elena ralli
ELECTRONIC COMPOSITION & SOUND ENGINEERING

BassPhotons

Technical Documentation

This documentation refers to the Interactive Installation:
BassPhotons

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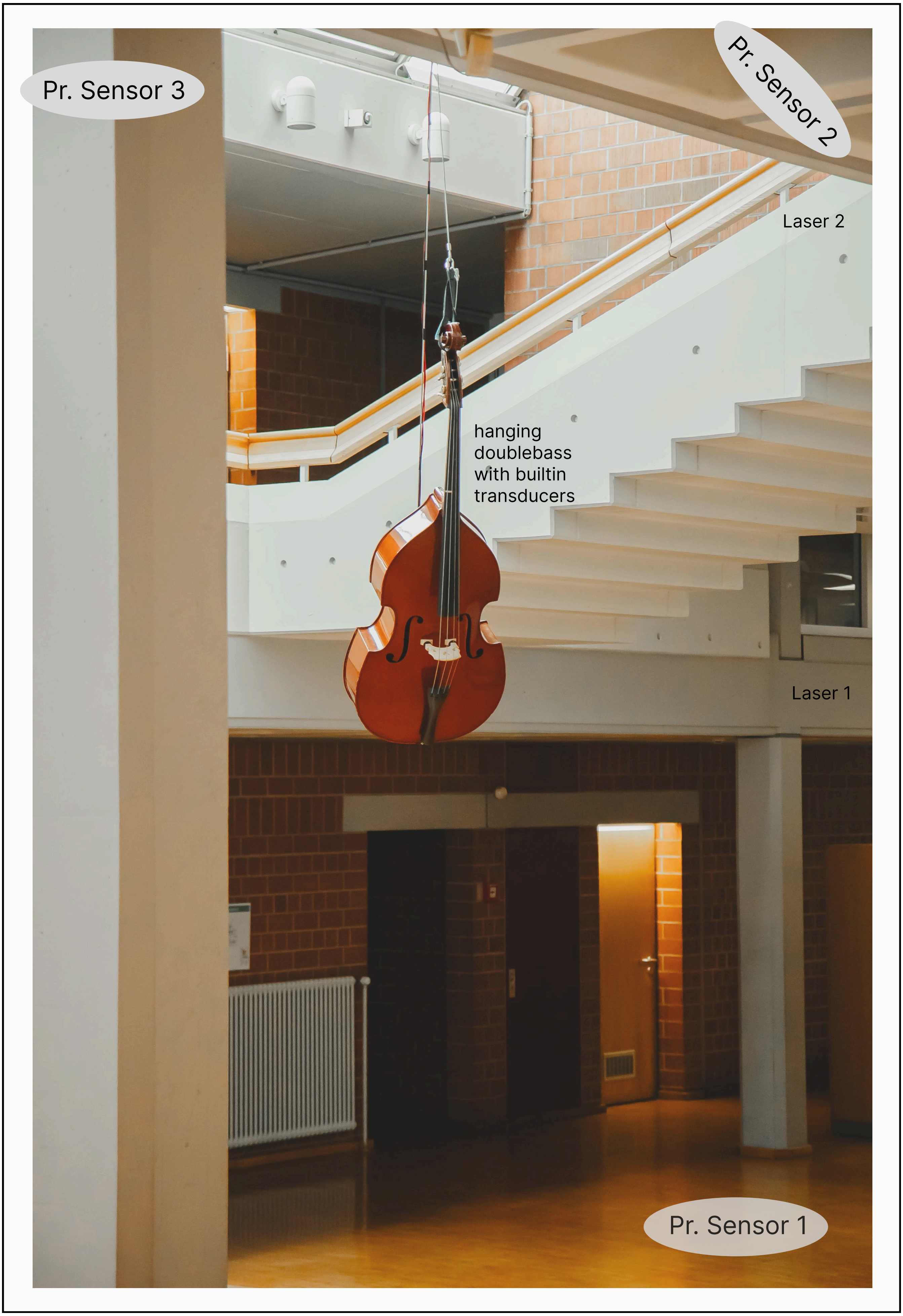
Presentation dates:
15-29 June 2024, JUNE festival, Freiburg im Breisgau
08 September 2024, Tag des offenen Denkmals, Freiburg im Breisgau

program note:
The installation uses astrophysical data as compositional material, based on the stochastic random walk that photons follow within the sun. However, this movement has been adapted to our perceptual capabilities: while an actual photon takes approximately 30,000 years to travel from the sun's core to its surface, the sound "photons" reach their highest pitch in less than 10 minutes. The double bass body itself generates the sound through embedded transducers - special loudspeakers that create the impression that sound originates from within the instrument.
Two laser pointers are aimed at the bass, translating sound vibrations into visible light. The laser beams reflect off the bass, making the physicality of sound visible through light variations.
Like scientists, visitors are invited to search for a way to listen to the random walk of a sound photon that emerges from the core of the double bass. The installation thus connects astrophysics, acoustics, and light physics into an interactive sound research experience.

Installation Setup



Technical Equipment

Main Processing Hardware
- Bela Board (ARM Cortex-A8, Linux-based real-time audio platform)
- MicroSD card (32GB, Class 10) for system storage and Pure Data patch
- USB power supply (5V, 2A) for Bela Board operation

Custom Sensor Components
- 6x Aluminum plates (electrode configuration for pressure sensors)
- 3x Adafruit Velostat/Linqstat conductive film sheets
- 3x Acrylic housing units (custom fabricated for floor installation)
- 6x XLR female panel-mount connectors (Neutrik or equivalent)
- 6x XLR male cable connectors for sensor wiring
- Assorted resistors for voltage divider circuits and pull-up configuration

Audio System
- 2x Electromagnetic transducers (embedded in double bass body)
- 2x XLR male connectors (hand-soldered for audio output)
- Stereo amplification system (12V DC, compatible with transducer specifications) (for example *the t.amp S-75 MK II)*
- Power supply unit for amplification (12V, 4A capacity)
- Professional audio cables (XLR to amplifier input)

Laser Control System
- 2x Laser beam projectors (Class 2 safety rating for public installation)
- Dedicated power supply units for laser operation
- Control circuits for binary switching operation
- Safety mounting hardware and beam positioning equipment

Mechanical Installation
- Heavy-duty steel clamp bracket (custom fabricated for double bass mounting)
- Professional climbing-grade steel carabiners for load distribution
- 6mm steel-core suspension rope (red, load-bearing primary)
- 4mm steel safety cable (black, secondary support)
- White powder-coated ceiling anchor hooks (150kg load rating)
- Floor installation hardware for sensor mounting

Tools and Fabrication
- Soldering station and professional electronics soldering equipment
- Wire stripping and crimping tools for XLR assembly
- Multimeter for circuit testing and sensor calibration
- Heat shrink tubing and electrical insulation materials
- Cable management systems for visitor safety

Installation Specifications:
- - Suspension height: Approximately 2.5m from floor
- - Horizontal clearance: 1.5m radius for visitor interaction
- - Cable tension: Balanced to maintain instrument stability while allowing
- controlled oscillation

Technical Notes:
- - Clamp positioned at upper bout to preserve structural integrity
- - Dual-cable design ensures redundancy and prevents rotation
- - Ceiling mounting allows 360° visitor access
- - Installation complies with venue safety regulations

Sensor & Laser System

Custom Pressure Sensor Design

The installation employs three custom-built pressure sensors constructed from aluminum electrode plates separated by Adafruit Velostat/Linqstat conductive film. Each sensor utilizes the piezoresistive properties of the carbon-impregnated polyethylene film, which exhibits decreasing resistance under applied pressure (typically 10kΩ at rest to 200Ω under full activation). The sensors are housed in clear acrylic casings designed for floor installation, with active sensing areas optimized for reliable foot activation by visitors.

Dual Sensor Architecture

Each interaction point incorporates two distinct sensor types operating in parallel: the analog pressure sensors described above, and custom-built binary switch sensors for laser control. Both sensors are positioned together to respond to a single visitor interaction, creating synchronized audio-visual feedback. The pressure sensors connect via XLR cables to the Bela Board analog inputs for continuous audio synthesis, while the switch sensors route through separate XLR connections to control the laser activation circuits.

Audio Processing Integration

The analog signals from the three pressure sensors feed directly into the Bela Board's analog inputs, where Pure Data patches process the sensor data in real-time. The system generates stereo audio output based on pressure intensity and sensor position, routing the processed signals through custom hand-soldered XLR connections to two electromagnetic transducers embedded within the suspended double bass body.

Laser Control System

Two laser beam projectors operate independently from the audio system, controlled by the binary switch sensors through dedicated XLR signal routing. The switch sensors function as simple on/off controllers, closing or opening circuits to activate laser projection when visitors apply sufficient pressure. This creates discrete visual responses that complement the continuous audio synthesis generated by the pressure-sensitive components.
The vibration of the body of the doublebass reflects the laser beam.
At the second presentation of the installation there were no laser beams.

System Integration

The complete system demonstrates a multi-modal interactive environment where single visitor actions (stepping on sensor pads) trigger simultaneous audio and visual responses through parallel processing pathways. The separation of analog audio processing and digital laser control ensures system reliability while maintaining synchronized user feedback across both sensory modalities.

Photo Documentation

- the solar phenomenon of photon random walk is translated into sound
- Loudspeakers in the bass, that use its body to produce the sound

Figure 1: transducer model and concept

Figure 2: Opening the doublebass to insert the transducers with the help of the violin maker Annegret Mayer-Lindenberg

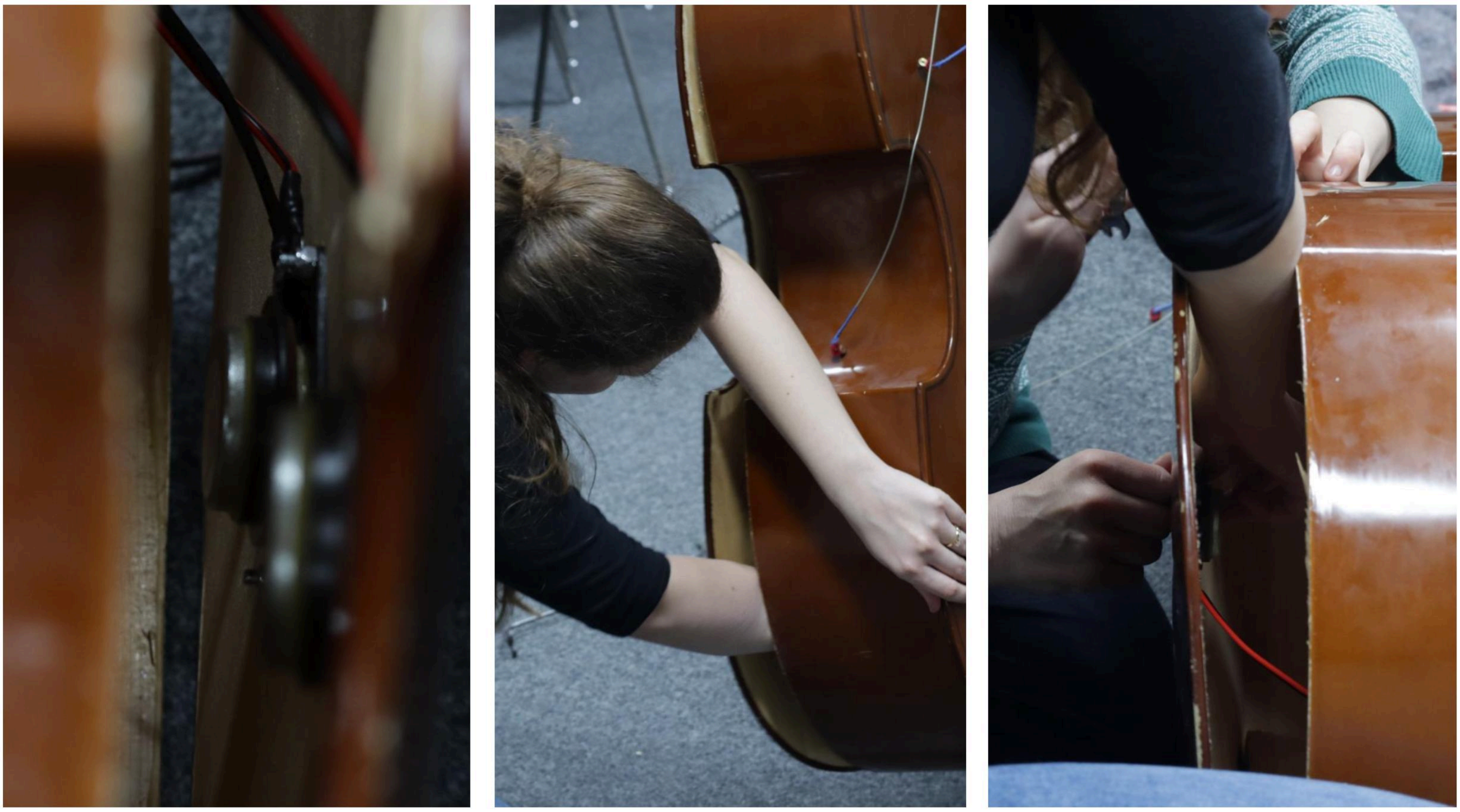


Figure 3: Setting the transducers into the bass

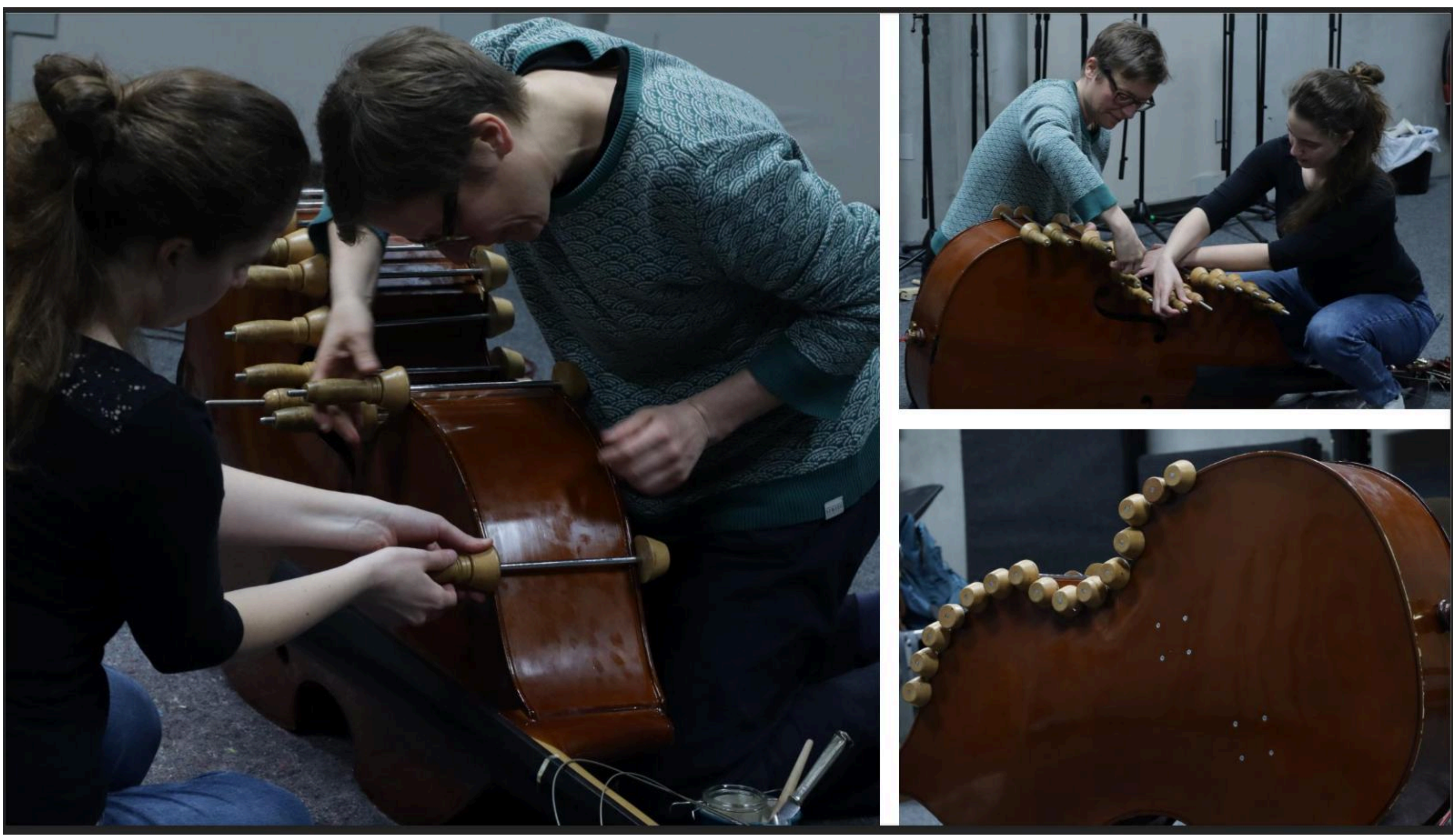


Figure 4: Closing the bass

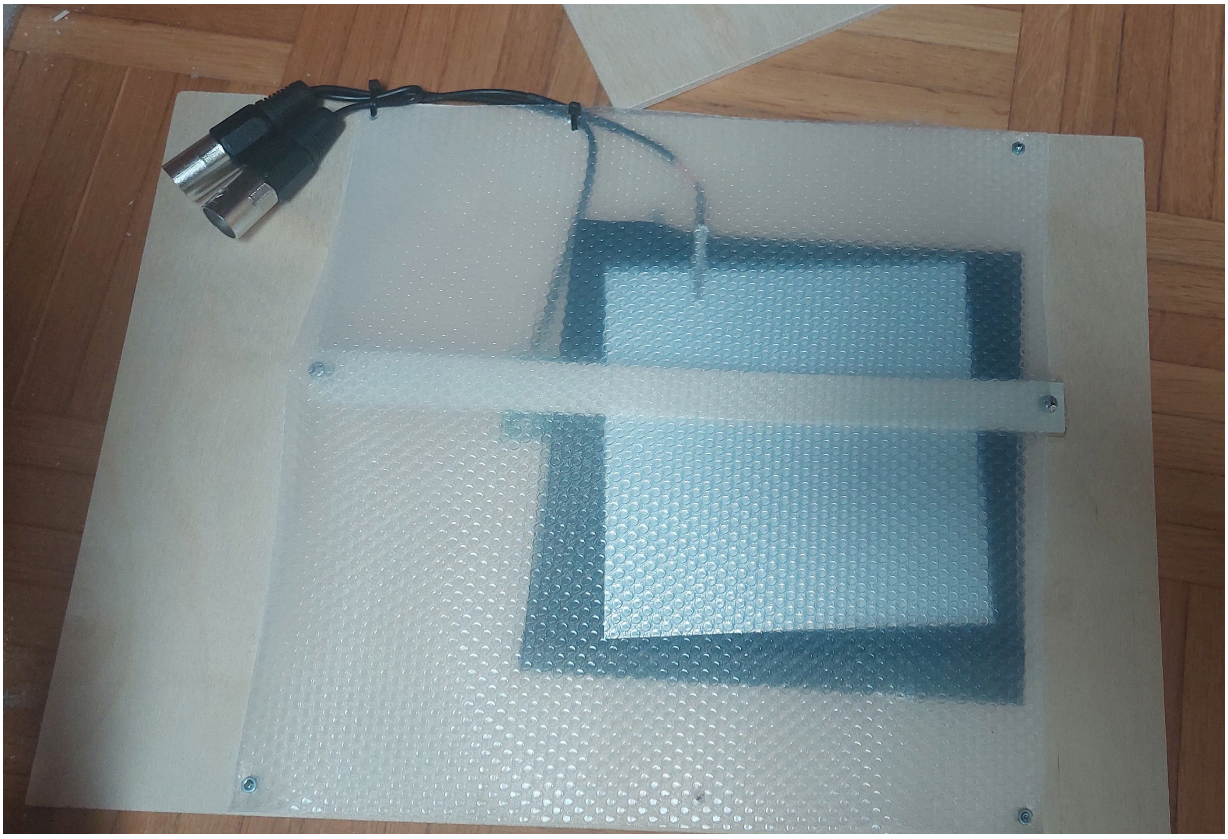


Figure 5: The custom sensor with dual functonality

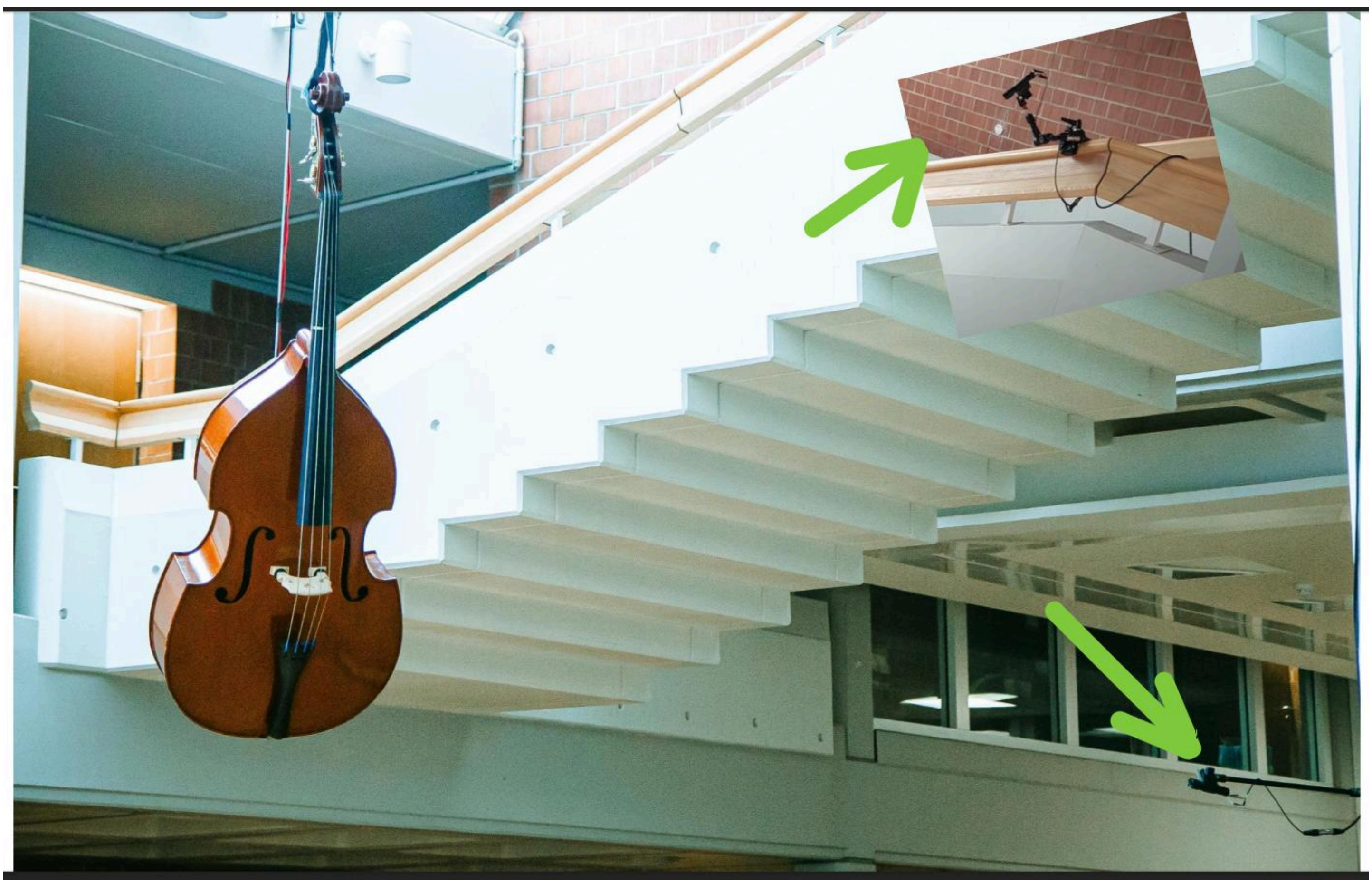


Figure 6: The two laser beams aiming to the bass

Figure 7: Suspension system for the doublebass

Figure 8: Laser beams from other perspective

Figure 9: Pressure sensors presented to the visitors

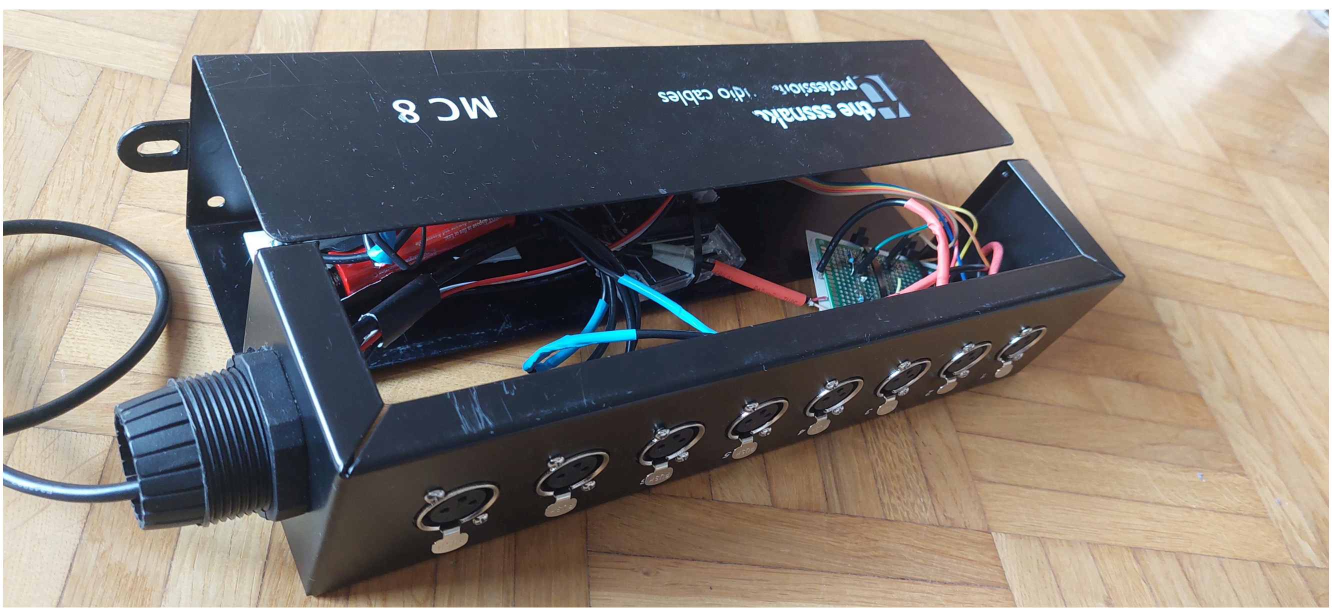


Figure 10: Hardware setup