Analysis of the Physical Behavior of Viruses Using the Integrated Virus Detection System (IVDS)

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ABSTRACT

A physical approach to virus detection, analysis and identification has been invented\(^1\) and patented\(^2\) at the US Army SBCCOM. The Integrated Virus Detection System (IVDS) is a reliable, high-speed instrument for detecting viruses\(^3\) that changes everything in respect to virus analysis. No culturing, no reagents, quick analysis, generic to all virus and virus like particles. The current instrument has been used to examine viruses separated from complex media\(^4\) with sensitivity to less than 10 viruses at the counter\(^5\). Other virus characteristics have been observed and calibrated, e.g. passage of viruses through filter membranes\(^6\) and exceptional survival in both extreme temperature and pH. This briefing reviews results from several studies and an operational review of the instrument.

BACKGROUND AND INTRODUCTION

IVDS is a new invention that utilizes the physical properties of virus, virus-like and other nanometer particles to determine a concentration, distribution and information for discrimination and characterization of nanometer particles (1 nm equals one billionth of a meter). Nanometer particles have been measured and calibrated from 5nm to more than 450 nm using a wide range of viruses and nanometer particles. This analysis has lead to a wide range of new discoveries including the ability of some viruses to pass through filters, change easily, live a long time under harsh environments, and live in soil and water. Identification can be made for the many known virus families pathogenic to man, as well as a new means for detecting unknown and emerging viruses. Another great advantage is that since the current IVDS instrument does not require complicated chemistry or reagents it can be used by nearly anyone. The technology was transferred by exclusive patent license agreement that includes a large team of scientists and engineers key to successful technology transfer.

Other more familiar sounding methods require specialized reagents, skill, and frequently time in making an analysis, most are very difficult to set up, destroy the sample and have limited application to un-named viruses.

The first objective after developing the IVDS instrument was to calibrate it over a wide range. This was accomplished using personnel and material from the National Institute of Standards and Technology.

The second objective was to demonstrate the effectiveness of IVDS is counting viruses under a wide range of conditions. This is important as there are many inherent challenges to virus detection and analysis, among the primary is purification and concentration from the background material. The first demonstration was the ability to count viruses in filter systems, both in the filtrate and those retained on the filter. The second demonstration was the ability to separate viruses from complex media, such as growth compounds,

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The third demonstration was the ability to observe viruses as they changed following exposure to temperature and pH.

**METHODS**

MS2 Bacteriophage was used as an example of a virus like particle. It was grown and prepared by the Life Sciences Division at Dugway Proving Ground, UT, lot #98110. IVDS methods were used for filtration, heating, and pH demonstrations.

**RESULTS AND DISCUSSION**

A typical output from IVDS is given in Figure 1. Virus size and concentration are given as a graph. Statistical information is given for the virus such as mean size, total concentration, and a table of all the particles in the size range is prepared for each sample. In this manner the size, concentration and details of the analysis are presented. There is enough data in this chart to make a preliminary discrimination among samples and evidence for a preliminary identification.

Results from the first demonstration illustrated the ability of MS2 to pass through 1M Dalton filters with ease, and to pass through 750K, 500K and 300K filters. MS2 was retained on 100K Dalton filters. This was an interesting result for an approximately 3M Dalton sized virus. The second demonstration illustrated the successful separation of MS2 from several proteins, salts, and growth media. The exposure of MS2 to continuous heat demonstrated a robust organism that retained structural integrity for more than 2 hours at 63°C and more than several minutes at 70°C. MS2 was further demonstrated to retain integrity for several hours at pH 1.41 and for several days at pH 10 and pH 11.1.

This briefng will review the results of these successful demonstrations and give an operational overview of the IVDS instrument. The immediate impact with a device of this type is virus screening and detection.