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USE OF A NOISE IoT DETECTION SYSTEM TO MEASURE THE ENVIRONMENTAL NOISE IN TAIWAN LIGHT SOURCE

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Abstract

In the past, the method of general noise monitoring altered little; noise was still measured with a human handheld mobile device, or the measurement at fixed sites was made using traditional analogue data-storage equipment. In recent years, with the rapidly improved network transmission capabilities, the development of a small noise-detection IoT system allows the detection data to be transmitted wirelessly without need for human strength measurements, and records noise information. The statistics of subsequent noise data become a basis for analysis and improvement. Taiwan Light Source (TLS) beamlines have many vacuum pumps, cooling pumps, liquid-nitrogen pressure-relief systems, computer servers etc. that generate much noise. This study is expected to prepare for installation of noise detection. The system uses a noise-detection box to detect, to disclose louder locations, to collect noise data, to determine the source and type of noise source, and to provide information to reduce the noise of the working environment. The TLS noise-detection results find that the inner-ring area has less noise and are more stable than the outer ring area. In addition, each beamline should have completed the coverage of the pump isolation noise to decrease the major noise.

INTRODUCTION

In the past the method of general noise measurement altered little. Measurement was generally performed manually by hand, or measurement at fixed sites used traditional analogue storage to store data for large-scale equipment. The measured sound value was transmitted to a computer for interpretation; data collection was complicated and trouble- some. In recent years, with the great speed of network transmission, many related Internet- of-Things devices (IoT) have been derived, so the trend of noise-monitoring equipment to join the Internet of Things has also emerged. A small noise-detection system has been developed, set in the facility of a noisy location of Taiwan Light Source (TLS). By designing a small noise-detection box, the detected signal can be transmitted wirelessly to the server database with no need for force measurement and recording. The noise- detecting system can collect relevant noise information for TLS, to undertake statistical analysis and improve subsequent noise data.

A TLS beam line has many vacuum pumps, cooling pumps, liquid-nitrogen pressure-relief devices, computer servers etc. that generate much noise. According to noise measurement in the environmental area, although the noise level is less than time-weighted average (TWA) 85 decibels (dB), employees and outside users have long been here, experimenters might cause a loss of hearing. Some colleagues must hence communicate with loud voices and emotions become easily irritable. This study is thus expected to develop a noise-detection system, using a small and lightweight noise-detection box to collect noise data to be deployed for much noise everywhere. The objectives are to determine the source and type of noise sources, to provide information to reduce and to prevent noise in the working environment, and to try to maintain the environment below 60 dB as much as practicable so that everybody can work in a comfortable environment.

TLS NOISE SOURCE

At present, the noise sources of TLS are mechanical pumps (scroll pump, dry pump etc.), computer server fans, ice-water chillers, and operating sounds of various experimental equipment. A hand-held noise meter randomly measures the noise of the beam line and the experimental station. As shown in Fig. 1, the location and environmental distribution of TLS everywhere is about 61.5 ~ 72.5 dB. In addition, according to somebody's piggyback noise dosimeter to work and walk everywhere in the TLS environment for 8 h, the noise value converted from the measured dose value is 71.7 dB, as shown in Fig. 2, which shows that the TLS ambient noise is greater than 60 dB.

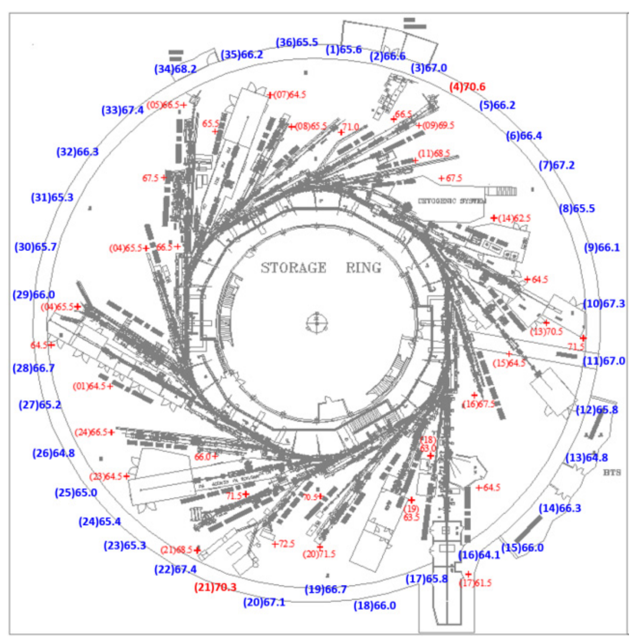

Figure 1: Hand held noise meter mapping.

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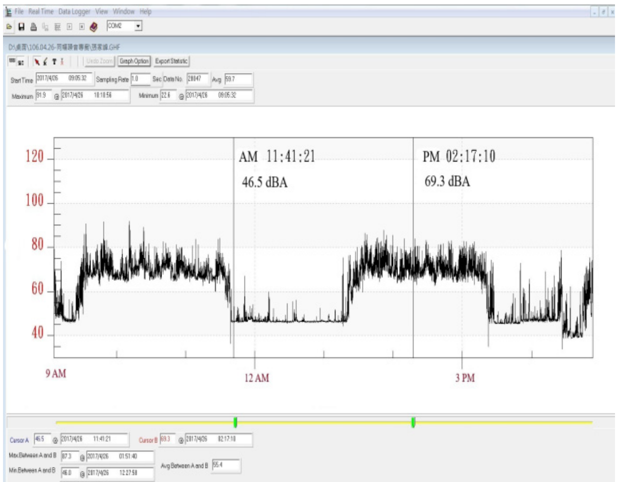

Figure 2: Piggyback noise meter results.

NOISE MEASUREMENT SYSTEM

In the past, a traditional noise meter was too large; data needed to be stored on a memory card or the meter was connected to a computer device to obtain measurement data. A small and lightweight noise-detection chip module such that the microphone and wifi module can be fitted together in a small box that meets required measurement standards is shown in Fig. 3. The development of an automatic continuous real-time monitoring system, without wasting time and manpower, thus stable and accurate for a monitoring method, is the technology that more important national-level facilities should possess [1-4].

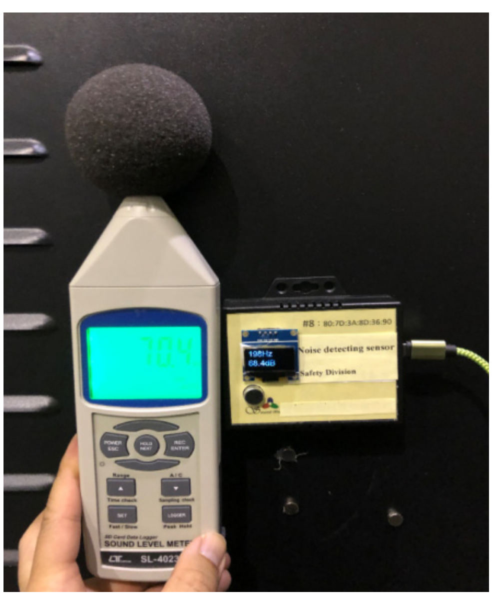

Figure 3: Small noise detection sensor.

The main function of this section is to seekhistorical noise data, which can be based on date and hour intervals as search conditions and displayed as a line chart. The 12 groups for real-time linear charts can be displayed within two hours as shown in Fig. 4.

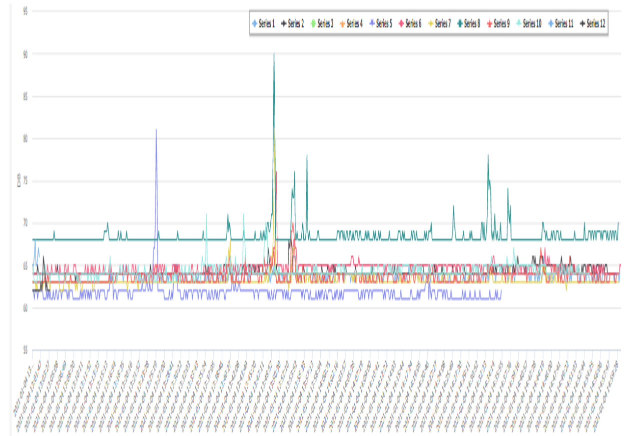

Figure 4: Real time detection chart.

As shown in Fig. 5, the main function of this section is to display the real-time noise-detection data in combination with the site floor plan. At present, there are six positions in the inner ring and six positions in the outer ring. Comparing the difference between the noise generated in the inner ring and in the outer ring, the decibel value in the yellow mark is updated every 10 s; the noise information for each location can be obtained in real time [5].

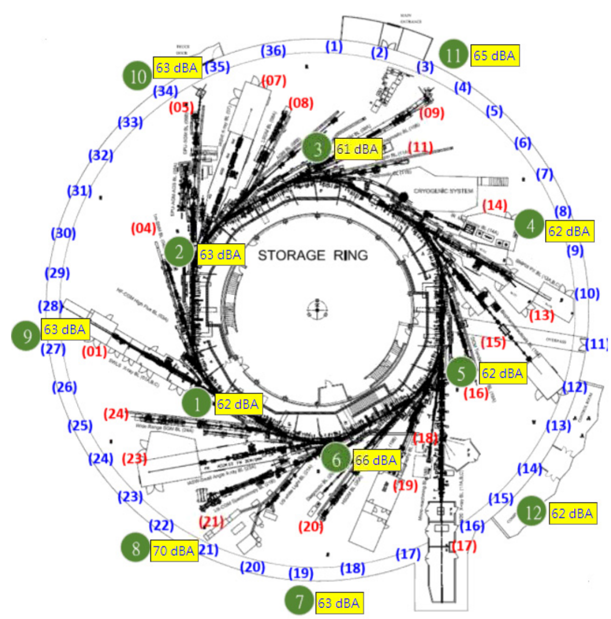

Figure 5: Noise detection locations.

RESULTS AND DISCUSSION

For the TLS configuration for 12 groups in Table 1 shows the noise-detection results by statistical analysis #1~ #6 inner ring from 2019 February to May compared with June to August; the noise was reduced about 0.1~1.1 dB; the most obvious decrease in location #4 is about 1.1 dB, and the rest is reduced. The amplitude is not high, only 0.1~0.3 dB. The noise reduction might be caused by the recent replacement with new pumps.

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Table 1: Noise Detection Results

Sensor	Location	2019/02~05	2019/06~08	2021/03~04	Difference
1	Inner	63.2	62.9	62.8	-0.1
2	Inner	64.0	63.9	64.4	0.5
3	Inner	62.3	62.2	63.2	1
4	Inner	64.3	63.2	63.0	-0.2
5	Inner	62.7	62.4	61.3	-1.1
6	Inner	65.0	65.1	64.1	-1
7	Outer	-	63.6	62.2	-1.4
8	Outer	-	68.5	67.7	-0.8
9	Outer	-	63.3	63.4	1
10	Outer	-	64.6	64.9	0.3
11	Outer	-	63.8	62.3	-1.5
12	Outer	-	62.4	61.5	-0.9

Then from June to August, the average of the inner ring at #1~#6 is 63.3 dB and the average of the outer ring at #7~#12 is 64.4 dB. The noise of the outer ring is higher than the inner ring by 1.1 dB. The biggest reason is more people talking and walking near the outer ring. The inner ring has less noise because people are less likely to approach it. # 8-outer ring, the zone of greatest noise has on average 68.5 dB, which might be due to the largest number of pumps near beamline 21. # 3-inner ring has a minimum noise level 62.2 dB, because there is no mechanical equipment nearby. In addition, comparing the sensors #1~#12 from 2019 June to August and 2021 March to April, we found an average difference -1.5~1 dB, and most sensors show reduced noise after 1 year. The beamline should have completed the coverage of the pump isolation noise.

CONCLUSION

The statistical analysis of the TLS noise detection can find areas with louder or fainter noise, which can be used as a reference for a continuous improvement of the noise. On monitoring the analysis results of noise in regular environmental areas, one can also test whether the amount of environmental noise has increased. It is possible that for some pumps or instruments and equipment, the long-term wear and tear or an increase of noisy equipment causes the noise to increase, which can provide an early indication of failure of mechanical equipment. The main source of noise in the TLS survey was the pumps. If these pumps cannot be concentrated in a soundproof box, the subsequent synthetic noise generated becomes difficult to improve. With the monitoring environmental noise, that could remind colleagues and outside users to understand the amount of noise in the environment, and to wear earplugs in a timely manner, so as to reduce a risk of hearing loss.

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