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CYLINDRICAL SPARK CHAMBER WITH LIGHT REFLECTING ELECTRODES

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A simple method of employing a cylindrical spark chamber is described: coordinates of the sparks are measured by using the multiple reflections along the electrodes themselves.

Several experiments to study e^+e^- annihilation reactions in the "Adone" storage ring of the Frascati National Laboratories are in progress. A general requirement in these experiments is a large solid angle subtended by the experimental set up in order to obtain a counting rate as high as possible. In some of these experiments a high spatial resolution is also required for the determination of the line of flight of the outgoing particles.

For instance in the $e^+ + e^- \to 2\gamma$ reaction[1]), the knowledge of the photon angular distribution is important to obtain information about the validity of quantum electrodynamics, as well as to discriminate against competing processes such as

$$\begin{aligned} e^+ + e^- &\to \pi^0 + \gamma \to 3\gamma \\ &\to \eta^0 + \gamma \to 3\gamma. \end{aligned}$$

The best geometry for this experimental set up would be of spherical shape but this is difficult when spark chambers must be used. Since cylindrical spark chambers seem to be a quite good tool also, we conceived of the spark chamber which we now describe.

Fig. 1 gives a sketch of two elements of the cylindrical spark chamber. Each element has two gaps 8 mm wide; curvature radius is ≈ 1 m, while the depth is 1 m. The electrodes are made of 0XI type aluminum, 1.5 mm thick, with highly reflecting surfaces supplied by Montedison[2]). Electrodes are held by annuli of polished plexiglas in which three grooves are machined. Aluminum and plexiglas are epoxied toghether with U.H.U. Plus; while the plexiglas-plexiglas junction is obtained by using Tensol no. 7. The central electrode is floating in the proper groove.

The optics of this chamber is unconventional as far the depth of the spark is concerned, while the front view is obtained in the usual way. In fact the depth position of the spark is obtained by looking along the direction which is tangential to the electrodes and normal to the cylinder axis. The sparks are therefore seen via the multiple reflections along the electrodes.

Fig. 1 shows a device which has been used to test this possibility. Images of a reticle made by scribing lines on a piece of plexiglas are precise and clear, as shown in fig. 2. Distances among the elements of the reticle have been measured by using a scanning device. It is found that they are reproduced in all 4 gaps within ± 1 mm in real space.

The quoted error is due to several effects, i.e., optical distortion due to refraction in plexiglas frames, as well as to reflections on cylindrical surfaces and on the plane mirror M.

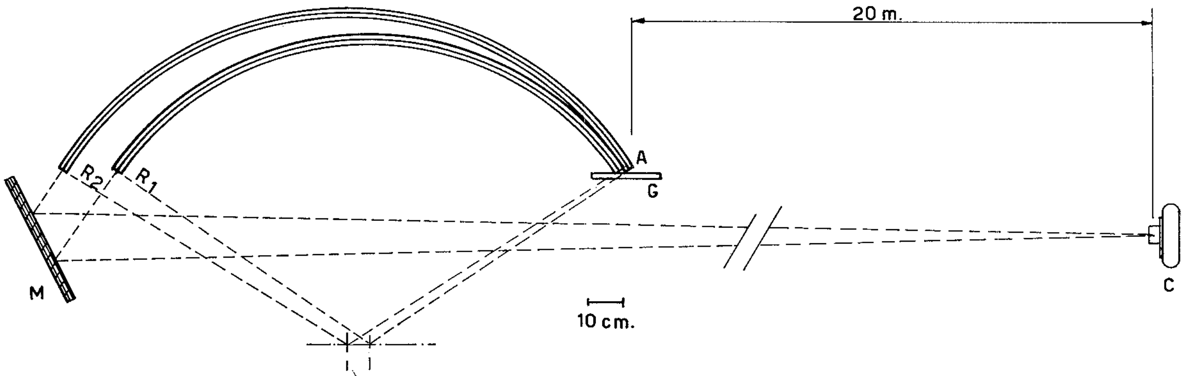

Fig. 1. Bright reticle G is placed at the end A of the two chambers cells. The reticle images are collected at the opposite end by a mirror M and sent to a 24′ focal length camera placed at ≈ 20 m from A. $R_1 = 90$ cm, $R_2 = 98$ cm. Images can be obtained up to until $\pm 10°$ from the tangential direction.

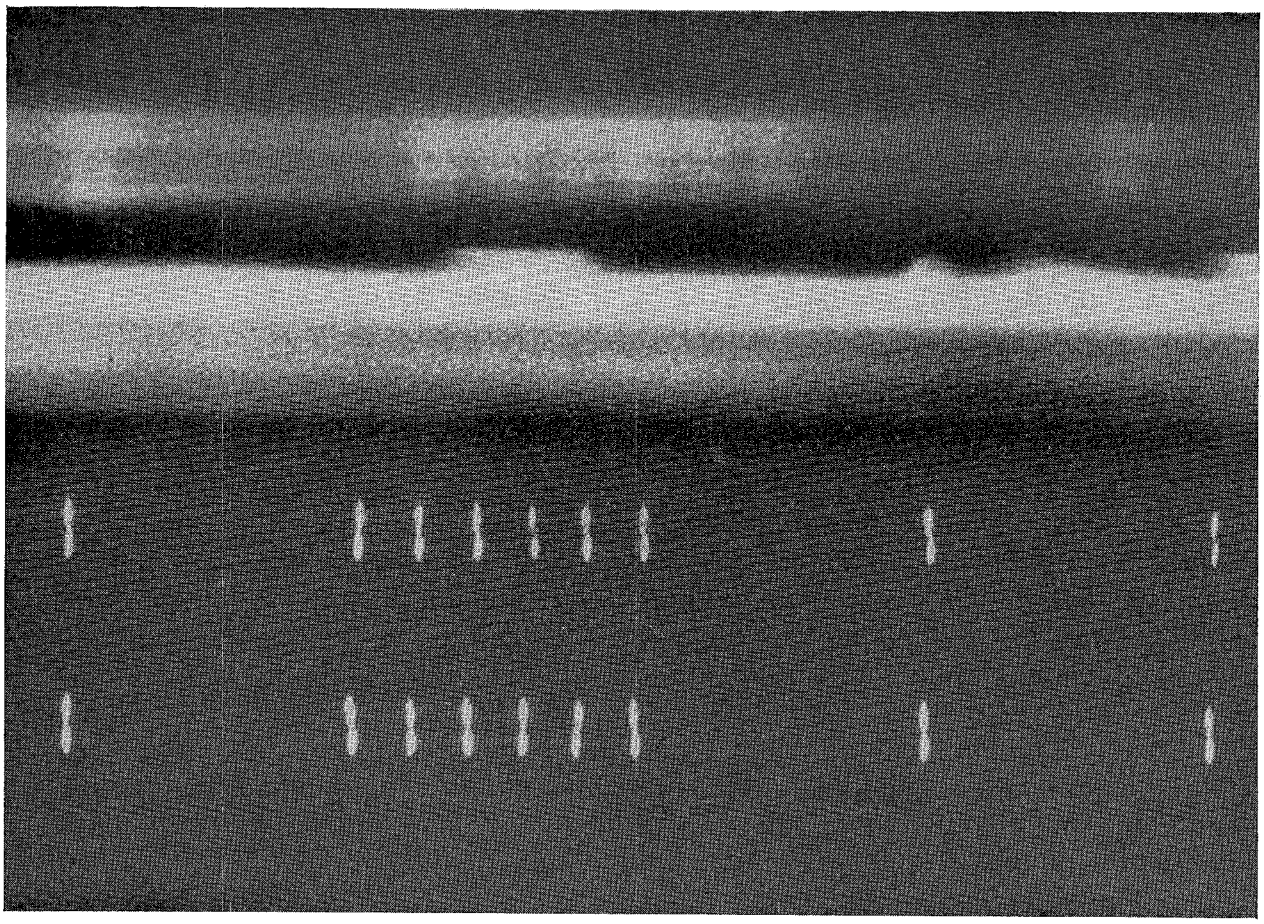

Fig. 2. Image of the bright reticle obtained with the device of fig. 1. Distances between lines are, in the order, 10; 2.13; 2; 2; 10; 10 cm

The electrical behaviour of the chamber has also been tested with the aid of a cosmic rays telescope; it presents no unconventional features with respect to cylindrical chambers used in other laboratories[3,4]); thus we do not emphasize this aspect of the problem.

The chamber used for the present test has an angular aperture of 110°. The results obtained do not indicate any upper limit to the aperture angle except the one due to the geometrical requirements of plane mirrors or other devices used to extract the optical information.

We also tested a spark chamber made of hand polished aluminum electrodes, but results were unsatisfactory because of bad image transmission. However, we are now informed that chambers of this kind have been prepared and used[5]).

In the chambers considered in [3,4]), the depth position z of the spark is obtained by measuring the distance $s = z\tan(2\alpha)$ (in paraxial approximation) between the spark and its image given by a fan shaped array of mirrors placed behind the chamber. Here α is the angle between a plane normal to chamber axis and each mirror segment of the array, and z is the distance between the spark and the mirror. As a consequence, the resolution in depth, is $\mathrm{cotg}(2\alpha)$ times worse than the resolution in the direct view. $\mathrm{Cotg}(2\alpha)$ is 14 in [3]), corresponding to a resolution in depth of ± 8.5 mm while it is 5 in [4]).

Our chamber gives substantially better resolution; it is characterized in addition by giving no possibility of track confusion due to image overlapping with multiple tracks (for instance in an electromagnetic shower). Finally the structure of the chamber and its optics is extremely simple.

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