

X/ γ -rays Detection during Streamer Development

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X or γ -rays have been produced in the developing discharge of a 2MV lightning surge generator. The generator provides a voltage waveform with 1.2/50 μ s rise/fall time. The waveform is truncated by a spark gap; two sharply pointed electrodes placed horizontally at 0.7 m distance with one electrode grounded. Gap breakdown occurs at about 850 kV. High energies has been recorded with BaF₂ and LaBr₃(Ce) γ -detectors facing the surge. Aluminum windows limit the detection to γ s with energy above 17 keV. The scintillator-photomultiplier combination has been calibrated by the 662 keV line of a ¹³⁷Cs source; the pulse output rise/fall time is 11/23 ns.

With 850 kV positive surges applied to the floating spark gap electrode, hard radiation is observed in 100% to 60% of the surges depending on the detectors distance from the surge. The radiation occurred in the leading edge, during the streamer development before a conducting channel was formed between the electrodes. This timing links the γ -production to the leader formation. The γ -signal consists of several pulses, well resolved in time. γ -pulses equivalent to several MeV were detected. From absorption measurements we conclude that these high energy pulses are pile-up of multiple γ -quanta, each over 100 keV. The pile-up occurs within the rise time of the detector response, 11 ns. Even a BaF₂ scintillator with 4 ns time resolution is not able to resolve the individual quanta. The consistent timing with the HV-surge excluded background radiation as a source for these high intensity pulses. When switching over to negative discharges three things change: more surges resulted in γ -pulses, more γ -pulses per surge, and more γ -energy. Gamma pulses up to the equivalent of 30 MeV have been recorded. These high equivalent energies are caused by streamers propagating from the measurement cabinet, right in front of the detector.

X-ray was also measured from streamer-corona plasma in a wire-plate reactor. A high repetition rate 15/25 ns rise/fall time HV-pulse with 100 ns width was applied to the wire. The voltage pulse's amplitude was 65 kV with an additional DC offset of +20kV. Energies equivalent to 45 keV have been recorded.

To unravel the signals into electron energy distribution function requires is difficult. In the developing discharge electrons are accelerated and collide with air-molecules. A minor fraction of these collisions leads to γ -production. The γ -quanta are completely or partly absorbed in the scintillator, giving rise to signals in the photo-peak or Compton ridge. The signals of several γ s may occur within the time resolution of the scintillator-multiplier combination, leading to pile-up. In addition the effects of Compton scattering makes the interpretation of the data more complicated. The absorption measurements

mentioned above are a first attempt to resolve this multiple integral. Different absorption materials are a second step.