ITEP — 151

INSTITUTE OF THEORETICAL
AND EXPERIMENTAL PHYSICS

A.Arefiev, Yu.Galaktionov, V.Plyaskin,
V.Pojidaev, E.Tarkovsky

THE WIRE, PAD AND DIRECT CATHODE READOUT OF STREAMER TUBES

MOSCOW 1983

УДК 539.12 М-16

Introduction

In the frame of the L3 hadron calorimeter design study we have built a number of "streamer tube" type detectors (chambers) to test and compare variuos methods of analogue readout.

We have studied three types of chambers:

1) for the pad readout: a classic Iarocci-type PVC - chamber equipped with pads /1/;
2) for the direct cathode readout: totally metallic (Cu) chamber with segmented cathode;
3) a chamber of an intermediate type: it was made of metallic (Al) open profile covered with a PVC - sheet with pads.

1. Chamber construction and operation

Schematic view of the tested chambers is shown in fig.1.

PVC chamber unit consisted of an 8 cell 9x9 mm^2 open profile coated with graphite. A plastic top cover was also coated with graphite. The resistivity of the inner walls of the chamber was $\sim$ 50 k$\Omega/\square$. The pads of 75x75 mm^2 size were cut out on the inner side of the printed circuit board with copper on both faces as signal and ground electrodes. 50 Ω cables were soldered to each signal electrode. The cable's screen was connected to the ground electrode. The printed circuit board was glued onto the top cover of the chamber unit (fig.1a).

The chamber of the intermediate type had the same construction except for the 8 cell profile which was made of machined aluminium.

The construction of the chamber designed for the direct cathode readout tests is shown in fig. 1b. The chamber consisted of a 40 cell *open* profile 6x12 mm^2 made of 100 μm copper foil. The inner face of the printed circuit board which served as a cover of the chamber was divided into 25 cathodes of 95x95 mm^2 size. Each cathode was grounded through 50 Ω .

All *chambers* had 50 μm gold plated tungsten anode wires. The chambers were operated in both proportional and streamer modes with 50/50 argon-isobuthane mixture (fig.2).

The distributions of the charge collected on the anode wire are shown in fig.3. The "double streamer" enhancement is much more pronounced in the "Al" chamber.

2. Results

2.1 PVC Chamber

A 5 mm diameter collimated Ru^{106} beta source put on top of the chamber was used for the PVC chamber tests.
A 20x20x10 mm^3 scintillator counter was used for triggering (fig.4).

In fig.5 pulse height spectra from the anode wires as well as from the pad are shown. The beta source was positioned at the center of the pad # 1 (see fig.6). The ratio of the pad to anode signal depended on the gate width and was 0.6 for 600 nsec gate. This ratio did not depend on the applied high voltage. Note (fig.6) that the shapes of the signals from the neighbouring pads are different. This can be qualitatively explained by charge-discharge processes of pad's capacities /2/.

The dependence of the collected charge on the width of the trigger gate is shown for different pads in fig.7.

The working pad to the neighbouring pad signals ratio increased with the shortening of the gate width.

2.2 Metallic chamber with resistive top cover

For this test we used cosmic rays. Two scintillator counters (50x50 mm^2 and 100x100 mm^2) were placed on top and below the tested module.

The pulse height spectra from the anode wires and from the pad are shown in fig.8. As compared to the PVC chamber the signal from the pad is relatively smaller and the ratio of the pad to the wire signal is about 0.14 . This ratio did not depend on the applied high voltage.

2.3 Direct cathode readout

In this case the trigger counters covered 6 cathodes as it is shown in fig.9. The spectra of the signals from wires and from the sum of the six cathodes are shown in fig.10. The cathode to wire signals ratio was ~ 0.35 .

To study the crosstalk between the neighbouring electrodes we used for triggering an additional 100x200 mm^2 scintillator counter which covered only the cathodes # 3 and # 4 .

The corresponding pulse height spectra are shown in fig.11.

The value of the crosstalk was found to be less then 10% of the working electrode peak value.

3. Performance of aluminium tubes of 4x4 mm^2 cross section

The aluminium 4x4 mm^2 tubes with 50 μm - diameter anode wires have also been studied. With the 50/50 Argon-Isobutane mixtire we could not reach the streamer mode operation because of the tubes breakdown. The use of the anode wires with smaller (30 μm) and larger (100 μm) diameters did not improve the tubes performance. The situation did change when the 23/77 Argon-Isobuthan mixture was used.

In fig.12 the dependence of collected charge on the applied high voltage for two tubes of different cross section is shown. The pulse height spectrum for HV corresponding to the single streamer mode is shown in fig.13.

Conclusions

In our tests we compared different methods of analogue readout using 3 kinds of chambers. The results are given in table 1. For plastic chambers with resistive coating the pad to wire signals ratio is 0.6 , while for the metalic chamber with the same readout this ratio is only 0.14. For the direct cathode readout the cathode to wire ratio is 0.35 , but the crosstalk between the working and the neighbouring electrodes is estimated to be less than 10% in the latter case whereas for the plastic tubes it is 15% ÷ 50% depending on the gate width.

Table 1

Q coll from different chambers

PVC chamber

HV v	Q coll pC		ratio
	wire	pad	
2700	2.1	1.2	.59
3200	44	26	.57
3600	90	55	.61

Al chamber with PVC cover

HV v	Q coll pC		ratio
	wire	pad	
2700	2.2	0.30	0.16
3100	31	4.9	.16
3200	49	6.0	.12

Cu chamber

HV v	Q coll pC		ratio
	wire	cathode	
2700	1.5	0.5	0.33
3080	33	12	0.36
3200	41	14	0.34

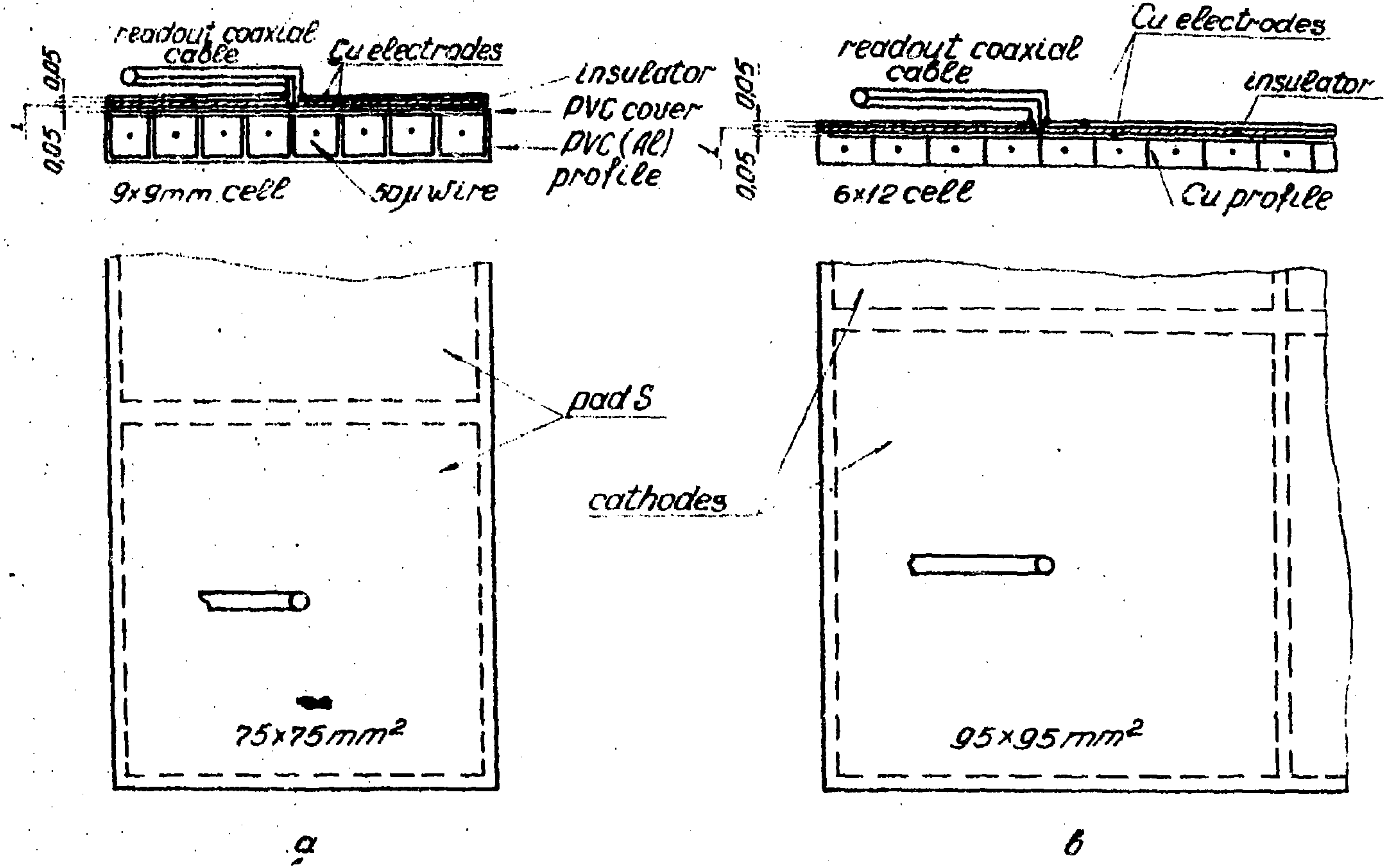

Fig. 1 **The test chamber arangement:**

a) PVC (Al) chamber with pads

b) Cu chamber with direct cathode readout.

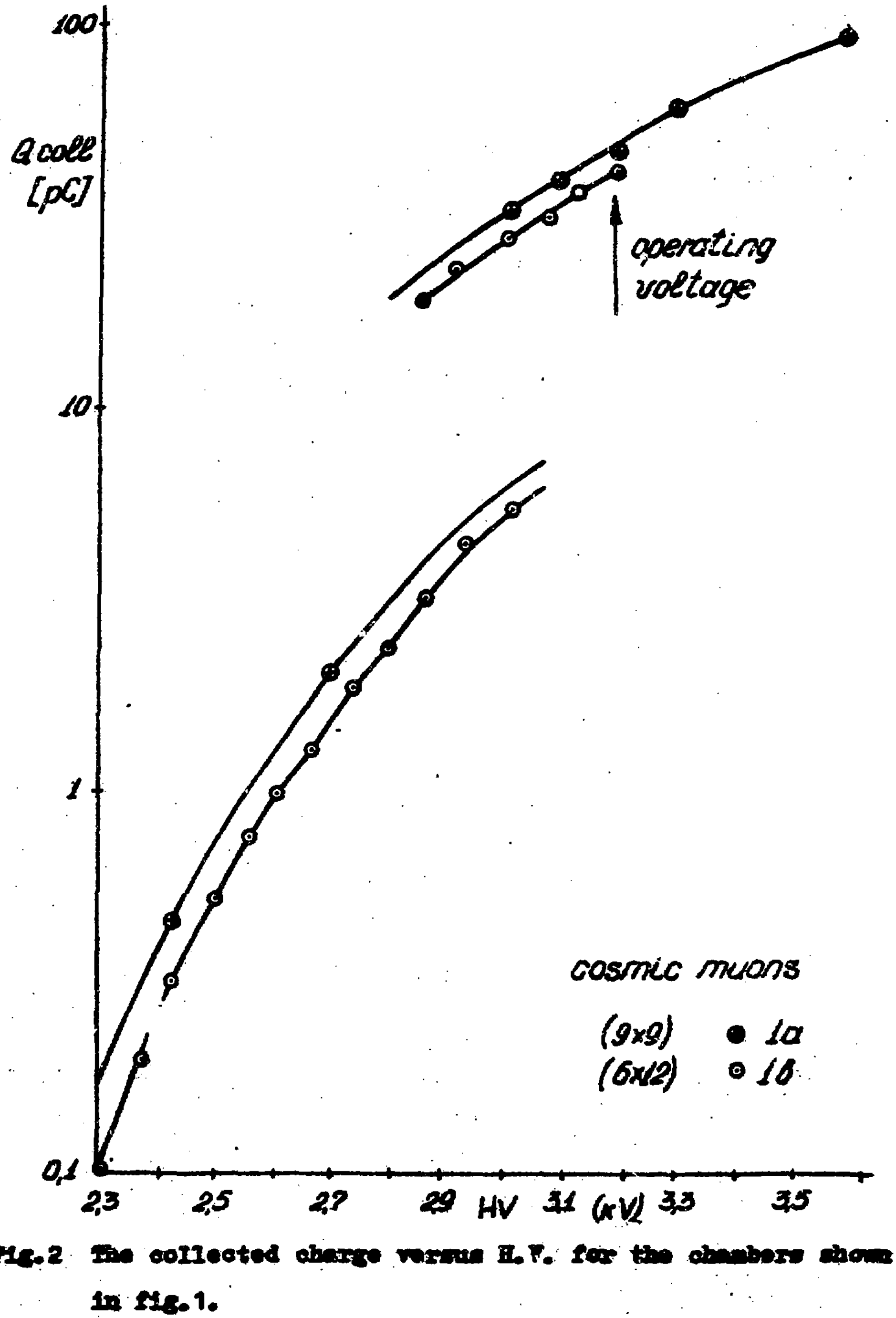

Fig.2 The collected charge versus H.V. for the chambers shown in fig.1.

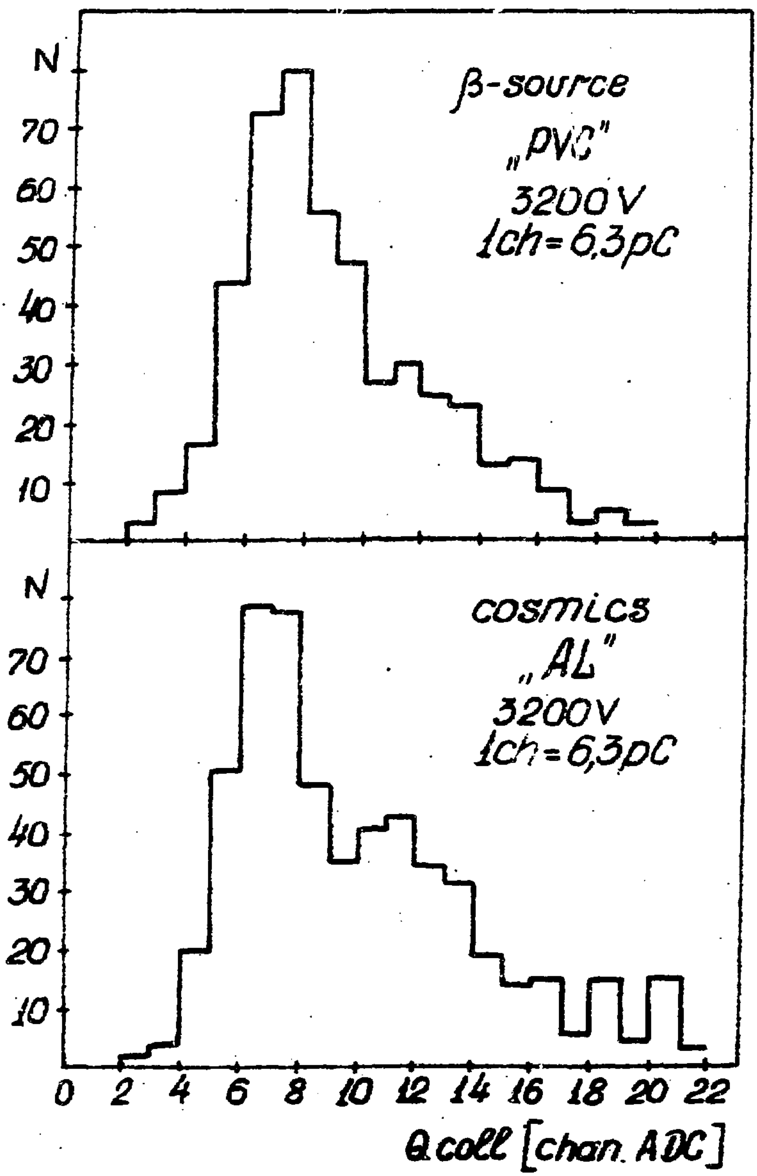

Fig.3 The collected charge distribution for the "PVC" and "Al" chamber anodes.

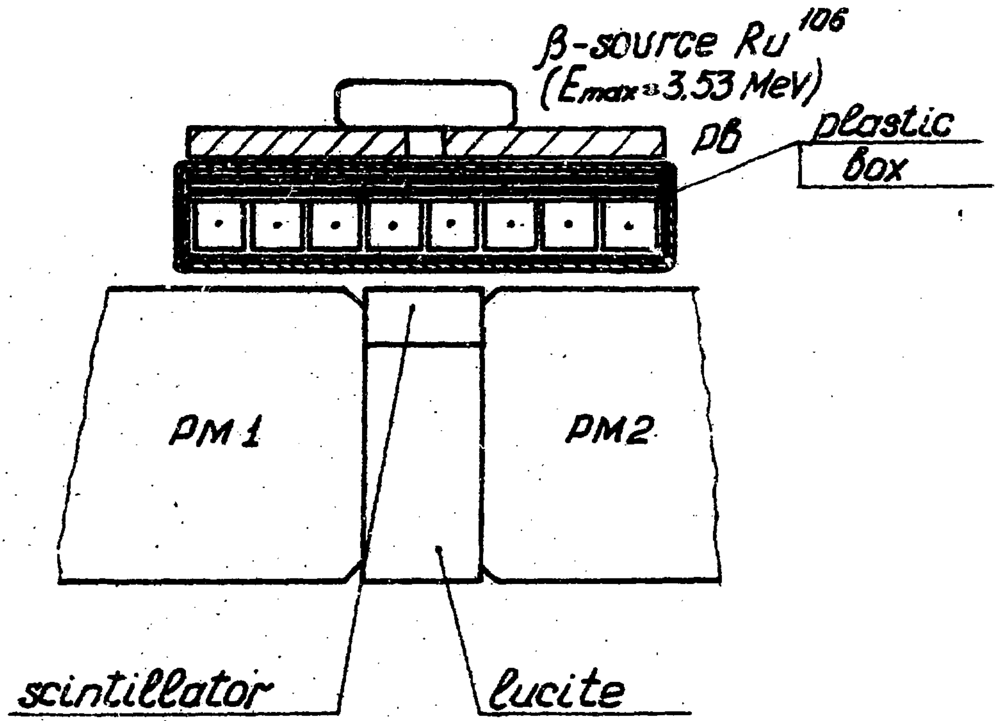

Fig. 4 The β -source test setup.

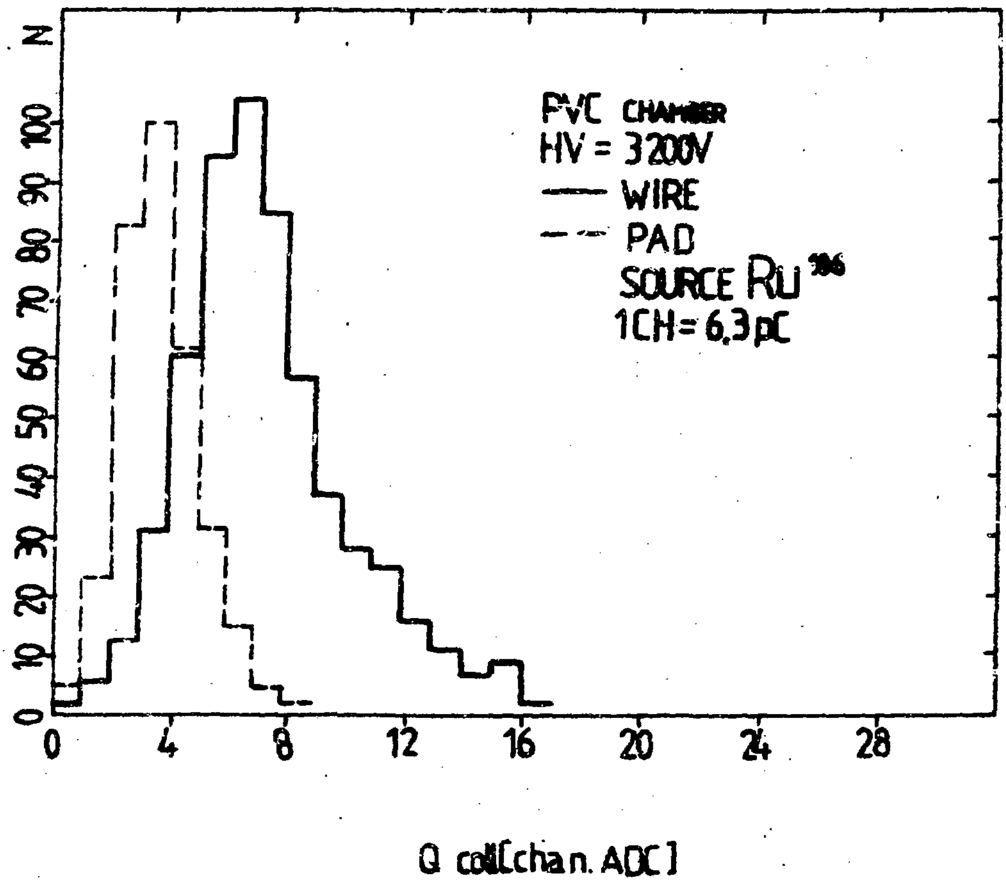

Fig.5 "PVC" chamber. Comparison of the charges collected on the wire and on the pad.

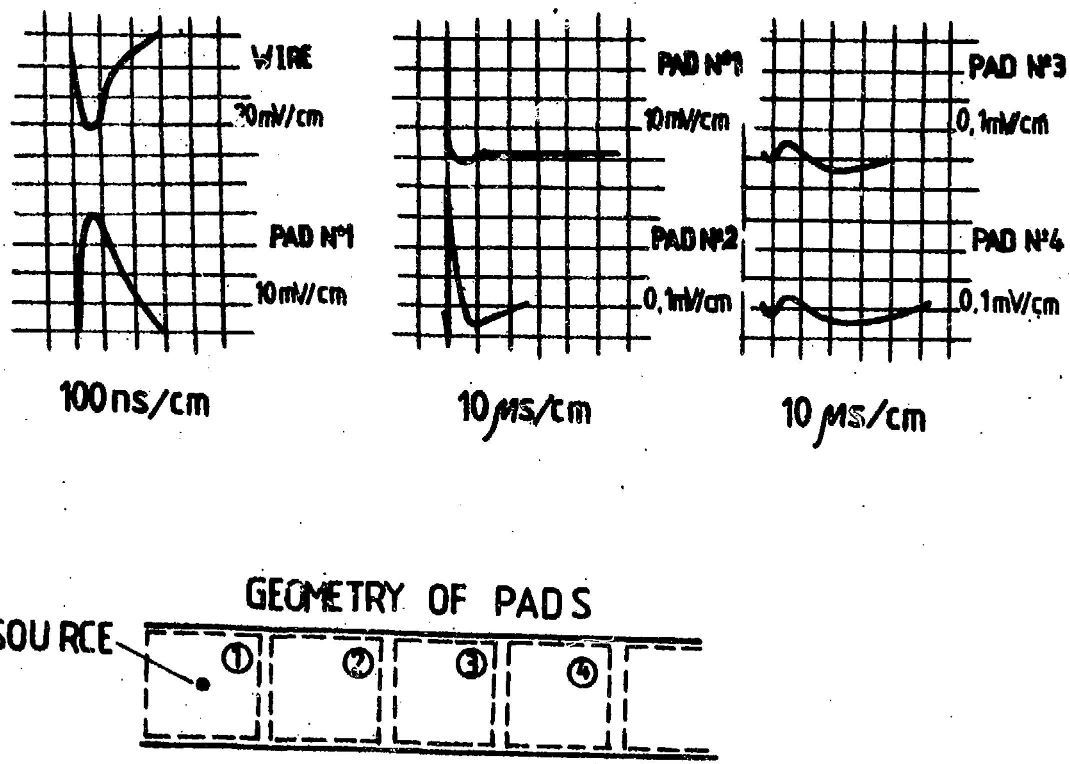

Fig.6 "PVC" chamber. The pulse shape diagrams.

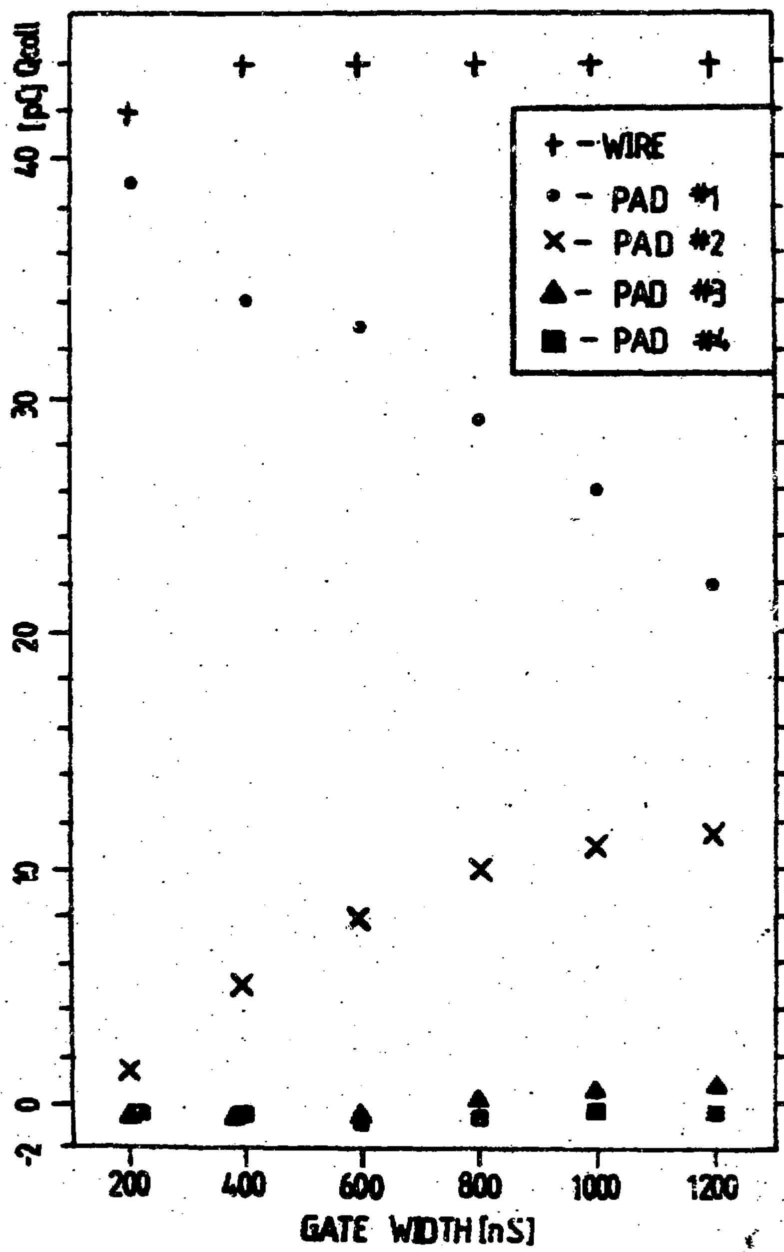

Fig.7 "PVC" chamber. Q collected versus gate width.

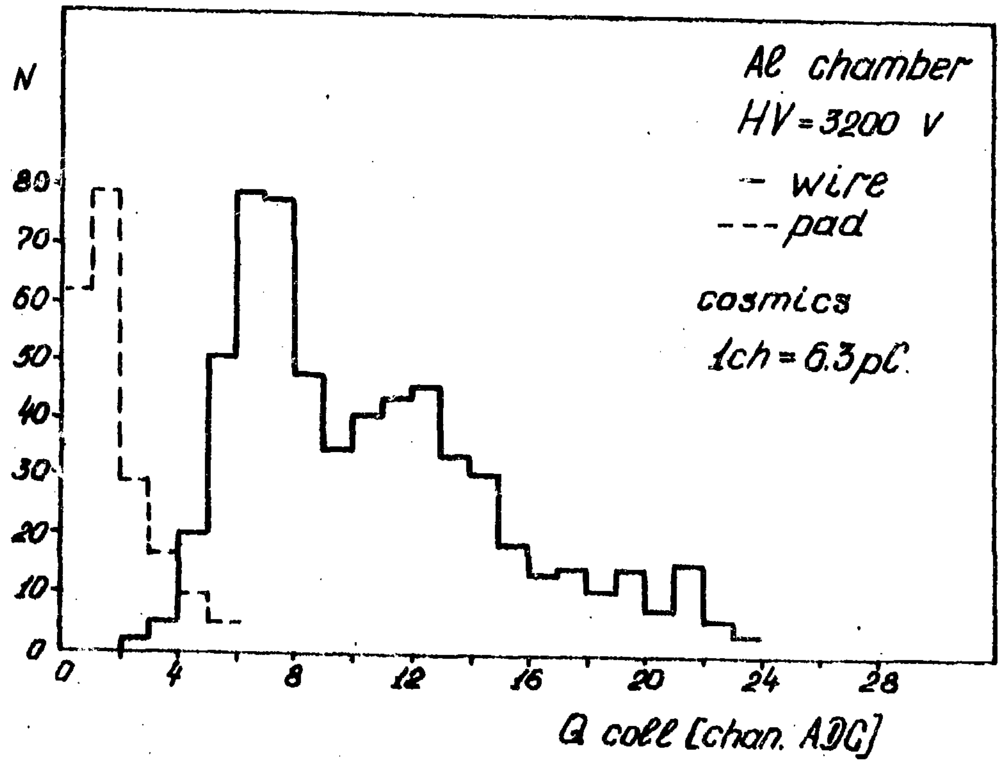

Fig.8 "Al" chamber. Comparison of the charges collected on the wire and on the pad.

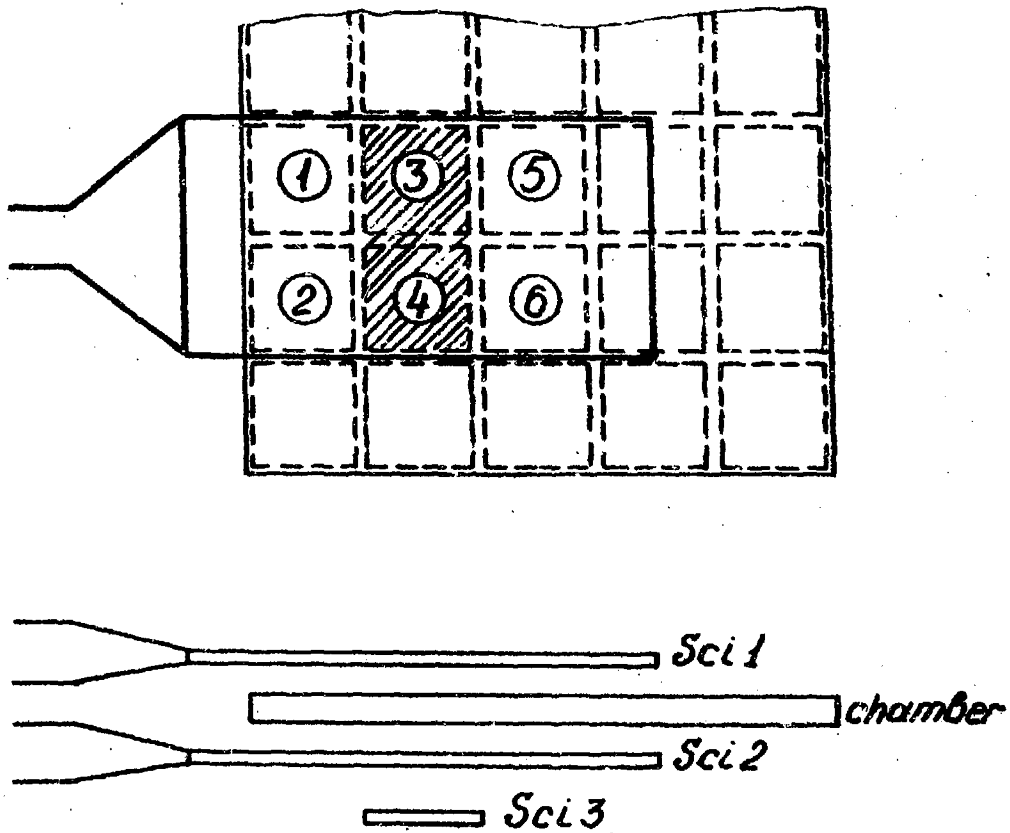

Fig.9 The direct cathode read out test set up.

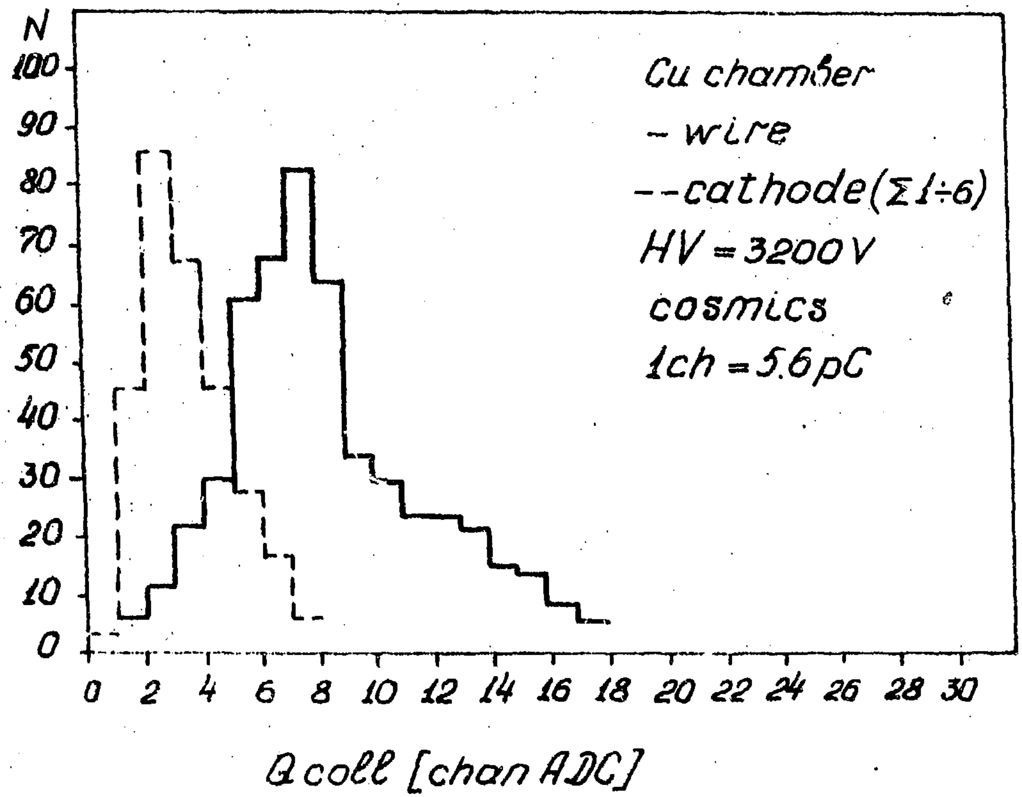

Fig. 10 "Cu" chamber. Comparison of the charges collected on the wire and on the cathode.

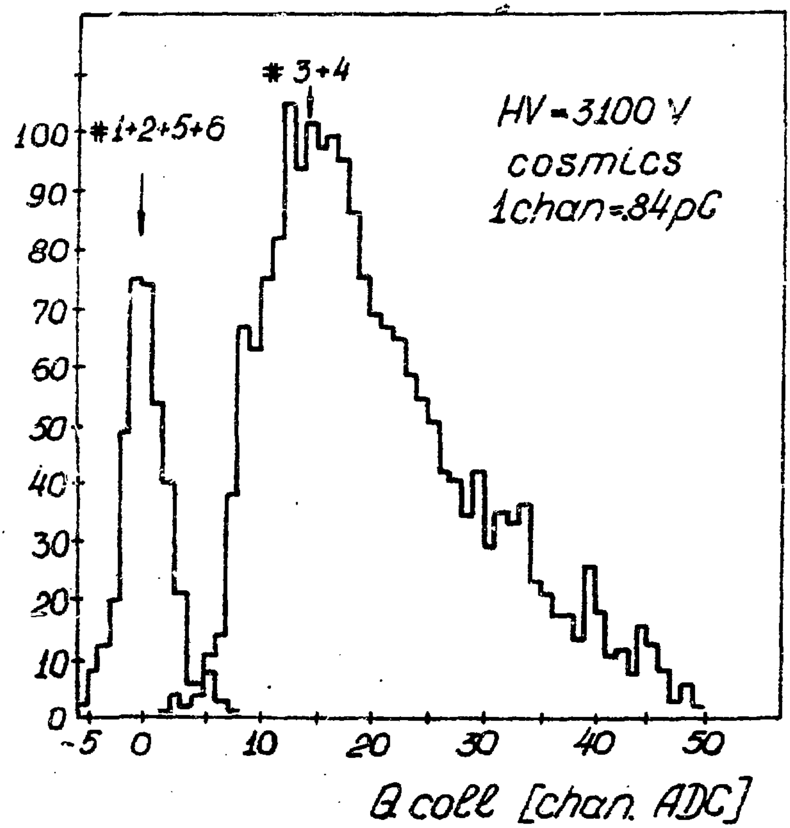

Fig.11 "Cu" chamber. Crosstalk check. The working cathodes are # 3 and # 4 . The rest (# 1, # 2, # 5, # 6) shoul be empty.

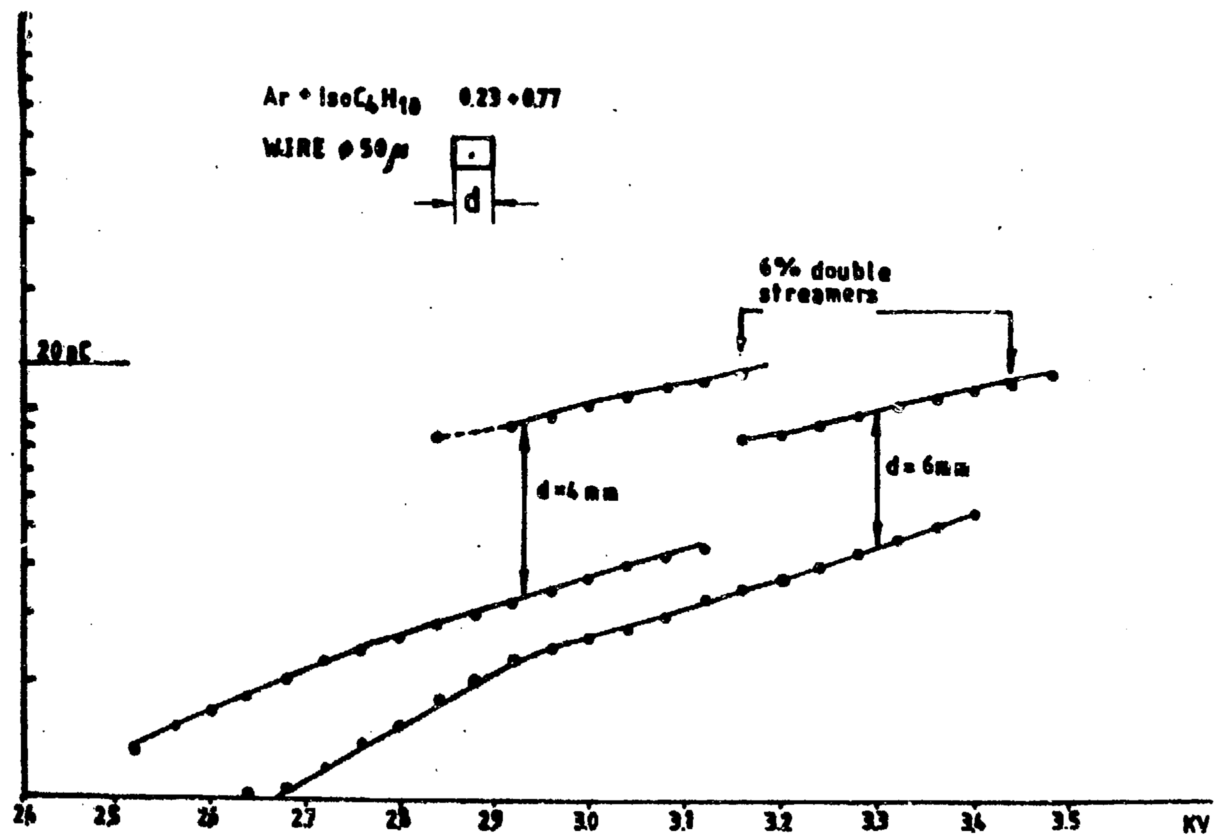

Fig.12 The collected charge versus H.V. for 4x4 mm^2 and 6x6 mm^2 tubes.

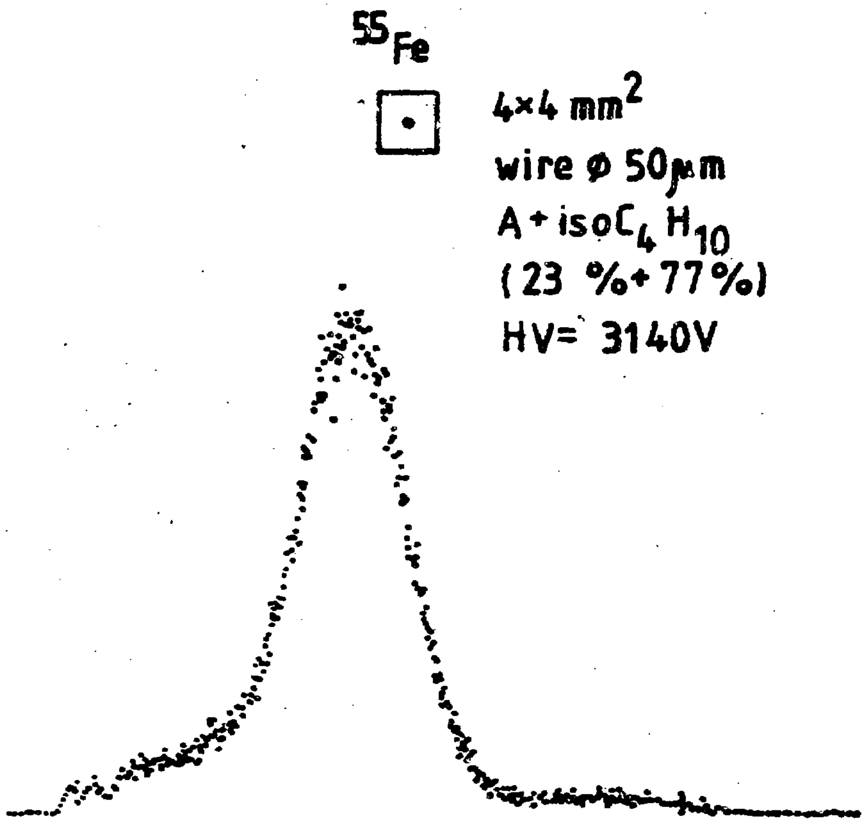

Fig. 13 The charge distribution for 4x4 mm^2 tube at 3140 V.

References

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2. Gygi E. and Schneider F. - EP-Int/83-06, 1983.

А.Арефьев и др.

Сравнение различных методов считывания информации со стримерных трубок

Работа поступила в ОНТИ 3.10.83

Подписано к печати 4.10.83 Т19746 Формат 60 х 90 1/16
Офсетн.печ. Усл.-печ.л.1,25. Уч.-изд.л.0,9. Тираж 290 экз.
Заказ 151 Индекс 3624 Цена 13 коп.

Отпечатано в ИТЭФ, 117259, Москва, Б.Черемушкинская, 25

ИНДЕКС 3624

М.,ПРЕПРИНТ ИТЭФ, 1983, № 151, с.1-20