2.5 JETS AND MASSIVE DILEPTONS AT LARGE p_T

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We have investigated the possibility of studying massive dileptons recoiling against large p_T hadron jets. While experiments of this type are of general theoretical interest, the experimental problems are formidable. The physics involved in the production of dileptons at large p_T is very similar to that discussed above for direct photons at large p_T and has been discussed by several authors.[1-4] Additional interest arises from the possibility of observing large p_T J/ψ's recoiling against jets.[5] Common to these authors' discussions is the desirability of studying the correlation of the jets and dimuons.

Experiments have been performed at Fermilab, ISR, and SPS which show a rather large $\langle p_T \rangle$ for massive dimuons.[5-9] Studying both the dilepton and the jet are possible at the Tevatron because of the increased rates at some moderate mass and p_T, say $M = 4$ and $p_T = 4$. The distinct advantage of the Tevatron is the variation of incident beams which can probe different production mechanisms and hadron structure functions.

We have considered experiments with either dimuons or dielectrons in the final state opposite high p_T jets.

Dimuons

We considered an open geometry with a large solid-angle calorimeter (e.g., E-609 or E-557) augmented by a downstream muon spectrometer as sketched in Fig. 1. The background from pion decay is enormous. Our crude estimate indicates that there will be approximately 5×10^5 dijet events (of which some $\lesssim 1\%$ will contain dimuons from π decay) for every dimuon event at a given p_T; however, it is possible that with a sophisticated trigger processor which required massive dimuons at large p_T and a veto on the same side jet that a signal might be observable.

We also considered a half-closed geometry as shown in Fig. 2. This geometry has the advantage of reducing the pion decay background. This geometry, however, has a greatly reduced acceptance for the dimuons, and because half of the detector is open for jet observation, it is not possible to increase the flux by large factors to overcome the acceptance loss. Another drawback occurs due to multiple scattering. This may not be a serious effect depending on the absorber and particular spectrometer arrangement.

There is an inherent incompatibility in the relatively large magnetic field required for good muon mass resolution and the relative small magnetic field required to reduce smearing of the jet p_T; perhaps a compromise can be achieved.

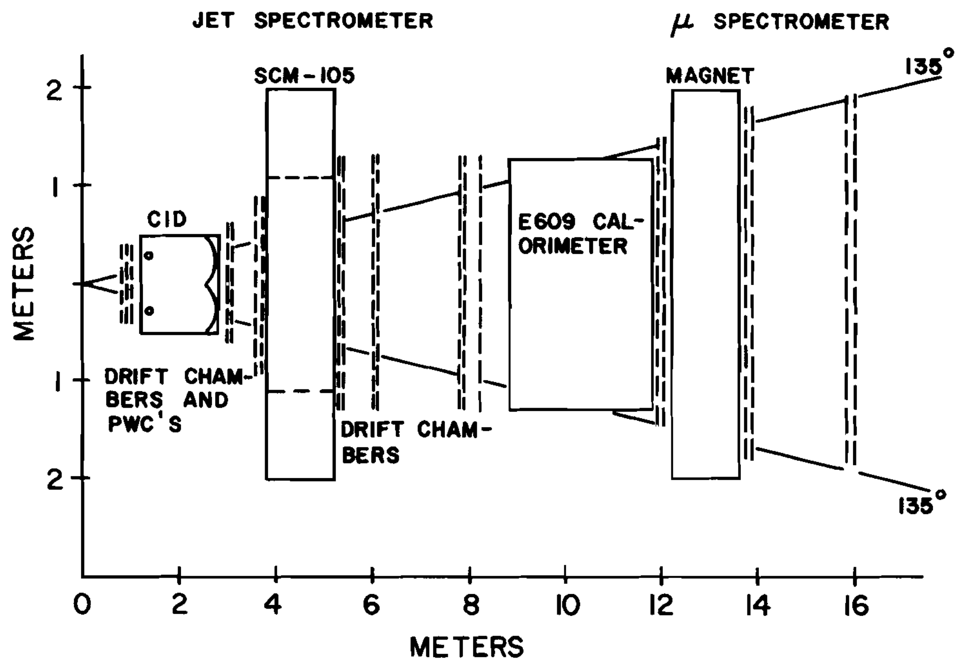

Fig. 1. Open geometry for detection of dimuons and jets.

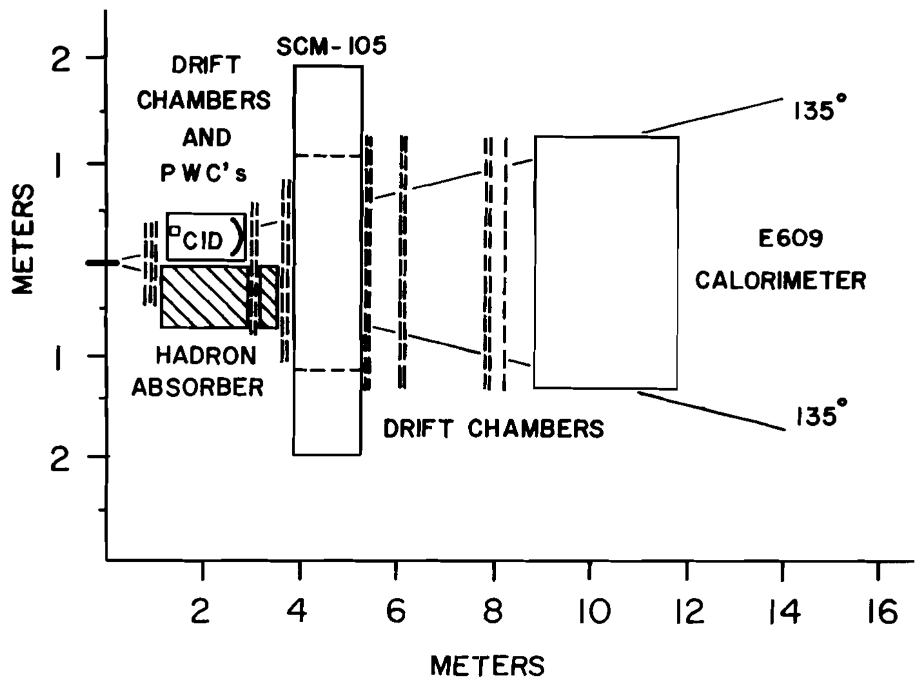

Fig. 2. "Half closed geometry" for detection of dimuons and jets.

The trigger for this experiment will still require a large p_T jet on one side along with mass requirement on the dimuons.

Dielectrons

For studying massive dielectrons at high p_T we have considered a geometry of the type shown in Fig. 3. Backgrounds of a different variety are inherent in electron-triggered experiments. The primary backgrounds are from hadrons simulating electrons in the electromagnetic detector and from the Dalitz decays and externally converted electromagnetic decays of π^0, $\eta, \eta, \ldots$

The signal at a given p_T is again approximately one part in 5×10^5 of the dijet cross section. The probability for π^0 conversion or for hadron simulation of electrons is about 1% each, and the probability for two such background electron "signals" is of the order of 10^{-3}. Consequently, a further rejection factor on the order of 10^3 is required in the trigger by requiring massive dielectrons at large p_T and the absence of a second high p_T jet. We remark, with guarded optimism, that such a trigger may be feasible but a detailed study would be required.

Finally, we show in Fig. 4 predicted rates in a high p_T dilepton trigger compared to the expected rates for a direct photon experiment. The rate calculations are based on a typical run of 100 hrs. with a flux of 10^7/s incident on 0.45 cm LH2 target.

We observe (as does McLeod in Section 2.5) that an apparatus of the type shown in Fig. 3 could simultaneously measure high p_T jets, direct photons, and jets, and perhaps dielectrons and jets.

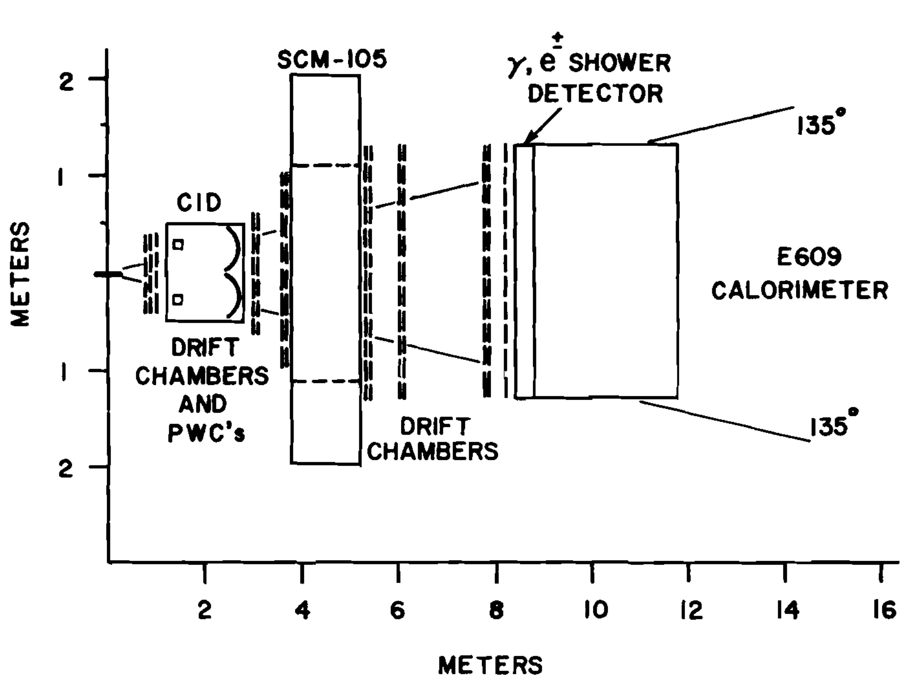

Fig. 3. Detector for study of dielectrons and high p_T jets.

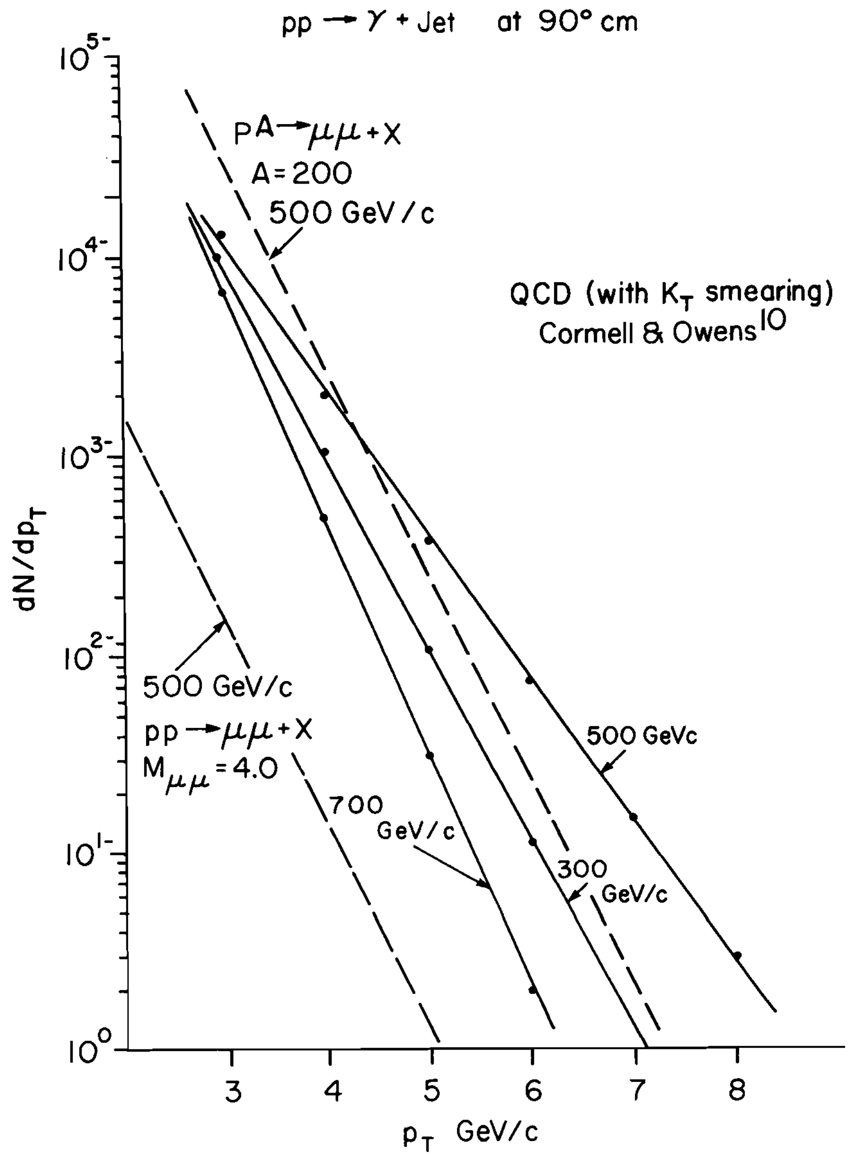

Fig. 4. Predicted rates for massive dimuons at large p_T compared with the predicted rates of direct photons and jets at p_{beams} = 500 GeV/c[10]. The rates are based on a run of 100 hrs at 10^7 proton/sec incident on a 10% target.

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