DESIGN AND PERFORMANCE OF KEKB SUPERCONDUCTING CAVITIES
AND ITS CRYOGENIC SYSTEM

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ABSTRACT

The installation of the superconducting rf acceleration cavities and deflection crab cavities to the KEKB have been proposed and the R&D studies have been carried out extensively at KEK. The satellite refrigeration scheme is considered for the cryogenic system for the superconducting crab cavities. The R&D studies of the satellite refrigeration system and the high performance transfer line for this system have been started at KEK.

INTRODUCTION

At KEK- High Energy Accelerator Research Organization, 32x5-cell 508MHz superconducting rf cavities in 16 cryostats were installed in the TRISTAN electron-positron collider and a large scale cryogenic system1,2,3 with 8kW cooling capacity at 4.4K was constructed for upgrading of the electron and positron beam energy from 27GeV to 32GeV. Operation of the system was started in 1988 and continued until end of the TRISTAN physics run in June 1995. During this period superconducting rf cavities and the cryogenic system were operated very stably and reliably 4. The total operation time of the cryogenic system was about 38,000 hours in 7 years.

After the TRISTAN project, construction of a high luminosity double-ring 8x3.5GeV asymmetric electron-positron high beam current collider KEK B-Factory5 (KEKB) in the existing TRISTAN tunnel was started in 1994 as a five year project. Figure 1 shows the configuration of the KEKB. The two ring of KEKB are build in the existing 3km circumference TRISTAN tunnel. The design beam currents of electrons and positrons are very high to attain high luminosity of $10^{34}$ cm$^{-2}$s$^{-1}$ for detailed studies of CP-violation and other topics on decays of B mesons.

Installations of 10 single cell superconducting higher-order-modes (HOMs) damped acceleration cavities to KEKB have been proposed6. The R&D studies of these superconducting cavities have been carried out extensively at KEK. High beam current test of the prototype model was performed successfully at TRISTAN accumulation ring AR in 19967. Construction of 4 Nb single cell superconducting HOMs damped cavities with design acceleration field gradient $E_{acc}$ of 6MV/m (acceleration voltage $V_c = 1.5$MV) has been started. These cavities will be installed in the straight section of Nikko area of HER in summer of 1998 and will be operated from the commissioning phase of KEKB in autumn of 1998. A finite crossing scheme of 2 x 11 mrad has been adopted in KEKB to reduce the background rates and to simplify beam optics at interaction region. Installation of 4 Nb 508

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MHz superconducting rf deflector crab cavities at Tsukuba straight section has also been proposed to eliminate the possibility of beam-beam instability due to the finite crossing angle scheme. The R&D studies of the KEKB superconducting crab cavities and cryogenic system of it have been started at KEK for the commissioning in autumn of 1999.

KEKB SUPERCONDUCTING CAVITIES FOR ACCELERATION

For high beam current electron positron storage ring such as KEKB the coupled-bunch instabilities arising from the HOMs of cavities and the accelerating mode must be sufficiently suppressed to attain high luminosity operation such as $10^{34} \text{cm}^{-2}\text{s}^{-1}$. In order to solve this problem, a new normal conducting accelerating cavity structure with an energy storage cavity, so called ARES\textsuperscript{5}, was proposed and extensively studied at KEK. Another solution is a superconducting cavity. An advantage of the superconducting cavity is, due to high

<table>
<thead>
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<th>R/O</th>
<th>93 ohm</th>
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<tr>
<td>Loaded Q</td>
<td>$8.9 \times 10^4$</td>
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<tr>
<td>LHe. volume</td>
<td>290 L</td>
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<tr>
<td>Static Loss</td>
<td>30 W</td>
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<tr>
<td>Max. volt.</td>
<td>2.9 MV</td>
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<td></td>
<td>(12MV/m)</td>
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Figure 2. Superconducting HOMs damped acceleration cavity for KEKB.