University of Zurich

Short/Long Exercises -Measurement of top quark mass and production cross section

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(Exercise based on CMS Data Analysis Tutorial 2014
by Prof.C.Sender and Dr. A.Schmidt)

PHYS451 - Experimental Particle Physics
Exercise class 13
13th December 2016

Info

- **Papers should be handed in by Tuesday, the 20th at 15:00**
  - Please, send them to decosa@cern.ch and silvio.donato@cern.ch in pdf format
- **You should include a minimum set of plots in the paper**
  - Which is summarised in the next slides

Today class will be devoted to questions and last missing pieces

Paper writing: shopping list

Cross section measurement

- **Show the data to simulation comparison of the following distributions for events having at least one isolated muon and triggered by a single muon trigger (triggerIsoMu24)**
  - Number of b jets
  - Number of jets
  - MET
- **Distribution of number of jets or MET after final selection is applied**
- **Table summarising the number of events at final stage for signal, each background contribution and data**
  - Include also the number of expected signal events, subtracting simulated background contribution from data
  - Include statistical error for both data and simulation

Paper writing: shopping list

Top mass measurement: Part I

- **Z→μμ invariant mass distribution (data/MC)**
- **Fit to the Z→μμ mass peak with a Breit Wigner**
- **2D likelihood-scan of signal strength vs mass**
  - Signal strength = measured σ/theoretical σ as from MC [15.8 pb])
  - Assume the MC has been produced with M_Z= 91.188 GeV
- **Perform the 2D scan moving and scaling the Breit-Wigner fit of signal MC histogram**

Extra

- **Perform the 2D scan moving and scaling the signal MC histogram**
  - Do not worry if you get results different from the SM!

Paper writing: shopping list

Top mass measurement: Part II

- **Show the invariant mass of the hadronic top using the MC truth objects**
- **Show the transverse invariant mass of the leptonic top using the MC truth objects**

Extra

- **Show the invariant mass of the hadronic top using the reconstructed objects matching the MC truth objects**
- **Show the transverse invariant mass of the leptonic top using the reconstructed objects matching the MC truth objects**

Paper writing: shopping list

Top mass measurement: Part III

- **Show the invariant mass of the two jets originating from the W boson decay**
  - The two jets which are not b tagged
- **Show the invariant mass of the three jets originating from the top quark decay**
  - W jets plus btag jet
- **Perform a gaussian fit the peak of top mass distribution**
  - Do not perform the mass scan
  - Estimate the top mass from the fit
- **Show the transverse invariant mass of top quark decaying leptonically**

Extra

- **Show the invariant mass of top quark decaying leptonically, resolving the p_z of the neutrino from the W mass.**

Changes to apply

- **Apply this fix to your likelihood computation function:**

```
######## Fix of the logLikelihood function ####
def logLikelihood(data,histo):
    m2ll = 0
    chi2 = 0
    for i in range(1,data.GetNbinsX()-1):
        x = int(data.GetBinContent(i))
        xErr = max(0.001,int(data.GetBinError(i)))
        sb = histo.GetBinContent(i)
        sbErr = histo.GetBinError(i)
        if sb<1 and x<1: continue
        if sb<=0: sb=0.001
        logLikelihood = x*TMath.Log(sb) - sb #-
TMath.Log(TMath.Factorial(x))
        m2ll += -2*logLikelihood
        chi2_ = (x-sb)**2/sb
        chi2 += chi2_
    return m2ll
```

Changes to apply

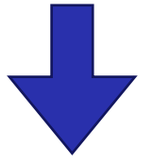
- **Apply this fix to your likelihood computation function:**

```
def logLikelihoodFunction(data,funct):
    m2ll = 0
    chi2 = 0
    for i in range(1,data.GetNbinsX()-1):
        x = int(data.GetBinContent(i))
        xErr = max(0.001,int(data.GetBinError(i)))
        sb = funct.Eval(data.GetBinCenter(i))
        sbErr = 0
        if sb<1 and x<1: continue
        if sb<=0: sb=0.001
        logLikelihood = x*TMath.Log(sb) - sb #-
TMath.Log(TMath.Factorial(x))
        m2ll += -2*logLikelihood
        chi2_ = (x-sb)**2/sb
        chi2 += chi2_
    return m2ll
```

Short exercise

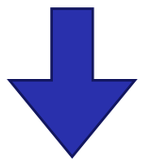
Minimal selection to apply

At least 1 muon with Muon_Pt>25 GeV and Muon_Iso/Muon_Pt < 0.05



Number of jets (with pt>30 GeV) > 0

Number of b jets (with Jet_btag > 2.0)



MET > 20 GeV

Extra: Optimise the cuts based on S/√B