

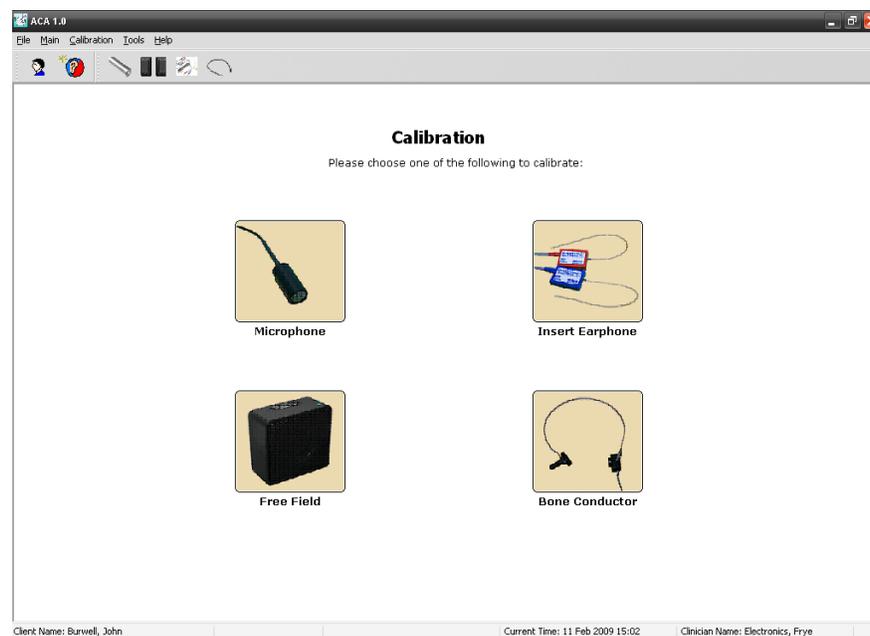
# Chapter 2: Calibration

All transducers must be correctly calibrated before any assessment is performed to ensure that the stimulus and masking levels presented to the client are accurate and the resulting assessment results are reliable. The following transducers must be calibrated:

- Control Microphone (or microphone), *required for ACA assessments*
- Speaker/left (or free field), *required for ACA assessments*
- Insert Earphones, *required for CTE assessments*
- Bone Conductor, *required for CTE assessments*

It is recommended that these calibrations be performed once a year except the speaker calibrations which should be performed daily for best test results.

**To access the Calibration window, press down the keys CTRL+SHIFT+ALT+K.**



*The Calibration window*

## 2.1 Control Microphone Calibration

The control microphone calibration process involves obtaining the sensitivity of the microphone to input signals. It must be performed before free field calibration, because the control microphone is used during the free field calibration process.

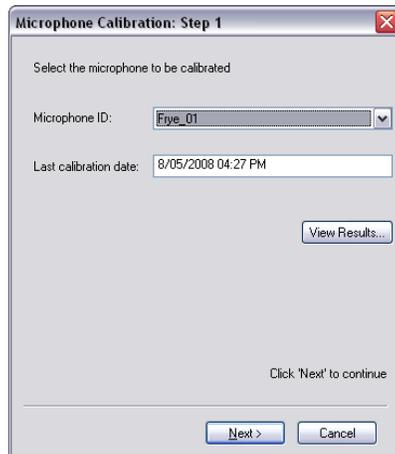
### 2.1.1 Opening the Calibration Wizard



Open the Calibration window by pressing **CTRL+SHIFT+ALT+K**.

In the Calibration window, open the Control Microphone Calibration Wizard by selecting the **Microphone** button.

*You will be asked to key in an access code. Type "QWERTY" (caps sensitive). Once successful, the Microphone Calibration wizard will be displayed:*



*The Microphone Calibration Wizard*

### 2.1.2 Step 1: Selecting the Control Microphone

By default, the existing control microphone is already selected. Click **Next** to proceed to the next step in the calibration process.

If you wish to add a new control microphone, see Section 2.1.7.

If you would like to view the current calibration table, click the **View Results** button. See Section 2.1.8 for details.

### 2.1.3 Step 2: Selecting the External Reference



If you are performing the calibration process with a sound level calibrator (recommended), select **Calibrator**.

If you do not have access to a sound level calibrator, you can perform the calibration with a sound level meter. Select this option if this is your calibration method.

Click **Next** after you have made your selection to proceed to the next step in the calibration process.

### 2.1.4 Step 3: Setting up the Equipment

#### Sound Level Calibrator Method

- Make sure that the control microphone is plugged into the Control Mic socket on the Stimulus Controller.
- Make sure the control microphone is correctly inserted into the sound level calibrator using the supplied adapter.
- Turn the calibrator on before proceeding.

#### Sound Level Meter Method

- Make sure the control microphone is plugged into the Control Mic socket on the Stimulus Controller.
- place the microphone of the sound level meter next to the HEARLab control microphone, with both microphones about 6 inches away from the loudspeaker grill.
- Set the sound level meter to measure the RMS dB SPL value using Fast time-constant with no weighting.
- Make sure the loudspeaker is connected to the Speaker Left socket on the Stimulus Controller.

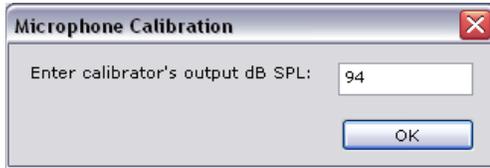
Click **Next** to proceed to the next step in the calibration process.

### 2.1.5 Step 4: Performing the calibration



*Sound Level Calibrator Method*

The control microphone will record and measure the signal coming from the calibration. This calibration process should take about three seconds. If the signal was successfully recorded, a window will appear and prompt you to enter the sound level calibrator's output dB SPL level:



Enter the level and click **OK** to return to the calibration wizard. Click **Next** to proceed to the next step.

### Sound Level Meter Method

During the calibration process, a 1 kHz warble tone is presented through the free field speaker. If the signal was successfully recorded, a window will appear and prompt you to enter in the sound level meter's reading:



Enter the level and click **OK** to return to the calibration wizard. Click **Next** to proceed to the next step.

### Unsuccessful Calibrations

If no signal was detected, you will be notified that the calibration was unsuccessful and prompted to try the calibration again.

Click **Yes** to try again (the wizard will return to Step 3), or **No** to cancel.

#### 2.1.6 Step 5: Completing the Calibration

Type in any additional notes regarding the calibration (e.g. serial number of the calibrator or sound level meter used).

Click **Finish** to save the calibration and exit, or **Cancel** to discard the calibration and exit. Unsuccessful calibration results can not be saved.

#### 2.1.7 Adding a New Microphone

To add a new control microphone, open the Calibration Wizard (see Section 2.1.1) and select **Other...** from the **Microphone Serial No.** list. The Add New Microphone window will be displayed.



Enter the new microphone's ID and click **OK** to return to the wizard.

### 2.1.8 Viewing Current Calibration Results

To view the calibration tables currently in use, open the Calibration Wizard (see Section 2.1.1) and click **View Results**. This will open the Calibration Record window. See Figure 2.1.8.

HEARLab ACA only stores the current calibration record. If you would like to keep a permanent copy of calibration records, use the **Save As...** button to store the record as a text file. The **Print** button can also be used for creating a hard copy of the record.

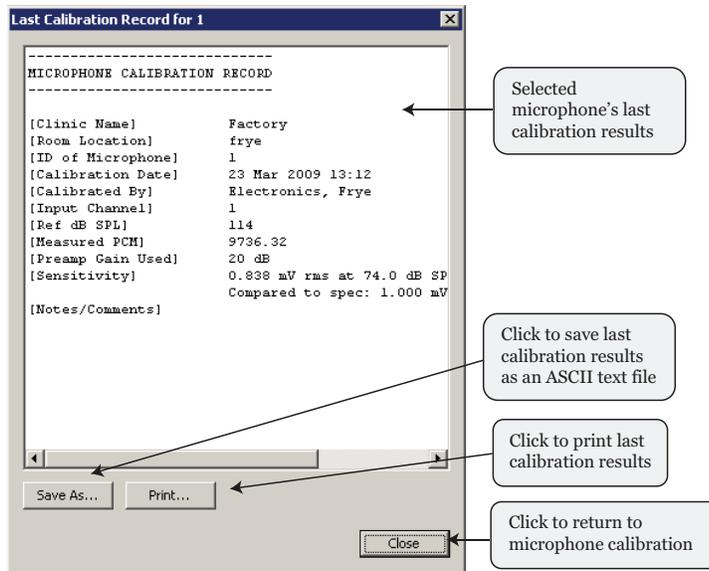


Figure 2.1.8: Calibration Record window

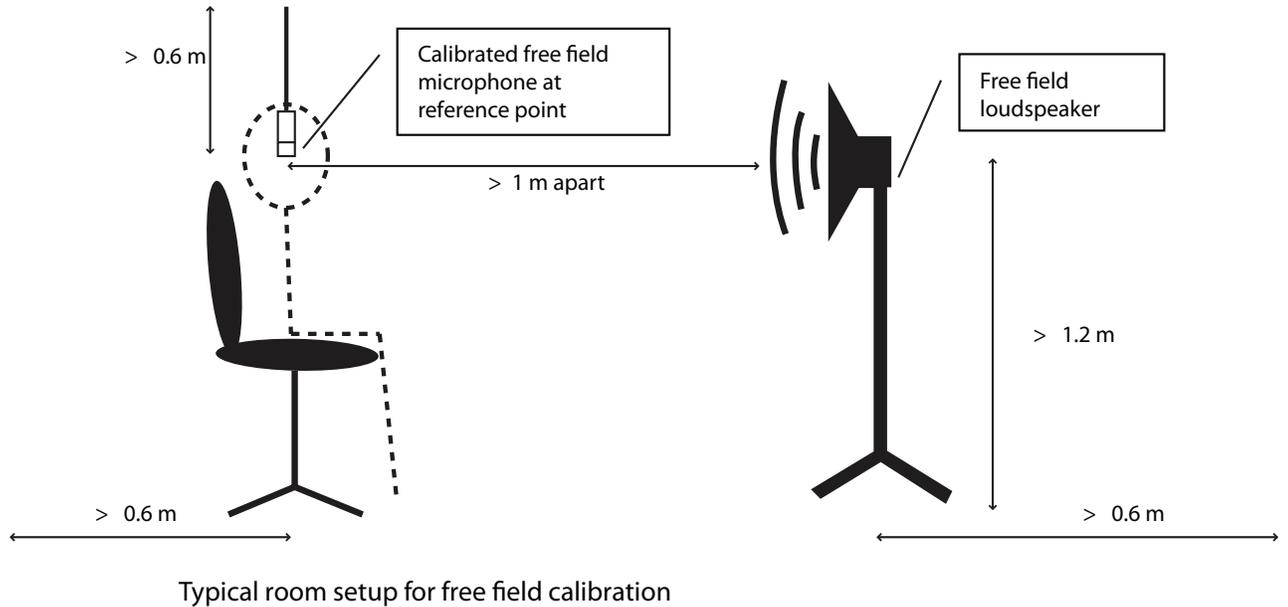
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## 2.2 Free Field Calibration

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The free field calibration process involves obtaining the frequency response of the free field environment (room acoustics + loudspeaker frequency response) and equalising the complex signals that are to be presented in that environment.

To set up the room for free field calibration, set up as you would for an ACA assessment. Place the control microphone at the approximate location where the patient's head is likely to be situated.



### 2.2.1 Opening the Calibration Wizard



Open the Calibration window by pressing **CTRL+SHIFT+ALT+K**.

In the Calibration window, open the Control Microphone Calibration Wizard by selecting the **Free Field** button. See Figure 2.2.2.

### 2.2.2 Step 1: Selecting the Loudspeaker Position

To specify the loudspeaker position in the room, use the **Loudspeaker Position** list. The last calibrated position is selected by default. See Figure 2.2.2.

To view the current calibration table, click the **View Results...** button. See Section 2.2.9 for details.

Click **Next** to proceed to the next step in the Calibration Wizard.

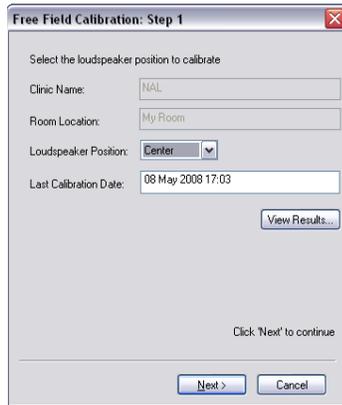


Figure 2.2.2: Free Field Calibration Wizard

### 2.2.3 Step 2: Selecting the Loudspeaker

Select the loudspeaker to be calibrated using the **LoudspeakerID** list. The existing loudspeaker will be selected by default. See Figure 2.2.3.



Figure 2.2.3: Loudspeaker Selection

Specify the distance between the loudspeaker and the test position.

Click **Next** to proceed to the next step in the Calibration Wizard.

### 2.2.4 Step 3: Selecting the Calibration Method

The control microphone is a standard accessory for HEARLab. The "Automatic" calibration method uses this microphone and should be selected for most calibrations. See Figure 2.2.4.

- The control microphone should be automatically selected for use in the calibration process. If necessary, use the list provided to specify the microphone.

- If an external amplifier will be used, select **External amplifier to be used**.
- If you would like to perform the calibration manually with a sound level meter, see Section XXX.

Click **Next** to proceed to the next step in the Calibration Wizard.

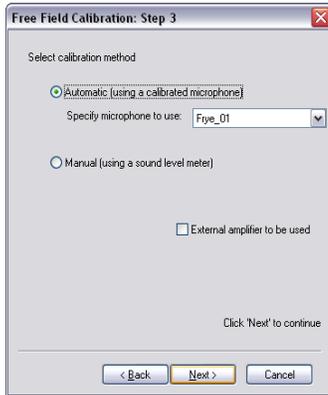


Figure 2.2.4: Calibration Method selection

### 2.2.5 Step 4: Positioning the Speaker

Make sure the loudspeaker is positioned as shown in the picture.

Click **Next** to proceed with calibration.

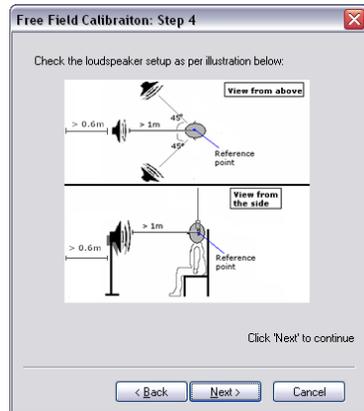


Figure 2.2.5: Speaker positioning

### 2.2.6 Step 5: Setting up the Equipment

- Make sure the control microphone is plugged into the Control Mic socket of the Stimulus Controller and properly placed at the test position.
- Make sure the loudspeaker is plugged into the Left Speaker socket of the Stimulus Controller.

Click **Next** to proceed to the next step in the Calibration Wizard.

### 2.2.7: Step 6: Performing the Calibration

During the calibration process, a series of warble tones (125-8000 Hz in 1/3 octave intervals) will be presented through the loudspeaker. The control microphone will measure and record these signals to obtain the frequency response of the free field environment. See Figure 2.2.7.

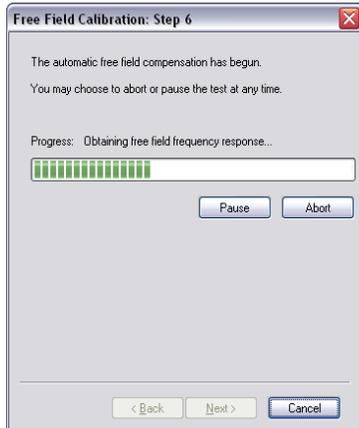


Figure 2.2.7: Automatic calibration in progress

- You may pause or abort the calibration process at any time, but during the calibration process, the **Back** and **Next** buttons on the wizard will be disabled. They will be enabled again when the calibration process has completed.
- If the system could not obtain a signal, or finds that the obtained frequency response exceeds  $\pm 8$  dB of the reference frequency but is still within  $\pm 11$  dB of it, a warning message will be displayed on-screen and you will be prompted to restart the automatic calibration process or to continue.
- After the first frequency sweep, the system will make automatic level adjustments as the second frequency sweep is presented in order to produce a (near) flat frequency response. The signals will again be recorded and measured by the microphone.
- Upon the completion of the second frequency sweep, the filtered (filter generated from obtained frequency response) ACA stimuli will be presented and recorded.

If the measured frequency response of the field exceeds  $\pm 10$  dB, or if the adjusted frequency response still exceeds IEC 645-2 tolerances, you will be notified and asked whether or not you wish to retry the calibration. You may wish to view the preliminary calibration results before making the decision. If you choose to retry, the calibration process will be repeated, and all previous adjustments will be discarded.

You may wish to adjust the room setup (e.g. moving furniture around, moving the loudspeaker and test position further away from the walls) to improve the frequency response of the sound field.

Click **Next** to proceed to the next step of the Calibration Wizard.

## 2.2.8 Step 7: Completing the Calibration

Type in any additional notes regarding the calibration (e.g. sound level meter used, name of the operators performing the calibration). See Figure 2.2.8.

Click **Finish** to save the calibration and exit, or **Cancel** to discard the calibration and exit. Unsuccessful calibration results can not be saved.

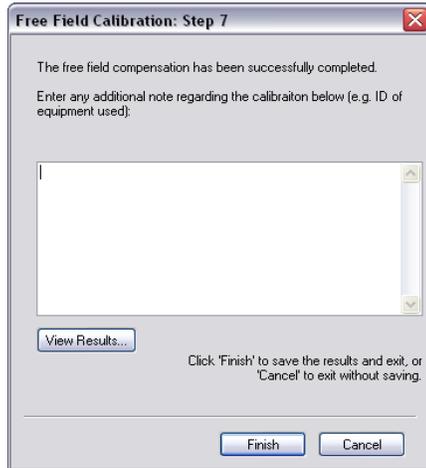


Figure 2.2.8: Completing the Calibration Wizard

## 2.2.9 Viewing Current Calibration Results

To view the existing calibration tables for the specified loudspeaker position, open the Calibration Wizard (see Section 2.2.1), select the loudspeaker position, and click View Results. A window will open with the calibration results. See Figure 2.2.9.

HEARLab ACA only stores the current calibration record. If you would like to keep a permanent copy of calibration records, use the **Save As...** button to store the record as a txt file. The **Print** button can also be used for creating a hard copy of the record.

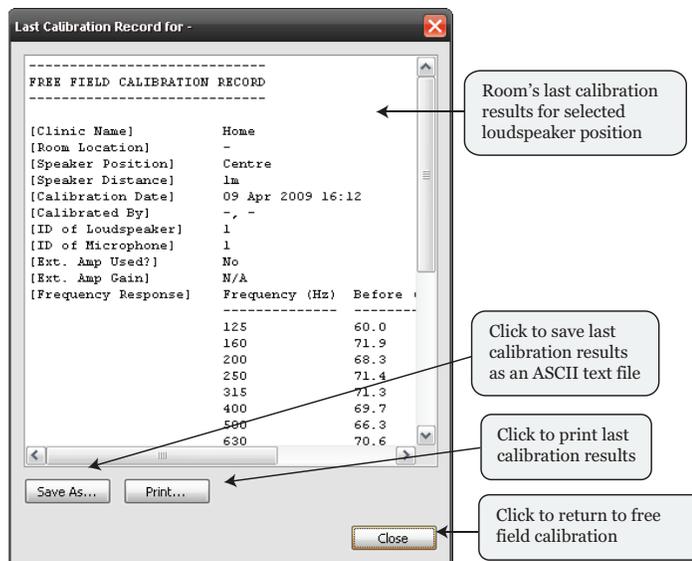


Figure 2.2.9: Viewing current calibration results

### 2.2.10 Adding a New Loudspeaker

To add a new loudspeaker, open the Calibration Wizard (see Section 2.2.1), select the loudspeaker position (see Section 2.2.2). In Step 2 of the Calibration Wizard, use the Loudspeaker ID list to select **Other**. This will open the Add New Loudspeaker window. See Figure 2.2.10.

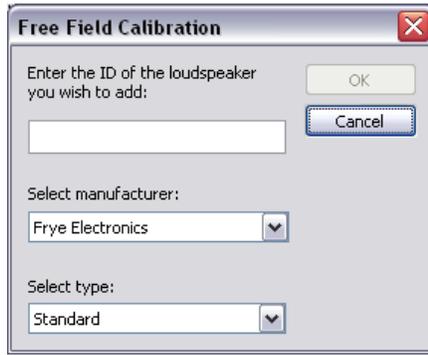


Figure 2.2.10: Adding a new loudspeaker

Type the ID of the new loudspeaker and click **OK** to return to the Calibration Wizard.

### 2.2.11 Using a Sound Level Meter (Manual Calibration)

It is possible to calibrate the sound field manually with a sound level meter instead of using the automatic calibration process with the control microphone. This method requires two people: one to operate the HEARLab controls and one to make sound level meter readings. The objective of the procedure is to adjust the levels at each frequency until the SLM reading gives the indicated Target dB SPL level.

1. Open the Calibration Wizard (see Section 2.2.1) and follow it to Step 3: Selecting the Calibration Method.
2. Select **Manual (using a sound level meter)**.
3. Make sure that the free field speaker is plugged into the **Free Field Speaker** socket of the SC
4. Position the sound level meter operator with the meter at the test position.
5. Set the SLM to measure RMS dB SPL with Fast time-constant and no weighting. Depending on the microphone used with the SLM, point the microphone towards the sound source or point it downwards.
6. Click through the Calibration Wizard until you reach Step 6: Free Field Calibration. See Figure 2.2.11.

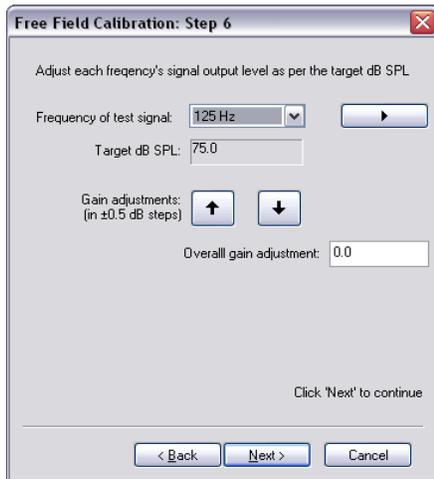


Figure 2.2.11: Manual calibration

7. Select the frequency by using the **Frequency of the test signal** list. The frequencies to be presented are: **125 Hz, 250 Hz, 500 Hz, 1 kHz, 1.5 kHz, 2 kHz, 3 kHz, 4 kHz, and 8kHz.**
8. Click the  button to present the signal. While the signal is being presented, the operator with the SLM should measure the signal level. If the reading is not within  $\pm 0.5$  dB of the target level, adjust the presentation level using the  button to increase the level, or the  button to decrease the level. Adjustments are in **0.5 dB** steps.  
Alternatively, you can input gain adjustments in the **Overall gain adjustment** text box and use the ENTER key to apply the specified gain.
9. Repeat steps 7 and 8 until all frequencies have been presented, measured and adjusted accordingly.

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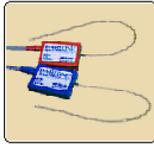
## 2.3 Insert Earphone Calibration

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The insert earphone calibration process involves obtaining the frequency response of the insert earphones and adjusting the output levels to compensate for that response. The additional equipment required for insert earphone calibration is:

- 2cc acoustic coupler (IEC 126) OR an occluded-ear simulator (IEC 711)
- Artificial ear
- Sound level meter

### 2.3.1 Opening the Calibration Wizard



Open the Calibration window by pressing **CTRL+SHIFT+ALT+K**.

In the Calibration window, open the Inset Earphone Calibration Wizard by selecting the **Insert Earphone** button.

You will be asked to key in an access code. Type "QWERTY" (caps sensitive). Once successful, the Insert Earphone Calibration wizard will be displayed. See Figure 2.3.1.



Figure 2.3.1: Insert Earphone Selection

### 2.3.2 Step 1: Selecting the Insert Earphone

Select the earphone to calibration by using the **Insert earphone ID** list. The last calibrated insert earphone is selected by default.

If you would like to add a new insert earphone, see Section 2.3.7.

If you would like to view current calibration results, click the **View Results** button. See Section 2.3.8 for details.

Click **Next** to proceed to the next step in the Calibration Wizard.

### 2.3.3 Step 2: Selecting the Output Channel

Use the **Output Channel** list to select whether you are calibrating the left insert earphone or the right insert earphone. See Figure 2.3.3.

Click **Next** to proceed to the next step in the Calibration Wizard.

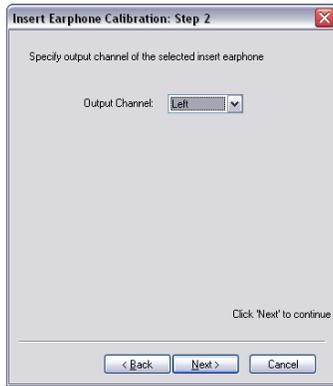


Figure 2.3.3: Insert earphone output channel selection

### 2.3.4 Step 3: Specifying the Coupler

This step selects the type of coupler used in the calibration process. This step is very important because it selects the RETSPL values that are used in HL to SPL conversion calculations. **Selecting the wrong coupler will lead to incorrect calibration corrections.** See Figure 2.3.4.

If you are using a 2-cc coupler for the calibration, select **Acoustic Coupler** and input the Coupler ID.

If you are using an **Occluded Ear Simulator**, choose that selection and input the OES ID.

Click **Next** to proceed to the next step in the Calibration Wizard.

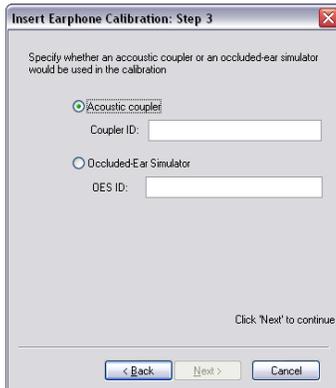


Figure 2.3.4: Specifying the coupler

### 2.3.5 Step 4: Setting up the Equipment

- Make sure the insert earphone is connected to the Insert Left or Insert Right socket on the back of the Stimulus Controller.
- Make sure the insert earphone is connected properly to the coupler or ear simulator.

- Insert the sound level meter microphone into the coupler or ear simulator.
- Set the sound level meter to measure RMS dB SPL with fast time constant and no weighting.

Click **Next** proceed to the next step in the Calibration Wizard.

### 2.3.5 Step 5: Performing the Calibration

During the calibration process, a series of pure tones are presented through the insert earphone. Measure the output level using the sound level meter. The objective of the procedure is to adjust the levels at each presentation frequency until the SLM reading matches the indicated Target dB SPL level.

The frequencies to be presented are: 500Hz, 1 kHz, 1.5 kHz, 2 kHz, 3 kHz, 4 kHz.

1. Use the **Frequency of test signal** list to select the frequency to present.
2. Click  to present the signal. Use the SLM to measure the signal level. If the reading is not within  $\pm 0.5$  dB of the target level, adjust the presentation level using the  or  buttons. Adjustments are in **0.5 dB** steps.

Alternatively, you can type the adjustment into the **Overall gain adjustment** box and hit ENTER.

3. Repeat this procedure until all frequencies have been presented, measured and adjusted accordingly.

In cases where the sensitivity of the insert earphone output exceeds manufacturer's specifications by  $\pm 6$  dB, or if the frequency response exceeds  $\pm 10$  dB, you will be notified and asked whether or not you would like to retry the calibration. You may wish to view the preliminary results before making a decision. Should you choose to retry the calibration, all previous adjustments would be discarded.

Click Next to proceed to the next step in the Calibration Wizard.

### 2.3.6 Step 6: Completing the Calibration

Enter any additional notes regarding the calibration (e.g. sound level meter used, name of the operators performing the calibration, artificial ear used).

Click **Finish** to save the results and exit, or **Cancel** to discard the results and exit.

### 2.3.7 Adding a New Insert Earphone

To add a new insert earphone, open the Insert Earphone Calibration Wizard by following the instructions found in Section 2.3.1.

In the **Insert Earphone ID** box, select Other. This will open the Add New Insert Earphone window. See Figure 2.3.7.



Figure 2.3.7: Adding an Insert Earphone

Enter the ID of the new insert earphone, select the manufacturer and the type of the insert earphone, then click **OK** to return to the wizard.

### 2.3.8 Viewing Current Calibration Results

To view the current calibration tables, follow the instructions in Section 2.3.1 to open the Insert Earphone Calibration Wizard and click **View Results**. A window will appear, displaying the results (dB adjustments to obtain target dB SPL level). See Figure 2.3.8.

HEARLab ACA only stores the current calibration record. If you would like to keep a permanent copy of calibration records, use the **Save As...** button to store the record as a txt file. The **Print** button can also be used for creating a hard copy of the record.

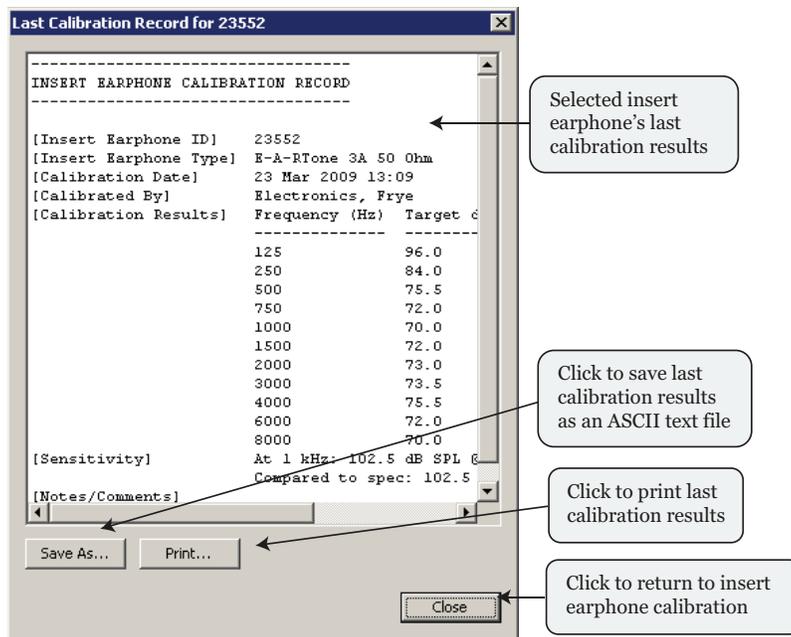


Figure 2.3.8: Calibration Record

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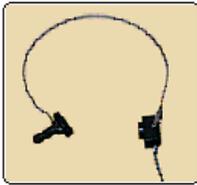
## 2.4 Bone Conductor Calibration

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The bone conductor calibration process involves obtaining the frequency response of the bone conductor and adjusting the output levels to compensate for that response. The additional equipment required for bone conductor calibration are:

- A calibrated artificial mastoid
- A sound level meter

### 2.4.1 Opening the Calibration Wizard



Open the Calibration window by pressing **CTRL+SHIFT+ALT+K**.

In the Calibration window, open the Bone Conductor Calibration Wizard by selecting the **Bone Conductor** button.

You will be asked to key in an access code. Type "QWERTY" (caps sensitive). Once successful, the Bone Conductor Calibration wizard will be displayed. See Figure 2.4.1.

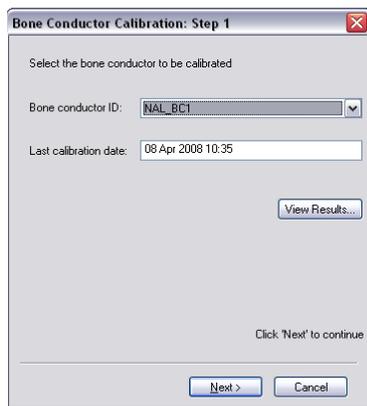


Figure 2.4.1: Bone Conductor Calibration Wizard

### 2.4.2 Step 1: Selecting the Bone Conductor

The bone conductor should automatically be selected in the **Bone Conductor ID** list.

If you would like to add a new bone vibrator, see Section 2.4.7.

If you would like to view current calibration results, click the **View Results** button. See Section 2.4.8 for details.

Click **Next** to proceed to the next step in the Calibration Wizard.

### 2.4.3 Step 2: Setting up the Equipment

The instructions for connecting the bone conductor and the sound level meter to the artificial mastoid will be displayed.

- Make sure the bone conductor is connected to the Bone jack on the Stimulus controller.
- Make sure the bone conductor and the sound level meter are connected correctly to the artificial mastoid.
- Set the SLM to measure dB SPL with fast time setting and no weighting.

Click **Next** to proceed to the next step in the Calibration Wizard.

### 2.4.4 Step 3: Inputting Mastoid Corrections

Type the Artificial Mastoid ID into the box and input the correction figures from the mastoid's calibration results for each of the listed frequency. See Figure 2.4.4.

Click **Next** to proceed to the next step in the Calibration Wizard.

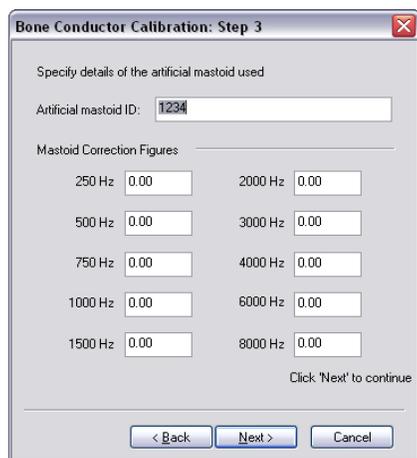


Figure 2.4.4: Artificial Mastoid Corrections

### 2.4.5 Step 4: Performing the Calibration

During the bone conductor calibration process, a series of pure tones are presented through the bone conductor and measured using a sound level meter. The objective of the procedure is to adjust the levels at each presentation frequency until the SLM reading reaches the indicated Target dB SPL level. The frequencies to be presented are: 500Hz, 1 kHz, 1.5 kHz, 2 kHz, 3 kHz, 4 kHz. See Figure 2.4.5.

1. Select the frequency of the pure tone to present using the **Frequency of test signal** list.
2. Click the  button to present the signal.
3. Check the SLM. If the reading is not within  $\pm 0.5$  dB of the target level,

adjust the presentation level using the   buttons. Adjustments are in 0.5 dB steps.

Alternatively, enter the gain adjustments in the **Overall gain adjustment** box and use the ENTER key.

4. Repeat this procedure until all frequencies have been presented, measured, and adjusted accordingly.

In cases where the frequency response of the bone conductor exceeds  $\pm 10$  dB, you will be notified and asked whether or not you wish to retry the calibration. You may wish to view the preliminary results before making a decision. Should you choose to retry the calibration, all previous adjustments would be discarded.

5. Click **Next** to proceed to the next step in the Calibration Wizard.

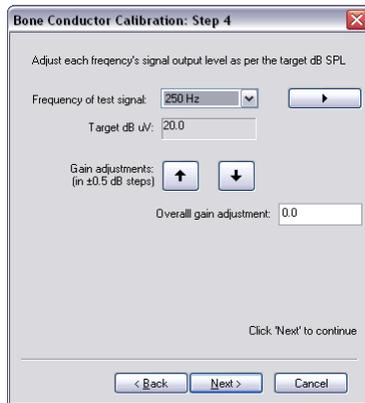


Figure 2.4.5: Performing the calibration

### 2.4.6 Step 5: Completing the Calibration

Enter any additional notes regarding the calibration (e.g. sound level meter used, name of the operators performing the calibration). See Figure 2.4.6.

Click **Finish** to save the results and exit, or **Cancel** to discard the results and exit.

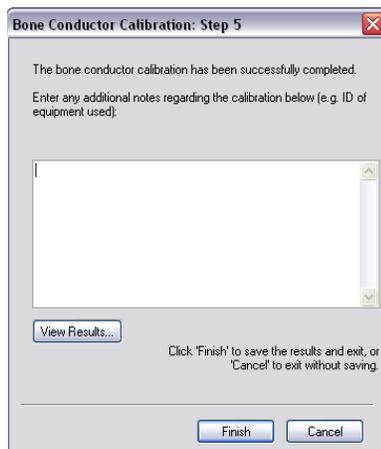
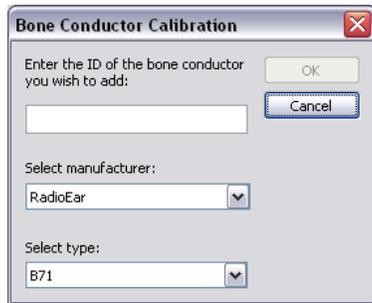


Figure 2.4.6: Completing the calibration

## 2.4.7 Adding a Bone Conductor

To add a new bone conductor, follow the steps in Section 2.4.1 to open the Bone Conductor Calibration Wizard and select **Other...** in the **Bone Conductor ID** box. This will open the Add New Bone Conductor window. See Figure 2.4.7.



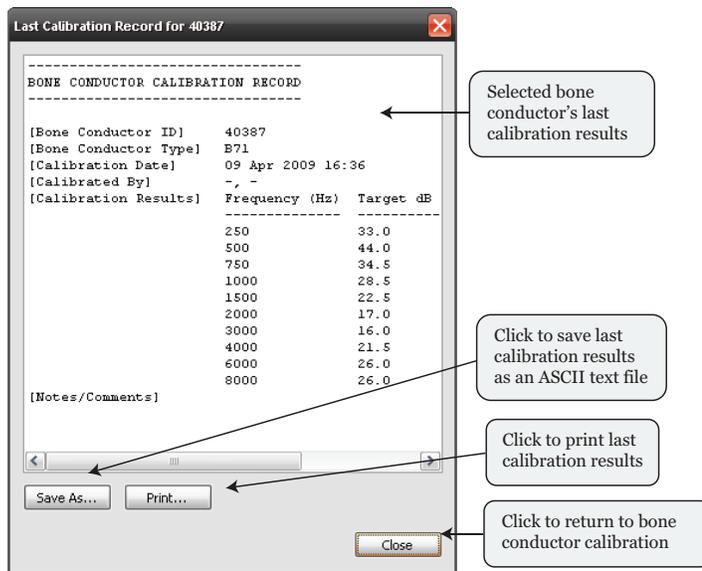
The dialog box is titled "Bone Conductor Calibration". It has a close button (X) in the top right corner. The main area contains a text input field with the label "Enter the ID of the bone conductor you wish to add:". Below this is a "Select manufacturer:" dropdown menu currently showing "RadioEar". Below that is a "Select type:" dropdown menu currently showing "B71". At the bottom right, there are "OK" and "Cancel" buttons.

Figure 2.4.7: Adding a new bone conductor

Enter the ID, manufacturer, and type of the new bone conductor and click **OK** to return to the wizard.

## 2.4.8 Viewing Current Calibration Results

To view the current calibration results of the bone conductor, open the Bone Conductor Calibration Wizard as described in Section 2.4.1 and click **View Results**. A window will open displaying the results (dB adjustments to obtain target dB SPL level).



The window is titled "Last Calibration Record for 40387". It displays the following text:

```
-----  
BONE CONDUCTOR CALIBRATION RECORD  
-----  
[Bone Conductor ID] 40387  
[Bone Conductor Type] E71  
[Calibration Date] 09 Apr 2009 16:36  
[Calibrated By] -, -  
[Calibration Results] Frequency (Hz) Target dB  
-----  
250 33.0  
500 44.0  
750 34.5  
1000 28.5  
1500 22.5  
2000 17.0  
3000 16.0  
4000 21.5  
6000 26.0  
8000 26.0  
[Notes/Comments]
```

At the bottom, there are "Save As...", "Print...", and "Close" buttons. Callout boxes provide instructions:

- Selected bone conductor's last calibration results (points to the table)
- Click to save last calibration results as an ASCII text file (points to "Save As...")
- Click to print last calibration results (points to "Print...")
- Click to return to bone conductor calibration (points to "Close")

Figure 2.4.8: Calibration Record

HEARLab ACA only stores the current calibration record. If you would like to keep a permanent copy of calibration records, use the **Save As...** button to store the record as a text file. The **Print** button can also be used for creating a hard copy of the record.