Performance of the ATRAP Experiment at CERN in 2008

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The goal of the ATRAP experiment at the anti-proton decelerator AD of CERN is to study the physics of cold antihydrogen ($\bar{H}$) atoms. For this reason ground-state $\bar{H}$ atoms have to be confined in magnetic traps for e.g. a test of the CPT invariance by the comparison of hydrogen (H^0) to antihydrogen ($\bar{H}^0$) atom spectroscopy and a measurement of the gravitational force on antimatter atoms.

The investigations in 2008 concentrated on significant improvements of the second experimental set-up (called BTRAP) in the second generation facility of the ATRAP collaboration (ATRAP-II). The complete apparatus as being moved from the place of assembly to the super-conducting solenoid is shown in Fig. 1, with the photo of the pin-base underneath the $\bar{p}$ solenoid in Fig. 2.

Fig. 1: The BTRAP-experimental set-up showing (from top to bottom) the liquid He dewar, the xy-table, the Ioffe-trap, and the new $\bar{p}$ solenoid.

Fig. 2: Photo of the pin-base before the $\bar{p}$ solenoid is mounted.

The construction of the $\bar{p}$ solenoid, adding a magnetic field of up to 5 T to the main magnetic field when being operated at 89 A, provided a drastic increase in loading $\bar{p}$'s. Using for safety reasons only 54 A (additional 3 T to the main field of 1 T) a gain factor of up to five was observed depending on the electrical field profile of the electrodes. Thus with the new $\bar{p}$ solenoid the main magnetic field could be kept at a rather low value in favor of an effective deeper Ioffe-trap potential.

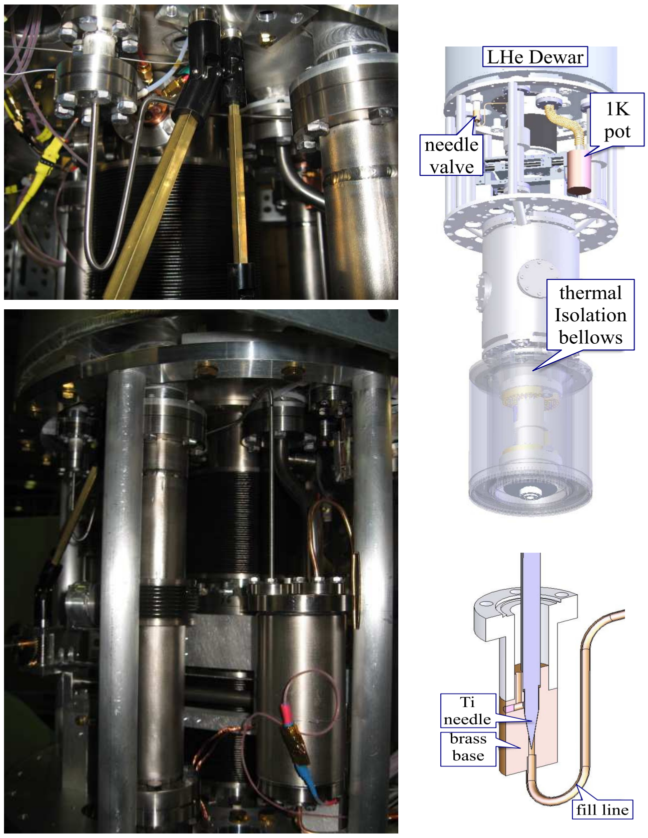

Fig. 3: Photo and technical drawing of the 1 K pot arrangement in BTRAP.

As demonstrated in Fig. 3 via photos and technical drawings a 1 K pot has been added to the BTRAP apparatus and has been successfully operated during the last year. Via pumping through a needle valve the 4K liquid He in the 250 cc pot is cooled to a temeperature of 1.1 ± 0.02 K. This improvement should provide lower temperature $\bar{p}$'s and subsequently lower temperature $\bar{H}$ atoms, necessary to keep them in the Ioffe-trap for times long enough for experiments.

Extensive plasma shape studies of e^- and e^+ clouds have been investigated taking advantage of the low temperature. As one example: using 20 eximer laser shots up to 40×10^6 e^+ were loaded during a continuous change of the electrical well in steps of 1 V/s up to a final value of 75 V. It has been observed that the plasma shape changes on the history of its loading. Different cloud shapes ranging from an axial ratio from α = 0.3 (pancake structure) to α = 2.2 (cigar shape) could be created, a very important step for achieving an optimal overlap between clouds of e^- and $\bar{p}$ to produce cold $\bar{H}$ atoms.