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INFORMATION PAPER (IP/25)

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Agenda Item 6: Research, development and other initiatives

SHORT-RANGE LIDAR APPLICATIONS FOR LOW-LEVEL WIND SHEAR AND WAKE VORTEX MONITORING AT HONG KONG INTERNATIONAL AIRPORT

(Presented by Hong Kong China)

SUMMARY

This paper presents Hong Kong's deployment of Short-Range Lidar (SRL) systems for detecting low-level wind shear and monitoring wake turbulence. The technology supports enhanced safety for arrival/departure operations in complex urban-airport environments.

1. INTRODUCTION

1.1 Recent advancements in Doppler lidar technology have enabled new capabilities for monitoring critical wind phenomena affecting aviation operations. The coastal location of the Hong Kong International Airport (HKIA) is favourable for the development of land-sea breeze circulation. When combined with frequent airport-area urban developments (e.g., commercial, logistical or support buildings and structures) and its proximity to the mountainous terrain (Lantau Peak, 934 m), this creates a unique environment conducive to low-level wind hazards. The Hong Kong Observatory (HKO) has deployed Short-range lidar (SRL) systems at HKIA to address:

- Low-level wind shear and turbulence detection
- Aircraft wake turbulence monitoring
- High-resolution wind profile generation

2. DISCUSSION

2.1 The HKO has strategically positioned SRL systems around HKIA to address site-specific wind hazards, as indicated in Figure 1 below.

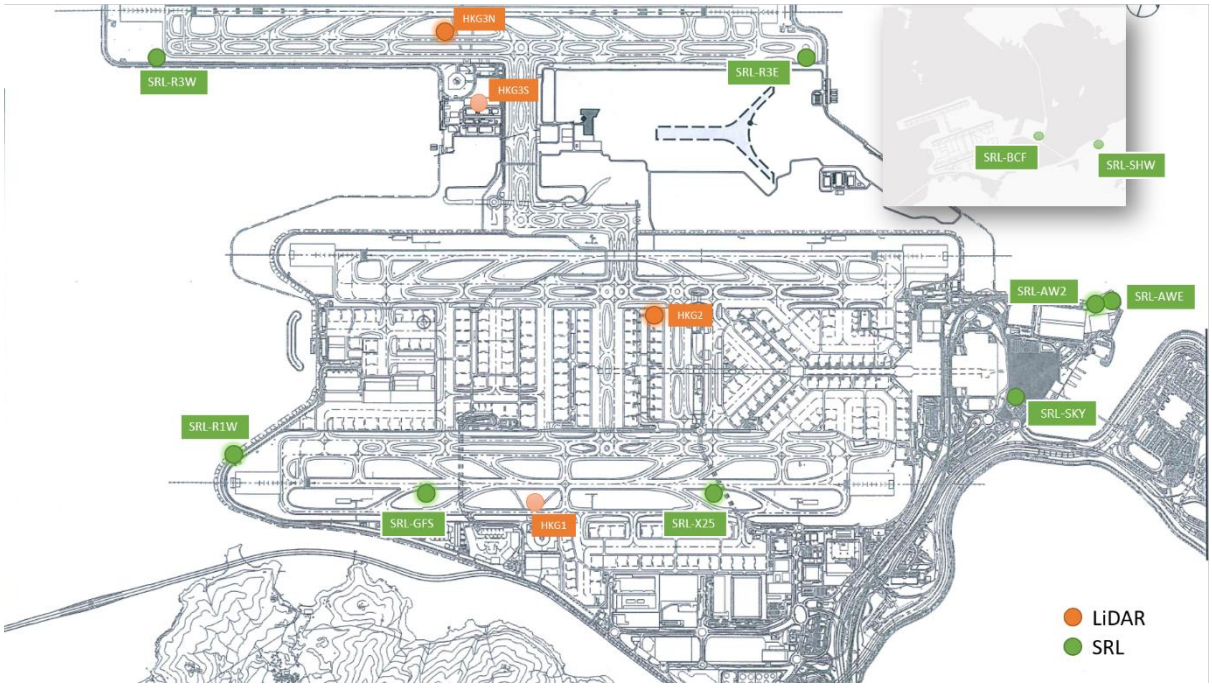

Figure 1. Locations of SRL (green dots) installed around HKIA

Low-Level Wind Effects Monitoring

2.2 Based on computer simulation studies using CFD models, possibility of building-induced low-level wind shear and turbulence has been detailed in the latest version of Aeronautical Information Publication [1].

Figure 2. Possibility of building-induced low-level wind effects on landing and departure at HKIA

2.3 The SRL systems at HKIA were deployed to detect wind shear and turbulence close to the touch down area with 10 to 20-second update cycles and 10 to 30-metre resolution, critical for mitigating risks associated with urban obstacles near the final approach. SRL-AWE in Figure 1 was installed for monitoring relevant wind effects under strong southerly winds associated with the wake of a building influencing the landing aircraft to Runway 25C, the middle runway [2]. The alerts from the SRL have been an integral component of HKO's Windshear and Turbulence Warning System (WTWS) since 2019. Recently, another SRL (SRL-SKY in Figure 1) was installed at a height of 53 m on the rooftop of a commercial building approximately 1 km upstream of the touchdown zone. Landing aircraft on the 3-degree glide path to Runway 25L (the South Runway) will pass through the building's wake influence zone under strong northly winds which can result in significant crosswind fluctuations. The SRL installed (Figure 3 and Figure 4) can monitor such wind variations and provide near real-time

information to assist the alerting of such building-induced low-level wind effects. Criteria for automatic alerting would be studied when more cases are collected.

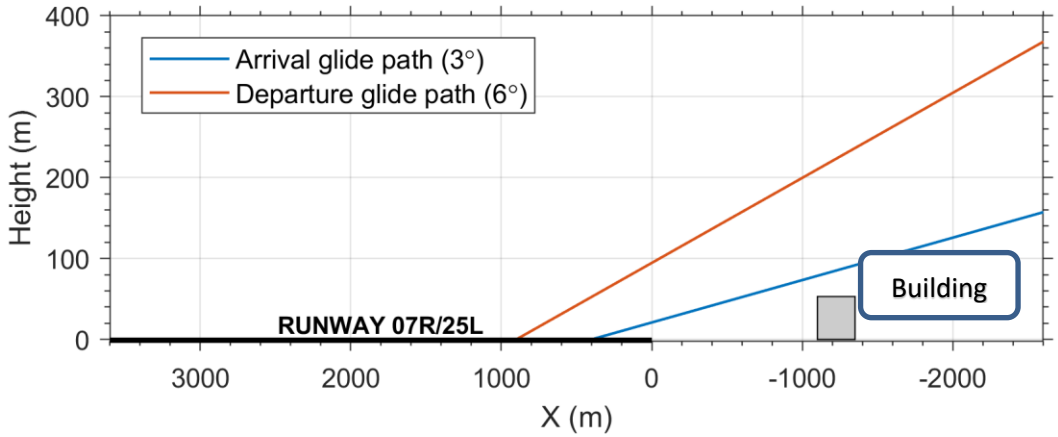

Figure 3. Arrival and departure glide paths with respect to the commercial building

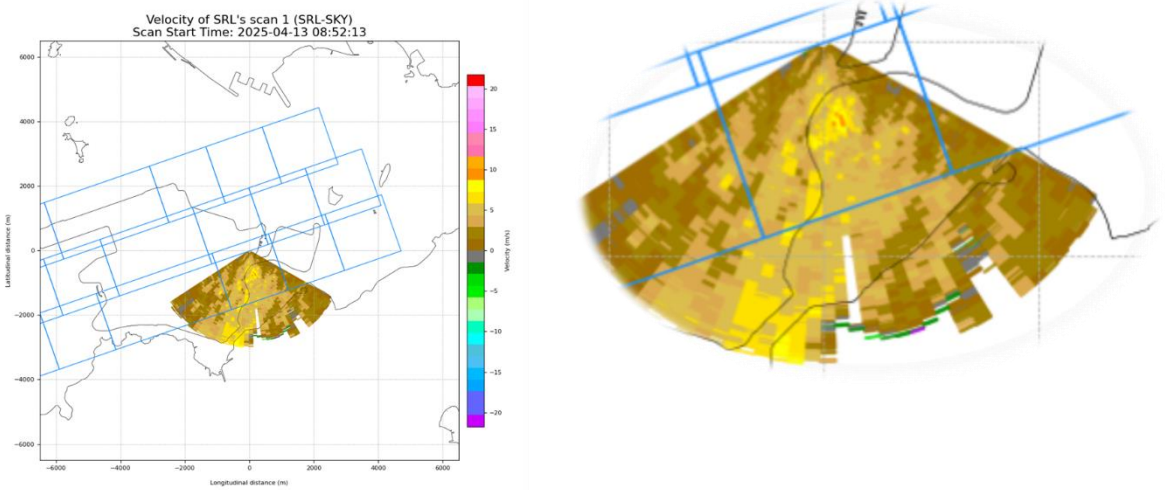

Figure 4. SRL scanning data is being received at HKO in near real-time, with cases being collected

Wake Turbulence Monitoring

2.4 As mentioned in an ICAO State Letter issued in 2007 [3], there is a need for the collection and analysis of information on wake vortex encounters of all aircraft types on a worldwide basis. The Hong Kong Civil Aviation Department has established procedure for collecting and documenting the information provided by the pilots through the "Wake vortex encounter reporting form for pilots".

2.5 HKO has conducted preliminary studies to identify wake vortices automatically using SRLs. With the automatic algorithm in place, it is possible for HKO to detect and monitor aircraft wake turbulence in near real-time for arrivals over the North Runway (Figure 5).

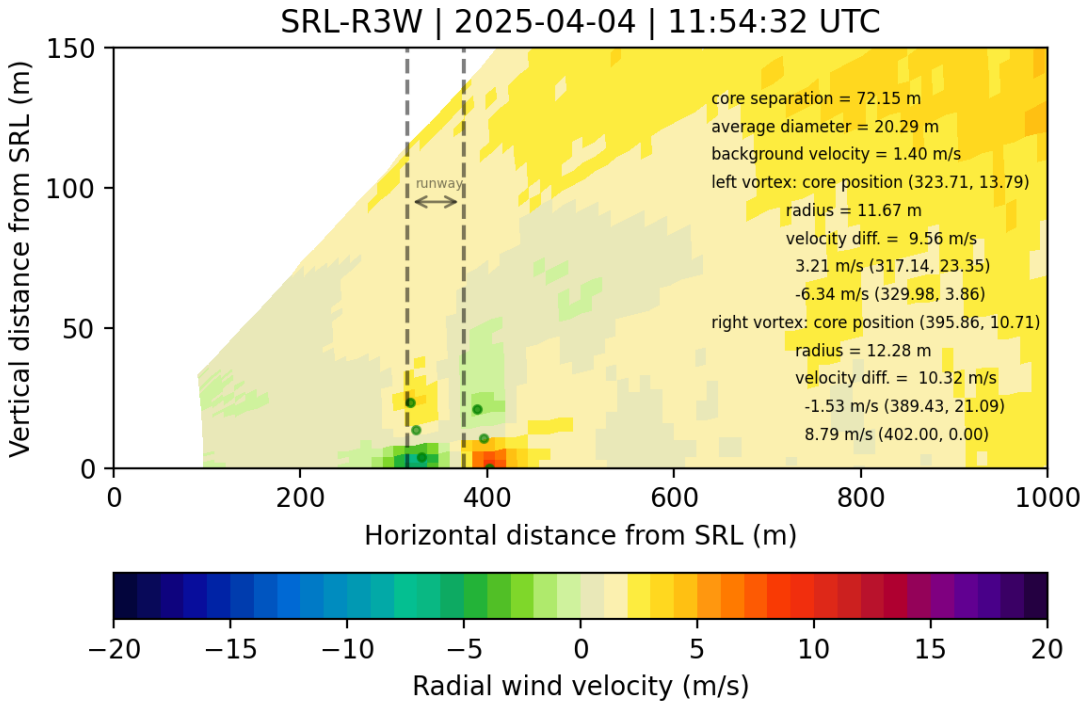

Figure 5. An example of a pair of wake vortex detected in a SRL RHI (Range Height Indicator) scan

High-Resolution Wind Profile Generation

2.6 SRL systems are also use to produce vertical wind profiles at 10-metre to 40-metre vertical resolution from ground level to 500m AMSL, refreshing at every 3-5 minutes. These profiles support runway configuration decisions by mapping:

- Sea breeze fronts (common in summer afternoons)
- Wind disturbances due to Lantau
- Vertical wind shear and low-level jets

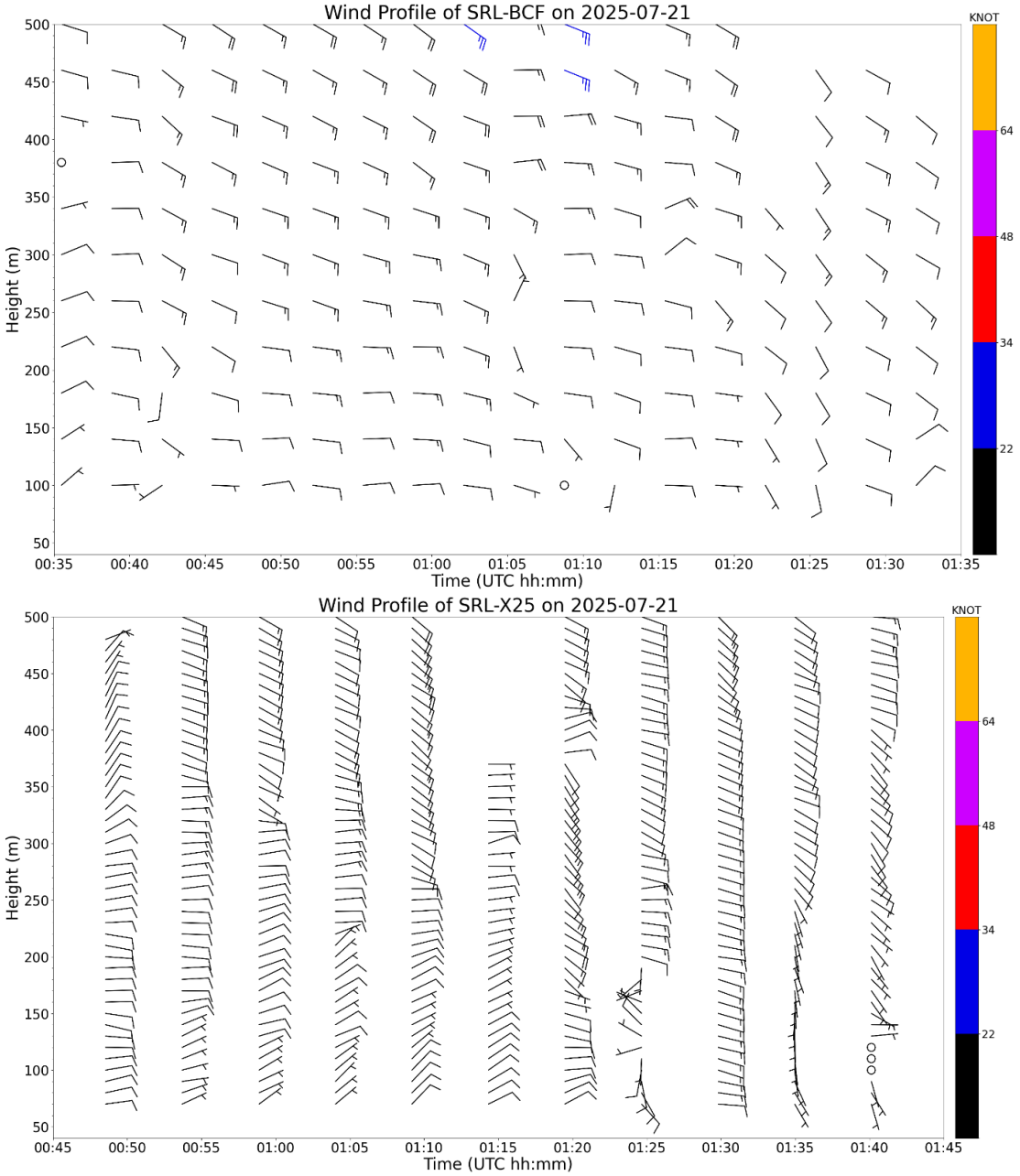

Figure 6. Examples of vertical wind profile from two different SRL scans

3. ACTION BY THE MEETING

3.1 The meeting is invited to note the information contained in this paper.

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References:

[1] Aeronautical Information Publication Hong Kong, GEN 3.5 section 17.6. 2025. Civil Aviation Department Hong Kong. https://www.ais.gov.hk

[2] Hon K-K, Chan P-W. Alerting of hectometric turbulence features at Hong Kong International Airport using a short-range LIDAR. Meteorol Appl. 2020; 27:e1945. https://doi.org/10.1002/met.1945

[3] ICAO State Letter issued in 2007.
https://www.icao.int/safety/fsix/Documents/wakevortex/sl_wakevortex_en.pdf