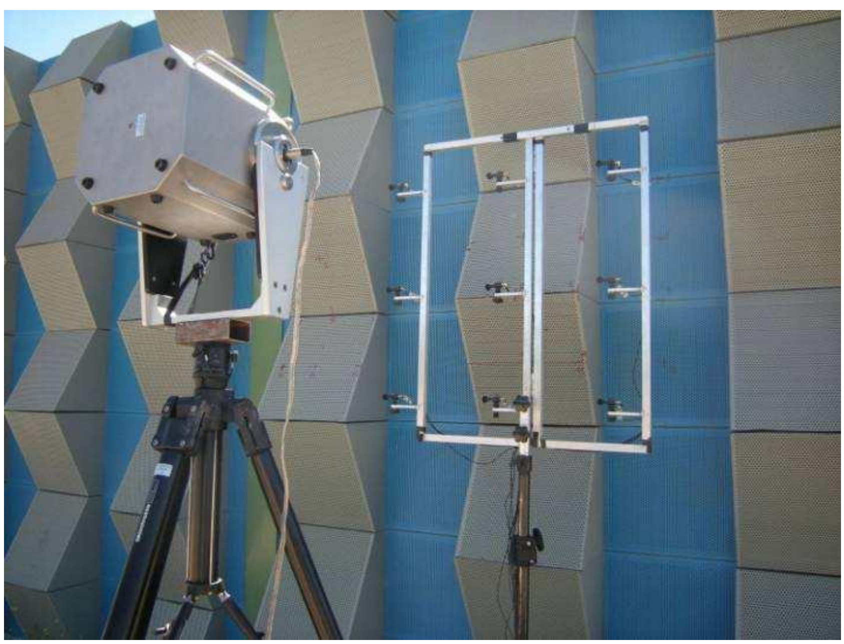
Acoustics Engineering

TN012

Technical Note

Using Dirac for EN 1793-5 measurements



Version 5.1

Copyright © 2019 Acoustics Engineering

Contents

EN 1793-5 3

Acquiring impulse responses 3

- Synchronous recording 3
- Importing the measurements 4

Processing the measurements 7

- Checking the measurements 10
- Setting the time windows 13
- Using the EN 1793-5 spreadsheet 15
- Exporting the results 15
- Source directivity 16

EN 1793-6:2012 17

Further reading 18

EN 1793-5

This document is based on the EN 1793-5 standard of March 2016 (including the corrigendum of August 2018) for the in-situ measurement of sound reflection of road traffic noise reducing devices. Compared to the 2003 version of the standard, numerous changes have been introduced, the most prominent of which are the use of a 9-microphone array, and modified calculations. These changes are such that the existing support for EN 1793-5:2003 in Dirac is insufficient for the new standard.

In this document, we will describe a procedure for using Dirac to produce results in compliance with the new standard. Familiarity with EN 1793-5:2016 and Dirac is assumed.

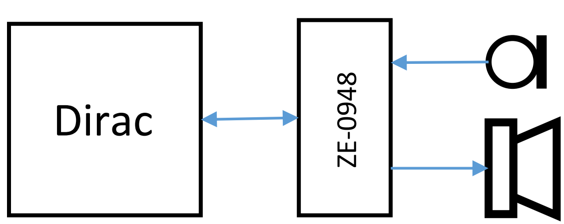
Acquiring impulse responses

The current version of Dirac is limited to recording 2 channels simultaneously. To acquire the signals of 9 microphones simultaneously, a separate recording device is required. There are of course many devices that can be used. The B&K LAN-XI Type 3053 is an example with 12 input channels.

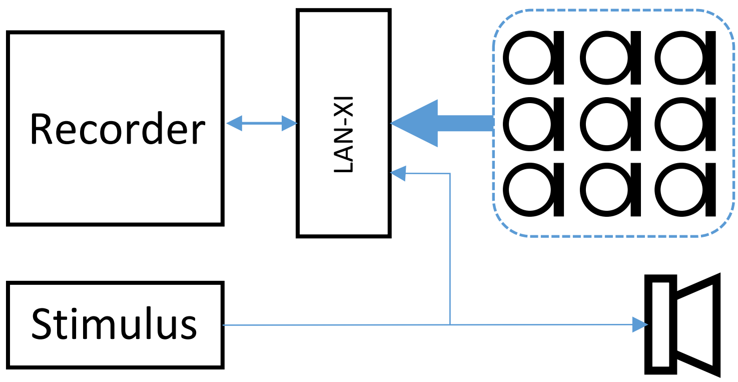
In combination with Time Data Recorder software Type 7708 it is well suited to record the microphone signals. Note that no level calibration is required for this type of measurement because the reflected signal is compared with the free-field signal and only their relative levels are important.

Synchronous recording

It is of paramount importance that the measured impulse responses reflect the accurate timing of the direct signal and the reflections. For this, the relative timing of stimulus versus response must be known exactly. This normally requires a synchronous measurement method, in which the clock of the device that generates the stimulus runs synchronously to the clock of the device that samples the input signals. In measurements following the EN 1793-5:2003 standard this was accomplished by selecting an internal stimulus in Dirac, using the output of the same device that acquired the microphone signal.



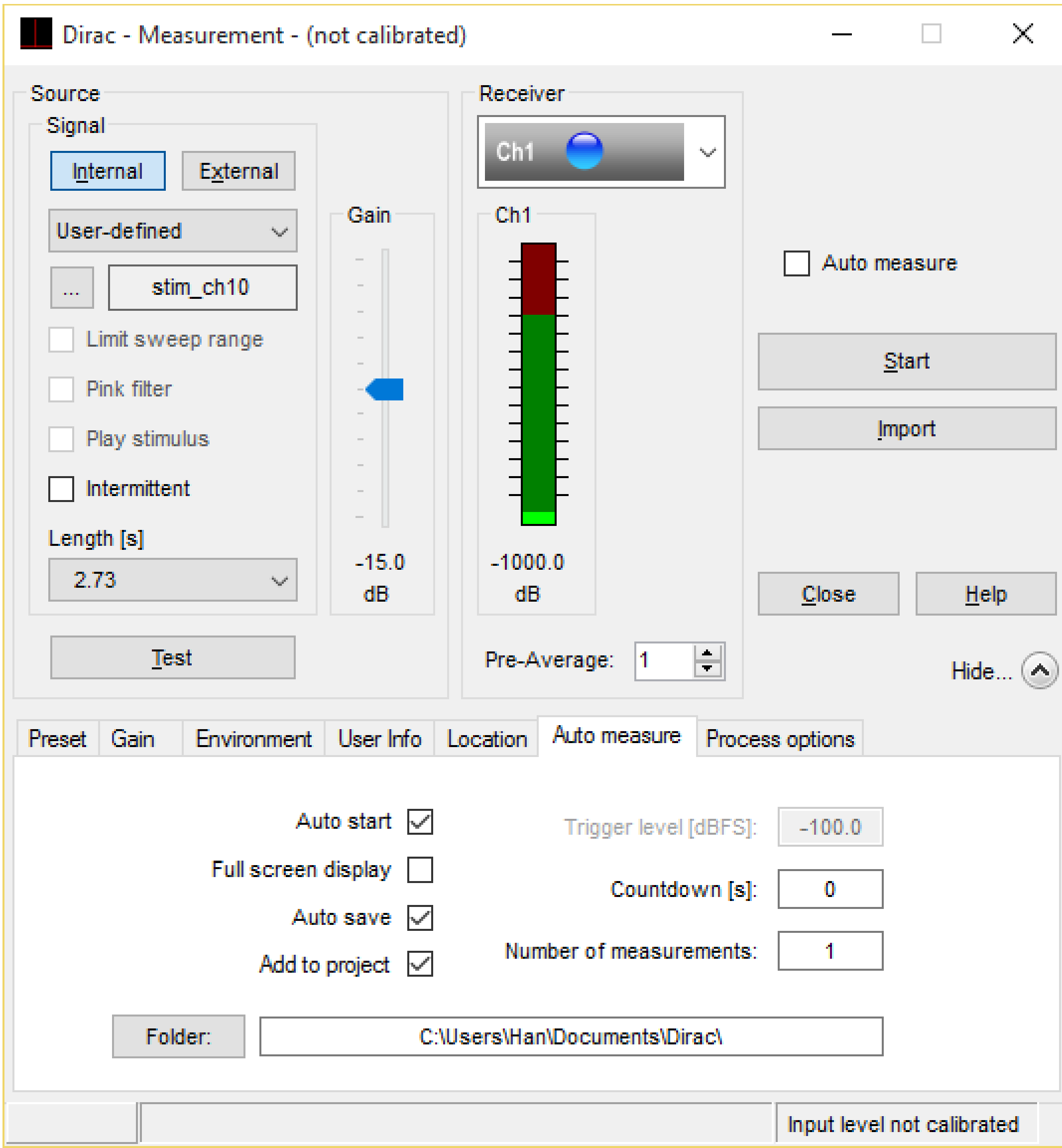
To keep the timing relation between output and input signals where the recording takes place with an external device/software, the stimulus signal must be recorded in the same way the responses are recorded. This means that 10 channels are required for each measurement as in the schematic below.



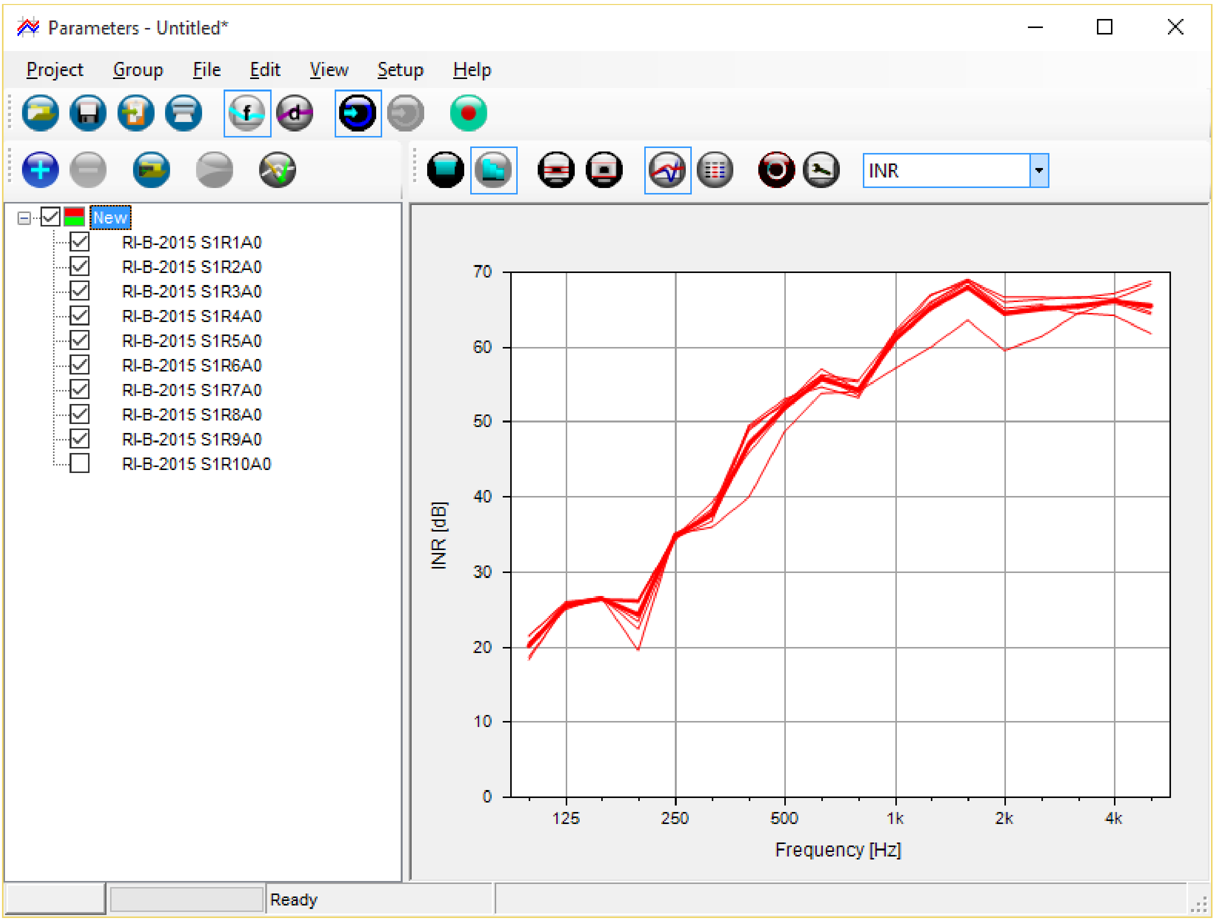
Importing the measurements

If the measurements are available in a single multi-channel file, then the quickest way to import and process the recordings to impulse responses is to select the ‘Internal, User defined’ stimulus. The selected stimulus should be the recorded stimulus from the 10th (stimulus) channel.

Make sure the length of the measurement is at least the capture time multiplied by the pre-averaging number. On the ‘Auto measure’ tab check the ‘Auto save’ and ‘Add to project’ options to make the subsequent handling of the imported impulse responses easier.



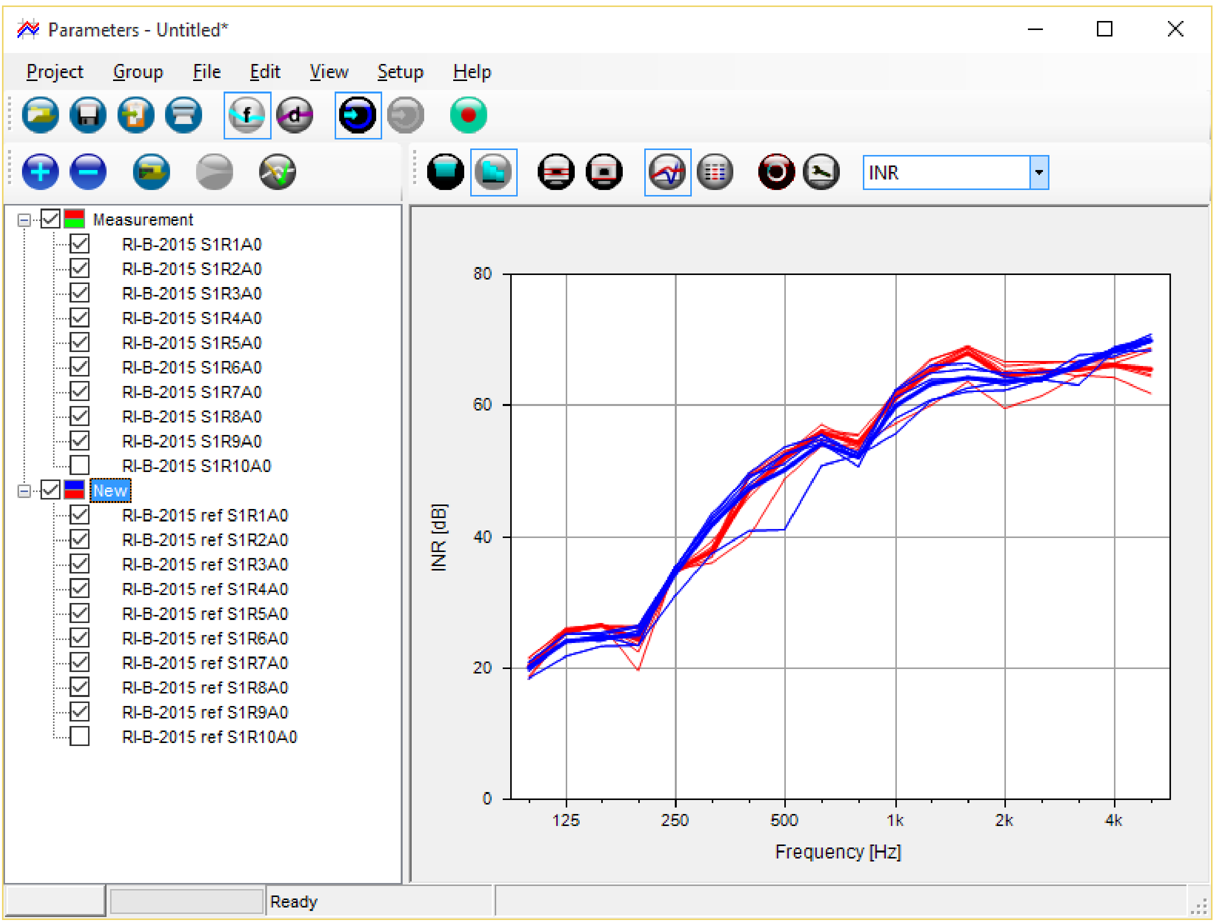
Click the **Import** button and select the multi-channel file. Dirac will automatically split the file into separate channels, and add the impulse responses to a group called **New** in the project window.



Note that in each file the **Receiver** number as found in the **File Properties** on the **Location** tab is set to the channel number from the imported multi-channel file. This number is also visible in the file name. It us useful to have the **Receiver** number set correctly, and to have it correspond to the microphone number as defined in EN 1793-5:2016. This means that microphone 1 should be recorded to channel 1, microphone 2 to channel 2 etc.

Note that if you import channel 10 (the loopback channel) together with the actual microphone signals, the result should be a perfect Dirac pulse. You can verify this by opening the file in **Impulse Response view**.

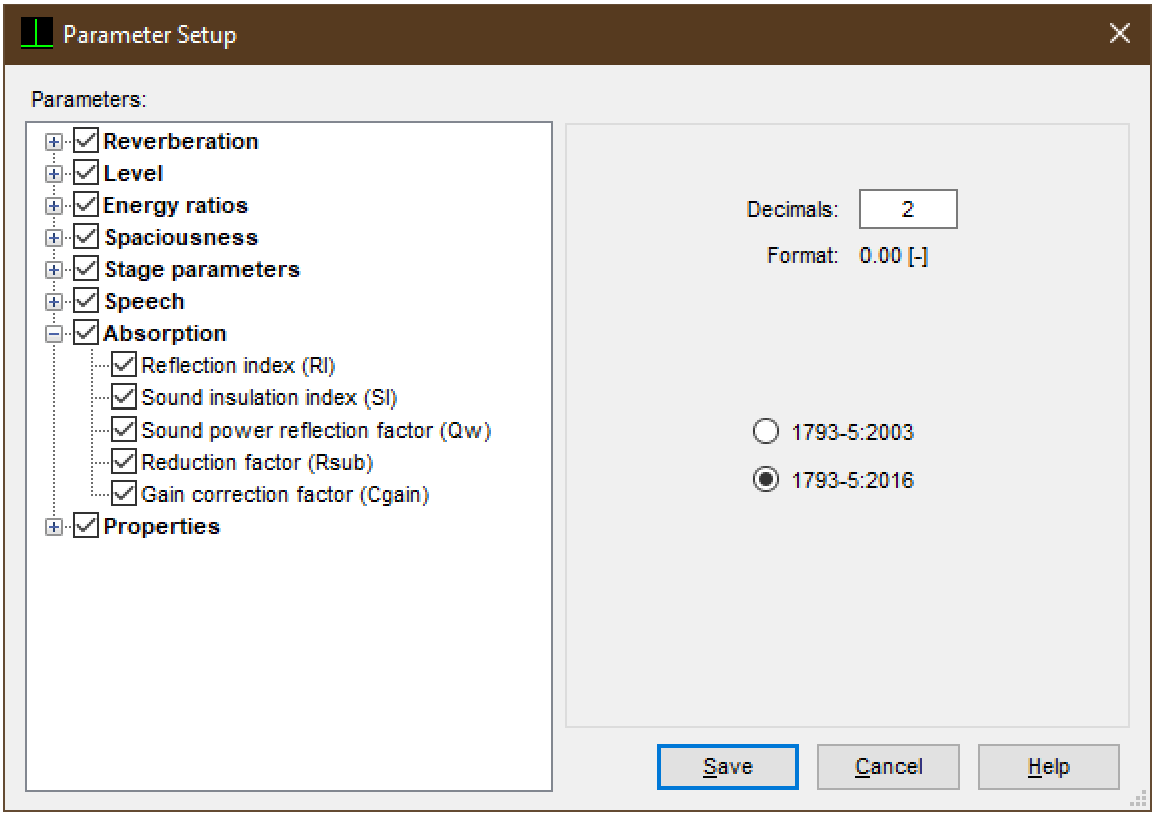
The next step is to rename the group from **New** to **Measurement**. Now we can import the reference measurements in the same way we imported the reflection measurements. In the example below we have used the Position field on the **User Info** tab of the **Measurement window** to get the 'ref' in the filenames for the reference measurements. However, this is optional and Dirac will generate unique names for the reference files if needed.



The group **New** should now be renamed to **Reference** and the files containing channel 10 can be removed from the groups.

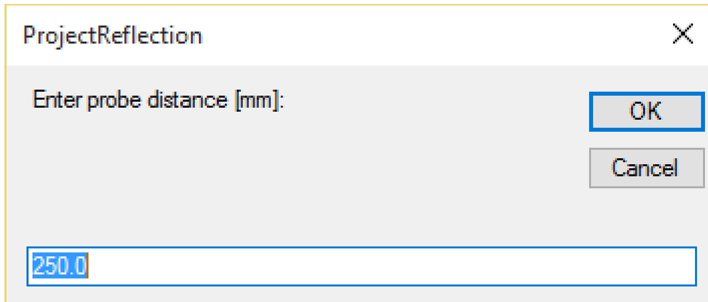
Processing the measurements

Because the calculations in EN 1793-5:2016 have changed, Dirac needs to be setup so that it uses the correct procedures. This can be done in the **Parameter Setup** window, which can be found on the **Setup** menu.



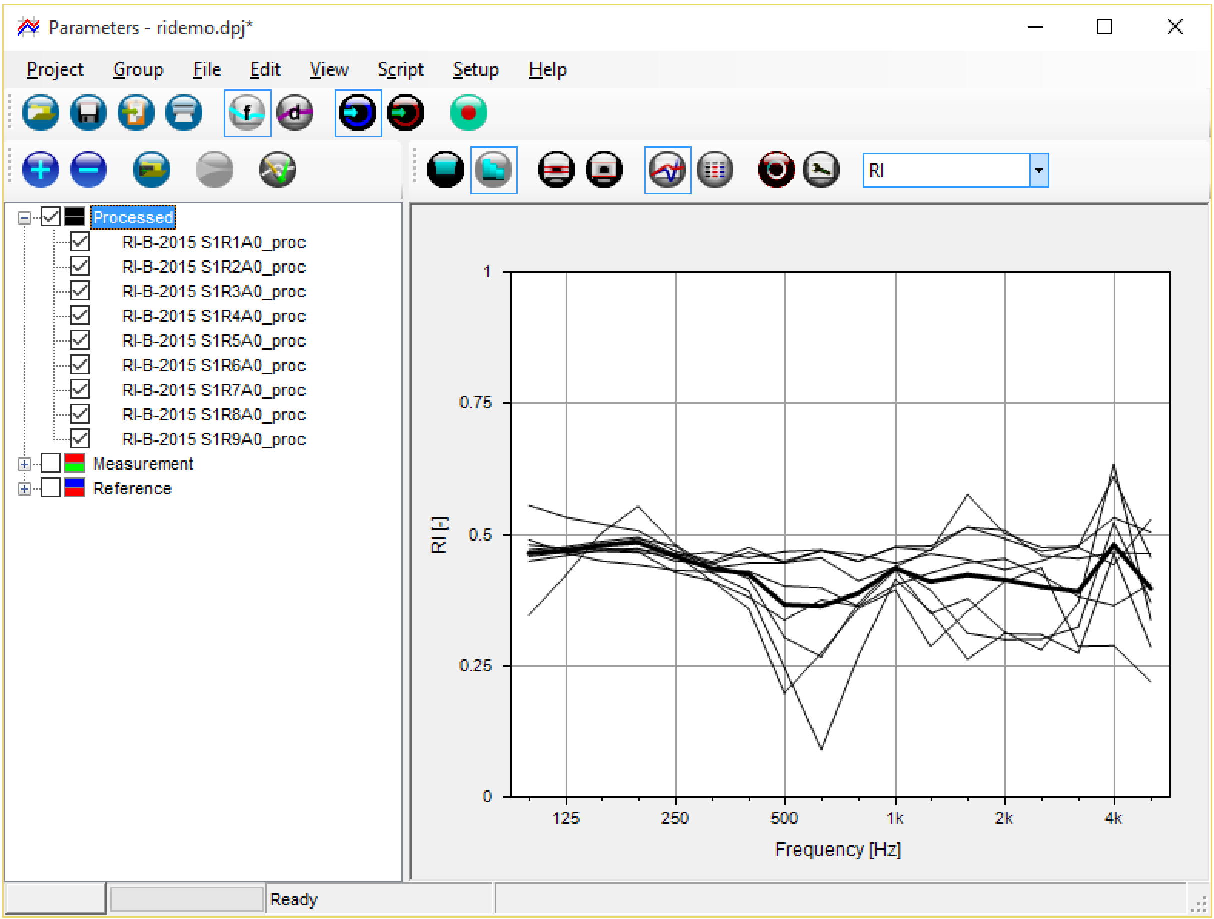
Select the **1793-5:2016** option for the calculations from the standard.

The current version of Dirac supports the subtraction technique for single measurements only, as explained in the help file. For the purpose of the new standard, a script was developed to perform the subtraction technique on all 9 measurements. The script is named **ProjectReflection** and is available on the **Script menu** in the project window after the script file 'ProjectReflection.py' is copied to the **Plugins** folder. The script will execute the subtraction method on the files in the project. It expects to find a group named **Measurement** and a group named **Reference**, each containing at least 9 files with **Receiver** numbered from 1 thru 9.



When you start the script you will first be prompted to enter the distance between the microphone array and the surface under test in mm.

The result is a new group called **Processed** in the project containing 9 files, each with a channel for the result of the subtraction and a second channel for the reference. Each of these files has the name of the corresponding reflection measurement file with the suffix '_proc' appended.

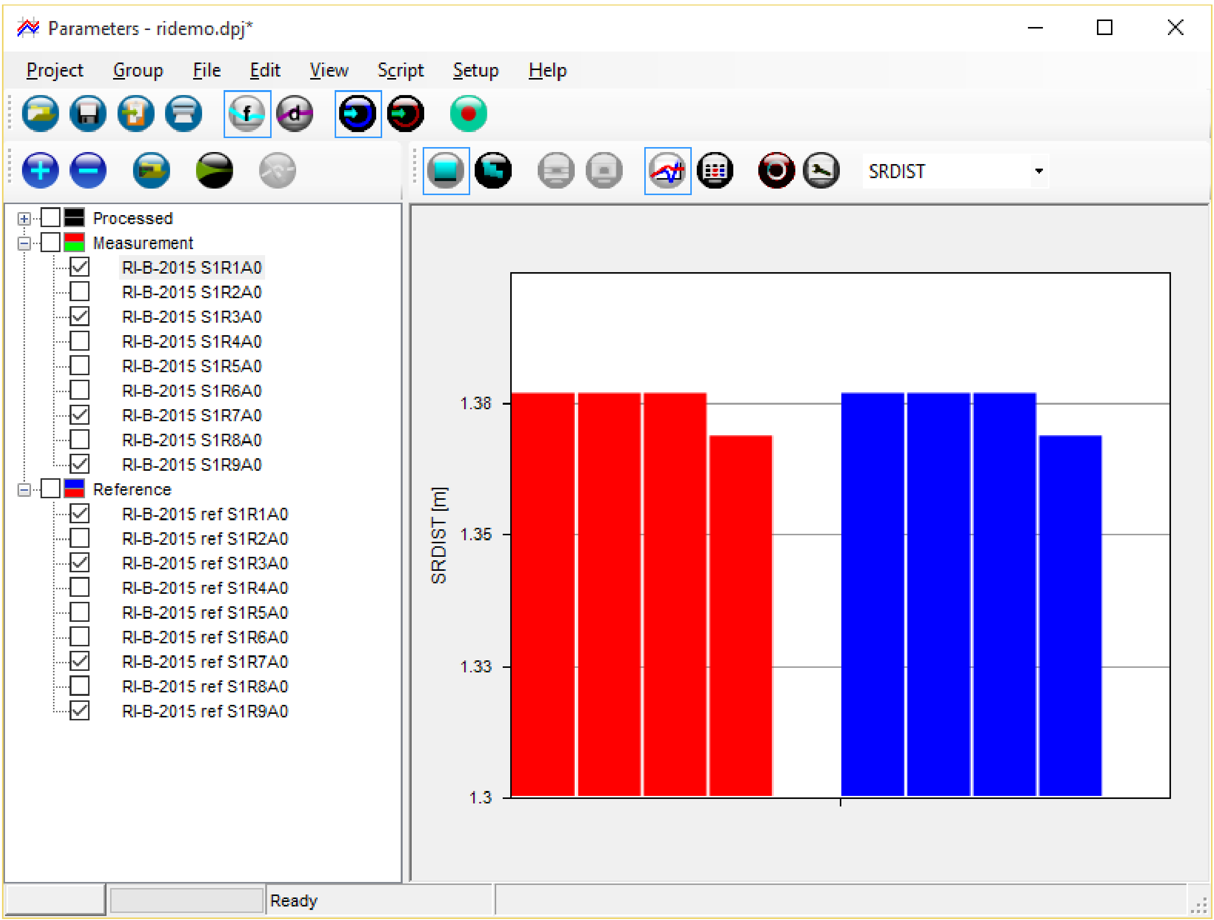


Checking the measurements

In EN 1793-5:2016 several checks are described to verify the correct positioning of the microphone array and the quality of the signals.

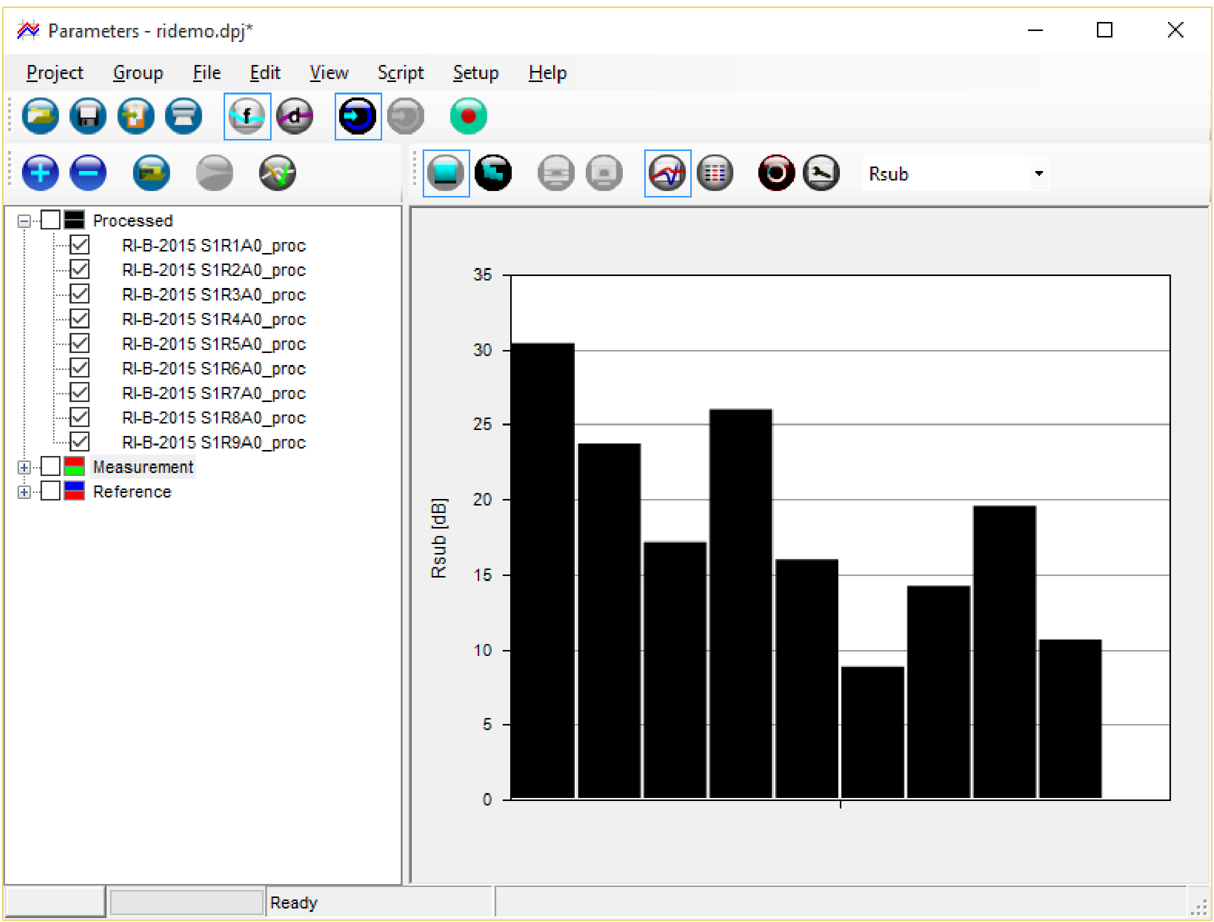
Source-Receiver distance

To check the correct positioning of the microphone array in relation to the sound source, we can look at the source receiver distances calculated from the impulse responses. Select the SRDIST parameter and select a bar graph. Only microphones 1, 3, 7 and 9, at the corners of the array, need to be considered. The source-receiver distance for these microphones should be 1.37 m ± 0.025 m.
Note that this check should be performed on the **Measurement** and **Reference** groups, not on the **Processed** group.


Parameters - ridemo.dpj*
Project
Group
File
Edit
View
Script
Setup
Help
SRDIST
Processed
Measurement
RI-B-2015 S1R1A0
RI-B-2015 S1R2A0
RI-B-2015 S1R3A0
RI-B-2015 S1R4A0
RI-B-2015 S1R5A0
RI-B-2015 S1R6A0
RI-B-2015 S1R7A0
RI-B-2015 S1R8A0
RI-B-2015 S1R9A0
Reference
RI-B-2015 ref S1R1A0
RI-B-2015 ref S1R2A0
RI-B-2015 ref S1R3A0
RI-B-2015 ref S1R4A0
RI-B-2015 ref S1R5A0
RI-B-2015 ref S1R6A0
RI-B-2015 ref S1R7A0
RI-B-2015 ref S1R8A0
RI-B-2015 ref S1R9A0
SRDIST [m]
1.38
1.35
1.33
1.3
Ready

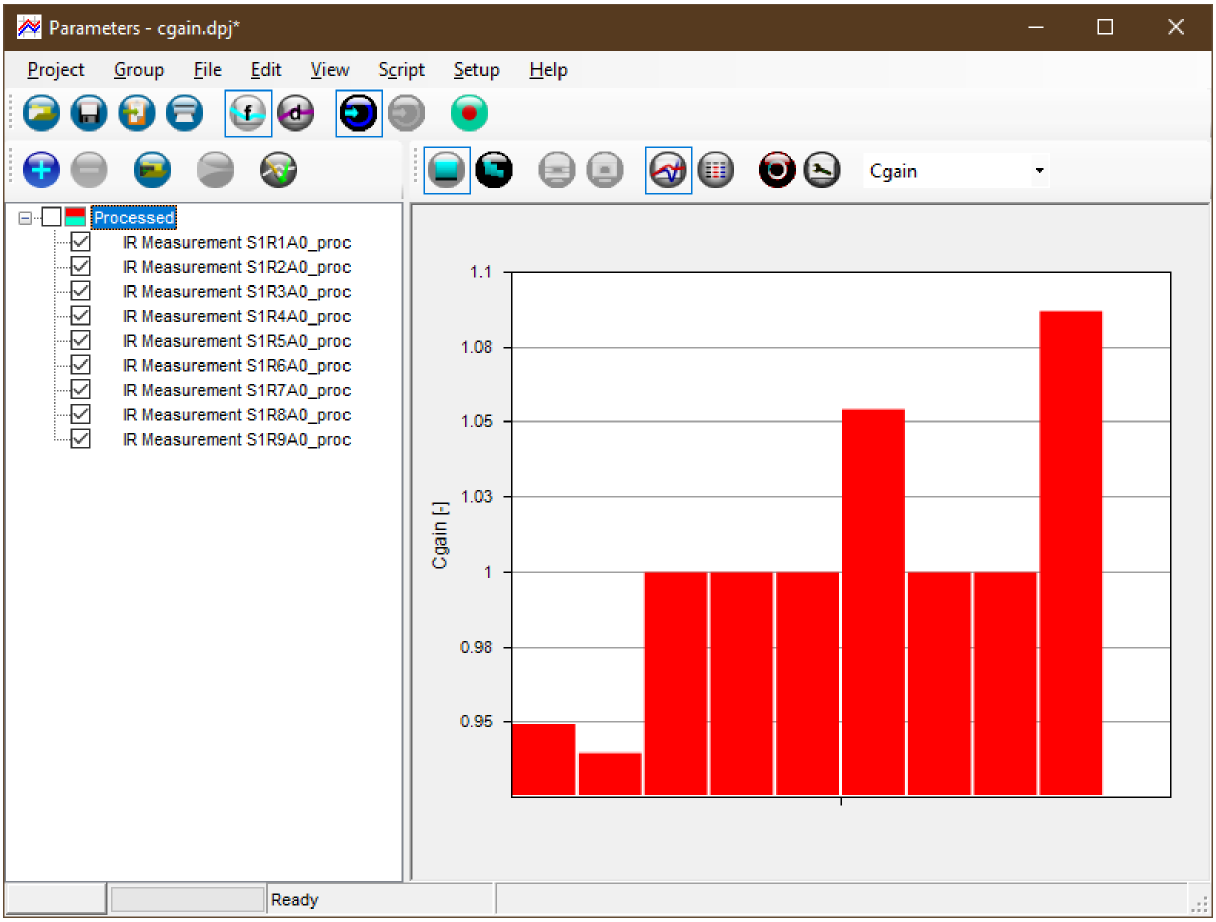
Reduction factor

The quality of the subtraction result can be judged with the help of the Rsub parameter. It should be calculated for the **Processed** group, and each file should have an Rsub higher than 10 dB.



Gain correction factors

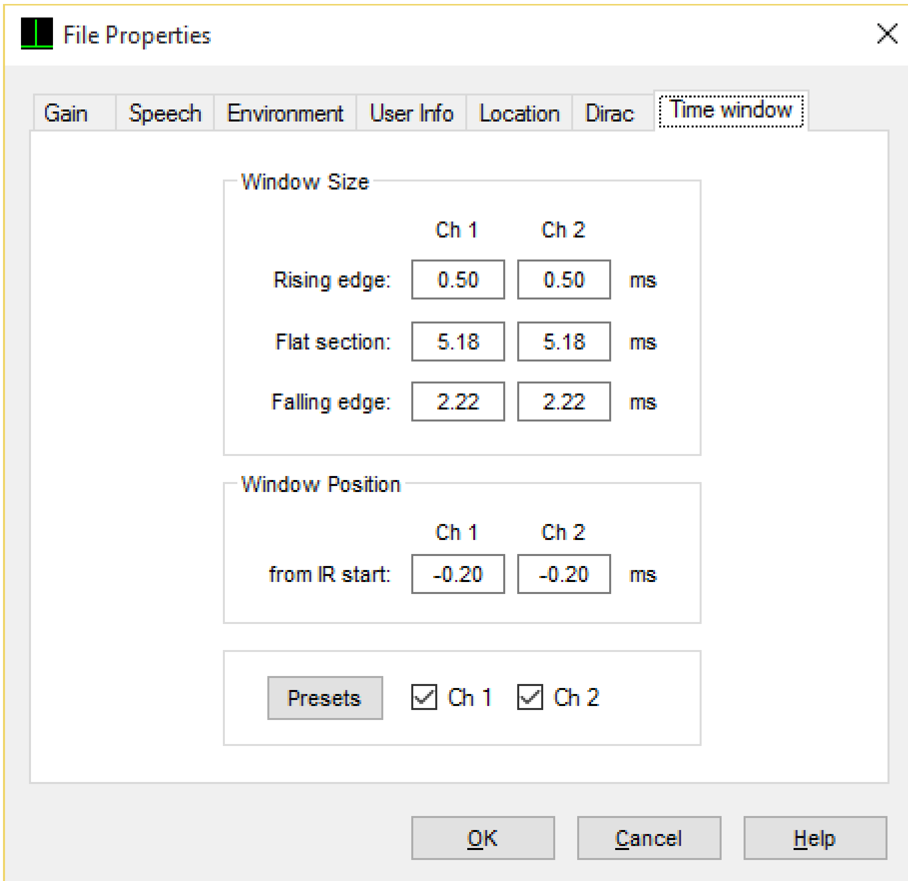
Any intentional gain change between reference and reflection measurements can be entered on the **Gain** tab of the **File Properties**, as usual in Dirac. The EN 1793-5:2016 standard introduces a new parameter (Cgain) to check for accidental level differences between incident components of both reference and reflection measurements. The parameter Cgain which represents the ratio between the incident waves should not deviate more than 20% from unity. If large deviations (>20%) are found, the measurement setup should be checked, and the measurements performed anew. Deviations smaller than 5% are ignored, and for these the Cgain is set to 1.



Setting the time windows

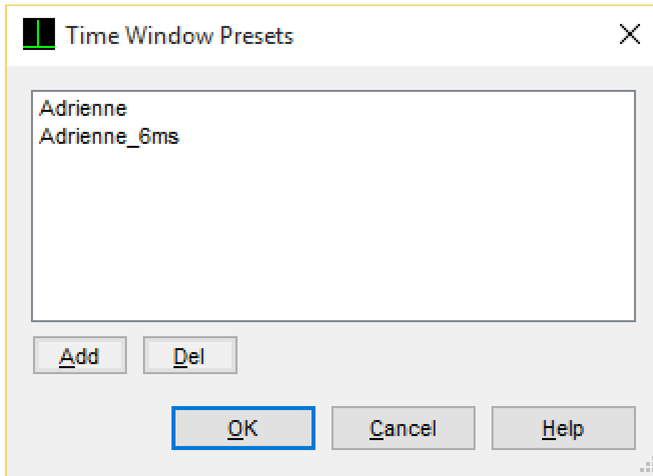
While performing the subtraction technique, Dirac assigns the default 7.9 ms Adrienne window to all resulting files. In most cases microphones 7, 8 and 9 also need to be evaluated with a shorter, 6 ms, Adrienne window. To set the time windows for all processed files at once, make sure they are all check marked and select **File Properties** from the **Edit menu** of the Project window.

On the **Time window** tab any Adrienne type time window can be specified. In most cases both channels will have the same time window. The default 7.9 ms Adrienne window is set after the subtraction processing.



To set another time window, modify the values on the **Time window** tab, or select a preset time window. To apply the preset to both channels, make sure that the check marks for CH1 and Ch2 are set. Then click **Presets** and select one of the preset windows.

You can add a new preset by setting the desired values on the **Time window** tab, and then click **Add** in the **Presets window**.



Using the EN 1793-5 spreadsheet

To average the calculated RI values for the 9 microphones, and to calculate the single number quantity **DL_{RI}**, a spreadsheet can be used. The spreadsheet uses the partial RI values calculated by Dirac and combines them with geometric correction factors, gain factors and source directivity values.

Three sets of data need to be transferred to the spreadsheet. The first is a set of the 9 partial RI values calculated with the standard 7.9 ms Adrienne window, and the second is a set of the 9 partial RI values calculated with a shortened Adrienne window of 6 ms.

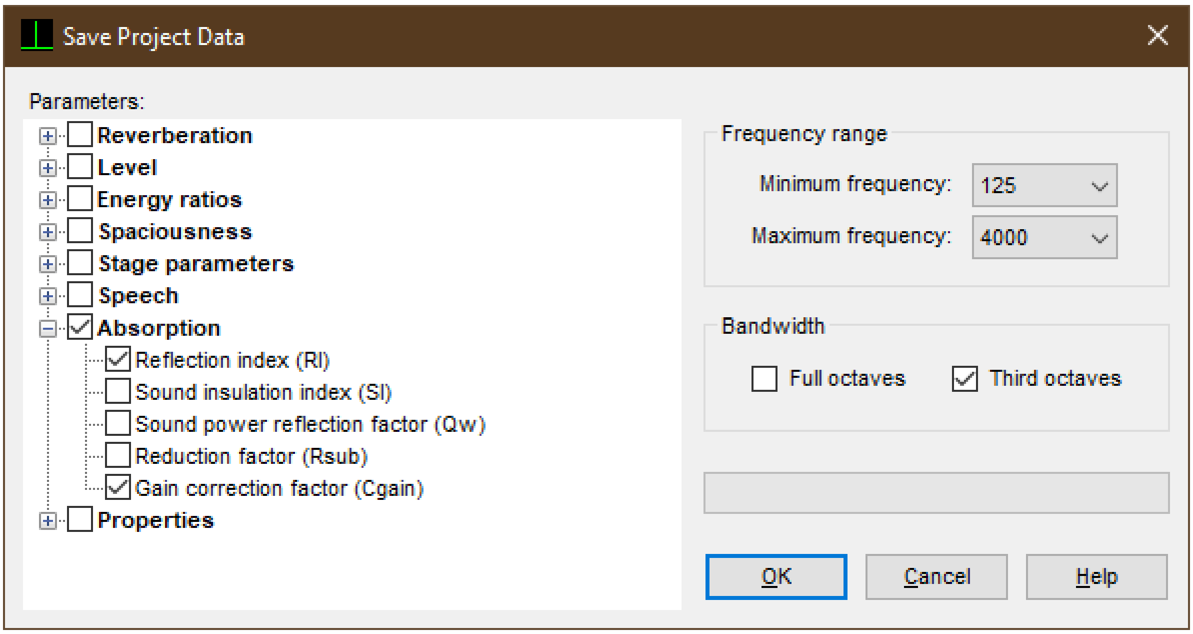
	Default Adrienne	*Shortened Adrienne*
Rising edge [ms]	0.50	0.50
Flat section [ms]	5.18	3.85
Falling edge [ms]	2.22	1.65
Position from IR start [ms]	-0.20	-0.20

In addition to the partial RI values, the Cgain correction factors can be exported.

Exporting the results

To transfer the values calculated by Dirac into the spreadsheet the **Save Data** option on the **Project menu** should be used. First make sure the **Reference** and **Measurement** groups are unchecked (or removed), with the **Processed** group checked. Then select the **Save Data** option and select only the

RI and Cgain parameters. Set the third-octave frequency range from 125 to 4000 Hz. This will export the data from the 100 Hz to the 5000 Hz third octave band.



The file containing the results calculated with the default Adrienne window should be imported into the sheet **Long**. The file containing the results calculated with the short Adrienne window should be imported into sheet **Short**.

Note that the spreadsheet will use the Cgain values from the **Short** sheet.

Source directivity

New in the standard is the use of source directivity data in the RI calculations. The spreadsheet contains a table with the directivity values of the Zircon. These values were the result of measurements performed in an anechoic room.

EN 1793-6:2012

The workflow described above can also be used for sound insulation measurements following EN 1793-6:2012.

The same hardware setup can be used to acquire 9 insulation measurements and 9 reference measurements.
The script named **ProjectTransmission** can be used, which is available on the **Script menu** in the project window after the script file 'ProjectTransmission.py' is copied into the **Plugins** folder. This script will use the files in the **Measurement** and **Reference** groups to produce 9 new files in the **Processed** group.

The calculated **SI** values can be exported using the **Save Data** option on the **Project** window, and the resulting file can be imported into the EN 1793-6 spreadsheet to calculate the **DL_{SI}**.

Further reading

- EN 1793-5, March 2016, “Road Traffic Noise reducing devices – Test method for determining the acoustic performance – Part 5: Intrinsic characteristics – In situ values of sound reflection under direct sound field conditions”.

- EN 1793-5:2016/C1:2018, August 2018, Corrigendum concerning the Cgain calibration.

- EN 1793-6, November 2012, “Road Traffic Noise reducing devices – Test method for determining the acoustic performance – Part 6: Intrinsic characteristics – In situ values of airborne sound insulation under direct sound field conditions”.

- M. Garai, P. Guidorzi, “Sound reflection measurements on noise barriers in critical conditions”, accepted for the publication on Building and Environment, (2015).
DOI: http://dx.doi.org/10.1016/j.buildenv.2015.06.023.

- M. Garai, E. Schoen, G. Behler, B. Bragado, M. Chudalla, M. Conter, J. Defrance, P. Demizieux, C. Glorieux, P. Guidorzi, “Repeatability and reproducibility of in situ measurements of sound reflection and airborne sound insulation index of noise barriers”, Acta Acustica united with Acustica, 100, 1186-1201, (2014). DOI:http://dx.doi.org/10.3813/AAA.918797.

- P. Guidorzi, M. Garai, “Advancements in sound reflection and airborne sound insulation measurement on noise barriers”, Open Journal of Acoustics, 3(2A), 25-38, (2013).
DOI: http://dx.doi.org/10.4236/oja.2013.32A004.

Acoustics Engineering develops systems for the prediction and measurement of acoustical parameters, resulting in user-friendly tools that enable you to perform fast and accurate acoustical measurements and calculations.

For information on our products, please contact

Acoustics Engineering	Email:	info@acoustics-engineering.com
	Phone:	+31 485 520996
	Mail:	Acoustics Engineering Groenling 43-45 5831 MZ Boxmeer The Netherlands
	Website:	www.acoustics-engineering.com

Brüel & Kjær is the sole worldwide distributor of Dirac. For information on Dirac, please contact your local B&K representative or the B&K headquarters in Denmark:

Brüel & Kjær	Email:	info@bksv.com
	Phone:	+45 45 80 05 00
	Fax:	+45 45 80 14 05
	Mail:	Brüel & Kjær A/S
		Skodsborgvej 307
		DK-2850 Nærum Denmark
	Website:	www.bksv.com