ESRF	**Experiment title:** $(\gamma, e\gamma)$-Spectroscopy	**Experiment number:** HC-287
Beamline: ID15 A	**Date of Experiment:** from: 22.11.95 to: 30.11.95	**Date of Report:** August 30, 1996
Shifts: 24	**Local contact(s):** Th. Tschentscher	***Received at ESRF:***

Names and affiliations of applicants (*indicates experimentalists):

F. Kurp*, HASYLAB at DESY, Hamburg, Germany

F. Bell*, Sektion Physik der Universität München, Germany

H. Bräuning*, IKF Frankfurt, Germany

J.R. Schneider, HASYLAB at DESY, Hamburg, Germany

Report:

The experiment was split into two parts in order to concentrate onto the two main objectives : The measurement of the S-dimensional electron momentum density (EMD) of laser-annealed carbon and the first run with two 2-dimensional detectors. For both parts of the experiment the incident beam has been monochromatieed by means of a 4 mm thick Si 220 crystal, which was cut with an asymmetry of 9.8" and was bent to a radius of 60 m. The beamspot used was 3 * 3 mm^2 and the energy 175 keV. A monochromatic flux of $10^{11}\, ph/s/0.3\%BW/100mA$ impinged onto the samples mounted in the sample chamber in a vacuum of $\approx 10^{-5}$ ***mbar.*** In the first part of the experiment a free-standing carbon foil of 22 nm thickness was investigated, which was produced by laser-ablation and afterwards laser-annealed at 4200 K. Electron diffraction from this samples showed graphite-like structure with crystallites of $\approx$ 10 nm diameter [l]. The crystallites are ordered randomly in the foil and thus the measurement reveals the spherical averaged EMD only. We had available a theoretical EMD for graphite obtained from pseudo-potential calculations [2]. For this first part of the experiment a single element Ge-detector was used to detect the compton-scattered photons and a 2-dimensional electron detector. The later detector is build of 33 pixels of Si-PIN-diodes of 5*5mm^2 size, each equiped with independent readout chains. Coincidences are detected between the photon detector and the pixels of the electron detector as a function of the energy of the scattered photon. The coincidence rates were about 0.15Hz at 150mA storage ring current. The energy of the recoil electrons is 65.6 keV, thus reducing electron multiple scattering to a fraction of 8 % for the samples used in this experiment. After transformation of photon energy and pixel coordinates to momentum scale the intensities are proportional to the 3-dimensional EMD of the sample. The figure shows cuts of the 3D momentum distribution along directions p_z with $(p_x = p_x^o - 0.13\, p_z, p_y = 0)$.

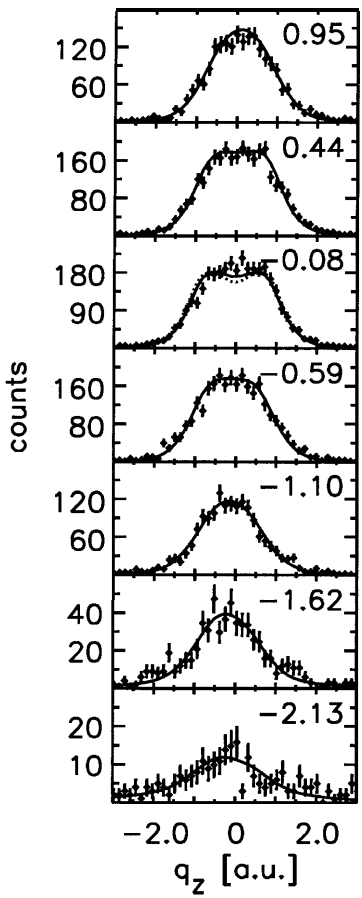

Figure : Cuts through the EMD for various values of $(p_x^o, p_y = 0)$. The solid and dotted lines represent theory.

The symbols correspond to data points and the solid line is the theoretical EMD which is averaged spherically. It includes the remaining electron multiple scattering and is convoluted with the resolution function. The theoretical distribution has been scaled to the data by a single scale factor only. Good agreement is obtained and a nearly flat plateau in the EMD around the origin $p_z = 0$ can be seen for small p_x^o. The same behaviour can be seen in the theoretical distributions, where the effect remains even after averaging and convolution as a consequence of the p-character of the bond for the T-electrons of graphite along the c-axis. The dotted line in the panel with p_x^0 = -0.08 corresponds to an EMD without convolution of the resolution function.

After having measured the full 3D-EMD of annealed laser-ablated carbon foils we wanted to improove the experimental situation, and here especially the integral countrates, by the use of two 2D-detectors. We replaced therefore in the second part of the experiment the Ge-detector with a methan-filled multi-wire proportional chamber used as a position sensitive photon detector [3]. Due to its only moderate energy resolution we intended not to measure photon energies, but to integrate over them and measure angular correlations between the compton-scattered photons and the recoil electrons. The result is proportional to the 2D-EMD which corresponds to 2D-ACAR measurements in positron annihilation. The large area $(\approx 3 \star 10^3 mm^2)$ compared to the single element Ge-detector increased the coincidence rate by a factor of 100, even though the efficiency of the MWPC for 100keV photons is only about 10 %. Because the electron detector covers for the different photon scattering angles seen by the MWPC a different volume in p-space the spectra have to be weighed by an efficiancy before they can be overlayed. First analysis of the data has shown reasonable results, but a further analysis is necessary to compare the results with theory or other experimental techniques.

References

[l] G. Dollinger, P. Maier-Kmorr, Nucl. Instr. Meth. A303, 50(1991)

[2] Lou Yongming, B. Johansson, R.M. Nieminen, J. Phys.: Condens. Matter 3, 1699(1991)

[3] H. Brauning et al., Annual Report 1995 IKF, Frankfurt, Germany