

ORNL Detection Component Summary
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1. Charging, Electrostatic Deposition and Deflection, and Particle Mobility:

Charged particles will be produced on-the-fly by electrospray deposition of highly charged nanodroplets or corona discharge. Once charged the airborne particles can be deflected electrostatically, deposited on an oppositely charged surface such as an electron microscope grid or the tip of a fine needle for insertion into a tiny reservoir containing buffer for on-the-chip flow cytometry analysis. The mobility of the charged particles will also be measured to provide another variable to further narrow the definition of a threat and thereby reduce the false alarm rate.

2. On-the-Fly Dyeing of Alarm Particles and Measurement of Dye-Induced

Fluorescence: Fluorogenic dye will be deposited on the surfaces of alarm particles. Reaction with proteins on the surfaces of the particles will strongly increase the fluorescence and indicate a biological origin. Fluorogenic dye will not penetrate the outer protein coat of spores to react with the proteins on the insides of the cell as it may with vegetative cells. Consequently, it may be possible to differentiate spores from vegetative cells by comparing the total fluorescence. Alternatively, vegetative cells and spores maybe differentiated using a cocktail of fluogenic dyes. A dye that will penetrate the cell wall to react and produce fluorescence in another region of the spectrum could be used in conjunction with the dye that will not penetrate the cell wall to differentiate vegetative cells from spores. Choosing a dye system will be part of the effort.

3. On-the-Fly Deposition into a Microchip Reservoir for Flow Cytometry Analysis:

Lab-on-a-chip analysis of alarm particles is being proposed as a rapid and relatively inexpensive method of threat confirmation. It is envisioned to be the last element in a threat detection array. Deposition of alarm particles into a lab-on-a-chip reservoir can be accomplished in a number of different ways depending on the method of formation of the particle beam. LLNL is proposing the use of an aerodynamic lens system to create a tightly collimated particle beam with detection components analyzing the particles as they pass by in vacuum. The particles that are not a threat can be deflected away electrostatically while alarm particles are permitted to proceed unimpeded into the reservoir of the lab-on-a-chip to be collected by impaction. Vacuum can be broken at the chip by closing a ball valve and thereby permitting in situ injection of buffer solution followed by flow cytometry analysis. Alternatively, tightly collimated particle beams can be generated near atmospheric pressure using sheath air flow methods. Native fluorescence, light scattering, charging, dyeing, dye-induced fluorescence, etc, measurements can also be done on-the-fly to define the alarm particles. Particles that are not defined as a threat can be deflected in a number of ways such as electrostatic deflection and puffing while alarm particles are left to proceed unimpeded to impact into the buffer containing reservoir of a lab-on-a-chip for flow cytometry analysis. Alternatively, charged alarm particles could be collected on the tip of a charged needle. The needle could then be pneumatically inserted into the reservoir of a chip for subsequent analysis. Positive alarm particles can be harvested from the chip for later PCR analysis to define the strain.

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