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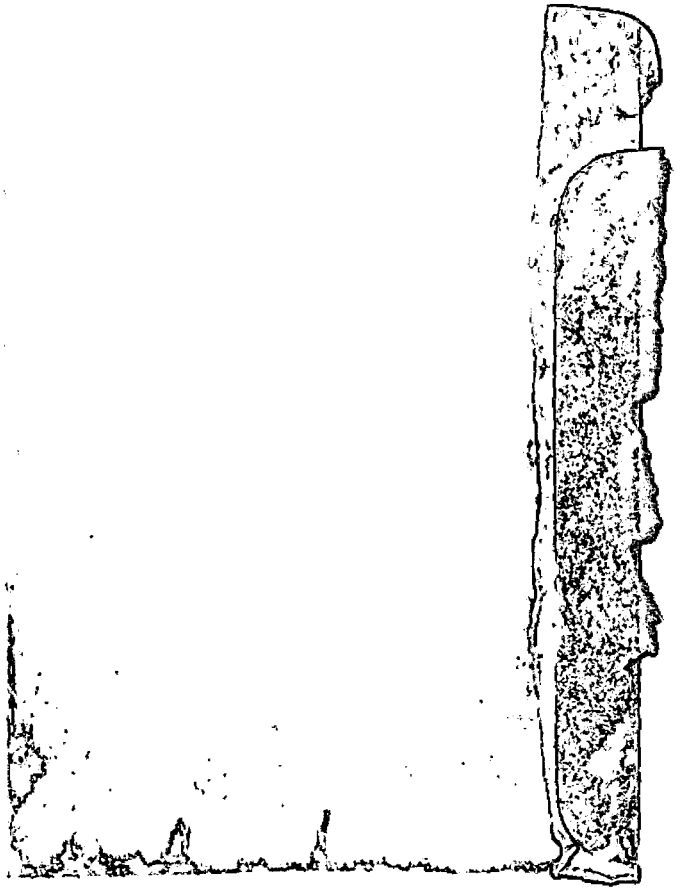

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WIRE SPARK CHAMBERS IN SPECTROMETER EXPERIMENTS*

Victor Perez-Mendez, Johnie M. Sperinde and Albert W. Stetz

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I. INTRODUCTION

This paper describes some of our experience in the use of wire spark chambers with magnetostrictive delay line readout in experiments performed at the accelerators of the Lawrence Radiation Laboratory and the Stanford Linear Accelerator Center. Experimental situations where we found these wire chambers most useful were in those cases where the possibility of measuring the vector momentum of one particle very precisely, and its mass, by time-of-flight or by Cerenkov counters, enabled us to select the desired reaction out of a large number of competing events.[1]

These experiments have been performed with spectrometer arrangements as shown in Fig. 1a, where the particles' momentum is determined by a symmetrical, redundant arrangement of wire chambers at the upstream and downstream side of the magnet. We have used the arrangement shown in Fig. 1b at SLAC since the background from the photon beam was too intense on the upstream side of the magnet.

In the sections below we discuss some of the construction and electrical characteristics of the chambers that we have found important. The use of on-line small computers and some of the computing techniques we have used are discussed.

II. CHAMBER CHARACTERISTICS

We have built our chambers in modules consisting of two closely-spaced gaps with the pulsed high voltage applied to the two central wire planes. For use in magnetic spectrometers we have usually made the ground planes of vertical wires and the central planes with wires oriented at $\theta = \pm 30$ relative to the vertical direction. This choice

has the advantage that it gives a higher accuracy for measurement of the X coordinate (parallel to the plane of the deflection); the magnetostrictive delay line is then also in the X direction where it is least affected by the fringing field of the spectrometer magnet.[2]

Since we want our chambers to have a high uniform efficiency for single and multiple track events (in case that there are some background particles) we have built all of our newer chambers with transmission-line characteristics.[3] The construction of these is shown in Fig. 2a. The capacity of the chamber is charged by the use of auxiliary aluminum (or aluminized Mylar) planes placed close to the wire planes and connected to them only by the bus bar which is parallel to the long edge of the chambers and to the magnetostrictive readout wire. For the central planes, one auxiliary aluminum plane coupled to both gaps is sufficient. Using gap spacings of $\approx$ 1 cm and chamber widths of 0.5-1 meter, the characteristic impedance is then 4-8 ohms per gap. A convenient circuit for charging this gap is formed from two sections of a distributed charging line, as shown shcematically in Fig. 2b.

We have used hard aluminum wire of diameter 0.1-0.2 mm for the wire planes. We find it necessary to limit the discharge currents to less than 10 microcoulombs per spark in order to prevent damage to the thin wires as well as to obtain high efficiency for multiple tracks. This is done by the addition of $\approx$ 1% alcohol to the gas mixture and by regulating the length of the high voltage pulse.

The wire spacing we use is 1 mm; this appears to be quite satisfactory since we have measured in cosmic ray experiments that the accuracy of track location for particle trajectories at $90^{\circ} \pm 20^{\circ}$ to

the plane of the chamber is ≈ 0.3 mm. For this reason we have standardized our electronic scalers to operate at 20 Mega-Hertz which provides a maximum accuracy of one digit = 0.25 mm since the velocity of sound in the Fe-Co magnetostrictive wire is 5000 meters/sec.

III. COMPUTING TECHNIQUES

We have usually used small computers such as PDP 5 types (and one IBM 1800 used at SLAC) located close to our experimental area to monitor the performance of the wire chambers and the other equipment in the experiment. All the extensive computing needed for calculating momenta and other kinematic quantities was done on our central laboratory computer.

The most useful monitoring functions of the on-line computer are to provide a display of single events projected on a scope to show the fiducials of each wire plane, the sparks that occurred, the counters that triggered events, and other data of the run. Since the operator has to look at the scope, only one out of N events is selected for display for visual convenience; however, the computer is programmed to show histograms of spark distributions, number of sparks per event per plane, time-of-flight distribution, and other technical quantities from which the performance of the electronics can best be judged.

Calculating the accurate momentum of the particles is the single most time-consuming job for the computer. It takes less than 1 millisecond for our central laboratory computer (Control Data 6600) to combine spark coordinates from the four planes of any one module and to remove stereo ambiguities for 2-3 track events. The selection of the interesting events from the larger background can usually be done with an approximate value of the momentum. For this purpose, the method we

have used is as follows: using measured values of H_Z, the perpendicular component of the magnetic field which we know over the volume of the magnet, including the fringing field, we construct a polynomial

$$P = f_1(X_1X_2X_3) = \sum_{ijk=012} A_{ijk} X_1^i X_2^j X_3^k$$

which gives the approximate momentum ($\approx 1\%$) as a function of $X_1X_2X_3$. We also construct a second polynomial $X_4 = f_2(X_1X_2X_3)$ which gives the approximate value X_4 as a function of $X_1X_2X_3$. We check that X_4 (computed) - X_4 (measured) is sufficiently small to indicate the trajectory of a particle which has not scattered or decayed in the volume of the field. For the events of interest, we recompute the momentum by integrating the orbit through the magnetic field using f_1 and the line X_1X_2 as the starting direction; by a process of iteration we arrive at the value of the momentum to the desired accuracy, usually 0.1%. The need for this two-step process in selecting interesting events can be appreciated from the following numbers: it takes our central computer 1-2 milliseconds to compute a momentum to $\approx 1\%$ accuracy by the polynomial method. It takes a time of 80-120 milliseconds to compute a final momentum to the desired accuracy.

We conclude that direct electronic readout wire chambers have proven to be a very powerful tool for high energy elementary particle physics in the energy region of a few GeV. With the development of higher energy accelerators at Serpukhov and Batavia it becomes necessary to improve the accuracy of these devices in order to satisfy the experimental requirements. Some recent work has shown that both the

accuracy of the magnetostrictive readout[4] and the correlation of spark positions with particle tracks[5] can be improved by a factor of three or better.

FOOTNOTE AND REFERENCES

* Work done under the auspices of the U. S. Atomic Energy Commission.

1. P. E. Boynton, T. J. Devlin, V. Perez-Mendez, J. Solomon; Double Charge Exchange Scattering of Positive π Mesons on Complex Nuclei, Phys. Rev. 174, 1083 (Oct. 1968).

L. Kaufman, V. Perez-Mendez, J. Sperinde, π^- - ^{4}He Inelastic and Capture Reactions Leading to Excited and Multi-Neutron Final States, Phys. Rev. 175, 1358 (Nov. 1968).

R. Bulos, W. Busza, R. Giese, R. R. Larsen, D. W. G. S. Leith, B. Richter, SLAC; V. Perez-Mendez, A. Stetz, S. H. Williams, LRL Berkeley; M. Beniston, J. Rettberg, IBM Scientific Center, Palo Alto; Photoproduction of Rho Mesons from Complex Nuclei at 9 BeV, Phys. Rev. Letters 22, 490 (1969).

2. L. Kaufman, V. Perez-Mendez, J. M. Pfab, Magnetostrictive and Piezoelectric Readout of Spark Chambers in Magnetic Fields, IEEE Trans. Nuc. Sci., Vol. NS-13, 583 (1966).

3. R. L. Grove, V. Perez-Mendez, R. Van Tuyl, New Techniques for Large Wire Spark Chambers with Magnetostrictive Readout, Nuc. Inst. and Methods 70, 306 (1969).

4. Kai Lee, Lawrence Radiation Laboratory, Berkeley, California - private communication.

5. J. Fischer, G. J. Igo, S. B. Orbesen, Paper #5, Vol. III, Proceedings of Versailles International Symposium on Nuclear Electronics.

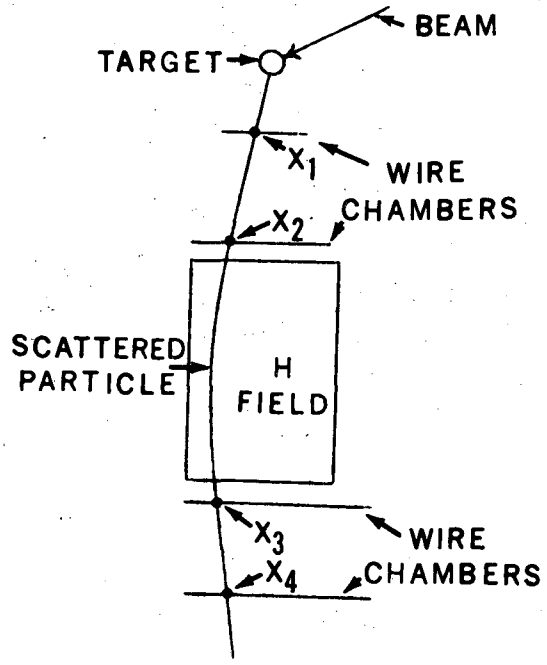

Fig. 1a: Magnet spectrometer used at LRL 184" cyclotron.

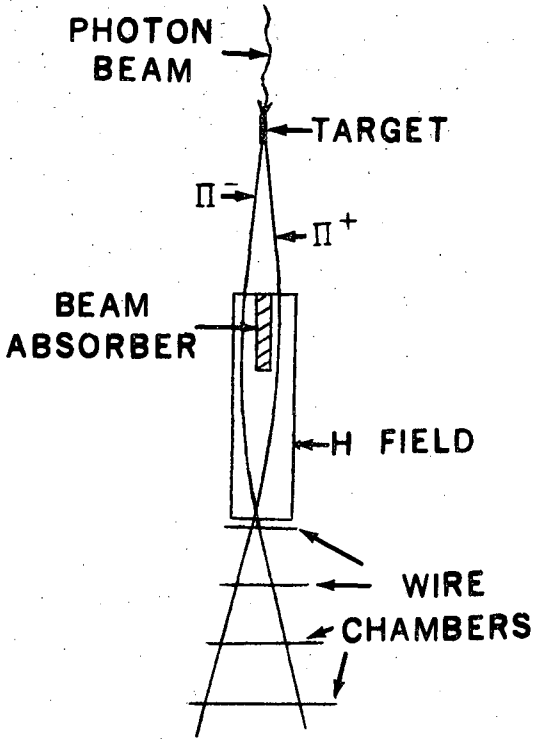

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Fig. 1b: Magnet spectrometer used in photoproduction experiments at SLAC.

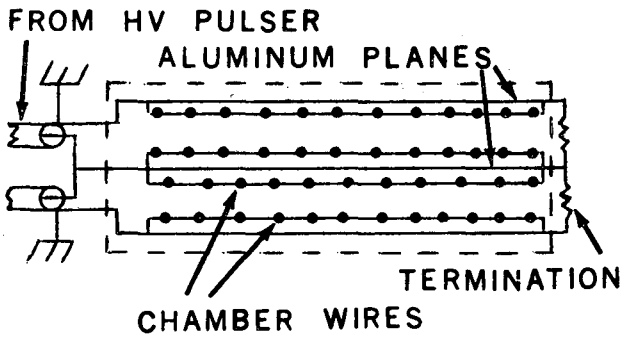

Fig. 2a: Schematic of wire chamber with auxiliary aluminum planes having transmission-line characteristics.

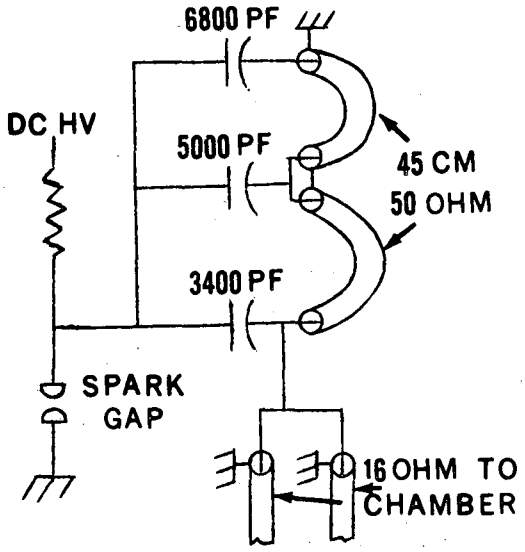

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Fig. 2b: Schematic of two section pulse-forming network.

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