

Space Distribution of Streamers in Straw Drift Tubes

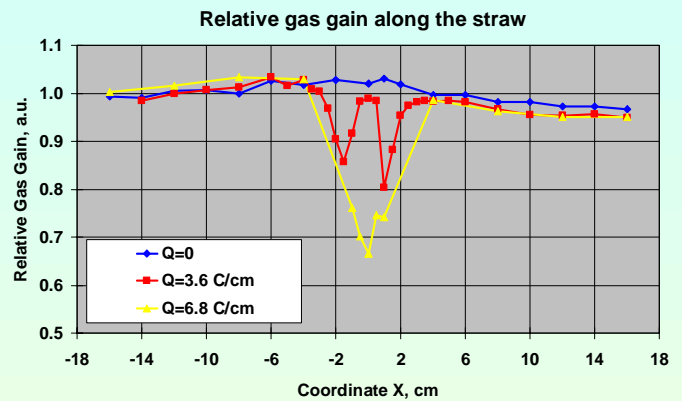
Studies of a space distribution of streamers has been performed for straw drift tubes operating with 70%Xe+10%CO₂+20%CF₄.

Straw tube parameters:

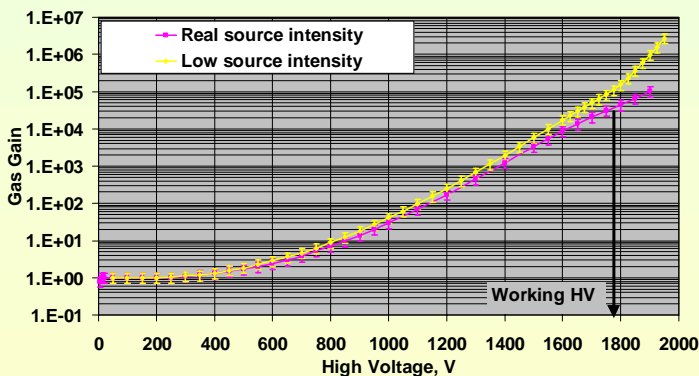
Anode wire diameter 35 μm
Cathode diameter: 4 mm

Motivation

Aging test with 70%Xe+10%CO₂+20%CF₄ gas mixture has shown that first signs of aging has appeared not at the center, but at the edges of the irradiated zone.



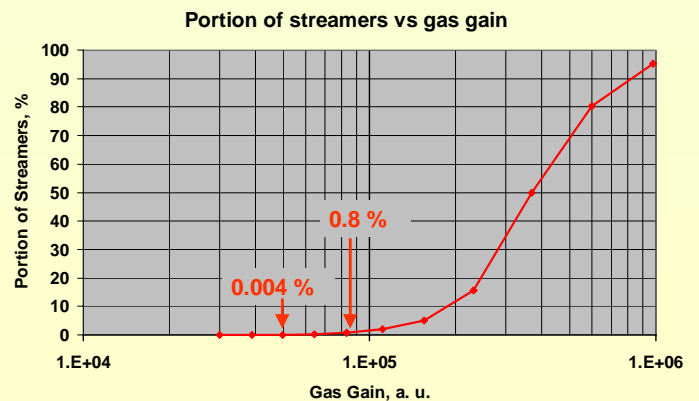
Gas Gain for different irradiation densities



Spectra from ⁵⁵Fe have shown the presence of limited streamer modes (LSM) starting from the gas gain of about 5·10⁴. The obtained data prompted to more thorough investigation of streamers.

During the test, an applied high voltage was chosen so as to provide a gas gain of 3·10⁴ at the center of the irradiation zone.

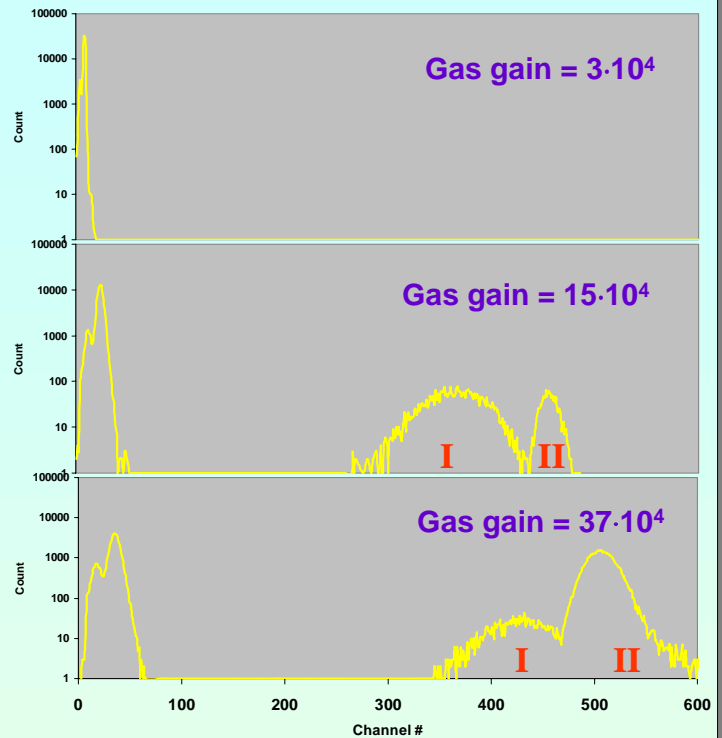
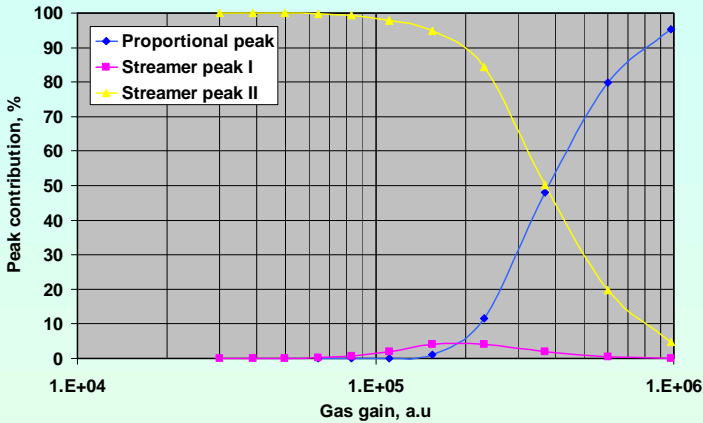
According to a source intensity distribution, at edges of the irradiated zone the gas gain exceeded 8·10⁴.



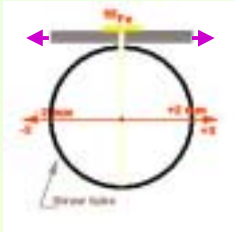
Streamer modes

Spectra from ^{55}Fe have also shown a double structure of the streamer peak. Peak II corresponds to double streamers.

A contribution of the streamer modes strongly depends on the gas gain.



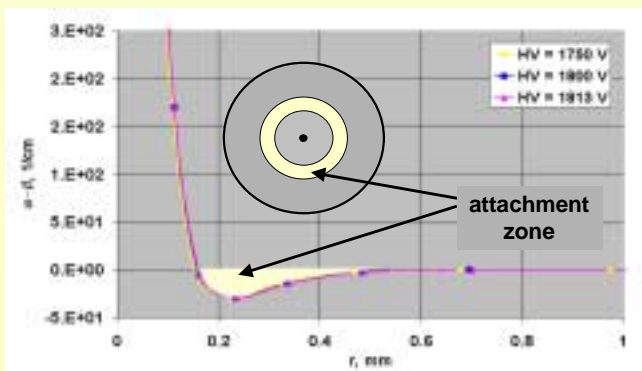
Space distribution



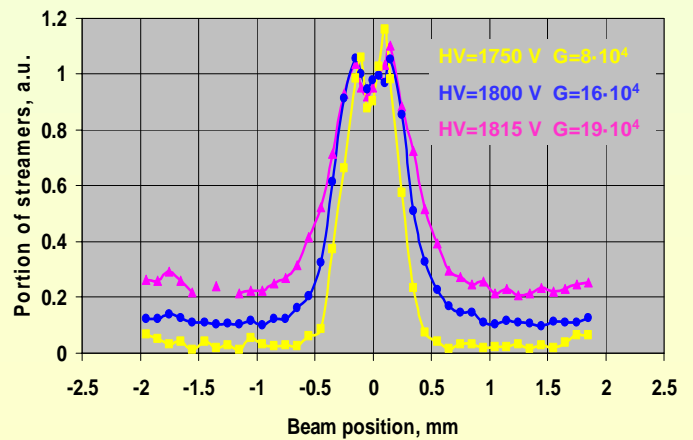
Space distribution of the streamers has been obtained by a cross-scanning of the tube with a narrow-collimated ^{55}Fe source.

It was shown, that the main part of streamers are generated at a narrow zone ($\pm 0.4\text{mm}$) around the wire.

Behavior of a difference between the Townsend and attachment coefficients calculated with MAGBOLTZ program allows to make an assumption that a probability of a streamer generation increases according to a reduction of an electron path through the attachment zone.

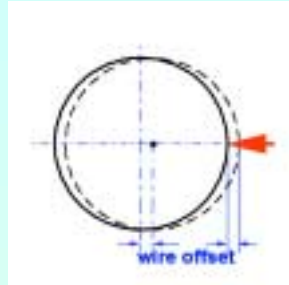


Relative portion of streamers vs beam position across straw for different high voltages

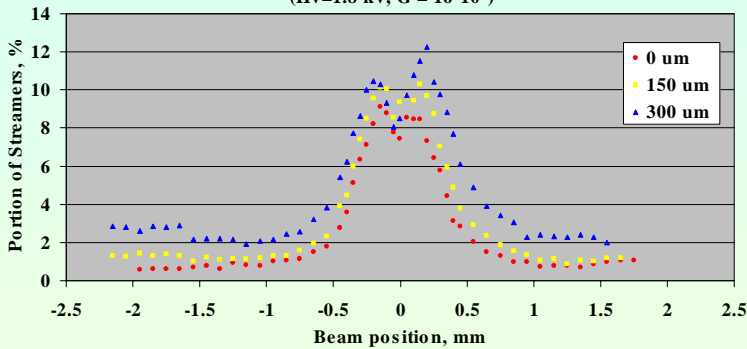


Streamers in a bent tube

Study of streamers in a bent tube has given the dependence of number of streamers on an anode wire offset.



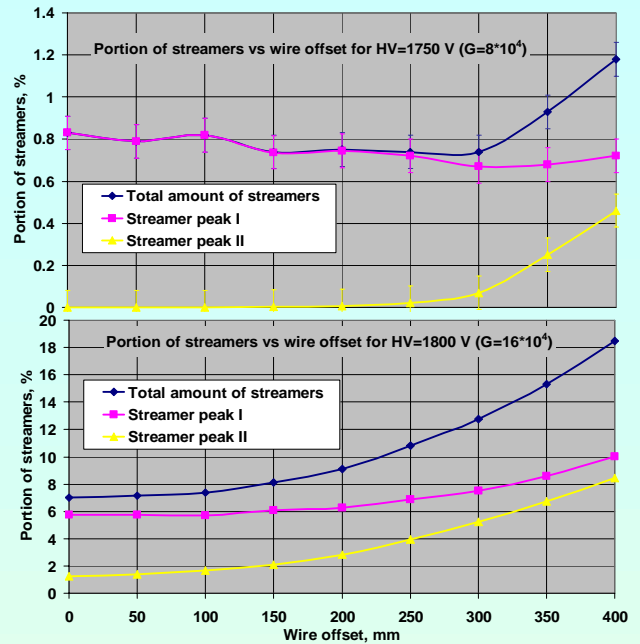
Portion of streamers vs beam position for different wire offsets
(HV=1.8 kV, $G = 16 \cdot 10^4$)



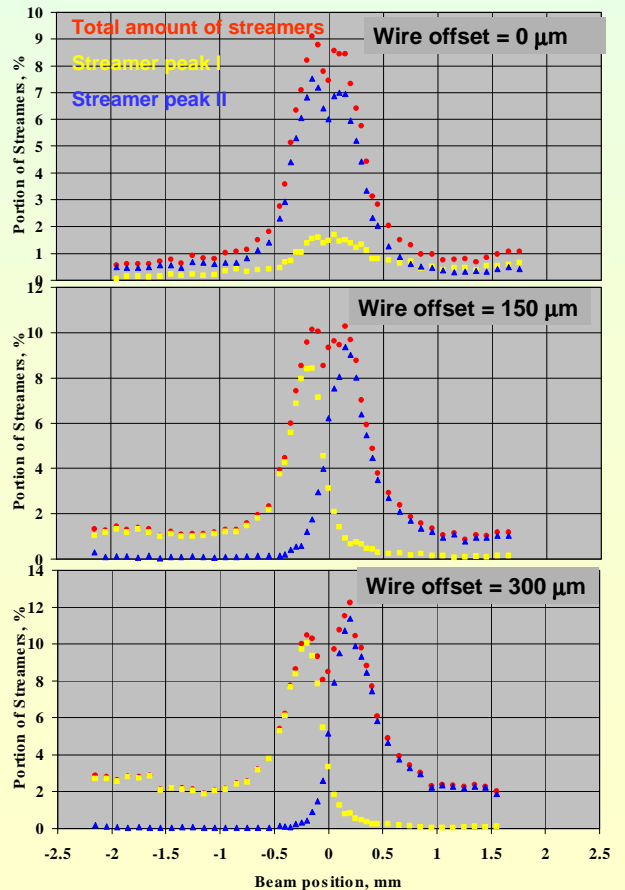
Dependence of number of streamers on a wire offset has shown influence of field strength and gradient upon a probability of generation single (I) and double (II) streamers.

The electric field in the bent tube has higher strength and higher gradient on the right of the wire, which increase the probability of a double streamer generation.

Reduction of the field gradient on the left of the wire causes increase of the probability of a single streamer appearance.



Portion of different streamer modes vs beam position
(HV=1.8 kV, $G = 16 \cdot 10^4$)



Conclusion

- ▶ Limited Streamer Mode appears starting from the gas gain of $5 \cdot 10^4$. A rapid increase of the streamer contribution is observed starting from the gas gain of about $8 \cdot 10^4$.
- ▶ Anode wire offset results in a rise in the number of streamers.
- ▶ It was observed that the main part of streamers is generated at a narrow area around the anode wire. The number of streamers generated at this area is 5-10 times more than at the rest part of the tube. A bound of the area corresponds to the beginning of the attachment zone.
- ▶ Two types of the streamer modes were observed. A probability of these modes generation depends on the electric field structure.

- ▶ Obtained data led us to conclude that the presence of the limited streamer mode accelerate a wire aging.