PYTHIA tuning for DCA decomposition

2012/06/07
RIKEN VTX software meeting
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DCA decomposition

- Yields of charm and bottom are evaluated from DCA distribution.
  - DCA distribution decrease as DCA become larger, but slop is not simple exponential decrease since what we know is information of daughter particles, not mother particle.
  - evaluate DCA distribution with simulation to extract the yields.
- DCA distribution depends on
  - pT distribution of charm and bottom : put weight w.r.t quark pT
  - particle fraction of mother hadrons
- There are many heavy flavored hadrons which have $e^{\pm}$ as a daughter, but some of the hadrons can be combined if it is assumed that the fragmentation function is not different from that in p+p or e+e- collisions.
  - This assumption will be valid if charms or bottoms are not thermalized well.

$e^{\pm}$ sources (charmed hadrons)

hadron	branching ratio [%]	$c\tau$ [μm]	fraction to D^0
$D^{\pm}$	16.07	311.8	0.3998±0.0173
D^0	6.47	122.9	1
D_s	6.5	149.9	0.1412±0.0088
Λ_c	2.1	59.9	0.1914±0.0169
$\Xi_c^{\pm}$	2.3	132	-
Ξ_c^0	seen	33.6	-
$\Omega_c^{\pm}$	seen	21	-

- Fractions are from arXiv:1112.3757v1
  - use data measured at HERA (H1 and ZEUS) and at e+e- storage rings (LEP, ARGUS, and CLEO)

$e^{\pm}$ sources (bottomed hadrons)

hadron	branching ratio [%]	$c\tau$ [μm]	fraction to B^0
$B^{\pm}$	10.8	491.1	1.054±0.075
B^0	10.1	457.2	1
B_s	7.9	441	0.267±0.026
Λ_b	10.7	417	0.577±0.290

- f(bbar→B^+) = 40.99±1.38 % (DELPHI)
- f(bbar→B_s^0)×B(B_s^0→D_s^-X)×B(D_s^-→$\phi\pi^-$) = (5.9±2.2)×10^{-3} (OPAL)
- $f_s/(f_u+f_d)$×B(D_s^+→$\phi\pi$) = (5.76±0.48)×10^{-3} (CDF)
- f_u/f_d = 1.054±0.075 (CDF)
  - B(B_s^0→D_s^-X) = 93±25 % (PDG 2011)
  - B(D_s→$\phi\pi$) = 4.5±0.4 % (PDG 2011)
- f_s/f_d = 0.267±0.021(LHCb)
- $f_{\Lambda b}/(f_u+f_d)$ = (0.404±0.110)×[1-(0.031±0.005)×pT(GeV/c)] (LHCb)
- $f_{\Lambda b}/(f_u+f_d)$ = 0.281±0.141 (CDF)
  - Since $f_{\Lambda b}/(f_u+f_d)$ depends on pT, $f_{\Lambda b}/(f_u+f_d)$ is tuned to the result of CDF.

PYTHIA setup

- version : 6.421
- I used some parameters used in PPG094 except for quark masses.
  - They are tuned for CDF.
- Particle decay in PYTHIA
  - only hadrons with cτ<50μm decay.

Table 5.15: PYTHIA tuning parameters

parameter name	value
charm mass	1.25 GeV
bottom mass	4.3 GeV
k_T	1.5 GeV/c
PDF	CTEQ5L
PARJ(13) (charm production)	0.55
PARJ(2) (charm production)	0.36
PARJ(2) (bottom production)	0.44
MSTP(82)	4
PARP(81)	1.9
PARP(82)	2.0
PARP(83)	0.5
PARP(84)	0.4
PARP(85)	0.9
PARP(86)	0.95
PARP(89)	1800
PARP(90)	0.25
PARP(67)	4.0

Parameter tuning (charm)

- Tuning for charmed hadrons are finished.
- Particle fraction after tuning : fit pT distribution by constant at 1-5 GeV/c
  - Some distributions have pT dependence, but it is ignored.

Hadron	Data	After tuning	tuned value	PYTHIA default
$D^{\pm}/D^{0}$	0.3998±0.0173	0.402±0.0030	PARJ(13)=0.63	PARJ(13)=0.75
D_s/D^{0}	0.1412±0.0088	0.139±0.0016	PARJ(2)=0.20	PARJ(2)=0.30
Λ_c/D^{0}	0.1914±0.0169	0.198±0.0019	PARJ(1)=0.15	PARJ(1)=0.10

Parameter tuning (bottom)

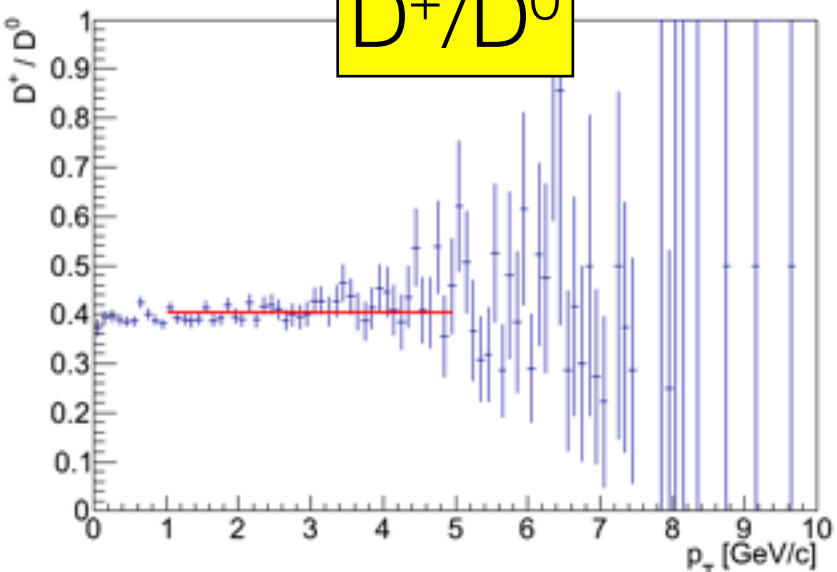
- Tuning for charmed hadrons are finished.
- Particle fraction after tuning : fit pT distribution by constant at 1-5 GeV/c

Hadron	Data	After tuning	tuned value	PYTHIA default
$B^{\pm}/B^{0}$	1.054±0.075	0.995±0.021	PARJ(13)=0.75	PARJ(13)=0.75
B_s/B^{0}	0.267±0.026	0.261±0.0085	PARJ(2)=0.29	PARJ(2)=0.30
Λ_b/B^{0}	0.577±0.290	0.552±0.015	PARJ(1)=0.34	PARJ(1)=0.10

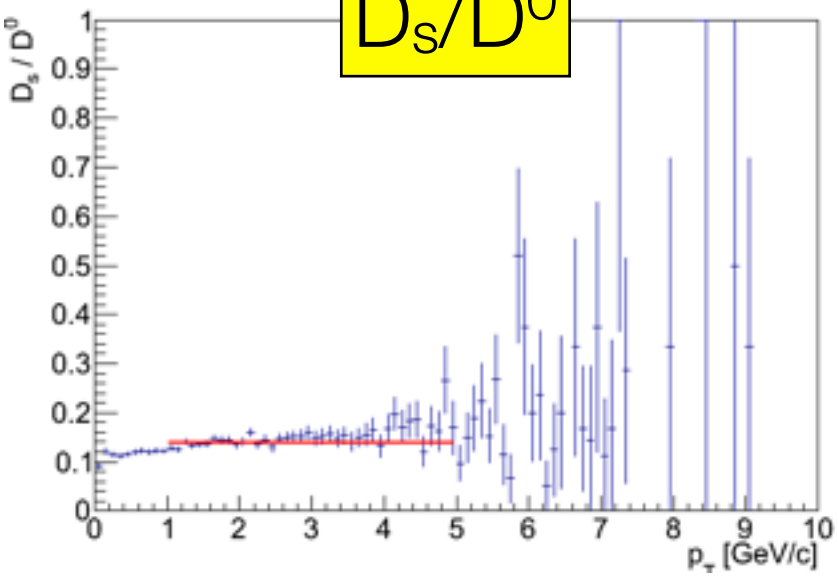
Backup

pT distributions (charm)

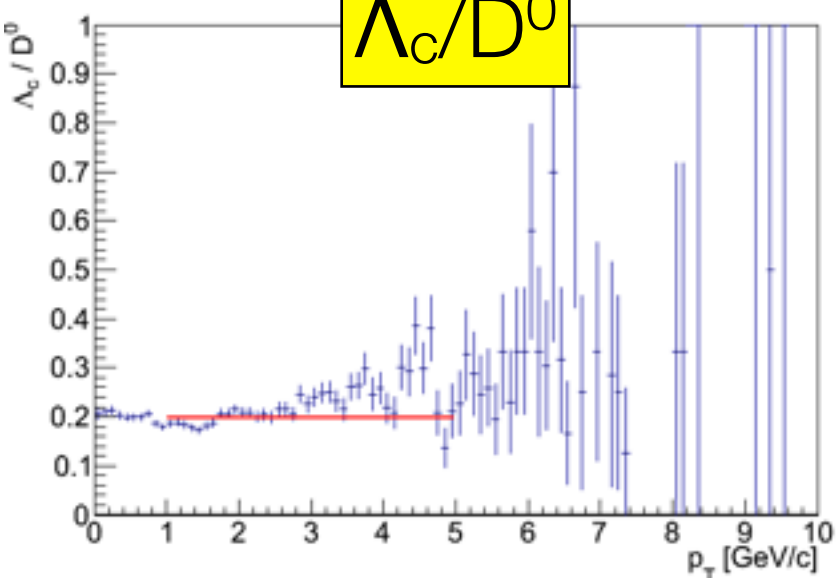
D^+/D^0



D_S/D^0

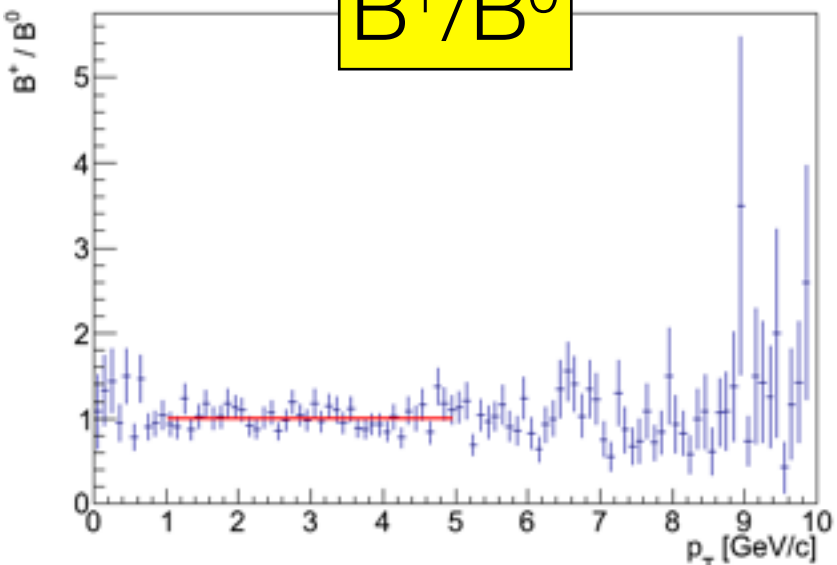


Λ_c/D^0

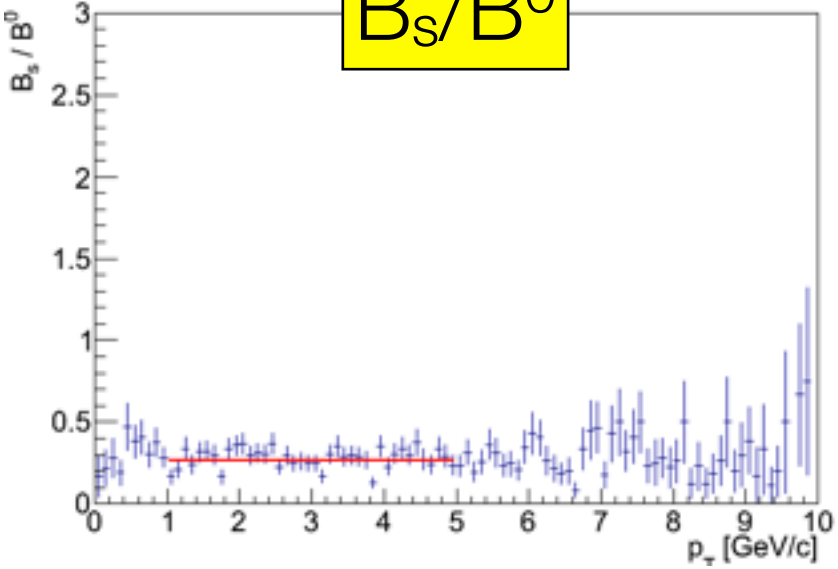


pT distributions (bottom)

B^+/B^0



B_s/B^0



Λ_b/B^0