

Chapter Six

Conclusion

6.1 Conclusion

This experiment has successfully proved that an arc array discharge can generate output in nitrogen. The maximum output obtained is only $1.70 \pm 0.01 \text{ mJ}$, since the system has not been optimized as yet. The rather low output pulse energy is due to refractive losses and the discharge voltage of the laser is not high enough to produce higher temperature plasma.

The electrodes, which can hold higher voltage before breakdown, is preferred. There are no significant differences in results between the flat cylinder electrodes and cylindrical electrodes. The only possible difference is that the gap between each arc will be smaller when the cylindrical profiled electrodes are employed.

The inductance of the loop where charges in storage capacitor are transferred to the peaking capacitors is 452 nH while the inductance of the laser channel is 5 nH . This inductance should be reduced. Design of new setup geometry can reduce the inductance of the first loop while reducing the dimension of the laser channel may reduce the inductance of the second loop.

Table 6.1 shows the summary of the results of this study. Some of the results are measured while others are calculated.

Table 6.1 : Summary of results with 100nF as storage capacitor and 64 units of 2nF peaking capacitors.

	Flat electrode profile	Cylindrical electrode profile
Maximum output energy	1.70 \pm 0.01 mJ	1.55 \pm 0.01 mJ
Peak current	2.38 \pm 0.01 kA	2.13 \pm 0.01 kA
Optical pulse width	5ns	5ns
Delay of optical pulse after discharge	16ns	20ns
Current density	4.76 \pm 0.01 kA/cm ²	4.26 \pm 0.01 kA/cm ²
Delay of current peak after discharge	40ns	50ns

When compared with the existing nitrogen or excimer lasers, the output of the present nitrogen laser has a lower efficiency and output pulse energy. However, the main objective of this experiment is to investigate this new setup to produce shorter wavelength lasers such as VUV or x-ray lasers.

As mentioned in Chapter 2, the capillary discharge system is scaled by increasing the length of the capillary tube. However, the scaling of the present system is through the increment of the number of arcs. More arcs will produce higher output or gain for the laser system. This will mean that more pin electrodes are needed and the separation between each electrode will affect the efficiency and output of the laser system.

6.2 : Future Studies

It is suggested that, in the future, a Marx generator should be built to provide a higher charging voltage. This is because the results show that higher charging voltage will give higher output energy.

In addition, in order to reduce losses of the laser in between the gaps of the electrodes, the separation of each electrode should be reduced to the minimum. This will not only reduce the losses of the laser energy but will also reduce the divergence of the laser beam.

Furthermore, a spark gap array may be needed instead of one single spark gap in the circuit. If an array of isolated spark gap is setup, the problem of faster charging of the peaking capacitor at the center portion will be overcome. Each peaking capacitor now will have the same distance from their spark gap. The position of the peaking capacitors will not make much difference in the inductance if the wires are all put close to the ground plate. Thus, the charging and discharge time of every peaking capacitor will be the same.

Besides, employment of separated storage capacitors can reduce the inductance of the loop where charges are transferred from each of the storage capacitor to the peaking capacitors. If the ratio of 1:1 is applied, the capacitance of each of the storage capacitor need only be 2nF or 5nF. Another advantage is that this setup will fully isolate each electrode. The storage and peaking capacitors, spark gap are independent from the other electrodes. Each electrode corresponds to a separated 'C-to-C' circuit.

Impurity of gases in the laser channel will reduce the output of the laser. Therefore, a better vacuum laser channel should be built in the future. A laser channel with fewer components should be designed because leakage may occur when these various components are assembled together. Moreover, if shorter wavelength laser such as VUV or x-ray laser is to be studied, the system must provide very high vacuum.

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