

STATUS OF KEKB SUPERCONDUCTING CAVITIES AND STUDY FOR FUTURE SKEKB



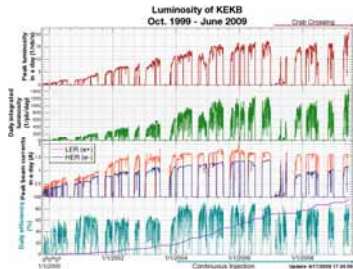
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Abstract

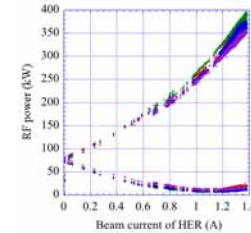
With superconducting crab cavity, 8 superconducting accelerating cavities were stably operated last two years and KEKB luminosity reached the world record of $2.1 \times 10^{34}/\text{nb/s}$. For future Super KEK B-Factory (SKEKB) we are developing a high power input coupler for 600kW, a HOM damper for high power absorption more than 30 kW and a cavity operation with reversed phase position for high power loading. The reversed phase experiment at 150 mA of a beam current in KEKB showed potential for the low voltage and high power application.

KEKB achieved luminosity record

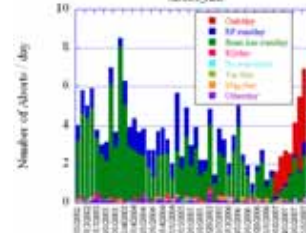


8 superconducting accelerating cavities were stably operated last two years and KEKB luminosity reached the world record of $2.1 \times 10^{34}/\text{nb/s}$ with crab cavities.

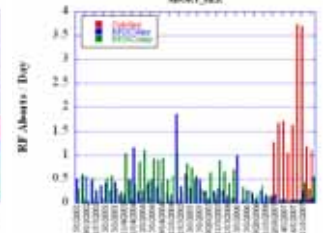
Delivered RF powers and trip rates



Input and reflected powers of each SC cavities for the external Q of 5×10^4 at 1.4 MV.



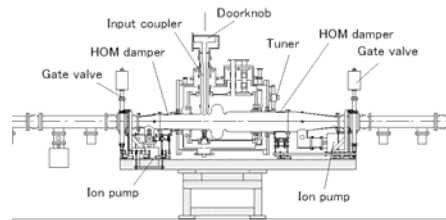
All of beam trips have been classified by the cause; crab cavity, RF cavities, beam loss, earthquake (EQ), vacuum (VAC), magnets (Mag), others and unknown.



Beam trips caused by Crab, SC and ARES cavities. Trip rate of the SC cavity is 0.5/day at 1.4 A and 0.1/day at 0.85 A.

KEKB superconducting accelerating cavity

KEKB, an energy-asymmetric electron-positron double ring collider for B-factory, was commissioned in December 1998. Four heavily-damped superconducting (SC) accelerating cavities were installed in the high energy electron ring (HER) and commissioned. Another four cavities were installed in 2000. A hybrid RF system of eight superconducting cavities together with twelve normal conducting accelerating cavities (ARES) provided the total RF voltage of 14 MV in the HER ring. The maximum current stored in the HER is 1.4 A. Two crab cavities were installed and started crab crossing operation in 2007. The HER currents gradually increased up to 1.2 A with crab cavities. KEKB recently achieved the world luminosity record with crab crossing. SC cavities were operated stably during the crab crossing operation and contributed stable operation for the crab crossing.



A cross sectional view of the KEKB superconducting accelerating cavity. A 509 MHz single cell cavity with a large iris diameter of 220 mm has ferrite HOM absorbers on both sides and a coaxial-type input coupler. The cryo-modules of 3700 mm in length are connected to the beam ducts of 150 mm in diameter.

Achieved parameters of the KEKB SC cavities

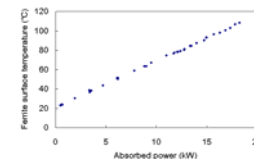
Parameter	design	achieved	unit
Beam Current	1.1	1.4	A
Bunch charge	2	10	nC
RF voltage	1.5	1.2-2	MV/cav.
Beam loading	250	350-400	kW/cav.
HOM power	5	16	kW/cav.

R&D for SKEKB

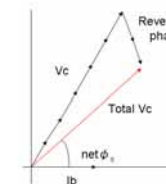
R&D for the SKEKB is under way.

- 1) HOM damper
- 2) Input coupler
- 3) Reversed phase mode

HOM damper



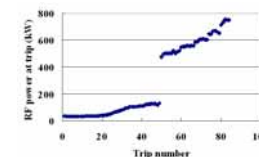
High power test stand for a large beam pipe (LBP) ferrite damper. A cylindrical ferrite of a thickness of 3 mm is sintered on the inside surface of a copper pipe by the hot isostatic press (HIP) method. A cooling water channel is wound on the outer surface of the copper pipe.



Reversed phase mode

Design parameters of the super-KEKB require high beam current, while the RF voltage is much lower than the present KEKB. The loaded Q factor of the SC cavities should be sufficiently reduced. Exchange of input couplers for low Q factor may cause two problems. One is a risk of particle contamination into the cavity, and the other is possible heating at the tip of the input coupler. A new operation scheme, reversed phase mode, was proposed. In this mode, the synchronous beam phase of some SC cavities is reversed so as to obtain lower total RF voltage.

Input coupler



RF processing history.

New KEKB coupler has single cooling path to increase cooling capacity, and also to reduce fabrication cost. Recently a prototype coupler was fabricated and RF tested up to 750 kW.

Summary

Eight superconducting accelerating cavities in KEKB have been operated stably. The cavities provides a total RF power of 10MV and deliver 2.8 MW to the electron beams up to 1.4 A. Recently KEKB achieved the world luminosity records with crab cavities. Stable SC operation contributes to increase luminosity with crab crossing. R&D for SKEKB is under way. A feasibility study for a new SC operation mode, a reversed phase mode, was successfully conducted with low beam current, and showed strong potentiality applicable for SKEKB.