

BIAS 7
HANDBOOK
ON MEASURING WOODWINDS



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BIAS IS A PRODUCT BASED ON RESEARCH PROJECTS DONE AT THE INSTITUTE OF MUSIC ACOUSTICS
AT THE UNIVERSITY OF MUSIC AND PERFORMING ARTS VIENNA

BIAS⁷

for woodwinds

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PREFACE

In principle Woodwinds work like Brasswinds: the oscillator is the vibrating air column and its length and shape defines the pitch. The function of the valves is substituted by the tone holes. Nevertheless there are some differences which have to be taken into account when measuring woodwinds and interpreting the results:

- Whilst the scope for lipping the intonation at brasswinds is limited, woodwinds give a generous leeway to the player. Flutes for example allow the player to shift the intonation of a note by partly capping the embouchure hole to an extent which brass player only can dream of.

Therefore measured discrepancies between the intonation offered by the instrument and an "ideal" intonation are less crucial in the case of woodwinds.

- The sound of woodwinds is generated by the reed (with exception of the flute instruments), the function of the musician's lips is only a "supporting" one for selecting the correct resonance frequency.

This means that the properties of the reed define the sound color and to a certain extent the intonation - but cannot be captured by an input impedance measurement as well as the properties of the human lips in the case of brasswinds.

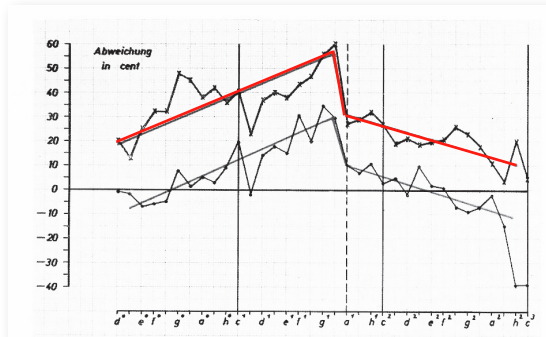
- A simple coupling of the BIAS measurement head to the instrument at a position where the sound is generated, is not possible for woodwinds because of several reasons:
 - at the embouchure hole of flute instruments exists a pressure node instead of the required pressure antinode.
 - in the case of clarinets and saxophones the complex and largely diverse shape of the facing curve makes an air tight coupling of the measurement head to the instrument very difficult up to impossible.
 - the shape of the double reed of oboes and bassoons prevents a common coupling and requires specific adapters.
- Therefore the mouthpiece and the remaining part of a woodwind instrument can be measured separately and afterwards put together by the BIAS software.



With a click on this icon, the BIAS software calculates from the two measurements the impedance curve and all other features of the entire instrument already known from brass instruments.

- For "separated" measurements adapters have to be used. The additional volume of such adapters and its influence on the impedance is automatically eliminated during the composing procedure by the BIAS software.

clarinets

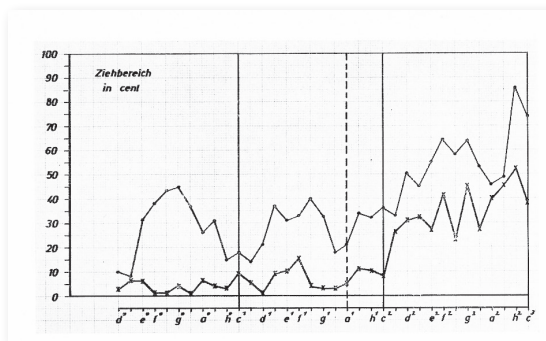


The diagram shows the played intonation **without any correction** by the player for a heavy "thick" reed (upper curve) and a light "thin" reed (lower curve). The horizontal lines show the mean values.

The vertical lines mark the register change, the note where the player starts to overblow.

Another difference to brass winds is the "**FAR**" (Frequency Adjustment Range), the possible range to "lip up" or "lip down" the pitch of a note by the player. This is at brass instruments between 20 cent in the low register and max. 10 cent in the high register.

For clarinets and saxophones the FAR depends on the reed and is much higher!



The diagram shows the FAR for a "heavy reed" (lower curve) and for a light reed (upper curve).

It can be seen, that the heavy reed in the low and middle register allows almost no pitch adjustment by the player (like brass winds in the high register), whereas the light reed offers the chance to the player to adjust the pitch over the whole frequency range up to 85 cent!

SUMMARY of reed characteristics

Heavy reed: generally higher pitch, smaller FAR, larger "dynamic range" (pp - ff), more darker timbre

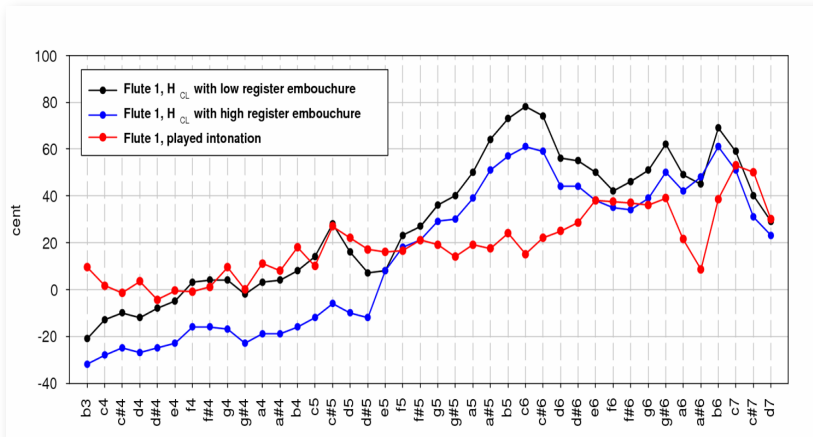
Light reed: generally lower pitch, large FAR, smaller "dynamic range", lighter timbre.

For the interpretation of the measurement results these particularities of reed instruments should be taken under consideration.

Nevertheless and despite of the influence of the reed, it is not irrelevant which intonation is offered by the instrument, because the offered frequency adjustment range determines the easiness for the player to run his individual "ideal intonation"!

flutes

Depending on the register (low, middle or high) the player varies the measure of capping parts of the embouchure hole with his lips and thereby also the angle and distance of the air jet to the edge of the lip plate. Doing so the player systematically modifies the acoustic properties of the instrument.



The figure left shows an input impedance measurement of a flute for the lip position playing in the low register (black) and the high register (blue). The red curve marks the intonation played by a real musician.

No measurement with a lip position according to the middle register was available.

It can be seen that the intonation of a modern flute is adjustable "by will" within a wide range - only by capping parts of the embouchure hole. Nevertheless it is of relevance which intonation is offered by the instrument, because the offered frequency determines the easiness for the player to run his individual "ideal intonation"!

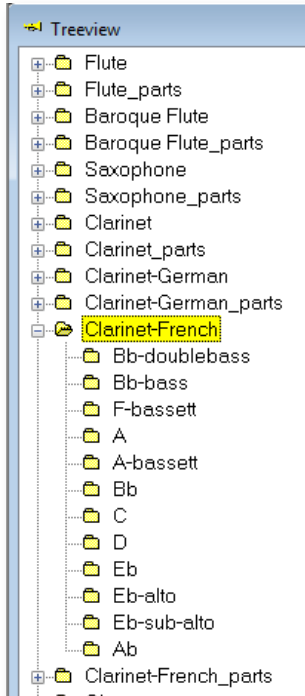
For an exact scientific investigation this would require 3 measurements with a variable covered embouchure hole for each register. Nevertheless in practical life one measurement for each note is sufficient, because it shows the "offered" intonation and can be compared with other instruments.

For flutes BIAS is primary useful for quality control by comparative measurements, either to identify the most appropriate head joints or as support for troubleshooting in the case of notes with a poor response or intonation.

Instead of a pressure antinode a pressure node is located at the embouchure hole of flute instruments, therefore a measurement similar to brasses is impossible. In order to obtain valid data the headjoint and the remaining instrument body must be measured separately. The merging of the headjoint impedance curve with the impedance curve of the instrument body in order to obtain an impedance curve for the entire instrument (like the brass instruments) is done by the BIAS software by a simple mouse click.

Such a new "calculated" impedance curve can be saved like a real measured impedance curve.

Woodwind Database



The database for woodwinds is organised like that for brasswinds but with some particularities.

There are folder for each kind of instrument (flute, clarinet, etc) and sub-folder for the various types (clarinet Bb, A, Eb-alto, etc) which contain the folder for the various fingerings (=valve position at brass instruments).

Particularity 1: to catch all playable notes the database needs about 36 up to 42 folders for each instrument because differing from brass instruments, each note has its own fingering and therefore needs a separate measurement.

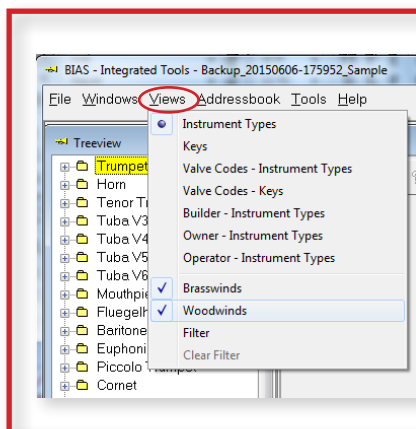
Particularity 2: in some cases the coupling of the measurement head to the instrument bears some problems. Therefore the mouthpiece / head-joint and the remaining instrument body are measured separately and later on the BIAS software merges both measurements to get a valid impedance curve for the entire instrument. For your convenience the database provides for each instrument an additional folder called e.g. "Flute_parts" which contains a folder for the mouthpiece measurement and the various fingerings.

Merged impedance curves by the BIAS software of such a "Flute_parts"-folder can simply be saved in the common "flute" folder.

This allows you to combine in a simple way various mouthpieces with instruments to find out the most appropriate combination.

Particularity 3: as a woodwind instrument is represented by about 40 different fingerings it means not only a huge data volume, but also an unreasonable expenditure of time!

The BIAS database helps to save time and offers the option to define in a simple way a "standard set" with only those fingerings you want to measure. After first tests where you maybe measure all fingerings of an instrument, you soon will know which notes are important for your instruments and which not.



If you use a BIAS version with both, brasses and woodwinds, the database lists more than 200 instruments! It can be very exhausting to scroll down again and again to finally get the required instrument folder.

With a simple mouse click on the "View" command you can select what you want to see: only the brasswinds or only the woodwinds or both (default setting).

hints for measuring

**CLARINETS**

Our experience measuring clarinets is, that the person which presses the keys for the selected notes gets by and by irritated by the weight of the measurement head if the measurements are done in conventional playing position.

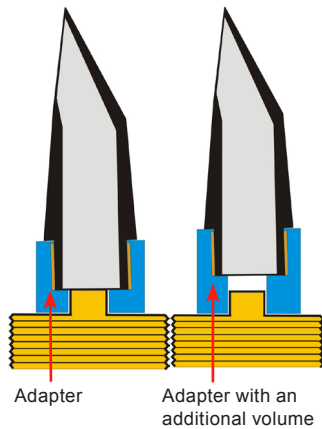
Therefore we took a robust microphone stand and mounted the instrument inclusive the measurement head on it using a simple ring.

FLUTES

The pictures below show the measurement set up for flutes.



hints for measuring: Adapters

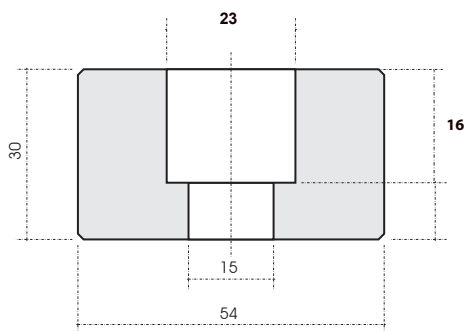


Clarinet mouthpiece adapter

The picture left shows how to use adapters for coupling a clarinet mouthpiece to the measurement head (adapters in blue color).

left: a custom fit adapter (maybe you need several adapters for different brands)

right: adapter with an additional volume. Can be used for all types. Any additional volume which comes into operation only in the case of a measurement is no problem because before merging the mouthpiece data with the instrument body data the software asks for it and takes it into account.

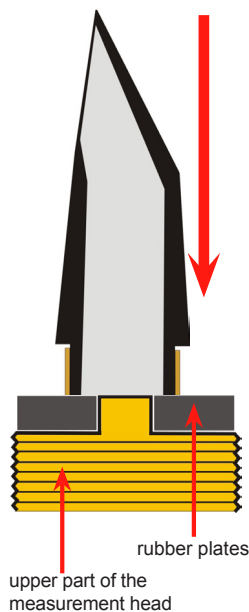


The design of an adapter we use. Measures in mm. You can use any material you want. Important only is an air tight coupling.

Measuring the mouthpiece without an adapter

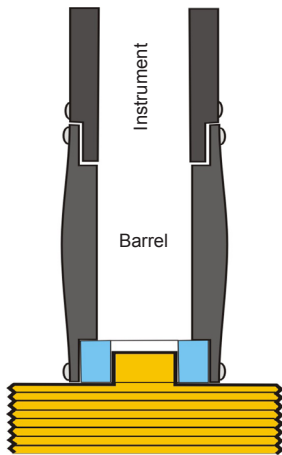
The mouthpiece also can be measured without any adapter if the following hints are kept in mind:

- take as much as necessary of the delivered rubber plates (starting with the thickest one) and mount them on the measuring cylinder till it's plane with the upper edge of the cylinder.
- take any reed (the properties have no influence on the measurement) and mount it on the mouthpiece. Press it against the side rails and the tip rail in order to close the window 100% air tight and fix it with an adhesive tape.
- press the mouthpiece as strong as you can against the rubber plates to guarantee a 100% air tight coupling with the measurement head and start the measurement.



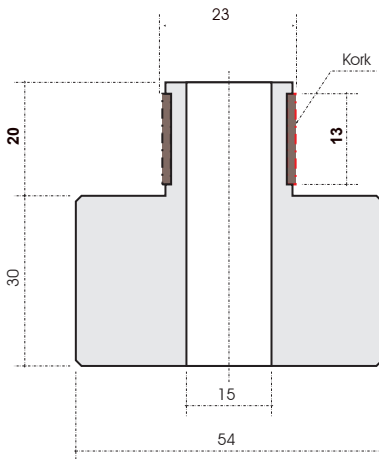
Keep in mind, that the reproducibility will be poor if you cannot guarantee to use always the same pressure.

hints for measuring: Adapters



Clarinet instrument body adapter

The figure left shows an example for such an adapter (blue). Again this adapter creates a small additional volume.



The design of an adapter for measuring the instrument body we use. Measures in mm. You can use any material you want. Important only is an air tight coupling.

COMPENSATING VOLUME

An alternative approach measuring clarinets and saxophones is to use instead of the original mouthpiece a "compensating volume". This is an adapter like the above shown, but with a volume which matches the net volume of the original mouthpiece.

Advantage: you save measurement time and get the curve for the entire instrument for each fingering by one measurement.

Disadvantage: you need some experiments to get out the exact volume of the mouthpiece and the best "shape" of the compensating volume. This, because the shape (not only the volume) also has an influence on the amount of the impedance.

how to measure

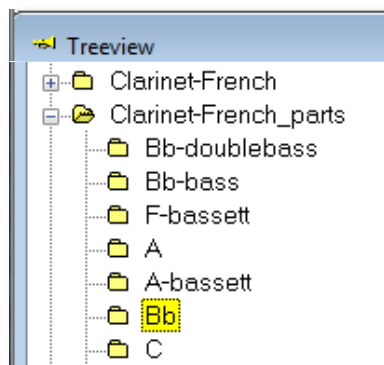
OVERVIEW:

- create a folder for the new instrument
- measuring the mouthpiece
- measuring the instrument body
- merging both curves to the final curve of the entire instrument

The following example shows all steps necessary for measuring a Bb clarinet with the mouthpiece and the remaining instrument body separately.

1

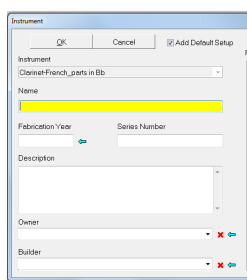
CREATING THE INSTRUMENT FOLDERS



- open the folder "Clarinet-French_parts" and mark "Bb" by a mouse click



- click on the icon "New Instrument"

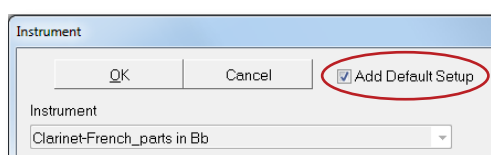


- give the instrument a name and enter it

HINT: we recommend to fill in as much as possible, especially enter the kind of mouthpiece (or its data) into the field "Description".

Detailed information on how to use the description fields "Owner" and "Builder" you find at page 50 of the BIAS 7 Software handbook.

- click on "OK" and BIAS creates this instrument with folders for all fingerings
- Do the same now with the folder "Clarinet-French"! This is the location where the merged curves for the entire instrument can be saved!

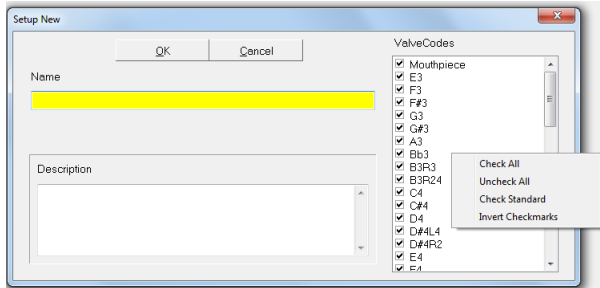


HINT: If you already know that you only want to measure particular fingerings (and not all ones) deactivate this checkbox by a mouseclick. The instrument will be created without a playlist (without any folder for fingerings).



After the successful creation of the instrument click on the Icon "New Setup" which opens a window where you can create your individual configuration of fingerings ("Playlist").

how to measure



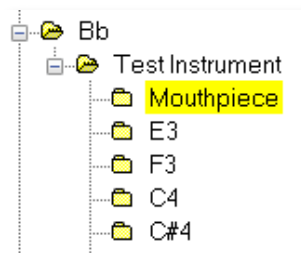
You can disable each fingering by a mouse click into the check box separately or alternatively:

you get the context menu by a right mouse click into the area "ValveCodes" which provides you with some commands to save time like e.g. the command "uncheck all".

Click on "OK" and the software creates the sub-folders for only those fingerings you marked in the playlist.

2

MEASURING THE MOUTHPIECE



- Mark the "Mouthpiece folder" in your new created instrument and



- click on the "measure icon" which opens the acquisition window.



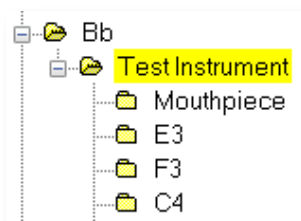
- with a click on the the "measure icon" in that window the measurement starts.



- click on the "save" icon to save your measurement into the correct folder

3

MEASURING THE INSTRUMENT BODY

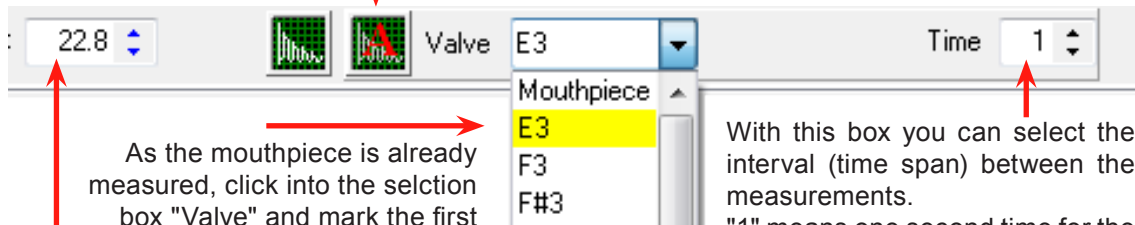


- Mount the measurement head to the instrument body and mark the correct instrument by a mouse click (in our example the "Test Instrument" in the folder "Clarinet-French_parts" and "Bb")

- open the acquisition window with a click on the "Measure" icon (right upper corner of the BIAS screen).

how to measure

As we now measure more than one part/fingering it makes sense to use the "automatic" icon



As the mouthpiece is already measured, click into the selection box "Valve" and mark the first fingering you want to start with (in our case the E3).

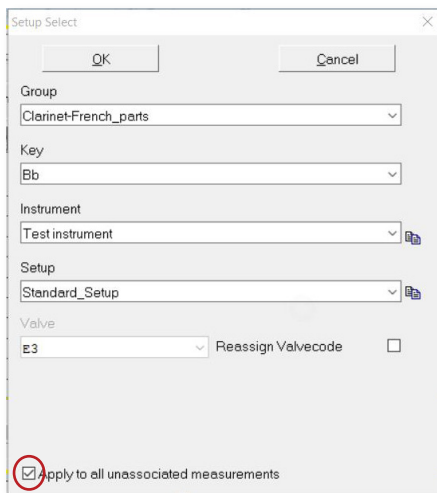
With this box you can select the interval (time span) between the measurements. "1" means one second time for the player in order to change the fingering. We recommend at least 2 seconds.

Don't forget to enter the room temperature (in °C). This enables you to compare measurements done at different room conditions.

4 SAVING THE MEASUREMENTS



- save all measurements by a click on this icon



- this window automatically opens and give you the chance for control. If e.g. you have not marked the right instrument before, you can select it now.

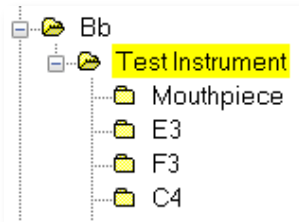
- don't forget to mark this check box ("Apply to all unassociated measurements") by a mouse click! It guarantees that all unsaved measurements are stored in the correct folder.

how to measure

5

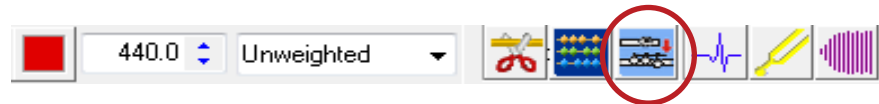
MERGING THE MOUTHPIECE WITH THE BODY

to get the impedance curve for the entire instrument

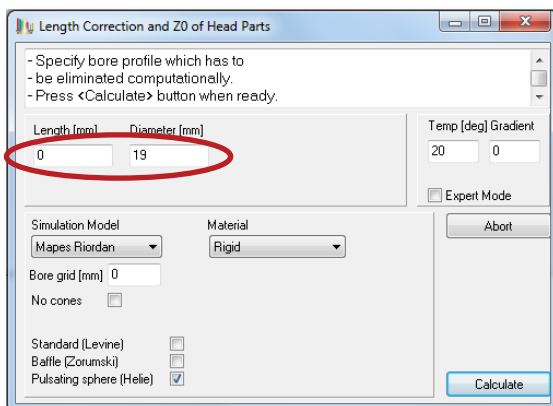


- open the acquisition window by a mouse click on the "measure" icon
- drag the whole instrument into the acquisition window or open the instrument folder and drag the mouthpiece and selected fingerings separately into the acquisition window.

- a new icon appears in the icon bar of the acquisition window



with a click on this icon 2 windows open where you can enter the size of the additional volume caused by the adapters (window 1: mouthpiece adapter, window 2: body adapter)



- enter the length and the diameter of the additional volume caused by the **mouthpiece adapter** and click on the "Calculate" button.

- if you didn't use a mouthpiece adapter or no additional volume was caused by the adapter leave this form without any changes **by a click on the "Calculate" button**.

- after that the same window appears - now ready for entering an additional volume caused by the adapter used for the **instrument body** measurement.

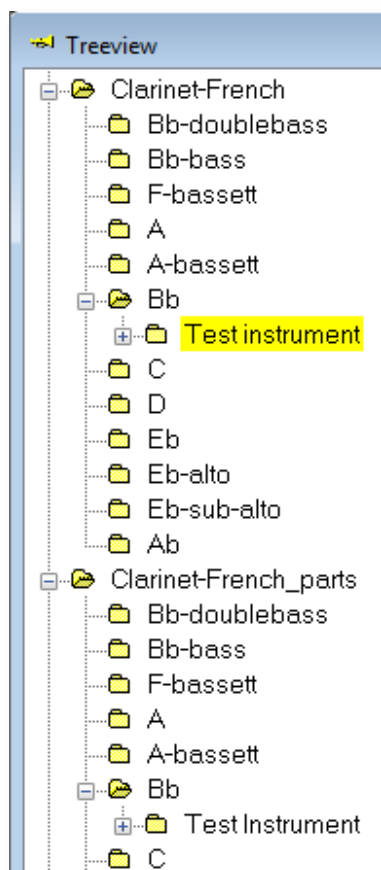
- after the click on the "Calculate" button the software composes the measurements and removes the mouthpiece and body curves from the window so that only the impedance curves of the entire instrument for the selected fingerings are remaining.

how to measure

6 SAVING THE COMPOSED CURVES

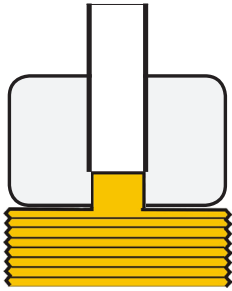
As these curves now represent the entire instrument and are ready to be used for e.g. intonation plots etc., we recommend to save them in the instrument folder "Clarinet-French" -> "Bb" you have created together with the "Clarinet-French_parts" folder (see page 10 of this handbook).

- to define the new location for saving the composed curves simply mark the folder "Test Instrument" as shown in the figure.



- click on the "save all" icon of the acquisition window and check with the new opened window (see page 12) if the location is correct.
- don't forget to mark the check box "Apply to all unassociated measurements" and click on "OK".

hints for measuring flutes



- in the case of flutes there is no alternative - headjoint and body must be measured separately.

- the adapters are simple: adapter body of any material and a piece of tube with an appropriate diameter and length. The tube can also be taken from an old, broken instrument.

- headjoint measurement: if the open area of the embouchure hole should be reduced by the players lips he can use a position which is similar to the playing position in reality.

- instrument body measurement: to make the pressing of the correct key combination easier, the measurement head can be mounted at eye level on a music stand or simply put on a table



