

## Superconducting detector

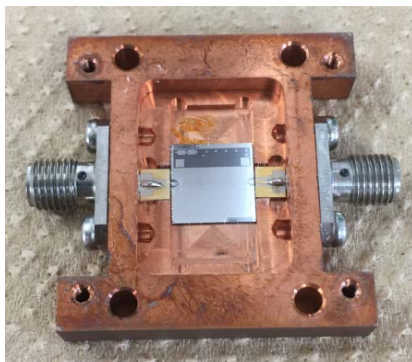
Instructor: Koji Ishidoshiro ([koji@awa.tohoku.ac.jp](mailto:koji@awa.tohoku.ac.jp), RCNS Annex 221) GPPU  
Experimental Point (GEP): 4

### *Goal of Study*

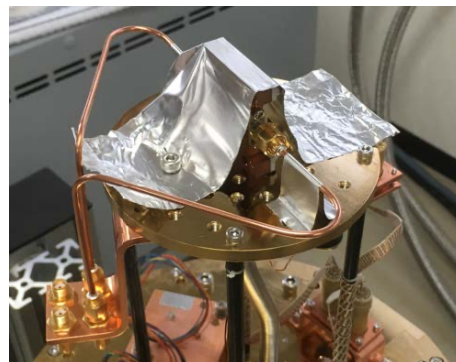
The students will understand superconducting detectors and their wide application to particle and nuclear physics and astrophysics. The students will also learn basics of superconductor, electronics, cryocooler, digital signal processing, data acquisition system and data analysis from detector characterization and response measurements of cosmic rays and/or gamma rays.

### *Contents*

Superconducting detectors are extremely sensitive and have a wide variety of application from particle and nuclear physics to quantum measurement and biology. However, it is difficult to integrate into large arrays like a CCD camera. Kinetic Inductance Detectors (KIDs) provide a promising solution to produce the large array. Several KID arrays have been constructed for astronomical observations and TeraHertz imaging. Research Center for Neutrino Science in Tohoku University is developing KID arrays for next generation dark matter and double-beta decay experiments. Using that facility, the students will learn basics of superconductor, electronics, cryocooler, digital signal processing, data acquisition system and data analysis from detector characterization and response measurements of cosmic rays and/or X rays.



KID detector used in the course



KID detector and 3He cryocooler

***Textbook and References***

- [1] KID detector: P. K. Day *et al.*, *Nature* 425, 817 (2003)
- [2] KID detector: S. Doyle *et al.*, *J. Low Temp. Phys.*, **155**, 530 (2008).
- [3] Application example for elementary particle experiment: E. S. Battistelli *et al.*, *Eur. Phys. J. C* **75** 53 (2015).
- [4] Application example for space observation: S. Oguri *et al.*, *J. Low Temp. Phys.* **184**, 786 (2016)

***Progress Schedule***

- ◇ Day 1  
Lecture on superconducting detector, microwave, and cryocooler.  
Fabrication of superconducting detectors
- ◇ Day 2  
Fabrication of superconducting detectors  
Preparation of cooling.
- ◇ Days 3  
Lecture on application of superconducting detector to particle physics.  
Detector characterization at 0.3 K.
- ◇ Days 4  
Measurement of detector response with cosmic-ray and/or gamma-ray source.

***Other Details***

<b>Course Period</b>	February-March 2023
<b>Place</b>	Research Center for Neutrino Science Annex I-03, 125
<b>Number of Students</b>	1—2
<b>Evaluation method</b>	The evaluation method will be based on report (100 %).

***In Addition***

Language used in this course is only Japanese since the fabrication require helps from technical staffs.