Bistable Electromechanical Receiver For Ultra-low Frequency Wireless Power

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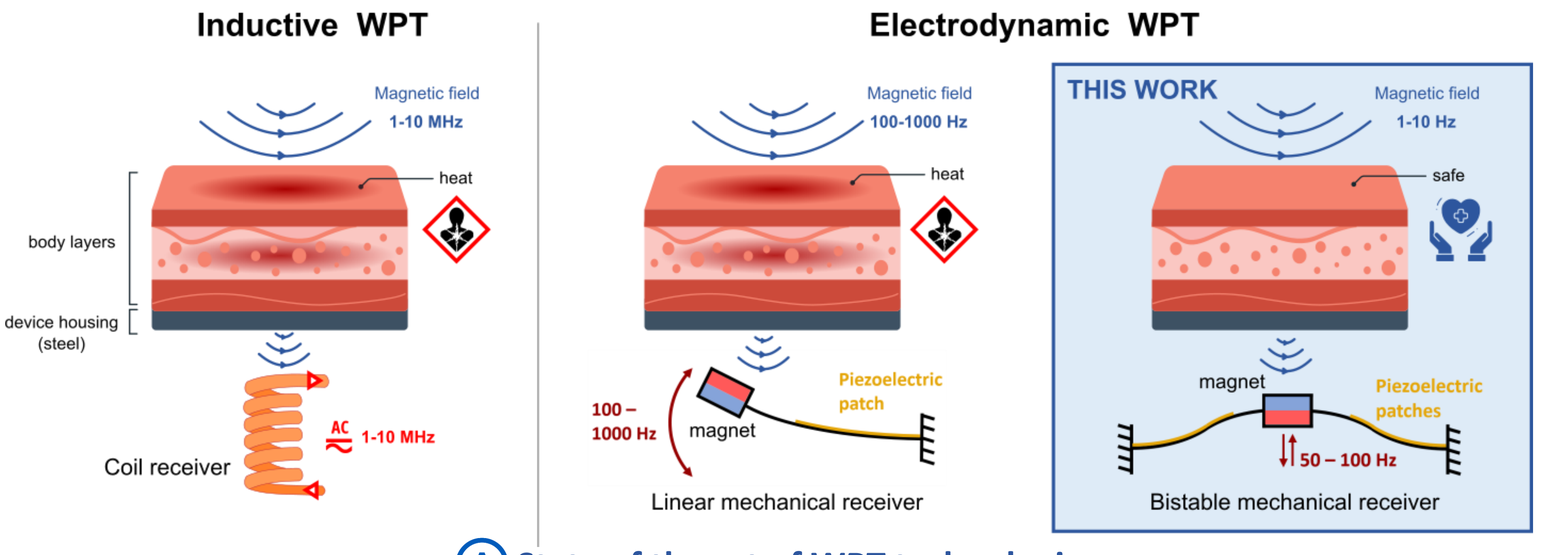
Aim

*To design a safe and efficient wireless power transfer **(WPT)** to charge implantable biomedical devices.*

Traditional inductive WPT transmitters operate at a **magnetic field** of ~1 Mhz, which is incompatible with health standards.

We aim at reducing this frequency to **~1 Hz**, to limit the absorption into the body and allow **greater efficiency at no risk to health**.



(A) State of the art of WPT technologies

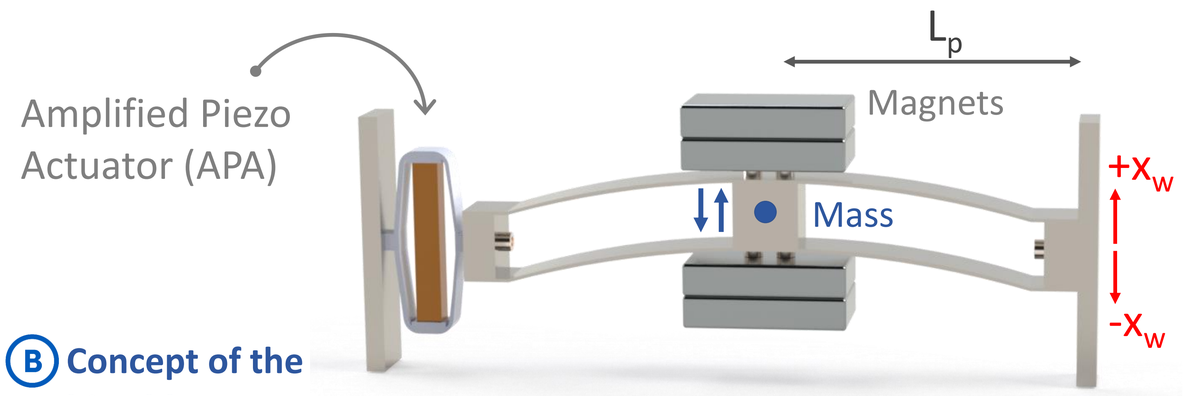
Concept

To decrease the frequency of magnetic field we proposed to:

- Use a **mechanical receiver** (instead of inductive) to lower the natural pulsation.
- Exploit structural **multistability** to enhance low-frequency energetic behaviours.

To achieve this, we designed a receiver with:

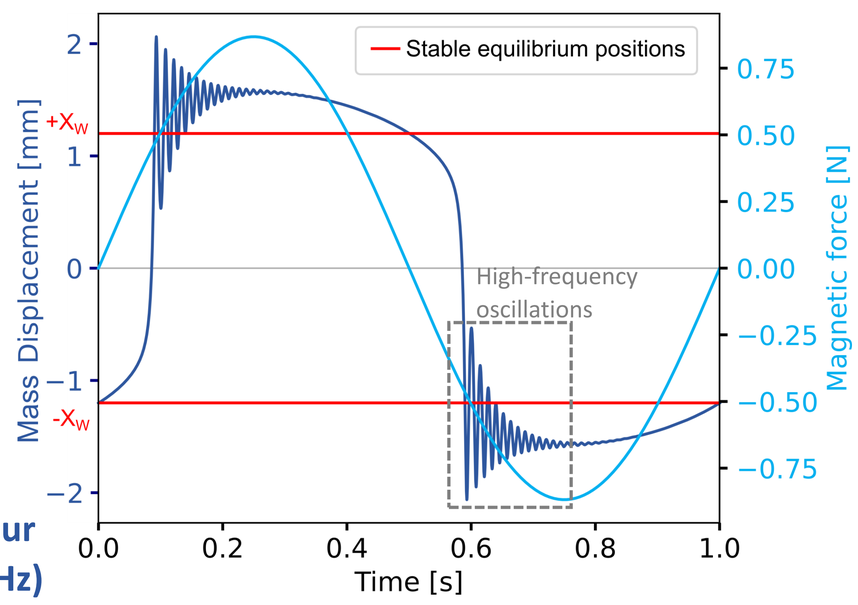
- A buckled-beams based structure inducing **bistability**.
- A magnetic mass moving with the B field.
- A **piezoelectric stack** converting mechanical energy to an electrical form.



(B) Concept of the bistable EM receiver

Numerical Analysis

Simulations of the receiver's mechanical behaviour, modelled by a system of coupled ODE.

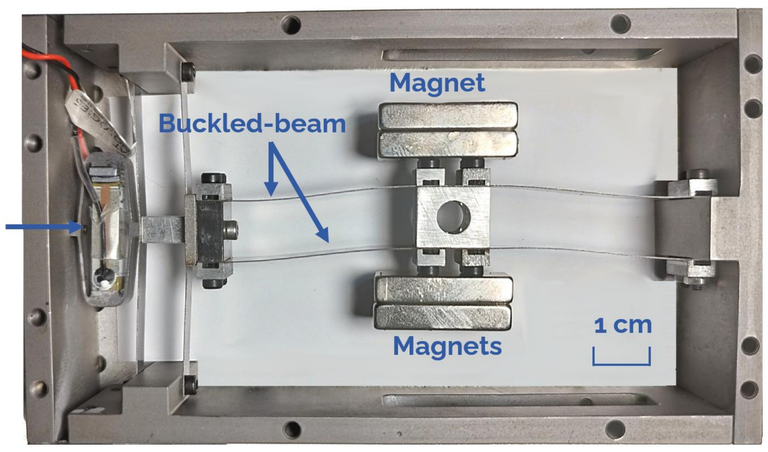


(C) Time behaviour (excitation 1 Hz)

Experimental tests

A first non-optimized prototype has been created and tested under a magnetic field of 1 Hz and 20 mT amplitude.

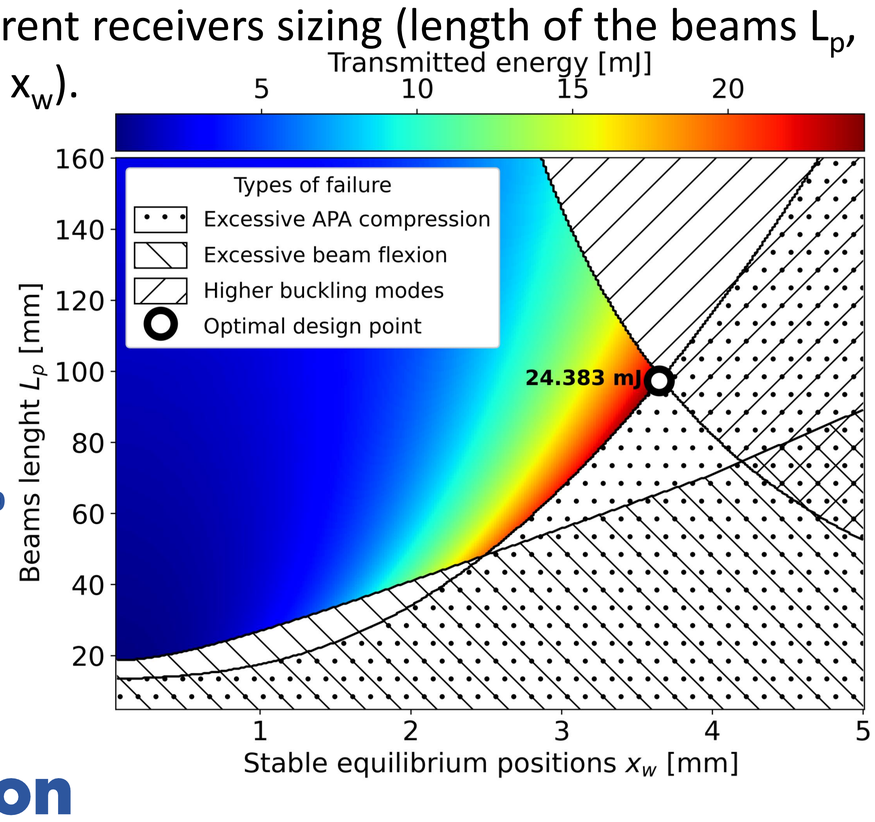
Results: **5.6 mW** of transmitted power.



(D) First prototype

Optimization

For optimizing the transmitted energy, we computed a large number of different receivers sizing (length of the beams L_p, stable positions x_w).



(E) Optimization map

Excitation freq: 1 Hz
Excitation Bmag: 20mT
Mass: 22.8 g
APA120S

Conclusion

We realized a first prototype of a WPT system operating with **ultra-low frequency** magnetic field (1 Hz).

Further works will push the maturation of the nonlinear receiver concept with the fabrication of an optimized and miniaturized prototype.

More info

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