first commissioning was done by using a two-electrodes extraction system, and 171 eμA dc H^- beam was measured with a Φ55 opening Faraday cup at 590 mm downstream from the plasma electrode.

Fig. 5 The three-electrode extraction system.

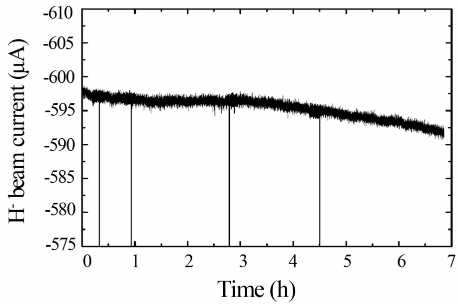

Fig. 6 Beam stability within 7 h.

In 2012, we solved several other problems and began to tune the source with the three-electrode system. We shielded ceramic tubes in the water cool filament bases with stainless steel rings to protect them from bombardment by plasma. Six acrylic glass sheets were mounted on the inner side of the metal cover of the cabinet for the power supplies floated on high voltage, which decreased high-voltage drain current from 3.5 to 0.3 mA. An outside protection circuit, including electronic components such as voltage-dependent resistor (VDR), transient voltage suppressor (TVS), spark gap (SPG), resistor, and capacity, was designed to protect equipment working on the high voltage platform from high-voltage surge. To reduce stripping rate of H^- ions by residual H_2 molecule and other particles, four 700 L/s pumps were used on drift tube instead of original combination of a 1300 L/s pump and a 700 L/s pump, meanwhile the Faraday cup was moved upstream to 380 mm from the plasma electrode.

On Jan 5 th, 2013, more than 1 mA dc H^- beam was extracted using the three-electrode system with parameter setting as follow: a Φ5 hole aperture plasma electrode, a Φ10 hole aperture extraction electrode at 4 mm from the plasma electrode, and a Φ14 hole aperture ground electrode at 35 mm from the plasma electrode. As is shown in Fig. 6, the beam stability of 600 μA dc H^- was tested within 7 h, and the data result showed the fluctuation was better than five thousandths. Further experiments to improve the source performance are scheduled.

6 - 24 A Low Energy Beam Transport System for C-ADS

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To treat the spent nuclear fuel from the power stations in china, a project named China Accelerator Driven System (C-ADS) has been proposed and related R/D has begun since 2011. The accelerators designed for the C-ADS are a superconducting CW proton linac and a room temperature radio frequency quadrupole (RFQ). A 2.45 GHz electron cyclotron resonance (ECR) proton source and a low energy beam transport (LEBT) system are employed to produce and transport a cw proton beam of 10 mA to the RFQ. These apparatus have been designed and are under construction at the Institute of Modern Physics (IMP) in Lanzhou, China.

A dual-solenoid LEBT has been designed for the C-ADS accelerator injector. Fig. 1 shows the layout of the LEBT in which a Test Chamber 2 takes the place of the RFQ for early development. To reduce the length of drift-1 for less aberration, test chamber-1 is placed after the solenoid-1 instead of between the ion source and the solenoid-1. A DCCT with magnetic field shield is incorporated in drift-2 to monitor the CW beam current. To better match the downstream RFQ, the LEBT requires a shortest possible drift-3. However, elaborate engineering efforts have to be taken to accommodate, in a very limited space, a water-cooled collimator, a fast beam chopper, a water-cooled cone, an ACCT and an electron trap. A compromise in accommodating all the required apparatus needed for the transport line has lead to a LEBT of 1670 mm with drift-1 of 220 mm, solenoid lens of 260 mm, drift-2 of 780 mm and drift-3 of 150 mm.

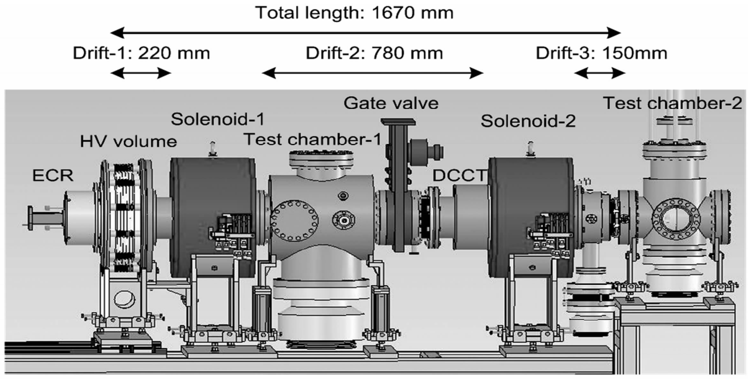

Fig. 1 Layout of the LEBT for C-ADS where the Test Chamber-2 takes the place of the RFQ for early development.

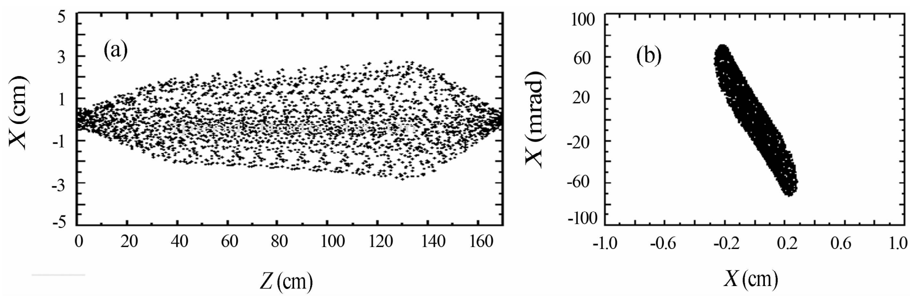

Fig. 2 (a) BEAMPATH simulated beam trajectories along the length of C-ADS LEBT; (b) Simulated phase space distributions.

Fig. 2(a) illustrates the simulated beam trajectories and Fig. 2(b) shows the phase space distribution with matched twiss parameters at the RFQ entrance. A conservative estimate of 90 % space charge compensation (with total beam current of 10 mA) is assumed in the simulations.

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