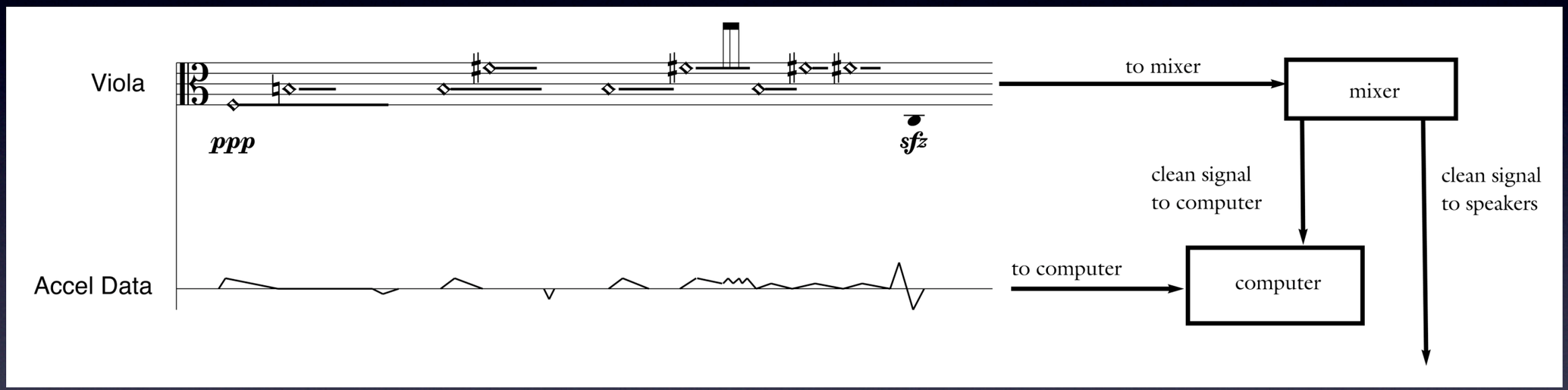
Aperture for viola and real-time electronics

Richard Karpen

The following pages provide descriptions of the computer processes for *Aperture for viola and live electronics*. All processes are labelled with a letter, and appear in the analysis score to show where they appear in the recording of *Aperture.*

General notes:

1. The viola is amplified through the use of a microphone attached to the viola. The clean viola signal is sent straight to the mixer. This signal is independently routed out to the performance speakers and into a buffer of memory on the computer. The entire viola performance is captured into this buffer, so it is essential that the computer has enough RAM to capture the signal, and that this RAM is allocated before the actual performance begins (at least 25 minutes worth of memory is needed).
2. Many processes depend on the use of an accelerometer to track the changes of velocity in the bow. A three axis accelerometer is needed so the effects of gravity can be detected and cancelled out. A single control signal representing the velocity of the bow must be calculated from the axes of the accelerometer to control the signal processing for the piece.


Viola
ppp
sfz
Accel Data
to mixer
mixer
clean signal
to computer
clean signal
to speakers
to computer
computer

Process A:
Brief description - layers past material over live performance.
Details:

1. A time-stamp is taken when the process begins.
2. A window of past material is played back with a duration of 4 to 8 seconds. The starting point for this material is chosen by taking a random value between the starttime of the process and an interpolated value from an envelope based on the time since the process began, plus a random value between zero and five seconds. Values tend to favor material from the beginning of the process. Each window has its own envelope, and is randomly panned in stereo space.
3. Step two is repeated until the process is completed at a specified duration. The scheduling of the next window is calculated according to values polled from an envelope (based on the current elapsed time of the process) and a random function. In general, the longer the process continues, the more overlaps will be created.
4. All output is routed through a global envelope. This envelope takes one second to open to full value, and is sustained until the process is released. The release of the process takes either 14 or 19 seconds. Envelope curves are sinusoidal.
5. Multiple layers of this process may occur at the same time.

~60 seconds

A

A rel.

Viola

pp *f* *pp* *f*

Computer

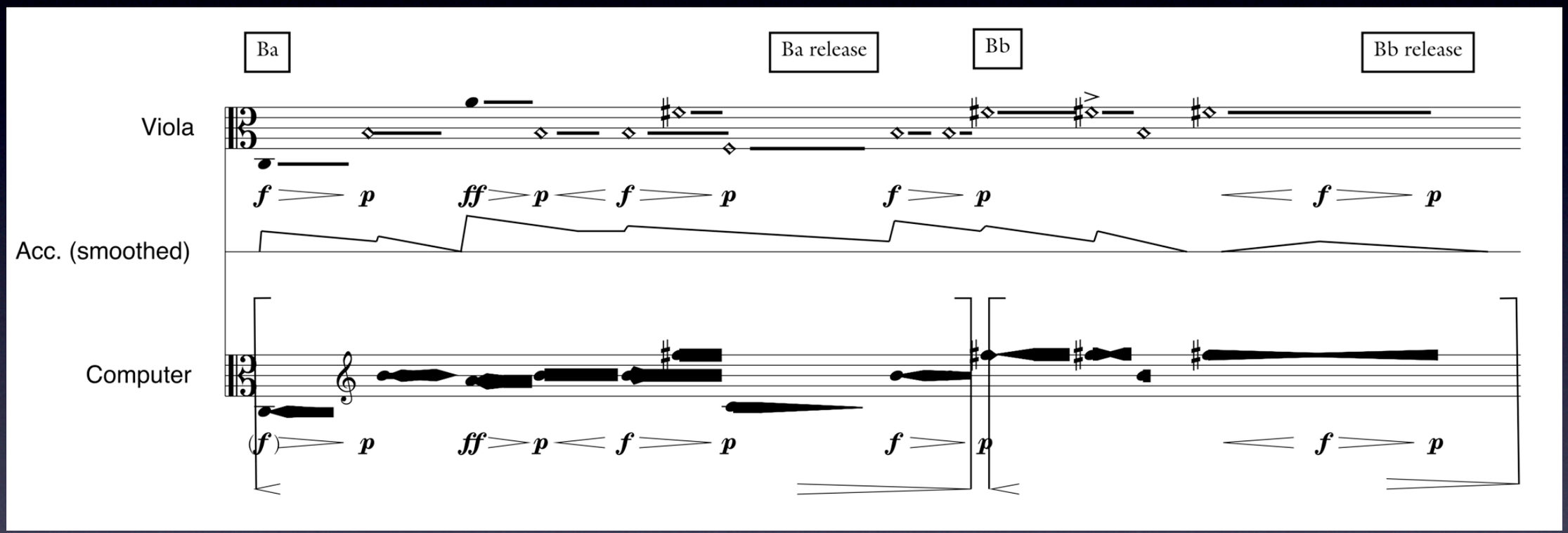
(*f*) *pp* (*f*) *pp*

(*f*) *pp*

global envelope of process A

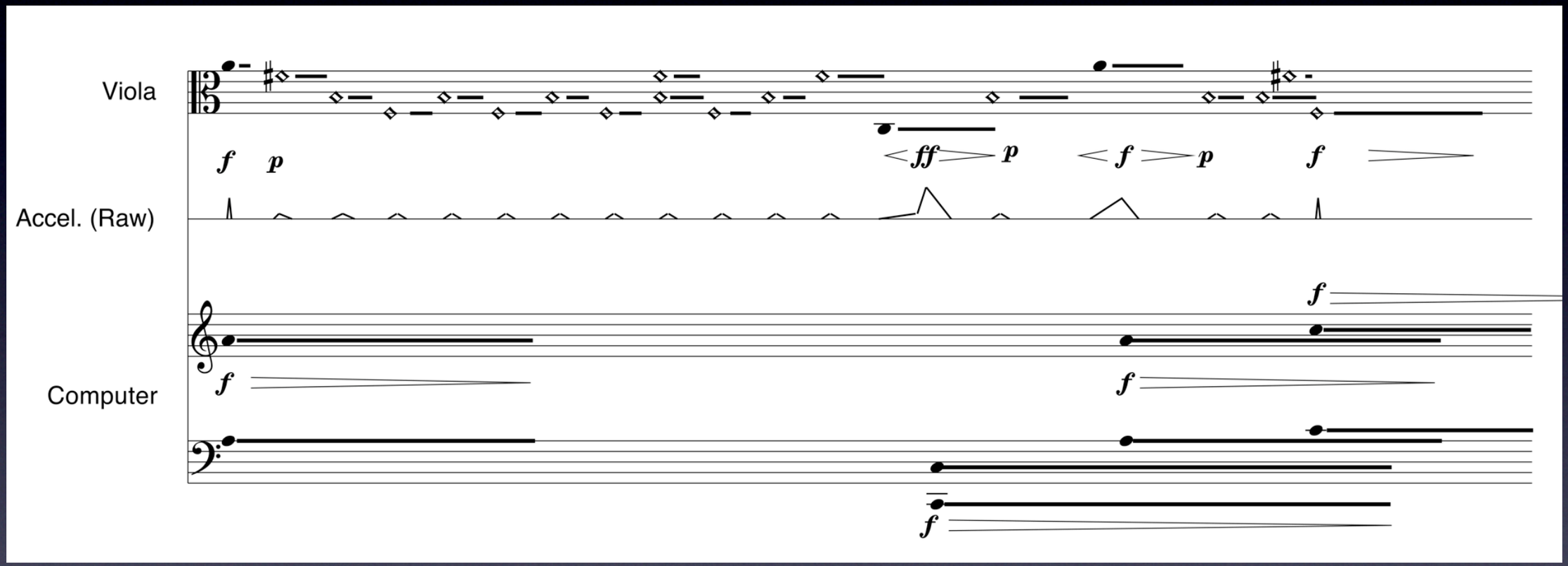
Process Ba and Bb
Brief description - based on the accelerometer input, pitch-shifted layers of the viola input swell around the viola pitch.
Details:

1. Viola input is fed into a number of granular pitch shifting processes.
2. The amount of pitch shift is based on a smoothed version of the accelerometer data that accesses curves stored in an envelope (with 0 equalling the least amount of swell, and 1 the most). This polled envelope data is then multiplied by the maximum amount of swell (approx. 1.5 halfsteps) times a random float between -1.0 and 1.0 (creating dense clusters around the central pitch).
3. Process Ba causes the pitch shifted versions to expand above and below the viola pitch the faster the bow moves. Process Bb causes the pitch shifted layers to focus in on the pitch of the viola the faster the bow moves.
4. All output is routed through a global envelope that takes 0.2 seconds to open, and 5.2 seconds to close after the process is released.
5. Both processes may occur the same time.


Ba
Ba release
Bb
Bb release
Viola
Acc. (smoothed)
Computer

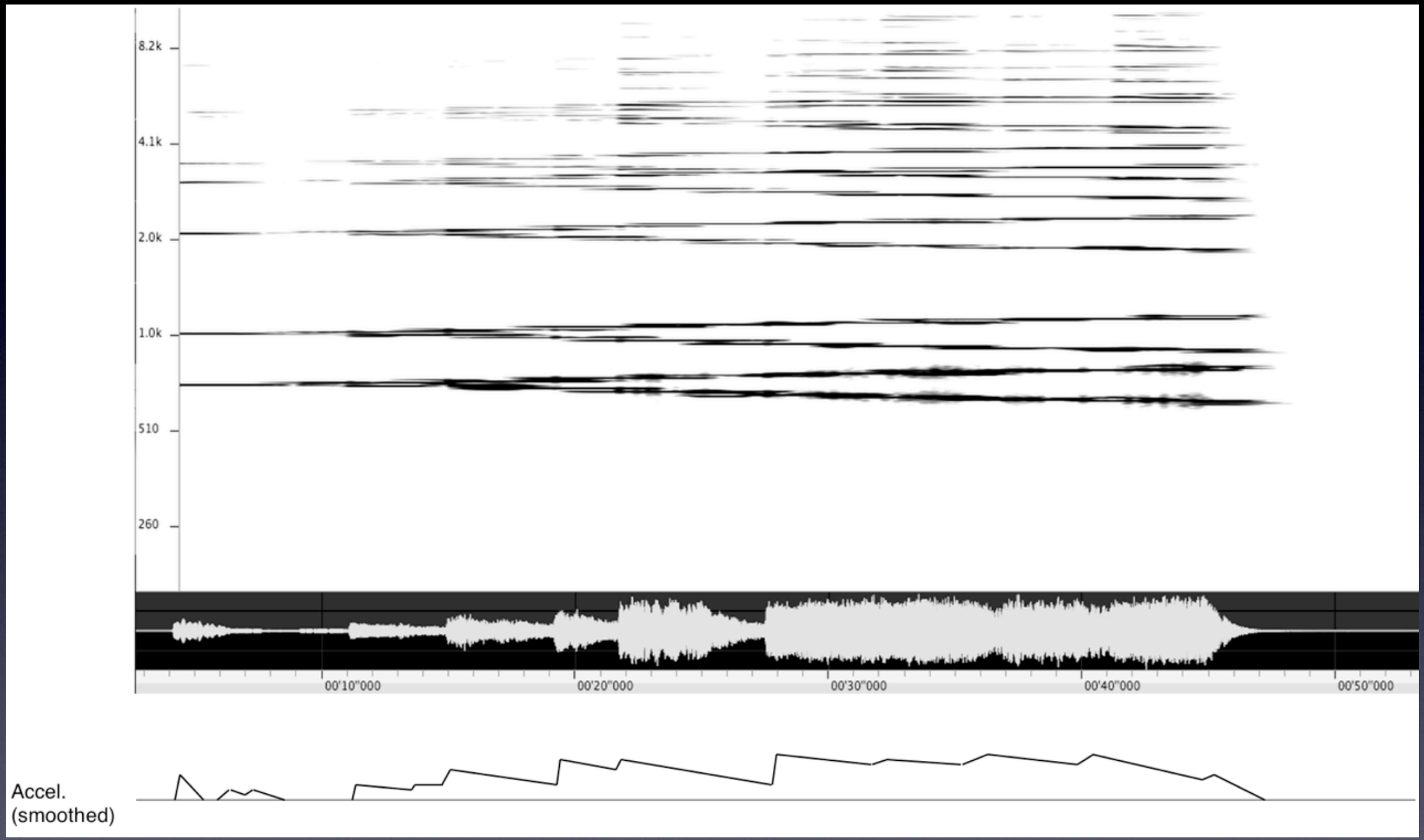
Process C:
Brief description - based on the accelerometer input, stretch and orchestrate specific moments of the performance
Details:

1. When an accelerometer value is read above a specified value, create a trigger.
2. The timestamp of the trigger access the memory buffer containing the recording of the performance.
3. This creates a new instance of a synth where the sound that has just happened is stretched, and additional pitch shifted layers of sound are added to the stretched version to give a larger sound through doublings.


Viola
f
p
ff
p
f
p
f
Accel. (Raw)
f
Computer
f
f
f

Process D:
Brief description - based on the accelerometer input, creates bell like sinusoidal textures.
Details:

1. When an accelerometer value is read above a specified value, create a trigger.
2. The trigger creates a sinusoidal texture with a strong attack. As long as motion continues to be read by the accelerometer, the texture will continue and will spread out spectrally from a central pitch. The amount of motion in the accelerometer once the initial trigger is created will also effect the amplitude of the gesture.
3. When motion ceases, a second trigger records a timestamp.
4. If motion does not resume within a given amount of time from the occurrence of the second trigger, the texture is released, and waits to be triggered again.


8.2k
4.1k
2.0k
1.0k
510
260
00'10"000
00'20"000
00'30"000
00'40"000
00'50"000
Accel.
(smoothed)

The Accelerometer and the SHAKE

In the initial rehearsals and performance of *Aperture*, a custom built three-axis accelerometer was built by Joel Kollin and James Coupe from the Center for Digital Arts and Experimental Media. The device was enclosed in a plastic case that could be strapped onto the wrist of the performer (violist Melia Watras). The device required a cable to supply power to the chip, and returned three voltage signals representing to output from the chip of acceleration values for the x, y and z axes.

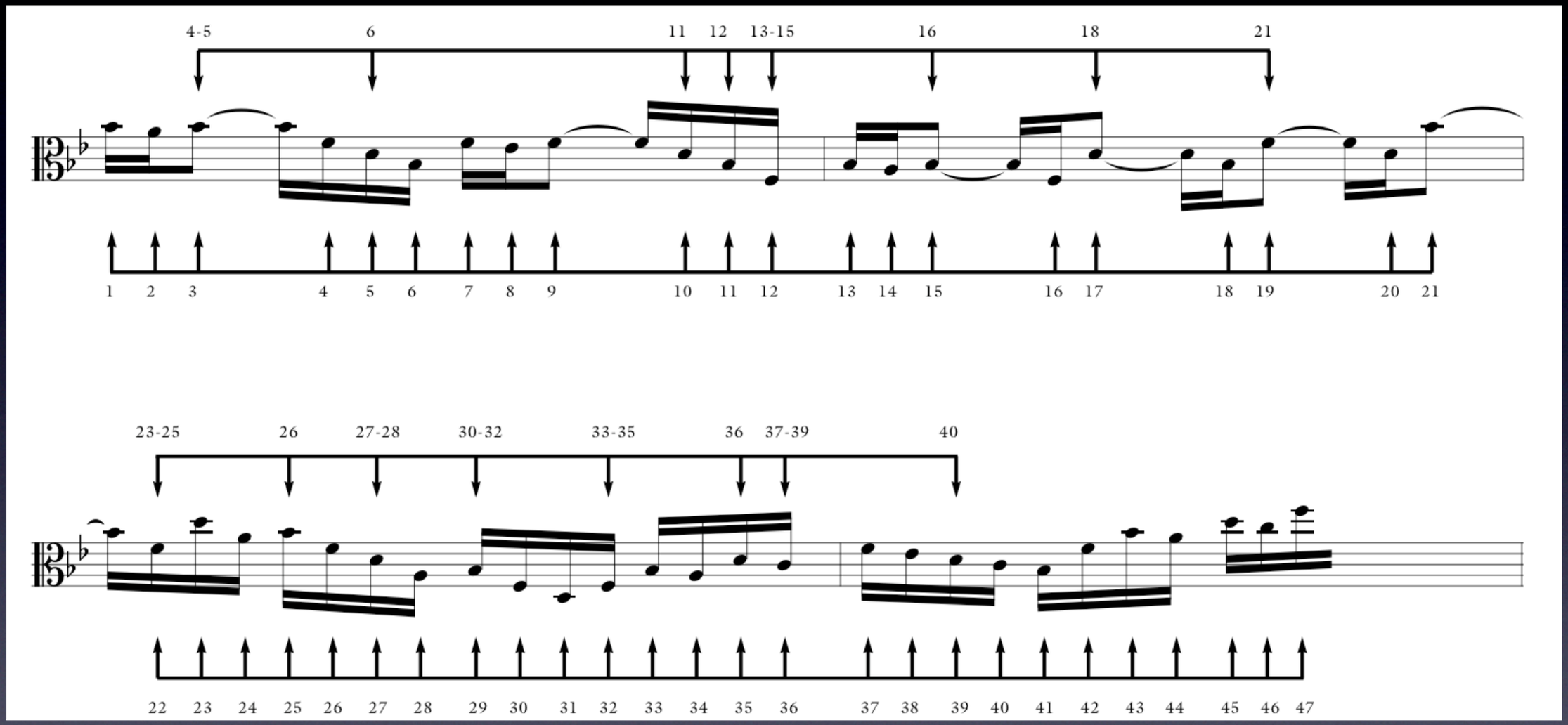
Inside SuperCollider, the voltage signals were read through the audio input. Before performance a calibration was taken for each plane of the device on a flat surface to see what voltage values the device output for +- one gravitational force of acceleration (1g) depending on the orientation of the chip towards Earth. Once these values were known, the voltage signal was sent into a table lookup function to calculate how much acceleration was detected on each plane. One was then subtracted from the sum of the absolute values of these three signals to calculate the amount of acceleration that was present from moving the bow at any given moment. The main draw backs of the original device were the cable (to supply power and retrieve data) and the need to calibrate it often (since the amount of power from the battery could cause readings to change over time).

In Winter 2007/8, work began to interface Stephen Hughes' SHAKE sensor device with SuperCollider to replace the custom built accelerometer. The SHAKE is a bluetooth wireless device with a three axis accelerometer, magnometer, capacitive sensors and optional angular rate sensors (gyroscopes). It has a built in rechargeable battery and can be controlled with ASCII over a serial connection.

For *Aperture*, the accelerometer data from the SHAKE is used in a similar fashion, without the need for constant re-calibration. Accelerometer data is collected at a rate of 50 Hz, and is available to the SuperCollider language and to the synthesis server through the use of control busses.

Instructions for the second half of *Aperture* (10’51”)

Play several slowly bowed long notes on the open A string. After about four bowings, pause for a deep-breath-like moment, then begin again in the same way on the open A string. After a several more As, start to play B-flats and open As, and over time, the As should become less and less prominent. After about 90 seconds, begin to play through the Bach below at an extremely slow temp (there should be approximately 10 seconds of duration between each arrow on the bottom line - usually two bows at a low dynamic level). The upper arrows show notes that are held over and are played as double stops with the lower line. For example, for notes pointed at by 4 and 5 in the lower line, the B-flat shown in the upper line is held over resulting in a double stop. For notes 41-46, the duration is reduced to about 5 seconds (or a single bowing). The dynamic also should gradually increase here. The final note, an F (arrow 47), is held for at least 10 seconds. After the F is held, take a breath, and continue on to the material on page ***


4-5
6
11
12
13-15
16
18
21
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
23-25
26
27-28
30-32
33-35
36
37-39
40
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47

♩≈ 20 *accel* ♩= 140 *(for all measured notes, to end)*

Bb

C

ff

10"

80"

The following is an analytical transcription of the recording of *Aperture*

Aperture for viola and live electronics by Richard Karpen

Documentation of the recording
by Joshua Parmenter

A

A

32″

pp

18″

27″

25″

sfz

D

15″

at the tip ...

at the tip (throughout) ... (throughout)

pp

sfz

24″

pp

21″

13″

sfz

Ba

19″

18″

f *p*

15″

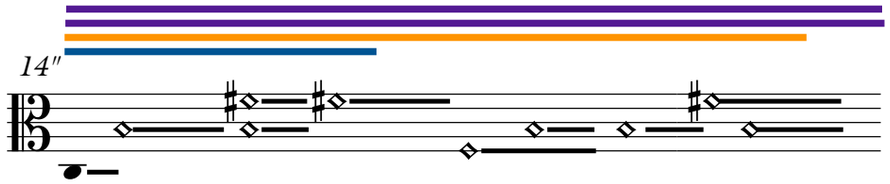
<*ff*>*p* <*f*>

D

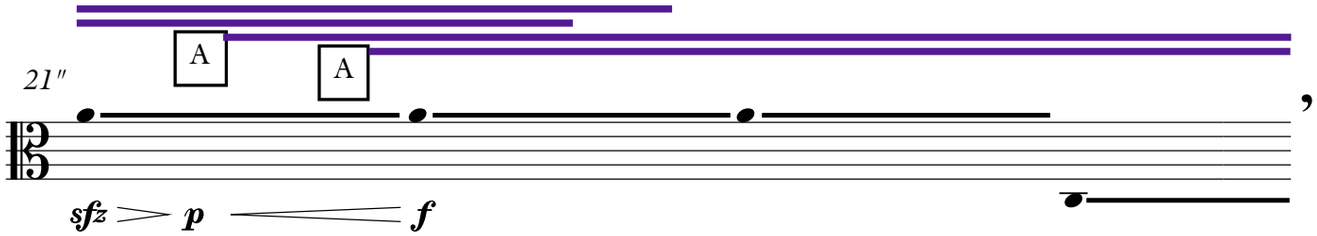
15″

f

14"

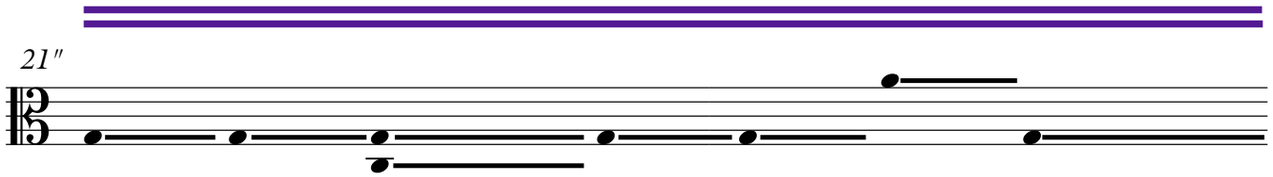


21"

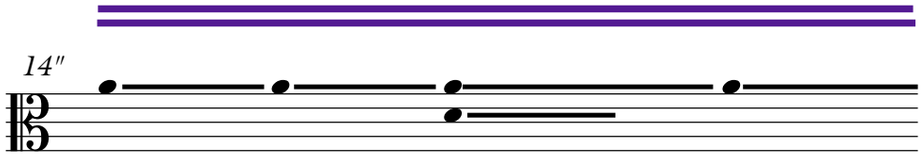


24"

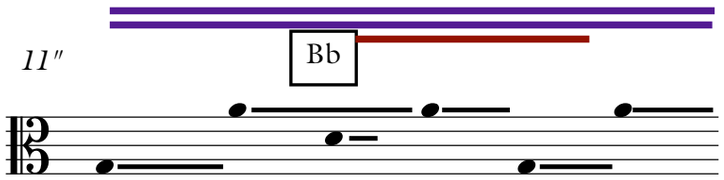
21"

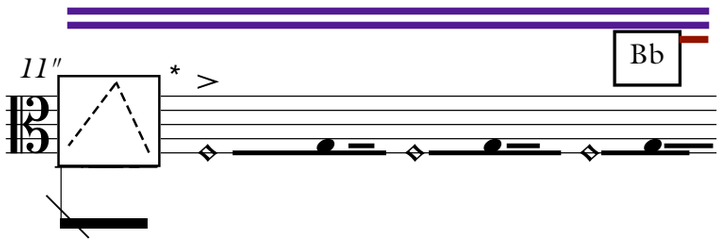


14"

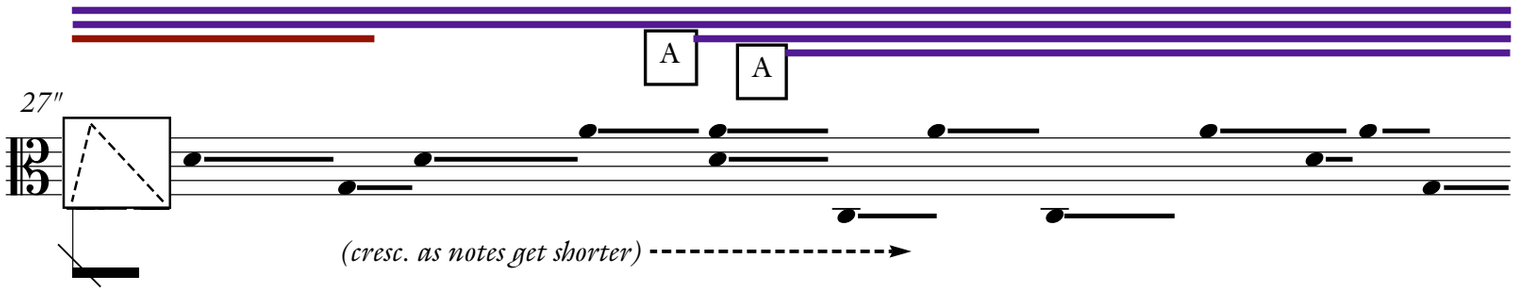


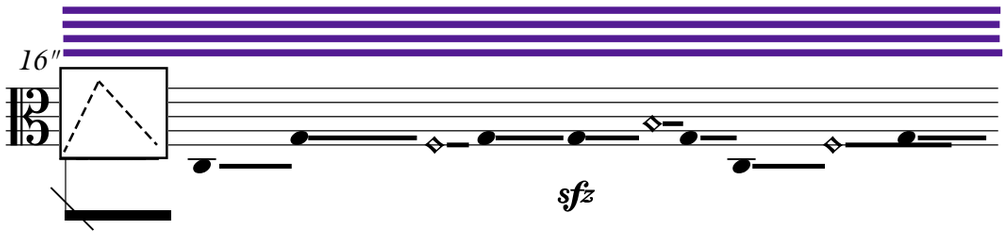
11"

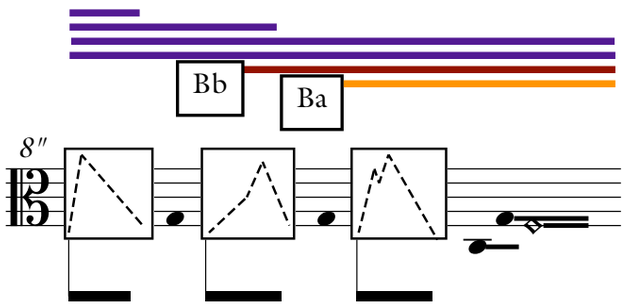


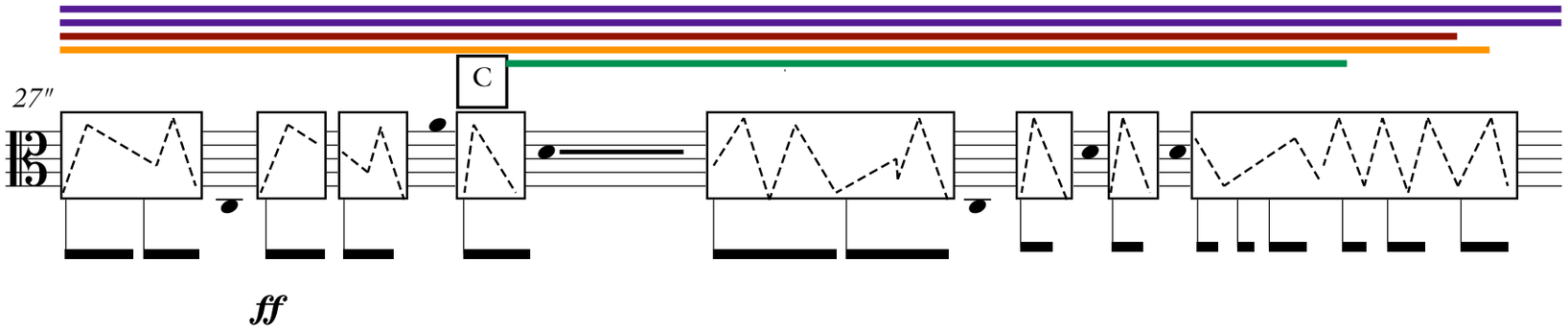


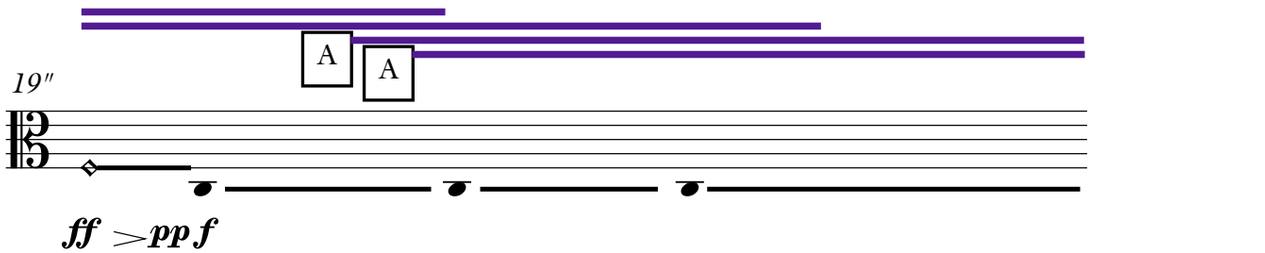
* The rhythm from these gestures come primarily from the bow due to rapid string crossings. The fingers are held nearly straight so that the fleshy part of the fingers lightly touch the strings and move VERY FAST across a number of positions. The shape inside the box gives some idea about how low or high in position the hand is on the fingerboard.

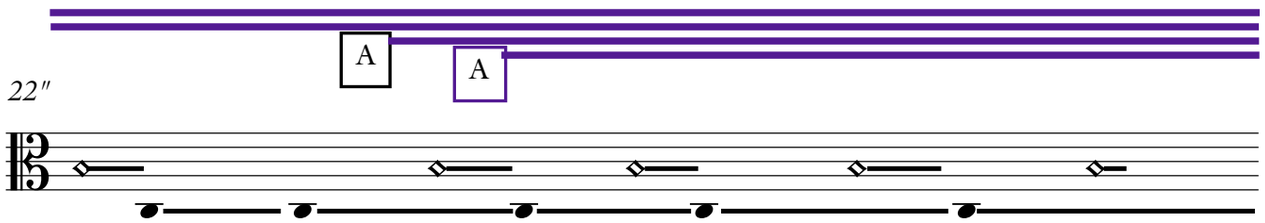


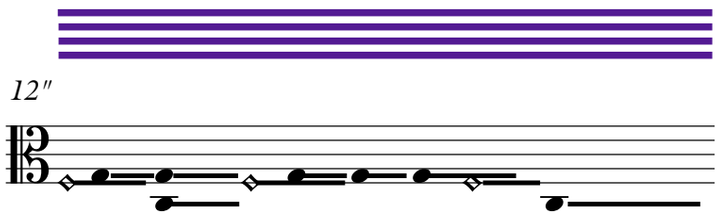


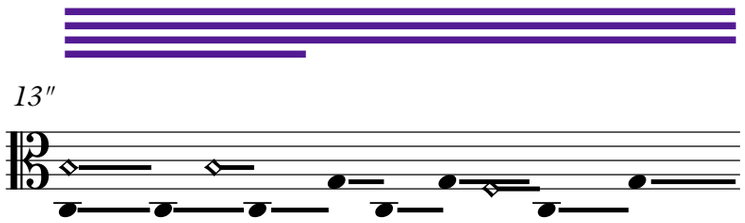


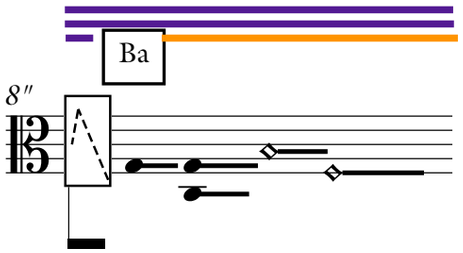


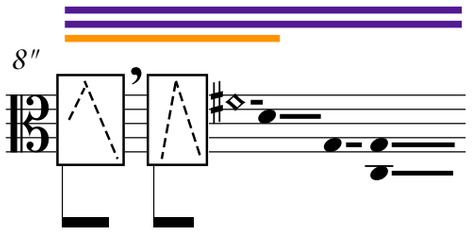

A
A
19"
ff > pp f

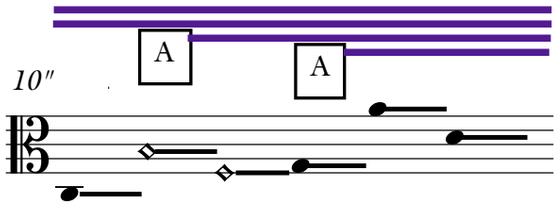

A
A
22"

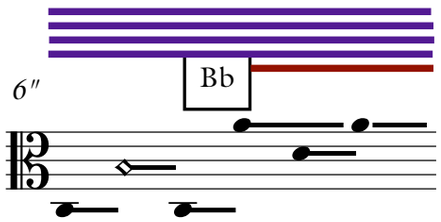

12"

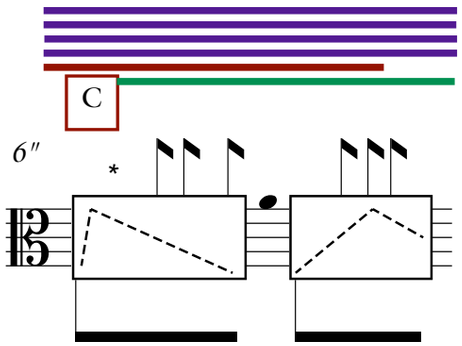

13"


Ba
8"



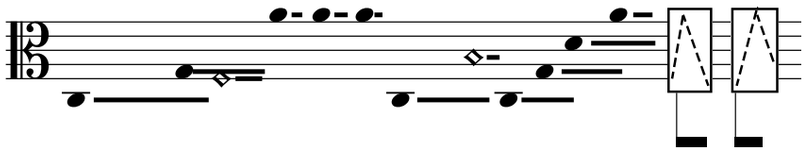




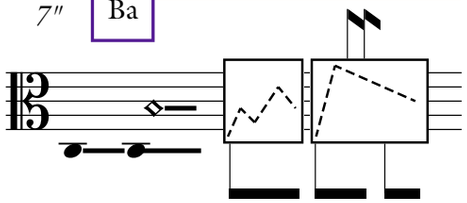


**upward stems represent left hand pizzicatos*

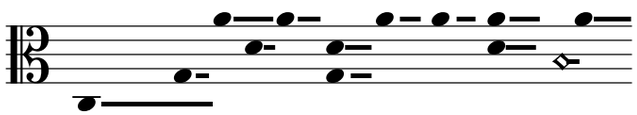
13″



7″ Ba

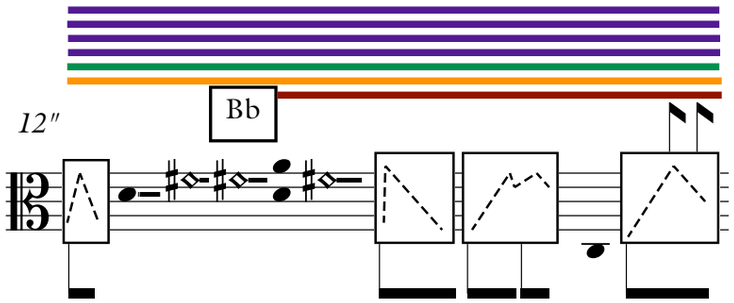


10″

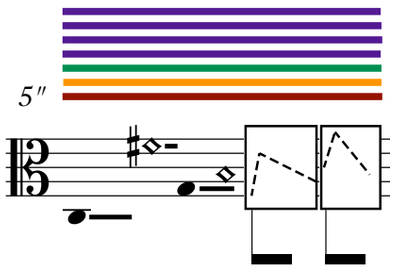


(cresc little by little)

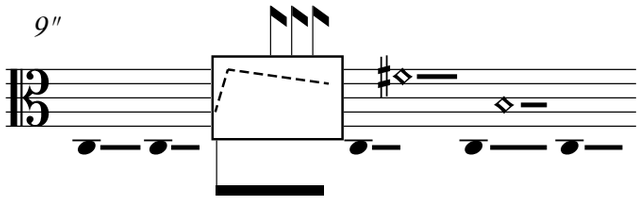
12″ Bb



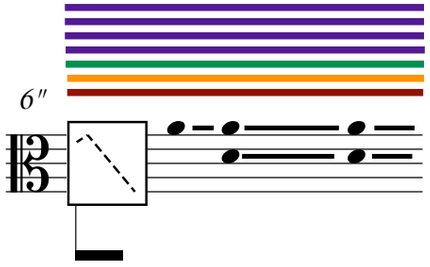
5″



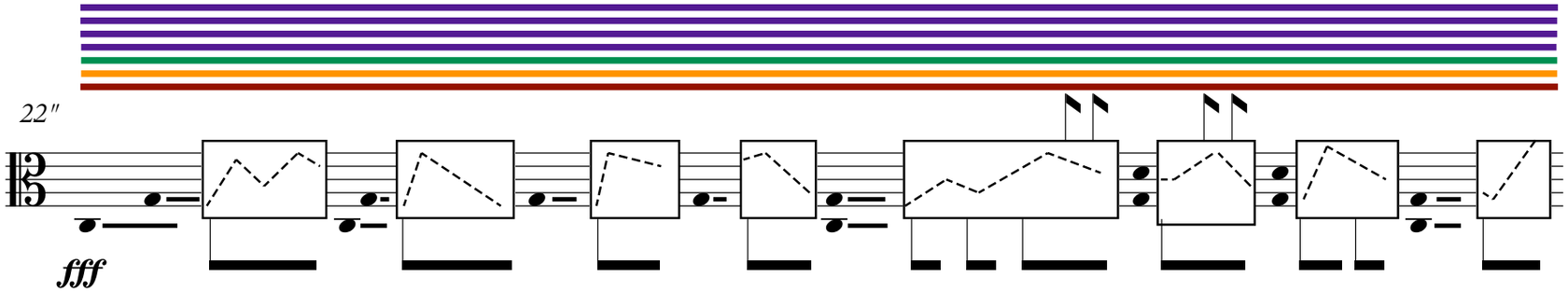
9"



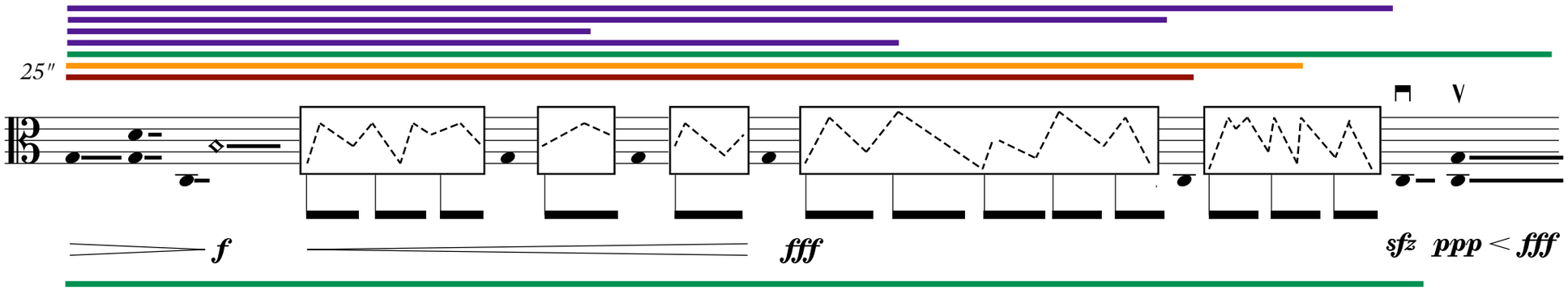
6"

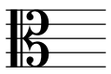


22"



25"





~60" tacet (wait for computer to end)

A A A

p

Begin Bach

A A

A A A A A

A A

A

f

♩≈ 20 *accel* ♩= 140 *(for all measured notes, to end)*

Bb

C

ff

10″

80″