DEVELOPMENT OF A SLOW-POSITRON SOURCE

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We study positron cooling of highly charged ions, in which a large number of positrons must be stored in an electromagnetic trap.[1)] In order to capture positrons with high accumulation rate, a high-intensity slow positron source is under development.[2)]

Slow positrons are produced through moderation of fast positrons from a β^+ decay radioisotope. The energy spread of slow positrons so prepared are typically a few eV. In our study, the combination of a ^{22}Na radioactive source (1.5GBq) and a solid neon (Ne) moderator is used.[2)]

Rare gas solids, especially solid Ne, are well known to be efficient moderators for positrons. Fast positrons injected into a moderator lose their energy via collisions till their energies reach the lowest electronic excitation energy of Ne (~16eV). Below this energy, the energy loss rate drastically decreases because only phonon excitation processes can contribute to the energy loss. Because of this, the diffusion length of these positrons get as long as ~um and a considerable fraction of them are ejected into the vacuum as slow positrons.[3-4)] A efficiency of a solid Ne moderator, which is defined by the ratio of the number of extracted slow positrons to the number of β^+ decays of the radioisotope, is typically ～0.5%[5)]. Slow positrons with an intensity of $7*10^6$ /sec are expected to be available with the 1.5GBq ^{22}Na.

Figure 1 shows a drawing of the positron source assembly. An encapsulated ^{22}Na positron source is mounted on the top of a refrigerator and is cooled down to 5K so that a solid rare gas moderator is formed on the front surface of the source. Slow positrons are accelerated with electrodes in front of the source.

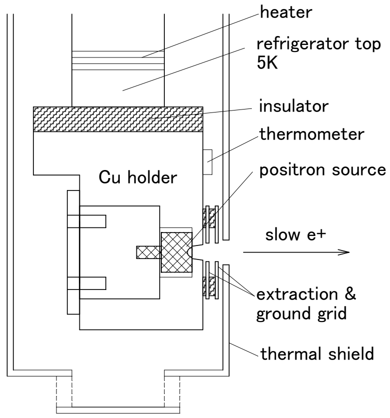

Figure 1: Drawing of a slow positron source assembly.

A schematic drawing of the positron beam line is shown in Fig.2. The solenoid and coils installed along the beam line yield an axial magnetic field of about 10mT and guide the slow positrons. The beam profile is observed by a multi-channel plate (MCP). The beam intensity is evaluated by the count rate of the annihilation

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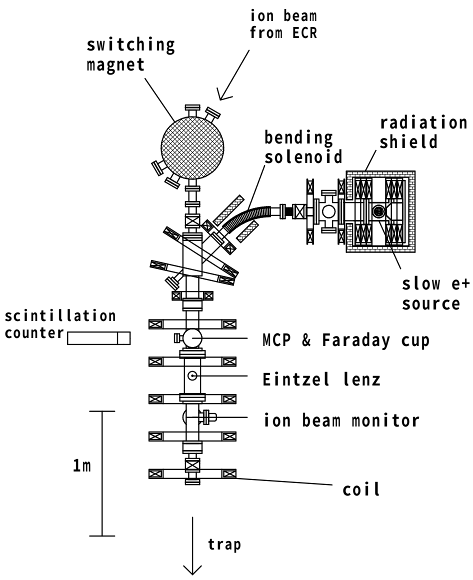

Figure 2: Constructed slow positron beam line. A positron beam profile can be measured by an MCP and a beam intensity is evaluated by the count rate of the positron annihilation gamma rays.

gamma rays of positrons, which is measured by a scintillation counter.

A profile of the extracted beam observed by the MCP is shown in Fig.3. The beam intensity was $1.5*10^{6}$/sec and then, moderation efficiency was determined to be $1.0*10^{-3}$. This moderation efficiency is still 20% of the one in reference 5). In order to improve the moderation efficiency, we are redesigning of the positron source assembly.

Figure 3: Positron beam profile observed by an MCP. The MCP active diameter is 10mm.

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