A 50-MEV ELECTRON LINAC FOR THE KEK SLOW-POSITRON FACILITY


Abstract
A 50-MeV electron linac is constructed as a primary beam source for the production of slow-positron beams at the KEK slow-positron facility. This linac comprises a gun, a pre-buncher, a buncher and a 4-m accelerating structure with a 40-MW klystron unit. Utilizing a 1-kW electron beam, more than one hundred million slow positrons per second will be available in various fields of solid state physics.

1 INTRODUCTION
A positron beam is a useful probe for investigating the electronic states in solids, especially concerning the surface states and defect distribution. However, such studies, as low-energy positron diffraction, positron microscopy, positron remission 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 slow-positron facility [7, 8], utilizing our 2.5-GeV electron linac [9, 10] as its primary beam source.

Although we had opened this facility to slow-positron users [11,12], we had to relocate our facility to the south of our linac, relevant to the upgrade plan of the KEK 2.5-GeV linac. The upgraded linac (the KEKB linac) supplies 8-GeV electron and 3.5-GeV positron beams to the asymmetric collider KEKB [13-15]. There is a heavy competition between the KEKB and the PEPB, the KEKB linac is and will be almost fully occupied by the continuous (top-up) injection to the KEKB rings in order to achieve a possible maximum luminosity. We therefore decided to install a 50-MeV electron linac as a dedicated primary electron beam source for the KEK slow-positron facility utilizing the remnants of the KEK 2.5-GeV linac. We describe here this 50-MeV electron linac and our slow-positron facility.

2 KEK SLOW-POSITRON FACILITY
The KEK slow-positron facility consists of a 50-MeV electron linac as a primary beam source, a target-moderator assembly, a slow-positron beam-transport line and relevant assemblies. The 50-MeV linac comprises a gun, a pre-buncher, a buncher and a 4-m accelerating structure with a 40-MW klystron unit. This linac can supply a 1-kW long and a 100-W semi-long beams to the positron production target. Characteristics of the 50-MeV linac are listed in Table 1. Utilizing a 1-kW electron beam, more than one hundred million slow positrons per second will be achievable.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Long</th>
<th>Semi-long</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beam energy</td>
<td>25 MeV</td>
<td>50 MeV</td>
</tr>
<tr>
<td>Pulse length</td>
<td>2 µs</td>
<td>20 ns</td>
</tr>
<tr>
<td>Beam current</td>
<td>400 mA</td>
<td>2 A</td>
</tr>
<tr>
<td>Pulse repetition</td>
<td>50 pulses/s</td>
<td>50 pulses/s</td>
</tr>
<tr>
<td>Beam power</td>
<td>1 kW</td>
<td>100 W</td>
</tr>
<tr>
<td>Positron intensity</td>
<td>10*8 positrons/s</td>
<td>10*7 positrons/s</td>
</tr>
</tbody>
</table>

The primary electron beam is injected into the target. The extracted slow-positron beam is directed by a 10-m long beam-transport line with an axial magnetic field of 100 G to an experimental area. Several sets of steering coils were installed along the slow-positron beam-transport line in order to adjust the slow-positron beam trajectory. Penning-trap electrodes are also installed in order to make a dc beam from a pulsed beam. As for the beam monitors, micro-channel plates (MCP) for the beam profile are intensively used.

3 PRESENT STATUS
Almost all components of the 50-MeV electron linac, a target-moderator assembly and a slow-positron beam-transport line are installed. The commissioning of the 50-MeV electron linac started from this March. At the initial stage, a slightly low-power primary beam of 15 W (an energy of 40 MeV, a pulse length of 15 ns, a bunch current of 30 nC and a repetition rate of 12.5 pulses/s) was successfully accelerated and an appreciable number of slow positrons were observed by MCP which locates at the end of the 10-m slow-positron beam-transport line. Since the insufficiency of the radiation shielding was recognized during this commissioning, we are planning to reinforce the shielding in the near future.

4 FUTURE PLAN
Linac based high-intensity slow-positron beam enables us to investigate the defects mapping (two dimensional or three dimensional information of defects distribution). More intense slow-positron beam will be achievable utilizing a primary electron beam power of 5 kW by upgrading the rf source of this test linac.
5 SUMMARY

A 50-MeV electron linac is constructed as a dedicated primary beam source for the KEK Slow-Positron Facility. During its preliminary performance test, a low-power primary electron beam of 15 W was injected into the positron production target and slow-positron beams were successfully generated. After reinforcing the radiation shield, we will open this facility to slow-positron users.

6 ACKNOWLEDGMENTS

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7 REFERENCES