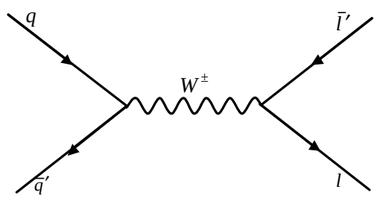
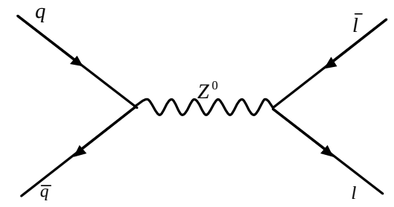
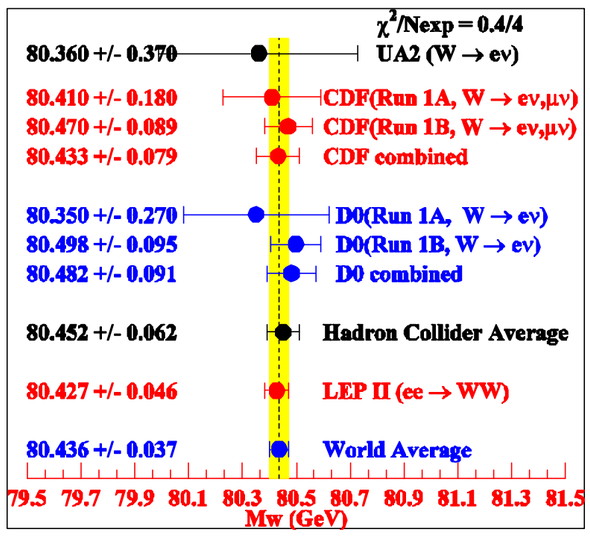


Higher order radiative corrections to Drell-Yan processes @ hadron colliders



The problem

State of the art of determination W mass



Present precision

Tevatron runIIa ⇒ 27 Mev

Target precision

* **TevatronrunIIb ⇒16 Mev**
* **LHC ⇒ 15 Mev**

Systematic uncertainties (MeV/c^2)

Source of uncertainty	Electron channel	Muon channel	common
Lepton scale	75	85	
Lepton resolution	25	20	
Transverse P	15	20	3
Recoil	37	35	
Higher order QED	20	10	5
Trigger & Lepton ID bias	==	15+10	
PDFs	15	15	15
backgrounds	5	25	
TOTAL	92	103	16

The uncertainties due to QED will become not negligible in future hadron collider experiments

We need precise theoretical prediction in order to estimate W mass with such a high accuracy, including (higher order) radiative corrections!

The effects depend strongly on detector acceptance and lepton ID requirements

MonteCarlo event generator
Including multiphoton emission

Framework

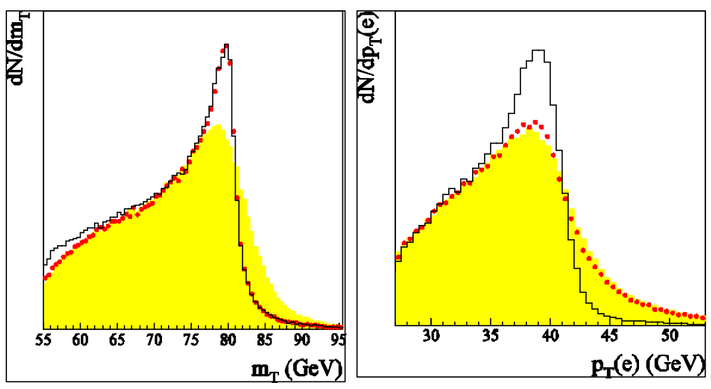
HOW TO EXTRACT W MASS FROM OBSERVABLE

study $W \to l n_l$ decay kinematics (Jacobian peak)

Which observable to take?

$M_T \equiv \sqrt{2 p_t^l p_t^n (1 - \cos \phi_{l n})}$ **Transverse mass**

Less sensitive to the W transverse momentum, which is difficult to model



— No detetector effects & No P_W^T
• Including P_W^T
■ Including det.effects & P_W^T

Order α Effects are known exactly : they shift the extracted W mass by O (100 MeV)

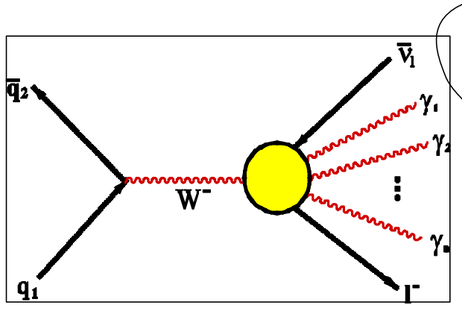
U. Baur, S. Keller, D. Wackeroth, PRD 59, 013002 (1999)

S. Dittmaier, M. Kramer, PRD 65,073007(2002)

Multiphoton emission

Final state photon radiaton is the main effect

It distorts significantly the M_t spectrum



Large logarithms coming from Initial State (quarks) can be reabsorbed into PDFs, in analogy with QCD

H. Spiesberger, PRD 52, 493 (1995)

How to include the effect of virtual and real photonic radiation?

QED structure functions $D(x,Q^2)$

MC PARTON SHOWER SOLUTION
Exact iterative solution
Allows exclusive generation of photons

Solution of the DGLAP equation for QED

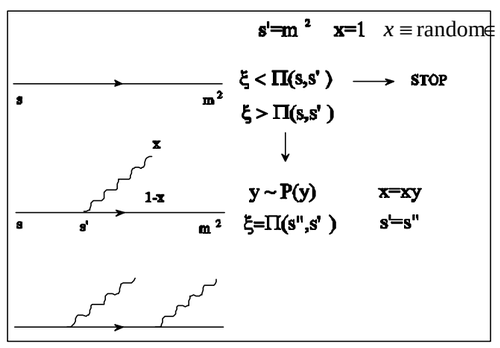
$$Q^2 \frac{\partial}{\partial Q^2} D(x,Q^2) = \frac{a}{2p} \int_x^1 \frac{dy}{y} P_+(y) D\left(\frac{x}{y}, Q^2\right)$$

$$P_+(x) = \frac{1+x^2}{1-x} - d(1-x) \int_0^1 dt\, P(t)$$

Introducing Sudakov form factor : $\prod(s,s') = \exp[-\frac{a}{2p} \ln \frac{s}{s'} \int_0^{x^+} P(x)\,dx]$

$$D(x,s) = \prod(s,m^2) d(1-x) + \frac{a}{2p} \int_{m^2}^{s} \prod(s,s') \frac{ds'}{s'} \prod(s',m^2) \int_0^{x_+} dy\, P(y)\, d(x-y) + 2 \text{ branching } + 3 + \cdots$$

$\prod(s,m^2)$ has a meaning of probability



results

For the numerical simulations we adopt Lepton ID & detetector similar to those used in runII D0 analisys

HigherOrderRAdiativeCorrEctions

C.M. Carloni Calame, G. Montagna, O. Nicrosini, M. T. hep-ph/0303102

MonteCarlo event generator for W & Z production @ hadron colliders

- It is interfaced to PDFs (CTEQ6,MRST2001,PDFLIB)
- Lepton identification requirements and detector can be accounted for
- Photonic correction can be switched from order **a** to all orders

PROCEDURE

1. generate a sample of pseudo-data at Born level for a reference W mass, M_W^{ref}
2. consider the M_T spectrum and bin it into 100 bins within the fit region 65 - 100 GeV
3. consider N different W mass values around M_W^{ref} and generate N $\mathcal{O}(\alpha)$-corrected M_T spectra
4. for each mass, calculate the χ^2 between $\mathcal{O}(\alpha)$ and Born spectra

$$\chi^2(M_W) = \sum_{i=bins} (\sigma_{i,\alpha} - \sigma_{i,Born})^2 / (\Delta\sigma_{i,\alpha}^2 + \Delta\sigma_{i,Born}^2)$$

5. at the minimum of the χ^2 distribution, read the M_W shift

Same procedure for higher-order corrections, replacing

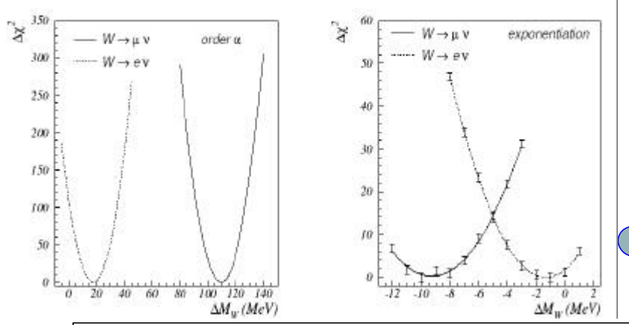
Born ⇒ $\mathcal{O}(\alpha)$
$\mathcal{O}(\alpha)$ ⇒ all orders

the shifts due to order a corrections are in agreement with previous estimates

$\Delta M_W^{\alpha,e} \sim 20$ MeV
$\Delta M_W^{\alpha,\mu} \sim 110$ MeV

conclusions

W mass shifts



The shifts due to higher Order corrections Are found to be:

$\Delta M_W^{\alpha,e} \sim 2$ MeV
$\Delta M_W^{\alpha,\mu} \sim 10$ MeV

Future planning

Merging exact order a Electroweak corrections with exponentiation

Study with HORACE of higher order corrections to Z production