## A.4: Development of filament arc discharge based multicusp $H^-$ Ion Source

A filament arc discharge based multi-cusp $H^-$ ion source has been indigenously designed and developed in Ion Source Lab of PLSCD. It will be used as an injector to the front end of $H^-$ Linac for SNS applications. An experimental prototype of ion source is shown in Fig. A.4.1.

*Fig. A.4.1: An experimental prototype of filament arc discharge based multi-cusp $H^-$ Ion source.*

A high voltage ignitor electrode has been developed and introduced to create the background glow discharge hydrogen plasma inside the multicusp plasma chamber by floating ignition electrode at -5.5 kVDC at ~ 2 mA current. The ignition electrode is shown in Fig. A.4.2.

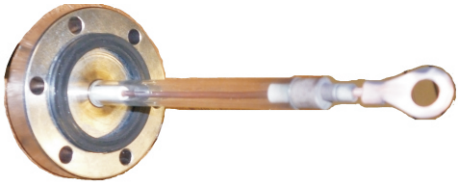

*Fig. A.4.2: Ignition electrode for background glow discharge plasma creation for $H^-$ ion source.*

With this arrangement, filament can be operated in cold conditions. This not only reduces the power requirement of filament heating, but also reduces continuous erosion and sputtering of filament. Thus, it significantly enhances the operation lifetime of filament. The main hydrogen plasma was created by pulsed arc discharge with maximum of 100 A current. The ion beam was accelerated by floating the plasma chamber at -50 kV DC potential with respect to the ground electrode. $H^-$ ion beam was accelerated towards the ground electrode. The ion source was operated in pulsed arc mode and $H^-$ ion beam extracted using 3-electrode extraction system, as shown in Fig.A.4.3. The plasma chamber was isolated from extraction chamber with two high voltage isolator disks made of Metlon (50 mm thick) and PVDF (80 mm thick) and voltage divider HV resistors. It enables to operate the ion source at -50 kV potential. The vacuum level in the extraction chamber was maintained at $8.5 \times 10^{-5}$ mbar.

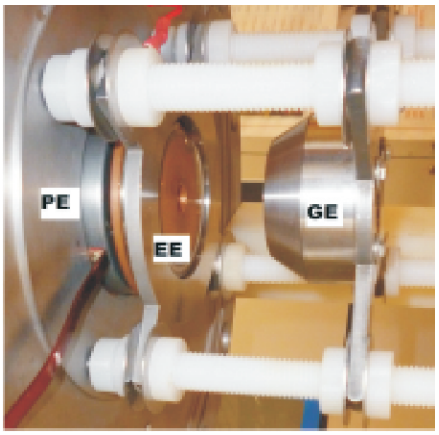


*Fig.A.4.3: $H^-$ ion beam extraction geometry using plasma, extraction and ground electrodes (PE,EE & GE respectively).*

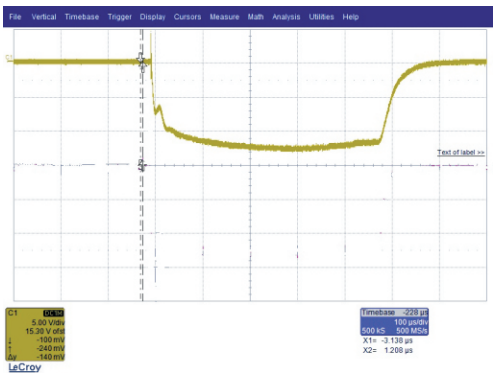


*Fig. A.4.4: Recorded waveform of 12 mA $H^-$ ion beam current extracted from 3-electrode geometry.*

A maximum of 12 mA $H^-$ ion current was extracted at 50 keV beam energy, is shown in the recorded waveform on oscilloscope in Fig. A.4.4. It takes nearly 100 µsec time for the $H^-$ ion beam signal to get stabilized. In order to avoid the thermal effects due to steering out of co-extracted electrons from the $H^-$ ion beam and dumping them on extraction electrode the ion source was operated at 2 Hz repetition rate.

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