# Modular Bench Top Automation

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## Abstract

ELISA is one the most utilized assay formats in biomedical research. Numerous clinical, veterinary, and research assays use the specificity of antibodies to identify a diverse array of analytes from any number of different matrices. Despite the diversity of analytes the general process of ELISA is constant. With a typical ELISA protocol, several repeat cycles of microplate washing, reagent addition and incubation are executed to elicit the chemistries and remove unbound material before data collection. Manual processing requires a technician to manage timings and be available to move the plate between washer, multiple dispensers, and a reader.

We have designed a modular bench top workstation capable of automating the assay process steps of most conventional ELISA assays. The robotic system employed uses a plate moving technology allowing full 360° access to ELISA instrumentation. Two configurations of ELISA instruments were employed to carry out the necessary assay process tasks. In one configuration a combination washer dispenser was used to perform the wash steps as well as provide reagent addition. The other configuration the wash steps were performed using a full plate washer and modular dispenser for reagent additions. In both configurations room temperature incubations were carried out using the plate mover's random access plate storage hotel and absorbance measurements were made using a microplate spectrophotometer.

Using the modular ELISA workstation we have automated the assay process steps of an HIV ELISA assay kit. Plates with samples and controls can be loaded on to the system and the user simply presses a button and walks away. This poster will detail specifics of such a system, with automation workflows and details regarding throughput and performance provided.

## Introduction

The robotic system employed utilizes a Thermo Scientific Orbitor® RS plate mover to move microplates to and from each station. In addition to the Orbitor RS, either an EL406™ Microplate Washer Dispenser or a combination of an 405™ Touch Microplate Washer and a MultiFlo™ Microplate Dispenser (BioTek Instruments) were used to perform assay washes and reagent dispensing. Room temperature incubations were carried out using the random access plate hotels of the Orbitor system and absorbance measurements were made using a Eon™ Microplate Spectrophotometer (BioTek Instruments).

The robotic system was configured on a standard double lab bench. The fully configured system had a footprint that was 60" x 48". While an open bench end was used the short stature (29") allows the plate mover to be used under many commonly used center bench shelving units. An optional mezzanine table was used to support the 405 Touch, MultiFlo fluid handling instruments. The mezzanine table unit provides upper and lower shelves capable of supporting multiple instruments. The top shelf is configured on sliding rails, while the bottom shelf pivots outward allowing easy access to the instruments for offline use or maintenance.

The Orbitor RS plate mover employs a 360° rotating lift unit that moves a bidirectional telescoping arm up and down. The telescoping arm passes through the base allowing rapid transfers without necessarily rotating, improving speed and efficiency.

The 405 Touch Microplate Washer is an automated microplate processor that can perform microplate washing steps in 96- and 384-well microplates. In addition to standard wash routines, the 405 Touch has built-in cell-washing capabilities. A buffer switching valve allows for up to four different wash buffers to be selected without changing bottles. A built-in ultrasonic cleaner allows for automated maintenance of the wash manifold. The MultiFlo dispenser has up to four different reagent dispenser heads. Two heads are peristaltic pump devices capable of dispensing from 1 µL to 3000 µL. The MultiFlo can also be configured with an additional module that has two independent syringe pump dispenser heads capable of delivering from 5 µL to 3000 µL.

## System Configuration

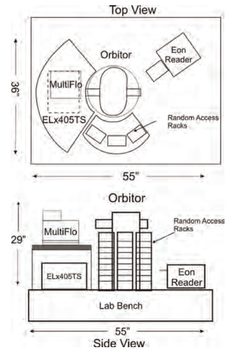


***Figure 1 –*** *Schematic diagram of a Modular Automated system. Modular system configured with an 405 Touch Washer a MultiFlo Dispenser and an Eon Reader.*

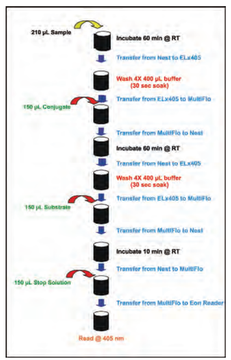


***Figure 2 –*** *HIV ELISA Test procedure steps using Modular Automated System. The HIV-1 micro-ELISA assay (Avioq, RTP, NC) was performed using a 405 Touch to perform the wash steps and a MultiFlo Dispenser for reagent addition. The absorbance of the wells at 405 nm was determined using a Eon Microplate Reader. Wash processes by the 405 Touch Microplate Washer are indicated in Red, reagent additions carried out by the MultiFlo are indicated in Green, plate read step by the Eon is indicated in Orange, while plate movement tasks performed by the Orbitor RS are indicated in Blue.*

## Comparison to Manual Methods

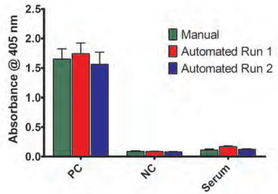


***Figure 3 –*** *Comparison of manual and automated assay formats. Batch runs of the Avioq HIV-1 assay were performed manually (3 plates) or two separate runs using the automated Orbitor RS ELISA workstation (5 plates each). Data represents the mean and standard deviation of all the data points for each batch experiment.*

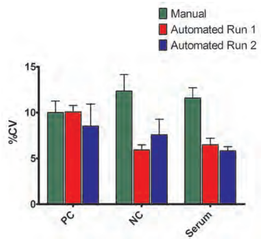


***Figure 4 –*** *Intra-Assay Precision comparing manual to automated procedures. %CV of the Positive control (PC), negative control (NC) and pooled serum samples were calculated for individual plates. Data indicates the mean %CV for each assay run.*

## Assay Repeatability

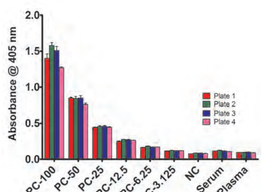


***Figure 5 –*** *Repeatability of the Automated Avioq HIV-1 Microelisa Assay. Dilutions of the Positive Control (PC) along with the negative control (NC), pooled human serum and pooled human plasma were assayed in replicates of eight on four separate microplates. Data represents the mean and standard deviation of each microplate.*

## Gantt Chart

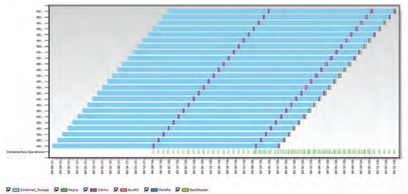

***Figure 6 –*** *Gantt Chart of a 24-plate run. The process timing of 24 plates of the Avioq HIV-1 assay are indicated as a timeline. Initiation of each plate was set to a delay of 3 minutes in order to allow for plate loading and avoid instrument-timing delays. Light blue bars indicate incubation periods in storage hotels, the 405 Touch and MultiFlo process steps are indicated with red and dark blue respectively. Green marks indicate robot regrip process steps necessary to orient plate correctly in modular instruments.*

## Quantitative Results

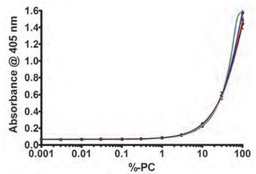


***Figure 7 –*** *Demonstration of Automated System to perform quantitative assays. Log dilutions of the Avioq HIV-1 positive control (PC) were assayed and the mean and standard deviation plotted for 4 separate assay plates. Each data point represents the mean of four wells.*

## Modular Automated System

***Figure 8 –*** *Images of Modular Robotic Assay System. Photo depicts complete modular automated system with random access stacks, Mezzanine Table, 405 Touch Microplate Washer and MultiFlo Microplate Dispenser. The Eon Microplate Spectrophotometer (not seen) is located on other side of Orbitor RS plate mover*

## Instrumentation


***Figure 9 –*** *Instrumentation utilized to configure the Modular Automated Assay System. The 405 Touch Microplate Washer (A) a MultiFlo Microplate Dispenser (B) and an Eon Microplate Spectrophotometer (C) from BioTek Instruments were interfaced with using an Orbitor RS microplate mover (D) from Thermo Scientific Robotics.*

## Conclusions

- Modular Automated System Provides Equivalent Results as Manual Method
- Assay Results are Quantitative, Precise and Repeatable
- 24-plate Avioq HIV-1 ELISA run can be completed in less than 3.5 hours
- Plate Washing and Reagent Dispense can be Accommodated using 405 Touch Microplate Washer and MultiFlo Dispenser
- Modular Automated System Provides Complete Automation of Assay Process Steps
- Automated System is Compact and Uses Conventional Bench top rather than Customized Table
- Mezzanine Tables allow for Easy Access to Individual Components; allowing for stand alone operation and/or maintenance
- Modular System is Easily Reconfigurable as Assay Requirements and Throughput needs change