Moncrieff Gun Pit Acoustics

Mike Fedeski and Glenn Davidson of Artstation, 20 August 2026

The Moncrieff Gun Emplacement next to the Lighthouse on Flat Holm island once housed a single large gun for marine defense. When fired, the gun's recoil propelled it back down into a subterranean hiding place. This enclosure, in the shape of a circular pit, is all that survives.

Artstation made several visits to the island through 2022 and 2023 whilst creating artist interpretations of the island's heritage, commissioned under Lottery funding for the city's website. When we explored the acoustic properties of the gun pit, we found it has unique acoustic properties that we believe hold a very special opportunity for sonic performance.

As a test we led two informal sonic performances, one by a group of architecture students from the Welsh School of Architecture investigating the heritage soundscape of the island, and another by members of the Flat Holm warden's team along with some volunteers on a visit to the island. These were short, improvised events using voices and percussion.

In the hope that others would be interested in developing this performative potential with us further, we go on to explain the acoustics more fully.

Description of the phenomena

On our visit to the Moncrieff gun emplacement, we observed two distinctive sonic qualities that we think will be particularly interesting to musicians.

The emplacement is a shallow cylindrical pit about 18 ft in diameter and 10 ft in depth, as shown in Drawing A appended to this document. Its circular walls also curve upwards and inwards, like a rock shelter. This double curvature turns the overall profile from pit to pot, a shape which tends to retain sound inside it even though its top is open to the atmosphere above.

Inside the pit, a whisper made near its edge clings to the wall in a journey around the pit, and returns to the whisperer almost undiminished. It's a whispering gallery. Consequently people distributed around the periphery of the pit can engage in intimate conversation at a distance. In contrast, if they try to talk from side to side across the pit, or even from the centre, their voices get lost in the void. This is the first of our observations on the pit's unusual sonic qualities: sound made near the wall appears to be contained in a belt around the periphery, behaving as though caught in a tube (the red lines in Drawing A), like sound inside a musical wind instrument.

As with other wind instruments, notes at some pitches resonate more strongly than notes at others. This is very noticeable to someone singing inside the pit anywhere alongside the wall, particularly in the low and middle vocal ranges. Their voice resonates at pitches discrete enough to define a musical scale, standing out from the background reverberation. This is the second of our observations on the pit's unusual sonic qualities. The belt of sound around the periphery peaks at a series of notes with distinct pitches, which can be played like notes on a musical instrument.

The intervals between them are dictated by the geometry of the space. It seems that the lowest note of the pit, which can be heard by striking the ground with a rock, is at the bottom end of the audible range, so that most of the notes in the scale above it lie happily within the vocal range. So in effect we have a tubular musical instrument in the shape of a doughnut, large enough for a dozen or so players to occupy, spread out in a circle. The tube's inner walls are, of course, open so that the players can see one another across the middle of the pit. They can interact both with the enclosure and with one another.

For example, a group of singers improvising on the harmonic scale would synchronise as they moved towards and away from the resonant notes.

Or percussionists, exploiting the whisper effect, could make play with intimate rustling sounds that appear to be nearby, in ways familiar to ASMR artists. A recording made by a binaural head mounted in the tube should pick up every detail, regardless of the performers' locations.






Suggested explanation of the phenomena

A simple explanation of the whisper effect is that when sound is deflected along a path around the wall it retains its energy, whereas when it is launched across the space it disperses energy in all directions, including upwards to the sky, so only a fraction reaches a listener on the other side.

The resonant scale of notes can be explained by considering how the volume of air in the pit moves. The energy a singer feeds into the air forces it to oscillate at the frequency of the note. At particular frequencies it will oscillate in simple regular patterns that fit neatly into the doughnut, dividing the motion into an exact number of segments. This idea is illustrated in Drawing B appended below. Such regular patterns of motion are easily amplified as the singer feeds in more energy, which results in the sound becoming louder. Notes at in-between frequencies vibrate more haphazardly.

The simplest pattern, as long as the right note is sounded, is for the air to slosh to and fro around the edges between the source and the place diametrically opposite. This is the bottom note (number 1) which oscillates at about 22 cycles/second (calculated from the diameter of the pit). The other patterns split the motion into two, three, four oscillations, and so on, each with a higher frequency, resulting in the harmonic series shown (1, 2, 3 etc).

In standard musical theory, these patterns would be standing waves of sound. This means we could be looking at places around the doughnut where the air oscillates with maximum energy, alternating with places where it does not move at all.

If this explanation is correct, then there is the possibility that the pit has a third sonic quality. The resonant notes in the doughnut are heard spatially as alternating points of loud and soft. As the diagram shows, their separation would be significant at human scale: what one performer hears would differ from what another further around the doughnut hears. We have not up to now investigated this further possibility. After a note has sounded, the waves would persist for a while and, as there is nothing to fix the positions of the loud and soft points, they could drift around the perimeter. All this could pose challenges to sound recording, but would be another element contributing to composition and performance.

It is the ***shape*** of the pit that is responsible for the whispering gallery effect and for the resonance. It is its ***scale*** that ensures that the resonant frequencies are both well separated and in the vocal range, and that the patterns of loudness, if they exist, have human scale. It is the combination of shape and scale that makes this monument sonically unique.

The harmonics that are shown are calculated theoretically for an ideal solid doughnut, and are unlikely to be the actual ones present. Not only is the doughnut missing its inner walls, so that it is open to the centre of the the pit, but the pit itself has no roof and is open to the atmosphere. The conclusions reached here need on-site verification. But we hope they give a basis for discussing ways of exploiting the sonic qualities of the Moncrieff gun pit.

The harmonic notes we calculate are shown related to musical pitches in the appended Drawing C, to help in discussing musical potential.

The project idea

We are thinking in terms of a performance, or a sonic event, taking place in this very particular architectural setting. Normally when performers play, it is their instruments which amplify the sound, making characteristic tones which the performance space modifies. But in this instance the space and the instrument are one and the same. The performers play the space.

There are several kinds of resonance which playing this pit affords:

a - its ***acoustic resonance***, which is very particular and, although an unalterable given, can be manipulated dynamically by the players;

b - the ***harmonic relationship*** of the sounds they produce, which not only evolves through time but may be expressed spatially;

c - the ***social interplay*** between the players, facing one another across the pit, and bonding through their mutual control of the acoustics.

A performance plays out in the confluence of these three resonances. It reaches its acme at moments of resonance between *them* - super-resonance. These are exilarating moments, and can be reached only by live performance in the singular geometry of this pit on this island.

The value of the outcome is in the first place the experience of the performers creating the work. Any live audience is bound to be small, as travel to the island is limited. For them, however, there will be the particular thrill of sharing the moments of super-resonance with the performers.

We are proposing to use a binaual head to record the event, capturing as nearly as possible the live experience of being present.

Appendices

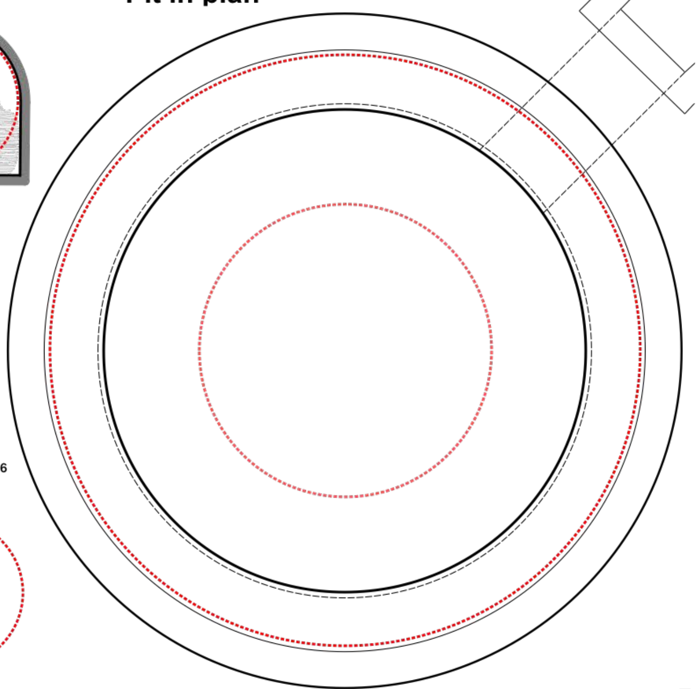
Drawing A: Moncrieff gun emplacement - the architecture

Pit in section

Moncrieff gun emplacement

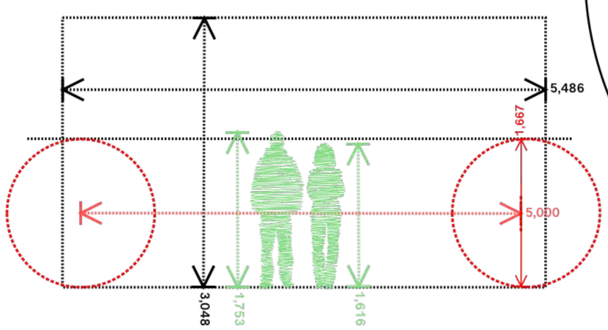
showing the size of a toroidal tube of air able to generate a fundamental of 22 Hz

Pit in plan

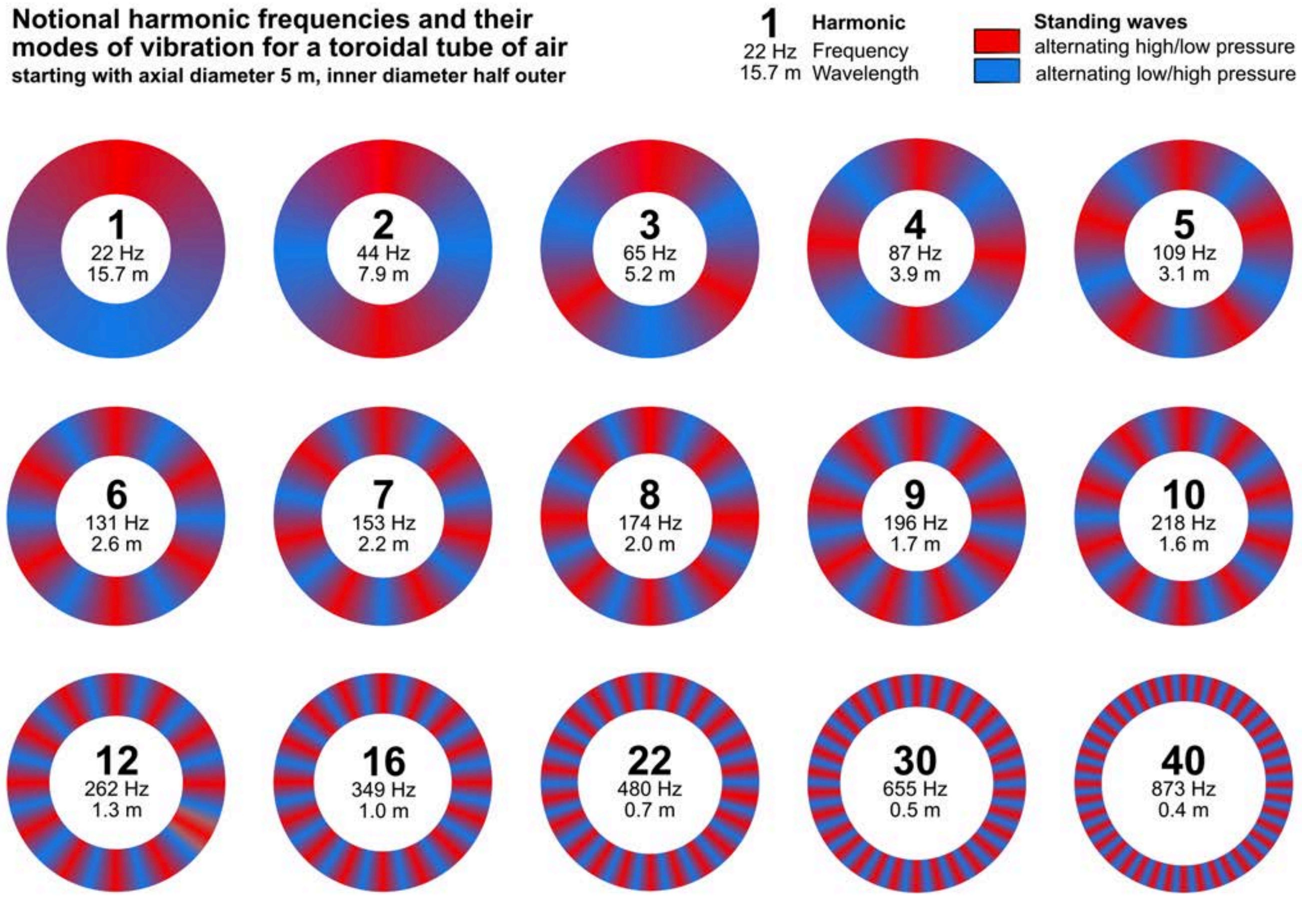


Diagrammatic section with dimensions

main dimensions from Flat Holm guide - 18' x 10'
axial and cross-sectional diameters of torus
current average male and female heights in UK



Drawing B: Notional modes of vibration - the standing waves



Drawing C: Notional harmonics - performance potential