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New Adventure in Gaseous Positronics - A Cryogenic Beam[1]

C.M. SURKO[2], University of California, San Diego

Buffer-gas-trap based beams have proven a reliable workhorse to study positron scattering and annihilation.[3] The state of the art beam has a total energy spread $\sim$ 40 meV FWHM using 300 K gas. Described here is work to create beams with narrower energy spreads (goal: total spread $\leq$ 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.[4] 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.[5] 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 $\leq$ 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.
[3]J. R. Danielson, et al., Rev. Mod. Phys. 87, 247 (2015).
[4]M. R. Natisin, et al., J. Phys. B 47, 225209 (2014).
[5]M. R. Natisin, et al., Phys. Plasmas 22, 033501 (2014).