Trumpet Mutes

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Abstract: What make mutes sound different ? Which effects have particular mutes on trumpet-playing ? Results of an investigation of trumpet mutes are presented where the influence of the most common trumpet mutes on the dynamic, timbre, intonation, sound radiation and responsiveness of trumpets is demonstrated. Some examples of typical effects are presented.

1. Types: Surveys of the author - in Austria, Germany and withon the trumpet newsagroup of the Internet - result in a ranking list of mostly used types: **1. Cup** (93 % of using); **2. Straight** (92%); **3. Harmon** (75%); **4. Plunger** or anything alike (44%); **5. Wah-Wah** (40%); **6. Velvet** or Bucket (22%); **7. Whisper** (8%); **8. Hat** or Derby) (6,%); **9. Mega-Clear-Tone** (3,%); **10. Buzz WOW** (3%); **11. Mel-O-Wah** (2%); **12. Pixie** or Snubtone (2%) *[The Practicemute (47 %) is out of ranking, because different types are used as Practicemute].* The six most-used mutes have been subject of an acoustical investigation.

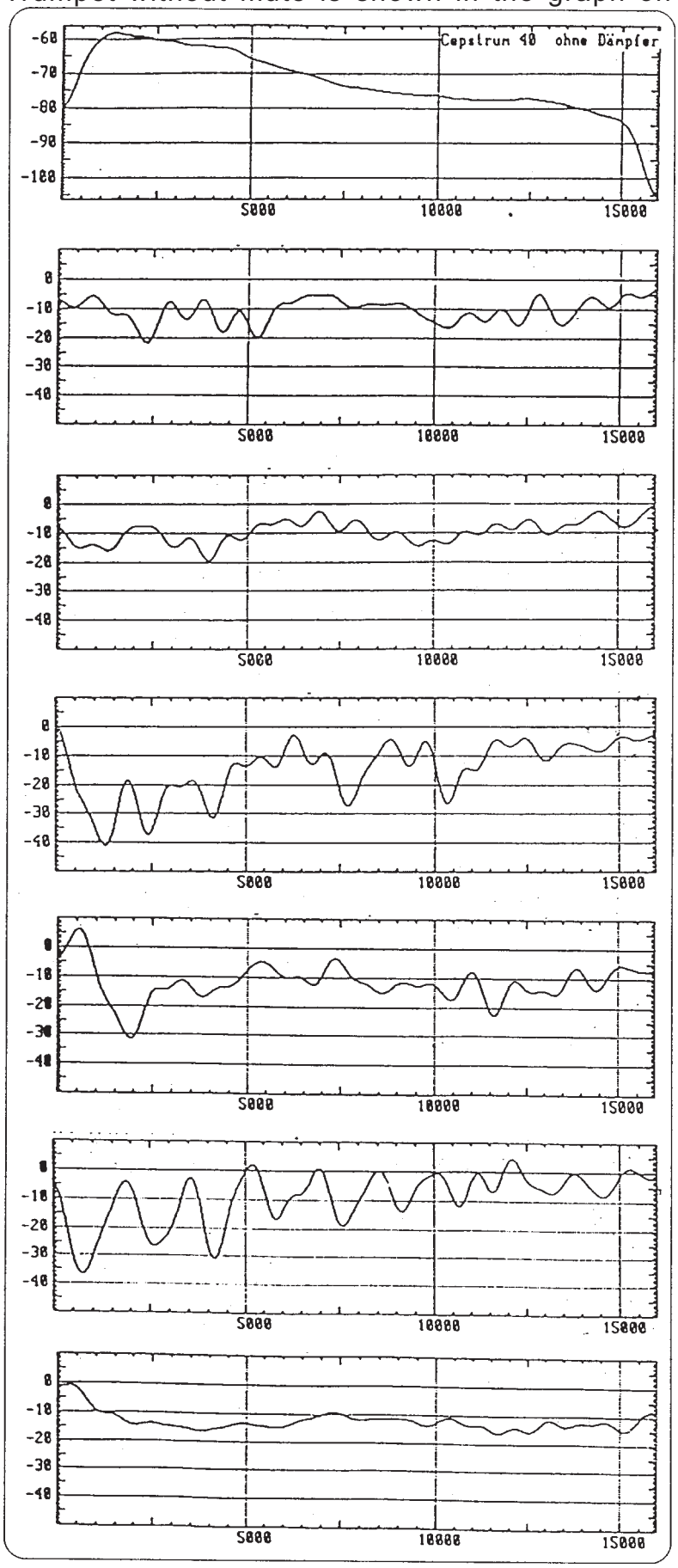
2. Dynamics: The dynamic range of the trumpet without mute depends on the register: about 30 phone in the lower and about 13 phone in the upper register (Meyer/1980). Measurements of a crescendo-tone in the anechoic chamber of the IWK reveal dynamic range values for the lower-register (written c1). The reference-amplitude 0 dB corresponds with the ppp (as soft as possible) on the trumpet without mute. The dynamic range of the trumpet without mute and with the plunger almost opened is about 30 dB. The Cup, Wah-Wah, Straight and Velvet Mutes have reduced dynamic ranges of about 24 dB. The Plunger has 21 dB at the almost-closed position and the Harmon reduces the dynamic range to 17 dB. The ability to play softer with a mute is only valid for the Cup, Wah-Wah, Straight and Velvet and Harmon mute. The ppp (as soft as possible) sounds -5/-8 dB lower than with without mute. The chance to play fff (as loud as possible) is extremly reduced with the Harmon. A fff is 20 dB weaker than without mute. This explains why the Harmon mute is usually amplified when it is in use. The fff played with Cup, Wah-Wah, Straight or Velvet mute is 12 dB softer than without. The dynamic level of the Plunger depends very much on the gap size. Almost closed (1cm gap) the fff is about 6dB lower than without mute.

Comparison of dynamic ranges

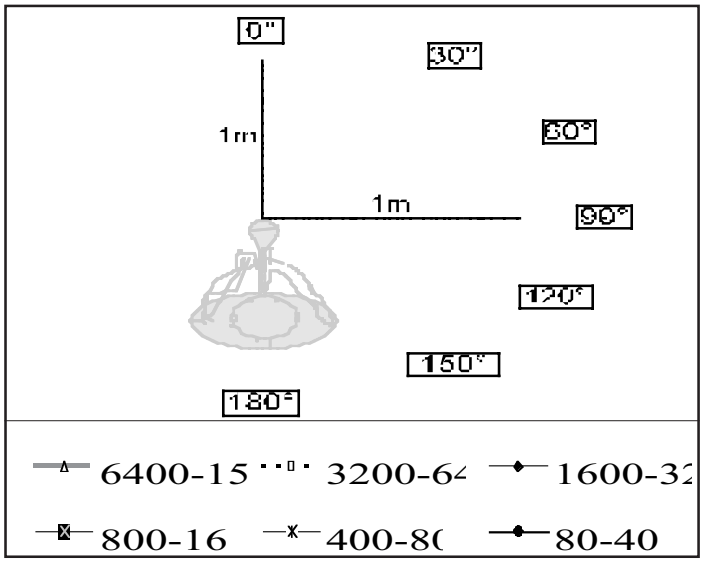
	ppp	fff	
ohne	***0***	***30***	
straight	-7	17	(-13)
cup	-5	18	(-12)
velvet	-7	17	(-13)
harmon	-8	9	(-21)
wah-wah	-7	16	(-14)
plunger zu	3	24	(- 6)
plunger offen	0	27	(- 3)

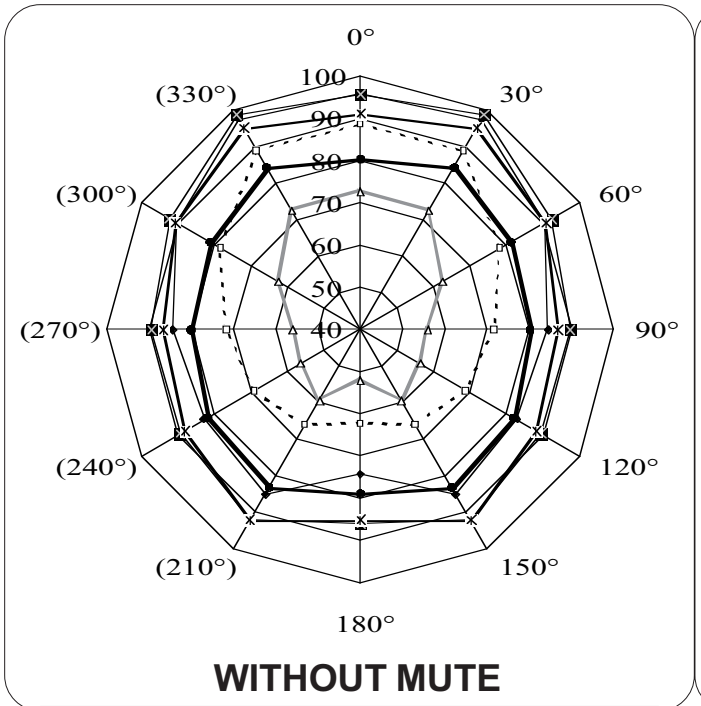
Values in relative dB in comporison to the trumpet without mute. 0 dB correspond about 65 dB(A).

3. Timbre: The sounds produced by some mutes are very characteristic, others sound similar. Physical reasons for a particular timbre are changes in the spectrum. Mutes cause typical formants and above all antiformants. The Cepstrum (40 Coeffizients) of the Trumpet without mute is shown in the graph on the top (tone written “c1”, blown fortissimo). The formant area is around 1.2-1.5 kHz. The intensity of higher partials diminish gradually. Below you can see the differnce-Cepstrum of the other typer. The values of the trumpet without mute are substracted. The difference-spectrum of the Cup mute indicates antiformants at 2.5 and 5 kHz. Also to be seen are the weakened partials over 10 kHz. The Cup prevents the radiation of wavelenghts shorter than the dimension of the mute. Very characteristic is the "Donald Duck" sound of the Wah-Wah mute. The difference-spectrum shows the alternating formants and antiformants. The foundamental is very faint. The strong partials around 1.5 kHz entail the nasal timbe. Some more examples for particular characteristics of other types: The "classical" Straight mute has weak low partials, a formant around 2 kHz and an antiformant at 4 kHz. The Velvet produces no antiformant or formant. It darkens the sound by attenuating generally high frequencies. (Frequencies with small wavelengths disappear in the cotton wool bucket). The Formants of some mutes correspond with vocal formants. E.g. the Harmon sounds like"ee"(it nickname is bee) and the Plunger sounds in the closed posititon like "oo" (doo-wah discribes the closed-open onomatapoeicly).

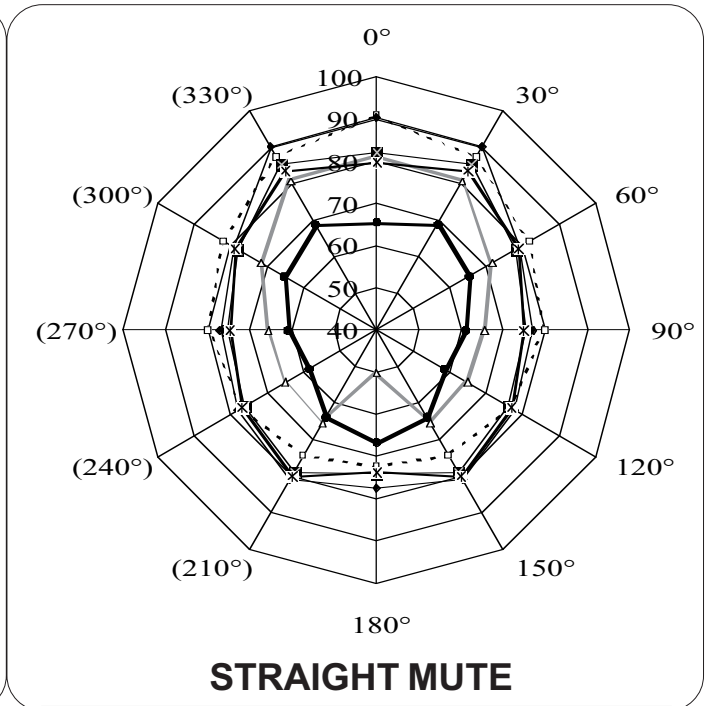


4. Sound Radiation: The radiaton of the trumpet is more or less affected by the use of different trumpet mutes. Measurements with seven mikrophones *(see illustration)* in the anechoic chamber at our Institute allow the analysis of the radiated signal energy in different frequency bands. The four diagramms below show the RMS recorded at the seven positions in 6 bands for the trumpet without mute, the trumpet with Straight,- Harmon- and Velvet mute. The antiformants remain dominant in all directions, through the higher frequencies are much more focused to the 0° frontal direction.



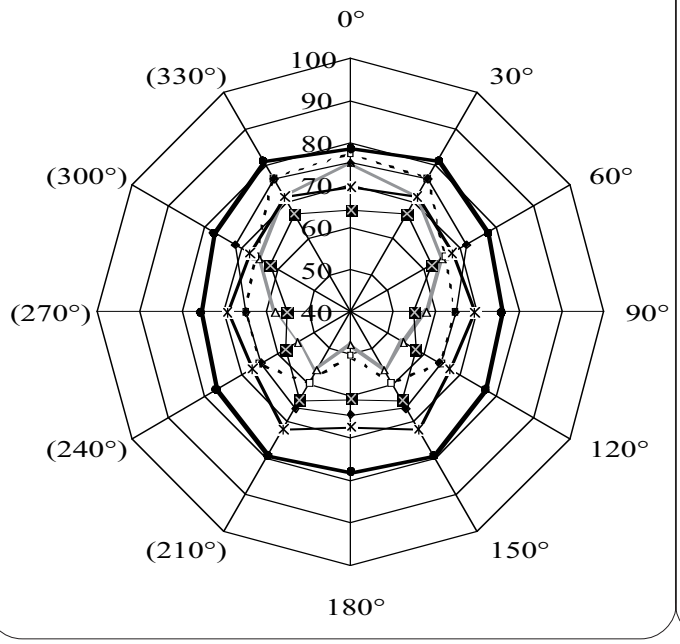


WITHOUT MUTE

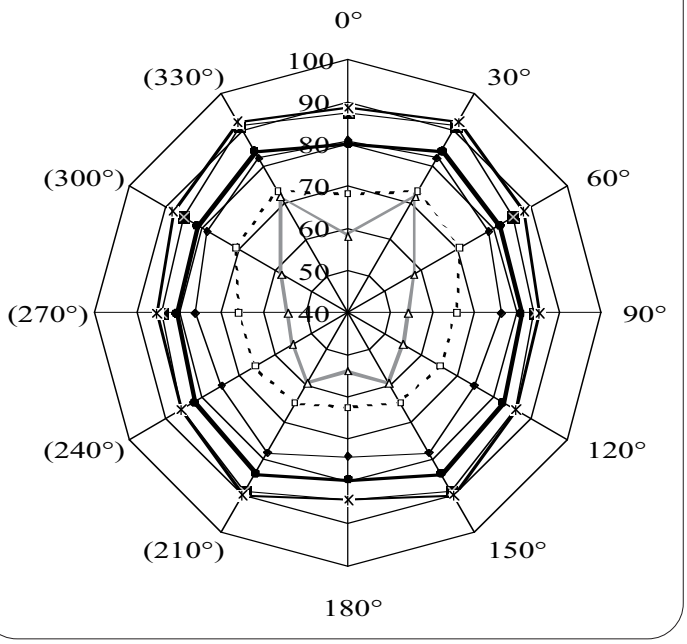


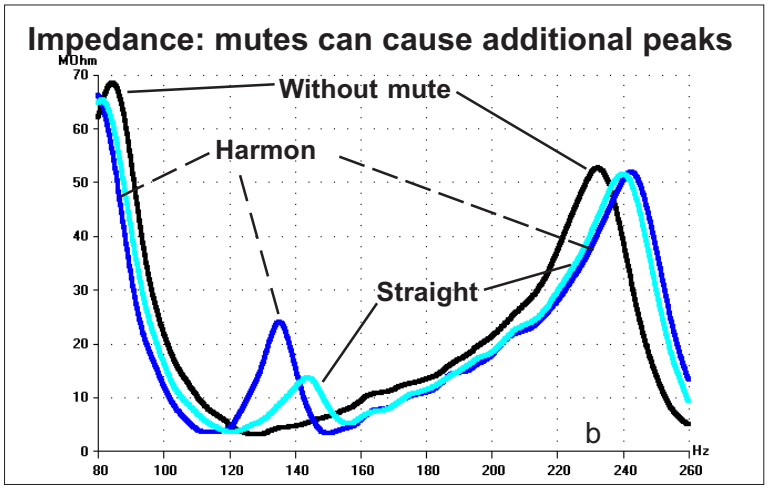
STRAIGHT MUTE

HARMON MUTE

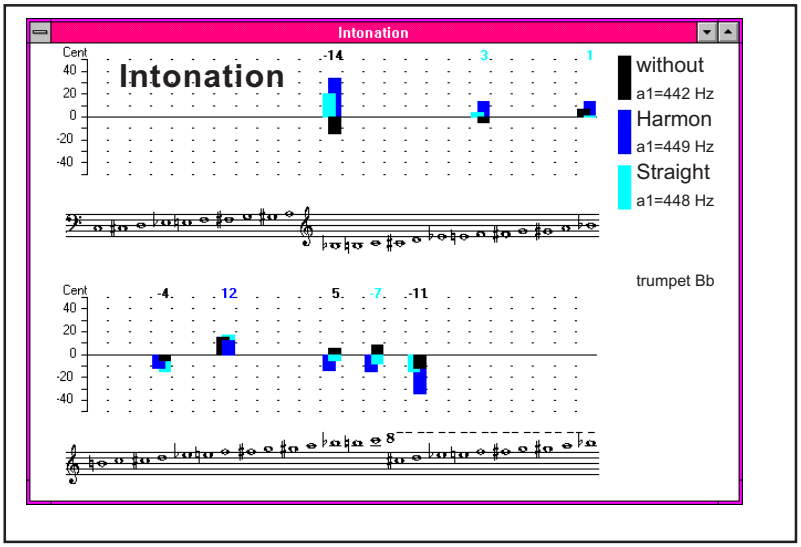


VELVET MUTE





5. Response: Impedance-measurements display the influence of mutes on acoustical behaviour. All investigated mutes - except the Velvet - add an additional resonance peak to the curve. This peak causes a shift-effect on further resonance peaks. The dimension of the shift depends on the positon and magnitude of this additional peak. Good specimens of the Cup-, Straight-, Harmon,- Wah-Wah,- mute push the peak below the playing range of the trumpet, and the unwanted shift is less disturbing. Bad specimens shift, and even suppress resonance peaks of the lower register considerable. The additional peak caused by the Plunger (closed position) is located within the playing range and prevents the sound generation of a "correct" musical pitch. That doesn´t matter, because the Plunger is mostly used for special effects like the "growl-technique". In the impedance graph you can see the additional peaks caused by the use of the Straight and Harmon mute. The lowest blown tone on the B-trumpet (written"c1"-second resonance peak) is shifted to higher frequencies because of the use of the mutes.



. Intonation: The shifts of the resonance-peaks described above influence the intonation. The graph shows one example. In the lower register the trumpet with Wah-Wah mute is much sharper than the trumpet without mute (28 Cent above the values of the equal temperature scale instead of 10 Cent below). The mutes causes a shift not only to the individual resonances but also the intonation in general (which can be reduced with the main tuning slide).

The intonation is less affected because of the use of the Straight, Cup and Bucket mutes, more with the Wah-Wah and Harmon mute and most with the plunger in the closed position (what doesnt matter for most musical purposes). For the most mutes the intonation of the lower playing-range of the instrument is in particular critical.

References: - BACKUS, John. Input impedance curves for the brass instruments. (in: JASA, Vol 60, No2. 1976) - BERTSCH, Matthias. Der Einfluß des Dämpfers auf das akustische Verhalten und die Klangfarbe der Trompete. (Dipl.-Arb.,Universität Wien 1992) - KURKA, Martin. A study of the acoustical effects of mutes on wind instruments. (Chicago, 1961) - MARTIN, Daniel W. Lip Vibrations in a Cornet Mouthpiece (1942) - SLUCHIN, B. CAUSSÉ, R. Sourdine des Cuivres. (Paris, 1991)