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Comment on an unusual event in the E594 detector
from the direction of Cygnus X-3.

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M.C. Goodman
Argonne National Laboratory
Argonne, Ill. 60439

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A small array located near the 80 m² E594 neutrino detector at Fermilab had a two week run. I would like to make two comments related to ultra high energy gamma ray physics.

The first regards the question of angular resolution from muons. A not atypical event from the run is shown in Fig. 1. This event includes a hadronic, electromagnetic and muonic component. Three muons are seen in the bottom view which traverse from the top of the detector to the bottom. For a muon traversing from the front to the back of the detector, the geometrical resolution, σ_0 is 1 mr. The actual achieved resolution for these muons was 1.5 mr. The geometrical resolution for typical cosmic ray muons, which enter at an angle from 20 to 50 degrees is 3 mr.

In general, the angle of a muon will not reflect the angle of the shower for reasons which include transverse momentum at production, multiple scattering in the atmosphere, multiple scattering in the detector and detector angular resolution. In multiple muon events, the angle between each muon and the average muon angle samples all of these deviations. Therefore this is a good measure of the angular resolution of the shower using the muons on an event by event basis. This measured angular resolution, in the E594 detector is 13.4 mr, or about .7°. The sample that went into that measurement is as follows: The trigger was two .6 m² counters about 6 m apart. Twenty percent of the events had analyzable multi-muons, ranging from 3 to 78 muons. The distribution of muon angle deviations had about 400 events and 4000 entries. A small non-gaussian tail was cut out (< 1%).

Good angular resolution is not considered important for proton and nuclei induced showers which probably cause the high muon events. Photon showers are generally expected to be muon poor. However some of the fine good angular resolution shower arrays could be calibrated using the muons from our detector with a two day run. I invited anyone who wants to calibrate their shower array to contact me.

The second comment regards an unusual event from Cygnus X-3. The angular resolution of our 14 element array was about 5°, so we looked at the events in a 10° box around the direction of Cygnus X-3. The phase diagram is shown in Fig. 2. The background is not expected to be flat for a two-week run, but the plot is featureless anyway. All 77 events in the plot were examined for evidence of a photon induced shower, which might have an electromagnetic part, but an absence of hadronic and muon components. No such events were found, which indicates the ability to reject such events of at least 77 to 1. All 77 events were also scanned for any unusual features, because unusual physics may

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be involved in explaining the Kiel results and underground muon reports. One event was considered unusual. It has one clear hadron shower, one good muon, and four examples of a vertex with non-showering penetrating tracks. The event was considered unusual by three physicists who are familiar with looking at such events. It is shown in Fig. 3. The full path length for the muon was at least 660 gm/cm^2 . The event is possibly suggestive of particles with a low cross section. It also may indicate nuclear breakup without beam fragmentation. It occurs at a phase of .747, which is within the peaks in the phase distributions of Nusex and Soudan I, although not any of the photon induced showers. Based on the flux of photons presented at this conference, 0.5 events are expected. Fifteen events of an unknown and probably low trigger efficiency would be expected based on the Soudan I result.

RUN 6020 EVENT NO. 44 CHAMBERS 1 - 608

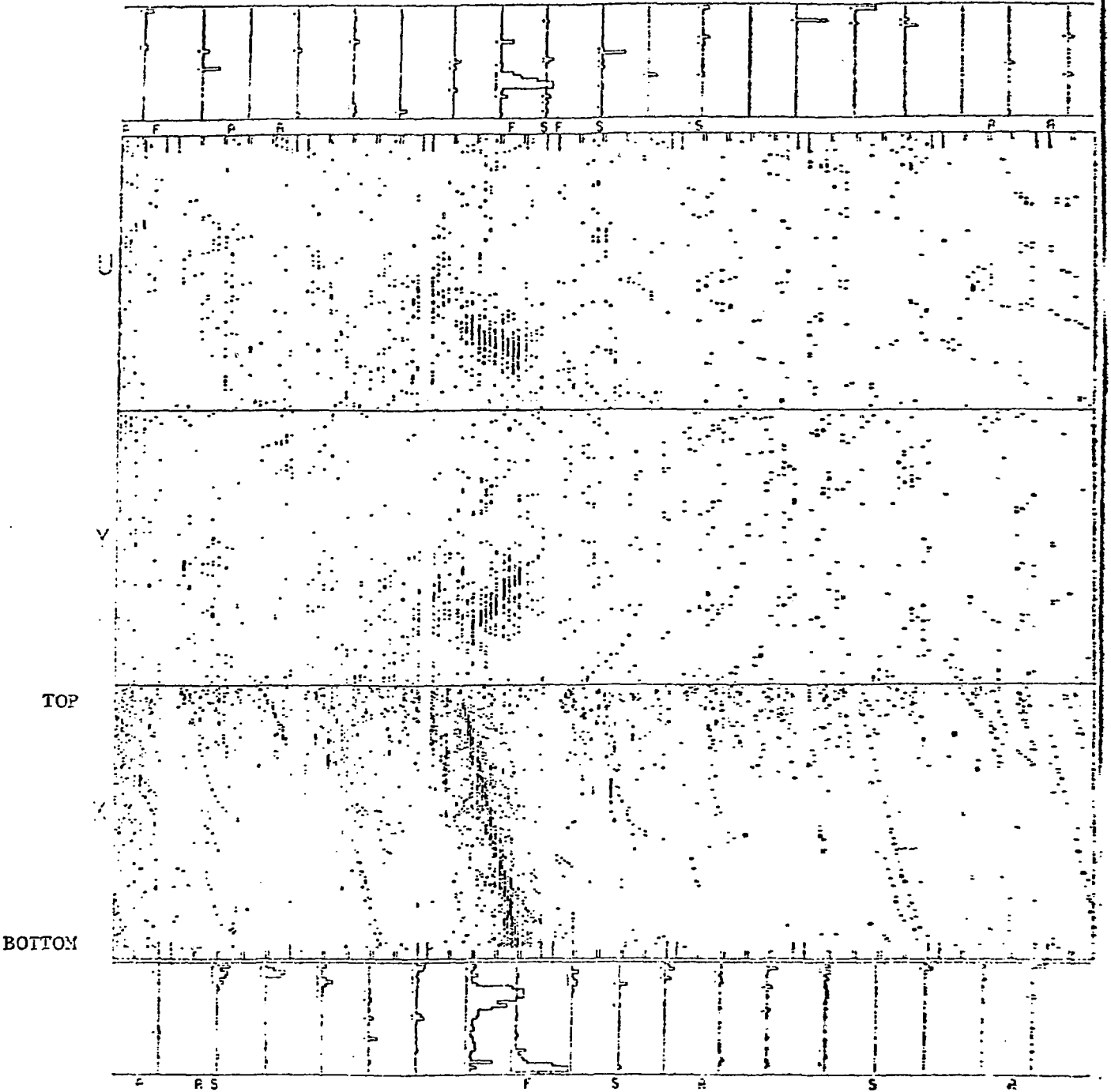


Fig. 1. Event with Electromagnetic Shower, Three Muons and One Hadron

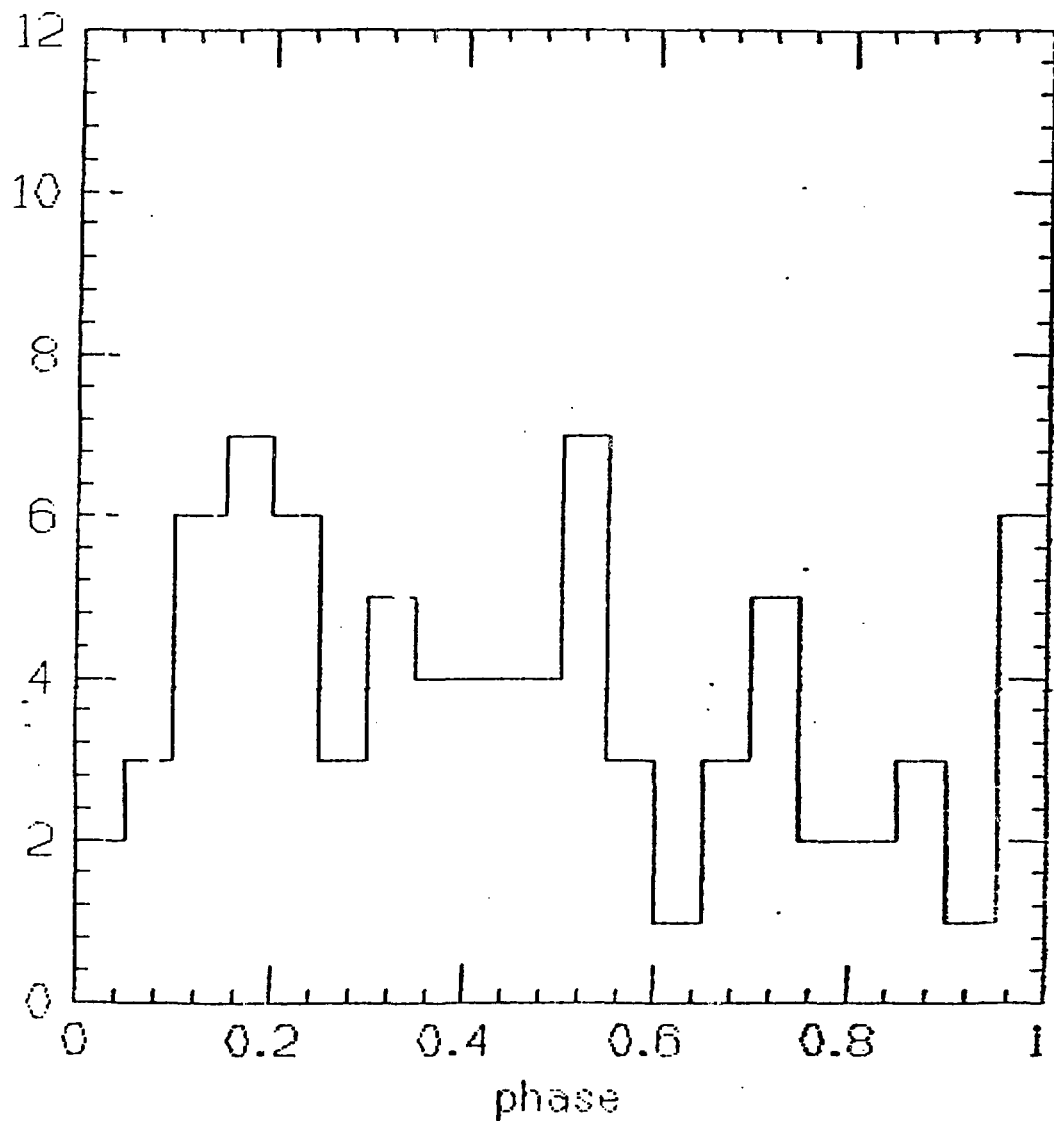


Fig. 2. Phase Diagram of 77 Events in a 10° box around the Direction of Cygnus of X3 from the E594 Detector

RUN 6686 EVENT 366
HITTOT= 9322
PHT: MAX= 8192 SUM= 21911 HBT= 19151

$\phi = .747$

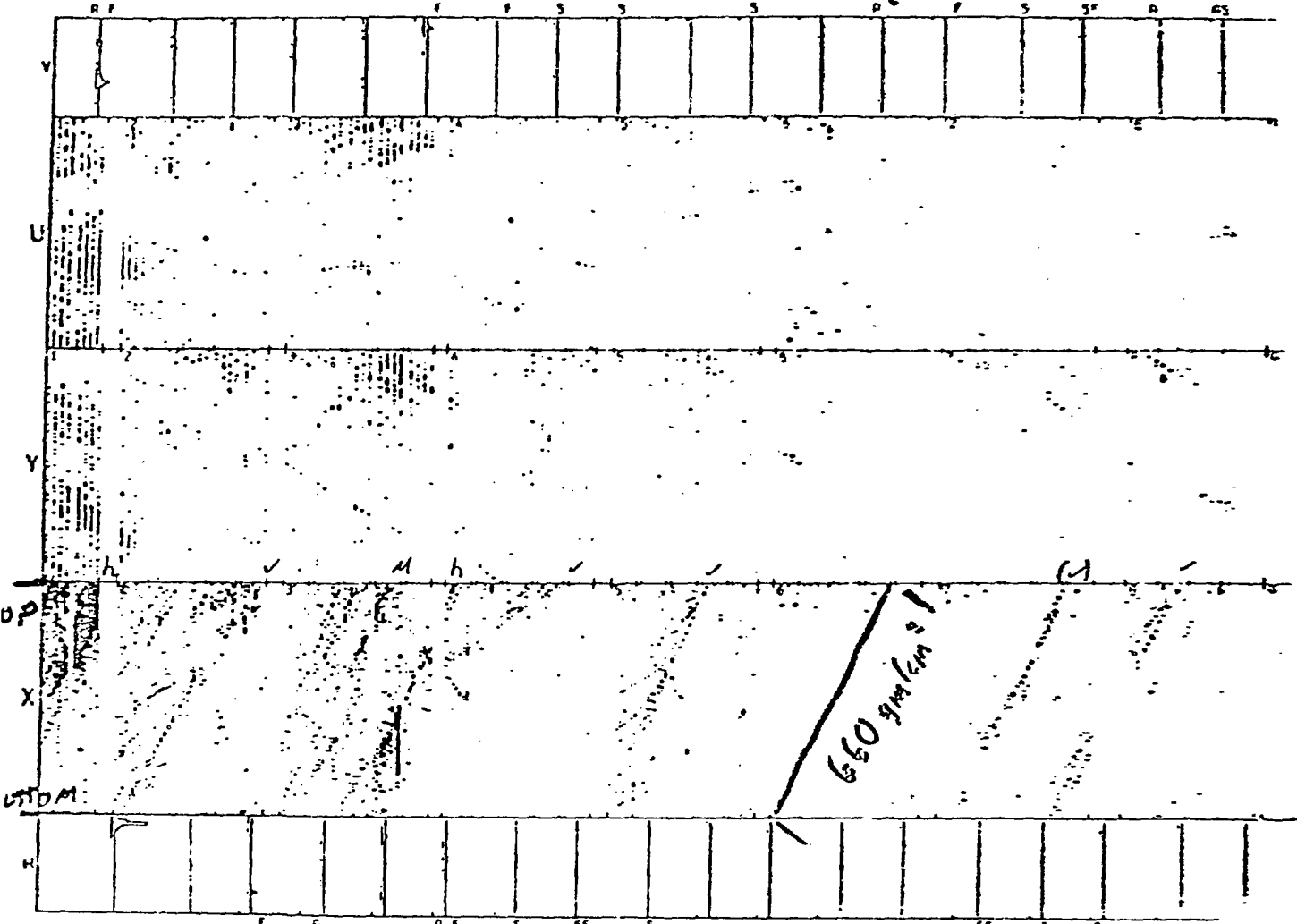


Fig. 3. One Unusual Event from the Direction of Cygnus X-3

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