Very first look at Z' and Higgs

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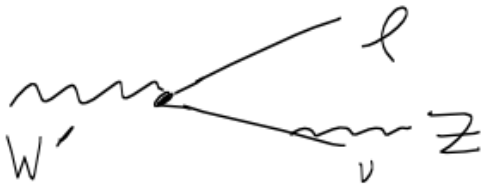
Who are we

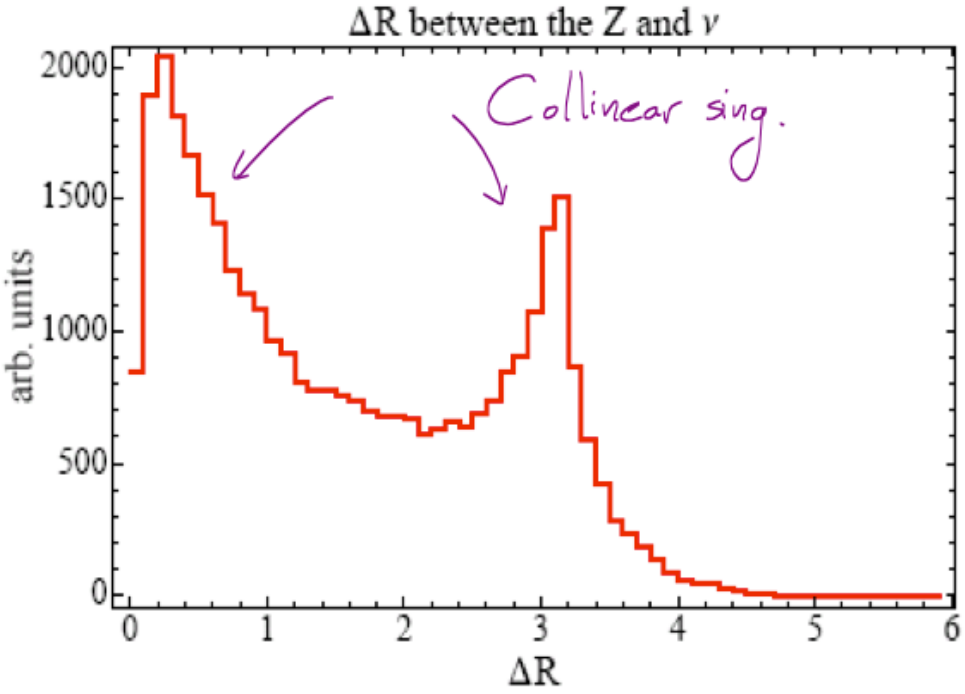
- ATLAS members starting to think about FHC studies:
  - M. Baak, C. Doglioni, M. Duehrssen, J. Ferrando, D. Froidevaux, F. Gianotti, H. Gray, C. Helsens, A. Sfyrla
- Very little time, but together might be able to produce enough results for the kickoff meeting
- Also thinking to develop in parallel an ATLAS independent way of producing results
  - More realistic after the kickoff meeting, but would be interested to know what other groups are developing and thinking to do

At higher energies

- Event structure at the highest energies presents new features w.r.t. LHC
- International Workshop on Future High Energy Circular Collider: http://indico.ihep.ac.cn/conferenceOtherViews.py?view=standard&confId=3813

Arkani Hamed's Talk





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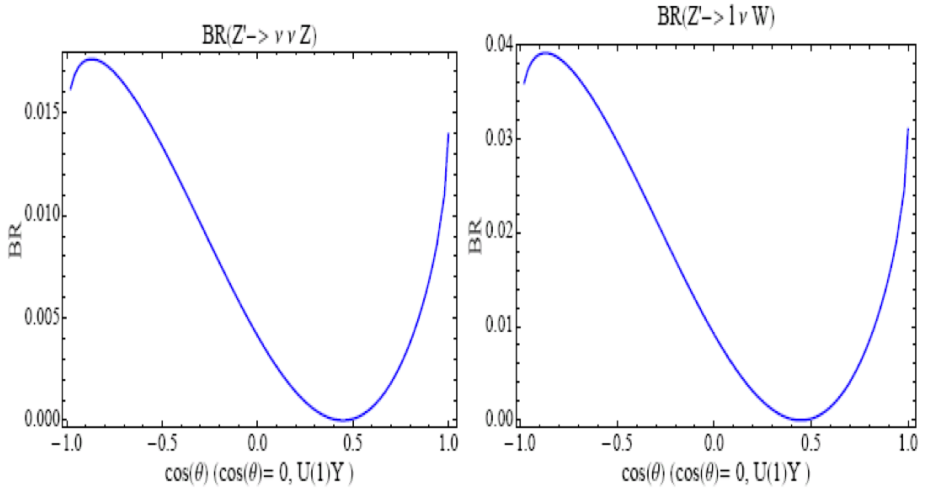

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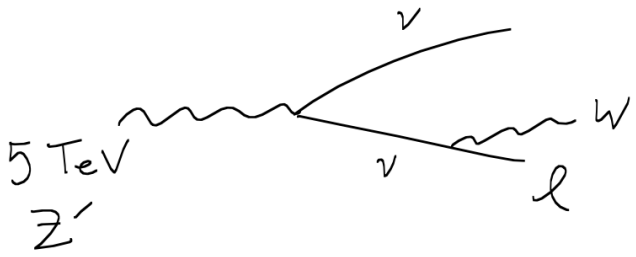


First look

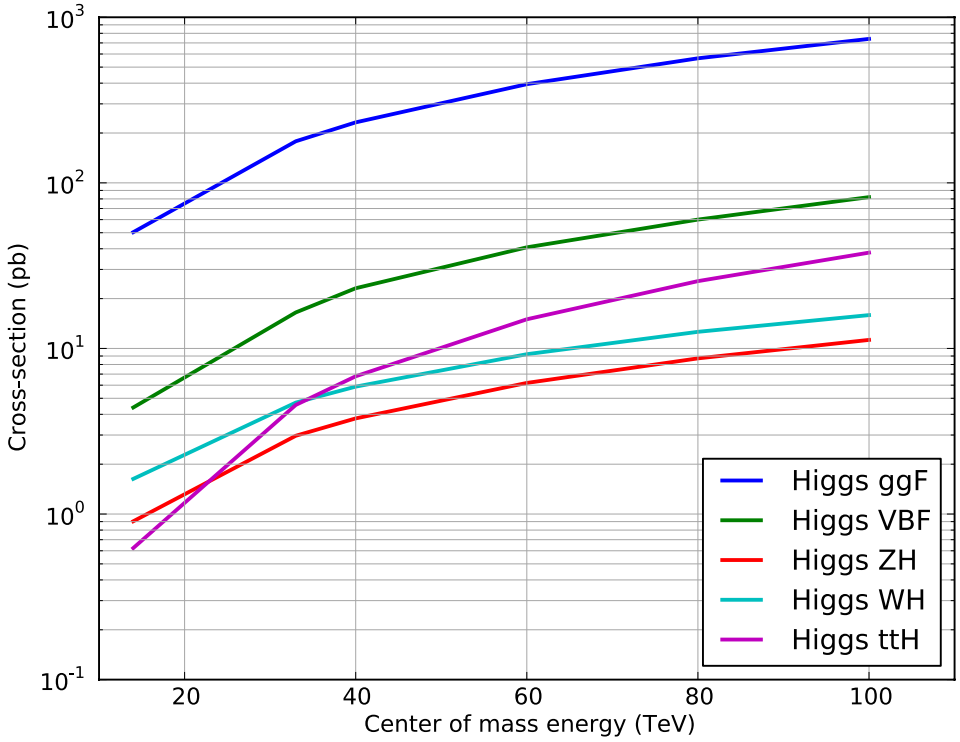
- Started to think about FHC studies 2.5 months ago
- Using ATLAS infrastructure for the moment
- Using Pythia8 to generate events
  - Gets the cross section from there is no other real estimates available
- Just started, mostly a hobby for the moment, but plan to dedicate more time on this
- Will mostly detailed our planned contributions that realistically achievable for the kickoff meeting
- For expected number of events considered 100fb^{-1} and an acceptance of 10% so it's easily scalable

First look

- Started to generate for various collider energies (33, 60, 80 and 100TeV):
  - Higgs 125GeV
    - All production modes
    - Inclusive Higgs decays
  - Z' -> μμ :
    - Even if the muon is not the best channel for a clean and early discovery we will learn about the lepton kinematic
    - Drell-Yann as main background
  - Z' -> ttbar
    - ttbar as main background
  - Excited quarks starting right now

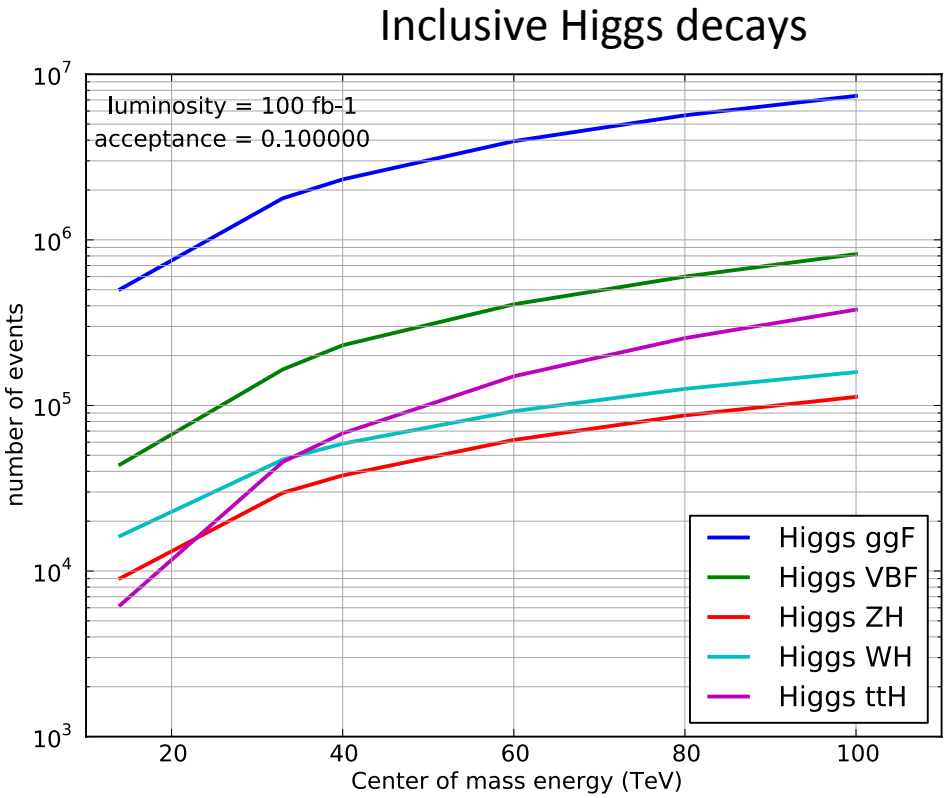
Higgs cross section

- From https://twiki.cern.ch/twiki/bin/view/LHCPhysics/HiggsEuropeanStrategy2012



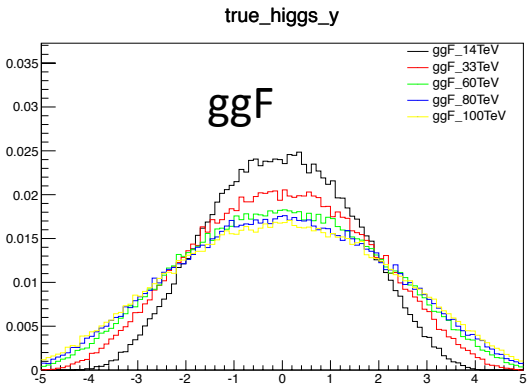
Higgs number of events

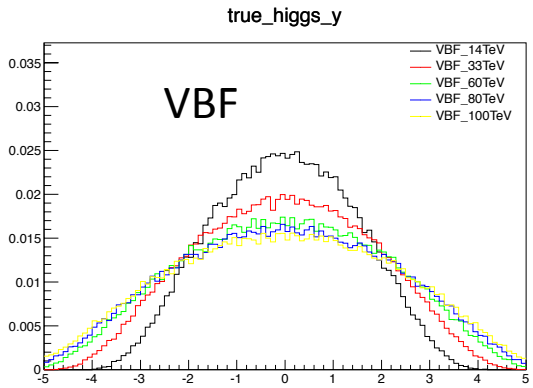
- For a luminosity of 100fb^{-1} and an acceptance of 10%
- No branching ratio
- 6000/400 000 ttH events @ 14/100TeV

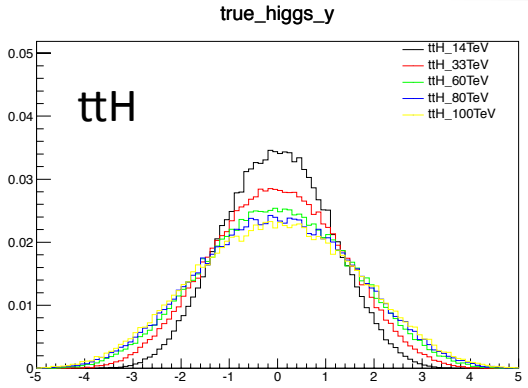


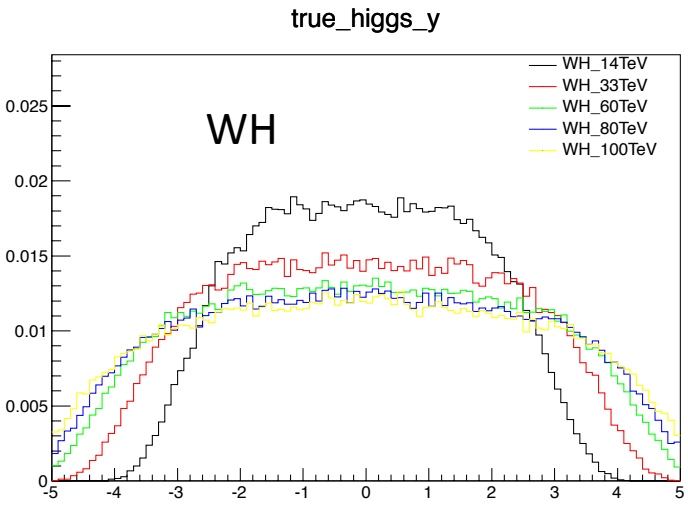
Higgs rapidities

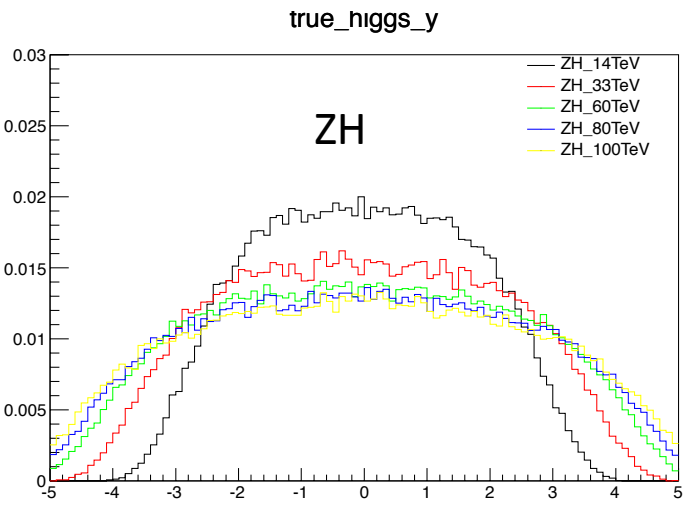
- For the different production mode and different energies









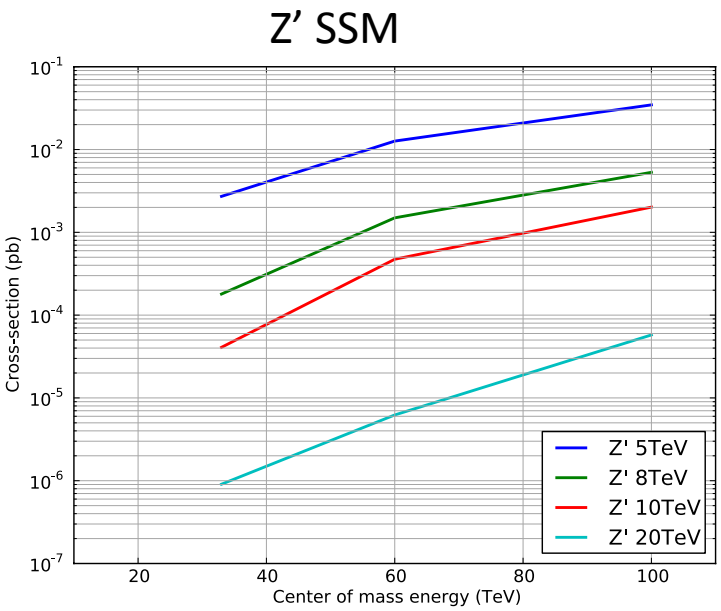


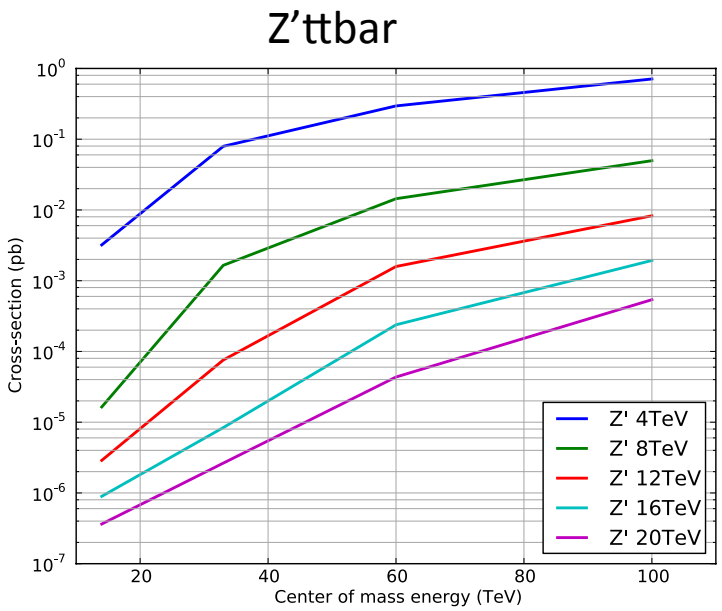
Higgs plans

- Look a the Higgs decay products kinematics with the events we already have to start with
- Self couplings (H. Gray)
  - James Ferrando confirmed that Spannowsky and Englert will generate events for us
- VBF (H. Gray)
  - to be done in second priority
  - First thing would be to look at the VBF jets
- ttH (H. Gray, C. Helsens)
  - Some events already produced, but would need more to study the γγ and μμ channels

Z’ cross section

- Z’ SSM model (Z’ -> ll) and (Z’ -> ttbar)

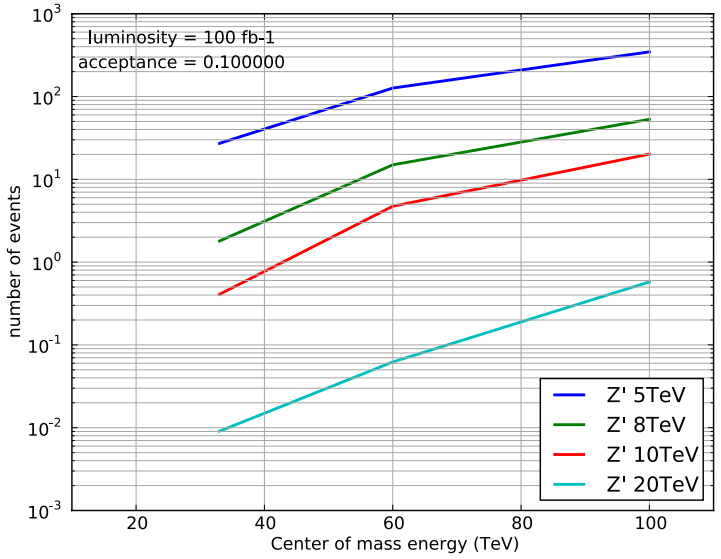




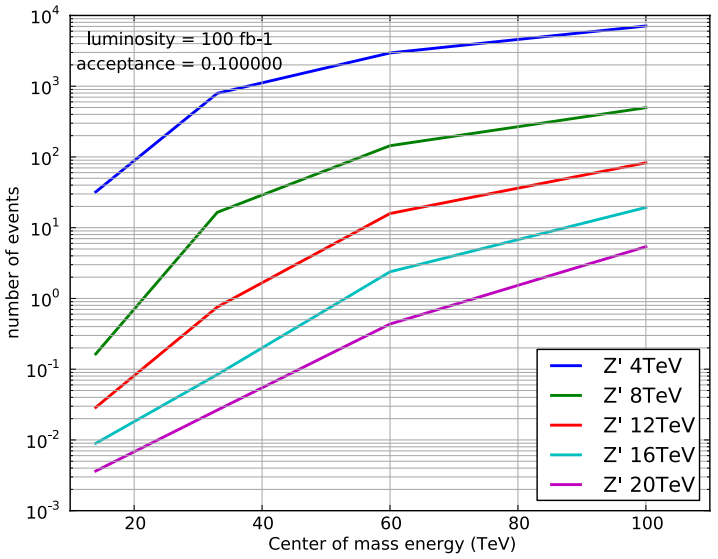
Z' number of events

- For a luminosity of 100fb^{-1} and an acceptance of 10% (pessimistic for a heavy object like this)
- Very few events for a 20TeV Z' even at 100TeV

Z' SSM

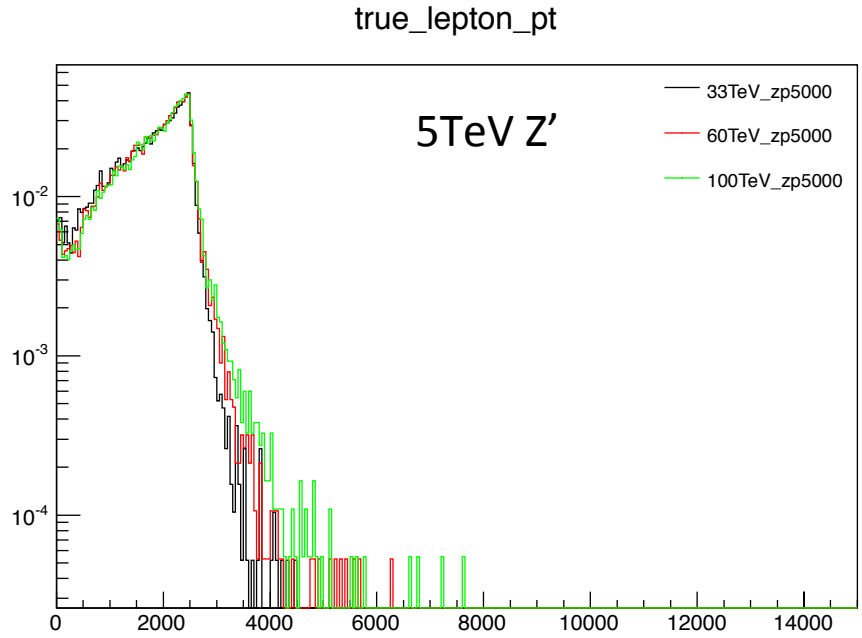


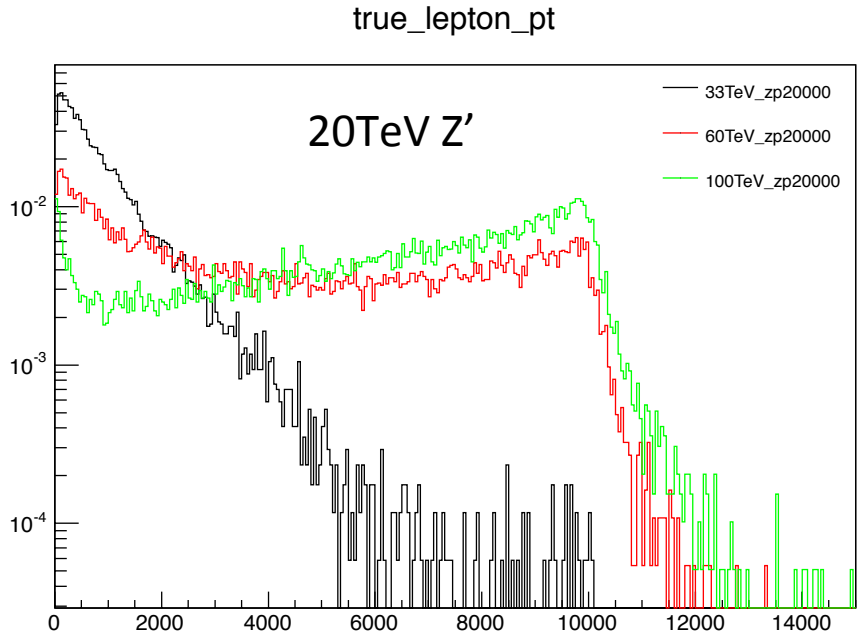
Z'ttbar



Muon (lepton) p_T

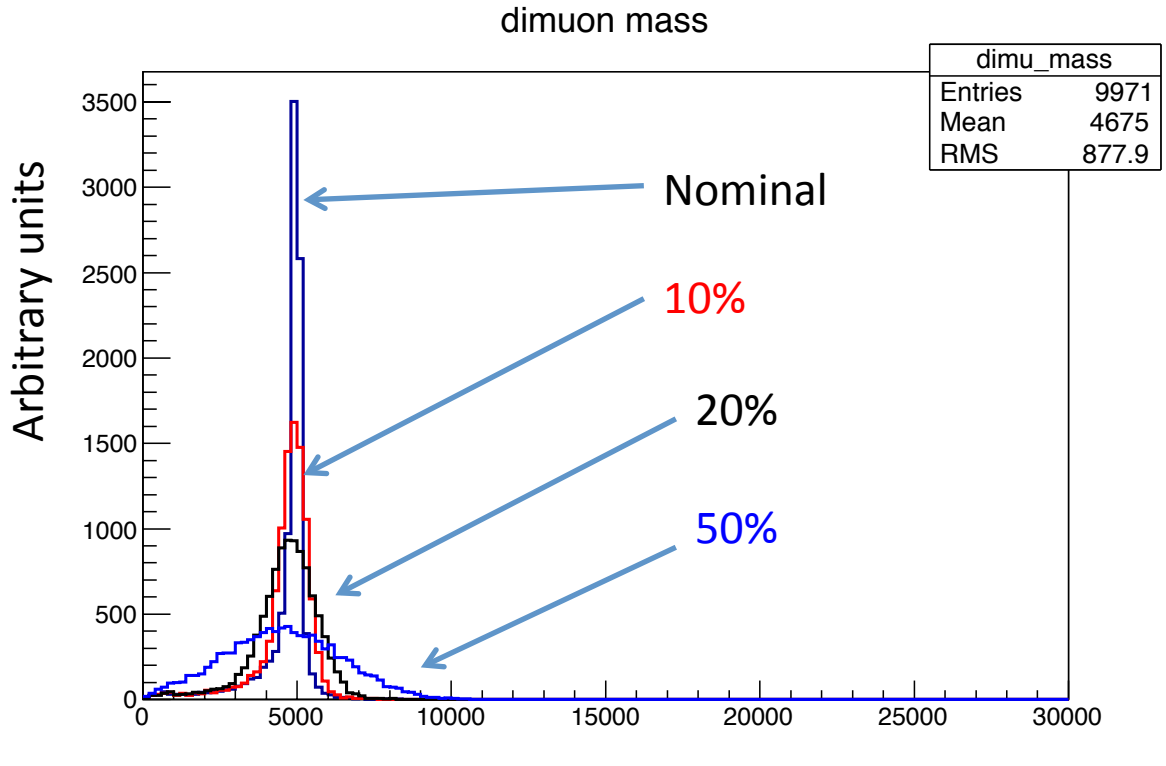
Normalized to unity





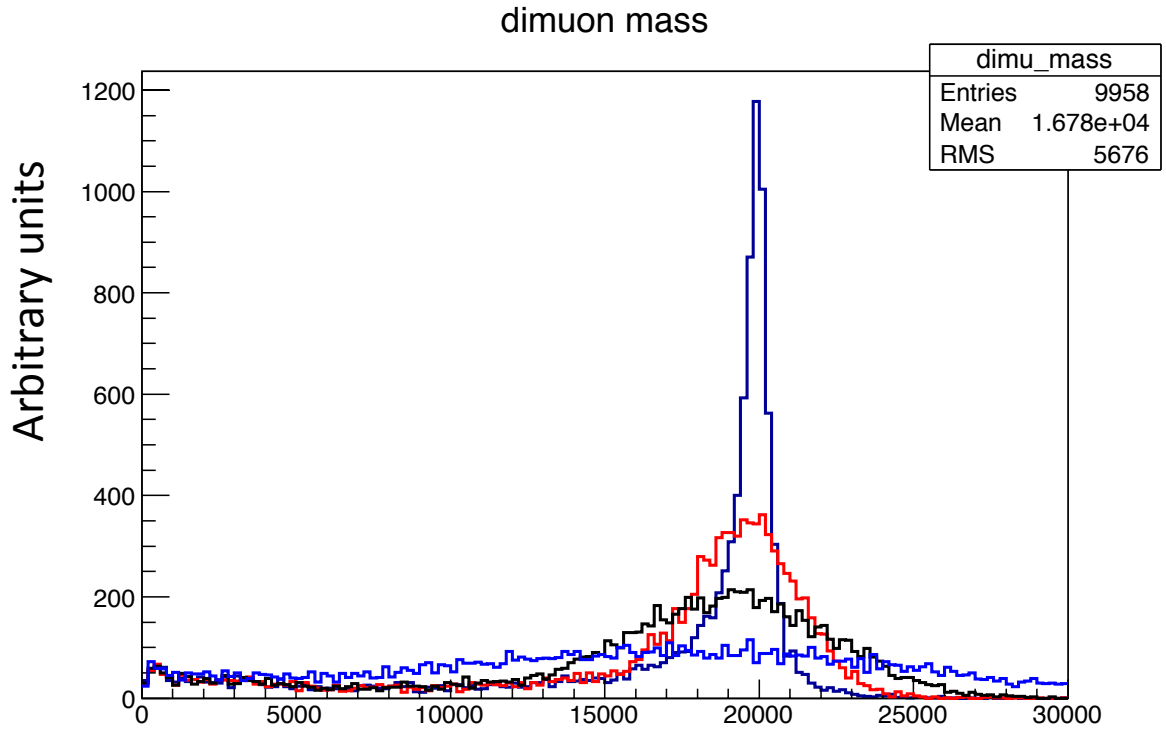
5TeV Z' ->μμ, 100TeV

- Select the two highest muons in the event with pT > 25GeV
- 99% efficiency
- Build the invariant mass
- Consider a smearing of 10, 20, 50% of the pT



20TeV Z' ->μμ, 100TeV

- Select the two highest muons in the event with pT > 25GeV
- 99% efficiency
- Build the invariant mass
- Consider a smearing of 10, 20, 50% of the pT

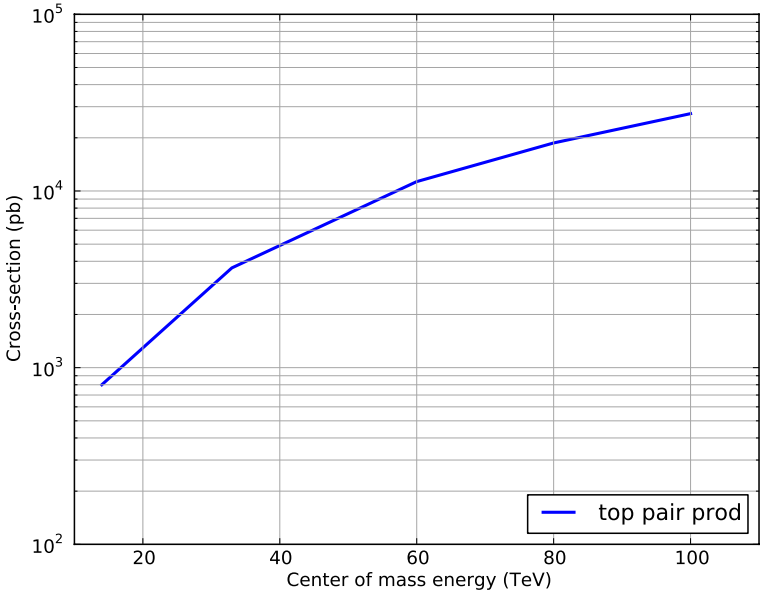


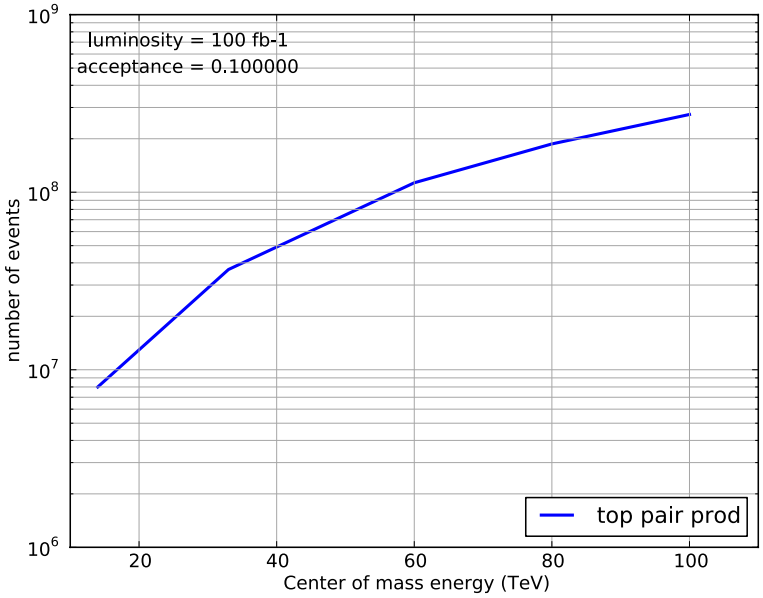
Muon resolution?

- High pT muons are not the expected to be a discovery channel
- The experimental resolution of any EM calorimeter measurement for a 50 TeV Z' would be below 1% of the mass and would depend only on the understanding of the behavior of the calorimeter at very high energy and not on any stochastic term in the resolution.
- An aggressive target for the muon could be:
  - resolution based on eg not more than doubling the natural width from the experimental resolution at the edge of the kinematic phase space, i.e. 50 TeV Z'

ttbar

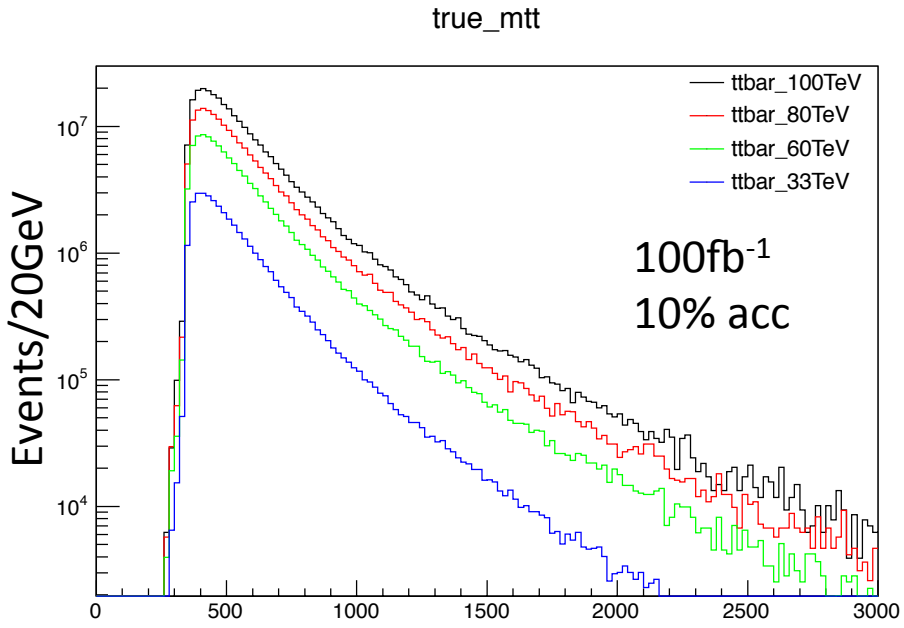
- Cross section and number of event for the same configuration (100fb^{-1} luminosity and 10% acceptance)
- No branching fraction considered





ttbar

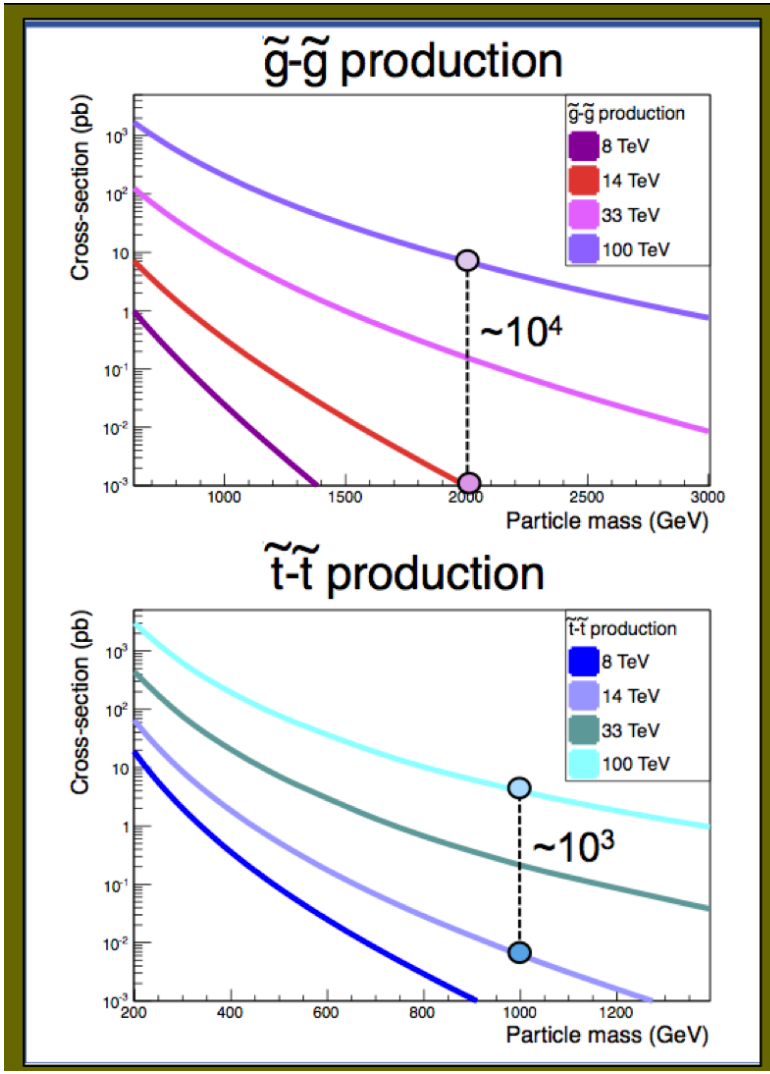
- Generated ttbar as a main background for Z'-> ttbar
- But as could expect 10's of billions of ttbar pairs at 100TeV -> Probe "interesting" level of FCNC in top decays
- Would need detailed studies but nobody expressed interest for this yet
  - Would be interesting to study in detailed the acceptance of the decay products



Exotic plans

- Z'-> ll (J. Ferrando, C. Helsens)
  - plan to look at e+e- as well. Generating now Drell-Yann as the main source of background
  - Natural end of kinematic reach for Z' production which is ~ 50% of the machine √s related to the stronger and stronger distortions due to the combination of pdfs and the natural width of the resonance (this is at least true at 2 TeV and 8 TeV)
  - First thing we will do once DY will be ready is to study the discovery potential (machinery ready for a shape analysis) as function of mass and luminosity
  - a natural requirement for the ultimate lumi of a new hadron collider machine is to achieve ~ 10 events produced per year at design lumi for mZ' ~ 50 TeV for √s = 100 TeV
- Z' -> ttbar (J. Ferrando, C. Helsens)
  - need to generate ttbar sliced in mttbar as the inclusive spectrum is not enough
- Excited quarks (C. Doglioni)
  - Just started to generate signal and QCD background events
  - Machinery is pretty much ready for a dijet shape analysis and it should be a relatively simple analysis with the current MC tools
  - Jacob Anderson already did some studies at 100TeV, counting method, exclude q* <50TeV with 3ab^{-1} integrated luminosity (http://arxiv.org/pdf/1309.0845v2.pdf)
- W' -> lν, tb and Z'->νν (J. Ferrando, C. Helsens)
  - Think to start working on this after the kickoff meeting

Susy



SUSY cross sections (Anna Sfyrla)

- 8 & 14TeV at NLO+NLL.
- 33 & 100TeV at NLO.
- Large increase in SUSY cross-sections for relevant ('natural') particle masses.

Thanks to Robin van der Leeuw for his help with Prospino

Susy plans

- Gluino mediated stop production (A. Sfyrla)
  - Just started to generate events
  - Could be interesting to first estimate the sensitivity range for 100 fb^{-1} in mass for gluino and stop based on extrapolating how many events produced are required for our current limits at 8 TeV

Summary

- Just started to work on FHC related studies
- Detailed the analyses we plan to work on
- Open to already start collaborating in a more experiment independent way
- Expect lots of progress to be done in the coming weeks and in time for the kickoff meeting
  - Ready to perform detailed acceptance and sensitivity studies
- Feedback welcome if you think important signatures are missing!