

Same-side and opposite-side tagging for $B_s \rightarrow \mu\phi\pi$ decay mode

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July 05, 2007

B Mixing and Lifetime Meeting

http://www-d0.fnal.gov/~rakitin/d0_private/tex/2007.July.05.Bmix/tr.pdf



List of used same-side taggers:

We are using the following SSTs (one-track and many-track taggers):

➔ Min. p_t^{rel}

➔ Max. p_L^{rel}

➔ Max. p_t

➔ Min. $|\Delta\vec{P}| \equiv |\vec{p}(B_s) - \vec{p}(K)|$

➔ **Best: Min. ΔR**

➔ Max. $\cos \alpha$

➔ Min. $\cos \theta^*$

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➔ Min. $m(B_s K)$

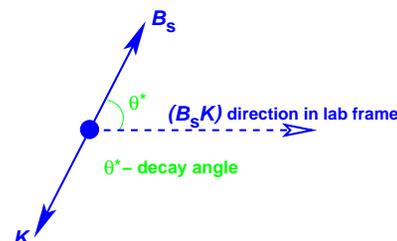
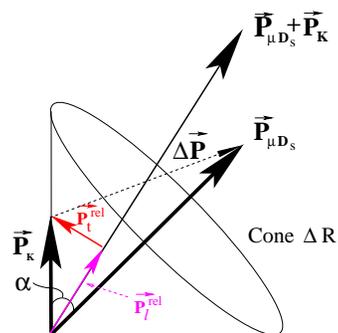
➔ Random track

➔ $Q_{jet}(p_t, \kappa) = \frac{\sum q \cdot p_t^\kappa}{\sum p_t^\kappa}$

➔ $Q_{jet}(p_t^{rel}, \kappa) = \frac{\sum q \cdot (p_t^{rel})^\kappa}{\sum (p_t^{rel})^\kappa}$

➔ $Q_{jet}(p_L^{rel}, \kappa) = \frac{\sum q \cdot (p_L^{rel})^\kappa}{\sum (p_L^{rel})^\kappa}$

➔ **Best: $Q_{jet}(p_t, \kappa = 0.6)$**



- One-track: p_t^{rel} and p_L^{rel} are \perp and \parallel components of SST candidate's momentum $\vec{p}(K)$ w.r.t $\vec{p}(B_s K)$
- $\Delta R \equiv \sqrt{\Delta\phi^2 + \Delta\eta^2}$ and angle α are taken between $\vec{p}(B_s)$ and $\vec{p}(K)$
- θ^* - decay angle of $B_s K$ -system, *i.e.* angle between directions of $\vec{p}(B_s K)$ and $\vec{p}(B_s)$ in reference frame of $B_s K$ system
- $\kappa = 0.0, 0.1, 0.2, \dots 1.0$
- Q_{jet} : p_t^{rel} and p_L^{rel} are \perp and \parallel components of SST candidate's momentum $\vec{p}(K)$ w.r.t $\vec{p}(B_s)$



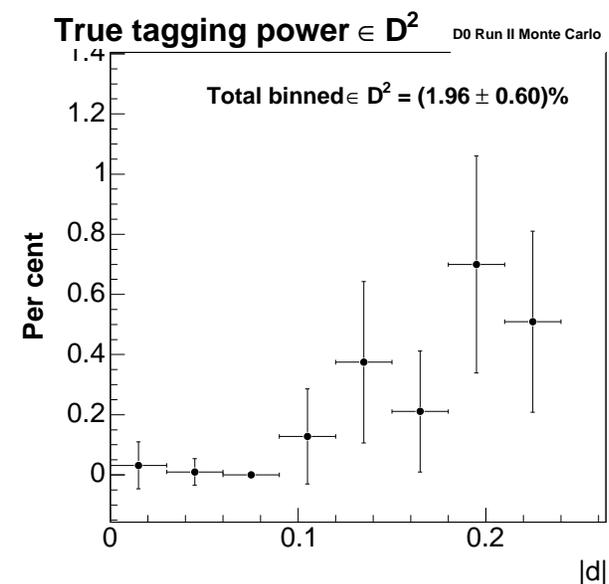
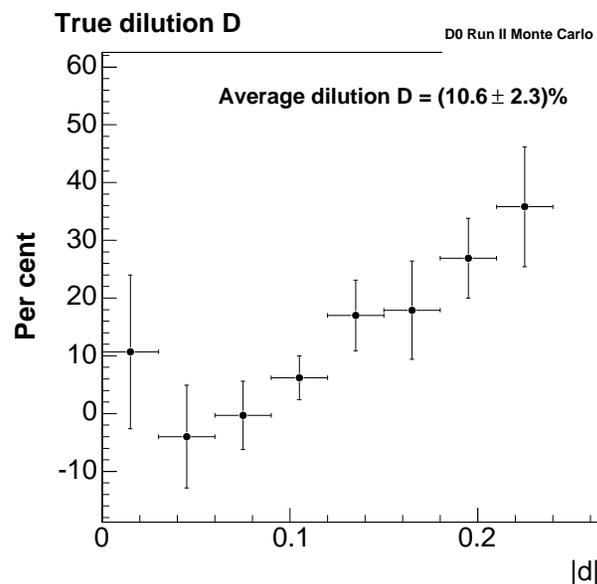
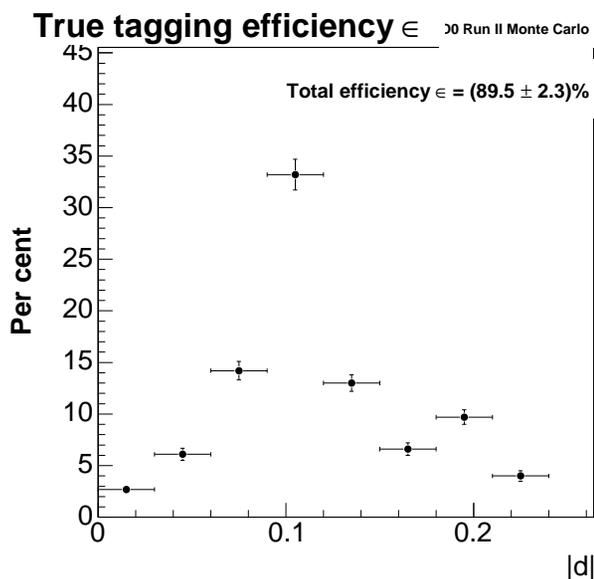
Comb. SST in $B_s \rightarrow \mu D_s X$ MC

- “Min. ΔR ” and “ $Q_{jet}(p_t, 0.6)$ ” are best taggers for $\mu\phi\pi$ decay mode (as well as for $J/\psi\phi$)
- Use class TagCombinedSame in BANA package
- **Combination improves results compared to individual taggers**
- The results depend on the level of trust to Monte Carlo:
 - If we do not match B_s decay products to the tracks, ϵD^2 is lower
 - If we do match them, ϵD^2 is factor of 2 – 3.5 higher

		Tagger	ϵ , %	D , %	Unbinned ϵD^2 , %	Binned ϵD^2 , %	Comment
Unbiased MC	No match to tracks	“Min. ΔR ”	74.6 ± 0.2	7.0 ± 0.2	0.36 ± 0.02	0.50 ± 0.03	Numbers reported previously
		“ $Q_{jet}(p_t, 0.6)$ ”	83.3 ± 0.2	5.5 ± 0.2	0.25 ± 0.02	0.35 ± 0.02	
		“Comb. SST”	83.3 ± 0.2	6.4 ± 0.2	0.34 ± 0.02	0.65 ± 0.03	
	Match to tracks	“Min. ΔR ”	80.0 ± 2.7	10.6 ± 2.5	0.90 ± 0.42	1.12 ± 0.46	Numbers to be used now
		“ $Q_{jet}(p_t, 0.6)$ ”	89.4 ± 2.9	9.4 ± 2.3	0.79 ± 0.39	1.67 ± 0.56	
		“Comb. SST”	89.4 ± 2.9	10.6 ± 2.3	1.00 ± 0.44	1.96 ± 0.60	



ϵ , D and ϵD^2 versus $|d|$



Combined SST



SST calibration curve

For reference we use standard $|d|$ bins:

$ d $	$D, \%$	ϵD^2
0.00 - 0.10	0.9 ± 4.0	0.00 ± 0.02
0.10 - 0.20	13.3 ± 3.1	0.90 ± 0.42
0.20 - 0.35	32.9 ± 7.7	0.79 ± 0.38
Total	–	1.69 ± 0.56



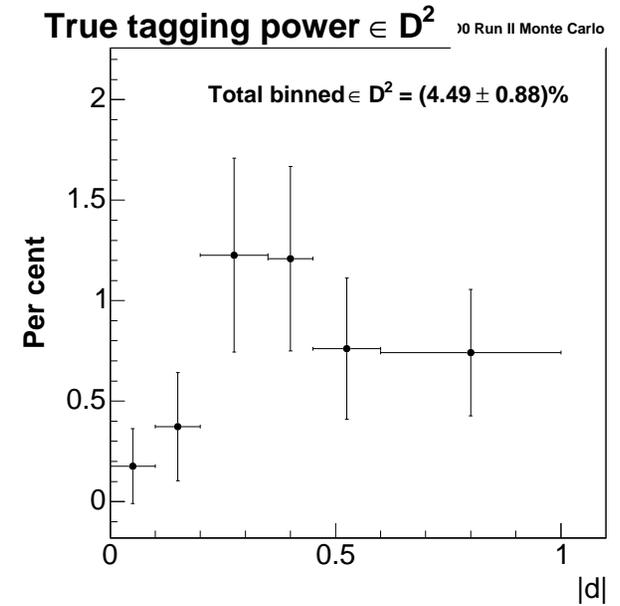
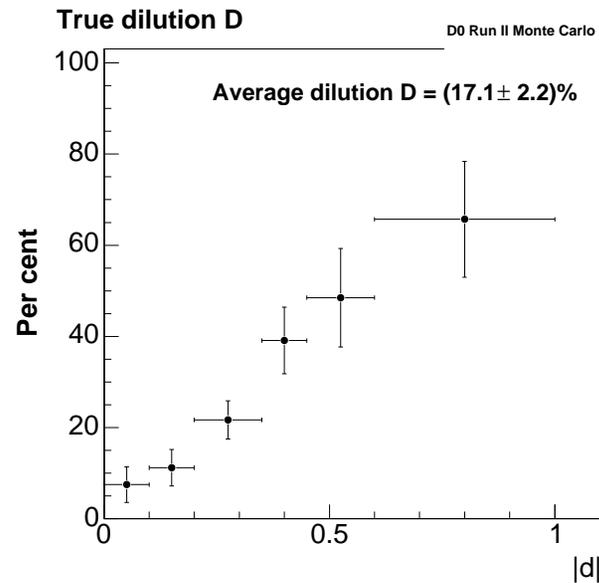
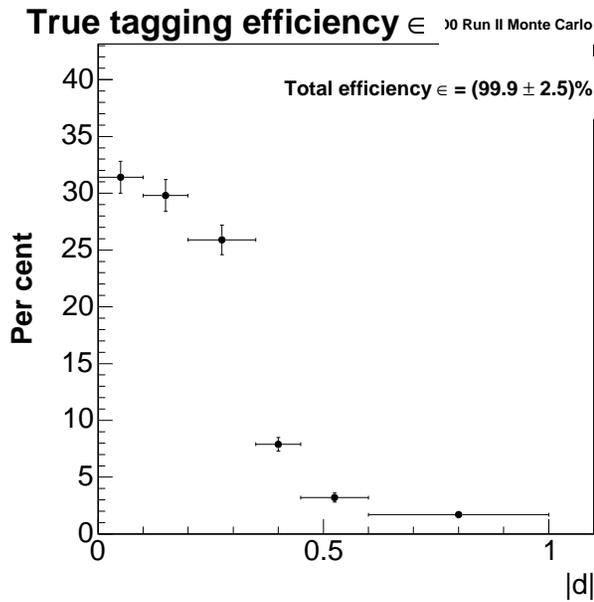
Further tagger combination in MC

- Combine SST, OST and EventCharge taggers
- Implemented in class TagCombinedAll
- OST is a standard combination of μ , e and SV charge
- EventCharge is average charge of all tracks outside cone $\cos \alpha > 0.8$
- If there is no OST, we take EventCharge
- Again, **combination improves results compared to individual taggers**

		Tagger	ϵ , %	D , %	Unbinned ϵD^2 , %	Binned ϵD^2 , %	Comment
Unbiased MC	No match to tracks	"Comb. SST"	83.3 ± 0.2	6.4 ± 0.2	0.34 ± 0.02	0.65 ± 0.03	Numbers reported previously
		"Comb. OST"	20.7 ± 0.1	40.0 ± 0.4	3.31 ± 0.07	3.67 ± 0.07	
		"SST + OST"	88.4 ± 0.2	15.2 ± 0.2	2.05 ± 0.05	4.08 ± 0.07	
		"Event Charge"	99.9 ± 0.7	12.5 ± 0.5	1.57 ± 0.13	2.07 ± 0.15	
		"All"	100.0 ± 0.7	17.9 ± 0.5	3.20 ± 0.18	4.99 ± 0.22	
	Match to tracks	"Comb. SST"	89.4 ± 2.9	10.6 ± 2.3	1.00 ± 0.44	1.96 ± 0.60	Numbers to be used now
		"Comb. OST"	6.4 ± 0.6	57.3 ± 7.2	2.11 ± 0.56	3.94 ± 2.05	
		"Event Charge"	100.0 ± 3.1	10.2 ± 2.2	1.04 ± 0.45	1.53 ± 0.54	
		"All"	100.0 ± 3.1	17.1 ± 2.2	2.93 ± 0.75	4.49 ± 0.88	



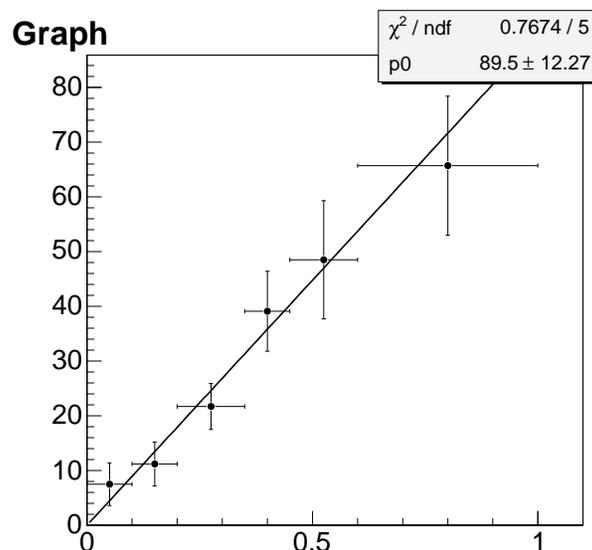
ϵ , D and ϵD^2 versus $|d|$



Combined SST + OST



SST + OST calibration curve



$ d $	$D, \%$	ϵD^2
0.00 - 0.10	7.5 ± 3.9	0.18 ± 0.19
0.10 - 0.20	11.2 ± 4.0	0.37 ± 0.27
0.20 - 0.35	21.7 ± 4.2	1.23 ± 0.48
0.35 - 0.45	39.1 ± 7.3	1.21 ± 0.46
0.45 - 0.60	48.5 ± 10.8	0.76 ± 0.35
0.60 - 1.00	65.7 ± 12.7	0.74 ± 0.31
Total	–	4.49 ± 0.88

Fitted with straight line $y = (89.50 \pm 12.27)x$



Conclusion

- SST works for $B_s \rightarrow \mu\phi\pi$ as well as for $B_s \rightarrow J/\psi\phi$
- Combination of two best SST taggers (“Min. ΔR ” and “ $Q_{jet}(p_t, \kappa = 0.6)$ ”) increases total ϵD^2 compared to individual taggers
- Combination SST + OST also increases total ϵD^2 compared to individual taggers
- Combination SST + OST has a reasonable value of ϵD^2 ($\sim 4.5\%$)
- Calibration curve for SST+OST is a straight line $y = (89.50 \pm 12.27)x$