



## L.4 Development of high current fast capillary discharge plasma setup

Discharge created plasma systems are very attractive as gain medium for coherent amplification of XUV-soft x-ray radiation. In particular fast capillary discharge plasmas have been used in setting up table-top soft x-ray lasers. A high current fast capillary discharge plasma device has been set up for pursuing R&D work in soft x-ray lasing at Laser Plasma Division and Laser Electronics Support Section.



Fig.L.4.1: Photograph of the capillary discharge system.

Main components in capillary discharge setup are 400 kV, 750 J Marx generator, a water capacitor, a SF, spark gap, a pre-pulse power supply and a capillary. A photograph of the full system is shown in Fig.L.4.1 and the schematic diagram of the set-up is shown in Fig.L.4.2. The Marx generator is made of 10 stages, with each stage consisting of a 60 nF capacitor, spark gap and two 6 kΩ charging resistors. All the capacitors can be charged up to 50 kV by means of a dc power supply. The controller sets charging voltage of the Marx capacitors and gives trigger pulse. A water line capacitor is used because water has a high dielectric constant of 81. This reduces the dimensions of the capacitor for a given capacity, and its equivalent inductance becomes small. A pre-pulse generator is connected to the electrode of the spark gap at the capillary end, through a 1 kΩ liquid resistor fed into the chamber. This resistor is made of a Delrin cylinder filled with

copper sulphate solution, and fitted with copper electrodes at both the ends. Pre-pulse generator consists of a dc charging power supply of 20 kV, which charges a capacitor bank of 400 nF which is discharged into the capillary through an inductance of 120  $\mu H$  and  $CuSO_4$  resistor of 1 k $\Omega$ . This generates a current pulse of around 20 A for a duration of 100 $\mu s$ . The capillary is filled with argon gas and its pressure is kept in the range of 0.2-0.5 mbar. The setup also includes a  $CuSO_4$  voltage divider and a Rogowski coil for voltage and current measurements respectively.

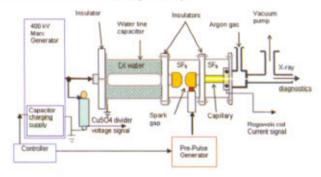


Fig.L.4.2: Schematic diagram of the capillary discharge plasma setup.

The pre-pulse supply is triggered to create pre-plasma in the capillary for few microseconds before the Marx generator is fired. Marx generator in turn charges water capacitor up to self breakdown voltage of SF, spark gap. Due to breaking of spark gap, the water capacitor discharges into capillary and generates peak current required for capillary discharge plasma experiments.

This setup has been assembled and tested in our laboratory up to 250 kV (with 25 kV /stage of charging voltage of the 10-stage Marx generator). The pre-pulse generator is being coupled to the setup. Voltage and current pulses recorded with the Marx bank charged to 18 kV /stage are shown in Fig.L.4.3.

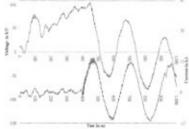


Fig.L.4.3: Voltage from a divider at Marx generator (upper trace) and the current through the capillary (lower trace).

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