NAL PROPOSAL # 230

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# A Search for "Schein Events" and Events with a High Multiplicity of $\gamma$'s

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## Abstract

Cosmic ray emulsion experiments by Schein et al. and by other groups have periodically found events which showed a large number of high-energy $\gamma$'s which were not accompanied by charged particles. Ruderman and Zwanziger have suggested that these events could come from the annihilation of a magnetic monopole and an antimonopole. T.D. Lee has pointed out they could arise from other processes such as the annihilation of high-Z lepton pairs. In any case, it would be most interesting to search for such phenomena at NAL energies.

We propose to use wide-gap spark chambers which are already set up in a small-angle neutral beam for these studies. Essentially all we require are a few shifts of beam time. Production by neutrons and $\gamma$'s would be studied. We note that in one beam pulse our target will be exposed to many more particles with energies > 100 GeV than the emulsion in which the first "Schein event" was discovered.

Physics Justification

In 1954 Schein, Haskin, and Glasser[1] reported the observation of a narrow shower apparently containing ~20 photons without any charged particles. The event was found in an emulsion stack flown for six hours at an altitude >100,000 feet. The total energy of the $\gamma$'s was very crudely estimated as $\geqslant$ 50 GeV. Two similar events were later reported by deBenedetti et al.[2] It appears very difficult to explain these events by conventional shower theory. In 1969 Ruderman and Zwanziger[3] suggested that magnetic monopoles would most likely be produced as bound pole-antipole pairs because of their strong, long-range interaction. The bound state would then be expected to annihilate with the production of many gammas. They suggested that the "Schein events" might be due to this process. T.D. Lee has also suggested that the events could be due to other processes such as the creation and annihilation of high-Z lepton pairs.

More recently, Yuan et al.[4] have observed a surprisingly large rate for the production of multigamma events (with $\gamma$ multiplicities as high as 16) in p-p collisions at the ISR.

Whatever their source, the "Schein events" emphasize that there could be some highly important physics to be found in the terra incognita of multiple gamma production at very high energies. Beam energies available at NAL are high enough to make such studies of great interest. Furthermore, with one beam pulse we could expose a target in a neutral beam to ~100 times as many particles (with energies > 100 GeV) as the emulsion

in which the first Schein event was found.

We note that the use of a neutral beam has significant advantages over a charged beam. In particular:

(1) with a neutral beam it is possible to use considerably higher beam intensities without being confused by accidental beam tracks in the chambers.

(2) by removing the lead filters we normally use to filter out gammas in our beam it is possible to look at the production of multigamma events by high-energy gammas.

The proposed experiment is strictly exploratory in nature. Thus the fact that the energy of the incident particle is not well known is not a serious handicap. We would propose to use a high Z target (e.g. - lead) and a low Z target (e.g. - $CH_2$). The targets would be exposed to a "pure" neutron beam and a mixed neutron-gamma beam.

The experiment we propose has some relevance to the monopole search of Collins et al. (E-22). However we emphasize that we have a much more modest experiment in mind. Our experiment might be considered a trial run for E-22. In this vein we shall be happy to share our results with Collins et al. The information obtained should allow a much more effective design for E-22 with significant savings in beam time.

Experimental Arrangement

Wide-gap chambers seem a natural choice for this experiment because of their potential for high multitrack efficiency. Since events with ~100 tracks may be expected this is obviously of paramount importance. We have already made fairly extensive tests to establish the best parameters for good multitrack

performance (see below), but somewhat more testing will be required.

The proposed experimental arrangement is shown in Figure 1. The wide-gap chambers are already set up in the beam, and most of the triggering counters are in place. The triggering arrangement is fairly flexible. The sort of events we are looking for are those with a neutral particle coming into the target, no (or at most several) charged particles coming out, and many charged particles coming out of the lead. Preliminary tests with a simple triggering arrangement of the sort required are encouraging.

The most "Schein-like" event observed so far (in a total of about 40 minutes of running with very poor beam) is shown in Figure 2. The geometry and running conditions are described in the caption. The target (about 5 cm of lucite) was in the 1 mr. neutral beam about 15 m upstream of the chambers. In this event there are no charged particles within a cone of about ±2° from the target and perhaps 6 $\gamma$'s materializing in the lead (about 3 rad. lengths thick for this picture).

As mentioned previously, we believe that the multitrack efficiency of the chambers is adequate. Our original reason for setting up the chambers in the beam was to study their efficiency for events with a high multiplicity of tracks. Similar chambers were used by Jones et al.[5] in cosmic ray experiments at Mt. Evans, so our group has considerable expertise with wide-gap chambers. Our tests at NAL show that if the chambers are driven hard (i.e. high voltage, large capacitance) and a large aperture used on the camera, good

efficiency can be obtained even with ~100 tracks. However, careful control of the chamber running conditions is required, and somewhat more testing will be needed. Figure 3 shows a high multiplicity event. Note that in the side view it is hard to even count the number of tracks. In the projected view (taken through the mesh electrode of the last chamber), it will be possible to count the tracks and measure their distance from the beam with good accuracy.

The goals of this experiment are clearly exploratory. We believe we could, with a very modest investment in running time, settle the question of the Schein events — at least to the extent that they can be studied at 300 GeV. We also hope to look for anomalies such as events with a very high multiplicity of $\gamma$'s which could signal the annihilation or decay of massive new particles.

Perhaps the major technical problem with the experiment is the fact that wide-gap chambers, because of their propensity for generating "noise", do not make good neighbors. We have done a lot of work to minimize inteference with adjacent experiments and probably succeeded in reducing the noise to a tolerable level. However there is a natural tendency on the part of other experimenters to worry that the firing of the chambers might generate "quarks" or other anomalies in their data. We therefore need some official status to allow us to take further measures to suppress noise and to encourage neighbors to determine conclusively if it is detrimental to their experiment and, if so, to cooperate in eliminating the problem. In the unlikely event that completely

compatible running is not possible we would make every effort to operate the chambers when they would be least disruptive.

Our minimum running time requirements are the following:

(1) approximately 6 periods of one hour each to tune up the chambers.

(2) approximately 4 periods of one shift each for data taking.

If compatible running with other experiments is possible, we could use more time; doubling the above numbers would be desirable.

During the above running the calorimeter for Experiment 4-I would be moved out of the beam. We believe the wide-gap chamber setup is physically compatible with Experiment 27 (Rosen), or can easily be made compatible. The total material in the beam in our apparatus is $\approx 12$ gm/cm$^2$. This should allow E-27 to use the beam when we are running. It is fairly easy to move our chambers out of the beam entirely.

Apparatus

No significant apparatus is required from NAL. We would, at most, request several NIM modules from PREP, but could get along without them.

The apparatus is essentially complete, in place, and working. Personnel for this experiment would be generally the same as those involved in Experiment 4-I, but, since little additional effort is required we anticipate no difficulty manning both experiments.

## References


1. M. Schein, D. Haskin, and R. Glasser, Phys. Rev. 95, 855 (1954), and 99, 643 (1955).
2. A. deBenedetti et al., Nuovo Cimento 12, 954 (1954), and 2, 220 (1955).
3. M. Ruderman and D. Zwanziger, Phys. Rev. Letters 22, 146 (1969).
4. L. Yuan et al., submitted to the Vanderbilt Conference on New Results from Experiments on High Energy Particle Collisions, March 1973.
5. L.W. Jones et al., Nucl. Phys. B43, 477 (1972).

## Figure Captions

1. Plan view of experimental arrangement as it now exists in Beam M-3. The chambers are approximately 1 m square, each with two 15 cm gaps. The total material in the beam is approximately 12 $gm/cm^2$ so most of the beam passes through and can be used by E-27 for tuning.
2. A "Schein-like" event with no charged particles and about 6 $\gamma$'s. On the left are the side views of the 4 chamber gaps. Between the second and third gaps are 3 rad. lengths of lead and the trigger counters. At the right is a projected view of the fourth gap (as seen looking toward the accelerator) viewed through the mesh electrode. The "blotches" seen in the projected view are due to reflections off the aluminum center electrode. These have now been eliminated by blackening it.
3. An event with many tracks (~100) in gaps 3 and 4. The conditions are as in Fig. 2. As mentioned above, the blotches in the projected view have now been eliminated; this will make recognition of $e^+e^-$ pairs much easier. The lead will be reduced in thickness to approximately one rad. length so that the showers will normally be much less spectacular. (The original negatives are much clearer.)

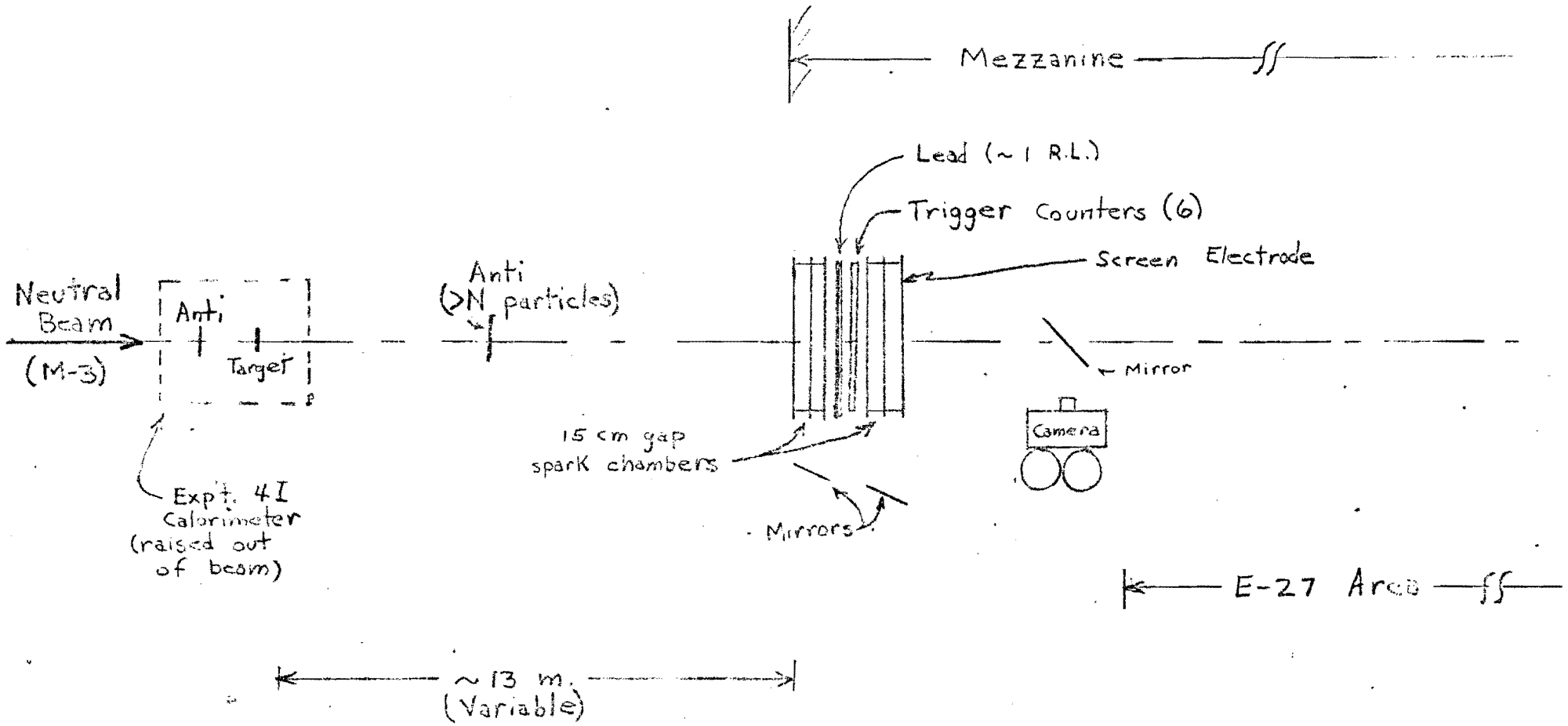


Figure 1 — (Roughly to scale)

Figure 2

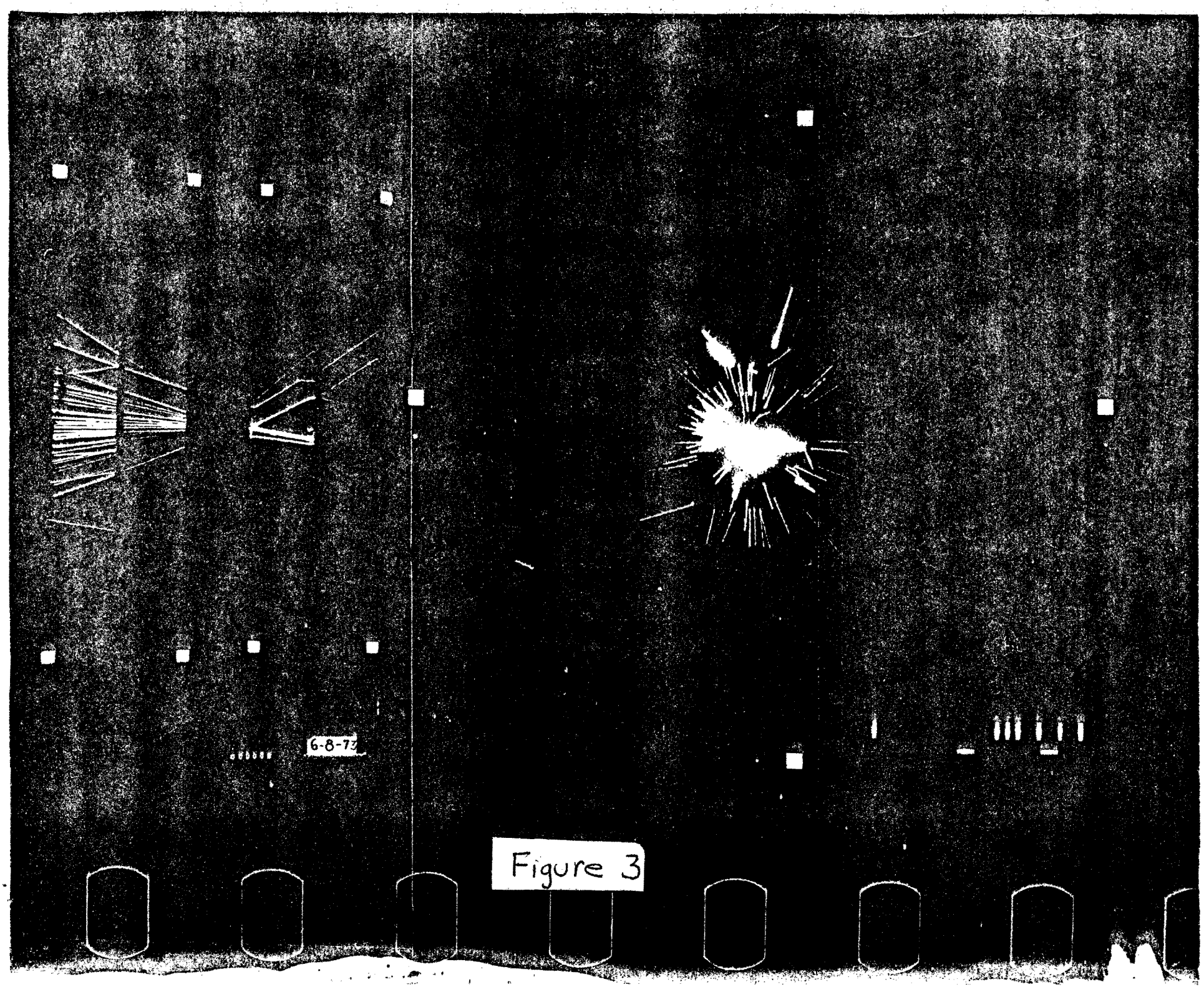


Figure 3