Short exercise - part 3

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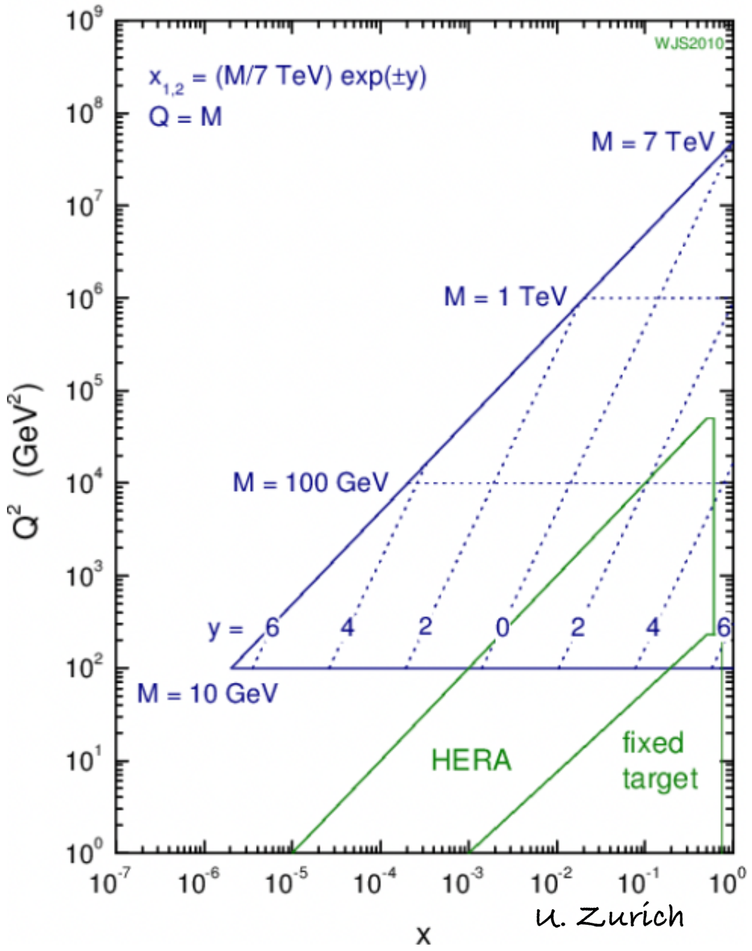
Short exercise - part 3

Introduction

- In addition to the cross section
  - measure W (lepton) charge asymmetry
- At LHC, being a pp collider, we expect to observe a W charge asymmetry
- Cross-section asymmetry depends on the momentum fraction x of the partons
  - dependence on rapidity y of Q (W)
  - $m_W^2 = x_1 x_2 s$
  - $x_1/x_2 = e^{2y}$
  - for a given Q, rapidity relates the x_1 and x_2 of the two partons
- Difficult to reconstruct W rapidity
  - use lepton charge asymmetry



- Measure the W charge asymmetry in the phase-space
  - muon $p_T > 30$ GeV and $|\eta| < 0.4$

$$A_\mu = \frac{d\sigma_{W\mu^+}/d\eta_\mu - d\sigma_{W\mu-}/d\eta_\mu}{d\sigma_{W\mu^+}/d\eta_\mu + d\sigma_{W\mu-}/d\eta_\mu}$$

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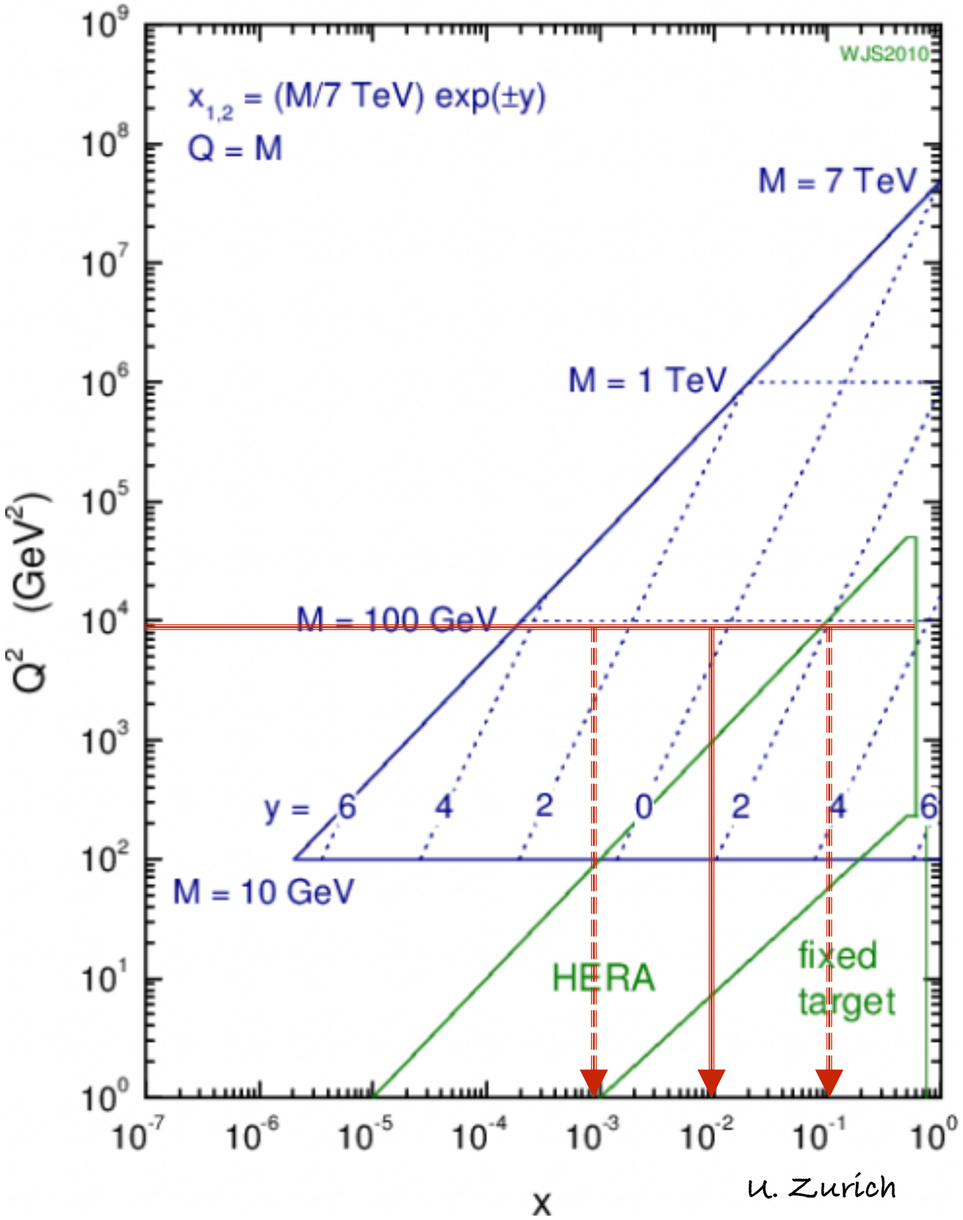
Introduction

- For a W at |y| = 0, we need
  - two quarks with x1 ~ 0.01 and x2 ~ 0.01
- For a W at |y| = 1, we need
  - two quarks with x1 ~ 0.03 and x2 ~ 0.003
- For a W at |y| = 2, we need
  - two quarks with x1 ~ 0.1 and x2 ~ 0.001



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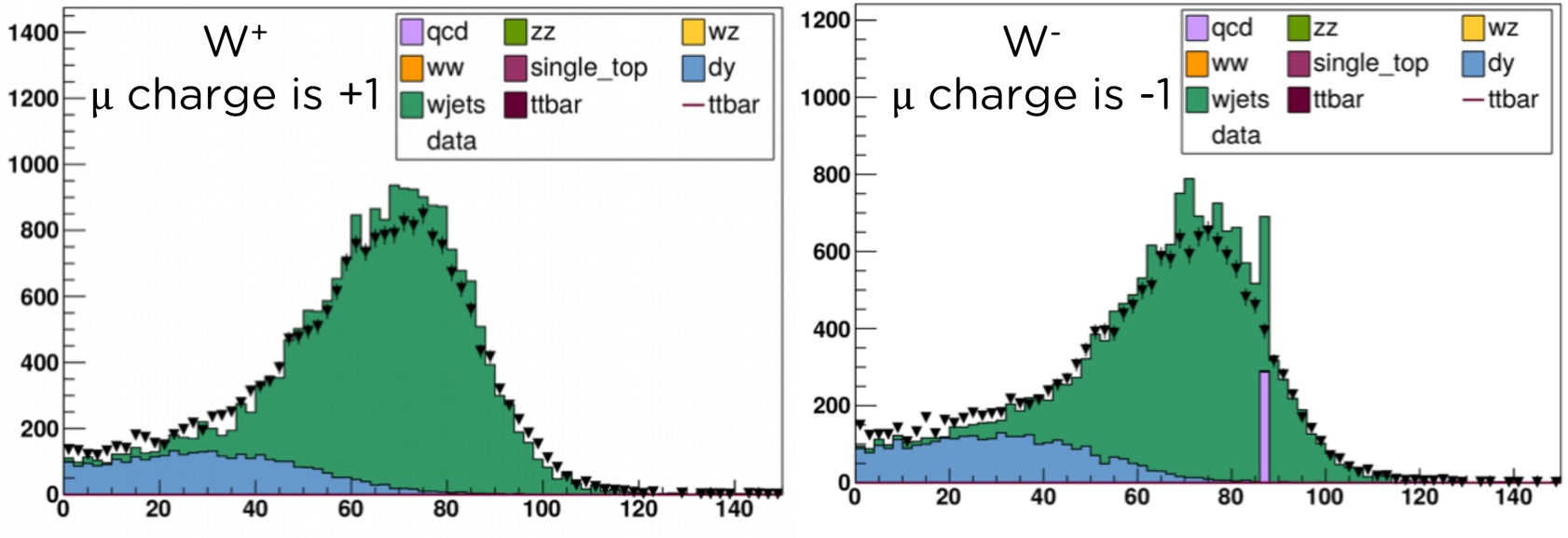
W charge asymmetry measurement

- In case that Data / MC agreement is not good
  - need to estimate the background in a data-driven method
- Use MC samples to validate our fit function
- Use
  - double Gaussian for signal
  - error function for background
  - combination of the above for data



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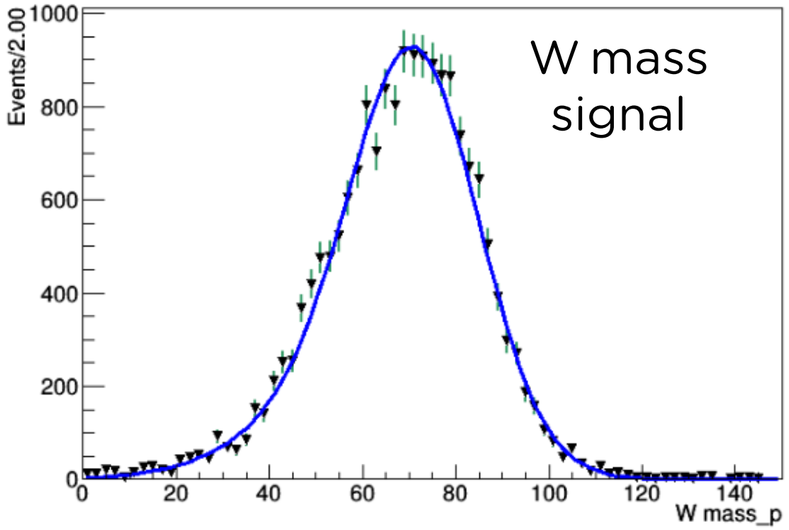
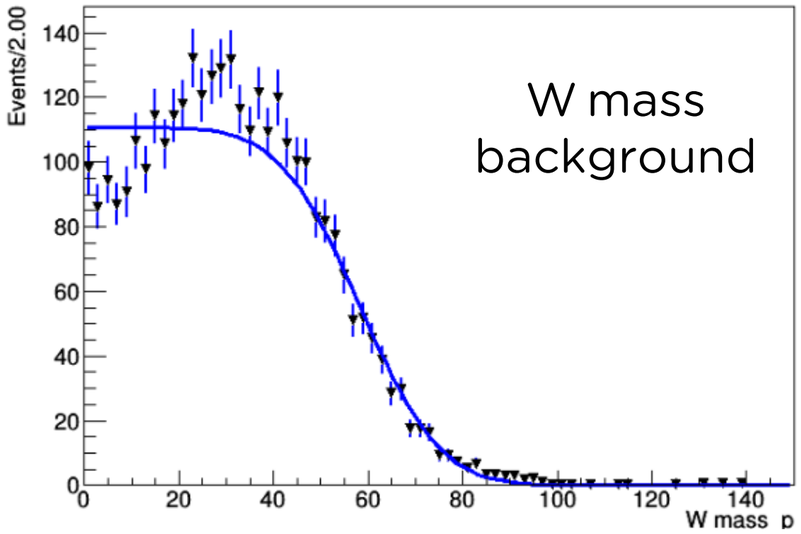
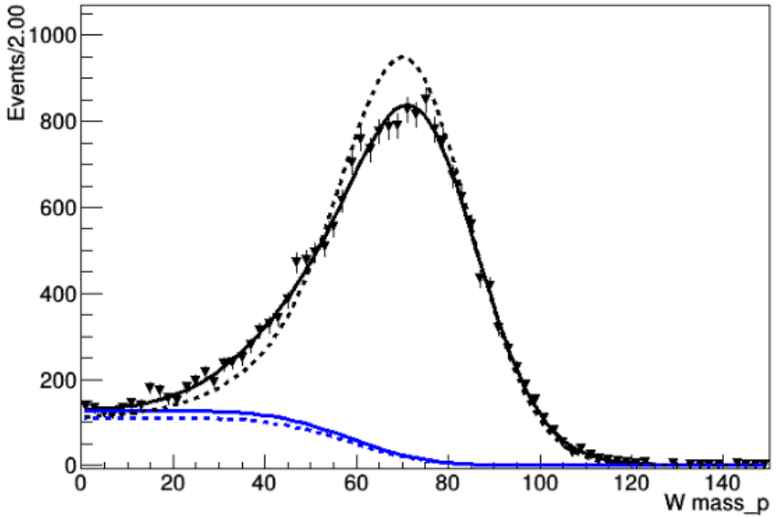
Fit results



W mass signal



W mass background



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W charge asymmetry measurement - option 1

```
fit_sig = ROOT.TF1("fit_sig","gaus(0)+gaus(3)",0,150)
fit_sig.SetParameters(500,100,10,300,50,40)
fit_bkg = ROOT.TF1("fit_bkg","[0]*(TMath::Erf((x-[1])/[2])+1.)",0,150)
fit_bkg.SetParameters(10,60,-10)
fit_bkg_sig = ROOT.TF1("fit_bkg_sig","[0]*(TMath::Erf((x-[1])/[2])+1)+gaus(3)+gaus(6)",0,150)


sig.Fit(fit_sig) bkg.Fit(fit_bkg)
for i in range(9):
    if i==0:
        fit_bkg_sig.SetParameter(i,fit_bkg.GetParameter(i))
    elif i<=2: ## we fix background parameters, but the normalization
        fit_bkg_sig.FixParameter(i,fit_bkg.GetParameter(i))
    else:
        fit_bkg_sig.SetParameter(i,fit_sig.GetParameter(i-3))
```

Be careful on the statistical uncertainty computation!

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W charge asymmetry measurement - option 2

RooFit and extended maximum likelihood fits

- Measure asymmetry as the ratio of the difference to the sum of N(W+) and N(W-)
  - since the W+ and W- events are independent
  - errors combined in quadrature

Extra:

- Task is to make the measurement for $|\eta| < 0.4$
- In case you want and have time
  - [0.0, 0.4]
  - [0.4, 0.8]
  - [0.8, 1.5]
  - [1.5, 1.8]
  - [1.8, 2.1]

BACKUP