Generator Effects For $t\bar{t}$ Pairs

Top Mass In Semileptonic Decays

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DESY

CMS Hamburg Meeting, January 16th 2008

Contents

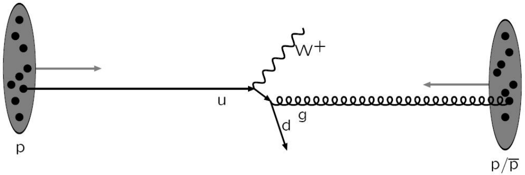
Generator event

The structure of an event

Warning: schematic only, everything simplified, nothing to scale, . . .

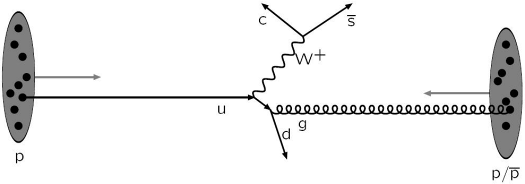
Incoming beams: parton densities

Generator event



Hard subprocess: described by matrix elements

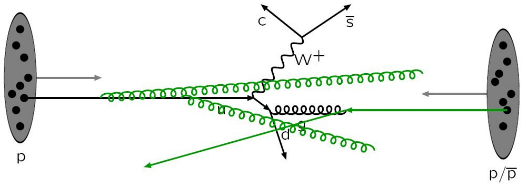
Generator event



Resonance decays: correlated with hard subprocess

Torbjörn Sjöstrand, Aronsborg 2006

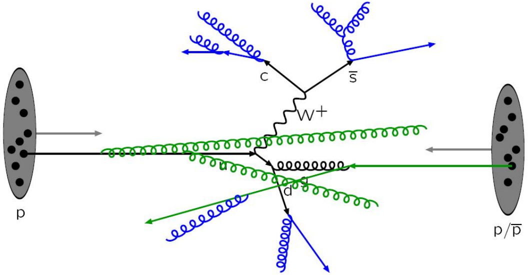
Generator event



Initial-state radiation: spacelike parton showers

Torbjörn Sjöstrand, Aronsborg 2006

Generator event



Final-state radiation: timelike parton showers

Torbjörn Sjöstrand, Aronsborg 2006

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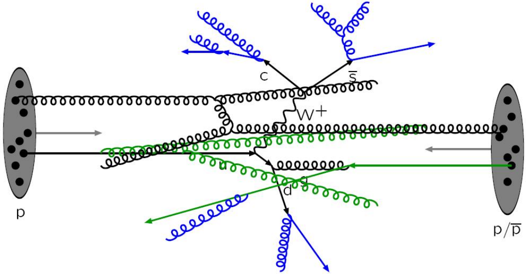
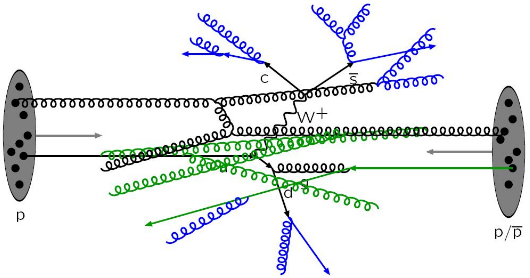


Multiple parton–parton interactions . . .

Torbjörn Sjöstrand, Aronsborg 2006

Generator event



. . . with its initial- and final-state radiation

Torbjörn Sjöstrand, Aronsborg 2006

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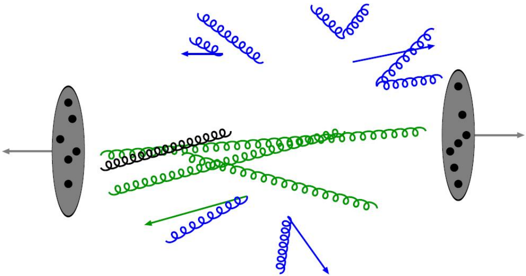

Beam remnants and other outgoing partons

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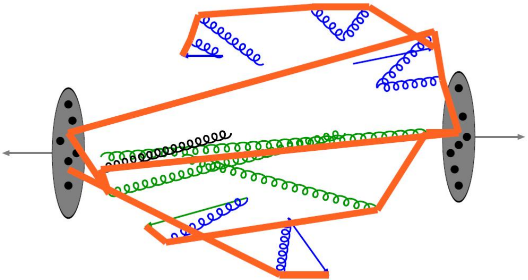

Everything is connected by colour confinement strings

Recall! Not to scale: strings are of hadronic widths

Torbjörn Sjöstrand, Aronsborg 2006

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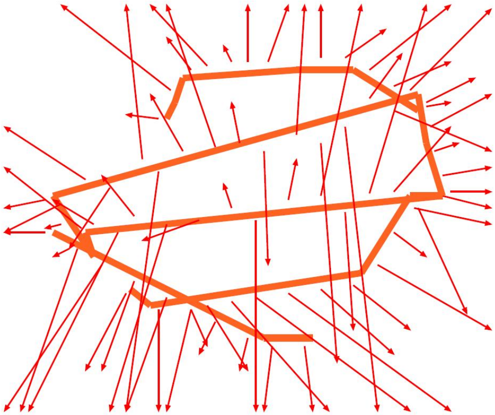

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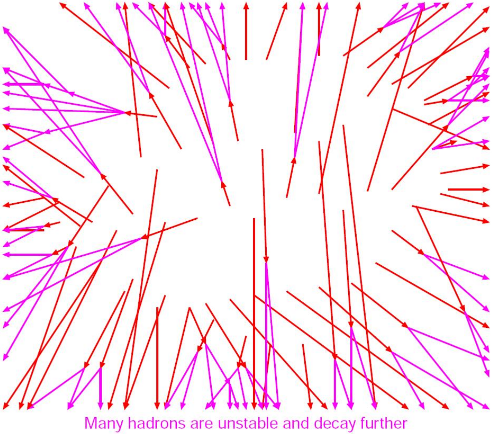
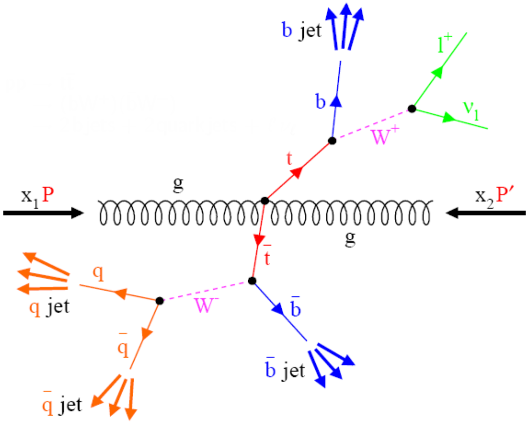
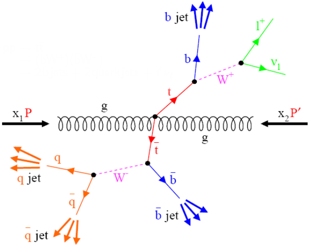


Torbjörn Sjöstrand, Aronsborg 2006

Semileptonic $t\bar{t}$ decay



Reconstruction of the top mass



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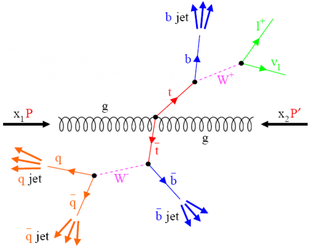

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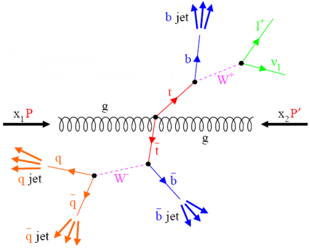

- only signal events are considered ($m_t = 172.3\mathrm{GeV}$, $\sigma_{m_t} = 3.2\mathrm{GeV}$)
- lepton and neutrino four momentums are taken from the generator information
- iterative cone jets with a cone 0.5 are used
- jets are required to have $p_T > 20\mathrm{GeV}$

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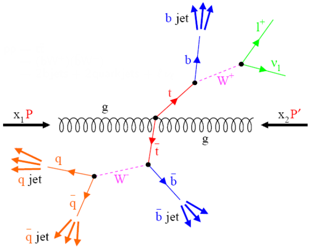

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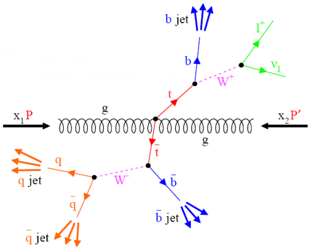

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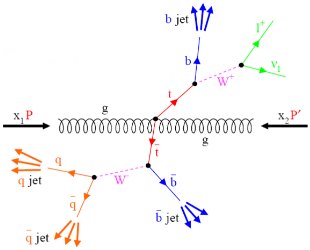

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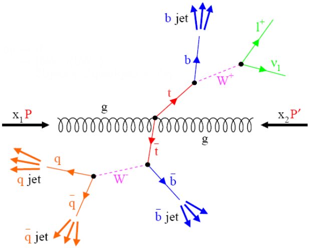
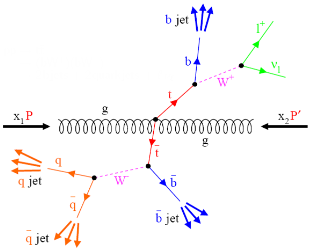


- jets with $\Delta R \geq 0.3$ with respect to the lepton are discarded, i. e. the lepton is isolated
- jets are assigned to the four initial quarks by minimizing ΔR sum between them
- $\Delta R < 0.3$ for each quark jet pair is required
- result is an event with only four (correct) jets

Reconstruction of the top mass



- perfect b-tagging: the two jets assigned to the quarks are known to be b jets

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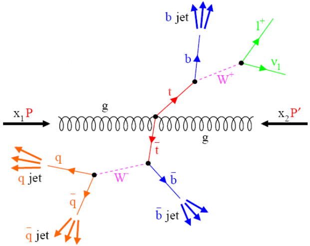

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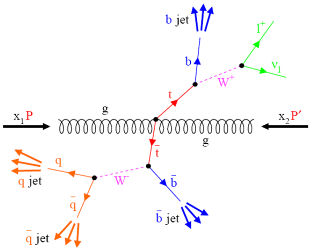

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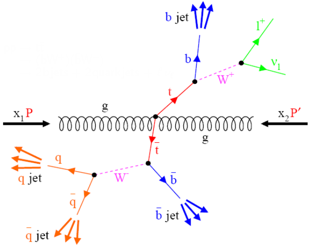
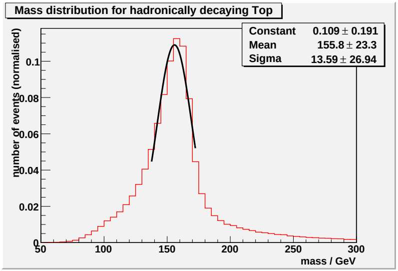


- perfect b-tagging: the two jets assigned to the quarks are known to be b jets
- leptonic W reconstructed from lepton and neutrino
- hadronic W reconstructed from the two non-b jets
- b jets are assigned to the Ws in the way, that the difference in the invariant mass of the two systems is minimized

Mass of hadronically decaying top

- Reconstruction on final state hadrons
- in good agreement with result from Skands and Wicke: shift of approx. $15\mathrm{GeV}$



Mass of hadronically decaying top

- Reconstruction on final state hadrons
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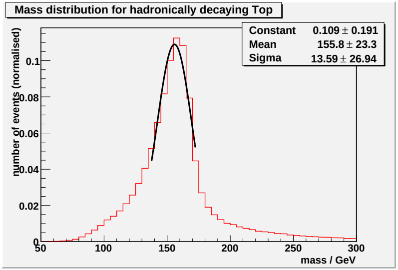
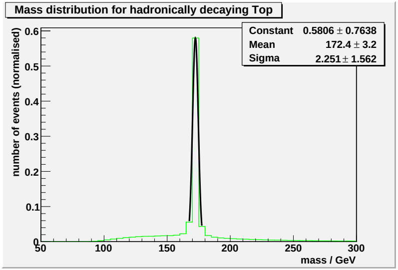
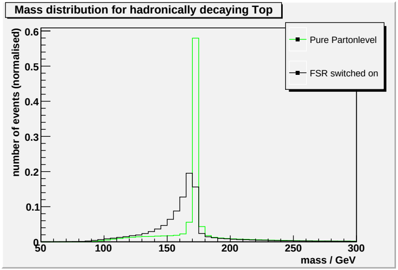
- ISR/MI, FSR and Hadronisation switched off
- Reconstruction on parton level





Top mass with FSR

- FSR switched on
- missing energy in parton level jets shifts mass



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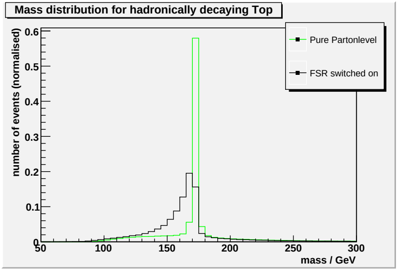
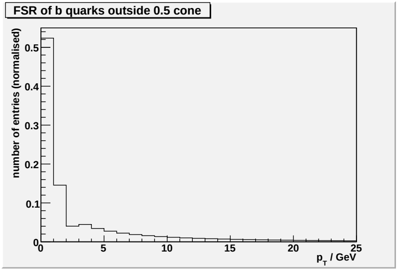
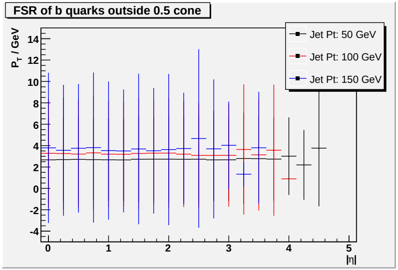


- FSR lost outside cone 0.5

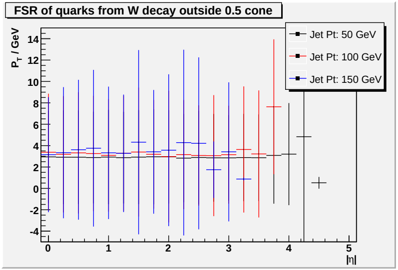


FSR of different quark types

- FSR outside cone 0.5 for b quarks

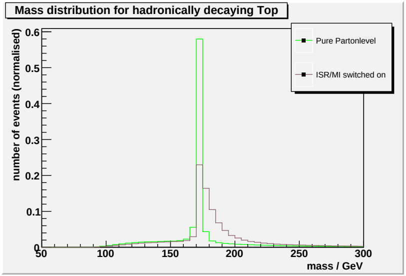


- FSR outside cone 0.5 for quarks from W decay



Top mass with ISR/MI

- ISR and MI switched on
- mass distribution shifted due to additional particles collected by the jet algorithm



Underlying event content in $|\eta| < 5$

UE includes everything except the hard process, i. e. ISR, MI and proton remnant

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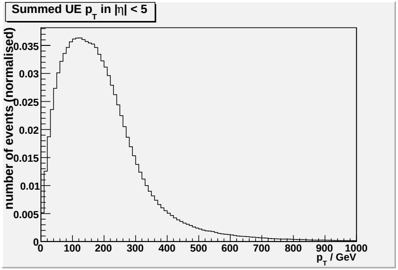
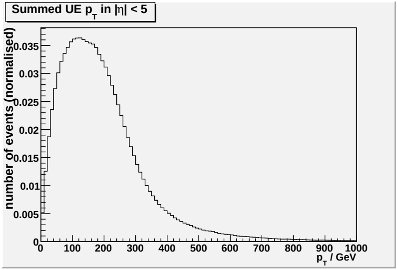
- significant amount of p_T in $|\eta| < 5$ due to UE

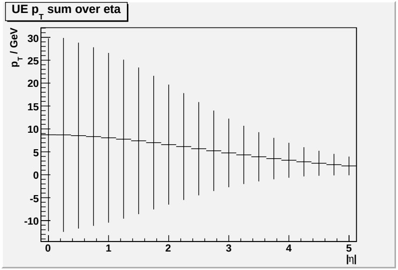


Underlying event content in $|\eta| < 5$

UE includes everything except the hard process, i. e. ISR, MI and proton remnant

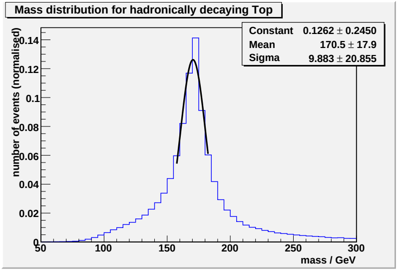
- significant amount of p_T in $|\eta| < 5$ due to UE
- influence of UE per jet approx. half as big as influence of FSR





Top mass with ISR/MI and FSR

Without corrections



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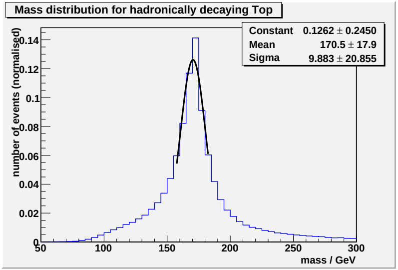
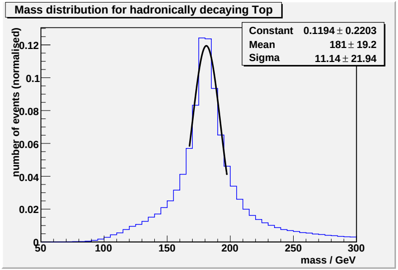


Corrected for UE and FSR



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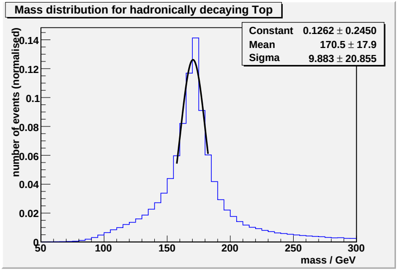

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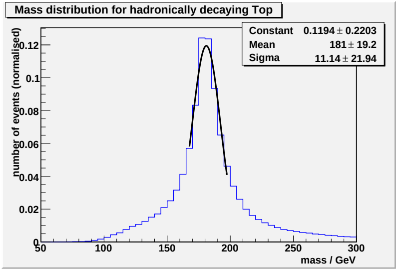
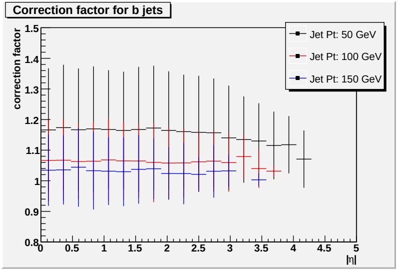
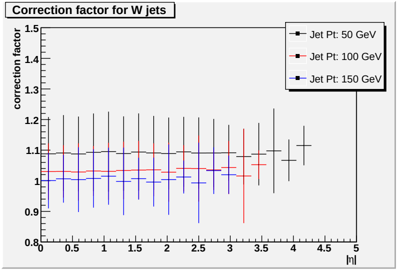


Sample	mean	sigma	shift	sigma ratio
Pure parton level	172.4	2.3	0.1	1
With UE and FSR	170.5	9.9	1.7	4.3
With UE/FSR correction	181.0	11.1	8.7	4.8

Hadronisation corrections

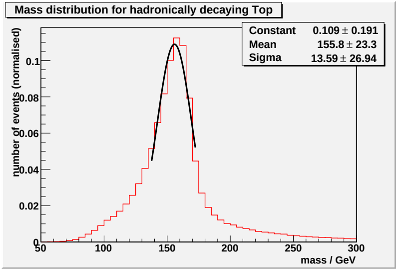
- jets are matched to initial quark ($\Delta R < 0.1$)
- jets are corrected for p_T according whether they are b or non-b jets





Top mass with hadronisation

Without corrections



Top mass with hadronisation

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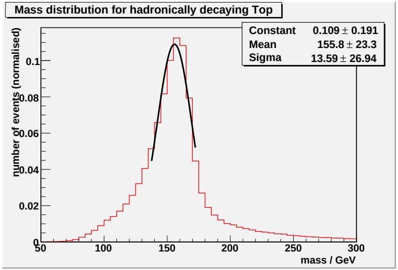
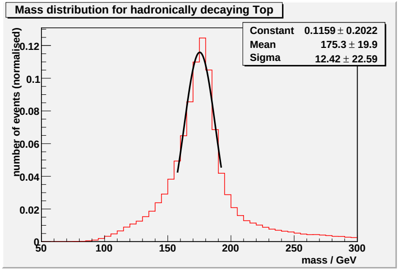


With corrected jets



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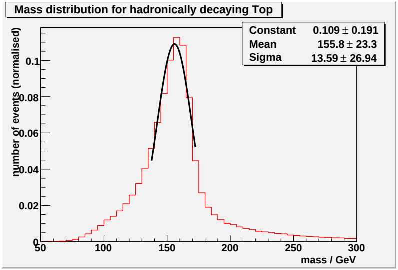

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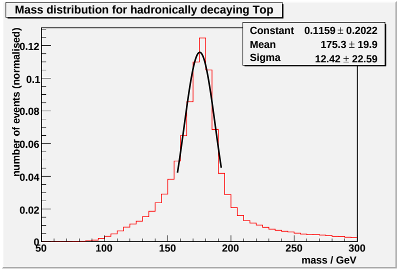

Sample	mean	sigma	shift	sigma ratio
Pure parton level	172.4	2.3	0.1	1
With hadronisation	155.8	13.6	16.5	5.9
With hadronisation corrected	175.3	12.4	3.0	5.4

Comparison with fully simulated events

Simple reconstruction

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- muon assignment is uniquely

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- reconstruct neutrino with MET and W mass constraint (ambiguity in p_z)
- four jets with highest p_T with correction factors, no b-tagging
- assign those two jets to hadronically decaying W which are cloest to W mass
- assign b jets to tops by minimizing the difference of the top masses

Comparison with fully simulated events

	mean	sigma
Generator level	168.4	19.0
Reco level	177.5	41.6

- ISR, FSR, hadronisation on the one hand and detector effects on the other hand both have big influences on the width of the mass distribution
- detector effect approx. twice as big as generator effect

Summary

Influences on top mass distribution

- ISR/MI and FSR lead to a widening of the distribution
- hadronisation widens the distribution and shifts the mean significantly
- on generator level reasonable corrections can be applied
- detector effects influence mean and width as well

Summary

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Influence on the width

effect	widening
ISR/MI and FSR	4.3
hadronisation	1.4
detector	2
total	12