Study of the $e^+e^- \rightarrow Z\ e^+e^-$ process with L3 Detector

Ricardo Vásquez Sierra

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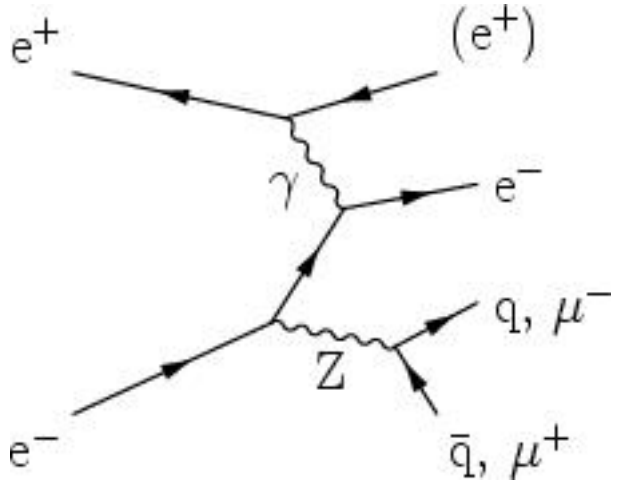
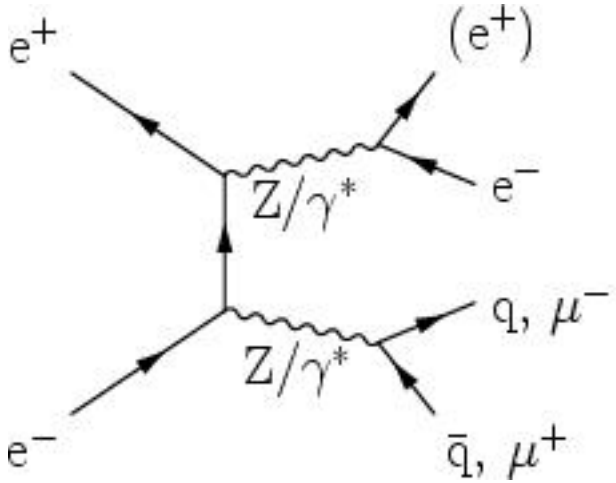
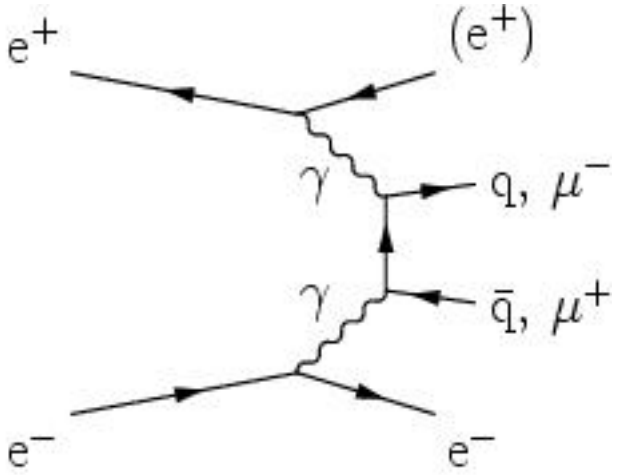
Process studied



Diagrams leading to the same final state

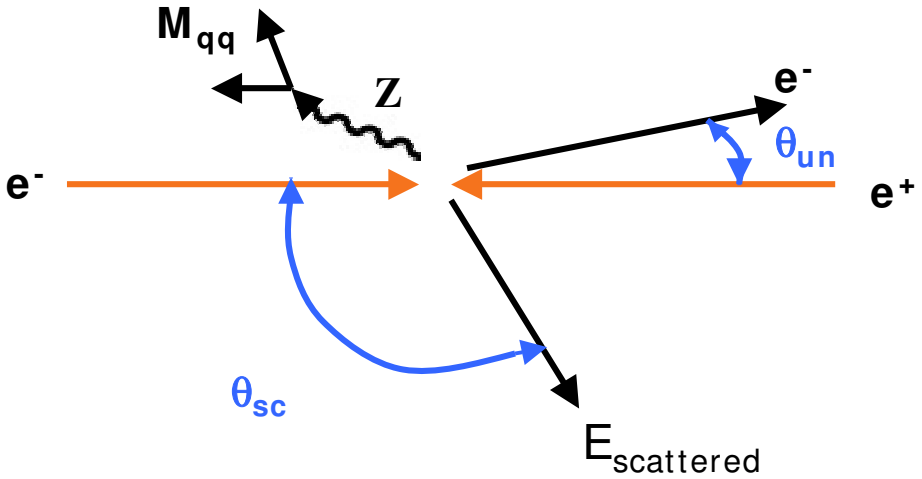




Charge conjugation is implied through out the talk

Signal Definition

Cuts on Monte Carlo Generator Phase Space:



$\theta_{unscattered} < 12.0^{o}$

$60.0^{o} < \theta_{scattered} < 168.0^{o}$

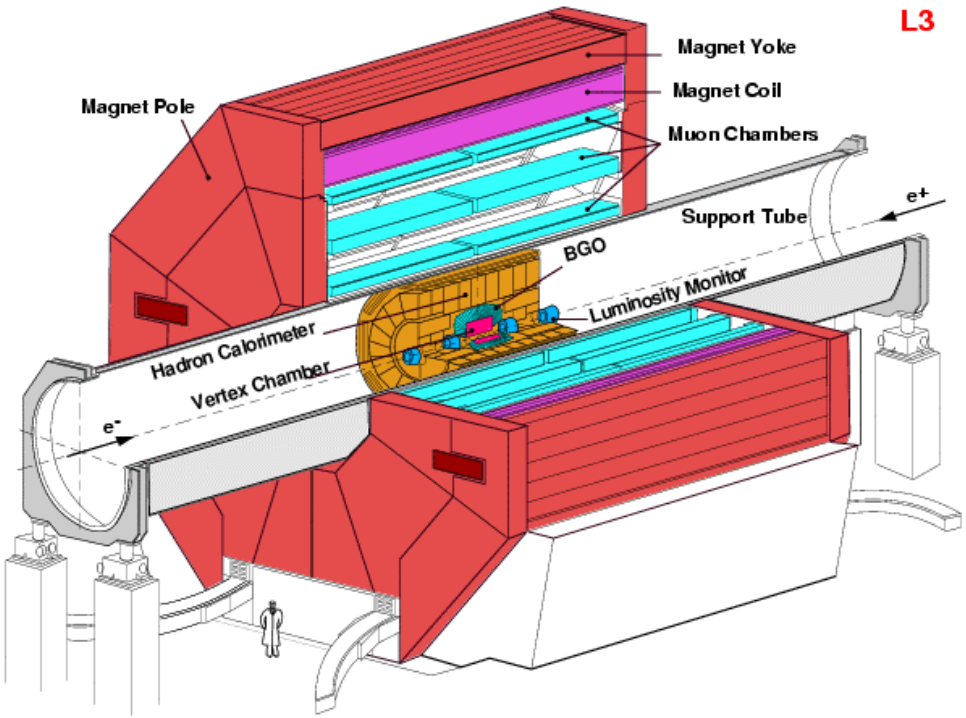
and

$E_{scattered} > 3.0$ GeV

$M_{q\bar{q},\mu+\mu-} > 60.0$ GeV

Expected Cross Section for hadron channel at 200.0 GeV is 0.57 pb

L3 Detector



Main detector components:

- Tracking chambers (electron's track)
- EM calorimeter (electron's energy)
- Hadron Calorimeter (2 jets from Z decay)
- Muon chambers (2 muons from Z decay)

Analysis performed on 1997-2000 data

$\sqrt{s}$ = 183-207 GeV

Luminosity ≈ 0.7 fb^{-1}

Preselection Cuts for the $q\bar{q}$ channel

- At least one identified electron (shower shape, crystal energies and track)
- # of clusters around the most energetic electron < 2
- Energy of the most energetic electron > 3.0 GeV
- 50 GeV < hadronic mass < 130 GeV
- Visible energy > $0.4\sqrt{s}$
- Missing momentum > $0.24\sqrt{s}$

With an efficiency of 54%

and a purity of 13%

Luminosity (pb^{-1})	Expected Background	Expected Signal	Expected B+S	Data
675.5	1343 ± 4	208 ± 1	1551 ± 4	1551

Selection Cuts for the $q\bar{q}$ channel

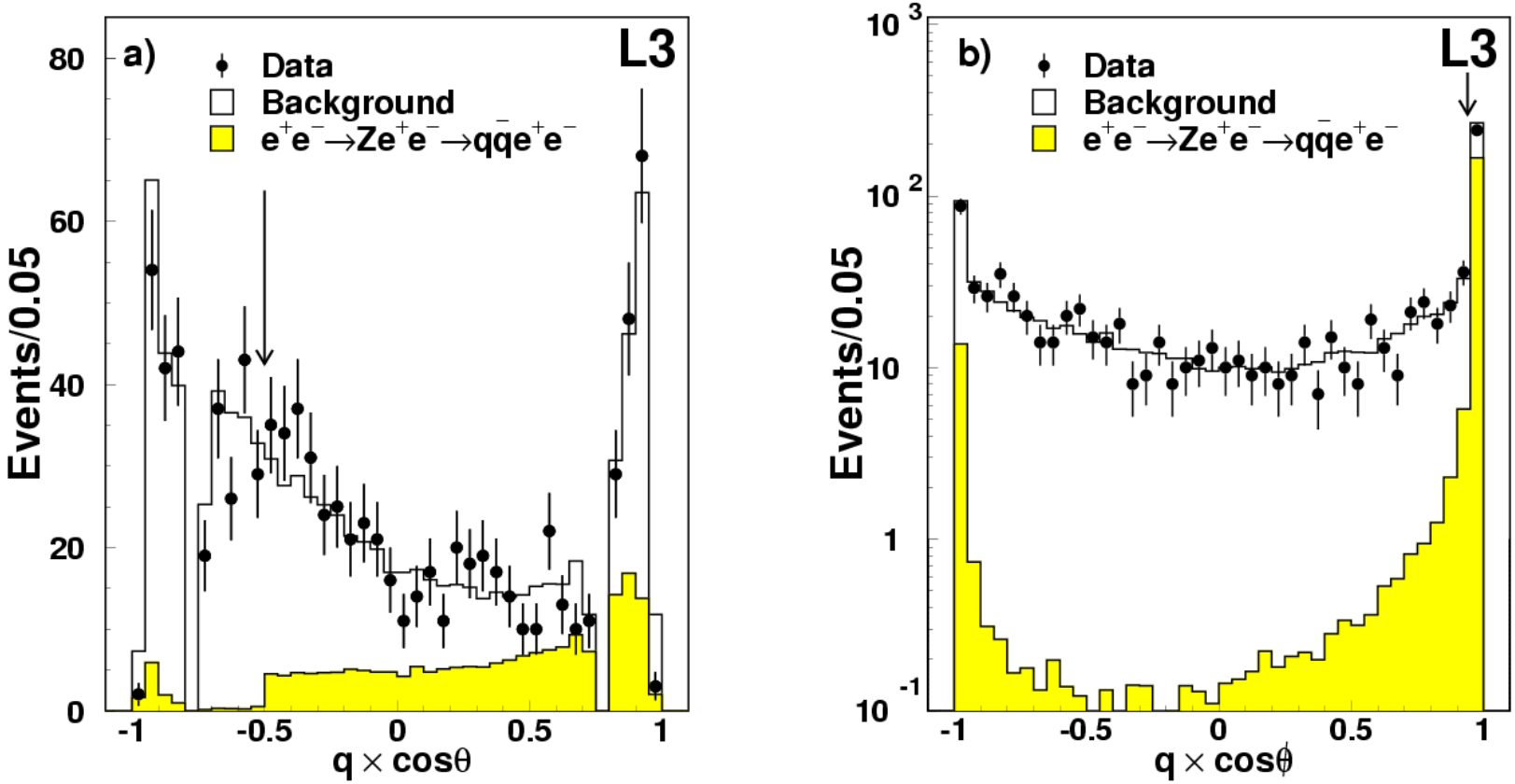
The two main selection criteria are:

- $\frac{q}{|q|} \times \cos\theta_{scattered} > -0.5$
- $\frac{q}{|q|} \times \cos\theta_{miss} > 0.94$

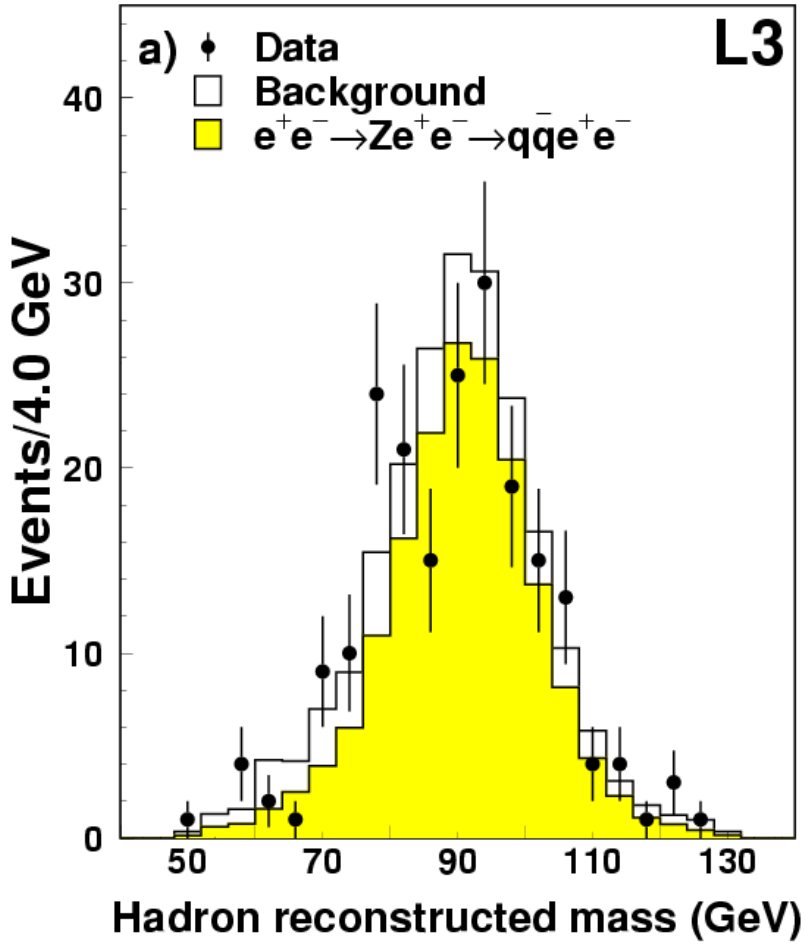
Average efficiency of 44% and a purity of 79%

Luminosity (pb^{-1})	ε [%]	N_{Data}	$N_{expected}$	N_{signal}
675.5	43.8	202	213.7±1.9	168.3±1.1

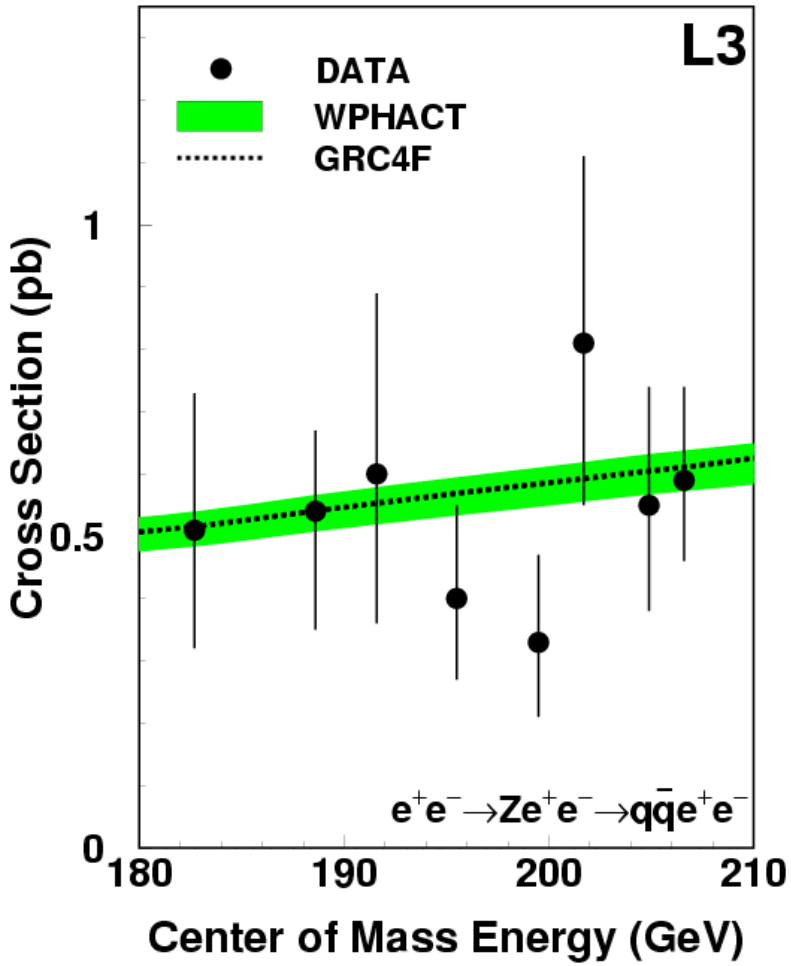
In addition to preselection cuts these selection cuts were applied for the $q\bar{q}$ channel



Final Variable Fitted for Cross Section Measurements



We measure the Cross Section



Cross Section measurements for the $q\bar{q}$ channel

Preselection Cuts for the $\mu^+\mu^-$ channel

- Low multiplicity events with 3 tracks in the central tracker (one electron and two muons)
- Energy of the electron > 3.0 GeV
- Energy of each muon > 18.0 GeV
- 55.0 GeV < muons invariant mass < 145.0 GeV
- Kinematical fit requiring conservation of transverse momentum

With an efficiency of 25%

and a purity of 29%

Luminosity (pb^{-1})	Expected Background	Expected Signal	Expected B+S	Data
675.5	18.7 ±0.1	7.5 ± 0.2	26.2 ± 0.2	26

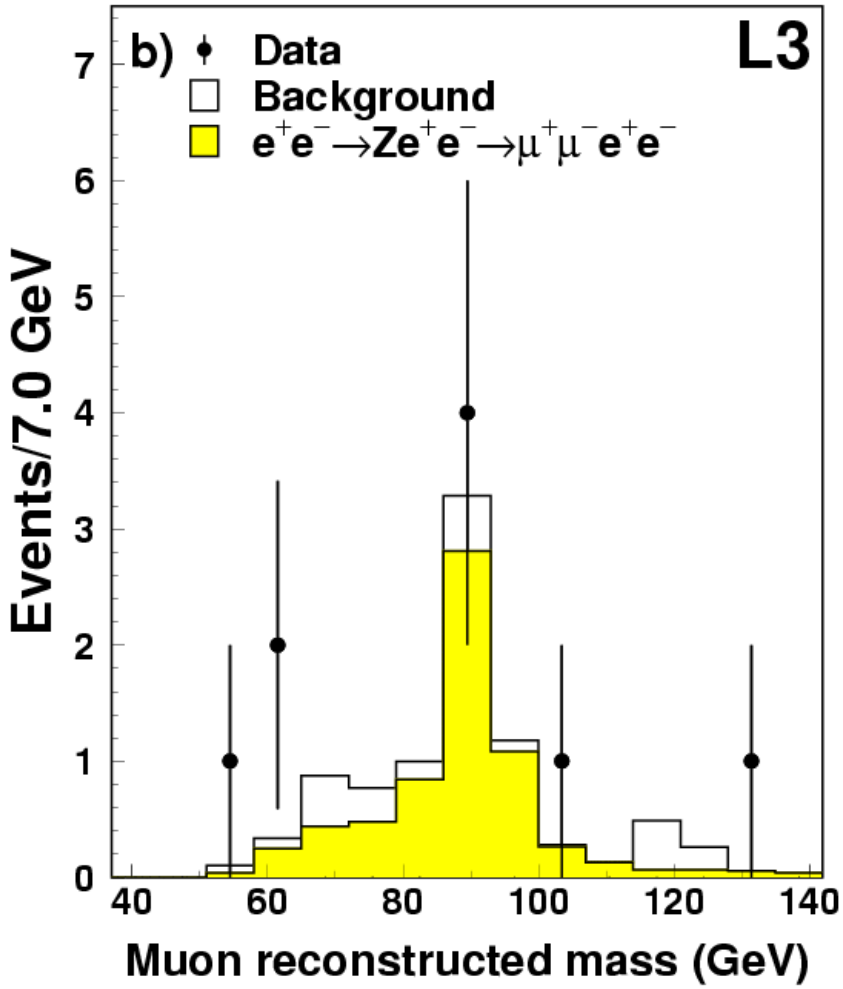
Selection Cuts for the $\mu^+\mu^-$ channel

The three main selection criteria are:

- $$-0.5 < \frac{q}{|q|} \times \cos\theta_{scattered} < 0.93$$
- $$\frac{q}{|q|} \times \cos\theta_{miss} > 0.50$$
- $$\frac{q}{|q|} \times \cos\theta_{Z} > 0.40$$

With an efficiency of 22%
and a purity of 81%

Final Variable Fitted for Cross Section Measurement



Results after selection for the $\mu^+\mu^-$ channel

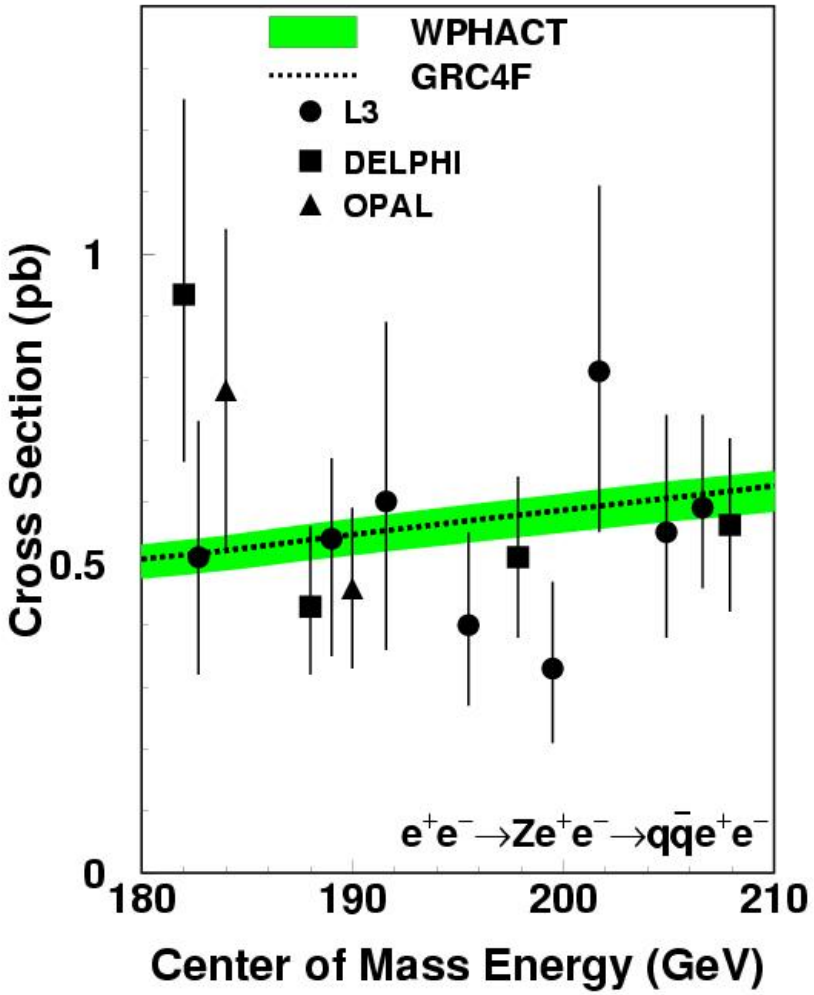
For this channel we treated all data as an only sample

Luminosity (pb^{-1})	ε [%]	N_{Data}	$N_{expected}$	N_{signal}
ALL	22	9	8.1±0.1	6.6±0.1

By fitting the invariant mass of the $\mu^+\mu^-$ pair we measure the following cross section

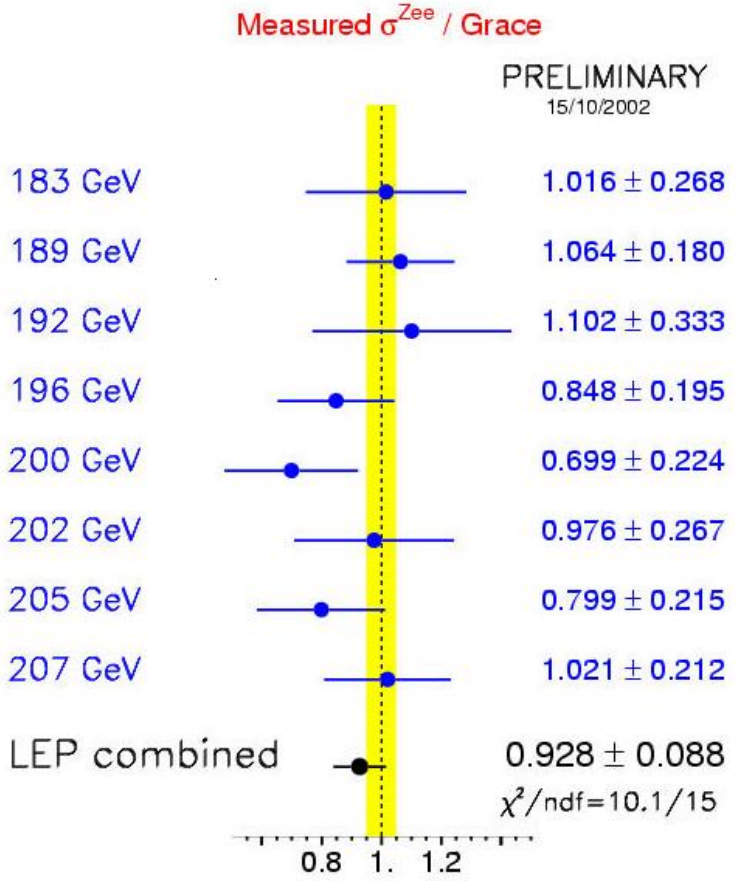
$\sigma = 0.043 \pm 0.016$ pb $\quad (\sigma^{SM} = 0.044$ pb)

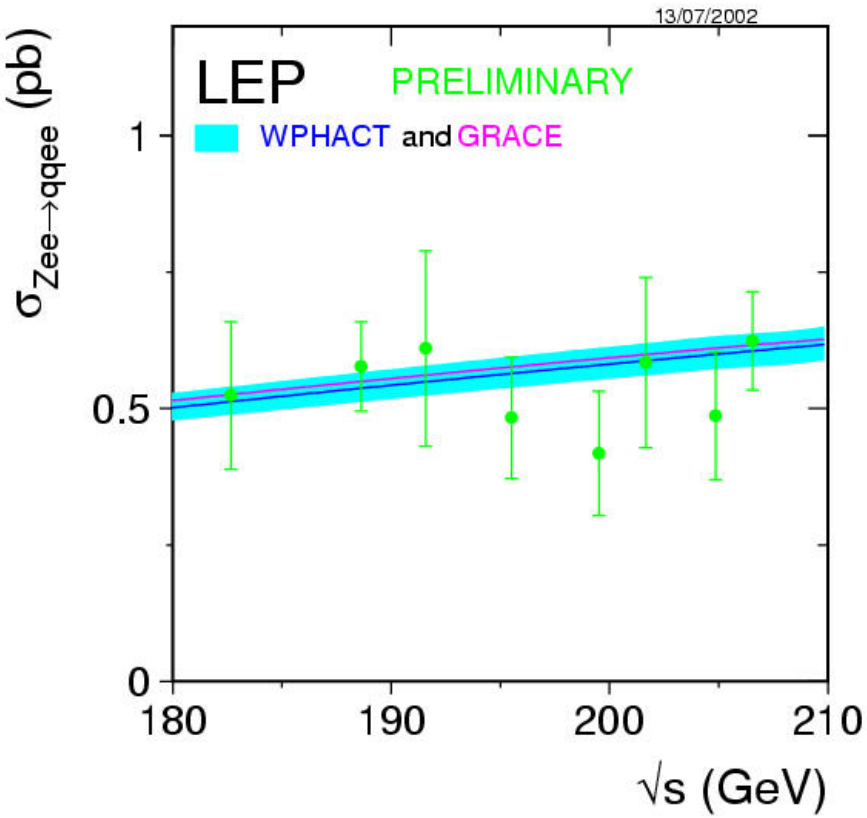
Comparing results with other LEP experiments



All measurements are for the $q\bar{q}$ channel

LEP Combined results





Conclusions

- The cross section for this inelastic “Compton Scattering” was measured for the energy interval 183-207 GeV using data colleted by L3 detector. The measurements were found to agree with the theory of the Standard Model.