

# Improving frequency resolution in BASE

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The BASE collaboration at the antiproton decelerator facility of CERN is testing the Standard Model by comparing the fundamental properties of protons and antiprotons at lowest energies and with highest precision. Several world-record measurements have been performed in BASE such as the comparison of the antiproton-to-proton charge-to-mass ratio with a fractional precision of 69 parts per trillion [1], and the comparison of the proton/antiproton magnetic moments with a fractional precision of 1.5 parts per billion [2].

With the recent implementation of direct cyclotron frequency measurements and phase sensitive detection methods, we've reached frequency resolutions with a shot-to-shot fluctuation on the level of about 300 parts per trillion [3]. These limits are imposed by drifts and fluctuations of environmental laboratory parameters such as the temperature, pressure variation in the cryoliquid recovery lines and fluctuations in the external magnetic field in the AD-hall.

The goal of this project is the implementation of advanced stabilization systems such as an active pressure stabilization for the superconducting magnet, for both the LN2 and LHe vessel. Moreover, a mechanical decoupling of the cryogenic experiment stage from the experiment cryostats and an interferometric stabilization of the experiment stage will be implemented. In addition, the laboratory temperature will be actively stabilized, with the goal to overcome the current limits in frequency measurements induced by fluctuations in the environmental conditions and to perform improved measurements of fundamental antimatter constants on the parts per trillion level.

[1] S. Ulmer et al., Nature 524, 196 (2015).

[2] C. Smorra et al., Nature 550, 371 (2017).

[3] M. Borchert, PhD Thesis (2021).

**Primary author:** JÄGER, Julia Ines (RIKEN, CERN, Max Planck Institute for Nuclear Physics)

**Co-authors:** BORCHERT, Matthias Joachim (RIKEN, Leibniz Universitaet Hannover, Physikalisch-Technische Bundesanstalt); DEVLIN, Jack (RIKEN, CERN); ERLEWEIN, Stefan (RIKEN, CERN, Max Planck Institute for Nuclear Physics); FLECK, Markus (RIKEN, University of Tokyo); LATACZ, Barbara (RIKEN); MICKE, Peter (RIKEN, CERN); NUSCHKE, Phil (RIKEN, Leibniz Universitaet Hannover); UMBRAZUNAS, Gilbertas (RIKEN, ETH Zurich); VOLKSEN, Frederik (RIKEN, GSI-Helmholtzzentrum fuer Schwerionenforschung GmbH); WURSTEN, Elise (RIKEN); ABBASS, Fatma (Institute for Physics, JGU Mainz); BOHMAN, Matthew (RIKEN, Max-Planck-Institute for Nuclear Physics); MOOSER, Andreas (RIKEN, Max Planck Institute for Nuclear Physics); POPPER, Daniel (Johannes Gutenberg Universitaet Mainz); WIESINGER, Markus (RIKEN, Max-Planck-Institute for Nuclear Physics); WILL, Christian (Max-Planck-Institute for Nuclear Physics); BLAUM, Klaus (Max-Planck-Institute for Nuclear Physics); MATSUDA, Yasuyuki (University of Tokyo); OSPILKAUS, Christian (Leibniz Universitaet Hannover, Physikalisch-Technische Bundesanstalt); QUINT, Wolfgang Peter (GSI - Helmholtzzentrum fuer Schwerionenforschung GmbH); WALZ, Jochen (Institut für Physik, JGU Mainz, Helmholtz-Institut Mainz); YAMAZAKI, Yasunori (RIKEN); SMORRA, Christian (RIKEN, Institute for Physics JGU); ULMER, Stefan (RIKEN)

**Presenter:** JÄGER, Julia Ines (RIKEN, CERN, Max Planck Institute for Nuclear Physics)

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