Short exercise - part 3

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Can be done with the same dataset, ignoring the previous parts

PHY451 Particle Physics I
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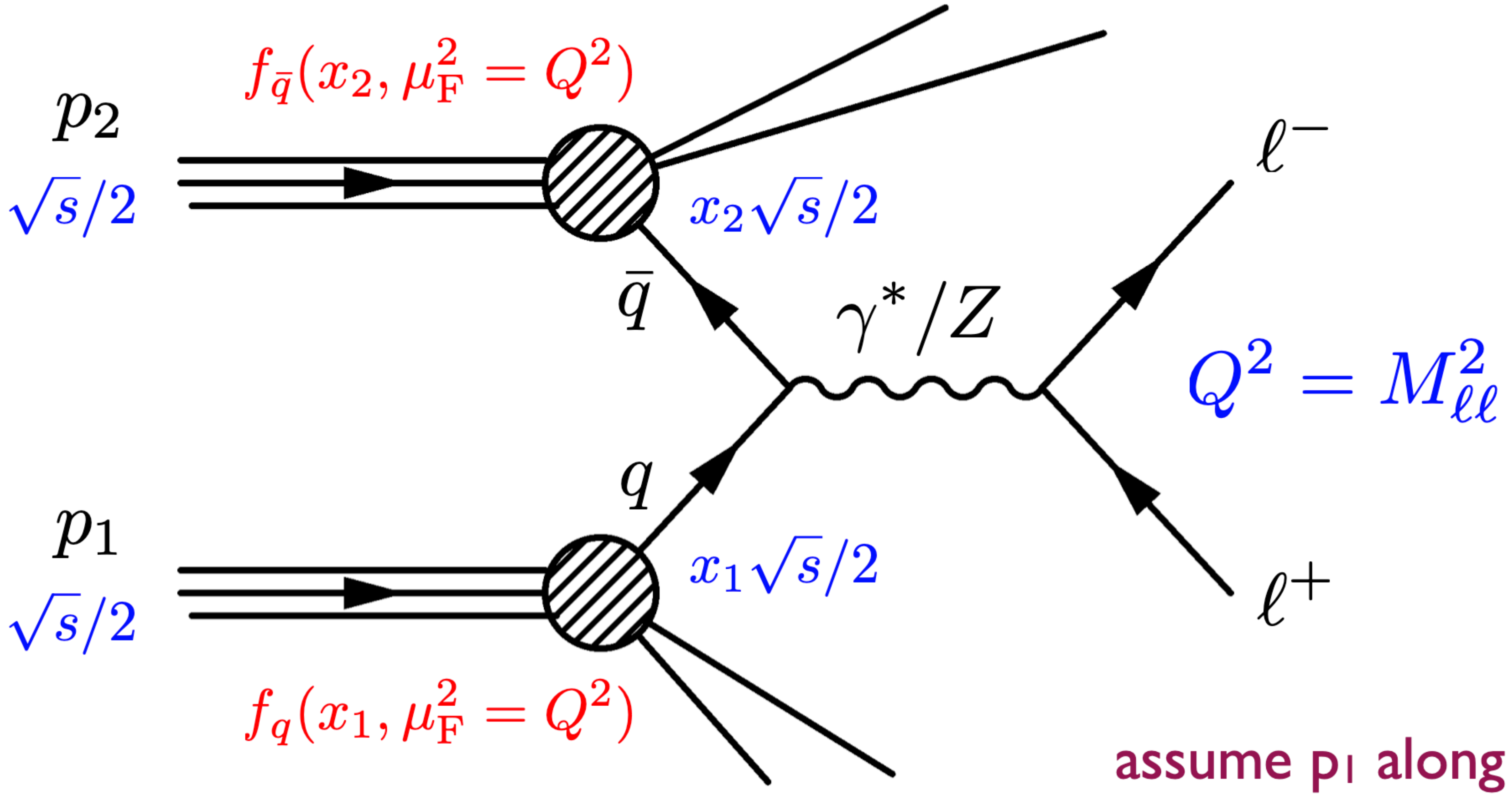
Short exercise - part 3

Introduction

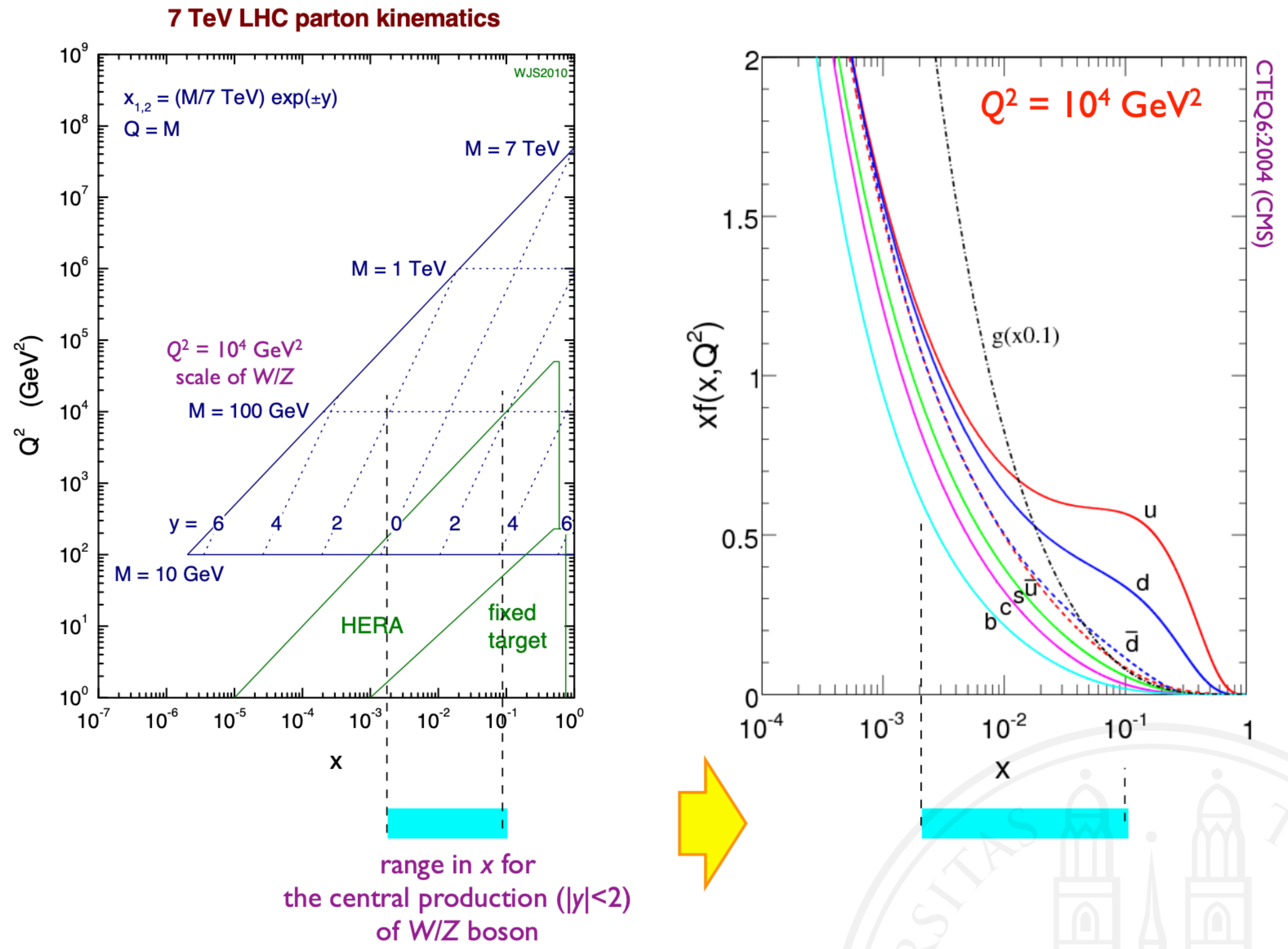
- Example of the Drell-Yan process - lepton pair production via quark-antiquark annihilation

- 4-momentum of lepton pair (LO)
  - $E = (x_1+x_2)\sqrt{s}/2$
  - $p_z = (x_1-x_2)\sqrt{s}/2$
  - $Q^2 = E^2 - p_z^2 = x_1x_2s$

  - rapidity (y) definition: $x_1/x_2 = (E+p_z)/(E-p_z) = e^{2y}$
  - $x_{1,2} = (Q/\sqrt{s})\, e^{\pm y}$



assume p_l along positive beam axis



For a given Q^2, the rapidity relates the x_1 and x_2 of the two partons

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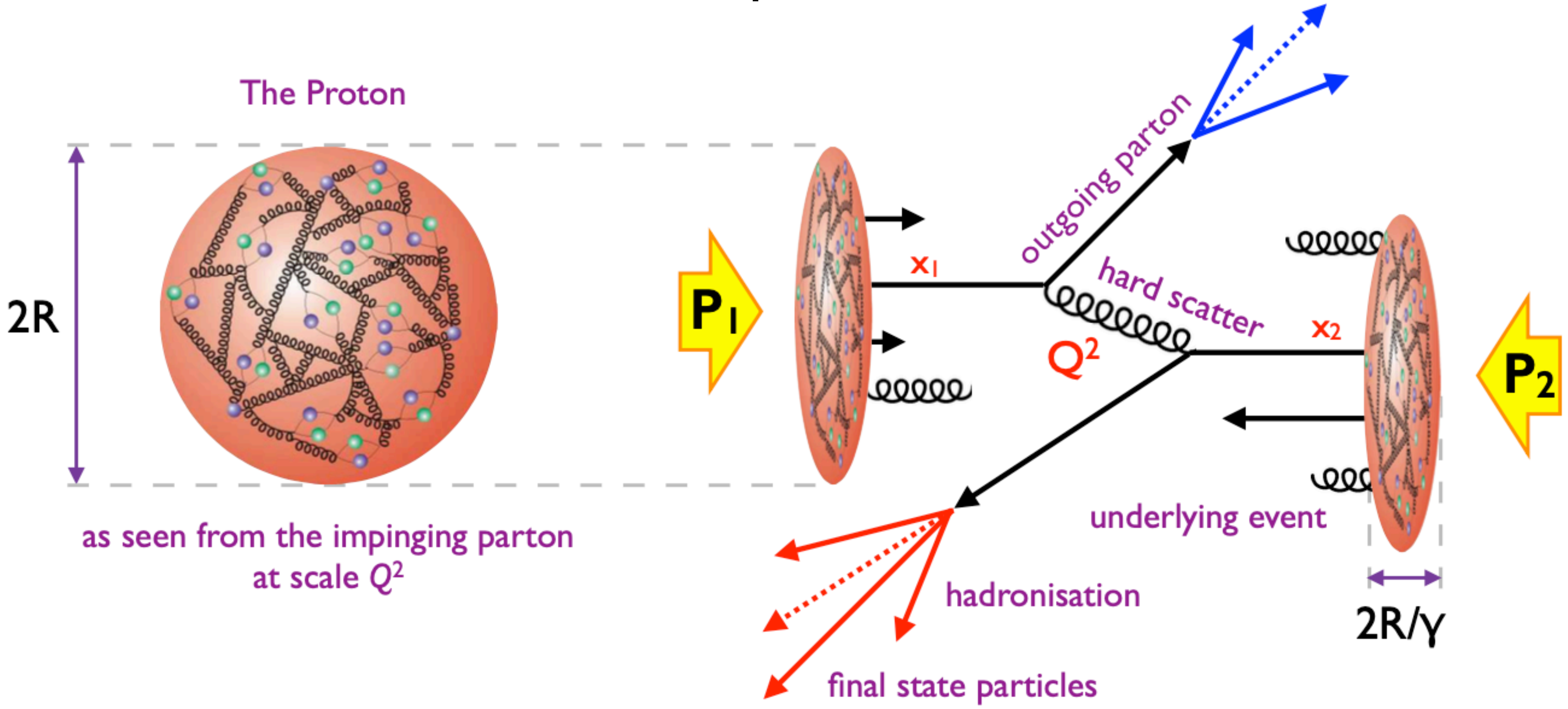
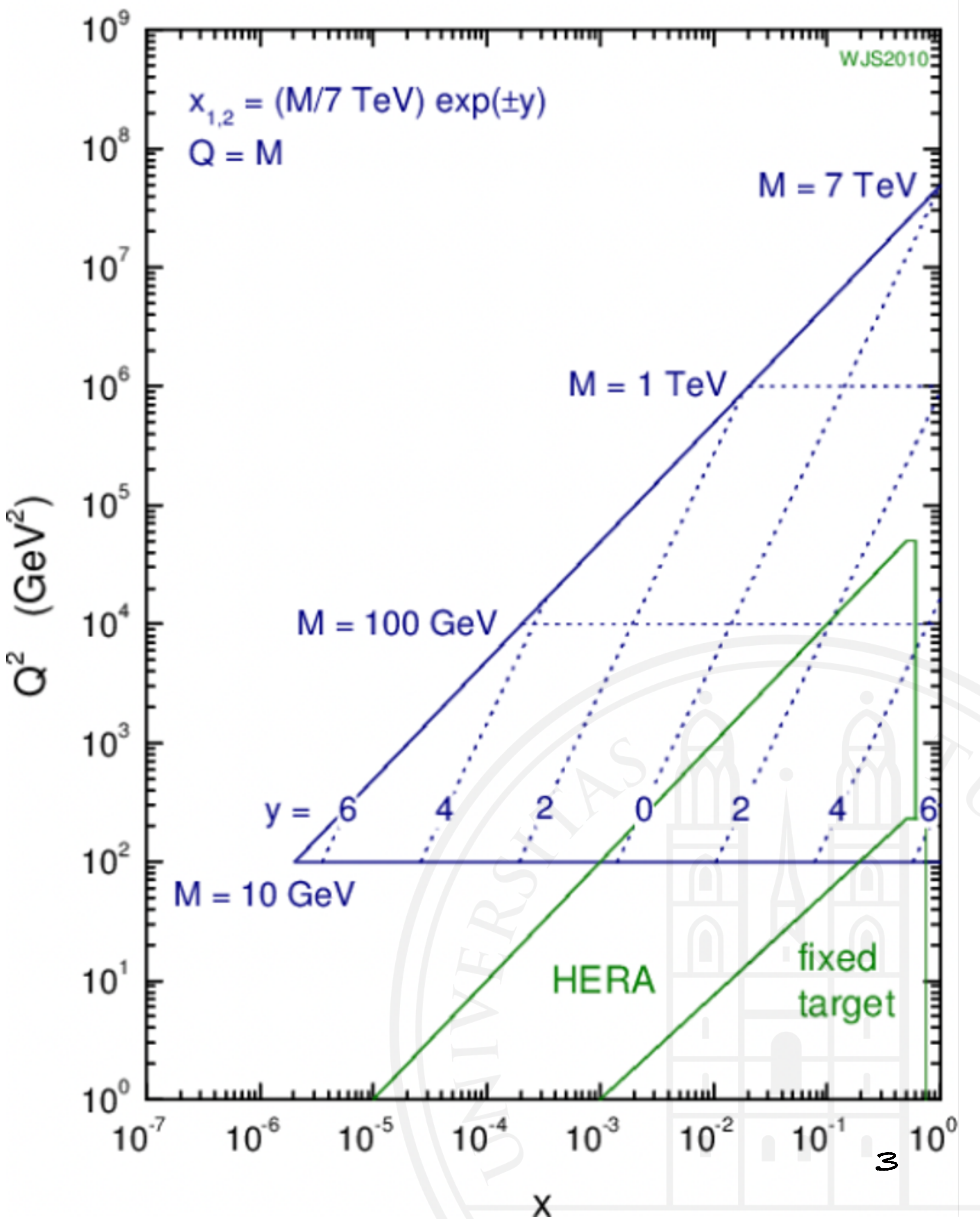
Introduction

What processes produce W:
- protons have more up's than downs -> assymmetry in W

- 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)
  - 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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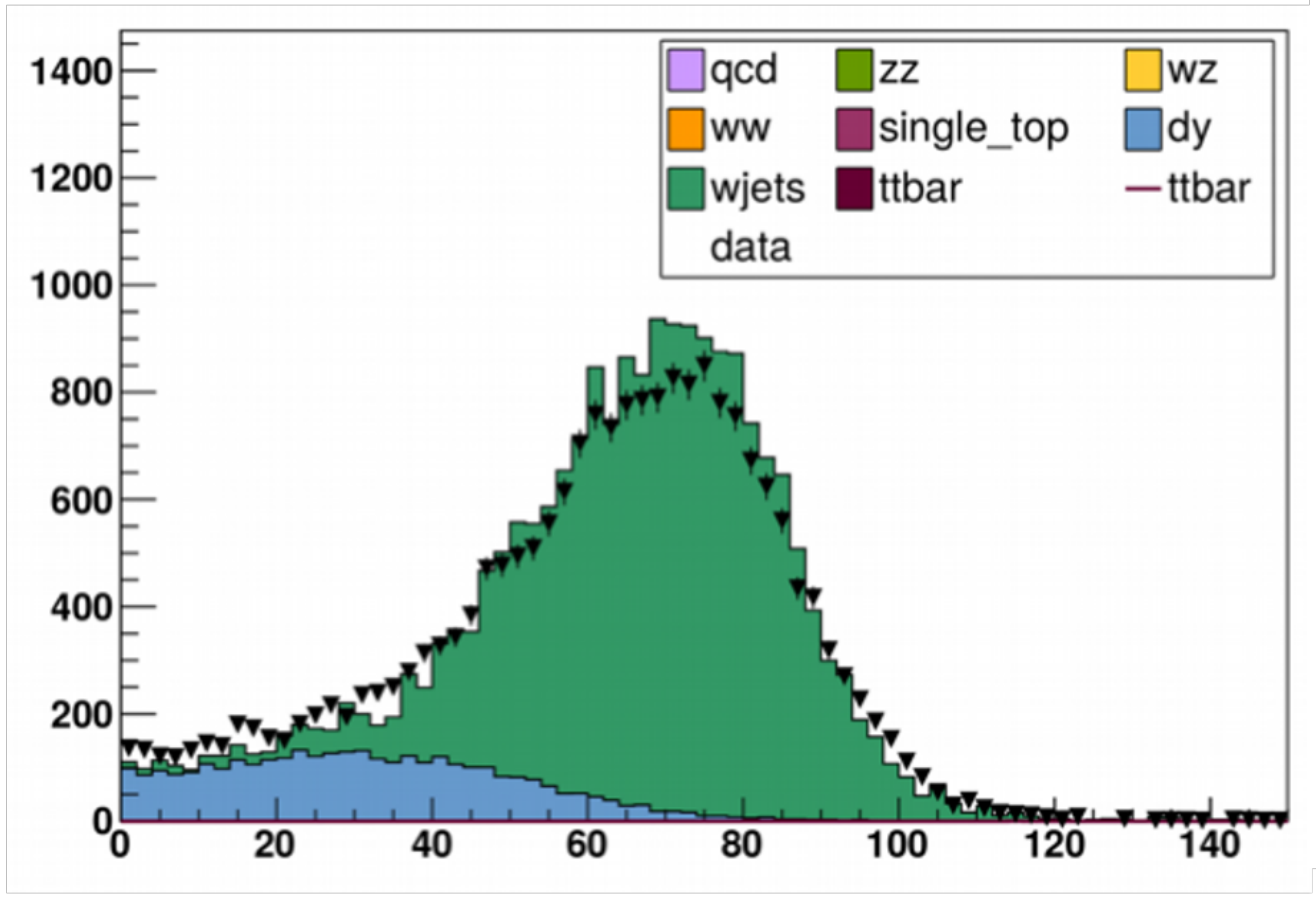
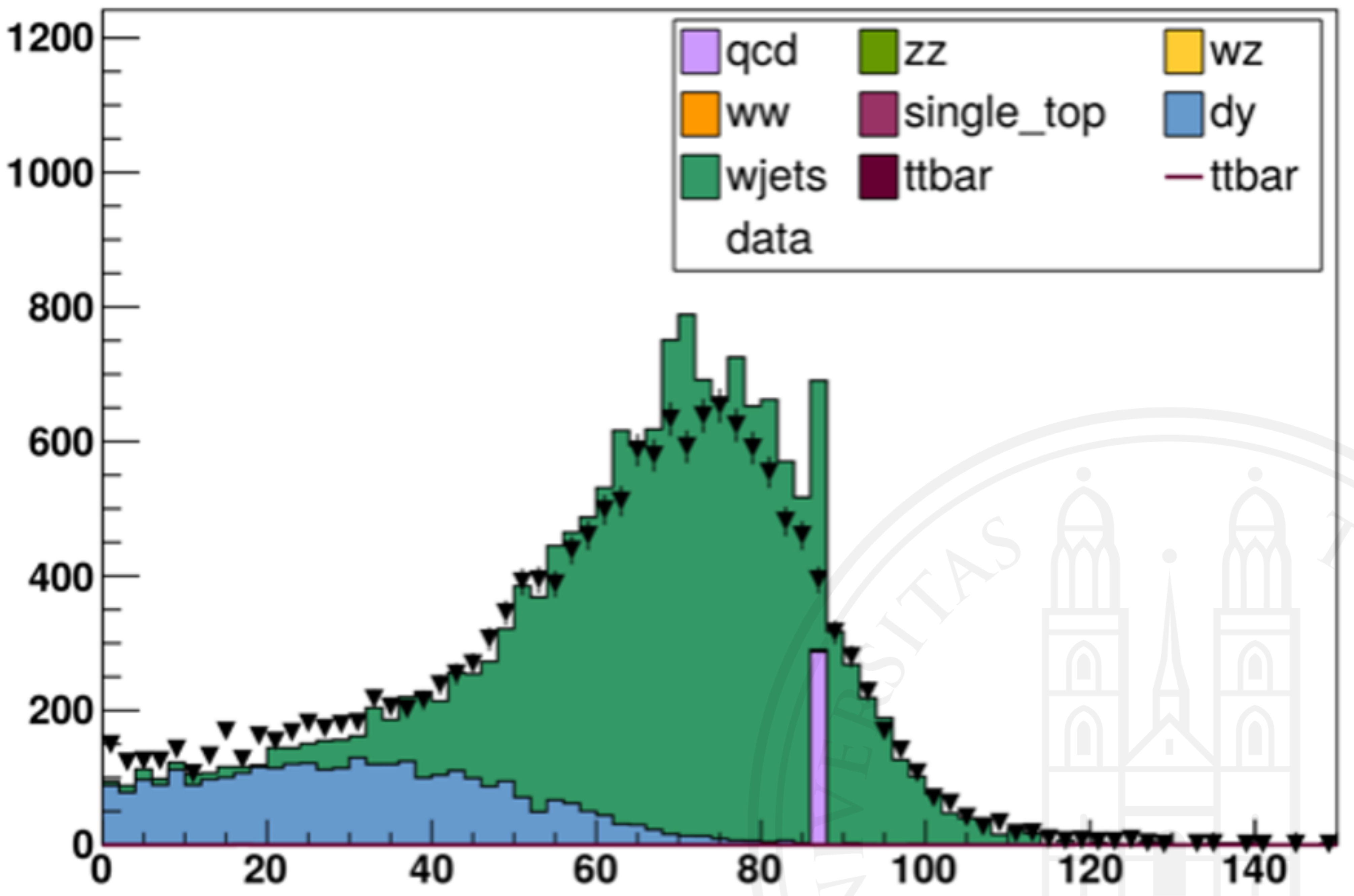
W charge asymmetry measurement

- 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

Already discrepancy in peak height

QCD Peak: small # -> weighting gives it a boost





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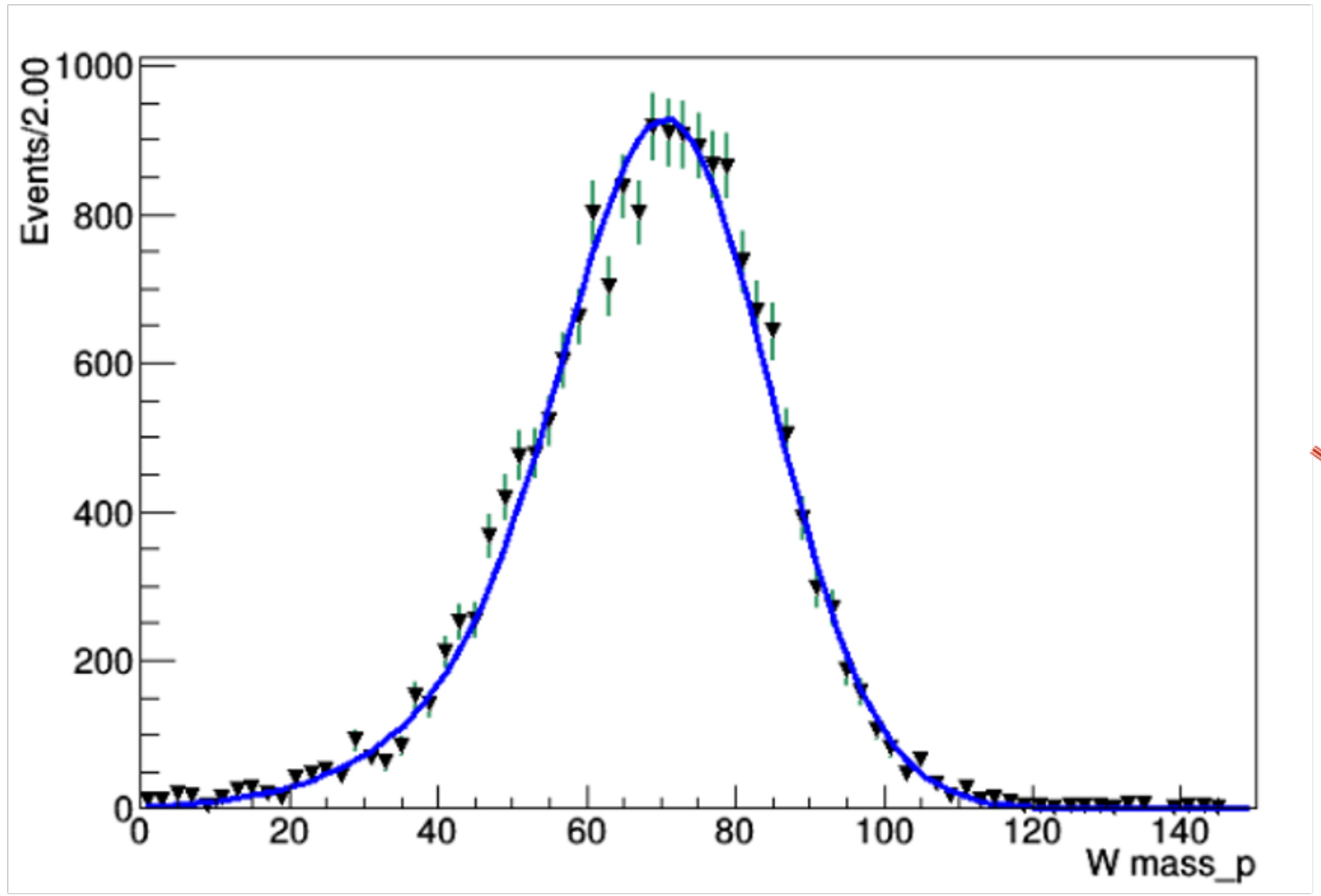
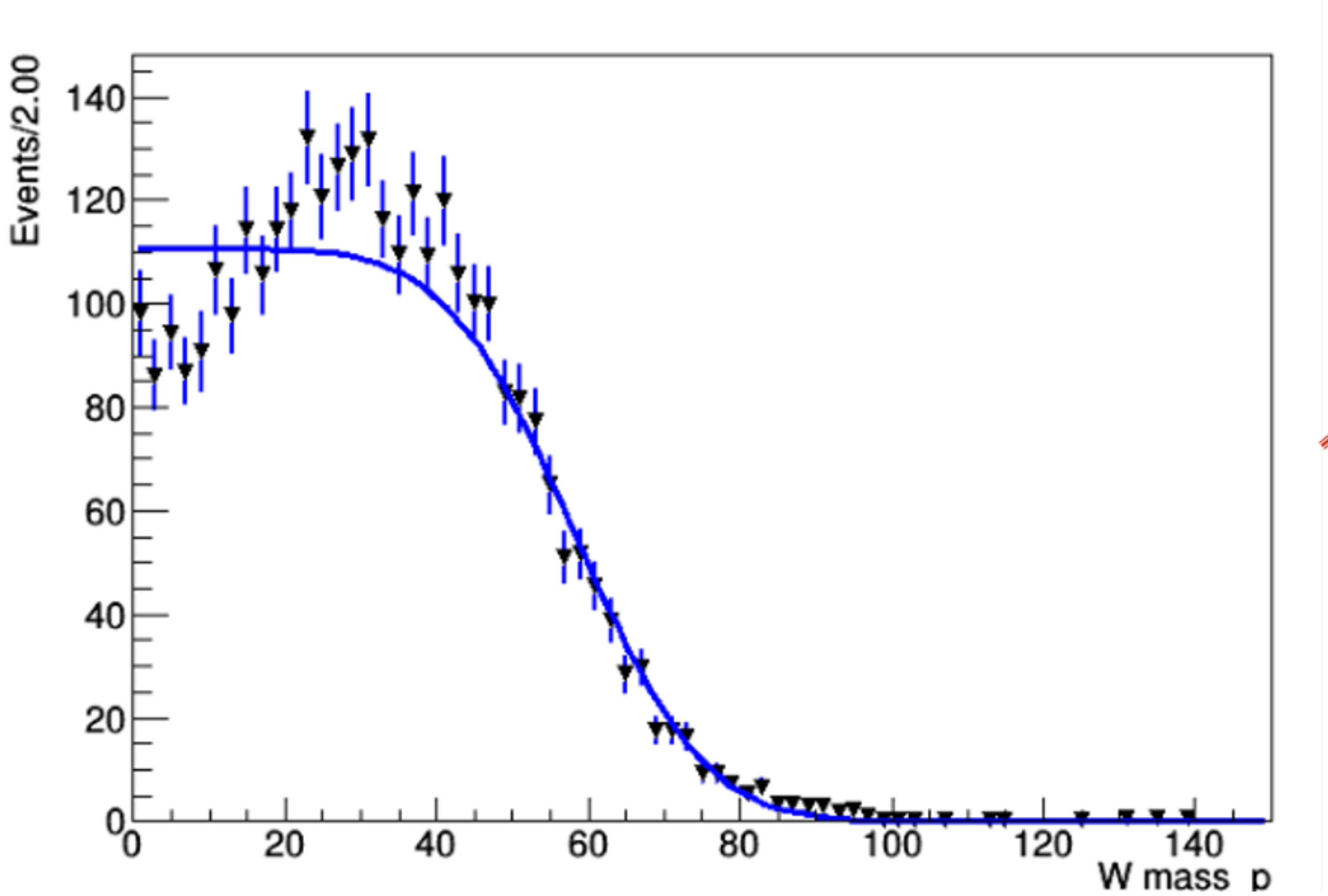
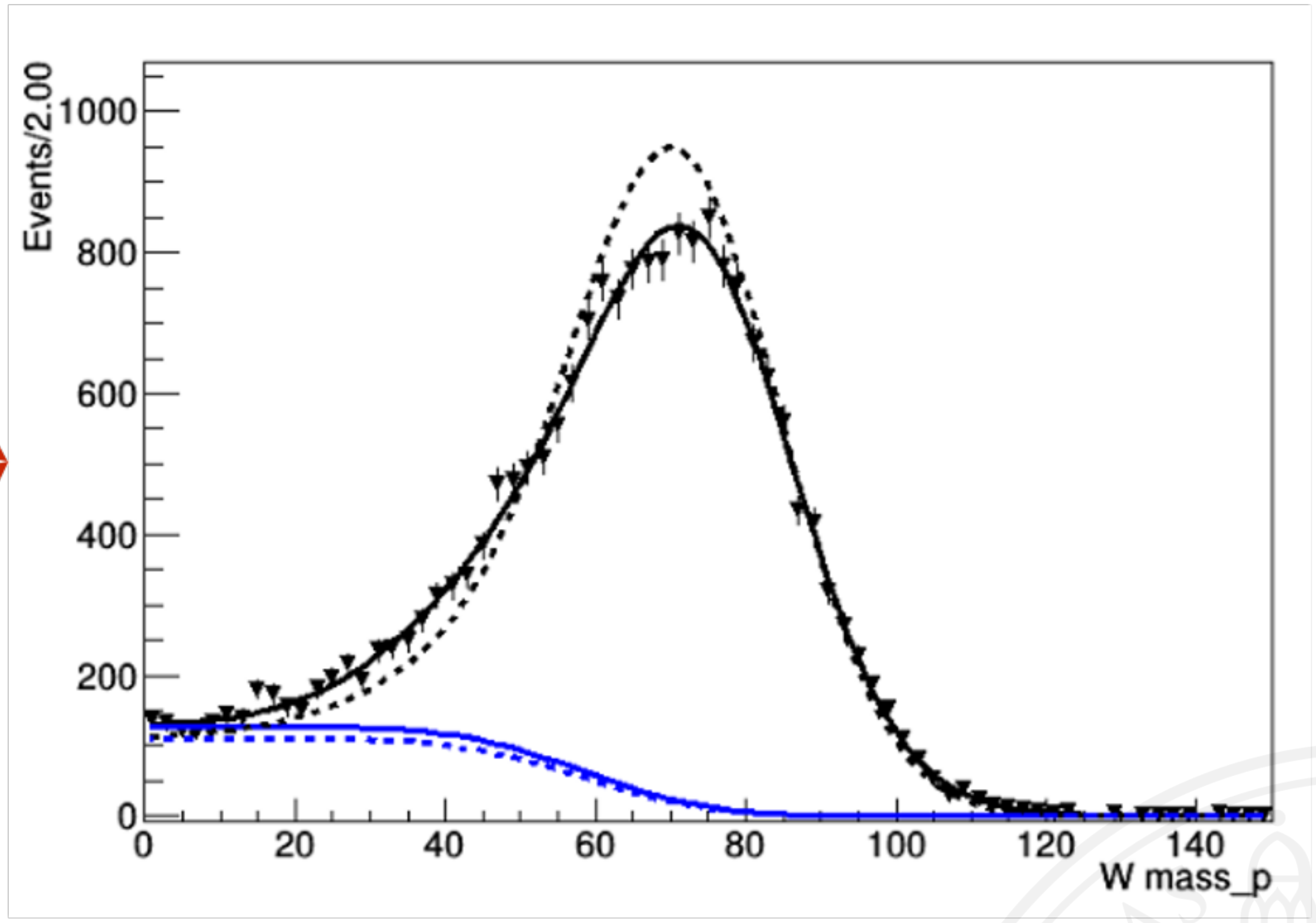
Fit results







Idea:
- only use 40+ mass for fit

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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]

This is not flat; there is a trend

=> Then compare with theory or literature

backup