The 50 kV inverted source of polarized electrons at ELSA

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Abstract. The future medium energy physics program at the electron stretcher accelerator ELSA of Bonn University mainly relies on experiments requiring a beam of polarized electrons and a polarized target. To provide a polarized beam with high polarization and sufficient intensity a pulsed 50 kV inverted gun of polarized electrons has been set into operation. The gun is operated in space charge limitation, producing a peak current of 100 mA in rectangular $1\mu s$ long electron pulses. Photocathode lifetime during operation is higher than 3000 hours. Using a Be-InGaAs/Be-AlGaAs superlattice photocathode a polarization of 80 % and a corresponding quantum efficiency of 0.4 % could be obtained.

INTRODUCTION

Medium energy experiments requiring circularly polarized photons (produced by Bremsstrahlung of longitudinally polarized electrons) have started at the electron stretcher ELSA in Bonn [1]. To fullfill the demands of the experiments a new pulsed source of polarized electrons was developed [2] and set up. In order to enhance the overall efficiency it operates with a newly installed pulsed injector linac which requires an injection energy of 50 keV, a pulse length of $1\mu s$ and a repetition rate of 50 Hz [3]. In this paper, we will report on first measurements and our operation experience with the source.

GUN AND LOAD LOCK SYSTEM

A cross section of the gun and the load lock system is shown in Fig. 1. The cathode electrode is supported on three insulating macor rods, bolted to the upper flange of a bellow mounted on top of the gun chamber. High voltage is supplied to the cathode from the side via a pin-ball contact using a standard feedthrough which can be tilted without breaking the vacuum of the gun chamber. In this inverted configuration, the anode, the gun body and the load lock are on ground potential. The distance between cathode and anode can be varied from 45 to 70 mm. This permits to change the perveance of the gun and allows a space charge

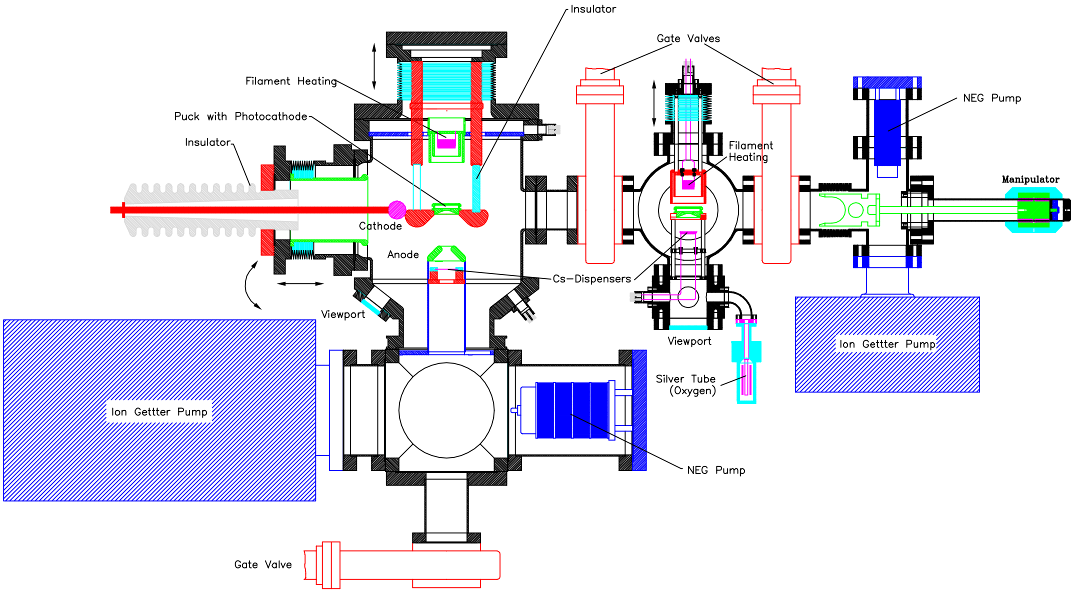

FIGURE 1. Setup of the 50 kV inverted gun and the load lock system.

limited operation over a wide range of currents. The range of operation can be enlarged using photocathodes with different photoemitting areas (see Fig. 2). To improve the gun vacuum and consequently the lifetime of the source heat cleaning and activation of the photocathode are carried out in the preparation chamber of the load lock system which is attached to the gun chamber. In addition this setup allows to exchange photocathodes without breaking the vacuum of the gun chamber.

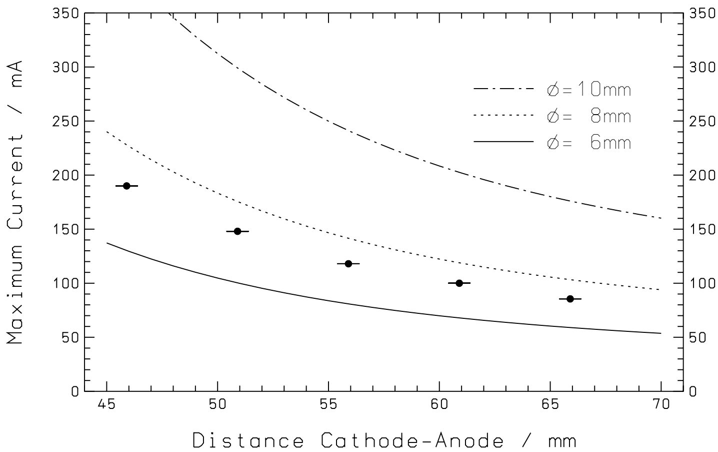

FIGURE 2. Simulated and observed space charge limitation. The simulation, represented by the lines, was carried out for three different photocathode diameters using the EGUN-code.

LASER SYSTEM

The light source is based on a tunable (700-900 nm) free running flashlamp-pumped 50 Hz Ti-Sapphire laser. The laser pulses (pulslength 10 μs) are chopped to 1 μs, fed via a 85 m long optical multimode fibre to the source and become circularly polarized after passing a linear polarizer and a pockels cell. A cw beam of polarized electrons of low intensity (typ. 100 pA), which is needed for the measurement of the beam polarization, is produced using a continous wave tunable (700-900nm) Ti-Sapphire laser. This laser is pumped by an argon vapor laser and can be fed into the fibre as well.

FIRST MEASUREMENTS

Maximum currents of up to 190 mA were obtained from a 8 mm diameter Be-InGaAs/Be-AlGaAs superlattice photocathode [5]. Electron emission could be varied from 85 mA to 190 mA (see. Fig. 2) by changing the cathode-anode-distance. A rectangular pulsstructure was obtained in all cases. The observed space charge limitation differ significantly from the calculated one which may be attributed to the different emission properties of a (cold) photocathode and a (hot) thermionic cathode, which is not implemented in the EGUN code [4] so far.

In Fig. 3 the wavelength dependance of polarization and quantum efficiency, obtained from Mott-scattering off thin gold foils, is presented. A maximum polariza-

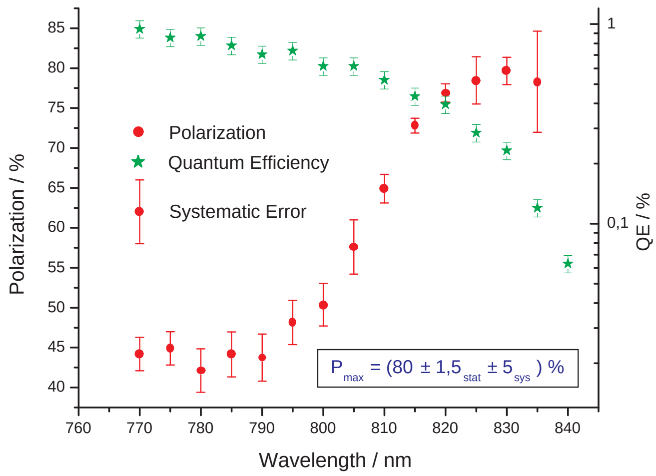

FIGURE 3. Polarization and quantum efficiency versus wavelength, obtained from Mott-scattering off thin gold foils. The error bars represent the statistical error only. A systematic error of 5 %, caused by an insufficient knowledge of the effective Sherman function, has to be taken into consideration for all data points.

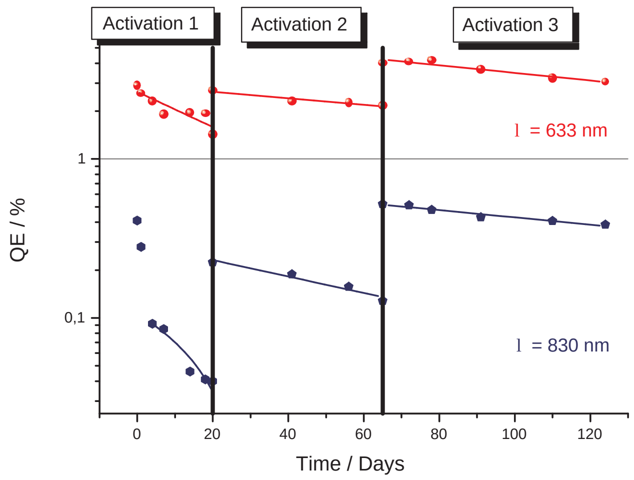

FIGURE 4. Observed decrease of quantum efficiency with time, measured at two different wavelengths.

tion of P = 80 % is achived at 830 nm, using a Be-InGaAs/Be-AlGaAs superlattice photocathode. The corresponding quantum efficiency was 0.2 %.

The degradation of the photocathode was determined by measuring the time dependent decrease of the quantum efficiency (QE) using a diode laser (wavelength 830 nm) and a He:Ne laser (wavelength 633 nm). We found lifetimes higher than 4500 hours for the last most successful activation of the photocathode (see Fig. 4). No siginificant decrease of the lifetime was observed during operation of the source.

CONCLUSIONS

A 50 kV source of polarized electrons has been set successfully into operation. A polarization of P = 80 %, QE = 0.4 % and a current of 100 mA were obtained. First experience showed a reliable operation and indicate a high source availability close to 100%.

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