

Figure 1

We try to understand effects of lack of the Higgs boson using Effective Vector Boson Approximation (EVBA) [1, 2]. Although we are aware of drawbacks of this method, and role of nonscattering diagrams [3] we will use it to understand where to look for what we call signal, in which only remnant of nonscattering diagrams is their interference with Higgs exchange diagrams.

We start by analyzing distribution functions of probability for quark to emit W boson with fourmomentum squared  $q^2$  caring fraction  $x$  of quark energy [2].

$$P_T(x, q^2) = (C_V^2 + C_A^2) \frac{-q^2 x \left( \frac{2}{(x - \frac{q^2}{S})^2} - \frac{2}{x - \frac{q^2}{S}} + 1 \right)}{(q^2 - M_W^2)^2} \quad (1)$$

$$P_L(x, q^2) = (C_V^2 + C_A^2) \frac{M_W^2 x \left( \frac{2}{(x - \frac{q^2}{S})^2} - \frac{2}{x - \frac{q^2}{S}} \right)}{(q^2 - M_W^2)^2}$$

We substitute  $q^2 = \frac{S}{2}(1-x)(\cos \theta_j - 1)$  and integrate functions (1) over  $x$  to get distribution as a function of angle between incoming and outgoing quark  $\theta_j$  (Fig. 1a). We see that both polarizations prefer small angles but longitudinal polarization is produced at smaller angle than transverse one.

To get distributions as a function of energy of outgoing quark we integrate (1) over  $q^2$  and reproduce results given in [2]. WW scattering depends on energies of W bosons but this dependence is similar for longitudinal and transverse W's in Standard Model thus we expect only qualitative agreement between ratio of distribution functions (Fig. 1b) and ratio of  $uu \rightarrow ddWW$  differential crosssections in SM.

By substitution  $q^2 = \frac{S}{2}(\pm\sqrt{(1-x)^2 - p_T^2} - (1-x))$  and integration of (1) over  $x$  we get distribution as a function of transverse momentum of outgoing quark  $p_T$  (Fig. 1c).

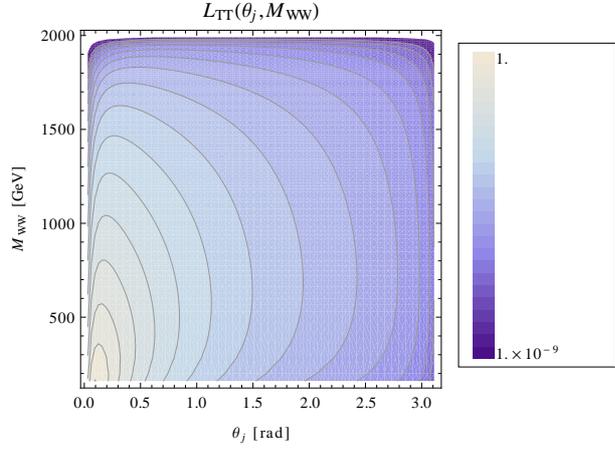
As seen in Fig. ?? WW scattering in No Higgs scenario is enhanced in large WW invariant mass region, but in leptonic W decay channels WW invariant mass is not observable, so we

need other means to select this region. W bosons emission from quarks don't depend on existence of Higgs particle, but remaining after emission quark carry some information about kinematics of produced W boson and can be used to select desired kinematical regions of WW scattering. First effect is that larger WW invariant masses are reached when angle between incoming W's momenta is closer to  $\pi$  which is achieved for smaller final quark angles (Fig. 1d). Second, smaller final quark energies lead to larger emitted W energies which leads to larger WW invariant masses. This is seen in Fig. 1e. Those two effects lead to enhancement of signal for small transverse momentum of final quarks (Fig. 1f).

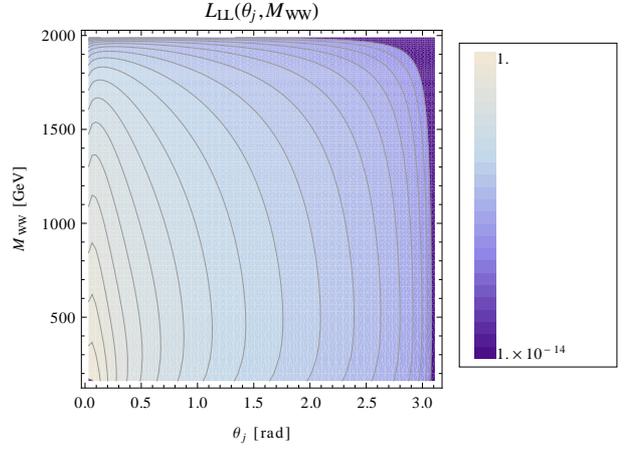
We try to select outgoing W's with high transverse momentum. First reason is that higher  $p_T$  of W's correspond to higher invariant mass of WW pair. Second reason is that, as seen in Fig. ??, excess of No Higgs scenario over Standard Model occurs mostly for W's outgoing perpendicular to direction of incoming W's in their center of mass frame. So if preferred in WW CM frame direction is similar to direction perpendicular to incoming quarks momenta selecting high  $p_T^W$  exploits also second reason. Thus by selecting events with lower transverse momentum of jets we force emitted W's to be more colinear with emitting quarks and enhance effect of high  $p_T^W$  selection.

## References

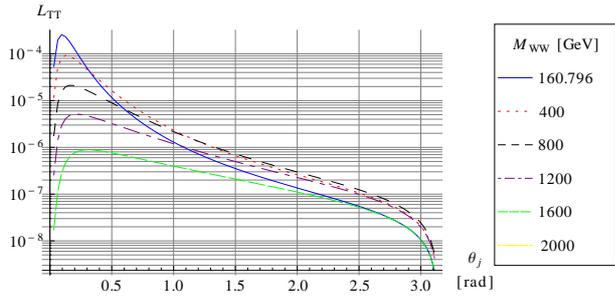
- [1] S. Dawson, Nucl. Phys. **B249**, 42 (1985)
- [2] P. W. Johnson, F. I. Olness, and Wu-Ki Tung, Phys. Rev. **D36**, 291 (1987)
- [3] E. Accomando, A. Ballestrero, A. Belhouari, E. Maina, hep-ph/0608019 (2007)



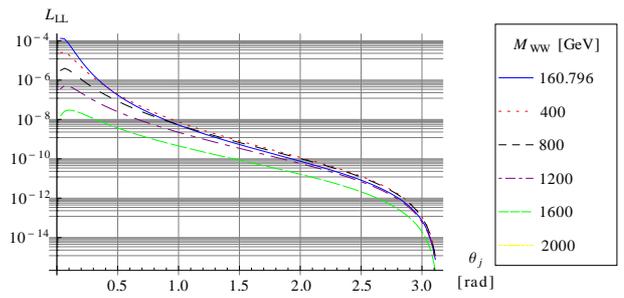
(a)



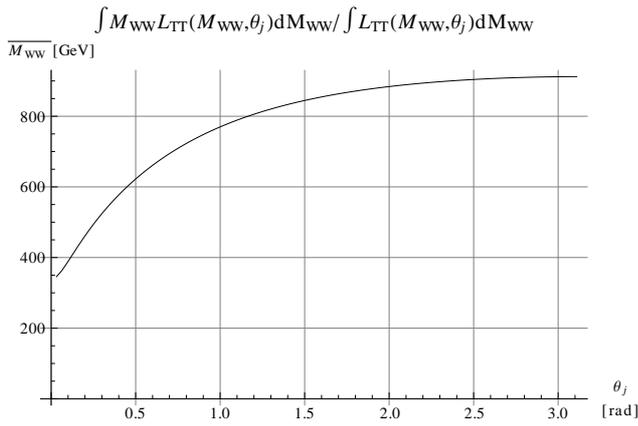
(b)



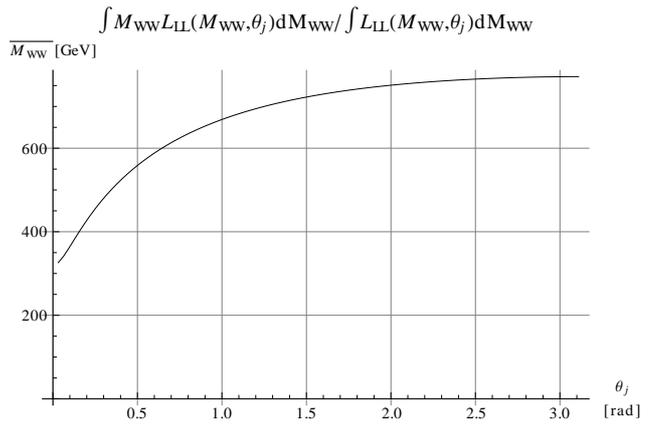
(c)



(d)

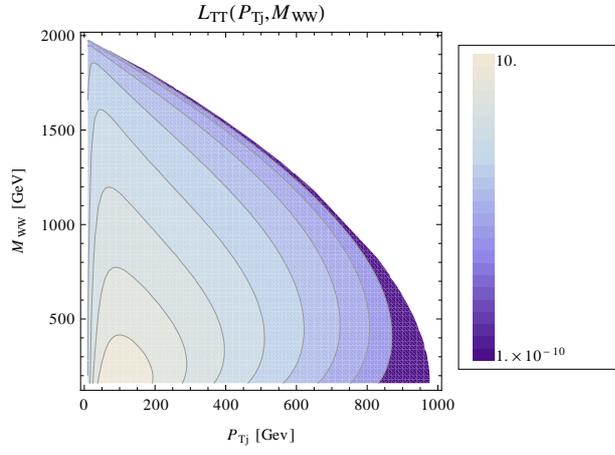


(e)

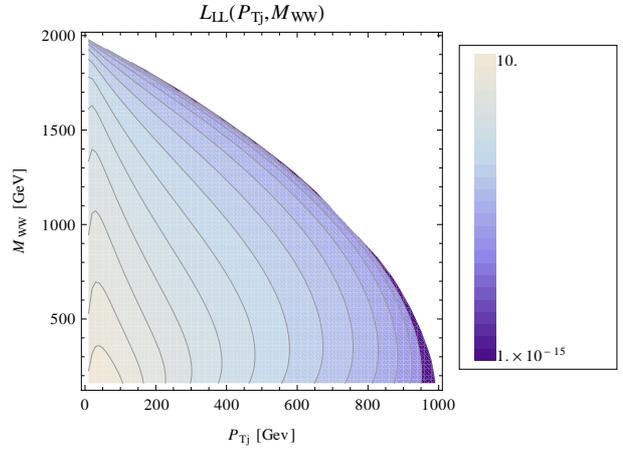


(f)

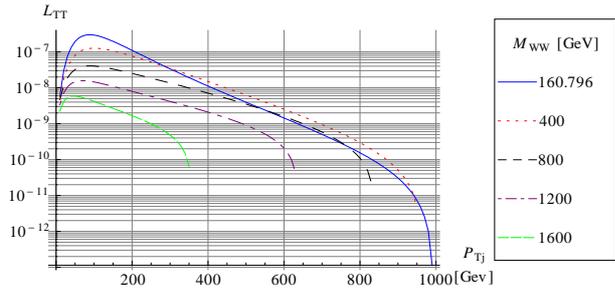
Figure 2



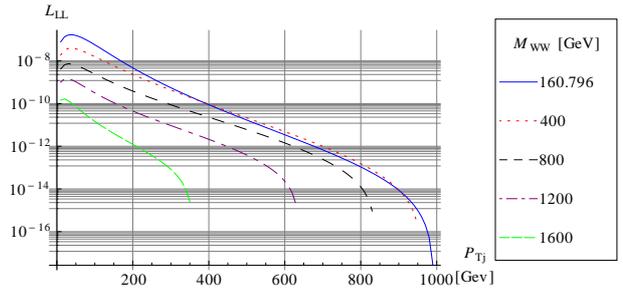
(a)



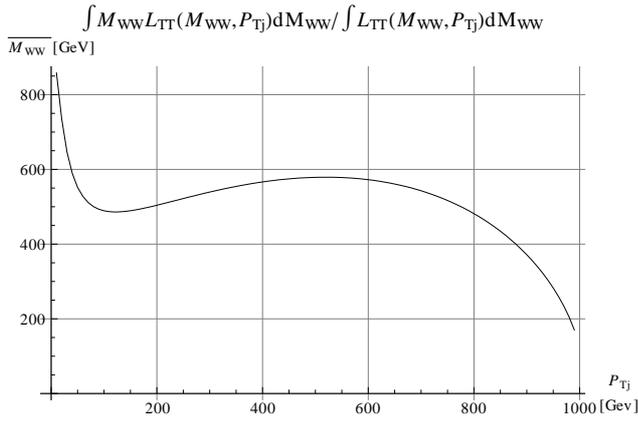
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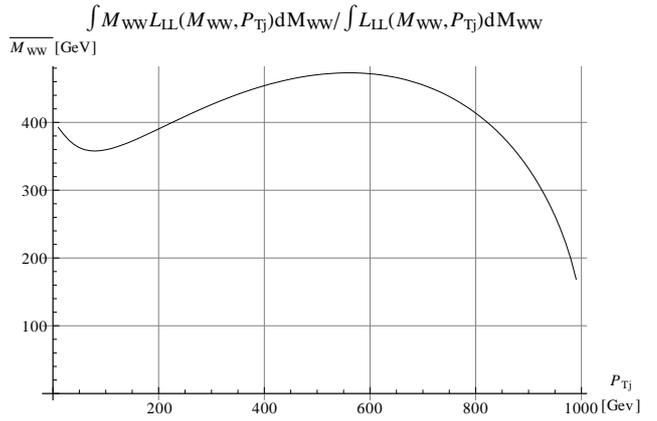
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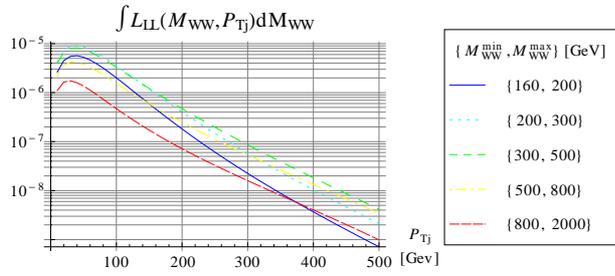


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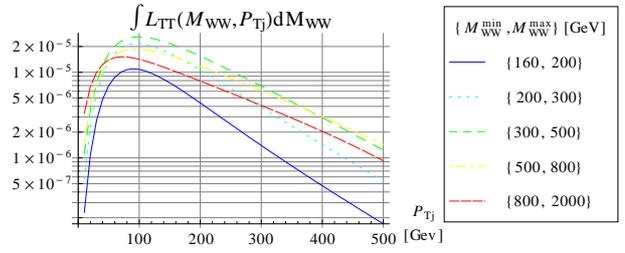


(f)

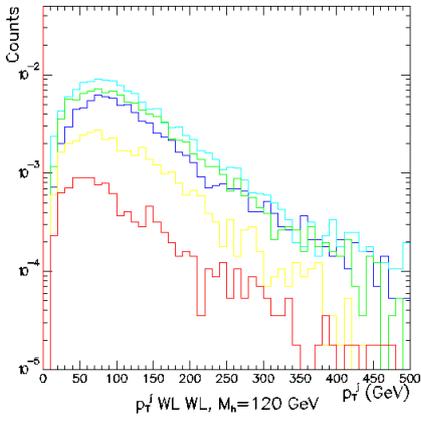
Figure 3



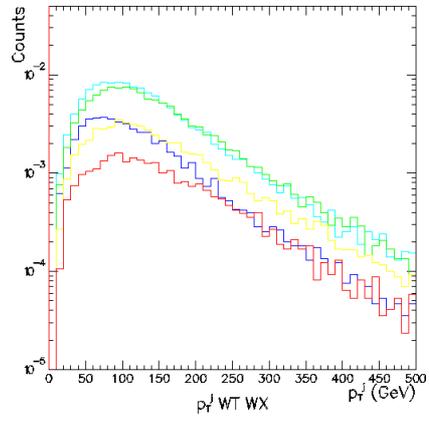
(a)



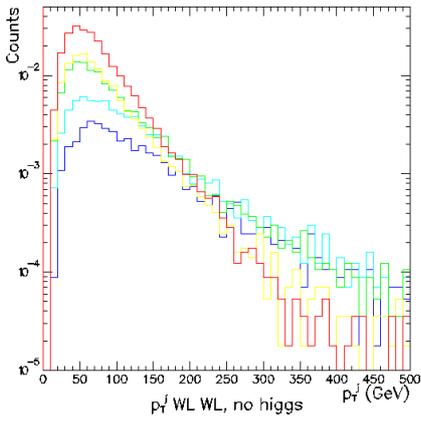
(b)



(c)



(d)



(e)

Figure 4