A SUGGESTED DETECTOR

S. Yellin

Abstract

A conceptual detector to measure $e^+e^- \rightarrow (\mu^+\mu^-, e^+e^-, \gamma\gamma$ and hadrons) is described. Drift chambers are used for high spatial resolution. An inner lead-scintillator sandwich provides an e - γ detector. A toroidally magnetized iron-scintillator sandwich absorbs and measures hadrons calorimetrically and deflects muons for detection in an outer system of chambers.

The apparatus is designed to measure a) the cross section and charge asymmetry of $e^+e^- \rightarrow \mu^+\mu^-$ down to an angle of 15°, b) the cross section for $e^+e^- \rightarrow e^+e^-$ or $\gamma\gamma$, c) the total cross section.

A particle moving out of the beam pipe from the interaction region passes through at least 25 cm of drift chambers and scintillators. Assuming the drift chambers measure position to within a standard deviation of 0.3 mm and are 20 cm apart, angles are measured to 2 mr. After leaving the drift chamber-scintillator region, the particle enters a roughly 15 X_0 lead-scintillator shower counter. The total energy of electrons and photons would be measured to $\sigma_E / E = 0.1/\sqrt{E\,(GeV)}$ The phototubes viewing the shower would be pulse height analyzed separately for several depths in order to get an idea of the shower development and thereby better distinguish hadrons.

Hadrons and muons pass through the shower counter (.45 absorbtion lengths) into a 150 ton iron-scintillator calorimeter. The particle trajectories head through at least one meter of material, of which at least 75 cm (4.4 absorbtion lengths) is iron. Muons with energy under 900 MeV from $e^+e^- \rightarrow e^+e^-\mu^+\mu^-$ and nearly all hadrons will be absorbed by the approximately 5 absorbtion lengths of material. The calorimeter will be able to measure the total energy of the hadronic system to 30%. The phototubes for the calorimeter and shower counter come out parallel to the beam pipe on both electron and positron sides of the apparatus. This arrangement permits some azimuthal hodoscoping.

The iron is toroidally magnetized in order to momentum analyze muons. Multiple scattering in the iron is about 6.5 mr for 15 GeV muons, while a magnetic field averaging 12 KG over 1 meter would deflect a 15 GeV trajectory by 27 mr = 4.1 x multiple scattering error. This ratio between magnetic deflection and multiple scattering is energy independent.

Particles passing all the way through the iron go through another scintillator-drift chamber system. The magnetic field causes a displacement of tracks by at least 13 mm perpendicular to the initial direction; so the momentum can be measured adequately by a single drift chamber with a resolution of 2 mm. But a system of two such drift chambers 50 cm apart would also measure the direction of the outgoing particles accurate to within the effects of multiple scattering. Then the apparatus as pictured would be 5 meters wide and high instead of 4. In any case, two drift chambers are needed to measure and combat inefficiencies. Triggers are as follows:

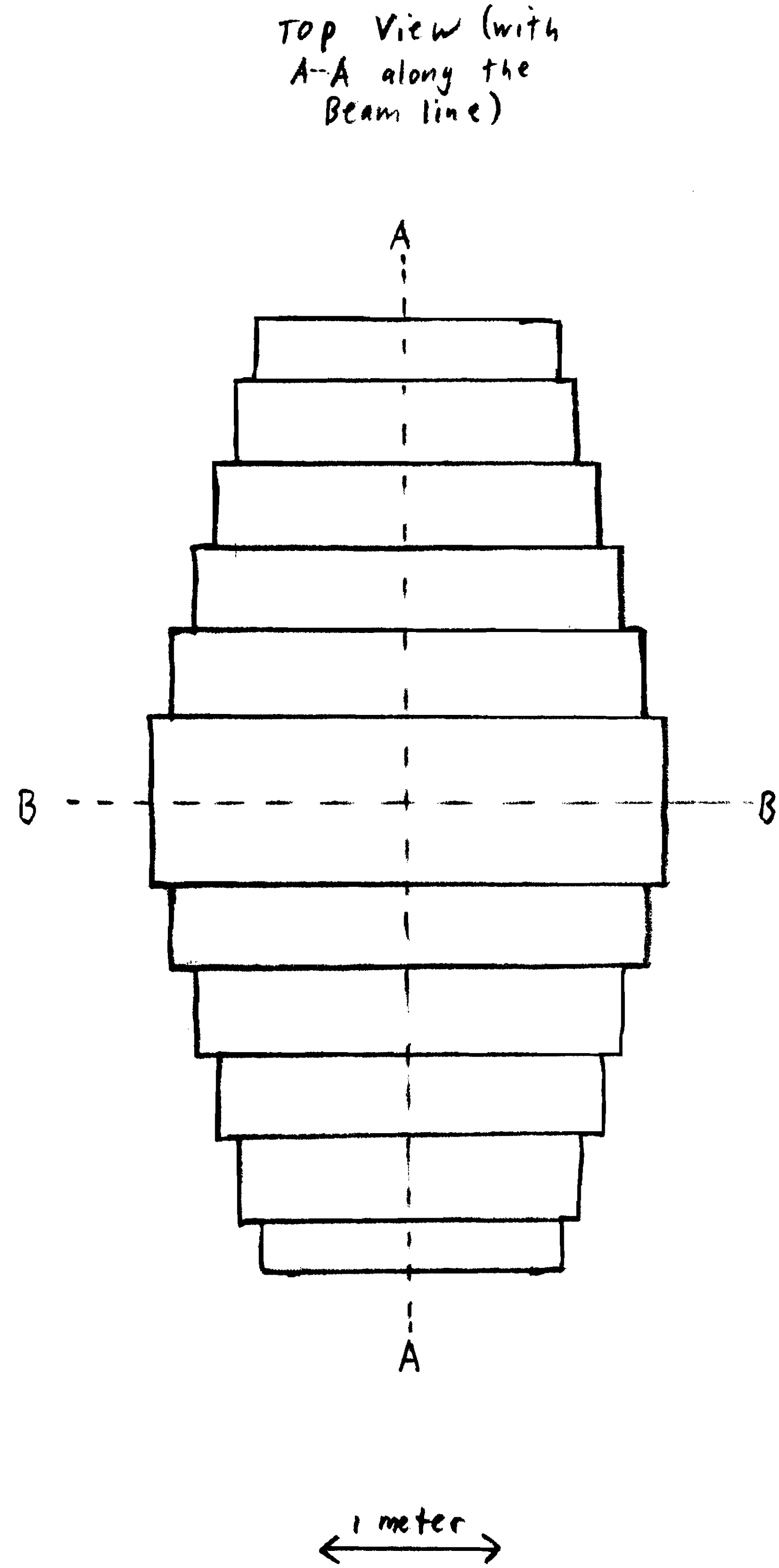
a) For $\mu^+\mu^-$ we demand in two opposite quadrants of the apparatus a signal in the shower counter and calorimeter, a signal in the inner and outer scintillators with timing such as to exclude cosmic rays, and no large signals in any calorimeter or lead-scintillator shower counter. The four-fold symmetry of the apparatus suppresses biases in the measurement of cos 2ϕ and sin 2ϕ terms in the muon angular distribution.

b) For $e^+e^- \rightarrow e^+e^-$ or $\gamma\gamma$ we demand large signals in the lead-scintillator shower counters in each of two opposite quadrants and no large signal in any other shower counter or in the calorimeter. We also demand that the corresponding inner scintillators fired for e^+e^- or did not fire for $\gamma\gamma$.

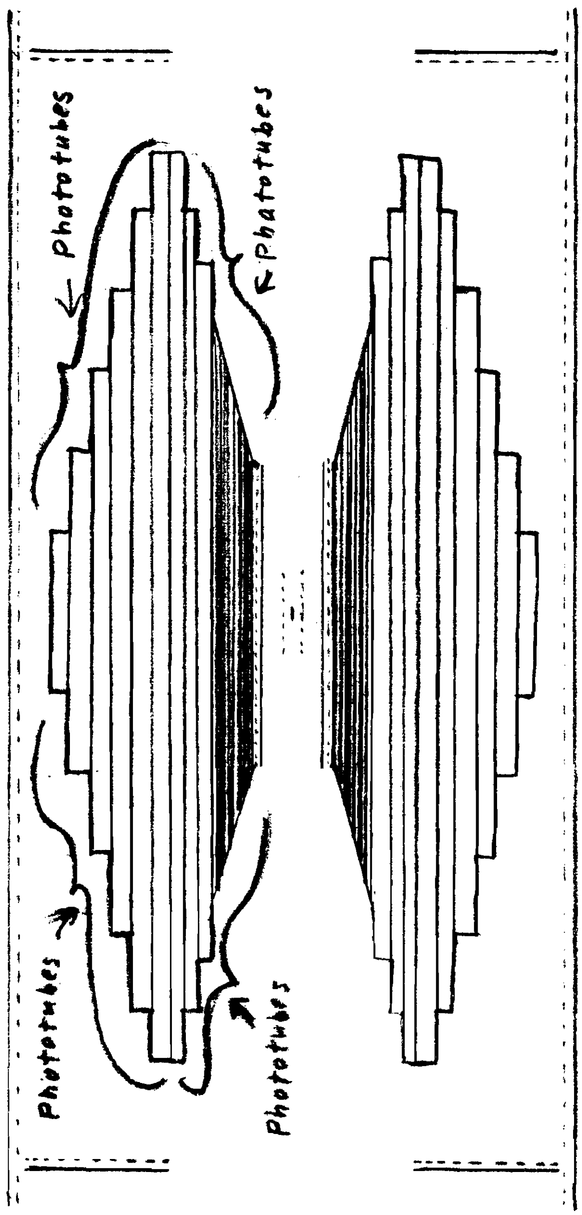
c) For the total cross section we demand a large total energy be deposited in the shower counters and calorimeter. Off-line analysis is then needed to distinguish the hadronic from purely electromagnetic events.

End caps can be placed on the two ends of this apparatus to allow the possibility of small angle calorimetry and/or electromagnetic detection, including tagging. A luminosity monitor is required.

The device shown represents a concept, not a proposal. For more details on how to do a total cross section measurement by calorimetry, see the writeup by the corresponding group at this summer study.


Top View (with
A--A along the
Beam line)
A
B
B
A
1 meter

Cut A---A



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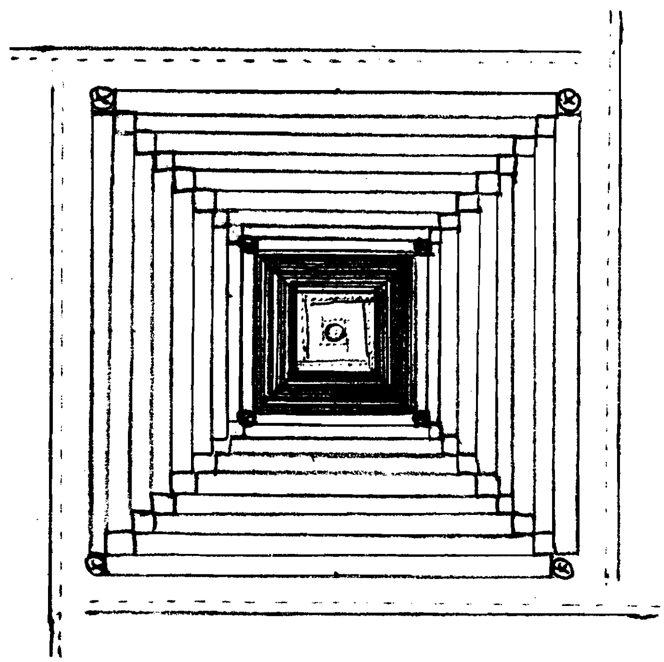

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