Level 3 Muons

- Local filter and CentralMatch filter-

L3 Algorithms Meeting, Jan 29 2003

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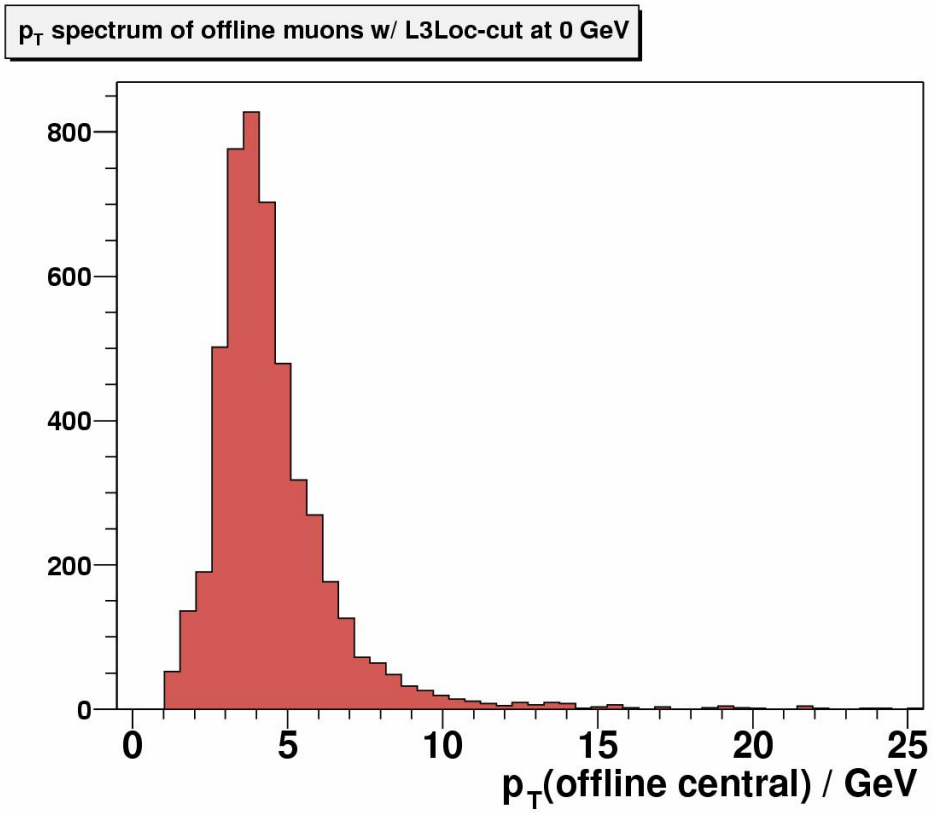
Data Sets

- **Run 163078**
  - **Special run with**
    - **exclusively muon triggers at L1**
    - **various combinations of L2 and L3 muon triggers**
  - **42000 events reconstructed.**
- **J/Ψ events (runs 151831...156471)**
  - **Picked di-μ sample by the "tracking task force" (30938 events)**
- **Z events (runs 146381...166782)**
  - **Picked di-μ events with p_T>10GeV (1794 events)**

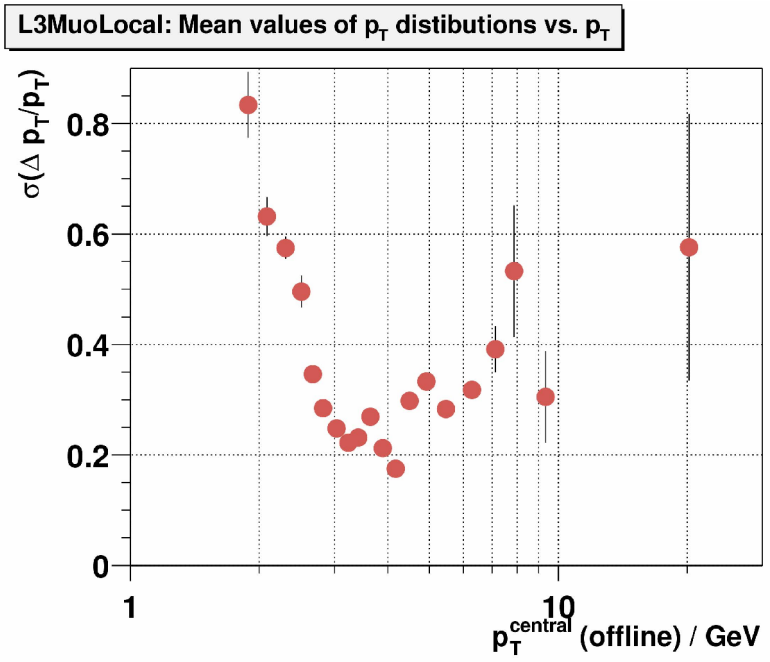
➔ **All events have been re-reconstructed and "TrigSim"ed with p13.04.00**

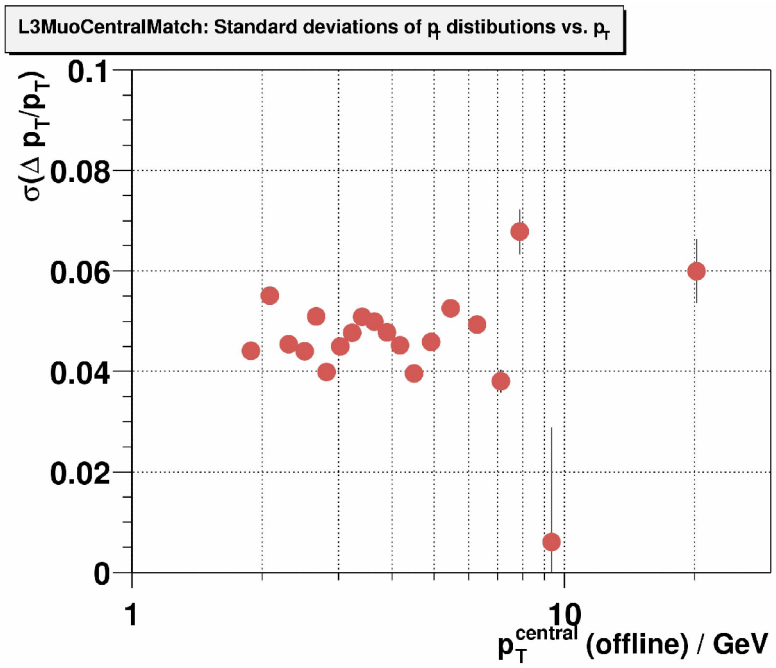
p_T -Spectrum of Muons



- Muons with p_T<4GeV are filtered out by the iron between A and B layer
- For p_T>4 GeV the spectrum shows a strong exponential decline

p_T Resolution of both muon triggers





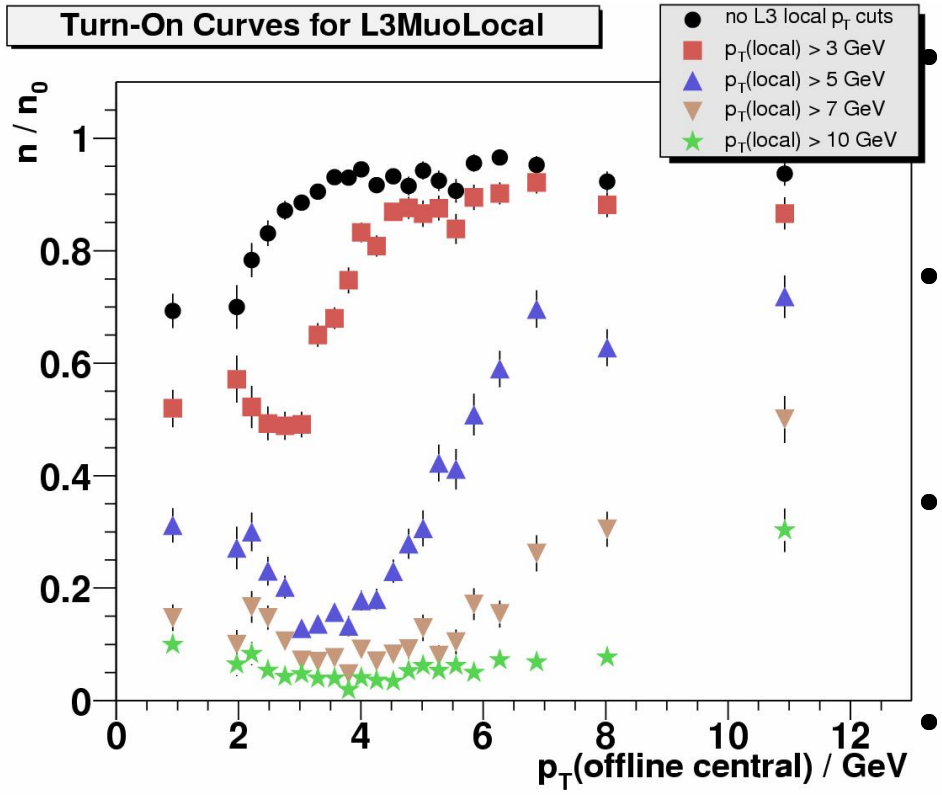
Resolution of L3MuoLocal:

- bad for p_T<3.5 GeV(as expected)
- raising from ≈0.2 @3.5GeV to ≈0.6 @20GeV

Resolution of L3CentralMatch

- for 1.5GeV < p_T < 8GeV constant at ≈0.05

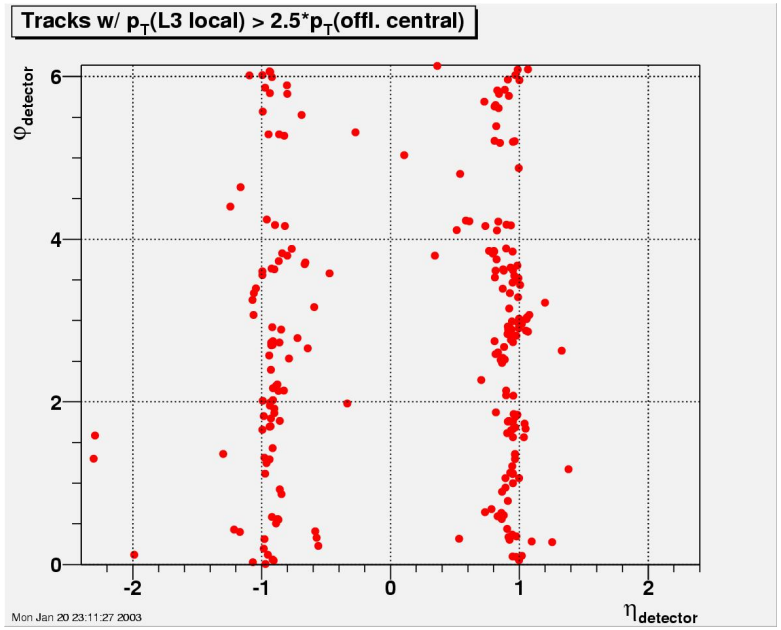
L3MuoLocal: Turn-on curves

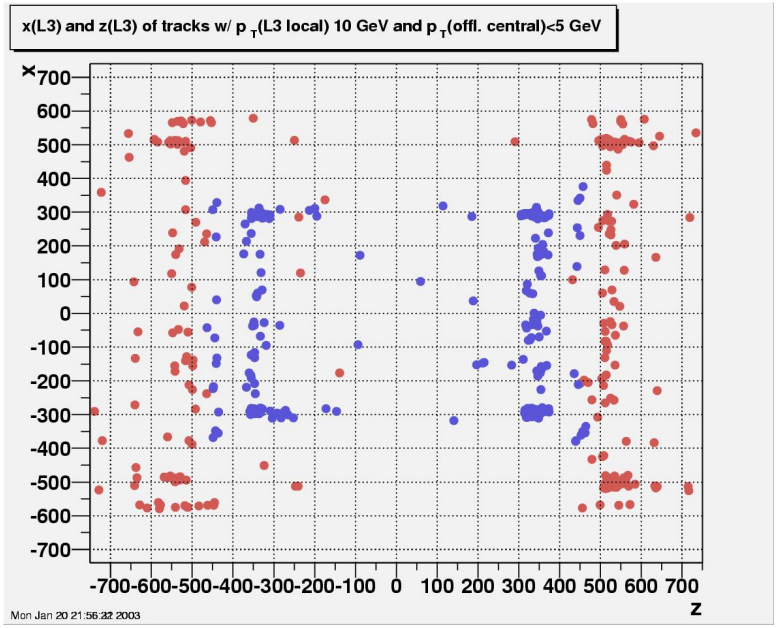


Decline at low p_T is understood
(And neglegible in absolute numbers.)

- All efficiencies are with respect to medium offline muons .
- L3MuoLocal without p_T cuts reaches a plateau efficiency of $\approx$ 94% ($|\eta|$<2.0)
- With increasing pT cut the edges of the curves "wash out"
- Higher p_T cuts lower the plateau efficiency significantly ($\varepsilon^{plateau}$ < 40% for p_T^{cut}=10 GeV)

Location of L3 Tracks with abnormal high local p_T

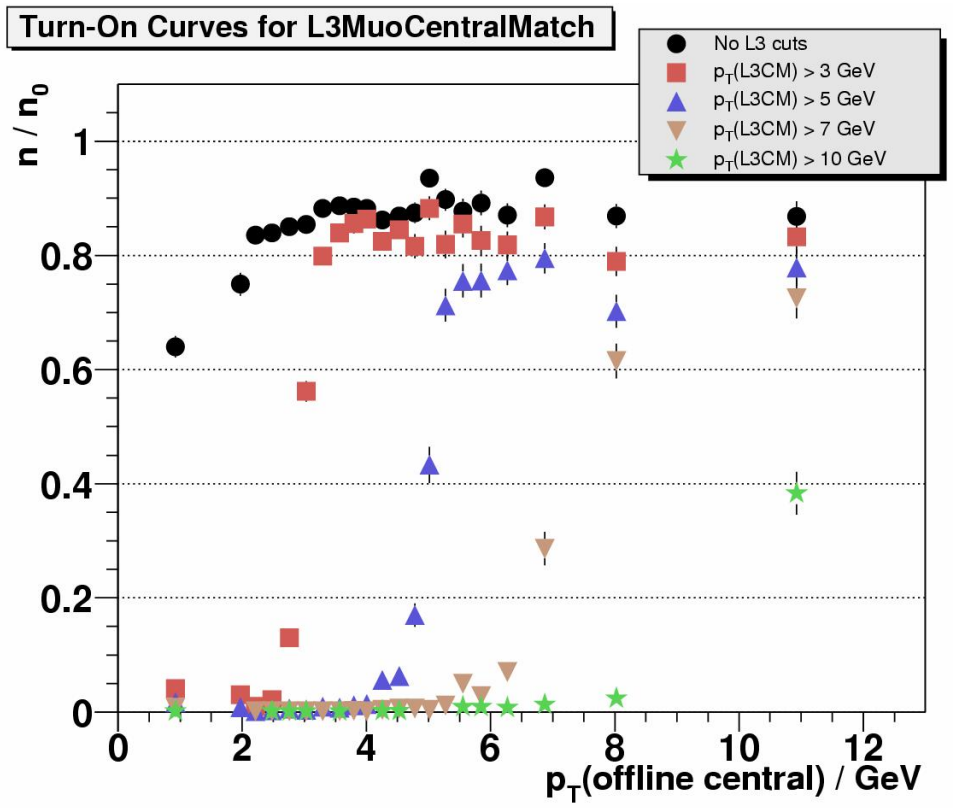




η - φ **plane**

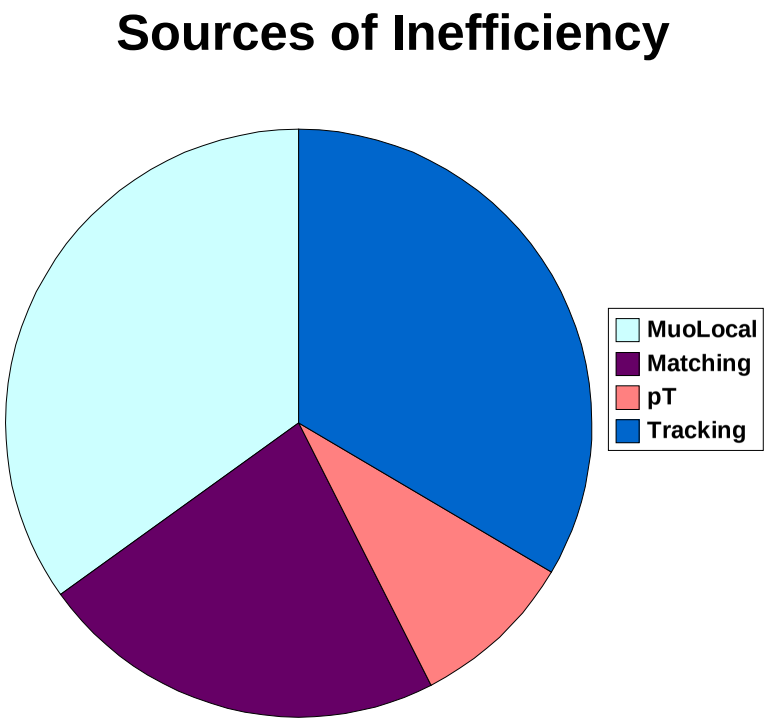
x-z plane
blue: A-layer
red: BC-layer

L3MuoCentralMatch: Turn-on curves



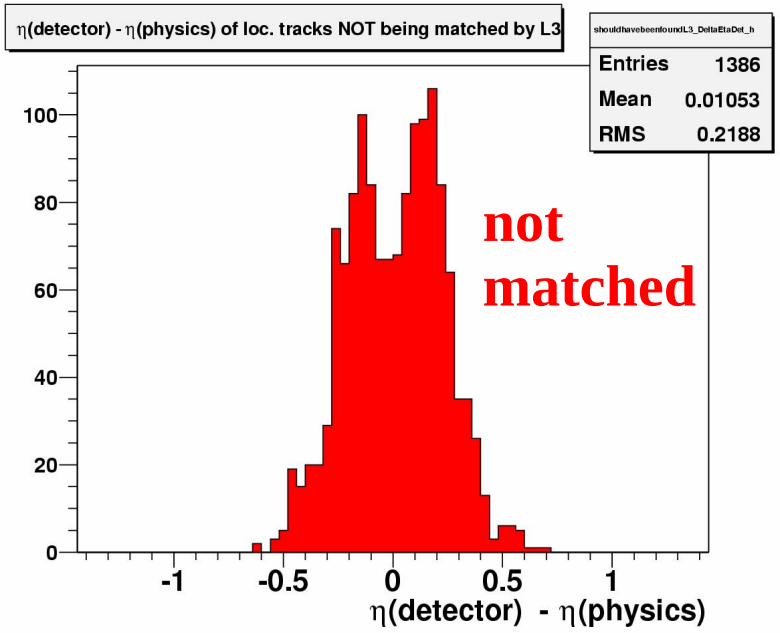
- All efficiencies are with respect to medium offline muons with matching central track.
- L3MuoCentralMatch without p_T cuts reaches a plateau efficiency of ≈85-90% (For comparison: L3Gtr w/o matching: ≈96%)
- Steep edges of the turn-on curves provide a sharp p_T cut.

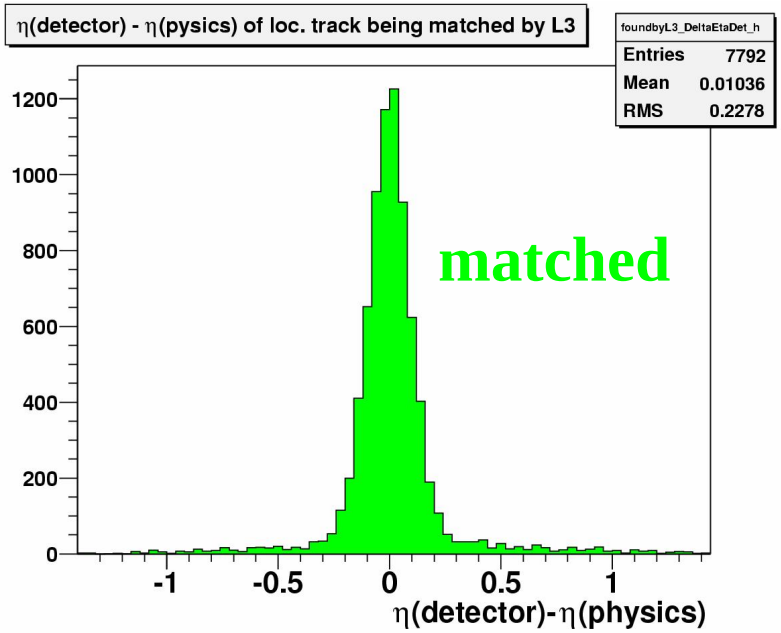
Where are the Muons lost?



- **Sources of inefficiency at L3MuoCentralMatch:**
  - **L3MuoLocal: 4.5%**
  - **Matching: 2.9%**
  - **p_T determination: 1.2%**
  - **Tracking: 4.3%**
  - **SUM: 12.9%**

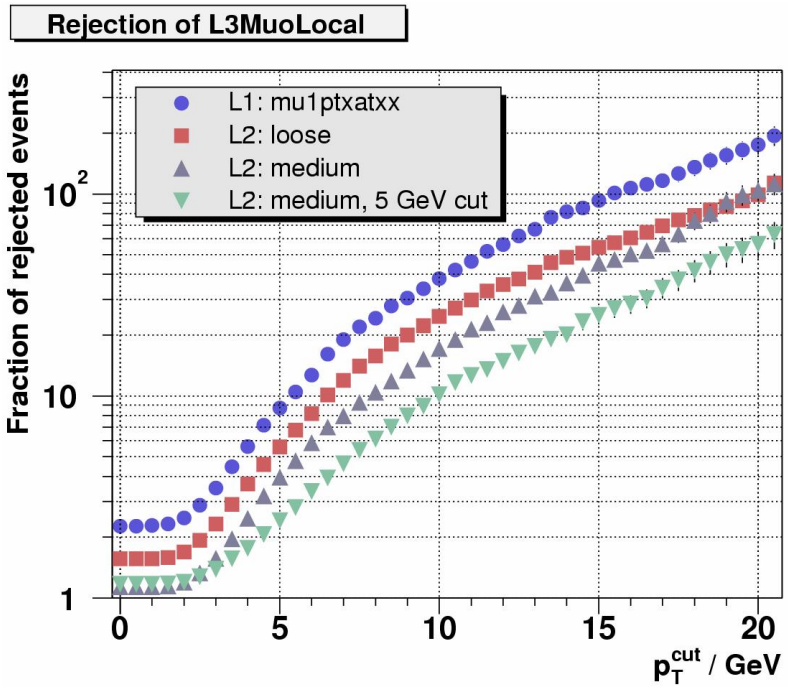
Why are some muons not matched?

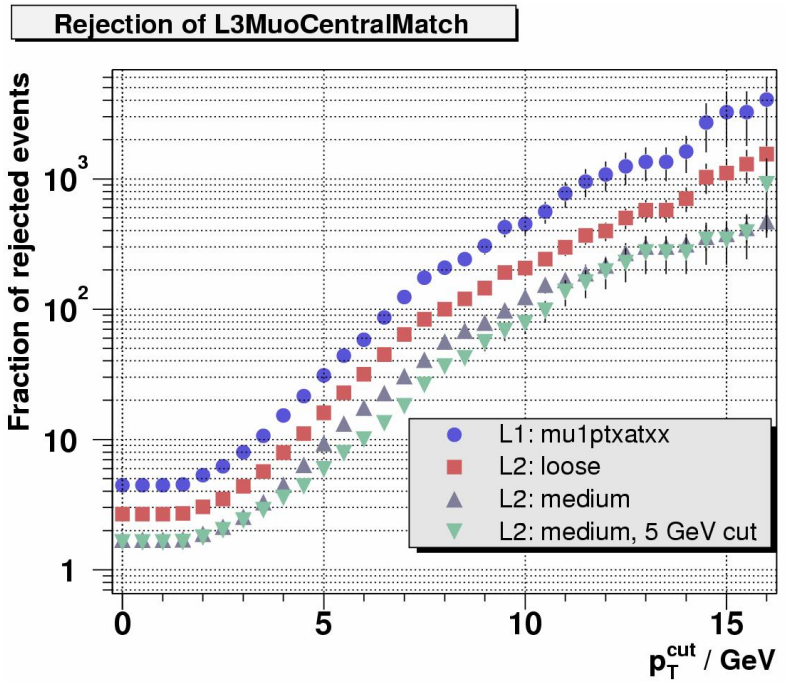




- The difference of "detector" η (i.e. the h from (0,0,0) to the track's location in the A-layer) and "physics" η is a (rough) measure for whether a track points to the primary vertex
- Obviously those local tracks for which no matching central track was found are much more skew than the other ones.

Rejection of L3MuoLocal and L3MuoCentralMatch





L3 local rejections without cut:

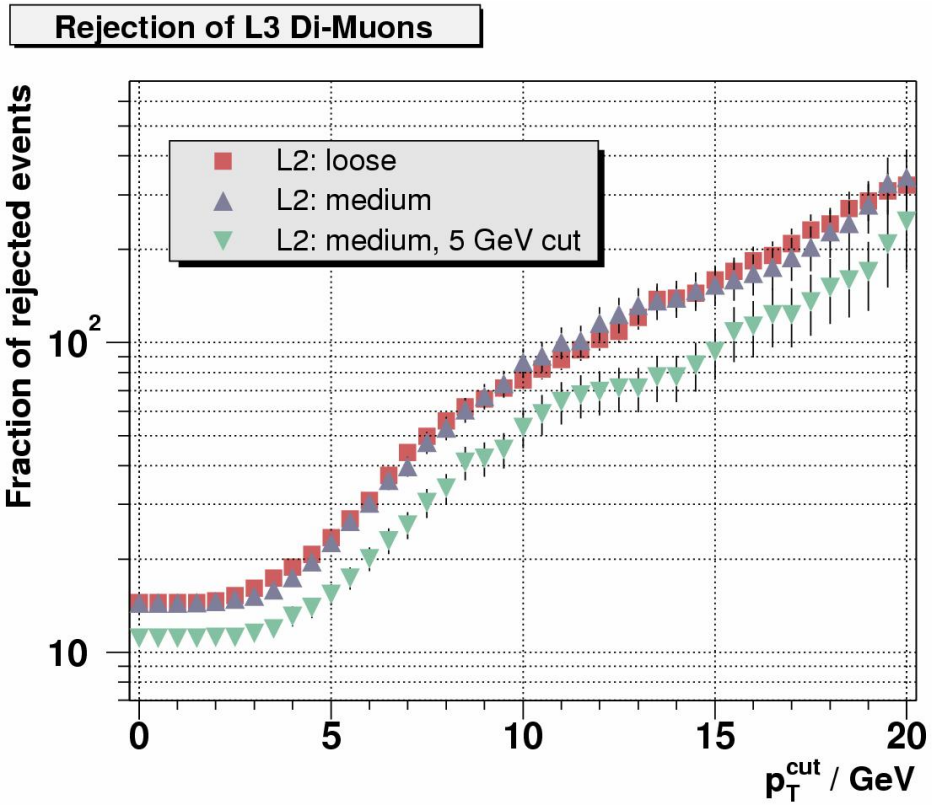
- 1.1 wrt. L2 medium
- 1.6 wrt. L2 loose
- 2.3 wrt. L1 tight scint.

L3 CM rejections without cut:

- 1.7 wrt. L2 medium
- 2.7 wrt. L2 loose
- 4.5 wrt. L1 tight scint.

- The rejection in the forward region for high p_T is higher by a factor of 1.5-2 compared to the central region

Di-Muon Filter: Rejection

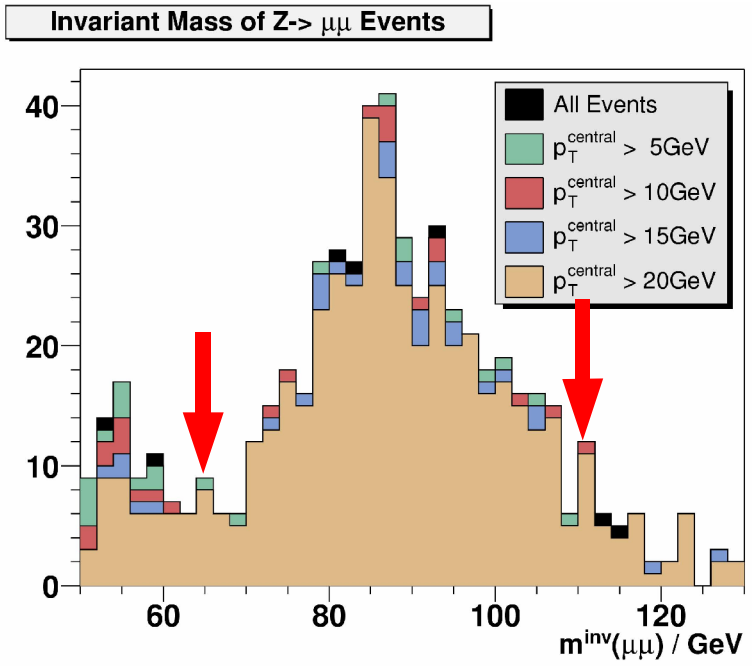


- Two loose L3 muons with no common hits reqired
- The p_T cut was applied to one of them

What about Physics?

- **How do J/Ψ and Z->$\mu\mu$ Events with our triggers?**

Efficiency of L3MuoLocal in Z-peak



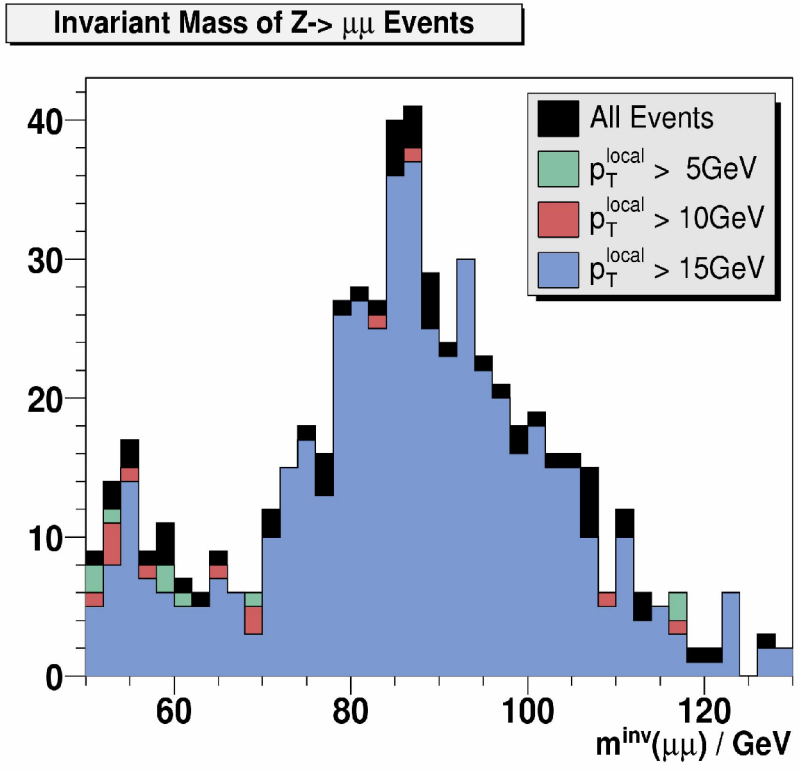
muon efficiency in Z-Peak:

	1 out of 2	per μ (meas.)	(calc.)
– No cut:	99.7%	96.8%	94.5%
– p_T^{cut}= 5GeV:	99.4%	90.2%	92.3%
– p_T^{cut}=10GeV:	97.0%	80.8%	82.7%
– p_T^{cut}=15GeV:	94.5%	73.0%	76.5%
– p_T^{cut}=20GeV:	89.6%	61.4%	67.7%

The "calculated" efficiencies are obtained from the "1 out of 2" efficiencies with the assumption of stochastical independence.

➔ **Even with our limited local p_T resolution we could apply a 20 GeV cut at L3 and would still keep ≈ 90% of the Zs (But gain a rejection of 25)**

Efficiency of L3MuoCentralMatch in Z-peak

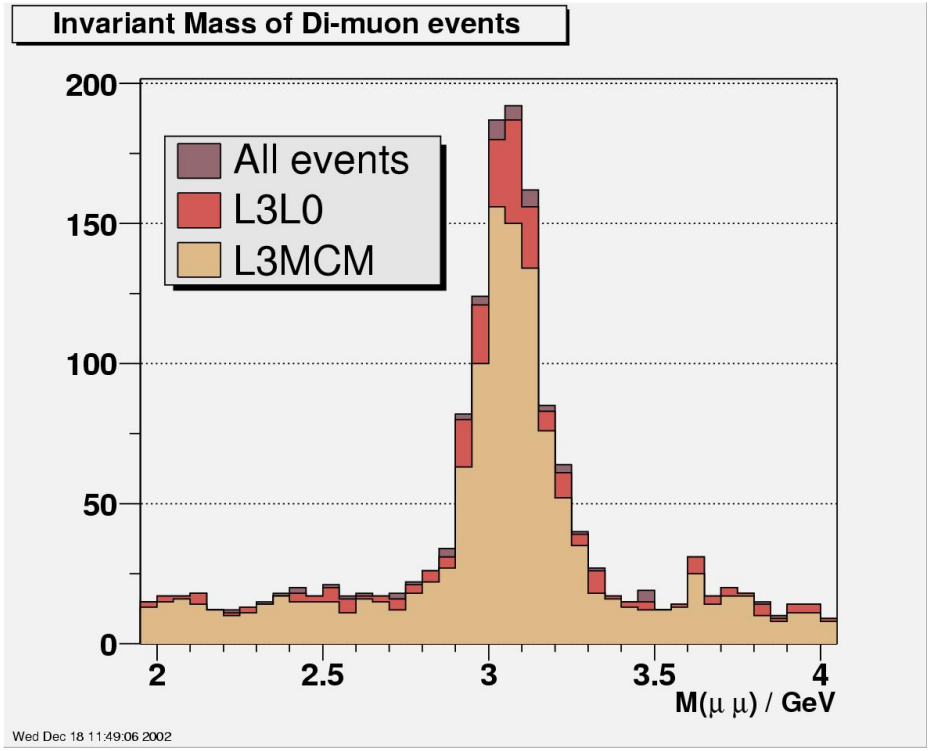


muon efficiency in Z-Peak:

	1 out of 2	per muon (measured)
– No cut:	92.4%	74.3%
– p_T^{cut}= 5GeV:	92.4%	73.4%
– p_T^{cut}=10GeV:	92.2%	72.9%
– p_T^{cut}=15GeV:	90.9%	72.1%

➔ A CentralMatch Filter with p_T>5GeV cut would keep 92.4% of the Zs and gain a rejection of 11 (wrt. L3M0)

Trigger Efficiency in J/Ψ peak



muon efficiency in J/Ψ-Peak:

"one out of two"

- **L3MuoLocal: 96.7%**
- **L3MuoCentralMatch: 81.9%**

per-muon efficiency:

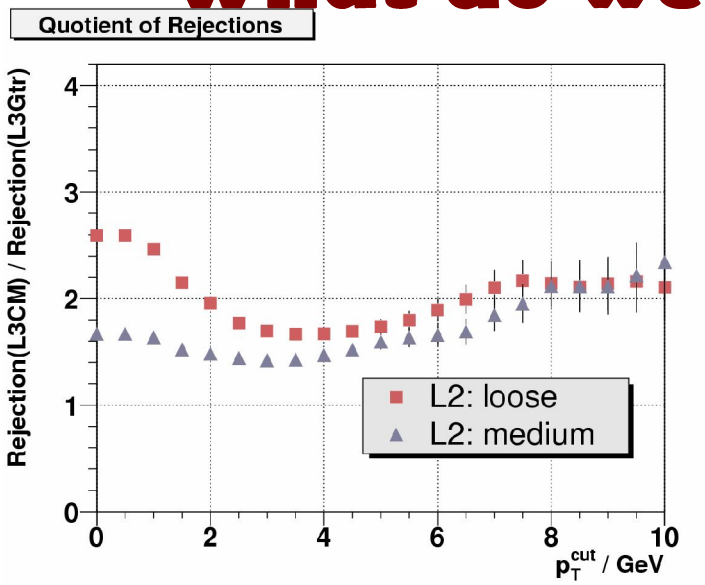
Measured "per muon" efficiency :

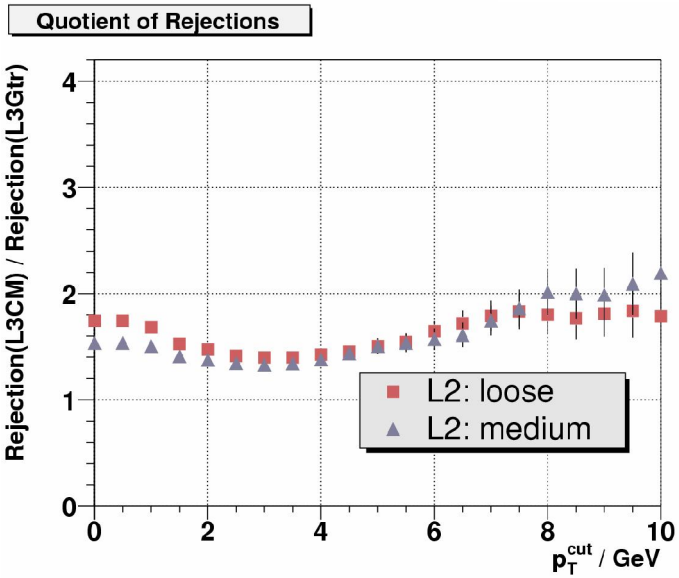
- **L3MuoLocal: 96.0%**
- **L3MuoCentralMatch: 70.1%**

➔ *theoretical* "one out of two" efficiencies:
99.8% (L3L0) resp. 91.0% (L3CM)

➔ Probabilities to find both muons with L3MuoCentralMatch are *not stochastically independent*.

What do we gain by Matching?





- Compared to only requiring a L3 Global Track we gain a factor of 1.5-2.2 wrt. L2M0 with L3CM
- Compared to *independently adding* a L3 Global Track requirement we gain a factor of 1.6-2.8 wrt. L2M0 (1.4-2.2 wrt L2L0) in rejection by *matching* the track
- Since the loss of efficiency is only ≈10% this means a definite improvement of purity