

Background Studies for Higgs production at the LHeC (Update)

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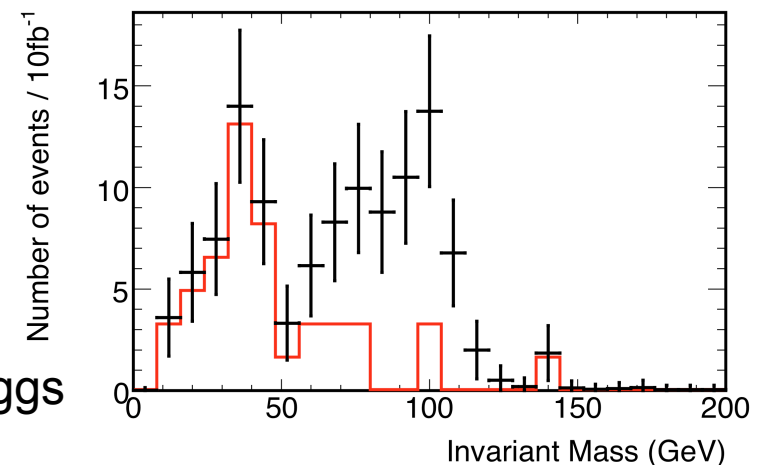


LHeC WG convenors meeting, CERN, 15 Dec. 2009

Reminder: in Divonne 2009

- MadGraph + PYTHIA + PGS detector sim.
- Using inclusive CC ($e^- p \rightarrow \nu_e + \text{jet} + X$) MC,
 $S(\text{Higgs})/N(\text{CC}) = 38.5/3.3$ [events for 10fb^{-1}]
was obtained after “double B-tag jets” cut.
($E_e = 140\text{GeV}$, $M_H = 115\text{GeV}$)
- rather promising...

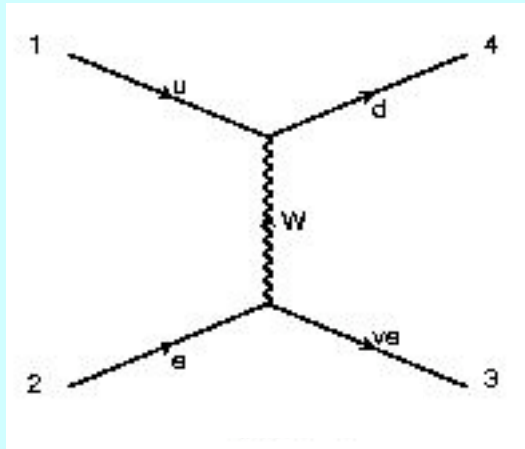
Red: CC
Black: CC+Higgs



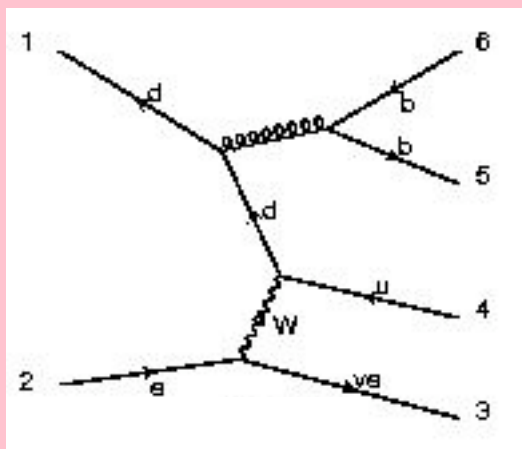
Progress since then

- Tried to cross check with Liverpool study (U.Klein)
- $E_e=150\text{GeV}$, $M_H=120\text{GeV}$ (mass window [80,125])
- Generator-level cuts on jet energy, angle, M_{jj}
- Selection of two jets for making M_{jj}
Highest $E_t \rightarrow$ Lowest η (also total $E_T > 100\text{GeV}$)
- Instead of inclusive CC (“mono-jet”),
“dijet” (actually 3-jet, i.e. 3 partons in final state)
diagrams (~ 540) were generated by MadGraph

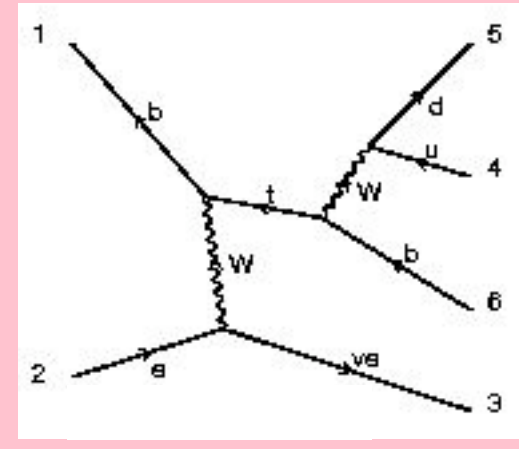
Result: a big surprise!



mono jet background
2 diagrams
cross-section $\sim 503\text{pb}$

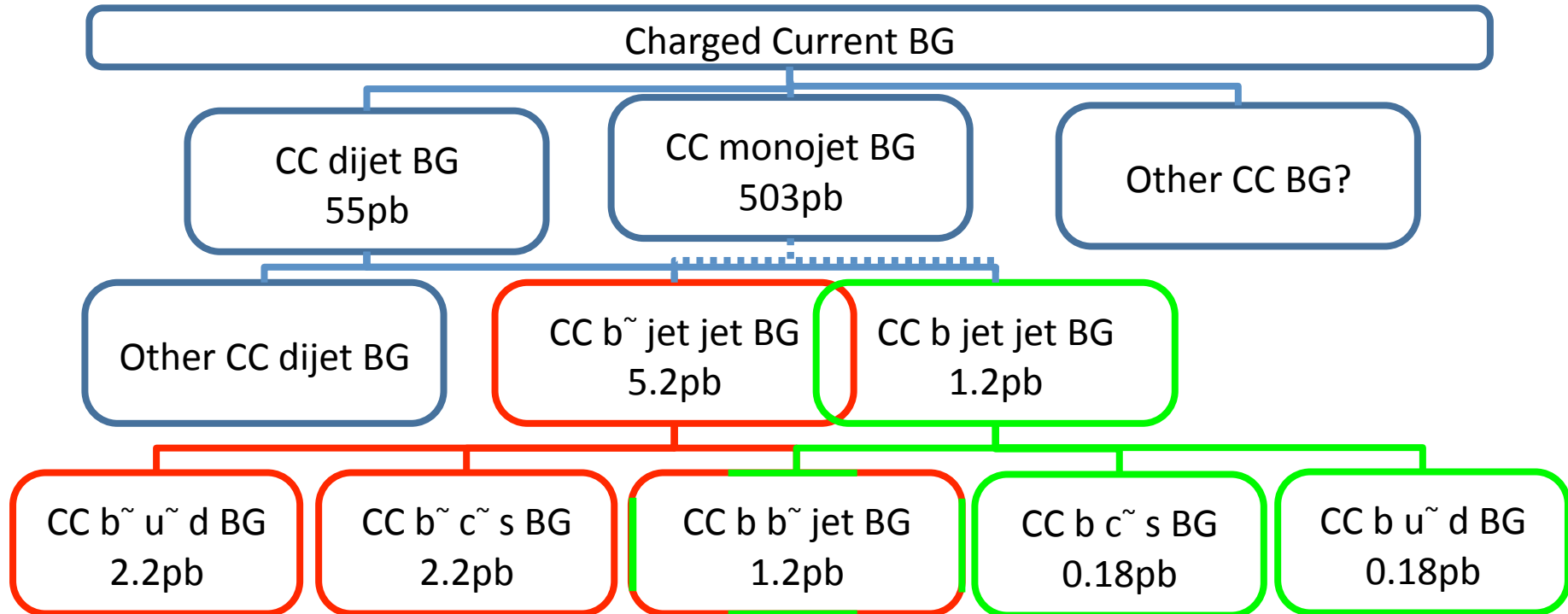


dijet (3-jet) background
536 diagrams
cross-section $\sim 54.9\text{pb}$



- $S/N = 35.6/235$ [events] after “double B-tag jets” cut!
- PYTHIA’s QCD radiation and hadronization not enough for all final states?
- Looked at details of dominant sub-processes giving final candidates.

Subprocess cross sections by MadGraph



Large cross section of $b\bar{c}s$ or $b\bar{u}d$ 3Jets events.

More than 90% of these processes is single-top production $t\bar{t} \rightarrow W^- b\bar{c} \rightarrow (c\bar{s} \text{ or } u\bar{d}) b\bar{c}$

They are the suspected dijet bg for Higgs search.

Number of events from each process for 10 fb⁻¹

	Higgs event	CC monojet BG	CC "dijet" BG	CC b [~] jj BG	CC bjj BG	CC b [~] b j BG	CC b [~] c [~] s BG	CC b [~] u [~] d BG
All events	2340	5.03e+6	5.49+e5	51700	9430	8540	22300	22300
1Jet B-tag + 80<M<125 (GeV)	175	547	6260	4200	263	213	2060	1900
2Jets B-tag + 80<M<125 (GeV)	47.7	15.7	235	189	27.6	25.2	138	34.2

- Dominant process in the final "dijet" MC is b[~] c[~] s (c-jet has high B-tag efficiency!)
- 90% of it comes from single-top diagram (cf. p.4)
- It is an **electroweak** HO diagram, so naturally PYTHIA does not produce it?

Summary

- It could be the S/N shown in Sept. based on inclusive CC is too optimistic.
- Higher order EW diagram, single-top, dominantly contributes to double B-tag Higgs candidates.
- MadGraph picks up b-quark PDF: is it reliable?
- Needs confirmation (Liverpool group!)
- If it is true, further kinematic cuts can be tried to reject $top \rightarrow bW$ events.

Latest plot: 3-Jet mass

$Q_2 > 400 \text{ GeV}^2$, & $\gamma > 0.9$ & $\text{missET} > 20 \text{ GeV}$
& $N_{\text{Jet}}(\text{PT} > 20 \text{ GeV}) \geq 3$ & $N_{\text{Jet}}(\text{tight B-tag} \ \& \ \text{PT} > 20 \text{ GeV}) \geq 2$

After double B-tag jets, additional jet was searched and M_{jj} was calculated.
Left: $90 \text{ GeV} < M_{jj} < 120 \text{ GeV}$, Right, No M_{jj} cut was imposed.
CC 3jet backgrounds peak at $\sim 160 \text{ GeV}$ (m_{top} ?), so $M_{jj} > 200 \text{ GeV}$ cut seems effective to reduce bg and keep \sim half of Higgs events.

— higgs — CC dijet BG — CC $b\bar{b}$ BG

