HAPTIC INTERFACES BASED ON PIEZO THIN FILMS

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Leti MEMS Workshop, June 25 2019, Estrel Congress Center, Berlin

HAPTIC MAIN APPLICATIONS

- **Haptic: to interact with environment by the sense of touch**
- **Many applications can be enabled by high performances haptic feedback interfaces**

→ Promising solution for an advanced human-machine interface

Better immersion for gaming

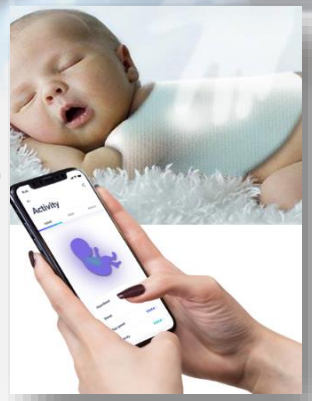
New way to purchase (online)

Smartphone, Tablet : New way to communicate

New practice of driving (receive information keeping attention on the road)

Bosch and Ultrahaptics show contactless haptics at CES 2017
Image source: Bosch

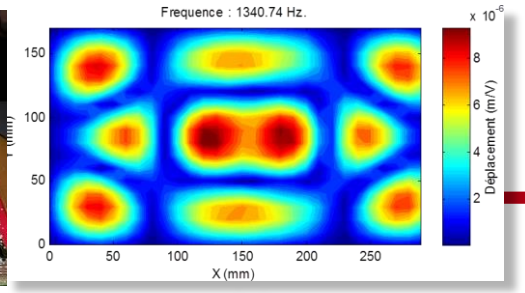
New way to interact



Industry or medicine

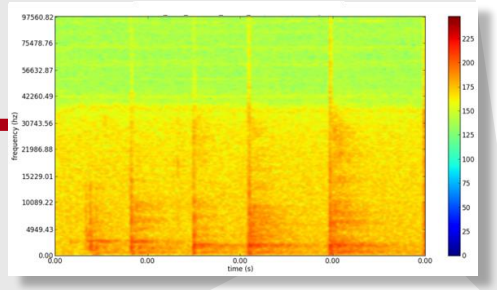
FROM HAPTIC MODULE TO SYSTEM VALIDATION

Towards prototype evaluation



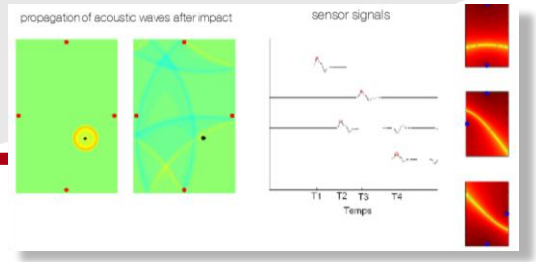
Haptics characterisation

Signal processing



Driving Electronics

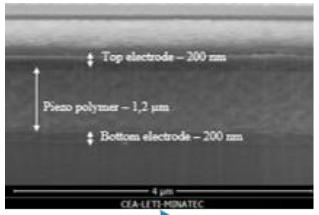
Acoustic simulations

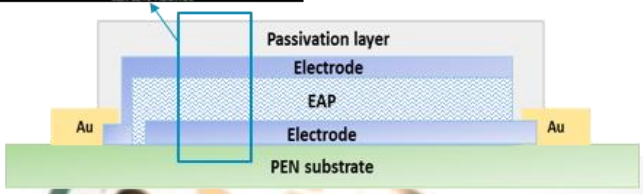


CEA covers the whole chain of development

VIBROTACTILE BUTTON

- **Polymer buttons realization using screen printing and polymer technologies**
  - PVDF actuator (Arkéma) on PEN substrate (CEA-LITEN technology)

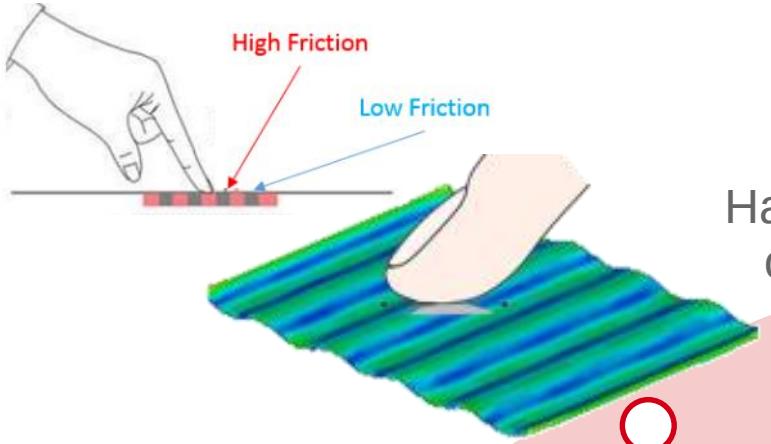


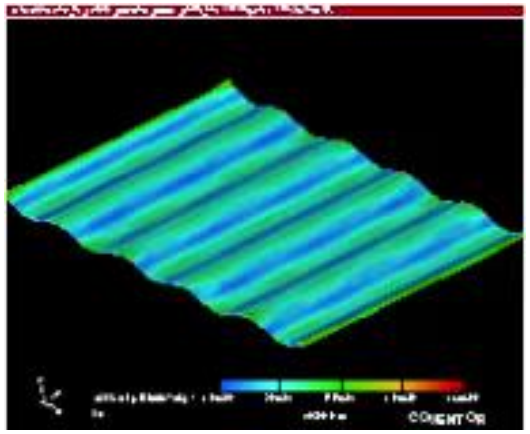


[Poncet et al. Actuator Journal 2017]

SQUEEZE-FILM PRINCIPLE FOR COMPLEX HAPTIC EFFECTS

- **Antisymmetric Lamb vibration mode**
- **Rectangular plate**

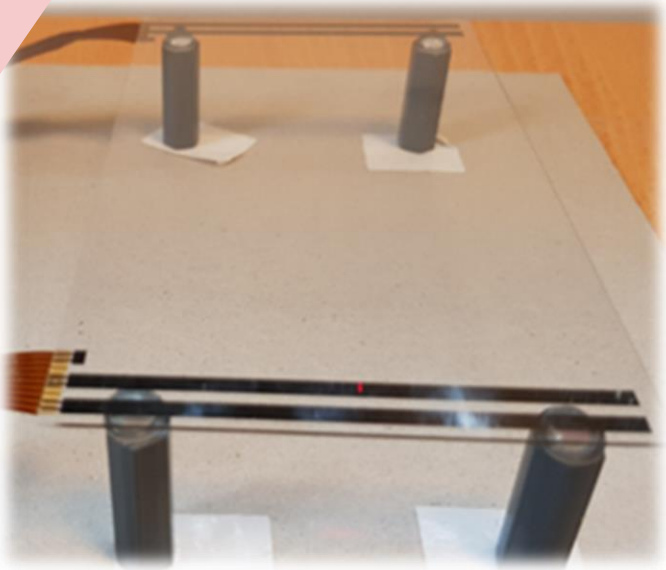




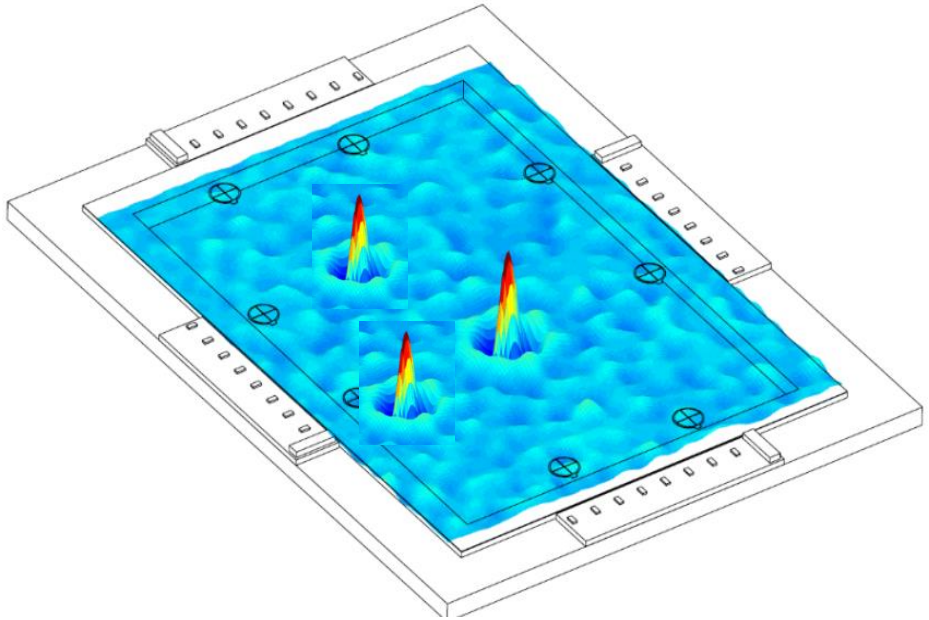
Haptic effect ➔ Feeling of textured surfaces

Thin air layer between finger and plate
Overpressure that tries to lift the finger
➡ Modification of the friction of the plate

Lamb mode vibrating plate
Vibration amplitude > ± 2µm



MULTI-TOUCH LOCAL HAPTIC FEEDBACK USING TIME REVERSAL



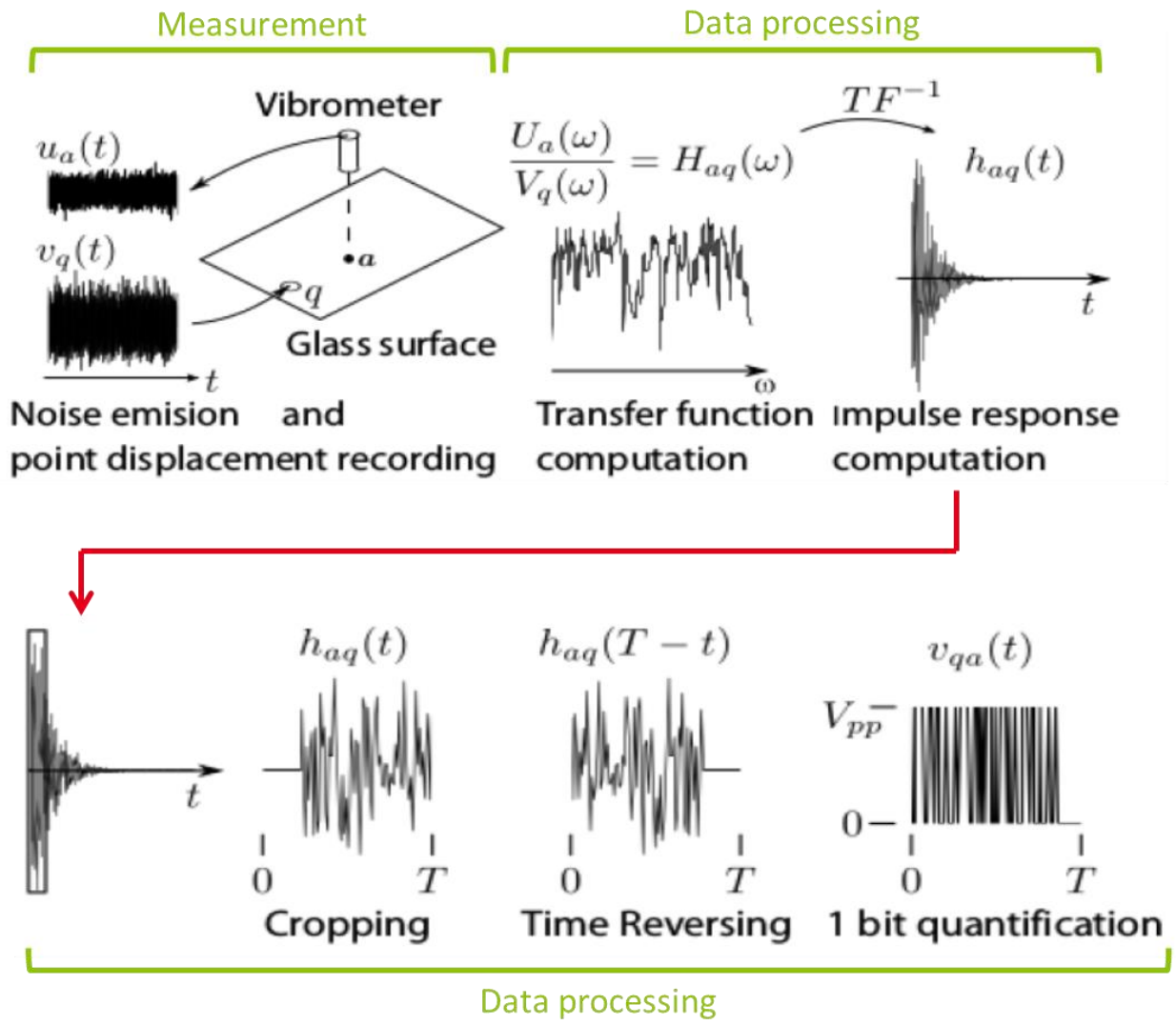
- ✓ Dependence of time reversal of acoustic waves in plates on mean frequency and plate's characteristics
  H. Zophoniasson, C. Hudin, C. Bolzmacher, M. Hafez
  Microsystem Technologies, p. 1-8, 2016.

- ✓ Localized Tactile Feedback on a Transparent Surface through Time-Reversal Wave Focusing
  C. Hudin, J. Lozada, and V. Hayward,
  IEEE Transactions on Haptics, Apr. 2015.

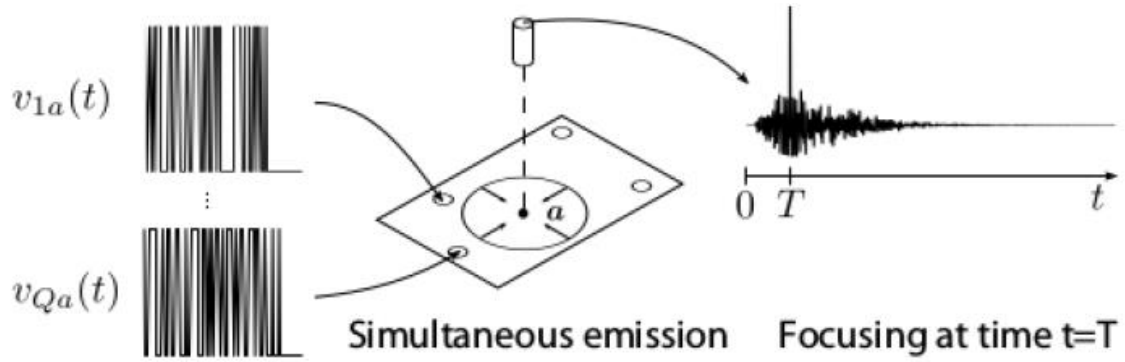
- **IP: 4 patents**

TIME REVERSAL HAPTIC PRINCIPLE

- **Propagating waves calibration & focalization**

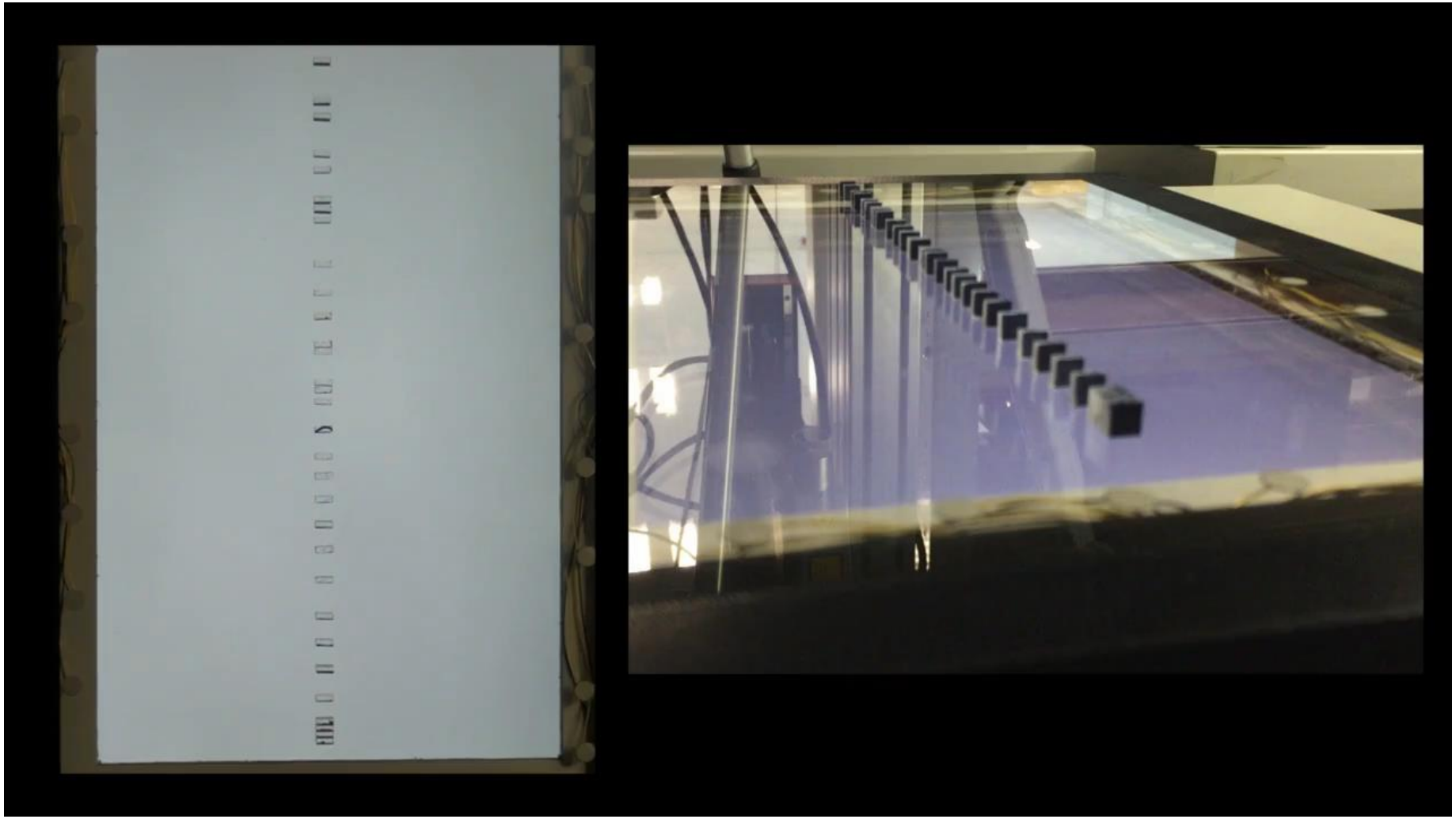


Localized vibration pattern restitution by simultaneous excitation of each actuator

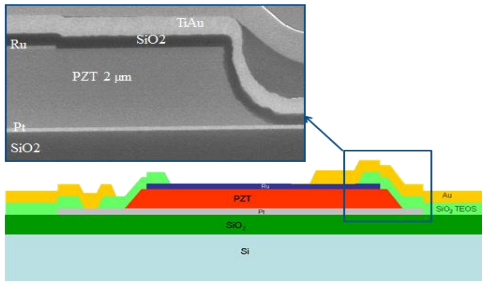
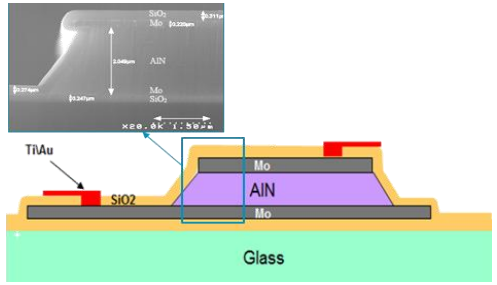
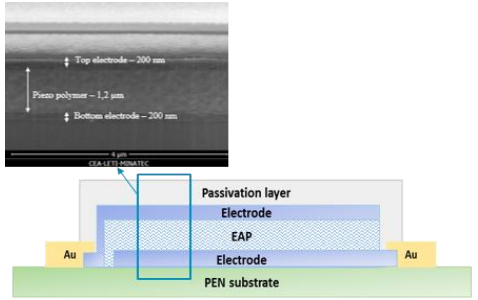
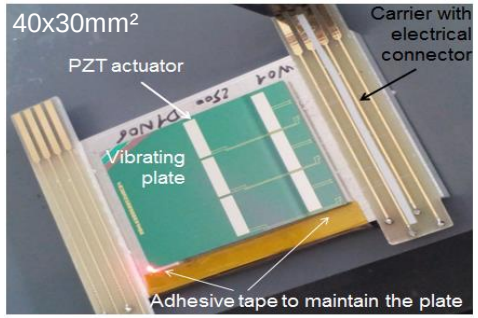
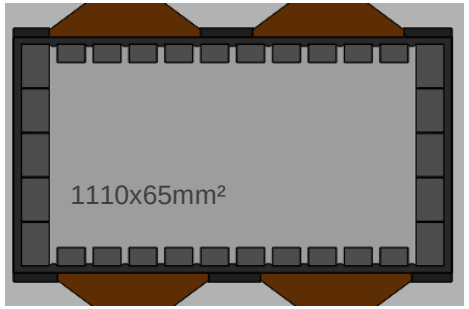
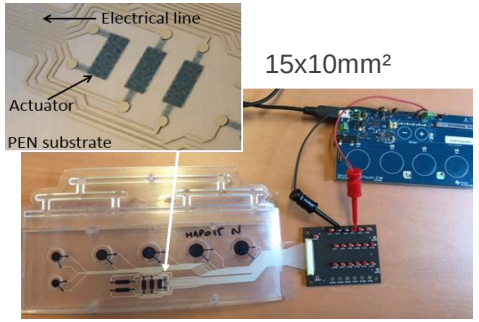


TIME REVERSAL HAPTIC PROOF-OF-CONCEPT

- Local vibration stimulation (temporally & spatially controlled)



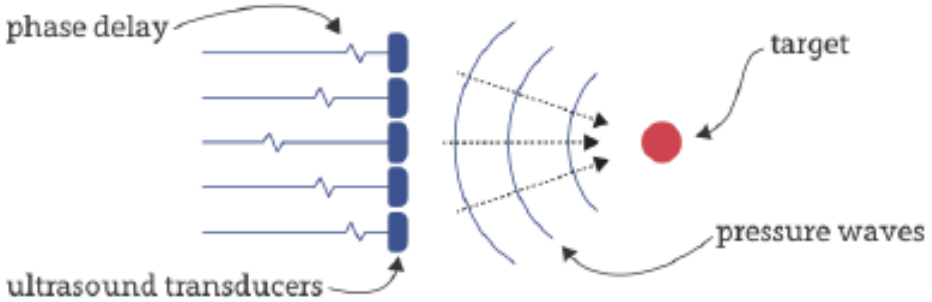
PIEZOELECTRIC MATERIAL VS. HAPTIC TECHNOLOGIES

Material	PZT	AlN	PVDF	Transparent piezo stack
Technology				
Example				ongoing realization of devices based on fully transparent piezo stack (see poster W3P.084)
Haptic Technology	✓ Time reversal ✓ Squeeze film	✓ Time reversal ✓ Squeeze film	✓ Vibro-Tactile button	✓ Local friction modulation

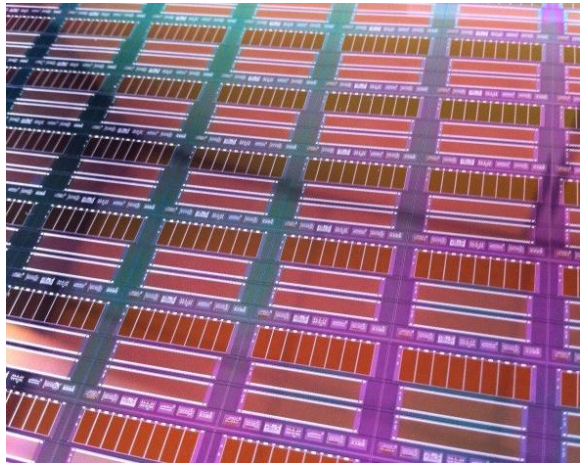
HAPTICS MID-AIR

- **Mid-air haptic feedback based on ultrasound**

Micro Ultrasonic Transducers (P and C – MUTs)



CEA-Tech solutions under developments

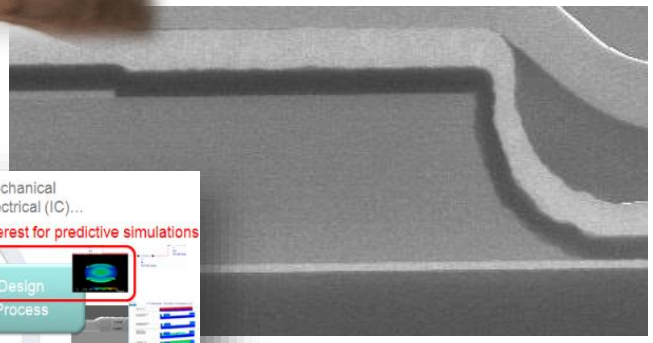


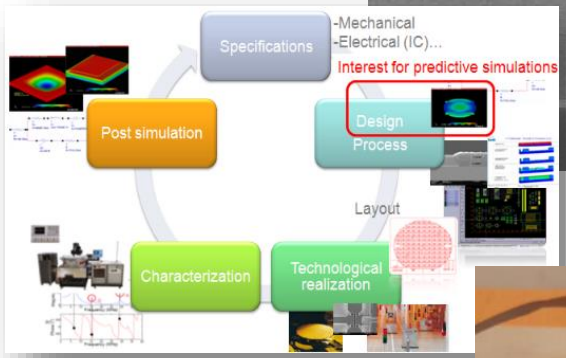
CMUTs

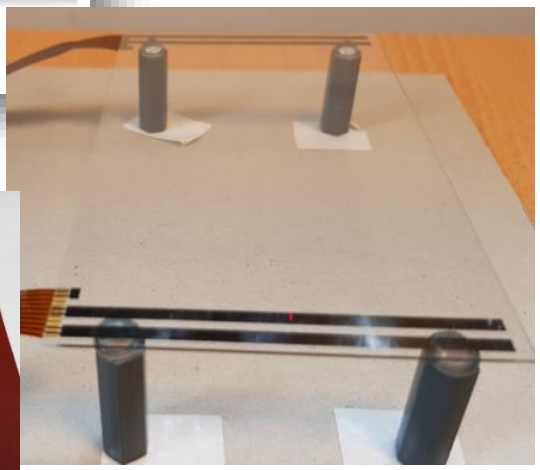
PMUTs

CONCLUSION

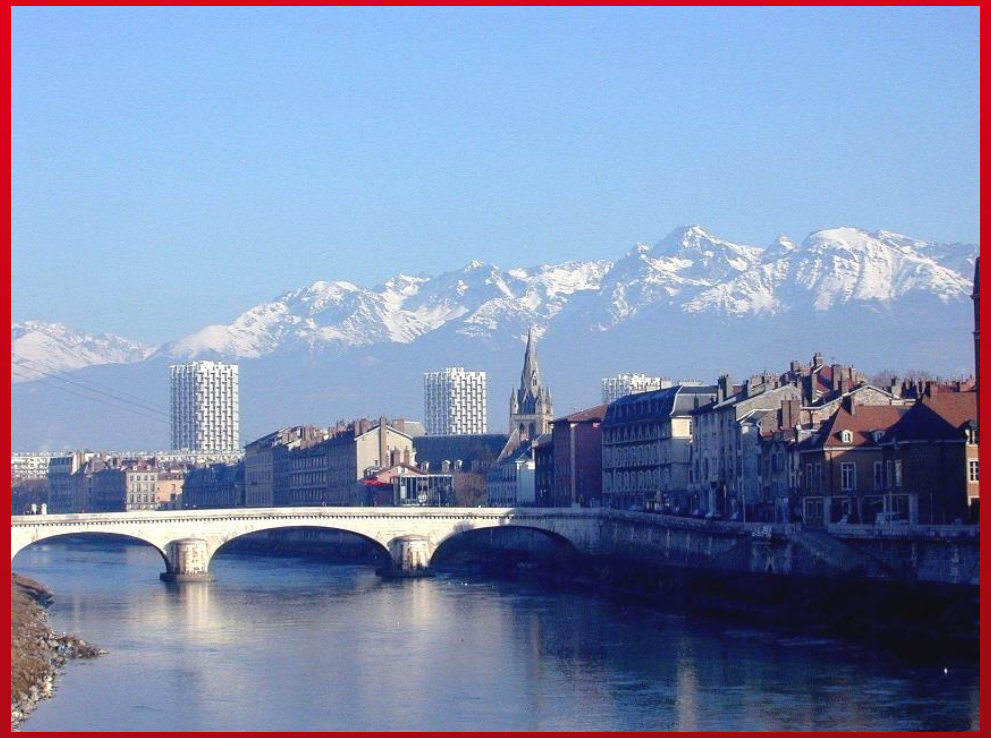
- Haptic is a promising human-machine interface
- Thin-film piezoelectric actuators for integrated haptic devices
- Generic design methodology & design rules
- Proof-of-concept & Existing Haptic demonstrators
- Perspectives…towards transparent piezo stacks







Thank you for your attention



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