Total Reflection High-Energy Positron Diffractometer at NEPOMUC

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Total Reflection High-Energy Positron Diffraction (TRHEPD) has been established as an ideal technique to determine the atomic positions of the topmost and immediate subsurface crystalline structure with highest accuracy [1]. Recently, the precise structure of the rutile-TiO_2 (110)-1x2 reconstructed surface - which has been under debate over the past 30 years - has been uncovered with the aid of TRHEPD [2]. Novel materials such as topological insulators or 2D materials can be investigated to determine not only the surface structure, but also the substrate spacing and potential buckling [3]. Moreover, the new approach of azimuthal analysis of the diffraction pattern might enable an even better separation of the signal that stems from different subsurface layers. However, up to now, there is just one TRHEPD setup available worldwide, which is located at the Slow Positron Facility (SPF) at the accelerator KEK in Japan.

We developed a new positron diffractometer coupled to the high-intensity positron source NEPOMUC at the research reactor FRM II in Munich. For the TRHEPD experiments, we plan to use the continuous, remoderated NEPOMUC beam, which has an intensity of ~ $5 \cdot 10^7$ e^+/s. The setup features an additional transmission-type remoderator using a 100nm thin Ni (100) foil to optionally further enhance the brightness. After the e^+ beam passes a magnetic field termination, it is electrostatically focused and accelerated up to 30keV energy (25keV for the twofold remoderated beam). We simulated the e^+ trajectories to optimize the system for different beam energies and for both, remoderated and twofold remoderated beam. The simulation for the focus onto the remoderator foil is shown in figure 1. After the twofold remoderation, we expect a slightly converging beam with a diameter of ~1mm on the MCP. The characterization of the e^+ beam and first experimental results are expected for summer 2019.

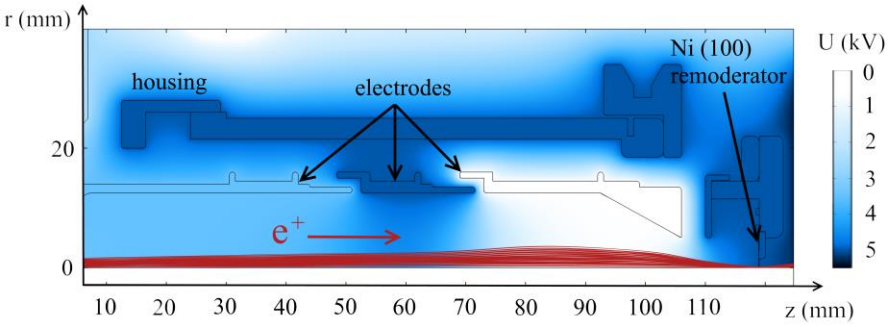

Figure 1
Simulation of the positron beam, that is focused onto the remoderator foil.

References

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