

RESEARCH ON PEKING UNIVERSITY SUPERCONDUCTING ACCELERATOR FACILITY (PKU-SCAF)*

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Abstract

Peking University Superconducting Accelerator Facility (PKU-SCAF) is under development now. This facility is mainly composed of a DC-SC photocathode injector and a main accelerator with 9-cell cavity. It will provide high quality electron beams with 1 mA average current and 20 MeV energy.

1 INTRODUCTION

The purpose of PKU-SCAF is to provide high quality electron beams with high average current. The facility is mainly composed of a DC-SC photocathode injector[1][2] and a superconducting accelerator with 9-cell cavity[3]. It will be operated at continuous wave mode. Since superconducting technology is used, the whole facility will be a compact one. As to the 9-cell cavity, we hope to use TESLA technology. Thus, It should be collaboration between TESLA and PKU.

PKU-SCAF will supply a lot of research opportunity to related research fields at Peking University. For example, through the design and construction of PKU-SCAF, we hope to learn and grasp the most advanced superconducting technology; through the research of high average power FELs, we hope to provide a user facility for various scientific or industrial applications; Using the laser and the electron bunches provided by PKU-SCAF, we can do some theoretical researches and principle-proof experiments of the interaction between the high power laser and the ultrashort electron bunch.

2 PKU-SCAF

Figure 1 shows the layout of Peking University Superconducting Accelerator Facility (PKU-SCAF). It consists of the DC-SC photocathode injector[2], the superconducting accelerator, the RF-power system, and the laser driver system.

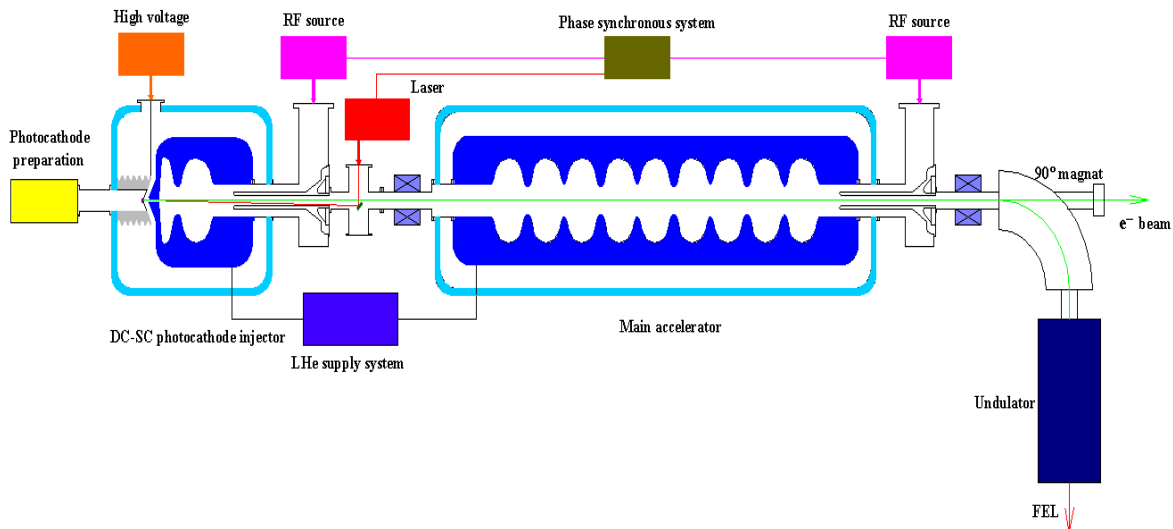


Fig.1 The layout of PKU-SCAF

The DC-SC photocathode injector (Fig. 2) combines a pierce gun with a 1+1/2 cell superconducting cavity. This design has several advantages. First, it can avoid the decrease of Q value so that SC cavity can be operated at very high gradient; secondly, the separation of the

photocathode from SC cavity can avoid the consistent problem between them. Since the distance between the photocathode and the SC cavity is very short, the emittance growth is not serious. Thus, this kind of injector can provide high quality electron beams with high average-current for the main accelerator.

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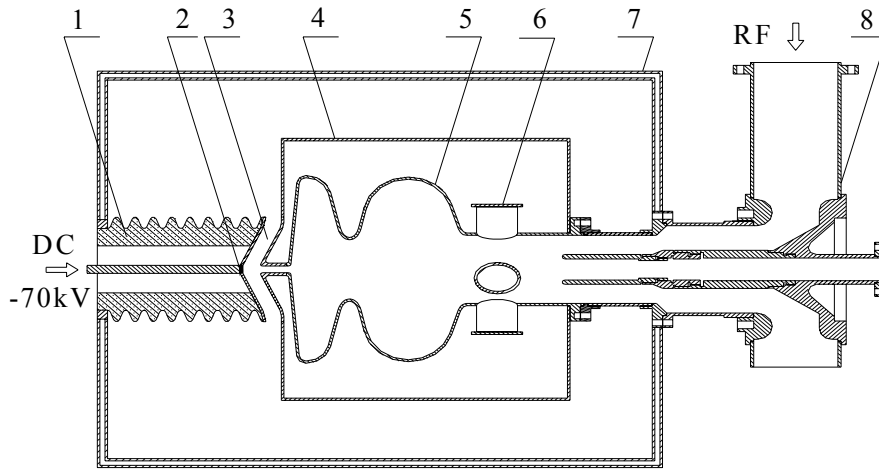


Fig. 2 Configuration of DC-SC photocathode injector
 (1) Ceramics insulation (2) Photocathode (3) Pierce gun (4) LHe tank
 (5) SC cavity (6) HOM coupler (7) LN shield (8) Coaxial input coupler

As to the main accelerator, we will use the 9-cell capture cavity [4] of the TESLA. It should be able to work at continuous wave mode. The energy of the electron bunches got from the main accelerator is about 20-25 MeV and the current of the electron beam is about 1mA.

The RF system consists of two RF sources, one is a 1.3 GHz, 5 kW, CW solid-state power source for the DC-SC injector, another is a 1.3GHz, 20KW, CW-mode power source for the 9-cell cavity.

The drive laser is used to deliver IR light pulses (800nm) to the cathode. In order to obtain high average current, the repetition rate of the laser pulses should be several tens MHz. The laser system is mainly composed of a CW frequency-doubled diode-pumped Nd:YAG laser which provides energy to pump a CW mode-locked

Ti:sapphire oscillator. A synchronous system is designed to control the phases of the two RF sources and the laser system.

3. SIMULATION OF BEAM DYNAMICS

3.1 The beam parameters after The DC-SC photocathode injector

The process of simulating the performance of the injector has been completed. Now the injector is under construction. The initial conditions and the simulation results are shown in table 1. The results show that the injector can meet our requirements.

Table 1 Simulation results of the DC-RF injector

Initial conditions			Simulation results	
Electron bunch	Radius	3.0 mm	Anode inclination	65°
	Length	10 ps	Synchronous phase	-50°
	Charge	60 pC	Energy	2.43 MeV
	Emittance	0 mm-rad	Radius	2.8 mm
SC cavity	Average gradient	15 MV/m	$\Delta E_k/E_k$ (rms)	2.63%
Pierce gun	Distance between cathode and anode	15 mm	Bunch Length	7.8 ps
	Cathode voltage	-70 kV	ϵ_x (90%, n)	8.249 mm-mrad
	Anode voltage	0 kV	ϵ_y (90%, n)	8.832 mm-mrad
			ϵ_z (90%, n)	55.223 keV-degrees

3.2 The beam parameters after the 9-cell cavity

The electron beam from the DC-SC injector will be injected into the 9-cell capture cavity. PARMELA[5] is used to obtain the beam properties at the output of the capture cavity. Figure 3 is the electric field distribution in

the 9-cell cavity. The simulation results under different accelerating gradients are listed in table 2. From the table, we can come to a conclusion that combination of DC-SC photocathode injector with the 9-cell main accelerator can provide high quality electron beams.

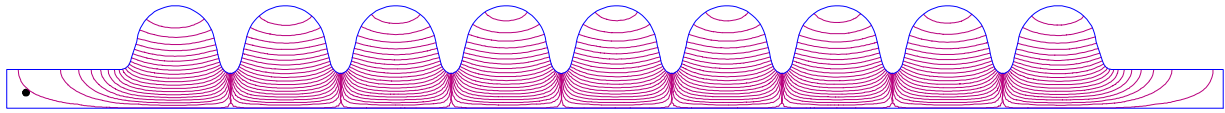


Fig.3 Electric field distribution in the 9-cell cavity

Table 2 Simulation results of PKU-SCAF

E_{acc} (MV/m)	Phase	$\epsilon_x(90\%,n)$ (cm-mrad)	$\epsilon_y(90\%,n)$ (cm-mrad)	$\Delta E_k/E_k(\%)$	E_k (MeV)
25	20	0.8799	0.8116	0.24	24.91175
20	20	0.7936	0.7408	0.29	20.40224
15	20	0.7138	0.6693	0.40	15.55215
10	20	0.6625	0.6275	0.53	11.38277

4 CONCLUSION

A superconducting facility will be constructed by the RF superconducting group at Peking University. It can supply high quality beams with high average current, normalized emittance lower than 3π mm-mrad, and energy about 20MeV. It mainly contains a DC-SC photocathode injector and a 9-cell superconducting cavity. The beam dynamics analysis has been completed. The injector will be completed at the end of 2001, and the manufacture of the 9-cell cavity is on our schedule.

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