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LHC: p+p $\to W^+W^-t\bar{t}$

Ivan Melo

p+p $\rightarrow W^+W^-t\bar{t}$ goes through 9 channels (our model version 13 - 'QCD' version):

1. $u + \bar{u}$ ... 131 diagrams
2. $d + \bar{d}$ ... 131
3. $\bar{u} + u$ ... 131 (σ same as 1.)
4. $\bar{d} + d$ ... 131 (σ same as 2.)
5. $s + \bar{s}$ ... 131 (5.-8. likely much smaller than 1.- 4.,9.)
6. $c + \bar{c}$ ... 131
7. $\bar{s} + s$ ... 131 (σ same as 5.)
8. $\bar{c} + c$ ... 131 (σ same as 6.)
9. $g + g$ .... 39 (likely the biggest one)

It seems we have to deal with 1.,2. and 9.

$\boxed{g + g \to W^+W^- t\bar{t}}$

39 diagrams

Symbolic calculation ..... 30 min

Compiling .... 90 min

ρ res.: M $= 700$ GeV, $b_2 = 0.08, g'' = 10, (\Gamma_\rho = 3.9499$ GeV)

No res.: $M = 3 \times 10^4$ GeV, $b_2 = 10^{-8}, g'' = 10^5, (\Gamma_\rho = 1.19191$ GeV

Regularization ......(34, 0, 0, 2), (34, 91.1876, 2.49444, 2), (34, 700, 3.9499, 2)

Run 1 No cuts

$\sigma(\rho) = 10.2 - 10.3$fb $\quad Err.1.3 - 1.5\%$ $\quad 2 \times 5 \times 10^4$

$\sigma(nores.) = 10.5 - 10.7$fb $\quad Err.1.6 - 1.3\%$ $\quad 2 \times 5 \times 10^4$

Run 2 Cut: $650 < M_{WW} < 750$ GeV

$\sigma(\rho) = 2.1 - 2.2$fb $\quad Err.2.8 - 2.3\%$ $\quad 2 \times 5 \times 10^4$

$\sigma(nores.) = 0.61 - 0.66$fb $\quad Err.2.9 - 1.9\%$ $\quad 2 \times 5 \times 10^4$

Run 3 Cut: $650 < M_{WW} < 750$ GeV, $T3, T4, T5, T6 >$ 100 GeV, $|Y3, Y4, Y5, Y6| < 2$

$\sigma(\rho) = 0.99 - 1.09$fb $\quad Err.2.8 - 3.8\%$ $\quad 2 \times 5 \times 10^4$

$\boxed{u + \bar{u} \to W^+ W^- t\bar{t}}$

131 diagrams ... too many for our computers

Signal .. just assume on the basis of $pp \to \rho tt$ analysis that $u\bar{u}$ channel is much smaller than gg channel.

Background ...delete diagrams with ρ and make no resonance limit. We encountered certain problems with the no Res data set. The background results oscillated wildly for different definitions of the no resonance. The best choice is now 'No res 6':g1 = 0.667028, v=241.138, a=0.061911, g''=1000, b1=b2=0, Γ_ρ=11916.1 GeV, $M_\rho = 30000$ GeV.

Summary of $WW \to H(\rho)$ fusion at LHC

SM heavy H (ATLAS TDR)

$pp \to Hqq \to WWjj \to l\nu jjjj$

$\sigma(M_H = 800$ GeV): ???

Bgr: $pp \to Wjjjj$, $pp \to tt \to WWbb$, irreduc. $WWjj$

$S/\sqrt{B} > 10$

ρ (Tao Han1 - hep-ph/0301039)

$pp \to \rho qq \to ttqq \to ttjj$

$\sigma(M_H = 800$ GeV,some simple cuts): 25 fb

Bgr: irreduc. QCD $ttjj$ with $\sigma > 100$ pb !!!... kills all

Summary of $pp \to H(\rho)tt$ at LHC

CompHEP SM $pp \to Htt$

$\sigma_{gg}(M_H = 100) = 943 fb$ $\sigma_{gg}(M_H = 700) = 8.2 fb$

$\sigma_{uu}(M_H = 100) = 98 fb$ $\sigma_{uu}(M_H = 700) = 0.27 fb$

$\sigma_{dd}(M_H = 100) = 59 fb$ $\sigma_{dd}(M_H = 700) = 0.15 fb$

SM H (ATLAS TDR)

$pp \to Htt \to bbtt \to l\nu jjbbbb$

$\sigma(M_H = 100$ GeV$)\times$ BR: 290 fb

Bgr: $ttjj$, $Wjjjjjj$, $WWbbjj$, irreduc. $ttbb, ttZ$

$S/\sqrt{B} > 5$ for $M_H < 120$ GeV

SM H (Z. Kunszt NPB 247, p.339) small top mass !

$pp \to Htt \to tttt(M_H < 2M_W)$ Bgr.tttt too big

$pp \to Htt \to WWtt(M_H > 2M_W)$ Bgr.WWtt estimated small

ρ (Tao Han2 - hep-ph/0405055)

$pp \to \rho tt \to bbtt$

$\sigma \sim$ few fb Bgr: irreduc. $bbtt$ not bad

$pp \to \rho tt \to tttt$

$\sigma \sim$ few fb Bgr: irreduc. $tttt$ worse