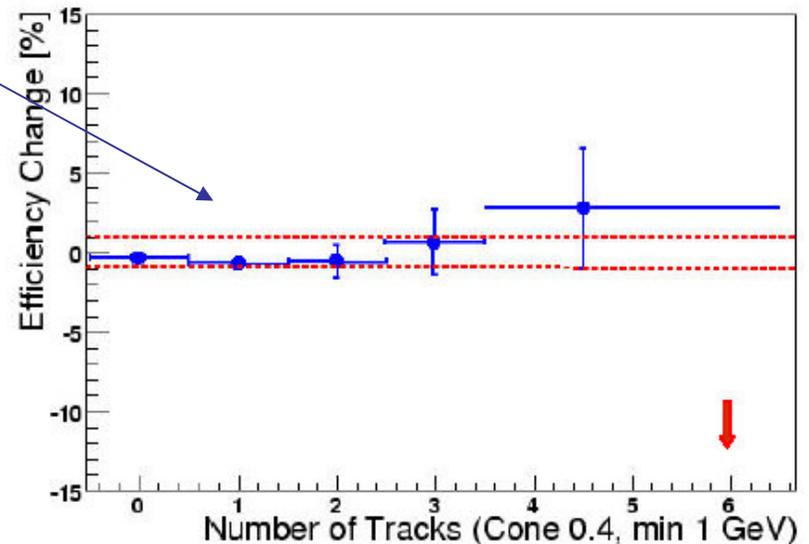

Cross-check of the SLT Efficiency Using High-pT btag MC Samples

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Thanks for Chris Neu for providing the MC samples and discussions

Motivation

- A Soft Muon Tagger (SLT) has been used in $t\bar{t}$ cross-section measurement (note 8482)
- The SLT efficiency has been measured using muons from JPsi/Z samples
 - Isolated muons
- However, in $t\bar{t}$ events
 - The muons are not isolated (track multiplicity ~ 6)
- Is the SLT efficiency independent of the track multiplicity around the muon?
 - Seems so, tested in $b\bar{m}c\bar{l}$ data samples, but limited by the statistic
took uncertainty: 0%, -5%
Is it reasonable?
 - **Cross-checked with the study in this talk (note 8738)**



Samples

- MC
 - Gen5: btop5a, btop6a
 - Electron sample: at least one electron with $p_T > 7$, $|\eta| < 1.3$, filtered at HEPG level
 - Muon sample: at least one muon with $p_T > 7$, $|\eta| < 0.8$, filtered at HEPG level
 - Gen6: btopoa(Herwig), btopla(PYTHIA)
 - Electron sample: at least one electron with $p_T > 8$, $|\eta| < 1.2$, filtered at HEPG level
 - Muon sample: at least one muon with $p_T > 9$, $|\eta| < 0.2$, filtered at HEPG level
- Data (8 Gev lepton triggered sample)
 - blpckd, kh
 - bmclkd, kh

Lepton Jet

- **Electron selection**

Electron Variable	Value
Fiducial and CEM	= 1
E_T	>9 GeV
P_T	>8 GeV/c
E/p	>0.5 & <2.0
E_{had}/E_{EM}	<0.055
L_{shr}	<0.2
$CES \Delta x $	<3.0 cm
$CES \Delta z $	<5 cm
χ^2_{Strip}	<10
Isolation	>0.1
$ Z_{vtx} - Z0 $	<5cm

- **Muon selection**

Muon Variable	Value
Region	CMUP
P_T	>8 GeV/c
$ \Delta x _{CMU}$	<10.0 cm
$ \Delta x _{CMP}$	<15.0 cm
$ Z_{vtx} - Z0 $	<5cm
Isolation	>0.1

- **Selected lepton is used to find the lepton jet**

- **$E_t > 15$, $dR < 0.4$**

- **Muon jet energy correction**

(l-jet ONLY, NOT on a-jet)

$$E_T^{mu-corr} = \frac{(E - 2)}{E} \times E_T + P_T^{mu}$$

- **Only electrons are selected for electron sample, same treatment for muon sample**
- **If find more than one lepton, take the one with the highest pT**

Away Jet and SLT Taggable Tracks

- **Away Jet Selection:**
 - $E_t > 15$, $|\eta| < 1.5$, $\Delta\phi(ljet, ajet) > 2$
 - If more than one away jet found, pick the one with largest $\Delta\phi$
- **SLT Taggable Tracks**
 - At least 3/2 Axial/Stereo super layers (> 5 hits/SL)
 - ΔZ_0 (slt_z, pvtx_z) < 5 cm
 - Impact parameter $d_0 < 0.2$ cm
- **SLT Taggable Tracks in an a-jet**
 - ΔR (slt, a-jet) < 0.6
 - If an taggable track is SLT tagged, the a-jet is SLT tagged

Cross Check the SLT Tagging Efficiency

- Select events with both l-jet and a-jet are tagged by SecVtx (b-tag)
 - This ensures the a-jet is almost pure b-jet (~ 94%) and
 - Makes the MC and data sample comparable in this analysis
- Compare

Predicted SLT and SVX tagged a-jet

- Get SLT efficiency to tag an SVX tagged a-jet from MC $\mathcal{E}_{SLT}^{SVX+} = \frac{N_{ajet}^{SVX+_{-}SLT}}{N_{ajet}^{SVX+}}$
(based on SLT Eff. measured in JPsi/Z samples, see next slide)
- Count the number of SVX tagged a-jets in data N_{SVX+}
- The predicted number of tags

$$N_{predicted}^{SVX_{-}SLT-jet} = \mathcal{E}_{SLT}^{SVX+} \times N_{SVX+}$$



Observed tags found in data sample

$$N_{observed}^{SVX_{-}SLT-jet}$$

SLT Efficiency in btag MC Samples

- Real efficiency

- real muons, toss random numbers based on SLT efficiency curve

- Fake efficiency

- SLT tags that are

$$\epsilon_{tag}^{SLT} = \epsilon_{real} + \epsilon_{fake} \times (1 - F_{HF})$$

not from real muons, toss randoms based on fake matrix (note 8436)

Electron sample

Sample	svxtag_ajet	$\epsilon_{real}(\%)$	$\epsilon_{fake}(\%)$	$\epsilon_{SLT}^{SVX+}(\%)$	systematic(%)
btop5a	375	3.20(.91)	0.80(.46)	3.83(.98)	-
btop6a	421	3.33(.87)	0.48(.34)	3.70(.91)	-
Gen5 sum	-	-	-	3.76(.67)	(.28)
btopla (PYTHIA)	5555	3.47(.25)	0.74(.11)	4.05(.26)	-
btopoa (HERWIG)	2043	2.89(.37)	1.17(.24)	3.81(.42)	-
Gen6 sum	-	-	-	3.93(.25)	(.29)

Muon sample

Sample	svxtag_ajet	$\epsilon_{real}(\%)$	$\epsilon_{fake}(\%)$	$\epsilon_{SLT}^{SVX+}(\%)$	systematic(%)
btop5a	920	4.02(.65)	0.76(.29)	4.62(.69)	-
btop6a	820	2.90(.58)	0.73(.30)	3.47(.63)	-
Gen5 sum	-	-	-	4.05(.47)	(.30)
btopla (PYTHIA)	11172	3.91(.18)	1.00(.09)	4.70(.20)	-
btopoa (HERWIG)	4125	3.64(.29)	1.09(.16)	4.49(.32)	-
Gen6 sum	-	-	-	4.60(.19)	(.34)

Predicted Tags vs Observed Tags

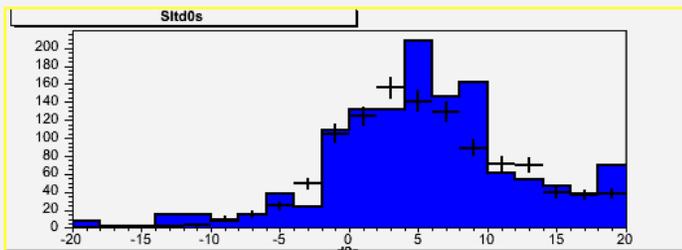
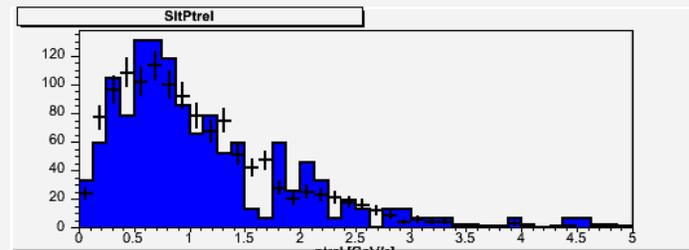
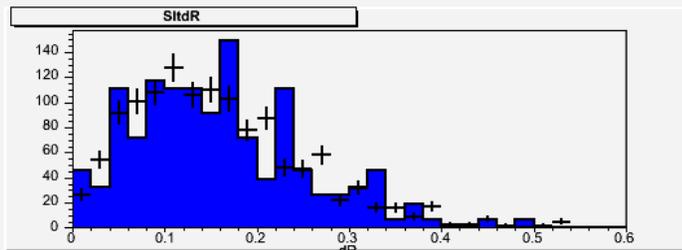
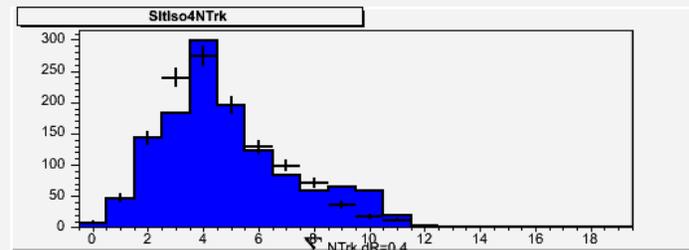
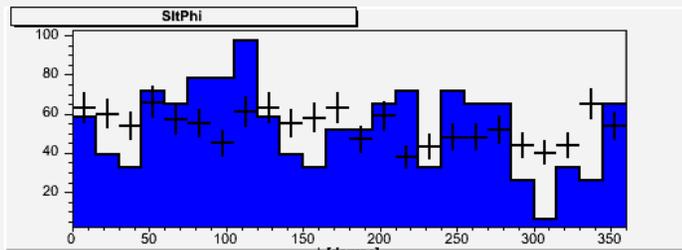
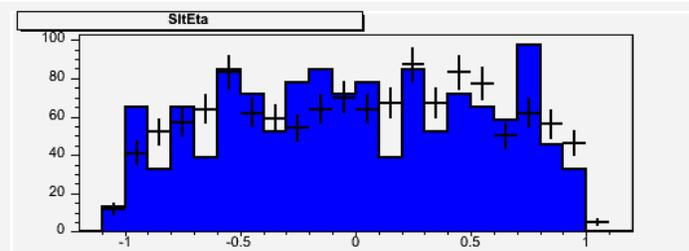
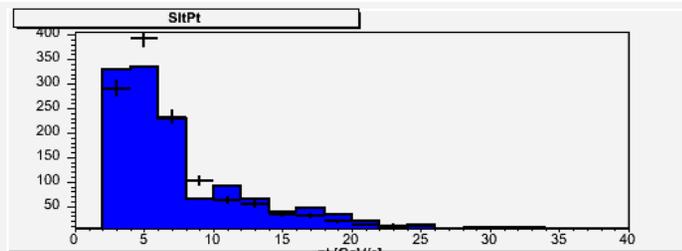
- Good agreement! The SLT tagging efficiency is independent of the track multiplicity around it.
- In the Gen6 samples, systematic uncertainties dominate

Gen5 samples		tags	Stat. Uncert.	syst. Uncert.
	electron sample			
	Gen5 MC predicted	213.8	38.1	15.9
	tags in data	226	-	-
	muon sample			
	Gen5 MC predicted	552.3	64.1	40.9
tags in data	575	-	-	
Gen6 samples		tags	Stat. Uncert.	syst. Uncert.
	electron sample			
	Gen6 MC predicted	441.2	28.1	32.6
	tags in data	474	-	-
	muon sample			
	Gen6 MC predicted	1272.5	52.6	94.1
tags in data	1258	-	-	

Systematic Uncertainties

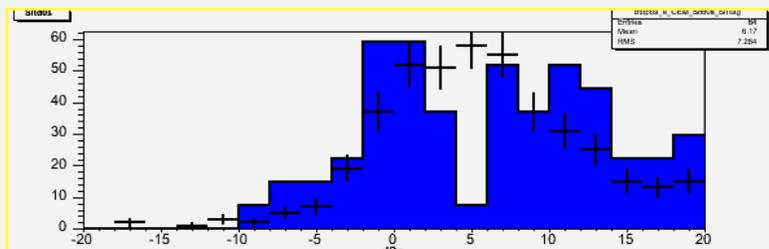
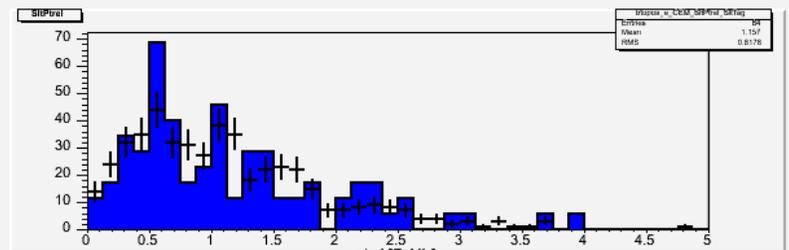
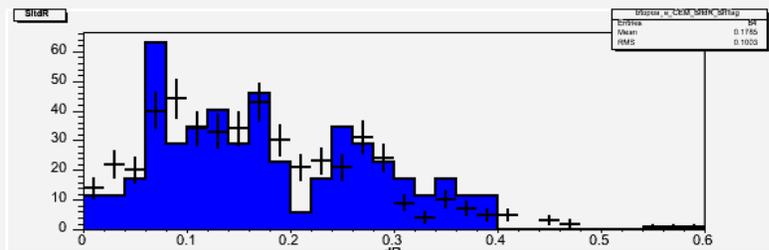
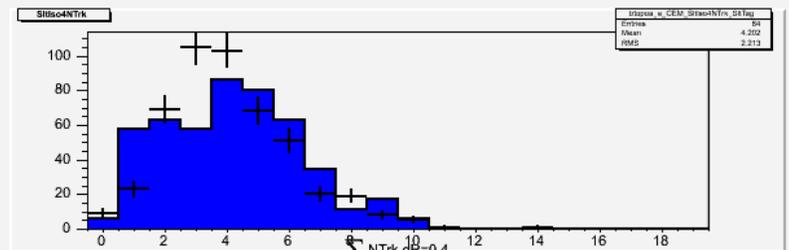
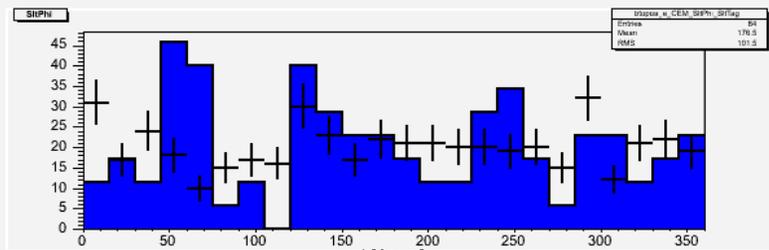
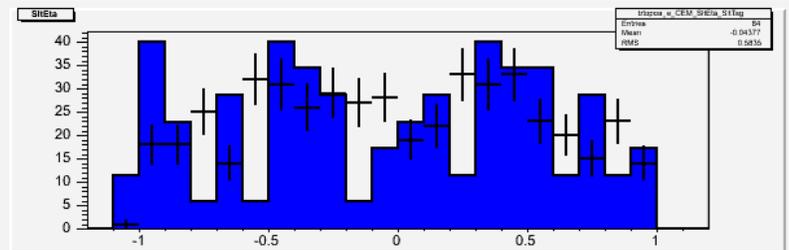
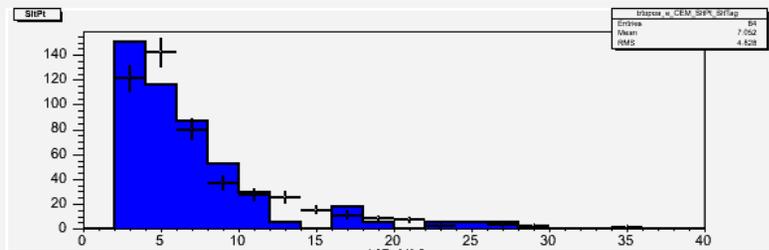
- **Includes**
 - 6% for the difference between Herwig and Pythia samples
 - 5% uncertainty for the isolation dependence
 - 5% scale factor of tracking efficiency in jet
 - 1% for the variation of $\pm 1\sigma$ of the SLT efficiency curve
- **For the fake rate**
 - 10% from the fake matrix
 - 1.8% from the Heavy Flavor fraction
 - 13% from the statistics in obtaining fake rate from the MC

Kinematic Variables Comparison



Muon sample

Kinematic Variables Comparison



Electron sample

Summary

- **Cross checked the SLT tagging efficiency using high pT btag MC samples and 8GeV lepton triggered data samples**
- **Good agreement found between the observed SLT-SVX tags of away jets and the predicted SLT-SVX tags based on**
 - **The SLT efficiency curve measured in JPsi/Z samples**
 - **Fake matrix measured in the photon data samples**
- **The study indicates that we may be able to reduce the systematic uncertainties**
- **It also validates our MC procedure for determining that tagging efficiency of ttbar events, within the uncertainties.**