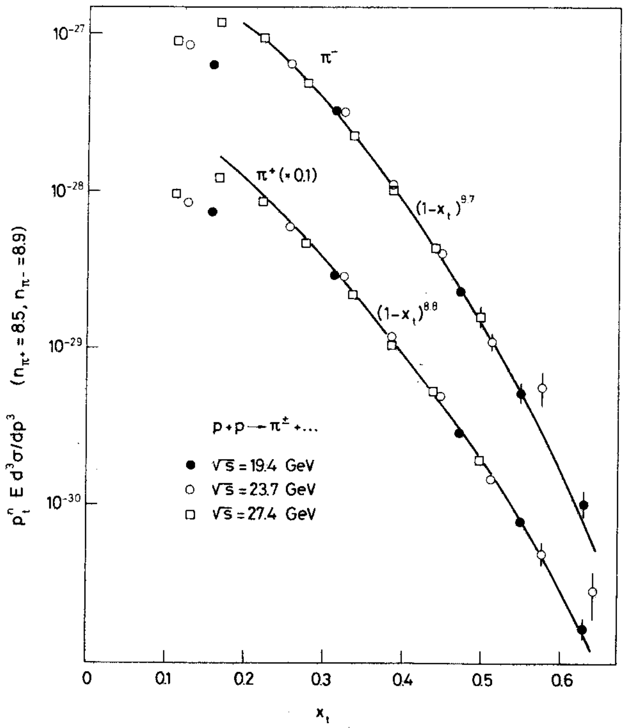

Fig. 8

In the scaling region $x_T > 0.3$ the data from the various energies all fall on the same curve. The results for the various final state particles are tabulated below together with the CIM predictions. The results are in general agreement with the CIM model.

	Data		CIM prediction	
Process	n	f	n	f
$pp \to \pi^+ X$	8.5	8.8	8	9
$pp \to \pi^- X$	8.9	9.3	8	9
$pp \to K^+ X$	8.4	8.8	8	9
$pp \to K^- X$	8.9	11.7	8	11,13
$pp \to p X$	11.7	6.8	12	5
$pp \to \bar{p} X$	11.9	8.0	12	11

Fit to $E d^3\sigma/dp^3 = A\, p_T^{-n} (1-x_T)^f$

References

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CORRELATIONS IN COLLISIONS WITH A HIGH-$p_\perp$ PARTICLE PRODUCED

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In order to study the mechanism responsible for the production of secondaries with large transverse momenta we have to analyse the high-$p_\perp$ collision as completely as possible. The Split Field Magnet detector (SFM) installed at the CERN Intersecting Storage Rings offers such a possibility for high-energy proton-proton collisions. In this review we will discuss the data obtained by three experimental groups which analysed collision at 26 + 26 GeV with a high transverse momentum secondary using the SFM detector.

The CERN group was dealing with the collisions in which a high-$p_\perp$ neutral pion was emitted at 90° c.m. production angle. The analysed sample contained ~ 8000 events [1].

The British-French-Scandinavian Collaboration [2] has studied events with a high-$p_\perp$ charged particle emitted also at 90° c.m. angle. This particle has been identified with a Cerenkov counter as being K, π or a proton. The data are preliminary. The sample analysed so far contains 38 000 events from which 8700 have a charged particle with the transverse momentum above 2 GeV/c.

The CERN-Collège de France-Heidelberg-Karlsruhe Collaboration [3] has presented the data based on about 270 000 events with a charged secondary of transverse momentum bigger than 2 GeV/c. The production angle of high-$p_\perp$ secondaries was equal to about 45° (80 000 events) and about 20° (190 000 events).

It has been found in all three experiments that whenever a high-$p_\perp$ particle is detected the probability to observe another particle(s) emitted roughly in the same direction increases. This is shown in fig. 1 where a clear peak in the rapidity distribution is observed at rapidities close to that of the high-$p_\perp$, triggering particle. In this figure are plotted only those particles which are emitted at azimuthal angles similar to that of the high-$p_\perp$ particle. In the same figure the rapidity distribution for normal events (without a high-$p_\perp$ secondary) is shown as a dashed curve.

The observed excess of secondary particles above the distribution for normal collisions increases with the transverse momentum of secondaries which is shown in fig. 2. It increases also with the transverse momentum of the high-$p_\perp$ particle what can be seen in fig. 3.

However the correlation for same charged particles is weaker than for different charges. This can be seen in fig. 4 where the average multiplicities of particles in the region around a high-$p_\perp$ particle are plotted for different charge combinations of the high-$p_\perp$ and low-$p_\perp$ particles. The average multiplicities are about twice as big for opposite charges than for the same ones. This effect depends weakly on the nature of a high-$p_\perp$ particle. Nevertheless there is an indication that for the same charge the multiplicity associated with a high-$p_\perp$ pion is higher than that associated with a high-$p_\perp$ kaon or a proton (antiproton). One of the possible explanation of this fact could be the Goldhaber effect.

Finally, the excess of particles in the region around the high-$p_\perp$ particle decreases with the increase in the rapidity of the high-$p_\perp$ particle. This is illustrated in fig. 5.

The excess of particles around a high-$p_\perp$ particle is often considered as a manifestation of a jet of hadrons originated, for example, in the hard scattering of two partons. We can then ask what is the distribution of the momentum component perpendicular to the jet axis. The corresponding data are shown in fig. 6. It can be seen that the transverse momentum distribution in respect to the jet axis is similar to that observed in ordinary soft hadron-hadron collisions as expected from the jet concept.

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However, we cannot exclude the possibility that the observed excess of particles flying roughly in the direction of the high-$p_\perp$ secondary is due to the resonance production. It may be that the observed high-$p_\perp$ particles are mostly the decay products of known (or unknown) resonances. The discussed SFM experiments show that resonances do exist at high-transverse momenta and a significant number of high-$p_\perp$ secondaries are the decay products of ρ or K (fig. 7).

So far we have discussed the emission of secondaries in roughly the same azimuthal direction as that of the high-$p_\perp$ particle. The SFM detector allows us to study particles in nearly 2π interval of the azimuthal angle. It has been found already before [4] that collisions with a high-$p_\perp$ secondaries exhibit a large excess of particles emitted at the azimuthal direction opposite to that of a high-$p_\perp$ particle (away direction). This effect has been confirmed and studied extensively by all three SFM experiments. In fig. 8 is shown the rapidity distribution of secondaries emitted in the away azimuthal direction. It can be seen that the excess of the multiplicity in this region covers a wide rapidity interval from −2.5 to 2.5. This excess increases with the transverse momentum of the high-$p_\perp$ particle and is equally strong for negative and positive secondaries. There is no clear dependence of the effect on the nature of the high-$p_\perp$ particle. An interesting question concerning the emission of particles in the azimuthal direction away from the trigger is, whether they form in each collision a collimated bunch of particles-jets. Such a behaviour is suggested by the hard-scattering picture. The data presented by the three experiments discussed here suggest the existence of the correlated groups of particle which balance the most of the transverse momentum of the triggering particles.

In fig. 9 we see a clear demonstration of the short range correlation. Whenever a particle is detected in the "away" direction other particle tend to follow it. The similar correlation is shown in fig. 10. The distribution of the rapidity difference Δy exhibits a maximum at $\Delta y = 0$ which is much stronger than expected for the uncorrelated emission. This correlation is bigger for the high-$p_\perp$ collisions than for normal events. It is also bigger for secondaries with high transverse momenta (see fig. 11).

From the above discussion we see that the jet concept is supported by the data, however, the final proof of the existence of jets remains to be given.

The experimental data show that the higher is the transverse momentum of a triggering particle more numerous are the high-$p_\perp$ particle in the away direction. We can verify whether this effect exhibits a scaling behaviour [5] in the reduced transverse momentum, $x = p_x/p_\perp^t$. The quantity p_x stands here for the transverse momentum component parallel to the transverse momentum of the triggering high-$p_\perp$ particle, $p_\perp^t$. The distribution of the number of particles versus x is shown in fig. 12 for three intervals of $p_\perp^t$. The lack of scaling is evident. However, the lack of scaling in variable x does not mean necessarily the lack of scaling in the longitudinal reduced momentum in jets. This is because the emission angles of away jets covers a wide interval around 90° and often the x variable differs strongly from the longitudinal reduced momentum in jets.

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[3] CERN-Collège de France-Heidelberg-Karlsruhe Collaboration, papers A4-127 and A4-129 submitted to this conference.

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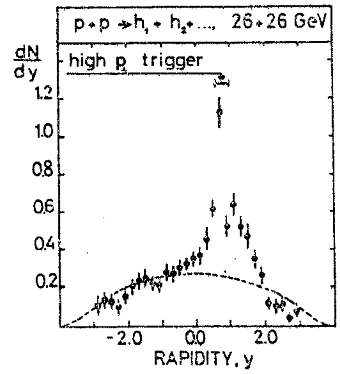

Fig. 1 The rapidity distribution of negative secondaries produced in events triggered on a large $p_\perp$ particle of positive charge with $\theta \sim 45^\circ$ and $p_\perp > 2.0$ GeV/c. Only secondaries are entered in the histogram being near in azimuth to the triggering particle, $\Delta\phi = \pm 25^\circ$, and having a transverse momenta $0.5 < p_\perp < 1.0$ GeV/c. The full line represents the equivalent distribution for normal events [3].

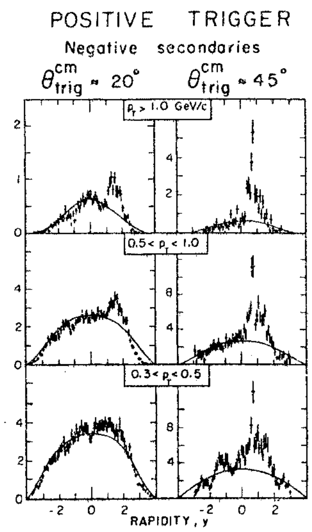

Fig. 2 The same distributions as shown in fig. 1 plotted for different intervals of the transverse momenta of secondaries and for two values of the emission angle of the high-$p_\perp$ particle [3].

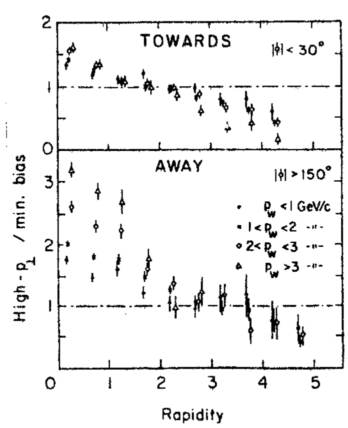

Fig. 3 The ratio of the rapidity distributions for high-$p_\perp$ events to

that for normal (minimum bias) events for the different values of the transverse momenta of a high-$p_\perp$ particle, p_W. The high-$p_\perp$ particles is emitted at $\phi = 0$ [2].

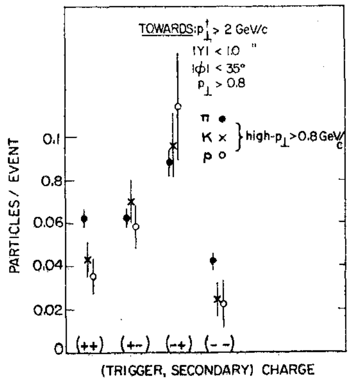

Fig. 4 The average number of secondaries with $p_\perp > 0.8$ GeV/c emitted around the high-$p_\perp$ particle for four combinations of the charges of the high-$p_\perp$ particle and a secondary [2].

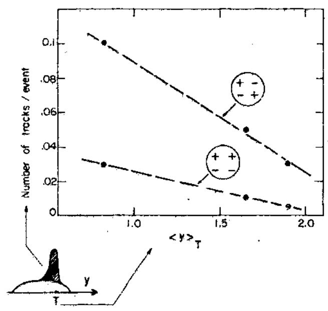

Fig. 5 The increase of charged multiplicity with respect to normal events in the azimuthal angle region "towards" trigger as a function of the rapidity of the large $p_\perp$ triggering particle. Points on lower line refer to secondaries of the same as the trigger, on upper to those of opposite charge [3].

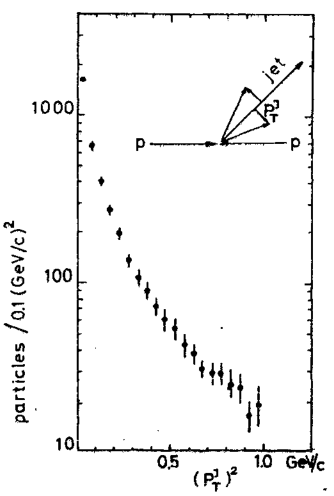

Fig. 6 The transverse momentum squared distribution with respect to the jet axis of particles forming a jet, containing the triggering large $p_\perp$ particle [3].

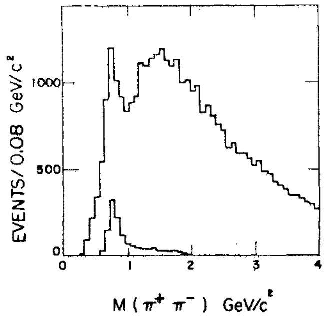

Fig. 7 $\pi^+\pi^-$ invariant mass distribution. The π^- is the high-$p_\perp$ triggering particle emitted at 20° and identified by a Čerenkov counter ($p_\perp(\pi^-) > 1.5$ GeV/c). An estimation of the ρ^0 signal corresponding to $\rho^0/\pi^- = 1.2$ is shown.

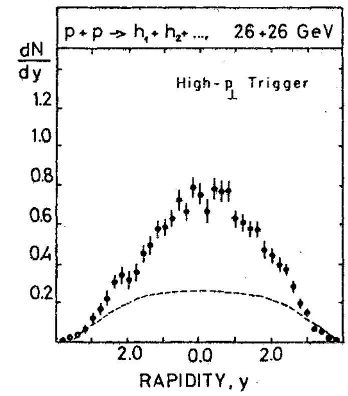

Fig. 8 Same as fig. 1, but for secondaries in the azimuthal angle region away from the trigger, $140° < \phi < 220°$ [3].

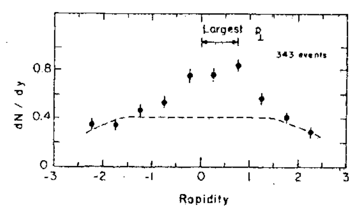

Fig. 9 The rapidity distribution of charged particles away from the 90° high-$p_\perp$ π^0 trigger when the fastest away particle not included in the plot has $p_x > 1.2$ GeV/c and $0 < y < 0.75$ [1].

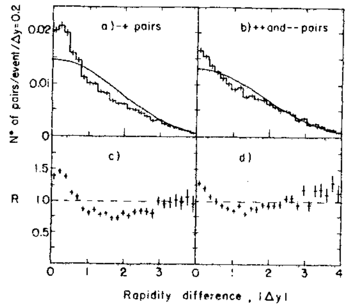

Fig. 10 The distribution of the rapidity difference of pairs of particles (a) with opposite charge and (b) with same charge produced in

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].

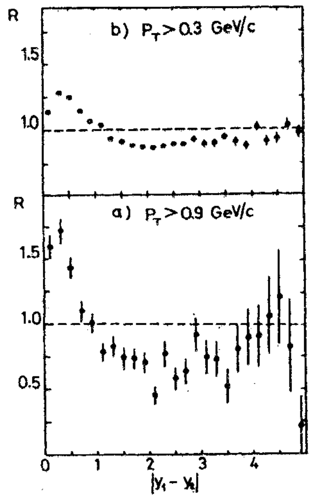

Fig. 11 Normalized rapidity difference for secondaries of opposite charge with $p_\perp > 0.3$ GeV/c (fig. 11 (a)) and $p_\perp > 0.9$ GeV/c (fig. 11 (b)) [3].

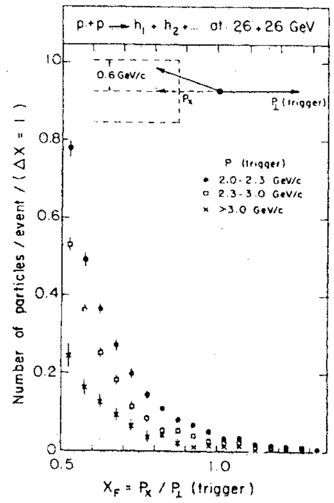

Fig. 12 The distribution of the number of secondaries per event emitted in the away direction versus the reduced transverse momentum $X = p_\perp/p_\perp^t$. Three sets of points correspond to three values of the transverse momentum of the triggering particle. Only particles with the momentum component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