SPEED OF SOUND

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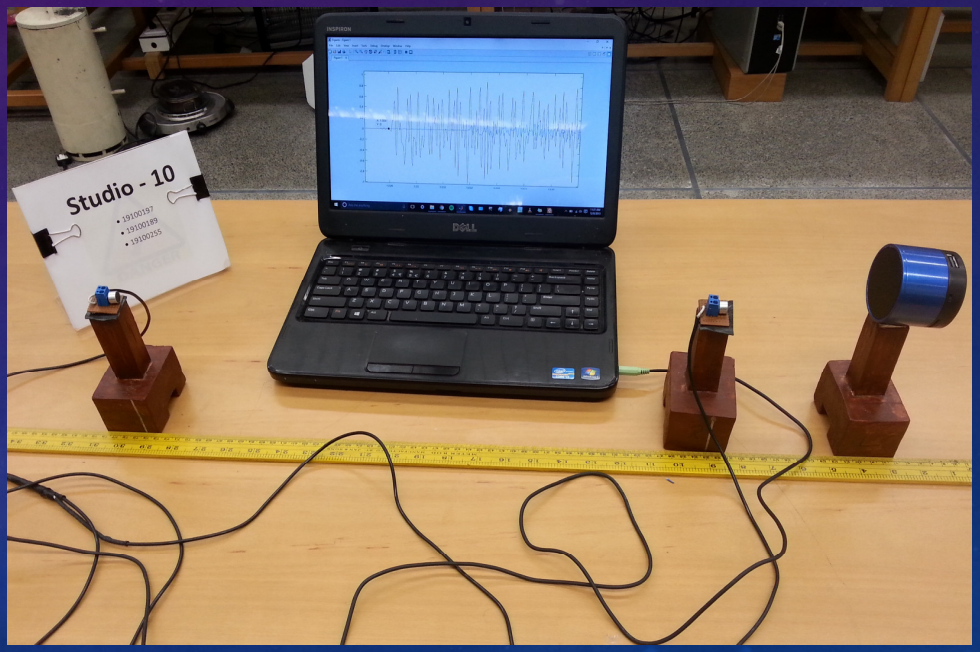
AIMS AND OBJECTIVES

- To develop an experiment for verifying the speed of sound under normal laboratory conditions.
- To verify the speed of sound through the time of flight method, using computer soundcards.

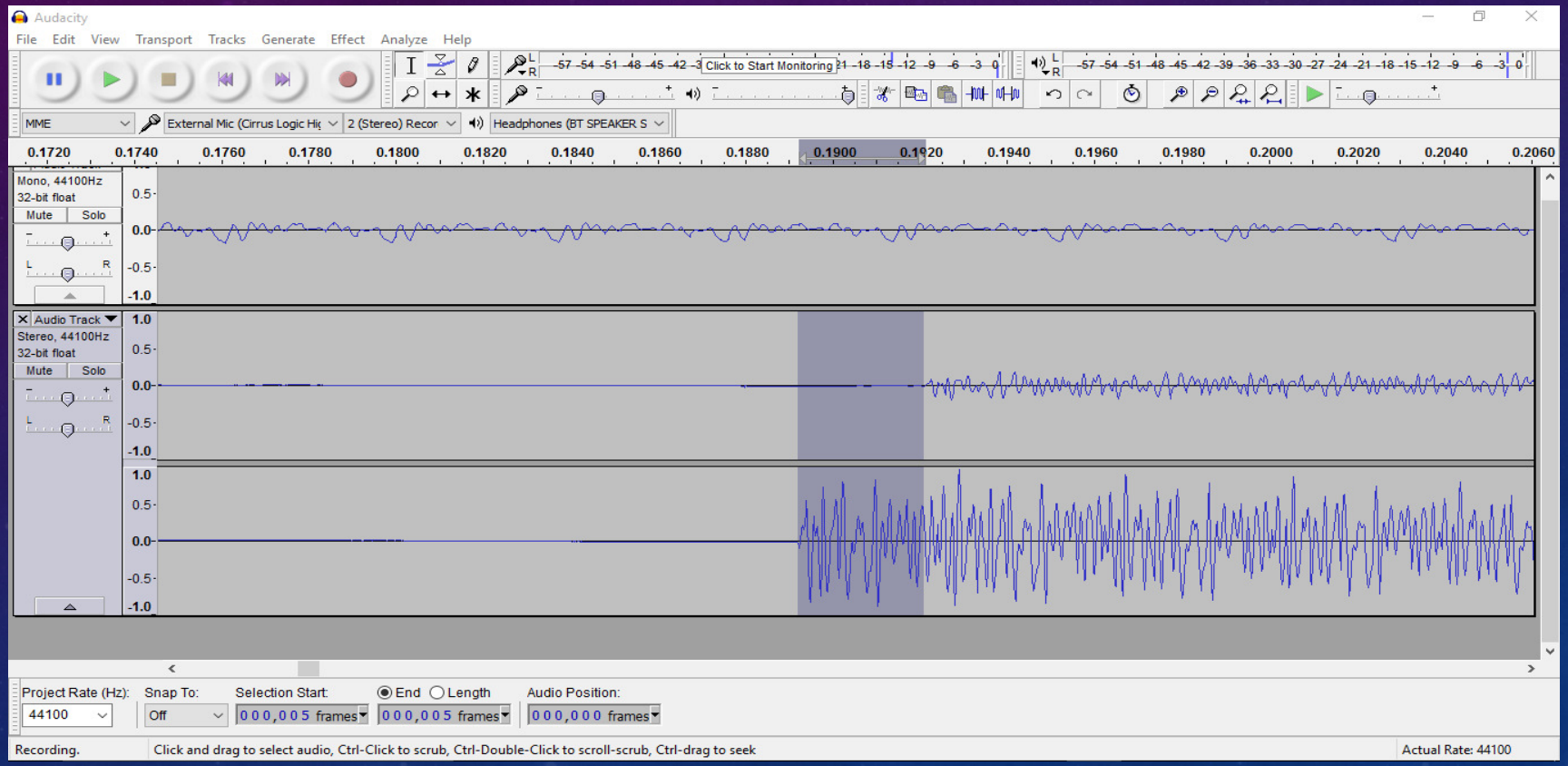
METHOD ADOPTED:
TIME OF FLIGHT USING COMPUTER SOUND CARD

1) Two microphones are placed a distance ‘d’ apart.
2) Sound is played at one end and the input received by the microphones is recorded using computer sound cards.
3) The audio signals are analyzed and the time difference(Δt) is noted by viewing the initial pulse recorded by each microphone.
4) This time difference corresponds to the time taken by sound to travel distance ‘d’ between the two microphones.
5) Speed of sound is calculated using v=d/ Δt.



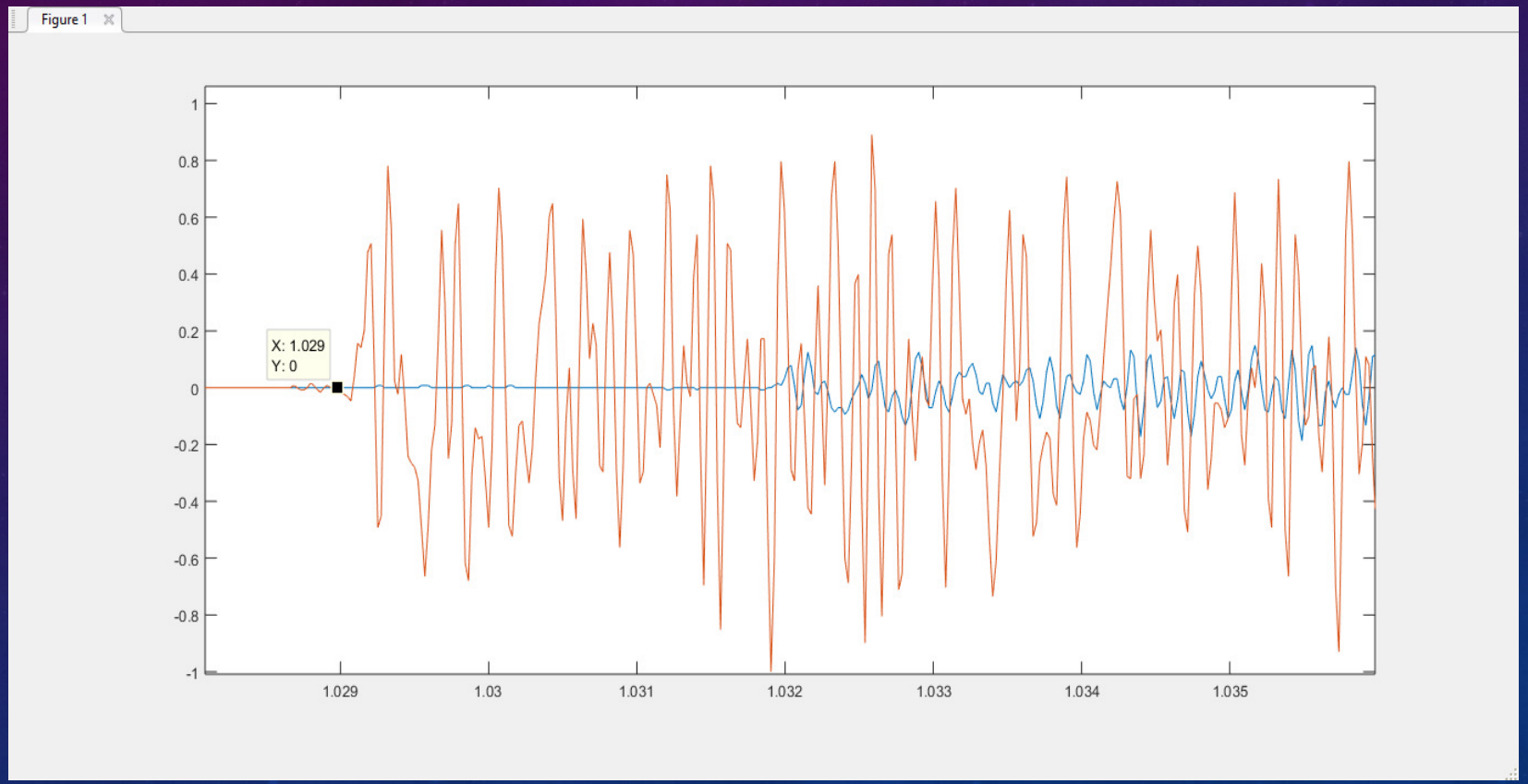
EXPERIMENTAL PROCESS: ANALYZING AUDIO SIGNALS

1. Using Audacity Software (Audio analysis freeware).



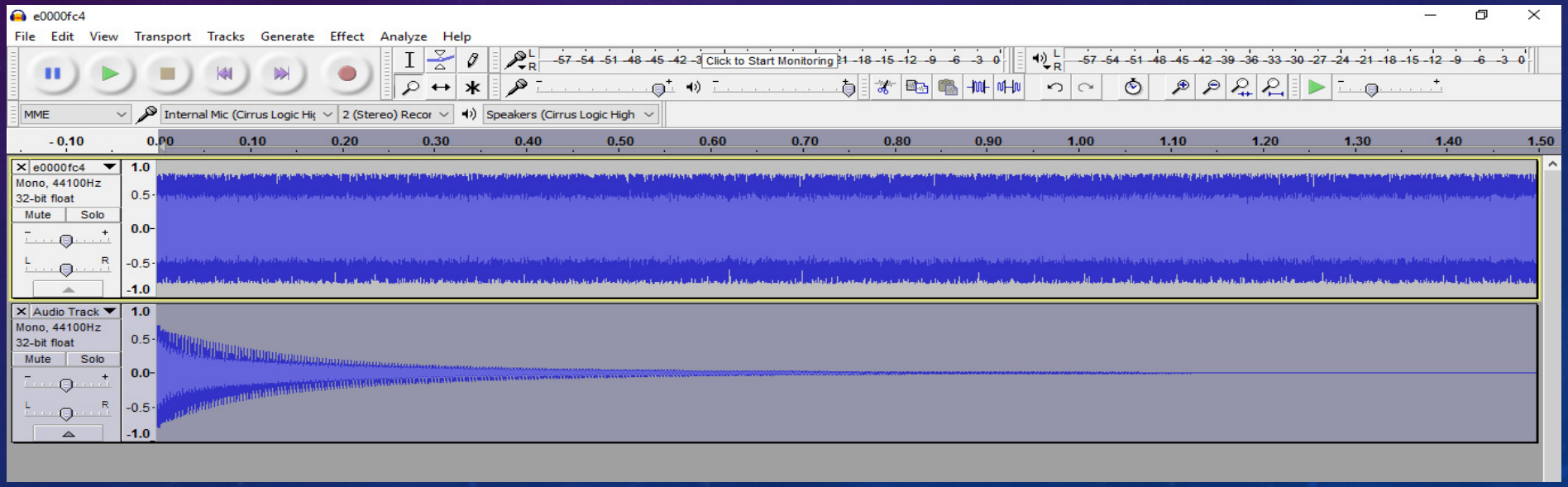
EXPERIMENTAL PROCESS: ANALYZING AUDIO SIGNALS

2) Using MATLAB



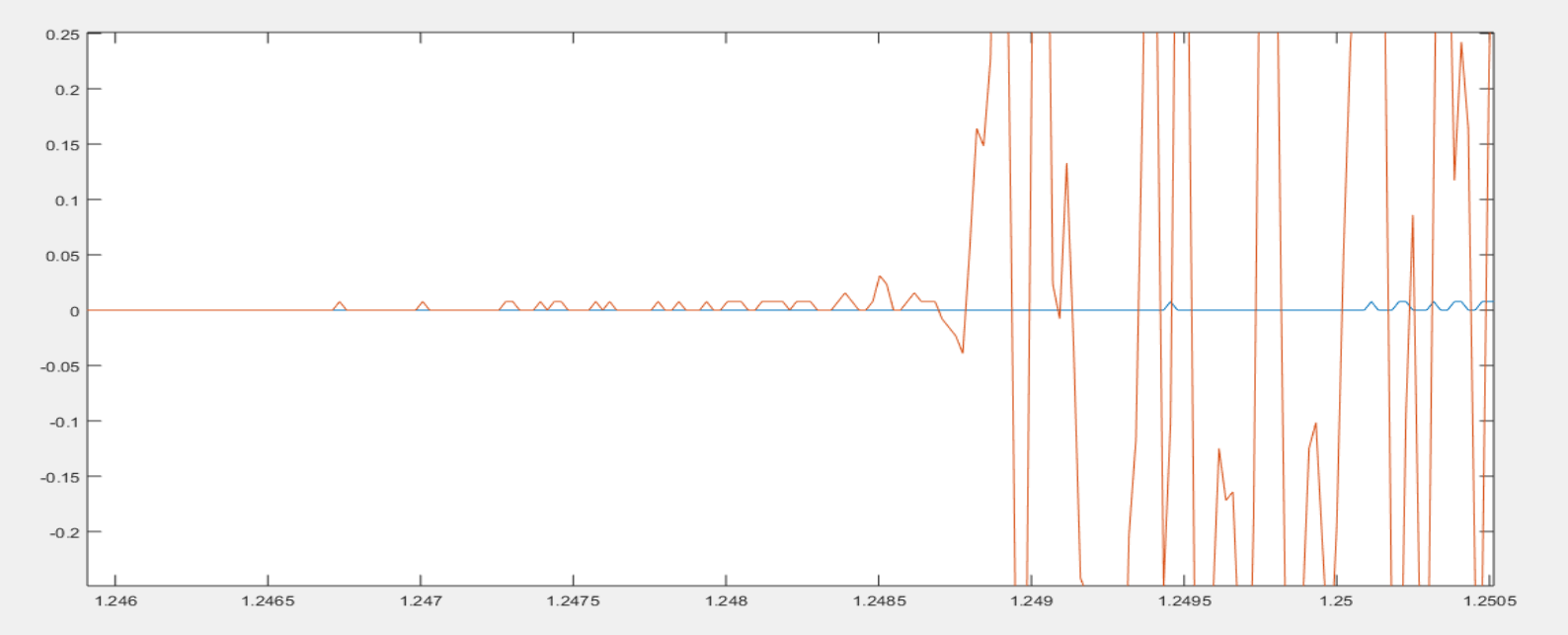
DEVELOPMENT OF PROCEDURE AND PROBLEMS ENCOUNTERED

1. Initial use of white noise caused the input from the two microphones to be super imposed resulting in an un-discernable time difference between the two waves. Pluck was used as a sound source to counter this problem.



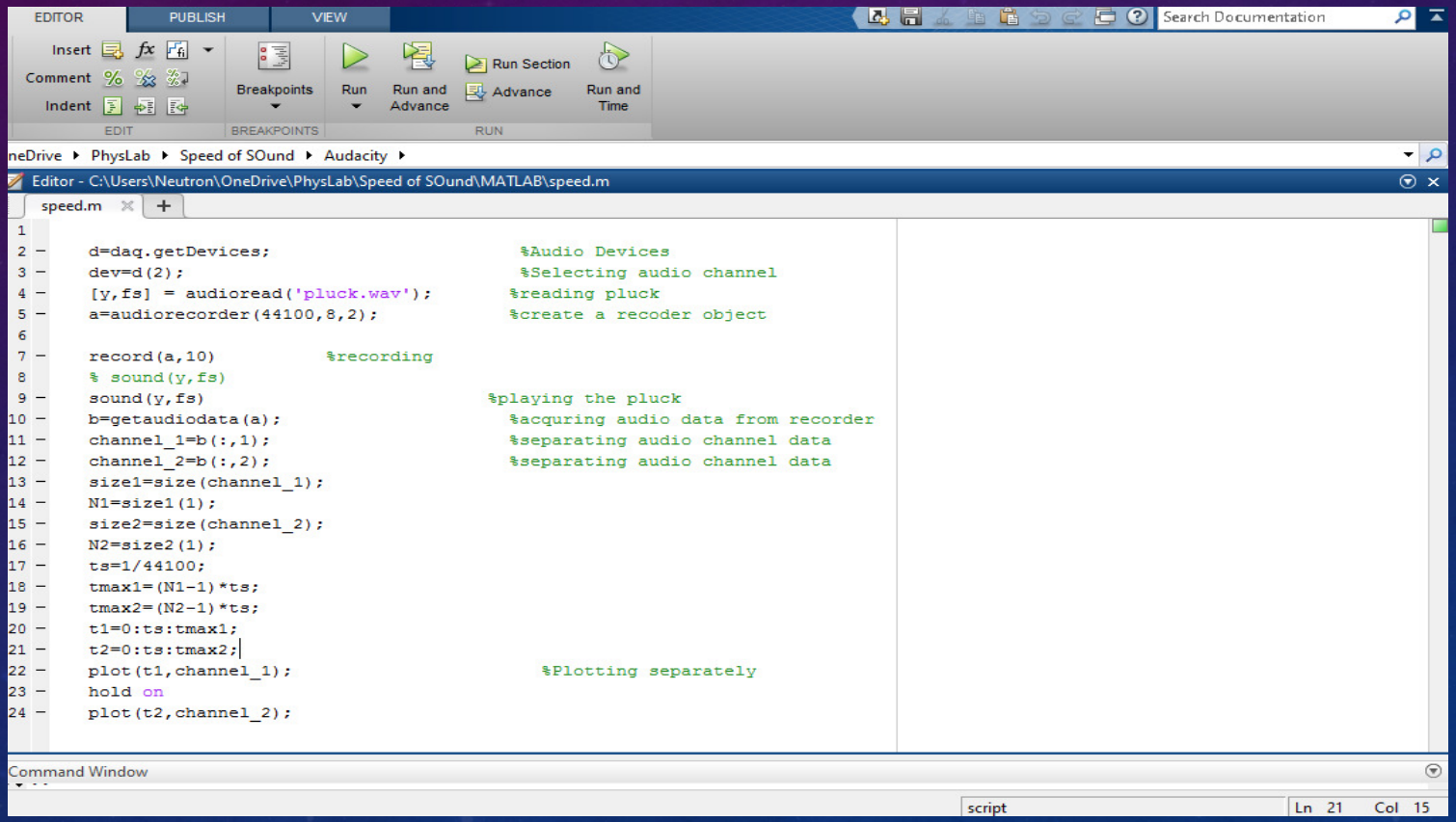
DEVELOPMENT OF PROCEDURE AND PROBLEMS ENCOUNTERED

2. Background noise made it difficult to identify the initiation of the pulse recorded by microphones due to sound source. The experiment was performed in a quite environment to minimize noise.



DEVELOPMENT OF PROCEDURE AND PROBLEMS ENCOUNTERED

3. Developing code to record and analyze sound in MATLAB



EXPERIMENTAL DATA

- Five reading for each separating distance between microphones were taken to reduce uncertainity

Distance (m)	T1 (sec)	T2 (sec)	Time Diff (sec)	Average Time Difference (sec)
1	1.0319	1.0291	0.0028	0.00292
	1.0541	1.051	0.0031	
	0.9112	0.9083	0.0029	
	1.137	1.134	0.003	
	0.8204	0.8176	0.0028	
0.9	1.0273	1.0247	0.0026	0.0027
	1.0757	1.0732	0.0025	
	1.2513	1.2486	0.0027	
	1.1903	1.1875	0.0028	
	2.2305	2.2276	0.0029	
0.8	1.2299	1.2276	0.0023	0.0024
	0.8953	0.8929	0.0024	
	1.3391	1.3367	0.0024	
	0.7567	0.7542	0.0025	
	1.2543	1.2519	0.0024	
0.7	1.4668	1.4647	0.0021	0.00212
	0.9133	0.9112	0.0021	
	1.3701	1.368	0.0021	
	1.0906	1.0884	0.0022	
	1.1136	1.1115	0.0021	
0.5	1.35	1.3486	0.0014	0.00144
	1.1563	1.1548	0.0015	
	0.9391	0.9376	0.0015	
	1.1402	1.1388	0.0014	
0.4	1.0972	1.0959	0.0013	0.00128
	1.0792	1.078	0.0012	
	1.0747	1.0734	0.0013	
	0.88	0.8787	0.0013	
	1.3216	1.3203	0.0013	
0.3	0.9079	0.9069	0.001	0.00092
	1.0152	1.0143	0.0009	
	1.0123	1.0113	0.001	
	1.6096	1.6087	0.0009	
	0.8904	0.8896	0.0008	
0.2	0.9529	0.9522	0.0007	0.00068
	1.0539	1.0533	0.0006	
	0.8926	0.8919	0.0007	
	0.9175	0.9168	0.0007	
	0.8369	0.8362	0.0007	
0.1	1.2012	1.2008	0.0004	0.00038
	1.0547	1.0543	0.0004	
	0.9332	0.9329	0.0003	
	1.0208	1.0204	0.0004	

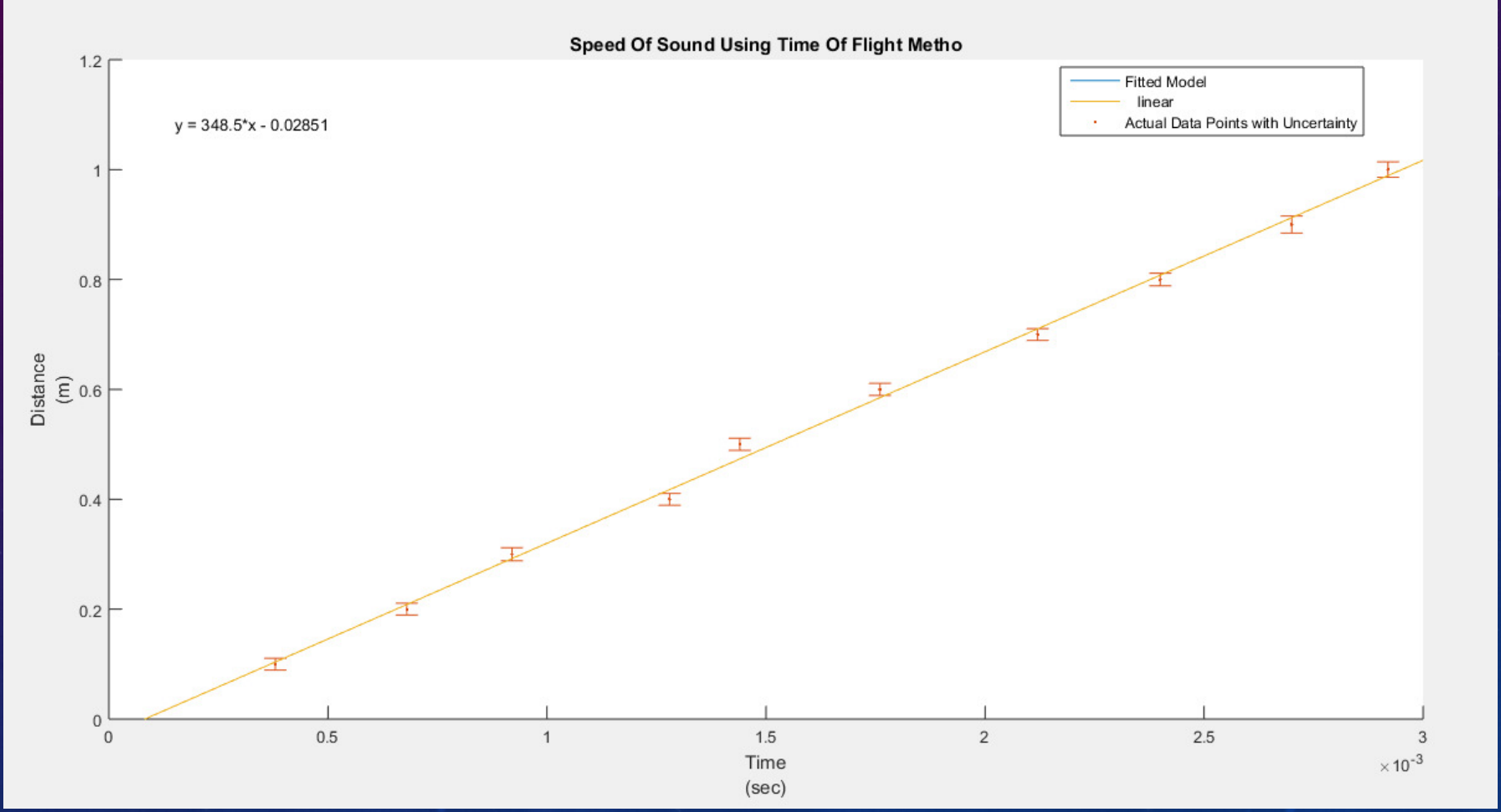
UNCERTAINITIES

Obs	Uncertainty in time due to Scale (sec)	Uncertainty in Distance due to Scale (m)	Uncertainty in time due to Mean (sec)	Total Uncertainty in time (sec)	Uncertainty transferred to Distance (m)	Total Uncertainty in Distance (m)
1	2.89E-05	0.002041241	4.12E-05	5.03E-05	0.01754083	0.0177
2	2.89E-05	0.002041241	5.00E-05	5.77E-05	0.020120711	0.0202
3	2.89E-05	0.002041241	2.24E-05	3.65E-05	0.012725455	0.0129
4	2.89E-05	0.002041241	1.41E-05	3.21E-05	0.011202738	0.0114
5	2.89E-05	0.002041241	1.73E-05	3.37E-05	0.01173229	0.0119
6	2.89E-05	0.002041241	1.73E-05	3.37E-05	0.01173229	0.0119
7	2.89E-05	0.002041241	1.41E-05	3.21E-05	0.011202738	0.0114
8	2.89E-05	0.002041241	2.65E-05	3.92E-05	0.01364653	0.0138
9	2.89E-05	0.002041241	1.41E-05	3.21E-05	0.011202738	0.0114
10	2.89E-05	0.002041241	1.41E-05	3.21E-05	0.011202738	0.0114

RESULTS

Speed of Sound (unweighted)	348.5 m/s
Speed of Sound (weighted)	349.36 m/s
Uncertainty in Speed	5.32 m/s
Percentage Uncertaity	1.346

RESULTS


Speed Of Sound Using Time Of Flight Metho
y = 348.5*x - 0.02851
Fitted Model
linear
Actual Data Points with Uncertainty
Distance (m)
Time (sec)
×10^-3
0
0.2
0.4
0.6
0.8
1
1.2
0.5
1.5
2
2.5
3

THANKS