SRF ACTIVITIES AT PEKING UNIVERSITY*

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Abstract

At Peking University, there has been significant progress in the development and testing of Peking University Superconducting Accelerator Facility (PKU-SCAF) for FEL project based on the SRF technology. PKU-SCAF is composed of an SC photoinjector and an SC main accelerator. The injector is a photocathode electron gun, including 1+1/2 cell Nb cavity, cryostat, RF subsystem, photocathode preparation chamber, drive laser, timing stabilizer and beam diagnostic tools. Testing of the DC-SC photo injector is nearing completion.

Fresh effort has been initiated to design a main SC accelerator for PKU-SCAF. Two 9-cell cavities of TESLA type and Rossendorf cryostat will be adopted. To support this effort, the collaboration with DESY and Rossendorf is underway, where focuses are 9-cell cavity, cryostat and main coupler etc.

INTRODUCTION

In autumn 2001 it was decided to build Peking University Superconducting Accelerator Facility (PKU-SCAF) [1]. The main focus is on the production of minimum transverse emittance beams at a high average current (~1mA). The major goal of PKU-SCAF is to develop an electron source for PKU Free Electron Laser (PKU-FEL) [2]. Figure 1 is the overview of PKU-FEL facility.

In January 2003 the DC-SC photo-injector test facility was constructed [3]. The injector is the first photocathode electron gun to integrate Pierce DC gun with 1.3GHz SC cavity. Testing of the DC-SC photo-injector is nearing completion. The design of a main SC accelerator for PKU-SCAF has been started. Two 9-cell cavities of TESLA type and the cryostats of the Rossendorf type will be adopted.

At the same time, in order to get higher peak current, we are working on the design of a 1.3GHz 2+1/2 cell SRF gun followed by a 40MeV SC Linac for possible application at infrared SASE FEL, which is designed to produce a 50MW saturation output with a wavelength of 7μm[4].

R&D OF PKU-SCAF

Parameter of PKU-SCAF

PKU-SCAF mainly comprises a photoinjector and a SC linac. Details of the hardware components of PKU-SCAF are described below.

Code PAMELA [5] is used to simulate the performance of the beam line. The optimized results at the exit of the linac are listed in Table 1.

Recent Achievements on DC-SC Photoinjector

The DC-SC photoinjector is designed to provide an electron beam of average current 1~5mA with the energy of ~2.6MeV and normalized rms transverse emittance of 3mm-mrad. Figure 2 is the current set-up of the DC-SC photoinjector facility.

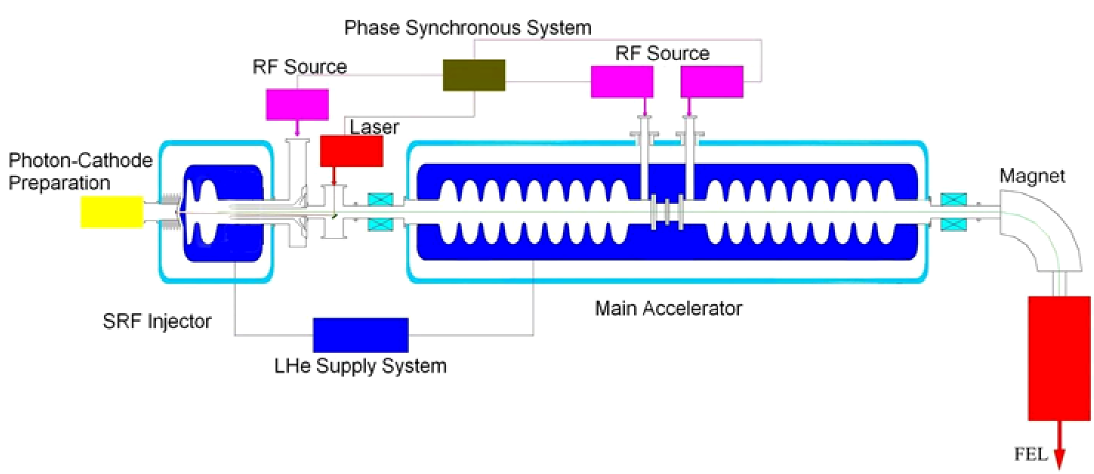

Figure 1: Overview of PKU-FEL facility.

* Supported by National Natural Science Foundation of China (10075006)(19985001)
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Table 1: Simulation results of PKU-SCAF.

Frequency	1.3GHz
Eacc	15MV/m
Energy	29.60MeV
Average current	1mA
RMS emittance	3.5mm·mrad
RMS energy spread	0.12%
Bunch duration	2.1ps

Figure 2: DC-SC photoinjector test facility.

The procedure of the preparation of 1+1/2 cell cavity was done at Peking University (see the figure 3) [6]. Four half cells and two tubes are made of 2.6mm thick sheet niobium (RRR=250) by spinning, followed by trimming and electron beam welding. After heat treatment, the cavity undergoes mechanical polishing, electric etching, buffered chemical polishing (BCP) and ultraclean water rinsing. The assembled cavity is mechanically tuned to adjust the resonance frequency to the design value.

The first cold RF-test of the gun cavity has been carried out up to date. The cavity was tested without the cathode in it to evaluate the cavity and to prove the compatibility of the superconducting cavity and the DC Pierce gun. A resonant at 1300MHz at 4.2K is achieved. The first test showed that the unloaded Q value of 1+1/2 cell was ~10^8 and the average gradient was about 4~5MV/m, limited by multipacting.

The cavity is powered by a 4.5kW solid-state power amplifier via a coaxial input coupler, which has a Q_{ext} of 4×10^7. The transition between the waveguide from the generator and the coaxial line of the coupler is realized by a doorknob configuration. To decrease the thermal loading and RF loss, the inner conductor is made of thin stainless, coated with copper outside, and the metal of outer conductor is stainless coated with copper inside too.

The Cs_2Te photocathode and the Nd:YVO_4 laser pumped by a semiconductor laser are commissioned.

Figure 3: Picture of the 1+1/2 cell cavity.

Main Linac

The main accelerator includes two 9-cell 1.3 GHz superconducting cavities of TESLA type and a cryostat of Rossendorf type. The cavities are operated below 2 K. Each cavity is driven by a CW klystron amplifier. We have analyzed the performance of the main linac [7]. According to our calculation, the optimal current of the beam loading is 1.5mA. In the first step, the average current is projected to 1mA.

To support the program of main linac, the collaboration with DESY and Rossendorf is underway, where focuses are 9-cell cavity, cryostat and main coupler etc.

FURTHER STUDY

In late 2002, SASE FEL was projected at Peking University, which focuses on getting saturation output at 7μm wavelength based on superconducting technology [4].

The electron beams with high peak current of 200A will be provided by the updated PKU-SCAF, comprising a 2+1/2 cell SRF gun and a 40MeV SC Linac, followed by a beam compressor (fig 4). Table 2 gives the

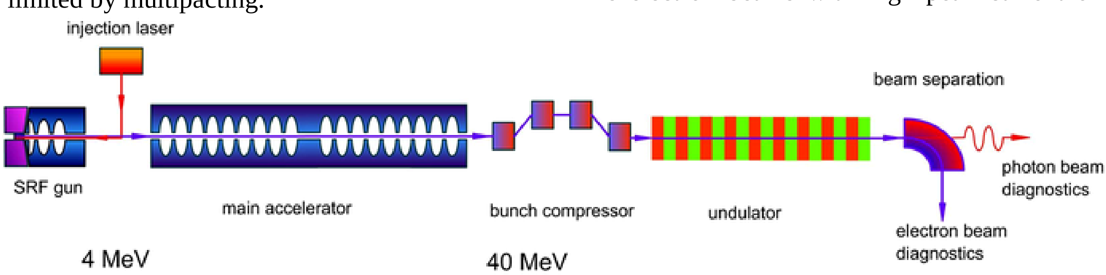

Figure 4: Overview of the updated PKU-SCAF for SASE FEL.

simulation results of the beam produced by the updated linac facility.

Table 2: Simulation results of updated PKU-SCAF.

Electron beam	
Energy	40MeV
Peak current	>200A
RMS emittance	5mm.mrad
RMS energy spread	80keV
RMS bunch duration	1 ps
Bunch repetition rate	50Hz

SUMMARY

We introduce the active progress in the R&D of PKU-SCAF project at Peking University. The test facility of the DC-SC photoinjector has been installed, and the beam test is ongoing. Meanwhile, the work on the supercondusting linac has started.

We also research the production of electron beam for the future infrared SASE-FEL. In order to generate high peak current of 200A, an updated PKU-SCAF has been proposed.

ACKNOWLEDGMENT

We should give our thanks to many colleagues who are supporting our work with their advice and helping us in the experiments. Special thanks to Dr. Proch，our guest professor, for his support to our work. Also we wish to thank Dr. Peter Michel for many helpful discussions.

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