6 - 6 Design of RF System for CIADS Injector II RFQ*

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A new RF system for a proton linear accelerator named as C-ADS at Institute of Modern Physics (IMP) has been designed and developed to match its related RFQ cavity, which is a quadrilateral four-vane resonator with two separate coupling ports and 80 tuners. Its RF system design including mainly all simulation for coupler and two-port configuration have also calculated and analysed to be operated in continuous wave (CW) mode with 120 kW forward power resulted from the simulated shunt impedance of 45.62 kΩ and accelerating voltage of 65 kV for RFQ resonator, respectively. The design and measurements for the power source, transmission line, two identical couplers and power transmission system, even final two-port configuration were finished in the beginning of 2014. Some valuable experiences were accumulated in the original power conditioning and beam experiments on a previous prototype RFQ, which has 560 keV output energy and one-meter size operated by the end of 2013[1]. Until now, on the new RFQ, almost 120 kW CW power have already put into cavity to accelerate 10 mA proton beam, an overview of the RF system design is to be given, including some specific simulation, even the two-port coupling configuration were analysed and evaluated in the paper.

The two couplers were going to install on the second part of cavity, and the same direction from magnetic drive can confirm the merged power of 120 kW into the cavity. An extra quarter wave part of EIA 6 1/8″ waveguide was designed to connect with the coupler for improving thermal situation, the length of it can be confirmed by CST software or something else, the S parameter reached up to close -40 dB. The calculated dimensions and results are presented in Fig. 1.

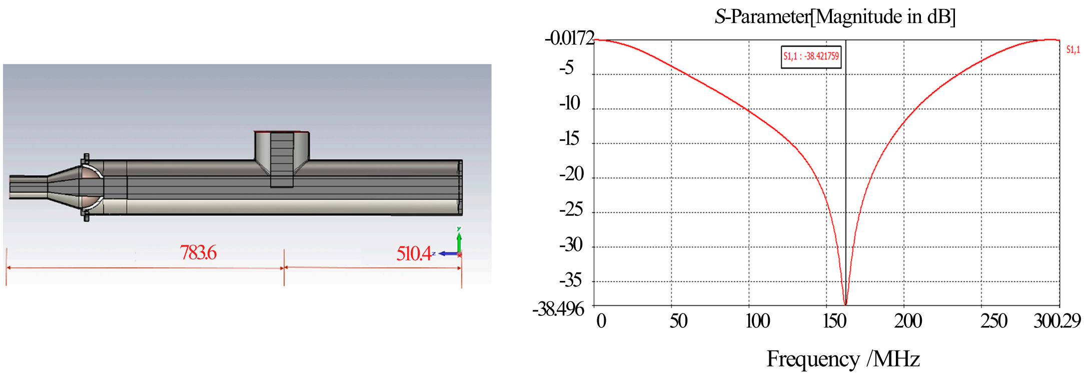

Fig. 1 (color online) The S_{11} result from the matching port.

According to the beam dynamics, the output energy of 2.1 MeV comes from 65 kV accelerating voltage. Through the X-ray measurements, the shunt impedance agree with the simulated one, the specific results are shown in Fig. 2(a).

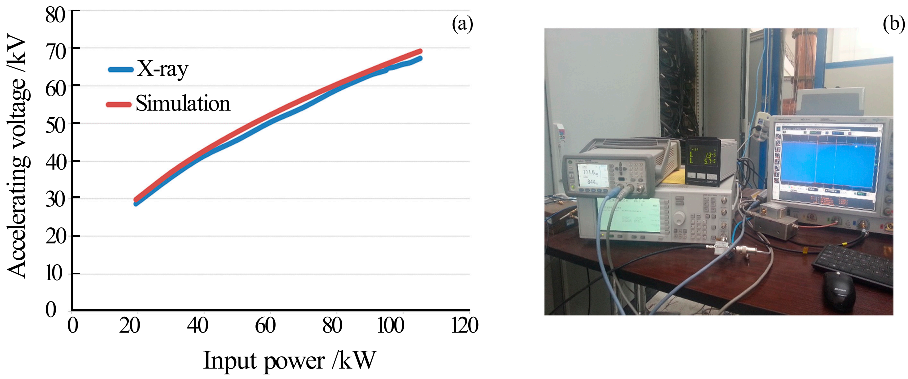

Fig. 2 (color online) (a) The accelerating voltage calibration from simulation and X-ray Radiation; (b) Situation of 10 mA (111 kW) beam experiments.

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Fortunately, the power conditioning[2] and commissioning have been completed for three months, the experiments of continuous 10 mA beam were carried out to measure on its energy, transmission efficiency and emittance, which agreed well with the dynamics goals. Now the effect from strong beam load was also solved a month ago, the commissioning situation with 10mA was shown in Fig. 2(b).

On July 18th, 2014, the measurements about RFQ from many national famous experts were done through testing the all beam results, including output energy, beam intensity, and so on. The test result of the 10 mA CW beam which runs several hours indicates RFQ development including its RF system fully meet the requirements of original design goal.

References

[1] Zhouli Zhang, Yuan He, Aimin Shi, et al., Design of a four-vane RFQ for CHINA ADS project, Proceedings of LINAC2012, Tel-Aviv, Israel. THPB039. (2012).

[2] Hartmut Buttig, A. Arnold, A. Buchner, et al., Nuclear Instruments and Methods in Physics Research Section A, 704(2013)7.

6 - 7 Mechanical Design and Fabrication of 162.5 MHz Buncher for C-ADS Injector II

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Two room temperature quarter wave resonator (QWR) buncher cavities with frequency of 162.5 MHz have been designed as parts of the medium energy beam transport line (MEBT1) for injector II in China Accelerator Driven Sub-critical System (C-ADS) project in order to focus the beam longitudinally, thus keeping the bunch length and matching the beam to the acceptance of the superconducting linac.

Buncher is one of major equipments in MEBT1. Fig. 1 shows the layout of the MEBT1. Its structure directly affects the performance of MEBT1. Buncher cavity takes an open-ended quarter-wavelength coaxial line cylinder type structure, the mechanical design of buncher cavity was done according to the physical design, adequate consideration ought to be given to the factors of electromagnetic field distribution, power coupling, frequency tuning, cavity cooling and manufacturing, and so on.

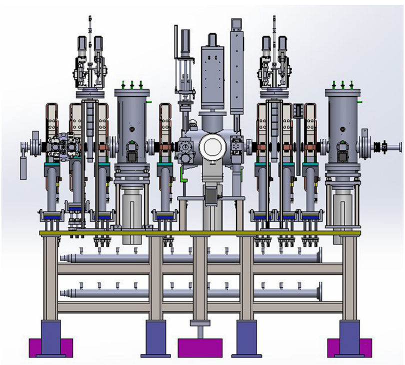

Fig. 1 (color online) The layout of the MEBT.

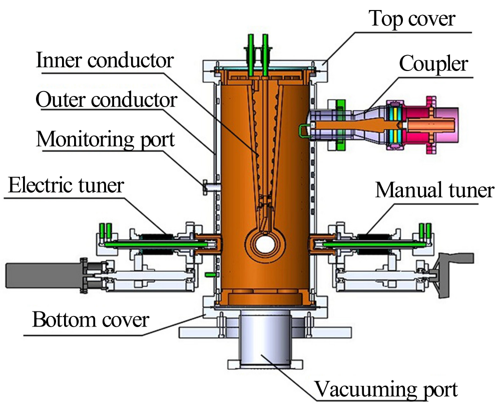

Fig. 2 (color online) The mechanical structure of buncher.

Cylinder type vacuum-tight cavity was applied to meet the needs of high thermal conductivity, high conductive, air impermeability and weldability, which mainly includes outer conductor, inner conductor, top and bottom vacuum end cover, left and right drift tube, coupling and tuning port, vacuuming and monitoring port, cooling water passages, *etc.* Coupling port is equipped with power coupler and located in the place of strong magnetic field in order to realize the buncher matching with the power source. Monitoring port is equipped with feed through to monitor cavity voltage and provide the signal for phase and amplitude control loop. Factors

Fig. 3 (color online) Test site of buncher.