SuperB:
DCH studies using FullSim

Dana Lindemann
McGill University

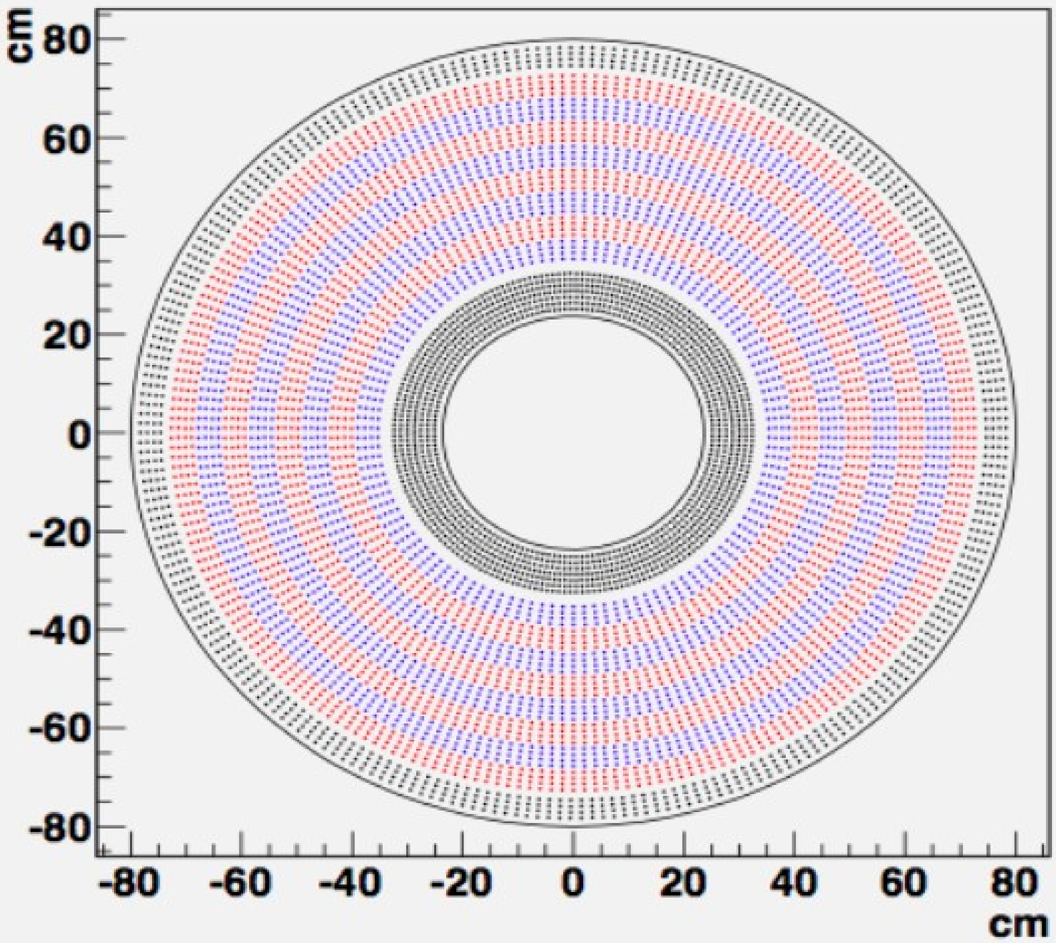
DCH Session
SuperB General Meeting
September 27, 2010

Outline

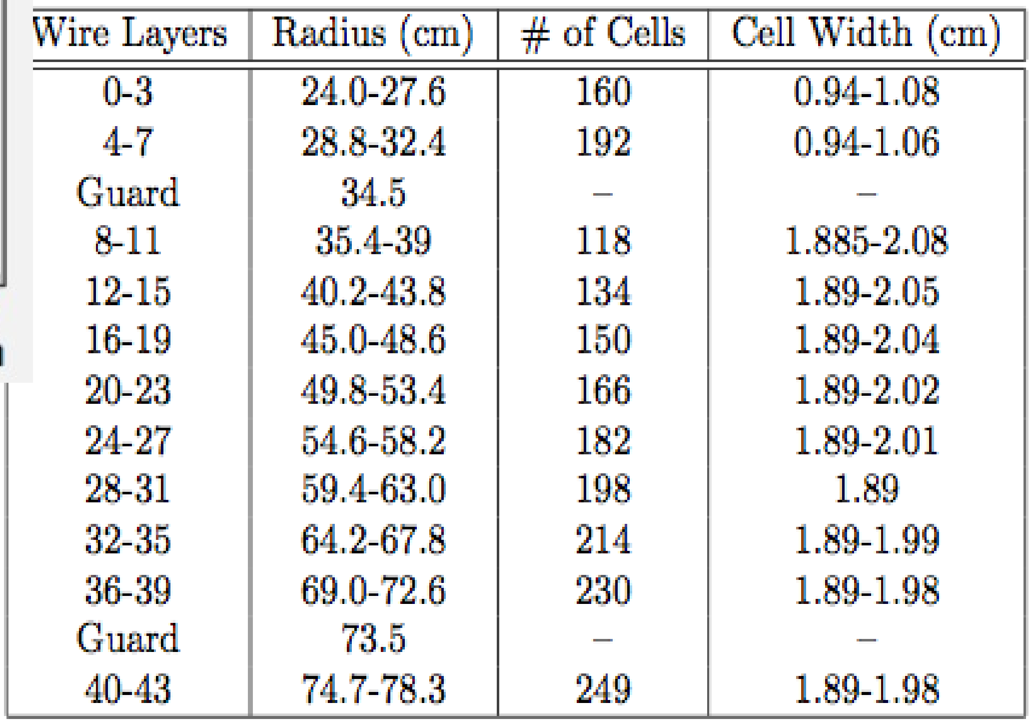
- DCH Geometry plots
- Shield Thickness plots
- B-physics and B-reconstruction Studies

- Updated version of BAD (v3) will be available at www.hep.physics.mcgill.ca/~danaml/SuperB-Dana.pdf

Wire Layout used in Occupancies



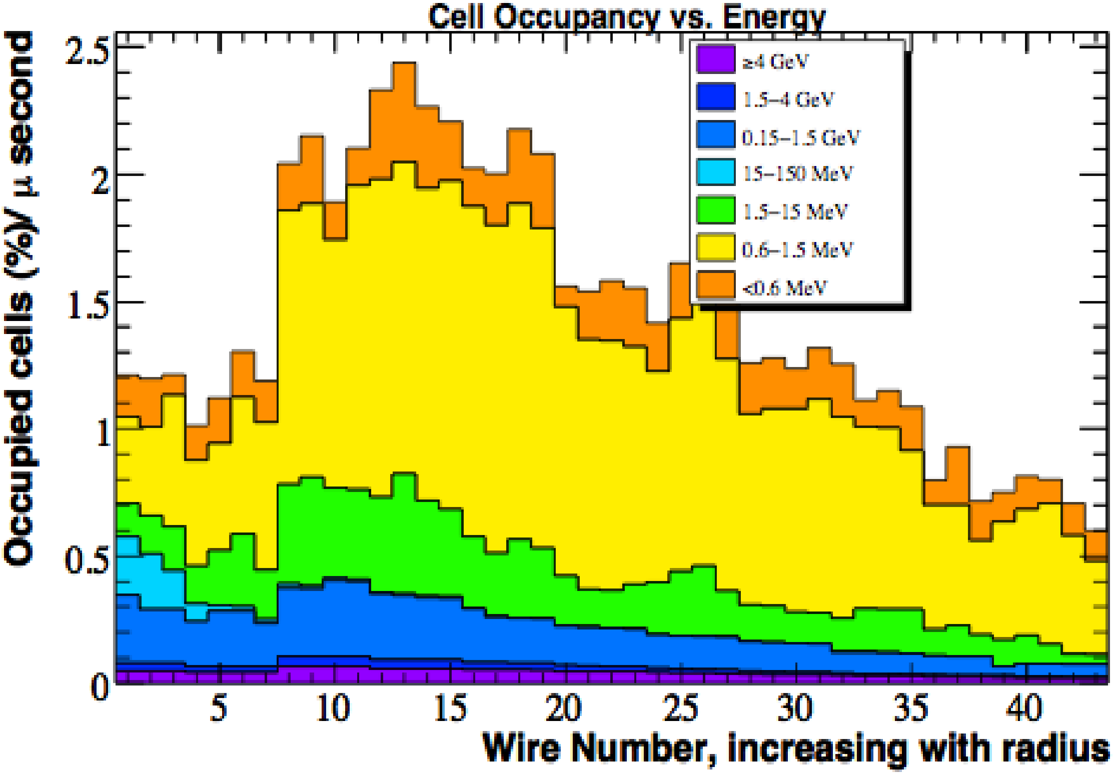
Wires are evenly spaced 1.2 cm apart within a superlayer

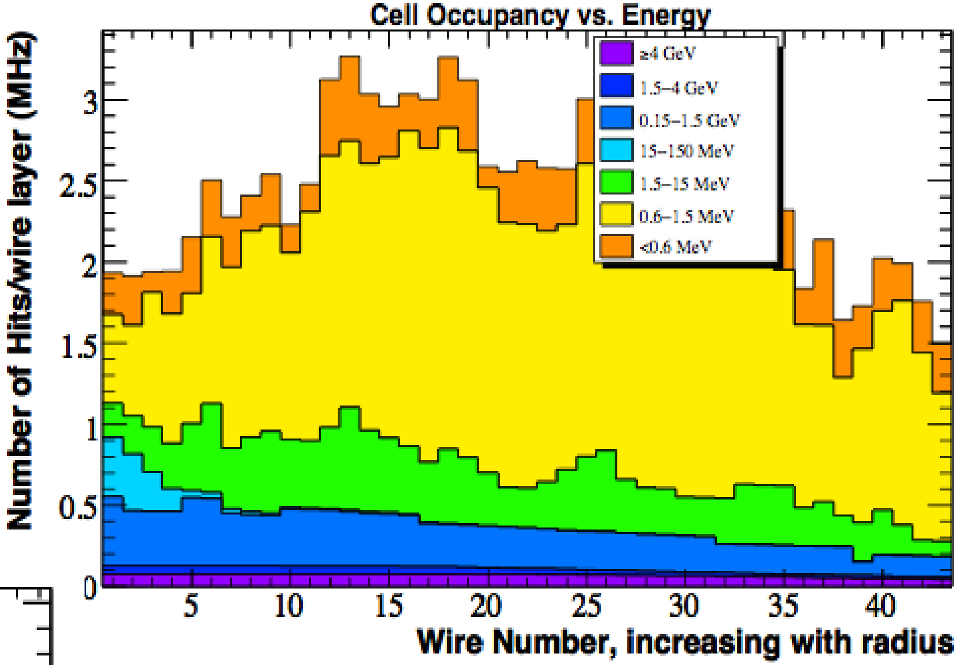


Wire Layers	Radius (cm)	# of Cells	Cell Width (cm)
0-3	24.0-27.6	160	0.94-1.08
4-7	28.8-32.4	192	0.94-1.06
Guard	34.5	–	–
8-11	35.4-39	118	1.885-2.08
12-15	40.2-43.8	134	1.89-2.05
16-19	45.0-48.6	150	1.89-2.04
20-23	49.8-53.4	166	1.89-2.02
24-27	54.6-58.2	182	1.89-2.01
28-31	59.4-63.0	198	1.89
32-35	64.2-67.8	214	1.89-1.99
36-39	69.0-72.6	230	1.89-1.98
Guard	73.5	–	–
40-43	74.7-78.3	249	1.89-1.98

Occupancies vs. Energy

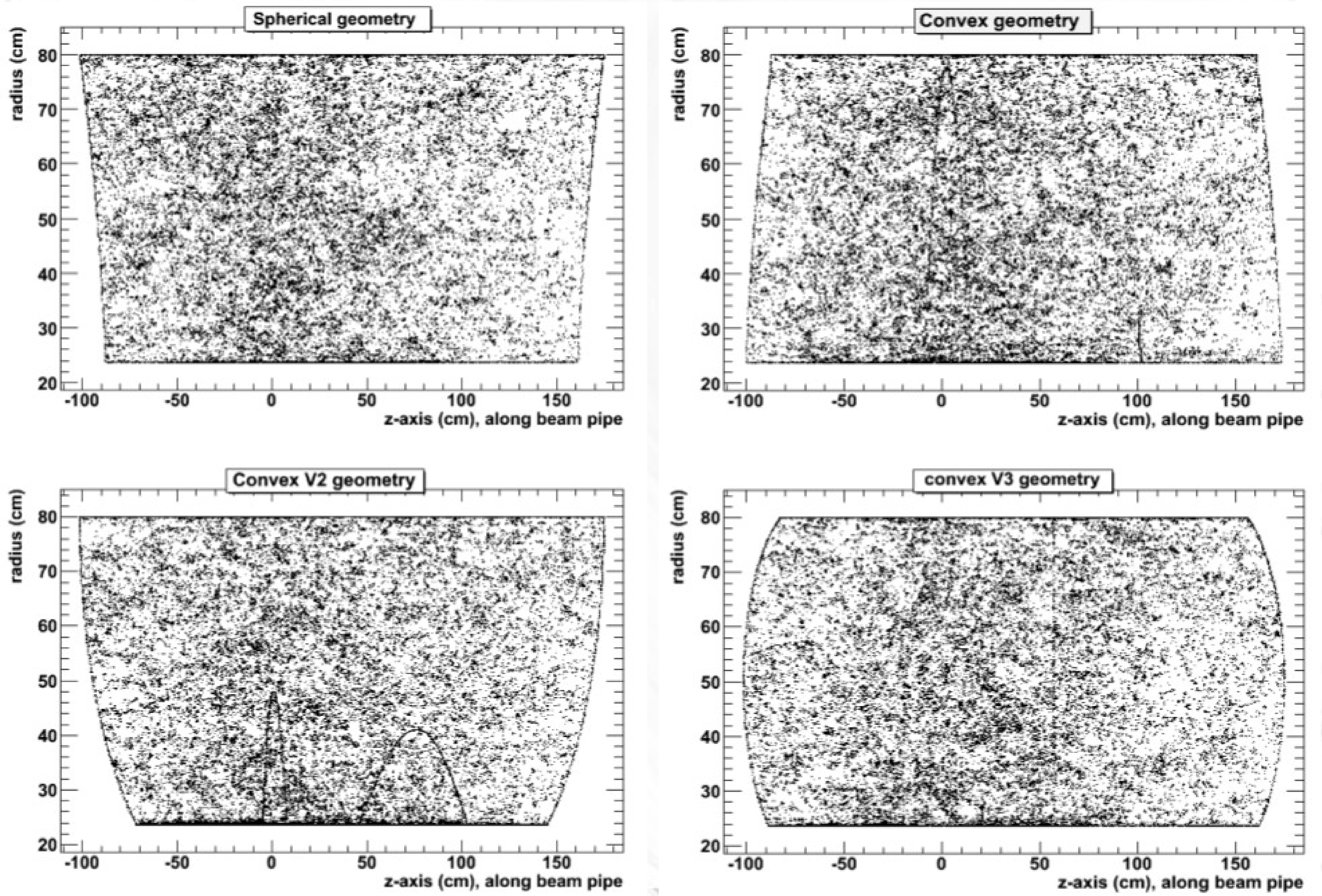
New occupancy y-axis. Note also the occupancy dip due to the 2nd superlayer



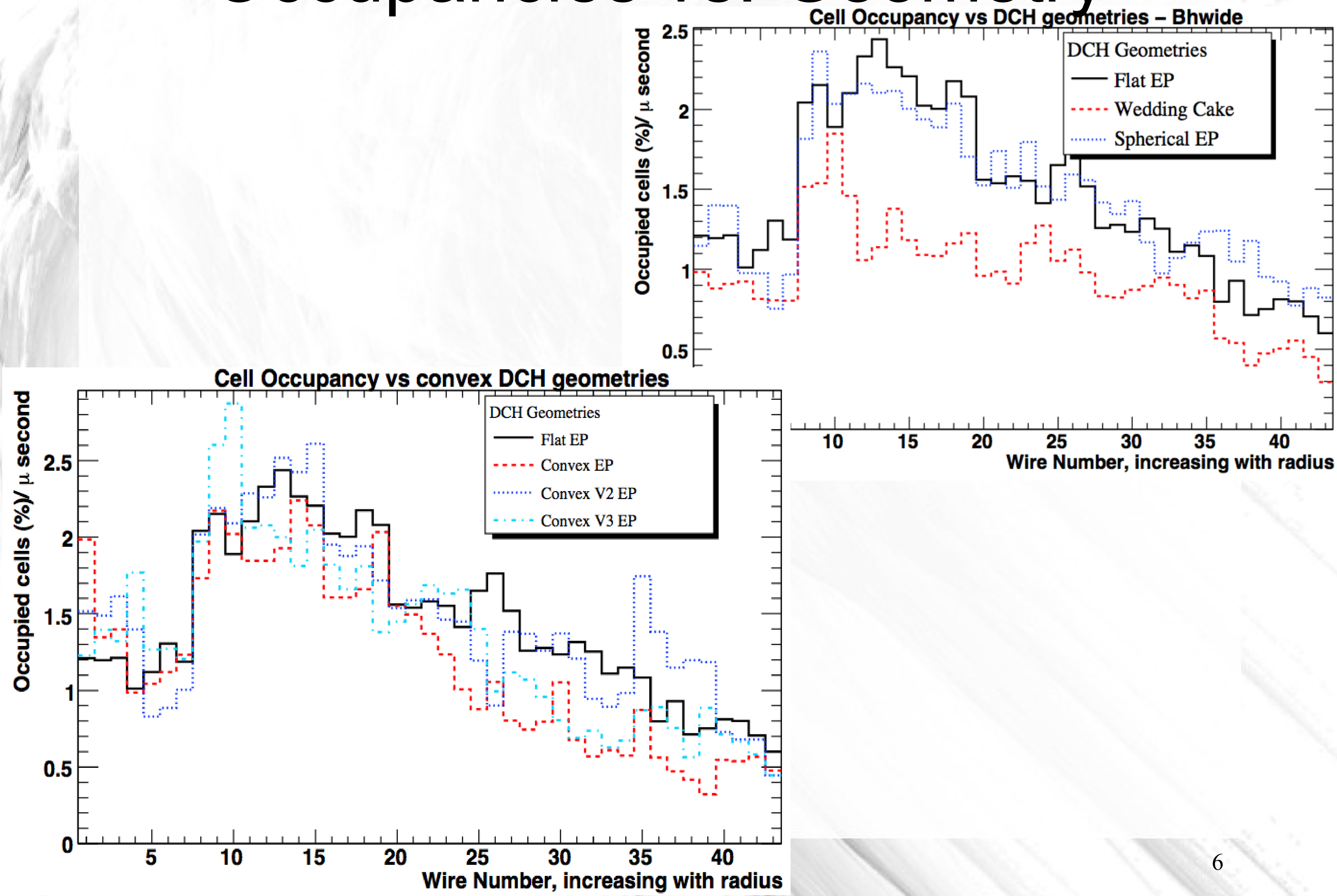


Original occupancy y-axis

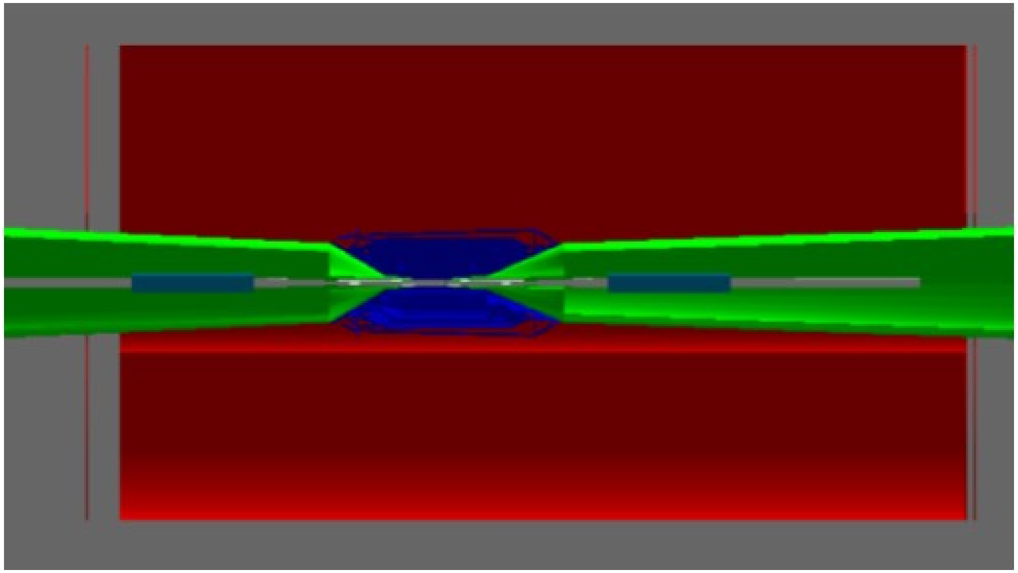
Curving Geometries

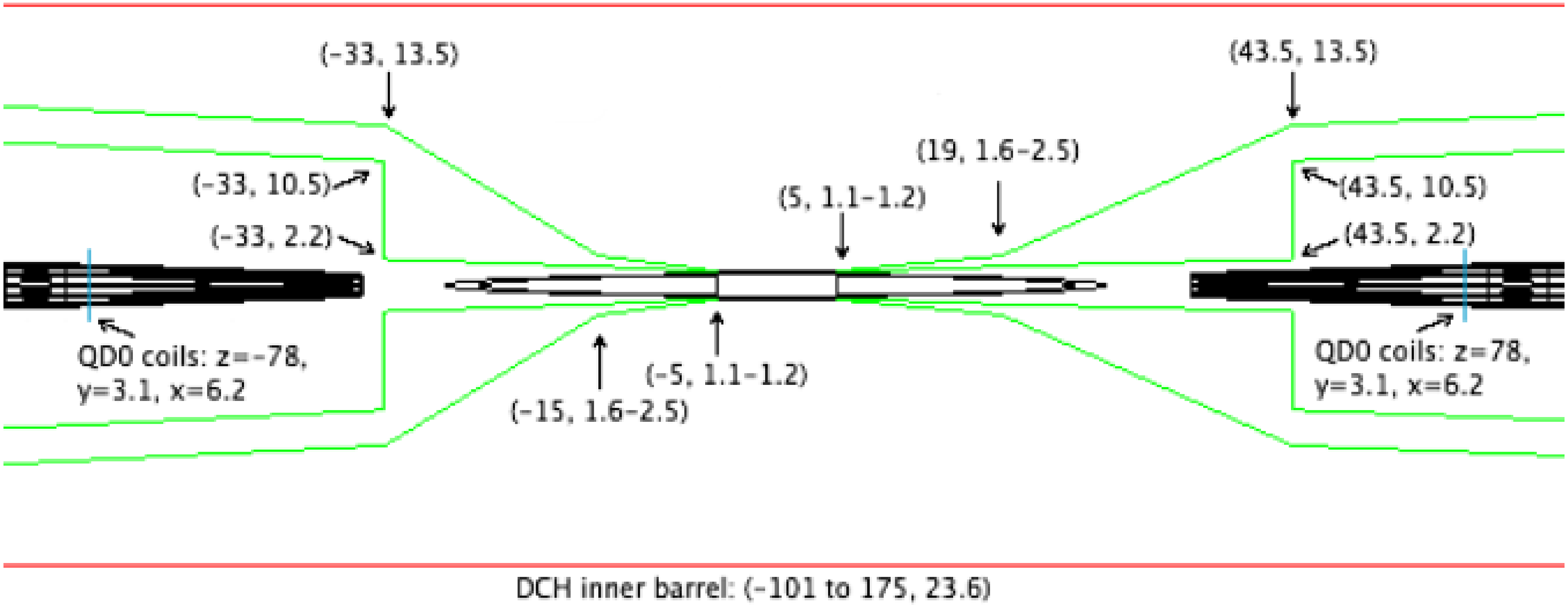


Occupancies vs. Geometry

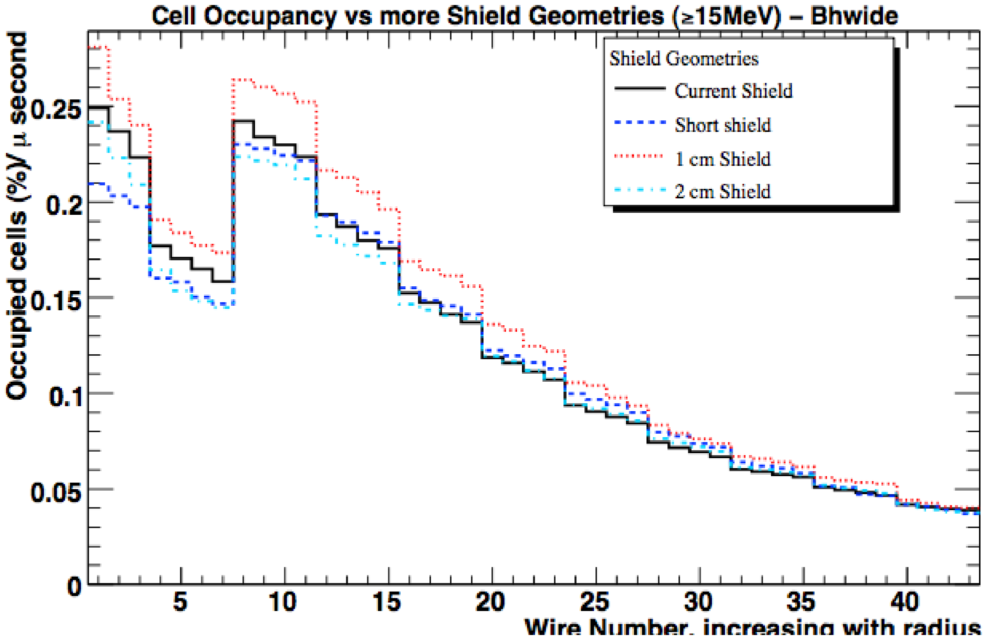


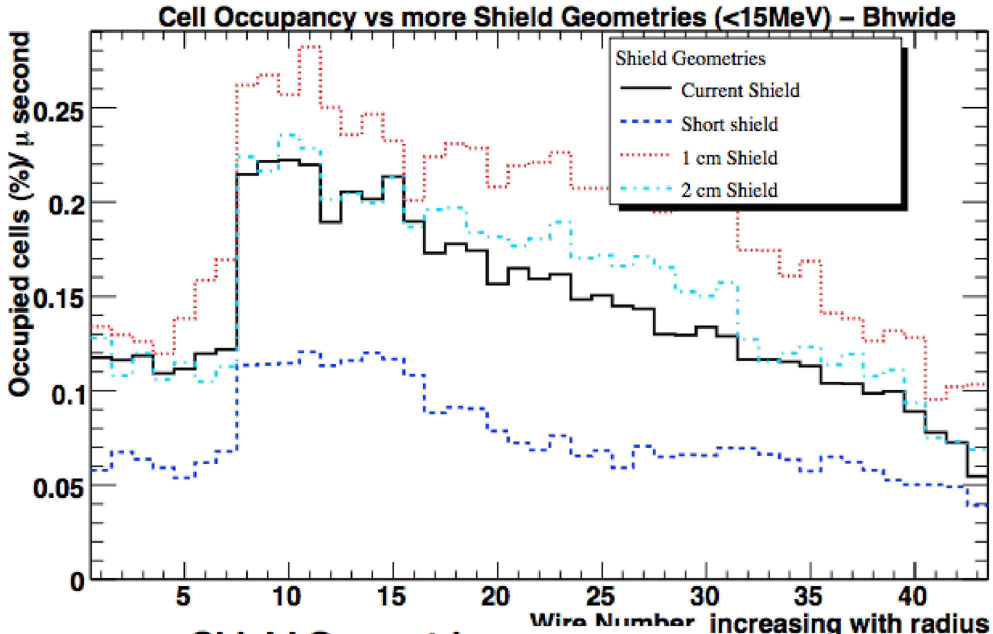
Shield Geometry



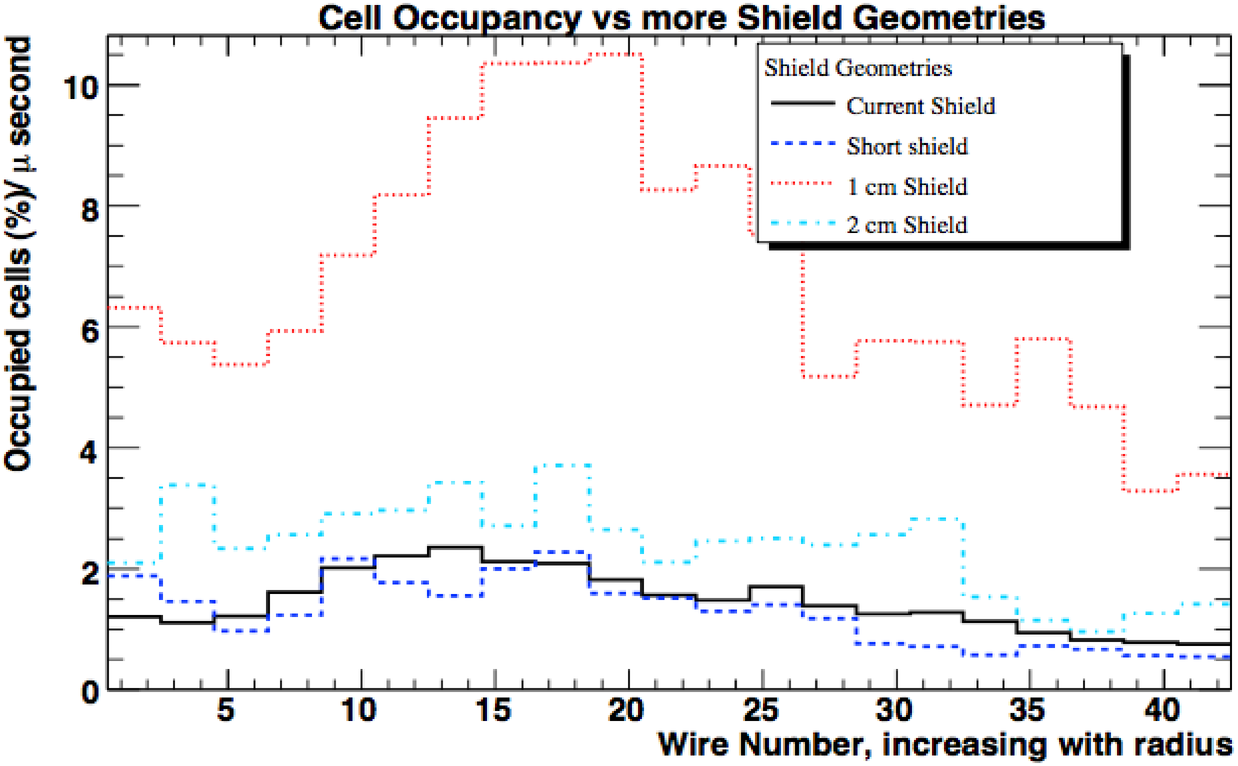


Occupancy vs. Shield Thickness





Current shield geometry has a 3 cm thickness



B-physics

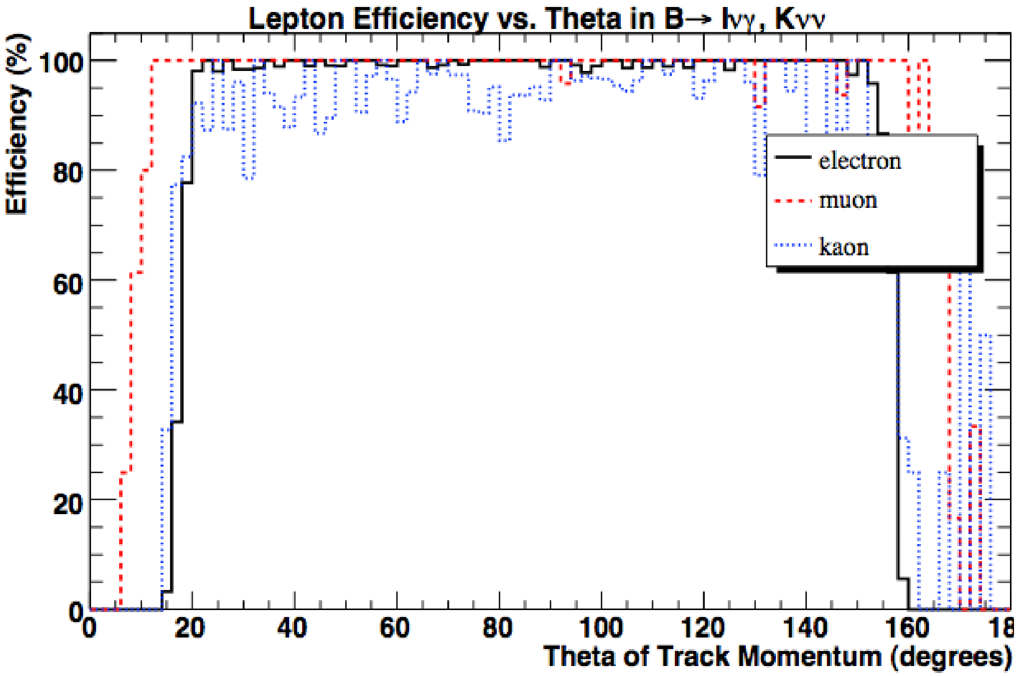
Made B decay samples using EvtGen and dec files. Ran thru FastSim, converted output into Bruno input using FastSimToFullSim package, and produced FullSim samples:

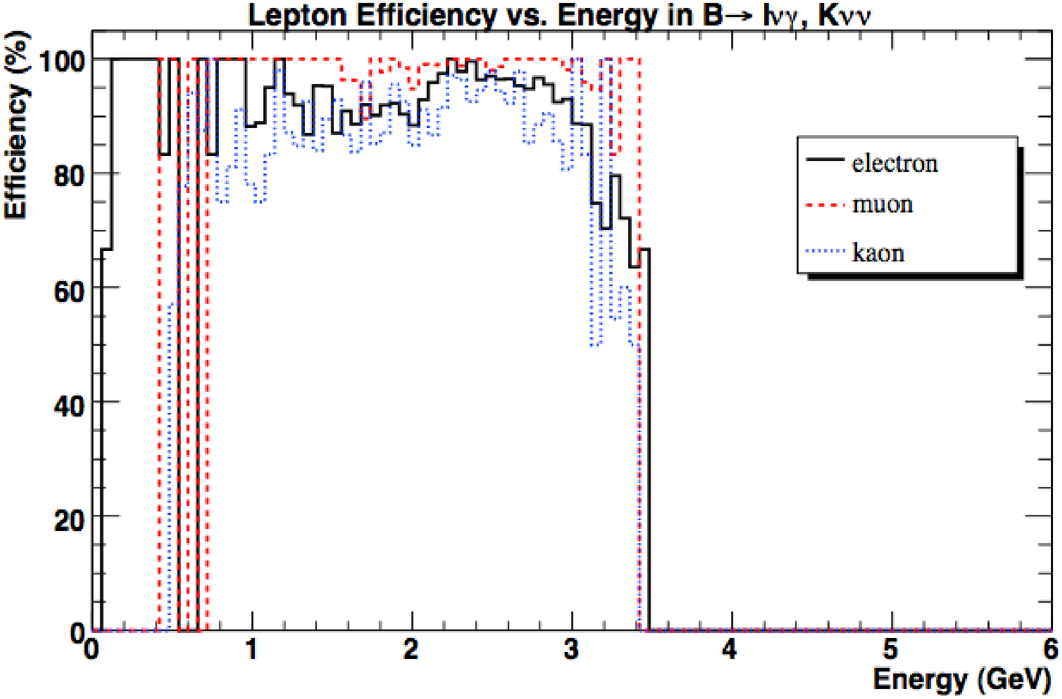
- Generic B^+B^-
- Generic $B^0\overline{B}^0$
- $B^+ \rightarrow \ell^+\nu_\ell\gamma$ where $\ell = e, \mu$, $B^- \rightarrow$ generic
- $B^+ \rightarrow K^+\nu\nu$, $B^- \rightarrow$ generic
- $B^+ \rightarrow \ell^+\nu_\ell\gamma$ and $B^+ \rightarrow K^+\nu\nu$, $B^- \rightarrow D^0\pi^-$ where $D^0 \rightarrow$ charged tracks only ($K^\pm\pi^\mp$, $4\pi^\pm$ through K_S^0, $K^\pm 3\pi^\pm$ directly or through K_S^0, K_s^{*0}, K_1^+, or ω resonances)

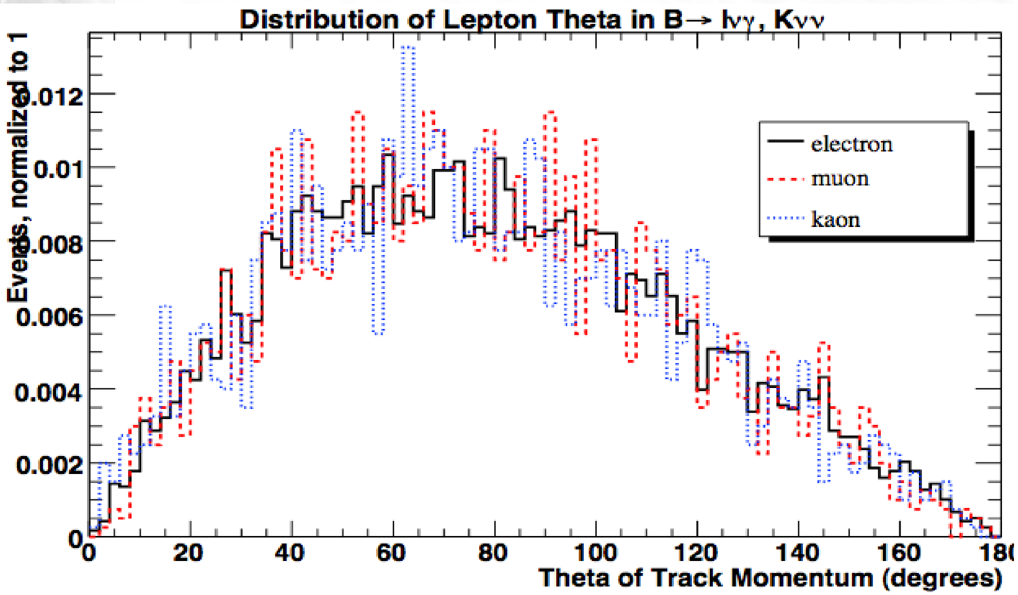
Lepton Efficiency (%) for various geometries using $B^+ \rightarrow \ell^+\nu_\ell\gamma$, $B^+ \rightarrow K^+\nu\nu$ samples

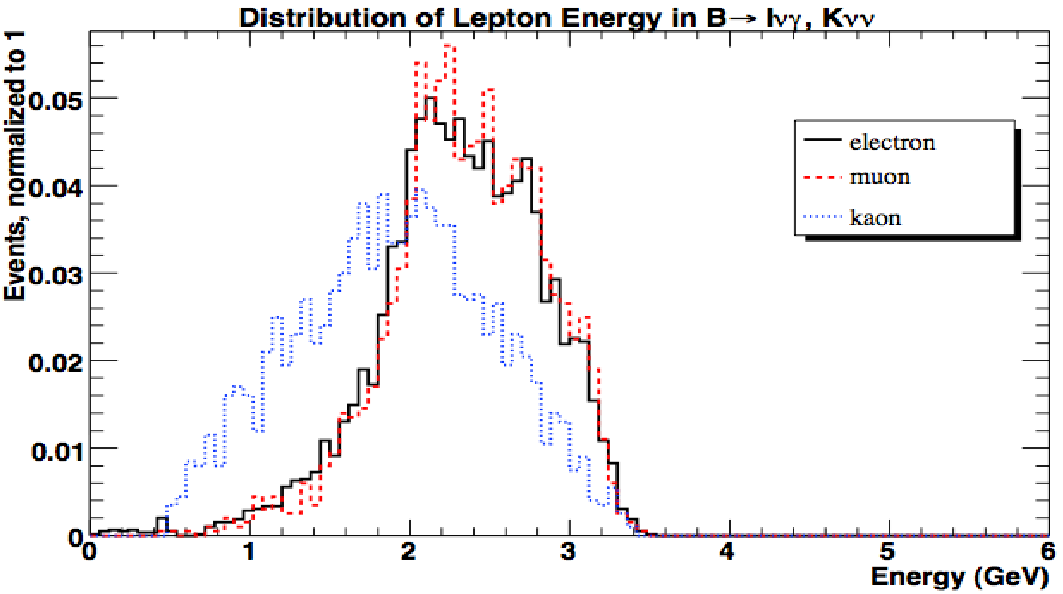
Lepton	flat	WC	spherical	shortShield	flat-unsh
Electron	93.6102	93.9	93.6	93.6667	97.2778
Muon	98.7	96.1	98.65	98.75	99.1579
Kaon	89.4	88.8421	89.8421	89.8947	92.2105

Lepton Efficiency

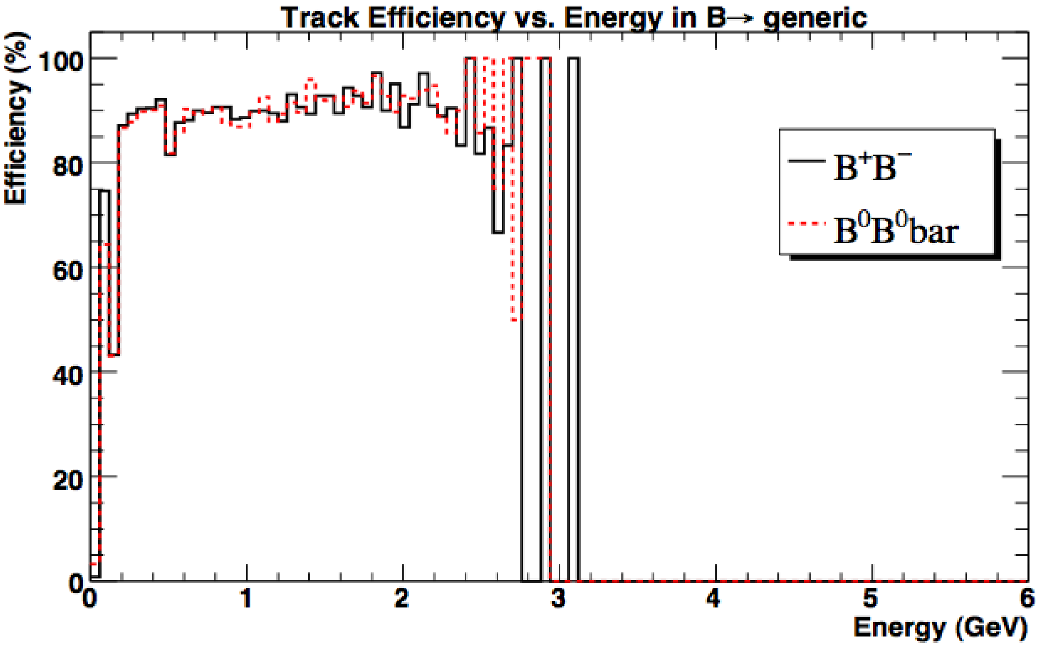

Lepton Efficiency vs. Theta in $B \to l\nu\gamma$, $K\nu\nu$

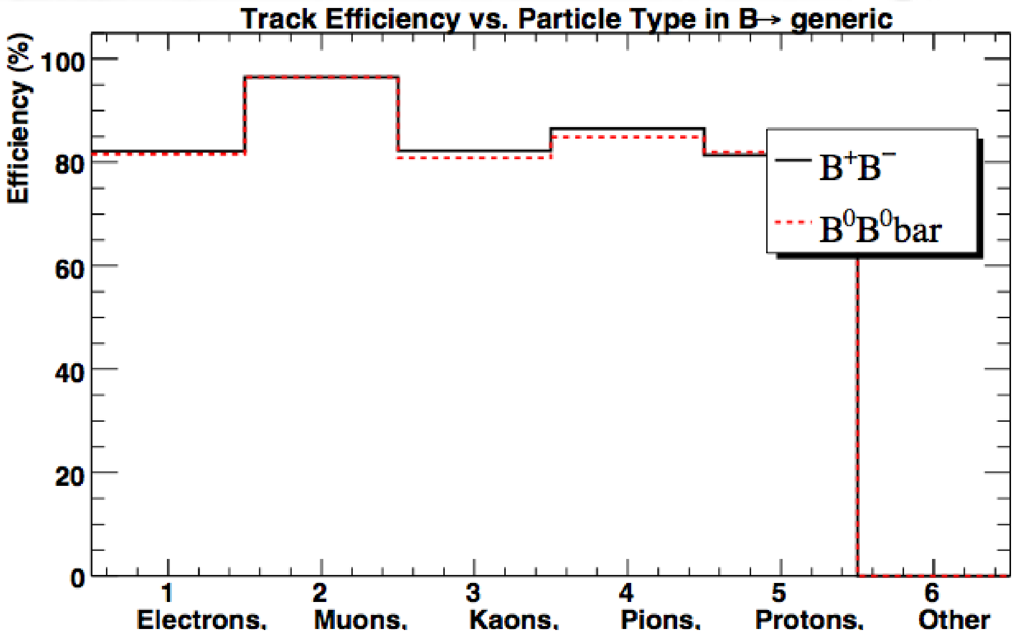

Lepton Efficiency vs. Energy in $B \to l\nu\gamma$, $K\nu\nu$

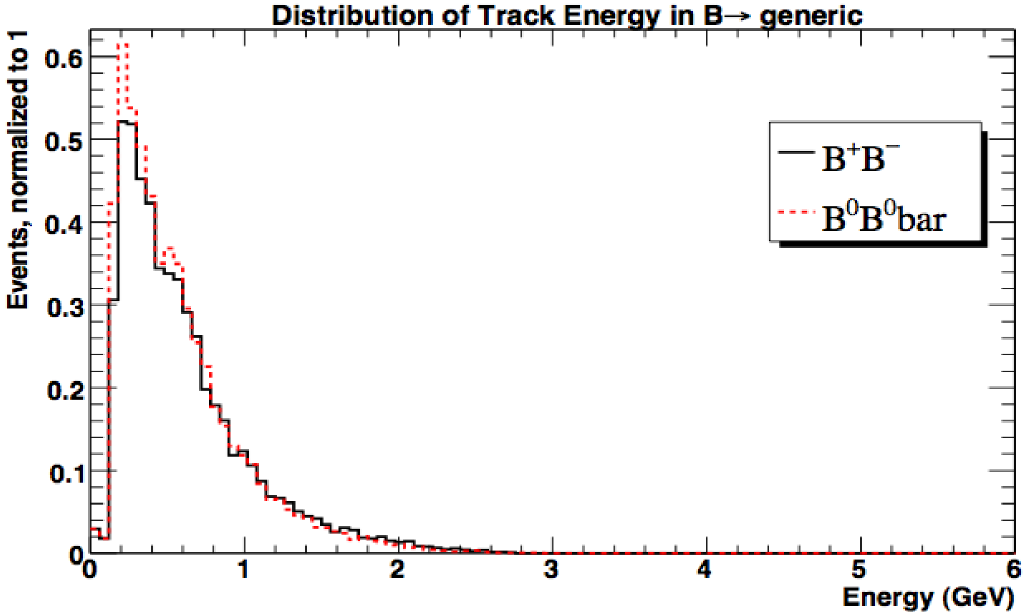

Distribution of Lepton Theta in $B \to l\nu\gamma$, $K\nu\nu$

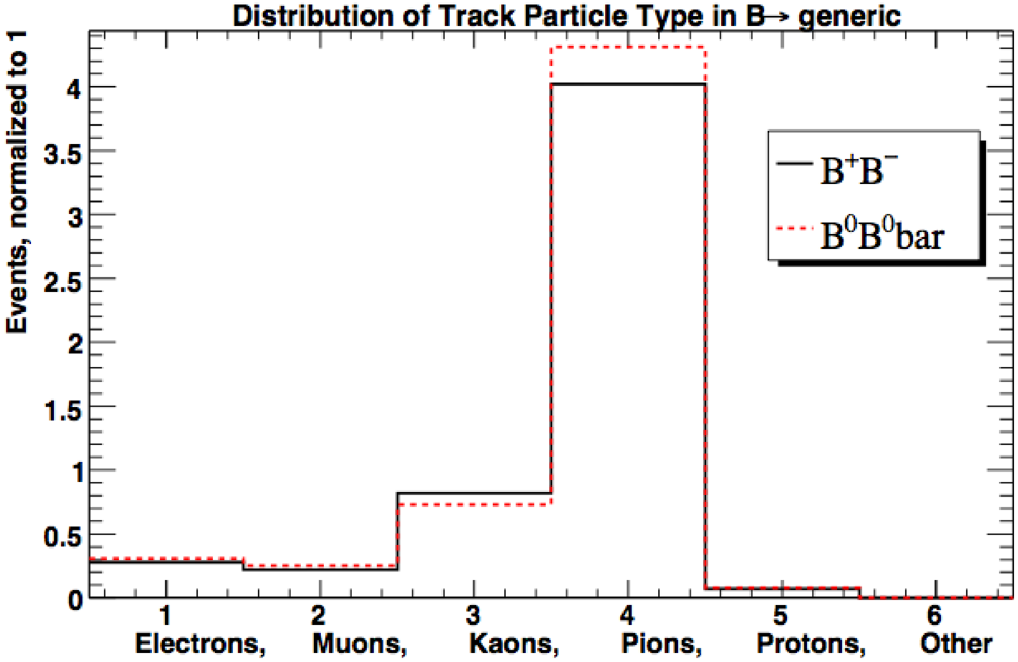

Distribution of Lepton Energy in $B \to l\nu\gamma$, $K\nu\nu$

Generic B Track Efficiencies

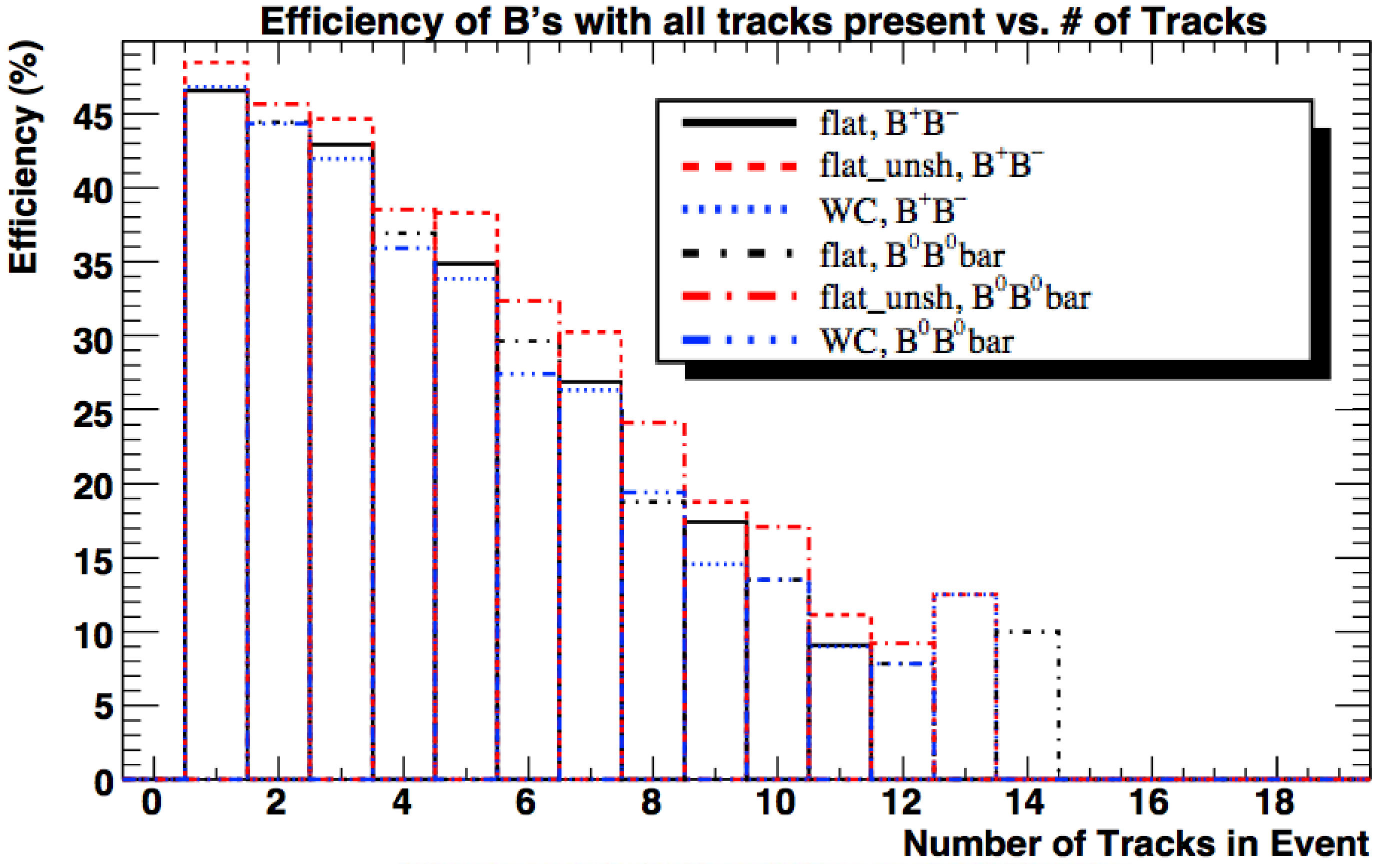

Track Efficiency vs. Energy in B→ generic

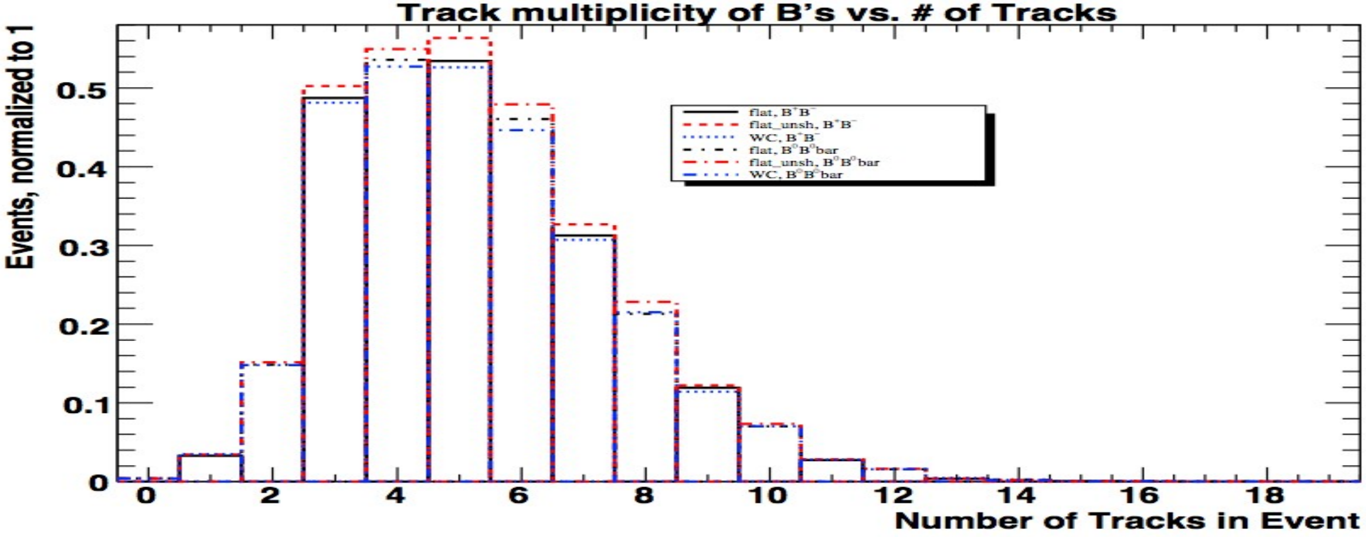

Track Efficiency vs. Particle Type in B→ generic


Distribution of Track Energy in B→ generic


Distribution of Track Particle Type in B→ generic

Efficiency of all Tracks in Generic B


Efficiency of B's with all tracks present vs. # of Tracks


Track multiplicity of B's vs. # of Tracks

Efficiency of all Tracks in Generic B

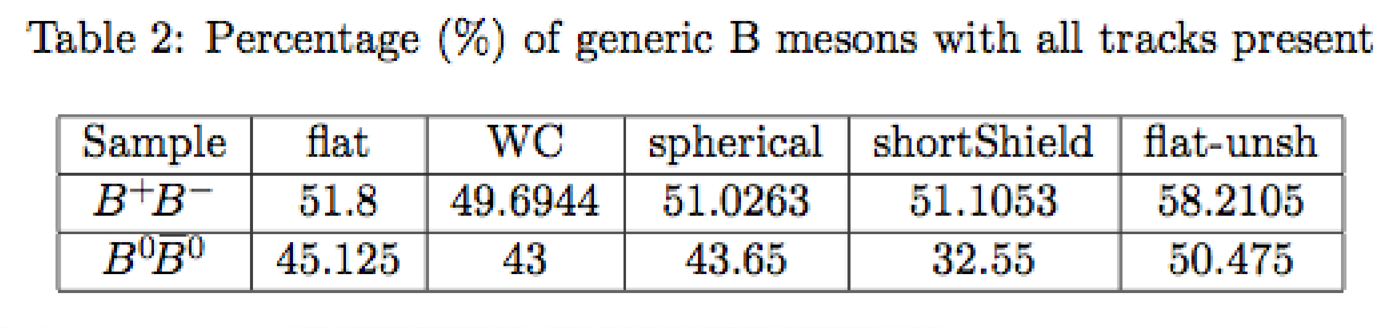


Table 2: Percentage (%) of generic B mesons with all tracks present

Sample	flat	WC	spherical	shortShield	flat-unsh
B^+B^-	51.8	49.6944	51.0263	51.1053	58.2105
$B^0\overline{B}^0$	45.125	43	43.65	32.55	50.475

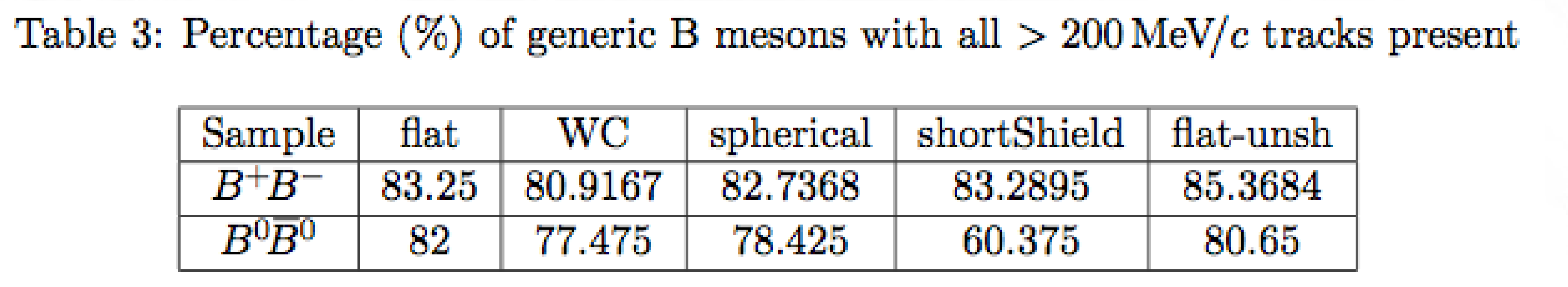
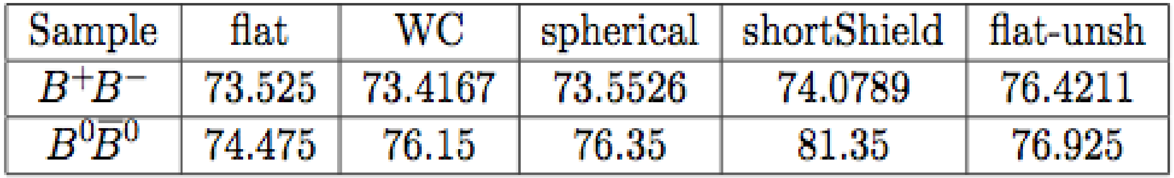


Table 3: Percentage (%) of generic B mesons with all > 200 MeV/c tracks present

Sample	flat	WC	spherical	shortShield	flat-unsh
B^+B^-	83.25	80.9167	82.7368	83.2895	85.3684
$B^0\overline{B}^0$	82	77.475	78.425	60.375	80.65

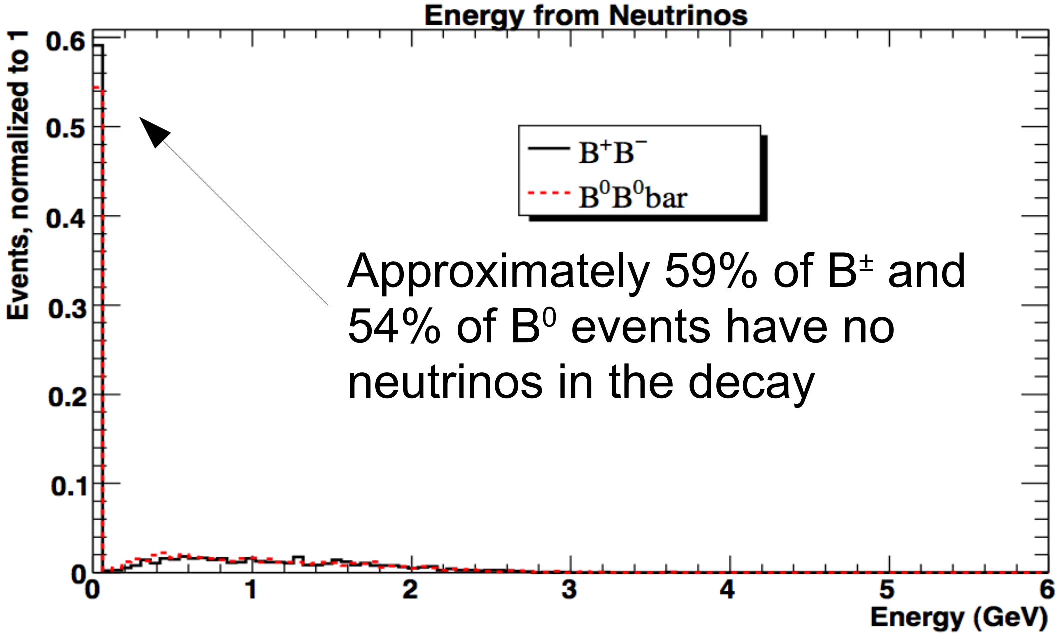
Simple B Reco - neutrinos

Table 4: Percentage (%) of generic B mesons with $m_{\mathrm{ES}} > 5.2$, calculated using all present tracks and neutrals



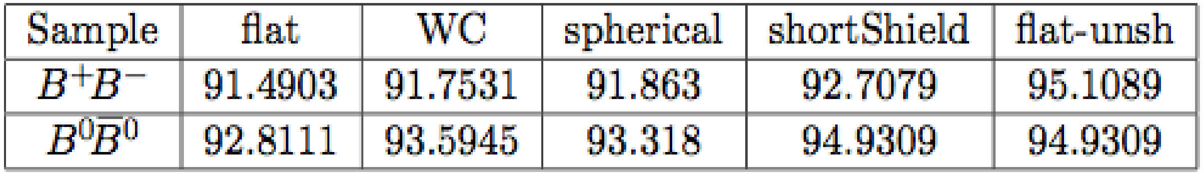
Sample	flat	WC	spherical	shortShield	flat-unsh
B^+B^-	73.525	73.4167	73.5526	74.0789	76.4211
$B^0\overline{B}^0$	74.475	76.15	76.35	81.35	76.925

Reconstruction is done using truth information of the “primary” tracks/neutrals only – ie final-state particles of B decay according to EvtGen



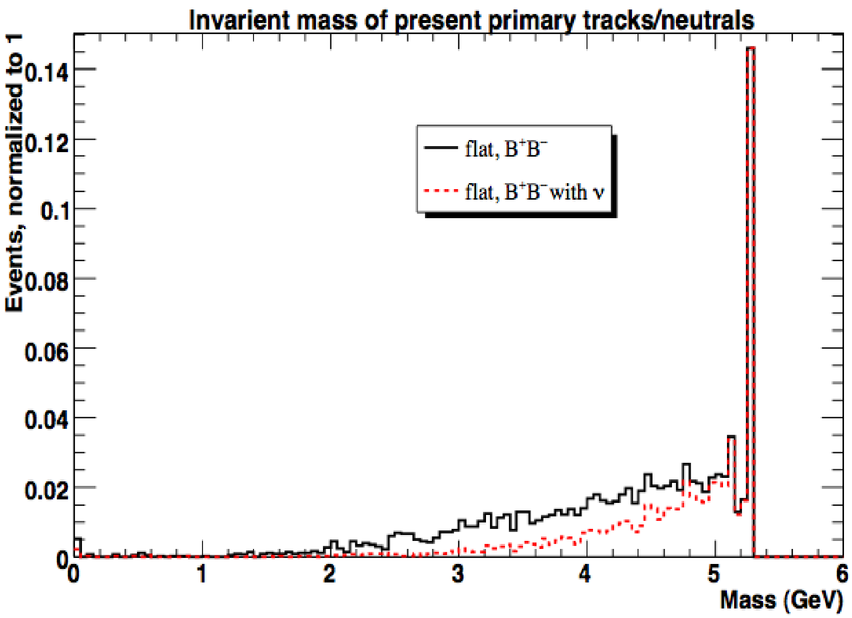
Approximately 59% of B± and 54% of B⁰ events have no neutrinos in the decay

Table 5: Percentage (%) of generic B mesons with $m_{\mathrm{ES}} > 5.2$, calculated using all present tracks and neutrals and removing removing events with a neutrino in the decay



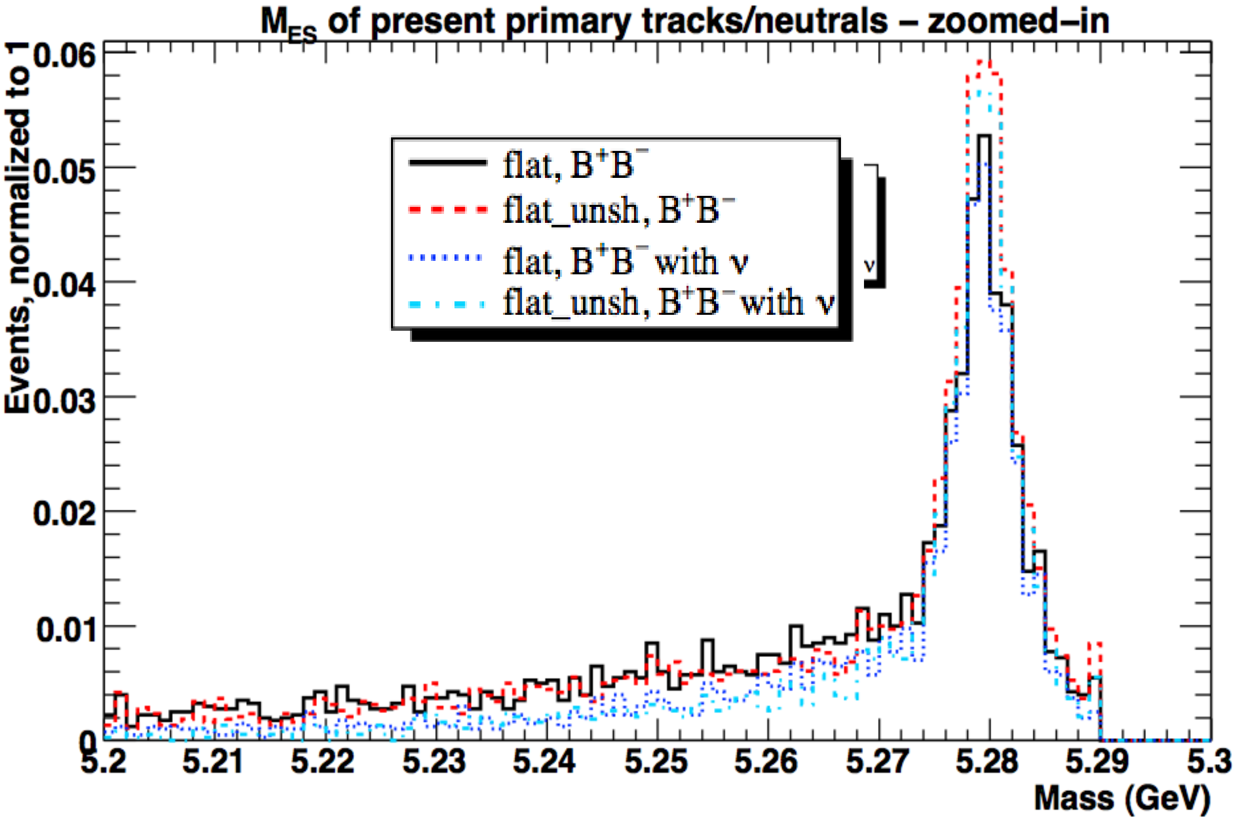
Sample	flat	WC	spherical	shortShield	flat-unsh
B^+B^-	91.4903	91.7531	91.863	92.7079	95.1089
$B^0\overline{B}^0$	92.8111	93.5945	93.318	94.9309	94.9309

Simple B Reco - mes



Invarient mass > 5.20 GeV

Sample	flat	WC	spherical	shortShield	flat-unsh
B^+B^-	24.2168	21.7248	21.7875	21.9209	31.6585
$B^0\overline{B}^0$	20.4608	19.0783	20.3687	15.023	29.1705

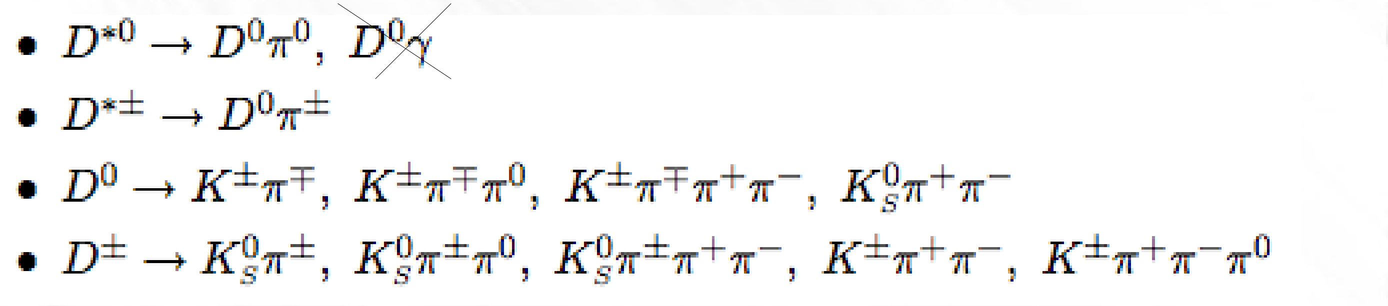


Mes > 5.27 GeV

Sample	flat	WC	spherical	shortShield	flat-unsh
B^+B^-	61.558	61.1216	62.739	61.5385	71.0983
$B^0\overline{B}^0$	61.7512	65.023	64.0553	71.4747	73.0415

BSemiExcl-like B Reco

- Use similar algorithm to BaBar's BSemiExcl reco. Use momentum/energy truth information at particle's originating vertex (or DCH boundary if non-primary track)
- Tracks required to have 50 MeV p_T (CM frame) and enter DCH. Particle ID is used. Photons required to have lab energy greater than 30 MeV and exit DCH
- Reconstruct Ks^0 and pi^0 using requirements similar to BaBar but with tighter invarient mass requirements.
- D seeds must be 1 MeV away from PDG mass:

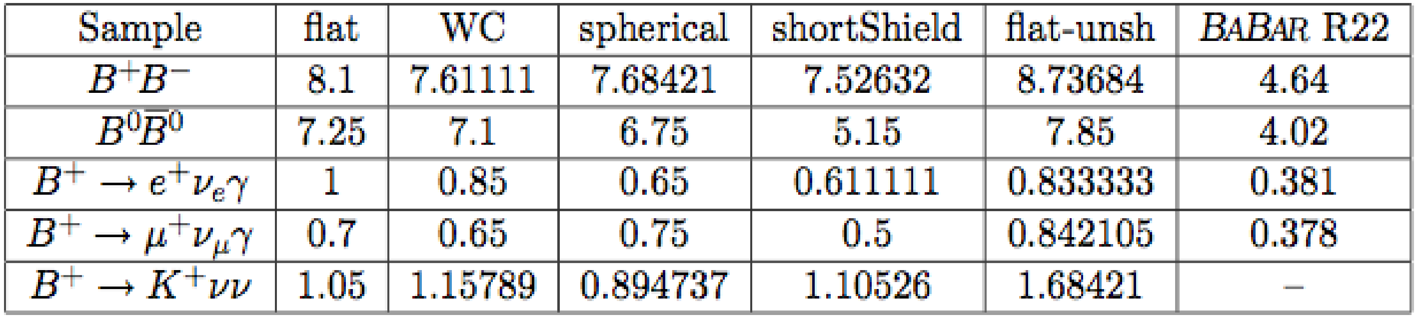


- $D^{*0} \to D^0\pi^0,\ \cancel{D^0\gamma}$
- $D^{*\pm} \to D^0\pi^\pm$
- $D^0 \to K^\pm\pi^\mp,\ K^\pm\pi^\mp\pi^0,\ K^\pm\pi^\mp\pi^+\pi^-,\ K^0_S\pi^+\pi^-$
- $D^\pm \to K^0_S\pi^\pm,\ K^0_S\pi^\pm\pi^0,\ K^0_S\pi^\pm\pi^+\pi^-,\ K^\pm\pi^+\pi^-,\ K^\pm\pi^+\pi^-\pi^0$

- B->DX must have a charged X, no more than 5 particles, ≤2 being K± or Ks^0, ≤2 being pi^0. Require |Delta E| < .2 GeV and mes > 5.2
- BestB currently chosen by the X with the lowest number of tracks/photons used, with ties broken using Delta E.

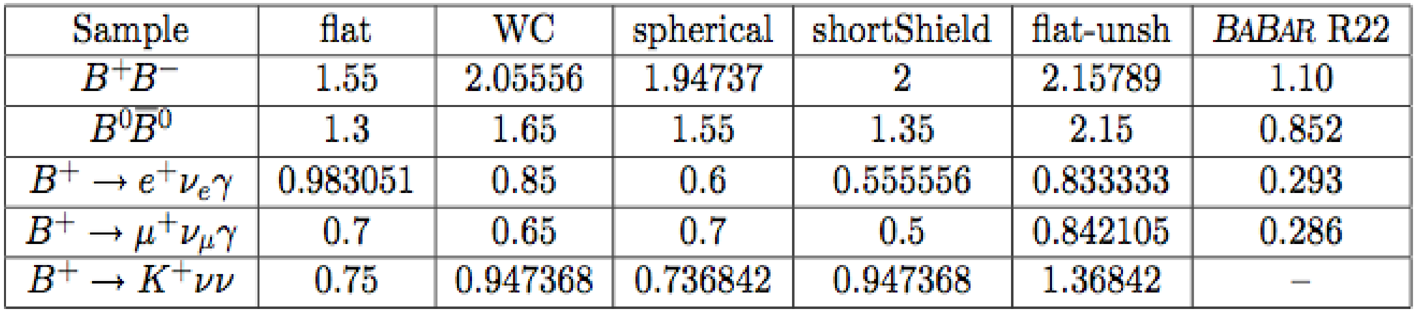
BsemiExcl-like B Reco

Table 15: Percentage (%) of events with a reconstructed B meson



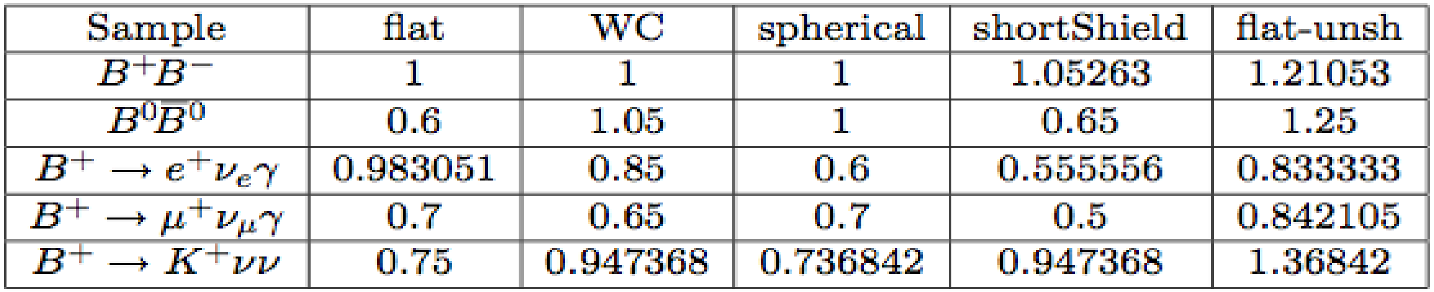
Sample	flat	WC	spherical	shortShield	flat-unsh	BABAR R22
B^+B^-	8.1	7.61111	7.68421	7.52632	8.73684	4.64
$B^0\overline{B}^0$	7.25	7.1	6.75	5.15	7.85	4.02
$B^+ \to e^+\nu_e\gamma$	1	0.85	0.65	0.611111	0.833333	0.381
$B^+ \to \mu^+\nu_\mu\gamma$	0.7	0.65	0.75	0.5	0.842105	0.378
$B^+ \to K^+\nu\nu$	1.05	1.15789	0.894737	1.10526	1.68421	–

Table 16: Percentage (%) of events with a reco B with $m_{\mathrm{ES}} > 5.27$



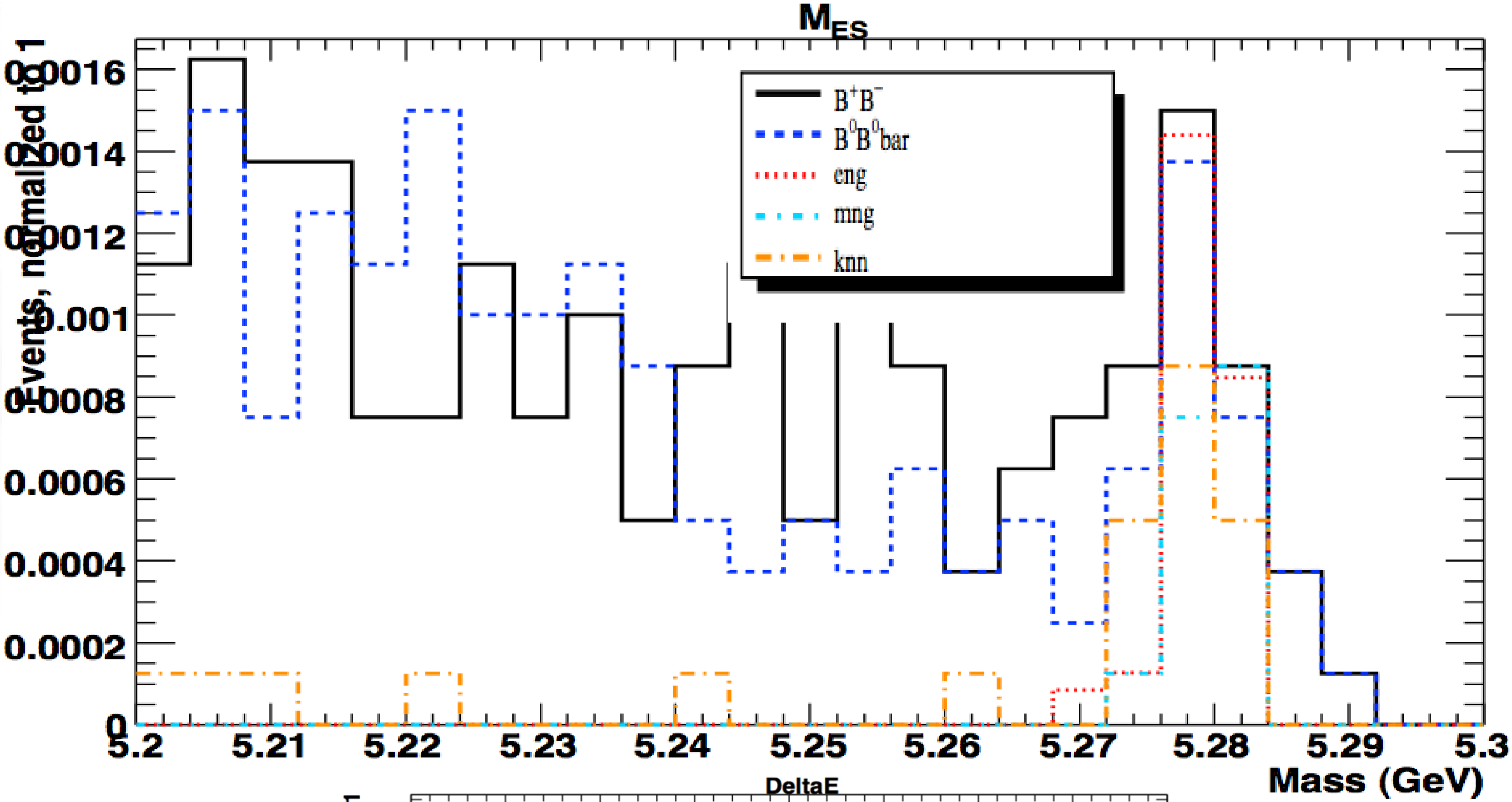
Sample	flat	WC	spherical	shortShield	flat-unsh	BABAR R22
B^+B^-	1.55	2.05556	1.94737	2	2.15789	1.10
$B^0\overline{B}^0$	1.3	1.65	1.55	1.35	2.15	0.852
$B^+ \to e^+\nu_e\gamma$	0.983051	0.85	0.6	0.555556	0.833333	0.293
$B^+ \to \mu^+\nu_\mu\gamma$	0.7	0.65	0.7	0.5	0.842105	0.286
$B^+ \to K^+\nu\nu$	0.75	0.947368	0.736842	0.947368	1.36842	–

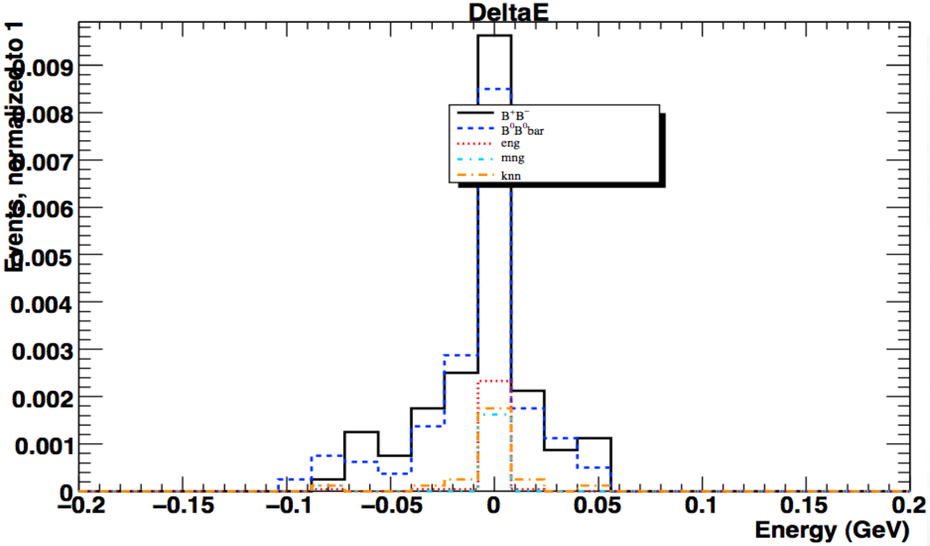
Table 13: Percentage (%) of events with a reco B with $m_{\mathrm{ES}} > 5.27$ with no Bsig particles



Sample	flat	WC	spherical	shortShield	flat-unsh
B^+B^-	1	1	1	1.05263	1.21053
$B^0\overline{B}^0$	0.6	1.05	1	0.65	1.25
$B^+ \to e^+\nu_e\gamma$	0.983051	0.85	0.6	0.555556	0.833333
$B^+ \to \mu^+\nu_\mu\gamma$	0.7	0.65	0.7	0.5	0.842105
$B^+ \to K^+\nu\nu$	0.75	0.947368	0.736842	0.947368	1.36842

BsemiExcl-like B Reco





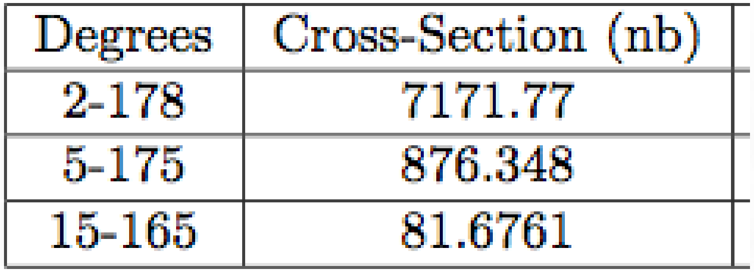
Conclusion

- The convex geometries show little difference in occupancy, as does the 2 cm shield. The 1 cm shield has higher occupancies
- The track acceptance shows little difference between geometries, although flat_unsh is highest and WC is lowest.
- More work to be done with B reconstruction algorithm? Perhaps...

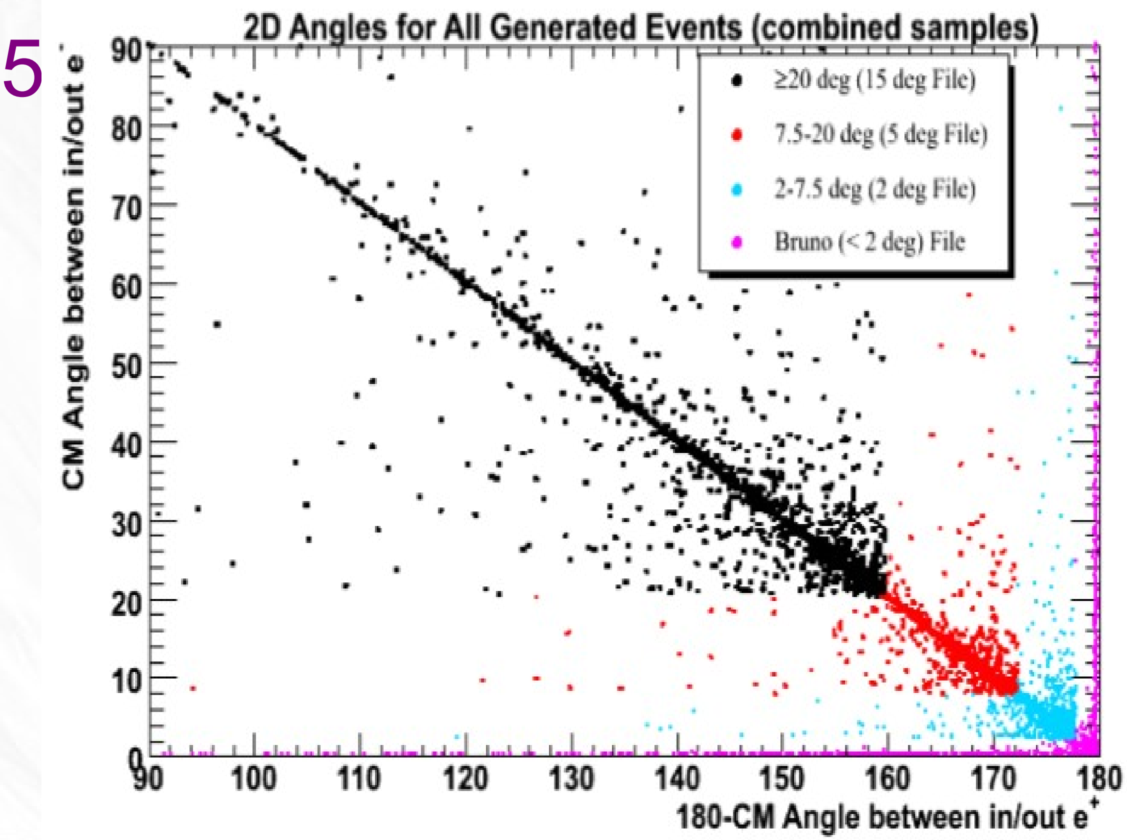
Backup Slides

Analysis Procedure

- Bhwide generator in FastSim (No Bhwide with Bruno)
- Transfer events to FullSim by converting StdHepAsciiDump output to guinea generator input
- Create tuples with e+e- at 2-178, 5-175, 15-165 degrees (CM frame)

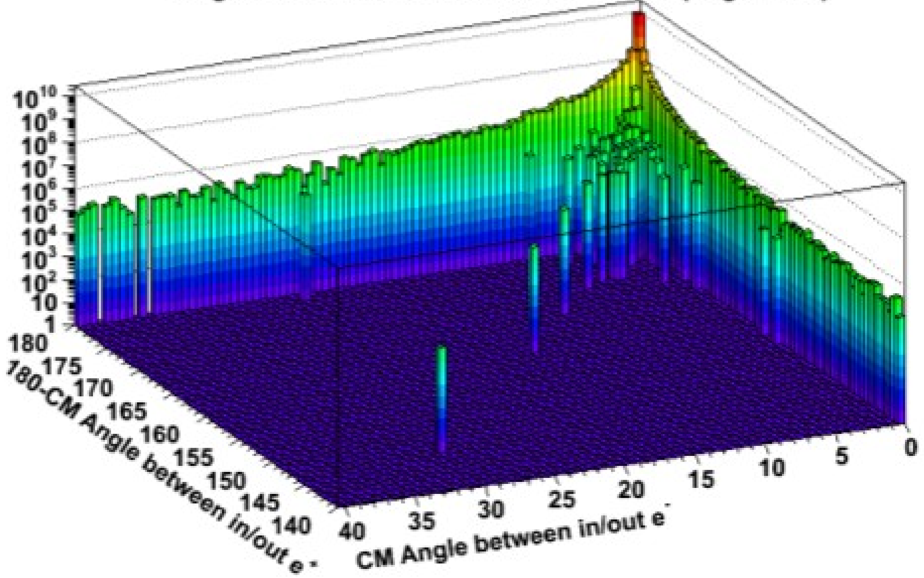


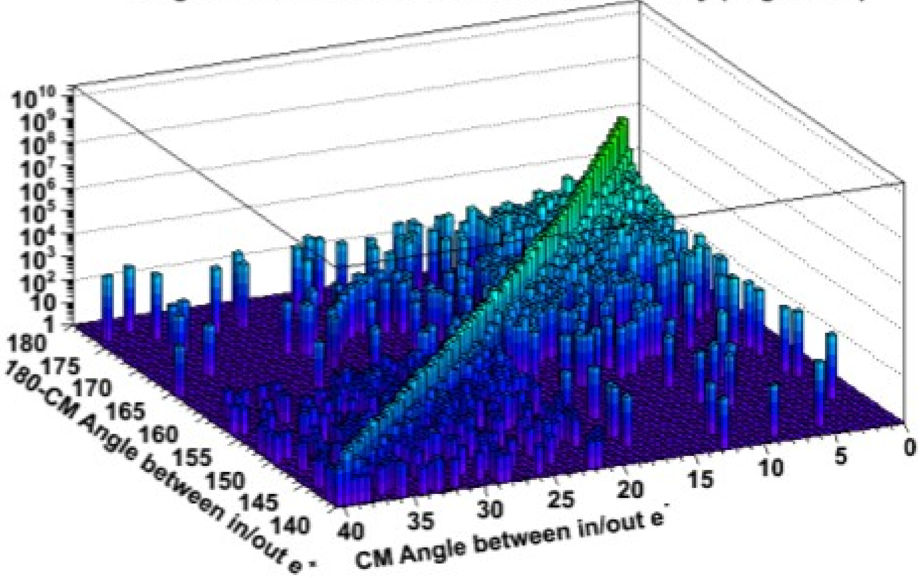
Degrees	Cross-Section (nb)
2-178	7171.77
5-175	876.348
15-165	81.6761

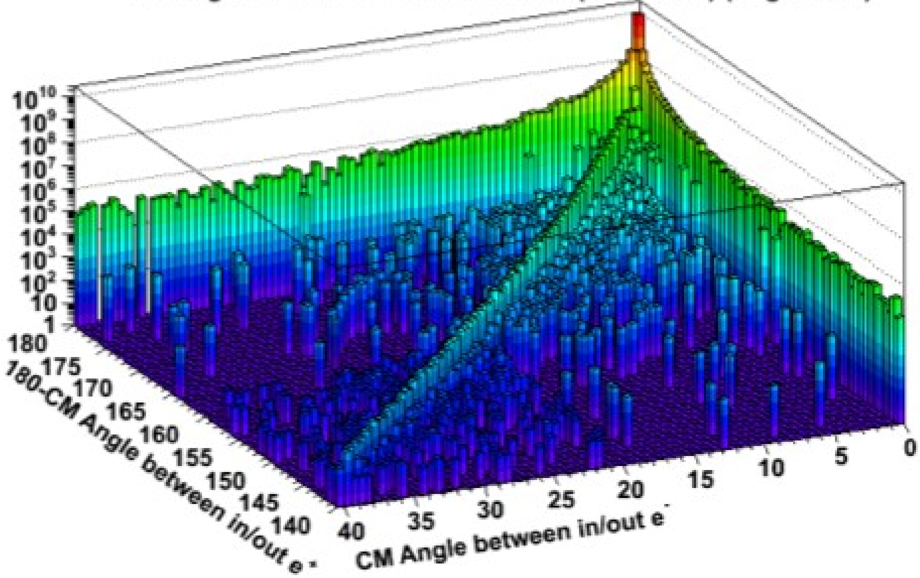


- Combine with tuples created using Bruno's Bbbrem generator. weight = 4.644 ns^{-1}

Combining Samples

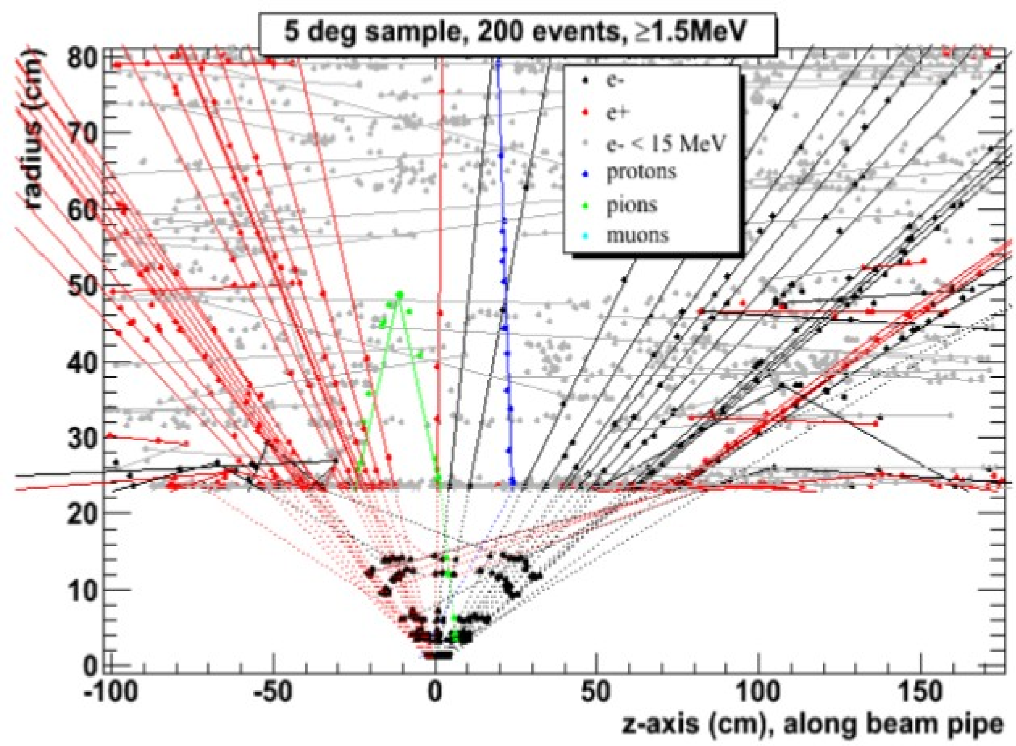

Angles for All Generated Events - Bruno (Log Scale!)


Angles for All Generated Events - Bhwide only (Log Scale!)

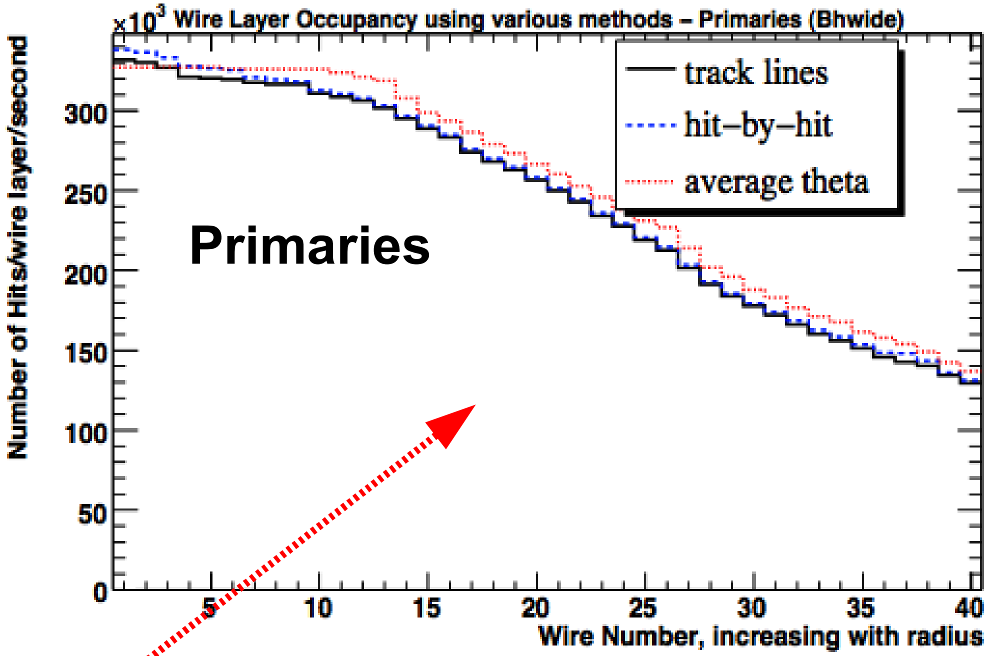

2D Angles for All Generated Events (combined) (Log Scale!)

Tracking Algorithm

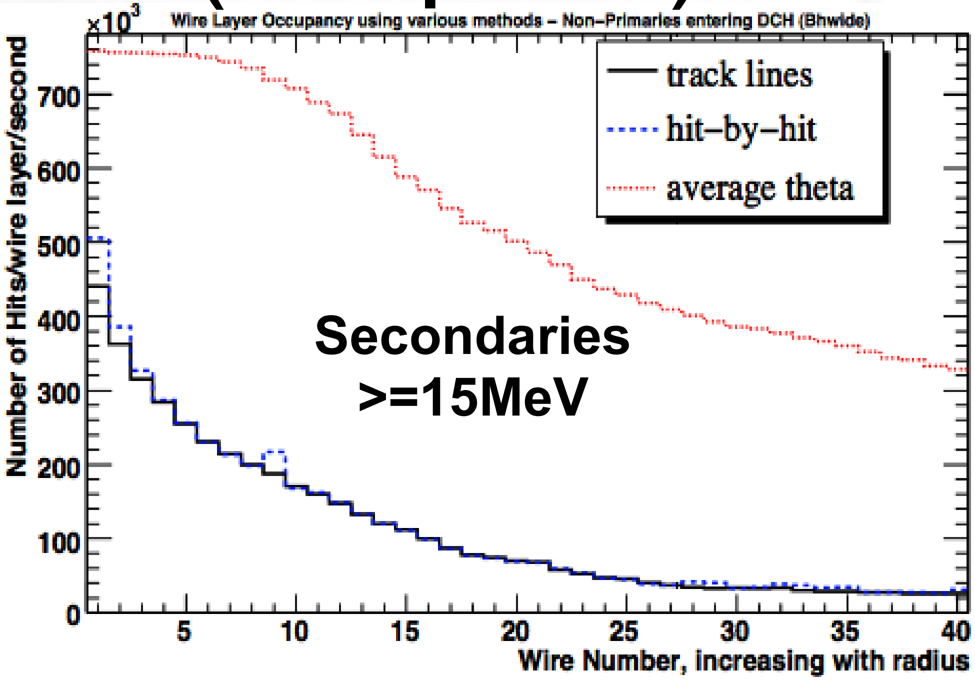
- Bruno only provides deposited energy (hit) information within a chamber that's void of wires. All wires are assumed to be axial and uniformly spaced.
- Using the TrackID of time-ordered hits, I define a track and extrapolate the number of wires the track would cross.
- Use Truth Info to determine where track enters/exits DCH:
  - Tracks that enter/exit DCH are approximated with 2 straight lines: from DCH entrance location to hit with max radius, then to DCH exit location
  - Tracks starting within DCH are drawn with one straight line: from first to final hit. (98.9% of tracks, 99.99% have E<15MeV, 98% E<1.5MeV)



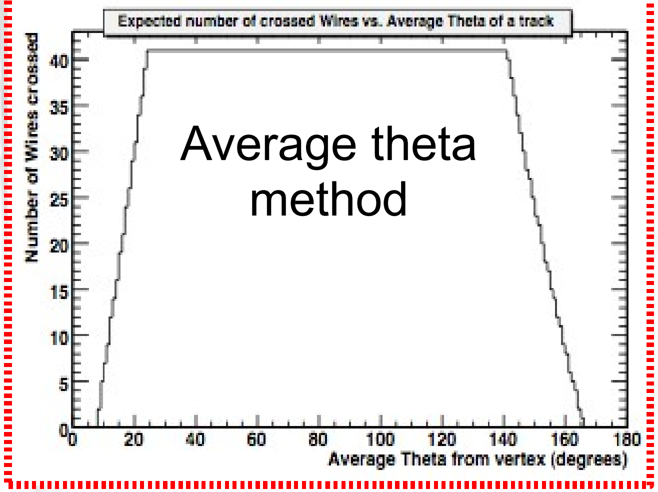
Occupancy Method (old plots)



Primaries

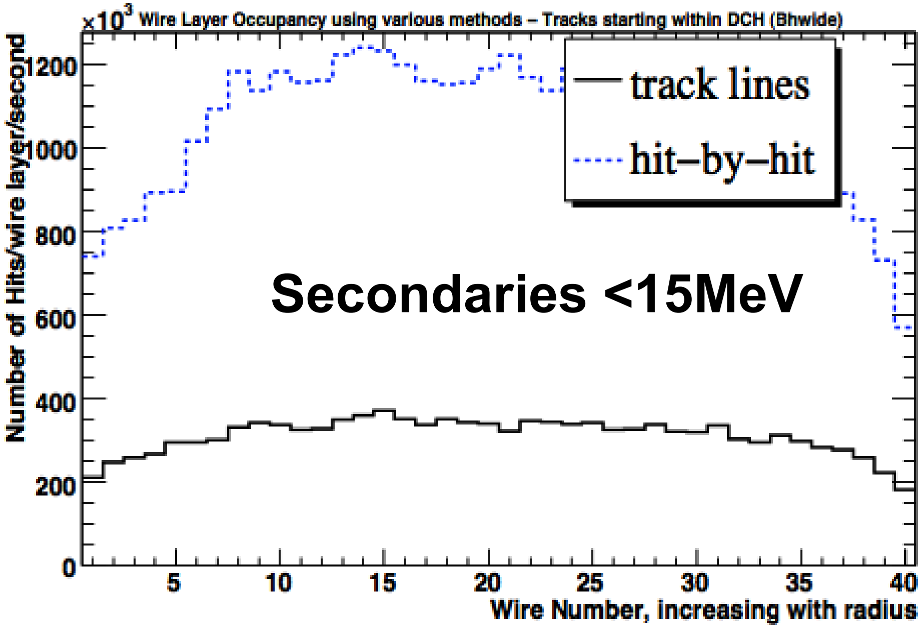


Secondaries >=15MeV



Average theta method

Hit-by-hit method: # wires crossed between EACH hit



Secondaries <15MeV

I under-estimate Low E hits!