Rockefeller University
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A STUDY OF DIRECT SINGLE PHOTONS AND CORRELATED PARTICLES IN PROTON-PROTON COLLISIONS AT $\sqrt{s}$ = 62.4 GeV

(CCOR Collaboration)

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(CCOR Collaboration)

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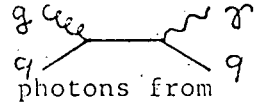
Recent interest in the production of single photons in hadron-hadron collisions has been stimulated because significant experimental data became available[1] and theoretical studies showed[2], that this process provides a good determination of the gluon distribution in the proton, mainly via the QCD-Compton-Diagram.



The main experimental problem for all single photon experiments is the large number of background single photons from π^0, η, η'... decays. That means, it is much easier to find a "signal" than to exclude one. Data taken at $\sqrt{s}$ = 62 GeV and with thresholds of 3, 5, 7 and 9 GeV/c in p_T are presented here. The apparatus is shown in Fig. 1. Essential for this experiment is the lead glass shower detector, the scintillation counters "B", and the coil and cryostat of the solenoid. Because the spatial resolution of the lead glass did not allow to separate high p_T γ, π^0, η... an unconventional method has been developed to extract single photon data with a statistical procedure. If an incident high energy photon hits an absorber t radiation length thick, the probability that this photon passes through the absorber without converting to an e^+e^- pair is given by $\nu_1 = \exp(-7t/9)$. So, the probability that out of the two photons of a π^0 both do not convert is given by $\nu_0 = (\nu_1)^2$. In this experiment the coil and cryostat (1 radiation length thick), were used as a converter so ν_1 = .46 and ν_0 = .21. Because of acceptance corrections ν_0 is slightly p_T-dependent and not the same for both of the lead glass walls. (ISR CM-motion). As a detector for converted photons the counters "B" just outside the cryostat have been used. To avoid confusion, events with a track pointing to the relevant B-counter have been excluded from the analysis. So, the observed non-conversion probability ν_{obs} is obviously related to the fraction $f_\gamma = \gamma/\text{all}$ of single photon events in the data sample by $\nu_{obs} = \nu_E (1-f_\gamma) + \nu_1 f_\gamma$ where ν_E is the expected non-conversion probability for all processes contributing to the trigger other than single γ. The results for f_γ are shown in Fig. 2a. Multiplying the measured invariant cross-section for the whole sample with f_γ gives the invariant cross section for direct photon production (Fig. 2b).

Further analysis of this production of single γ's gives the

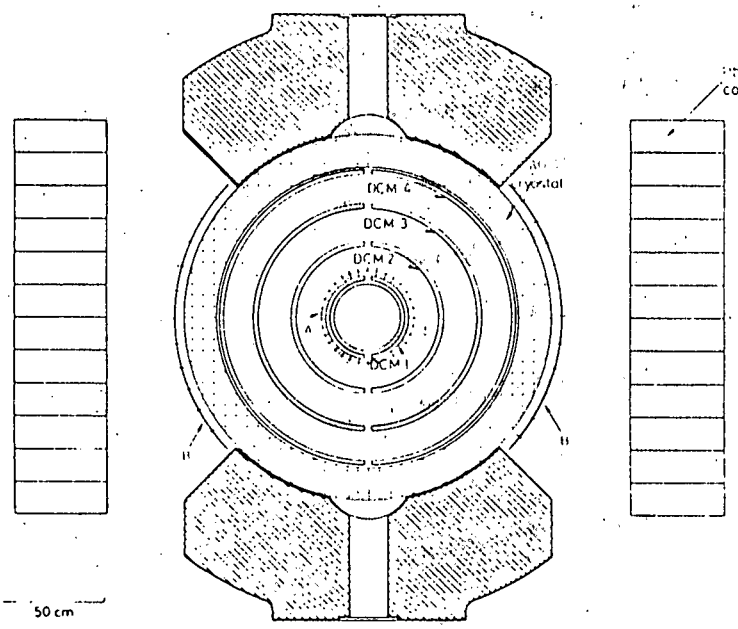


Fig. 1. View of the apparatus

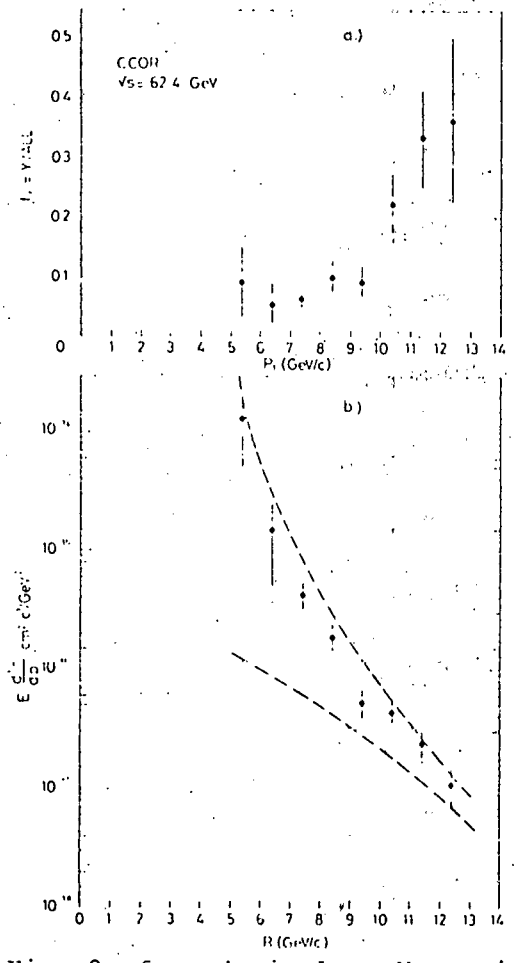


Fig. 2. f_γ and single, γ X-section

following preliminary results. In some models, directly produced photons are expected to be unaccompanied by particles on the same side. Thus the value of $f_\gamma = \gamma/\text{all}$ should be enhanced for such events. By a method similar to the above, f_γ has been obtained separately for two classes of events. Those in Fig. 3a have at least one charged or neutral particle other than the trigger in the trigger hemisphere, while those in Fig. 3b do not. The f_γ for the accompanied trigger particles are consistent statistically with zero for $p_{T\,trig} < 11$ GeV/c. However, for the unaccompanied particles, f_γ clearly rises with $p_{T\,trig}$, and for $7 < p_{T\,trig} < 11$ GeV/c, 20% ± 2% (statistical) of this sample may be attributed to direct single γ's.

If the process yielding direct single photons is $gq \to \gamma q$ then theory predicts that because of the quark charges and abundances in the proton the quark involved will be a u quark eight times more often than a d quark. This large excess of positive to negative in the parent quark should be reflected in the structure of the 'jet' opposite to the single γ[3]. This has been investigated by the measurement of the charge ratio R = positive particles/negative particles in the hemisphere opposite the trigger, as a function of $X_E = -\vec{P}_{T\,track} \cdot \vec{P}_{T\,trig} / |P_{T\,trig}|^2$. Fig. 4 shows R as a function of x_E for four trigger bands and two subsets of the data. The "π^0-type" subset consists of those events where the trigger particle has

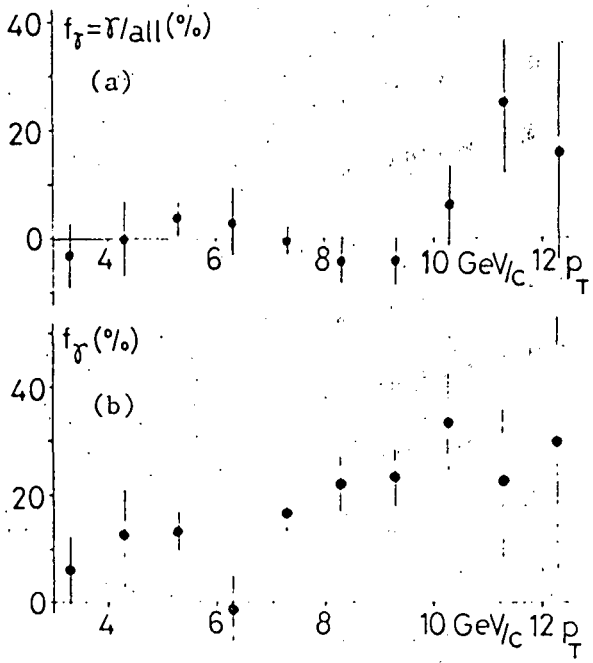


Fig. 3. f_γ for events with accompanied (top) and unaccompanied (bottom) trigger particles

converted and is accompanied by a same side particle. As shown above these events contain essentially no single γ's. Conversely, the "single γ-type" subset comprises those events where the trigger particle has not converted and is not accompanied by a same side particle. There is no systematic difference in the value of R between these two subsets below 7 GeV/c. However, above 7 GeV/c there is an indication that there is an excess of high x_E positive particles in the single-γ enhanced sample. From the values of f_γ shown in Fig. 4, and the non-conversion probabilities for γ's and for other particles, it is possible to extract R for single-γ events. The value obtained for 7 GeV/c < $p_{T\,trig}$ < 13 GeV/c, 0.3 < x_E < 1.05 is R = 3.7 ± 1.2 (statistical). This result favours the idea that the process $gq \to \gamma q$ is significant in high p_T single photon production.

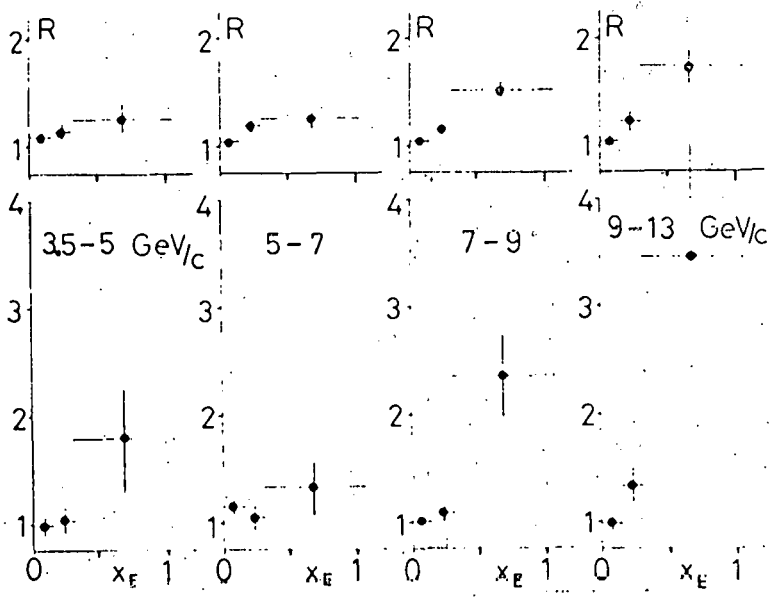


Fig. 4. Charge ratio for π^0-type (top) and single γ-type (bottom) events. Momenta shown are trigger p_T bands.

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