Space Distribution of Streamers in Straw Drift tubes

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The appearance of the limited streamer mode in straw drift-tubes operating with a $Xe/CO_2/CF_4$ gas mixture has been investigated. Space distributions of the streamer mode across the straw with different gas gains and wire offsets in the straw have been measured. It has been found that the streamers are generated in the narrow zone (FWHM = 400 μm) surrounding the anode wire. It was shown that the streamer contribution sharply increases with high voltage and that it reaches practically 100% at a gas gain of about 10^5. The number of streamers was observed to increase a few times when the wire is offset by 300 μm, even at a not too high gas gain of $3.5 \cdot 10^4$. This can greatly boost the aging of anode wires because the streamer mode is an additional noticeable source of oxygen ions and active radicals generated in the gas discharge since the total charge produced per streamer may be a hundred times larger than that of a proportional pulse. The results of a corresponding aging investigation of straws with an accumulated charge of 9 C/cm are presented.

Summary of Poster: The data were obtained during investigations of the appearance of limited streamer mode in straw-tubes with a working gas mixture of $Ar/CO_2/CF_4$ 70:10:20. This test was carried out using a ^{55}Fe-source. The straw-tubes used in our investigations are being designed for the TRT in the ATLAS experiment. They have a diameter of 4 mm. The cathode consisted of a 50 μm carbon-coated Kapton film and the anode wire was made of gold-coated tungsten with a diameter of 35 μm. In order to be as close as possible to the real experimental conditions, the high voltage was chosen to compensate the space charge effect that decreases the gas gain at intense irradiation. This resulted in a gas gain that was too high for the non-irradiated parts of wire because at the edges of the irradiated zone the gas gain was 50% higher than nominal. It was shown that the first signs of aging were observed at both edges of the irradiated zone. This effect is due to the higher gas gain and streamer mode contribution observed in these areas. The contribution of Limited Streamer Mode (LSM) in the straw-tubes quickly increases as a function of the high voltage applied to the straws. Thorough studies of the LSM appearance across the straw were performed. It is shown that the LSM has a space distribution with a width and an intensity that strongly depend on the gas gain and anode wire offset. It was shown that the contribution of the streamer mode is so large that it reaches more than 20% even at a moderate gas gain of $5 \cdot 10^4$. It is necessary to note that the limited streamer mode could be one of the very important reasons for anode wire aging since the total charge produced per streamer is around 10 – 20 times larger than that from a proportional pulse. Preliminary calculations for both the multiplication and attachment coefficients were performed with the "MAGBOLTZ" program. It was shown that an electronegative zone exists around the anode wire that has dimensions that match the space distribution of the LSM.