BASE – testing fundamental symmetries by high precision comparisons of the fundamental properties of protons and antiprotons

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BASE is an international collaboration focused on testing CPT invariance by performing ultra-precise measurements of the fundamental properties of antibaryons and baryons.

In this talk, we will focus on our flagship experiment at CERN which is dedicated to measure the antiproton and proton magnetic moments. To date, determined these quantities with a fractional resolution of 1.5 p.p.b. [1] and 300 p.p.t. [2], respectively. We will report on the status of the current measurement campaign with the goal to improve the fractional accuracy of the antiproton magnetic moment by at least a factor of 10. An important ingredient is the development of a new cooling trap, which provides orders of magnitude improved cyclotron-mode cooling which resulted in error-free, non-destructive antiproton spin quantum transition spectroscopy [3]. Additionally, we will present the first implementation of coherent spin-state spectroscopy of a single antiproton spin, enabling measurements at 16-fold narrower line-width than in previous experiments. Finally, we will summarize the status of improved measurements.

Currently, the precision of our experiments is limited by magnetic noise in the accelerator hall. To overcome this limitation, we have developed an open Penning trap system, BASE-STEP [4], which will enable the transport of antiprotons to fully equipped offline laboratories at Heinrich Heine University Düsseldorf and CERN. In the stable environment of these new laboratories, we aim to achieve measurements at 100-fold improved precision.

Additionally, we are currently developing new measurement techniques that will allow us to continue operating the experiment in the accelerator hall. To that end, we will implement synchronized cyclotron frequency measurements on two-particles, simultaneously trapped on magnetron-locked orbits.

References

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