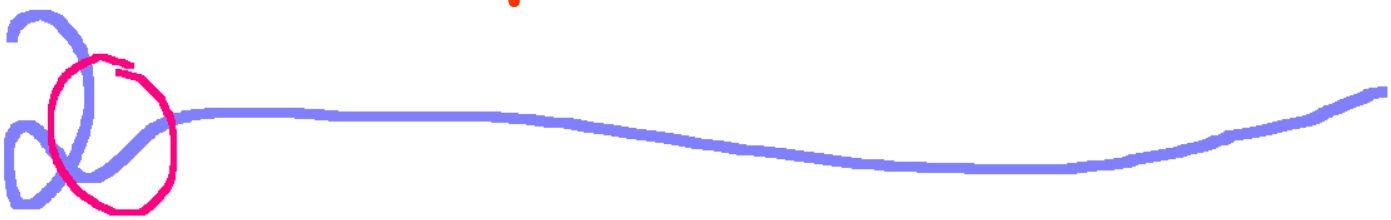
L1 and L2 Triggers for MSP's and τ's



Yu. Gershtein
Brown U

DØPAM, Sep/30/99

Outline

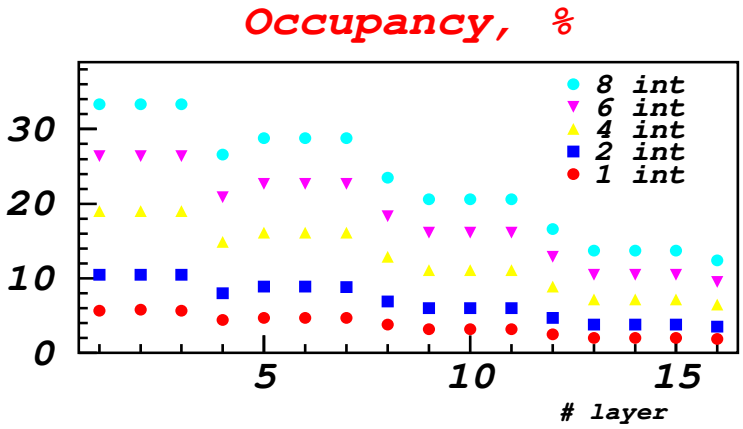
- Introduction
  - why trigger with tracker
- What makes it difficult
- Changes to L1 terms
  - track isolation
  - estimate of number of interactions at L1 (total occupancy)
  - local occupancy
- New features of L2CTT
- Summary

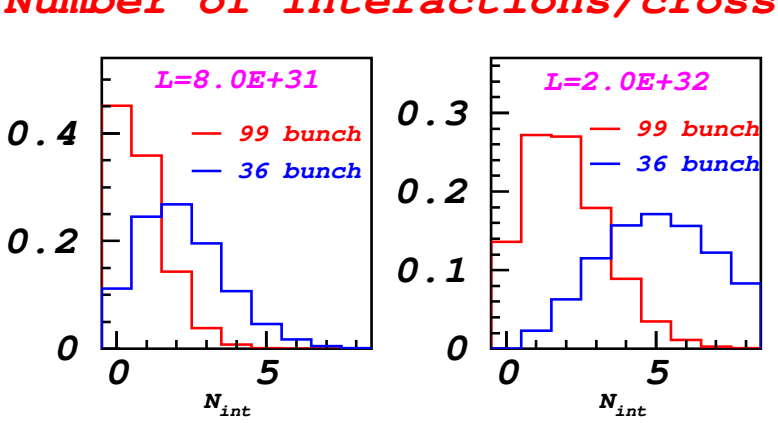
Why Tracker?

- Sometimes it is all we have
  - Massive Stable Particles
    - can be too slow or decay before the muon system
- More efficient
  - τ leptons
    - recover low Et (≈10 GeV) taus which often do not give a triggerable jet
- Just because
  - Stiff isolated track is always interesting!!
    - flavor blind lepton trigger
    - physics we don't know about

Why Is It Difficult?

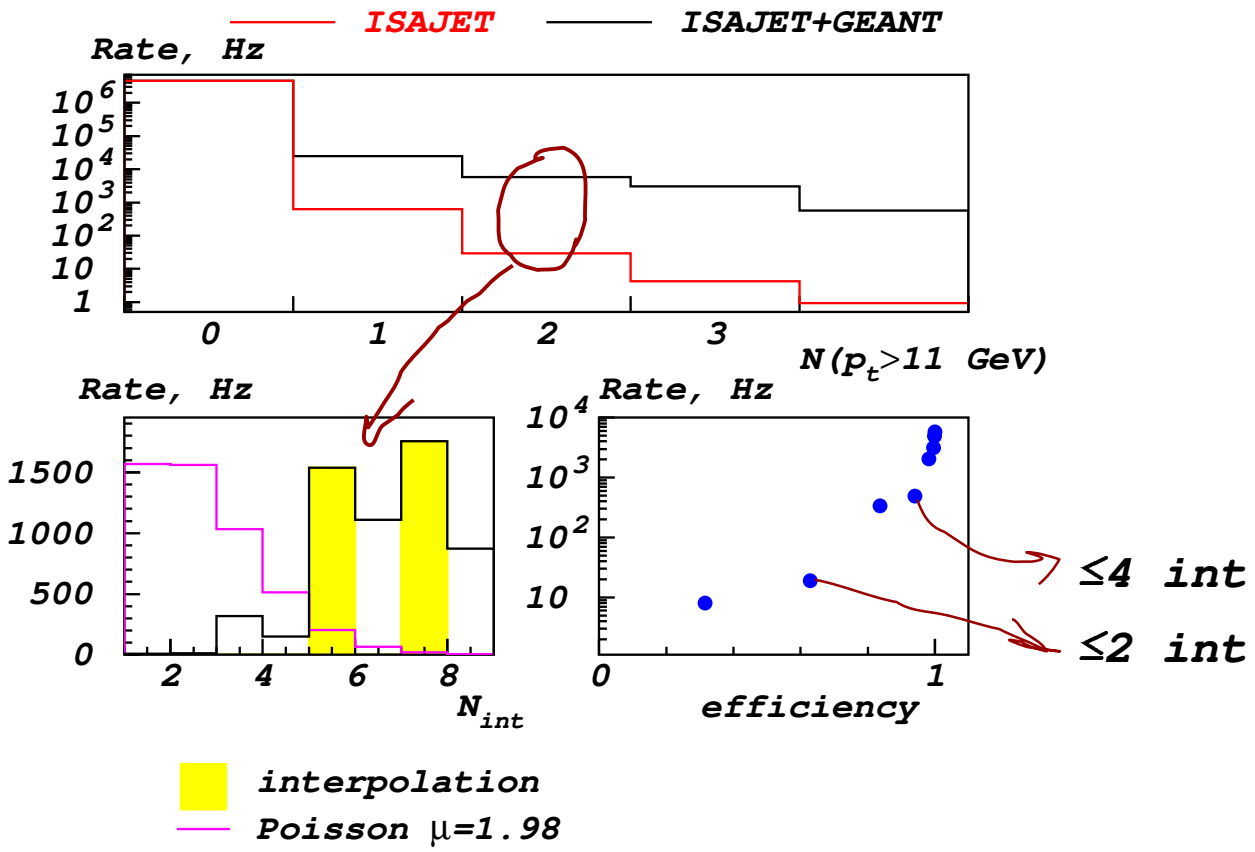
- Only 8 axial fiber layers in L1 track finder -> fakes!!!





Fake L1 Tracks

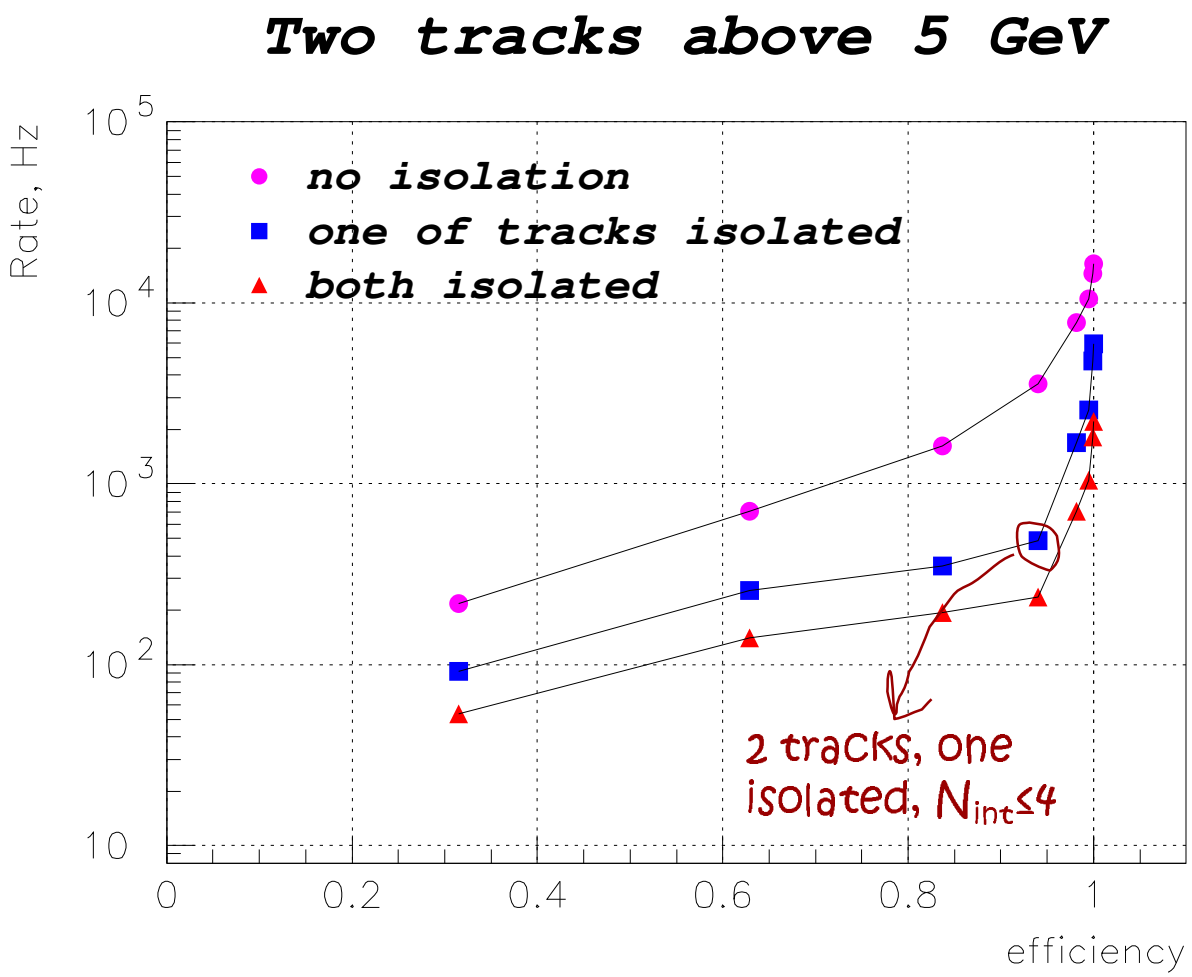
- Tracks with p_t > 11 GeV/c



- huge rate at high N_{int} comes from fake tracks
  - ➡ check occupancy near high p_t track
  - ➡ suppress high N_{int} events

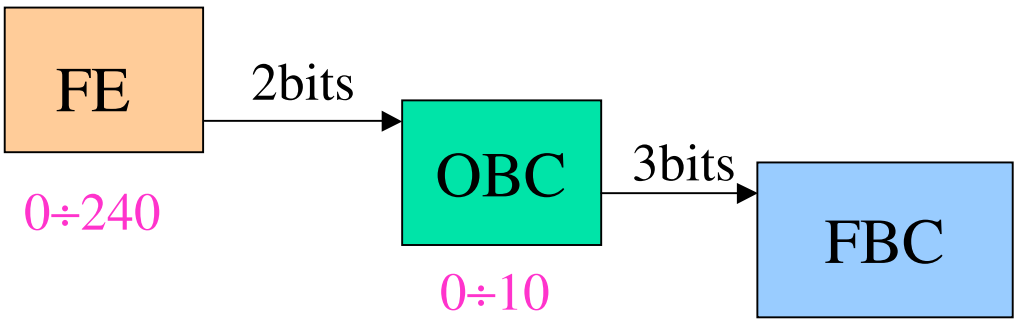
Track Isolation

- L1 track is isolated if it is the only track in the home and both adjacent sectors (3 sectors out of 80)



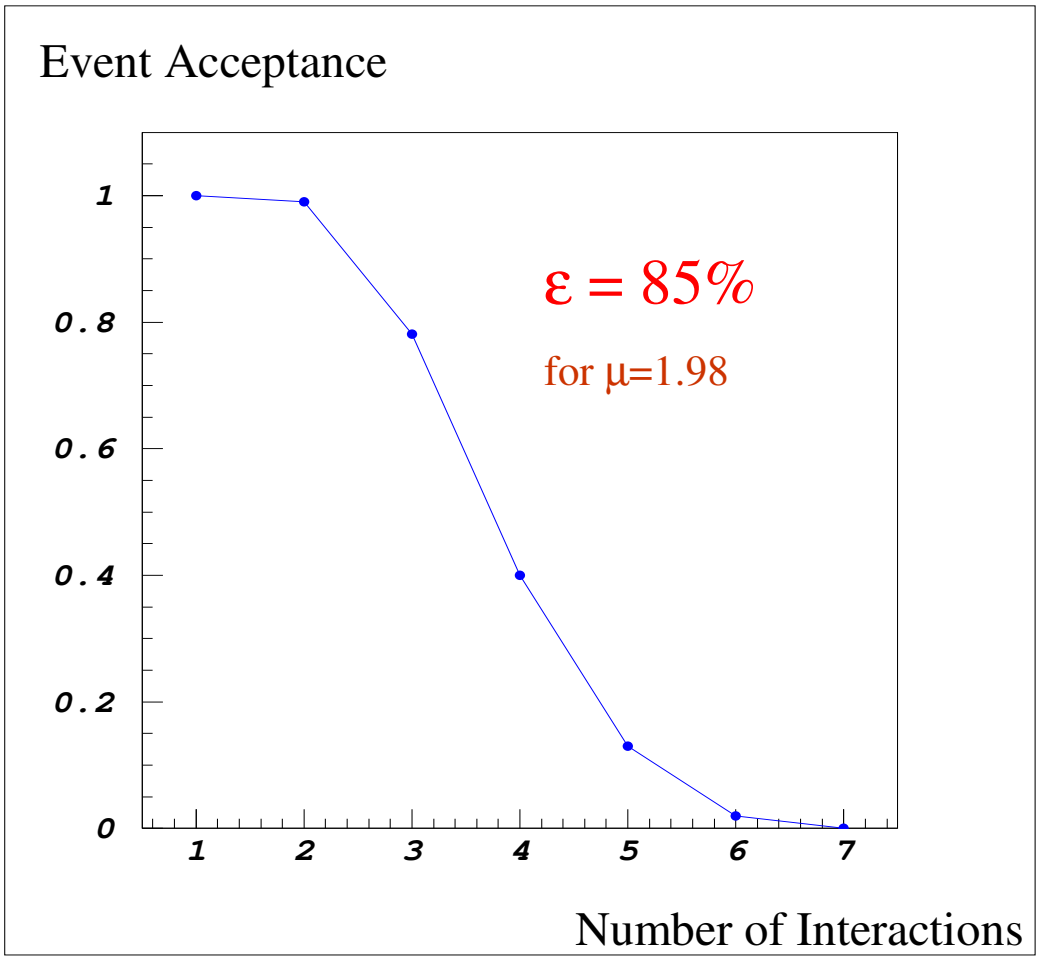
Total Occupancy

- Occupancy in CFT is determined by the number of soft (untriggerable) tracks and strongly correlated with number of interactions



- count hits in each of 80 FE and set bit if the number of hits is over a threshold (29 =12%)
- OBC counts sectors with set bits and reports the number to FBC.
- 0→0, 1→0, 2→1, 3→2, 4→3, 5→4, 6→5, 7→6, 8→7, 9→7, 10→7
- FBC adds 8 OBC reports and sets "high number of interactions" bit if the sum is greater than 15

Total Occupancy



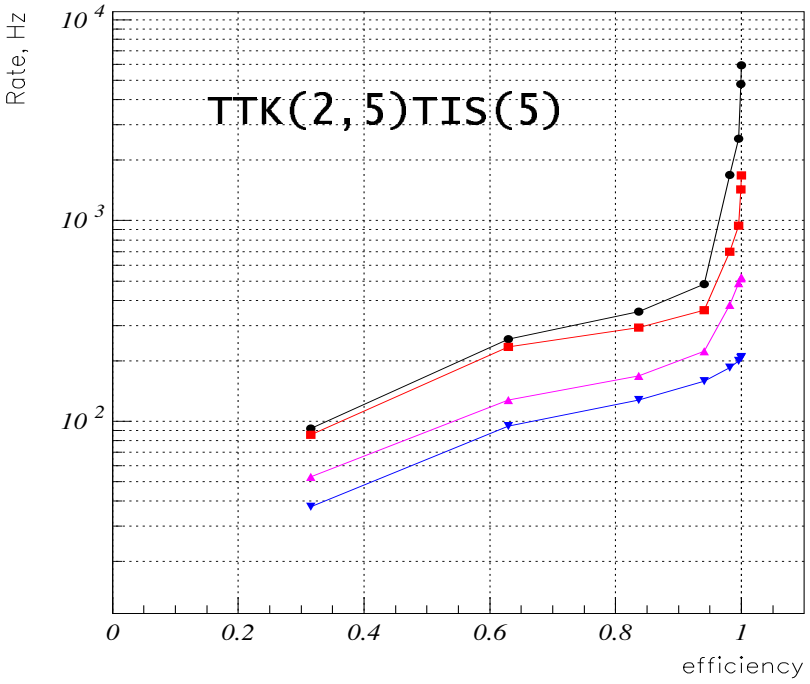
Note, that this is signal efficiency.
The background rejection can be
Much higher.
No way to simulate at the moment ☹

Local Occupancy

- One step further:
  - probability to have a fake track is a very steep function of occupancy in the home sector
  - Cut on it!
- Note: Inefficient for tau decays…

L1 Strategy

- If not for the fake tracks one could trigger, for example, just on a pair of tracks with p_t>5 GeV
- Most of the fake tracks come from low E_T events with high number of interactions ->
  - Suppress very high $N_{interactions}$
  - Suppress very low E_T events



Require L1 jet seeds of

3 GeV,

5 GeV,

6 GeV

L1/L2 Strategy

Level 1

MIXED--LEPTON TRIGGERS

	L1 TRIGGERS	Scale	Physics Fields
ELE_TAU_A	TTK(2,5) TEL(5,h) CEM(1,L) CJT(2,3) CJR(1,C) P1C_el P1C_jt	U	Di-boson, New Phenomena, Di-tau
DITAU_5C	TTK(2,5) TIS(5) CEM(1,L) CJT(2,3) CJR(2,C) P1C_jt P1A_shLO	U	Di-boson, New Phenomena, Di-tau

TRACK-MINBIAS TRIGGERS

	L1 TRIGGERS	Scale	Physics Fields
LL_TEL	TEL(10,l) TLO	P	NP: "stable" highly ionizing tracks, di-tau THT->TLO if possible
TIS_MSP	TIS(10) MUO(1,10,C,Tslow)	U	NP, "stable" highly ionizing track, require low CFT occupancy
TTK2_THT	TTK(2,5) TIS(1,5) THT(lo)	U	Inclusive flavor blind dilepton
TTK2H_TLO	TTK(2,10) TLO	U	quasi-stable MSPs THT->TLO

Level 2

- Confirmation of tracks in the silicon should kill most of the fakes
- Many other handles
  - dE/dx in silicon
  - dE/dx in CPS
  - Calorimeter tau tool
  - ...
  - more sophisticated isolation in CFT

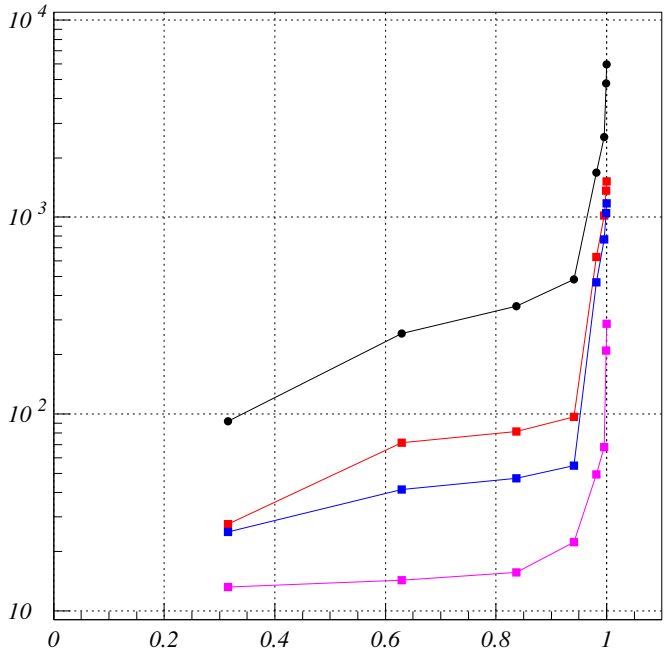
Isolation at L2

- At L2 one can examine the event topology in more detail
- Things we look for have a common feature: they are narrow isolated objects
- One prong
  - track with p_T>5 GeV and in $\Delta\varphi$<0.5 there is no more than one track with p_T<2 GeV and no tracks with p_T> 2 GeV
- Three prong
  - as one prong, but allow up to two additional tracks in $\Delta\varphi$<0.1 around the track

Isolation at L2

Can have more elaborate isolation at L2

* One-prong:
  -> no tracks over P_0 GeV in ±0.5 rad
  -> one or no tracks below P_0 GeV



TTK(2,5)*TIS(5)

P_0 = 3 GeV

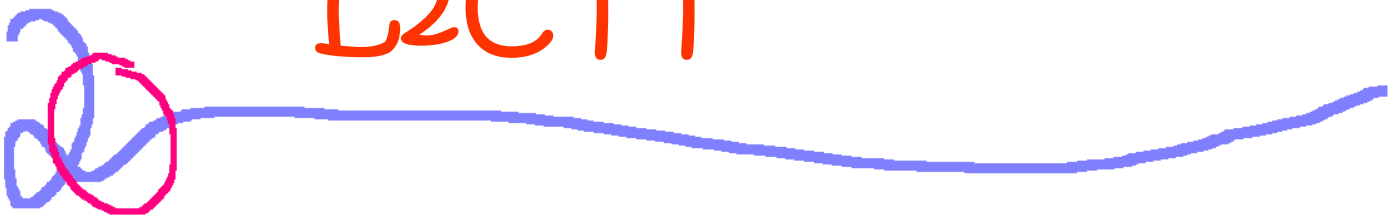
P_0 = 2 GeV

P_0 = 0 GeV

* Three-prong:
  -> allow one or two tracks within ±0.1

-> less pure object but still factor of ≈5

L2CTT



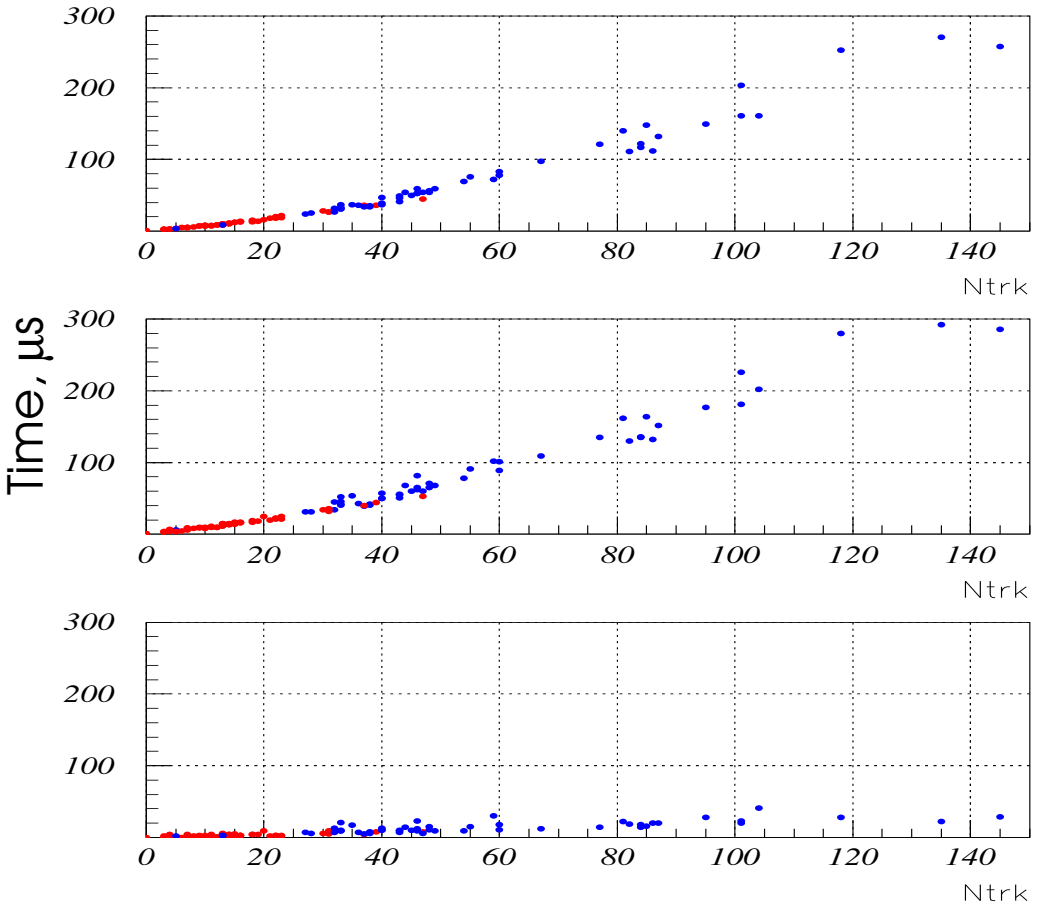
- Recieves a list of tracks from L1FT or L2STT
- Recalculates p_T
- Sorts tracks in p_T
- Has some spare time for low track multiplicity events

Algorithm

- Only one pass trough the track list
- As the tracks are uploaded from the input buffers they are
  - tagged as a one/three prong candidate if p_T>5 GeV
  - two 160-bit bitmaps are filled for tracks with p_T>P_0 and for p_T<P_0, making a "histogram" of track azimuth angle
  - for all one/three prong candidates (usually a very short list) bit sums are performed, giving a track count "almost" in wedges $\Delta\varphi$<0.5 and $\Delta\varphi$<0.1
- The L2CTT output words format has enough spares to accommodate two bits for one and three prong tags

L2CTT Timing

- Run optimized code on d02ka for 20-40 GeV QCD and for ttbar + 2 minbias



Before

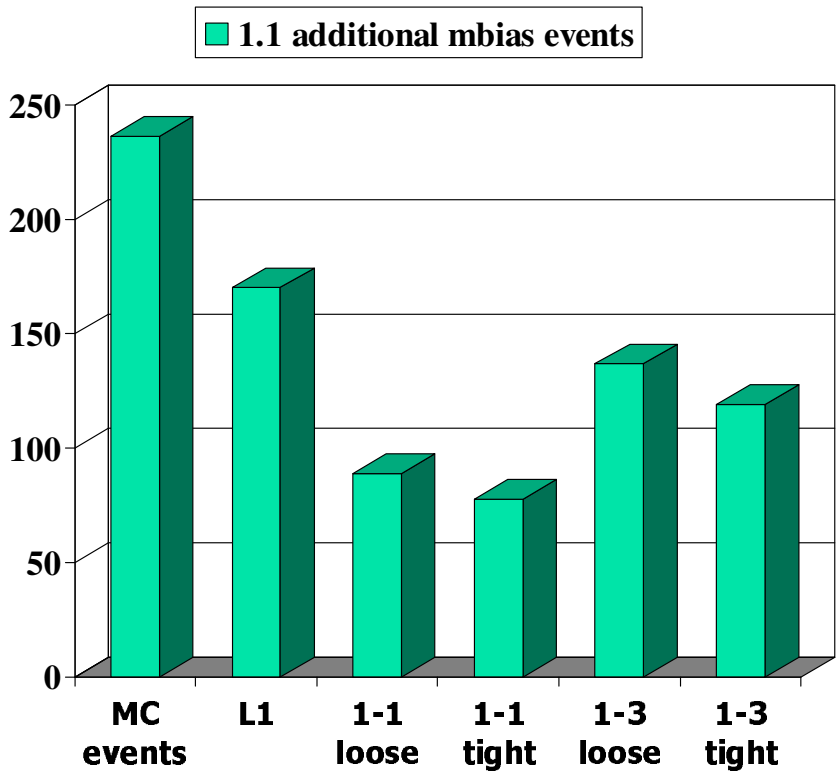
After

Increase

The Efficiency

Study efficiency on Z->tau+tau-

- select events with two taus $|\eta|<1.5$ $p_T>10$
- Require TTK(2.5)·TIS(5) at L1
- L2 loose means P_0=2 GeV, tight -> P_0=0



Eff(L1)=72%

85%/tau

Eff(L1·L2)=40-60%

NOTE that THT efficiency of 85-90% is not included

Summary

- The improvements of the tracking system in Run II gives new opportunities
- New L1 terms are included in the design
- Modifications to L2CTT algorithms are coded and timed
- New items in the trigger menu