L3 Report to LEPC

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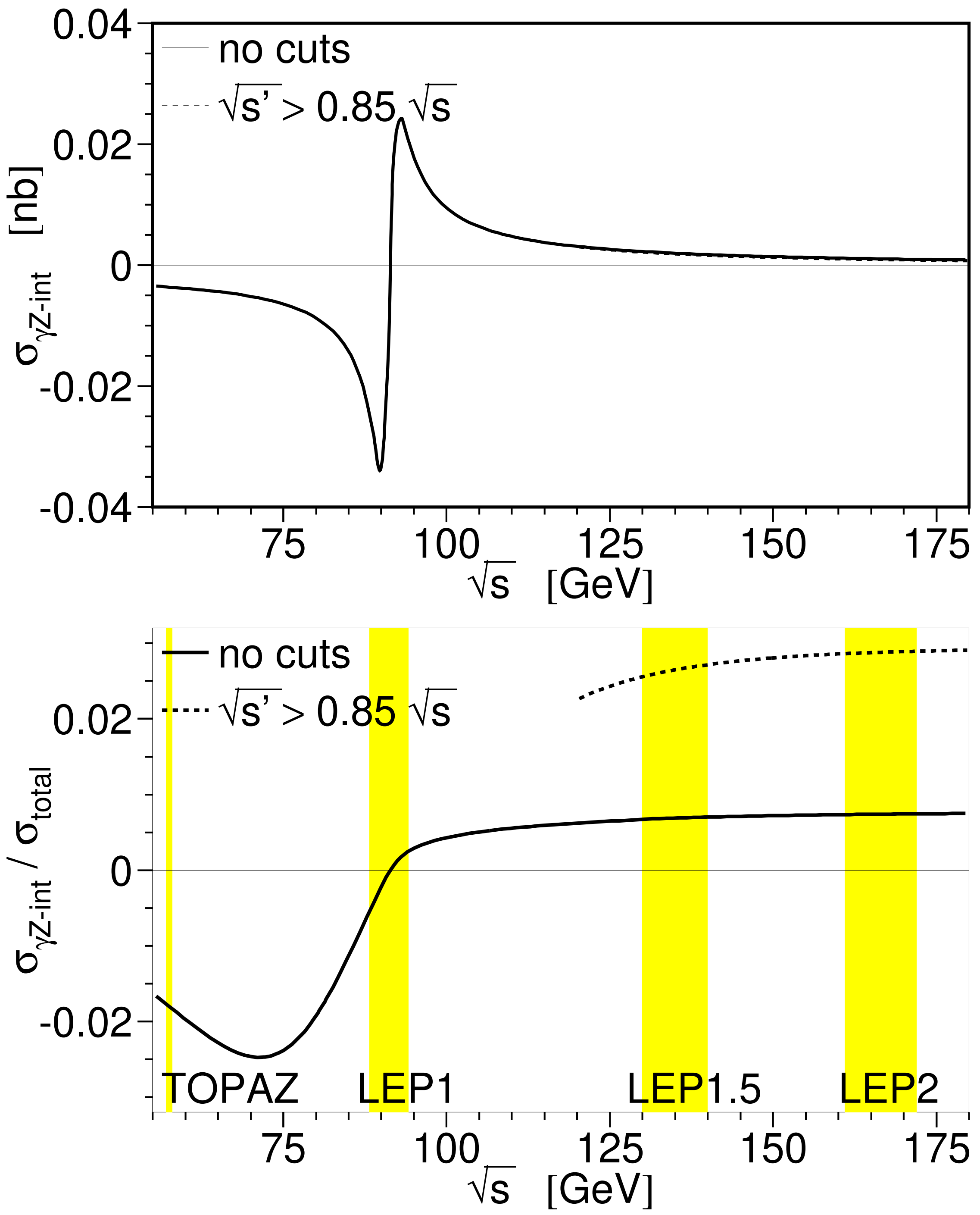
May 29, 1997

Outline:

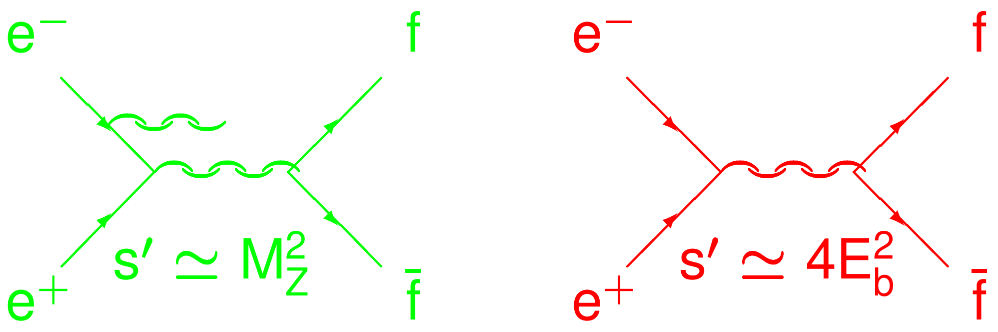
- **Results from 1996 run**
  - 10.9 pb^{-1} **at 161.34 GeV**
  - 1.0 pb^{-1} **at 170.31 GeV**
  - 9.25 pb^{-1} **at 172.32 GeV**
- **Detector status for 1997 run**
- **Comments on long term running of LEP**

Fermion Pair Production

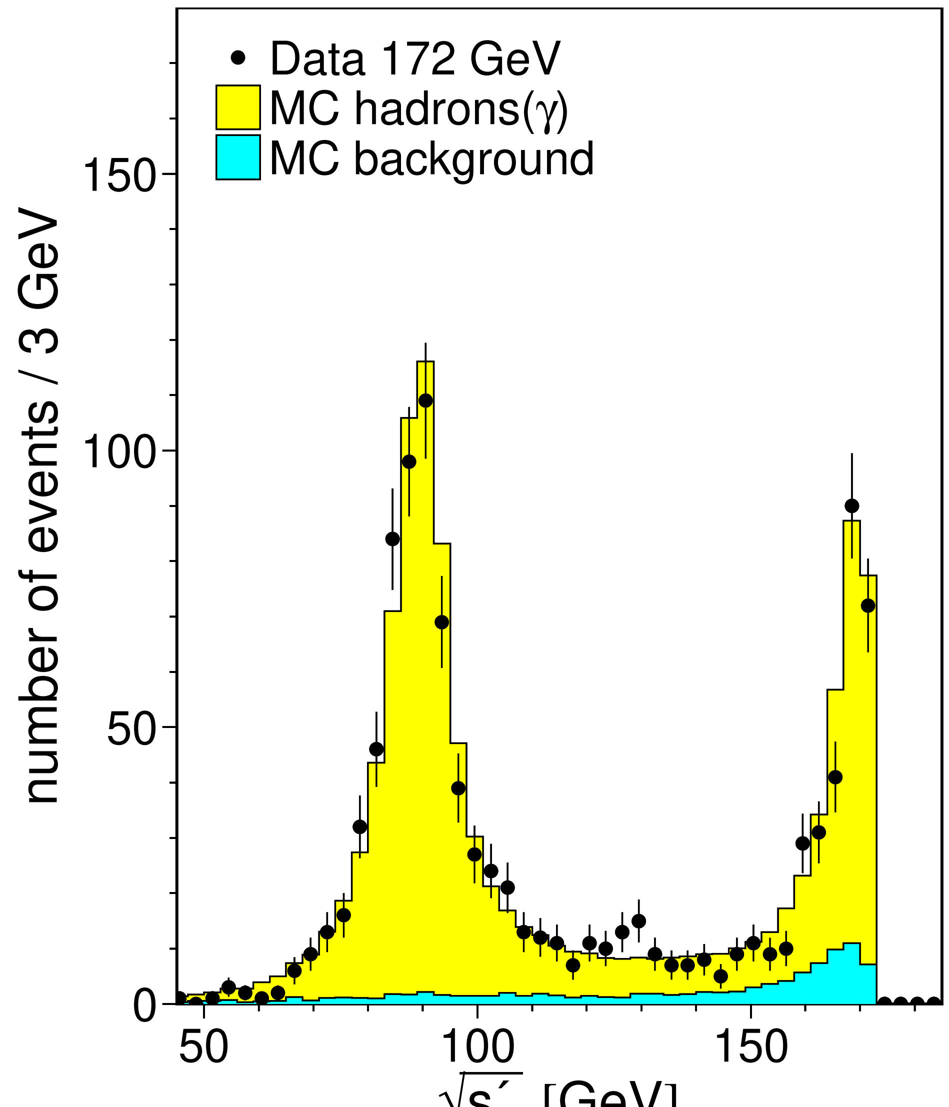


Results recently submitted to Phys. Lett.

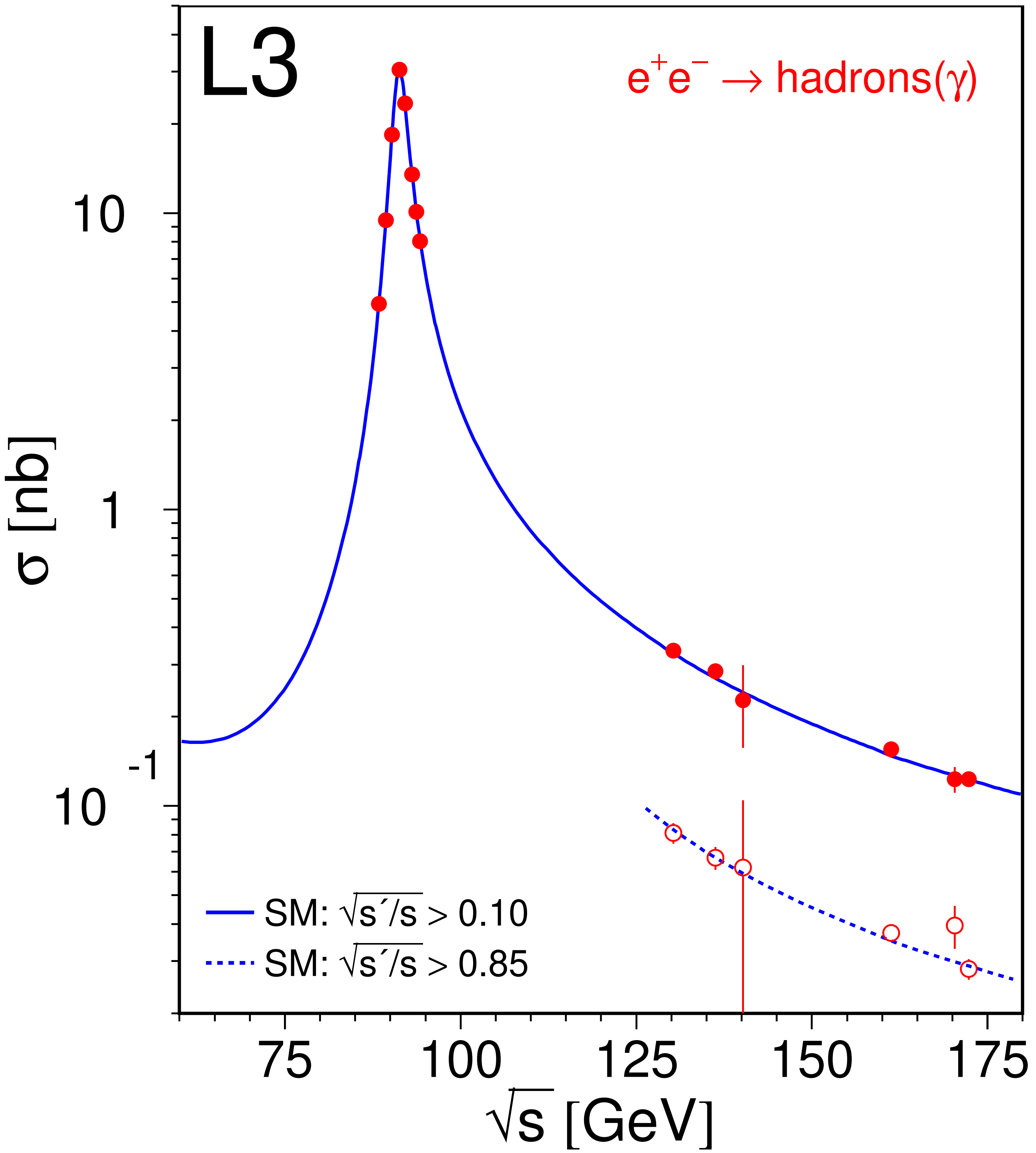
Effective Center of Mass Energy



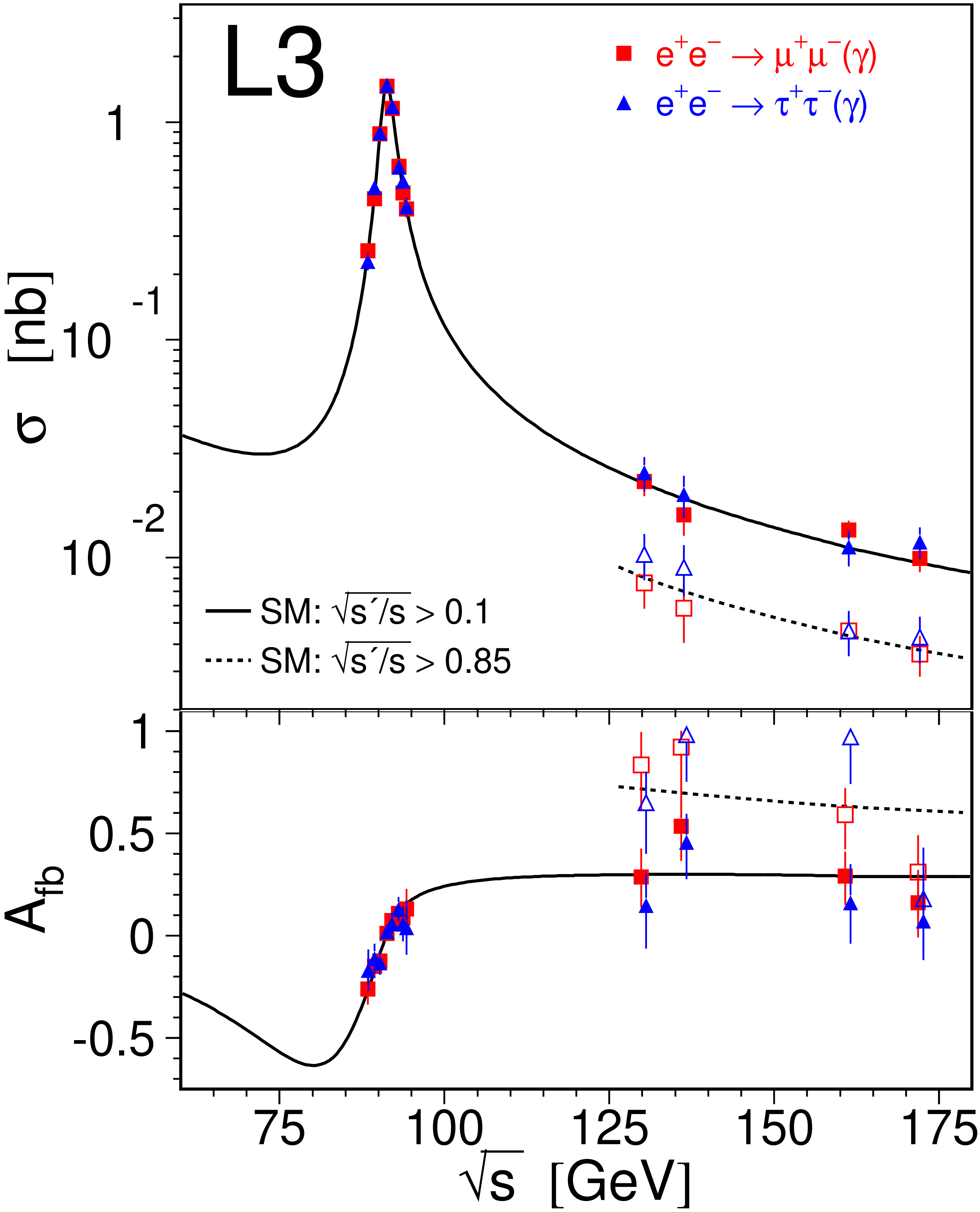
radiative return **genuine high energy**



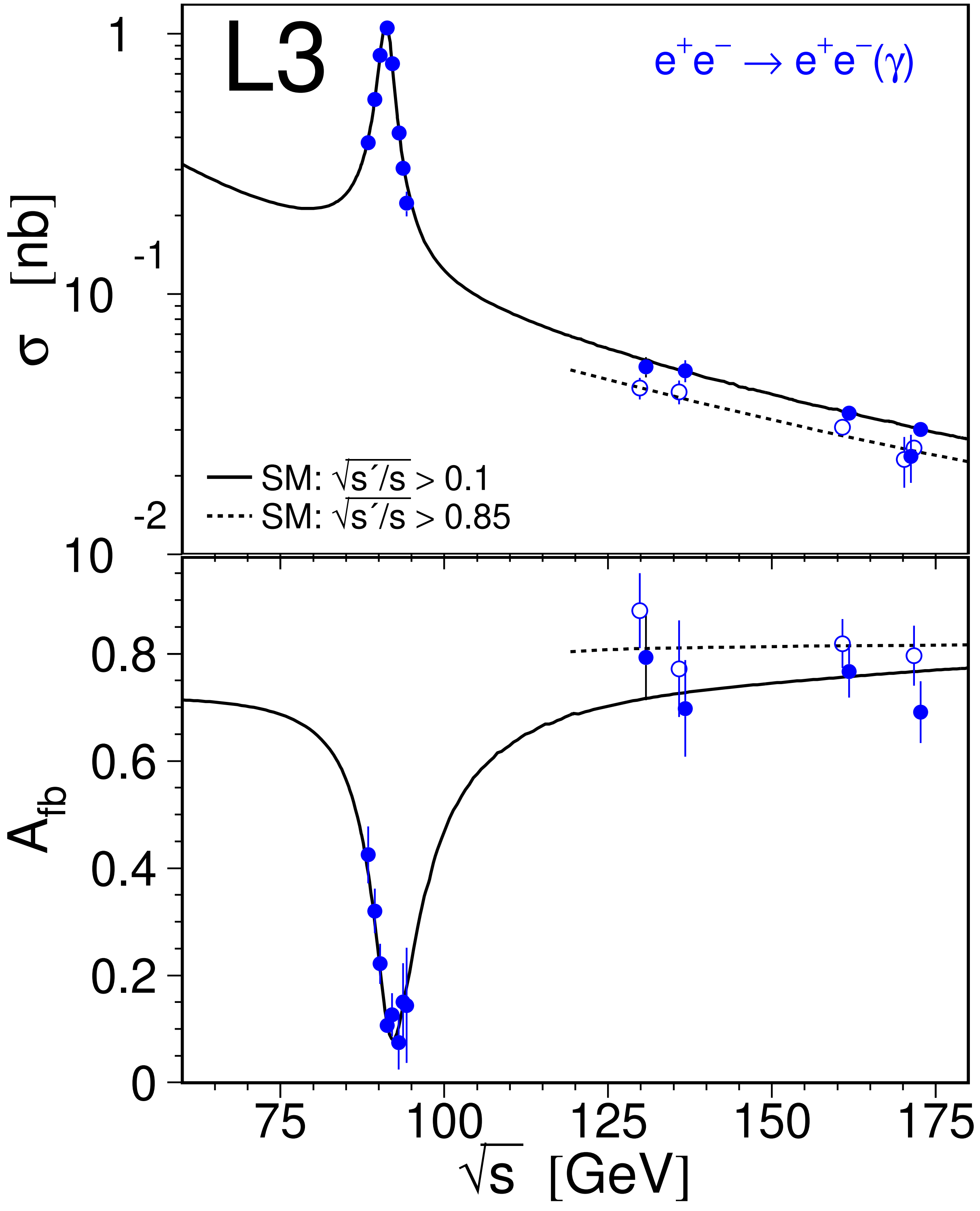
Hadronic Cross Sections at LEP 2



Muon and Tau Lepton Pairs

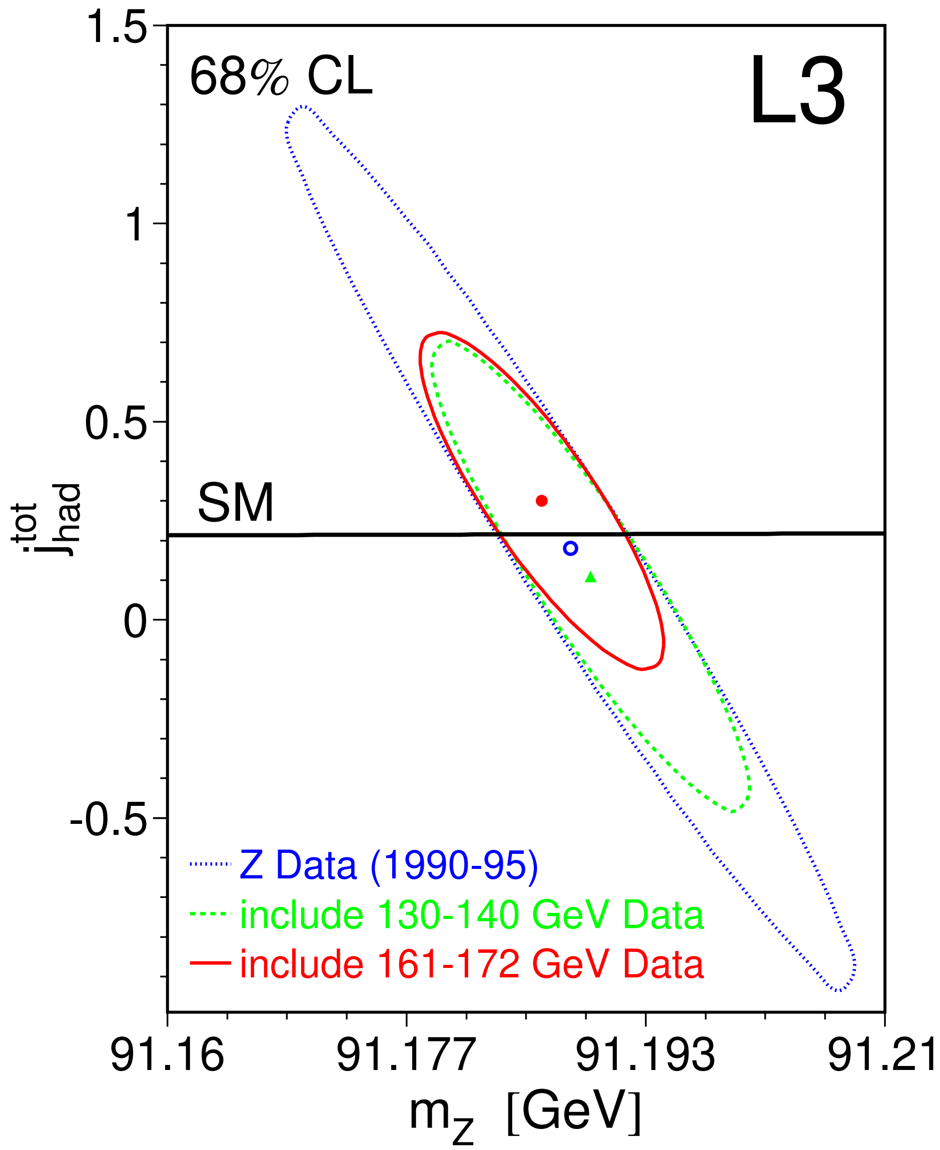


Electron Pairs



Both leptons inside $44^\circ < \theta < 136^\circ$, $\xi < 90^\circ$

Hadronic Interference Term

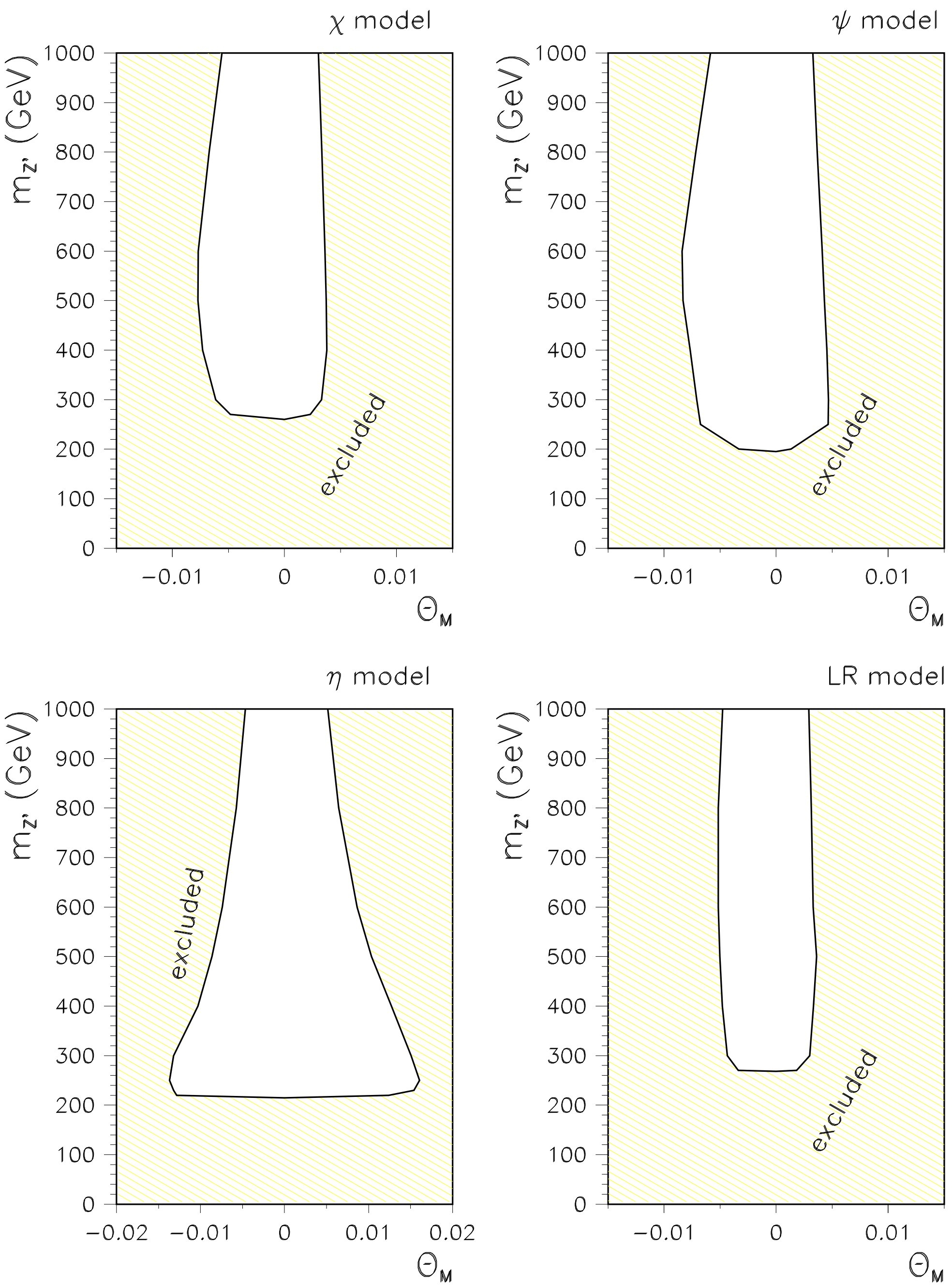


Data	j^{tot}_{had}	M_Z
LEP 1	0.18 ± 0.73	$91154. \pm 13.$
LEP 1 + LEP 2	0.30 ± 0.28	$91152. \pm 5.6$
SM:	**0.21**	

Search for Additional Neutral Currents

Specific SM extensions: E_6, LRS, SSM

L3 Preliminary



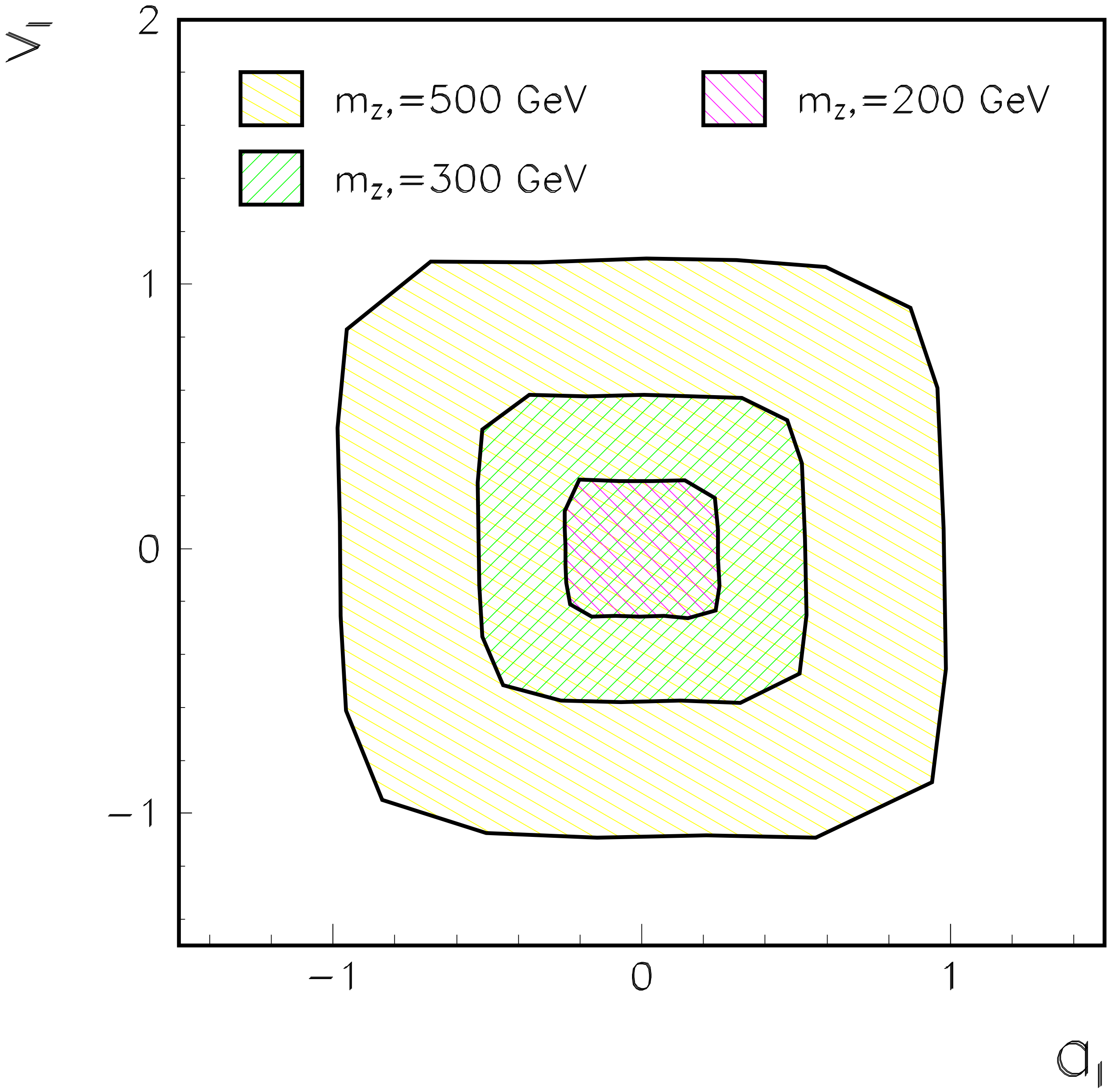
Mass limits from CDF

Mixing from L3: $-0.007 \leq \theta_M \leq 0.005$ **(95% CL)**

Search for Additional Neutral Currents

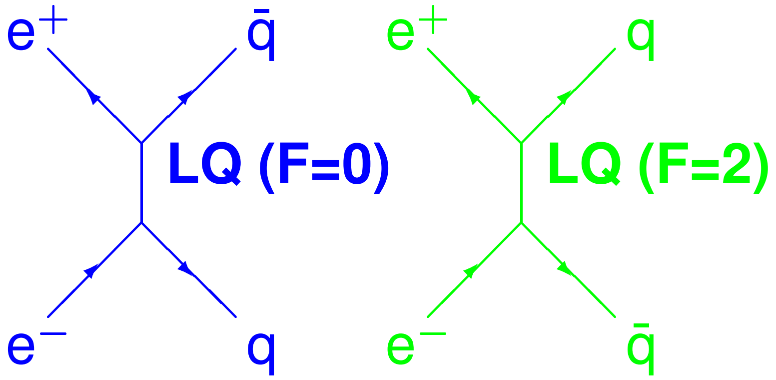
Construct hadrophobic Z' invisible at Fermilab

L3 Preliminary

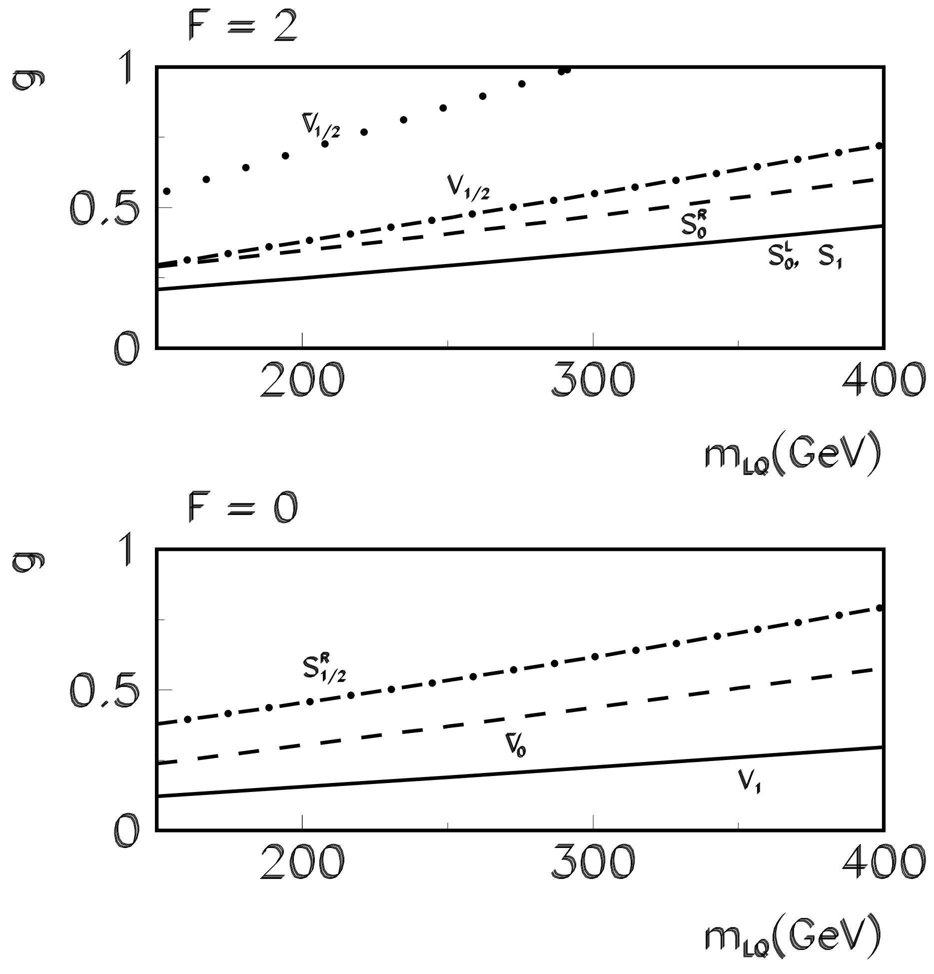


Model independent limit on leptonic couplings

Search for Leptoquark Contributions



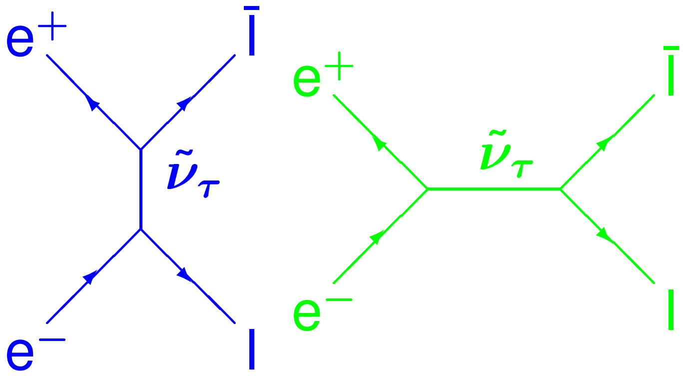
Kalinowski et al., DESY 97-038



L3
Preliminary
u-type LQ

Similar limits for d-type LQ
Contact interactions: $\Lambda < 1$ to 2 TeV (95% CL)

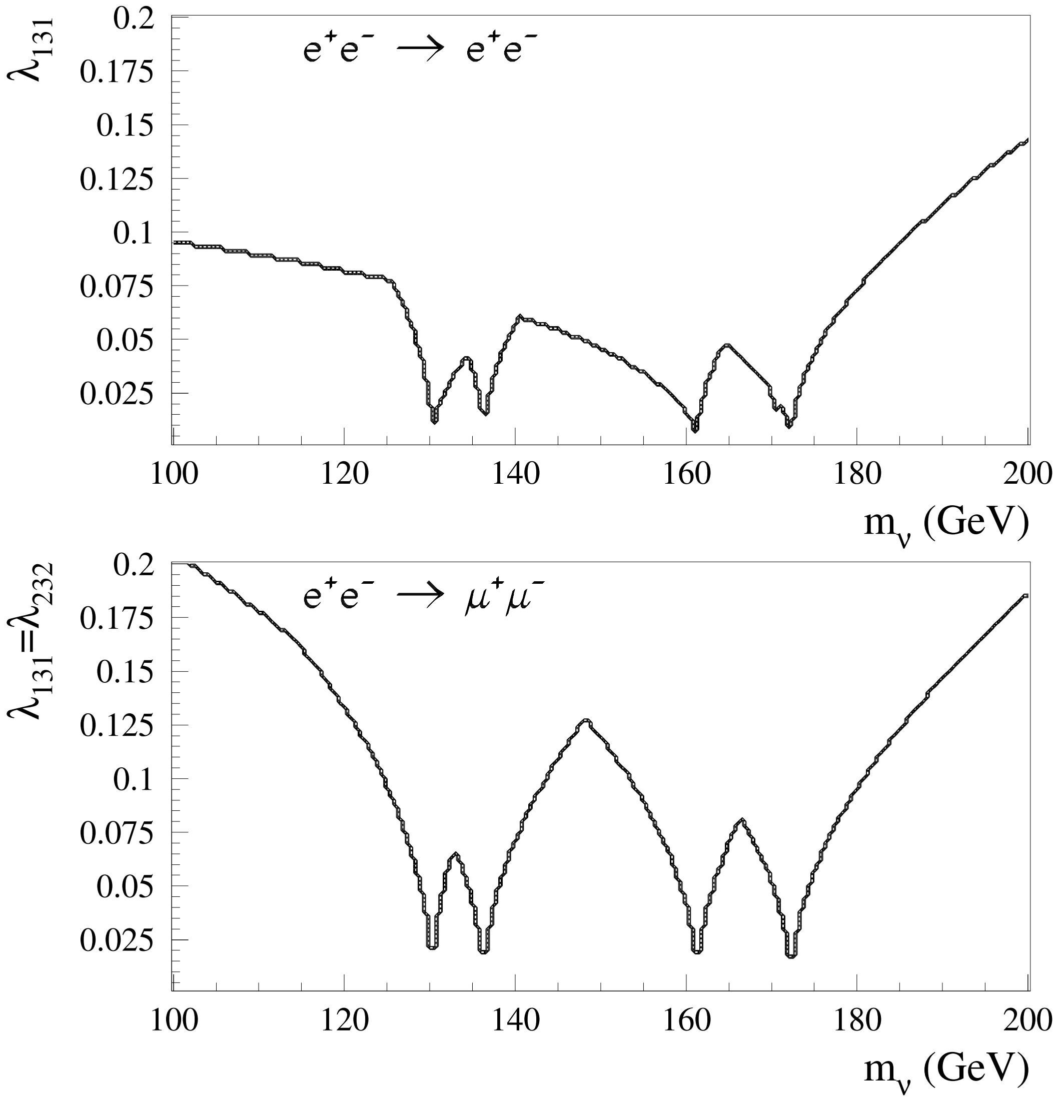
Contribution from R-Violating Sneutrinos



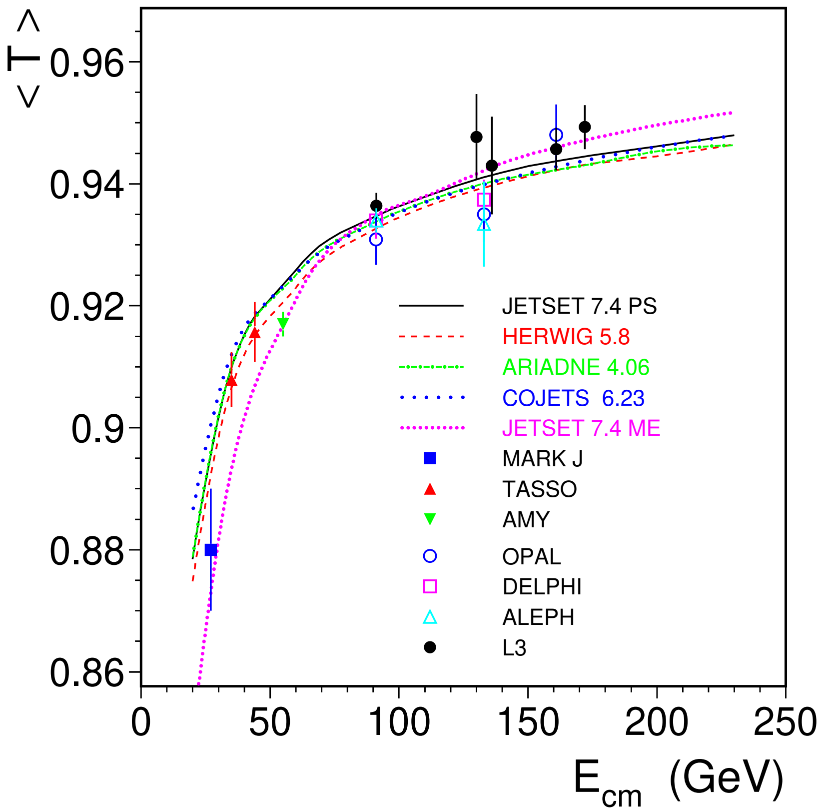
Kalinowski et al., DESY 97-044

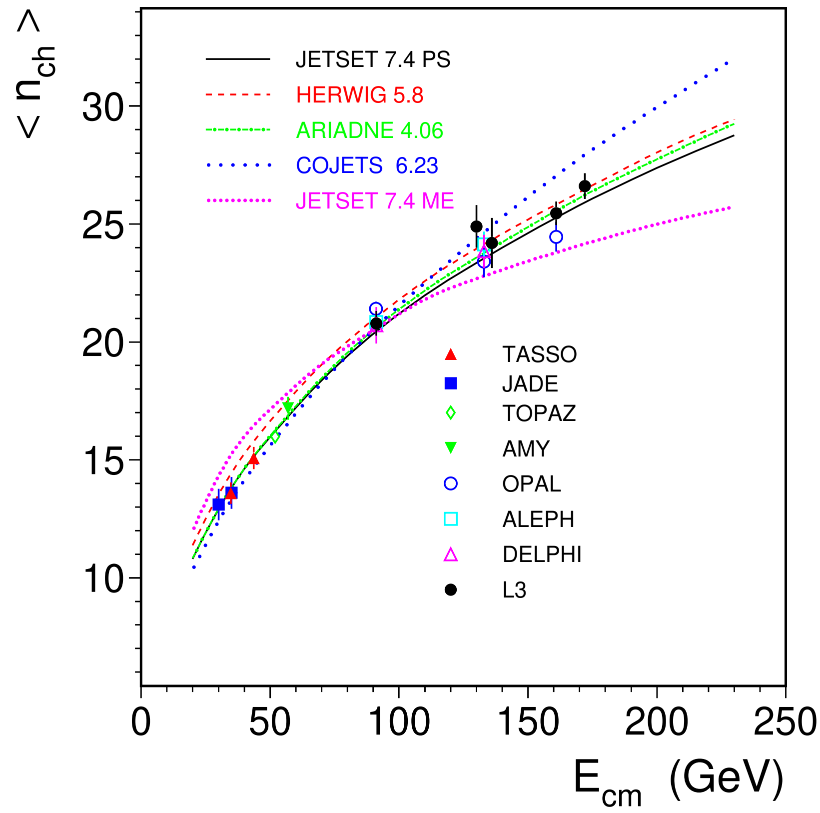
Preliminary

Excluded by L3 at 95 % CL



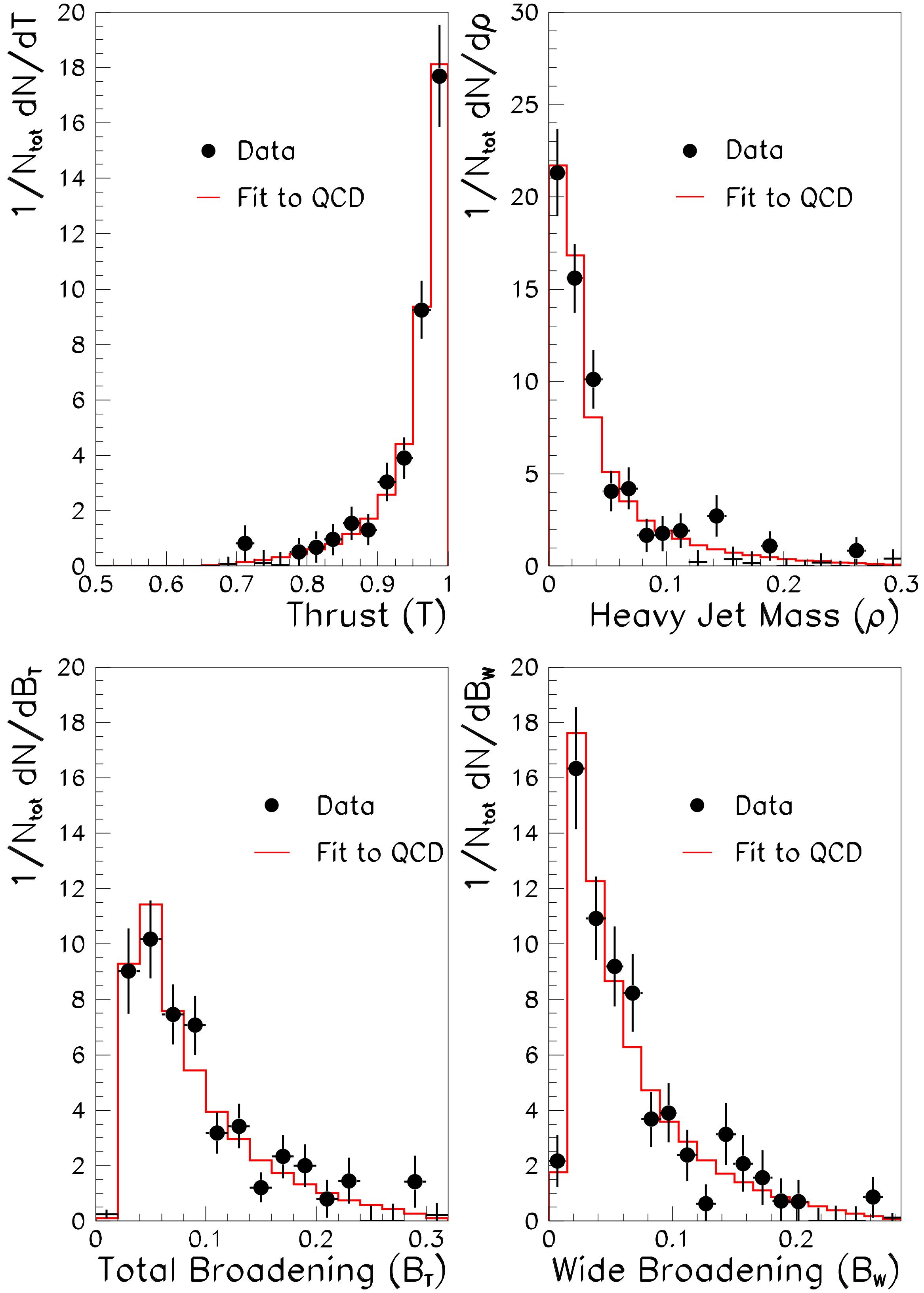
Properties of Hadronic Events





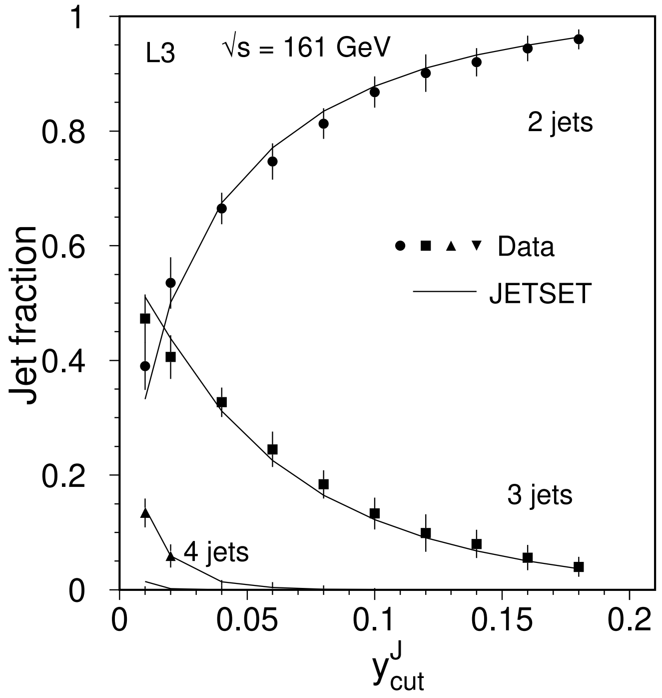
Need parton shower and coherence

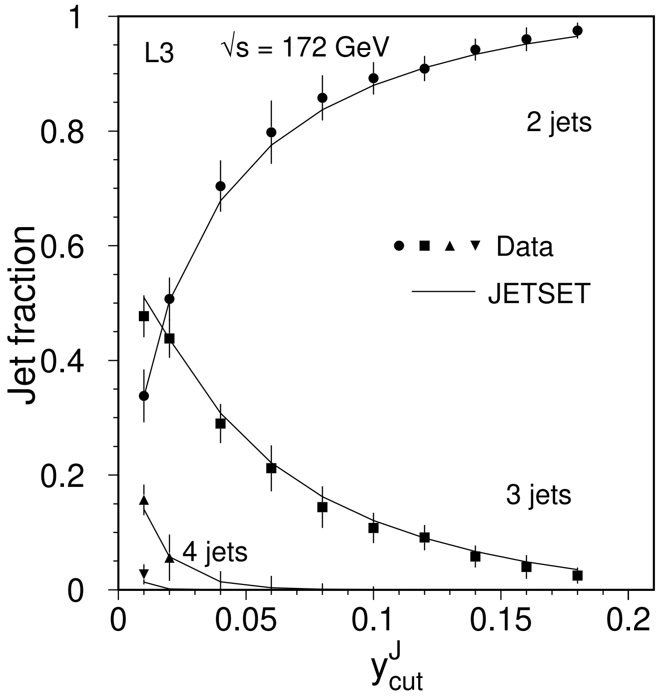
Event Shape Variables at 172 GeV



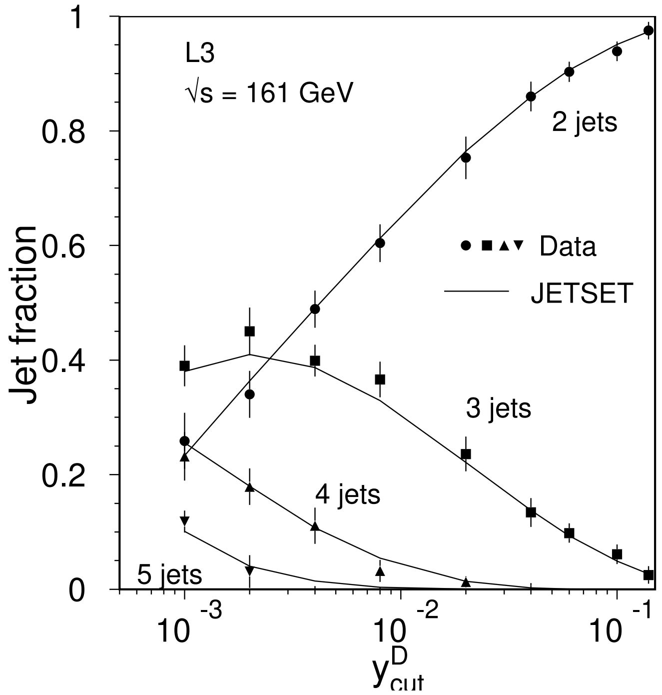
Jet Multiplicities

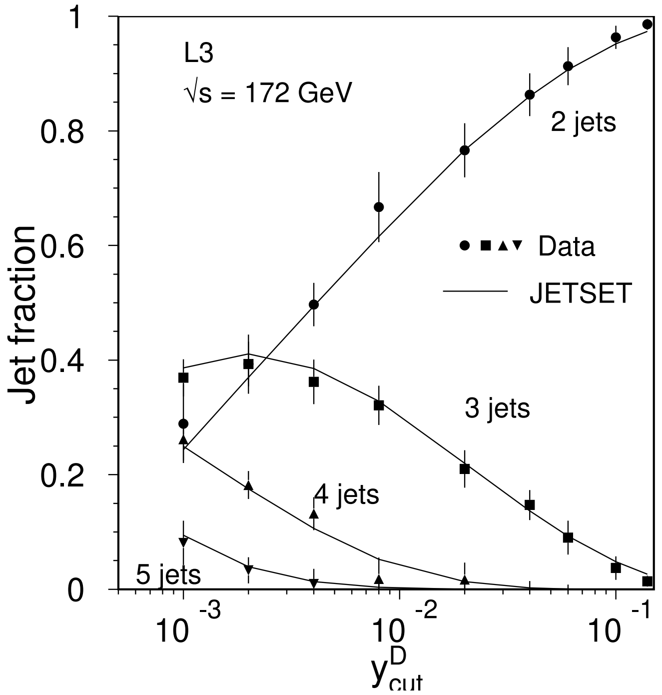
161 GeV JADE 172 GeV





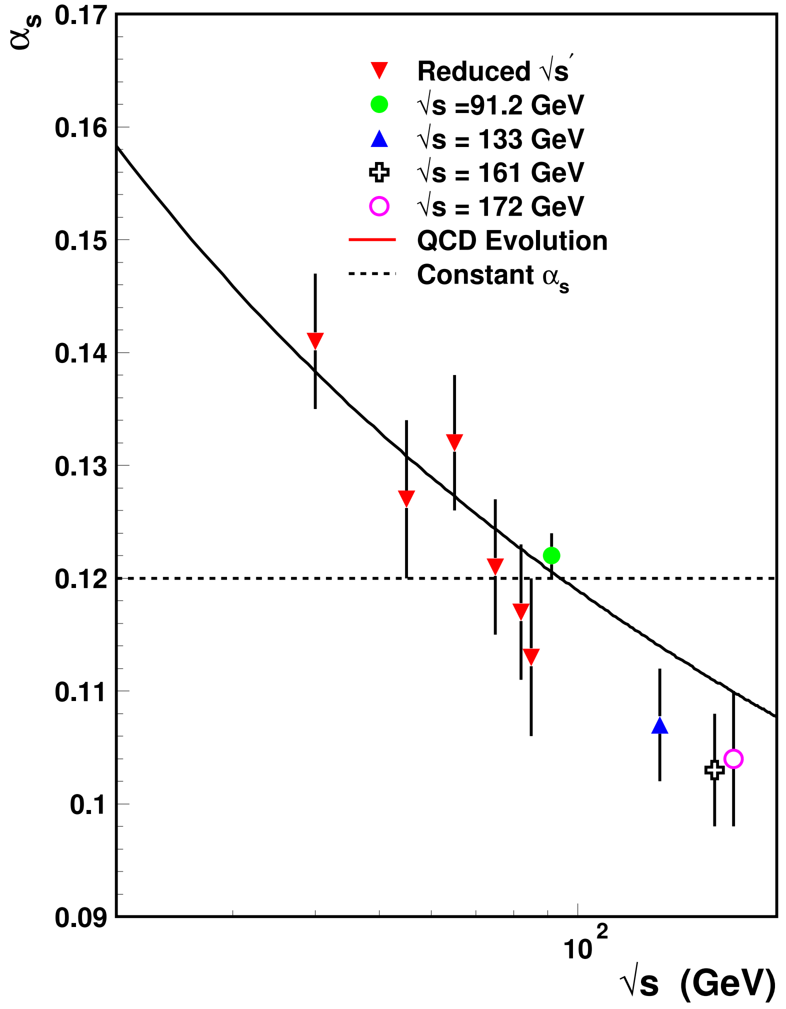
161 GeV Durham 172 GeV





Strong Coupling Constant

L3 Preliminary **Experimental errors only**



Fit with QCD evolution:

$$\alpha_s(91.2\text{GeV}) = 0.1206 \pm 0.0016\ \textbf{(exp)} \pm 0.0066\ \textbf{(theo)}$$

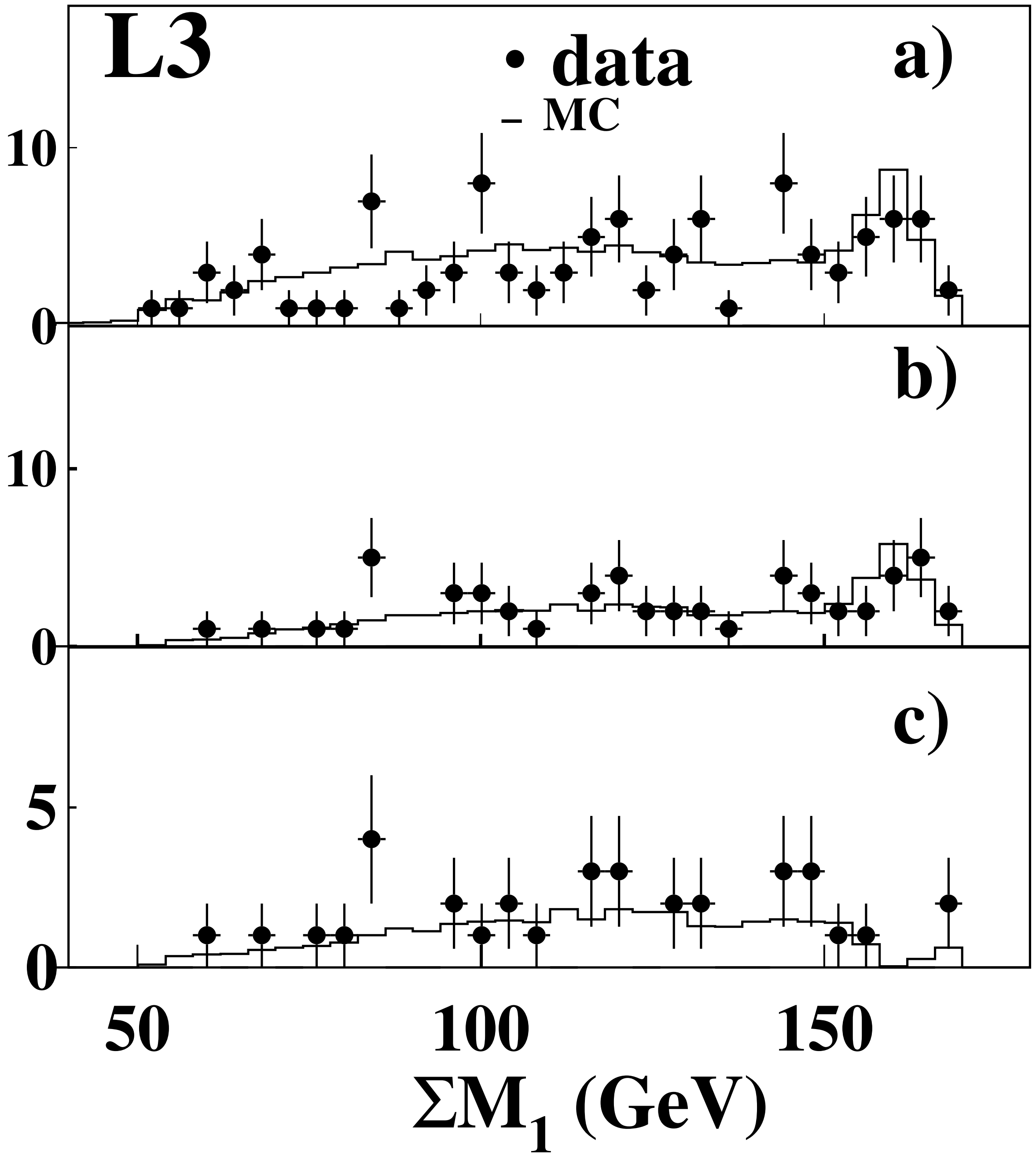
$$\chi^2/\textbf{dof} = 12.0/9 \quad P(\chi^2) = 0.21$$

Fit with constant α_s:

$$\chi^2/\textbf{dof} = 45.1/9 \quad P(\chi^2) = 0.88 \times 10^{-6}$$

Search for Anomalous 4-Jet Production

130 - 172 GeV



4 jets

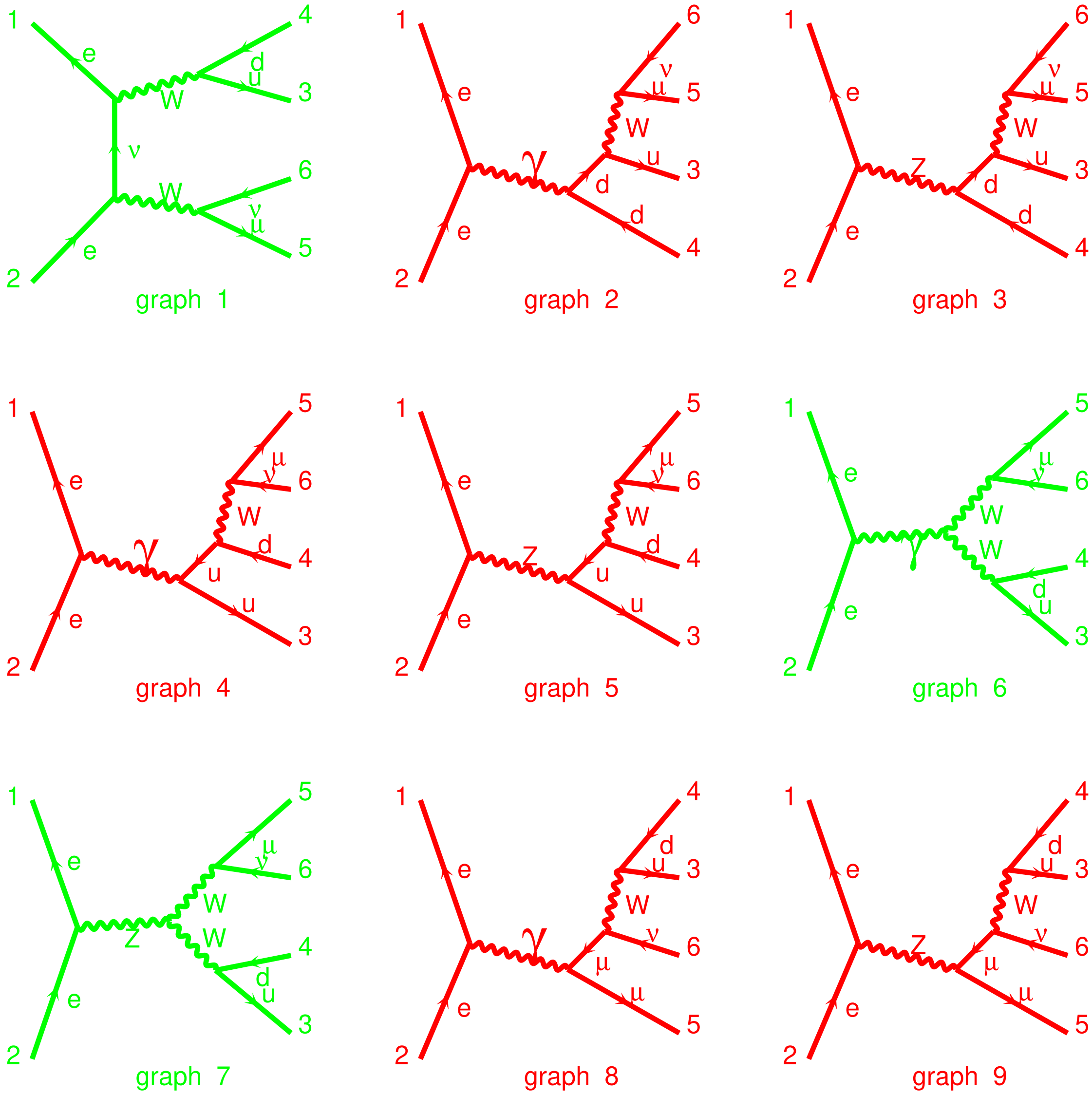
kine

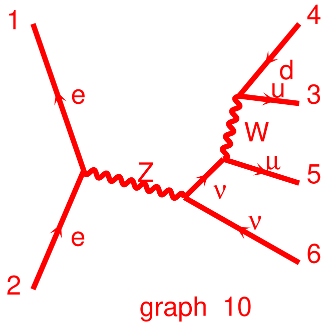
all cuts

No indication for a signal beyond QCD and WW

Four-Fermion Production

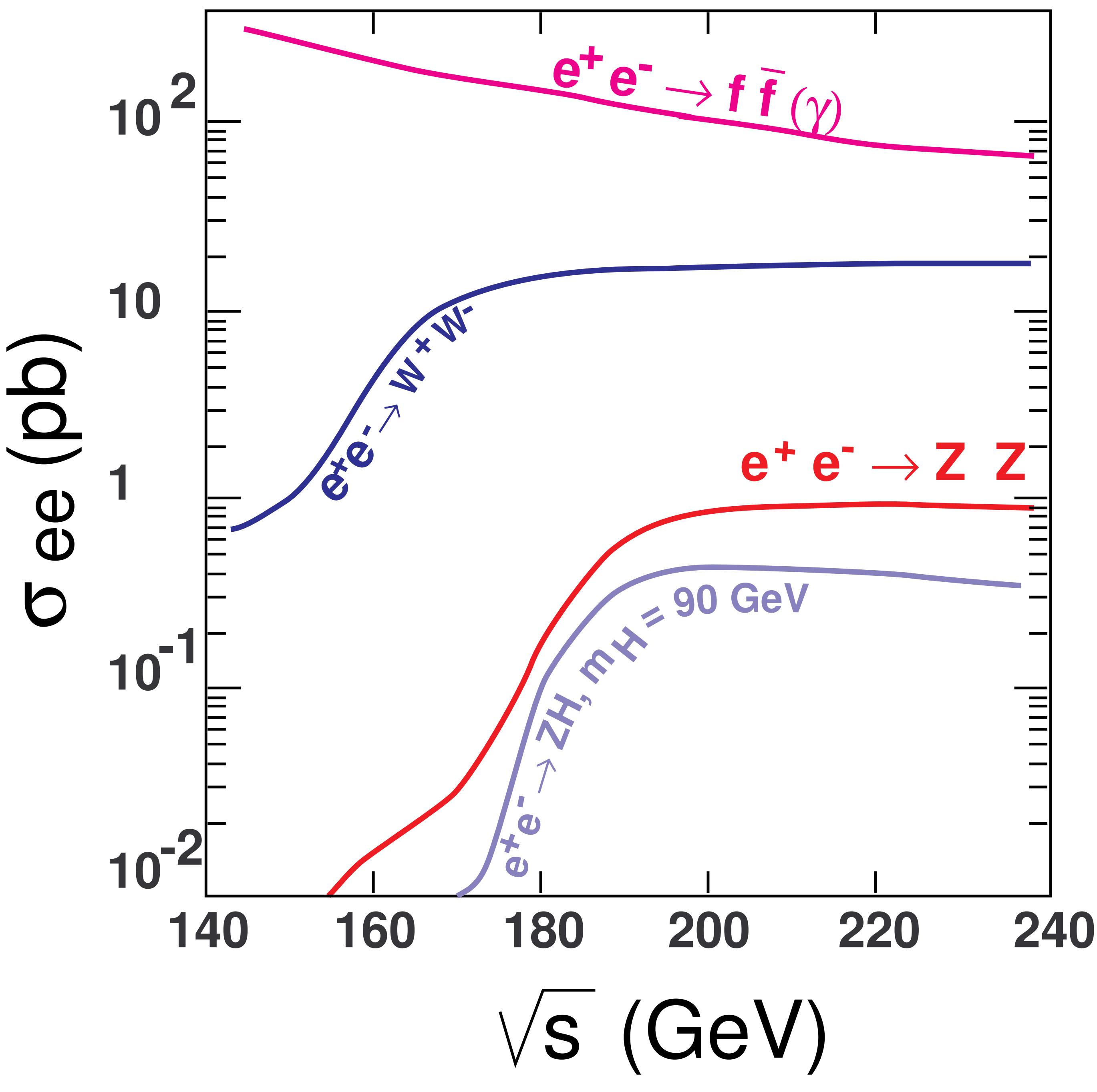
Diagrams by MadGraph





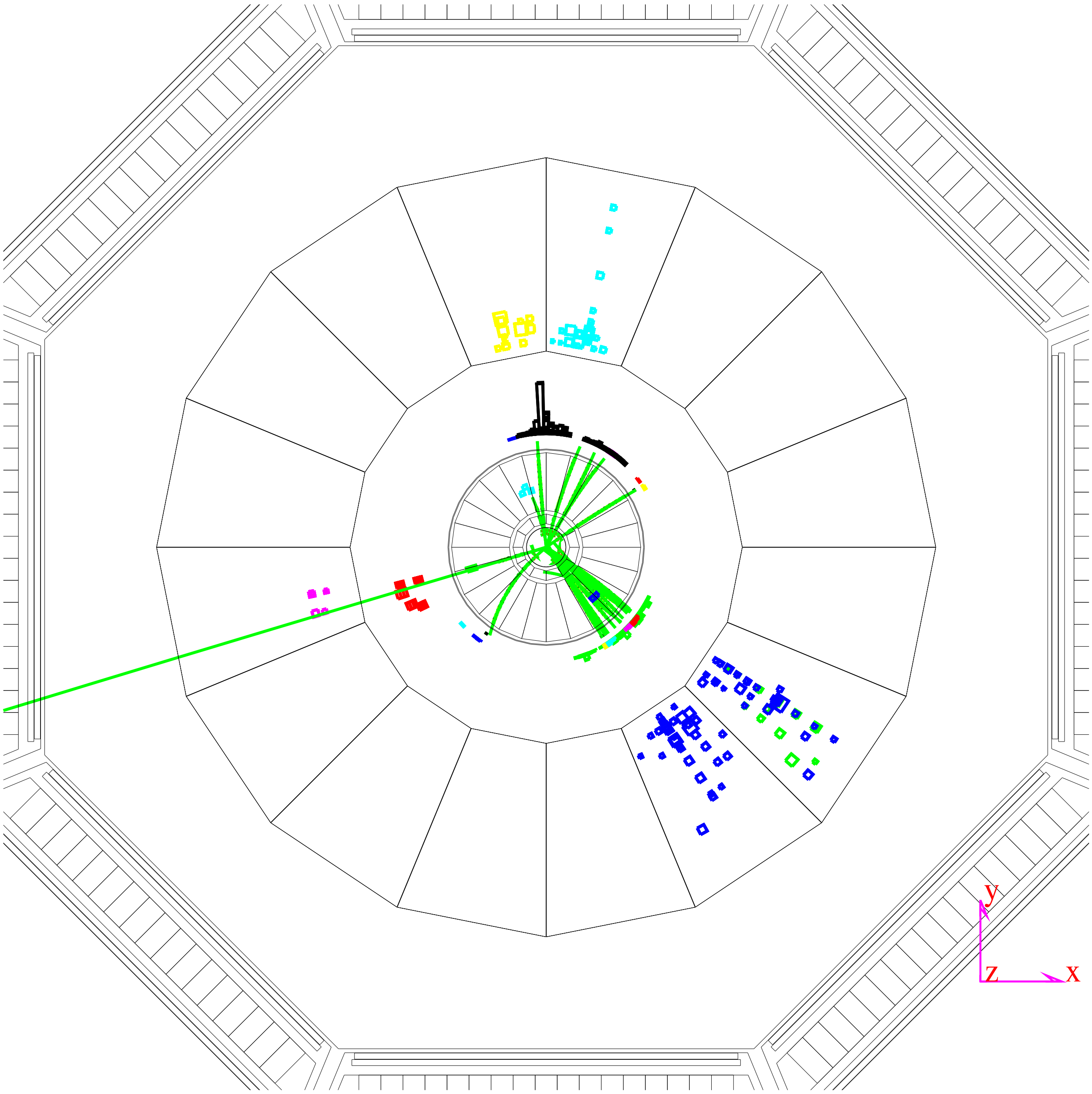
$$e^+e^- \rightarrow u\bar{d}\mu^-\bar{\nu}_\mu$$

Non-resonant background:
small, reduced by M_{inv} cuts



Cross section $\sigma(W^+W^-(\gamma))$: Threshold behaviour

W Pair Production at 172 GeV



- WW production cross section increases
- W's no longer at rest

Xsection at 172 GeV and Combined BR

172 GeV **Preliminary**

Process	ϵ [%]	N_{data}	N_{bg}	$\sigma \times$ BR [pb]	Syst. [%]
$e^+e^- \rightarrow qqe\nu(\gamma)$	79.3	19	0.64	$2.44^{+0.64}_{-0.55}$	3
$e^+e^- \rightarrow qq\mu\nu(\gamma)$	74.1	9	0.38	$1.06^{+0.44}_{-0.36}$	3
$e^+e^- \rightarrow qq\tau\nu(\gamma)$	46.6	12	2.12	$1.60^{+0.81}_{-0.67}$	5
$e^+e^- \rightarrow l\nu l\nu(\gamma)$	45.1	9	0.34	$1.93^{+0.74}_{-0.60}$	4
$e^+e^- \rightarrow qqqq(\gamma)$	84.1	61	12.6	$5.48^{+0.92}_{-0.85}$	3

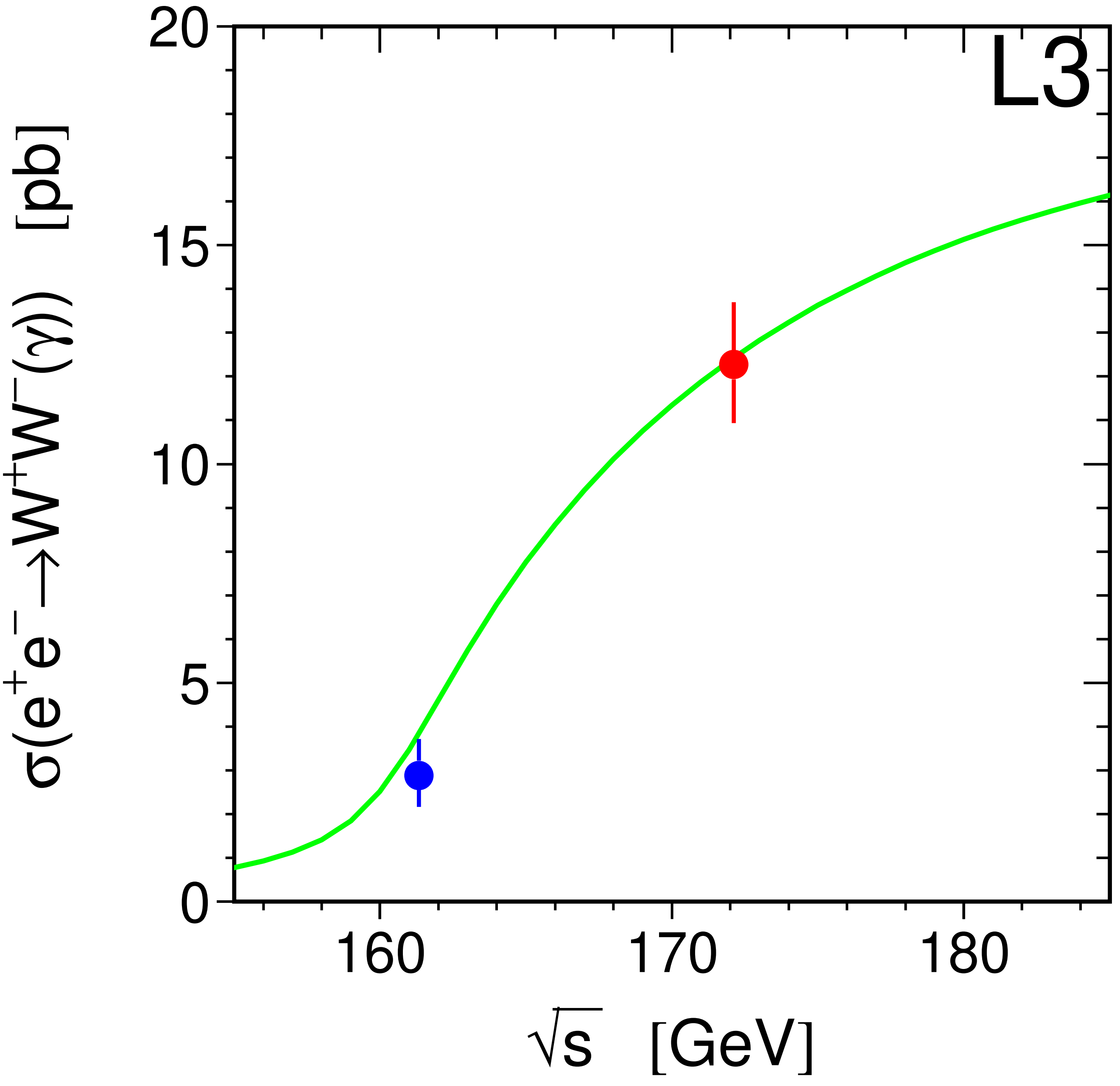
161 + 172 GeV **Preliminary**

Parameter	No Lepton Universality	Lepton Universality	SM
$B(W \rightarrow e\nu)$ [%]	$16.5^{+3.7}_{-3.3}$	—	
$B(W \rightarrow \mu\nu)$ [%]	$8.4^{+2.8}_{-2.4}$	—	
$B(W \rightarrow \tau\nu)$ [%]	$10.9^{+4.2}_{-3.9}$	—	
$B(W \rightarrow l\nu)$ [%]	—	$11.9^{+1.3}_{-1.2}$	10.8
$B(W \rightarrow qq)$ [%]	$64.2^{+3.7}_{-3.8}$	$64.2^{+3.7}_{-3.8}$	67.5
$\sigma_{WW}(172)$ [pb]	$12.37^{+1.47}_{-1.37}$	$12.40^{+1.44}_{-1.34}$	12.43

With BR from SM:

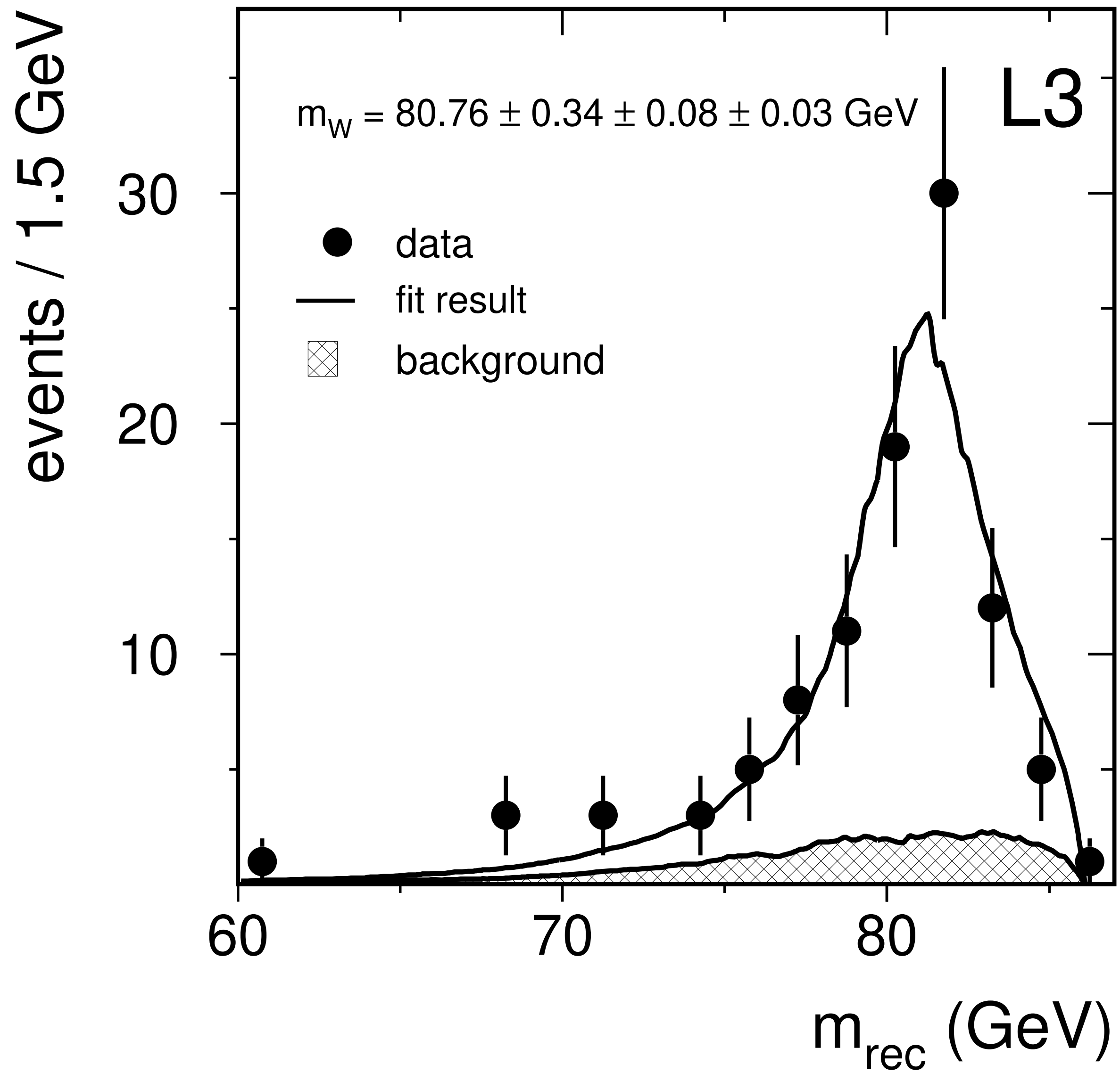
$$\sigma_{WW}(172) = 12.27^{+1.41}_{-1.32} \pm 0.23\,\text{pb}$$

W Pair Excitation Curve



W Mass from Direct Reconstruction

L3 $\sqrt{s} = 172$ GeV **Preliminary**



Fit for mass and width:

$\Gamma_W = 1.38^{+0.87}_{-0.73}$**GeV** ; $M_W = 80.71 \pm 0.33$**GeV** ; $\rho = 20\%$

Mass errors from fit result

W Mass Overview

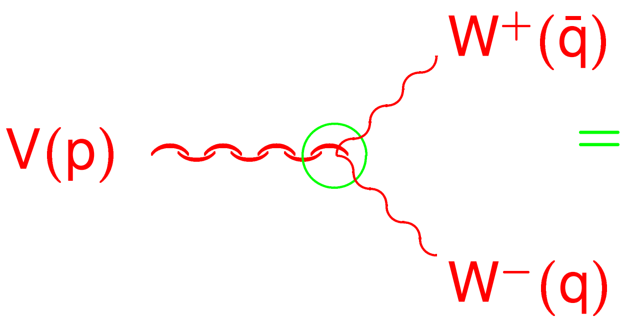
L3 **Preliminary**

Source	M_W **(GeV)**
qqqq **direct**	$81.03 \pm 0.42 \pm 0.12$
qqlν **direct**	$80.31 \pm 0.54 \pm 0.07$
all 172	$80.76 \pm 0.34 \pm 0.08$
$\sigma(161)$	$80.80^{+0.48}_{-0.42}$

All data: $M_W = 80.77 \pm 0.27$ **(exp.)** $\pm\, 0.03$ **(LEP) GeV**

ZWW Couplings

General three-boson vertex function:



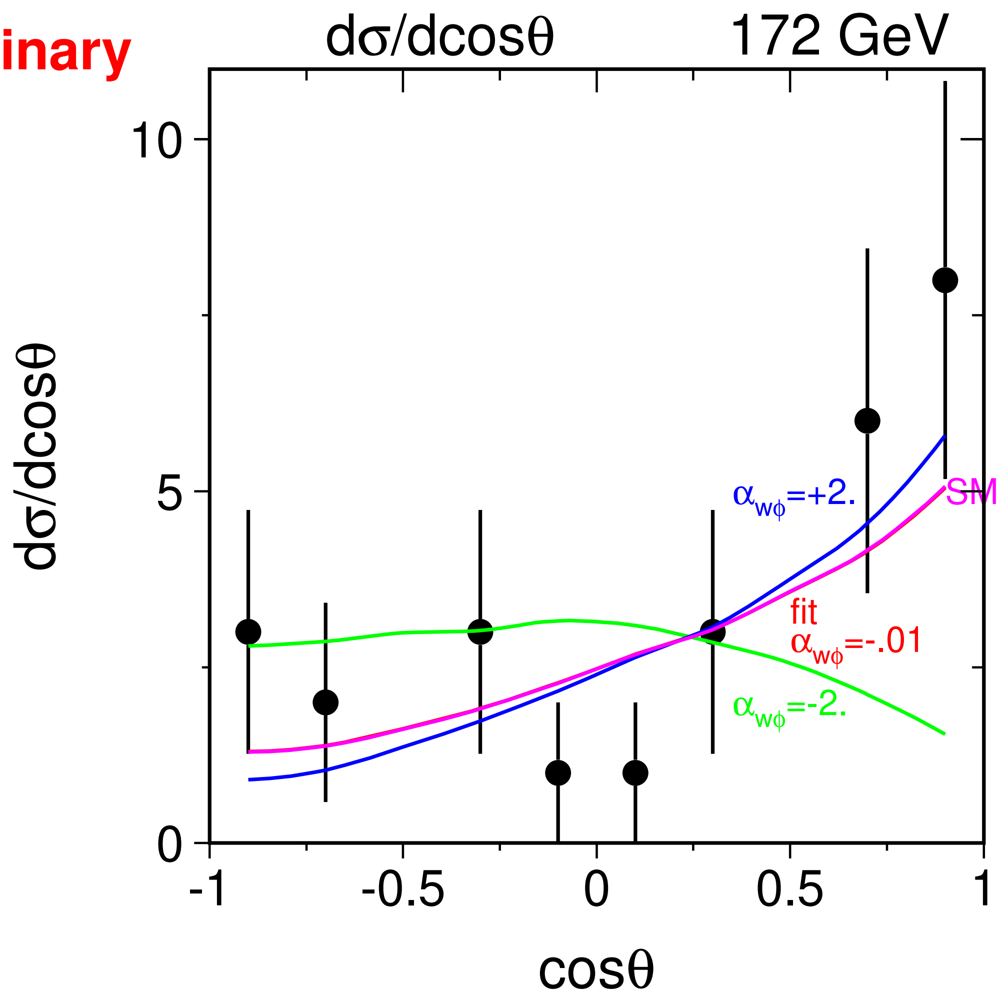
$$= -ieg_{VWW}\Gamma_V^{\alpha\beta\mu}(q, \bar{q}, p)$$
$$g_{\gamma WW} = 1$$
$$g_{ZWW} = \cot\theta_W$$
$$\delta_Z = g_{ZWW} - \cot\theta_W$$

First thing to check: does ZWW vertex exist?

In principle: W mass from threshold position, couplings from height
In practice: W mass from hadron machines
Syst. err. from W mass is small, syst. err. from W width is negligible

Distribution of W Production Angle

Preliminary **L3**



Using total cross section and angular distribution, L3 finds for single anomalous couplings:

$$\delta_Z = -0.02^{+0.97}_{-0.85} \quad \alpha_{W\phi} = -0.01^{+0.43}_{-0.37}$$

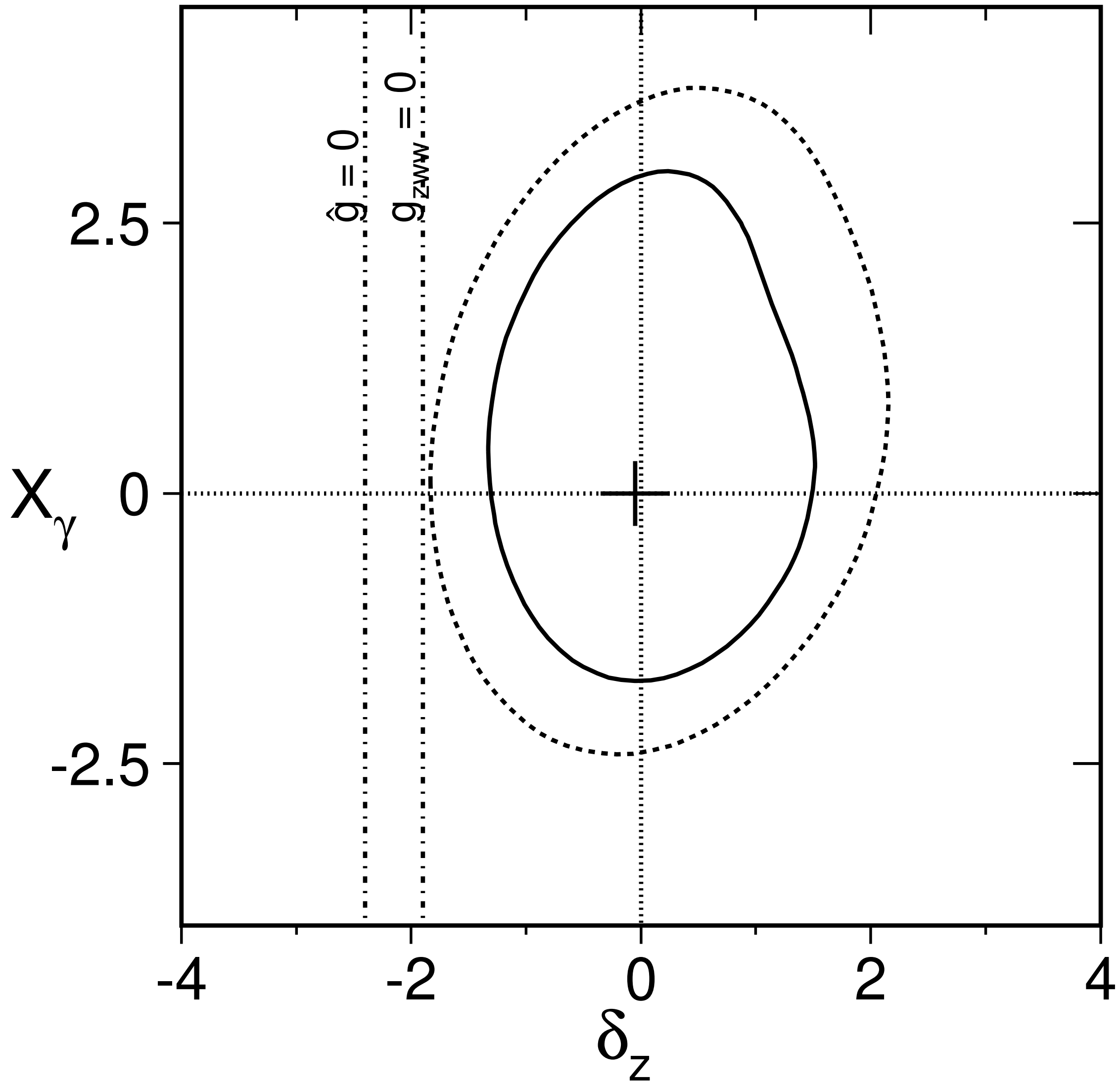
$$\alpha_W = -0.05^{+0.67}_{-0.56} \quad \alpha_{B\phi} = -0.05^{+2.49}_{-1.25}$$

Stat. and syst. error included

Existence of ZWW vertex strongly favored

W Weak Charge and Magnetic Moment

161 and 172 GeV **L3 Preliminary**

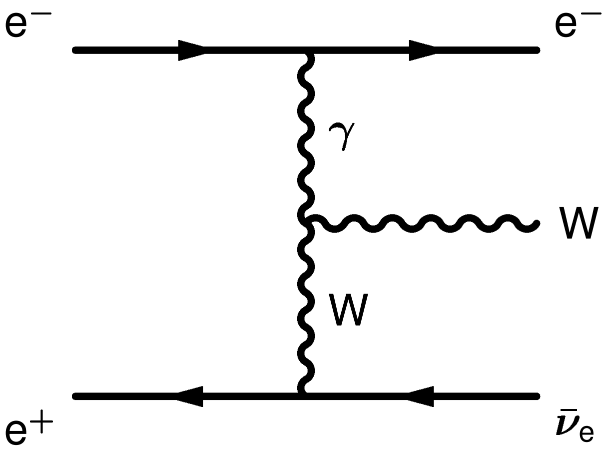


$$\delta_Z = -0.0^{+1.1}_{-1.0}$$
$$x_\gamma = \Delta\kappa_\gamma = +0.1^{+2.5}_{-1.3}$$

Existence of ZWW vertex strongly favored

Single W Production

Non resonant single W production cross section sensitive to $WW\gamma$ vertex:



Signal: $\theta_e < 0.08$ **rad,** $\min(E_f, E_{f'}) > 15$ **GeV**

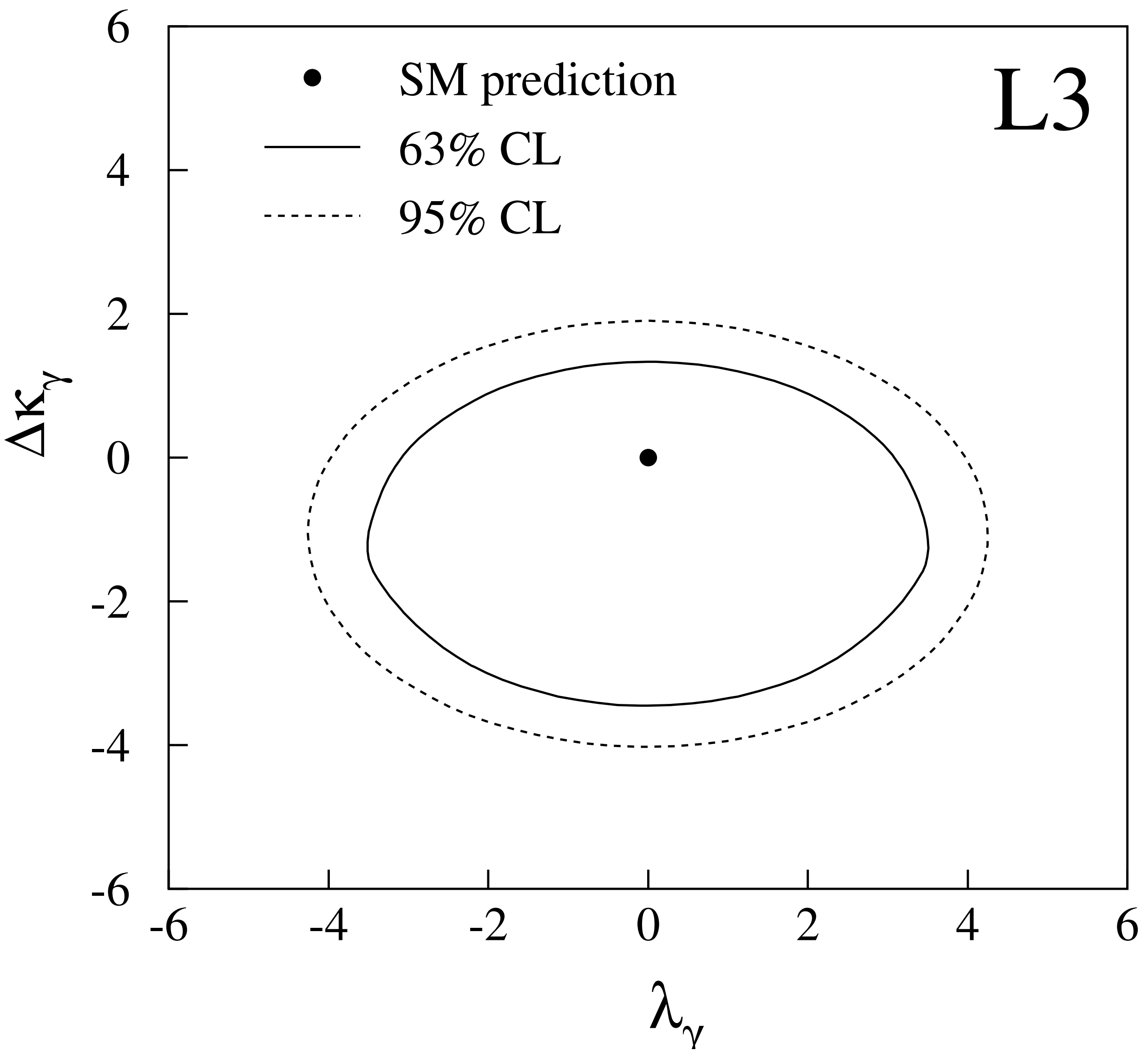
161 and 172 GeVdata combined:

Process	**σ (pb)**
$e^+e^- \to e\nu_e\ell\nu_\ell$	$0.17^{+0.20}_{-0.12} \pm 0.02$
$e^+e^- \to e\nu_e q\,q'$	$0.45^{+0.41}_{-0.32} \pm 0.04$
$e^+e^- \to e\bar{\nu}_e W$	$0.61^{+0.43}_{-0.33} \pm 0.05$

CERN-PPE/97-28

Single W Production

From cross sections measurement:



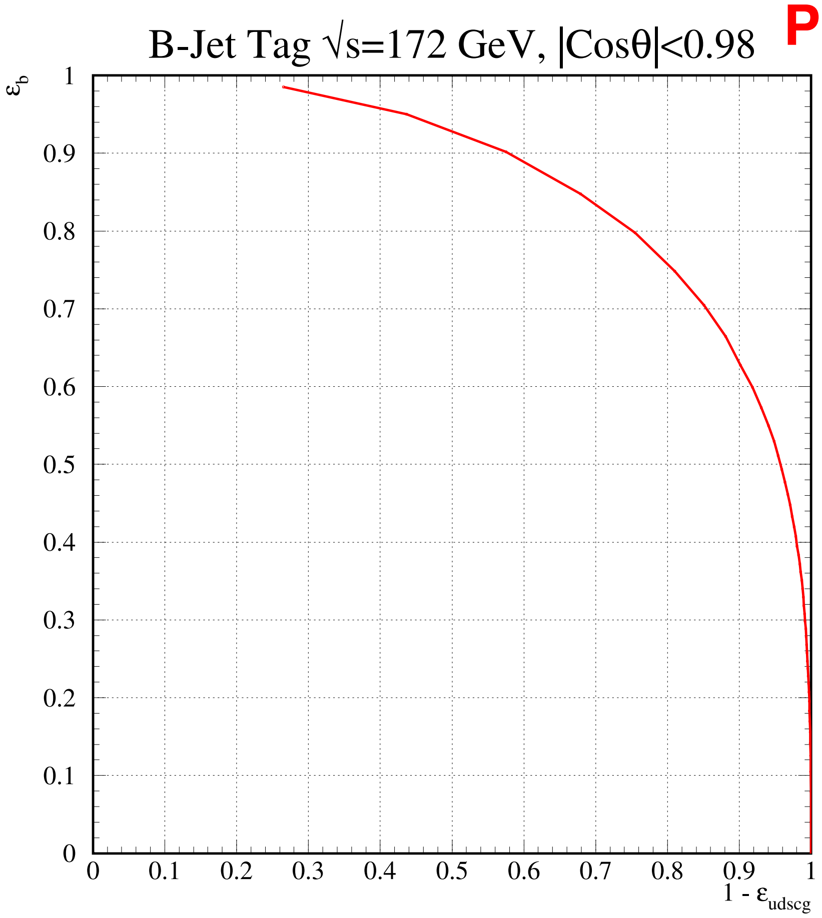
$$-3.6 < \lambda_\gamma < 3.6 \quad \textbf{at 95\% C.L.}$$
$$-3.6 < \Delta\kappa_\gamma < 1.5 \quad \textbf{at 95\% C.L.}$$

Standard Model Higgs

Two different methods:

- NN or multivariate
- Using topological variables, jet b-tag and mass

L3 Preliminary



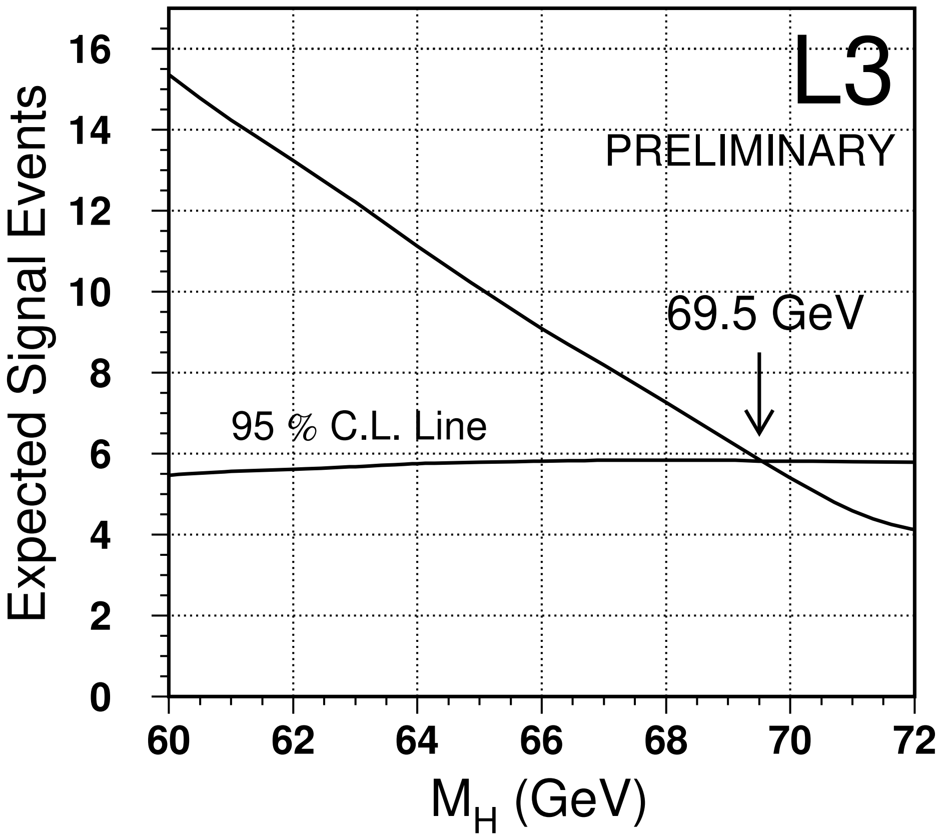
Jet b-tag discriminant derived from NN output, using:

- single track 3D decay length significance
- secondary vertex information (mass, decay length, multiplicity, etc.)
- jet shape variables and inclusive leptons

Standard Model Higgs

No significant signal found:

	161 GeV			172 GeV		
Channel	ϵ	**BG**	**Data**	ϵ	**BG**	**Data**
Hll	0.49	1.09	1	0.53	2.13	3
$H\nu\nu$	0.66	5.08	5	0.75	4.79	3
$\tau\tau$qq	0.28	0.79	0	0.37	1.82	0
bbqq	0.53	8.18	6	0.55	8.60	8
Total		15.1	12		17.3	14



Same limit obtained also if all Higgs decays are into invisible particles

Supersymmetric Particles

Search for 11 topologies in three different ΔM ranges:

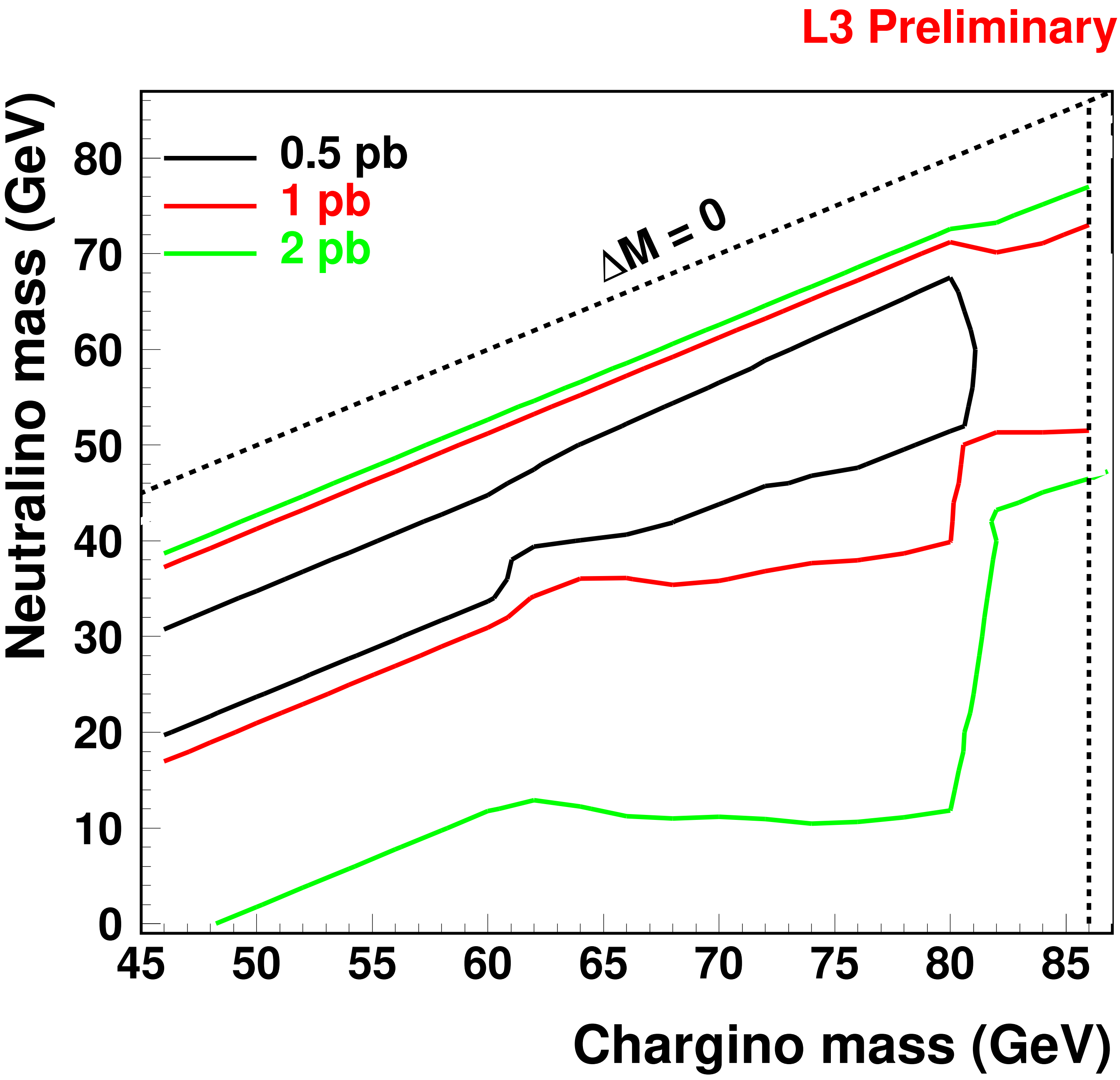
- Two acoplanar e, μ or τ
- Hadrons with an isolated e, μ or τ
- Purely hadronic final state with high multiplicity
- Monojet or two acoplanar jets
- Single photons or acoplanar photon pairs

all with missing energy, momentum, mass etc.

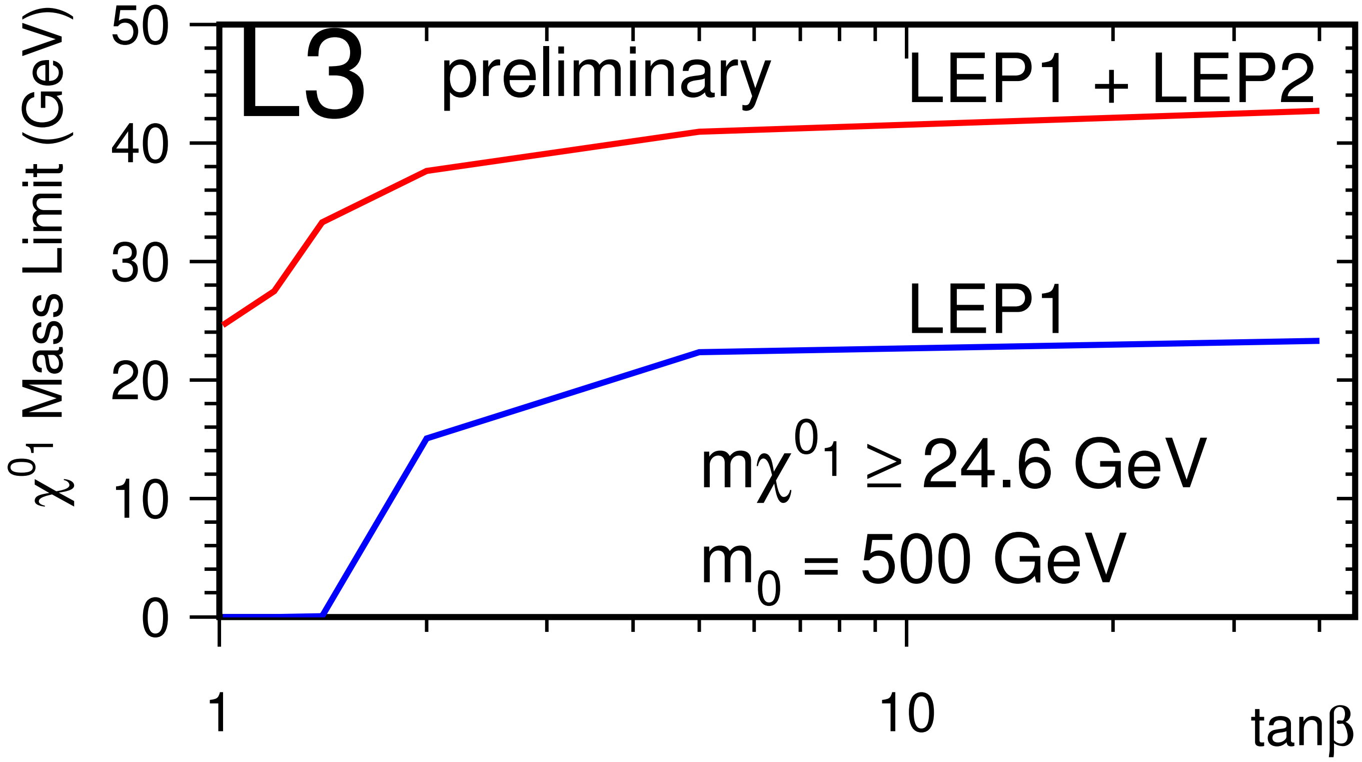
L3 Preliminary

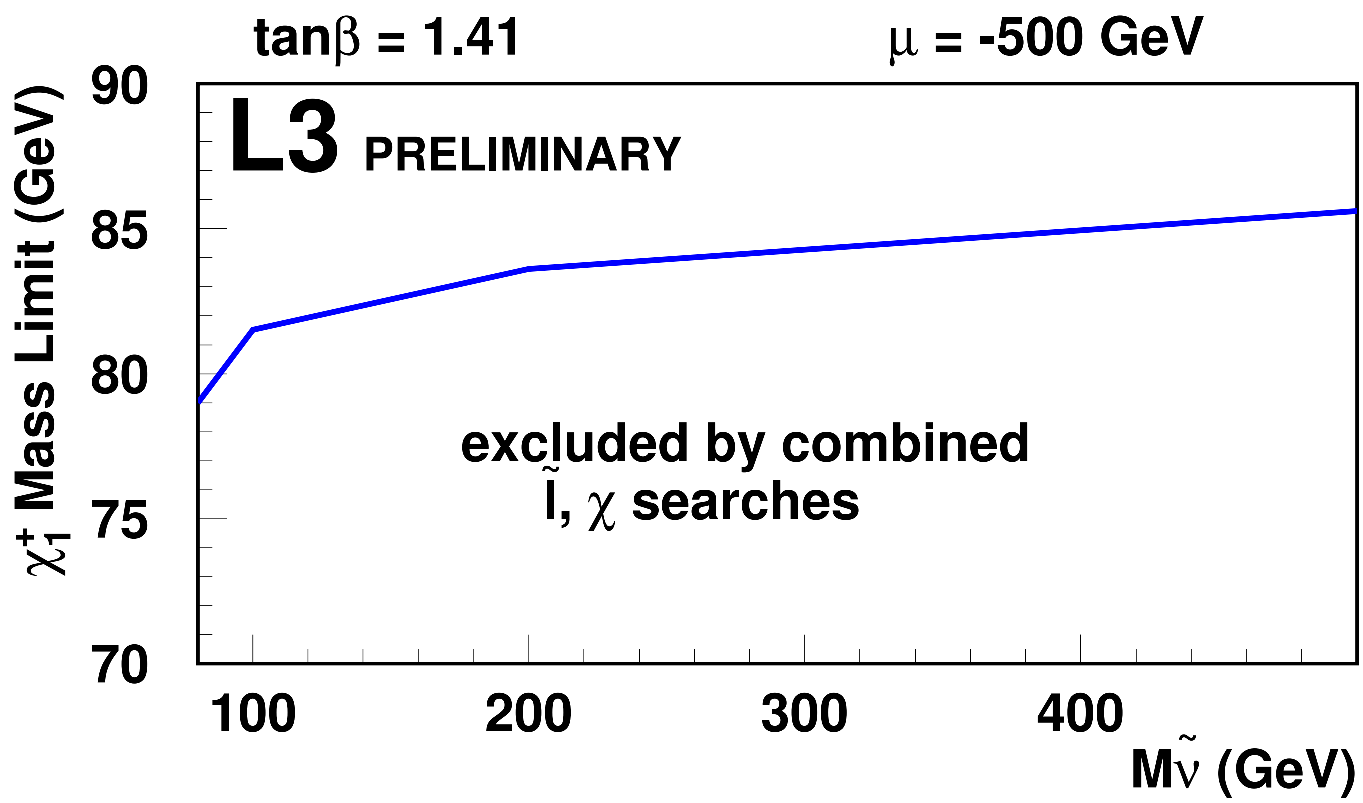
Class	Data Events	Expected Background
$\tilde{\chi}^{\pm}, \tilde{\chi}^{0}$	5	3.9
$\tilde{\mathrm{e}}$	4	1.7
$\tilde{\mu}$	0	1.2
$\tilde{\tau}$	1	1.6
all	8	8.4

Cross section limit for production of charginos and neutralinos:



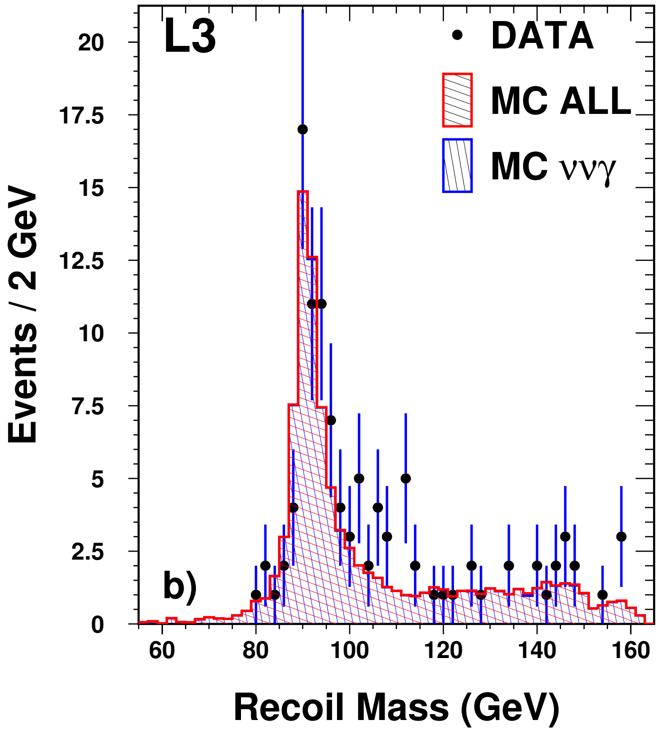
Interpretation in MSSM



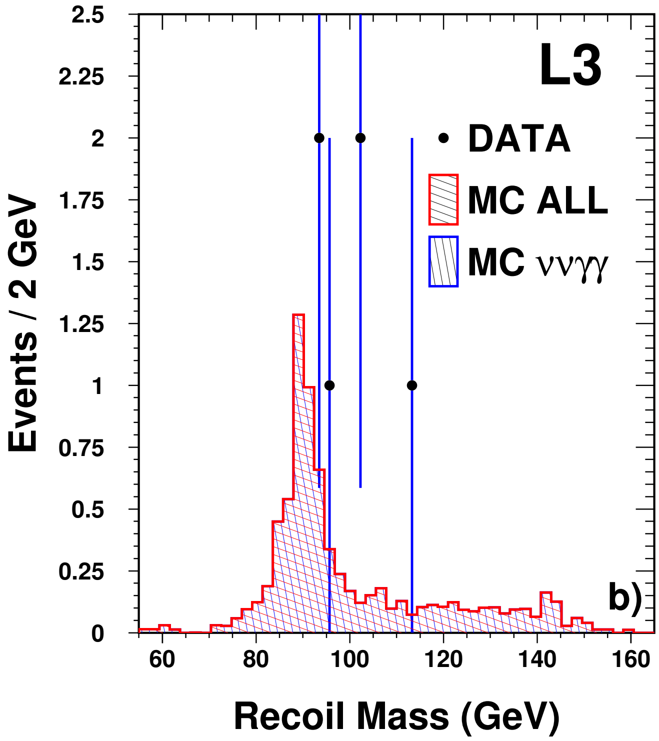


Radiative Neutralino Decays

Single Photons

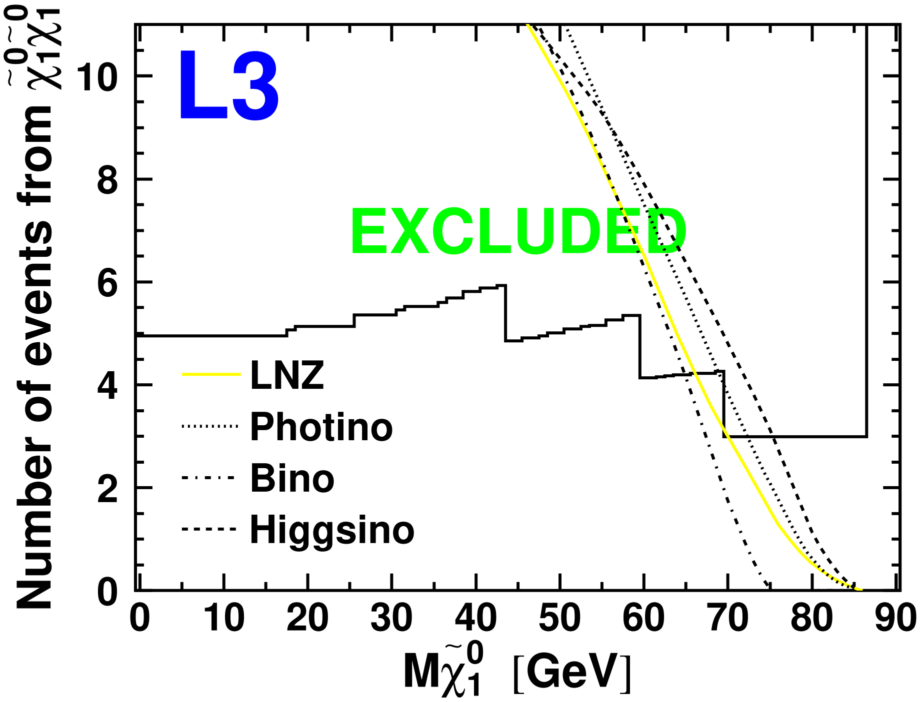


Acoplanar Photon Pairs



$\tilde{\chi}_2^0 \to \tilde{\chi}_1^0 \gamma$ or $\tilde{\chi}_1^0 \to \tilde{G}\gamma$

Preliminary



Operational Status of L3

- All subdetectors operational
- Reinstallation of one damaged support tube jack delayed, but not crucial
- RFQ calibration of BGO being prepared
- Flammable gas in muon chambers and TEC:
  - Flushing since May 12
  - Ready for HV since May 21
  - TEC mixture will be stable by June 2

Since exact duration of LEP delay is not known, flammable gas will be kept and safety shifts will be maintained

To make use of the delay time, additional checks will be performed. We also take the opportunity to move forward a level 3 trigger upgrade originally planned for later this year

Every effort is made so that L3 is in optimum condition at start of run

Comments on Long Term Schedule

L3 trusts that the original LEP program can in principle be completed until the end of 1999:

- 1997: 100 pb^{-1} at 184 GeV
- 1998 and 1999: 2×200 pb^{-1} at $\simeq$ 190 GeV

There is no important constraints from equipment lifetime that would keep L3 from continuing afterwards.

Continuing to run in 2000 requires a substantial effort by the collaboration and its funding agencies.

- L3 is willing to make this effort and seek funding, provided that the schedule for 2000 promises a substantial physics benefit.
- One way would be to boost up the energy significantly.
- Another way would be to significantly increase the luminosity at the highest energy.
- We will appreciate all efforts by SL to push the highest energy beyond what it is seen to be now.