3.

BNL 28452

Presented at XXth International Conference
on High Energy Physics, University of
Wisconsin, Madison, July 17-23, 1980

OG 569

CONF-800724--50

Observed Differences in Event Structures of High-p_T π^0 and Single Photon Events Produced in pp Collisions at the CERN ISR

Athens-BNL-CERN-Copenhagen-Lund-Rutherford-Tel Aviv Collaboration
CERN, CH-1211 Geneva 23, Switzerland

presented by D.C. Rahm

The submitted manuscript has been authored under contract DE-AC02-76CH00016 with the U.S. Department of Energy. Accordingly, the U.S. Government retains a nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or allow others to do so, for U.S. Government purposes.

OBSERVED DIFFERENCES IN EVENT STRUCTURES OF HIGH-p_T π^0 AND SINGLE PHOTON EVENTS PRODUCED IN pp COLLISIONS IN THE CERN ISR

Athens-BNL-CERN- Copenhagen-Lund-Rutherford-Tel Aviv Collaboration *)
CERN, CH-1211 Geneva 23, Switzerland
presented by D.C. Rahm

ABSTRACT

The direct photon production in pp collisions for c.m. energies $31 \leq \sqrt{s} \leq 63$ GeV and transverse momenta of up to 9 GeV/c were measured at the ISR using a segmented lead/liquid argon calorimeter. The observed γ/π^0 ratio is found to be significantly larger than zero at 4 GeV/c in p_T increasing to 0.4 at 9 GeV/c. The average multiplicity on the trigger side for the single-photon events was found to be significantly lower than for π^0 events. The correlations in Δy and $\Delta\phi$ between the trigger particle and an additional particle are found to differ mainly at small Δy and $\Delta\phi$.

The possibility of using direct photon production to probe the constituent structure of hadrons has been extensively investigated [1-12]. According to present theoretical views, direct photons are produced in proton-proton interactions predominantly via the process $qg \rightarrow \gamma q$ with important contributions also coming from the $qq \rightarrow qq\gamma$ process, where the photon is radiated in a bremsstrahlung process from the scattered quark. The production of high p_T mesons, on the other hand, is thought to proceed via the hard scattering of the proton constituents (quarks, gluons and antiquarks) and their subsequent fragmentation. The different production mechanisms for high p_T mesons and single photons are thus likely to be reflected in the event structure associated with each particle.

We have previously reported the observation of direct photons and differences in the event structures associated with π^0 or photon-triggered events [11-13]. Here we report on recent results on the same subjects.

The apparatus used for the direct photon measurement consists of two lead/liquid-argon calorimeters, which are described in more detail elsewhere [11-14]. These were subdivided both longitudinally (in the direction of shower development) for effective hadron-photon discrimination, and laterally. We were able to reconstruct each of the showers from the π^0 decay and thus separate π^0 from single photon events on an event-by-event basis.

Figure 1 shows the apparent γ/π^0 ratio and the background contribution expected from all the known meson decays. This background is mainly due to decays where one photon falls in the calorimeter and the other outside. Effects due to cosmic rays, beam gas interactions, and hadrons simulating electromagnetic showers have all been included.

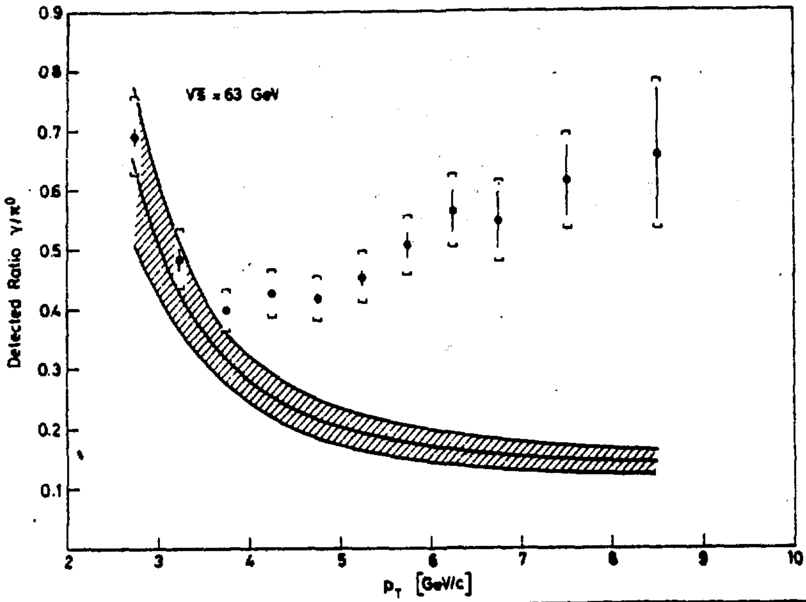

Fig. 1

In addition to the liquid-argon calorimeters, there was an array of 44 scintillation counters surrounding the interaction region at a distance of 18 cm. Each counter covered 8° in azimuth and about 2 units in rapidity. In Fig. 2 we show the multiplicities in these counters for π^0 and single-photon triggered events. Figure 2a gives the total multiplicities and 2b the same side multiplicities in the seven counters centred on the trigger direction. On the away side, the observed difference for the two different triggers was small. The trigger-side multiplicity for the π^0 events is consistent with being constant for all p_T bins, while the single-photon sample shows a decrease with increasing p_T. If one corrects for the meson decay background in the single-photon sample, assuming it has a multiplicity structure similar to that of the events with identified π^0's, one obtains a value of the multiplicity for the real direct single-photon events which is consistent with being constant for all p_T bins, but which is lower than that of the π^0 events.

In another configuration of the apparatus where proportional [13] chambers were in front of the calorimeters and the whole apparatus was placed much nearer the intersection region, we were able to obtain more detailed information on charged particles correlations. This set-up had the advantage that we were able to go to higher p_T, but had the disadvantage that the π^0 single photon separation was not as clean. In Fig. 3 we show the relative number of events versus the pseudo rapidity differences (Δy) between the trigger particle and charged tracks in the region $20° < \Delta\phi < 70°$ ($\Delta\phi$ is azimuthal difference) and for $p_T > 6.5$ GeV/c. The solid lines represent the expected distributions for uncorrelated tracks calculated assuming a random distribution and our experimental acceptance.

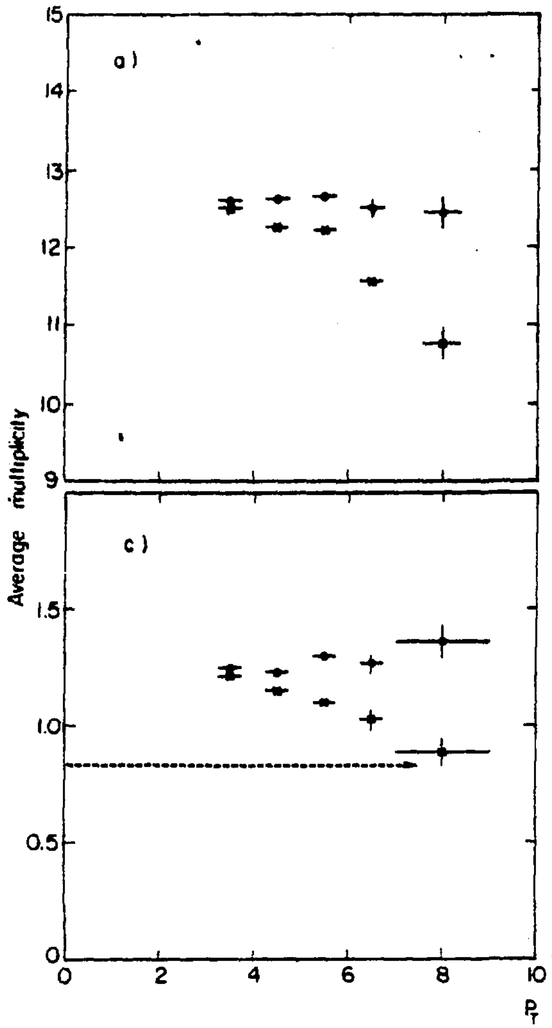

Fig. 2

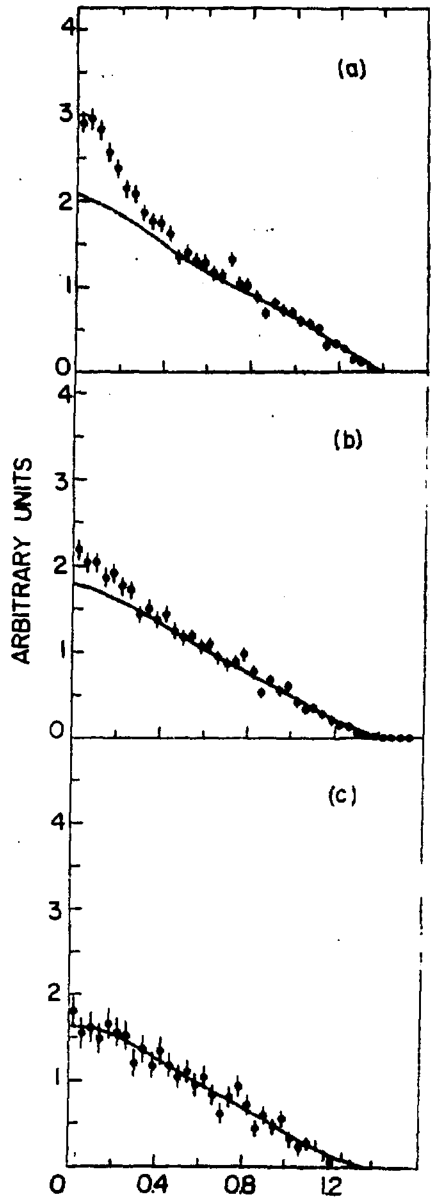

Fig. 3

The curves are normalized to the number of events at large Δy where most of the tracks are expected to be uncorrelated. In Fig. 3a this distribution is shown for π^0 events and a clear excess is observed for small Δy. Figure 3b shows the same distribution for the single photon candidate sample. If we subtract the calculated background due to misidentified π^0's, we obtain the distribution in Fig. 3c which shows no excess above that of the uncorrelated particles expected to come from the fragmentation of the other proton constituents.

In conclusion, we observe that the single photon events have considerably lower numbers of associated charged tracks as well as π^0 particles on the trigger side. Most of the difference is concentrated in the small $\Delta\phi$ and Δy region, where the accompanying particles of the same "jet" are expected to be found. The relative magnitude of the effect increases with increasing transverse momentum of the second particle. These observations are consistent with the hypothesis that high p_T single photons produced in pp collisions are unaccompanied, while high p_T π^0's are part of a "jet" of particles.

REFERENCES

*) Members of the collaboration are: C. Kourkoumelis, L.K. Resvanis, T.A. Filippas, E. Fokitis, S. Karpathopoulos, C. Trakkas (Athens), A.M. Cnops, T. Killian, T. Ludlam, R.B. Palmer, D.C. Rahm, P. Rehak, I. Stumer (BNL), D. Cockerill, C.W. Fabjan, A. Hallgren, I. Mannelli, W. Molzon, P. Mouzourakis, B.S. Nielsen, Y. Oren, L. Rosselet, W.J. Willis (CERN), O. Botner, H. Bøggild, E. Dahl-Jensen, I. Dahl-Jensen, G. Damgaard, K.H. Hansen, J. Hooper, R. Møller, S.Ø. Nielsen, B. Schistad (Copenhagen), T. Akesson, S. Almehed, G. von Dardel, S. Henning, G. Jarlskog, B. Lörstad, A. Melin, U. Mjörnmark, A. Nilsson, L. Svensson (Lund), M.G. Albrow, N.A. McCubbin (Rutherford), O. Benary, S. Dagan, D. Lissauer (Tel Aviv).

1. G.R. Farrar and S.C. Frautschi, Phys. Rev. Lett. 36 (1976) 1017.
2. C.O. Escobar, Nucl. Phys. B98 (1975) 173.
3. E.L. Feinberg, Nuovo Cimento 34A (1976) 391.
4. H. Fritzsch and P. Minkowski, Phys. Lett. 69B (1977) 316.
5. R. Rückl, S.J. Brodsky, J.F. Gunion, Phys. Rev. D18 (1979) 2469.
6. R.D. Field, Proc. 19th Int. Conf. on High-Energy Physics, Tokyo 1978 (Phys. Soc. Japan, Tokyo, 1979), p. 743.
7. A.P. Contogouris, S. Papadopoulos, M. Hongoh, Phys. Rev. D19 (1979) 2607.
   A.P. Contogouris, J. Kripfganz, McGill University preprint (1979).
8. P. Aurenche, J. Lindfors, preprint CERN TH.2768 (1979).
9. U. Amaldi et al., Nucl. Phys. B150 (1979) 326.
10. R.M. Baltrusaitis et al., Fermilab Pub-79/38-Exp (1979).
11. M. Diakonou et al., Phys. Lett. 87B (1979) 292.
    M. Diakonou et al., Phys. Lett. 91B (1980) 296.
12. M. Diakonou et al., Phys. Lett. 91B (1980) 301.
13. C. Kourkoumelis et al., Observed differences in the structure of events with a high p_T π^0 or single photon. Submitted to Nucl. Phys. B.
14. J.H. Cobb et al., Nucl. Instr. and Meth. 140 (1977) 413.
    J.H. Cobb et al., Nucl. Instr. and Meth. 159 (1977) 93.

This research was supported in part by the U.S. Department of Energy under Contract No. DE-AC02-76CH00016.