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Modelling backscattered positron capture at the coincidence Doppler broadening spectrometer

Tuesday, 5 December 2023 14:00 (3 hours)

The coincidence Doppler broadening spectrometer (CDBS) at the MLZ provides state-of-the-art, depth dependent detection of defects and chemical composition at the annihilation site. A monoenergetic positron micro-beam (50 μm FWHM) is guided onto a sample where positrons may thermalise and annihilate with electrons. The Doppler broadening of the characteristic 511 keV annihilation peak is measured by observing both emitted photons simultaneously.
The measurement quality depends on the size and energy of the beam, both of which are monitored and controlled [1]. However, up to ~ 40% of the incident positrons are backscattered at the sample surface, resulting in a distribution of positrons with a large spread in energy and scattering angle. The annihilation events occurring when these backscattered positrons return to the sample or annihilate in experimental hardware contribute unwanted signal to the measured spectrum which cannot be removed in data processing.
We present simulations and hardware design for an upgrade to the CDBS which will allow backscattered positron capture. We use an in-house particle tracking code to design a positron dump that will capture backscattered positrons at a negatively biased electrode and will be shielded from detector lines of sight. This will remove the unwanted signal from the detected spectrum and improve the quality of CDBS data.
[1] Gigl, T. et al. (2017). New Journal of Physics, 19(12), 123007.

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