International Research Group

Belgrade Sound Cannon Incident of March 15th

Draft Preliminary Report, April 7th 2025

Contents

I. Who are we:

The International Research Group is a spontaneous alliance of journalists, hackers, audio engineers and activists from various European countries, including Serbia and Germany. German non-profit news outlet netzpolitik.org is part of the International Research Group. The group can be reached via kontakt@netzpolitik.org

II. How do we work

The work of the group is based on the different areas of knowledge of the participants. It combines technical expertise in various fields such as IT, technology and sound engineering with investigative journalism, a deep understanding of the nature of large demonstrations and the evaluation of state actions from a human rights perspective.

With this basic structure, we have collected all available information and evidence regarding the incident and evaluated it from different perspectives. The collected information and evidence is not the work of the research group, but was compiled by numerous individuals, initiatives and civil society organizations in an open and spontaneous, often internet-based crowd research, which collaborated and interacted on an ad hoc basis on a wide variety of platforms in the aftermath of the incident.

The aim of the research group is to process these clues and make them available for further research and to develop theories themselves about what kind of weapon was used. The group's goal is to contribute to the collaborative investigation of the incident.

Part of this work is a map of the incident. This map collects videos, evidence, hints, traces and events related to the incident at the mass demonstration in Belgrade on March 15th. This map does not claim to be complete, nor can it guarantee the authenticity of all recordings. It serves as a repository and collection for civil society and journalistic research with the aim of clarifying the incident.
https://umap.openstreetmap.de/de/map/belgrade-sound-cannon-incident_86993#18/44.80793/20.46383

III. Theories/Scenarios:

III.1 Vortex device/cannon -- possible camouflage sounds/whistles - and other (coordinated) provocations around the incident

Our hypothesis assumes a source for the vortex that we informally call a 'vortex cannon', but this does not imply any assumptions with regard to form factor or method of action.

III.1.1 Why could it be a vortex cannon or something which creates a vortex:

Sound analysis of others:
Earshot NGO https://x.com/earshot_ngo/status/1901661518153781534
Vestoholik@X: https://x.com/vestoholik/status/1903457823742108106

Soundanalysis of our experts:
Our Sound experts could also extract the sound of a vortex in several videos. We have no recordings which indicate infrasound, only the testimonials telling about such effects. Infrasound is below the usual recording spectrum of the small microphones in mobile phones and CCTV cams. Record infrasound requires a specialized microphone to record properly.

Propagation vortex/incident in video:
About 108 km/h or 30 m/s

Video and timecode-analysis:
Based on metadata extracted from 11 videos and the reaction of people we could estimate the exact time of the incident and its geolocation. Further, we calculated the distances between people's reactions, thereby estimating the approximate speed of incident propagation. We concluded an average speed of 30m/s of the incident along the street Kralja Milana (from Terazije to Slavija)

Sound analysis:
Our Soundexperts calculated also a speed about 30 m/s of incident propagation. So we conclude that the speed of the incident must been around 108 km/h or 30m/s.

Further observations regarding the propagation:

We see also see in the videos that people react earlier more south of the incident.

Between

Cam25 https://umap.openstreetmap.de/de/map/belgrade-sound-cannon-incident_86993?feature=Cam%2025A#19/44.80797/20.46381

and

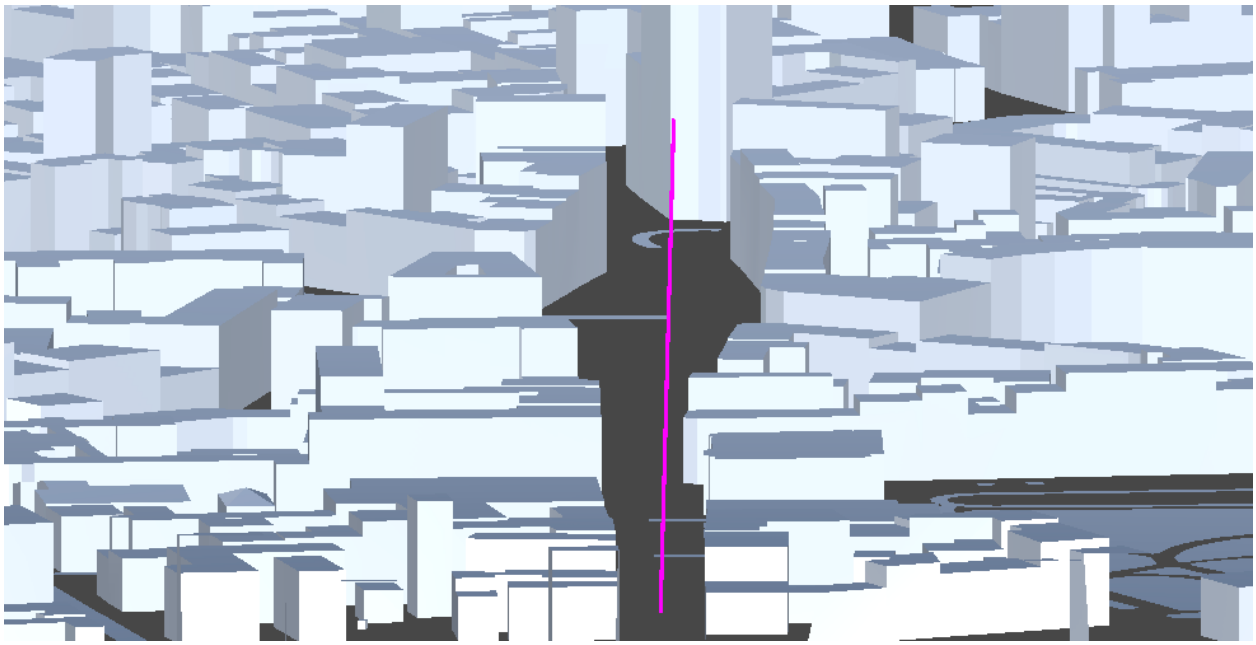
Cam06 https://umap.openstreetmap.de/de/map/belgrade-sound-cannon-incident_86993?feature=Cam%2006A#19/44.80569/20.46501)and

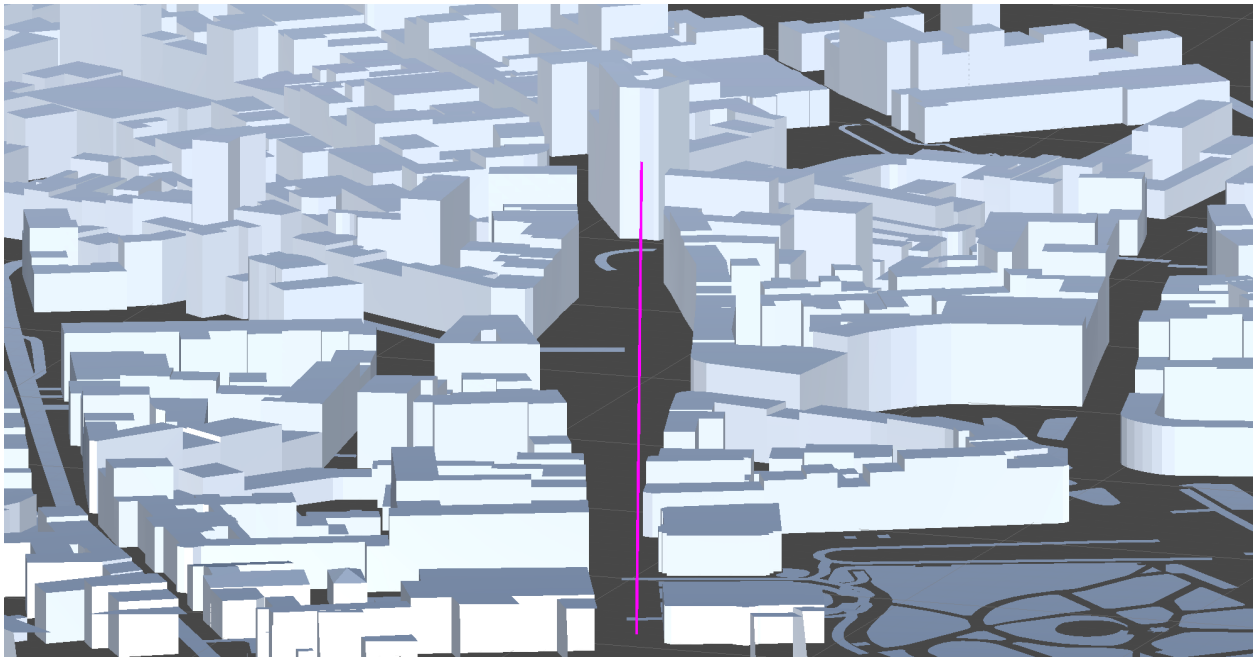
there is a distance about 250m. Cam25 which is more north of the street, people reacting 5 seconds before they separate, but on Cam06 further south they react already 10 seconds before they separate.
That proves that the sound of panicing people (and possible other sound devices to camouflage) is propagating faster than the vortex.

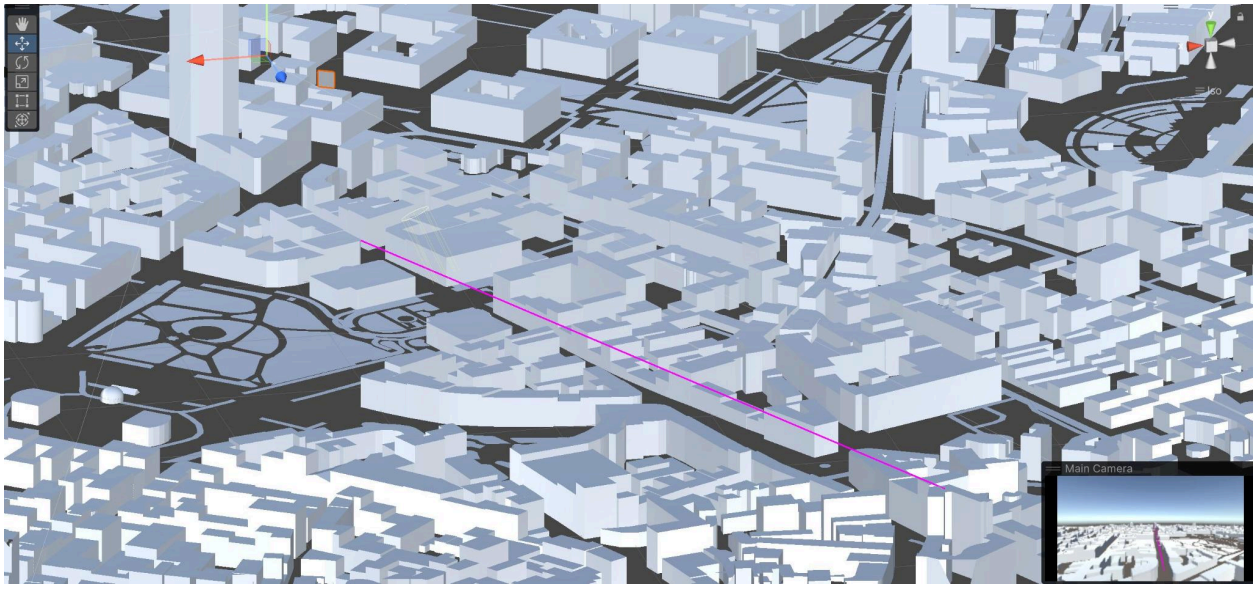
III.1.2 Where could it been shot from:

a) from Palata Albanija:

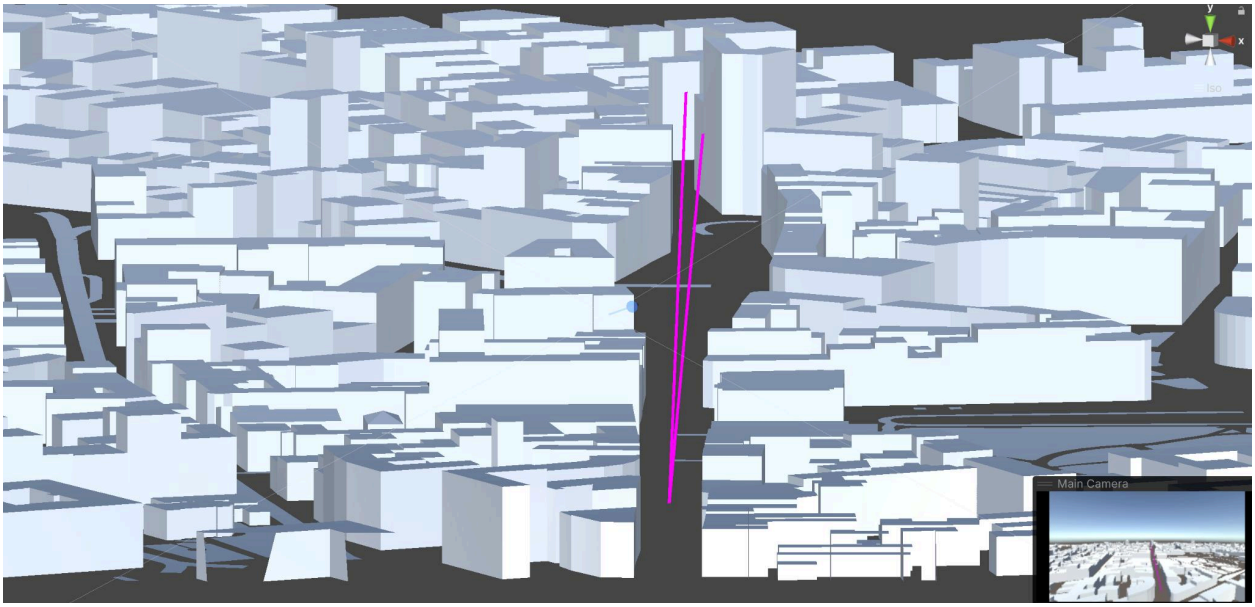
- could only be shot from very high or the windows on the maximum left side, if not wave would be breaking at houses before reaching the crowd (see graphic)
- possible devices/weapons: Real Vortex Cannon







b) House Complex Embassy Montenegro / Rooftop Hotel
- (Address: Knez Mihailova 10)
forms a better direct line for the effect/wave (see graphic)



<u>Is there evidence at these houses?</u>

- Analysis of drone footage of March14 / 5pm of both buildings did not bring any sightable evidence.
- Analysis of drone footage of March15 of both buildings did not bring any sightable evidence (too dark)

We suggest that witnesses in the vicinity of these houses be asked whether they noticed anything on March 15.

c) North of Novi Dvor

- A third new theory is considering if the origin could be a little further North of Novi Dvor.

III.1.3 Possible Camouflage Sounds or additional sounds

In many videos we heard loud whistles (and a lot of testimonials described whistling sounds also). LRAD with whistling sound could have been used to cover vortex explosion or firing of the device. Perhaps little/portable LRAD 100 X in Backpacks from north to southh - but we have no evidence for that.

III.1.4 Other provocations around 19:11

Around the incident (19:11) there are several provocations documented. The research group did not focus on these incidents, but they could be connected:

- Firecrackers thrown in the crowd from Kings Circle
  - Around 18:30-18:45 https://vreme.com/vesti/ko-je-gadjao-demonstrante-u-kralja-milana-sa-hukom-doleteli-i-topovski-udari-sa-gradilista/
  - Shortly after 19:11 https://vreme.com/vesti/ko-je-gadjao-demonstrante-u-kralja-milana-sa-hukom-doleteli-i-topovski-udari-sa-gradilista/
  - Around 19:20 https://umap.openstreetmap.de/de/map/belgrade-sound-cannon-incident_86993?feature=Around%2019%3A20%20Firecrackers%20Exploding#18/44.80618/20.46573
- Provocations from Pionirski Park
  - 19:19 https://umap.openstreetmap.de/de/map/belgrade-sound-cannon-incident_86993?feature=Unclear%20situation%20around%2019%3A19#17/44.80942/20.46594
- Near Parliament
  - 18:46 Pyrotechnics/Firecrackers audible https://umap.openstreetmap.de/de/map/belgrade-sound-cannon-incident_86993?feature=Pyrotechnics%20audible%20#17/44.80991/20.46594
  - 19:02 Pyrotechnics audible
- https://umap.openstreetmap.de/de/map/belgrade-sound-cannon-incident_86993?feature=Live%20stream%20entering%20the%20street%20and%20pyrotechnics%20audible#18/44.81136/20.46226

- 19:10 People running away on Bulevar Aleksandra close to parliament (unclear what was the cause) captured on N1 livestream: https://umap.openstreetmap.de/de/map/belgrade-sound-cannon-incident_86993?feature=Unclear%20situation%20around%2019%3A19#17/44.80942/20.46594
- 19:11 Three pyrotechnics audible
- https://umap.openstreetmap.de/de/map/belgrade-sound-cannon-incident_86993?feature=Three%20audible%20pyrotechnics#18/44.81066/20.46250

IV.2. Infrasound with vortex sequences to create inrasound & possible camouflage sounds/whistles - and other (coordinated) provocations around the incident

From numerous victim reports it is plausible, that the effects experienced are consistent with a combination of a brief overpressure wave (causing e.g. ear bleeding) plus infrasound effects on the body.

Infrasound symptoms and their effects are listed in the open standard literature used for determining workplace safety regarding low frequency vibrations (Rasmussen, G., Human Body Vibrations Exposure And Its Measurement, Bruel and Kjer Technical Paper, 1982. Abstract 1983, Journal of Acoustical Society of America, 73(6) 2229.,, fetched from https://www.windturbinesyndrome.com/wp-content/uploads/2009/08/human-body-vibration-exposure-and-its-measurement.pdf as primary souces is paywalled)

Symptoms for vibration exposure at frequencies of 1 to 20 Hz are shown in Table 1. The frequency ranges given are those where the symptoms are most predominant.

Symptoms vs. Frequency
General feeling of discomfort 4-9 Hz
Head symptoms 13-20 Hz
Lower jaw symptoms 6-8 Hz
Influence on speech 13-20 Hz
"Lump in the throat" 12-16 Hz
Chest pains 5-7 Hz
Abdominal pains 4-10 Hz
Urge to urinate 10-18 Hz
Increased muscle tone 13-20 Hz
Influence on breathing movements 4-8 Hz
Muscle contractions 4-9 Hz

The individual effects on a person largely depend on the size of their respective body parts as the infrasound wave needs to resonate with them for full effect. This can explain why some victims in the impact zone felt nearly nothing while next to them others suffered dramatically.

From the camera footage collected, the associated audio recordings, the victim and witness desicriptions of the sound passing and the timing of events, it is plausible that the effect on the crowd was caused by a vortex weapon that is tuned to create infrasound effects by using a fast sequence of vortexes, shaking the victims at a infrasound frequency.

It is known from past research and development in crowd control weapons, that a fast sequence of vortexes fired at at a cadence that matches infrasound frequencies can create infrasound effects.

Example:
(https://defense-update.com/20071205_vortex-ring.html (archived copy: https://web.archive.org/web/20050208223010/http://www.defense-update.com/products/v/vortex-ring.htm)

US Army Research Laboratory work explored and tested the feasibility of building vortex guns for crowd control based on existing 40mm grenade launchers. The goal of the research was aimed at "attacker knockdown".

Lucey, G & Jasper, L., Vortex Ring Generator, United States Army Research Laboratory, Adelphi, MD 1998. NLD III Conference, 25 February 1998, Johns Hopkins Applied Physics Lab

https://apps.dtic.mil/sti/tr/pdf/ADA351056.pdf

Feasibility and optimization studies for explosives driven vortex generators, again with a focus on knockdown and delivery of incapacitating agents was further conducted.

George K. Lucey Jr., Vortex Ring Generator: Mechanical Engineering Design For 100Kpsi Operating Pressures, ARL-TR-2096, United States Army Research Laboratory, Adelphi, MD, January 2000.

https://apps.dtic.mil/sti/tr/pdf/ADA372518.pdf

This research is from 25 years in the past. Given the time between and now and the Defense-Update post from 2007 (see above) specifically mentioning infrasound

effects, it is very plausible that in the meantime further development has been taken place.

There are other methods of generating fast sequences of high-energy air vortexes besides explosive generation.

One plausible is a construction with a large cylinder chamber containing a stiff membrane that is driven by an surrounding electromagnet or with a rod from behind. The membrane is accelerated very quickly mechanically, pushing out the volume of air (or extra injected gas) towards the vortex generating nozzle. Similar contstructions are known in the live music industry as "motor bass driver" or "ServoDrive subwoofer" (e.g. https://patents.google.com/patent/US4564727A/en)
Similiar principles are being used for non-explosive anti-hail cannon applications (e.g. https://stil-hagelkanon.nl/en/home-en/)

Again, the weapon would direct the generated sound pressure wave into an carefully designed expansion chamber for the formation of the vortex and then operated so that a quick sequence of vortexes is generated with a cadence that leads to an infrasound effect at the target.

A vortex in air typically moves slower than the speed of sound. The forward velocity is determined by a number of parameters like diameter, length and geometry of the nozzle, the speed of the accelerated air (or gas) and the internal velocity of the air rotating inside the vortex.

III.2.3 Possible Camouflage Sounds or additional sounds
see above in III.1.3

III.2.4 Other provocations around 19:11
see above in III.1.4

III.3 Vortex Sound via Speakers / LRAD / other accoustic cannon devices - and other coordinated provocations

We did not follow these theory

III.4 Other Waves (Microwaves, etc.) perhaps in combination with LRAD and other coordinated provocations

We did not follow these theory
Microwaves need a lot of electric power and devices are really huge

IV. Human Rights Impact:

Whatever the technology used in Belgrade on March 15th, 2025, we classify it as a novel crowd dispersal technology of unknown origin and using an unknown mechanism of action.

Due to the secretive and invisible nature of the application and the fact that there were no warnings or announcements from security forces before the application, a mass panic arose that only by chance did not claim any victims through trampling or similar. The use of such technology in this way means that people can be injured or killed by the reaction of the crowd. We therefore consider the technology used in this manner to be a dangerous an potentially deadly weapon.

In contrast to the use of traditional crowd control methods such as water cannons, batons or similar, the secretive nature of these weapons means that people have no chance to move away before they are used.
In view of this, we condemn the use of such weapons and consider it to be incompatible with human rights, especially since there is no legal basis for the use of such weapons in Serbia.

The use of such weapons in this way also has an impact on future protests and is an ongoing restriction of freedom of assembly. After an initial use, people may be deterred from protesting for fear of further mass panic (chilling effects). From the point of view of the International Research Group, this is therefore not only a human rights violation during the operation on March 15th, but also beyond.

We have also found evidence that forces allegedly protected by the state were deployed at various points during the mass demonstration to provoke and carry out coordinated attacks against people. We see these attacks as part of a strategy together with the technology which was seen on Kralja Milana. This was aimed, according to all we know, at provoking mass panic or violent confrontations in a coordinated action. We consider such actions to be an attack on the freedom of assembly and the physical integrity of persons who were using their right to protest.

V. Conclusion

We cannot say exactly what caused the effect and we currently consider our two theories/scenarios to be the most likely.

What is clear to us is that a previously unknown new technology was used to control crowds – in combination with further provocations.

We consider it almost impossible that the effect seen on March 15 could have been caused by a normal panic situation.

The use of such technology in this way means that people can be injured or killed by the reaction and panic of the crowd. We therefore consider the technology used in this manner to be a dangerous an potentially deadly weapon.