INSTITUTE FOR HIGH ENERGY PHYSICS

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STUDY OF THE HADRON SCATTERING PROCESSES AT LARGE

TRANSVERSE MOMENTA

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I. PHYSICS

During last years investigations of hadron interactions where secondaries gain large transverse momentum, have become of great interest. It is connected with the fact that, as it was shown by recent experiments at CERN, IHEP, Brookhaven, Batavia, just the investigations of deep inelastic processes, the processes with large transverse momenta provide us with information on internal structure of particles, give us the possibility to reveal new features of their interactions and to observe new particles.

The following directions of the further investigations of these processes may be pointed out as the most perspective:

a) A study on inclusive distributions in a wide range of kinematic variables.

b) A study on correlations in multiple particle production in deep inelastic processes.

c) A study on effective mass spectra and search for new particles.

One may expect that by the moment the aforementioned experiments are in progress, i.e. in 3-4 years, a number of problems in physics of deep inelastic scattering we face nowdays will be solved. Still no doubt, that for a long period of time this direction of investigations will remain one of the most important in high energy physics.

For studying this class of interactions at the CERN SPS
we propose to build a multipurpose spectrometer. The distin-
guished feature of the spectrometer is the ability to detect
and identify simultaneously a large number of both charged
and neutral particles (see Appendix I). Up to now the space-
-momentum distributions of secondaries have been studied expe-
rimentally either for charged particles or for neutral ones.
The exception is the data obtained with heavy liquid bubble
chambers. However a considerable ambiguity arises in this case
due to the complex nuclei involved in the reactions, and lack
of statistics makes the large transverse momentum range we are
interested in unavailable.

Still to understand the interaction mechanism we need da-
ta on momentum and angular distributions, as well as distribu-
tion in the effective mass for all the particles, both charged
and neutral ones. Only in this case the information on the fi-
nal states of scattering processes stops being fragmentary and
becomes complete and free from assumptions on the character of
the correlations of distribution.

A simultaneous detection of charged and neutral particles
will allow us to determine a number of important characteris-
cics of deep inelastic interactions such as the dependence of
the mean number of neutral particles on the multiplicity of
the charged ones, total multiplicity in different ranges of
effective missing mass, topology of inclusive spectra for
resonances, etc.

One of the interesting studies would be charge-exchange
inclusive processes, such as $\pi^- + p \to \pi^0 + X^0$. A study of

this process alongside with the process $\pi^+ + p \to \pi^- + x^+$ will make it possible to extract a contribution of triple-Reggeon diagram, that tends to zero at small momentum transfers. This opens one of the possibilities to check selfconsistency of Regge model for particle interaction at high energies.

One of the most important points in the program under discussion is the study on the correlation of the states in scattering with large transverse momenta, $P_\perp \geqslant 2$ GeV/c. These experiments provide us with knowledge on particle structure at small distances and are the test for parton model of deep inelastic interactions.

A simultaneous detection of charged and neutral particles gives the information on exclusive processes in the region of large $P_\perp$ and opens the ways for effective search for new particles with large masses and for observation of the associated particle production. Unique advantages to search for neutral particles in charge exchange reactions, where background is considerably suppressed, should be underlined. Universal character of the set-up allows to search for heavy charged particles with new quantum numbers, as decay product of the neutral ones.

II. THE EXPERIMENTAL SET-UP

It is proposed to build a universal multipurpose spectrometer for neutral and charged particles for investigation on the scattering processes with large transverse momenta. The spectrometer is supposed to be installed in high-intensity, high resolution hadron beam with maximum energy (e.g.

H2/P2) in the North experimental area of the CERN SPS[1].
A brief description of the main part of the apparatus (fig. 1)
is given below.

The differential (D) and threshold (C_1, C_2, C_3) gas
Čerenkov counters of high resolution will be used to identify
pions, kaons, protons and antiprotons in the beam. The dif-
ferential counter 20 m long, the emission angle of Čerenkov
light is 6 mrad. The expected velocity resolution will be
5×10^{-7}. The background level is expected to be less than
10^{-6}. The length of the threshold counters C_1, C_2, C_3 are
10, 20 and 40 m respectively. All the Čerenkov counters will
be filled with helium. Photomultipliers of high sensitivity
with a quarz window and high efficient first dinode will be
used to detect Čerenkov light. The design of the Čerenkov
counters are similar to those described earlier[2,3].

The proportional chambers PC_1-PC_3 and scintillation ho-
doscopes H_1, H_2 are to be used to define the incident particle
direction with the accuracy better than 0.1 mrad and their
coordinates better than 1 mm.

The particle beam is focused onto the liquid hydrogen
target T with thin walls. Its length is about 50 cm. The tar-
get is surrounded with the set of scintillation hodoscopes H_3
and proportional chambers PC_4, that detect the recoil proton,
i.e. they measure the proton angle and its momentum by time-
of-flight technique. These detectors may also be used as
a "guard" system, required for a neutral trigger.

A wide-aperture magnet with a set of wire and drift
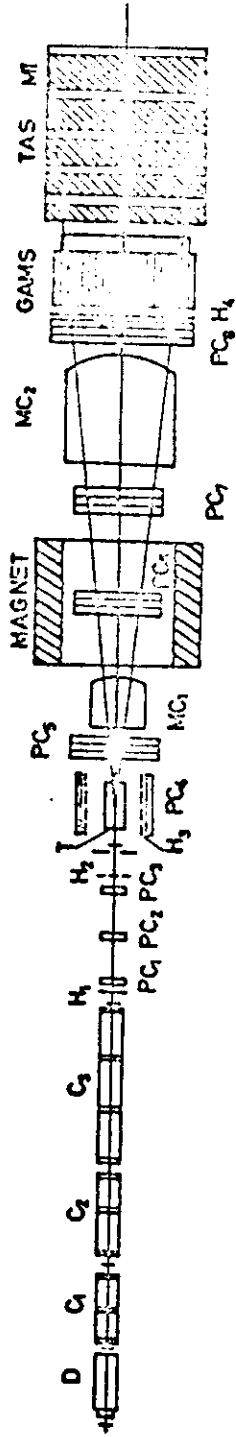chambers P_5-P_7, and hodoscope H_4 are used to measure the mo-

Fig. 1. A schematic layout of the apparatus. D – differential
Čerenkov counter ; C_1-C_3 – threshold Čerenkov counters;
H_1-H_4 – scintillation hodoscopes; T – target; MAGNET –
large aperture magnet; $MC_{1,2}$ – multicell Čerenkov counters;
GAMS – hodoscope spectrometer for photons and electrons;
TAS – total absorption spectrometer; MI – muon identifier.

mentum of charged secondaries. The field is equal to 20 Tesla meter, the particle momenta are measured with an accuracy of 1%. The magnet accepts the particles, going at the angle up to 100 mrad with respect to the beam axis. The magnet aperture is $2 \times 1 m^2$. This part of the set-up is similar to the system used in the spectrometer "Sigma"[7,8].

The magnet is followed by a multicell threshold Čerenkov counter HC_2, used for simultaneous identification of a large number of charged secondaries. Its lenght is 10 m, the aperture is $4 \times 2 m^2$, velocity resolution is 10^{-6}. The counter reminds the one described in ref.[9].

After the threshold counter there comes the universal spectrometer for photons and electrons (GAMS) (see Appendices 1, 2), that allows one to measure with a high accuracy both the coordinates and energy of large number of photons and electrons simultaneously, as well as to reconstruct the mass and kinematic characteristics of the decaying particles. It is a hodoscope detector,consisting of 4096 total absorption Čerenkov counters made of lead glass. The spectrometer GAMS may be exploited in the experimental set-up described above and separately (see Appendix 1).

The set-up ends with a hadronic spectrometer TAS and muon identifier MI[7]. The TAS is used to detect hadrons and to determine their energy with an accuracy 10%. The total thickness of the steel absorber in the muon identifier is 4 m.

The signals from the particle detectors are recorded by electronics in CAMAC ("Vector") standard. The number of crates amounts about 20.

In front of the magnet there is the multicell differential Čerenkov counter[4,5], that uses hodoscope photomultiplies[6]. This counter allows one to measure simultaneously the velocity of several particles (including the short living ones with life-time $\geqslant 10^{-10}$ sec). It is 2 m long, with velocity resolution of 10^{-6}. The optical system of this counter consists of a spherical and conical mirrors. The light is focused on 48 hodoscope photomultipliers, placed near the focal plane of the counter.

Three computers of Hewlett-Packard 2100 type will be used "on-line" at the initial stage of the experiment. One of them will perform the control over the parameters of the apparatus as well as the digital quidance of the detectors. Another two computers will provide the data aquisition, their preliminary processing and recording onto the magnetic tapes. For the future it is planned to widen the possibilities of multiaccess and of preliminary analysis of the data by including small computers into the system of the "FOCUS" type. The amount of the recorded information will be almost 10^7 bits per accelerator cycle.

The final data analysis will be realized at the IHEP computer center and those of the participants from CERN.

It is worth underlying the necessity of exploiting a wide system of computers for controlling and monitoring the huge set-up, for recording the spectrometer data and to analyze them "on-line". As a rule such system consists of 3-4 small computers and the main one of moderate power. An example of such installation is a multipurpose photon spectrometer NICE deve-

loped at the IHEP[10,11], in which 4 small computers are used.
The flux of the recorded information in this system is almost
2×10^6 bits/sec. More than 3000 of the set-up parameters are
controlled.

III. THE SCHEME FOR APPARATUS DEVELOPMENT

The Soviet group can produce the principle part of the
set-up including: the 4096-channel hodoscope spectrometer for
photons and electrons (GAMS), hadronic calorimeter, muon iden-
tifier, high resolution Čerenkov counters, scintillation hodo-
scopes and some part of proportional and drift chambers. This
apparatus can be designed and built at the IHEP and tested in
the beams of the 70 GeV IHEP accelerator in conditions of real
experiments in 1975-1977 years. IHEP will ensure manufacturing
of the associated electronics in CAMAC ("Vector") standard and
will deliver two computers of Hewlett-Packard 2100 type on line
with the electronics of the set-up and supplied with the neces-
sary software.

It is our wish, that the groups, participating in the ex-
periment from the CERN side, would built the magnet, liquid
hydrogen target, some part of the proportional and drift cham-
bers with electronics and appropriate computers, as well as
would provide apparatus to control the beam. We would like
to use CERN computer of moderate size as the main one in the
system of FOCUS type. It will be linked to 4-5 small computers
of the spectrometer.

IV. PARTICIPANTS. TIME SCHEDULE

It will be a joint group of collabotators from IHEP, CERN and CERN country-members to work at the CERN SPS with the universal spectrometer. One should account on 2-3 year experimental program with the spectrometer.

To design the equipment, to test its units in the particle beams, to create software one needs about 2-2.5 years from the starting point. The experiment may be started at CERN in 1978, i.e. by the time the main North Hall Zone 1 of the SPS will be put into operation.

In the framework of the program of preparing for afore-
mentioned experiments, in 1974 we started our work on designing
a full scale prototype of the gamma-spectromster and checking
the principle of its operation in the particle beams (see Ap-
pendix 2). Besides the construction of multicell Čerenkov
counters, big drift chambers, digital and logic electronics
and software are in progress.

> The proposal is prepared by the Expe-
> rimental Physics Department of IHEP.

November, 30, 1974.

Appendix 1

ON DESIGNING AN UNIVERSAL GAMMA SPECTROMETER FOR THE
EXPERIMENTS AT THE CERN SPS.

Here we discuss the possibilities of constructing at IHEP
a detector of new type, designed for simultaneous and precise
measurements of the coordinates and energies of a large number
of photons. It is proposed to build a multipurpose universal
spectrometer*) that would be able to detect π^o-mesons and other
particles, decaying into photons (η , ω , X^o, f, φ , A_2 etc)
having in mind to use it at energies above 100 GeV and first of
all at the CERN SPS.

As we are speaking about the preparing of the experiments
that are to be started at CERN not earlier than 1978 (North
Experimental Zone), their details will be largely determined by
the development of the experimental programs in Batavia and
CERN ISR by that time. However, already now we would like to
stress the interest in problems, related to those scattering
processes, that result in production of particles with large
transverse momenta ($P_\perp \geqslant 2$ GeV/c). In these processes one can
"touch" a particle structure at ultimatly small distances and
here such phenomena as increase of total cross sections at high
energies may be explained at last. Study on deep inelastic in-
teractions is a long term program, that seems to us not to be
exhausted in the coming five years.

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*) Further we will refer to this spectrometer as CAES.

The spectrometer GAMS we are speaking about is oriented
to the investigations of deep-inelastic scattering processes.
The characteristic feature of those processes is the produc-
tion of large number of secondaries, among which π^{o}-mesons
and other neutral particles decaying into photons comprise a
large fraction. Therefore spectrometer should be capable of
simultaneous identification of a considerable number (10 or
more) of photons and reconstruction of kinematic charactiris-
tics of decaying particles with an efficiency close to 100 %.

The spectrometer GAMS is the hodoscope detector, whose
cell is a block of lead glass with the length of about 20 r.l.
The Čerenkov light is detected at the edge by a photomultip-
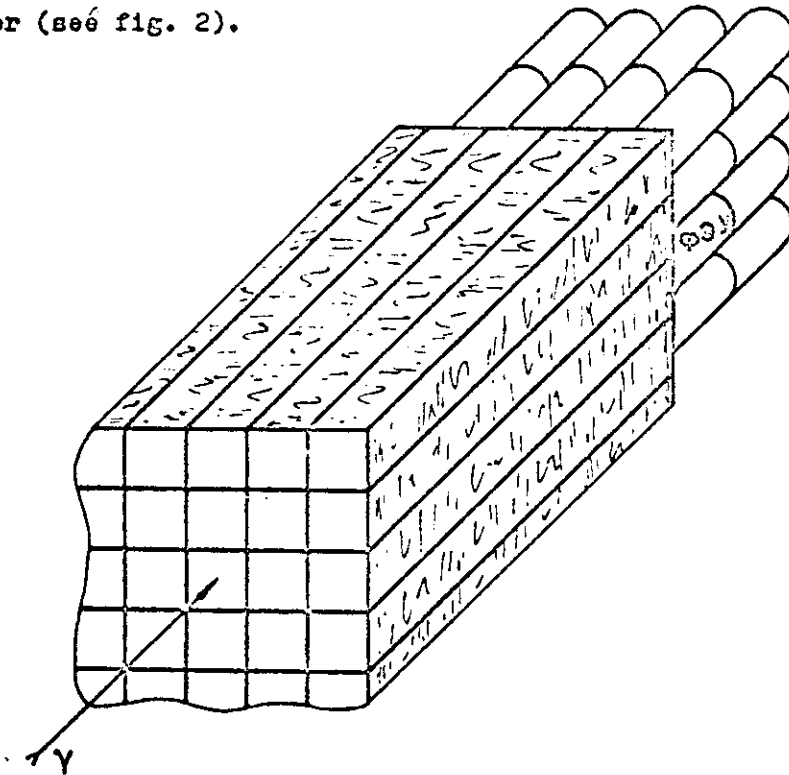lier (see fig. 2).

Fig. 2. The block-diagram of universal hodoscope spectrometer
GAMS.

The principal question, when designing the hodoscope detector is a choice for the cell dimension 2Δ . If $\Delta \gg b$, where b is an effective width of an electromagnetic shower (5-10 mm), then the detector being a good spectrometer that measures the photon energy with an accuracy of few percents within range of tens GeV, will allow one to determine the coordinates of photons only very roughly, with an accuracy $\sim \Delta$. Lead glass Čerenkov spectrometers developed up to now ($\Delta =$ = 50 - 150 mm) are such devices.

The method of precise (< 1.5 mm) defining of photon coordinates[12] was realized for the first time in the scintillation hodoscope spectrometer NICE ($\Delta =$ 7.6 mm) built at IHEP[13]. A device of this type allows one to measure both photon energy and the angle of their emission from the target with a high accuracy. Due to these properties it becomes a precision mass spectrometer for particles decaying into photons, it makes possible the reconstruction of masses with the accuracy of some percents.

What dimension should a cell of a hodoscope spectrometer have so as high accuracy in measuring coordinates may be realized? If a shower has an exponential transverse profile, then the condition $\Delta < (1.5 - 2)b =$ 10 - 30 mm should be fulfilled. Studies on the spectrometer prototype, performed by our group in 15 GeV electron beam (see Appendix 2) have given the following limitation: $\Delta \leqslant 15$ mm. In this case an error in locating the shower is about 3 mm. With the increasing the cell sizes, the accuracy of defining the photon coordinates is rapidly becoming worse. A $\Delta =$ 30 mm it is large as 2 cm.

With the increase of the cell size the method of defining
the photon coordinates by the centre of gravity of the shower
profile used in NICE spectrometer becomes considerably nonli-
near[12]. However another method may be applied, where infor-
mation on the shower peripheria is used. From the test of the
prototype in the electron beam nonlinearity does not exceed 2 mm
in this case if $\Delta = 15$ cm (see Appendix 2).

The number of elements in the hodoscope spectrometer is
determined by the number of simultaneously detected pnotons,
kinematics of the reaction, etc. To detect a wide class of
processes a detector aperture of 4 m^2 is sufficient. Such a
spectrometer consist of a set $64 \times 64 = 4096$ cells 3×3 cm^2
with the lenght of ≈ 30 cm each.

To detect the Cerenkov light the small-size photomulti-
pliers FEU-85 will be used. The pulse hight of the signal from
each tube are measured with A-D converters with 1024 discrimi-
nation levels. The spectrometer elcctronics is a huge system
for 4096-dimensional precize pulse-height analysis,its volume
is 4×10^6 bits. It will occupy 5 CAMAC ("Vector") racks. Elec-
tronics developed at IHEP in 1972 for the spectrometer
NICE[14-16] is similar but 5 times smaller in volume.

Many ideas of NICE set-up will be used in designing the
universal hodoscope spectrometer. Still some problems should
be solved in a quite a new manner. For example, it is true
for the H.V. power supply system and the spectrometer calib-
ration, that should be highly automized. Due to the big amount
of information the requirement to the computer are also at
a higher level. At the very first stage it will be sufficient

to have 2 computers of Hewlett-packard 2100 type with fast
tape units. In the future we will need the more powerful com-
puters to fully realize the capability of the spectrometer.

The estimated total cost of the spectrometer GAMS, electro-
nics and computers needed, comprises about 1.5 million rubles.
Its manufacturing will take about 10^5 working hours. The man-
power needed to build the spectrometer at the IHEP Experimen-
tal Physics Department is estimated as 60 manyears.

Here is the summary. The considered universal photon spec-
trometer GAMS have the following characteristics:

cell size	- 3 x 3 x (30 - 40) cm^3
number of cells	- 4096
aperture	- 4 m^2
glass volume	- 1.25 m^2
energy resolution for photons at 50 GeV	$\pm$ 2%
accuracy in defining the photon coordinates	$\pm$ 3 mm
mass resolution of decaying particle	- some percent
number of simultaneously detected photons	- some tens

As the device is of modular type, its geometry can be
easily changed to meet the requirements for the different
experiments.

The following possible ways of using the hodoscope spec-
trometer can be enumerated now.

1) It may be a part of a multipurpose spectrometer, designed to study a wide class of inelastic processes. One of the possible experiments is an experiment in a high intensity hadron beam H2/P2 in the North Experimental Zone H1 of CERN SPS. Deep inelastic scattering processes are analyzed in this experiment by the magnetic spectrometer with a vertex detector (charged particles); π^o-mesons and other neutral particles are detected with the hodoscope spectrometer.

2) Besides the hodoscope spectrometer may be used autonomously for solving such problems as:

a) investigation of inclusive processes of π^o-meson production in the wide range of $P_\perp$;

b) study of rare processes and decay channels, i.e. $\pi^- p \to X^o$, $X^o \to 2\gamma (\sigma \sim 10^{-32} \text{ cm}^2)$, a precise determination of octetsinglet mixing angle for pseudoscalar mesons at high energies;

c) vector meson (ω, φ) production at large $P_\perp$;

d) precise measurements of ρ-trajectory and A_2-trajectory at small $|t|$ in the charge-exchange reactions $\pi^- p \to \pi^o n$ and $\pi^- p \to \eta^o n$;

e) search for heavy particles, including particles with high spin; search for new particles decaying into photons, electrons and π^o-mesons.

A preliminary study on some of these problems may be performed at the 70 GeV IHEP accelerator with the prototype of the hodoscope spectrometer when the latter is being studied.

An universal hodoscope spectrometer GAMS is also very promising devise for future experiments at even higher energies.

The higher the energies are, the better its resolution. Such a spectrometer may widely be applied to detect π^0-mesons and other particles decaying into photons (or π^0-mesons) at energies above 1000 GeV.

A choice for the hodoscope spectrometer as a basic set-up in the experiments at the CERN SPS is partially determined by the fact, that we have gained a considerable experience in designing such spectrometers and carrying out experiments with them.

The spectrometer described above is a complicated set-up. Its construction will demand considerable efforts in carrying out a methodological studies, in studying its prototype in designing the electronics and software. It may be built in the Experimental Physics Department of IHEP in 2-2.5 years.

Yu.D. Prokoshkin

November, 15, 1974.

RESULTS ON EXPERIMENTAL STUDY OF THE HODOSCOPE

SPECTROMETER PROTOTYPE

The hodoscope spectrometer prototype was tested in the electron beam energy $E = 15$ GeV. The electrons were selected in the negative secondary beam to the 70 GeV IHEP accelerator with Čerenkov counters[17]. The structure of the spectrometer is shown in fig. 3. The cell size is 3.2 cm. The energy resolution obtained was $\sigma_E = 2.5\%$ (fig.4).

The measurements of the signal pulse-heights in the spectrometer counters were taken at different displacements (X_c, Y_c) of a thin (3 mm) electron beam with respect to the axis of the central cell.

1. The Shower "Profile"

Fig. 3 presents the dependence of the ratio of the average pulse heights in the i-th counter to (i + 1)th one upon the electron beam coordinates X_c. $X_c = 16$ mm corresponds to the border between two cells. The dependence is not described with the single exponent[12]

$$A(X) = A(0) \exp (-|X| /b). \qquad (1)$$

If two exponent are introduced: one that gives the shower core, and the other that describes the shower peripheria, then the experimental data are well fitted (fig. 5). The model of the shower profile in this case is:

$$A(X) = A_1 \exp (-|X| /b_1) + A_2 \exp (-|X| /b_2), \qquad (2)$$

$b_1 = 4$ mm, $b_2 = 13$ mm. The presence of a narrow "core" in the central part of the shower is confirmed also by the pulse height spectra, measured at the border of two cells.
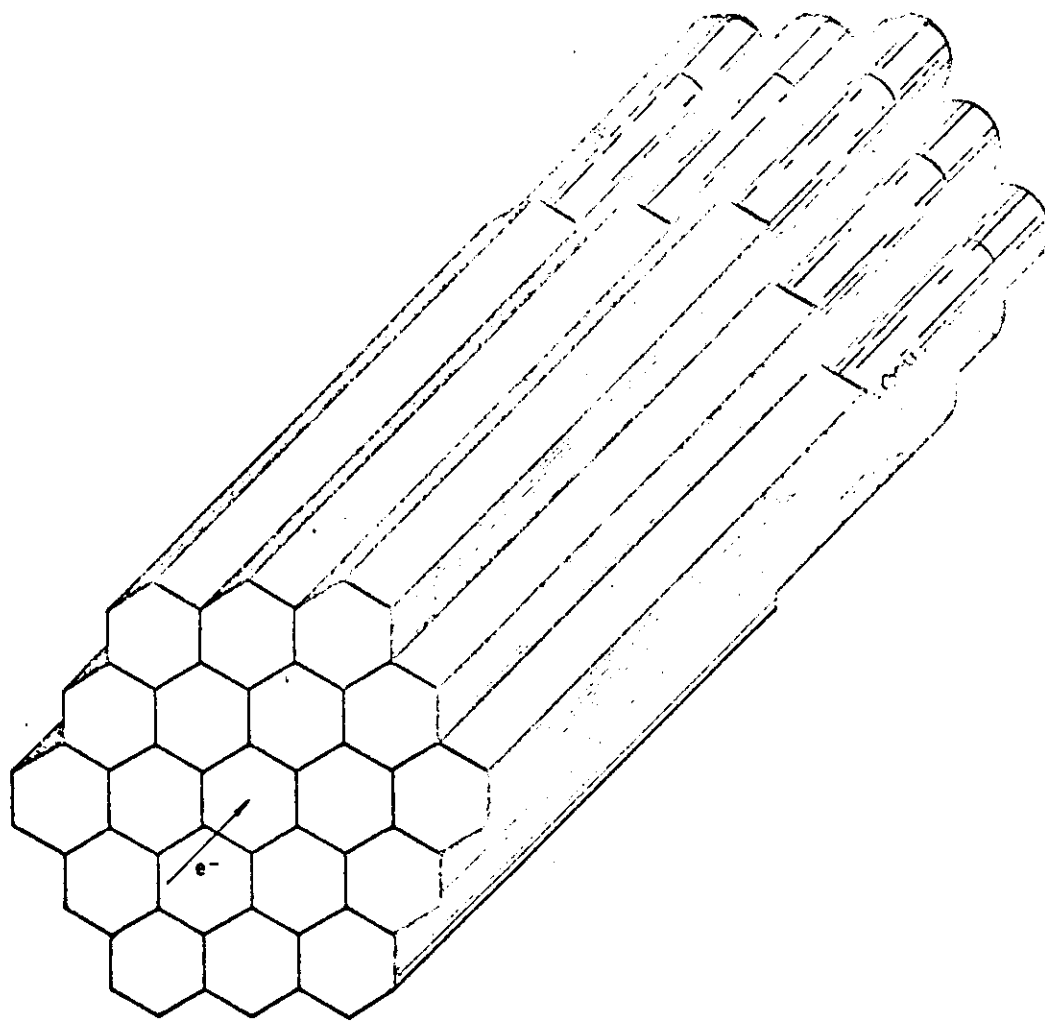
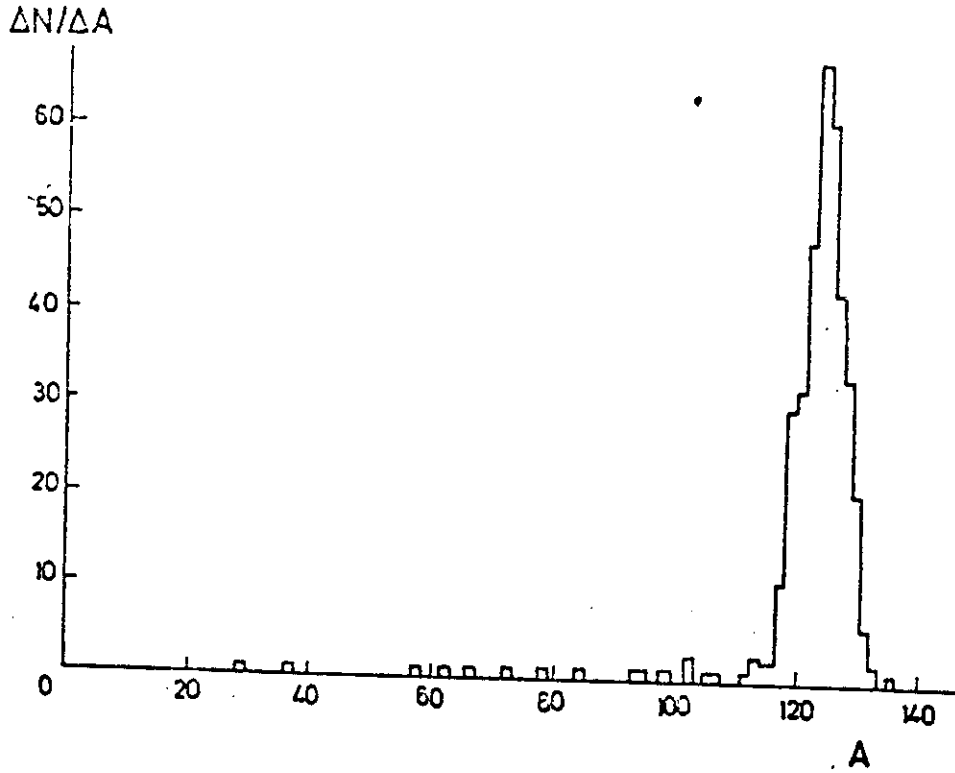Fig. 3. Prototype of the hodoscope Čerenkov spectrometer GAMS.

Fig. 4. Pulse-height spectrum of the pulses from the prototype of hodoscope Čerenkov spectrometer exposed to 15 GeV electrons.
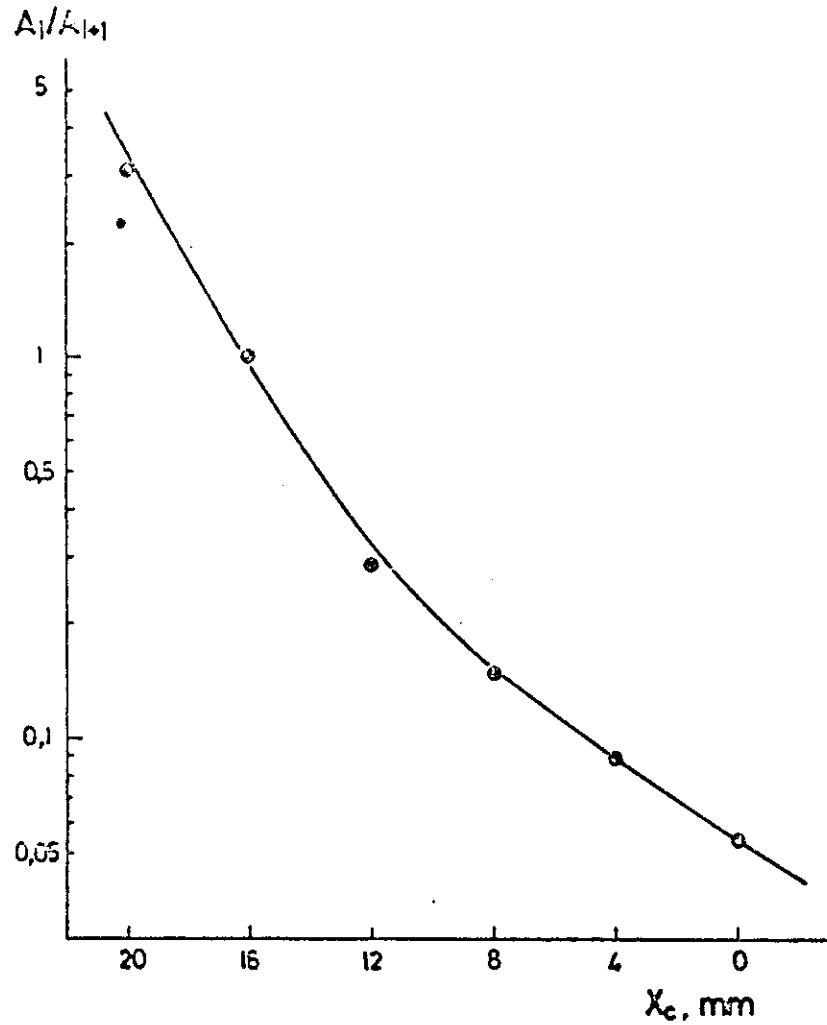
Fig. 5. The ratio of the average pulse heights in the adjacent
cells depending on the electron beam coordinates X_c.
X_c = 16 mm corresponds to the boundary between i-th
and (i + 1)-th cells. The curve is the calculated depen-
dence for model (2) with the parameters, indicated in
the paper.

2. DEFINITION OF THE COORDINATES BY THE CENTRE OF GRAVITY

In the hodoscope spectrometer NICE the coordinate of photons or electrons X_c was measured by the centre of gravity of the shower X_0 is the shifted estimate of the coordinate X_c [12];

$$X_0 = b \ \text{arcsh} \ (\frac{X_0}{\Delta} \ \text{sh} \delta), \ |X_c| \leqslant \Delta \tag{3}$$

where Δ is the half-width of the hodoscope cell, $\delta = \Delta/b$. $X_c = 0$ in the cell centre. However the difference between X_0 and X_c is not large at $\delta < 1$:

$$(X_c - X_0)_{max} \simeq \Delta \frac{\delta^2}{16} (1 - \frac{\delta^2}{20}) \ . \tag{4}$$

In the case of the spectrometer NICE ($\delta = 1 - 1.5$) it comprises $\leqslant 1$ mm. With the centre of gravity method the accuracy achieved in measuring the coordinates of photons in this spectrometer was 1.5 mm.

In our case the half-width of the hodoscope cell, $\Delta =$ = 16 mm, is much larger than the effective width of the shower. Therefore the dependence of the coordinate determined by the centre of gravity X_0 upon true coordinate X_c is considerably nonlinear (fig. 6). The dependence of X_0 upon X_c is well described by the exponential model (1) with the shower effective width

$$b = (5.7 \pm 0.6) \ \text{mm} \ .$$

It corresponds to $\delta = 2.8 \pm 0.3$. The difference between X_0 and X_c amounts to 5 mm. From formula (4) it is clear that the magnitude $(X_c - X_0)_{max}$ increases with Δ as Δ^3. As compared with the spectrometer NICE the nonlinearity becomes 10 times
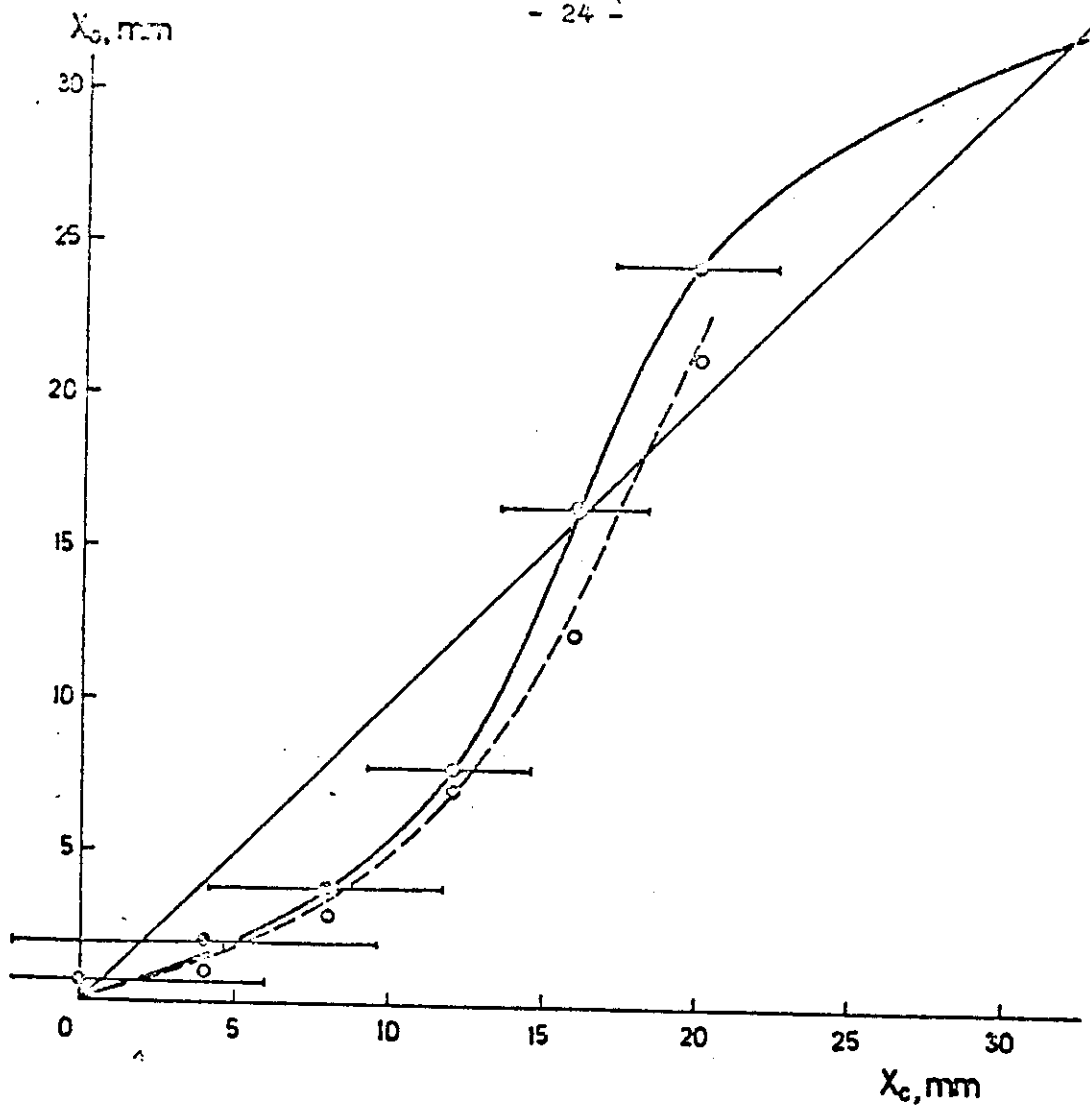
Fig. 6. Coordinates for the centre of gravity of the shower
X_0 at different positions of the electron beam X_c.
X_c = 0 corresponds to the centre of the cell. Black
circles are values for X_0, errrors indicate the
uncertainties in the X_c coordinate reconstruction.
Solid curve is from calculations made with formula
(1) at b=5.7 mm. Open circles and broken curve are
the same, but along y-axis.

larger. Besides the error σ_x has also increased, at small X it is almost 6 mm (fig. 6). At $X_c \approx \Delta$, at the border between the cells, $\sigma_x = 2.5$ mm. It is worth looking for other ways of defining the shower coordinates, since the centre of gravity method has become unsufficient and not precise. Below we will indicate two new methods.

3. OTHER ALGORYTHMS OF THE DEFINITION OF COORDINATES

a) In the case of the exponential shower model (1) the unshifted estimate of the shower coordinate X_c is

$$X_0 = \frac{b}{2} \ln \frac{A_{i+1}}{A_{i-1}} \tag{5}$$

Here A_{i+1} and A_{i-1} are the pulse heights of the signals in the $(i + 1)$-th and $(i - 1)$-th cells, shower centre positioned at the i-th cell. As it was noted, the shower profile model is more complicated in reality than (2). However in the case of the exponents (2) dependence (5) turns out to be quite precise in a wide range of X (fig. 7). There is only one parameter in formula (5), the shower width b, and it is very conventient for fast calculations.

b) The coordinate X_c may also be defined through the value of the ratio A_i/A_{i+1}. In this case

$$X_0 = \Delta - b \ln \left[(\frac{A_i}{A_{i+1}} + 1)/2 \right] . \tag{6}$$

The values for b in formulae (5) and (6) are quite different. In (5) we use the shower peripheria where $b \approx b_2 > \bar{b}$ to define X_0, while in (6) it is the shower central part and $b \approx b_1 < \bar{b}$.
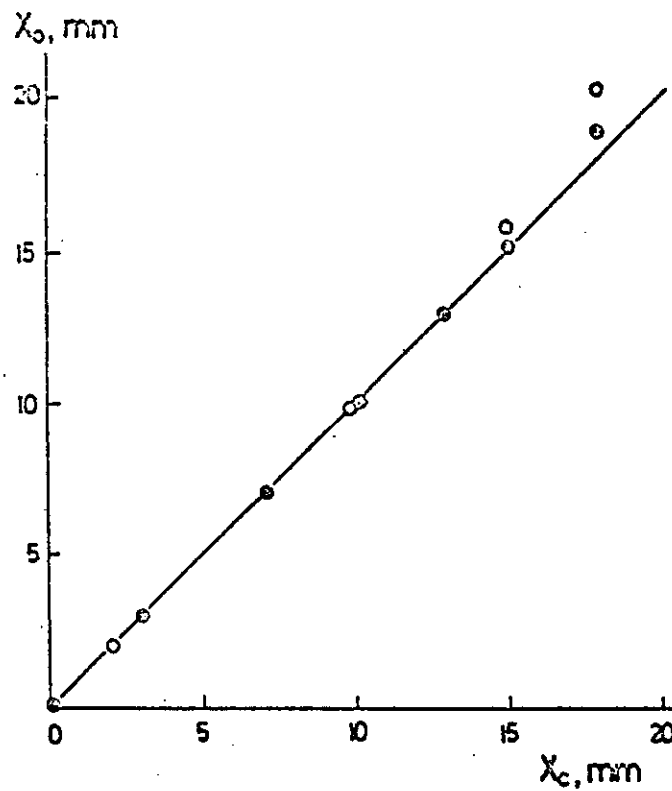
Fig. 7. The coordinate X_o, calculated with formula (5) for
model (1) (straight line) and model (2) (dots).
Dark circles are for $b_1=3$ mm, $b_2=9$ mm; open circles
are for $b_1=2$ mm, $b_2=10$ mm.

The distributions of the shower coordinates X_0 at diffe-rent X_c, calculated with (5), are presented in fig. 8. The magni-tudes b were chosen from the conditions $X_0 = X_c$. They are equal b = 6 mm for the case a) (formula (6)) and b = 17 mm for the case b) (formula (5)). It once again confirms the mo-del (2).

One may expect that formula (5) is valid only in a small neighbourhood of $X \simeq 0$ and (6) is applicable near the cell bor-der. However from the measurements it is clear, that the both formulae provide a good estimation for X_c and are linear in the whole range $-\Delta < X < \Delta$ (fig. 9).

The dispersion of the distribution over the coordinate X_0, defined with (6) is independent of X. Its square root is equal to

$$\sigma_X = 2.5 \text{ mm}$$

When using formula (5) we have the error of defining the coordinate $\sim$ 4 mm.
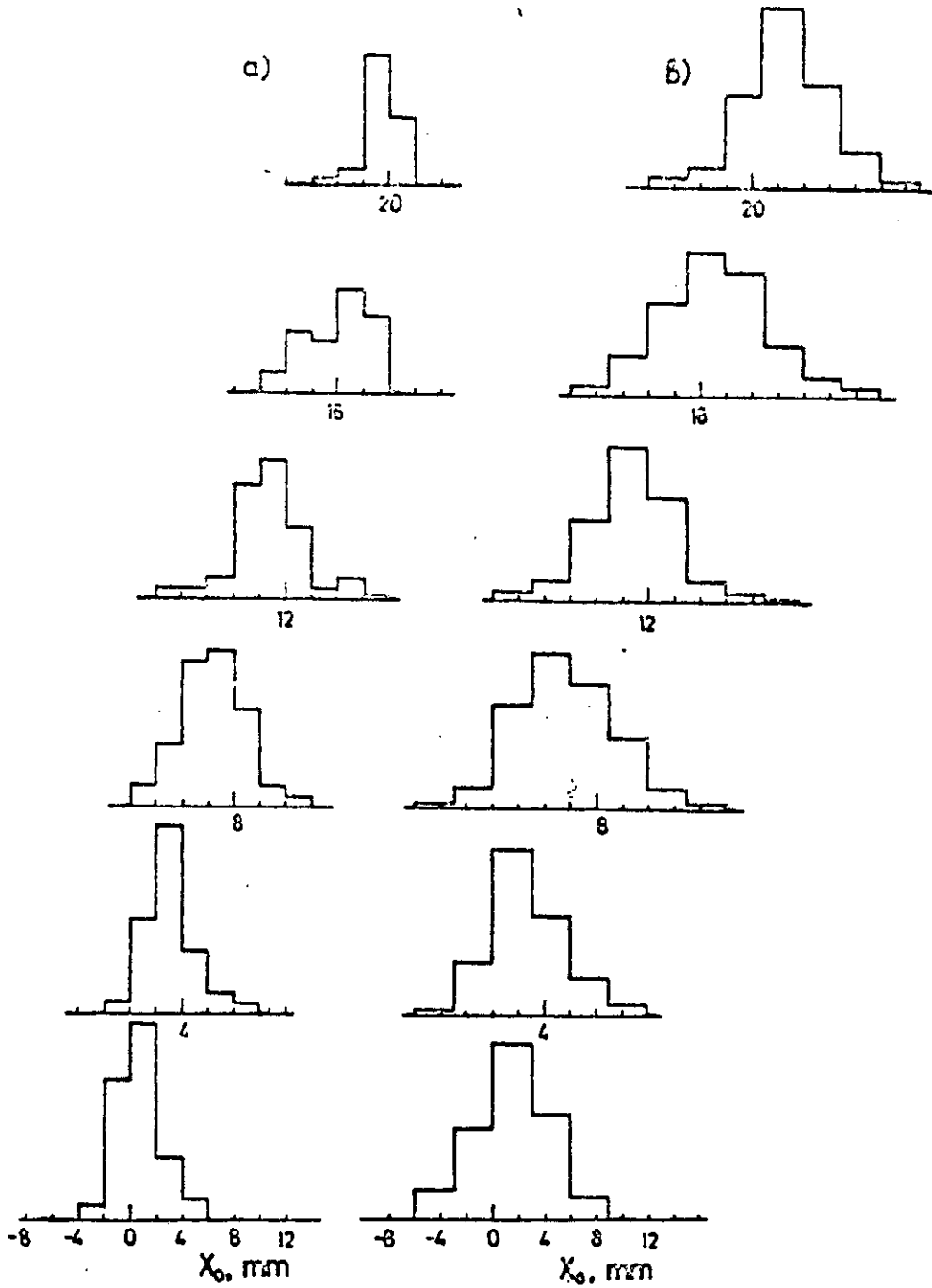
Fig. 8. The distribution of X_0 shower coordinates for different
X_c, calculated: a) with formula (6) and b) with formula
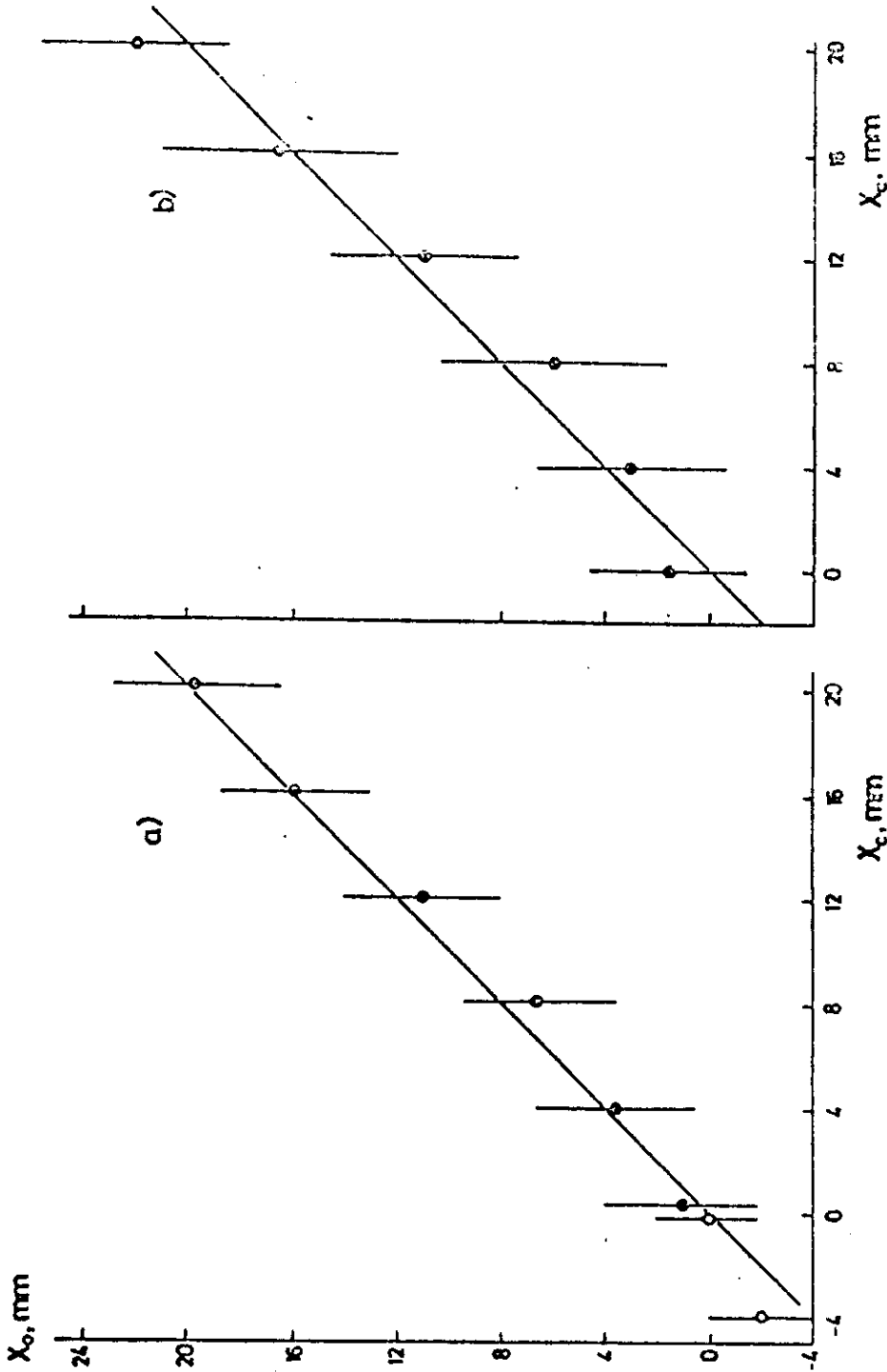(5). The electron beam shifts in 4 mm steps.

Fig. 9. The dependence of X_o shower coordinate upon the X_c electron beam position reconstructed: a) with formula (6) and b) with formula (5). The errors near the points are the values of σ_x.

4. CONCLUSIONS

The studies on the spectrometer prototype in the electron beam showed that the detector of this type allows us to measure photon and electron coordinates as well as their energy with high accuracy. The masses of particles decaying into photons and electrons are reconstructed with an accuracy $\approx \sigma_E$ /E ($\sigma_M/M \approx 2\%$ at E = 100 GeV).

December, 5, 1974.

R E F E R E N C E S

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