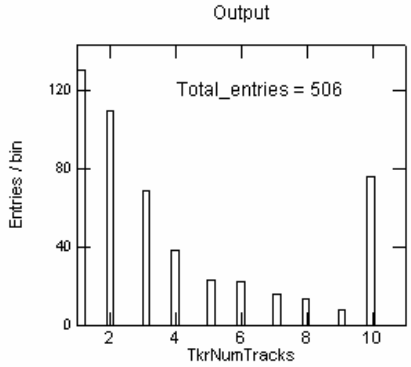
Electron Runs (for background subtraction)

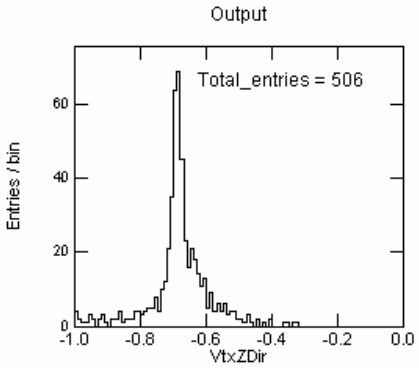


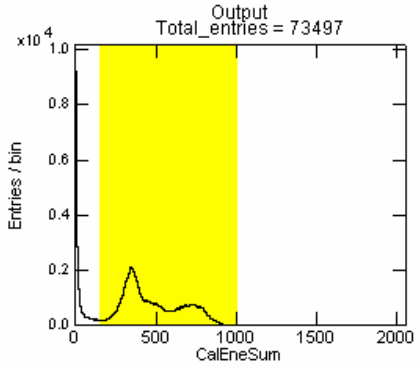


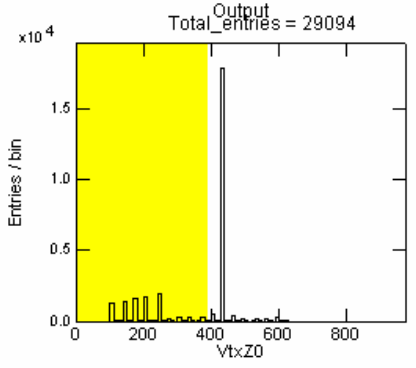


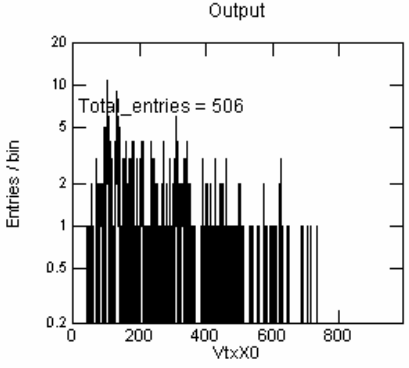


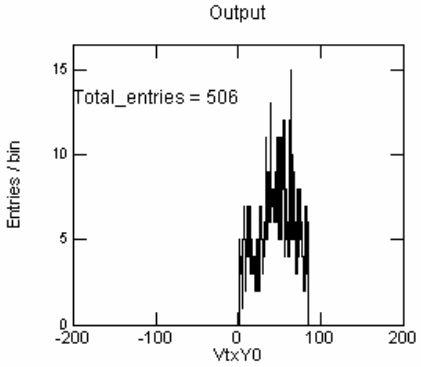


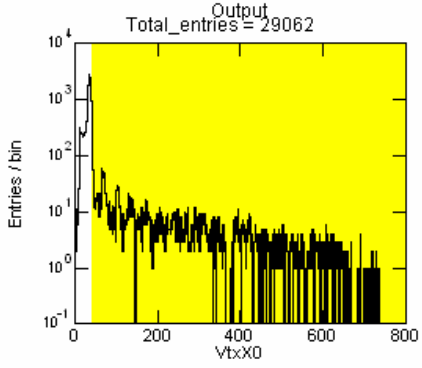


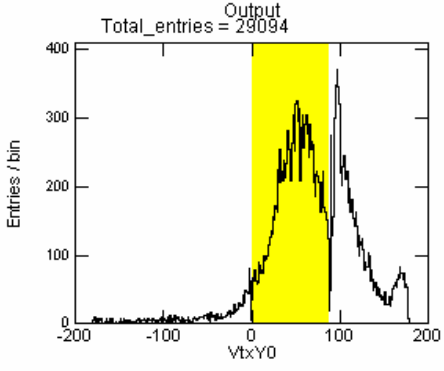












Number e+ Annihilation of Events

	e+ Beam	e- Beam (background)
# of Triggers	1.016×10^6	1.025×10^6
# of events with no ACD hits	105,896	103,196
# of annihilations after all cuts	827	506
# of annihilations after all cuts scaled to # of e+ triggers		501
(e+ - e-) annihilations	326 ± 36	
QED Calculation for 4 MLI thick (3.3×10^{-4} annihilation probability)	335	

Ratio (2-Track / 1-Track)

	e+ Beam	e- Beam (background)
# of Triggers	1.016×10^6	1.025×10^6
# of e+ annihilations after all cuts (e- scaled to # of e+ triggers)	827	501
For Vrtx1 : (2 Track / 1 Track) (e- scaled to # of e+ triggers)	303 / 524	137 / 364
(e+ - e-) (2 Track / 1 Track)	166 ± 21 / 160 ± 30	
Ratio (2 Track / 1 Track)	$1.04 \pm .24$	
Ratio (2 Track / 1 Track) MC	???	

Summary

1) ~ 1 x 10^6 1 GeV e+ were sent into a 4 x LAT thickness of MLI.

2) ~ 1 x 10^6 1 GeV e- were also sent in for background subtraction.

3) A signal of 326 $\pm$ 36 annihilations in flight were seen (335 expected).

4) For the first vertex the measured ratio (2 Trks/ 1 Trk) = 1.04 $\pm$ .24

5) Still need e+ and e- MC data for MC comparison !

Calculation of Annihilation Rate

Positron Annihilation in Flight in ACD

Dec 8,2000
Gary G. + Al O.
D:\Winmcad\Glast\Pos_Annihilation.mcd

$\alpha := \frac{1}{137}$ $\quad me := .511$

Bjorken and Drell Pg 135

$$\sigma(Epos) := \left(197\cdot10^{-13}\right)^2 \cdot \frac{\pi\cdot\alpha^2}{me\cdot Epos}\left(\ln\left(\frac{2\cdot Epos}{me}\right) - 1\right) \qquad \frac{\sigma(1000.)}{10^{-24}} = 9.24\cdot10^{-4} \quad [barns]$$

1) Beam Test Considerations

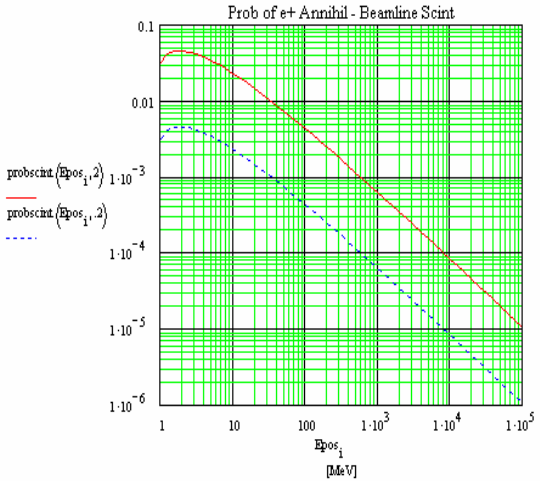
Probability of positron annihilation in t [cm] of plastic scintillator (CH). Assume 1) the positron annihilates in 2 cm of beam defining scintillator that is upstream of the ACD, or 2) annihilates in .2 cm of ACD on GLAST which is less dE/dx than the .4 MeV ACD discriminator threshold.

$$probscint(Epos, t) := \frac{6.023\cdot10^{23}}{12+1}\cdot(6+1)\cdot1.032\cdot t\cdot\sigma(Epos)$$

$i := 0..50$

$probscint(50, 2.2) = 8.006\cdot10^{-3}$

$Epos_i := 10^{\frac{i}{10}}$



2) Flight Background considerations

Consider the LAT micrometeorite shield. What fraction of the positrons striking the shield will annihilate and send perfectly good gammas into the LAT ? (= irreducible diffuse background !). Micrometeoroid shield described in LAT-TD-01122-01.pdf 10/6/2003. The shield may have become thicker since this document.

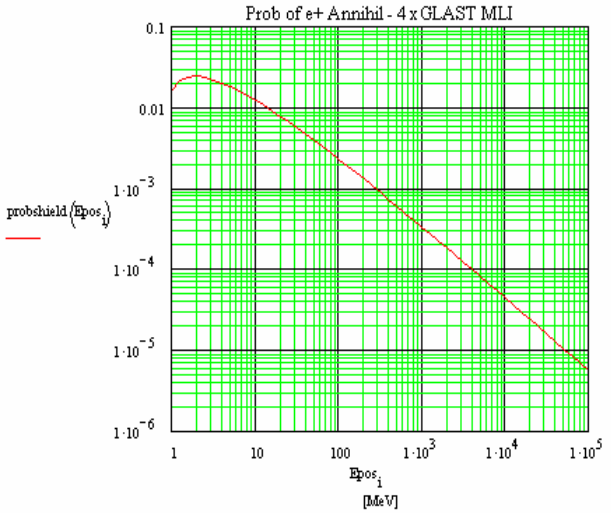
http://www-glast.slac.stanford.edu/software/ACD/blanket/default.htm

Simplify the materials in one MMS layer by assuming:

Nextel = AL .100 g/cm2
Foam+Thermal+Kevlar = C .195 g/cm2

In BeamTest2006 we have a stack of 4 MMS layers all taped together.

$$probshield(Epos) := 6.023\cdot10^{23}\cdot\left(\frac{13.}{26.}\cdot.100 + \frac{6.}{12.}\cdot.195\right)\cdot\sigma(Epos)\cdot4$$



$probshield(1000) = 3.29\cdot10^{-4}$