Search For Flavor Changing Decays Of The Z^0 At LEP

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Abstract

We report on the preliminary result of the search for flavor changing Z decays at LEP in the process $e^+e^- \rightarrow Z^0 \rightarrow bl\ l = d, s$. The analysis of 1 million hadronic events collected by L3 in 1994 relies on the silicon microvertex detector for the b quark tag and antitag. An upper limit of 5.6×10^{-3} at 95% confidence level for the corresponding branching ratio has been set.

One of the most important features of the Standard Model (SM) is that neutral currents are flavor diagonal [1]. Any flavor changing neutral current (FCNC) processes in the SM are therefore obliged to arise at higher orders, through loops, and as such are highly suppressed. The existence of further new physics could lead to a significant increase. At LEP it is possible to search for FCNC decays of the real Z^0 in the channels $e^+e^- \rightarrow Z^0 \rightarrow bl\ l = d, s.$ using the different life–time signature of b and light quark jets $[2, 3]$.

The L3 detector is described in reference [4]. The data sample used in this analysis consist of 7.54×10^5 hadronic events collected during the 94 run. In order to simulate the background we use 1.85×10^6 $Z^0 \rightarrow q\overline{q}$ events generated with JetSet 7.4 Parton Shower. For the signal we use 5.97×10^4 $Z^0 \rightarrow b\overline{q}$ $(q = d, s)$ events generated with a modified version of JetSet.

In our analysis we apply the hadronic selection described in reference [5]. To identify jets in hadron final states the Durham algorithm is used with $Y_{cut} = 0.02$. To ensure that the selected events are amenable to an analysis based on life–time information, we require the primary vertex to be reconstructed and $|cos(\Theta_T)| < 0.7$, being Θ_T the polar angle of the thrust. In order to get rid of gluon splitting systematics only two jet events are selected.

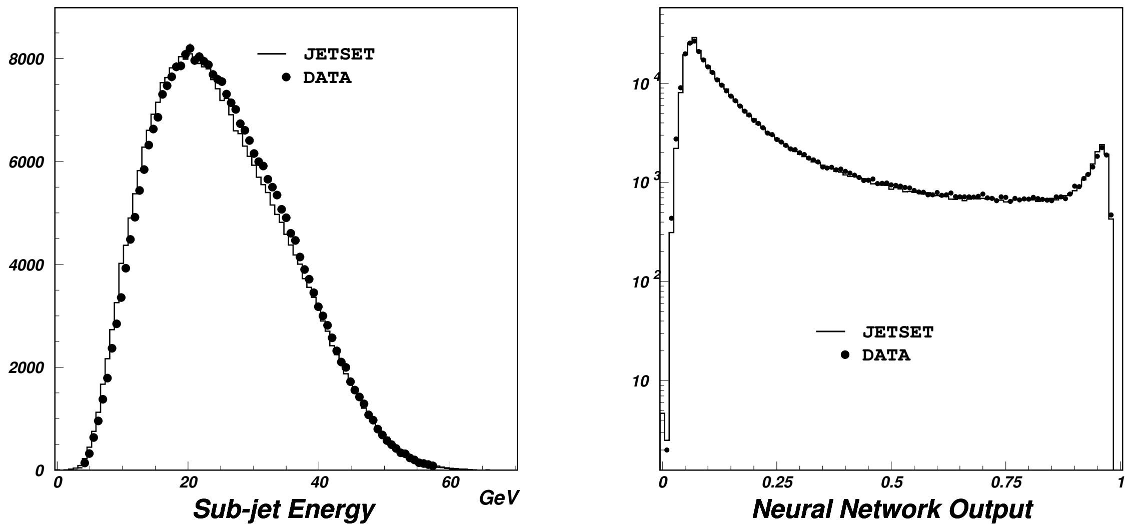

Figure 1: *Distribution of the tagging variables for Data and Monte Carlo.*

The light quark tag (l tag) is achieved requiring a jet to have a high energy sub–jet: due to the hard fragmentation function of c and b hadrons, and their subsequent decays, it is very rare to find a particle with high energy in c and b jets [6]. A jet is defined to be l–tagged if an associated sub–jet with energy greater than 30 GeV is found (fig. 1).

The b tag variable (OUT_{NN}) is the output of a Neural Network that compose the two dimensional Impact Parameter and Decay Length L3 tags [7]. A jet is defined to be b–tagged if $OUT_{NN} > 0.7$ and is defined to be b–antitagged if $OUT_{NN} < 0.1$ (fig. 1).

We define the flavor violating ratio $R_{bl} = \sum_{q=s,d} \frac{\Gamma(Z\to bq)}{\Gamma(Z\to hadrons)}$. In order to select FCNC events we ask a jet to be b-tagged while the other jet has to be b–antitagged and l–tagged. With the assumption $\sum_{q=u,d,s,c,b} R_q + R_{bl} = 1$ the flavor violating ratio can be expressed in terms of the analysis cut efficiencies as $R_{bl} = \frac{\epsilon^{data} - \epsilon^{backg}}{\epsilon^{sign} - \epsilon^{backg}}$, where ϵ^{data} is the efficiency for the data sample, ϵ^{backg} is the background efficiency and ϵ^{sign} is the signal efficiency.

We find $R_{bl} = 0.8 \times 10^{-3} \pm 1.9 \times 10^{-3}$ $(stat)$ $\pm 1.7 \times 10^{-3}$ (sys) that is compatible with $R_{bl} = 0$. The result is very stable with respect to the variation of the analysis cuts and allows to set the first preliminary limit on FCNC decays of a real Z: $\sum_{q=d,s} B_r(Z \to bq) < 5.6 \times 10^{-3}$ at 95 % $C.L.$.

References

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