

Validation of CDF single-top signal samples with NLO differential cross sections

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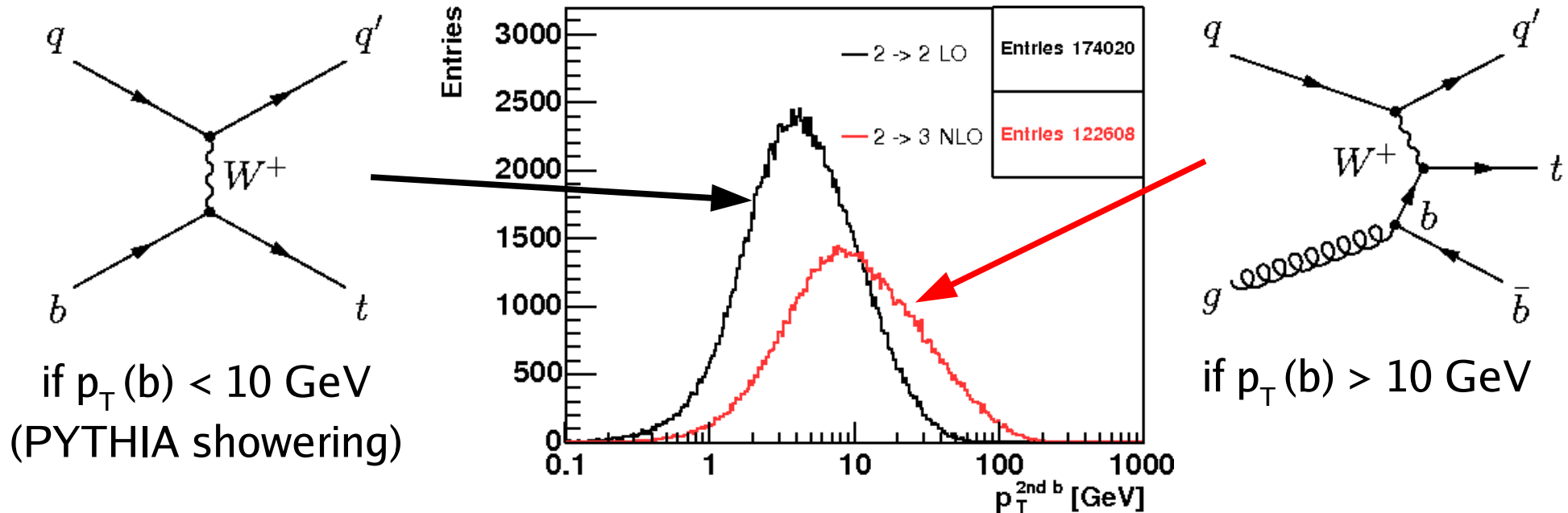
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Tev4LHC Workshop

10/20/2005

MadEvent: MC Event generator by F. Maltoni, T. Stelzer

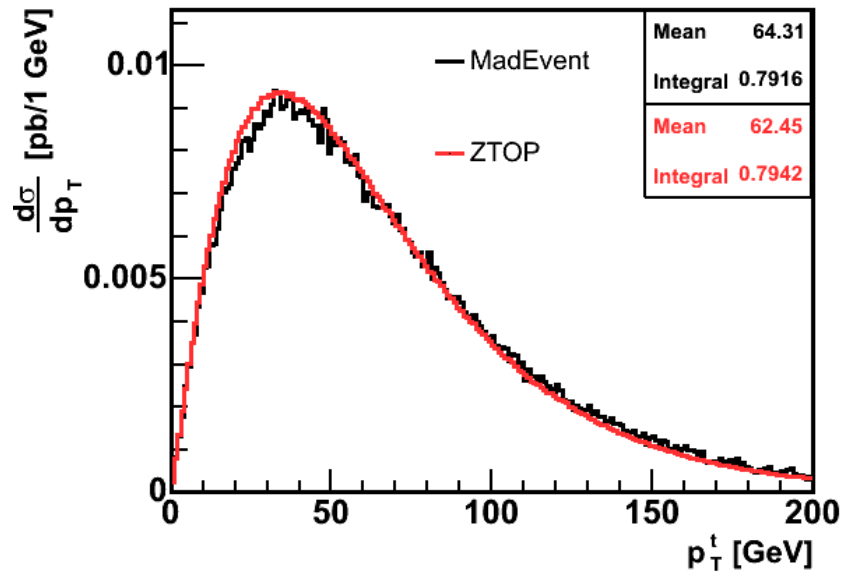
t-channel matching according to Boos/Dudko/Savrin CMS Note 2000/065



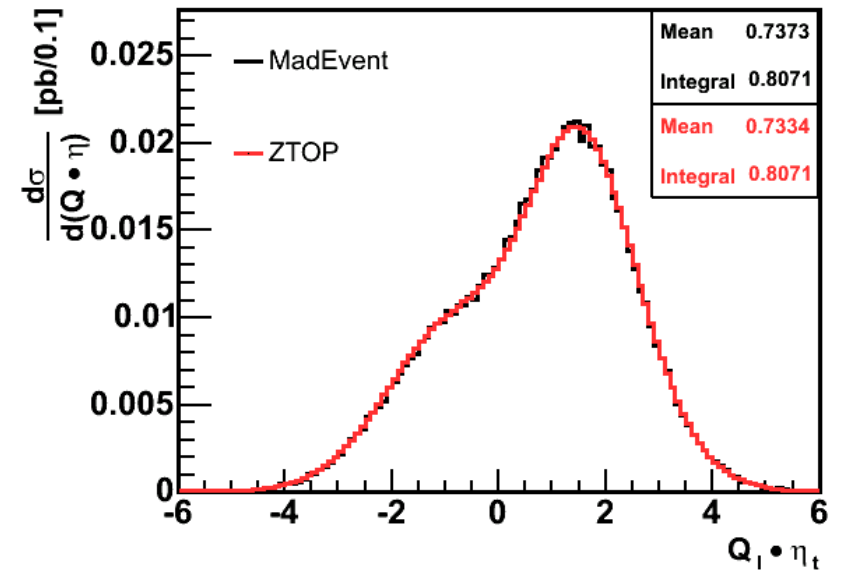
ZTOP: Software by Z. Sullivan calculating NLO-distributions (p_T , η) of top quark, p_T -leading jets and p_T -2nd-leading jets. It does not decay the top quark.

Comparison with:

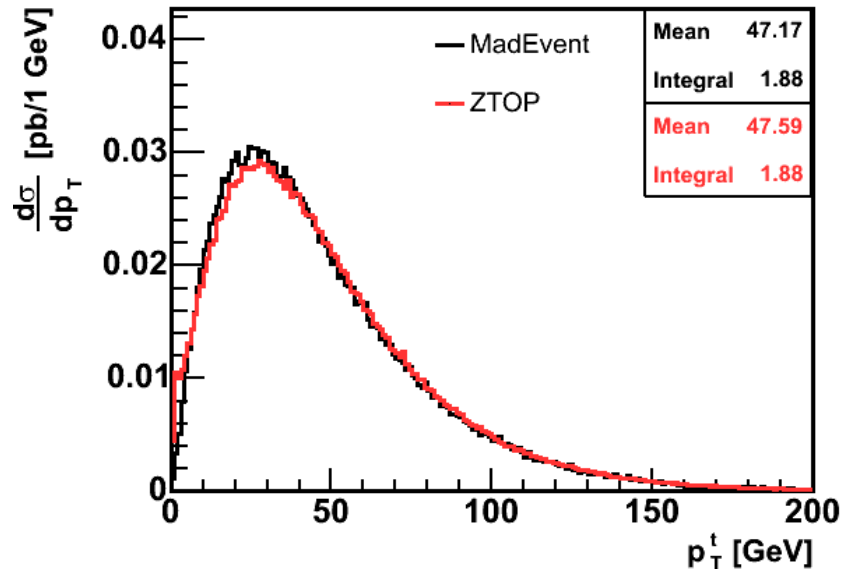
- b-jet from top decay not considered in jet-ordering
- cuts on all but top quark distributions: $p_T > 15$ GeV and $|\eta| < 2.8$



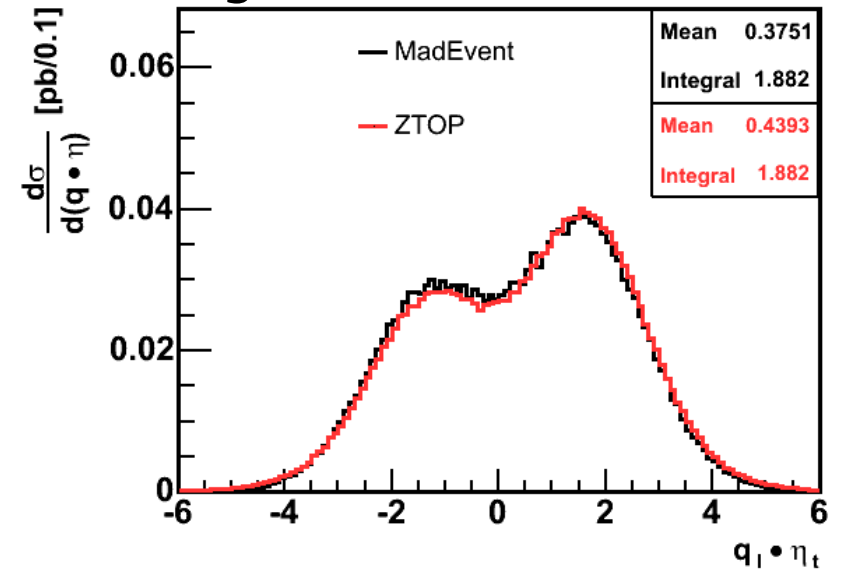
Top quark s-channel

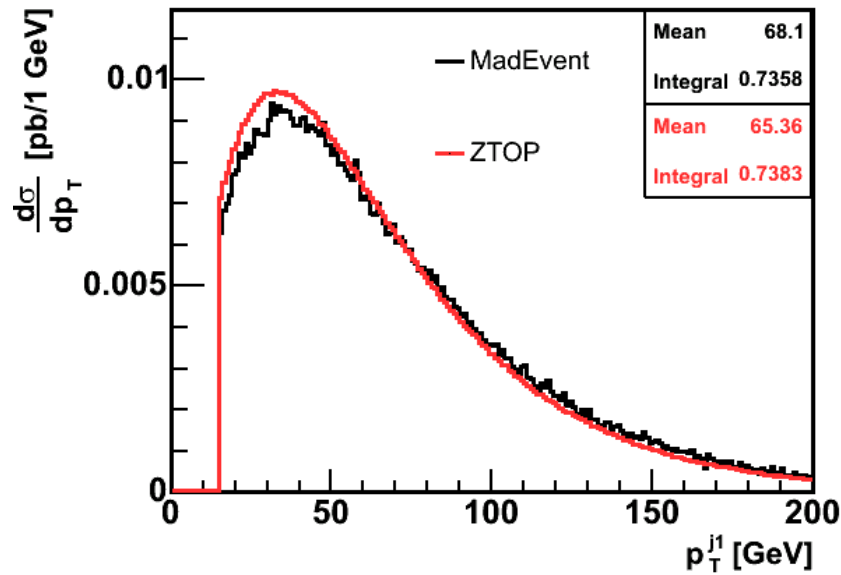


- Distributions have equal area
- Used for normalization of all following distributions

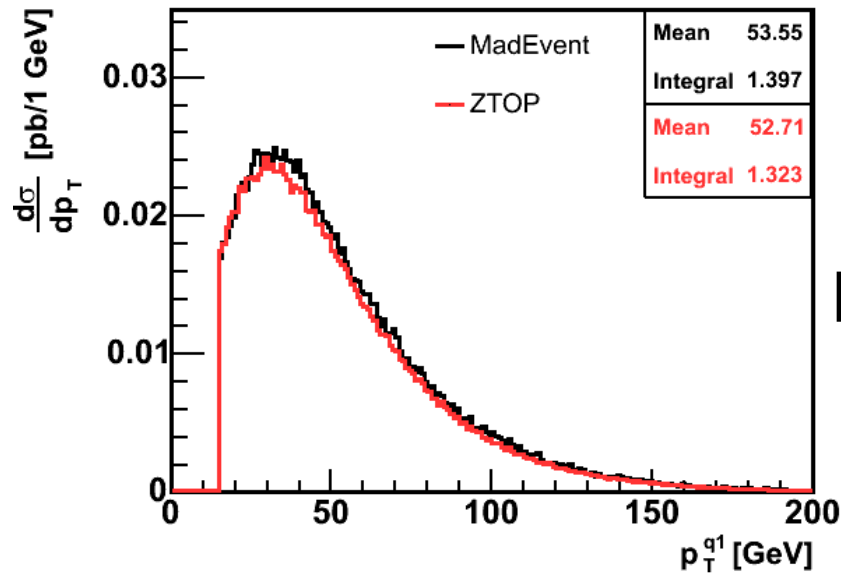
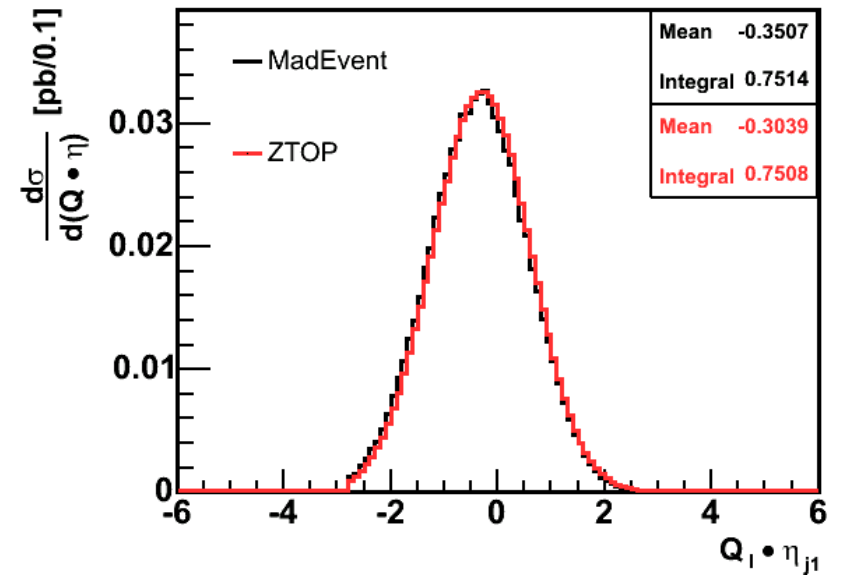


Top quark t-channel

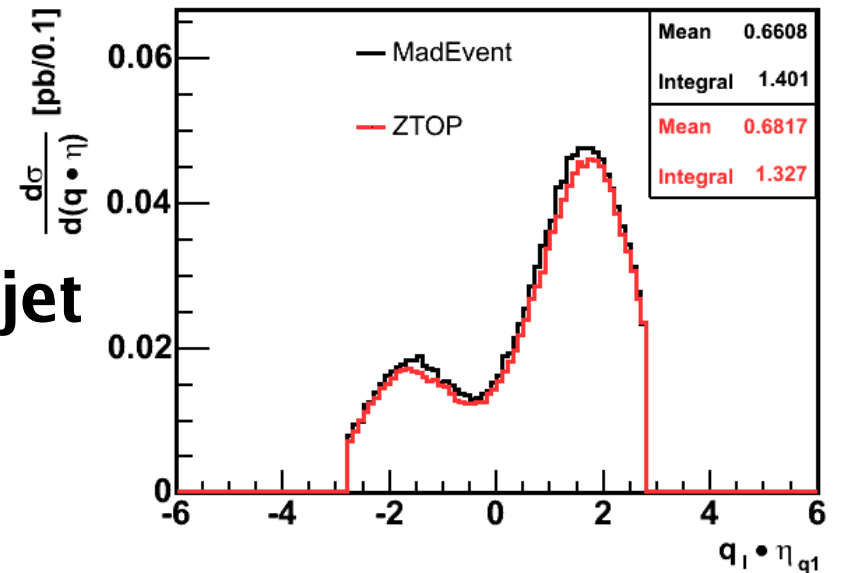


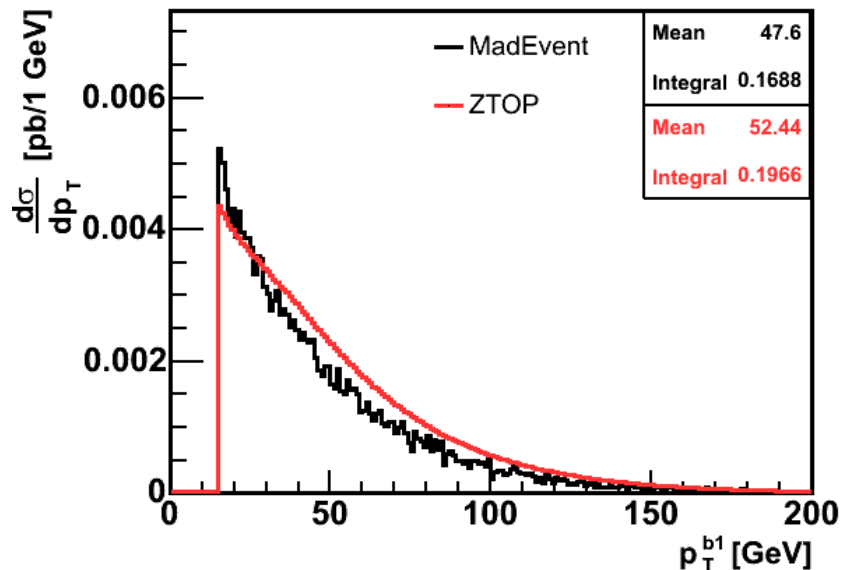


**Leading jet
s-channel**

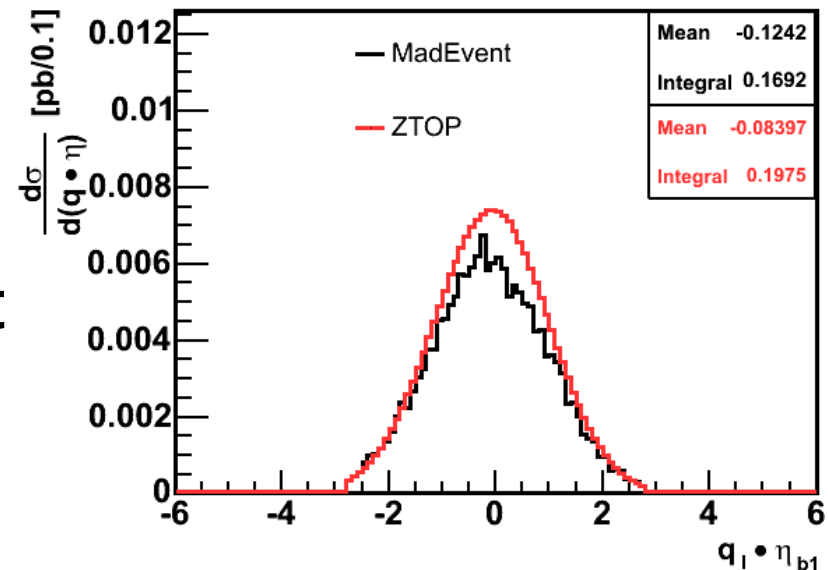


**Leading light jet
t-channel**

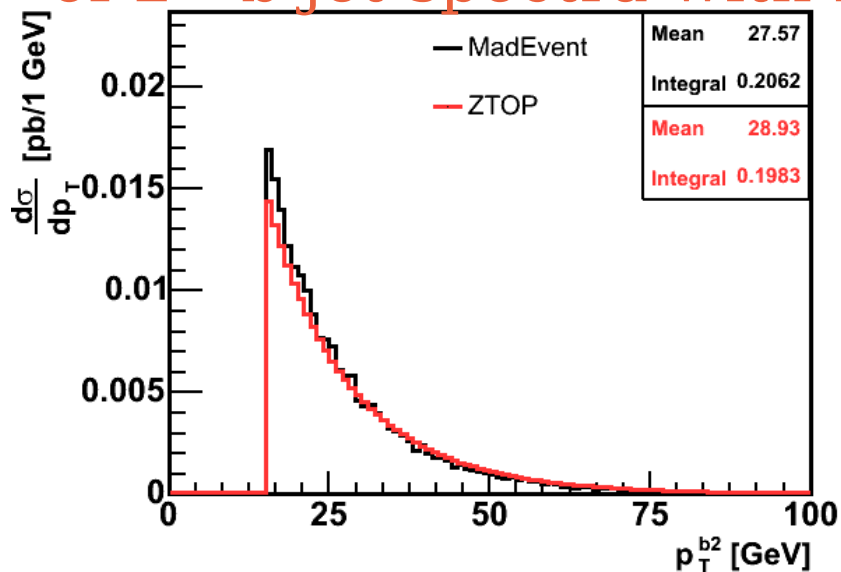




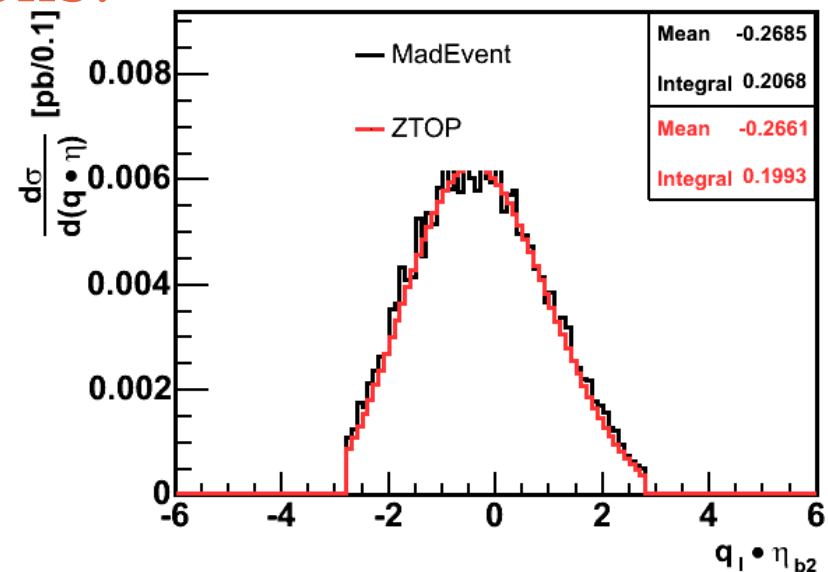
**leading b jet
 t -channel**



Matching of t -channel samples accomplishes good agreement of 2nd b jet spectra with NLO predictions!

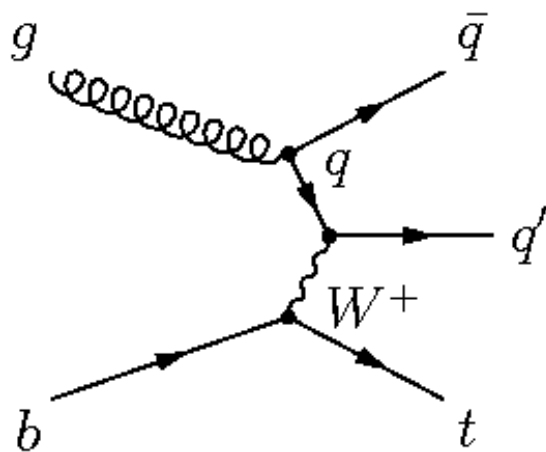


**2nd-leading
 b jet
 t -channel**

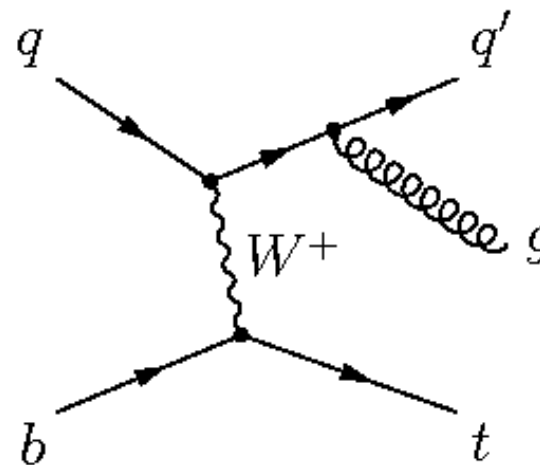


parton level 2nd-leading light quark \neq 2nd-leading light jet

- following NLO matrix elements not included in the matched MadEvent sample:



IS gluon splitting



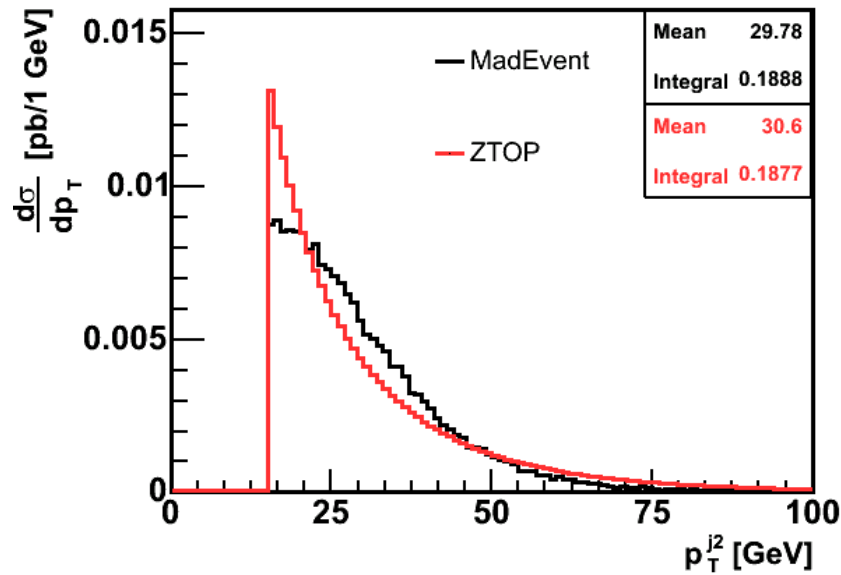
IS + FS gluon radiation

- contribution especially to soft p_T -2nd-leading light jets

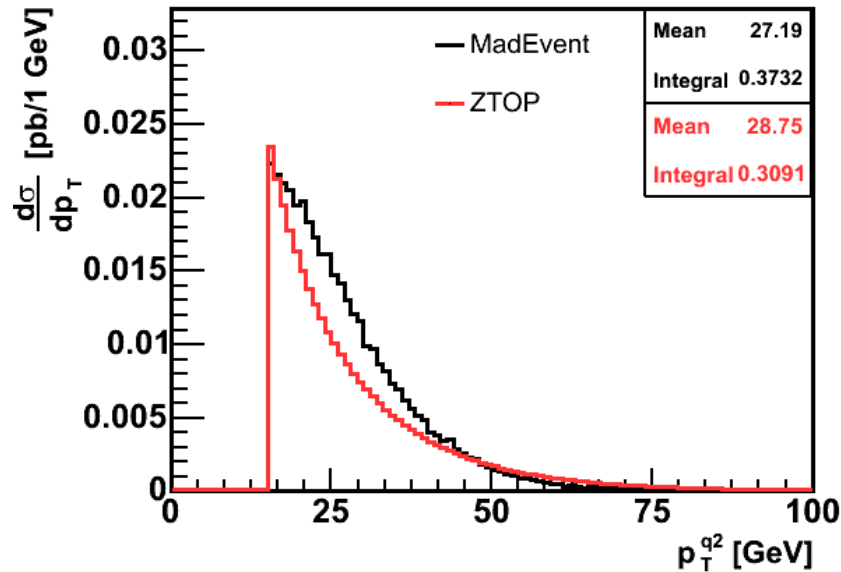
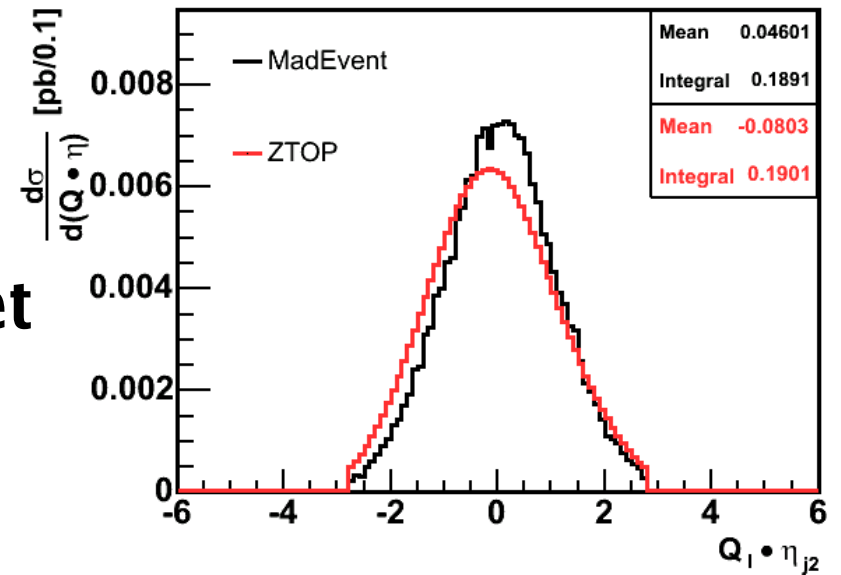
- FS gluon radiation modeled by PYTHIA => not visible at parton level
=> jet-clustering of stable particles (k_T cluster algorithm)

- Similar circumstances for the light jet in the s-channel

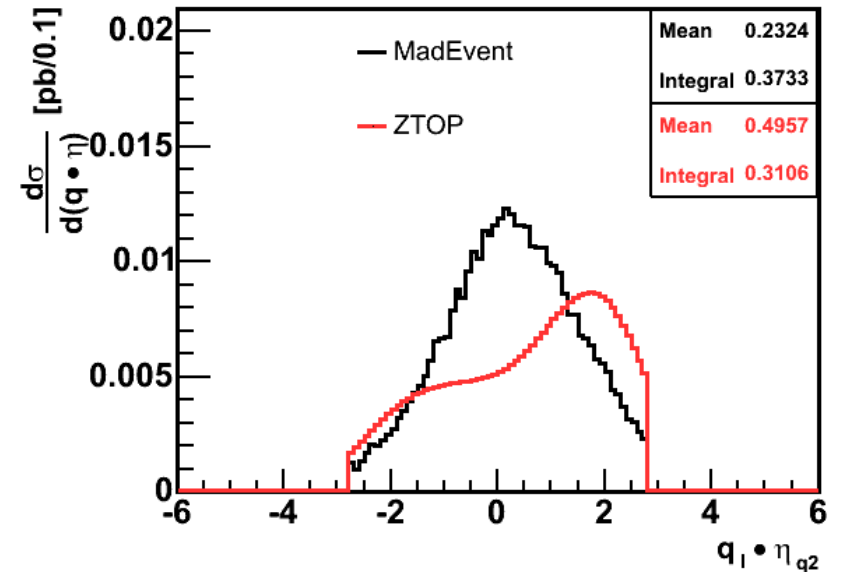
Validation of single-top signal samples with NLO differential cross sections



**2nd-leading jet
s-channel**



**2nd-leading
light jet
t-channel**

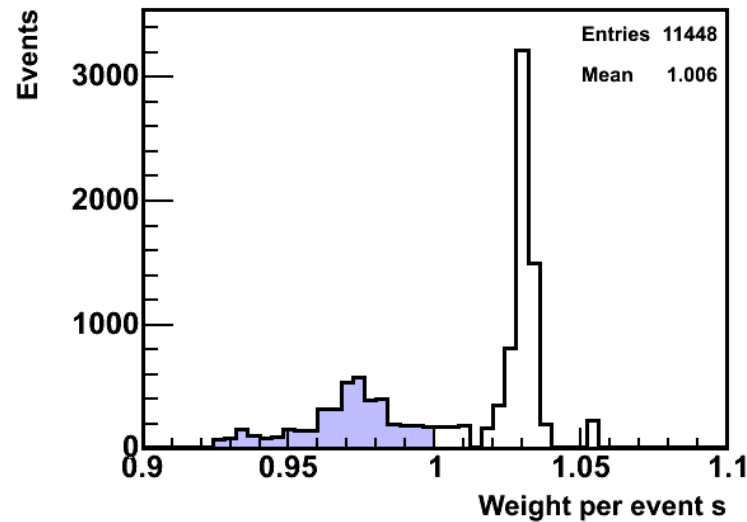
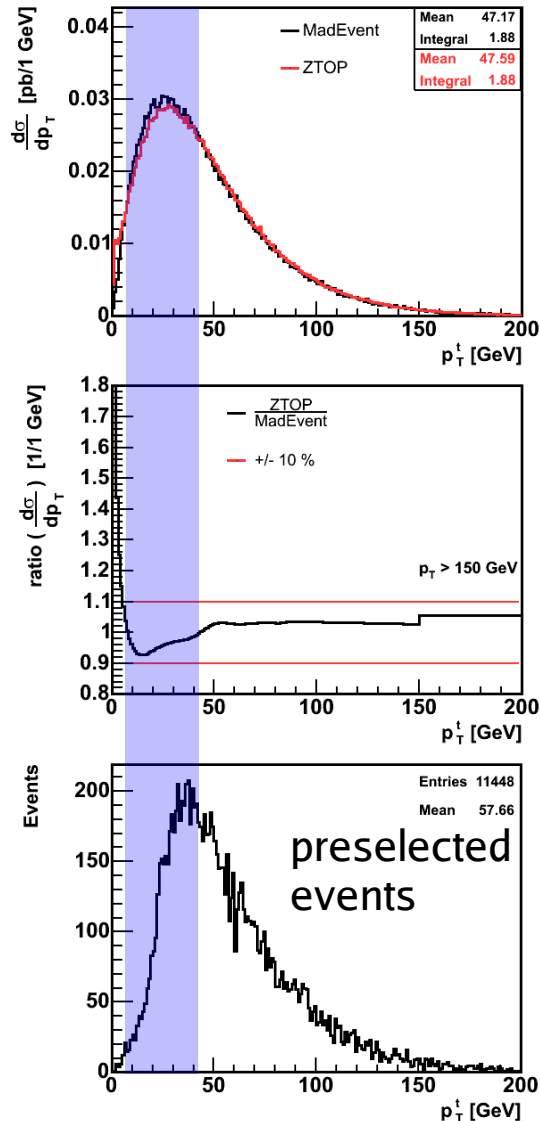


Acceptance Correction and Systematic Error Estimation on MC model

- We have no NLO-MC, but:
 - MC with matched LO+NLO matrix elements (MadEvent)
 - AND
 - Kinematic NLO distributions without event information (ZTOP)
- Combine this to get best estimate of acceptance and its error:
 - Find out where MadEvent under/overestimates signal => ratio
 - Each preselected event gets scaled by weight dependent on its ratio
 - Sum of all scaled preselected events gives estimate of „true“ acceptance

Illustration of correction method using only one variable

t -channel: p_T of top quark (2+3-JetBin)



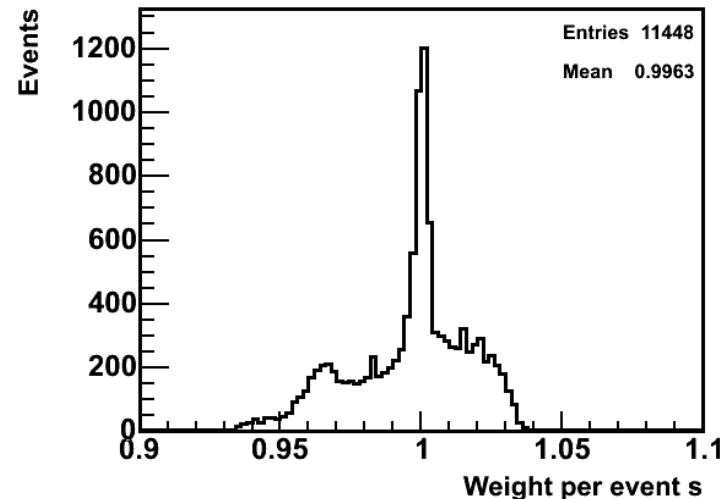
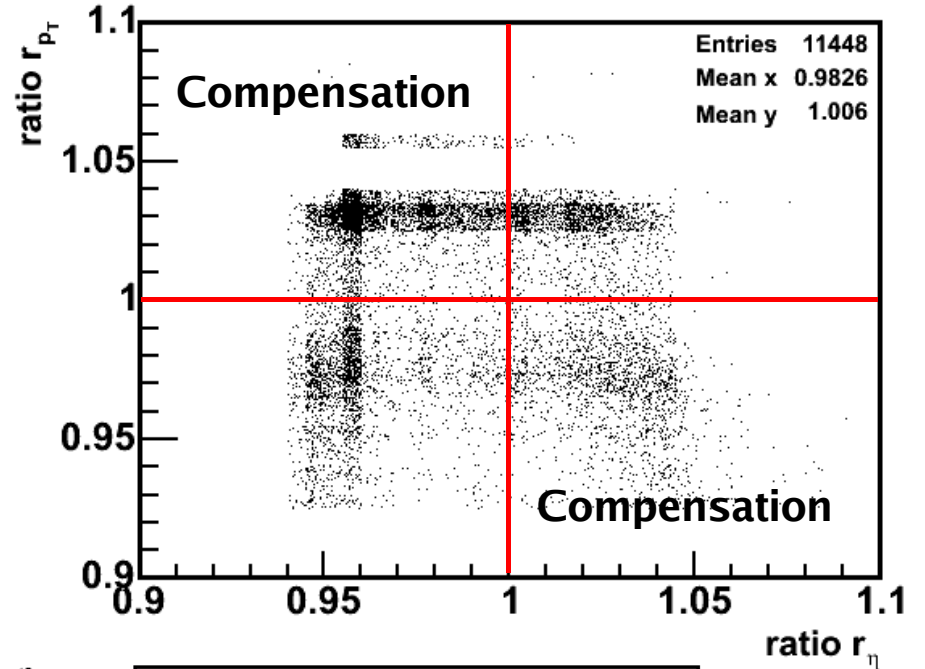
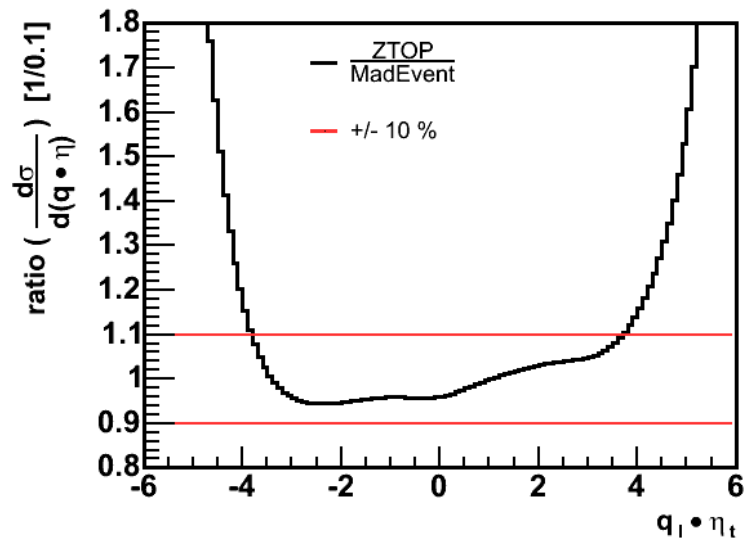
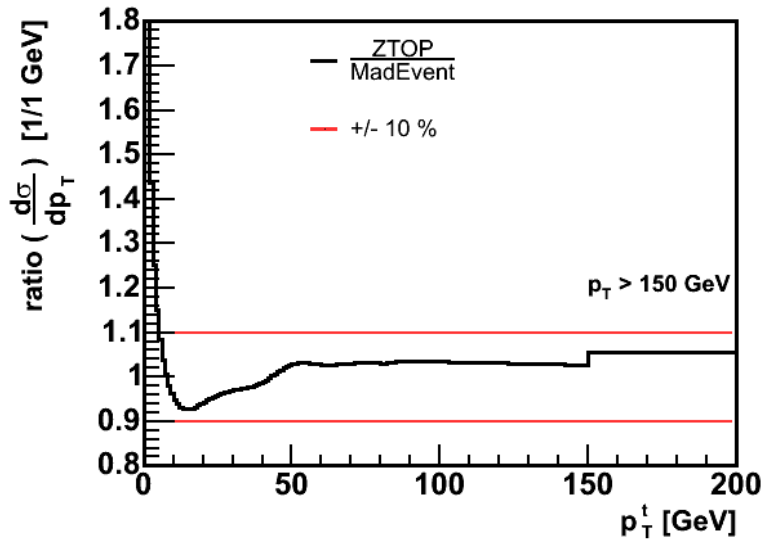
~4400 preselected events with weight < 1.0

On average MadEvent underestimates the signal by 0.68 %

Scale preselected events by 1.0068.

Illustration of correction method using two variables

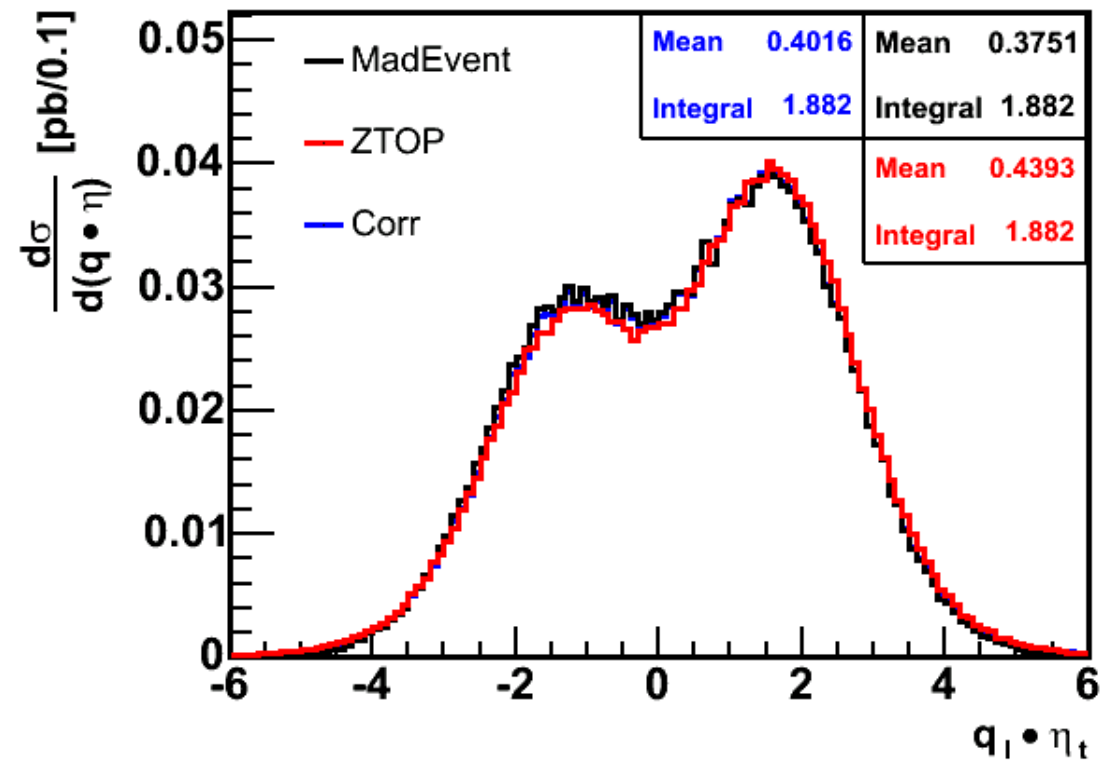
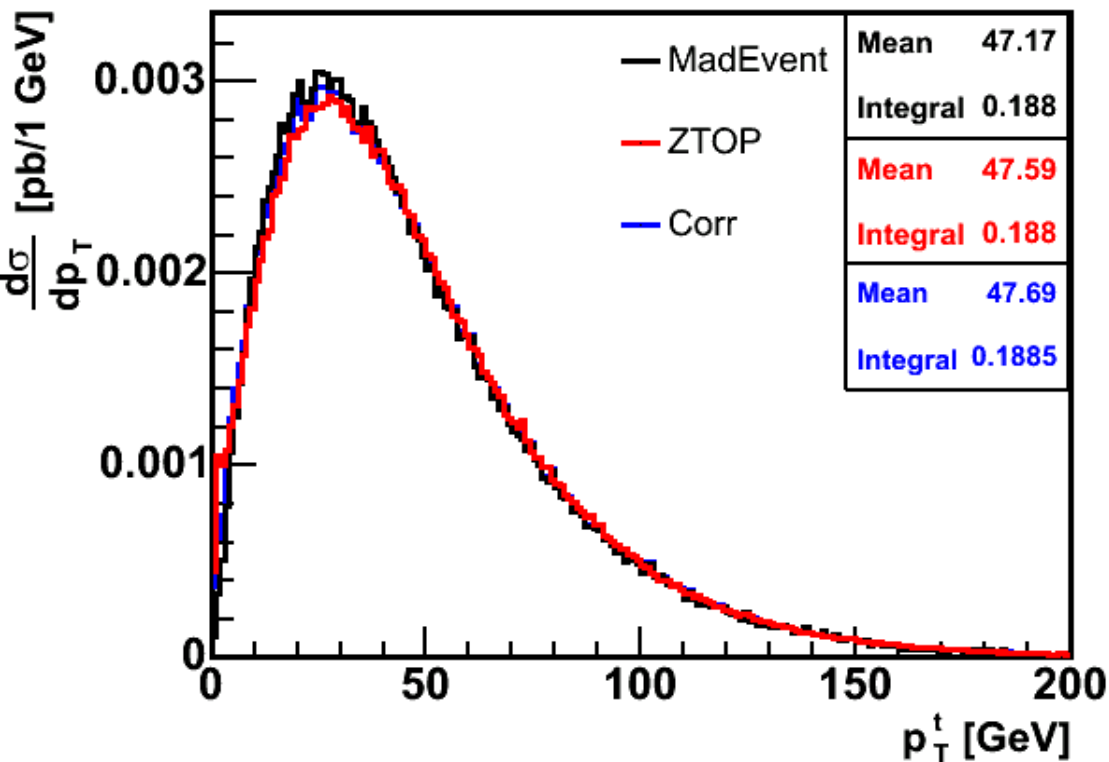
t -channel: p_T and h of top quark (2+3-JetBin)



=> Correction: -0.3 %

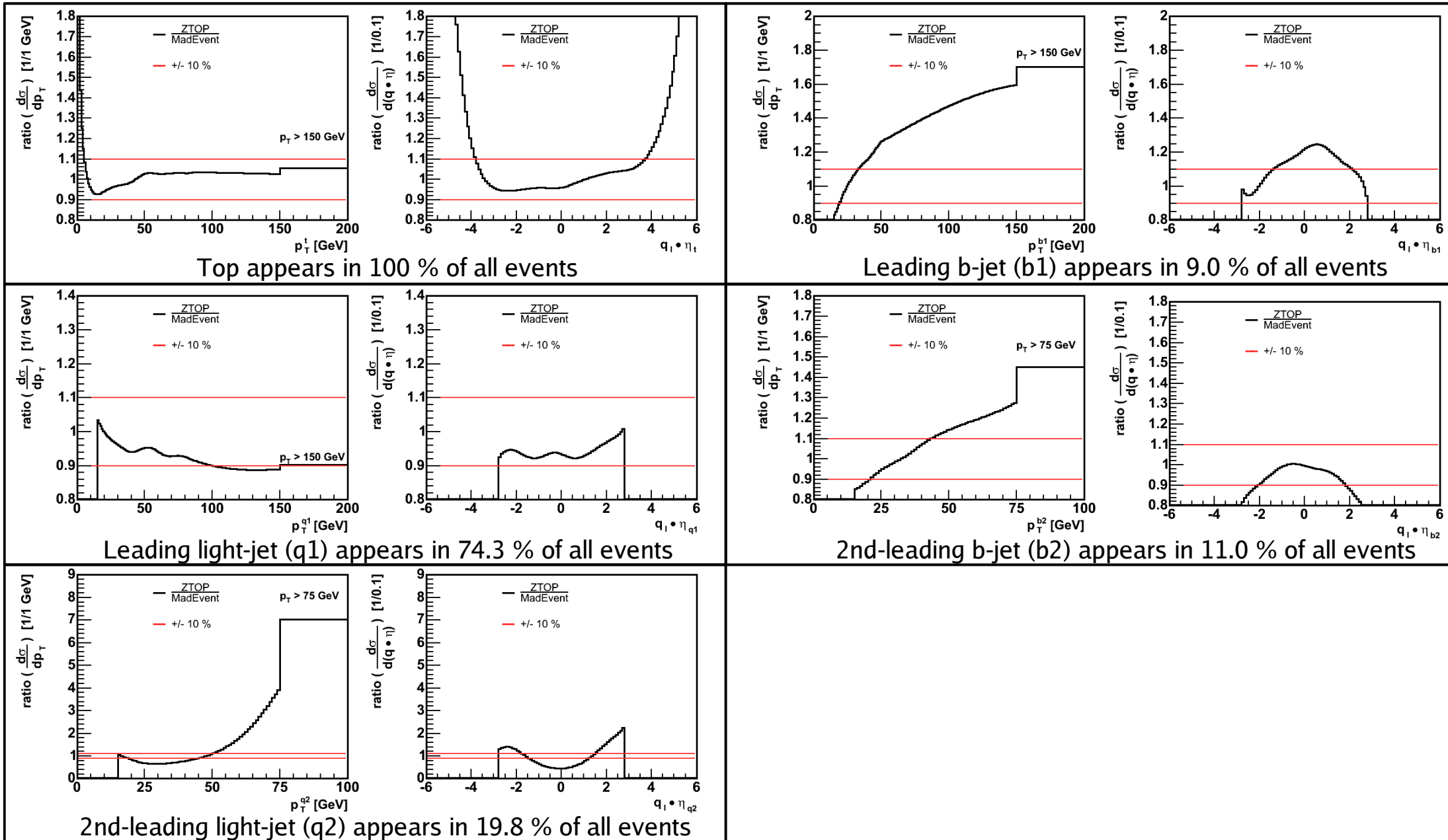
Check: Correction of the full sample

t -channel: p_T and h of top quark (2+3-JetBin)

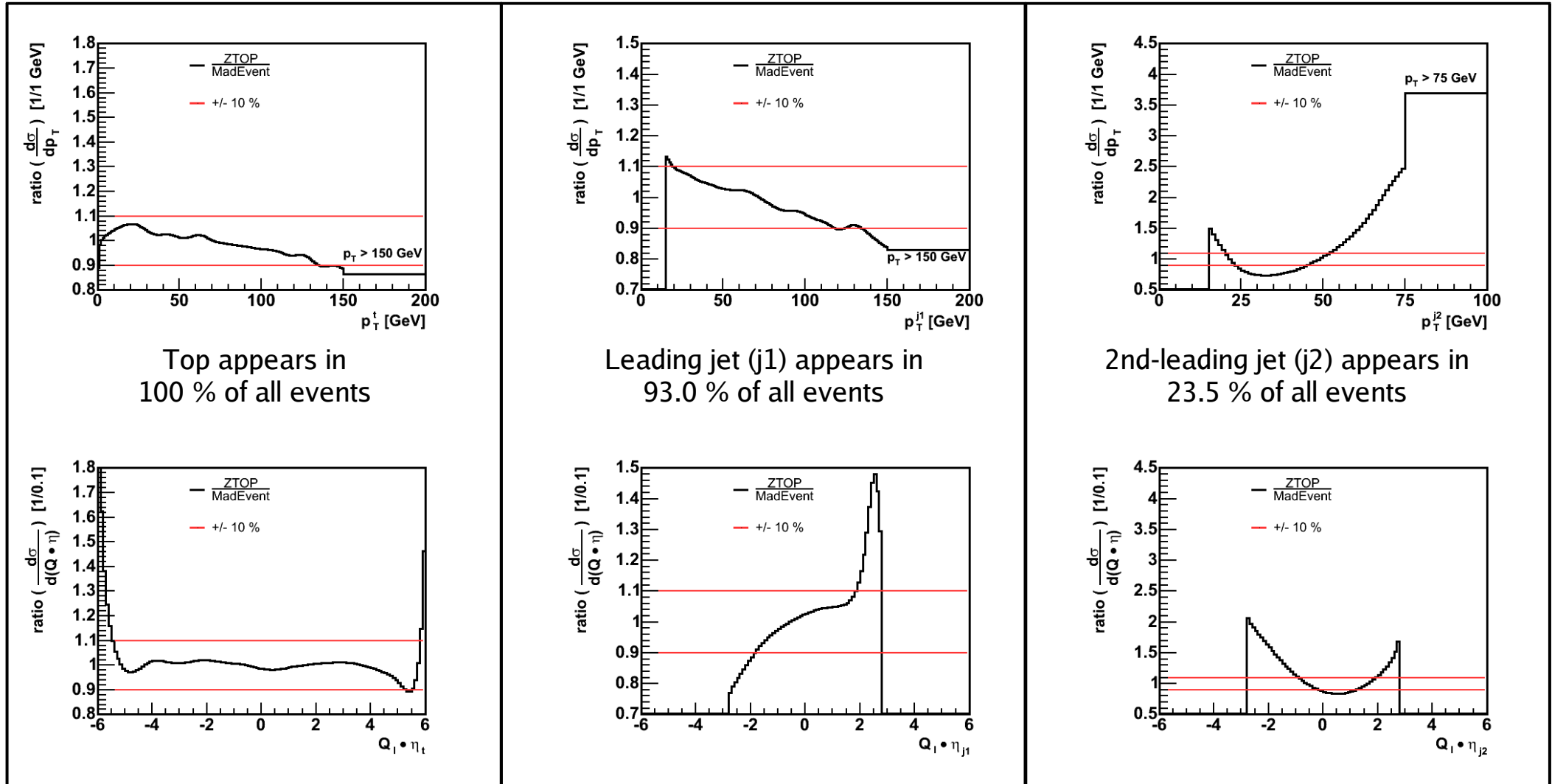


Both distributions improve: values move towards ZTOP

t-channel: correction ratios



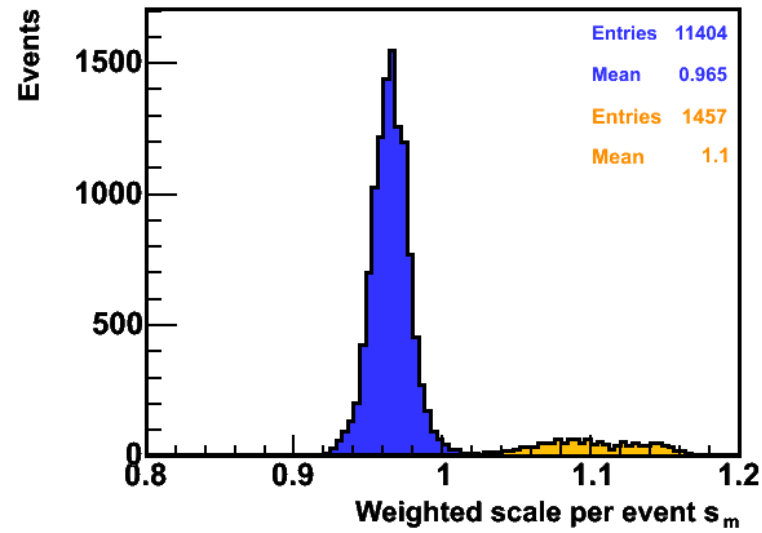
s -channel: correction ratios



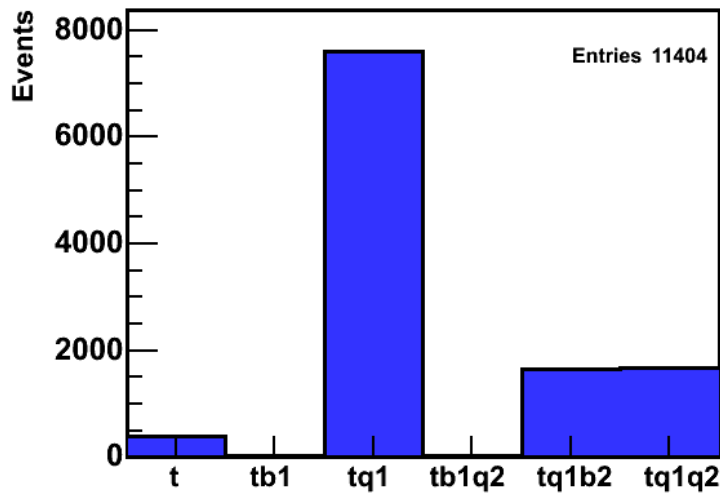
We want to use not only one but all distributions available from ZTOP.

- Combine all correction ratios r_i into one event weight
 - Take into account correlations between variables r_i
- Compute the covariance-matrix
- Compute weighted average
- Allow cancellations
 - Obtain corrected acceptance by summing up all event weights

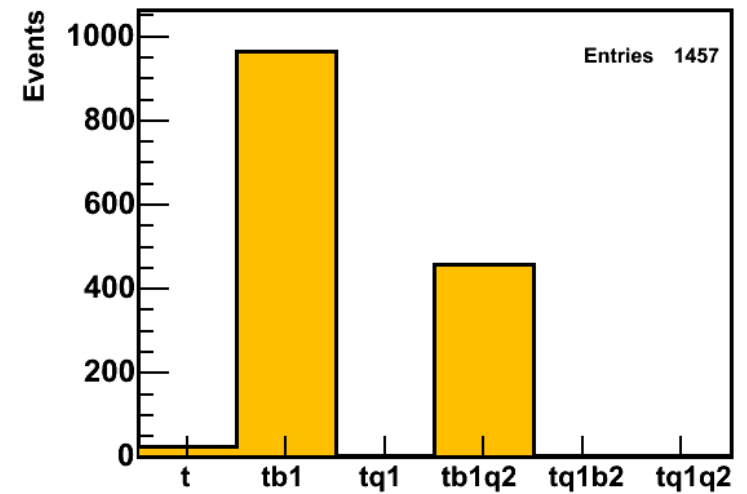
Event weights in the 2+3-Jet-Bin (t -channel)



Low weights dominated by leading light-jet (q_1)



High weights dominated by leading b-jet (b_1)



Calculated acceptance corrections

	2-Jet-Bin	3-Jet-Bin	2+3-Jet-Bin
<i>t</i> -channel	-2.5 %	-0.6 %	-2.2 %
<i>s</i> -channel	-0.2 %	-0.3 %	-0.2 %

- Plan:**
- Correct the acceptances by these scales
 - Take half the scale as systematic uncertainty

Conclusion

- In general, s - and matched t -channel MadEvent samples successfully describe single-top kinematics as predicted by NLO calculations.
- In particular: matching of 2- \rightarrow 2 and 2- \rightarrow 3 allows to model the 2nd b jet quite well.
- For light p_T -2nd-leading jet we find discrepancies. Since we did not include the respective processes at ME level this is to be expected.
- Single-top is being implemented into MC@NLO.
For the next but one analysis (say Moriong 2007) we might be able to use that.