b-tagging efficiency determination on data

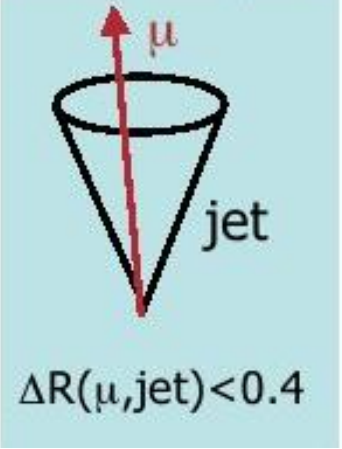
- determination of b-tagging trigger efficiency on single jet
  - $t\bar{t}$ (semileptonic):
    - tag one side, study the other
    - b-tagging not needed to extract the signal
    - only few dozens/hundreds events in $10-100\ pb^{-1}$
  - di-jets:
    - plenty of events
    - enrich in b-jets (non isolated μ+jet)
    - measure b-tagging efficiency using pTrel (fitting pTrel distributions) or system8.

b-tagging efficiency determination on data: system8

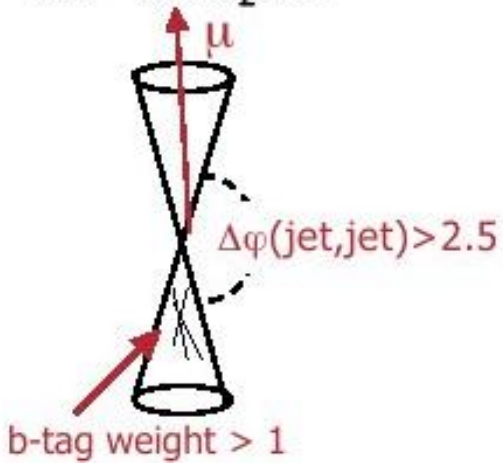
Event Selection

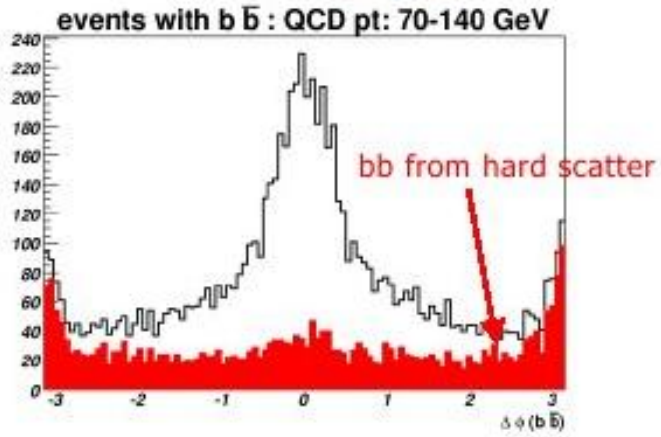
- Using Jets with an associated muons: Muon Jets (MJ)
  - ~20% B-mesons decay semileptonically
- Need different event topologies: different HF content
  - dijets ($\Delta\phi(jj)>2.5$) enriched of bb direct production (DT)

MJ sample



DT sample





System 8

- Relies on **2 taggers** (track based and muon) and **2 samples** (**MJ *n*** and subsample **DT *p*** with opposite track based tagged jet)
- Allows to solve **8 equations** with **8 unknowns:**
- Solved analytically
  - Minuit used to estimate statistical errors
- $n_{Tr,\mu}$ = number of events passing track based or muon tag
- ε, r = efficiency for b (light) quarks
- β, α = efficiency sample dependency for b and light quarks
- k_b, k_{cl} = correlation between muon tag and track based efficiency for b and light quarks
- Two samples must have different b-content, two efficiencies must be different: avoid triviality

$$n = n_b + n_{cl}$$

$$p = p_b + p_c$$

$$n_\mu = \varepsilon^\mu\, n_b + r^\mu\, n_{cl}$$

$$p_\mu = \varepsilon^\mu\, p_b + r^\mu\, p_{cl}$$

$$n_{Tr} = \varepsilon^{Tr}\, n_b + r^{Tr}\, n_{cl}$$

$$p_{Tr} = \beta\, \varepsilon^{Tr}\, p_b + \alpha\, r^{Tr}\, p_{cl}$$

$$n_{all} = k_b\, \varepsilon^\mu\, \varepsilon^{Tr}\, n_b + k_{cl}\, r^\mu\, r^{Tr}\, n_{cl}$$

$$p_{all} = k_b\, \beta\, \varepsilon^\mu\, \varepsilon^{Tr}\, p_b + k_{cl}\, \alpha\, r^\mu\, r^{Tr}\, p_{cl}$$

- For this study:
  - All coefficients set to 1
  - **Track based tagger: w > 4.**

5

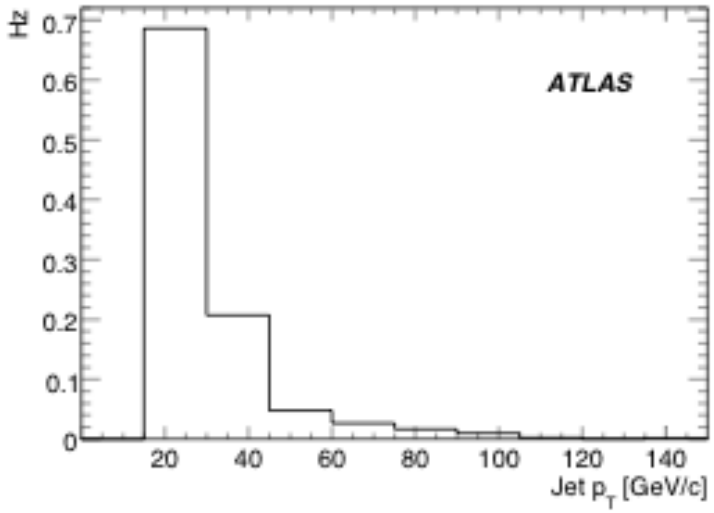
Efficiency error of about $\sim$ 5% with 15k muon-jet events.

b-tagging efficiency determination on data: trigger aspects

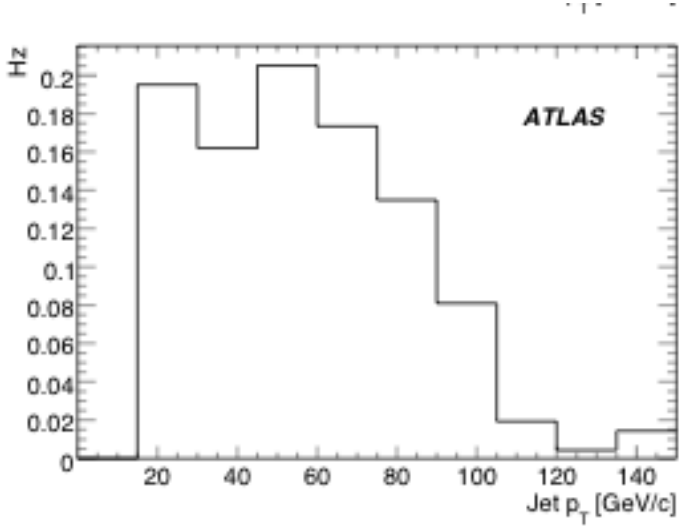
Dedicated trigger to select only useful events (bandwith for calibration trigger is small $\sim$ $1Hz$). Match L2 muon (mu4) with jet RoI (J10) $\rightarrow$ purity moved from 20% (L1_MU4_J10) to about 80% (L2_mu4_J10_matched)

Further evolution: combination of different jet thresholds in order to get an "almost" uniform distribution on the jet E_T $\rightarrow$ b-tagging efficiency can be determined with similar efficiency over a large E_T interval.

L2_mu4_J10



Multithresholds trigger



b-tagging efficiency on data: further developments

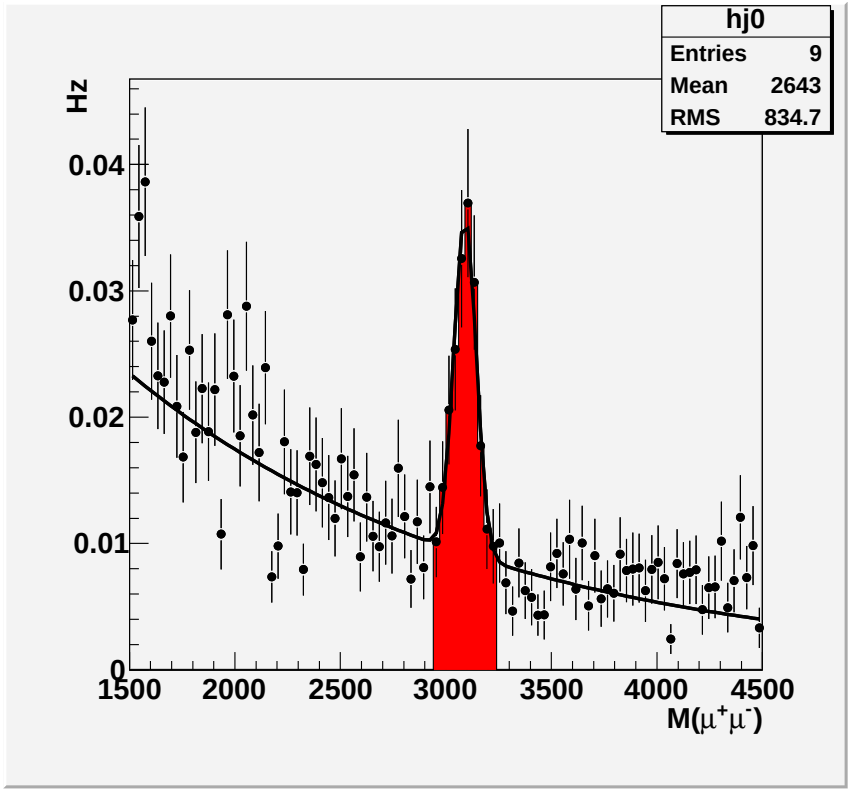
Enhance $b\bar{b}$ fraction:

- J/psi
  - pros: the signal events only contains b-jets and non b-jets (without secondary vertices)
  - cons: lower statistics (w.r.t. semileptonic)
- $D\ell$ ($D^0\ell$ first option to investigate)
  - pros: the signal events only contains b-jets (with very good approximation). Tag and probe possible !
  - cons: lower statistics (w.r.t. semileptonic), no specific trigger to enhance this contribution

Explore different "systemN" options

b-tagging efficiency on data: J/ψ

First study using dijets sample filtered with one "true" muon



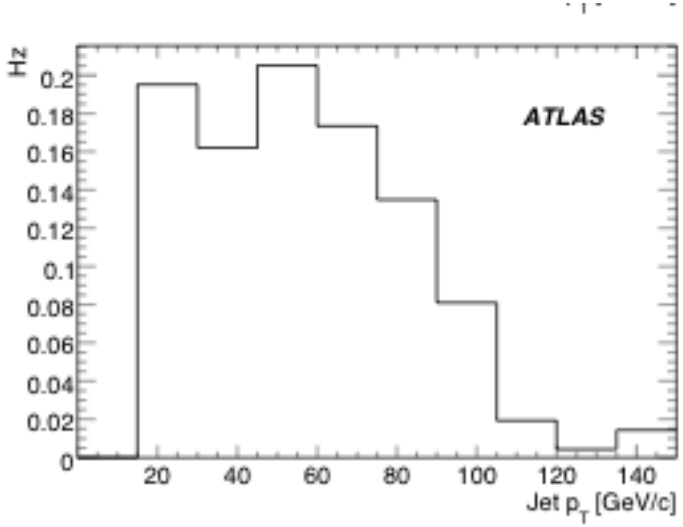
0.12 Hz in the peak (the only usable statistics)
0.21 Hz under the peak

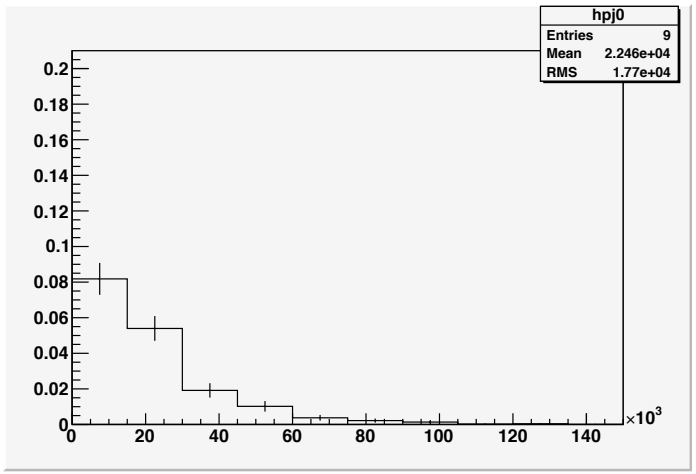
b-tagging efficiency on data: J/ψ

p_T distribution of the jet containing the J/ψ.

Multithresholds trigger

$J/\psi + X$





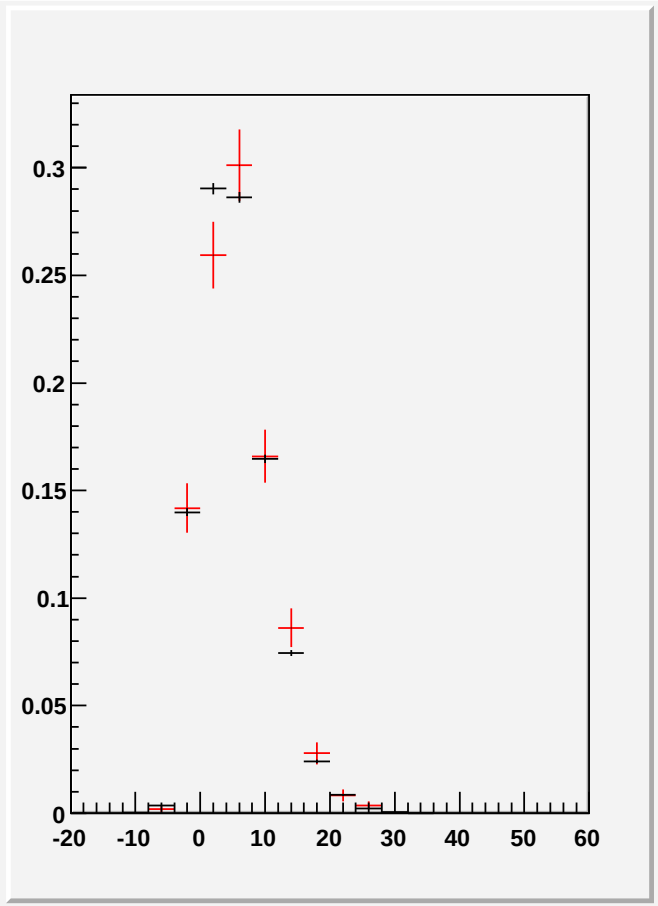
Contribution only at low p_T.

b-tagging efficiency on data: bias on J/Psi jets ?

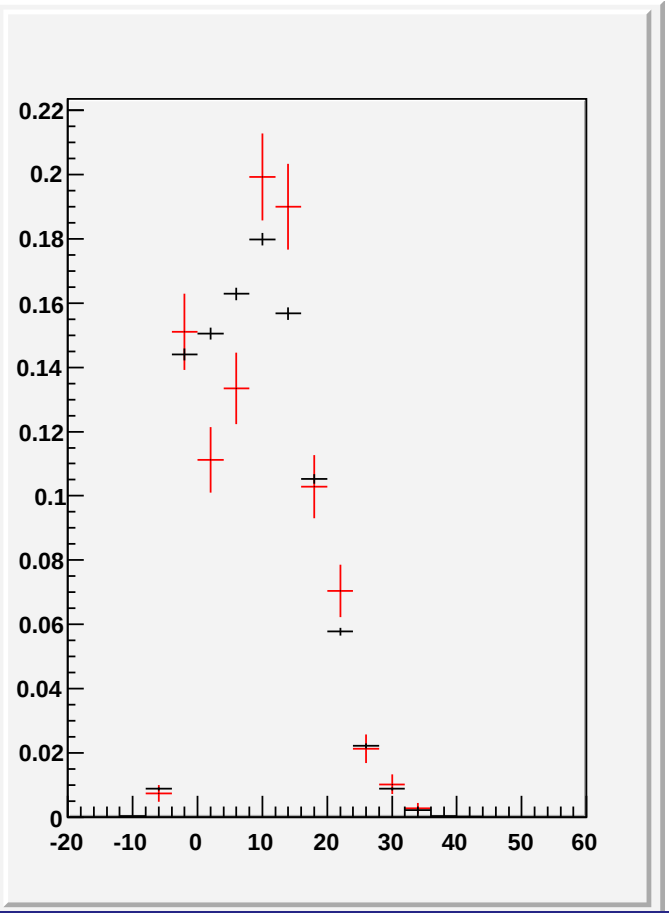
(Bianca)

jets having a J/Psi in the cone all jets

IP3D



IP3D+SV1



b-tagging efficiency on data: J/Psi

System8-like analysis with J/Psi doesn't seem very promising (mainly because of the statistical argument).

Other option would be to perform a pTrel-like analysis using the J/Psi proper time distribution (back-ground substracted).. Same problem as pTrel (with lower statistics): MC parametrization.

b-tagging efficiency on data: systemN

Possible extensions:

- use more sub-samples (>2) with different purities
- use samples with cascade semileptonic decay

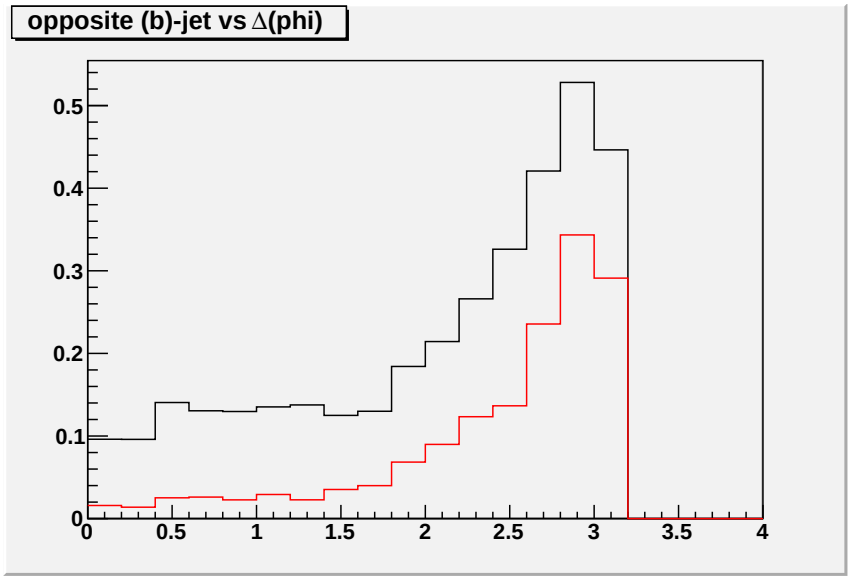
This requires Minuit implementation of system8 (work started by Elisa).

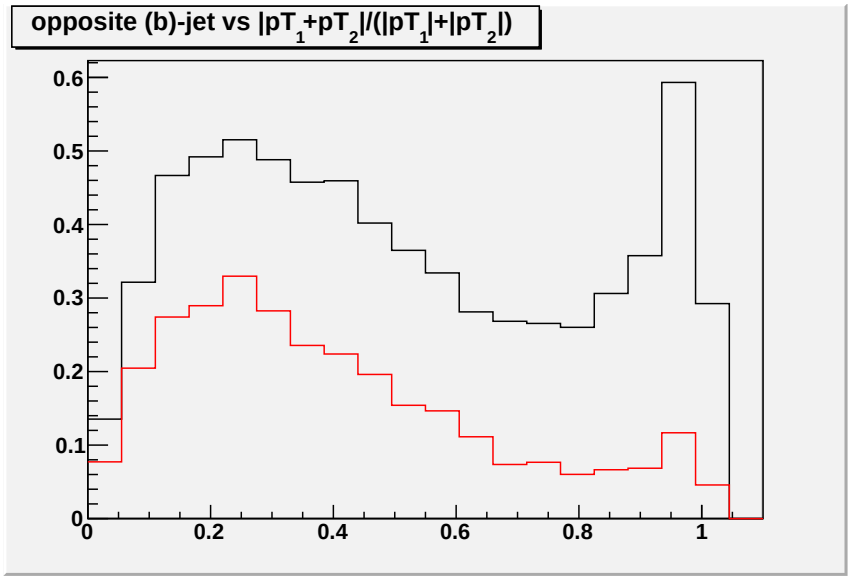
b-tagging efficiency on data: use back-to-back jets ?

This question can be rephrased to: why people decide to use system8 instead of tagging very tightly one jet and looking to the opposite jet ?

Take one *b*-jet and look to the flavor of other jets (*b* light)

All jets





b-tagging efficiency on data: use back-to-back jets ?

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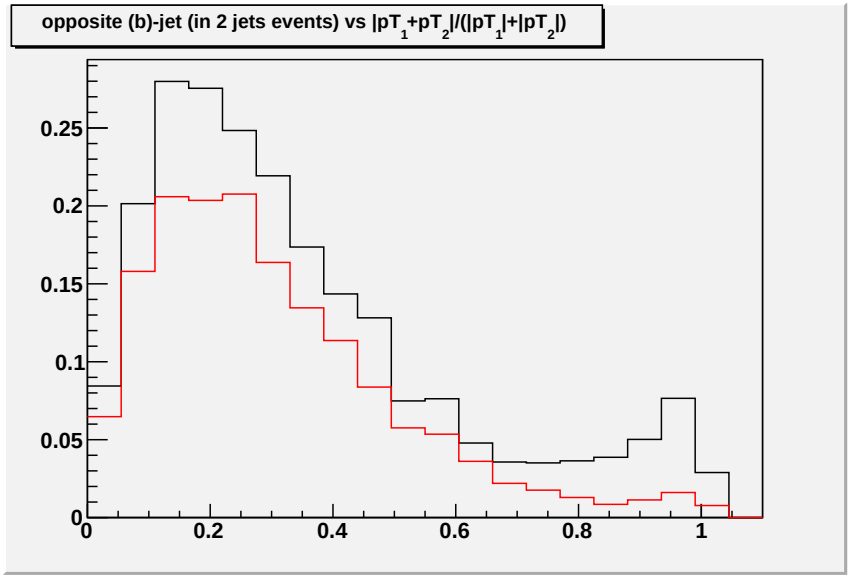
Take one *b*-jet and look to the flavor of other jets (*b* light)

Only 2 jets in the event



b-tagging efficiency on data: use back-to-back jets ?

This question can be rephrased to: why people decide to use system8 instead of tagging very tightly one jet and looking to the opposite jet ?

Take one *b*-jet and look to the flavor of other jets (*b* light)

Only jets having one lepton in the cone