tracking and dE/dx vs DCH length

M. Rama, SuperB general meeting
2 December 2009

Outline

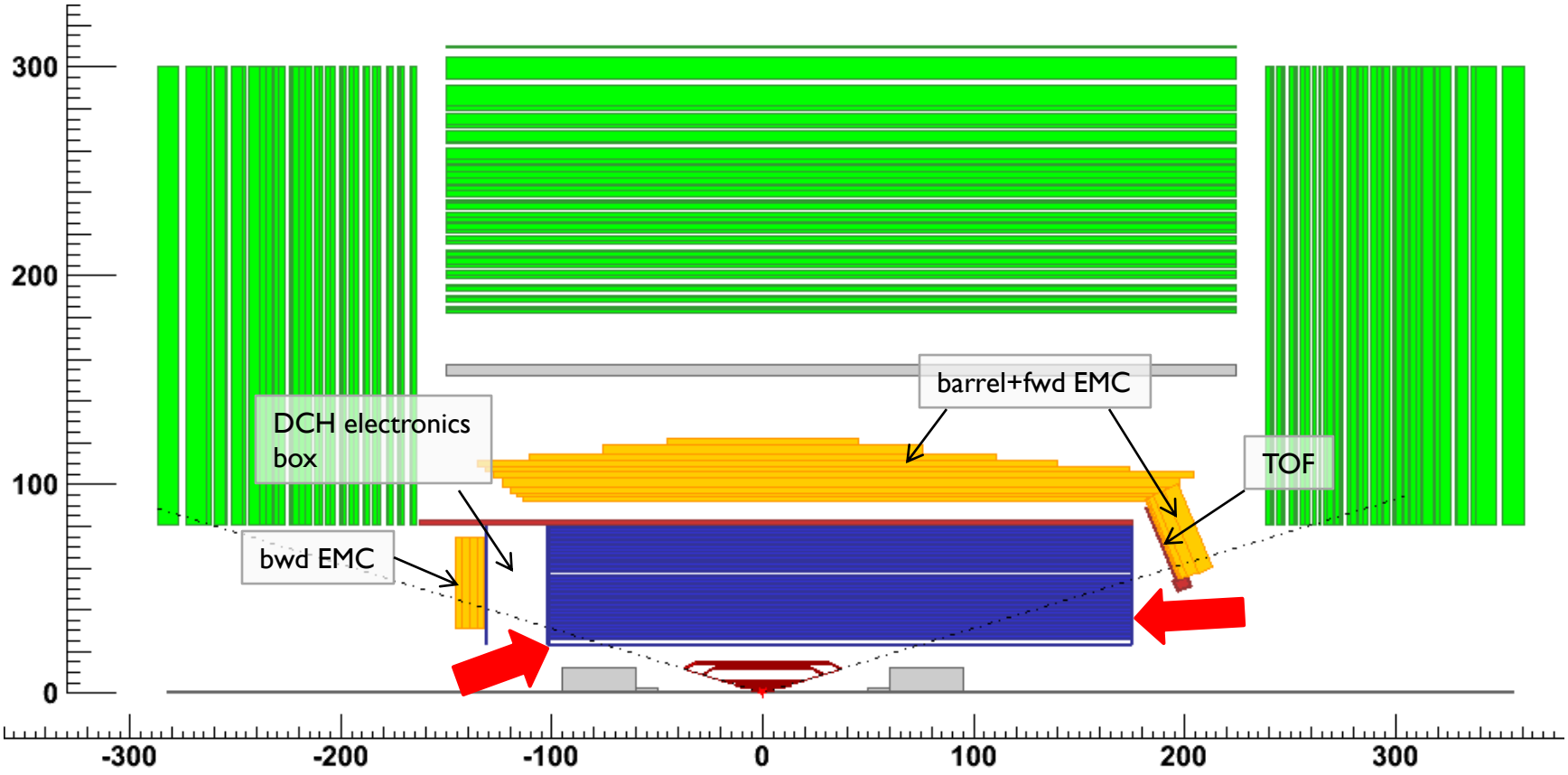
4 DCH configurations:

Unmasked (sl. 3)
Masked (sl. 4)
Long (sl. 6)
Short (sl. 7)
shifted IP (sl. 8)

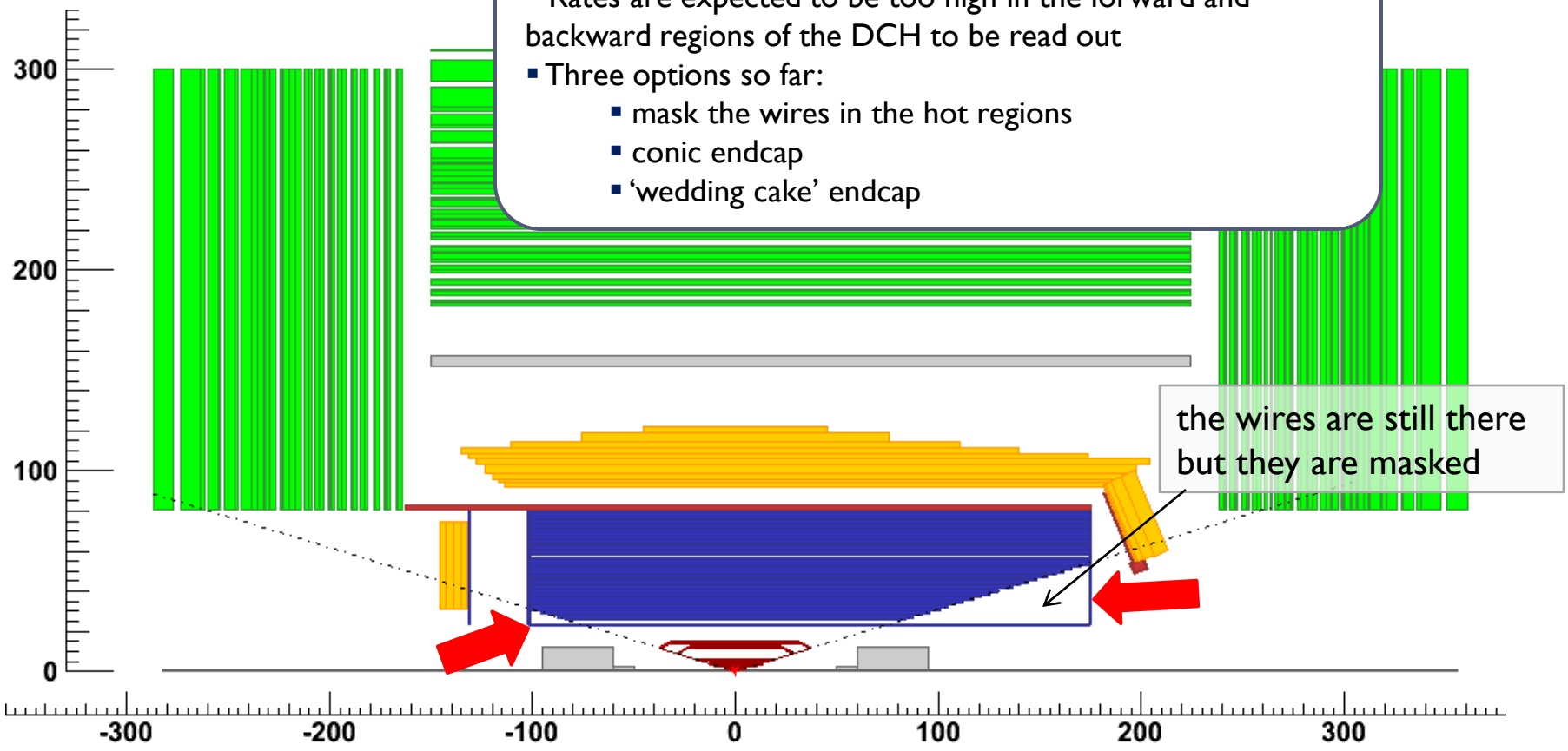
- Compare the 'Masked' DCH with the 'Long' and 'Short' cfg
  - track reconstruction
  - DCH dE/dx

tested with:
10k $B^0 \rightarrow \pi^+\pi^-$ events
10k $B^0 \rightarrow D^*K$ events
50k single particles

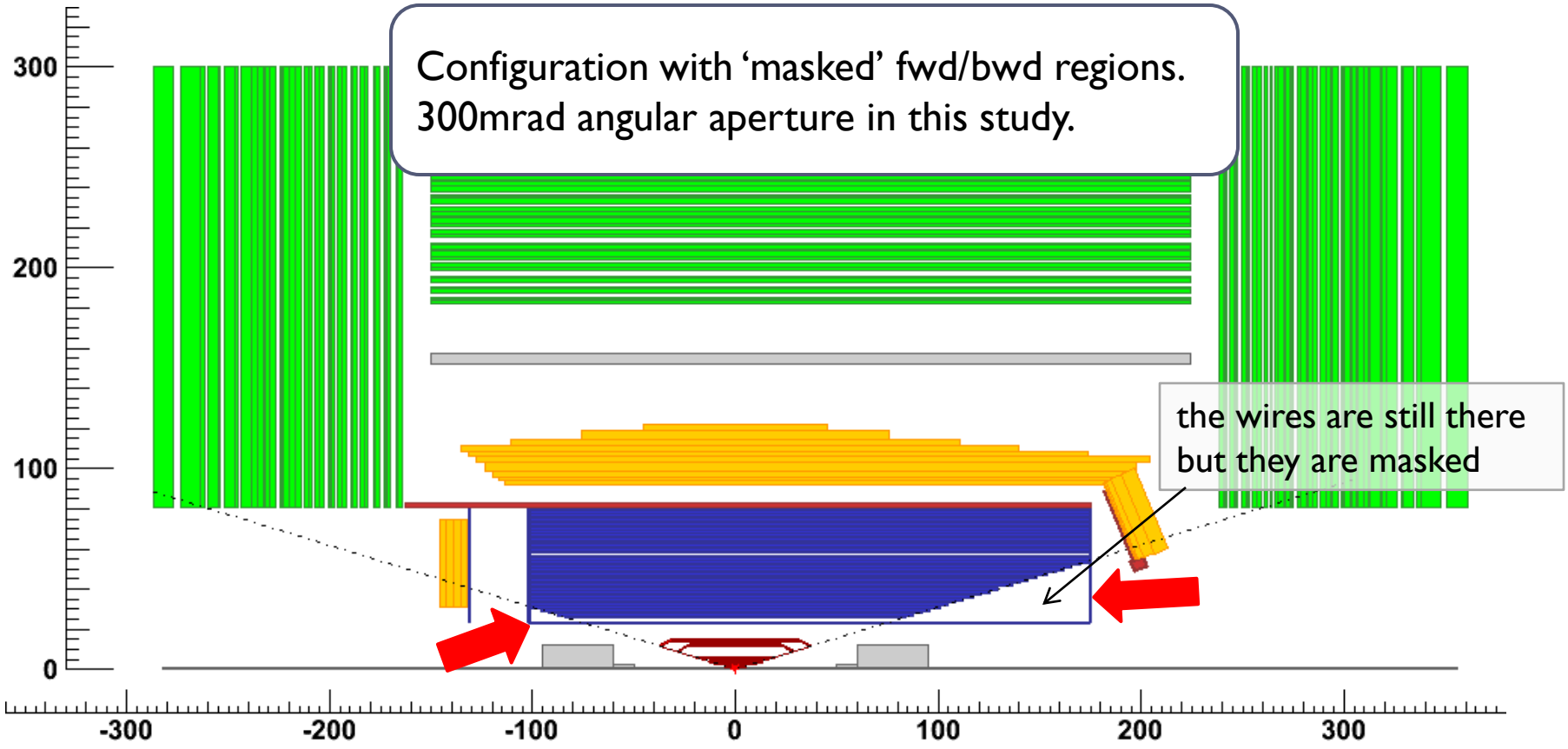
‘standard’ DCH (“Unmasked”)



standard DCH with masked fwd/bwd regions

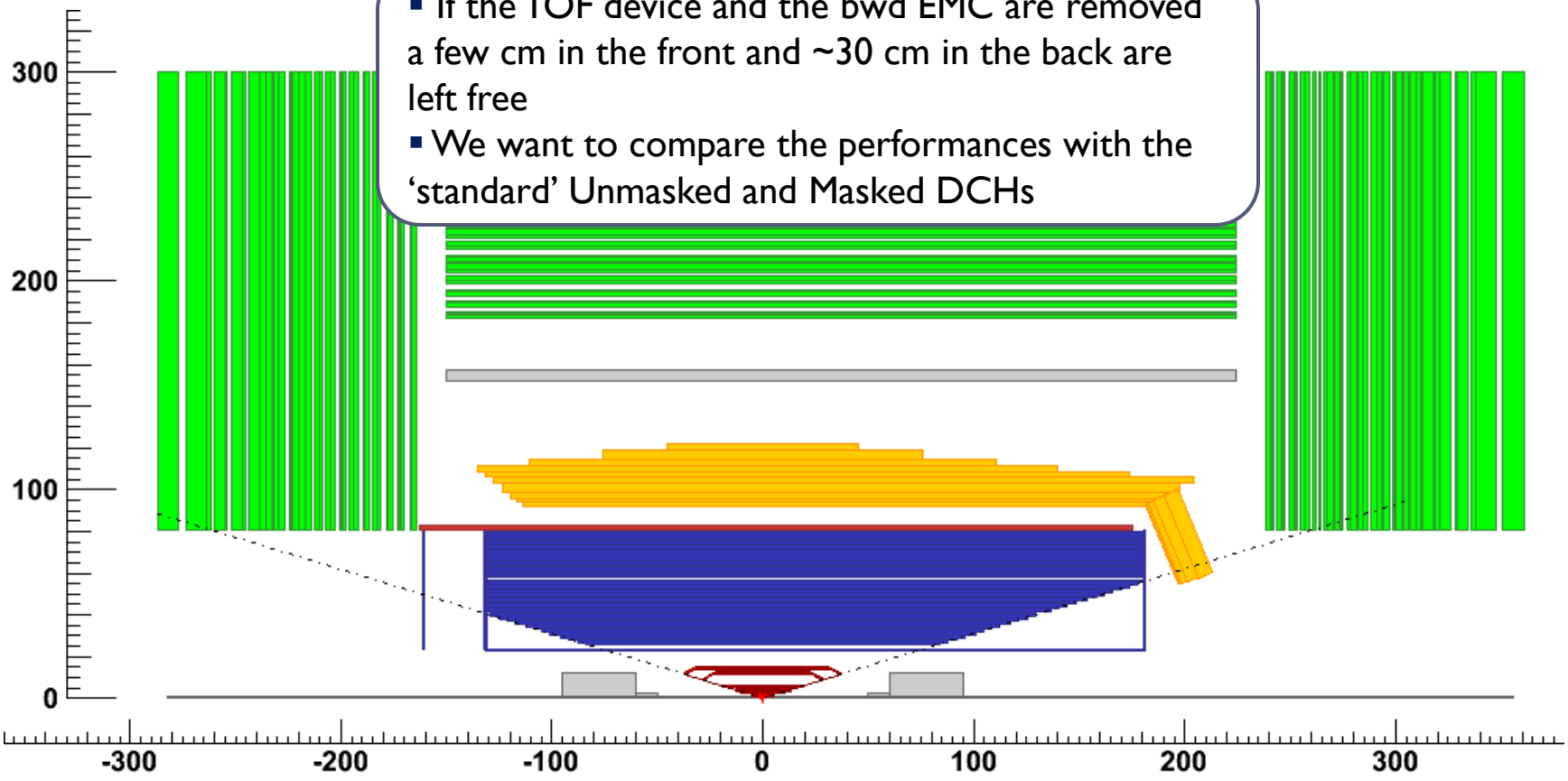


standard DCH with masked fwd/bwd regions

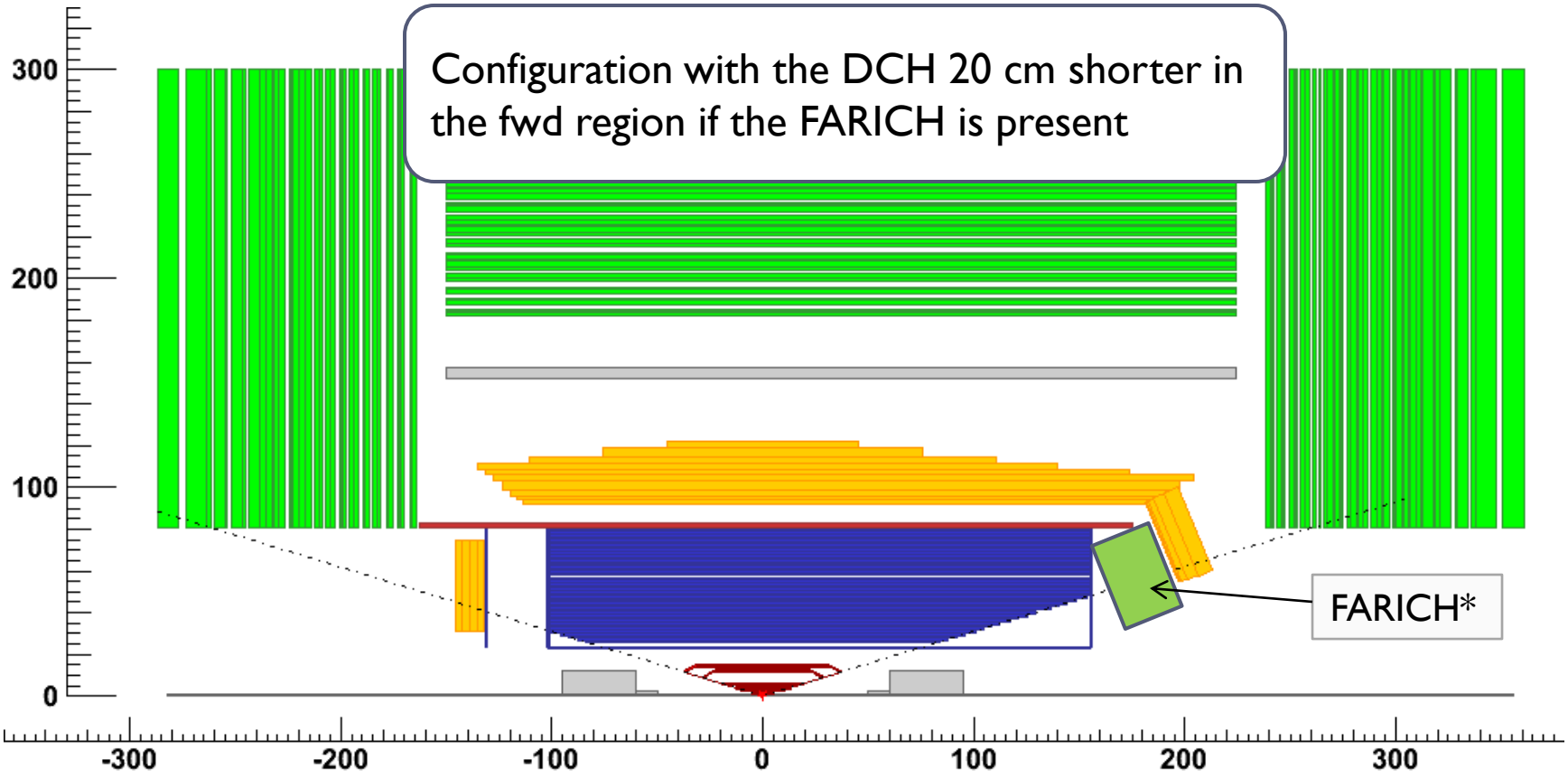


Long DCH

- If the TOF device and the bwd EMC are removed a few cm in the front and ~30 cm in the back are left free
- We want to compare the performances with the 'standard' Unmasked and Masked DCHs



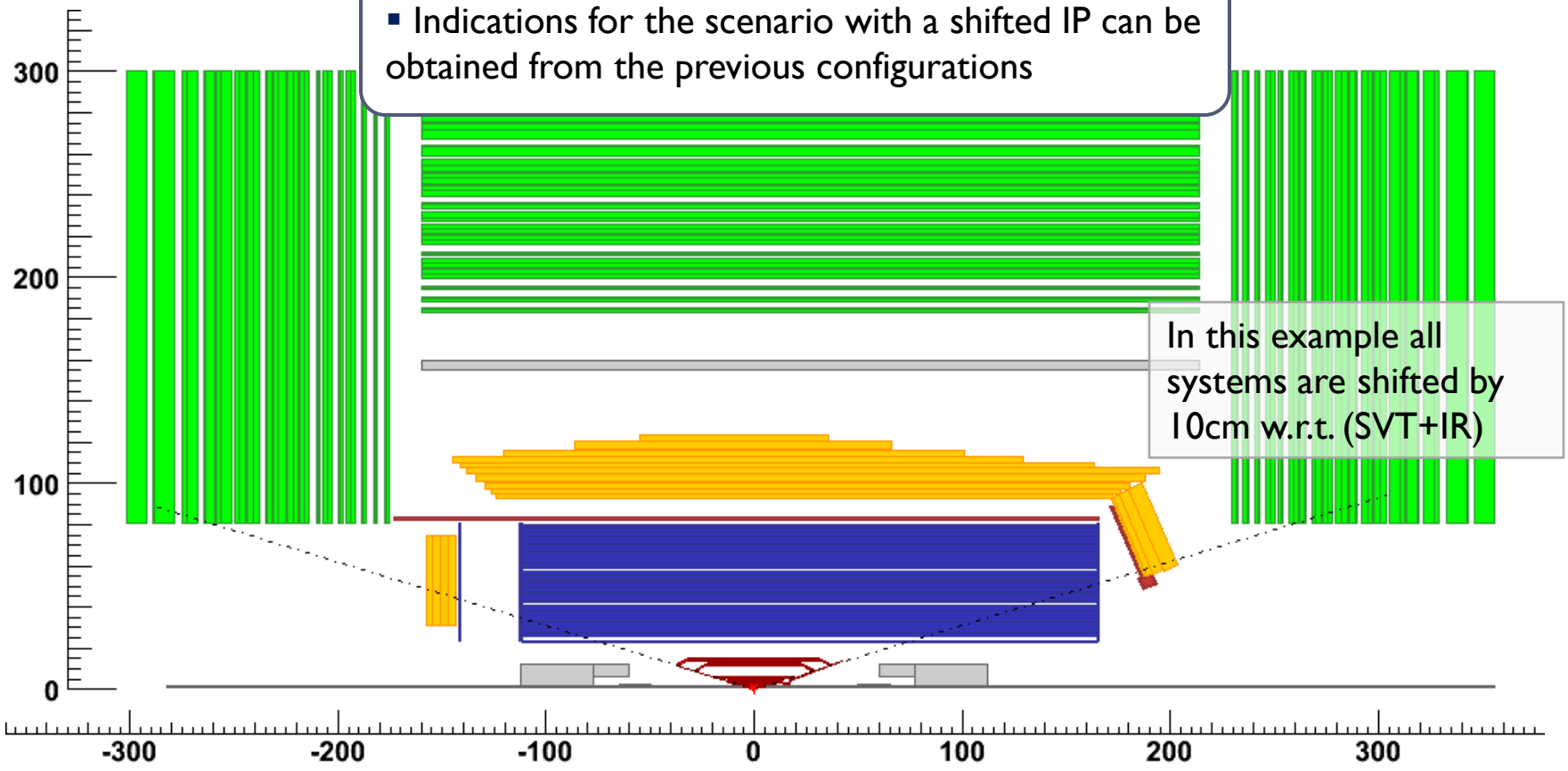
Short DCH



*see E.Kravchenko at the SLAC Oct09 SuperB meeting

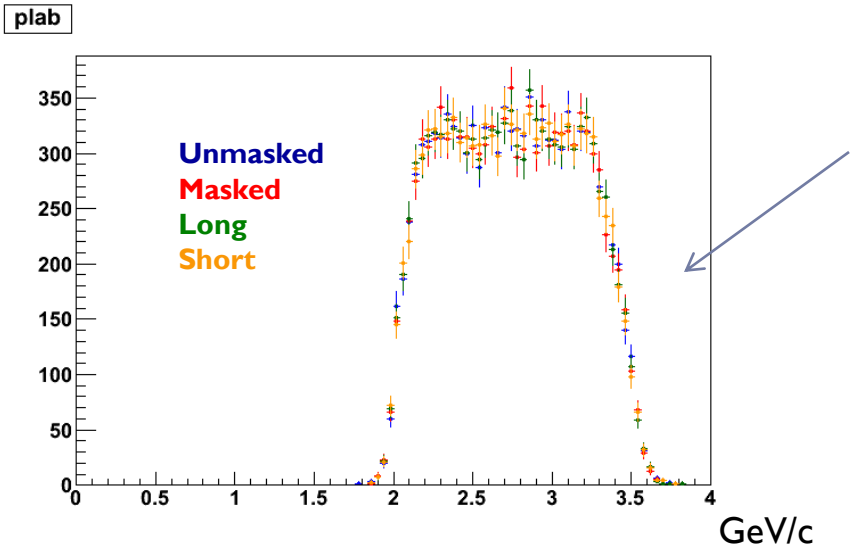
shifted IR+SVT w.r.t. DCH and outer detectors

- Indications for the scenario with a shifted IP can be obtained from the previous configurations



In this example all systems are shifted by 10cm w.r.t. (SVT+IR)

Reconstruction efficiency of $B \rightarrow \pi^+\pi^-$



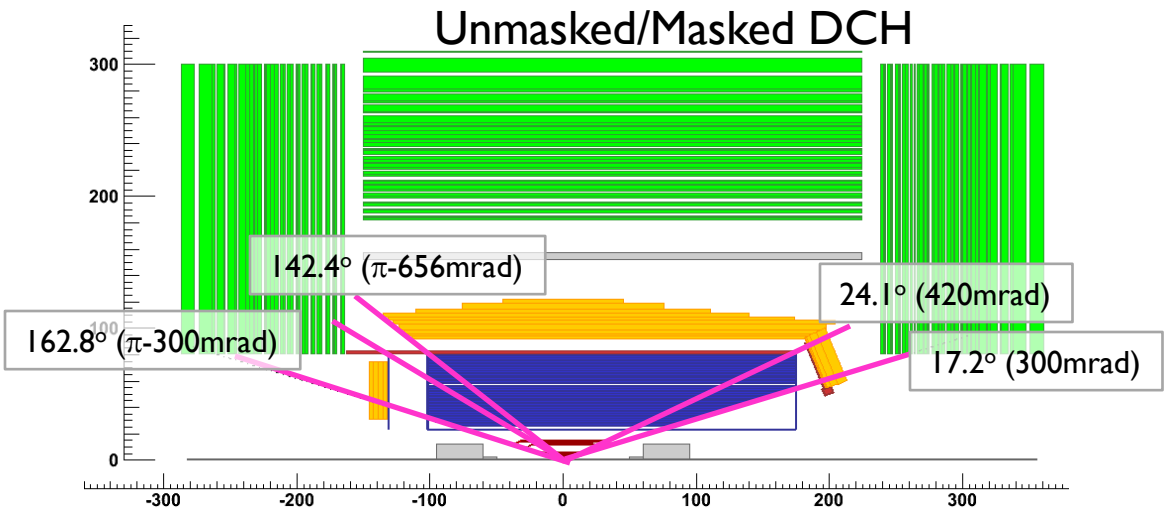
high momentum range complementary to $B^0 \rightarrow D^{*-}K^+$, $D^{*-} \rightarrow D^0\pi^-$, $D^0 \rightarrow K\pi$

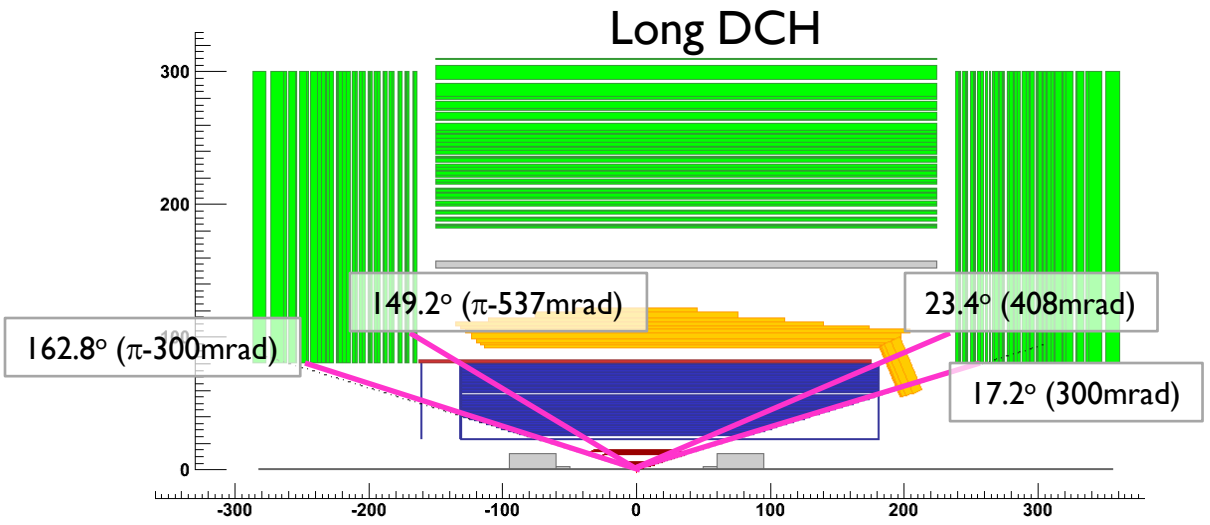
DCH configuration	eff. mc-truth
Unmasked	0.805 +/- 0.004
Masked	0.805 +/- 0.004
Long	0.806 +/- 0.004
Short	0.804 +/- 0.004

note: same run numbers (i.e. same generated events) for the 4 configurations

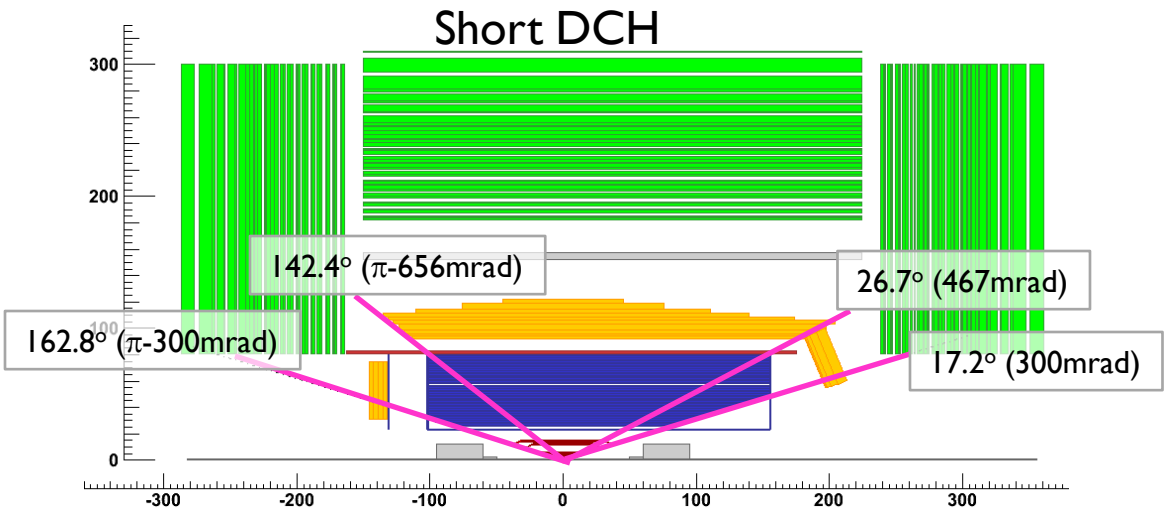
the $B^0 \rightarrow \pi^+\pi^-$ reconstruction efficiency is not affected

Angles useful to interpret the patterns in next slides

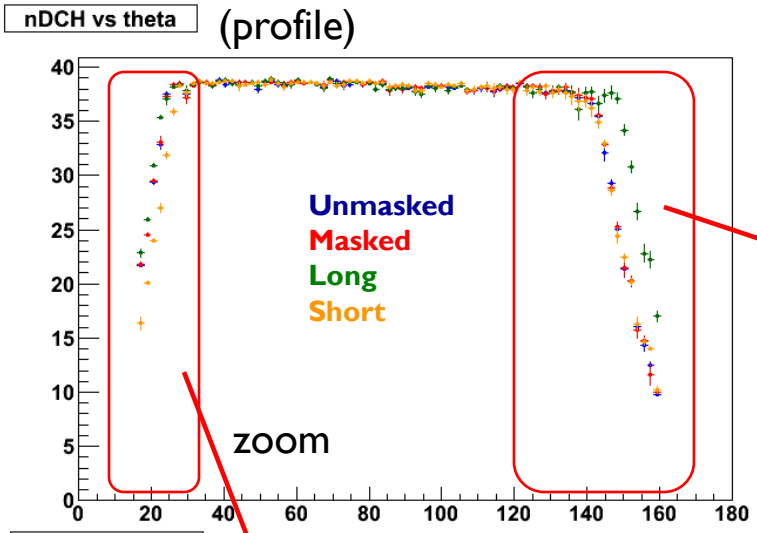




Angles (II)

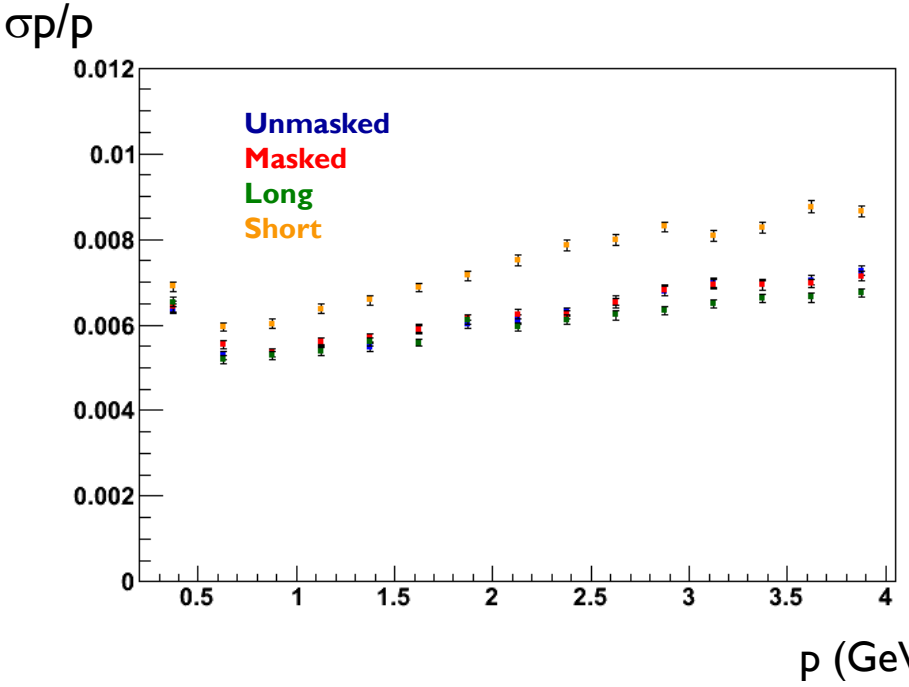

Short DCH
142.4° (π-656mrad)
26.7° (467mrad)
162.8° (π-300mrad)
17.2° (300mrad)
300
200
100
0
-300
-200
-100
0
100
200
300

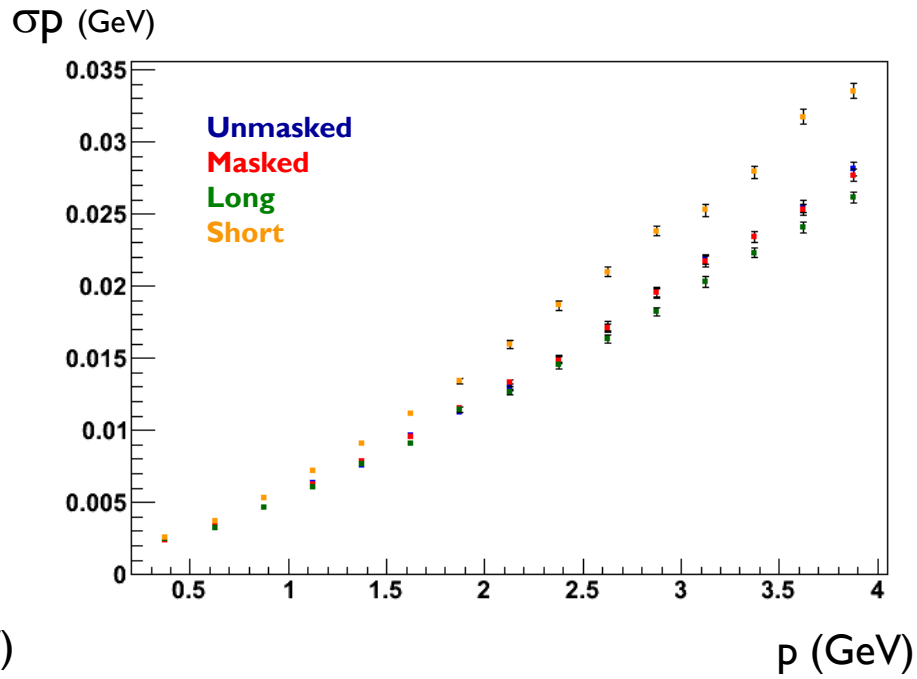
B→ππ: #DCH hits vs polar angle



- The number of DCH dE/dx sample hits has an analogous pattern (it is scaled by 80%, which is the truncation value)

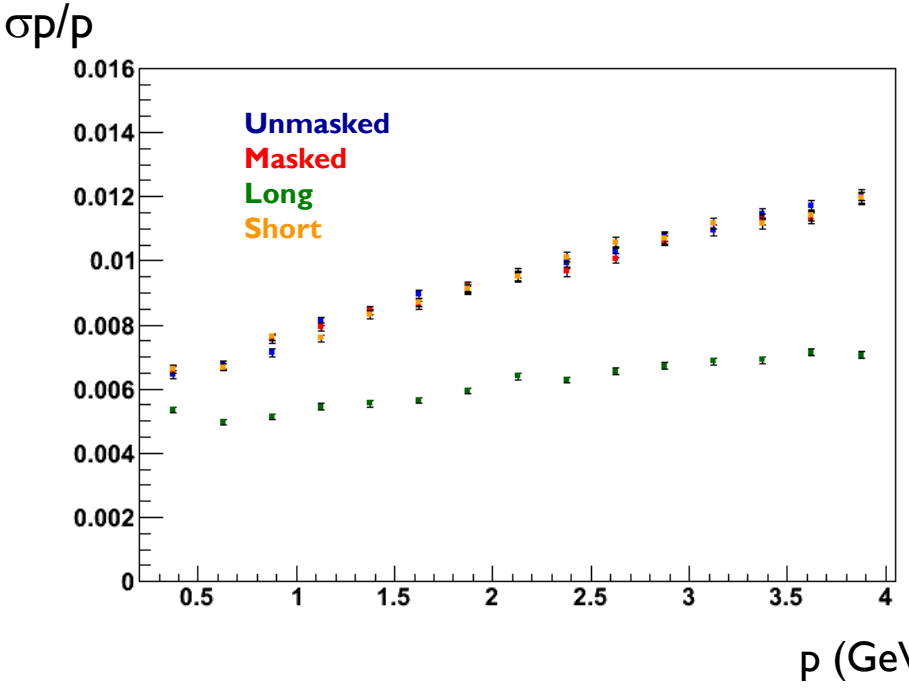
single particles: p resolution at θ=23°

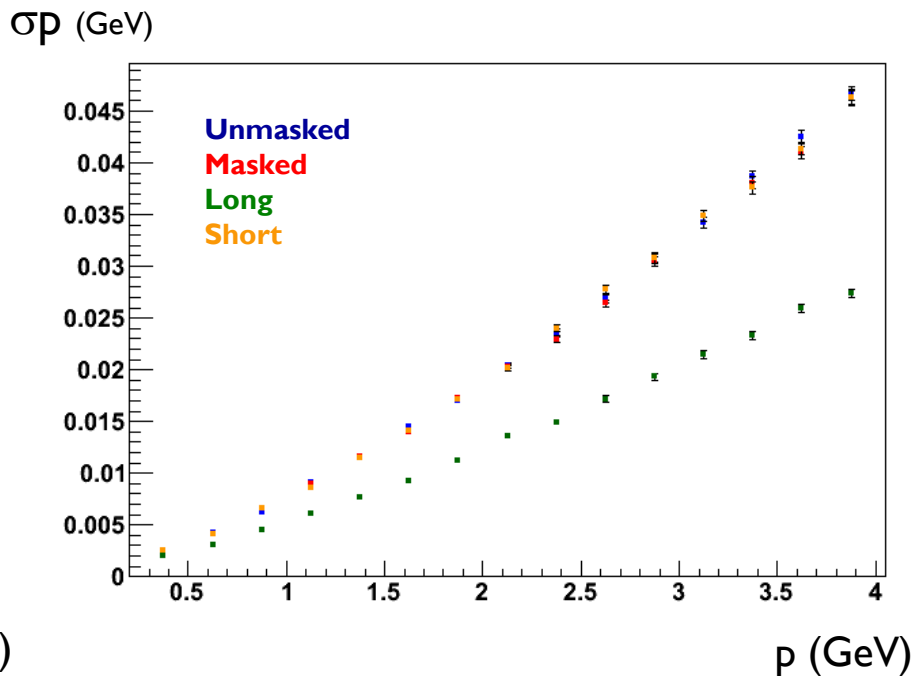




p resolution in Short DCH worsens by ~25% in fwd region (for θ=23°)
negligible effect in Long DCH vs. Masked DCH

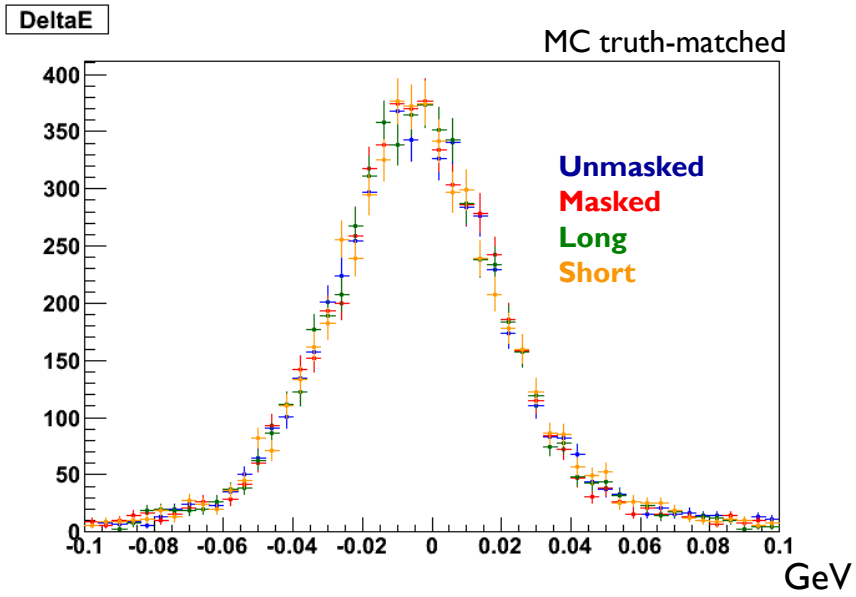
single particles:
p resolution at θ=150°

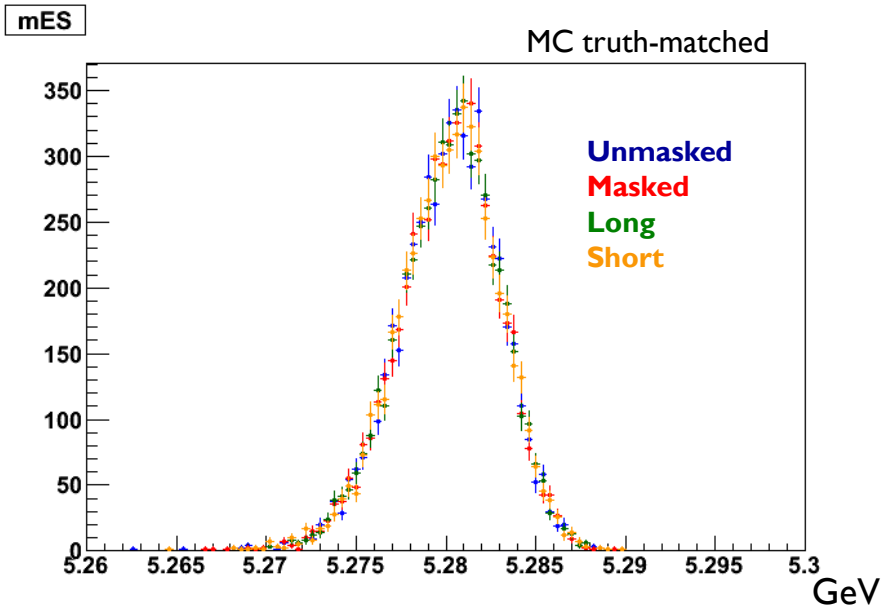




p resolution in Long DCH improves by ~30% in bwd region (for θ=150°)

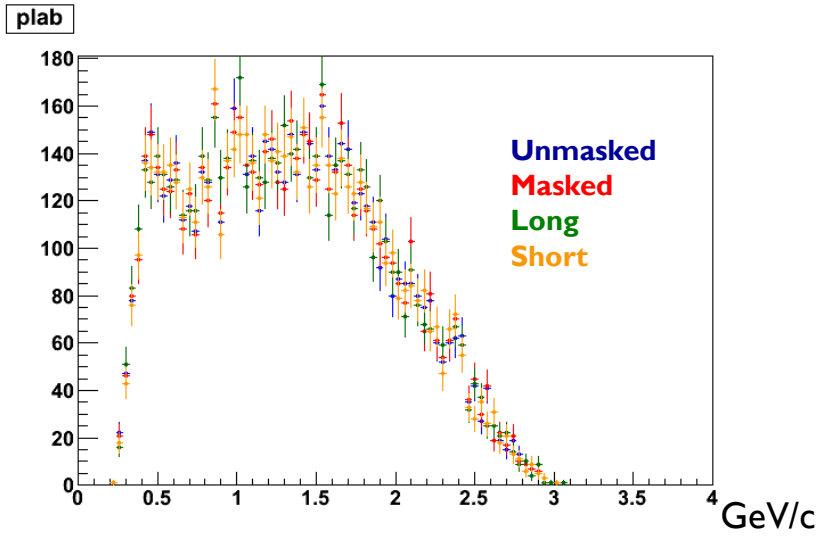
B→ππ: ΔE and m_{ES}





no significant difference in the overall ΔE and m_{ES} resolution

B→D*K

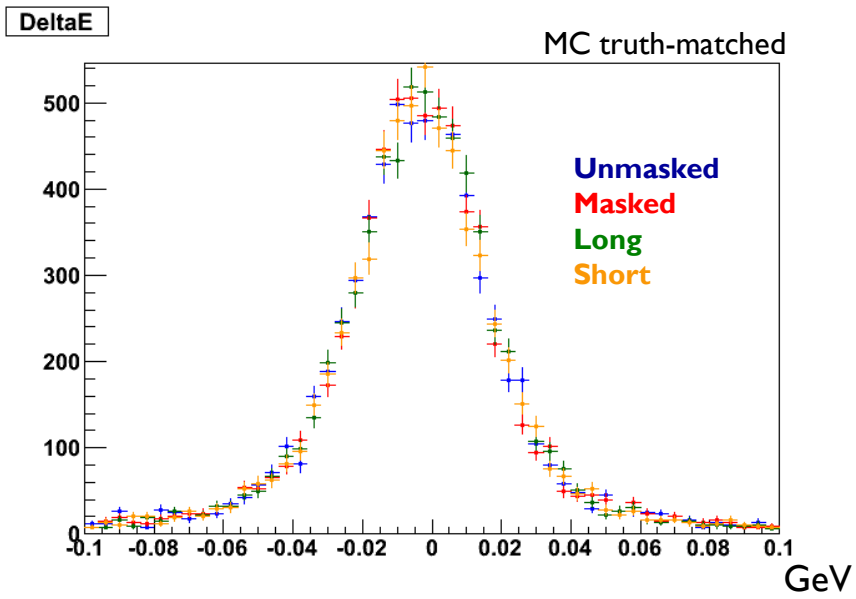


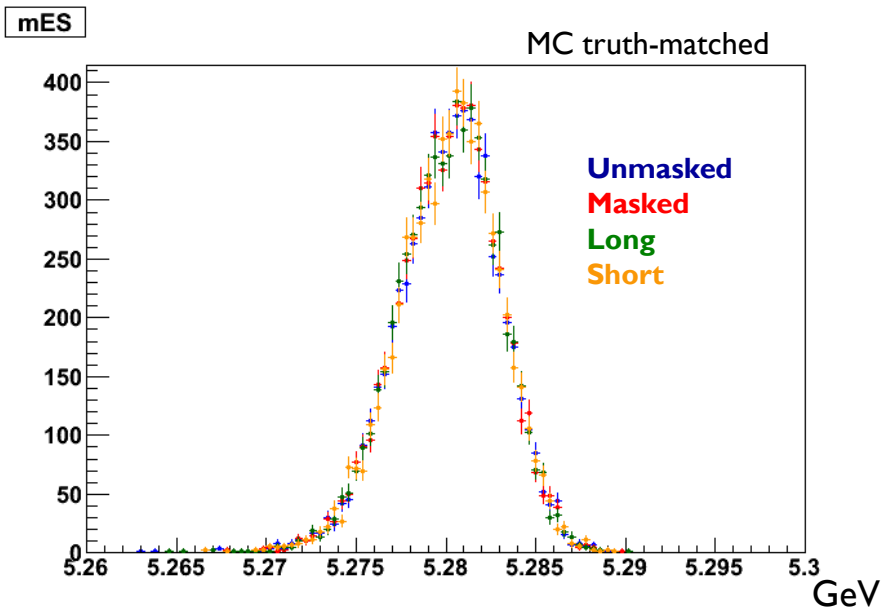
DCH configuration	eff. mc-truth
Unmasked	0.650 +/- 0.005
Masked	0.652 +/- 0.005
Long	0.655 +/- 0.005
Short	0.647 +/- 0.005

note: same run numbers (i.e. same generated events) for the 4 configurations

the difference in the $B^0 \rightarrow D^{*-}K$ reconstruction efficiency is small

B→D*K: ΔE and m_{ES}



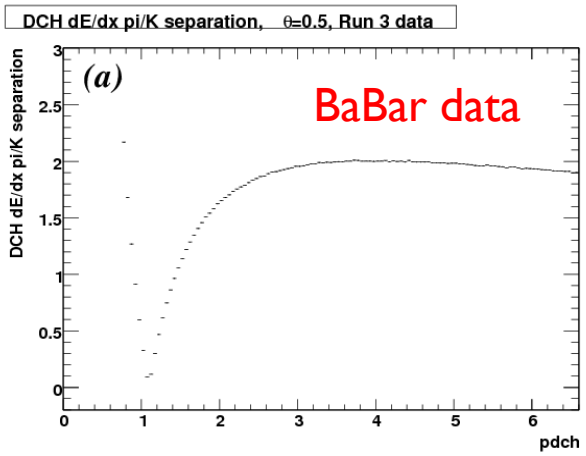


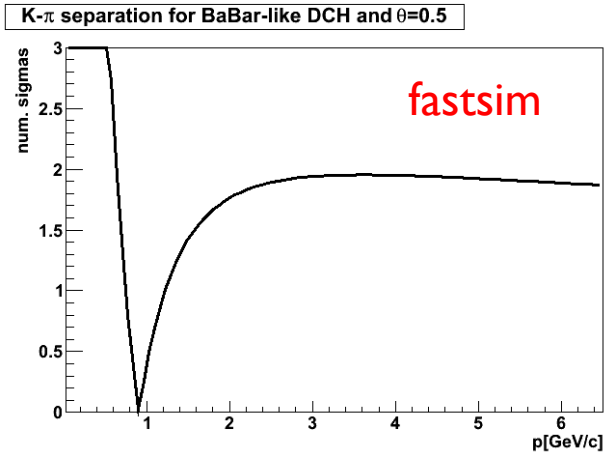
no significant difference in ΔE and m_{ES} resolution

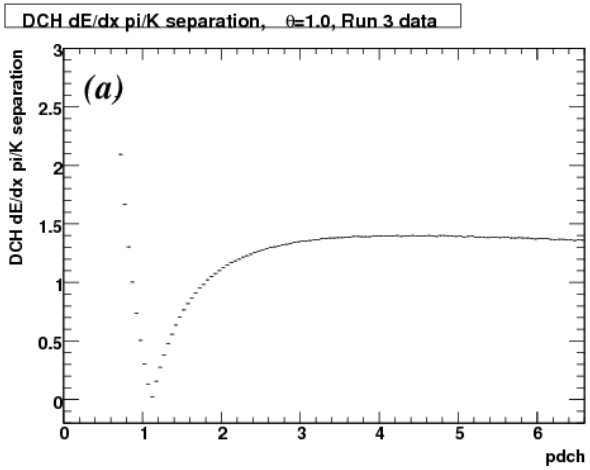
dE/dx tuning

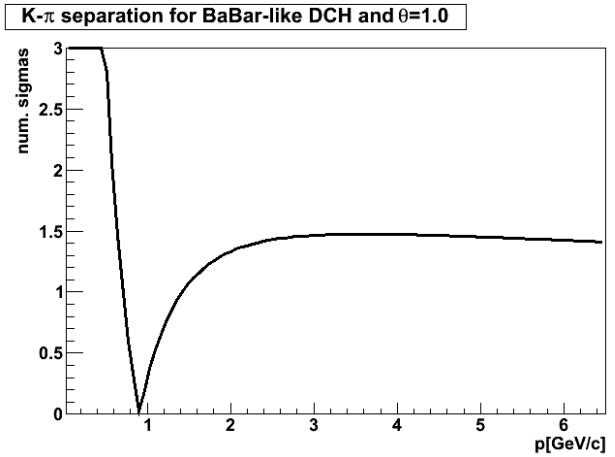
- dE/dx tuned according to BaBar DCH (BAD#1500)

K-π separation vs p

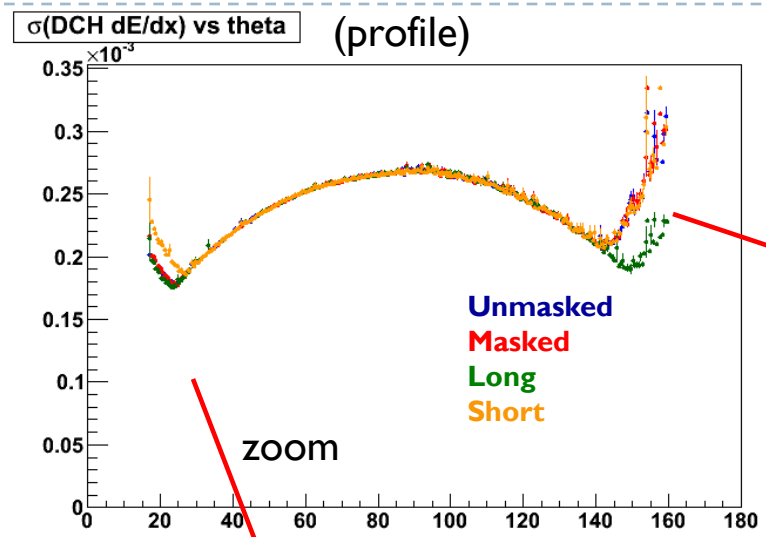


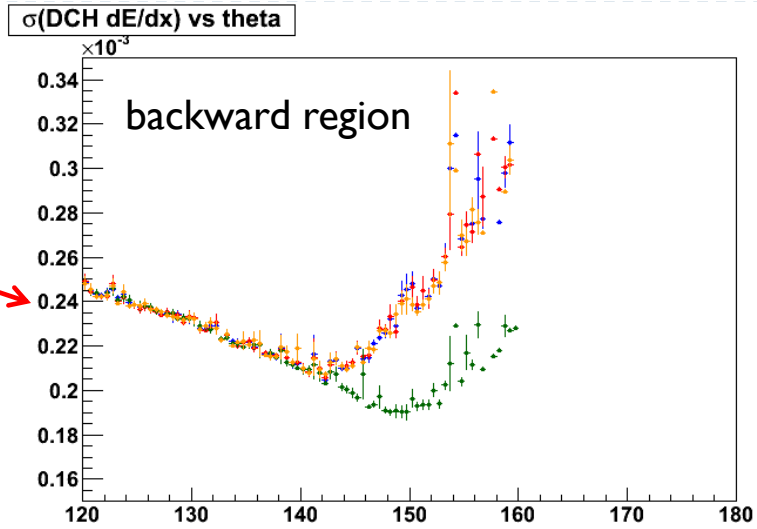


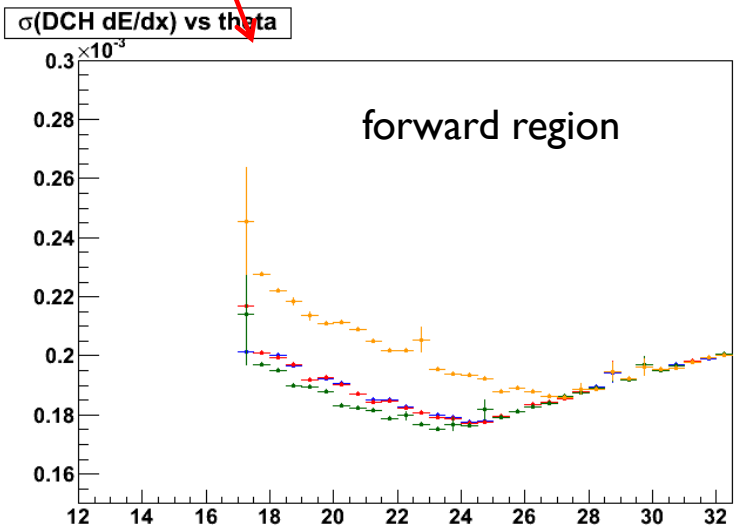




tracks from B→ππ: σ(DCH dE/dx) vs polar angle







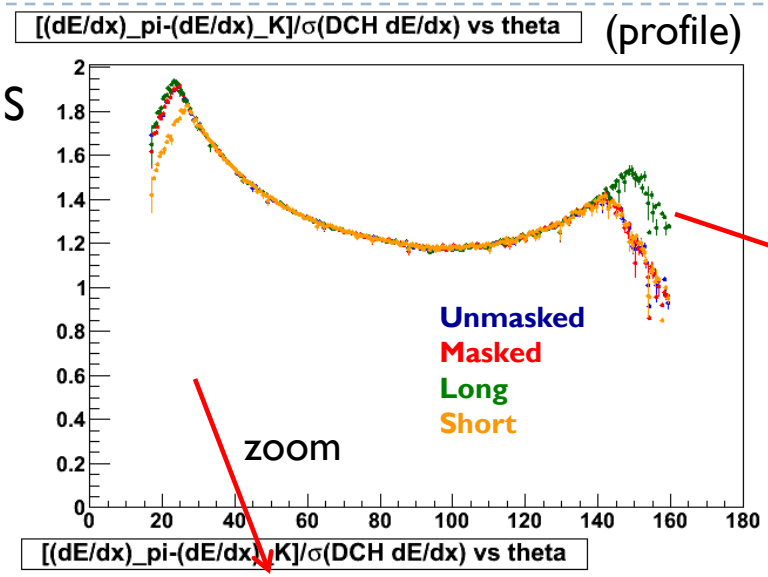
Note: the spread of the dE/dx measurement of the single hit is parameterized as:

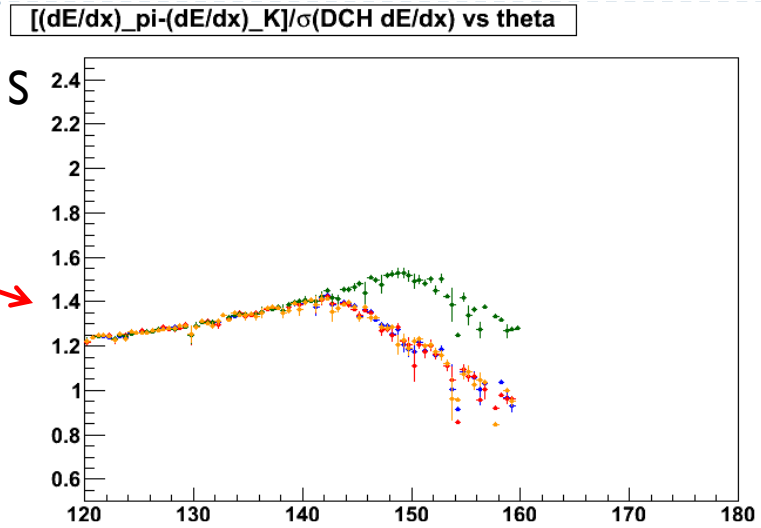
$$\sigma(dE/dx) = a_1 (dE/dx)^{a_2} dl^{a_3}$$

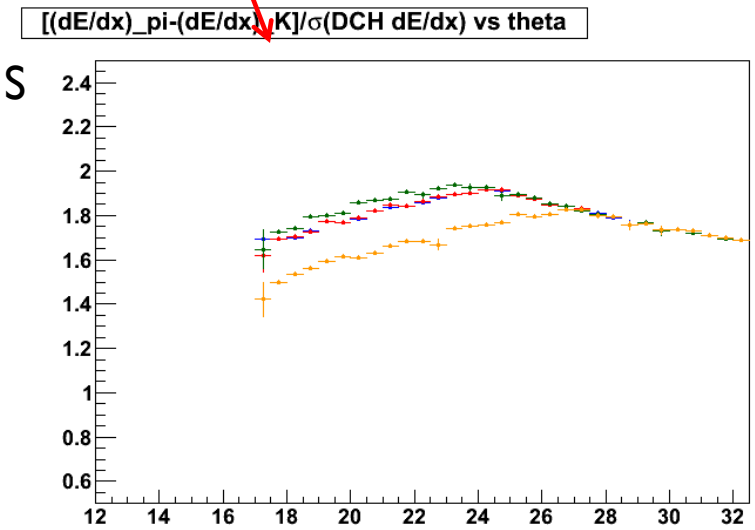
a_2=1
a_3=-0.5

a_1 (and also a2) is tuned to resemble the dE/dx π/K separation measured in Babar data (sl. 9)

tracks from B→ππ: DCH dE/dx K-π separation vs theta







S=[Expected_dE/dx(pi)-Expected_dE/dx(K))]/σ(dE/dx)

Long DCH w.r.t. Masked:

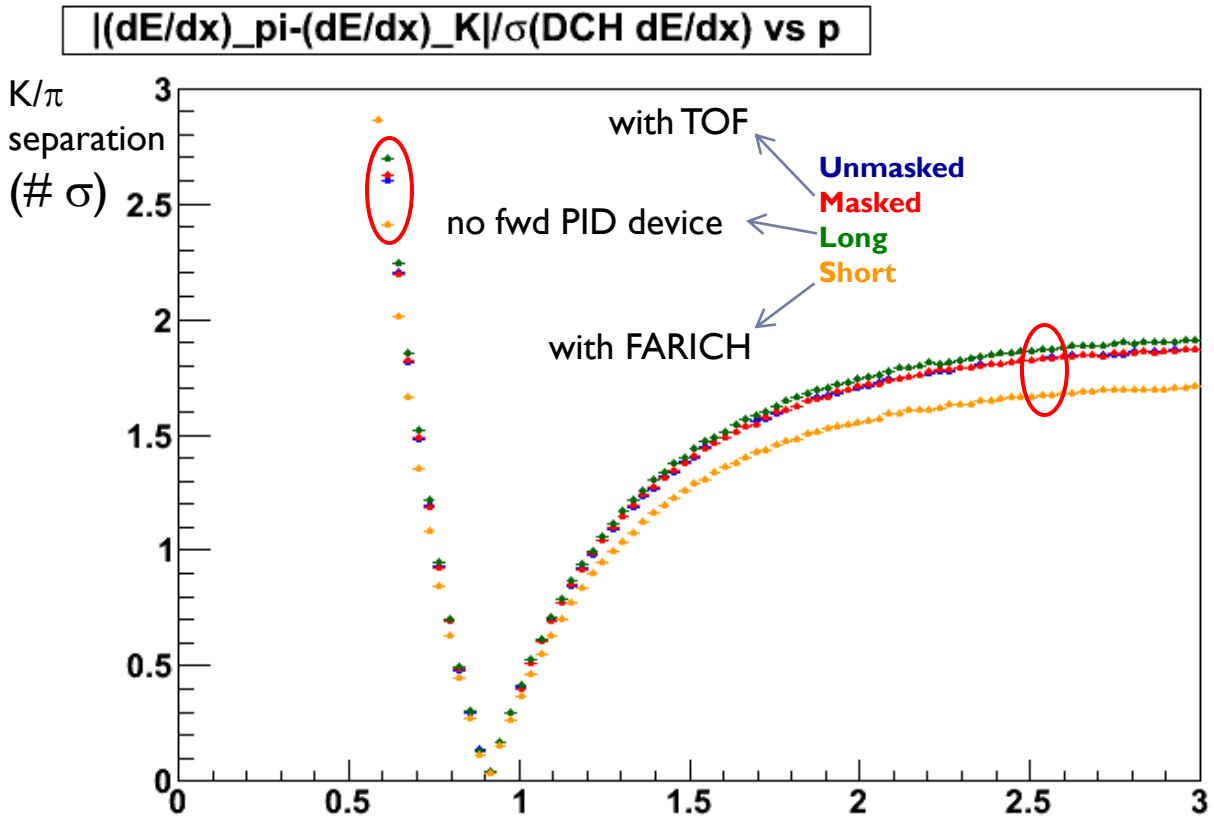
- 3.6% of tracks fall in the fwd region, where the dE/dx separation increases by ~0.06σ
  - to be compared with TOF pi/K separation in this momentum range (3.2-3.6 GeV)
- 2.8% of tracks fall in the bwd region, where the dE/dx separation increases by ~0.3σ
  - to be compared with possible PID from the bwd calorimeter in this momentum range (1.9-2.2 GeV)

Short DCH w.r.t. Masked:

- 3.6% of tracks fall in the fwd region, where the dE/dx separation decreases by ~0.2σ

single particles:
K/π separation vs p at θ=23°

see drawings in sl. 10-11

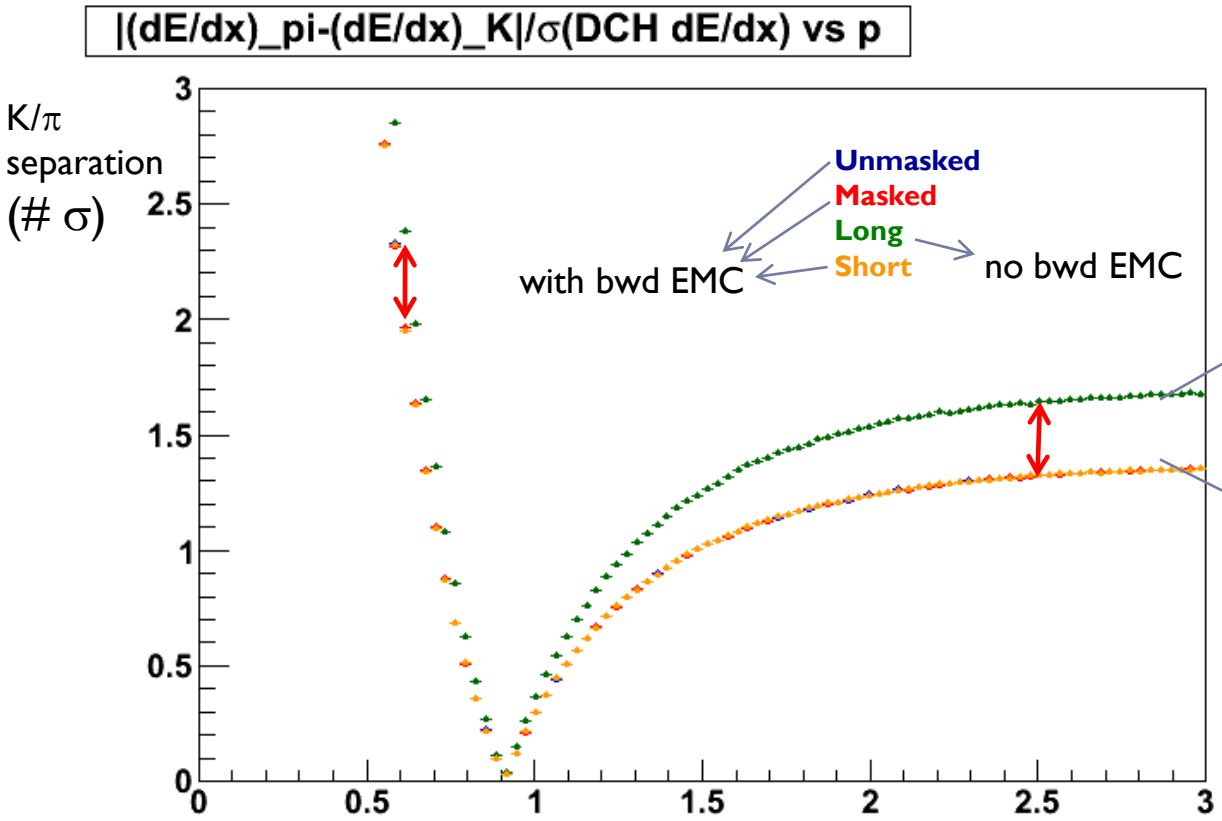


between Short and Masked:
0.16σ difference @2.5GeV
0.21σ difference @0.6 GeV

between Long and Masked:
~0.04σ difference @2.5GeV
~0.07σ difference @0.6GeV

single particles:
K/π separation vs p at θ=150°

see drawings in sl. 10-11



no bwd EMC ('Long')

~0.4σ difference @2.5GeV
~0.3σ difference @0.6GeV

with bwd EMC

Summary

Preliminary study of tracking and $(dE/dx)_{DCH}$ performance vs DCH length

tracking

- significant improvement of momentum resolution in bwd region with Long DCH (no bwd EMC)
- significant worsening of momentum resolution in fwd region with Short DCH (FARICH)

BUT

- the fraction of tracks going in fwd and bwd region is quite small (modes considered: $B \to \pi\pi$, $B \to D^*K$) ➔ Impact on B reconstruction (reco. efficiency, ΔE resolution) is very small

dE/dx (tuned on BaBar)

- moderate improvement of K/π separation in bwd region with Long DCH (~0.4σ @2.5GeV or 0.6GeV)
- moderate worsening of K/π separation in fwd region with FARICH (~0.2σ @2.5GeV or 0.6GeV)
- negligible improvement of K/π separation in fwd region with Long DCH (no TOF)

- Eventually it is the combined dE/dx+other-PID-devices performance that must be compared

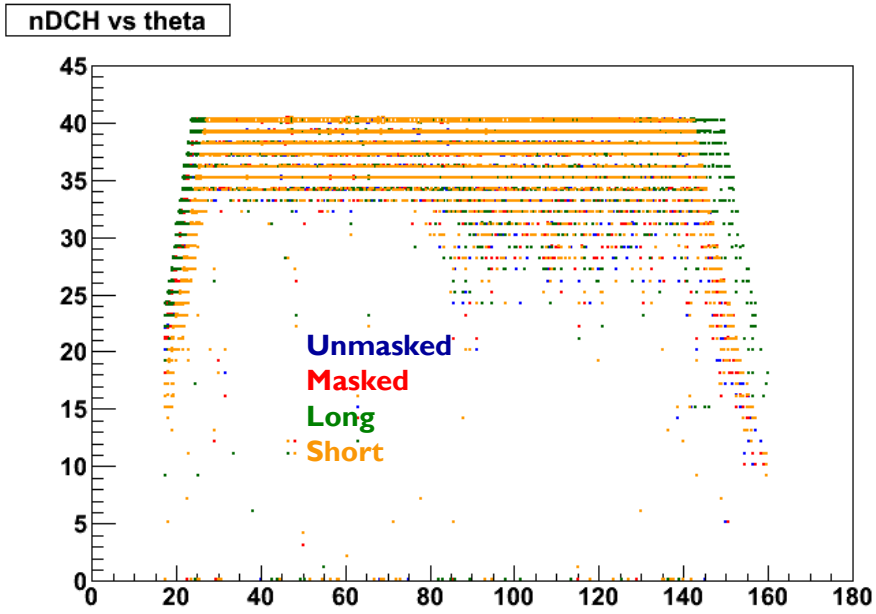
Next steps

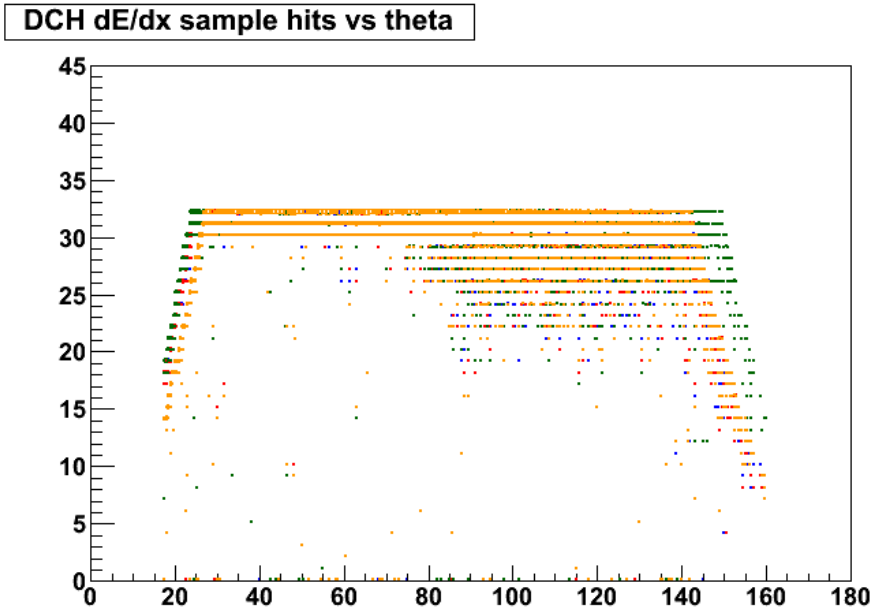
- Look closer at reconstruction of very low p tracks
- dE/dx of electrons needs investigation
- Review the dE/dx simulation and possibly consider different gas/techniques (e.g. performance with cluster counting)
- Study the performance of combined PID information (together with the PID group)

backup

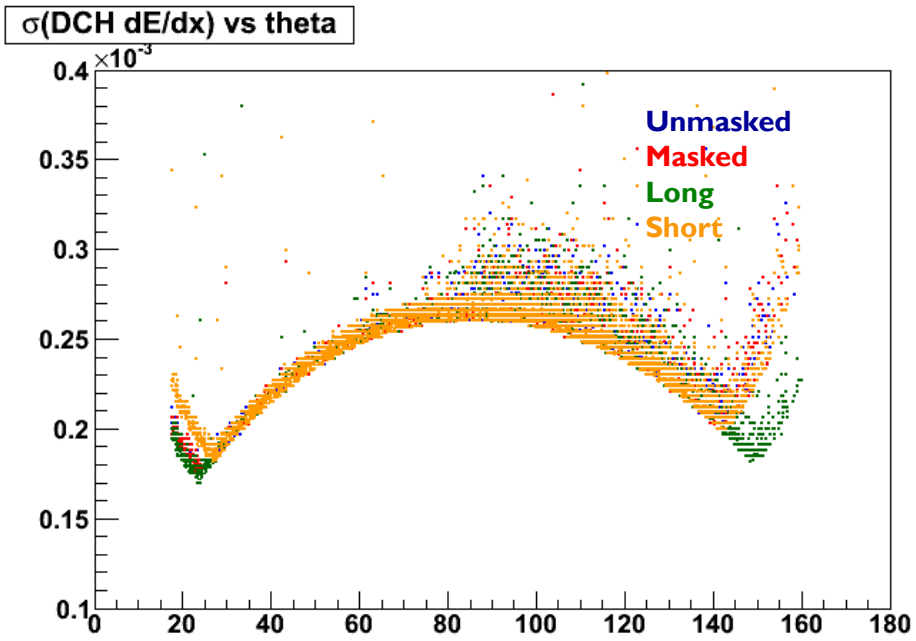
$B \rightarrow \pi^+\pi^-$: #DCH hits and #DCH dE/dx hits vs theta

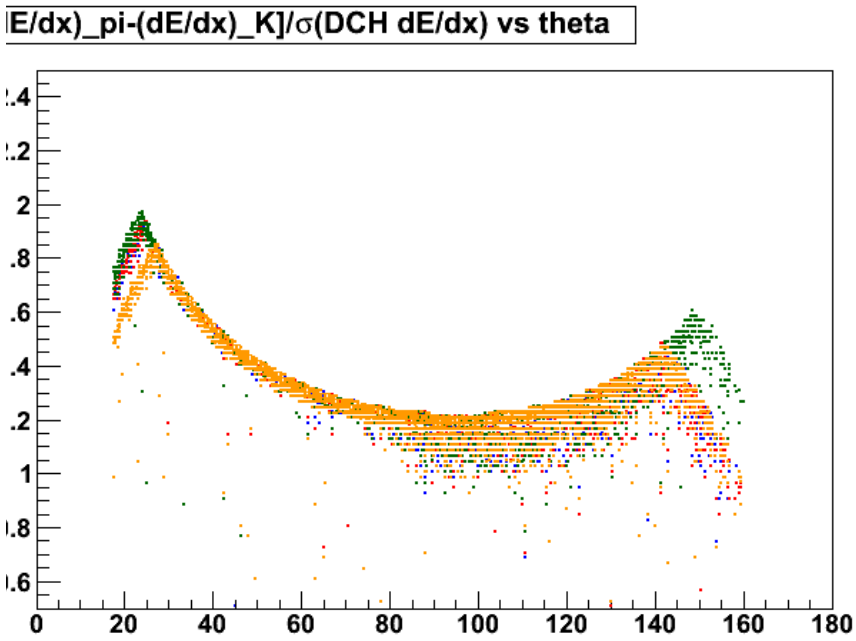
$B \rightarrow \pi\pi$



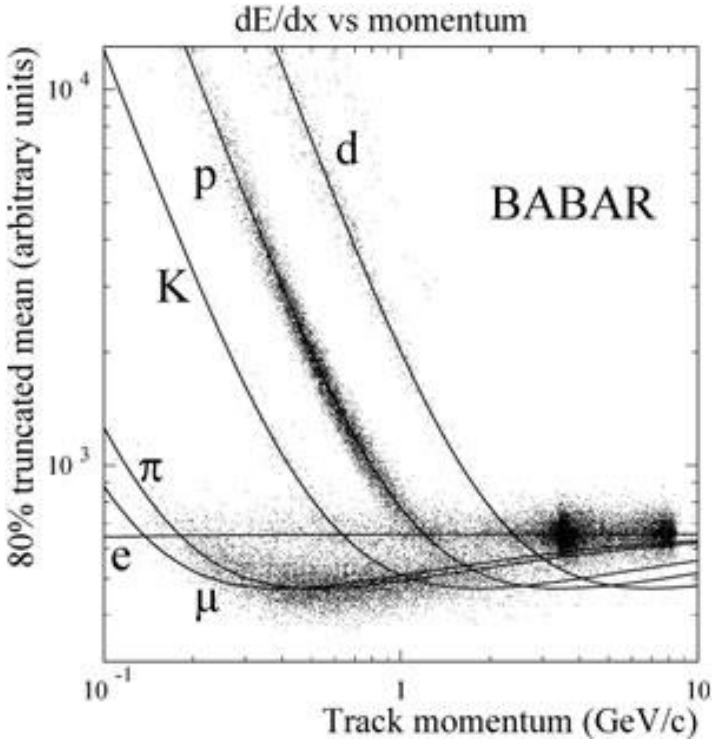


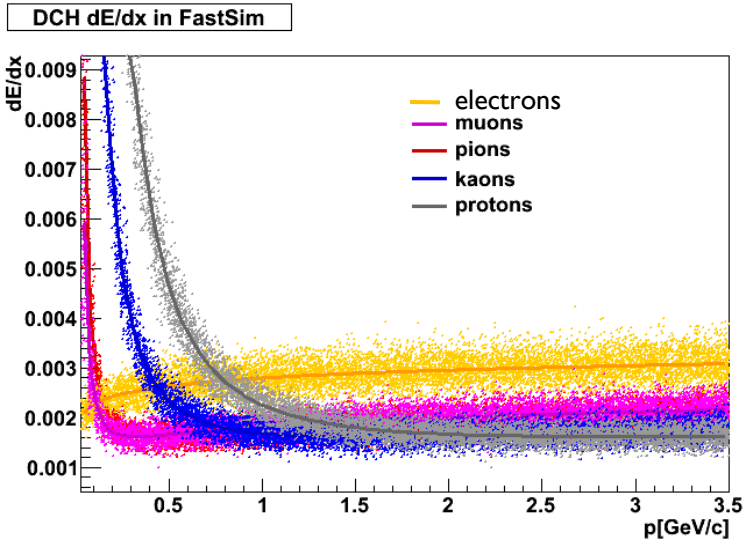
$B \rightarrow \pi^+\pi^-$





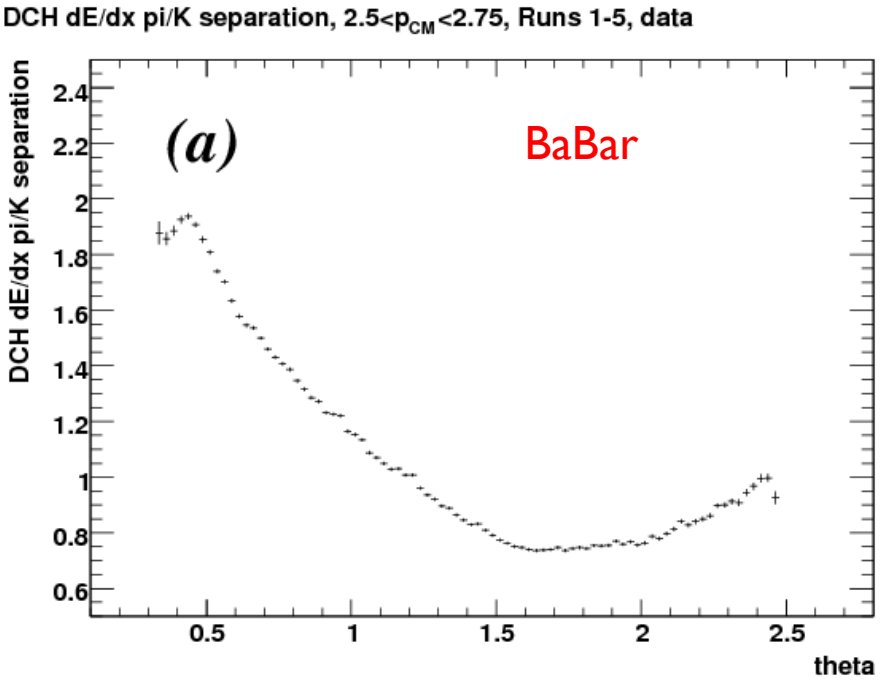
dE/dx BaBar vs fastsim

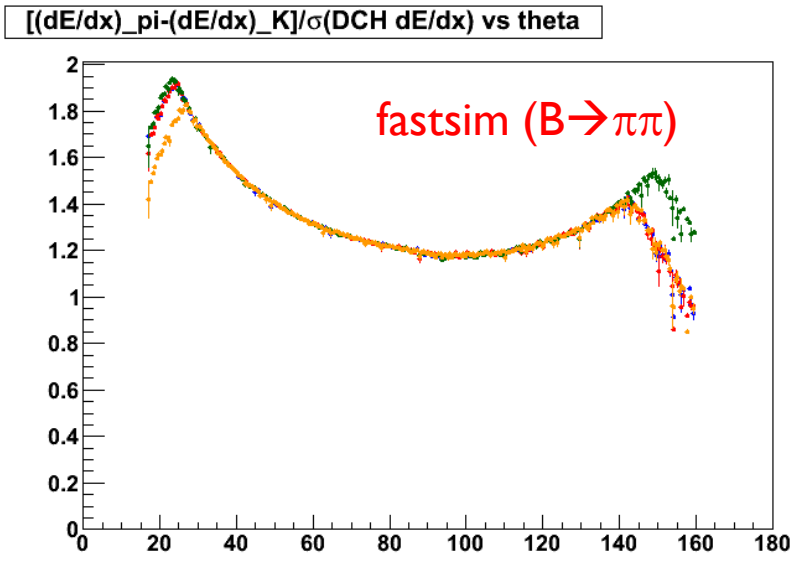




muons→protons: reasonable
electrons: need work

dE/dx BaBar vs fastsim





In BaBar the range of separation is ~1.2. In fastsim is ~0.6-0.8
One reason could be the fact that the DCH hit efficiency in fastsim does not depend on the polar angle