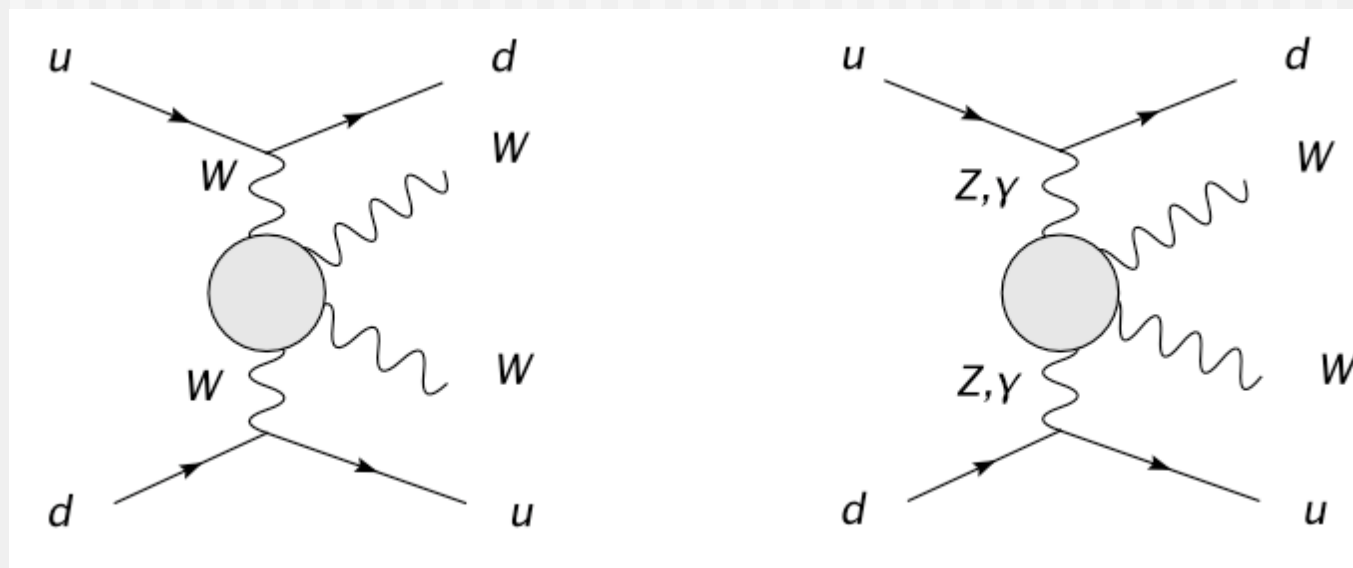




PHANTOM 1.0

Higgs, Top and Boson Boson Scattering Six fermion(+g) simulations at the LHC

E. Maina
U. Torino



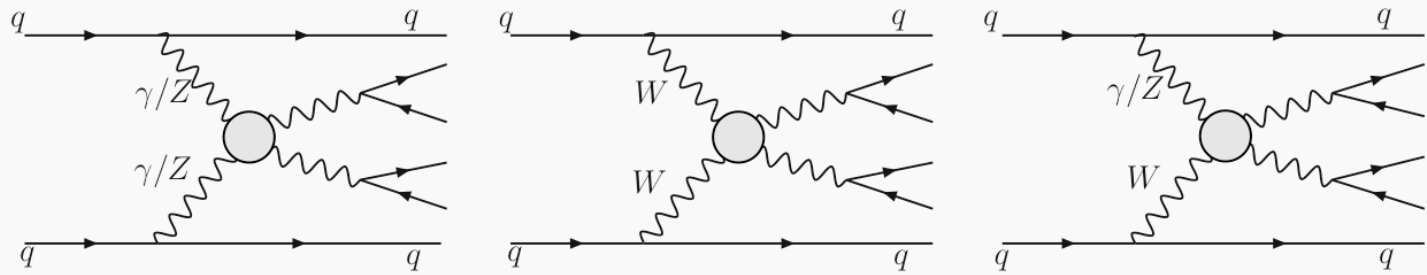
Phantom

Ballestrero, Belhouari, Bevilacqua, E.M.

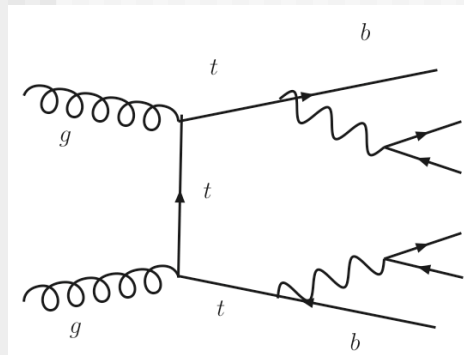
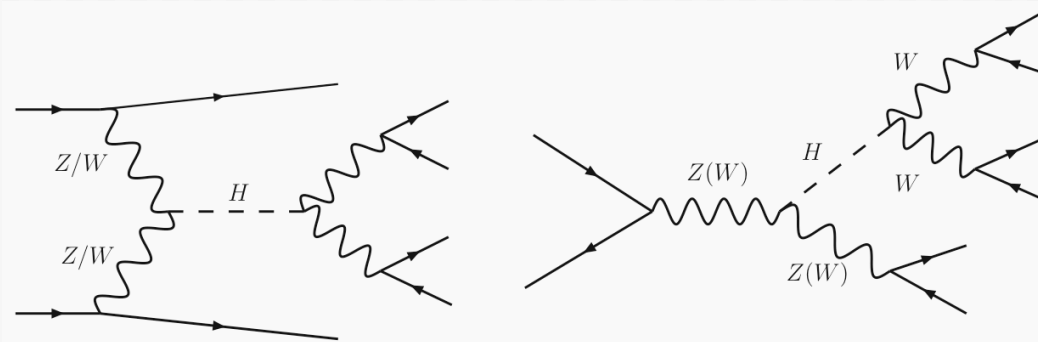


- Dedicated event generator
- Complete $2 \rightarrow 6$ $O(\alpha^6) + O(\alpha^4 \alpha_s^2)$
- $q_1 q_2 \rightarrow f_1 f_2 f_3 f_4 f_5 f_6$ $O(\alpha^6) + O(\alpha^4 \alpha_s^2)$
 $gg \rightarrow f_1 f_2 f_3 f_4 f_5 f_6$, $gq \rightarrow gq f_1 f_2 f_3 f_4$, $qq \rightarrow gg f_1 f_2 f_3 f_4$,
- Exact matrix elements. No production \otimes decay or EVBA
- Fast
- One-shot: generates unweighted events for all processes simultaneously
- Efficient: good mapping of phase-space

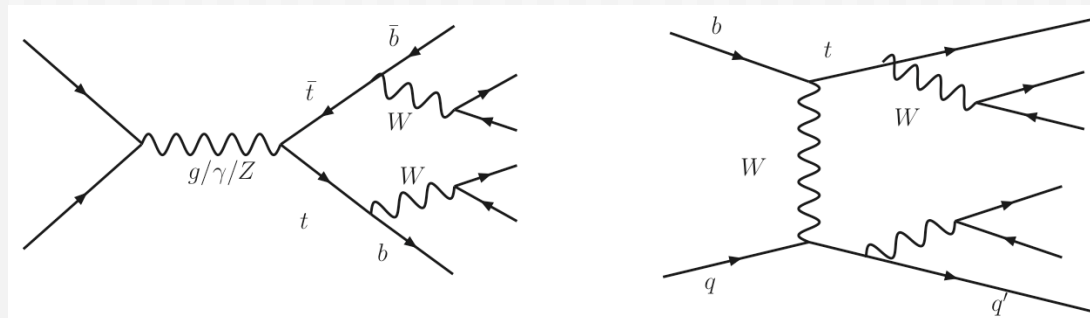
qqVV prod VV scattering



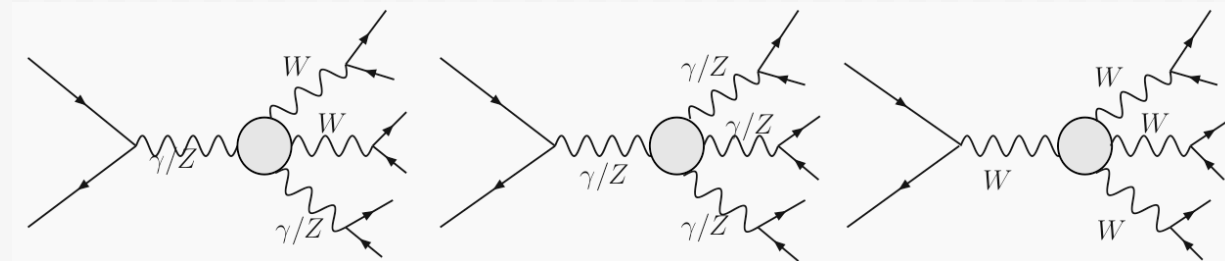
Higgs



top



VV couplings



An interesting example:

$$\bar{u}d \rightarrow \bar{u}d\bar{d}u\bar{\nu}\mu$$

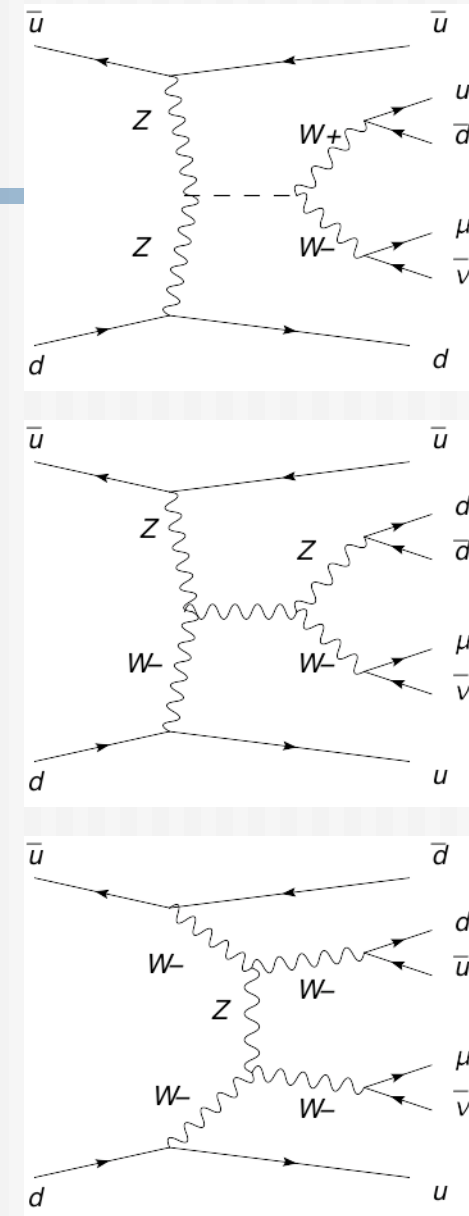
1046 diagrams

It includes:

- $ZZ \rightarrow W+W-$ Higgs $\rightarrow WW$
- $ZW- \rightarrow ZW-$
- $W-Z \rightarrow ZW-$
- $W-W- \rightarrow W-W-$
- $W- \rightarrow W-W+W-$ 2 Higgs $\rightarrow WW$ channels
- $W- \rightarrow ZZW-$ Higgs $\rightarrow ZZ$

Adaptive Integration + multichannel

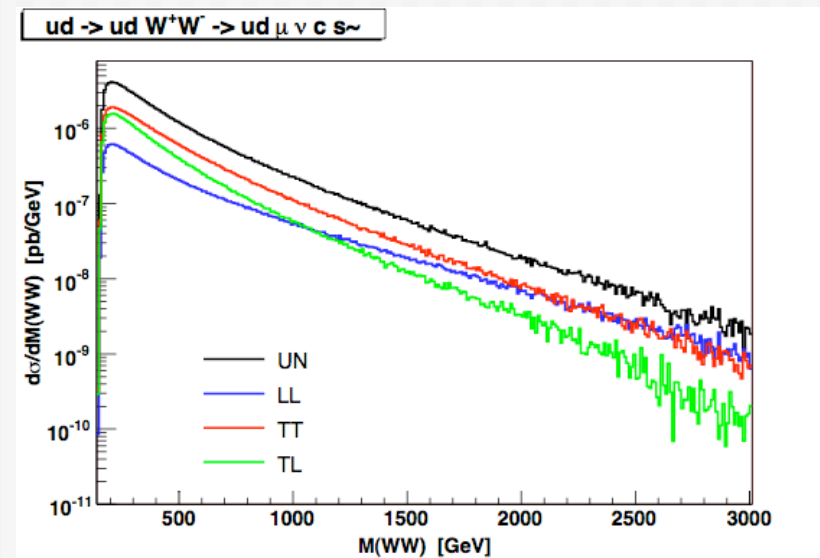
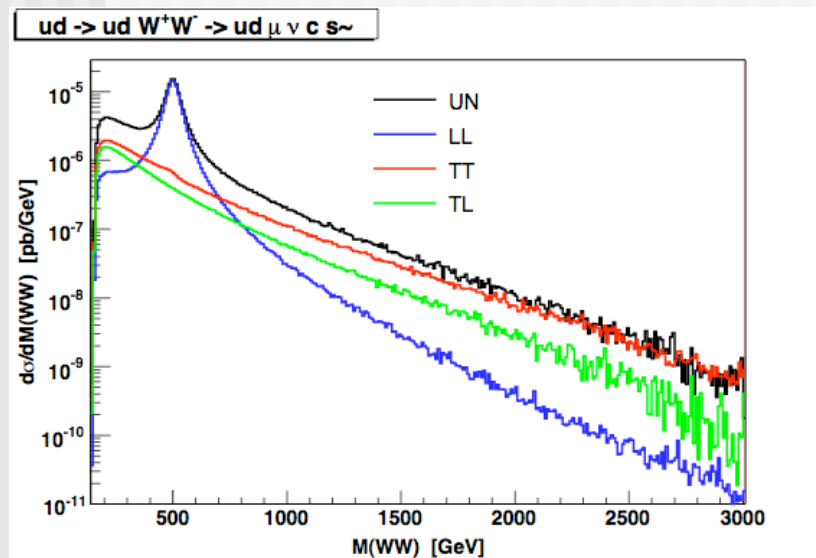
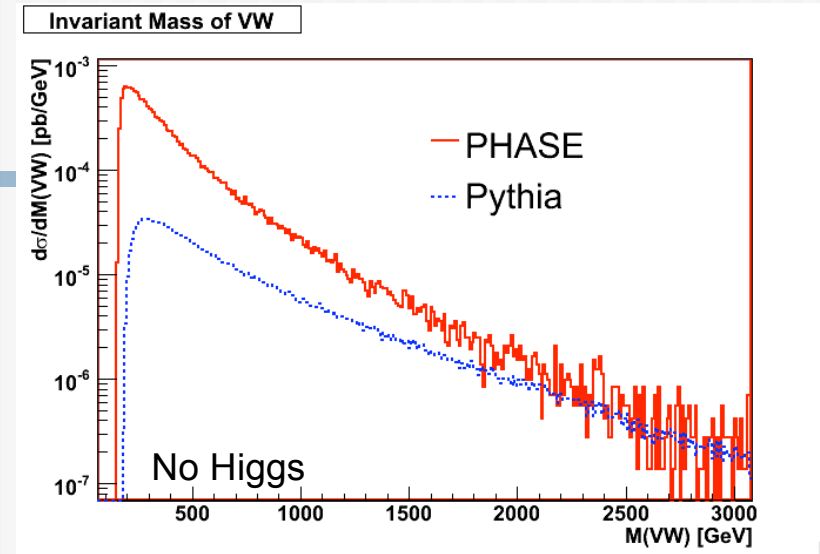
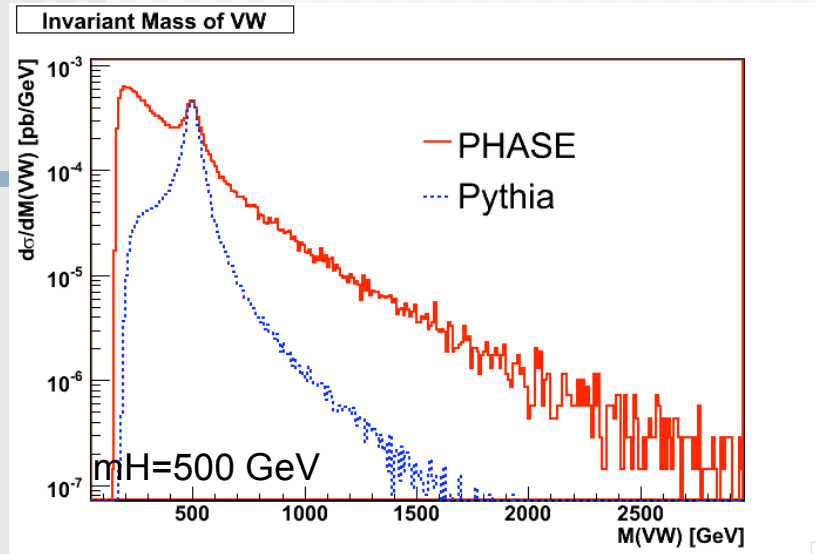
- Two steps:
- Grid generation
 - Event generation: one shot



$qq \rightarrow 4q\bar{l}\nu$

PHASE vs PYTHIA

After: Top veto, W mass cut
 $p_T^W > 50$ GeV in WW CM



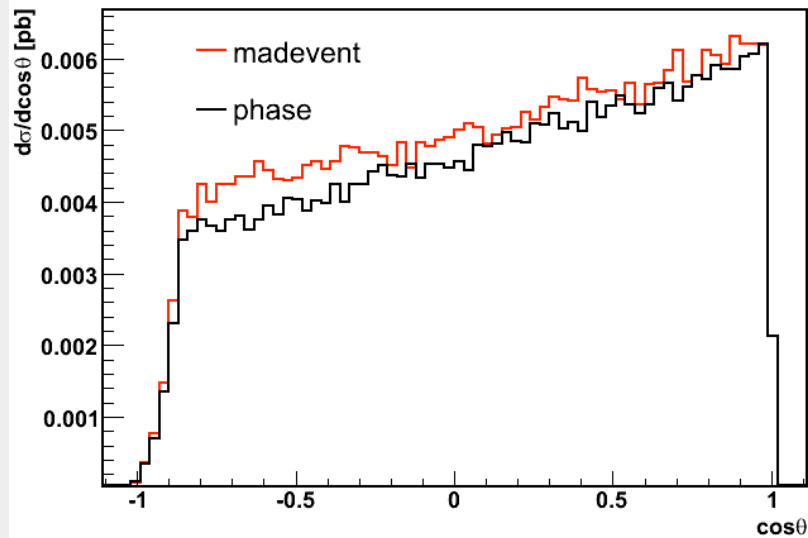
PYTHIA has only LL in EVBA approximation

PHASE vs MADEVENT

$uu \rightarrow uuqq\mu\nu$
 $qq = u\text{-dbar}, c\text{-sbar}$

Single process

Lepton angular distribution (W center of mass RF)

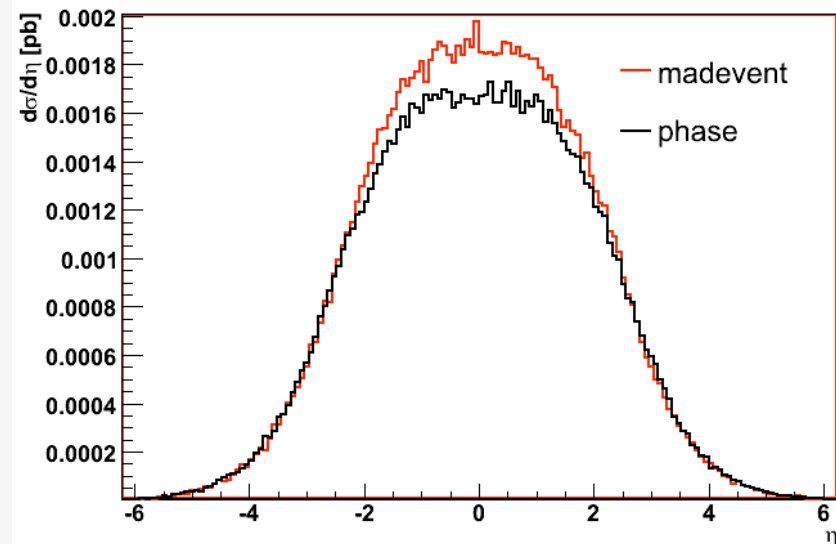


MADEVENT: $qqWV \otimes$ Decay

Could produce exact result
Long CPU time

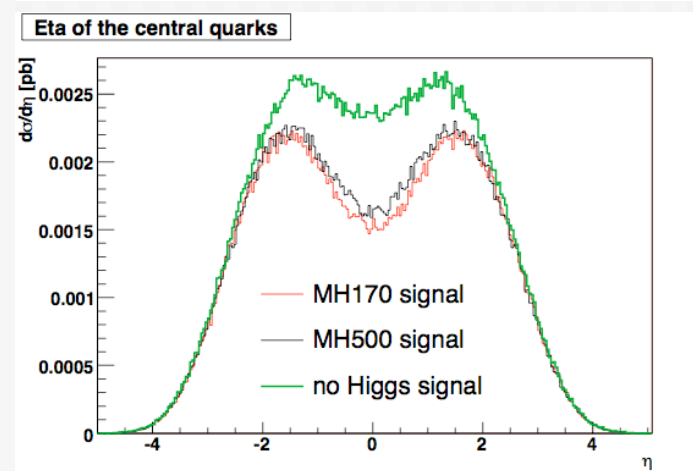
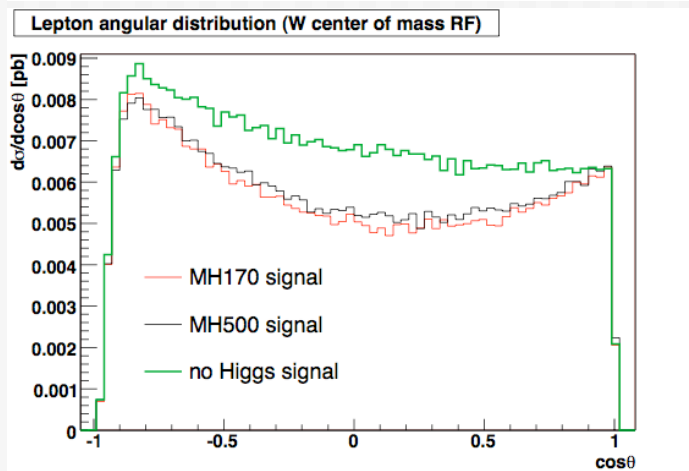
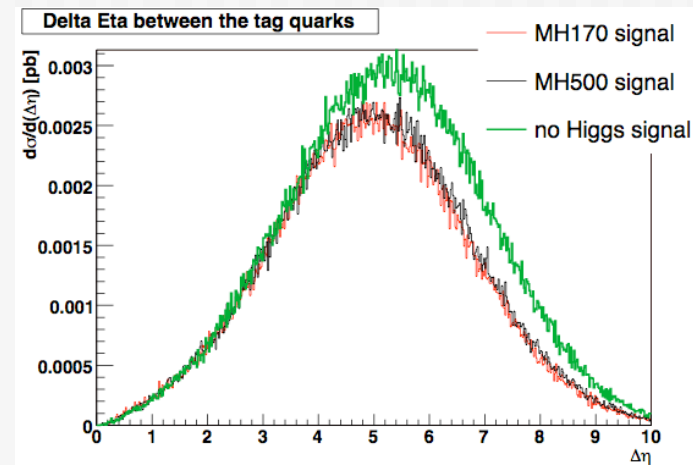
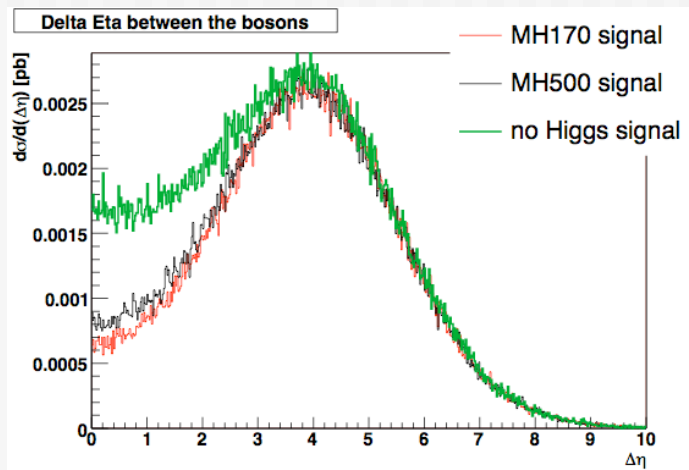
Tuned comparison
VVV production vetoed

Eta of the bosons



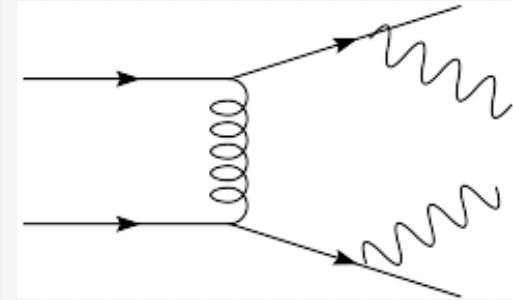
$qq \rightarrow 4ql\nu(\text{EW})$ $M(\text{VW}) > 800\text{GeV}$ $+p_T + E + \eta + M_{ij}$ cuts

Small sensitivity to MH in SM range \Rightarrow SM predictions well defined.
Not just counting exp



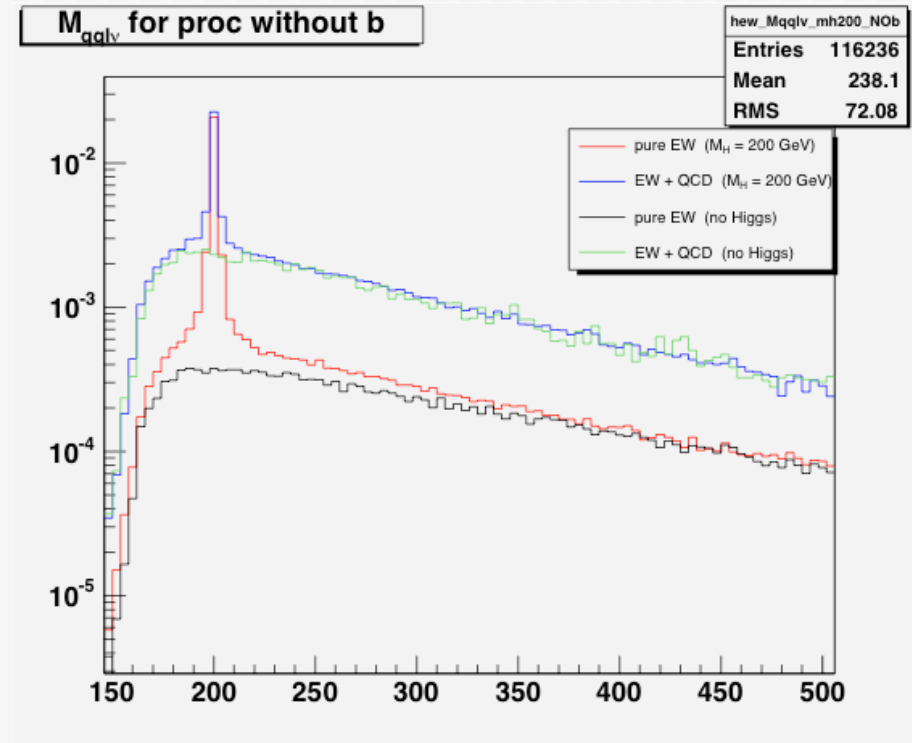
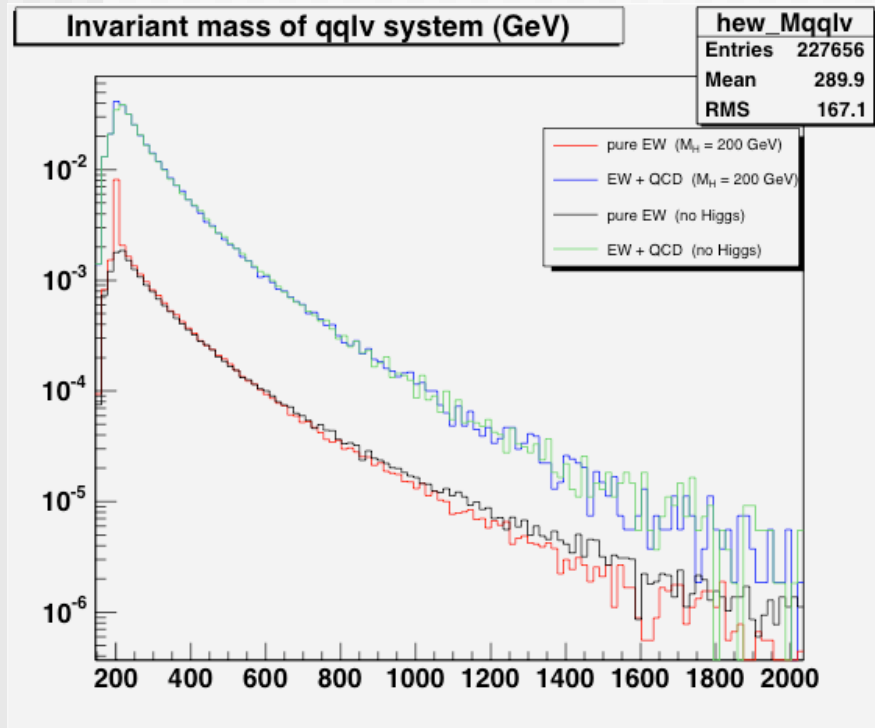
Internal gluon QCD corrections

with G. Bevilacqua (Torino)



Includes $qq \rightarrow tt$
No external g

All $qq \rightarrow 4q\ell\nu$ processes



First results: no real analysis

$70 < M(jcjc) < 90 \text{ GeV}$

Phantom 1.0



- Fast, efficient, dedicated event generator
- Complete $2 \rightarrow 6$ $O(\alpha^6) + O(\alpha^4 \alpha_s^2)$
- Exact, complete LO ME

Projects:

- t-tbar: spin correlations
- qqWW \rightarrow qqllvv
- Alternative models of EWSB

qq → 4qlv

Particles	type	diag	#proc(2+1)
$c\bar{s}d\bar{u}c\bar{s}\mu\bar{\nu}$	4W	202	6 + 2
$u\bar{u}u\bar{u}c\bar{s}\mu\bar{\nu}$	2Z2W	422	6 + 2
$u\bar{u}c\bar{c}c\bar{s}\mu\bar{\nu}$	2Z2W	422	10 + 1
$u\bar{u}s\bar{s}c\bar{s}\mu\bar{\nu}$	2Z2W	422	10 + 1
$u\bar{u}b\bar{b}c\bar{s}\mu\bar{\nu}$	2Z2W	233	15 + 0
$d\bar{d}d\bar{d}c\bar{s}\mu\bar{\nu}$	2Z2W	422	6 + 2
$d\bar{d}c\bar{c}c\bar{s}\mu\bar{\nu}$	2Z2W	422	10 + 1
$d\bar{d}s\bar{s}c\bar{s}\mu\bar{\nu}$	2Z2W	422	10 + 1
$d\bar{d}b\bar{b}c\bar{s}\mu\bar{\nu}$	2Z2W	233	15 + 0
$c\bar{c}c\bar{c}c\bar{s}\mu\bar{\nu}$	2Z2W	1266	3 + 2
$c\bar{c}b\bar{b}c\bar{s}\mu\bar{\nu}$	2Z2W	466	10 + 1
$s\bar{s}s\bar{s}c\bar{s}\mu\bar{\nu}$	2Z2W	1266	3 + 2
$s\bar{s}b\bar{b}c\bar{s}\mu\bar{\nu}$	2Z2W	466	10 + 1
$b\bar{b}b\bar{b}c\bar{s}\mu\bar{\nu}$	2Z2W	610	6 + 2
$u\bar{u}d\bar{d}c\bar{s}\mu\bar{\nu}$	2Z2W+4W	312	15 + 0
$c\bar{c}s\bar{s}c\bar{s}\mu\bar{\nu}$	2Z2W+4W	1046	6 + 2
TOTAL			141 + 20



All particles outgoing

Adding $ud \leftrightarrow cs$, $e \leftrightarrow \mu$, CC

⇒ 1K processes

16 amplitudes

2 basic sets of diags

Total: 5 basic sets

4W, 2Z2W, 4Z

2gZ2W, 2g3Z

