Experiment HM-6: Stimulation of Antagonistic Muscles

WARNING - The Stimulator should only be used for the method of application for which the Stimulator is intended as shown in the directions below.

NOTE: If using the IXTA and built in HV stimulator – all changes in Amplitude are entered directly into the Stimulator Control Panel. Click "APPLY" to make any changes.

Exercise 1: Recruitment and the Maximum Response of the Tibialis Anterior Muscle

Aims: To determine the minimum stimulus amplitude needed to cause the maximum response of the tibialis anterior muscle.

Procedure

1. Instruct the subject to sit on a bench or chair and relax. The bench or chair should be tall enough that the subject's foot does not touch the ground when it is pointed downward.
2. Click the Stimulator Preferences icon on the LabScribe toolbar (Figure HM-6-L1) to open the stimulator control panel (Figure HM-6-L2) on the Main window.

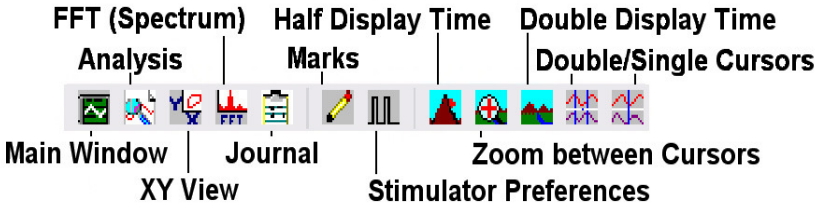

Figure HM-6-L1: The LabScribe toolbar.

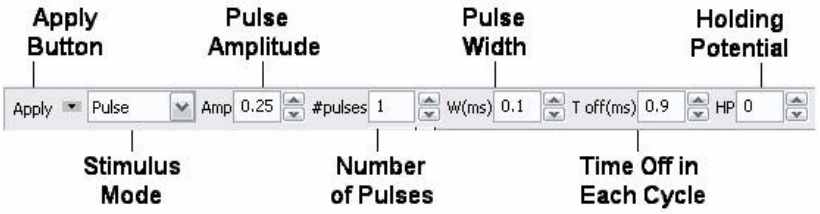

Figure HM-6-L2: The stimulator control panel.

3. Check the values for the stimulus parameters that are listed in the stimulator control panel on the Main window:
   - the pulse amplitude (Amp) should be set to 5.0V;
   - the pulse width (W) to 2ms;
   - the frequency (F) to 1 Hz;

- the number of pulses (#pulses) to 0, which will program the stimulator to pulse continuously.

4. The value for a stimulus parameter can be changed by either of two methods:
    - click on the arrow buttons to the right of the window that displays the value of the parameter to increase or decrease the value; or,
    - type the value of the parameter in the window next to the label of the parameter.
    - Click the Apply button to finalize the change in any stimulus parameter.

Warning: Make sure the Pulse Amplitude knob on the SI-200 is set to zero before turning on the SI-200.

5. Flip the power switch on the back of the SI-200 to the On (I) position. If the SI-200 is working properly, the Power light on the front of the isolated stimulator will glow.
6. Push the Arm button on the SI-200 to activate the output of the unit. The Stimulator Ready light next to Arm button will glow indicating that the isolated stimulator is ready to deliver a stimulus pulse.
7. Type the < Subject's Name> Tibialis Response in the Mark box that is to the right of the Mark button.
8. Click on the Record button on the LabScribe Main window to generate stimulus pulses from the SI-200. Either click on the Mark button or press the Enter key on the keyboard to label the recording. There should be no response from the subject's muscle since the current output is zero. Continue to record.
9. Slowly rotate the Pulse Amplitude knob clockwise 1 turn, which is equal to a current output of 2 milliamperes (mA). Ask the subject to indicate when he or she first feels a tingling sensation under the stimulating electrodes.
10. If no foot movement is detected, the pulse amplitude is below the current level needed to create a muscle contraction. The pulse amplitude that first causes a muscle contraction is known as the Threshold Amplitude.

Note: *The pulse amplitude required to cause a foot flexion will differ between subjects. Some subjects require as low as 6 milliamperes of current to create a maximum response, while other subjects may require 10 or more milliamperes to create the strongest response.*

11. If a foot flexion does not occur at 2 mA after 4 or 5 pulses, rotate the Pulse Amplitude knob an additional half turn to increase the stimulus current by 1 mA. Stimulate for another 4 or 5 pulses. Ask the subject to indicate if tingling and foot movement is detected. Increase the current output in increments of 1 mA, and record 4 or 5 pulses, until the subject's foot flexes with the largest range of motion (Figure HM-6-L3).

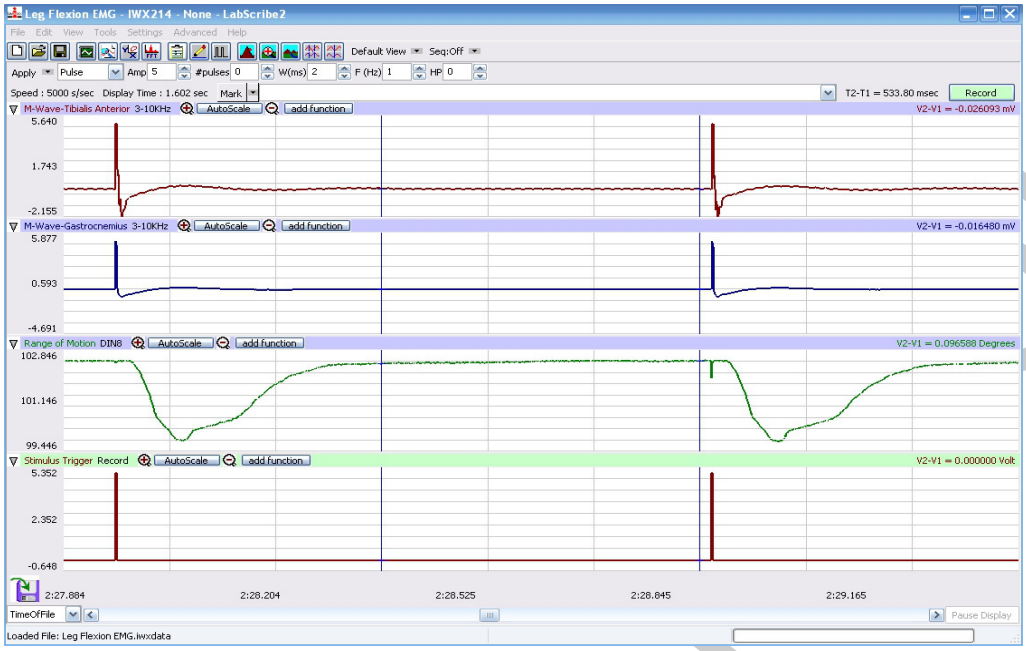

Figure HM-6-L3: The M-waves, ranges of motion, and stimulus pulses recorded during the stimulation of the tibialis anterior muscle with maximal stimulus pulses. The movement of the foot, which is a dorsiflexion, is recorded on the Range of Motion channel as a negative change in angle of the foot.

Note:*The lowest stimulus that causes the largest possible response is called the maximal stimulus. Any stimulus that is above the maximal level is known as supra-maximal. Currents above threshold and below maximal are called sub-maximal.*

12. Click on the Stop button on the LabScribe2 Main window.
13. Select Save As in the File menu, type a name for the file. Choose a destination on the computer in which to save the file, like your lab group folder). Designate the file type as *.iwxdata. Click on the Save button to save the data file.

Exercise 2: Dorsiflexion and Summation

Aims: To measure the angle of deflection of the foot during dorsiflexion at different frequencies of stimulation.

Procedure

1. Except for the number of pulses (#pulses), use the same stimulus parameters that were found in Exercise 1 to create the maximum response of the tibialis anterior muscle.
2. On the stimulator control panel, change the number of pulses (#pulses) to 10, which will program the stimulator to pulse ten times. Click the Apply button to finalize the change in any stimulus parameter.
3. Type the < Subject's Name> Dorsiflexion-1Hz in the Mark box that is to the right of the Mark button.

4. Click on the Record button on the LabScribe Main window to stimulate and record the response of the tibialis anterior muscle. Either click on the Mark button or press the Enter key on the keyboard to label the recording.
5. Click on the Stop button after the last contraction of the tibialis anterior muscle. The results should be similar to the recording in Figure HM-6-L4.

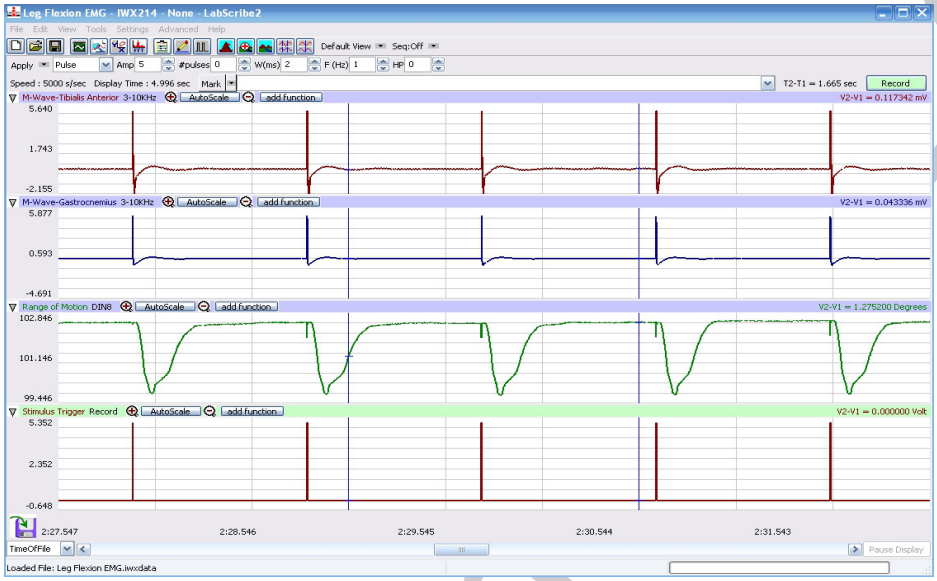

Figure HM-6-L4: The M-waves, ranges of motion, and stimulus pulses recorded during the stimulation of the tibialis anterior muscle with maximal stimulus pulses at 1Hz. The average range of motion for these dorsiflexions is -2.666 degrees.

6. On the stimulator control panel, change the frequency (F) to 2 Hz, which will program the stimulator to stimulate the muscle twice every second. Click the Apply button to finalize this change to the stimulus parameters.
7. Type the Dorsiflexion-2Hz in the Mark box that is to the right of the Mark button.
8. Click on the Record button on the LabScribe Main window to stimulate and record the response of the tibialis anterior muscle. Either click on the Mark button or press the Enter key on the keyboard to label the recording.
9. Click on the Stop button to halt the recording after the last contraction of the tibialis anterior muscle.
10. Repeat Steps 7 through 10 for 3, 4, 5, and 8 Hz.
11. If stimulating the tibialis anterior muscle at 8Hz does not cause summation of the muscle response as indicated by an increase in the range of motion of the foot (Figure HM-6-L5), increase the stimulus frequency until summation occurs.
12. Click Save in the File menu.

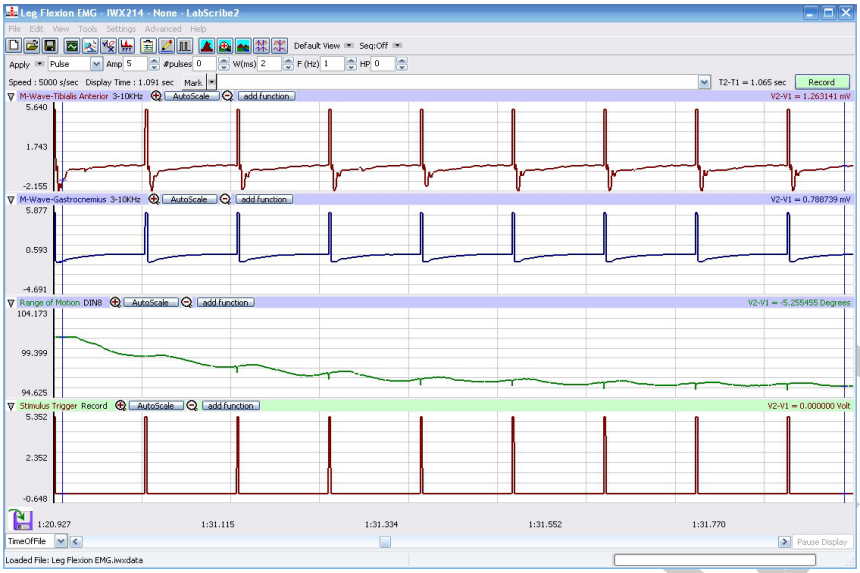

Figure HM-6-L5: The M-waves, ranges of motion, and stimulus pulses recorded during the stimulation of the tibialis anterior muscle with maximal stimulus pulses at 8Hz. The range of motion for the summation of the flexions is -5.288 degrees.

Data Analysis

1. Scroll through the recording and find the section of data recorded while the subject's tibialis anterior muscle was contracting at 1 Hz (Figure HM-6-L4).
2. Use the Display Time icons to adjust the Display Time of the Main window so that three adjacent flexions of the same approximate amplitude are displayed on the Main window. The three flexions can also be selected by:
    - Placing the cursors on either side of the three adjacent flexions; and
    - Clicking the Zoom between Cursors button on the LabScribe toolbar to expand the segment with the three flexions to the width of the Main window.
3. Click on the Analysis window icon in the LabScribe toolbar or select Analysis from the Windows menu to transfer the data displayed in the Main window to the Analysis window (Figure HM-6-L6).
4. Look at the Function Table that is above the channel displayed in the Analysis window. The mathematical functions, T2-T1 and V2-V1, should appear in this table. The values for T2-T1 and V2-V1 are seen in the table across the top margin of the channel.
5. Once the cursors are placed in the correct positions for measuring the latency, contraction time, range of motion, and relaxation time, the values for the times and angle can be recorded in the on-line notebook of LabScribe by typing the names and values directly into the Journal.

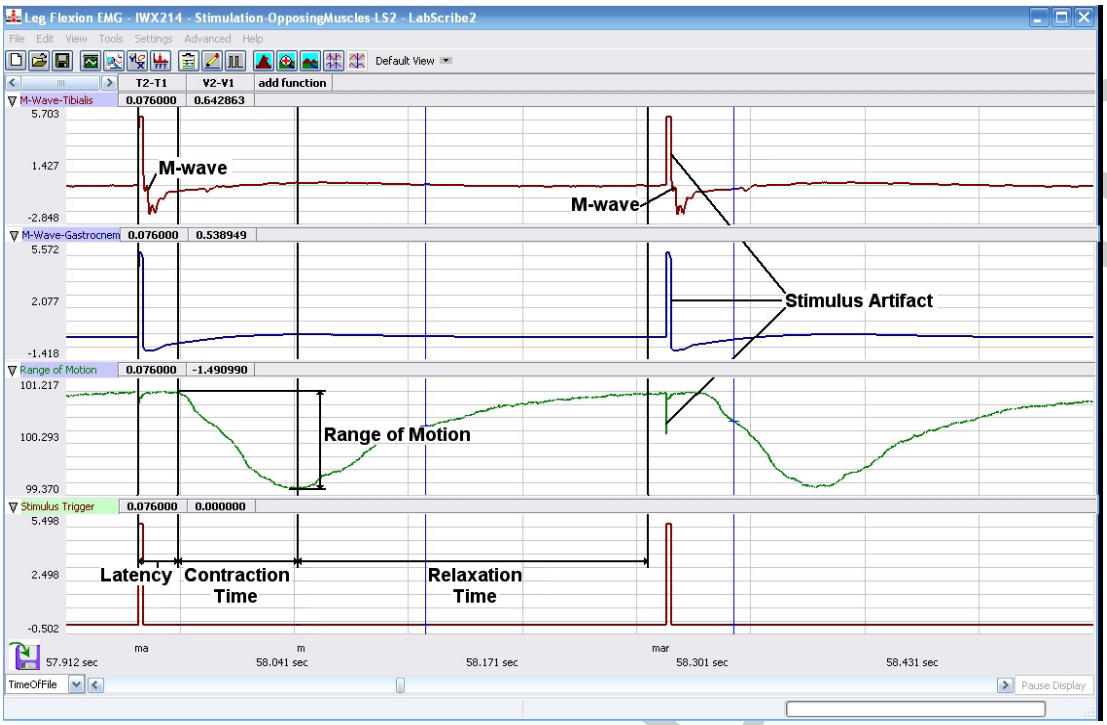

Figure HM-6-L6: Labeled recording of the M-waves, ranges of motion, and stimulus pulses from two dorsiflexions displayed in the Analysis window. The cursors are positioned to measure the range of motion (-1.491 degrees) and the contraction time (76.000 msec) on the Range of Motion channel.

6. The functions in the channel pull-down menus of the Analysis window can also be used to enter the names and values of the times and angle in the Journal. To use these functions:
    - Place the cursors at the locations used to measure the times and angle.
    - Transfer the names of the mathematical functions used to determine the times and angles to the Journal using the Add Title to Journal function in the Range of Motion channel pull-down menu.
    - Transfer the values for the times and angles to the Journal using the Add All Data to Journal function in the Range of Motion channel pull-down menu.

Note: *Dorsiflexion is the upward movement of the foot, but the range of motion for dorsiflexion is recorded as a negative angle. The range of motion during plantar flexion is recorded as a positive angle.*

7. On the Goniometer and Stimulus Trigger channels, use the mouse to click on and drag the cursors to specific points on the recording to measure the following parameters:
    - Latency, which is the time between the onset of the stimulus pulse and the initial response of the goniometer during dorsiflexion of the foot. To measure the latency, place

one cursor at the beginning of the stimulus pulse displayed on the Stimulus Trigger channel, and the second cursor on the beginning of the goniometer's response displayed on the Range of Motion channel. The value for the T2-T1 function on any channel is the latency. Record this value in the Journal and on Table HM-6-L1.

- Contraction Time, which is the time it takes the foot to move from the relaxed position to dorsiflexed position. To measure the contraction time, move the cursor that is on the beginning of the stimulus pulse to the peak of the goniometer's response. Keep the other cursor on the beginning of the goniometer's response. The value for the T2-T1 function on any channel is the contraction time. Record this value in the Journal and on the data table.
- Range of Motion, which is the change in angle of the foot between the relaxed position and the dorsiflexed position. Keep the cursors in the same positions used to measure contraction time. The value for the V2-V1 function on the Range of Motion channel is range of motion for dorsiflexion of the foot. Record this value in the Journal and on Table HM-6-L1.
- Relaxation Time, which is the time it takes the foot to move from the dorsiflexed position back to the relaxed position. To measure the relaxation time, move the cursor that is on the beginning of the goniometer's response to the end of the goniometer's response to dorsiflexion. Keep the other cursor on the peak of the goniometer's response. The value for the T2-T1 function on any channel is the relaxation time. Record this value in the Journal and on the data table.

8. Repeat Step 7 for the other two dorsiflexions recorded at 1 Hz.
9. Repeat Step 7 for each of three dorsiflexions recorded at 2, 3, 4, and 5 Hz.
10. Measure the total range of motion of the foot during summation of the dorsiflexions at a stimulus frequency of 8Hz or greater. On the Range of Motion channel:
    - Place one cursor on the section of the recording when the foot was in the relaxed position
    - Place the other cursor on the section of the recording when the foot reached maximum flexion.
    - The value for the V2-V1 function on the Range of Motion channel is total range of motion during summation.
    - Record this value in the Journal and on data table.
11. Select Save in the File menu.

Table HM-6-L1: Contraction & Relaxation Times, Latency and Range of Motion during Dorsiflexion at Different Frequencies.

Parameter	Dorsiflexion at 1Hz			
	1st	2nd	3rd	Average
Latency (ms)				
Contraction Time (ms)				
Range of Motion (^{o})				
Relaxation Time (ms)				
Parameter	Dorsiflexion at 2Hz			
	1st	2nd	3rd	Average
Flexion Latency (ms)				
Contraction Time (ms)				
Range of Motion (^{o})				
Relaxation Time (ms)				
Parameter	Dorsiflexion at 3Hz			
	1st	2nd	3rd	Average
Flexion Latency (ms)				
Contraction Time (ms)				
Range of Motion (^{o})				
Relaxation Time (ms)				
Parameter	Dorsiflexion at 4Hz			
	1st	2nd	3rd	Average
Flexion Latency (ms)				
Contraction Time (ms)				
Range of Motion (^{o})				
Relaxation Time (ms)				

Parameter	Dorsiflexion at 5Hz			
	1st	2nd	3rd	Average
Flexion Latency (ms)				
Contraction Time (ms)				
Range of Motion (^{o})				
Relaxation Time (ms)				
Parameter	Dorsiflexion at 8Hz			
				Total
Range of Motion (^{o})				

Questions

1. Is the latency of the muscle's response the same for each stimulus frequency?
2. Are the contraction and relaxation times the same for each stimulus frequency?
3. Is the range of motion of the subject's foot the same for each stimulus frequency?

Exercise 3: Recruitment and the Maximum Response of the Gastrocnemius Muscle

Aims: To determine the minimum stimulus amplitude needed to cause the maximum response of the gastrocnemius muscle.

Procedure

1. Move the stimulator lead wires to the stimulating electrodes for the gastrocnemius muscle (refer to the set up document), so that:
    - the black (-) lead is on the electrode on the back of the knee.
    - the red (+) lead is on the electrode just above the ground electrode over the gastrocnemius muscle.

Warning: Make sure the Pulse Amplitude knob on the SI-200 is set to zero before clicking the Record button.

2. Use the stimulator control panel on the Main window to set the stimulus parameters to the following values before beginning the recording:
    - the pulse amplitude (Amp) should be set to 5.0V;
    - the pulse width (W) to 2ms;
    - the frequency (F) to 1 Hz;
    - the number of pulses (#pulses) to 0, which will program the stimulator to pulse continuously.
    - Click the Apply button to finalize the change in any stimulus parameter.
3. Use the same procedures employed in Exercise 1 to determine the minimum stimulus amplitude that generates the maximum response of the gastrocnemius muscle.

Warning: If the negative (-) stimulating electrode has been placed over a nerve, the muscles on both sides of the lower leg will contract simultaneously and cause the foot to move outward rather than downward. If this occurs move the negative (-) stimulating electrode closer to the middle of the back of the knee.

4. Label the recording to indicate that the responses came from the subject's gastrocnemius muscle.
5. Make sure the data file is saved at the end of the exercise.

Exercise 4: Plantar Flexion and Summation

Aims: To measure the angle of deflection of the foot during plantar flexion at different frequencies of stimulation.

Procedure

1. Except for the number of pulses (#pulses), use the same stimulus parameters that were found in Exercise 3 to create the maximum response of the gastrocnemius muscle.
2. On the stimulator control panel, change the number of pulses (#pulses) to 10, which will program the stimulator to pulse ten times. Click the Apply button to finalize the change in any stimulus parameter.
3. Use the same procedures employed in Exercise 2 to determine the response of the gastrocnemius muscle to stimulus pulses of different frequencies. Recording should be similar to Figure HM-6-L7.
4. Label the recording to indicate the stimulus frequency used for each group of plantar flexions recorded.
5. Make sure the data file is saved at the end of the exercise.

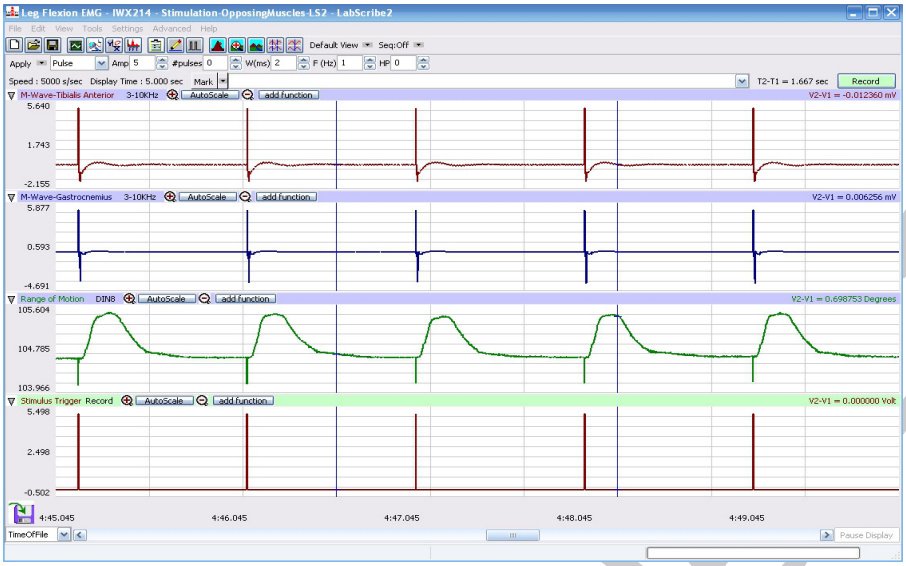

Figure HM-6-L7: The M-waves, ranges of motion, and stimulus pulses during the stimulation of the gastrocnemius muscle with maximal stimulus pulses at 1Hz. Plantar flexion is recorded as a positive change in angle of the foot.

Data Analysis

1. Use the same techniques employed in Exercise 2 to analyze the response of the gastrocnemius muscle to stimulus pulses of different frequencies.
2. Record the measurements in the Journal and on Table HM-6-L2.

Questions

1. Is the latency of the muscle's response the same for each stimulus frequency?
2. Are the contraction and relaxation times the same for each stimulus frequency?
3. Is the range of motion of the subject's foot the same for each stimulus frequency?
4. For each stimulus frequency, compare the ranges of motion for dorsiflexion and plantar flexion. How do the ranges of motion during dorsiflexion compare to the ranges of motion during plantar flexion?

Table HM-6-L2: Contraction & Relaxation Times, Latency and Range of Motion during Plantar Flexion at Different Frequencies.

Parameter	Plantar Flexion at 1Hz			
	1st	2nd	3rd	Average
Latency (ms)				
Contraction Time (ms)				
Range of Motion (^{o})				
Relaxation Time (ms)				
Parameter	Plantar Flexion at 2Hz			
	1st	2nd	3rd	Average
Flexion Latency (ms)				
Contraction Time (ms)				
Range of Motion (^{o})				
Relaxation Time (ms)				
Parameter	Plantar Flexion at 3Hz			
	1st	2nd	3rd	Average
Flexion Latency (ms)				
Contraction Time (ms)				
Range of Motion (^{o})				
Relaxation Time (ms)				
Parameter	Plantar Flexion at 4Hz			
	1st	2nd	3rd	Average
Flexion Latency (ms)				
Contraction Time (ms)				
Range of Motion (^{o})				
Relaxation Time (ms)				

Parameter	Plantar Flexion at 5Hz			
	1st	2nd	3rd	Average
Flexion Latency (ms)				
Contraction Time (ms)				
Range of Motion (^{o})				
Relaxation Time (ms)				
Parameter	Plantar Flexion at 8Hz			
				Total
Range of Motion (^{o})				