Platform EGG

Mechanical characterization of human oocytes

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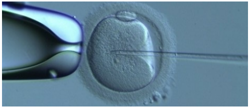
Context of this work



Infertility

- In France : 10 - 16 % of couples have conceiving difficulty

Assisted reproductive technology ART

- In the world : 1.5×10^6 ART per year
- ART represents in France 1 birth / 34

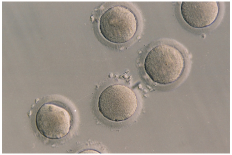
ICSI

- France 2013 : 40 006 ICSI attempts
- Success rate **21.8 %**

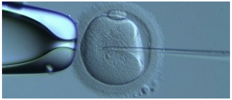
Context of this work

ICSI procedure

- Ovarian stimulation
- Ovarian puncture within 36 hours



- Selection of oocytes on morphological criteria
- In vitro fertilisation and culture of embryos for 2-5 days



- Transfer to the uterus

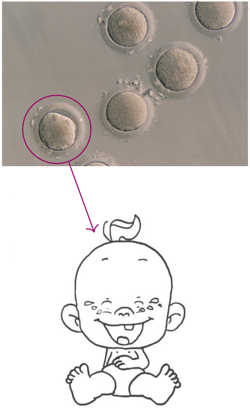
Context of this work

Cause of miscarrying

- Technical problem
- Spermatozoon quality
- Oocyte quality

Oocyte choice criteria

- Morphological (classical)



Context of this work

Cause of miscarrying

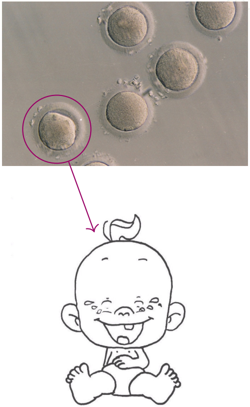
- Technical problem
- Spermatozoon quality
- Oocyte quality

Oocyte choice criteria

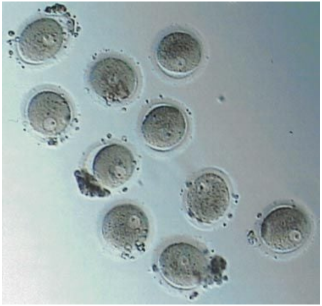
- Morphological (classical)

Platform EGG

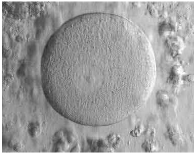
Produce objective mechanical criterion to help physicians determine which oocyte should be inseminated and transferred



Morphological selection criteria



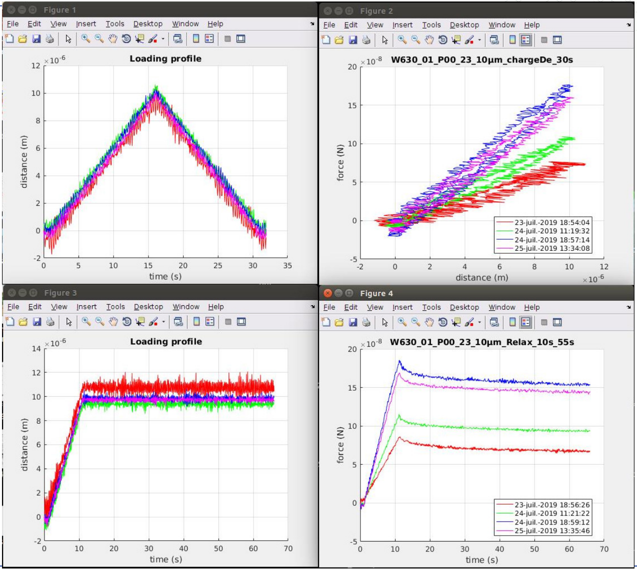
VG



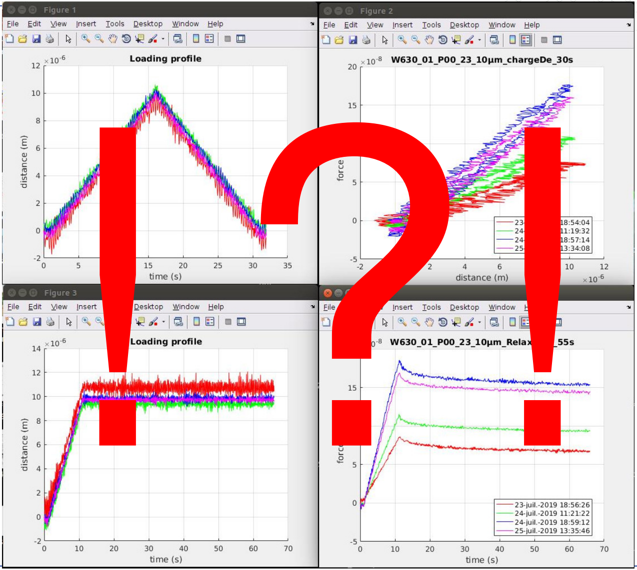
M1

M2

Mechanical selection criteria



Mechanical selection criteria



A mechanical test

Our first Time

Outline

Outline

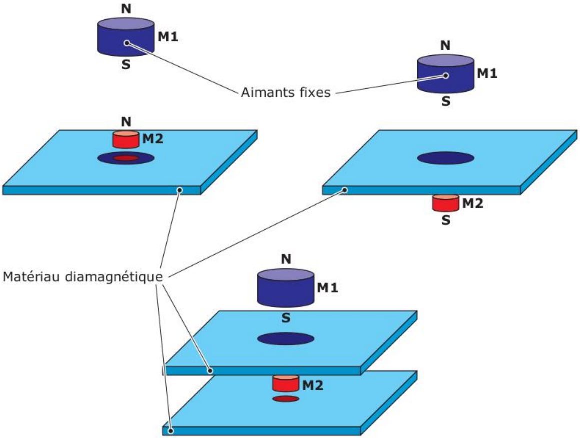
1. Concept of Magnetic spring
   - Simplest configuration
   - First force sensor design
   - Oocyte characterisation platform
   - Active magnetic springs
2. Capteur EGG
   - Global design
   - Magnetic springs design
3. Conclusion and perspectives

Magnetic levitation

Quite simple

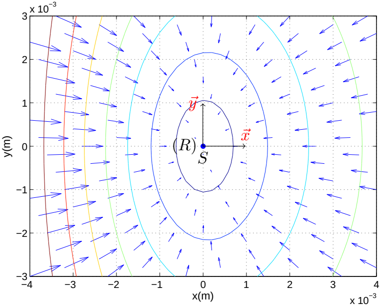
Magnetic levitation

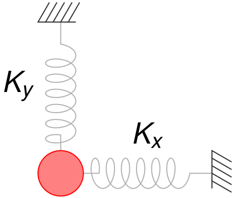
Basics



Magnetic levitation

Horizontal behavior



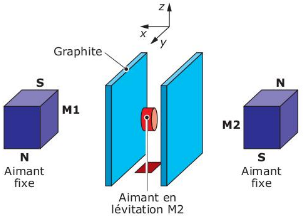


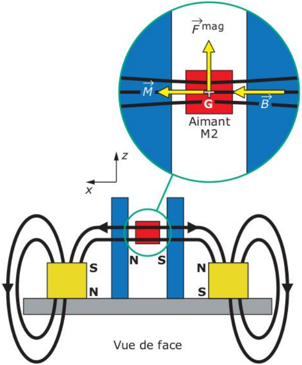
$K_x \approx 0.01$ N/m

Displacement of 1 μm $\Longrightarrow$ force of 10 nN

First force sensor design

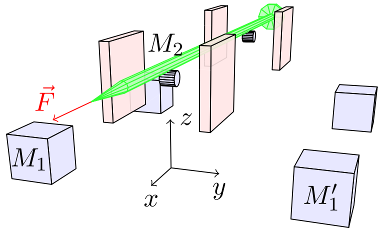
Design modification

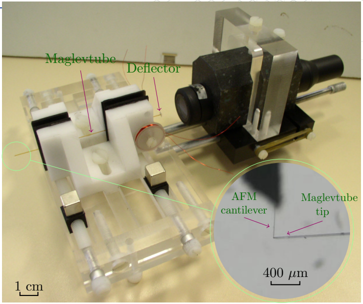


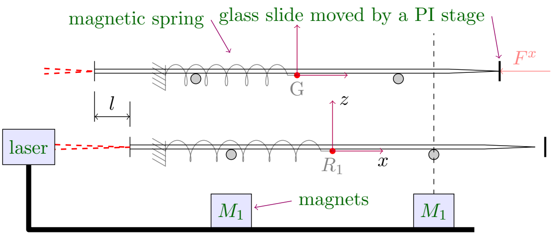


First force sensor design

Final design



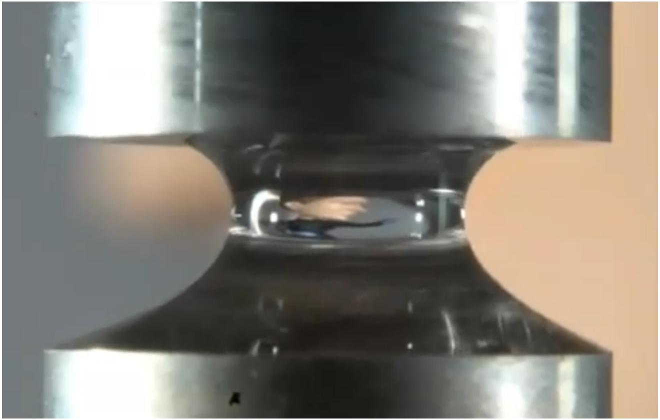




First force sensor design

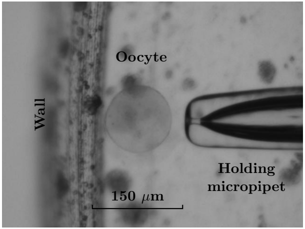
Application to oocyte characterisation

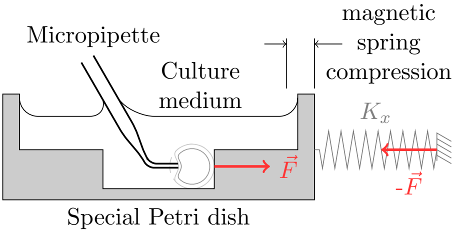
Problem of surface tension



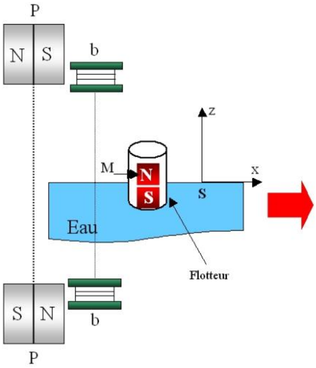
First oocyte characterisation platform

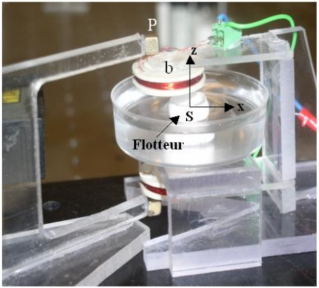
Force instrumented Petri dish





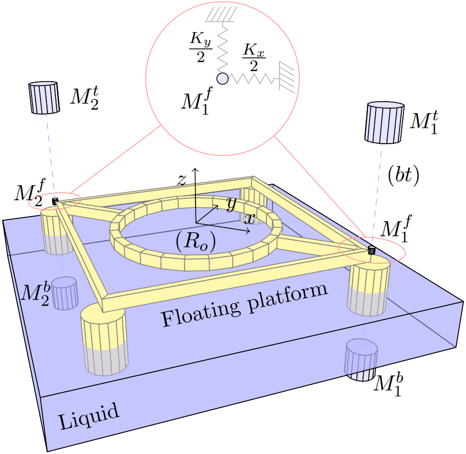
First oocyte characterisation platform
Using buoyancy





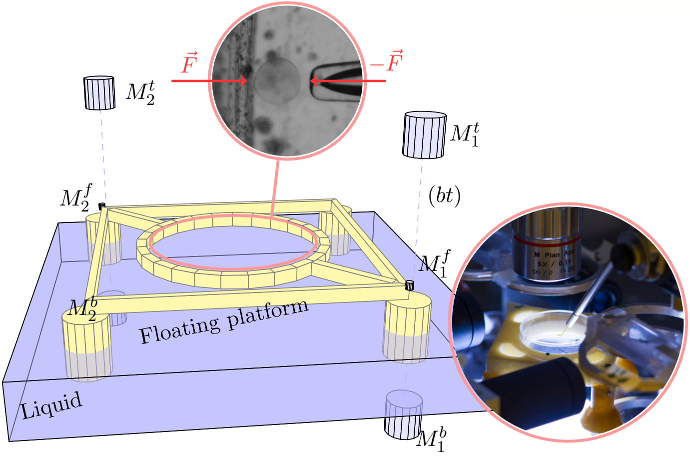
First oocyte characterisation platform

Entire platform



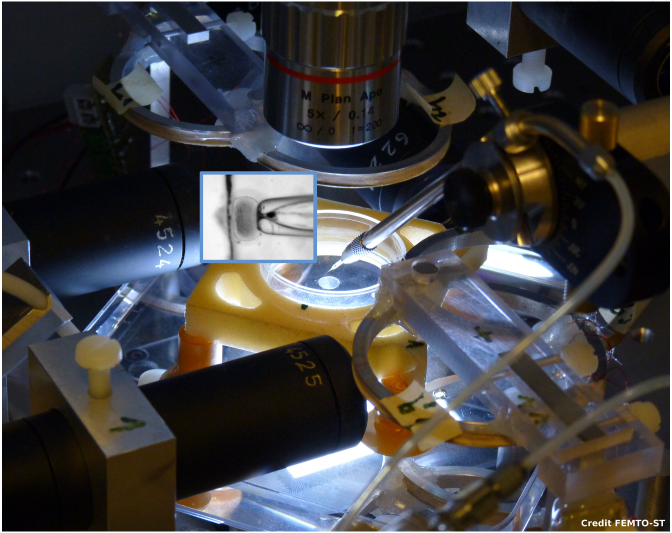
First oocyte characterisation platform

Entire platform



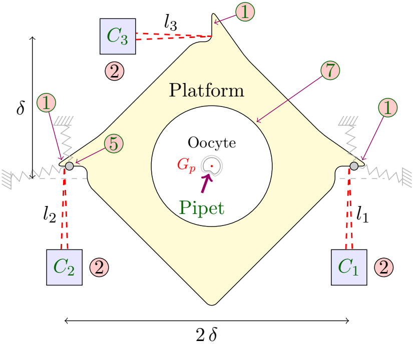
First oocyte characterisation platform

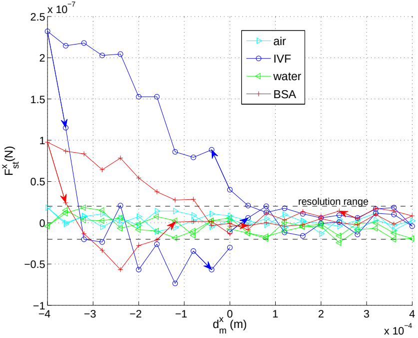
Entire platform



First oocyte characterisation platform

Results

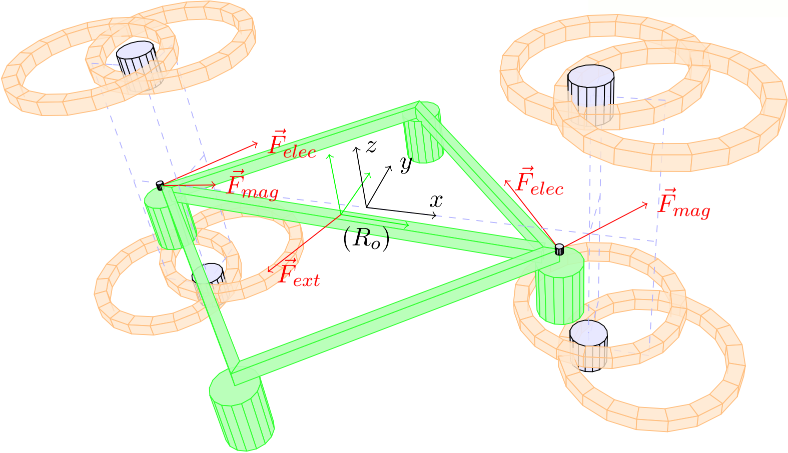




Problem of surface tension remains

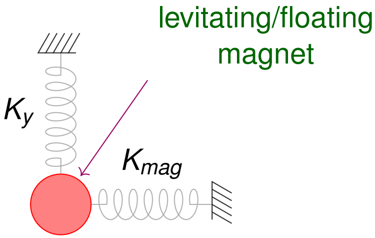
First oocyte characterisation platform

3 DOF active control



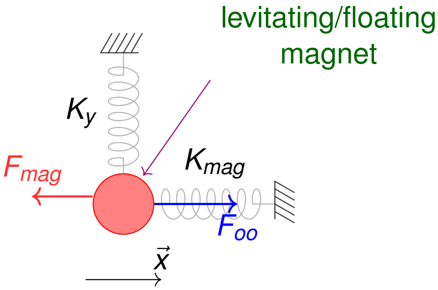
Active magnetic springs

Basics



Active magnetic springs

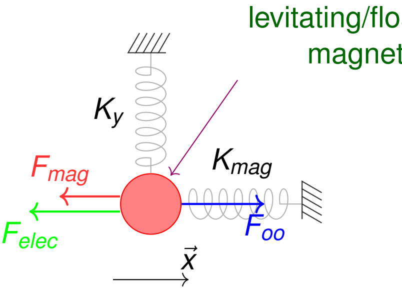
Basics

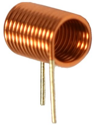


$$F_{mag} = K_{mag} \, . \, x \qquad \Longrightarrow \qquad \hat{F}_{oo} = K_{mag} \, . \, x_{measured}$$

Active magnetic springs

Basics



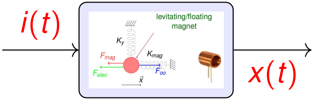


$$F_{mag} = K_{mag} \, . \, x \implies \hat{F}_{oo} = K_{mag} \, . \, x_{measured}$$

$$F_{elec} = K_{elec}(x) \, . \, i \implies \hat{F}_{oo} = K_{elec} \, . \, i_{measured} + K_{mag} \, . \, x_{measured}$$

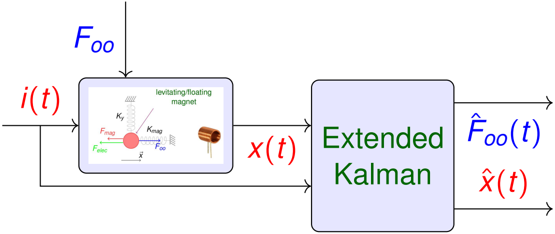
Active magnetic springs

Position active control



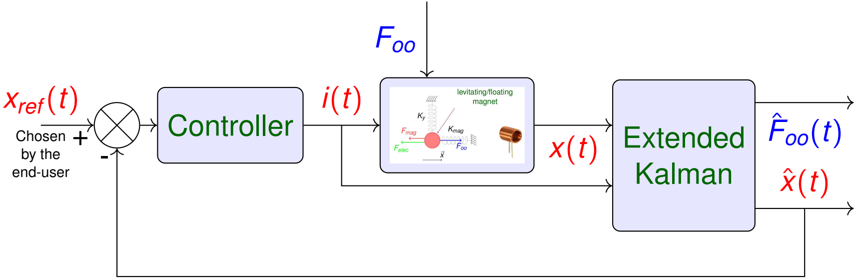
Active magnetic springs

Position active control



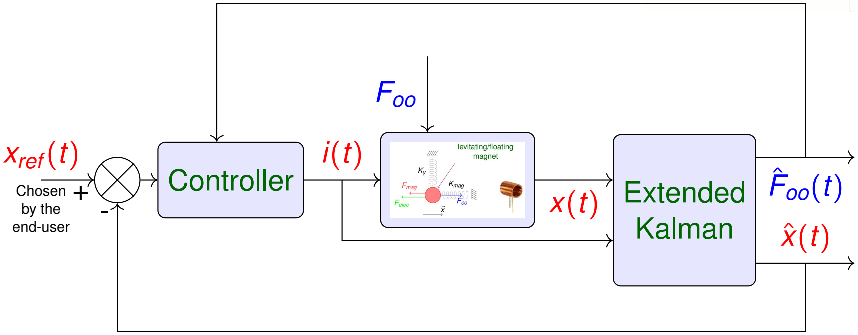
Active magnetic springs

Position active control



Active magnetic springs

Position active control



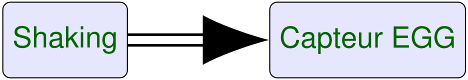
VIRCO : Virtual Input Rejection COntrol

Outline

Capteur EGG
Design

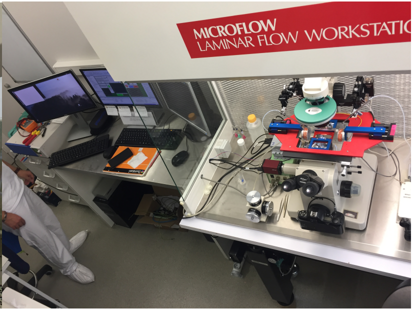
- Magnetic levitation
- Magnetic springs
- Buoyancy
- Active magnetic springs
- Unknown input observer (Kalman or GELESO filters)
- Advanced robust control law (VIRCO)

- Medical and biological requirements
- habits of ART centers



Platform EGG

In ART center of Besançon hospital

Platform EGG

In ART center of Besançon hospital

1. WO2018172688 - DISPOSITIF POUR LA CARACTERISATION MECANIQUE D'UN ELEMENT D'INTERET PAR EXEMPLE UN OVOCYTE

Données bibliographiques PCT | Description | Revendications | Dessins | ISR / WOSA / A17 (2) (a) | Phase nationale | Famille de brevets | Notifications | Documents

Lien permanent   Traduction automatique ▼

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Date du dépôt international
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G01N 3/40 2006.1 | G01N 3/42 2006.1 | C12M 1/42 2006.1

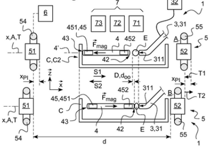
CPC
C12M 35/06 | C12M 41/46 | G01N 2203/0078 | G01N 2203/0085 | G01N 2203/0087 | G01N 2203/0089

Voir plus de classifications

Déposants
CENTRE NATIONAL DE LA RECHERCHE

Titre
[EN] DEVICE FOR MECHANICALLY CHARACTERIZING AN ELEMENT OF INTEREST SUCH AS AN OOCYTE
[FR] DISPOSITIF POUR LA CARACTERISATION MECANIQUE D'UN ELEMENT D'INTERET PAR EXEMPLE UN OVOCYTE

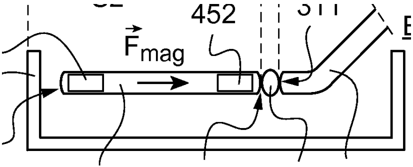
Fig.2



Abrégé
[EN]
The invention relates to a device for mechanically characterizing an element of interest (E), for example an oocyte. The mechanical characterization device comprises: - support means (2) for receiving a container (C) suitable for containing a liquid medium, - holding means (3) for holding said element of interest (E), - an indenting member (4), - magnetic means (5) for generating a magnetic field in which said indenting member (4) is intended to move and which participates in suspending said indenting member (4) with an unstable horizontal direction (x) oriented coaxially to the longitudinal axis (4'), - control means (6), intended to control said magnetic means (5) so as to maneuver the indenting member (4) in translation along the unstable horizontal direction (x), and - means (7) for

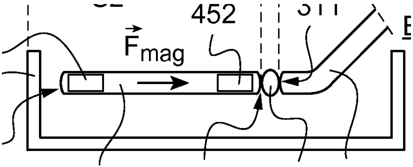
Platform EGG

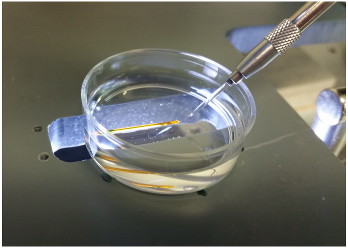
Magnetic springs inside the Petri dish

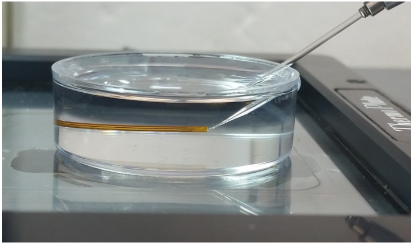


Platform EGG

Magnetic springs inside the Petri dish



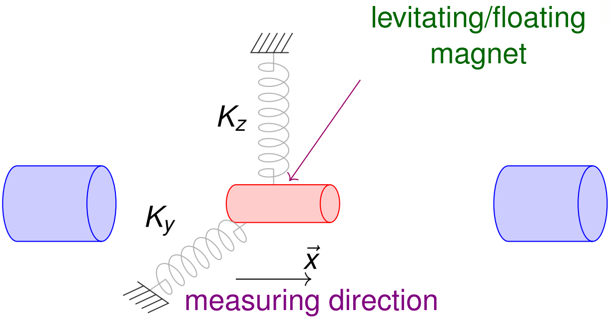




Single use magnetic glass indenter of 16 mm length and 0.8 mm diameter

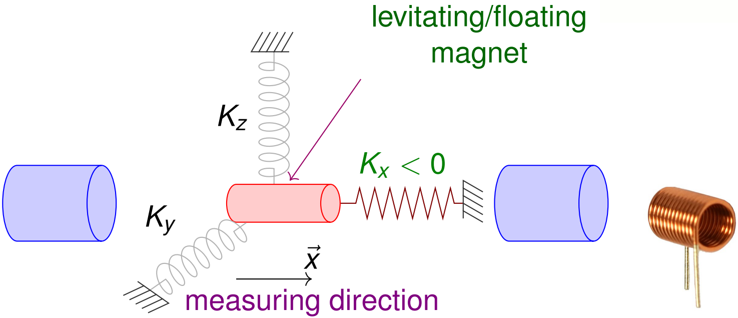
Platform EGG

Negative stiffness magnetic spring



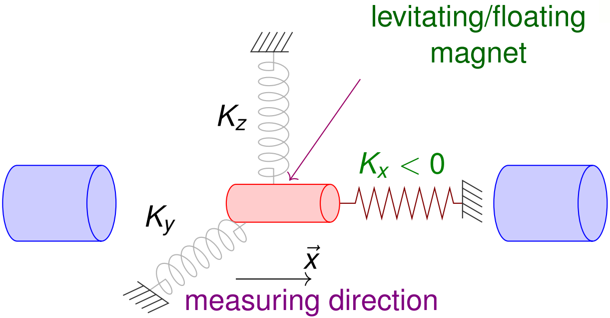
Platform EGG

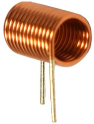
Negative stiffness magnetic spring



Platform EGG

Negative stiffness magnetic spring





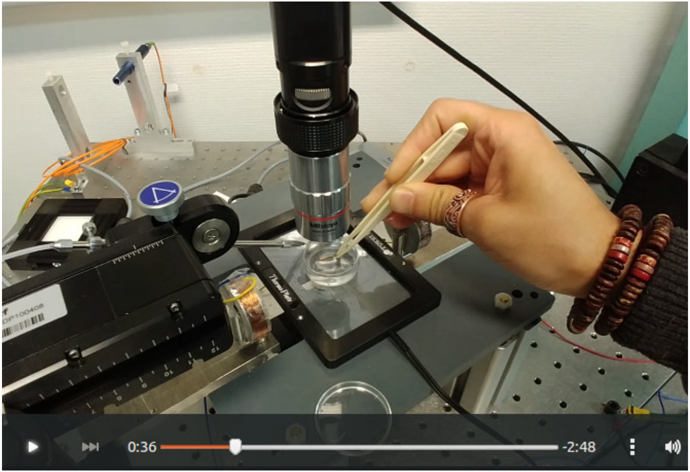
$K_x \approx -0.001$ N/m

Unstable behavior along $\vec{x}$

Displacement of 1 μm $\Longrightarrow$ force of 1 nN

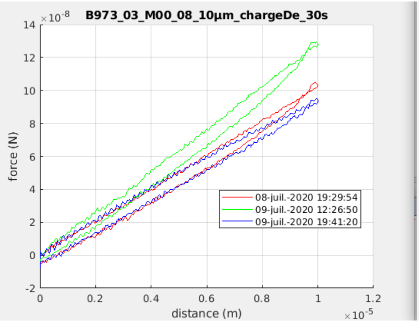
Platform EGG

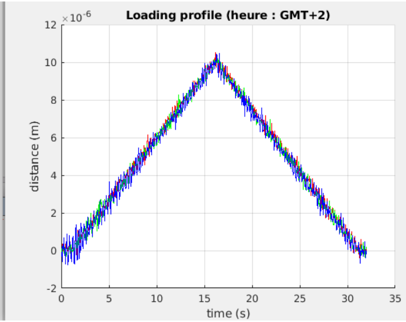
Conducting experiments on oocytes



Oocytes mechanical properties

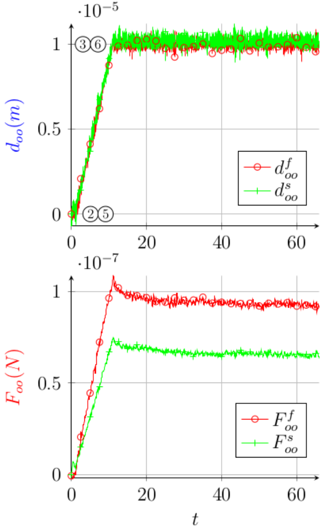
Loading and unloading tests





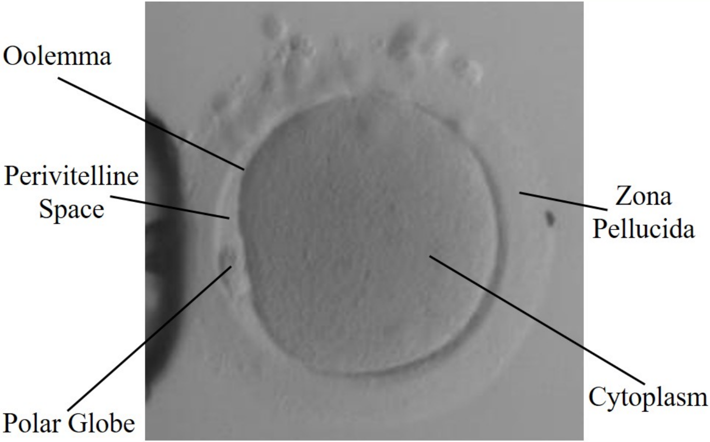
Oocytes mechanical properties

Relaxation tests with flat or sharp tip



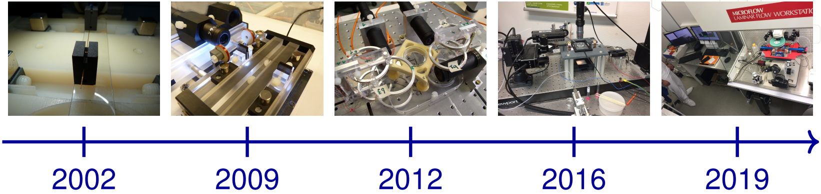
Oocytes mechanical properties

Oocyte constitution



Outline

Conclusion and perspectives



- Approximately 80 supernumerary oocytes already tested
- Each oocyte exhibit a particular mechanical profile

Next steps

- Fine modelling of the different oocyte parts
- Clinical trial on 20 patients...

Thank you for your attention...

Contributors

Mehdi Boukallel, Ali Cherry, Stéphane Oster, Racha Gana, Juan Antonio Escareno, Margot Billod, Reda El Hirech, Fadoua Nana Najim, Jorge Andres Perez, Francois Vuillemin, David Purwins, Mickael Ohruh, Fawzia Amokrane, Mélanie Béduer, Romain Merillo, Danielle Lyne Cambou, Benjamin Heinzman, Ferdinand Shäffer, David Grams, Zhuldyzay Temirzhanova, Rachid Laydi, Adrien Drouot, ...