## ***Abstract***

A novel discharge scheme is proposed for the pumping of short wavelength lasers. This scheme had been tested to produce fast current pulse and a 5 kA current in 60 nsec is obtained. Lasing action has been observed by using nitrogen gas. The laser line is 337 nm from the strong $C^3\pi \rightarrow B^3\pi$ transitions of nitrogen molecules.

The new discharge scheme is based on the concept of an arc array amplifier. It essentially consists of 48 pairs of electrodes which are lined up to form an array of arc discharge. Its electrical circuitry allows each pair of the electrodes to be decoupled from the rest electrically. Each pair of the electrodes is fed by individual storage and peaking capacitors in an extended C-to-C charge transfer circuit. Such a configuration allows the system to have high current density with a fast rise-time.

The electrical circuitry of this system was optimised with respect to the scalability to pump in higher current density in a faster pulse. The effect of the inductance and the capacitance of the system were investigated in the present project. The inductance of the system was minimized by carefully positioning every component of the system to minimize inductive current loop. The role of the spark gap has also being investigated to obtain a faster discharge. Different values of storage and peaking capacitances were used to obtain higher discharge current.

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It is found that a low inductance transfer loop between the storage and the peaking capacitors allows the peaking capacitors to charge up faster, resulting in higher breakdown voltage in the laser channel. Larger capacitance of each individual electrodes has also increased the current density. However, the optical power has dropped from 1.4 mJ by using 2 nF capacitor to 1.2 mJ for the case of 5 nF capacitor. This is due to the longer discharge pulse-width in the latter configuration.

This study show that the new arc array discharge circuit is capable to generate laser output due to its fast discharge characteristics. More importantly, it has demonstrated a new way of electrical discharge pumping method that can be scaled up to higher energy coupling through arc discharge. Further work is needed to scale up the input energy needed to pump gases to higher state of ionisation for output in the VUV and soft x-ray region.

# *Abstrak*

Satu skema nyahcas baru telah dicadangkan untuk mengepam laser jarak gelombang pendek. Skema ini berupaya menjana denyutan arus yang pantas dan suatu arus 5 kA dalam julat masa 60 ns telah diperolehi. Keluaran laser telah diperhatikan dengan menggunakan gas nitrogen. Garisan laser 337 nm ini berasal dari peralihan $C^3\pi \rightarrow B^3\pi$ dalam molekul nitrogen.

Skema nyahcas baru ini berasaskan konsep pembesar susunan arka (arc array amplifier). Ia mengandungi 48 pasang elektrod yang tersusun dalam satu barisan membentuk susunan nyahcas arka. Litar eletriknya membolehkan setiap elektrod tersasing secara elektrik dengan elektrod lain. Setiap pasang elektrod dibekalkan dengan kapasitan 'storage' dan 'peaking' yang berasingan dalam suatu litar C-to-C pindahan cas (charge transfer). Konfigurasi sedemikian membolehkan sistem tersebut mempunyai ketumpatan arus yang tinggi dan 'risetime' yang cepat.

Litar elektrik sistem ini telah dioptimisasikan dengan kemampuan peningkatan ketumpatan arus di samping mempercepatkannya. Kesan induktan dan kapasitan telah dikaji. Induktan sistem diminimakan dengan mengatur komponen sistem supaya lingkaran arus yang induktif dikurangkan. Peranan 'spark gap' diselidiki untuk mendapatkan nyahcas yang lebih pantas. Kapasitan 'storage' dan 'peaking' yang berlainan nilai telah diuji untuk memperolehi arus yang lebih tinggi.

Adalah didapati induktan lingkaran pindahan antara kapasitor 'storage' dan 'peaking' yang rendah membolehkan kapasitor 'peaking' dicas dengan lebih cepat dan menyebabkan runtuhan voltan yang lebih tinggi dalam saluran laser. Kapasitan yang lebih tinggi juga meningkatkan ketumpatan arusnya. Namun, kuasa keluarannya berkurangan dari 1.4 mJ dengan kapasitor 2 nF kepada 1.2 mJ dengan kapasitor 5 nF akibat tempoh nyahcas yang lebih panjang.

Kajian ini telah menunjukkan bahawa litar nyahcas susunan arka ini beupaya menhasilkan laser keran ciri nyahcasnya yang pantas. Yang lebih penting, ia menunjukkan satu cara mengepam laser melalui nyahcas elektrik yang baru yang mampu mengandingkan tenaga yang tinggi melalui nyahcas arka. Usaha masih diperlukan untuk meningkatkan tenaga inputnya untuk mengepam gas-gas ke tahap pengionan yang lebih tinggi untuk keluaran laser dalam linkungan VUV dan XUV.