STATUS OF THE 3½ CELL SRF GUN PROJECT IN ROSSENDORF

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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 caused by 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
To provide low emittance electron beam with 1 mA current and 9.5 MeV energy for the ELBE superconducting electron linear accelerator.
To demonstrate the capability for future applications in FEL light sources and energy recovery linacs [2].

Status: fabrication of two cavities (RRR 40 & 300) at ACCEL finished
Cavity: waiting for tuning in Rossendorf; BCP, HPR tests at 2K at DESY
Cavity tuners: design and fabrication finished
Cryomodule: design and fabrication finished
Cathode cooling system: fabrication finished, tests are running
Cathode transfer system: design finished, in the workshop
Cathode preparation chamber: design and fabrication finished, assembling and testing

Parameters

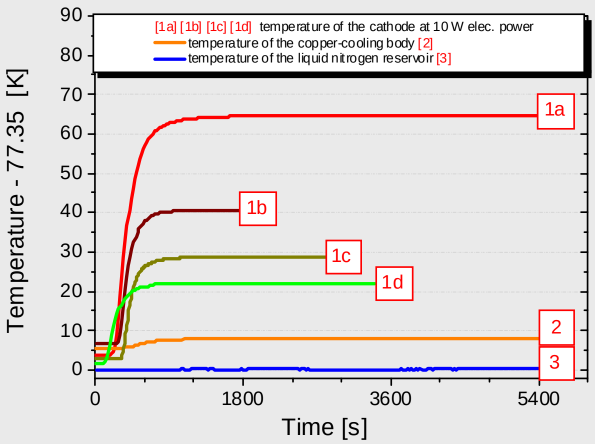
Parameter	ELBE mode	High charge mode	BESSY-FEL mode
RF frequency	1.3 GHz		
beam energy	9.5 MeV		
operation mode	CW		
drive laser	262 nm		
photocathode	Cs_2Te		
quantum efficiency	≥1 %		≥2.5 %
average current	1 mA		2.5μA
laser pulse length	5 ps	20 ps	~ 30 ps
repetition rate	13 MHz	1 MHz	1 kHz
bunch charge	77 pC	1 nC	2.5 nC
transverse emittance	1 μ m	2.5 μ m	~ 3 μ m

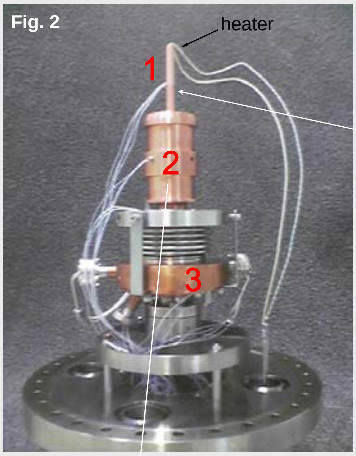
Photocathode and Cooling System

The normal conducting photocathode (Fig.1) is mounted inside the super conducting cavity (Fig.3). Therefore, the photocathode is fixed in a cooling body (Fig.2) by a bayonet socket system. A spring affords the force between the touched cone areas of the photocathode body (position 1) and the cooling body (position 2).The cooling body is connected to a liquid N_2 reservoir (position 3) which amounts 77 K. The temperature of the cavity amounts 2 K. The mounted heater on the top burden the cathode respectively the cooling system with 10 W heat power, which corresponds to the estimated power input from the RF field into the cathode.

The measured temperature values of the cathode (curves [1a,b,c,d]) shows an improvement of the thermal conductivity between the cathode and the cooling body. By the heat process the liquid N_2 reservoir (curve [3]) retains 77 K and the cooling body (curve [2]) shows a negligibly increasing temperature.

The starting temperature value (curve [1a]) of the cathode amounts ΔT = 64.6° K with regard to liquid N_2 temperature. An improved matching of the touched cone shapes leads to a temperature value (curve [1b]) of ΔT = 40.6° K. In a next step, the spring are strengthened from roughly 20 N to roughly 39 N elastic force. The temperature (curve [1c]) decreases to ΔT = 28.8° K. Once more the matching of the touched cones are improved, so the final best low temperature value of ΔT = 21.9° K is achieved (curve [1d]). This temperature corresponds to a radiation power of roughly 8.6 mW from the cathode calculated by Stefan-Boltzmann law (~ 0.2% from the cooling power of the helium system).





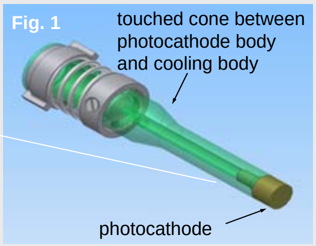


Fig. 1: Cs_2Te photocathodes will be used in the SRF gun and a quantum efficiency of at least 1% is required. The standard method and co-evaporation will be adopted [3]. The Cs_2Te photo layer will be produced in a separate preparation chamber and then transferred to the SRF gun in an UHV storage chamber.
The cathode cool body, made of Cu, holds the photocathode and provides the thermal connection to the liquid N_2 tank.

Fig. 2: Test facility for the cathode cooling system. The temperature is measured at significant points when cooling is running.

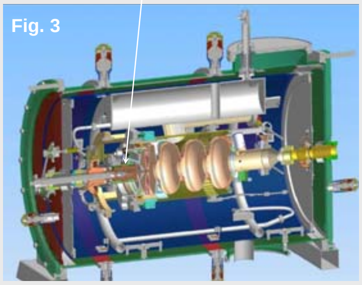


Fig. 3: 3-D view of cryomodule, cavity, photocathode, cathode cooler, and transfer rod. The cavity has an rf power coupler, two higher-order mode couplers, and a pick-up adopted from the TESLA cavity [3] and one extra pick-up especially for the cathode half-cell

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References

1.D. Janssen, et al., Nucl. Instr. and Meth. A507 (2002) 314.
2.J. Teichert, et al., 1st Workshop of ELAN, Frascati, 4-6 May 2004.
3.G. Suberlucq, PHIN Collaboration Meeting 05/05/04

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