ExHuME Updates and Single Diffractive Overlap Background to Higgs

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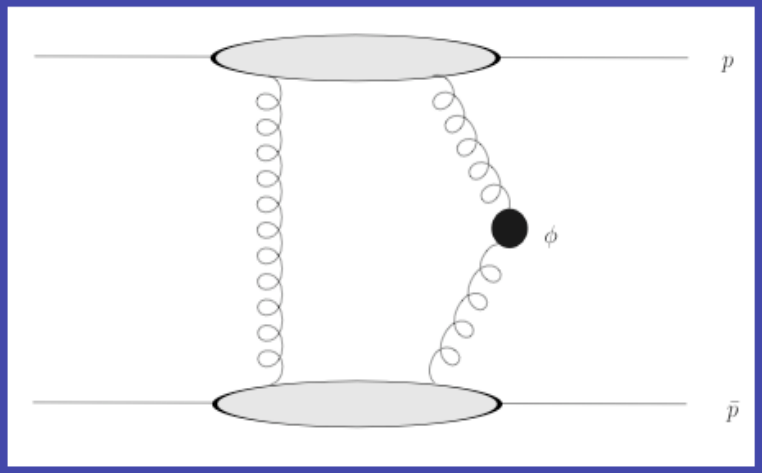
The ExHuME Event generator.

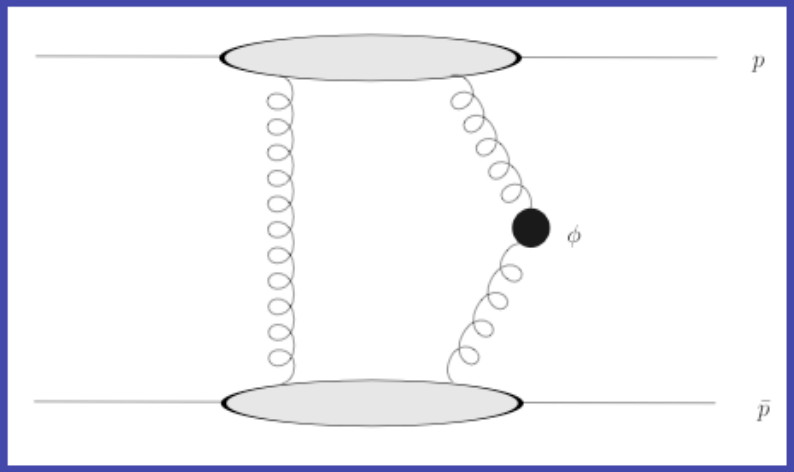
- Project started with James Monk (then Manchester, now UCL) to implement the Durham Model of central exclusive production.
- Released in January 2005 with Higgs, di-quark and di-gluon production. (v1.0) after lots of discussions with Durham.
- Current version is 1.3.2. Involves a few bug fixes, improvements, removed dependencies on CERNLIB. Available from COMP-PHYS (or from me).

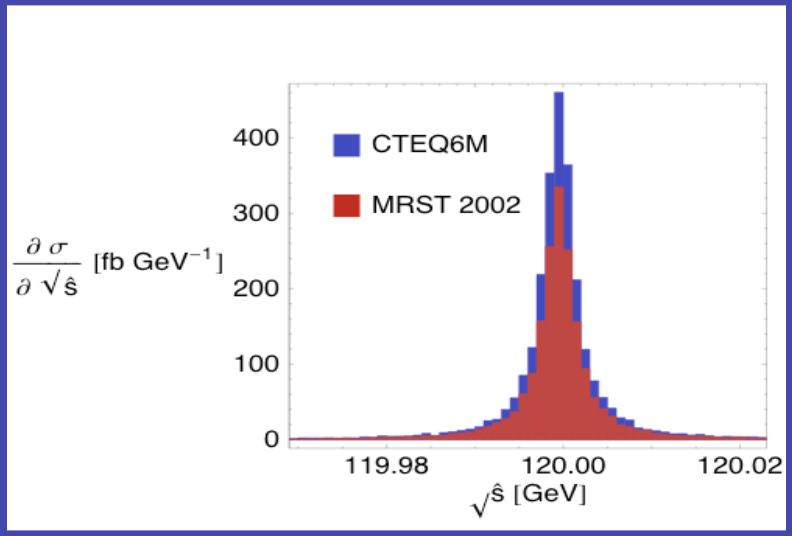


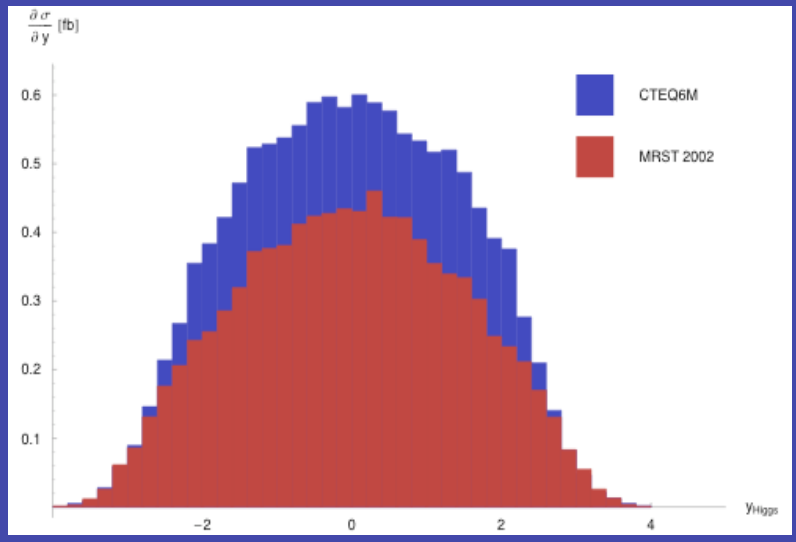
ExHuME simulates up to parton level using LHAPDF for the PDF's. Then Pythia used for parton showering and hadronisation.

Studies using standard ExHuME

- Pot acceptance of FP420 project.
- Higgs (WW and bb decay channels) at LHC.
- Dijet prediction at CDF







Modified ExHuME....

- Di-Photon studies at CDF (Andrew Hamilton)
- Di-gluino production and
- Gluinoball production (with T.Coughlin and J. Forshaw)
- CP violating Higgs in the tri-mixing scenario (model of Ellis. Pilaftsis and Lee) with A. de Roeck and L. Rurua.

- Some of these modifications have required some hacking of ExHuME which makes an add on package difficult, but we will release one anyway (will not be properly backward compatible).

Towards a new, rewritten ExHuME.

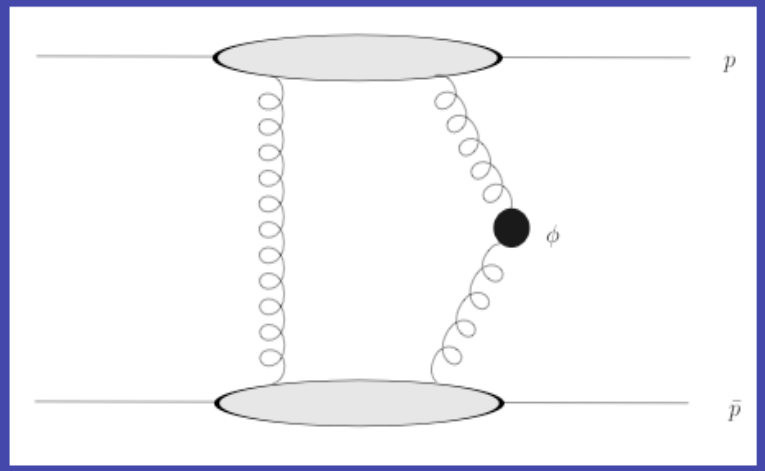
- Why re-write?
  - There are things we want to add but will be very difficult unless we make the code work in a different way.
  - These are (for example) 3 particle final states which are background to Higgs signals (bbg, qqW) and improved soft-survival models to get azimuthal correlations between protons correct.

Another Advantage: Can add in different production mechanisms. Will Plano (Manchester) is adding gamma-gamma fusion to this new ExHuME.

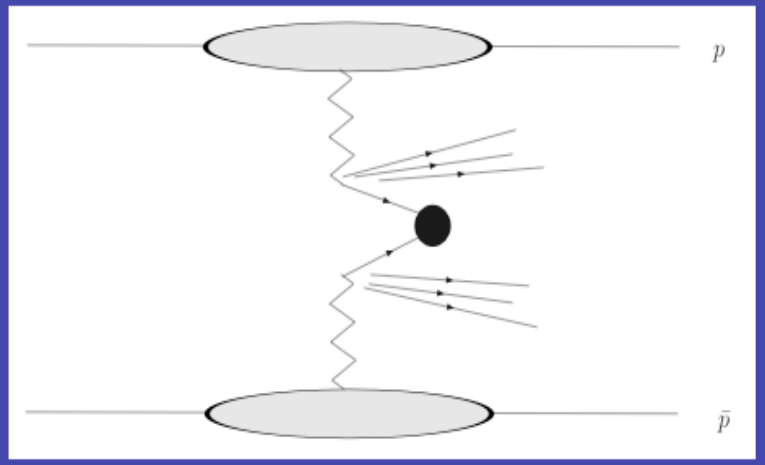
Release Date: Late 2006.

Higgs + Backgrounds for FP420

- Three types of processes:
  - Central Exclusive (a); Higgs, bb, gg.
  - Double Pomeron Exchange (b); bb, gg, Higgs.
  - Pile up, 2*SD + QCD; bb, gg uu etc. This turns out to be very large.



(a) Central Exclusive



(b) Double Pomeron

Fast Timing in FP420

- Two complementary designs, QUARTIC + GASTOF.
- Basic Idea: Tag 2 protons in FP420. Measure time-of-flight difference, δt, using fast timing (about 10ps resolution). Construct vertex position.
- This gives vertex accurate to approx 3mm (QUARTIC).
- Get vertex of hard interaction - veto if not inside constraint set by QUARTIC.
- Rejects 97.4% of SD + SD + QCD pile-up background.
  - see (e.g) Andrew Brandt's talk at hep.uchicago.edu/workshops/2005-picosecond/

QCD Background Estimate

- Inclusive bb events generated with Herwig
- Take cross section (σ) on input. E_T > 40GeV (jets)
- Multiply by probability that an event at LHC is SD and proton ends up in the pots (P_i). Found by running Pythia taking SD protons and running through FPTRACK (Peter Bussey).
- Multiply by Number of Overlap (N) in this event.
- Repeat previous 2 steps to get second overlap event. Do not double count (divide by 2)
- Quartic Rejection Factor Q.
- $\sigma_{new} = 0.5\ N\ (N-1)\ P_i^2\ Q\ \sigma$

- σ_{new} = 116000 fb ($L=2.10^{33}$). Need to remove by kinematic matching.

Kinematics of CEP

1) Collision energy = s
2) Momentum loss of proton k = x_k -measured by FP420.

3) Mass measured in pots, $M_X=(x_1x_2s)^{0.5}$
4) Rapidity of central system measured in pots, $y = 0.5\mathrm{Ln}(x_1/x_2)$.

Find jets on hard sub-process (cone or KT)…….

5) $y_{jj} = 0.5*(\eta_1 + \eta_2)$. ($\eta_a$ is pseudo-rapidity of jet a)
6) M_{jj} is mass measured in 2 highest E_T jets.
7) Dijet mass fraction, $R_{jj} = M_{jj}/M_X$.

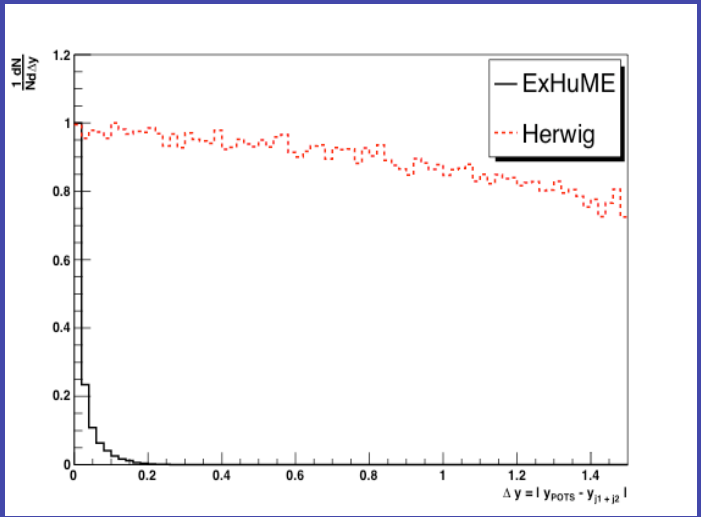
Generating Background.

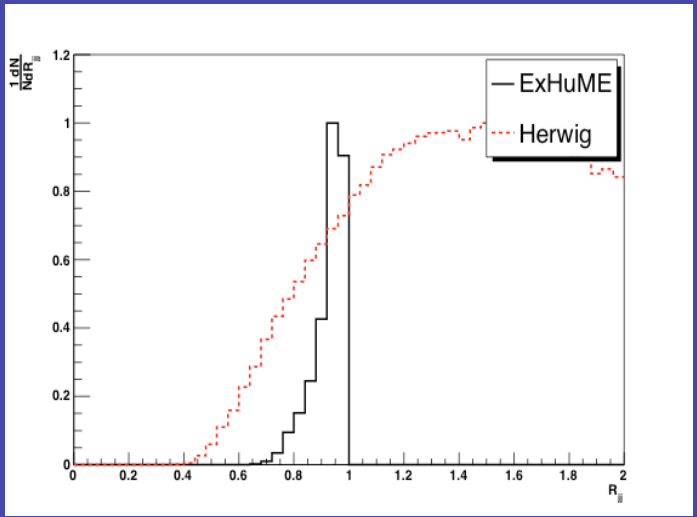
- Generate bb background with Herwig.
- Use knowledge of pomeron flux to get 2 SD protons:
  - Generate x values according to pomeron flux between min and max values of x using monte carlo methods.
  - Assume t=0 (can be changed to allow other t's later.

Advantage: Fast do not need to run lots of Event Generators and add them together.

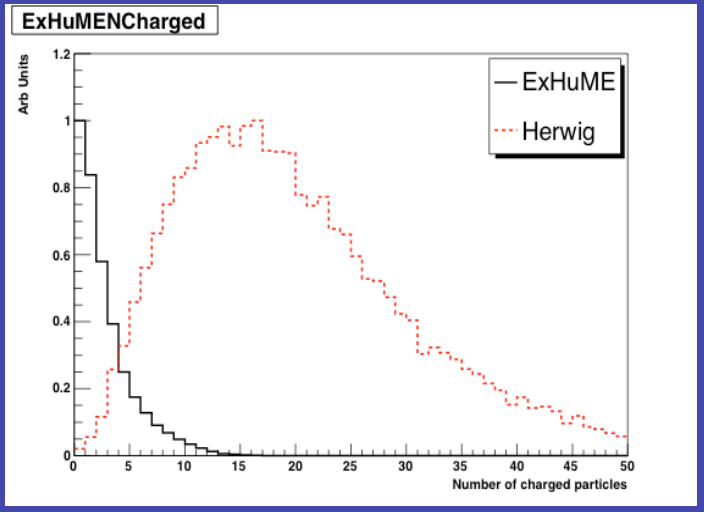
Disadvantage: No proton debris from SD events - does not matter much because we are only interested in the hard sub-process.

Results





$N_{CHARGED}$ is the number of charged particles ($|\eta|<2.5$) associated with the 2 jet vertex that is NOT contained within the jets.



Fraction of events remaining after kinematic + exclusivity cuts.

CUT	ExHuME	HERWIG
$\Delta y < 0.1$	0.851	0.043
$0.8 < R_{jj} < 1.0$	0.941	0.039
$N_{charged} < 5$	0.885	0.071
Combined	0.708	0.00012

Final Results

- Rejection factor of approximately 10^4 of SD overlap background using kinematic + exclusivity cuts.
- Background cross section now about 15fb but spread over large mass range. Reduced by cutting on a mass window around Higgs mass.
- If ΔM = 2.5GeV either side of Higgs Mass (120GeV), then background = 0.6fb. Smaller than signal.
- Background remains smaller up until L = 3.3×10^{33}.