B Tagging @ SuperB

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16 April 2009

Y(4S)

Observable	B Factories (2 ab^{-1})	Super$B$ (75 ab^{-1})
$\sin(2\beta)$ $(J/\psi K^0)$	0.018	0.005 (†)
$\cos(2\beta)$ $(J/\psi K^{*0})$	0.30	0.05
$\sin(2\beta)$ (Dh^0)	0.10	0.02
$\cos(2\beta)$ (Dh^0)	0.20	0.04
$S(J/\psi\pi^0)$	0.10	0.02
$S(D^+D^-)$	0.20	0.03
$S(\phi K^0)$	0.13	0.02 (∗)
$S(\eta' K^0)$	0.05	0.01 (∗)
$S(K^0_S K^0_S K^0_S)$	0.15	0.02 (∗)
$S(K^0_S\pi^0)$	0.15	0.02 (∗)
$S(\omega K^0_S)$	0.17	0.03 (∗)
$S(f_0 K^0_S)$	0.12	0.02 (∗)
γ ($B\to DK$, $D\to CP$ eigenstates)	$\sim 15°$	2.5°
γ ($B\to DK$, $D\to$ suppressed states)	$\sim 12°$	2.0°
γ ($B\to DK$, $D\to$ multibody states)	$\sim 9°$	1.5°
γ ($B\to DK$, combined)	$\sim 6°$	1–2°
α ($B\to\pi\pi$)	$\sim 16°$	3°
α ($B\to\rho\rho$)	$\sim 7°$	1–2° (∗)
α ($B\to\rho\pi$)	$\sim 12°$	2°
α (combined)	$\sim 6°$	1–2° (∗)
$2\beta+\gamma$ ($D^{(*)\pm}\pi^\mp$, $D^\pm K^0_S\pi^\mp$)	20°	5°

$\lvert V_{cb}\rvert$ (exclusive)	4% (∗)	1.0% (∗)
$\lvert V_{cb}\rvert$ (inclusive)	1% (∗)	0.5% (∗)
$\lvert V_{ub}\rvert$ (exclusive)	8% (∗)	3.0% (∗)
$\lvert V_{ub}\rvert$ (inclusive)	8% (∗)	2.0% (∗)
$\mathcal{B}(B\to\tau\nu)$	20%	4% (†)
$\mathcal{B}(B\to\mu\nu)$	visible	5%
$\mathcal{B}(B\to D\tau\nu)$	10%	2%
$\mathcal{B}(B\to\rho\gamma)$	15%	3% (†)
$\mathcal{B}(B\to\omega\gamma)$	30%	5%
$A_{CP}(B\to K^*\gamma)$	0.007 (†)	0.004 († ∗)
$A_{CP}(B\to\rho\gamma)$	~ 0.20	0.05
$A_{CP}(b\to s\gamma)$	0.012 (†)	0.004 (†)
$A_{CP}(b\to(s+d)\gamma)$	0.03	0.006 (†)
$S(K^0_S\pi^0\gamma)$	0.15	0.02 (∗)
$S(\rho^0\gamma)$	possible	0.10
$A_{CP}(B\to K^*\ell\ell)$	7%	1%
$A^{FB}(B\to K^*\ell\ell)s_0$	25%	9%
$A^{FB}(B\to X_s\ell\ell)s_0$	35%	5%
$\mathcal{B}(B\to K\nu\bar{\nu})$	visible	20%
$\mathcal{B}(B\to\pi\nu\bar{\nu})$	–	possible

B Flav Tagging

Determination of the flavour of the neutral B meson

The effective tagging efficiency:

$$Q = \epsilon(1-2w)^2$$

ω mistag fraction
ε tagging efficiency

depends on:

- SuperB acceptance of the Detector
- SuperB PID Performance
- Tagging Algorithm

From BaBar to SuperB

Preliminary SBTag:

(1) reuses core of the B tagging code from Babar

(2) reuses the NN infrastucture of Tag08

(mostly the same but some inputs and/or subtaggers can change)

(3) relies on available "SuperB" muon, elector and kaon selectors

(4) revises tightness of PID selection to optimize B flav-tag performance (second step)

(5) produces the NN output for analyses (third step)

B/D Vertex Separation

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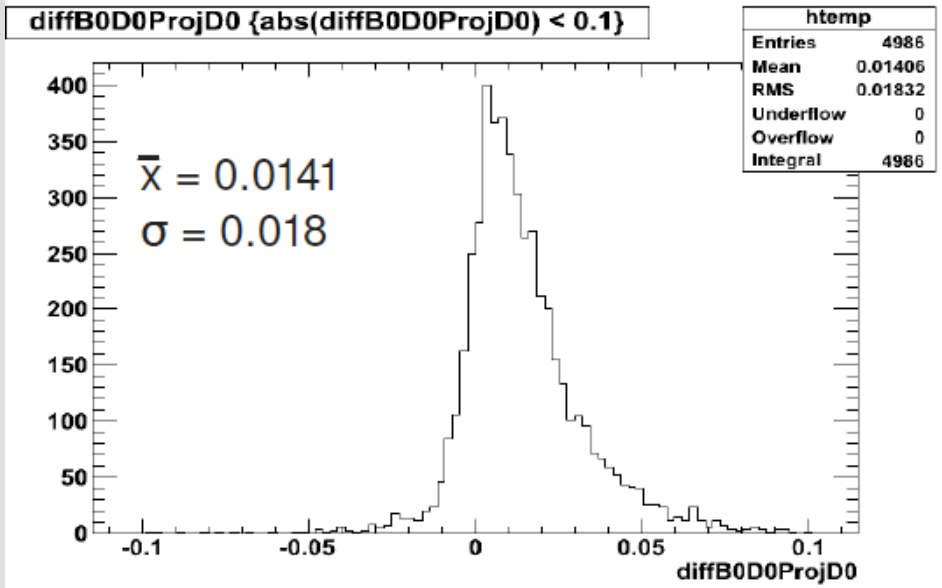
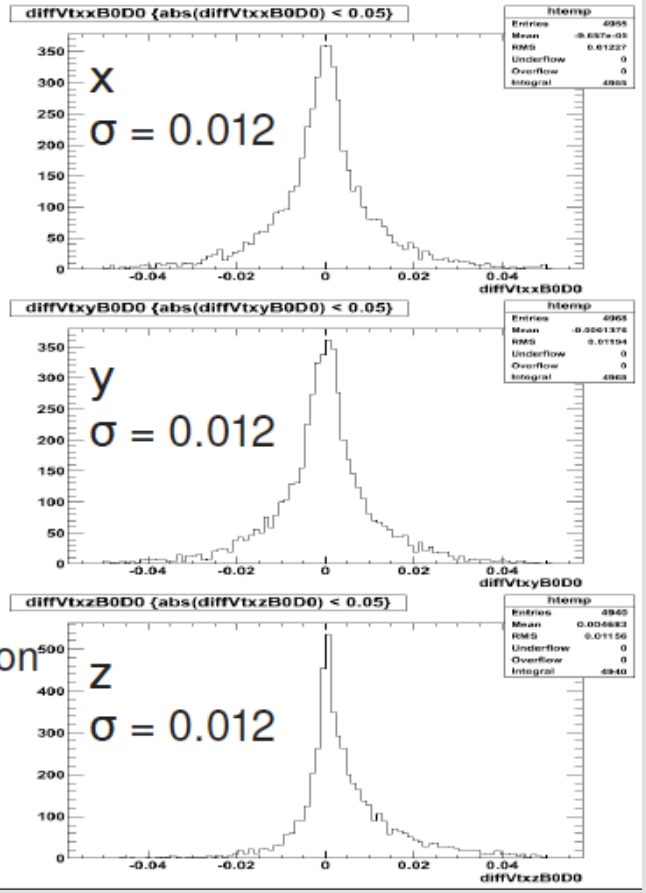
(D° - B°) Vertex Separation

- Study if its possible to distinguish B° and D° vertex
  → Plot vertex position difference in direction of momentum of D°

Vertex difference along D0 momentum



Vertex difference along x-y-z



- Separation along momentum is bigger than resolution
- Average 3.5σ away
- Vertices are separable

B Tagging Code

- Moved to FastSim/V0.0.4
- dE/dx and new PID should be available in 2 weeks
- Waiting for reliable PID selector to create useful BTagging lists to test as input to NN
- Adapting the core of the BaBar B Tagging code to use it with FastSim.
- Two packages will contain the reconstruction code, the variables needed to train the NN and the NN output to be used by analysts.

-PacBTaggingUser (PacTagUserApp)

-PacBTaggingTools (variables input to NN, definition of the BTagging lists, etc..)

Input to NN

- check if we can run the adapted code on B->ππ MC events and dump the discriminating variables required as input to the NN
- not interested in training the NN at this stage, we just need that the adapted code for FastSim works
- when reliable PID selectors will be available -> training NN

Tag name	Network arch.	Discriminating variables	Training target
Electron	4:12:1	p^*, E_{90}^W, $\cos\theta_{miss}$, q	Classify B^0 versus $\overline{B}^0$
Muon	4:12:1	p^*, E_{90}^W, $\cos\theta_{miss}$, q	Classify B^0 versus $\overline{B}^0$
KinLep	3:3:1	p^*, E_{90}^W, $\cos\theta_{miss}$	Recognize leptons from direct decays
Kaon	5:10:1	$K1$, $K2$, $K3$, nK_s, ΣP_t	Classify B^0 versus $\overline{B}^0$
SlowPion	3:10:1	p^*, $\cos\theta_{thrust}$, $\mathcal{L}_K$	Recognize true slow pions
MaxPstar	3:6:1	p^*, $doca_{xy}$,$\cos\theta$	Recognize fast tracks
KPi	3:10:1	Kaon tag, SlowPi tag, $\cos\theta_{k,\pi}$	Recognize pairs of true kaons and slow pions
FSC	6:12:1	$\cos_{SlowFast}$, p^*_{Slow}, p^*_{Fast}, $\cos_{SlowThrust}$,$\cos_{FastThrust}$, $\mathcal{L}_{KSlow}$	Recognize fast-slow correlated tracks
Lambda	6:14:1	M_Λ, χ^2, $\cos\theta$, flight length, p_Λ ,p_{proton}	Recognize lambda decays
Tag04/Tag08	10:20:1	All af the above tags	Classify B^0 versus $\overline{B}^0$

We can dump just the discriminating variabes we need and/or add other variables (B-D vertex separation for example)

B Tagging Lists

PID selectors and criteria for the BaBar B Tagging lists in BaBar are in BetaPid/PidTaggingMicroSequence.tcl, .cc, .hh, moved in the PacBtagging packages.

	SBTag	Crit.	Tag08	Crit.
Muon	?	?	PidMuonBDTSelector	LFR
Electron	?	?	PidKMSelector	L
Kaon	?	?	PidKaonBDTSelector +KKM SuperLoose	NP

- Example selectors written:

PacPidFirstElectronSelector	'LH'-type selectors
PacPidFirstKaonSelector	PID barrel (DIRC) only so far
PacPidFirstPionSelector	Need tuning/code improvement
PacPidTruthBasedSelector	→ MC-truth based

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To do List

-Adapte the B tagging code of BaBar for FastSim (work in progress)

- Use available "SuperB" PID Selectors to create the B Tagging Lists without any optimization on the tightness criteria

- Generate and reconstruct the usual MC events used to train the NN architecture of BaBar.

- Check if we can dump all the required variables to be used as input to the NN.

- Check if they look reasonable.