MRI-compliant piezo micro-actuator

4th Summer School on Surgical Robotics

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ADAPTED SOLUTIONS

MAGSOFT

GROUPE

utbm
université de technologie
Belfort-Montbéliard

m3m
Laboratoire Mécatronique
Méthodes, Modèles et Métiers

Myself

- French

- Mechanical and Design Engineer

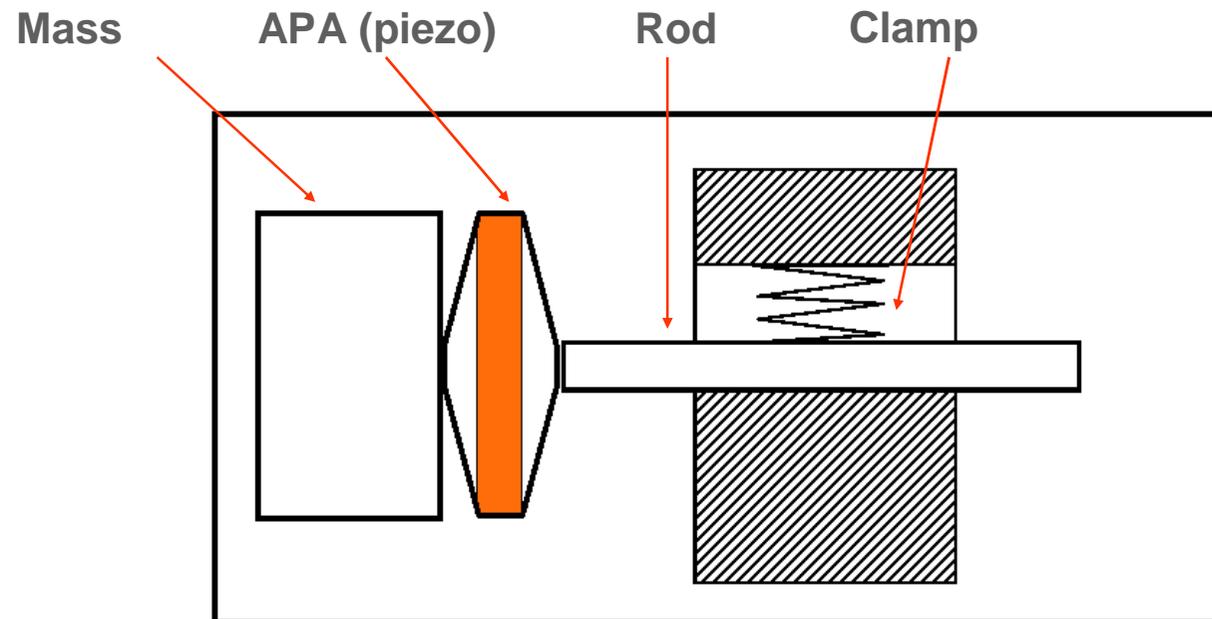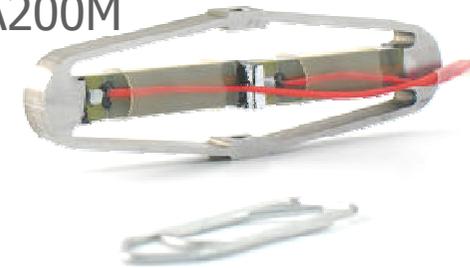- Special PhD: CIFRE (Uni. Lab. + Company)

- Subject: Inertial Piezo Motor: Design, tests and applications
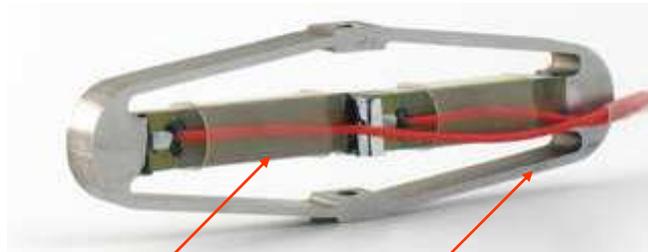
Stepping Piezo Actuator

APA200M

- **What is it?**
  - Linear piezo motor
    - ✓ Long stroke
    - ✓ High resolution
  - Components:
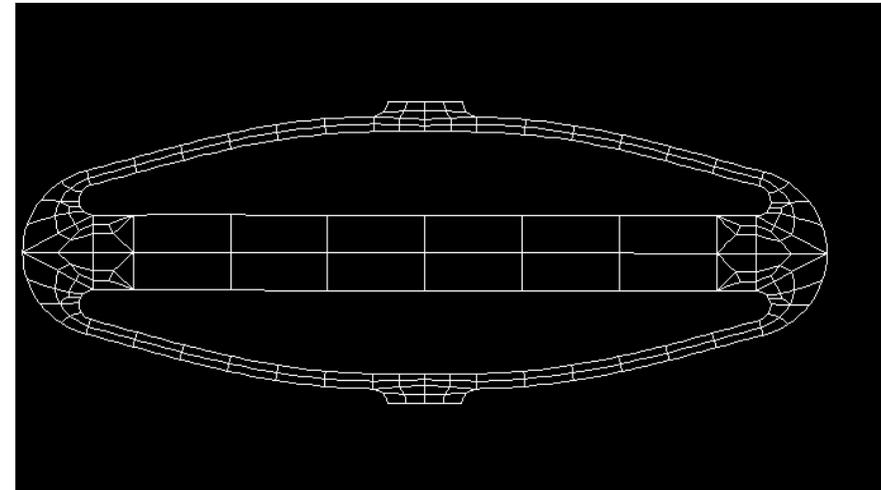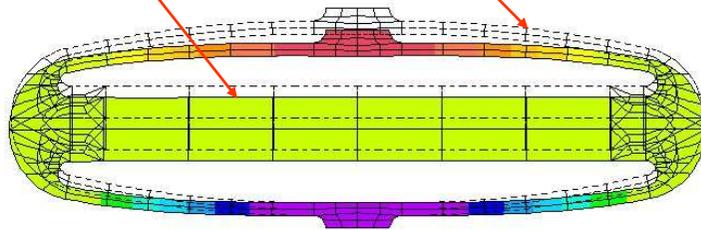
Mass   **APA (piezo)**   **Rod**   **Clamp**

Amplified Piezo Actuator

● APA Amplified Piezo Actuators

Piezo ceramic

Shell to amplify & prestress

ATILA FEM, accounting for piezo coupling

» APAs are compatible with non-magnetism & cryo, vacuum environments …
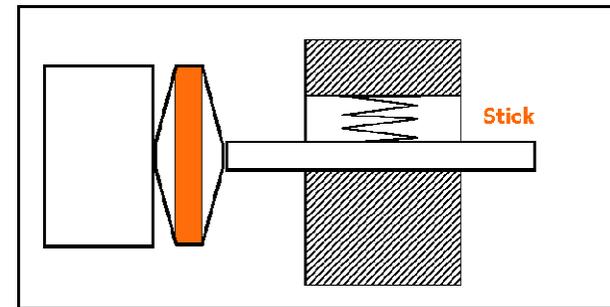
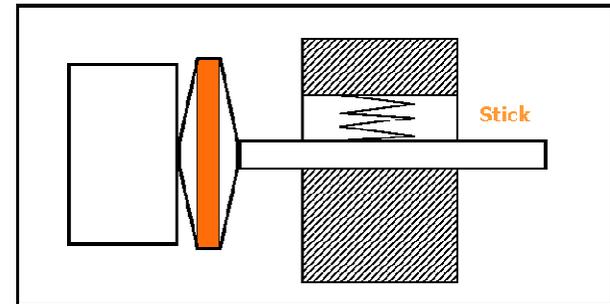# Stepping Piezo Actuator

● How does it work?

⟫ 2 working modes
- ✓ Stepping mode (M1)
  - ▪ Saw tooth signal
  - ▪ Stick-slip of the rod in the clamp
- ✓ Deformation mode (M2)
  - ▪ Load fixed on the Mass
  - ▪ APA deformation proportional to voltage

⟫ 2 complementary modes
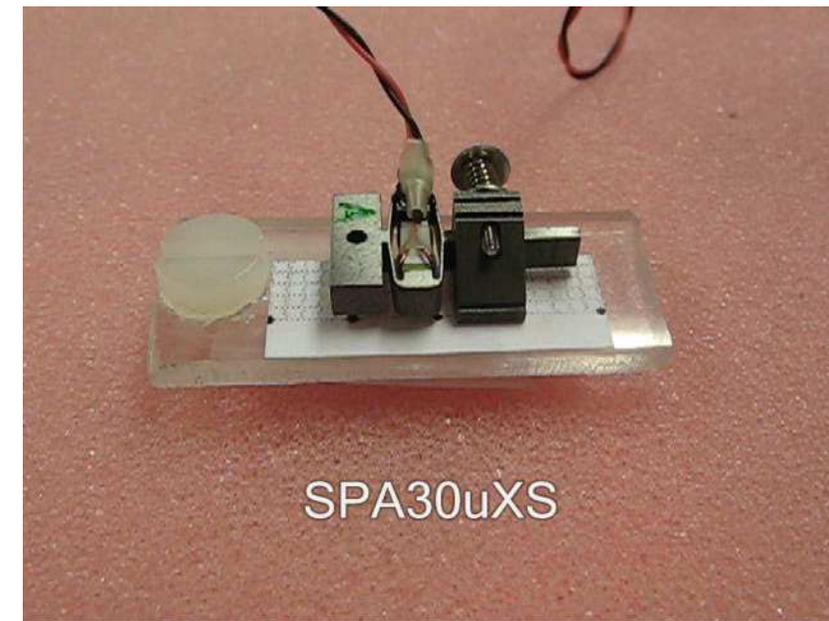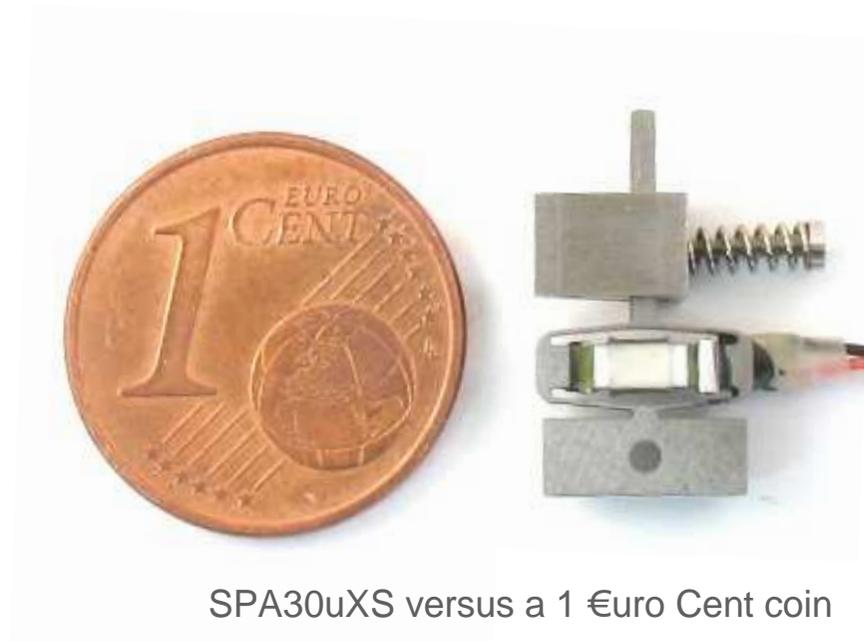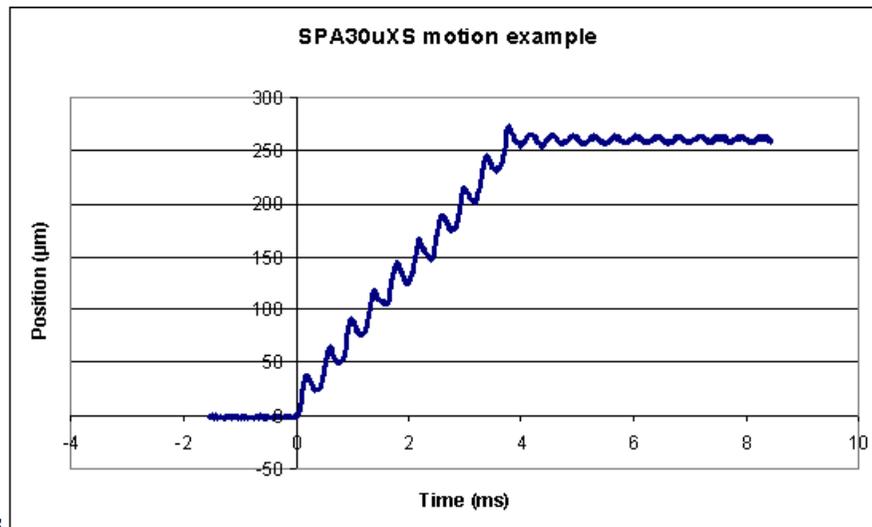- ✓ Important stroke/resolution ratio

Stepping Mode

Deformation Mode

Prototype

SPA30uXS versus a 1 €uro Cent coin

- SPA30uXS
  - » Mass < 2 grams
  - » Volume < 500 mm^3
  - » Stroke = 4mm
  - » Resolution<5nm
  - » Speed : Up to 70 mm/s
  - » Force : Up to 0,2 N

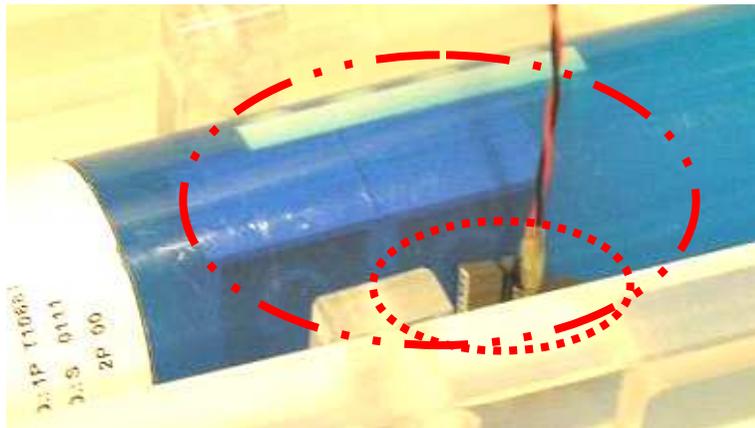

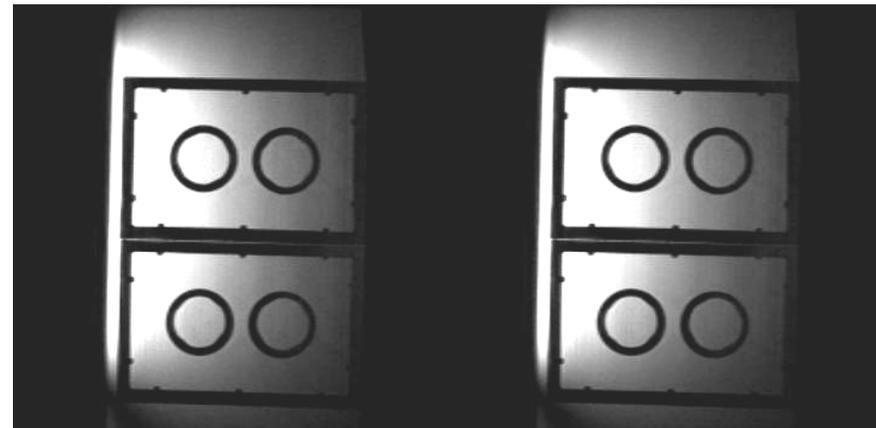SPA30uXS motion example

SPA30uXS

MRI-compatibility

- ## Non-magnetic actuator
  - ### Tests performed into an MRI 4,7 Tesla magnet
    - ✓ Is not attracted by the magnet (safety)
    - ✓ It does not perturb the MRI image SNR, <u>even when moving</u>
    - ✓ Performances are not affected by magnet: need a sensor adapted

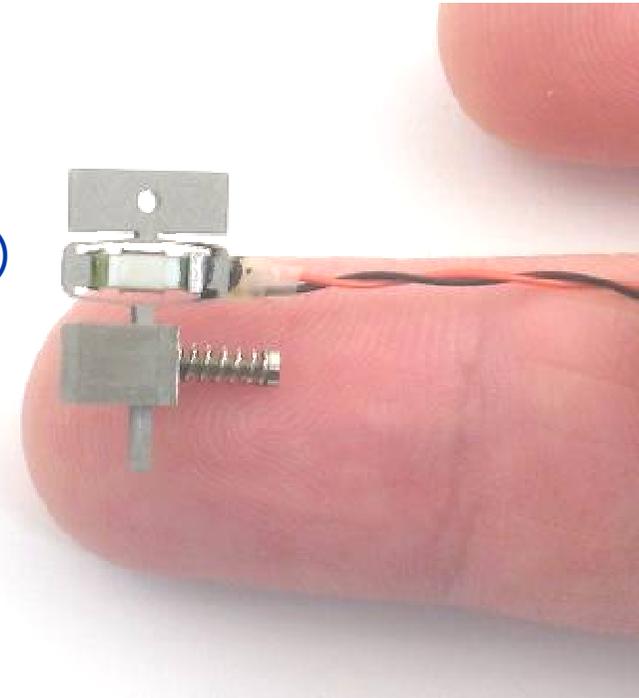Actuator position (dot) against measured position (dashed)

Ghost capture without and with actuator in the field of view

These tests have been performed on Small Animals platform, INSERM Grenoble, France

Conclusion

● SPA quick facts

» Tiny motor

» Total control of the speed
» High maximum speed (Up to 70 mm/s)

» Holding force with no consumption

» MRI compatible

Thank you

Feel free to ask questions