

# QED radiative corrections in COMPASS

Barbara Latacz

University of Warsaw

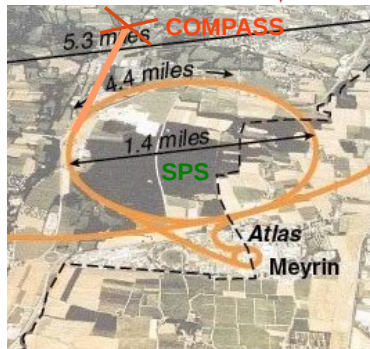
12 August 2015

Summer Student Session

# COmmon Muon Proton Apparatus for Structure and Spectroscopy

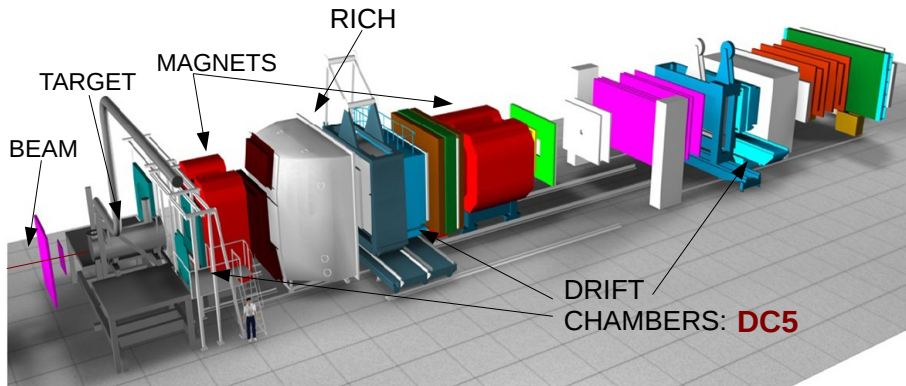


- the largest ground experiment at CERN
- more than 220 physicists and engineers from 13 countries and 24 institutions
- the experiment was approved by CERN in September 1998
- located on the M2 beam from SPS accelerator ("Super Proton Synchrotron")
- measurements: hadron spectroscopy, structure of hadrons



# Two-stage spectrometer

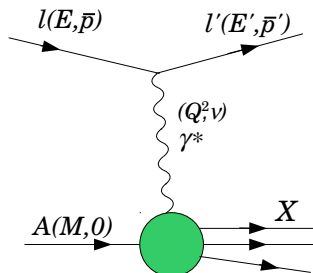
- polarised muon beam or hadron  $\pi/K/p$  beam
- different targets: polarised p,d with possibility of rapid polarisation change



- about 350 detector planes gives great:
  - 1 particle identification
  - 2 detection of a particle position

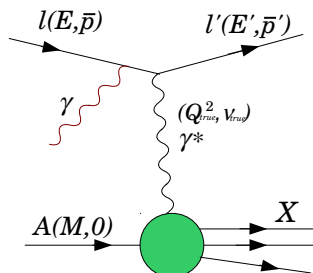
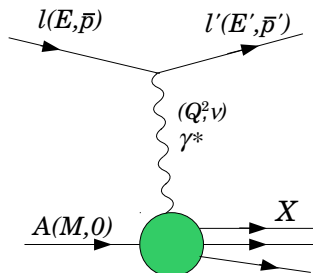
# QED interaction

- inclusive reaction  $lA \rightarrow l'X$ :  $Q^2 = -(p - p')^2$ ,  $\nu = E - E'$



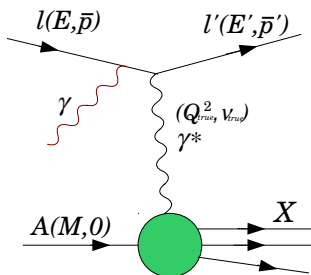
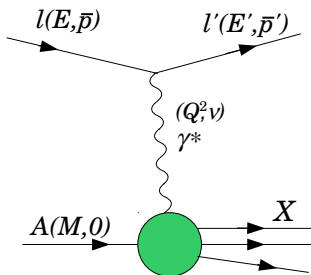
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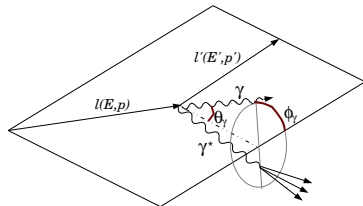
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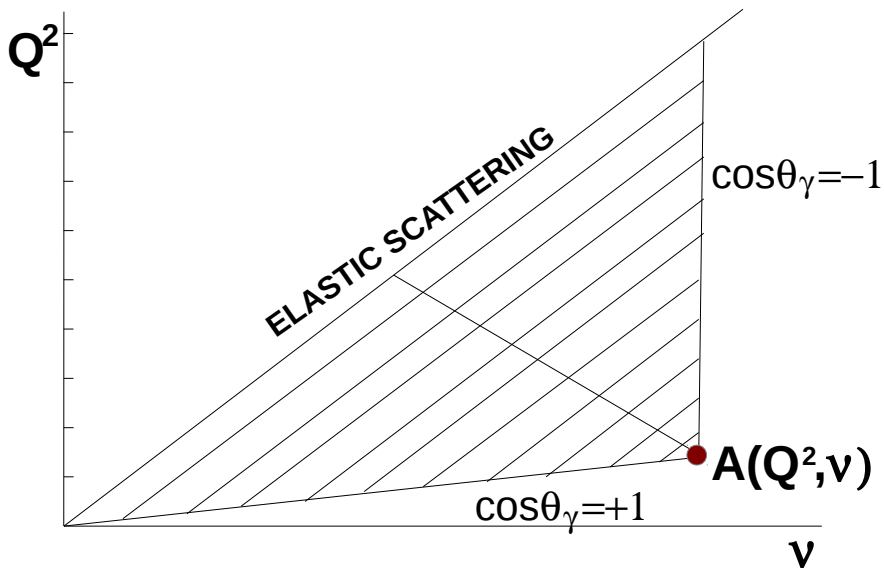


- Radiative event - an event containing a real hard radiated photon

$$Q_{true}^2 = Q^2 + 2E_\gamma (\nu - \sqrt{\nu^2 + Q^2} \cos\theta_\gamma)$$

$$\nu_{true} = \nu - E_\gamma$$

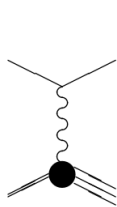
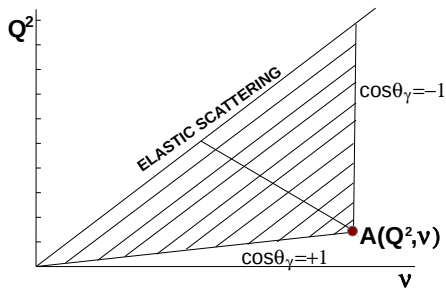




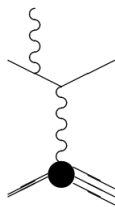
# Definition

- Definition of radiative correction:

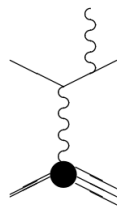
$$\eta(x, y) = \frac{\sigma_{born}(x, y)}{\sigma_{total}(x, y)}$$



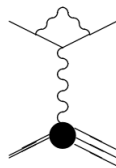
a)



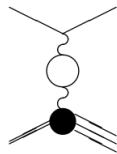
b)



c)



d)



e)

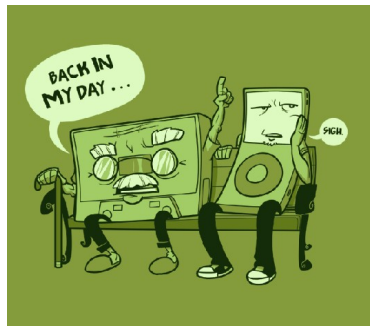
a) Born approximation b-c) internal bremsstrahlung d) vertex correction e) vacuum polarisation



# Software

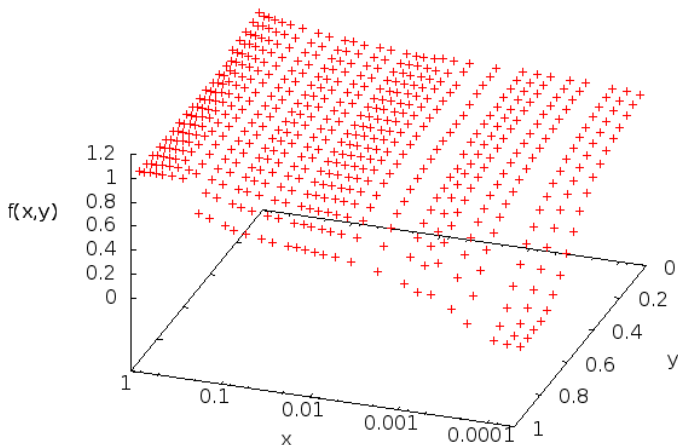
- COMPASS experiment uses two programs to calculate radiative corrections:
  - TERAD - a program which calculates the exact values of  $\eta(x, y)$  [2];
  - RADGEN - Monte Carlo generator [3].
- Input information:
  - elastic form factor  $F_{el}$  for a given target;
  - quasielastic form factor  $F_{qel}$  for nuclear targets;
  - $F_2$  and  $R$  structure functions for nucleons.

**TERAD is written using Patchy packet, now obsolete, and therefore has to be modified.**



# Radiative corrections contribution

- The biggest contribution: low  $x$  ( $x = \frac{Q^2}{2M\nu}$ ,  $y = \frac{\nu}{E}$ ,  $\eta(x, y) = f(x, y) = \frac{\sigma_{\text{born}}(x, y)}{\sigma_{\text{total}}(x, y)}$ )
- Results from TERAD for hydrogen target, energy  $E = 200\text{GeV}$ .






# My work

- Past**
  - I learnt about the program - it almost has no documentation.
  - I managed to make it work properly.
  - It was working at only one computer: now with some work it can be used by everyone.
- Preset**
  - I am getting out the Patchy.
  - I am trying to make it user friendly.
  - I am removing useless part of the code.
- Future**
  - Get out of Patchy to make it easy to run on every computer.
  - Put new parametrisations of proton and deuterium elastic form factors - maybe some others also.
  - Make user friendly documentation.

# Summary

- COMPASS is an experiment which investigates: spectroscopy and structure of hadrons.
- Radiative effects give large contribution to observed variables.
- To calculate QED radiative corrections one can use programs like TERAD and RADGEN. Original versions of this software need to be upgraded, but after it they are still very useful.

## References:

-  COMPASS experiment web page: [wwwcompass.cern.ch](http://wwwcompass.cern.ch).
-  A.A. Akhundov, D. Bardin, L. Kalinovskaya, and T. Riemann, Fortschr. Phys. 44, 373 (1996).
-  I. Akushevich, H. Bottcher, D. Ryckbosch, arXiv:hep-ph/9906408.

# Thank you for your attention

