Inclusive Charmonium Production in Hadronic Z Decays in L3 at LEP

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For the L3 Collaboration

1. Theoretical Overview
2. The L3 Experiment
3. Production of J/ψ, ψ'
4. Production of χ_c
5. Conclusions

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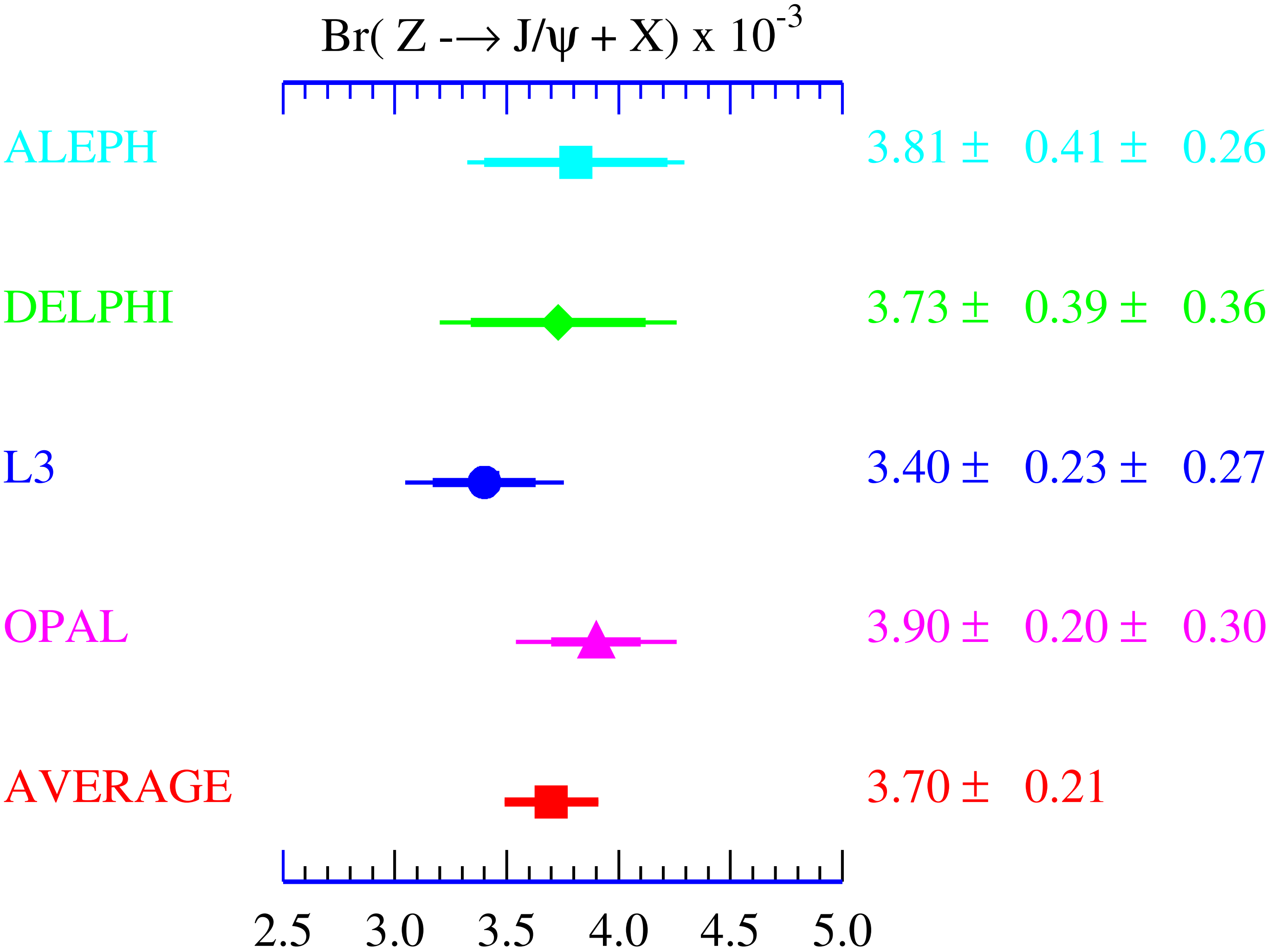
LEP Average



$$\chi^2 = 3.4/4$$

L3 Collaboration , PPE Preprint 97-44; 25 April 1997.
ALEPH Collaboration , Phys. Lett. B 295 (1992) 396.
DELPHI Collaboration , Phys. Lett. B 341 (1994) 109.
OPAL Collaboration , Z. Phys. C 70 (1996) 197.

χ_c Production

World Average branching fractions :

$$\mathrm{Br}(\chi_{c0} \rightarrow J/\psi\gamma) = 0.66 \pm 0.18\ \%$$
$$\mathrm{Br}(\chi_{c1} \rightarrow J/\psi\gamma) = 27.3 \pm 1.6\ \%$$
$$\mathrm{Br}(\chi_{c2} \rightarrow J/\psi\gamma) = 13.5 \pm 1.1\ \%$$

NB : χ_{c0} and χ_{c2} forbidden in CSM

J/ψ and γ Selection :

- Relax cuts to increase J/ψ statistic :

  $\hookrightarrow$ 440 ± 32 J/ψ in $2.8 \leq M \leq 3.4$ GeV

- Photon identification :

  $\hookrightarrow$ Isolated clusters without charged track in the central tracking chamber

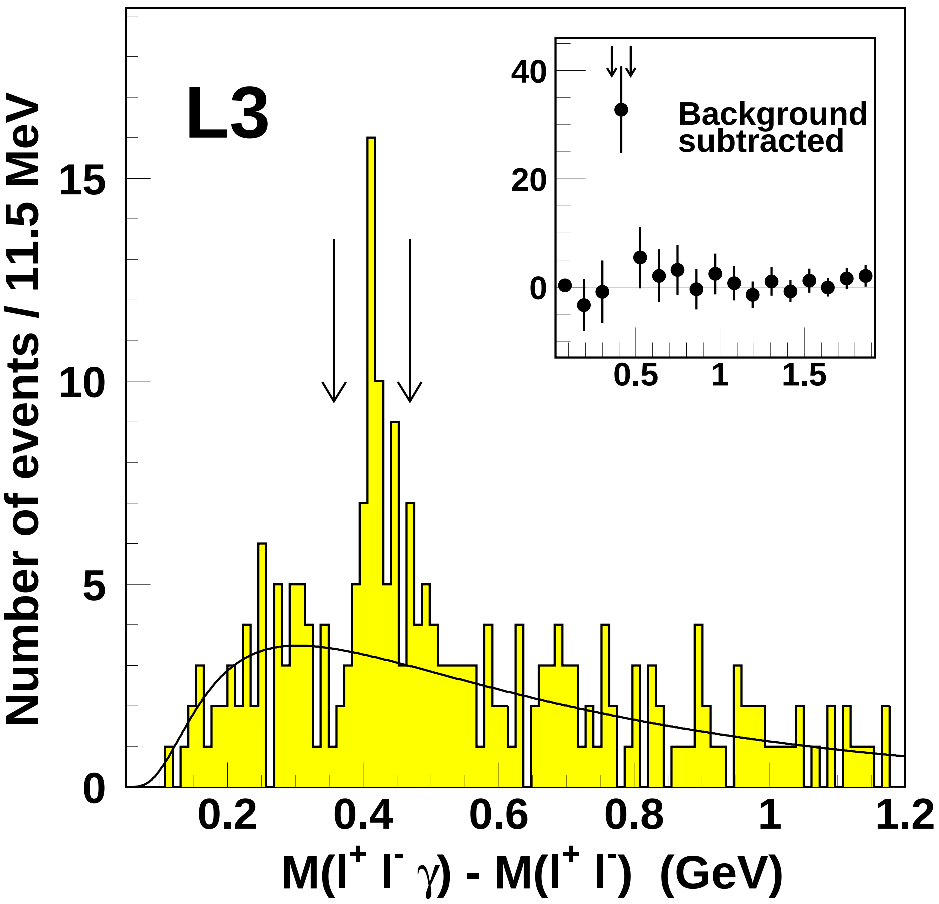
  $\hookrightarrow$ γ in a cone of 40^o around reconstructed J/ψ

  $\hookrightarrow$ $E_\gamma > 1.1$ GeV

- Efficiency :

  $\hookrightarrow$ $8.1 \pm 0.4\ \%$

Signal : M($\ell^+\ell^-\gamma$)-M($\ell^+\ell^-$) = 414 ± 56 MeV
backg. : Fit A·exp(ax + b/x^2)



χ_{c1} : 32.8 ± 8.0

$$\mathrm{Br}(Z \to \chi_{c1} + X) = (2.7 \pm 0.6 \pm 0.5) \times 10^{-3}$$

Assuming $\mathrm{Br}(Z \to \chi_{c1} + X)_p$ negligeable :

$$\mathrm{Br}(b \to \chi_{c1} X) = (0.84 \pm 0.20 \pm 0.16) \times 10^{-2}$$

$R^b_{\chi_{c1}}$ measurement : $R^b_{\chi_{c1}} = \frac{\mathrm{Br}(\mathrm{b} \to \chi_{c1} + \mathrm{X})}{\mathrm{Br}(\mathrm{b} \to \mathrm{J}/\psi + \mathrm{X})}$

NB : Most of QCD uncertainties cancel out!

- Assuming all the J/ψ are decays of b :

$$R^b_{\chi_{c1}} = 0.75 \pm 0.19 \pm 0.15$$

- To be compared to theoretical prediction : $R^b_{\chi_{c1}} \approx 0.2$ (CSM)

$\hookrightarrow$ Significantly higher than the Colour Singlet Model expectation

$\hookrightarrow$ χ_{c2} signal ??

Conclusions

$\mathrm{Br}(Z \to J/\psi X) = (3.40 \pm 0.23 \pm 0.27) \times 10^{-3}$
$\mathrm{Br}(Z \to \psi' X) \quad = (1.6 \pm 0.5 \pm 0.3) \times 10^{-3}$
$\mathrm{Br}(Z \to \chi_{c1} X) = (2.7 \pm 0.6 \pm 0.5) \times 10^{-3}$

$\mathrm{Br}(Z \to \chi_{c2} X) < 3.2 \times 10^{-3}$ (90 % CL)

- Results on J/ψ and ψ' are consistent with LEP experiments
- $b \to J/\psi\ (\psi') + X$ consistent with $\Upsilon(4S)$
- $R^b_{\chi_{c1}}$ higher than expected from Colour Singlet Model and consistent with CLEO result within $1.5\ \sigma$
- Need more tests on Colour Octet Model