New Adventure in Gaseous Positronics - A Cryogenic Beam

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Buffer-gas-trap based beams have proven a reliable workhorse to study positron scattering and annihilation. The state of the art beam has a total energy spread ~ 40 meV FWHM using 300 K gas. Described here is work to create beams with narrower energy spreads (goal: total spread ≤ 5 meV FWHM using 50 K buffer gas). A Born-approximation model is used to describe cooling on vibrational and rotational excitations. Positron cooling from 1,200 K to 300 K was studied for CF$_4$, N$_2$ and CO to obtain the relevant cross sections (by fits to the model) and then predict cooling to 50 K. Using an additional cryogenic trapping stage, positrons have now been cooled to 50 K on N$_2$ and CO. Since the beam is generated in a magnetic field, the total energy spread is characterized by spreads parallel and perpendicular to the field. While the perpendicular temperature is 4 meV (i.e., kT at 50 K), the parallel energy spread is larger. The currently projected total spread is ≤ 10 meV FWHM - a factor of four better than the 300 K result. Work is in progress to reach the predicted total spread at 50 K of 5 meV FWHM.

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$^2$In collaboration with M. R. Natisin and J. R. Danielson.

