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THORLABS

EV101 - May 5, 2020

Item # EV101 was discontinued on May 5, 2020. For informational purposes, this is a copy of the website content at that time and is valid only for the stated product.

TIDE® WHOLE-SLIDE-SCANNING RESEARCH MICROSCOPE

- High-Speed Scanning of Whole Slides
- 72 mm x 107 mm Maximum Scan Area
- Monochrome and Color Imaging Available
- Exposures from 3 ms to 499 ms

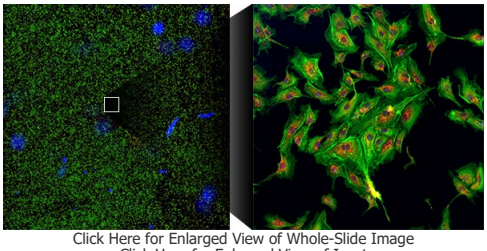
TIDE® TIMED INTEGRATION DIGITAL EXPOSURE

Hide Overview

OVERVIEW

Features

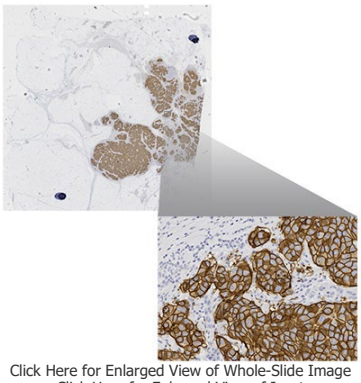
- High-Speed Scanning of Whole Slides Based on Object Scanning Charge Accumulated Readout (US Patent 9,402,042):
  - Image 10 mm x 10 mm at 15X[a] in 35 seconds
  - Image 10 mm x 10 mm at 31X[a] in 94 seconds
- Complete Microscope Systems Configurable for the Following Widefield Techniques:
  - Fluorescence Imaging
  - Brightfield Imaging
  - Combination Brightfield and Fluorescence Imaging
- Fast, Dynamic Autofocus (US Patent 9,869,852):
  - Operates on the Moving Slide
  - Eliminates the Need for Focus Maps
- High-Performance PC with Software and Camera Control Boards
  - Non-Proprietary File Formats for Image Export and Viewing
  - Full-Featured GUI for Data Acquisition and Visualization (See the *Advantages* and *Software* Tabs for Details)



Click Here for Enlarged View of Whole-Slide Image
Click Here for Enlarged View of Inset
A fluorescence image of bovine pulmonary artery endothelial (BPAE) cells. The mitochondria were stained with MitoTracker® Red CMXRos, the f-actin was stained with Alexa Fluor® 488 phalloidin, and the nuclei were counterstained with DAPI. The image (scan area: 15 mm x 15 mm) was taken at 31X[a] magnification. The inset view shows a small area (604 µm x 627 µm) of the whole-slide image to illustrate the clarity and level of detail.

Scientific Challenge

Conventional whole-slide imaging methods employ a "stop-and-stare" approach, which requires an automated system to step across a sample by repeatedly accelerating and stopping at each location to acquire an image. This time-consuming process is fraught with challenges associated with microscope stage acceleration, deceleration, and settling time. As researchers seek to acquire whole-slide images as part of their workflow, the throughput of conventional scanning systems presents a significant performance bottleneck.



Click Here for Enlarged View of Whole-Slide Image
Click Here for Enlarged View of Inset
A color image of a sample stained with DAB and counterstained with hematoxylin. The image (scan area: 20.5 mm x 21.5 mm) was taken at 31X[a] magnification. The inset view shows a small area (1.3 mm x 1.27 mm) of the whole-slide image to illustrate the clarity and level of detail.

Solution

Thorlabs' family of TIDE® (Timed Integration Digital Exposure) Systems provides a fast, accurate solution for whole-slide imaging. Our object scanning charge accumulated readout technology (US Patent 9,402,042) synchronizes the position of the stage with the transfer of charges across the camera's CCD sensor to effectively eliminate the relative motion between the sample and the imaging array. This technology enables longer effective exposure times without stopping motion, while also eliminating image alignment errors due to the stage settling times inherent to stop-and-stare imaging. An additional benefit is the significant increase in scanning throughput: up to 5 times compared to stop and stare methods for similar exposures.

The dynamic autofocus feature (US Patent 9,869,852) of TIDE adjusts for variations in the slide and sample. Once the whole-slide scan is complete, regions of interest can be drawn on the slide image displayed in the TIDE GUI. The stage can be moved to these regions for more detailed study with the fully featured Nikon Eclipse Ti-E microscope. Thorlabs' TIDE is available in three configurations: fluorescence imaging, brightfield imaging, or both.

Advantages

Thorlabs' TIDE systems offer many advantages over stop-and-stare imaging techniques, including increased imaging speed and large format images that don't require stitching. The TIDE LS software package controls image acquisition and includes a zoom function that allows the output image to be examined at a variety of scales. While stop-and-stare systems require the scans to overlap in order to align the individual image frames, TIDE uses the high positional accuracy of the scanning stage to tile the images. The table below outlines the increase in scanning speed that can be expected from TIDE. More details can be found on the *Advantages* tab.

Area	Magnification[a]	Scan Time		Throughput Improvement
		Stop and Stare[b]	TIDE	
10 mm x 10 mm	15X	1 min 32 sec	35 sec	260%
10 mm x 10 mm	31X	6 min 30 sec	1 min 34 sec	415%
25 mm x 75 mm	15X	18 min	5 min 50 sec	308%
25 mm x 75 mm	31X	86 min	23 min	374%

a. Magnification Calculated using DICOM (Digital Imaging and Communications in Medicine) Standard with 20X Objective
b. Stop-and-Stare scan times do not include the time needed to create a focus map.

TIDE System Pricing

The pricing shown below is base pricing and does not include the cost of light sources, optics (such as objectives and fluorescence filter sets), and the PC required for operation. Our sales team is available to discuss your specific imaging requirements and will provide a quote for an optimized system. The large datasets generated by TIDE require careful selection of a computer; therefore the PC must be purchased from Thorlabs. In certain circumstances, we can incorporate customer-supplied optics.

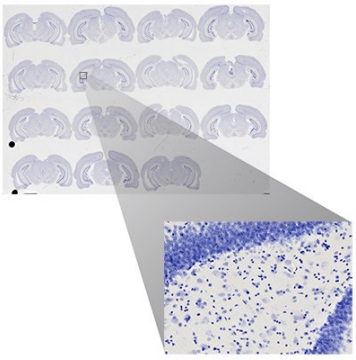
This system is for research applications only.

Hide Advantages

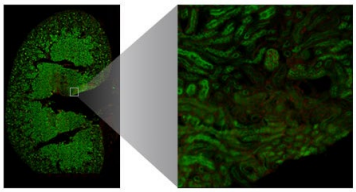
ADVANTAGES

Speed

The advantages of our TIDE® systems increase as magnification increases. By taking advantage of the scanning stage's control-loop feedback, the Thorlabs TIDE systems produce images with high positional accuracy at significantly faster speeds than stop-and-stare imaging methods. Additionally, the proprietary autofocus monitors the sample in real-time, removing focus map generation from the workflow. Some typical examples of slide scan times using a standard stop-and-stare system versus Thorlabs' TIDE are outlined in the table below.



Click Here for Enlarged View of Whole-Slide Image
Click Here for Enlarged View of Inset
Image of rat brain sections stained with Thionine (scan area: 63.4 mm x 45 mm) imaged at 31X magnification*. The inset shows a small area (448 µm x 315 µm) of the whole slide image. Sample from NeuroScience Associates.



Click Here for Enlarged View of Whole-Slide Image
Click Here for Enlarged View of Inset
A merged dual-fluorescence image (scan area 6 mm x 9.4 mm) of a mouse kidney stained with Alexa Fluor® 488 WGA, Alexa Fluor® 568 Phalloidin, and DAPI imaged at 31X magnification*. The inset shows a small area (607 µm x 628 µm) of the whole slide image.
*Magnification Calculated Using DICOM Standard with 20X Objective

Area	Magnification[a]	Scan Time		Throughput Improvement
		Stop and Stare[b]	TIDE	
10 mm x 10 mm	15X	1 min 32 sec	35 sec	260%
10 mm x 10 mm	31X	6 min 30 sec	1 min 34 sec	415%
25 mm x 75 mm	15X	18 min	5 min 50 sec	308%
25 mm x 75 mm	31X	86 min	23 min	374%

a. Magnification Calculated Using DICOM Standard with 20X Objective
b. Stop-and-Stare scan times do not include the time needed to create a focus map.

Higher-Quality, Large-Format Images

Thorlabs' TIDE systems, incorporating our patented object scanning charge accumulated readout technology, are ideal for applications where positional accuracy is paramount. The integration of the camera into the control loop of the scanning stage allows for precise image registration on the pixel level while capitalizing on the speed of the stage. This unique implementation can provide images with better positional information than standard stop-and-stare methods. For more details on our scanning technology, see the *How It Works* tab.

High positional accuracy is achieved by using the encoder of the stage to tie the rows of pixels to absolute positions in the resulting images, which allows these images to be precisely tiled. The resulting image is created based on absolute position without the use of overlapping images and stitching. Conversely, stop-and-stare scanners require the adjacent images to overlap slightly in order to use post-processing to align the images. Furthermore, this overlapping data can be a challenge when analyzing image stacks. Additionally, TIDE allows for large-format imaging with high positional image alignment for samples with sparse features. This is typically a challenge with off-the-shelf stitching programs that rely on feature recognition to align images. The result is one large image without the risk of lost data inherent in many standard stitching schemes.

Image Output

The included TIDE LS software GUI provides a user-friendly viewer that allows seamless zooming of the high-resolution images and the ability to select and save regions of interest. In addition to composite large-format images, TIDE LS can also save each high-resolution image in TIFF or JPEG format. These file formats provide full flexibility for any post processing required. The file structure also allows the user to either save the entire data set or only save regions of interest to reduce the amount of data saved and improve ease of sharing results with remote collaborators.

For more information on the software and image export options please see the *Software* tab.

Hide Software

SOFTWARE

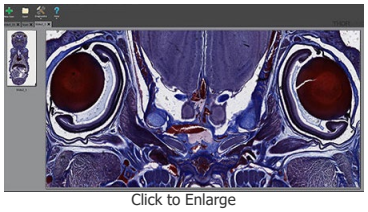
TIDE® LS Software

- Fully Featured Windows 7 GUI for Image Acquisition
- Intuitive Setup of Whole-Slide-Scanning Parameters
- Save-to-Disk and Visualization of Whole-Slide Images
- Interactive Zoom In/Out Capabilities with Inset View
- Non-Proprietary File Formats for Easy Image Export and Viewing

A screenshot of Thorlabs' TIDE LS software. The whole-slide view of the Tiki Goddess, a trichrome-stained frontal young mouse tissue section, is shown on the left side of the window. Selected regions of interest from the whole slide view are displayed in the main window. Sample courtesy of Dr. George McNamara, MD Anderson Cancer Center, Houston, Texas.

View and Manipulate Data from Anywhere Using Your Favorite Software Package

All image data is saved in a non-proprietary JPEG or TIFF format, leaving the user to view and manipulate the data with any software supporting these formats. Thorlabs' TIDE LS software can also be freely shared on multiple machines, making it easy to review and share images.



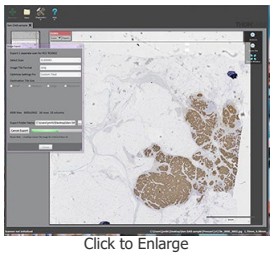
Click to Enlarge

Export Control for Manageable Data Sets

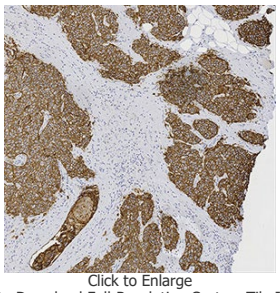
Slide scanning systems allow for large-area, high-resolution image creation. This results in very large file sizes that can be a challenge to manage and work with. The included image exporter allows users to easily export images in a number of ways. Full-resolution data sets can be broken into smaller subsets for analysis; conversely, full-resolution images can be combined into larger images or downsampled for publications.

- Export to JPEG or TIFF
- Options for Creating Large Single Images:
  - Downsampling Ideal for Publications and Notes
  - Preserve the Full Resolution
- Easily Create Custom Tiled Images: Preserve the Full Resolution while Choosing the Size of Images

Custom Tiled Images



Click to Enlarge

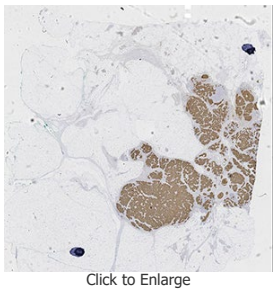


Click to Enlarge

Click to Download Full-Resolution Custom Tile Image

Selecting "Custom Tiled" from the Image Export window allows the user to optimize the size of the individual high-resolution images for either smaller file size or smaller number of images. Selecting a smaller number of larger full-resolution images can often save processing time. In the example shown above, the whole-slide scan is saved as a matrix of 16 x 15 full-resolution images. One of these tiles is shown to the right of the software screenshot.

Downsampling



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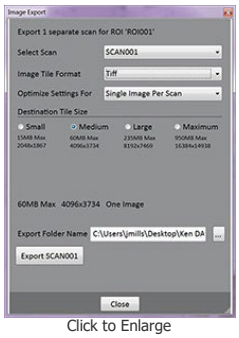


Click to Enlarge

Click to Download Full-Resoultion Single Scan Image

Selecting "Single Image Per Scan" from the Image Export window allows the user to export one single image. This reduces the image size by sampling the image to fit a user-selected size, which is ideal for exporting the whole-slide image for publishing.

Natively Open Scans in Fiji

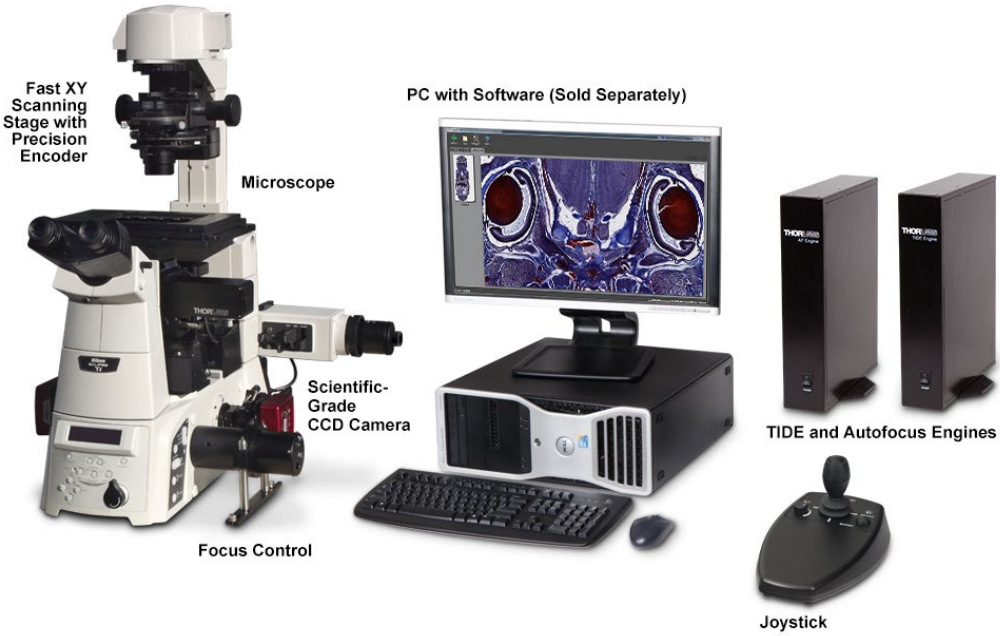
Each scan can be natively opened from Fiji by simply clicking a button. Users no longer need to create image stacks for export.

Hide Components

COMPONENTS

Click on the TIDE® Whole-Slide Scanning System Components, shown below, for further details.

The image shows an EV103 system configured for both brightfield and fluorescence imaging.



Microscope

- TIDE may be used for Brightfield and/or Fluorescence Microscope Systems
- Built on a Nikon Eclipse Ti-E Microscope (Other Options Available)
- Compatible with Air or Oil Immersion up to 40X Magnification
- Up to 5 Interchangeable Filter Sets
- Visible DIC Imaging Supported

Click Here to return to the top of the page.

Click to Enlarge

Scientific-Grade Interline CCD Camera

Click to Enlarge

- Low Noise, High Sensitivity
- USB3 or GigE Interface

More information about Thorlabs' line of scientific-grade CCD cameras can be found here.

Click Here to return to the top of the page.

High-Speed Precision Stage with Encoder

Click to Enlarge

- Encoder Generates Precise Position Information
- Linear Motors Provide Smooth Motion for Improved Accuracy
- Slide Holder, Well Plate Adapter, and Other Stage Accessories Available

More information about Thorlabs' MLS203 fast XY scanning stage and compatible adapter plates can be found here.

Click Here to return to the top of the page.

Joystick

Click to Enlarge

- Enables Efficient XY Location of Home Position as well as Areas of Interest
- Speed Adjustment for Fast or High Precision Moves
- Ergonomic Design Ensures Quick, Tactile, and Interactive Workflow
- High-Quality Anodized Aluminum Casing

More information about the MJC001 joystick console is available here.

Click Here to return to the top of the page.

Autofocus Module and Focus Control Motor

- Dynamically Adjusts Focus for Variations in the Slide and Sample
- Operates on the Moving Slide
- Eliminates the Need for Focus Maps
- Uses MFC1 Motorized Focus Controller to Continuously Adjust the Microscope's Focus (More Information on the MFC1 is Available Here)

Click Here to return to the top of the page.

Click to Enlarge
MFC1 Motorized Focus Controller

Click to Enlarge
Autofocus Control Engine

TIDE Engine

- Controls Movement of the Stage During Imaging
- Performs all Computation and Synchronization Necessary for Operation
- Connection Cables for Stage, Camera, and PC Included
- Control via TIDE LS Software on PC

Click to Enlarge

TIDE LS Software and Computer*

TIDE LS Software

- Full-Featured Windows 7 GUI for Image Acquisition
- Intuitive Setup of Whole-Slide-Scanning Parameters
- Save-to-Disk and Visualization of Whole-Slide Images
- Interactive Zoom In/Out Capabilities with Inset View
- Non-Proprietary File Formats for Easy Image Export and Viewing

For more details, please see the *Software* tab.

Click to Enlarge

Computer*, Monitor, Keyboard, and Mouse (Purchase Separately)

- Fully Configured with Software, Drivers, and Boards

- 32" Flat Panel Monitor
- Optimized for Whole-Slide-Scanning Workflow

*PC model and configuration subject to change. The Computer must be purchased separately.

Click Here to return to the top of the page.

Hide How It Works

HOW IT WORKS

In the object scanning charge accumulated

readout imaging technology implemented in our TIDE® sytems, the charge pattern on the CCD's pixels is accumulated and shifted row-by-row while moving the sample through the field of view of the microscope. The integration of the camera into the control loop of the scanning stage allows for precise image registration on the pixel level while capitalizing on the speed of the stage. This unique implementation can provide images with better positional information than standard stop-and-stare methods.

The user starts by entering a "home," or starting position, and the region of interest in the TIDE LS software. The stage moves past the objective, changing the field of view seen by the camera. The encoder in the stage sends signals to the system electronics, allowing it to track the position of the stage.

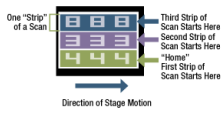
The region of interest is divided into strips to determine the scanning pattern. Figure 1 below shows an example of a slide divided into strips, each one indicated by a different color. Although we will only look at three strips for this example, the actual number of strips is calculated to accommodate the entire slide at the desired magnification. The program will begin the scan at the home position. Images from each strip are used by the software to create the full image of the slide.

Figure 2 shows the TIDE system in the "Home" position, before the user has pressed the "Start" button in the software.

When the field of view moves by the equivalent of a pixel row, the system will trigger the camera to shift the accumulated charge to the next row. When the row of charge reaches the edge of the CCD chip, it is read out to the computer. Charges are accumulated in the direction of the scan, increasing the effective exposure time, as shown in Figure 3.

Once the first strip of the slide is scanned, the stage will move to its starting x-position and shift the y-position by the width of the first strip. It will then begin to scan the next strip of the slide, as shown in Figure 4. In this way, the entire slide can be quickly scanned while moving the stage and without introducing blur.

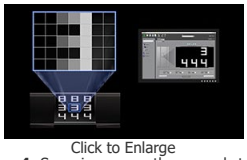
Figure 5 shows the final strip being read out of the CCD chip. After the scan is finished, a complete image, comprised of all of the strips, is displayed in the software. This image can be zoomed in and examined to identify features that require further examination.



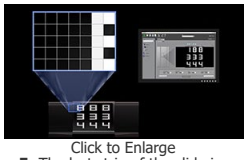
Click to Enlarge
Figure 1: The Region of Interest (ROI) is divided into strips as shown here. The "home" position is in the lower right hand corner.

Click to Enlarge
Figure 2: The system configuration prior to acquiring data. The number array represents a sample on a microscope slide, and the grid represents the CCD array.

Click to Enlarge
Figure 3: Scanning across the first strip of the slide.



Click to Enlarge
Figure 4: Scanning across the second strip of the slide.



Click to Enlarge
Figure 5: The last strip of the slide is scanned and read out to complete the whole slide image.

Hide Part Numbers

Part Number	Description	Price	Availability
EV101	TIDE Whole-Slide-Scanning Microscope for Fluorescence Imaging	$111,394.50	Lead Time
EV102	TIDE Whole-Slide-Scanning Microscope for Brightfield Imaging	$95,481.00	Lead Time
EV103	TIDE Whole-Slide-Scanning Microscope for Brightfield and Fluorescence Imaging	$127,308.00	Lead Time