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The development of the antihydrogen beam detector and the detection of the antihydrogen atoms for in-flight hyperfine spectroscopy

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Synopsis We have been developing ground-state antihydrogen atomic beams to test CPT symmetry via in-flight hyperfine spectroscopy. A new antihydrogen beam detector has been developed. The overview of the experiment, the detail of the detector and latest results will be presented.

We have been developing ground-state antihydrogen ($\bar{\mathrm{H}}$) atomic beams to test CPT symmetry via in-flight hyperfine spectroscopy [1,2]. Figure 1 shows schematic view of the main part of our experimental setup which consists of the double cusp trap, a microwave cavity, a sextupole magnet, and a new $\bar{\mathrm{H}}$ beam detector.

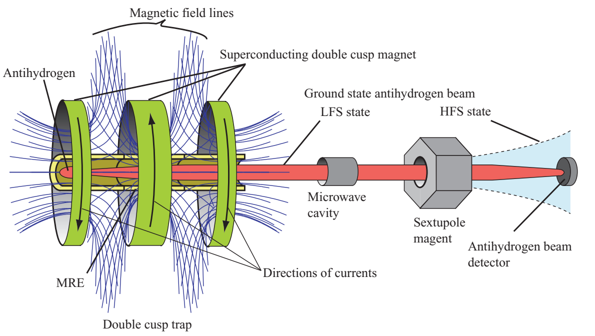

Figure 1. Schematic view of our experimental setup

We have been created $\bar{\mathrm{H}}$ atoms in the double cusp trap and tried extracted to the downstream of the trap. From our simulations, $\bar{\mathrm{H}}$ atoms were polarized to low field seeking (LFS) state in the magnetic field and transported as a beam well characterized by a focal length with a thin lens formula [3,4]. The polarized beam passes through the cavity and the sextupole magnet, and is focused on the $\bar{\mathrm{H}}$ beam detector. The $\bar{\mathrm{H}}$ atoms change their polarizations by spin-flip and are defocused on the detector when we apply the microwave tuned to the hyperfine frequency in the cavity. Therefore we can determine the hyperfine frequency by counting the number of $\bar{\mathrm{H}}$ atoms detected as a function of the microwave frequency.

The detector consisted of a BGO calorimeter and a hodoscope. The BGO crystal ($9\mathrm{cm}\phi \times 0.5\mathrm{cm}^{\mathrm{t}}$) was placed in UHV. The photons created by the charged particles in the BGO were detected by 4 multi-anode PMTs (256ch). We succeeded to measure the two-dimensional energy distribution by this setup without the segmentation of the BGO. This detector realize to be a two-dimensional calorimeter. The hodoscope surrounded the BGO calorimeter and was composed of 2 layers of 32 scintillator bars. The overview of the experiment, the detail of the detector and latest results will be presented.

References

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