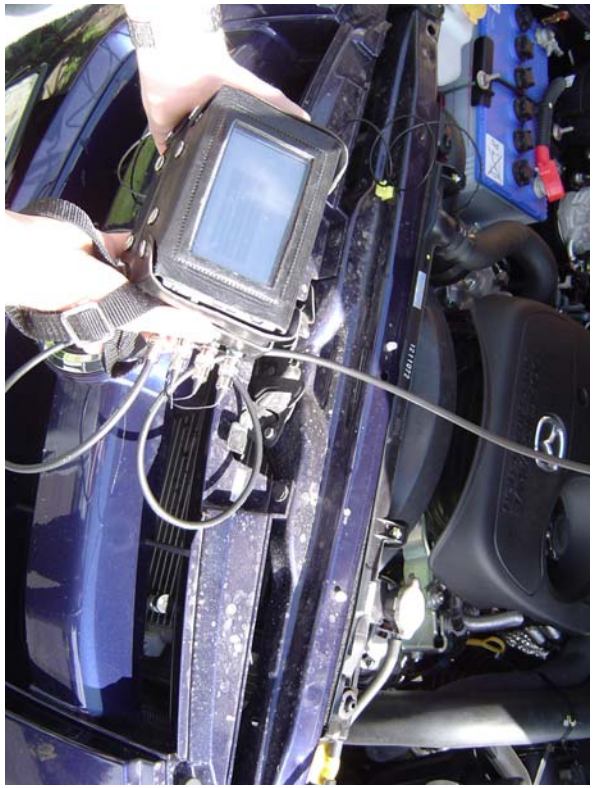
Bay Systems 09

Noise and Vibration Systems, services and facilities.



Contents

Bay Systems' Mission statement.

To provide effective NVH solutions; that increase productivity by being :-

1. Easy to learn and use; they should help do a job not become the job.

2. Application focused; they should provide the answers that are needed not more data.

3. Affordable; both to purchase and maintain.

Making better products is about communication of:-
Ideas,
Designs,
Prototypes,
Test Results,
Customer Reactions.

Facilities and systems play an important part in this process by providing reliable numbers upon which decisions can be based.

Reliable numbers are not the automatic result of testing. They are only produced when systems, technicians and engineers are working in harmony with each other.

The user interface and how it relates to the job is the key to a more productive working environment. A stable design, that is easy to understand and use, is the basic requirement.

For acquisition the BARS software system puts every control within two mouse clicks and every graph is easily found and understood.

Better Faster Cheaper is the request.

In the data acquisition market many suppliers have retained an outdated high cost business model that is no longer justifiable. Software can be written using new development technologies that does operate properly and does deliver the answers you need without the vendors support engineer sitting on the end of your desk!

The digital revolution primarily in mobile telephones and personal entertainment technologies mean that what was rare and expensive is now essentially available for little more than the cost of the packaging!

We offer solutions to both low and high channel count data acquisition, importantly we offer them at a purchase and through life support price that all customers can afford.

BARS Micro System

- 24 bit ADC
- Parallel sample and hold
- IEPE 2ma transducer power
- Anti-alias protection
- AC/DC coupling
- Tachometer input
- Trigger input
- Analogue output
- ...

Channel counts from 4 and a card configuration to suite most applications.
All of the nVision post processing and specialist modules work with the BARS micro-system and the Sony EX gathered data. If your company needs specialist signal conditioning or large channel counts then the Sony EX is the correct choice but for the regular jobs that make up most of the work that we all do then the BARS micro-system is the right choice.

Sample rates on all channels up to 225,000 samples per second per channel to disk on a note book PC.
The slowest card samples at 52kHz per channel – fast enough for most NVH work.
All cards sample at many lower rates to suite all applications and conserve disk space.

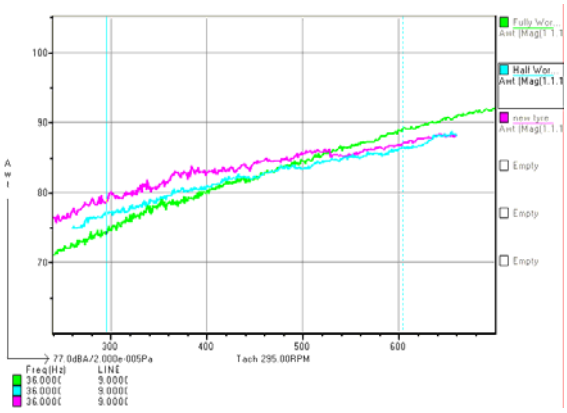
Taking data in the field and in the laboratory.

In car recording

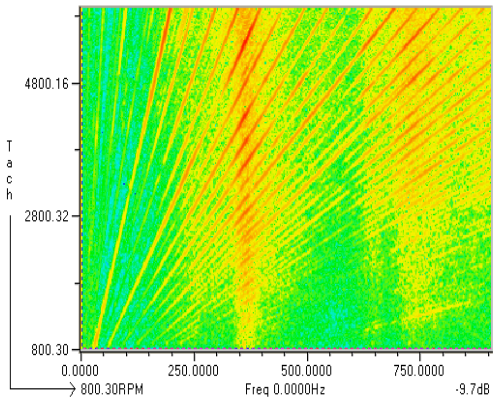
Sound power testing

EXtra-Vision is the combination of BARS hardware and nVision. The BARS system is the most capable hardware platform to be fully integrated into nVision. The software that controls the hardware was designed and written by the engineers who have designed, written and maintained nVision. The proven application modules of nVision are natural choice for post processing BARS.

Tyre noise testing



Tyre noise performance as a function of wear



Order plot

Data Acquisition BARS

Features of the BARS hardware:-

1. Excellent 24 bit ADC

2. Sample speeds to 52kHz per ch.

3. Ultra small package size

4. Light weight < 500g

5. input / output options:
   Voltage with IEPE
   24 DAC output

7. Power supply independence.
   Power from P.C. USB

8. From 4 to 192 channels.
   In 4 and 8 channel modules

8. Best price structure in market

9. Low cost of ownership
   6% annual support contract.

Benefits of owning the BARS

No time wasted re-taking data due to the excellent dynamic range & sampling capabilities of the hardware.

Easy to carry & support safely; will fit in the slimmest briefcase and stow in the overhead aircraft locker

Capture any NVH signal first time from voltage and IEPE transducer with no external boxes.
Reduces clutter and guarantees the calibration accuracy

With the micro Vaio PC you will get > 1 hour recording with no external power.

Replay what you have recorded into headphones, speakers or shakers.

Direct excitation of structures for FRF and other transmission test measurements

Use it anywhere with confidence

Start small at low cost and grow as your needs expand. Swap 4 channel modules between measurement groups for true flexibility.

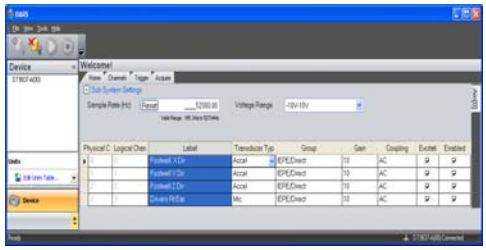
Quality measurements even when budgets are tight.

No hidden costs – probably the lowest cost of ownership in the industry.

The acquisition software BARS

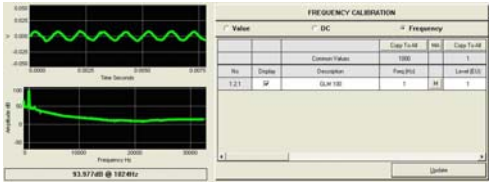
Only buy what you need; there are no upgrade penalties and what you need is sensibly priced.

BARS – Standard.



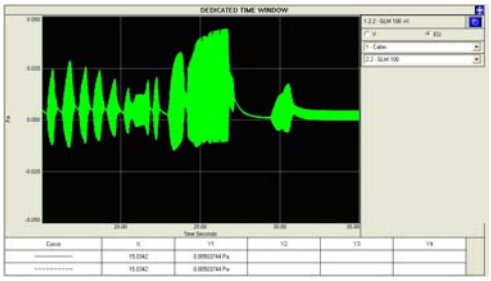
This software is always supplied with the hard-ware and is included in the purchase it : -

- Sets up all the channels using a layered panel with copy and paste for speed.

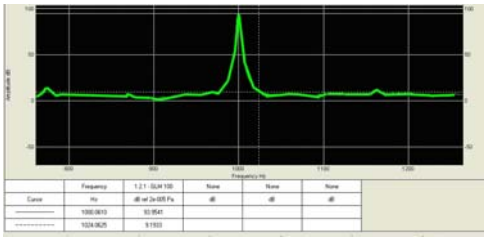


- Validates the inputs channels using an auto-matic multi-channel display.

- Calibration of channels individually or in groups.
- Triggering on all inputs on level and time
- Time history display with over-view



- Frequency display with 95– 65,000 spectral lines.
- Full control over the displays while re-cording to disk



- Large choice of output file formats available

Additional Bars software modules include:
Advanced online signal processing including FRF, Coherence, Correlation ……

Solutions for common tasks

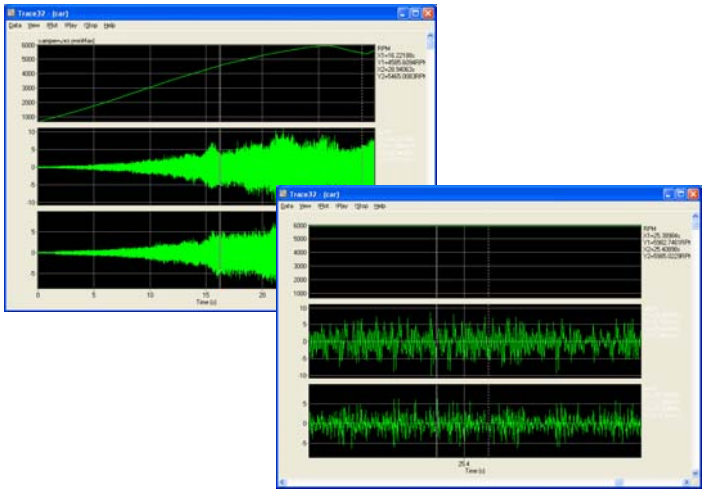
Recording signals for playback or analysis

A variety of solutions are available: -
Sound card – The sound card driver and calibration routine is shipped in every nVision system.

Data Translation USB acquisition card - a low cost multi-channel front end. The open layers driver makes this solution a very affordable multi-channel acquisition system.

BARS – a modular high performance front end with a range of inputs possible.
Data objects created are imported automatically into nVision

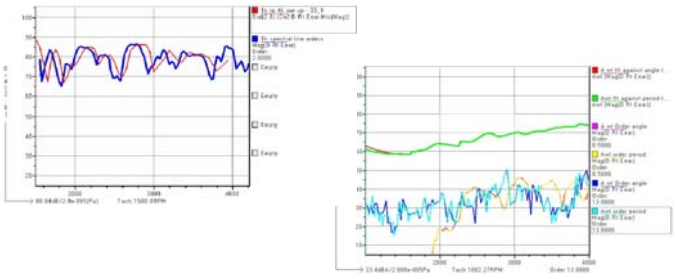
Once the data is recorded it can be viewed in the Trace display, again standard in the Base nVision system. Up to 256 channels can be accepted. The number displayed can be as large as the screen resolution permits. Simply dragging the solid cursor "zooms" the display
Times marked by the cursors can be edited and new data objects created. When using the BARS where large numbers of channels might be recorded the input dialogue allows for selected channels and events.



Clicking on the PLAY button causes the selected channel to play through the PC's sound card. Choices include mono, Stereo and back to back. This simple arrangement makes sound quality evaluation possible when using good quality headphones.

When undertaking a new project it is a good idea to try at least two measurement and analysis techniques to prove that the results are not a product of a certain approach. The correct answer should be independent of the measurement/analysis method used to obtain it. nVision provides a wide range of acquisition, filtering and analysis techniques. The principle choices :

Bandwidth
window function
FFT size
Tacho processing
Averaging type.

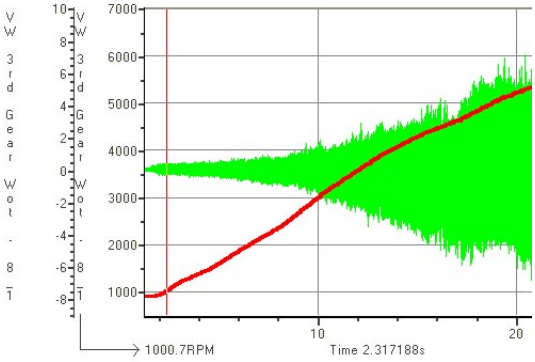


The two traces on the right are analysis of the same engine run up using two different analysis techniques. The original data was unwittingly under sampled, this led to a severe tacho pulse jitter. The effect of jitter in the tacho pulse train is to mask the true instantaneous rpm. If the true rpm is not known then the FFT block with the correct order data cannot be reliably selected. The result is the wrong values in the orders and even for overall level. The 2nd order trace demonstrate that these errors can be significant and will make comparisons invalid.

Analysing data
Presenting the results

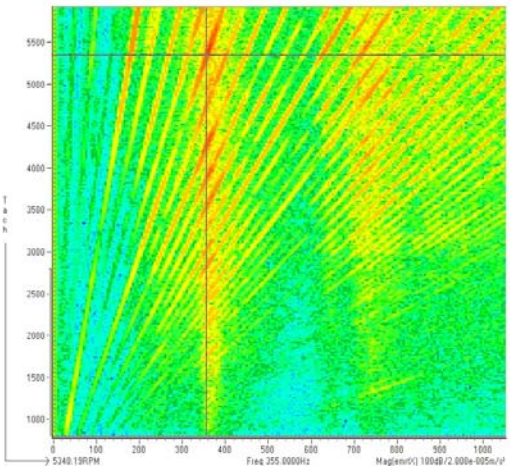
nVision-Standard

All the basic and advanced 2 & 3D displays plus the advanced signal processing capabilities needed by everyone analysing data. In addition to what you might expect there are also a powerful set of tools that allow you to manipulate the data. These include the standard acoustic and vibration weightings A,B,C,D, Whole Body and hand Arm.



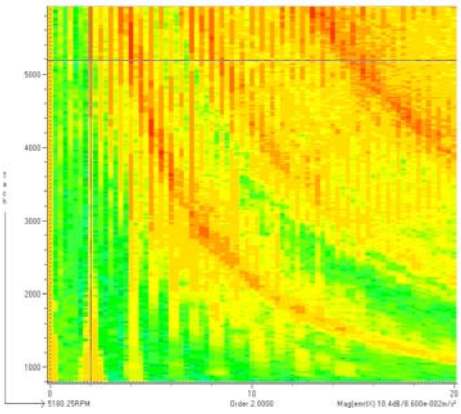
Signal overlaid with the rpm profile

An important aid to productivity is the ability to synchronise the way different data sets are viewed. It is normal to want to compare precisely the same point in a number of events. If this has to be found in four independent data sets containing three or four hundred spectra the task will become tedious and with tedium comes error. nVstan contains the standard tacho pulse processor that converts a tacho pulse train to an rpm profile. The data produced can then be displayed with order cursors.

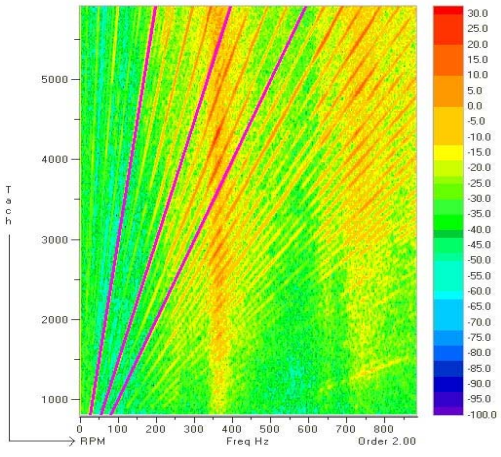


Spectra at every 20 rpm plotted as a colour map; the orders are clear to see.

The order cursors, shown bottom right, provide a quick and easy way to identify orders and the critical spacing between orders. Once the important orders and their separation is established the full order set can be successfully extracted from the FFT data and presented, see the figure, bottom left.



Order map shows orders as straight lines

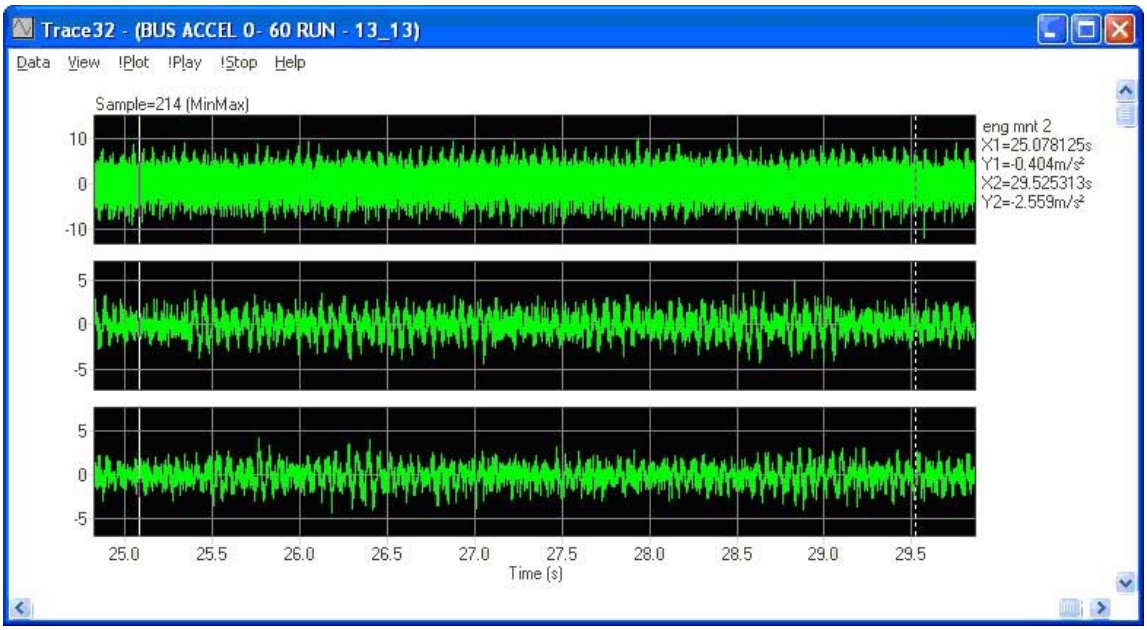


Order Cursors help identify the orders

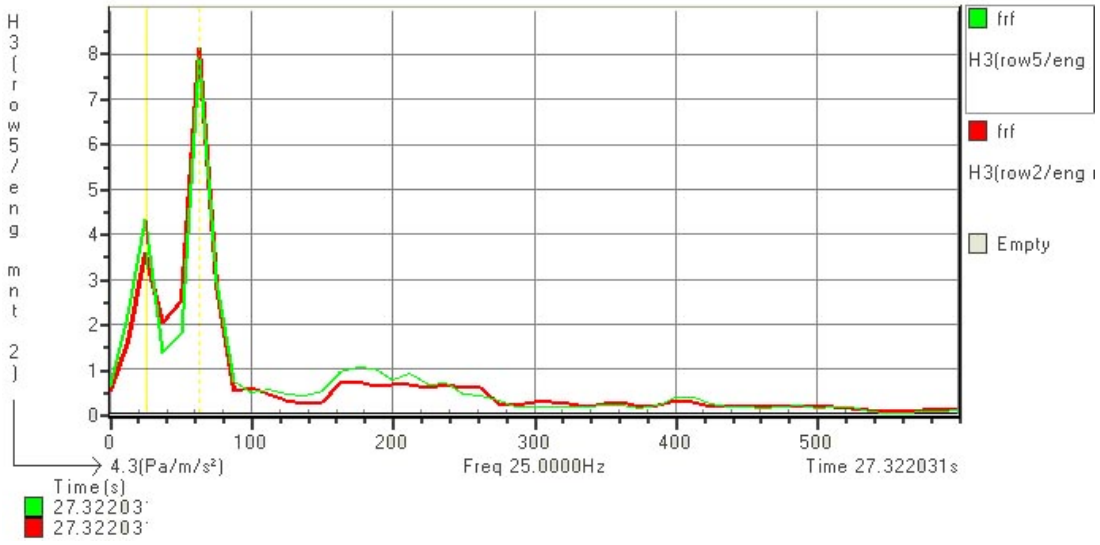
Solutions for common tasks

Performing Frequency analysis

BARS has a standard FFT capability giving Magnitude, Power Spectrum and Power Spectrum Density in narrow band and 1/3rd octave presentations. The time history can be stored to disk allowing the data to be post processed. It is common practice for the definitive analysis to be completed using recorded rather than live data. The ability to record to disk while viewing results on the screen is very important to many users. The basic FFT capability of the BARS is then all that is typically required to confirm the quality of the recorded data. BARS advanced signal processing and display modules are available that allow additional online capabilities. The two figure below shows the typical engine mount acceleration (channel 1) and two microphone responses. The upper figure is the time history and the bottom the acceleration to sound pressure level "Transfer Function".



Time history

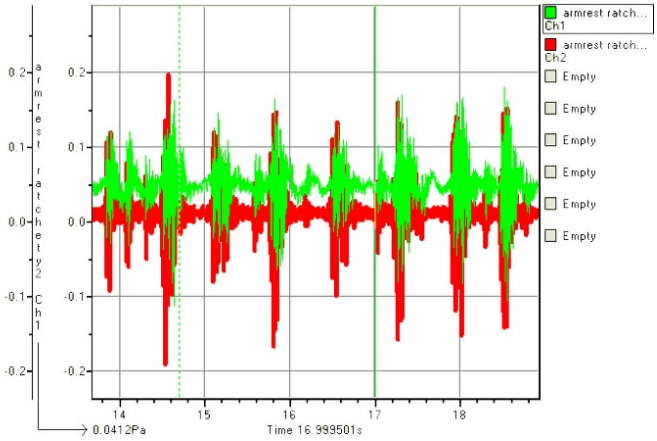


Transfer function

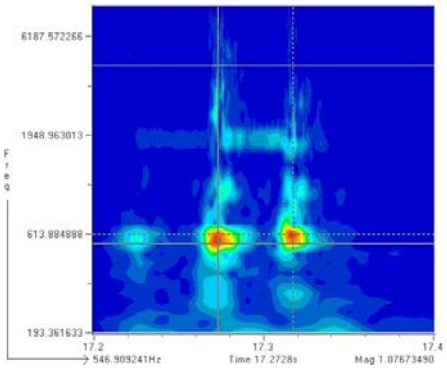
Solutions for common tasks

Time/Frequency Analysis– Wavelets

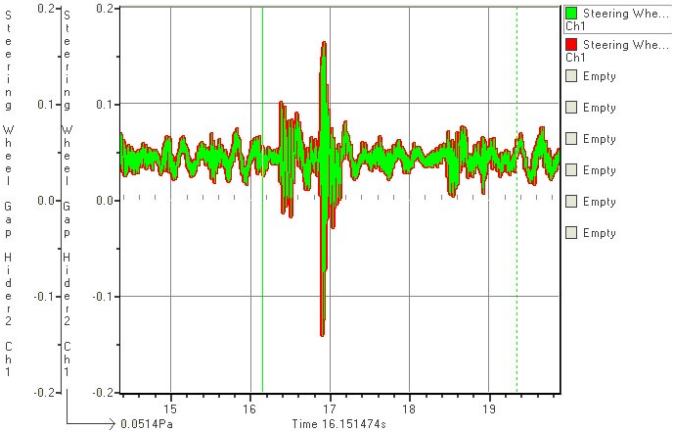
There are many possible applications for wavelet analysis; one that has been a success is the "finger printing" of Buzz, Squeak & Rattle (BSR) noises in cars and other products. The nVstan bundle provides all the acquisition and processing needed. A short training course is also available.



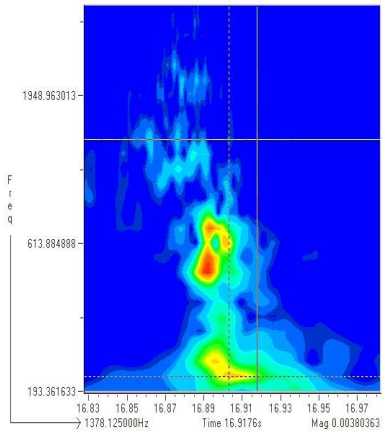
Time history of armrest squeak



Armrest wavelet display



Time history of steering wheel gap hider



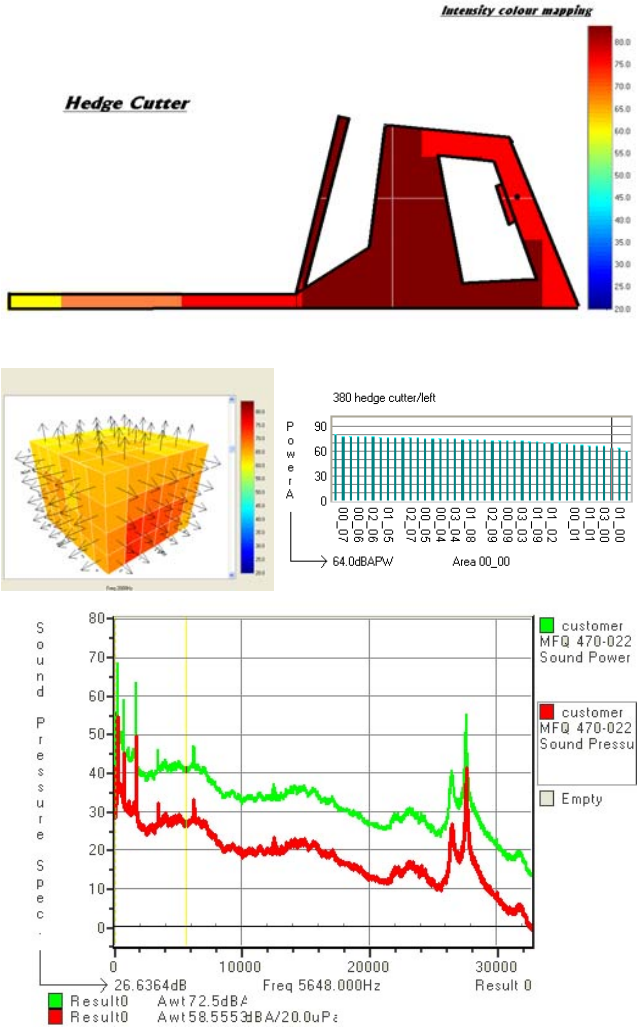
Steering wheel gap hider wavelet

The two time histories are similar but the wavelet plots are clearly different. Wavlet plots allow the event to be represented in a meaningful way and comparisons made before and after a "cure" has been applied. For companies manufacturing products around the world the wavelet plot together with a sound file will provide a definite record of the problem and aid production facilities in finding and eradicating defects. The wavelet plots can be tuned to be very sensitive to damping in a structures response. This means that in an automotive application sample doors can be tested to check on quality.

Solutions for common tasks

Sound Power and Sound Intensity

Sound power measurements are made in the genuine free field, a reverberant, semi or fully anechoic room. For the UK the free field i.e. out of doors measurement is impractical due to aircraft noise and the ever present chance of rain. Bay Systems designs and builds economical semi-anechoic chambers that achieve very low background noise levels; e.g. NR20 when the ambient exterior noise level is 80+ dBA. The sound power acquisition system is a simple to operate module that requires only an averaged sound pressure level data object to be dropped into it.



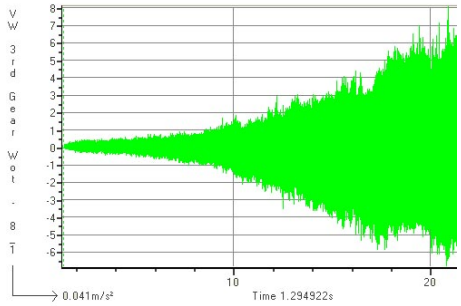
software accepts data from B&K and Larson Davis analysers. These more expensive laboratory grade systems are still a less expensive alternative to building a semi-anechoic chamber. The workshop standard probe with notebook sound card offers repeatable measurements for less than £6000.00. This solution is ideal for the smaller company or where the primary need is to track effect of engineering changes on sound power radiated.

The alternative to building or renting time in a semi-anechoic room is to measure the acoustic intensity vector and hence deduce the sound power. In principal sound intensity measurements can be made in any stationary sound field where the local environment is not close to reverberant. The best option is usually to move the product to be tested to a quiet open field. To make measurements in an open field requires a fully portable, battery powered solution. The nVision solution uses the sound card built into a notebook computer. For this to work the response has to be normalised. The low cost (workshop quality) sound intensity probe includes a white noise source for this purpose. This configuration enables a sound power probe to be supplied for less than £1500. Where budgets allow the nVision sound intensity

Analysing difficult data

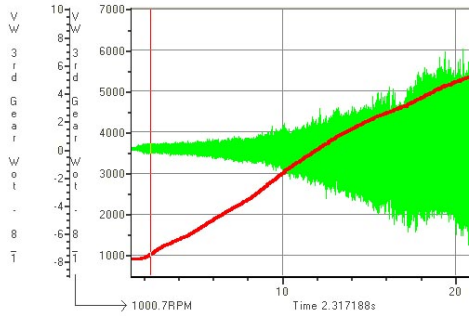
Data from rotating machinery will occasionally be difficult to analyse for at least one of the following reasons: -

- The tacho pulse train is missing
- The tacho pulse train is poor
- The run up/down is very fast

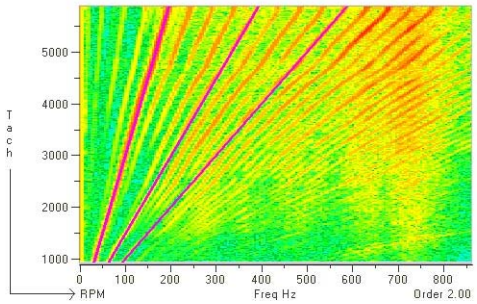


Raw time history

This data was taken when there was no tacho available



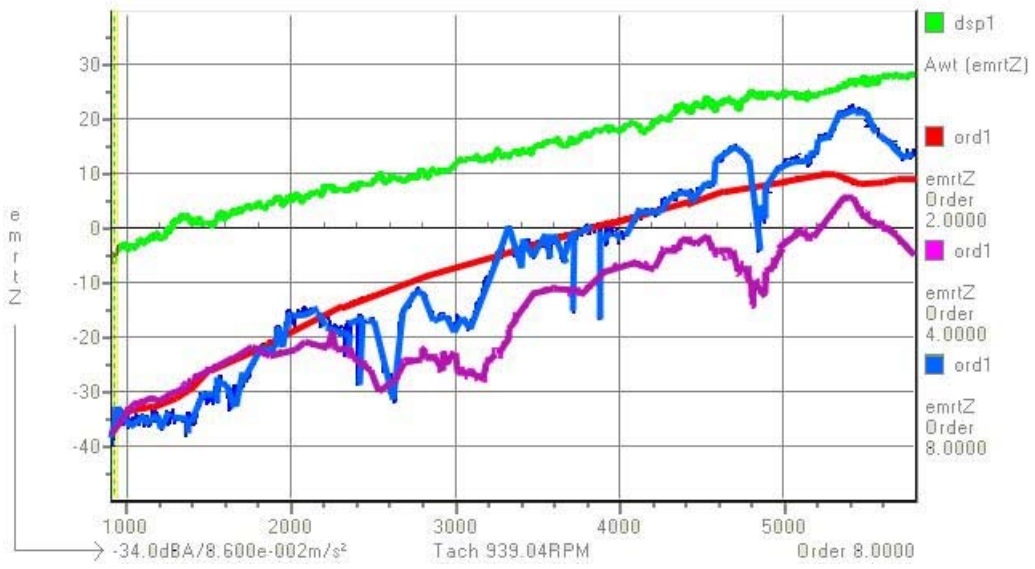
Synthesised rpm profile



Contour plot with order cursors

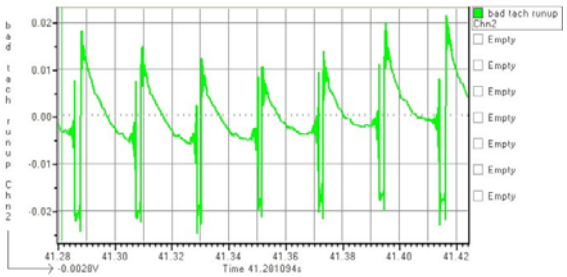
The sequence of events is: - the raw signal with no tacho pulse train, the synth tacho module produces the red rpm profile which is used to compute the rpm referenced colour contour plot that is shown above with order cursors.
The raw data is now A weighted and the A weighted overall level is plotted against rpm. Superposed upon this result are the levels of a number of A weighted orders. For this vehicle, like many others, the 2nd order levels are not necessarily the most important after A weighting is applied.

NB. Levels are uncalibrated



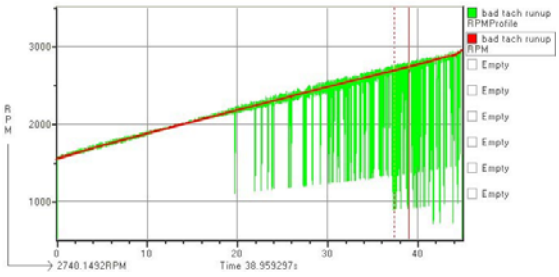
Analysing difficult data

Angle domain and time series editing help to recover good order plots from very poor data. The original tacho may have various defects such as changing level and missed pulses. These can be corrected by hand in some cases but doing so is very time consuming.



The pre-pulse spike and the slow drift away of tacho level make this a very difficult pulse train to process. This type of diesel fuel line sensor is not commonly used in the laboratory but is fast to fit when benchmarking competitors vehi-

The angle domain tacho module allows for missed and extra pulses and rejects pulses that would cause an instantaneous acceleration beyond a user set limit.
The red trace is the result of an angle domain tacho the green is a normal period tacho with quadratic smoothing.



The rpm profile calculated using a standard period estimator is shown in green. The red rpm profile has been generated using the Angle Domain technique.

Angle domain editing is a way to remove unpleasant valve train and piston slap noise from an engines signature. By doing this a development engine, with a correctable defect, can be fairly evaluated. The module will remove and substitute a better/worse section of time history data on a cycle-by-cycle basis irrespective of how fast the run up is. In the example below the piston slap in the upper trace will replace the slap of another cylinder. As a result the engine can be listened to with and without the poorly performing cylinder/piston. Two bad pistons can also be inserted to demonstrate the noise from an engine built with two bad pistons.

Useful features

Systems on the market today typically have a host of features some useful and some less so; nVision is no exception.

Features	Advantages & Benefits
Import /Export of Files Read and write many file formats	Import and export data to lots of formats and so allow many people to share the data
Display of data records Graph module accepts irregular data	Plot 0-500Hz data on top of 0-10kHz data and see the whole 0-10kHz with the 0-500Hz neatly positioned on top.
Line types Graph modules have many styles, line types and thickness	Plots can be made to stand out regardless of the presentation media chosen.
Object sequencer Automatic object naming	Reduces the chance of misnaming the data. Produces accurate and logical file names.
Synchro Synchronises cursor position and view across data objects	For example when comparing run ups from a group of vehicles the exact matching rpm can be found with one mouse click allowing accurate comparisons to be made.
Weighting, Leq & noise dose For any frequency data block the overall Lin, A, B, C, D weights are added as additional information in the block.	Produce Awt and other wtd orders as required by many automotive manufacturers. The large choice of weighting functions allows the significance of acoustic data to be quickly assessed. Weightings can be removed (un-weight).
The actual weighting curve can be imposed on the data. Hand/arm and whole body vibration curves are also supplied. User defined curves can be easily added. Time domain A weighting is provided in the Leq module	Time domain weighting with Leq allows the calculation of noise exposure. The Noise dose module allows short recordings to be used to produce a full shift exposure calculation. If the desired limit is exceeded then the mix of exposures can be changed to allow the optimum working practice to be adopted. This can make an enormous contribution to efficiency in enabling a safe full shift to be worked even in noisy conditions.
DataBase Optional when saving data the user defined fields may be completed	Quality assurance ISO 9000 type record keeping is much simpler using a database. Finding data takes seconds rather than hours and all archived locations are recorded.
Channel Tools Add, subtract, multiply, divide and average one or more channels in a data record	Performing simple operations is often needlessly complex using some systems. This simple tool allows the basic manipulations to be completed by anyone. Averaging the output from 10 microphones when making a sound power measurement requires only two mouse clicks.

Useful features – continued

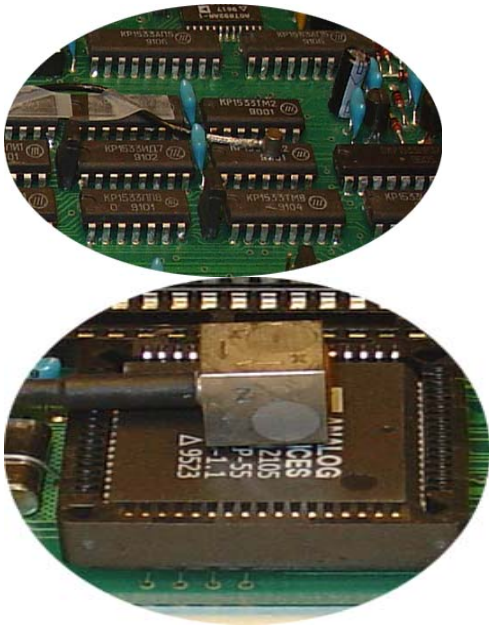
Features	Advantages & Benefits
Angle domain Tacho and editing Uses pulse arrival and other smoothing techniques to produce an accurate rpm profile even when the pulse train is very poor.	Allows excellent results to be derived from data with a poor tacho. Saves the time that would have been spent retaking the data.
Articulation Index & Sound Quality Calculates all the standard sound quality indicators used by the major motor and other manufactures in a straightforward manner	Articulation Index and other indicators make noise comparisons between vehicles easier. In general each indicator tries to mimic a human's reaction to noise. Loudness is always the primary indicator & the least subjective.
Kalman Filtering & Digital Order Tracking Extracts individual order signals from the composite recorded noise. The "sound" of each order can then be heard in isolation and re-mixed to form a "new" acoustic signature	Used with the Angle Domain Tacho to improve the quality of the tacho pulses this module will extract the Kalman order tracks where other systems fail. This means that results can be computed without repeating the test. The Digital order tracking output is in the order domain and allows very fast run ups to be analysed. Used with Angle Domain Tacho to recover very poor quality data.
Buzz Squeak and Rattle Fingerprinting The system produces reliable colour map fingerprints of BSRs.	Describing BSRs is nearly as difficult as finding them. The system provides a universally applicable method of identify BSRs. This has enabled OEMs and suppliers to work together to effectively remove them from their products.
Sound Power Calculates the sound power radiated by a product for n microphones and makes full allowance for the environment.	The dedicated module takes care of all processing needed producing the total sound power and sound pressure levels together with the averaged spectra. The module saves a considerable amount of time when compared to a manual calculation.
RASTI Rapid Speech Transmission Index is an alternative to AI (Articulation Index) for the assessment of speech intelligibility in a noisy environment. The system generates a test signal and then processes the measured response. The results are used to certificate public address systems on trains and in buildings.	The system can be run entirely from a note book computer. Provided the characteristics of the source and receiving devices are acceptable the results of each measurement can be stored to disk and analysed later. The availability of the measured data for archive is a major advantage of this system over an instrument based approach.

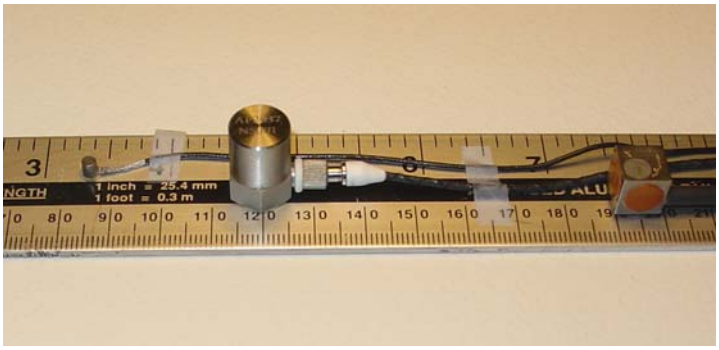
Useful features – continued

Features	Advantages & Benefits
Leq and time domain Awt Applies the Awt Computes the Leq directly on the time domain signal rather than the traditional method of using the FFT algorithm and subsequently weighting the result	Very fast and simple to use and you can see the original time history, its A wt overall level and the Leq in a single scrollable display.
Tacho-Generator Used to add a tacho signal to data where no tacho exists. The module Generates a tacho signal using an order identified in the colour contour plot produced from overlap FFT processing.	The module saves many hours by removing the need to fit a tacho sensor. The time spent in deriving an accurate tacho profile is less than 5 minutes while the time spent fitting a tacho is normally > 1 hour.
Calculate Hand Arm Vibration Legislation requires that operators of equipment are not exposed to high levels of vibration. The limit for an 8 hour day is 5 MS^{-2} .	CHARM accepts narrow band and third octave data generated by the Sony EX and other acquisition front end systems. The module calculates the exposure value for any number of channels and also tri-axial combinations. The resulting spectrum is available for viewing and the test result is produced as a printable html file.
Transmission Loss Calculates the transmission loss due to a material sample. The module is a calculator designed to remove any chance of error when making large number s of measurements.	Results are calculated reliably with minimum operator intervention meaning.
Watchdog Automatically imports defined data types as they are created on disk by an acquisition front end e.g. Sony EX.	The data you need is immediately in memory and displayed in the data list on the screen; ready for use – saves time and the tedium of loading files from disk.
Watchdog AI Articulation Index (AI) is a very useful tool in assessing the noise environment. This module automatically processes the raw time domain data gathered by a front end and computes the AI	Of particular interest to automotive engineers involved in wind and road noise testing as the AI value is computed quickly and easily direct from the time domain.
Module descriptions The tool bar document contains a description of every module in the nVision system.	Modules are members of a tool bar or as options to tool bars. The custom modules can often be configured with just the base tool bar making them very cost effective.

AP Accelerometers

The accelerometers have been developed to meet some very specific measurement challenges. Typical problems are the need for transducers of both small size and mass. The AP19 at 0.14 grams is tone of the smallest accelerometer available. Tri-axial measurements are often needed and the AP20 with maximum dimension of 1cm and mass of 5 grams is again one of the smallest accelerometers.
The AP range comprises both charge and IEPE types; typically charge types are slightly smaller.





High temperature and underwater environments are places where a standard accelerometer will exhibit a shortened life. The AP range includes 250 and 400 degree C transducers as well as an underwater design that is good for a depth of 50 metres. Cable length is the standard 2 metres but the cable can be supplied to any length up to 30 metres. The underwater designs include single axis at 10 gram and tri-axial at 6 gram.
Detection of defects using ultra-Sonics requires a transducer and the GT200 cover the 100-400 kHz frequency range.

Hand Arm and Whole Body accelerometers kits that include all the fittings for attaching and sitting are available.

Calibration and accessories.
The AT01 calibrator provides 159.2Hz giving a displacement of 10 micro-metres, velocity of 10mm/second and acceleration of 10m/s^{-2}
Mounting pads, charge converters and amplifiers are also available.

Microphones

MICROPHONES

The microphones and pre-amplifiers offered are designed to fill a gap that exists in the microphone market. Laboratory grade microphones with their associated pre-amplifier and power supply are available from reputable sources and usually have the following characteristics: -

1. The assembly comprises microphone capsule, pre-amplifier and a combined power supply and variable gain amplifier. The microphone capsule, with it's matched pre-amplifier, will be quite heavy typically weighing 100g and measuring some 7 cm long. Supporting this mass requires care and a robust clamp; particularly if the transducer is to be mounted in a vehicle.

2. It will have been manufactured and corrected for diffraction and other effects and be ideal for one of the following conditions : - Free field, Diffuse field or Pressure field. Usually you can use the microphone, with suitable correction in any of the above environments.

3. They are expensive > $2000 for capsule, pre-amp and power supply/amplifier.

4. They do not like to get wet.

5. They do not like to get hot > 50 deg C.

6. They are very accurate.

7. They are normally required to be inspected and subject to a broad range frequency calibration annually.

8. Before use calibrate with a calibrator costing approximately $500

The real world is a far different environment to the laboratory and the BAY SYSTEM microphones are suitable for this more robust environment :

1. The microphone is enclosed in a rubber housing and weighs 5g. The capsule is separate from the pre-amplifier by a 3 metre cable. The microphone can be attached using a clip similar to a tie clip to just about anything.

2. The microphone is set up for use in a diffuse field; this is what most sound fields in rooms and cabins turn out to be.

3. The microphone capsule costs < $200 and the pre-amp a similar amount and it is separated from the microphone by 3 metres of thin light cable. This means that the microphone can be replaced for $200. Although not an insignificant amount it is an amount low enough to allow an microphone to be risked.

4. Soak the microphone in a bucket of water; dry it with a hair dryer and it will be working fine.

5. It will work to specification right up to 60 degrees C and will still work at 125 degrees but may be 3 dB out. It will recover from being exposed to 125 degrees and will again work normally when calibrated.

6. Frequency response is flat to +/- 1 dB from 40Hz to 10kHz and +/- 5dB 20Hz to 20kHz. Most mechanical noise is within the 40 to 10kHz band and most results are quoted with a weighting factor, typically "A". This means that even though the Bay microphone is not in theory suitable as a microphone for use with a Class 1 sound level meter the results obtained for overall "A" weighted levels will be identical in 99% of cases.

7. No inspection or expensive annual calibration is necessary as there is no delicate diaphragm to damage, the microphone will be found to be working or not so by use of the calibrator. There is no failure mechanism that will allow it to pass at the calibration frequency, typically 1kHz, but give bad results at other frequencies.

8. The calibrator costs a $500 and will calibrate BAY and other standard microphones: 1 inch, ½ inch and ¼ inch.

Amplifier and Power Supply

Single and racked power supply with fixed or variable gain amplifiers are supplied to customer specification. Standard 2 channel amplifier battery powered modules are available in very robust IP65 enclosures. The pre-amplifier can be power by 10-40 volts DC; optionally a stabilised DC to DC converter can be added that will allow "dirty DC power source to be used.

Hemi-Anechoic Chamber using Bay Microphones.

Although the Bay Microphones have been tested for use in hot and wet environments they are also suitable for standard applications such as measuring Sound Power. The free field sound field found in a hemi-anechoic chamber is not the diffuse field that the microphone is designed for. This can be compensated for by simply pointing the end of the microphone capsule at the sound source. The data taken with the Bay microphone then agrees with the standard laboratory micro-

Microphones shown in a typical situation attached to the car's head restraint using the standard clips supplied with every microphone. Clipping the microphones to a hat enables recording of the driver noise while car is being driven.

Radio Linked Microphones

Two formats are available:-

1. **Mini Microphone**

The microphone transmitter package (58x52x30mm) is very compact containing an integrated microphone and/or a mini jack socket to allow an external microphone to be connected. In this form the radio link allows a microphone to be attached almost anywhere e.g. in a wheel arch to capture break squeal or inside the tyre to capture cavity resonances.

2. **Standard Microphone.**

ICP or the very rugged GLM100 microphone may be connected to the radio transmitter (1– 24 channels). Allowing precision measurements in buildings and other locations to be made without running cables.

General Specifications.

The radio link reduces the time taken to make measurements while removing the danger of tripping over cable runs. The radio link provides a flat transmission path with a flat (typically +/- 1dB) and a frequency response from 50Hz to 15kHz. The dynamic range of the link is 100 dB. The battery life is always greater than 8 hours and transmission ranges always >100 metres. When used with a standard receiving antenna typical range is typically 200+ metres; a high gain receiving antenna can extend range to 600+ metres.

Facilities

Acoustic Test Facilities (ATFs)

Making reliable measurements in the open air can be very difficult as they are subject to the vagaries of:- weather, aircraft, road traffic and farming noises. These factors work in unison to ruin either the measuring equipment or the measurement or both. In most companies a development program cannot accommodate the vagaries of weather and environmental noise. The need for an accurate acoustic testing facility to both certify the output of production and to guide the development process for new products is vital.

The timely completion of the project will control the ultimate success of the resulting product(s). Missing the market due to development delays can be one of the worst errors a company can make but it is not the only trap that the unwary manager can fall into. Throwing unlimited resource and money at a project will result in a huge up-front cost loading that might break the company or reduce the real profit from the products developed to zero. Spending too much on R&D and the facilities needed is as bad as spending to little and in some cases it is worse because the overspend can kill the company within a year while understanding often kills a company in five years or it may take even longer. Neither outcome is desirable for the shareholders or the people who work for the enterprise.

The Bay Systems approach to the design and build of Acoustic Test Facilities (ATFs) is that they should be as good as they need to be but not better. This approach ensures that the facilities are in place to support R&D and production and that the company can afford them. This means that facilities are created, when possible, from the buildings that are. The design is optimised for the tasks that the company can foresee being undertaken. The usability that results from the individually tailored design ensures that the staff will be productive in the ATF. It is easy to find Hemi-Anechoic and Reverberant rooms which are tedious to work in and where staff are understandably lacking in enthusiasm. By discussing all aspects of the facility, with the staff involved, productivity in the new facility exceeds expectations.

MAC– Mini Acoustic Chamber

Why would you want a MAC?

If the acoustic environment inside your workplace is too noisy for the measurement that you need to make then a MAC can provide a noise refuge in which you and /or the test item can be placed. The level of attenuation that can be achieved > 50 dB.

If the testing you have to do generates very high sound pressure levels then by placing the test inside the MAC you will stop annoying your neighbours.

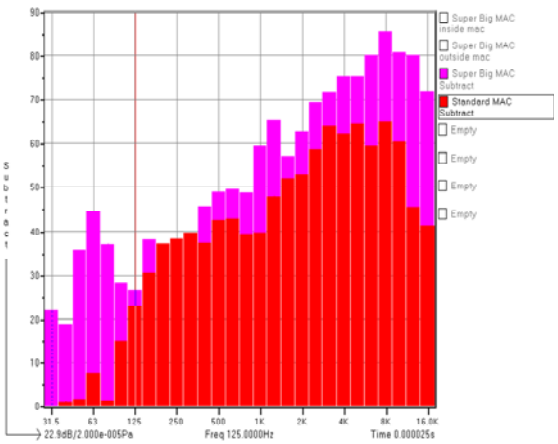
MACs can be manufactured to meet a wide variety of applications and can be made to fit the space that you have available. The dimensions of the MAC will influence what you can reliably measure.

Degree of isolation.

A MAC designed for high frequency attenuation >500 Hz will be light enough to reposition easily within your laboratory.

To achieve good absorption/attenuation and provide a valid measurement at frequencies below 500 Hz will normally mean a MAC with dimensions exceeding 1 metre and weighing more than 300 kg. Consequently this MAC is assembled on site and is not easily moved.

Typical MAC noise isolation characteristics



The 1/3rd Octave levels record the difference in sound pressure level measured inside and outside the MAC. The external microphone was positioned 0.3 metres from and positioned directly in front of the MAC's door. This is the point where sound attenuation should be the weakest.
At frequencies in excess of 2000 Hz the attenuation exceeds 60dB and it is at 50dB for frequencies between 400 and 16000 Hz.
The RT60 decay time for frequencies > 300Hz is 0.012 seconds.
Purple = Big MAC Red = MAC

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