ALEPH 94-160
PHYSIC 94-136
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24 October 1994

Minutes of the Heavy Flavour Meeting, Heidelberg, October 13th 1994

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1 General remarks (R. Forty)

More frequent subgroup meetings are needed to allow for presentations of status reports. The present subgroups are (ALNEWS by R.Forty 19/10/94): Lifetime/Mixing (H.G. Moser), Charm (P. Colas), R_b (J. Steinberger), Electroweak (R. Tenchini), Weak/rare decays (V. Sharma). The next Heavy Flavour Meetings will take place in weeks with a Thursday meeting:

25	November	1994	(during the software week)
26	January	1995	(during the ALEPH week)
1	March	1995	(preparation for Moriond)
27	April	1995	(during the ALEPH week)

2 1995 Monte Carlo preparation (B. Bloch-Devaux)

Brigitte gave a status report on the preparations for the 1995 Monte Carlo production which should be finished shortly after the winter conferences.

The new HVFL05 Monte Carlo is based on JETSET 7.4. The new code for the generator should be set-up by end of December. Several aspects of JETSET 7.4 have been studied.

- Charm meson branching ratios (P. Henrard)
  Discrepancies were found in $BR(D^+ \to K^+) = 33\%$ (JETSET 7.4), $24.2 \pm 2.8\%$ (PDG '94, new measurements from '91,'92: 27–28%) and in the $D^+ \to$ 1(2) charged particles: 29.3%(62.4%) in JETSET and $38.4 \pm 2.3\%$ ($54.1 \pm 2.3\%$) from MARK III.

- Charm inclusive production (P. Colas)
  HVFL05 should reproduce the measurements of $P_V = D^*/(D + D^*) = 0.49 \pm 0.06$ (ALEPH/DELPHI). It is foreseen to include the production of the four P wave states (D^{**}).

- $B \to \tau\nu X$ (I. Tomalin, L. Duflot)
  The τ decays will be simulated using KORALZ including polarization effects.

- $B \to \ell\nu X$ (L. Bellantoni, A. Falvard, N. Marinelli)
  Semileptonic exclusive decays $B \to D, D^*, D^{**}\ell\nu$ will be simulated using a model (e.g. ISGW).

- Strangeness production (G. Rudolph)
  An overall parameter fit is necessary to reproduce the measurement of γ_s and the D_s and B_s production ratios.

A status report on HVFL05 will be given at the software week (21.-25.11.).

3 Measurement of R_b using combined tags (P. Perret, S. Monteil)

A combination of a lifetime tag and a single lepton tag was used to measure R_B, $BR(c \to \ell)$, $BR(b \to \ell)$, $BR(b \to c \to \ell)$ and $< X_b >$ ('92 data only):

$$\begin{aligned} R_b &= 0.2207 \pm 0.0041 \pm 0.0022 \\ BR(c \to \ell) &= 9.28 \pm 0.73 \pm 0.31\ \% \\ BR(b \to \ell) &= 10.86 \pm 0.19 \pm 0.19^{+0.37}_{-0.18}\ \% \\ BR(b \to c \to \ell) &= 8.59 \pm 0.29 \pm 0.43^{+0.55}_{-0.38}\ \% \\ < X_b > &= 0.698 \pm 0.007^{+0.009}_{-0.006} \end{aligned}$$

R_b and $BR(c \to \ell)$ were determined from a fit in the $p, p_\perp$ plane of leptons. The fit function is proportional to the probability to find a lepton with a given value of p and $p_\perp$: $Prob(p,p_\perp) = R_b \cdot Prob_b(p,p_\perp) + R_c \cdot Prob_c(p,p_\perp) + R_{uds} \cdot$

$Prob_{uds}(p, p_\perp)$. $Prob_b(p, p_\perp)$ is determined from event hemispheres with a lifetime tag from the other hemisphere. $Prob_c(p, p_\perp)$ is taken from Monte Carlo using the MARK III and DELCO data for $c \to \ell$ decays. For the determination of $R_{uds} \cdot Prob_{uds}(p, p_\perp)$ see ALEPH-NOTE # 94-55.

$BR(b \to \ell)$, $BR(b \to c \to \ell)$ and $< X_b >$ were measured from a fit to the spectrum of the transverse lepton momentum $p_\perp$. Here the probability to find a lepton in $b\bar{b}$ events with transverse momentum $p_\perp$ is: $Prob_b(p_\perp) = BR(b \to \ell) \cdot Prob_{b\to\ell}(p_\perp) + BR(b \to c \to \ell) \cdot Prob_{b\to c\to\ell}(p_\perp) + Prob_{background}(p_\perp)$. $Prob_{b\to\ell}(p_\perp)$ was measured from lifetime tagged events. To use only $p_\perp$ in the fit reduces the uncertainty from the b decay model.

With 6 M Z^0 a measurement of R_b with an error of 1% is expected.

4 Measurement of $BR(b \to \ell)$ (F. Ligabue, D. Abbaneo, N. Marinelli)

Using lifetime tagged events $BR(b \to \ell)$ and $BR(b \to c \to \ell)$ were measured from events with one or two leptons in the same jet:

$$\begin{aligned} BR(b \to \ell) &= 11.08 \pm 0.10 \pm 0.29\ \% \\ BR(b \to c \to \ell) &= 7.75 \pm 0.19 \pm 0.56\ \% \end{aligned}$$

A lifetime tag was required for one hemisphere. Events were selected with a jet in the other hemisphere containing one lepton or two opposite charged leptons. Monte Carlo spectra for $b \to \ell$ and $b \to c \to \ell$ were fitted to the $p_\perp$ distribution of the single lepton sample. For the double lepton sample the fit was made in the $(p_\perp^1, p_\perp^2)$ plane.

5 Electron ID using combined estimators (M. Schmitt)

A quantity η combining R_T, R_L and R_5 was proposed for electron identification. η is constructed using data distributions of R_T, R_L and R_5 to minimize the systematic uncertainty of the identification efficiency.

The quantity η is defined in two steps. First the three cumulative probabilities $C_{T,L,5}$ are calculated from $R_{T,L,5}$: $C = \int_R^\infty f(R')\, dR'$. The probability distributions $f(R')$ are obtained from converted photons in data events. Using the correct probability functions $f(R)$ guarantees that $dN/dC_{T,L,5}$ is constant in the range between 0 and 1. In a second step $C_{T,L,5}$ are combined to $G = C_T C_L C_5$ which fulfills $\frac{dN}{dG} = \frac{1}{2}\ln^2(1/G)$. η is given by $\eta = \int_G^1 dG' \frac{dN}{dG'}$. The distribution $dN/d\eta$ is constant between 0 and 1 by construction as long as the correct functions $f(R)$ are used.

First studies were made with an approximation of simple gaussians for $f(R)$. The systematic error on the electron identification efficiency can be improved significantly using this method.

6 Estimate of B-hadron fractions in $b\bar{b}$ events (O. Hayes, V. Sharma)

Using measurements of semileptonic B decay rates and of lifetimes, the production ratios for B_s and Λ_b were estimated:

$$\begin{aligned} f(b \to B_s) &= 10.67 \pm 2.34 \pm 2.40\ \% \\ f(b \to \Lambda_b) &= 9.96 \pm 2.96 \pm 3.10\ \% \\ f(b \to B_d) &= 39.69 \pm 1.89 \pm 1.96\ \% \end{aligned}$$

$f(b \to B_d)$ is defined as $f(b \to B_d) \equiv \frac{1}{2}(1 - f(b \to B_s) + f(b \to \Lambda_b))$.

At ALEPH the product of branching ratios $BR(Z^0 \to B_s) \cdot BR(B_s \to D_s \ell \nu)$ was measured. This quantity is related to the B_s production ratio: $BR(Z^0 \to B_s) \cdot BR(B_s \to D_s \ell \nu) = R_b \cdot f(b \to B_s) \cdot BR(B_s \to D_s \ell \nu)$. Assuming that the semileptonic decay widths are the same for B_d and B_s ($\Longrightarrow BR(B_d \to X\ell\nu)/\tau_{B_d} = BR(B_s \to X\ell\nu)/\tau_{B_s}$), $BR(B_s \to D_s\ell\nu)$ can be written as:

$$BR(B_s \to D_s\ell\nu) = \frac{BR(B_s \to D_s\ell\nu)}{BR(B_s \to X\ell\nu)} \underbrace{\frac{BR(B_s \to X\ell\nu)}{BR(B_d \to X\ell\nu)}}_{=\tau_{B_s}/\tau_{B_d}} BR(B_d \to X\ell\nu) \qquad (1)$$

The branching ratio for $B_d \to X\ell\nu$ is known from ARGUS and CLEO. The ratio $BR(B_s \to D_s\ell\nu)/BR(B_s \to X\ell\nu)$ was estimated taking into account D_s^{**} production. This leads to $f(b \to B_s) = 10.67 \pm 2.34 \pm 2.40\ \%$.

$f(b \to \Lambda_b)$ was determined in the same way.

7 A direct, time integrated limit for x_s (A. Greene, G. Quast, C. Zeitnitz)

A status report was given on a measurement of time integrated B_s mixing using reconstructed D_s mesons and a jet charge method for the two most energetic jets.

205/105 D_s were reconstructed in the decay channels $D_s^\pm \to \phi\pi^\pm$ / $K^*K^\pm$ ('91-'93 data). The B_s charge at production time was determined from a jet charge from the two most energetic jets, one of them containing the D_s ("D_s jet"). The jet charge is defined as:

$$Q = \frac{\sum_{D_s\ jet}\ w_i(p_\perp, p_{||})\ q_i}{\sum_{D_s\ jet}\ |w_i(p_\perp, p_{||})|} - \frac{\sum_{2.\ jet}\ p_{||}\ q_i}{\sum_{2.\ jet}\ p_{||}} \qquad (2)$$

The weights $w_i(p_\perp, p_{||})$ are constructed using Monte Carlo information, namely the probability distribution $x(p_\perp, p_{||})$ that a given track has the same charge as the b quark in the same jet. $1 - x$ is the corresponding probability for a $\bar{b}$ quark. The weight is defined as: $w_i = \log \frac{x}{1-x}$. The method gives the correct charge in about 80% of the events independent on the fact whether the B_s has mixed or not.

Under study is the correct simulation of D_s production in $b\bar{b}$ and $c\bar{c}$ events since only $\approx 50\%$ of D_s are expected to come from B_s decays.

8 Observation of $\Lambda_b \to \Lambda_c^+ \ell\nu \to \Lambda\pi^+\pi^+\pi^-\ell\nu$ (P. Spagnolo)

10 decays $\Lambda_b \to \Lambda_c^+ \ell\nu \to \Lambda\pi^+\pi^+\pi^-\ell\nu$ were reconstructed with a background of 2 ± 1 events. 7.3 ± 3 decays are expected to be seen. The events will be used together with the 23 events with the Λ_c decay $\Lambda_c^+ \to pK\pi$ to measure the Λ_b lifetime.

9 Observation of $\Xi_c \to \Xi^-\pi^+$ (P. Marrocchesi, S. Bettarini)

Using the '91-'93 data $44.7^{+12.5}_{-11.5}$ Ξ_c^0 were reconstructed with a mass of $M_{\Xi_c^0} = 2465.0^{+4.5}_{-4.6} \pm 1.8$ MeV (PDG '94: $M_{\Xi_c^0} = 2470.3 \pm 1.8$ MeV).

A sample of 3619 ± 60 reconstructed $\Xi^\pm$ with a background of less than 10% was used. In $\Xi^-\pi^+$ combinations a signal with a significance of 5.2σ was found. Nothing was seen in the wrong charge combination $\Xi^-\pi^-$. The reconstructed Ξ_c will be used to search for $\Xi_b^- \to \Xi_c^0\pi^-$.

10 Another B^* analysis (P. Colrain)

The B^*/B mass splitting and the B^* production rate was measured using converted photons from the decay $B^* \to \gamma B$:

$$\begin{aligned} M_{B^*} - M_B &= 46.5 \pm 0.7 \text{ MeV} \quad \text{(statistical error only)} \\ \frac{N_{B^*}}{N_B + N_{B^*}} &= 0.697 \pm 0.061 \pm 0.051 \end{aligned}$$

Converted photons were reconstructed (QPAIRF) in the energy range $E_\gamma = 0.35 - 1.0$ GeV in tagged $b\bar{b}$ events. The B^* energy is determined from the jet energy (JADE algorithm, YCUT=0.004, $E_J > 30$ GeV) with a correction, estimated from Monte Carlo events. The result, found for the B/B^* mass difference, is independent of the cut on the photon energy. Final results will be given after finishing the studies of the systematic error.

11 Search for $B^- \to D^{**0}(2460)\ell\nu \to D^+\pi^-\ell\nu$ (S. Armstrong)

Steve reported on a search for the decay $B^- \to D^{**}(2460)\ell\nu \to D^+\pi^-\ell\nu$. An enhancement was found for $\ell D^+\pi^-$ events compared to $\ell D^+\pi^+$ events. A signal for $D^{**}(2460)$ production of marginal significance was found ($7.0^{+4.3}_{-3.5}$ events).

The D^+ decay vertex was reconstructed from the $K^+\pi^-\pi^-$ decay products yielding ≈ 360 $\ell^\pm D^\mp$ combinations. The $\ell^\pm D^\mp$ vertex was required to be separated from the main vertex by 2 standard deviations. An additional pion was selected with an impact parameter $\delta > \sigma_\delta$ with respect to the main vertex. It has to form a common vertex with the $\ell^\pm D^\mp$.

From the observed $7.0^{+4.3}_{-3.5}$ decays $B^- \to D^{**}(2460)\ell\nu$ a branching ratio of $BR(B^- \to D^{**}(2460)\ell\nu) = (0.49^{+0.30}_{-0.25}\ \%)$ was estimated. It is planned to investigate the decay $B^0 \to D^{**}(2460)^-\ell^+\nu \to D^0\pi^-\ell^+\nu$ in a similar way.

12 Search for $B^0 \to K^*\gamma$ (M. Corden)

An upper limit of

$$BR(B^0 \to K^*\gamma) \; < \; 1.7 \cdot 10^{-4}$$

for the penguin decay $B^0 \to K^*\gamma$ was obtained. This limit does not include systematic uncertainties due to the Monte Carlo model or the $b \to B^0$ fragmentation. The K^* was reconstructed in the channel $K^* \to K^+\pi^-$. The selection includes cuts on the lifetime tag probability and the impact parameters of the K^+ and π^-.

13 Search for B_s and Λ_b gluonic penguins (P. Coyle, C. Herrmann)

The following upper limits were obtained in a search for B_s and Λ_b penguin decays (ALEPH NOTE # 94-156):

$$\begin{aligned} BR(B_s \to \phi\phi) &< 0.44 \cdot 10^{-3} \\ BR(B_s \to K^0\overline{K}^0) &< 1.8 \cdot 10^{-3} \\ BR(\Lambda_b \to \phi\Lambda) &< 1.4 \cdot 10^{-3} \end{aligned}$$

The selection cuts were optimized using the method applied in the Higgs and B_c search. No candidates were observed in any of the studied decay channels. The theoretical predictions for the decays $B_s \to K^0\overline{K}^0/B_s \to \phi\phi$ are a factor of 20/40 smaller than the present upper limits.