P6 (GEP=4)

Microwave technology for particle and astroparticle physics.

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GPPU Experimental Point (GEP): 4

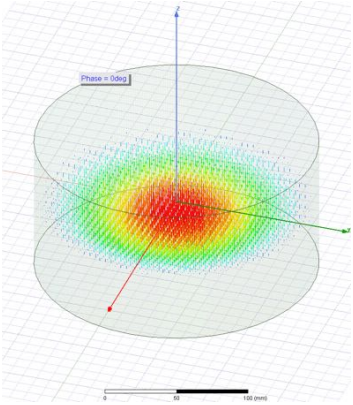
Goal of Study

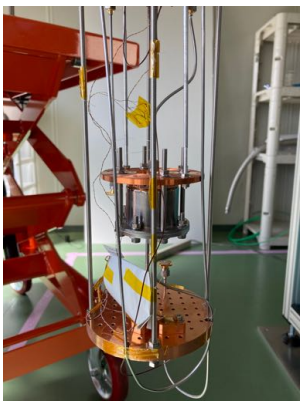
Microwave plays important roles in experimental particle physics. The most typical one is accelerator cavity and in recent years, microwave measurements themselves are the observables, such as CMB and dark matter search for axion/hidden photon. In this course, the students acquire basic knowledge of microwave and some measurement techniques through an experiment on a superconducting microwave cavity. The students also get knowledge on the super conductor.

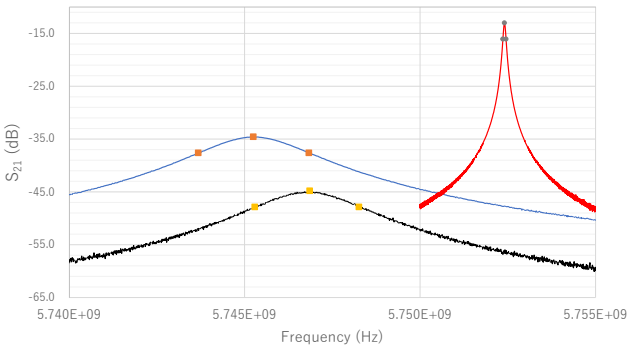
Contents

Microwaves have been used in particle physics and astro-particle physics. One of the traditional examples is microwave accelerator cavity, and newer one is a experimental search for Axion, dark photons, etc. In this course, we will conduct basic experiments on a superconducting microwave cavity, which is used in the above two examples, and learn their principles and applications.

- Microwave technology and particle physics
- Basic of microwave and microwave cavity
- Experimental setups (Vector Network Analyzer and Cryostat)
- Transmission (S21) measurement of a superconducting 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] 「超伝導加速空洞」の 2.2 節～2.3 節 (http://accwww2.kek.jp/oho/OHO15/OHO15_txt/07_Sakai_Hiroshi_3.pdf)

[6] Q factor measurements, analog and digital, D. Kajefz の1～4節 (https://people.engineering.olemiss.edu/darko-kajfez/assets/rfqmeas2b.pdf)

[7] 「超伝導入門」 荻津 透, 古屋貴章の1～3.3 節 (https://www.pasj.jp/kaishi/cgi-bin/kasokuki.cgi?articles%2F16%2Fp240-250.pdf)

[8] 「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

[9] S-Parameter Design, Agilent AN 154 (http://www.sss-mag.com/pdf/AN154.pdf)

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 superconducting microwave cavity (Q-value measurement via S21 spectrum)

Other Details

Course Period	2021 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