DESIGN OF AN IMPLANTABLE ANTENNA FOR MICROWAVE HYPERTHERMIA

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INTRODUCTION

* Technological advances in healthcare
* Joint replacement surgery
* increasing trends 2000 → 30% → 2015

OECD (2017), “Hip and knee replacement”, in Health at a Glance 2017: OECD Indicators, OECD Publishing, Paris.

INTRODUCTION

* Revision surgery → expensive , risky
* Why revision surgery ? → Infection

INTRODUCTION

* The agents of implant infection : Staphylococcus aureus, Staphylococcus epidermidis

* Antibiotic therapy ⟶ not successful

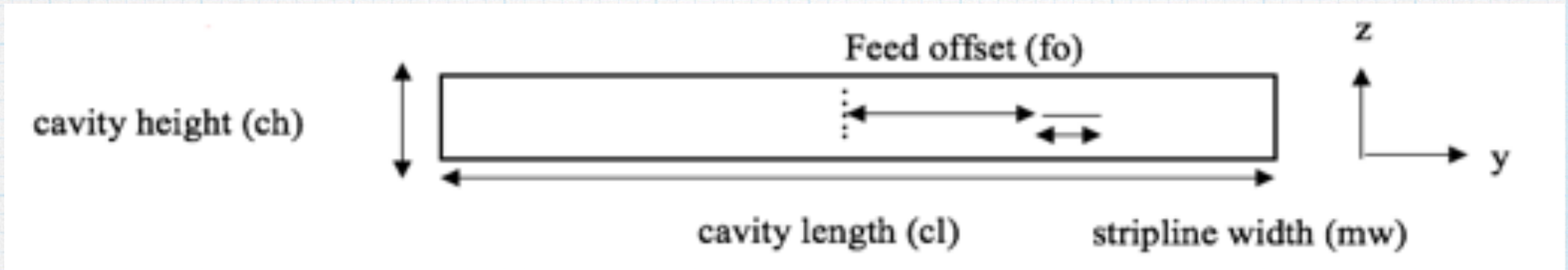
* Why ? ⟶ AMR

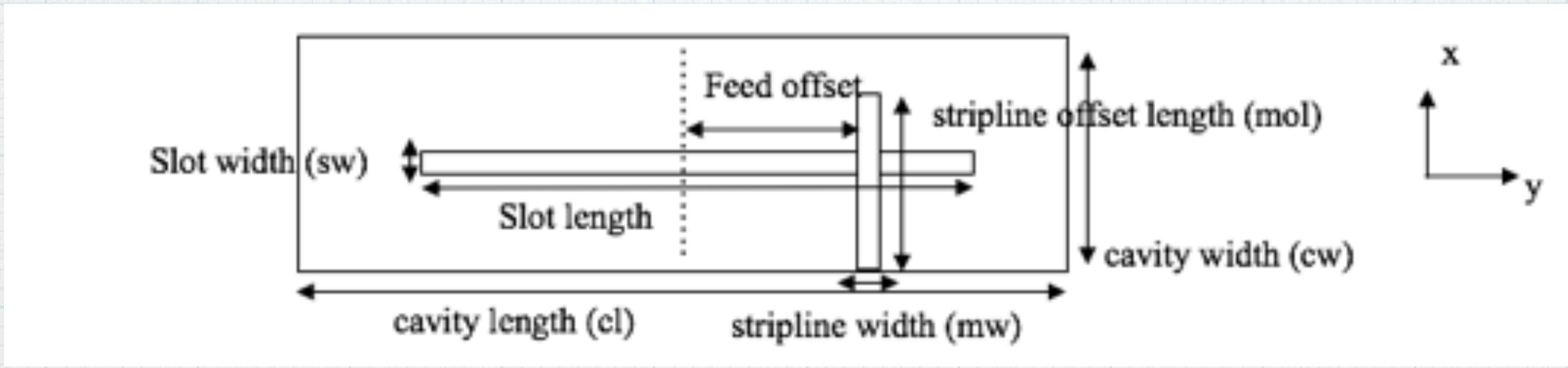
* An antenna taking action against infection before and during biofilm formation

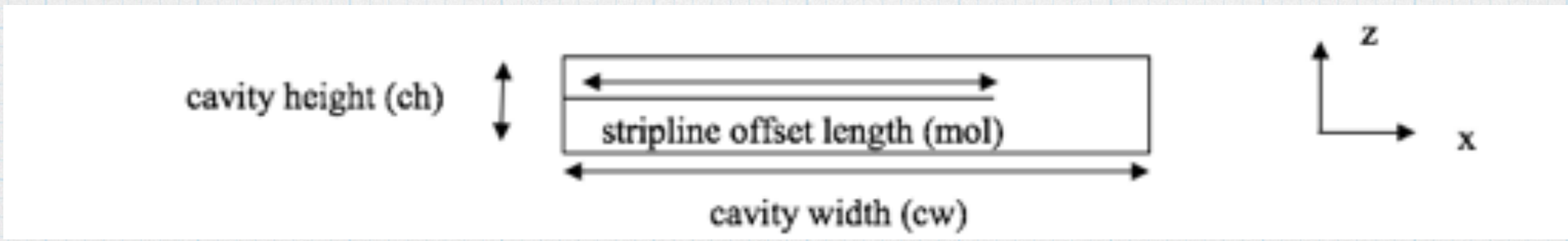
CBSA

* Why CBSA?
* Microstrip-fed CBSA → simple structure
* In vacuum
* 2.4 GHz - ISM band

The model


cavity height (ch)
Feed offset (fo)
z
y
cavity length (cl)
stripline width (mw)


Feed offset
stripline offset length (mol)
Slot width (sw)
Slot length
x
y
cavity width (cw)
cavity length (cl)
stripline width (mw)


cavity height (ch)
stripline offset length (mol)
z
x
cavity width (cw)

Dimensions of the model

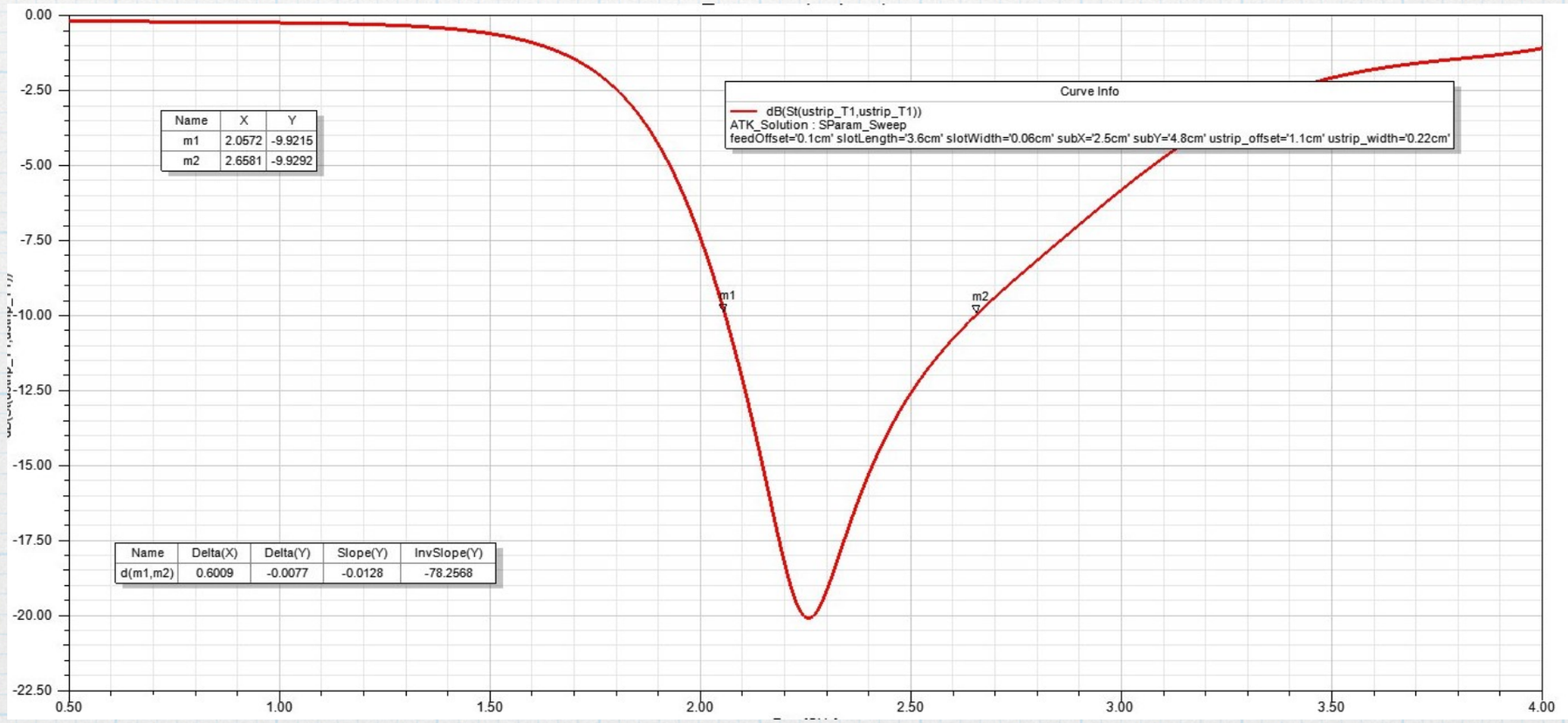
* optimisation process for operation at 2.4 GHz with -20 dB

* Conclusion : slot length ⟶ resonance frequency

* Matching ⟶ the width and the length of the stripline

in vacuum

in fat



Thermal analysis

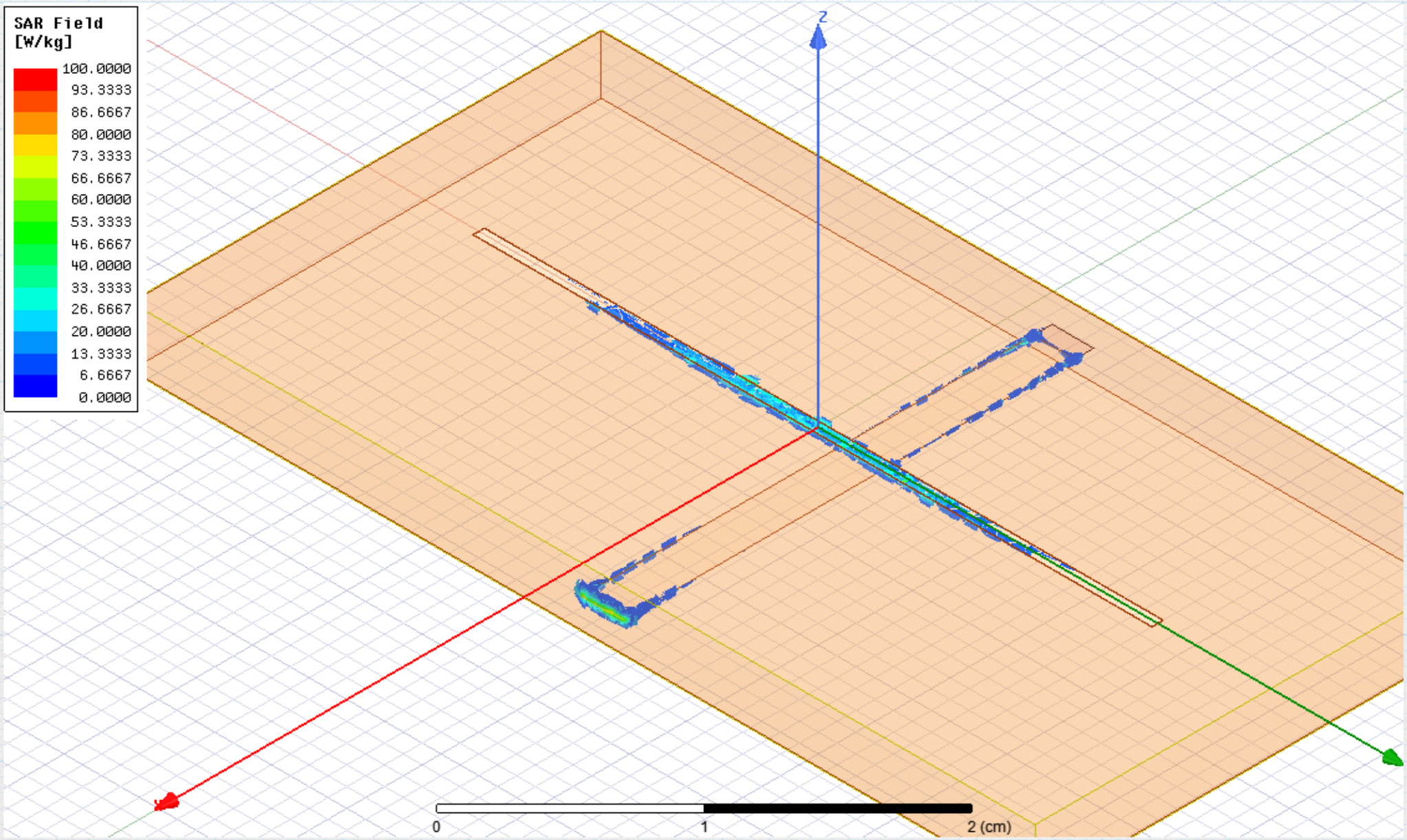
* ANSYS Workbench

* Not satisfactory : from 37 °C to 37.13 °C

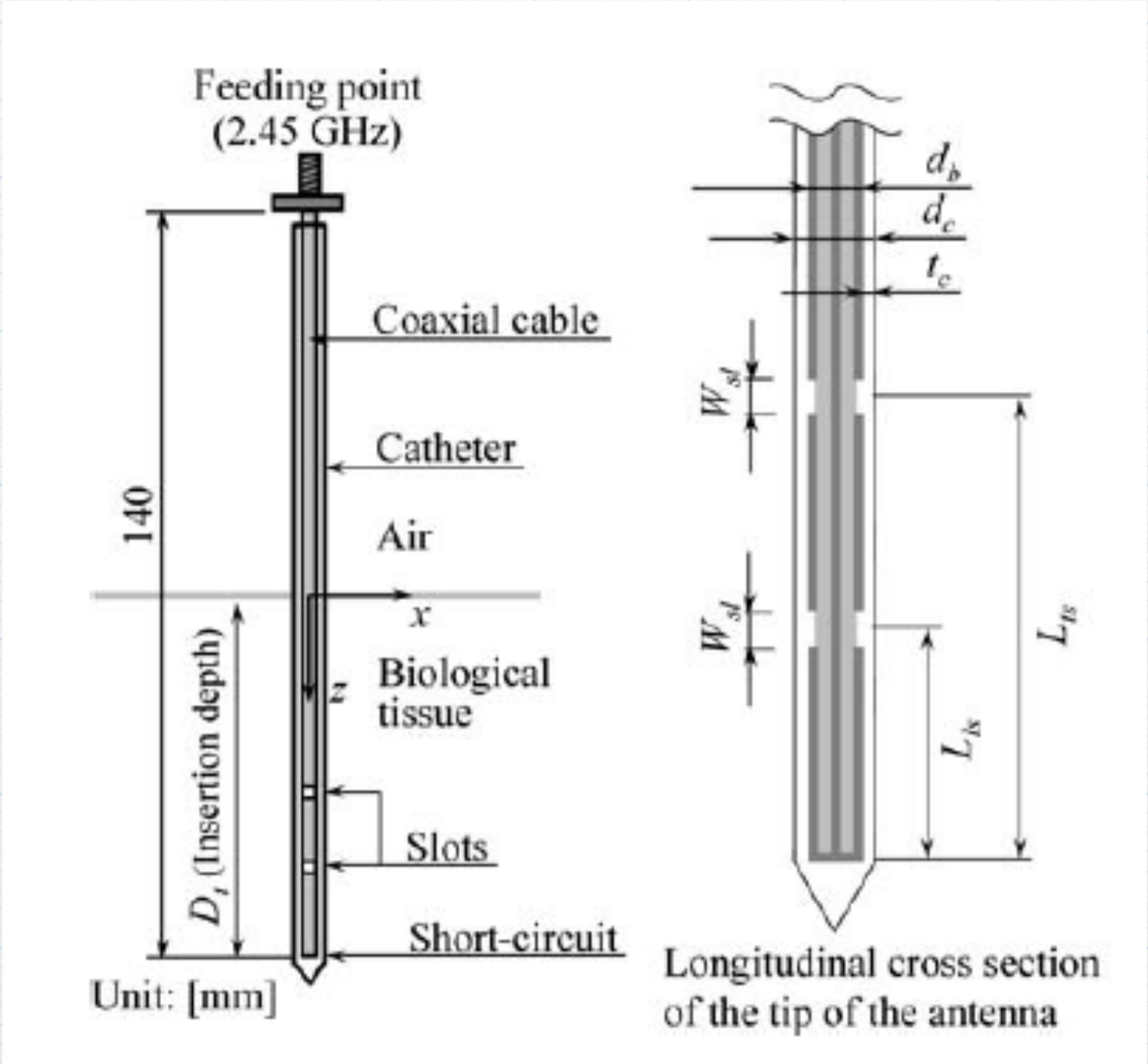
* Antennas for telecommunication : radiation pattern

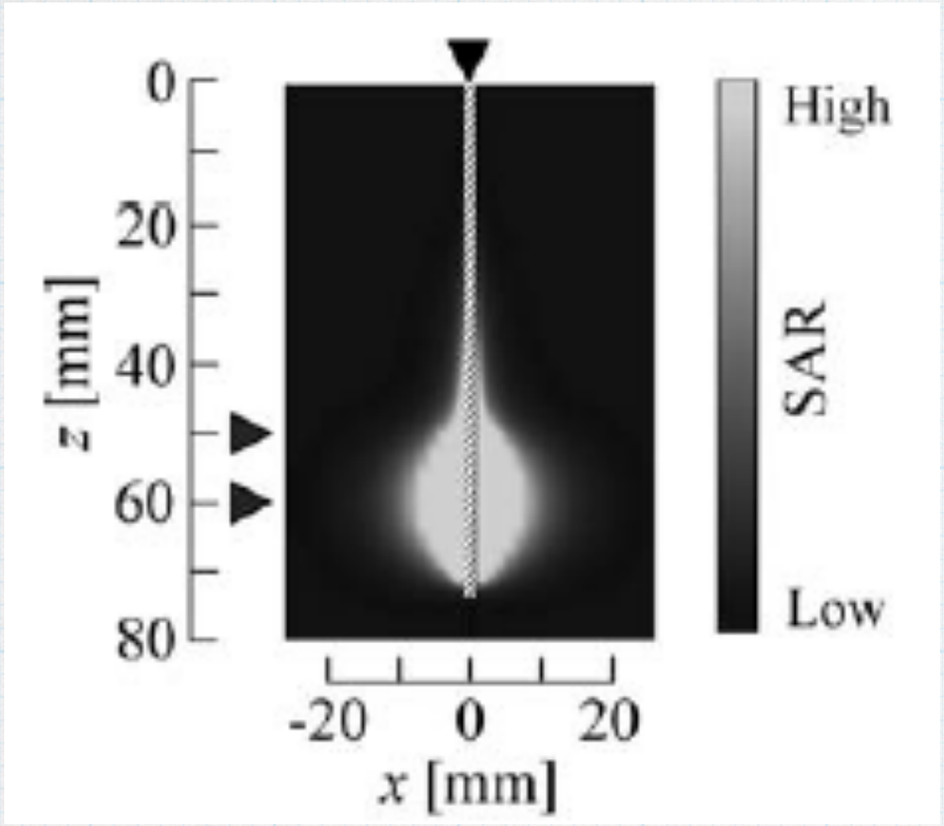
* Antennas for thermal treatment : SAR

SAR Field of CBSA



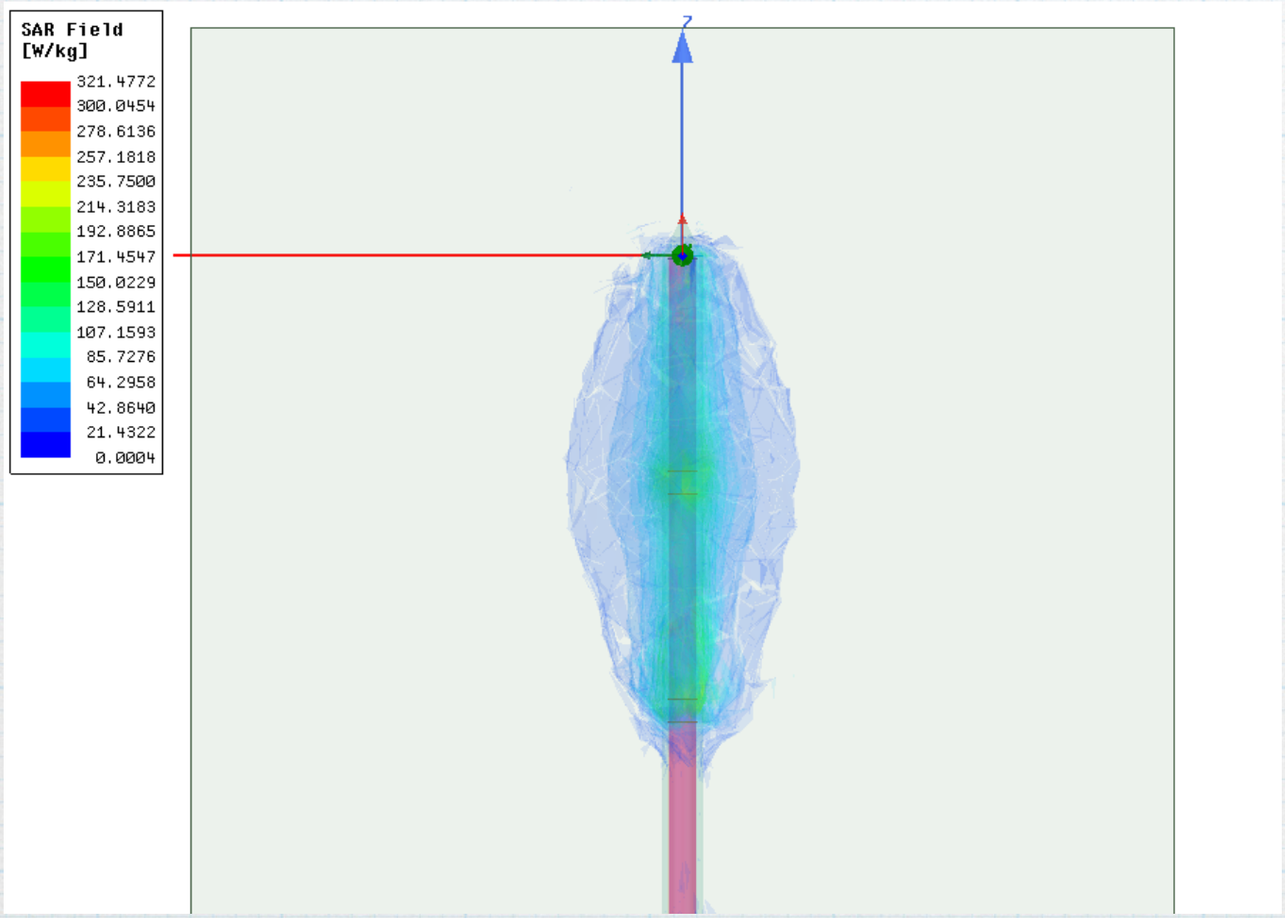
Coaxial Slot Antenna

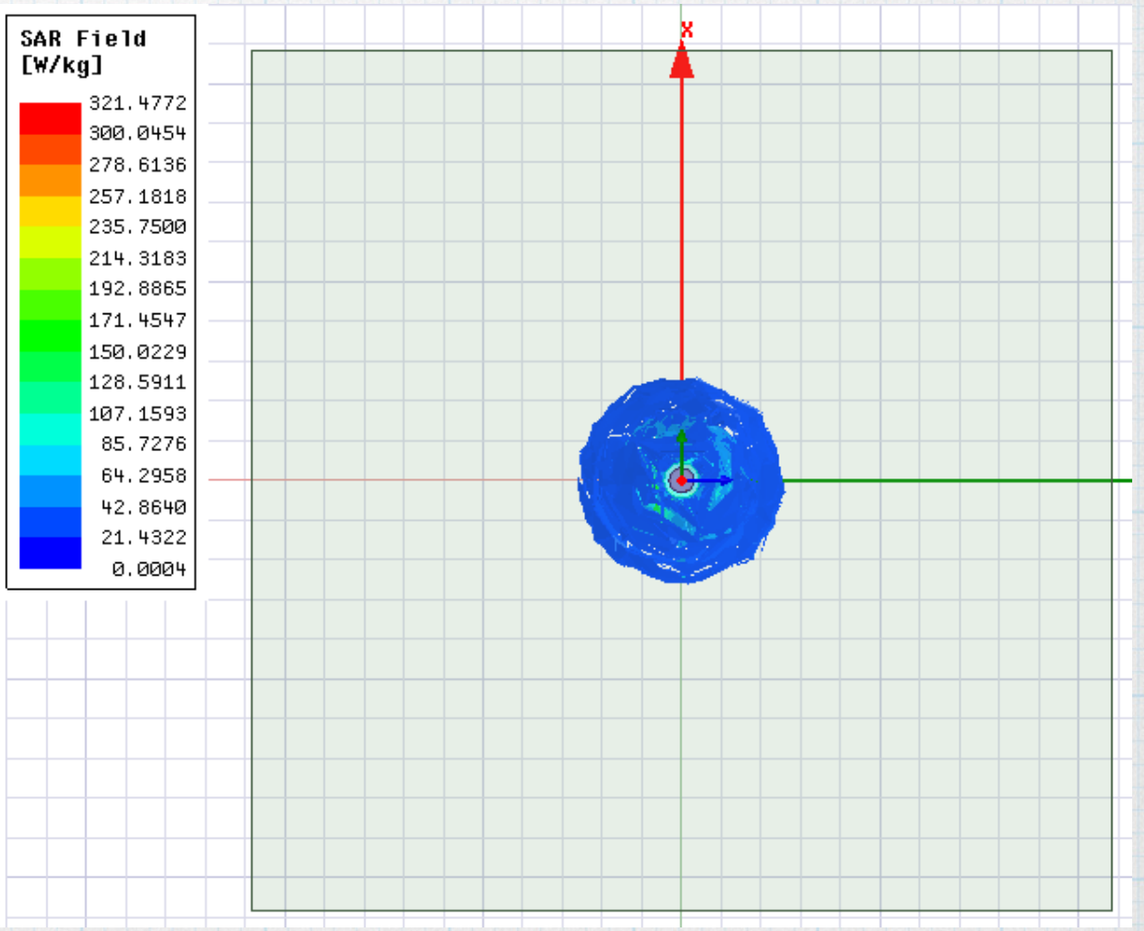




← Measured SAR distribution

Simulated SAR distribution

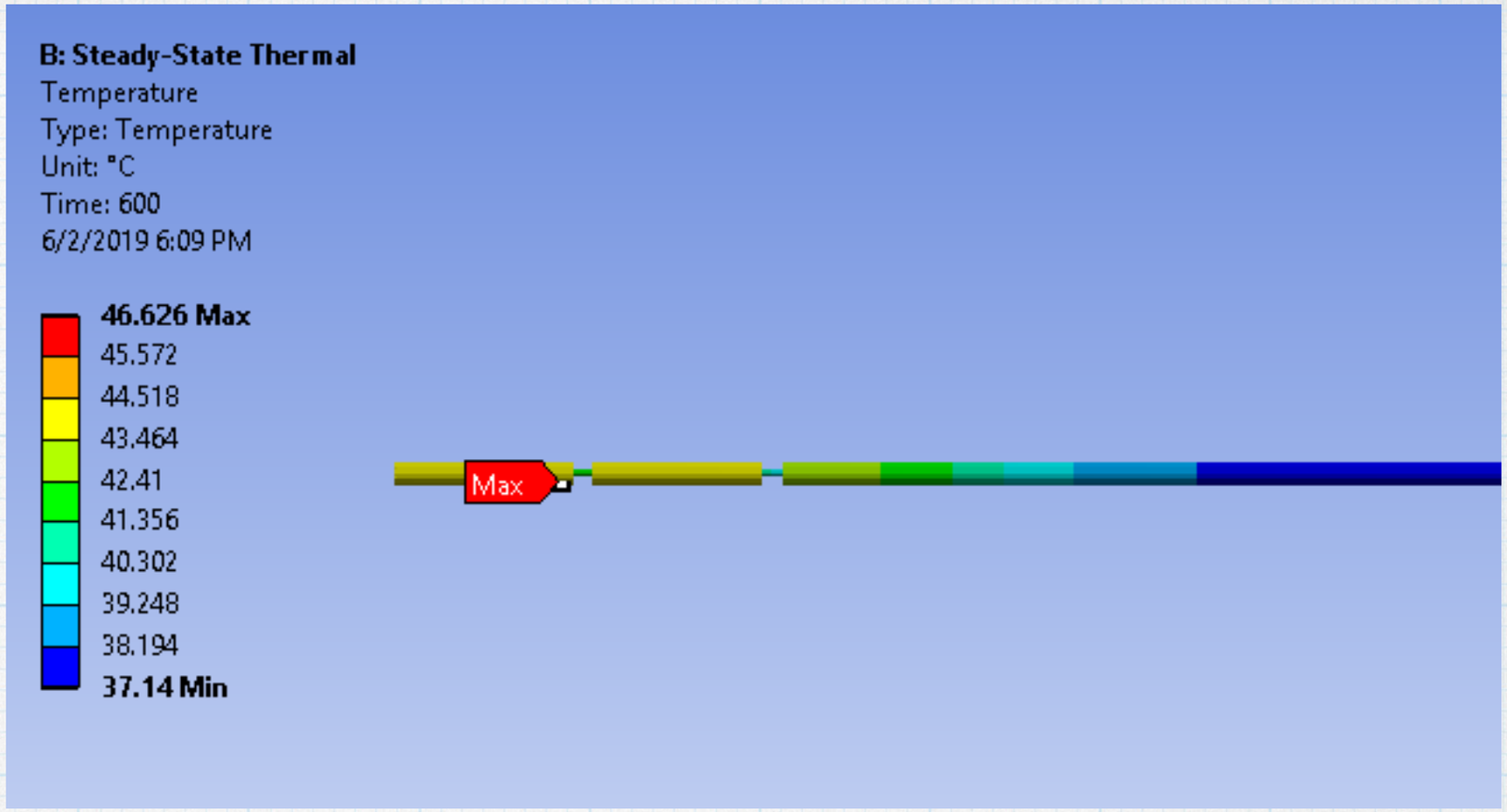




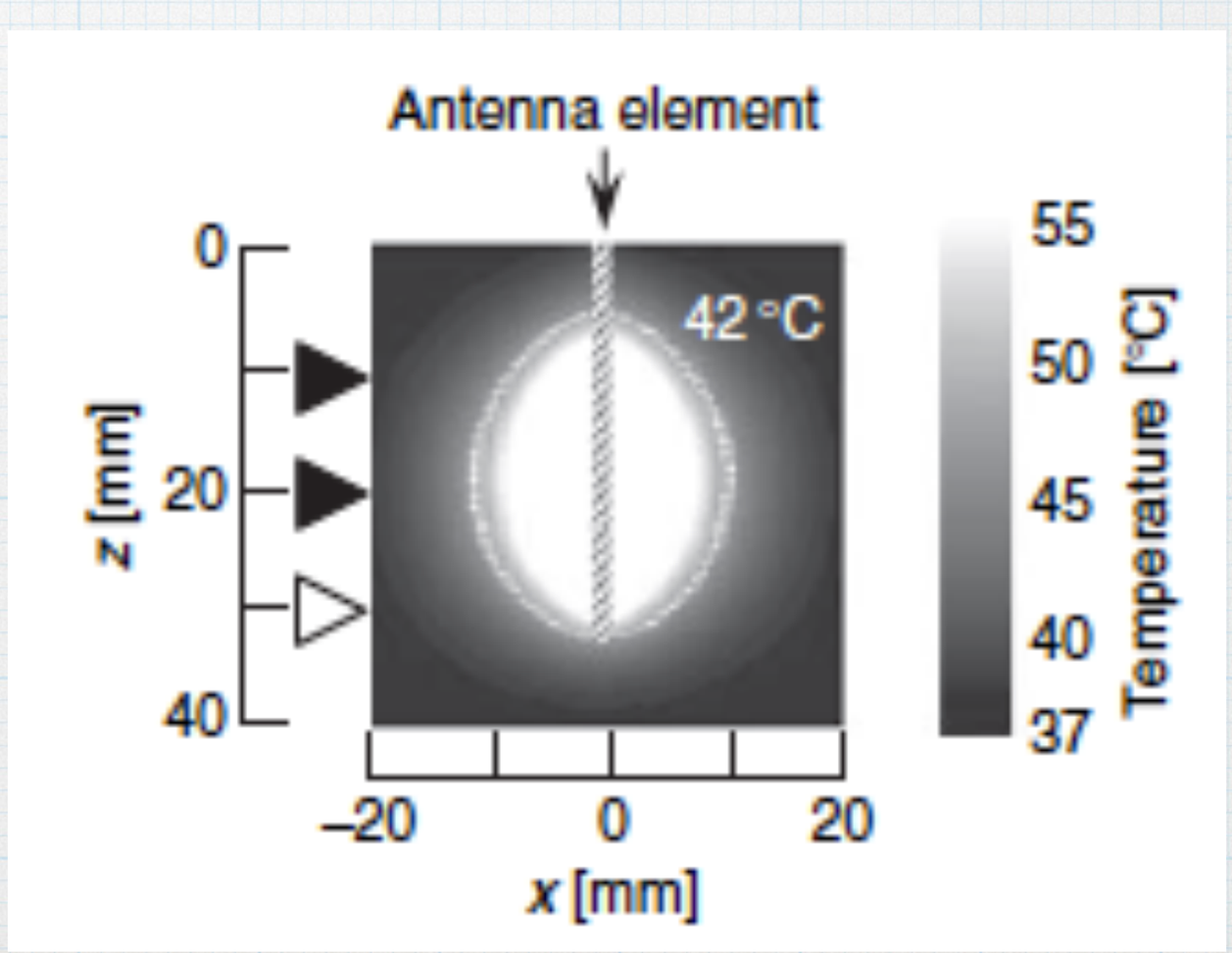
Thermal analysis Setup

* Net input power : 5 W
* Heating time : 600s
* Initial temperature (muscle): 37 °C.

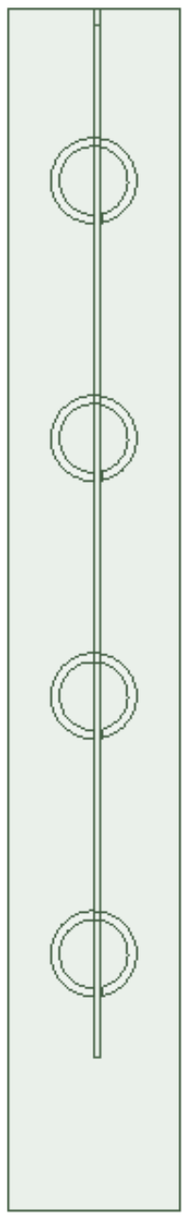
Simulated temperature distribution

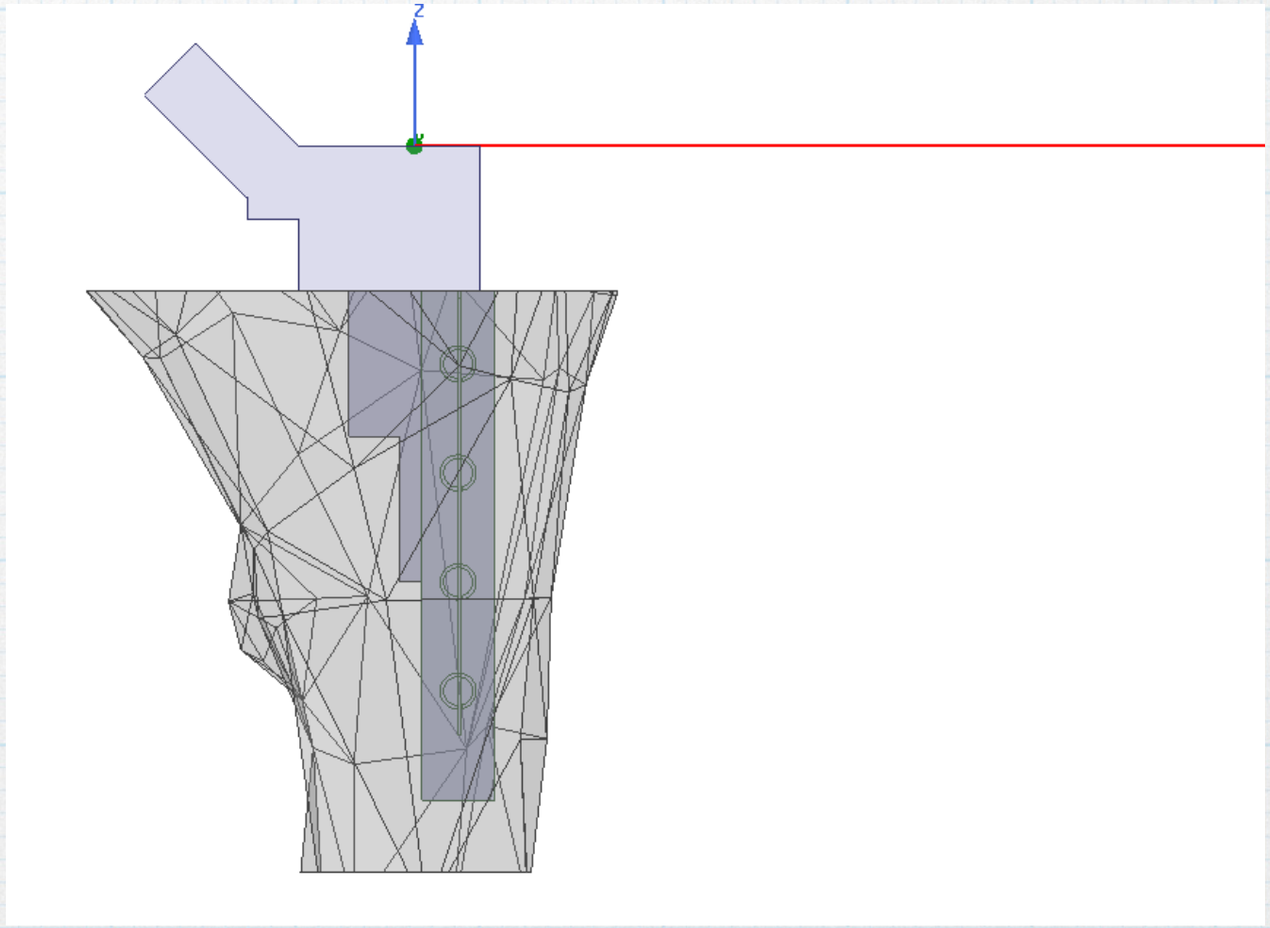


Measured temperature distribution

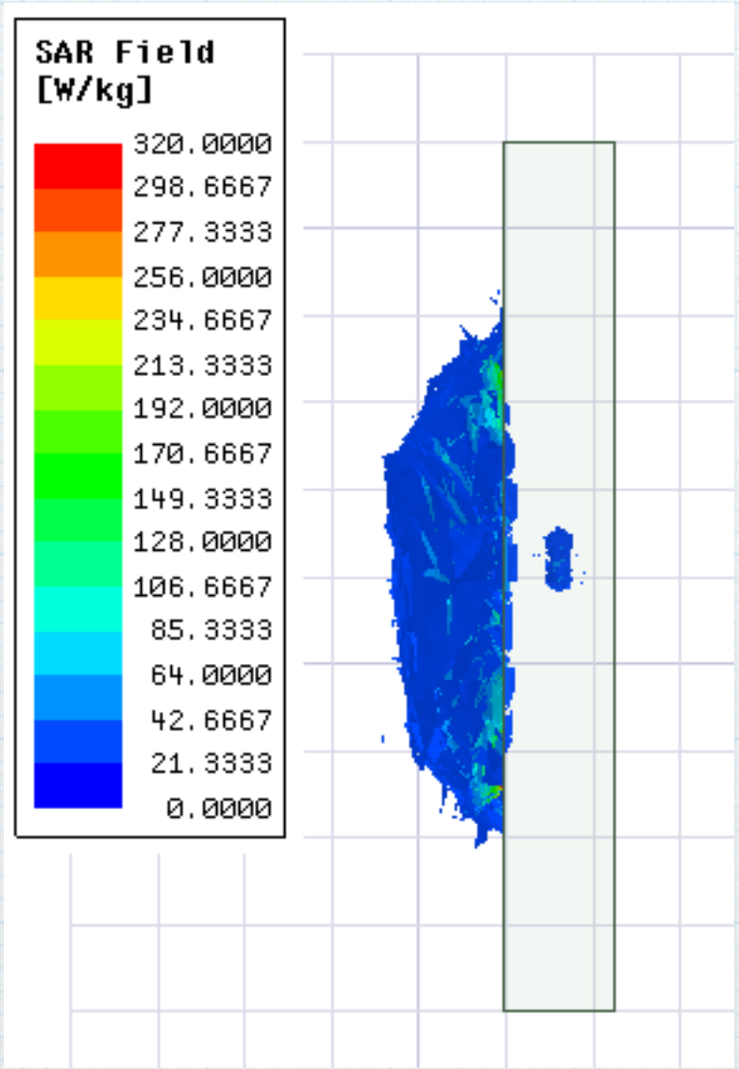


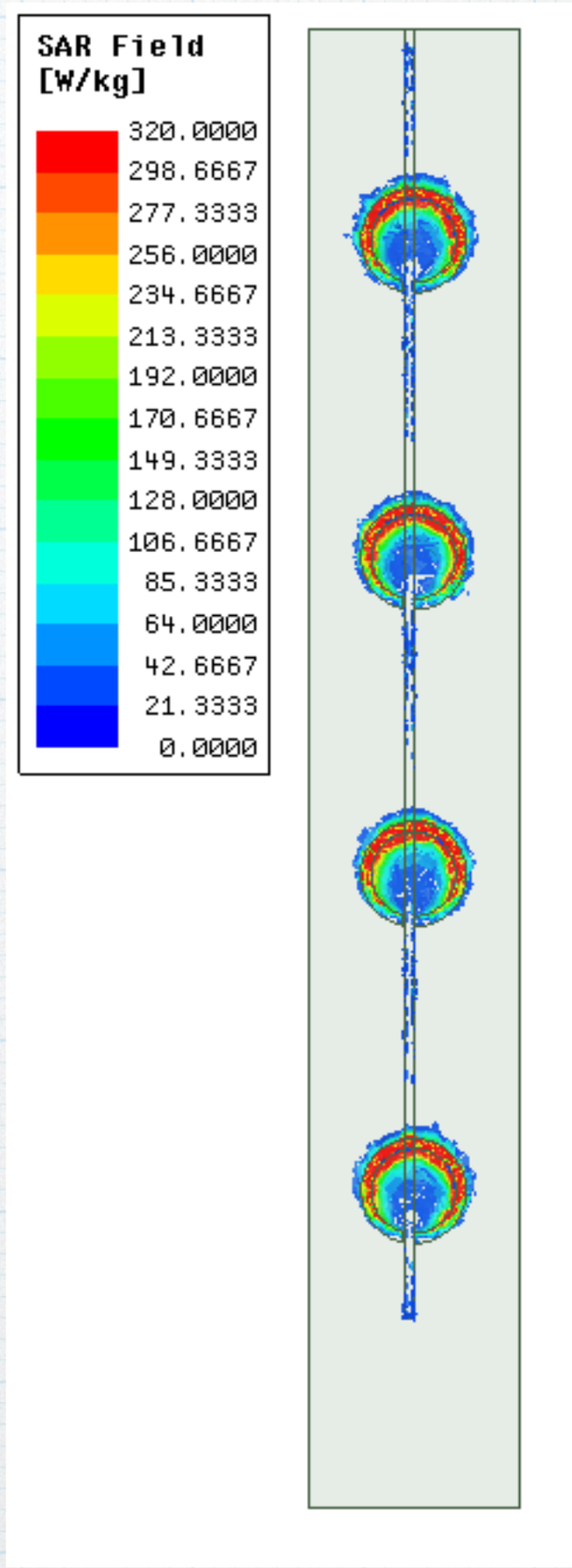
Antenna with C-type slots





Simulated SAR distribution of the designed antenna





Thermal Analysis

* Temperature : 37 °C ⟶ 38.53 °C
* Does not meet the performance evaluation criterion

Future Work

* Design an antenna that shows better heating performance
* Specify the antenna that I want to prototype until the beginning of Fall 2019
* In EE 492 complete simulations, start prototyping and measurements