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Meter-long laboratory sparks generate high-energetic radiation in a similar way as lightning: Bremsstrahlung generated in collisions between high-energy electrons and air molecules. This study aims to localize and characterize the X-ray source and to visualize the relevant processes.

A Marx generator delivers a standardized lightning impulse voltage pulse of 1.2/50 μs rise/fall time of positive or negative polarity. The generator was loaded by a spark gap formed by two conical electrodes at about 1 m distance; one of the electrodes was grounded. Applied voltages were 1 MV, which lead to breakdown of the gap. The voltage was measured by a high-voltage divider. Both electrodes were equipped with current probes to determine the electrical characteristics of the discharge. Two La(Ce)Br_3 scintillation detectors measured the X-rays; different distances and angles gave information on the spatial distribution around the spark gap. Lead collimators limited the field of view. Lead attenuators of different thicknesses helped to determine the energy distribution. An intensified CCD camera allows us to capture images of pre-breakdown phenomena with ten-ns resolution. All diagnostics was synchronized to better than 1 ns. Many hundreds of discharges allowed statistical analysis.

The X-ray emission area is concentrated in the vicinity of the cathode. The variation with detector position shows a $1/r^2$ dependence of the detection rate, characteristic of a point-like source of constant luminosity. The reduction with attenuators of variable thickness agrees with a characteristic X-ray energy of 200 keV. The X-rays never occur before there is any cathode current.

The nanosecond-fast photography allowed us to follow all pre-breakdown stages of the discharge, from the formation of a first inception cloud, to the formation and propagation of streamers crossing the gap. At a later stage, some cold streamer channels developed into hot leaders which then lead to breakdown. For the X-ray production negative streamers were a necessary and sufficient condition, for positive *and* for negative generator voltage.