Trigger Studies for the W analysis

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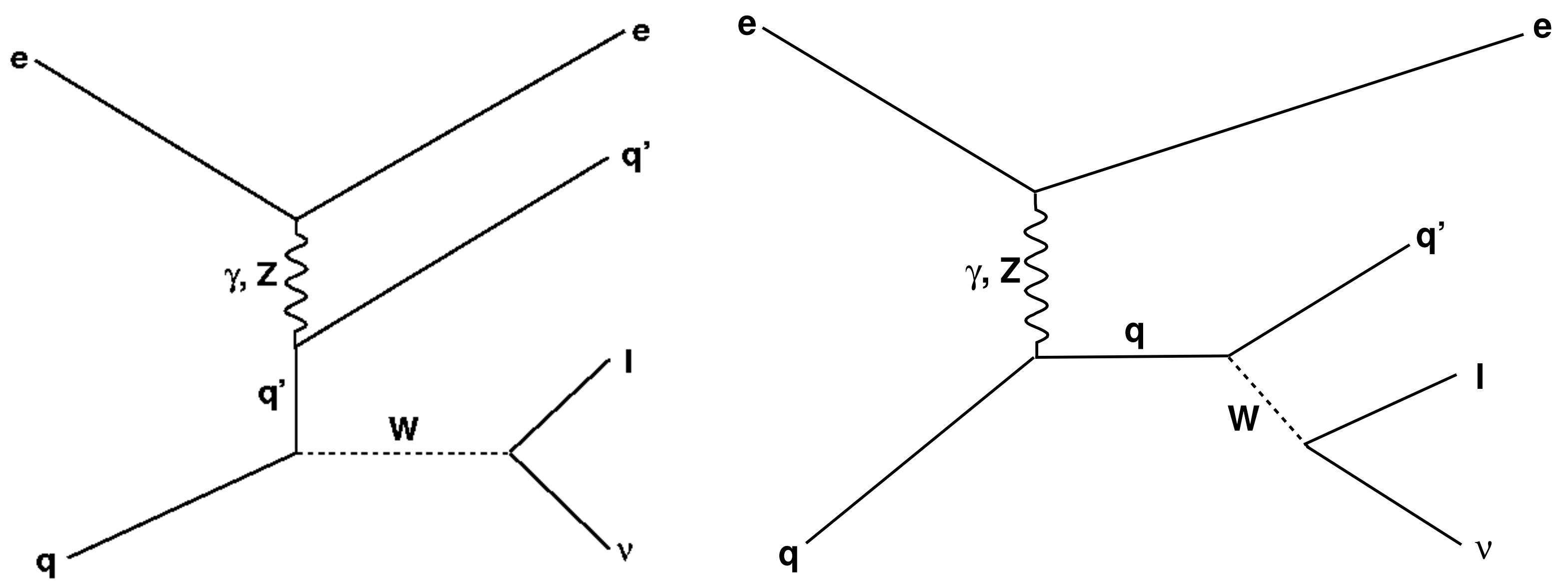
- **W Production at HERA**
- **A New Trigger, and Summary of Pre-Ringberg Talk**
- P_T^X **Investigations**
- **Resolution and Rate**
- **Forward Region**
- **Conclusions, Future Work and Proposal**

W Production at HERA

- Excess of High P_T Isolated Lepton events in 94-00 H1 data
- Most likely SM interpretation of events: *W Production*

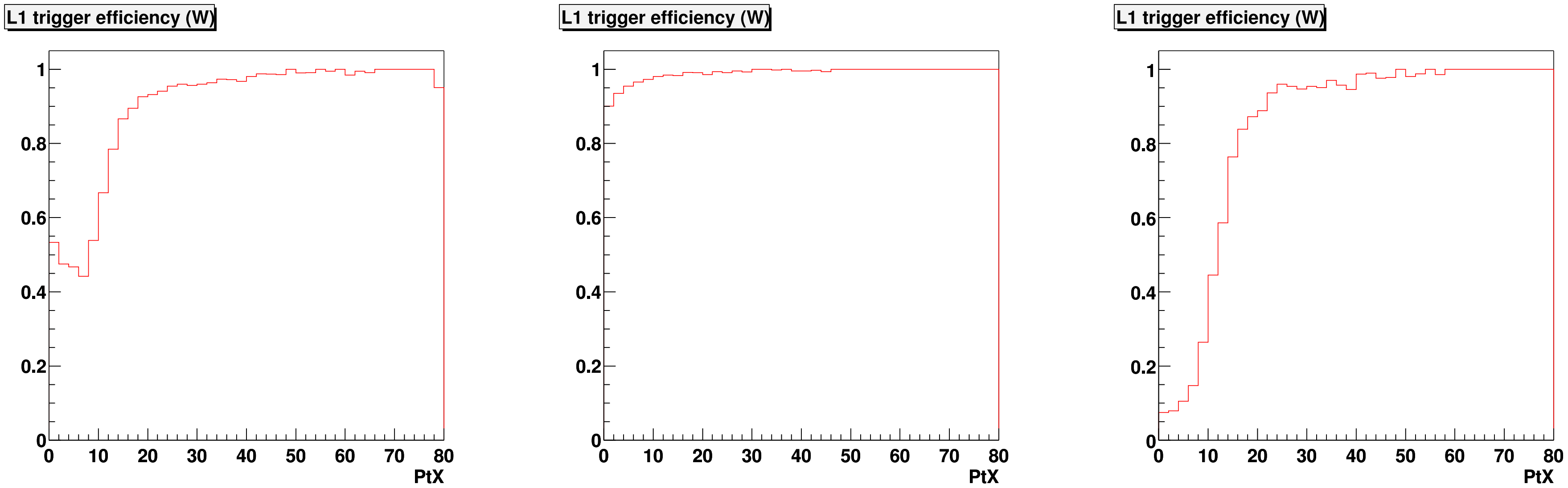


- Small Cross section: $\sigma_{tot} \sim 1.0pb$
- We would like efficient triggers in the W analysis $\longrightarrow$ *They are rare events!*

Initial Efficiency Studies

- Examine trigger efficiencies, ϵ, for L1 subtriggers currently used in analysis, ST66, ST67, ST75, ST77 using W Monte Carlo *EPVEC*

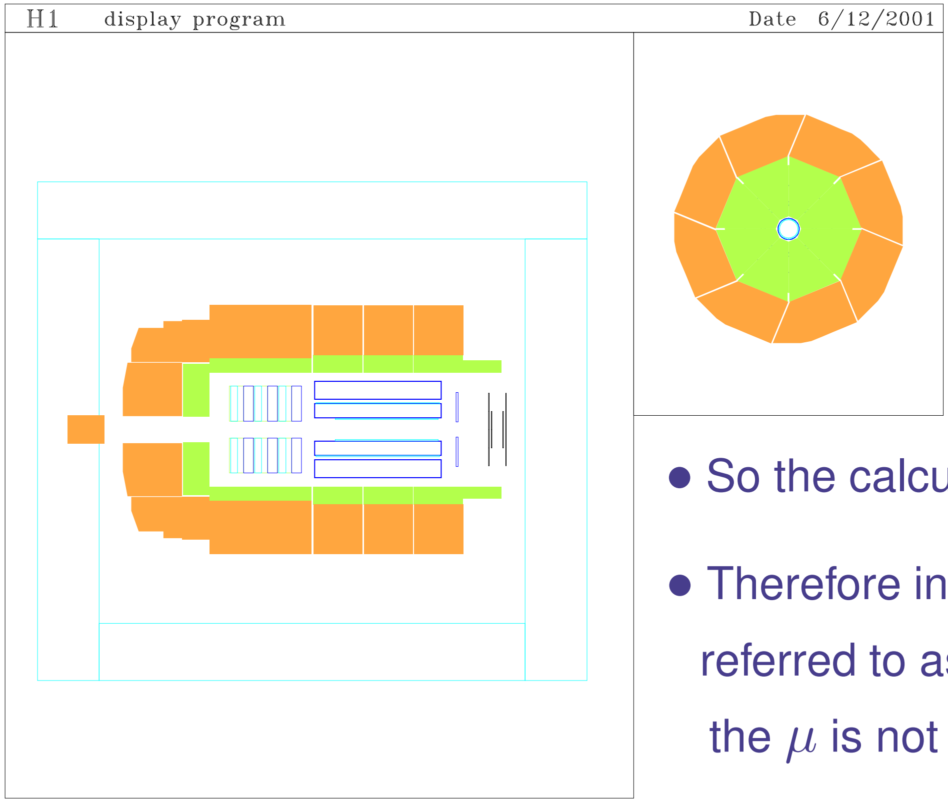
$$\epsilon = \frac{\text{sum of all weights of events firing at least one ST}}{\text{sum of all weights}}$$



No Cuts $\quad P_T^e > 10GeV \quad P_T^\mu > 10GeV$

- Poor efficiency at low P_T^X in the $W \rightarrow \mu\nu$ channel...

Brief Description of Problem with $W \rightarrow \mu\nu$ Events at Low P_T^X



- In such events, only X system deposits significant energy in the calorimeter
- Current triggers are based on missing P_T in the LAr, referred to as P_T^{Calo}
- So the calculation does NOT include track information
- Therefore in these events total missing P_T in the event, referred to as P_T^{miss} will be underestimated because the μ is not included in the sum
- Consequently, efficiency at low P_T^X is *severly depleted*
- A dedicated trigger, including track information in P_T^{miss} could be the solution $\rightarrow$ *FTT*

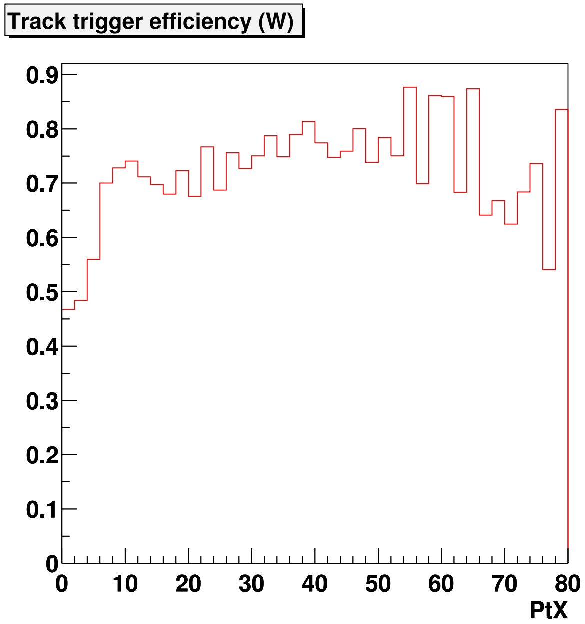
New Trigger, "Track"

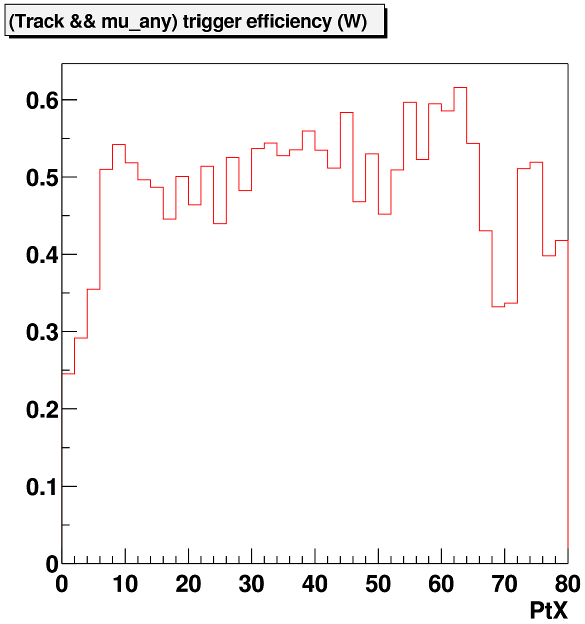
Developed using existing information on *HAT* / μ*ODS*

- Loop over all tracks in the event and perform the following cuts:

$$P_T^{track} > 8GeV \text{ and } 25^\circ < \theta_{track} < 155^\circ$$

- Can also combine *Track* with Mu_Any, an existing L1 trigger





- But this leads to a drop in efficiency from $\simeq 70\%$ to $\simeq 50\%$

Summary of Pre-Ringberg Talk

Finally, combine this new trigger with current triggers

to see any improvement

- Definite improvement with both combinations

- although better with no muon requirement

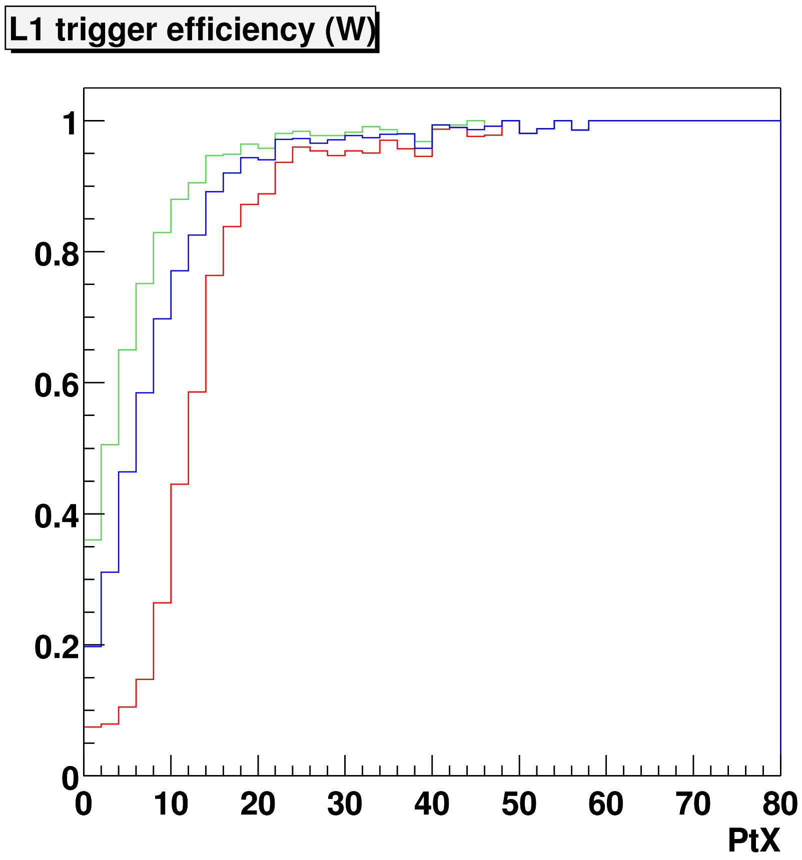
- Problem with efficiency of *Track* trigger

at low P_T^X - should be flat?

- L1 *FTT* resolution - how high can we go?

- At what *rate* would this trigger fire?

- Forward region - can this be involved?

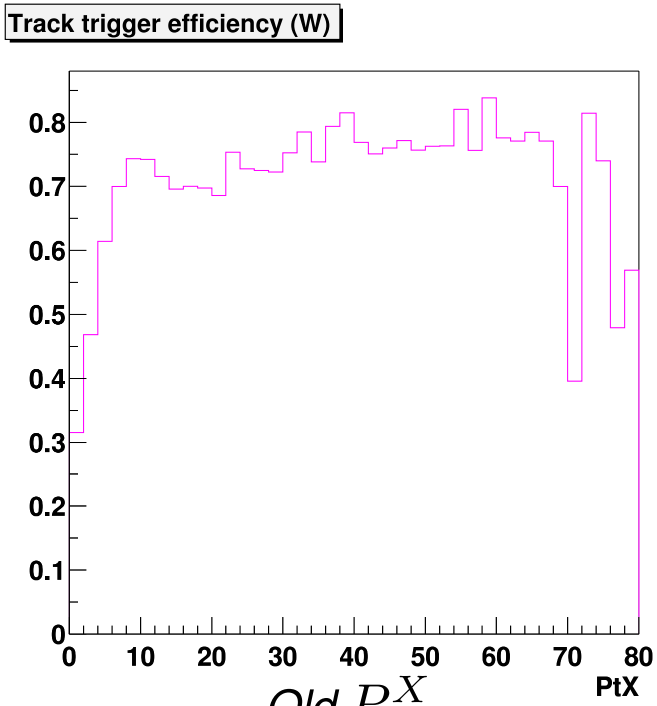


Existing L1 only : Red

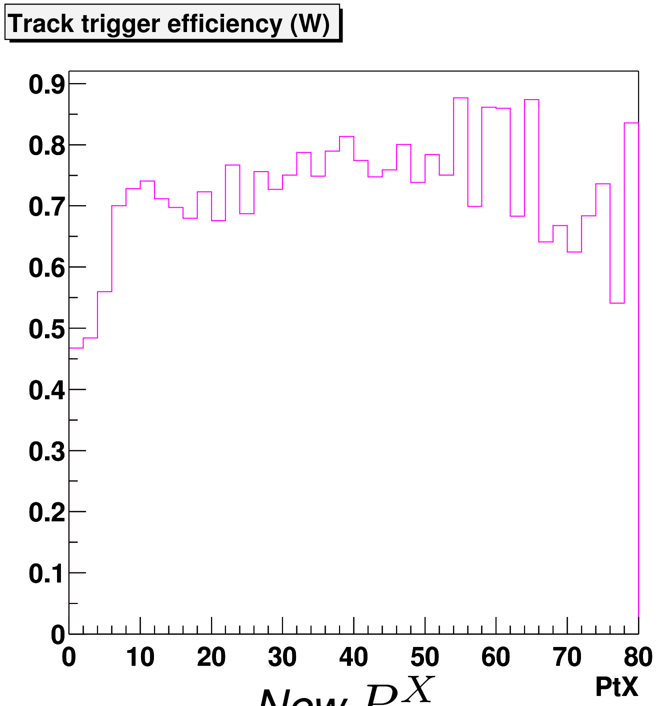
L1 || (Track && Mu_Any) : Blue

L1 || Track : Green

P_T^X Problem : Redefinition of Variable



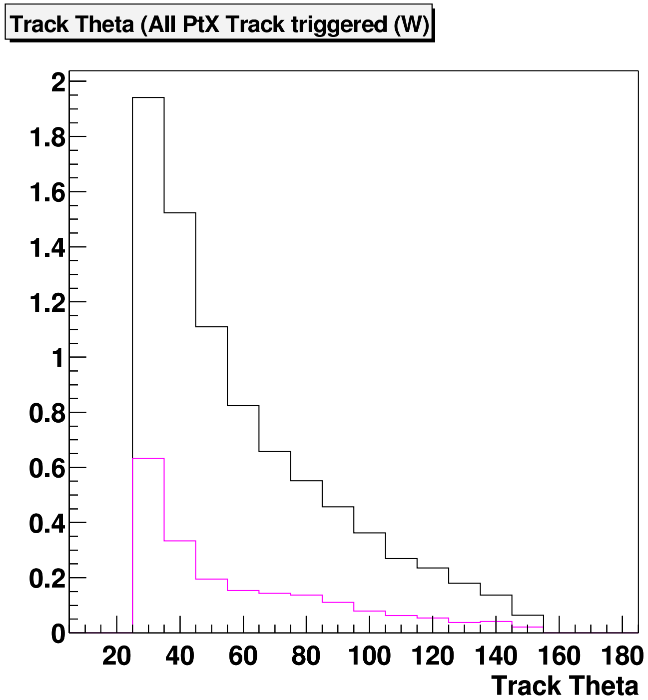
Old P_T^X



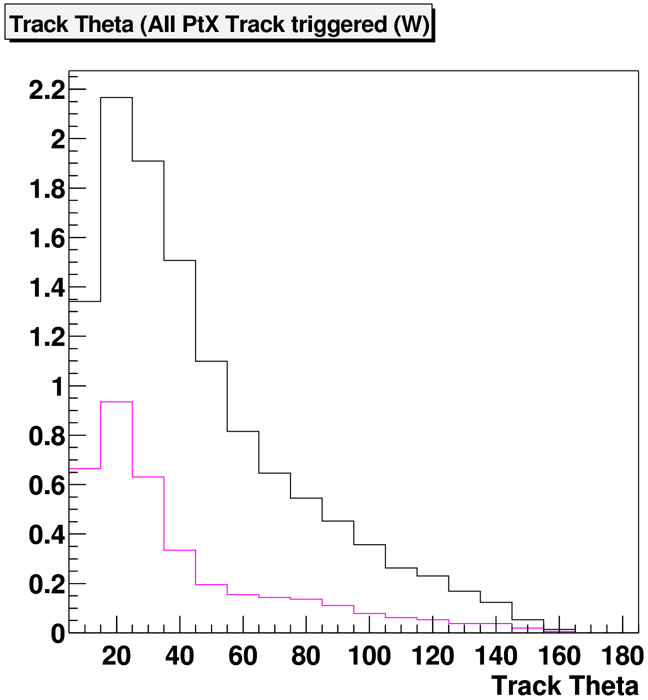
New P_T^X

- New version removes *isolated* muon calorimetry deposits
- Improves efficiency of trigger at low values of P_T^X
- At low P_T^X was isolated μ the main contribution to the sum, ie P_T^X was overestimated?
- Not fully understood... needs further investigation - also μ's in jets not masked?

Track Theta Distributions at Low P_T^X



$25^o < \theta_{track} < 155^o$



All θ_{track}

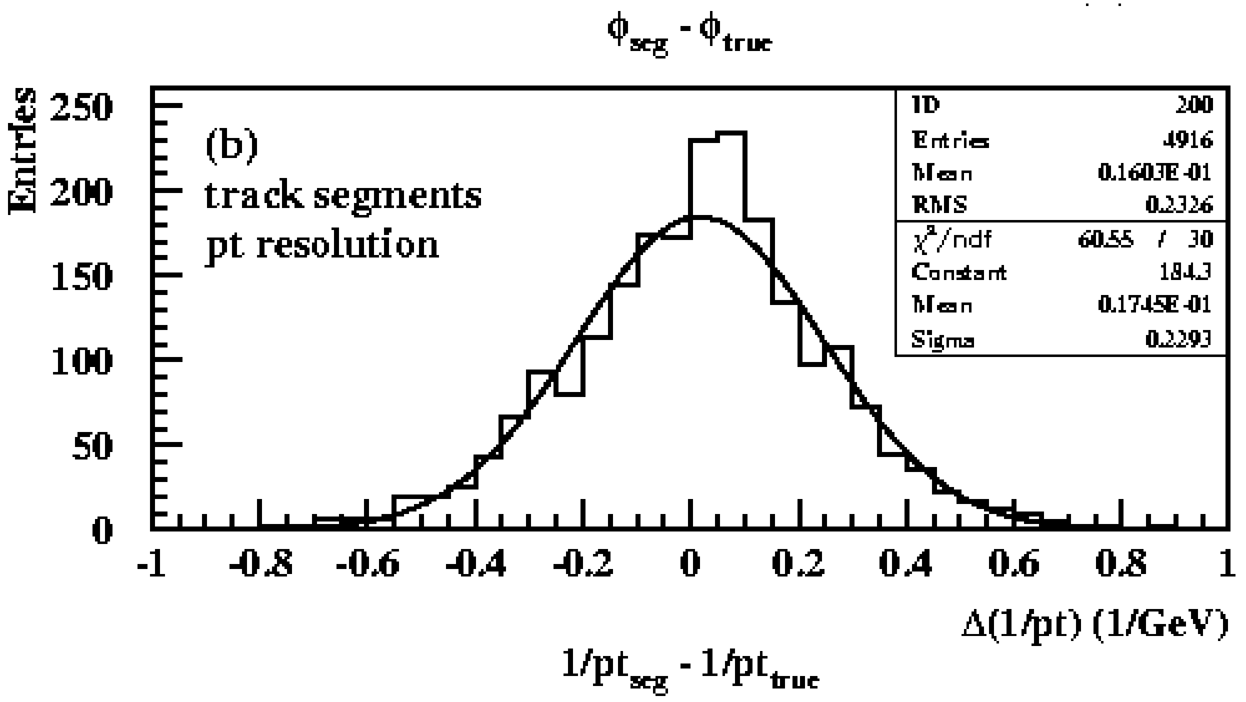
θ_{track} ($P_T^X < 5GeV$) : Magenta

θ_{track} (All P_T^X) : Black

- Distributions peaked at low values of θ_{track}
- In low P_T^X region, distributions peaked more steeply
- Over whole θ range, highest bins in low P_T^X are below cut threshold
- Muons at low P_T^X go more forward?

Resolution of FTT at L1

- New trigger *Track*, cuts on $P_T^{track} > 8GeV$, but is this possible at L1 on the *FTT*?



- Resolution in $\frac{1}{P_T^{track}}$, $1\sigma \simeq 0.23$, $2\sigma \simeq 0.46$
- So for a $10\ GeV$ track: $\frac{1}{P_T^{track}}$ = 0.1 $\pm$ $n\sigma$ at the $n\sigma$ level

Resolution of FTT at L1

- So, for a real $10\,GeV$ track, the *FTT* will measure $2\,\sigma$ of these as $1.8\,GeV \longrightarrow \infty$

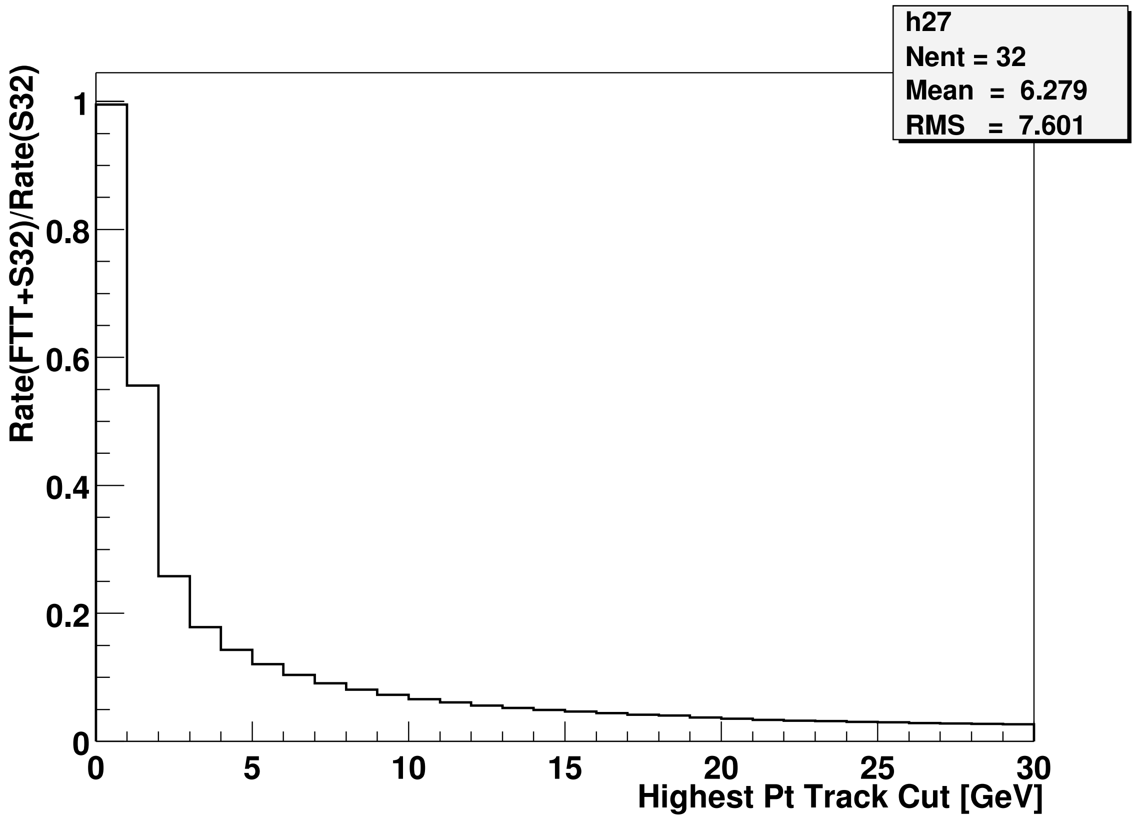
- Therefore a cut at $P_T^{track} > 8\,GeV$ on L1 would lose many $10\,GeV$ tracks
- But a cut at around $P_T^{track} > 1.8\,GeV$ would keep $\simeq 95\%$ of them
- This threshold could be increased to $8\,GeV$ on L2, where the resolution is much better
- Of course the lower the P_T^{track} threshold on L1, the higher the trigger *rate*...

Initial Rate Investigations

- Investigate rate at L2 using 97 L2, L4 transparent run

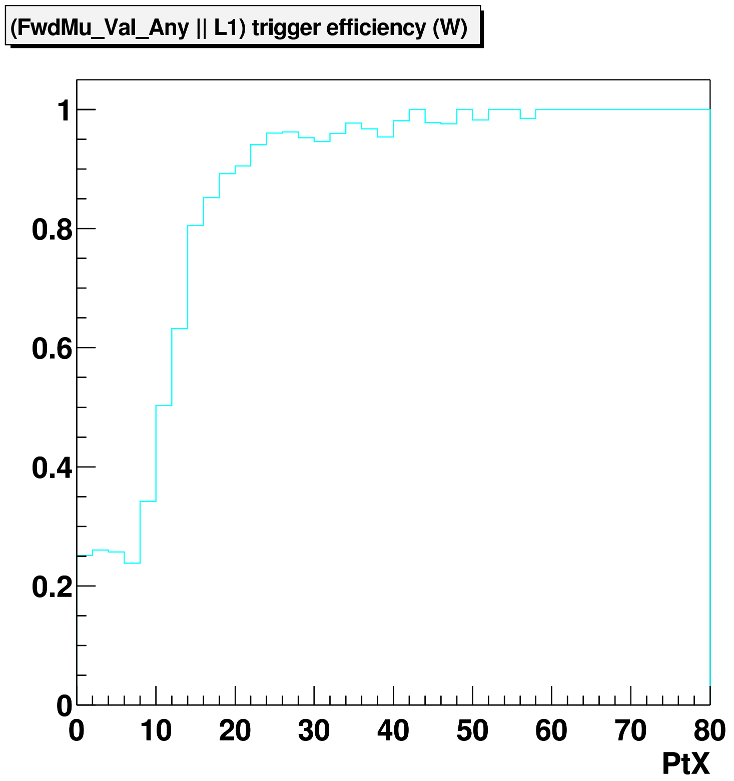
- Use ST32, a basic Z-vertex and ToF timing trigger, with highest P_T^{track} on FTT L2 simulation

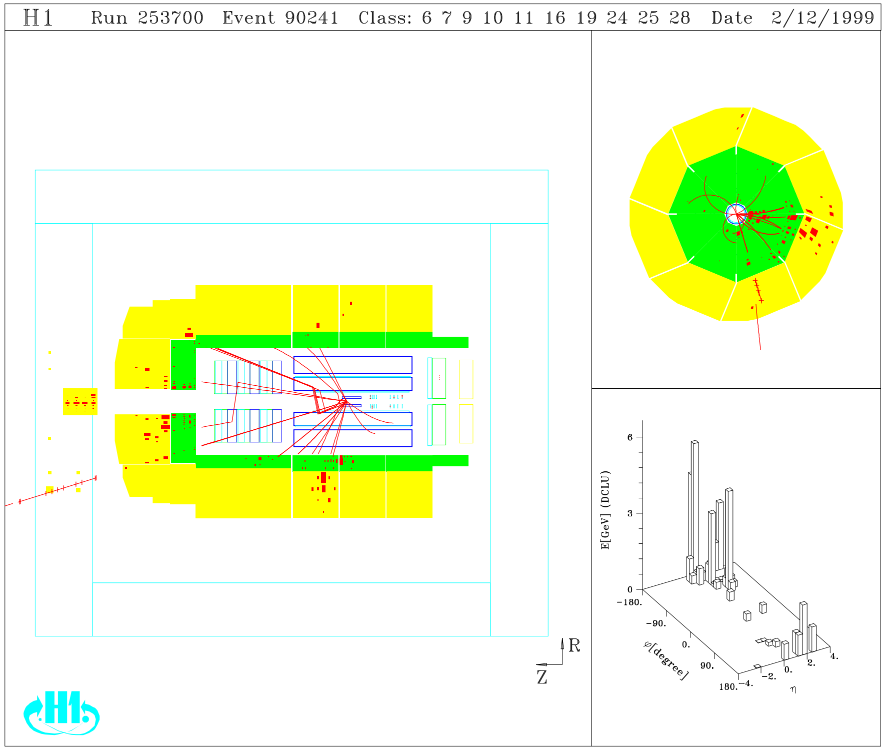
- Rate significantly reduced for $P_T^{track} > 8\,GeV$, but needs further constraints - must use Mu_Any?



- Need simulation at L1 as well to understand rate at the $P_T^{track} > 1.8\,GeV$ threshold

Can Forward Muons also be Triggered?

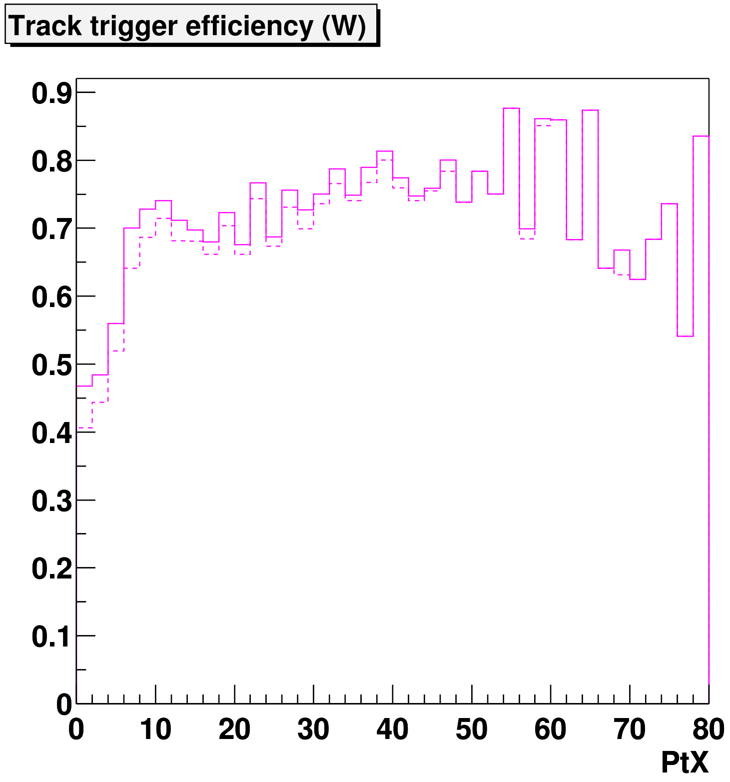




- Some events in W anlaysis contain muons in the forward region
- Combine existing L1 triggers with trigger element 32, *FwdMu_Val_Any*
- Efficiency drops off with decreasing P_T^X, but with plateau at lowest values

(Track && Zvtx_T0) Efficiency Studies

- Attempt to reduce non-ep background *(cosmics, beam-gas)* by asking for a Z-vertex timing requirement

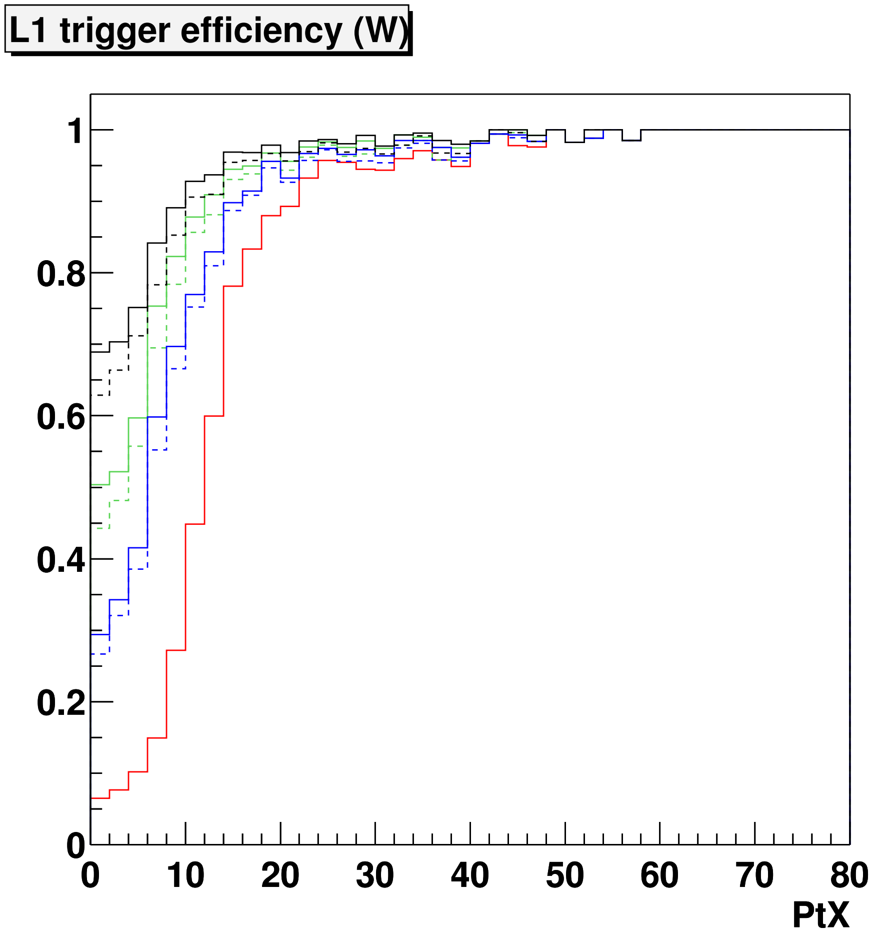


- Try Combining *Track* with trigger element 24, *Zvtx_T0* : $\longrightarrow$ dashed line

- Efficiency not affected too badly across all P_T^X

- How does this affect the previously shown combinations with *Track*?

Trigger Efficiency Plot with All Combinations



- All new combinations are an improvement on the existing L1 triggers

- Dashed lines refer to applying the (Track || Zvtx_T0) condition to *Track*

Existing L1 only : Red

L1 || (Track && Mu_Any) : Blue

L1 || Track : Green

L1 || Track || FwdMu_Val_Any : Black

Conclusions / Future Work

- Triggering $W \to \mu\nu$ events at low P_T^X is a problem due to the low efficiency
- A dedicated high P_T^{track} trigger could be the solution to this
- Efficiency studies look promising, including using the forward region
- Low P_T^X region still needs further investigation
- Resolution of *FTT* means the threshold must be lower at L1 than at L2 and L3
- Zvtx_T0 condition does not affect efficiency too badly
- Rate study is in the preliminary stage, but looks promising at L2

Trigger Proposal

- Existing subtrigger ST32 combined with *Track* trigger on L1, with $P_T^{track} > 1.8\,GeV$

- If the rate on L1 is too high, than Mu_Any could be used to try to bring this down

- On L2 and L3, increase the threshold to $P_T^{track} > 8\,GeV$, to tighten selection, taking advantage of the better resolution and to reduce rates