Source of Polarized Electrons for MAMI B

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Abstract
A source of polarized electrons based on photoemission of a GaAsP-cathode has been set up to inject polarized electrons in the Mainz microtron MAMI. A beam transport system for the low energy 100 keV beam of 20 meters is being built up. In order to compensate the spin precession in MAMI a spin rotator system has to be integrated in the beamline to achieve the required longitudinal spin direction at target position.

First results on measurements of source parameters like brightness and life time and of electron optical properties of the beam transport system will be presented.

Introduction
The injection system for the operation of MAMI with polarized electrons consists of three major components:

- the source of polarized electrons, based on photoemission of a GaAsP-Photocathode.
- a beam transport system for 100 keV electrons connecting the source and the injector linac of MAMI.
- a spin rotator that is used to adjust the spin orientation relative to momentum

Electron gun and laser system (figure 1)
The electron gun is similar to that used at the Mainz Linac [1]. The electron emitter is a GaAsP Photocathode activated to negative electron affinity (NEA). It is illuminated by 640nm radiation from a dye laser that is pumped by an argon ion laser. A maximum of 1.6 Watt c.w. power at 640nm is available from the system. The laser beam may be chopped by cavity dumping, which gives light pulses with a duration of 8ns FWHM and a repetition frequency that may be varied in the range from 0 to 10MHz. Pulse modulation of the electron beam produced is needed for beam diagnostics in MAMI or may be applied in time of flight experiments. The electrode configuration of the gun has been designed with the help of an improved EGUN code written originally by Hertmannsfeldt [2]. The gun delivers a beam with a phase space of 1π·mm·mrad at 100keV, which is small enough to meet the emittance requirements of MAMI. Currents of 100μA (d.c.) have been achieved so far.

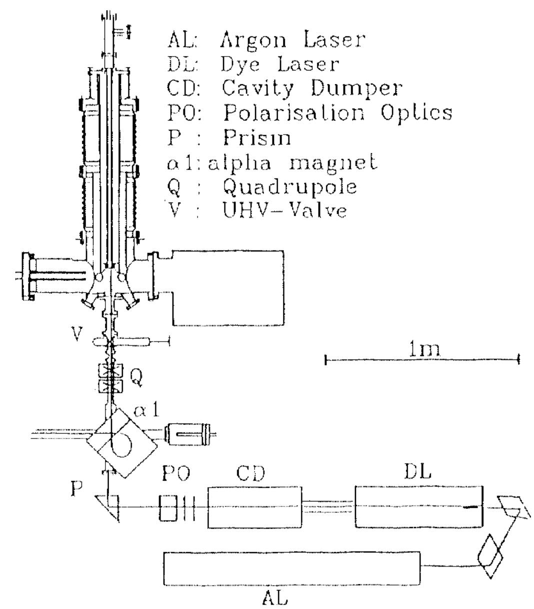

Figure 1: laser system, electron gun and first part of beamline

The spin polarization of the beam has not been measured yet, but we think that the beam will be polarized to a degree of about 40 %, a value that is observed at our linac source which is operating with the same type of GaAsP cathode [1]. Spin analysis will be done at source

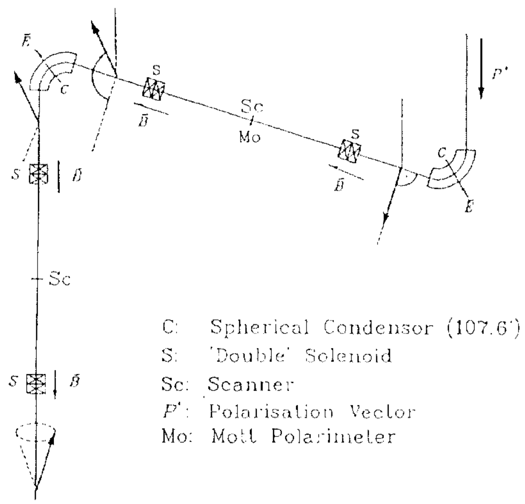

Figure 2: Spinrotator for 100 keV

energy (100keV) by a Mott polarimeter integrated in the spin rotator system (see below) and at accelerator energy (855MeV) by a Møller-polarimeter [3]. The source is operated under UHV conditions with a total pressure of less than $1 \cdot 10^{-10}$ mbar. This is necessary to avoid poisoning of the very sensitive NEA layer of the cathode.

The beamline

A beam line transports the 100 keV beam of polarized electrons from the source to the injector linac of MAMI over a distance of 20m. The beginning of the beamline is sketched in figure 1. It consists of a sequence of about 30 quadrupol magnets, 90°-deflections and several beam diagnostics equipment. The 90°-deflections are accomplished by the 270°-deflection of so-called α-magnets, which are particularly suitable for low energy beams. In addition to the fact that α-magnets are more simple than other deflection systems, higher field strengths can be used. The electron optical characteristics are determined by the form of the fringe field which can be varied by variation of the magnetic field strength.

The spin rotator (figure 2)

The spin rotator consists of two spherical electrical condensors and two pairs of twin solenoids. The source produces a beam with longitudinal polarization. During deflection in the first spherical electrical condensor the spin precesses slower than the momentum. Thus the longitudinal polarization is transformed to a transverse. Here is the best location to measure the polarization at 100 keV, because for mott scattering transverse polarized electrons are needed. The polarization can be rotated azimuthally by the solenoids following the condensor. The next electrical deflection bends the beam back to the primary direction which is accompanied by a small change in spin orientation only. The last two solenoids allow another azimuthal rotation of the polarization vector. The overall system may be used to orientate the polarization vector of the beam in any direction without affecting the beam optics. In each twin-solenoid the two coils are driven back-to-back. In this way spin rotation may be adjusted independently from beam focussing.

The spin rotator is needed to compensate for the (g-2)-precession of spin relative to momentum in the dipole magnets of MAMI. The correct adjustment of the polarization vector is determined by a Møllerpolarimeter at target position at the high energy end of MAMI.

References

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