Intensive, Relativistic Electron Pulses

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The interaction of relativistic electrons with a metallic grating can induce electromagnetic radiation [1]. To study this effect an electron beam of high brilliance is needed. For achieving this, we have installed NEC tubes that have previously been used at the MP Tandem, in the test Van de Graaff Elefant [2]. Other steps were the conversion of the Elefant from positive to negative potential and positioning an adjustable laser-driven electron-gun inside the high-voltage terminal (fig. 1).

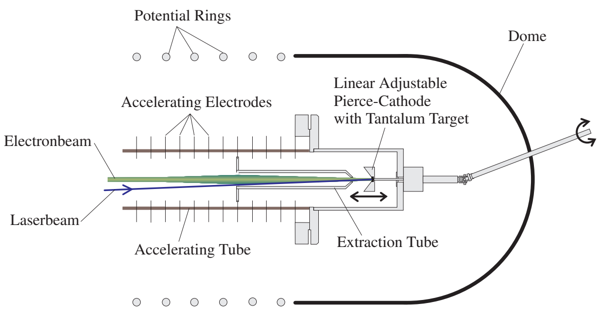

Fig. 1: Laserdriven photoelectrongun

The extraction is designed in a Pierce geometry. Furthermore, two steerers and a quadrupole doublet have been placed after the exit of the machine that allow to shape and position the beam appropriately above the metallic grating. The laser for driving the electron-gun is situated at the exit of the Elefant.

The pulsed beam of a Nd:YAG is fourfold increased in energy to 266 nm. A convex-concave lens system serves for focusing. A quartz window allows the UV beam to enter the electron beam line. After a 90°-deflection by a dichroic mirror, that has been positioned off axis of the electron beam axis, the laser beam hit the cathode of the electron-gun. A beam-grating interaction chamber and an optical system have been designed to allow observation of the emitted radiation in the extreme forward and backward direction, relative to the electron beam. The detection itself is accomplished by means of a spectrometer followed by a Ge:Ga detector. Fig. 2 shows the laser system, the Elefant, the electron beam line and the detection system. Tests have been performed up to about 2.5 MeV. To measure the shape of the electron beam a removable fluorescence screen is positioned right after the interaction chamber. For determination of the electron yield a long Faraday cup positioned after the screen is used. The screen itself allows to measure the yield, too. The deviation is about 90 %. The accelerated currents are up to 1 A, this is the first time that electron yields in the range of amps have been accelerated with a Van de Graaff. The duration of the pulses were between 10 and 20 ns. The shape was less than 1 mm high and 2 mm wide.

References

[1] G. Doucas, J.H. Mulvey, M. Omori, J. Walsh and M.F. Kimmitt, Phys. Rev. **69**(12) (1992) 1761
[2] Jahresbericht 1980, p. 121

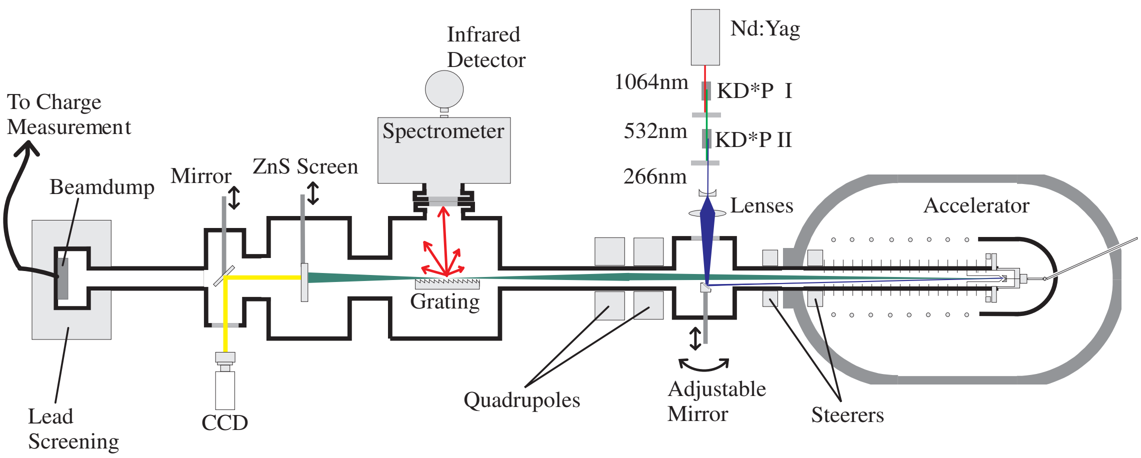

Fig. 2: Experimental arrangement