K.T. McDONALD

PROGRESS REPORT AND PLANS FOR AUTUMN DATA TAKING

EXPERIMENT 331

DIMUON PRODUCTION WITH A LARGE-ACCEPTANCE SPECTROMETER

K. J. Anderson, G. G. Henry, K. T. McDonald, J. E. Pilcher,
and E. I. Rosenberg, University of Chicago.

James Branson, G. H. Sanders, A. J. S. Smith,
and J. J. Thaler, Princeton University.

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INTRODUCTION

This note is to report the activities of Experiment 331 since April 23 of this year, at which time the Chicago-Cyclotron Muon Spectrometer became available to our group. We wish to demonstrate that this very complex system is operating successfully in our configuration, and that our trigger is efficiently selecting muon pairs. There is every prospect of obtaining exciting physics results, perhaps even from data of this May-June test run, and in any case from our next run planned for the autumn.

In what follows below, we shall briefly review the more important aspects of the design and installation of the experiment, and then discuss in a most preliminary fashion the quality of the data we are accumulating.

SPECTROMETER DESPCRIPTION

This experiment wishes to measure the processes

$$\binom{\pi}{p} + \text{Target} \rightarrow \mu_+ \mu_- + X$$

over a large range of dimuon mass (.7Gev -12 Gev) with large acceptance and good resolution. To accomplish this, we use most of the existing E - 98 spectrometer, with three major changes:

(1) Beam

We require a hadron beam with an intensity of 10^6/pulse and slow spill. Cerenkov counters are used to tag pions and protons.

(2) Hadron Absorber and New Multi-wire Proportional Chambers

To select muon pairs and suppress final-state hadrons we have removed the E-98 LH_2 target and installed an iron absorber, approximately 2 meters thick (see Fig. 1). Our target is placed 1 meter upstream of the absorber. The present running is done with a 0.25-interaction-length beryllium target. One 4-plane module of MWPC (X,Y,U,V) is placed between the target and the absorber to determine the muon directions before they are scattered by the tantial reconfiguration of the fast electronics was also completed by the time the first beam arrived on May 17.

We find ourselves in a somewhat strange position at present -- we had expected to use most of the May-June run just to understand the E-98 detector and to produce a satisfactory trigger. With luck we would get to test some of our new MWPC's and accumulate a modest sample of prototype data to study over the summer. Instead, both the E-98 spectrometer and the new trigger hodoscope and logic were tuned up and working within less than a week, and a few improvements to veto unwanted triggers produced a 50-per-cent pure dimuon trigger a week later. About this time the first new MWPC, 55cm by 55 cm in size, was installed, but it was unlikely that any more of them would be ready till near the end of the run. We therefore decided to begin data-taking, to survey the production of high-mass dimuons ($\gtrsim$ 1 GeV), where the chamber upstream of the absorber would be enough to give good resolution and to separate muon pairs produced in the target from those produced in the absorber. An obvious physics goal is to measure and compare the production of J particles from pions and protons.

OBSERVATIONS AND MEASUREMENTS FROM 3 WEEKS OF RUNNING

(1) <u>Beam Composition and Fluxes</u>

So far we have run entirely on 150 GeV/c positive beam. We first verified that the two Helium Cerenkov counters in the beam have $\gtrsim$ 95 per-cent efficiency on pions when sitting just below proton threshold (the kaon efficiency is not really known, but kaons constitute only $\approx$ 2 per cent of the beam). At this momentum, we measured the beam to contain $\approx$23 per cent pions, 75 per cent protons. We therefore use the Cerenkov counters to separate pions and protons as follows: events with pulses in both Cerenkovs are called pions; those with no Cerenkov pulses are called protons; the 5 per cent or so events with only one Cerenkov pulse are simply thrown away.

The remaining half of the triggers are dimuon events having two and only two clean, oppositely charged tracks. An example is shown in Fig. 2. The showers appearing in the E-98 muon chambers demonstrate the need for our lead wall. The surprising cleanliness of the tracks in the E-98 1m X 1m MWPC's is due to the stray field of the cyclotron (a few hundred gauss in this region), which sweeps out low energy electrons. The multiplicities in the 55cm x 55cm chamber agree with design estimates, and are very tolerable -- a histogram is shown in Fig. 3. Even at the highest rates we have encountered so far ($\approx 10^6$/pulse) there is no substantial contamination of stale tracks in any of the chambers, nor significant reduction in trigger purity from accidentals. For future runs at higher intensity we have planned rather simple devices to supress the dominant low-mass dimuons as well as the single-muon triggers, so that we will not be dead-time limited in searches for high-mass objects. Finally, we have measured the target-out rate to be about 10 per cent of that with the target in place.

DATA ANALYSIS

It is only very recently that we have been able to devote substantial effort to data analysis other than monitoring the experiment on line. Therefore what is known at this time is very preliminary and based on an extremely small data sample. First, and perhaps most important, the programs are working, and successfully reconstructing 30 percent of the triggers. This is more than half of the "prima facie" dimuons observed by scanning the on-line oscilloscope display, and as such is very satisfactoryafter only a week or two! To be classed as good events, candidates must have two tracks which intersect, within resolution, half-way through the field of the cyclotron magnet. A histogram of the error in this intersection is shown in Fig. 4, and is perfectly consistent with calculated resolution. We also require that the tracks intersect with the hodoscope counters which triggered the event. As the data taking has become relatively routine, more time

Plans for Autumn Running Period

Experiment 331

In the fall we plan to complete our proposed study of muon-pair production from nuclear targets. Data will be collected in two modes, emphasizing different mass ranges:

I. Low mass, Moderate intensity, High resolution.

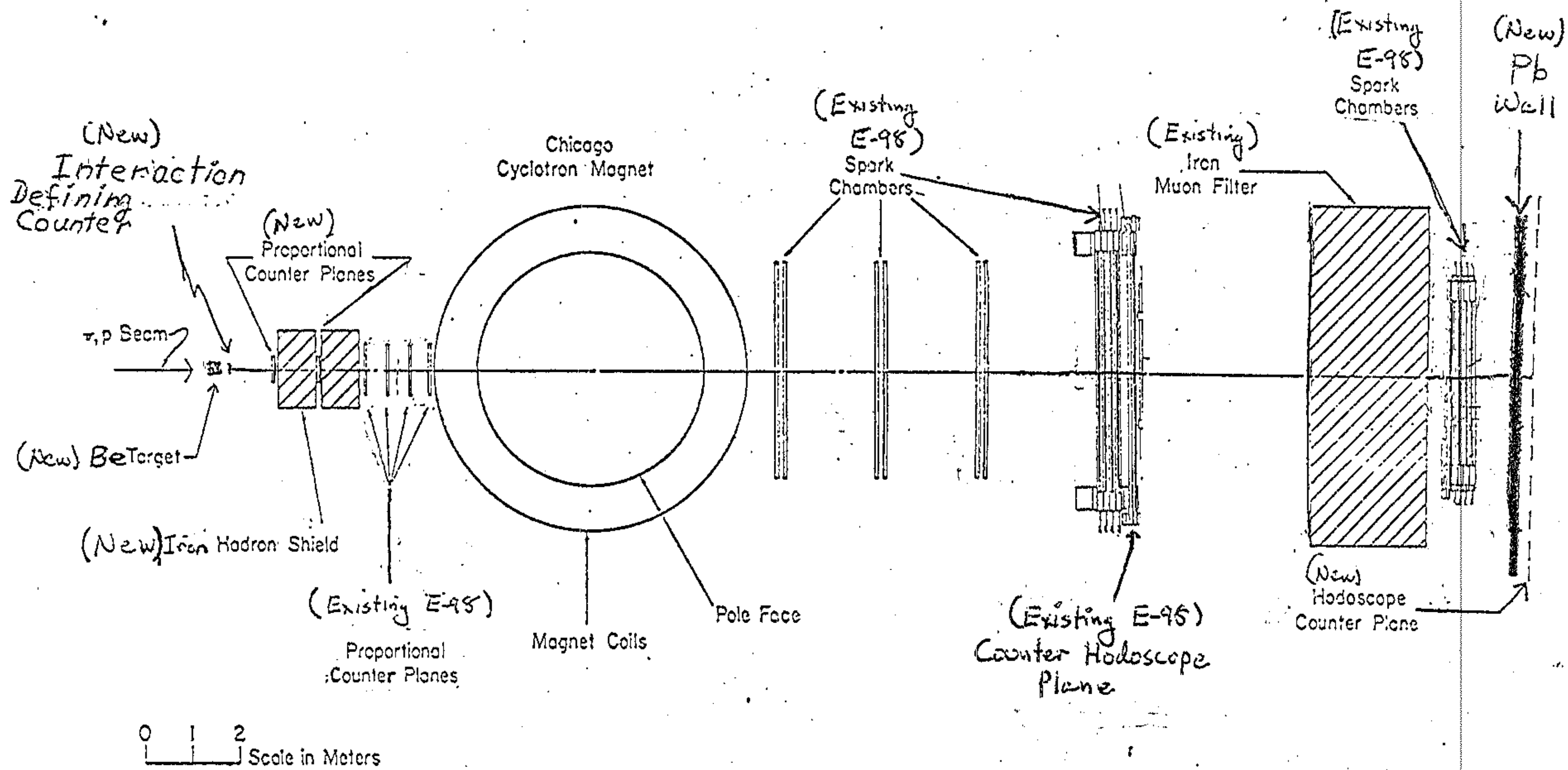
Utilizing the proportional chambers before and in the hadron absorber we can obtain good mass resolution down to about 0.5 GeV. Because lower-mass pairs are quite copiously produced, the dead time per event limits the useful beam to $2 \cdot 10^6$ particles per burst.

II. Higher mass, High intensity, Moderate resolution.

Biasing the trigger against low-mass events would allow us to run at up to 10^7 particles/burst. To do this we can use, for example, a hardware opening-angle requirement provided by a hodoscope (probably MWPC) placed just upstream of the cyclotron magnet. At this intensity the effectiveness of the MWPC's upstream of the hadron absorber is reduced, with a consequent loss in mass resolution. However, for masses 3 GeV and above this is not a serious defect.

In each mode, data will be collected for several beam energies, target materials, and both positive and negative beams. To obtain the high beam fluxes discussed, we should prefer to run with the quadrupole triplet train if possible. If not, the present beam will suffice, but we shall require approximately $4 \cdot 10^{12}$ protons/burst on the neutrino target for high intensity runs and for negative-beam runs. The fluxes of pions and kaons, especially at 200 GeV/c beam momentum, will be greatly improved if the accelerator runs at 400 GeV.

To complete this program, we estimate that at least 8 weeks of running is necessary. The partitioning of this time among the various topics will be strongly influenced by the results of our current run.



MUON LAB. SPECTROMETER AS USED FOR E-331 (MAY-JUNE 1975)

Figure 1

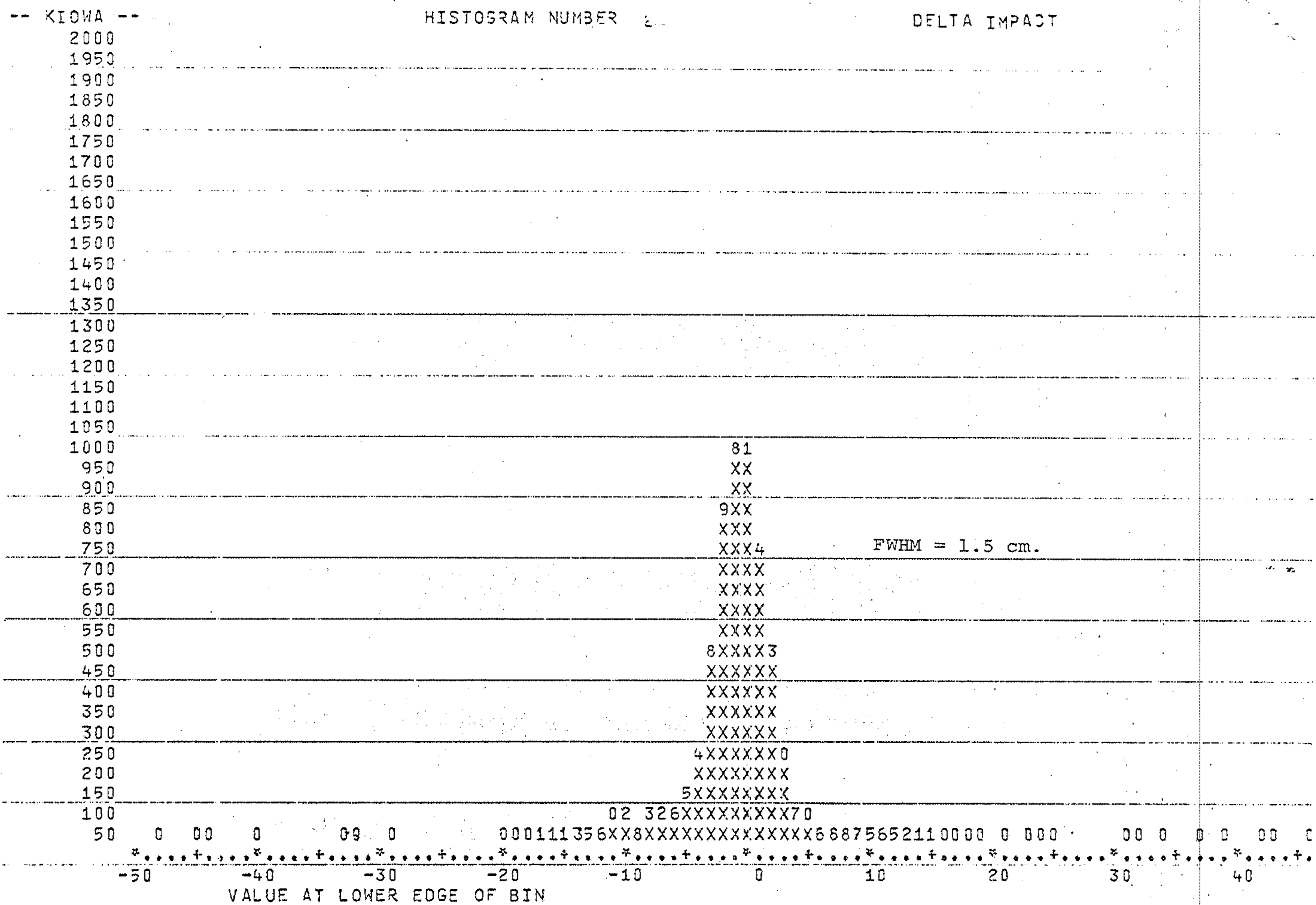


Figure 4. Discrepancy between impact parameters of tracks upstream and downstream of the Chicago Cyclotron Magnet, in bins of 0.25 cm.