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INVESTIGATION OF THE OPERATIONAL STABILITY OF PLASTIC STREAMER TUBES AFTER POLISHING OF THEIR GRAPHITE CATHODE

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In recent times plastic streamer tubes with resistive graphite cathodes /1/ have become very popular detectors. However from experience gained it is established that detectors with a large cathode resistivity are rather unstable in operation. This instability shows up as a short counting plateau restricted by the appearance of selfsustaining discharges leading to large increases of dark current.

In previous work /2/ this phenomenon was investigated and possible explanations were given. More recent work /3/ observed similar behaviour of tubes for a particular method of graphite painting of the cathodes. It should be emphasized that the details of the mechanism of the appearance and development of the selfsustaining discharge aren't clear.

All qualitative explanations of selfsustaining discharges in tubes with resistive cathodes /2-4/ are based on the Malter effect /5/ which is well known and often mentioned also for the explanation of selfsustaining discharges in normal wire chambers (see, for example references /7,8/). The main idea is that small centers ("bad" points) with too high a resistivity exist on the cathode. Thus, ion charge is accumulated on these centers leading to the emission of electrons from the cathode.

Available data shows that the operational stability of plastic streamer tubes depends not only on the resistivity of the cathode surface but also on the method of making this. One may point out the following aspects which influence the operational stability: kind of plastic /2/, kind of resistivity (volume or surface), conductive material, value /3/ and

It should be noted that the improvement was obtained without any considerable complication of manufacture.

After assembling and testing about 13000 3.6 m long tubes (polished) for the DELPHI hadron calorimeter we rejected less than 5% of them. The tests were carried out with an X-ray source (gas mixture Ar : CO_2 : C_5H_{12} = 1 : 2 : 1, the high voltage being 200 V above the knee of the counting curve, the radiation intensity was about 100 $cm^{-2}s^{-1}$, and the scanning was arranged so as to radiate each point of the surface during 0.1 s).

To summarise we find that the polishing procedure gives a large improvement in operation of plastic streamer tubes with graphite painted cathodes.

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It should be emphasized that the notion of a "bad" point is not absolute. Whether some point on a cathode surface of a detector is "bad" or "good" depends on the radiation intensity and the high voltage applied to the detector. In Fig. 2 the behaviour of an unpolished tube operating in the self-quenching streamer mode under the different radiation intensities in the region of a "bad" point is seen. It is evident that the larger the intensity the lower the threshold high voltage for the appearance of a selfsustaining discharge. The current of a selfsustaining discharge has a typical hysteresis behaviour, i.e. after decreasing the high voltage the discharge does not disappear after passing below the point of the discharge threshold. It should be observed that a sharp increase of current hardly influences the counting characteristic, i.e. this current is due to very small pulses which were even impossible to see on the oscilloscope. Similar behaviour was noticed in the paper /2/ in the case of volume resistivity of cathode.

The method of checking the effectiveness of polishing was as follows. "Bad" points had been found by slowly scanning a β-source along the unpolished detectors with a radiation intensity of about 1000 $cm^{-2}s^{-1}$ and a high voltage of 4.7 kV (the knee of the counting curve for the gas mixture is in the region 4.4-4.5 kV). The tubes were then disassembled and the regions of "bad" points (on the profile and the cover) were polished (5-6 moves with suede). The resistivity decreased on average by a factor 1.5-4 and became 50-300 kOhm/□ for profiles and 200-900 kOhm/□ for covers.

It was found that this way of improving the detectors is rather effective: after the assembling of the detectors there was only one "bad" point from 10 "bad" points found initially, and this point disappeared after short (about 5 min) operation