

Tau Track Multiplicity Fitting

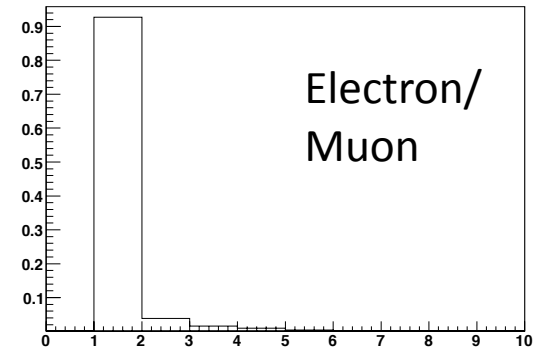
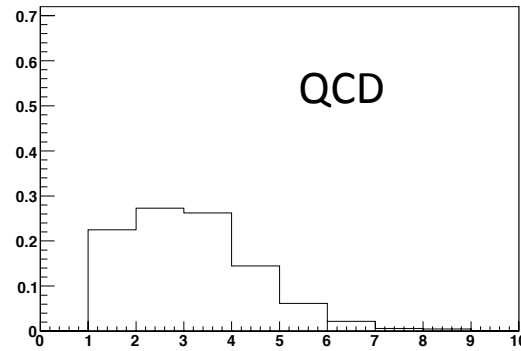
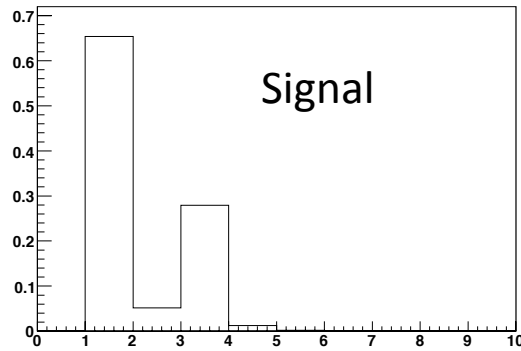
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Junichi Tanaka (Tokoyo)

16-04-09

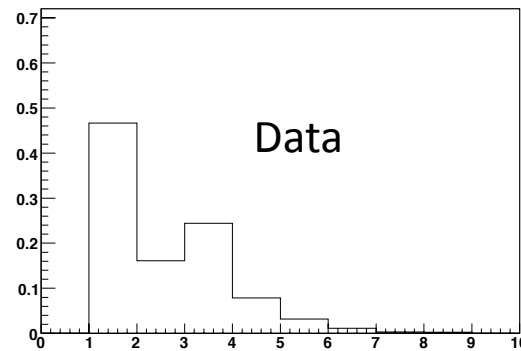


Introduction



- Find Isolated Lepton
- Find An Identified Tau

- Apply Track Fitting After All Cuts To Extract Cross Section



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Outline

- Track Selection Criteria
 - Cuts Used to Select Extra Tracks
 - Results
- Removal of Tracks from Underlying Event
 - Introduce Distance Parameter
- Track Fitting Procedure
 - Statistical Errors
 - Preliminary study of Systematics



• Conclusions

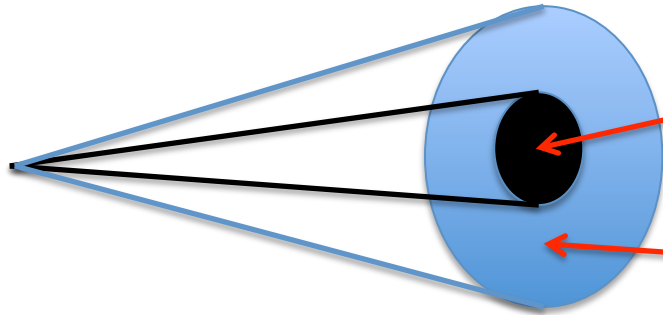
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Track Selection Criteria



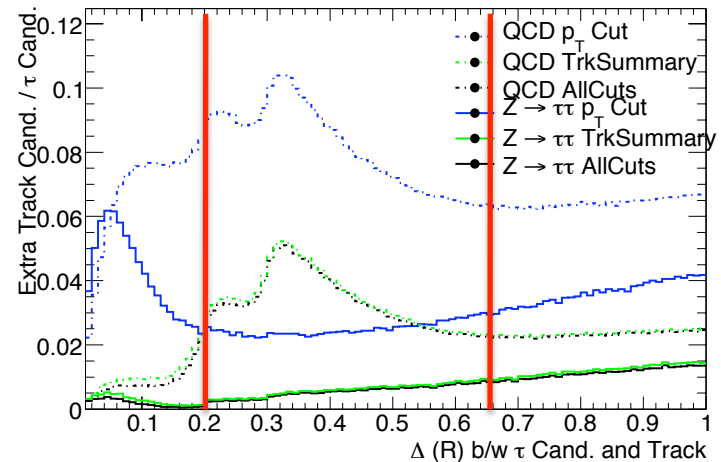
Default Tau(1p3p)

Track Searching
Cone ($\Delta R < 0.2$)

Extra Track

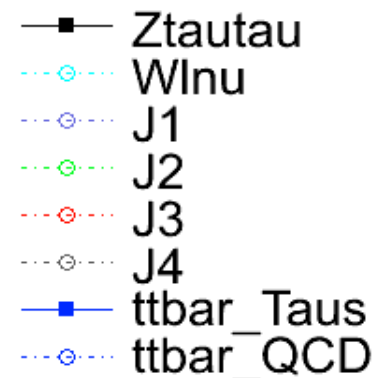
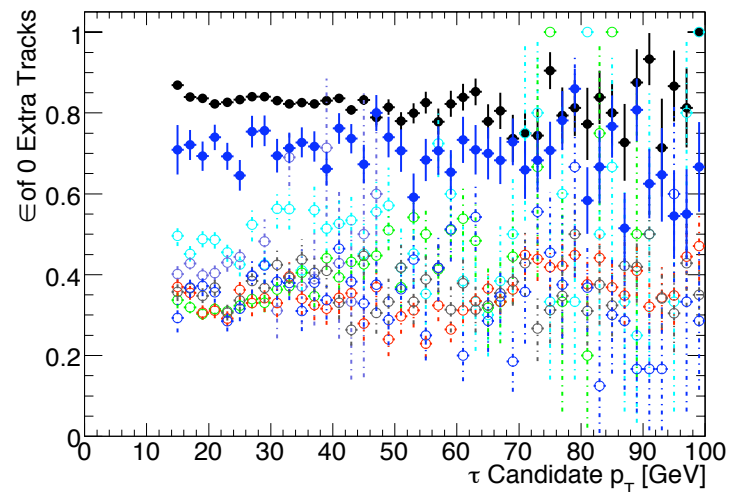
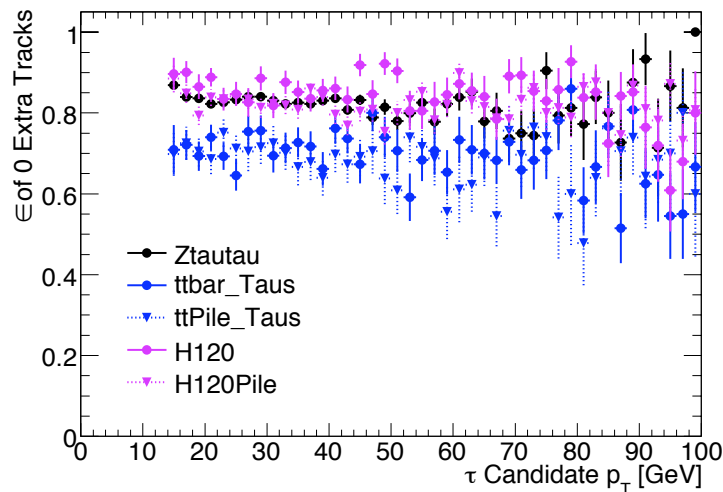
Searching Annulus
($0.2 < \Delta R < 0.65$)

- Track $p_T > 1.0$ GeV
- Track Summary Cuts
 - At least one BLayer Hits
 - At least 7 SCT Hits
- Fit Quality
 - $\chi^2/\text{numberDoF} < 3.5$
- Vertex Requirements
 - $|d0Cor| < \text{PrimaryVtx Resolution}$
 - $|z0| < 200$
 - $|\Delta z0|$ (Track and Primary Vertex) < 10



P_T Dependence of Adding Extra Tracks

- Define Efficiency for Retaining Default Tau Track Distribution:
 - Fraction of tau candidates with no extra tracks



Tau Candidates Passing TauCutSafeTight

$$P_T > 15 \text{ GeV}, |\eta| < 2.5$$

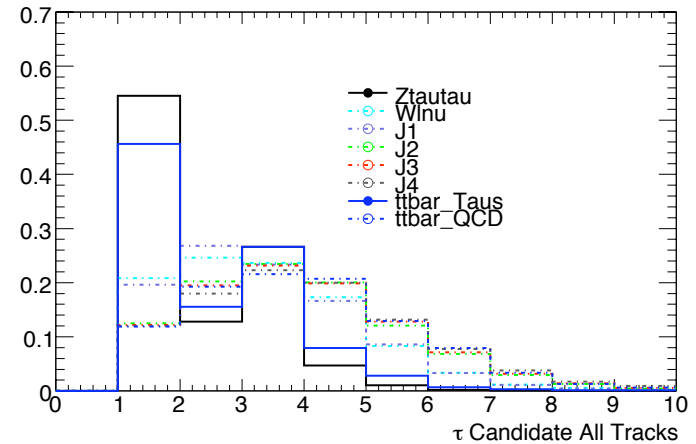
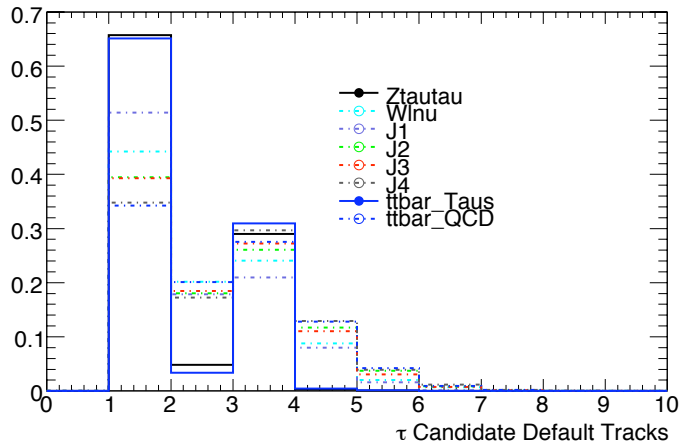
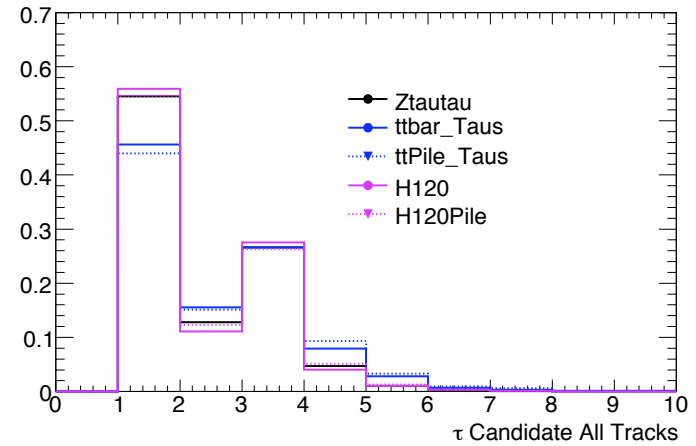
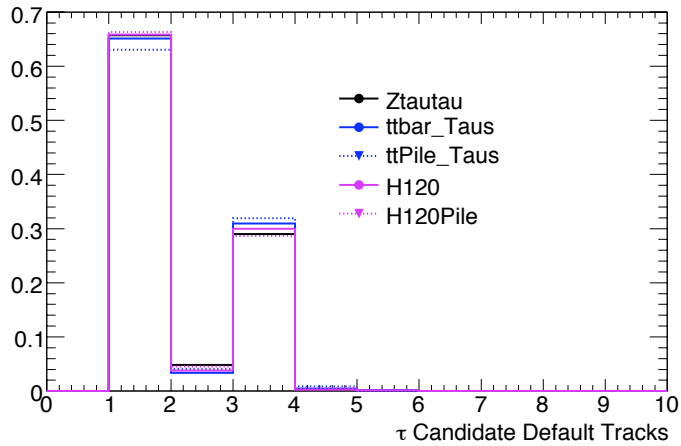
From Now On Will Be Considering Taus of This Type Unless Otherwise Stated



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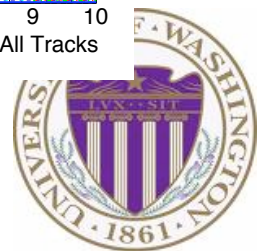


Recalculated TrackDistributions



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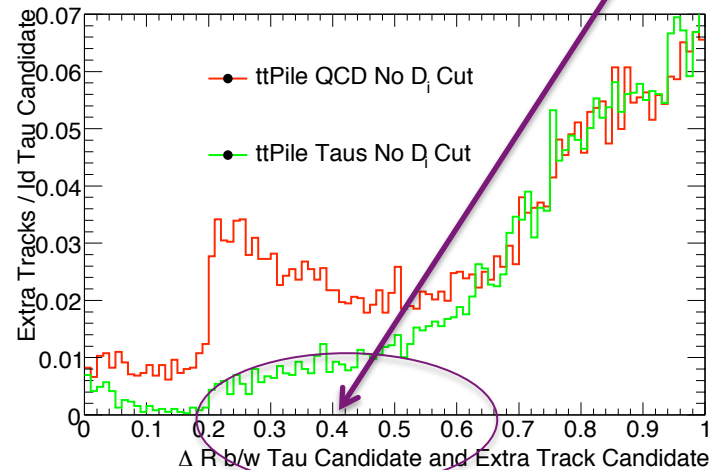
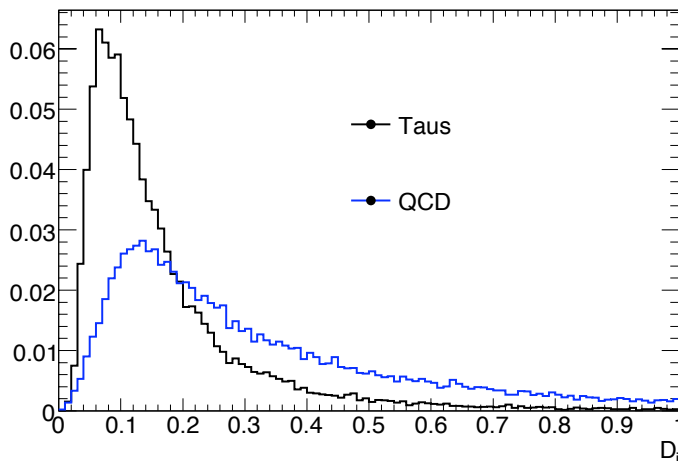
Cleaning Up The Signal Distributions

- We would like to Minimize number of Tracks from Underlying Event.
- Introduce D_i Parameter :

$$- D_i = \text{Min} \{ \text{track } p_T / (\tau_{\text{track}(i)} p_T(\Delta R)) \}$$

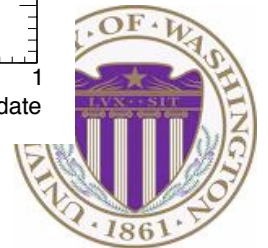
- ATL-COM-PHYS-2007-050 (S. Tsuno, J. Tanaka)

Want To Eliminate Underlying Event

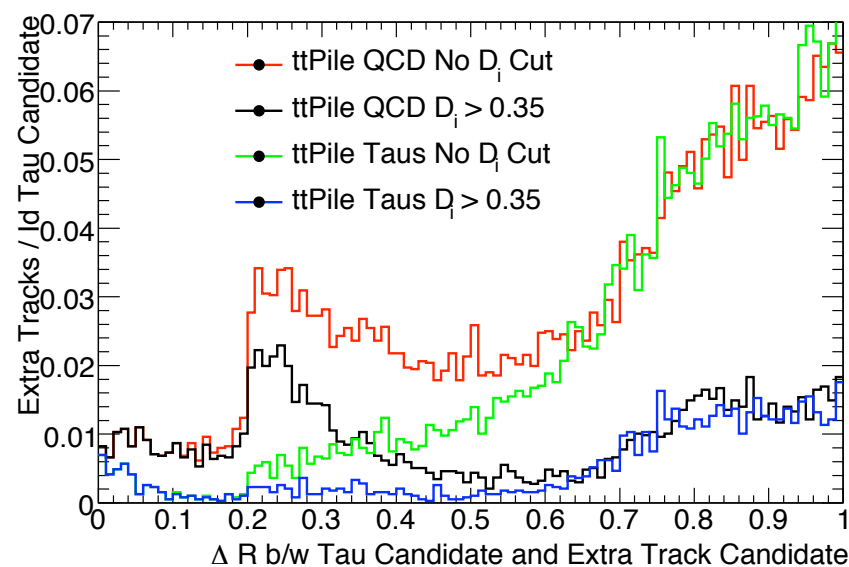
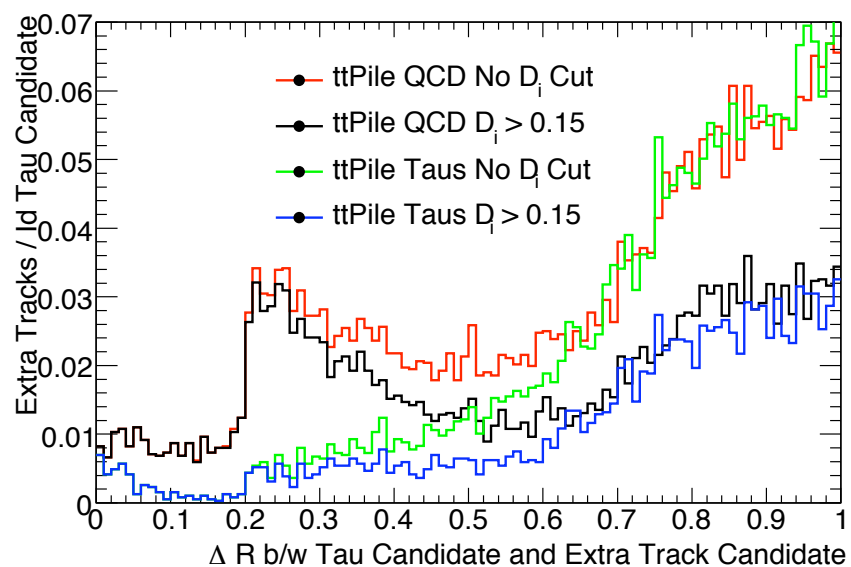


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Removing Tracks From Underlying Event



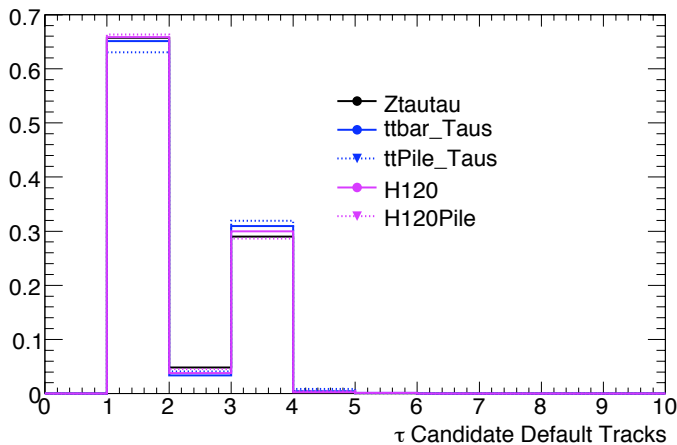
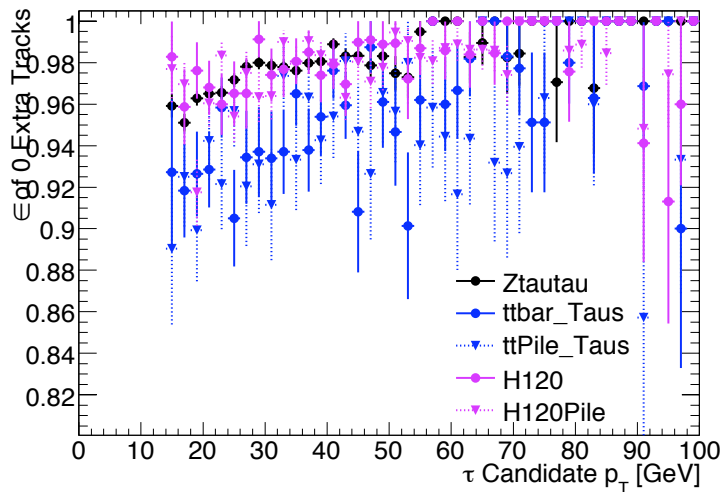
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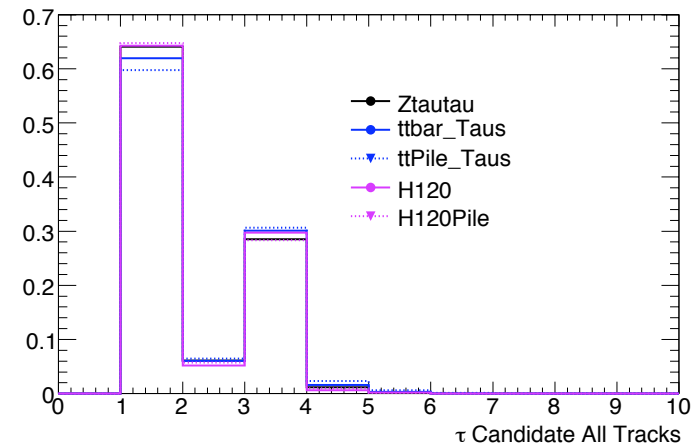
Recalculated Track Distributions

$$D_i > 0.35$$

- With A Strict D_i Cut We Can Maintain the Signal Shape



Extra
Tracks

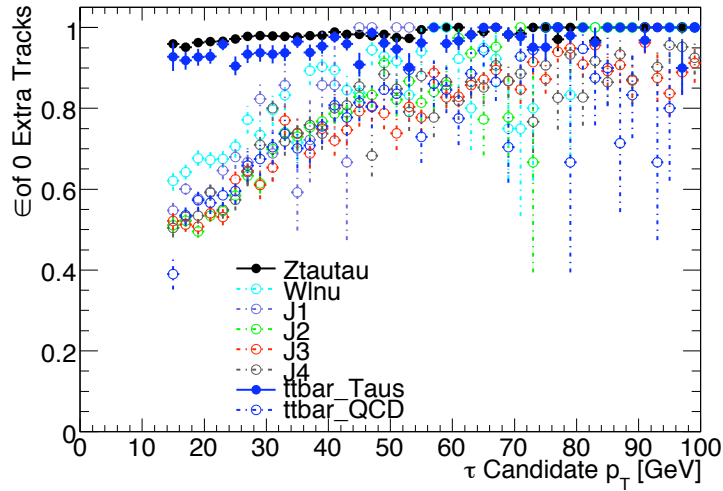


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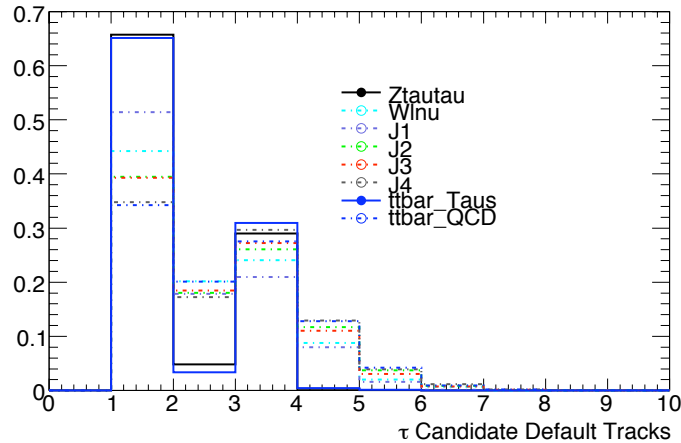
Recalculated TrackDistributions

$D_i > 0.35$

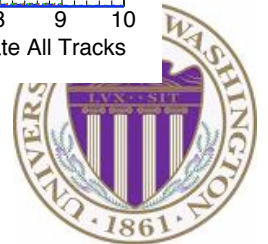
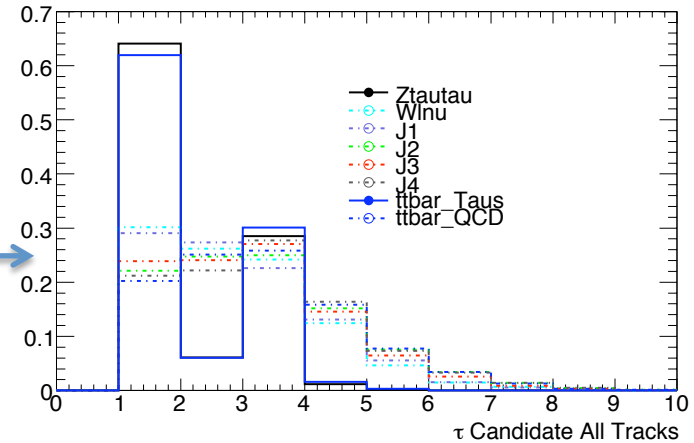


- We Still Have Separation between Signal and Background

- Introduced a p_T Dependence



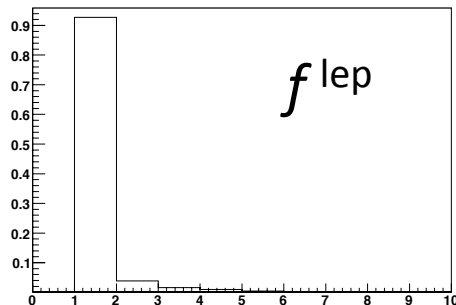
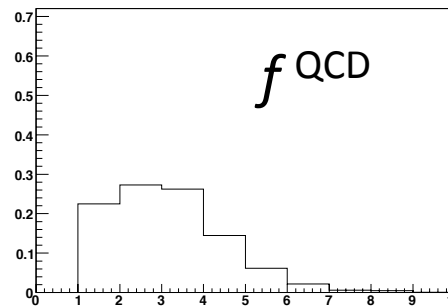
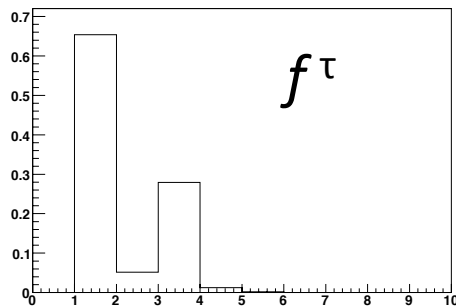
Extra Tracks
→



Track Fitting

- Fit the Track Distribution to the Following Likelihood Function:

$$L = \prod_i^N (Pois(n_{tot}^{exp} (r_{\tau} f_i^{\tau} + r_{lep} f_i^{lep} + (1 - r_{\tau} - r_{lep}) f_i^{QCD}), N_i^{Tot})) \\ \times Gaus(n_{tot}^{exp}, N_{obs}^{tot}) \\ \times Gaus(n_{tot}^{exp} r_{lep}, N_{lep}^{measured})$$



- Input Parameters Modeled From Data (except f^{τ})



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Determination of Statistical Errors

- Test Fitting Procedure with Toy Monte Carlo.
 - Construct Pseudo Data From Input Template Histograms with Flat Random Numbers
 - Construct Pseudo Data Varying S/B and Luminosity running 1000 experiments for each S/B and Luminosity Bin.
- Test Separation Power vs. D_i Cut.
- Test Separation Power vs $p_T > 15$ or 30 Gev



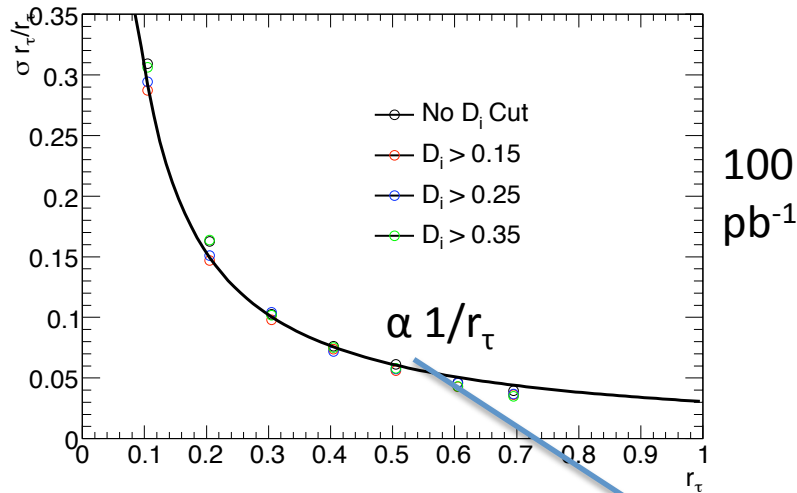
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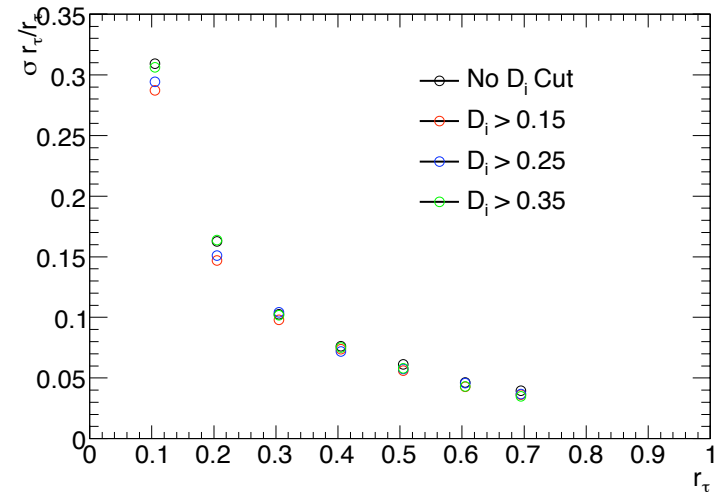


Results

$p_T > 15 \text{ GeV}$

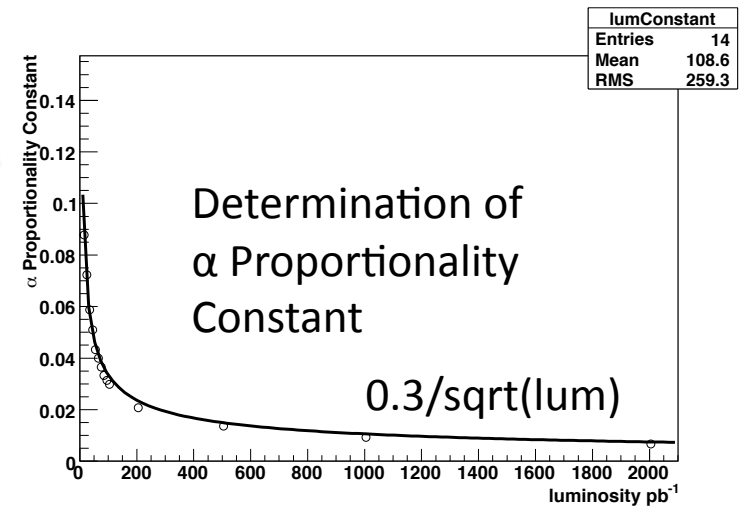


$p_T > 30 \text{ GeV}$



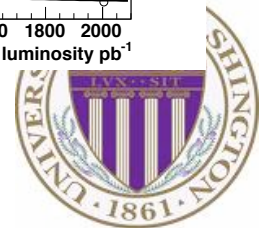
- $\sigma_r/r \sim 0.3 / r_\tau / \sqrt{\text{Lum}}$
 $p_T > 15 \text{ GeV}$
 (D_i Independent)

- $\sigma_r/r \sim 0.35 / r_\tau / \sqrt{\text{Lum}}$
 $p_T > 30 \text{ GeV}$
 (Slight D_i Dependence)



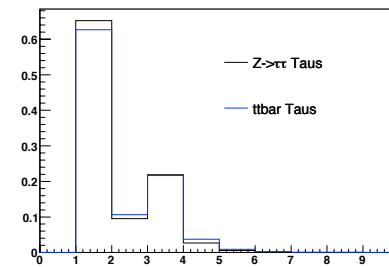
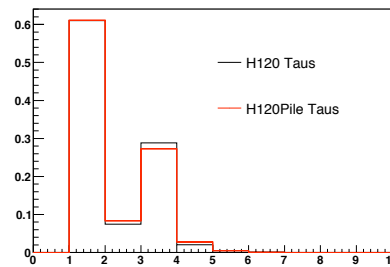
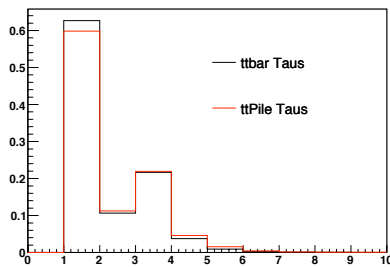
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Preliminary Determination of Systematic Errors

- Not accounting for possibility of Pileup in Template Signal Shape

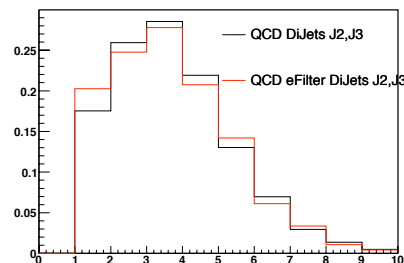


- Differences in Background Shape before and after Lepton Identification

$D_i > 0.15$ For All Plots



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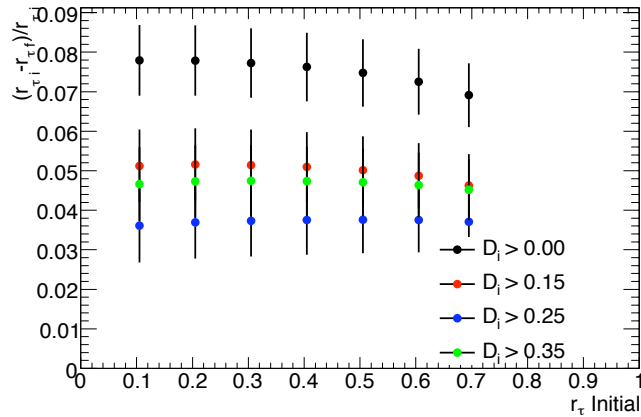


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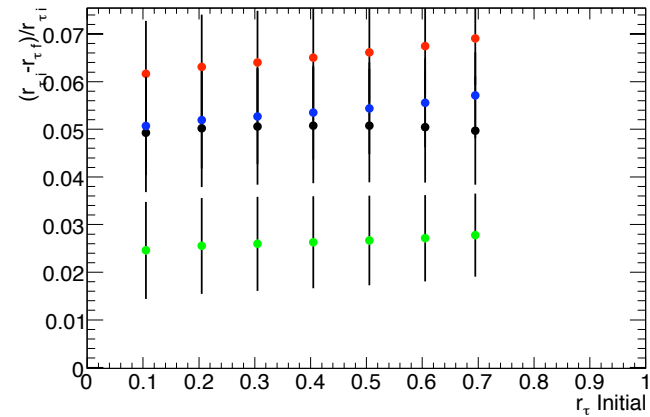


Produce "Contaminated Data"

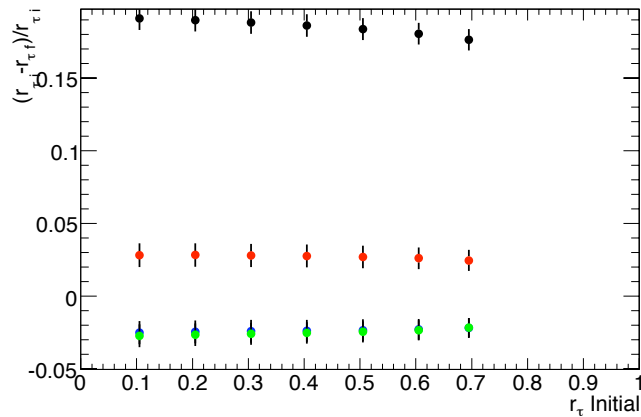
H120VBH Pileup



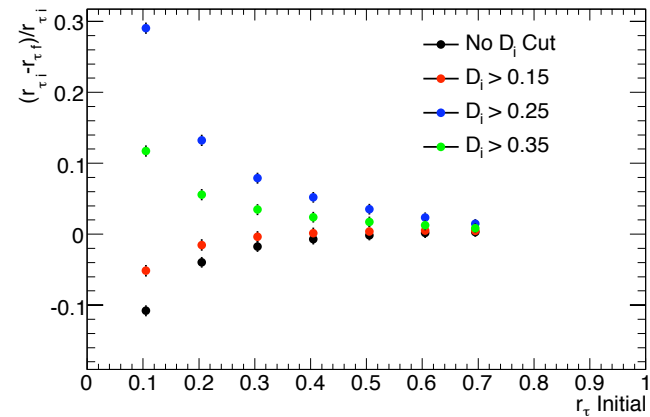
tbar Pileup



Z(taus) vs tbar(taus)



QCD vs QCD Filtered



Summary

- We can Separate Tau Track Distribution from QCD Background.
 - We can Preserve the Tau track distribution with tight D_i Cuts
 - We can model our Statistical Error as:
 $\sigma_r/r \sim 0.3 / r_\tau / \sqrt{\text{Lum}}$
 - We can Suppress Systematics with a Tight D_i Cut
 - We Still need to study systematics of the Evolution of the QCD shape as more cuts are applied.
- For Early Data ,200 pb⁻¹ , assuming approximately 50 % purity our error will be
 - 4% (Stat.) 4%(Sys. Tau Shape Uncertainty) 5%(Sys. QCD Shape Uncertainty)
- For Very Early Data, Statistical Errors will Dominate
 - 14 % (Statistical Error at 20 pb⁻¹)



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Backups



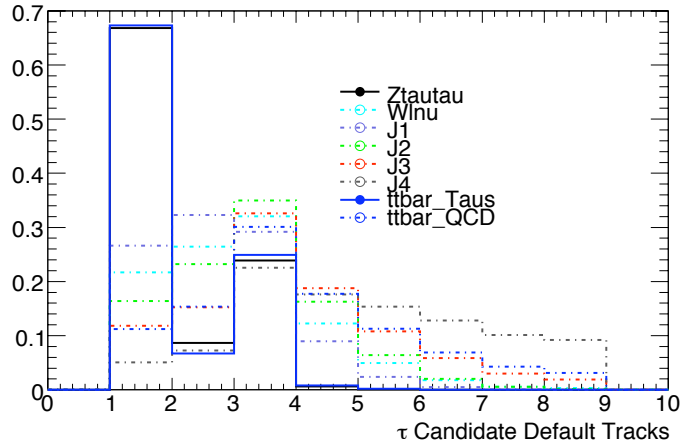
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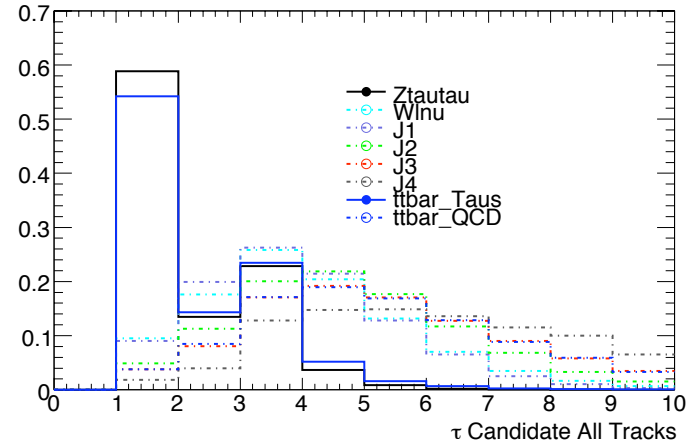


TauCutSafeLoose

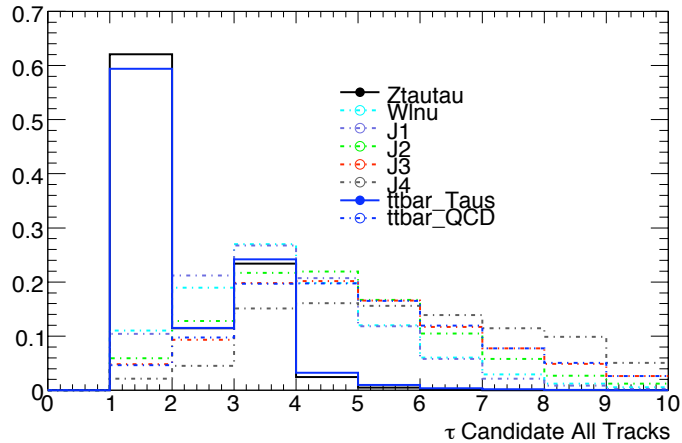
Default (No Extra Tracks)



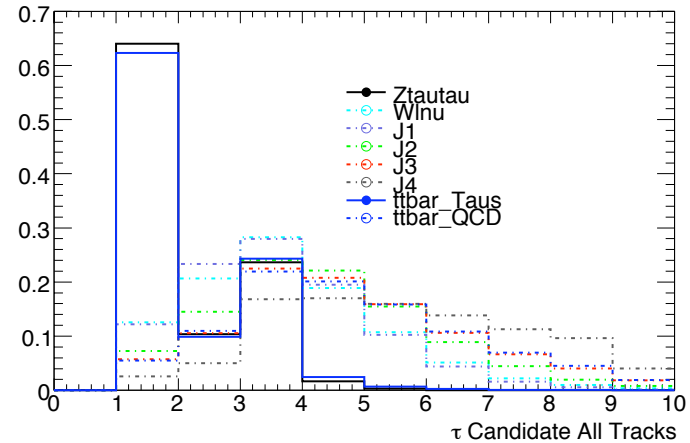
Extra Tracks $D_i > 0.15$



Extra Tracks $D_i > 0.25$



Extra Tracks $D_i > 0.35$



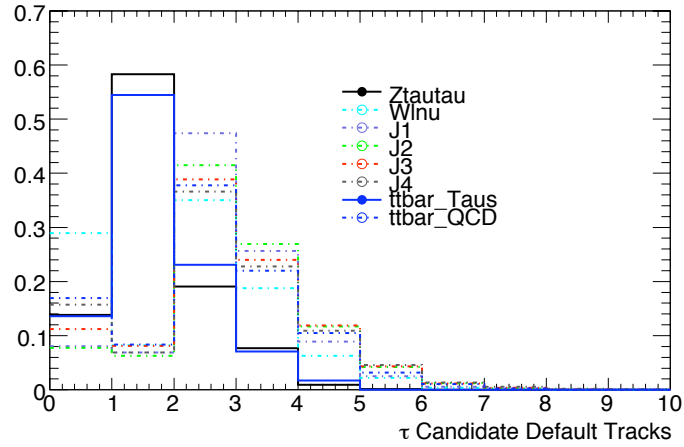
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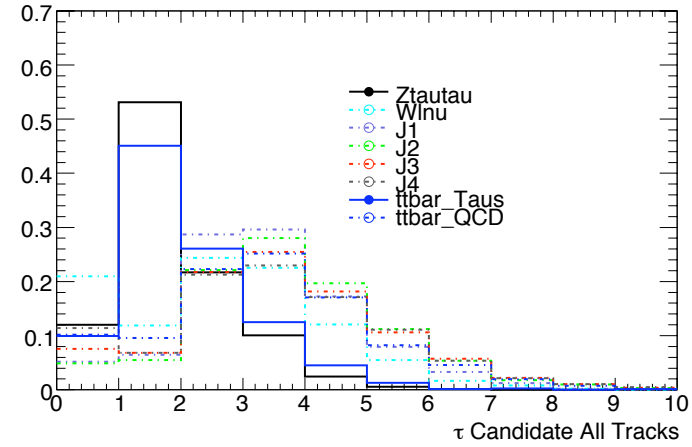


TauCutCaloSafeTight

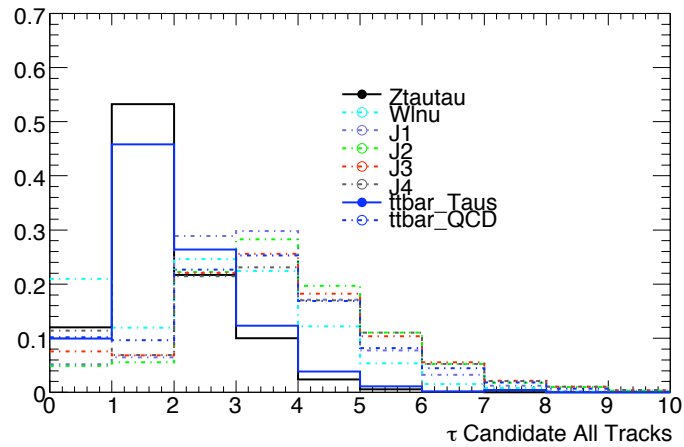
Default (No Extra Tracks)



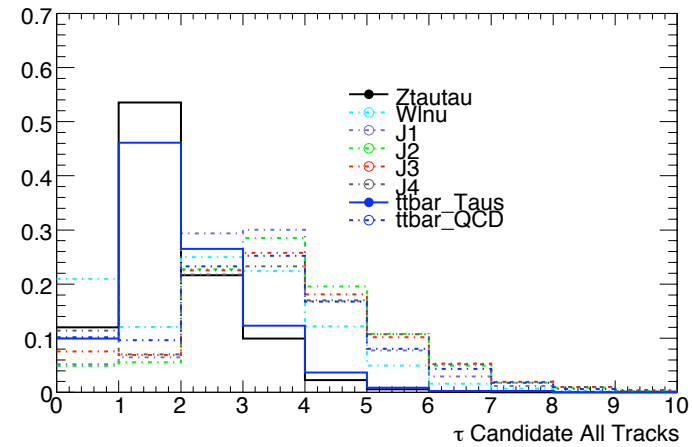
Extra Tracks $D_i > 0.15$



Extra Tracks $D_i > 0.25$

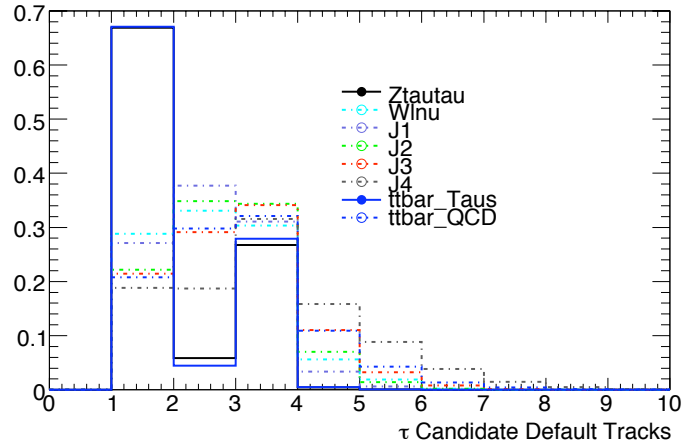


Extra Tracks $D_i > 0.35$

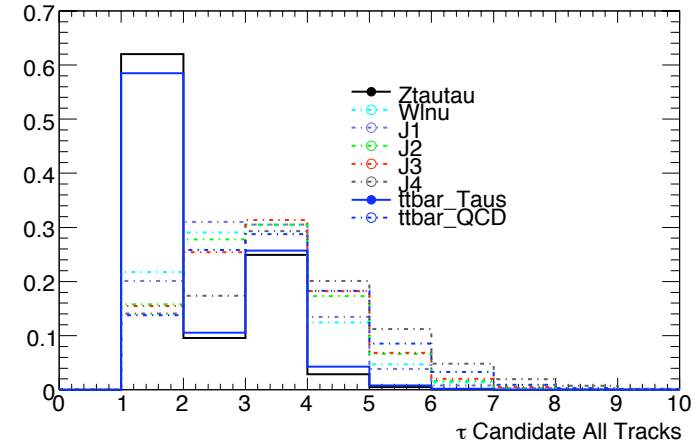


Likelihood > 4.0

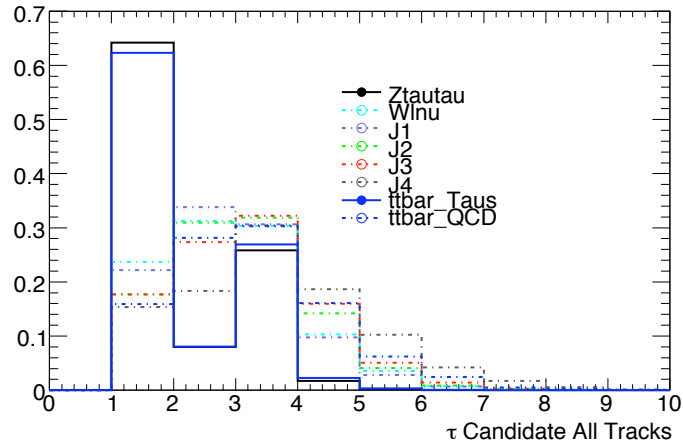
Default (No Extra Tracks)



Extra Tracks $D_i > 0.15$



Extra Tracks $D_i > 0.25$



Extra Tracks $D_i > 0.35$

