Introduction

In 1964 I composed **MIXTUR** (MIXTURE) *for orchestra, 4 sine-wave generators and 4 ring modulators*, work number 16. In 1967, I added a second score entitled **MIXTUR** *for small orchestra* (work number 16 $\frac{1}{2}$). Both were published by *Universal Edition* in Vienna.

I took part in numerous performances as sound projectionist. During this time, many changes and supplements became necessary, especially in regard to dynamics, successions of pitches, timbres, sound equipment, performance practice.

For many years, I had intended to write **a new score** in which all of these experiences were taken into account. In 2003, I wrote this score, entitled **MIXTUR 2003** *for orchestra* (work number 16 $\frac{2}{3}$).

MIXTUR is the genesis of live electronic orchestra music and it has left its imprint on the awareness of electronic sound transformation.

What concerns the ring modulation: In addition to the original analogue equipment which was monitored by ear, with manual regulation of the sine waves, I have also experienced performances using digital equipment and programmed setting of the sine-wave frequencies and glissandi. Presently (2003), I still prefer the "*old*" equipment. Especially when the frequencies are set and changed, and the glissandi are performed by ear by good musicians – interacting with the conductor – a unique quality results.

Concerning the sound mixture: The sound projectionist must regulate a great deal by ear and must practice balancing the 5 groups during all rehearsals. When regulating the general dynamic level, he can support the envelope curves which result. To do this, a mixer with 8 VCA faders is very useful. The overall sound should be full, spatially plastic. To accomplish this, it is important that the front loudspeakers are not hung above the stage apron, but rather further to the back, **above** the orchestra. The rear loudspeakers should be spread apart as shown in the drawing on page XV.

The unmodulated and modulated orchestra sounds should be equally loud; the sound of the modulated orchestra should even be slightly louder. Especially the low ring modulation – which should be heard **as rhyhm** – must be as strong as possible.

Instrumentation with 35 players

Tuning: A = 440 Hz.

SCH = **3 percussionists,**
each with one tam-tam and one cymbal.

H = **4 woodwind players**: flute (also piccolo flute),
oboe,
clarinet (also E-flat clarinet and bass clarinet),
bassoon (also contrabassoon).

S = **8 ARCO strings**: 4 violins,
2 violas,
1 violoncello,
1 double bass.

P = **8 PIZZICATO strings**: 4 violins,
2 violas,
1 violoncello,
1 double bass.

B = **4 brass players**: trumpet,
horn 1 (high),
horn 2 (low),
trombone (with F-attachment).

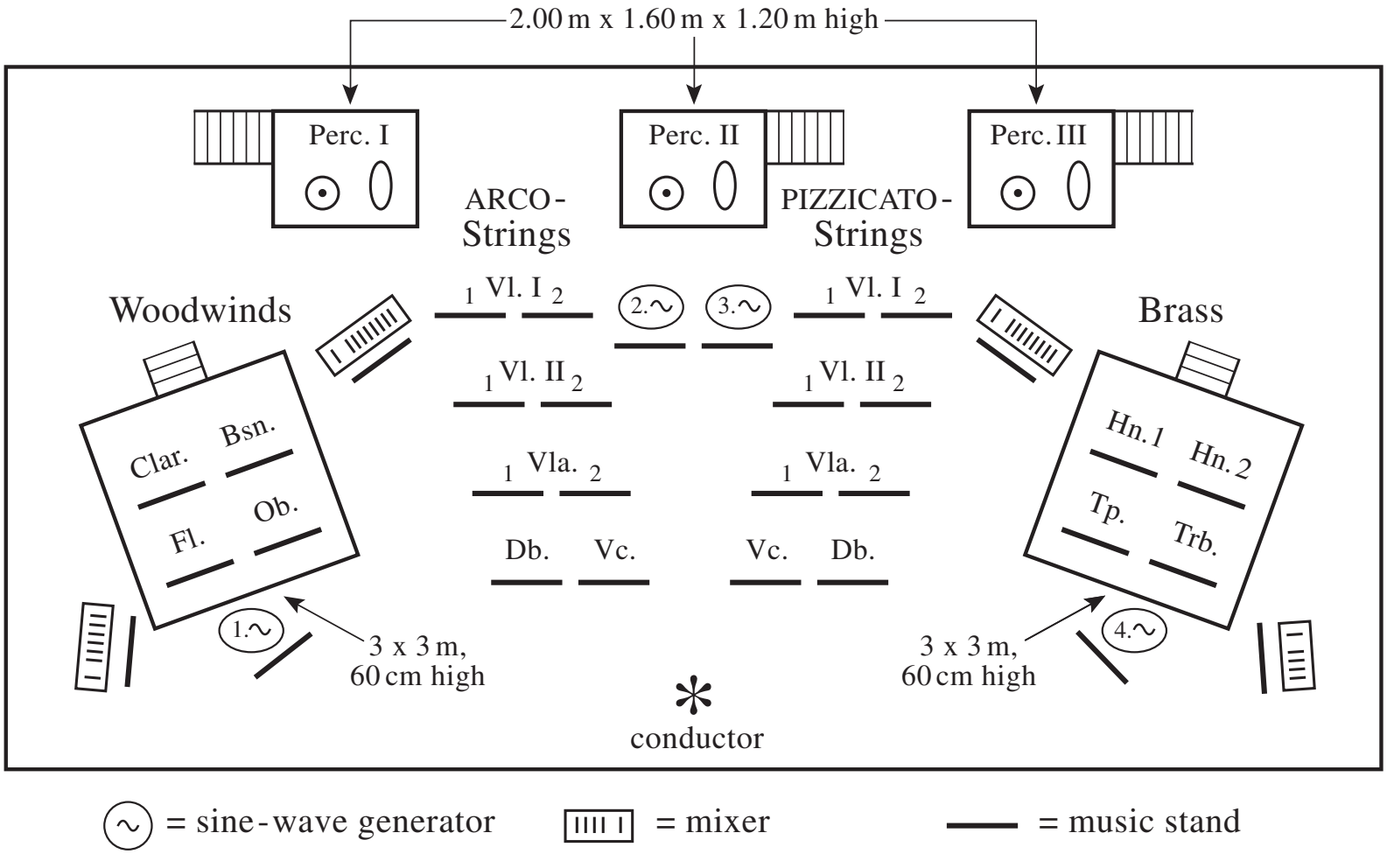
4 sine-wave generators: 4 players.

4 small mixers with 4 ring modulators : 4 sound mixers.

Suggestion for clothing (coloured shirts)

1st percussionist *dark blue*; 2nd percussionist *orange*; 3rd percussionist *violet*;
WOODWINDS *bright blue* (also sine-wave player and mixer);
ARCO strings *yellow* (also sine-wave player and mixer);
PIZZICATO strings *bright green* (also sine-wave player and mixer);
BRASS *bright red* (also sine-wave player and mixer);
conductor *white* or other; sound projectionist *burgundy*; technicians *black*.

Seating plan



Each group and each percussionist must be **lit individually**.

Equipment for MIXTUR 2003

Sound equipment for tutti rehearsals and performance

24 microphones (6 **H**, 7 **S**, 7 **P**, 4 **B**);
2 contact microphones for 2 double basses;
6 contact microphones for percussion;
4 mixers on the stage (one with 4 →4, one with 6→4, two with 8 →4);
1 mixing console in the hall (14 inputs, 9 outputs), with 8 VCA faders;
5 sine-wave generators (10 000–32 Hz / 32– 0.2 Hz, with **one** switch, or none): (1.~) (2.~) (3.~) (4.~) plus a fifth one for rehearsals;
4 ring modulators;
4 earphones for the sine-wave generator players.
7 loudpeakers are suspended high above the stage: four of them about 6 m high above the orchestra groups **H – S – P – B**, and between them, slightly to the rear and lower (ca. 4 m high), three for the 3 percussionists.
4 monitor loudspeakers for the 4 sound mixers stand on the stage.

2 x 2 loudspeakers stand or are suspended about 4.5 high in the **rear** of the hall at the left and right. These loudspeakers are for the **softer** projection of the 4 ring-modulated orchestra groups (not the percussion instruments) distributed stereophonically from the left to right, to create a surrounding spatial sound with clear orientation toward the front.

Sound equipment for 2 rehearsal rooms

During the first 4 days of rehearsals, rehearsals take place in **2 rooms simultaneously** (see ***Rehearsals*** on page XVI).

In the larger **room A**, 8 ARCO **or** 8 PIZZICATO strings rehearse in alternation, each group with its **sine-wave generator player** and **sound mixer**.

Also the 3 PERCUSSIONISTS rehearse in this **room A** (see ***Set-up in 2 rehearsal rooms*** on p. XVI).

In **room B**, the winds rehearse: 4 WOODWINDS **or** 4 BRASS in alternation, each group with its **sine-wave generator player** and **sound mixer** (see p. XII) The 4 sine-wave generator players also rehearse in this room B (see ***Set-up in 2 rehearsal rooms*** on p. XVI).

For the sectional rehearsals the **following equipment** is necessary:

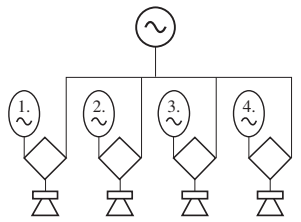
in room A
2 x 7 microphones, so that the positions for the ARCO strings and PIZZICATO strings do not have to be changed between rehearsals;
2 contact microphones for the 2 double basses;
6 contact microphones (3 x 2) for the 3 percussionists;
2 sine-wave generators;
2 earphones for the sine-wave generator players;
2 mixers having 8 inputs each for the sound mixers with 2 ring modulators;
2 monitor loudspeakers for the sound mixers;
1 mixer for the outputs of the
2 ring modulators,
2 mixers,
6 inputs of the 6 percussion contact microphones;
2 x 2 loudspeakers on stands at the left and right for hearing the total sound.

For sectional rehearsals of the 4 sine-wave generators with the ring modulators, the equipment is moved from room A to room B: see ***Rehearsals*** on page XVI.

in room B
6 und 4 microphones for the woodwinds and brass respectively, so that the positions do not have to be changed even if the groups alternate;
2 sine-wave generators;
2 earphones for the sine-wave generator players;
2 small mixers for the sound mixers with 2 ring modulators;
2 monitor loudspeakers for the sound mixers;
1 mixer for the outputs of the 2 ring modulators,
2 mixers;
2 x 2 loudspeakers on stands at the left and right for monitoring the total sound.

For both rehearsal rooms the following personnel is necessary:
2 sound technicians (who are responsible for both rooms),
1 sound projecionist.

For the **rehearsals** of the 4 sine-wave generator players, either a 5th sine-wave generator (eg. with a constant 880 Hz) is circuited to the 4 second inputs of the ring modulators instead of the microphones, and their outputs are circuited to the loudspeakers,



or the 4 sine-wave generators **unmodulated** are heard directly over 4 monitor loudspeakers, the volumes of which can be controlled by the players themselves.

Each of the 4 sine-wave generator players must be able to hear his sine-tones over **earphones**.

The 4 small stage mixers must have *Vu-Meters* or better volume indicators. If high quality equipment is used, then **limiters** are recommended.

In addition to the sound projectionist, the 4 sine-wave generator players, and the 4 sound mixers, also **2 sound technicians** should participate: one for regularly testing the sine-wave generators and mixers, and the other one for setting up, adjusting and checking all the microphones. Therefore, **all sectional rehearsals** are to take place **with sound equipment** in the separate rooms, and the equipment should remain unchanged from rehearsal to rehearsal.

For the evening rehearsals with all 4 sine-wave generators and 4 small mixers, those from room A have to be moved to room B. Room B, where the small groups rehearse, must be large enough so that the loudspeakers can be set up far enough from the instruments.

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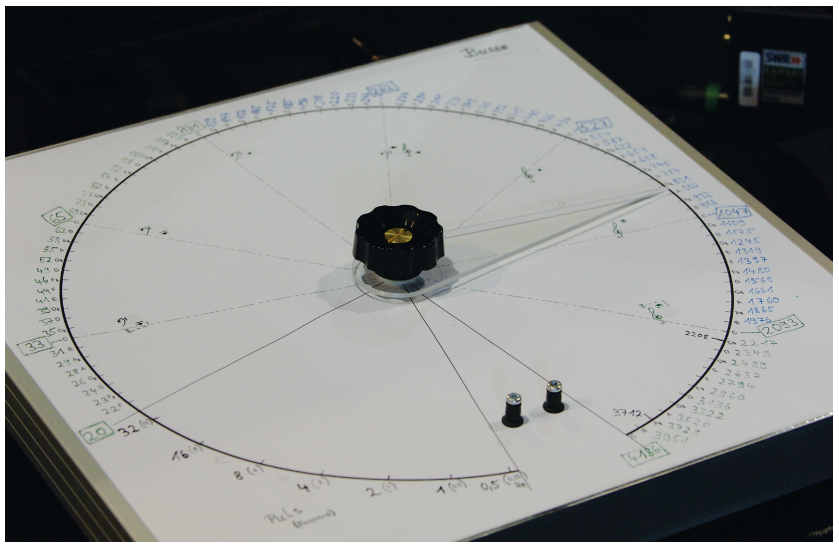
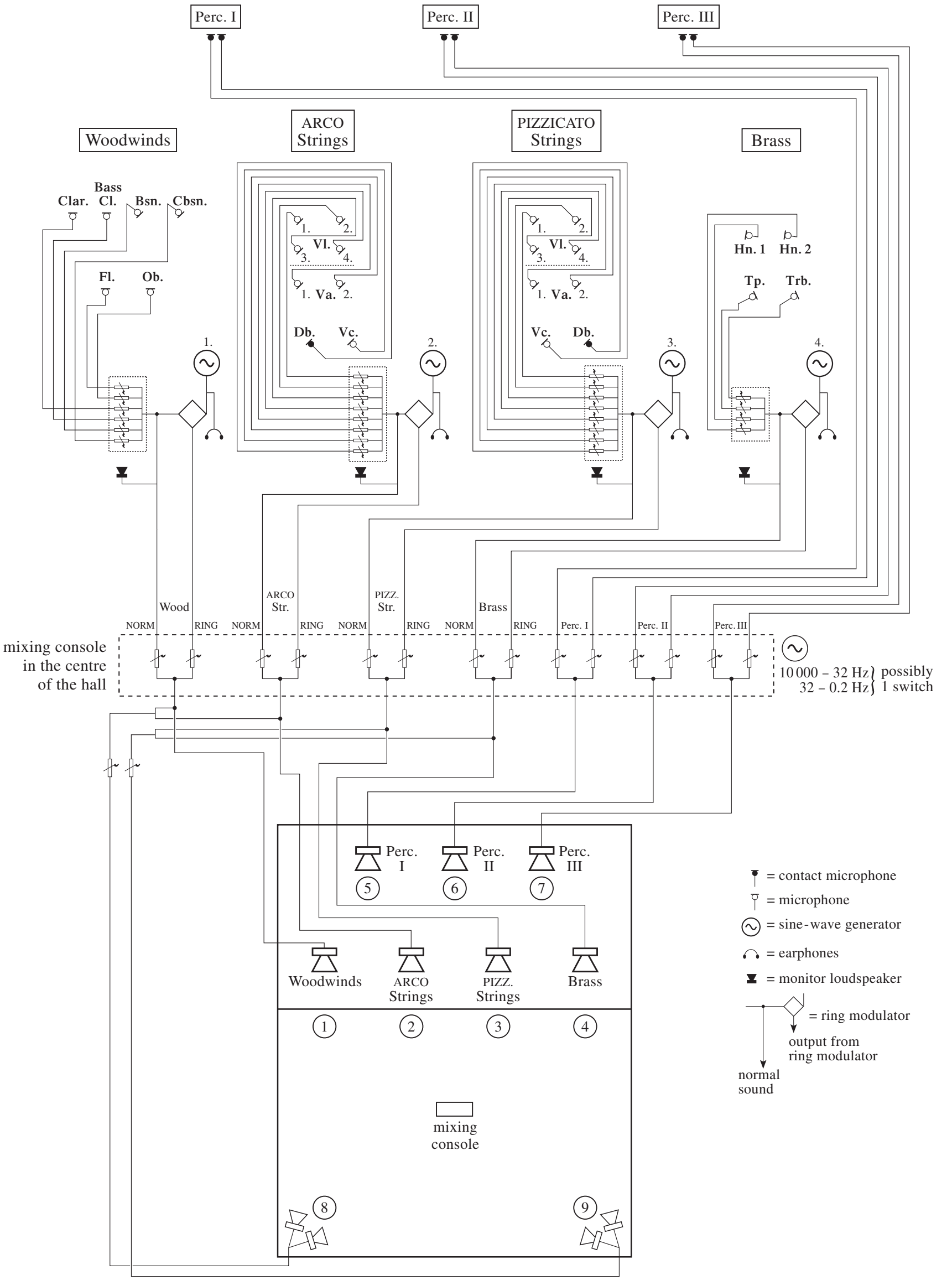


Das speziell im Freiburger *Experimentalstudio für akustische Kunst e.V.* entwickelte Steuergerät eines Sinusgenerators: eine kreisrunde Scheibe mit Eintragungen des Spielers für die 12-oktavige Frequenz-Papierscheibe, und von der Mitte der Scheibe aus ein Plexiglas-Pfeil, der mit dem Knopf in der Mitte von Hand gedreht wird.

This device for controlling a sine-wave generator was specially designed by the *Experimental Studio for Acoustical Art* in Freiburg: The player's entries may be seen on the calibrated paper circle which encompasses the 12-octave frequency range. A plexiglas arrow extending from the middle of the disc can be turned manually using the knob in the middle.

Circuit diagram



Rehearsals

The rehearsals of the **6 groups** WOOD - ARCO - PIZZICATO - BRASS - PERCUSSION - 4 SINE-WAVE generators with ring modulators and sound mixers **on 4 days** necessitates having a **conducting assistant** in order to rehearse in **2 rooms** simultaneously: **Room A** for 2 x 10 plus 3 players (ARCO and PIZZICATO strings in alternation, each with one sine-wave generator player and one sound mixer; 3 percussionists; conductor; 4 loudspeakers); **Room B** for 2 x 6 players (WOOD and BRASS in alternation, each with one sine-wave generator player and one sound mixer; assistant conductor; 4 loudspeakers).

Rehearsals for the world première with the *Deutsche Symphonie-Orchester Berlin* from August 21st–25th 2006 in Berlin and from August 26th–30th in Salzburg:

1st day	**Set-up in 2 rehearsal rooms.**				
	Conductor in room A (larger room):			**Conductor's assistant in room B:**	
2nd day	10.00–13.00 ARCO strings	15.30–18.30 PIZZ. strings	19.00–20.30 PERC.	10.00–13.00 WOOD	15.30–18.30 BRASS	19.00–20.30 SINE
3rd day	The same.					
4th day	The same, but conductor and assistant conductor exchange rooms: assistant with ARCO, PIZZ. and PERC. in **room A**, conductor with WOOD, BRASS and SINE in **room B**.					
5th day	The same as the 4th day.					
6th day	Set-up of the sound equipment in the concert hall.					
7th day	10.00–13.00 technical tests / 16.00–19.00 tutti rehearsal.					
8th day	10.00–13.00 / 16.00–19.00 tutti rehearsals.					
9th day	10.00–13.00 / 16.00–19.00 tutti rehearsals.					
10th day	Dress rehearsal 10.00–13.00 and performance in the evening.					

1 more day of rehearsals is recommended for the strings.

Set-up in 2 rehearsal rooms

For the rehearsals of MIXTUR 2003, the following must be prepared:

1. In **ROOM A**, set up at the *half-left* (as seen by the conductor):

   8 chairs and 8 music stands for the ARCO strings (1 stool for the double bass),
   2 chairs, 2 tables and 2 music stands for the sine-wave generator player and sound mixer,
   1 music stand and 1 stool for the conductor,

   At the *half-right* in **ROOM A**:

   8 chairs and 8 music stands for the PIZZICATO strings (1 stool for the double bass),
   2 chairs, 2 tables and 2 music stands for the sine-wave generator players and sound mixers.

   On the stage at the *left*, *middle* and *right* in **ROOM A**:
   3 music stands and 3 chairs for the percussionists,
   low, middle and high-pitched tam-tams and 3 cymbals, with 3 tables for the percussion instruments.

   In Berlin (2006) the **hall mixing console** was set up in this room A and the sound projectionist took part in all rehearsals.

2. In **ROOM B**, the following should be set up at the *half-left*:

   4 chairs and 4 music stands for the woodwinds,
   2 chairs, 2 tables, and 2 music stands for the sine-wave generator players and sound mixers,
   1 music stand and 1 stool for the conductor.

   At the *half-right* in **ROOM B**:

   4 chairs, 4 music stands and 4 mute stands for the brass players,
   2 chairs, 2 tables and 2 music stands for the sine-wave generator players and sound mixers.

These set-ups remain for all the sectional rehearsals.

It is recommended that both the conductor and assistant conductor use a small portable keyboard to check the pitches of the sine-waves.

Programme

MIXTUR 2003 should be performed in **two versions**:

MIXTUR 2003 *Forward Version* (ca. 30')

– intermission –

MIXTUR 2003 *Backward Version* (ca. 30')

Thus, the sound equipment can remain in place (microphones, podia, music stands, small mixers, sine-wave generators, loudspeakers, mixing console in the hall).

There are two scores for the two versions (bound together) and different sets of parts (also bound together).

If the two versions of MIXTUR are performed in the same concert, it would be possible – directly following the intermission –to have a spoken introduction or to project a **4-track work** before performing the *Backward Version*, for instance the electronic music GESANG DER JÜNGLINGE (ca. 13 $\frac{1}{2}$ Min.).

Beauty of mirrored overtone harmonies

The essential aspect of MIXTUR is, on one hand, the transformation of the familiar orchestra sound into a new, enchanting world of sound. It is an unbelievable experience, for example, to see and hear string players bowing a sustained tone and to simultaneously perceive how this tone slowly moves away from itself in a glissando, the pulse accelerates, and a wonderful timbre spectrum emerges. Orchestra musicians are astonished when they hear the notes they play being modulated timbrally, melodically, rhythmically, and dynamically. All shades of the transitions from tone to noise, noise to chord, from timbre to rhythm and rhythm to pitch come into being from such *ring modulations,* as if by themselves.

Finest **micro-intervals**, extreme **glissandi** and **register changes**, **percussive attacks** resulting from normally smooth entrances, **complex harmonies** (also above single instrumental tones), and many other unheard-of sound events result from this modulation technique and from the variable structuring.

Secondly, the *ring modulation* adds new **overtone**- and **sub-tone series** to the instrumental spectra, which can be clearly heard, especially during sustained sounds in MIXTUR. Such mixtures do not occur in nature or with traditional instruments. Through these **mirrored overtone harmonies**, one is moved by alien, haunting sensations of beauty, which are completely new in art music.

Only such renewal in how music affects us imbues new techniques with meaning.

MIXTUR was the genesis of ***live electronic music*** which, in the four decades since its birth, has already developed multifariously, as witnessed by many parts of my work, LICHT.

Notation

1 = moment 1 of 20 moments.

3.1 = Page 1 of moment 3.

SCH = 3 percussionists:

I ⊥ = relatively low-pitched cymbal,
◯ = 1 relatively low-pitched tam-tam.

II ⊥ = middle- to high-pitched cymbal,
◯ = middle- to high-pitched tam-tam,

III ⊥ = relatively high-pitched cymbal,
◯ = relatively high-pitched tam-tam.

Each percussionist is seated with quite a large cymbal ⊥ **in front** of him (her) and a tam-tam ◯ (ca. 60–80 cm Ø) **at his left**; the cymbal is on a stand so that it is seen from above; the tam-tam is hung in such a way that it is possible to *scratch*, *rub*, and *scrape* its surface (usually the edge of the back) while seated. A small table with the utensils with which the cymbal and tam-tam are played is in front of him, next to the music stand.

The tam-tams should have a rough surface, not a smooth one like PAISTE tam-tams usually have, so that a **tone** is produced by rubbing it (for example by exerting pressure on the end of a drumstick).

The rack for the music is above the cymbal. The chairs must be **high** enough so that it is possible to easily see the conductor over the music.

For the rehearsals and performance, each of the 3 x 2 instruments are amplified using contact microphones.

A **special rehearsal room** should be reserved for the percussionists, where they can rehearse by themselves during the day. It should not be too far away from room A so that their instruments, music stands and chairs can be moved there.

The instruments are **seldom struck** in the normal way. The percussion technique of MIXTUR originated in my works KONTAKTE, MIKROPHONIE I, MOMENTE, etc. Therefore, each player must prepare and experiment with a selection of small **tin cans** with sharp edges, **plastic** and **cardboard boxes** with hard edges, and relatively narrow **cardboard tubes**.

For some places iron clappers (as in cowbells) are needed, for instance percussionist 3, bar (8) *Knall (bang)*.

For some beats, a stick may also be used.

Where ***Schlag*** (***beat***) is indicated, one of the utensils (for instance a metal can, as in bar (62)) is used for beating.

In the **solo of the 3 percussionists** (bars (8) to (16)) and at other places (for instance (116) to (122) etc.) the desired timbre is described using words such as : *Schrei (shriek) - Knall (bang) - kreisch (screech) - heulen (howl) - quietschen (squeak) - kratzen (scratch)*, or with **phonetic syllables** such as [kɛŋ] - [brrɑʃ] - [hʊ–rɑm] - [tʊŋ–ʊa] - [kax] - [pʊŋ] - [tɛŋ] - [kri–x] - [pʊŋ] - [ka–i].

For the **tam-tams**, **soft, heavy beaters** are needed for the slow rolls (soft, thick timpani beaters?), for example starting at bar (158).

The word ***Ruck*** (***jerk***) often occurs. To do this, the edge of a metal or plastic box is pressed against the cymbal or tam-tam and is very briefly **jerked**, through which the instrument is **suddenly** set into vibration and resonates.

The three percussionists seemingly "do not have much to do". But it would be good if they would develop their **timbre art** to such an extent that their sounds would mix well with the ring modulated sounds of the orchestra.

In any case, there is much to be discovered and invented.

H = WOODWINDS,
H~ = sine-wave generator for H.
Fl = flute (also piccolo).
Ob = oboe.
Kl = clarinet (also **E-flat clarinet** and **Bkl** = bass clarinet).
Fg = bassoon (also **Kfg** = contrabassoon).

S = STRINGS, who usually play *ARCO*.
S~ = sine-wave generator for ARCO **S**trings.
Vl = violins (1–4).
Va = violas (1–2).
Vc = violoncello.
Kb = double bass.

P = PIZZICATO strings, who occasionally also play **arco**.
P~ = sine-wave generator for P.
Vl = violins (1–4).
Va = violas (1–2).
Vc = violoncello.
Kb = double bass.

B = BRASS,
B~ = sine-wave generator for B.
Tp = trumpet.
Hn 1 = horn 1 (high).
Hn 2 = horn 2 (low).
Pos = trombone.

Horns: ○ = open;
\+ = stopped;
● = quasi closed,
○–● = quickly close (from open);
●–○ = quickly open (from closed), occasionally also long transitions (e.g. bars (206)/(207) or (214)).

Dämpfer (mute) = insert mute, ∅ = remove mute.

Trumpet and trombone:

(W) = wawa mute: ○ = open, ● = nearly closed,
○——● = gradually close,
●——○ = gradually open.

(Spitz) = straight mute.

(C) = cup mute.

Dpf. = mute.

∅ = remove mute.

Flzg. = flutter-tongue.

norm. = normal.

pont. = *sul ponticello* (at the bridge).

tasto = *sul tasto*.

legno = *col legno tratto* (with wood and hair).

batt. = *col legno battuto*, but clear pitch.

(See the signs for **special** ways of playing in 13.1 to 13.7 etc.)