INTRODUCTION OF 9-CELL ACCELERATOR AT PEKING UNIVERSITY

Zhenchao Liu, Shengwen Quan, Feng Zhu, Xiangyang Lu, Baocheng Zhang, Feisi He, Dai Jin, Song Jin, Wencan Xu, Jiankui Hao, Kui Zhao, Jia-er Chen, IHIP, Peking University

Abstract

The 9-cell superconducting accelerator module of Peking University (PKU) is in the end of factory check and will be constructed very soon. It will be the first home-made 9-cell superconducting accelerator module at Peking University and in China. As the main part of the PKU ERL and FEL project, it is composed of one 9-cell superconducting cavity, liquid helium tank, liquid nitrogen tank, tuning system, power coupler, suspending device, magnetic shielding, measurement and control device. This paper will give a brief description of the 9-cell accelerator module.

INTRODUCTION

With the development of the 1+1/2cell photocathode injector at Peking University and the aim of constructing the ERL and FEL project, a home-made 9-cell superconducting accelerator module is put forward. It is a challenge for PKU as this is the first attempt to build such a complex facility for accelerating electrons working at 2K. As the first try of the 9-cell accelerator, one 9-cell cavity is in the module for cost saving. It is also the first step for the multi-cavity accelerator module which will be built based on the one cavity type. This module is the main accelerating part of the PKU ERL and FEL project. Figure 1 shows one layout of the plans [1]. The 9-cell accelerator will be used to accelerate the electrons from the photo injector to about 30MeV/m for the IR-FEL. A new designed 3+1/2cell photocathode injector will provide 77pC low emittance electrons for the 9-cell accelerator module. And then the electrons will be accelerated to 25 MeV for the undulator to get Infrared FEL. The accelerator includes one 9-cell superconducting cavity, liquid helium tank, liquid nitrogen tank, tuning system, power coupler, suspending device, magnetic shielding, measurement and control device.

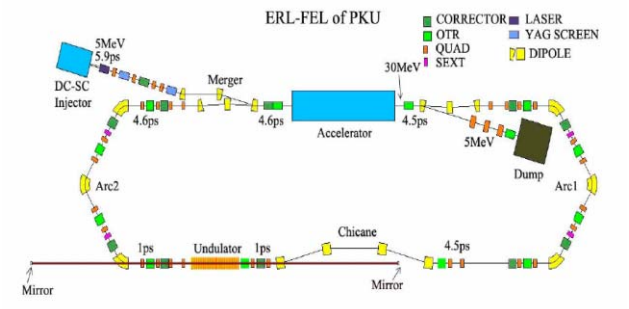

Figure 1: One layout of the PKU-ERL-FEL

THE ACCELERATOR MODULE

Figure 2 and figure 3 show the sketch of the accelerator module. It is 2 meters long and the diameter of the outer shell is about 0.7 meters. The LHe port will connect to the LHe cryogenic system made by the company of Linde. LN_2 port will connect with the LN_2 dewar. Tuning motor

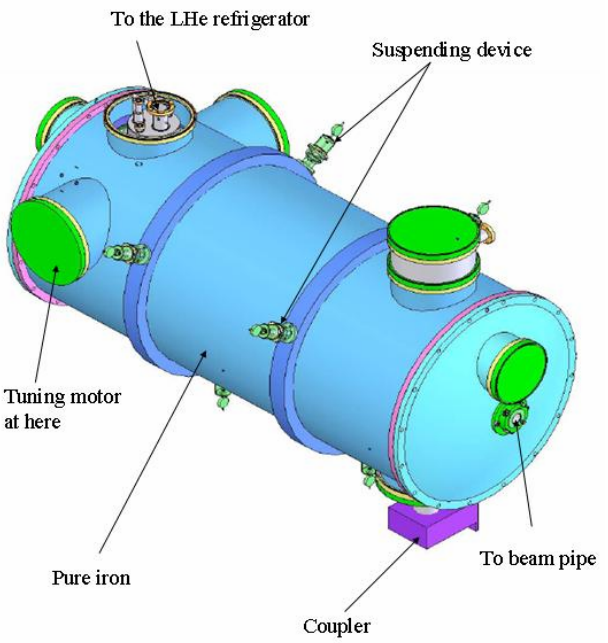

Figure 2: 9-cell accelerator viewed from the outside

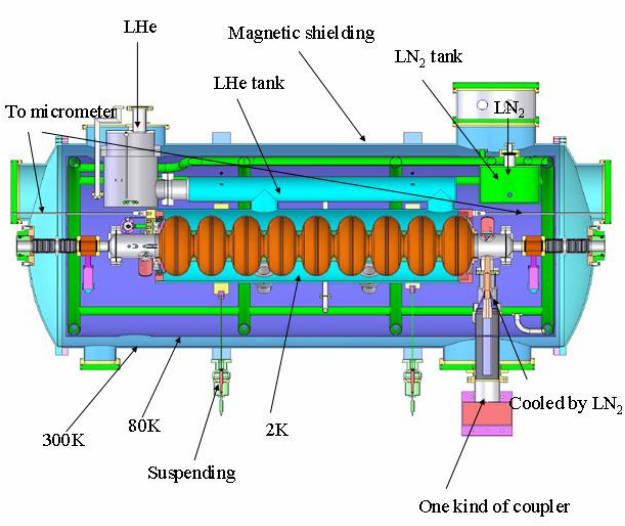

Figure 3: The profile of the 9-cell accelerator.

*Work supported by the National Basic Research Project.
#lzhchao@pku.edu.cn

is put in the outside of the module. This will make much easier to operate and maintain. As it is in the outside of the outer shell made by pure iron, the magnetic field of the motor will have little influence on the cavity. The LHe tank will be adjustable to keep the cavity axes in the same line with the module axes by the two group of suspending device. The power coupler is in the bottom of the module.

9-cell superconducting cavity

This is the core part of the 9-cell superconducting accelerator module. It is a TESLA type 9-cell cavity. The material is from Ningxia, and all the fabrication will be home made. The copper 9-cell cavity is already made and tested. And a 5-cell Nb is made too. With the experience of these two cavities, the 9-cell Nb cavity will be fabricated soon. The material of the 9-cell cavity is fine grain niobium. Large grain and single grain 9-cell cavities are also in schedule.

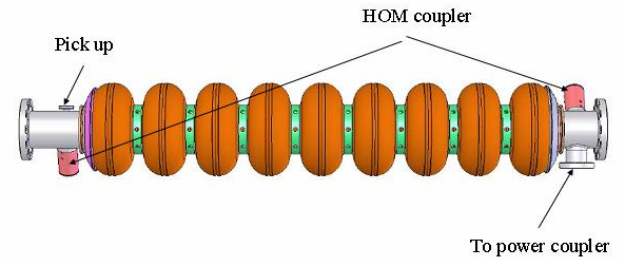

Figure 4: TESLA type 9-cell cavity.

Liquid helium tank

There are two temperature stages for the module as the usual low temperature facility cooled by liquid helium. The outer one is from room temperature to 80K, and the inner one is from 80K to 2K. The 9-cell cavity is dipped in the 2K helium tank. There is a pre-cooling pipe at the bottom of the tank. It will help to cool the helium tank at a faster speed. The temperature will be kept at 2K when there is beam load at the cavity. It is controlled by the pump of the refrigerator. It will be a challenge for us to accomplish this. And the facility will give a test bed for us to get experience.

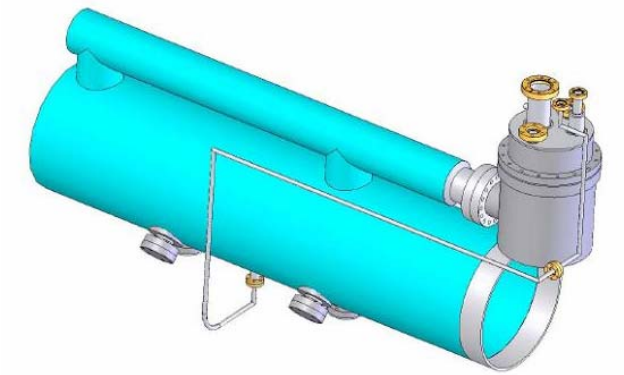

Figure 5: The LHe module of 9-cell accelerator.

Liquid nitrogen tank

The outer of the LHe tank is surrounded by the pipe of LN_2 to keep a temperature level at 80K. And the outer of the pipes are covered with copper plates. There is a tank at the upper side to make an enough injection interval. So the tank must have a proper volume. The designed volume of the tank is 4.5L. And the consumed LN_2 per hour is calculated as 0.4L. So if the LN_2 is filled in when the surface level of the liquid is below 25% and then stop at 75%, the time interval is about 5.5 hours.

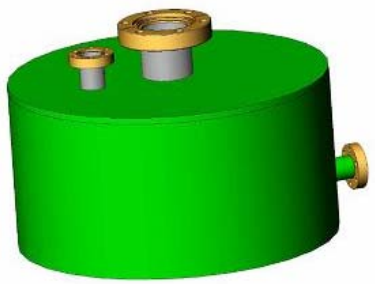

Figure 6: LN_2 tank.

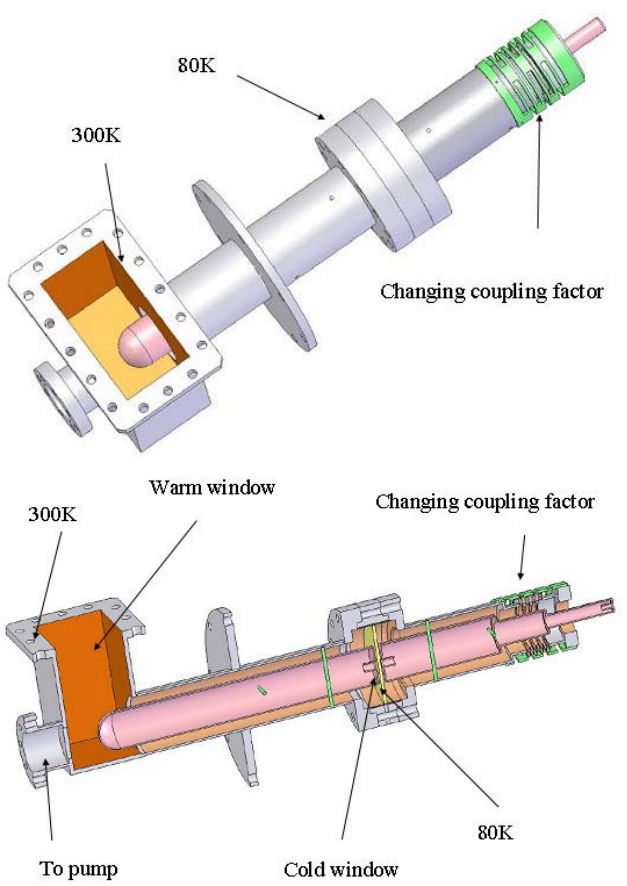

Figure 7: The sketch of one kind of coupler used in the 9-cell accelerator

Power coupler

The new type of coupler put forward by H. Matsumoto in 2005 [2] will be adopted in the module. It is simple and fitting the requirements of the 9-cell accelerator. It is

optimized for the Peking University 9-cell accelerator module. The coupler is designed to pass 20MW without breaking the ceramic window. The purity ceramic is 95%.

Magnetic shielding

The outer shell of the 9-cell accelerator is 8cm and made of pure iron. So this shell is used for magnetic shielding. Magnetic shielding material also will be used at the outside of the LHe tank to reduce the magnetic field near the cavity. The magnetic field will be reduced to less than 5mG at the area of cavity.

SUMMARY

This is the brief introduction about the 9-cell accelerator module at Peking university. Many of the parts refer to the widely used ones in the world and the experience of PKU at the last twenty years. Some parts are optimized for PKU solution. This new accelerator module will be built soon and tested.

REFERENCES

[1] Zhenchao Liu, Kexin Liu, “Optical Design of the Energy Recovery Linac FEL at Peking University”, FEL’2006, Berlin, Aug. 2007.

[2] H. Matsumoto, S. Kazakov, “A NEW DESIGN FOR A SUPER-CONDUCTING CAVITY INPUT COUPLER”, PAC’2005, Knoxville, May 2005, p.4141