

BRIDGING INSTRUMENT CONTROL ASPECTS OF BRASS INSTRUMENTS WITH PHYSICS-BASED PARAMETERS

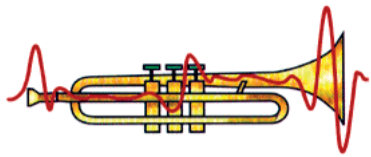
Matthias Bertsch, Institute for Musical Acoustics (IWK),
University of Music Vienna, Austria

Bertsch@mdw.ac.at
http://www.bias.at/TRP

Is there a connection between what we feel when playing an instrument and what we can measure? Physical models and measuring tools have been developed to provide a better understanding of brass instruments and objective physical documentation of their acoustics.

Musicians and instrument makers still criticize the enormous gaps between the physics-based parameters and the empirically reported feelings of brass players on quality aspects of their instruments. Deviations between played and measured parameters like intonation and their variability have already been focused on in earlier studies. Attempts at finding a theoretical explanation of these deviations using physical modeling continue.

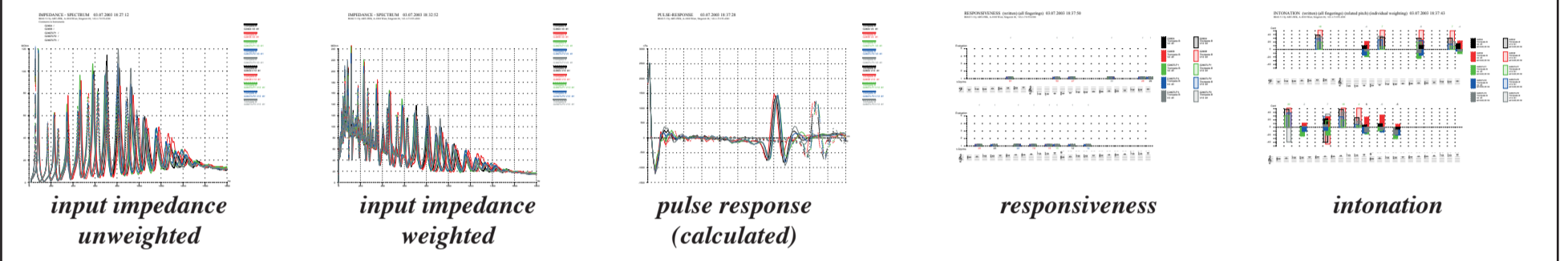
For musicians, one of the most important quality factors of a brass instrument is its response. A new series of playing tests has been designed to correlate empirical data with objective physical parameters (impedance measurements). International instrument makers provided special test instruments (modular trumpets).



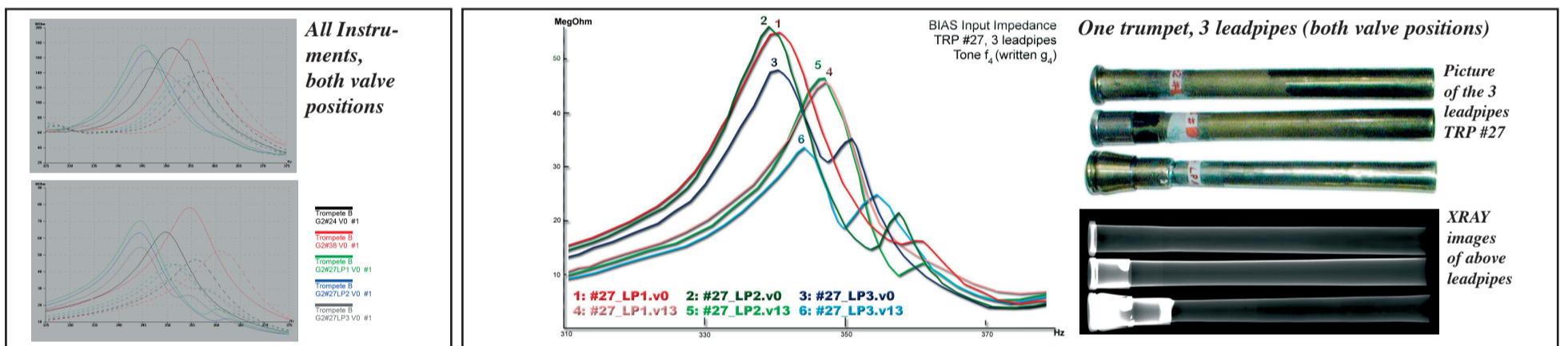
Input impedance data of test instruments



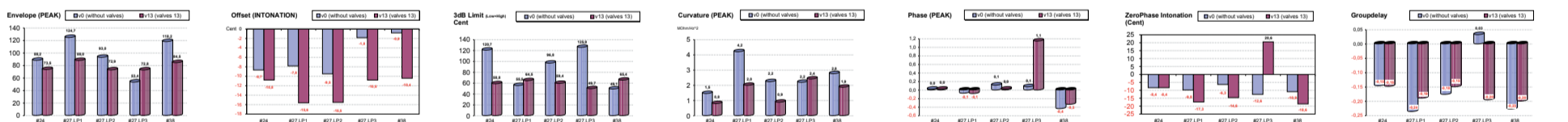
BIAS analysis of all Instruments (#24, #38 and #27 with three different leadpipes) and for both valve positions (v0 and v13)



Impedance plot zoom to the written note „g4“



New BIAS 6.0 analysis export features: Example figures for note „g4“ of the all Instruments. Values should correlate to impedance curves. (Do they?)



Envelope: Absolute peak height of impedance peak in MegOhm

Offset: Intonation given by the impedance peak center frequency. Intonation error related to the equal temperature in Cent. Tuning reference frequency is adjusted in order to minimize the overall intonation error of all playable notes.

Bandwidth: Low3dbLimit plus High3dbLimit. (Inverse Q factor in Cent)

Curvature: Absolute value of the 2nd derivative of impedance curve at peak center in MegOhm/Hz². Calculated as parabolic fit using the Savitzky-Golay convolution.

Phase: Phase value at peak center in Rad. Should be close to zero at least for prominent peaks.

ZeroPhase Intonation: Intonation given by zero phase frequency. Intonation error related to the equal temperature in Cent. Tuning reference frequency is adjusted in order to minimize the overall intonation error of all playable notes.

Groupdelay: Group delay, 1st derivative of impedance phase at peak center in Rad/Hz.

→ trumpet:

#24

#27.LP1

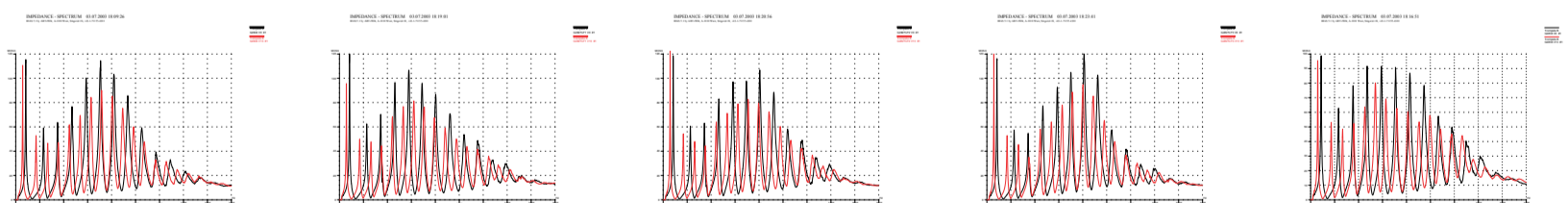
#27.LP2

#27.LP3

#38

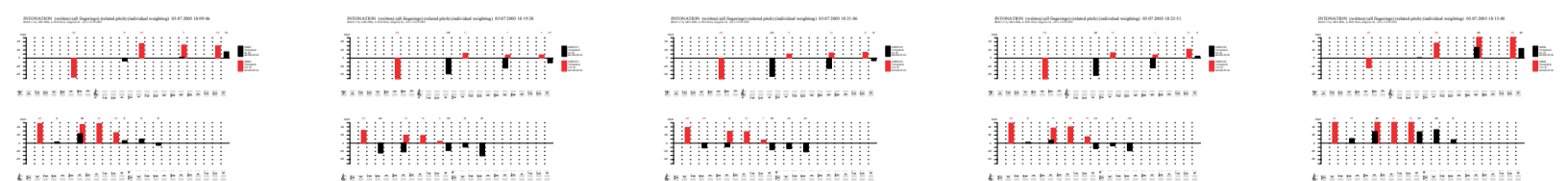
BIAS impedance

v0 - black
v13 - red



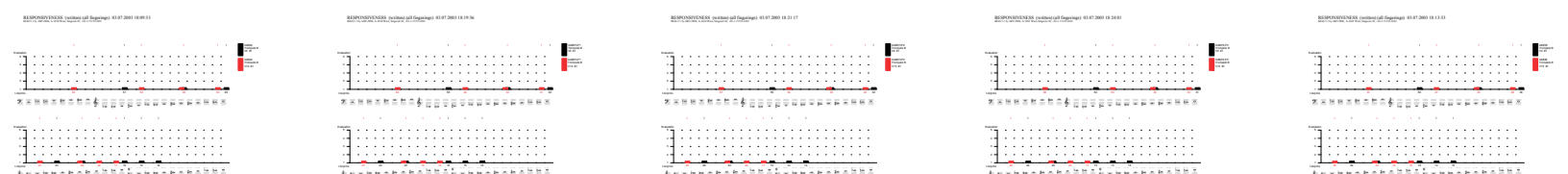
BIAS intonation

v0 - black
v13 - red











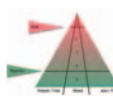
BIAS response

v0 - black
v13 - red



Results of blind performing tests

Questions asked during the playing tests and answers given by players in Vienna (student and professional players) for five rotary trumpets.

			trumpet #24	trumpet #27 leadpipe 1	trumpet #27 leadpipe 2	trumpet #27 leadpipe 3	trumpet #38	statistic (mean & variances)	
start	Question 01: „How fast is the feedback at the start of the note?“ „How quickly does the note speak?“ Answers: [-2] very quickly /[-1] /[-0] ok /[+1] /[+2] not quickly, slow		g4 no valves (v0)						
			g4 valves 13 (v13)						
32nd	Question 02: „How quickly can the note be repeated? Play 32nd notes staccato!“ Answers: [-2] fast /[-1] /[-0] ok, normally /[+1] /[+2] not so fast		g4 no valves (v0)						
			g4 valves 13 (v13) forte						
ppp	Question 04: „How quietly can the note be played? How easily does it speak at ppp?“ Answers: [-2] very easily /[-1] /[-0] ok, normally /[+1] /[+2] not easily		g4 no valves (v0)						
			g4 valves 13 (v13)						
			g3 valves 13 (v13) pianissimo c6						
			g4 no valves (v0) piano						
air	Question 06: „Required air (energy) for maintaining a forte note?“ Answers: [-2] very low, not much air /[-1] /[-0] ok /[+1] /[+2] very high, alot of air		g4 no valves (v0)						
tuning	Question 07: „How is the intonation of single notes?“ Answers: [-2] very flat /[-1] /[-0] ok /[+1] /[+2] very sharp		g4 no valves (v0)						
			g4 valves 13 (v13)						
resistance	Question 08: „Blowing resistance (maintaining a forte note)“ Answers: [-2] very low /[-1] /[-0] ok /[+1] /[+2] very high		g4 no valves (v0)						
			g4 valves 13 (v13)						
	Question 09: „How easily are the notes lipped, or how centered are they?“ Answers: [-2] lick up or down difficult, note is extremely centered /[-1] /[-0] ok, normally /[+1] /[+2] lick up or down easy, note is not so centered		g4 no valves (v0)						
			g4 valves 13 (v13)						
	Question 11: „Tone quality (bright- dark)“ Answers: [-2] very dark /[-1] dark /[-0] ok, neutral /[+1] bright /[+2] very bright		g4 no valves (v0)						
	Question 13: „Tone color quality (colorless- brilliant)“ Answers: [-2] very colorless /[-1] /[-0] ok, neutral /[+1] / [+2] very brilliant		g4 no valves (v0)						
full round	Question 14: „Tone quality (thin- full, round, open)“ Answers: [-2] very thin, flat /[-1] /[-0] ok /[+1] / [+2] very full and round		g4 no valves (v0)						
sound pref	Question 16: „Tonal preference, Sound preference“ Answers: [-2] don't like it /[-1] /[-0] ok, neutral /[+1] / [+2] like it alot		g4 no valves (v0)						
	Question 17: „Tonal power, Radiation (weak- strong)“ Answers: [-2] very weak /[-1] /[-0] ok /[+1] / [+2] very strong		g4 no valves (v0)						
brassiness	Question 19: „Tendency to split notes, or to „scream“; (brassiness)“ Answers: [-2] very little /[-1] /[-0] normal, ok /[+1] / [+2] very much		g4 no valves (v0)						
	Question 31: „This instrument is appropriate for which player level?“ Answers: [1=prof.], [2=semi-prof.], [3=student], [4=advanced], [5=beginner]		g4 no valves (v0)						
good? bad?	Question 44: „How do you like the instrument on the whole?“ Answers: [-2] very bad /[-1] rather bad /[-0] neutral /[+1] rather good / [+2] very good		g4 no valves (v0)						

ANSWER SCALE

-2	-1	0	1	2
minimal	-	standard	+	maximal
--	-	neutral	+	++
worst	worse	OK	better	best