New type of thermal sensors for vertical testing of nine-cell cavities for the ILC

New thermal sensor components. Two sensing units on the right and a switching circuit on the left.

New thermal sensor attached to cavity for vertical testing. Both new type and carbon resister type are attached.

Scientists at Kyoto university are testing a new type of thermal sensor for superconducting cavities on the vertical test for ILC at the Superconducting radiofrequency Test Facility (STF) at KEK. This sensor is under development by a Kyoto-KEK collaboration The team is developing this new device to address issues in the components of the sensor – tangled wires and resistors. At STF, a carbon resistor is used for vertical testing of nine-cell cavities. They have already installed 350 sensors on the outer surface of the nine-cell cavity, and 700 lead wires were needed to connect both ends of sensors through cryogenic area and outside, in order to measure the temperature. “For a shorter developing time, I have chosen carbon resistor which is technologically proven in the past superconducting cavity R&D. This structure is simple, not so sophisticated.” said Yasuchika 'Kirk' Yamamoto, the scientist at KEK who designed the present system. When the cavity is being tested, it is cooled to 2 kelvins, and has to stay at that temperature as much as possible. In general, it is best to use the smallest possible number of lead wires to prevent heat invasion to the cryogenic area. “The current system needs too many lead wires, and the production of the carbon resistor has been discontinued, we thought we should develop a new thermal sensor to replace it,” he said.

The new thermal sensors consist of 16 to 32 small chip sensors lined up equally spaced on a "band" made of flexible polyimide film, to wrap up the superconducting cavity. This shape will drastically improve the density of the sensors on the cavity surface enabling to obtain more detailed thermal distribution data. “We are planning to place small sensors one centimetre apart. This way, each one cell will have 1024 sensors attached,”, said Yoshihisa Iwashita, associate professor at Kyoto University. They are planning to use more than ten thousands sensors per cavity to measure the temperature. Another distinctive feature of this new device is an analogue multiplexer, a kind of switching circuit. Those sensors are electrically connected to the multiplexer, which switches the electric connection every several tens of microseconds from one sensor to another. This function helps to solve wiring problem since it needs fewer lead wires to connect to the cryogenic area. “We will only need 32 wires for one cell,” Iwashita said.

The commercialised products were used to develop this new device. “We have tested these sensors under the cryogenic conditions and confirmed their operability. The polyimide film stayed flexible, the sensors worked fine, and multiplexers switched the circuit well”. They are planning to advance their effort with displaying a large volume of data and speeding up switching time. They also select and verify an X-ray sensor to implement with the thermal sensor.

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