L3 Status Report

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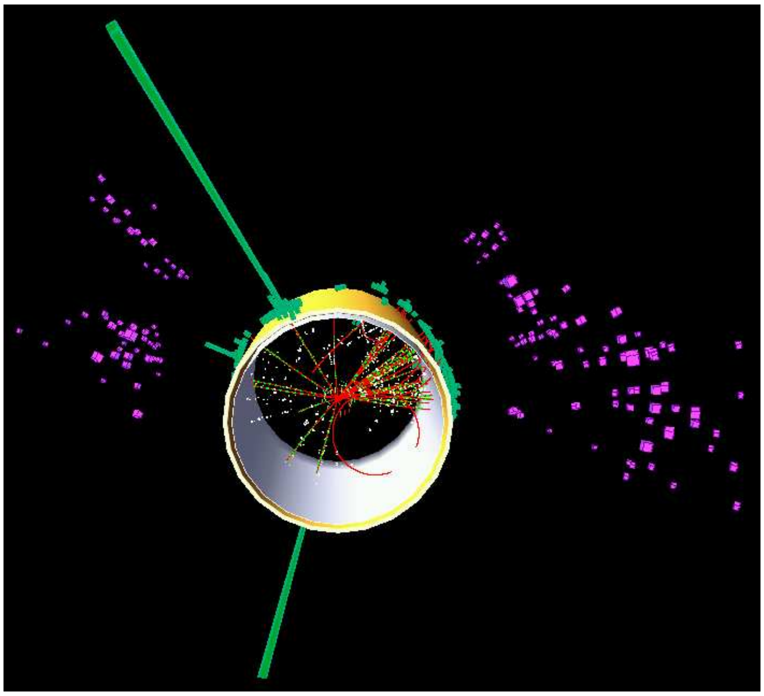


LEPC

20 July 2000

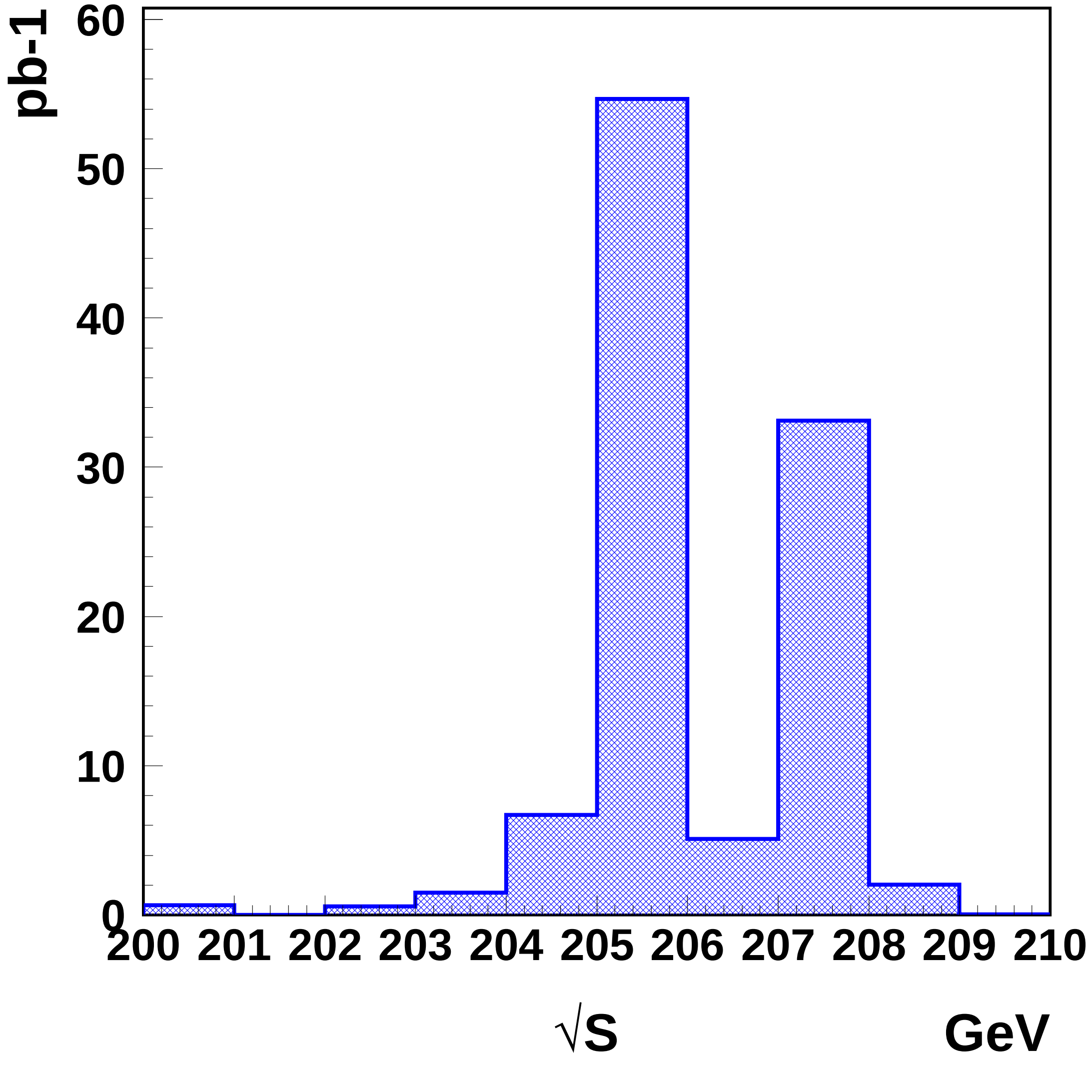
- Fermion-pair pair production at $\sqrt{s} > 200$ GeV
- Test of QCD and α_s
- W^+W^- production
- ZZ production

- Searches for new particles:
- Higgs bosons
- SUSY particles
- Exotica

- Conclusions

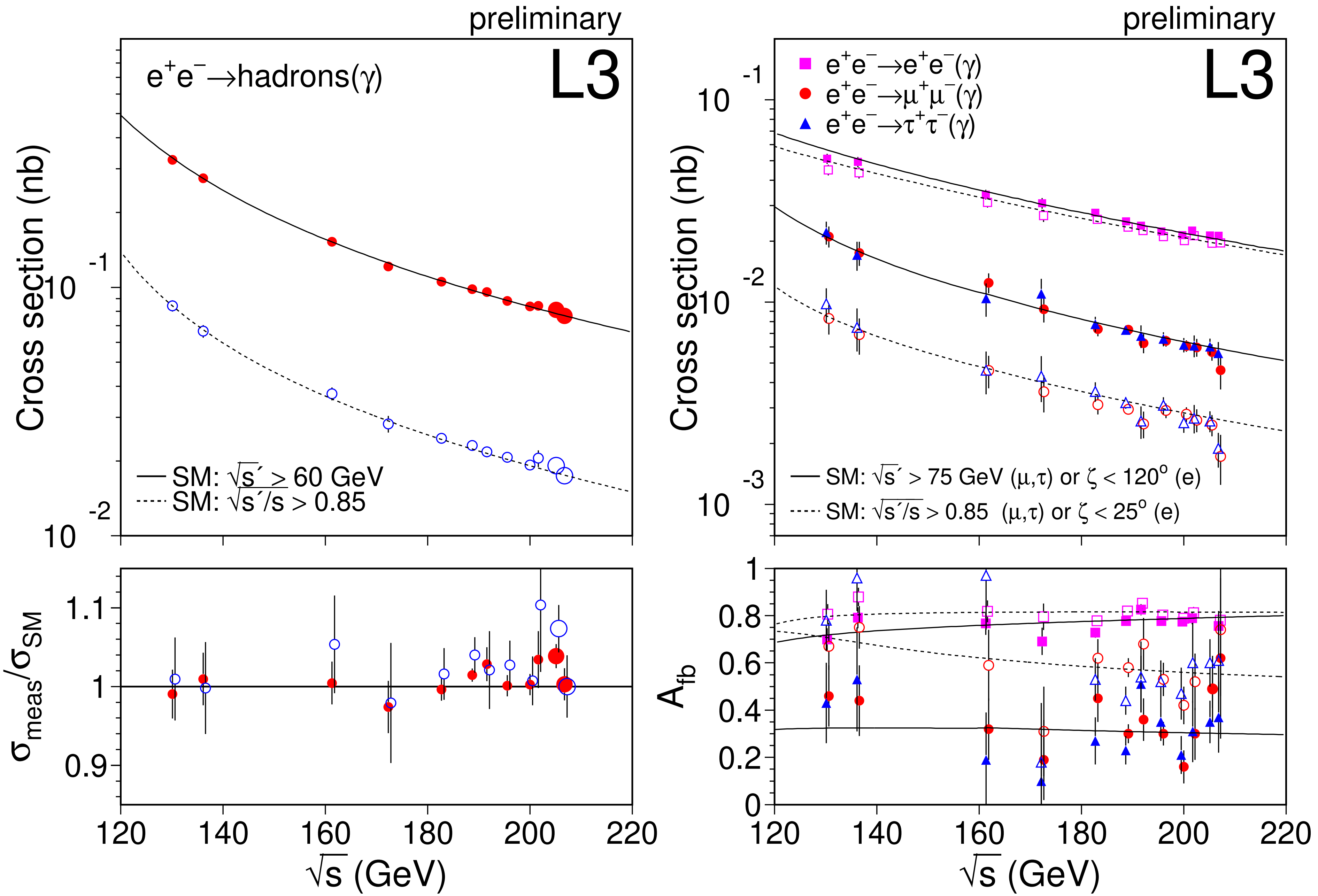
Year 2000 Data sample

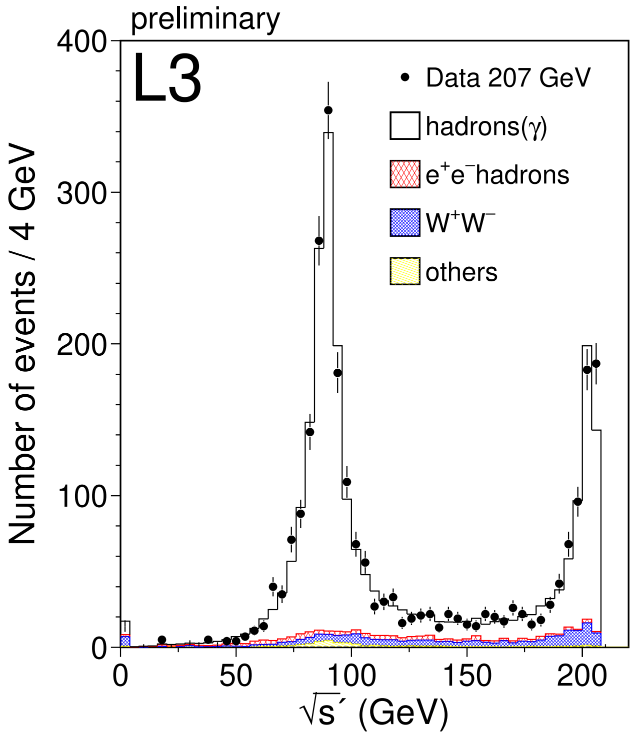
- 91 GeV : $3.26 pb^{-1}$



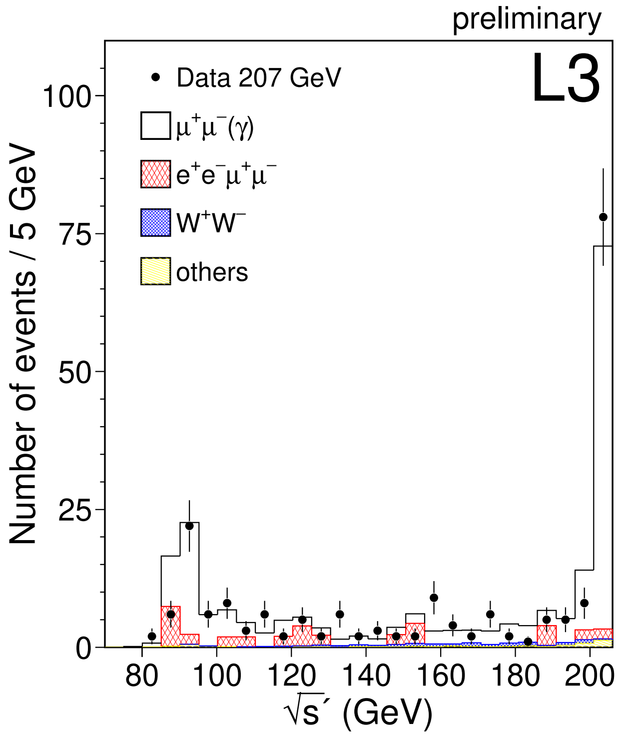
Data Acquisition Efficiency: $\sim$ 91%

Fermion-Pair Production

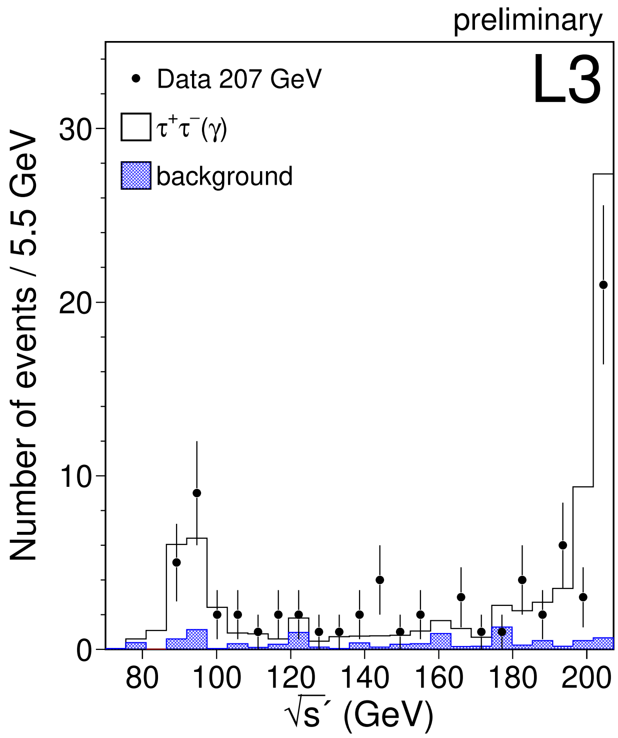




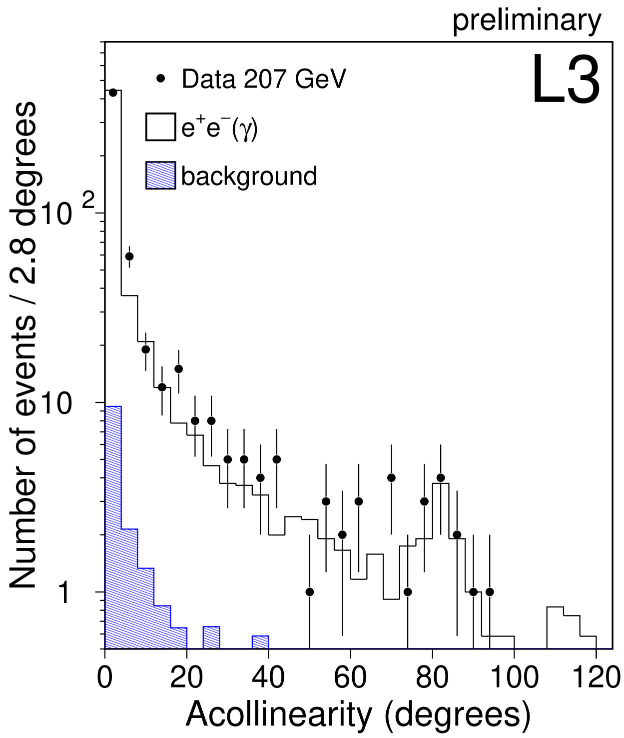
preliminary
L3
Data 207 GeV
hadrons(γ)
e⁺e⁻hadrons
W⁺W⁻
others
Number of events / 4 GeV
√s´ (GeV)



preliminary
L3
Data 207 GeV
μ⁺μ⁻(γ)
e⁺e⁻μ⁺μ⁻
W⁺W⁻
others
Number of events / 5 GeV
√s´ (GeV)

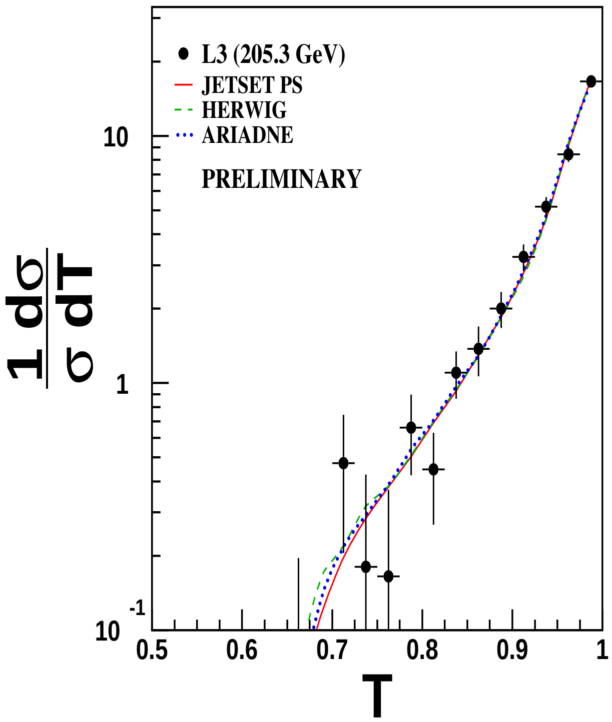


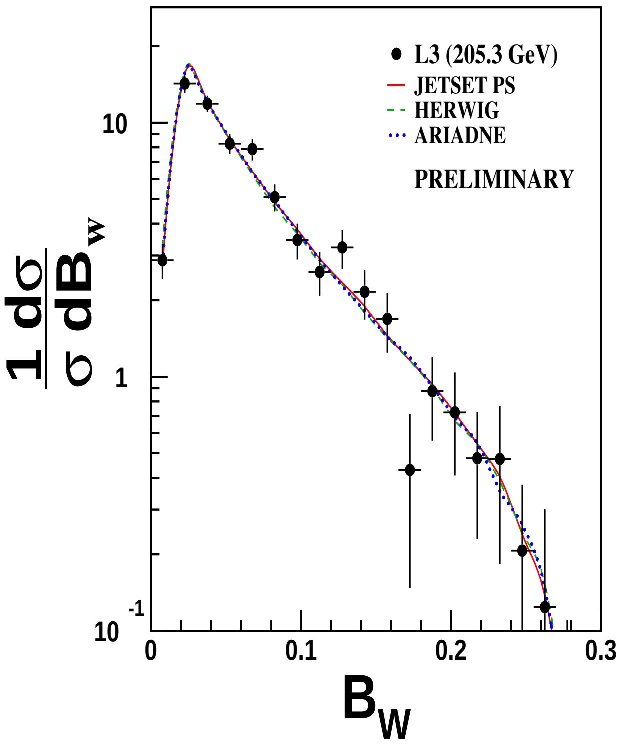
preliminary
L3
Data 207 GeV
τ⁺τ⁻(γ)
background
Number of events / 5.5 GeV
√s´ (GeV)



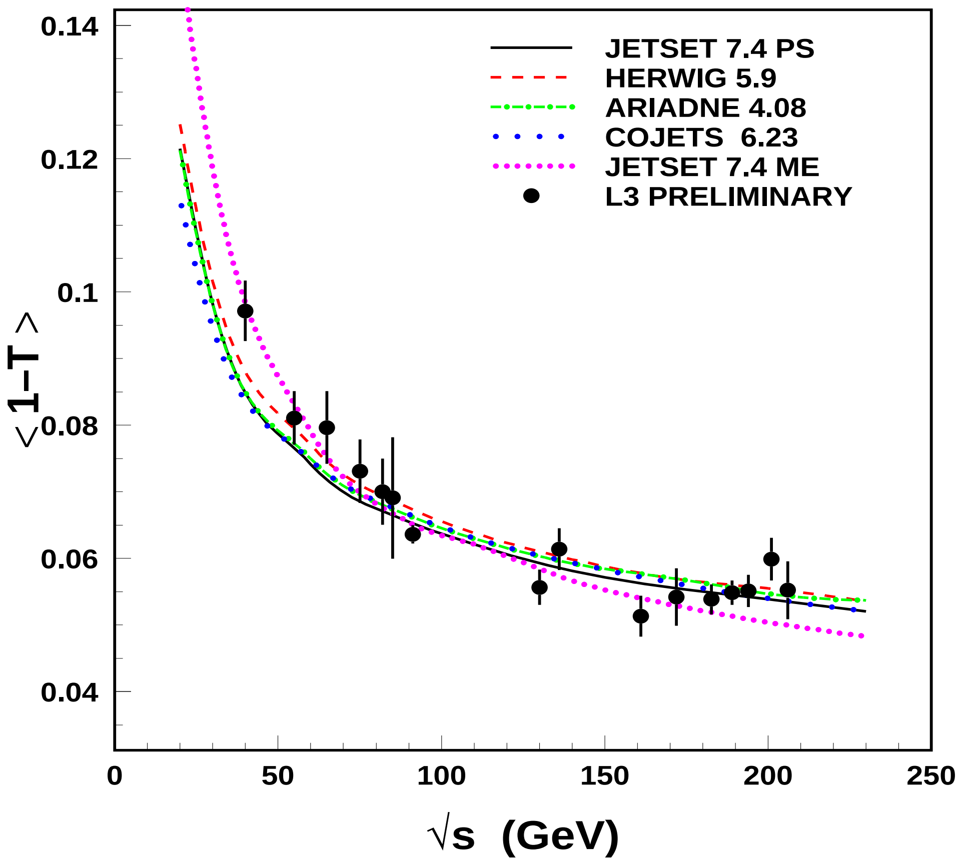
preliminary
L3
Data 207 GeV
e⁺e⁻(γ)
background
Number of events / 2.8 degrees
Acollinearity (degrees)

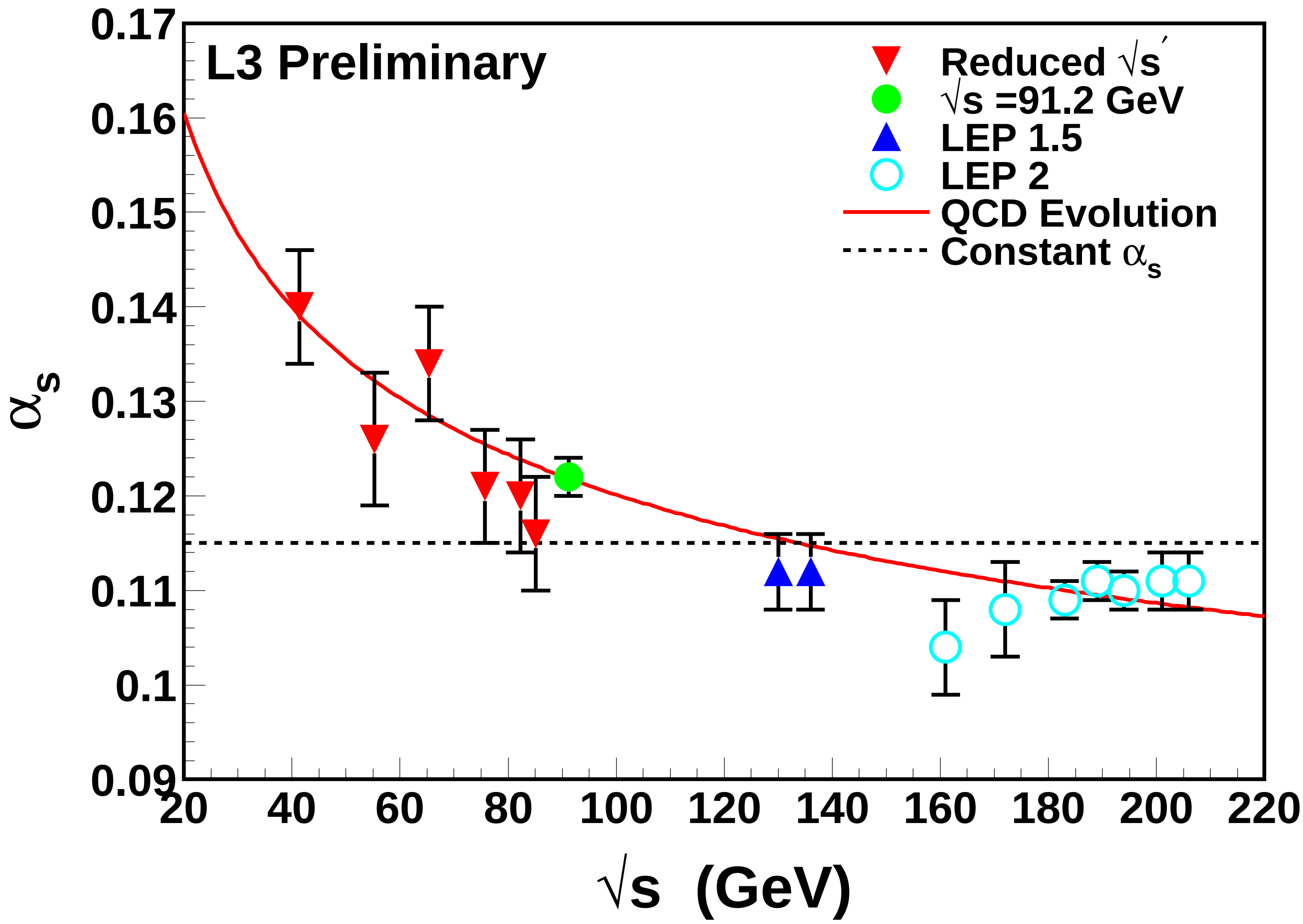
Event Shapes (corrected) @ $\langle\sqrt{s}\rangle = 205.3\text{GeV}$





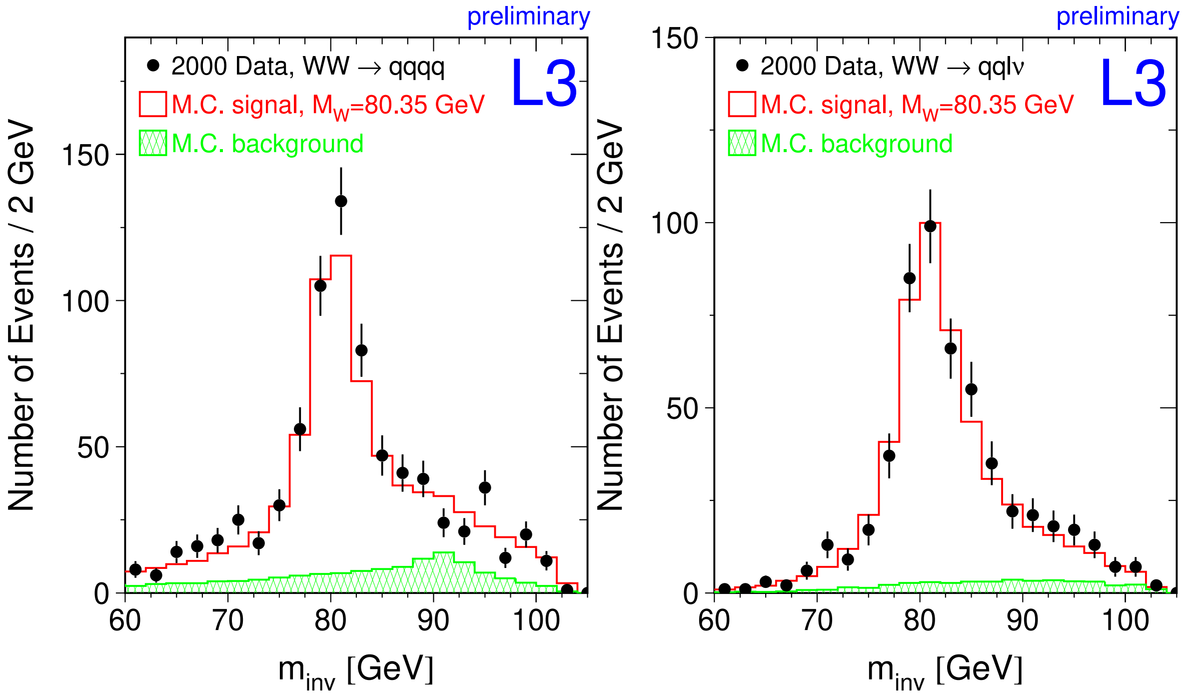
Energy evolution of $\langle 1 - T\rangle$



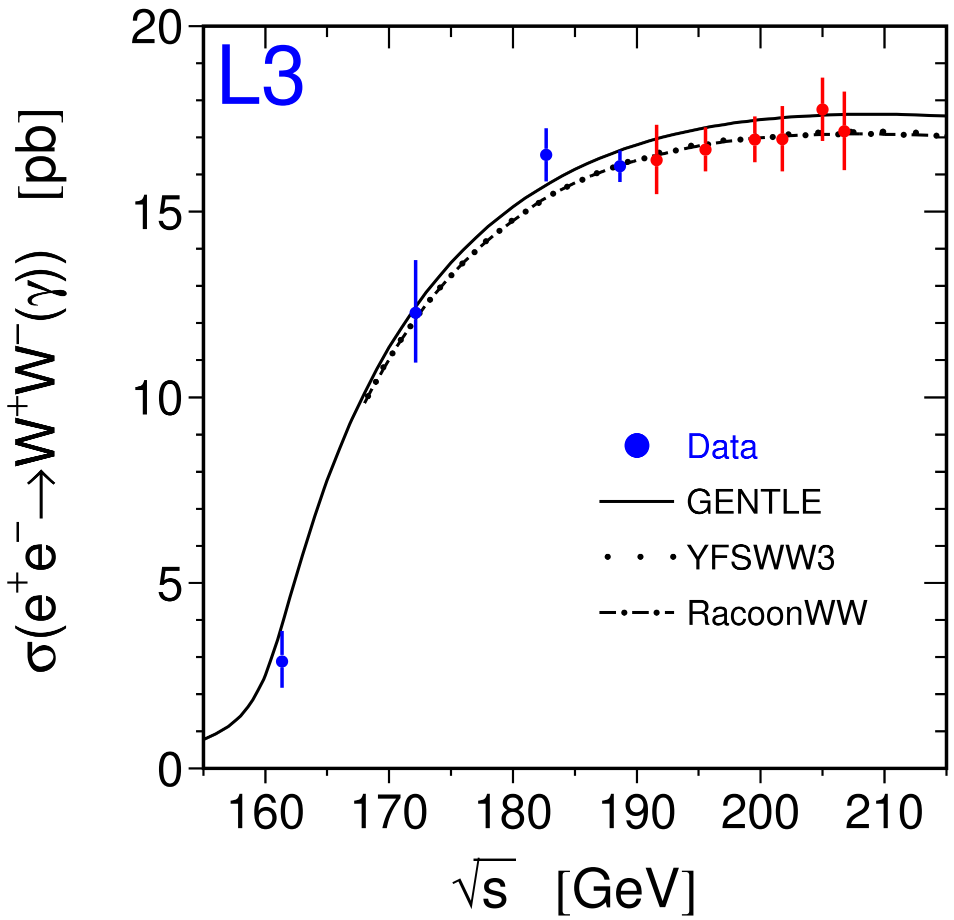


$$\boxed{\alpha_s(m_Z) = 0.1218 \pm 0.0012 \pm 0.0061}$$

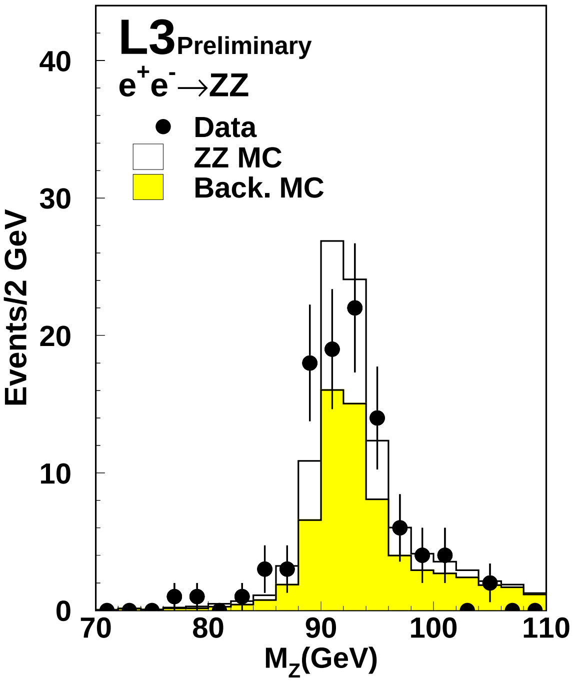
$$\boxed{\mathrm{N}_f = 5.1 \pm 1.3 \pm 1.9}$$

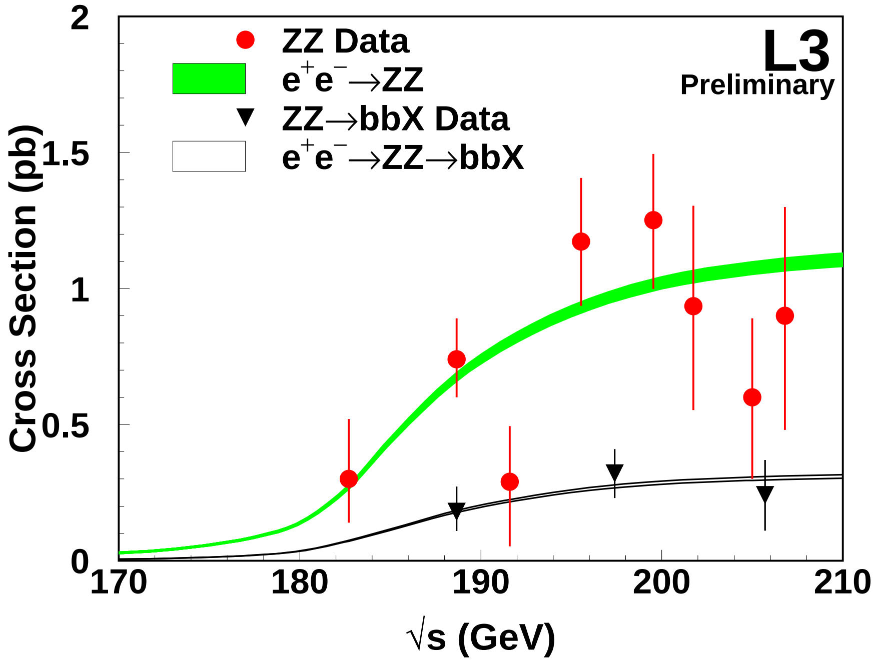


preliminary
2000 Data, WW → qqqq
M.C. signal, M_W=80.35 GeV
M.C. background
L3
Number of Events / 2 GeV
m_{inv} [GeV]
preliminary
2000 Data, WW → qqlν
M.C. signal, M_W=80.35 GeV
M.C. background
L3
Number of Events / 2 GeV
m_{inv} [GeV]

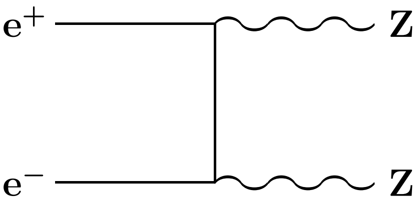


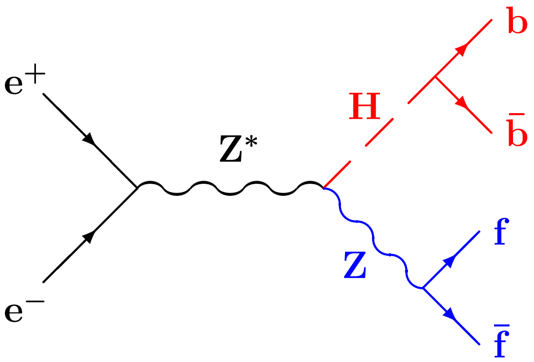
L3
Data
GENTLE
YFSWW3
RacoonWW
$\sigma(e^+e^- \to W^+W^-(\gamma))$ [pb]
$\sqrt{s}$ [GeV]





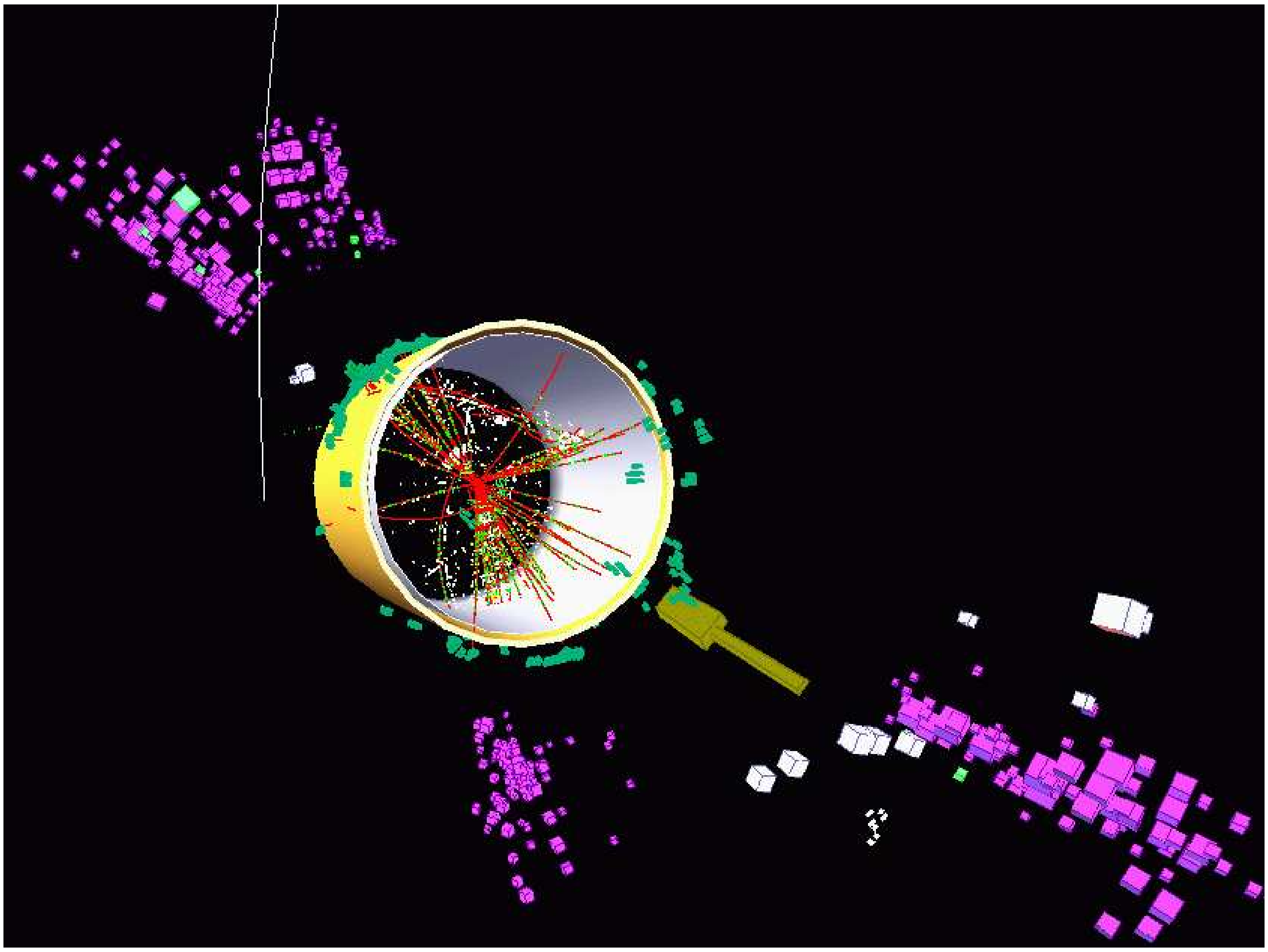
- We have measured $e^+e^- \to ZZ \to f\bar{f}f'\bar{f}'$ and $e^+e^- \to ZZ \to b\bar{b}f\bar{f}$.
- We are then sensitive to $e^+e^- \to HZ \to b\bar{b}f\bar{f}$





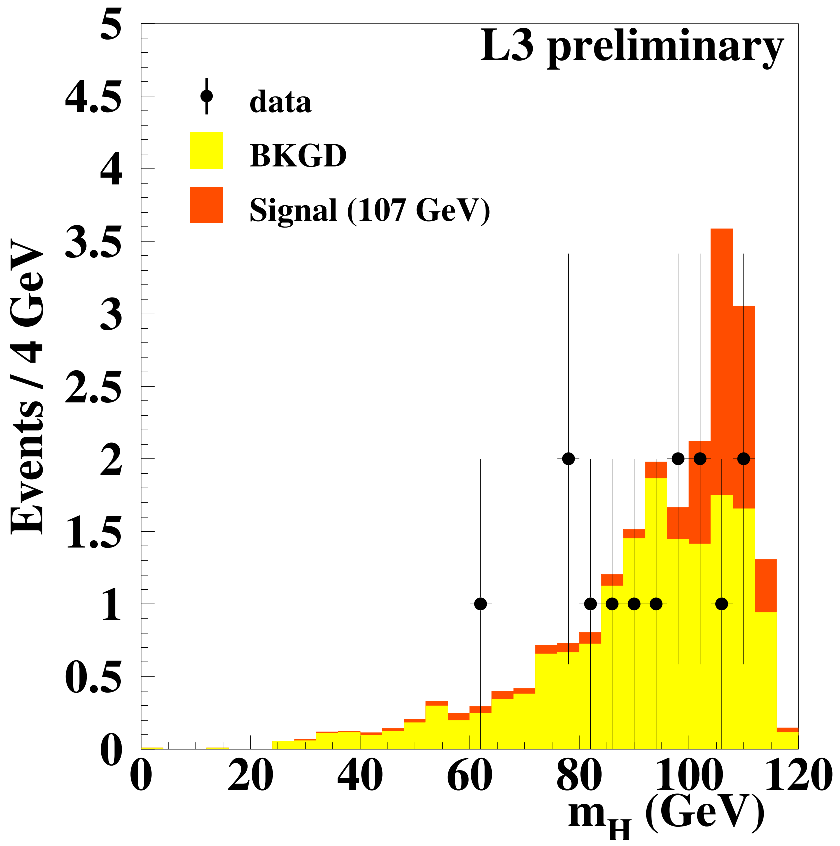
NEW PARTICLE SEARCHES

HZ $\rightarrow$ qqqq candidate ($\sqrt{s} = 206.6$ GeV)



$\mathrm{m_H} = 109.9$ GeV, event b tag = 2.6

Combined mass plot of this year data after cut on b tag



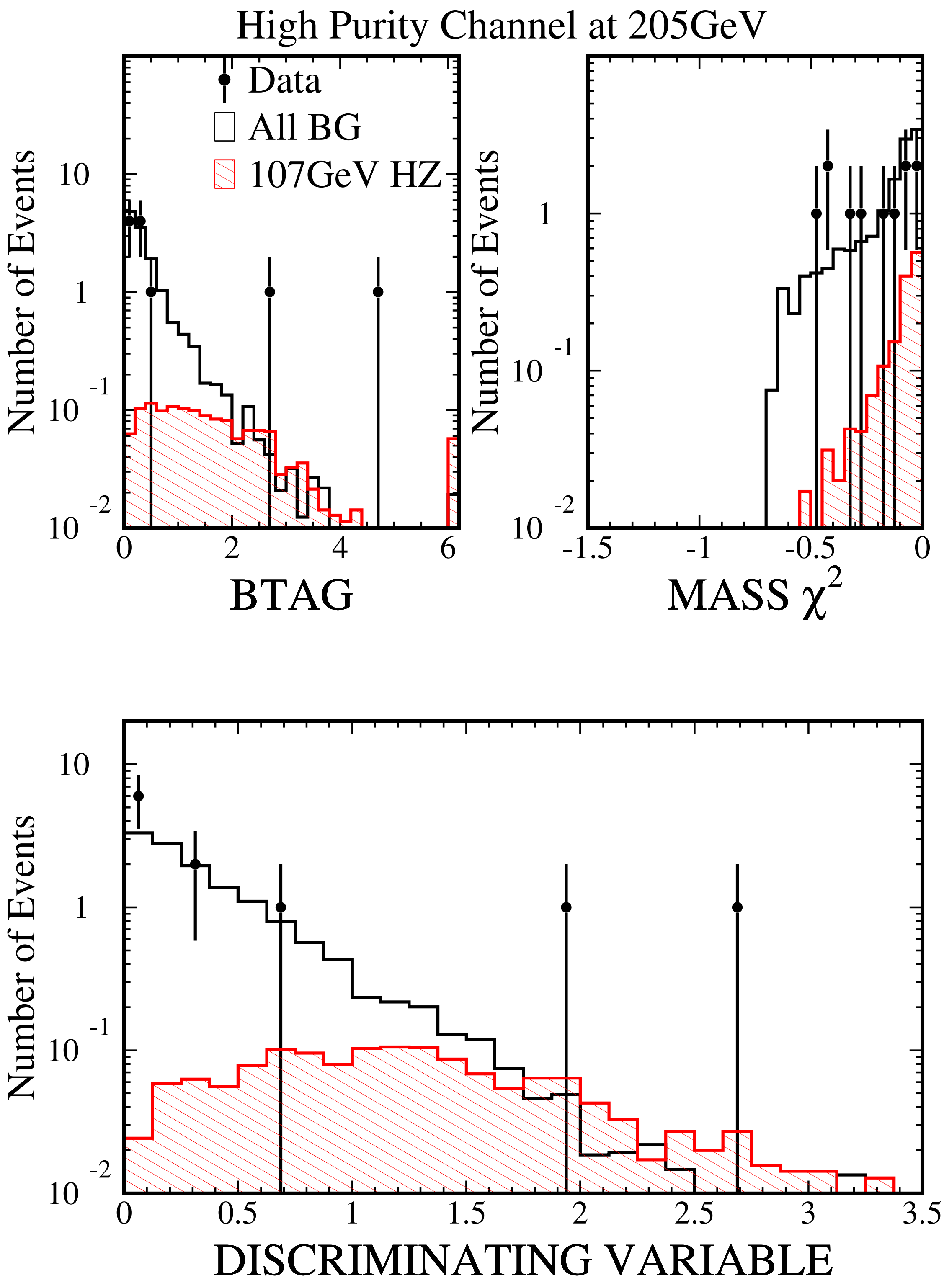
reconstructed Higgs mass

observed / expected events

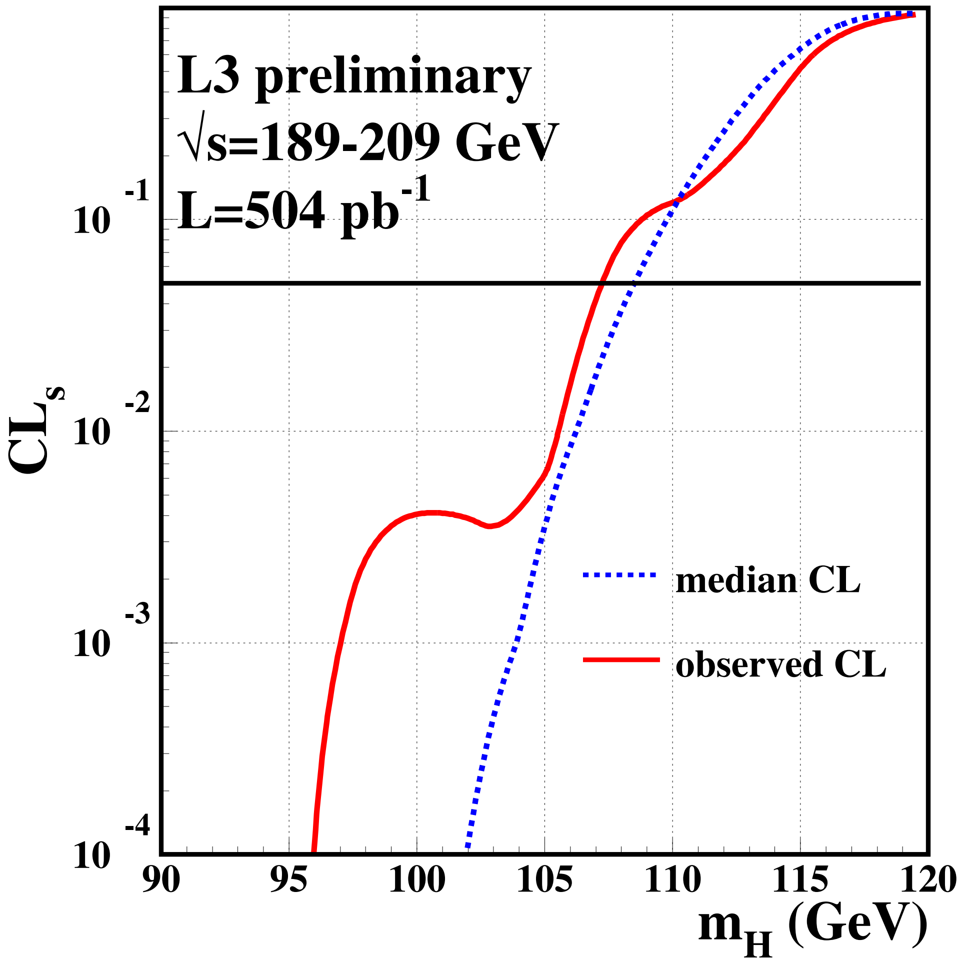
Channel	Data	BG	Signal 107 GeV	$m_H \geq 100$ GeV Data	$m_H \geq 100$ GeV BG	$m_H \geq 100$ GeV Signal 107 GeV
qqqq	9	9.9	2.8	4	2.9	2.0
$qq\nu\nu$	5	4.6	2.0	1	2.8	1.9
$qq\ell\ell$	0	1.5	0.5	0	0.2	0.4
Sum	14	16.0	5.3	5	5.9	4.3

Four jet channel HZ → qqqq

Mass, b tag and discriminating variable distribution



No signal observed
→ limits set at 95% CL

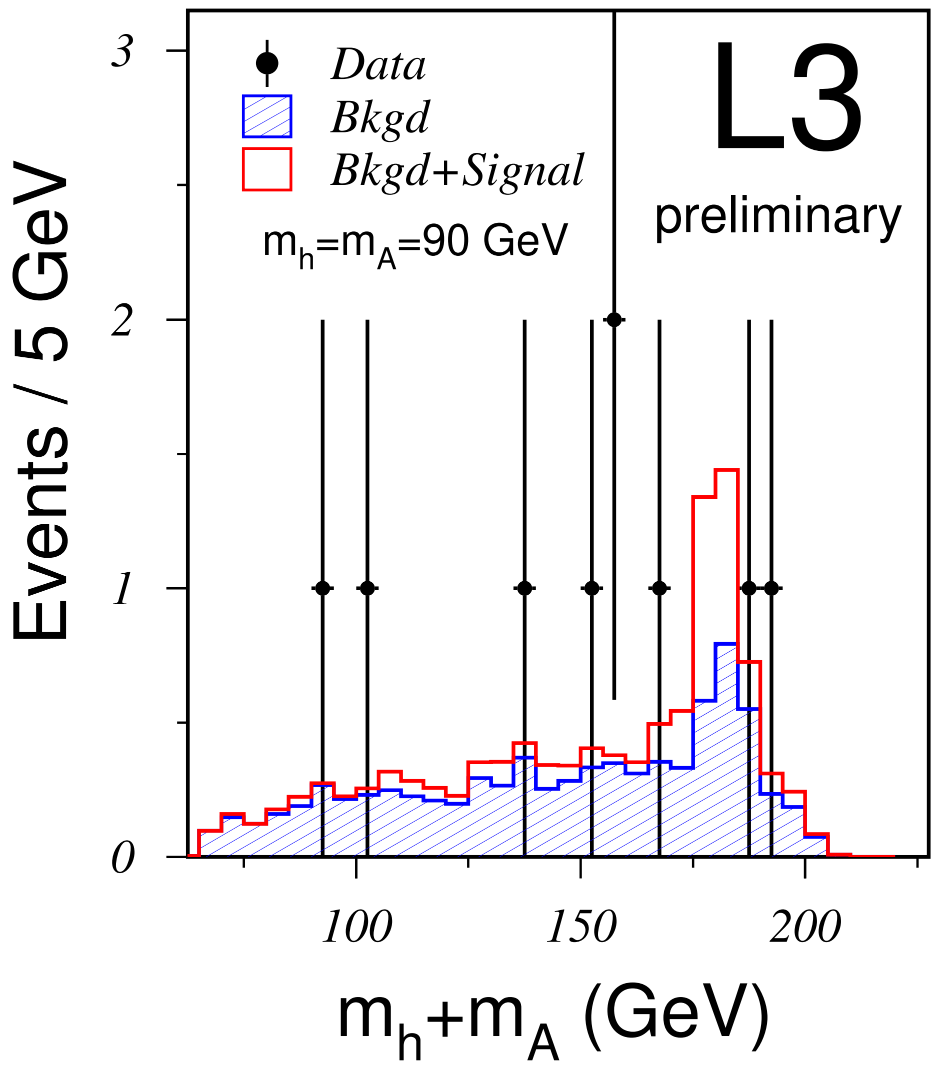


Observed: $m_H > 107.6$ **GeV**

median expected: $m_H > 108.5$ **GeV**

IMPORTANTE

Four jet channel hA → bbbb



			$m_h + m_A \geq 160$ GeV		
Data	BG	Signal 90 GeV	Data	BG	Signal 90 GeV
9	7.9	2.9	3	3.5	2.1

MSSM high tan β limit:

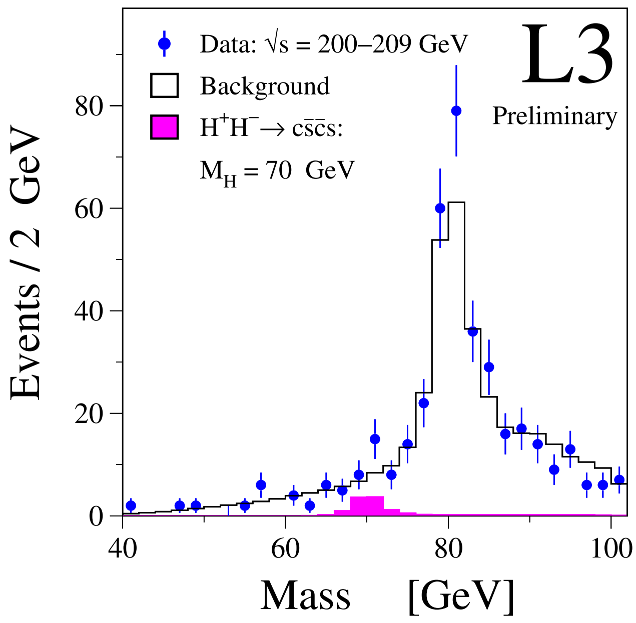
$m_h > 87$ GeV (expected 87 GeV)

$m_A > 87$ GeV (expected 87 GeV)

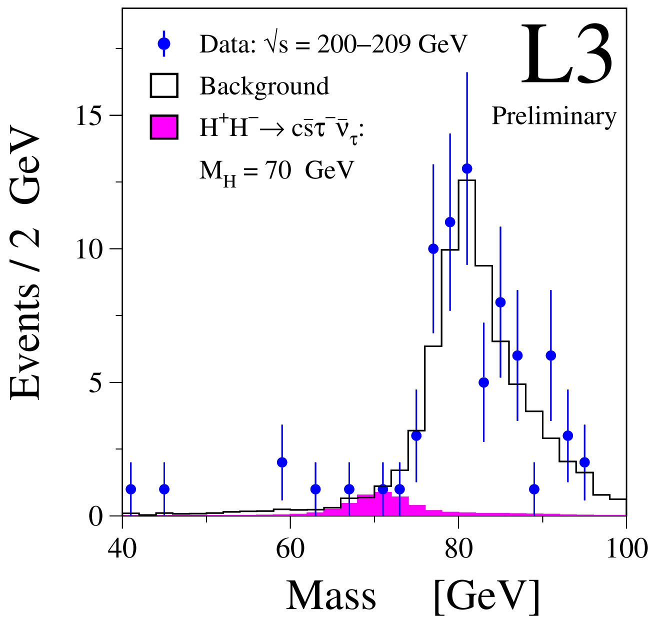
Searches for Charged Higgs Bosons $H^{\pm} \to cs, \tau\nu$

Higgs candidate masses (this year data, $\int \mathcal{L}dt \approx 92.1\mathrm{pb}^{-1}$)

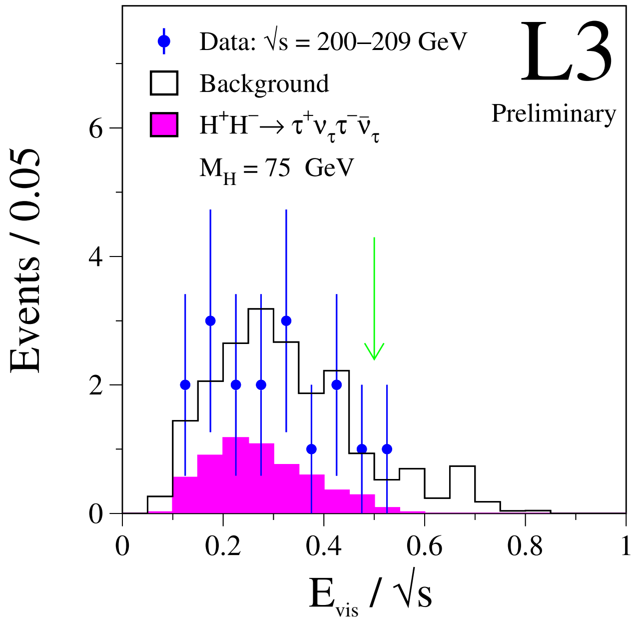
cscs



$cs\tau\nu$



$\tau\nu\tau\nu$



- At $\sqrt{s} > 202$ GeV searches in the following channels are performed:
  - $\tilde{\chi}_1^{\pm}$, $\tilde{\chi}_1^0$
  - $\tilde{e}, \tilde{\mu}, \tilde{\tau}, \tilde{t}, \tilde{b}$
  - γ+missing energy, $\gamma\gamma$+missing energy:

- Basic assumptions:

R-parity conservation: pair production of S-particles

and Lightest S-particle (LSP) $\tilde{\chi}_1^0$ stable and invisible

- Sleptons: $e^+e^- \rightarrow \tilde{\ell}\tilde{\ell} \rightarrow \ell\ell\tilde{\chi}_1^0\tilde{\chi}_1^0$
  2 leptons, E_{miss}
- Squarks: $e^+e^- \rightarrow \tilde{q}\tilde{q} \rightarrow q\bar{q}\tilde{\chi}_1^0\tilde{\chi}_1^0$
  2 jets, E_{miss}
- Charginos: $e^+e^- \rightarrow \tilde{\chi}_1^+\tilde{\chi}_1^- \rightarrow W^*W^*\tilde{\chi}_1^0\tilde{\chi}_1^0$
  E_{miss} and :4 jets, or 2 jets and 1 lepton,or 2 leptons

$$\Delta M = (M_{Sparticle} - M_{LSP})$$

Most important parameter for all analyses

- **30 selections for Charginos, Neutralinos, Sleptons**

Neutralinos

$\sqrt{s} = 202 - 208$ GeV, $\int \mathcal{L}\,dt = 56.7\text{pb}^{-1}$

$\sqrt{s} > 205.5$ GeV, $\int \mathcal{L}\,dt = 14.0\text{pb}^{-1}$ (high energy sample)

	Low ΔM		Medium ΔM		High ΔM		.OR.	
	N_{data}	N_{exp}	N_{data}	N_{exp}	N_{data}	N_{exp}	N_{data}	N_{exp}
$\tilde{\chi}^0_2$	11	13.3	1	3.5	0	1.2	12	17.4
$\tilde{\chi}^0_2$	4	3.3	0	0.9	0	0.3	4	4.3

$$N^{\text{Exp}}_{\tilde{\chi}^0_2} \sim 28 \quad N^{\text{Exp}}_{\tilde{\chi}^0_2} \sim 7$$

Charginos

$\sqrt{s} = 202 - 208$ GeV, $\int \mathcal{L}\,dt = 84.3\text{pb}^{-1}$

$\sqrt{s} > 205.5$ GeV, $\int \mathcal{L}\,dt = 28.0\text{pb}^{-1}$ (high energy sample)

	Low ΔM		Medium ΔM		High ΔM		.OR.	
	N_{data}	N_{exp}	N_{data}	N_{exp}	N_{data}	N_{exp}	N_{data}	N_{exp}
$\tilde{\chi}^\pm_1$	20	16.7	17	10.5	9	13.8	44	37.4
$\tilde{\chi}^\pm_1$	7	5.4	3	3.4	3	4.6	13	12.4

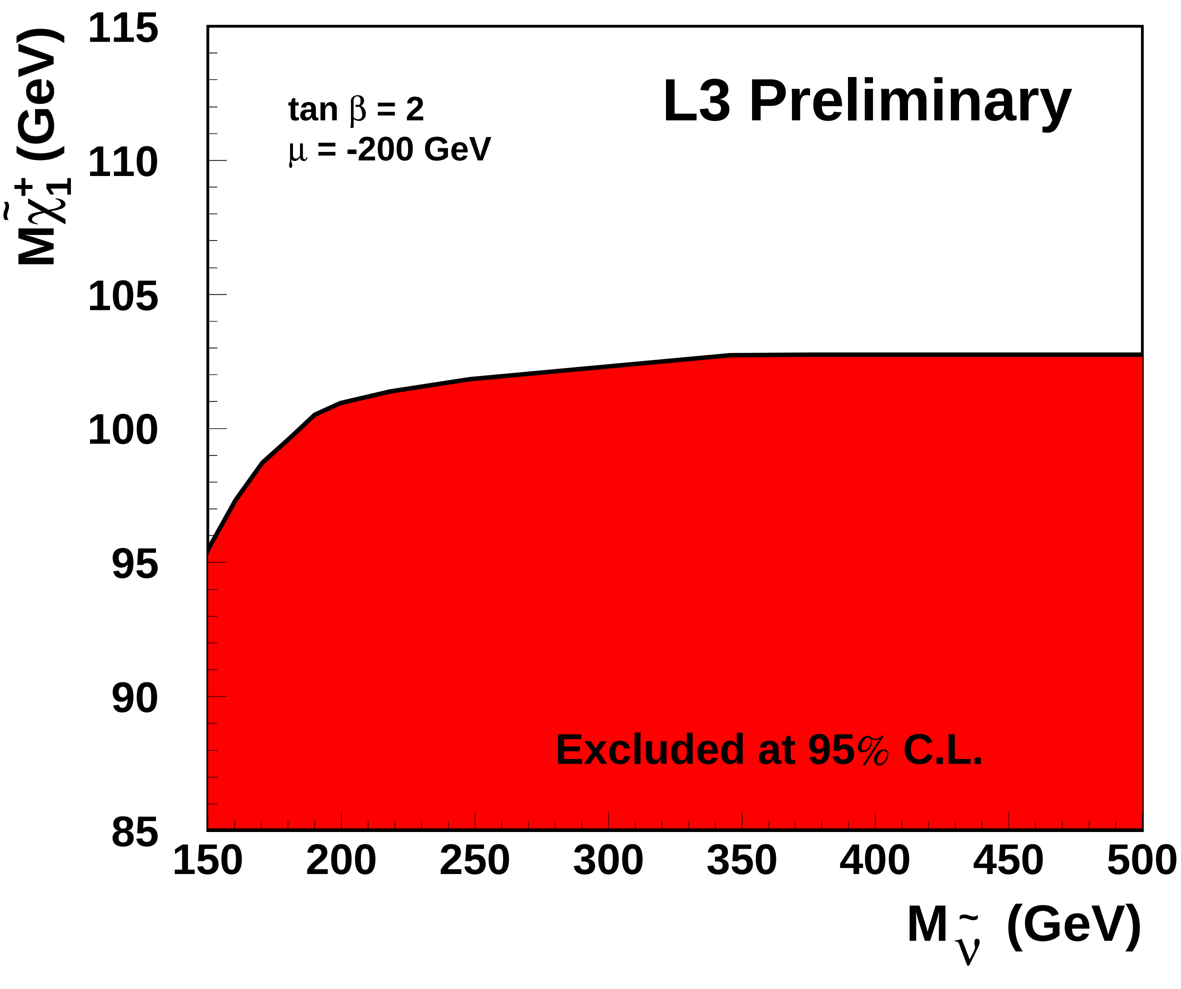
$$N^{\text{Exp}}_{\tilde{\chi}^\pm_1} \sim 42 \quad N^{\text{Exp}}_{\tilde{\chi}^\pm_1} \sim 14$$

No excess respect to SM predictions

- **Enough $\int \mathcal{L}\,dt$ for $\tilde{\chi}^\pm_1$ exclusions**

- $M_{\tilde{\chi}_1^\pm} > 102.7$ GeV
  for large s-neutrino masses

- Very small s-neutrino masses are indirectly excluded by s-lepton exclusions (in particular s-electrons)

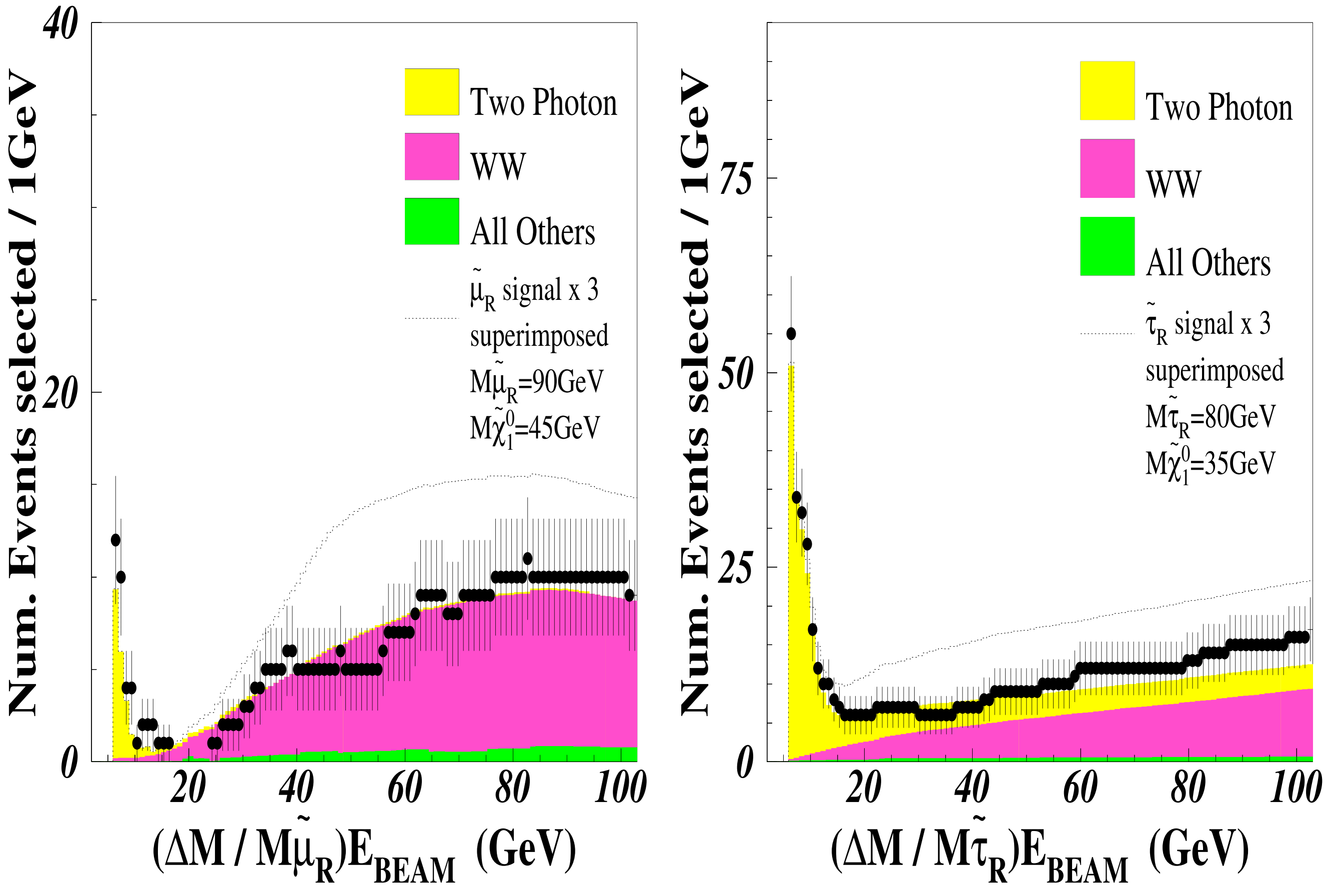


$\sqrt{s} \approx 205$ GeV, $\int \mathcal{L}\,dt = 84.6\text{pb}^{-1}$

	Low ΔM		Medium ΔM		High ΔM		.OR.	
	N_{data}	N_{exp}	N_{data}	N_{exp}	N_{data}	N_{exp}	N_{data}	N_{exp}
$\tilde{e}$	9	9.9	0	4.3	5	9.2	14	20.4
$\tilde{\mu}$	17	13.6	6	5.4	14	12.8	33	27.5
$\tilde{\tau}$	76	66.4	21	21.6	17	12.5	89	76.6

$N^{exp}_{\tilde{e},\tilde{\mu},\tilde{\tau}} \sim 4 - 10$

smuons　　staus



At $\sqrt{s} \sim 205\text{GeV}$ $\int \mathcal{L}\, dt = 49.3\text{pb}^{-1}$

- **Scalar top**

$$e^+e^- \to \tilde{t}_1\bar{\tilde{t}}_1 \to c\tilde{\chi}^0_1\ \bar{c}\tilde{\chi}^0_1 \quad \Longrightarrow 2\text{jets} + E_{\text{miss}}$$

$$e^+e^- \to \tilde{t}_1\bar{\tilde{t}}_1 \to b\ell^+\tilde{\nu}\ \bar{b}\ell^-\tilde{\nu} \quad \Longrightarrow 2\text{b-jets} + 2\ell + E_{\text{miss}}$$

- **Scalar bottom**

$$e^+e^- \to \tilde{b}_1\bar{\tilde{b}}_1 \to b\tilde{\chi}^0_1\ \bar{b}\tilde{\chi}^0_1 \quad \Longrightarrow 2\text{b-jets} + E_{\text{miss}}$$

Channel	Vlow ΔM		Low ΔM		Medium ΔM		High ΔM		OR	
	Data	N_{MC}	Data	N_{MC}	Data	N_{MC}	Data	N_{MC}	Data	N_{MC}
$\tilde{t}_1 \to c\tilde{\chi}^0_1$	21	14.2	0	2.12	3	2.00	4	3.03	28	21.1
$\tilde{t}_1 \to b\ell\tilde{\nu}$	10	8.11	5	2.52	1	0.20	-	-	16	10.60
$\tilde{t}_1 \to b\tau\tilde{\nu}$	4	4.98	2	4.08	1	0.91	-	-	7	9.39
$\tilde{b}_1 \to b\tilde{\chi}^0_1$	13	9.93	1	1.138	0	0.34	0	0.33	14	11.74

No significant excess with respect to SM

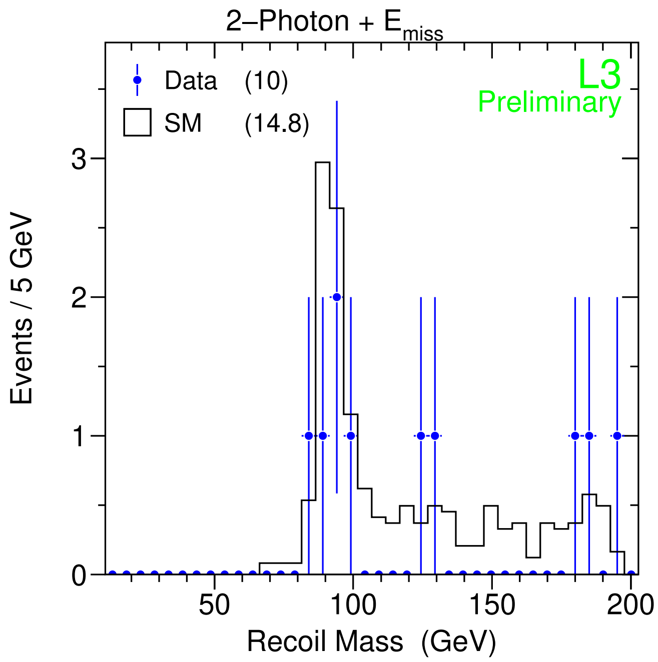
$\gamma(\gamma)$ + missing energy

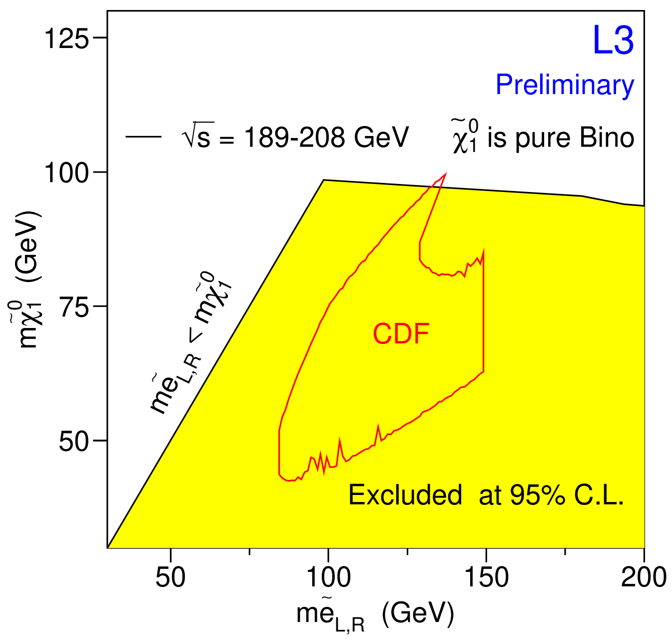
Standard Model Process $e^+e^- \to \nu\bar{\nu}\gamma(\gamma)$

In the GMSB scenario, with $\tilde{G}$ LSP,
the possible decay channels are :

- $e^+e^- \to \tilde{\chi}_1^0\tilde{G} \to \tilde{G}\tilde{G}\gamma$
- $e^+e^- \to \tilde{\chi}_1^0\tilde{\chi}_1^0 \to \tilde{G}\tilde{G}\gamma\gamma$

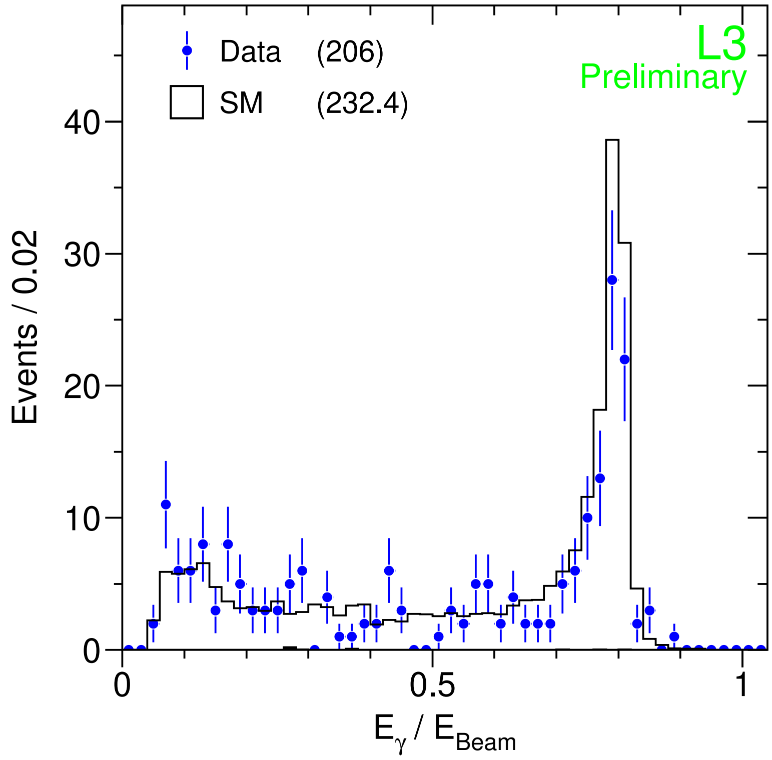
$\sqrt{s} > 202$ GeV ($\theta \geq 14$ deg)





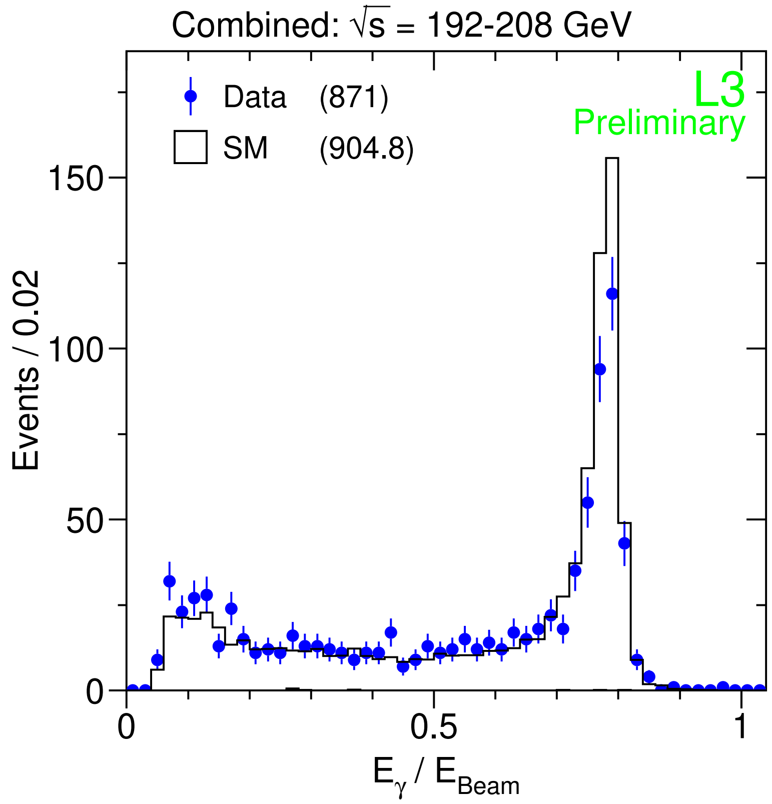
Rule out SUSY interpretation of CDF $ee\gamma\gamma$ event

$\sqrt{s} = 202 - 208$ GeV, $\int\mathcal{L}\,dt = 90.7\mathrm{pb}^{-1}$

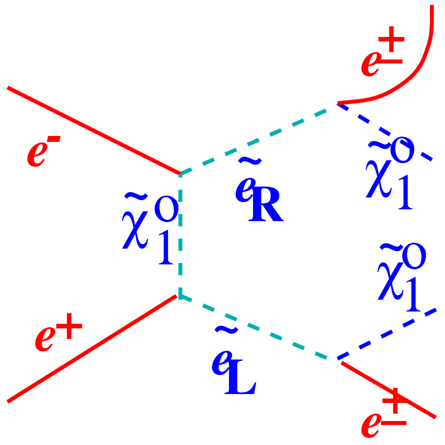


This year's data confirm continue to show a slight disagreement in the shape of the differential cross section.

$\sqrt{s} = 192 - 208$ GeV, $\int\mathcal{L}\,dt = 323\mathrm{pb}^{-1}$



$$\boxed{\tilde{e}_{\mathrm{R}}\tilde{e}_{\mathrm{L}} \longrightarrow (e)e\tilde{\chi}^0_1\tilde{\chi}^0_1}$$



$$0 \text{ GeV} \leq M_{\tilde{e}_{\mathrm{R}}} - M_{\tilde{\chi}^0_1} \leq 3 \text{ GeV}$$
$$M_{\tilde{e}_{\mathrm{R}}} + M_{\tilde{e}_{\mathrm{L}}} \leq \sqrt{s} \simeq 200 \text{ GeV}$$

RESULTS at $\sqrt{s}$ = 192 to 209 GeV

$\sqrt{s}$	Hard + soft		Single-electron		Total	
	N_{Data}	N_{Expec}	N_{Data}	N_{Expec}	N_{Data}	N_{Expec}
192 GeV	1	0.4	2	1.8	3	2.2
196 GeV	1	1.0	7	6.0	8	7.0
200 GeV	1	0.9	9	6.4	10	7.3
202 GeV	3	0.6	5	2.8	8	3.4
205-209 GeV	1	0.9	8	7.0	9	7.9
All $\sqrt{s}$	7	3.8	31	24.0	38	27.8

4 experiments combined : N_{data} =132,N_{MC} = 134

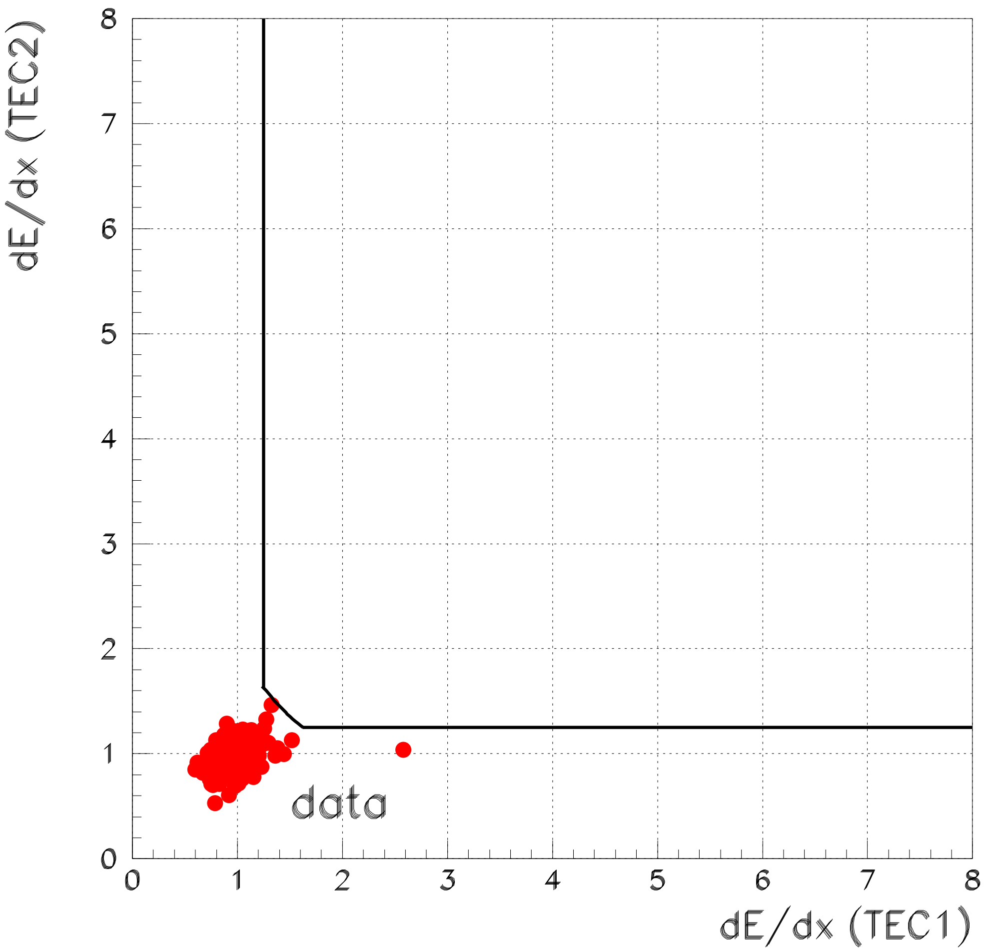
Search for new Unstable Neutral Heavy Leptons. $\mathcal{L} = 96\ \mathrm{pb}^{-1}$

Channel	Data	Background
$e^+e^- \to L^0L^0 \to eWeW$	2	2.1
$e^+e^- \to L^0L^0 \to \mu W \mu W$	1	0.6
$e^+e^- \to L^0L^0 \to \tau W \tau W$	20	26.5

No signal - good agreement between the number of candidates and expected background

Search for Stable Charged Heavy Leptons

103.4 GeV and above, L=23pb-1



Two highly ionising tracks are searched for

No signal $\Longrightarrow$ $Mass > 102.4$ GeV

Search for Pair Production of Excited Leptons. $\mathcal{L} = 90$ pb^{-1}

Signal	Data	Bkg	Signal	Data	Bkg
$e^*e^* \to ee\gamma\gamma$	0	0.3	$\nu_e^*\nu_e^* \to eeWW$	0	0.1
$\mu^*\mu^* \to \mu\mu\gamma\gamma$	0	0.2	$\nu_\mu^*\nu_\mu^* \to \mu\mu WW$	0	0.3
$\tau^*\tau^* \to \tau\tau\gamma\gamma$	0	0.1	$\nu_\tau^*\nu_\tau^* \to \tau\tau WW$	1311	1255
$\ell^*\ell^* \to \nu\nu WW$	1311	1255	$\nu^*\nu^* \to \nu\nu\gamma\gamma$	1	0.7
$e^*e^* \to e\gamma\nu W$	3	2.6	$\nu_e^*\nu_e^* \to \nu\gamma eW$		
$\mu^*\mu^* \to \mu\gamma\nu W$	1	1.3	$\nu_\mu^*\nu_\mu^* \to \nu\gamma\mu W$	2	2.3
$\tau^*\tau^* \to \tau\gamma\nu W$	15	13	$\nu_\tau^*\nu_\tau^* \to \nu\gamma\tau W$		

No signal $\Longrightarrow$ Mass limits are set

Excited Lepton Coupling	95% CL Mass Limit (GeV)		
	$f = f'$	$f = -f'$	Coup. Indep.
e^*	102.5	95.9	95.7
μ^*	102.5	95.9	95.9
τ^*	102.4	95.9	94.9
ν_e^*	101.5	102.1	101.3
ν_μ^*	101.8	102.1	101.3
ν_τ^*	93.5	101.9	92.7

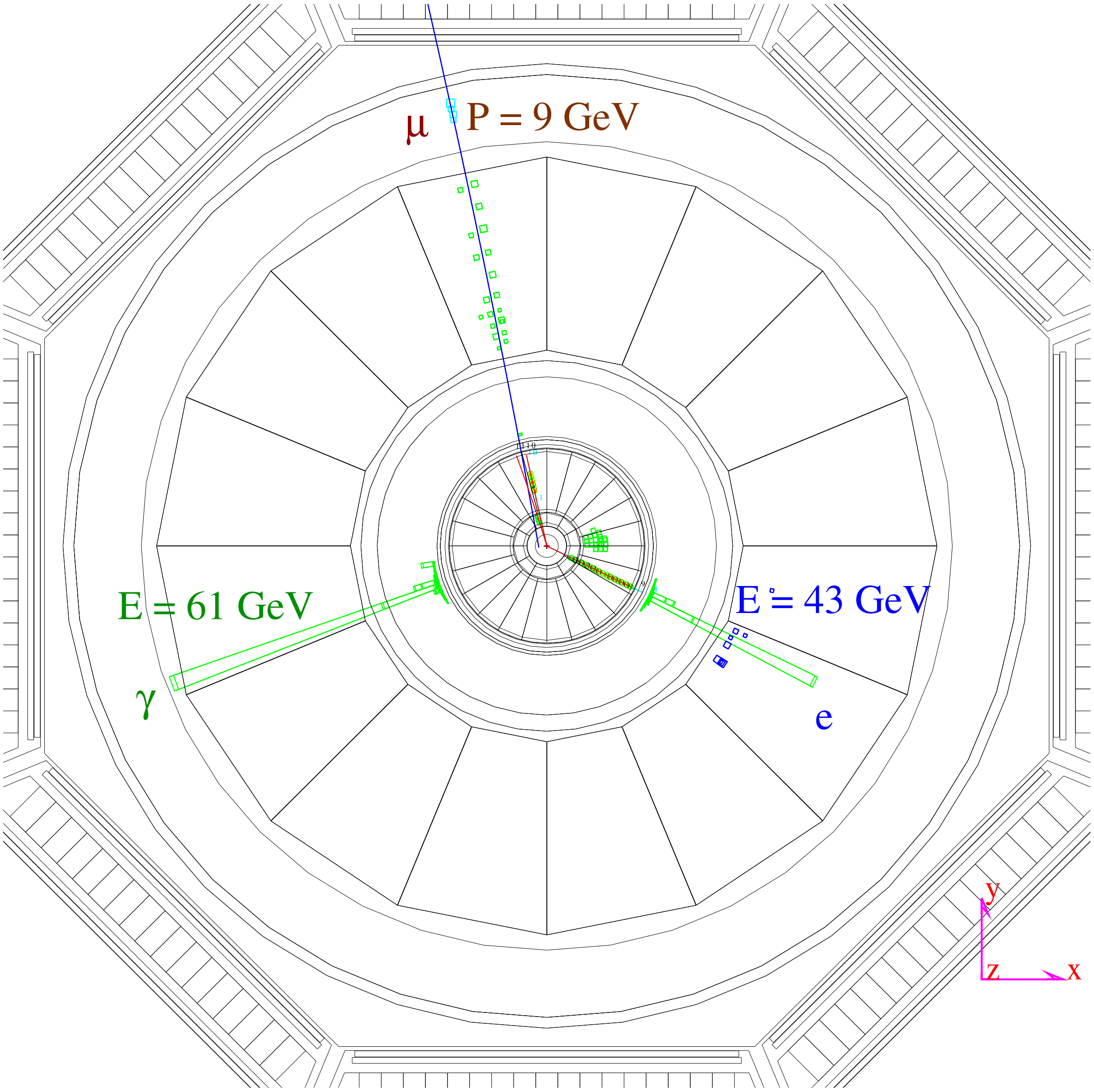
From single production searches, limits are derived on the coupling constant $|f|/\Lambda$

Excited Electrons Candidate

Candidate to e*e* production at $\sqrt{s} = 204\text{GeV}$

m(e , γ) = 95 GeV   m_recoil(e ,γ) = 90 GeV

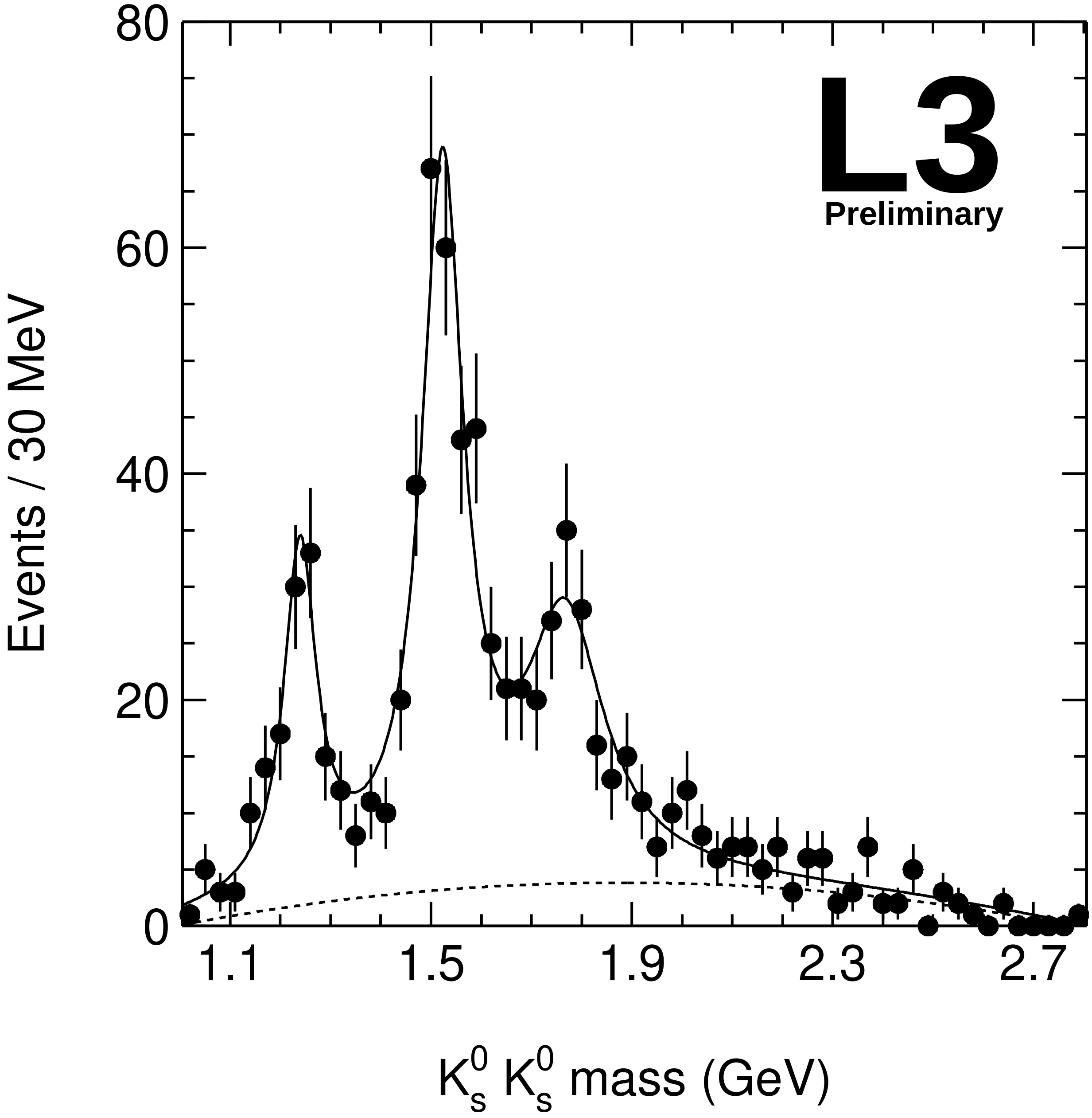
Run # 812802 Event # 630 Total Energy : 121.44 GeV



Transverse Imbalance :	.2681	**Longitudinal Imbalance :**	.0098
Thrust : .8491	**Major :** .4177	**Minor :** .1099	
Event DAQ Time :	*420 52213*		

$$e^+ e^- \longrightarrow e^* e^* \longrightarrow e \gamma \nu W \longrightarrow e \gamma \nu \mu \nu$$

The $K^0_s K^0_s$ Mass Spectrum



Four regions of interest:

- **$f_2(1270) - a_2(1320)$ destructive interference**
- **Clear $f_2'(1525)$ signal**
- **Clear enhancement in the 1750 MeV region**
- **No signal in the $\xi(2230)$ region**

L3 has collected $\sim$ 100 pb^{-1} in 2000
no significant excess

- L3 strongly supports running in weeks 38 and 39, "LEP reserve"
- supports running in 2*2 mode as soon as possible in order to collect more luminosity at 208 GeV