



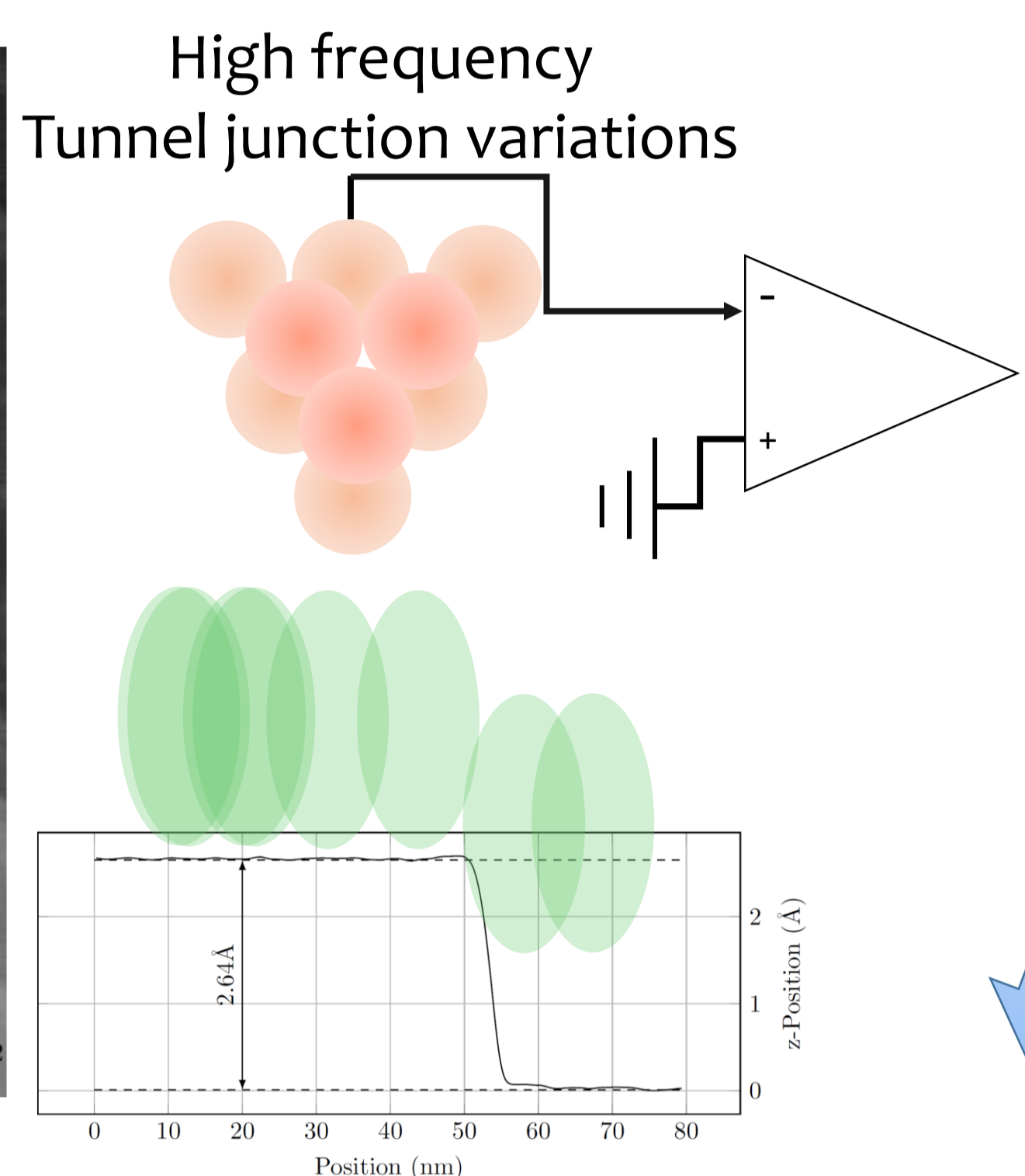
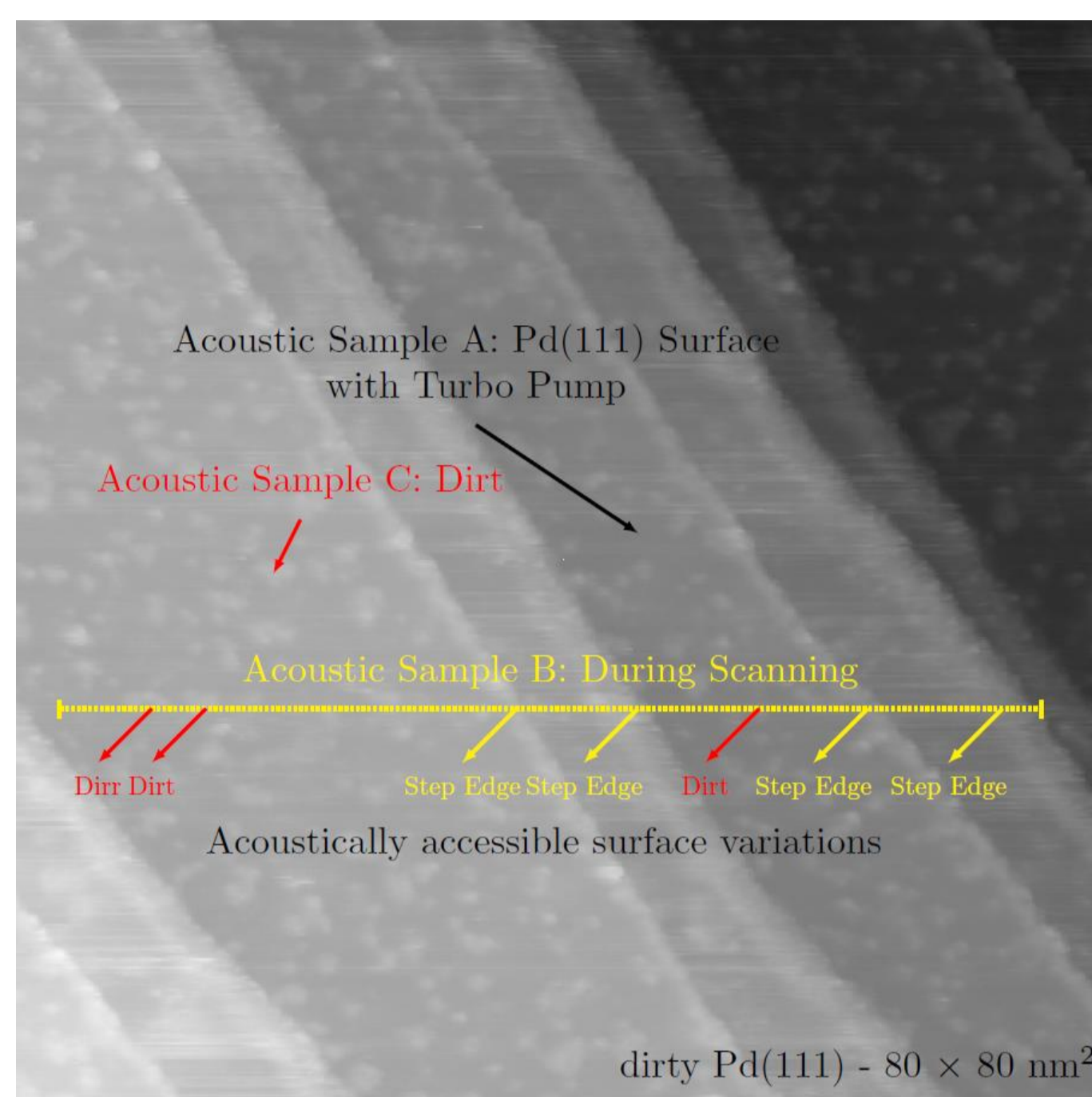
The Sound of Atoms

Acoustic Monitoring of the STM Tunneling Current

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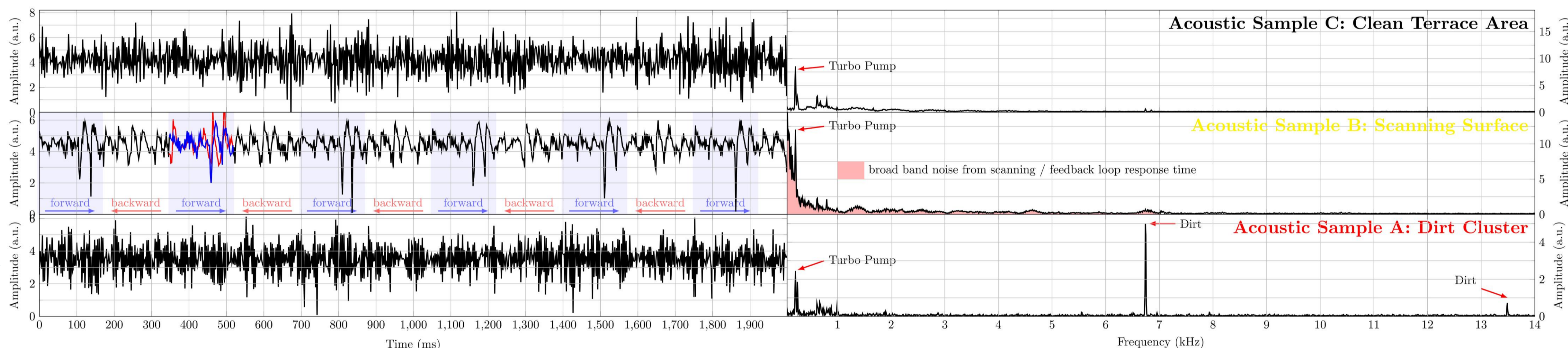
Introduction

Tired of spying on oscilloscope waveforms? Does staring at the oscilloscope distract you? It's time to embark on an Arduino audio journey. We're replacing traditional oscilloscopes with an innovative project. Experimenting while keeping an eye on the Fourier transformation on the oscilloscope can be challenging. However, our ears are sensitive to changes in frequency. Therefore, use your ears as a natural autonomous FFT machine, leave the oscilloscope behind and explore the world of sound.



Low frequency (< 1 kHz) experimental results (for example Topographical Information)

No/Negligible visual contrast



Time delayed visual contrast
Visually distracting concentration

Ears:
A natural autonomous FFT machine (Frequency Analysis in kHz)

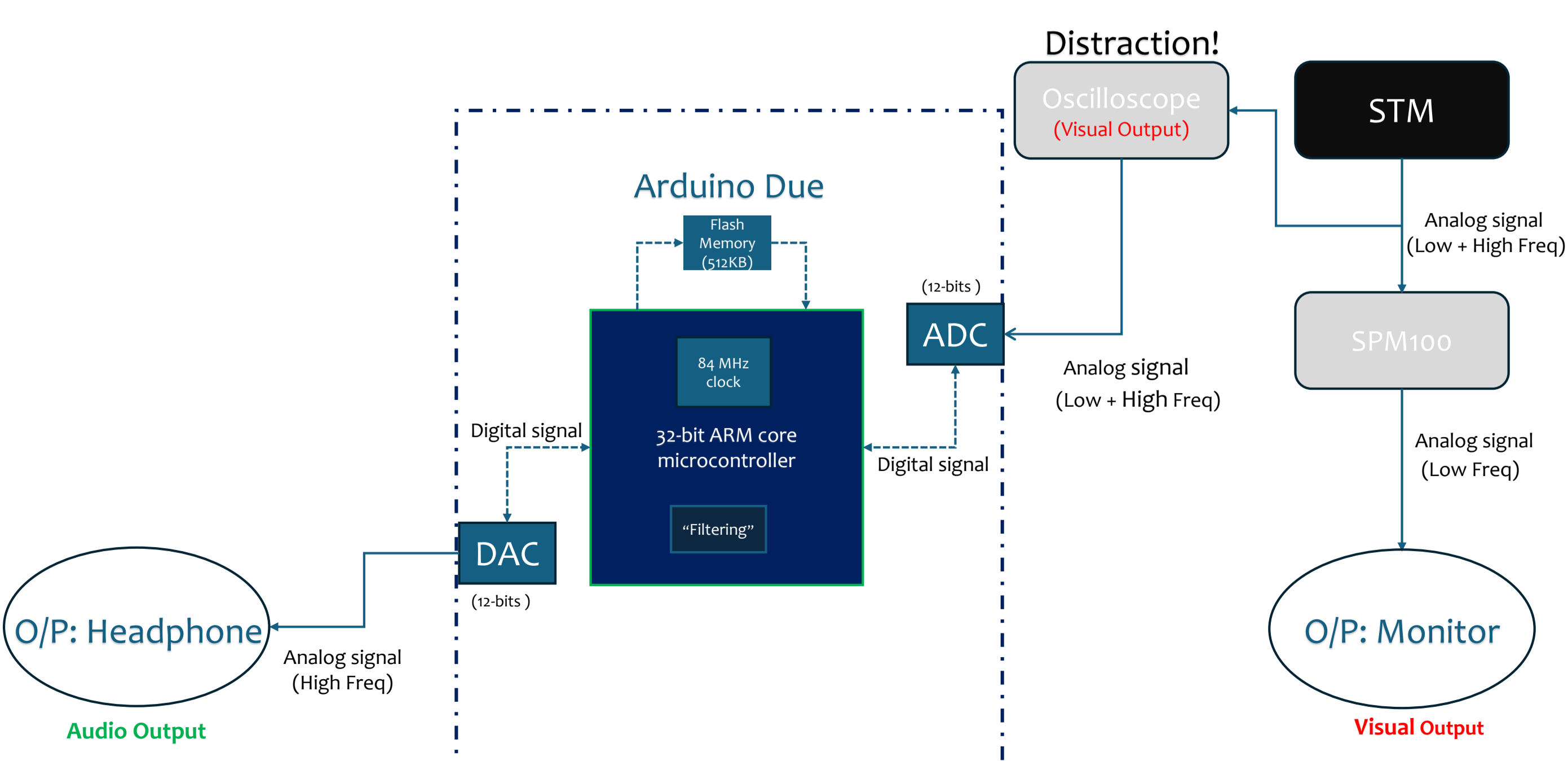
Arduino Controlled Voltage-Audio Converter

High frequency signal
Noise
Tip-Sample interaction
Motion of nm-particles
Mechanical vibrations

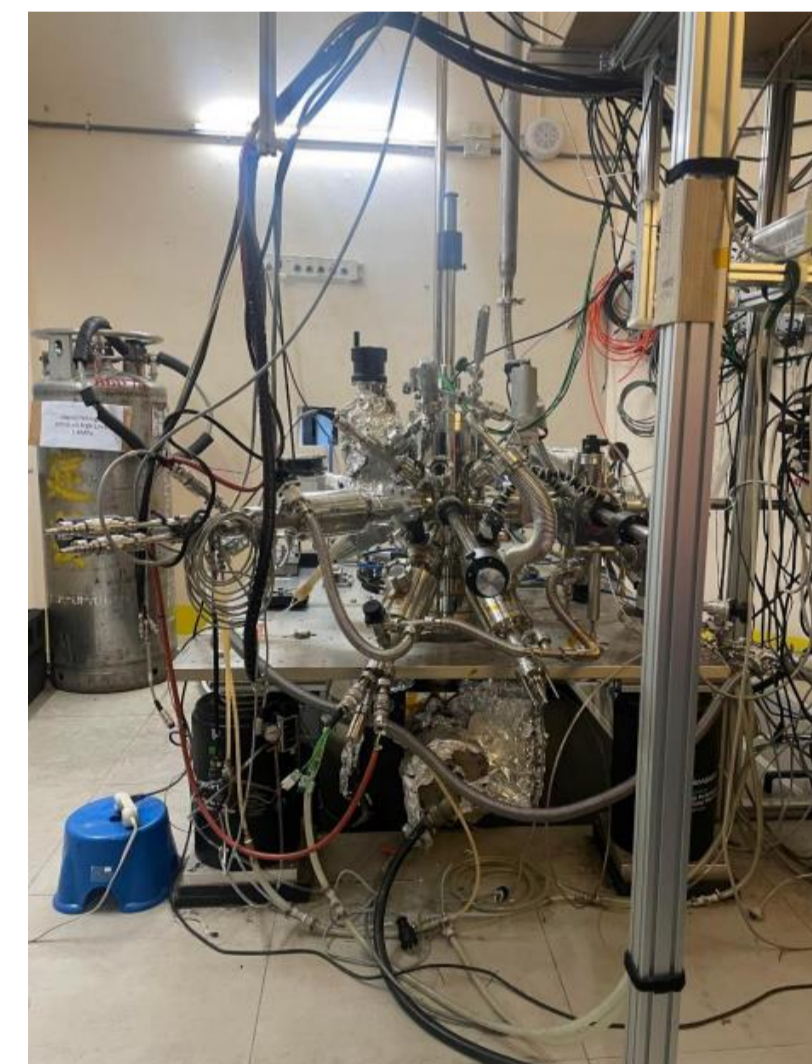
Visual versus Acoustic Access

- Tunneling current carries **low frequency** information related to the **topography** of the current position.
- The **high frequency** component is equally vital. It contains information about the variations in the probe-sample geometry.
- While **low frequency** signals are observable visually, they remain inaudible. In contrast, **high frequency** signals, challenging for the eyes, reveal their distinct characteristics through auditory perception.

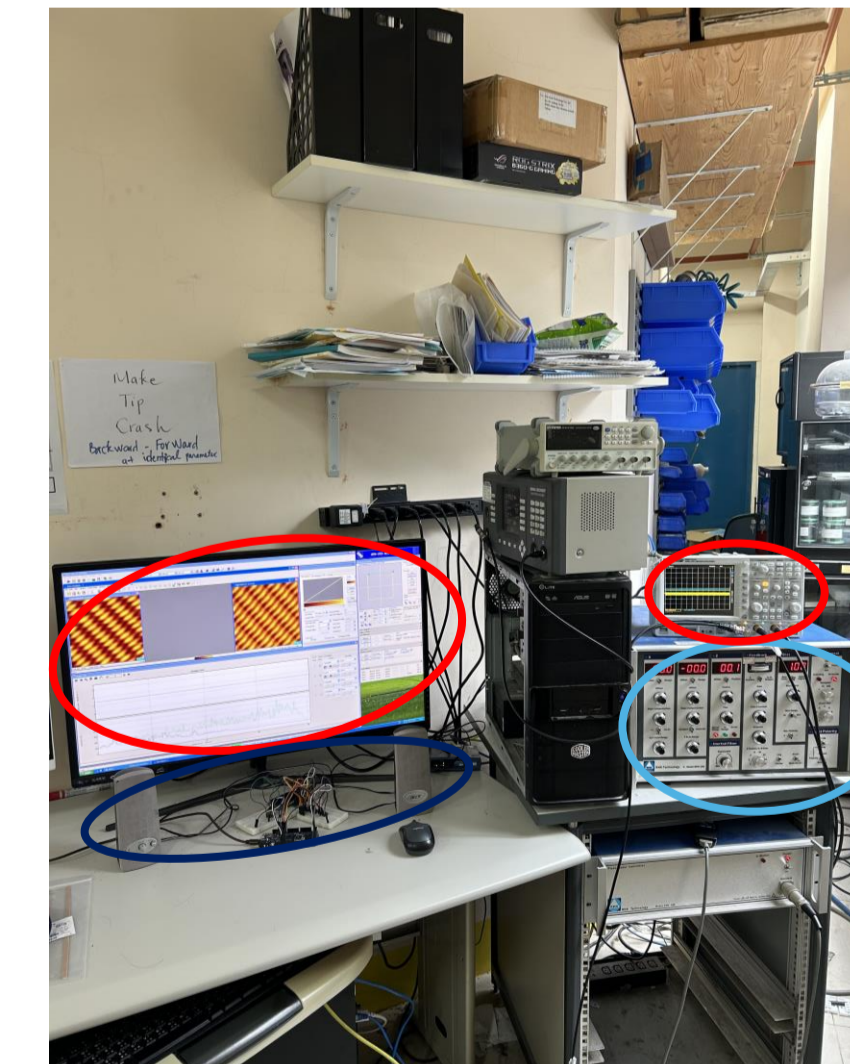
Detail of Arduino



Setup



- STM
- ultra-high vacuum
 - 77K



- Electronic device
- Visual Access**
 - Acoustic Access**

tactile control

Conclusion

This Arduino project replaces the traditional scope by an acoustic access to high frequency signals. Conventional visual control distracts the experimentalist and is time delayed. Superior access is acoustically gained and tunnel junction variations originating from

- Tip changes
- Adsorbates
- Misadjusted Feedback...

are easily discernible and allow for immediate, undistracted reaction by the user. We free ourselves from distractions and no more struggling with FFT on the scope.