Gas Gain & Space Charge in Quick Aging

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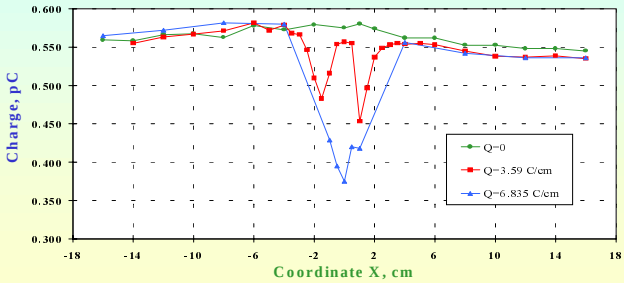
The influence of Space Charge under different irradiation densities with $Xe/CO_2/CF_4$ mixture has been studied in PNPI (Gatchina, Russia).

Significant affecting of Space Charge on Quick Aging performances was shown.

Motivation

This work was initiated by phenomena of fast aging on edges of irradiation zone, when the first signs of aging appears not at the center, but at the edges of the irradiated zone.*

Collected charge along the straw for different accumulated dozes

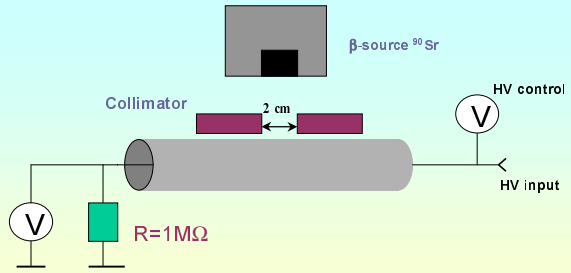


*G.Gavrilov,A.Krivshich et al., Ageing Investigation of ATLAS TRT Straws, Preprint PNPI EP-43-1999 N2328

TEST SETUP

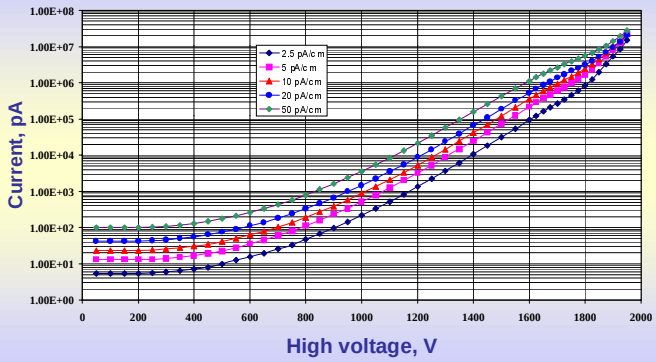
Detector: drift tube ∅ 4 mm
Wire: ∅ 35 mm, gold-plated tungsten
Irradiation densities: 2.5 ÷ 50 pA/cm
Gas mixture: Xe + 10%CO_2 + 20%CF_4

Gas Gain (GG) was defined as a ratio of current at applied high voltage (HV) to the current of ionization plateau. The measurements of current were performed with PREMA multimeter. Irradiation density (ID) was modified by changing of the distance between straw and β-source

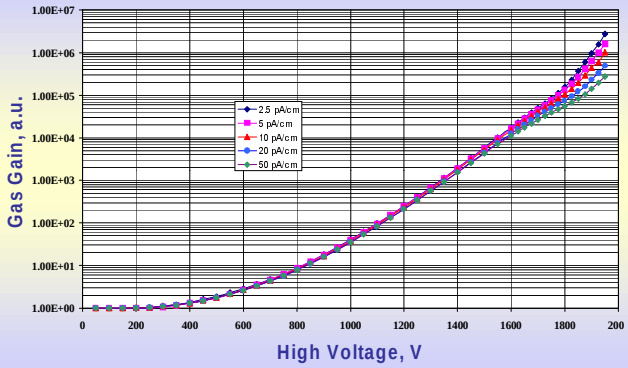


RESULTS of Measurements

Current due to ^{90}Sr for different irradiation densities



Gas Gain for different irradiation densities



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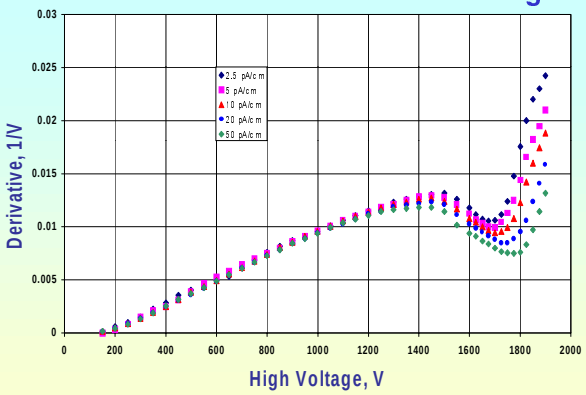
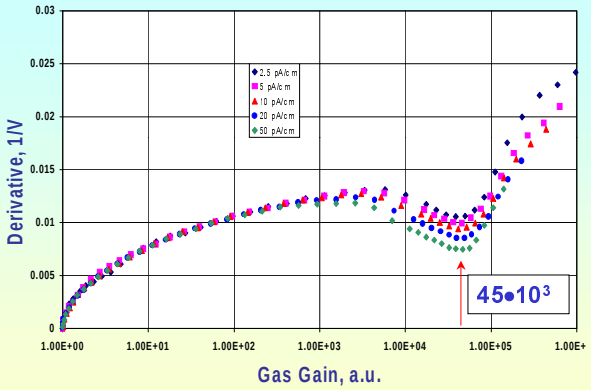
ANALYSIS OF DATA

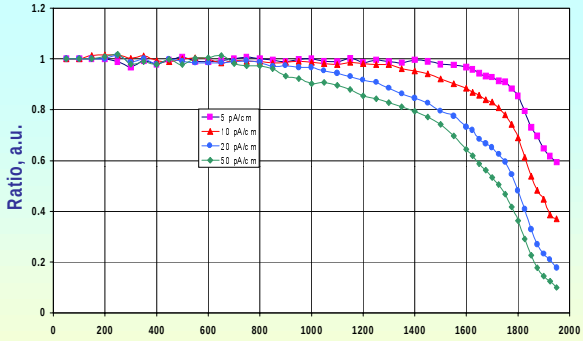
Derivative of Gas Gain Logarithm for different irradiation densities



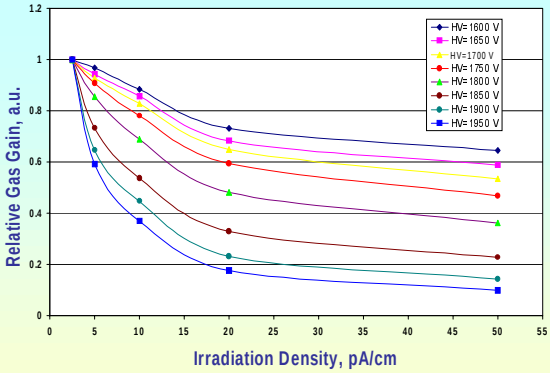
The drop of Derivative corresponds to effect of space charge. The increasing of Derivative is explaining by appearance of streamers. The point of appearance of streamers is shifting to more high voltage with increasing of irradiation densities.



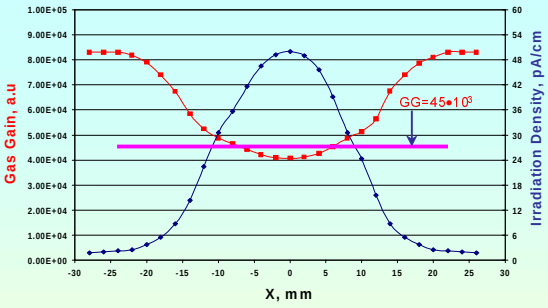
One can see that the streamers appear at the same Gas Gain for different irradiation densities.



The relative incidence of the GG at different irradiation rates is demonstrated. All curves are normalized to the curve at ID=2.5 pA/cm. It is to see that GG drop achieves 50% at HV=1.7 kV for ID=50 pA/cm (GG is equal $50 \bullet 10^3$ for minimum irradiation rate)



The degradation of GG versus ID is shown for different HV.



The blue curve is the measured distribution of irradiation density. The red curve shows distribution of gas gain under HV=1.75 kV calculated with taking into account the dependence of the GG on irradiation density. One can see that gas gain is less than $45 \bullet 10^3$ in region -8mm<X<8mm. That means there are no streamers in this region. But on the edges of irradiation zone the GG is more than $45 \bullet 10^3$ and the streamers are present there. This fact can explain the fast aging on edges of the irradiation zone.

CONCLUSION

- Our study shows the significant influence of space charge on performance of gas filled detectors at irradiation densities more than 10 pA/cm. It is shown that in this case the GG strongly drop in the irradiation zone.
- The fast aging phenomena on the edges could be explained by the presence of streamers in these regions.
- To avoid this problems we would recommend to compensate the influence of space charge by increasing of HV. It leads to arising of the gas gain on the edges of irradiation zone. We would also recommend to extend the irradiated zone as possible to reduce the contribution of edges.

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