SLAC-PUB-8658
OUNP-2000-04
October 2000

Studies of Hadronic Decays of Z^0 Bosons at SLD*

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The latest SLD results on light-quark fragmentation and tests of hadronisation models are presented.

Presented at the XXX International Conference on High Energy Physics
Osaka, Japan, 27 July - 2 August 2000

* Work supported by Department of Energy contract DE-AC03-76SF00515.

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We have a poor understanding of hadronisation in terms of quantitative predictions from QCD. Phenomenological models provide useful insights, but no model accounts successfully for all the observed features of jet fragmentation. Heavy jet fragmentation is relatively well understood; the quark mass provides a cutoff against divergences, allowing pQCD calculations to be performed. Also, the decay signatures of B or D hadrons allow high-purity b or c jet samples to be identified with high efficiency. The study of u, d or s-jet fragmentation is less tractable both theoretically and experimentally: the quark masses are comparable with Λ_{QCD}, leading (and non-leading) light hadrons (π, K, p, $\ldots$) can be produced in jets of *any* flavour, making the isolation of u,d or s-jets problematic; a dedicated particle i.d. system is required to identify these light hadron species.

The clean $Z^0 \rightarrow$ u$\bar{\text{u}}$, d$\bar{\text{d}}$, s$\bar{\text{s}}$, c$\bar{\text{c}}$, b$\bar{\text{b}}$ events provided by SLC are ideal for quark fragmentation studies; updated results presented here are based on the complete sample of 550k Z^0 decays recorded by SLD. The unique CCD vertex detector allows high-purity b/c/uds/g jet separation with good efficiency. The unique polarised SLC electron beam allows quark/antiquark jet separation with a purity of 73% and 100% efficiency. The Cerenkov Ring Imaging Detector allows $\pi^\pm$/K$^\pm$/p$^\pm$ separation within $0.5 \leq p \leq 35$ GeV/c.

Our light-hadron fragmentation functions in inclusive-flavour jets[1] are shown in Fig. 1; the momentum coverage spans the kinematic range in Z^0 decays. The dependence on primary jet flavour is illustrated in Fig. 2, in terms of ξ=ln$(1/x_p)$; the peak position and height depend strongly on jet flavour, implying that light and heavy jets should be separated before performing pQCD fits to these distributions[1].

The ratio of heavy- to light-jet $\pi^\pm$, K$^\pm$ or p$^\pm$ fragmentation functions is compared with model predictions[2] in Fig. 3; HERWIG, in particular, has difficulty reproducing these ratios. Hadron (h) and antihadron ($\bar{\text{h}}$) fragmentation functions in light-*quark* jets[2] are shown separately in Fig. 4; the excess of h over $\bar{\text{h}}$ at high x_p is an indication of leading-particle production.

We have studied correlations in rapidity (y) between pairs of hadron species[3]. The excess of opposite-charge over like-charge (high-p) pairs at small Δy (Fig. 5) indicates local charge compensation in the fragmentation process. The excess at large Δy (most noticeable for the K$^\pm$) is further evidence of leading-particle production. We observe[3] a significant hadron-species and jet-flavour dependence of these long-range correlations. We have defined a new observable, the rapidity distribution for the case in which the thrust axis is signed to point in the *quark* direction. These distributions for h and $\bar{\text{h}}$ are noticeably different, indicating a preference for high-rapidity h ($\bar{\text{h}}$) to point along (against) the quark direction, again an indicator of leading particles. This effect can be enhanced by considering the distribution of the charge-ordered difference in rapidity between opposite-sign and like-sign pairs of $\pi^{\pm}$, $\text{K}^{\pm}$ or $\text{p}^{\pm}$; details are given in ref.[3].

We have exploited the overwhelming evidence in our data for a leading strange-particle effect to measure directly the EW coupling of the s-quark to the Z^0, via the polarised forward-backward asymmetry of strange-hadron production[4]. We find $A_s = 0.895 \pm 0.066 \pm 0.062$.

[*] Work supported by Department of Energy contracts: DE-FG02-91ER40676 (BU), DE-FG03-91ER40618 (UCSB), DE-FG03-92ER40689 (UCSC), DE-FG03-93ER40788 (CSU), DE-FG02-91ER40672 (Colorado), DE-FG02-91ER40677 (Illinois), DE-AC03-76SF00098 (LBL), DE-FG02-92ER40715 (Massachusetts), DE-FC02-94ER40818 (MIT), DE-FG03-96ER40969 (Oregon), DE-AC03-76SF00515 (SLAC), DE-FG05-91ER40627 (Tennessee), DE-FG02-95ER40896 (Wisconsin), DE-FG02-92ER40704 (Yale); National Science Foundation grants: PHY-91-13428 (UCSC), PHY-89-21320 (Columbia), PHY-92-04239 (Cincinnati), PHY-95-10439 (Rutgers), PHY-88-19316 (Vanderbilt), PHY-92-03212 (Washington); The UK Particle Physics and Astronomy Research Council (Brunel, Oxford and RAL); The Istituto Nazionale di Fisica Nucleare of Italy (Bologna, Ferrara, Frascati, Pisa, Padova, Perugia); The Japan-US Cooperative Research Project on High Energy Physics (Nagoya, Tohoku); The Korea Research Foundation (Soongsil, 1997).

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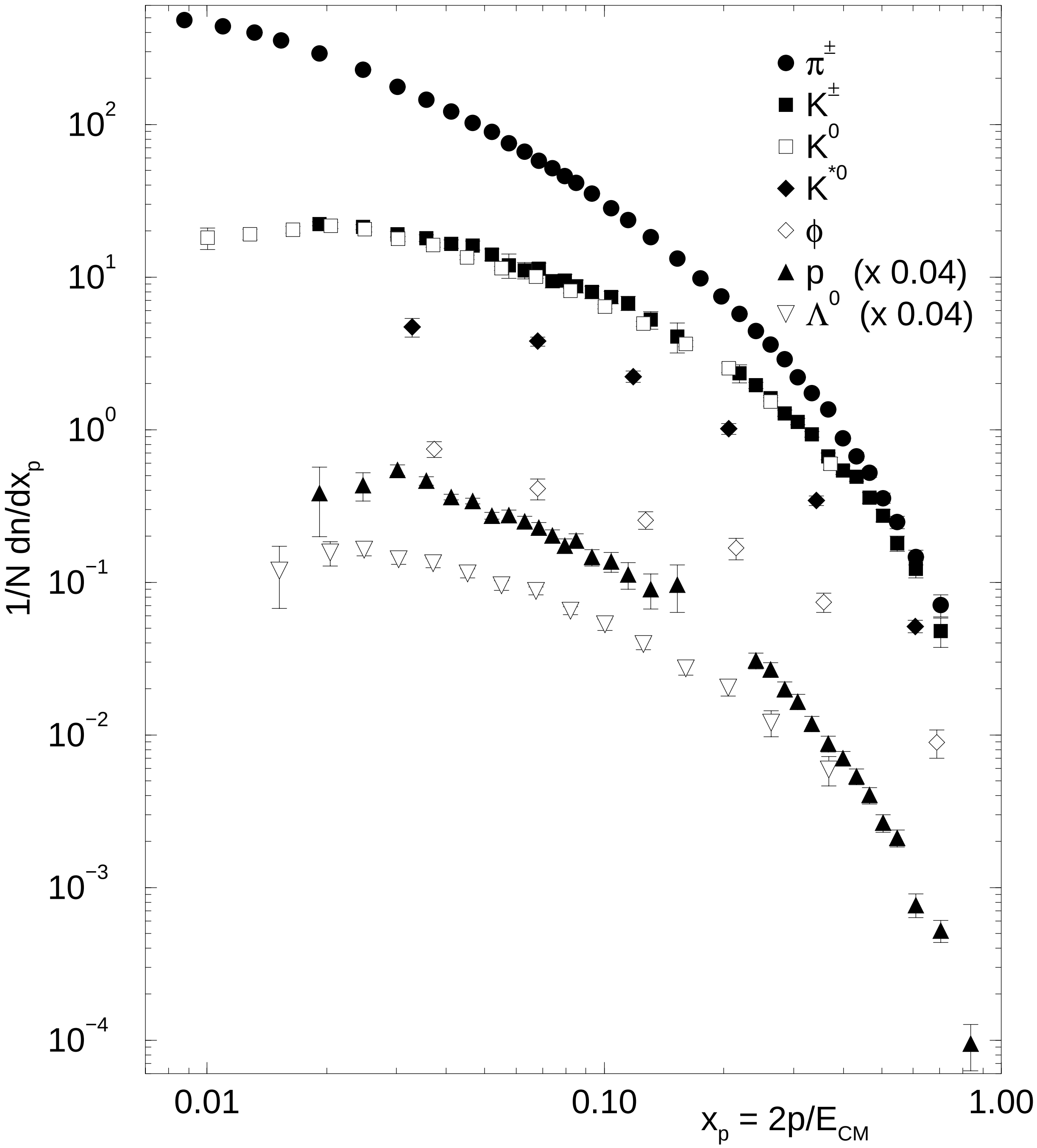

Figure 1: Light hadron fragmentation functions.

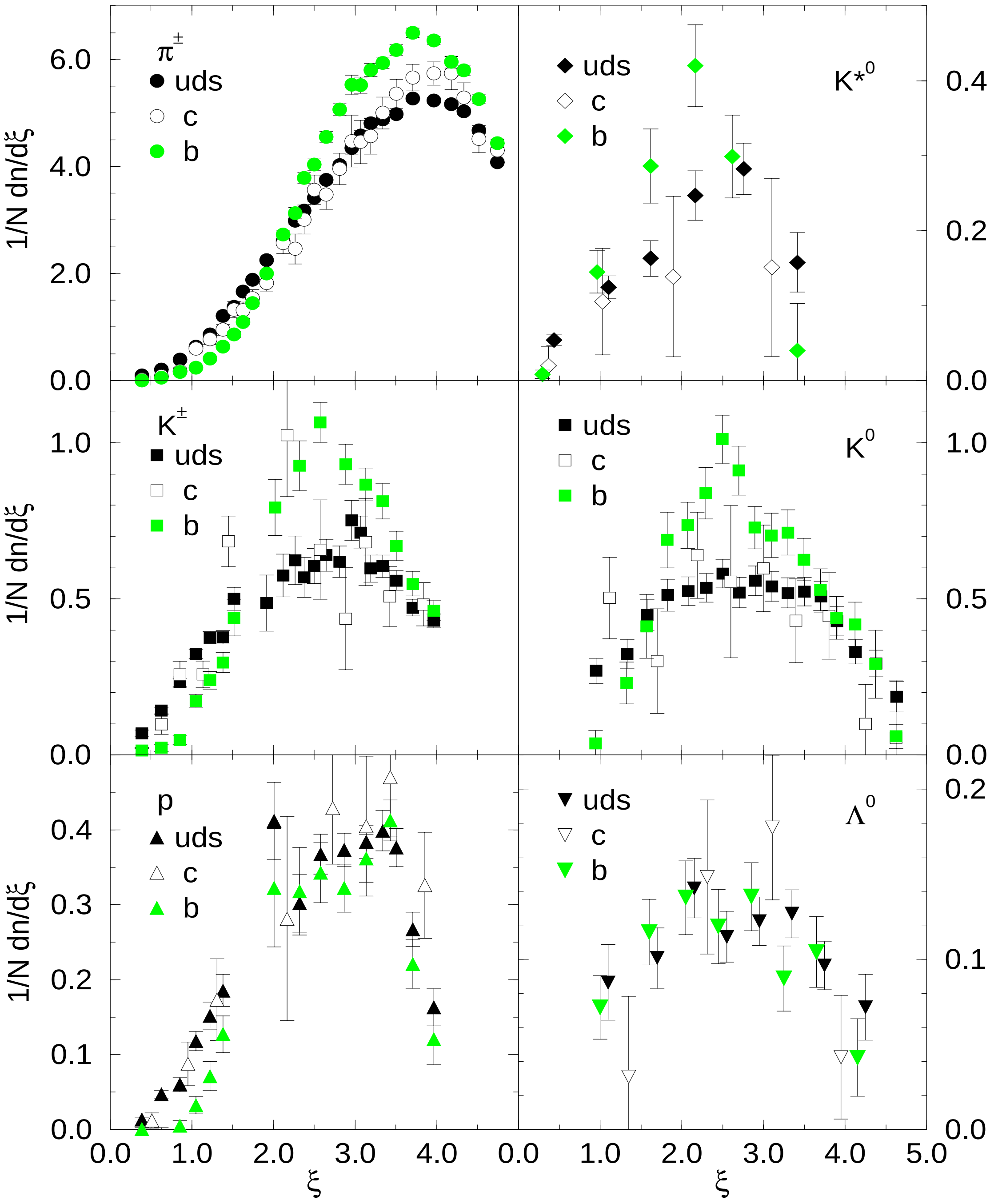

Figure 2: ξ distributions vs. primary jet flavour.

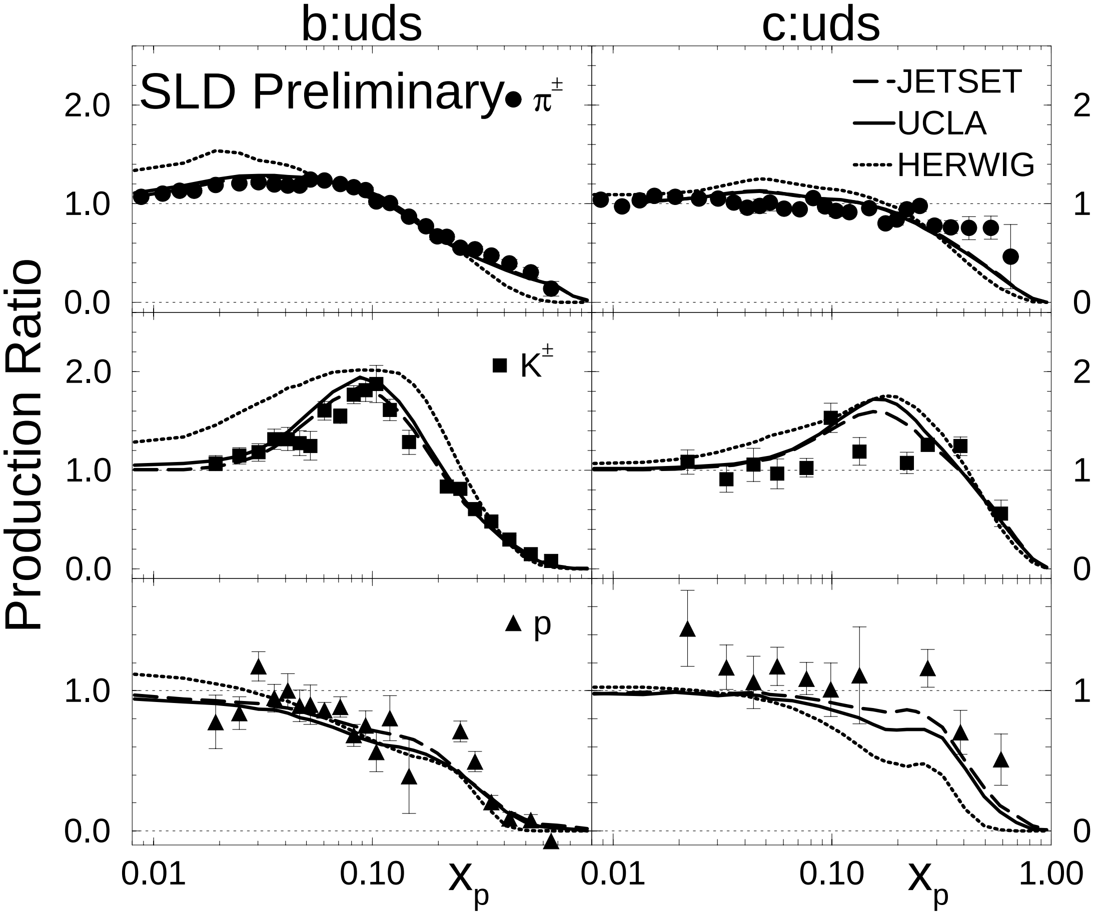

Figure 3: Flavour ratios of x_p distributions.

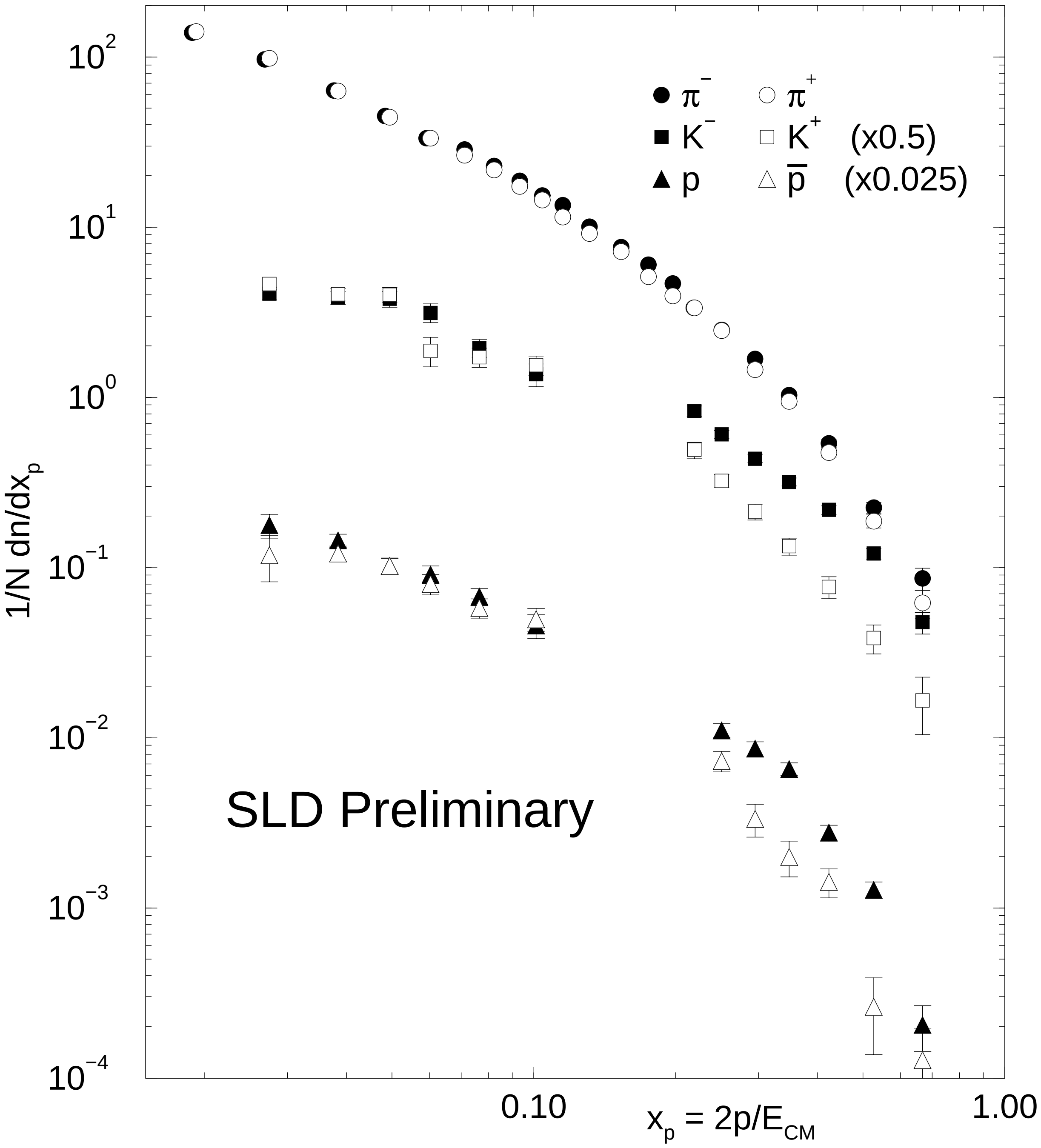

Figure 4: h vs. $\bar{h}$ production in light-quark jets.

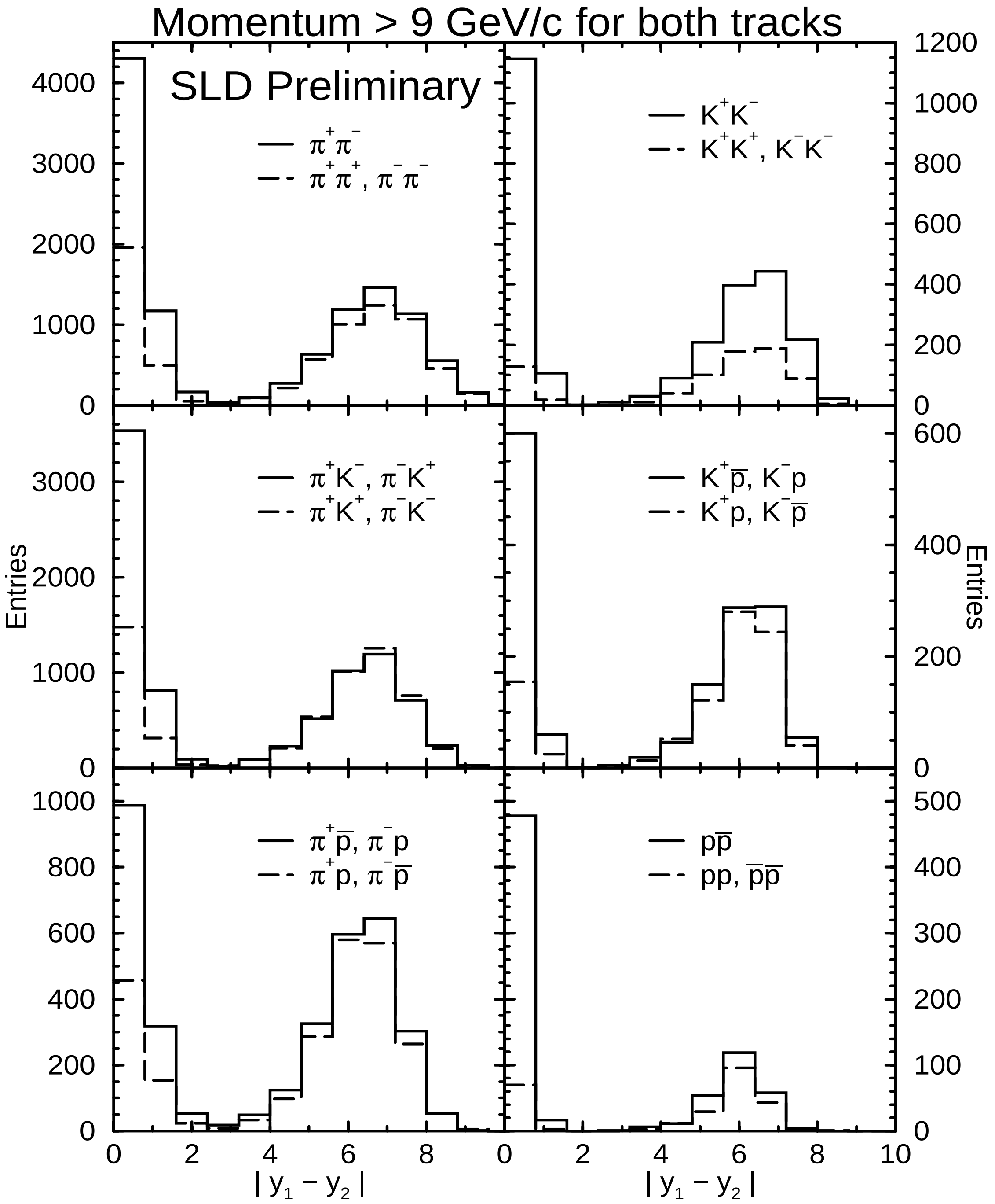

Figure 5: Rapidity differences in all-flavour jets.