

Positioning stage accuracy and flexibility enhance cutting edge genomic, proteomic, and drug discovery tools

As the density of microplate wells increase, flexible, high performance positioning stages are a must

Recent advancements in genomic research are creating a ‘gold rush’ in the biotechnology and pharmaceutical industries as drug corporations, biotech firms, research labs and universities strive to take advantage of the new research at their disposal. Years in drug development time and hundreds of millions of dollars can be saved getting a single drug to market. With stakes this high, drug companies are asking tool makers to enhance the speed and efficiency of their products. Miniaturization of liquid dispensing microplates and precision nanoliter volume dispensing are key aspects of speeding up the drug discovery process. Gilson Inc, a worldwide leader in drug discovery tools, has developed tools that can take advantage of the eventual move from 96 and 384 well microplates to 1536 well microplates. “We know that the requirements for high density micro array instruments have increased dramatically over the past several years. Even though the selected configuration met all of our current requirements, we recognized the long term economy of a system where we could increase the resolution without having to change the exterior of the instrument. Should the industry suddenly take another quantum leap in density requirements, we will be able to respond much more quickly with this type of system.” says John Primm, Project Coordinator for the Constellation 1200.

The move to high density microplates has substantially increased the demands of the positioning systems used to align the dispensing tips to the microplate wells. Gang tip configurations require accurate, repeatable, and orthogonal motion to ensure proper placement of the tips over the correct wells. Primatics Inc. (Corvallis, OR), a manufacturer of precision positioning stages, assisted Gilson during the design phase of this new class of machine. “Gilson’s small error budget over a large surface area created many challenges for us to overcome,” says Phil Williams, vice president of engineering. In addition, Gilson needed to have a way to increase system speed and accuracy for future products, without changing the overall look or design of the machine. “quote from Gilson about constellation platform being flexible for future requirements”.



Constellation 1200

Primatics PLG line of precision positioning stages fit the needs of the constellation 1200 on several fronts.

PRECISION

Aspirating and dispensing into a 1536 well microplates requires a high level of repeatability in the positioning stage system to ensure proper needle placement. “This is a desktop machine, so we could not afford the space and cost necessary to incorporate vision feedback to ensure proper placement. We needed the positioning system to be repeatable enough so we could rely on it without vision” says John Primm of Gilson. In addition, each axis needed to be orthogonal to 10 arc-sec over the entire travel. Orthogonality errors in the Y and Z axis would create abbe errors sufficiently large to shift the position of the needle tips away from the desired well. Flatness and straightness errors during travel could also contribute to this problem. In addition to using a precision ground ballscrews drivetrain, the PLG series stage bases are machined from a solid block of stress relieved cast tooling plate. This type of aluminum is much more dimensionally stable than an extrusion, ensuring the performance of the stage system would remain constant over time. In addition, the PLG stage bases remain flat, even when they are not fully supported on a rigid, flat surface. “It’s easy for a positioning stage to offer flatness when it is rigidly mounted to a flat surface such as granite. The real challenge in this application was guaranteeing flatness of travel with a large portion of the Y axis completely unsupported” says Phil Williams, engineering manager at Primatics. “The PLG stages from Primatics were a perfect blend of performance and cost for the Constellation 1200”

STIFFNESS

In order to reduce the working envelope of the constellation 1200, Gilson decided on a cartesian XYZ positioning system. In order to accommodate up to 12 microplates, the Y axis needed 600mm of travel. This configuration, with almost 2 feet of overhung load on the X axis, was susceptible not only to deflections due to gravity but also multiple resonant frequencies. To prevent these problems, the positioning system required an oversized bearing system on the X axis, but also an exceptionally stiff base geometry on both the X and Y axes. The PLG series bases were designed for maximum stiffness. The PLG bases have been optimized so that the bearing systems have an uninterrupted support post of aluminum, right down to the mounting pads. The stiffness of the base is related to the cubic of the amount of material underneath the bearings, so this uninterrupted support post has a dramatic effect on the overall stiffness of the stage.

The Y axis was rotated 90 degrees to optimize it’s stiffness and a custom mounting bracket was designed to attach the Y axis to the X without sacrificing any travel. The result was an unsupported, but exceptionally stiff positioning system with a natural frequency high enough so resonant frequency oscillations can be avoided during operation.

FLEXIBILITY

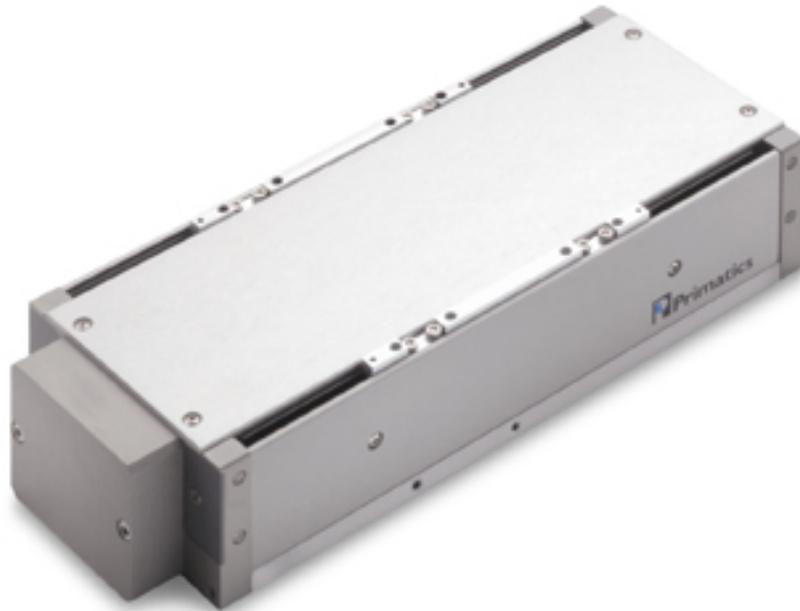
Since the Constellation 1200 is a new high end dispensing platform that will be around for many years, Gilson engineers wanted a flexible positioning system that could be upgraded with a minimum design impact on the whole machine. “We know the market place is going to demand higher performance in the future, so we ideally wanted a positioning system that had several levels of performance available to us”, says Jeff Acker, Constellation lead designer at Gilson. The PLG line of positioning stages are available with several ballscrew and linear motor drivetrains, all in the exact same package. In addition, internal linear encoders as well as Class 10 clean room options are available. With over 6000 variations available to them, Gilson engineers were able to choose exactly what they needed, while knowing they could scale the performance in the future without any machine re-design.



PLG Family w/Linear Motor, Frameless Motor, Nema 23 In-line Motor Mount

AESTHETICS

Unlike many machines where the positioning system is buried deep inside and for the most part unseen, in the Constellation 1200, the positioning stages are front and center and contribute to the overall look of the machine. As a result, the aesthetics of the positioning stages was of prime importance during the selection process. Not only did the stages need to look good, but also the cable management needed to be simple and elegant. The PLG series stages fit both of these requirements. “In addition to the demonstrated positioning performance of the system, the look of the PLG stages was absolutely a factor in the decision to go with the Primatics offer” says John Primm. Gilson choose the frameless motor option for the PLG for its small work envelope as well as its aesthetics. The frameless motor PLG stage uses the ballscrew shaft as the rotor of the motor, while the motor itself is enclosed in a machined housing to protect the motor and improve its appearance. The coupler between the motor and ballscrew is also eliminated, reducing the length of the stage and improving dynamic response. One final touch, a custom clear anodize was used on the outer surfaces of the PLG in order to match the color of the rest of the machine.



PLG110 Linear Motor Stage w/Internal Linear Encoder

CABLE MANAGEMENT

Cable management is one of the most important and forgotten portions of many machine designs. Not only can poorly designed cable management systems destroy the aesthetic of a machine, poorly thought out cable management can increase maintenance headaches dramatically. “Unfortunately, cable management is often an afterthought, with serious degradation of machine performance and life as a result” says Alan Petersen, electrical engineering manager at Primatics. Primatics unique ‘Prima-Flex’™ internal cable management system solves these problems by eliminating all external cables, even for stages with linear encoders and motors. Multi-axis internal cable management systems are also available. The result is a very clean positioning system with virtually no visible cable management for the three axis assembly.

The Constellation 1200 is a cutting edge genomic tool and required a cutting edge positioning system. The Primatics PLG series positioning stages were the perfect fit for the requirements of this demanding application.