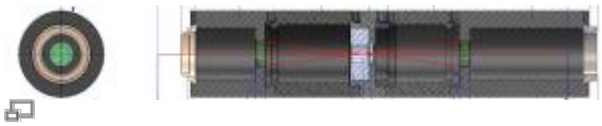
Brief on Tunable Lens Assembly



ASIs Tunable Lens 4F Assembly

Tunable Lens 4F Assembly leverages Tunable Lens to remotely focus an image on a microscope (ie without moving the objective itself).

- Assembly is easy to install: it screws into the C-mount (see Photo) port of most microscopes.
- Only active component of the assembly is the tunable lens; it plugs into the Tunable Lens card
- The Focal length of the Tunable Lens changes between 8 to 20 diopter. The resulting focus change will depend on your optics.
- A known issue at the moment is Tunable lens' focal length is varied, cause a slight X and Y shift in the image.

For example on a ASI RAMM Infinity microscope, the following objectives caused the varying Z focus change.

^Objective Magnification ^Z focus change for full 4000 units travel ^

5x	1600um
20x	80-90um
40x	50um
50x	15um
60x	8um

The relation between objective magnification and focus change is

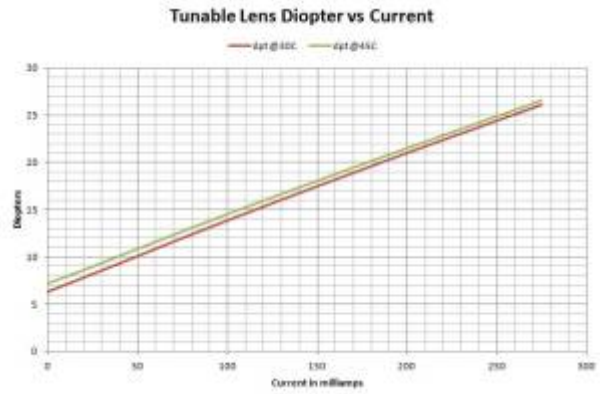
$$\text{Focus Change} = \frac{-1}{M_{obj}^2}*\frac{n*f_r^2}{f_{ETL}}$$

where M_{obj} is objective magnification; n is refractive index of immersion medium; f_r is focal length of the two lenses in 4F assembly; F_{ETL} is effective focal length of the ETL in combination with any offset lens.

As described in Fahrbach, Florian O., et al. “Rapid 3D Light-Sheet Microscopy with a Tunable Lens.” Optics Express, vol. 21, no. 18, 2013

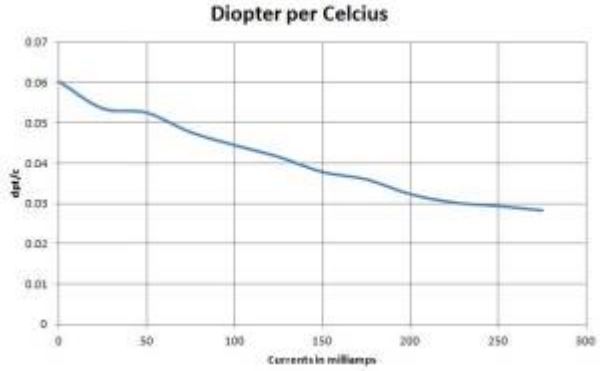
Temperature Compensation

Tunable Lens are susceptible to temperature change, their diopter decrease as temperature increases.Below is a graph of diopter vs current at two different temperatures



Graph showing diopter vs Current at two different temperatures

This diopter per celcius change isn't constant and varies too. Below is a graph of the change diopter change per celsius vs current.



diopter per Celsius change at various current

Fortunately this effect is predictable and the manufacturer has built a temperature sensor into the Tunable lens and provided characterization data. At the factory , we analyze this data and build a model. The parameters for this model are saved on the Tunable Lens EEPROM itself. The Tunable Lens card reads the EEPROM on starup. These parameters can be read and altered thru serial commands ERROR(E), PCROS(PC), PG and PSG

When Temperature compensation is enabled (thru the PM [Axis]=2) command, firmware periodically reads the temperature sensor on the Tunable Lens and adjust the DAC. This change won't be reflected in the position of the Tunable Lens read with WHERE(W) or set with MOVE (M). The correction is happening on a internal layer , right before the DAC and current amplifier.

Calculation

Below is how the temperature compensation is calculated and applied.

- First for a given current , Diopter per Celsius (*D/T*) at that current is calculated

$$\frac{D}{T} = I_{user}*K_1+C_1$$

- Then current temperature is measured by reading the temperature onboard the Tunable lens , and subtracting that from the set point temperature. This set point temperature is where the Tunable lens was characterized at factory, and coefficients like K_1 and C_1 were calculated.

- This temperature change is multiplied with Diopter per Celsius (*D/T*) to get Diopter change

$$D = \frac{D}{T}*(T_{current}-T_{setpoint})$$

- The Diopters are converted back to current by multiplying it with Diopter to current coefficient K_{D2I}. Then subtracted from the user input current before being applied to the Tunable Lens

$$I_{applied} = I_{user}- D*K_{D2I}$$

The coefficients K_1 , K_{D2I} and constants C_1 and $T_{setpoint}$ are calculated from two Diopter vs Current curves the Tunable lens manufactured provides with each Tunable lens. They are calculated by ASI technicians and stored onboard the tunable lens itself. If a user would like to alter any of these settings , they may do it thru the following commands.

- C_1 is set thru PC [AXIS]=###
- $T_{setpoint}$ is set thru PSG [AXIS]= ###
- K_{D2I} is set thru E [AXIS]=###
- K_1 is set thru PG [AXIS]=X. Where X is

$$X=\frac{K_1*-1}{10000000}$$

Applications

One of the main application of Tunable Lens system is with ASIs XYZ Tracker plugin as a continuous focus device. For more info refer ASIs XYZ Tracker

Additional Reading

- Optotune EL-10-30 datasheet
- App Note: Optical focusing in microscopy with Optotune’s focus tunable lens EL-10-30

Add CRISP to a MIM1

In order to add a CRISP autofocus device to the simplest form of ASI's inverted Modular Infinity Microscope[1)], an additional optical path must be installed on the microscope, a control card must be inserted into the Tiger controller and plugged into the card of the axis it will control (typically the Z-axis), and the firmware of that card must be updated.

An optical path for CRISP

1. Remove the Prism Block from the LS-50 (Z-stage) body.
    1. Move the epi-illumination assembly.

1. Loosen the three set screws connecting the epi-illumination assembly (Tube/Condenser lens, Filter Wheel, Liquid Light Guide adapter) to the CUBE III, requires 2 mm hex driver.
2. Lightly loosen the two screws in the ring clamp supporting the epi-illumination assembly, requires 2 mm hex driver.
3. Slide (and jiggling a bit helps too) the epi-illumination path assembly away from the CUBE III.

2. Move the imaging assembly back.
    1. Loosen the three set screws in the Prism Block (Figs 1 & 2: green); requires 2 mm hex driver.
    2. Lightly loosen the two screws in the ring clamp supporting the imaging path assembly; requires 2.5 mm hex driver. (The imaging assembly includes: CUBE III, polarizer slider, Tube lens “B”, C-mount adapter, and camera). (Tip: Do not loosen the screws with 5 mm hex heads in the drop arms.)
    3. Remove the camera if it is currently mounted.
    4. Slide the imaging path assembly away from the Prism Block by a few centimeters.
3. Remove the four bolts (Fig 2: pink) to finally remove the Prism Block, requires 5 mm hex driver.

2. Mount the 2nd Port and Prism block.
    1. Mount the 2nd Port (Figs 2: orange) in the position previously occupied by the Prism Block, requires 5 mm hex driver.
    2. Mount the Prism Block (Fig 2: pink) directly under the 2nd Port’s coupling tube.
3. Replace the imaging assembly and epi-illumination assembly.
    1. Slide the imaging assembly up to the 2nd Port; tighten at least 3 set screws on the 2nd Port (Fig 2: blue), requires 2 mm hex driver.
    2. Slide the epi-illumination path up to the CUBE III; tighten the 3 set screws that secure them together.

Adjust the detector position for optimum performance

1)Click Step 2 “Dither” state. Adjust the main CRISP adjusting Thumb Screw for maximum ERR number. 2)Click Step 3 “Set Gain” and wait a few seconds for it to finish. 3)Re-focus microscope on sample and set the Z-axis controller position to Zero. (HERE Z=0) 4)Be sure NA setting is correct for the objective and click “GRAPH” button.

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Figure 5

5)Choose and operating point and adjust the main CRISP adjusting Thumbscrew to get there. If you only adjust for maximum ERR number, then the point you choose will be at the steepest part of the focus curve. Sometimes this can be very close to where the curve makes a sudden change in slope.

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Maintenance

The MPPI-3 Milli Pulse Pressure Injector, has been designed and tested to provide years of reliable service.

Note: In order to insure that the unit operates as designed, use only nitrogen or clean dry compressed air as the pressure source.

The design of the MPPI-3 requires little maintenance on the part of the user. In fact, there are only two areas that the user needs to be aware. The first is to periodically check for moisture and other contaminants in the pressure source. The internal in-line filter that protrudes from the back of the unit has a small needle valve located on the bottom. This valve should be depressed periodically to check for moisture from the pressure source. If excessive moisture is noted, the pressure source should be changed. In the event that the filter becomes degraded or plugged, contact ASI for a replacement.

The second area of maintenance that the user should be aware is the replacement of the fuse. In the event that the MPPI-3 fails to turn on, the line fuse located inside the MPPI should be checked. If the fuse is blown, an exact replacement needs to be used. The MPPI-3 uses a 250mA fast-blow fuse. If the fuse blows again after replacement, please contact ASI for instructions on returning the unit for repair.

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<html> <iframe width="560" height="315" src="https://www.youtube.com/embed/o4qVIpkSC_U?start=02&end=122" frameborder="0" allow="autoplay; encrypted-media" allowfullscreen></iframe> </html>

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- ASI Plugin *2012-26-02* by Vikram, Chris P. Jobling; Stephan Chazelas; Andy Webber
  Renders transcripts of serial interactions
- authorstats plugin *2022-3-12* by George Chatzisofroniou, Constantinos Xanthopoulos
  Plugin that outputs statistics about the wiki's authors.
- Bookcreator Plugin *2024-02-07* by Gerrit Uitslag (previous: Luigi Micco)
  Allow to make a book (PDF, ODT, HTML or text) from selected pages
- Cloud Plugin *2023-02-11* by Michael Hamann, Michael Klier, Gina Haeussge
  Displays the most used words in a word cloud.
- DataTables Plugin *2023-08-31* by Giuseppe Di Terlizzi
  Add DataTables support to DokuWiki
- Dw2Pdf plugin *2023-11-25* by Andreas Gohr and Luigi Micco
  DokuWiki to PDF converter
- Gallery Plugin *2024-04-30* by Andreas Gohr
  Creates a gallery of images from a namespace or RSS/ATOM feed
- Plugin imagebox *2023-08-21* by Lukas Rademacher, CvH, Dr-Yukon, FFTiger & myst6re
  Syntax for display an image with a caption, like Wikipedia.org
- include plugin *2023-09-22* by Michael Hamann, Gina Häussge, Christopher Smith, Michael Klier, Esther Brunner
  Functions to include another page in a wiki page
- Info Plugin *2020-06-04* by Andreas Gohr
  Displays information about various DokuWiki internals
- MathJax plugin *2021-11-20* by Mark Liffiton

Enables MathJax (https://www.mathjax.org/) parsing of TeX math expressions in wiki pages
- Outliner Plugin *2024-01-23* by Vincent Voisin
  Allows collapsible outline layout
- Pagelist Plugin *2023-08-27* by Matthias Schulte, Michael Hamann, Michael Klier, Gina Haeussge
  Lists pages in a nice formatted way
- Page Redirect *2024-03-01* by Elan Ruusamäe, David Lorentsen
  Redirects page requests based on content
- Snippets Plugin *2022-10-07* by Myron Turner
  Provides toolbar button+popup for template insertion; can track and insert sinppet updates
- Tag Plugin *2023-10-17* by Michael Hamann, Gina Häussge, Christopher Smith, Michael Klier, Esther Brunner
  tag wiki pages
- Wrap Plugin *2023-08-13* by Anika Henke
  Universal plugin which combines functionalities of many other plugins. Wrap wiki text inside containers (divs or spans) and give them a class (choose from a variety of preset classes), a width and/or a language with its associated text direction.

- ACL Manager *2015-07-25* by Andreas Gohr
  Manage Page Access Control Lists
- authorstats plugin *2022-3-12* by George Chatzisofroniou, Constantinos Xanthopoulos
  Plugin that outputs statistics about the wiki's authors.
- Bookcreator Plugin *2024-02-07* by Gerrit Uitslag (previous: Luigi Micco)
  Allow to make a book (PDF, ODT, HTML or text) from selected pages
- DataTables Plugin *2023-08-31* by Giuseppe Di Terlizzi
  Add DataTables support to DokuWiki
- denyactions plugin *2018-12-30* by Otto Vainio
  Prevent actions
- Dw2Pdf plugin *2023-11-25* by Andreas Gohr and Luigi Micco
  DokuWiki to PDF converter
- EditTable plugin *2023-01-14* by Andreas Gohr
  Provide a custom editor for tables
- Extension Manager *2015-07-26* by Michael Hamann
  Allows managing and installing plugins and templates
- Gallery Plugin *2024-04-30* by Andreas Gohr
  Creates a gallery of images from a namespace or RSS/ATOM feed
- Google Analytics Plugin 1.1.0 *2020-11-03* by Terence J. Grant
  Plugin to embed your Google Analytics code for your site, which allows you to track your visitors.
- Plugin imagebox *2023-08-21* by Lukas Rademacher, CvH, Dr-Yukon, FFTiger & myst6re
  Syntax for display an image with a caption, like Wikipedia.org
- include plugin *2023-09-22* by Michael Hamann, Gina Häussge, Christopher Smith, Michael Klier, Esther Brunner
  Functions to include another page in a wiki page
- MathJax plugin *2021-11-20* by Mark Liffiton
  Enables MathJax (https://www.mathjax.org/) parsing of TeX math expressions in wiki pages
- Move plugin *2024-05-07* by Michael Hamann, Gary Owen, Arno Puschmann, Christoph Jähnigen
  Move and rename pages and media files whilst maintaining the links.
- Page Redirect *2024-03-01* by Elan Ruusamäe, David Lorentsen
  Redirects page requests based on content
- Popularity Feedback Plugin *2015-07-15* by Andreas Gohr
  Send anonymous data about your wiki to the DokuWiki developers

- safefnrecode plugin *2012-07-28* by Andreas Gohr
  Changes existing page and foldernames for the change in the safe filename encoding
- showphperrors plugin *2017-07-26* by Michael
  Small plugin to show php errors without changing php.ini file. Intended for development
- Snippets Plugin *2022-10-07* by Myron Turner
  Provides toolbar button+popup for template insertion; can track and insert sinppet updates
- styling plugin *2020-06-14* by Andreas Gohr
  Allows to edit style.ini replacements
- Tag Plugin *2023-10-17* by Michael Hamann, Gina Häussge, Christopher Smith, Michael Klier, Esther Brunner
  tag wiki pages
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second

[1)]

Adding a CRISP to a MIM1 makes a MIM2.