The new positron beam line of the GBAR experiment at CERN

L. Liszkay[1*]
for the GBAR collaboration

[1]*IRFU, CEA, University Paris-Saclay, 91191 Gif-sur-Yvette Cedex, France*

The aim of the GBAR experiment is to measure the gravitational acceleration of antihydrogen, the simplest anti-atom formed by an antiproton and a positron. Direct measurement of the acceleration requires anti-atoms at extremely low temperature, well below the limit of cooling neutral particles. The distinctive idea behind GBAR is to cool positively charged antihydrogen ions with the help of laser-cooled ordinary matter atoms in several steps to the 10 microkelvin range. The cold anti-ion is then neutralized by photodetachment of a positron and the time until annihilation on the wall of the experimental chamber is measured to determine the acceleration. Antihydrogen ions are created in two consecutive reactions in a dense positronium cloud. Positrons are generated by a 9 MeV linear energy accelerator (linac), slowed down and shortly stored in a buffer gas trap and accumulated in a 5T multi-ring Penning-Malmberg trap. The accumulated particles are ejected from the trap, accelerated to 4 keV and implanted into a positron-positronium conversion target, placed in a magnetic field free target chamber. The conversion target is a thin mesoporous silica film, deposited on silica single crystal. The new ELENA facility at CERN supplies antiprotons at 100 keV kinetic energy for the experiment. GBAR will add later a Penning-Malmberg trap to optimize the antiproton pulses. A proton source is installed to test the beamline and measure the cross section of the matter equivalent of the relevant reactions.

The experimental setup has been installed in the AD Hall at CERN. The linac, the positron beamline and the two positron traps are operational and we demonstrated efficient positronium creation in the conversion target. The experimental setup has been shortly tested with antiproton pulses from the ELENA antiproton decelerator ring. During LS2 (Long Shutdown 2, until 2021) we will improve the positron line, install the antiproton trap and measure reaction cross sections using the GBAR proton source.

We present the experimental setup and discuss the performance of the positron beamline.

References

[1] P. Perez et al., Hyperfine Interactions 233, 21 (2015)

*Corresponding author, Email: laszlo.liszkay@cea.fr