A Position Sensitive Microstrip Gas Chamber for Single VUV-Photons

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An interesting application of Microstrip Gas Chambers (MSGC) is the use of such devices in large area VUV-photon detectors. We successfully tested a MSGC with semitransparent solid CsI photon converter and a 2-dimensional position sensitive pixel readout [1]. The device is sensitive to single photons in the wavelength region $160\,\mathrm{nm} < \lambda < 220\,\mathrm{nm}$. It is operated at p = 1000 mbar with Ar-C_4H_{10} (90/10) at a gain $g \simeq 3 \cdot 10^4$. A schematic view of the detector is shown in Fig. 1.

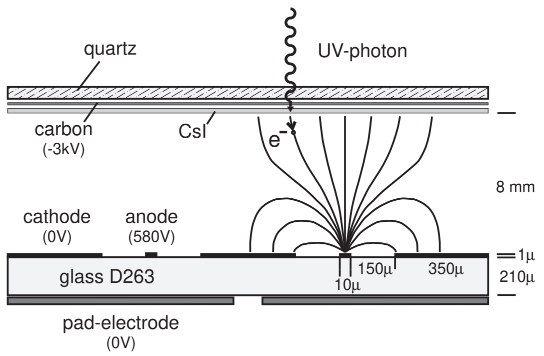

Fig. 1: Schematic view of the MSGC with a semitransparent CsI photon converter.

Within an active area $A = 53 \times 45\,\mathrm{mm}^2$ $10\,\mu$m wide anode and $350\,\mu$m wide cathode strips (Al) are deposited in alternating order on a $210\,\mu$m thick glass substrate using photolithography. 10 strips of each type are connected together and are read out with charge sensitive preamplifiers, shaping amplifiers and a CAMAC-ADC. The back electrode is formed by an array of 64 aluminium pads of rectangular shape $A' = 5.3 \times 6.3\,\mathrm{mm}^2$. Each pad is read out individually using a frontend module carrying 4 AMPLEX-chips [2]. The multiplexed analog signals are sent to a CAMAC-based DRAMS-module [3] performing 8-bit A/D-conversion, individual pedestal subtraction and threshold comparison. Thus, the position of the incident photon can be deduced from the hit pattern of the pad plane. The drift electrode of the MSGC is formed by the $8\,\mu\mathrm{g/cm}^2$ thick CsI photon converter evaporated onto the quartz entrance window. Due to the high resistivity of thin CsI-layers ($\rho_{CsI} > 10^{10}\,\Omega\,\mathrm{cm}$), a $0.7\,\mu\mathrm{g/cm}^2$ thick intermediate conductive Carbon-layer ($R_\square \simeq 2.3 \cdot 10^8\,\Omega$) with high VUV-transparency ($T \simeq 84\,\%$) had been deposited onto the quartz window using laser plasma ablation deposition.

The MSGC was irradiated with single VUV-photons ($\lambda \simeq 172 \pm 7\,\mathrm{nm}$) from a pulsed collimated Xe-excimer light source. Fig. 2 shows the resulting single electron pulse height spectra of the illuminated anode group and a corresponding central pad with the event trigger provided by the lamp. A mean "visible" gain $g \simeq 3.5 \cdot 10^4$ of the MSGC and a fraction $f \simeq 20\,\%$ of the anode charge collected by the pad can be deduced from the spectra. Fig. 3 shows a pulse height plot of the pads for two single photon events and a sample of 18000 accumulated events. The mean pad multiplicity for single photon events is M = 1.04. From a comparison of the incident photon flux deduced from the normalized trigger rate of the VUV-lamp with the flux measured with the anode (pad) readout a detection efficiency $\varepsilon_{tot} \simeq 9\,\%$ ($\varepsilon_{tot} \simeq 3.5\,\%$) for single VUV-photons ($\lambda \simeq 172\,\mathrm{nm}$) was deduced. Stable performance of the detector without deterioration of the efficiency was obtained for several days of operation.

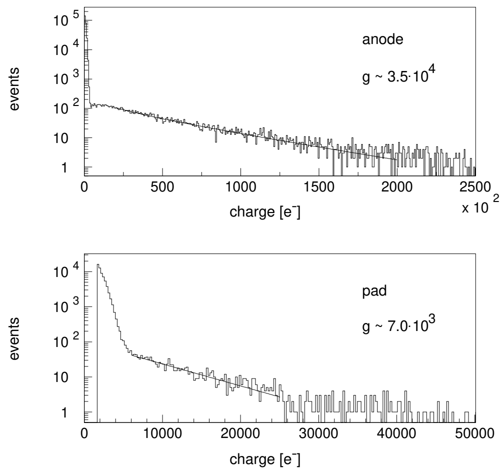

Fig. 2: (Upper part:) Calibrated pulse height distribution of an anode group resulting from irradiation of the MSGC with photons of wavelength $\lambda = 172\,\mathrm{nm}$. (Lower part:) Pulse height distribution of the corresponding pad.

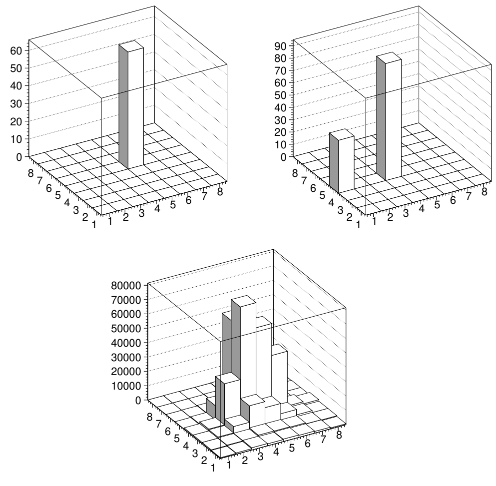

Fig. 3: (Upper part:) Pulse height of the 64 pads for two single photon events. (Lower part:) Sample of 18000 accumulated photon events reflecting the position of the light source.

References

[1] K. Zeitelhack et al., to be published in NIM A
[2] E. Beuville et al., Nucl. Instr. Meth. **A288** (1990) 157
[3] E. Chesi et al., CERN PS202 note, 1989