## Ortho-Positronium lifetime measurements with a new PET-like detector

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Positronium, as a simple leptonic system, allows us to make precise QED predictions on its properties, such as its lifetime. Second-order loop corrections to the ortho-Positronium decay rate have been calculated, predicting the lifetime up to the 1ppm level [1]. Compared to the state-of-the-art measurements [2] [3], the theory is two orders of magnitude ahead in precision. As the main limitations so far are of systematic as well as statistical nature, we propose a new experiment that partly combines previous methodologies to measure the ortho-positronium decay rate in vacuum. The main systematic improvements lay in the new method to account for the pick-off of an electron from the cavity walls, after which the ortho-Positronium decays into 2 photons prior to its vacuum decay. This method will be possible with the usage of a new PET-like detector with a fine spatial resolution, high time, and energy resolution. A new design of a spatial confinement cavity for the positronium will be used and has been tested [4]. This will allow to reduce the systematic error by at least an order of magnitude. The setup at the ETH pulsed high intensity positron beam, together with a dedicated tagging system, further allows to obtain the sought-after statistics, and with that to reduce the statistical uncertainty to the region of comparability to the state of art calculations.

The status of the detector, preliminary measurements with this detector, and the detailed plan will be presented.

## References

- [1] G. S. Adkins et al, Annals of Physics 295, 136–193 (2002).
- [2] R.S.Vallery et al, Phys. Rev. Lett. 90, 203402 (2003).
- [3] O. Jinnouchi et al, Physics Letters B, 572 1172 (2003).
- [4] P.Crivelli et al, arXiv 1005.4802 (2010).