Report on MERIT Long-term Oversea Dispatch

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Overview

I have stayed in a research group fo Prof. Dr. Hans Christian Enss at Kirchhoff-Institute for Physics of Heidelberg University, Germany, from April 20th 2016 to June 27th 2016.

Research

Hosting researcher, Prof. Dr. Enss is famous for the studies on low temperature physics and known as the author of widely used textbook "Low temperature Physics". One of the research subject in this group is to develop high-resolution particle detector which operates at ultra-low temperature of 10 – 100 mK. I joined the project during my stay for about 2 months.

A particle detector called Metallic Magnetic Calorimeter (MMC) detects a particle by following process. The energy of a particle absorbed in Au absorber is changed to magnetic signal and finally read out by SQUID magnetometer. MMC has surprisingly high energy resolution and it is expected to be used for many applications such as X-ray astrophysics and neutrino mass measurement. However, if one try to mount many MMC pixels on cryostat, electric wiring will increase resulting in circuit complexness and large heat flow through wires.

I developed and tested the multiplexer which conveys MMC signals to room temperature electronics. The multiplexer consists of one feedline and many superconducting resonator with different resonant frequency coupled capacitively to the feedline. Changing different MMC signals into different frequency signals by the multiplexer reduces the number of wires to electronics at room temperature, which results in efficient measurement.

The first measurement on Nb resonators did not show sharp resonant peaks. The reason of this was revealed later. Poor electrical grounding of plates on the both side of coplanar waveguide caused difference in electric potential. Therefore, I designed new resonators which have bridges over the waveguide which connect ground plates to obtain even electric potential. These resonators showed better result but resonant peaks was not deep as expected, whose reason was probably

that bridges interfered microwave in waveguide. This result indicated further optimization of bridge shape and density.

Life in Germany

Heidelberg, a city located on about 80 km south of Frankfurt, boasts famous ancient castle, Heidelberg Castle, and the oldest university in Germany, Ruprecht-Karls-Universität Heidelberg. This city is known as a tourist spot and academic city. The castle can be seen from a bridge I crossed every day to go to the university, and I was strongly impressed by the beautiful castle which showed a variety of sceneries depending on weather or time.

I used a bicycle which the host of my apartment kindly lent me to go to the university. I felt at that time that Germany is better country than Japan for bicycle riders. Most streets had the lane for bicycles and commuters ran in a procession. That was quite different from bicycles in Japan which runs everywhere. Moreover, one can take a train with a bicycle as it is if he pay additional fee (a bicycle must be deconstructed to be brought in a train in Japan), so I made a trip to Munich with the bicycle. I felt that it is difficult for Japan to make environments for bicycles as good as that in Germany because of smaller available space for a road. Some foreign student belonged to the group and basically group meetings and announcements were done in English. So, I did not have serious trouble about communication. However, it was tough work for me to explain Japanese political system. There were some big political events during my stay, G7 summit at Ise-shima and British referendum (Brexit), so I had a chance to talk about politics with group members. I realized that it is needed to improve my English skill and understand more about my own country to work globally.

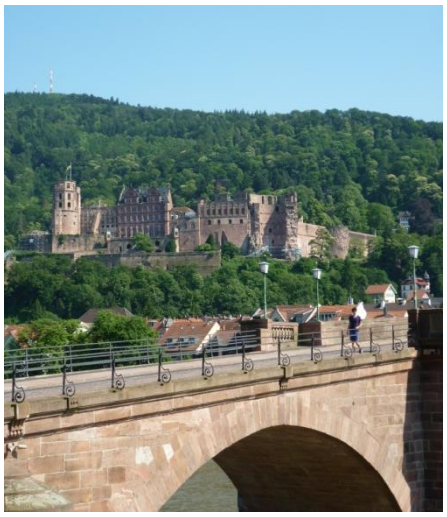

Fig.1 Heidelberg Castle and Karl-Theodor Bridge

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