High mass diffraction at the LHC

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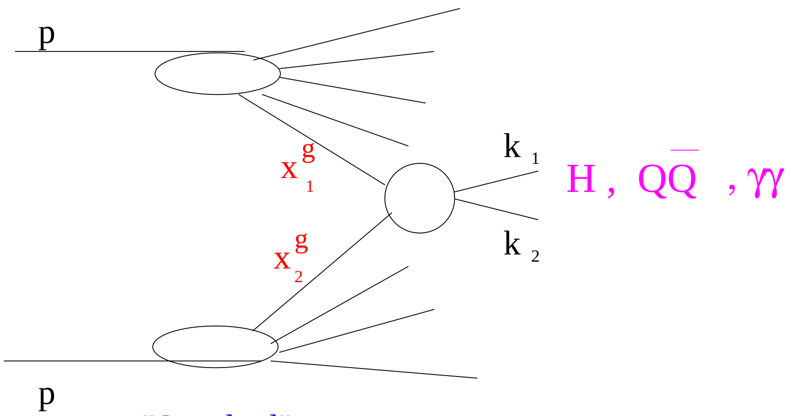
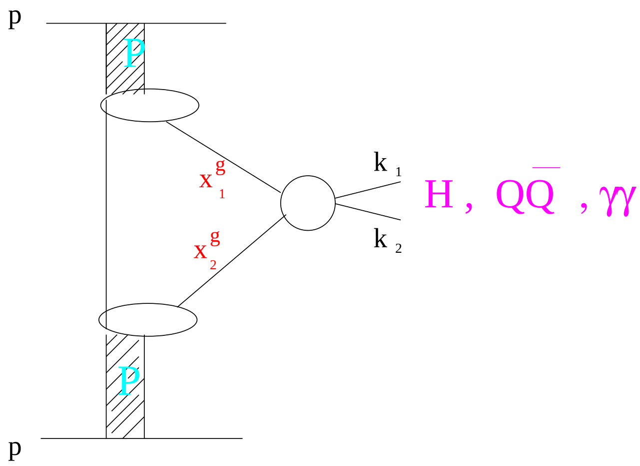
Contents:

- Exclusive standard model and SUSY Higgs production: S/B
- W, top and stop production cross section
- W, top and stop mass reconstruction

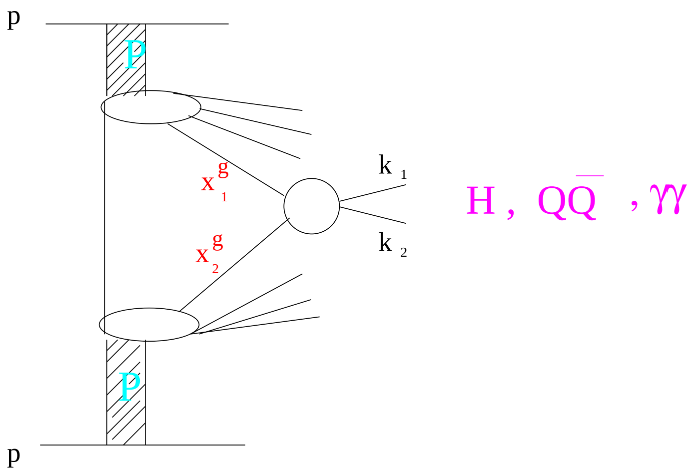
“Exclusive models”



"Standard"



"Exclusive "

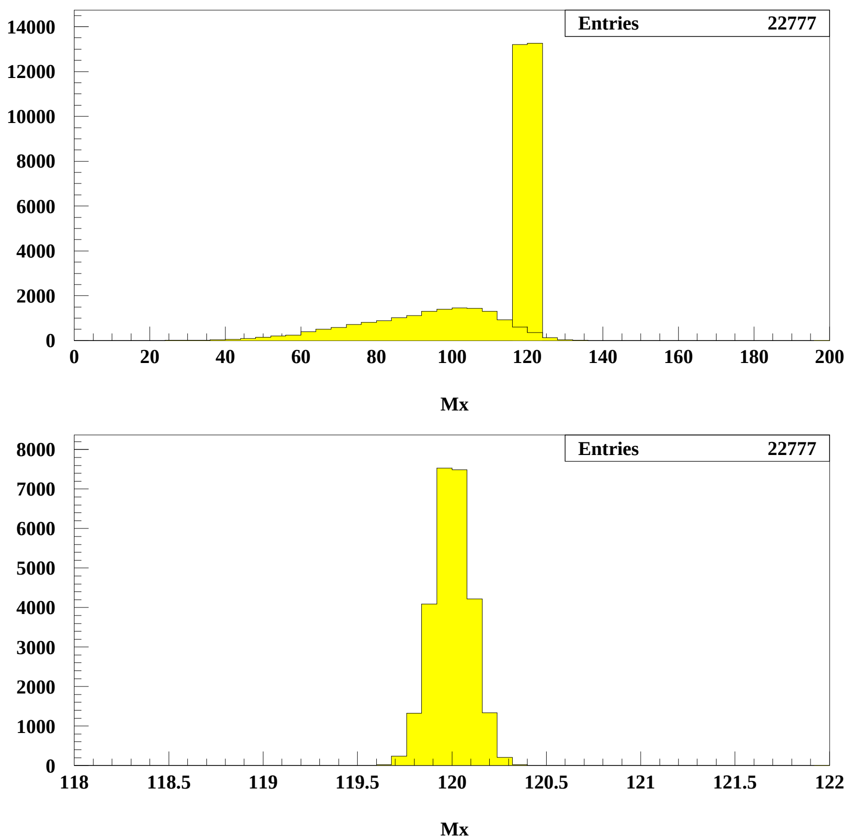


"Inclusive"

All the energy is used to produce the Higgs (or the dijets), namely $xG \sim \delta$

Advantage of exclusive Higgs production?

- Good Higgs mass reconstruction: fully constrained system, Higgs mass reconstructed using both tagged protons in the final state ($pp \to pHp$)
- $M_H = \sqrt{\xi_p \xi_{\bar{p}} S}$
- No energy loss in pomeron "remnants"



DPEMC Monte Carlo

- DPEMC (Double Pomeron Exchange Monte Carlo): New generator to produce events with double pomeron exchange
  http://boonekam.home.cern.ch/boonekam /dpemc.htm, hep-ph/0312273
- Interface with Herwig: for hadronisation
- Exclusive and inclusive processes included: Higgs, dijets, diphotons, dileptons, SUSY, QED, Z, W...
- DPEMC generator interfaced with a fast simulation of LHC detector (as an example CMS, same for ATLAS), and a detailled simulation of roman pot acceptance

“Exclusive” production at the LHC

- Higgs decaying into $b\bar{b}$: study S/B
- Exclusive $b\bar{b}$ cross section (for jets with $p_T > 25$ GeV): 2.1 pb
- Exclusive Higgs production (in fb)

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

- NB: a survival probability of 0.03 was applied to all cross sections

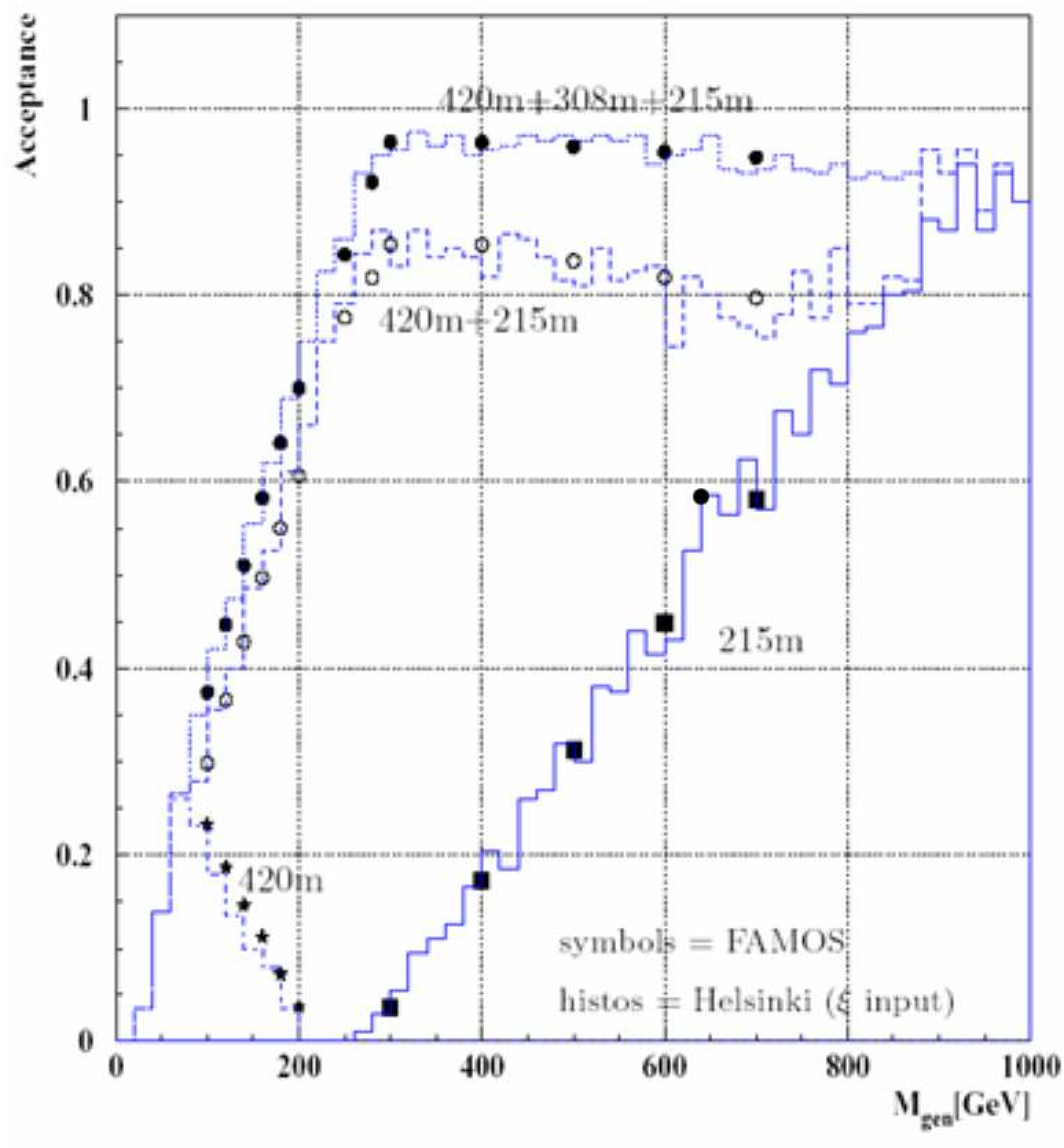
LHC: where to put roman pot detectors

3 different options to implement roman pot detectors

- (1) 215 meter pots (warm section) in addition to Totem $|t| < 2$ GeV^2, $0.02 < \xi < 0.2$, can be introduced in trigger and for luminosity determination
- (2) 308-336 meter pots (cold section) $|t| < 2$ GeV^2, $0.003 < \xi < 0.025$ difficult technically
- (3) 420 meter pots $|t| < 2$ GeV^2, $0.002 < \xi < 0.016$
- In the following, we keep options (2) and (3) together

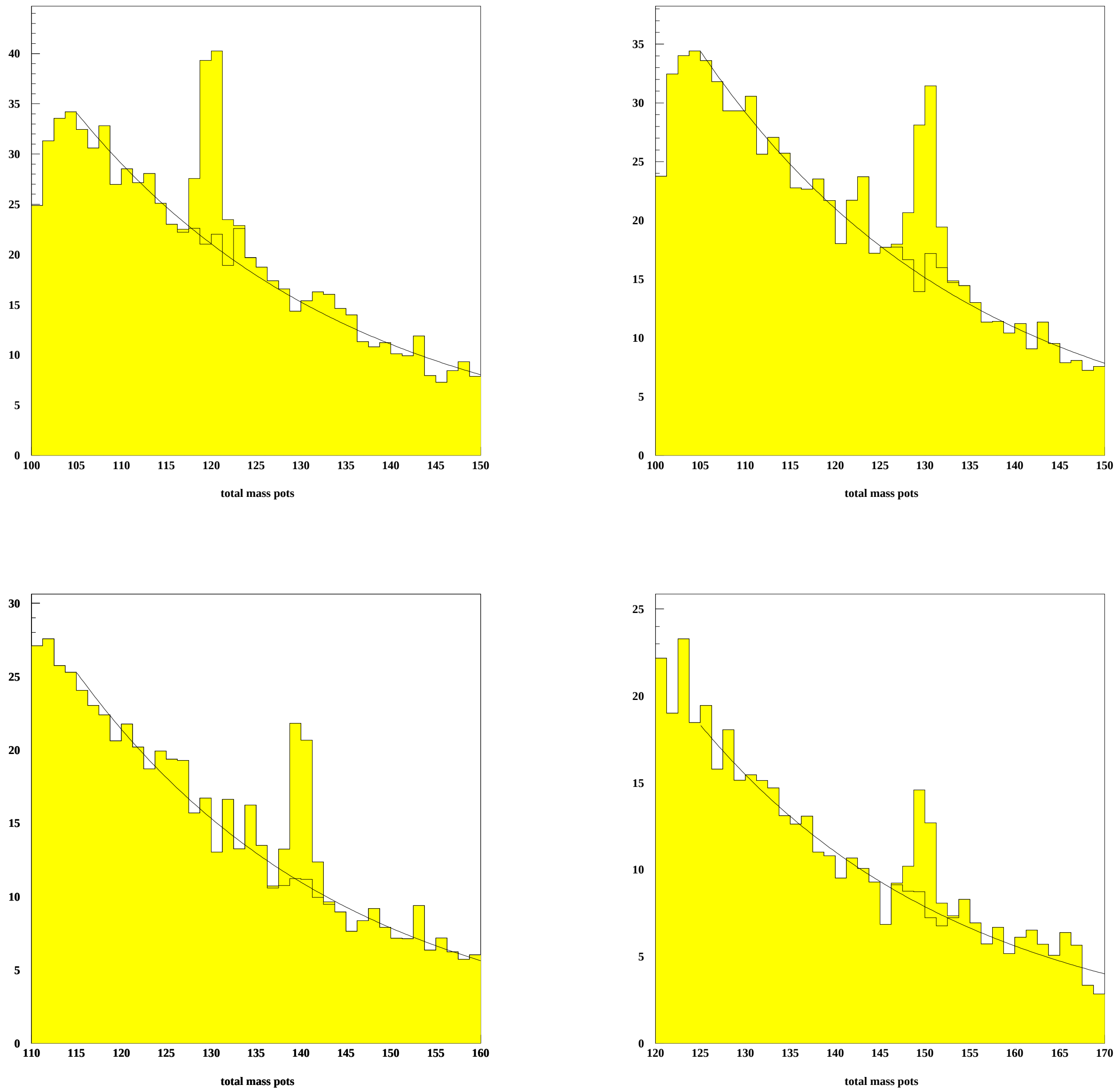
LHC: roman pot acceptance

Acceptance as a function of Higgs mass for different roman pot configurations



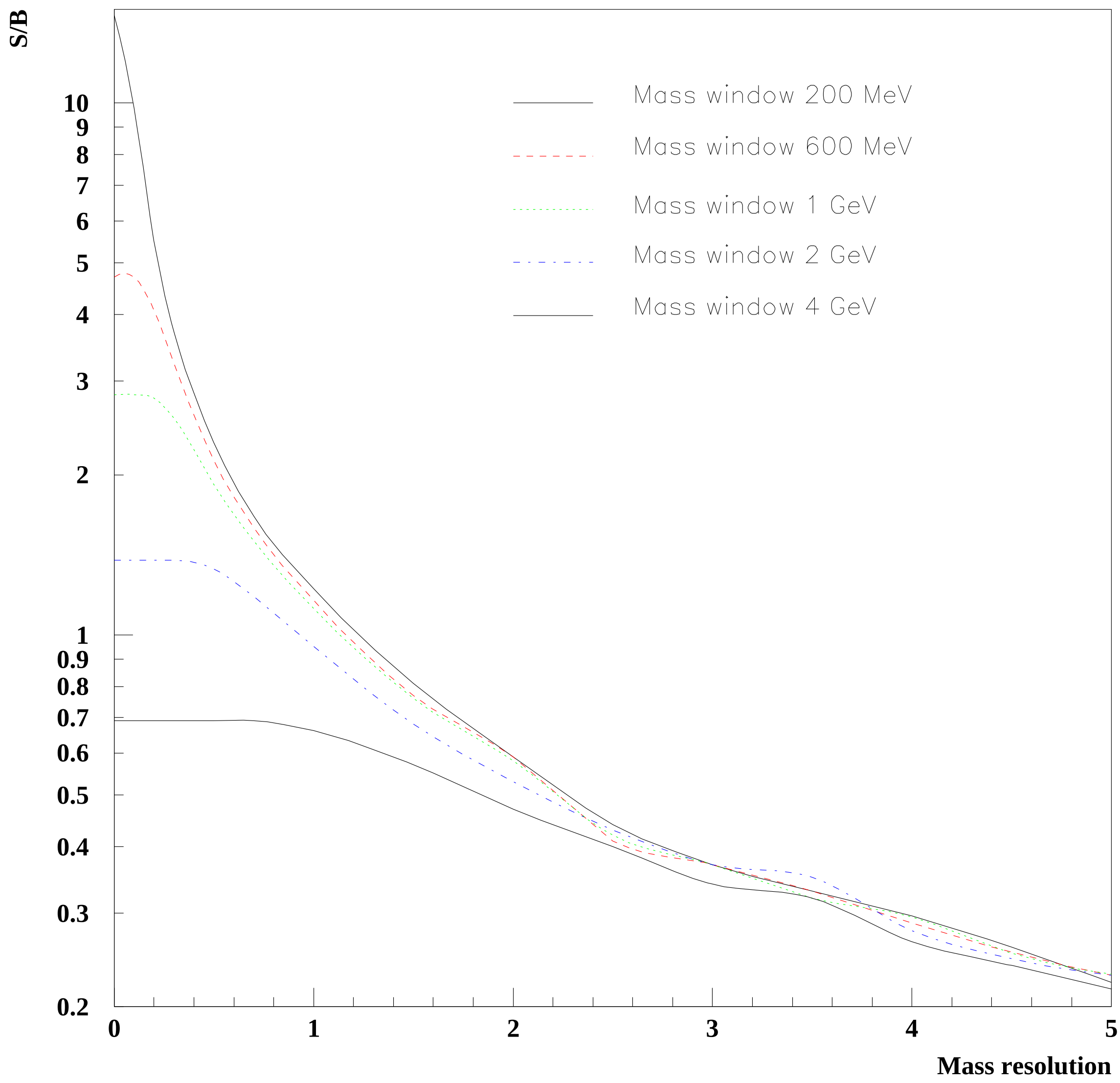
Signal and background

Signal and background for different Higgs masses for 100 fb^{-1}



Signal over background: standard model Higgs

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



Signal over background

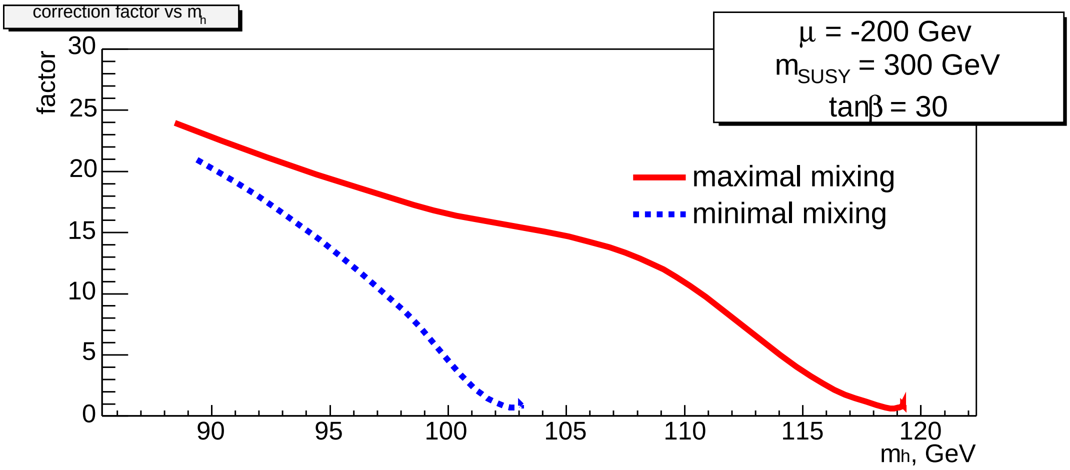
Signal over background for 1 mass window (2 GeV wide) for 100 fb^{-1} assuming a Higgs mass resolution of 1 GeV

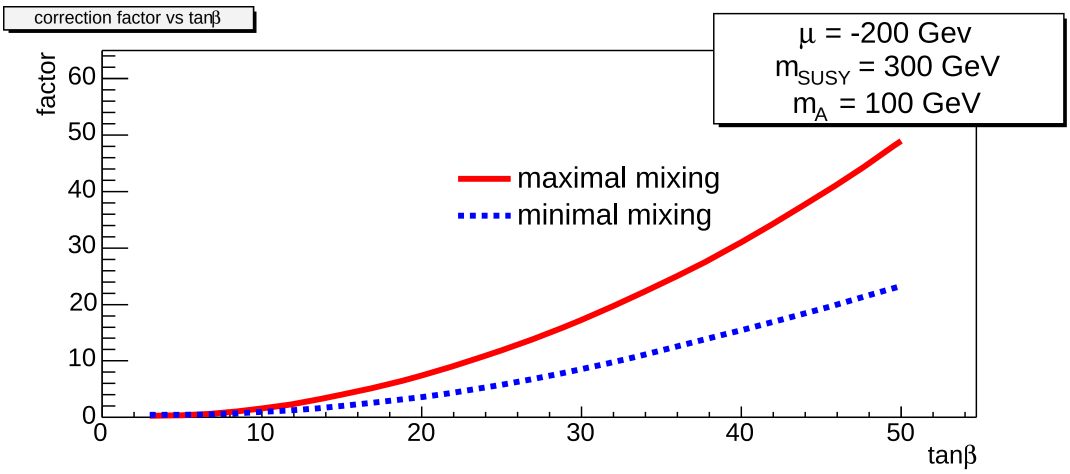
M_{Higgs}	signal	background	S/B	σ
120	27.1	28.5	0.95	5.1
130	20.6	18.8	1.10	4.8
140	12.6	11.7	1.08	3.7
150	7.0	8.9	0.69	2.3

NB: if only tags at 420 m, numbers have to be divided by about 50%

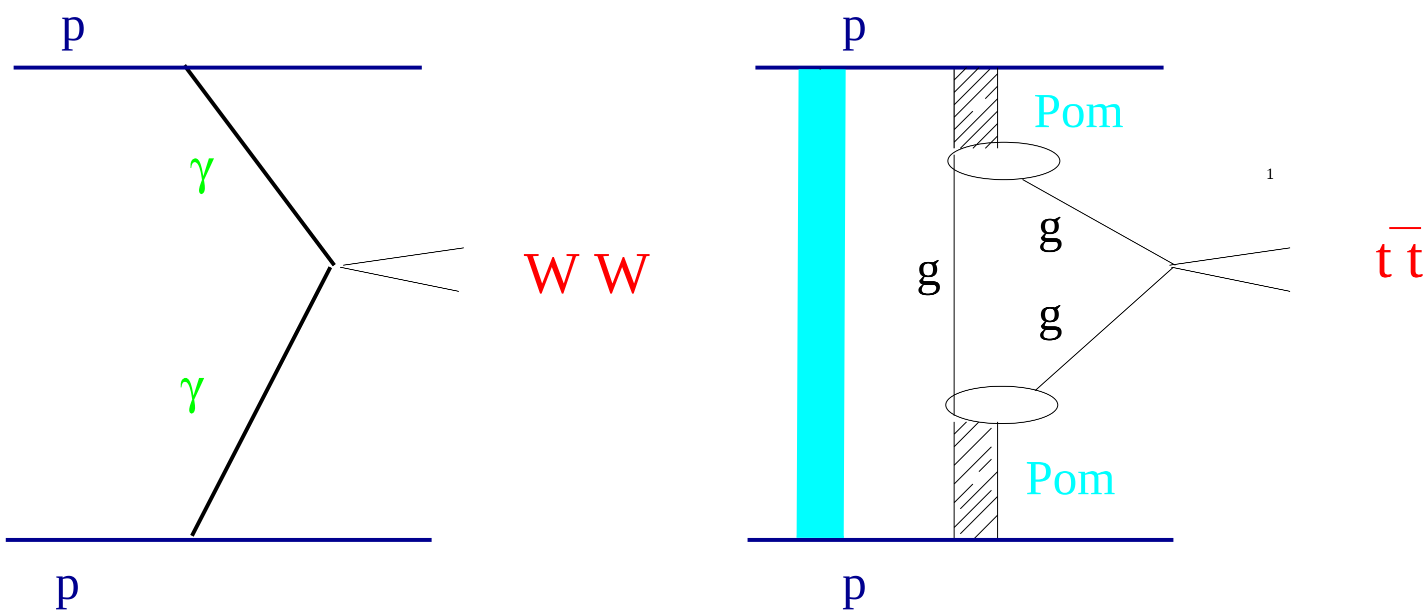
Diffractive SUSY Higgs production

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)



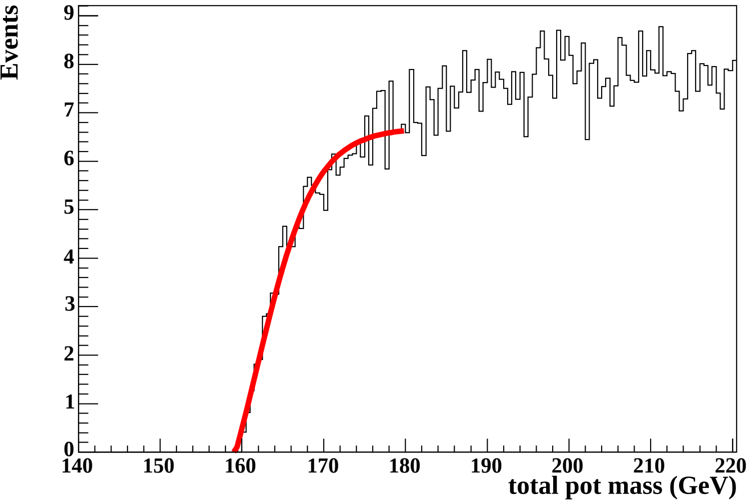


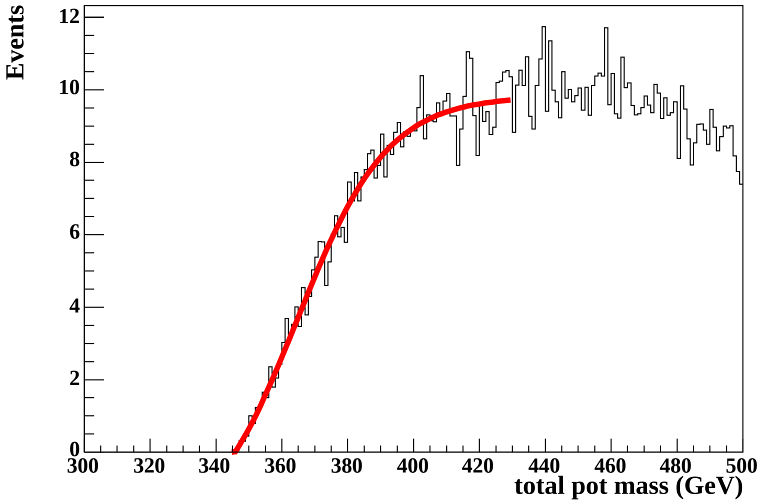
W, top and stops



All the energy is used to produce the W, top (stop) pairs: W: QED process, cross section perfectly known, top: QCD diffractive process

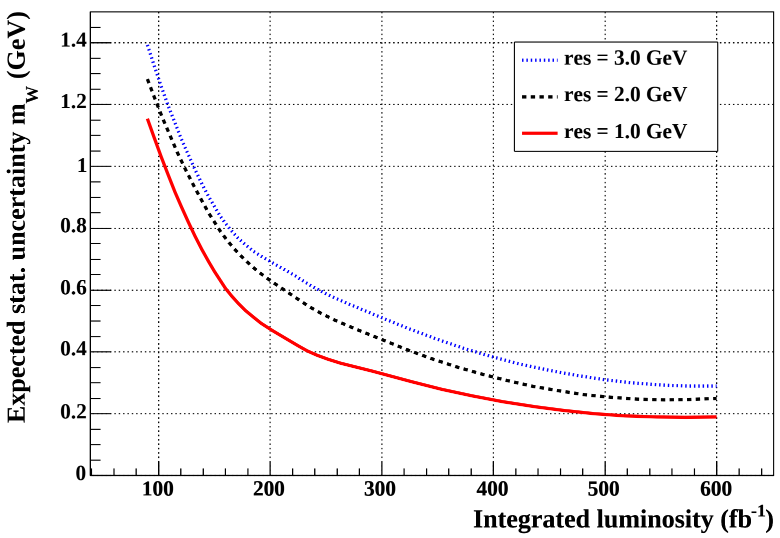
Top and W events

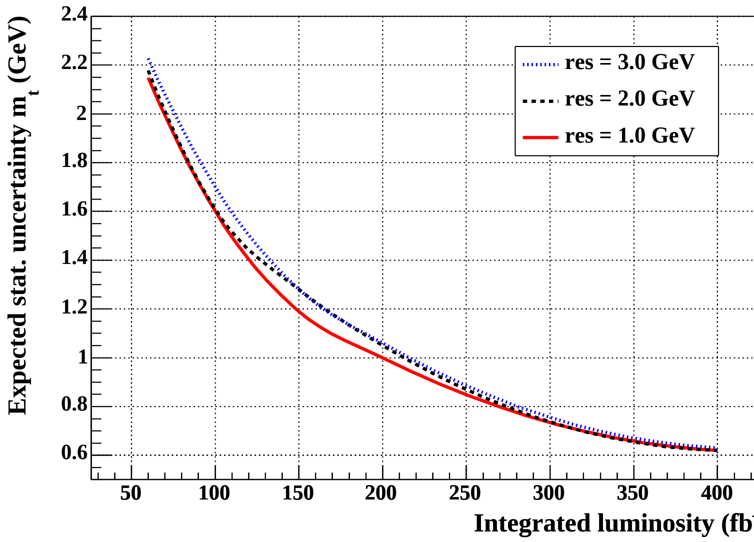




- W boson cross section and acceptance: $\sigma \sim$ 56 fb, pots at 420 m needed, about 60%
- Top quark cross section and acceptance: $\sigma \sim$ 40 fb, pots at 220 m, about 85%
- Reconstruct the W and top mass using the threshold scan method: Fit the increase of the cross section at threshold

Resolution on W and top masses

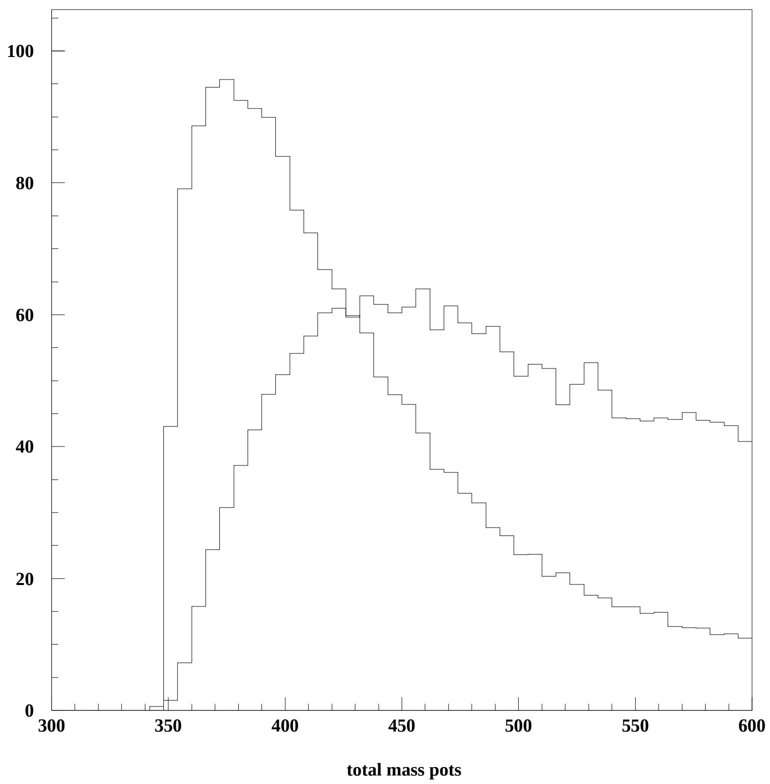




- 2 methods uaed to reconstruct the top mass: histogram: (compute χ^2 between number of events in bins in MC and data for the same lumi), turn-on fit: fit the turn-on point of the missing mass distribution at threshold
- W mass resolution: $\sim$ 400 MeV, not competitive, but allows to calibrate (align) roman pots very precisely
- Top mass resolution: $\sim$ 1 GeV, competitive measurement

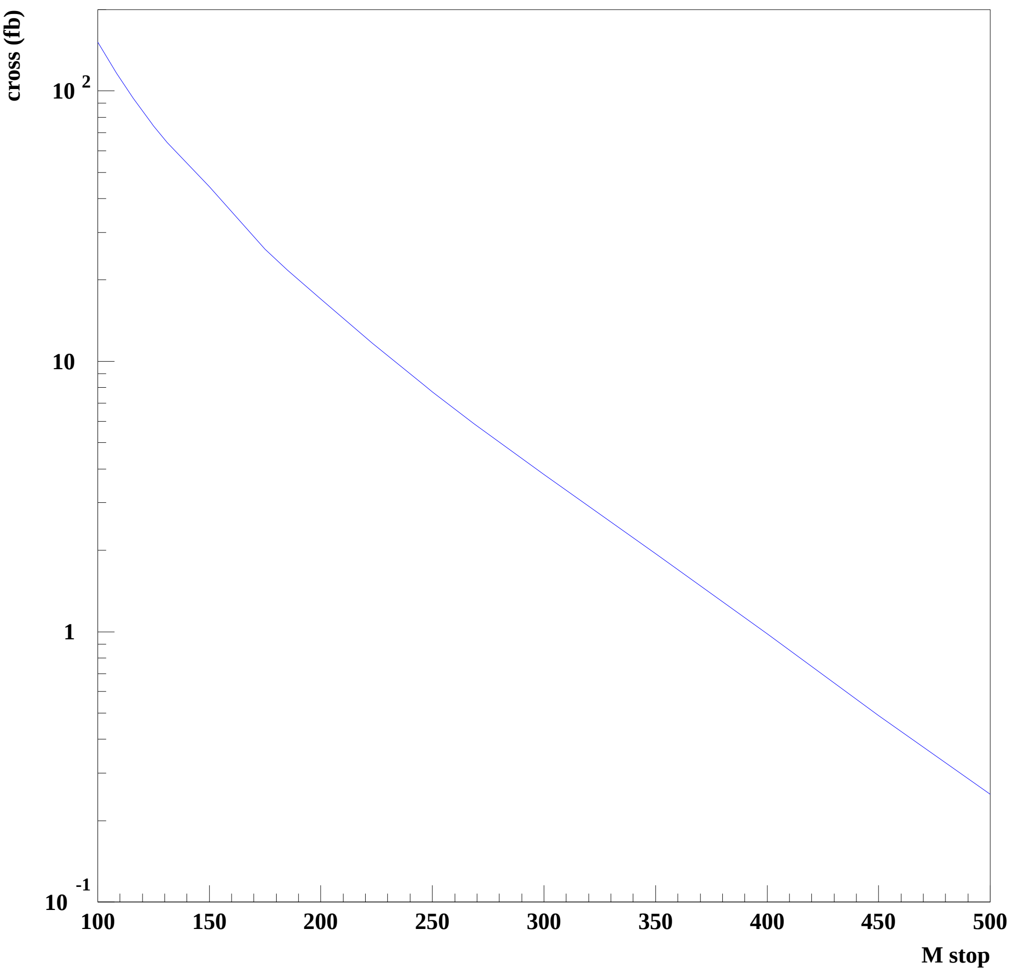
Top and stops

- Cross section for a stop mass of 250 GeV: $\sigma_{tot} = 8$ fb, $\sigma_{acc} = 6$ fb
- Possibility to distinguish between top and stop even if they have about the same mass: using the differences in spin (as an example: $m_{\tilde{t}} = m_{top}$)
- Very fast turn-on for stops



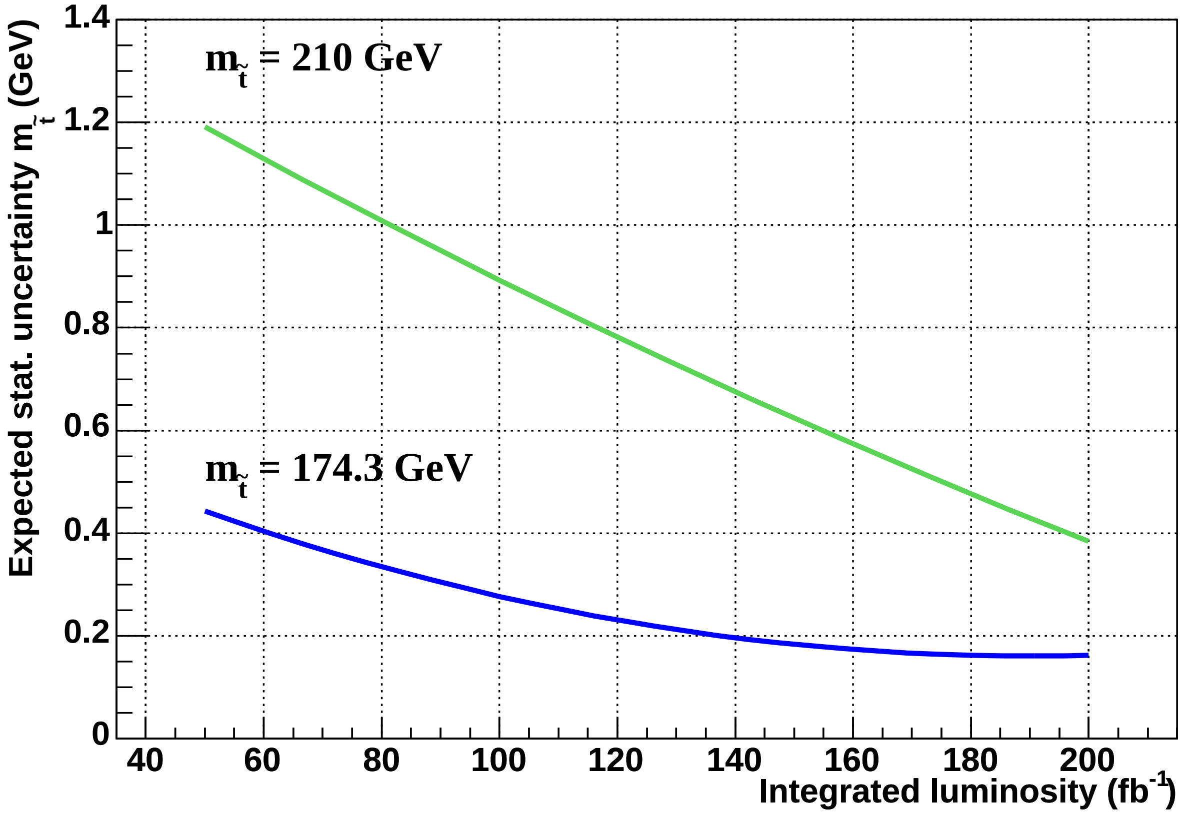
Stop production cross section

- Stop production cross section as a function of the stop mass: quite high cross section (1 fb for a stop mass of 400 GeV)
- Numbers be multiplied by the roman pot acceptance of about 80%



Resolution on stop mass

Resolution on stop mass by using roman pot detectors with a resolution of 1 GeV $\longrightarrow$ Resolution better than 1 GeV at high lumi!



Conclusion

- Study of exclusive Higgs production
- Exclusive events still to be observed in particular at the Tevatron
- Signal over background: ~ 1 if one gets a very good resolution using roman pots (better than 1 GeV), enhanced by a factor up to 50 for SUSY Higgs at high $tan\beta$
- QED WW pair production: cross section known precisely, allow to calibrate prescisely the roman pot detectors
- Diffractive top, stop pair production: possibility to measure top and stop masses by performing a threshold scan with a precision better than 1 GeV (same idea as linear collider, without ISR problem), Caveat: evidence of exclsuive events, cross sections???...