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Letter of intention

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PRODUCTION OF CHARGED PARTICLES ON INTERNAL TARGETS AT THE 70 GeV SERPUKHOV PS

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The measurement of the charged particle spectra produced by 70 GeV protons on an internal target in the new Serpukhov Proton Synchrotron has a twofold interest:

i) the study of collision mechanisms at an energy three times that of the CERN PS (high-energy tail of the spectra, presence of nucleon resonances);

ii) the evaluation of parameters for possible identified or separated secondary beams.

It should also give important reference data for the conception of experimental areas and beams to be foreseen near the future 300 GeV machine. Extrapolation of the spectra of secondary particles from 25 to 300 GeV would be much more secure with 70 GeV data.

This measurement can be made with a DISC spectrometer such as the one being used for the S61 experiment on 19 GeV/c p-p collisions which was started in 1966[1] and will be resumed in October 1967. It is so far unique for detecting low-abundance high-energy particles as, for example, in the high-energy tail of spectra.

We would like to put forward a proposal to perform this type of measurement with our Russian colleagues in the first high-energy beams that they are preparing. The existing DISC allows identification of all kinds of known charged particles with a mean life larger than 10^{-8} sec, up to 70 GeV, but for the $(\pi-\mu)$ doublet where the maximum energy is 25 GeV. Background rejection power is such that intensity ratios as

small as 10^{-6} can be measured for the different particles going through the counter. The required space is small: the beam length occupied by the DISC is about 3 metres.

We recall in the attached Appendix the main characteristics of the DISC, as well as the desirable parameters for the spectrometer, in order to allow the evaluation of the best working conditions in the available beam configurations, and to prepare with our Russian colleagues a more precise and technical proposal.

A Russian physicist engaged in this work would be very welcome to participate in the experiment S61 at the PS in October.

Appendix

DISC SPECTROMETER (Fig. 1)

DISC counters have three independent parameters:

i) the useful aperture of diameter $\emptyset$ over which sensitivity and resolution are constant;

ii) the Čerenkov angle Θ;

iii) the angular aperture $\delta\Theta$ of the diaphragm.

The choice of these parameters largely defines the desirable properties of the beam transport as well as the required counter length. The target size also comes into the evaluation of the acceptance and the mass resolution of the DISC spectrometer.

Beam survey of abundant particles species does not require quadrupoles in the beam transport. It suffices to have an analysing magnet for bending the wanted particles through an angle D. For rarer particles and for studying the high-energy tails of the spectra, conditions of maximum acceptance should be realized. The DISC works with full acceptance when the beam is made parallel with lenses and when it covers the aperture $\emptyset$ of the counter.

The mass resolution of the DISC spectrometer combination is given by the formula[2)]

$$\frac{\delta M}{M} = \frac{1}{2}\gamma^2 \, tg\Theta \, \delta\Theta \times \frac{\varphi}{FD}$$

if $$D\,\gamma^2 \, tg\,\Theta > 1 \quad \text{and} \quad \frac{\varphi}{F} \leq \Theta$$

where φ is the target diameter and F the focal length of the beam transport.

The DISC at present in operation has the following characteristics:

i) diameter of useful aperture $\emptyset$: 10 cm;

ii) Čerenkov angle Θ : 44 mrad;

iii) angular aperture of the diaphragm : variable from 0.2 to 4 mrad.

Its mass resolution for a point target is shown on Fig. 2. The target size effect vanishes if no magnetic lenses are used. This DISC shows fairly good performance: $K^{\pm}$ peaks 10% wide in mass and p (or $\bar{p}$) peaks 2.5% wide in mass at 70 GeV.

With a 20 metres focal length triplet and a target size of 2 mm, i.e. for $\varphi < F \cdot \delta\Theta$, the momentum resolution $\Delta p/p$ depends only on the deflection angle D. $\Delta p/p$ is 3×10^{-3} for D = 60 mrad, which is a reasonable value for standard magnets (Fig. 1).

Typical acceptance of the DISC spectrometer (Fig. 1) is of the order of 10^{-7} $cm^2 \cdot sr$ GeV/c for 50 GeV pions and of 3×10^{-5} $cm^2 \cdot sr$ GeV/c for 50 GeV kaons with a mass resolution of 20%.

A precise study of the shape of spectra requires an elaborate spectrometer in which high momentum resolution magnetic analysis is combined with the DISC velocity measurement, as for example in the experiment S61.

There is probably no counting rate limitation as it can safely be taken as 10^7 particles per burst with the present multipliers and electronics.

Figure 3 shows the limits of useful mass resolution for the existing DISC and three others designed to cover the energy range up to 300 GeV. Counter B could be built in the spring of 1968.

REFERENCES

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2) R. Meunier, M. Spighel, J.P. Stroot, CERN/ECFA 66/WG2-US-SG4/ ALL-1, January 1967.

DISC SPECTROMETER SYSTEM

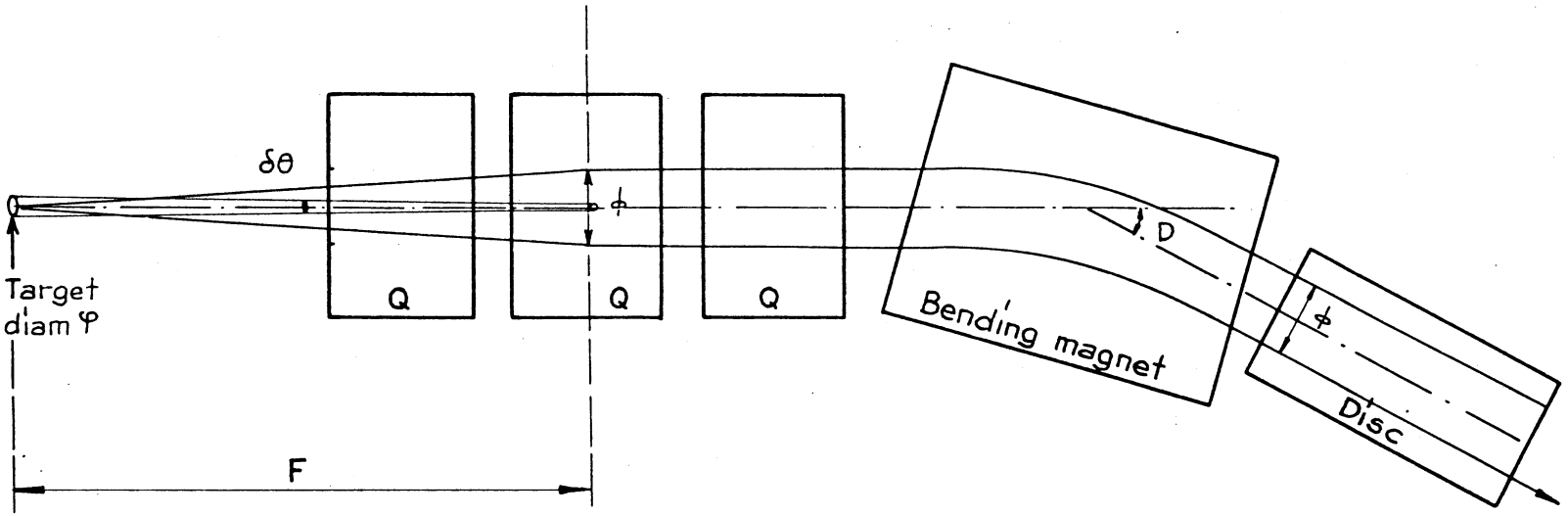

FIG. 1

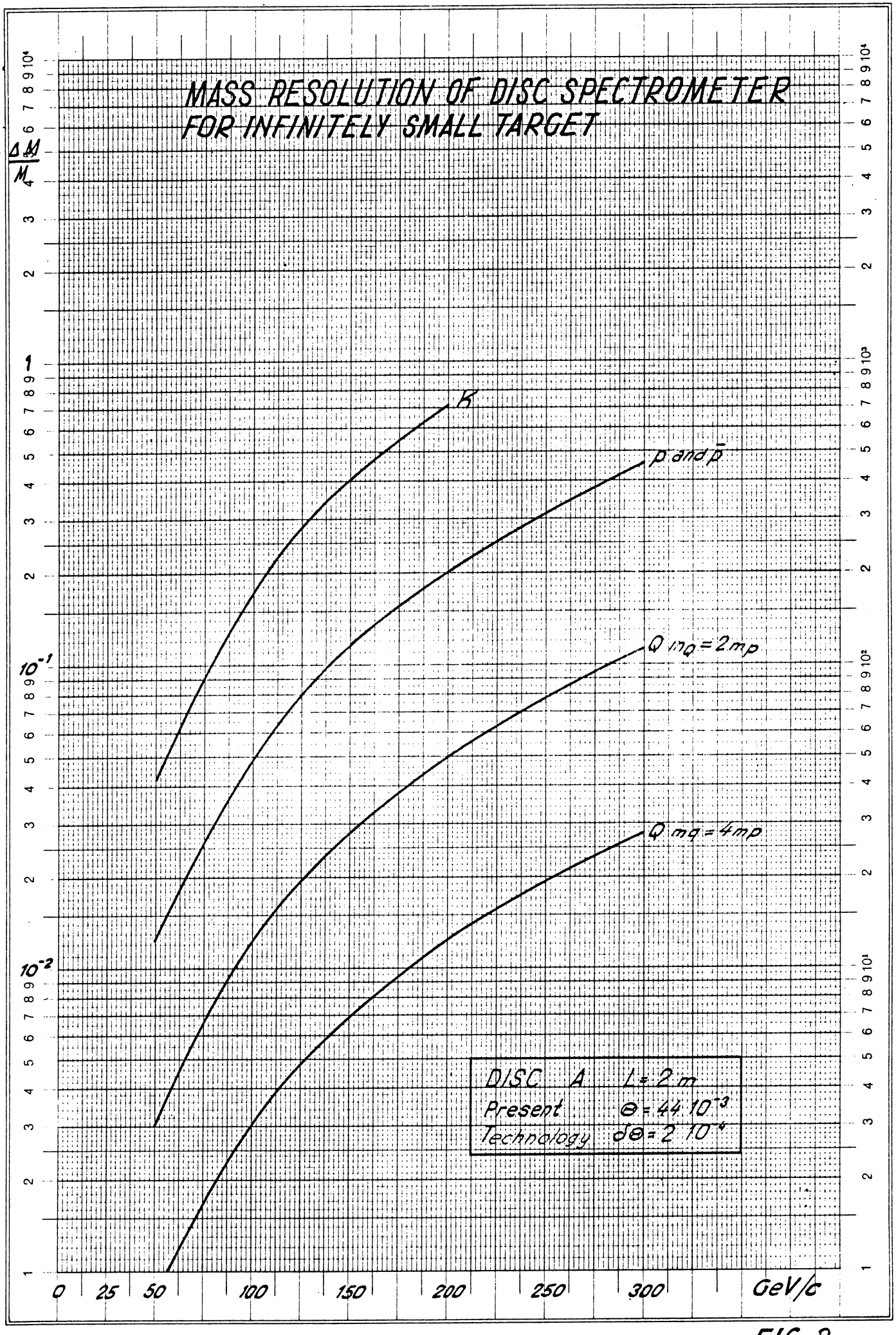

FIG. 2

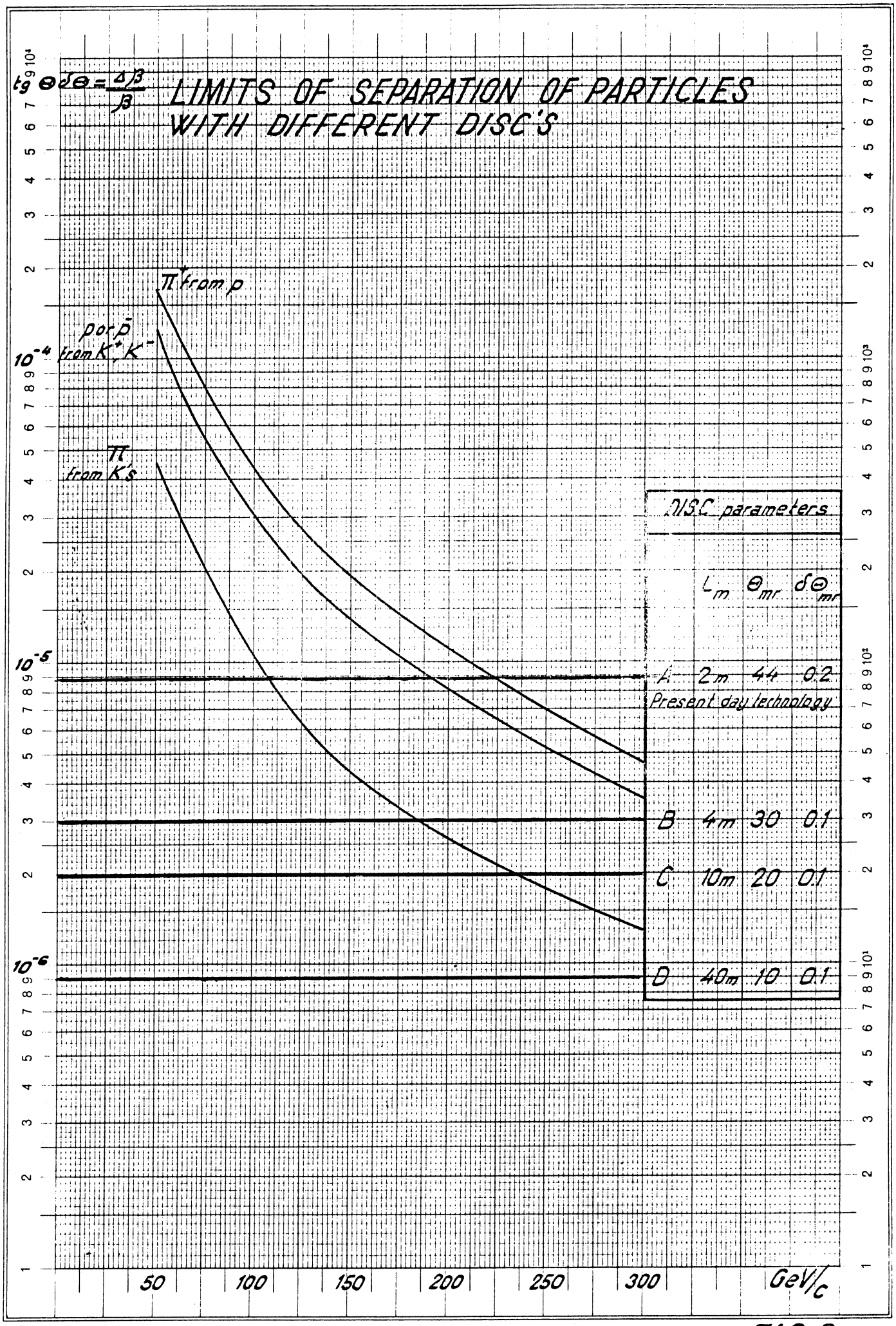

FIG. 3