Radiation Source ELBE

Forschungszentrum Rossendorf

Progress of the Rossendorf SRF Gun Project

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Introduction

Advantages:

The SRF photo injector will produce short pulses with high bunch charges and low transverse emittance like the traditional photo injector. Additionally, it will easily operate in the CW mode because of the low RF power losses in the superconducting material.

The proof-of-principle experiment on the SRF gun with a half-cell cavity was successfully demonstrated in 2002 [1].

Goals:

The SRF gun will provide low emittance electron beams with 1 mA average current and 9.5 MeV energy for the ELBE superconducting electron linear accelerator.

It will demonstrate the capability for future applications in FEL light sources and energy recovery linacs [2].

It is scheduled to install the gun in autumn 2006 and to generate the first beam in 2007.

Design Parameters

Parameter	ELBE mode	High charge mode	BESSY-FEL mode
RF frequency	1.3 GHz		
beam energy	9.5 MeV		
operation mode	CW		
drive laser	262 nm		
photocathode	Cs_2Te		
quantum efficiency	≥1 %		≥2.5 %
average current	1 mA		2.5µA
laser pulse (FWHM)	5 ps	20 ps	50 ps
repetition rate	13 MHz	1 MHz	1 kHz
bunch charge	77 pC	1 nC	2.5 nC
transverse rms emittance	1.5 µm	2.5 µm	3 µm

Cryomodule

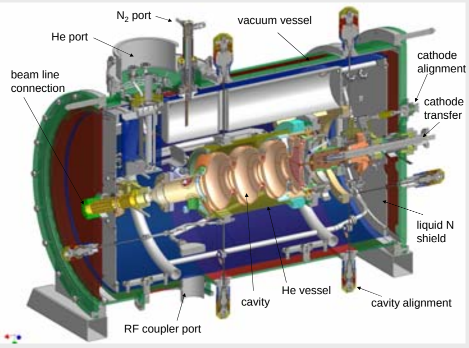

Fig. 1: 3-D view of the cryomodule with Nb cavity, He tank, photocathode, N_2 cathode cooler, cathode transfer rod, liquid N_2 shield and vacuum vessel.

The cryomodule design of the SRF gun is based on the ELBE module design and experience. He tank design and level control, RF coupler, cavity support, tuner design are adopted from ELBE. The module has a liquid N_2 shield, a warm magnetic shielding and on-air tuner drives. Main parts like vacuum vessel, liqud N_2 and magnetic shields have been delivered. The tuner test is under way.

Photocathodes

Fig. 2: Photocathode preparation chamber

Cs_2Te photocathodes will be used in the SRF gun. A quantum efficiency of at least 1% is required. The standard method and co-evaporation will be adopted [3]. The Cs_2Te photo layer will be produced in a separate preparation chamber (Fig. 2) and then transferred to the SRF gun in an UHV storage chamber. The equipment is ready and was tested. Now the parts are being cleaned and assembled in the clean room. The Cs_2Te photo layer and cathode body are normal conducting. In the gun a vacuum gap prevents the heat flow from the cathode to the SC cavity. A Cu cooling element holds the photocathode and provides the thermal connection to the liquid N_2 tank. The cooling system was successfully tested [4].

Superconducting 3½ Cell Cavity

Fig. 3: Photograph of the Nb cavity.

The SRF gun cavity consists of three TESLA cells, a specially designed half-cell and the choke filter. It has a rf power coupler, two higher-order mode couplers, a pick-up adopted from the TESLA cavity [5] and one extra pick-up especially for the cathode half-cell. It will be equipped with two tuners, one for the half-cell and one for the TESLA cells.

Fig. 4: Field profile measuring (bead pull) and warm tuning machine.

The production of two Nb cavities, with RRR 300 and RRR 40 respectively, has been finished. They were shipped to Rossendorf in March 2005. The RF tests and the warm tuning are now under way. For that reason a cavity tuning machine with an integrated bead pull measuring device [6] has been built. After that, further preparation of the cavities will be proceed at DESY.

References

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