



# DCH configuration studies using FastSim

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# FastSim

- Fast simulation developed for SuperB
- V0.0.2 just released
  - [http://mailman.fe.infn.it/superbwiki/index.php/SuperB\\_fast\\_simulation\\_User\\_Guide](http://mailman.fe.infn.it/superbwiki/index.php/SuperB_fast_simulation_User_Guide)
- Geometry, material and resolutions are easily configurable through xml interface
- Developed in the BaBar framework → composition and analysis tools developed in BaBar are compatible with FastSim output

# goals

- short term goal (subject of this talk)
  - test and improve the drift chamber simulation in FastSim
  - compare the performance of different configurations
- longer term goal:
  - optimize the design using additional inputs: machine bkg, spatial reso. for different cell/gas configuration, etc.

# Standard BaBar material vs. our calculation

- Homogeneous effective medium with combined gas+wires properties
- spatial resolution is  $125\mu\text{m}$  (flat)

name	rho	Z <sub>eff</sub>	A <sub>eff</sub>	X <sub>0</sub>	$\lambda$	
dch-He-Ibu-Wir_1	8.40e-4	15.	31. 0	28.56	84.00	standard
dch-He-Ibu-Wir_4	1.01E-03	25.9	52.1 0	27.47	87.28	our estimate

resolution [MeV]	dch-He-Ibu-Wir_1 flat reso 125um	dch-He-Ibu-Wir_4 Flat reso 125um
$\Delta E (B \rightarrow \pi^+\pi^-)$	$24.6 \pm 0.3$	$23.9 \pm 0.3$
$\Delta E (B \rightarrow \text{Phi } K_s)$	$14.5 \pm 0.2$	$14.7 \pm 0.2$
Pt [1.0,2.0]	$10.0 \pm 0.2$	$9.5 \pm 0.1$
Pt [2.0,2.5]	$12.7 \pm 0.1$	$12.7 \pm 0.1$
Pt [2.5,3.0]	$15.5 \pm 0.2$	$15.3 \pm 0.2$

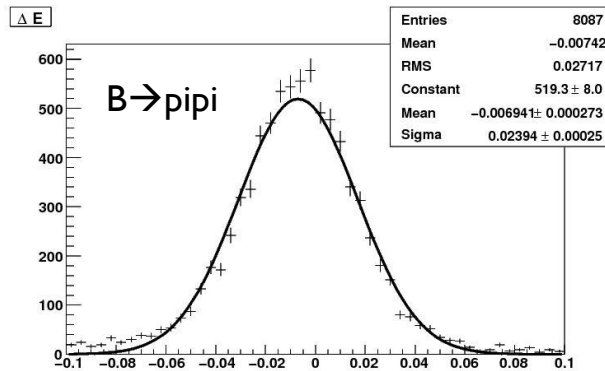
# Homogeneous material vs. “gas + wires”

- Gas + wires: 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 it only senses the low density gas
  - BaBar-like configuration (10 SL, 40 layers)

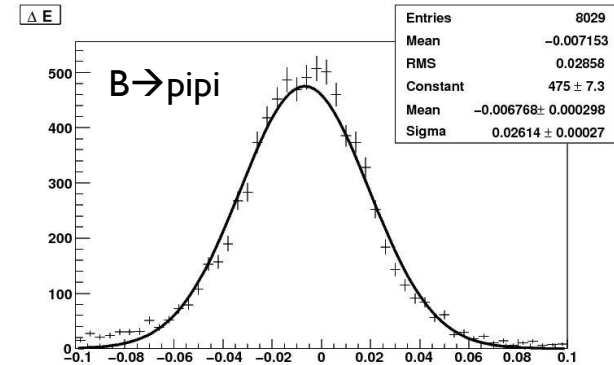
	name	rho	Z <sub>eff</sub>	A <sub>eff</sub>	X <sub>0</sub>	$\lambda$	
homogeneous material	dch-He-lbu-Wir_4	1.01E-03	25.9	52.1	0	27.47	87.28
	dch-He-lbu_14	6.408E-04	23.8	46.1	0	51.16	75.65
gas and wire material	dch-Wires_14	6.237E+00	29.0	62.4	0	15.31	118.56

# Homogeneous material vs. “gas + wires”

homogeneous mat.



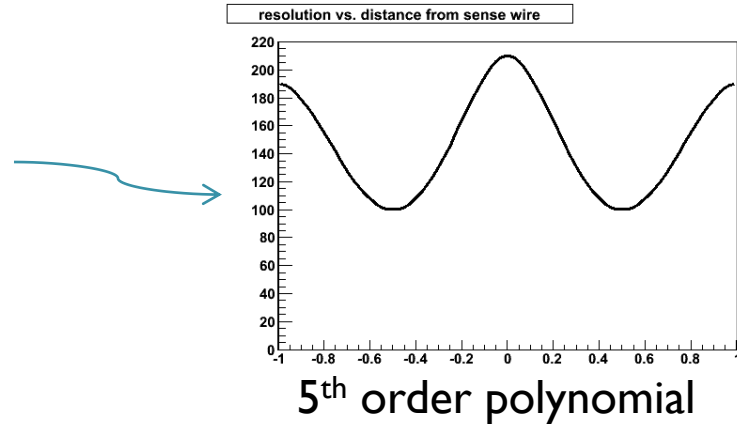
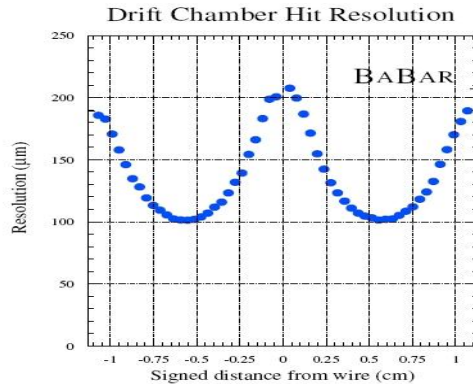
gas + wires



resolution [MeV]	homog. material flat reso 125um	gas+wires flat reso 125um
$\Delta E (B \rightarrow \pi^+\pi^-)$	$23.9 \pm 0.3$	$26.1 \pm 0.3$
$\Delta E (B \rightarrow \Phi K_S)$	$14.7 \pm 0.2$	$16.3 \pm 0.2$
Pt [1.0,2.0]	$9.5 \pm 0.1$	$10.5 \pm 0.2$
Pt [2.0,2.5]	$12.7 \pm 0.1$	$13.8 \pm 0.1$
Pt [2.5,3.0]	$15.3 \pm 0.2$	$16.3 \pm 0.2$

# Use of realistic cell spatial resolution

the spatial resolution is not constant



resolution [MeV]	Gas+wires flat reso 125um	Gas+wires realistic reso 125um
$\Delta E (B \rightarrow \pi^+ \pi^-)$	$26.1 \pm 0.3$	$25.4 \pm 0.3$
$\Delta E (B \rightarrow \text{Phi } K_s)$	$16.3 \pm 0.2$	$15.6 \pm 0.2$
Pt [1.0,2.0]	$10.5 \pm 0.1$	$10.2 \pm 0.2$
Pt [2.0,2.5]	$13.8 \pm 0.1$	$13.4 \pm 0.1$
Pt [2.5,3.0]	$16.3 \pm 0.2$	$15.8 \pm 0.2$

# x2 number of cells

- Same number of layers, x2 cells on each layer

resolution [MeV]	gas+wires realistic reso 125um	gas+wires realistic reso 125um x2 #cells
$\Delta E (B \rightarrow \pi^+ \pi^-)$	$25.4 \pm 0.3$	$26.3 \pm 0.3$
$\Delta E (B \rightarrow \text{Phi } K_s)$	$15.6 \pm 0.2$	$17.0 \pm 0.2$
Pt [1.0,2.0]	$10.2 \pm 0.2$	$11.3 \pm 0.2$
Pt [2.0,2.5]	$13.4 \pm 0.1$	$13.9 \pm 0.2$
Pt [2.5,3.0]	$15.8 \pm 0.2$	$16.7 \pm 0.2$



- Same number of layers, x2 cells on each layer
- spatial resolution enlarged to 140um

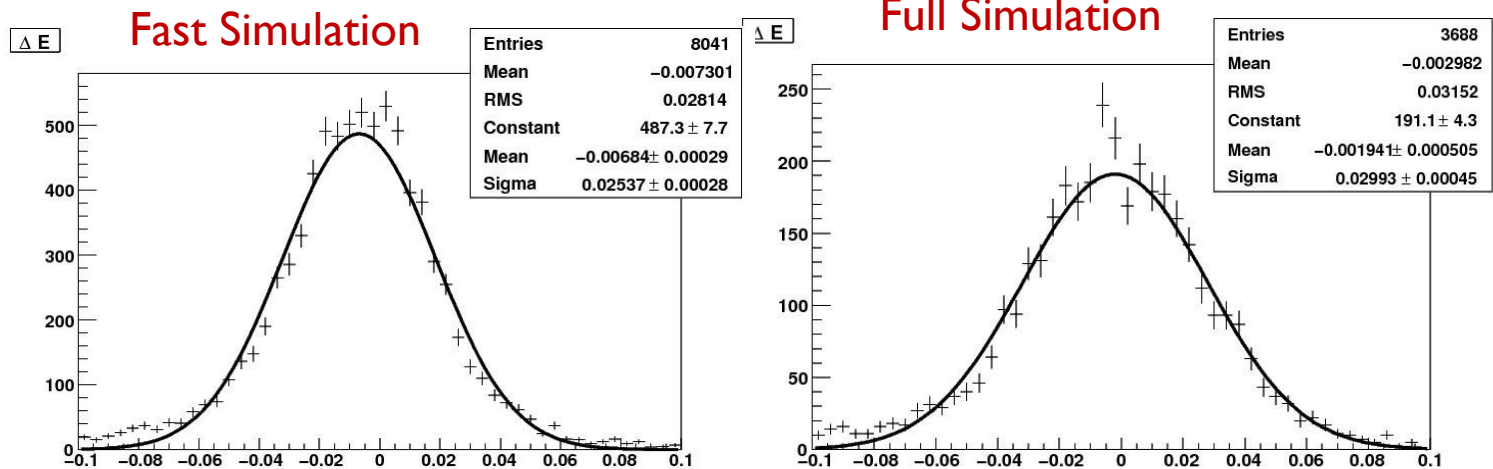
resolution [MeV]	gas+wires realistic reso 125um	gas+wires realistic reso 140um x2 #cells
$\Delta E (B \rightarrow \pi^+ \pi^-)$	$25.4 \pm 0.3$	$27.4 \pm 0.3$
$\Delta E (B \rightarrow \Phi K_s)$	$15.6 \pm 0.2$	$17.6 \pm 0.2$
Pt [1.0,2.0]	$10.2 \pm 0.2$	$11.7 \pm 0.2$
Pt [2.0,2.5]	$13.4 \pm 0.1$	$14.5 \pm 0.2$
Pt [2.5,3.0]	$15.8 \pm 0.2$	$17.5 \pm 0.2$

# Exercise:

## what happens with a 30-layer DCH

resolution [MeV]	gas+wires realistic reso 125um 40 layers	gas+wires realistic reso 125um 30 layers
$\Delta E (B \rightarrow \pi^+ \pi^-)$	$25.4 \pm 0.3$	$26.8 \pm 0.3$
$\Delta E (B \rightarrow \text{Phi } K_s)$	$15.6 \pm 0.2$	$17.0 \pm 0.2$
Pt [1.0,2.0]	$10.2 \pm 0.2$	$11.0 \pm 0.2$
Pt [2.0,2.5]	$13.4 \pm 0.1$	$14.5 \pm 0.2$
Pt [2.5,3.0]	$15.8 \pm 0.2$	$17.2 \pm 0.2$

# Comparison with BaBar full simulation



resolution [MeV]	gas+wires realistic reso   25um	FullSim
$\Delta E (B \rightarrow \pi^+ \pi^-)$	25.4 ± 0.3	29.9 ± 0.5
$\Delta E (B \rightarrow \text{Phi } K_s)$	15.6 ± 0.2	21.8 ± 0.3
Pt [1.0, 2.0]	10.2 ± 0.2	11.9 ± 0.3
Pt [2.0, 2.5]	13.4 ± 0.1	16.7 ± 0.3
Pt [2.5, 3.0]	15.8 ± 0.2	19.3 ± 0.3

# Next developments in FastSim

- non uniform hit efficiency
  - now the hit efficiency is set to 0.99 corresponding to what is measured in Babar DCH averaged over the polar angle
  - in reality hit efficiency has minimum at  $\theta=90^\circ$
  - effect expected to be small
- hit confusion
  - background + pattern recognition
  - **LARGE** effect on track reconstruction

# Conclusions

- Preliminary study of DCH performance under different conditions
- Configurable spatial resolution implemented (from rel. V0.0.2)
- We do not observe large differences in track reconstruction among tested FastSim configurations. Observed differences are consistent with expectations.
- 15-20% resolution difference between FastSim and full simulation. Main reason likely due to 'hit confusion' not simulated in FastSim. Ongoing work in fast simulation group to include it.



backup

# flat vs. realistic spatial reso function

Measured hit position – True hit position

