large $p_\perp$ events in the azimuthal angle region away from the trigger (full line). Also shown is the equivalent distribution for uncorrelated pairs obtained by combining secondaries from different events. In both cases only secondaries with $p_\perp > 0.6$ GeV/c were entered. Figs 10(c and d) show a normalized rapidity difference distribution obtained by taking the ratio of the distributions of figs 10(a and b) respectively, to the background distributions of these figures [3].

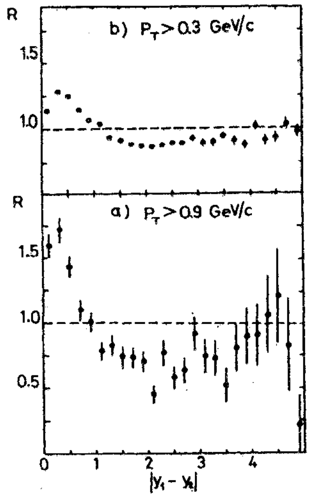

Fig. 11 Normalized rapidity difference for secondaries of opposite charge with $p_\perp > 0.3$ GeV/c (fig. 11 (a)) and $p_\perp > 0.9$ GeV/c (fig. 11 (b)) [3].

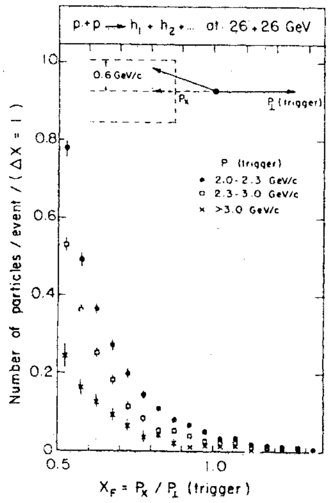

Fig. 12 The distribution of the number of secondaries per event emitted in the away direction versus the reduced transverse momentum $X = p_\perp / p_\perp^t$. Three sets of points correspond to three values of the transverse momentum of the triggering particle. Only particles with the momentum component perpendicular to the trigger plane smaller than 0.6 GeV/c are plotted.

LARGE TRANSVERSE MOMENTUM PHOTONS FROM HIGH ENERGY PROTON-PROTON COLLISIONS

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(presented by G.Vesztergombi (JINR, Dubna))

Large transverse momentum production of photons has been the object of many investigations /1-4/ . However, no systematic investigation concerning the source of the observed photons has been made and it has been generally assumed that they are the products of π^0 or η decays. In order to clarify this situation here we report on a simultaneous measurement of the yields of single photons and of photon pairs produced in proton-proton collisions of total c.m. energies $\sqrt{s} = 45$ and 53 GeV.

The photon detector is a lead glass hodoscope located at 90° production angle in an intersection region of CERN ISR. Its properties and performance have been described in detail in previous publications /5/ . The distance to the beam intersect is 3.62 m, corresponding to a solid angle acceptance of 0.05 sr. To analyse the pattern of energy distribution in the lead glass array, we reduce it to a number of clusters of connected cells with pulse heights significantly above zero. In the following the number of above defined clusters will be referred as number of observed photons. The question of purity of this "photon sample" will be discussed in later paragraphs.

The space around the beams is covered by a large acceptance magnetic spectrometer, the Split Field Magnet Facility, where charged particles produced in association with the lead glass trigger are detected /6/ .

Events were recorded when they simultaneously satisfied two conditions: an energy deposition above an adjustable threshold (usually 1.4 GeV) in the lead glass counter and the detection of at least two charged particles either in the SFM wire chambers or in each of two scintillation hodoscopes positioned at small angles to the beam lines. The second condition ensures that the detected photons are produced in a genuine beam-beam interaction while it may cause a loss of at most 10% to the inclusive photon spectrum.

The comparison of the measured single photon yield to that expected from π^0 decays involves three operations: the measurement of the yield of ^{0}'S (identified as photon pairs with correct invariant mass), a calculation of the single photon yield expected from π^0 decays seen by the detector (using the measured π^0 cross section) and the measurement of the single photon yield itself.

Applying this method the accurate knowledge of the shape of the energy response curve of the lead glass counter is essential because a single photon detected in the counter usually carries most of the energy of its parent π^0 (87% on the average) while photons from a resolved photon pair carry about half of the π^0 energy. Therefore we performed extensive studies on lead glass calibration, whose details are discussed in our subsequent paper /7/ .

In order to determine the inclusive π^0 spectrum we select a pure sample of $\pi^0 \rightarrow \gamma\gamma$ decays by the following selection criteria: we retain only "symmetric pairs" i.e. $\alpha = |E_1 - E_2|/(E_1 + E_2) < 0.5$ where E_i represents the measured energy of the photon. We require the distance between the photon impacts to be larger than 27 cm and the invariant mass m of the photon pair to lie within the range $50 < m < 200$ MeV/c^2 . When more than two clusters are detected in the lead glass array (in 8% of the cases) we take the pair with the highest total energy. The background due to wrong pairing is estimated from 3 cluster events to be less than 2%.

Photon conversions in the vacuum pipe and in the material of the SFM detector cause a loss of events which is estimated by Monte Carlo calculations tracking $e^{\pm}$ in the inhomogeneous SFM field to be of 15 ± 3%.

The resulting invariant cross sections are displayed in figure 1 (open cicles) together with the data of ref. 8 for π^+ (full circles) and π^- (crosses).

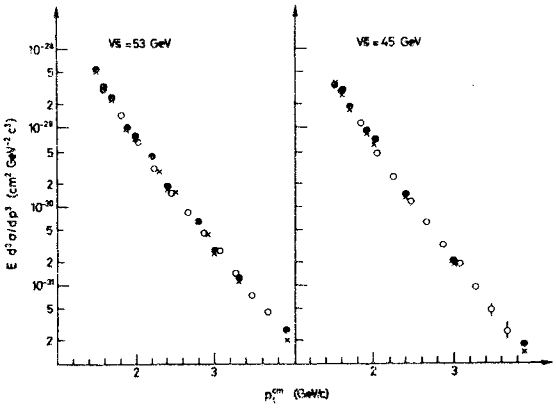

Fig.1

Our results are compatible with the assumption that the π^0 spectrum lies somewhere in between the π^+ and π^- ones.

Selecting single photons we retain those events where a cluster is detected in the lead glass array either alone or, in 2.8% of the cases, accompanied by additional cluster of less than 100 MeV energy. This requirement helps in selecting a pure sample but the loss of single photon events accompanied by an independent cluster must be corrected for. From the rate of occurence of asymmetric ($\alpha > 0.5$) photon pairs we expect this loss to be of the order of 8%.

We also correct for conversions in the material between the interaction region and the lead glass counter. They cause an event loss of 5 to 10% depending upon energy. We compared the observed and calculated fractions of events with a track detected in the SFM wire chambers and pointing to a cluster in the lead glass counter. Electrons and positrons are expected to contribute 1.5% each. In fact we observe 2% positive tracks but a larger fraction, 6% of negative tracks. We tentatively attribute the excess to antiprotons which may deposit much more than their kinetic energy when they annihilate in the lead glass. This brings up the question of the antineutron contamination, over which we have no direct control since antineutrons leave no track in the SFM wire chambers. For this reason we restrict the range of our analysis to momenta larger than $p_t^{cm} = 2.8$ GeV/c, above which value the contamination of $\bar{p}$ and $\bar{n}$ with $p_t^{lab} = 0.5$ GeV/c is negligible. In this high momentum range we calculate the combination of $\bar{n}$ to be about 11% of the whole single photon yield assuming that $\bar{p}$ and $\bar{n}$ are produced with the same cross section.

Radiative decays of particles other than π^0's also enrich the single photon sample. The largest contribution is expected from $\eta \to \gamma\gamma$ decays, for which the inclusive production cross section has been measured in previous experiments /1,2/ . By η decays we can explain 12-13% of the observed single photon spectrum. Radiative decays from other known particles, such as ω and η' , are expected to give negligible contribution due to their small branching ratios.

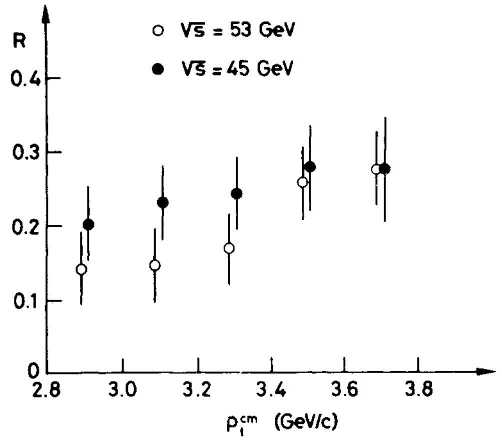

Fig.2.

The ratio between the single photon yield in excess to that from π^0 and η decays and the π^0 yield itself is displayed in figure 2 in the momentum interval 2.8 GeV/c $< p_t^{cm} <$ 3.8 GeV/c . It typically amounts to 20% for both values of $\sqrt{s}$. To quote an uncertainty on this number we separate that coming from the energy response curve, which amounts to ± 7%, from that coming from all other sources, including statistics, and which amounts to ± 6%.

While this is the first time that a copius production of single photons is mentioned in proton-proton collisions, it had previously been reported in a large p_t photoproduction experiment /9/ .

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