Diffractive Higgs Production at the LHC

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Work done in collaboration with Maarten Boonekamp, Robi Peschanski, Alexander Kupĉo
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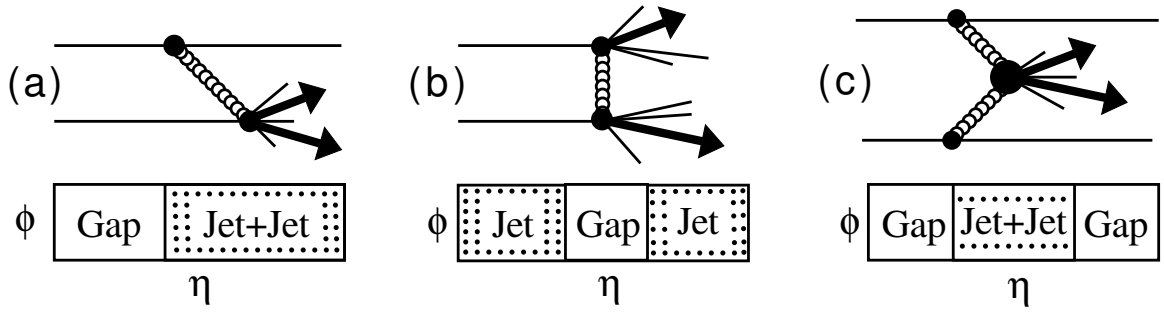
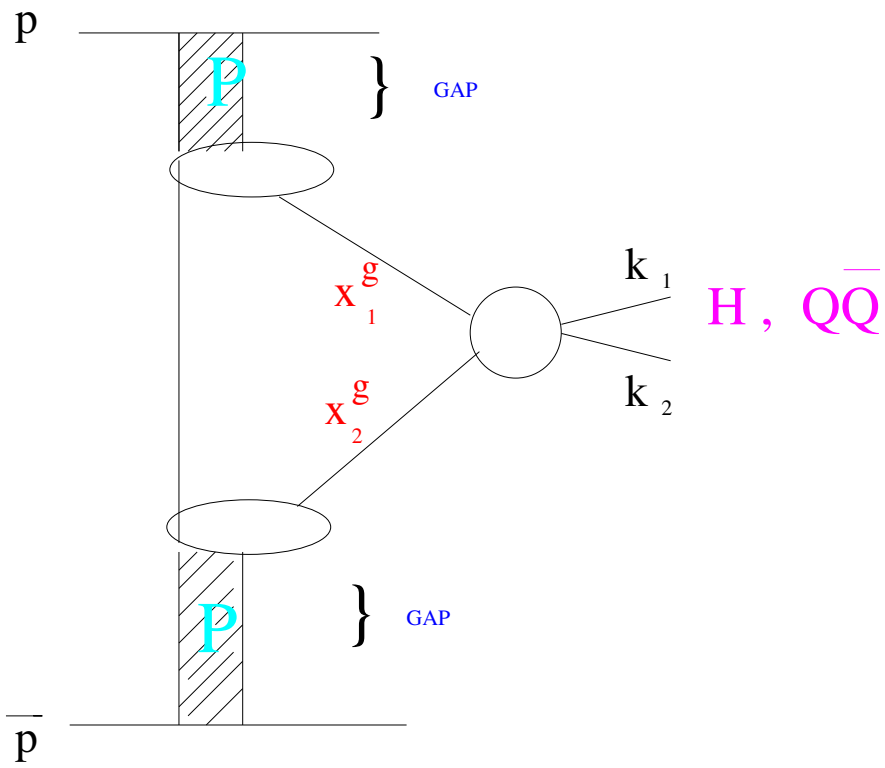
Diffraction at Tevatron/LHC



Kinematic variables

- t: 4-momentum transfer squared
- ξ: proton fractional momentum loss (momentum fraction of the proton carried by the pomeron)
- $\beta = x_{Bj}/\xi$: Bjorken-x of parton inside the pomeron
- $M^2 = s\xi$: diffractive mass produced
- $\Delta y \sim \Delta\eta \sim \log 1/\xi$: rapidity gap

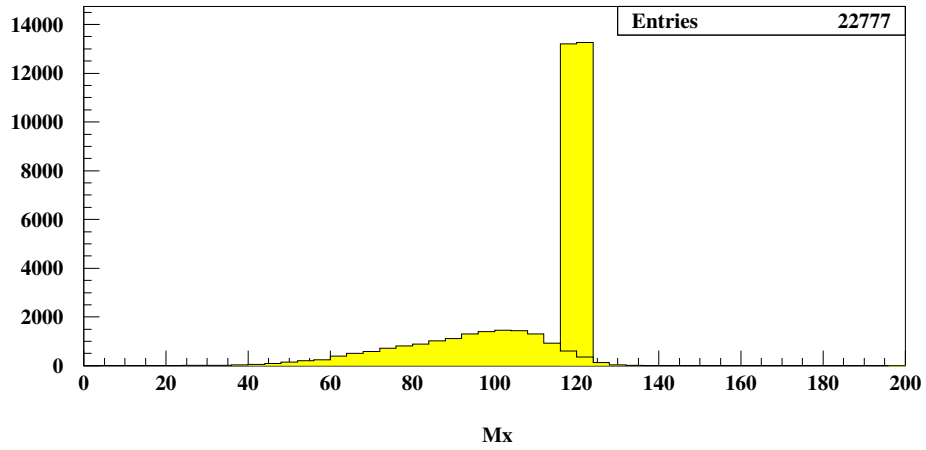
"Exclusive models"

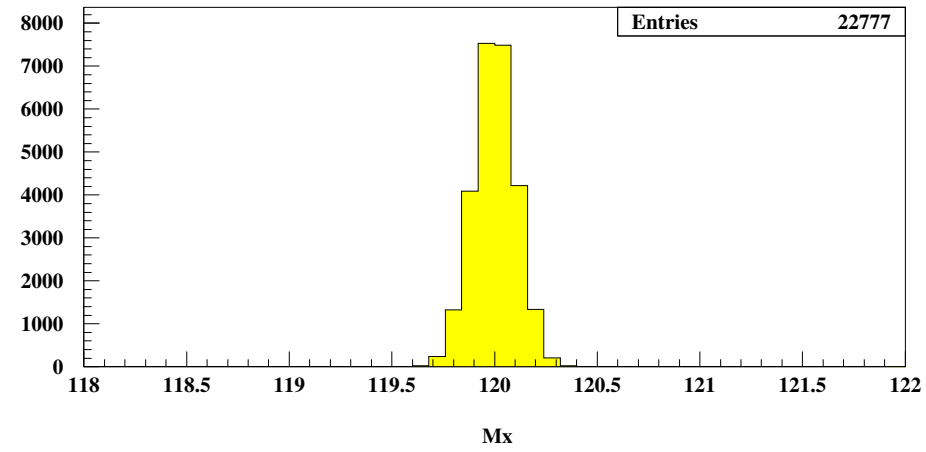


All the energy is used to produce the Higgs (or the dijets), namely $xG \sim \delta$ (model leading to similar results as Durham)

Advantage of exclusive Higgs production?

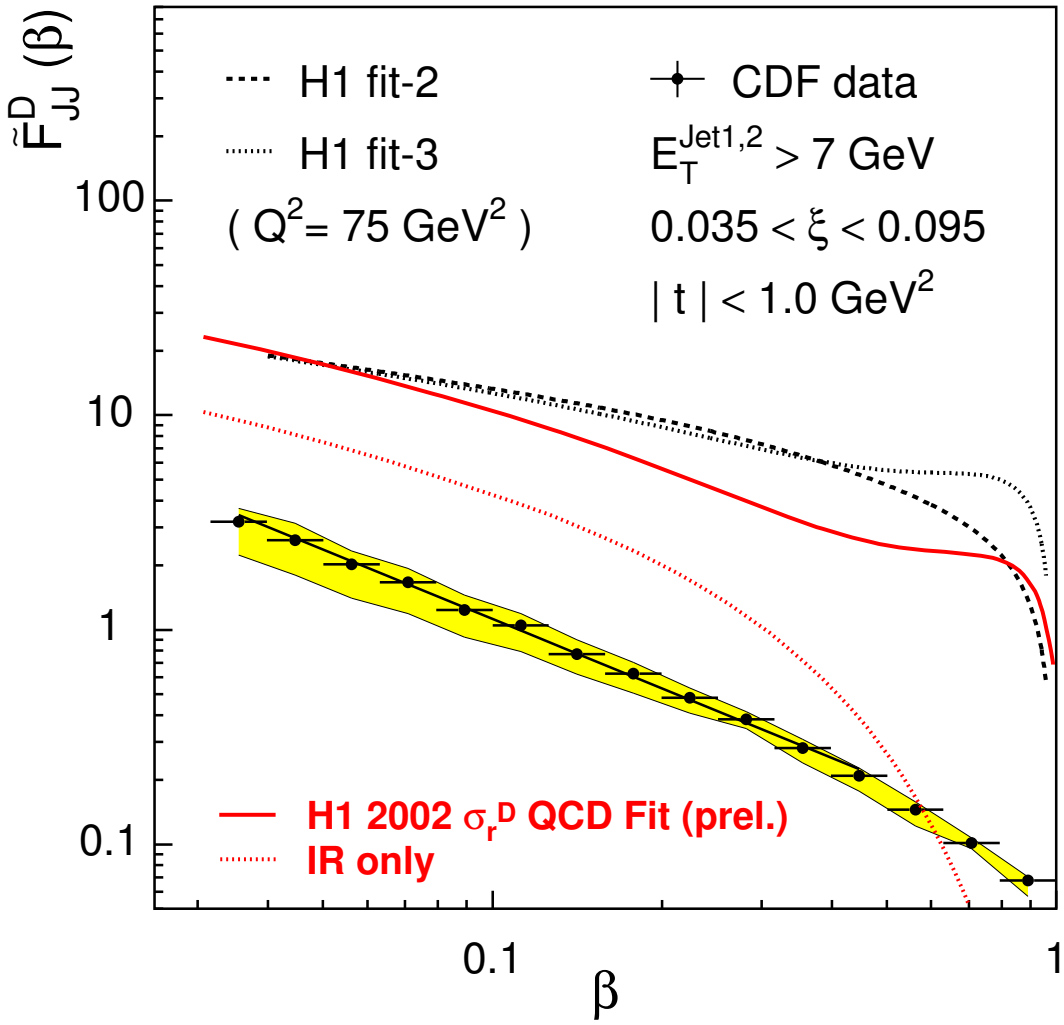
Very good Higgs mass reconstruction: fully constrained system, Higgs mass reconstructed using both tagged protons in the final state $(p\bar{p} \to p\bar{p}H)$, $M_H = \sqrt{\xi_p \xi_{\bar{p}} S}$





Survival probabilities

Diffraction at HERA: $\sim 10\%$ of events, Single diffraction at Tevatron $\sim 1\%$ of events $\rightarrow$ factorisation breaking due to soft gluon exchanges between p and $\bar{p}$ which destroy the gaps

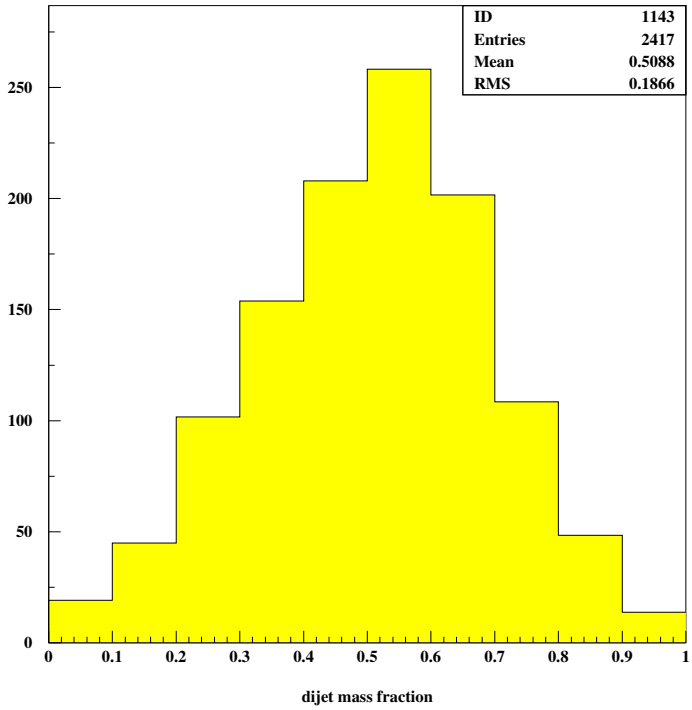


DPEMC Monte Carlo

- DPEMC (Double Pomeron Exchange Monte Carlo): New generator with Bialas Landshoff formalism, http://boonekam.home.cern.ch/boonekam/dpemc.htm, hep-ph/0312273
- Interface with Herwig: for hadronisation, same interface as for Pomwig
- Exclusive and inclusive processes included: Higgs, dijets, diphotons, dileptons, SUSY, QED, Z, W..., Durham formalism being implemented
- New MC in preparation: based on Durham formalism, B. Cox, J. Monk..., useful for comparison

"Exclusive" jet production at the Tevatron

- Cross section for exclusive jets within the CDF run I acceptance (jets with $p_T > 7GeV$): 64 nb, after survival gap probability: $\sim$ 6.4 nb
- Cross section after cut on dijet mass fraction at 0.8: 0.16 nb (limit from CDF: 3.7 nb) Very few events at high values of the dijet mass fraction: huge smearing after simulation...



"Exclusive" production at the LHC

- Survival probability: estimated to be ~ 0.03
- Exclusive $b\bar{b}$ cross section (for jets with $p_T > 25$ GeV): 70.1 pb * 0.03 = 2.1 pb
- Exclusive Higgs production (in fb) after applying the gap survival probability

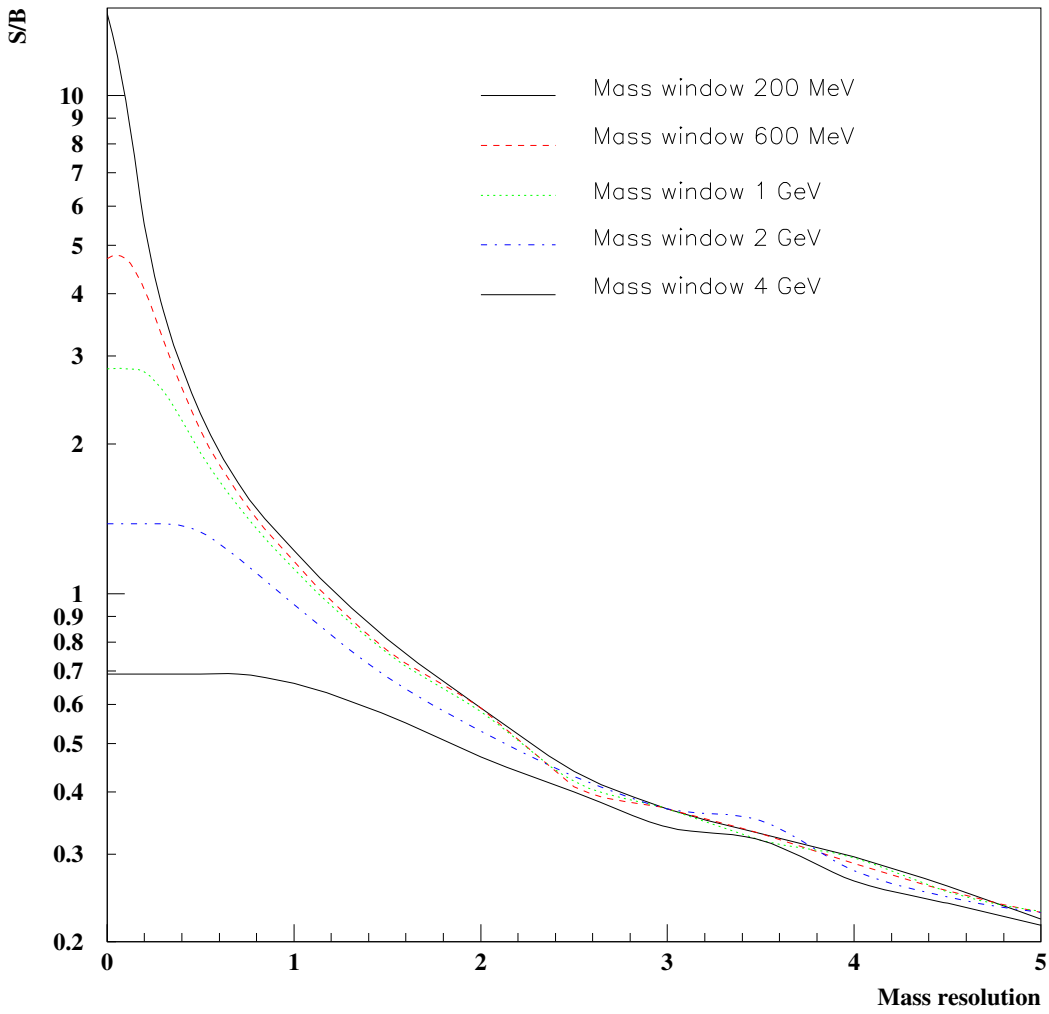
M_{Higgs}	σ (fb)
120	3.9
125	3.5
130	3.1
135	2.5
140	2.0

Background and signal

- Signal: DPEMC in exclusive mode production with the Bialas Landshoff formalism
- Exclusive background: Exclusive $b\bar{b}$ production with DPEMC in exclusive mode
- Roman pot acceptance: $t < 2$ GeV^2, $0.002 < \xi < 0.2$ (roman pots at 215 m, 308-336 m, 420 m) (roman pot acceptance from Helsinki group (full simulation of the beam line using the MAD program)
- Simulation: Fast simulation of the CMS detector

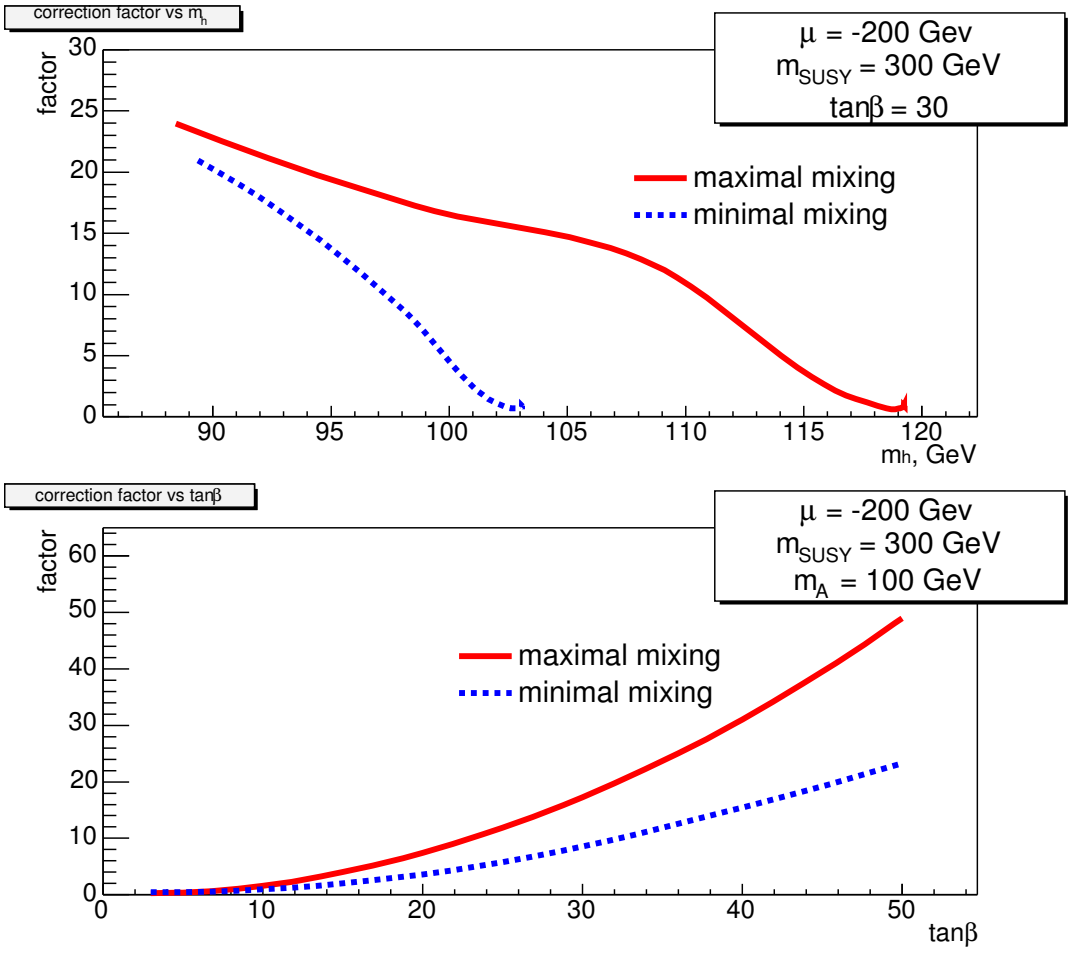
Signal over background

For a Higgs mass of 120 GeV and for different mass windows as a function of the Higgs mass resolution



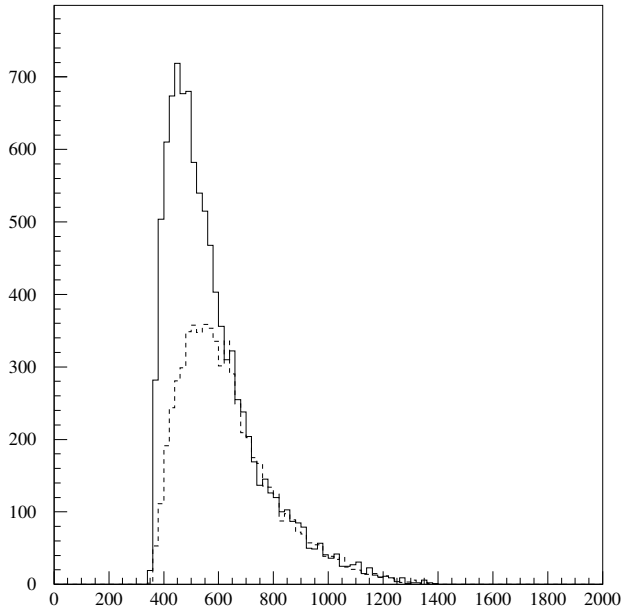
Diffractive SUSY Higgs production

High $\tan\beta$: top and bottom loops to be considered, enhance the cross section by up to a factor 50 (worth looking into Higgs decaying into $b\bar{b}$ since branching ratio of Higgs decaying into $\gamma\gamma$ smaller at high $\tan\beta$, standard search in $\gamma\gamma$ does not benefit from the increase of cross section)



Acceptance for top events with 200m pots

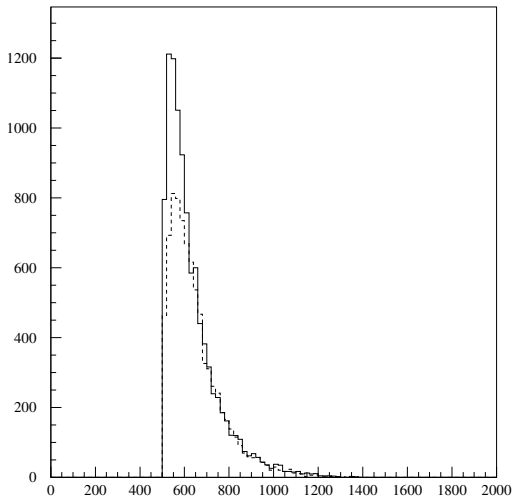
Number of events as a function of central mass

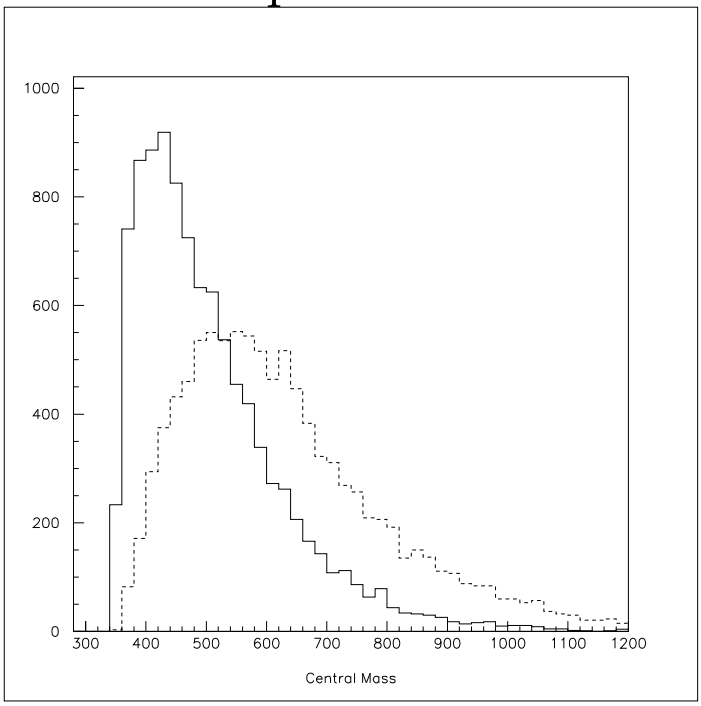


- For a top mass of 175 GeV: $\sigma_{tot} = 40$ fb, $\sigma_{acc} = 26$ fb
- High cross section to make precise measurement of top properties: measurement of top mass using production at threshold (measurement of $t\bar{t}$ production cross section as a function of the missing mass computed using missing mass method)

Acceptance for stop events with 200m pots

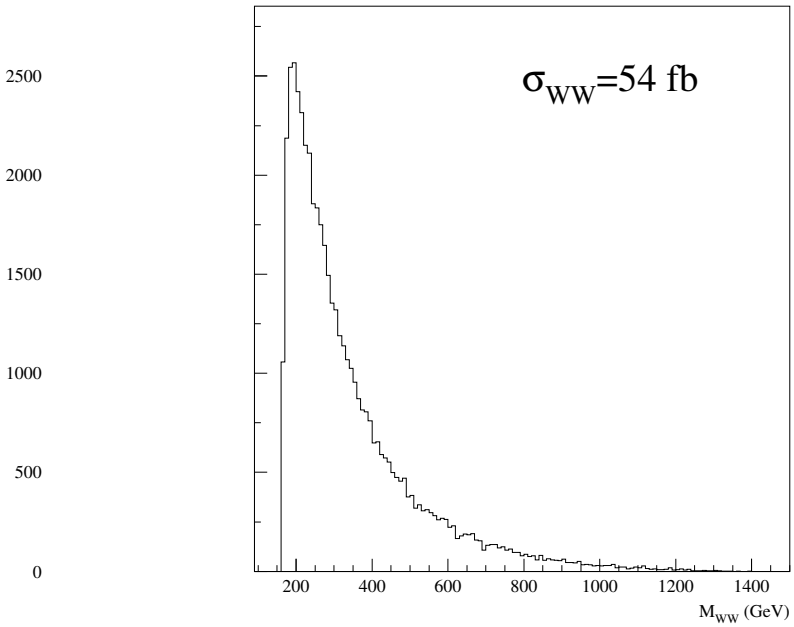
- Cross section for a stop mass of 250 GeV: $\sigma_{tot} = 8$ fb, $\sigma_{acc} = 6$ fb
- Possibility to distinguish between top and stop: using the differences in spin





W mass and properties (420 m pots)

WW events produced via QED ($\gamma\gamma$) processes: cross section perfectly known $\longrightarrow$ Precise measurement of W mass, W properties



Conclusion

- Studies of exclusive Higgs production, fast simulation of the CMS detector
- Signal over background: ~ 1 if one gets a very good resolution using roman pots (1GeV)
- Survival probabilities: possibility to test survival probabilities at DØ , cf Alexander's talk
- DPEMC: generator ready for many DPE processe
- Interesting processes in addition to Higgs: top, stop, W..., possibility to measure top and W mass by performing a threshold scan (same idea as linear collider, without ISR problem)