Project of CW Photoinjector for the High Power Free Electron Laser

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Abstract

A project of a high-brightness photoinjector for a high power free electron laser (FEL) of the Siberian Centre of Photochemical Research is described. It will be capable to produce the electron beam with 100 mA average current and 300 keV energy for the injection into a race-track microtron.

1 INTRODUCTION

A high average power infrared FEL is under construction at Novosibirsk [1, 2]. As other FELs, it also demands the electron beam with high peak current, and low emittance and energy spread. One of the possibilities to meet these requiriments is to use a photoinjector [3, 4]. At present many laboratories investigate laser-driven guns [5].

However, all these photoguns work in the pulse regime, and therefore cannot be used as injectors for CW FEL with high average power. So, we decided to develop the photoinjector with DC power supply [6]. This approach has better vacuum conditions (and longer photocathode lifetime), less energy spread of the electron bunch, and has no emittance degradation specific to the RF guns [7].

2 GENERAL LAYOUT

The photoinjector consists of an entrance chamber, a photocathode preparation chamber, two manipulators, a DC high voltage power source, a photogun, an illuminatig laser, and a control system (see Fig. 1).

The photocathode holder is loaded into the entrance chamber where it is preliminary baked for outgassing. To avoid the contamination of high vacuum volume, the entrance chamber is isolated from the main vacuum volume by a vacuum valve. After outgassing, the holder is transferred to the phocathode preparation chamber by the first manipulator.

During the photocatode activation the photogun vacuum volume is separated from the cathode preparation chamber by a vacuum valve. The holder is transferred inside photocathode preparation chamber and photogun by the second manipulator.

Before the photoinjector is installed at the accelerator the experiments will be carried out, which are aimed at developing photocathode preparation technology and possibility of simple preparation and/or change of the photocathode, and measuring the electron beam parameters, quantum efficiency, and photocathode lifetime.

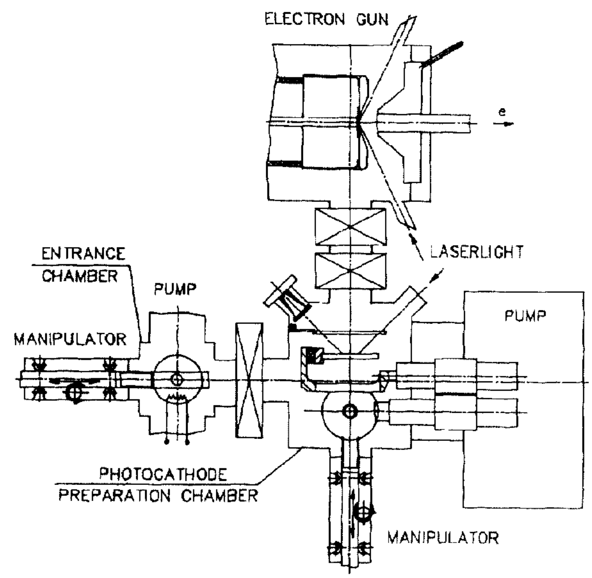

Figure 1: The photoinjector layout

2.1 Photogun

The photogun is a diode one with a photocathode active area of 0.5 cm^2. Its crossection is shown at Fig. 2. For better vacuum conditions the anode is cooled with liquid nitrogen. The photocathode surface is illuminated by laser light at an incidence angle of 70°.

The high voltage power source is a commercial one developed at BudkerINP for use in industrial accelerators "Malutka". It is capable to produce 300 kV voltage at 100 mA current.

2.2 Photocathode Preparation Chamber

The photocathode preparation chamber (see Fig. 3 comprises two sections: in the first, the photocathode surface is finally cleaned, in the second, the photocathode is activated. The quartz window and the photoelectron collector are situated here for measuring quantum yield while the photocathode is being prepared.

2.3 Illuminating Laser

The illuminating laser produced by the Institute of Automatics and Electrometry (Novosibirsk) is an argon one

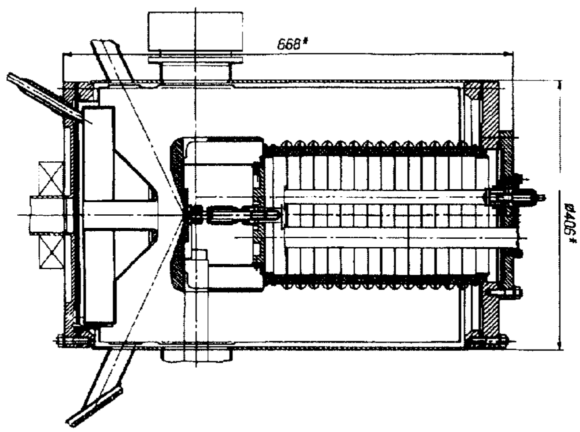

Figure 2: The photogun crossection

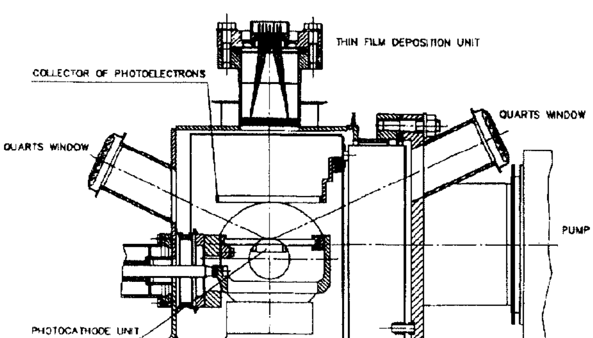

Figure 3: The photocathode preparation chamber

with active mode-locking and has the following parameters:

Wavelength	458 nm
Average Power	10—15 W
Repetition Frequency	45 MHz
Pulse Duration	200 psec

The illuminating laser is supplied by a modified commercial DC source capable to produce current up to 500 A and voltage up to 600 V and has system for the suppresing arc discharge.

Taking into account laser output power and average photogun current one can easily obtain the 2.5% minimal photocathode quantum efficiency .

2.4 Control System

All processes for better reproducibility and accuracy are computerized.

3 ELECTRON BEAM PARAMETERS

We expect that the electron beam will have the following parameteres:

Emittance	10^{-7}cm rad
Electron energy	300 keV
Energy Spread	< 1 keV

4 CURRENT STATUS

At present the manipulators, the entrance and photocathode preparation chambers, the illuminating laser are manufactured and will be assembled in the near future. The photograph of the photocathode preparation chamber and high voltage insulator are shown at Fig. 4.

5 REFERENCES

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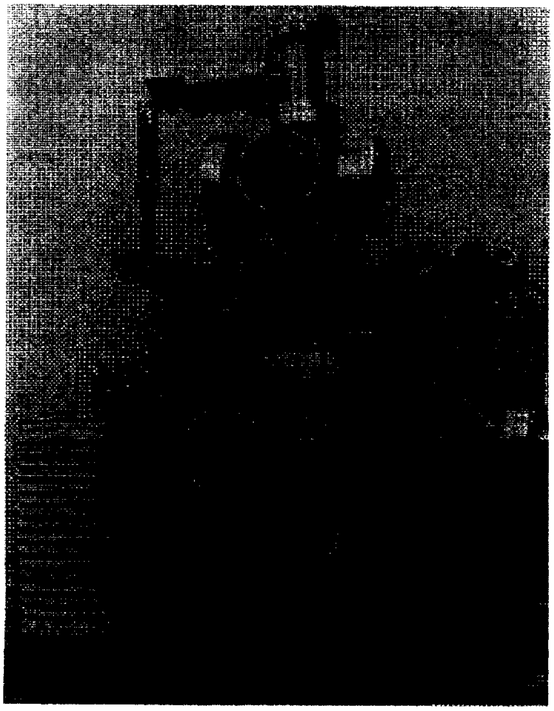

Figure 4: The photocathode preparation chamber and high voltage insulator

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