Towards to $qq \to W(l\nu)W(jj)$ and $W(l\nu)Jets$ reconstruction

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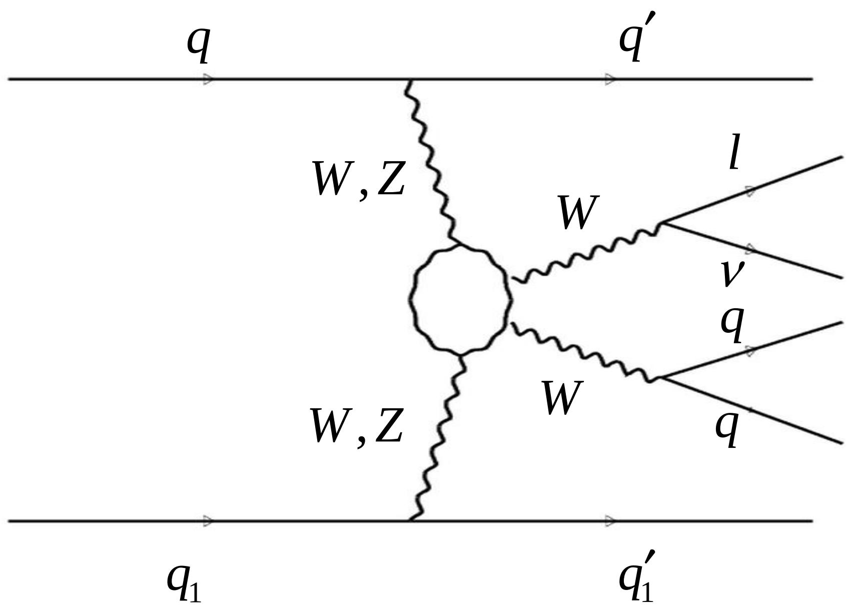
$$qq \to W(l\nu)W(jj)$$



- WW scattering in a large range of WW invariant mass

  300GeV< M_{WW} <2TeV

- Semileptonic final state is chosen in order to reduce hadronic background

What's interesting

- ✓Precision test of Standard Model

- ✓If no higgs exists, some theories offer an alternative way for giving masses to the W and Z by using strong dynamics for electroweak symmetry breaking. $\sigma_{WW \to WW}$ is very sensitive to this kind of new physics.

  - *M.S.Chanowitz, hep-ph/9812215*
  - *C.T.Hill&E.H.Simmons, hep-ph/0203079*
  - *W.Killian, DPF 2001*
  - *J.M.Butterworth et al, hys.Rev. D65 (02) 096014*

- ✓In the framework of the Standard Model fit of existing electroweak data with assumption that generation of leptons and quarks exists is compatible with Higgs masses as large as 500GeV

  - *V.A.Novikov, L.B.Okun, A.N.Rozanov, M.I.Vysotsky, hep-ph/0203132 14Mar 2002*
  - *H.-J.He, N.Polonsky and S.Su, Phys.Rev. D64(2001) 053004; hep-ph/0102144*

Full reconstruction of this channel seems interesting because it requires usage a plenty of different objects and algorithms

Objects:

- Jets
  - central
  - forward
- Missing Et
- μ
- e

Algorithms:

- $W \to JetJet$ mass reconstruction
- Fake jets suppression
- Pile-up subtraction
- ……

Signal $WW \to WW$

✓PYTHIA $W_L W_L \to W_L W_L$

✓Generator for $W_T W_T \to W_T W_T$ is developing by Alessandro Ballestrero (INFN)

W+Jets

This type of events is interesting itself. Probably it will provide the first evidence for new physics beyond the Standard Model.

Comparison between PYTHIA and COMPHEP:

✓PYTHIA generates W+1Jet events ($q_i \bar{q}_j \to Wg(16), q_i g \to W q_k (31)$) the rest of jets are created by showering

✓COMPHEP generates W+1jet, W+2jets and W+3jets events (at the parton level). Then partons are substituted in PYTHIA for showering, fragmentation and decay.

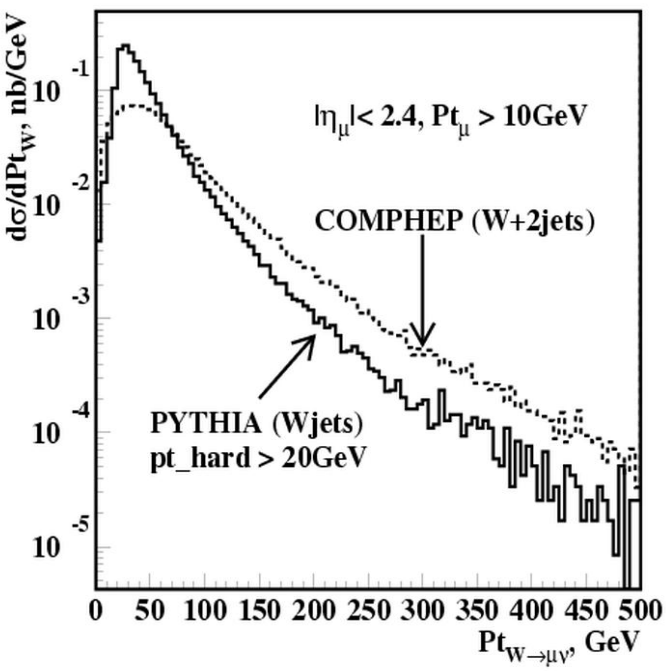
Comparison between PYTHIA and COMPHEP

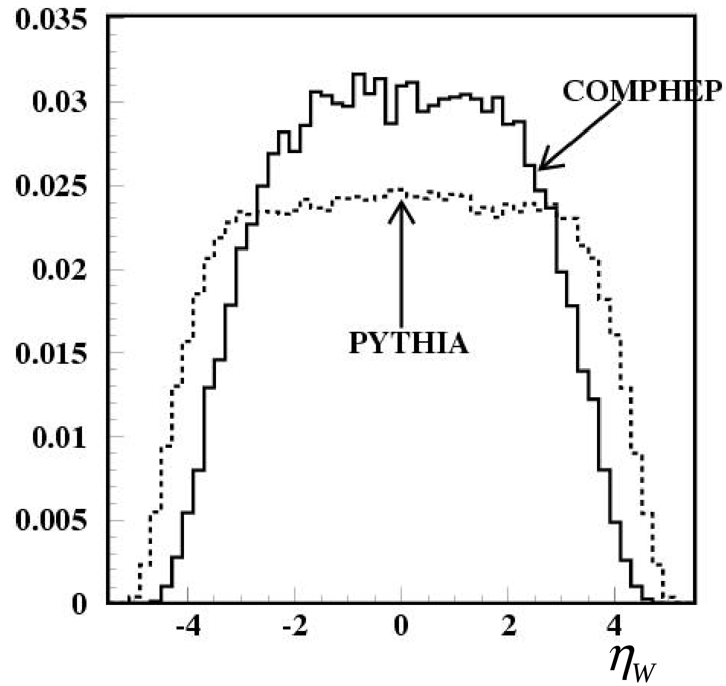
Event samples:

PYTHIA pt_hard>20GeV, 200.000 events

COMPHEP 308.500 events

Pt spectrum of W in COMPHEP is much harder





PYTHIA with D0 data

PYTHIA results superimposed on D0 data show good agreement

a) $q_i\bar{q}_j \rightarrow Wg(16)$

$q_i g \rightarrow Wq_k(31)$

pt_hard>20GeV

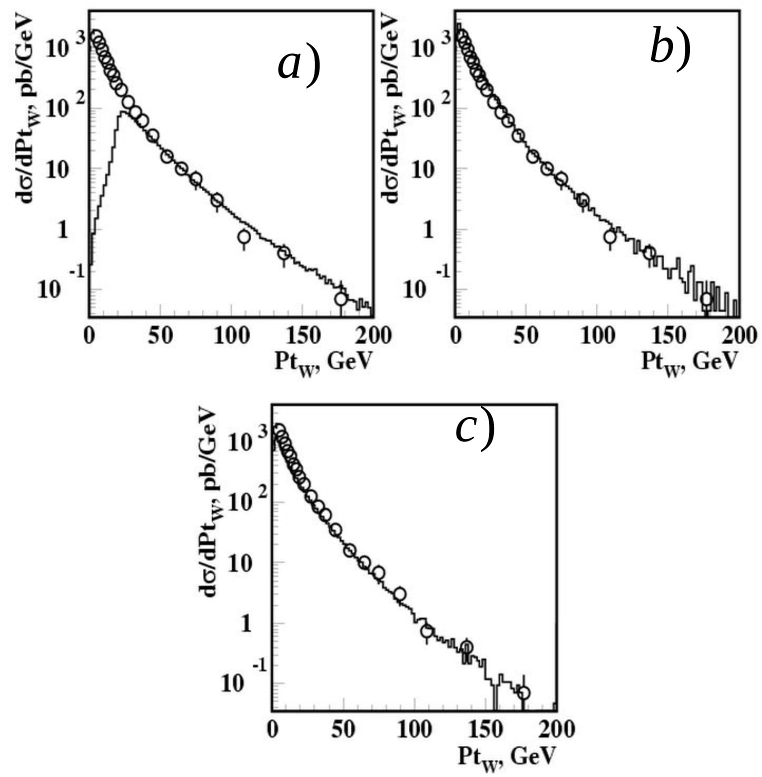
b) $q_i\bar{q}_j \rightarrow Wg(16)$

$q_i g \rightarrow Wq_k(31)$

pt_hard>0GeV

c) $q_i\bar{q}_j \rightarrow W(2)$

pt_hard>0GeV



Comparison between PYTHIA and COMPHEP

Typical cuts applied to suppress background:

✓ $\nu : E^{\nu}{}_T > 30GeV \qquad l : P^{l}{}_T > 30GeV, |\eta_l| < 2.4$

$W : M_T^{W\to\mu\nu} < 100GeV \; a) P_T^{W\to\mu\nu} > 100GeV \;\; b) P_T^{W\to\mu\nu} > 150GeV \;\; c) P_T^{W\to\mu\nu} > 200GeV$

	PYTHIA	COMPHEP
$P_T^{W\to\mu\nu} > 100GeV$	53pb	125pb
$P_T^{W\to\mu\nu} > 150GeV$	19pb	56pb
$P_T^{W\to\mu\nu} > 200GeV$	8pb	27pb

~3 times difference !!!

✓*Central Jets:* $|\eta| < 3, \; P_T^{J1} > 40GeV, \; P_T^{J2} > 40GeV, \; 60GeV < M_{JJ} < 100GeV$

$a) P_T^{W\to JJ} > 100GeV \quad b) P_T^{W\to JJ} > 150GeV \quad c) P_T^{W\to JJ} > 200GeV$

	PYTHIA	COMPHEP
$P_T^{W\to JJ} > 100GeV$	1.8pb	10.8pb
$P_T^{W\to JJ} > 150GeV$	0.9pb	4.5pb
$P_T^{W\to JJ} > 200GeV$	0.4pb	1.8pb

~5 times difference !!!

✓*For further analysis cuts on tagging jets and central jet veto are applied. But due to lack of statistics it's difficult to compare.*

SUMMARY:

✓ Channel $qq \rightarrow W(l\nu)W(jj)$ is challenging for analysis with full detector simulation

✓ Analysis of W+Jets background is started. Preliminary study shows that PYTHIA significantly underestimate the number of these events.

✓ Current production (30.000 events):

$W(\rightarrow \mu\nu) + 2Jets$ *(COMPHEP),* $Pt\_hard > 100GeV$

Production was done together with muon group (Nicola Amapane)

✓ People going to take part in analysis

INFN-Torinio participants:

Experimental ph: Nicola Amapane, Michele Arneodo,
Gianluca Cerminara, Chiara Mariotti,
Ernesto Migliore

Theoretical ph: Elena Accomando, Alessandro Ballestrero,
Ezio Maina, Roberto Pittau

RDMS participants:

Experimental ph: Natalia Ilyana, Olga Kodolova,
Andrei Krokhotine, Alexei Oulianov,
Irina Vardanyan

Theoretical ph: Eduard Boos, Alexander Sherstnev

A Preliminary Model Independent Study of the Reaction $pp \rightarrow qqWW \rightarrow ql\nu qq$ at CMS

◆Gianluca CERMINARA **(SUMMER STUDENT)**

◆**MUON group**

The Project

A Study of the WW-Fusion Channel in a Model Independent way

- **Purpose**: The aim of my work is to verify if it's possible to extract the **signal** from the **background** for the process

$$pp \to qqW_L W_L \to qql\nu qq$$

- **Tools**:
  - PYTHIA for the event generation
  - CMSJET for the detector simulation
  - ROOT for the data analysis
  - … a complete simulation will follow…

Event Generation

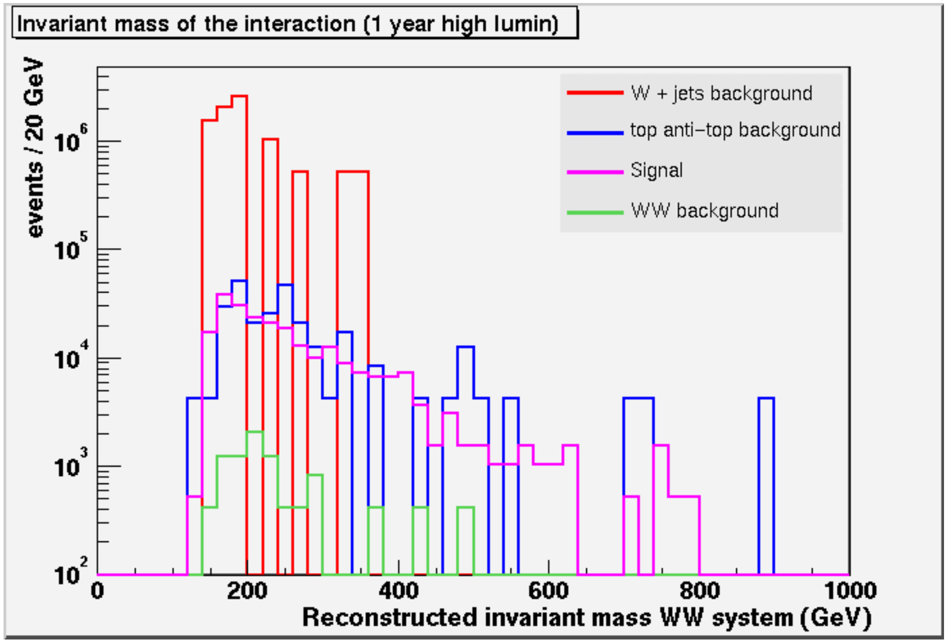
Events generated with PYTHIA Monte Carlo package.

	Signal	t-tbar	W+jets	$WW \to l\nu qq$
Cross section	18 pb	378 pb	46395 pb	11 pb
Number of generated events	3572	8949	8885	2726
PYTHIA Process code ("Isub")	72, 77	81, 82	16, 31	25

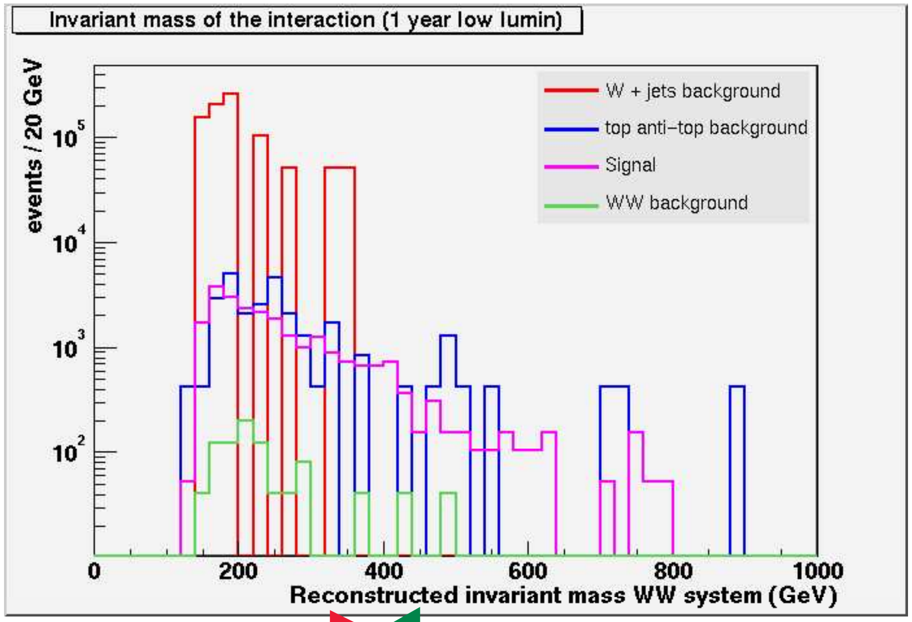
PYTHIA 6.158

Only a little Monte Carlo statistics was available.

Preliminary Results



Even if the W+jets background is still important at high invariant masses the signal to background ratio is quite good.



S/B = $2.1\times10^4/8.9\times10^5$

S/B = $2.9\times10^3/4.3\times10^3$

The high energy region is the most interesting for the new physics we are looking for.

1 year "Low Luminosity" = 10 fb^{-1}

1 year "High Luminosity" = 100 fb^{-1}

Conclusions

At this stage the measurement appears possible:

- **Good signal to background ratio at high WW invariant masses**

  $S/B \approx 1$

- **Very good resolution on $M_{WW} \equiv$ energy scale of the process**

  $\sim 10 \div 15\%$