# Measuring the radius of the plasma at the plasma-liquid interface in a pulsed-current, DC discharge

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***Abstract*—The study of plasma-liquid interactions is an emerging field with multifarious applications, including medicine (wound healing, sterilization), environmental remediation (water purification, fracking fluid treatment), and material synthesis. These applications are driven by chemical species created in the plasma or at the plasma-liquid interface, such as hydroxyl radicals (OH), hydrogen peroxide (H2O2), and solvated electrons (eaq-). Solvated electrons are free electrons in a polar solution, loosely confined in a sphere of polar charge, notable for their speed of reaction (ns). In our previous work, we detected eaq-, using absorption spectroscopy, as they are injected steadily into a solution by a gas discharge. To measure extremely small optical densities (~ 10-5), the plasma current was pulsed at high and low values, at a carrier frequency of 20 kHz. Essential to the analysis of the absorption data is the value of the current density at the liquid interface, which can be determined based on the current and plasma radius. However, while the high, low, and average currents are easy to measure, only the average radius of the plasma beam under pulsing conditions can be captured by a conventional camera. This averaging poses a problem because the uncertainty of the plasma-liquid contact area and the current density manifest themselves as significant bias uncertainties in the data analysis. In this work, we used a high-speed camera with a recording speed of 20,000 fps and a 10 µs exposure time to accurately measure the dynamically changing plasma radius. The camera is triggered as the plasma switches between the high and low current states, and with a suitable delay, the states are captured separately. The image processing of the averaged images reveals the plasma radius, and in turn, reduces the uncertainty in the calculation of key solvated electron parameters (such as the penetration depth) from the absorbance data.**