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# A Scanning Positron Microscope for 3D defect mapping

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Positron annihilation lifetime spectroscopy (PALS) is a powerful tool for defect investigation at the atomic scale in a wide variety of materials. To investigate inhomogeneous defect distributions with PALS, for example in the vicinity of fatigue cracks or irradiated wall materials, it is necessary to employ a monochromatic pulsed positron beam of variable energy, with a diameter in the range of 1 μm and a pulse width of 150 ps FWHM.
To this aim, the Scanning Positron Microscope (SPM) [1-2] was developed and built at the Universität der Bundeswehr München. To overcome the limit of low count-rates in the laboratory the SPM has been transferred to the intense positron source NEPOMUC at the MLZ in Garching (FRM II) where it will be operated as a user facility.
A sophisticated beam preparation, including multiple remoderation steps, is needed to reach a lateral resolution in the micro-meter range. The SPM finally prepares a monochromatic pulsed positron beam suited for position resolved PALS measurements [3]. By varying the implantation energy and the position of the beam over an area of 1x1 $mm^2$ 3D-mapping of defect distributions down to ~250 nm below the surface becomes possible for the first time.
This contribution will provide a comprehensive overview of the SPM, with a focus on its future applications.

References:
[1] A. David et al., Phys. Rev. Lett. Volume 87, 067402 (2001)
[2] G. Kögel et al., Appl. Surf. Sci., Volume 116, Pages 108-113, (1997).
[3] J. Mitteneder, PhD Thesis UniBwM (2025).

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