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Advanced streamer imaging techniques

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Streamers are the precursors to sparks, which have undesired effects in many high voltage applications. An example of this is a circuit breaker where high voltages are switched by physically opening the electrical circuit, thereby creating an arc. This arc, which short circuits the separated electrodes is extinguished by flushing with an electronegative gas. After extinguishing, the circuit breaker needs to remain open for a successful switching operation. Therefore, new streamers which initiate at the high voltage electrodes and create electrically conducting paths, need to be prevented.

The electronegative gas of choice for the best performance in extinguishing arcs is SF6. However, due to its extreme potency as a greenhouse gas, alternative gasses are under investigation. This research focuses mainly on streamer discharge properties in CO2 in addition to air and N2.

Due to the complex nature of streamers and the simplified conditions used in numerical modeling of streamers, we attempt to simplify the streamer morphology in our experiments by reducing the applied voltage. These simplified streamers can then be imaged using stroboscopic and stereoscopic techniques. Using path tracking, grouping and triangulation algorithms, the 3-D morphology can be reconstructed. The reconstructed streamers can then be compared in detail to simulations.

When the streamer morphology becomes too complex and cluttered for these techniques, the cylindrical symmetry of the point to plane geometry can be used to perform an Abel inversion. Single shot streamer images are not cylindrically symmetric, but when numerous discharges are stacked, this symmetry appears.

Both methods operate in their respective streamer morphology complexity regime, where the full 3D reconstruction certainly extracts more detailed information compared to the stacked Abel inversions. The main challenge now lies in detailed diagnostics for the full regime.

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