CAN DOGS FLY?
IMPROVED METHODS OF NOISE SOURCES IDENTIFICATION

KEYWORDS:#NOISE DIRECTIVITY #NOISE MONITORING #AIRCRAFT NOISE

Jacek Kuczyński
Marketing Manager - Svantek Sp. Z o.o.
Warsaw, 04-872 Poland
jkuczynski@svantek.com.pl

Abstract

Can dogs fly? This question has been asked when analysing a time history of an aircraft noise measurements carried out in a residential area.

When extracting an aircraft noise from the data, one particular noise event has been detected – the noise clearly wasn't an aircraft noise, but it was coming from above the microphone located at 4 m above the ground.

What was it? Thanks to the audio recording, the analysis of the event indicated the noise to be a dog barking. A dog barking coming from above the station located at 4 meters? How this could happen, many have different ideas: a dog climbed up a tree, dog jumped out of a plane or maybe it could fly? The answer to this question is the selection of a measurement site. The location of the site is critical in obtaining accurate and useful data.

To detect the direction of a noise source a Svantek SV 200A noise monitoring station has been used. The solution has a single traditional condenser microphone mounted centrally but it also has an additional four microphones located equidistant from each other on the sides of the housing. These use a pairs of signal and phase difference technique to detect the direction of a dominant noise source both in the vertical and the horizontal axes. Use of noise direction improves the noise sources recognition process and when it is combined with more tools such as audio recording, spectrum analysis and GPS data, it helps to automize the process of noise sources verification.

1. Introduction

1.1. Environmental noise measurements.

Following ISO 1996-2:2017, there are two main strategies for environmental noise measurements:

a) a single measurement under very well-defined meteorological conditions while monitoring the source operating conditions carefully;

b) a long-term measurement, or many sampled measurements, spread out over time while monitoring the meteorological conditions.

Both types of measurements require post processing of measured data.

1.2. Selection of measurement site

Importance of selection of the measurement site is emphasised in ISO 1996-2: 2017 which states that sites for measuring microphones shall be chosen to minimize the effect of residual sound from non-relevant sound sources.

The location of the site is critical in obtaining accurate and useful data. The selection of measurement sites should be considered in the early development of a measurement plan once objectives for the measuring system have been clearly identified.

Selection of the measurement site must take into account the **uncertainty** of results at that site. If relation between residual sound and maximum sound pressure levels (LASmax) related to a source is greater than **15 dB** the influence of residual sound is negligible. For an acoustically reliable measurement, the event to be measured shall be at least 3 dB and preferably 5 dB above the average residual sound.

1.3. Noise Events.

Discrete sound event data is a typical method of data processing used in aircraft of rail traffic noise measurements. A discrete event is established when the A-weighted sound pressure level exceeds a threshold for a continuous period and is related to a specific noise source (e.g. an aircraft).

Method described in ISO 20906, distinguish three stages of data postprocessing: event extraction, event classification and event identification.

Event extraction is based on acoustic criterions such as A-weighted sound pressure levels. Usually a post-processing software offers tools for data searching for a given query, e.g. LAeq above 55 dBA.

Event classification is based on additional acoustical information, for example an event duration, e.g. LAeq above 55 dBA with a minimum duration of 10 s. Modern monitoring systems use **information about direction of the noise** to automate the event classification process – in addition to the threshold and minimum duration, events are classified based on the direction of the noise. For example, noise of an aircraft is expected to come from the above of the station's microphone.

Event identification uses non-acoustic data such as information from a radar or operational flight-plan from an airport.

During the evaluation of the measurement results it is necessary to **remove unwanted events**. Depending on the actual circumstances different methods of elimination of unwanted sound can be used. **Audio recording** is an important tool in the stage of an event identification. In analysed case listening to the actual noise helped to identify the dog barking as the unwanted noise source that was excluded from the further analysis.

1.4. Noise monitoring terminals.

The term **automated sound monitoring system** appears in 2017 version of ISO 1996-2 and is defined as a continuous sound monitoring system including all monitors and data collection. The term **monitor** simply refers to a class 1 **monitoring station**, and is defined as an automated continuous sound monitoring terminal which monitors A-weighted sound pressure levels, their spectra and meteoritical quantities such as wind speed, wind direction, rain, humidity, etc.

In accordance to ISO 20906 : 2009 For long-term monitoring of several days or more, a monitoring station should provide an automatic system check, at least once per day (preferably during a time of low aircraft activity). Typically, monitoring stations use **electrostatic actuator** or insert **voltage methods** as a function of a system check. New systems, such as Svantek's SV 307, use **dual system check** – a combination an acoustic check with a speaker and dynamic system check with reference microphones. Whatever method used, it should be documented by the manufacturer.

Photo 1 Svantek SV 200A Noise Monitoring Terminal with noise directivity detection.

1.5. Noise Directivity.

The SV 200A noise monitoring station monitors noise directivity in both the horizontal and vertical axes. The solution has a single traditional condenser microphone mounted centrally but it also has an additional four microphones located equidistant from each other on the sides of the housing. These use a pairs of signal and phase difference technique to detect the direction of a dominant noise source both in the vertical and the horizontal axes. Thanks to this approach the Leq distribution in angle sectors is saved as the time-history and can be used for data filtering and reporting.

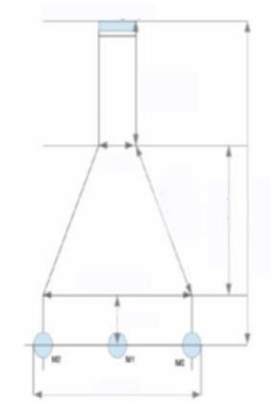


Photo 2 Location of side microphones in relation to the main microphone in SV 200A

In practice, the measurement of directionality gives the opportunity to indicate the dominant source of noise in the area of measurement or to exclude unwanted events. The accurate GPS module also provides information on the location as well as time synchronisation measurement.

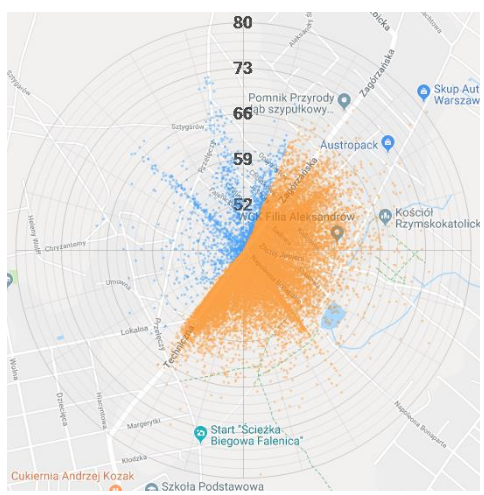


Photo 3 Visualisation of the noise directivity time history data on a map

2. Testing object and measurement performance

2.1. Measurement instrumentation and localisation of measurement points.

The study has been performed with **SV 200A** (Svantek Sp. Z o.o., 2020), SVANTEK's noise monitoring station meter that meets IEC 61672-1:2013 Class 1 specification and is designed to perform automated continuous noise measurements. During the measurement instrument was powered from its internal batteries. The monitoring station has been installed on a 4m mast and has been remotely connected to the cloud server SvanNET (Svantek Sp. Z o.o. 2020).

The measurement settings have been set to record data containing, 1s time history of LAeq, LAmax and 1/3 octave analysis, noise directivity in XY and Z direction and audio recording for listening (24 kHz). The built-in GPS has been used for time synchronization and localization purpose.

Measurement points were located in a proximity to an airport in two locations:

- Measurement point A – near a household and a road, located in a close proximity to trajectory
- Measurement point B – in a open field located in a close proximity to trajectory

The measurements were carried on different days during the operational time of the airport.

For the purpose of this experiment, location of the monitoring station at two sites have been compared. Both monitoring points were selected in proximity to the aircraft routes near the same airport.

In both cases, the microphone has been located at the height of 4 meters. However in the first location the nearest reflections came from the building wall in proximity of around 3 m from the microphone and a tree distanced around 4 m from a microphone.

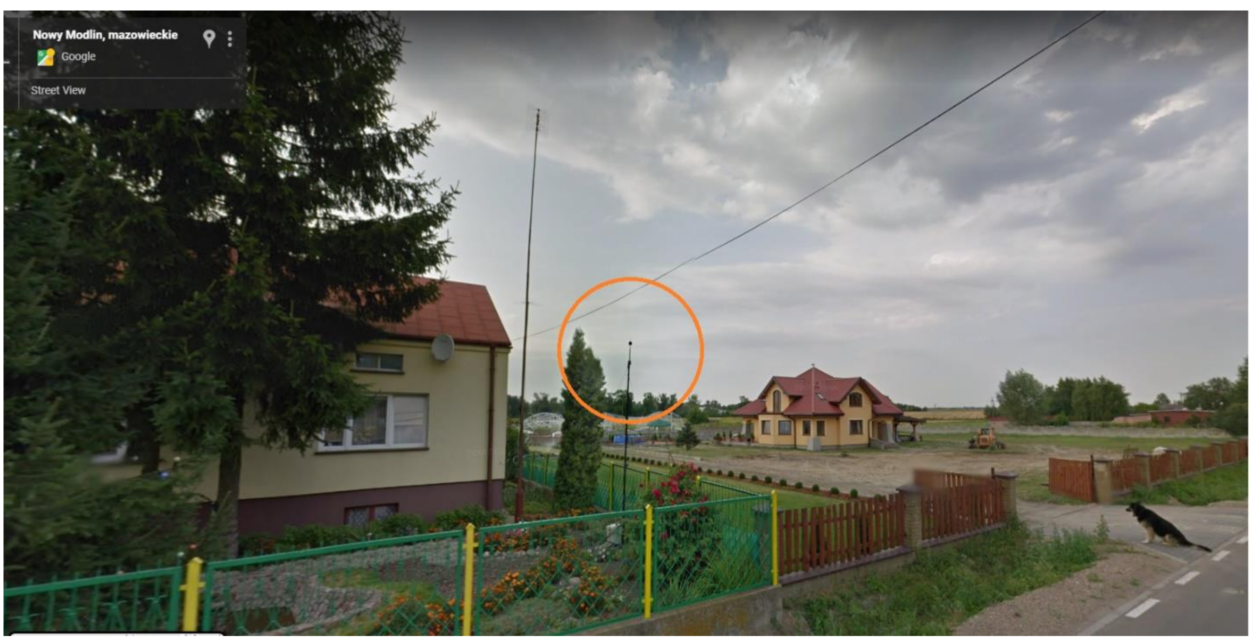


Photo 4 Location of the monitoring point A near a household.

Photo 5 Location of the monitoring point B in the open field.

2.2. The measurement goal and method

The goal of the experiment was to verify an influence of the selection of the measurement point on data accuracy and usability. For the purpose of the study two measurements of aircraft noise in a close proximity to aircraft trajectories have been performed.

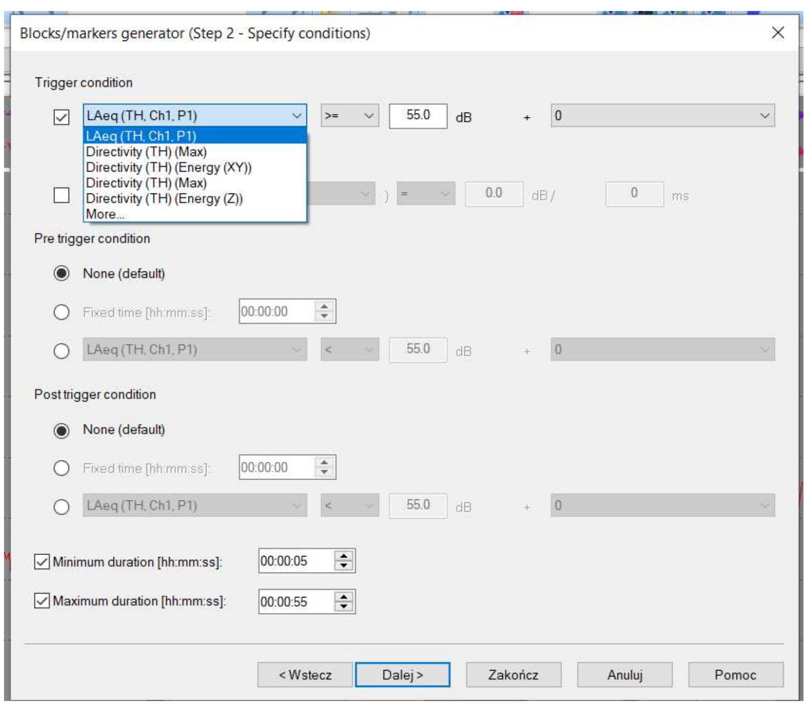
In both points the method of the study was to measure the A-weighted LEQ values, with 1/3 octave analysis along with noise directivity in XY and Z directions and record values with 1 second logger step. The measurements were carried on different days during the operational time of the airport.

The data has been collected remotely via Svantek SvanNET cloud service from the measurement points and post-processed in Svantek SvanPC++ software. The main goal of post-processing was extraction, classification and identification of noise events related to aircraft passages.

3. Measurement results

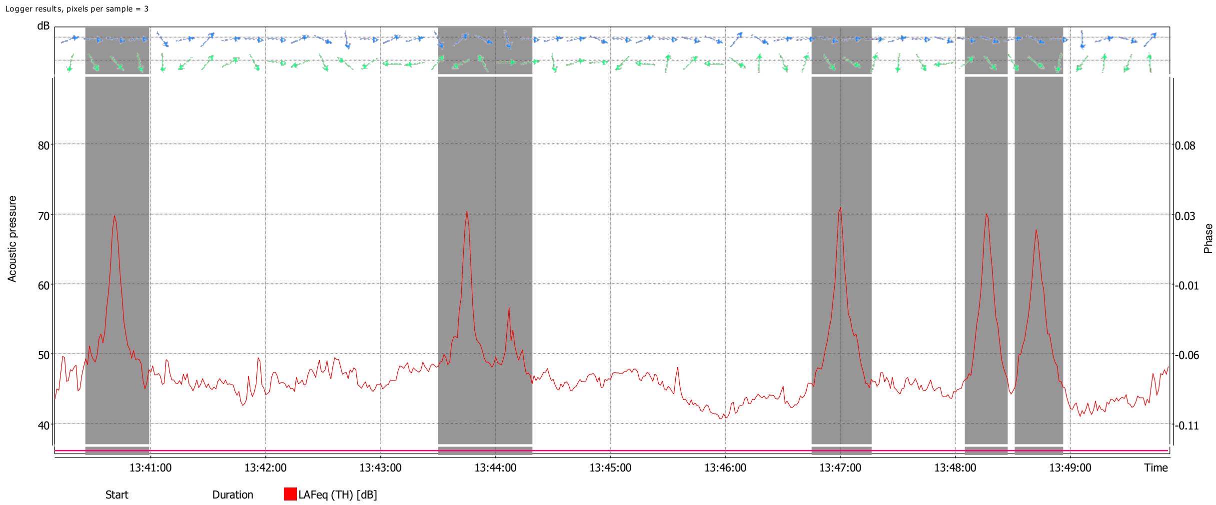
3.1. Event extraction from time-history.

The common technique of events extraction is to use LEQ and LMAX results to browse time history data. Svantek's SvanPC++ software allows to extract events that meet minimum and maximum duration and have a defined LEQ slope for example in relation to LMAX time history. With additional use of noise directivity the process of extracting events is fast and easy.

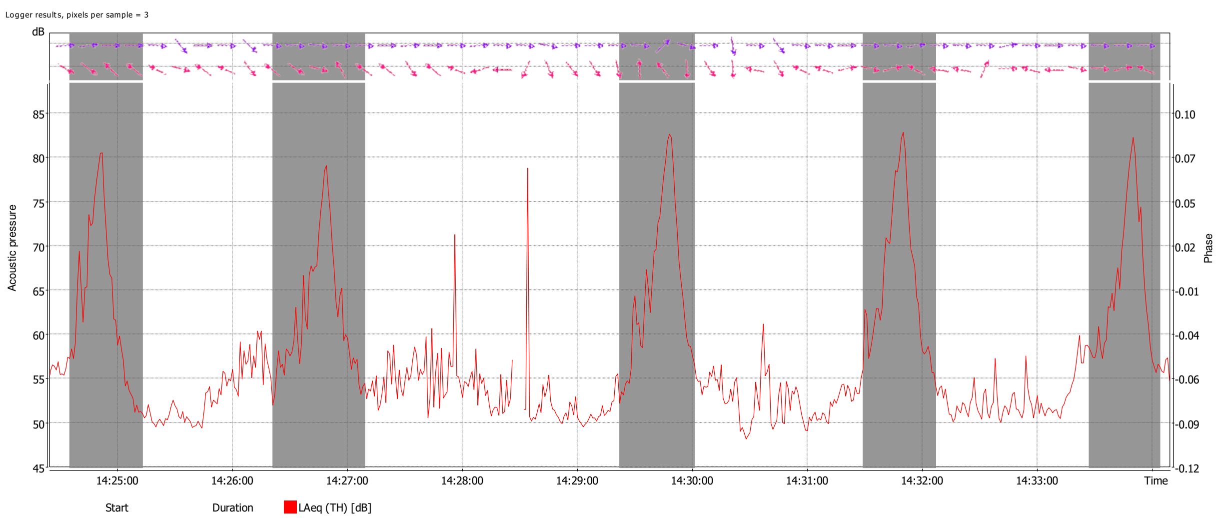


Picture 1 SvanPC++ software data browser options

Pictures below present an automatic selection of aircraft passages in SvanPC++ in both measurement points.



Graph 1 Selection of aircraft passages in point A

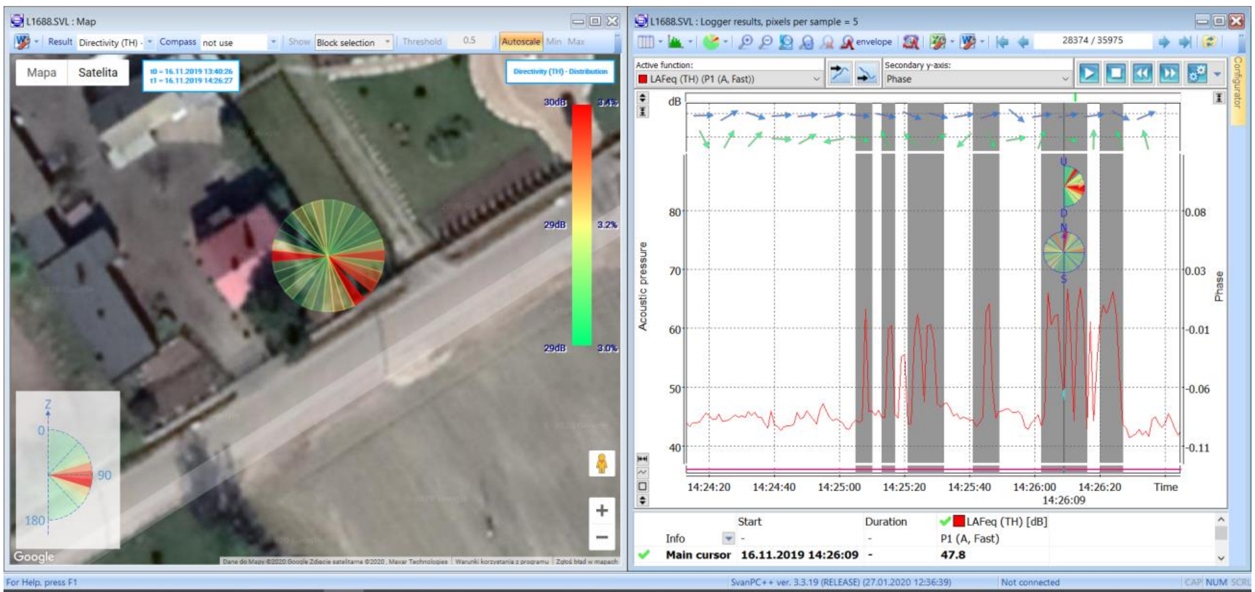


Graph 2 Selection of aircraft passages in point A

3.2. Events classification and identification

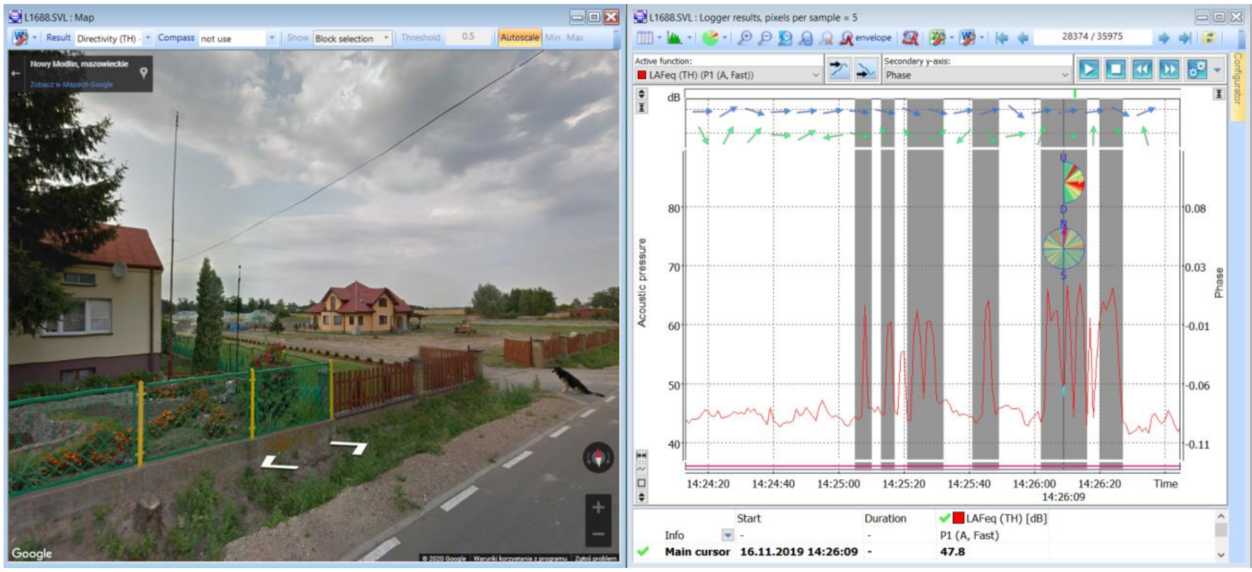
With use of SvanPC++ software aircraft noise passages have been extracted from the time-history. During the data analysis in location A, suspicious events have been detected. The analysis of directivity showed clearly that a dominant source have been above the microphone although shape of slopes differ from aircraft ones, the distance from a background was similar to aircraft events. Listening to the audio records allowed to identify that the source of the noise was a **dog barking.**

The verification of the noise direction was possible thanks to the SV 200A built-in GPS and embedded Google Maps function in SvanPC++. The picture below shows both vertical and horizontal directions where the noise came from, but still the question remained: how a dog could be above the station located at 4m? **Can dogs fly?**



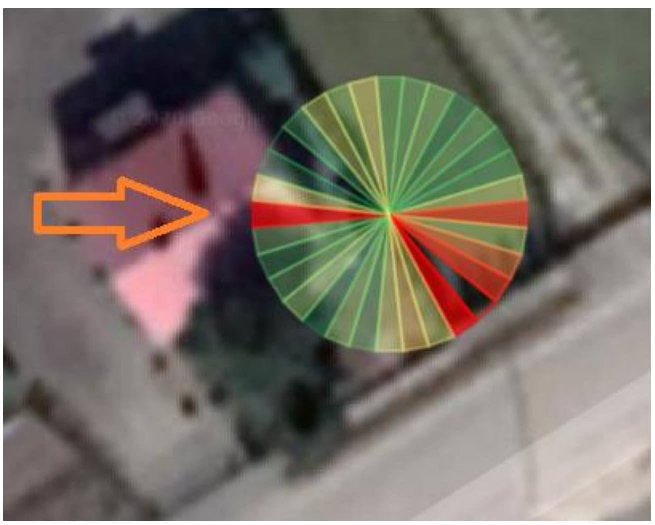
Picture 2 SvanPC++ software showing noise directivity on a Google Maps

To investigate further a function of Google Map Street View has been used. An amazing coincidence happened that the map has been updated during the measurements, so the picture showed both, the measurement point and … the dog.



Picture 3 SvanPC++ software in a Street View mode

The XY noise directional analysis clearly and further zoom in the Street View mode made it clear that the dog has been running around the house barking and the noise has been reflected by the roof of the house.



Picture 3 SvanPC++ software in a Google Maps Satellite mode

Picture 4 SvanPC++ Google Maps Street View mode indicating the SV 200A station, the dog and reflecting surface – the roof of the house.

4. Conclusion

The conducted study proven that the selection of the measurement location has a great effect on automatization of event identification in a measurement data post-processing. The localization of the measurement point B in an open field with a non-reflecting surface enabled an automatic and accurate extraction of aircraft passages. The localization of the measurement point A, however in accordance to measurements practise standards, caused difficulties due to noise reflections from the building wall located around 3 meters from the microphone.

Tools used in the data post-processing, such as audio recording, GPS localisation and noise directivity enabled a precise event verification and confirmed, at this stage that **dogs can't fly**, it's the noise that can.

5. References

International Organization for Standardization, ISO 20906:2009 Acoustics — Unattended monitoring of aircraft sound in the vicinity of airports

International Organization for Standardization, ISO 1996-2:2017 Acoustics — Description, measurement and assessment of environmental noise — Part 2: Determination of sound pressure levels

Svantek Sp. Z o.o. (2020) SV 200A Noise Monitoring Station http://svantek.com/lang-en/product/149/sv_200a_noise_monitoring_station.html#about

Svantek Sp. Z o.o. (2020) SvanPC++ software http://svantek.com/lang-en/product/19/svanpc_software.html#about