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ISR BACKGROUND STUDIES AT THE PS

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For experimentation at the ISR it is vital to know the intensity of the background radiation not due to beam-beam interactions. To investigate this problem, an optical 12-gap spark chamber with a sensitive surface of 80 × 63 cm^2 was installed in the PS ring. It was placed between magnet 15 of the PS and the outer wall of the ring. This position was chosen since both, magnet 15 and magnet 14, are open at the outer side (Fig. 1,2). Secondaries from beam-gas interactions reach the spark chamber without being absorbed in the yokes of the magnets.

A counter telescope directed tangent to the vacuum pipe upstream was placed in front of the chamber. It consisted of two scintillation counters each with a sensitive surface of 3 × 3 cm^2 (Fig. 1). A television camera transmitted the view of the spark chamber onto a TV screen, which was situated together with the electronics in the South Hall, next to the ring entrance door 3. Polaroid photographs of the chamber could be taken when it was triggered.

A monitor made of two counters was placed 80.5 cm away from the vacuum chamber on the inner side of the PS ring between magnet 9 and magnet 10. Figure 3 shows the monitor signal displayed on an oscilloscope. One sees an increase during the acceleration of the protons to a constant signal during "flat top". The two spikes at the beginning of the acceleration cycle are due to beam losses at the times of injection and transition. A pulse of 100 ms length gated on the electronics 635 ms after injection; it is displayed with the monitor signal. The delay to trigger the spark chamber was 900 ns. During the gate the energy of the circulating protons was about 22 GeV. The pressure in the vacuum pipe was measured by six vacuum gauges.

Photographs were taken under different conditions.

1. The chamber was positioned as close as possible to the ring (position A on Fig. 1). Ten telescope-triggered photographs (Fig. 4) and ten random (Fig. 5) were taken at this position; the average number of circulating protons per burst was 1.9×10^{11}; the average gas pressure in the section 14-15 was 2×10^{-6} Torr.
2. The chamber was placed at position B (Fig. 1) and ten triggered photographs (Fig. 6) and five random (Fig. 7) were taken. The

number of circulating protons was 1.8×10^{11} in average per burst; the average gas pressure was 2×10^{-6} Torr in section 14 - 15.

3. The same geometrical conditions as under 2, but with a change in machine intensity, which was brought to its maximum, corresponding to an average of 9.9×10^{11} protons per burst (Fig. 8).

4. To investigate roughly the sensitive time of the spark chamber, additional delays of 1.0 μs, 1.5 μs, 2.0 μs were introduced on the chamber trigger. The performance of the chamber under the same condition as at 2 but with an additional delay of 1.5 μs is shown in Fig. 9. Taking into account the 0.9 μs delay of the electronics we conclude the sensitive time of the chamber to be about 2 μs.

Describing the background by

Background $\propto$ beam current $\times$ gas pressure $\times$ sensitive time of the chamber

a comparison of the conditions under which this investigation was done with that expected at the ISR can be made

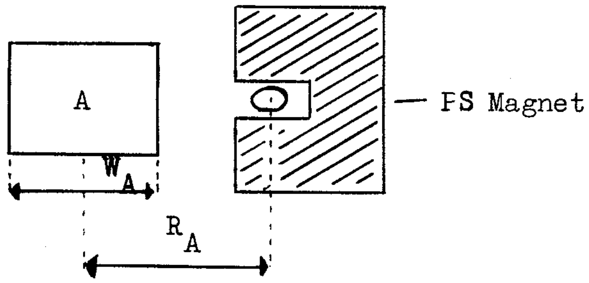
$$\frac{\text{Background PS}}{\text{Background ISR}} = \frac{1.9\times 10^{11}\times 2\times 10^{-6}\times 2\times 10^{-6}}{8\times 10^{14}\times \quad 10^{-11}\quad \times 2\times 10^{-6}} \approx 48$$

The difference in the gas composition H_2O and heavy gases at the PS and H_2 at the ISR will bring about an additional factor of 7 in favour of the conditions at the ISR.

The track multiplicity of triggered photographs is displayed in Fig. 10

From the random triggered photographs (Fig. 5) we can evaluate the particle flux per second passing a ring of width w = 1 m centred in the vacuum pipe. (N.B. This flux is independent of the ring radii[1]).

On the average 2.4 particles /2μs were traversing the sensitive surface A of the spark chamber.



Since the particle flux falls off as 1/R[1] we calculate the particle flux N through a ring of width 1 m centred in the vacuum pipe to be

$$N = 2.4 \times \frac{2\pi\, W_A R_A}{A} \times \frac{1}{W_A} = 2.4 \times \frac{2 \times 3.14 \times 0.8 \times 1.125}{0.63 \times 0.8} \times \frac{1}{0.8} = 33.7\ [2\ \mu s]^{-1}$$

Taking into account the factor of 48 from the ratio of PS background/ ISR background we expect at the ISR in a 1 m ring a flux of 3.5×10^5 particles per second, even assuming the ISR residual pressure gas to be heavy molecules.

We want to thank Professor R.L. Cool for helpful discussions.

REFERENCES

1. B.D. Hyams, ISR Users' Meeting, CERN, 2-3 December, 1968.

FIGURE CAPTIONS

Fig. 1 Experimental layout.

Fig. 2 View of the chamber in the ring of the PS.

Fig. 3 Oscilloscope display of the monitor signal and timing of the gate.

Fig. 4 Triggered photographs of the chamber taken at position A.

Fig. 5 Random photographs of the chamber taken at position A.

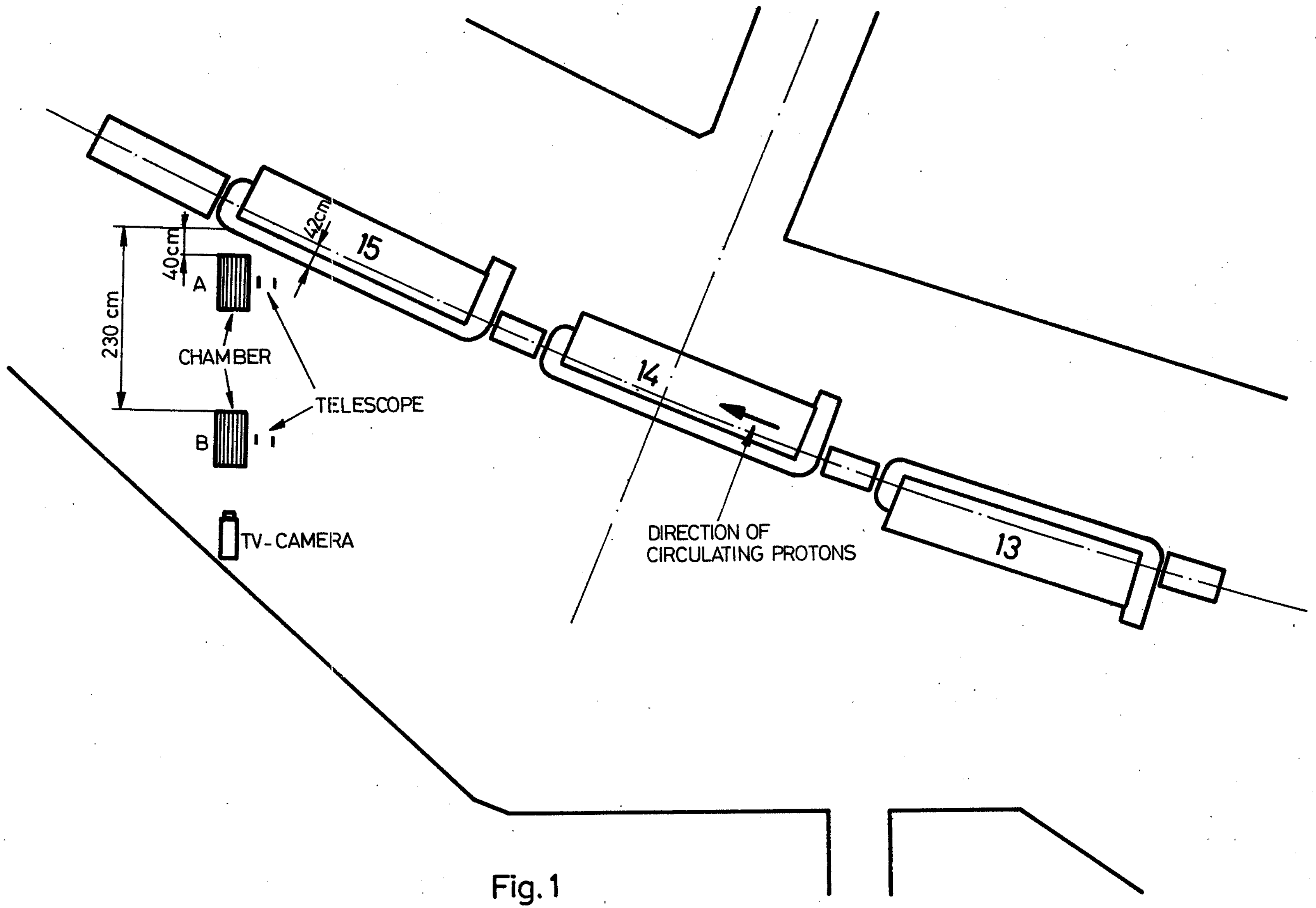
Fig. 6 Triggered photographs of the chamber taken at position B.

Fig. 7 Random photographs taken at position B.

Fig. 8 Triggered photographs taken at position B with maximum machine energy.

Fig. 9 Performance of the chamber with an additional delay of 1.5 μs.

Fig.10 Display of the track multiplicity for triggered photographs at position A, position B with low and high machine intensity respectively.



15
14
13
42cm
40cm
230 cm
A
B
CHAMBER
TELESCOPE
TV-CAMERA
DIRECTION OF
CIRCULATING PROTONS

Fig. 1

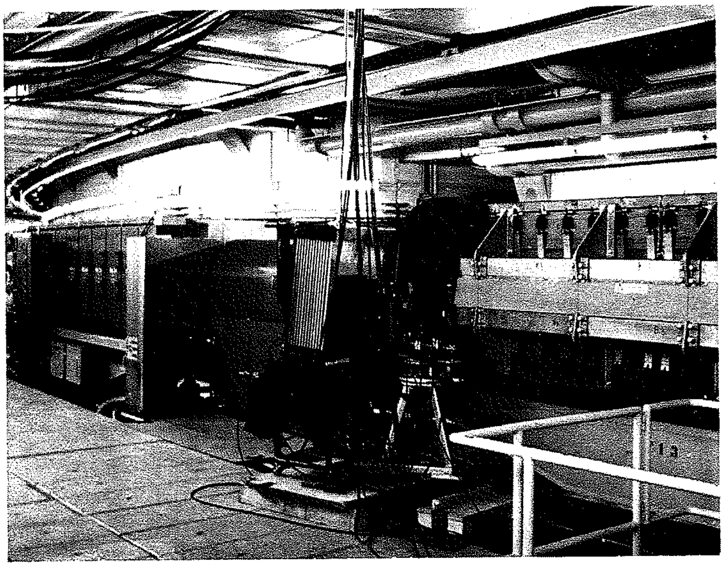


FIG. 2

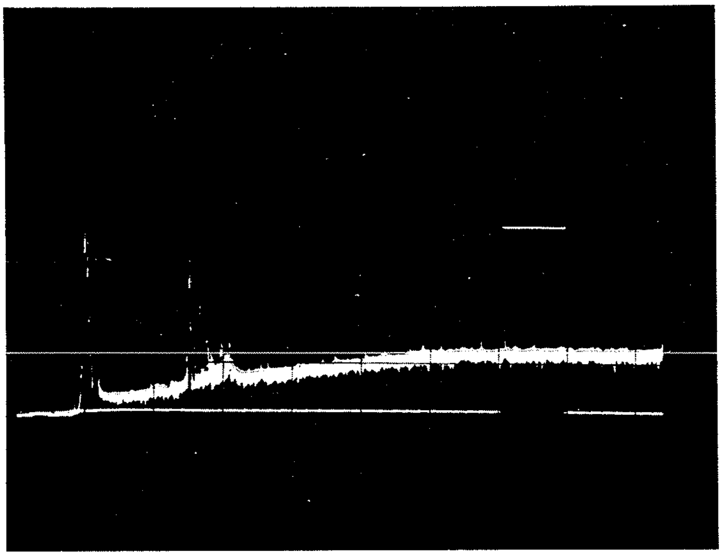


FIG. 3

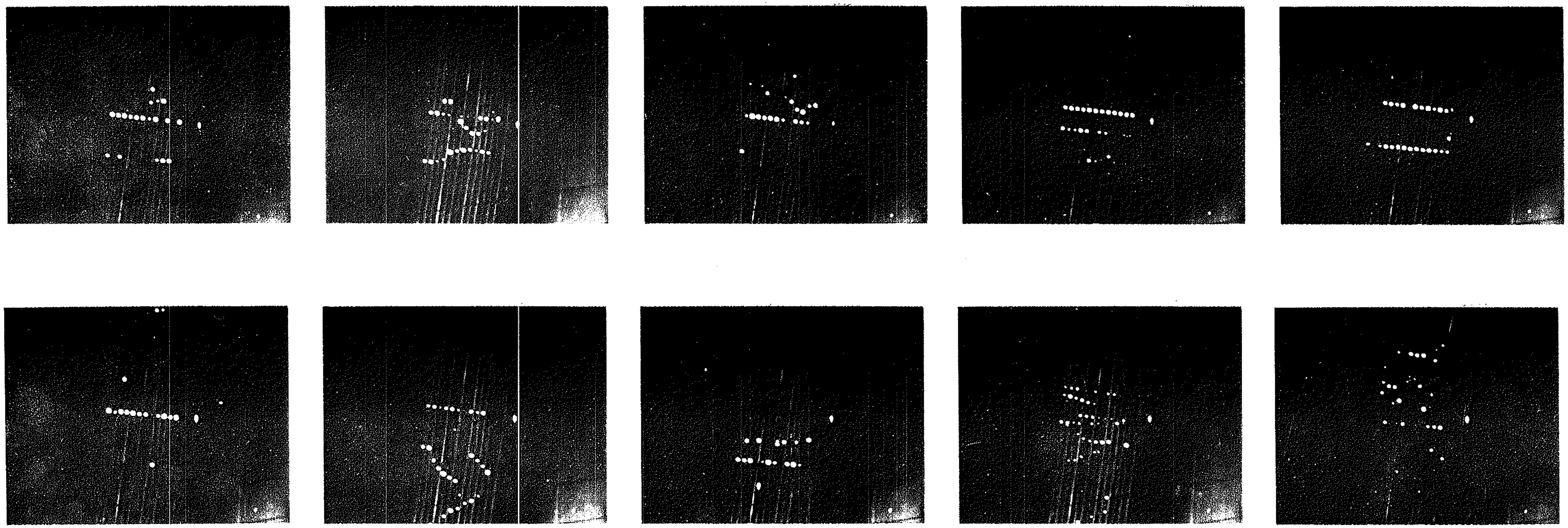


Fig 4

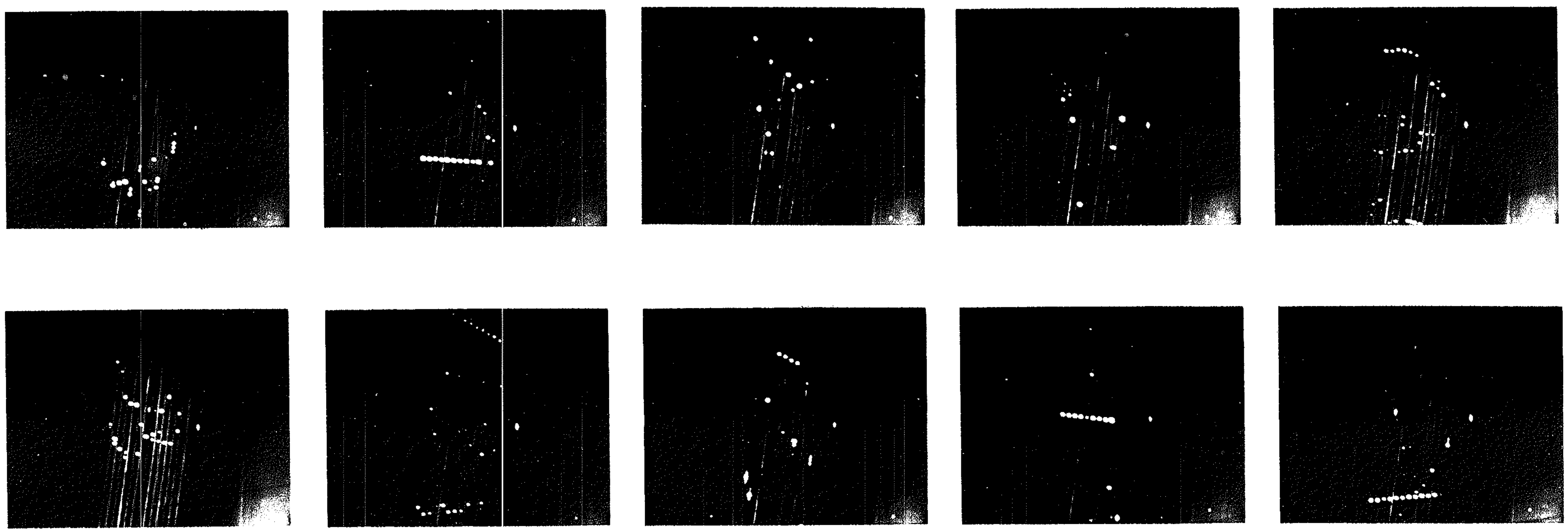


Fig. 5

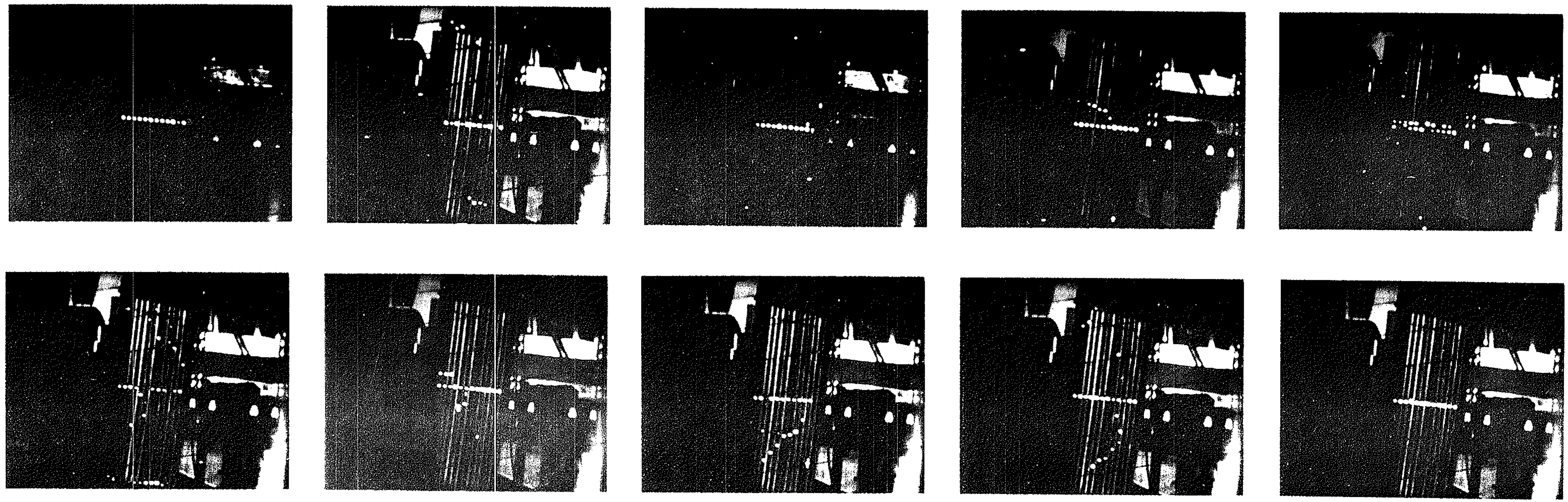


Fig. 6

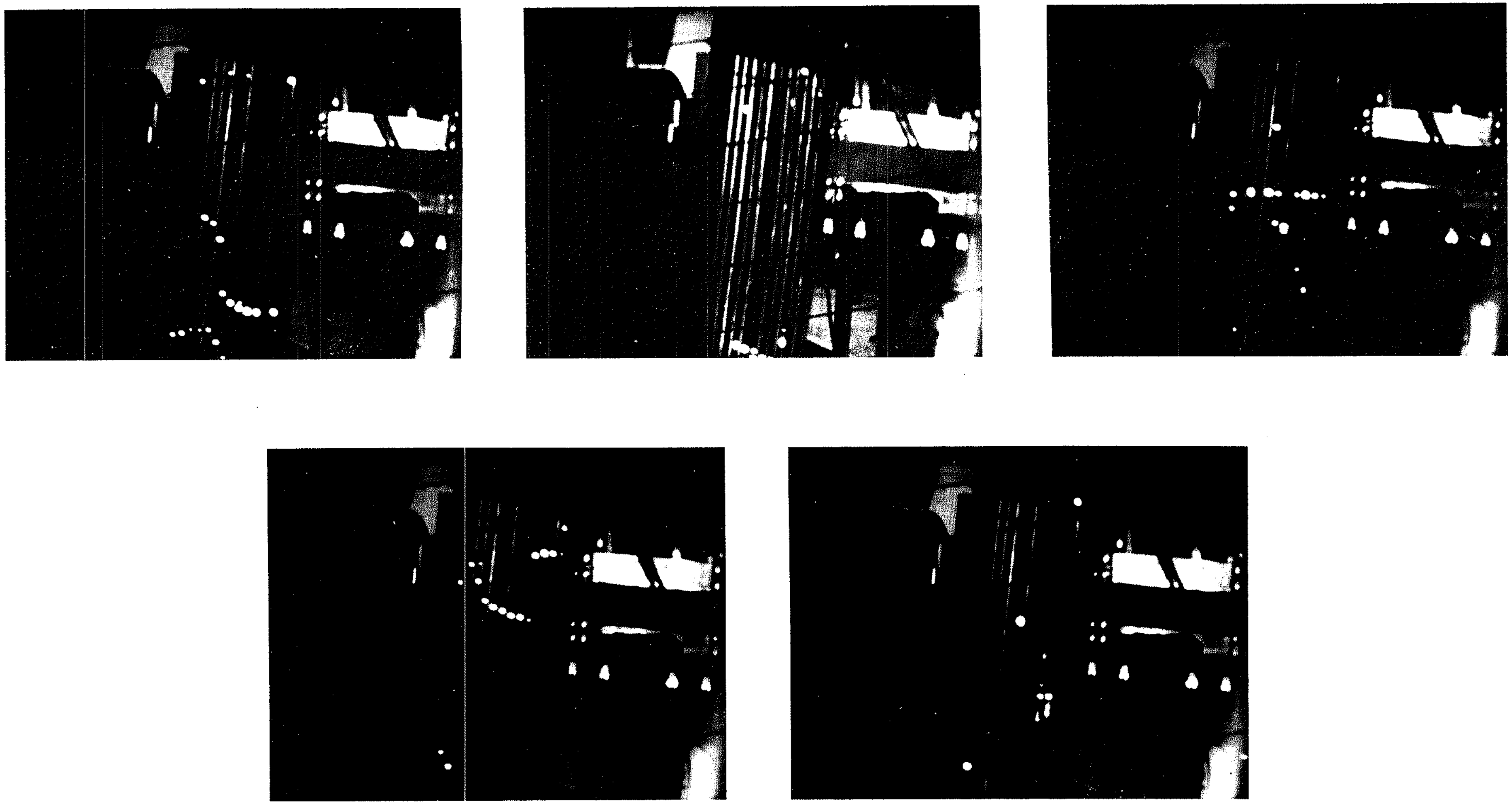


Fig. 7

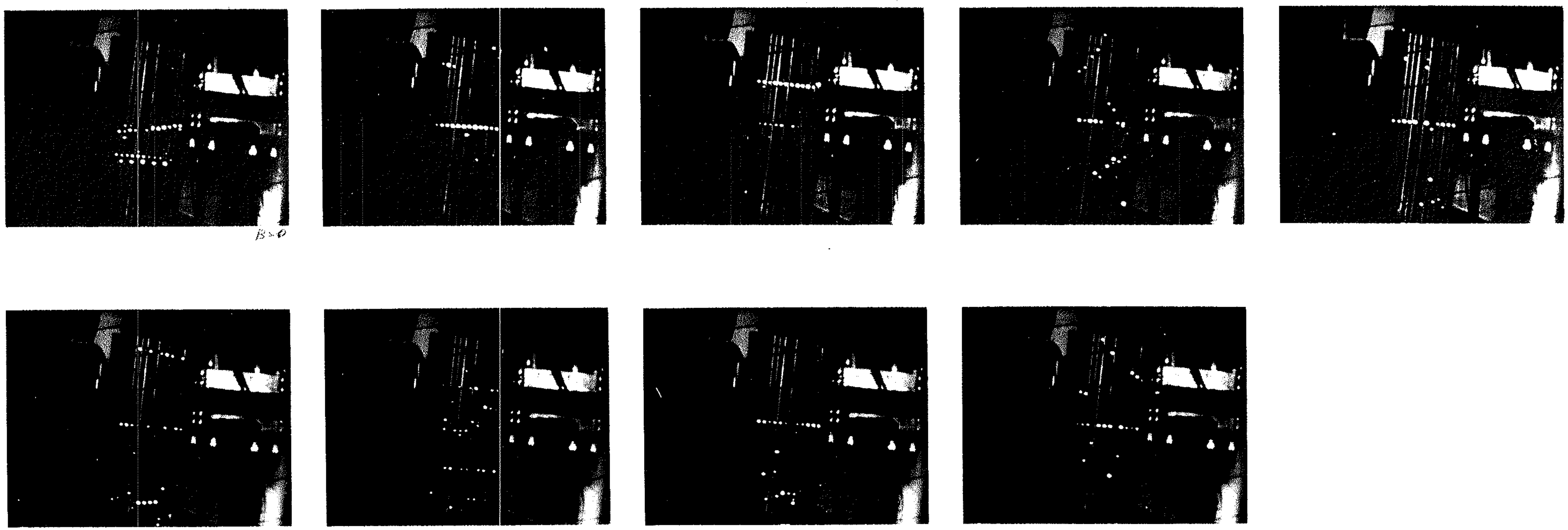


Fig. 8

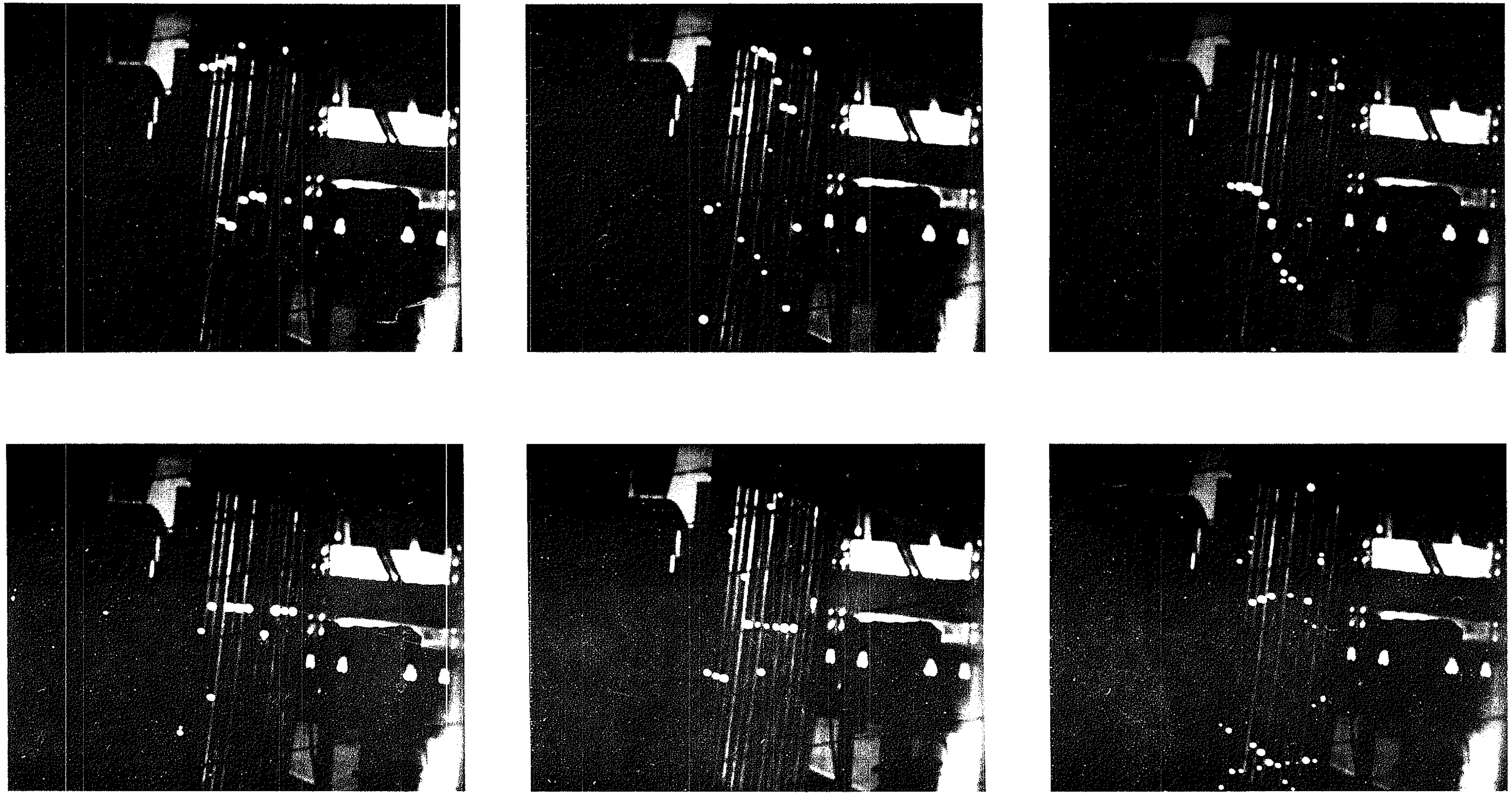
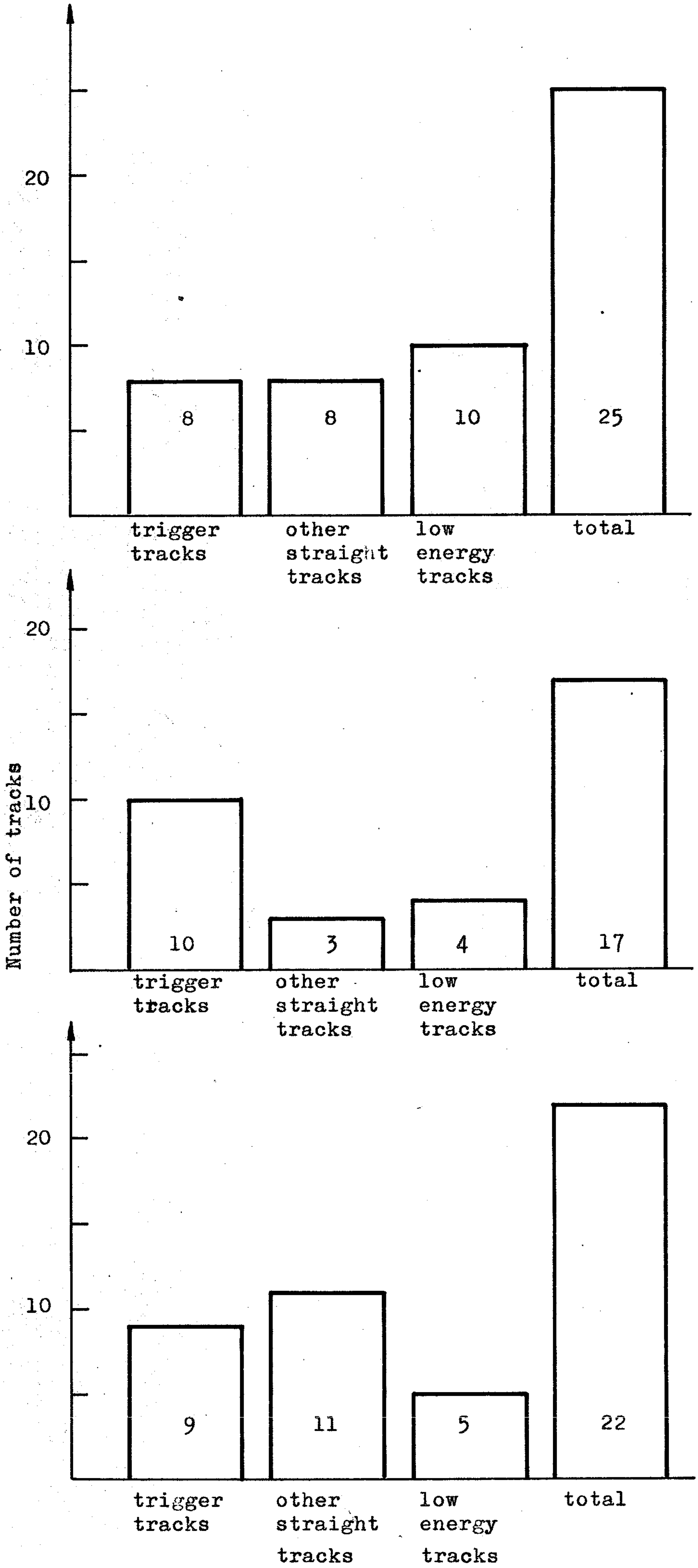


Fig. 9



POSITION A
triggered on coincidence
statistics from 10 photographs
1.9×10^{11} protons in ring per burst

POSITION B
triggered on coincidence
statistics from 10 photographs
1.8×10^{11} protons in ring per burst

POSITION B
triggered on coincidence
statistics from 9 photographs
9.4×10^{11} protons in ring per burst

FIG. 10