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Update of the branching ratio measurement of $D_s^+ \to \eta\prime\pi^+$

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In a previous ALEPH note [1], we presented the result of the study of the D_s^+ decay into $\eta\prime\pi^+$ obtained using about 302,000 hadronic Z events from 1991 data. The $\eta\prime$ has been searched for in the decay mode $\eta\prime \to \eta\pi^+\pi^-$ with $\eta \to \gamma\gamma$.

Since more than one million events including 1990 and 1992 data are now available, we updated the analysis and tried to measure the absolute branching ratio of the D_s for the above decay mode. The absolute measurement, however, depends on theoretical assumptions on the D_s production rate which has been taken into account in evaluating the systematic error.

We used micro-DST events from 1990 to 1992 corresponding to 1,208 K hadronic Z decays and 3,000 Monte Carlo events for each of the two decay channels, $Z \to c\bar{c}$ and $Z \to b\bar{b}$, where each heavy quark was forced to produce a D_s decaying in the decay chain described above.

The analysis proceeds as before using the energy flow objects (Charged tracks + GAMPEC photons).

Requirements for the photons are :

- Energy > 0.75 GeV
- No other photon with Eγ > 250 MeV for which $m_{\gamma\gamma}$ is within 60 MeV/c^2 of the nominal π^0 mass
- No associated charged track within 4 cm of the reconstructed photon position
- No cut on the energy fraction in the 1st stack has been applied in constrast with the previous analysis.

For the η selection, we require that the two photons come from two single clusters or from a cluster containing two photons and have :

- Momentum of $\eta > 3.0$ GeV/c
- Opening angle between two photons : $cos(\theta_o)$ >0.80
- Decay angle of η : $|cos(\theta_d)|$ <0.80, where the decay angle θ_d refers to the opening angle between the the line of flight of the η and the direction of one of the photons in the η rest frame
- $|M(\gamma\gamma) - m_\eta| < 60$ MeV/c^2. According to Monte Carlo, the η mass resolution varies from 40 to 80 MeV/c^2 depending on its energy.

Then a fit is performed to readjust the photon energies using the η mass constraint taking the calorimeter energy resolution into account. An $\eta\prime$ candidate is formed when the η is combined with two charged tracks of opposite sign satisfying :

- Momentum > 0.5 GeV/c
- Opening angle between π^+ and π^- : $cos(\theta_o)$ >0.98

- Opening angle between η and $\pi^{\pm}$: $cos(\theta_o)$ >0.99.

If $|M(\eta\pi^+\pi^-) - m_{\eta\prime}| < 20$ MeV/c^2, which is twice the $\eta\prime$ mass resolution, we call it an $\eta\prime$ and we use its momentum and the nominal $\eta\prime$ mass to recalculate its energy.

We then associate it with a charged track with momentum > 3.0 GeV/c to make a D_s candidate. The D_s momentum is required to be greater than 10 GeV/c and the decay angle $|cos(\theta_d)|$ <0.80.

The resulting $\eta\prime\pi$ mass spectrum is shown in Fig.1. To count the number of D_s, we fitted the curve using two gaussians and a 2nd order polynomial. The first gaussian describes the contribution of the decay $D_s^+ \to \eta\prime\rho^+$, where the π^0 from the ρ^+ is not seen. The width of the second gaussian was fixed at 22 MeV/c^2, the resolution on the D_s mass determined from the Monte Carlo. The peak is centered at 1.974 ± 0.007 GeV/c^2 and it contains 104 ± 27 D_s. Also shown in the same plot(dotted line) is the spectrum for events in the $\eta\prime$ sidebands comprising $0.918 < M(\eta\pi^+\pi^-) < 0.938$ GeV/c^2 and $0.978 < M(\eta\pi^+\pi^-) < 0.998$ GeV/c^2.

Parameter	value	Contribution to systematic error
$\Gamma_{c\bar{c}}/\Gamma_{had}$	0.181 ± 0.030	0.17 %
$\Gamma_{b\bar{b}}/\Gamma_{had}$	0.218 ± 0.014	0.06 %
$B.R.(c \to D_s)$	0.15 ± 0.03	0.21 %
$B.R.(b \to B_{u,d})$	0.75 ± 0.10	0.05 %
$B.R.(b \to B_s)$	0.15 ± 0.03	0.11 %
$B.R.(B \to D_s + X)$	0.115 ± 0.028	0.08 %
$B.R.(B_s \to D_s + X)$	0.90 ± 0.05	0.03 %
$efficiency(c\bar{c})$	4.34 ± 0.31	0.07 %
$efficiency(b\bar{b})$	2.03 ± 0.23	0.10 %

Table 1: Parameters used in the evaluation of the branching ratio

The absolute branching ratio has been evaluated using the efficiencies and parameter values listed in the left column of the Table 1. We found

$$B.R.(D_s^+ \to \eta\prime\pi^+) = 1.90 \pm 0.50 \pm 0.33\,\%$$

Here the first error is statistical and the second error is due to the uncertainties in the parameters used and the statistical errors on the efficiencies. The systematic uncertainties corresponding to each parameter are also shown in Table 1.

This result is still consistent with the CLEO II measurement of the ratio of two branching ratios $B.R.(D_s^+ \to \eta\prime\pi^+)/B.R.(D_s^+ \to \phi\pi^+) = 1.20 \pm 0.15 \pm 0.11$[2], where $B.R.(D_s^+ \to \phi\pi^+) = 2.8 \pm 0.5\,\%$ according to the Particle Data Group[3].

References

[1] J. Boucrot, D.E. Jaffe, and D.W. Kim, ALEPH note 92-169 (1992)
[2] CLEO Collaboration, Phys. Rev. Lett. **68**, (1992) 1275
[3] Particle Data Group, Phys. Rev. **D45**, Part 2 (June 1992).

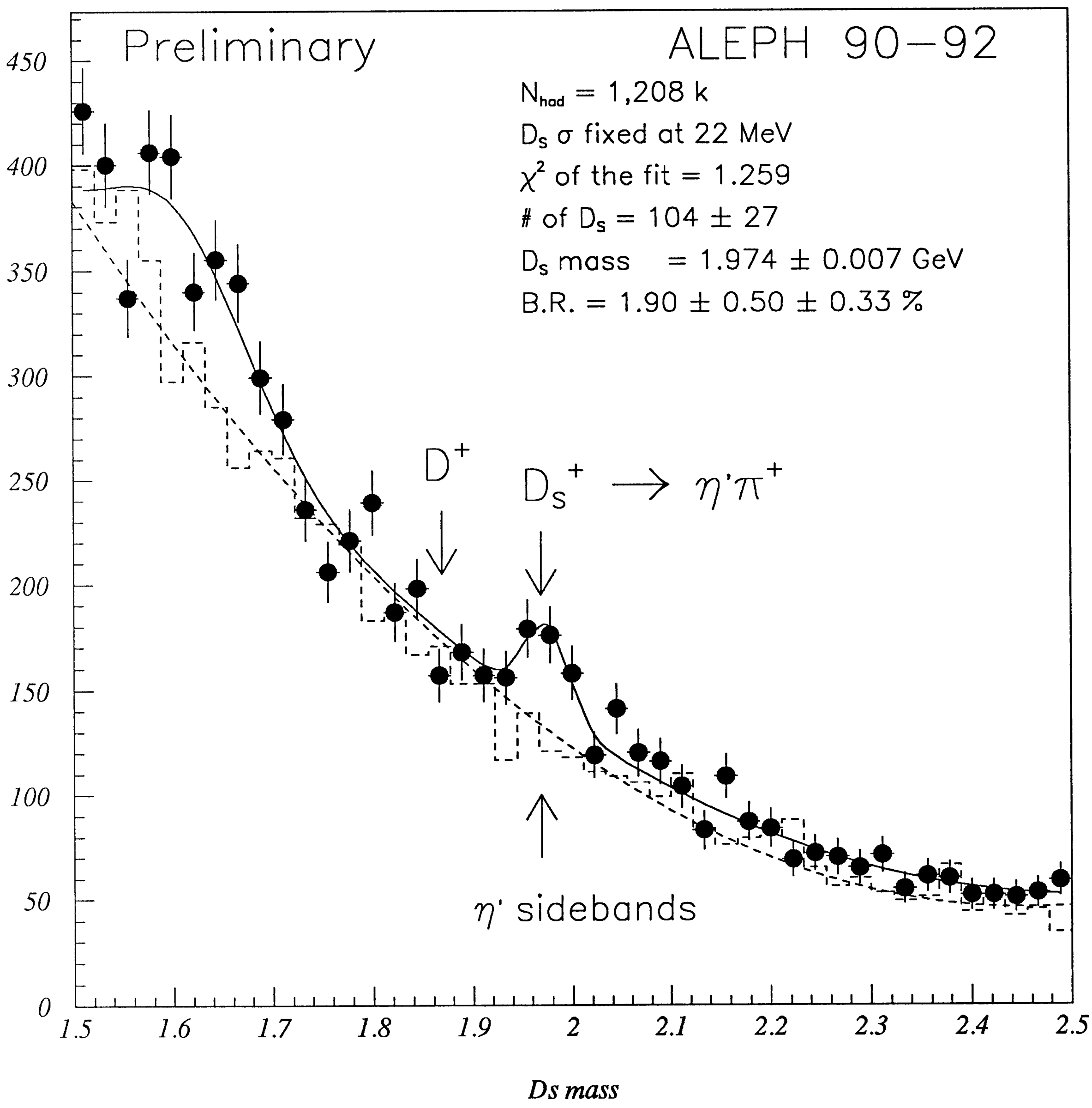

Figure 1: The $\eta\prime\pi^{\pm}$ invariant mass spectrum