Date: Feb 28, 2012
In attendance: Jonathan and Tibi
Location: Nori's place
Topic: testing of the joint-type transducer

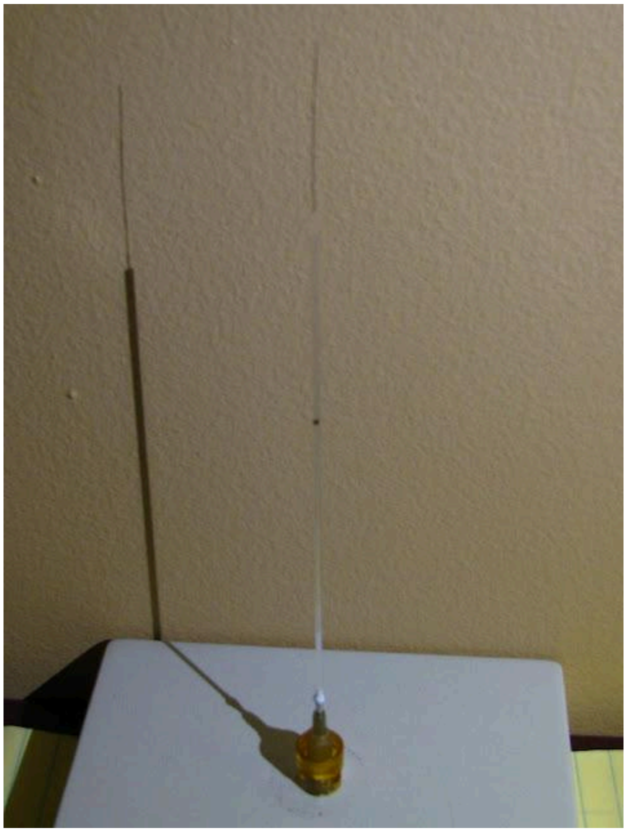
See pictures taken documenting this Work.
See video.

ATTENTION: to understand the language of this document you may need to refer to these documents.

Contents

Main Goal

Test the same joint-type transducer built by Tibi and Francois (see work party on Feb 16, 2012), using the circuit built by Jonathan after his work (Feb 26, 2012) described in this document.



Electronic Setup

Conditioning and detection

See this document for info on the old circuit (used in this work party)

Laser and detector

PDLD bidirectional

Laser Driver

EK2000 from Thorlabs

Detection

LabJack U3 HV and Jonathan's oscilloscope.

Summary of results

See pictures taken documenting this Work.

- We ended up measuring a larger signal than the last time (the first time we tested the transducer only using the LabJack connected directly to the photodiode, with no amplification and with no filtering). See Transducer signals.
- We also discovered that our transducers can work in two directions, sensing an increase in signal if bent in one direction and a drop in signal if bent in the opposite direction. See section Bidirectional sensing.
- The mechanical properties of the transducer were acceptable. See Transducer signals.
- We detected some wired signals: a pulsed signal picked up by the oscilloscope
- This is not ideal, but we are making progress. We now have ideas about how to improve the electronics for analog signal conditioning and acquisition.

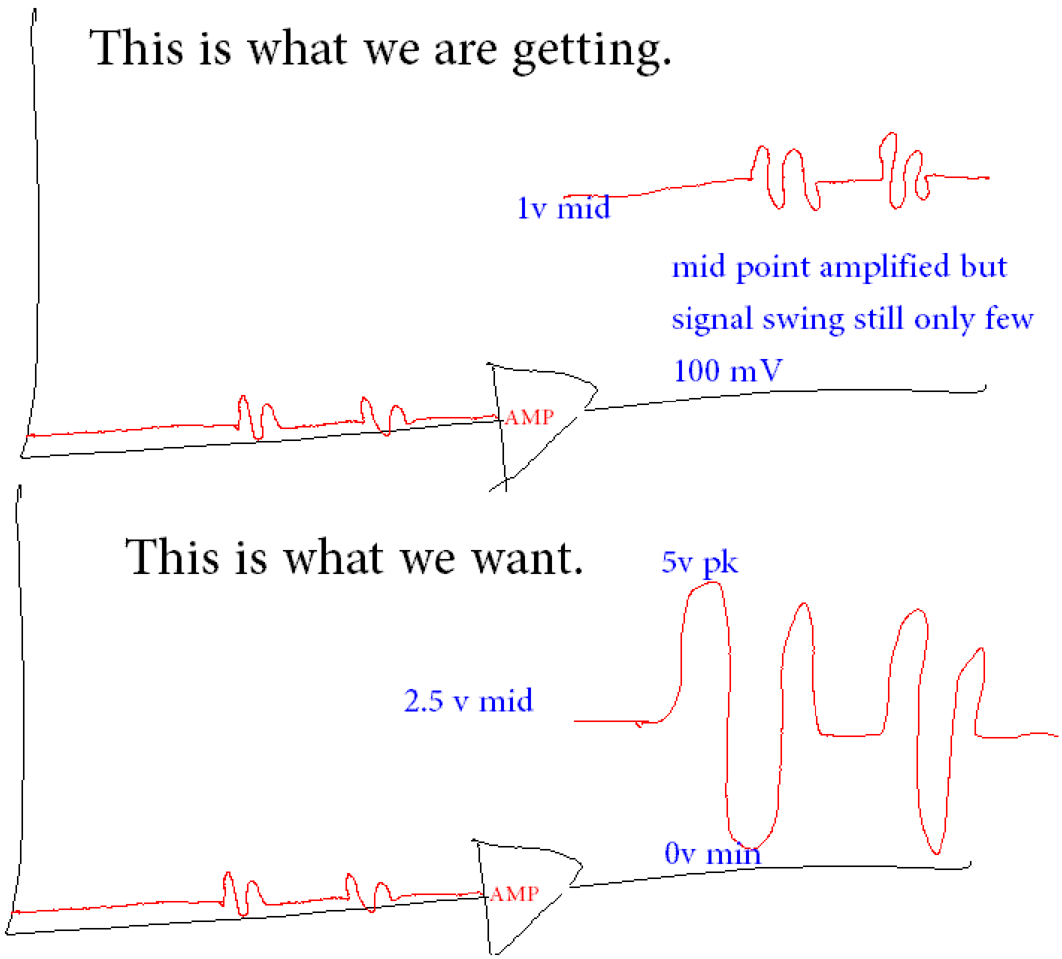
Conclusions

See pictures taken documenting this Work.

Amplifier

Gain is adjustable using a variable resistor. Not too happy with the DC voltage [Jonathan].
The problem is that we have a DC baseline when laser is on. Adjusting the gain changes the baseline. How can we keep the DC baseline down and amplify the signal produced by the transducer, modulating the laser intensity sent back the the potodetector.
From Jonathan:

> *The midpoint adjusted according to the gain, which is good, however we are not getting the signal amplified enough, ideally we want the baseline adjusted to the midpoint of the digitizer and the +/- swing to reach the maximum and minimum potential. See fig.*



Filter

We used 7410 butterworth 5th order low pass 6.4 KHz
It filters a MHz signal that seems to come from the photodiode.

We need to perform some FFT on the signal to analyse all sources of noise. The LabJack is not that fast to perform fast sampling. We can go at 1ms/sample - 1KHz. We would need a faster acquisition card to do that, something like Dilson's DAQ at 500KHz.

Jonathan's scope can do Fast Fourrier Transform. From Jonathan:

> *Yes it can, ill read the manual to get more familiar with it. I hope to digitize the signal with the ADC I have here. I have a few that do over 10M sample per second. Which may be enough to feed into matlab. However if we just bring it to the Dilson's lab and goes much faster I'm all for it.*

Detection

We detected a few unwanted signals...

We really need to to methodical signal characterization in order to understand these strange unwanted signals! See comment above about fast acquisition and FFT.

Unwanted signals

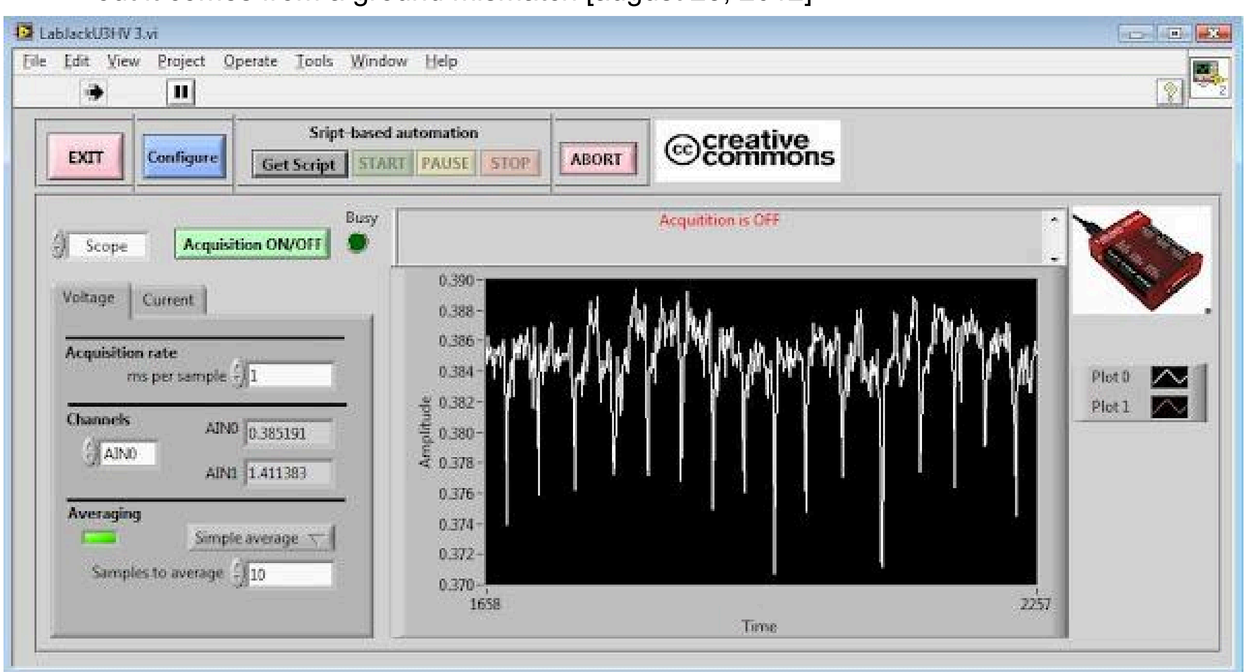
Low repetition rate signal dip

We detect a strange periodic signal, which doesn't seem to be related to the the force transducer, see picture below, the spikes pointing downwards, spaced approx. 1.5 sec apart. To find the source we tried a few things:

- We picked up the force transducer from the table, holding it in hand to make sure that this was not some regular mechanical noise picked up by the transducer.
- The LabJack sends a clean 0 signal when we connect the AI channel to the ground of the LabJack, so this signal disappears in this case.
- The LabJack sends a clean 5V signal when we connect the AI channel and the ground of the LabJack to a 5V battery, so this signal disappears in this case.
- We cut the power completely to the circuit and we still measured if the LabJack is connected to the circuit.

It seems that this signal comes from the circuit board, which is opened with a lot of wires sticking out. Can it be an RC resonance? We even tried to see if cell phones were the problem...

> **Jonathan**: 20mv is the noise of the system, this should be simply ignored.
> **Tibi**: actually, this signal is very characteristic. We also found it at Dilaon's and it turns out it comes from a ground mismatch [august 23, 2012]

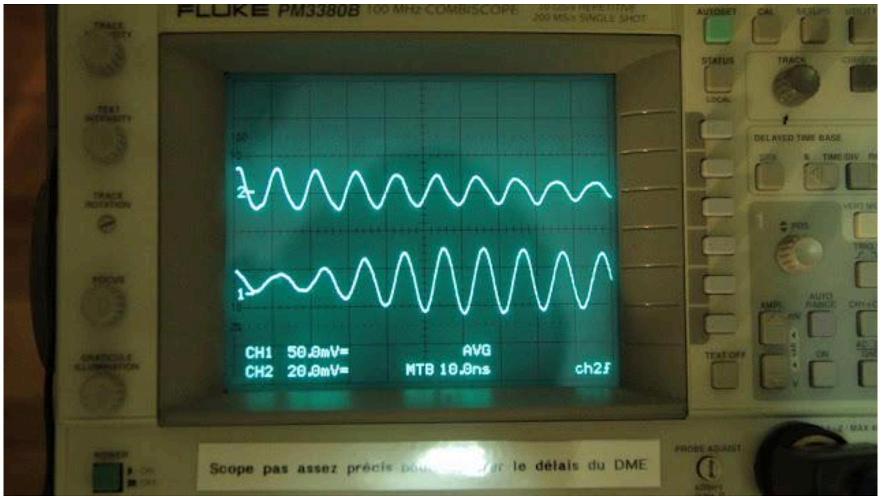


High freq. photodiode signal

We don’t have a picture to show this...

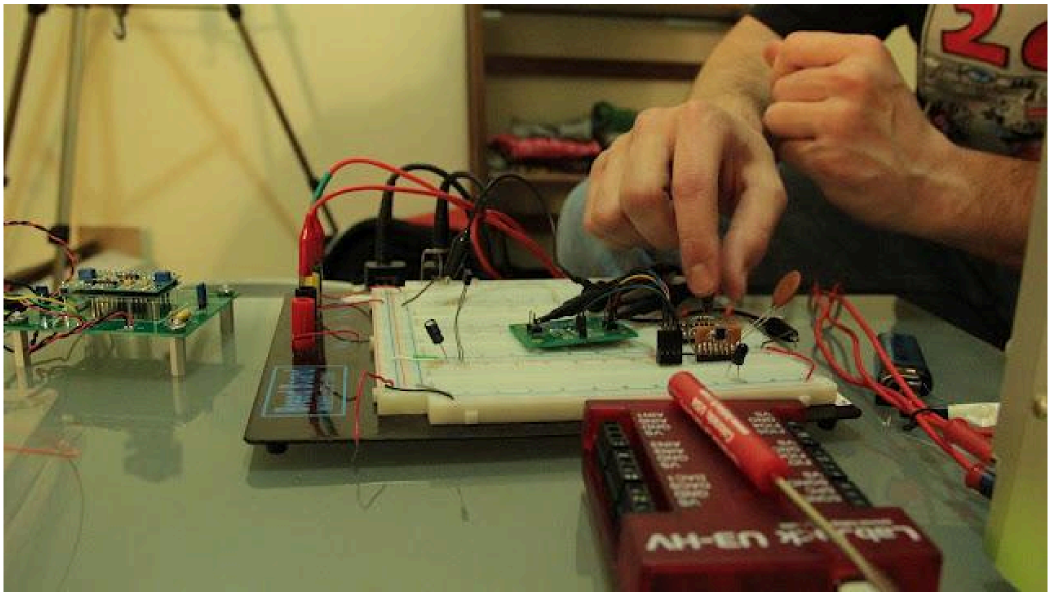
Some other signal

Dark noise of the photodiode, top(ch2) is the potodiode and bottom (ch1) is the laser monitor potodiode.



Detection system

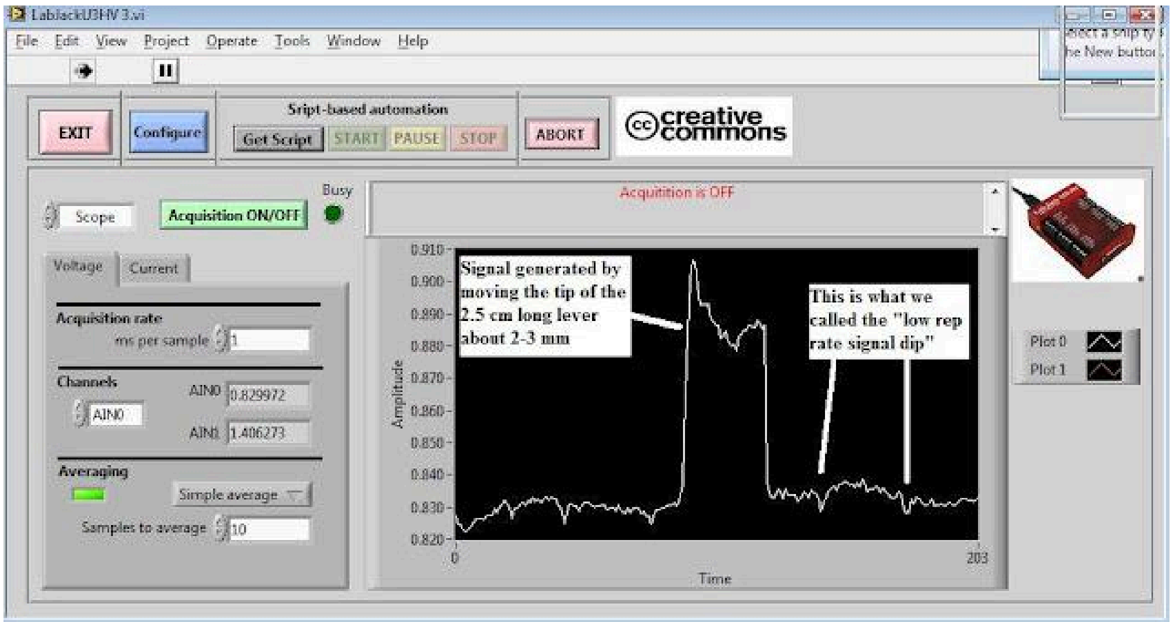
We used Jonathan’s electronics assembly for amplification and filtering. Data was acquired with our [LabJack U3 HV](). We used a modified version of the [LabView program for the LabJack]().



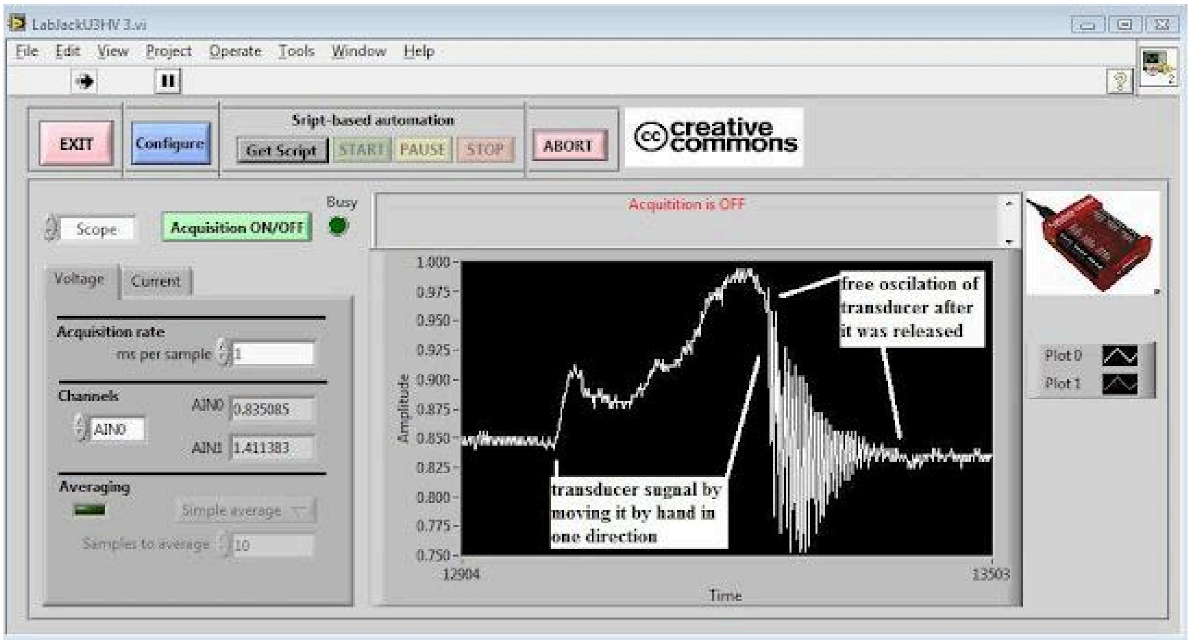
In parallel we used Jonathan's digital oscilloscope to monitor the signals.

Transducer signals

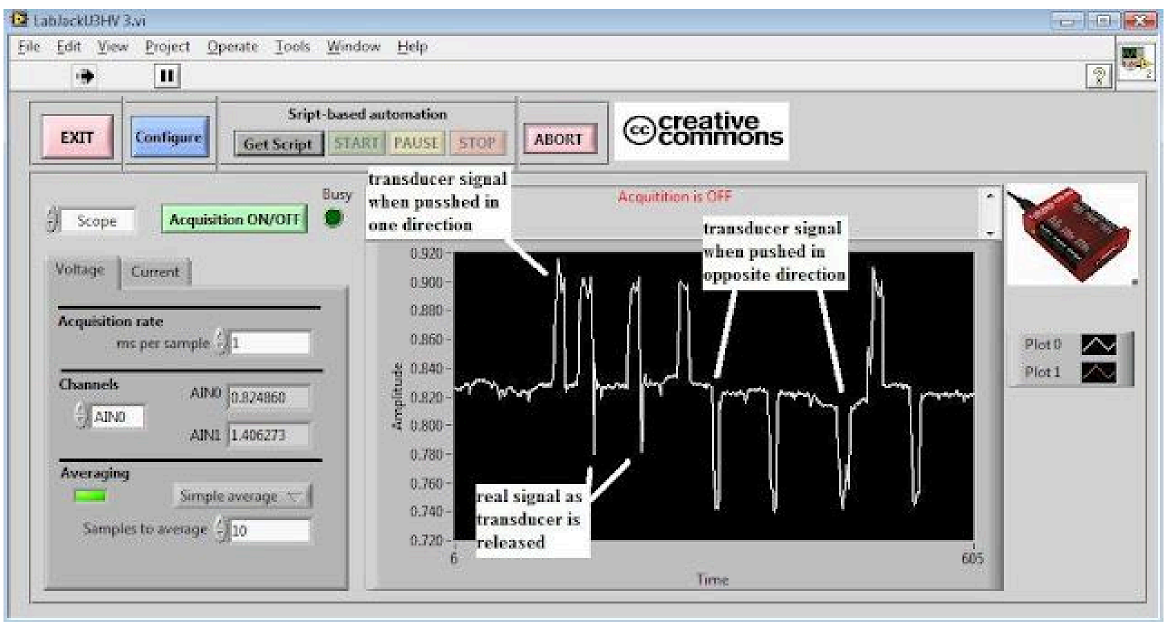
Graph below shows a signal from the transducer as it was pushed with the feather, by hand. We can also see what we called the "low repetition rate signal dip".



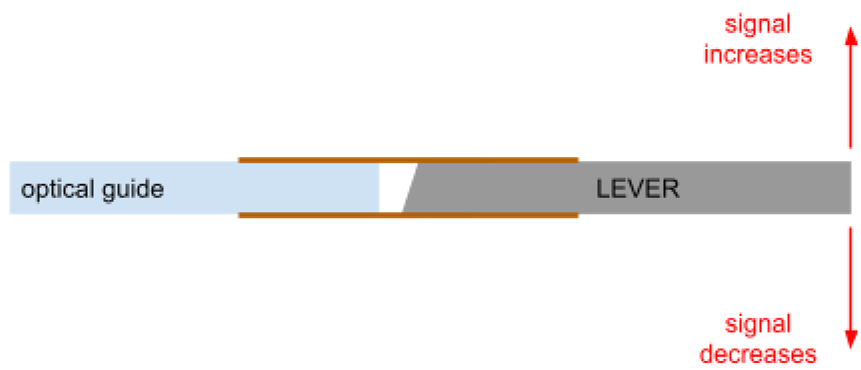
The picture below shows a signal from the transducer as it was pushed with the feather, by hand, and the free oscillation of the transducer as it was suddenly released. Based on the oscillation period we can calculate the stiffness of this transducer. There was no averaging during this acquisition. The acquisition rate was 1 kHz. It seems that the oscillation freq of this particular transducer is lower than that. We are talking here about a metal lever, 2.5 cm long. Having a lighter and shorter lever will increase the oscillation frequency, which means that the temporal resolution of the transducer gets improved.



Bidirectional sensing



Possible explanation: the lever is NOT cut perpendicular, so the mirror is not parallel to the cross section of the optical fiber. **This is actually a nice feature!**



Suggestions

- To improve detection, can we do the ratio between the laser feedback and the actual signal before amplification?
- We need to shield the circuit in order to reduce interference with the environment. We don't need to build a board at this stage, because our design is still evolving fast.

Other documents

- Joint transducer Fabrication
- See video made during this work party