First DCH FastSim studies with $B^0 \to \pi^+\pi^-$

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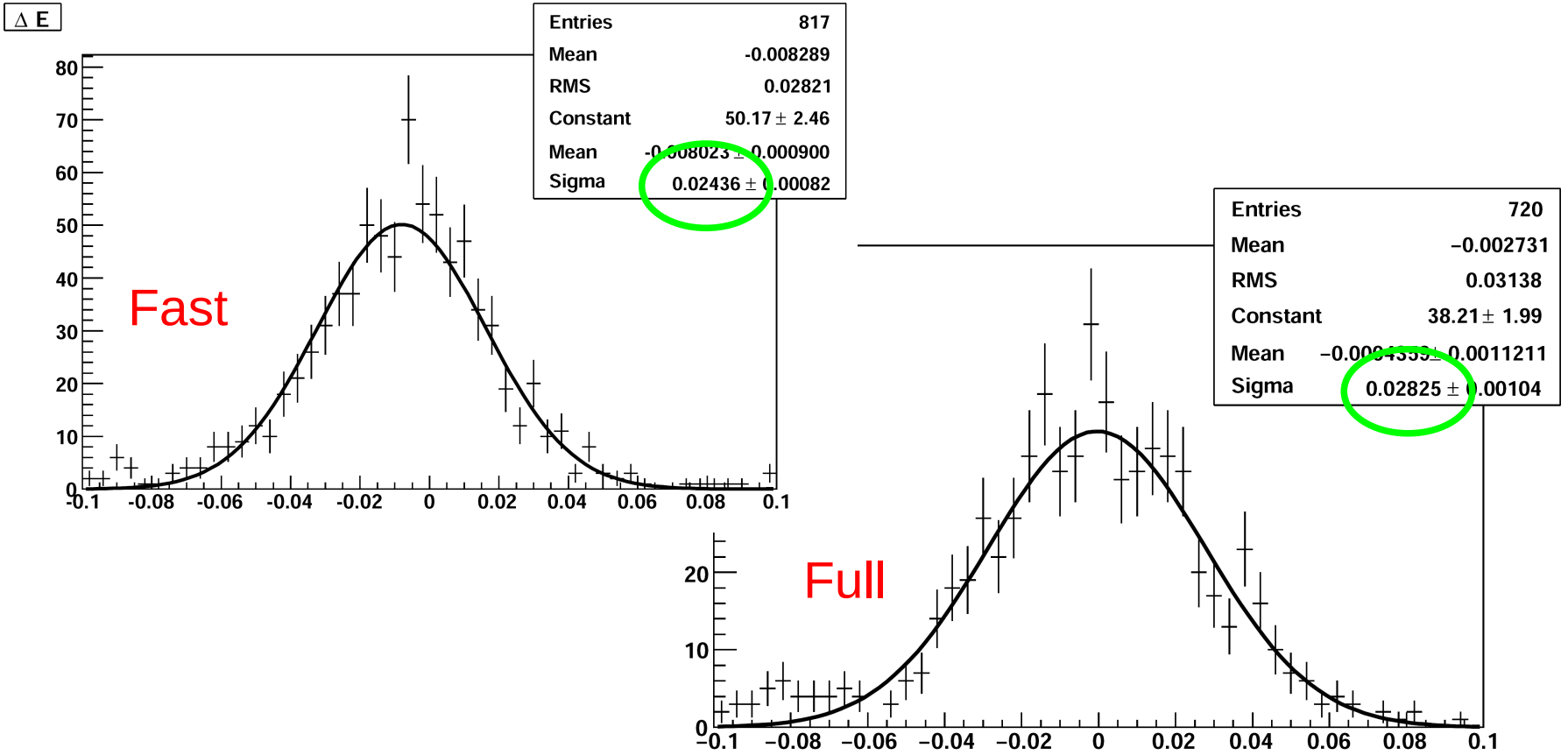
A comparison of different descriptions of DCH properties

- ✗ Two alternative approaches
  - ✔ Effective medium with combined gas+wire properties (*BABAR* approach)
    - ✔ Correct on average over many measurements along the track
  - ✔ Cylindrical shells of dense material immersed in a gas atmosphere
    - ✔ If the track hits the “wire shell” (which happens with a given probability, depending on the amount of material) then it undergoes a hard scattering, otherwise only senses the low density gas
    - ✔ Expect more accurate description of the tails
- ✗ In both cases, every cell layer provides a measurement with given spatial resolution
- ✗ *All results are preliminary*

FastSim vs. Full simulation of $B^0 \to \pi^+\pi^-$ events



FastSim slightly more optimistic

Standard *BABAR* material vs our calculation (I)

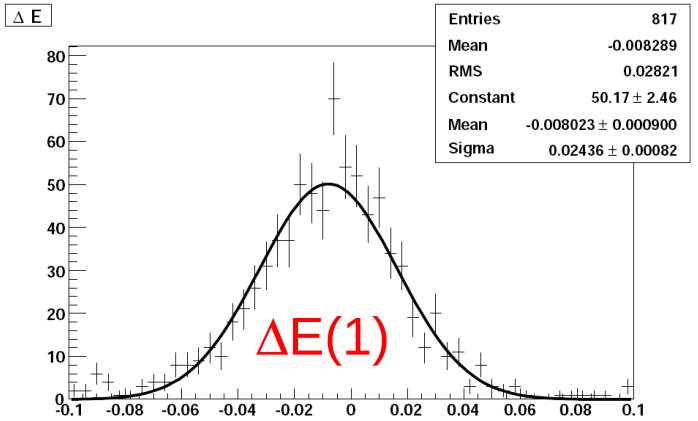
Material is defined by a line in file
`PacEnv/MaterialsList.data`

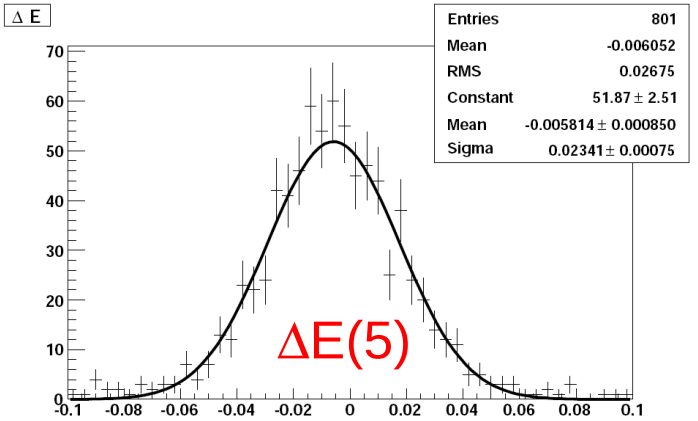
Material	density	Z_{eff}	A_{eff}	X0	lambdaI	
dch-He-Ibu-Wir_1	8.40E-04	15.0	31.0	28.56	84.00	STANDARD
dch-He-Ibu-Wir_5	9.58E-04	21.9	43.5	34.01	84.51	CALCULATED

- Spatial resolution is 125 micron flat (i.e., does not depend on drift distance)
- Variables considered in the comparison:

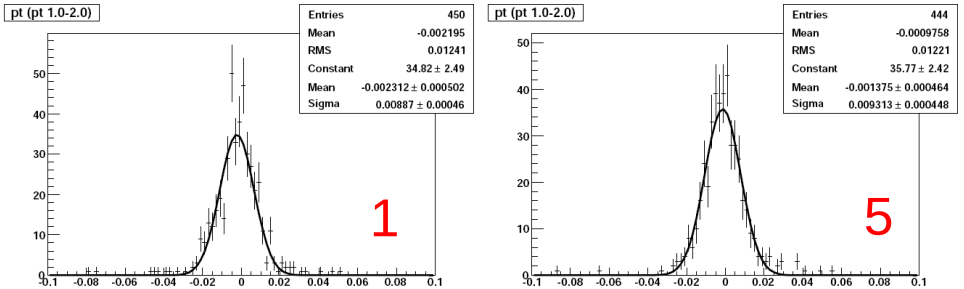
ΔE, δp_T, $\delta\cos(\theta)$, $\delta\phi$ not shown in this talk)

Standard *BABAR* material vs our calculation (II)

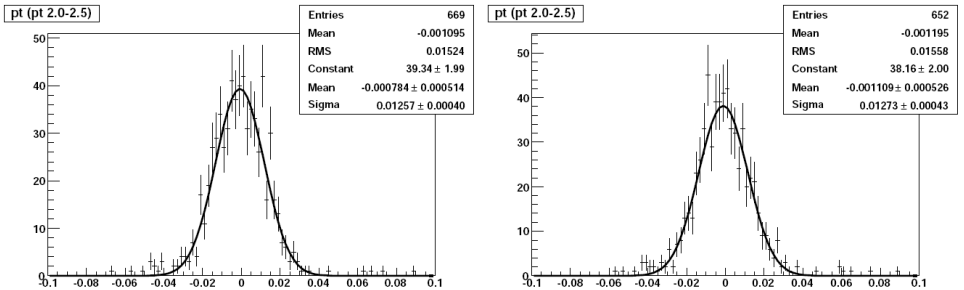




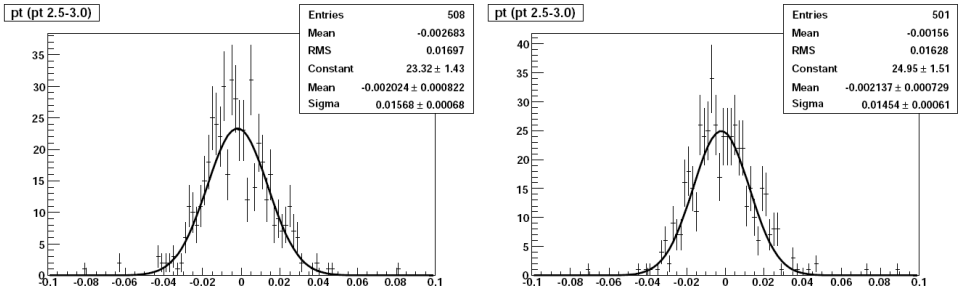
δp_T in different momentum bins



δp_T 1.0-2.0



δp_T 2.0-2.5



δp_T 2.5-3.0

“Average” material calculation including gold plating on wires

More realistic material description: add 0.7μm thick gold plating on wires

- ✗ Some effect on Al wires

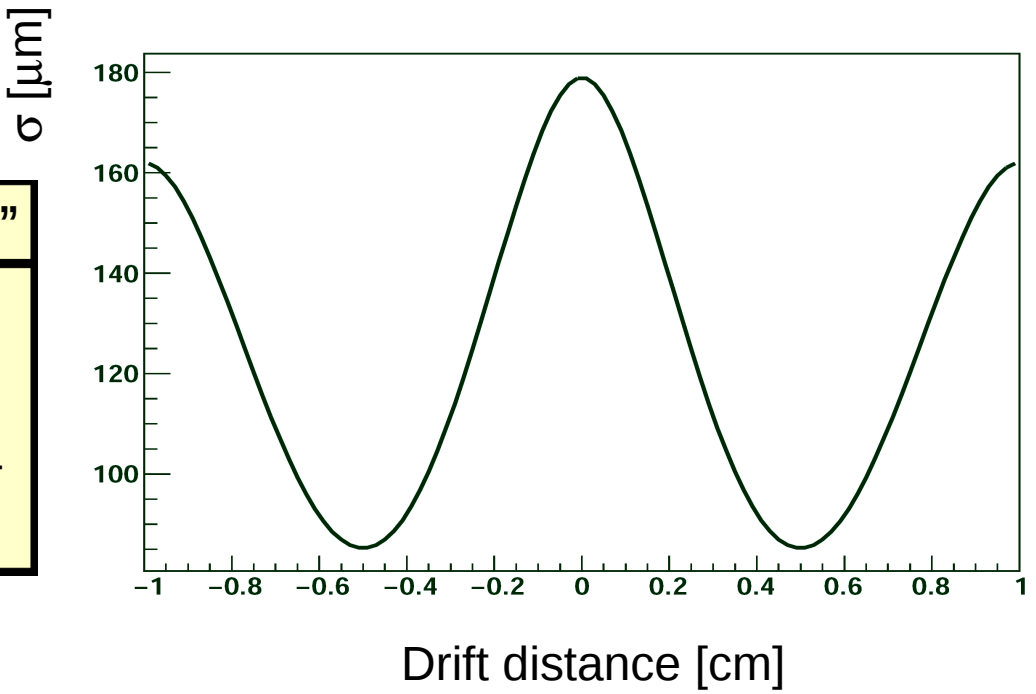
Material	density	Z_{eff}	A_{eff}	X0	lambdaI	
dch-He-Ibu-Wir_4	10.14E-4	25.9	52.1	27.47	87.28	0.7μm plating
dch-He-Ibu-Wir_5	9.58E-4	21.9	43.5	34.01	84.51	no plating

sigma of...	Dch-He-Ibu-Wir_5	Dch-He-Ibu-Wir_4
DeltaE [MeV]	23.4±0.4	23.9±0.8
pT(1.0-2.0) [MeV/c]	9.3±0.4	9.4±0.5
pT(2.0-2.5) [MeV/c]	12.7±0.4	12.0±0.4
pT(2.5-3.0) [MeV/c]	14.5±0.6	15.0±0.6

Flat vs. “realistic” spatial resolution

- We have implemented a more realistic parameterization of the spatial resolution
- For each layer, we assign randomly the spatial resolution associated with the measurement, using the parameterization below (average over the entire cell is 125 micron)

sigma of...	125μm flat	“realistic”
DeltaE [MeV]	23.4±0.4	21.2±0.6
pT(1.0-2.0) [MeV/c]	9.3±0.4	8.5±0.4
pT(2.0-2.5) [MeV/c]	12.7±0.4	11.5±0.4
pT(2.5-3.0) [MeV/c]	14.5±0.6	14.8±0.8

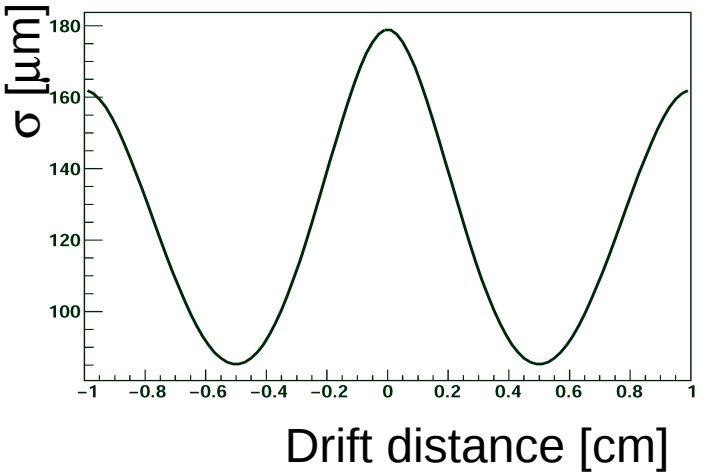


“Average” vs. “shells + gaps” material

Material	density	Z_{eff}	A_{eff}	X0	lambdaI	
dch-He-Ibu-Wir_5	9.58E-4	21.9	43.5	34.01	84.51	average
dch-Wire_7	3.90	18.2	38.3	20.27	110.73	solid
dch-Gas_7	6.41E-4	23.8	46.1	51.16	75.65	gas

sigma of...	average	“shell+gas”
DeltaE [MeV]	23.4±0.4	23.3±0.7
pT(1.0-2.0) [MeV/c]	9.3±0.4	9.8±0.5
pT(2.0-2.5) [MeV/c]	12.7±0.4	12.7±0.5
pT(2.5-3.0) [MeV/c]	14.5±0.6	15.8±0.7

“shells + gaps” material: flat vs. “realistic” spatial resolution



sigma of...	“shell+gas” flat σ	“shell+gas” “realistic” σ
DeltaE [MeV]	23.3±0.7	25.0±0.8
pT(1.0-2.0) [MeV/c]	9.8±0.5	9.8±0.5
pT(2.0-2.5) [MeV/c]	12.7±0.5	13.7±0.5
pT(2.5-3.0) [MeV/c]	15.8±0.7	15.4±0.7

“shells + gaps” material: standard vs. x2 number of cells

Same number of layers, x2 cells on each layer

sigma of...	“shell+gas” 7104 cells	“shell+gas” 14208 cells
DeltaE [MeV]	23.3±0.7	25.5±0.9
pT(1.0-2.0) [MeV/c]	9.8±0.5	10.0±0.6
pT(2.0-2.5) [MeV/c]	12.7±0.5	13.8±0.5
pT(2.5-3.0) [MeV/c]	15.8±0.7	15.5±0.6

“shells + gaps” material, 14208 cells 125μm vs 140μm resolution

Average spatial resolution is larger in smaller cells

sigma of...	“shell+gas” 14208 cells, 125μm	“shell+gas” 14208 cells, 140μm
DeltaE [MeV]	25.5±0.9	26.2±0.9
pT(1.0-2.0) [MeV/c]	10.0±0.6	10.4±0.5
pT(2.0-2.5) [MeV/c]	13.8±0.5	14.0±0.5
pT(2.5-3.0) [MeV/c]	15.5±0.6	14.2±0.5

“shells + gaps” material, 14208 cells 140μm “realistic” resolution

sigma of...	“shell+gas” 14208 cells 140μm flat	“shell+gas” 14208 cells 140μm “realistic”
DeltaE [MeV]	26.2±0.9	26.5±0.8
pT(1.0-2.0) [MeV/c]	10.4±0.5	10.8±0.6
pT(2.0-2.5) [MeV/c]	14.0±0.5	14.1±0.5
pT(2.5-3.0) [MeV/c]	14.2±0.5	16.8±0.8

Summary and outlook

- *Preliminary* study of DCH performance under different conditions has been shown
- (More) realistic parameterization of materials and spatial resolution implemented
  - Easy to change configuration
- We do not observe big differences among the tested configurations
  - Other observables, or channels where charged track spectrum is softer than in $B^0 \to \pi^+\pi^-$ could be more sensitive to changes in amount of material, and will be investigated