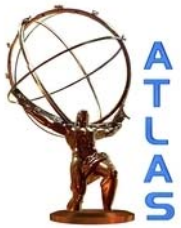

The top quark charge measurement

using semileptonic decay of B-mesons

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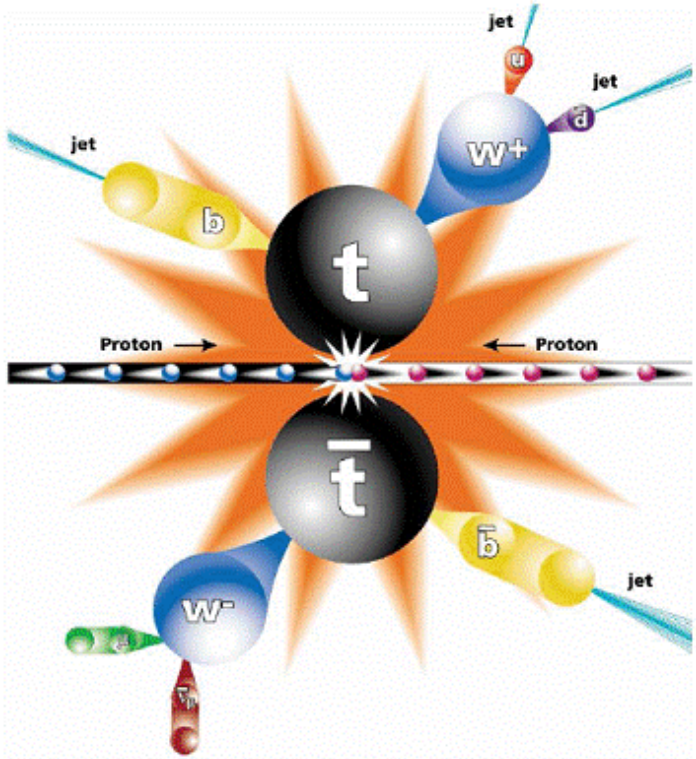
Motivation

- Tevatron experiments have not yet definitively measured top quark with SM 2e/3 charge,
- Possible for exotic -4e/3 charge scenario to exist
- Measurement of the flavour of the original b-jet charge is essential for top-quark charge analysis.
- For other analyses, knowledge from flavour of b-jet can improve sensitivity.



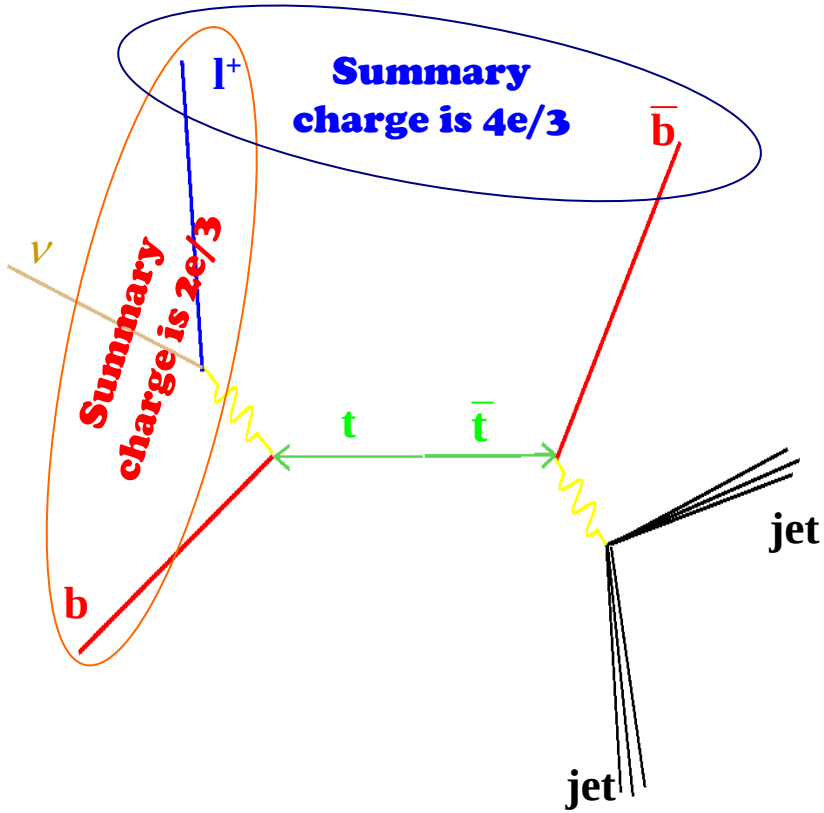
Data sample & Kinematic cuts

- D3PD Ntuples of 105200 sample
  - 10 TeV collisions
  - Top-antitop decays having at least 1 lepton
  - 683.919 events (3.37 fb^{-1})
  - Athena 14.2.25.8

- 1 isolated lepton with Pt > 20 GeV
- 2 and more light jets with Pt > 25 GeV
- 2 b-jets with Pt > 25 GeV
  - B-tagging S1+IP3D. Weight > 4.2
- All objects have |eta| < 2.5
- Missing energy > 20 GeV

Steps towards the top charge measurement

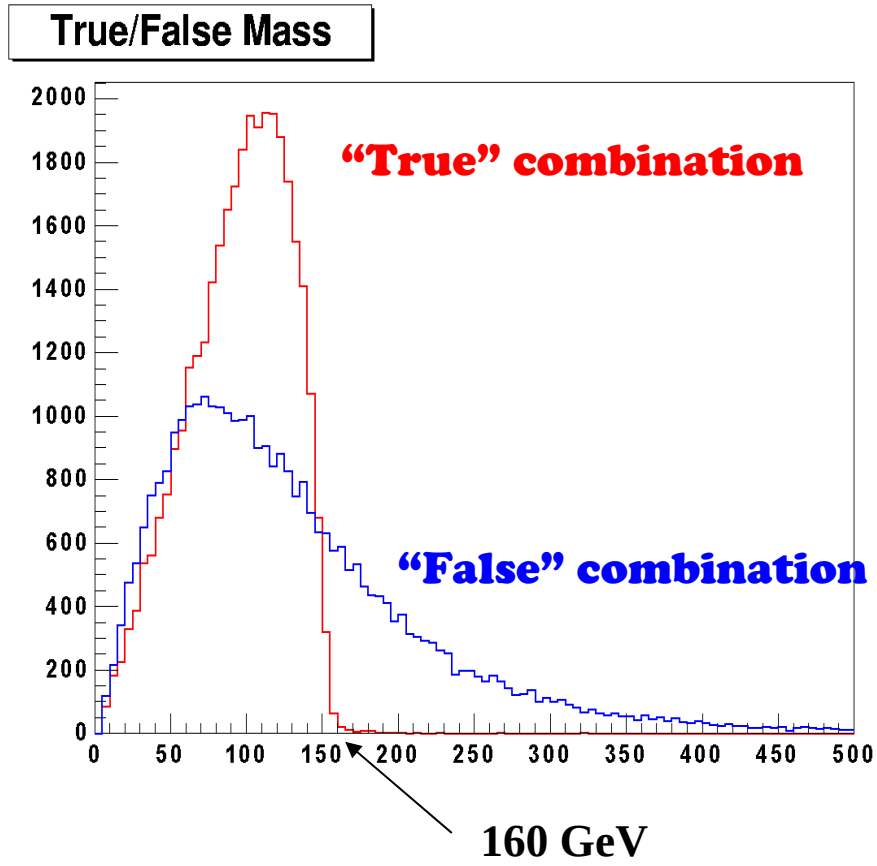
- Top charge is the sum of isolated lepton and b-quark (leptonic top)
- It is not difficult to determine lepton's charge
- Determination of b-quark's charge is more complicated (it hadronizes and produces b-jet)
- We have 2 b-jets and must choose the right one (from the same top as the lepton)



Associate b-jet and the isolated lepton using leptonic top decay

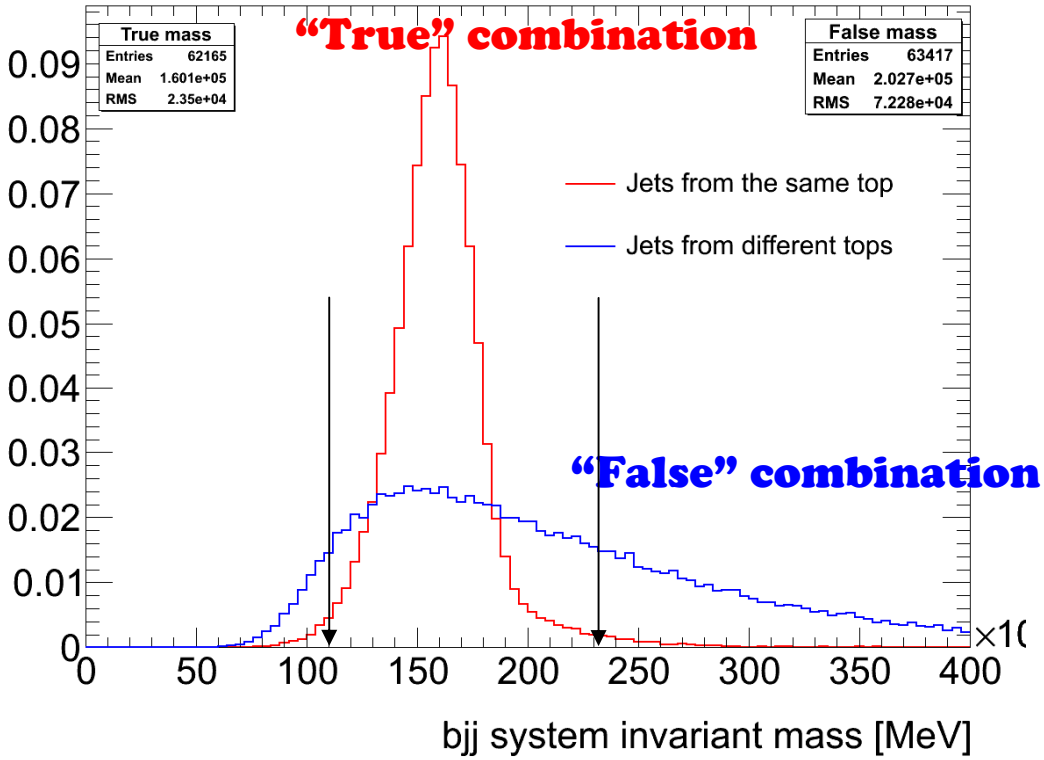
- For "true" combination $m_{lb} < m_{top}$
- For "false" combination m_{lb} can be both < and > than m_{top}

- If $m_{lb_1} < 160$ GeV and $m_{lb_2} > 160$ GeV, then lb_1 is the "true" combination
- Clear but tight
  - Contamination ~5%
  - Cuts 70% of events



Associate b-jet and the isolated lepton using hadronic top decay

- Products of hadronic top decay can also help to associate b-jet and lepton
- We can select the true pairing asking one combination to have invariant mass between 110 and 230 GeV and the another to be outside of this range



Hadronic top decay method

- The following is the procedure of hadronic top decay usage
  - Choose the pair among the light b-jets which has invariant mass closest to known $M_W = 80.4$ GeV
  - If $M_{jj} > M_W \pm 40$ GeV, reject the event
  - Reconstruct invariant mass of these jets together with each of two b-jets
  - If one of combinations have invariant mass within the range (110, 230) GeV and the another outside this range we assume that the one which has it outside is coming from the same top as the isolated lepton

- Apply this method only if the direct lepton b-jet pairing does not give a solution

B-jet charge measurement

- Two methods
  - Charge Weighting method
  - Semileptonic B-decay method

- Weighting method

$$Q_{jet} = \frac{\sum_i q_i \, | \vec{p}_i \, |^k}{\sum_i | \vec{p}_i \, |^k}$$

q_i - charge of i_{th} particle
p_i - momentum of i_{th} particle
k – weighting factor

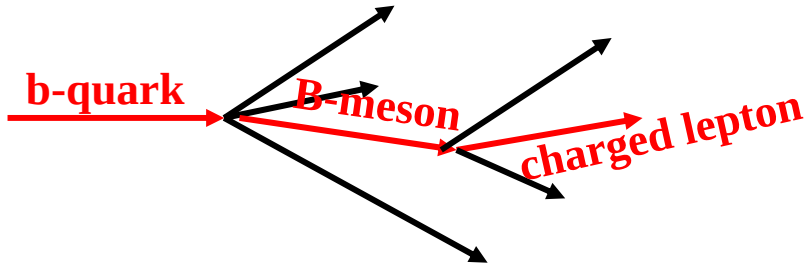
- Summed over all charged particles from jet, in some cone around jet axis. (min track Pt > 500 MeV).

Semileptonic decays of B mesons

- The charge of b-quark, which initiated the b-jet could be determined via semileptonic decay of B-meson inside b-jet

$$b^{-1/3} \to c,u + l^-$$

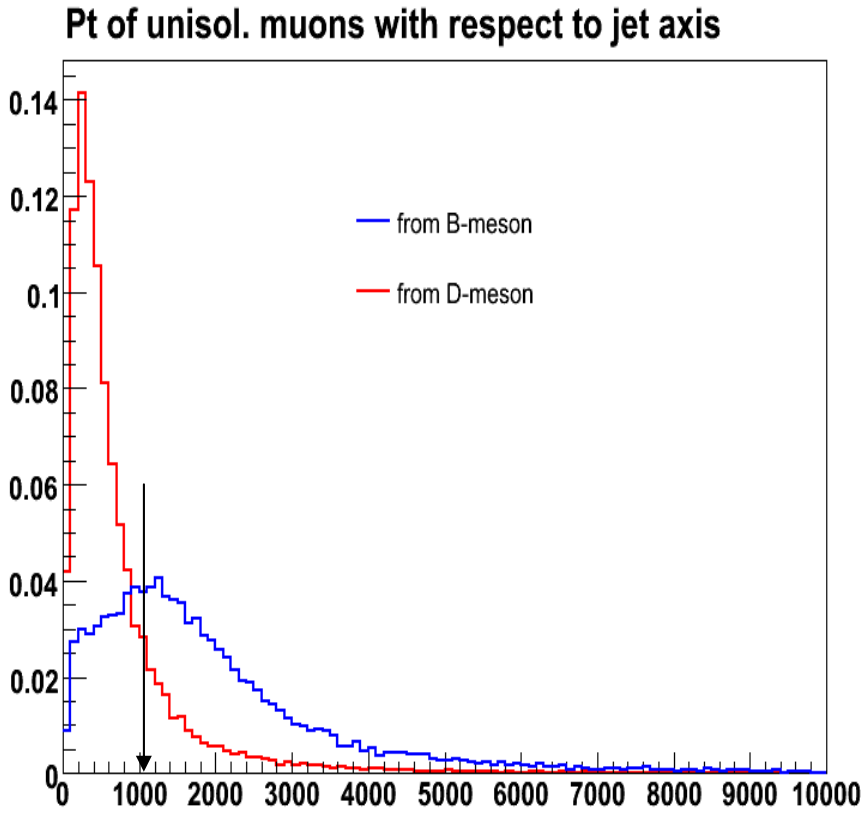
$$\bar{b}^{+1/3} \to \bar{c},\bar{u} + l^+$$



- But the non-isolated lepton inside b-jet does not necessarily have the same sign of charge as b-quark (because of B^0-mesons oscillations and D-mesons semileptonic decay inside b-jet)

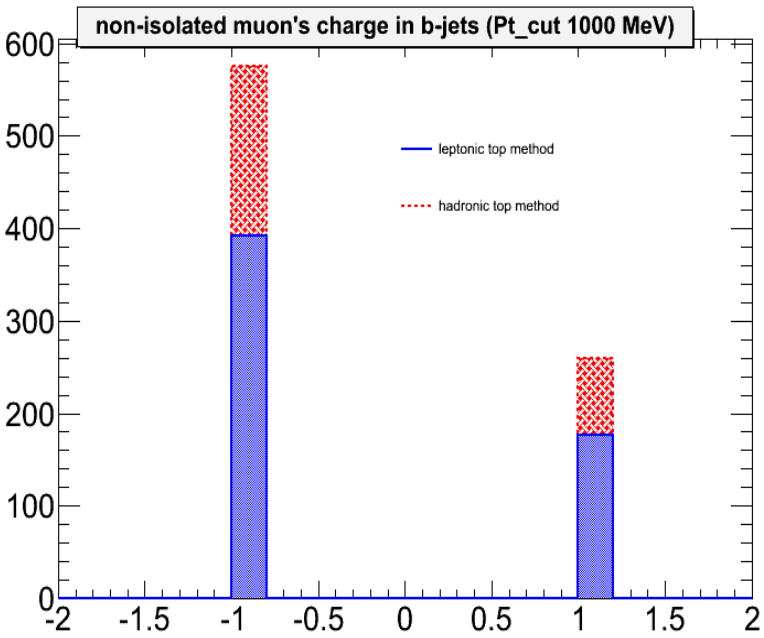
Pt of unisolated lepton with respect to jet axis

- To suppress leptons from D-mesons decay we apply cut on Pt of the lepton with respect to b-jet axis
  - Pt_resp > 1000 MeV
- Since non-isolated electrons are hard to identify, we deal only with muons
- Assume that muon is in the b-jet if it is inside the cone 0.4 around jet axis

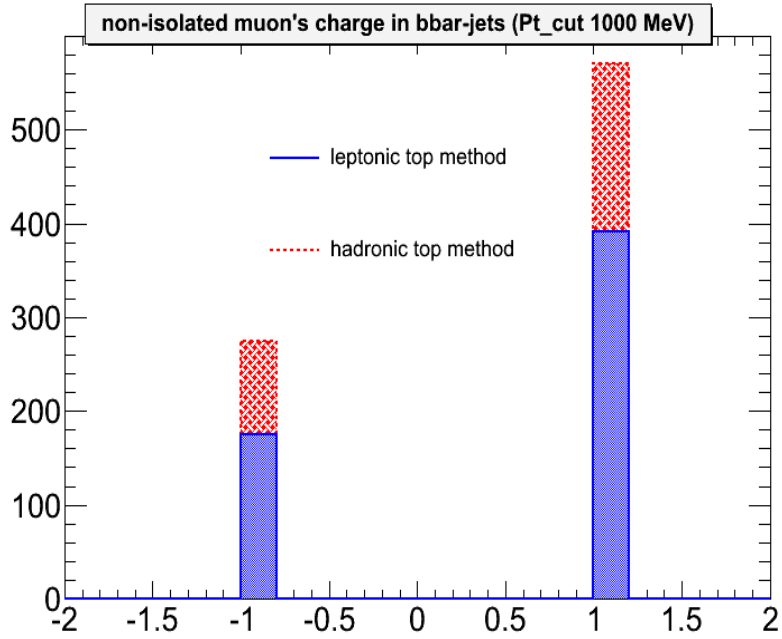


Charge of unisolated muon

Charge of muon inside b-jet, associated with isolated lepton with positive and negative charge



Q_{mean}= -0.38 ± 0.03



Q_{mean}= +0.35 ± 0.03

Conclusions

- Statistics may be increased by 50% when applying hadronic top reconstruction method in addition to the leptonic one.
- The events selected using hadronic top are more contaminated since one has to deal with 3 jets. Contamination with wrong combination for hadronic top method is ~14%, while leptonic top pairing method introduces ~5% contamination.
- With rough estimation we need 200 pb^{-1} data to be able to distinguish between top and exotic scenarios with "semileptonic B-decay" approach
  - Can be used as addition to "charge weighting" method