LETTER OF INTENT

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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, DESY, 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 nowadays 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 distinguished 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 experimentally 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 data on momentum and angular distributions, as well as distribution in the effective mass for all the particles, both charged and neutral ones. Only in this case the information on the final 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 characteristics 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 \( \pi^- + p \rightarrow \pi^0 + X^0 \). A study of
this process alongside with the process $\pi + p \rightarrow \pi^+ + X$ 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, $p_t \geq 2$ 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 $p_t$ 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 (C1, C2, C3) gas Čerenkov counters of high resolution will be used to identify pions, kaons, protons and antiprotons in the beam. The differential counter 20 m long, the emission angle of Čerenkov light is 6 mrad. The expected velocity resolution will be $5 \times 10^{-7}$. The background level is expected to be less than $10^{-6}$. The length of the threshold counters C1, C2, C3 are 10, 20 and 40 m respectively. All the Čerenkov counters will be filled with helium. Photomultipliers of high sensitivity with a quartz window and high efficient first dynode will be used to detect Čerenkov light. The design of the Čerenkov counters are similar to those described earlier/2,3/.

The proportional chambers PC1-PC3 and scintillation hodoscopes H1, H2 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 target is surrounded with the set of scintillation hodoscopes H3 and proportional chambers PC4, 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 P5-P7, and hodoscope H4 are used to measure the mo-
Fig. 1. A schematic layout of the apparatus. D - differential Čerenkov counter; C₁-C₃ - threshold Čerenkov counters; H₁-H₄ - scintillation hodoscopes; T - target; MAGNET - large aperture magnet; MC₁₂ - multicell Čerenkov counters; GAMS - hodoscope spectrometer for photons and electrons; TAS - total absorption spectrometer; MI - muon identifier.
momentum 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 $2 \times 1 \text{ m}^2$. 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 $M_2$, used for simultaneous identification of a large number of charged secondaries. Its length is 10 m, the aperture is $4 \times 2 \text{ m}^2$, 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 $M_1$/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 photomultipliers\(^6\). This counter allows one to measure simultaneously the velocity of several particles (including the short living ones with life-time \(\gg 10^{-10}\) 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 guidance of the detectors. Another two computers will provide the data acquisition, 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 INP/10,11/, in which 4 small computers are used. The flux of the recorded information in this system is almost $2 \times 10^6$ 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 (GAAS), hadronic calorimeter, muon identifier, high resolution Čerenkov counters, scintillation hodoscopes and some part of proportional and drift chambers. This apparatus can be designed and built at the INP 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 CALAC ("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 necessary software.

It is our wish, that the groups, participating in the experiment from the CERN side, would build the magnet, liquid hydrogen target, some part of the proportional and drift chambers 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 collaborators 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 aforementioned experiments, in 1974 we started our work on designing a full scale prototype of the gamma-spectrometer and checking the principle of its operation in the particle beams (see Appendix 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 Experimental Physics Department of INR.

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 HEF a detector of low 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 \( \pi^0 \)-mesons and other particles, decaying into photons (\( \eta, \omega, X^0, \phi, A_2 \) 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 moments (\( P_T > 2 \text{ GeV/c} \)). In these processes one can "touch" a particle structure at ultimately small distances and here such phenomena as increase of total cross sections at high energies may be explained at last. Study on deep inelastic interactions is a long term program, that seems to us not to be exhausted in the coming five years.

*) Further we will refer to this spectrometer as CALS.
The spectrometer GAMS we are speaking about is oriented to the investigations of deep-inelastic scattering processes. The characteristic feature of these processes is the production of a large number of secondaries, among which Λ⁰-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 characteristics 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 photomultiplier (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 $2\Delta$. 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 percent 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\textsuperscript{12} was realized for the first time in the scintillation hodoscope spectrometer NICE ($\Delta = 7.6$ mm) built at IHEP\textsuperscript{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 percent.

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: $\Delta \leq 15$ 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 nonlinear/12/. However, another method may be applied, where information on the shower periphery is used. From the test of the prototype in the electron beam nonlinearity does not exceed 2 mm in this case if \( \Delta = 15 \) mm (see Appendix 2).

The number of elements in the hodoscope spectrometer is determined by the number of simultaneously detected photons, kinematics of the reaction, etc. To detect a wide class of processes a detector aperture of 4 m\(^2\) is sufficient. Such a spectrometer consists of a set 64 \( \times \) 64 = 4096 3 \( \times \) 3 cm\(^2\) cells, with the length of \( \approx 30 \) cm each.

To detect the Čerenkov light the small-size photomultipliers FEU-85 will be used. The pulse height of the signal from each tube are measured with A-D converters with 1024 discrimination levels. The spectrometer electronics is a huge system for 4096-dimensional precise pulse-height analysis, its volume is 4 \( \times \) 10\(^6\) bits. It will occupy 5 CAMEL ("Vector") racks. Electronics 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 calibration, that should be highly automated. 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 IHBP 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  
number of cells    
aperture   
glass volume   
energy resolution for photons at 50 GeV   
accuracy in defining the photon coordinates   
mass resolution of decaying particle   
number of simultaneously detected photons   

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 N1 of CERN SPS. Deep inelastic scattering processes are analyzed in this experiment by the magnetic spectrometer with a vertex detector (charged particles); π⁰-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 π⁰-meson production in the wide range of P₁;
   b) study of rare processes and decay channels, i.e.
      \( \pi^- p \rightarrow X^0, X^0 \rightarrow 2\gamma(\sigma \approx 10^{-32} \text{ cm}^2) \), a precise determination of octet-singlet mixing angle for pseudoscalar mesons at high energies;
   c) vector meson (Ω,Φ) production at large P₁;
   d) precise measurements of ρ-trajectory and A₂-trajectory at small |t| in the charge-exchange reactions \( \pi^- p \rightarrow \pi^0 n \) and \( \pi^- p \rightarrow η^0 n \);
   e) search for heavy particles, including particles with high spin; search for new particles decaying into photons, electrons and π⁰-mesons.

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

An universal hodoscope spectrometer GAMS is also very promising device 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 $\pi^0$-mesons and other particles decaying into photons (or $\pi^0$-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 INEP in 2-2.5 years.

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Appendix II

RESULTS ON EXPERIMENTAL STUDY OF THE HODOSCOPE SPECTROMETER PROTOTYPE

The hodoscope spectrometer prototype was tested in the electron beam energy \( E = 15 \text{ GeV} \). The electrons were selected in the negative secondary beam to the 70 GeV HEP 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 \( X_c \cdot X_c = 16 \text{ mm} \) corresponds to the border between two cells. The dependence is not described with the single exponent/12/

\[
A(X) = A(0) \exp \left( -\frac{|X|}{b} \right). \quad (1)
\]

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

\[
A(X) = A_1 \exp \left( -\frac{|X|}{b_1} \right) + A_2 \exp \left( -\frac{|X|}{b_2} \right), \quad (2)
\]

\( b_1 = 4 \text{ mm}, b_2 = 13 \text{ mm} \). 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 \( X_0 \). \( X_0 = 16 \text{ mm} \) corresponds to the boundary between \( i \)-th and \( (i + 1) \)-th cells. The curve is the calculated dependence 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 $X_0$ was measured by the centre of gravity of the shower. $X_0$ is the shifted estimate of the coordinate $X_c/12$:

$$X_0 = b \text{ arctan} \left( \frac{X_0}{L} \right) \cdot \left| X_0 \right| \ll \Delta$$

(3)

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

$$(X_c - X_0)_{\text{max}} = \Delta \frac{\delta^2}{16} \left( 1 - \frac{\delta^2}{20} \right)$$

(4)

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

In our case the half-width of the hodoscope cell, $\Delta = 16 \text{ mm}$, 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 $\delta = (5.7 \pm 0.6) \text{ mm}$.

It corresponds to $\delta = 2.3 \pm 0.3$. The difference between $X_0$ and $X_c$ amounts to $5 \text{ mm}$. From formula (4) it is clear that the magnitude $(X_c - X_0)_{\text{max}}$ increases with $\Delta$ as $\Delta^3$. As compared with the spectrometer NICE the nonlinearity becomes 10 times
X₀, mm

X₀, mm

Fig. 6. Coordinates for the centre of gravity of the shower X₀ at different positions of the electron beam X₀. X₀ = 0 corresponds to the centre of the cell. Black circles are values for X₀, errors indicate the uncertainties in the X₀ 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 $S_x$ has also increased, at small $X$
it is almost 6 mm (fig. 6). At $X_0 = \Delta$, at the border between
the cells, $S_x = 2.5$ 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 ALGORITHMS OF THE DEFINITION OF COORDINATES

a) In the case of the exponential shower model (1) the
unshifted estimate of the shower coordinate $X_0$ is

$$X_0 = \frac{D}{2} \ln \frac{A_i + 1}{A_i - 1}$$

(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 convenient for
fast calculations.

b) The coordinate $X_0$ may also be defined through the value
of the ratio $A_i/A_i + 1$. In this case

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

(6)

The values for $b$ in formulae (5) and (6) are quite
different. In (5) we use the shower periphery where $b = b_2 > 5$
to define $X_0$, while in (6) it is the shower central part and
$b = b_1 < 5$. 
Fig. 7. The coordinate $X_0$, 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 different $x_0$, calculated with (5), are presented in fig. 8. The magnitudes $b$ were chosen from the conditions $x_0 = x_0$. 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 model (2).

One may expect that formula (5) is valid only in a small neighbourhood of $x = 0$ and (6) is applicable near the cell border. However from the measurements it is clear, that the both formulae provide a good estimation for $x_0$ 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. 6. The distribution of $X_0$ shower coordinates for different $X_0$, calculated: a) with formula (6) and b) with formula (5). The electron beam shifts in 4 mm steps.
Fig. 9. The dependence of $X_0$, shower coordinate upon the $X_e$ electron beam position reconstructed: a) with formula (4) and b) with formula (5). The errors near the points are the values of $\sigma_x$. 
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 $\approx \frac{C_E}{E}$ ($C_{\mu}\approx 2\approx 2\%$ at $E = 100$ GeV).

December, 5, 1974.
REFERENCES