

## NEXT-GENERATION BIOAEROSOL DETECTION & IDENTIFICATION

# Kromek Automated Pathogen Scanner - Air Sequencing (kapscan-as): Agnostic Airborne Pathogen Detection And Identification Via Fully Automated And Autonomous Long Read Sequencing

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**Background information:** Minimising the impact of pathogen-initiated outbreaks, whether naturally occurring or intentional biological attacks, depends on our ability to detect and identify the causative agent, in order to diagnose, properly triage and treat those infected, and gauge the extent and dynamics of an outbreak. DNA sequencing can provide a sample's constitution and its pathogenic burden. Advances in genome engineering (e.g., CRISPR) and synthetic biology mean that variations of pathogens can be created as bioweapons which evade detection by standard targeted techniques like PCR.

**Purpose/Methods:** We are developing a novel fully automated and autonomous biosensing system (KAPscan-AS (Kromek Automated Pathogen Scanner–Air Sequencing)) that detects the presence of airborne pathogens (viral and bacterial) based on long read sequencing. Our integrated environmental monitoring system allows early detection of any biological threat across large areas and can inform appropriate and timely response to a potential threat.

**Objective/Rationale/Results:** We are developing a mobile version of KAPscan-AS for a proof-of-concept study. This device will be capable of rapidly identifying the pathogens used in any biological attack in an urban environment. The device collects autonomously and continuously air samples which are immediately processed and analysed. Our end-to-end sample processing pipeline consists of air sampling, wet lab, and data analysis. KAPscan-AS collects air via a bespoke wide area air sampler, concentrates the air and collects pathogens in a liquid phase. Viral and bacterial pathogens are separated by filtration and processed in two parallel pipelines through a modular system of several alternating steps using microfluidic and millifluidic solutions (concentration, lysis, clean up, amplification, library preparation, sequencing). Proprietary software maps the generated data against all organisms and delivers fast results on a species level in under 20 min. The results do not require analysis by trained individuals or specialist laboratories. The whole process takes 2 hours from collection to results. The information is reported back to central base over a data aggregation network. Our system identifies a panel of 40 pathogens with future upgrades moving towards agnostic detection of unknown pathogens.

**Impact to the DTRA mission and war fighter:** Our ongoing systems integration for non-scientific end-users (e.g., war fighters) and cost-down work will result in a commercial system which can achieve widespread adoption within mobile and static CBRN applications. KAPscan-AS can either be deployed as an autonomous system for monitoring air or an automated portable sequencing lab with minimal user interaction. As an early warning system it can operate both as a standalone device in a specific location, and as part of a network of monitoring devices. This will allow fast actionable information to military authorities without resource burden. In-field analysis of suspicious samples provides results which are rapidly available to troops. Threats are identified down to strain level and countermeasures can be rapidly enacted. This has recently been recognized when KAPscan-AS won first prize at the NATO Innovation Challenge 'Bioresponse'. Our novel technology will make ubiquitous DNA sequencing a reality and finally transform DNA sequencers into sensors.