Branching Ratio Of Fully Leptonic To Semi Leptonic $t\bar{t}$ Decays

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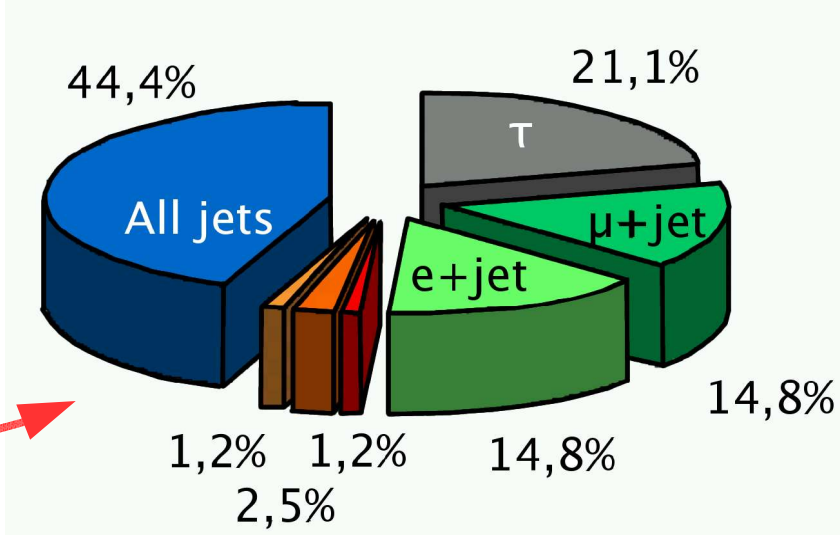
- semi leptonic and dileptonic decays
- why a measurement of the ratio?
- early results in the semi leptonic channel
- topological variables
- outlook

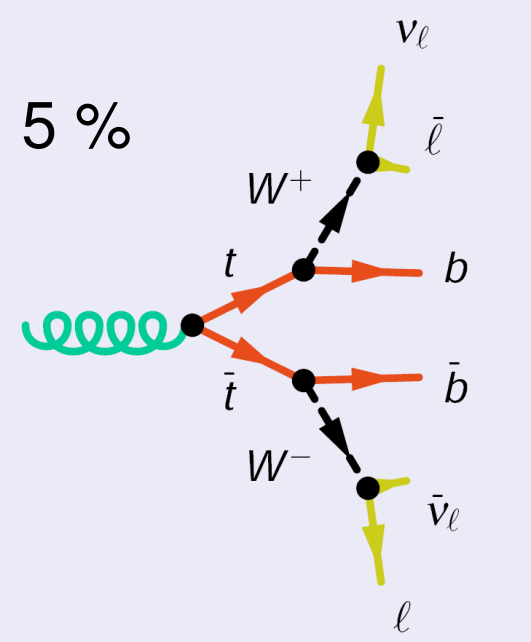
$t\bar{t}$ decays

t	→	W + b	(≈100%)
		$W \to e,\mu,\tau + \nu$	(each 1/9)
		$W \to q\bar{q}$	(2/3)

combinatorics

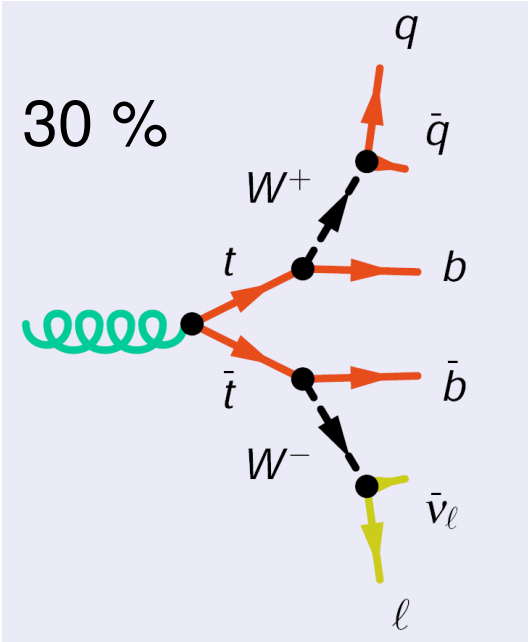


dileptonic decay



	signature	
2	jets	4
2	thereof b-jets	2
2	charged Lept.s	1
2	missing E_T	1

semi leptonic decay



Advantage Of A Ratio Measurement

compensate:

- experimental uncertainties, e.g.

luminosity (as $N = \sigma \cdot \int \mathcal{L}\, dt$)

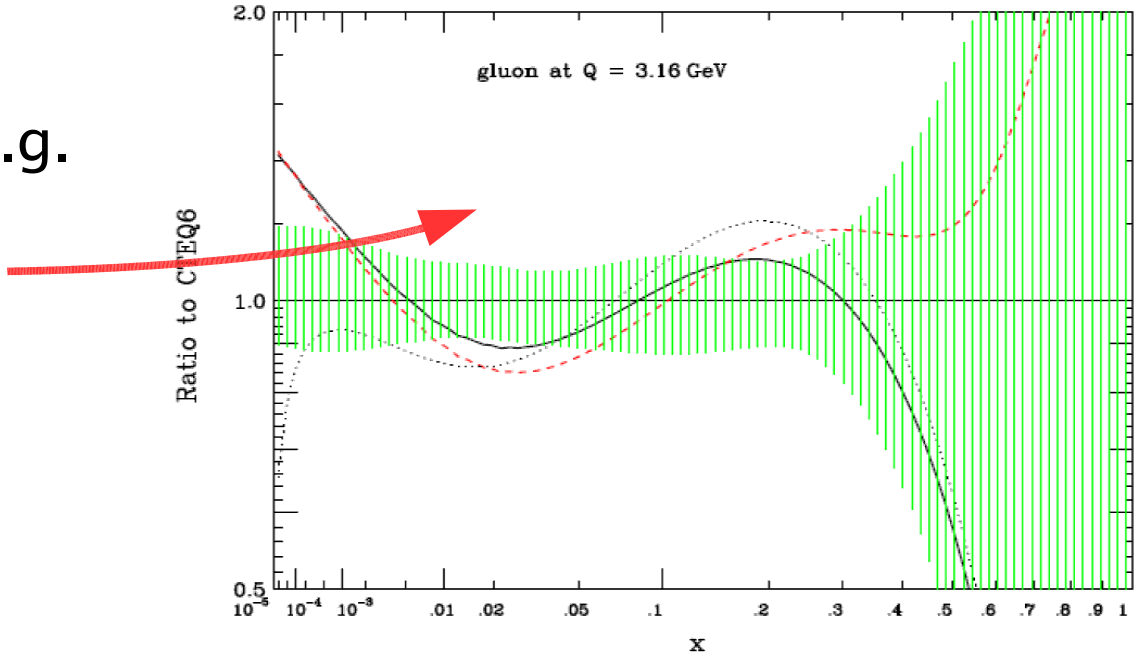
energy and momentum scale uncertainties

(might affect counting efficiencies)

- theoretical uncertainties, e.g.

parton density functions

unknown effects of higher order

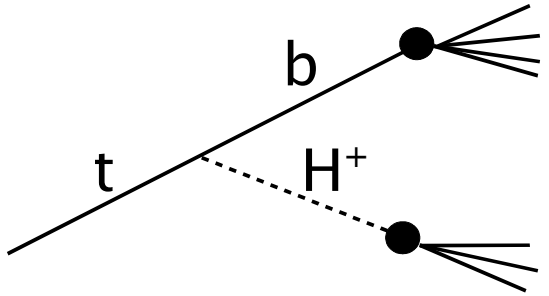


BUT: two channels

Branching Ratio Full Leptonic / Semi Leptonic

SM expectation: $R_{\ell\ell/\ell} = \frac{BR(t\bar{t}\to 2l+2\nu+2q)}{BR(t\bar{t}\to l+\nu+4q)} = N_{\ell\ell} / N_{\ell} = 1/6$ (LO)

discrepancies due to rare top decays, e.g.



$t \to H^+ + b$

$H^+ \to \tau\nu,\ c\bar{s}$

▶ deficit of electrons and muons

stat. precision @ 1 year with $\int \mathcal{L}\, dt = 10\ fb^{-1}$:

$\Delta R_{\ell\ell/\ell} / R_{\ell\ell/\ell}$ (stat.) ≈ 0,5% (source:TDR)

cuts: $p_T(\ell) > 20GeV$, $\not{E}_T > 20GeV$,

min. 2 b-jets with $p_T > 20GeV$

But now we want to do it with full simulation (& without b-tagging)!

Signal MCs

Rome production:

semi leptonic: 4520.ttbarWm, 4521.ttbarWp

fully leptonic: 4522.ttbar_lep (official?)

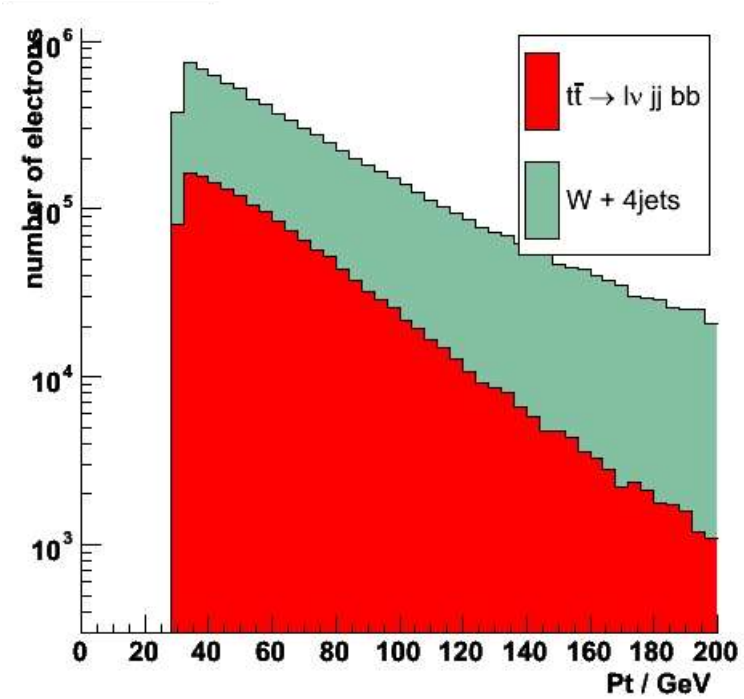
(/castor/cern.ch/user/r/resende/dilep/rome.004522.aod.ttbarWm_lep._00*.pool.root)

Background MCs

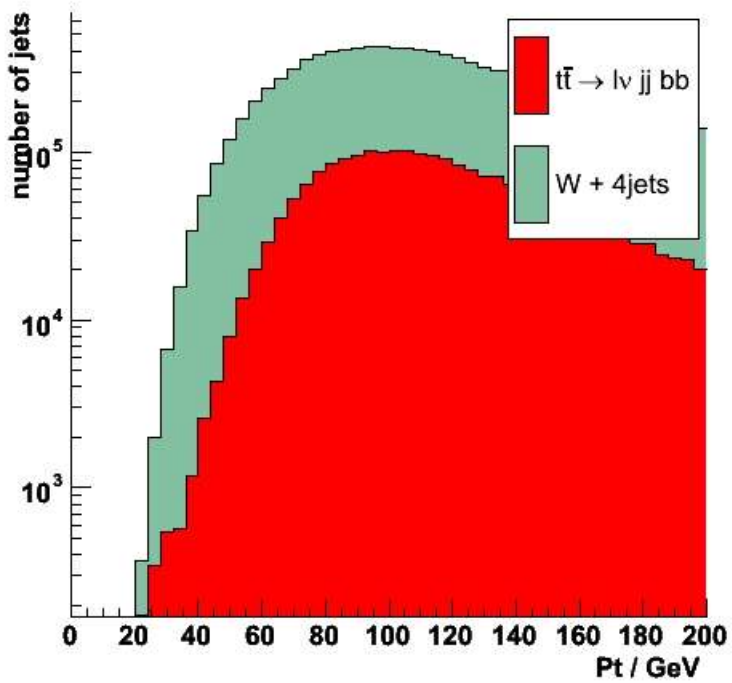
	Rome MCs:	not available:
semi lept.:	W + 4jets	W + n jets (later in CSC) QCD n jets (statistics!)
all lept.:	Z + jets WW, ZW, ZZ	

P_T distributions with P_T cut only

Lead. Electron Pt

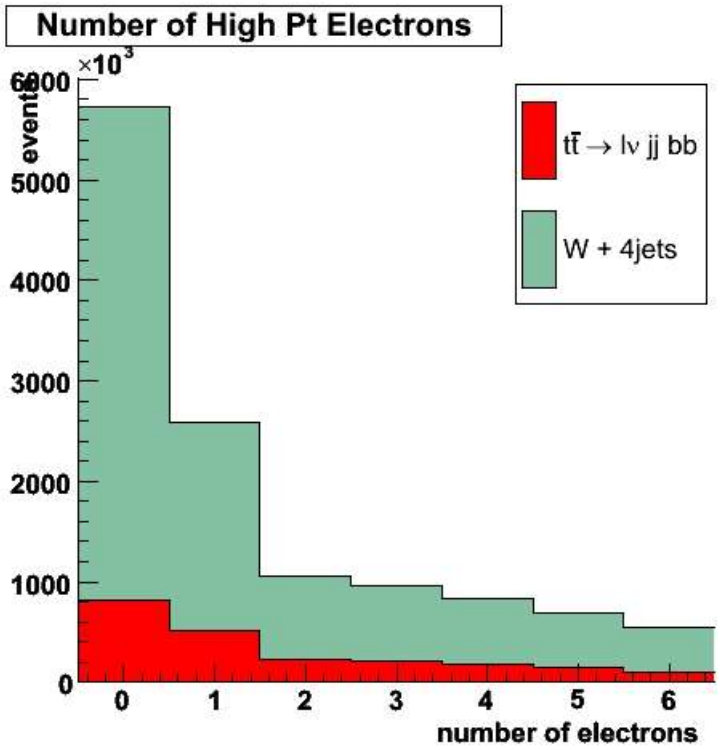


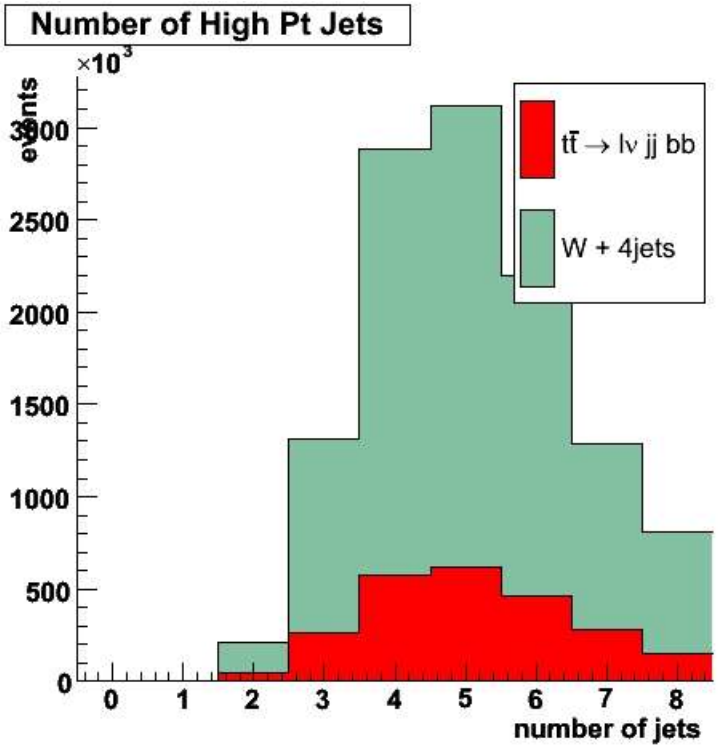
Lead. Jet Pt



W + n jets not complete & no QCD background

Frequencies in the Semi Leptonic Channel





electrons with $P_T > 30$ GeV
(similar for muons)

jets with $P_T > 20$ GeV
(kT-algorithm)

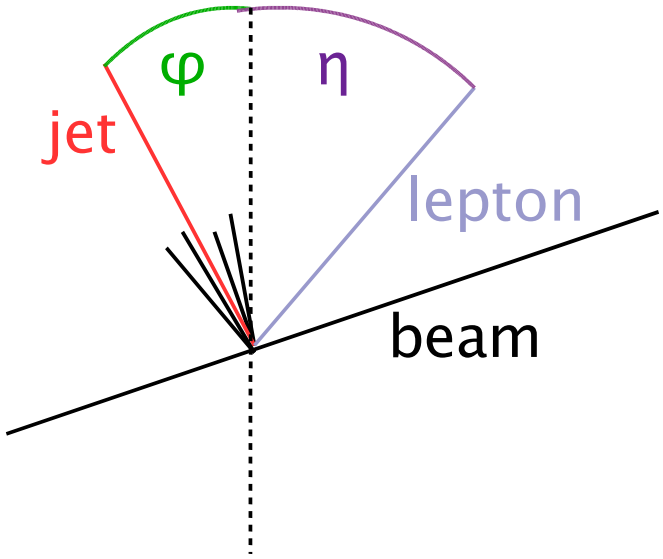
- take events with exactly 1 high energetic lepton (e, μ) and 3 – 7 high energetic jets

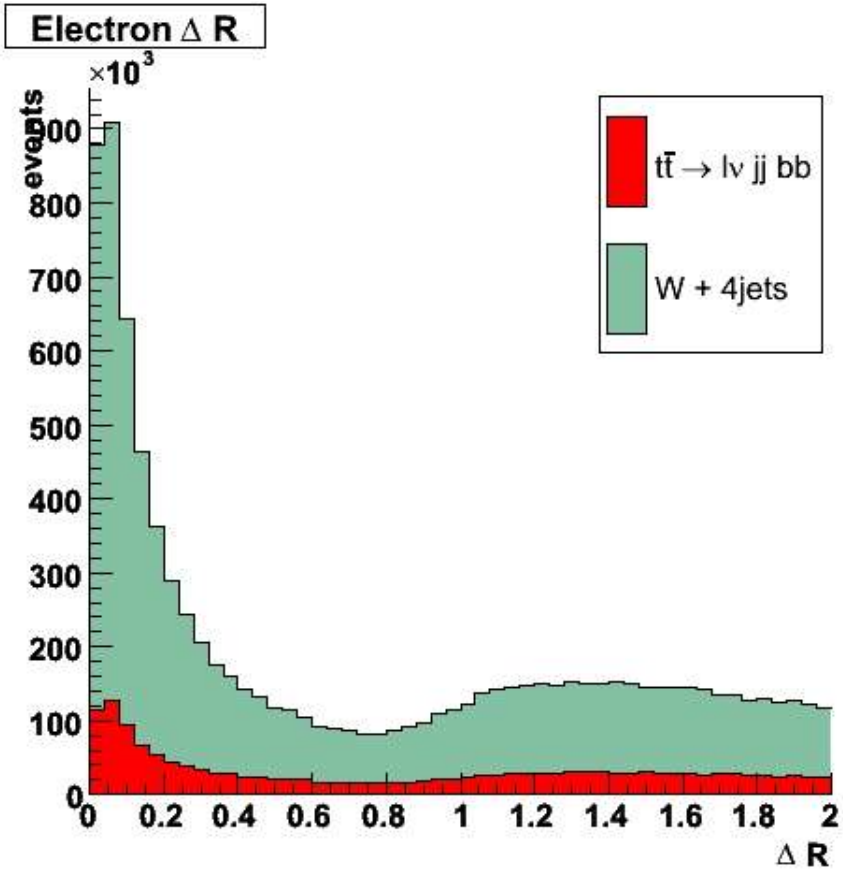
Lepton Isolation

simple observable:

min. ΔR to jet axes

$$\Delta R^2 = \Delta\varphi^2 + \Delta\eta^2$$



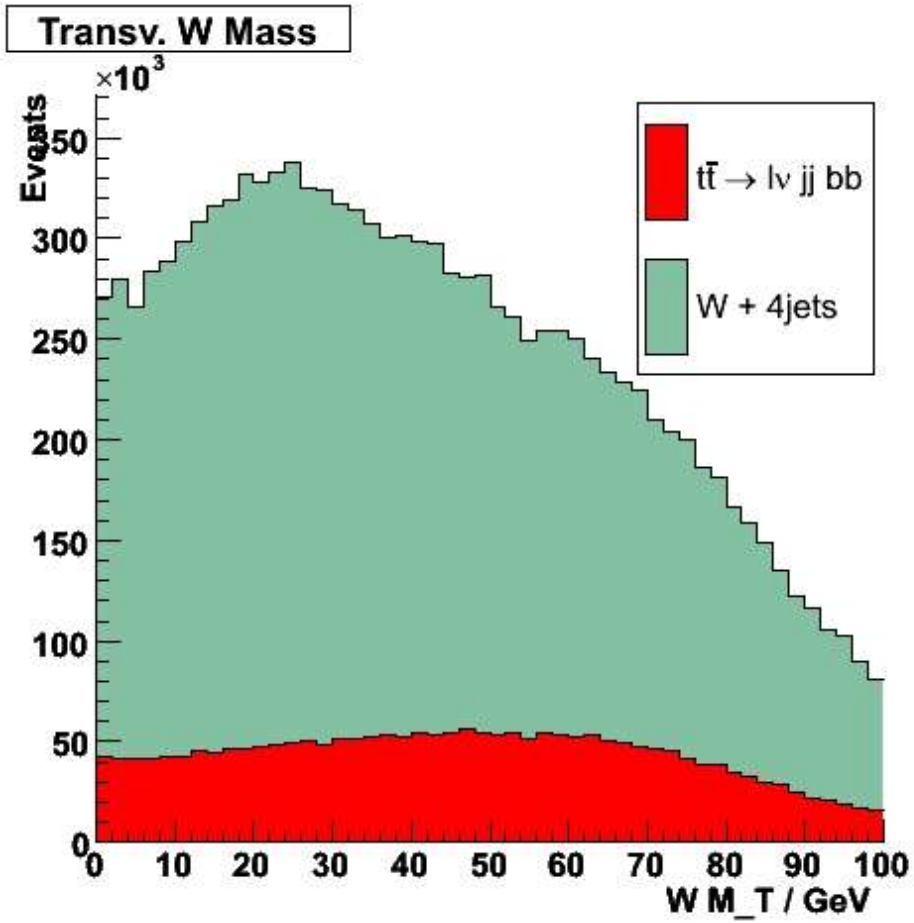


- From D0 experience: ΔR > 0.4 cut reduces QCD background

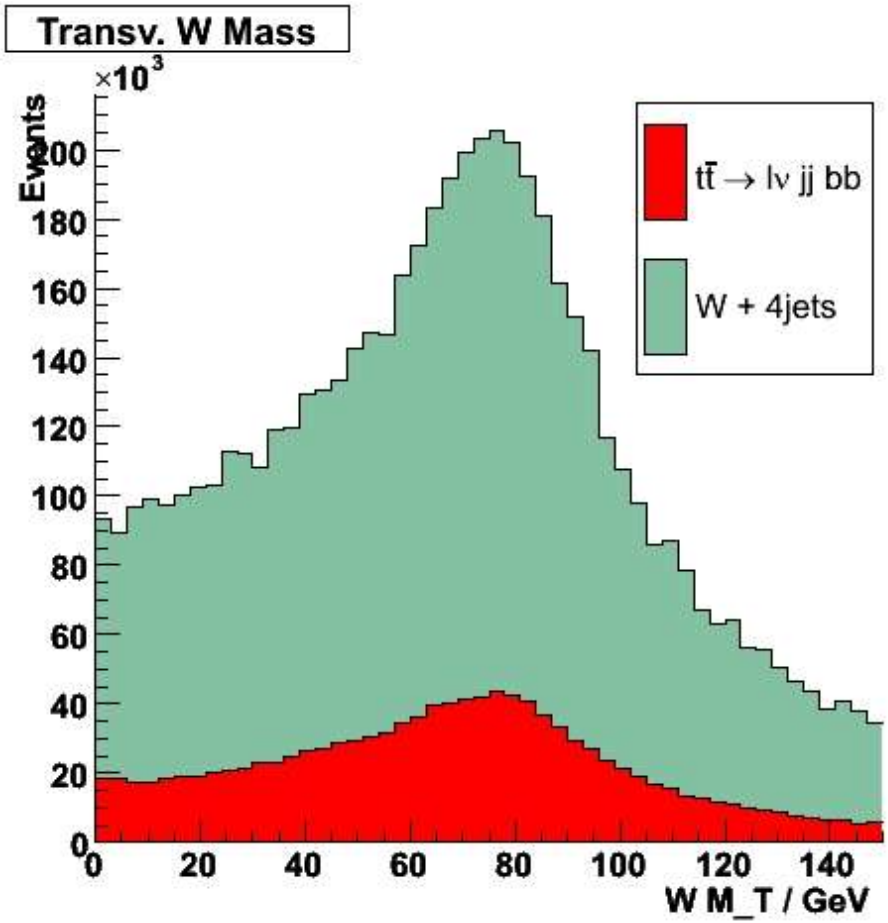
Transversal W Mass

M_T from leading lepton (e, μ) and missing E_T:

without ΔR cut



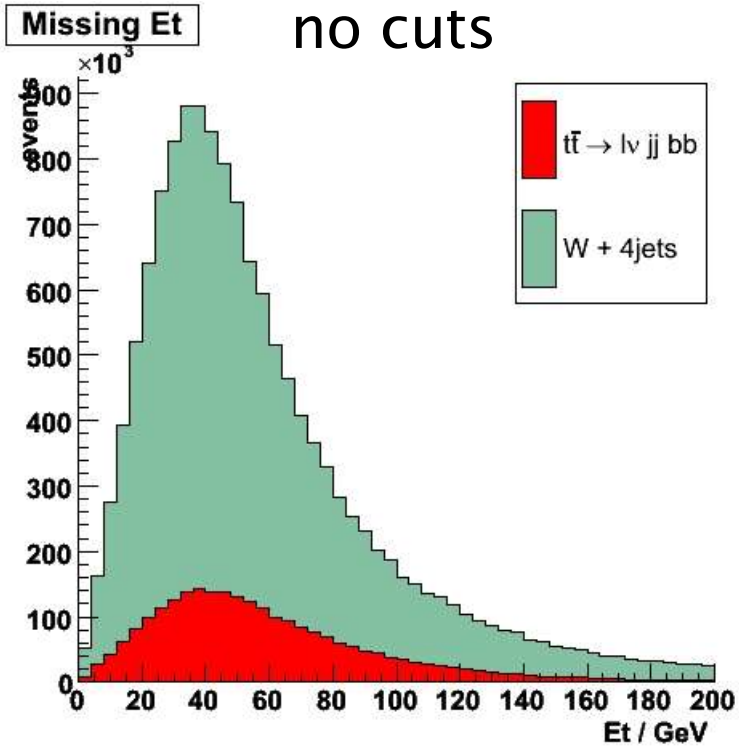
with min. ΔR(Lept., Jet) > 0.4 cut



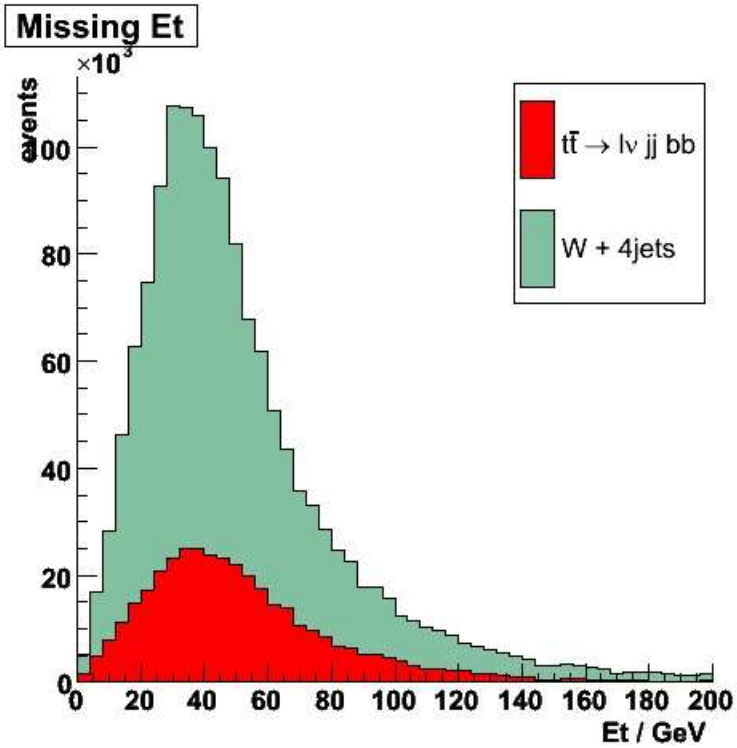
Application Of The Cuts

Example: missing transversal energy (expected from neutrinos)

no cuts

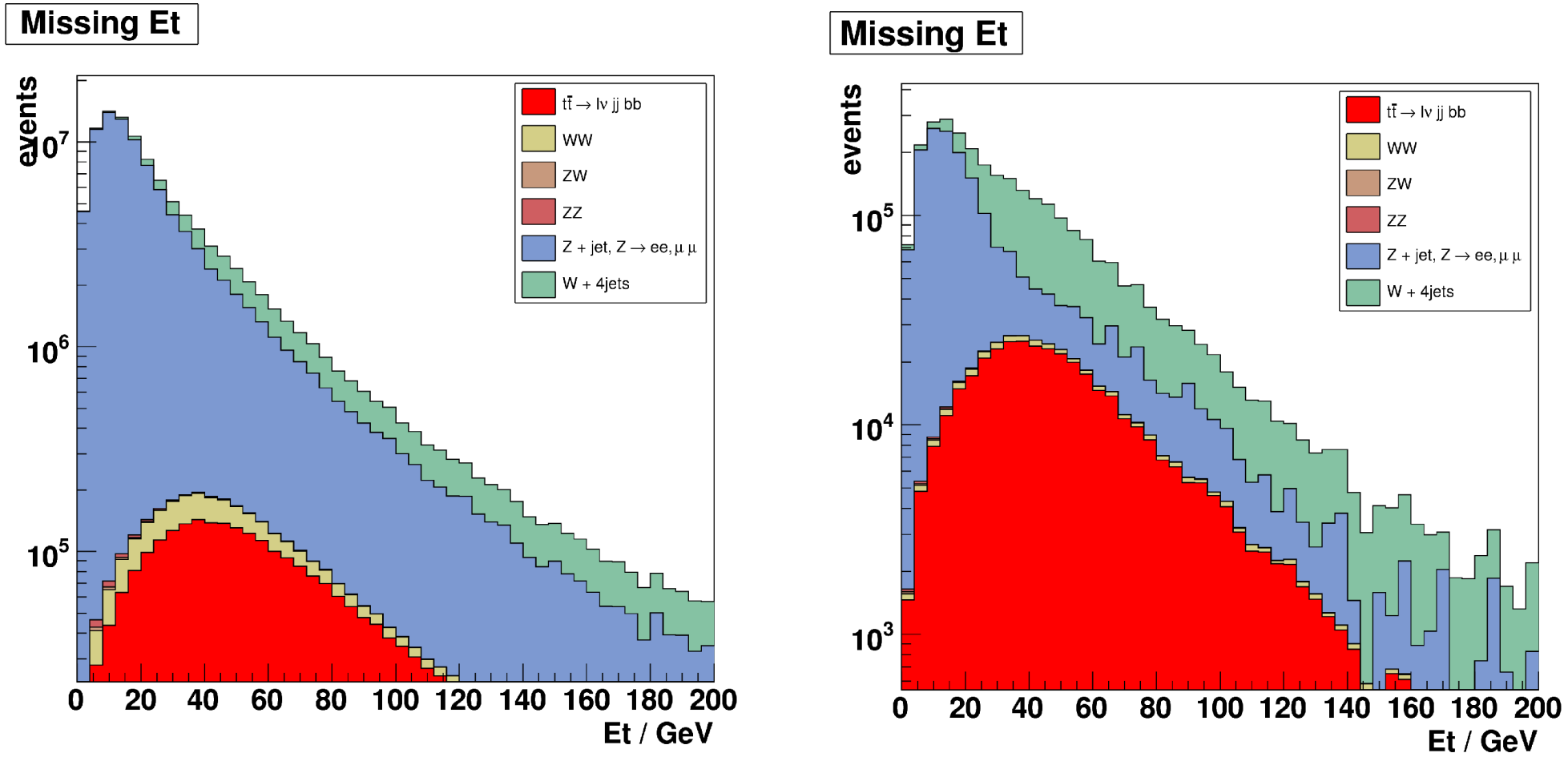


1 lepton with P_T > 30 GeV
3–7 jets with P_T > 20 GeV
min. ΔR(Lept., Jet) > 0.4



only slight improvement
(no surprise as W+4jets is irreducible)

With Some Reducible Backgrounds

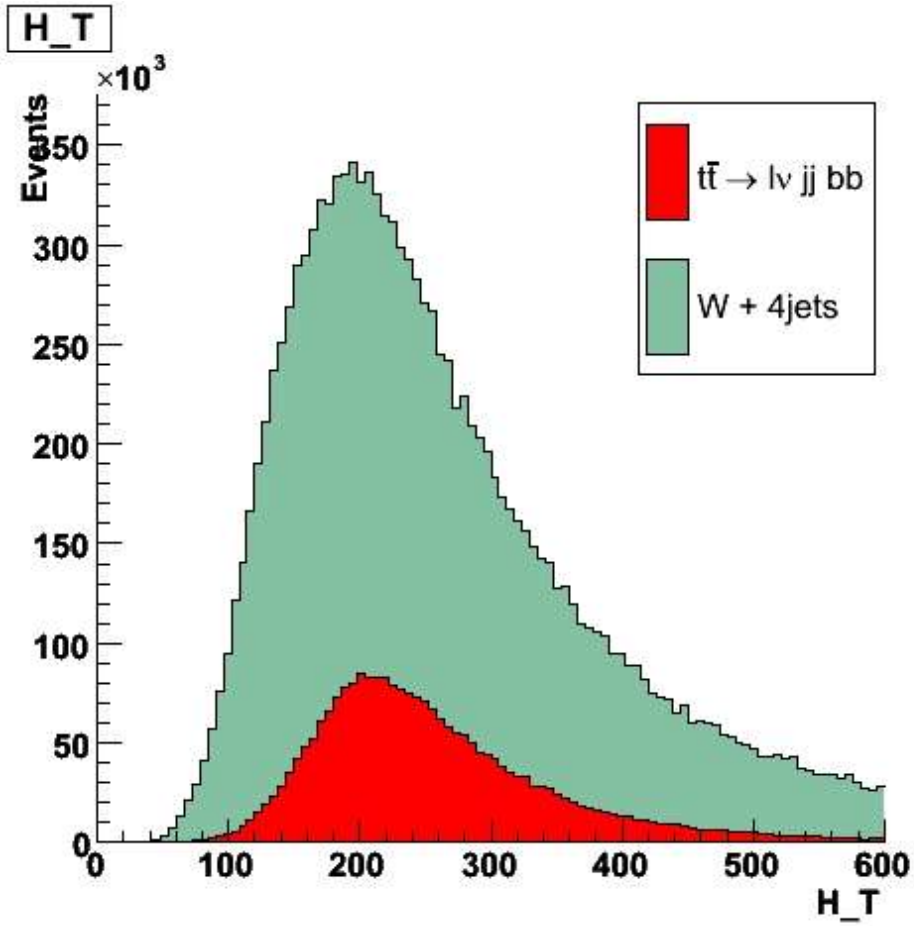


cuts from previous slide suppress reducible backgrounds as Z + n jets & WW

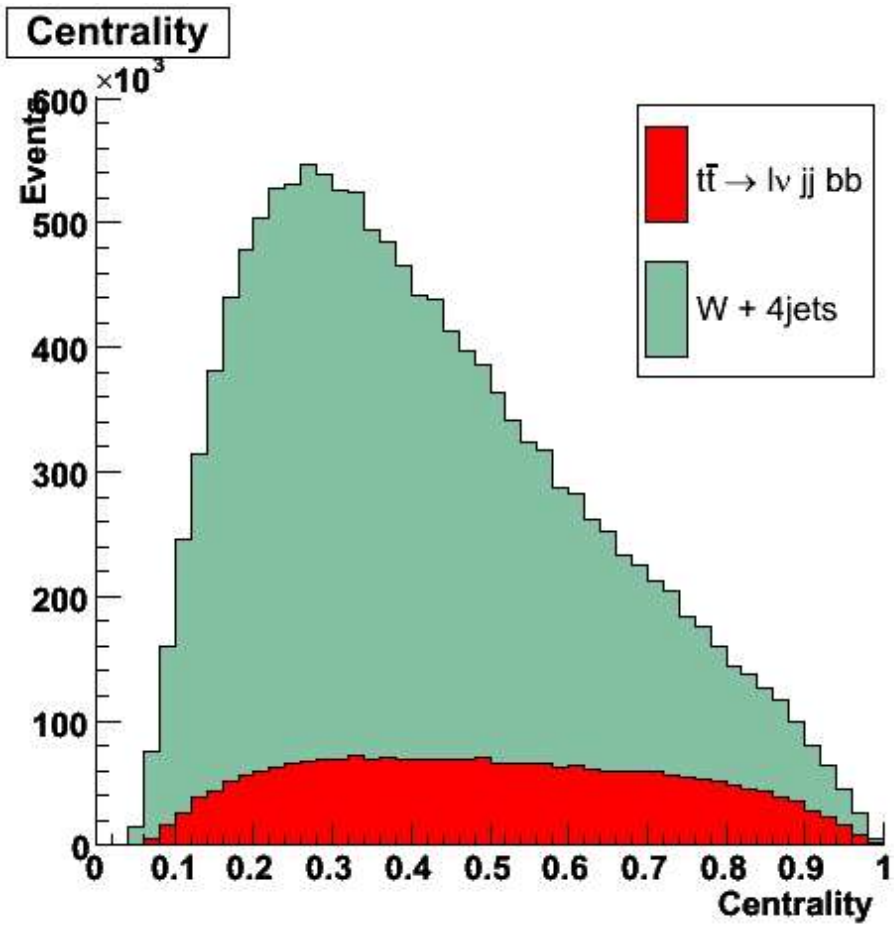
D0 experience: only W + jets & QCD relevant in the end

Topological Variables

H_T: scalar sum of the 4 lead. jet P_Ts



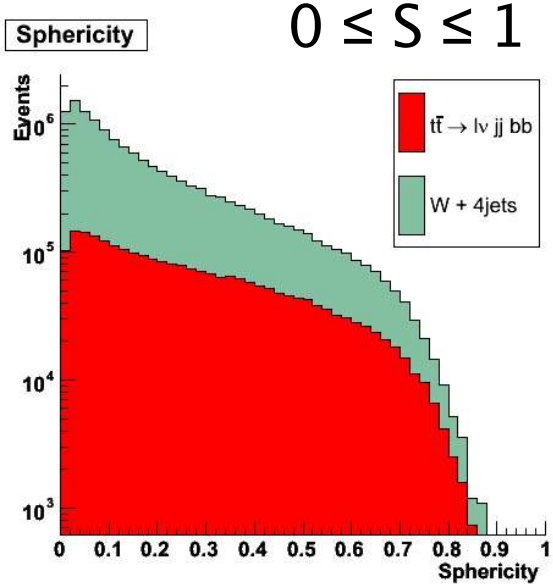
Centrality: H_T/H
H: scalar sum of jet energies



Topological Variables

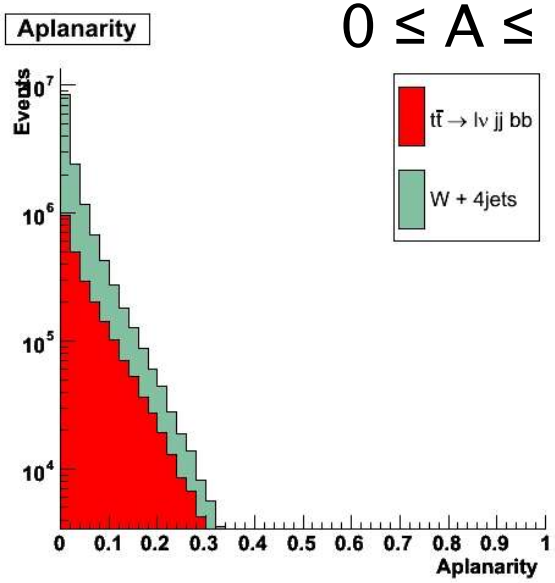
Sphericity: how spherical is event

$0 \leq S \leq 1$



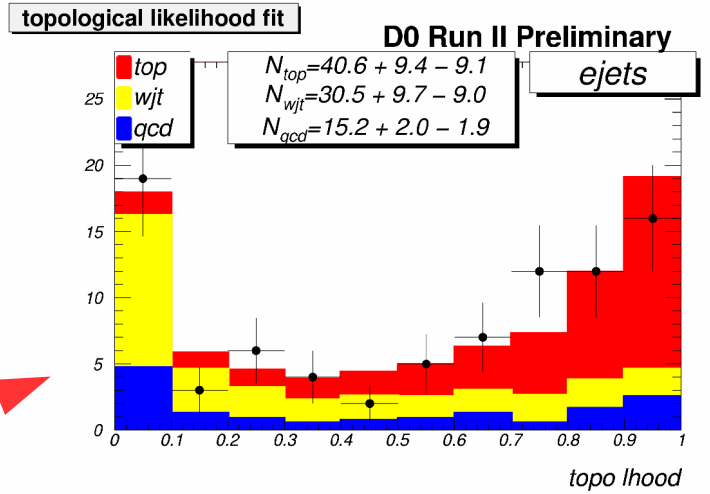
Aplanarity: deviation from plane event

$0 \leq A \leq 0.5$



Aim to do it like D0:

several topological variables
in topological likelihood fit
allows for good signal / background separation

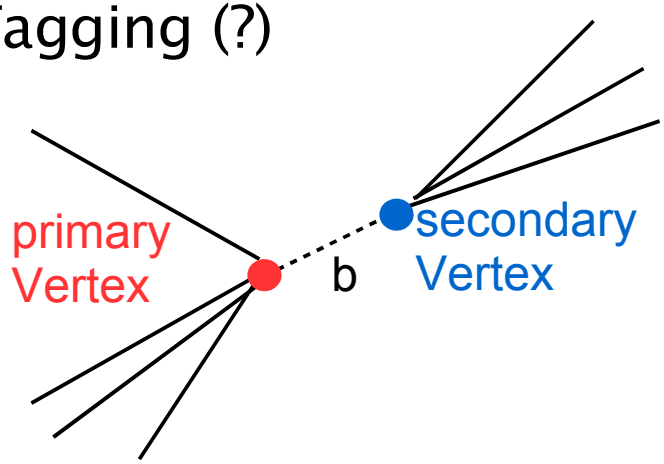


Outlook / Next Steps

- continue semileptonic and start fully leptonic channel
- complete the backgrounds (W + n jets, QCD)

  what about QCD? ATLFAST, generator level only?

- b-Tagging (?)



- include trigger information

▶ aim: measure the ratio $R_{\ell\ell/\ell} = \frac{BR(t\bar{t} \to 2l + 2\nu + 2q)}{BR(t\bar{t} \to l + \nu + 4q)}$

in the early phase of ATLAS & LHC