Measurement of the Fermi energy by the angular correlation of γ-radiation form annihilation of electron-positron pairs

One of the most fundamental properties of a metal is its Fermi energy as it determines together with the band structure the Fermi surface. By knowing the Fermi surface other fundamental magnetic and electronic features can be predicted. The most common methods to determine the Fermi surface and the Fermi energy are the de Haas-van Alphen effect (dHvA) and Angle Resolved Photo Emission Spectroscopy (ARPES). Both are experimentally very demanding: While dHvA-measurements requires high magnetic fields and low temperatures, ARPES will only work under ultra-high vacuum conditions.

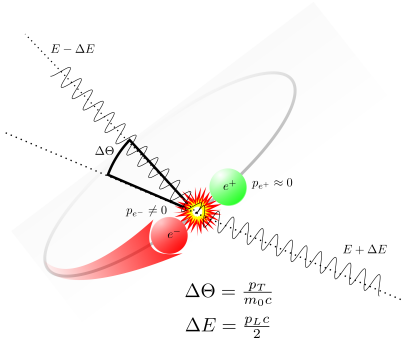

Fig. 1: A positron annihilates with an electron. The momentum is conserved by the two γ-Quanta.

A further method to determine the Fermi surface is the measurement of the Angular Correlation of electron-positron Annihilation Radiation (ACAR). With a little effort it is possible to get a 1D projection of the Fermi surface and to extract the Fermi energy by ACAR spectroscopy.
During this experiment you will build up a 1D-ACAR spectrometer by means of nuclear electronics and, using Python or LabView, you will write a small program to control the spectrometer. From the measurement, the Fermi energy of the specimen can be determined.

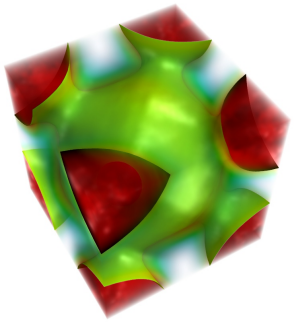

Fig. 2: Fermi surface of Cu measured with 2D-ACAR