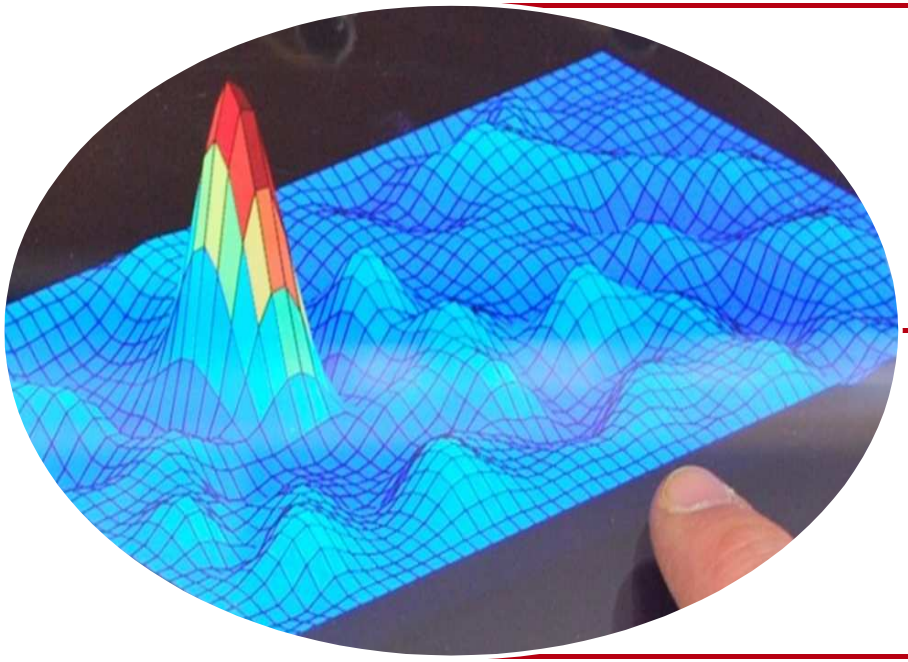
HAPTICS ACTIVITIES @ CEA TECH

MOUSTAPHA.HAFEZ@CEA.FR

HAPTIC APPLICATIONS



FUTURE COCKPITS

CONTROL PANELS

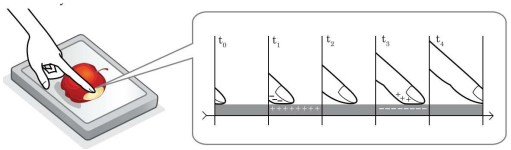
MOBILE DEVICES

HAPTIC FEEDBACK : STATE OF THE ART

- Motors vibrations

immersion actronika

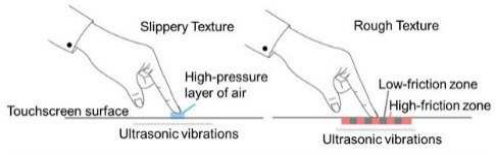
- Electrostatic forces



Senseg Tanvas

Disney Research

- Ultrasonic lubrification



HAP2U FUJITSU

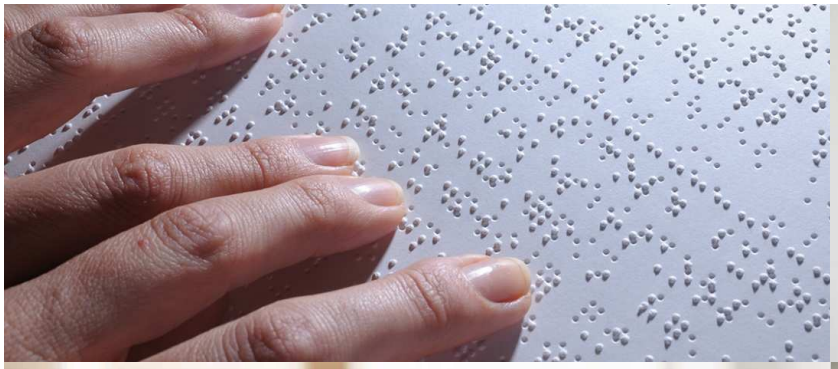
INSTITUT CARNOT TN@UPSaclay université PARIS-SACLAY

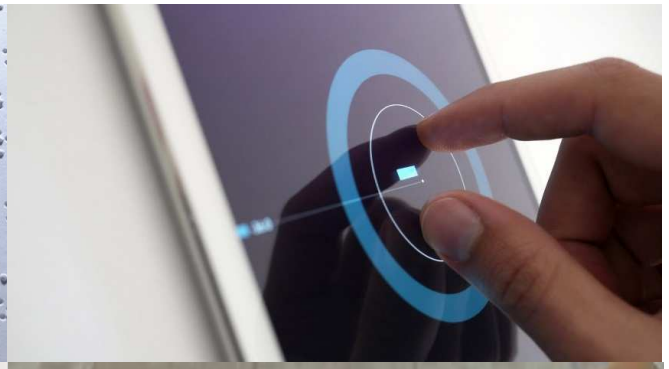
TACTILE INTERACTION IS MULTIFINGER AND MULTIFUNCTIONAL

Braille reading

Digital content manipulation

Bumps





Compliance

Keyclick

Texture

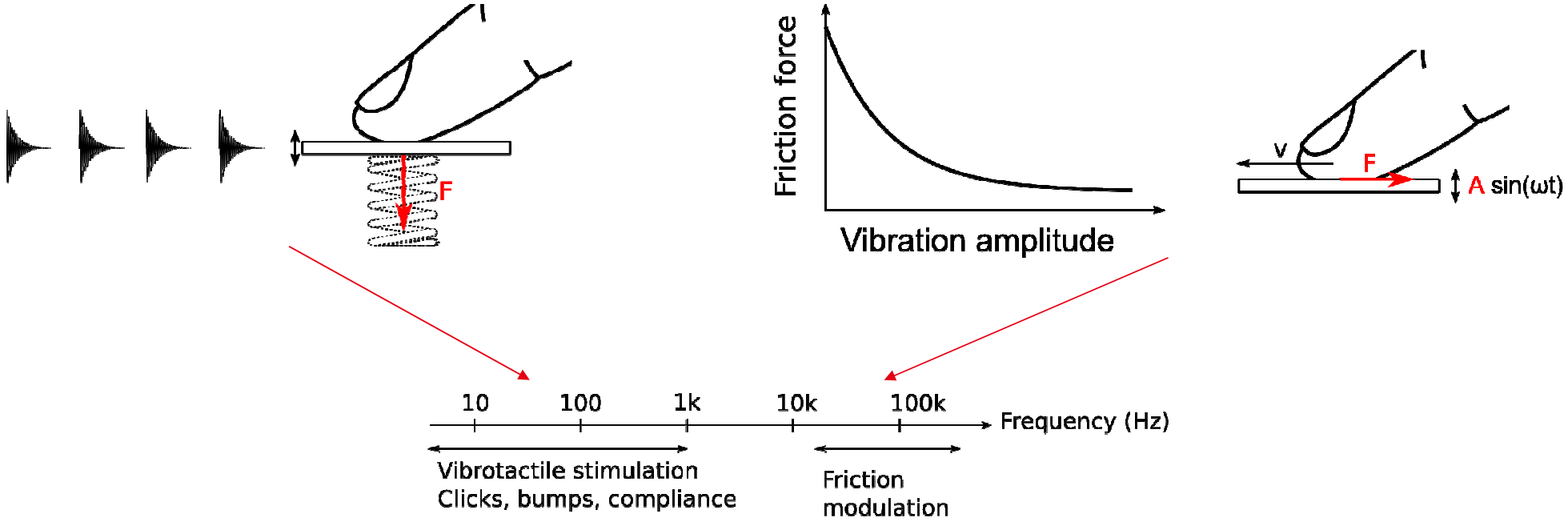
Text typing

Multi-user interaction

CEA APPROACH : TACTILE RENDERING USING VIBRATIONS

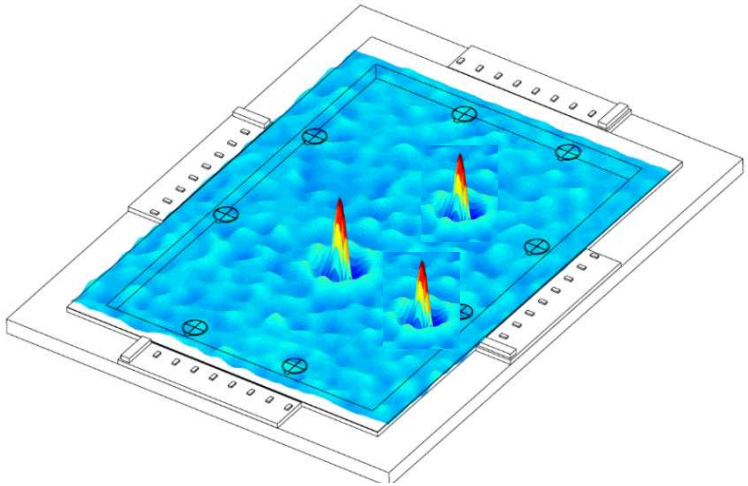
Low frequency vibrations: Clicks / Compliance

Ultrasonic friction modulation: Textures / (Clicks)



MULTI-TOUCH LOCAL HAPTIC FEEDBACK USING TIME REVERSAL

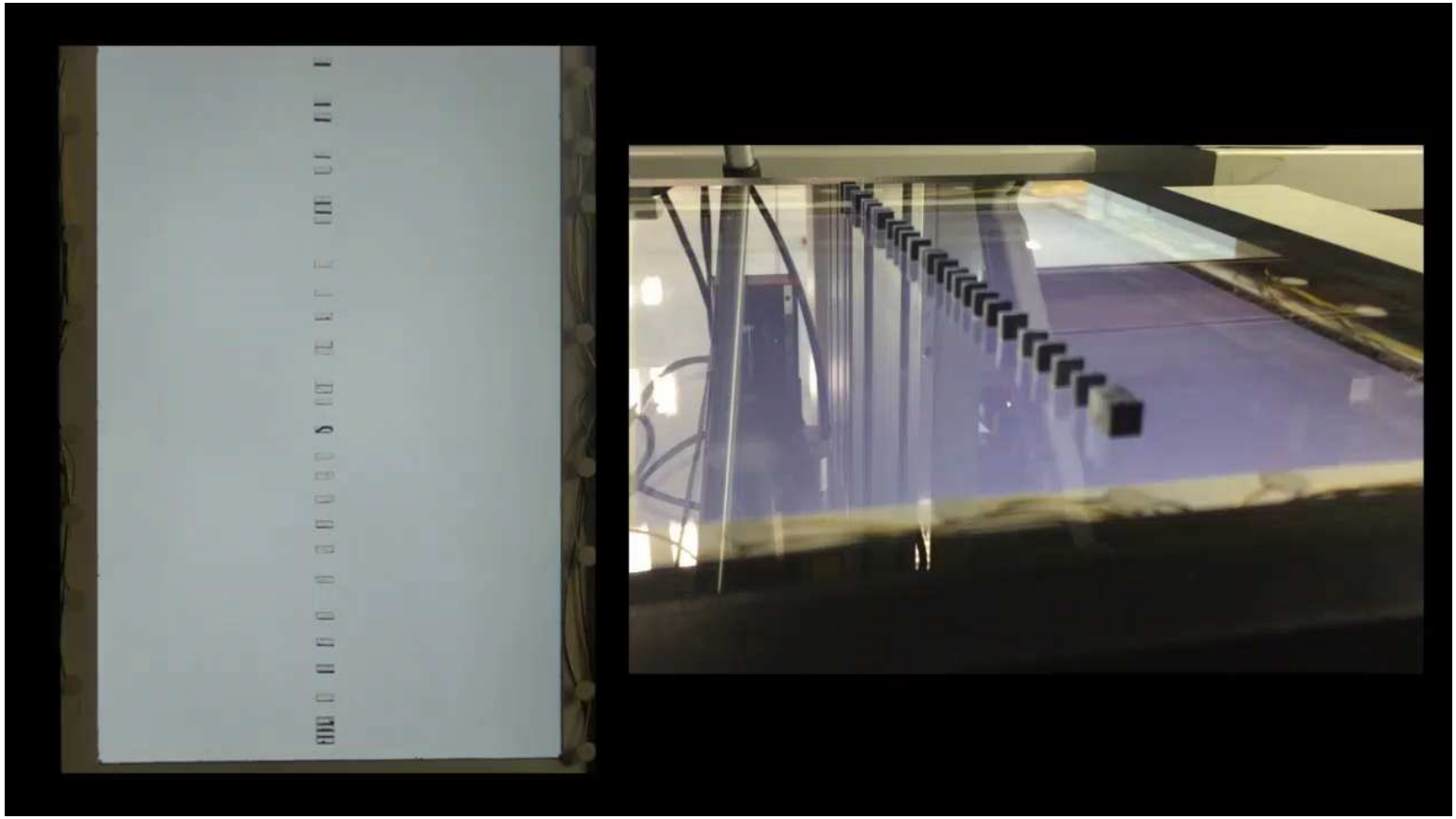
- Waves are controlled to focus at any chosen location
- Produce very sharp and short mechanical impulses
- Well suited for raised dots and click rendering



✓ 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.

LOCAL VIBRATION STIMULATION



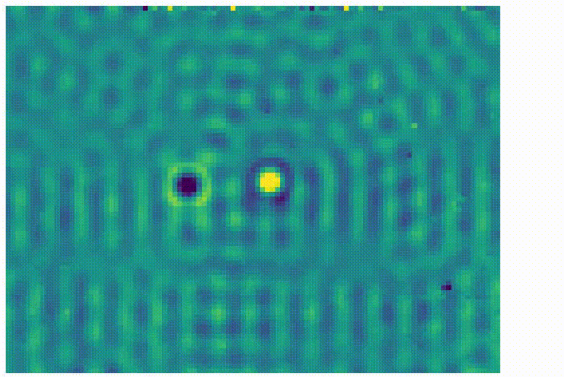
Best Demo Honorable Mention IEEE World Haptics 2017

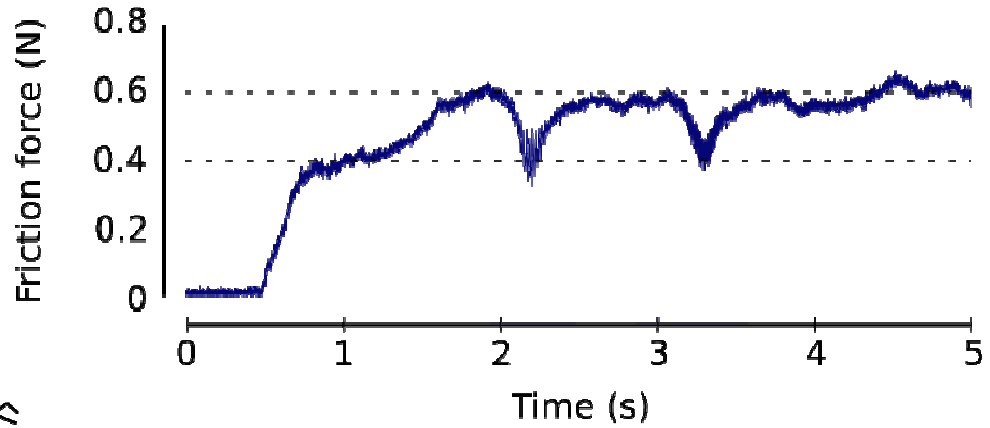
« Local tactile feedback through time reversal focusing », C.Hudin, H. Zophoniasson, C. Bolzmacher, and M. Hafez
June 6-9, 2017 | Fürstenfeldbruck (Munich), Germany

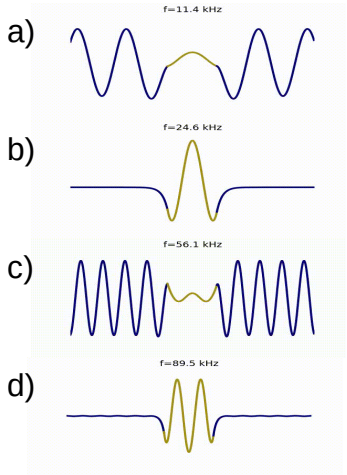
EXPLORING TEXTURES

NON RADIATING FREQUENCIES

- Waves do not propagate in the surface at specific frequencies
- Independent control of finger friction on top of each actuator
- Local actuation
- Well suited for local friction rendering



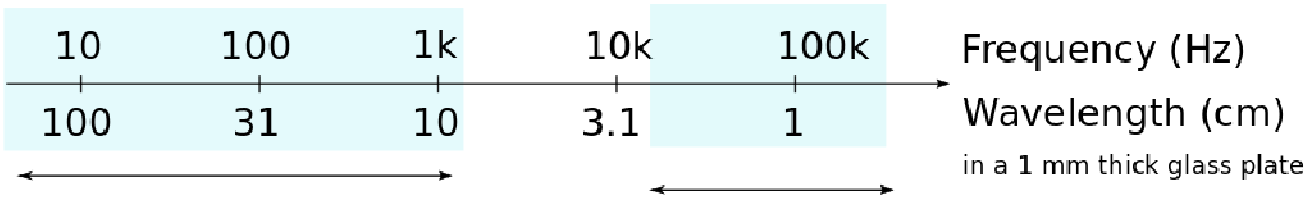




Best paper Award IEEE World Haptics 2017, C Hudin

June 6-9, 2017 | Fürstenfeldbruck (Munich), Germany

Toward a multitouch clicks and texture rendering surface

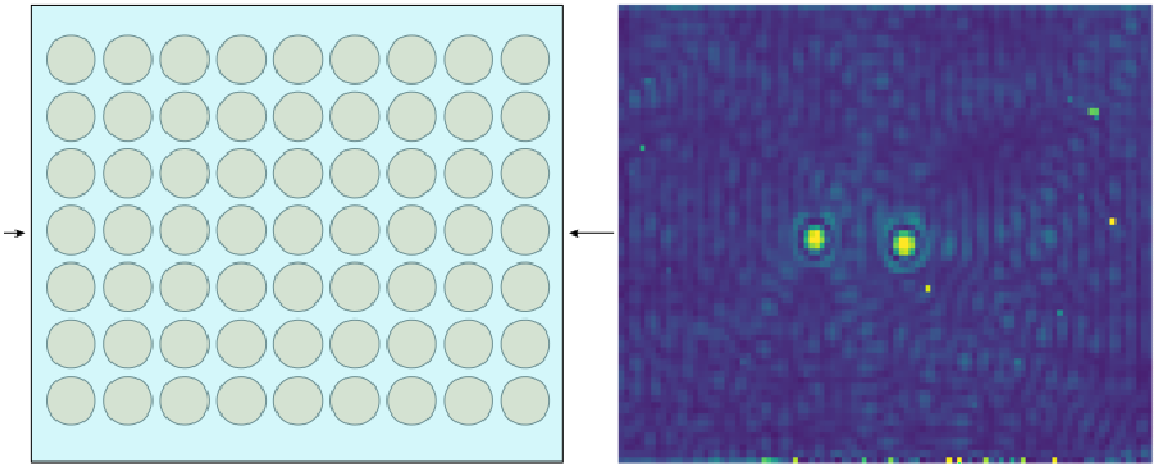


Vibrotactile stimulation
- Clicks
- Bumps
- Compliance

Friction modulation
- Texture

Multitouch texture and clicks rendering surface

Local friction modulation

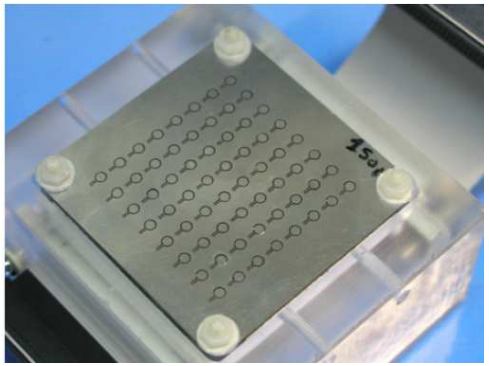


« Local friction modulation using non-radiating ultrasonic vibrations », WHC 2017

Issues with the localisation of vibrotactile stimuli

Patterned / damped surface

S. Papetti et al. « Multi-point vibrotactile feedback for an expressive musical interface »
Int. Conf. on New Interfaces for Musical Expression, 2015.



M. Benali-Khoudja et al., « VITAL: An electromagnetic integrated tactile display »,
Displays, 2007.

Uniform surface

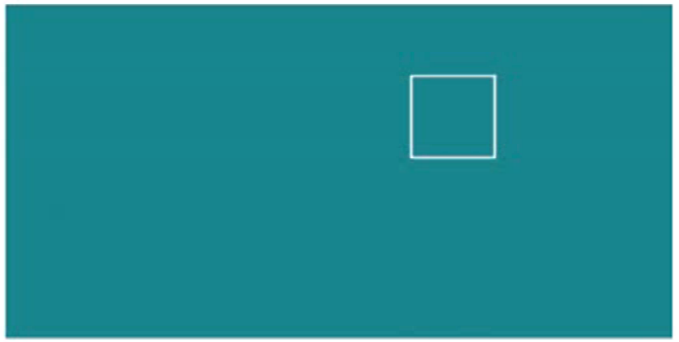
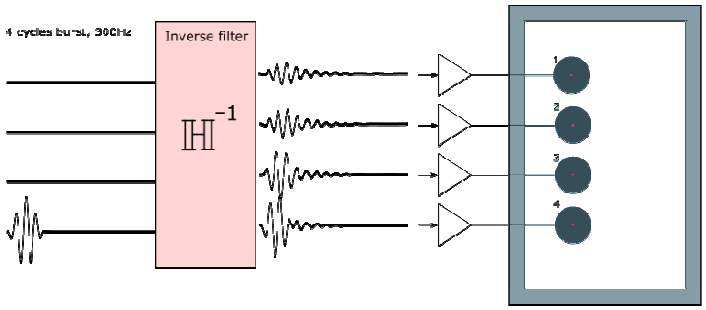
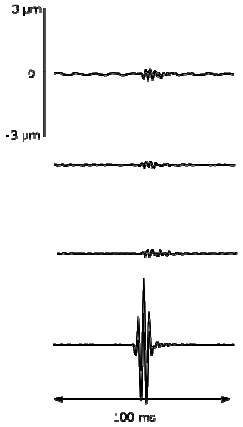


Plate response to a burst sine on a piezo actuator

VIBRATION ACTIVE CANCELLATION

- Waves are cancelled at specific chosen location
- Independent arbitrary vibrotactile signals on top of each actuator
- Local actuation
- Well suited for keyclick rendering





Best paper Award Honorable Mention 2018 EUROHAPTICS

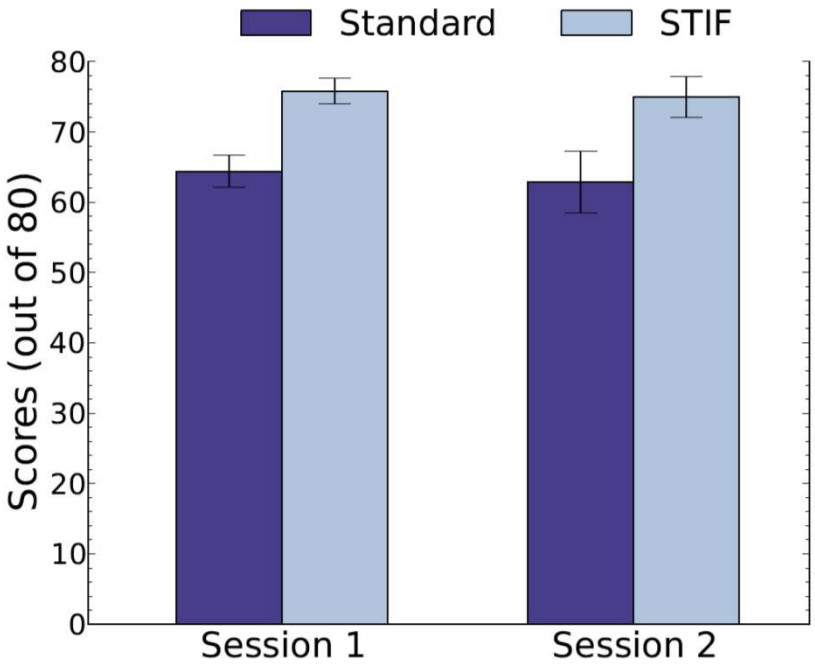
Localisation of Vibrotactile Stimuli with Spatio-Temporal Inverse Filtering

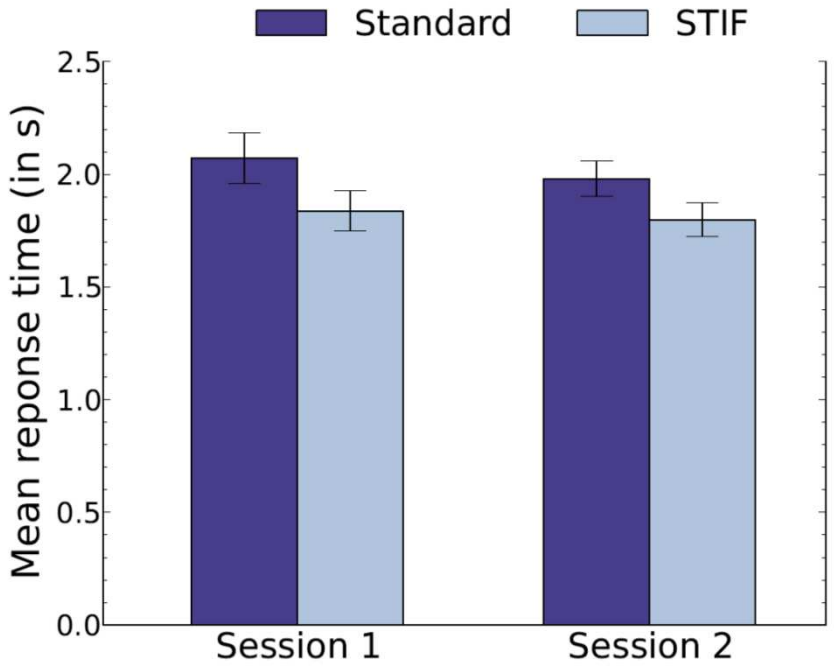
C Hudin and S Paneels

June 12 - 16, 2018 | PISA, Italy

USER STUDY – RESULTS

- **The Inverse Filter method has significantly improved discrimination of stimuli (better identification rates and faster response times)**





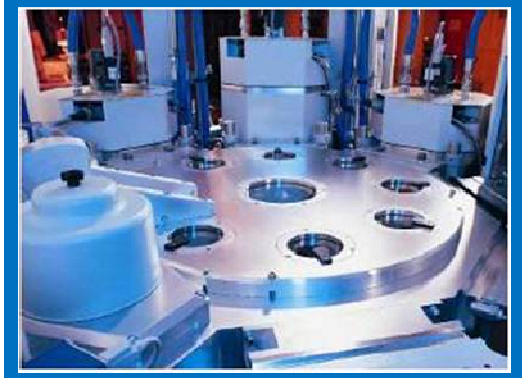
15 YEARS' EXPERTISE IN THIN FILMS PIEZO MATERIALS AT LETI AND LITEN

PZT
(LEAD ZIRCONIUM TITANATE)

- Sol gel deposition

ALN
(ALUMINIUM NITRIDE)

- Sputtering deposition



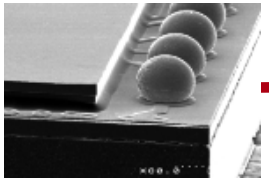
ELECTRO-ACTIVE POLYMER

- Polymer screen printing

PROCESS CAPABILITY

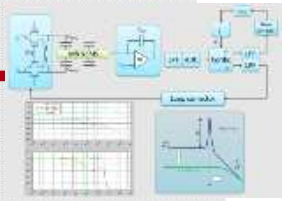
FROM MEMS DESIGN TO HAPTIC MODULE

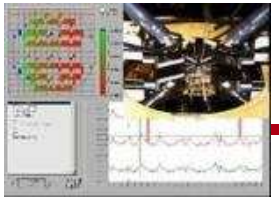
Prototyping



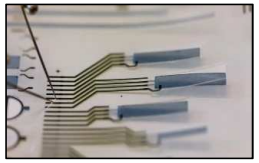
3D assembly

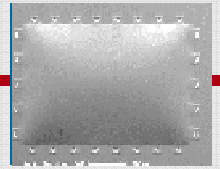
Electronic design



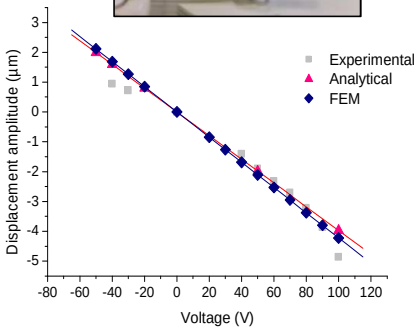


Characterizations

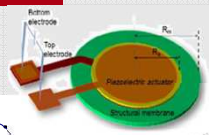




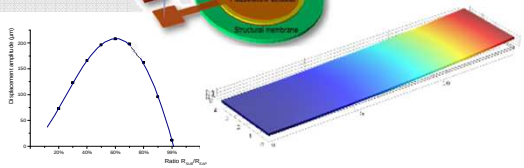
WLP & TFP Packaging



MEMS Technology



MEMS Design

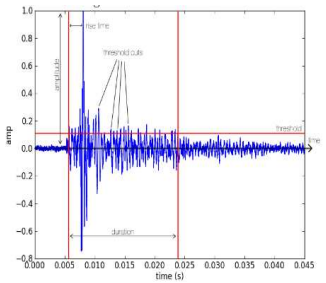


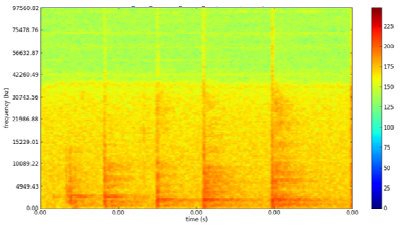
CEA covers the whole chain of development

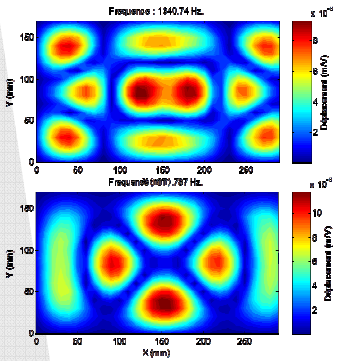
FROM HAPTIC MODULE TO SYSTEM VALIDATION

Towards prototype evaluation

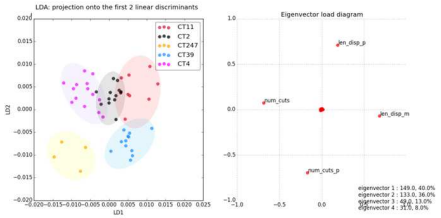
Haptics characterisation



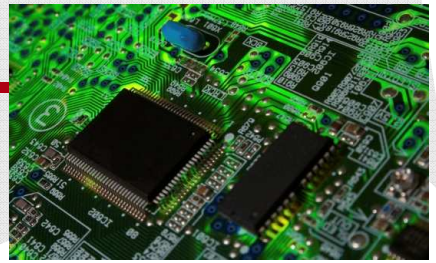




Signal processing



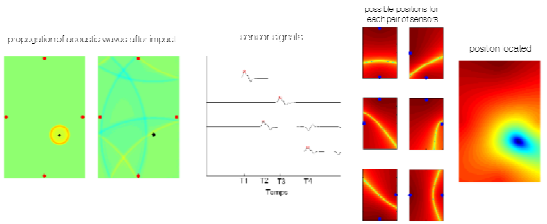
Driving Electronics



Design guidelines

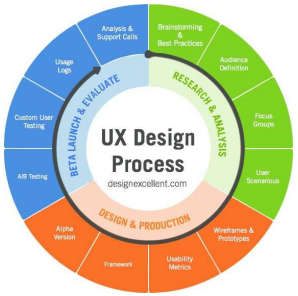
Parameter	Squeeze Film	Local Friction Modulation - LFM	Time Reversal - TR
Driving frequency	Fixed 23kHz, 60kHz	Fixed above 20kHz	Large band 25 – 125 kHz
Tactile interaction	Single Touch	**Multi-Touch**	Multi-Touch
	Texture stimulation	**Texture** stimulation	**Clicks**, bumps, or softness rendering.
No. of transducers	Few PZT transducers	Array of transducers	Multi transducers, arrays (8 – 16 sensors)
Excitation signal	Sinusoidal excitation	Sinusoidal excitation	More complex signals
	Dedicated technology	Incremental: same set up can generate both Time reversal and Squeeze film	Incremental: same set up can generate both Time reversal and Squeeze film
Technology Readiness Level	State of the art	Beyond state of the art	Beyond state of the art

Acoustic simulations

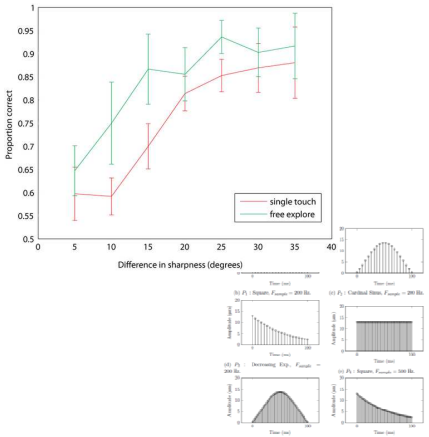


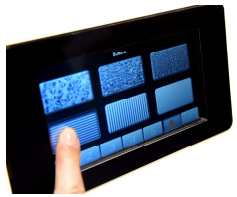
CEA covers the whole chain of development

FROM USER REQUIREMENTS TO BETTER USER EXPERIENCE

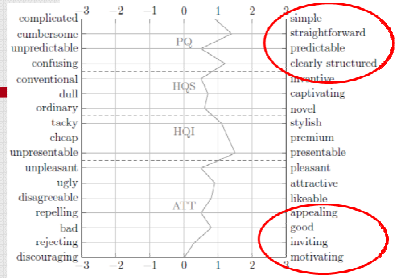


Iterative design





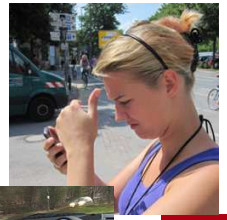
User experience evaluation



Haptic pattern optimisation

Rapid prototyping

Interaction design



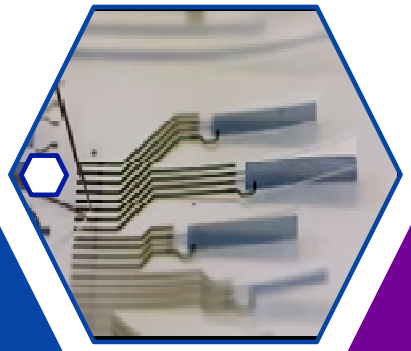
User requirements

CEA covers the whole usability cycle

INSTITUT CARNOT TN@UPSaclay — université PARIS-SACLAY

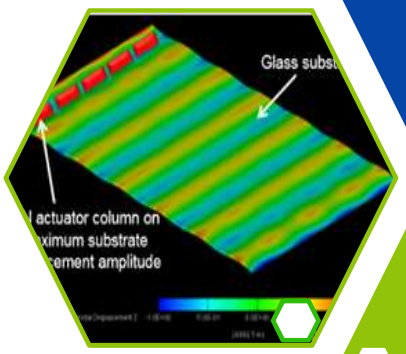
CEA TECH OFFER IN HAPTICS

DEVICES
Touch screens
Haptic knobs
Wearables



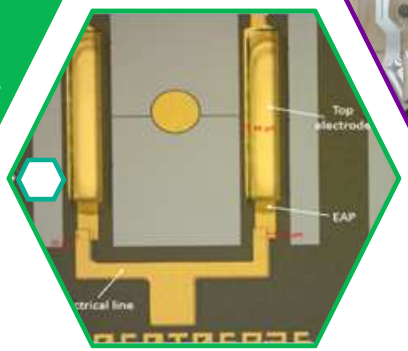
HMI INTEGRATION WITH PARTNERS

USER EXPERIENCE
User requirements
Haptic patterns



NEW MATERIAL INTEGRATION
THIN-FILM PIEZOELECTRIC
MAGNETORHEOLOGICAL FLUIDS

SIMULATION
DESIGN GUIDELINES



Commissariat à l'énergie atomique et aux énergies alternatives
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