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ROTATING DOUBLE ARM SPECTROMETER TO STUDY HARD SCATTERING INTERACTIONS AT SERPUKHOV ACCELERATOR

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Abstract

Abramov V.V. et al. Rotating Double Arm Spectrometer to Study Hard Scattering Interactions at Serpukhov Accelerator: IHEP Preprint 91-144. – Protvino, 1991. – p. 18, figs. 13, tables 2, refs.: 14.

The double arm magnetic spectrometer designed to study high P_T particle production with intense proton and pion beams is described. Particle trajectories are measured by the drift and proportional chambers. Particles are identified by Cherenkov ring spectrometer and muon identifier. The spectrometer can be rotated around the target up to 160 mrad.

Аннотация

Абрамов В.В. и др. Поворотный двухплечевой спектрометр для исследования жестких взаимодействий на Серпуховском ускорителе: Препринт ИФВЭ 91-144. – Протвино, 1991. – 18 с., 13 рис., 2 табл., библиогр.: 14.

Описывается двухплечевой магнитный спектрометр для исследования образования частиц с большими P_T в интенсивных протонном и пионном пучках. Траектории частиц измеряются системой дрейфовых и пропорциональных камер. Идентификация частиц осуществляется спектрометром колец черенковского излучения и мюонным идентификатором. Предусмотрен поворот всей установки вокруг мишени на угол до 160 мрад.

INTRODUCTION

High P_T hadron production - hard scattering interactions - remains one of the essential sources of information about quark and gluon interaction and hadron structure.

In the framework of the experiment E155 to continue the study of the hard scattering processes started with the spectrometer FODS [1] there has been developed and constructed an apparatus [2] with the following features:

- to operate with the pion and proton beam intensities up to 10^9 particles/s;
- to identify one and more secondary particles (μ, π, K, p) of both signs in each arm;
- to separate measurements of momentum and projection of particle emission angle on the horizontal plane;
- to measure in a wide range of the particle emission angles.

The apparatus is intended for systematical study of a single and pair particle production at high p_T at the angular range from 0 to 320 mrad in the lab. system:

$$\begin{pmatrix}\pi\\ p\end{pmatrix} + \begin{pmatrix}H\\ D\\ A\end{pmatrix} \rightarrow \begin{pmatrix}h\\ h_1 + h_2\end{pmatrix} + X,$$

where H, D, A are hydrogen, deuterium or solid nuclear targets, h is a single hadron $(\pi, K, p, \mathrm{or}\bar{p})$, $h_1 + h_2$ is a pair of charged hadrons emitted in opposite directions in the c.m.s. of the interacting particles.

1. BEAM AND MONITORS

The spectrometer is placed in beam line N 22 [3], which provides protons with momentum up to 70 GeV/c and other charged particles of both signs in the momentum range of 10-60 GeV/c. The proton beam intensity is limited by the radiation shield to 10^{10} particles/spill. The beam extraction time depends on the method of extraction and can be up to 2 s. The proton beam on the target of the spectrometer has the following dimensions: 3 mm high and 5 mm wide (90% of the intensity) and the beam divergence is 1.1 mrad in the horizontal plane and 4 mrad in the vertical one.

The pion beam intensity is defined by the number of extracted protons on the intermediate target, and for $5 \cdot 10^{12}$ protons/spill the pion intensity is $2 \cdot 10^{8}$ π^-/spill at 40 GeV/c and $\Delta P/P = \pm 10\%$. The pion beam on the spectrometer target is 12 mm high and 14 mm wide (90% of the intensity). The beam divergence is 2.7 mrad in the horizontal plane and 6.4 mrad in the vertical one. The decay muon background is reduced by an order of magnitude by a passive iron shield installed close to the beam line magnetic elements and by an active shield from magnetized iron placed upstream of the spectrometer.

The beam intensity and its position in space are measured by ionization chambers. The signal electrodes of the chambers for measuring space distribution of the beam particles are made of wires with 0.5 mm pitch and combined in groups 1, 2, 4 and 8 mm wide (the width increases from the center to the edge). The remaing wires are gathered into one group. The chambers are calibrated at low intensity (10^5 particles/spill) by scintillation and Cherenkov counters placed in the beam. The chambers are linear up to $2 \cdot 10^9$ particles/spill, which is determined by the linear range of the amplifiers-integrators. One ADC count corresponds to $2.5 \cdot 10^4$ particles/spill The calibration precision is estimated to be 10%. The total amount of the chamber material along the beam path is about 8 mg/cm^2.

A scintillation telescope MF directed at the scintillation counters S_1 is used as a relative monitor of the beam intensity. The spill duty factor during the beam extraction is measured each spill using the ratio of scintillation counters counts and its accidental coincidences. The layout of the apparatus is shown in Fig.1.

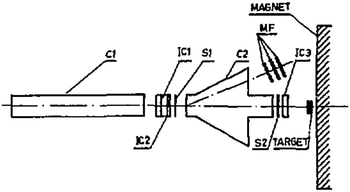

Figure 1. Layout of the apparatus for measurements of the beam characteristics. C_1 and C_2 are threshold gas Cherenkov counters; IC_1 and IC_3 are ionization chambers for measurements of the beam position; IC_2 is ionization chamber for beam intensity measuremenrs; S_1 and S_2 are scintillation counters; MF is the telescope of the scintillation counters of the relative monitor of the beam intensity.

2. TARGETS

The nuclear targets used (Be, C, Cu, Sn, Pb) are of 0.05-0.2 nuclear absorption lengths. They are set on a turning wheel with 12 fixed positions. The center of the targets is 18 cm from the magnet yoke. The 40 cm long and 5 cm diameter cryogenic target is filled with hydrogen or deuterium. Liquid helium is used for liquifying. The targets are remotedely put into the beam.

3. MAGNET

A two gap analysing magnet is made from the magnet SP-12A. The width of each gap is changing from 7 to 20 cm in the horizontal plane and the poles are 50 cm high and 3 m long. For symmetric position of the spectrometer the angle between the beam axis and the arm axis is 160 mrad, which corresponds to 90° for secondary relativistic particles in the c.m.s. of two interacting nucleons with $\sqrt{s}$ =11.5 GeV. The charged particles are bent in the vertical plane. In each arm particles of both signs are simultaneously detected. The magnet is installed on ball-shaped supports and can be rotated around the target up to 160 mrad. Thus the spectrometer can detect particles produced at angles from 0 to 320 mrad relative to the beam axis.

The magnetic field in the both gaps has been measured by a computer controlled magnetometer in $1.5 \cdot 10^4$ points with precision 10 gauss at five values

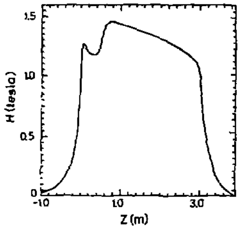

Figure 2. Magnetic field distribution along the arm axis. The distance is given from the forward face of the magnet yoke.

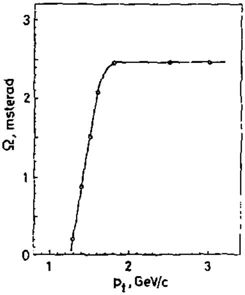

Figure 3. Solid angle of one arm dependence on particle momentum for maximum current.

of the current. The integral field is 4.2 Tm at the maximum current. Fig.2 shows the magnetic fiel shape along one of the spectrometer arms. The strong nonuniformity in the forward part of the gap is due to the cut of the part of the central pole to accomodate the beam absorber.

The solid angle dependence of one arm on P_T at maximum current is shown in Fig.3. The beam is dumped in the absorber inside the magnet along its axis. The absorber consists of 40 cm of tungsten and 2 m of iron.

4. MEASUREMENT OF PARTICLE TRAJECTORY

The particle trajectory is measured only downstream the magnet. The particle coordinate before the magnet is supposed to be the center of gravity of the beam cross section on the target. The precision of the momentum measurement depends on the vertical beam dimension on the target. *Thus for beam of* 2 mm diameter and for maximum current in the magnet the precision of the *momentum measurement in the range 6-10 GeV/c is 2%.*

The charged particle trajectory is measured by drift chambers [4] with dimensions 256 × 512 mm^2 and 512 × 512 mm^2. The chambers are filled with $Ar + 6\% CO_2$. In each arm of the spectrometer there are installed 6 drift chamber modules to measure X coordinate, 5 drift chamber modules to measure Y coordinate and 3 drift chamber modules tilted at 12° relative the vertical axis. The drift chambers layout is shown in Fig.4. The drift gap is 16 mm. Each module consists of two chambers in which the signal wires are displaced by the drift gap. The precision of particle coordinate measurement is σ= 0.18 mm. The drift chamber electronics allows to measure up to 4 particle coordinates in each chamber. The total number of the drift chamber channels is 786.

The precision of the particle trajectory reconstruction by drift chambers is determined by the accuracy of the chamber positioning and the electronics calibration, multiscattering of particles in matter along the path in the spectrometer (air, scintillator etc.). The positioning of the chambers is realized by a geodesic method with precision of 1 mm. There is some problem to attach the beam detectors coordinate system and the spectrometer coordinate system. Measurements with zero magnet current are carried out to verify the geodesic constants. Instead of the standard targets narrow vertical and horizontal targets 2 mm width and 0.1 nuclear absorbtion length along the beam are installed. Then the measured particle trajectories are reconstructed into target. The deviation of the reconstructed image from its real position allows one to make the geodesic constants more accurate. The final precision of the trajectory measurements is 0.5 mm.

The number of interactions in the target is limited by the counting rate of the slowest detector of the spectrometer. In this case the detector is the drift chamber. Because the drift chamber electronics is capable of detecting not more than 4 hits per trigger, then the main factor determining the chamber efficiency is the particle multiplicity growing with counting rate due to pile up. Nevertheless the efficiency of the particle trajectory reconstruction is high due to the surplus number of chambers. The dependence of the efficiency of the particle trajectory reconstruction on the drift chamber counting rate for a lead target (the worst case from the point of view of the counting rate) is presented in Fig.5.

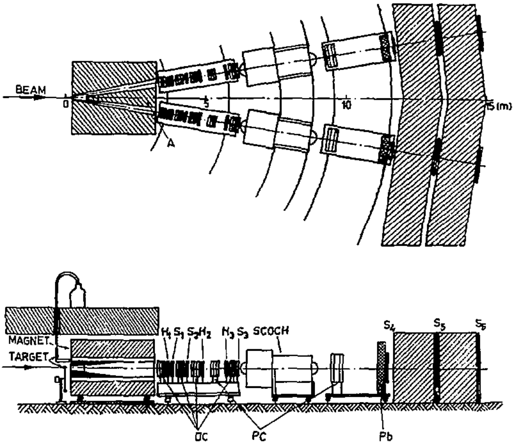

Figure 4. Layout of the apparatus. S is the scintillation counter; DC is the drift chamber; PC is a proportional chamber; H is a hodoscope; SCOCH is spectrometer of Cherenkov ring radiation; A is beam absorber; Pb is lead absorber.

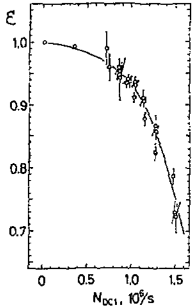

Figure 5. Efficiency of particle trajectory reconstruction on the counting rate of the first drift chamber (for lead target).

Two stations of proportional chambers are installed in each arm (see Fig.4). The station includes X, Y and V (tilted) modules. The chamber have the following dimensions: $240 \times 640\ mm^2$ and $512 \times 1216\ mm^2$. The signal wires spacing in X and Y modules is 2 mm, and 3 mm — in V modules, the cathode-to-anode distance is 6 mm. The angle between the signal wires and the vertical axis in V modules is 22.5°. The chambers are filled with Ar + 5% methylal. The signals from the wires are fed to the amplifiers-shapers set on the chambers connected through telephon cables to electronics made in standard "MISS" [5]. The amplifier-shaper threshold is, in average, 1.2 μA. After the information is compressed it is read by *HP2100* computer. The proportional chambers allow to select particles which have not interacted in the matter of the Cherenkov ring spectrometer.

To reduce the background particles at the magnet entrance 17 cm from the target center there are placed scintillation hodoscopes, one in each arm. Each hodoscope has 32 channels with scintillator paddles 2.9 mm wide. The active area of the hodoscope is $70 \times 93\ mm^2$. The strong magnetic field in the region of the hodoscope (0.8 T) makes it necessary to guide the light to phototubes placed outside of the magnetic field. The light guides made from optical fibers 1 mm in diameter and 1.8 m long are connected to the phototube FEU68 with photocathode diameter of 10 mm. Each scintillator is coupled to 7 fibers. Due to high counting rate of the hodoscopes they have large multiplicity limiting the level of background suppression at high beam intensity. At the intensities up to 2×10^8 particles/s the requirements to have a hit in the hodoscope close to the coordinate reconstructed by the system of chambers allows one to cut the background two times.

5. PARTICLE IDENTIFICATION

Charged hadron identification in the momentum range of 6-30 GeV/c and in the angular range (relative to the arm axis) 0-40 mrad is realized by a spectrometer of Cherenkov rings (SCOCH). Fig.6 shows the SCOCH optical layout consisting of a spherical glass mirror, reflecting cone, cylindrical lenses and flat reflectors. This optics transforms two-dimensional photon coordinate of the Cherenkov radiation into one dimensional coordinate. Photons are detected by 24 hodoscopic photomultipliers (HPM) by measuring electron drift time in crossed electrical and magnetic field. The averaged multiplicity of phototube hits for π-meson at the momentum above 6 GeV/c is equaled to 12. Fig.7 presents the momentum range in which hadrons are identified. As an example Fig.8 shows the mass distribution of particles at momenta higher than 12 GeV/c for a proton beam and the arm angle 160 mrad.

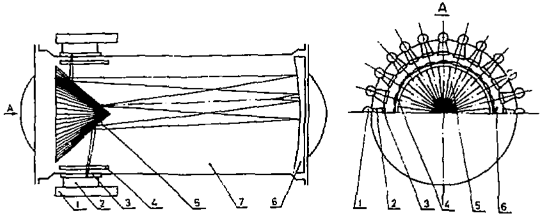

Figure 6. Optical diagram of the spectrometer of Cherenkov ring radiation SCOCH. 1 is hodoscopical photomultiplier; 2 is mirror air lightguide; 3 is window from PMMA; 4 is cylindrical lense; 5 is conical reflector; 6 is spherical mirror; 7 is gas radiator

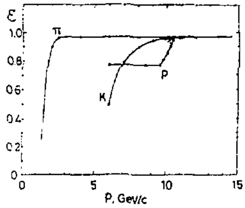

Figure 7. The range of momenta where hadrons are identified.

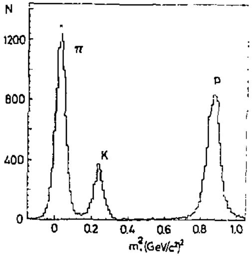

Figure 8. Particle mass distribution at momentum above 12 GeV/c in one arm obtained for arm angle 160 mrad and proton beam at 70 GeV.

Muons are selected by scintillation counters placed behind 150 and 300 cm of iron. Each counter consists of 6 scintillators paddles 20 cm wide, 250 cm long and 1 cm thick, light is detected by FEU110 phototube without optical contact. The sensitive area of the counters is 250 × 110 cm^2. The counters can be moved horizontally in accordance with the position of the arms.

6. TRIGGER

The single-arm triggers requiring a coincidence of scintillation counters $S_1 - S_4$, select particles with momenta above 5 GeV/c (at maximum magnet current). The scintillation counters properties are listed in Table 1. To suppress the trigger counts from low energy particles (mainly from electromagnetic showers) before S_4 a lead absorber 25 cm thick is placed. The dependence of the hadron detection efficiency on the particle momentum is presented in Fig.9. In the momentum range accepted by the spectrometer the detection efficiency does not depend on hadron species. The efficiency is measured by analysing the results obtained with and without the counter S_4 in the trigger.

Table 1.

Number of scint. count.	Dimensions of sensitive area (cm^2)	Thickness along the beam (mm)	Prototube type	Number of phototubes
1	25 × 25	5	XP-2020	2
2	25 × 50	10	XP-1210	1
3	50 × 50	10	XP-2020	2
4	50 × 100	20	XP-2020	2
5	110 × 250	10	FEU-110	6
6	110 × 250	10	FEU-110	6

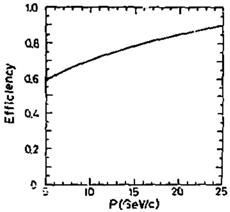

Figure 9. Momentum dependence of hadron detection efficiency with scintillation counter S_4 placed after lead absorber in trigger.

The double-arm trigger requires a coincidence of the two single-arm triggers.

The analysis of the data shows that main background detected by the apparatus originates from the magnet poles and the scintillation counters due to interaction of secondary particles. The ratio of the single-arm triggers without a target to a target of 0.1 nuclear absorption length is 8% for Be and 3% for Pb. The ratio for emply cryogenic target to the target filled with hydrogen is 20%.

The beam intensity on the target is limited by the counting rate of the apparatus (the nearest to the target scintillation counters and drift chambers). For resolution time of coincidence of the two single-arm triggers about 10 ns, event readout recording speed about 10^2 events/s and the level of accidental coincidences about 50% the number of the single-arm triggers must not exceed $7 \cdot 10^4$ 1/s. At the maximum magnet current and beam intensity on the target corresponding to the counting rate of S_1, which is about $5 \cdot 10^6$ 1/s, the number of the single-arm triggers is 10^6 1/s, hence the number, must be suppressed by an order of magnitude. Fig.10 shows the particle momentum distribution for the trigger based on the coincidences of scintillation counters $S_1 - S_4$. For steep transverse momentum (P_T) dependence proportional to $exp(-6P_T)$, in general, only low P_T particles are detected. Thus it is necessary to increase the momentum threshold. To increase the momentum threshold a hardware look-up table [7] is used with three hodoscopes in each arm [8]. Each hodoscope consists of 32 scintillators. The geometrical characteristics are listed in Tables 2. The scintillators are coupled to phototube without light guides. The output signals from the phototubes are fed to amplifier-discriminators mounted on the hodoscope frame and then through telephone cables to the registers which encode the hit channels (three in each hodoscope) into a 5-bit address. These addresses are received by the look-up tables and in the case of coincidence of the hit channels (three hits in three hodoscopes) with one of 27 precalculated combinations the output signal is produced to read out the event. Since the decision time is only 160 ns the signal is used in common logics of the trigger signal. The dotted line shows in fig.10 the momentum distribution of particles for 11 GeV/c threshold. The trigger with the hodoscopes increases 5 times the data acquisition of high P_T events. The described system allows one to introduce restrictions on the trajectory angles relative to the SCOCH axis which increases the fraction of identified particles 2-3 times.

Figure 10. Particle momentum distribution in one arm for maximum magnet current with hodoscopes in trigger with momentum threshold 11 GeV/c (dotted line). The solid line is the same without hodoscopes in the trigger.

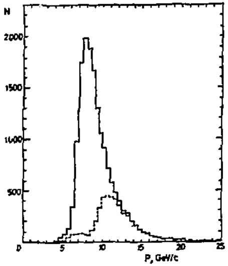

Table 2.

Hodoscope number	Step of scintillator (mm)	Dimensions of sensitive area (mm^2)	Thickness along the beam (mm)	Distance from the target (m)
1	16	259 × 512	10	4.5
2	17.5	429 × 560	10	5.6
3	19	525 × 608	10	6.6

7. TIME MEASUREMENTS

Time measurements are used for the determination of particle trajectory in the drift chambers, photon coordinate in SCOCHs, and in the time coincidence between the arms. These measurements are organized in the following way. The trigger produced by the scintillation counters and the hodoscopes, fires a timer-generator which forms a strobe pulse and whose gating generator output is connected to ADC and R-43 [9]. Their "stop" inputs are connected to the phototubes of the scintillation counters, the hodoscope phototubes and drift chambers. The time measurement precision for the drift chambers is $2\tau = 1.8\ ns$ and for other detectors is $2\tau = 1.2\ ns$.

In each channel during the measurement interval (400 ns) there are recorded up to 4 hits. Thus the lost of information occurs only at very high counting rates. Fig.11 shows the time distribution of the scintillation counter S_1. The

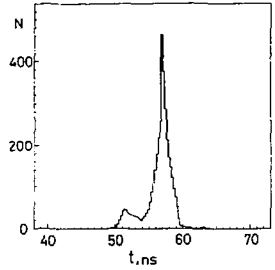

Figure 11. Time distribution for one scintillation counter.

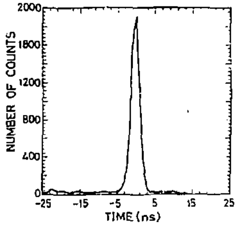

Figure 12. Time distribution of two arm coincidence.

following procedure is adopted to cancel from the time measurements the time jitter of the trigger signal. Consider time distribution of pulses in one arm $T_k^n = t_k^n - t_o$, where t_o is the time origin of the trigger signal and t_k^n is the time origin of a signal from k^{th} scintillation counter in n arm. Since up to 4 signals can be detected from one phototube by the combinatorial analysis, a combination of signals with minimal deviation from the value determined in calibration measurements is chosen. Then from the selected in one arm signals there is calculated a value

$$T = \frac{1}{N}\sum_{1}^{N}(T_k^1 - T_k^2),$$

where N is the number of the selected signals from the phototubes. The example of T values distribution is presentedd in Fig.12.

8. DATA ACQUISITION AND PROCESSING OF THE INFORMATION

The information from the detectors is fed to electronics in the standard "SUMMA" consisting of 16 crates organized into 3 branches. The information from the drift chambers and SCOCHs is read, processed and buffered in the buffer memory modules by controllers KD-248 [10] and KD-255. The computer HP-2100 is connected with the electronics by a controller KS-20 [11]. Due to the information compression the average length of an event from one arm is 100 to 150 16-bit words depending on the beam intensity and particle multiplicity. For inclusive trigger, when the information from one arm is read independently the rate of data acquisition is about 150 events/spill for each arm.

The information from the beam ionization chambers is read by an autonomous system based on microcomputer ME-80 [12] which also processes the data and displays the information. After the signal "the end of the spill" the information from the microcomputer and different counters is transmitted to HP-2100. The computer realizes the following functions: test and calibration of the electronics, data acquisition and recording it on the magnetic tape, technical control of the apparatus. For information presentation on a colour display a system of two microcomputers is used [13]. The system is supplied with a sensor panel and has autonomous software for histogram processing.

The trajectory reconstruction, momentum evaluation, determination of particle species and physical control of the apparatus is carried out by computer "Electronica 79".

9. TRAJECTORY RECONSTRUCTION OF PARTICLE

The algorithm of selection and particle trajectory reconstruction is determined by the following conditions imposed on the drift chambers:

— large angle divergence of particle trajectories (up to 200 mrad);

-- high counting rate ($\sim 10^6$ 1/s).

The large angle divergence of the particle trajectories made reason of refusal from previously adopted on the apparatus FODS procedure for coordinate information checking on "sum of times" which allows significantly to cut the hits connected with low energy component of electromagnetic showers. The high counting rate requires from the procedure of the trajectory selection maximum stability of the algorithm to large number of background hits.

The procedure of the particle trajectory reconstruction has three stages:

i) Evaluation of coordinate array of all detected hits according to the following expression: .

$$x_{ijk} = j\delta - C_i \pm (A_{ik}N_{ijk} - B_{ik} - \tau_{ij})v_i,$$

where i is the chamber number, j is the signal wire number in the chamber, k is the number of the electronics register, δ is the distance between the adjacent wires, C_i is the coordinate of the chamber center in the coordinate system of the arm, A and B are the parameters of the linear part of time-coordinate dependence of TDC modules, τ is the delay time of the signal, N is the counts of TDC. As one can see from the above expression for each hit two coordinates are evaluated both of each are used further for reconstruction. Two coordinates are obtained due to the left-right ambiguity. These ambiguities are resolved at the next stage.

ii) The trajectories are reconstructed independently in the X-Z plane and in Y-Z plane (Z axis is directed along the arm axis). The calculated array of coordinates is used as input for program PTRAK which searches successively in each plane for the tracks by sorting all possible strait lines passing through any two points detected by the drift chambers. The final trajectories are the ones which containe sufficient number of points (N_{min}) depending on specific task and experimental conditions. The typical value of N_{min} for X plane is $NX_{min} = 6 \div 8$ (12 chambers) and for Y plane the value is $NY_{min} = 5 \div 7$ (10 chambers). The program PTRAK searches for not more than 4 tracks. The coordinates of the points which lie on a straight line are excluded from further considerations, besides the corresponding "twin" points due to the left-right ambiguities are also excluded.

iii) To obtain the parameters of the particle trajectory in space the tracks reconstructed independently in the X-Z plane and in Y-Z plane using the information from the tilted chambers are matched. For each pair of the trajectories the points are selected for in the tilted chambers corresponding to this pair. The trajectory in space is considered to be reconstructed if the number of points in the tilted chambers is not less than some predefined number depending on experimental conditions. Usually it is chosen to be equal to $NH_{min} = 3 \div 4$ for the total number of the tilted chambers 6.

To calculate the efficiency of the particle trajectory reconstruction there has been developed a procedure which takes into account the efficiencies of each drift chamber and given minimal number of points on the trajectory. The efficiency of separate chambers is interpreted as the ratio of the trajectory numbers for which a particular chamber gives a point to the trajectories in which the total number of points was not less than $N_{min} + 1$, where $N_{min} = NX_{min} + NY_{min} + NH_{min}$. Such method takes into account the fact that for the procedure not all trajectories are used but only those where the total number of points is not less than N_{min}.

For the calculation of the efficiency of the particle trajectory reconstruction procedure the program examines all possible combinations of successful and unseccessful firings the of chambers. Considering the firing of different chambers for the given trajectory to be independent, we can define the probability of each combination and on the basis of these calculations find the probability of an event when the number of fired chambers was bigger or equal to N_{min}. The probability defined in such a way is considered to be the efficiency of the particle trajectory reconstruction procedure.

It should be stressed that the method of the reconstruction efficiency of the procedure gives correct result only in case if the firings of the chambers are independent events. Since the drift chamber electronics can register only 4 hits in one chamber in case of very large background of electromagnetic showers, the successive and unseccessive firings of the chambers might turn out to be correlated. In this case the described procedure of the calculation of the efficiency of the particle trajectory reconstruction gives overestimated result.

10. RECONSTRUCTION OF THE PARTICLE TRAJECTORY INTO THE TARGET

Since the charged particle trajectory is bent by the magnet in the vertical plane the production angle of the particle is measured independently of its momentum.

Passing through the magnetic field the particle can scatter on the structure of the magnet and the particle momentum will not be measured correctly. The subtraction of these background events is realized by extrapolation of the background level outside of the target into the target location. The background outside of the target is approximated by a polynomial. For a cryogenic target beforehand the background from the empty target is subtracted. Fig.13 shows the distribution of the reconstructed into the target location the particle trajectories.

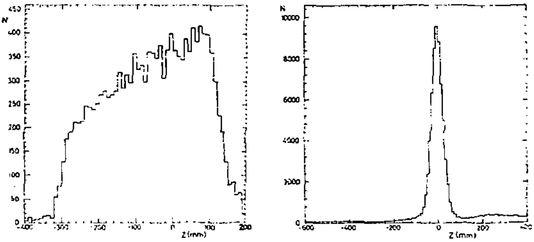

Figure 13. The distribution of the reconstructed into the target trajectories along the beam axis for single particle production: a) for the cryogenic target filled with hydrogen (background from the empty target has been subtracted), b) for solid nuclear target.

11. THE MAIN CHARACTERISTICS OF THE SPECTROMETER

The main characteristics of the spectrometer are as follows:

— momentum resolution is 2% in the range 6-10 GeV/c;

— identification of one or more particles of both signs (μ, π, K, p) in each arm;

— the range of particle production angle θ in the laboratory system is 0 — 320 mrad;

— the range of momentum measurements is above 5 GeV/c;

— the solid angle of one arm for particle of a given sign is $2.5 \cdot 10^{-3}$ mstrad.

12. CONCLUSION

The apparatus has successully been operating for 4 years. Significant time has been required for to study the spectrometer itself and the development of the system of programmes for the data analysis. The apparatus has been used for collection of $2 \cdot 10^7$ triggers with the proton beam at 70 GeV energy and about 10^7 triggers with π^--meson beam at 40 GeV energy. There has been used nuclear as well as hydrogen and deuterium targets. The first physical results on the A-dependence of symmetrical pair production [14] has been published. The remaining data are being proceded and analysed.

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