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SOME TESTS OF A MULTIGAP PROJECTION CHAMBER

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Projection chambers are being considered as an alternative solution to streamer chambers. They are built with wire electrodes perfectly aligned in such a way that an infinite transparency is obtained in some privileged directions¹⁾.

Recent progress has been made in the construction of the electrodes with a separate storage capacity for each wire²⁾. The discharges from each wire are thus decoupled and a good density of discharges is obtained along the track, typically three discharges per cm in a 5 mm gap and 5 discharges per cm in a 3 mm gap. This density is very similar to the one obtained in streamer chambers with the same streamer length. The accuracy in the determination of spark position for the case of a straight track in a 10 cm chamber was shown to be $\sigma = 0.15$ mm, independent of the angle between the track and the wire direction.

One may suspect that when one increases the dimensions of the projection chambers, one may encounter unexpected problems.

As a first step we have built a detector using old frames of ordinary spark chambers, which were available to us. Its characteristics are:

length	:	80 cm
width	:	20 cm
gap width	:	0.7 cm
number of gaps	:	33
wire diameter	:	200 μ m
wire spacing	:	1.5 mm

Operational conditions

The chamber was filled with henogal plus 0.8% methylal^{*)}. A 6 kV pulse of about 1 μ sec length and 40 nsec rise-time was delivered to the wire planes by a single thyratron (Fig. 1). The wires belonging to the same plane were not decoupled in this construction. Edge sparking was prevented by using a thick PVC insulated wire of 1 mm outer diameter as the outmost wire on the high-voltage electrodes. Photographs were taken at an aperture of $f/2.5$ with an $f = 100$ mm lens on Kodak S0265 film.

A cylindrical lens of 365 cm focal length was put in front of the chamber in order to allow an unobstructed view of all gaps. The optical set-up (Fig. 2) resulted in an average demagnification of 44.

*) $(\text{OCH}_3)_2\text{CH}_2$

Performance of the chamber

The chamber was operated in a beam with protons and pions of various momenta between 0.4 GeV/c and 1 GeV/c. Photographs were taken in two different geometrical configurations: particles running in a single gap (perpendicular to the wires) as shown in Fig. 3, and particles traversing several gaps. In the latter case characteristic "dead zones" appear along the particles trajectory, which result from the drift of the electrons during the relatively long rise-time of the pulse (see Fig. 4). Since the centre of a group of sparks lies always on an anode plane, this shadow allows, in principle, a determination of the dip angle without stereoscopic views. The size of the "dead zones" could certainly be reduced in a set-up allowing for shorter rise-times (see Fig. 5b). The accuracy of a spark position in the projection of the film plane has been calculated from a straight line fit through all sparks of a track as measured by hand on an IEP machine. Every spark was measured, thus giving a total of 50-70 points per track. Figure 6 shows a histogram of the mean deviation σ for various conditions. Tracks which show an apparent curvature due to multiple scattering, especially at low momenta, were not excluded. No correction for eventual optical distortion has been done. The precision ($\sigma = 0.4$ mm), including a considerable error of the order of 0.2 mm due to the hand measurement, is less than previously obtained in a small chamber²⁾, but it certainly represents only a lower limit to what could be achieved in a more sophisticated design.

One of the attractive features of the chamber is its almost isotropic behaviour. Despite the poor decoupling of the wires, it shows a good efficiency for local complex configurations of several tracks. In Fig. 5 we show some characteristic pictures of tracks with low-energy δ -rays. It seems reasonable to expect that the complex configuration existing around an interaction vertex could be as visible as in a streamer chamber.

Acknowledgements

We wish to thank Mr. D. Berniers and Mr. V. Beck for the construction of the chamber, and Messrs. G. Brandon, K. MacDonald and V. Diemont for their collaboration in the experimental set-up and in the measurements.

REFERENCES

- 1) G. Charpak, A. Breskin and F. Piuz, Nuclear Instrum. Methods 100, 157 (1972).
- 2) A. Breskin, G. Charpak and K. Geissler, Some progress in projection chambers. Submitted to Nuclear Instrum. Methods, October 1972.

Figure captions

- Fig. 1 : High-voltage supply of the chamber: 33 gaps are pulsed by one thyatron, but HV planes are supplied in groups of two by one capacitor. Pulse rise-time about 40 nsec.
- Fig. 2 : Sketch of the experimental set-up. The beam crosses along the space diagonal through almost all the gaps.
- Fig. 3 : Trajectory parallel to one electrode plane and perpendicular to the wires.
- Fig. 4 : Space-angle determination and dead regions.
- a) Sketch to explain the formation of the dead zones.
 - b) Enlarged view through the plexiglas frames parallel to the electrode planes showing the dead zones and the effect of dislocation of spark groups when a particle passes through the anode plane.
- Fig. 5 : Some characteristic photographs of the projection chamber.
- a) Photographs taken perpendicular to the wire planes. The capability to resolve details as, for instance, outgoing soft δ -rays, is clearly visible. Rise-time about 40 nsec.
 - b) Rise-time about 25 nsec (R_{17} to $R_{32} = 0$ in Fig. 1). Obviously the dead zones are shorter.
 - c) Photographs taken through the plexiglas frames, parallel to the electrode planes, i.e. the classical case of a multi-plate spark chamber. The reduced luminosity of sparks produced at great depth is due to the poor wire alignment.
- Fig. 6 : Distribution of the r.m.s. values versus particle momentum.

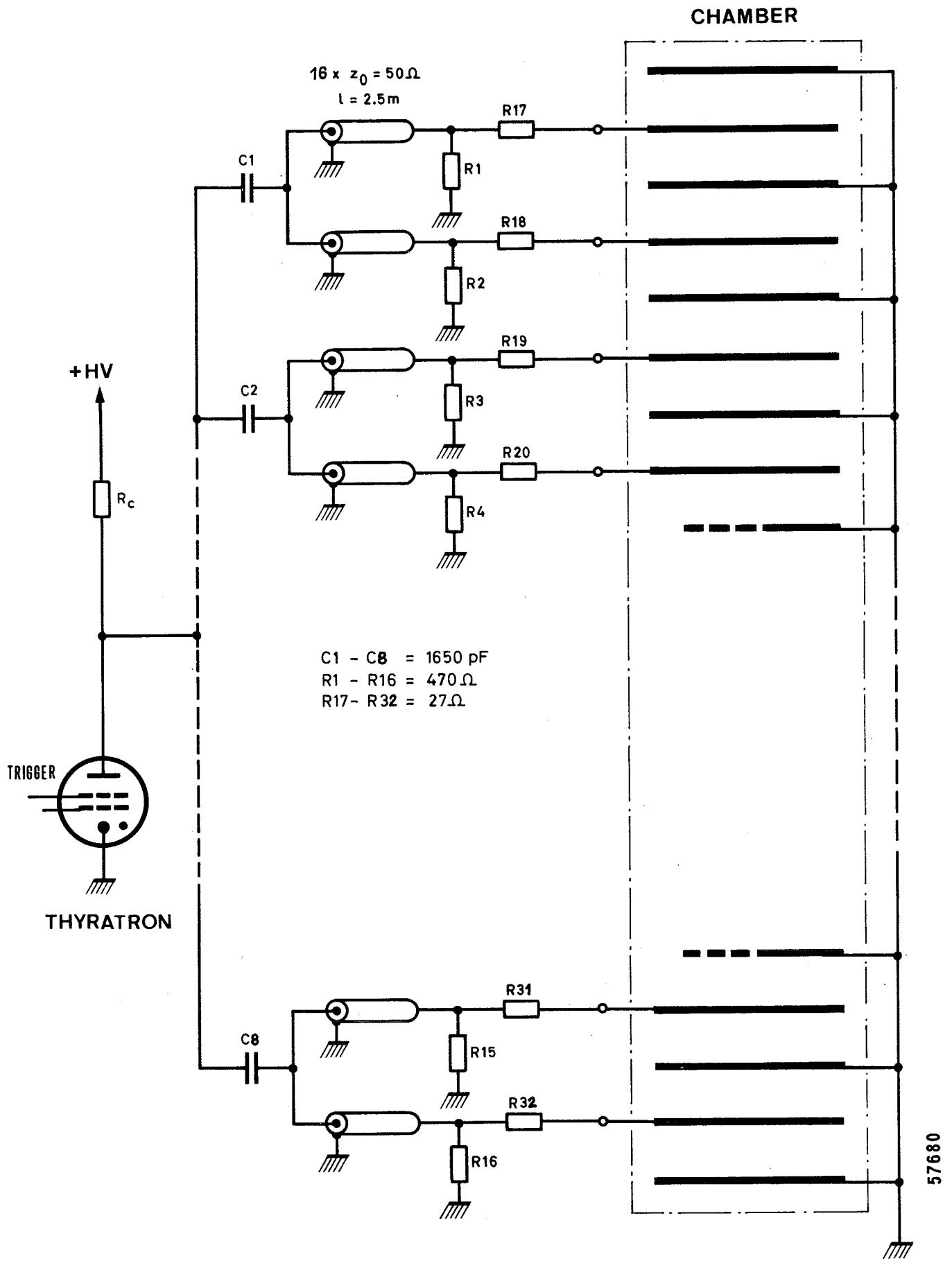


Fig. 1

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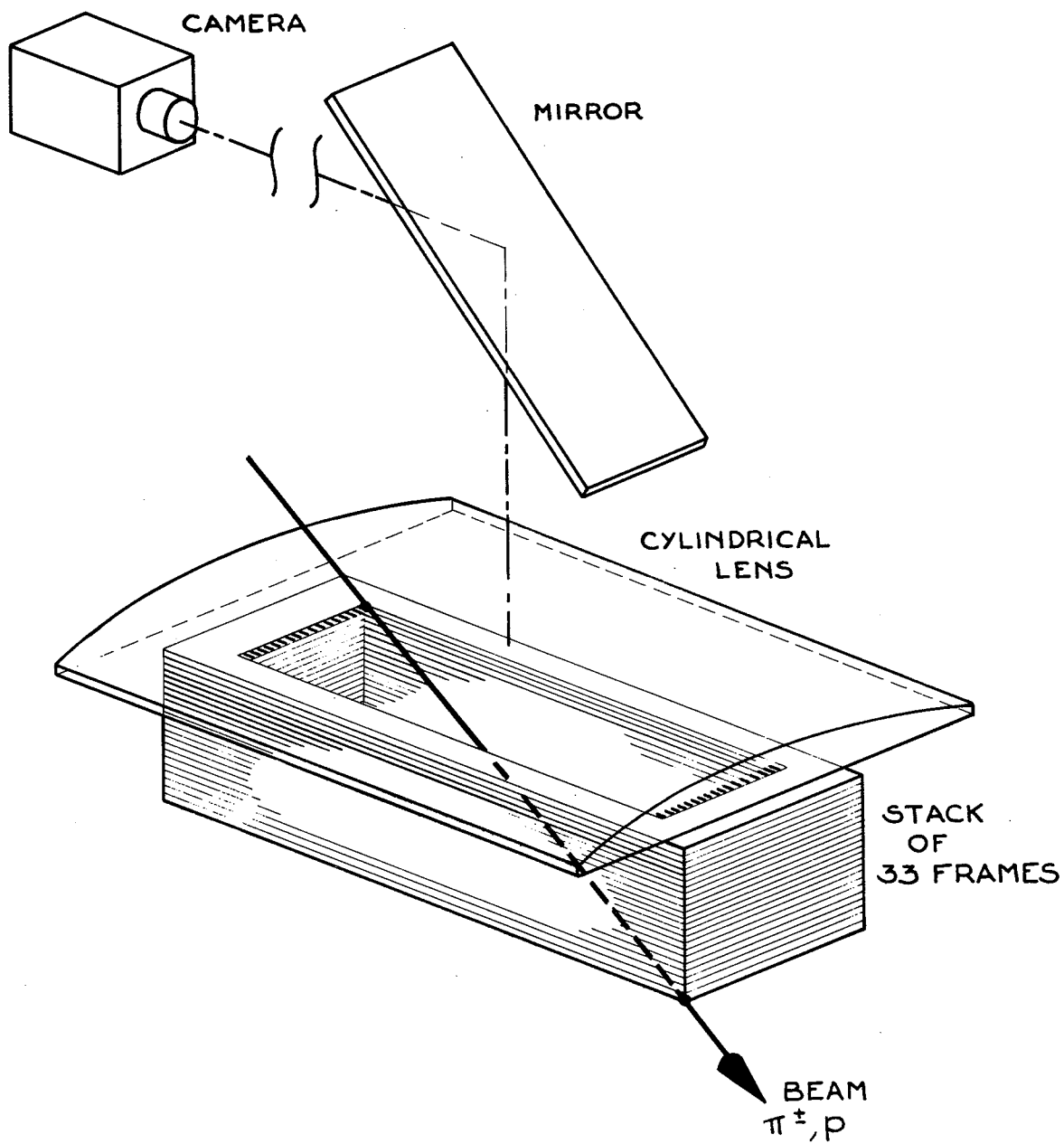


Fig. 2

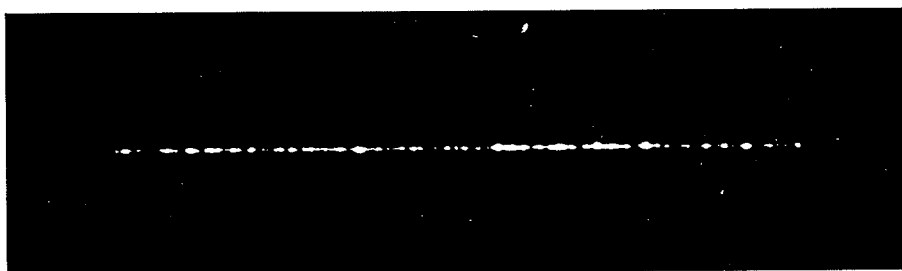


Fig. 3

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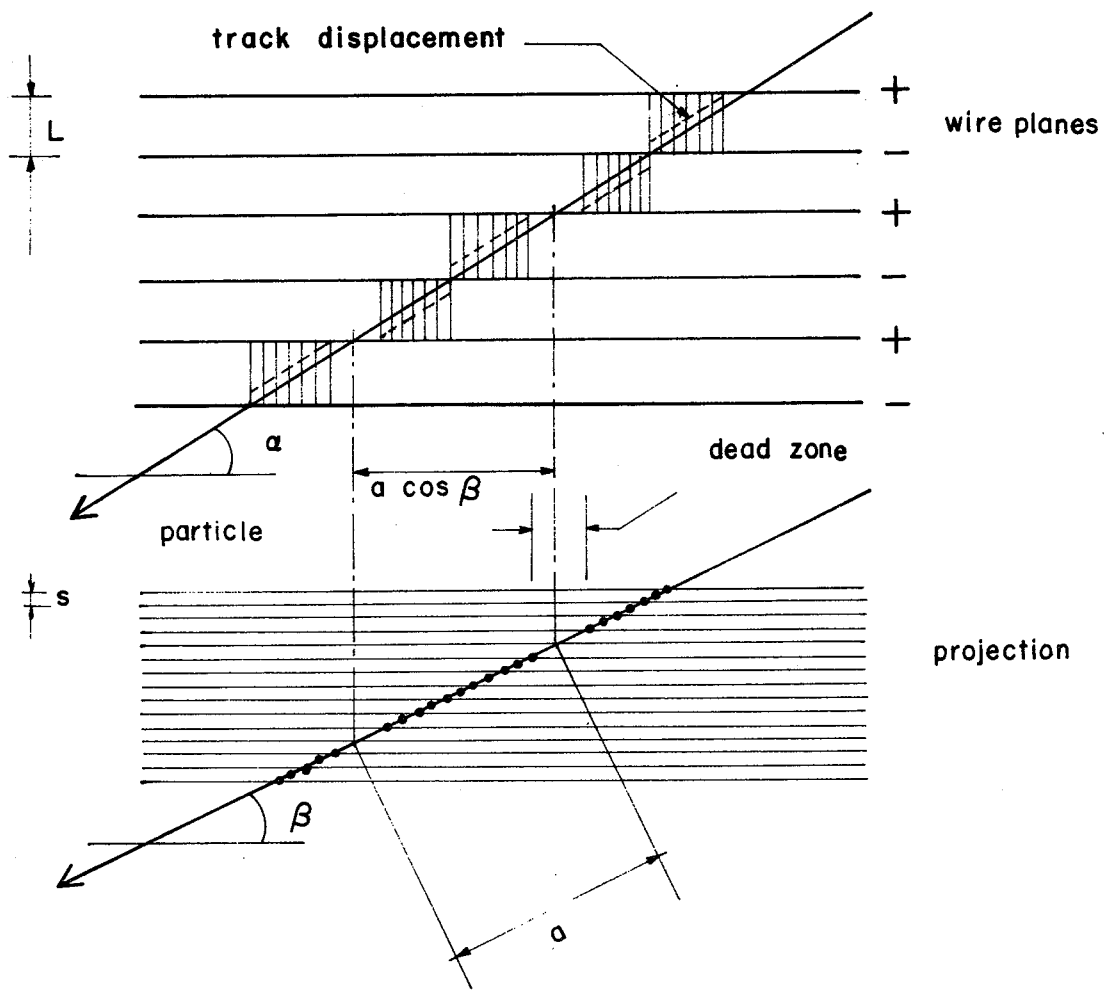


Fig. 4a

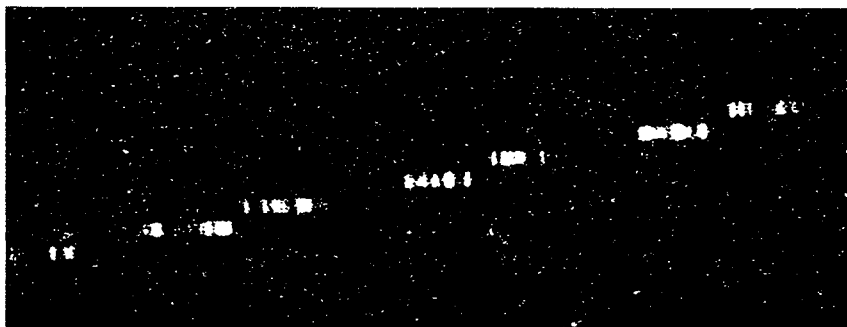
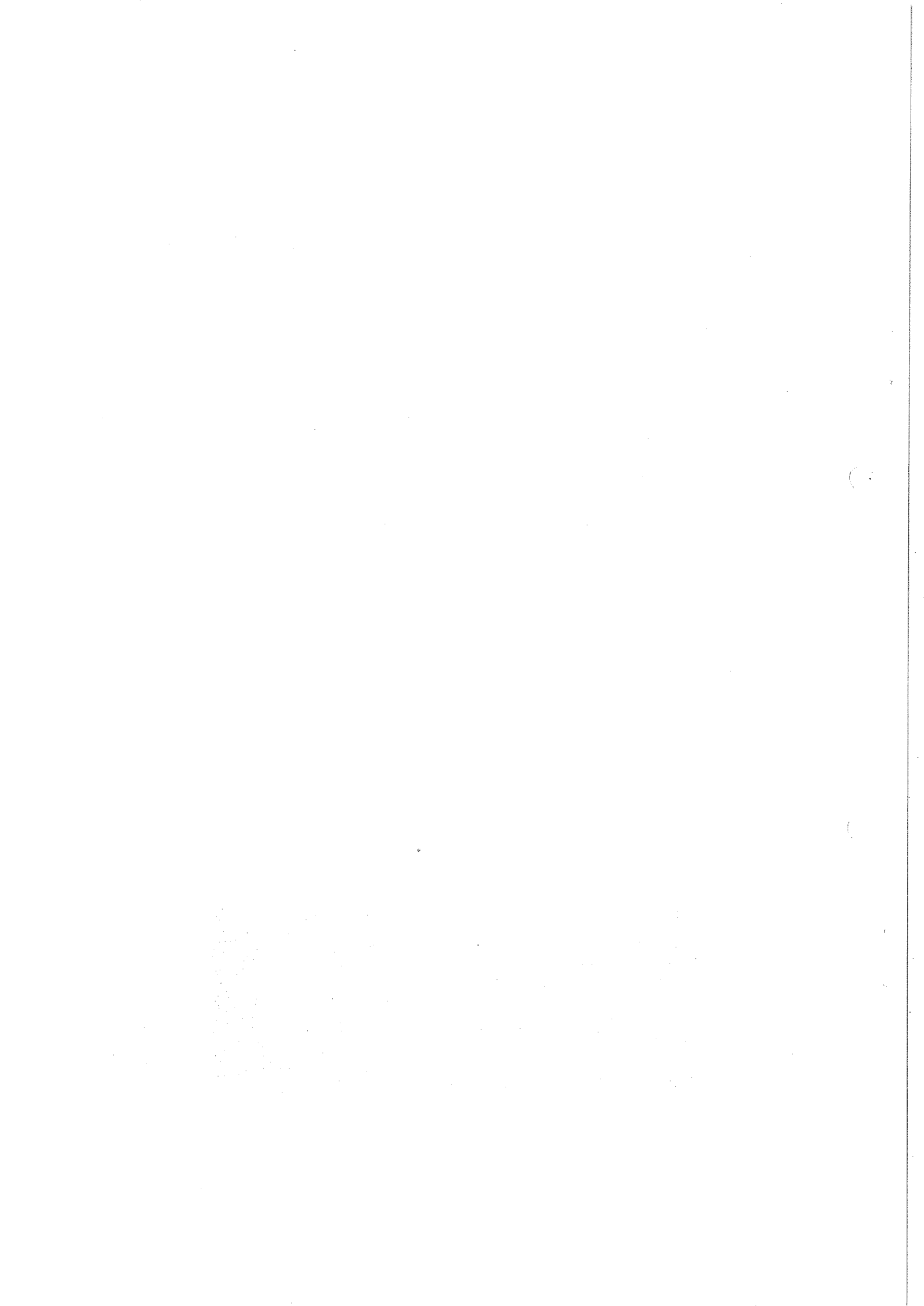
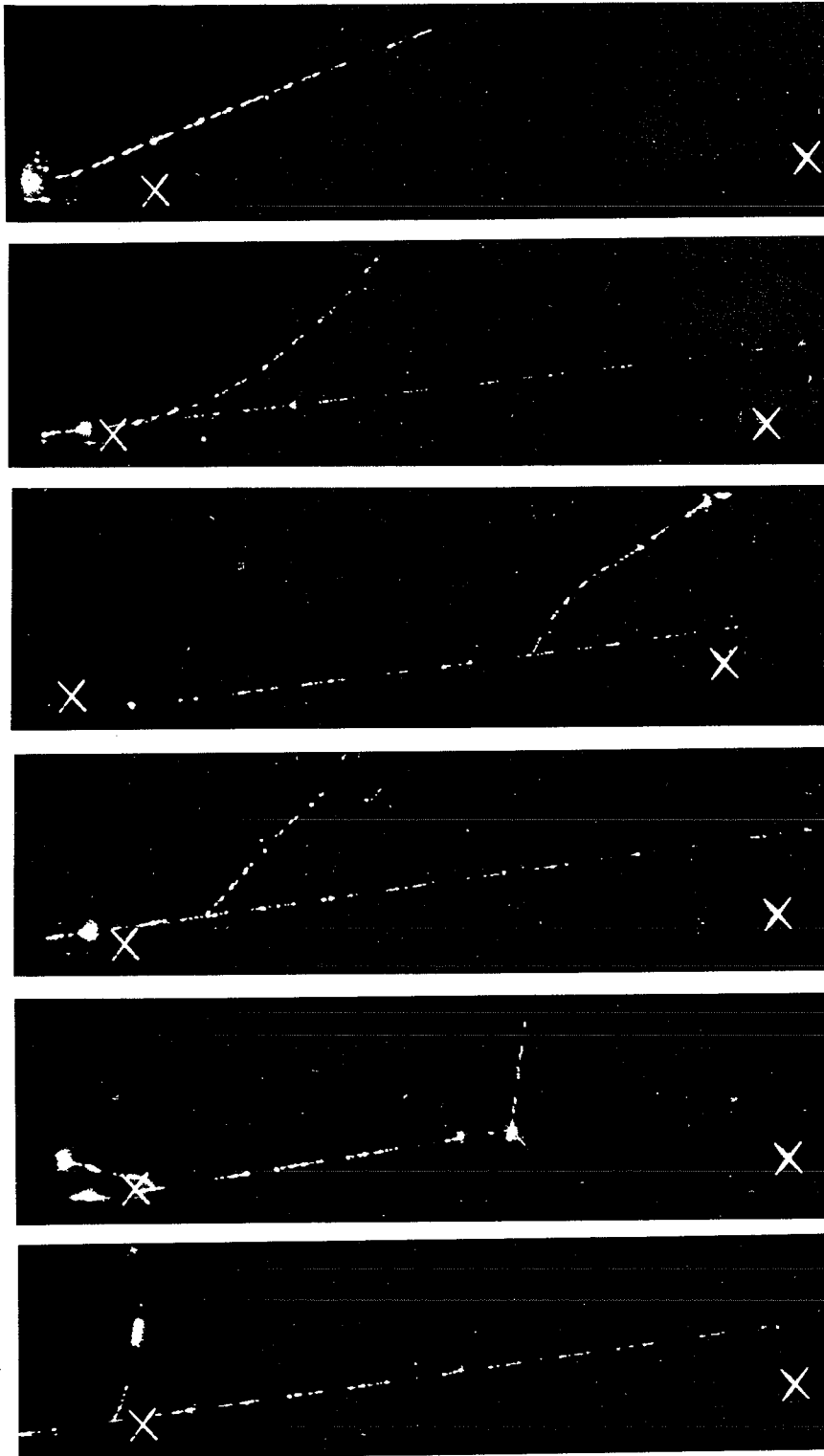


Fig. 4b

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Fig. 5a

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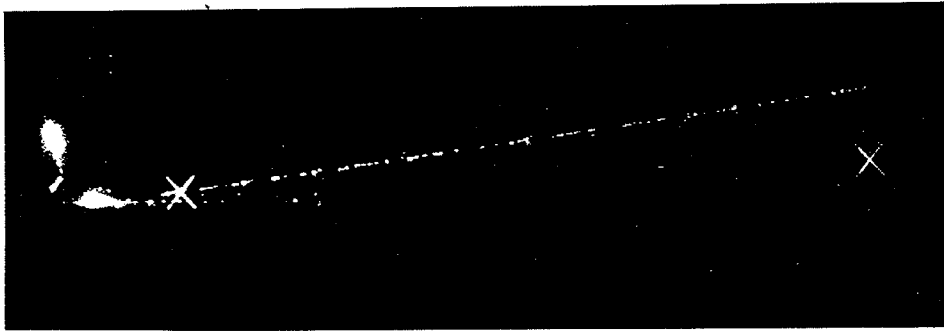
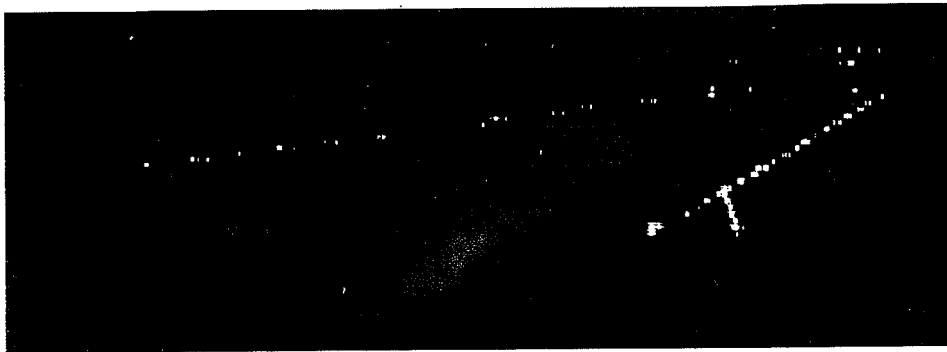


Fig. 5b



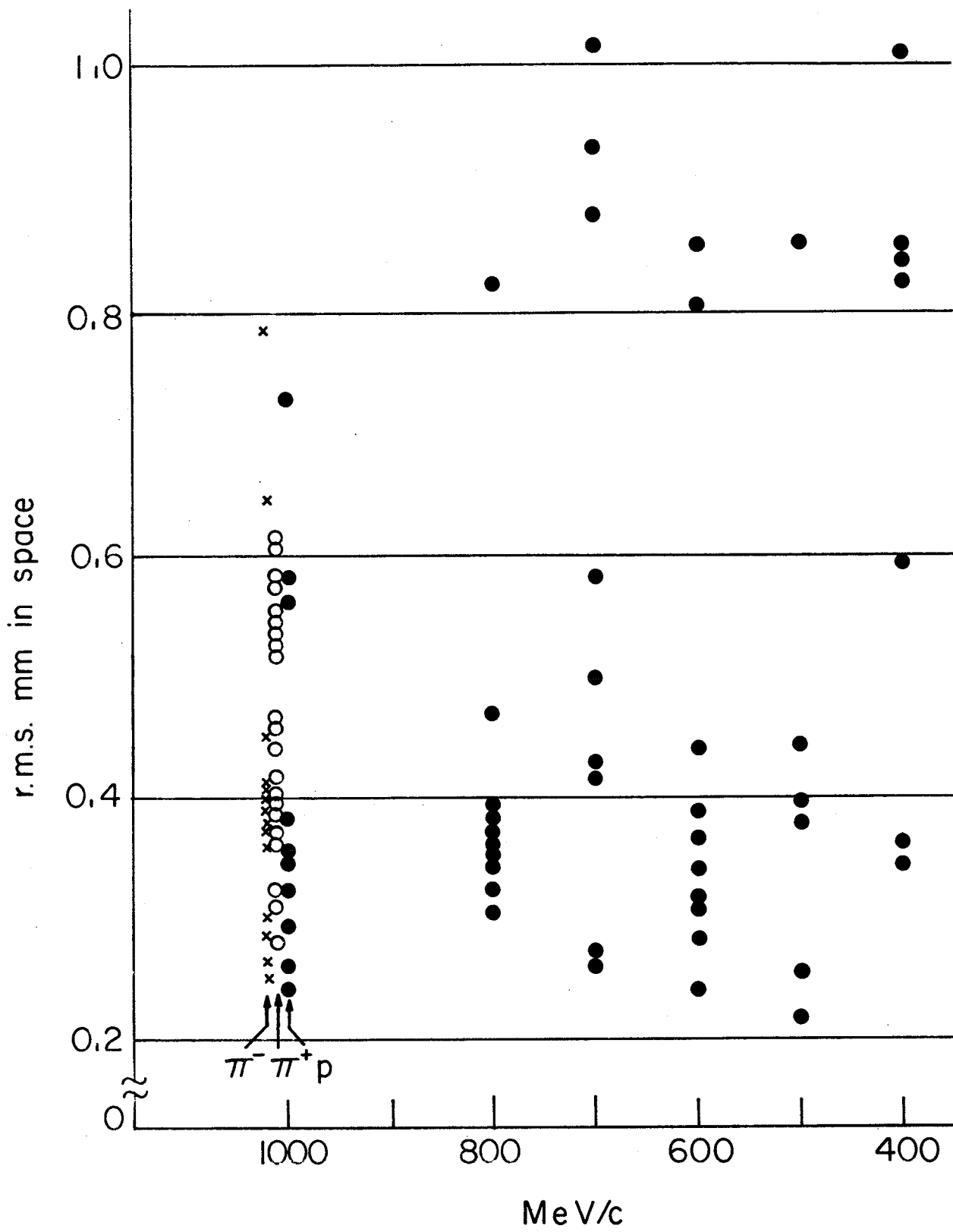
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Fig. 5c

1. The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that proper record-keeping is essential for the integrity of the financial system and for the ability to detect and prevent fraud. The text notes that without reliable records, it would be difficult to verify the accuracy of financial statements and to identify any irregularities.

2. The second part of the document focuses on the role of internal controls in ensuring the reliability of financial information. It describes how internal controls are designed to prevent errors and fraud by establishing a clear separation of duties and by requiring proper authorization for all transactions. The text also highlights the importance of regular audits to test the effectiveness of these controls and to ensure that they are being followed.

3. The third part of the document discusses the impact of external factors on the financial system. It notes that changes in the economic environment, such as inflation and interest rate fluctuations, can affect the value of assets and liabilities. The text also mentions that regulatory changes and new accounting standards can require companies to adjust their reporting practices. The document concludes by stating that companies must stay informed of these external factors and adapt their financial reporting accordingly to maintain transparency and trust.



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Fig. 6

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that this is essential for ensuring transparency and accountability in the organization's operations.

2. The second part of the document outlines the various methods and tools used to collect and analyze data. It highlights the need for consistent data collection procedures and the use of advanced analytical techniques to derive meaningful insights from the data.

3. The third part of the document focuses on the role of technology in data management and analysis. It discusses how modern software solutions can streamline data collection, storage, and processing, thereby improving efficiency and reducing the risk of errors.

4. The fourth part of the document addresses the challenges associated with data security and privacy. It stresses the importance of implementing robust security measures to protect sensitive information and ensure compliance with relevant regulations.

5. The fifth part of the document concludes by summarizing the key findings and recommendations. It reiterates the importance of a data-driven approach and encourages the organization to continue investing in data management capabilities to support its long-term growth and success.