

A Real-Time Simulator for Virtual Reality conceived around Haptic Hard Constraints

CASTET Julien - COUROUSSE Damien - FLORENS Jean-Loup - LUCIANI Annie
Laboratory ICA - ACROE – INP Grenoble, France

E-mail: julien.castet@imag.fr, damien.courousse@imag.fr, jean-loup.florens@imag.fr, annie.luciani@imag.fr

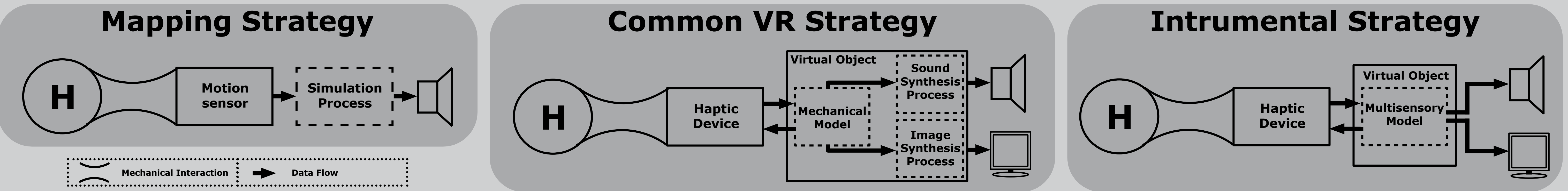
A real-time physically based platform for multi-sensory interactive simulation :

- Centered on high quality dynamic requirements driven by the concept of instrumental interaction.
- Oriented towards the simulation of vis-à-vis human-object interactive simulation for a broad range of physical phenomena.
- Specific focus on simulations with demanding capacities regarding dynamics.

« Tool use, Object manipulation, Music instrument playing, etc. »

Two versions have been implemented corresponding to specific simulation requirements.

Strategies of Haptic implementation for Virtual Reality



Constraints for Instrumental Strategy

- **Simulation bandwidth should encompass the cut-off frequency of the physical phenomenon simulated.** (Simulated model includes acoustical parts, simulation bandwidth should be high enough to generate acoustical frequencies)
- **Range of the physical variables should encompass the dynamic range of the reference physical phenomenon.**
- **The simulation process should be synchronized with devices (haptic device or loudspeakers).** (I/O latency of the simulation process should not exceed one simulation period as latency introduces physical distortion. Time determinism is the only way to guaranty this synchronization: a step of simulation must be computed within fixed time windows.)

Two Versions of the platform driven by the Instrumental Strategy

The platform consists of a synchronized multiprocessor and multifrequency architecture extended with a DSP.

- **Multiprocessor** computers (bi or quadri) from Concurrent Computer. with Opteron (2GHz / 1Go) and 64 bits architecture.
- A **DSP** (TMS320C6711) board from Innovative integration, called TORO board, with a computation frequency of 150MHz. This card provides **16 simultaneous analog inputs and outputs** up to 250 KHz each, both at 16-bit resolution.
- The **haptic device** used is from ERGOS technologies. It is synchronized on the clock used for the simulation process.

- 1 a light and highly reactive simulator for models with strong dynamical requirements but low computation needs
- 2 a 64 bit floating point multiprocessor architecture for large 3D models with complex interactions such as fluids, smoke...

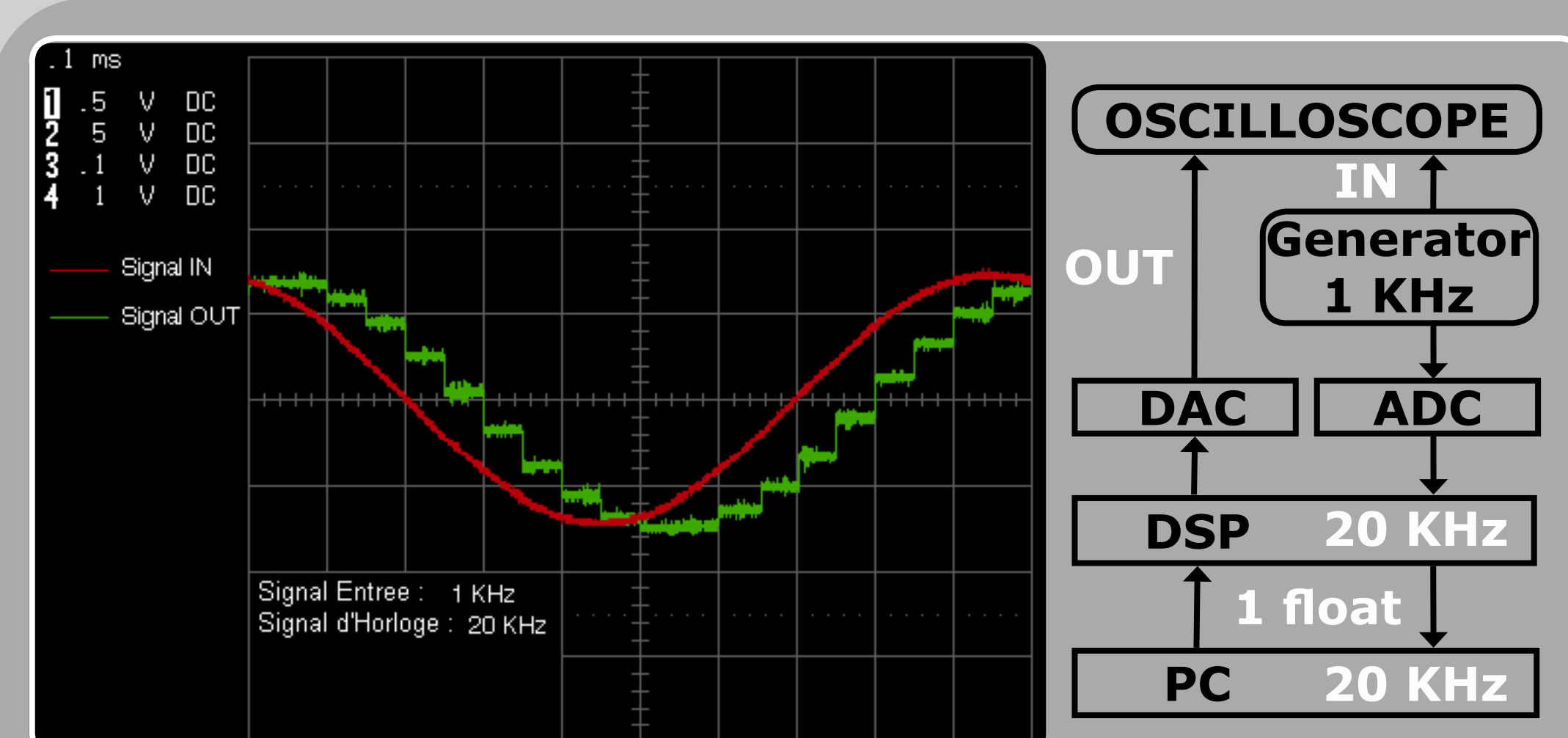
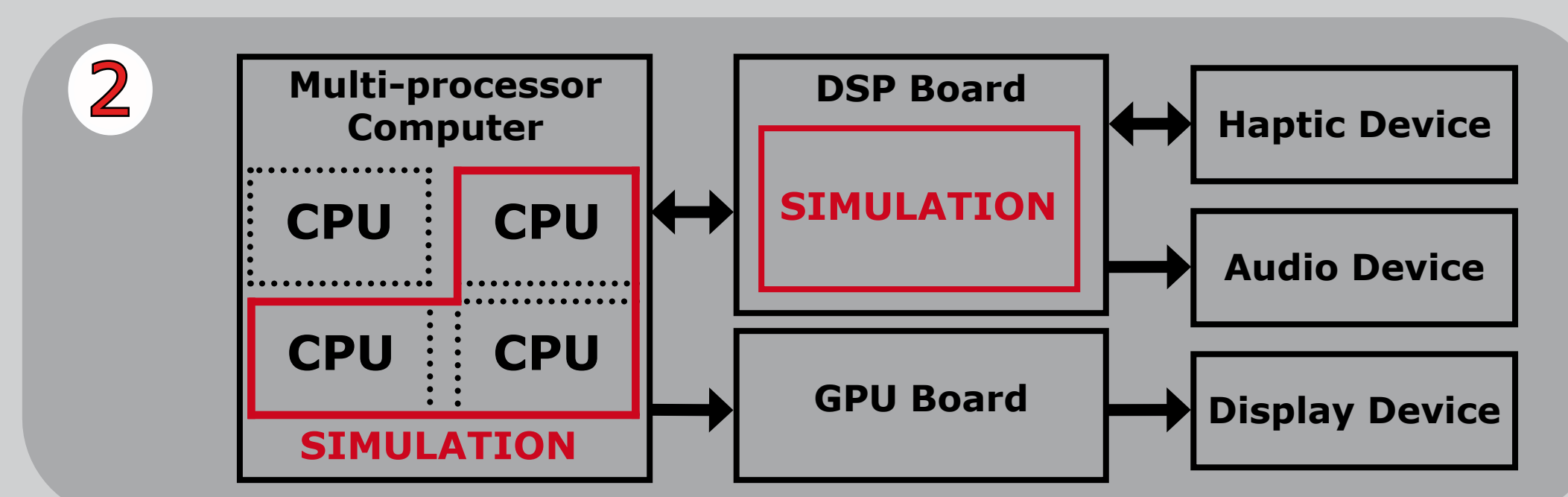
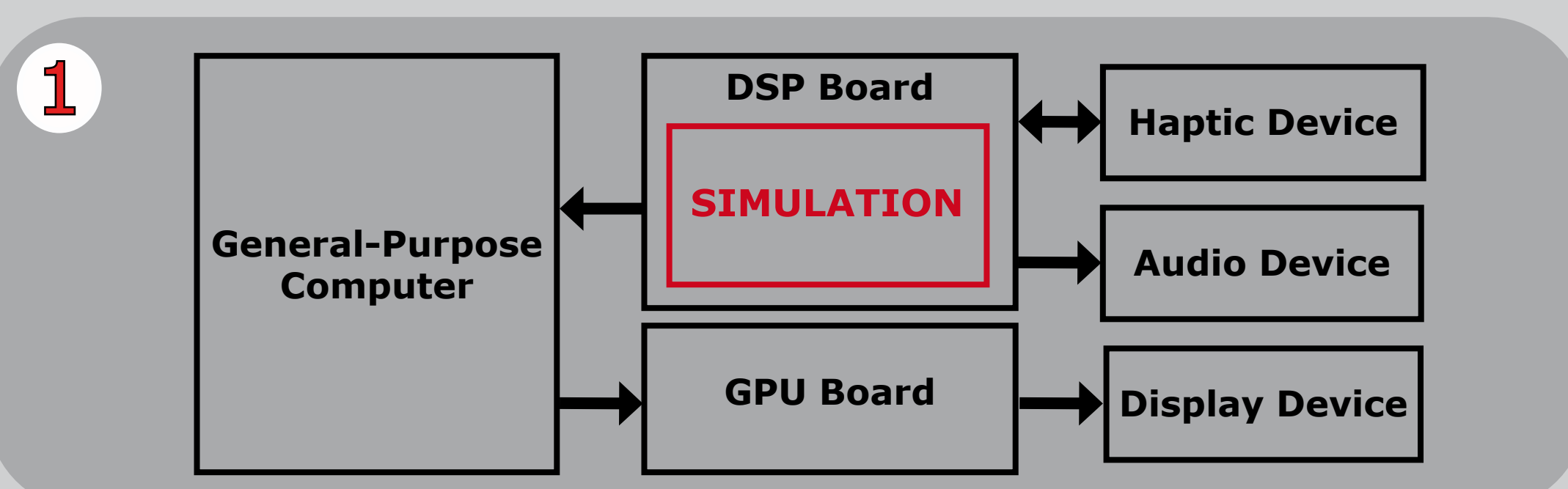


figure 1. Bypass Biprocessor Monofrequency

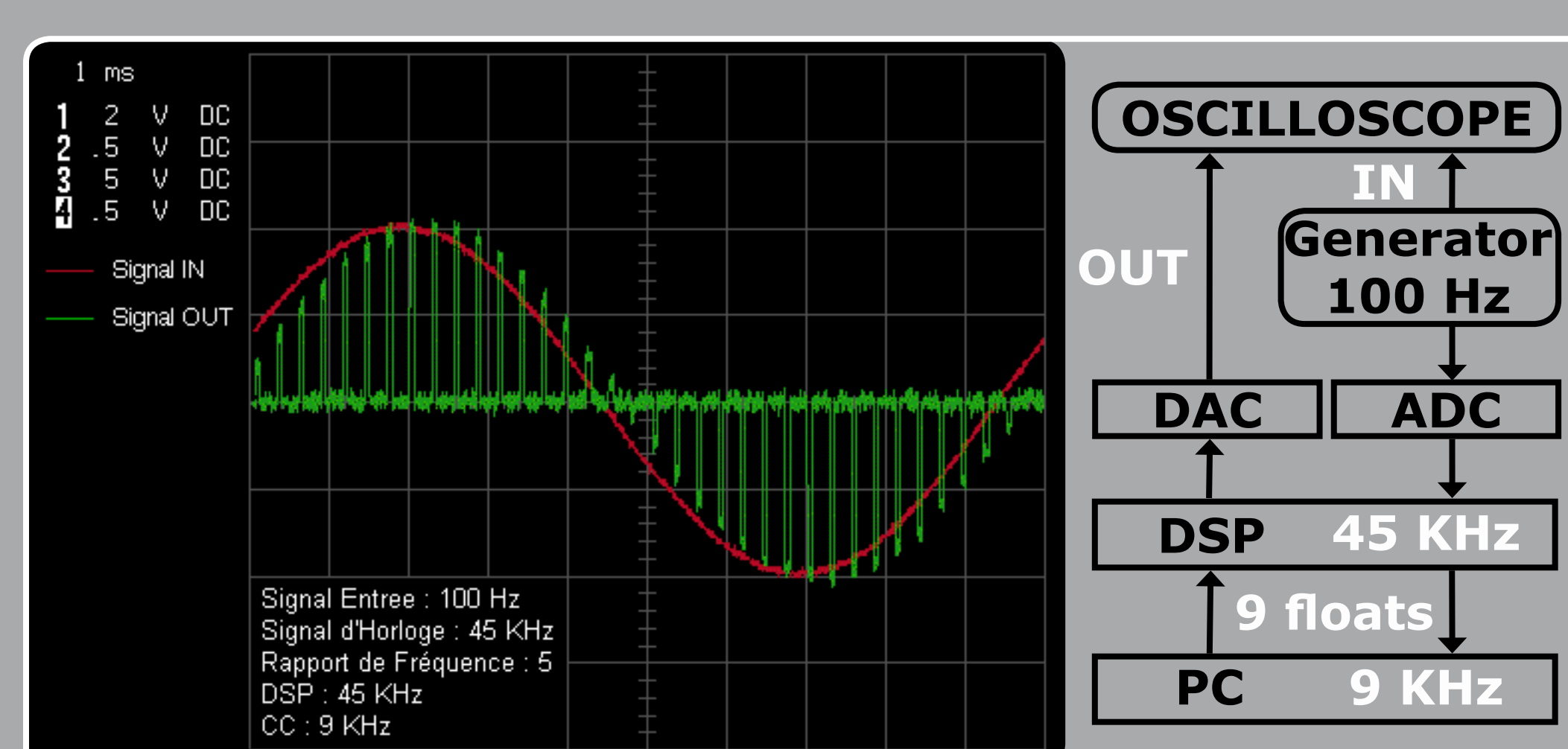


figure 2. Bypass Biprocessor Bifrequency

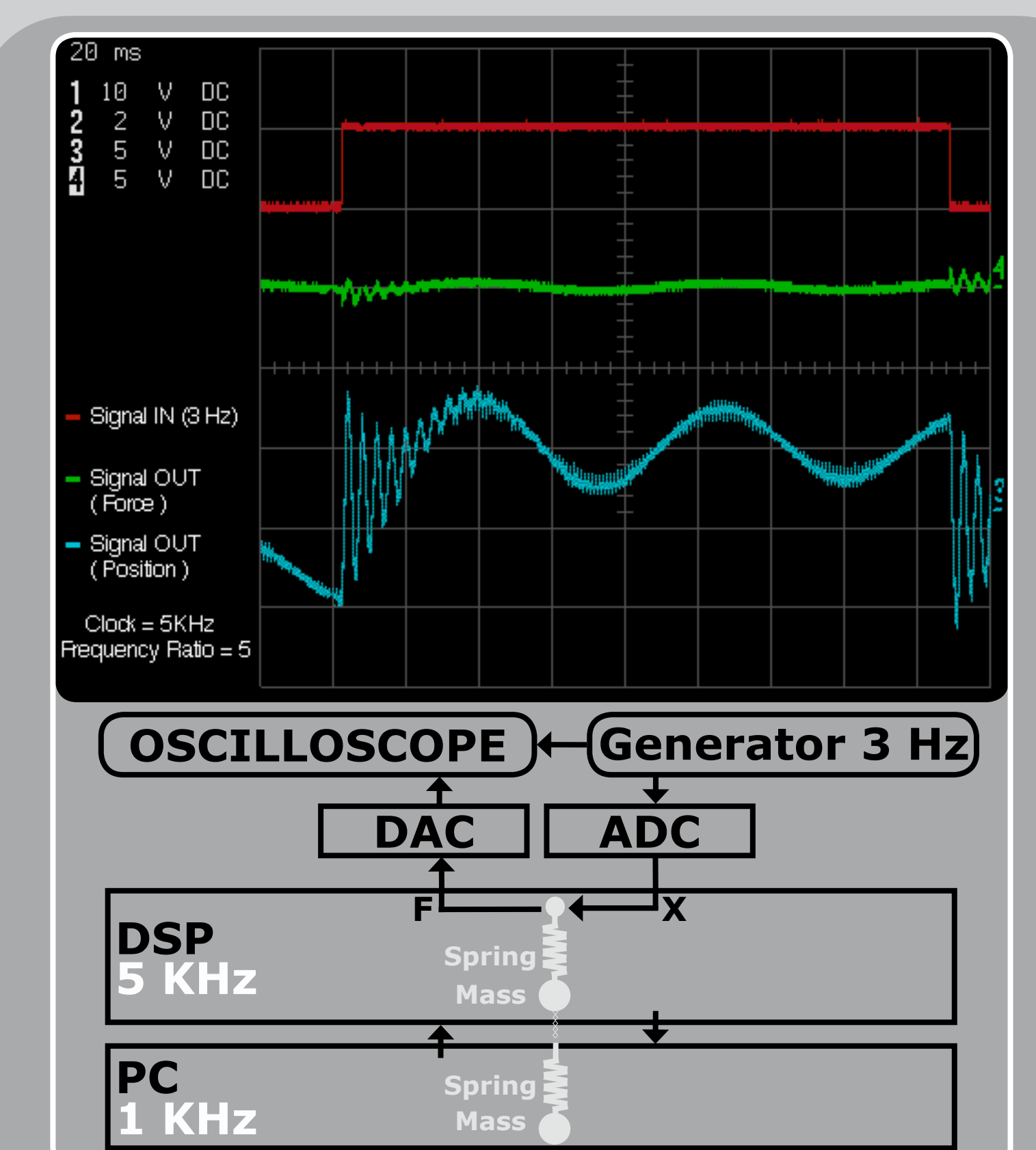


figure 3. Impulse Response of two oscillators coupled, one per processing unit

Conclusion

First Realization : « La crepe »

A complex scene with high quality of haptic interaction :

Crepe on CPU : 200 masses and 40000 interactions 2D - 1KHz

Cinematic transform 6 dofs to 2 Dofs on DSP : 9 masses - 5KHz

The new real-time hardware platform allows :

- a synchronous multi-sensory interactive simulation
- a range of configuration adapted to different issues

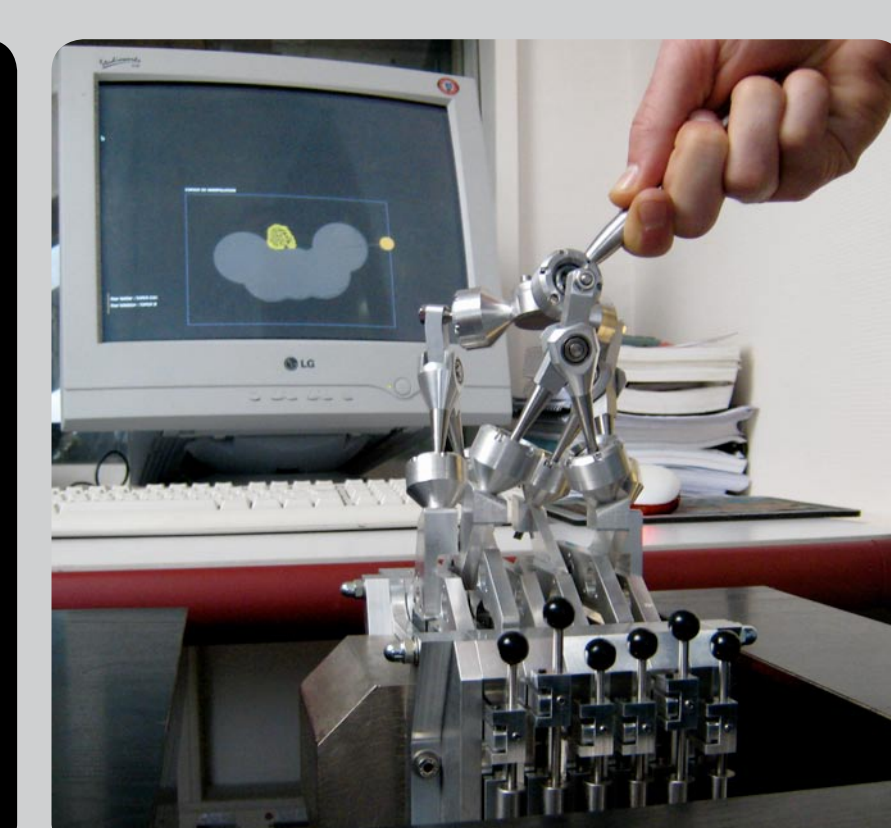
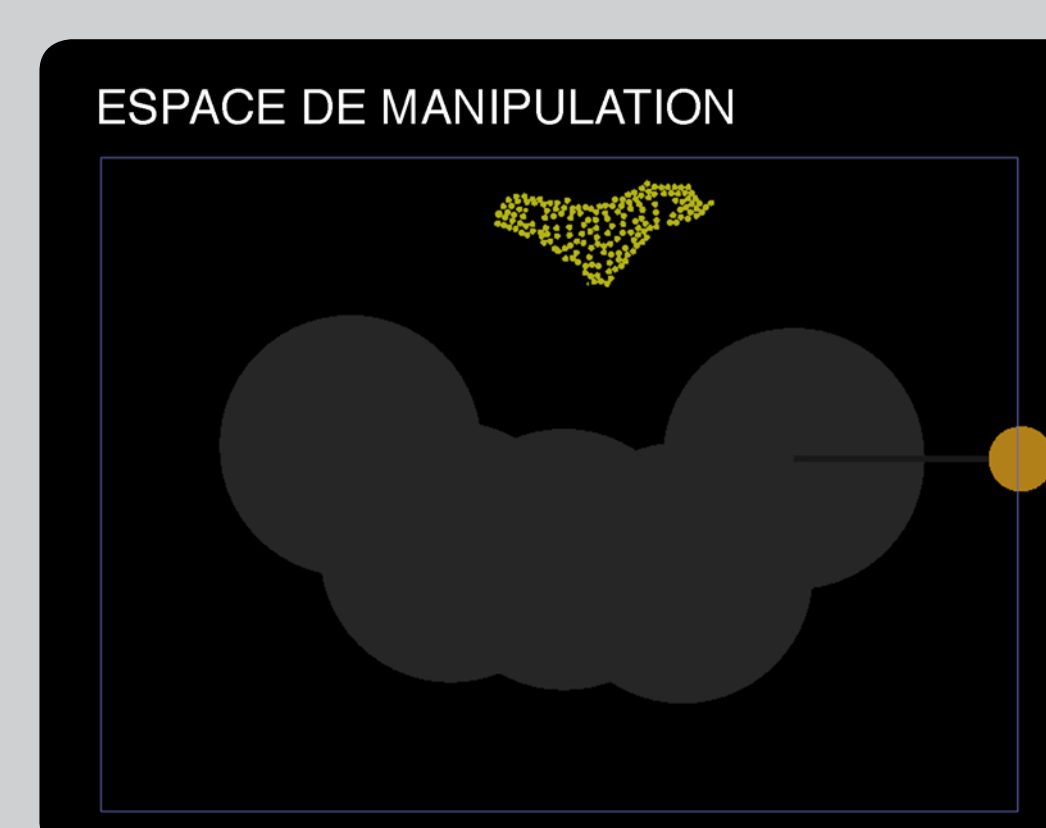


figure 4. Screenshot and Picture of «La crepe»