

Microwave technology for particle and astroparticle physics.

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GPPU Experimental Point (GEP): 4

Goal of Study

Microwave technologies are widely used in experiments on particle physics and astroparticle physics.

One example is microwave resonant cavities used in accelerators, where particles are accelerated in a microwave cavity.

In another example, the search for dark matter candidate particles called axions uses microwave cavity in powerful superconducting magnets.

However, while the applications of microwave technologies are expanding in the fields of elementary particles and atomic nuclei, it cannot be said that there are many opportunities to learn them.

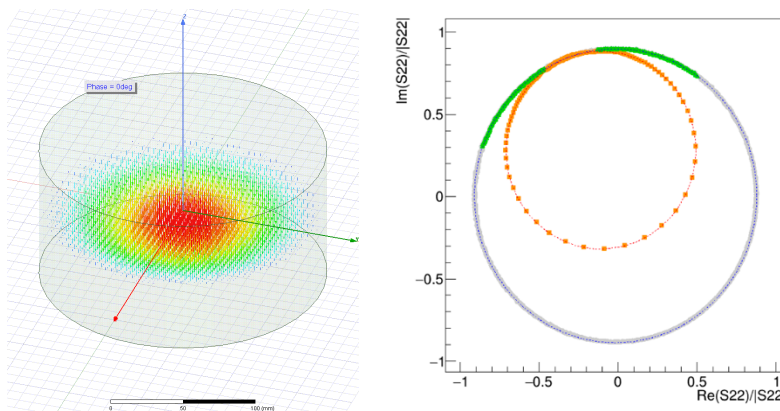
This course provides opportunities to use them.

Contents

As mentioned above, microwave technologies are very important factors.

In this course, you will learn basic but practically important applications using a microwave cavity.

- Microwave technology and particle physics.
- Basics of microwave and microwave cavity.
- Transmission (S_{21}) and reflection (S_{11}) measurement of a cavity.
- Simulation study on coupling between a cavity and a waveguide to feed microwave into cavity



Textbook and References

No specific texts. Some topical or related items are picked up from the following references.

- [1] 「高周波加速の基礎」 高田耕治 第1～2章 (https://www2.kek.jp/accl/people/takata/Publications/KEK_Report_2003-11.pdf)
- [2] Calculation for Cosmic Axion Detection, L. Krauss他, PRL 55, 17 (1985), p1797
- [3] WISPy Cold Dark Matter, P. Arias 他, DOI: 10.1088/1475-7516/2012/06/013
- [4] 「加速器のためのマイクロ波入門」 阿部哲朗 の第1部 (http://accwww2.kek.jp/oho/oho17/OHO17_txt/01_02_Abe_Tetsuo_180416.pdf)
- [5] Q factor measurements, analog and digital, D. Kajefz の1～4節 (<https://people.engineering.olemiss.edu/darko-kajfez/assets/rfqmeas2b.pdf>)
- [6] 「ネットワークアナライザの基礎」(キーサイト) https://www.keysight.com/upload/cmc_upload/All/Network_Analyzer_Foundation_for_WEB_Seminar.pdf
- [7] S-Parameter Design, Agilent AN 154 (<http://www.sss-mag.com/pdf/AN154.pdf>)
- [8] 「マイクロ波工学の基礎」, 平山仁, 日本理工出版会
- [9] “Microwave engineering”, D.A. Pozar, WILEY

Progress Schedule

- ◇ Day 1 Lectures about microwave and particle physics
- ◇ Day 2 Lecture about microwave cavity and exercise on design of a microwave cavity
- ◇ Day 3-4 Experiment on a microwave cavity (Q-value measurement via S11 spectrum, antenna tuning)

Other Details

Course Period	2026 Summer
Place	Research Center for Neutrino Science, Experimental room for strong magnetic field
Number of Students	1~3
Evaluation method	The evaluation will be based on report of the experiment (100%).

In Addition