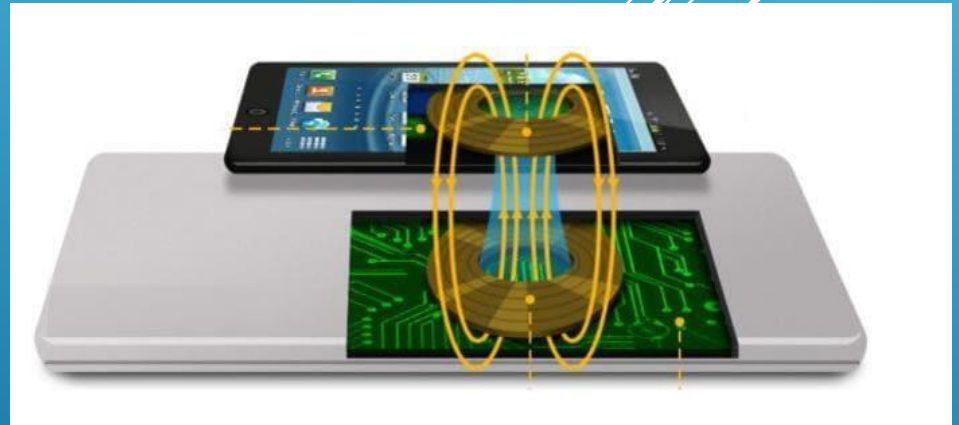


Optimisation d'un dispositif de recharge par induction

TIPE 2020-2021

THEME: ENJEUX
SOCIETAUX

N° CANDIDAT: 143



Plan:

Introduction

- 1) Etude théorique

- 2) Etude expérimentale

- 3) Les simulations

- 4) Réalisation du chargeur

Conclusion

INTRODUCTION

CIRCUIT PRIMAIRE



ALIMENTATION
12V 50Hz

REDRESSEUR

OSCILLATEUR
COLPITTS

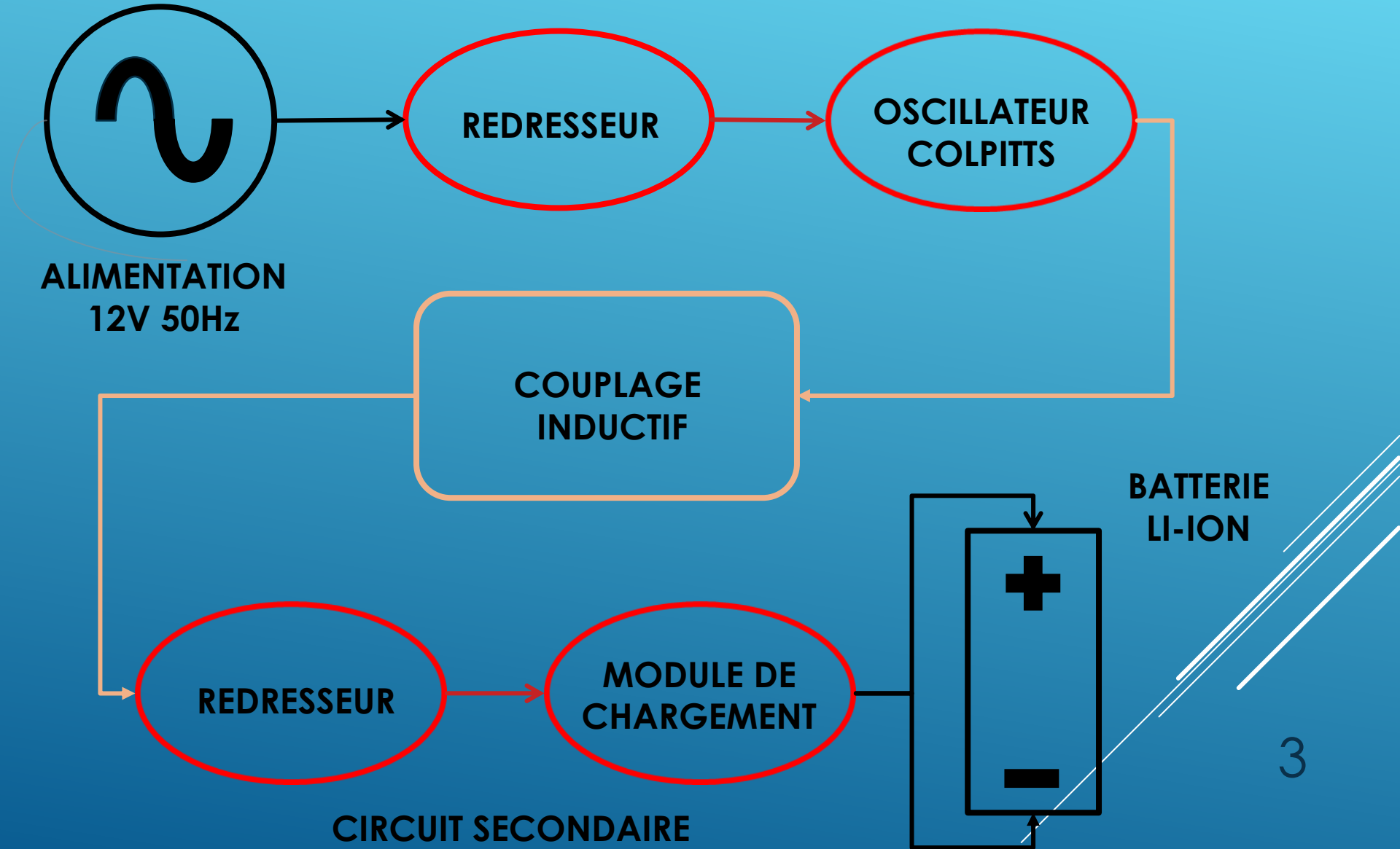
COUPLAGE
INDUCTIF

REDRESSEUR

MODULE DE
CHARGEMENT

BATTERIE
LI-ION

CIRCUIT SECONDAIRE



1) Étude théorique

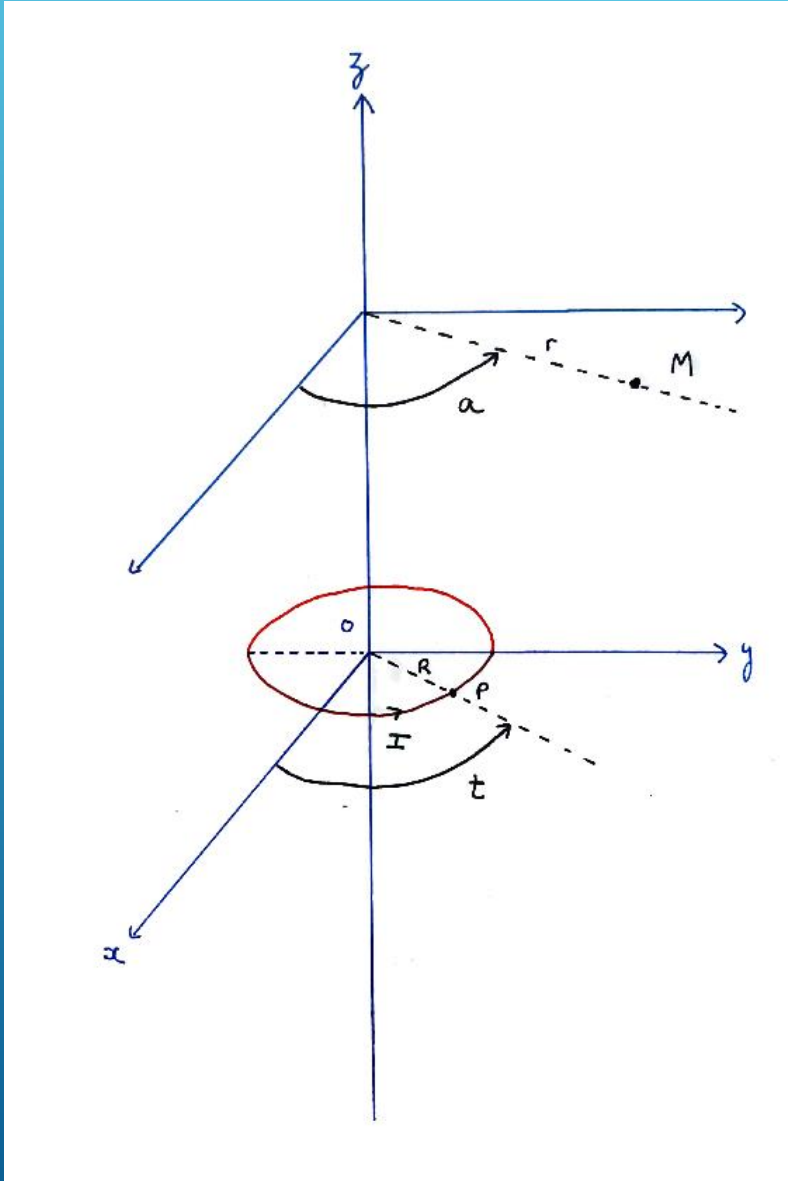
PRINCIPE DE LA RECHARGE PAR INDUCTION :

❖ Courant sinusoïdal + loi de Biot et Savart => Champ magnétique sinusoïdal

❖ Loi Faraday => f.e.m induite:
$$e = - \partial \phi / \partial t$$

❖ Circuit fermé => courant induit

1) Étude théorique



$$\vec{dB}(M) = \frac{\mu_0}{4\pi} I d\vec{l} \wedge \frac{\vec{PM}}{PM^3}$$

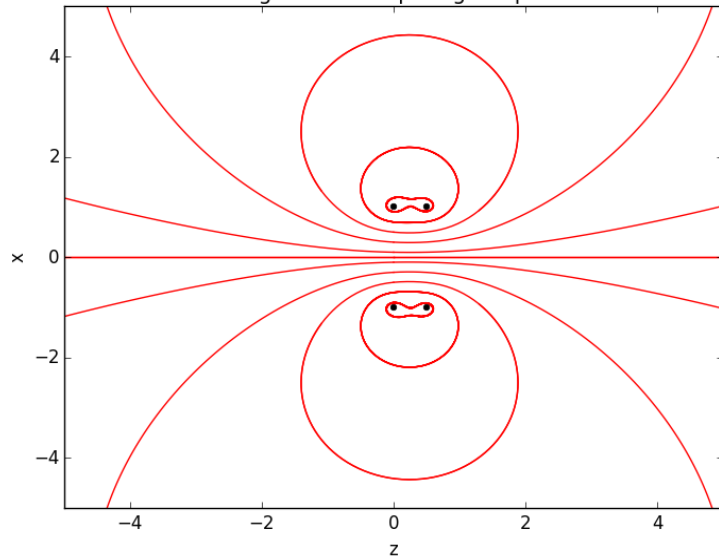
$$B_x = \int_0^{2\pi} \frac{zR \cos(t)}{D^3} dt$$

$$B_y = \frac{\mu_0 I}{4\pi} \int_0^{2\pi} \frac{zR \sin(t)}{D^3} dt$$

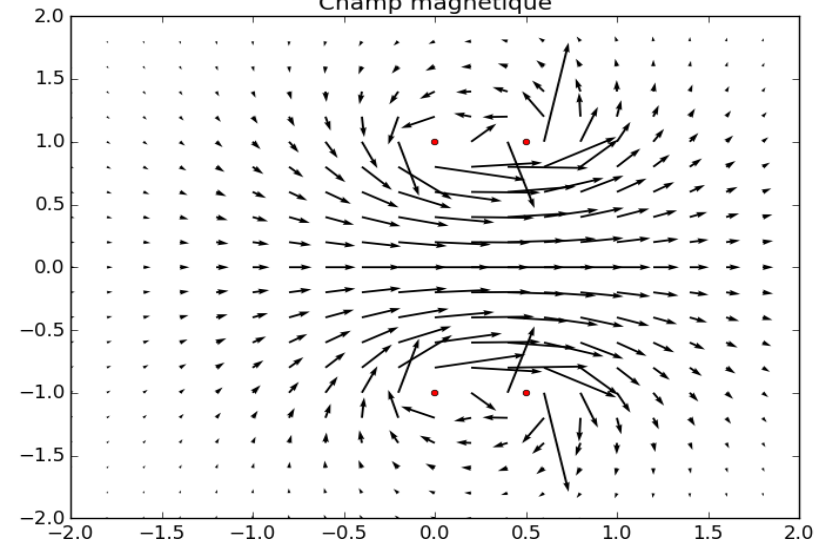
$$B_z = \frac{\mu_0 I}{4\pi} \int_0^{2\pi} \frac{R^2 - Rr \cos(t - \alpha)}{D^3} dt$$

1) Étude théorique

Ligne de champ magnétique



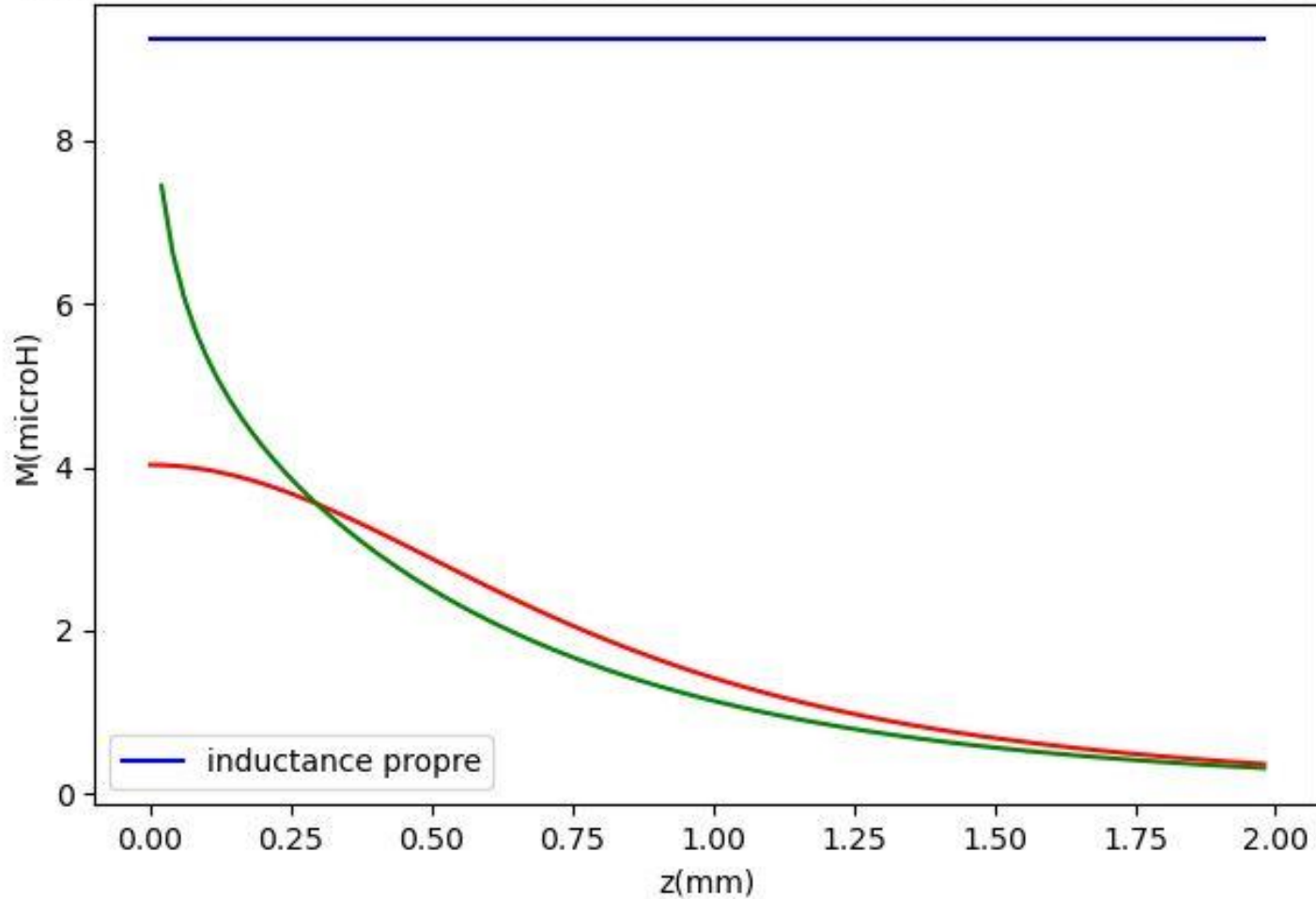
Champ magnétique



COURBES TRACEES AVEC PYTHON

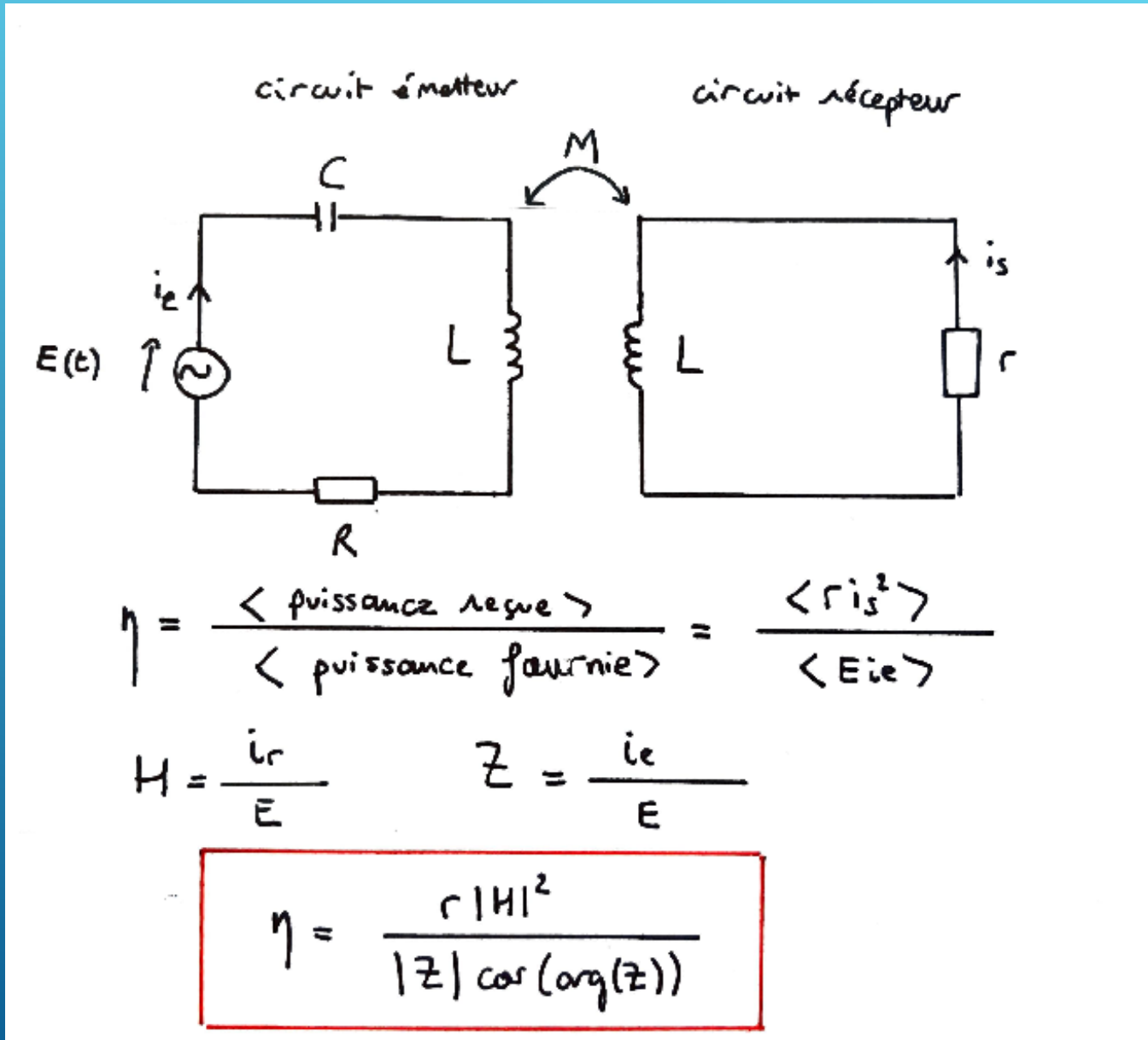
1) Étude théorique

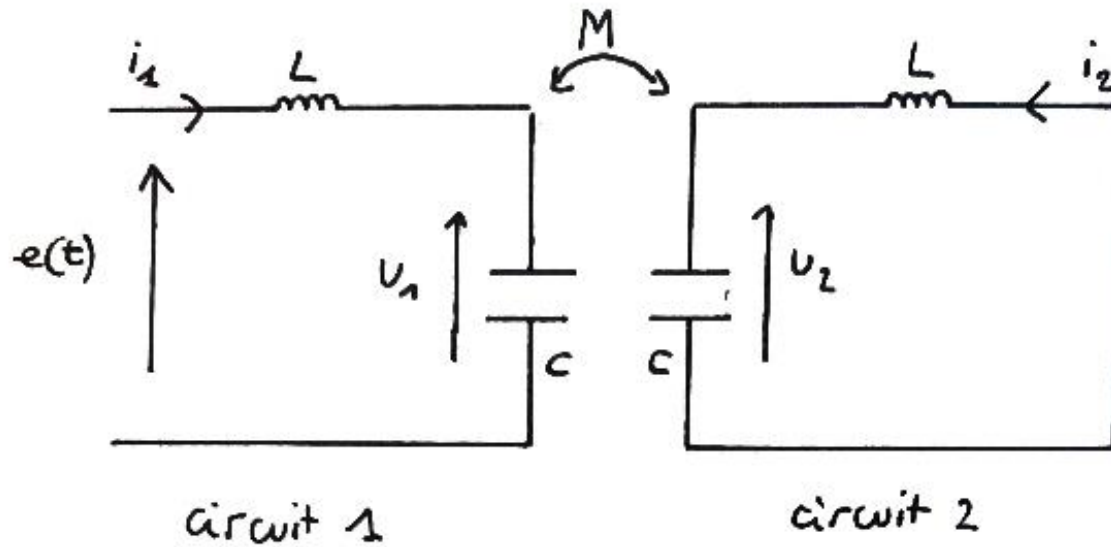
Représentation de l'inductance mutuelle en fonction de la distance sur l'axe



**COURBES TRACEES AVEC PYTHON
ANNEXE 2**

1) Étude théorique





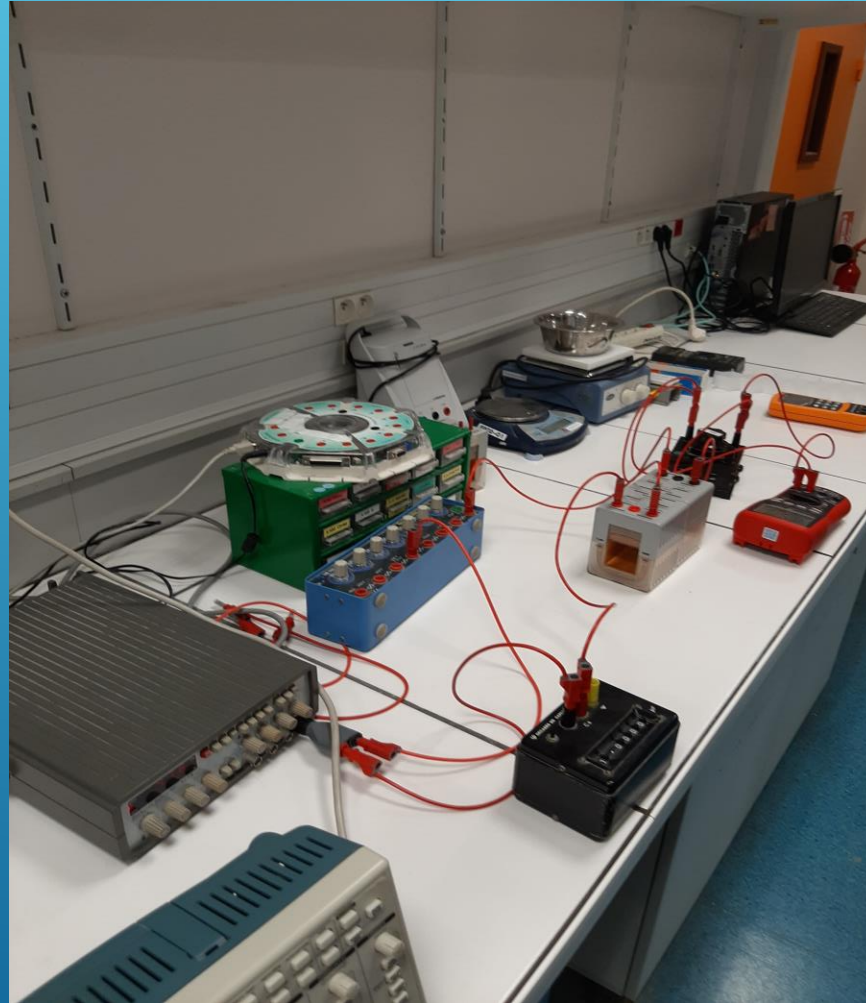
$$\omega_{01} = \frac{1}{\sqrt{C(L+M)}}$$

$$\omega_{02} = \frac{1}{\sqrt{C(L-M)}}$$

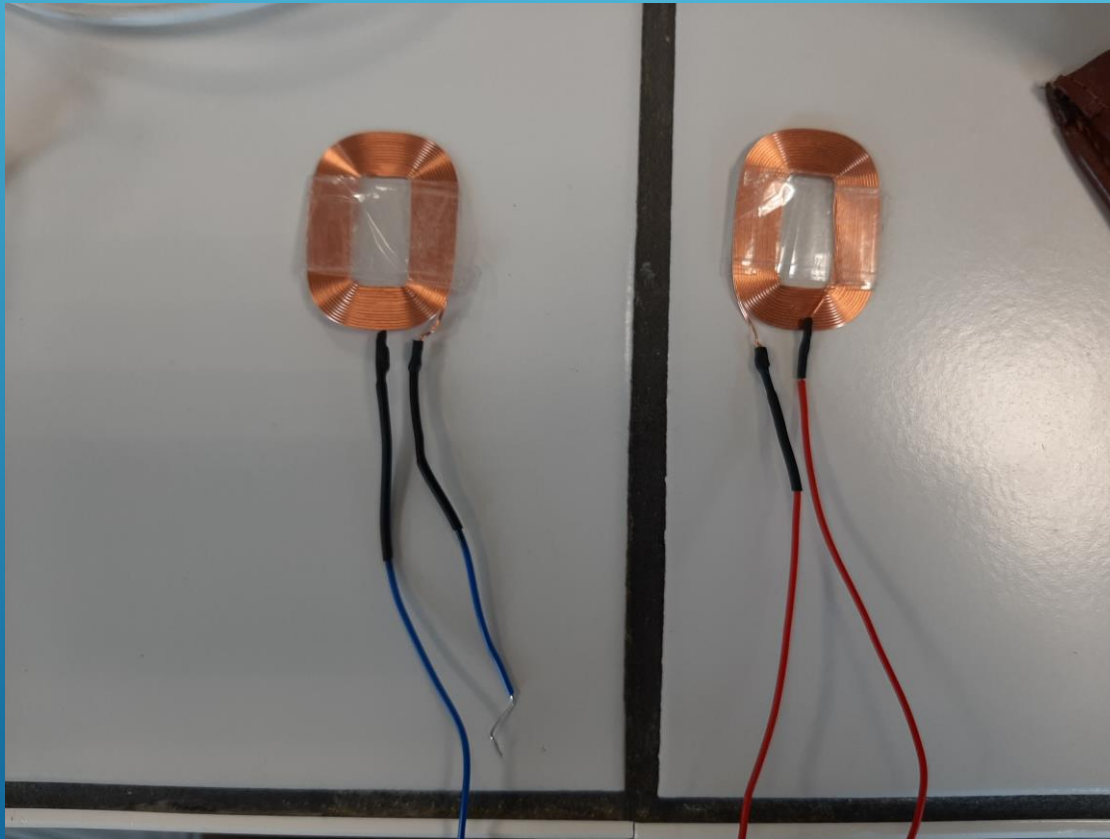
$$M = \frac{1}{2C} \left(\frac{1}{\omega_{01}^2} - \frac{1}{\omega_{02}^2} \right)$$

$$k = \frac{M}{\sqrt{L_1 L_2}} = \frac{M}{L}$$

2) Etude expérimentale



2) Etude expérimentale



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INDUCTANCES
INCONNUES

2) Etude expérimentale

DETERMINATION DE L PAR RESONANCE

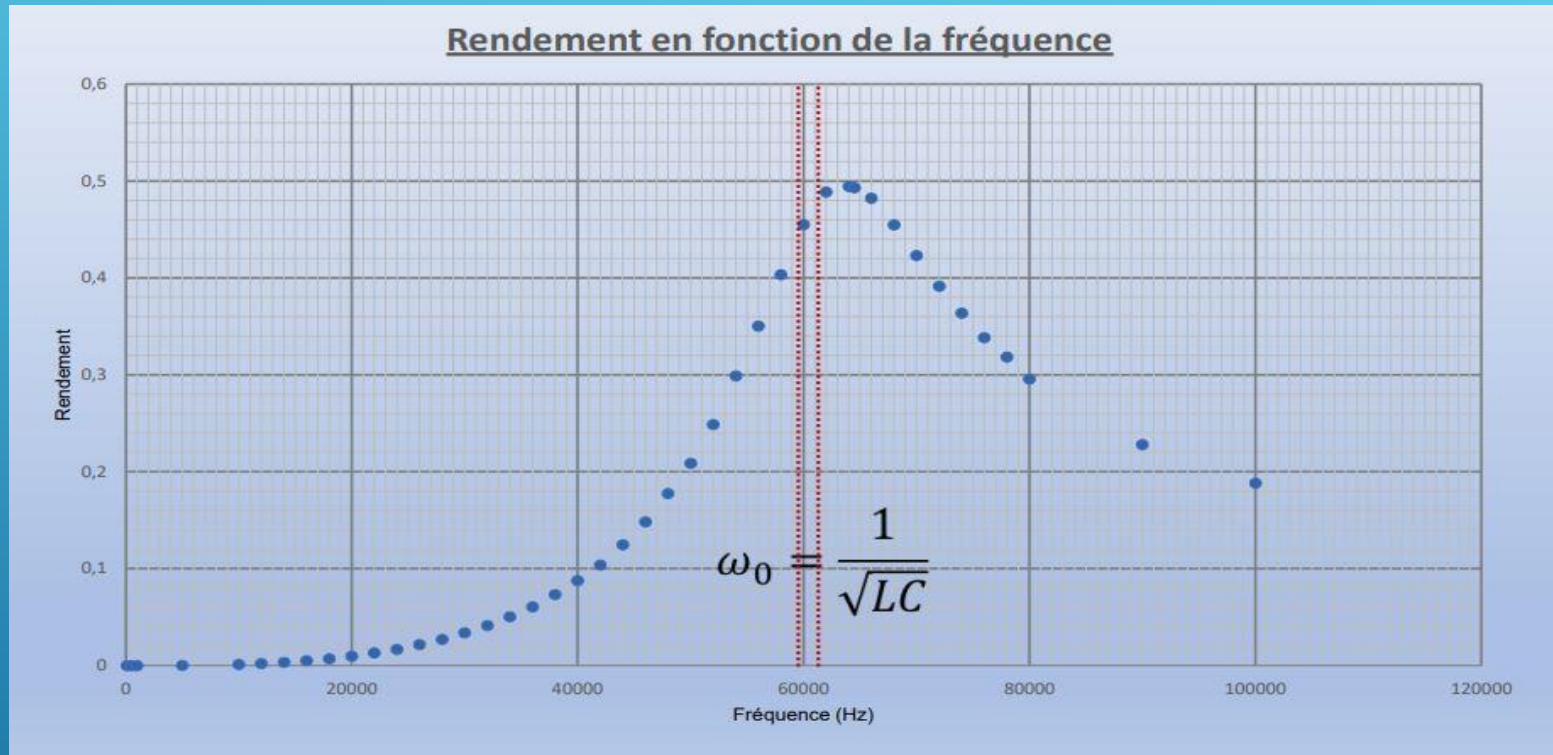
COMPOSANTES DU CIRCUIT RLC:

$$R = 10 \text{ Ohm} \quad C = 10 \text{ nF}$$

$$Q = \frac{1}{R} \sqrt{\frac{L}{C}} \quad \omega_0 = \frac{1}{\sqrt{LC}}$$

$$L = (1,16 \pm 0,02) * 10^{-5} \text{ H}$$

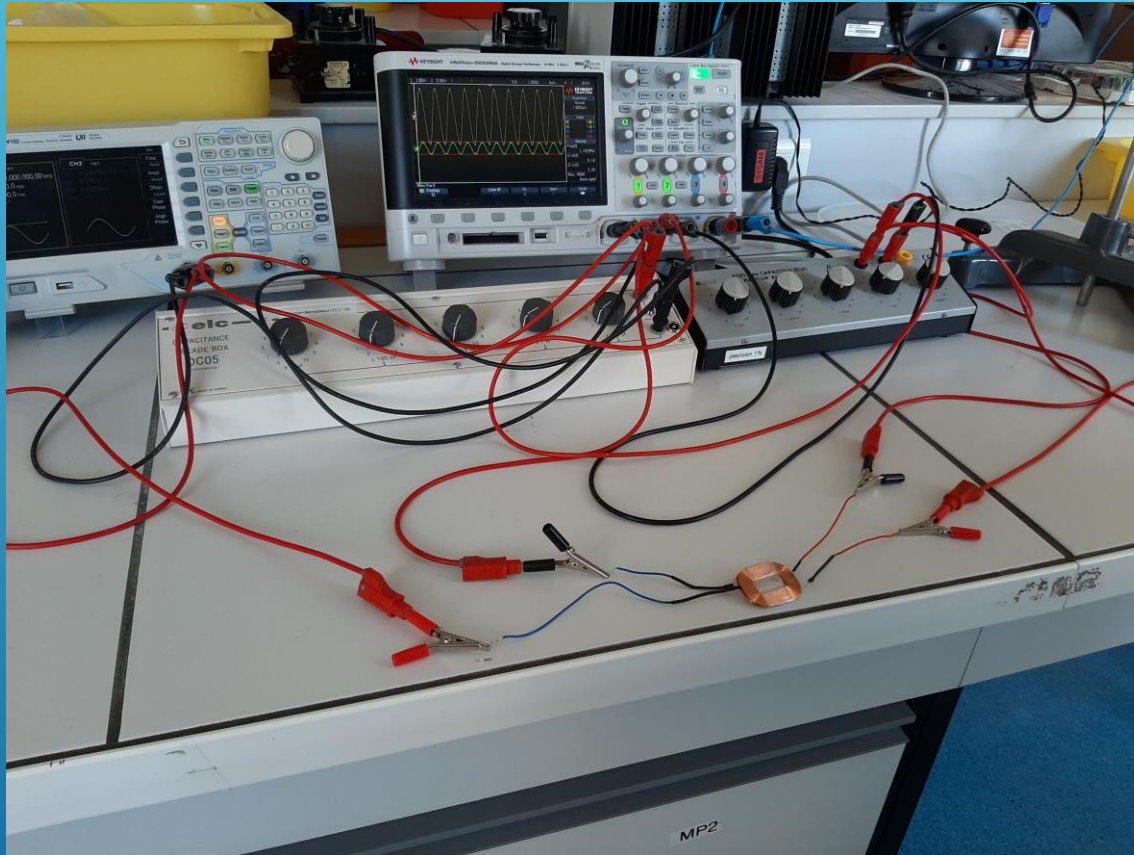
2) Etude expérimentale



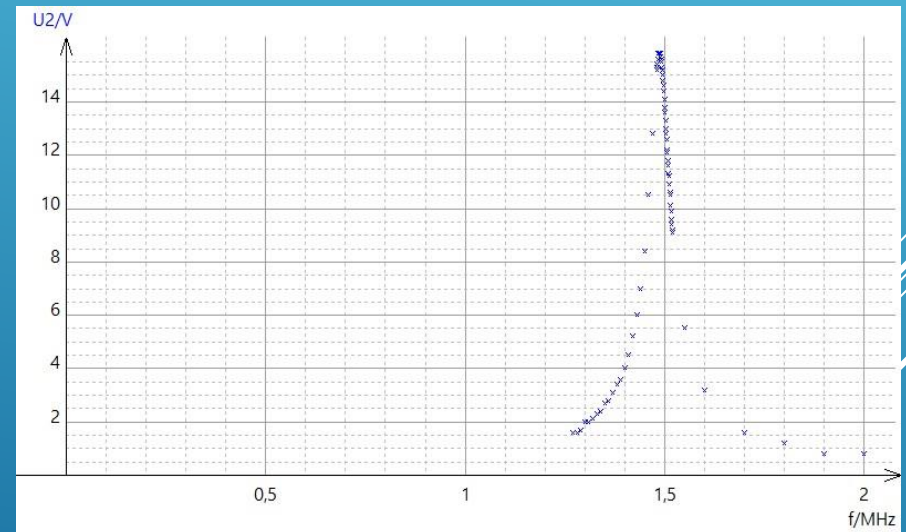
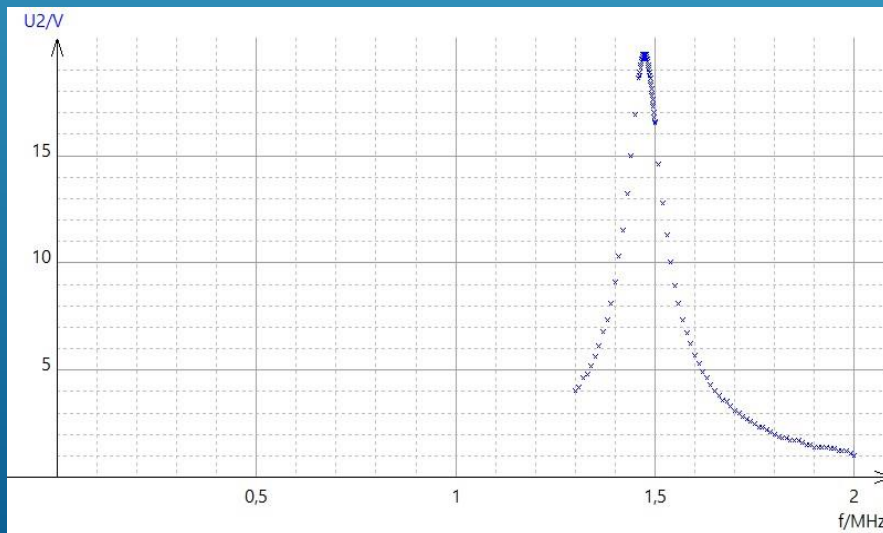
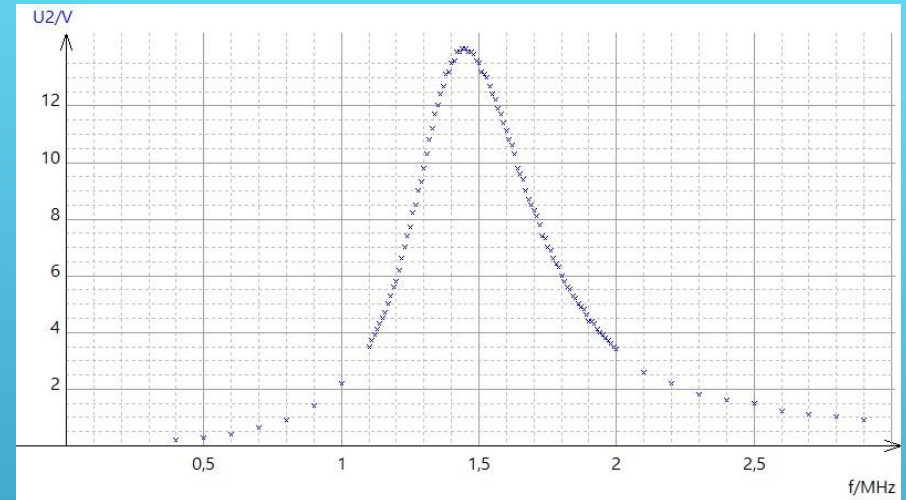
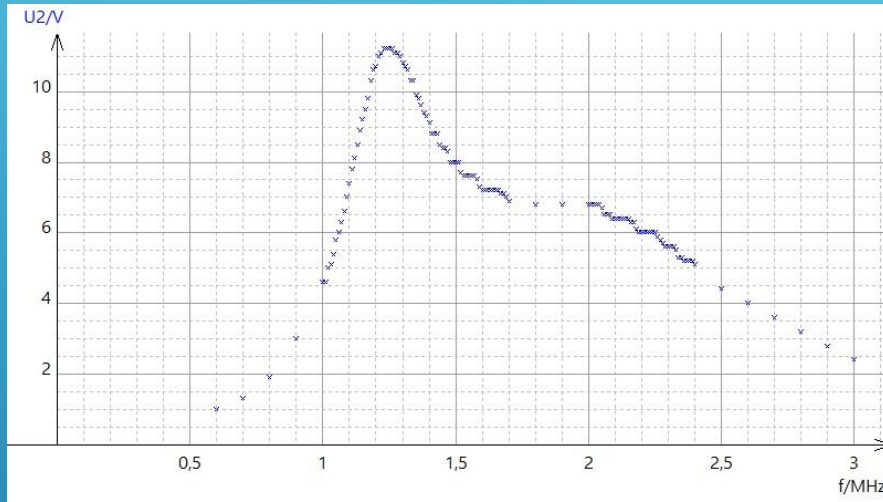
$$C=600 \text{ nF} \quad L=11,6 \mu\text{H}$$

$$f \text{ résonance} = (63 \pm 1) * 10^3 \text{ Hz}$$

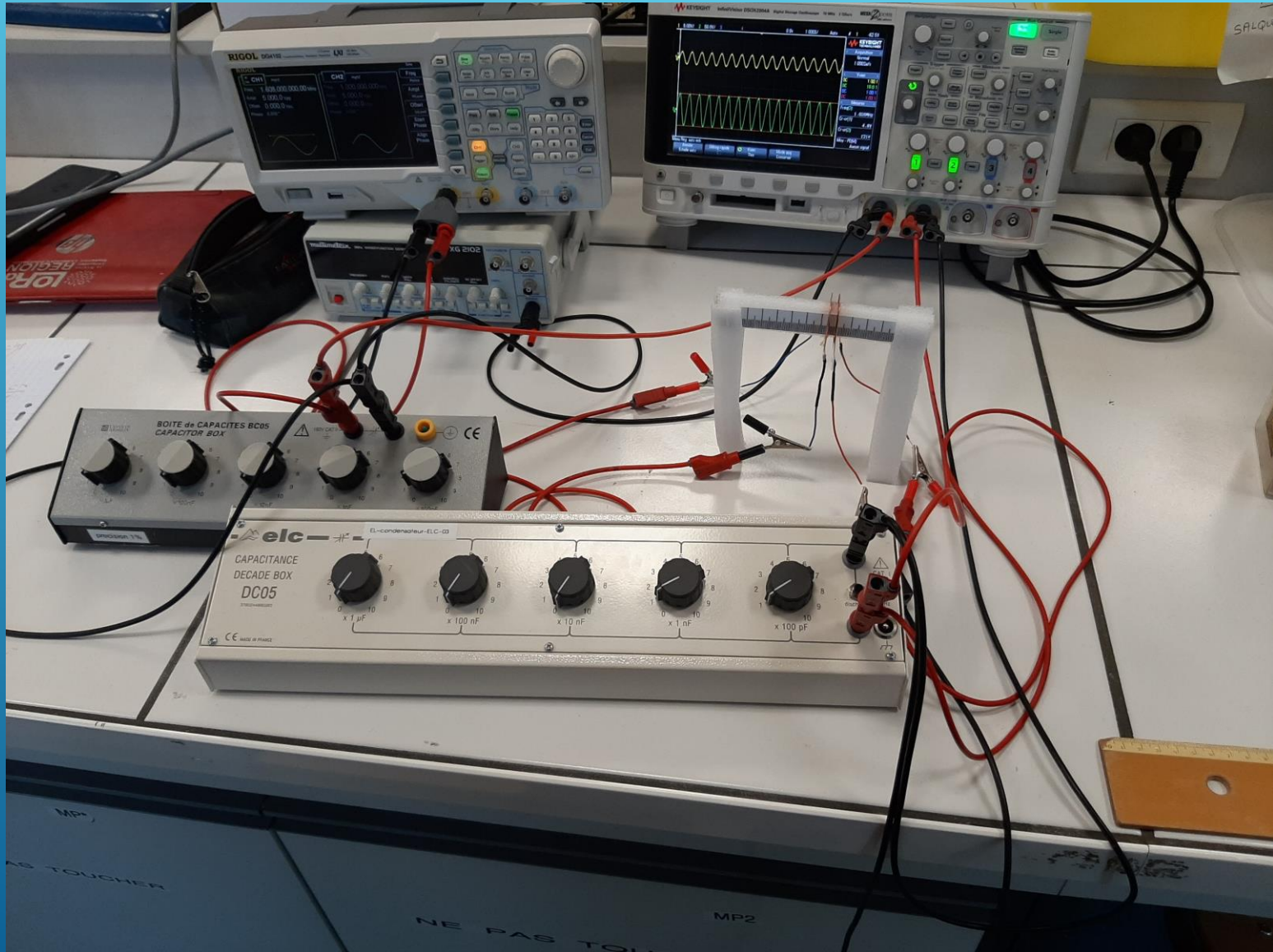
2) Etude expérimentale



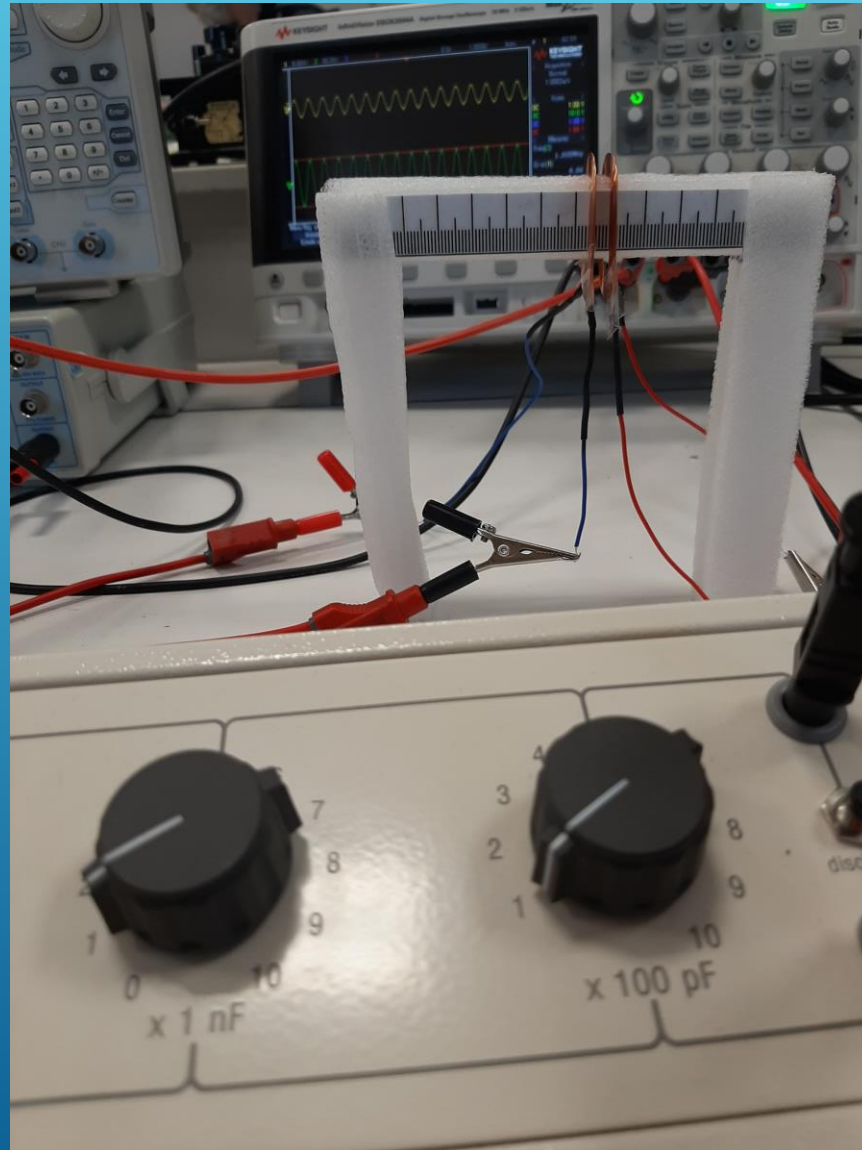
2) Etude expérimentale



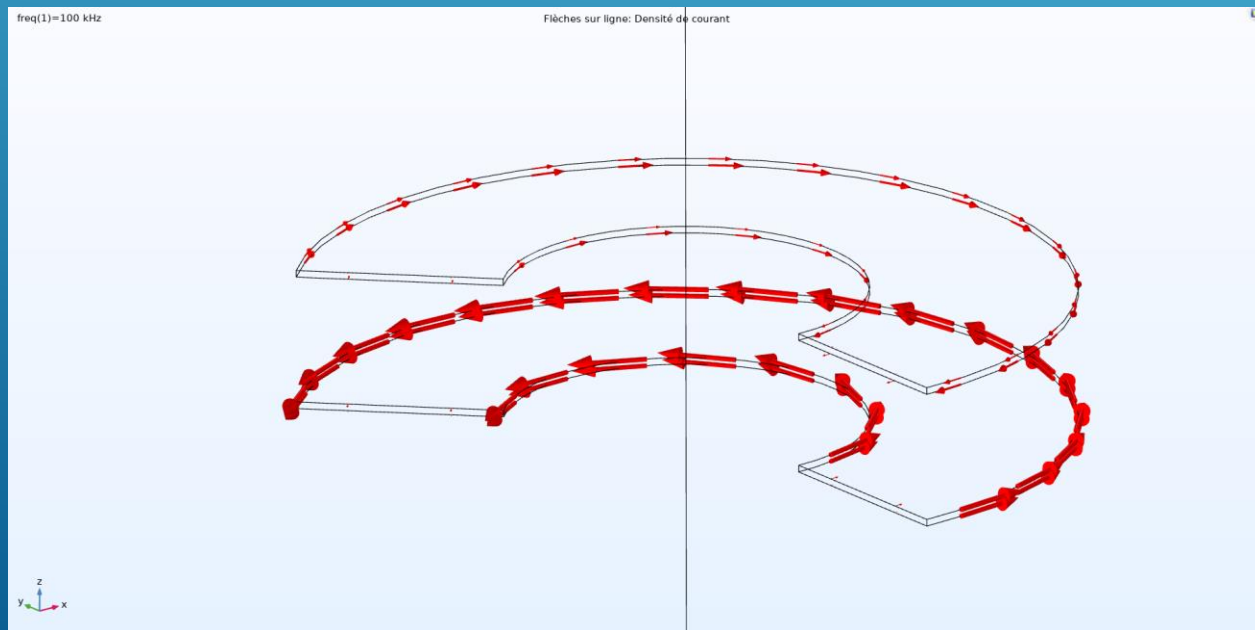
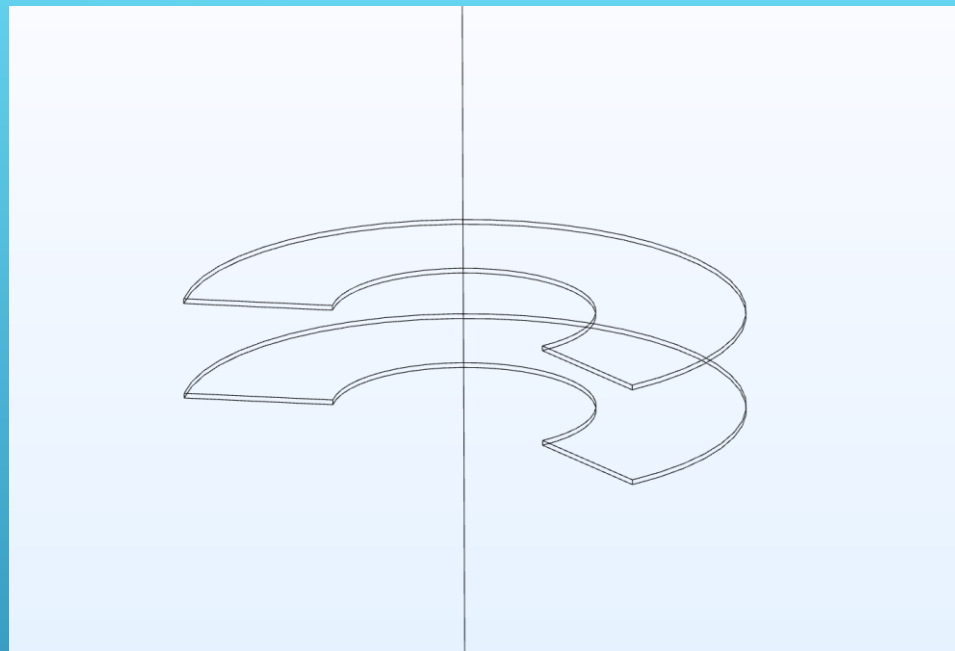
2) Etude expérimentale



2) Etude expérimentale



3) LES SIMULATIONS COMSOL



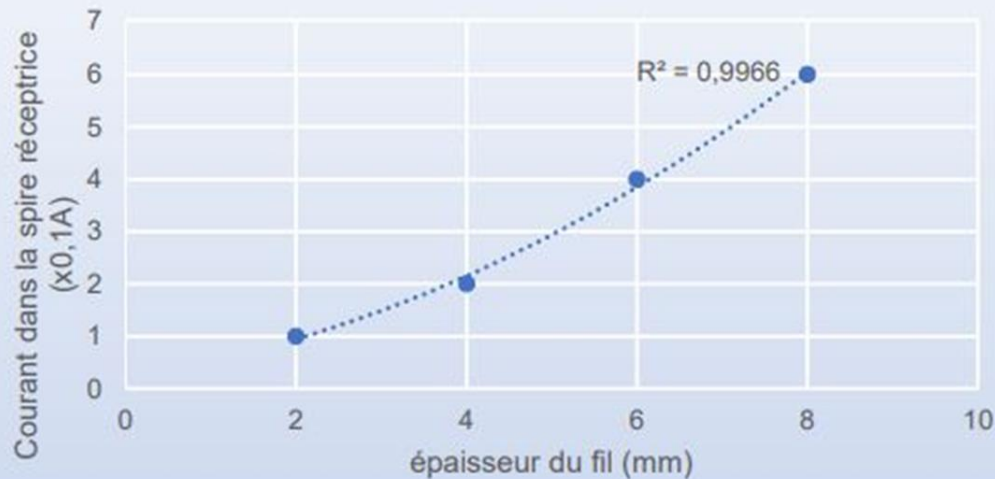
ANNEXE 4

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3) LES SIMULATIONS COMSOL

Nombre de spires (Rayon = 2,5 cm)	Inductance Mutuelle (μH)	Inductance Propre (μH)
10	4,3 ($\pm 0,3$)	10,4 ($\pm 0,2$)
15	8,7 ($\pm 0,4$)	19,2 ($\pm 0,8$)
20	14,8 ($\pm 0,5$)	32,6 (± 1)
25	23,3 ($\pm 1,4$)	47,5 ($\pm 1,5$)

Intensité du courant induit en fonction de l'épaisseur du fil (COMSOL)

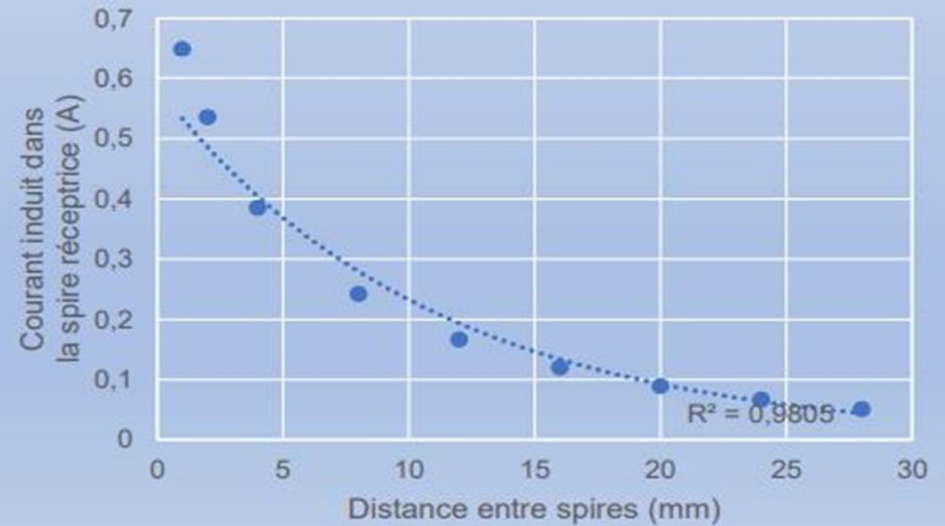


$$R = \frac{l}{\gamma S}$$

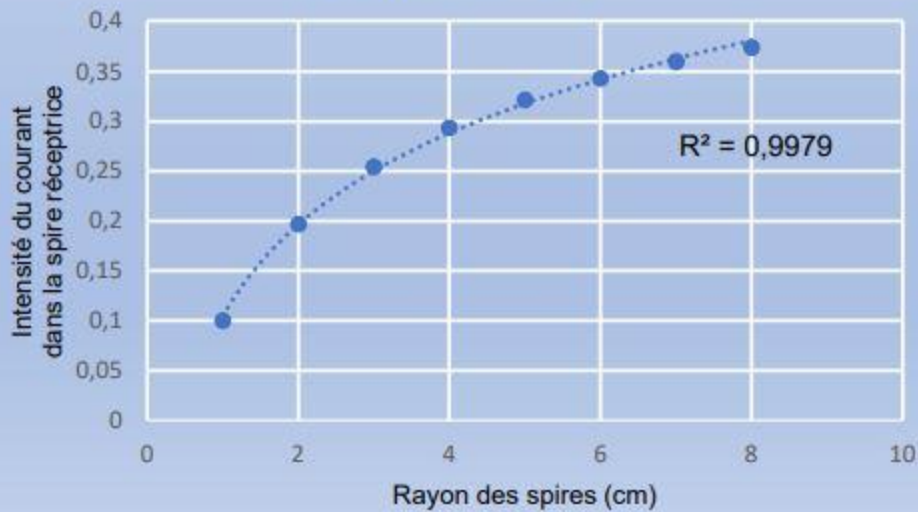
$$\delta = \frac{1}{\sqrt{\omega \mu_0 \gamma}} = 0,15 \text{ mm à } 100 \text{ kHz}$$

3) LES SIMULATIONS COMSOL

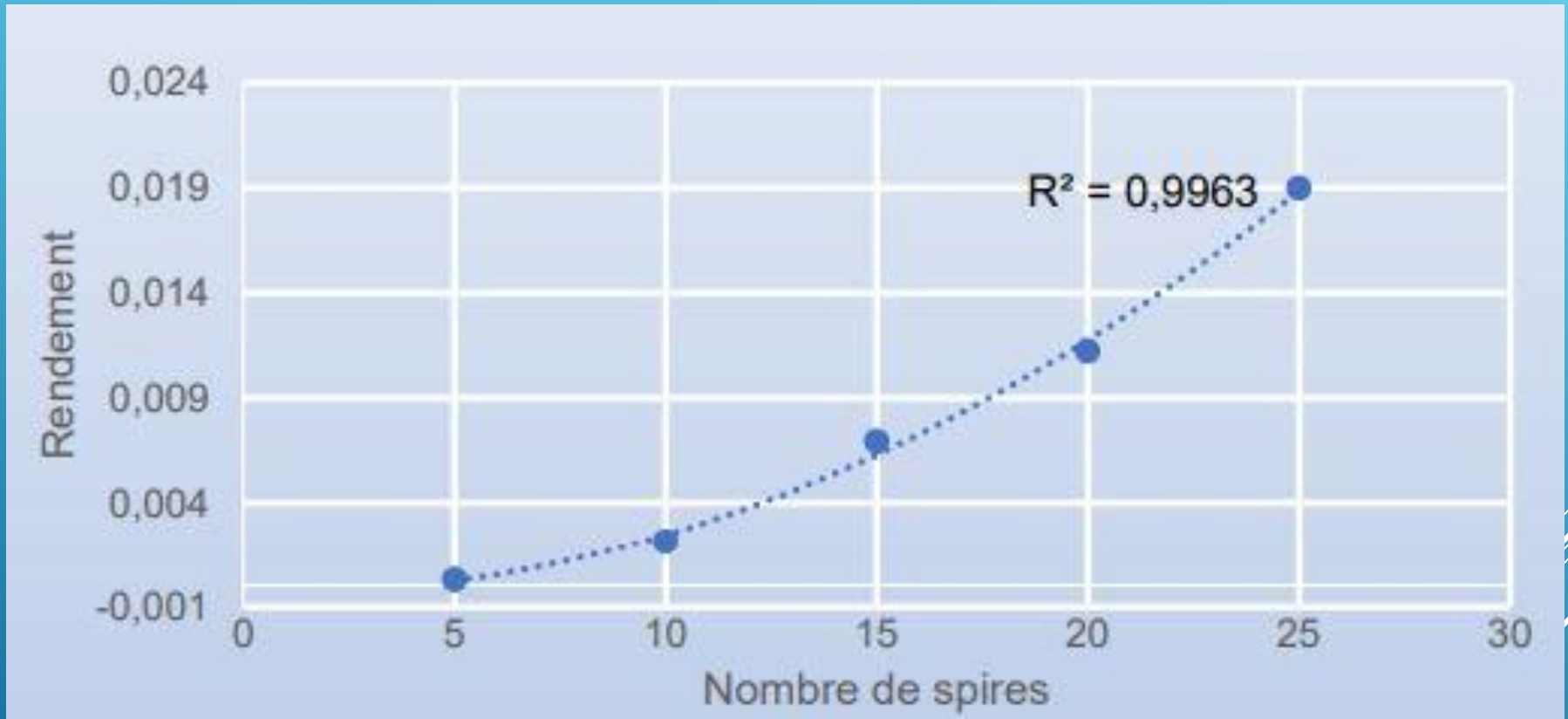
Intensité du courant induit en fonction de la distance entre spires (COMSOL)



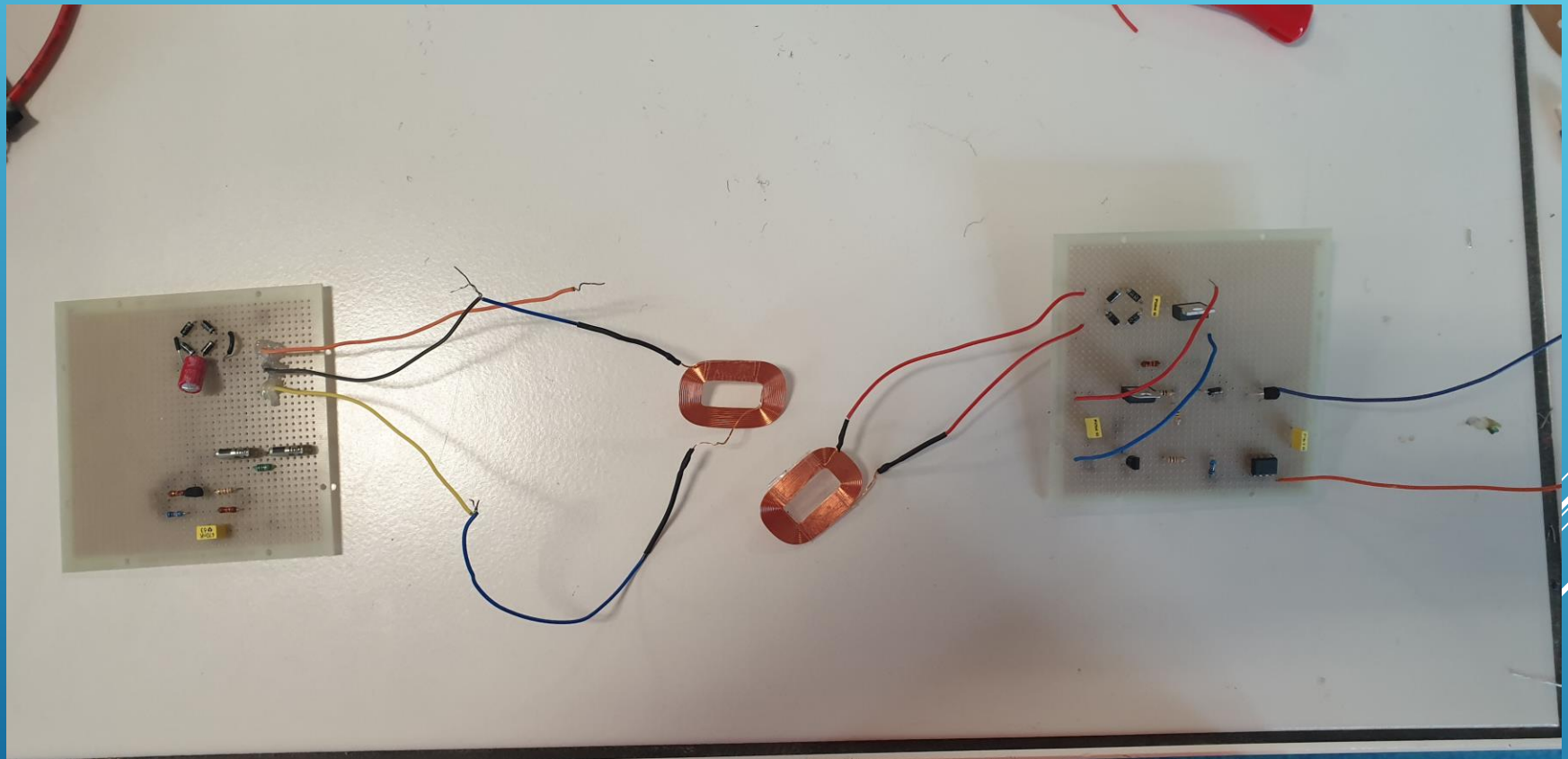
Intensité du courant induit en fonction du rayon (COMSOL)



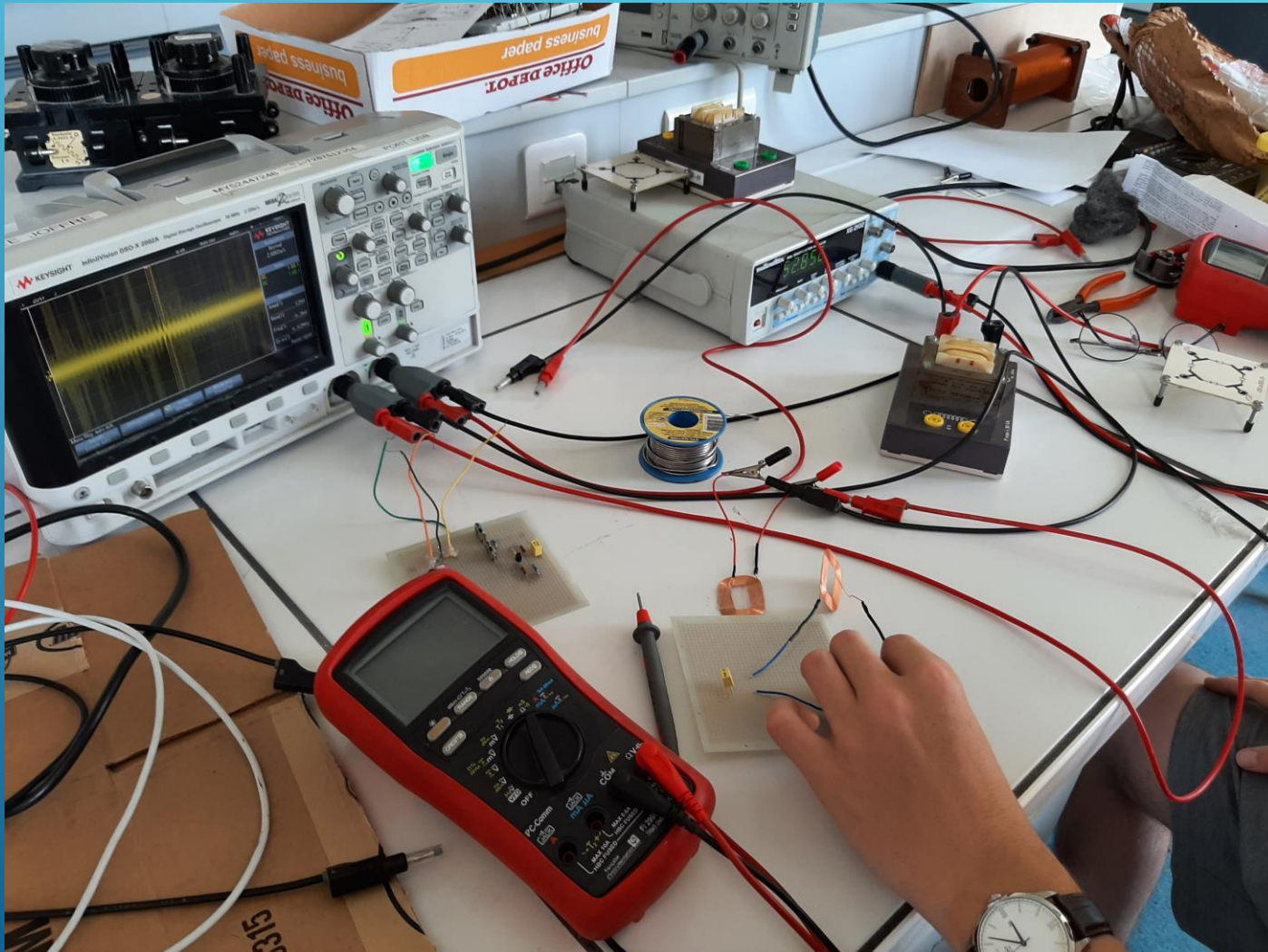
3) LES SIMULATIONS COMSOL

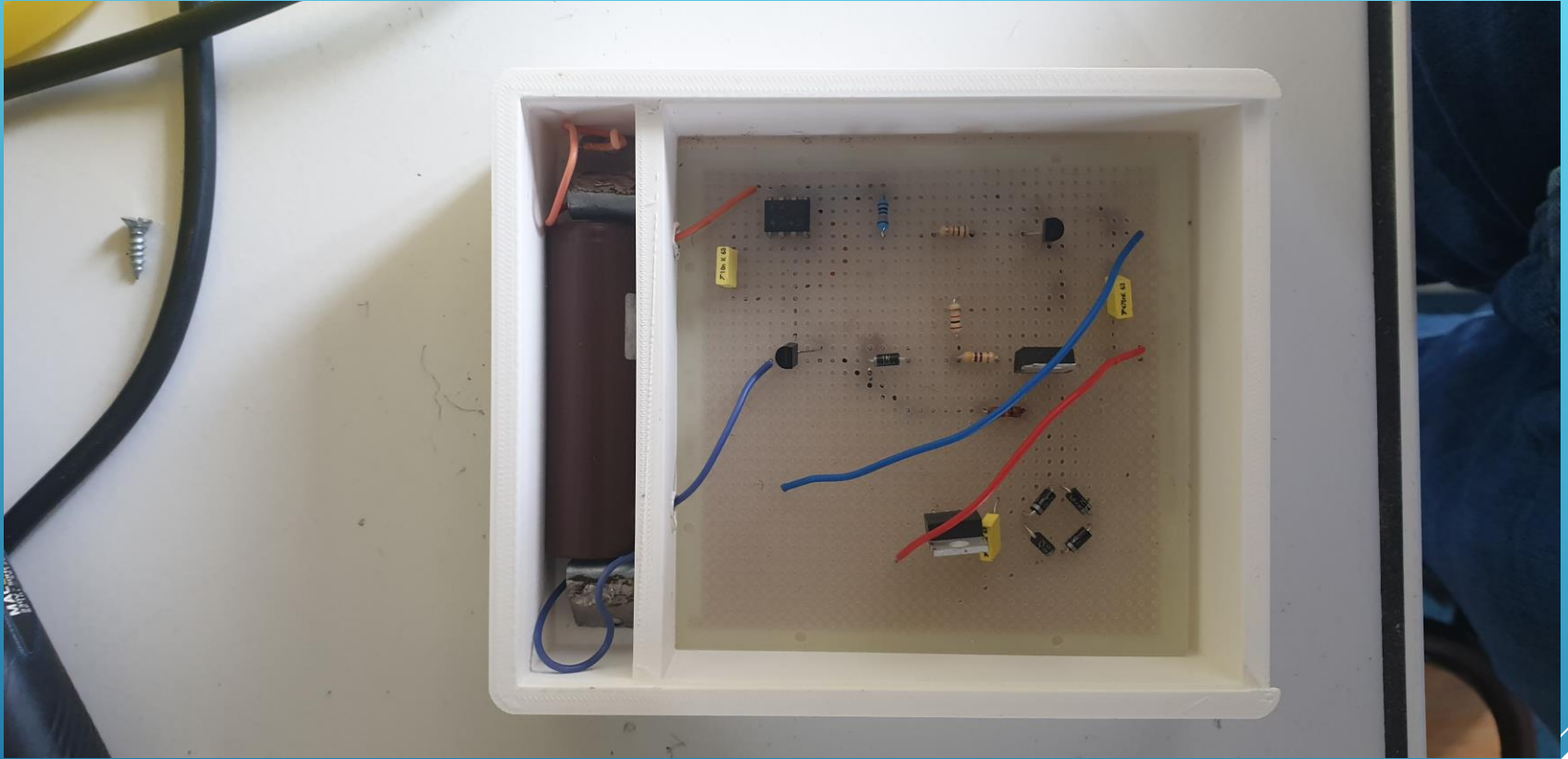


4) REALISATION DU CHARGEUR



4) REALISATION DU CHARGEUR





4) REALISATION DU CHARGEUR

RESULTATS:

BATTERIE DE 3500 mAh

COURANT DE RECHARGE

DE 160mA

22 h NECESSAIRES POUR LA

RECHARGE COMPLETE

CONCLUSION