RELOCATION OF THE KEK SLOW-POSITRON FACILITY

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Abstract

The KEK slow-positron facility, aiming at the use of slow-positron beams (ranging from eV to keV) in various fields of solid-state physics, is now undergoing a relocation process to the 1.5-GeV point of the upgraded linac relevant to the KEKB project. A dedicated linac for slow-positron use is also installed utilizing the remnants of the 2.5-GeV linac reformation. We expect a slow-positron intensity of more than 10^8 positrons/sec with a maximum primary beam power of 1 kW.

1 INTRODUCTION

A positron beam is a useful probe for investigating the electronic states in solids, especially concerning the surface states. However, such studies, as low-energy positron diffraction, positron microscopy and positronium spectroscopy, are very limited due to the poor intensity obtained from a conventional radioactive-isotope-based positron source. We, therefore, investigated accelerator-based slow-positron sources [1-6], and constructed the KEK-PF slow-positron facility [7,8], aiming to produce more than 2×10^9 e^+/s slow-positrons, utilizing our 2.5-GeV electron linac [9,10] as its primary beam source.

At the very initial stage of its performance tests, the observed positron yield was 1/20 of the estimated value [8]. This discrepancy was thought to be due to the condition of the moderator, since we put the moderator into the target-moderator chamber without performing any thermal treatment. An excellent improvement in the positron yield was achieved by annealing of the moderator assembly (tungsten foils) at 2270 K for 10 minutes under ultra-high-vacuum conditions. A slow-positron flux of 1×10^8 e^+/s was successfully achieved with a 2.0-GeV, 2-kW primary electron beam power.

The energy of the positron beam was successfully varied from 400 eV to 40 keV by applying a voltage to the high-voltage station at the initial part of the slow-positron beam-transport line.

A slow-positron beam with a beam energy of 800 eV was successfully switched from one direction to another utilizing the slow-positron beam-switch system. We can therefore supply slow-positron beams to several experimental stations without any waste of time.

Penning-trap electrodes were successfully operated in order to make a dc positron beam from a pulsed primary electron beam.

Although we had opened this facility to slow-positron users[11,12], we had to relocate our facility relevant to the upgrade plan of the KEK 2.5-GeV linac. There are two major goals of the upgrade [13,14]: 1) to increase the energy of electrons and positrons to 8 and 3.5 GeV, respectively, and 2) to increase the bunch intensities of positrons by roughly one order. In accordance with this upgrade plan, we must relocate our KEK-PF slow-positron facility to the 1.5-GeV point of the upgraded linac (the KEKB J-linac ; see fig.1).

We describe here the relocated KEK-PF slow-positron facility.

2 LAYOUT OF THE RELOCATED KEK-PF SLOW-POSITRON FACILITY

There are two primary-electron-beam sources for our slow positron facility; the 1.5-GeV beam of the KEKB linac and the test linac. The nominal beam power of the 1.5-GeV beam is 0.75 kW (an energy of 1.5 GeV, charge of 10 nC, a pulse length of 10 ps and a pulse repetition rate of 50 pulse/s). Since the injection interval of the J-linac for the KEKB rings might be relatively short, a dedicated linac for slow positron use only (the test linac) was installed utilizing the remnants of the J-linac upgrade plan. An average beam power of 1 kW can be expected from the test linac.

Figure 2 shows the relocated KEK-PF slow-positron facility, which locates at the 1.5-GeV point of the KEKB J-linac. It comprises beam lines for the primary electron beams, a target-moderator assembly, a slow-positron beam-transport line and relevant assemblies.

The primary electron beam is injected into the target. The extracted slow-positron beam is directed by a 30-m long beam-transport line with an axial magnetic field of 100 G to an experimental area. Twelve sets of steering coils were installed along the slow-positron beam-transport line in order to adjust the slow-positron beam trajectory. A high-voltage station capable of applying 60 kV was installed in order to vary the energy of the positron beam. A device controller, combining a personal computer and a programmable sequence controller through optical fiber, has been adopted to control the monitors and power supplies at a high-voltage potential. Penning-trap electrodes are also installed at this station in order to make a dc beam from a pulsed beam.

At an experimental area, a slow-positron beam switch system, which comprises a pair of beam deflecting coils and two pairs of Helmholtz coils with magnetic-field directions crossing each other, was installed. This system enables us to direct slow-positron beams to several experimental stations one by one without breaking the vacuum.

As for the beam monitors, channel-electron multipliers (CEM) for the beam intensity and micro-channel plates (MCP) for the beam profile are intensively used.

3 PRESENT STATUS

Almost all components of the KEK-PF slow-positron facility were relocated. The accelerating structures and necessary magnets of the test linac have already been installed in the linac tunnel.

The comissioning of the slow positron beam is planned to start from this April. We expect a slow-positron intensity of more than 10^8 positrons/sec utilizing the 1.5-GeV J-linac beam as its primary beam source.

4 FUTURE PLAN

In order to produce more than 10^9 e^+/s slow-positrons in our slow-positron facility, it is necessary to reinforce its primary beam source. If we add another two accelerating units to the present test linac, we will be able to achieve this positron intensity utilizing a beam power of 6 kW from the upgraded test linac.

5 SUMMARY

The KEK slow-positron facility was relocated to the 1.5-GeV point of the KEKB J-linac relevant to the KEKB project. A dedicated linac for slow-positron use is also installed utilizing the remnants of the KEKB J-linac upgrade plan. We expect a slow-positron intensity of more than 10^8 positrons/sec with a maximum primary beam power of 1 kW.

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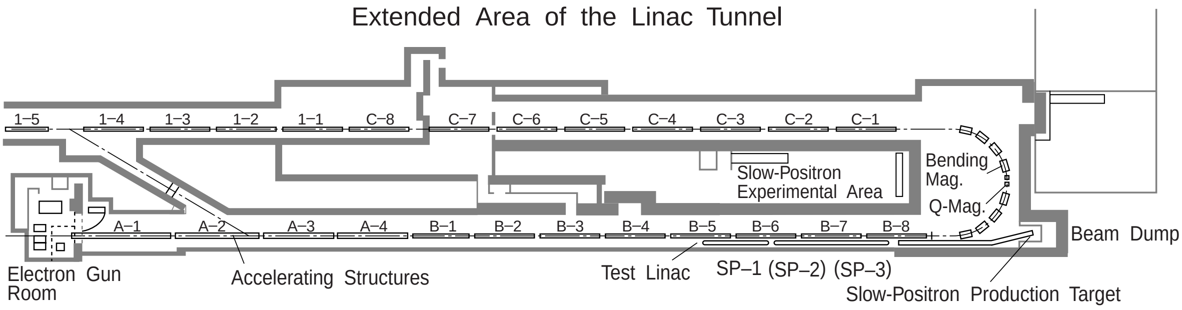

Figure 1. Extended area of the KEKB J-linac.

The extended area of the J-linac comprises three sectors (A, B and C). The positron production target chamber locates at the beam dump of the J-linac. A dedicated linac for slow-positron use is installed at sector-B just beside the J-linac.

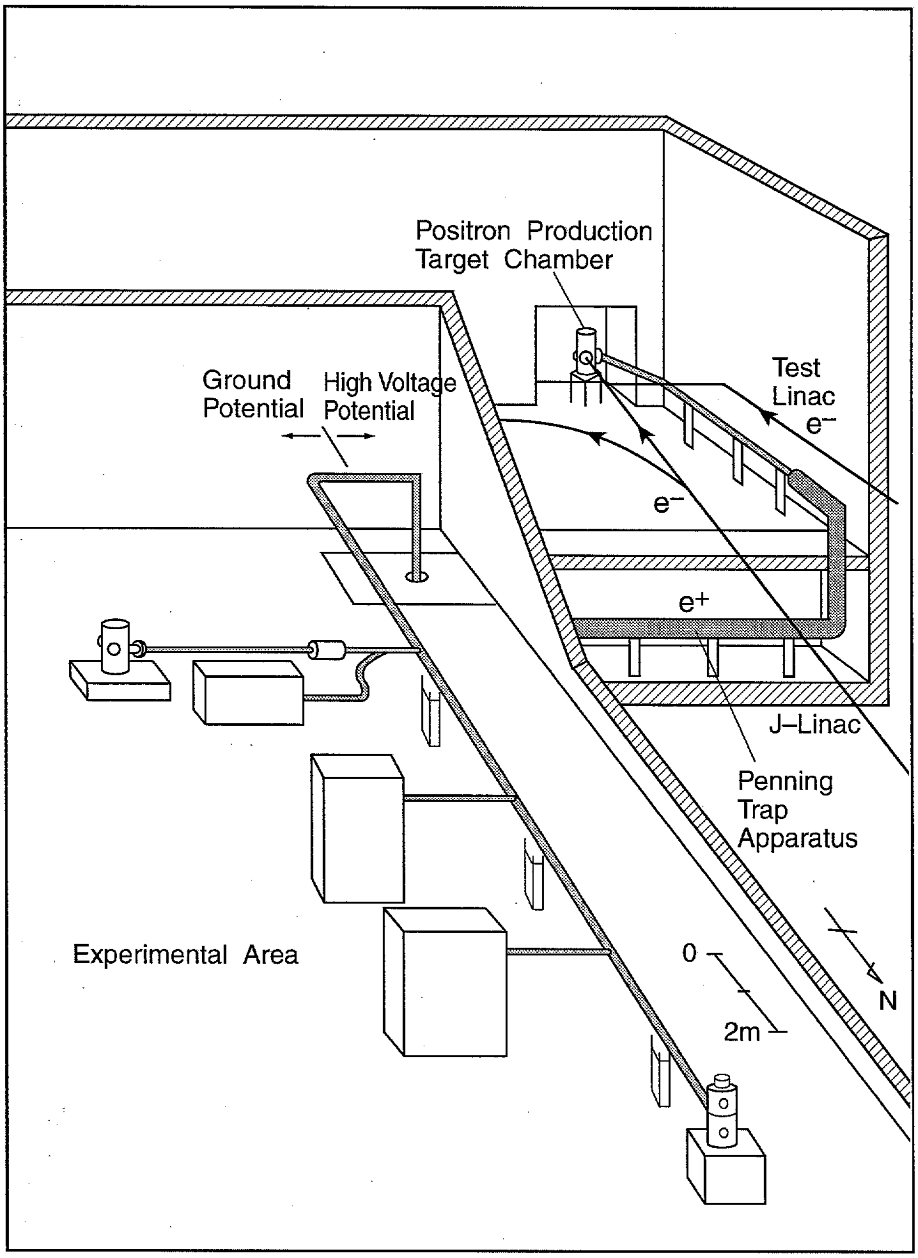

Figure 2. Bird's-eye view of the KEK slow-positron facility.

It comprises beam lines for the primary electron beams, a target-moderator assembly, a slow-positron beam-transport line and relevant assemblies.