Drift Chamber Performance Studies Using Bhwide Bhabha Monte Carlo Generator

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Outline

Part I: Checking Bhwide for consistency and accuracy

- Choose generator-level electron and positron cuts
- Calculate cross-sections for various bhabha scattering ranges

Part II: Modelling drift chamber tracking and occupancy rates

- Find fiducial region of detector w.r.t. electrons and positrons
- Choose generator-level electron and positron cuts based on fiducial region
- Simulate angular dependence of Dch response, occupancy rates per wire layer

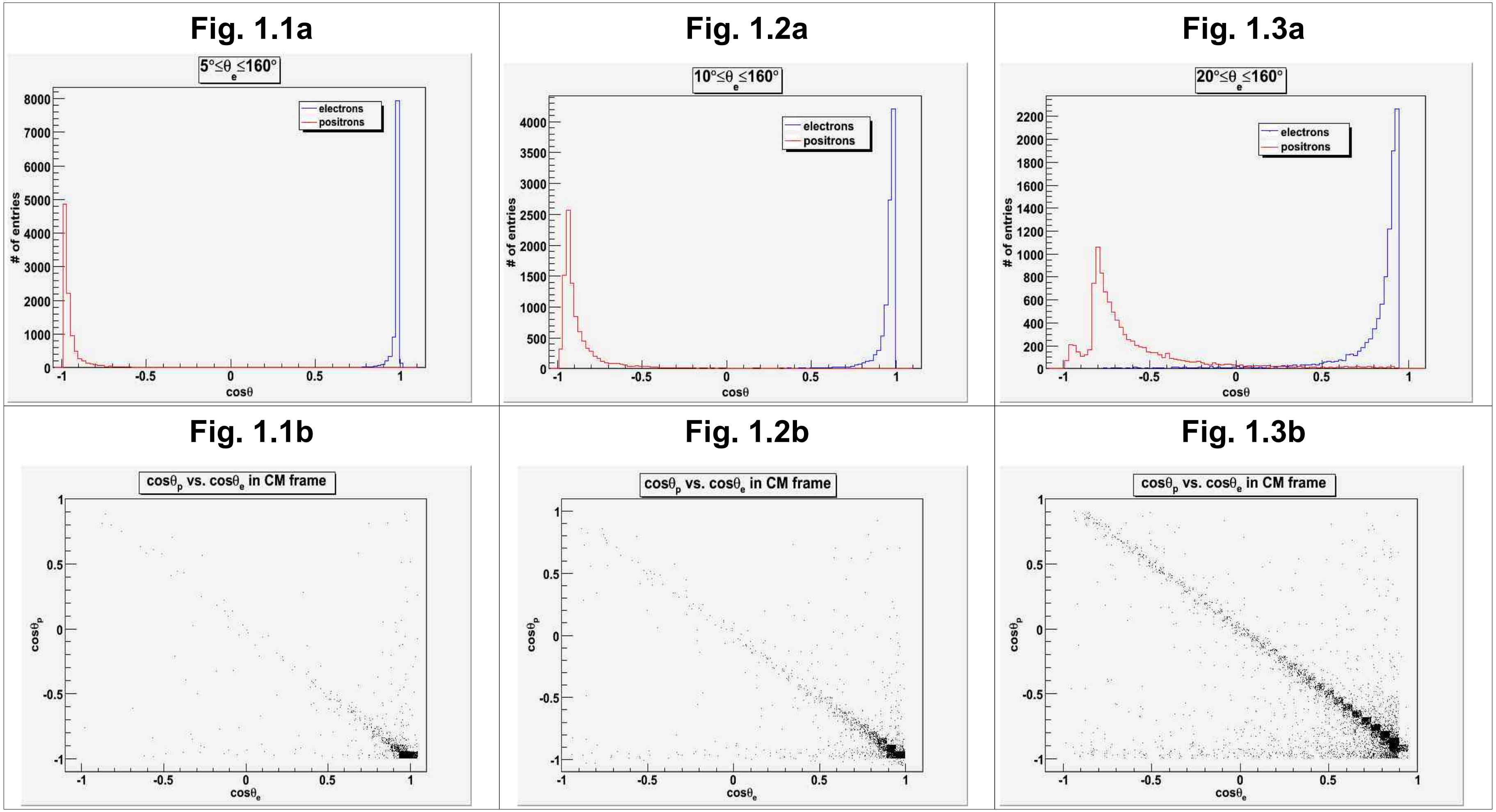
Final Remarks

Part 1: Determining Appropriate Generator Cuts

- Default generator cuts: $20° \leq \theta \leq 160°$ for electrons and positrons (θ is measured w.r.t. beam axis in direction of incoming electron)
  - Unless otherwise specified, θ is measured in the lab frame
- For this part, we are interested in electrons scattered at $\theta \geq 10°$
- 10 000 events simulated for each set of cuts
- Lab frame is boosted at ~0.273c w.r.t. CM frame
- Due to photon emission, electrons and positrons need not emerge back-to-back in CM frame
  - Need to make generator cuts sufficiently loose to account for various forms of bhabha scattering in region of interest

Part 1: Determining Appropriate Generator Cuts

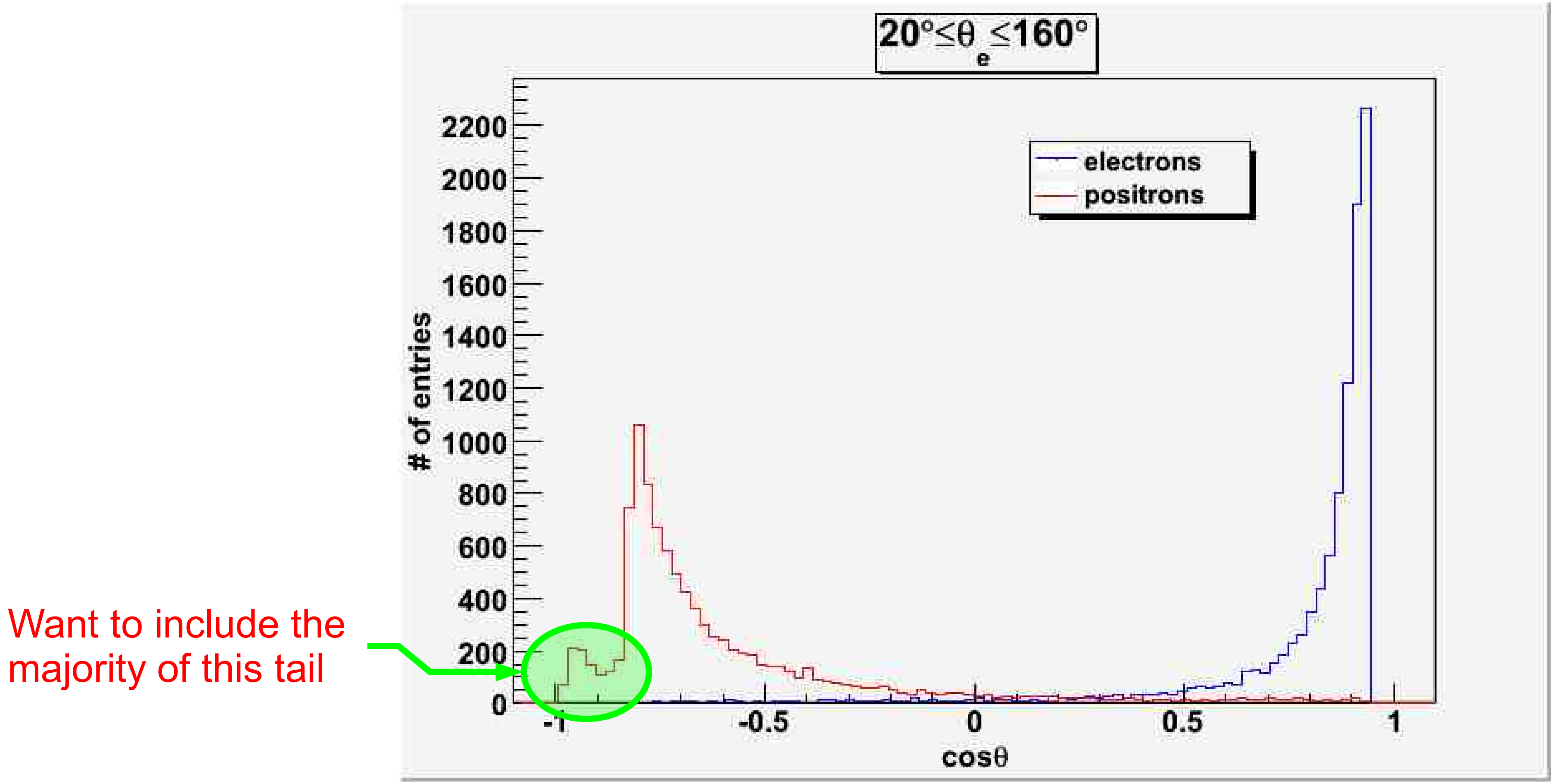
- Positron tail at large angles is due to photon emission, in this region the positrons do not scatter back-to-back with electrons in CM frame
- Default generator cuts for positrons, $\theta_e \leq 160°$



Figs. 1a, 2a, 3a: cosθ of scattered electrons and positrons
Figs. 1b, 2b, 3b: cosθ of positrons vs. electrons for each event

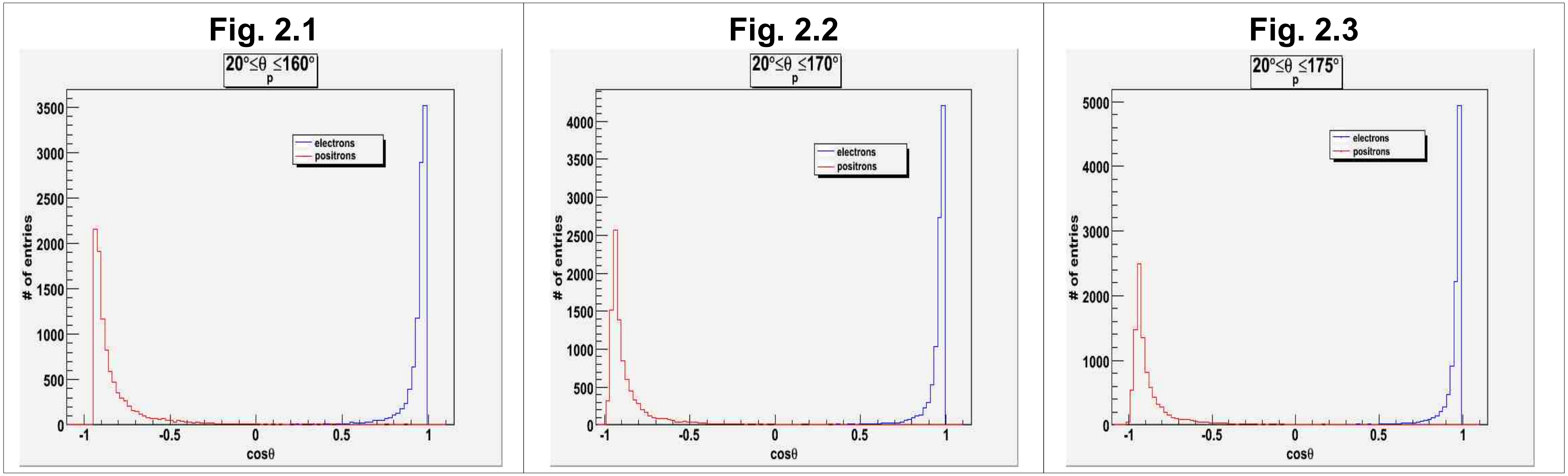
Part 1: Determining Appropriate Generator Cuts

Fig. 1.3a



Part 1: Determining Appropriate Generator Cuts

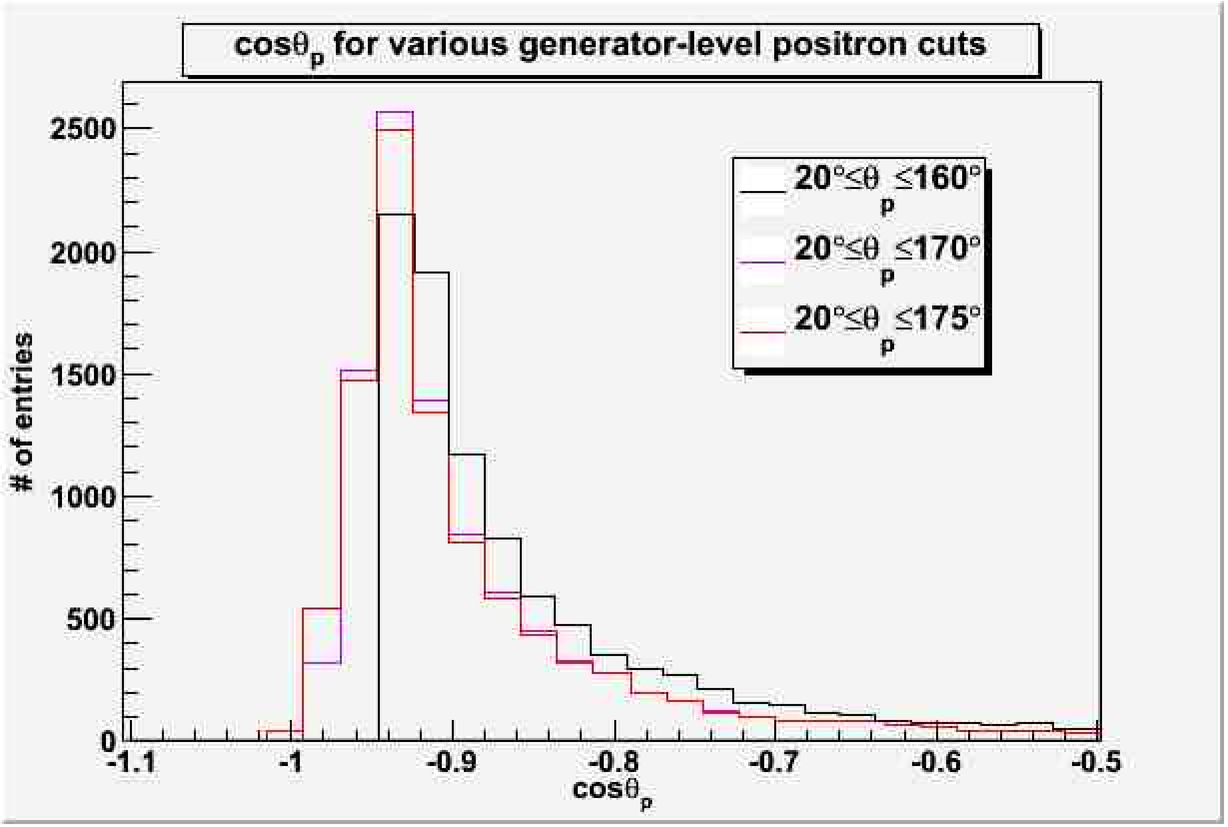
- For this part we only need to worry about small-angle electron scattering, large-angle portion is negligible by comparison
- Use default generator cuts for small-angle positrons and large-angle electrons ($\theta_e \leq 160°$, $\theta_p \geq 20°$)
- Use generator cut $\theta_e \geq 10°$ for small-angle electrons, variable upper bounds on θ_p



Figs. 2.1, 2.2, 2.3: cosθ of scattered electrons and positrons for different values of θ_p

Part 1: Determining Appropriate Generator Cuts

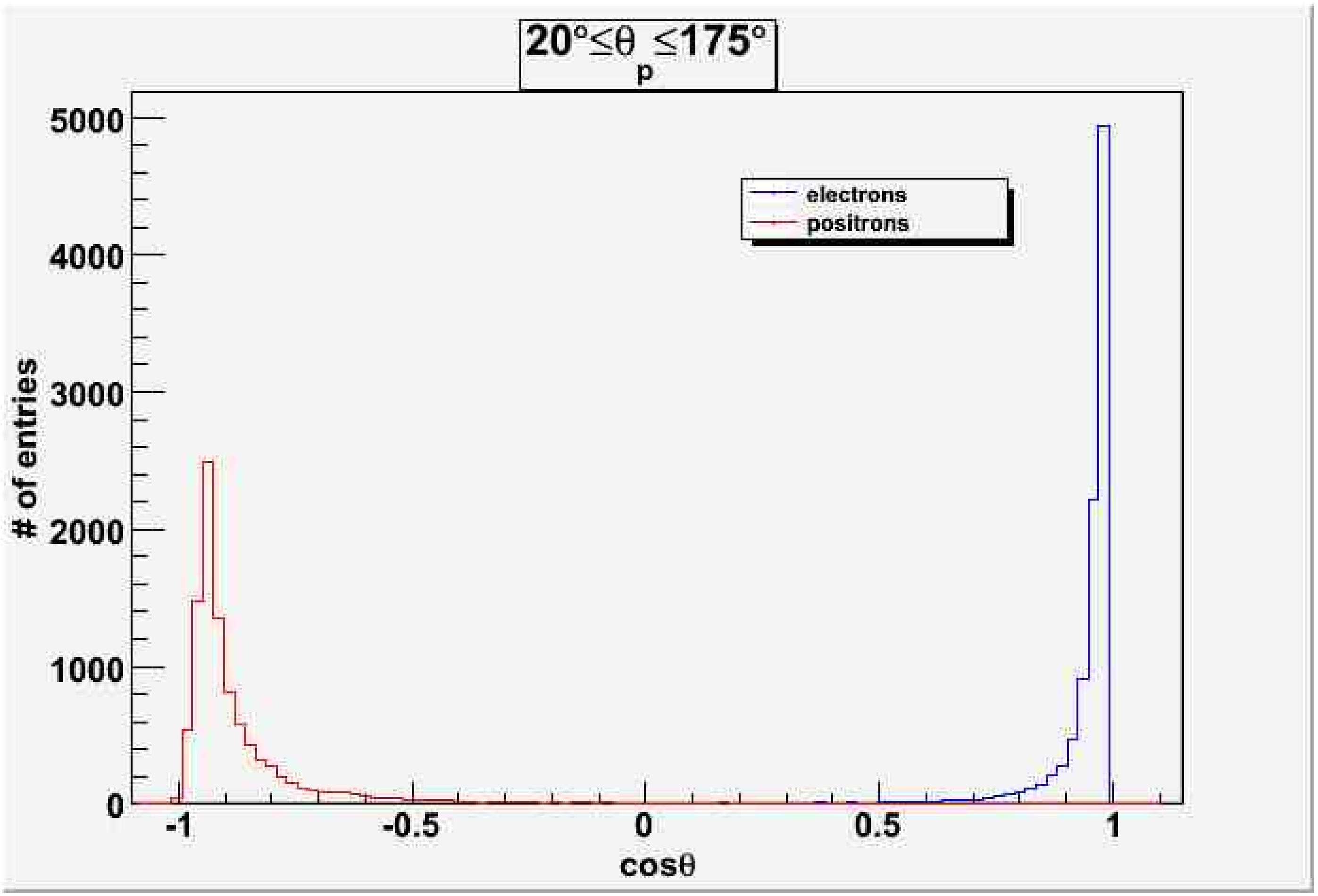
Fig. 2.4



- A cut of θ≤175° for positrons appears to be sufficient

Part 1: Final Results

Fig. 2.3



- 10 000 events simulated, used to calculate various cross-sections for electron scattering (see Table 1.1 on next slide)

Part 1: Final Results

Table 1.1

$\beta\gamma$	θ_{min}(Lab)	$\cos\theta_{max}$(CM)	# electrons	σ(nb)	σ_F(nb)*
0.56	200mrad	0.943	4520	63.2±3.2	62.3
0.56	300mrad	0.875	1953	27.3±1.4	25.9
0.28	200mrad	0.966	7669	107.2±5.4	113.2
0.28	300mrad	0.924	3363	47.0±2.4	48.6
Reference**		$-0.922 \leq \cos\theta \leq 0.927$	3504	49	

- All calculations and cuts are performed by switching to CM frame
- 5% error assumed in calculation of σ

* Figures estimated by Giuseppe Finocchiaro using Babayaga generator

** See BaBar Note #503

Part 2: Imaging the Drift Chamber Using Electron and Photon Decay Vertices

Fig 3.1b

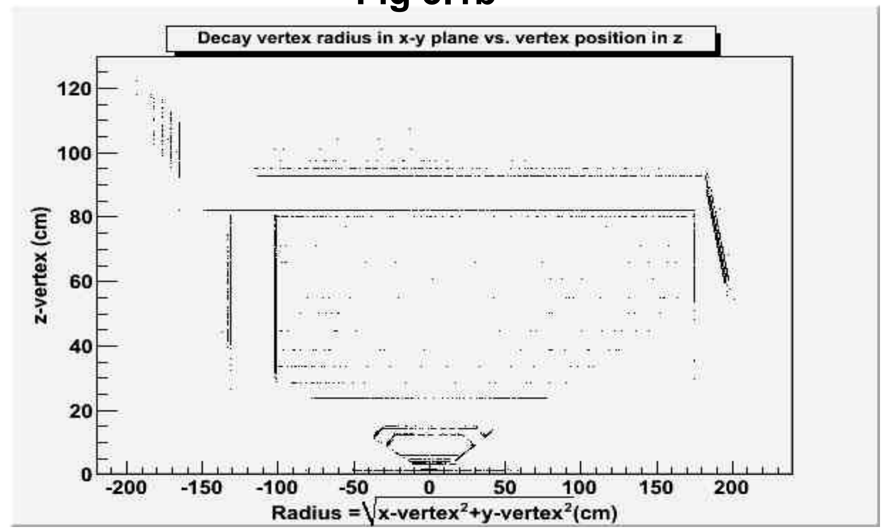


Fig 3.1a: 3D view

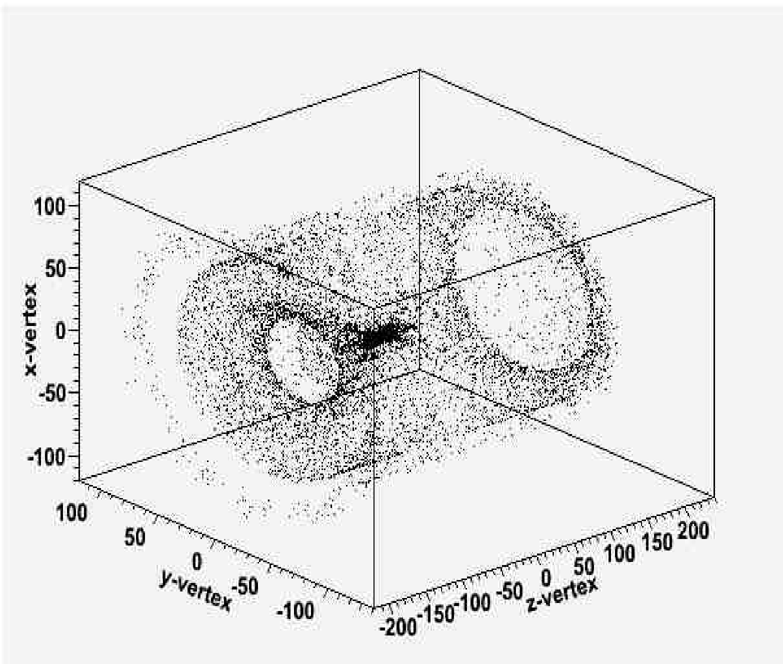
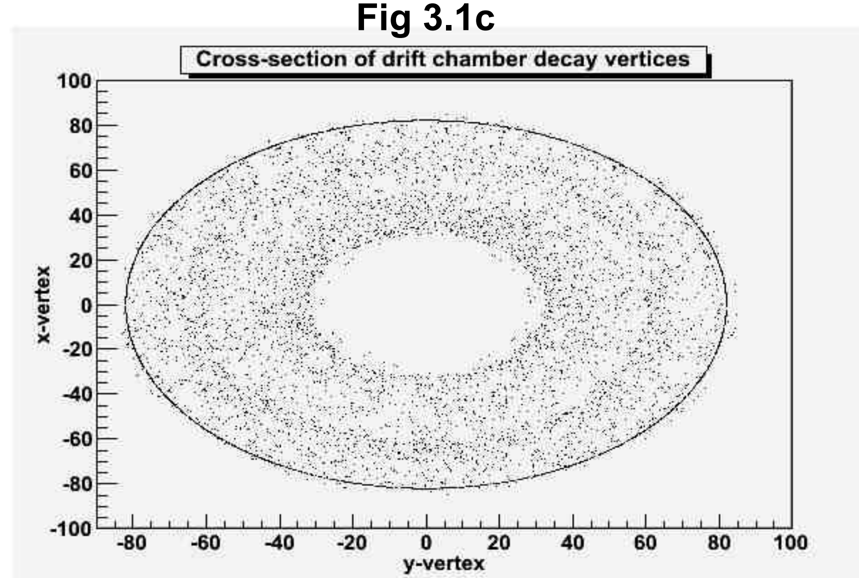


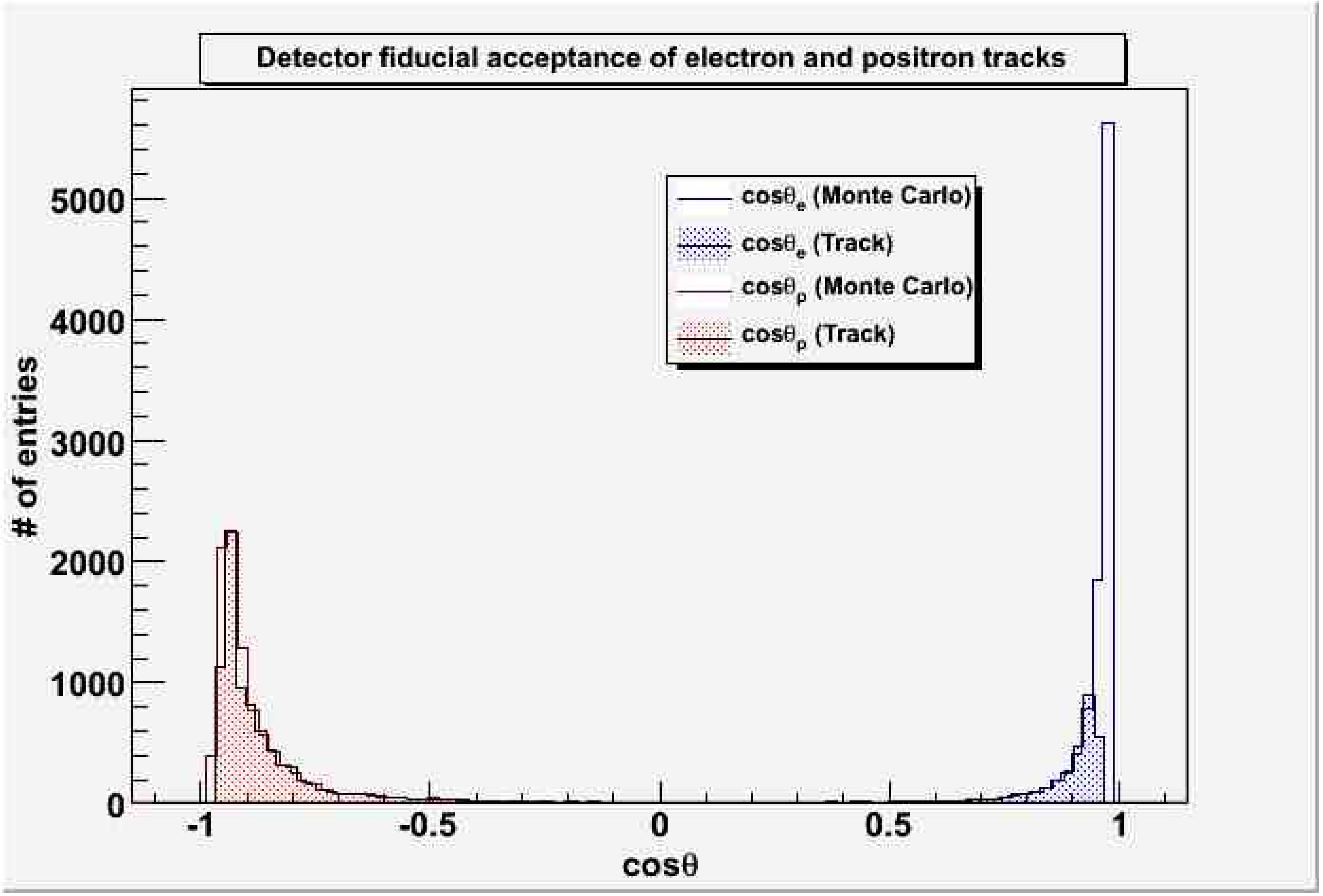
Fig 3.1c



- Modelled using 30 000 events (more events would clearly give a better picture)

Part 2: Finding the Fiducial Region

Fig. 3.2



- 10 000 positron entries, 10 000 electron entries in total
- Scattering angles required for positrons and electrons to be detected:
  - For electrons, $16.3° \leq \theta_e \leq 162.8°$
  - For positrons, $17.5° \leq \theta_p \leq 163.1°$

Part 2: Determining Appropriate Generator Cuts For Fiducial Area

Fig. 3.3a

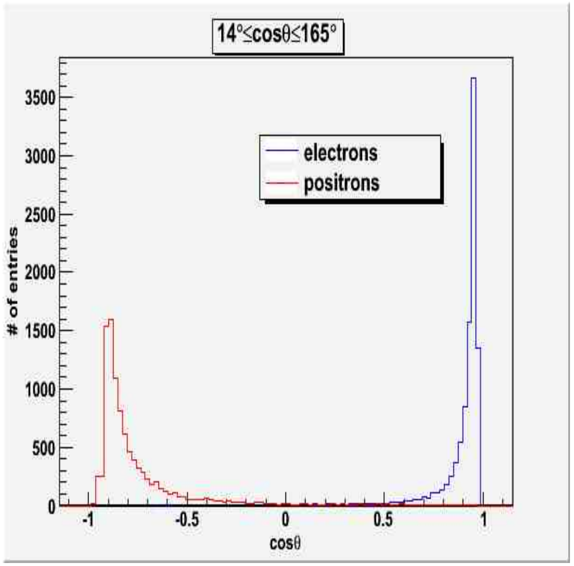


Fig 3.3b

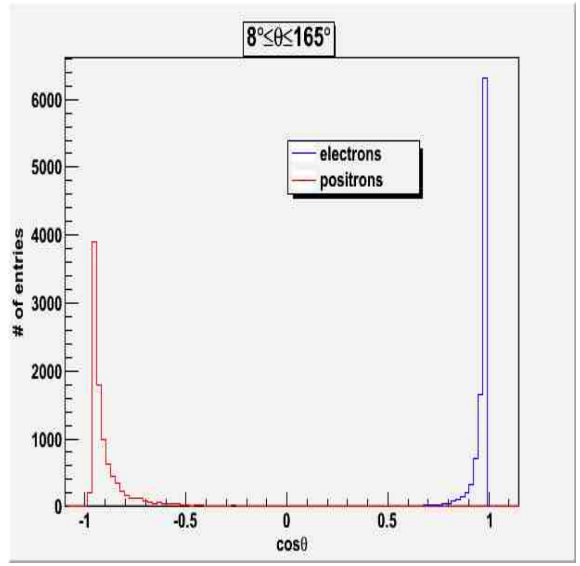
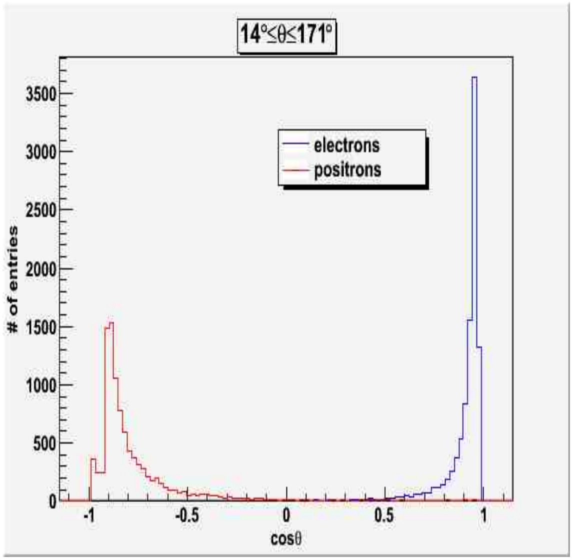


Fig. 3.3c



- Interested in the region 14°≤ θ ≤165°, but want to include scattering at more extreme angles due to bremsstrahlung
- Using a similar procedure to that in part 1, a cut of 8°≤ θ ≤171° is selected for the Dch study

Part 2: Results

Fig. 4.1

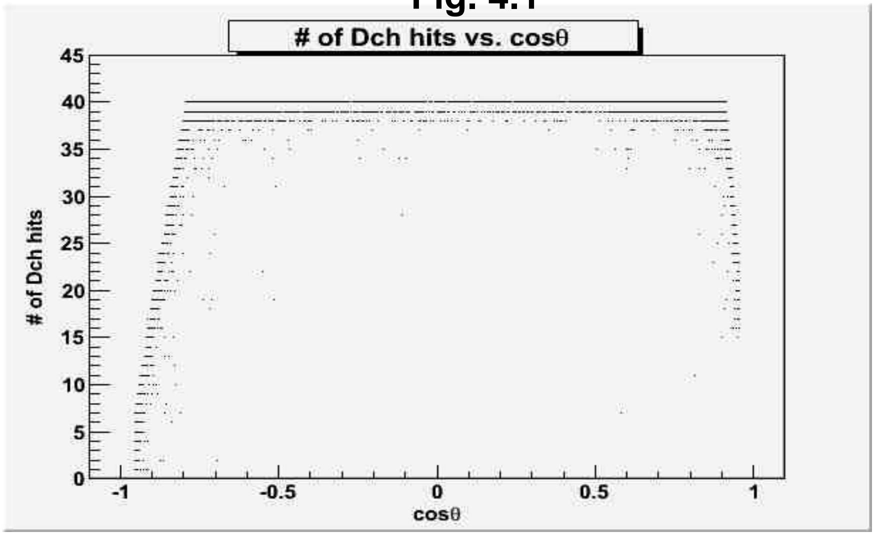
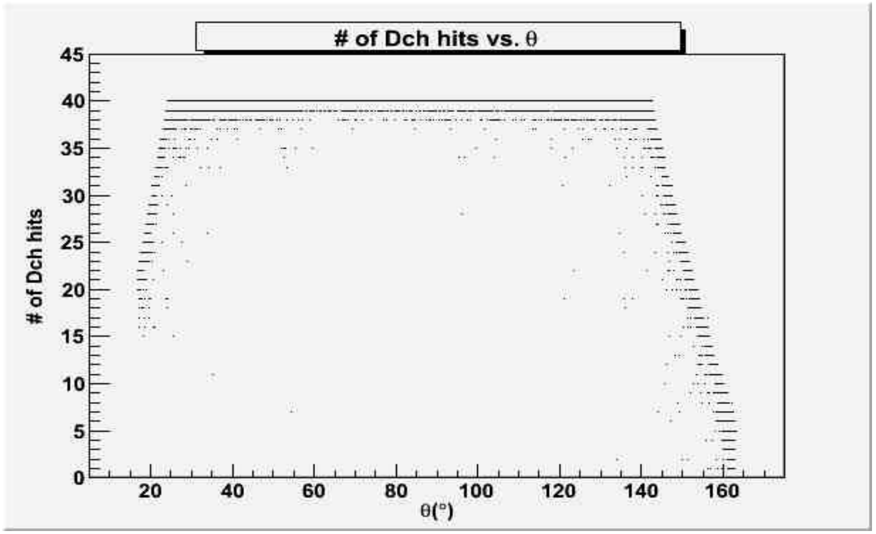


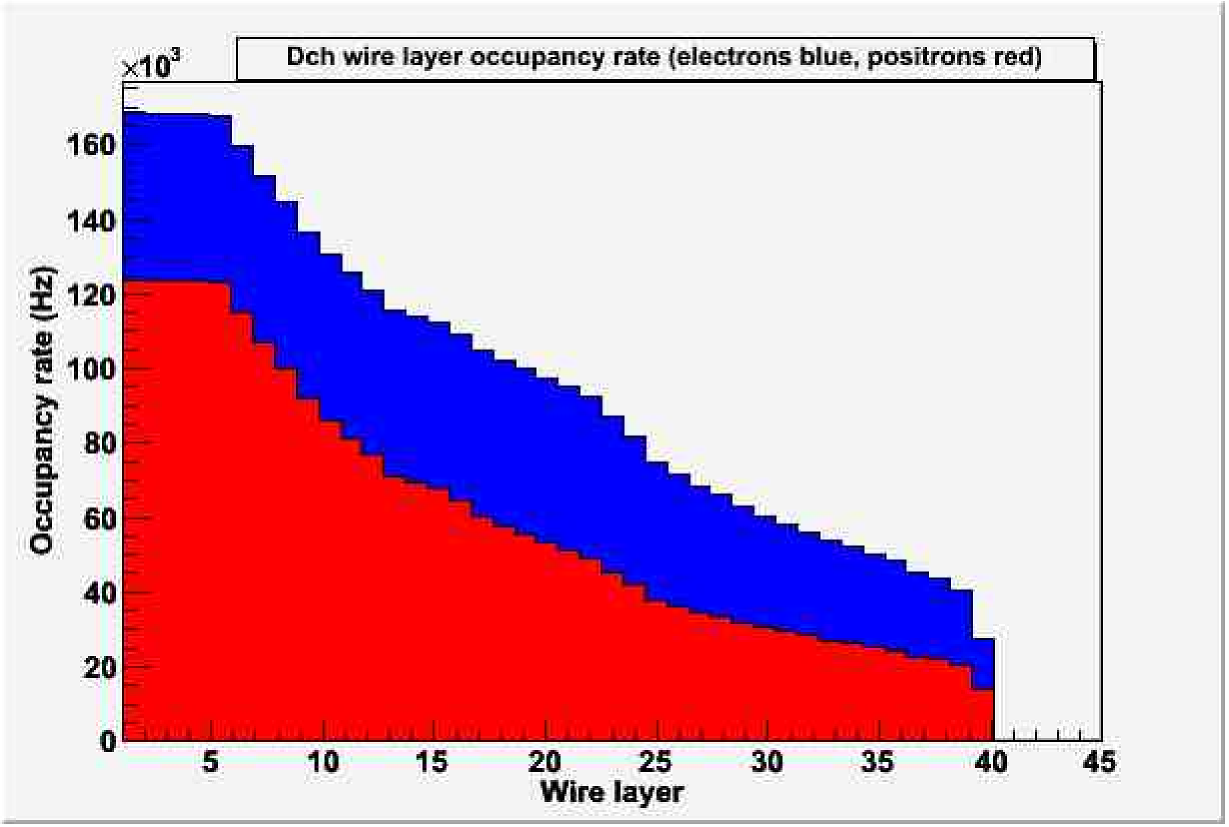
Fig. 4.2



- 30 000 events simulated
- Graphs include both positrons and electrons

Part 2: Results

Fig. 4.1



- Occupancy rates based on reference value of 49nb for electron cross-section in range $-0.922 \leq \cos\theta_{CM} \leq 0.927$
  - Assumed SuperB luminosity of $10^{-3}\,fb^{-1} \cdot s^{-1}$
  - In this range we have 6686 electrons (out of 30 000 total) → ~0.14s of data
  - Also assumes that if layer *n* is hit, then so are layers *1*,*2*,...,*n-1*

Final Remarks

- Would be useful to find a way of obtaining more data than what BetaTupleMaker provides
  - May want to consider using FastSim event display module
- Bhwide generator tends to overshoot generator-level angular cutoffs for positrons and electrons by ~1°

Future Goals:

- Plan to continue studying Dch occupancy rates, adding more details as I learn the tools and methods
- Will substitute in various test geometries for Dch and perform similar analyses on them