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Improved positron loading for antihydrogen research

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Positrons (e^+) for ATRAP antihydrogen studies are provided by a Surko-style room-temperature Penning trap with N_2 buffer gas. (e^+) emitted in radioactive decay of ^{22}Na are thermalized in a solid neon moderator. A short section of magnetic guide steers the e^+ to the axis of the Penning trap where interactions with N_2 molecules cool them into the bottom of the well where a rotating electric field compresses the accumulating cloud of e^+. e^+ are accumulated for approximately 30 s then accelerated by an electric field and launched into a magnetic guide that maneuvers the e^+ through a 15 degree bend and 5m of vacuum tube to a point 2m above the cryogenic Penning trap. The e^+ are mostly guided down the last 2m of the vacuum tube by the fringing field of the superconducting solenoid which houses the cryogenic Penning trap for antihydrogen research. The fringing field also radially compresses the e^+ so that they may pass through a 1.5mm diameter pumping restriction necessary to maintain the ultrahigh vacuum required for long term antimatter storage in the Penning trap. A barrier voltage is momentarily pulsed down to allow the e^+ into the Penning trap where collisions with electrons and synchrotron radiation rapidly cool the e^+. Additional accumulations are launched, guided and loaded into the cryogenic Penning trap to achieve the high numbers of e^+ required for antihydrogen experiments or lepton studies. Large number of e^+ (> $1x10^9$) can be loaded into the cryogenic Penning trap at a rate over $10^4 e^+$/s/mCi

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