# Tissue Impedance and Biomechanical Measurement Device


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## Abstract


Our Meng project was focused on the modification of a tissue impendence measurement device for Dr. Jonathan Butcher in the Biomedical Engineering department. Our goal was to modify the electrical components of system in order to improve its performance such as data measuring speed, device stability and portability. First goal of our project was to build a miniaturized fast frequency function generator using PIC32 Microcontroller and integrated it with the current system to increase data collection process as well as miniaturize the device size. Second goal was to replace the current DAQ component with a PIC32 MCU based design to further increase the data collection speed.

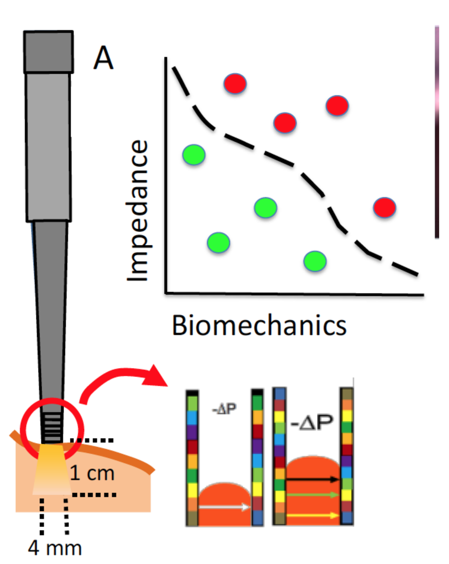
Currently, we have succeeded in replacing the old function generator with the new PIC32 based function generator. The new function generator was half size of the older function generator, and it increased the data collection speed dramatically. It took about 1 minute and 30 seconds the collect the same amount of data that took the old function generator 10 minutes to collect. Now we are working on replacing the old data acquisition device with the new one, and we believe it could further reduce the data collection time as well as improve the portability of whole system.


## Background

**Soft tissue mechanical and biological characterization**:

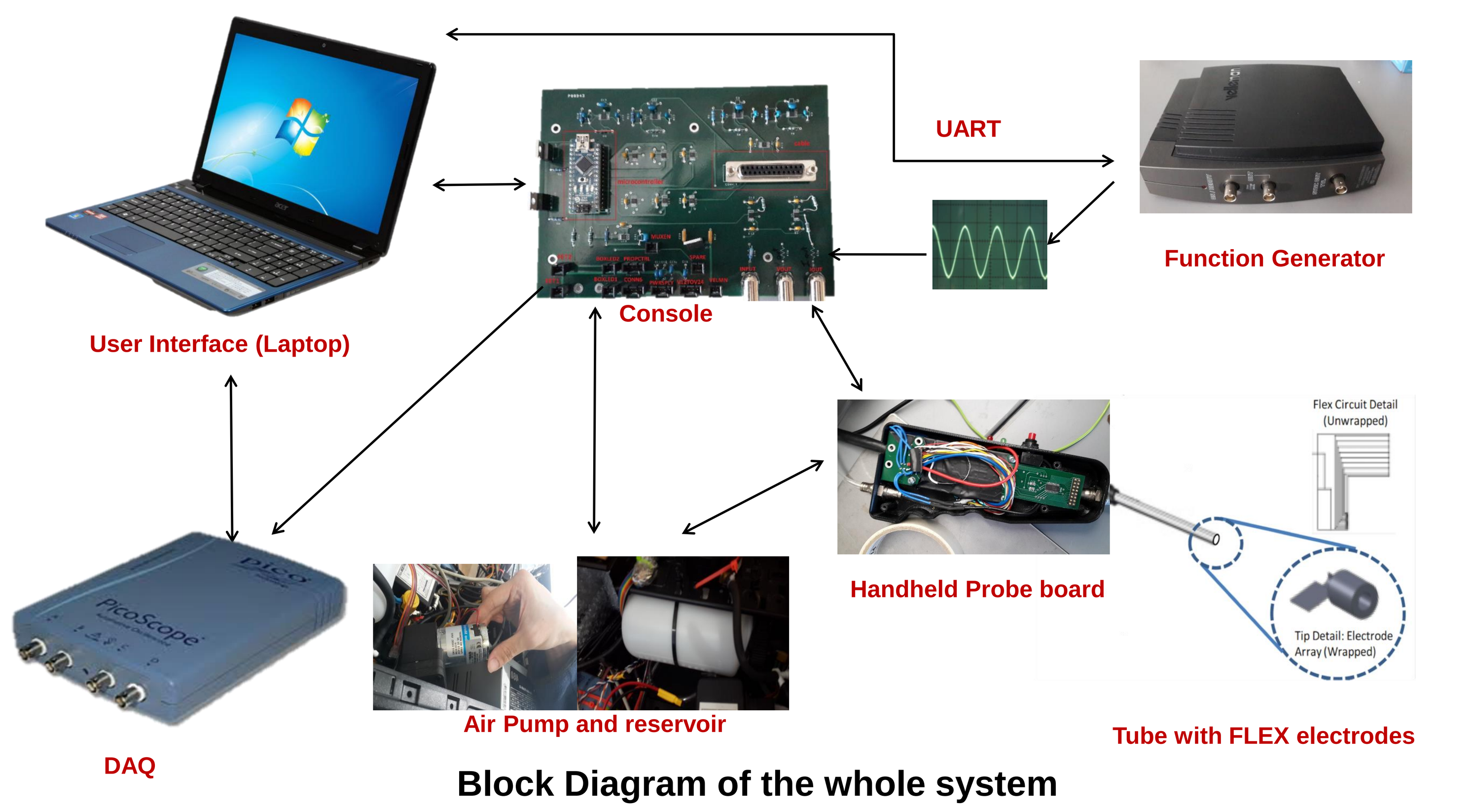
Soft tissues are complex living materials that despite many years of research remain challenging to quantitatively characterize mechanically or biologically.[1] There are many existing techniques to measure mechanical property of the soft tissues by removing them from their living environment. These in-vitro tests would undoubtedly change these tissues' original physiochemical states, and would be hard to identify tissues' true mechanical properties.[1] Few in-vivo technology available to measure the mechanical property of intact soft tissues. Most common one is called **surface indention**.[2]

Negative pressure is applied to the tissue through a tube, creating uniaxial tensile on the distended tissue. However, the challenge is to measure the tissue deformation. Although optical measurement of strain was prove to be effective, it only works for the tissue surface that is accessible. [3]




In order to overcome the limitations of previous technology, Dr. Butcher and his previous students developed a novel tissue mechanical and biological property measuring device, that uses resistance changes in electrodes at discrete intervals. (Figure on the left)

## Device introduction




Block Diagram of the whole system

1. Laptop contains an UI interface that allows the user to interact with the system. It is also responsible for analyzing the mechanical and bioelectrical property of the tissue.

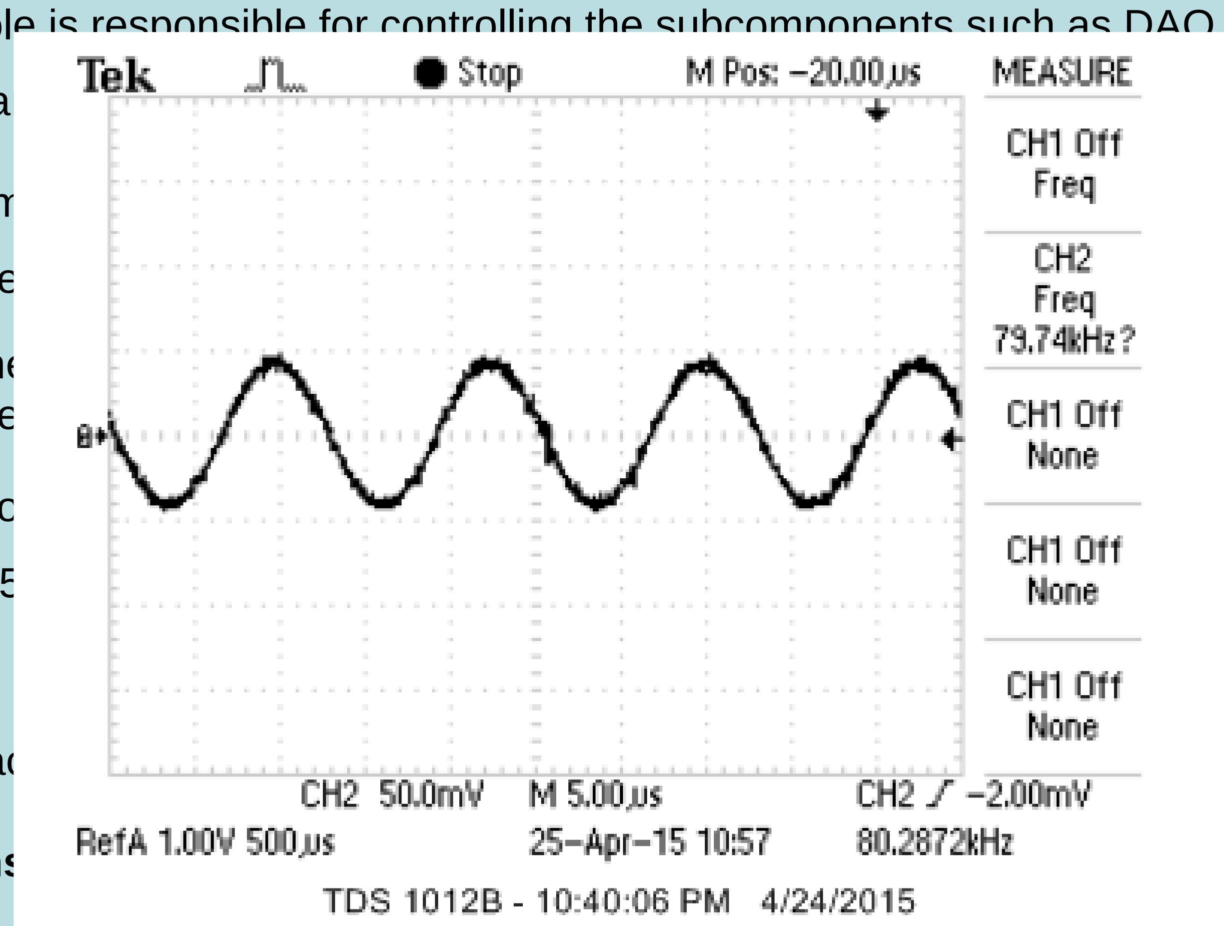
2. Console is responsible for controlling the subcomponents such as DAQ, air pump, ha

3. Air pum ... a thing tube

4. Handhe ... ach pair of ele

5. Functic ... cies (1K,10K 5 ... arget tissues.

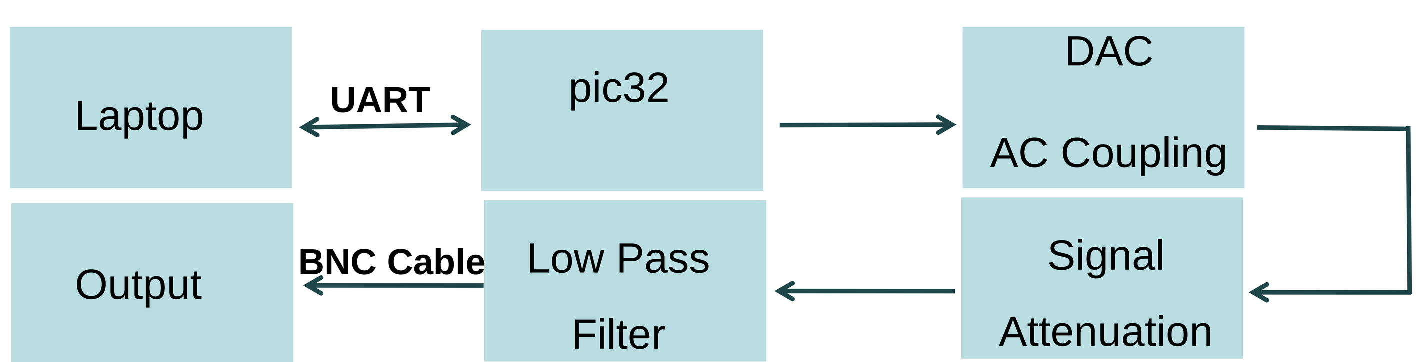
6. Data ac ... est.

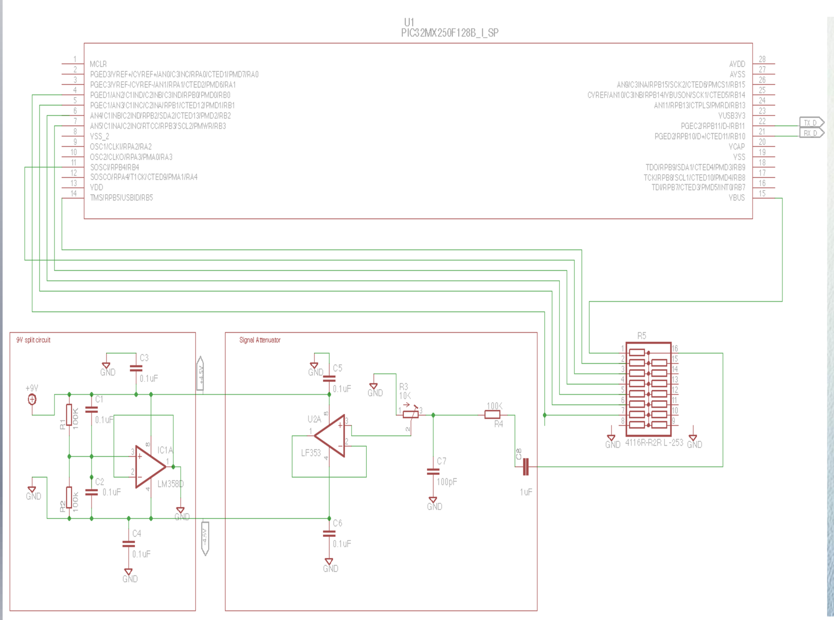



**Problems**

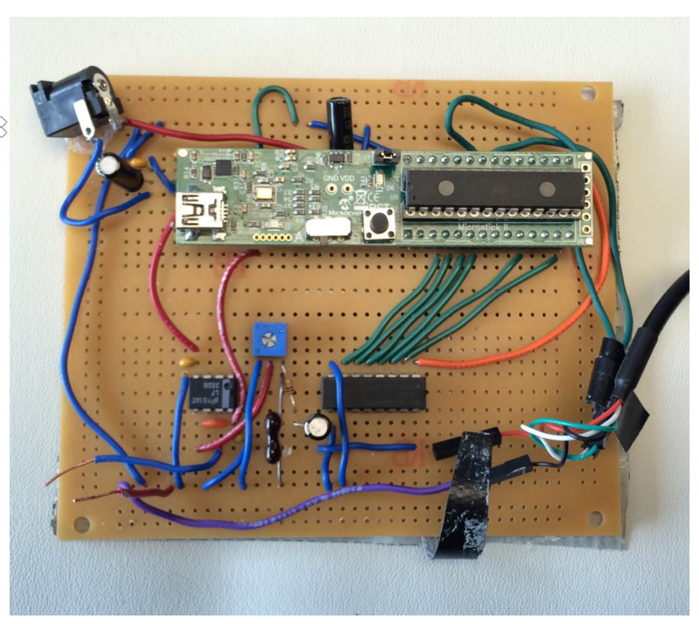
1. **Slow data collection process (10 min )**
2. **Bulky size (hard to carry)**

## Function Generator Design



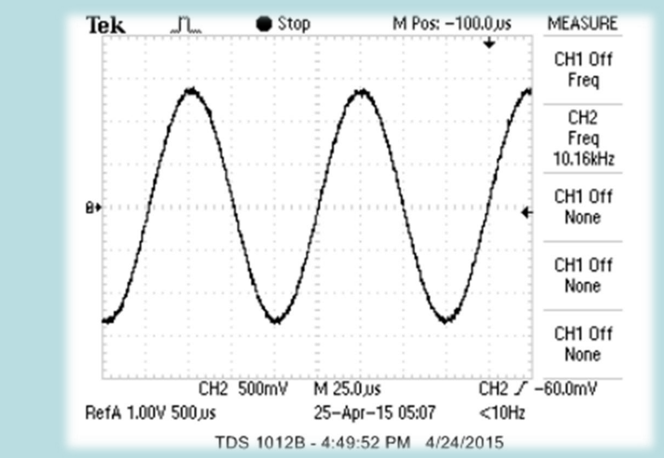
Circuit Schematic



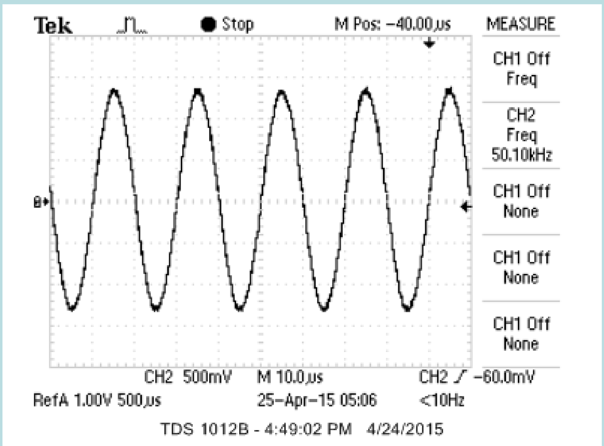
New Function Generator

## Function Generator Performance

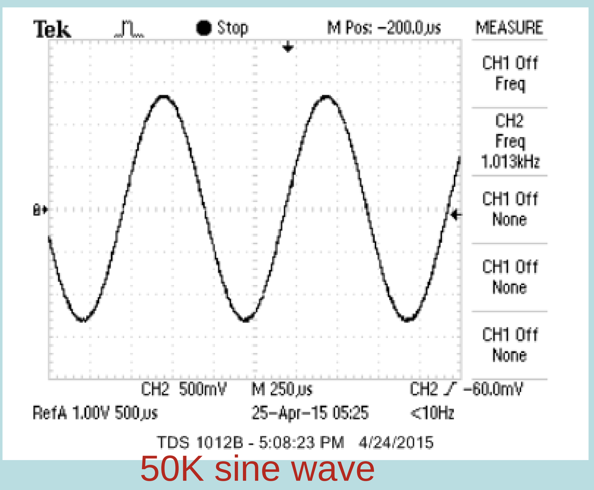
### Signal coming out of the DAC



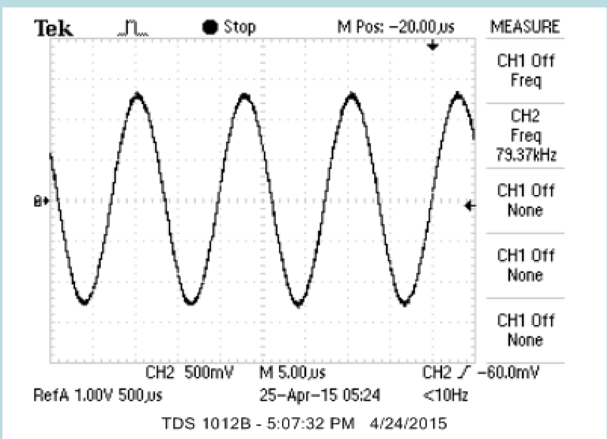
1K sine wave



10K sine wave

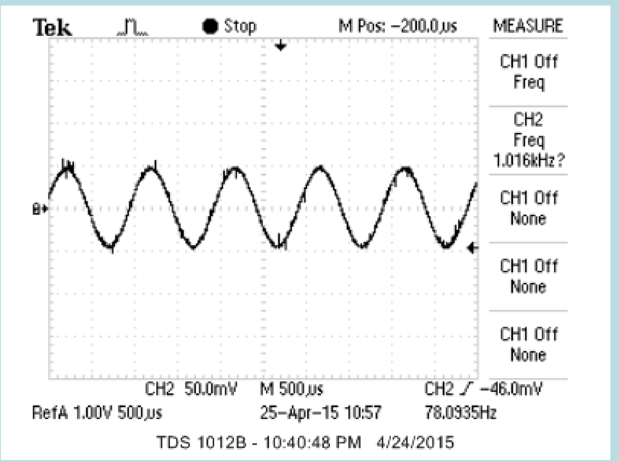


50K sine wave

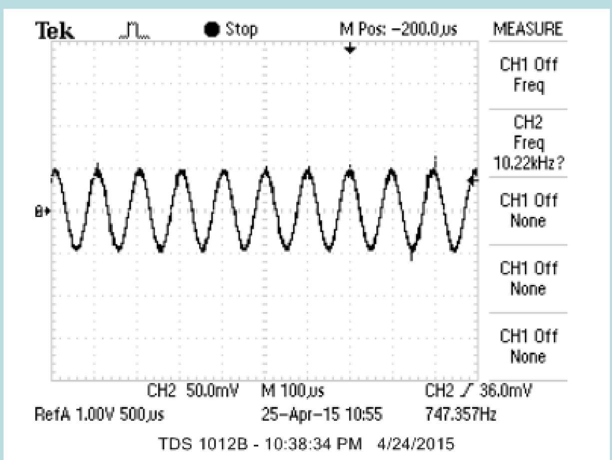


80K sine wave

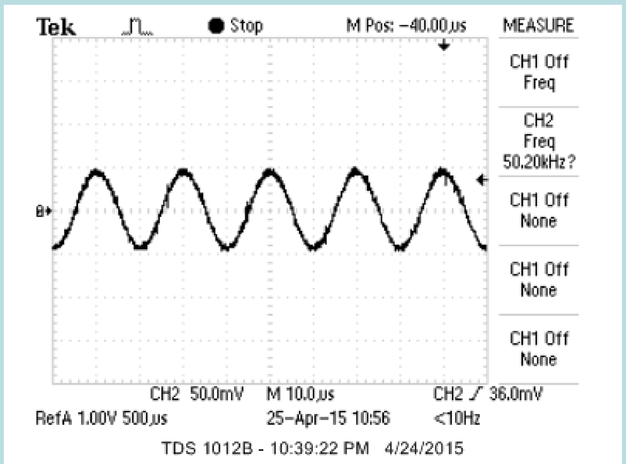
### Signal coming after attenuation



1K sine wave



10K sine wave

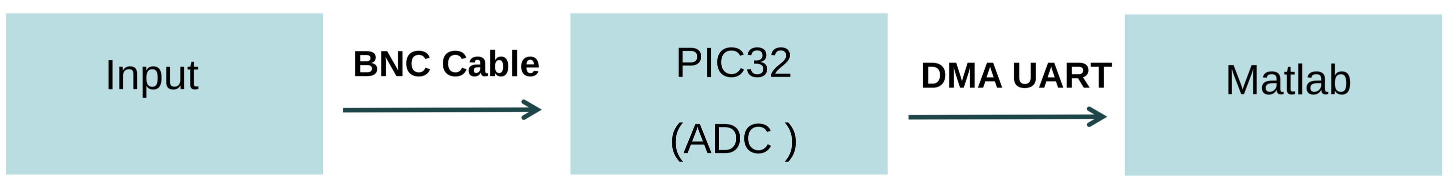


50K sine wave

80K sine wave

**First table shows that signals coming out of the PIC32 are perfect sine waves. Therefore, the PIC32 works properly in term of generating sine waves. In the second table, signals decrease to the desired voltage level (60-100mV) after the attenuation circuits. Although there are minor noises, it is still acceptable for the system.**

## Current work: Data Acquisition Device Modification




**Challenge: Synchronization among laptop, functional generator and DAQ for multi frequency measurements.**

## Reference


[1] Brommer, H., Laasanen, M.S., Brama, P.A., van Weeren, P.R., Helminen, H.J., Jurvelin, J.S., 2006. In situ and ex vivo evaluation of an arthroscopic indentation instrument to estimate the health status of articular cartilage in the equine metacarpophalangeal joint. Veterinary Surgery 35 (3), 259–266.

[2]Butcher, J.T., McQuinn, T.C., Sedmera, D., Turner, D., Markwald, R.R., 2007. Transitions in early embryonic atrioventricular valvular function correspond withchanges in cushion biomechanics that are predictable by tissue composition. Circulation Research 100 (10), 1503–1511.