ELECTRON DETECTOR FOR VERY SMALL ANGLES

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For measurements of the γp processes with real photons by ep interactions it is necessary to know the dependence of cross sections on Q^2 and then to extrapolate this values to $Q^2 \approx 0$.

At small angles $Q^2 \approx EE' \sin^2\Theta \approx EE'\Theta^2$ where E and E' are the energies of the electron before and after the collision, and Θ is the angle of scattering.

Since the energy of electrons in the beam E is known very well, it is necessary to measure E' and Θ. The errors of this measurements will define the error in Q^2

$$\frac{\Delta Q^2}{Q^2} = \left[\left(\frac{\Delta E'}{E'}\right)^2 + 2 \left(\frac{\Delta\Theta}{\Theta}\right)^2\right]^{\frac{1}{2}}$$

To measure the energy and angle of the scattered electrons we proposed to use total absorption cherenkov counters with radiators made from transparent monocrystals having small radiation length. It is known that hodoscopes of such detectors can measure the position of the center of gravity of the shower with an error much smaller than the radiation length of the material of the radiator.

As material of the radiator we propose the monocrystal KRS-6 |1|. It consists of TlCl (70 %) and TlBr (30 %), has a density of 7.7 g/cm^3, an index of refraction 2.2; radiation length X_o = 9 mm, and critical energy ε = 8.3 MeV.

This material is transparent for light at wavelength above 400 mm, is easily shaped mechanically and is nonhygroscopic. It is possible to obtain the crystals with dimensions up to 20 cm.

At high energies this type of detector has been used as part of the tagging system in experiments at the electron beam of the serpukhov accelerator. We used there a cherenkov detector with radiator, made from KRS-6 which had the form of a cylinder with 15 cm diameter and 11 cm height |2|. Cherenkov light was detected by a photomultiplier with 15 cm ø photocathode.

This detector was calibrated in the energy range from 100 MeV up to 45 GeV. It shows a linear response and an energy resolution, as shown in Fig. 1. The behaviour of the resolution in the high energy region can be explained by leakage of shower particles from the crystal.

These detectors were successfully used in experiments on measurements of the total hadronic photoabsorption cross sections on hydrogen and deuterium.

To investigate the possibility of using cherenkov detectors with radiators, made from KRS-6, as electron detector at very small angles for H1 we have produced 4 radiators from this material with dimensions $2 \times 2 \times 20$ cm^3 read out by 4 photomultipliers with 2 cm diameter of the photocathode.
We investigate now these counters in order to optimize construction and light collection.

A very important property of the material for an electron detector at very small angles should be high radiation resistivity. We have performed first experiments to study the radiation stability of KRS-6 crystals. For this purpose we used crystals in the form of discs with a diameter of 4 cm and a height of 5 mm.

The light transmission for a number of samples has been measured before and after they were in the bremsstrahlung beam of the synchrotron "PAMRA" which has a maximum energy of 850 MeV. These measurements show that at doses up to 10^6 Gy (1 Gy = 100 Rad) there was no change in transmission. At the same time we exposed also samples of lead glass, receiving the same dose of radiation. They became dark brown and intransparent.
We plan to continue these investigations to stronger doses of radiation.

If these investigations will be successful, then we will have an electron detector for H1 with an energy resolution of the order $10\ \% / E^{\frac{1}{2}}$ (GeV) (fWHM) and a space resolution of ~ 1 mm; rather fast and stable to work in a high radiation background.

The dimension of this detector and the number of its elements will be determined after the calculations of trajectories of scattered electrons in magnetic elements of the beam have be carried out.

References

1. A.S. Belousov et al. Instruments and Experimental Techniques N2,351, 1970.
2. A.S. Belousov et al. Instruments and Experimental Techniques v16,N6,1645, 1973.

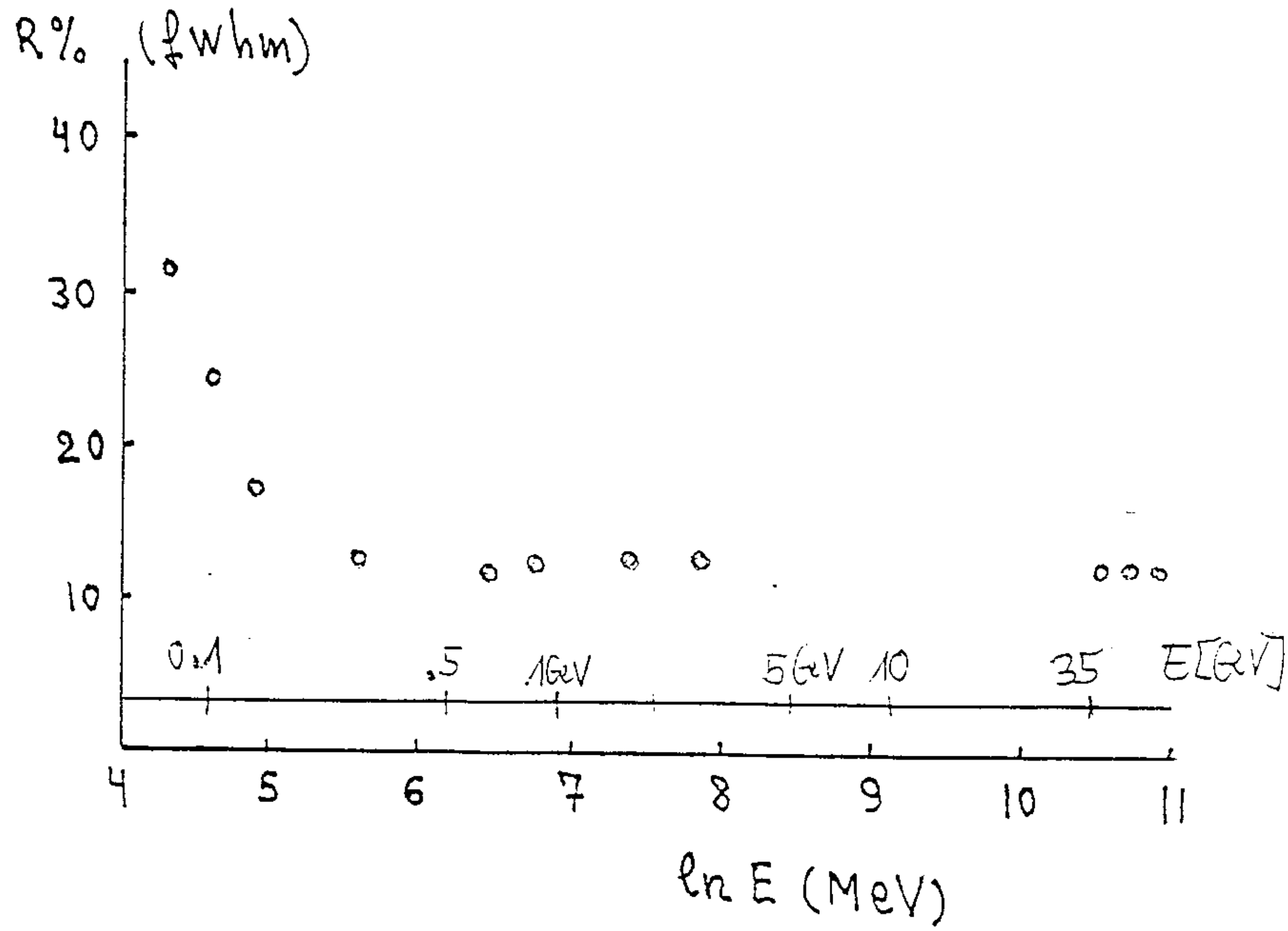

Fig. 1. Energy resolution of cherenkov detector, measured with monoenergetic electrons ($\Delta E/E = R/\sqrt{E}$ fWHM)