

LATEST L3 PHYSICS RESULTS

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CERN and University of Basel

on behalf of the L3 Collaboration

CERN Particle Physics Seminar,

LEP Physics Jamboree, July 10, 2001

OUTLINE

New results on Standard Model processes

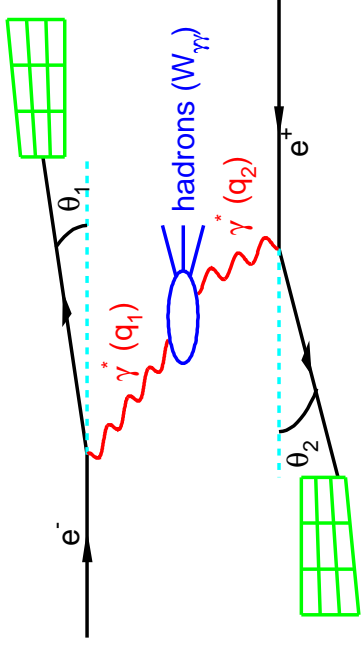
Charged Higgs bosons search

Standard Model Higgs boson search

Many interesting topics not presented here are available at:

<http://l3www.cern.ch/conferences/Budapest2001>

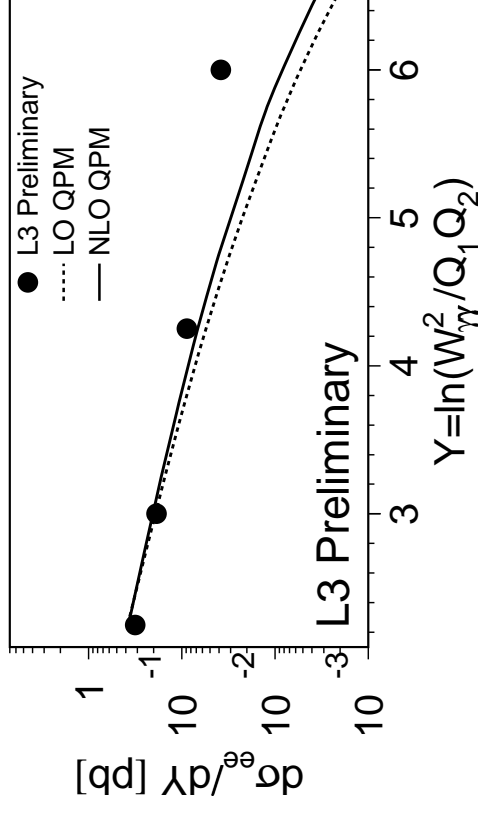
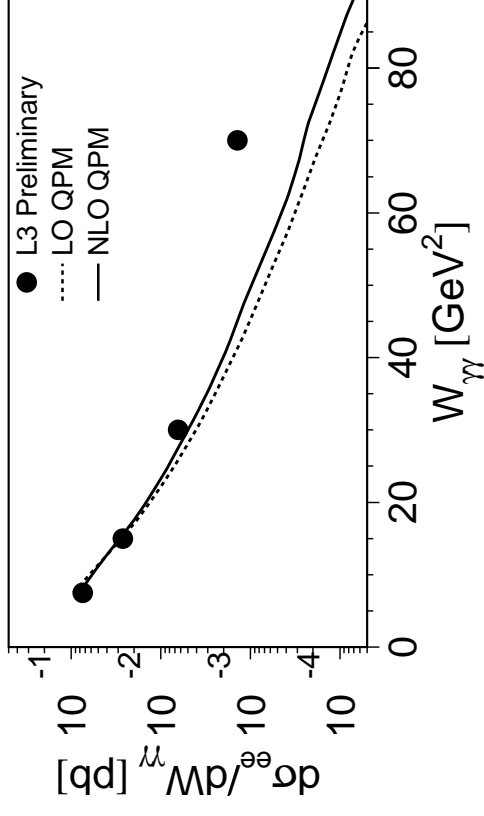
Double tag events in two-photon collisions



$$Y = \ln \frac{W_{\gamma\gamma}^2}{\sqrt{Q_1^2 Q_2^2}}$$

Y depends mainly on the angle of the scattered electrons.

The QED radiative corrections are important: they are included in the analysis.

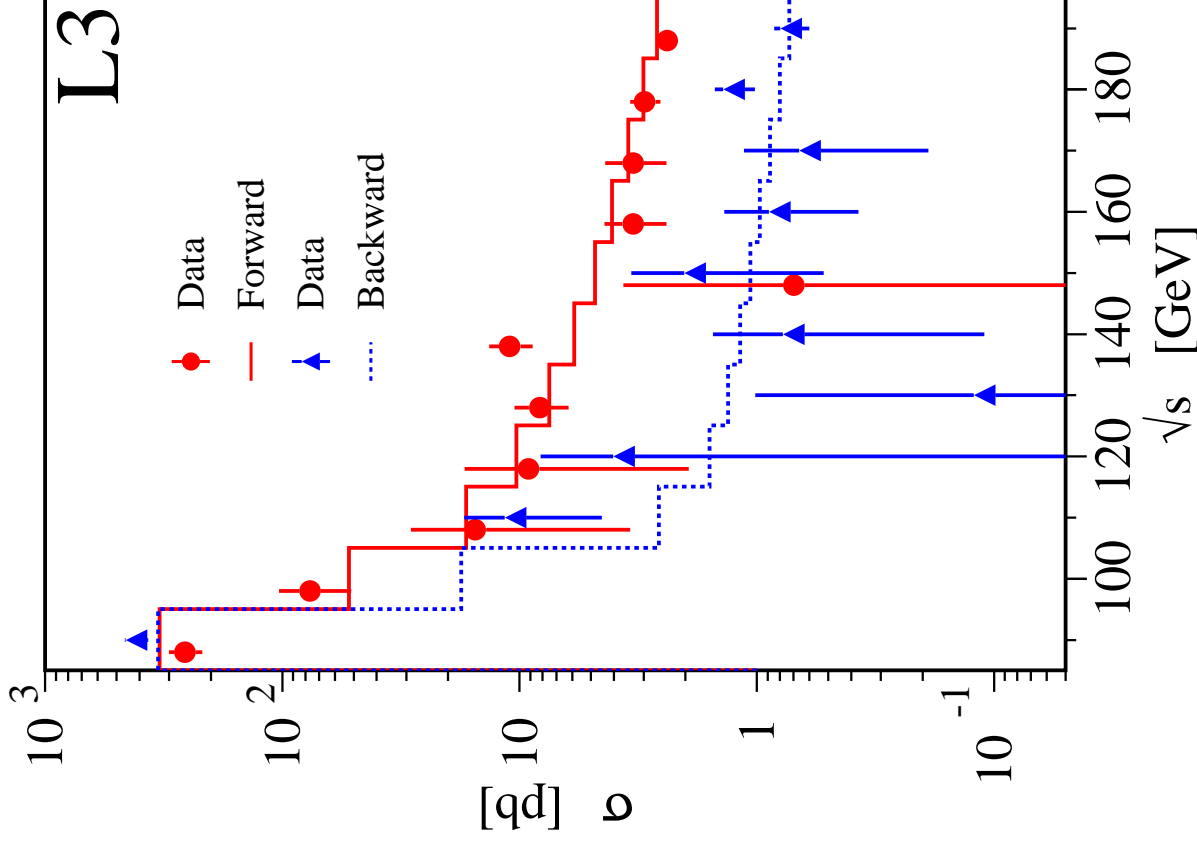
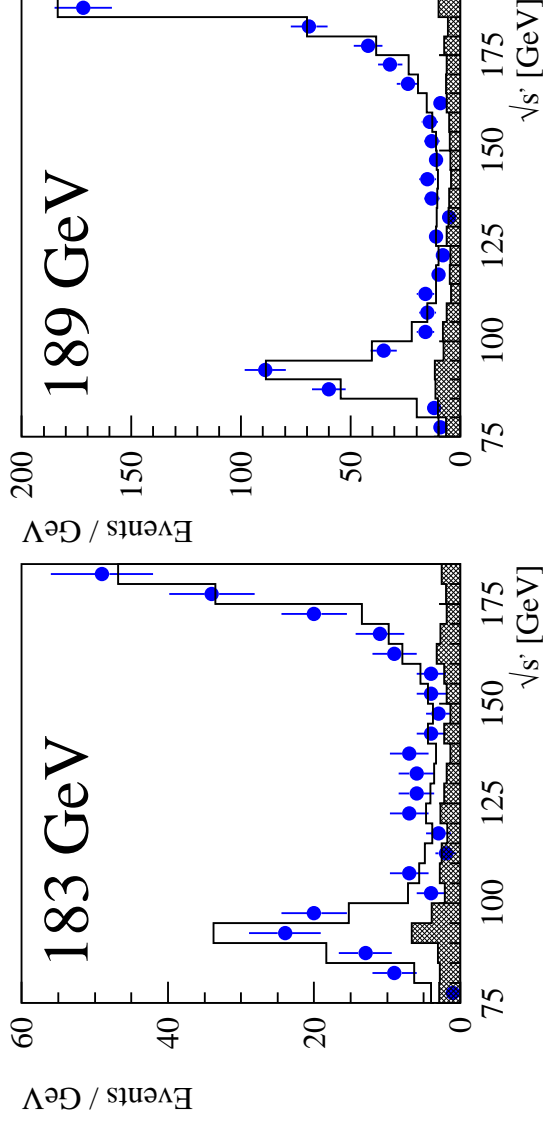


$\sim 4\sigma$, sign of other QCD diagrams or BFKL

Tau pair cross section at Born Level

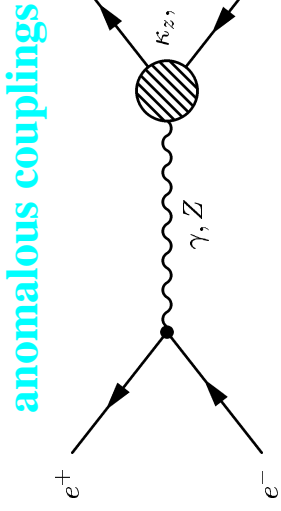
- Radiative contributions fill spectrum between Z peak and highest LEP energy,
- Deconvolution to Born level allows for combination of all data,
- This results provide a straight-forward method to check for new physics.

$$\sigma = \int_{4m_{\tau}^2}^s R(s, s') \sigma_{\text{BORN}}(s') ds'$$

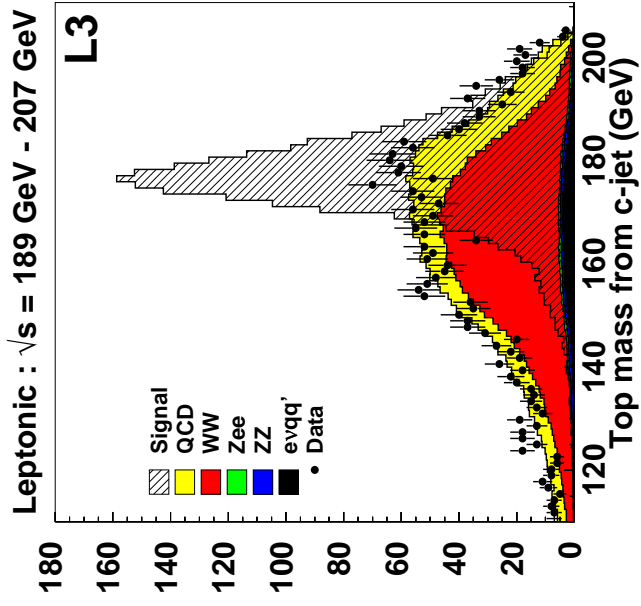


Search for single top production

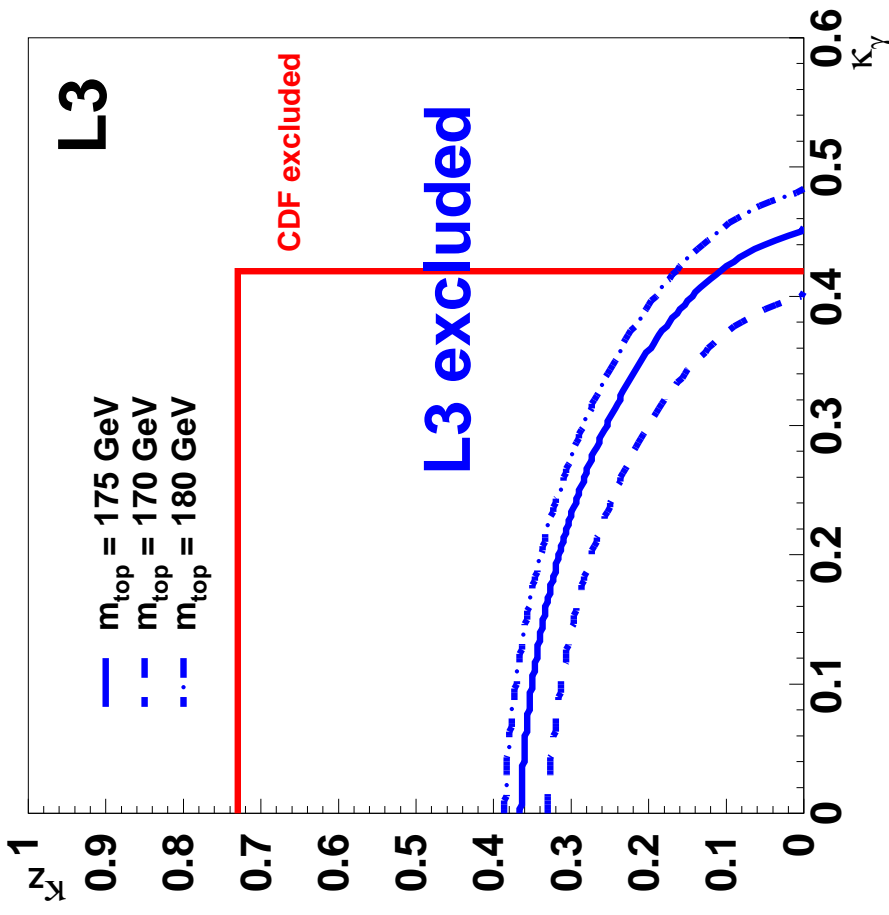
Parametrisation of FCNC transitions:



Two final states: $t \rightarrow Wb, W \rightarrow \ell\bar{\nu}, q\bar{q}'$



No excess observed



$\kappa_\gamma = 0$: $\text{Br}(t \rightarrow cZ) < 8.3\%$

Bose-Einstein correlations in hadronic Z decays

Enhanced production of pairs of identical bosons, π , close in phase space:

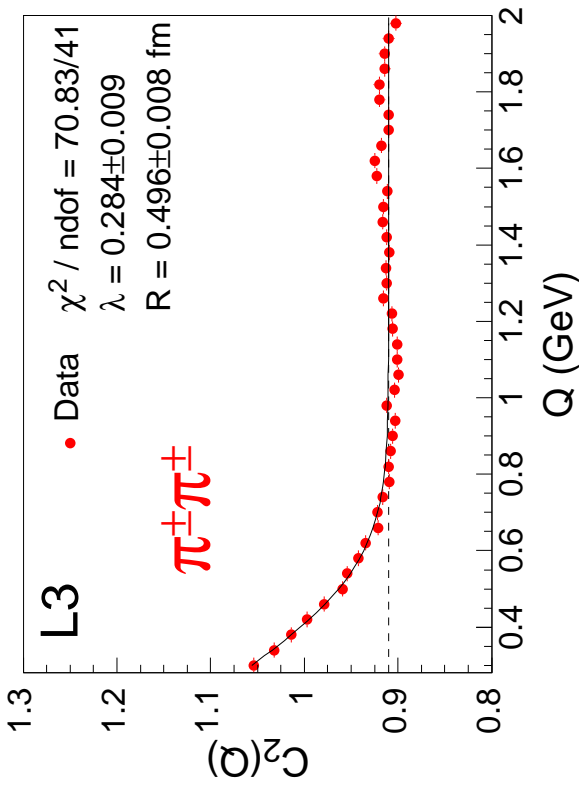
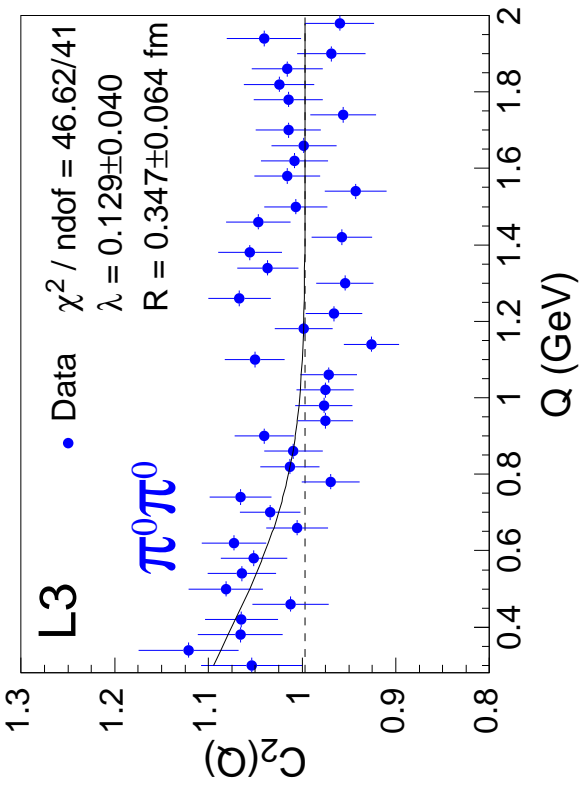
$$C_2(p_1, p_2) \equiv \frac{P_{BE}(p_1, p_2)}{P_0(p_1, p_2)}$$

$$C_2(Q) = \mathcal{N} \left(1 + \lambda e^{-Q^2 R^2} \right)$$

λ : fraction of interfering pion pairs

R : size of the boson source

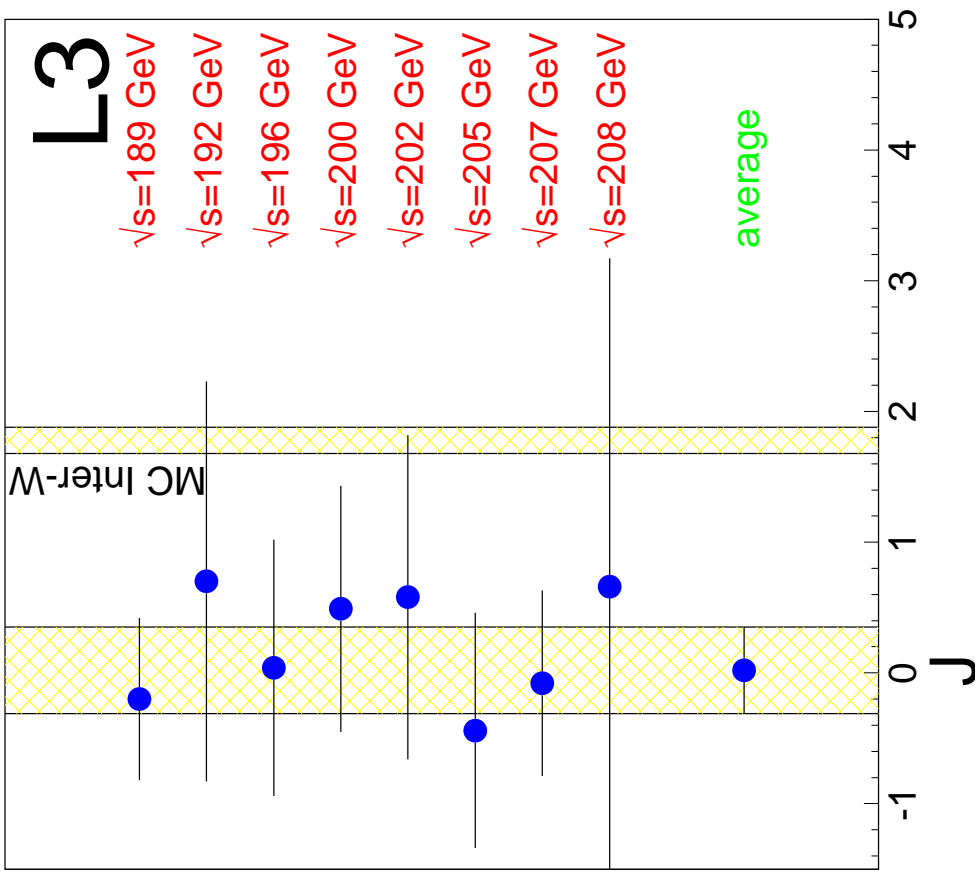
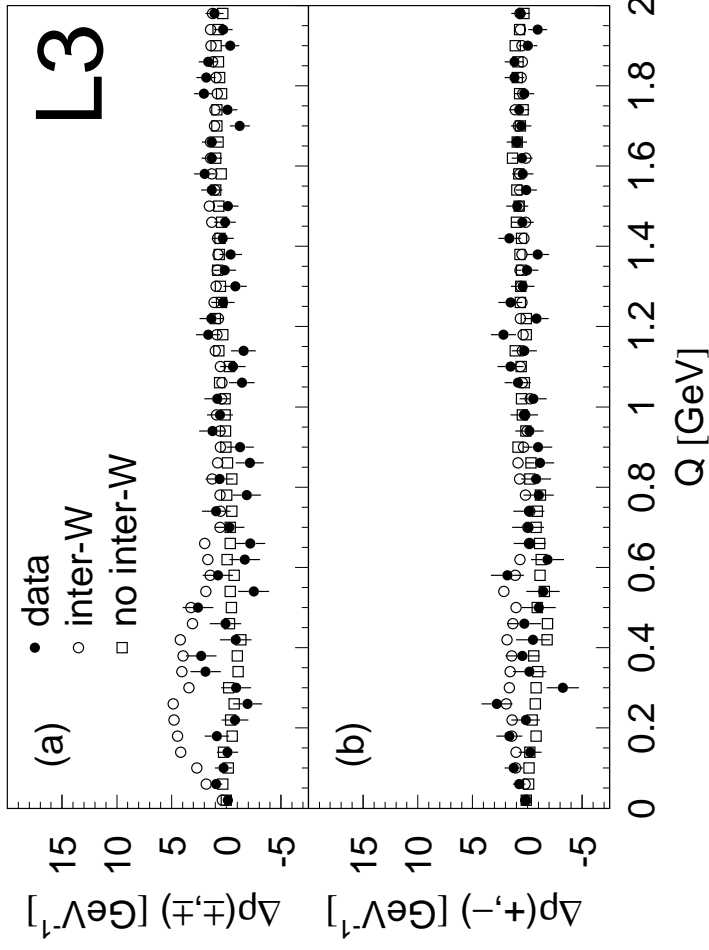
Weaker correlation and smaller source for $\pi^0\pi^0$ than for $\pi^\pm\pi^\pm$.



Bose-Einstein correlations in W decays

BEC studied between particles from different W's

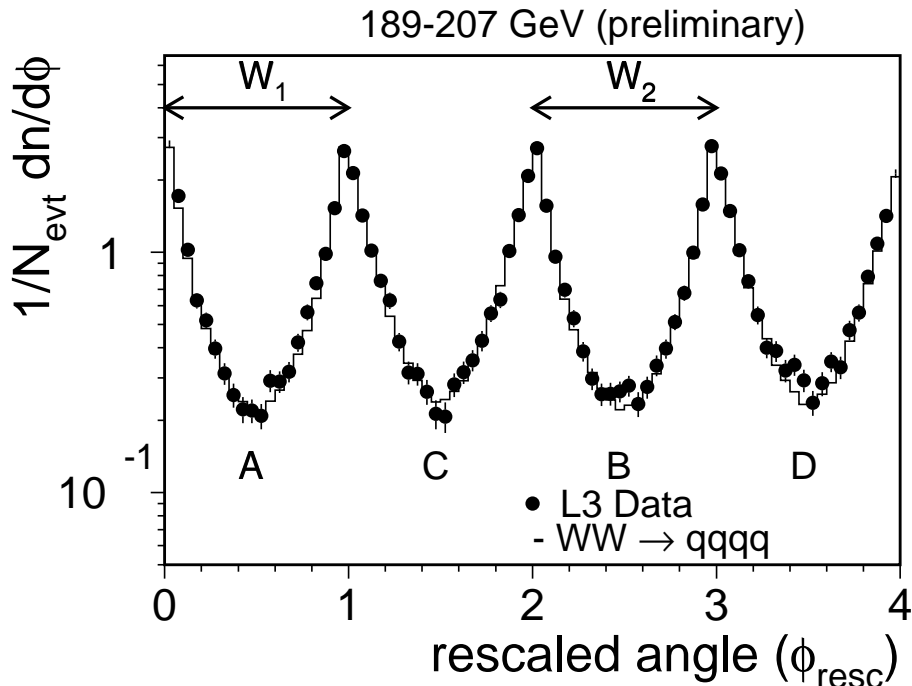
$$J \equiv \int \Delta\rho(Q) dQ$$



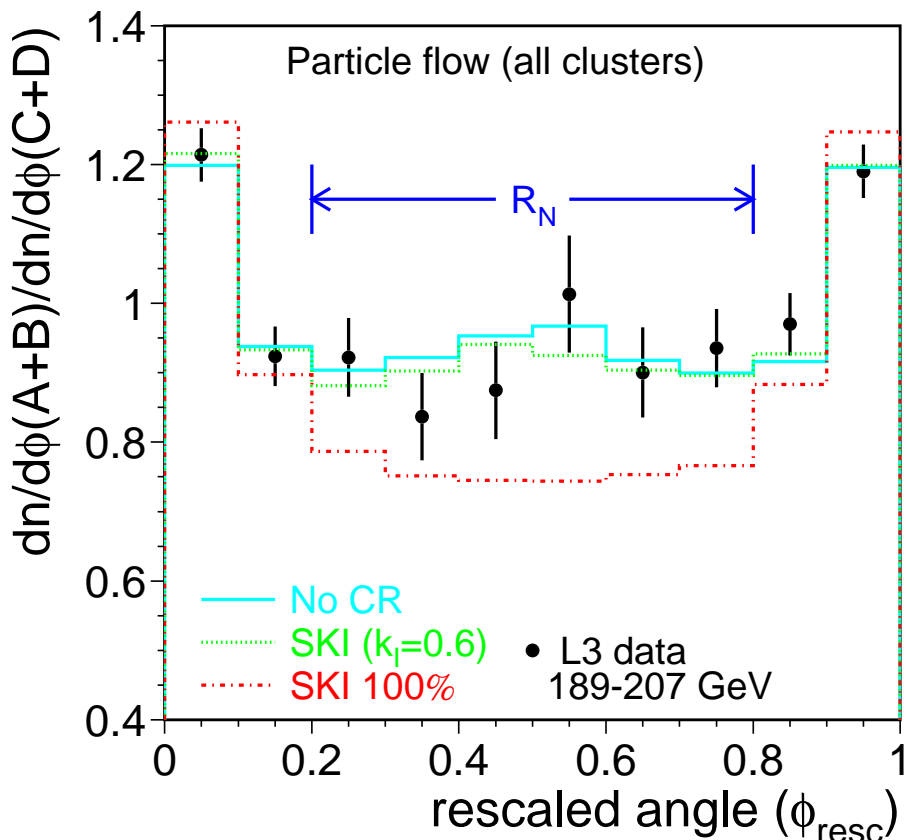
**No evidence for inter-W BEC is found,
A model with inter-W BEC is disfavoured by 4.7σ**

Colour reconnection effects in hadronic W^+W^- events

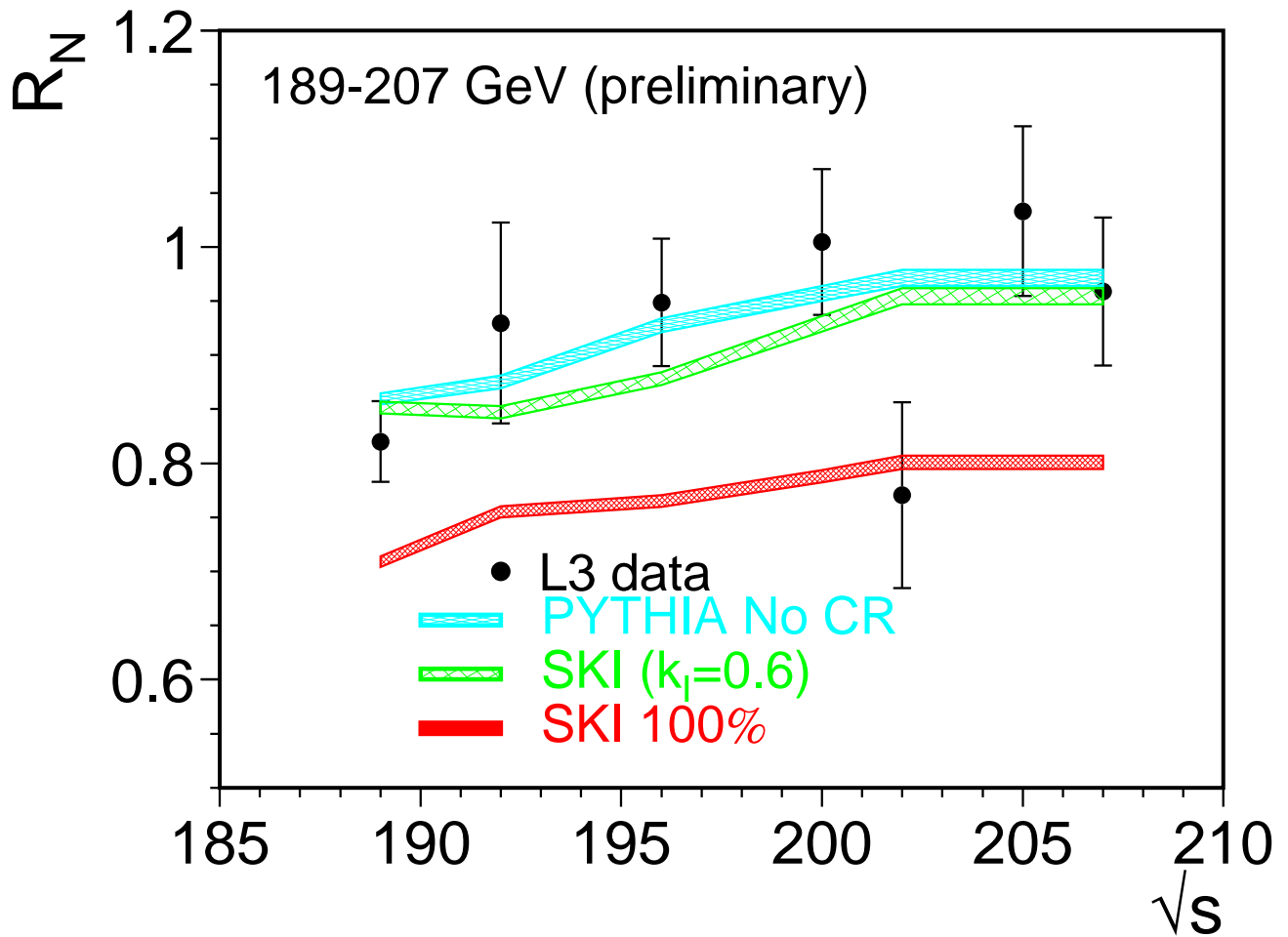
Particle flow between jets sensitive to colour reconnection
during the hadronisation



$$R_N = \frac{A + B}{C + D}$$

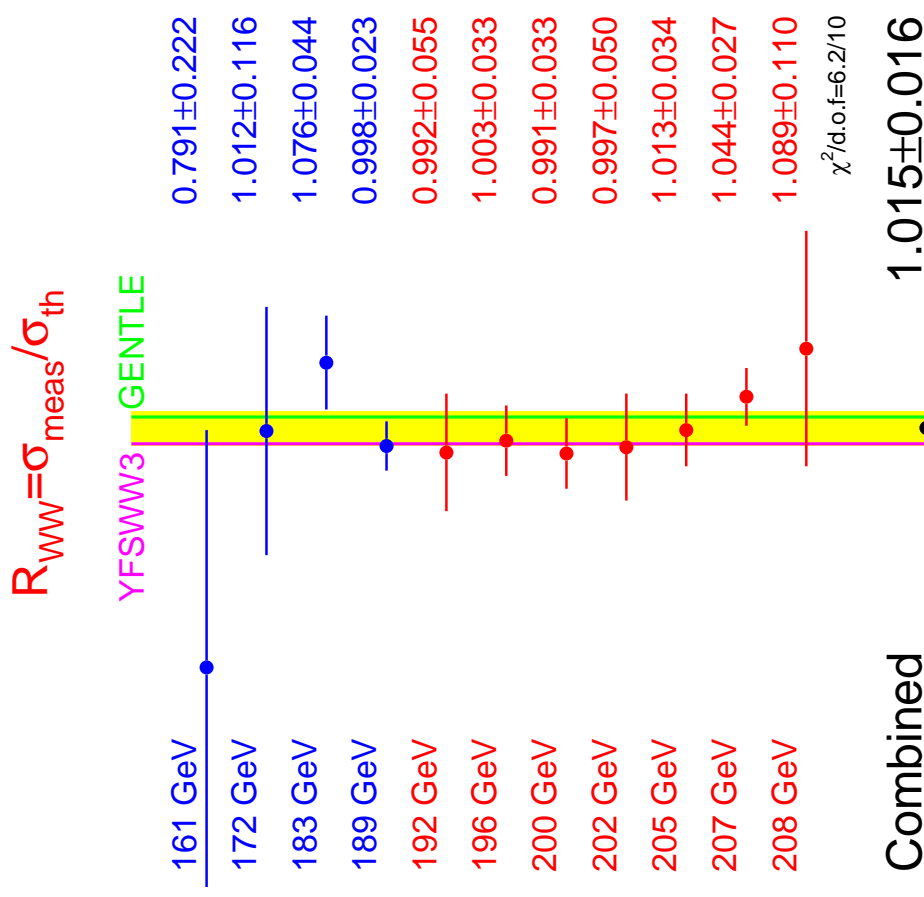
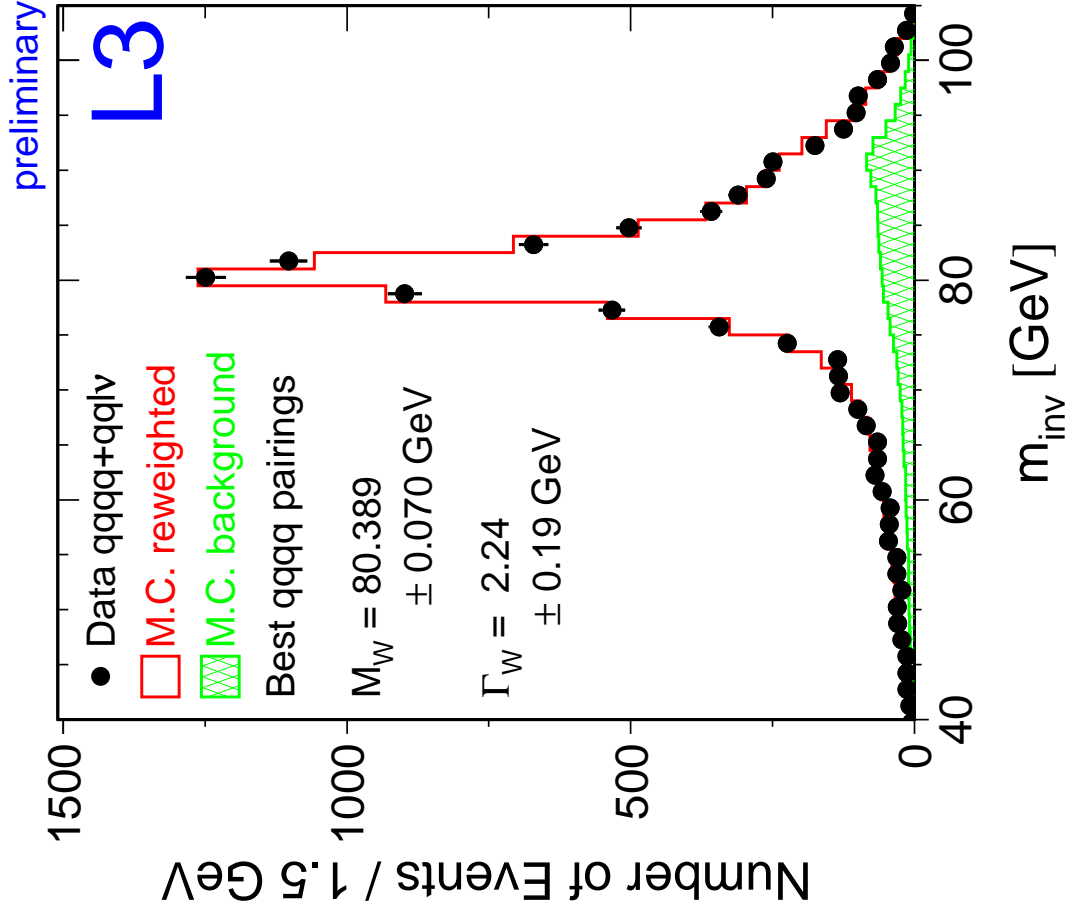


The data are consistent with a small reconnection probability



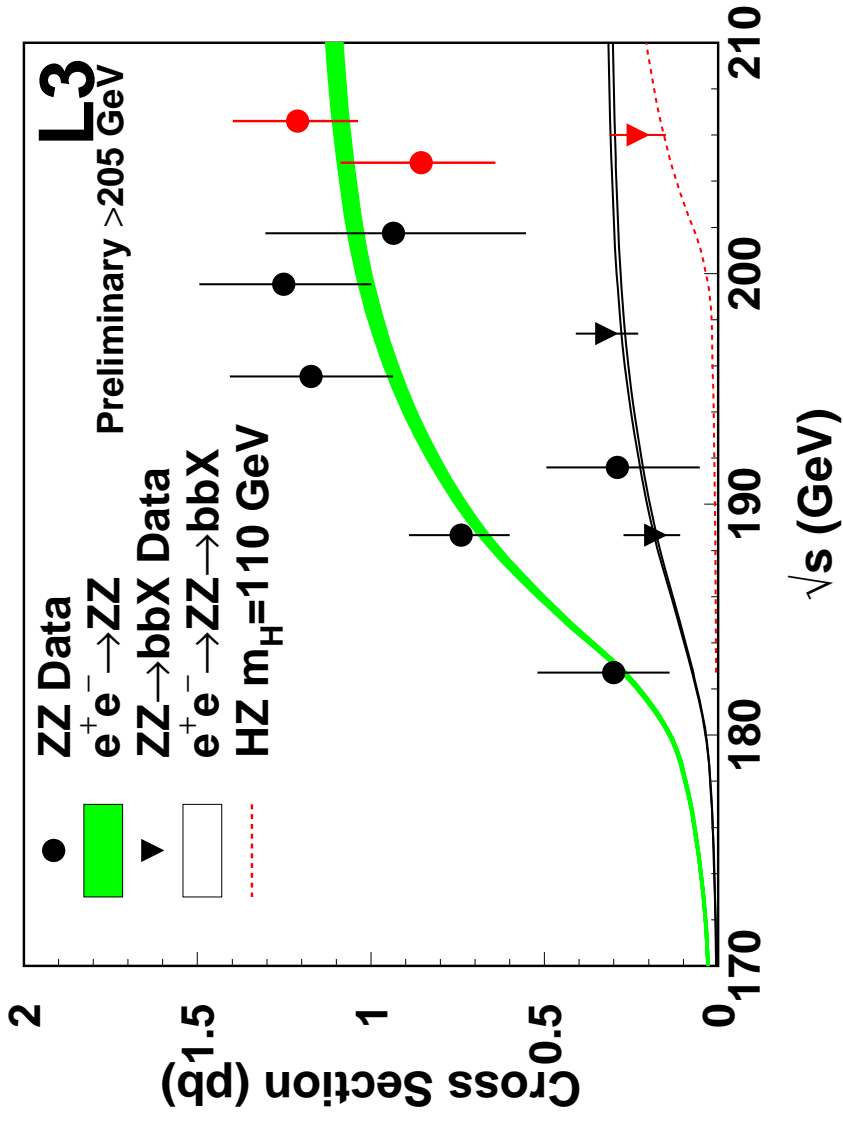
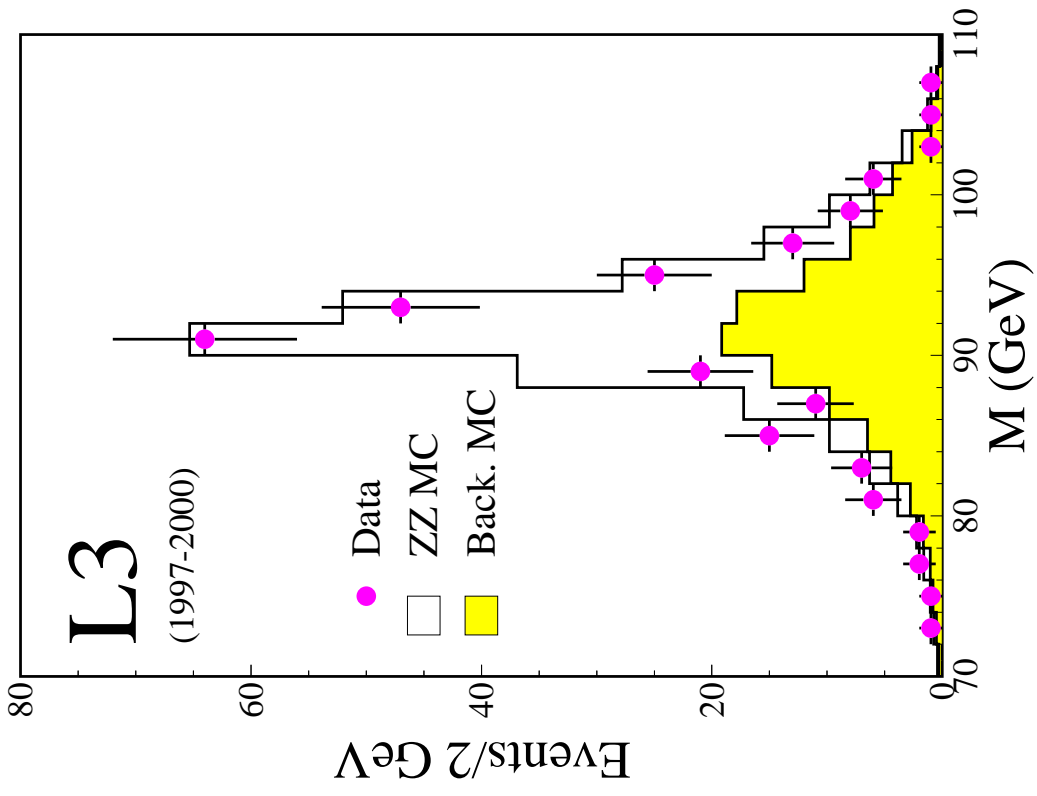
Similar results using the energy flow between jets

The W mass and W^+W^- cross section measurements



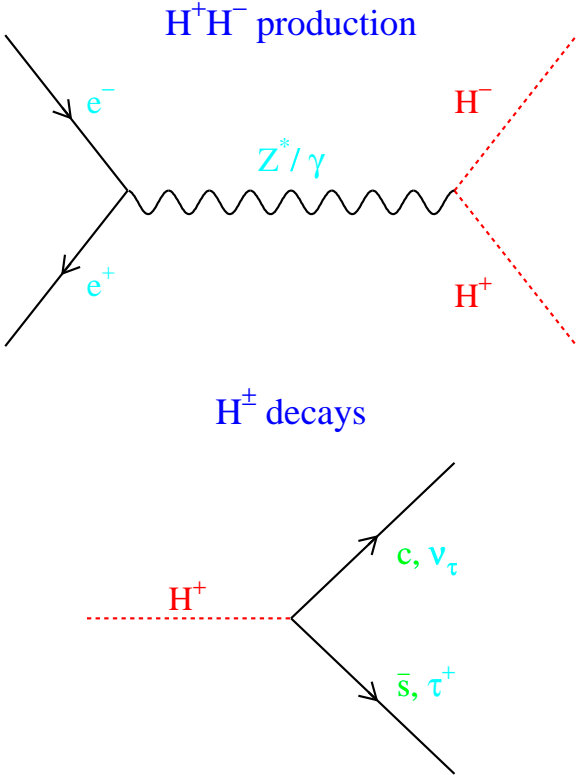
The reference is YFSWW3

The ZZ cross section measurement

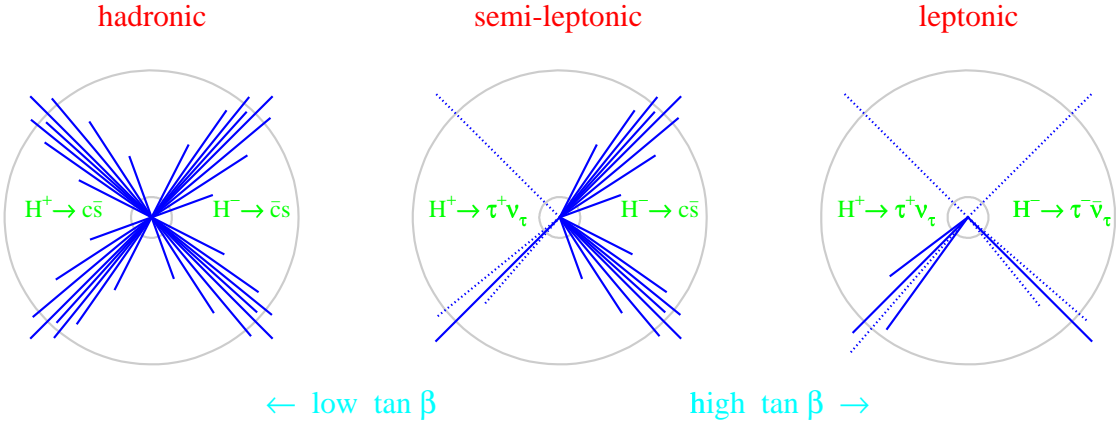


Charged Higgs production at LEP

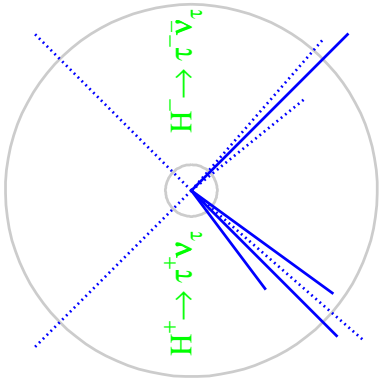
Two Higgs Doublet Models (Type I):



Three final states:



The expected number of events is **30** for $m_H = 70$ GeV.



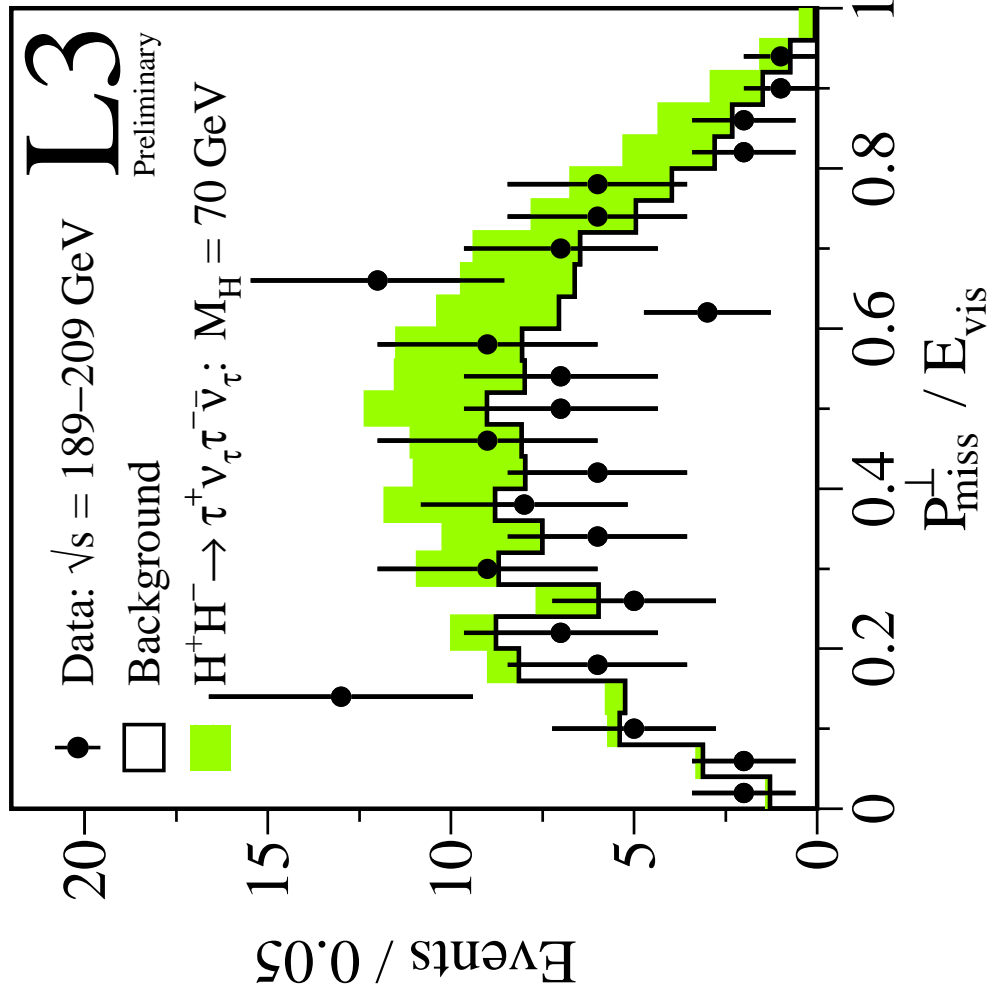
The $H^+H^- \rightarrow \tau^+ \nu_\tau \tau^- \bar{\nu}_\tau$ channel

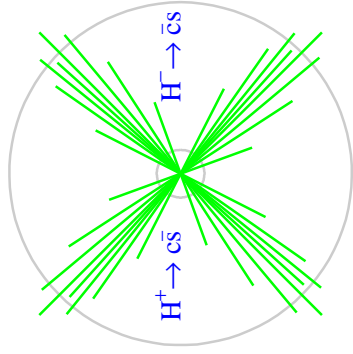
$Br(H^+ \rightarrow \tau^+ \nu_\tau) = 1$

- Two τ , at least four neutrinos
- the mass is not reconstructed
- New analysis, linear discriminant:

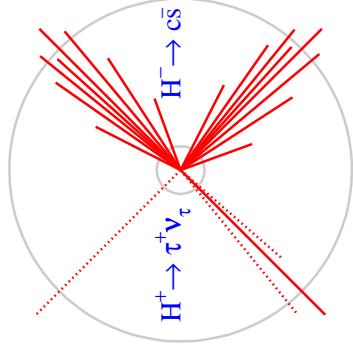
$$P_{\text{mis}}^\perp / E_{\text{vis}}$$

Expected limit 1.5 GeV higher

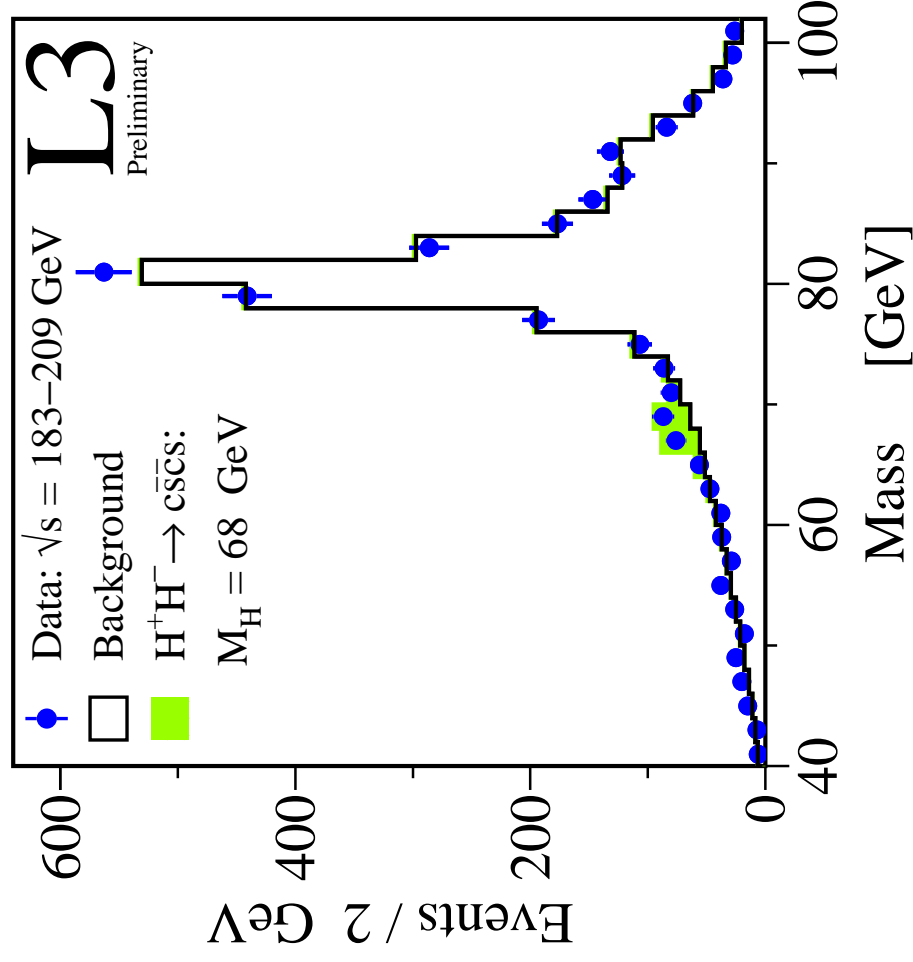




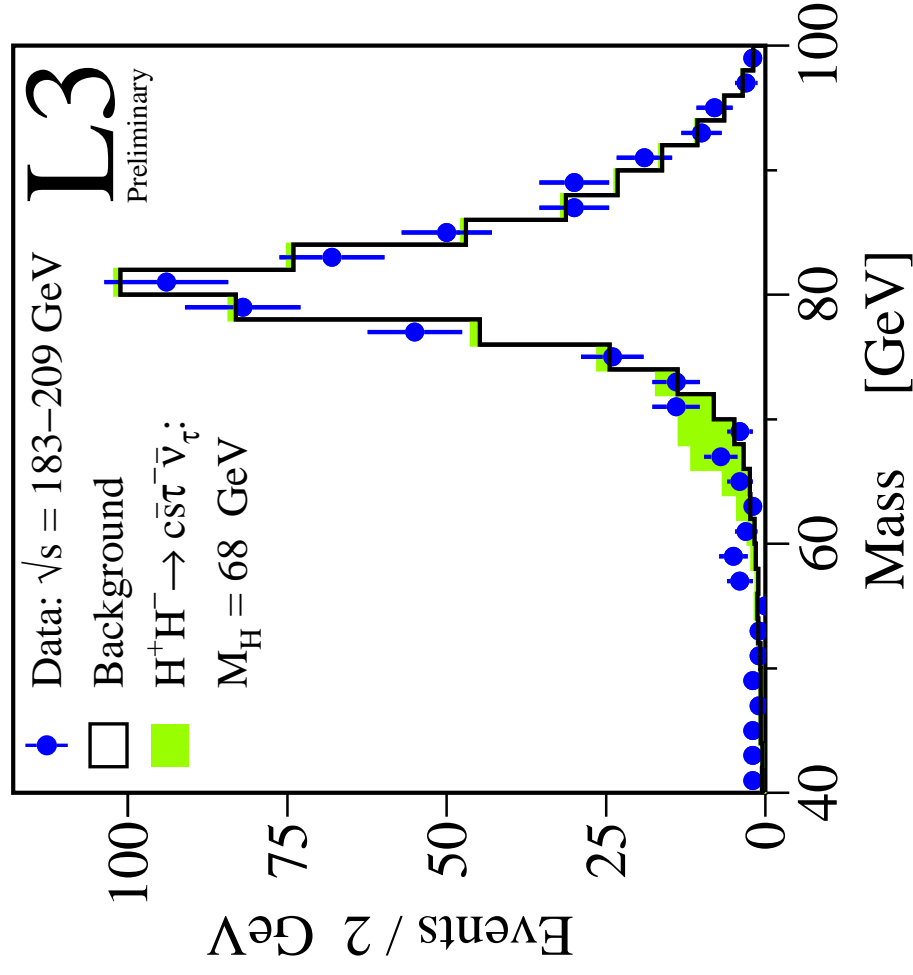
The $H^+H^- \rightarrow c\bar{c}s\bar{s}$ and $c\bar{s}\tau^-\bar{\nu}_\tau$ channels



$$\text{Br}(H^+ \rightarrow \tau^+\nu_\tau) = 0$$

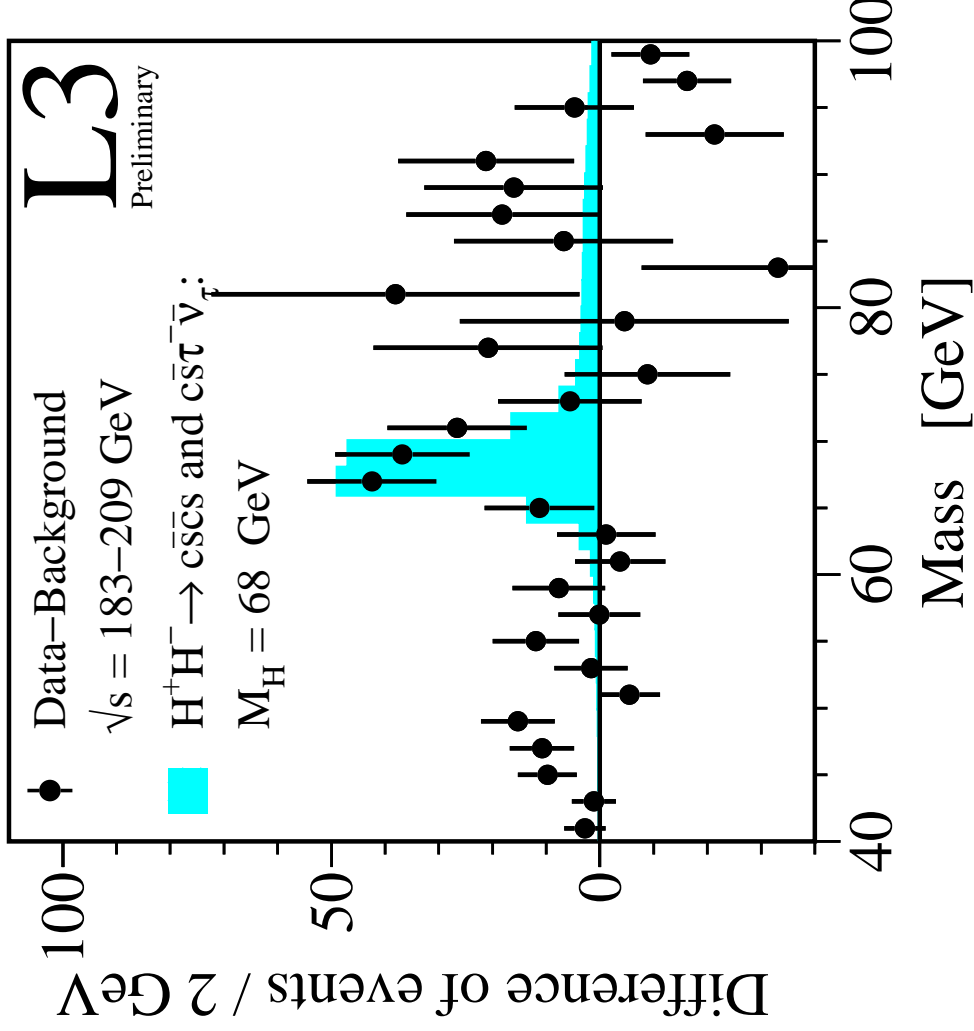


$$\text{Br}(H^+ \rightarrow \tau^+\nu_\tau) = 0.5$$

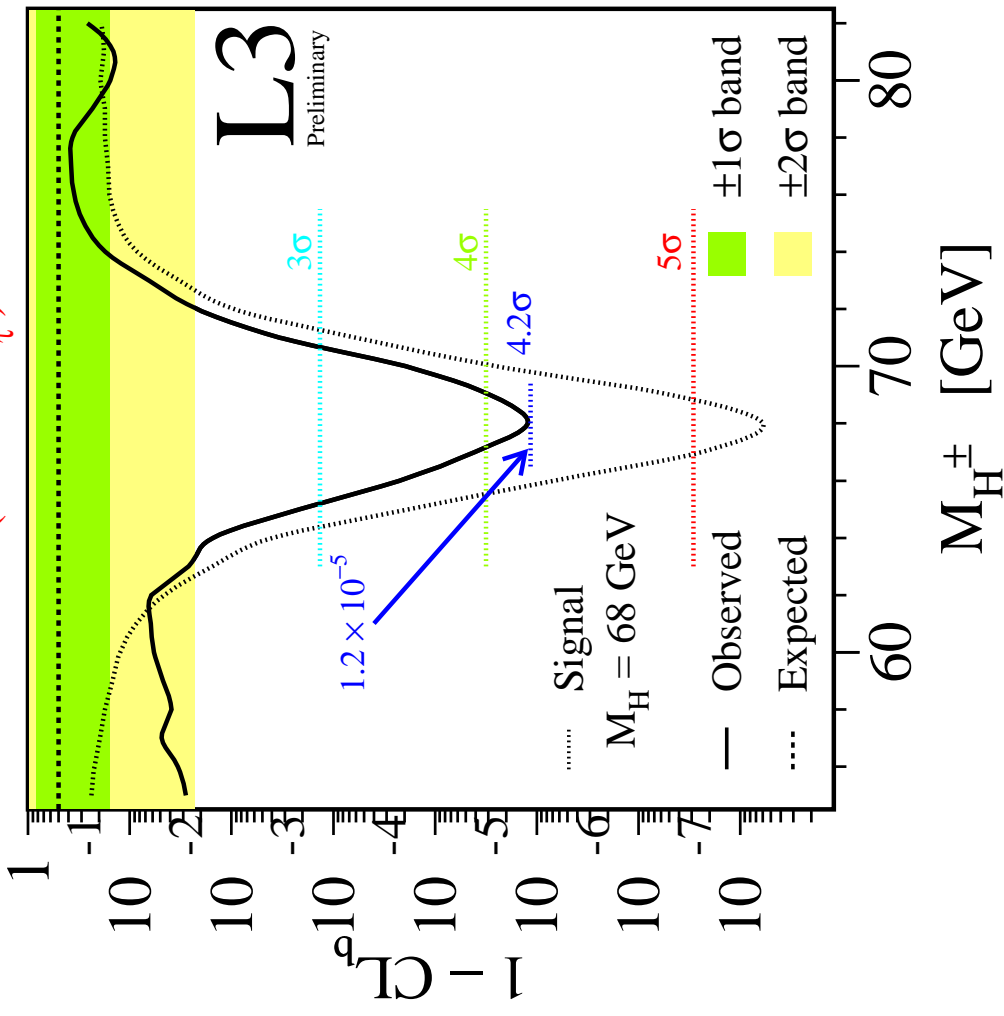


Excess of events at 68 GeV

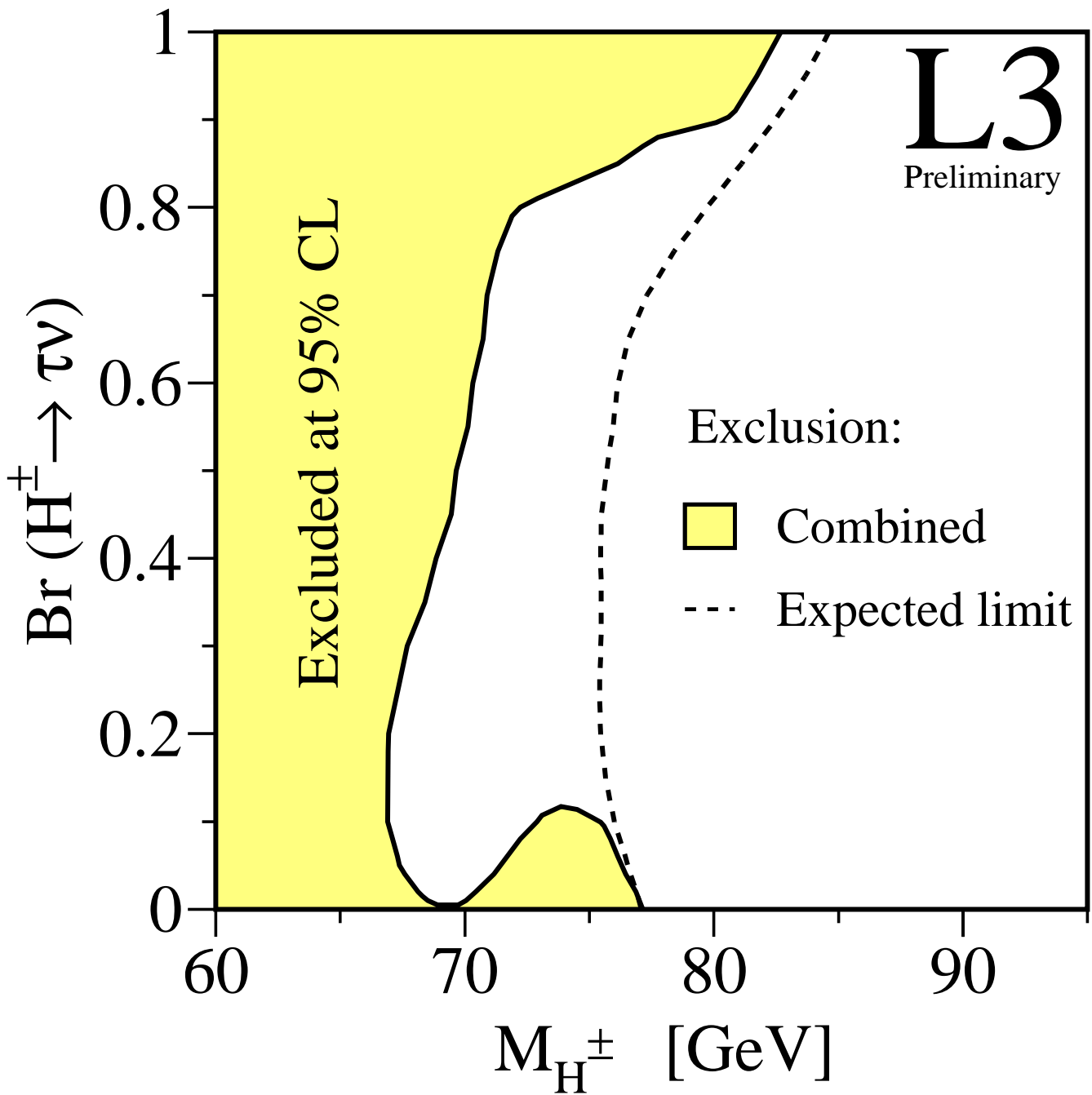
$$\text{Br}(H^+ \rightarrow \tau^+ \nu_\tau) = 0.1$$



$$\text{Br}(H^+ \rightarrow \tau^+ \nu_\tau) = 0.1$$



Exclusion

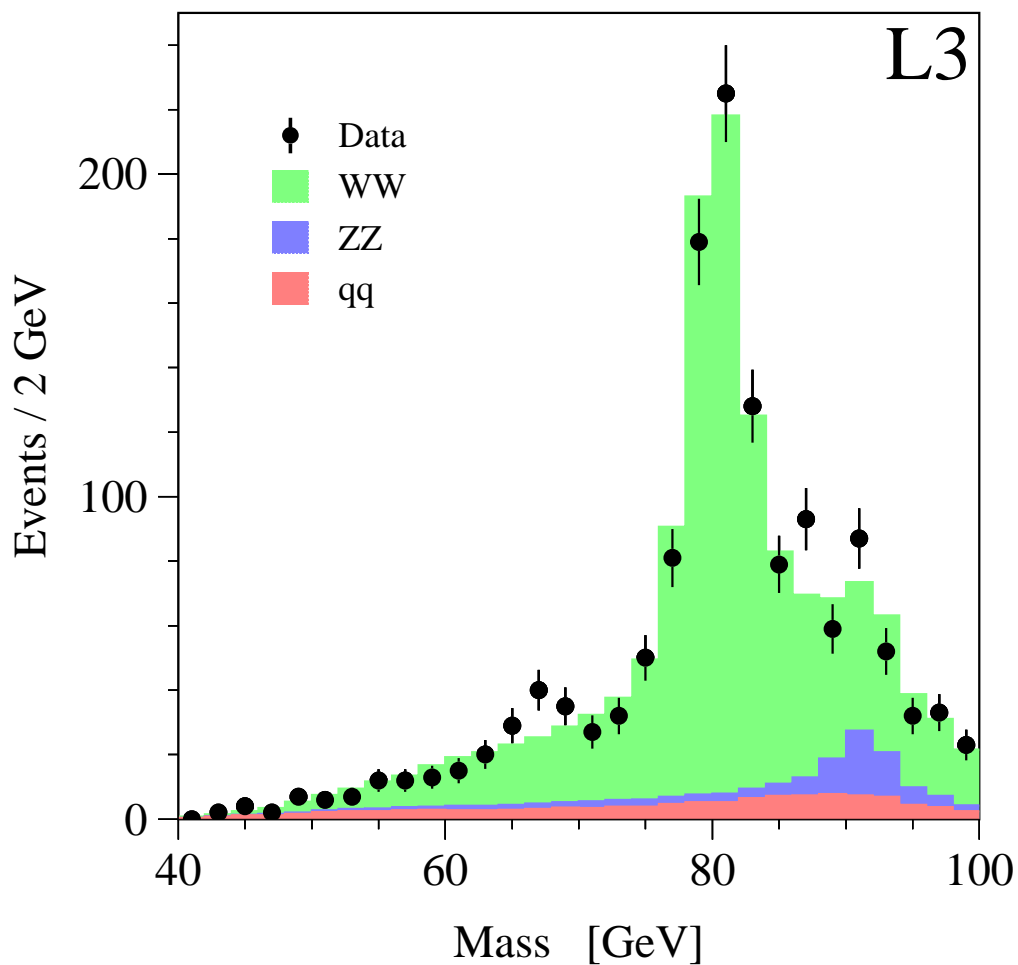


$Br(H^\pm \rightarrow \tau\nu)$	Lower limits at 95% CL (GeV)	
	observed	median expected
0.0	77.2	77.1
0.1	66.9	76.0
0.5	69.7	75.7
1.0	82.7	84.6

Cut based 4-jet analysis

- loose 4-jet preselection
- $\log(Y_{34}) > -4.0$
- $|\cos \theta_{prod}| < 0.8$
- $\chi_{5C}^2 < 10$

This is NOT the H^\pm analysis, but a simple cut based analysis



Further tests are being performed.

Standard Model Higgs boson search

- **L3 published the results right after data taking:**

[Physics Letters B 495 \(2000\) 7](#)

- **New L3 results (June 2001): FINAL**

[Submitted to Physics Letters B](#)

1. [Changes from November to June](#)

2. [Overview of the final results](#)

Changes since November

Luminosity:

Final: 217.3 pb⁻¹

November: 200.8 pb⁻¹

Additional luminosity at $\sqrt{s} > 206$ GeV

\sqrt{s} from LEP:

Shifted down by 200 MeV.

Known more precisely now than in November

Data rerun:

Final calibrations of all subdetectors

Monte Carlo rerun:

- a) final mapping of the detector behaviour*
- b) high statistics Monte Carlo samples (more than $\times 4$)*
- c) simulation on a finer grid of \sqrt{s}*

Analyses:

a) new $Hq\bar{q}$ analysis, likelihood based: higher sensitivity

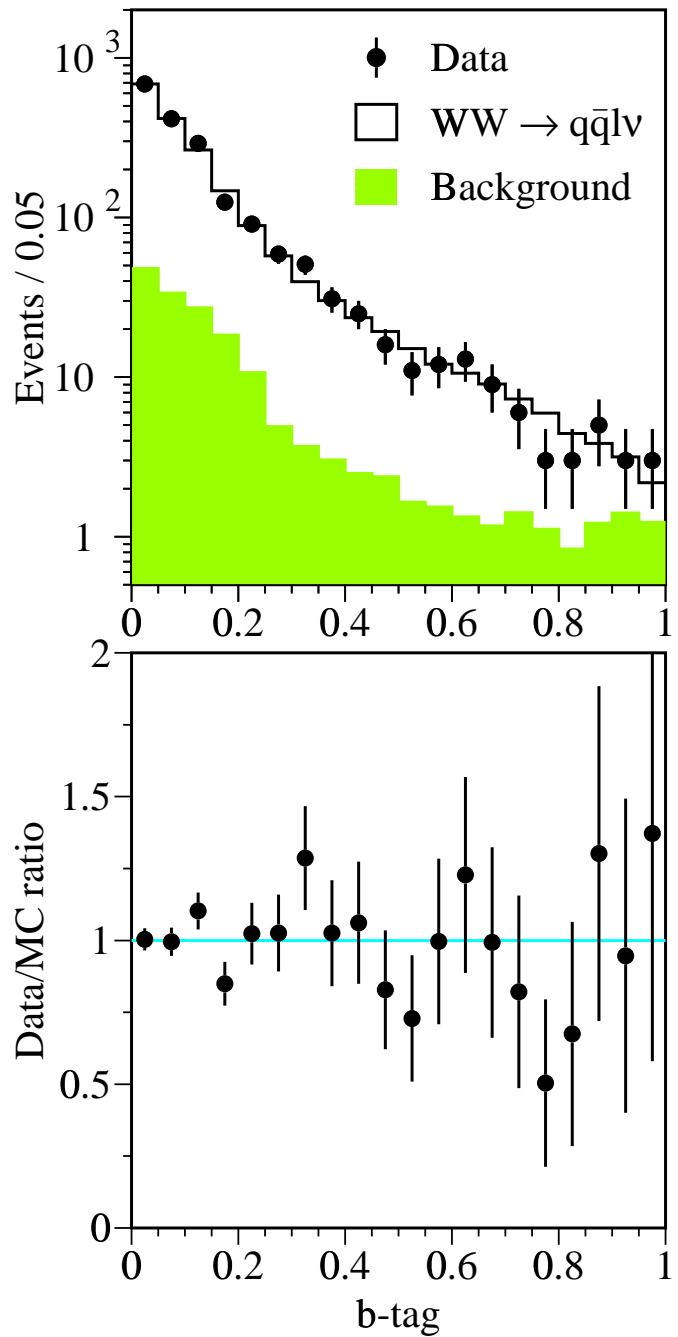
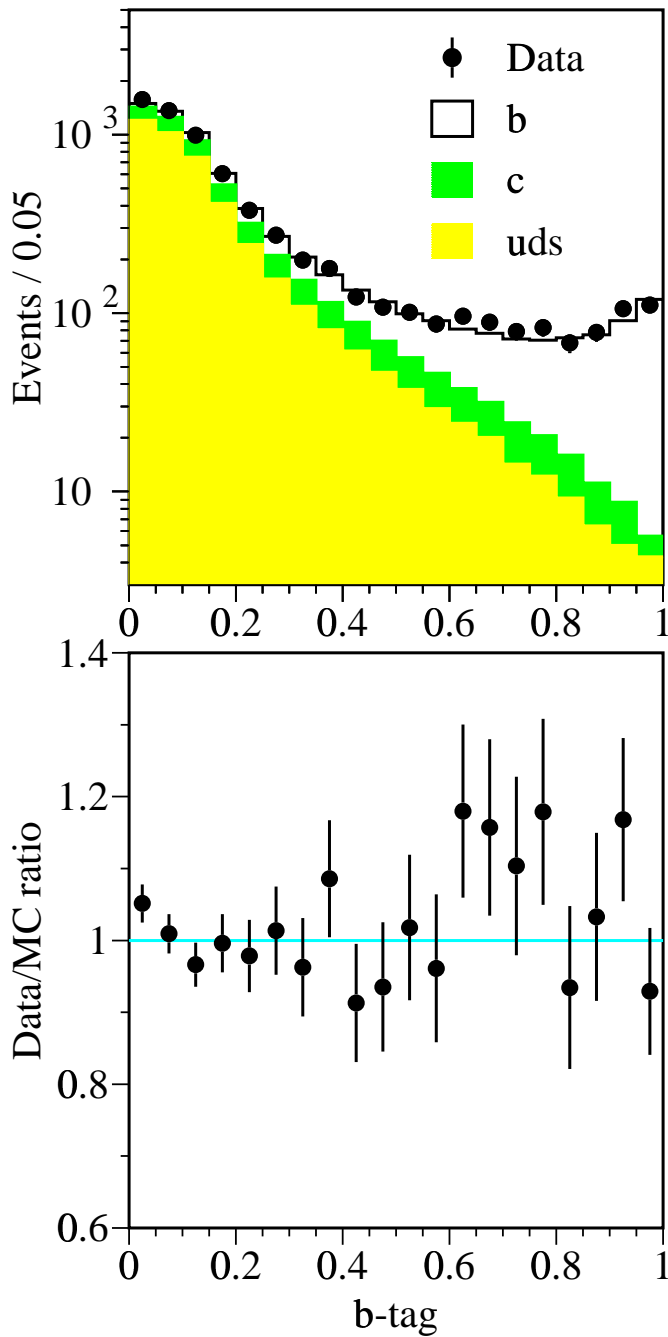
b) $H\nu\bar{\nu}$ analysis (NN based) optimised

Search performance improved by about 1 GeV in the mass limit expected at 95% CL

Main gain in performance is from the $Hq\bar{q}$ analysis.

B-tag in high-energy data samples

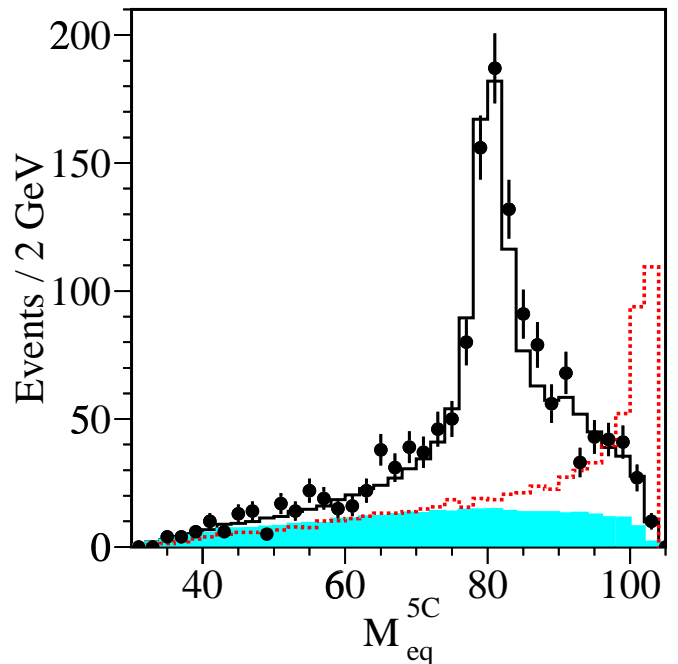
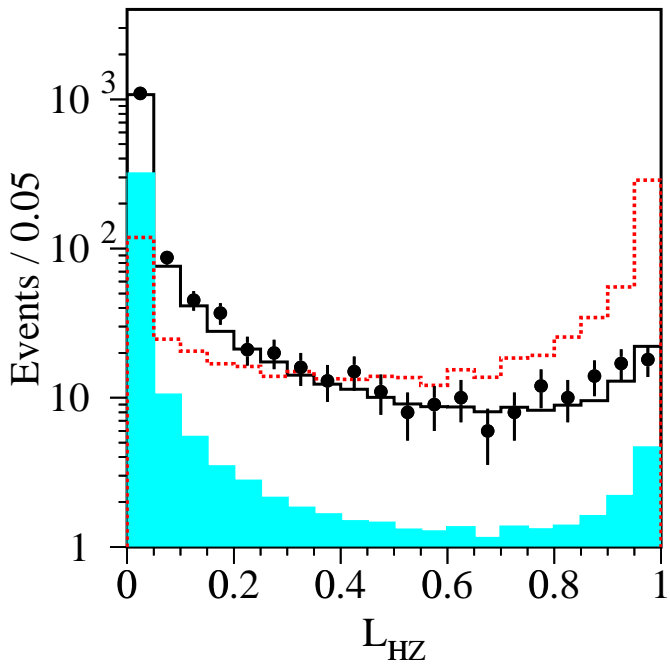
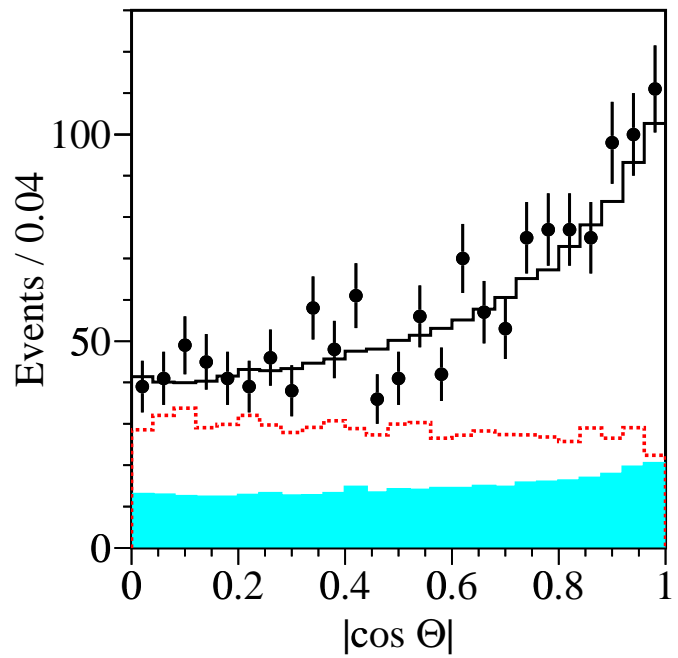
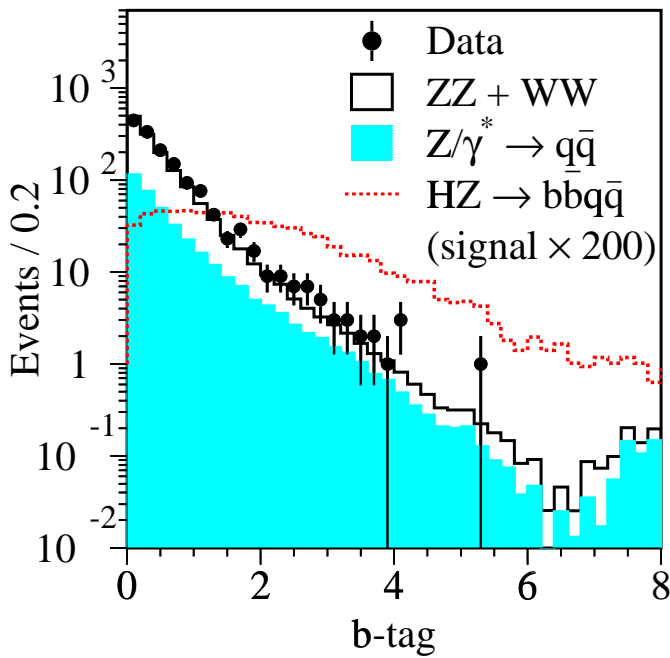
$$e^+e^- \rightarrow q\bar{q}(\gamma) \quad \text{and} \quad W^+W^- \rightarrow q\bar{q}l\nu$$



Hq \bar{q} analysis

Distributions of some discriminating
variables combined in the likelihood

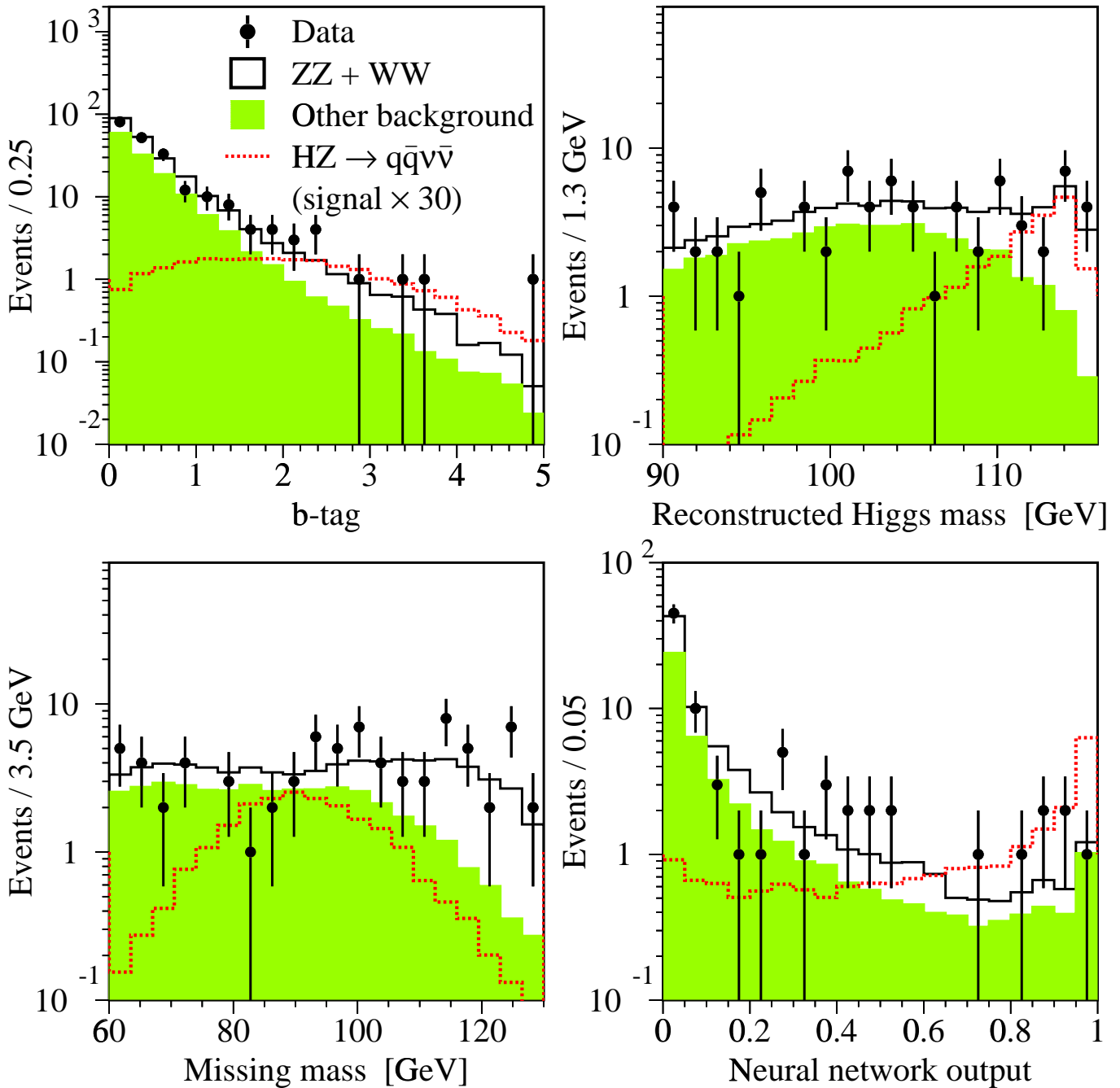
Signal: $m_H = 115$ GeV



H $\nu\bar{\nu}$ analysis

Distributions of some discriminating variables fed into the Neural Network

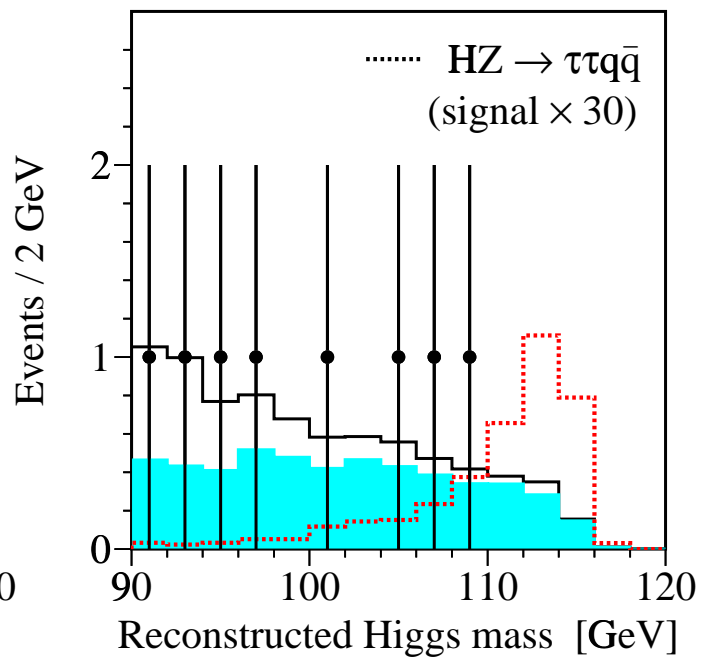
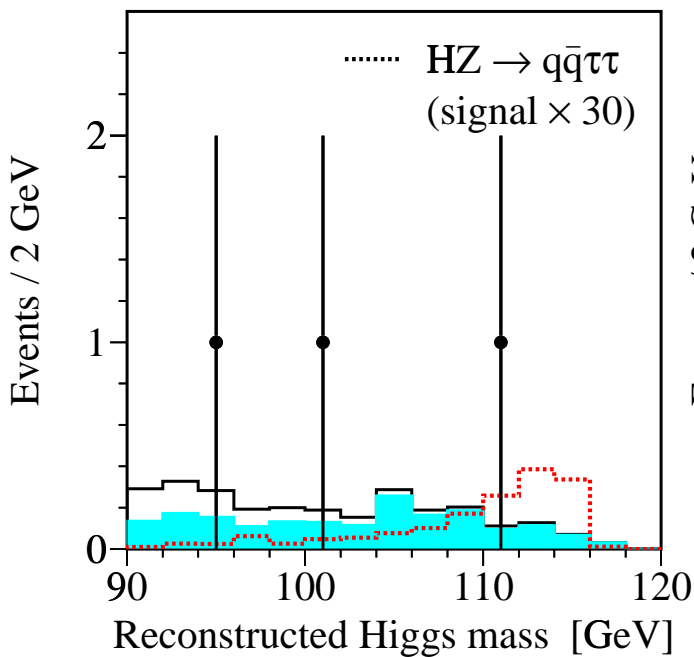
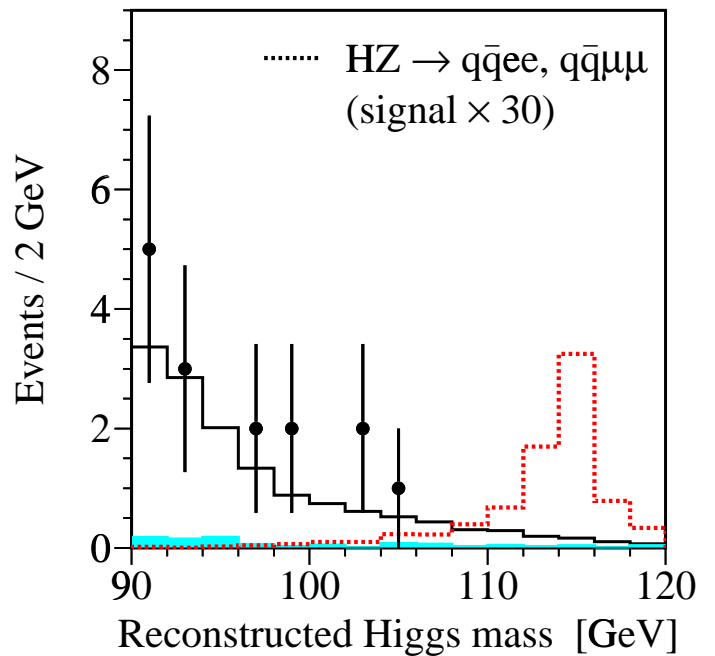
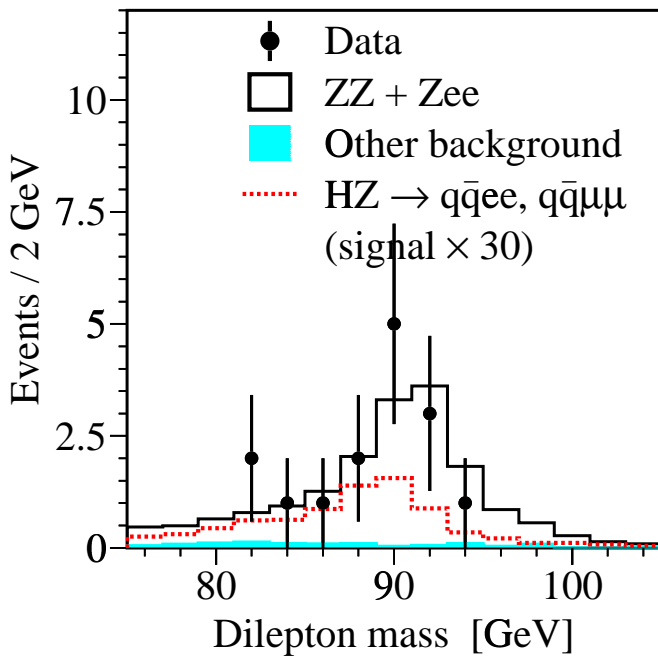
Signal: $m_H = 115$ GeV



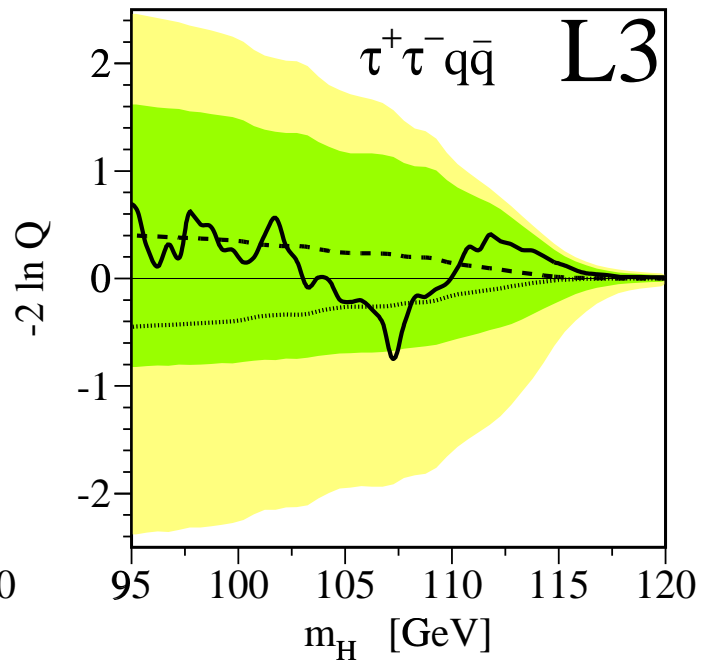
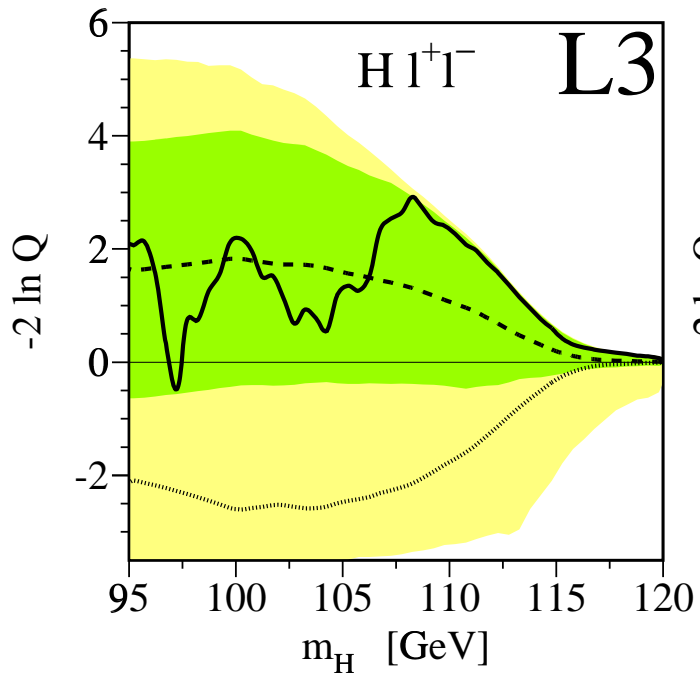
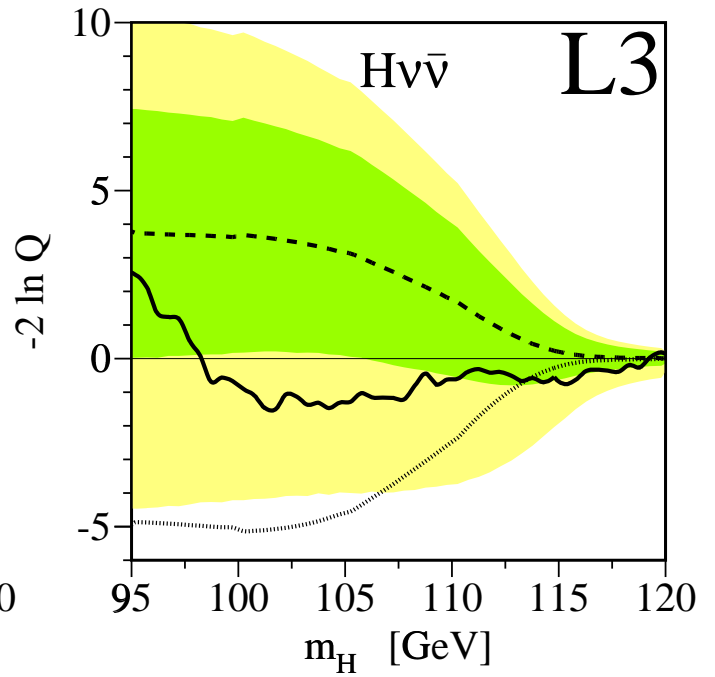
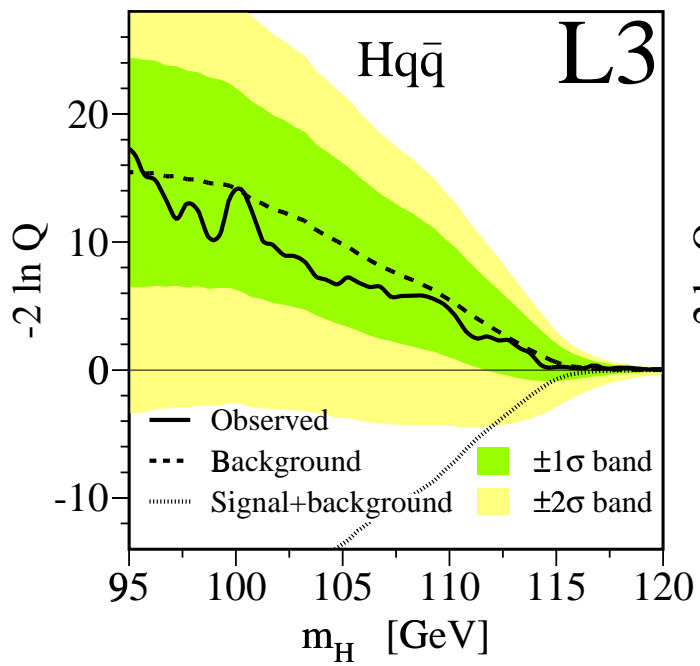
$H\ell^+\ell^-$ and $\tau^+\tau^-q\bar{q}$ analyses

Distributions of the dilepton mass and of the reconstructed Higgs mass

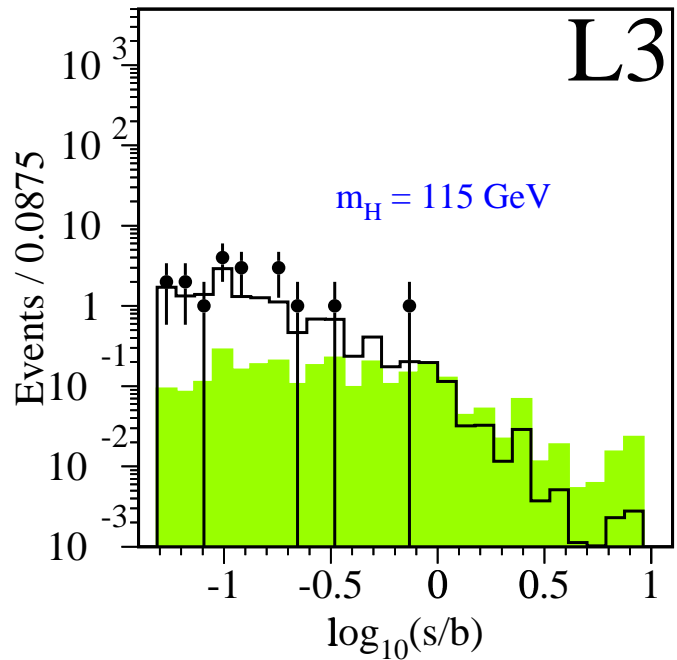
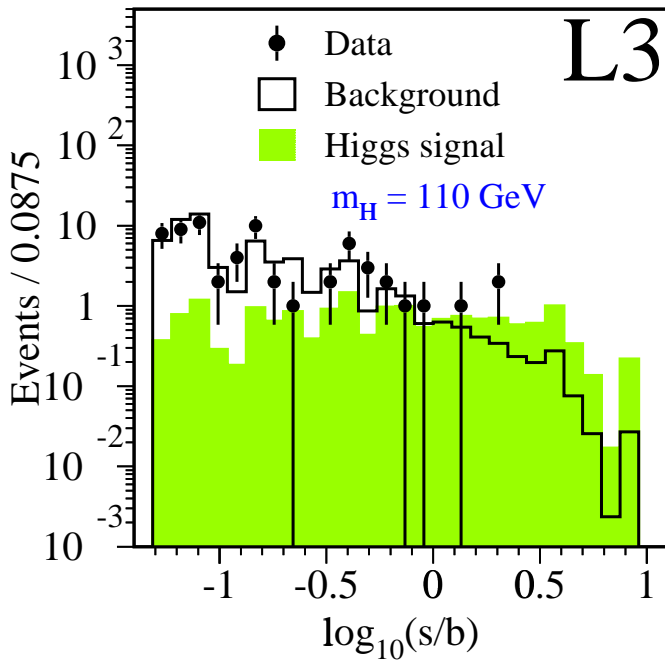
Signal: $m_H = 115$ GeV



The log-likelihood ratio for the individual search channels

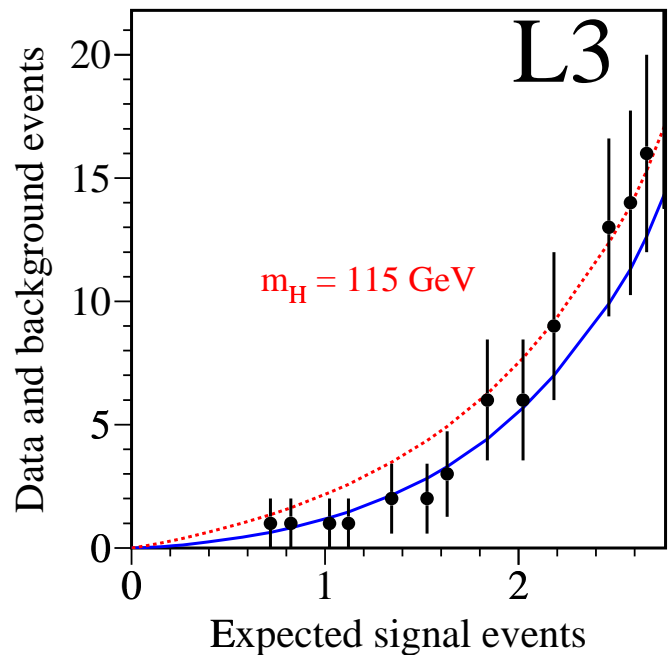
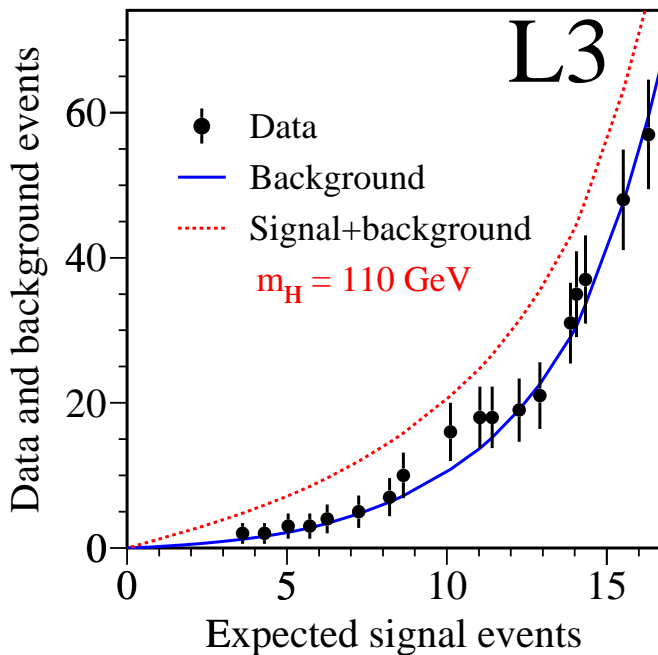


The s/b distributions

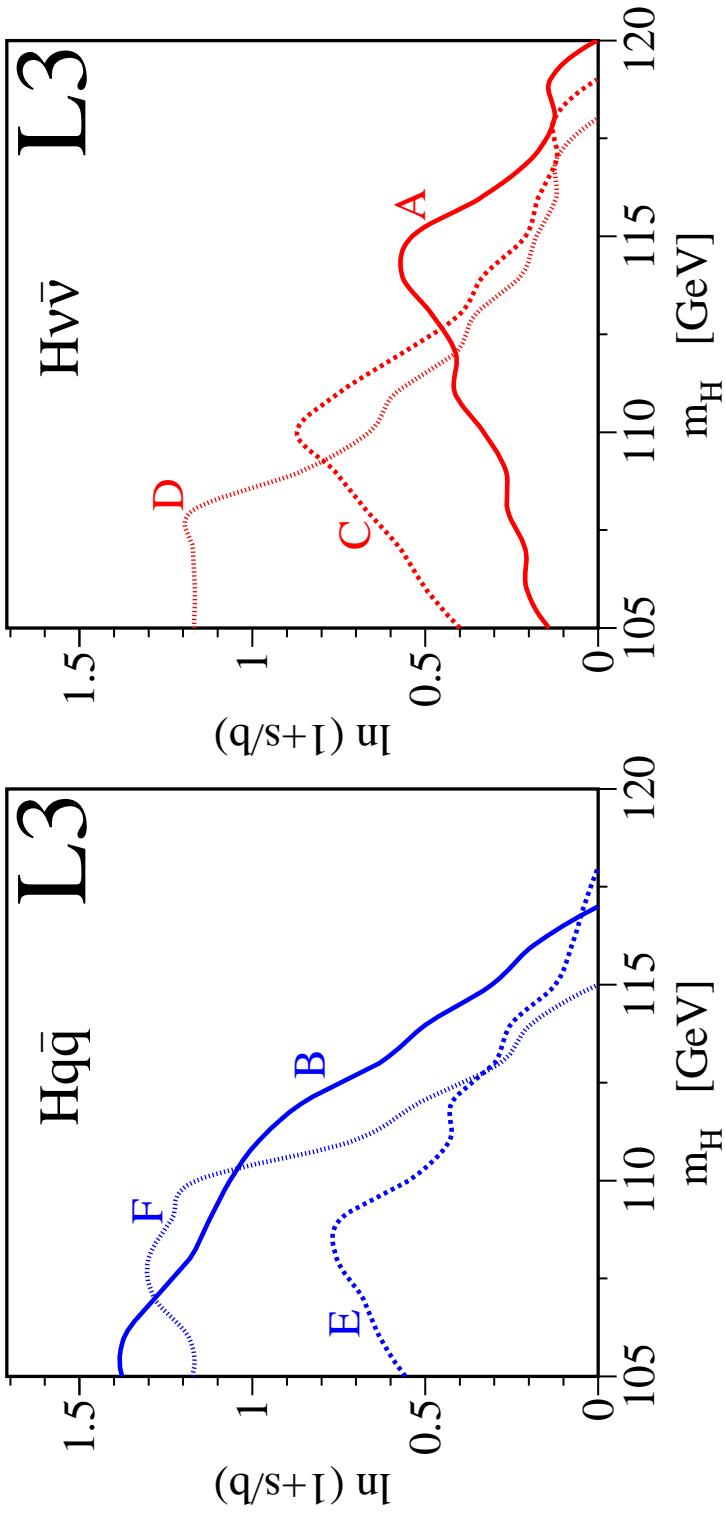


integrate above a given s/b value to obtain

Events versus expected signal

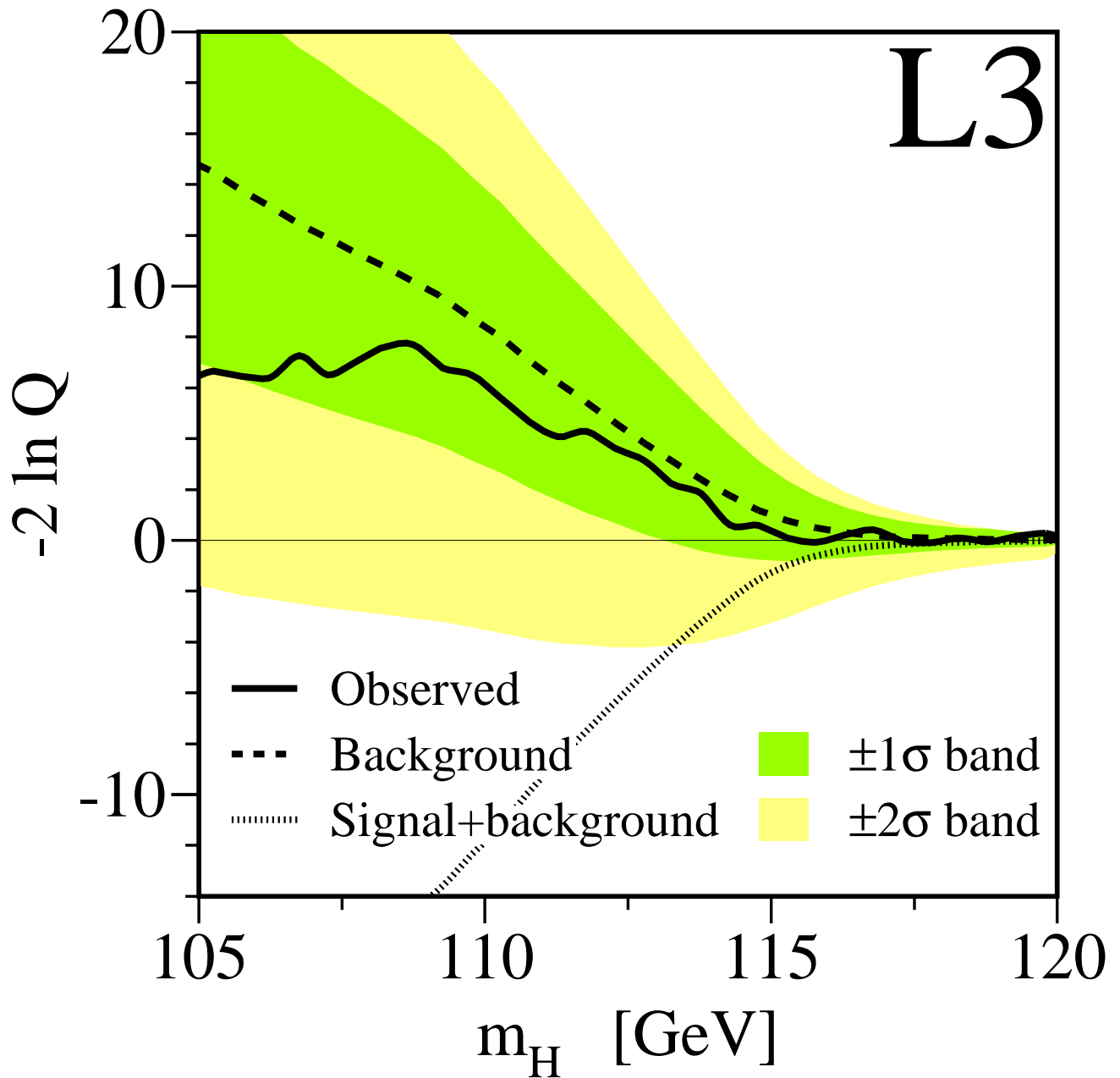


Event weight of the most significant high mass candidates

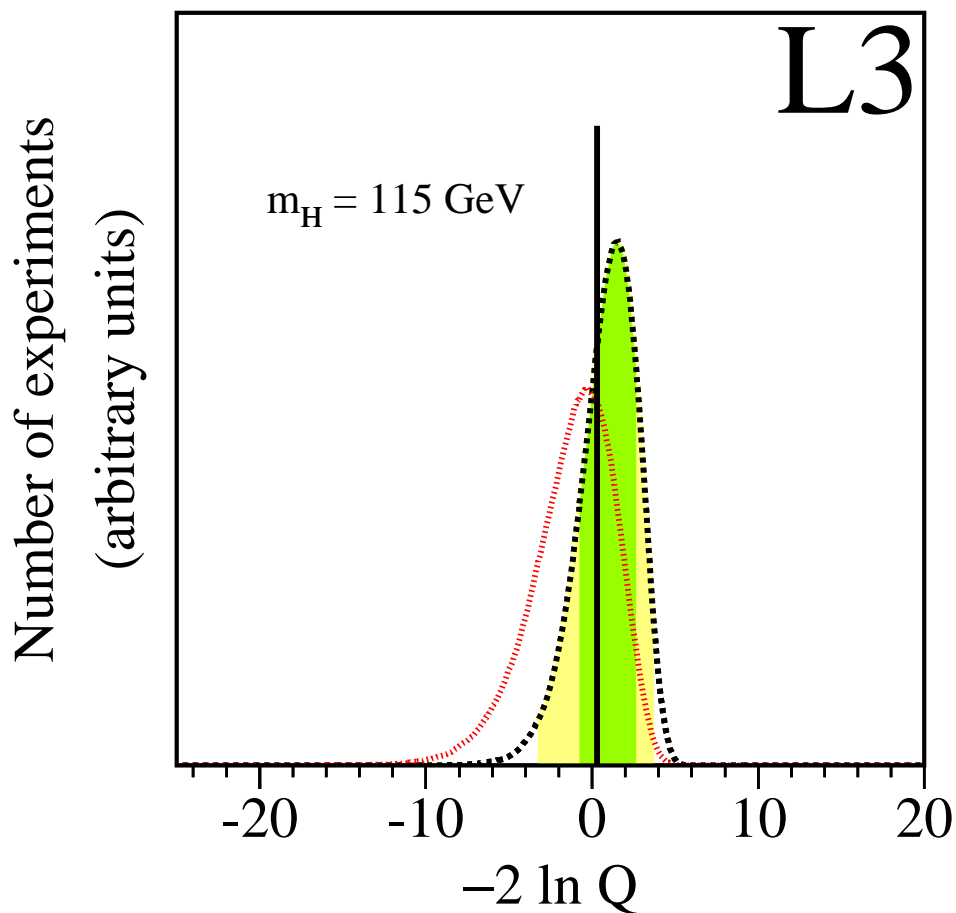
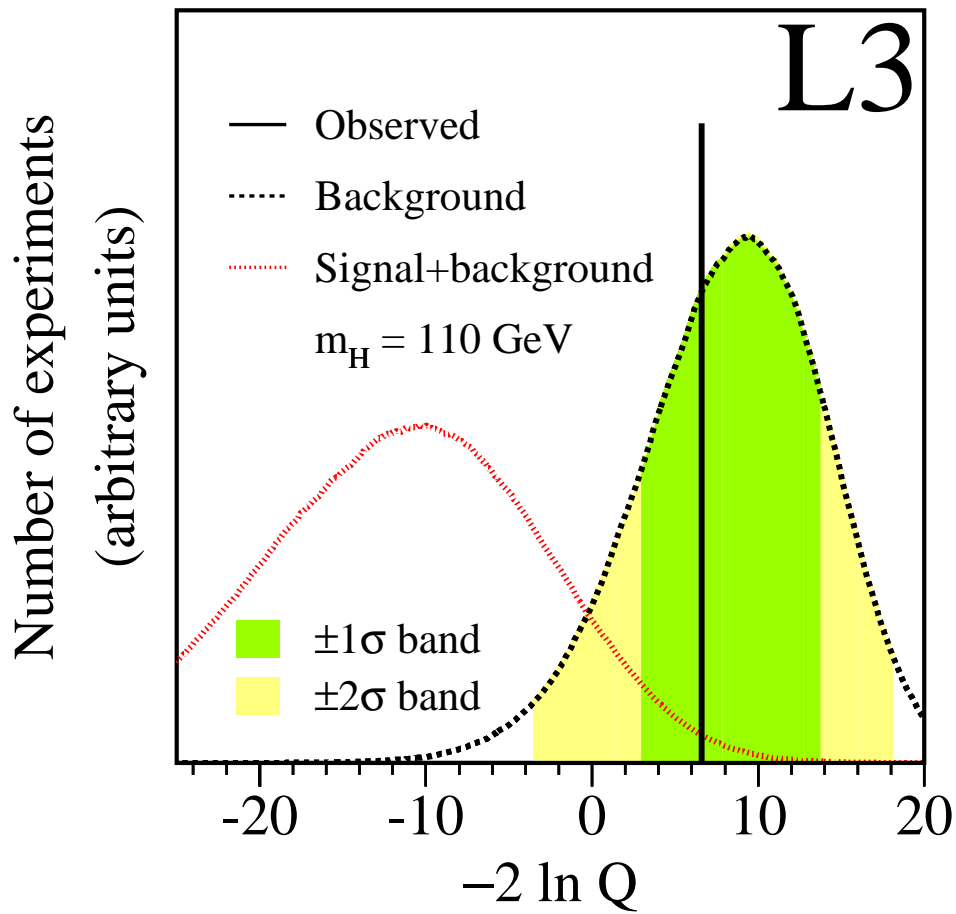


Event	Channel	M_H^{meas} (GeV)	\sqrt{s} (GeV)	$(s/b)_{115}$	$(s/b)_{110}$	$(s/b)_{max}$	m_H^{max} (GeV)
A	H$\nu\bar{\nu}$	115.0	206.4	0.70	0.39	0.77	114.3
B	Hq\bar{q}	108.3	206.4	0.36	1.90	2.96	105.1
C	H$\nu\bar{\nu}$	110.1	206.4	0.23	1.39	1.39	110.0
D	H$\nu\bar{\nu}$	107.1	206.6	0.20	0.94	2.31	107.6
E	Hq\bar{q}	109.9	206.6	0.13	0.73	1.12	107.7
F	Hq\bar{q}	107.1	204.7	0.01	2.20	2.67	107.9

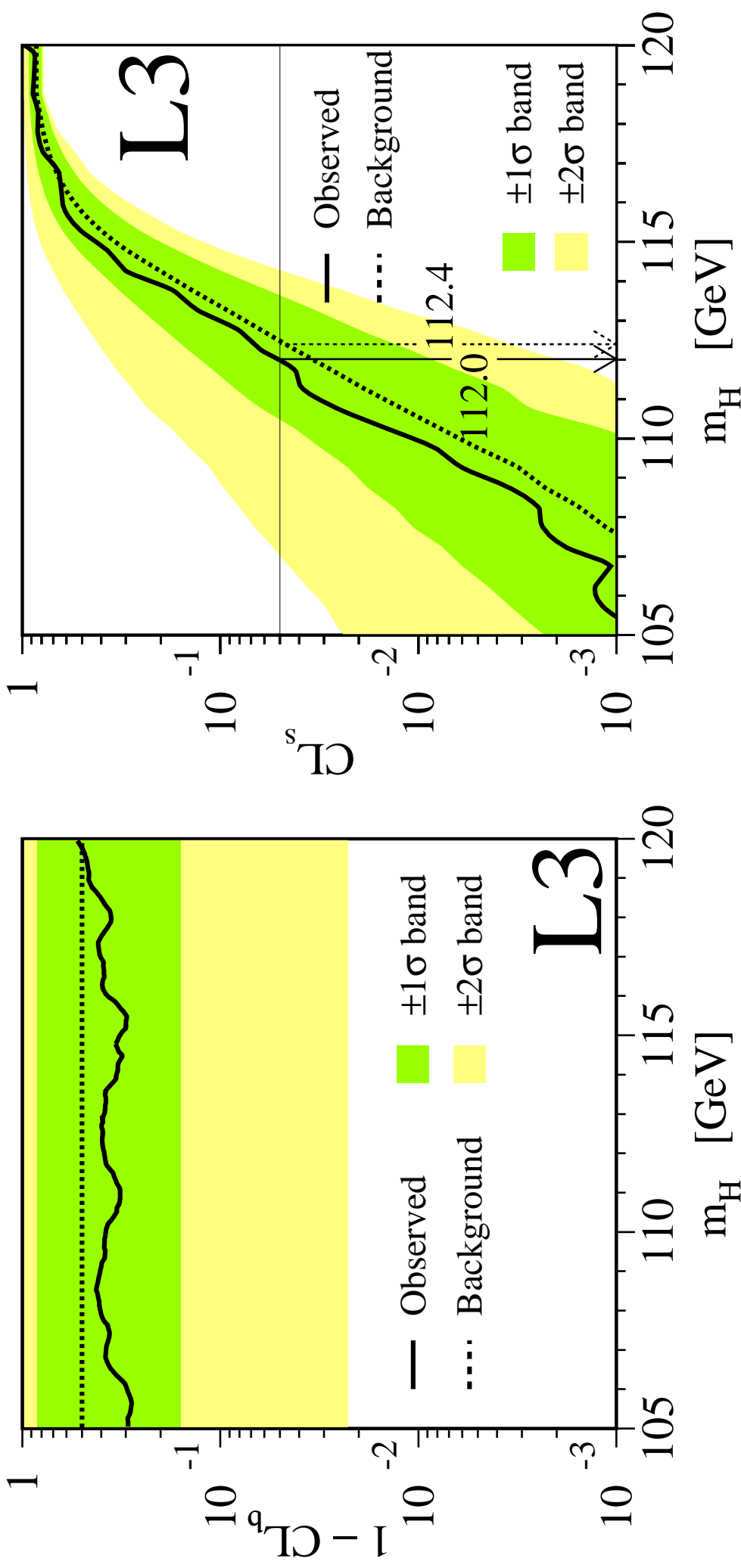
**The log-likelihood ratio for
all the search channels combined**



Distribution of $-2 \ln Q$ for two mass hypotheses



The background and the signal confidence levels: $1 - \text{CL}_b$ and CL_s

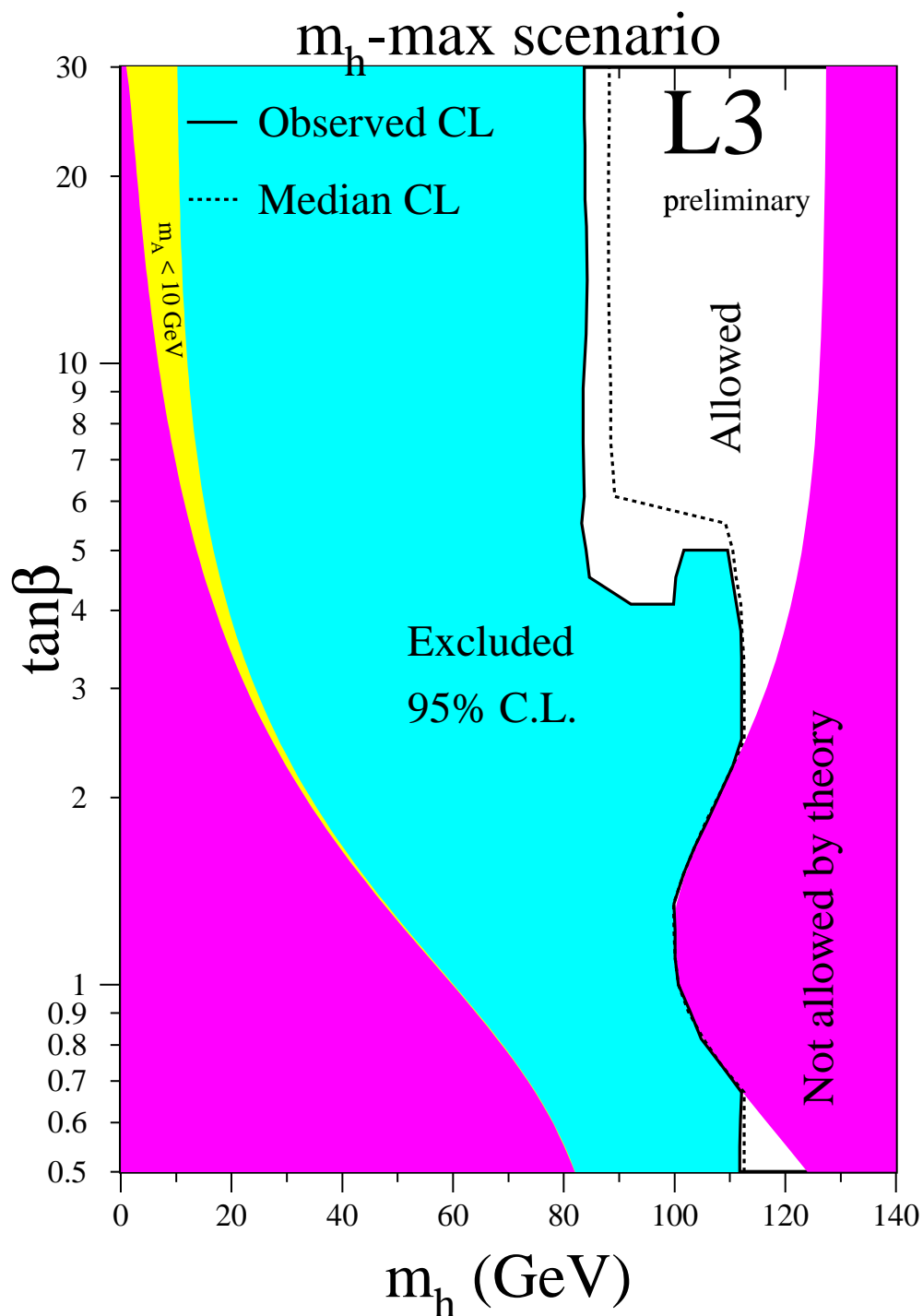


Exclusion limit at 95% CL:

$m_H > 112.0$ GeV

(112.4 GeV expected)

MSSM neutral Higgs bosons search



Exclusion limits at 95% CL:

$$m_h > 83.2 \text{ GeV} \quad (88.1 \text{ GeV expected})$$

$$m_A > 83.9 \text{ GeV} \quad (88.3 \text{ GeV expected})$$

$$0.7 < \tan\beta < 2.2 \text{ excluded}$$

Data analysis will continue till the end of 2003