Soft Lepton Tag for Top analyses

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- What is Soft Lepton Tag (SLT) ?
- Why was it used in Run I ?
- Why do we need it in Run II ?
- How is SLT implemented ?
- Status & plan on SLT for muons
- Conclusions

What is Soft Lepton Tag (SLT) ?

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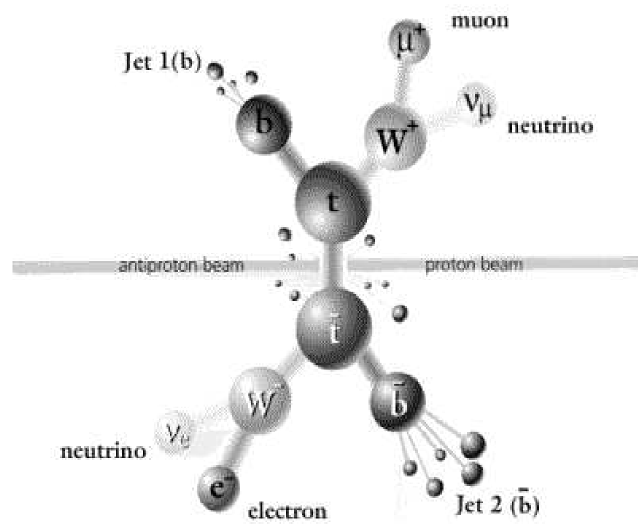
Top search relies on identification of 1 or 2 b-jets to reduce W+jets background



Two methods:

•SVX b-tagging (decay vertices of b hadron)

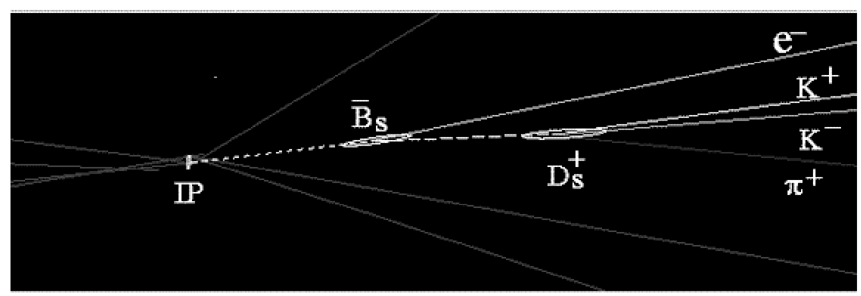
•SLT: semileptonic decay of b hadron

soft: because $p_T(l)$ low compared to $p_T(l)$ from W

Examples:

$$b \rightarrow l\upsilon X$$

$$b \rightarrow c \rightarrow l\upsilon X$$



What is Soft Lepton Tag (SLT) ?

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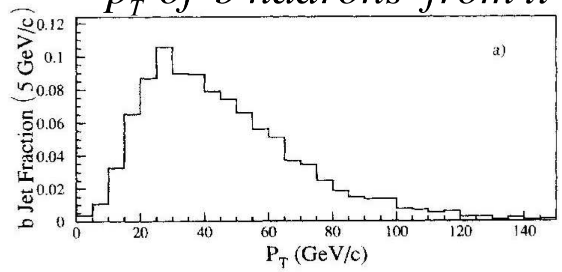
- Lepton ID in b-jets is more difficult than for W/Z
  - <b> momentum is ~50GeV/c: Stiff collimated jet.
  - Nevertheless-lepton momentum spectrum soft
  - b hadronisation particles in the jet
  - i.e leptons not isolated
    - Cannot use Had/Em, E/p, Isolation cuts

- <u>For electrons</u>
  detector granularity (CEM 50cm x 20cm)
  - electron shower ~3cm
  - Cluster size 2/3 towers (Pion, γ)
  - Backgrounds:
    - conversions $\gamma \rightarrow e^{+}e^{-}$
    - pions (shower early) $\pi^{\pm}, \pi^{0} \rightarrow \gamma\gamma$
- <u>For muons</u>:
  matching track/stub more difficult.
  - Backgrounds to SLT μ
    - decay in flight $K^{\pm} \rightarrow \mu^{\pm}\upsilon; K^{\pm} \rightarrow \pi^{\pm}\pi^{0}$
    - punchthrough

p_T of b hadrons from $t\bar{t}$



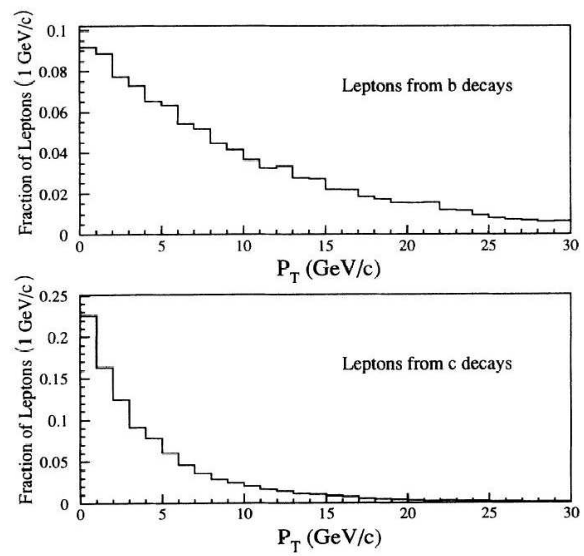


FIG. 31. P_T spectra of leptons from the decay of b and c quarks in top Monte Carlo events ($M_{\rm top} = 160$ GeV/c^2).

Why was SLT used in RunI ?

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- Limited Silicon coverage (± 30 cm long)
  - taggable jet definition requires 2/3 SVX tracks
- Small data set
  - limited statistics, maximize sensitivity...
- SVX .vs. SLT
  - test purity/efficiency by cross-checking with other tagger
- Improve top mass measurement by correcting jets for semileptonic b decay
  - missing neutrinos, muon (deposits only MIP)
  - top mass uncertainty dominated by E scale of the b-jets

Why was SLT used in RunI ?

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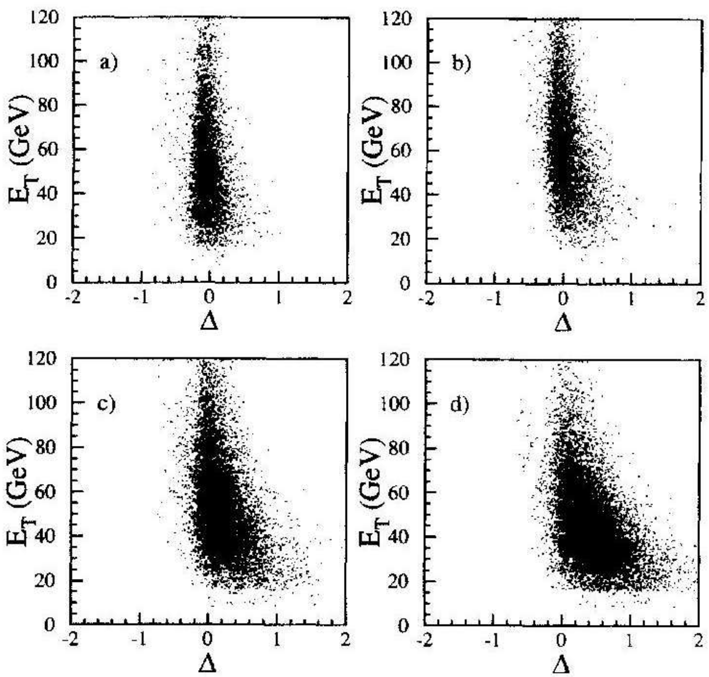
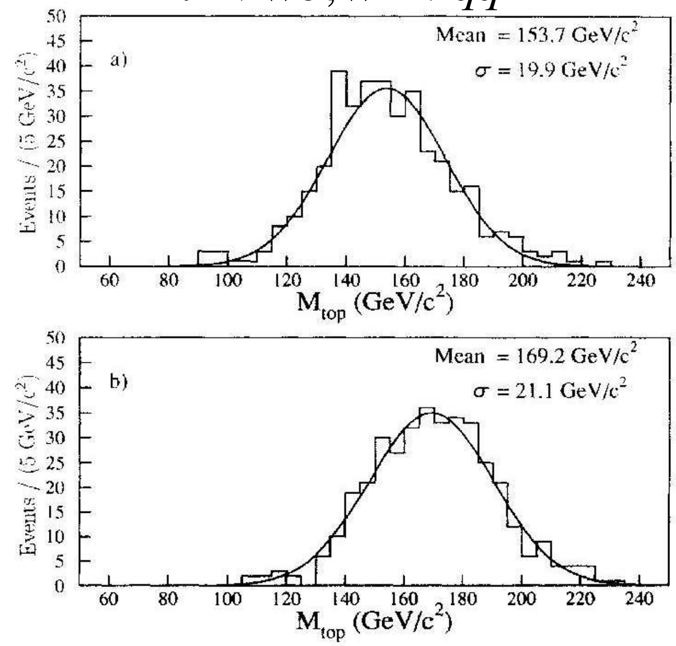


FIG. 57. Scatter plots of jet E_T corrected with standard jet corrections vs Δ for the four jet types: (a) light quarks, (b) generic b jets, (c) $b \to e\nu X$ jets, and (d) $b \to \mu\nu X$: $\Delta = [P_T(\text{parton}) - E_T(\text{jet})]/E_T(\text{jet})$. The Monte Carlo events have been generated with HERWIG at $M_{top} = 170$ GeV$/c^2$.

$$t \to Wb; W \to q\bar{q}$$



before

after

FIG. 59. Invariant mass of the b jet and the two jets from the W decay when the b jet contains a semileptonic decay to muon and neutrino. The jet momenta are corrected with standard jet corrections (top plot) and with the jet corrections used in the mass analysis (bottom plot). The events plotted are generated with HERWIG at $M_{top} = 170$ GeV$/c^2$.

Why do we need it in Run II

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- All Run I reasons are still valid
- Can use d0 cut on SLT tags, improve purity, reduce fake rate (correlation taggers SVX-SLT).
- If one has lot and lot of statistics, for Top mass:
  - use only top candidates with double SVX tags

    where jets do not have SLT tags (use SLT as veto)

How SLT is implemented ?

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SLT Tagger (Muon):

•Track-based (p_T>2GeV/c)

- determine fiduciality of the track $CMU\overline{P}, CM\overline{U}P, CMUP$
- apply set of cuts according to the type
  - cuts are parameterised as a function of p_T
  - need to be isolation-independent (jet surrounding activity)

CMX latter

How SLT is implemented ?

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Core variables for central muons (so far)

CMU dx: track-stub match

CMU dz: track-stub z match

CMP drϕ: track-stub match

N_{CMU}Hits: binomial

Correlation CMU-CMP

x_i is a set of n uncorrelated variables

$$\chi = \sum_{i=1}^{n} \frac{(x-\mu)^2}{\sigma_i^2}$$

Expected distributions

$$L = \frac{\chi - n}{\sqrt{2n}}$$

Isolation and pT independent

Status & plan of muon SLT

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- Parametrisation is done (CMUP)
  - Using J/Psi$\rightarrow\mu^+\mu^-$, $\Psi\rightarrow\mu^+\mu^-$, Z $\rightarrow\mu^+\mu^-$ (cover p_T from 2 to 40 GeV/c)
  - Performed side-band background substraction
  - Checked for possible η,ϕ,stub z position and correct when necessary

- Got preliminary Likelihood function ready to test/use:
  - Efficiency (J/Psi, Ψ,Z) RunI: 98±1% CMP, 96.1 ±1% CMU
  - Fake rate (generic jet samples: jet 20, jet 50, jet 100)
    - assume that $(\varepsilon_{tagger} \times F_{heavy\ quark})^{generic\ jet} << R_{fake} \times (1 - F_{heavy\ quark})$

$$R_{fake} = \frac{\#tracks\ id\ SLT}{\#\ tracks\ pass\ selection\ criteria}$$

RunI:0.5-1%

Conclusions

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SLT: lepton id of semileptonic b/c decay

Another method to tag b jets for Top analyses

Allows to:

- extend coverage
- cross check taggers (SVX-SLT)
- improve top mass measurement (correct for ν, μ; SLT veto on b-jets)

Run II muon SLT on its way… still lots to do…