**EXPERIMENT LOCATIONS AND TIMES, AMBIENT TEMPERATURE AND SALINITY, THE SOURCE AMPLITUDES AND WAVEFORMS, AND AN EXAMPLE ACOUSTIC SIGNAL**

## I. EXPERIMENT LOCATIONS:

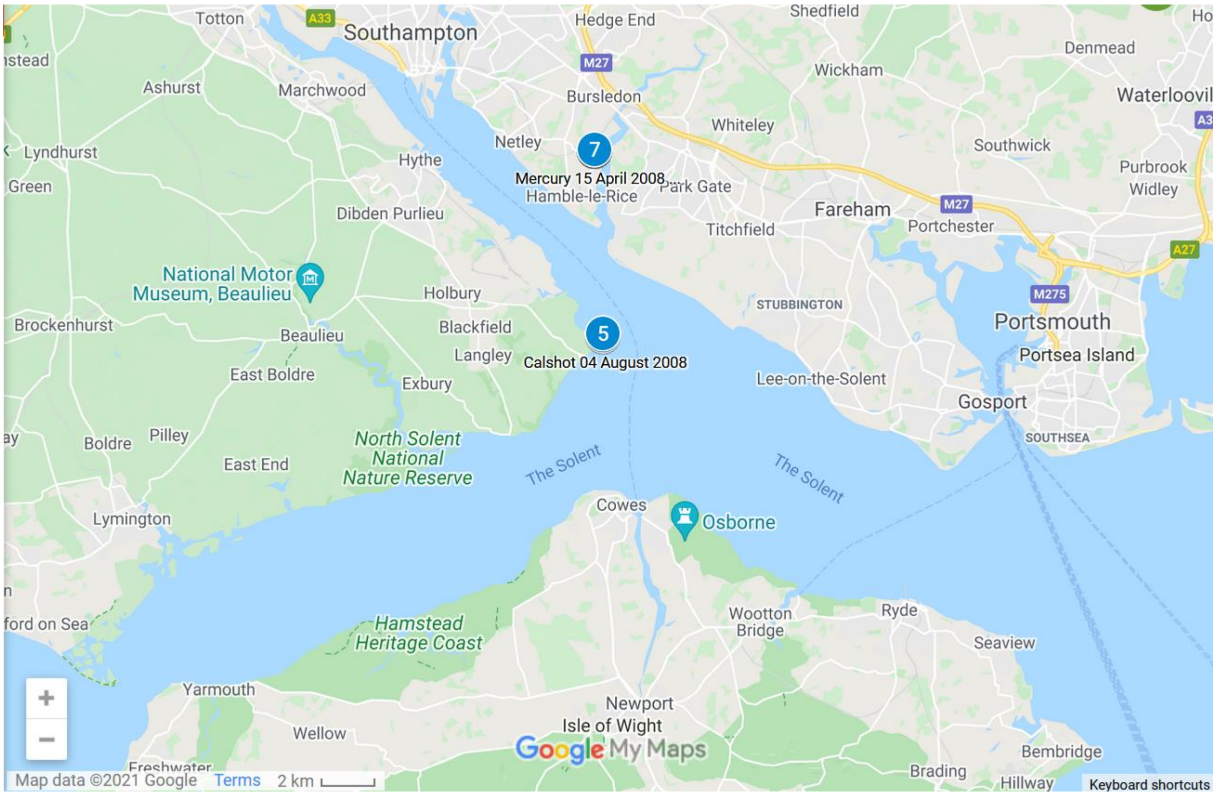


Figure E1: The experiment locations shown on Google Maps. The exact experiment position on each date can be found in the following web-link: https://www.google.com/maps/d/edit?mid=1oWCw9MgXTPECOPgukfj3mLQLYEsLqSx1&ll=50.81642747242577%2C-1.4655786944450289&z=10.

## II. EXPERIMENT TIMES

## A. TRANSMISSION EXPERIMENT:

### CALSHOT 10 APRIL 2008

| | Begin Time | | | End Time | | |
|---|---|---|---|---|---|---|
| **Folder (Set) Name** | **Hour** | **Min** | **Second** | **Hour** | **Min** | **Second** |
| 1 | 9 | 37 | 42 | 9 | 57 | 56 |
| 2 | 9 | 59 | 20 | 10 | 19 | 30 |
| 3 | 10 | 21 | 32 | 10 | 30 | 48 |
| 4 | 10 | 32 | 44 | 10 | 42 | 2 |

### MERCURY 15 APRIL 2008

| | Begin Time | | | End Time | | |
|---|---|---|---|---|---|---|
| **Folder (Set) Name** | **Hour** | **Min** | **Second** | **Hour** | **Min** | **Second** |
| 1 | 12 | 53 | 36 | 13 | 11 | 20 |
| 2 | 13 | 17 | 34 | 13 | 27 | 18 |
| 3 | 13 | 28 | 36 | 13 | 33 | 38 |
| 4 | 13 | 34 | 30 | 13 | 39 | 30 |
| 5 | 14 | 6 | 34 | 14 | 8 | 36 |
| 6 | 14 | 9 | 16 | 14 | 11 | 16 |
| 7 | 14 | 12 | 0 | 14 | 14 | 2 |
| 8 | 14 | 14 | 38 | 14 | 20 | 56 |
| 9 | 15 | 32 | 22 | 15 | 32 | 22 |
| 10 | 16 | 29 | 46 | 16 | 29 | 46 |
| 11 | 16 | 56 | 44 | 16 | 58 | 50 |
| 12 | 16 | 59 | 54 | 17 | 2 | 2 |
| 13 | 17 | 2 | 36 | 17 | 4 | 42 |
| 14 | 17 | 6 | 10 | 17 | 8 | 18 |
| 15 | 17 | 24 | 32 | 17 | 34 | 22 |
| 16 | 17 | 34 | 56 | 17 | 45 | 0 |
| 17 | 17 | 45 | 46 | 17 | 50 | 56 |
| 18 | 18 | 0 | 40 | 18 | 22 | 10 |

### CALSHOT 10 JUNE 2008

| | Begin Time | | | End Time | | |
|---|---|---|---|---|---|---|
| **Folder (Set) Name** | **Hour** | **Min** | **Second** | **Hour** | **Min** | **Second** |
| 1 | 13 | 59 | 0 | 14 | 14 | 18 |

### MERCURY 11 JUNE 2008

| Folder (Set) Name | Begin Time Hour | Begin Time Min | Begin Time Second | End Time Hour | End Time Min | End Time Second |
|---|---|---|---|---|---|---|
| 1 | 12 | 44 | 0 | 12 | 58 | 18 |
| 2 | 13 | 3 | 30 | 13 | 20 | 22 |
| 3 | 13 | 21 | 48 | 13 | 29 | 12 |
| 4 | 13 | 47 | 26 | 13 | 52 | 40 |
| 5 | 13 | 57 | 6 | 14 | 5 | 20 |
| 6 | 14 | 8 | 10 | 14 | 19 | 44 |
| 7 | 14 | 53 | 40 | 15 | 13 | 24 |
| 8 | 15 | 17 | 48 | 15 | 27 | 34 |
| 9 | 16 | 8 | 18 | 16 | 8 | 18 |

### CALSHOT 04 AUGUST 2008

| Folder (Set) Name | Begin Time Hour | Begin Time Min | Begin Time Second | End Time Hour | End Time Min | End Time Second |
|---|---|---|---|---|---|---|
| 1 | 10 | 18 | 26 | 10 | 38 | 12 |
| 2 | 10 | 50 | 12 | 10 | 55 | 24 |
| 3 | 11 | 8 | 34 | 11 | 13 | 46 |
| 4 | 11 | 18 | 34 | 11 | 27 | 20 |
| 5 | 11 | 29 | 2 | 11 | 41 | 10 |
| 6 | 11 | 47 | 48 | 11 | 49 | 34 |
| 7 | 11 | 50 | 50 | 11 | 52 | 44 |
| 8 | 11 | 54 | 18 | 12 | 19 | 12 |
| 9 | 12 | 7 | 48 | 12 | 8 | 42 |
| 11 | 12 | 20 | 42 | 12 | 26 | 14 |
| 12 | 12 | 27 | 46 | 12 | 28 | 32 |

## B. COMBINATION FREQUENCY EXPERIMENT TIMES:

### CALSHOT 23 JULY 2008

| Folder (Set) Name | Begin Time Hour | Begin Time Min | Begin Time Second | End Time Hour | End Time Min | End Time Second |
|---|---|---|---|---|---|---|
| 1 | 11 | 36 | 10 | 11 | 42 | 44 |
| 2 | 11 | 53 | 16 | 11 | 57 | 44 |
| 3 | 12 | 6 | 12 | 12 | 11 | 16 |
| 4 | 12 | 13 | 46 | 12 | 18 | 54 |
| 5 | 12 | 25 | 52 | 12 | 32 | 48 |
| 6 | 12 | 51 | 26 | 13 | 16 | 14 |
| 7 | 13 | 19 | 52 | 13 | 36 | 26 |
| 8 | 13 | 50 | 26 | 14 | 7 | 30 |
| 9 | 13 | 57 | 24 | 14 | 7 | 30 |

## MERCURY 25 JULY 2008

| Folder (Set) Name | Begin Time Hour | Begin Time Min | Begin Time Second | End Time Hour | End Time Min | End Time Second |
|---|---|---|---|---|---|---|
| 1 | 10 | 35 | 46 | 10 | 49 | 24 |
| 2 | 11 | 0 | 52 | 11 | 13 | 16 |
| 3 | 11 | 19 | 6 | 11 | 31 | 58 |
| 4 | 11 | 52 | 14 | 11 | 52 | 14 |
| 5 | 12 | 2 | 0 | 12 | 5 | 56 |
| 6 | 12 | 9 | 26 | 12 | 11 | 10 |
| 7 | 12 | 51 | 0 | 13 | 0 | 42 |
| 8 | 13 | 5 | 58 | 13 | 11 | 10 |
| 9 | 13 | 37 | 56 | 13 | 41 | 46 |
| 10 | 13 | 48 | 14 | 13 | 53 | 38 |
| 11 | 13 | 56 | 48 | 13 | 59 | 48 |
| 12 | 14 | 9 | 16 | 14 | 12 | 44 |
| 13 | 14 | 26 | 46 | 14 | 52 | 16 |
| 14 | 14 | 54 | 20 | 15 | 14 | 26 |
| 15 | 15 | 24 | 24 | 15 | 54 | 46 |

## MERCURY 28 JULY 2008

| Folder (Set) Name | Begin Time Hour | Begin Time Min | Begin Time Second | End Time Hour | End Time Min | End Time Second |
|---|---|---|---|---|---|---|
| 1 | 13 | 26 | 22 | 13 | 27 | 10 |
| 2 | 13 | 29 | 58 | 13 | 32 | 0 |
| 3 | 13 | 33 | 54 | 13 | 36 | 56 |
| 4 | 13 | 44 | 54 | 13 | 51 | 10 |
| 5 | 13 | 56 | 32 | 14 | 0 | 34 |
| 6 | 14 | 1 | 58 | 14 | 3 | 12 |
| 7 | 14 | 4 | 2 | 14 | 5 | 24 |
| 8 | 14 | 18 | 56 | 14 | 19 | 42 |
| 9 | 14 | 21 | 40 | 14 | 24 | 28 |
| 10 | 14 | 27 | 0 | 14 | 37 | 48 |
| 11 | 14 | 41 | 22 | 14 | 44 | 0 |
| 12 | 14 | 48 | 28 | 14 | 53 | 2 |
| 13 | 14 | 53 | 58 | 14 | 55 | 18 |
| 14 | 15 | 7 | 12 | 15 | 15 | 20 |
| 15 | 15 | 18 | 6 | 15 | 41 | 56 |
| 16 | 15 | 44 | 56 | 16 | 10 | 24 |
| 17 | 16 | 12 | 30 | 16 | 18 | 28 |
| 18 | 16 | 23 | 52 | 16 | 28 | 26 |
| 19 | 16 | 47 | 44 | 16 | 59 | 28 |
| 20 | 17 | 2 | 42 | 17 | 11 | 40 |
| 21 | 17 | 15 | 8 | 17 | 33 | 26 |

## III. AMBIENT TEMPERATURE AND SALINITY:

**10 April 2008**

GPS: 50° 48' 55.9'' N and 001°18' 34.7'' W

Temperature measurements from 30 cm deep along receiver line (°C): 9.2, 9.0 ,9.1

Salinity measurements from 30 cm deep along receiver line (ppt): 9.3, 9.5 9.4

**15 April 2008**

GPS: 50° 52' 23.3'' N and 001°18' 48.1'' W

Sets 1-8:

Temperature measurements from 30 cm deep along receiver line (°C): 10.5, 10.5, 10.5

Salinity measurements from 30 cm deep along receiver line (ppt): 10.8, 13.7, 12.6

Sets 11-18:

GPS: 50° 52' 23.4'' N and 001° 18' 48.5'' W

Temperature measurements from 30 cm deep along receiver line (°C): 10.5, 10.3, 10.2

Salinity measurements from 30 cm deep along receiver line (ppt): 10.9, 10.5, 10.3

**11 June 2008**

GPS: 50° 52' 56'' N and 001° 18' 34'' W

Temperature measurements from 20 to 30 cm deep along receiver line (°C): Range from 19-20 degrees.

Salinity measurements from 20-30 cm deep along receiver line (ppt): range of 9 to 10 ppt.

**23 July 2008**

GPS: 50° 48' 56.9'' N and 001° 18' 34.6'' W

| | Patch 1 | Patch 2 | Patch 3 |
|---|---|---|---|
| Temperature (°C) | 19.2-19.7 | 20.1 | 19.8 |
| Salinity (ppt) | 11 | 10.2 | 9.9 |

**25 July 2008**

GPS first patch: 50° 52' 23.2'' N and 001° 18' 48.7'' W

Temperature measurements from 20 to 30 cm deep along receiver line (°C): Range from 19.5-20 degrees.

Salinity measurements from 20-30 cm deep along receiver line (ppt): range of 12 to 13 ppt.

**28 July 2008**

GPS at the patch 3: 50° 52' 22.8'' N and 001° 18' 45.4'' W

| | Patch 1 | Patch 2 | Patch 3 |
|---|---|---|---|
| Temperature (°C) | 21.4 | 20.5 | 20.6 |
| Salinity (ppt) | 8.4 | 12 | 12.1 |

**04 August 2008**

GPS: 50° 48' 57'' N and 001° 18' 34.8'' W

Temperature measurements from 20 to 30 cm deep along receiver line (°C): Range from 20+/-0.5 degrees.

Salinity measurements from 20-30 cm deep along receiver line (ppt): range of 9 to 10 ppt.

**Note:** the intertidal zone is one in which temperature control cannot be enforced with interfering with the normal processes of biogenic decomposition, outgassing and gas dissolution, and the normal processes associated with benthic species.

If intertidal zones were  of for gas-free sediments, it would be straightforward to use the formulation in our ref [89]:

> D. R. Jackson and M. D. Richardson, "Seasonal temperature gradients within a sandy seafloor: implications for acoustic propagation and scattering," in *Acoustical Oceanography: Proc. Inst. Acoustics.*, vol. 23, part 2, pp. 361-368 (Leighton, T.G., Heald, G.J., Griffiths, H. and Griffiths, G. eds., Bath University Press) Southampton, 9-12 April  2001.

to show that the effect on sound speed by the 1°C-2°C change in ambient temperature observed in this study, would be small (less than 1-2 %). However the presence of bubbles complicates this, since changes in temperature affect the number and size of bubbles present, through Boyle's Law (thermal expansion of gas), Henry's Law (whether gas should be coming out of solution or dissolving) and Fick's Laws (the rate at which gas should be coming out of solution or dissolving).

The temperature changes observed here are similar to those modelled for small temperature changes during the acoustic cycle in Figs. 2 and 3 of

> Stricker, L., Prosperetti, A. and Lohse, D. (2011) "Validation of an approximate model for the thermal behavior in acoustically driven bubbles." *J. Acoust. Soc. Am*. 130 (5), Pt. 2, 3243–3251

(we use pump source amplitudes up to 40 kPa, image source amplitudes up to 100 kPa, the sediment density is larger than the water density, and of course sediments have shear strength that water does not have). Thorough logging of the environmental parameters during acoustic experimentation in the intertidal zone is very important to allow acousticians to have confidence in using it.

## IV. TRANSMISSION EXPERIMENT SOURCE AMPLITUDES AND WAVEFORMS:

### 10 April 2008

| folder | Frequency range (kHz) | Pump pressure (kPa) | Shots per frequency | Waveform envelope | Waveform length |
|---|---|---|---|---|---|
| 1 | 26:2:100 | 10 | 20 | square | 1 ms |
| 2 | 26:2:100 | 10 | 20 | square | 20 osc. |
| 3 | 26:2:100 | 10 | 10 | square | 1 ms |
| 4 | 26:2:100 | 10 | 10 | square | 20 osc. |

### 15 April 2008

**LOCATION 1:** 50° 52' 23.3'' N and 001° 18' 48.1'' W

| folder | Frequency range (kHz) | Pump pressure (kPa) | Shots per frequency | Waveform envelope | Waveform length |
|---|---|---|---|---|---|
| 1 | 26:2:100 | 50 | 20 | square | 1 ms |
| 2 | 26:2:100 | 43.5 | 20 | square | 20 osc. |
| 3 | 26:2:100 | 50 | 10 | square | 1 ms |
| 4 | 26:2:100 | 50 | 10 | square | 20 osc. |
| 5 | 10:2:24 | 12.5 | 20 | square | 1 ms |
| 6 | 10:2:24 | 12.5 | 20 | square | 20 osc. |
| 7 | 10:2:24 | 12.5 | 20 | square | 1 ms |
| 8 | 10:2:24 | 12.5 | 20 | square | 20 osc. |

**LOCATION 2:** 50° 52' 23.3'' N and 001° 18' 48.1'' W

| folder | Frequency range (kHz) | Pump pressure (kPa) | Shots per frequency | Waveform envelope | Waveform length |
|---|---|---|---|---|---|
| 11 | 8:2:24 | 10 | 20 | square | 1 ms |
| 12 | 8:2:24 | 10 | 20 | square | 20 osc. |
| 13 | 8:2:24 | 10 | 20 | square | 1 ms |
| 14 | 8:2:24 | 10 | 20 | square | 20 osc. |
| 15 | 26:2:100 | 17.5 | 20 | square | 1 ms |
| 16 | 26:2:100 | 17.5 | 20 | square | 20 osc. |
| 17 | 26:2:100 | 17.5 | 20 | square | 1 ms |
| 18 | 26:2:100 | 17.5 | 20 | square | 20 osc. |

## 10 June 2008

| folder | Frequency range (kHz) | Pump pressure (kPa) * | Shots per frequency | Waveform envelope | Waveform length |
|---|---|---|---|---|---|
| 1 | 26:2:100 | 15 | 50 for 26 to 44 kHz<br>2 for 46 to 100 kHz | square | 1 ms |

## 11 June 2008

| folder | Frequency range (kHz) | Pump pressure (kPa) | Shots per frequency | Waveform envelope | Waveform length |
|---|---|---|---|---|---|
| 1 | 26:2:100 | 30 | 20 | square | 1 ms |
| 2 | 26:2:100 | 30 | 20 | square | 20 osc. |
| 3 | 26:2:100 | 30 | 10 | square | 1 ms |
| 4 | 8:1:25 | 4.5 | 40 | square | 1 ms |
| 5 | 8:1:25 | 3 | 40 | square | 1 ms |
| 6 | 8:1:25 | 3 | 40 | square | 20 osc. |
| 7 | 20:2:40 | 5 | 40 | square | 1 ms |
| 8 | 20:2:40 | 5 | 40 | square | 20 osc |

**04 August 2008**

| folder number | Frequency range (kHz) | Pump pressure (kPa) | Shots per frequency | Waveform envelope | Waveform length |
|---|---|---|---|---|---|
| 1 | 30:2:100 | 5 | 30 | square | 1 ms |
| 2 | 30:2:100 | 5 | 30 | square | 1ms |
| 3 | 30:2:100 | 10 | 30 | square | 1 ms |
| 4 | 30:2:100 | 15 | 15 | square | 1 ms |
| 5 | 30:2:100 | 30 | 15 | square | 1 ms |
| 6 | 8:1:25 | 30 | 15 | square | 1 ms |
| 7 | 8:1:25 | 15 | 15 | square | 1 ms |
| 8 | 8:1:25 | 10 | 15 | square | 1 ms |
| 9 | 8:1:25 | 5 | 15 | square | 1 ms |
| 11 | 8:1:25 | 5 | 10 | square | 1 ms |

## V. COMBINATION FREQUENCY EXPERIMENT SOURCE AMPLITUDES:

## CALSHOT 23 JULY 2008

| Data set | Pump pressure (kPa) | Imager pressure (kPa) | comments |
|---|---|---|---|
| Patch 1 | | | |
| 1 | 5 | 50 | LF source |
| 2 | 5 | 40 | LF source |
| Patch 2 (approx. 1 meter away from the patch1) | | | |
| 3 | 5 | 50 | MF source |
| 4 | 5 | 40 | MF source |
| 5 | 5 | 60 | MF source |
| 6 | 5 | 60 | HF source |
| 7 | 4 | 60 | 34-70 kHz |
| Patch 3 ( these two sets are essentially one set of measurements) | | | |
| 8 | 5 | 60 | HF source |
| 9 | 5 | 60 | HF source |

## MERCURY 25 JULY 2008

| Data set number | Pump pressure (kPa) | Imager pressure (kPa) | comments |
|---|---|---|---|
| Patch 1 (the mud looked more fluid than on the 23 July 2008) | | | |
| 1 | 5 | 60 | HF source |
| 2 | 10 | 80 | HF source |
| 3 | 20 | 100 | HF source |
| 4 | 5 | 50 | LF source |
| 5 | 5 | 60 | LF source |
| 6 | 5 | 100 | LF source |
| 7 | 5 | 100 | LF source |
| 8 | 5 | 60 | LF source |
| Patch 2 (at the high site of mercury point) | | | |
| 9 | 5 | 60 | LF source |
| 10 | 5 | 60 | LF source |
| Patch 3 | | | |
| 11 | 10 | 100 | LF source |
| 12 | 15 | 60 | LF source |
| 13 | 15 | 60 | HF source |
| 14 | 15 | 80 | HF source |
| 15 | 15 | 100 | HF source |

## MERCURY 28 JULY 2008

| Data set number | Pump pressure (kPa) | Imager pressure (kPa) | comments |
|---|---|---|---|
| Patch 1 (the mud looked more fluid than on the 25 July 2008) | | | |
| 1 | 10 | 100 | MF source |
| 2 | 10 | 10 | MF source |
| 3 | 5 | 100 | MF source |
| 4 | 5 | 60 | MF source |
| 5 | 5 | 60 | MF source |
| 6 | 5 | 100 | MF source |
| 7 | 10 | 100 | MF Source |
| Patch 2 | | | |
| 8 | 10 | 100 | MF source |
| 9 | - | - | Nothing logged |
| 10 | 5 | 100 | MF source |
| 11 | 15 | 100 | MF source |
| 12 | 15 | 100 | MF source |
| 13 | 15 | 100 | MF source |
| 14 | 15 | 100 | HF source |
| 15 | 15 | 100 | HF source |
| 16 | 10 | 100 | HF source |
| 17 | 5 | 100 | HF source |
| 18 | 5 | 60 | HF source |
| Patch 3 | | | |
| 19 | 5 | 100 | HF source |
| 20 | 10 | 100 | HF source |
| 21 | 5 | 60 | HF source |

## VI. EXAMPLE ACOUSTIC SIGNALS

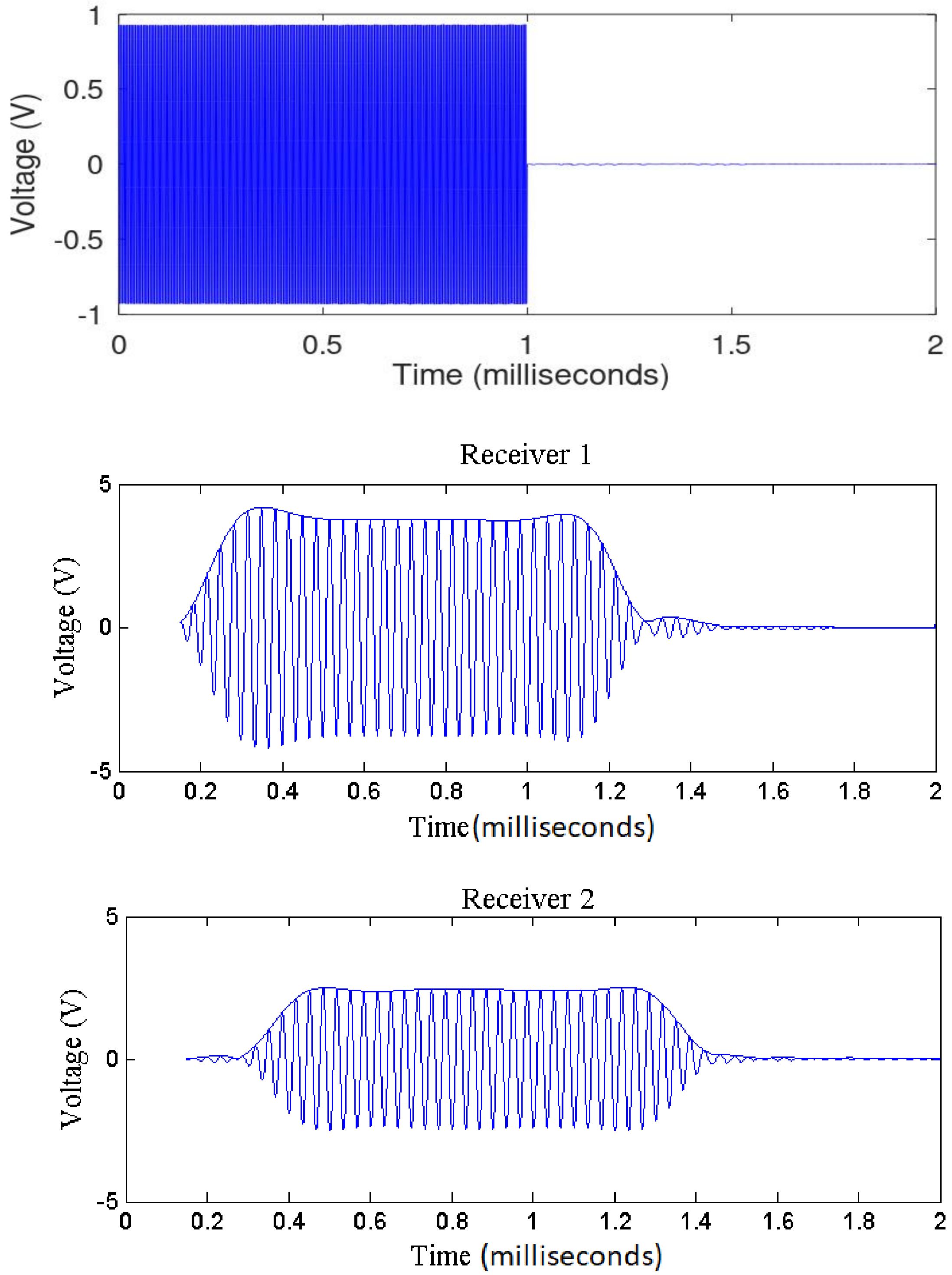


Figure E2: Example acoustic signals: (a) the emitted signal from the transducer, (b) the signal recorded at Receiver 1 and (c) the signal recorded at Receiver 2. The data was acquired in Calshot, Southampton UK on 04 August 2008, with driving frequency 30 kHz. A gain value of 14 dB was applied at Receiver 1 and Receiver 2.

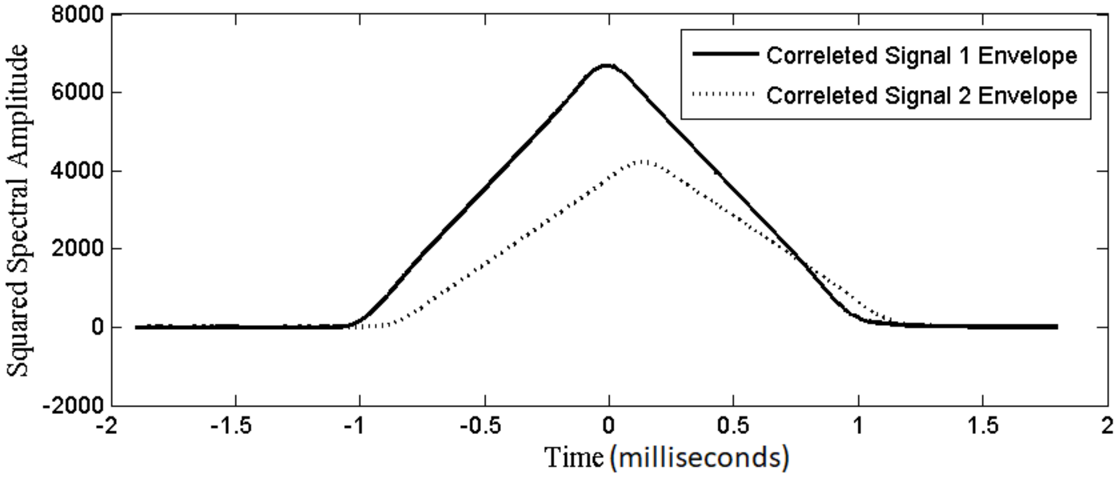


Figure E3: The cross-correlation of the envelope of the signal at Receiver 1 with the reference envelope (solid line) and the cross-correlation of the envelope of the signal at Receiver 2 with the reference envelope (dotted line). The reference envelope was constructed from the envelope of the signal at Receiver 1 by applying an amplitude threshold value of 0.25. The reference for the time axis in the plot was taken as the peak of the auto-correlation of the signal at Receiver 1.