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Prospects for forward emitted positronium from nanoporous membranes

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We present ongoing efforts to characterize forward-emitted positronium (Ps) from transmission positron/Ps converters. Utilizing innovative silicon membranes with pass-through nanochannels [1], we aim to build upon recent developments within the AEgIS collaboration. Our focus lies on understanding the velocity distribution of forward-emitted Ps and its interaction with ultraviolet (UV) laser light, with implications for future studies on Ps Bose-Einstein condensates, laser cooling within nano-cavities, and enhanced antihydrogen formation.
Preliminary investigations have demonstrated promising results, indicating up to 16% of positron to Ps conversion in transmission configuration for membranes with thicknesses of only 3.5 um [2]. By varying membrane thickness, nanochannel size, and positron implantation energy, we aim to defining the optimal conditions for maximizing Ps yield and controlling its velocity distribution. Furthermore, our study aims to assess the absorption properties of UV laser light by our transmission converters, offering insights into potential strategies for Ps manipulation and cooling.
These efforts offer potential for improving antihydrogen beam formation at AEgIS by enabling collinear installation without downstream obstacles. This integration can also lead to an exponentially increasing formation cross-section due to the co-propagating antiprotons and Rydberg-positronium atoms. Moreover, the membrane, when attached to a flat silicon surface, allows for the construction of a buried cavity enabling studies on laser-cooled positronium through a membrane, setting the stage for future studies on Bose-Einstein condensates with Ps.

[1] B. Rienäcker, Creation and manipulation of positronium for efficient antihydrogen production at AEGIS, Dissertation 2021, https://nbn-resolving.org/urn/resolver.pl?urn:nbn:de:bvb:91-diss-20210528-1597479-1-5
[2] S. Mariazzi, B. Rienäcker, et al., Forward emission of positronium from nanochanneled silicon membranes, PRB 105, 115422 (2022), 10.1103/PhysRevB.105.115422

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