L3 Status Report

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LEPC

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- Data taking status

- 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

2000 data sample:

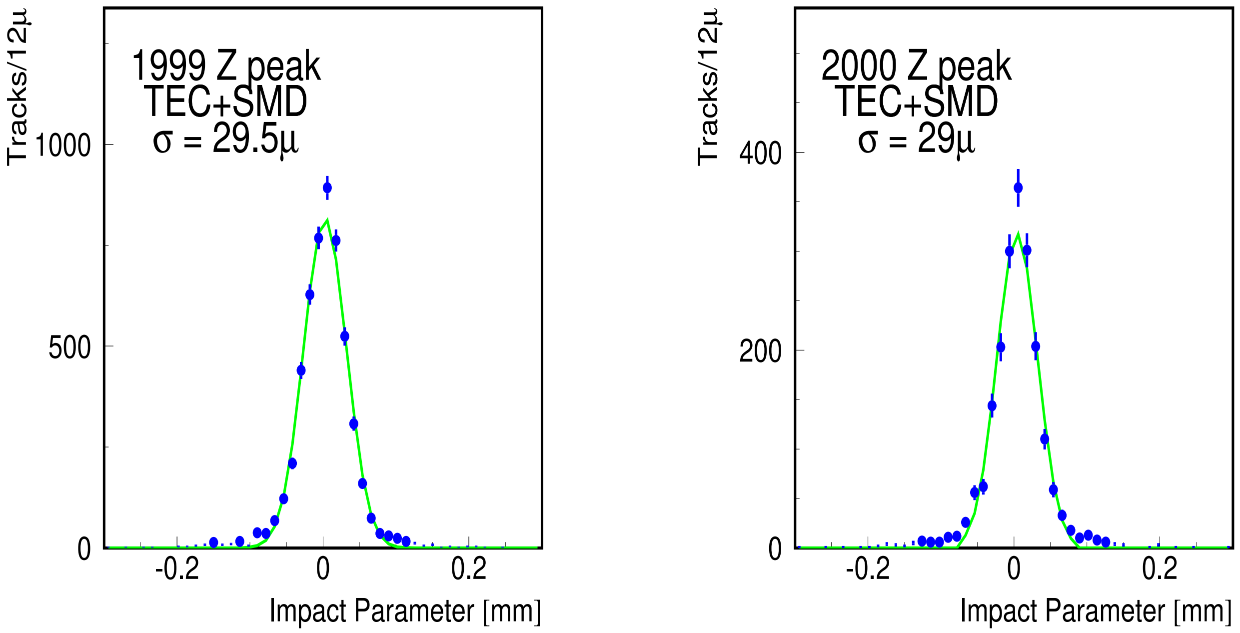
- $\sqrt{s}$=91 GeV , $\int\mathcal{L}\,\mathrm{d}t$ =0.5 pb^{-1}
- $\sqrt{s}$=201-205.5 GeV , $\int\mathcal{L}\,\mathrm{d}t$= xx pb^{-1} "¡205.5 GeV"
- $\sqrt{s}$=205-208 GeV , $\int\mathcal{L}\,\mathrm{d}t$= xx pb^{-1} "¿205.5 GeV"

$$\int\mathcal{L}\,\mathrm{d}t = \text{xx pb}^{-1} \text{ on tape}$$
$$\int\mathcal{L}\,\mathrm{d}t = \text{xx pb}^{-1} \text{ delivered}$$

DATA ACQUISTION efficiency :XX%

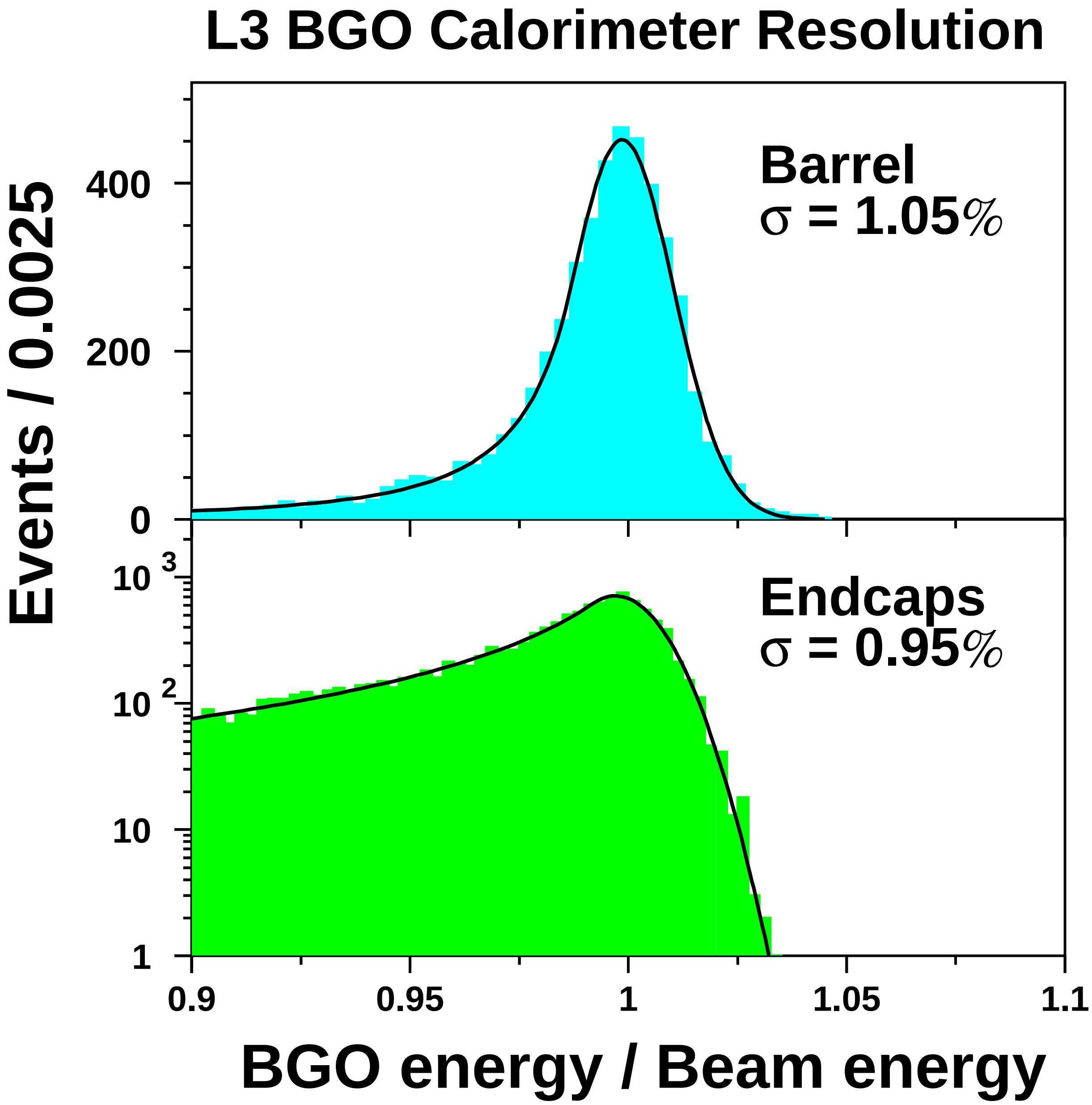
All results are preliminary

- Due to the loss of half sectors in 1999, decision was taken to run TEC at 88% of the cathodes nominal voltage (except 1 bone which is at 85%)
- Decision proven to be good: the resolution is maintained and no loss of half sectors this year.



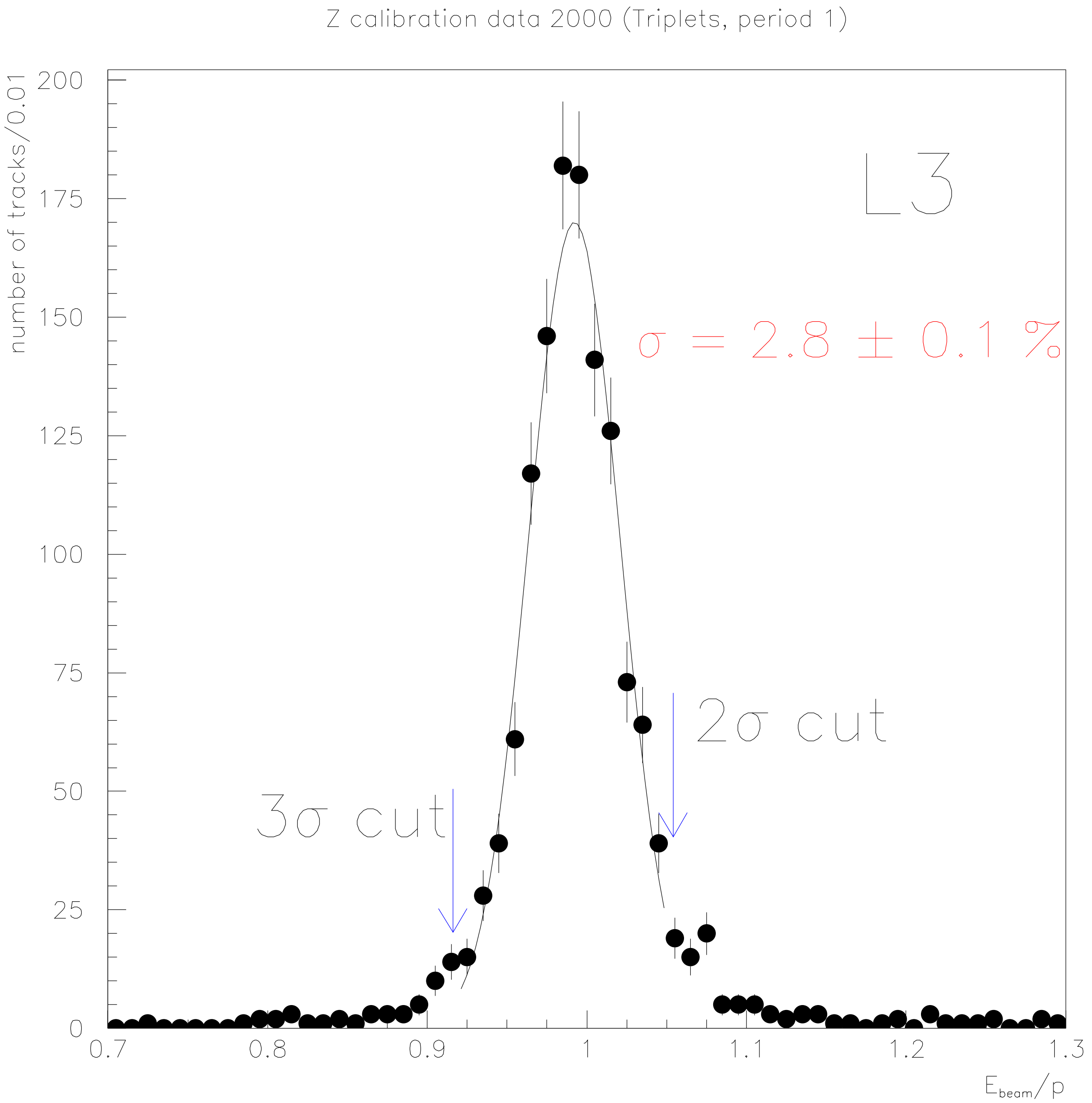
- Loss of 1/3 of the anode wires in sector 7 because high off-momentum background due to vacuum leak in one of the copper cavities.
- The central tracker is running smoothly in 2000

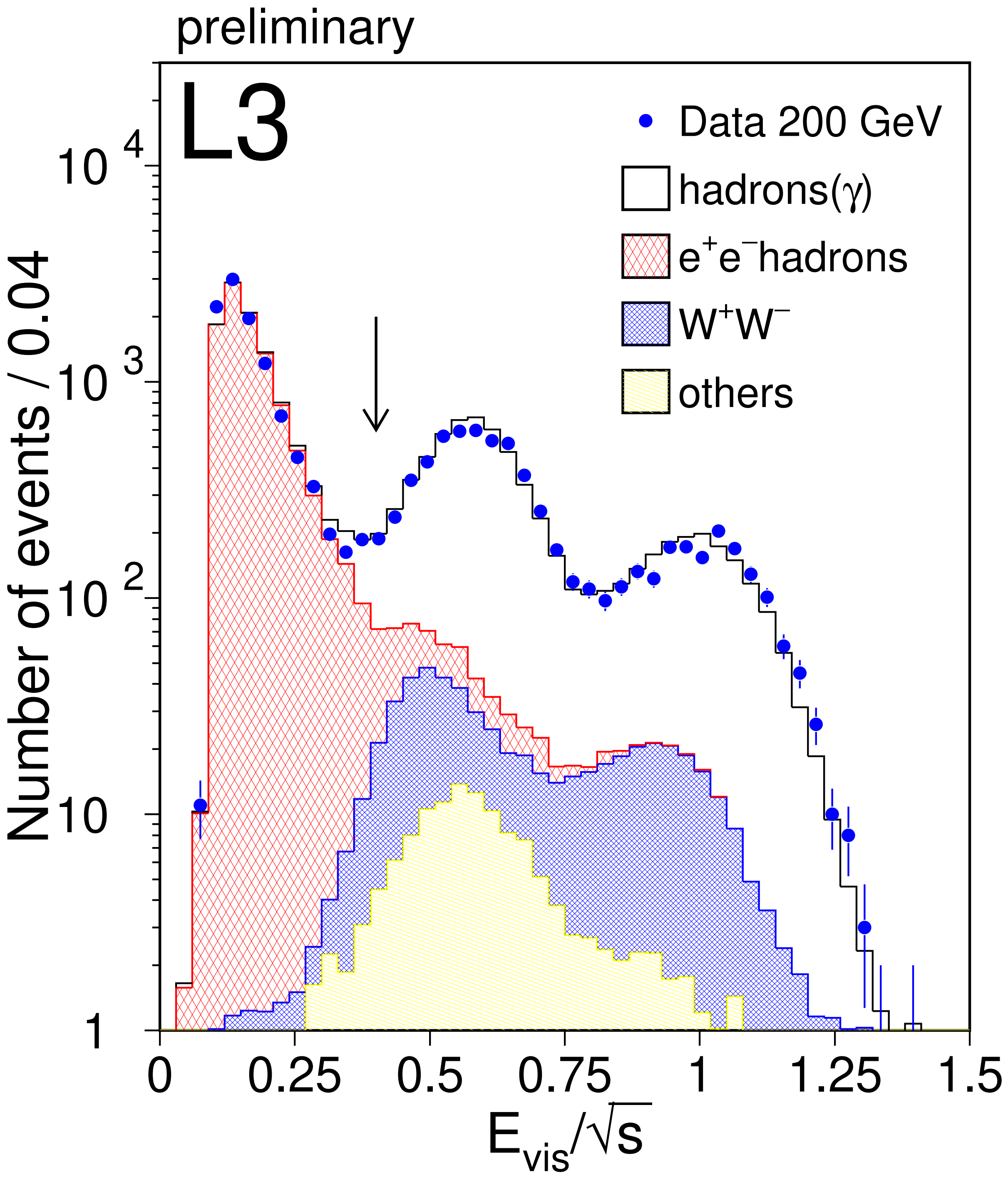
♠ 2000 year data at $\sqrt{s} = m_Z$: $Z \rightarrow e^+e^-$

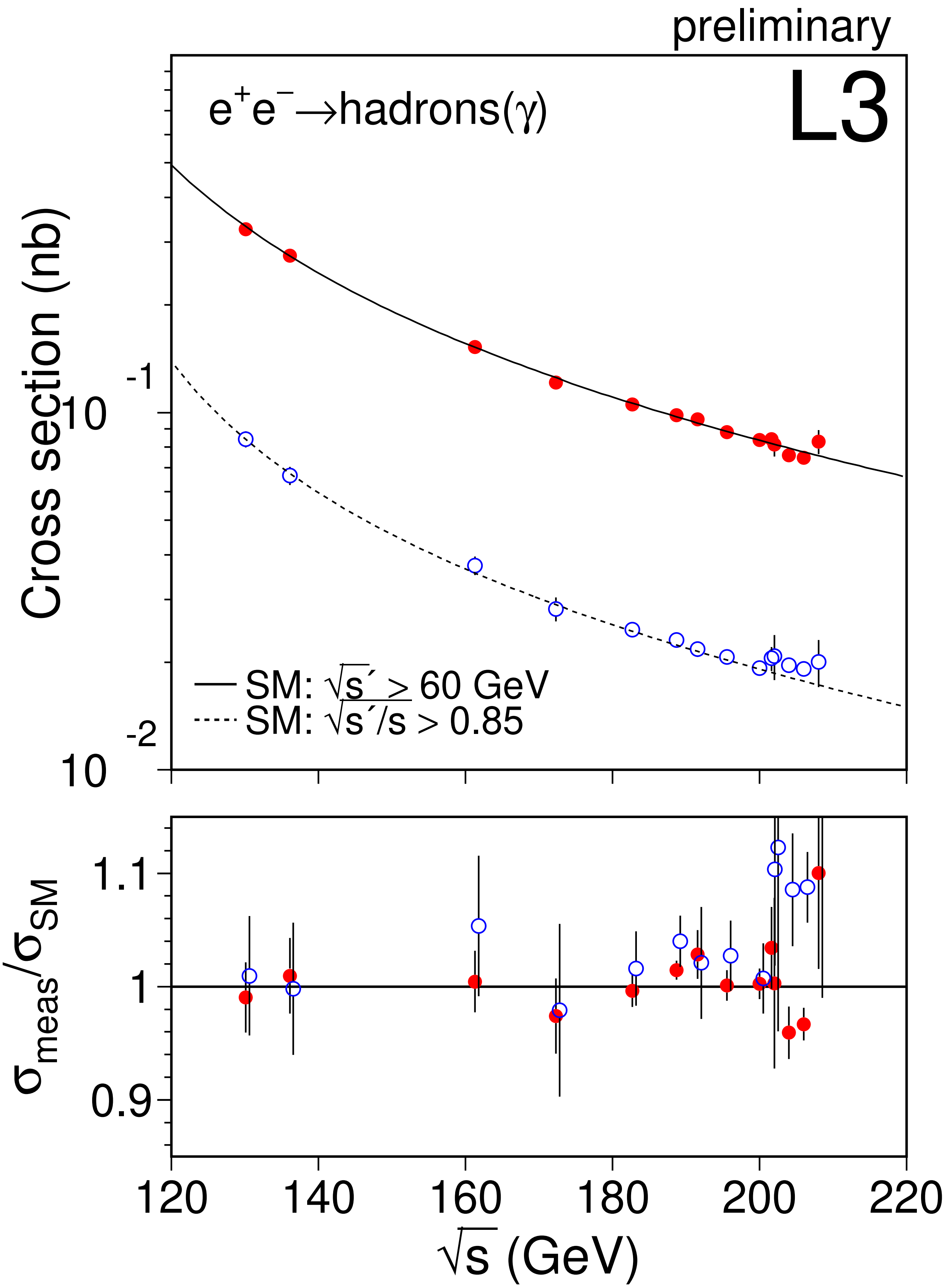


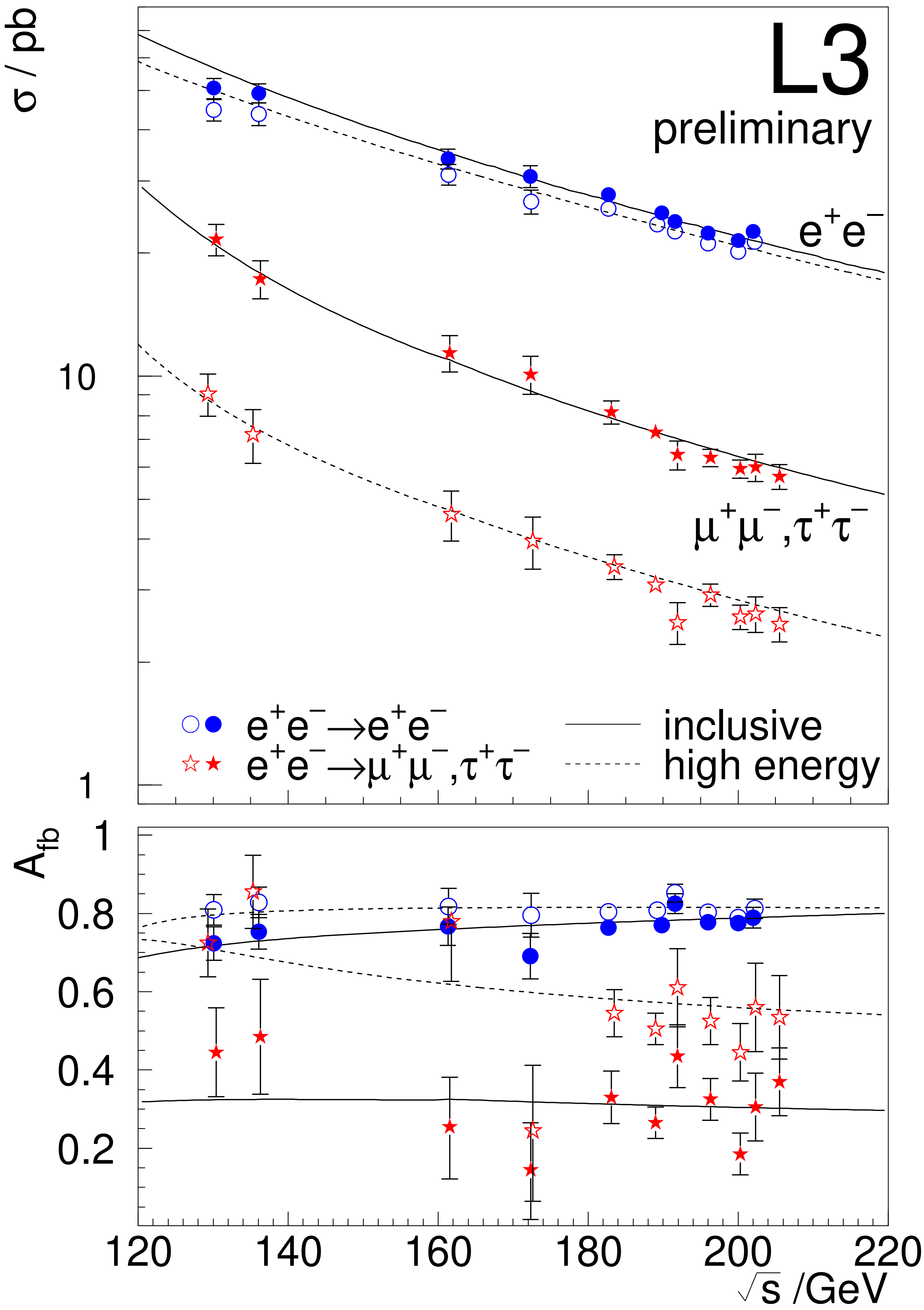
10734 crystals, calibrated with RFQ and Bhabha events.

♠ 2000 year data at $\sqrt{s} = m_Z$: $Z \to \mu^+\mu^-$

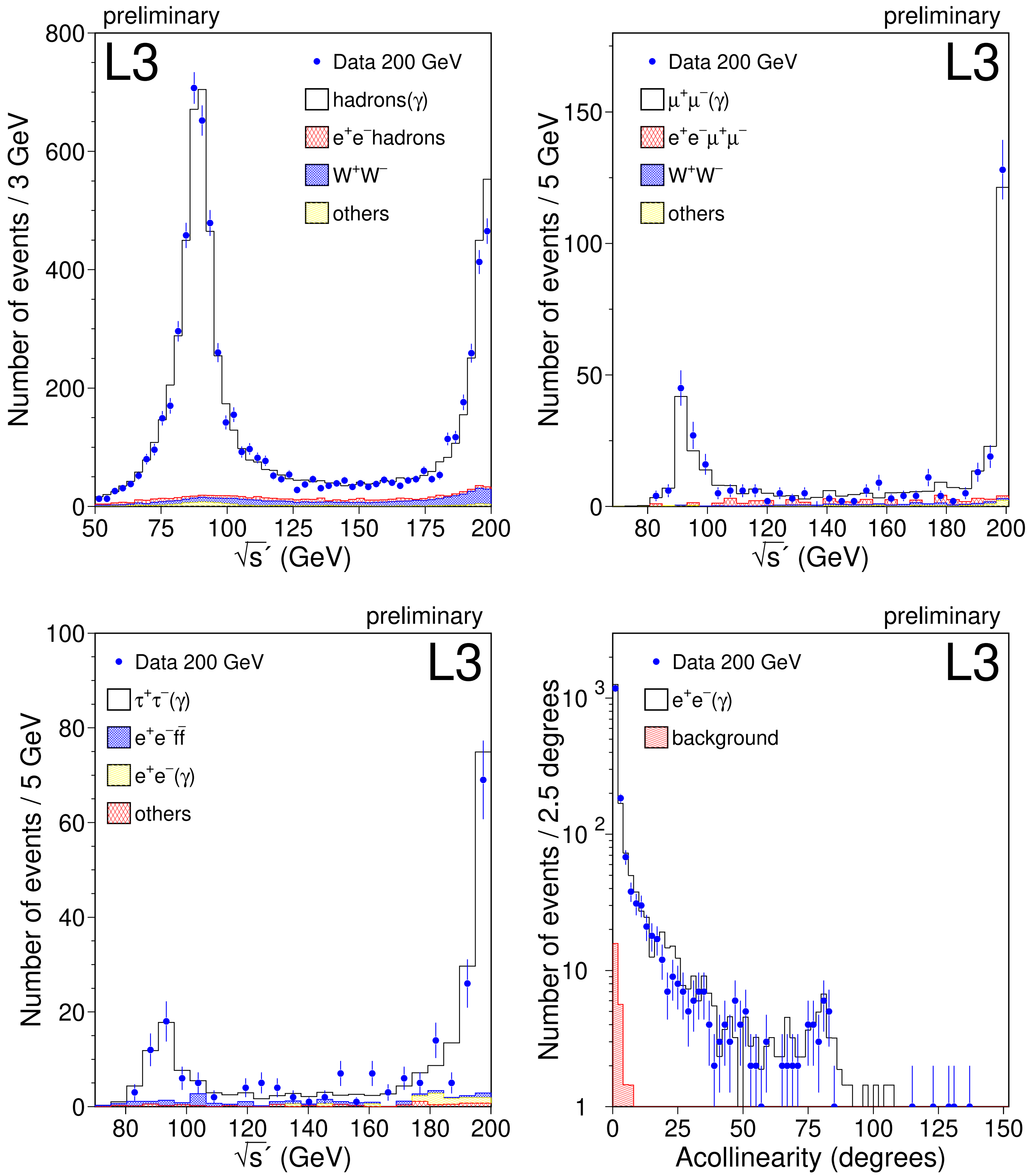



preliminary
L3
Data 200 GeV
hadrons(γ)
e⁺e⁻hadrons
W⁺W⁻
others
Number of events / 0.04
1
10
10 2
10 3
10 4
0
0.25
0.5
0.75
1
1.25
1.5
E_vis/√s


preliminary
L3
$e^+e^- \rightarrow$ hadrons(γ)
SM: $\sqrt{s'} > 60$ GeV
SM: $\sqrt{s'/s} > 0.85$
Cross section (nb)
10^{-1}
10^{-2}
$\sigma_{meas}/\sigma_{SM}$
1.1
1
0.9
120
140
160
180
200
220
$\sqrt{s}$ (GeV)

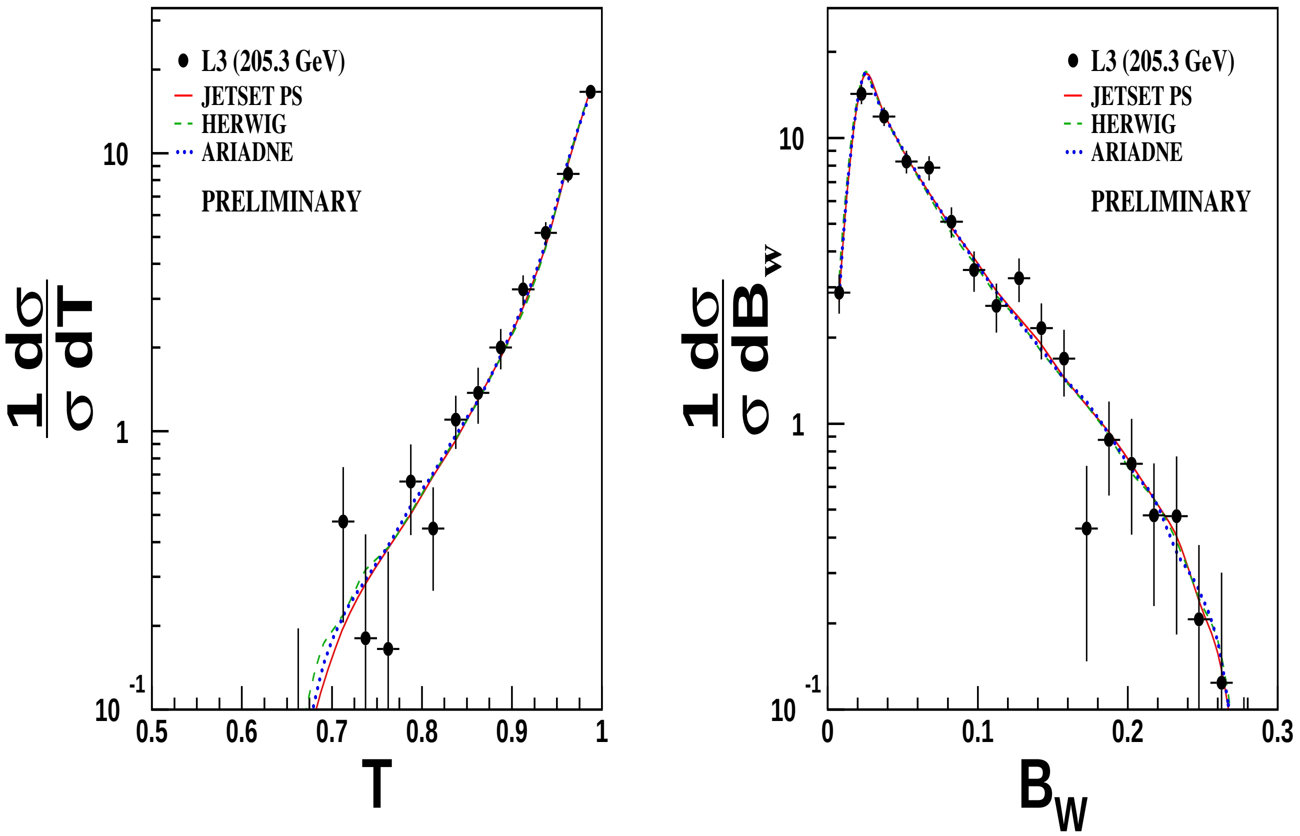

σ / pb
L3
preliminary
e^+e^-
$\mu^+\mu^-,\tau^+\tau^-$
10
1
$e^+e^-\rightarrow e^+e^-$
$e^+e^-\rightarrow\mu^+\mu^-,\tau^+\tau^-$
inclusive
high energy
A_{fb}
1
0.8
0.6
0.4
0.2
120
140
160
180
200
220
$\sqrt{s}$ /GeV

Fermion-Pair Production - $\sqrt{s'}$

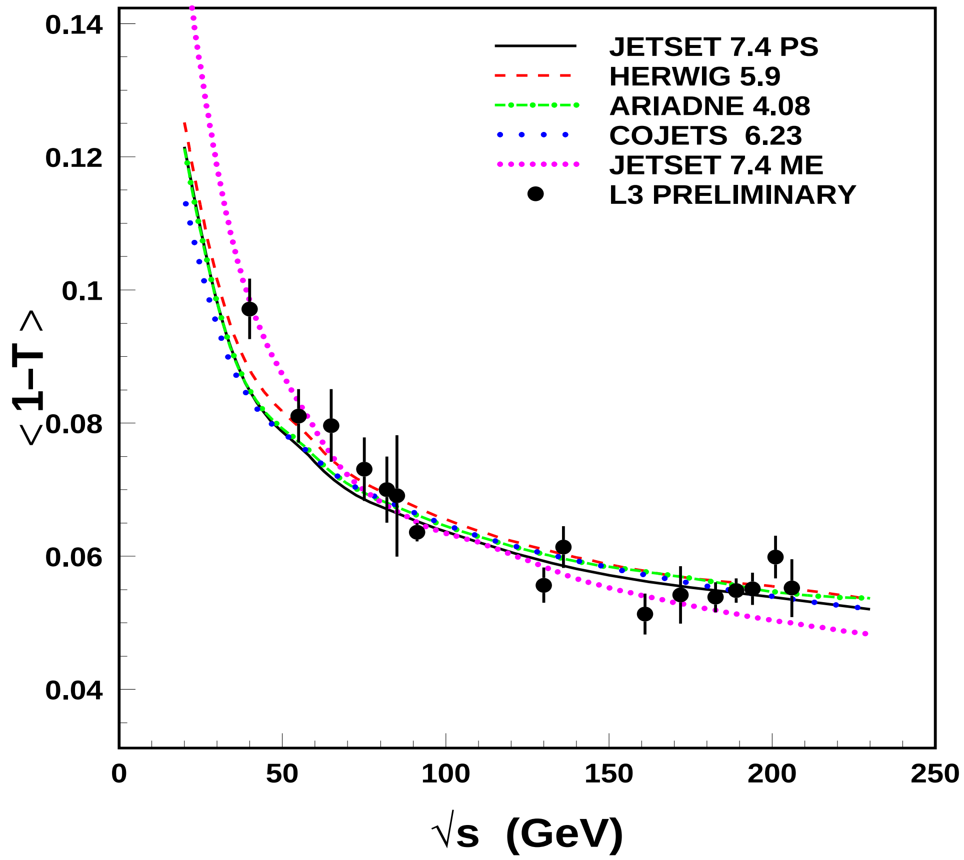


Test of QCD

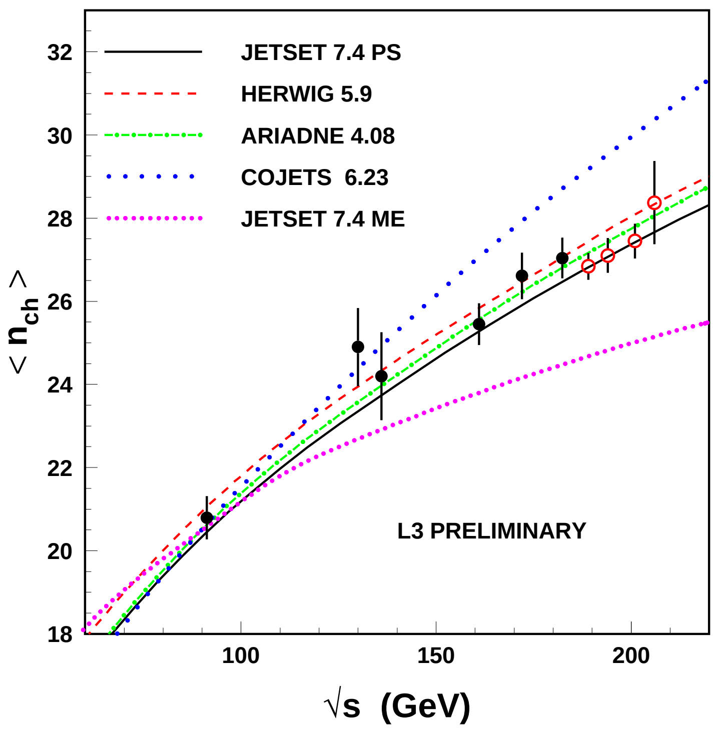
Event Shapes (corrected) @ $\langle\sqrt{s}\rangle = 205.3$GeV



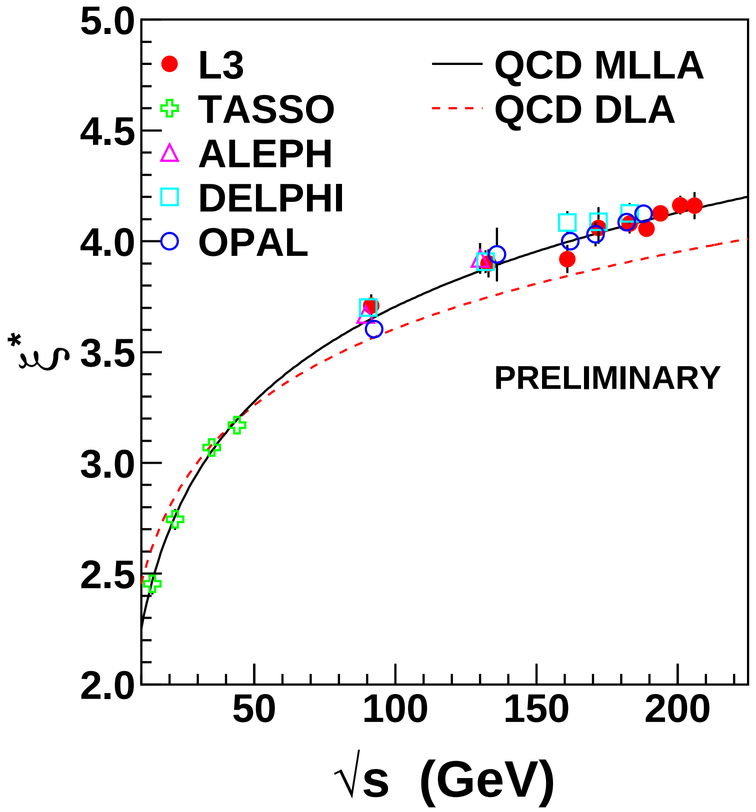
Energy evolution of $\langle 1 - T\rangle$



Inclusive Charged Particle Spectra



Mean of
Charged Particle
Multiplicity

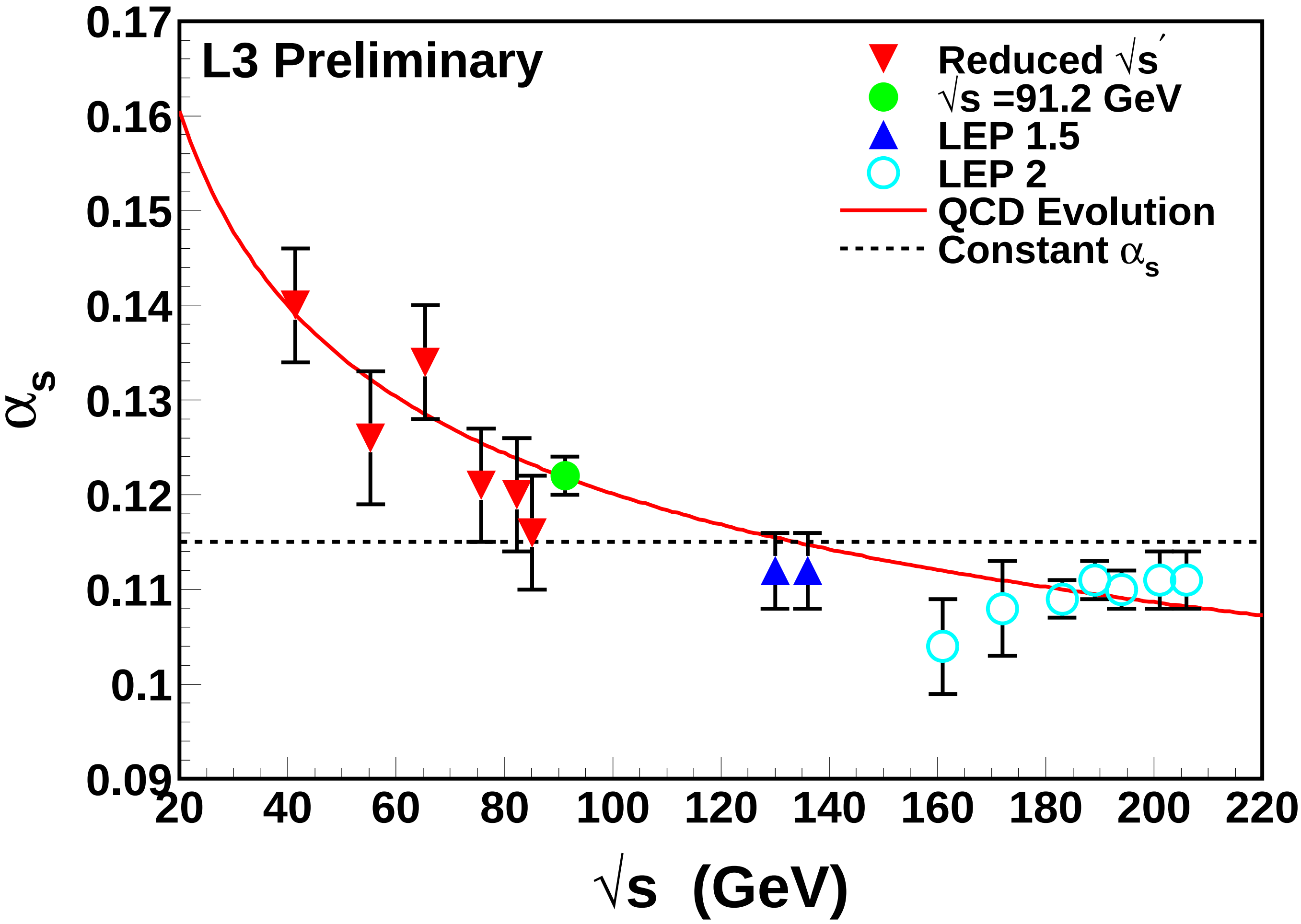


Peak position of ξ spectra

$$\boxed{\alpha_s(195.0\ \mathrm{GeV}) = 0.1108 \pm 0.0023 \pm 0.0056}$$

$$\boxed{\alpha_s(200.6\ \mathrm{GeV}) = 0.1120 \pm 0.0032 \pm 0.0056}$$

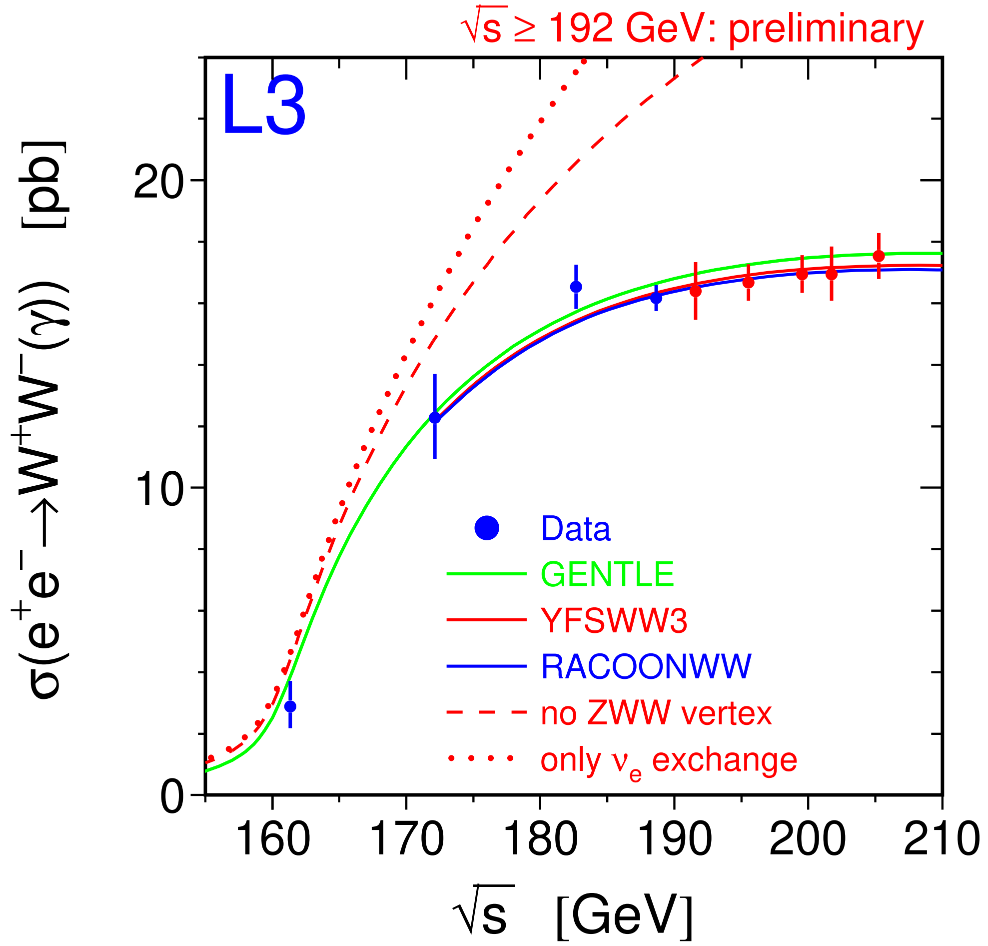
$$\boxed{\alpha_s(205.3\ \mathrm{GeV}) = 0.1112 \pm 0.0035 \pm 0.0055}$$

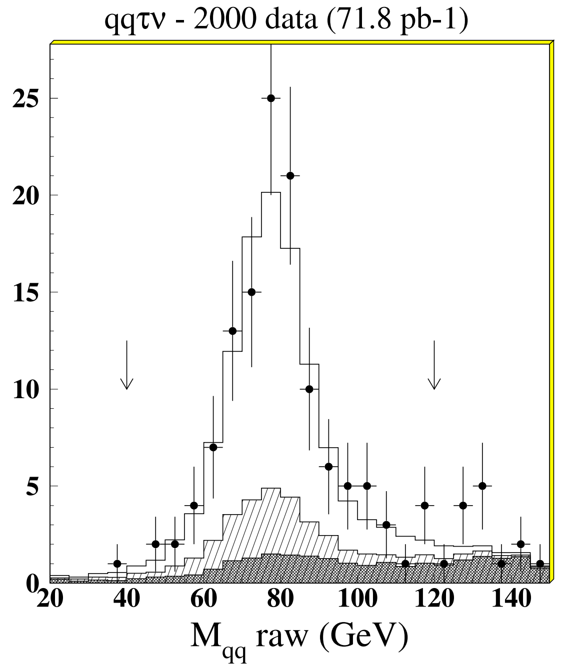


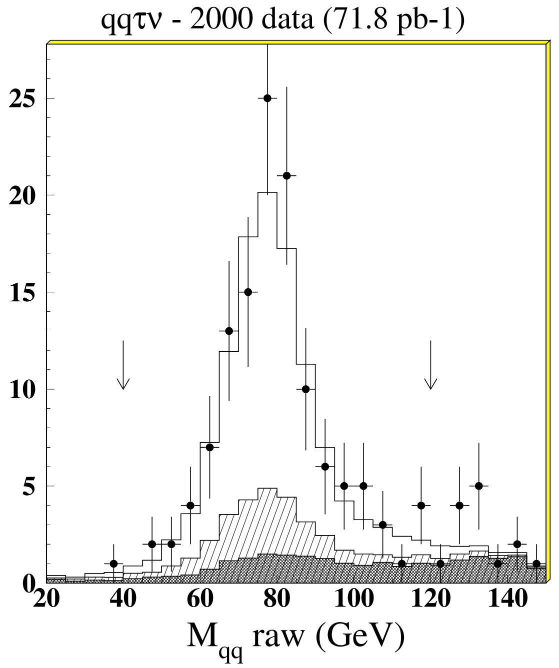
$$\boxed{\alpha_s(m_Z) = 0.1218 \pm 0.0012 \pm 0.0061}$$

$$\boxed{N_f = 5.1 \pm 1.3 \pm 1.9}$$

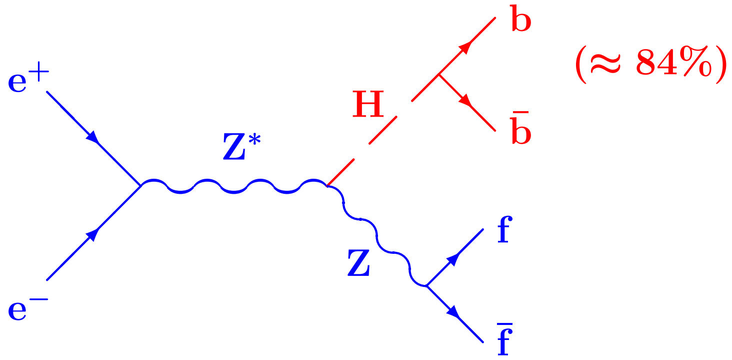
Cross sections and branching ratios are derived (combined with previous years data)

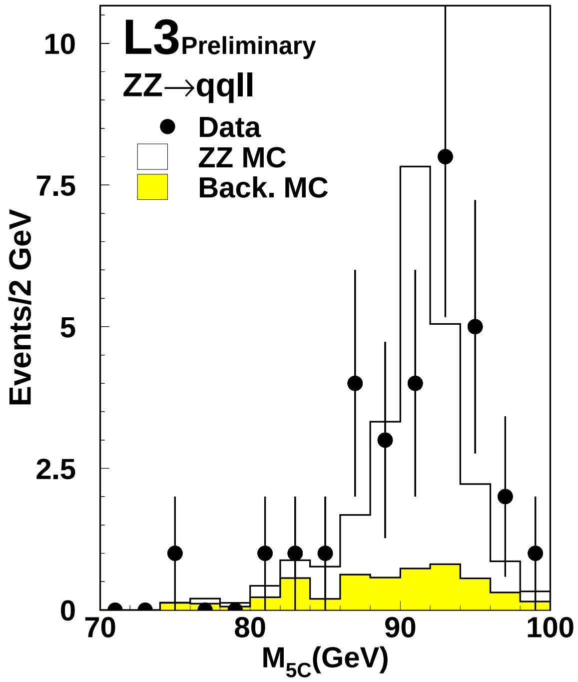


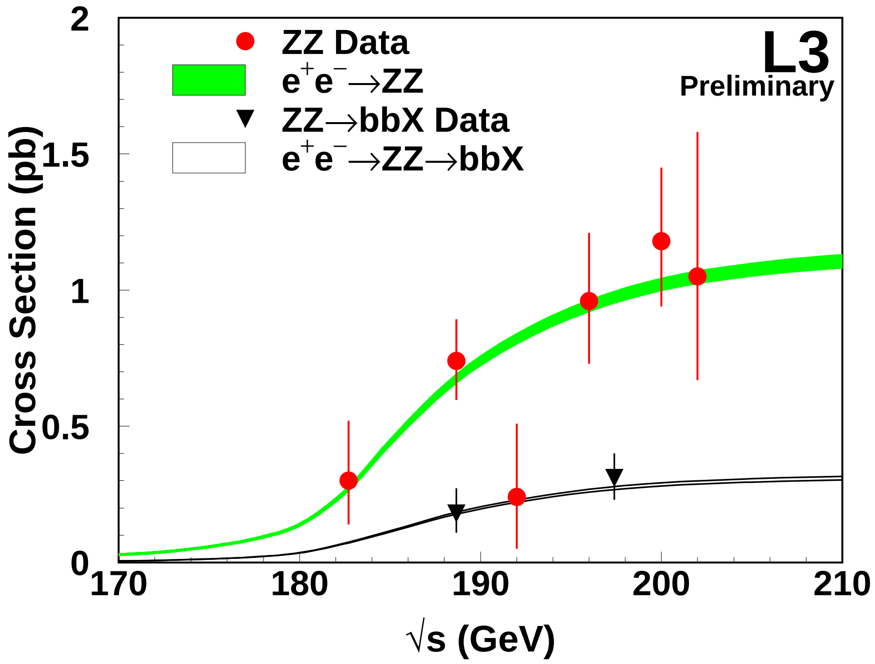




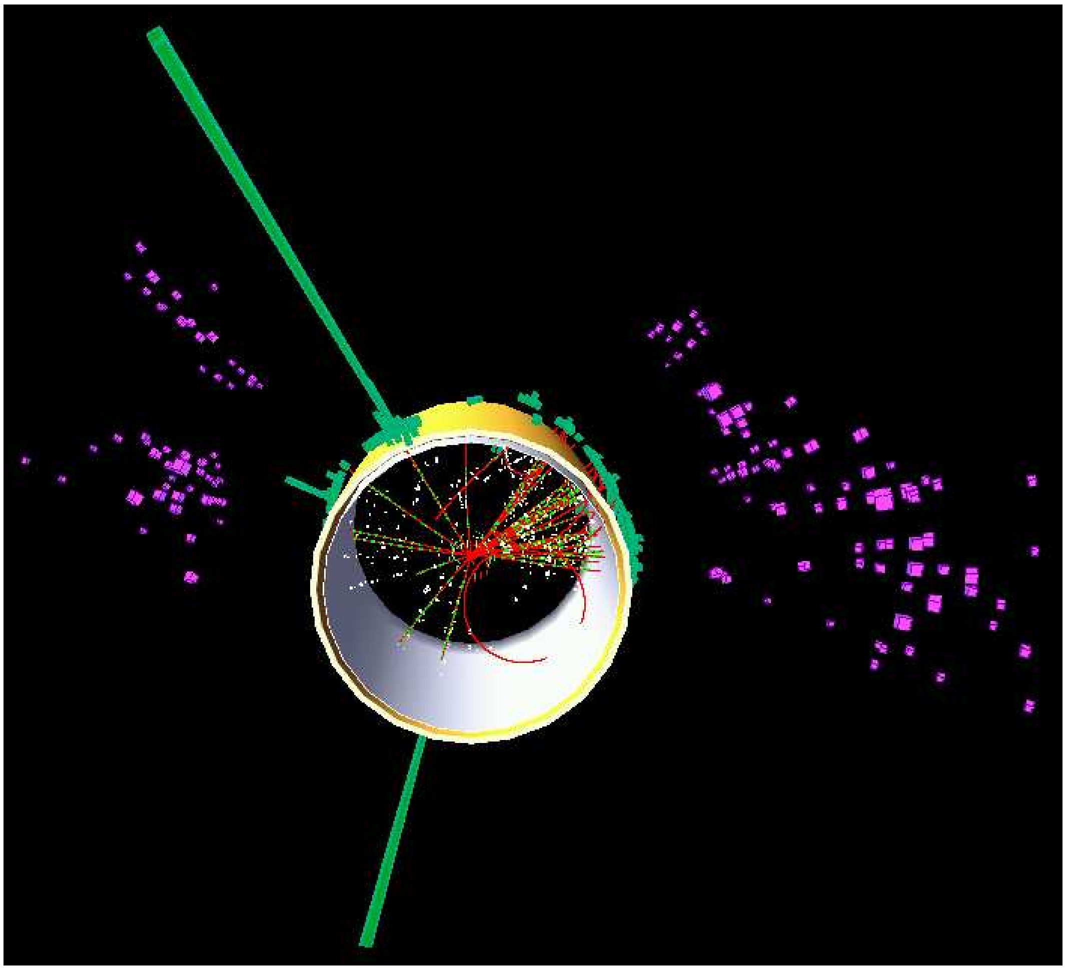
- Look for Higgs through $e^+e^- \to HZ \to b\bar{b}f\bar{f}$ with $e^+e^- \to ZZ \to b\bar{b}f\bar{f}$ as a background process.





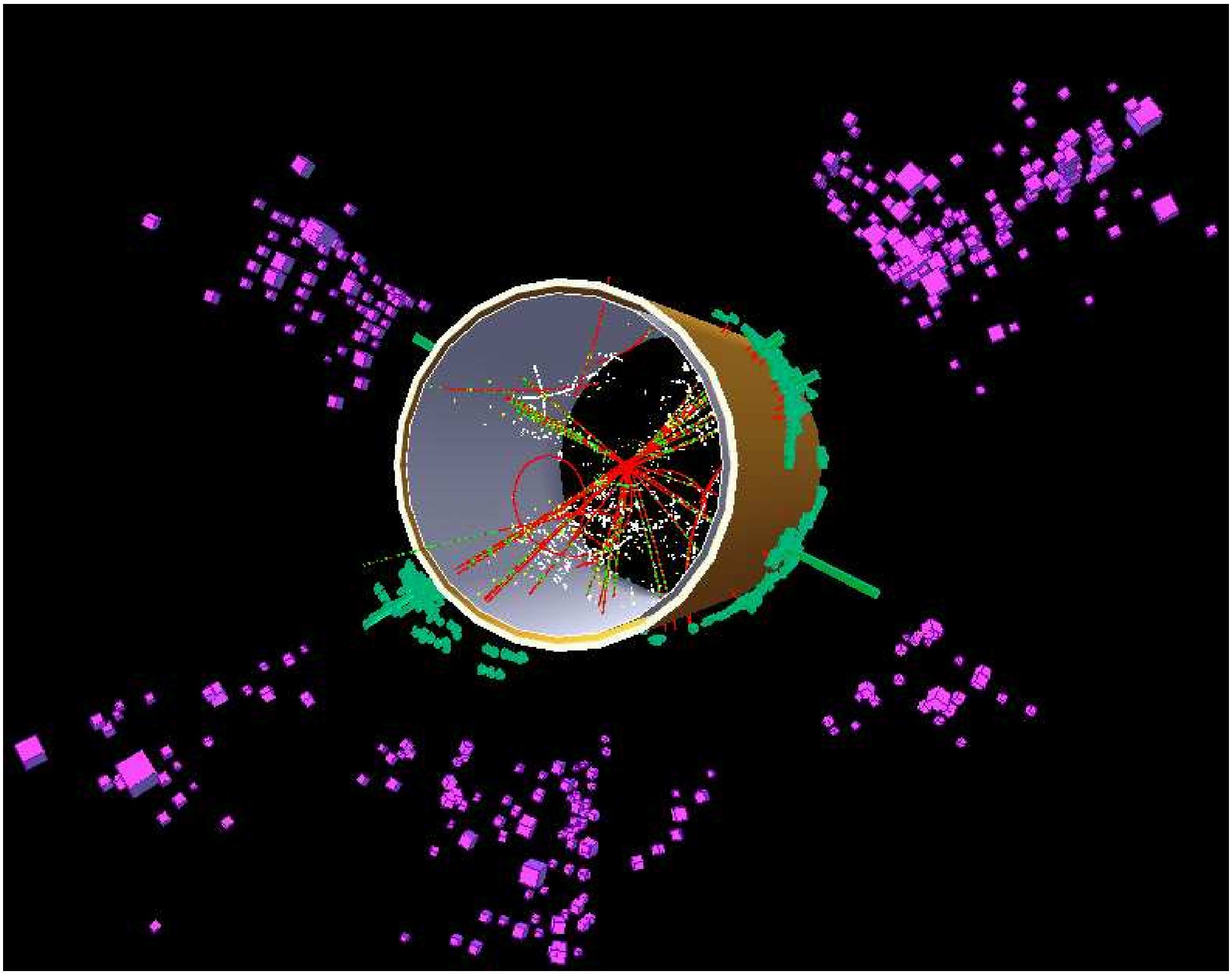


HZ $\rightarrow$ qqee: highest mass candidate ($\sqrt{s} = 205.4$)



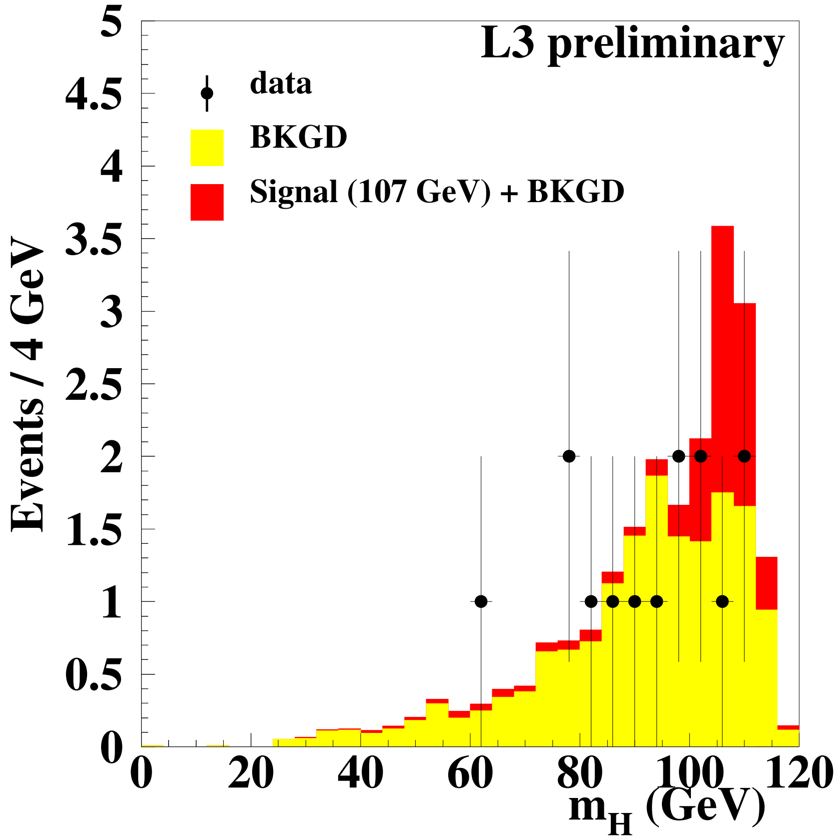
$m_H = 105.5$ GeV

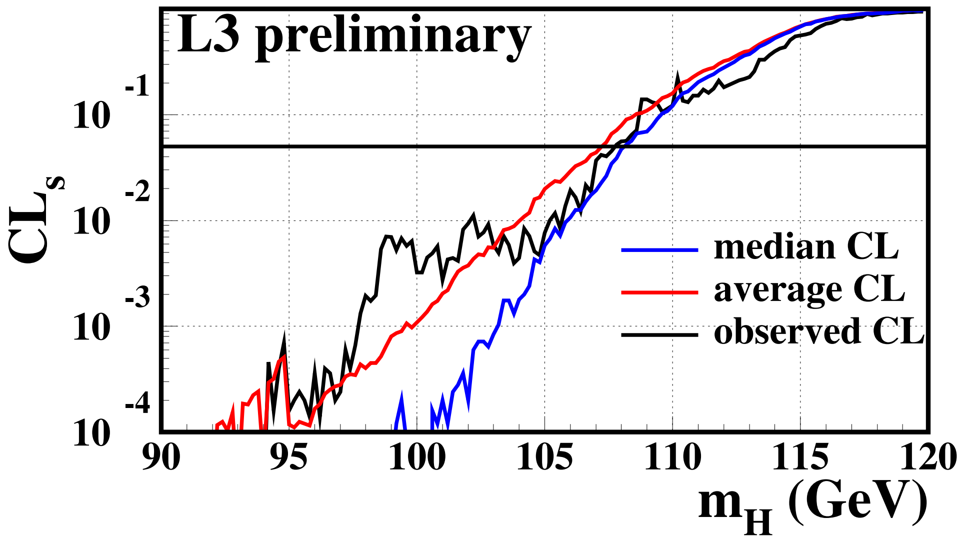
HZ $\rightarrow$ qqqq: highest btag candidate ($\sqrt{s} = 205.0$)



$m_H = 108.4$ GeV, event b tag = 7.4

Combined mass plot 2000 data



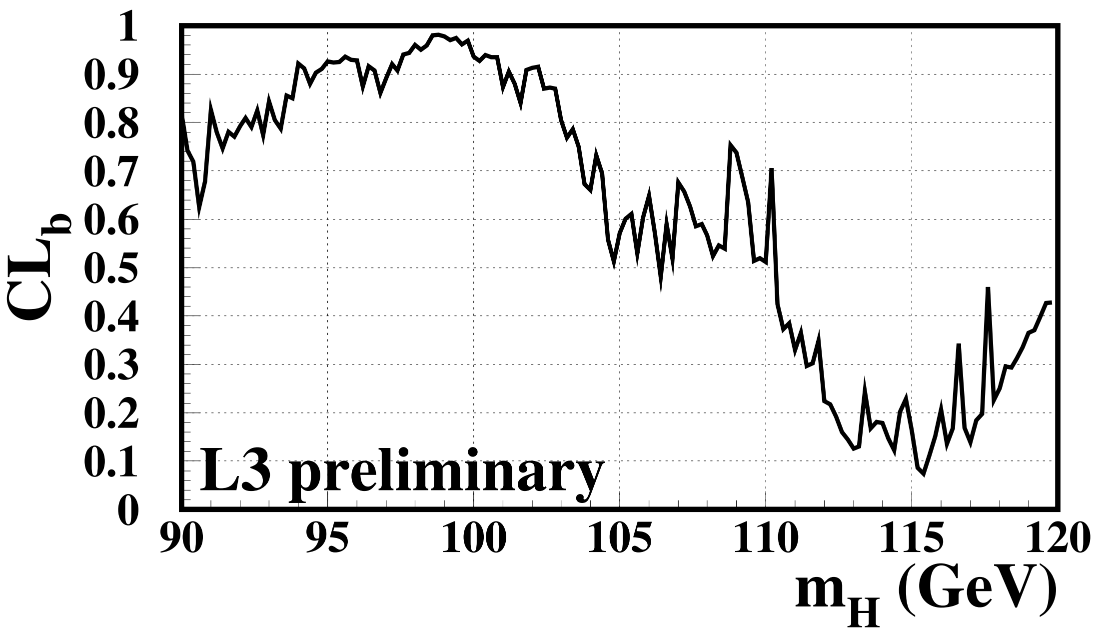


$m_h > 107.7$ **GeV at 95% CL**

Number of expected / observed events after mass independent cuts:

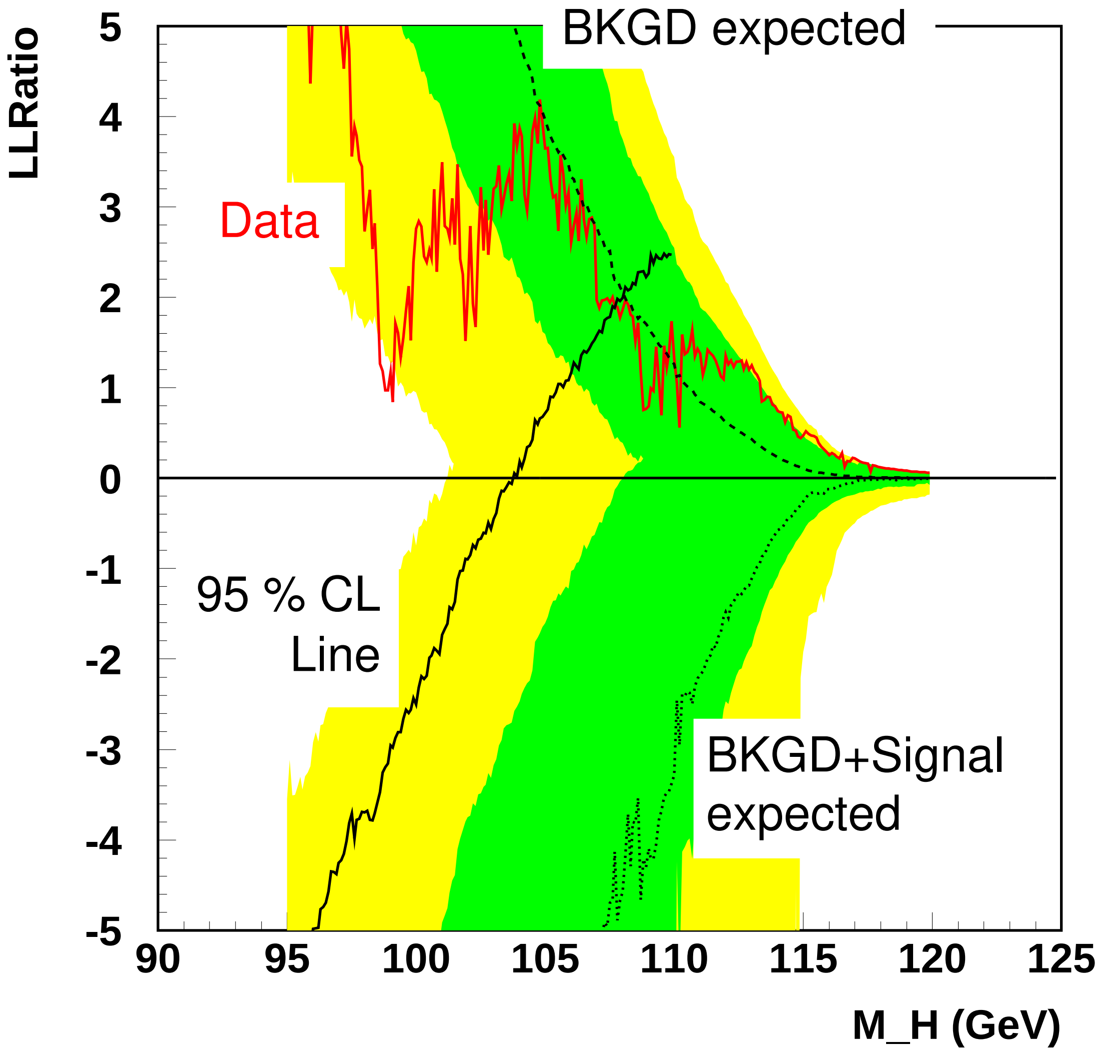
Channel	Data	BG	Signal 107 GeV	$m_H \geq 100$ GeV Data	BG	Signal 107 GeV
qqqq	9	9.9	2.8	4	2.9	2.0
qq$\nu\nu$	5	4.6	2.0	1	2.8	1.9
qq$\ell\ell$	0	1.5	0.5	0	0.2	0.4
Sum	14	16.0	5.3	5	5.9	4.3

Consistency with background:



- CL_b close to 1 $\rightarrow$ excess in data
- CL_b close to 0 $\rightarrow$ lack of data

Log Likelihood Ratio $\log \frac{\mathcal{L}(x|bkgd)}{\mathcal{L}(x|sig+bkgd)}$

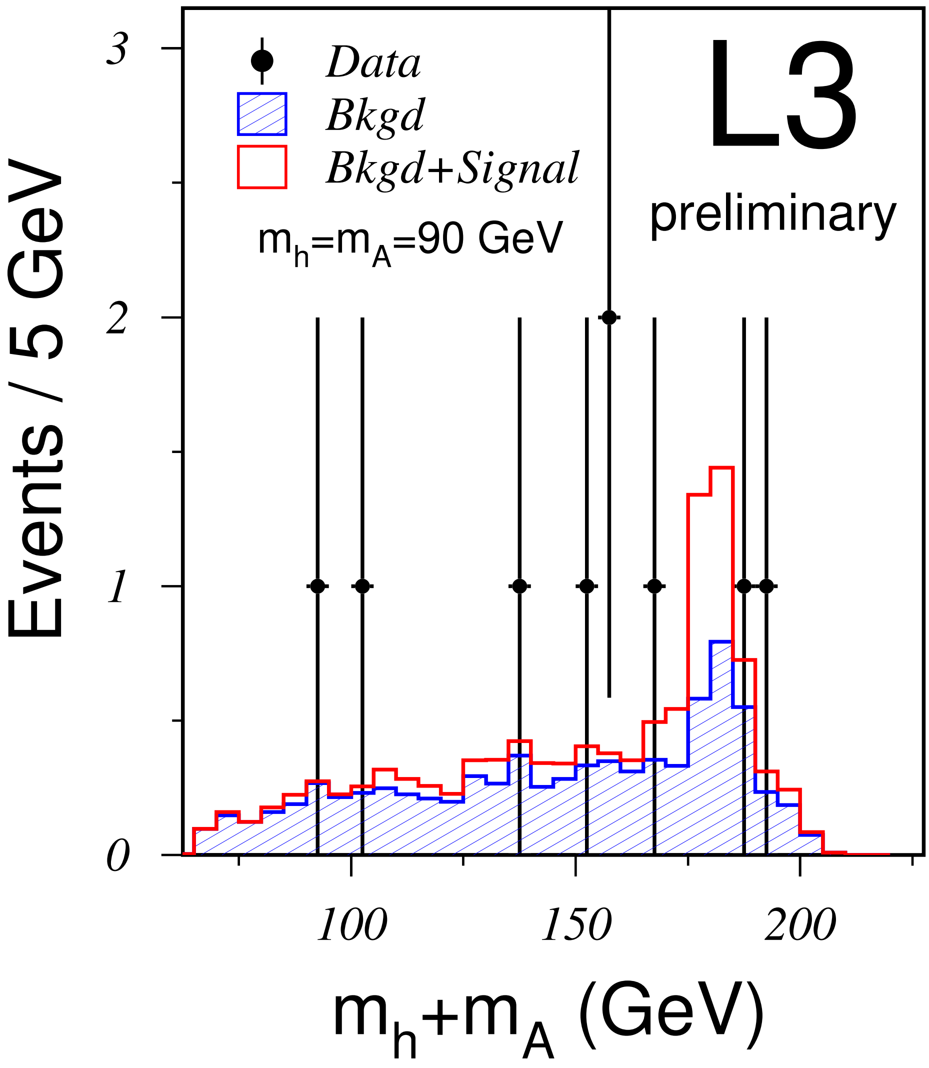


No clear evidence for a signal
$\rightarrow$ mass limits at 95% CL

Observed: $m_h > 107.7$ **GeV**
Median Expected : $m_h > 108.0$ **GeV**

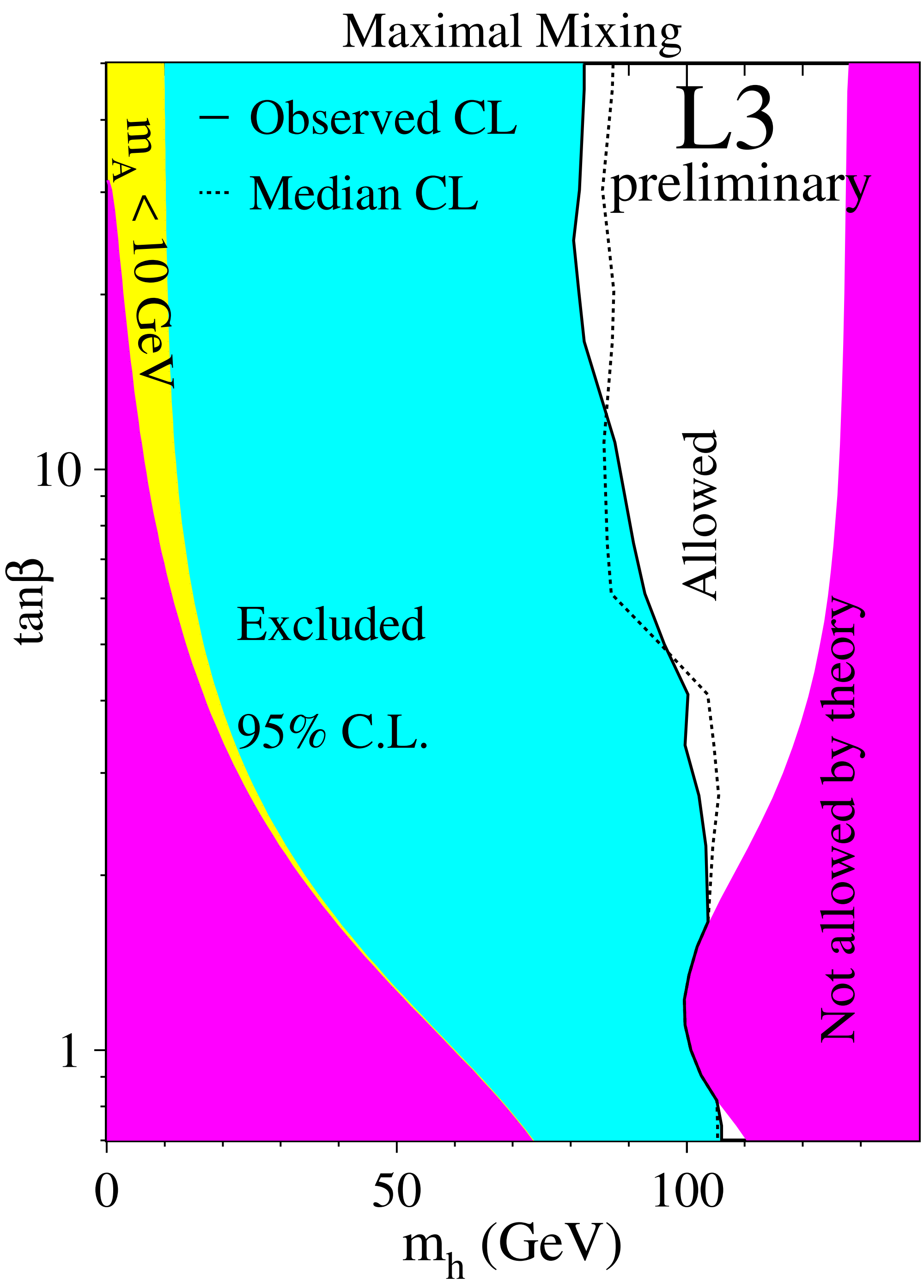
Four jet channel hA → bbbb

$hA \longrightarrow bbbb$ mass spectrum:



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

No clear evidence for a signal $\rightarrow$ we set limits (FROM MORIOND !)



Obs.: $m_h >$ ... $m_A >$ ... GeV

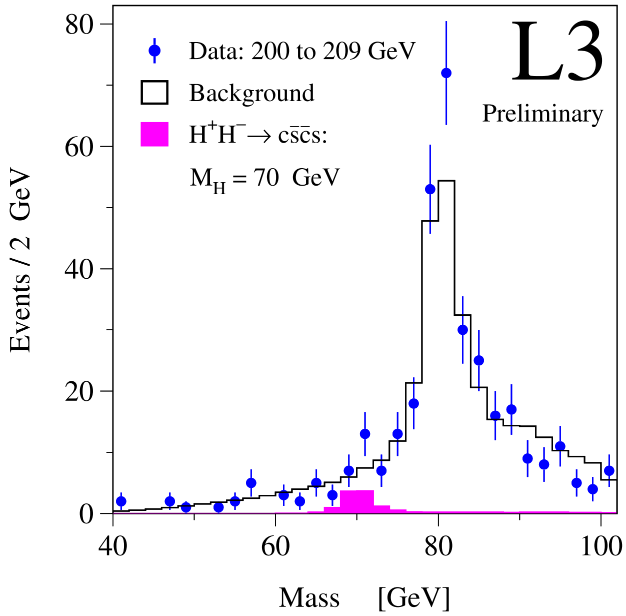
Exp.: $m_h >$ ... $m_A >$ ... GeV

Obs.: $m_h >$ ... $m_A >$ ... GeV
Exp.: $m_h >$ ... $m_A >$ ... GeV

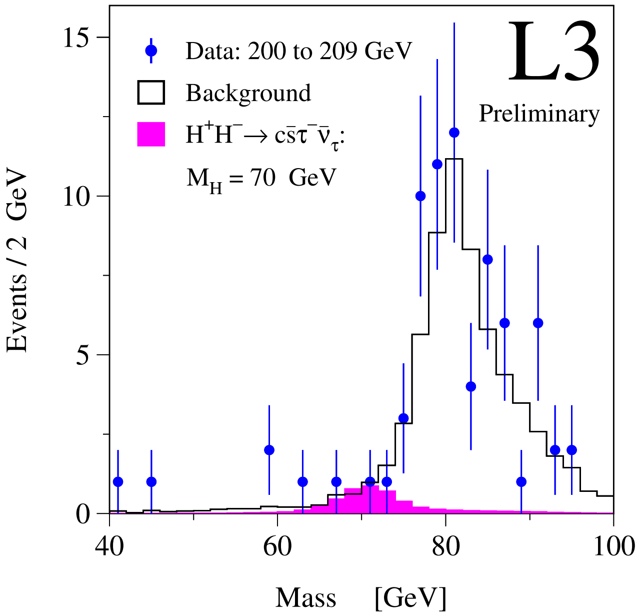
Searches for Charged Higgs Bosons $H^{\pm} \to cs, \tau\nu$

Higgs candidate masses

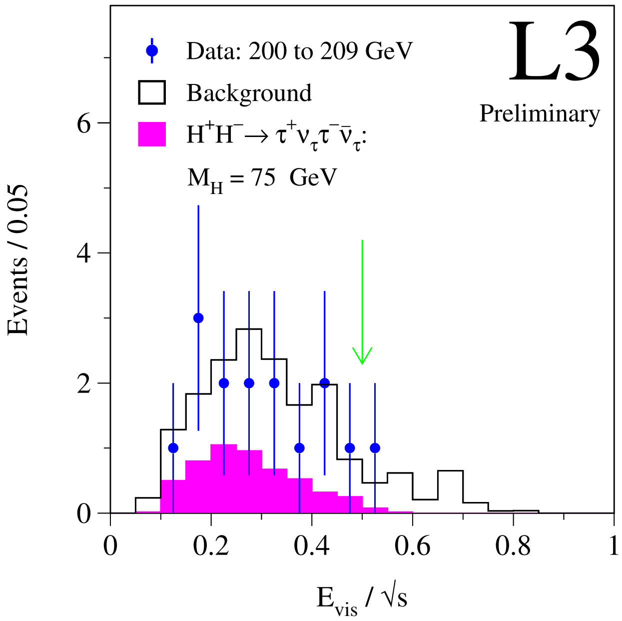
cscs



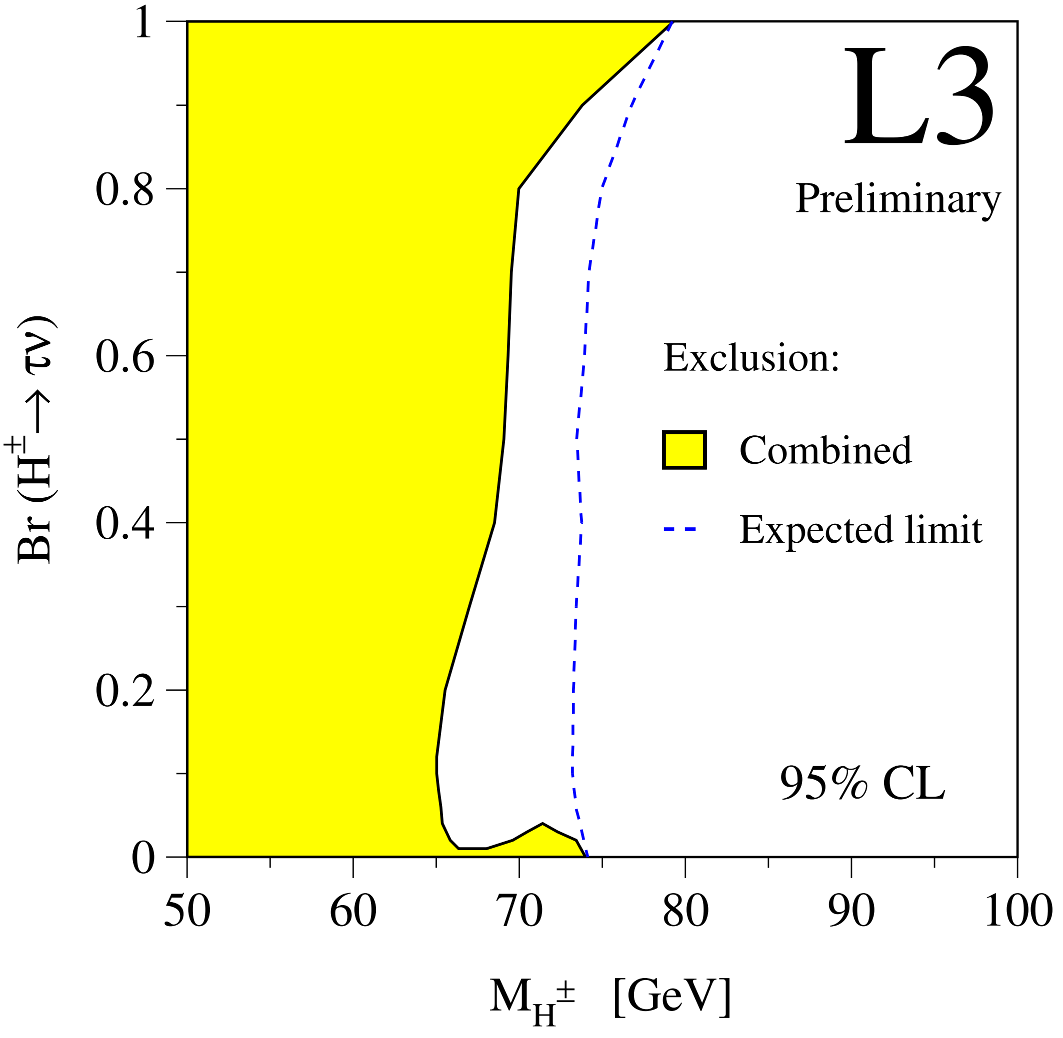
$cs\tau\nu$



$\tau\nu\tau\nu$



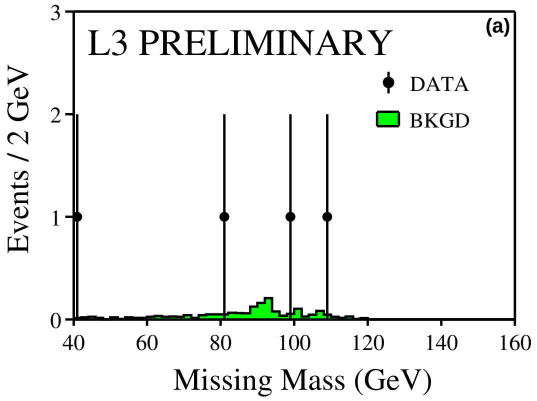
Exclusion plane $m_{H^{\pm}}$ vs. BR($H^{\pm} \rightarrow \tau\nu$) (FROM MORIOND !)



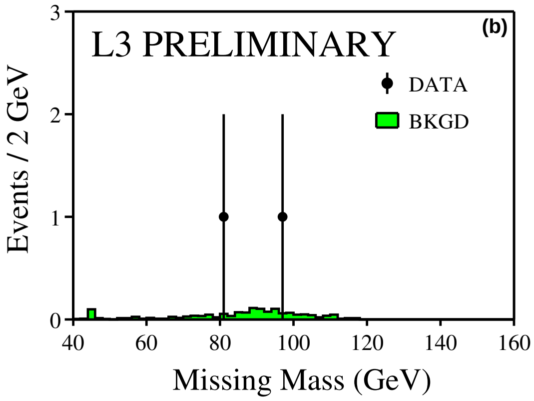
Observed limit significantly lower than the expected one !

$HZ \to$ (invis)Z: Invisible mass

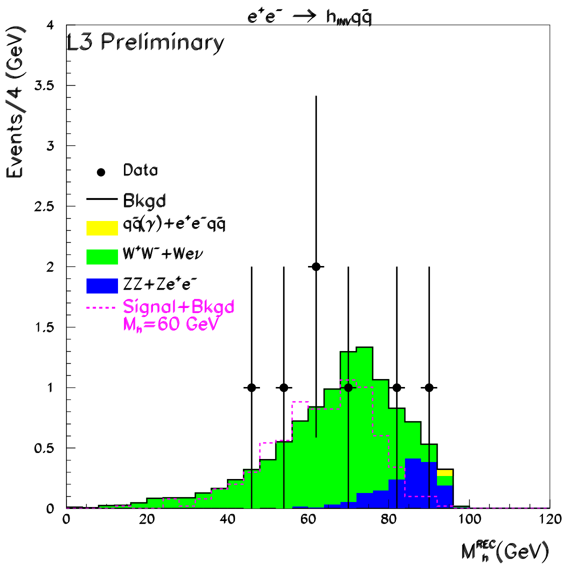
ee(invis)



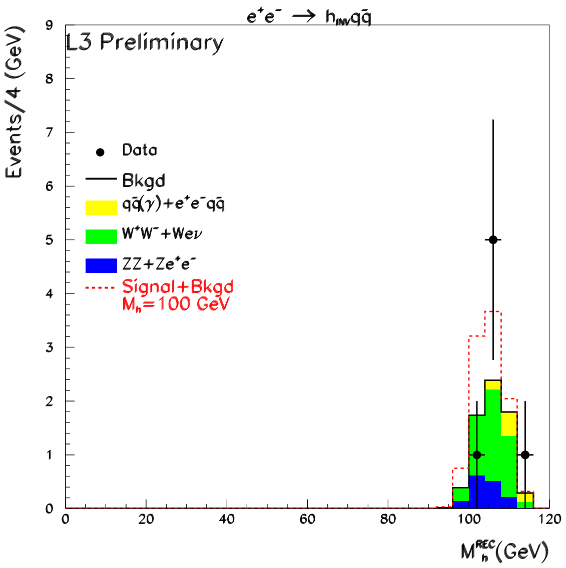
$\mu\mu$(invis)



qq(invis) light

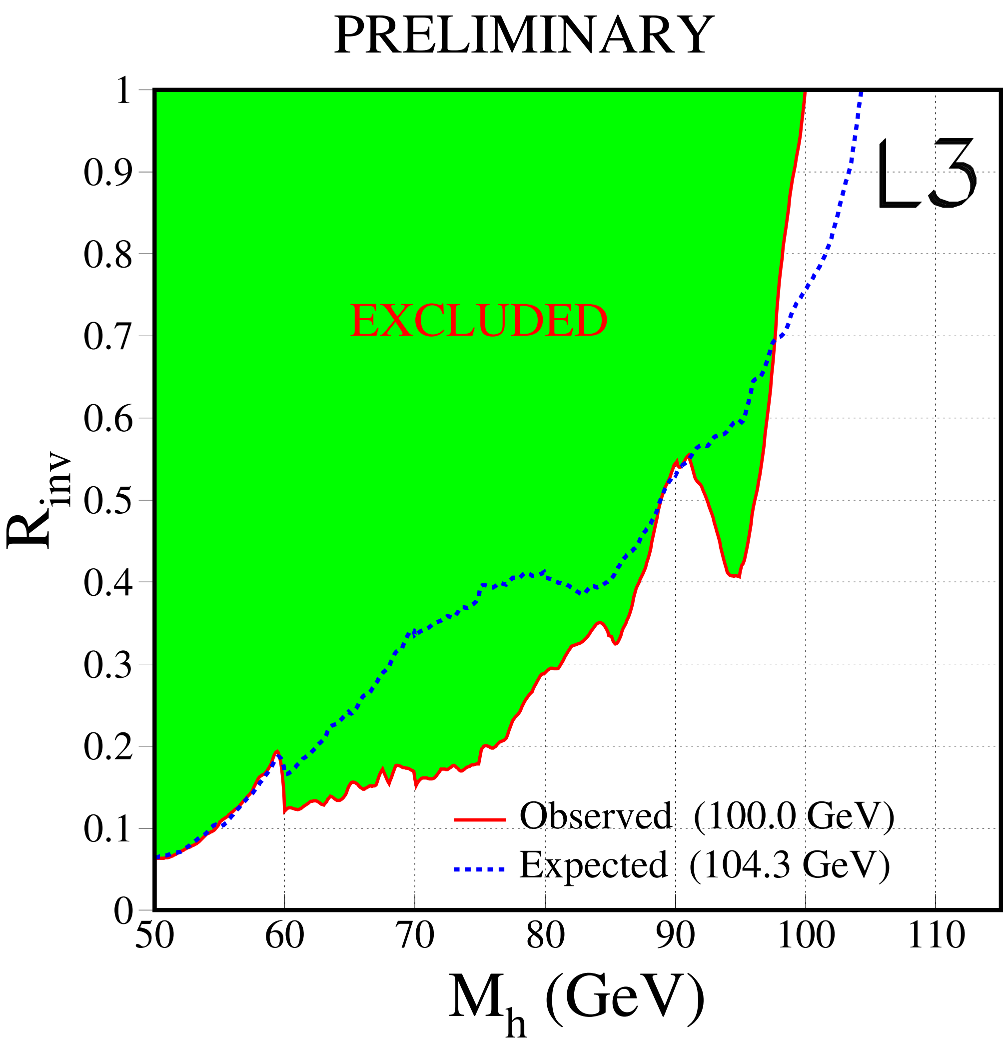


qq(invis) heavy



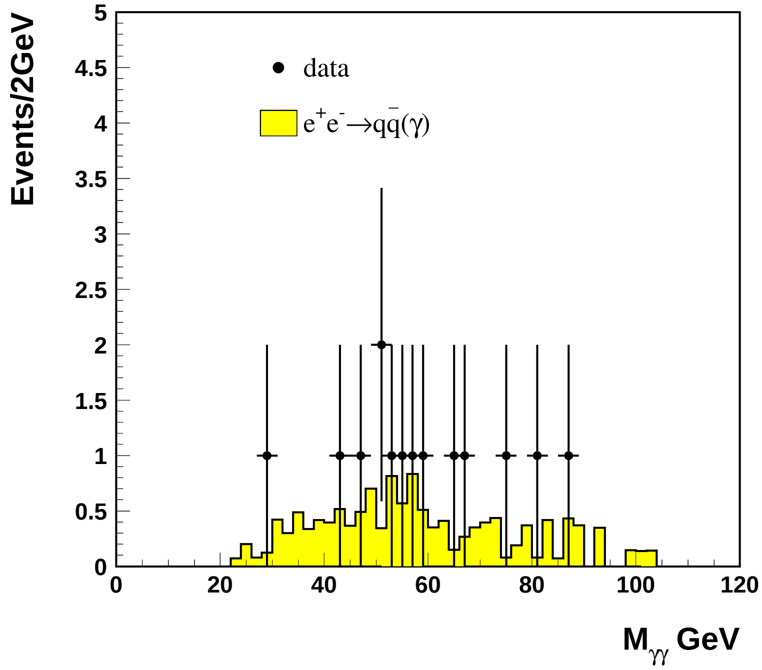
sum of all channels: Data: 20 BG: 20.9

Invisible Higgs excluded regions in the plane M_H vs. BR($H \to$ invisible)

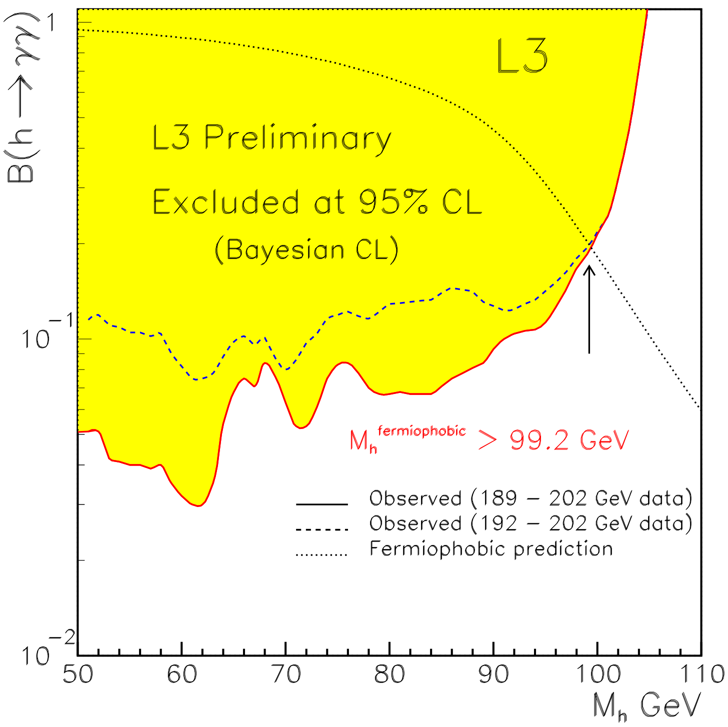


Fermiophobic Higgs scenario

$$e^+e^- \to ZH \to Z\gamma\gamma$$



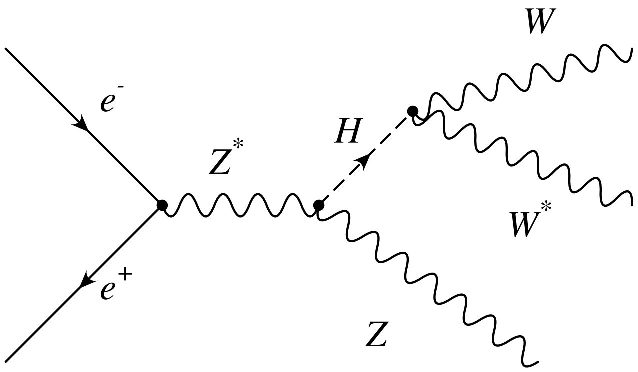
$H \to \gamma\gamma$: Invariant mass of photons (1999 data)



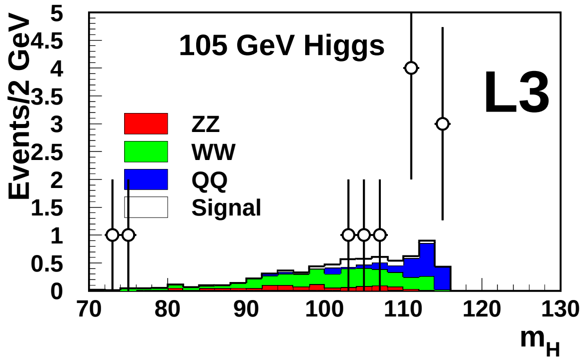
Excluded regions in the Plane m_H / $BR(H \to \gamma\gamma)$

New Analysis: H $\rightarrow$ WW*

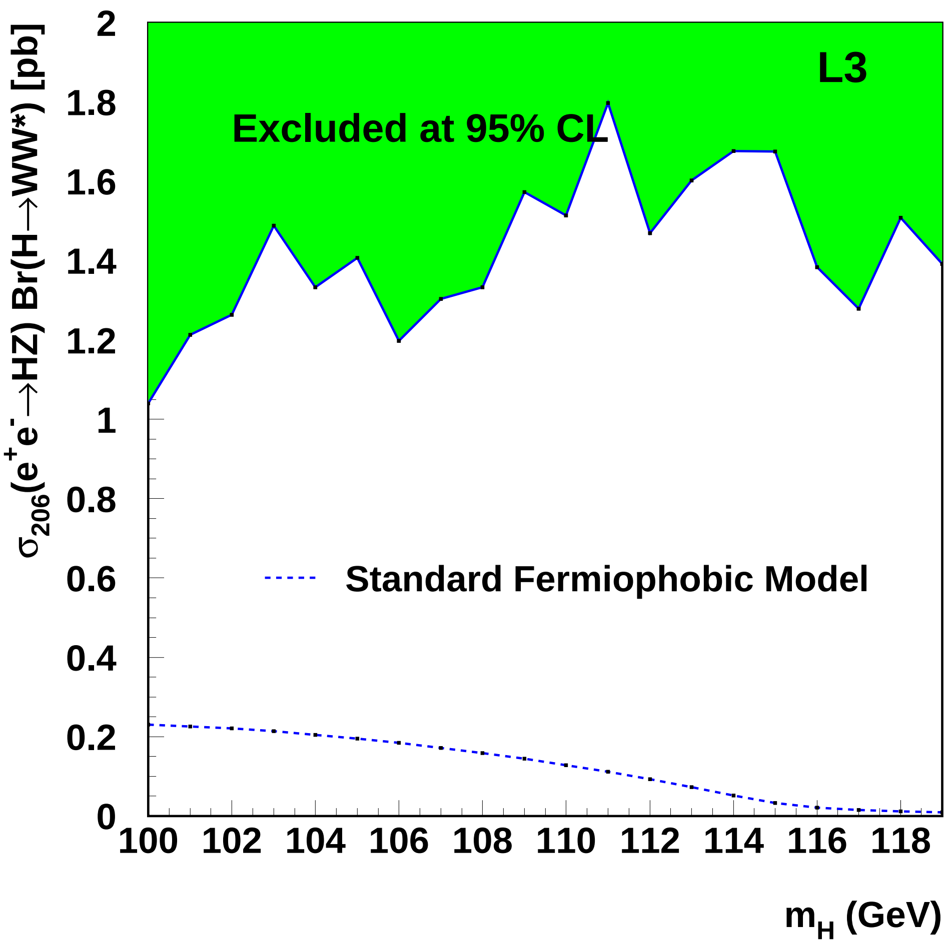
Production mechanism



reconstructed mass



Limits on Cross section $\times$ Br(H$\rightarrow$ WW*)



At $\sqrt{s} > 202$ GeV the search has been performed to following channels :

- $\tilde{\chi}_1^{\pm}$, $\tilde{\chi}_1^0$
- $\tilde{e}, \tilde{\mu}, \tilde{\tau}, \tilde{t}, \tilde{b}$
- γ+missing energy, $\gamma\gamma$+missing energy:

Updated limits of $\tilde{\chi}_1^{\pm}$ ($|\mu| \gg M_2$) and $\tilde{\chi}_1^0$ ($m_0 \geq 500\ GeV$).

NOT enough luminosity to improve 202 GeV limits for $\tilde{e}, \tilde{\mu}, \tilde{\tau}, \tilde{t}, \tilde{b}$

- $\tilde{\chi}_1^{\pm}$ M > 80.5 GeV$\Longrightarrow$ indep.MSSM par.
- $\tilde{\chi}_1^0$ M > 37.5 GeV$\Longrightarrow$ indep.MSSM par.
- $\tilde{e}$ M > 95 GeV,$\Delta M > 10$ GeV
- $\tilde{\mu}$ M > 79 GeV,$\Delta M > 15$ GeV
- $\tilde{\tau}$ M > 72 GeV,$\Delta M > 15$ GeV
- $\tilde{t}$ M > 92 GeV,$\Delta M > 15$ GeV
- $\tilde{b}$ M > 94 GeV,$\Delta M > 15$ GeV

30 selections for Charginos, Neutralinos, Sleptons

$\sqrt{s} \approx 205.3$ GeV, $\int \mathcal{L}\, dt = 56.7\mathrm{pb}^{-1}$

$\sqrt{s} \approx 206.6$ GeV, $\int \mathcal{L}\, dt = 14.0\mathrm{pb}^{-1}$

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

$\sqrt{s} \approx 205$ GeV, $\int \mathcal{L}\, dt = 56.3\mathrm{pb}^{-1}$

$\sqrt{s} \approx 207$ GeV, $\int \mathcal{L}\, dt = 28.0\mathrm{pb}^{-1}$

	Low ΔM		Medium ΔM		High ΔM		.OR.	
	N_{data}	N_{exp}	N_{data}	N_{exp}	N_{data}	N_{exp}	N_{data}	N_{exp}
$\tilde{\chi}_1^\pm$	13	11.3	14	7.1	6	9.2	31	25
$\tilde{\chi}_1^\pm$	7	5.4	3	3.4	3	4.6	13	12.4

$$N_{\tilde{\chi}_1^\pm, \tilde{\chi}_1^0} \sim xx \;\; N_{\tilde{\mathrm{e}},\tilde{\mu},\tilde{\tau}} \sim x.x$$

No excess to S.M. predictions

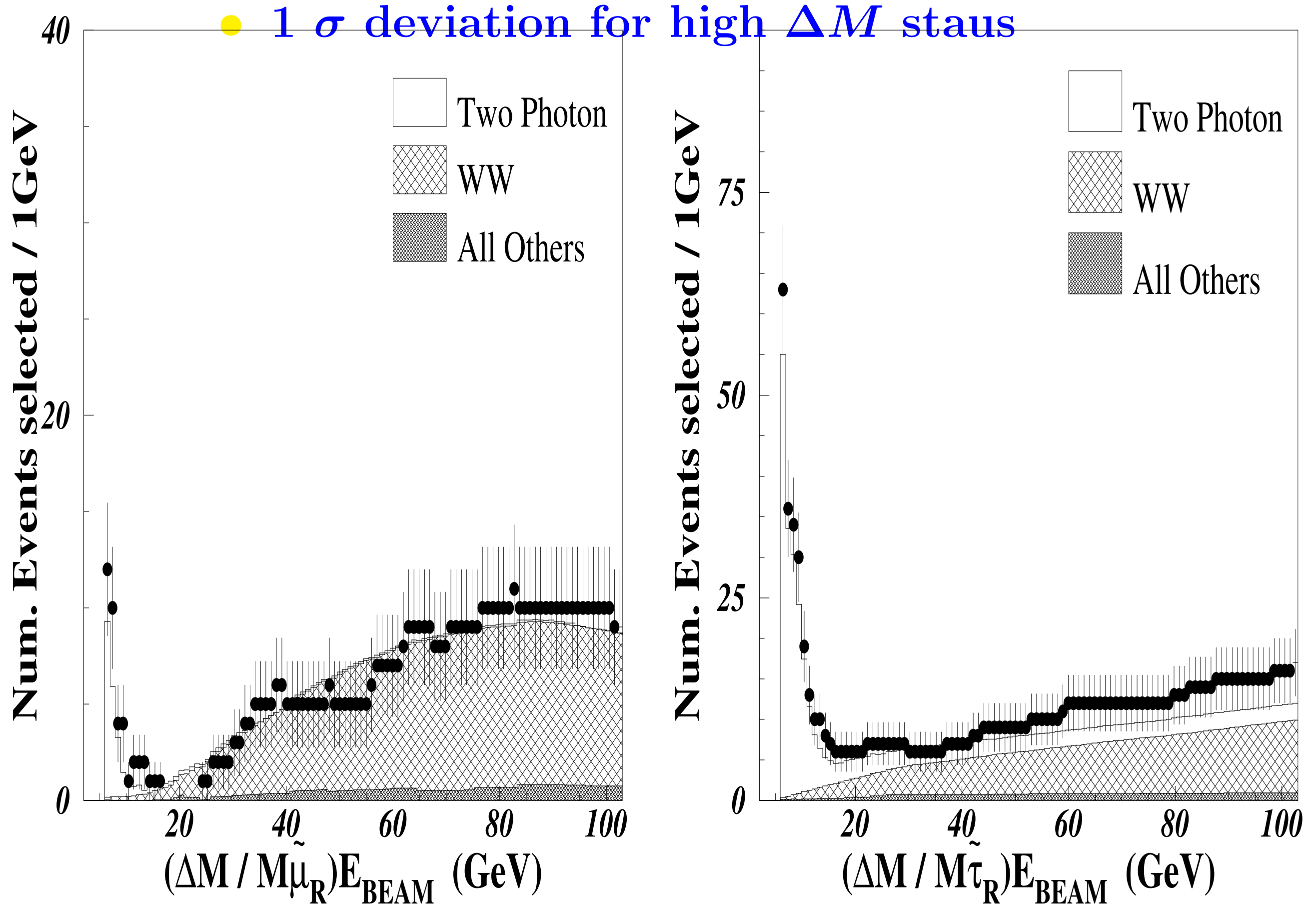
- Enough $\mathcal{L}$ for $\tilde{\chi}_1^\pm, \tilde{\chi}_1^0$ exclusions
- $M_{\tilde{\chi}_1^\pm} > 102.5$ GeV (For most MSSM param.)
- for m_0 =500 $M_{\tilde{\chi}_1^0} >$ XX.X GeV

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

	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
$\tilde{\mu}^0$	17	13.6	6	5.4	14	12.8	33	27.5
$\tilde{\tau}^0$	76	66.4	21	21.6	17	12.5	89	76.6

No excess to S.M. predictions

- 1 σ deviation for high ΔM staus



At $\sqrt{s} < 205.5\mathrm{GeV}$ $\int \mathcal{L}\,dt = 49.3\mathrm{pb}^{-1}$

- **Scalar top**

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

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

- **Scalar bottom**

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

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}
$\tilde{t}_1 \rightarrow c\tilde{\chi}^0_1$	21	14.2	0	2.12	3	2.00	4	3.03	28	21.1
$\tilde{t}_1 \rightarrow b\ell\tilde{\nu}$	10	8.11	5	2.52	1	0.20	-	-	16	10.60
$\tilde{t}_1 \rightarrow b\tau\tilde{\nu}$	4	4.98	2	4.08	1	0.91	-	-	7	9.39
$\tilde{b}_1 \rightarrow b\tilde{\chi}^0_1$	13	9.93	1	1.138	0	0.34	0	0.33	14	11.74

$N^{exp}_{Bkg} = 35.2 \pm 1.5$ $N_{Data} = 47$

No excess to S.M.

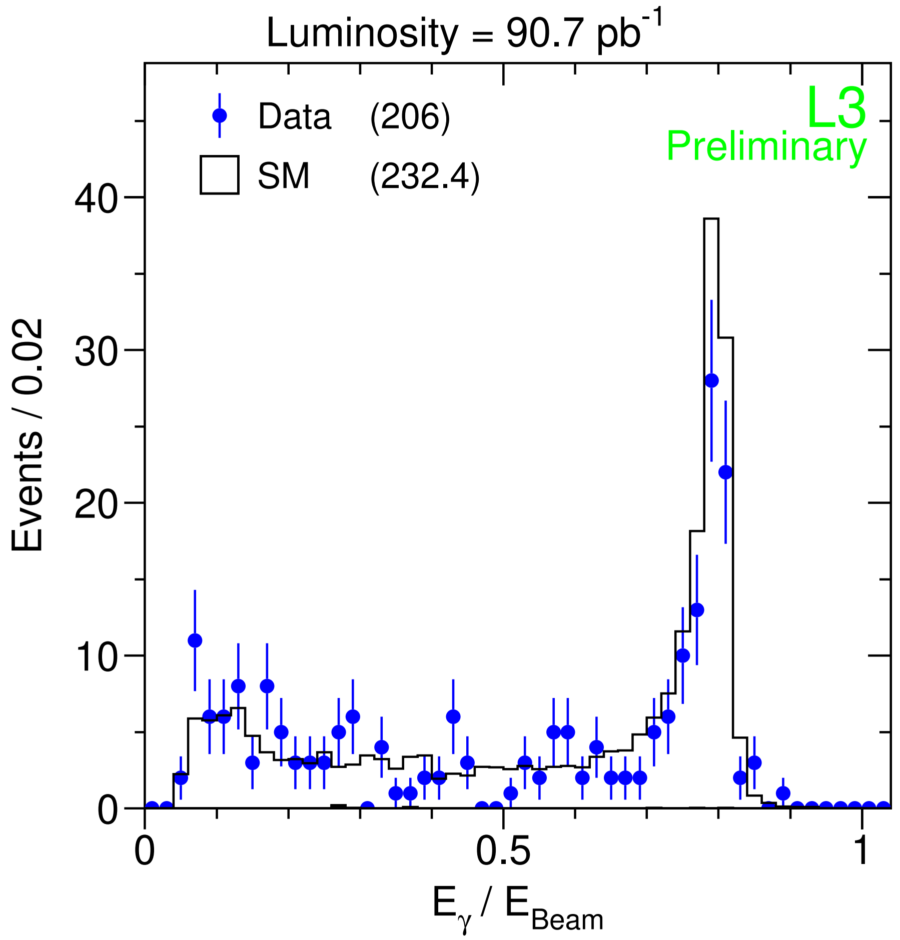
γ + missing energy

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

In GMSB scenario, with $\tilde{G}$ LSP, the decays channels possibles:

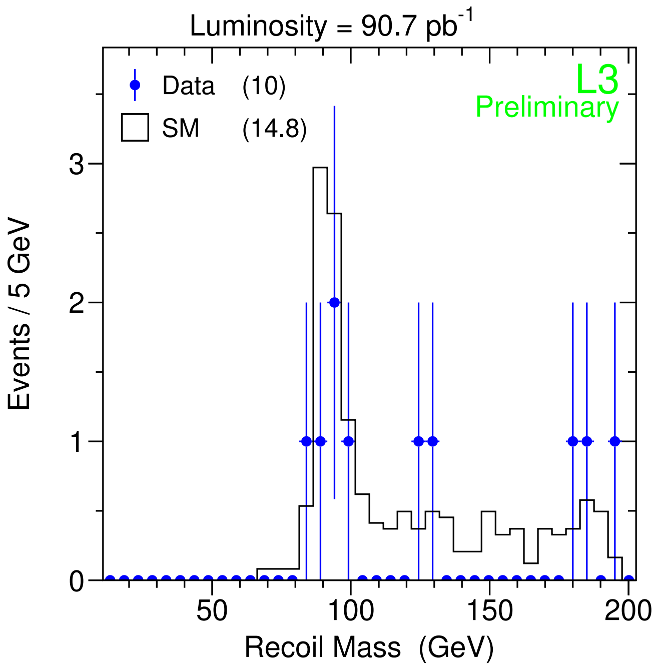
- $e^+e^- \to \tilde{\chi}_1^0\tilde{G} \to \tilde{G}\tilde{G}\gamma$
- $e^+e^- \to \tilde{\chi}_1^0\tilde{\chi}_1^0 \to \tilde{G}\tilde{G}\gamma\gamma$

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

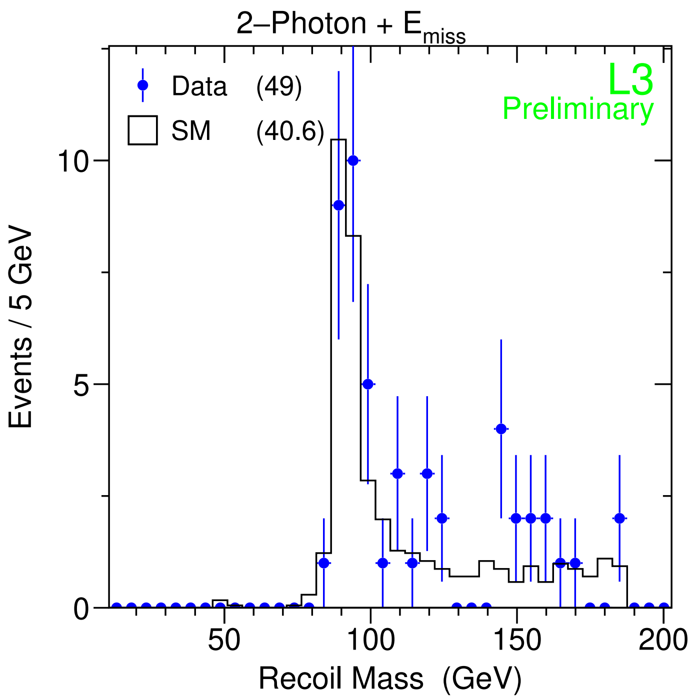


$\gamma\ \gamma$ + missing energy

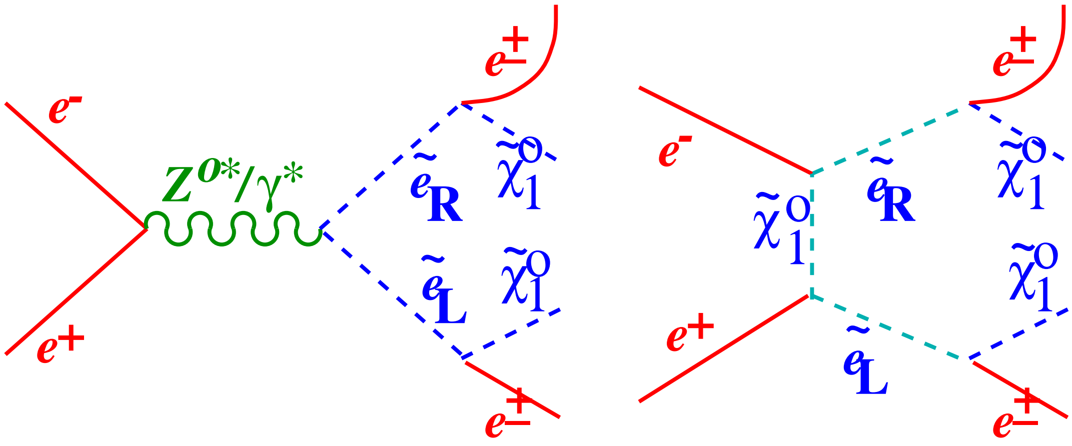
$\sqrt{s}\ =\ 202 - 208$ GeV, $\int \mathcal{L}\, dt = 90.7 \mathrm{pb}^{-1}$



$\sqrt{s}\ =\ 192 - 202$ GeV, $\int \mathcal{L}\, dt = 231.5 \mathrm{pb}^{-1}$



$$\boxed{\tilde{e}_R \tilde{e}_L \rightarrow (e) e \tilde{\chi}^0_1 \tilde{\chi}^0_1}$$

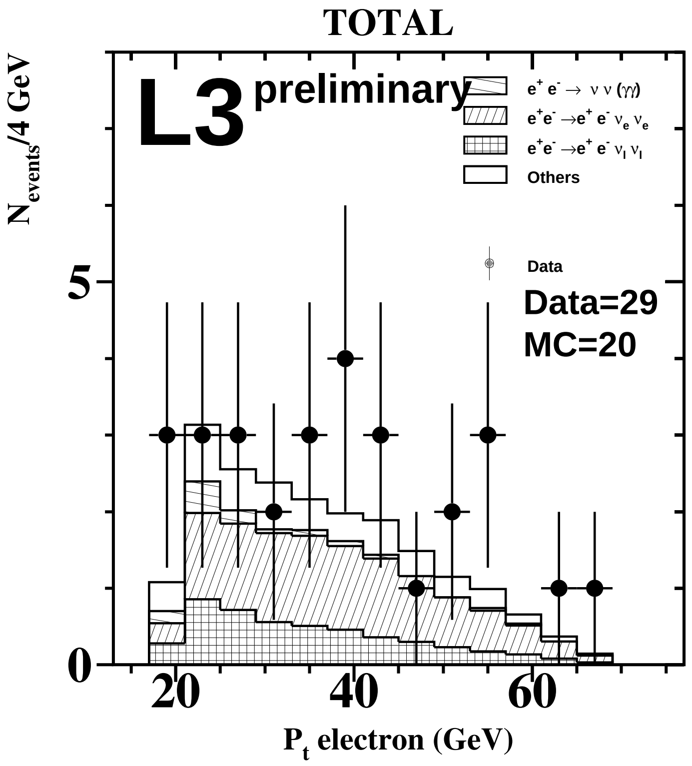


$$0 \text{ GeV} \leq M_{\tilde{e}_R} - M_{\tilde{\chi}^0_1} \leq 3 \text{ GeV}$$
$$M_{\tilde{e}_R} + M_{\tilde{e}_L} \leq \sqrt{s} \simeq 200 \text{ GeV}$$

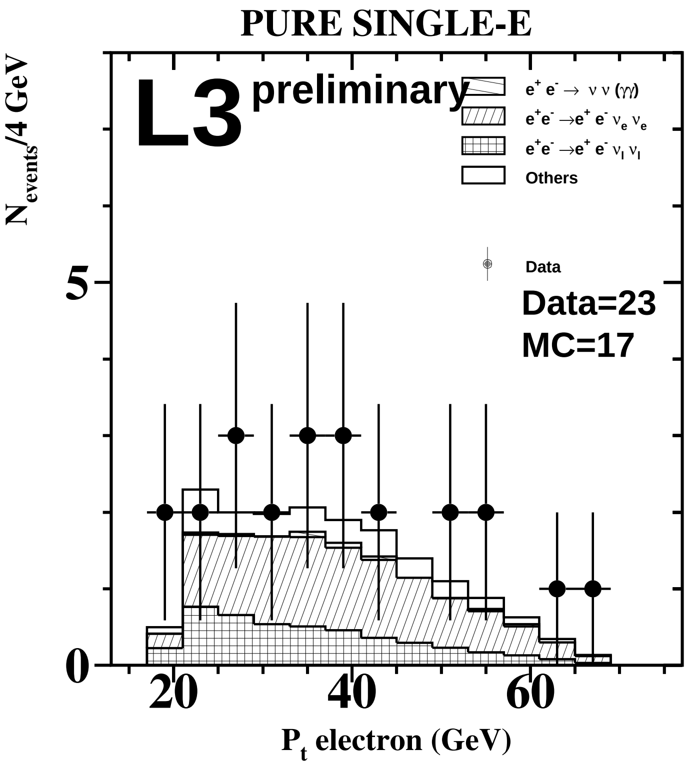
RESULTS at $\sqrt{s} = 192$ to 209 GeV

$\sqrt{s}$	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

DISTRIBUTIONS at $\sqrt{s}$ = 192-202 GeV



P_t of the
most energetic electron
1 electron + eventual
soft system

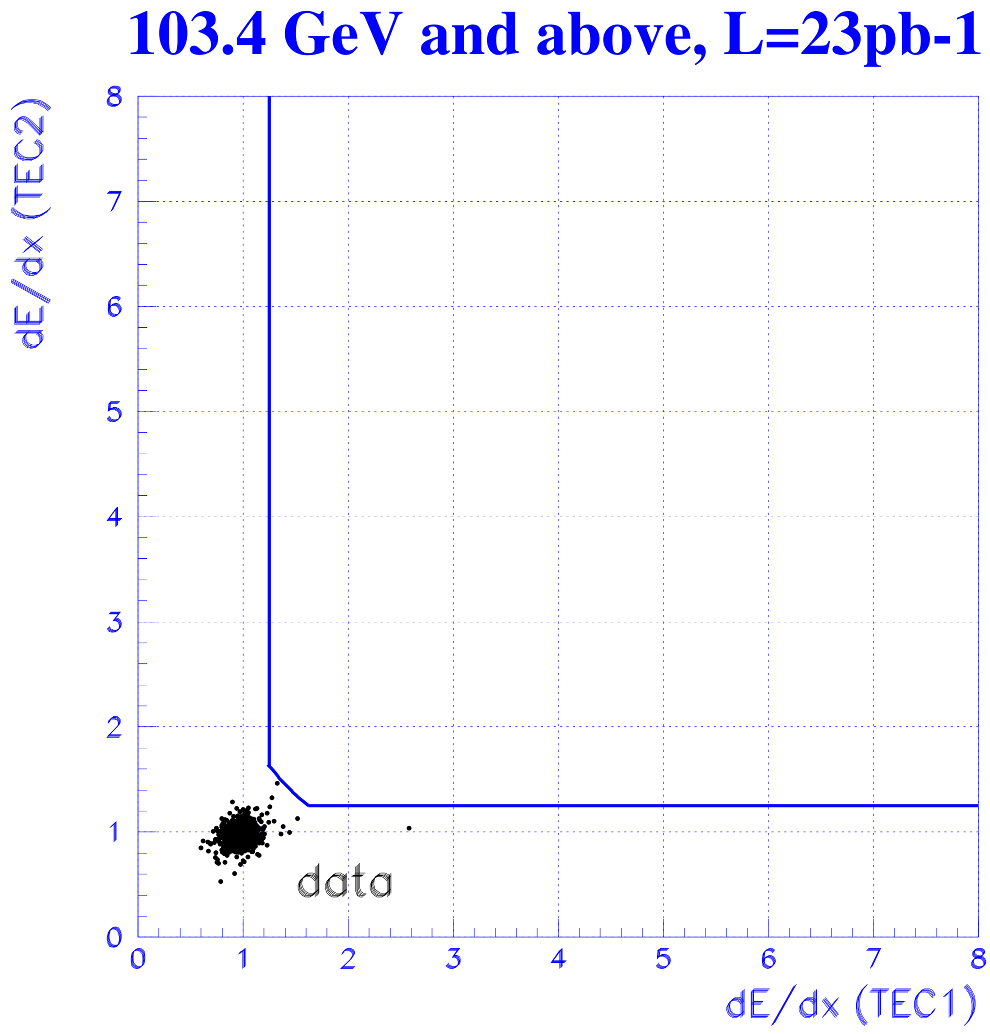


P_t of the electron
single-electron sub-sample

Search for new Unstable Heavy Neutrinos

Channel	Data	Background
$L^0 \to e^\pm W^\mp$	1	1.5
$L^0 \to \mu^\pm W^\mp$	1	0.4
$L^0 \to \tau^\pm W^\mp$	15	19.3

Search for Stable Heavy Leptons



Two highly ionising tracks are searched for

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

$$m_L \geq 102.4\text{GeV}$$

Search for Pair Production of Excited Leptons

Signal	Data	Bkg	Signal	Data	Bkg
$e^*e^* \longrightarrow ee\gamma\gamma$	0	0.3	$\nu_e^*\nu_e^* \longrightarrow eeWW$	0	0.1
$\mu^*\mu^* \longrightarrow \mu\mu\gamma\gamma$	0	0.1	$\nu_\mu^*\nu_\mu^* \longrightarrow \mu\mu WW$	0	0.2
$\tau^*\tau^* \longrightarrow \tau\tau\gamma\gamma$	0	0.1	$\nu_\tau^*\nu_\tau^* \longrightarrow \tau\tau WW$	1147	1088
$\ell^*\ell^* \longrightarrow \nu\nu WW$	1147	1088	$\nu^*\nu^* \longrightarrow \nu\nu\gamma\gamma$	1	0.5
$e^*e^* \longrightarrow e\gamma\nu W$	7	3.4	$\nu_e^*\nu_e^* \longrightarrow \nu\gamma eW$		
$\mu^*\mu^* \longrightarrow \mu\gamma\nu W$	2	2.5	$\nu_\mu^*\nu_\mu^* \longrightarrow \nu\gamma\mu W$	5	4.2
$\tau^*\tau^* \longrightarrow \tau\gamma\nu W$	19	16	$\nu_\tau^*\nu_\tau^* \longrightarrow \nu\gamma\tau W$		

No signal $\Longrightarrow$ Mass limits are set

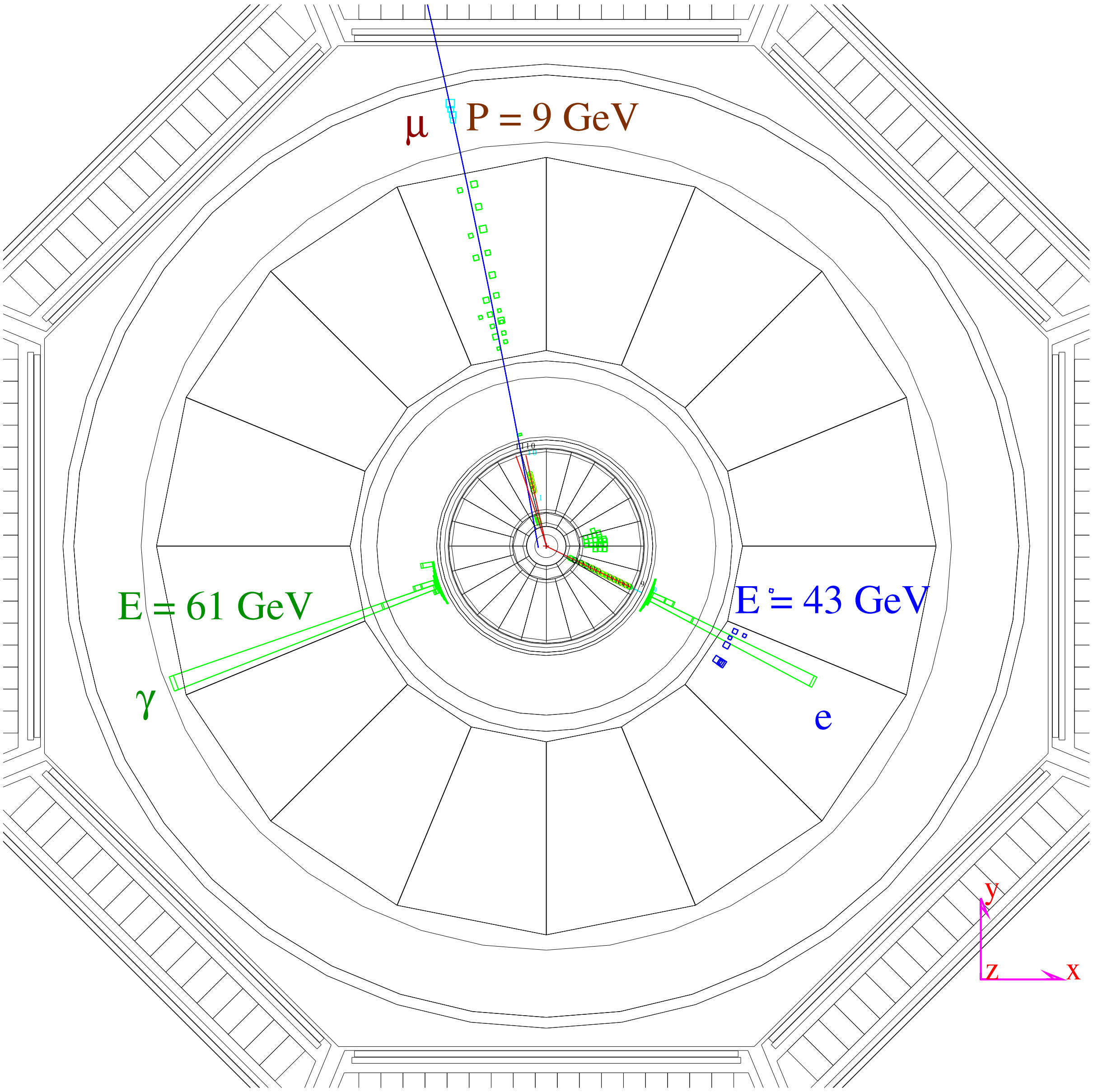
Excited Lepton Coupling	95% CL Mass Limit (GeV)		
	$f = f'$	$f = -f'$	Coup. Indep.
e^*	100.1	96.2	96.0
μ^*	100.3	96.2	96.2
τ^*	99.9	96.2	94.9
ν_e^*	99.3	99.5	98.5
ν_μ^*	99.4	99.5	98.5
ν_τ^*	93.9	99.4	92.7

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

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*		

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