

6 - 5 Progress of Superconducting Linac for China ADS

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The China accelerator driven sub-critical system (China ADS) proposed by Chinese Academy of Sciences (CAS) is one of “Strategic Technology Pilot Project” started in 2011. In the first 5 years, the China ADS project mainly focuses on the R&D of key technologies in accelerator, spallation target, and sub-critical reactor. A 25 MeV, 10 mA, continuous-wave (CW) superconducting proton linac will be built to demonstrate the key technologies and the feasibility of a high power beam at the Institute of Modern Physics (IMP).

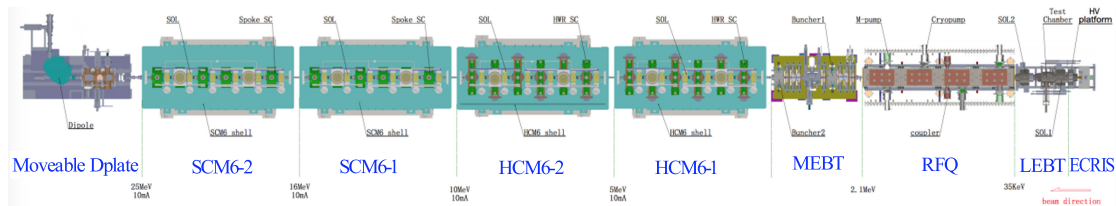


Fig. 1 (color online) Layout of 25 MeV superconducting Linac.

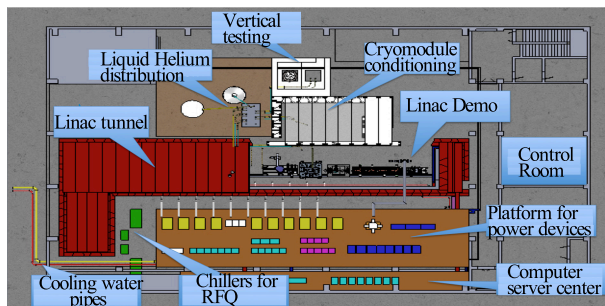


Fig. 2 (color online) Linac commissioning hall.

The design of the 25 MeV linac is shown in Fig. 1. It consists of a 35 keV ECR ion source, a low energy beam transport line (LEBT), a 162.5 MHz, 2.1 MeV RFQ, a medium beam transport line (MEBT), two superconducting segments, and a beam diagnostics platform (D-plate). The first segment is based on 162.5 MHz, half-wave resonators (HWR), and the second segment is based on 325 MHz, spoke resonators (Spoke). The commissioning hall of 25 MeV linac is shown in Fig. 2.

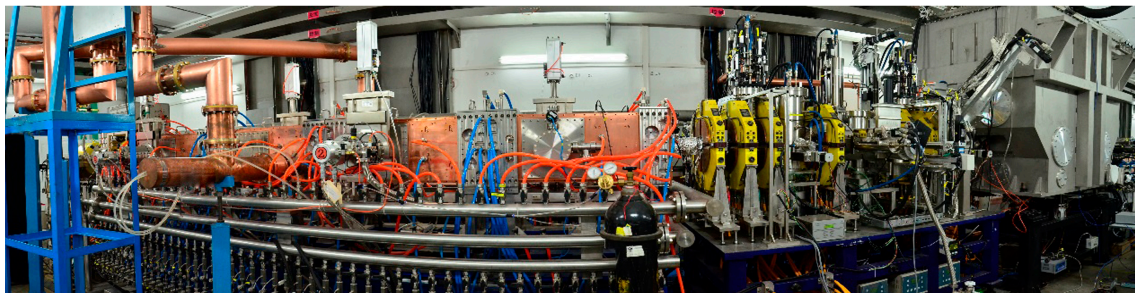
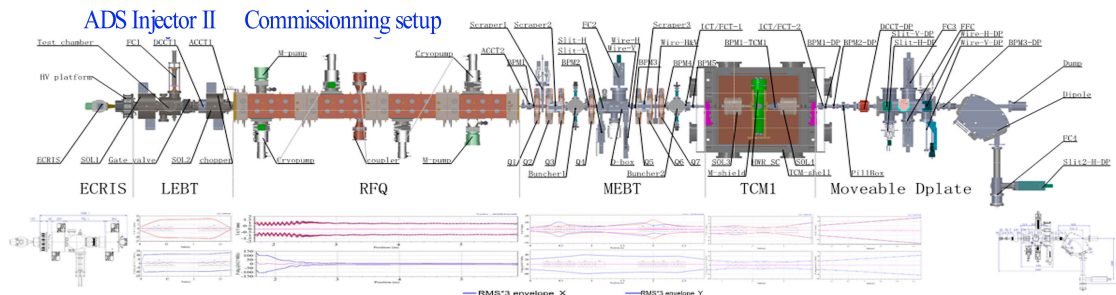


Fig. 3 (color online) Layout of prototype of superconducting linac (2.5 MeV) for China ADS.

In 2014, the prototype of superconducting linac for China ADS was installed in the tunnel and has been commissioned. The prototype system is shown in Fig. 3. It mainly includes the ECR ion source, the LEBT, the RFQ, a test crymodule (TCM), and the D-plate. The TCM consists of one HWR and two superconducting solenoids. It can accelerate the beam from 2.1 to 2.5 MeV. The first pulse beam from the RFQ was carried out at the beginning of June, and at the end of the month CW beam of 10 mA had been accelerated successfully for 4.5 h (Left in Fig. 4). The beam power is around 21 kW. The transmission efficiency was 95.3%, output energy was 2.165 MeV, and energy

spread was 1.9%. The first beam from the TCM was detected at Sept. 29th. It has carried on about 11 mA beam for 1 h on Feb. 13th (Right in Fig. 4). The beam energy was 2.55 MeV and the beam power reached 28 kW.

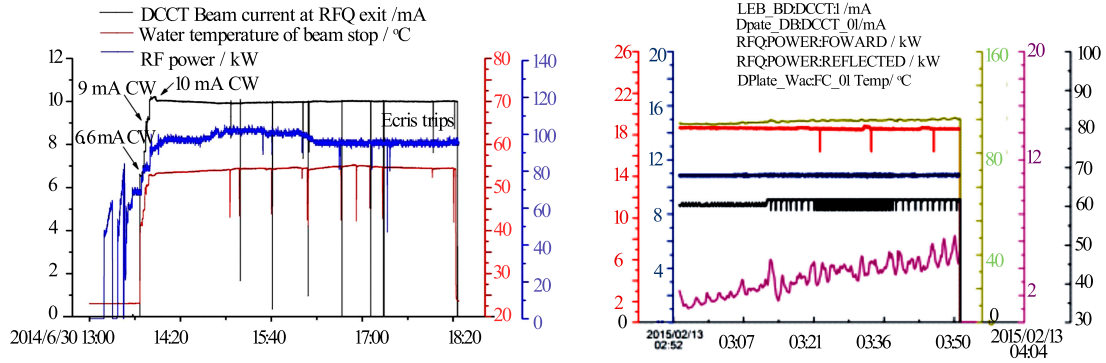


Fig. 4 (color online) Historical records of cw beam (Left: RFQ, Right: TCM).

Up to now, the RFQ has operated for about 900 h, including CW beam around 46 h. The record of non-trip operation time was about 220 h. The TCM has operated for about 200 h including CW beam around 12 h. The record of non-stop operation time was about 46 h.

Expect for installation of the demo linac, some key technologies for the future are also developed at IMP. The cross-bar (CH) superconducting resonator is one of top challenge in superconducting linac. A 162.5 MHz, β 0.063, CH-cavity was developed by IMP. It has six acceleration gaps, and can accelerate the proton beam from the 162.5 MHz, 2.1 MeV RFQ. It has been tested in 4.2 K. The drawing of CH-cavity and the test results are shown in Fig. 5. The Q value is 1.5×10^9 at the peak electric field of 61 MV/m. The acceleration voltage is around 4 MV at 700 mm (cavity length, flange to flange). It will be a kind of candidate for the superconducting linac of ADS due to the high acceleration voltage.

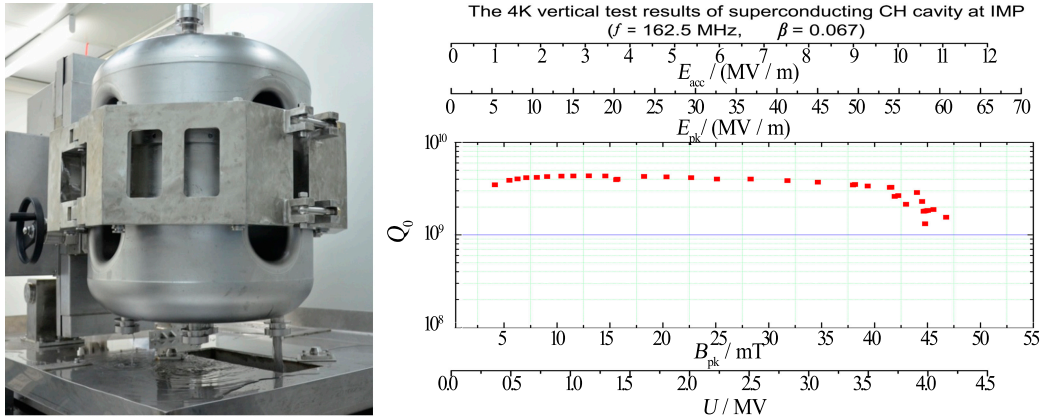


Fig. 5 (color online) Low beta superconducting CH cavity and test results.

The taper HWR is a high gradient cavity designed for ADS injector. The β is 0.15. It can be used to accelerate beam from 5 to 20 MeV. The first two prototypes have been tested. The E_{peak} is around 40 MV/m when the B_{peak} is 50 mT. At this field, the Q value is around 2.0×10^9 . It satisfies the requirements of the injector of superconducting linac for China ADS (Fig. 6).

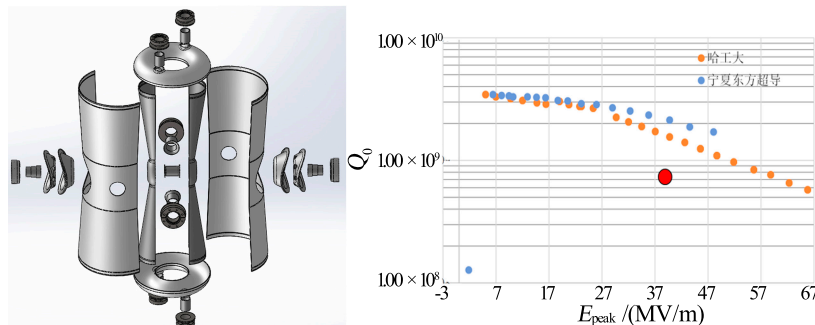


Fig. 6 (color online) The model of low beta taper half-wave resonator and test results.