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D^*'s for Winter Conferences

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Abstract

This short note is a compilation of the official, though preliminary numbers and main plots relevant to the D* study. It does not go into the details of the analysis, but is intended to fix the numbers for the ALEPH members who wish to present the D* in a conference or in a seminar. Other topics concerning charm are under study: measurement of the vector to pseudoscalar ratio, D* measurement through the inclusive soft π transverse momentum spectrum. These are still in a too preliminary state to be presented.

1) Saclay, 2) Florida State University, 3) Bari, 4) Heidelberg.

Aim of the study

We select a sample of fully reconstructed exclusive decays of D*+/- according to the chain D* -> D0pi, D0 -> Kpi. The XE=E(D*)/Ebeam distribution is fitted by the sum of 3 contributions :

- Background estimated, in normalization and shape, from the data by the event mixing technique.
- bbbar contribution, from decays of a b hadron into D*'s
- ccbar contribution, through hadronization of the c quark into D*.

This allows us to determine the epsilon_c fragmentation parameter and the D* production rate :
(c -> D*+/-) BR(D* -> D0 pi) BR(D0 -> K pi).

CUTS for the D* -> Kpi pi selection

Definition of a good track : 1) 0.2 < p < 500 GeV
2) >= 4 TPC hits
3) /cos theta/ < 0.95
4) /d0/ < 2 cm
5) /z0/ < 10 cm

cuts : at least 5 such good tracks.
Use only good tracks in the combinatorics.

To optimize the signal vs background, we concentrate on D*'s with X_E > 0.25.

1) Choose soft pion :
0.330 < p(pi soft) < 4.2 GeV (in fact this cut depends on the beam energy)
(this cut follows from kinematics and does NOT remove any event at X_E > 0.25)
2) Choose an additional pair of charged tracks with total charge=0 (i.e. the D0). Assign K mass to the track with charge opposite to pi soft's.
3) / cos theta* (K in D0 rest frame) / < 0.8
4) M 2 body (D0 candidate) in range 1865. +/- 30 MeV
5) Deltam = M3body - M2body in range 145.5 +/- 2 MeV

SIGNAL

resolution of the DeltaM spectrum : 0.9 MeV (in agreement with MC).
resolution of the 2-body spectrum : 16. MeV (in agreement with MC).
Number of candidates after cuts : 426
3 events have 2 D* candidates, but in the 3 cases they share 1 or even 2 tracks, which implies that they cannot be both real D*'s.
Background estimate from event mixing (3 methods) :

1) Mass difference : 73 +/- 3 events
2) 2-body mass : 70 +/- 5 events
3) cos(theta*) : 80 +/-25 events

EFFICIENCIES

The detection and selection efficiency in our cuts is estimated from the Monte-Carlo to range from 55% to 40% between XE=0.25 and XE=1.
This can be broken up approximately according to :

- 3 tracks with cos(theta)<.95 and p>.2GeV eps=90%
- cos (theta *) < 0.8 eps=80%
- 2body mass = MD0 +/- 30 MeV eps=80% (XE dependent)
- mass difference = MD*-MD0 +/- 2 MeV eps=90%

FIT OF THE XE SPECTRUM. RESULTS

A likelihood fit is performed using the following function :

$$\frac{dN}{dXE} = Nhad \cdot 2 \cdot BR(D^* \to K\pi\pi) \cdot (c \to D^*) \left[gamb\,(b/c)\, f_b(XE) + gamc\, f_c(XE, epsc) \right] + N_{BG}\, f_{BG}(XE)$$

Nhad = 188,489 evts * 0.994 (BG from taus and 2gamma = 0.6 %)
Let us call (c->Kpipi) = BR(D*->Kpipi) * (c->D*).
gamb and gamc are the heavy quark partial widths divided by the hadronic width.
b/c is the ratio b->D*+- / c->D*+-. We cannot fit this parameter due to lack of statistics. The present measurements on this are very uncertain and have been done at lower sqrt(s), thus do not necessarily hold at our energy, where Bs and B-baryons are produced. We are more confident in a value estimated using our Monte-Carlo model, which contains the best estimates of the various branching fractions, using altogether measurements, symmetry arguments, and simple modeling of the q unknown decays. This value is 0.95. This choice introduces a MODEL DEPENDENCE of our results, which we quantify by letting it vary between 0.85 and 1.05.

We perform a 2-parameter fit (c->Kpipi, epsc) assuming the standard model value gamc = 0.1705. The two parameters are not correlated.

The result of the 2-parameter fit is :
epsc = (60 +24/-18(stat)+/-2(syst)+6/-5(mod. dep.))*10**-3
which corresponds to
<XE(D*)>=0.491 +0.018/-0.016(stat) +/-0.002(syst) +/-0.004(mod dep)

(c->D*)*BR(D*->Kpipi) =
(6.78 +0.40/-0.39 (stat) +/-0.20 (syst) +0.36/-0.32 (mod. dep.(b/c))) 10**-3
syst: 2% on effic., 2% from epsb

Using the branching ratios measured by Mark III : 2.40+/-0.35 %, we get
c->D* = 0.282 +/-0.017(stat) +/-0.006(syst) +/-0.041(BR) +/-0.015(mod. dep.)
to be compared to CLEO's : 0.308+/-0.046
and HRS's : 0.315+/-0.046
(in the 3 cases, most of the error comes from the errors in the BRs of the modes used ; if one uses (instead of MARKIII) the PDG 90 BR : 2.04+/-0.20 %, one gets 0.332 for the central value).

The speaker can add the errors as he wants, but should keep the "model dependence" separate.

Figure captions

1) Mass difference distribution, for $X_E > 0.25$. The $K\pi$ mass is required to be between 1.835 GeV and 1.895 GeV. Data (points with error bars) compared to Monte Carlo (solid line).

2) 2-body mass, for $X_E > 0.25$. The mass difference is required to be between 0.1435 MeV and 0.1475 MeV. Data (points with error bars) compared to Monte Carlo (solid line). The second peak around 1.6 GeV is due to $D^o \to K\pi(\pi^o)$. It is well reproduced by the Monte Carlo.

3) Mass difference distribution, for $X_E > 0.25$. The $K\pi$ mass is required to be between 1.835 GeV and 1.895 GeV. The background, calculated by the event mixing technique, is shown.

4) 2-body mass, for $X_E > 0.25$. The mass difference is required to be between 0.1435 MeV and 0.1475 MeV. The background, calculated by the event mixing technique, is shown. The second peak around 1.6 GeV is due to $D^o \to K\pi(\pi^o)$.

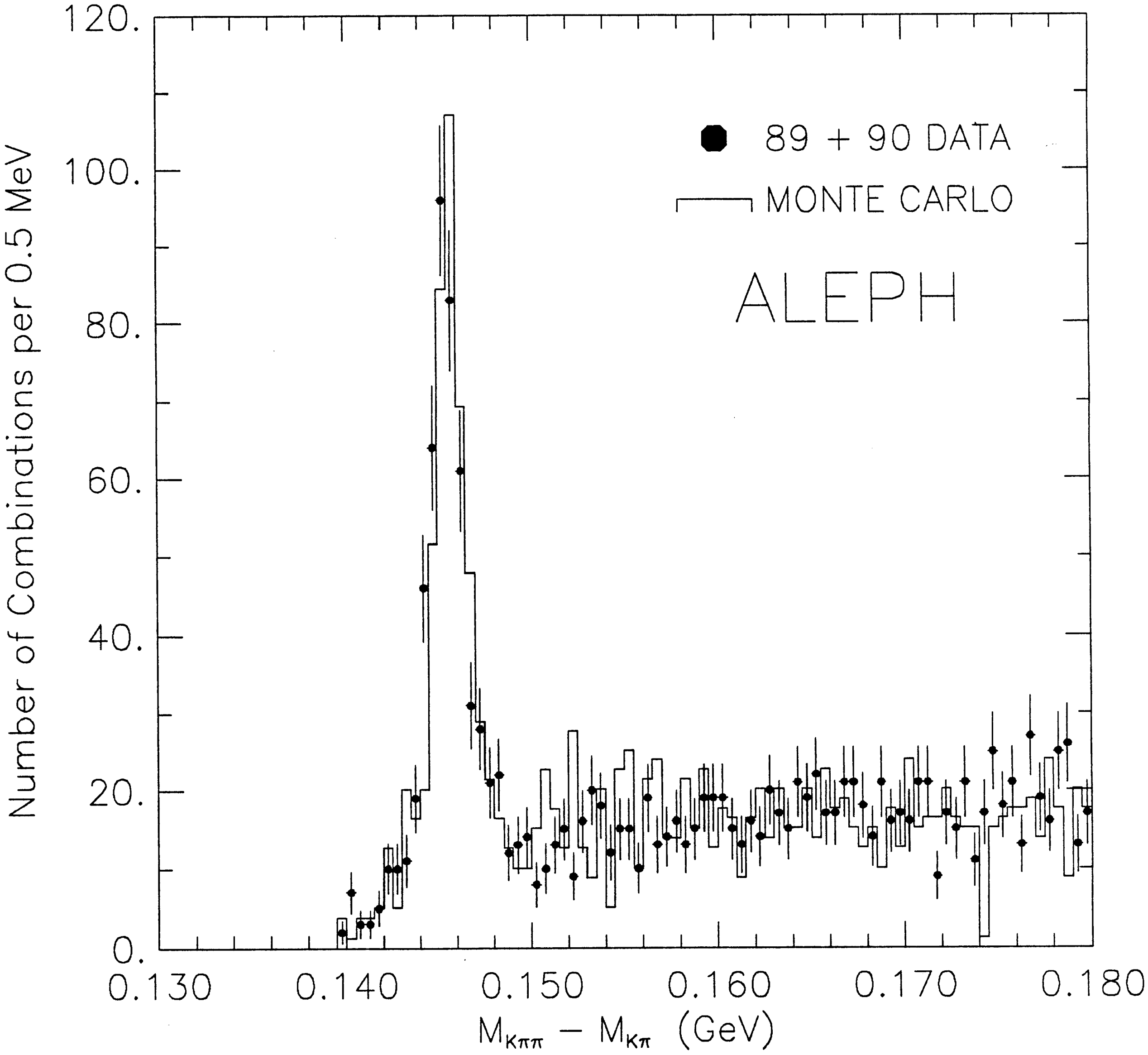
5) Confidence level contour of the 2 parameter fit. The correlation coefficient between the two parameters is very small : 5%.

6) X_E distribution. The data are represented by dots with error bars; the best fit is shown, broken up into the 3 contributions : $b\bar{b}$, $c\bar{c}$ and background.

7) Dependence of the fit results on the choice of the

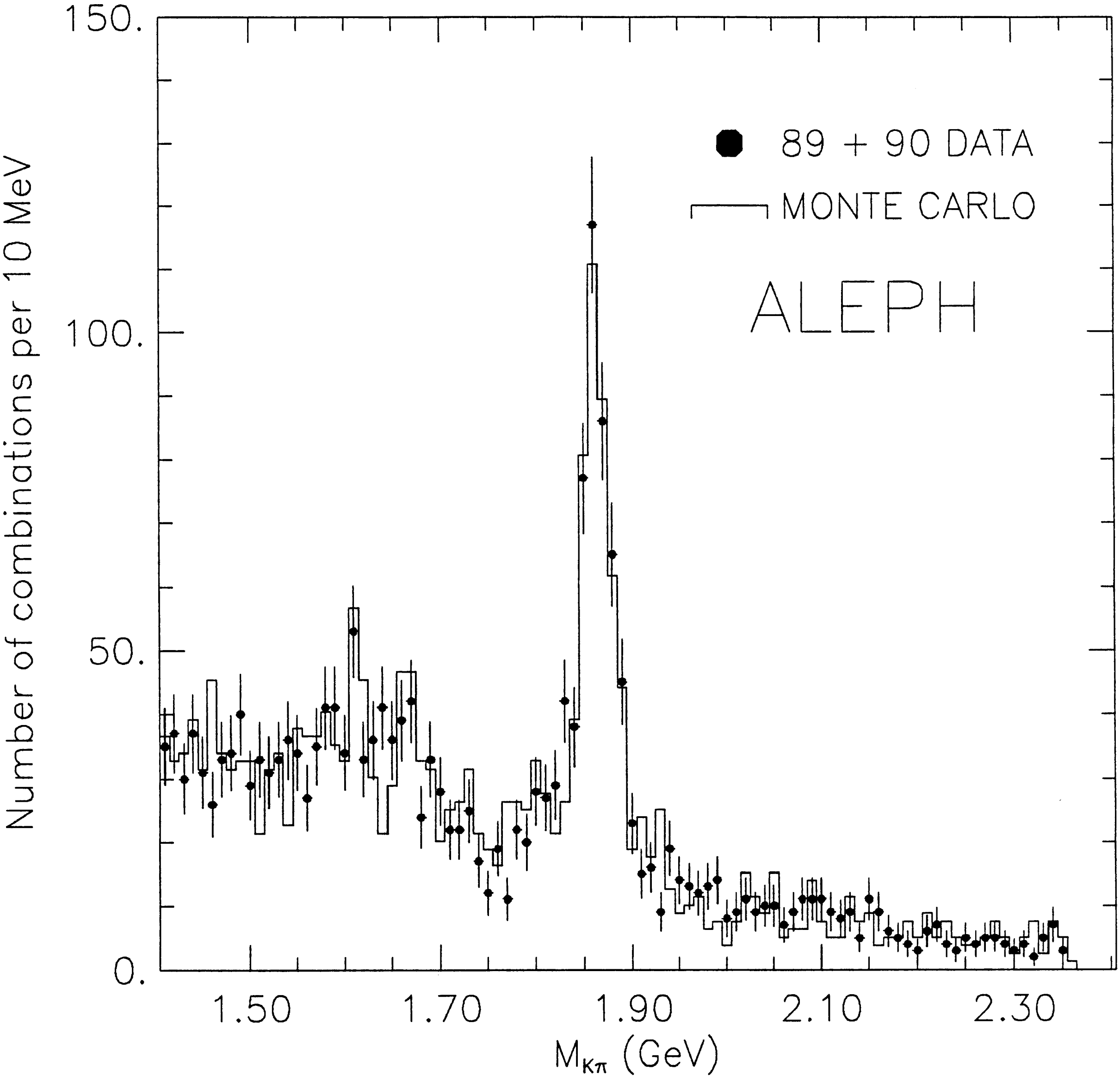
$$b/c = \frac{b \to D^{*\pm}}{c \to D^{*\pm}}$$

parameter.



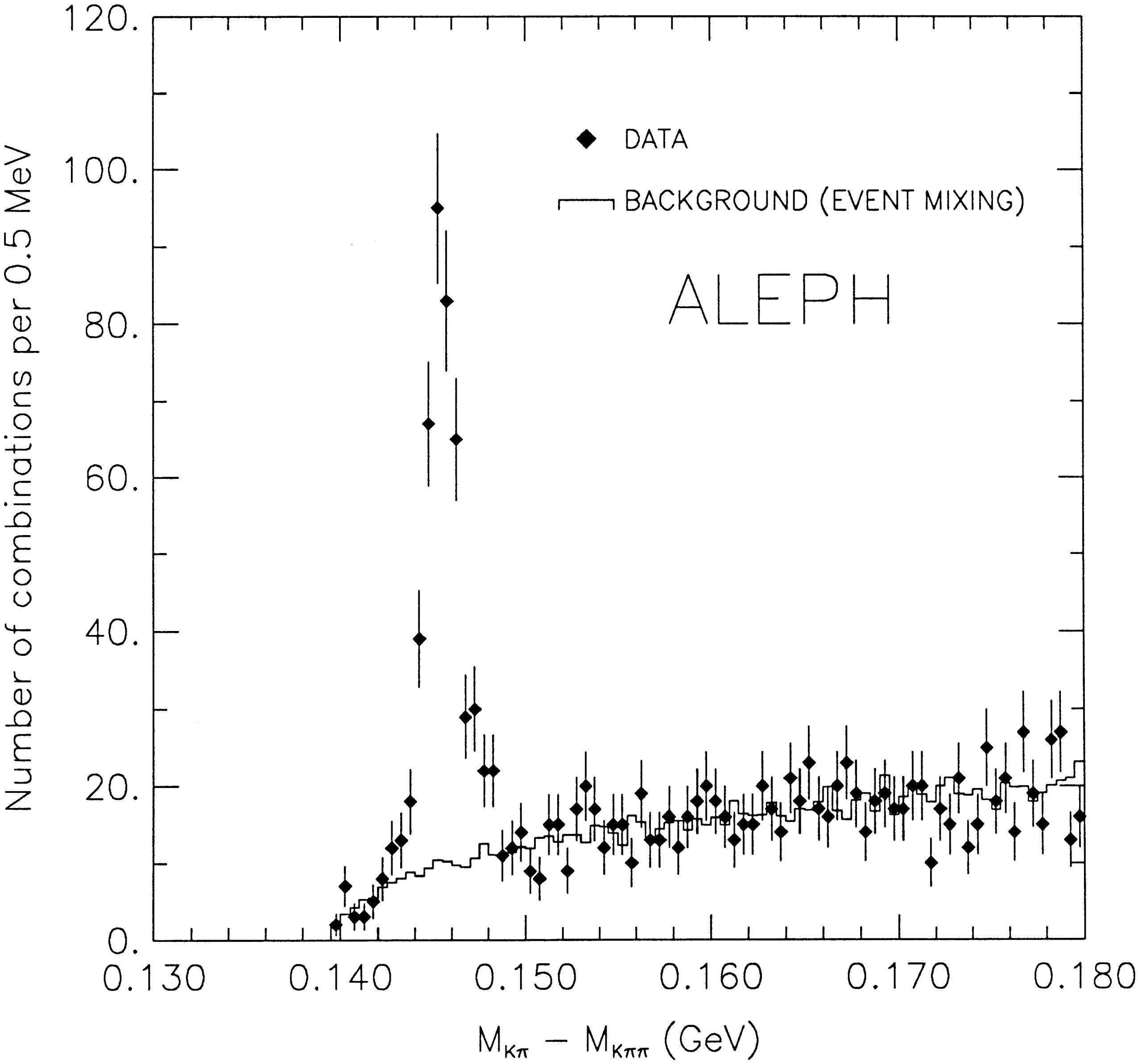
120.
100.
80.
60.
40.
20.
0.
Number of Combinations per 0.5 MeV
89 + 90 DATA
MONTE CARLO
ALEPH
0.130
0.140
0.150
0.160
0.170
0.180
$M_{K\pi\pi} - M_{K\pi}$ (GeV)

1)



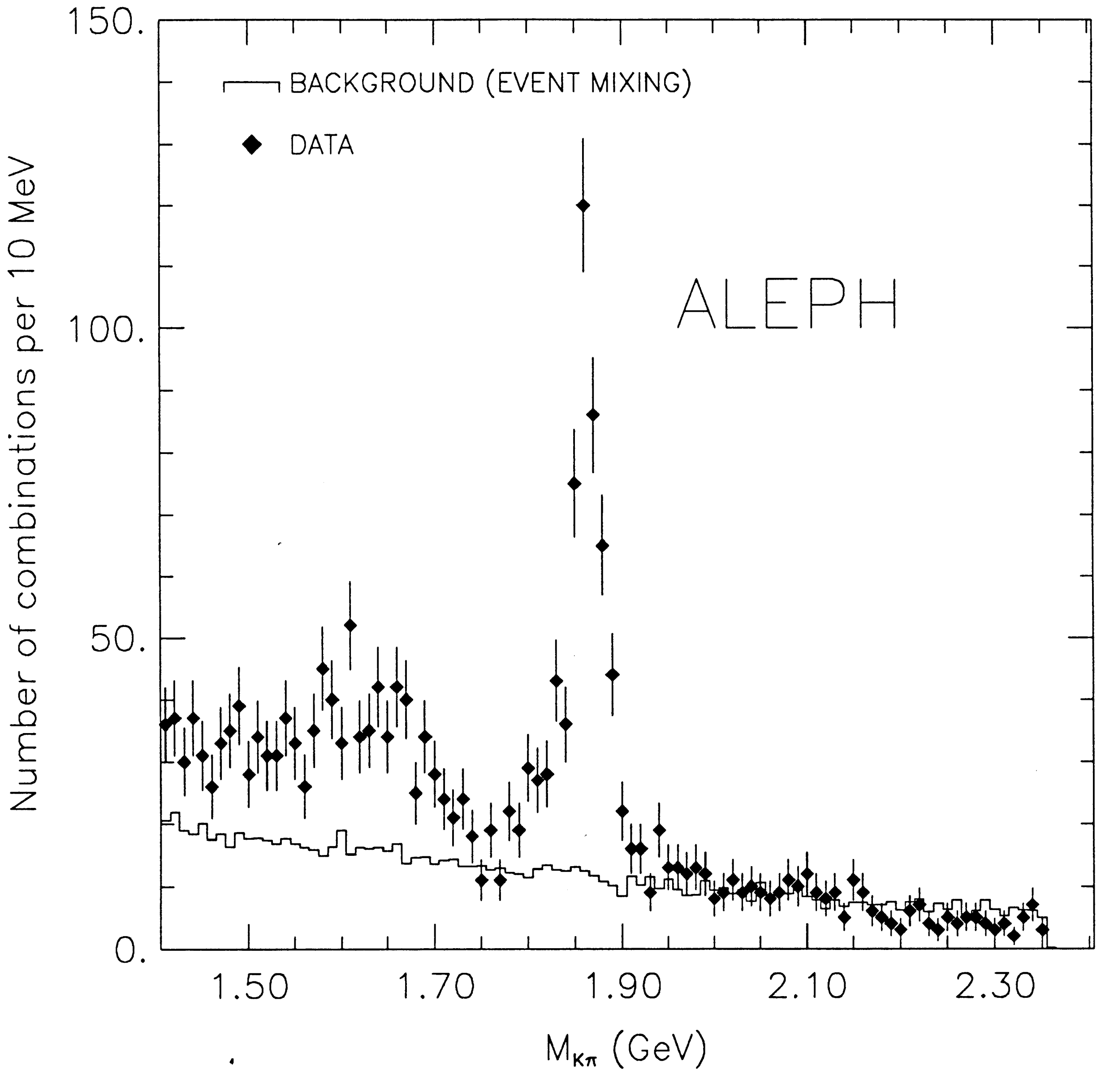
150.
100.
50.
0.
Number of combinations per 10 MeV
89 + 90 DATA
MONTE CARLO
ALEPH
1.50
1.70
1.90
2.10
2.30
$M_{K\pi}$ (GeV)

2)



DATA
BACKGROUND (EVENT MIXING)
ALEPH
Number of combinations per 0.5 MeV
120.
100.
80.
60.
40.
20.
0.
0.130
0.140
0.150
0.160
0.170
0.180
$M_{K\pi} - M_{K\pi\pi}$ (GeV)

3)



150.
100.
50.
0.
1.50
1.70
1.90
2.10
2.30
Number of combinations per 10 MeV
$M_{K\pi}$ (GeV)
BACKGROUND (EVENT MIXING)
DATA
ALEPH

4)

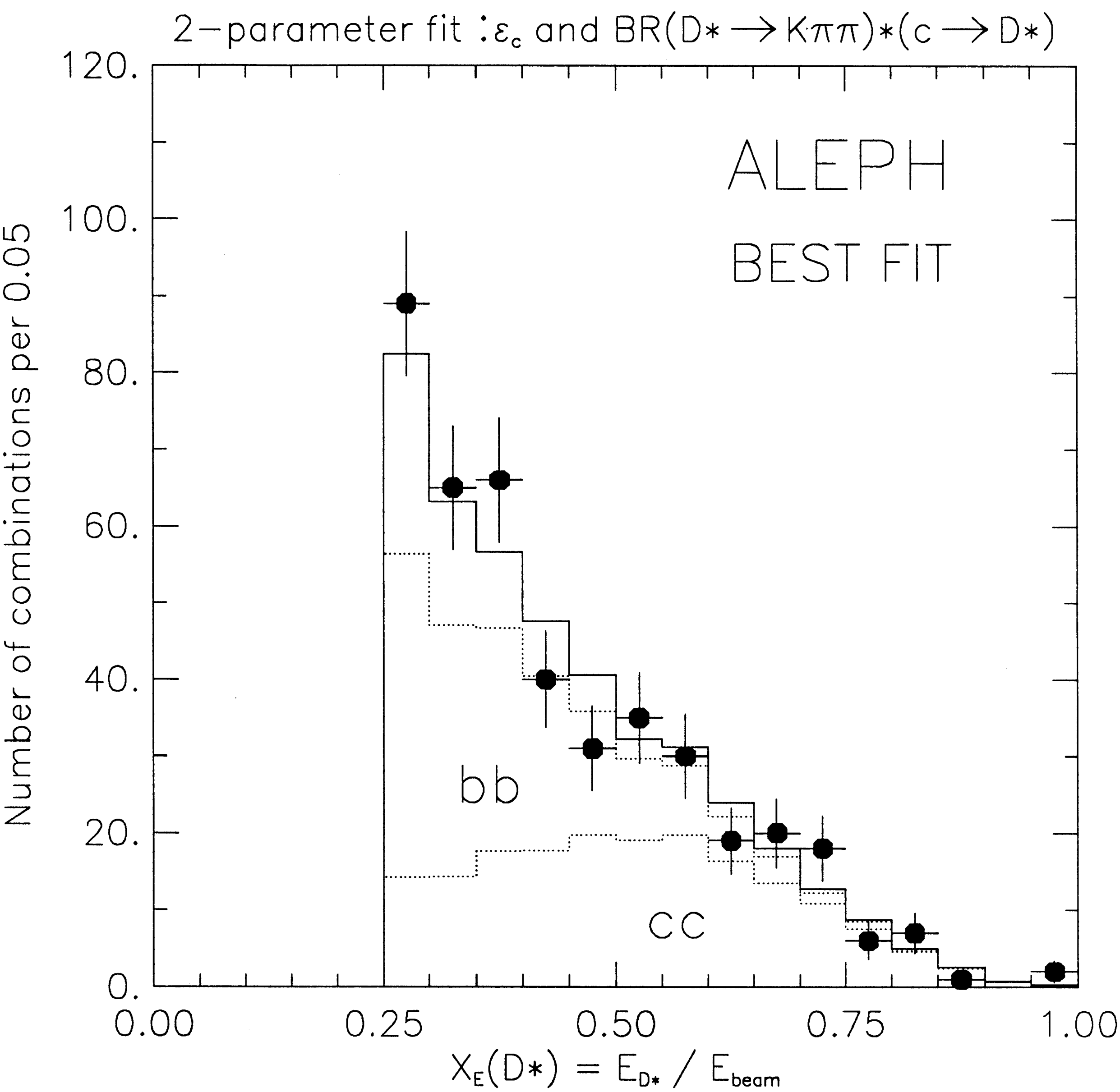
```
PARAMETER  CORRELATION COEFFICIENTS
      NO.  GLOBAL      1      2
       1  0.04466  1.000 0.045
       2  0.04466  0.045 1.000
ENTER MINUIT COMMAND:
**********
**    7 **CONTOUR    1.000        2.000        3.000        40.00
**********
Y-AXIS: PARAMETER   2: R
   1.295       4      333     *           33333
   1.286      44     33       *               3333
   1.276      4     33        *                  3333
   1.266      4    33         *                     3
   1.257     44   33          *
   1.247     4   33           *
   1.237     4   3        2222222222222
   1.228     4  33      222   *       2222
   1.218     4  3     222     *          2222
   1.209        3    22       *             222
   1.199       33    2        *               22
   1.189       3    22        *                222
   1.180       3    2         *                  22
   1.170       3   22      111111111              22
   1.160       3   2      11  *    111             22
   1.151       3   2     11   *      11             2
   1.141      33  22    11    *       11            2
   1.131      3   2     1     *        11
   1.122      3   2    11     *         1
   1.112     *3***2****1******00********1************
   1.103      3   2    1      00        1
   1.093      3   2    11     *        11           2
   1.083      3   2     1     *       11            2
   1.074      3   2     1     *      11            22
   1.064      33  22    11    *     11            22
   1.054       3   2     111  *  1111            22
   1.045       3   2       1111111              22
   1.035       3   22         *               222
   1.026       3    22        *             222
   1.016       33    2        *           222
   1.006        3    222      *         222
  0.9966        3      22     *     22222
  0.9870     4  33      2222222222222
  0.9773     4   3            *                     3
  0.9677     4   33           *                  3333
  0.9581     44   33          *               3333
  0.9485      4    33         *            3333
  0.9388      4     333       *       333333
  0.9292      44      333333  * 3333333
  0.9196       44          333333
             I                I                     I
         0.1500E-01          0.5974E-01          0.1150
      X-AXIS: PARAMETER  1: EPSLON      ONE COLUMN=  0.2500E-02
FUNCTION VALUES: F(I)=    42.19      +  0.5000      *I**2
ENTER MINUIT COMMAND:
**********
**    8 ***ONTOUR    2.000        11.00        3.000        40.00
**********
          UNKNOWN COMMAND IGNORED:*ONTOUR
ENTER MINUIT COMMAND:
**********
**    9 **END RETURN
**********

CALL TO USER FUNCTION WITH IFLAG = 3
```

BEST FIT

$R = \dfrac{BR(D^* \to K\pi\pi) \cdot (c \to D^*)}{2.04\,\% \times 0.30}$ ← $6.12\ 10^{-3}$

↑ R, → ε_c

5)


2−parameter fit :ε_c and BR(D∗ → Kππ)∗(c → D∗)
ALEPH
BEST FIT
bb
cc
Number of combinations per 0.05
120.
100.
80.
60.
40.
20.
0.
0.00
0.25
0.50
0.75
1.00
$X_E(D*) = E_{D*} / E_{beam}$

6)

Model-dependence of ε_c

and $R = \frac{(c \to D^*) \cdot BR(D^* \to K\pi\pi)}{6.12 \times 10^{-3}}$