

**Accumulating Positrons  
in an  
Ion Trap**

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by

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# Abstract

## Accumulating Positrons in an Ion Trap

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A Penning trap which accumulates positrons in a cryogenic, ultra-high vacuum has been demonstrated. Positrons from a 10 mCi sodium-22 source are moderated by a carefully prepared tungsten (110) crystal and enter the trap through an entrance tube in the endcap electrode. Due to the electric potentials at the entrance aperture and the positrons' magnetron motion, a fraction of the moderated positrons dissipate sufficient energy in a damping circuit to be trapped. After positrons have accumulated for some time, they are moved to the center of the trap via magnetron sideband cooling and counted non-destructively by their interaction with the circuit. With optimal adjustment of the experimental parameters, 0.2 positrons are accumulated per second, which is near the expected performance for this apparatus. Accumulation of more than  $3.6 \times 10^4$  positrons at one time has been demonstrated; the cryogenic vacuum and trap stability should allow positrons to accumulate indefinitely, limited only by trap capacity (more than three orders of magnitude higher in this case). The design and high vacuum operation of this trap make it easily compatible with existing ion traps, opening the way for low-temperature antihydrogen production and for ion cooling applications. Modifications in trap design and moderator preparation which could lead to substantially higher trapping rates are discussed.

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## Publications during Ph.D. study

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2. "Antihydrogen Production with Cold Trapped Plasmas,"  
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*Phys. Lett. A* **129**, 38 (1988).
3. "Electrical Resistivity and Thermopower of the Liquid Alloy MgZn,"  
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*J. Phys: Condens. Matter* **1**, 2923 (1989).
4. "Open-endcap Penning Traps for High Precision Experiments,"  
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5. "Cylindrical Penning Traps and Self-Shielding Superconducting Solenoids for High Precision Experiments,"  
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*Physica Scripta* **46**, 264 (1992); *RPS* **20**, 44 (1993).
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9. "Extremely Cold Antiprotons for Antihydrogen Production,"  
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