STATUS OF CPHS PROJECT*

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Abstract

Compact Pulsed Hadron Source (CPHS) project was initiated in Tsinghua University at middle of year 2009. It consists of a 13 MeV proton linac, a neutron target station and some neutron stations. The construction of 3 MeV linac has be finished at the end of 2012. And initial commissioning is started at the beginning of year 2013. The progress of construction, primary results of early commissioning are presented at this paper. Then we will report the next plan also.

INTRODUCTION

To meet the rapid development and requirement on neutron science and application, the Compact Pulsed Hadron Source (CPHS) was initiated in Tsinghua University at year 2009. It is a compact yet expandable system based on proton linac [1]. At first phase it consists of an accelerator front-end—a high-intensity ion source, a 3 MeV radiofrequency quadrupole accelerator (RFQ), and a 13 MeV drift-tube linac (DTL), a neutron target station—a beryllium target with solid methane and room temperature water moderators/reflector, and 2 neutron stations for imaging/radiography and small-angle neutron scattering (SANS). In the future, the CPHS may also serve as an injector to a ring for proton therapy and radiography or as the front end to an ADS test facility.

The 3 MeV part of the proton linac has finished and been tested recently.

LINAC SYSTEM

The CPHS linac design is consisted with 50 keV electron cyclotron resonance (ECR) ion source (IS) and low energy beam transport line (LEBT), 3 MeV radio frequency quadrupole accelerator(RFQ), 13 MeV drift tube linac (DTL). At the end of DTL, the high energy beam transport line (HEBT) deliveries proton beam to neutron target.

The main parameters of the linac are listed in table 1.

Table 1: Main parameters of CPHS linac

Proton power output	16	kW
Proton energy	13	MeV
Average beam current	1.25	mA
Pulse repetition rate	50	Hz
Protons per pulse	1.56×10^{14}	protons
Pulse length	0.5	ms
Peak beam current	50	mA

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The ion source, RFQ and RF power system is ready up to now. DTL model cavity will be finished at this year. And HEBT will be ready in June this year. Then 3 MeV proton beam will be introduced to beryllium target to produce neutron at the end of this year. Figure 1 shows the photograph of CPHS linac from ion source to HEBT.

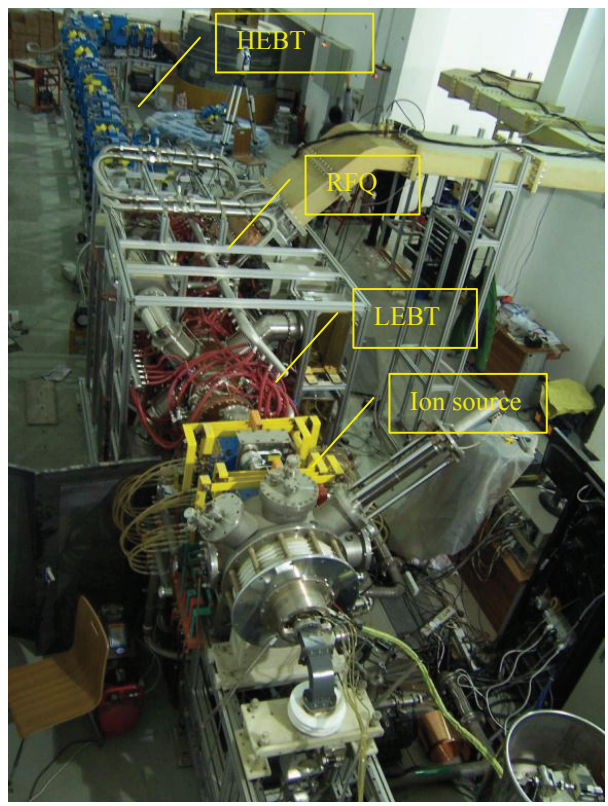

Figure 1: photograph of CPHS linac from IS to HEBT

Ion Source & LEBT

Ion source is electron cyclotron resonance type. The designed output energy is 50 keV.

The ion source was developed in Institute of Modern Physics (IMP) at Lanzhou, and shipped to Tsinghua University in April 2011. On site test was finished in September 2012 and the measured peak current is 60 mA. The normalized emittance is 0.19 π·mm·mrad (see Fig. 2).

Many effort are made to overcome arcing in electrodes. Now the ion source is stable.

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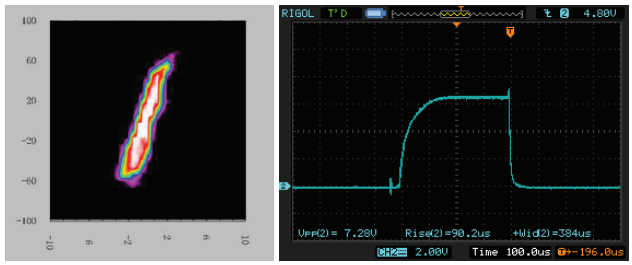

Figure 2: emittance (left) and current (right) measured at the exit of LEBT

RFQ

The RFQ accelerates 50 keV proton beam to 3 MeV. The design peak current is 50 mA and current capture efficiency is greater than 90%.

RFQ was manufactured at Kelin Company. It was shipped to Tsinghua at the beginning of 2012. High power conditioning was started at Feb. 2013. From 25th March, we begin beam commissioning of RFQ, and get 44mA output current at 27th March. [2]

DTL

The DTL accelerates proton beam from RFQ to 13 MeV. The transverse focusing is provided by permanent magnetic quadrupole (PMQ).

Figure 3: PMQ measurement of drift tube in IHEP

Manufacture of DTL model cavity is undergoing still. A tank of 1 meter long is finished. Several PMQs and drift-tubes are made and under test yet. The precision is a little lower than physical design. The main task is improving the drift tubes and PMQs manufacture process to meet the requirement of project recently.

Figure 3 show a drift-tube is under measuring PMQ parameters in IHEP. It can give the quadrupole strength, HOM strength and centre deviation of PMQs in one measurement.

We expect the experimentation can be finished at the first half year of 2013, and the manufacture of 13 MeV DTL can be started at the middle of this year.

RF Power System

The main devices of RF power system are modulator, high voltage source, and klystron, transmission system.

The modulator and high voltage source are made domestic.

The klystron is made in CPI Company and test at factory. The peak power is 3 MW and duty can be 3%.

The RF power transmission system is manufactured by AFT Company.

The whole system integration, test and debug were finished in Feb 2013.

Figure 4: RF power system of CPHS linac

HEBT

The main goal of HEBT is delivering proton beam to beryllium target uniformly. The main components of HEBT are electromagnets which are manufactured at Kelin Company. These magnets have been set on site and under alignment.

Some beam diagnosis setup, such as beam position monitor (BPM), time of flight (TOF) will be installed soon. And it will be tested on next commissioning.

Fig 5 shows the HEBT under installation. The blue objects are the magnet cores and the yellow things are coils.

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Figure 5: target station and HEBT

NEUTRON TARGET STATION & INSTRUMENTS

Neutron Target Station

The target station consists of the beryllium target, water moderators, water reflector, neutron transport windows and shielding. It is under constructing yet (see figure 5 left). We expect it will be finished at the middle of this year.

Instruments

2 neutron instruments are planned for CPHS project. One is neutron imaging and radiography station, the other is SANS. ^{3}He linear PSDs for imaging are under developing. Collimator and TOF tube for imaging station is developed (figure 6).

Figure 6: TOF tube for neutron imaging

NEXT PLAN

The alignment of electromagnets will be finished at the end of May expected. The proton beam will be guided to target as soon as installation of HEBT finished.

Then producing of thermal neutron will be tested. And main parameters of thermal neutron will be measure after this. We hope primary neutron image can be acquired at the end of this year.

CONCLUSION

It is almost 4 years from the launch of CPHS project. Now the first proton beam is gotten and we will continue to produce high quality thermal neutron. And upgrade to final 13 MeV is planning also.

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