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X-rays from very long laboratory sparks in air

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We report statistics and some preliminary observations of X-rays generated from very long laboratory sparks in the order of 3m to 7m. More than 1000 sparks of standard lightning impulse were applied during the tests. Different electrode configurations (the type of electrodes, gap length and orientation) were used with both positive and negative polarities. Sparks were generated with a Marx generator having a maximum charging voltage of 3.5MV. Three scintillation detectors were used to record X-rays produced. The voltage applied to a certain configuration and the current from both ground end and the high voltage end were measured. In addition a high speed video camera with a maximum frame rate of 1 million frames per second was used to record the sparks.

The results shows in general for negative polarity sparks X-rays are generated irrespective of a breakdown or an encounter of streamer fronts as seen from the high speed camera. This is also evident since, even for applied voltages much lower than breakdown voltage of a certain configuration, X-rays are generated. But for positive impulses, X-ray are generated when streamer fronts meet as seen by the high speed camera. In rare cases there seems to be two streamer front encounters, which does not lead to a breakdown, but still produce X-rays. In both negative and positive polarity impulses, the time of X-ray generation is around the crest of the applied voltage (i.e. around 1μs-2.5μs from the beginning of the applied voltage) whereas the breakdown can happen much later (could be as high as 50μs). It is also evident for positive impulses the X-ray occurrence happens later than that of a negative impulse with the same electrode configuration.