

# Standardization of Thermo Scientific LIMS-on-Demand at University of Miami Accelerates Discovery to Find a Cure for Spinal Cord Injury

The Miami Project to Cure Paralysis, part of the University of Miami Miller School of Medicine, is a multidisciplinary team of investigators with a common goal – to conduct neuroscience research that addresses traumatic injury to the central nervous system and that ultimately leads to new or improved treatments for spinal cord injury and other neurological disorders. Its research team is made up of both basic and clinical scientists with expertise in critical areas of neuroscience and is currently at the cutting-edge in its field.

The Miami Project to Cure Paralysis has a dedicated laboratory devoted to high-content screening (HCS) of neurons. The laboratory is run by Dr. Vance Lemmon and Dr. John Bixby, and is known as the LemBix Laboratory, currently employing 20 staff. In 2008, the laboratory adopted a laboratory information management system (LIMS) as part of its continuous focus on data management. To improve efficiencies, productivity and sample integrity the LemBix laboratory needed to invest in a data management solution that would enable the laboratory to integrate laboratory workflows and data. Today, the LIMS implementation encompasses an on-demand solution that serves the needs of the project's goals – to manage its workflows and operations in the most efficient and effective way to turn data into knowledge.

## Profile

The Miami Project to Cure Paralysis is the world's most comprehensive spinal cord injury research center, housed in the Lois Pope LIFE Center, a Center of Excellence at the University of Miami Miller School of Medicine. The Miami Project's international team of more than 200 scientists, researchers and clinicians take innovative approaches to the challenge of spinal cord injury.



Injury to the central nervous system (CNS) has devastating effects on the structure and function of the brain and spinal cord. Since the early 1980s, immense research progress has been made and has given hope that injuries to the CNS will one day be repairable. Still, there is much that researchers need to learn about the complex processes that occur in the brain and spinal cord after injury, and how those processes can be changed or reversed. Miami Project investigators carry out a broad scope of research to address the consequences of neurological injuries.



## High content screening

Traumatic injury to the CNS usually results in irreversible loss of function. There are two main reasons for this: one is due to the death of nerve cells and their support cells; the second is due to the severing of very long processes (called axons) that transmit electrical signals from one nerve cell to others. Transected CNS axons do not re-grow or re-establish connections with their targets. Consequently, individuals with injured spinal cords can be irreversibly paralyzed.

HCS offers an ideal way to identify genes; molecular pathways; and, ultimately, drugs that can promote the regeneration of CNS axons. HCS permits the quantification of cell morphology, including the lengths and numbers of axons, of neurons in culture. The LemBix laboratory can screen 3000 different genes in primary neurons and measure 120 different parameters in over 8 million neurons in the span of a few months.

Screening campaigns using primary neurons are uncommon due to the expense of culturing cells that require complex defined media and the variability between preparations of nerve cells. The LemBix laboratory tackles the variability between preparations, in part, by including a number of control treatments that are used for normalizing data across experiments. But it is clear that much of the variability between different experiments is due to variability in reagents and cell preparation.

CNS neurons are isolated as single cells before being transfected with expression vectors coding for potential regeneration-associated genes and green fluorescent protein. Then, neurons are plated into 96-well plates and cultured for 2-3 days before being fixed and stained to permit

visualization of nuclei and neuronal morphology. The plates are then imaged and analyzed using a Thermo Scientific Celloomics VTI ArrayScan and Celloomics BioApplications.

## The laboratory and its goals

The goal of the LemBix laboratory is to uncover signal pathways, genes, compounds, or drugs that can be used to promote nerve growth. HCS of various libraries on primary neurons requires a team based approach, a variety of process steps and complex manipulations of cells and libraries to obtain meaningful results. The approach of HCS itself produces vast amounts of data in the form of images, in addition to well-based and cell-based phenotypic measures. A single experiment can generate data from 300,000 neurons with 120 parameters per cell. Managing sample workflow and library data, along with the extensive amount of experimental results is challenging.

Within the laboratory's workload, hundreds of different reagents are used for a particular experiment and there are dozens of different steps to document the processes, such as recording the number of cells that are inserted into a particular well, how they were treated, when they were put into the incubator, etc. It is crucial that the laboratory keeps track of every detail of these processes.

## Challenges and requirements

In order to rapidly identify sources of variability, it is essential to have a LIMS that tracks supplies, reagents and workflows. As so many people are involved in the workflow of a particular experiment the only efficient way to do this is via an electronic system that can easily be used by all

the people who need to enter information. The laboratory needed an informatics solution to meet the ever growing data deluge and to turn data into knowledge.

Prior to implementing a LIMS the laboratory used paper-based worksheets and manual notebooks. The work conducted takes advantage of compound libraries and gene (cDNA and siRNA) libraries and the laboratory found that it was becoming overwhelmed with all the data. At the time, the laboratory was moving from traditional academic research, e.g., hypothesis and testing driven research where it was easier to keep track of information manually in notebooks, to a heavier workload that involved more complicated screening and more people. Keeping track of what each person was doing through the process of preparing the cells and perturbations, such as compound libraries, as well as staining and analysis was a challenge. The laboratory concluded that a paper-based process was not adequate and that an electronic method was required.

The Miami Project to Cure Paralysis sought a LIMS for the LemBix laboratory that would facilitate its laboratory workflows and automate its previously manual data management processes.

Dr. Vance Lemmon, Professor of Neurological Surgery at The Miami Project explains, "With the increasing workload involved in high-throughput screening, we required an informatics solution that could manage the flow of data, enhance productivity and allow the scientists to focus more of their effort on their goal of finding a cure. In addition, we needed to be able to readily access and analyze the data to provide us with knowledge that was previously difficult to acquire."

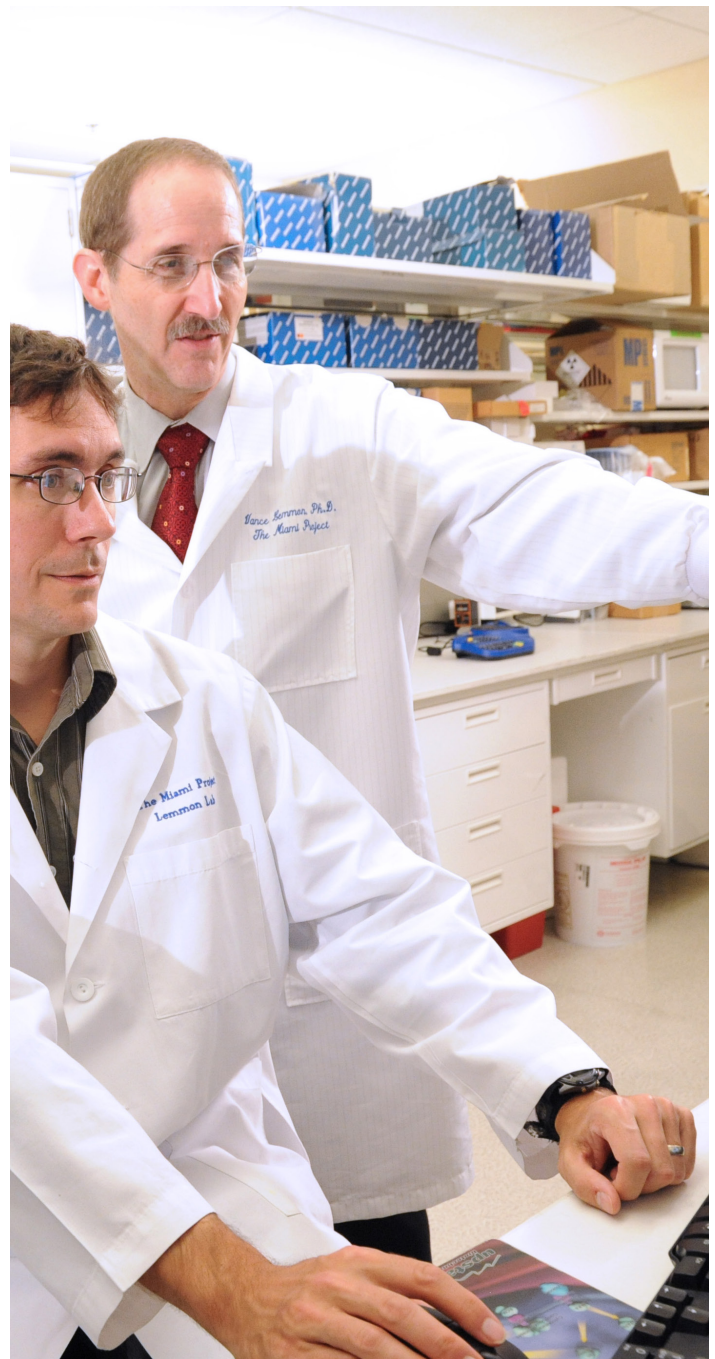
The goals of implementing a LIMS included improved tracking of data, plate management and workflow documentation. The laboratory required real-time reporting in order for laboratory members and supervisors to have immediate access to information on collaborative projects.

Dr. Vance Lemmon states, "It was essential that the laboratory implemented a solution to ease tracking reagents in multiple-well plates, link digital information with workflows and document stocks and lots used in experiments. We needed a solution to enhance our routines and ease the bottlenecks."

### The solution

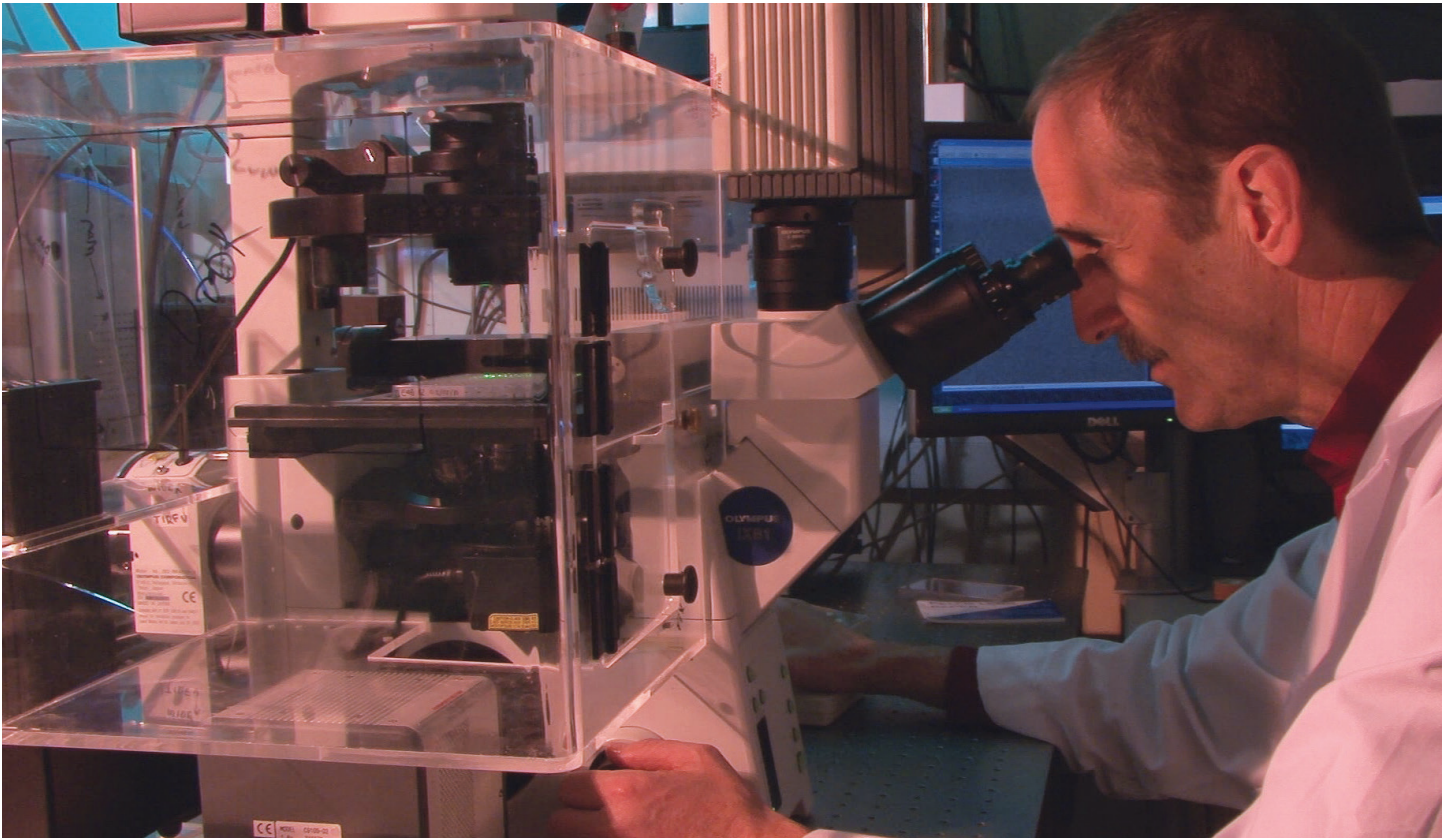
In 2008, the LemBix laboratory outlined its requirement to invest in a LIMS and conducted an evaluation process. The team selected Thermo Scientific Nautilus due to its ease of developing workflows. In comparison with other solutions on the market, they concluded Nautilus had the most sophisticated plate handling. The LemBix laboratory chose Thermo Scientific Nautilus LIMS to improve its efficiencies and sample management and to manage the enormous volumes of data in order to ease the administrative task of scientists so that they could focus on the laboratory's goal of finding a cure.

Dr. Vance Lemmon comments, "Following the evaluation process we found that no other system matched the capabilities of Thermo Scientific Nautilus in terms of consistency of flexibility, ease of use and automated complex plate-handling functionality. In addition, Nautilus had a wide user base which instilled our confidence in the LIMS." Vance continues, "Nautilus is a widely used LIMS for high throughput environments – we selected this proven system as a result of its history in the pharmaceutical industry and the fact that it is designed for the unique requirements of dynamic labs. We were confident it would offer



substantial productivity gains, eliminate manual and error-prone activities and enhance throughput and accuracy."

For the LemBix laboratory, a key driver for implementing a LIMS was the chance to reduce turnaround times, improve forward planning and ensure that standard operating procedures (SOPs) would be adhered to. It was important that a solution would ensure enforced business rules and be able to capture details about workflow to identify problems or optimal conditions. The LIMS keeps track of stocks and reagents throughout the different workflows as it is crucial to identify which reagents are worth progressing.



Dr. Vance Lemmon adds, “Workflow, reagent and stock tracking is imperative. For cell culture we use complicated media and different types of reagents and many of our experiments fail due to problems with the reagents and stocks. If an experiment fails we need to understand why. A LIMS greatly facilitates this.” Vance continues, “It is crucial that we keep track of all the information – it would be irresponsible not to. So many people are involved in the workflows that without a LIMS system it’s exceptionally difficult.”

### **The changing demands of the project**

The LemBix laboratory originally adopted a LIMS to facilitate its laboratory workflows and automate its previously manual data management processes, improving efficiencies, productivity and sample integrity. However, the laboratory realized that there was the possibility for further time and efficiency savings. With the increasing workload and high-throughput, the laboratory managers decided to invest in an on-demand solution that better serves the needs to the projects goals – to manage its workflows and operations in the most efficient and effective way. Laboratory managers needed to be able to readily access and analyze the data to provide them with knowledge that was previously difficult to acquire.

Furthermore, the LemBix laboratory had been struggling with in-house maintenance issues associated with the University’s servers. The laboratory was dependant on the University IT staff to maintain and repair the servers; if there was a problem with the server it could take weeks for the issue to be resolved because the laboratory is one of many areas supported by University of Miami IT, and its needs were not high priority

for the IT team. It was extremely time-consuming and laborious for the scientists in the LemBix laboratory, who spent a significant time on the phone and email, communicating with the server help desk.

The LemBix laboratory decided to migrate to an on-demand LIMS in order to remove the IT support bottleneck. The Miami Project to Cure Paralysis realized that an on-demand LIMS solution would be crucial in helping to accelerate discovery in its high-content screening laboratories, enabling the entire field to move forward at a faster rate. Due to Thermo Fisher Scientific’s strong track record of delivering a reliable and robust solution in the form of Nautilus LIMS, the laboratory did not look to any other vendors for an on-demand solution.

By automating its workflows and data management with an on-demand LIMS, the LemBix laboratory will gain efficiencies, reduce errors, and enable scientists to spend more time in the productive pursuit of science. An on-demand solution will allow the LemBix laboratory to realize the benefits of automated workflows and data management, enabling its scientists to spend more time in scientific pursuit and less time managing systems for handling the vast amount of data.

Dr. Vance Lemmon explains, “The on-demand LIMS solution will enable our laboratory to have access to data anywhere, at any time, from any web browser. With full featured LIMS functionality available over the Internet, we can have all the data reliability and security benefits that come from an installed LIMS but without the added hassle of maintaining an implemented application. Our scientists now have the added benefit of automated data reporting, eliminating the time-consuming tasks



associated with manual or paper-based processes and enabling our laboratory workers to make faster, more informed decisions.”

### **Benefits**

LIMS-on-Demand has made it possible for the laboratory to control its data more easily, freeing up valuable resources in the laboratory to focus on the core missions of finding a cure for spinal cord injury.

Dr. Vance Lemmon explains, “The on-demand solution from Thermo Fisher Scientific was an easy fit. We had already invested in workflow development and stock and reagent tracking for our Nautilus LIMS and the ability to very rapidly push this over to a SAAS system was very appealing. I was astonished at how fast we got going and how fast we got our data transferred from our client-based system to the on-demand solution. It was impressive; the transition from Nautilus to an on-demand solution has been seamless.” Vance continues, “It’s hard for me to see the difference – whether I’m using client-based or web-based LIMS – it just looks the same. LIMS-on-Demand provides all the benefits of a fully installed LIMS, such as built-in workflows, a powerful database, the ability to capture, store and analyze lab data, monitor resources and integrate with instrumentation, and reporting templates, while minimizing the need for IT resources and eliminating expensive hardware and software.”

In addition, as so many people are involved in the experiments, all of whom work on different computers, e.g., PC, MAC, laptop, etc., it is advantageous to be able to access the data from any computer, from any location. A client-server based model could not accomplish this, whereas

a web-based solution solves this problem and make it easier for the scientists in the lab to use whatever computer is available.

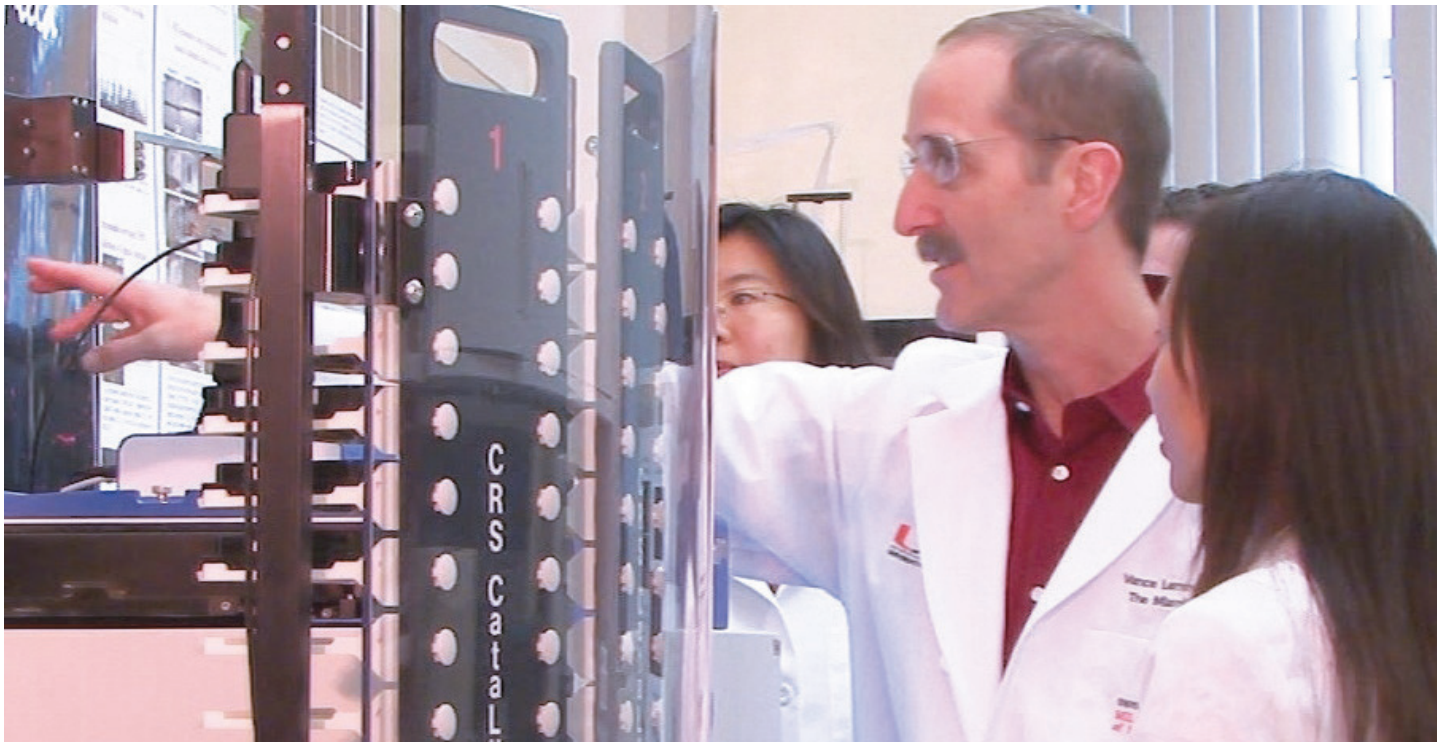
Dr. Vance Lemmon explains, “LIMS-on-Demand eliminates maintenance issues, resulting in significant time and productivity savings. The on-demand model just works from any computer – it is convenient and easy to use. Our scientists simply connect to the system over the internet – from anywhere and from any web browser – when they want and for as long as they want. The scientists do not have to worry about the servers, we don’t have to maintain the Oracle database, and updates are automatic.”

### **Funding benefits**

Private benefactors of medical research, often the source of seed money for new research endeavors in academic research institutions, prefer to fund buildings and equipment and are rarely willing to fund software projects that can appear intangible and have unknown outcomes or timelines. Thus, obtaining sufficient resources to purchase a LIMS for a single university laboratory can be a daunting task. As the Miami Project receives grants for research rather than grants for software and informatics solutions the payment structure for LIMS-on-Demand is better suited to this type of funding than CAPEX (capital expense).

### **Conclusion**

HCS is being counted on to uncover signaling pathways, genes, compounds or drugs that can be used to promote nerve growth. The screening pipeline includes solid experimental techniques combined with instrumentation and analytical tools. The process produces enormous amounts of data. An on-demand LIMS solution is ideal for scientists



undertaking high volumes of screening and for academics in the translational science community affronted with the generation of large quantities of data.

The on-demand LIMS solution solved a problem for the LemBix Laboratory. The scientists no longer have to rely on the university's IT team to maintain the servers and no longer have database licensing issues. The scientists can focus on the core business of finding a cure for spinal cord injury – not working as database managers and server experts. Being able to outsource all of the work to an on-demand LIMS has huge advantages for the LemBix Laboratory. The LIMS can be accessed on any computer, via any browser as no special software is required to interact with servers and the scientists can even access the data when they are away from the laboratory.

With both a productivity and efficiency driving rationale, the Miami Project has equipped its laboratory with the technologies and infrastructure that allow it to deliver consistent support to ensure the quality of its workflows. To deliver this cutting-edge research, the LemBix Laboratory has standardized on LIMS-on-Demand.

Dr. Vance Lemmon concludes, "The major benefit we have realized since the installation of LIMS-on-Demand is improved efficiency; the on-demand model has provided our laboratory with a means to manage data in a way that would never have been possible before. Only with LIMS-on-Demand can the Miami Project to Cure Paralysis continue to identify and treat novel mechanisms of injury following brain and spinal cord injury and translate these discoveries to the clinic."

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