The AAA Analysis of the Cornell Blackbox

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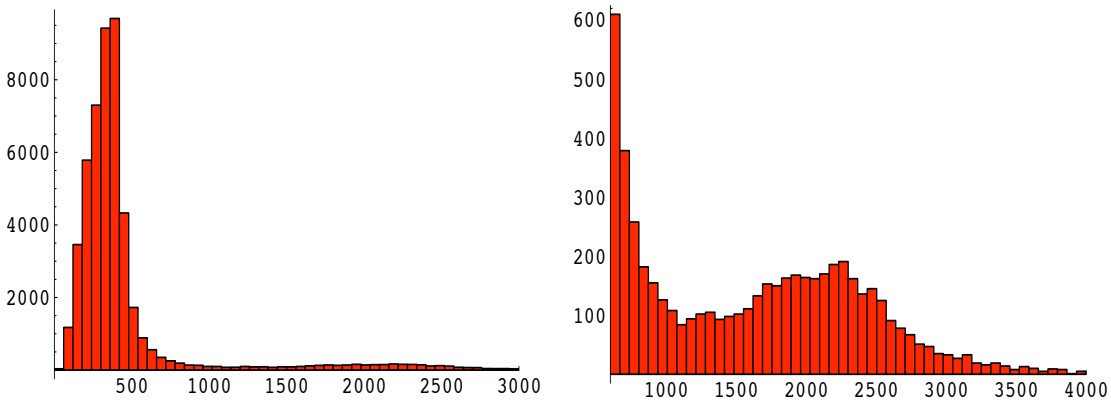
- Introduction
- Analysing the black box
- Guess

LHCO, March 21-24, 2007

Gross features

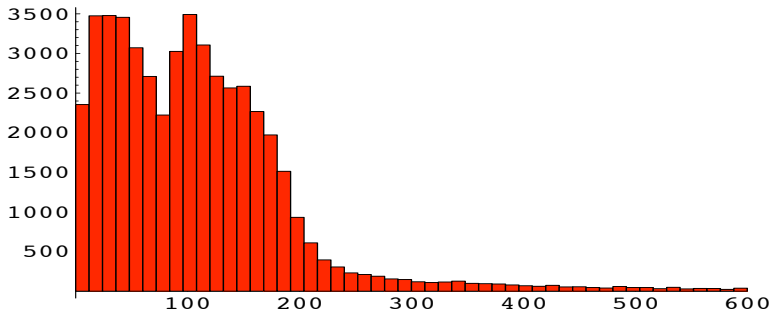
49244 events have been produced with 10 fb^{-1}



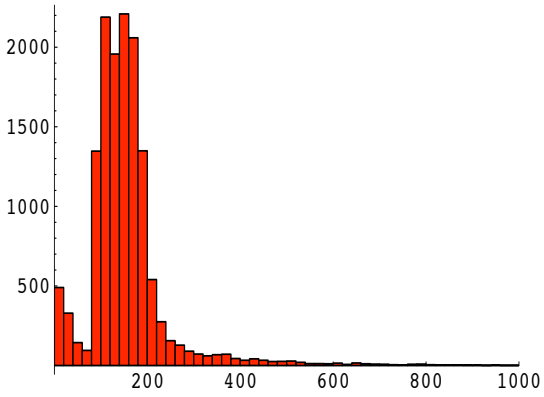
Effective mass

- **Strong interaction:** $\sigma \times \epsilon \simeq 5pb$
- **heavy particles produced**
- **TeV Physics**

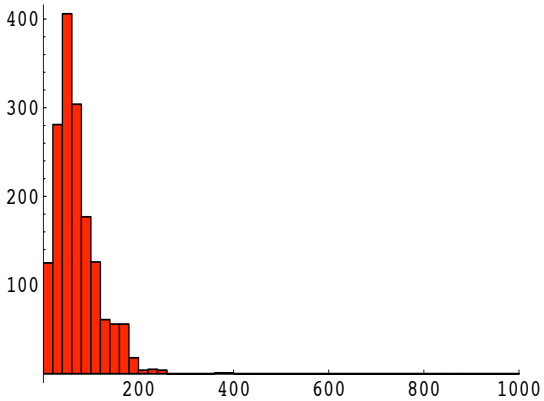
Missing P_T



in 90% of the events, the missing $P_T \leq 200$ GeV



jet sample



leptonic sample

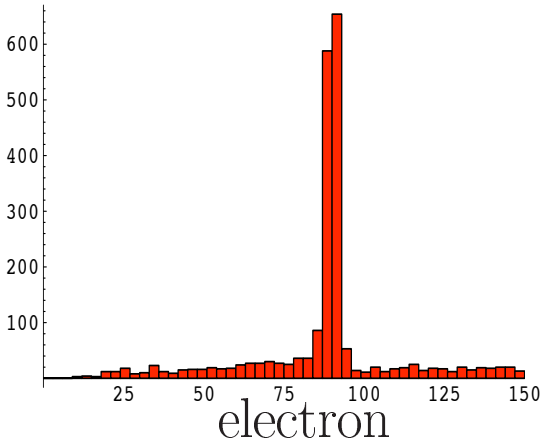
Lepton counting

Lepton rich sample: 75% of the events have leptons

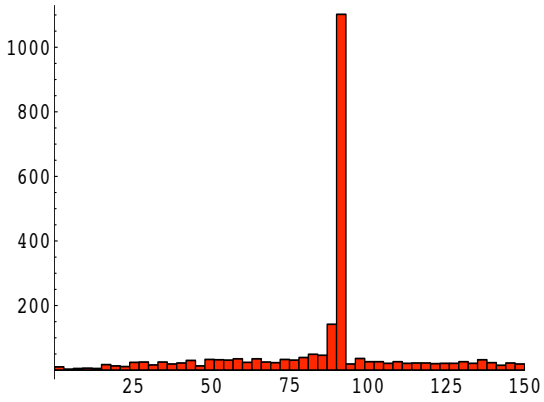
Dilepton events

−	e−	μ−	τ−	e+	μ+	τ+
e−	24	71	51	2431	909	223
μ−	0	23	50	1000	2709	198
τ−	0	0	4	180	240	50
e+	0	0	0	38	90	54
μ+	0	0	0	0	45	43
τ+	0	0	0	0	0	6

- Charge and flavour correlation → Z-boson
- Flavour uncorrelation → W-boson



electron



muon

- opposite-sign lepton pairs from the Z-boson decay

there are Z (and W) bosons in the semi-leptonic sample

Jet counting

- Medium number of jets:

  80% of the events with 1 to 4 Jets

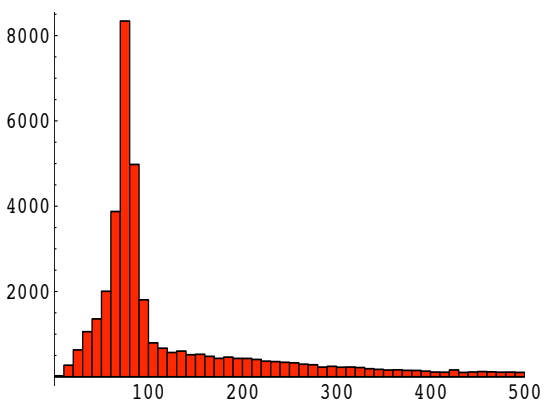
and with medium Pt (e.g. $Pt \geq 150$ GeV)

0	1	2	3	4	5	6
36675	8496	1597	1415	850	180	28

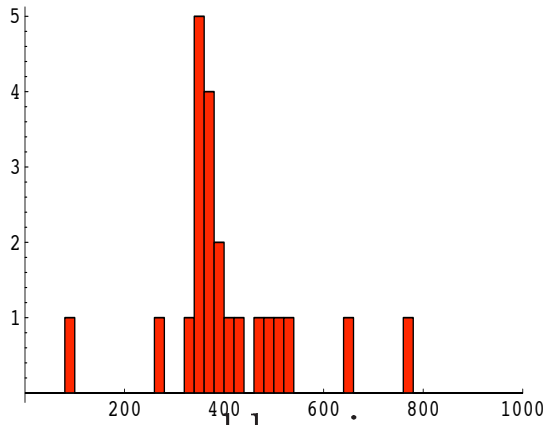
- Content of bottom-quark globally neglegible

0	1	2	3	4
43913	4637	653	41	0

only 10 % of the events have b-quarks



jj pair



bb pair

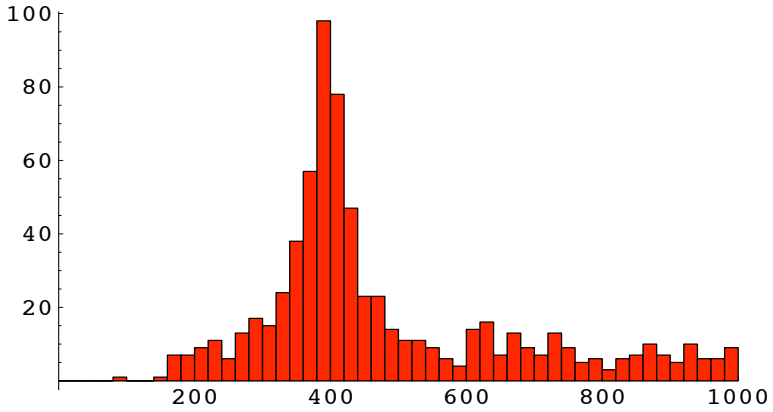
- The two Highest-Pt jet come from a W or Z-boson
- The two Highest-Pt b-jet come from a Z-boson

First resonance

select a cleaner sample with a lepton pair (e^+e^- and $\mu^+\mu^-$)

the $Z \to l^+l^-$ is associated to?

Z + 2 HighPt-jets



- a sharp resonance at $\simeq$ 420 GeV
- independent on the b-content (l^+l^-bb)

this suggest the production of:

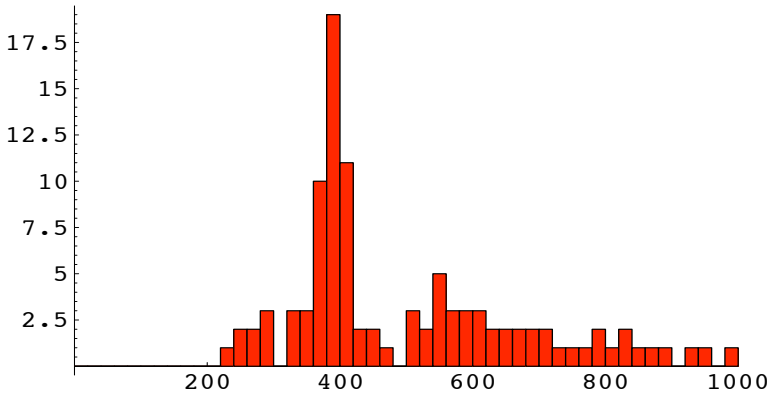
$$P(420) \to ZZ \to l^+l^-jj$$

First resonance

select a leptonic sample with four lepton

the $Z \to l^+l^-$ is associated to?

$\mathrm{Z} + l^+l^-$



- a clean resonance at $\simeq 420$ GeV

this suggest the production of:

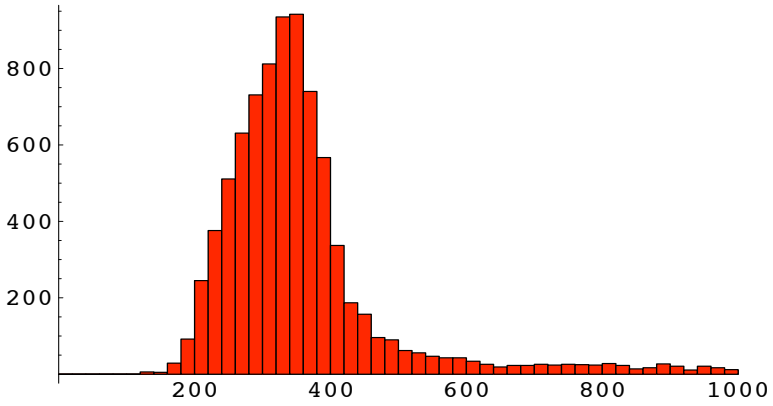
$$P(420) \to ZZ \to l^{\pm}l^{\mp}l^{\pm}l^{\mp}$$

First resonance

select a purely hadronic sample with two jets

the $Z \to jj$ is associated to?

Z + missing P_T



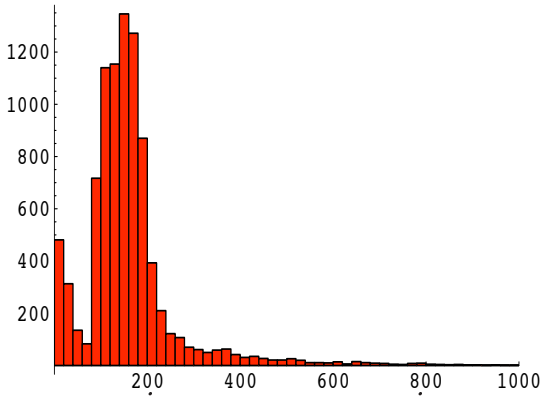
- a sharp edge at $\simeq 420$ GeV

this suggest the production of:

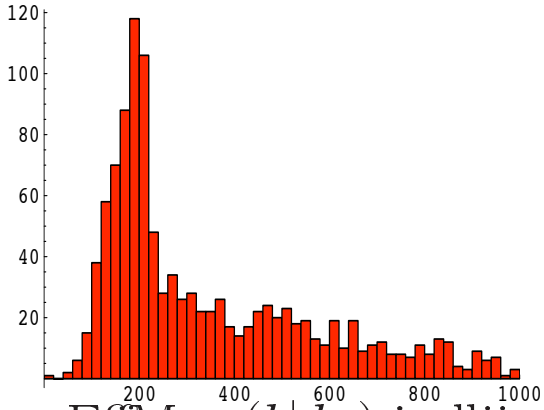
$$P(420) \to ZZ \to jj + \nu_l \bar{\nu}_l$$

First resonance

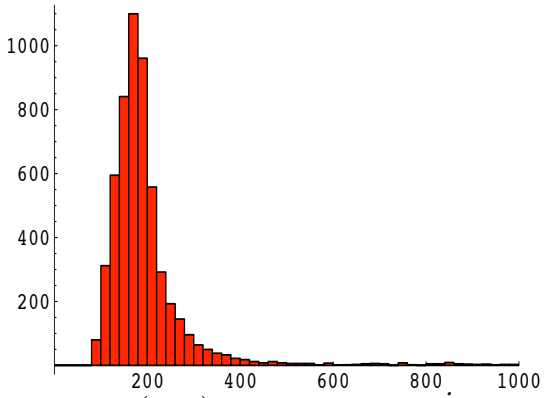
Missing P_T structure



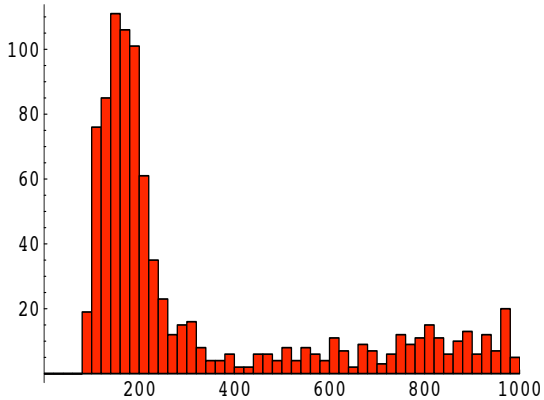
P_T^{miss} in jj+E_T^{miss}



EffMass(l^+l^-) in lljj



$P_T(jj)$ in jj+E_T^{miss}



$P_T(jj)$ in lljj

In both samples the two jets come from a Z-boson. The missing P_T distribution in the jj sample is consistent with the production

$$pp \to P(420) \to ZZ \to jj\nu_l\bar{\nu}_l$$

First resonance

The number of events is consistent with Z-boson branching ratios

$N_1(\mu\mu\mu\mu)$=8
$N_2(\mu\mu jj)$=539
$N_3(\nu\nu jj)$=5577

$N_1/N_2 \simeq 2\%$ **vs** $Br(Z \to \mu\mu)/Br(Z \to jj) \simeq 5\%$
$N_2/N_3 \simeq 10\%$ **vs** $Br(Z \to \mu\mu)/Br(Z \to \nu\nu) \simeq 15\%$

a further confirmation of

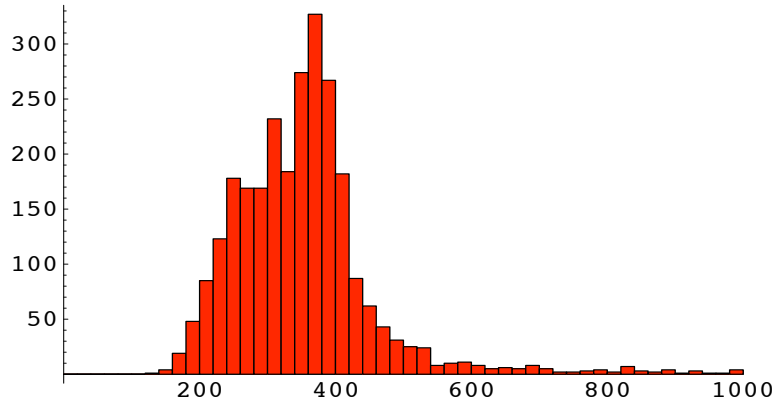
$$pp \to P(420) \to ZZ \to 4f$$

First resonance

select a second semileptonic sample with only one lepton

the $Z \to jj$ is associated to?

Z + 1 lepton + missing P_T



- a sharp edge at $\simeq$ 420 GeV

this suggest the production of:

$$P(420) \to W^+W^- \to l^{\pm}\nu_l jj$$

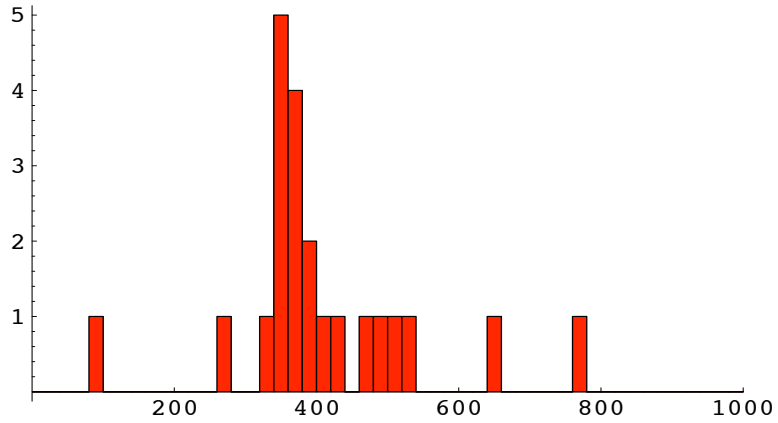
Summarizing, P(420) couples to the gauge sector

$$P(420) \to VV \to 4f$$

First resonance

select an hadronic sample with only two b-quarks

we impose $P_T(b) \geq 150 GeV$



- a sharp resonance at $\simeq$ 420 GeV

this suggests

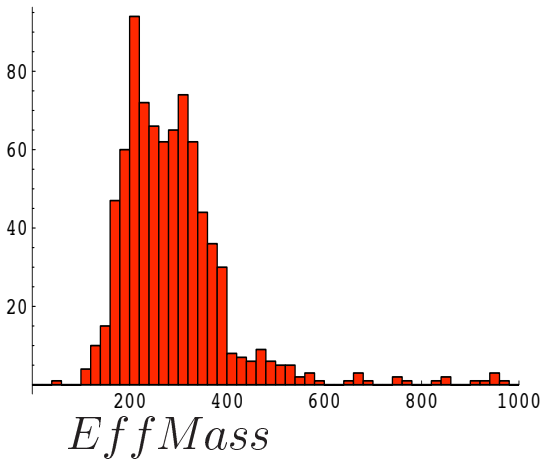
$$pp \to P(420) \to b\bar{b}$$

P(420) can be an Higgs

Its mass excludes SUSY models.

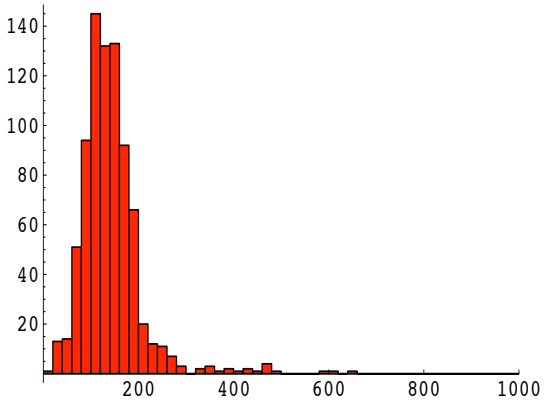
Monojet ?

select an hadronic sample with only one jet and missing energy

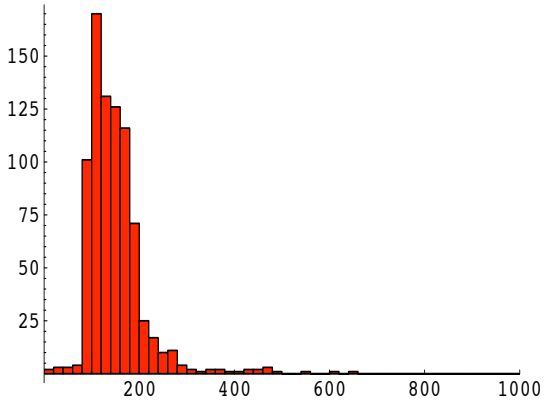


$EffMass$

sharp edge at around 400 GeV



$P_T(j)$



Missing E_T

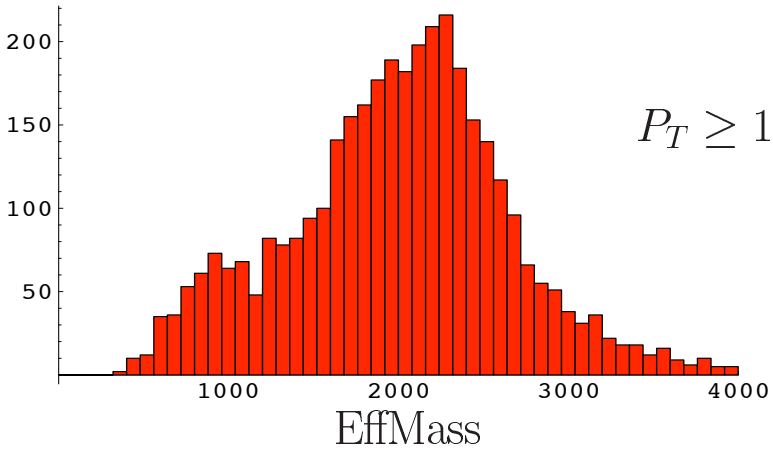
the effective mass and P_T distributions suggest that the signal is compatible with

$$pp \to P(420) \to ZZ \to j + E_T$$

with a lost jet. No extra source of missing P_T seems to be there.

TeV region

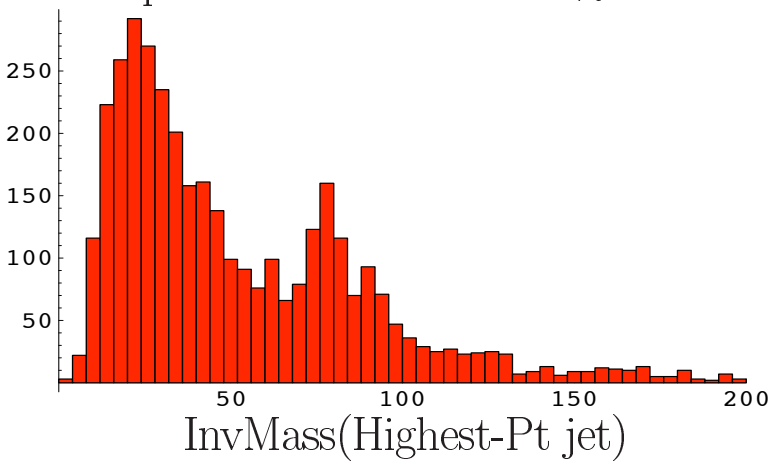
the TeV region is dominated by at least two high-Pt jets



$P_T \geq 180$ GeV

The number of events is quite small: N=3649 ($\simeq 10\%$ of N_{TOT})

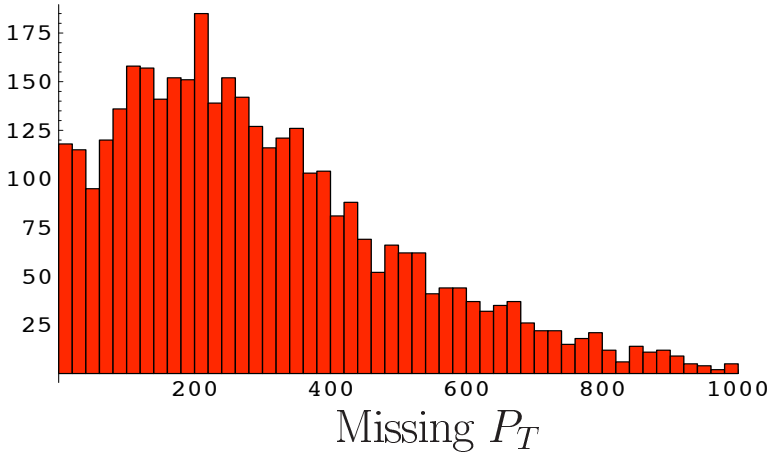
- 70% of these events contain at least one lepton
- 40% of these events contain an opposite-sign lepton pair: they do not reconstruct a Z-boson, also flavour uncorrelated
- the b-quark content is around 20% of the total



the Highest-Pt jets have a structure at the W and Z-boson mass, i.e. we have fat jets. They must come from the decay of an heavy particle.

TeV region

the TeV region is dominated by large missing energy

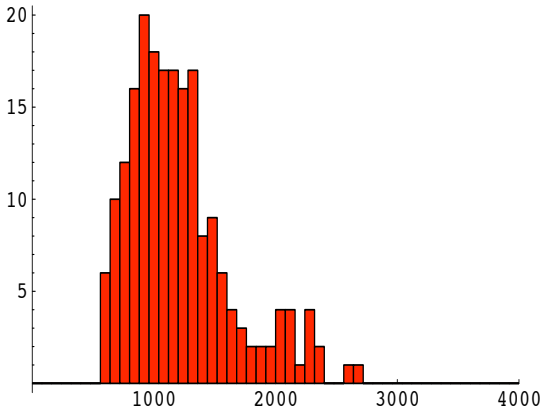


- UED?, Little Higgs?
- no purely leptonic sample
  the heavy leptonic sector must be decoupled
- two-jet sample has fat jets
  the heavy quark sector (first two gen.) must be decoupled
- gauge, scalar and top sector are on
  pair production or single production?

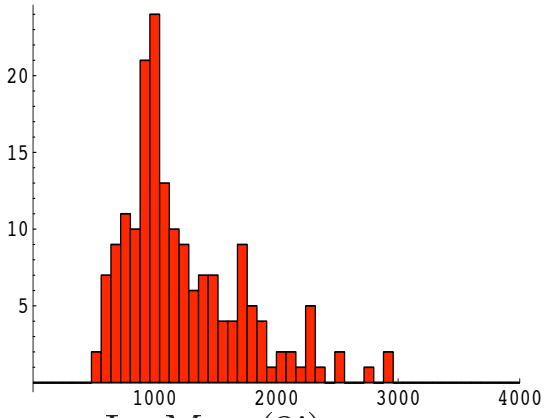
TeV region

a distinctive signature is the T-even top production in Little Higgs with T-parity, i.e.

$$pp \to T + j \to W^{\pm} bj \to bjjj/bjlE_T^{miss}$$



EffMass



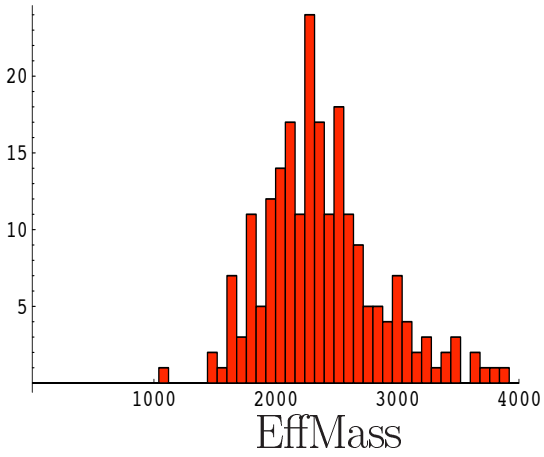
InvMass(3j)

the invariant mass of the two highest-Pt jets plus one extra jet shows a pale resonance at around $M = 1000GeV$.

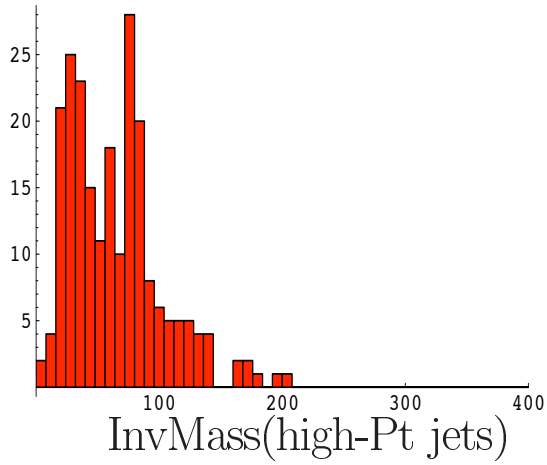
TeV region

are heavy particles pair-produced?

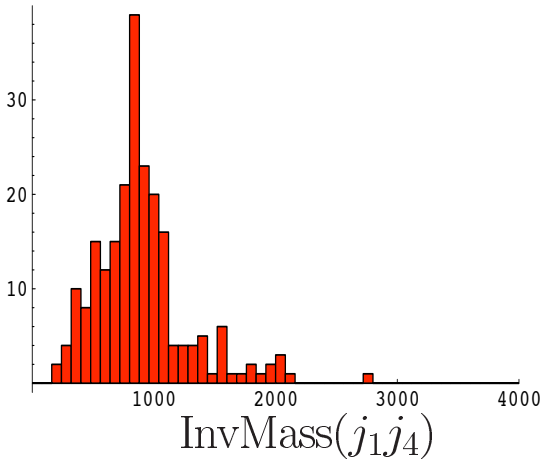
we select a 4-jet sample with high-Pt



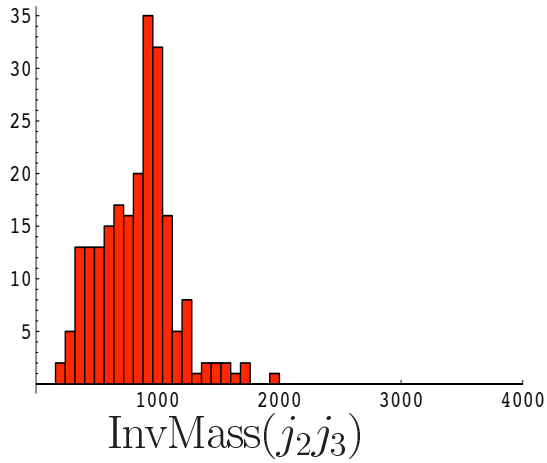
EffMass



InvMass(high-Pt jets)



InvMass($j_1 j_4$)



InvMass($j_2 j_3$)

we have two fat jets, j_1 and j_2, each reconstructing a 1 TeV structure.

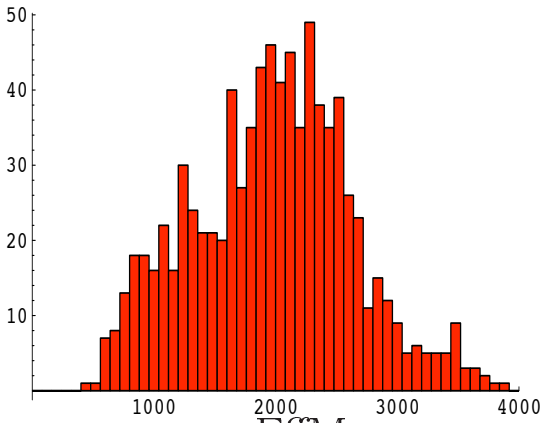
This is consistent with

$$pp \to TT \to WWjj \to 6j$$

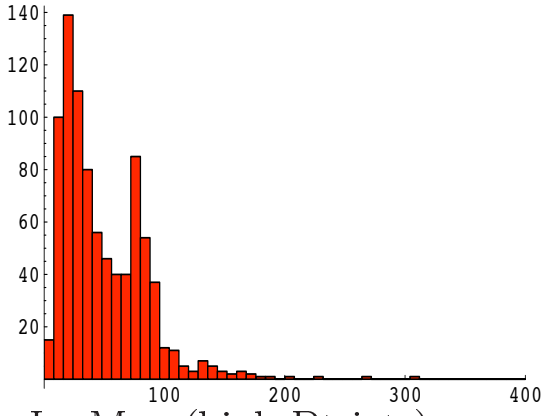
TeV region

are heavy bosons pair-produced?

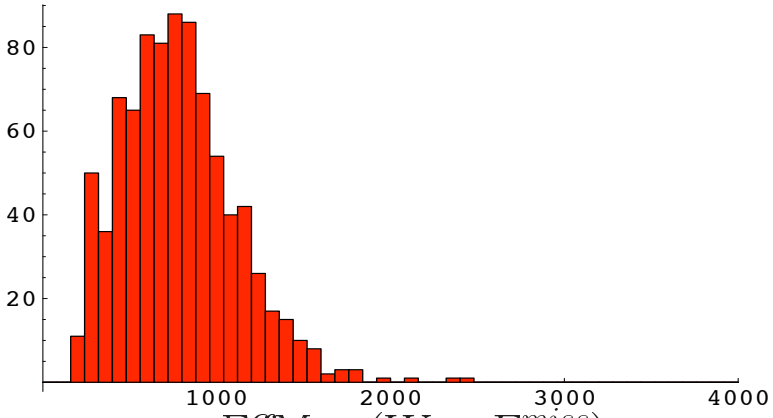
we select a 2-jet sample with high-Pt



EffMass



InvMass(high-Pt jets)



EffMass($W + E_T^{miss}$)

we have two fat jets, j_1 and j_2, each reconstructing a 1 TeV structure.

This is consistent with

$$pp \to W'W' \to 4j + E_T^{miss}$$

Guessing

Little Higgs could be the model, but too low statistics to draw conclusions.