Sabine K. Klaus

To Play or Not to Play? How BIAS Can Help

In 2007, the National Music Museum, University of South Dakota, launched a video project to record selected brass instruments in one of its collections: the Joe R. and Joella F. Utley Collection. This project resulted in DVDs to accompany a planned five-volume book series *Trumpets and Other High Brass*,[1] and also provided video clips for future museum displays and online publications. The initial question that arose during the preparation of this project was: how do we choose, from over 600 brass instruments, those that are potentially suitable for recording without testing them beforehand? The aim was to avoid playing historic instruments unnecessarily, only to find that they are not in playing condition.

Selecting instruments for recordings We have found that we can be guided in this selection process by acoustic input impedance diagrams, generated with BIAS (short for non-invasive Brass Instrument Analysis System, developed at the Institut für Wiener Klangstil).[2] Using rubber rings, a self-centring device and a bayonet locking ring, the mouthpiece is given an airtight seal to the BIAS apparatus before the instrument is attached. Acoustic input impedance is the ratio of sound pressure to the oscillating air flow that produces it. In the BIAS apparatus, a microphone in the mouthpiece cup senses the sound pressure there, and a second microphone within the apparatus measures the air flow injected into the instrument. To visualise measurements of acoustic input impedance at a particular frequency, one might imagine an oscillating piston pumping air in and out of the mouthpiece in a pure tone (a sine wave). Either by injecting multiple frequencies simultaneously, or by sweeping the frequency of a sine wave, the BIAS system traces out a curve of the impedance as a function of frequency. For a brass instrument, such an impedance diagram shows a sequence of peaks and valleys. Within the normal playing range of an instrument that plays well, the impedances of the peaks are high (typically in the order of 100 MOhm)[3] and their frequencies fall close

1 So far, four volumes of this series have been published: Sabine Katharina Klaus: *Trumpets and Other High Brass*, Vol. 1: *Instruments of the Single Harmonic Series*, Vol. 2: *Ways to Expand the Harmonic Series*, Vol. 3: *Valves Evolve*, and Vol. 4: *Heyday of the Cornet*, Vermillion 2012, 2013, 2017, and 2022. Each volume is accompanied by a DVD.

2 I want to thank Robert Pyle for his input in interpreting the acoustical analysis below, and for generating the impedance diagrams in the format in which they are presented in this article.

3 The unit of acoustic impedance is the acoustic ohm. Since the acoustic ohm is an inconveniently small unit for use with brass instruments, it is customary instead to use units of millions of ohm, or megohm (abbreviated MΩ).

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to integer multiples of the instrument's pedal frequency. Below I will discuss four categories of impedance diagram that have helped us to decide whether or not to play an instrument.

Example 1: Impedance diagram of an instrument that plays well Figure 1 shows the input impedance diagram of a bugle à pistons in 4½-foot B♭ by Louis Müller in Lyon, made in circa 1835 (NMM 10736), illustrating the position and strength of the natural notes that are playable on this instrument. The player can produce notes whose fundamental frequencies lie on or very near the frequencies of the impedance peaks. The peaks and valleys are regular; the peaks are at a reasonably high level and sharp at the top, suggesting that the natural notes lock in properly. We therefore concluded that this instrument is a good candidate for playing and recorded it with trumpeter Vince DiMartino.[4]

Example 2: An instrument with serious problems that is not fit for recording The most important English contribution to the development of valves was the disc valve.[5] Today, however, conflicting views as to its quality exist; this is due to difficulties in maintaining this complicated valve mechanism. The disc-valve cornopean NMM 7063 by Köhler of London, made after 1851, exemplifies the problems that one may face in keeping this valve type airtight. Figure 3 shows that the impedance peaks and valleys for NMM 7063 without the use of valves, or with the second valve in use, are as regular and well defined as in the Müller bugle à pistons (NMM 10736). However, the first valve displays a very irregular impedance curve that predicts serious problems. Tests with an air-pump device further confirmed that the first valve suffers from a serious leak. We therefore decided not to record the Köhler cornopean, but to leave it well alone.

Example 3: An instrument with plenty of playable notes at a low energy level Figure 5 illustrates the acoustical measurements of the double-piston-valve trumpet NMM 7061 by Joseph Lathrop Allen, made in Norwich, Connecticut, between 1846 and 1849, showing smooth impedance peaks on a low MOhm level. This indicates that the player does not get much support from the instrument and individual natural notes will not lock in very easily. On the other hand, the instrument gives a skilled player more opportunities to manipulate intonation to make up for its faultiness. Despite the predictable problems, we decided to play NMM 7061, mainly because the impedance diagram seemed to confirm a historical assessment about this instrument type. The New York band leader Allen Dodworth described the tonal quality of a family of narrow-bore instruments, to which

4 Klaus: Vol. 3: *Valves Evolve*, DVD track 2.

5 See Frank Tomes/Sabine K. Klaus/Arnold Myers: Shaw, Köhler and the Disc Valve in Britain, in: *Galpin Society Journal* 66 (2013), pp. 99–116.

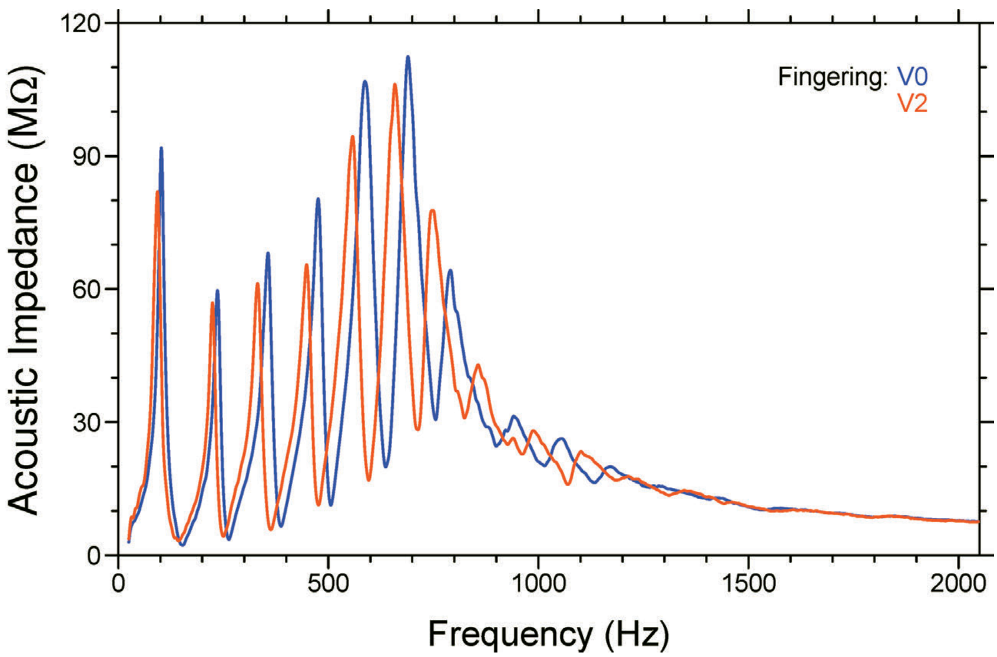

FIGURE 1 Input impedance of a bugle à pistons in 4½-foot B♭ by Louis Müller (NMM 10736). The blue curve shows the instrument without the use of valves, the red curve is generated when the second valve is used.

FIGURE 2 Bugle à pistons in B♭ by Louis Müller, Lyon, circa 1835 (NMM 10736)

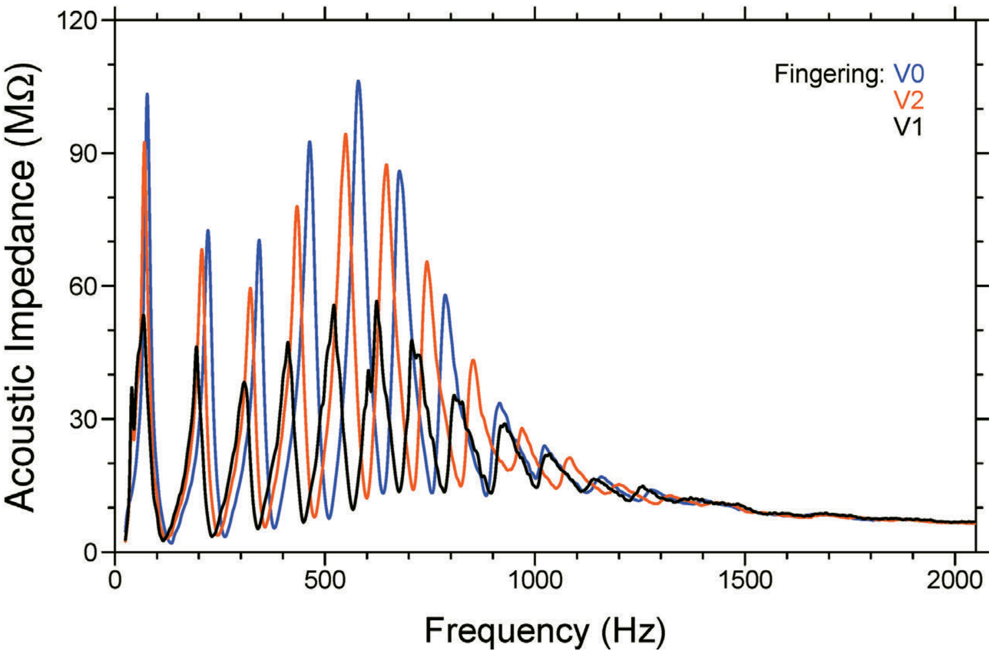

FIGURE 3 Input impedance of a cornopean by Köhler (NMM 7063). The impedance diagram is regular for the open instrument (blue) and with the second valve in use (red), but very irregular with the first valve due to air-leakage (black).

FIGURE 4 Cornopean with shanks and crooks for 4½-foot B♭ to 6-foot F by Köhler, London, after 1851 (NMM 7063)

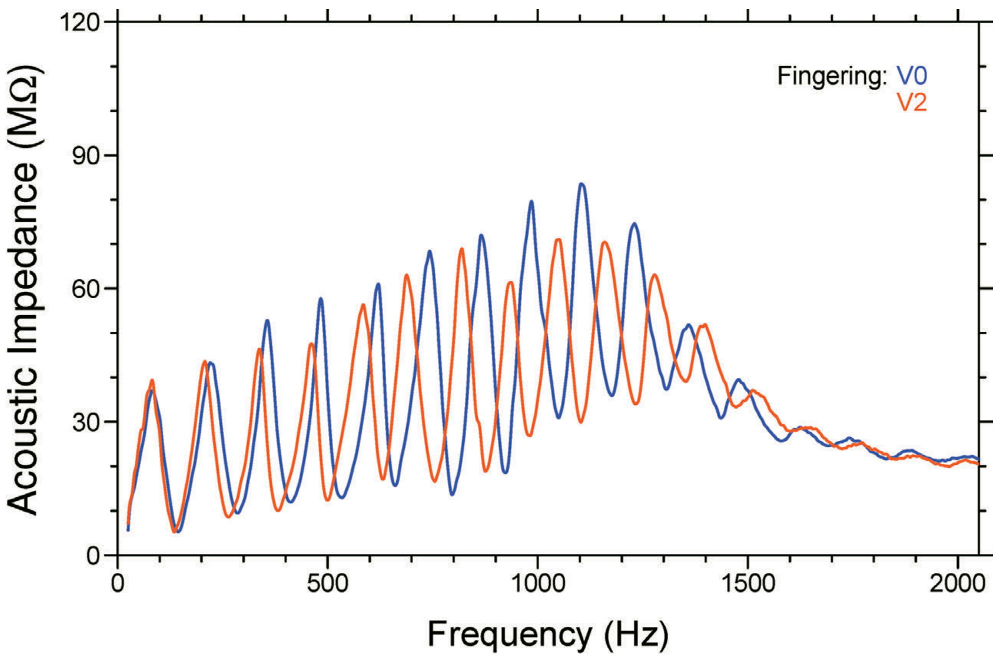

FIGURE 5 Input impedance of the 4½-foot B♭ trumpet (or 'posthorn') by Joseph Lathrop Allen (NMM 7061). The blue curve illustrates the acoustical behaviour of the instrument without valves, while the red curve was measured with the second valve depressed.

FIGURE 6 Trumpet in 4½-foot B♭ by Joseph Lathrop Allen, Norwich, Connecticut, between 1846 and 1849 (NMM 7061)

this trumpet (which he called “Posthorn”) belonged, as follows: It is “deficient in power, arising from the smallness of the tubing.”[6] Indeed, the playing test with Jeff Stockham showed a subdued tone quality.[7] It can therefore be stated that in this case BIAS helped to validate historical information.

Example 4: Musical instrument or ornament? Input impedance measurements can also help to answer the question as to whether an object was actually conceived as a musical instrument of some sort, or as just an ornament. This question arose in connection with a miniature horn, made in Nuremberg in 1681 by Johann Wilhelm Haas (NMM 7213). Figure 7 shows four distinct input impedance peaks, suggesting that the instrument might be playable, although the natural notes are not well aligned. Note that the impedance at the first peak is so high (167 MOhm) that this plot ranges up to 180 MOhm rather than 120 MOhm as in the other graphs. This little horn was played by Celeste Holler Seraphinoff, who managed to elicit a typical octave leap, as was used for signalling by postmen from the sixteenth to the nineteenth centuries, and entered music history as an idiom, for example in compositions by Johann Sebastian Bach and George Frideric Handel.[8]

Getting instruments ready for recordings Once selected with the help of BIAS, some instruments could be used without further treatment, while others required some preparation. The Haas miniature horn NMM 7213 has its original, integral mouthpiece and could simply be played. Often the initial tubing (mouthpiece receiver) of a historic brass instrument is not totally round anymore and requires some sealing with the mouthpiece; in these instances, wrapping the instrument’s initial tubing and the mouthpiece joint with simple cling film may suffice to make an airtight connection. The most drastic and problematic step in the preparation of a valve brass instrument is the use of valve oil, which in most instances is indispensable to make the valves functional and airtight. For a recording session of instruments in the Utley Collection in July 2014 with the trumpeter Vince DiMartino, I therefore decided to allow the use of valve oil, but planned to clean it off thoroughly after the recording session. We used the valve oils, much to my regret, without prior testing. Subsequent concerns were raised during the CIMCIM meeting in Scandinavia in August 2014 about the use of oils in mechanical clocks.[9] This led to an

6 Allen Dodworth: Brass Bands, in: *The Message Bird* (15 June 1850), p. 361.

7 Klaus: Vol. 3: *Valves Evolve*, DVD track 6.

8 Klaus: Vol. 1: *Instruments of the Single Harmonic Series*, DVD chapter 6.

9 Vera de Bruyn: *Material or Sound? Risk-Benefit Analysis in the Recording of Musical Instruments*. Paper presented at the Ringve Museum in Trondheim on 31 August 2014.

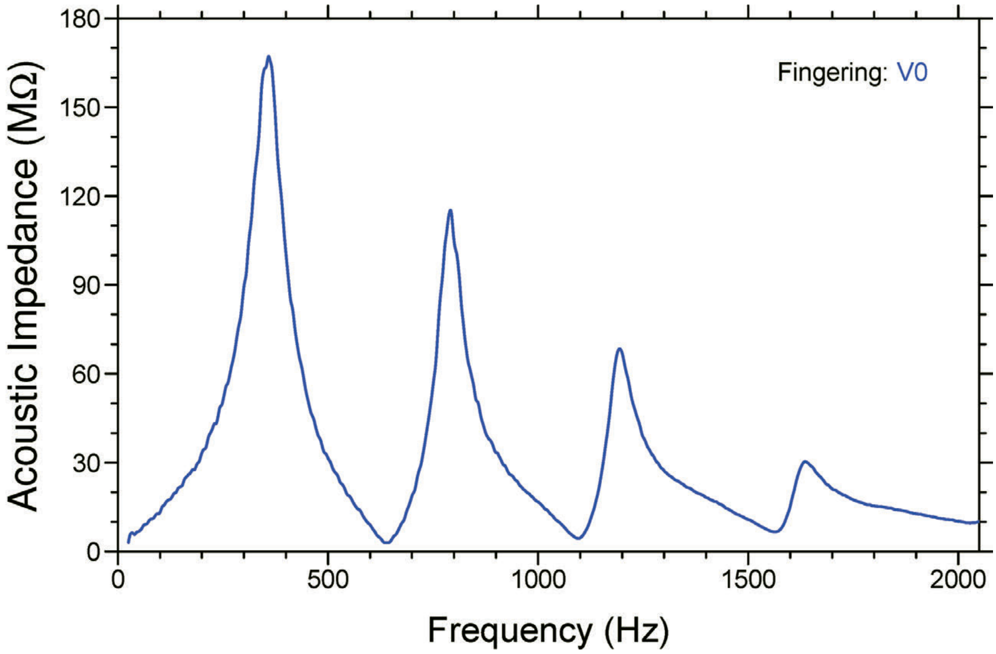

FIGURE 7 Four distinct peaks of input impedance are produced by the miniature horn by Johann Wilhelm Haas (NMM 7213), indicating that it can serve as signal instrument and is not just an ornament.

FIGURE 8 Celeste Holler Seraphinoff testing the miniature horn by Johann Wilhelm Haas, Nuremberg 1681 (NMM 7213)

analysis of the two types of valve oils applied during the recording session the previous month.

Valve oil analysis The two valve oils Vince DiMartino had used were the *Yamaha Synthetic Light Valve Oil* by Yamaha, Japan (P1), and *Synthetic Classic Piston Lubricant 3* by Hetman, USA (P2). Afterwards, both oils were analysed by the Rathgen-Forschungslabor in Berlin using an Oddy test.[10] The Oddy test, developed by conservation scientist William Andrew Oddy at the British Museum in 1973, is designed to detect harmful materials in display cases, museum environments or packaging in order to prevent damage to museum objects.[11] The Oddy test detects corrosive reactions between the materials to be tested and those present in museum objects.

In this examination, six airtight polyethylene containers were each filled with one of the valve oils to be tested and a 1 cm^2 metal foil of silver, copper or lead. A test tube filled with distilled water was added to each container to ensure constant humidity. The test was conducted over 28 days at 60° Celsius in a drying chamber. The following metal foils by the firm Goodfellow[12] were used in the test:

a) Silver: AG000450/13 silver; thickness: 0.25 mm, purity: 99.95+%, rolled;
b) Copper: CU000591/4 copper, thickness: 0.125 mm, purity: 99.9 %, hard;
c) Lead: PB000280/17 lead, thickness: 0.1 mm, purity: 99.95 %, rolled.

A control test was also conducted in which the metal samples were left in the drying chamber without the addition of the valve oils. Afterwards the metal samples were examined with a digital microscope.[13] Emission of the following compounds is indicated, if corrosion is detected by this test:

Silver:	Emission of sulphur compound;
Copper:	Emission of chloride, oxide and sulphur compounds;
Lead:	Organic acids and aldehydes.

When tested with the valve oil by Hetman (P2), none of the three metal samples showed any corrosion, while the test involving the oil by Yamaha (P1) showed noticeable corrosion of the lead sample. We can therefore conclude that the Yamaha oil should not be used

10 I am grateful to Dr Tom Lerch, Musikinstrumenten-Museum Berlin, for arranging this examination, and to Sabine Schwerdtfeger and Ina Reiche for carrying it out. Rathgen-Forschungslabor, Staatliche Museen zu Berlin, Examination report 88_101414 from 3 December 2014.

11 William Andrew Oddy: An Unsuspected Danger in Display, in: *Museums Journal* 73/1 (1973), pp. 27 f.

12 Goodfellow GmbH, Postfach 1343, Bad Nauheim, Germany, info@goodfellow.com.

13 Microscope VHX-500FD by Keyence.

with museum objects, while the Hetman oil does not raise any concerns when brought into contact with historic valve brass instruments.

Basic treatment after use After the recording session, movable parts such as slides were removed, the instruments and parts rinsed with distilled water, and subsequently dried with a hairdryer. Valves were disassembled as far as possible, although rotors were not removed. Despite efforts to clean off any remaining valve oil, there are areas that are difficult or impossible to access, such as corners in valve cases. When checked in October 2016, some valve oil remains were still found on rotary valves when the bottom valve caps were removed. For this reason, we shall continue to monitor the instruments that we recorded.

Conclusion Once again, we have to conclude that playing our instruments comes with risks attached. We can keep risk factors low, but we cannot eliminate them completely. Acoustical measurements can predict which instruments are potentially suited for recording and which are unplayable, thus protecting the latter from the unwarranted stress of being played with less than satisfying results. The Oddy test showed that it is essential to make sure, prior to playing, that no harmful substances are used in the process of preparing valve brass instruments for recordings, since the reliable removal of oils afterwards is almost impossible.

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To Play or Not to Play

Corrosion of Historic Brass Instruments

Romantic Brass Symposium 4 • Edited by Adrian von Steiger, Daniel Allenbach and Martin Skamletz

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Dieses Buch ist in gedruckter Form im Januar 2023 in erster Auflage in der Edition Argus in Schliengen/Markgräflerland erschienen. Gestaltet und gesetzt wurde es im Verlag aus der *Seria* und der *SeriaSans*, die von Martin Majoor im Jahre 2000 gezeichnet wurden. Gedruckt wurde es auf Eos, einem holzfreien, säurefreien, chlorfreien und alterungsbeständigen Werkdruckpapier der Papierfabrik Salzer im niederösterreichischen Sankt Pölten. Das Vorsatzpapier *Caribic cherry* wurde von Igepa in Hamburg geliefert. *Rives Tradition*, ein Recyclingpapier mit leichter Filznarbung, das für den Bezug des Umschlags verwendet wurde, stellt die Papierfabrik Arjo Wiggins in Issy-les-Moulineaux bei Paris her. Das Kapitalband mit rotschwarzer Raupe lieferte die Firma Dr. Günther Kast aus Sonthofen im Oberallgäu, die auf technische Gewebe und Spezialfasererzeugnisse spezialisiert ist. Gedruckt und gebunden wurde das Buch von der Firma Bookstation im bayerischen Anzing. Im Internet finden Sie Informationen über das gesamte Verlagsprogramm unter www.editionargus.de, zum Institut Interpretation der Hochschule der Künste Bern unter www.hkb.bfh.ch/interpretation und www.hkb-interpretation.ch. Die Deutsche Nationalbibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliografie; detaillierte bibliografische Daten sind im Internet über www.dnb.de abrufbar.
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