Upgrade of the NEPOMUC re-moderator

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The neutron-induced positron source Munich (NEPOMUC) provides a monochromatic low-energy positron beam with an intensity of $> 1 \cdot 10^9$ e^+/s [1] and a full width at half maximum (FWHM) diameter of about 10 mm. To create a small beam focus or sharp positron pulses of 100 ps FWHM the beam brightness needs to be enhanced by re-moderation. This is achieved by focusing the primary beam magnetically on a tungsten single crystal W(100) in reflection geometry. Afterwards the beam exhibits an intensity of $> 3 \cdot 10^7$ e^+/s and a diameter of less than 2 mm (FWHM) [2].
Based on the experiences with the remoderator setup, we redesigned and extended the existing construction to further optimize the beam quality with respect to intensity and beam brightness. The new design allows a replacement of the remoderator crystal within several minutes and without breaking the beamline vacuum. It enables, therefore, a systematic test of different remoderator materials. Additionally, it is possible to clean and anneal the crystal surface by heating in-situ through electric current. The new crystal holder system permits to move the remoderator with high accuracy in micrometer steps, which allows a positioning of the crystal surface precisely in the focus of the magnetic lens, resulting in an increase of the beam brightness. In addition, a fine metering valve can be used to treat the crystal surface with different gasses, e.g. atomic hydrogen or oxygen.

With the remoderator upgrade it was possible to increase the re-moderation efficiency and to raise both, the brightness and intensity of the remoderated NEPOMUC beam. The effects of the higher beam quality have been already detected in positron annihilation lifetime spectra obtained with the Pulsed Low-Energy Positron System PLEPS [3]. Here, the new setup leads to sharper pulses of $\leq$ 100 ps and a consequently better overall time resolution at higher beam intensities. Moreover, from the increase of the brightness also other applications benefit, e.g. the Coincidence Doppler-broadening Spectrometer [4] or the Scanning Positron Microscope [5], where the excellent phase space quality of the re-moderated beam is crucial for timing and a high spatial resolution. The increased beam intensity will further reduce the measurement time of all instruments. Additionally, we will present results of selected materials, which we have investigated with respect to their re-moderation properties.

References

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