



# A Loose SecVtx Algorithm in 4.11.2



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- Goal and Motivation
- A higher efficiency SecVtx algorithm (HE SecVtx)
  - Description of algorithm modifications
  - Scale factor (following talk)
  - Mistags (following talk)



# Goal and Motivations



- Multiple tag analysis benefit from higher efficiency b-tagging algorithms
  - Mistags are a smaller concern (as long as kept within a few percent)
  - Current default SecVtx algorithm has “low” efficiency
    - TDR promise: 65% ttbar efficiency (with run I SF= 0.87)
    - Currently: 52% ttbar efficiency
  - **Can we gain efficiency back?**
    - **20% increase in b-jet efficiency => 44% increase for double tagged events**
- Why 4.11.2?
  - Several MC available; can compare with current default SecVtx analysis;
  - Gain insights for 5.3.1 development
- HE SecVtx algorithm as closely as possible to the default algorithm
  - Try to increase sensitivity to b-quarks more than for charm
  - Use knowledge acquire for a few months while studying SecVtx



# Documentation



- Loose tagger studies
  - Talk by Sal, Aug. 15, 2003
- Updates to default 4.11.2 SecVtx
  - B-tagging talks by Sal, e.g. Jan 30, 2004
- Phi-dependence track corrections
  - CDF note 6885, Feb. 2004
  - CDF note 6824, Jan. 2004
- 5.3.1 optimization studies
  - Track Selection/Optimization Group
  - See recent talks from Stan Lai, Daniel Jeans and Oscar
- Scale Factor
  - CDF note 6786, Dec. 2003
  - CDF note 6912, Mar. 2003
- Mistags
  - CDF note 6533, Oct. 2003
  - Material effects in tag rates
    - CDF note 6906, Mar. 2004
  - Effect of track-d0 cut
    - B-Tagging talk by Sal, e.g. Jan 30, 2004



# SecVtx Algorithm (Run I)



## Track Selection

Associate tracks to jets w/in a cone of 0.4 of jet axis

Flag tracks surviving PASS 1 cuts as displaced

## PASS 1

Order displaced tracks by  $N_{\text{good}}$ ,  $P_T$  and  $S_{d0}$

Take Tracks from ordered list pairwise and try to form a seed vertex; one leg must have  $P_T > 2.0 \text{ GeV}/c$

Was a seed vertex found?

Yes

Loop thru rest of displaced tracks; attach to seed vertex if  $S_{\text{vtx}} < 3$

Was at least 1 track attached?

Vertex all the remaining tracks

Does any track contribute  $> 50$  to vertex  $\chi^2$ ?

Remove worst track

Yes

Is the track list exhausted?

No

No

No

## PASS 2

Take tracks with  $P_T > 1 \text{ GeV}$ , (at least one with  $P_T > 2 \text{ GeV}$ ) and  $S_{d0} > 3$

Are there at least 2 tracks?

No

Yes

Vertex all the remaining tracks

Remove worst track

Yes

Does any track contribute  $> 50$  to vertex  $\chi^2$ ?

No

## Final Vertex Cuts

We have a candidate vertex

Does it survive final vertex cuts?

Yes

Flag jet as TAGGED; flag tracks as used

No

Go to the next jet

No

Yes

Yes

Yes



# SecVtx Algorithm (Run II)



## Track Selection

Associate tracks to jets w/in a cone of 0.4 of jet axis

Flag tracks surviving PASS 1 cuts as displaced

## PASS 1

Order displaced tracks by  $N_{\text{good}}$ ,  $P_T$  and  $S_{d0}$

Take Tracks from ordered list pairwise and try to form a seed vertex; **one leg must have  $P_T > 1.5 \text{ GeV}/c$**

Was a seed vertex found?

Yes

Loop thru rest of displaced tracks; attach to seed vertex if  $S_{\text{vtx}} < 3$

No

Yes

Is the track list exhausted?

No

No

Was at least 1 track attached?

Yes

Vertex all the remaining tracks

## PASS 2

Take tracks with  $P_T > 1 \text{ GeV}$ , (at least one with  $P_T > 1.5 \text{ GeV}$ ) and  $S_{d0} > 3$

Are there at least 2 tracks?

Yes

Vertex all the remaining tracks

## Final Vertex Cuts

We have a candidate vertex

Does it survive final vertex cuts?

Yes

Flag jet as TAGGED; flag tracks as used

No

Go to the next jet



# SecVtx Algorithm in Run II



		Run I		Run II	
		Pass 1	Pass 2	Pass 1	Pass 2
Track  d0  (mm)	>		1.5		1.5
At least 1 Track $P_T$ (GeV)	>	2	2	1.5	1.5
Track prune chi2	<		50		1000
Vertex fit chi2	<		50		2000

- Places where the algorithm can be loosened
  - Track quality cuts
  - Track d0 significance cuts
- Looked at the two approaches



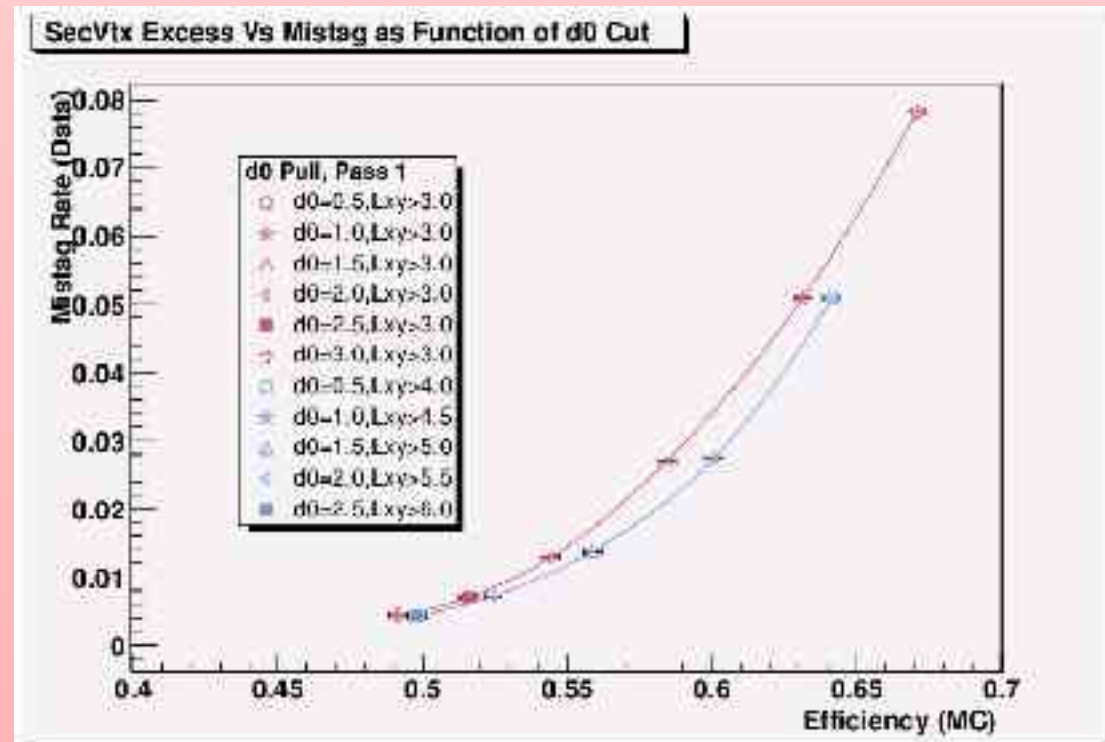
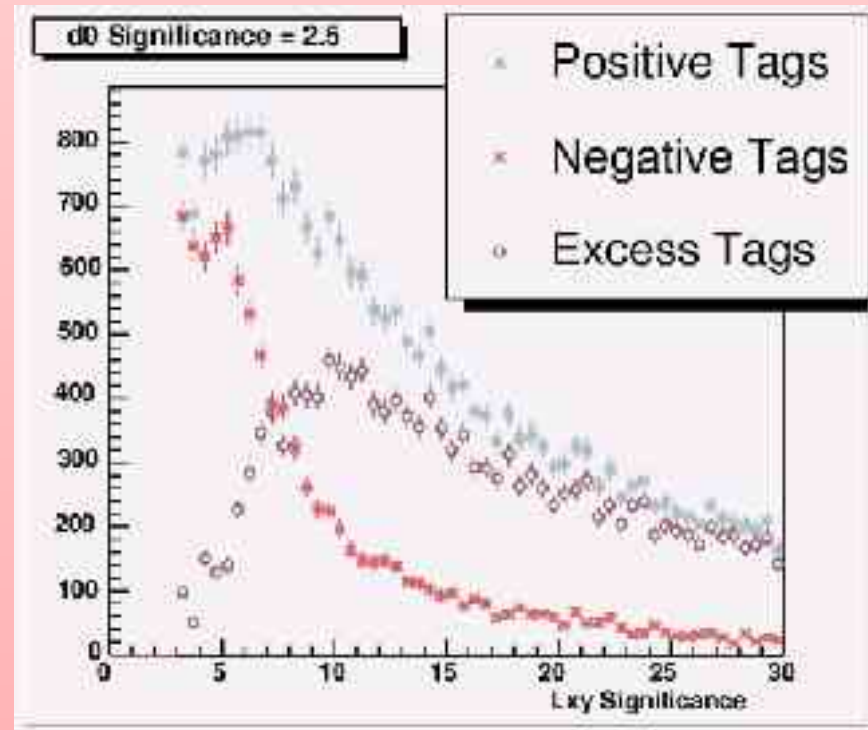
# Relax of track-d0 significance cut



- Study started in August 2003 (see talk at B-Tagging meeting)
- Default SecVtx: Track-d0 significance / Lxy significance not optimized

Jet 50 Data

ttbar event efficiency



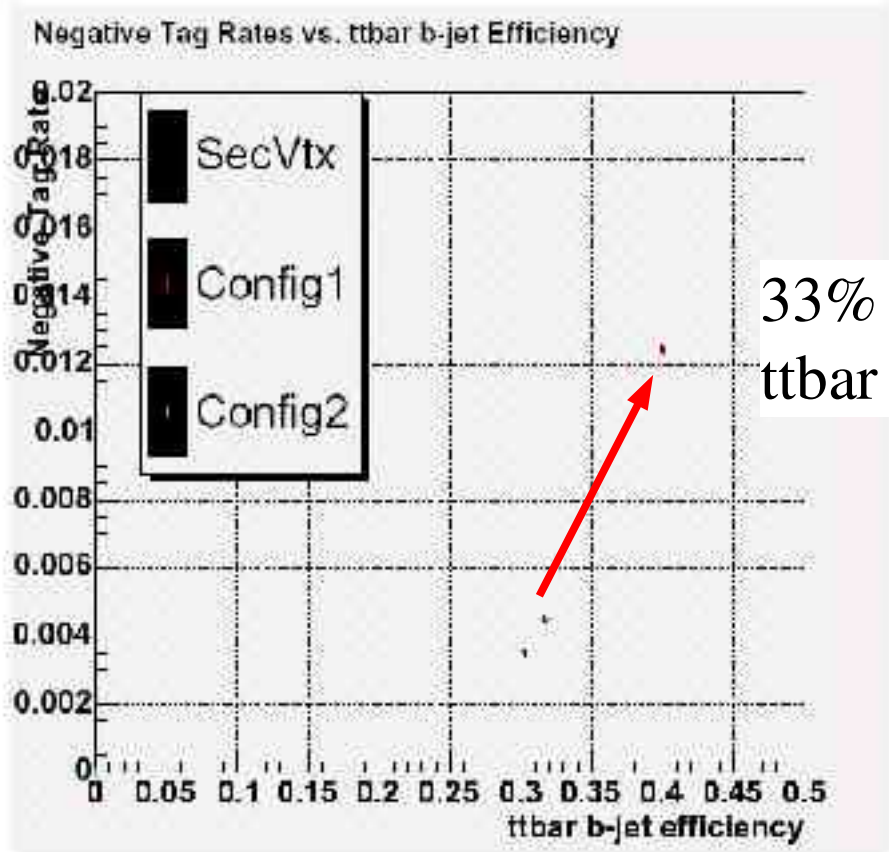
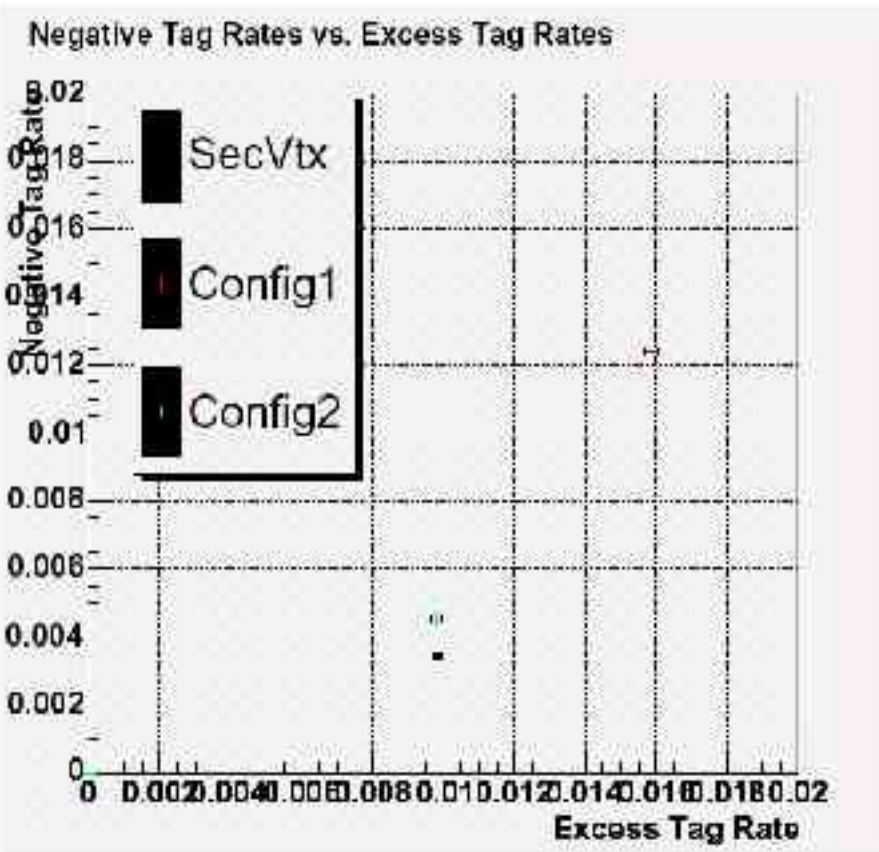
Considerable gains in efficiency (accompanied by gain in charm efficiency)



# Relax track quality cuts



- Started study for 5.3.1 SecVtx using defTracks
  - Then, require 3 Si axial hits on 3 different Si layers.
- Stan Lai: Mistags from Jet50, ttbar efficiency from 5.3.1pre2 MC
  - Fiducial jets



33% increase in ttbar efficiency

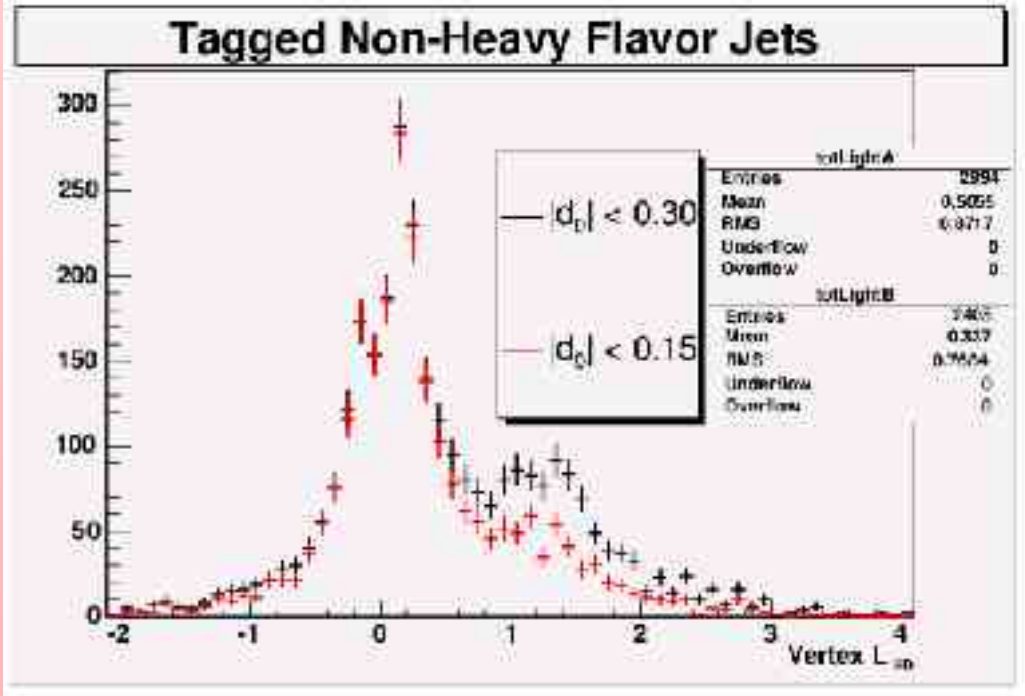




# SecVtx Positive Mistags (Tags in the material)



- Reduce positive mistags from long-lived particles and tags in the material
  - Change cut on track-d0 from 3.0 mm to 1.5 mm
  - Efficiency loss: about 3%
  - Positive mistag decrease: 34%





# Loose SecVtx Algorithm (Run II)



## Track Selection

Associate tracks to jets w/in a cone of 0.4 of jet axis

Flag tracks surviving PASS 1 cuts as displaced

## PASS 1

Order displaced tracks by  $N_{\text{good}}$ ,  $P_T$  and  $S_{d0}$

Take Tracks from ordered list pairwise and try to form a seed vertex; **one leg must have  $P_T > 1.5 \text{ GeV}/c$**

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Yes

Loop thru rest of displaced tracks; attach to seed vertex if  $S_{\text{vtx}} < 3$

Was at least 1 track attached?

Vertex all the remaining tracks

Yes

Is the track list exhausted?

No

## PASS 2

Take tracks with  $P_T > 1 \text{ GeV}$ , (at least one with  $P_T > 1.5 \text{ GeV}$ ) and  $S_{d0} > 3$

Are there at least 2 tracks?

Yes

Vertex all the remaining tracks

## Final Vertex Cuts

We have a candidate vertex

Does it survive final vertex cuts?

Yes

Flag jet as TAGGED; flag tracks as used

No

Pass 1 Vertex?

Yes

No

Go to the next jet



# HE SecVtx algorithm (for the record)



- Include improvements/bug fixes to be used in 5.3.1 tagger
  - Extrapolated track covariance matrix (reduce phi dependence)
- Simplified track quality selection
  - Use defTracks for OI, OIS and OIZ tracks
  - In addition require:
    - 3 SVX hits in 3 different SVX layers
    - Track  $\chi^2 < 20$
- Reduced track-d0 cut for all track from 1.5 mm to 3.0 mm
  - Reduce contribution from positive mistags (tags in material, Ks and Lambda)
  - Looser track selection can result in much larger contribution
- Attempt to use multiple Pass1 seeds if first fails
  - tryHarderPass1