

MATERIAIS INTELIGENTES  
PARA A RADIOCIÊNCIA

17°

CONGRESSO DO COMITÉ  
PORTUGUÊS DA URSI

LISBOA, 2023 DECEMBER

PRÉMIO “MELHOR PROJETO DE INVESTIGAÇÃO”

Designing Efficient Antennas for Wireless  
Charging of Implantable Medical Devices

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# MOTIVATIONS

**AIMDs** : one of the most extraordinary contributions of electrical engineering to society

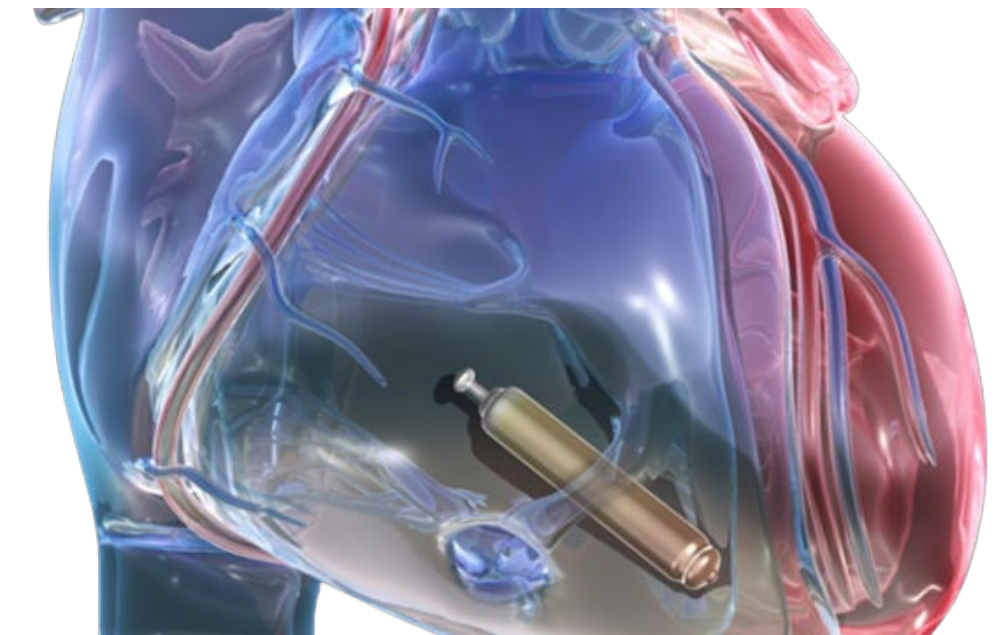
Deep brain stimulators, insulin pumps, cardiac defibrillators and pacemakers, cochlear implants, and gastric stimulators



## motivations

**Two majors causes of pacemaker failure (often requiring new surgery for replacement, increasing Risk of infection)**

- **Battery end of life (Electrical)**
  - The first implanted man had 26 pacemakers during his lifetime.
  - Wireless Power Transfer is required
- **Pacemaker Lead Rupture (Mechanical)**
  - Hearts beats around  $10^5$  times a day
  - Modern Leadless Pacemakers

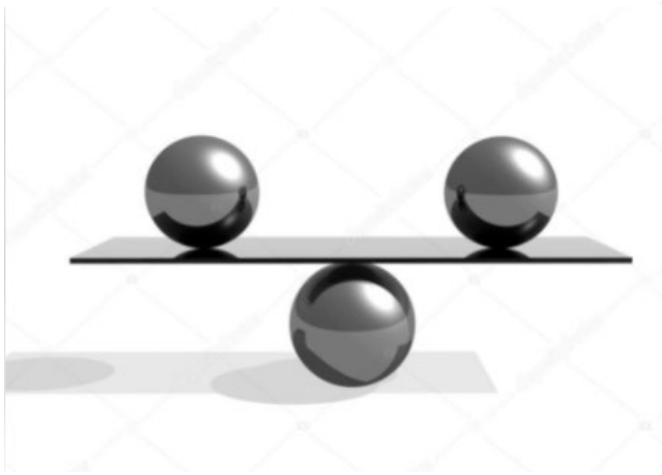


# State of the art

- Inductive Coupling
- Capacitive Coupling
- Propagating Electromagnetic
- Microwave
- Photo-electricity

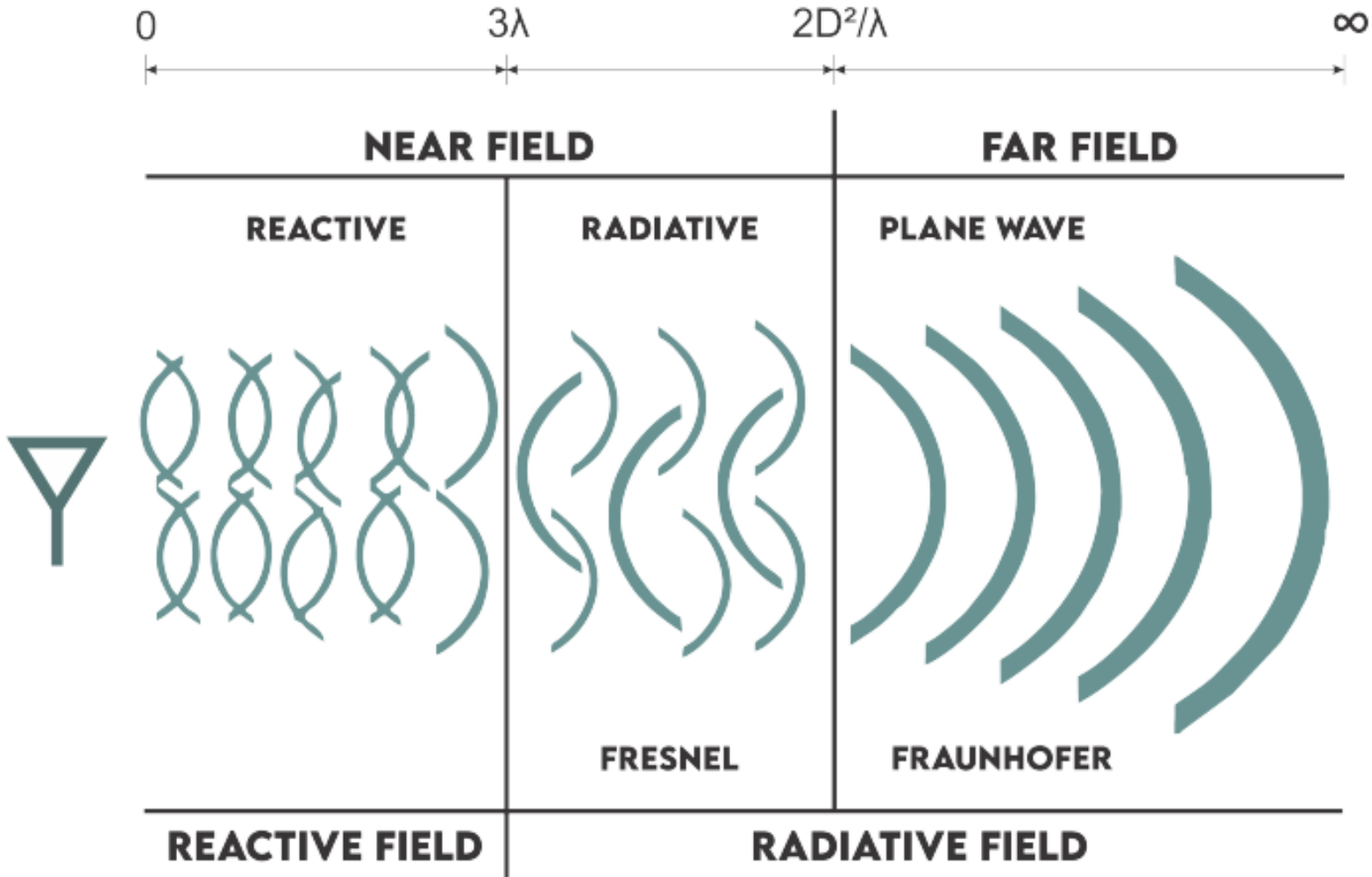
Freq	Directivity	Range	Penetrability	Efficiency
Low Hz~MHz	Weak	Short	Strong	High
Low Hz~MHz	Weak	Short	Strong	High
Medium MHz~GHz	Medium	Medium	Medium	Medium
High GHz~THz	Strong	Long	Weak	Low
High >THz	Strong	Long	Weak	Low

(Sun, 2013)



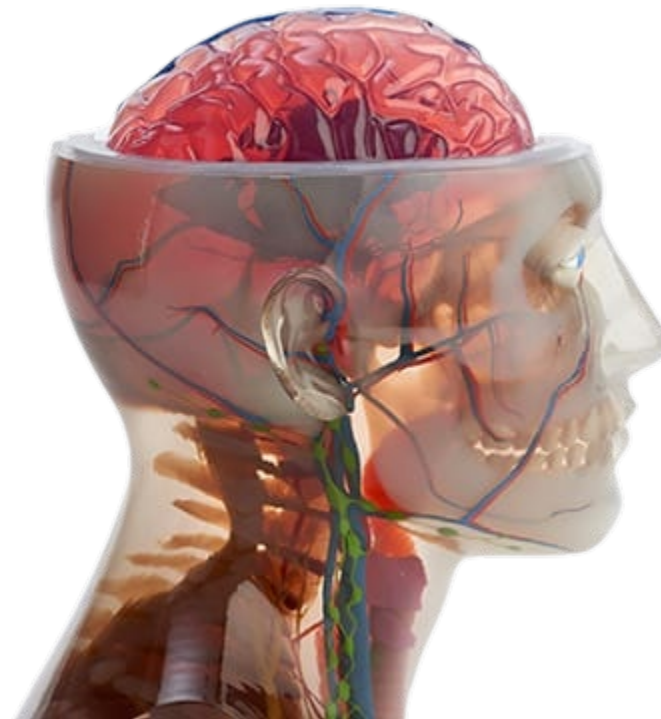
Trade-off between range and efficiency

# Antennas regions

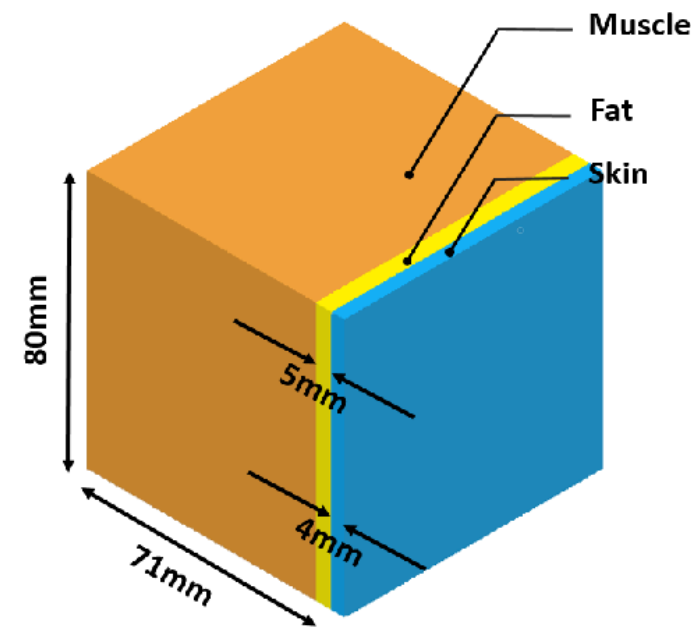


# State of the art

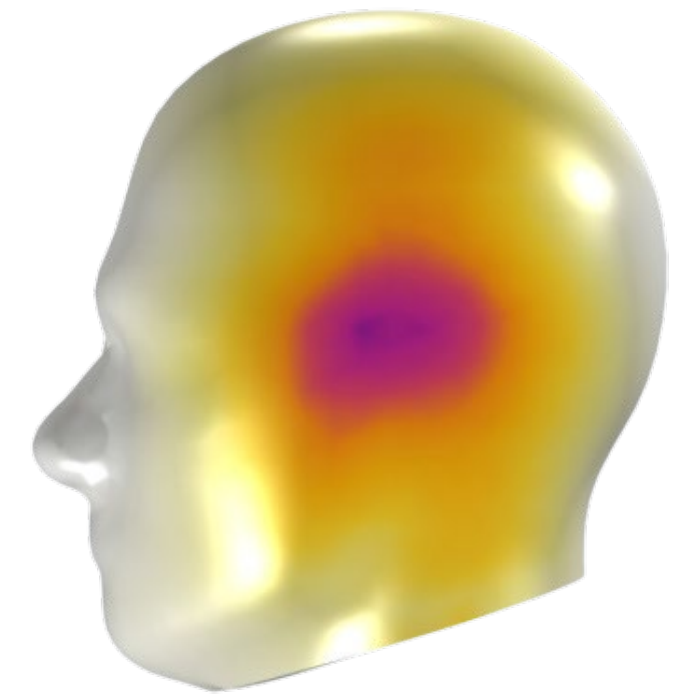
d r a w b a c k s



**Biocompatibility**  
(Titanium, silicone, alumina...)



**Human tissues modeling**  
(nonhomogeneous environment)



**Specific Absorption Rate**  
(exposition of electric fields on people)

Thanks for your attention!

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