PLUG TRANSFER SYSTEM FOR GaAs PHOTOCATHODES

P. Murcek, A. Arnold, J. Teichert, R. Xiang, HZDR, Dresden, Germany
P. Lu, H. Vennekate, HZDR & Technische Universität, Dresden, Germany
A. Burrill, K. Martin, Helmholtz-Zentrum Berlin, Germany

Abstract

The transport and exchange technology of Cs_2Te photocathodes for the ELBE superconducting rf photoinjector (SRF Gun) has been successfully developed and tested at HZDR. The next goal is to realize the transport of GaAs photocathodes into the SRF Gun, which will need a new transfer system with XHV 10^{-11} mbar. The key component of the setup is the transfer chamber and the load-lock system that will be connected to the SRF Gun. In the carrier, four small plugs will be transported, one of them will be put on the cathode-body and inserted into the cavity. The new transport chamber allows the transfer and exchange of plugs between HZDR, HZB and other cooperating institutes. In HZDR this transfer system will also provide a direct connection between the SRF Gun and the GaAs preparation chamber inside the ELBE-accelerator hall.

INTRODUCTION

The Rossendorf superconducting RF photo injector (SRF Gun), developed within a collaboration of the institutes HZB, DESY, MBI and HZDR, has been put into operation in 2007. It is designed for medium average beam current and operation in CW mode [1]. The superconducting cavity, the main part of SRF gun, consists of three TESLA cells and one optimized half-cell. The Cs_2Te photocathode is inserted in the half cell isolated by a 1mm vacuum gap.

CATHODE SYSTEM UPDATE

The design of the new transfer system for the SRF gun is shown in Fig. 1.

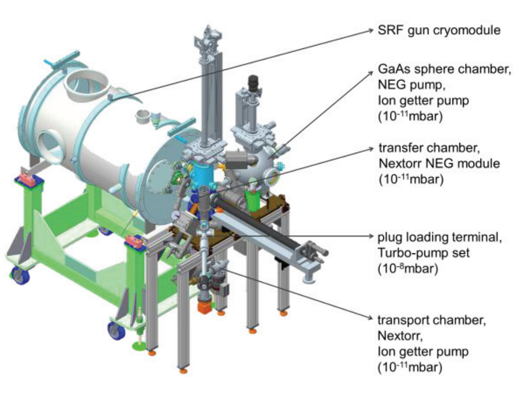

Figure 1: View of new transfer system on the cryomodule.

Figure 2: Photocathode of the new Transfer system.

The main difference of the new transfer system to that of the present one is, that the moving object is only the plug and not the entire cathode (Fig. 2).

• ELBE SRF Gun has been operated with Cs_2Te for medium current up to 400µA
• for high current operation in the future GaAs(Cs,O) is considered to be combined with the SRF Gun technology.
• SRF Gun is supposed to serve as a test bench for GaAs(Cs, O)

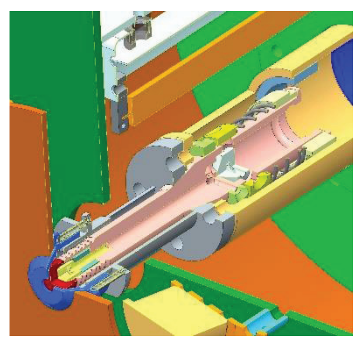

Figure 3: Arrangement in the coating chamber.

Cs_2Te (Fig. 3).
• driven by UV light
• UV laser shaping complicated
• medium current
• 10^{-9} -10^{-10} mbar

NEA-GaAs (Cs, O) [2]
• high QE in the visible light
• laser pulse shaping easier
• polarized electron source
• critical vacuum requirement

GaAs (Cs,O) will be in-situ activated before the transport into SRF gun through a new transfer system. XHV of less than 1×10^{-11} mbar is required.

ISBN 978-3-95450-178-6

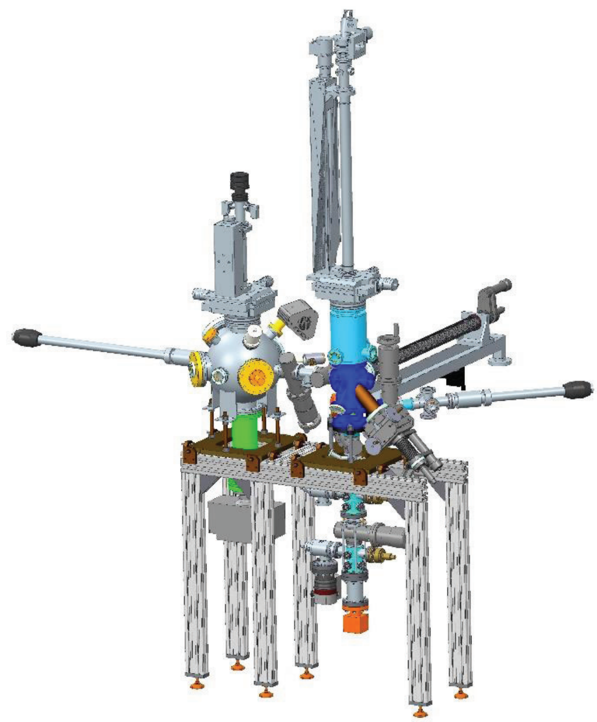

Figure 4: 3D view of transfer system with preparation chamber.

Net-working between different preparation chambers and analysis systems of HZDR (Fig. 4), HZB, JGU Mainz is intended

• plug Ø 10 mm × 8 mm
• four plugs in one carrier (Fig. 5)
• $CuBe_2$ spring for connection
• carrier is smaller (Fig. 6)

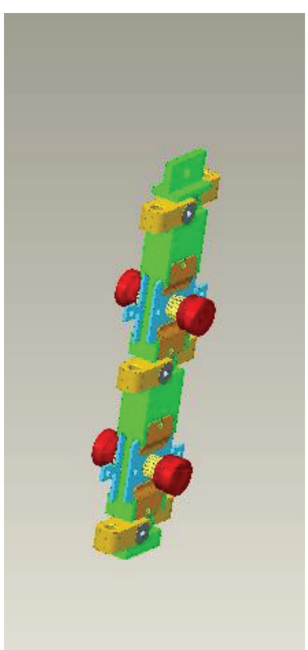

Figure 5: 3D view of new carrier.

Figure 6: Photograph of the new transport chamber

GaAs TRANSFERT CHAMBER

1. vertical movement of the plug carrier with jaws
   z = 610 mm movement (Fig. 7, Fig. 8)
   rotation
   X,Y table ± 12.5 mm
   2nd inner-Z movement of 12 mm for jaws (Fig. 9)
2. shift of one cathode plug on jaws from the GaAs preparation chamber to plug carrier
   movement 600 mm
3. transfer of the photo cathode into the electron gun
   original ELBE SRF Gun manipulator
4. plug exchange between carrier and cathode body
   230 mm movement
   X table ± 7.5 mm
   movement of one flag from the load-lock to plug carrier with jaw
   movement 330 mm

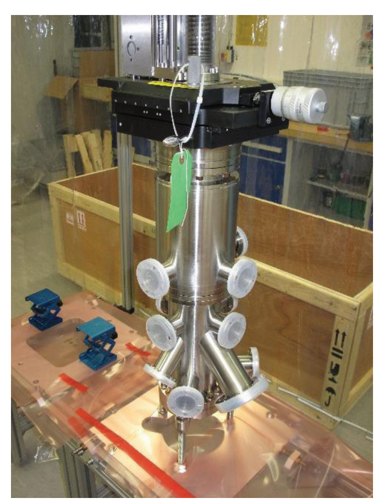

Figure 7: Photograph of assembly test.

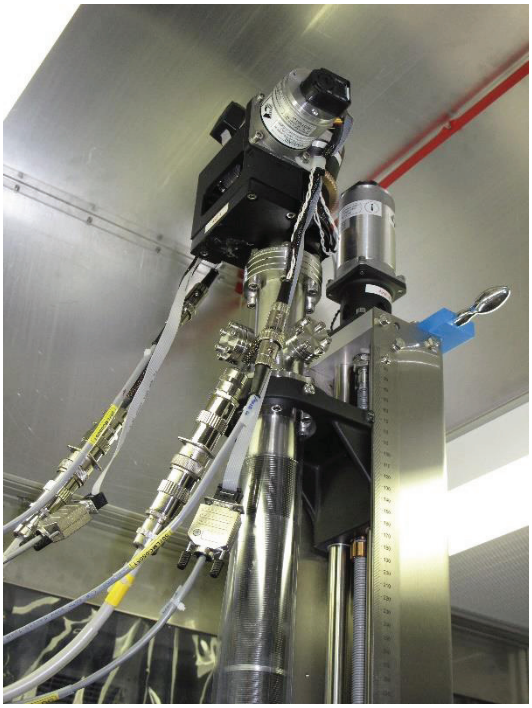

Figure 8: Photograph of manipulator.

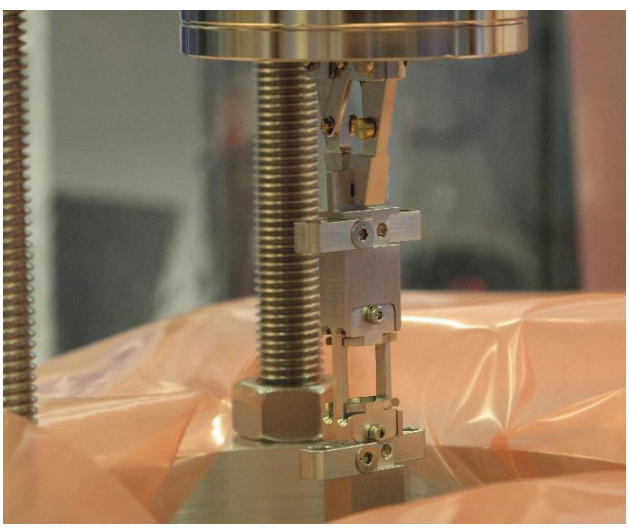

Figure 9: Interface between manipulator and plug carrier.

GaAs PREPARATION CHAMBER

In 2013, a new photocathode laboratory has been established and put into operation in the ELBE accelerator building. It consists of a laboratory room and a class 100 clean room. The existing preparation system for Cs_2Te photo cathodes was moved into the new laboratory. The photo cathode diagnostics have been upgraded to allow multi-wavelengths quantum efficiency measurements [3].

A new preparation system for GaAs photocathodes (see Fig. 10) is being built to allow the use of these photocathodes in the SRF Gun in future.

Figure 10: Photograph of the new preparation system for GaAs photocathodes.

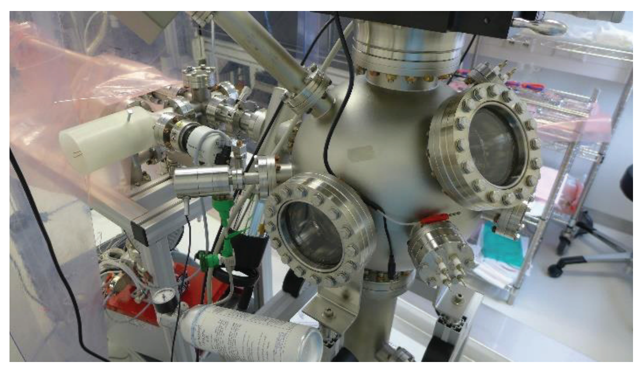

Figure 11: Photograph of the new preparation system for GaAs photocathodes.

Preparation system in clean room (see Fig. 11):
- ø 300 mm polished sphere chamber
- rotatable VgScienta® manipulator for the sample handling
- rest gas analyser (RGA)
- 532 nm green light
- load-lock system with magnetic manipulator
- vacuum < $4{\times}10^{-11}$ mbar

Preparation system inside (Fig. 12):
- halogen light with reflector/shielding
- SAES cesium dispenser
- anode up to 3 kV
- optical windows in different directions
- photocurrent detect
- O_2 leaking piezo valve
- momentum meter in future.

ISBN 978-3-95450-178-6

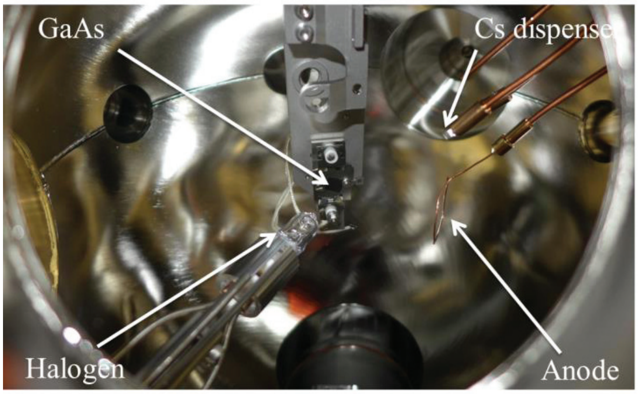

Figure 12: Photograph of the new preparation system for GaAs photocathodes.

The application of GaAs in SRF gun is planned for 2016.

ACKNOWLEDGMENT

We would like to thank the whole ELBE team for their help and assistance with this project. The work is supported by the European under the FP7 programme (EuCARD-2, contract number 312453, and LA3NET, contract number 289191), and by the German Federal Ministry of Education and Research grant 05K12CR1.

REFERENCES

[1] A. Arnold, et al., Nucl. Instr. and Meth. A 577, 440 (2007).

[2] R. Xiang, "NEA-GaAs (Cs, O) Photocathodes for the ELBE SRF gun", Proceeding and Poster of IPAC'14, June 15-20, 2014, Dresden, Germany.

[3] J. Teichert, et al., "Status of the SRF-Gun Operation at ELBE", Proc. FEL 2010, Malmö, Sweden, p. 453.