

Ultrasonic data analysis (GSECARS)

Prepared by Tony Yu and Zhicheng Jing; Last Updated: Dec 30, 2019

Waveform generator: Tektronix Arbitrary Function Generator (AFG3252C)

Oscilloscope: Tektronix Mixed Signal Oscilloscope (MSO54)

Travel Time Analysis

Introduction

Travel_Time_Out_Phase_2.ipf and *Travel_Time_In_Phase_2.ipf* are Igor procedures created by Dr. Zhicheng Jing at Southern University of Science and Technology, Shenzhen, China. The experimental setup and data acquisition for ultrasonic measurements are described in "*High-Pressure Sound Velocity Measurements of Liquids Using in-situ Ultrasonic Techniques in a Multi-anvil Apparatus*" by Zhicheng Jing, Tony Yu, Man Xu, Julien Chantel, Yanbin Wang. For questions, please contact Dr. Jing at jingzc@sustech.edu.cn.

Note: The *Travel_Time_Out_Phase_2.ipf* procedure works for “out of phase” data collected at GSECARS using the Tektronix MSO54, whereas the *Travel_Time_In_Phase_2.ipf* works for “in phase” data. The instructions in this manual mainly describe the use of the *Travel_Time_Out_Phase_2.ipf* procedure, but the steps would be similar for the use of the *Travel_Time_In_Phase_2.ipf* procedure. Differences between the use of two procedures are noted in brackets.

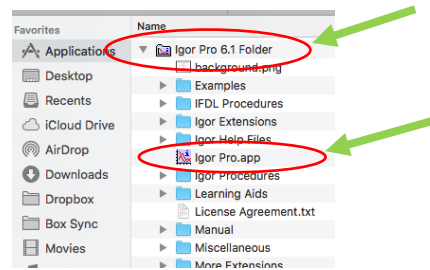
Preparation

Make sure you copy the following two procedures into the “Igor Procedures” Folder (Macintosh: *Applications\Igor Pro 6.1 Folder\Igor Procedures*).

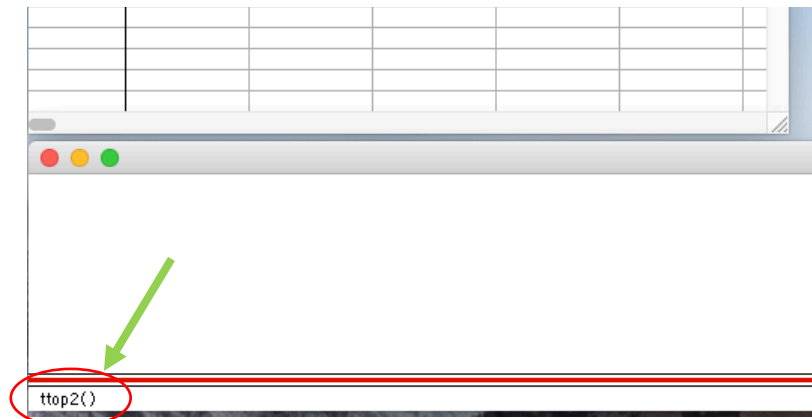
1. *Travel_Time_Out_Phase_2.ipf* (or *Travel_Time_In_Phase_2.ipf* if analyzing “in phase” data)
2. *Button.ipf*

Travel Time Determination Step by Step

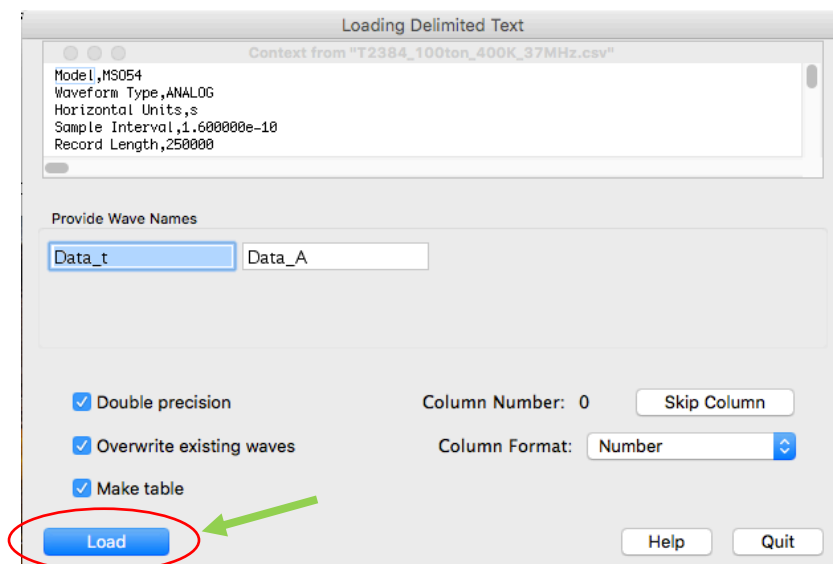
1. Open Igor Pro.app



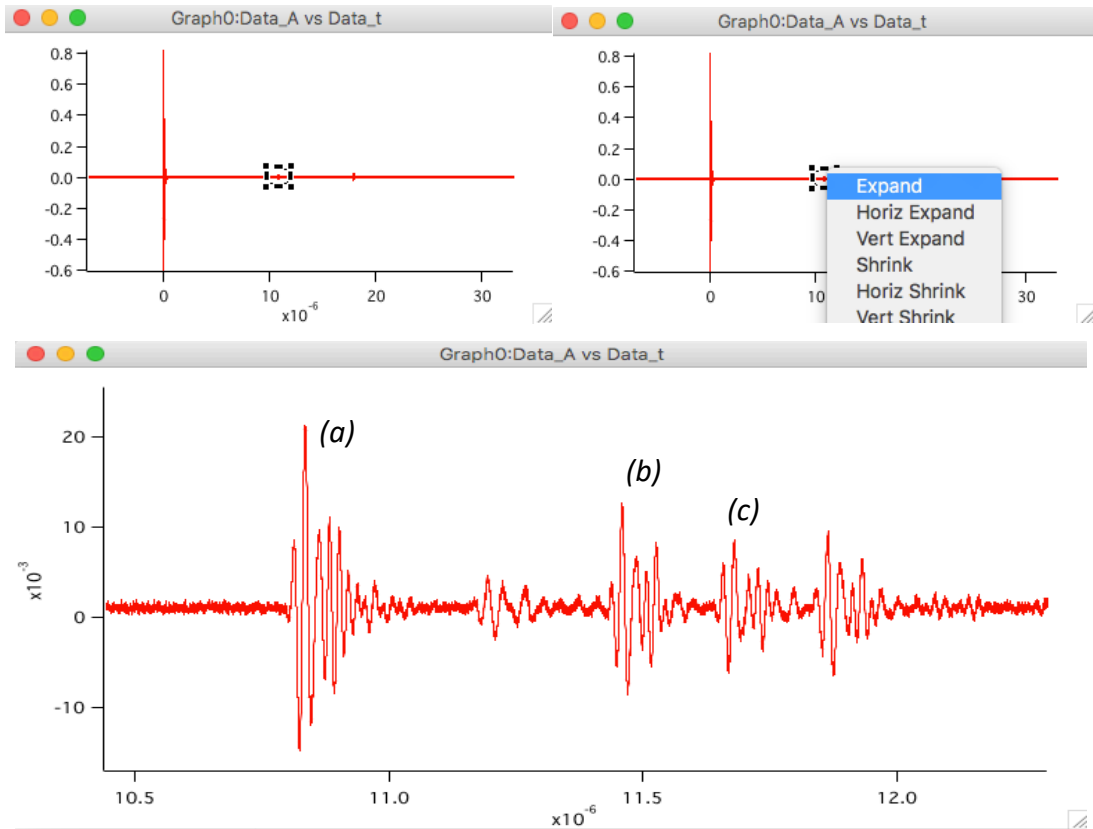
2. On the command line, type “ttop2()” (or “ttip2()”) to start the travel time analysis procedure. A pop-up window will ask you to open your file (*.csv).



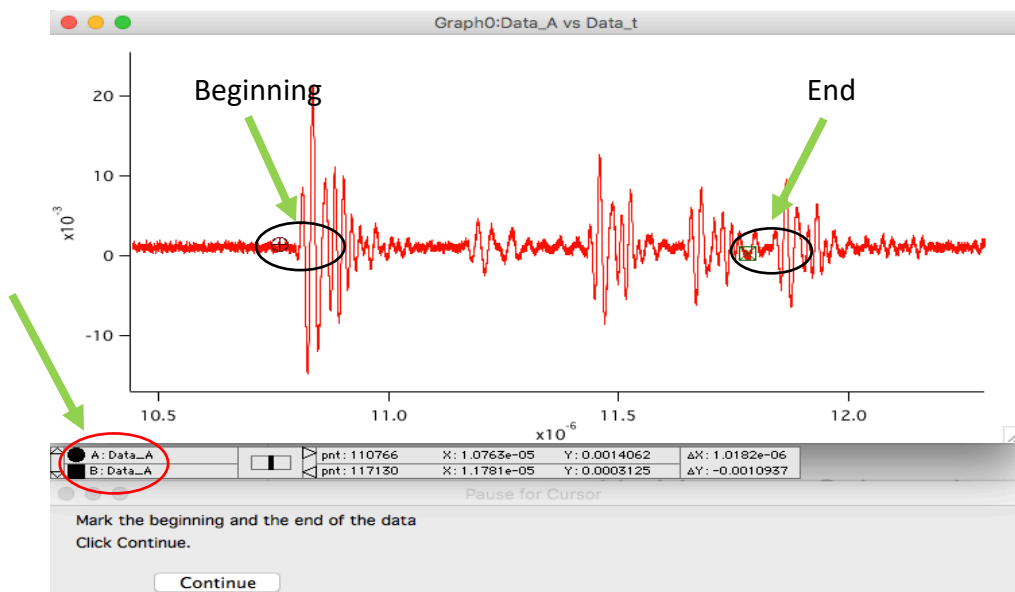
3. After selecting your data file, click “Load”.



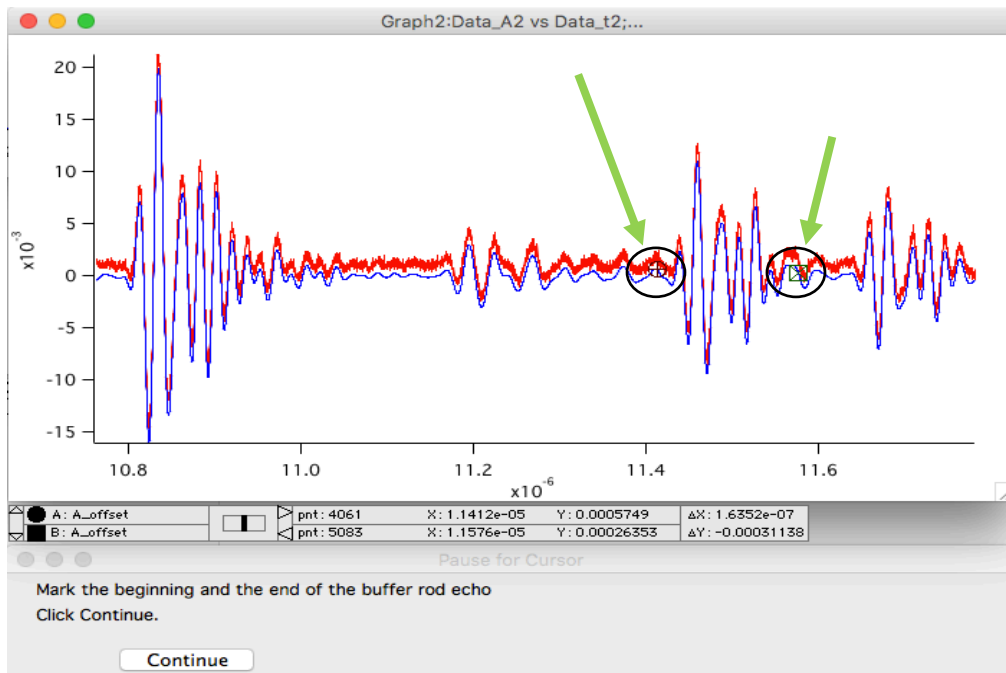
4. Zoom in to the P-wave (or S-wave) echo trains that contain the ^(a)anvil-buffer rod, ^(b)buffer rod-sample, and ^(c)sample-backing plate echoes from these three interfaces.



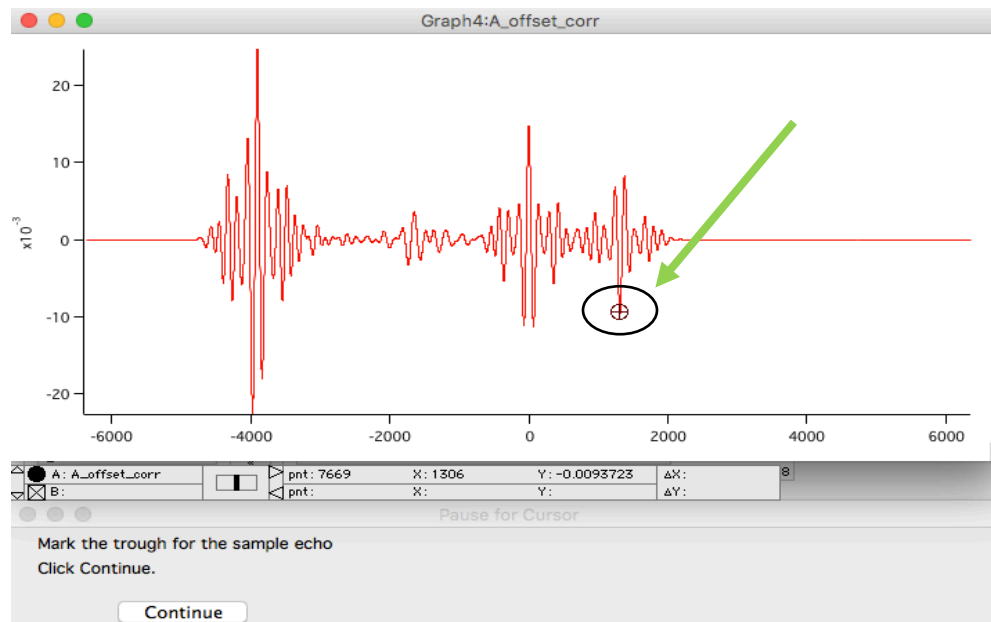
5. Mark the beginning and the end of the data by dragging and dropping the “buttons”. Button A goes to the beginning of the data while Button B marks the end of the data.



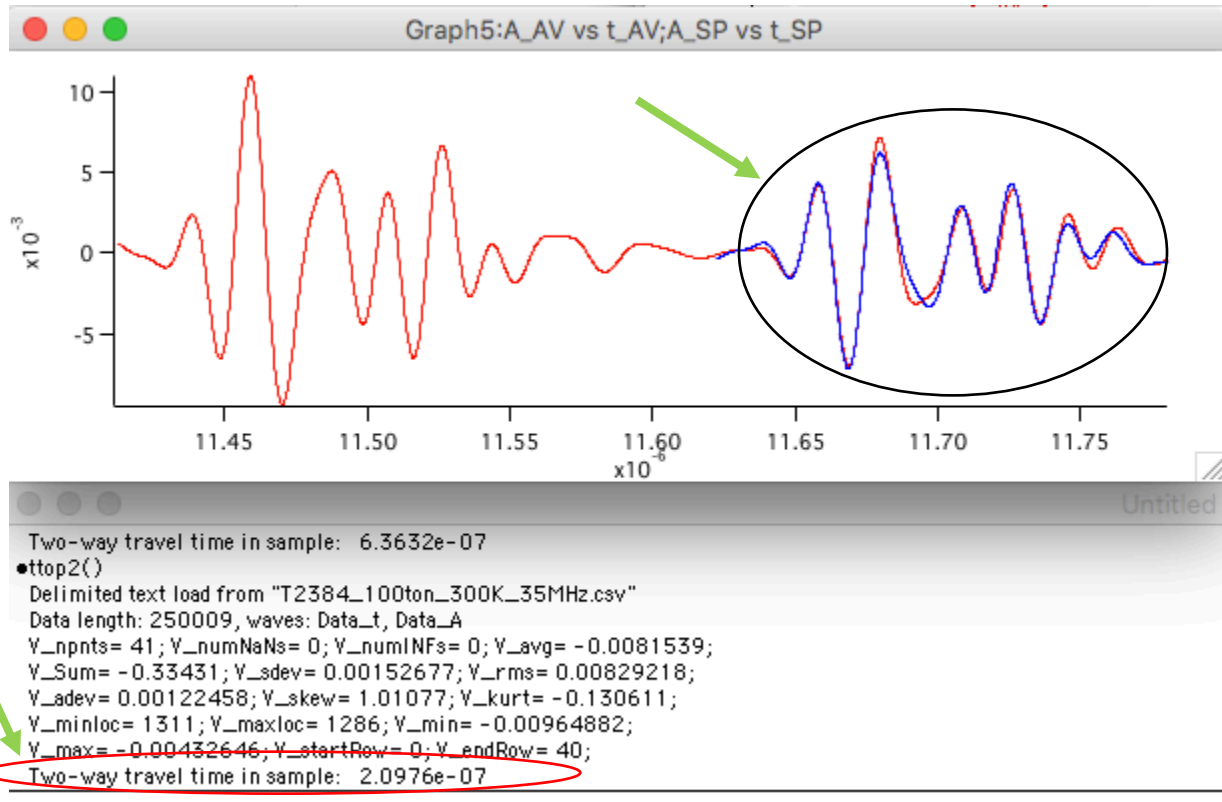
6. Mark the beginning and end of the *buffer rod- sample* interface echo



7. Mark the trough (or peak for “in phase” data) for the *sample-backing plate* interface echo. There is no need to find the exact minimum (or maximum) position of the trough (or peak) during this step. The procedure itself will automatically look for the minimum (or maximum), as long as the marker are placed close enough, within $\frac{1}{4}$ wavelength from the trough (or peak) position.

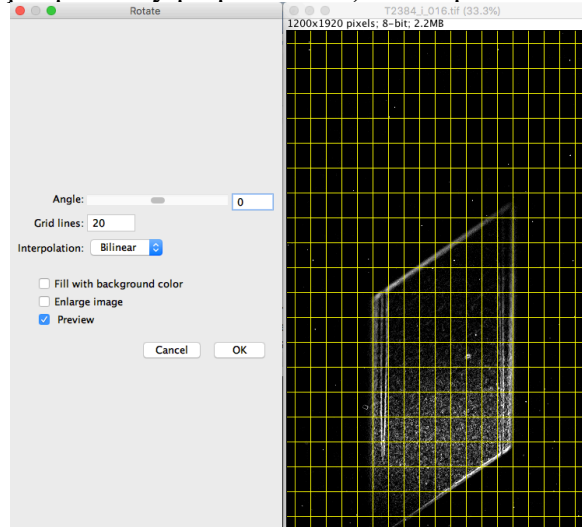


8. The overlapped echoes are shown in the figure below. And the calculated **two-way travel time** is shown on the last line: 2.0976e-07 sec.

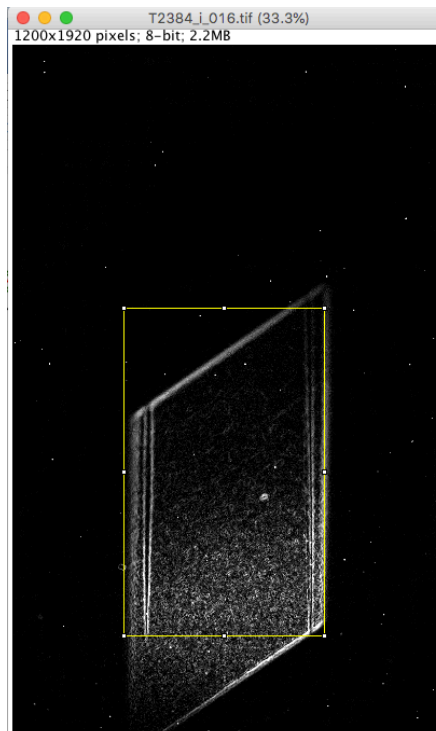


Sample Length Analysis

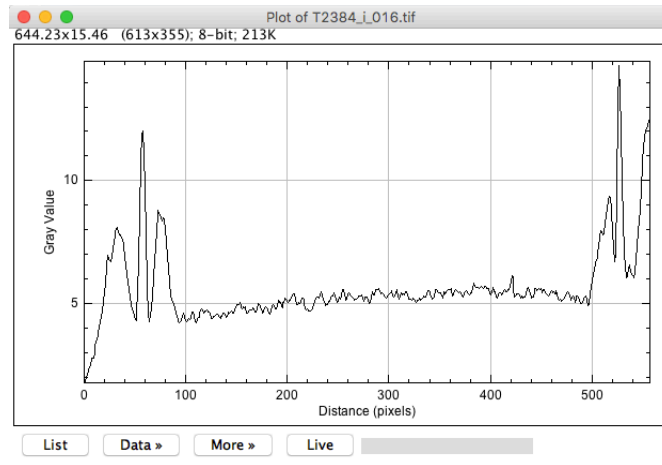
- In Image J
 - File / Import / Image sequence / Choose / Open
 - Process / Find edges / Yes
 - Image / Adjust brightness / Auto
 - Image / Transform / Rotate 90 right / Transform / Rotate / Preview / Angle (adjust manually to get sample perfectly perpendicular) / Accept / Yes



- Select the rectangular tool to define an area where one can see clearly the two parallel edges of the sample



- Analyse / Plot profile / Data / Copy All Data



- In Igor
- Paste

Table0:XW,YW

558R X 2C 0

Point	XW	YW				
0	0	1.7884				
1	1	1.8564				
2	2	2.0406				
3	3	2.1009				
4	4	2.341				
5	5	2.4243				
6	6	2.5154				
7	7	2.7752				
8	8	2.7961				
9	9	2.7906				
10	10	3				

- window / new graph / XW; YW / Do It

New Graph

Y Wave(s)

XW
YW

More Choices

☐ From Target

X Wave

calculated
XW
YW

Axis: left ☐ Swap Trace X & Y Axes

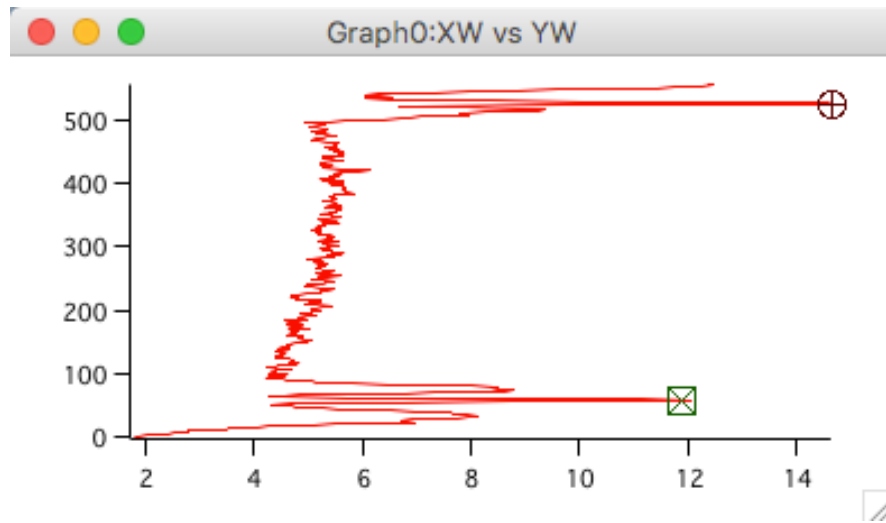
Title:

Axis: bottom Style: _none_

Display XW vs YW

Do It To Cmd Line To Clip Help Cancel

- Command i / Place the 2 markers on the maximums



- Read the pixels number and calculate the length (in pixels)
- Multiply by the camera calibration factor (xxx microns/pixel)