Appendix B

Experimental Setup Descriptions

B.1 Discharge

B.1.1 Pulsed Discharge Source

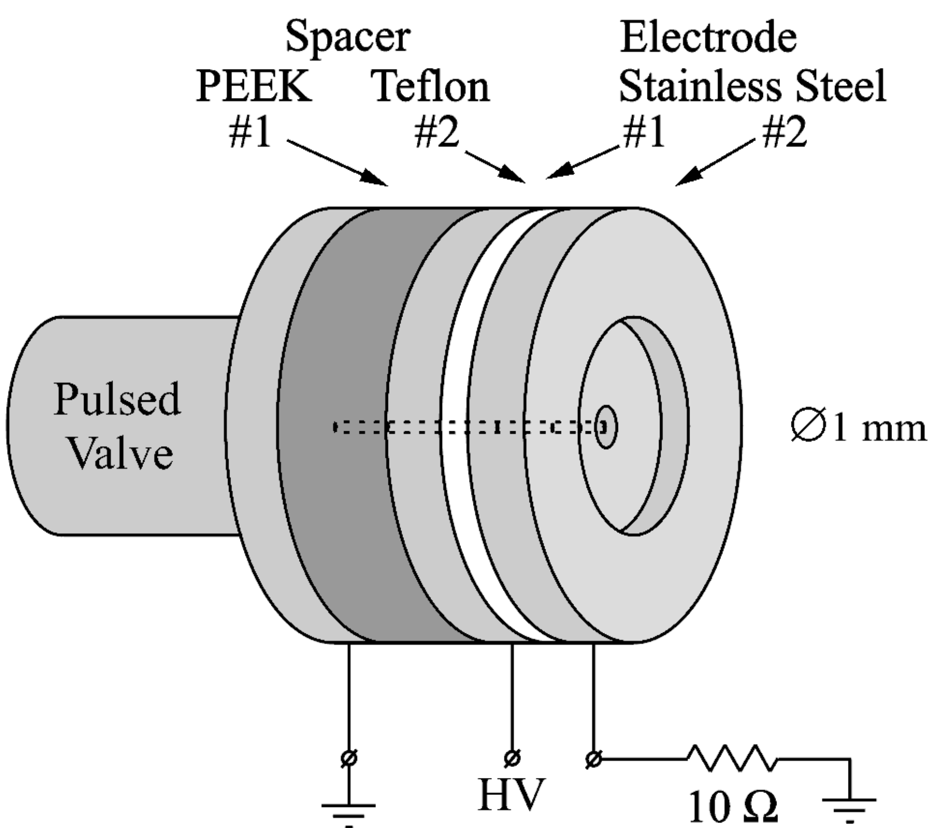

Figure B.1: Pulsed discharge source.

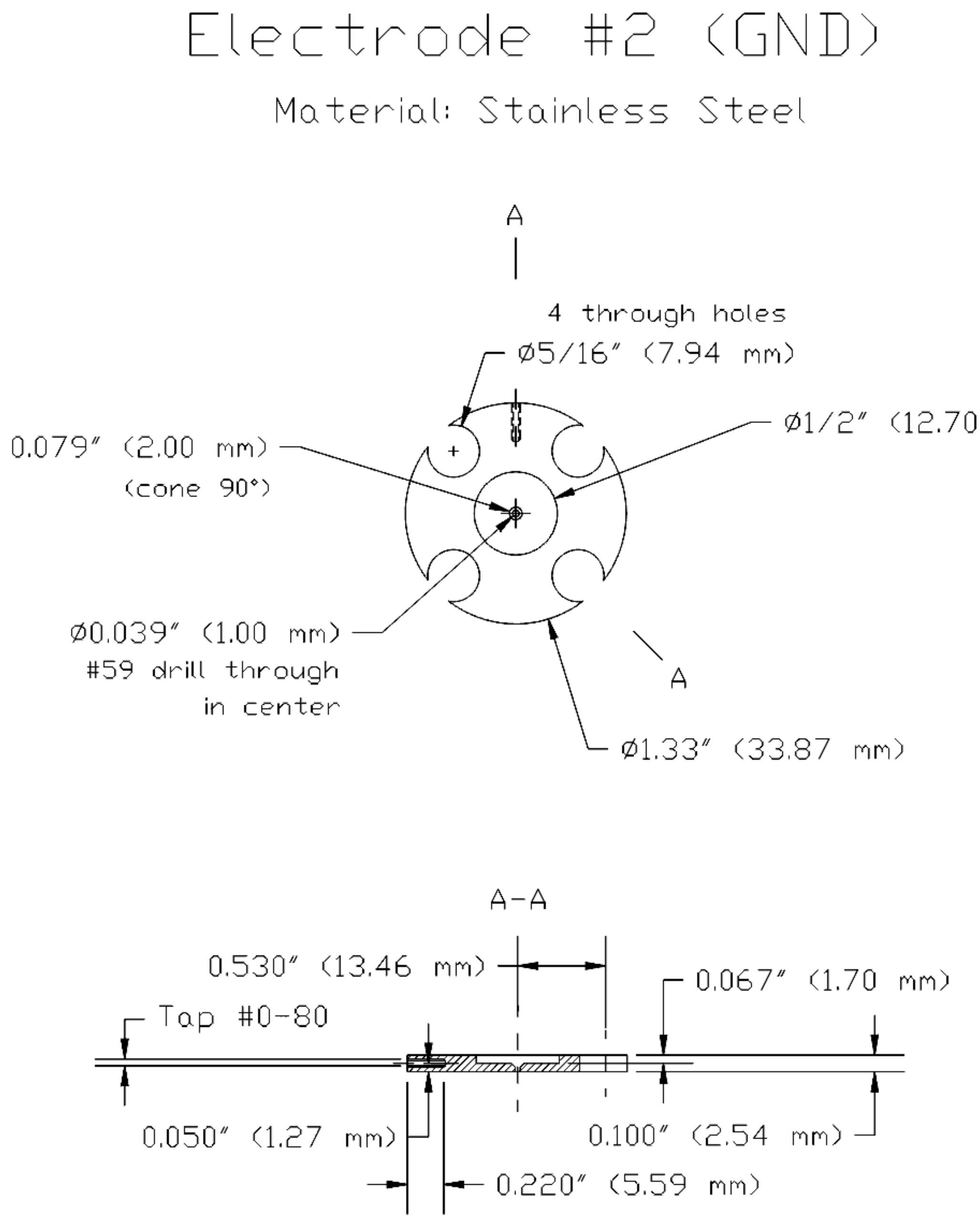

Figure B.2: Ground (outside) pulsed discharge electrode.

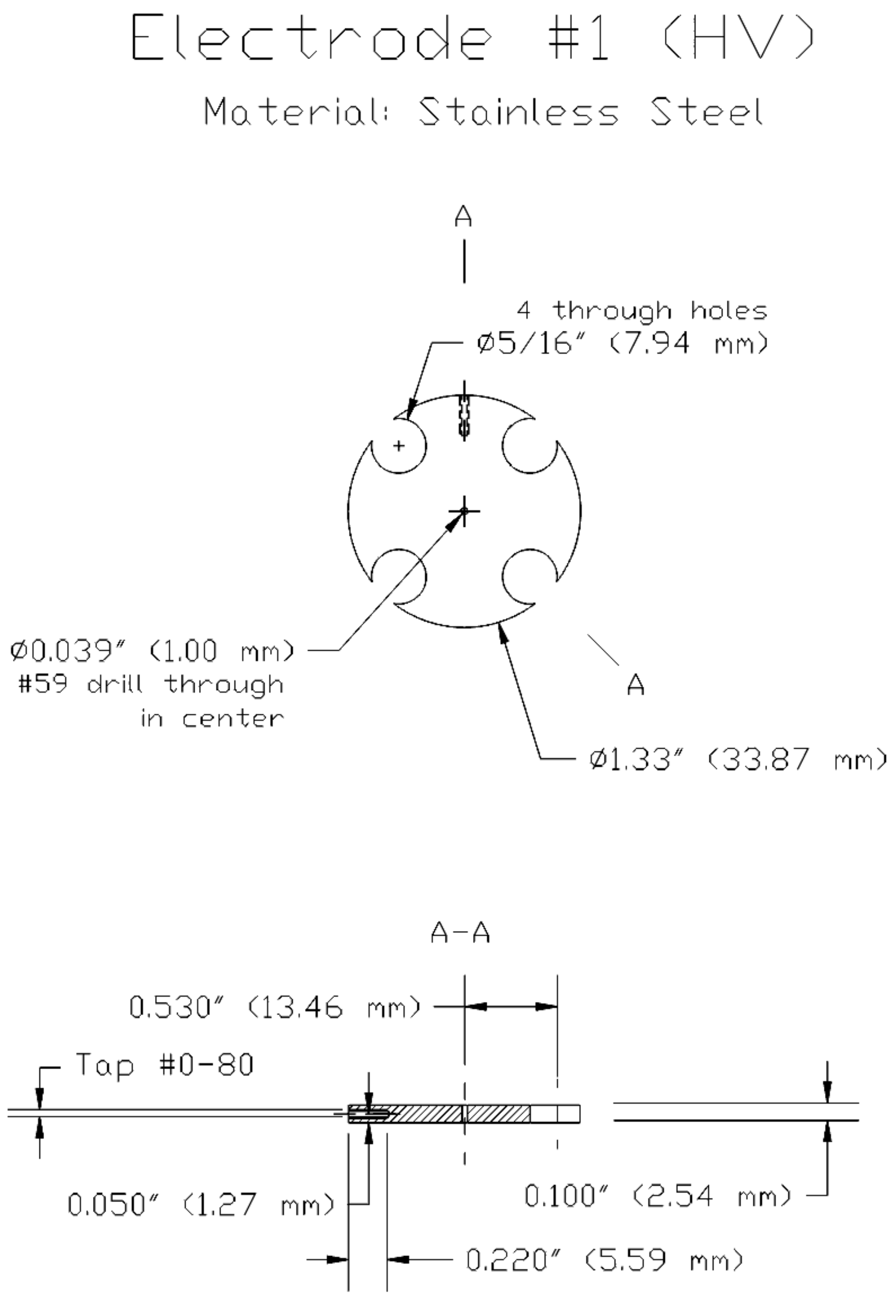

Figure B.3: High voltage (inside) pulsed discharge electrode.

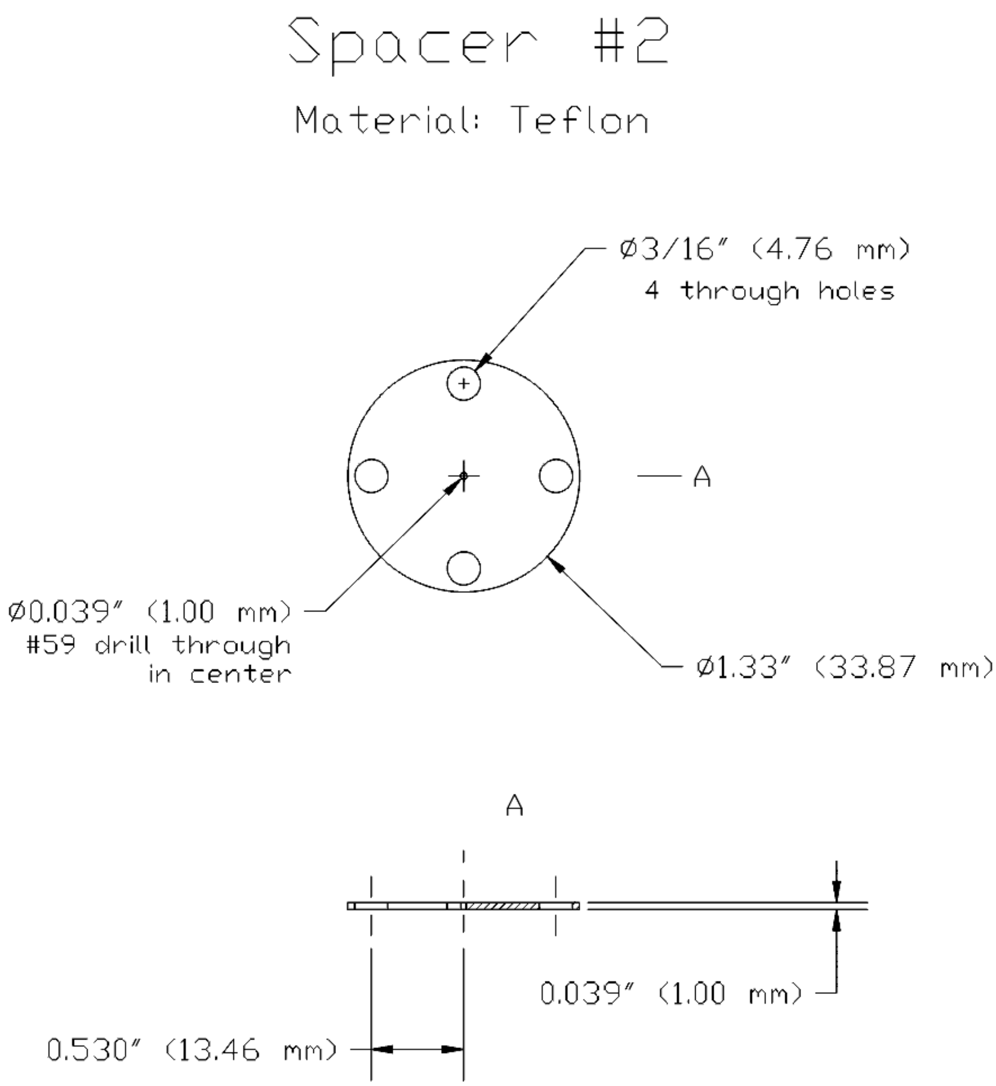

Figure B.4: Teflon insulating spacer between discharge electrodes.

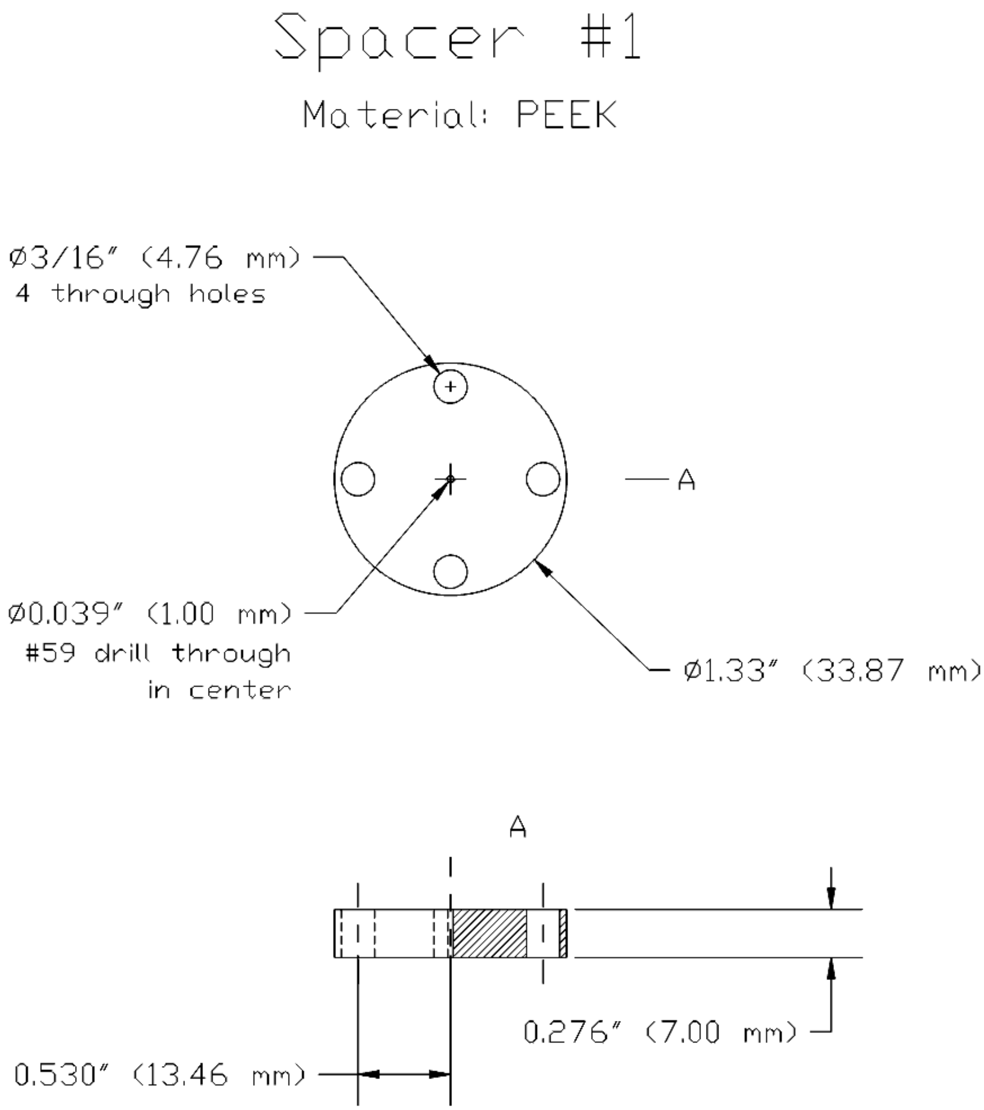

Figure B.5: PEEK insulating spacer between inside electrode and pulsed valve.

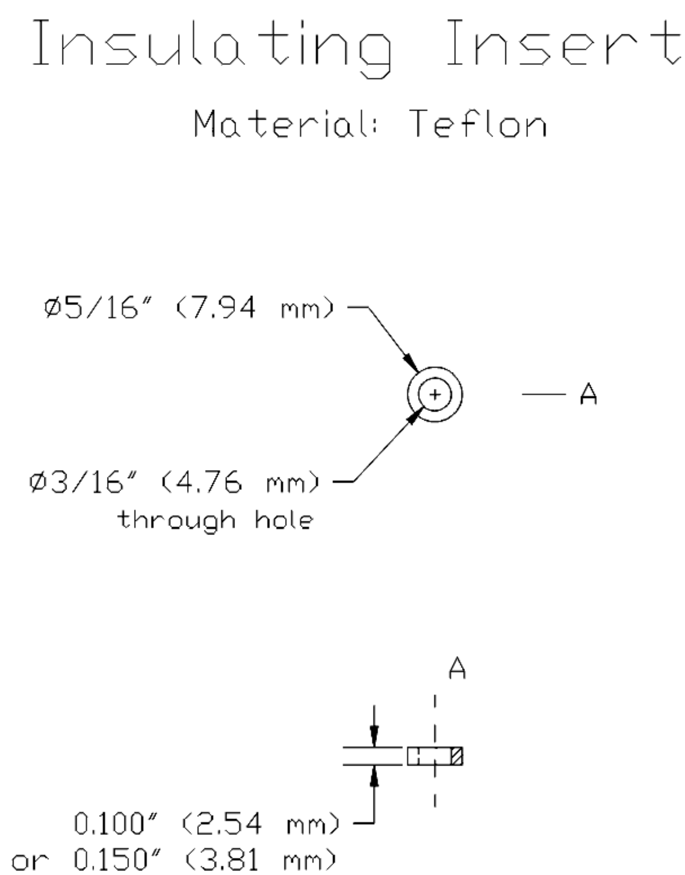

Figure B.6: Electrode inserts for screw insulation.

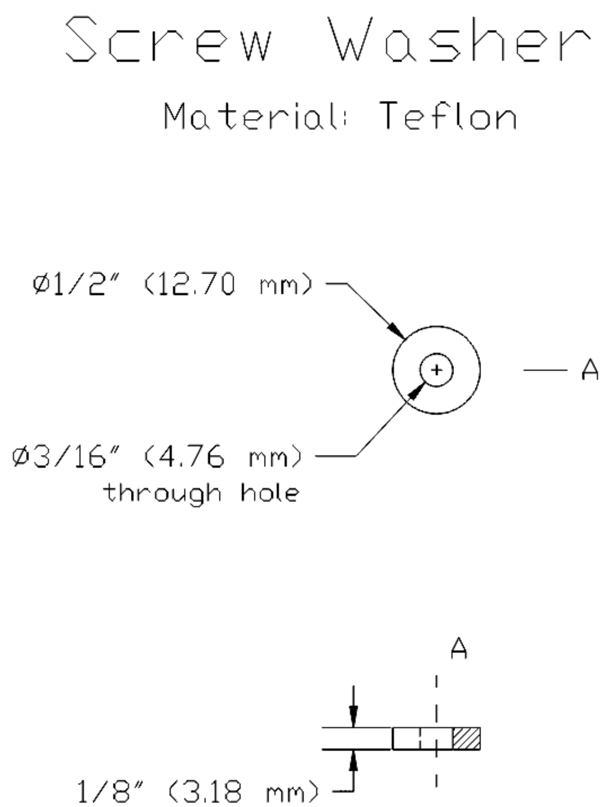

Figure B.7: Screw washer for insulation form outside electrode.

B.1.2 Pulsed Discharge Cluster Source

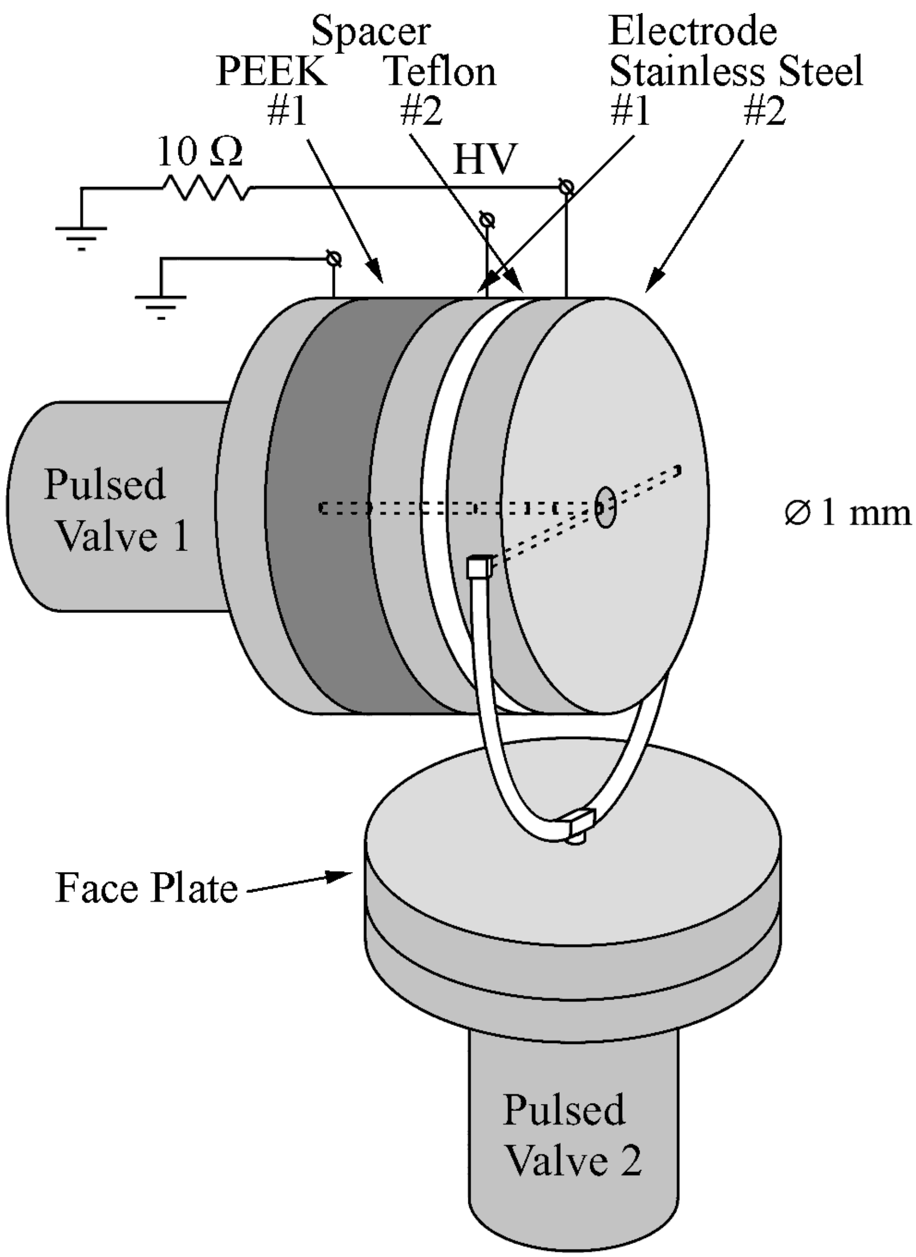

Figure B.8: Pulsed discharge cluster source with two pulsed valves.

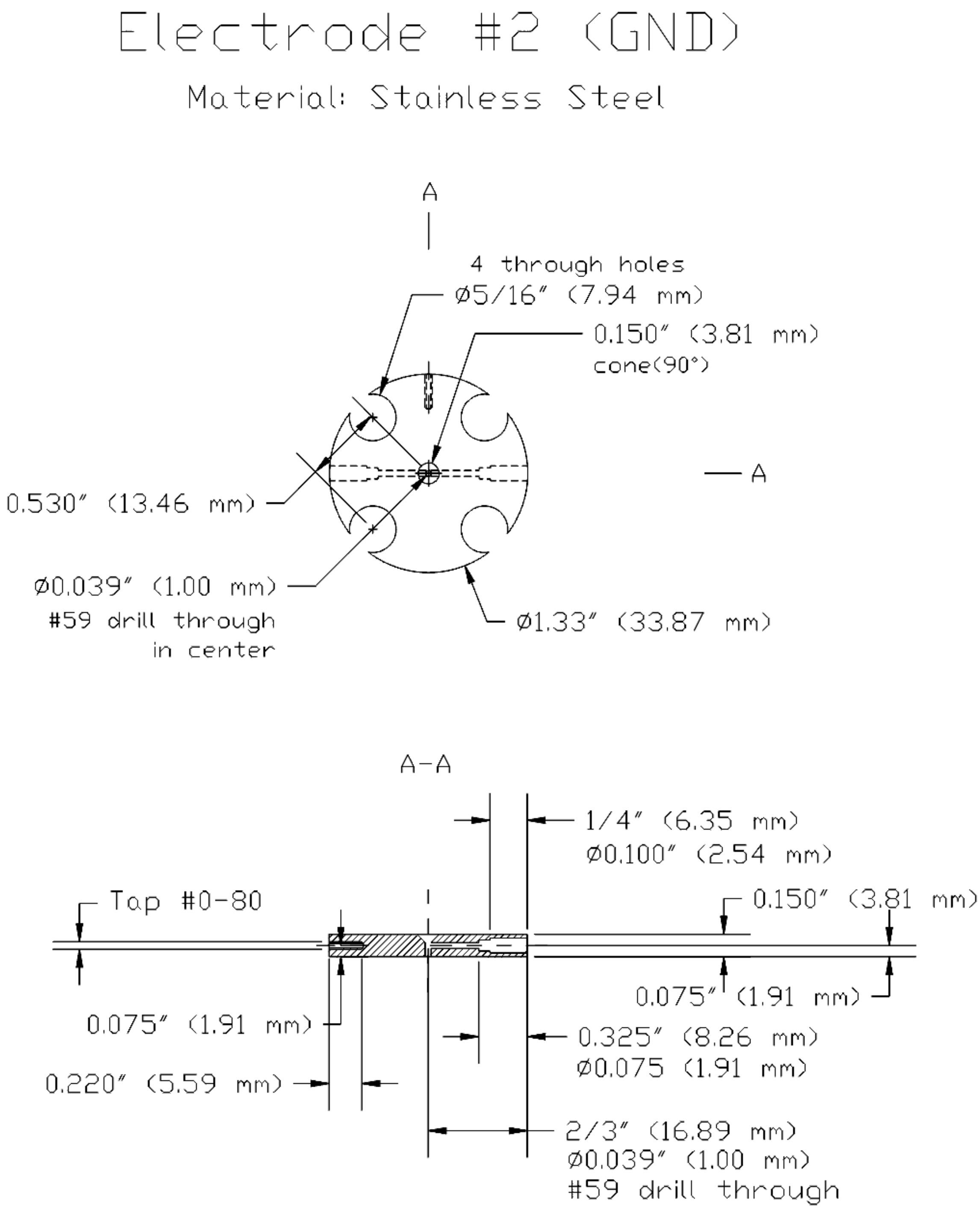

Figure B.9: Ground (outside) discharge electrode for cluster production.

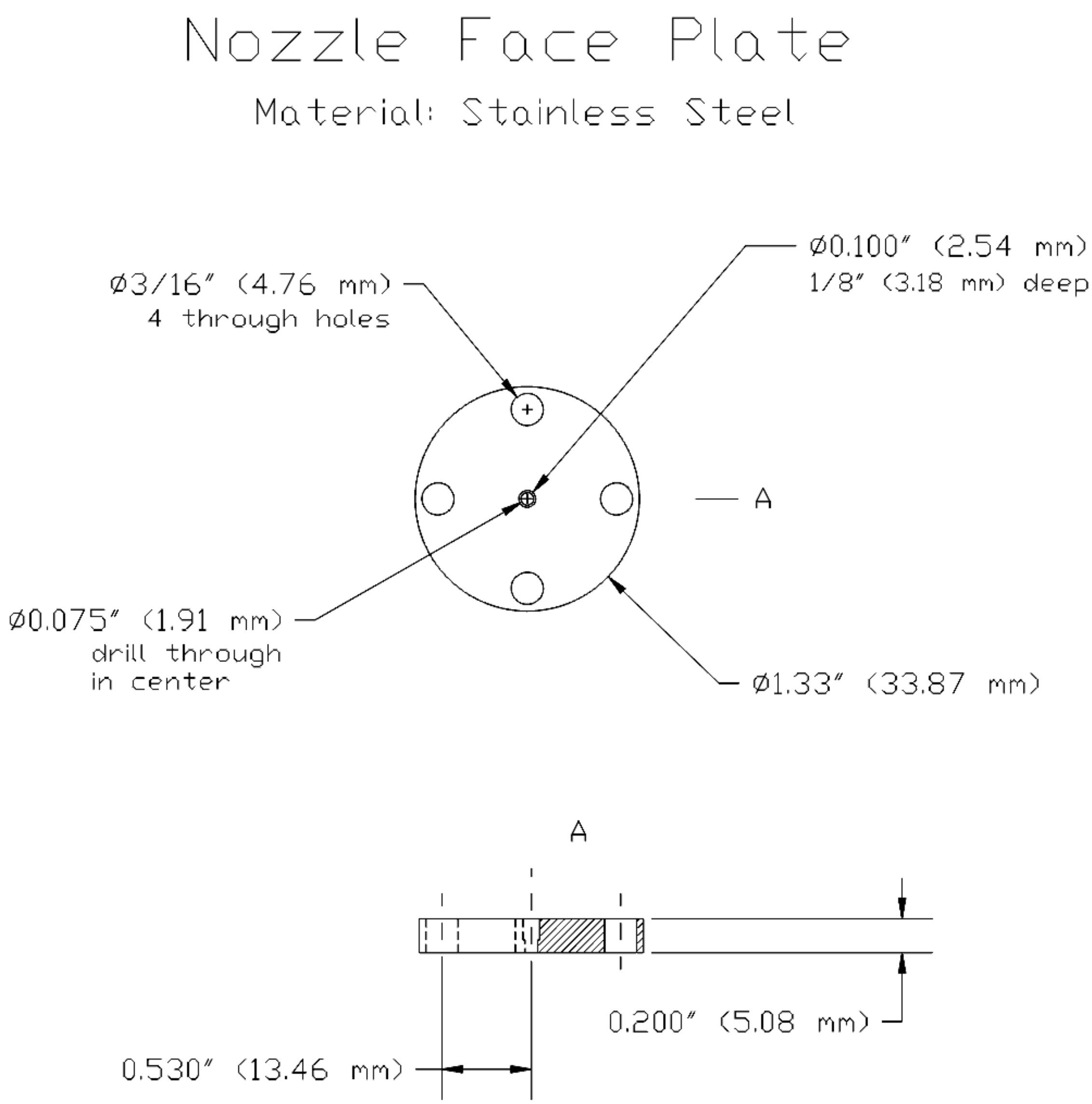

Figure B.10: Non-discharge pulsed valve faceplate flange for cluster production.

B.2 Circuits

B.2.1 TTL Pulse Width Selector

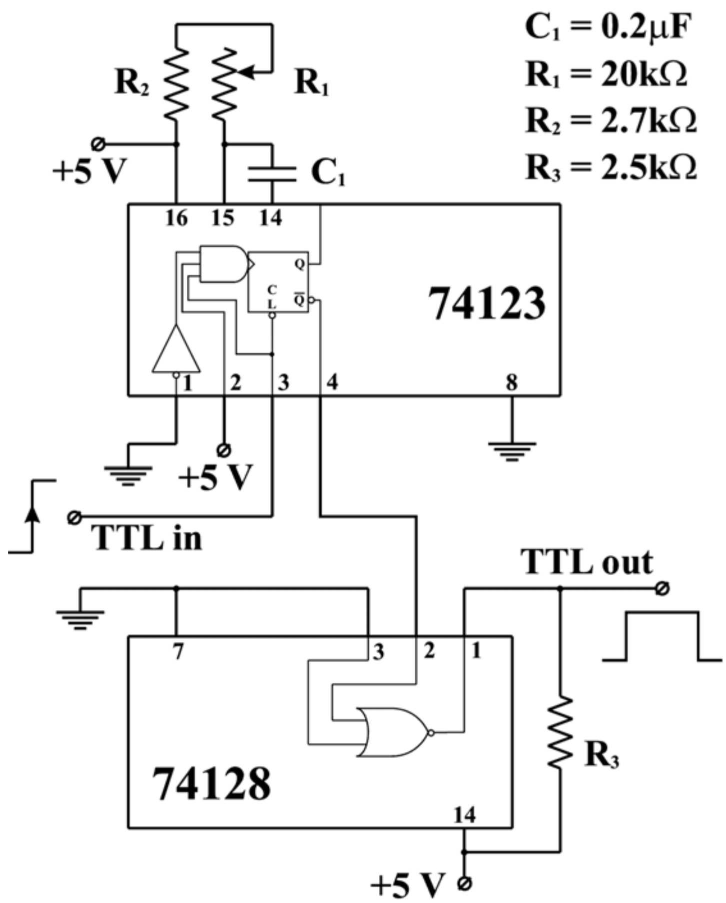

Figure B.11: TTL pulse width selector circuit, triggered by a TTL pulse rising front.

This circuit is triggered by the rising front of a TTL pulse and is used to produce a rectangular TTL pulse of desired duration (up to a few milliseconds). This helps to limit the number of triggering delay lines needed from a commonly used SRS 535 pulsed delay generator to only one. The pulse is produced by a retriggerable monostable multivibrator (74123). The pulse duration is determined by the $(R_1 + R_2)C_1$ time constant, and may be adjusted by the R_1 trim pot. The inverter (74128) is used to invert the pulse to the proper polarity and to isolate the input (delay generator) from the output (high voltage circuit).

B.2.2 Pulsed Valve Driver

The pulsed valve driver (Figure B.12) is based on a 2N6768 power MOSFET transistor. It applies high voltage to a solenoid pulsed valve whenever the transistor is opened. High voltage (up to 400 V) was produced by charging the C_1 capacitors in a voltage doubling arrangement. The voltage was regulated by a Variac, isolated from the rest of the circuit by a transformer. The R_1 resistor is used to discharge these capacitors when the circuit is turned off. The 1 kΩ, 25 W resistor was used to limit the current through the valve solenoid coil.

The high voltage transistor was opened by the TTL pulse width selector circuit (B.2.1). The necessary +5 V should be provided by a regulated +5 V power supply (300 mA or better).

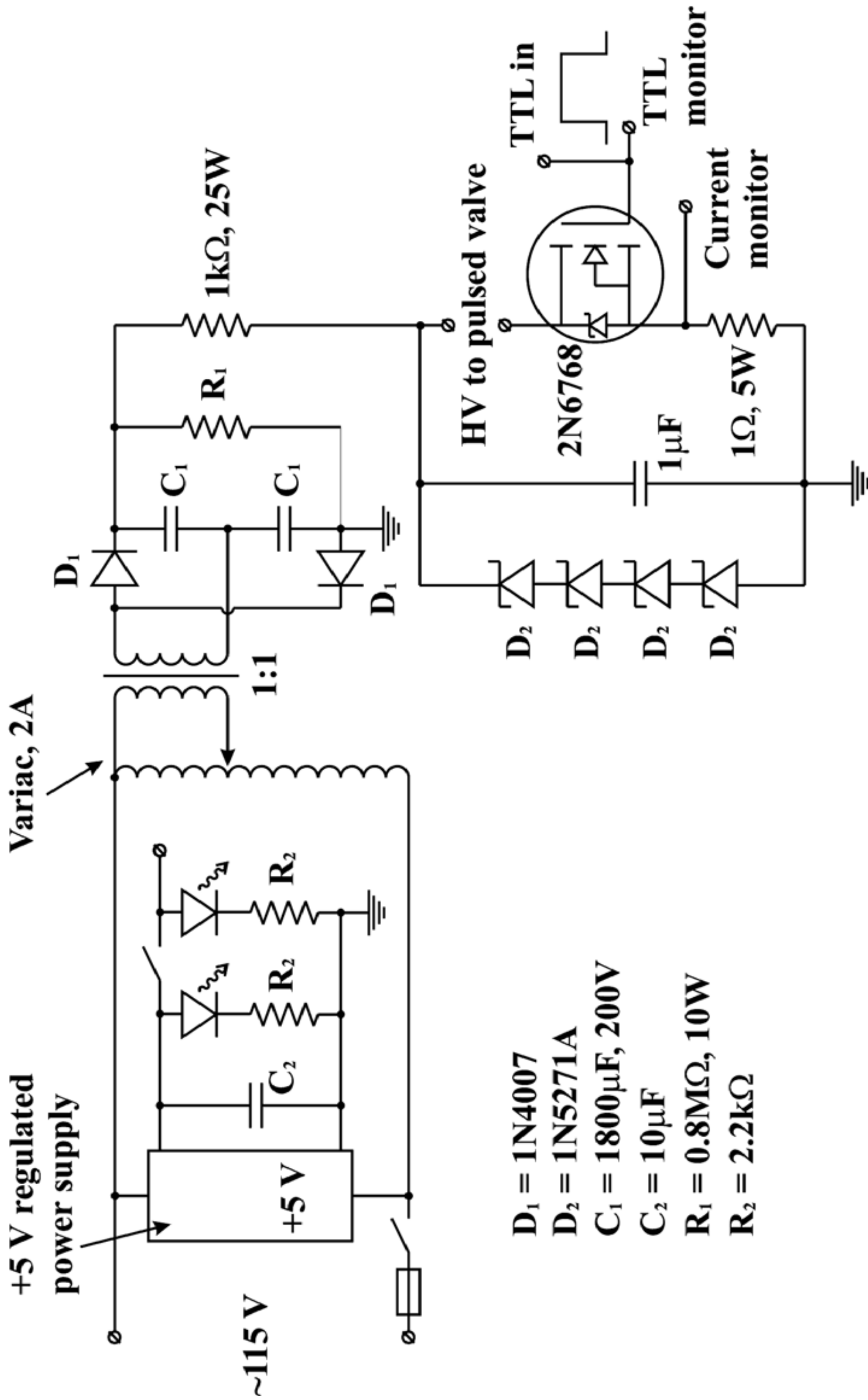

Figure B.12: Pulsed valve driver circuit.

B.2.3 TOF MS High Voltage Pulser

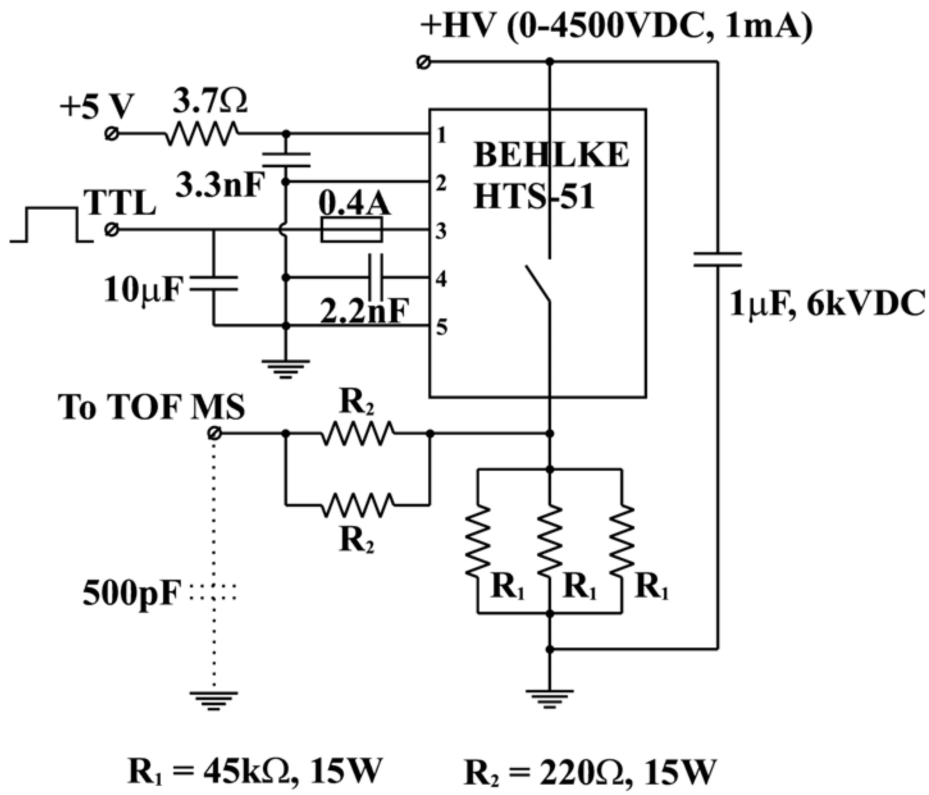

Figure B.13: One channel of the TOF MS high voltage pulser.

The pulser for high voltage ion extraction and acceleration in the time-of-flight mass spectrometer has two identical channels (Figure B.13). Each channel is based on a fast high voltage, high current switch HTS–51 (upto 5 kV, 30 A), manufactured by BEHLKE ELECTRONIC GmbH.

The high voltage capacitor was made of metalized polyester film rated up to 6 kV DC, custom made by Dearborn Electronics, Inc. It has been selected to be as large as possible to compensate for the low current from the power supply (1 mA maximum). It was therefore not possible to completely compensate for the high voltage overshoot at the beginning of

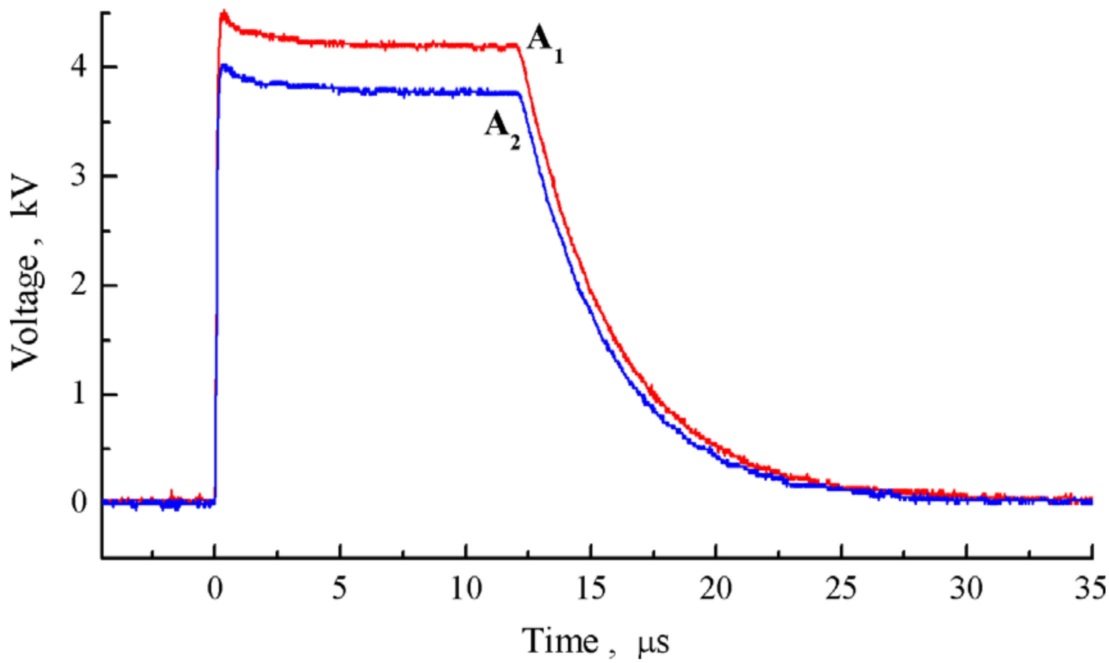

Figure B.14: TOF MS pulser high voltage pulse profile (full).

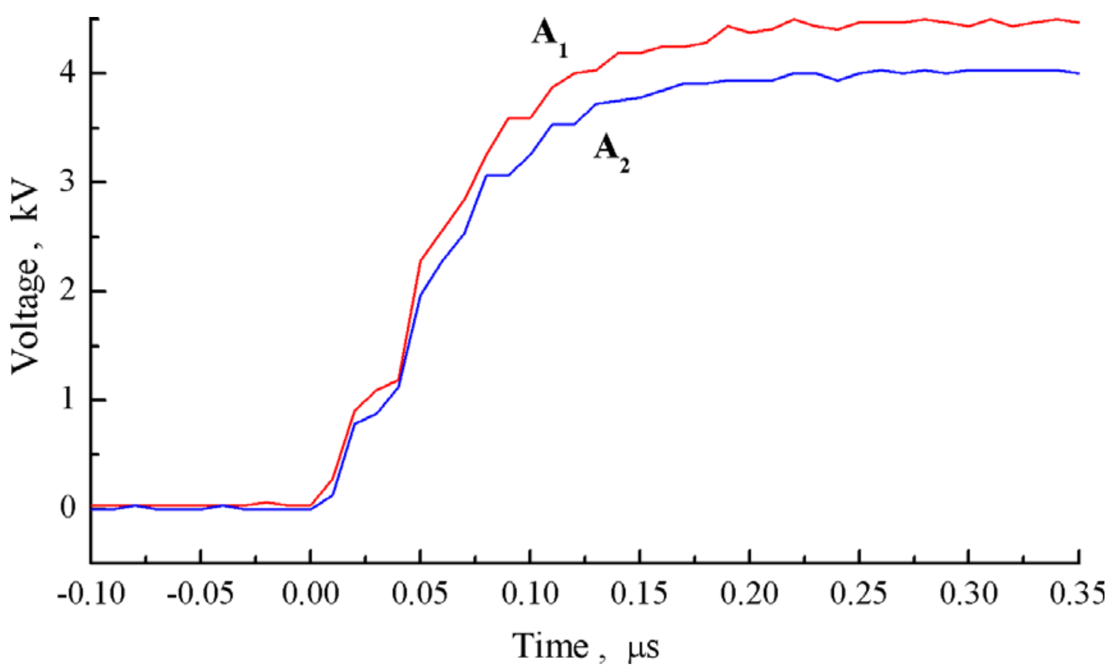

Figure B.15: TOF MS pulser high voltage pulse profile (front).

the pulse (Figures B.14, B.15; $V_{A_1} = 4200$ V, $V_{A_2} = 3800$ V).

The resistors R_1 were selected to adjust the voltage drop time constant at the pulse tail when the switch is turned off. The resistors R_2 were selected to adjust the voltage rise time constant at the pulse front after the switch is turned on, as well as to smooth out the voltage oscillations. Both R_1 and R_2 were type MS power film resistors (15 W) rated for up to 6 kV DC operation, manufactured by Caddock Electronics, Inc.

The TTL pulse width selector circuit (B.2.1) was used to adjust the duration of the high voltage pulse ($C_1 = 0.05$ μF, $R_1 = 10$ kΩ, $R_2 = 156$ Ω, $R_3 = 1$ kΩ). An AT type computer power supply was used to provide +5 V to the TTL circuit and the low voltage side of both of the high voltage switches.

After the pulser has been turned on, the high voltage should be applied to it gradually from 0 V to the desired +HV value. This should be done simultaneously on both channels (A_1 and A_2), to avoid large voltage gradients in TOF MS ion optics. According to the switch manufacturer, instant application of high voltage may damage switch circuits. In addition, the only power supply available was not able to quickly charge a 1 μF capacitor to the necessary few kV.

B.2.4 Frequency Divider

The TTL frequency divider (Figure B.16) is used to divide the frequency of an external source by an integer number $N = 1 - 256$. The desired divider is selected by setting the jumpers to logical 1 or 0.

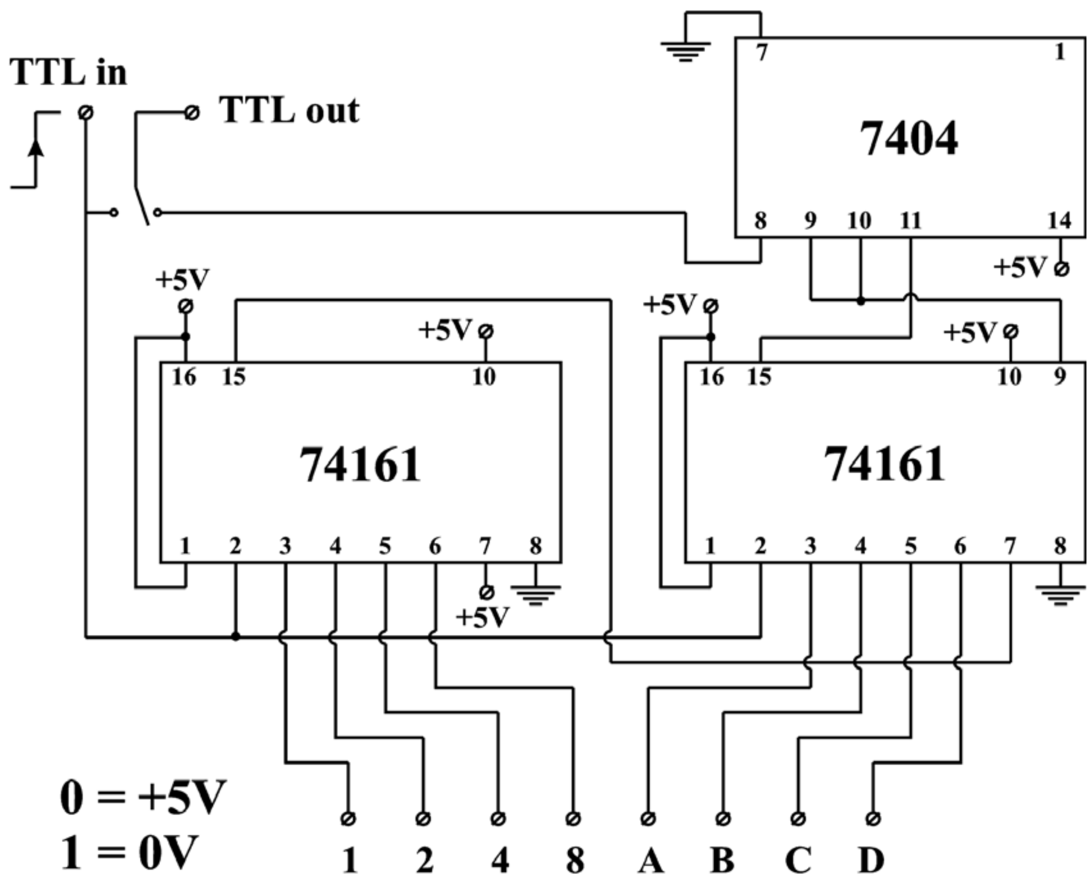

Figure B.16: TTL triggering frequency divider.