P6 (GEP=4)

Microwave technology for particle and astroparticle physics.

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GPPU Experimental Point (GEP): 4

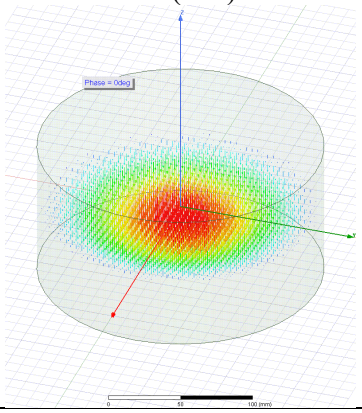
Goal of Study

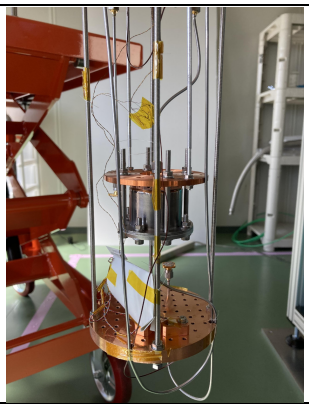
Technologies on superconductor and microwave technology are widely used in experiments on particle physics and astroparticle physics.
One example is microwave resonant cavities and superconducting magnets used in accelerators, where particles are accelerated in a microwave cavity and their trajectories are bent by a superconducting magnet.
In another example, the search for dark matter candidate particles called axions uses superconducting microwave detectors and powerful superconducting magnets.
However, while the applications of both superconducting and 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.

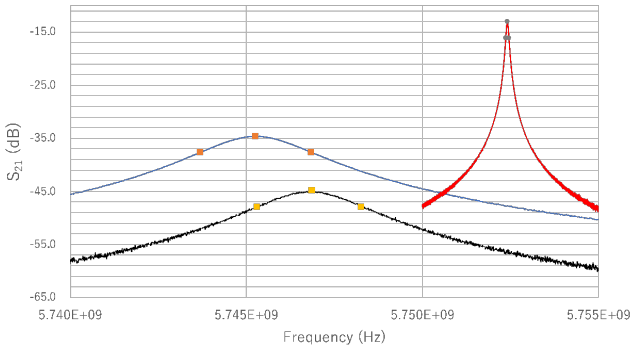
Contents

As mentioned above, microwave technology and superconducting technology are very important factors.
In this course, you will learn basic but practically important applications using a superconducting microwave cavity.

- 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	2023 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