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New beam-preparation techniques for the CERN-AD experiment on Gravitational Behavior of Antimatter at Rest (GBAR)

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The GBAR experiment, recently approved at the CERN AD facility, is designed to perform a direct test of the weak equivalence principle on antimatter by measuring the acceleration of anti-hydrogen atoms in the gravitational field of the Earth. GBAR will complement other experiments with antimatter by synthesizing Hbar+, to facilitate its manipulation.

Hbar+ will be obtained by two successive reactions with positronium (Ps). This requires a high-density Ps cloud as a target for antiprotons in the keV range. The Ps target will be produced by a pulse of over 10 billion positrons impinging on a converter.

GBAR is developing two novel approaches for preparation of the ingredient beams. One is the electrostatic deceleration of the 100-keV antiproton beam from the CERN-ELENA facility, avoiding a degrader foil and accumulation trap. The other is the use of an electron linac to produce positron bunches, avoiding a radioactive source. The positron bunches are accumulated in a Penning-Malmberg trap using an energy-bunching technique and cooled by a pre-loaded electron cloud.

Theoretical modeling of the Hbar+ reaction cross-section (see contribution by P. Comini et al.) predicts different possibilities that depend on incident antiproton energy and laser excitation of the Ps target. The antiproton decelerator will use a fast pulsing of a drift tube cavity and allow a tuneable antiproton energy to optimize the production of Hbar+.

Details of these concepts and preliminary results will be presented.

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