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V.I. Ivanov, N.S. Moroz, V.B. Radomanov,
V.S. Stavinsky, V.N. Zubarev

ЛАБОРАТОРИЯ ВЫСОКИХ ЭНЕРГИЙ

THE MEASUREMENT OF THE SCATTERING ANGLE OF PARTICLES BY VAVILOV-CERENKOV RADIATION AT HIGH ENERGIES

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Зубарев В.Н., Иванов В.И., Мороз Н.С., Радоманов В.Б., Ставинский В.С. E13-5459

Измерение угла рассеяния частиц при высоких энергиях по регистрации излучения Вавилова-Черенкова

В работе получены характеристики по угловому разрешению и эффективности 6-канального черенковского годоскопа, рассчитанного на интервал углов от 0 до 30 миллирадиан.

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Дубна, 1970

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The Measurement of the Scattering Angle of Particles by Vavilov-Cerenkov Radiation at High Energies

Angular resolution characteristics and efficiencies of the 6-channel Cerenkov hodoscope in the interval of angles from 0 to 30 mrad have been obtained.

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V.I. Ivanov, N.S. Moroz, V.B. Radomanov,
V.S. Stavinsky, V.N. Zubarev

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1. Physical Principles of the Method

In a focal plane of the Cerenkov counter objective the radiation of a relativistic particle moving along the optical axis gives a ring image, the radius of which is connected with the radiation angle (θ) by the relation:

$$R = F \cdot tg\theta ,$$

where F is the focal distance of the objective. If the particle moves at the angle a to the optical axis the ring image in the focal plane shifts by the value Δ being equal to:

$$\Delta = F \cdot tg a .$$

The method of measuring the value Δ is described in this paper. It is evident that the shift Δ is independent of the interaction point in a scatterer. Consequently, the new method makes it possible to reduce the procedure on measuring the scattering angle with an extended scatterer to the problem with a point scatterer.

2. Method

The experimental layout is shown in Fig. 1. The primary flux of pions was determined by the Cerenkov counter M_0. The Vavilov-Cerenkov radiation of pions came through the slit-spherical mirror d_0 and was collected by three photomultipliers in coincidence. The radiation of particles, forming an angle of ± 0.6 mrad (more than the given angle) with the optical axis and having a velocity different from the given one by $\pm 2.7 \cdot 10^{-5}$ units of light velocity, came through the slit d_1 and was collected by three photomultipliers in anticoincidence.

Thus, the monitoring counter M_0 registered the parallel beam of monoenergetic pions and determined the optical axis of the system with an accuracy of ± 0.6 mrad. The counter S_1 (with a 70 mm hole) was in anticoincidence and defined the beam dimensions.

Figure 2 shows how the efficiency of counting of particles with different masses depends on the gas (nitrogen) pressure in the counter.

The hodoscope Cerenkov counter (H) is placed on the optical axis of the monitoring counter. In the focal plane of the hodoscope the slits-spherical mirrors are mounted (6 zones). The radiation of pions passing along the optical axis is collected onto the slit-mirror "0" and then, collected by this slit, onto two photomultipliers in coincidence. The displacement of the image within the limits of the angular width $\Delta \theta_0$ of this zone determined a minimum angle for particles which had not been scattered. The value $\Delta \theta_0$ was chosen to detect pions having decayed into muons inside the hodoscope and was equal to 10 mrad.

When particles were scattered at an angle more than the angle $\Delta\theta_0$ the radiation image came through the slit-mirror "-1" (placed inside zone "0") and through the slit-mirror "1". The photomultipliers of zones "-1" and "1" were in coincidence. This combination detected particles scattered at an angle from $\Delta\theta_0$ to $\Delta\theta_0 + \Delta\theta_1$, where $\Delta\theta_1$ is the angular width of zone "1". Two other zones "2" and "3" being also in coincidence with zone "-1" were analogously constructed. The wide zone "4" was in anticoincidence with the other zones and located behind zone "3". The dependence of the counting efficiency of the zones upon the scattering angle of particles was formed by the selection method with the maximum number. The photomultipliers of zones 2,3,4 were in anticoincidence with zone "1", zones 3,4 etc. were in anticoincidence with zone "2" etc. Zones "-1" and "4" were in anticoincidence with zone "0".

Figure 3 presents the block-diagram of electronic logic for zones "0" and "2". The Cerenkov counter M_1 was placed behind the hodoscope and used for controlling the efficiency of zone "0" as well as for depressing accidental coincidences in the zones and not accidental anticoincidences in zone "0".

The dependence of the efficiency of particle detection upon the scattering angle is given in Fig. 4.

3. Results

As is seen from Fig. 4, the hodoscope Cerenkov counter represents a new 4-channel device permitting to measure the scattering angle of particles. With its help one can measure a flux of particles scattered at an angle not more than 10 mrad with the efficiency of 0.96 and background not more than $3 \cdot 10^{-3}$ (zone "0").

Besides, there exist three zones detecting particles scattering at angles of 15, 20 and 25 mrad. The angular resolutions of these zones are $\pm$ 2.5 mrad. The background in these zones does not exceed 10^{-4} when the efficiency is 0.65. In this case the fact operation of the system is restricted only by the photomultipliers and is equal to 100 megacycles.

In conclusion, we would like to express our gratitude to Drs. V.A. Sviridov, I.A. Golutvin, V.G. Perevozchikov, S.N. Plyash-kevich for their help in our work.

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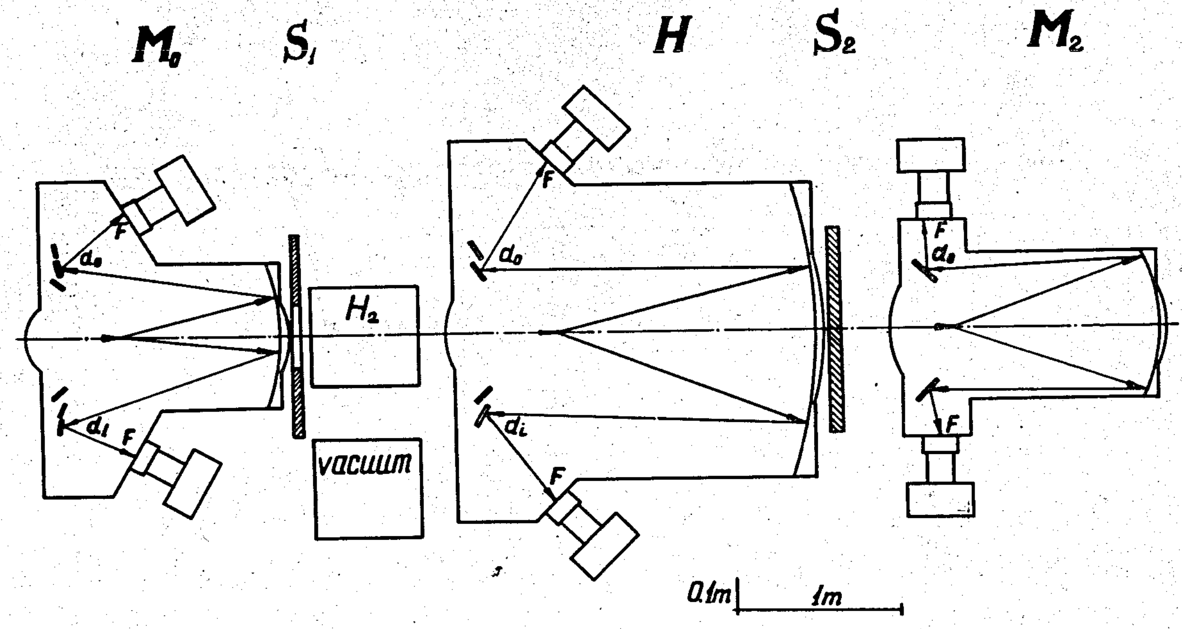

Fig. 1. The layout of the apparatus.

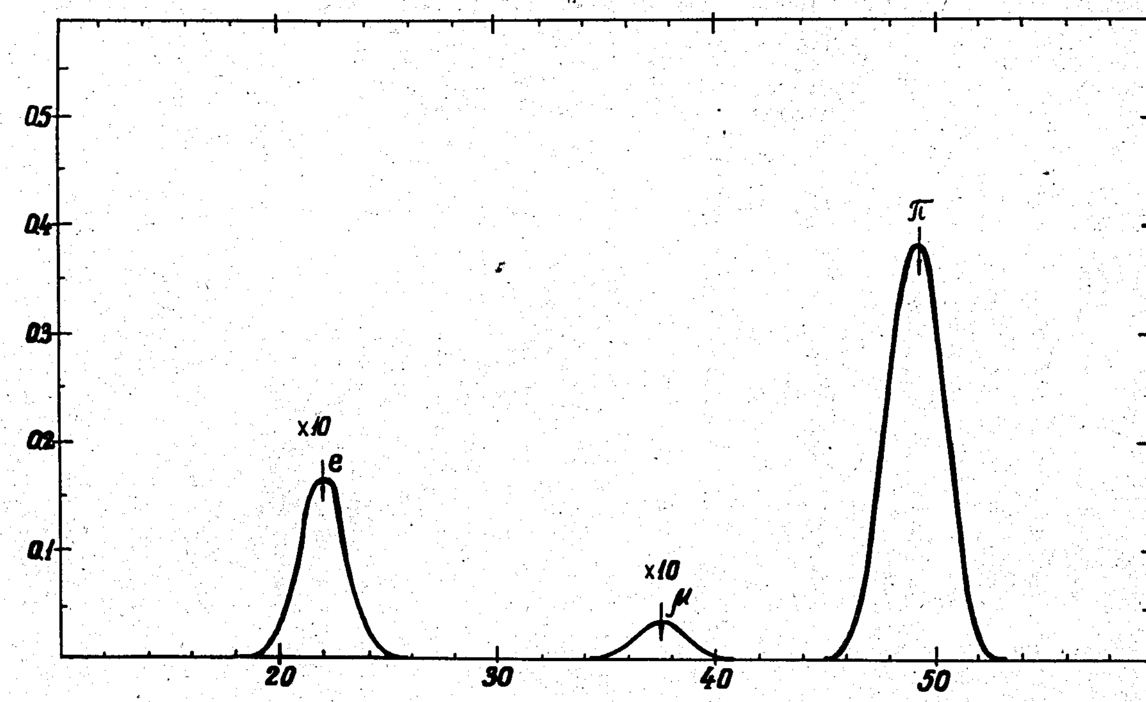

Fig. 2. The dependence of the counting efficiency of particles upon the gas pressure at 4.62 GeV/c.

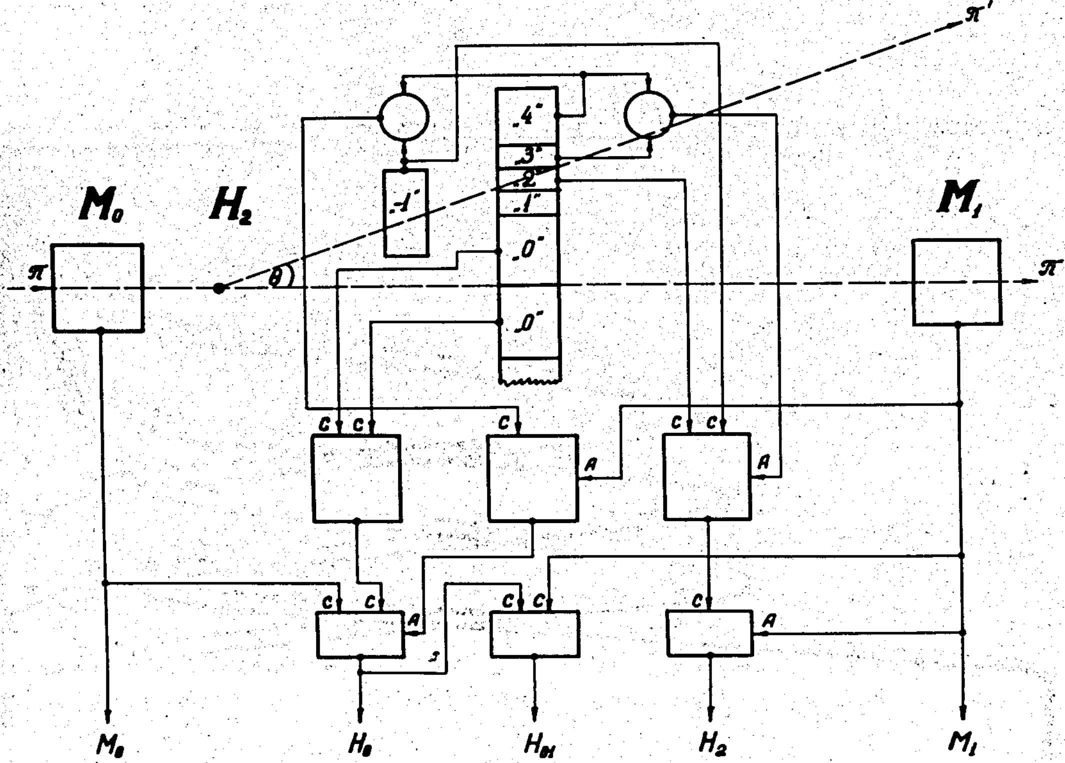

Fig. 3. The block-diagram of electronic logic.

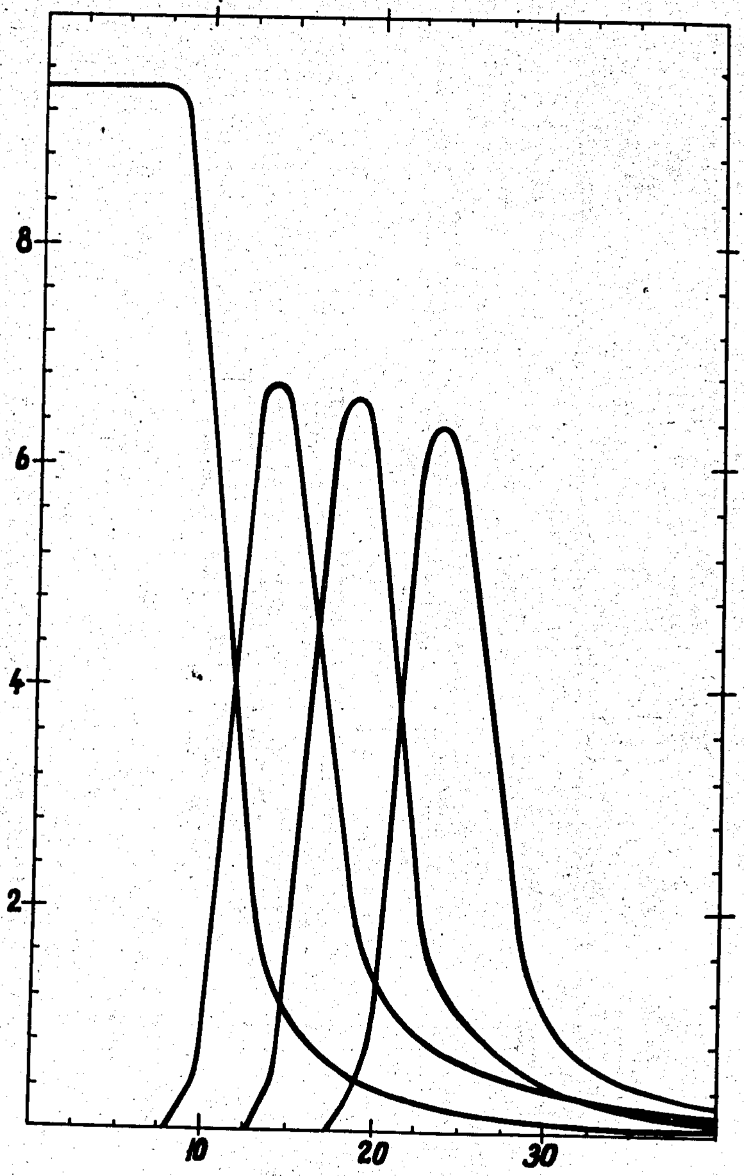

Fig. 4. The dependence of the efficiency of particle detection upon the scattering angle.