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Tech Notes

PANTHER: Rapidly identifying biological agents in aerosols

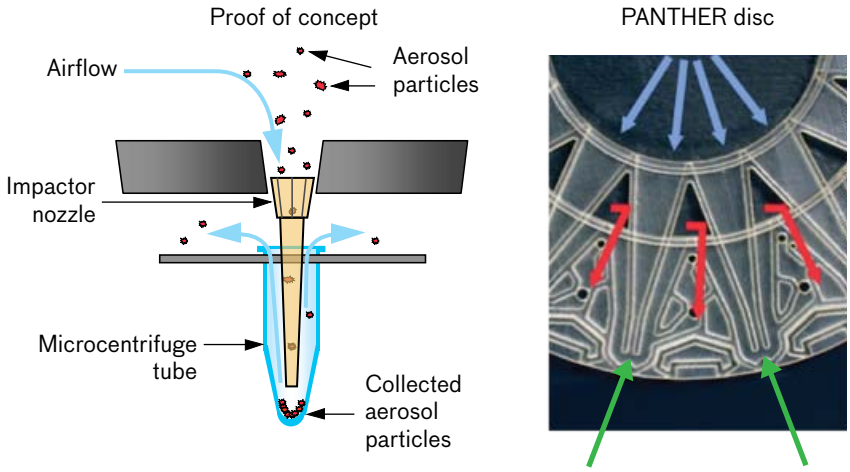
The threat of airborne hazardous biological agents within a building or in locations of high population density (e.g., sports arenas, subways) stresses the need for rapid, sensitive identification of the responsible biological agents. Lincoln Laboratory has developed instruments for rapid bioidentification and has transferred the technology to industry.

Continuing threats posed by pathogens—whether in intentional bioagent attacks or through unintentional spread of disease—highlight the need for a pathogen detection and identification method that can provide a warning before a susceptible population is infected. In order to reduce the impact of bioagent releases, the Department of Homeland Security and the Department of Defense need rapid, sensitive detect-to-warn identification. The Lincoln Laboratory-developed PANTHER (for Pathogen Analyzer for Threatening Environmental Releases) technology is a flexible bioaerosol sensor platform that was developed to meet that need.

PANTHER is made possible by the CANARY (for Cellular Analysis and Notification of Antigen Risks and Yields) technology. CANARY uses nature's bioidentifiers, B cells, the fastest pathogen identifiers known. B cells are a type of white blood cell that binds to and recognizes pathogens within seconds.

- The Laboratory's genetically engineered B cells bind specifically to pathogens of interest and then, within seconds, emit photons that indicate that binding (and therefore identification) have occurred.
- CANARY can be used to reliably detect <200 particles of pathogen in less than 2 minutes. In contrast, competing technologies take between 15 minutes and 4 hours, time spans that are inadequate for warning a population.

PANTHER uses a dry-aerosol-collection technology specifically designed to take full advantage of the speed of the CANARY assay. The advantages of the dry-impaction method are that (1) almost all consumables (e.g., liquid media) are



In proof-of-concept experiments, dry-impaction localizes bioagents to the surface of microcentrifuge tubes, eliminating the need to pre-spin the sample. This type of localization allows PANTHER discs to perform bioaerosol identification much faster and more simply than protocols used for liquid samples. A closer look at a PANTHER disk illustrates how ambient air (blue arrows) flows down the central portion of the impactor nozzle and is accelerated around a sharp turn where aerosol particles are collected (green arrows) before particle-depleted air exits from the device (red arrows).

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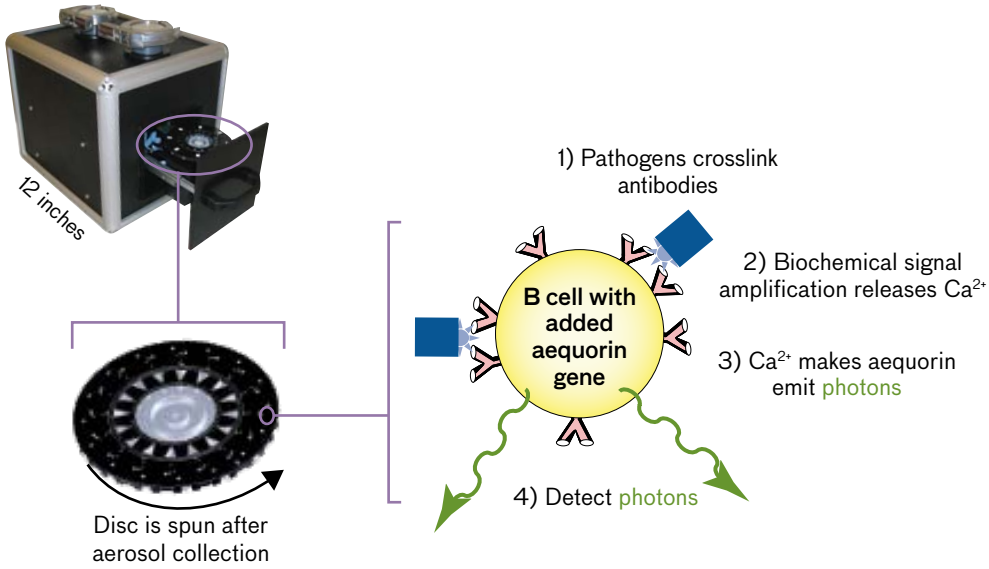

The fundamental components of the PANTHER biosensor include genetically engineered B cells that emit photons upon binding to specific bioagents and a photodetector that measures the luminescence. The PANTHER sensor collects aerosol samples, spins the disc to release B cells onto the collected particles, and detects the emitted light to determine what pathogens may be present.

eliminated from the CANARY process, and (2) the dry impaction localizes the bioagents to the test surface, eliminating the need to pre-spin samples for maximum concentration and thereby speeding up and simplifying the identification process.

The PANTHER detection process automates three steps inside the PANTHER disc:

- Aerosol particles within an airstream are accelerated through a nozzle and impacted onto a test surface. This process forms localized spots of collected aerosol particles at each of the 16 collection sites at the edge of the disk.
- The disks are spun at high speed to release B cells from a sealed reservoir. Within seconds of contact, the B cells begin to signal detection of pathogens by emitting light.
- The spinning disks containing the B cells rotate past a single sensitive light detector, a photomultiplier tube, that converts the light emission into electrical signals.

PANTHER sensors support 16 simultaneous tests for the presence of up to 48 agents to be performed on a single aerosol collection. PANTHER, which has shown high-confidence identification in less than 2 minutes, is intended for use in building/site protection, emergency response, and environmental monitoring. The sensitivity and speed of PANTHER, along with the multiple-sample capability and the sensor's portability, make the technology valuable for rapid onsite detection/identification needed in emergencies.

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Compact PANTHER

The compact 37 lb, 1 ft^3 PANTHER sensor unit could dramatically improve onsite biological detection capabilities. All the PANTHER components are packaged in a light-tight transportable case that can help reduce potential exposure to intentional bioagent releases by testing aerosol samples and giving rapid results without having to send samples to a laboratory. This unit has shown reliable identification of pathogens, and its modest cost, less than $20,000, (PathSensors, Inc., markets the BioFlash-E Biological Identifier, which is based on PANTHER) makes it viable for widespread biodefense use. ■

Additional Reading

Petrovick, M., J. Harper, et al., "Rapid Sensors for Biological Agent Identification," *Lincoln Laboratory Journal*, 17(1): 63–84, 2007.

Rider, T., M. Petrovick, F. Nargi, et al., "A B Cell-Based Sensor for Rapid Identification of Pathogens," *Science*, 301: 213–215, 2003.

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