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Pulsed production of antihydrogen at AEgIS for gravity measurements

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The AEgIS experiment is an international collaboration based at CERN aiming at measuring the free fall of antihydrogen in the Earth's gravitational field. To this end, AEgIS makes use of a charge exchange reaction where a cold antiproton plasma stored in a Pennning trap is exposed to a pulsed cloud of positronium atoms prepared in highly excited Rydberg states. Positronium (the bound state of an electron and a positron) is transferred to Rydberg states by two-photon resonant laser excitation which strongly enhances the probability to transfer a positron from positronium to the antiproton and form antihydrogen.
With this scheme, AEgIS recently demonstrated the first pulsed production of antihydrogen with an uncertainty of 250ns in the production time. This achievement is a milestone on the AEgIS roadmap towards measuring gravity on antihydrogen which is based on the use of an antiatomic deflectometer. In this scheme, a pair of transmissive gratings selects atoms with a well-defined velocity component in the plane orthogonal to the direction of the gravitational pull. The deflection of the fringe pattern created by the deflectometer is proportional to the gravitational pull and to the square of the time-of-flight of the atoms.
AEgIS is now focusing on increasing the antihydrogen production yield. A record high 50% antiproton trapping efficiency was demonstrated with the newly commissioned ELENA (Extremely Low ENergy Antiproton) decelerator. In addition to this development, a new geometry for the charge exchange reaction avoiding the self-ionization of high Rydberg states by motional Stark effect in a strong magnetic field has been designed as well as many other improvements over the recent long shutdown period without antiproton beamtime. Among others, the production trap electrodes have been upgraded to reach colder antiproton plasmas temperature and the laser path has been redesigned to avoid depositing energy and desorb gas from the trap's wall in the production trap area.
We will present the AEgIS experiment and report on recent achievements as well as future plans to measure the free fall of antihydrogen at AEgIS.

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