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A first look to the decay $D_s^+ \to \eta\prime\pi^+$

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Abstract :

We have searched for the decay $D_s^+ \to \eta\prime\pi^+$ in a sample of 302,000 Z0 hadronic decays registered in 1991 in Aleph . A signal of 36 ± 16 events is seen , allowing to estimate the branching ratio of the D_s meson in this channel . The result is found to be in fair agreement with recent measurements from the CLEO II experiment .

The decay modes of the D_s meson containing one or more neutral objects in the final state have been considered to constitute a large fraction of the D_s decays [1] .

Recently the CLEO collaboration has measured the D_s^+ branching ratios into $\eta'\rho^+, \eta\prime\rho^+, \eta\pi^+, \eta\prime\pi^+$, and $\phi\rho^+$, relative to the $\phi\pi^+$ mode [2]. (N.B. : charge conjugate states are always implied everywhere) . These decays involving neutral particles proved to account for more than 10 times the $\phi\pi^+$ branching fraction , in fair agreement with theoretical expectations.

As LEP is also a source of abundant $B-$ and $D-$mesons, but with different kinematics and background from those of the Cornell storage ring, the measurement of the above branching ratios with ALEPH data will be interesting in its own right. Also, a B_s search is expected to benefit from much increased statistics of explicitly reconstructed D_s mesons when decays with neutrals are included. The fine-grained electromagnetic calorimeter of ALEPH offers a unique opportunity among LEP experiments to search for these decay modes .

In this note, we present a preliminary measurement of the D_s^+ branching ratio into $\eta\prime\pi^+$, where the $\eta\prime$ decays into $\eta\pi^+\pi^-$, and the η into two photons. This analysis was done on about 302,000 Z0 hadronic decays from 1991 data .

To evaluate the detection efficiencies, we generated 3,000 Monte Carlo events for each of the two D_s sources, say, $Z \rightarrow c\bar{c}$ and $Z \rightarrow b\bar{b}$. We kept only generated events in which was produced at least one D_s giving the decay chain described above .

The analysis uses charged tracks and GAMPEC photons. First we take two photons which satisfy :

Energy > 0.75 GeV
Energy fraction in stack 1 of ECAL > 0.01
No other photon which makes a π^0 within 60 MeV of the nominal π^0 mass
No associated charged track within 4 cm of the reconstructed photon position

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

Momentum of η candidates > 3.0 GeV
Opening angle between the two photons : $cos(\theta_o)$ >0.80
Decay angle of η : $|cos(\theta_d)|$ <0.80
$|M(\gamma\gamma) - m_\eta| < 60$ MeV.

A fit is performed to readjust the photon energies using the η mass constraint , and taking into account the ECAL energy resolution .

Then the η is combined with two charged tracks of opposite sign satisfying :

Momentum > 0.5 GeV
Opening angle between π^+ and π^- : $cos(\theta_o)$ >0.98
Opening angle between η and π : $cos(\theta_o)$ >0.99, to get an $\eta\prime$ candidate .

If $|M(\eta\pi^+\pi^-) - m_{\eta\prime}| < 20$ MeV, 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 to it a charged track with momentum > 3.0 GeV to make a D_s candidate. The D_s momentum is required to be greater than 12 GeV and the decay angle $|cos(\theta_d)|$ <0.80. No dE/dx information was used and no vertex of the three charged tracks was formed.

The resulting $\eta'\pi$ mass spectrum is shown in Fig.1. From a gaussian fit with the background parametrized by a 2nd order polynomial we obtain 32 ± 16 D_s over a background of 54 ± 10 events . The parametrization of the background describes fake $\eta'\pi$ mass distribution well, where fake η' means η associated with two same sign charged tracks, as shown in Fig.2. The position and the width of the gaussian peak are : 1.959 ± 0.002 GeV and 8 ± 2 MeV, respectively. The measured D_s mass is lower than the nominal value by 10 MeV and the resolution is better than what is expected from Monte Carlo, i.e., 25 MeV. More statistics is required, however, to see any systematic effect causing these discrepancies. No indication of D^+ decay is observed in this channel.

The efficiencies for D_s reconstruction have been evaluated from Monte Carlo to be $4.3 \pm 0.3\%(c\bar{c})$ and $2.4 \pm 0.2\%(b\bar{b})$. The errors are statistical only.

To obtain a preliminary determination of the ratio of branching ratios of the $D_s^+ \to \eta'\pi^+$ decay to the of the $D_s^+ \to \phi\pi^+$ decay , we consider only high momentum D_s^+ (P > 18 Gev) which come mostly from c quarks . Apart from this momentum cut , the $D_s^+ \to \phi\pi^+$ decays are selected as described in Ref [3] . We get the following result :

$$B.R.(D_s^+ \to \eta'\pi^+)/B.R.(D_s^+ \to \phi\pi^+) = 1.31 \pm 0.45$$

The error is statistical only . Most contributions to the systematic error cancel out in this ratio and the total systematic error is expected to be low ; however it has not yet been studied .

This very preliminary result is in agreement with the CLEO II measurement of $B.R.(D_s^+ \to \eta'\pi^+)/B.R.(D_s^+ \to \phi\pi^+) = 1.20 \pm 0.15 \pm 0.11$. It is barely compatible with the first published data on this channel by MARK II [4] and NA14 [5] which claimed the above ratio to be 6.4 and 2.5 respectively , with large errors .

This first look at the decay $D_s^+ \to \eta'\pi^+$ seems rather promising in view of the increased statistics in 1992 . The results of the search for the other channels $D_s^+ \to \eta'\rho^+$ and $D_s^+ \to \eta\rho^+$ will be presented in a near future .

References

[1] M.Bauer, B.Stech, and M Wirbel, Z. Phys. 34,103 (1987)
[2] CLEO II Collaboration, CMU-HEP91-12 (1991)
[3] ALEPH Collaboration , Phys Lett 194B,145 (1992)
[4] MARK II Collaboration : Phys Rev Lett 61,1057 (1988)
[5] NA14/2 Collaboration : Phys Lett B255,639 (1991)

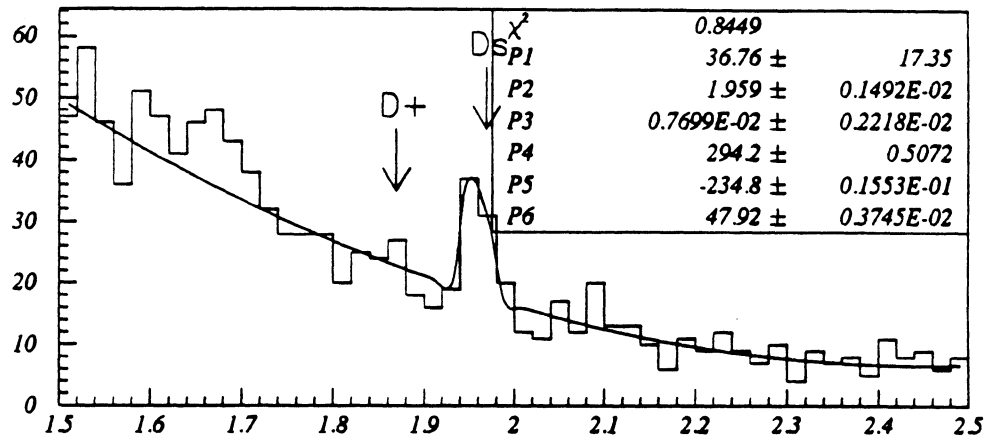

Fig.1 Ds mass Right sign

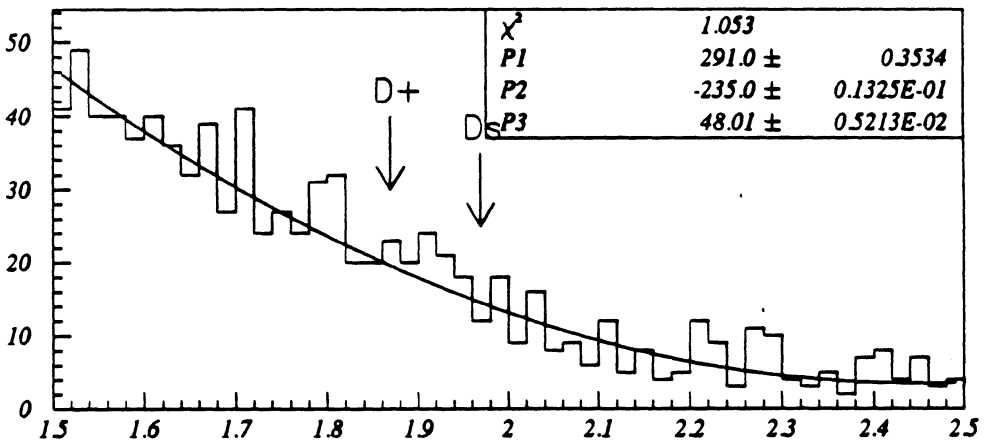

Fig.2 Ds mass Wrong sign