

# Cryogenic Particle Accumulation for ATRAP Antihydrogen Experiments

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ATRAP antihydrogen experiments continue to advance toward our eventual goal of producing large numbers of antihydrogen atoms for trapping and a spectroscopic comparison between matter and antimatter. Antihydrogen atoms are made from their charged constituents (positron and antiprotons) confined within a cryogenic Penning trap. Antihydrogen will be trapped in an Ioffe trap consisting of a radial quadrupole magnetic field with increased axial field at the ends from aligned coils. To allow for trapping of a significant fraction of antihydrogen produced the strength of the axial magnetic field for charge particle confinement must be reduced. This reduced Penning trap magnetic field brings new challenges for charged particle confinement and cooling in the Penning trap.

In spite of these challenges our ATRAP collaboration has increased the number of charge particles for antihydrogen production and produced atoms in the magnetic fields from the Ioffe trap. Positron from a  $^{22}\text{Na}$  radioactive source are accumulated in a room temperature Penning trap, accelerated by electric fields, guided by magnetic fields and enter from above into the cryogenic apparatus for antihydrogen production. Antiprotons are produced in collisions with high energy protons from the accelerators at CERN incident on a target. These particles are slowed in CERN's antiproton decelerator and are provided in bunches of 30 million particles every 100 seconds. These particles enter our cryogenic apparatus from below and are further slowed as they pass through a degrader foil within the cryogenic apparatus. For further cooling to cryogenic temperatures both antiprotons and positrons are cooled by collisions with electrons in separate Penning trap wells.

In this talk I will describe the techniques used for accumulation of antiprotons, positrons and cooling electrons which have led to our recent antihydrogen production within the magnetic field gradient for eventual antihydrogen trapping.