# Experimental Set-up and Procedure

## Set-up

The discharges were conducted in an xx cm diam test chamber, equipped with ports for inserting the test electrode, pumping, observation, and bombardment by a vacuum arc generated metal plasma (not used in the current experiments). The test electrode was a xx cm diam by xx mm thick Cu (???) disk. It was connected at its center to a xx mm diam rod, which was insulated by a xx mm o.d. ceramic insulator, which extended from an insulated vacuum feed-through. The air side of the feed-through was equipped with a high voltage coaxial connector.

High purity Ar gas (xxx%) was introduced into the test chamber via a mass flow controller, and evacuated with a diffusion pump backed by a rotary pump. A flow rate in the range of xx-xx sccm was chosen, and with the discharge running, the pressure generally stabilized at a pressure which was measured with a capacitive manometer (MKS Baratron, model xxx).

A repetitively pulsed electrical discharge was excited by applying negative pulses of 1.7 kV amplitude, 20 μs duration at a pulse repetition rate of 100 Hz from a xxxxx pulsed power supply via ~xx m of xxx coaxial cable to the electrode feed-through. The chamber walls were grounded, and thus served as the anode of the discharge.

The discharge was photographed via the observation window using a Cannon G15 in automatic mode for preliminary studies, and by a Hammamatsu xxxx fast camera, equipped with a xxxx framing plug-in, and a xxxx digital (?) output camera, which records the images produced on a multi-channel plate within the fast camera. The camera was equipped with a f/? xx-xx mm focal length zoom lens, mounted on its forward panel. This panel was located xx cm from the observation window, and xx cm from the center of the electrode.

The fast camera images were collected in a personal computer (PC) equipped with Hammamatsu xxx/xx software. Camera gate pulses as well as the discharge voltage and current waveforms were recorded on a Yokogawa DL1740 oscilloscope. The equipment was synchronized by 21 μs pulses generated at a 100 Hz repetition rate by a xxxx pulse generator. One output was connected to the camera sync input, was the other output was connected in parallel to the external trigger inputs of the pulsed power supply and the oscilloscope.

## Procedure

### Data Collection

The chamber was evacuated to a pressure less than 0.5 mTorr. Gas flow was established, a repetitively pulsed discharge was established, and the system was allowed to operate for several minutes until the pressure and discharge appeared to stabilize. The discharge was photographed in the framing mode, with 8 frames, each with an exposure time nominally of 0.5 μs, and a frame interval of 1 μs, and at maximum light amplification. Under control of the xxx software, images were acquired in the integrate mode, which integrates the output of the digital output camera for a time set via the software, for a maximum of 1 s). Thus the image transferred to the PC was the integration of up to 100 images, each containing 8 frames, where each frame was acquired at a set time during the repetitive pulse. The integration time was adjusted to its maximum value, or reduced so that the output image was not saturated.

### Data Analysis

Using the xxxx software, a narrow rectangular region of interest (ROI) was chosen, whose long axis was perpendicular to the disc electrode. One corner of the ROI was located approximately at the cornder of the ceramic electrode rod insulator, which was clearly visible in the photograph. Using the xxx software, light intensity profiles along the long axis of the ROI were collected for each frame, where each data point is the average in the direction perpendicular to the long axis. These \*.prf files were then opened using MS EXCEL, and graphed. Minima in the profile were identified as the center of the electrode, and the Faraday dark space on either side of the electrode. Maxima were identified as the center of the negative flow and the beginning of the positive column. The positions of these features were recorded and graphed, to show the location of these features as a function of time.