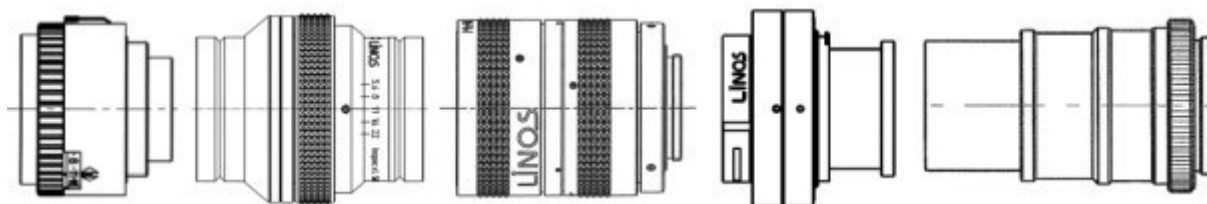


Introduction to MachVis 5.3

Excelitas Technologies and Machine Vision

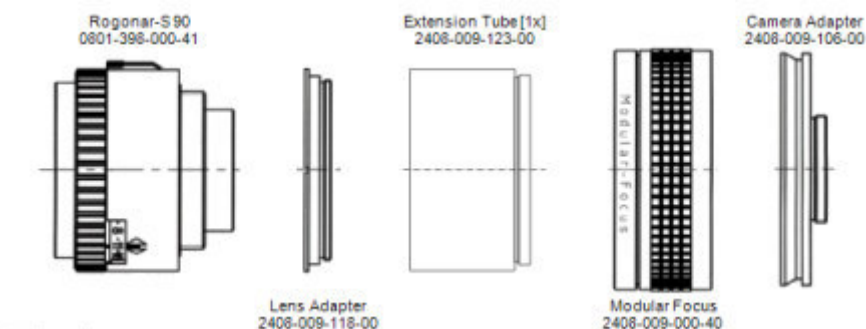
Background to MachVis [\[new features\]](#)

Excelitas Technologies Corp. is a world leader in the design and manufacture of machine vision optics - creator of the well known & respected *d.fine HR*, *Rogonar*, *Rodagon*, *Inspec*, *MeVis-C* & *Macro-CCD*, and the *mag.x* & [Optem Fusion micro inspection systems](#).



However even using a Excelitas lens is not enough to guarantee a good image! The lens must be rigidly mounted to the camera, and well focussed, so that a stable, sharp image is formed on the sensor - a key requirement for a successful machine vision system.

Excelitas therefore also makes a complementary range of high quality focuser, adapter, ring and extension tubes accessories, specifically matched to the Excelitas lenses, so that you can be confident of both fit and performance.



Often, many different combinations of lens and accessories could be suitable for a given task, and this very wealth of choice can be daunting. The machine vision team at Excelitas recognised the problem and so created the MachVis software for themselves and for external users.

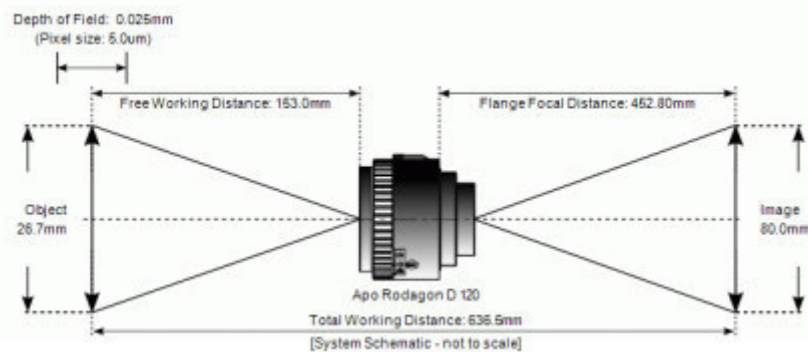
MachVis, Excelitas and Machine Vision

MachVis is an enhanced lens selector - designed to help you find the right Excelitas Technologies lens & accessories for your machine vision application.

You start by providing [four key parameters](#) [via the **specifications** tab]:

- Working distance [front or total]
- Object size [width, height or diagonal]
- Sensor size [rectangle or line]
- Camera mount [C, TFL, F, M42, M58, M72, M58 or M95]

MachVis takes your choices and calculates the theoretical optical solution. Then, from the Excelitas lens list, it selects those that most closely approach the ideal, along with any necessary focusers, extension tubes etc. The [solutions are listed in a spreadsheet](#) for more detailed inspection.



The 'current' solution is [displayed in more detail](#) via a schematic drawing, and also a diagram showing the components in order of assembly. The current solution can be changed by simply clicking another row in the spreadsheet.

You can easily [adjust the spreadsheet data](#) in various ways - showing more types of information [columns] and more or less solutions [rows] - via simple options in the **results** tab.

MachVis - more features

The basic functionality has been enhanced over time to include various other useful features:

- **File save/read:** The specifications, along with your own project notes, may be saved to disk for later recall.
- **Printout:** A printout detailing the task and the current solution may be generated at any time.
- **Camera lists:** You can [create one or more lists of cameras](#). These will contain exact details of the camera body depths, sensor sizes and mount types. MachVis displays any such in a selectable list - this will save much time, preventing typing errors if you have several devices to choose between.
- **Datasheets (PDF)** for each lens will show mechanical data and detailed optical performance plots [MTF].
- **3D models:** you can [download models](#) of most of the lenses and accessories can be download in Step or Parasolid formats to simplify integration into your inspection systems.
- **Popup lists of all [lenses](#), [accessories](#) and [cameras](#)** [if defined]. The lens and accessories popups link to datasheet pdf's and also to the 3D models for specific items.
- **Setup Dialog [standard]** - [help choose specifications](#) to see a specific standard lens in the results spreadsheet
- **Setup Dialog [mag.x]** - [help choose specifications](#) to see a specific mag.x micro inspection system in the results spreadsheet
- **Accessory configurator [mag.x]** - a [form to see/choose accessories](#) for the mag.x
- **Setup Dialog [Optem]** - [help choose specifications](#) to see a specific Optem micro inspection system in the results spreadsheet
- **Accessory configurator [Optem]** - a [form to see/choose accessories](#) for the Optem

In summary, MachVis is a powerful but simple solution to the task of defining a suitable Excelitas lens system for your specific machine vision task.



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Notes on lens selection

Background machine vision notes »

Background notes: choosing a lens

In most cases MachVis will display more than one lens in the [result table](#). The difficult task is now to select the best lens for your specific application. The order in which the lenses are displayed is based on the deviation of the EFL from the theoretical EFL and is therefore no measure for the quality of a lens or how suitable it is for the application. This section gives you some general hints for lens selection.

Lens dimensions

Sometimes the outer dimensions of a lens are restricted by the surrounding environment. To find out more about the dimensions of a specific lens you can open the data sheet of the respective lens (select it with a mouse click) with the View PDF button from the [toolbar](#).

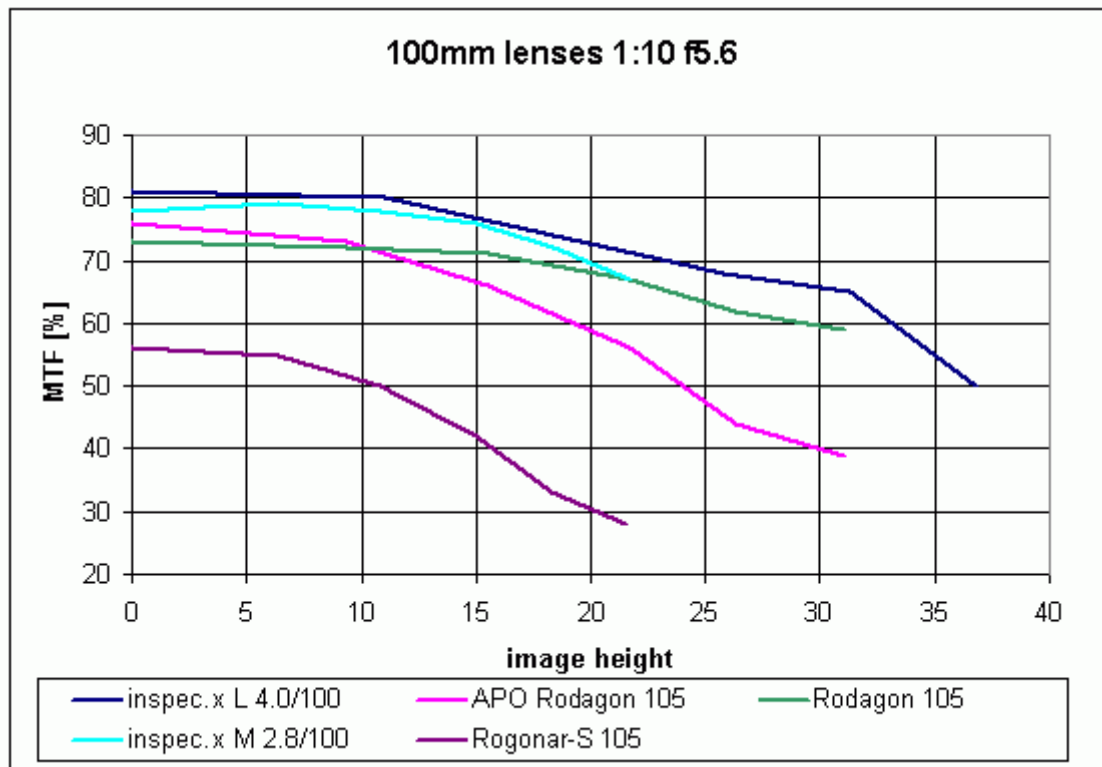
Lens resolution and contrast

The resolution and contrast of a lens is shown with the so called MTF graph (Modulation Transfer Function). The MTF graph shows the contrast of a lens at a given resolution. In general one can say that the higher the contrast the better the lens. For every Linos lens you find the MTF graph in the data sheet that you can for the respective lens with the View PDF button from the [toolbar](#). These MTF graphs show the contrast for at least 4 different spatial frequencies.

But the best lens is not needed for all applications. The required resolution of the lens is determined by the pixel size of the sensor. The smaller the pixel size of the sensor the higher the resolution that the lens must be capable of. The theoretically maximum achievable resolution in line pairs per millimeter (lp/mm) is given by $1000 / (2 * \text{pixel size})$. This resolution is called the Nyquist frequency, but in an optical system, this can only be achieved with a very careful, not to say artificial setup. For practical purposes, half the Nyquist frequency is a better measurement. Therefore the limiting resolution, r , is calculated using

$$r = 1000 / (4 * \text{pixel size})$$

For a sensor with a pixel size of $6.25\mu\text{m}$ you will therefore need a lens that resolves 40 lp/mm with good contrast. All Excelitas lenses can resolve 40lp/mm but the contrast at this spatial frequency is different. The following graphic shows the MTF for different 100mm lenses for 40lp/mm at $\beta' = -0.1$ and f5.6.



You see a great difference between the lenses for a given image height. It now depends on your application if 50% contrast at 10mm image height is sufficient or if you need more than 70%. In both cases you will see an image detected by the sensor. For higher resolutions you can assume that lenses that deliver high contrast at 40lp/mm are also performing well at higher resolutions.

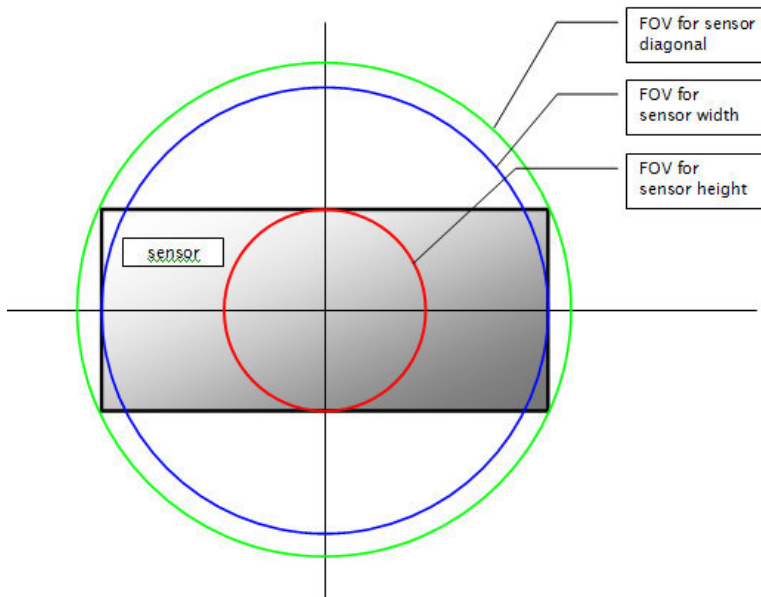
The MTF curves given in Excelitas datasheets are always computed curves. The performance of a real lens is always lower due to tolerances on optical and mechanical parts. With normal lenses you need to subtract about 10...15% of MTF performance to get the MTF value for the real lens.

In case you are unsure please do not hesitate to contact Excelitas for help. We will be glad to help you selecting the best lens for your application.

Image circle

MachVis only proposes lenses with an image circle or image size that is large enough for the given sensor

- and the currently chosen key sensor dimension
- height
- width
- diagonal



Magnification

The magnification is determined by the ratio of image and object. MachVis only proposes lenses that are suitable for the calculated magnification.

Focusing Internal or External

Many Excelitas lenses have no internal focusing but need a [focus device](#) instead. This makes the lenses more versatile as you can select from different focusing units or you can use the lens without any focusing at all for an application where no focusing is necessary and ruggedness is an issue. Furthermore you can adapt the lens to a large number of different camera mounts easily.

On the other hand lenses with internal focusing are normally more compact. Excelitas offers lenses both with internal and external focusing to provide you the best solution for your application.

Lens price

The cost of a lens and accessories is of course an important issue. Please do not hesitate to contact Excelitas Technologies for a quotation.

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Depth of field/Depth of focus

[Background machine vision notes >>](#)

Depth of Field/Depth of Focus

'**Depth of field**' and '**depth of focus**' are two related terms which are often used in optics. They do not have identical meanings. We will explain both terms quite simply - you can find much more detailed explanation on line...

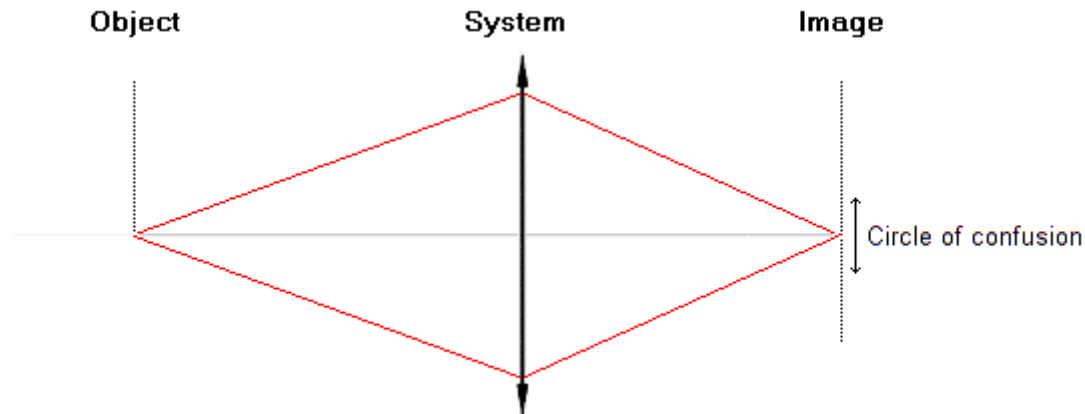
When thinking about machine vision systems, you will want some idea of:

- how accurately the camera must be located to avoid getting a blurred image [depth of focus]
- what features will be in focus [depth of field]

Both are determined by the systems '**circle of confusion**', so we will start with that.

Circle of Confusion.

This is defined as smallest feature that the system as a whole can resolve:



Lets assume that the lens is perfect, i.e. has no aberrations. From a **geometric optics** point of view, a point object would then have a point image, located on the specific plane determined by the simple lens equation. In that case, the system resolution [discernible detail] is determined by whatever records the image.

In machine vision circles this is the pixel dimension of the camera CCD. No matter how 'sharp' the lens, how many point images fall on a pixel, they will just register as a single data point. Detail below the pixel size cannot be resolved - hence the use of the word 'confusion'.

Typically the pixels are somewhere between 2 to 15microns across. Now pixels could be made much smaller [given the state of lithographic art], but there is no point. Diffraction effects mean that even a perfect lens will actually form a blurred image of a point object [such as a star]. This is known as the Airy disk, whose size is dependant on the wavelength of the light and the f# or numerical aperture of the lens.

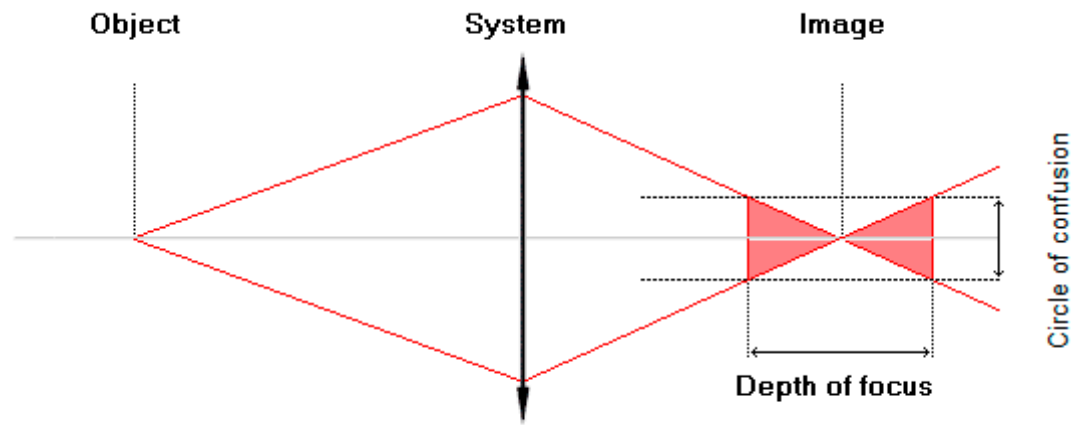
The circle of confusion therefore has a certain minimum size no matter how good the sensor technology.

Depth of focus

[this refers to the image or sensor side of the system]

As noted, the beam cross-section is a single point at the geometric image plane [ignoring diffraction], but - as shown below - becomes larger the further the detector is moved from the image plane. Beams from close object points will overlap and become less distinguishable.

However, provided the beam diameter is less than the circle of confusion, this will make no effective difference to the final image generated by the CCD. So we can allow for a certain amount of defocus without degrading the system performance.



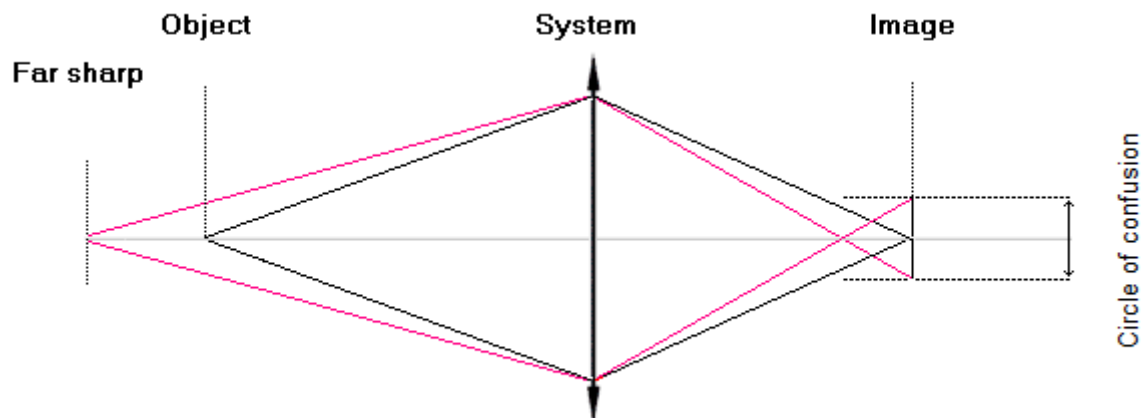
This distance is symmetric about the image plane, and is known as the depth of focus. Being symmetric, the depth of focus is usually given as a \pm value, e.g. depth of focus = $\pm 5\text{mm}$.

Depth of field

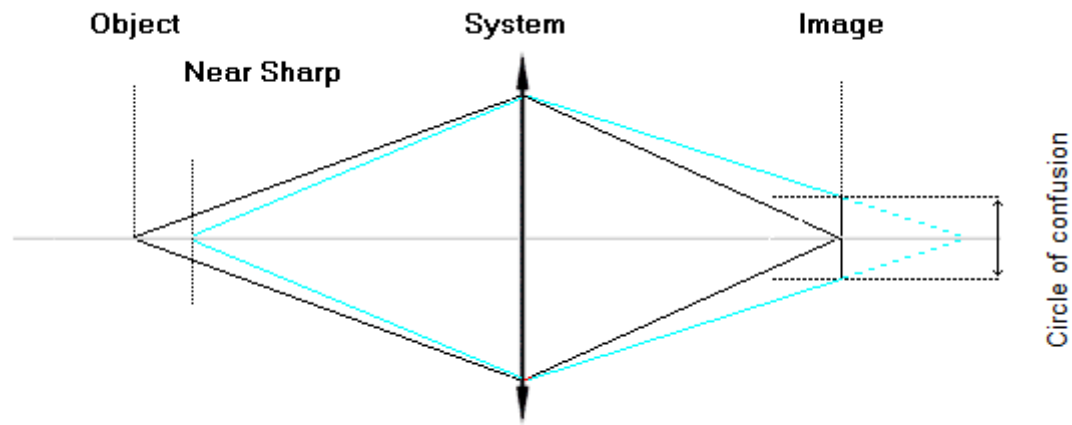
[this refers to the object side of the system - what the system is looking at]

Using a similar sort of argument, we can also establish how much the object can be moved toward or away from the lens and still be 'in focus'. This time we will assume that the sensor is fixed at the nominal image plane and does not move relative to the lens.

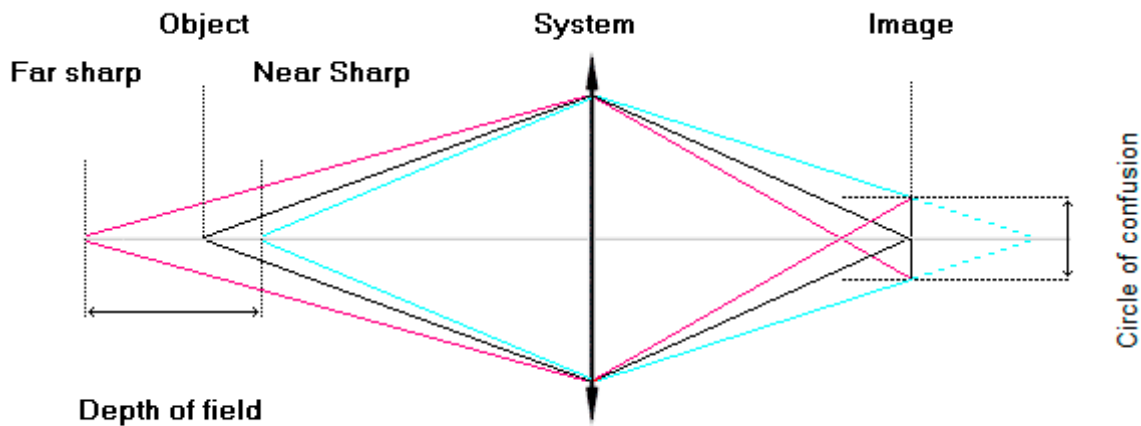
Lets start by moving the object plane away from the lens and toward infinity. We can move it away until the beam diameter on the sensor is the same size as the circle of confusion - here indicated by the red rays. This point is known as the 'far sharp plane'; object points more distant will be out of focus.



We can use similar thinking when moving the object toward the lens - here shown below by blue rays. This is known as the near sharp plane - object positions closer to the lens will be deemed as out of focus.



When we put both together [below] can see that the construction rays are not symmetric; in general the distance from far sharp plane to the object plane is greater than the distance from the object plane to the near sharp plane. The depth of field is defined as the distance between the near and far sharp planes, and we **don't** display it with a \pm symbol.



Values displayed in MachVis

In MachVis we only display the depth of field values.

For standard lens families [MeVis-C, Rogonar, Rodagon, Inspec & d.fine HR] the depth of field is calculated from geometric optical principles, using the selected pixel size.

For the inspection microscopes [mag.X and Optem] the value displayed is that given in the relevant data sheets. These were derived using diffraction based arguments.

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Excelitas focus devices

Background machine vision notes »

Background notes: focusing devices

Excelitas Technologies currently offers ~~four~~ three different focus devices for the lenses without internal focussing. These lenses are known as measuring lenses for large format sensors (e.g. RODAGON). The focus device has 2 tasks:

- Bring the lens into the correct position in front of the sensor. This position depends on the magnification needed.
- Adapt the lens mechanically to the camera, so that they are locked together.

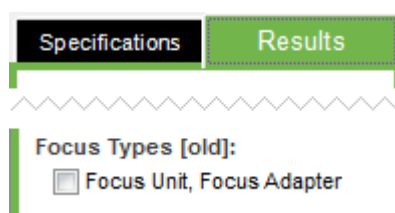
The following focus devices are available:

- Modular Focus: A helical mount. Will take different adapters to match Linos CCD lenses onto different camera threads. The Modular Focus is designed to keep the lens from rotating during focusing.
- Smart Focus: Low cost version of Modular Focus with M39 thread for lenses and using the camera adaptors from the Modular Focus system. Difference to Modular Focus? The lift is shorter (12.4mm) and the lens rotates while being focused.
- Focus Tube: Focus Tube adapts to M72 camera mounts and is designed specifically for each of the 10 different versions of the inspec.x L 5.6/105 and 4/105 lenses.
- Focus Adaptor System: The Focus Adapter System was created as a reasonable alternative to the existing helical mounts. It is mainly used in OEM applications where a quick and safe adaptation without helical mount is needed.

Obsolete focusing devices

Excelitas used to supply the Focus Unit - designed to quickly and safely adapt lenses to M72 camera mounts. As of MachVis 4.0 this is obsolete, and is no longer manufactured. It is still recognised by MachVis, since some customers will have them in stock.

As of MachVis 5.2 - the Focus Adapter system is now obsolete, but again is retained for those customers who have them in stock.



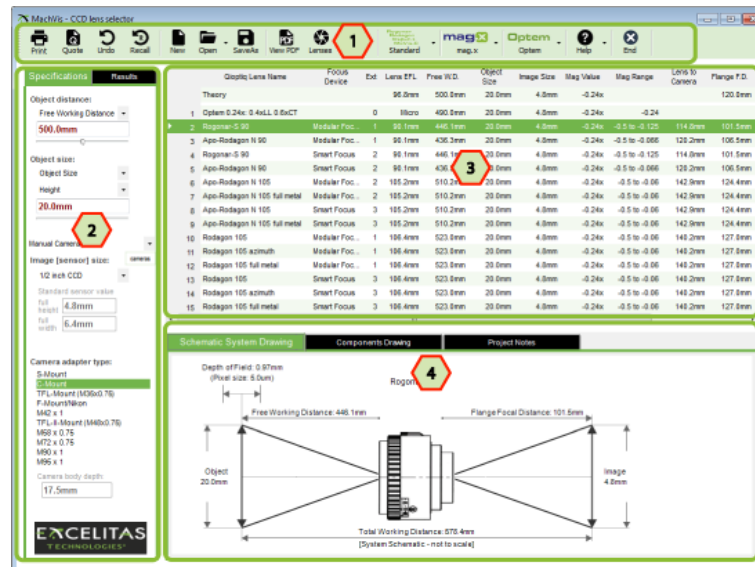
By default Focus Unit based solutions are NOT shown in the solutions list, but you can include them, by checking the Focus Unit checkbox on the lower part of the results tab

MachVis user interface - overview

MachVis: the basics »

MachVis UI: overview

We start with a quick overview of the main form, which is subdivided into 4 areas as shown here.



In more detail, these areas are:

Area 1: Toolbar

[The toolbar](#) lives at the top of the program window - its buttons provides access to many useful functions.

Area 2: Input section for user choices

The input section [tabbed area] to the left that contains:

- [Specifications tab](#) - to enter the key parameters that define your machine vision task
- [Results tab](#) - to 'filter' or 'extend' the results shown

Area 3: Results table

[The Result table](#) - all systems that meet the specifications. One system is highlighted - this is the 'current system'. To change the current system, simply click on another row in the table.

Area 4: The current system and notes area

[The Drawing section](#) (tabbed area) - shows the 'current system' in more detail:

- Schematic system drawing** - shows the meaning/values of the key parameters
- Components drawing** - shows all the components used in the current system, including lens, adapters, extension tubes etc.
- Project notes** - where you can enter your notes on the project as a whole. This is often useful when you need to review a project at a later date. These notes also appear in the printout, and can be very helpful when discussing a project with Excelitas machine vision engineers.

Excelitas Logo

If you click on the Excelitas logo at bottom left, your default web browser is opened and the web page www.gioptiq.com/machine-vision-lenses.html is visited.

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MachVis toolbar

MachVis: the basics »

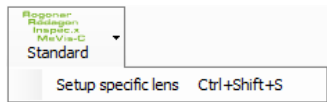
MachVis UI: toolbar

At the top of the program window, you will see the program toolbar:



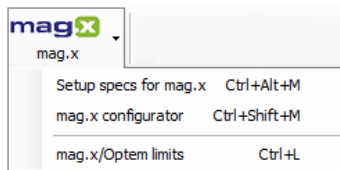
This provides access to various useful features, which are not directly part of the main calculator. Working from left to right:

- **Print:** Use this button to print a page that contains all necessary information on the selected lens - the printout includes the components drawing and project notes. A second page is added for mag.x system solutions - this lists the full configuration
- **Quote:** By clicking this button your email client is loaded with a template that shows the current system, ready to be sent to Excelitas sales department. You will probably need to adjust the number of lenses/accessories in the email.
- **Undo:** With this button you undo the last change (e.g. changing working distance or object size or even a previous undo)
- **Recall:** Sets all values and settings back to the state at the startup of the program.
- **Open:** Use this button to open a previously saved specification file. You can also see a list of the most recent projects.
- **Save As:** To save the values and settings to a file for later usage or reference you can save the current settings to a so called specification file (suffix .spec). The project notes are also saved.
- **View PDF:** With this button you can open the datasheet for the lens in the current system (this will be a PDF file).
- **Lenses:** Open a [popup form listing of all available Excelitas machine vision lenses](#). See detailed datasheets in pdf format and download 3D models.
- **Parts:** Open a [popup form listing of all available Excelitas machine vision accessories](#). See detailed datasheets in pdf format and download 3D models.
- standard lens setup form in a dropdown button



Setup specs for standard lenses - use this form to setup conditions to get a [specific standard lens](#) [MeVis-C, Rogonar, Rodagon, Inspec or Macro] in the solutions set.

- mag.x options in a drop down button:

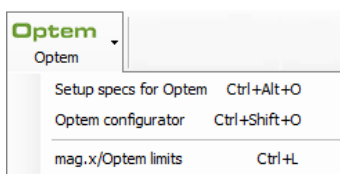


Setup specs for mag.x - the mag.x systems require fairly precise specifications. Click this to launch the [mag.x setup dialog](#) which offers simple options and then sets up the specs to give that specific mag.x system.

mag.x configurator - if you have a mag.x current solution, then click this to launch to use the [custom configurator form](#). With that you can select the mag.x base unit type and any accessories that you might need, for example filters, illumination options etc.

Finally you can [limit the number](#) of mag.x/Optem solutions.

- Optem options in a drop down button:

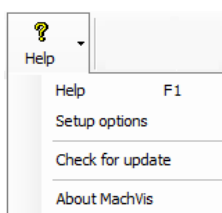


Setup specs for Optem - the Optem systems require fairly precise specifications. Click to launch the [Optem setup dialog](#) which offers simple options and sets up the specs to give that Optem.

Optem configurator - if you have an Optem current solution, then click this to launch to use the [custom configurator form](#). With that you can select the five key modules and any other accessories that you might want, e.g. beam splitters for dual branch systems, 90deg mirrors, illumination options etc.

Finally you can [limit the number](#) of mag.x/Optem solutions.

- **Help:** four options in a drop down button:



Help: Opens this help file.

Setup options: [dialog to allow user to choose locations for key files](#)

Check for update: looks on-line to see if a more up to date version is available

About: Opens a small dialog with information about the program and contact information

- **End:** Use this button to quit MachVis. Your current specifications and other choices will be retained in the INI file for recall when you next start MachVis.

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Setup: key parameters [conditions]

MachVis: the basics »

MachVis UI: key parameters [conditions]

The first step in finding a suitable lens is to provide the four key parameters or conditions that define your task. These are the

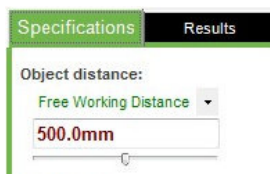
- [object distance](#)
- [object size/mag](#)
- [sensor size](#)
- [camera adapter](#)

The values are entered in the specifications tab on the left hand side of MachVis.

We will now discuss each parameter in more detail, working from the top downwards. This section concludes by introducing the [mag.x configurator](#) and the [Optem configurator](#) and some [general notes](#) on how MachVis chooses its solutions.

Parameter 1: Object distance

This is the distance from the object to a key point.



You can select from two distance values:

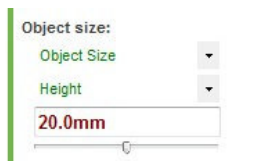
- Free Working distance [the distance from your object to the front edge of the lens]
- Total Working distance [the distance from the object to the sensor]

You can select either option from the drop-down box above the input field.

To change the value you can either type directly into the input field, or you can use the slider underneath [for quick alterations].

Parameter 2: Object size

This is the size of the object you want to image onto the sensor.



You may choose between object size and magnification [top drop down list]

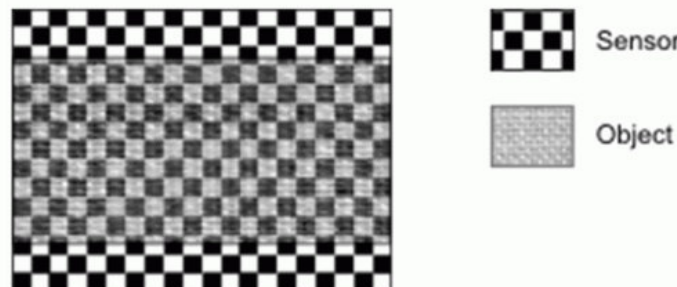
You may choose the height, width or diameter of the object by selecting the appropriate entry from the second drop-down box.

In either case the full [not half] dimensions are to be entered.

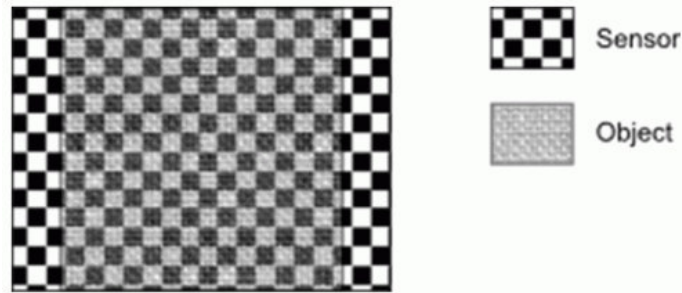
With the slider below the input box you can change the key dimension by small values.

It is vital to select the right dimension for the following reason: if the aspect ratio of the object does not match that of the sensor either the sensor will not be filled completely by the object or the object will not be completely imaged onto the sensor. The latter has to be avoided for obvious reasons.

The aspect ratio of a sensor is normally 4x3, with the exception of the 35mm format where it is 3x2. If the aspect ratio of your object is higher than the sensor's, e.g. 2x1, you have to use the width of the object as shown in the graphic below.



In the other case the object aspect ratio is less than that of the sensor, e.g. 2x3 (this will include square objects – 1x1 – and also applies to circular objects). In this case you have to specify the height of the object to make sure that the upper and lower edge of the object is captured by the sensor as shown in the graphic below.



Please note that MachVis assumes that the long edge (width) is horizontal and the short edge (height) is vertical.

TIP: If width or height are chosen as the object dimension, Machvis uses this dimension as if it was a 1-dimensional object. As a result, there may be cases in which a lens is suggested that does not fill the sensors diameter but only the width or height of the sensor. To avoid this you should specify the full diameter of the object, as in this case MachVis also uses the diameter of the sensor to check if the lenses image circle is large enough

Alternatively you can enter the magnification ratio directly. To do so select Magnification instead of Object size in the drop down box. Now you can enter the magnification ratio instead of the object size in the respective input field. Values from -0.001 to -1000 are allowed. If you enter a positive value, MachVis will add the minus automatically as the magnification of lenses is always negative.

Parameter 3: Image [sensor] size

This is the dimension[s] of the sensor that will be used.

You can select from a dropdown list of common sensor sizes field [CCD and linescan] - as per left screen capture. MachVis knows the values for these.

If the sensor you are using is not in this list you can select the Custom sensor size and input height and width of the sensor manually - as per right hand side diagram.

For a line scan sensor you should check the 'line sensor' option. In this case only the width of the sensor needs to be entered.

For accurate results it is advisable to look up the actual dimensions of the sensor in the camera data sheet as it is often the case that the camera is described as e.g. 1/2" camera but in fact the sensor dimensions are more or less different from the standard dimensions of that sensor size.

If you often need to model different cameras, then we suggest that you look into the [camera list capability](#) - this can save you a LOT of time and possible mistakes!

Parameter 4: Camera adapter type

Select the appropriate camera mount from this listbox.

For the S, C & F mounts there is a standard camera body depth, which is automatically used in MachVis.

NB the camera body depth is the distance from the front edge of the mount to the sensor.

For M42, M58, M72, M90 & M95 adapters, there is no standard camera body depth value. You MUST look up this dimension in the camera manual and enter the value in the input field for the camera body depth.

Again if you often need to model different cameras, then we suggest that you look into the [camera list capability](#) as the CBD is one parameter that will be defined.

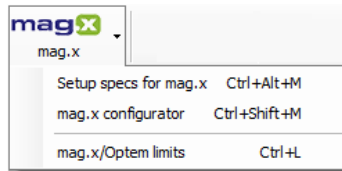
Setup and configurator for mag.x micro inspection system

As of MachVis v4, [mag.x micro inspection](#) systems were included in the machine vision lenses. These are quite different in many ways, being afocal for a start. They also have a wide range of options & accessories that need to be specified manually.

The mag.x items are now [v5] accessed via the mag.x icon in the main toolbar:

The mag.x systems require fairly precise conditions. If you want to use one, then we suggest that you use the [mag.x setup dialog](#) - either:

- click first item in the mag.x sub menu [shown left]



- press CTRL + ALT + M keys simultaneously

If you have selected a mag.x current solution in the results spreadsheet, then you can call up the [mag.x configurator](#) in one of three ways:

- click second item in the mag.x sub menu
- press CTRL + SHIFT + M keys simultaneously
- right click the that mag.x solution

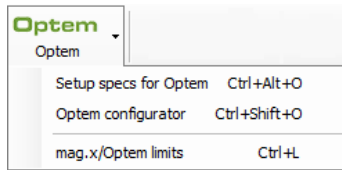
In the mag.x configurator, you can select the base unit type and any accessories that you might need, for example filters, illumination options etc.

Finally you can [limit the number](#) of mag.x/Optem solutions via the third option, or by pressing CTRL+L.

Setup and configuration for Optem Fusion micro inspection systems

As of MachVis v5, [Optem Fusion](#) systems are now included in the machine vision lenses. These are similar to the mag.x systems in that they are afocal and also have a wide range of options & accessories that need to be specified manually.

The Optem items are now [v5] accessed via the Optem icon in the main toolbar:



The Optem systems require fairly precise conditions. If you want to use one, then we suggest that you use the [Optem setup dialog](#) - either:

- click first item in the Optem sub menu [shown left]
- press CTRL + ALT + O keys simultaneously.

If you selected have an Optem current solution in the results spreadsheet, then you can call up the [Optem configurator](#) in one of three ways:

- click second item in the Optem sub menu
- press CTRL + SHIFT + O keys simultaneously
- right click that Optem solution

The custom interactive configurator form will load, and you will be able to select the key Optem modules and any accessories that you might need, for example filters, illumination options etc.

Finally you can [limit the number](#) of mag.x/Optem solutions in the results spreadsheet via the third option, or by pressing CTRL+L [By default this is limited to showing three Optems - mag.x's are unlimited by default.

General Notes

To change the value of an input field just click with the mouse into the field and start typing. The unit is added automatically by the program. You can also use the Tab key to navigate to the next input field. Changes of input fields take effect on the internal calculations as soon as you press the Enter key or click into another input field.

With the information specified in this step, MachVis calculates the parameters of a theoretical lens that would optimally fulfil your requirements, and then lists all of the Excelitas lenses that meet the following conditions:

- The focal length of the lens lies within $\pm 10\%$ of the calculated focal length. [*this can be altered in the results tab*]
- The calculated magnification lies within the range recommended for the lens.
- The lens can be attached using the selected camera mount.
- The flange focal distance of the lens for the particular magnification must be compatible with the selected camera mount using the available mechanical adapters.
- The image area of the lens must be large enough for the specified sensor.

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Setup options

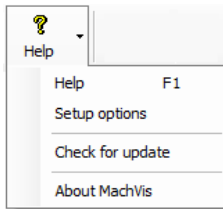
MachVis: the basics »

Setup options: file locations

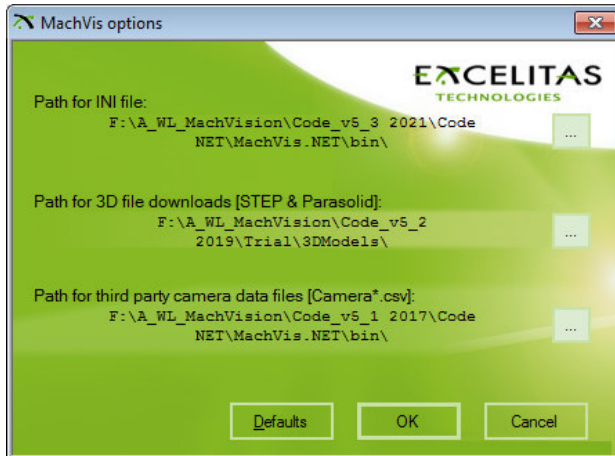
As from MachVis 5.1, you may specify the location of various of the key files and folders

click the Help button on the main toolbar

then select the 'Setup options'



you will see this simple dialog:



you can change location of:

- INI file
- download folder for 3D file downloads
- camera files in CSV format

simply click the [...] button to the right of the item that you want to change.
When you have selected a new location, MachVis will move the file[s] to the new location.

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Results table

MachVis: the basics »

MachVis UI: results spreadsheet

Once you have entered the key parameters, possible solutions are displayed in the result table. Each solution has its own row in the table. The top row shows the data for a theoretical system that exactly fulfils the specifications.

	Qioptiq Lens Name	Focus Device	Ext	Lens EFL	Free W.D.	Flange F.D.
▶	Theory			96.8mm	500.0mm	120.0mm
1	Optem 0.24x: 0.4xLL 0.6xCT		0	Micro	490.0mm	
2	Rogonar-S 90	Modular Foc...	1	90.1mm	446.1mm	101.5mm
3	Apo-Rodagon N 90	Modular Foc...	1	90.1mm	436.3mm	106.5mm
4	Rogonar-S 90	Smart Focus	2	90.1mm	446.1mm	101.5mm
5	Apo-Rodagon N 90	Smart Focus	2	90.1mm	436.3mm	106.5mm
6	Apo-Rodagon N 105	Modular Foc...	2	105.2mm	510.2mm	124.4mm
7	Apo-Rodagon N 105 full metal	Modular Foc...	2	105.2mm	510.2mm	124.4mm
8	Apo-Rodagon N 105	Smart Focus	3	105.2mm	510.2mm	124.4mm
9	Apo-Rodagon N 105 full metal	Smart Focus	3	105.2mm	510.2mm	124.4mm
10	Rodagon 105	Modular Foc...	1	106.4mm	523.0mm	127.0mm
11	Rodagon 105 azimuth	Modular Foc...	1	106.4mm	523.0mm	127.0mm

The number of visible rows & columns can be controlled via the settings on the **Results** tab [\[as discussed here\]](#). The following columns are always present:

Excelitas lens name: in this column you find the name of the lens. It will also show if the lens is in the retro orientation

Remark: This column is only present if there are lenses with remarks. The following remarks can be displayed:

- a) **Old:** this is a lens that is already or will be discontinued
- b) **Prism:** this lens is optimized for the use with a prism on the object side for coaxial illumination

c) **NIR**: this lens features a coating for the NIR range from 950 to 1350nm

d) **Mag**: this lens is operated outside the optimized magnification range with the selected specification. Please contact Excelitas to make sure that this lens is a good choice for your application.

Focus device: There are two groups of lenses:

a) Built in focussing and camera mount, e.g. *MeVis-C* lenses. For lenses of this group this column is empty. This also applies to mag.x and Optem solutions.

b) Fixed focal length with a standard thread to mount the lens, e.g. *ROGONAR-S* & *RODAGON* lenses. These lenses need a focussing device or at least an adapter tube that brings the lens into the right position and adapts it to the camera. There are several different Focus devices available. Please find out more about these adapters in the section [Focus devices](#).

Ext: number of extension tubes required for the solution

Lens EFL: This is the effective focal length of the lens. The true EFL sometimes differs slightly from the nominal focal length denoted on the lens. MachVis always performs calculations using the true EFL.

Free W.D.: The free working distance is the distance between object and front edge of the lens. The free W.D. shown in this column will differ from the value that you entered in the Specifications tab. This is due to the difference between the EFL of the ideal solution and the true EFL of the real Linos lenses, and the fact that the FWD is not identical to the optical object distance.

Flange F.D.: The flange focal distance is the distance between the mounting flange of the lens to the sensor plane. In case of lenses with a built in camera mount [c-mount or f-mount] this dimension is fixed by the standardized lens mount. In case of lenses without built-in camera mount, such as the *RODAGON* lenses, this dimension shows you the distance from the mounting flange of the lens to the sensor. In the case that you machine your own adapter tubes, please use this value minus the camera body depth you have given on the Specifications tab.

There are also a number of [optional columns](#) that you can choose to show/hide

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Filtering/extending results

MachVis: the basics »

MachVis UI: filtering/extending results

We have discussed the [basics of the results table](#) in the previous section.

Here we discuss how to customise the results table, using the **results** tab, to extend or to filter the results spreadsheet:

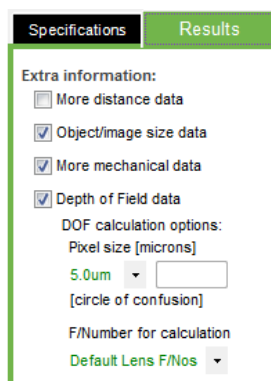
- controlling technical data displayed [columns]
- controlling number of solutions shown [rows]

NB The **results** tab is in the left hand side tabbed area of the main form, so you can access it while still viewing the results - changes made will cause the results table to update immediately.

Changes made in the **results** tab do not generally effect the basic optical requirements/calculations in MachVis.

1: Showing extra technical information

You may choose to show/hide four groups of extra columns - each group shows some related information.



We will discuss each of these options in detail below.

Note that the **Depth of Field** checkbox is associated to **Pixel size** and **F/Number** controls. The DOF is the one exception to the rule above - changes made to Pixel size & F/number do effect the optical calculations, but only the Depth of Focus values.

1.1: More distance data

By activating the **More distance data** option on the Results tab you can show a column for the Total W.D. (total working distance). This is the distance from the object to the sensor.

1.2: Object/Image size data

With the **Object/Image size data** option you make the following columns visible:

- Object size: this is the size of the object you have given on the Specifications tab.
- Image size: This is the size of the sensor you have selected. If you have selected to specify the Width of the object then the sensor width is displayed and in case of Height or Diameter the respective dimension of the sensor is shown in this column.
- Image Max: This is the maximum image circle of the lens.

- **Mag value:** This is the magnification needed to image the object onto the sensor. The magnification is calculated by dividing the image size by the object size.
- **MagRange:** This is the useful magnification range of the named lens. MachVis makes sure that the required magnification is within this magnification range. However, for critical applications, it can be advisable to make sure that the required magnification is quite in the middle of the magnification range of the selected lens.

1.3: More mechanical data

The **More mechanical data** option adds two columns:

- **Lens to Camera:** distance from the front of the lens to the rear of the last accessory [i.e front of the camera]
- **the Flange F.D. Range** to the result table. This range is defined by the mechanical movement range [extension] of the [focusing device](#). If no focusing device is used only one number is displayed.

1.4: Depth of Field Data

With the **Depth of Field Data** option you enable a column that shows the depth of field for the lens.

MachVis needs the pixel size of the sensor to perform an accurate calculation of the depth of field. You enter this pixel size by selecting the appropriate value from the list box below the option. You will find the pixel size in the data sheet of your camera. NB If you are using [camera lists](#), then the pixel size will be set from the list.

By default, this is calculated for the maximum lens aperture. To calculate the depth of field for a stopped down lens you can select the desired F/# from the **F/number for calculation** listbox.

NB For the Optem and mag.X systems we simply show the depth of field values given in the related datasheets. These values are based upon the Airy disc size for the full aperture. This diffraction based value gives the smallest DOF that can be seen with these systems.

2: Controlling solutions shown

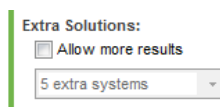
When 'solving' a particular set of specification, MachVis looks at each lens in its database to see if it is suitable. If suitable it will then generate solutions composed of different arrangements of focusers, extension tubes etc. As you can imagine, there might be a vast set of these, which are then assessed to see if they met certain constraints. The solution set is further pruned to one good solution for each lens/focuser combination - choosing the case with the least number of extension tubes [if any]. This gives a clearer picture of the different lens types that might be of interest.

Sometimes you may need to vary from the defaults, so with the controls detailed below, you can:

- Display 1, 2 or more secondary solutions [these will always be 'good']
- Filter out unwanted lens types
- loosen the MachVis solution constraints

2.1: Extra solutions

The **Extra solutions** section is aimed at fixed focus lenses which use multiple extension rings, and for C-mount with the MeVis-C series lenses.

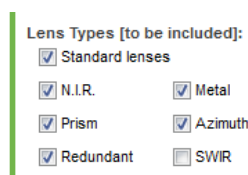


There may be situations where you prefer another solution with different extension ring combinations.

In this case activate the **Allow more results** option and select the appropriate number of extra results from the drop down box below.

2.2: Lens type filters

You can choose to show/hide solutions with specific types of lens.



Filtering out lens types that you know are irrelevant has two benefits

- reduces 'clutter' in the results table
- speeds up calculations [that is not usually a problem though]

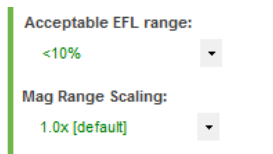
The six options in the Lens Types section enable you to fine tune the types of lenses that will be displayed in the result table. At least one checkbox is always active. The six options have the following meaning:

- **Standard lenses:** All current lenses for the visible wavelength range are displayed in the result table.
- **NIR lenses:** all available lenses with a coating from 950nm to 1350nm are displayed. These lenses are marked in the result table with the NIR entry in the Remark column.
- **Prism** optimized lenses: inspec.x L lenses that are optimized for the use of an object side prism are displayed. These lenses are marked in the result table with the Prism entry in the Remark column.
- **Redundant** lenses: if this option is activated also obsolete lenses are displayed. These lenses are marked in the result table with the Old entry in the Remark column.
- **Full metal** lenses [v5.0]: These are versions of lenses now come in a completely metal mount. These are especially useful in high vibration environments. Shown in the lens name.
- **Azimuth** lenses [v5.0]: These are versions of standard lenses which are individually tested and the azimuth with best optical performance marked for use with high performance line-scan detectors - the azimuth marking has to be **perpendicular** to the line sensor
- **SWIR** [v5.2]: applies to Optem systems only. Allows those which are suitable for the [SWIR](#) waveband

2.2.1: [Obsolete Focus Devices](#)

2.3: EFL and Magnification constraints

MachVis uses several constraints when selecting or rejecting systems to match the specs. You may loosen or tighten those on efl and magnification range.



MachVis calculates the focal length of a theoretical lens that would exactly match your specifications. Normally, however, there is no real lens with exactly that focal length. Therefore MachVis shows lenses in the result table within a range of $\pm 10\%$ of the theoretical focal length. You can change this range by selecting a different value from the drop down box titled 'Acceptable EFL range'. If you use a larger value, such as 20%, more lenses are displayed.

The drop down box titled 'Mag Range Scaling' is intended for experienced users only. The purpose of this drop down box is to widen the recommended magnification range of all lenses by the selected value. If a lens is recommended for a range of -0.1 to -0.01 and you select 2.0x from this list MachVis will calculate with a recommended range of -0.2 to -0.005. This feature has to be used carefully as MachVis may suggest lenses that are not optimally suited for the selected magnification. In the case of MeVis-C lenses that are to be used inside the minimum object distance, MachVis automatically calculates the proper extension ring.

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Current system display

MachVis: the basics »

MachVis UI: current system

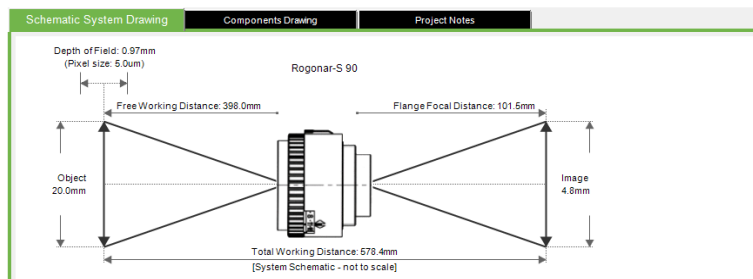
One solution, known as the current or selected system, is always shown in more detail in the tabbed area under the results table. You can see the following items:

- [schematic lens diagram](#)
- [component diagram](#)
- [optional] [spreadsheet summary](#) of components
- [project notes](#)

The current system is indicated by the highlighted row in the results spreadsheet. To change the current system, simply click on another row in the spreadsheet.

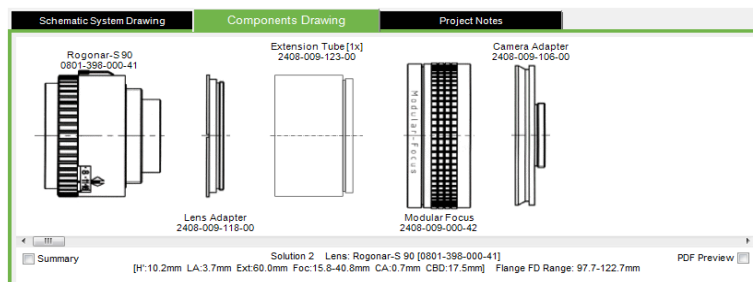
Schematic lens diagram

This shows the key opto-mechanical values for the current system. The drawing is fixed, so dimensions are purely schematic - definitely NOT to scale. The actual values are given in the text. If the lens has a frontal prism that is now shown.



Component diagram

This shows the components in order of assembly from left to right - lens at left and camera [not shown] at extreme right.



NB for mag.x and optem systems, this diagram is effectively a black box! Open the [mag.x configurator](#) or the [Optem configurator](#) to see the actual system and choose accessories.

Summary spreadsheet [optional]

At the bottom of the **component diagram** tab there is a check box called **Summary**. By clicking this box you enable a small table to the right of the components drawing that lists all elements of the current system.

The screenshot displays the MachVis user interface with three tabs: 'Schematic System Drawing', 'Components Drawing', and 'Project Notes'. The 'Components Drawing' tab is active, showing a 3D model of a lens assembly and a table of components. The table lists the following parts:

Component	Part number	#	3DModel STEP
Rogonar-S 90	0801-398-000-41	1x	Download
Lens Adapter	2408-009-118-00	1x	Download
Extension Tube	2408-009-123-00	1x	Download
Focuser	2408-009-000-42	1x	Download
Camera Adapter	2408-009-106-00	1x	Download
All files			All Files

Below the table, there is a 'Summary' section with a dropdown menu set to 'Step'. The summary text reads: 'Solution 2 Lens: Rogonar-S 90 [0801-398-000-41] PDF Preview'. Technical specifications are listed below: '[H]:10.2mm LA:3.7mm Ext:60.0mm Foc:15.8-40.8mm CA:0.7mm CBD:17.5mm Flange FD Range: 97.7-122.7mm'.

In this table, in the right hand column, you will also see the "Download" links to the 3D files. For reasons of space only one format [Step OR Parasolid] is shown at a time. To get the other, simply select the correct option from the drop down list under the checkbox.

You can download the individual files - one at a time - to the ..\3DModels subfolder in the MachVis directory. Alternatively there is an '**All Files**' link in the bottom right cell which will enable you to download all the files in the current system in one go.

NB for mag.x and Optem systems, this is a minimal listing, and you really should use the appropriate [mag.x configurator](#) or [Optem configurator](#) to see the full component list and make such changes as your require.

Project Notes

This consists of two text boxes:

- **project designer** at top to attribute the design to -shown in printout etc
- **project notes** [at bottom and much larger] - will also appear in the printout

Working with camera lists

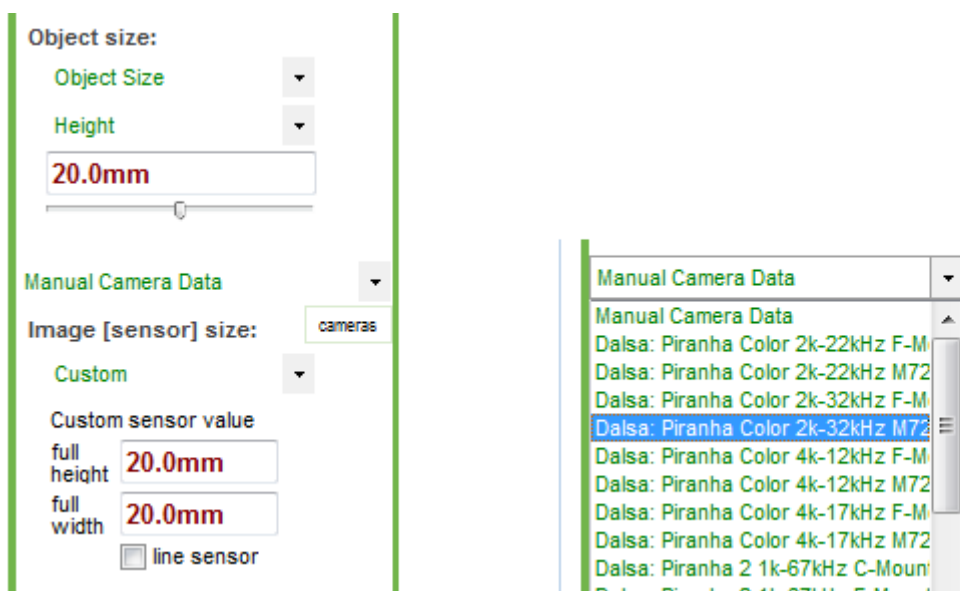
MachVis: extra features »

MachVis features: camera lists

In the standard MachVis operation mode, the user needs to know camera data such as sensor type [rectangle or line] and dimensions, lens mount type and body depth. These values have to be entered manually each time - with consequent scope for error.

With MachVis 3, 'camera files' were introduced. These files can be created and edited by any user or by a camera manufacturer. If a camera file is present, you will see a new drop down list in MachVis specifications tab.

This list shows all the cameras held in the camera file[s].



If you select a camera, MachVis will then automatically use the appropriate values for that camera, namely:

- Camera body depth
- Lens mount type [e.g. C-Mount etc]
- Sensor type [area or line]
- Sensor dimension[s] including pixel size [for depth of field calculations]

The relevant controls will be disabled, so that you cannot accidentally change the values.

Alternatively you can open a [camera list form](#) containing a more detailed spreadsheet with basic data of the each camera by clicking the button at the right of the drop down list. To select a camera from the dialog, simply click on the relevant row.

If you do not want to use a predefined camera, then just select the 'Manual Camera Data' option from the top of the list; the image sensor, camera adapter & camera body depth controls will be enabled and can be used as normal.

Camera file name & format

The camera file **must**:

- be a text file in CSV format (Comma Separated Values)
- be placed in the same folder as MachVis.exe

You MUST use the decimal '.' notation, e.g. '3.14' and NOT '3,14', since MachVis will take commas to separate different items.

The default filename is Camera.csv. You can also use multiple camera files by extending the filename after 'Camera'. Thus suitable names include:

- Camera.CSV
- CameraQIOPTIQ.CSV
- Camera2014.CSV

A sample camera file, Camera.csv, is included in the installation. The contents are as follows:

```
v3, 2009-04-15
vendor,camera name,line or area scan,sensor height,sensor width,pixel
size,mount,cbd,part number
abc, supercam, a, 15.16, 15.16, 7, 1, 11.65, 123456789
xyz, linecam, l, 0, 41, 10, 4, 6.5, 128654123
```

You can copy and paste these lines to a text editor [such as Windows Notepad or similar] and/or edit the included file in your text editor. Microsoft Excel can also open, edit and save .csv-files.

In more detail, the file has the following line structure:

- line 1: version info and date (not used by MachVis). Use this line for your reference.
- line 2: column header. Please do not change this line
- line 3: first camera info
- line 4: second camera info

... etc

Notes on camera files:

- Camera line[s] data must be in the order defined in the second line
- Add one extra line for each new camera
- All dimensions to be in millimeters, except pixel-size which is in microns!
- For the sensor type item [line or area scan] simply enter 'a' or 'l' - without the quote marks.
- The mount type is defined by a number as follows:
 - 1 - C Mount
 - 2 - F Mount
 - 3 - M42
 - 4 - M72
 - 5 - M58
 - 6 - M95
 - 7 - S Mount [flo.x only]
 - 8 - M90

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Camera list form

MachVis: extra features » Working with camera lists »

MachVis features: camera list form

This form is only available IF you have one or more [camera files defined!](#)

With this popup form you can:

- see the data on all cameras in your camera lists
- be able select one whose data will be applied in the main form

This is opened from the small button just below the camera list in the specification tab [which is only visible if you have a camera list]



The form contains a spreadsheet showing the cameras. Each camera has its own row which details camera name, part number, line or area scan, mount, camera body depth & sensor height, sensor width & pixel size.

	Maker	Camera Name	Select	Part Number	Camera Adapter	Detector Type	Camera Body Depth	Sensor Height	Sensor Width
1	Dalsa	Piranha Color 2k-22kHz	Now	PC-30-02160	F-Mount/Nikon	Line Scan	46.50mm	0.04mm	28.67mm
2	Dalsa	Piranha Color 2k-22kHz	Now	PC-30-02160	M72 x 0.75	Line Scan	6.56mm	0.04mm	28.67mm
3	Dalsa	Piranha Color 2k-32kHz	Now	PC-30-02180	F-Mount/Nikon	Line Scan	46.50mm	0.04mm	28.67mm
4	Dalsa	Piranha Color 2k-32kHz	Now	PC-30-02180	M72 x 0.75	Line Scan	6.56mm	0.04mm	28.67mm
5	Dalsa	Piranha Color 4k-12kHz	Now	PC-30-04180 F	F-Mount/Nikon	Line Scan	46.50mm	0.03mm	40.96mm
6	Dalsa	Piranha Color 4k-12kHz	Now	PC-30-04180 M72	M72 x 0.75	Line Scan	6.56mm	0.03mm	40.96mm
7	Dalsa	Piranha Color 4k-17kHz	Now	PC-30-04180 F	F-Mount/Nikon	Line Scan	46.50mm	0.03mm	40.96mm
8	Dalsa	Piranha Color 4k-17kHz	Now	PC-30-04180 M72	M72 x 0.75	Line Scan	6.56mm	0.03mm	40.96mm
9	Dalsa	Piranha 2 1k-67kHz	Now	P2-2x-01140	C-Mount	Line Scan	17.52mm	0.01mm	10.24mm

There is also a column of '**Now**' buttons to the right of the camera name column. **If you click on one of these buttons**, then MachVis will apply the data for the camera in that row to the key specifications. This form will close and the new results will be displayed automatically.

If you close the form via the **Close** button, then **no changes** are made to the specifications.

NB the screen capture shows a sample set, yours will almost certainly be different!

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Using 3D CAD data

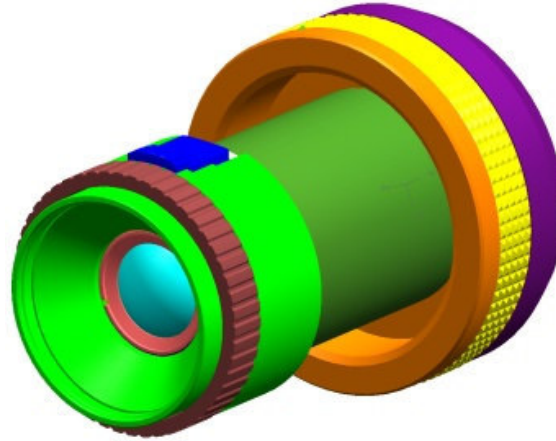
MachVis: extra features »

MachVis features: 3D CAD data files

Excelitas provides CAD data for all standard lenses and accessories to customers. This data is provided in two formats:

- Step214
- Parasolid

All models are created from the original design data and have only been modified to create one solid element. Therefore the mechanical designer only has to deal with one block.



Since the files are quite large, they are not included in the basic setup. Instead you can download them as required from the Excelitas website using MachVis.

To access the files display either the [Lenses form](#) or the [Parts form](#). Each form has a spreadsheet containing information about the relevant items. In particular, there are hyperlinks to each available CAD file in the right hand side columns. Click on the appropriate cell to download the file of interest, and repeat as necessary.

Alternatively, you can use the links in the [system summary table](#). This will naturally show only the file links for the current system [excepting the mag.x and Optem solutions]

To access the 3D files for mag.x or Optems systems, you must use the [mag.x configurator](#) or the [Optem configurator](#) respectively. The configuration spreadsheet in those forms has a similar links column.

All 3D files for a solution or configuration

NB as of MachVis v5, in the system summary table and the configurators, there is a link labelled '*all files*' at the bottom of the existing links column. This link will allow you to download all the files in the current solution or configuration at one hit.

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Lens list form

MachVis: extra features >>

MachVis features: lens list form

With this popup form you can:

- see an overview of the available machine vision lenses offered by Excelitas

- be able to view detailed data sheets pdfs with dimensional and performance data [MTF etc]
- be able to download 3D CAD files for the lens

To open the form click the button **Lenses** on the toolbar of the main window.

You will see a spreadsheet listing the currently available Excelitas machine vision lenses.

	Lens Name	Qloptiq Part Number	Remark	Lens EFL [mm]	Lens F/Nos	Image Size [mm]	M.O.D. [mm]	Mag Range	3DModel STEP	3DModel PARASOLID
1	Rogonar-S 25	0801-272-000-20	OLD	25.2	F/4.0	18.0		-0.1 to -0.03	Download	Download
2	Rogonar-S 35	0801-273-000-20	OLD	36.4	F/4.0	25.0		-0.1 to -0.03	Download	Download
3	Rogonar-S 50	0801-397-000-40		51.1	F/2.8	44.0		-0.4 to -0.08	Download	Download
4	Rogonar-S 60	0801-324-000-40		60.3	F/4.5	56.0		-0.5 to -0.1	Download	Download
5	Rogonar-S 75	0801-325-000-40		74.1	F/4.5	44.0		-0.5 to -0.1	Download	Download
6	Rogonar-S 75 full metal	0801-325-000-41		74.1	F/4.5	44.0		-0.5 to -0.1	Download	Download
7	Rogonar-S 90	0801-398-000-41		90.1	F/4.5	84.0		-0.5 to -0.13	Download	Download
8	Rodagon 28	0701-389-000-20		27.6	F/2.8	32.0		-0.2 to -0.03	Download	Download
9	Rodagon 35	0701-401-000-40		35.1	F/4.0	40.0		-0.2 to -0.03	Download	Download
10	Rodagon 60	0701-345-000-40		50.2	F/2.8	44.0		-0.5 to -0.07	Download	Download

On top of the dialog you will find three buttons

- **Load PDF:** With this button you can open a datasheet describing the currently selected lens (in PDF format).
- **Overview:** Open a PDF file that shows a concise overview of all currently available standard lenses from Excelitas with basic parameters
- **Close:** Closes this form.

When you activate the option **Enable PDF Preview** an extra window is opened that shows the data sheet of the currently selected lens. An example is shown here

Order number: 0701-349-000-40
Lens name: Apo-Rodagon-N 2.8/50

Specification:
 Image circle max. (mm): 44
 focal length f (mm): 50.2
 magnification (f/number): -0.11 to 0.5 (-0.05)
 spectral range (nm): 400 - 750

Design includes OOD cover glass: no

Specification Table:

Specification	Value	Unit	Remark
Image circle max. (mm)	44		
focal length f (mm)	50.2		
magnification (f/number)	-0.11 to 0.5 (-0.05)		
spectral range (nm)	400 - 750		
working distance (mm)	102 - 1025		
interface	M39 x1.25P-Subtop		
filter thread	MA05 M05		
weight (kg)	0.5		

Performance Graphs:
 - MTF of radius 0.14 f/ 2.8
 - relative light fall-off of radius 0.14
 - Distribution of radius 0.85 to 0.5
 - MTF of radius 0.14 f/ 5.6
 - Longitudinal color aberration of radius 0.14

To sort for different parameters you can click the column header of the respective column.

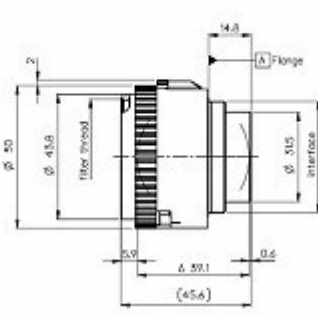
The columns of the table have the following meanings:

- **EXCELITAS lens name:** The designation of the lens
- **EXCELITAS part number:** the order number of the respective lens
- **Remark:** this column holds special features of lenses. The possible values are
 1. **OLD:** this lens is or will be discontinued
 2. **NIR:** this lens uses a special coating from 950-1350nm
 3. **Prism:** this lens is optimized for use with a beamsplitter prism on object side for coaxial lighting
- **Lens EFL [mm]:** The effective focal length. This focal length differs somewhat from the focal length used for the lens name in some cases.
- **Lens F/Nos:** The maximum aperture of the respective lens
- **Image size [mm]:** The maximum diameter that the sensor may have. With a larger sensor you might encounter dark edges and a drop in contrast.
- **H' [mm]:** The distance from rear principal plane to flange.
- **MOD:** the minimum object distance is given for lenses with internal focussing.
- **Mag Range:** The respective lens is optimized for the given magnification range.
- **3D Model STEP:** To download 3D CAD data of a lens in step214 format click the link in this column. The download is started via your default browser and you can save the file on your PC.
- **3D Model PARASOLID:** To download 3D CAD data of a lens in parasolid format click the link in this column. The download is started via your default browser and you can save the file on your PC.

Lens Datasheets

Excelitas lens datasheets are technically detailed. They contain both exact dimensions and optical performance data [MTF, distortion, chromatic aberration and illumination plots]. These will be very helpful when choosing between lenses for a specific purpose.

order number 0701-349-000-40	lens name Apo-Rodagon-N 2.8/50
---------------------------------	-----------------------------------



Specification	DN
image circle max. (mm)	44
working distance (mm)	32 - 12.5
focal length (f) (mm)	50.0
interface	M42 x 0.4 / G.42x0.4
magnification (f) (range)	+0.10 - 0.5 ... -0.051
filter thread	M42.5 x 0.5
spectral range (nm)	400 - 750
weight (g)	12.5
design includes OGD cover glass	no
SF (mm)	-27.2
1-stop of F _{max} of F _{min}	2.8
SF (mm)	51.6
2-stop of F _{max} of F _{min}	11.0
1st lens (mm)	-2.5
1st lens (mm)	12.5
2nd lens (mm)	23.0
2nd lens (mm)	5.5
3rd lens (mm)	-18.4
3rd lens (mm)	6.2
4th lens (mm)	28.4
4th lens (mm)	11
5th lens (mm)	-21.0
5th lens (mm)	16
6th lens (mm)	5.1
6th lens (mm)	2.5

axometric diagram

REL/LOC	DATE	APPROVED	DESIGN ENGINEER	FORM ORIGIN	SCALE
D	1988.10.21		DIETRICH/ROTH	150 2760-111	1:1
C	1988.10.21				
B	1988.10.21				
A	1988.10.21				

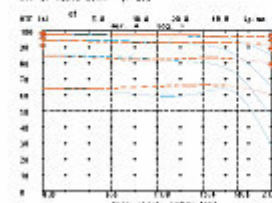
TITLE: Apo-Rodagon-N 2.8/50

DRAWING NO.: 0701-349-100-40-0001e

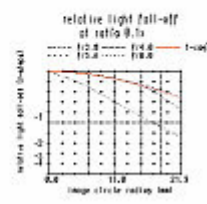
SHEET: 01

Apo-Rodagon-N_{2.8}/50


Resolution of detail (lp/mm)



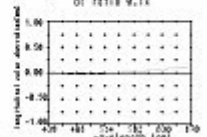
relative light fall-off of ratio 0.5



Distortion at ratio 0.5 to 0.5



Longitudinal color aberration of ratio 0.5



Named frequencies (line patterns) in resolution transfer function (MTF) as well as diagrams of relative light fall-off, distortion and longitudinal color aberrations refer to film plane.

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Parts list form
MachVis: extra features >>

MachVis features: parts list form

With this popup form you can:

- see an overview of the available machine vision mechanical accessories offered by Excelitas
- be able to view data sheets pdfs
- be able to download 3D CAD files for most parts

To open the form click the button **Parts** from the toolbar of the main window.

You will see a spreadsheet listing the currently available adapters, focusers, rings and extension tubes.

	Type	Description	Graphic Part Number	Status	3DModel: STEP	3DModel: PARASOLID
1	Focuser	Modular Focus	2408-009-000-42		Download	Download
2	Focuser	Smart Focus	2408-021-000-43		Download	Download
3	FocusTube H72	inspec.x L 0.33x-0.5x	2408-012-000-31		Download	Download
4	FocusTube H72	inspec.x L 0.75x-1x	2408-012-000-30		Download	Download
5	FocusTube H72	inspec.x L 3x-3.5x	2408-012-000-47		Download	Download
6	FocusTube H72	inspec.x L 5x	2408-012-000-33		Download	Download
7	FocusTube H72	inspec.x L 0.75x Retro	2408-012-000-38			
8	FocusTube H72	inspec.x L 0.5x Retro	2408-012-000-39			
9	FocusTube H72	inspec.x L 0.33x Retro	2408-012-000-40			
10	FocusTube H95	inspec.x L 0.33x-0.5x	2408-012-000-41		Download	Download
11	FocusTube H95	inspec.x L 0.75x-1x	2408-012-000-43		Download	Download

On top of the dialog you will find two buttons

- View PDF: With this button you can open the Datasheet of the currently selected part (in PDF format).
- Close: Closes this form.

To sort for different parameters you can click the column header of the respective column.

To download 3D CAD data of an accessory you just click the download link in the respective row. You can select between step214 format and parasolid format. The download is initiated via your default browser. When complete you can save the file on your PC.

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what are standard lenses?

Standard lenses »

Standard lens: what are they in MachVis?

Strictly speaking, standard lenses are the Excelitas 'photographic' type objectives:

- Rogonar
- Rodagon & Apo-Rodagon
- Inspec.x [.M's have built in focusing, .L's do not]
- d.fine HR
- MeVis-C [built in focusing]

Like normal photographic objectives, these are designed to work with a range of magnifications and Free Working Distances [FWD]. However these are specifically optimised for machine vision tasks.

The key point is that MachVis can define a complete system for a standard lens with focus devices [if necessary], adapters and spacers as appropriate.

*In contrast the **mag.x** and **Optem** systems are designed for a single FWD and magnification. They require user input to define the complete systems - this is handled in the [mag.x configurator](#) and the [Optem configurator](#) within MachVis. For this reason mag.X & Optem are not classed as standard lenses.*

There is also a set of Macro-CCD lenses. Like the mag.X and Optem systems, these are designed for a fixed FWD and magnification. However, they do not require any focus devices, spacers or adapters, nor any further user input. MachVis can therefore define such lenses completely without need for a configurator. For this reason the Macro-CCD lenses are included within set of 'standard lenses'

See how to [setup conditions](#) to get a specific standard lens.

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setup dialog for a specific lens

Standard lenses »

Standard lens: setup for a specific lens

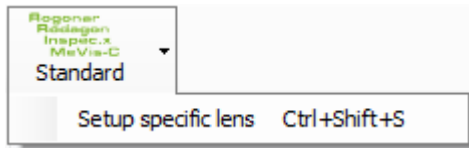
This dialog will enable you to setup the conditions that hopefully will ensure a specific lens, e.g. an Apo-Rodagon D 120 or Rogonar-S 60, is in the solution set - subject of course to the proviso that the lens can 'support' the current sensor size.

You can choose to use the existing sensor size information from the current values in the main MachVis form OR you can set use new values of your own...

How to load standard lens setup dialog:

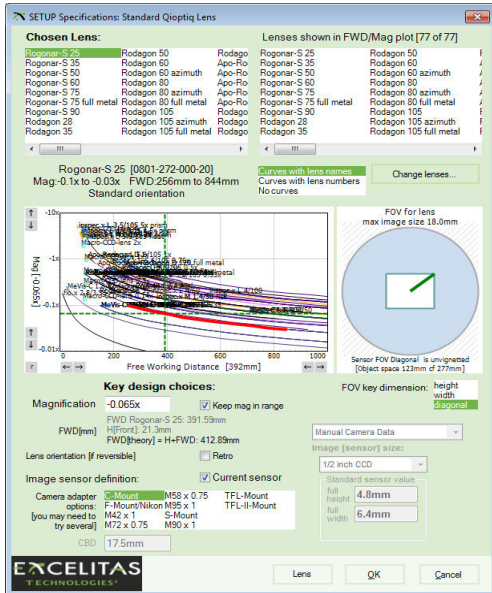
Press key combination: *Ctrl+Shift+S*

or



Click second item in the standard lens drop down menu in the main toolbar [shown here]

Here is the specific lens setup dialog - it is much more than a simple list of the current Excelitas Lenses!



Working from top to bottom, there are four main areas that will be discussed below:

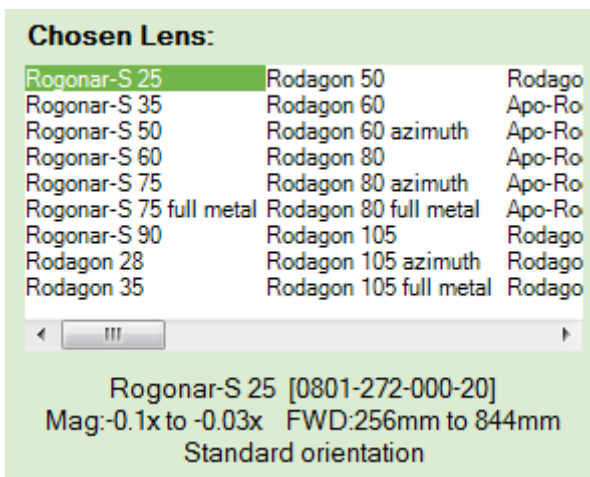
- A: [Lens lists](#)
- B: [Plots of mag v FWD](#) and also Field of View
- C: [Key choices](#) [magnification etc]
- D: [Sensor and camera](#) adapter choices

Obviously selections made in this form only apply if you press OK to return to the main form!

we then end with a 'warning' note on why you still may not find your selected lens in the solution set.

E: [on getting solutions](#) - or not!!

A: Lens lists



This is a list of all Excelitas standard lenses.

The highlighted name is the one that you wish to appear in the solution set in the main program.

We will refer to this as the **selected lens**.

Some key details for this lens are shown underneath the text box.

This is a list of the lenses that are displayed in the FWD v mag plot discussed below.

By default, this list shows all the Excelitas standard lenses.

To change your selections, using a [dedicated dialog](#), click on the 'Change lenses...' button below the list.

If changed, the list will be updated.

Lenses shown in FWD/Mag plot [77 of 77]

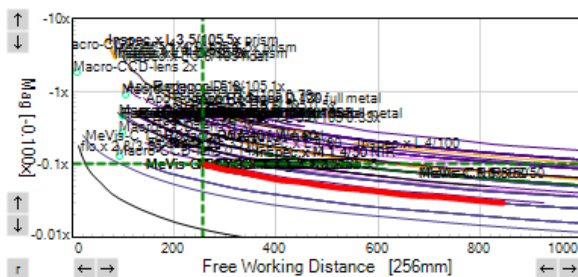
Rogonar-S 25	Rodagon 50
Rogonar-S 35	Rodagon 60
Rogonar-S 50	Rodagon 60 azimuth
Rogonar-S 60	Rodagon 80
Rogonar-S 75	Rodagon 80 azimuth
Rogonar-S 75 full metal	Rodagon 80 full metal
Rogonar-S 90	Rodagon 105
Rodagon 28	Rodagon 105 azimuth
Rodagon 35	Rodagon 105 full metal

Curves with lens names
 Curves with lens numbers
 No curves

Change lenses...

NB the short list at lower left refers to options for the graph below.

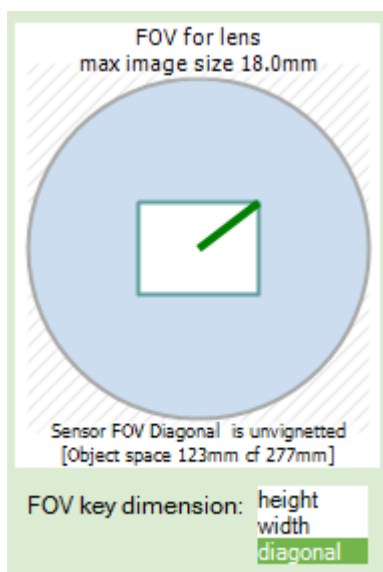
B: Plots of mag v FWD & Field of View



This is a interactive plot of mag v FWD for a selected number of the Excelitas standard lenses.

Each lens has its own curve on the plot, the selected lens being highlighted in red.

[A full description](#) can be found here, including how it can be used to select a specific lens.



This diagram shows the maximum **field of view** [circular] allowed by this lens v the field of view of the current sensor [rectangular].

Any vignetting is shown in red. The selected lens will then not appear as a solution to this set of requirements, on return to the main program.

The current key dimension [width, height or diagonal] is indicated by the line drawn from the center. Here we are showing the diagonal.

You can choose which is the [key dimension](#). This will impact the FOV plot above, and will be applied to the main system specifications. It may also change the vignetting colouring in the spreadsheet above!

C: Key values [magnification etc]

Key design choices:

Magnification Keep mag in range

FWD[mm] FWD Rogonar-S 25: 391.59mm
 H[Front]: 21.3mm
 FWD[theory] = H+FWD: 412.89mm

Lens orientation [if reversible] Retro

You can specify directly - in the text box - the magnification that you want to use.

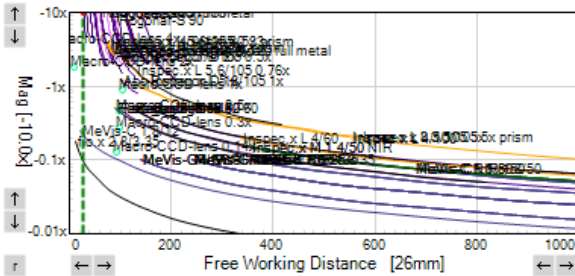
NB if you change the magnification via the [interactive FWD v Mag plot](#), then this value will be updated.

Underneath the mag text box, we see three lines of text:

- 1) FWD[plot] i.e. the value indicated on the FWD v Mag plot.

- 2) Distance H [Front], from the front of the lens to the first principle plane P. H[Front] will vary from lens to lens!
- 3) **modified FWD value to be used in the main form.** This is actually the true optical object distance, which is the full distance from the object to P. When used in the theoretical lens calculation, we get the same focal length as that of the selected lens - which helps put the selected at the top of the list. [\[sometimes that doesn't happen\]](#)

If checked, the "Keep mag in range" option will force the final displayed value to be within the design magnification values for the selected lens.



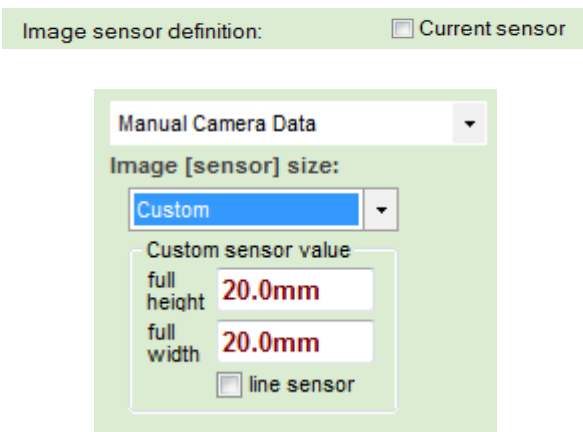
Finally, some lenses will work in the retro orientation. If the selected lens is one, then you can request the retro orientation by checking the 'Retro' checkbox.

The magnification limits are the inverse of those for the normal orientation.

The current mag value will also be inverted.

The curves for such lenses in the displayed lens list therefore lie in a different portion of the FWD v mag plot - upper left. If a displayed lens won't operate in the retro orientation than its 'normal curve' will be displayed.

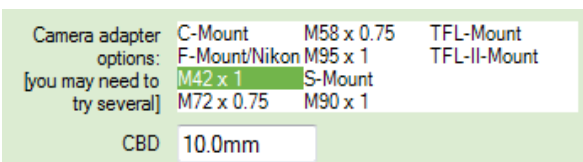
D: Sensor and camera adapter choices



Sensor choice: you can choose one of two options:

- 1) use the current sensor options from the main form [check 'current sensor' checkbox]
- 2) setup new sensor definitions which will be applied to the main form. [UNcheck 'current sensor' checkbox]

If you choose the latter, then the appropriate controls [shown here] will be enabled. Note that these are identical to those on the main form.



Camera Adapter: the camera adapter is a key choice. This list contains that that maybe suitable for the selected lens.

C & F mounts have a fixed Camera Body Depth [CBD] - you will need to supply a value for the others

E: On getting solutions - or not

Sometimes you will find that when you return to the main program, the desired lens may not be in the solutions set. There may be several reasons for this:

- 1) the sensor is vignetted - look at the FOV plot. If the dimension marker is red, or you can see red on the sensor rectangle, then there is vignetting.
- 2) your chosen camera adapter has no solution [maybe CBD is too large]. A good example would be trying to use an F-Mount adapter which has a fixed CBD of 46.5 mm. If you are trying to use one of the smaller efl lenses, e.g. a Rodagon 28, then there may not be physically room to fit in the camera and any other necessary accessories.
- 3) there may not be a focuser & spacer combination to cover the Flange Focal Distance for this lens. The FFD is the distance from the lens flange to the ideal image plane.

So check for vignetting, then if that's ok, maybe try a different camera adapter.

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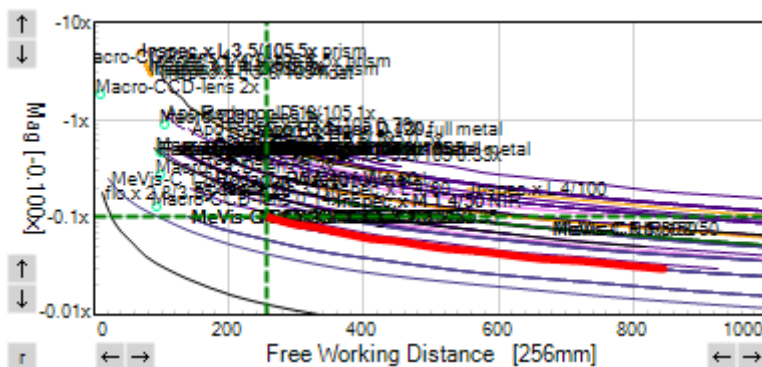
interactive plot: FWD v mag

Standard lenses » setup dialog for a specific lens »

Standard lens setup: Interactive FWD v mag plot

This plot forms part of the [setup dialog for a specific standard lens](#).

[Standard lenses](#) work over a range of magnifications. The Free Working Distance [FWD] is a function of the magnification - this can be represented by a monotonic curve, of limited extent, on a mag v FWD plot. Each lens will have its own curve.



By default, the plot shows curves for all the Excelitas standard lenses, but you can change this with the [lens selections dialog](#).

Change lenses...

For consistency with similar plots in MachVis [e.g. [Optem setup dialog](#)], the magnification is shown along the Y axis.

The curve for the selected lens is shown with a thick red curve.

The plot itself is interactive - in three ways

- 1) change scales by clicking the little arrow keys at either end of each axis. These will increment or decrement the upper or lower limits of the plot, so you can focus in on an area of interest.

The **r** button at bottom left of the plot will reset the scales to the default values.

- 2) single click on one of the lens curves, to.

- change the current lens to that for the curve you have clicked
- [maybe] change the magnification, **if outside the magnification range for that lens**, in which case it will go to the end of the range.

3) double click on one of the lens curves, to:

- change the current lens to that for the curve you have clicked
- change the magnification, to the point that you 'hit' on the curve.

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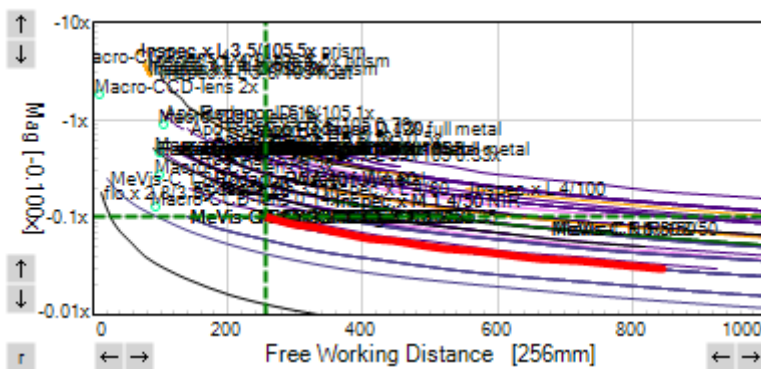
lens selections dialog

Standard lenses » setup dialog for a specific lens » interactive plot: FWD v mag »

Standard lens setup: lens selections dialog

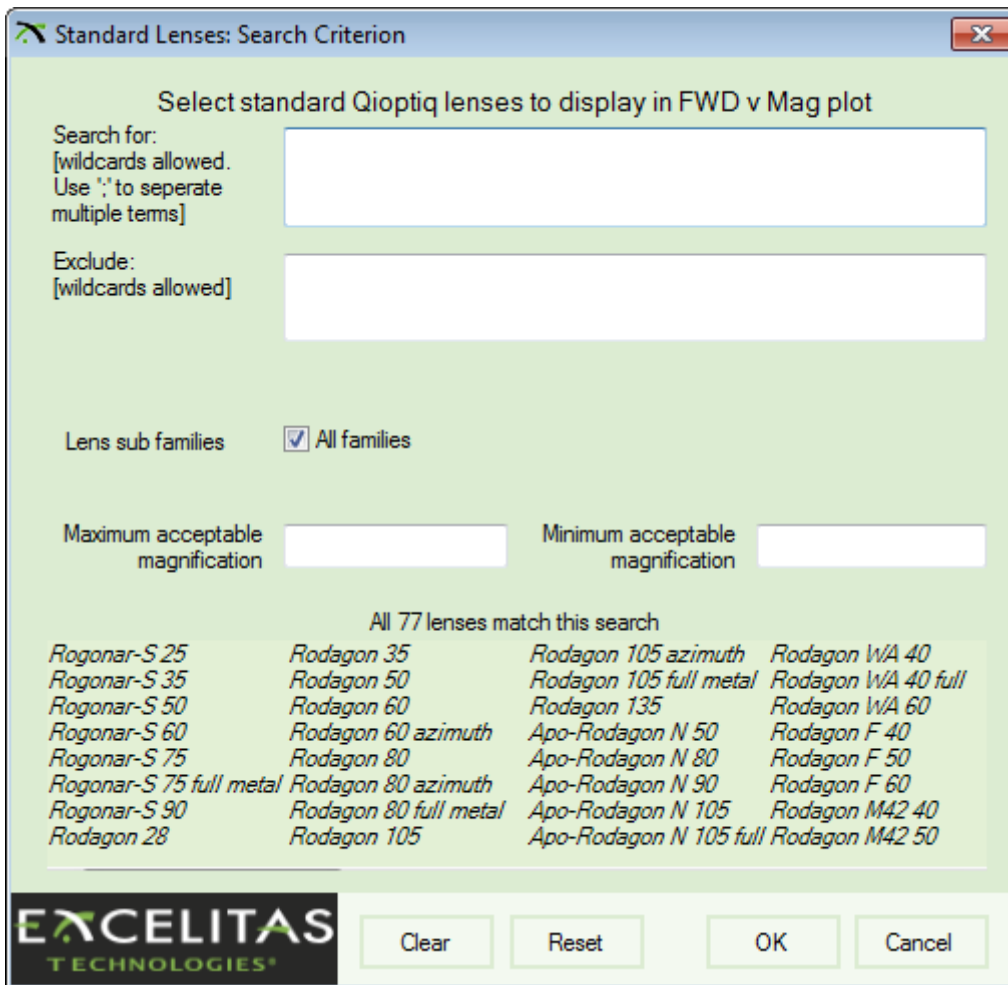
This is a popup dialog from the [standard lens setup form](#).

It enables you to select/limit the different standard lenses which are displayed in that setup form, in the Mag-FWD plot.



By default all standard lenses are displayed, but that maybe is confusing, so you can prune down the list of lenses that are displayed, for example to just showing Rodagons, or lenses with '50' in their title or...

The dialog is shown below, in its default state.



Working from top to bottom, there are four different ways to choose lenses to display

- 1) Search for lens titles containing particular strings. You may use the standard '*' and '?'. You can include several terms [OR] by using the semi colon ';' as a separator, e.g *Rod*; *50 - will give us lenses with Rod in the title and also lenses with 50.
- 2) Search for terms that do not contain the specified string.
- 3) Lens families. If 'All families' is unchecked, then a list of the different sub families will appear. You may choose one or more.



- 4) Magnification range - you may enter both maximum and minimum levels

mag.x & Optem
mag.x & Optem systems »

mag.x & Optem systems

[Mag.x](#) and [Optem](#) are afocal micro inspection systems composed of an lower [objective] lens and a camera tube [lens] plus other modules. These two lenses set the key optical properties...

Unlike most other Excelitas lenses, each individual Optem or mag.x operates at:

- a fixed free working distance [FWD] which is determined by the objective alone
- a fixed magnification which is the product of the magnifications of the objective and camera lens/tube

Each family is highly modular with a selection of interoperable objective and camera lenses with different powers. This is especially true for the Optem family for which there are over two hundred different combinations of objective and camera lens!

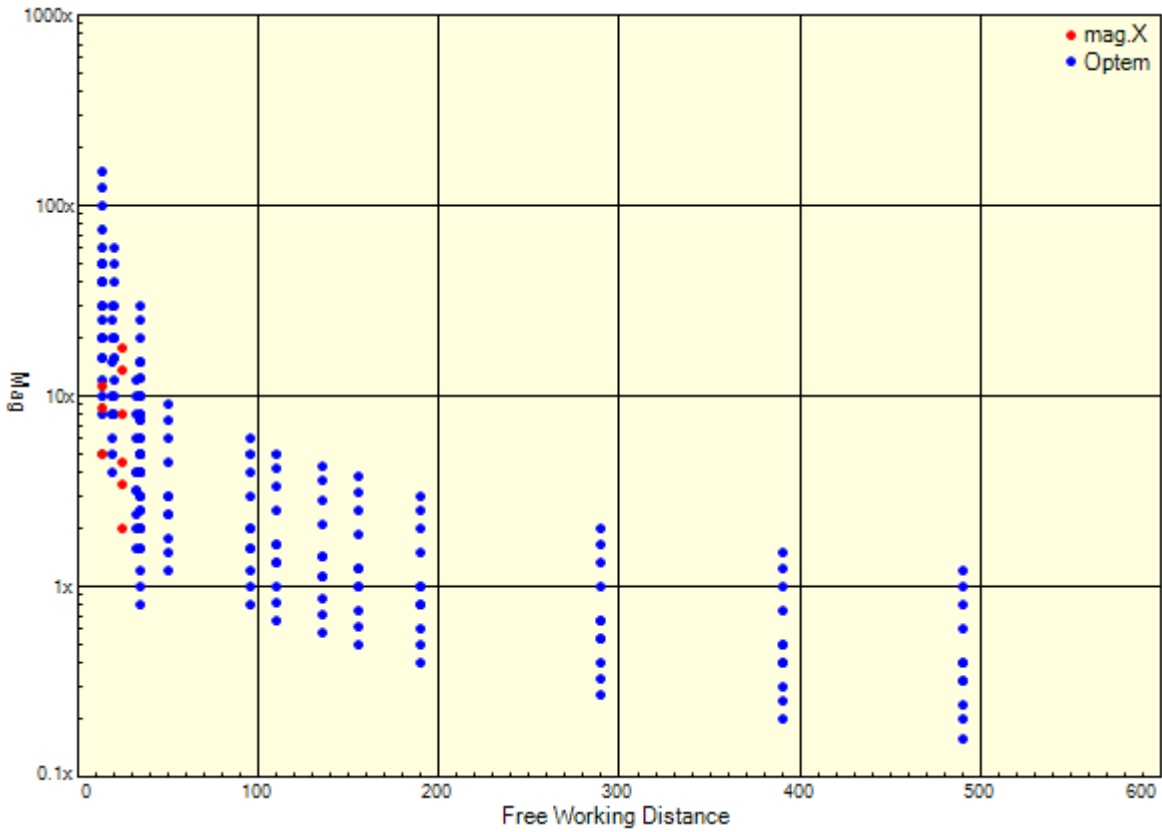


mag.x system



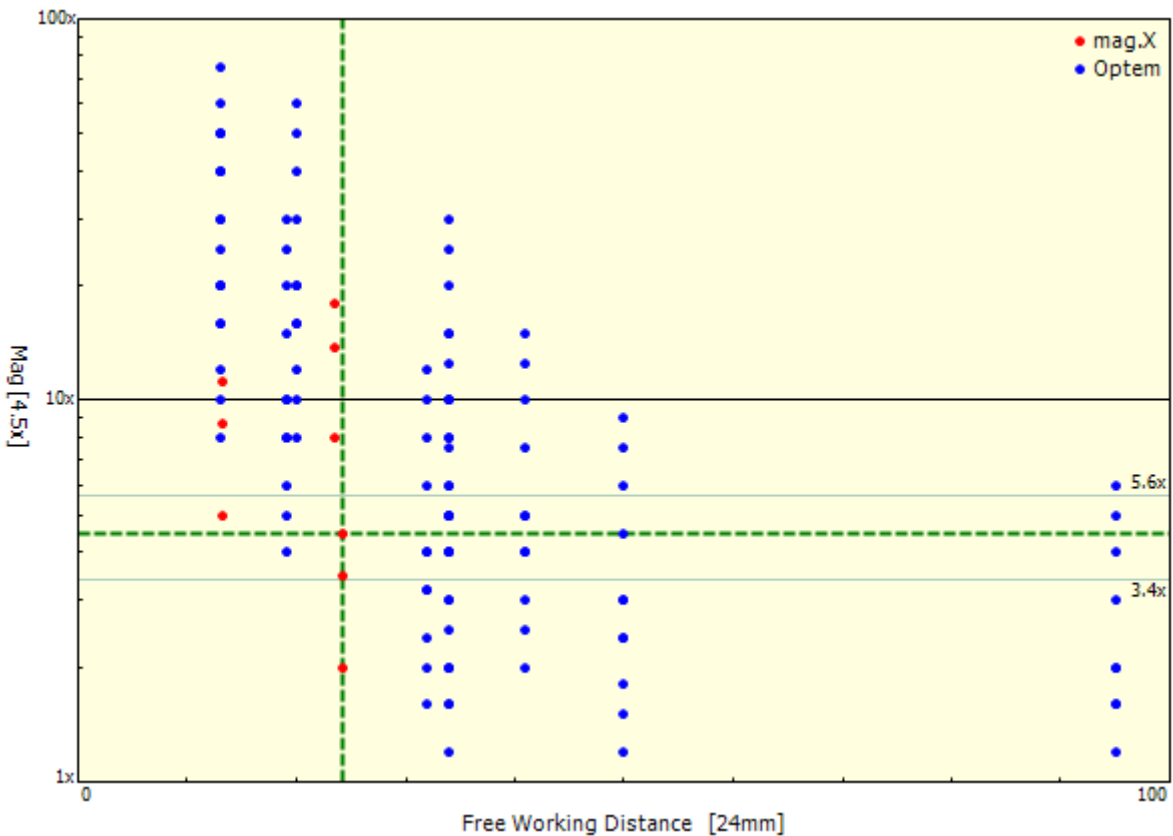
Optem system modules

Given these combinations there are therefore a considerable number of combinations of magnification and free working distance. These two optical properties alone may well determine what is suitable for your situation - so here we show the 'space' of the possible Optem and mag.x systems in a plot of FWD v Mag [this plot is actually generated by and used within MachVis as an interactive selection aid]



As mentioned, the objective alone determines the FWD; for the Optem we have objectives with thirteen different FWD values ranging from 13mm to 490mm. Hence the thirteen vertical 'blue bands' of Optems on the plot with the same FWD.

For the mag.x there are [currently] three different FWD's at 13, 24 and 25mm only, so three 'red bands' as shown in this zoomed in view:



Note - the addition of a zoom module to a specific Optem system [7:1 or 12.5:1] will allow the working magnification to 'float' around the nominal value without changing the FWD.

mag.x tools

[setup dialog](#)
[configurator](#)

Optem tools

[setup dialog](#)
[configurator](#)

Finally you can [limit the number](#) of mag.x/Optem solutions, since as you can imagine, for some FWD/Mag values, you will get a lot of other Optems in the 'near' vicinity.

Your choice may also be influenced by the following considerations:

mag.x: object side sub micron resolution over the FOV - handles a 57mm sensor. High end applications that need a large field of view

Optem: modular system - highly customisable, for low to medium end applications – more economical than the mag.x.

If in doubt [contact us](#) at Excelitas and we will be more than happy to advise you.

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mag.x introduction

mag.x & Optem systems » [mag.x micro inspection system](#) »

mag.x systems: introduction

The Excelitas mag.x system is an outstanding micro inspection system. It offers:

- High resolution with large field-of-view: 5mm object with resolution of <math><1\mu\text{m}</math>
- Only microscope style solution for sensors up to 56mm diameter
- Perfectly homogeneous illumination
- Achromatic correction: no refocusing with different wavelengths of illumination
- Near perfect telecentricity on object and image sides
- Integrated system with autofocus option
- Modular system that can be adapted to many applications [one of the many possible configurations is shown here]

[click here to see [Excelitas mag.x webpage](#) in your browser]

the mag.x brochure contains a more detailed description of the system.



[downloadable from the bottom of the webpage linked to above]

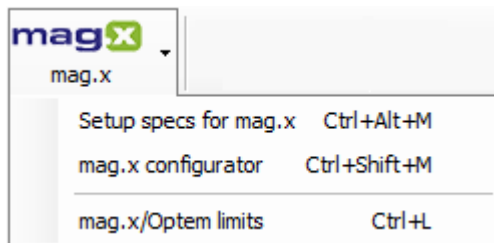
By choosing different objective [2x, 5x or 8x] and tube lenses [1x, 1.73x or 2.25x], the system offers magnifications of 2x, 3.46x, 4.5x, 5x, 8x, 8.65x, 11.25x, 13.84x & 18x. The objective alone determines the FWD which can be either 13, 24 or 25mm [5x, 8x & 2x respectively].

mag.x & MachVis - setup and configurator dialogs

Until v4.0, MachVis only modelled the standard Excelitas lenses with a finite focal length [typically 10 to 150mm]. The mag.x micro inspection system is a true afocal design with an infinite focal length, though obviously designed for and used at a close free working distance [FWD].

Each mag.x system [i.e. combo of objective and tube lens] has a specific magnification that is independent of the FWD. The object needs to be located fairly precisely at the design FWD!

mag.x systems are now modelled in MachVis. There are two special utilities to help [accessed via the mag.x drop down button in the toolbar]:



Setup specs for mag.x: mag.x systems can appear as solutions to a general task, but if you specifically want to use a mag.x, then it will help you to use the [mag.x setup](#) dialog.

You will make two simple choices and MachVis will setup the conditions that ensure that at least one mag.x solution will be visible.

mag.x configurator: mag.x systems have many accessories that may be of use for your specific task - illumination options, filters etc.

You can now see what is available and make your choices in the [mag.x configurator](#) dialog.

Multiple mag.x/Optem solutions. Along with a mag.x solution, you may find quite a few Optems appearing at once with similar magnifications and free working distances. You might find that somewhat annoying. If so, you can control and even limit the number of Optems/mag.x's appearing. Select the 'Afocal limits' option in the menu [or **press Ctrl + L**] and you will see the [mag.x/Optem limits dialog](#) where such details can be decided.

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mag.x key parameters [conditions] setup

mag.x & Optem systems » mag.x micro inspection system »

mag.x systems: setup conditions

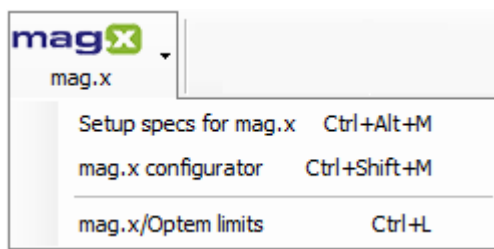
The mag.x setup dialog, when used, will indeed setup the key parameters or conditions that ensure that a mag.x system of your choice will be visible in the main form.

Your chosen system will specify:

- key optical components - objective lens [2x, 5x **or** 8x] and tube lens [1x, 1.73x **or** 2.25x]. The system magnification is the product of the objective and tube lens magnifications. The FWD is set by the choice of objective lens.
- camera adapter type - the available options are determined by the tube lens.

NB the sensor size information is taken from the current values in the main MachVis form.

Further configuration choices [base unit, filters, light source etc etc] can then be made in the [mag.x configurator](#).



How to load mag.x setup dialog:

Press key combination: *Ctrl+Alt+M*

or

Click first item in the mag.x drop down menu in the main toolbar [shown here]

Here is the mag.x setup dialog on first launch:



Initially you will see a list of all possible mag.x systems, grouped by objective.

The system magnifications, from low to high, are: 2x, 3.46x, 4.5x, 5x, 8x, 8.65x, 11.25x, 13.84x & 18x

The three different objectives have FWD values of 13, 24 & 25mm respectively.

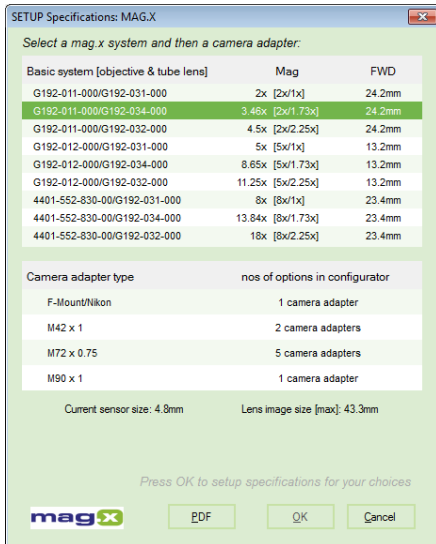
Click on the system with the magnification/FWD that you want.

NB there are 5 more combinations in MachVis 5.0 than MV 4.1, as a result of the new 8x objective and the 1.73x camera tube

MachVis will now show the camera adapters that are available for that mag.x system. These vary with the camera tube.

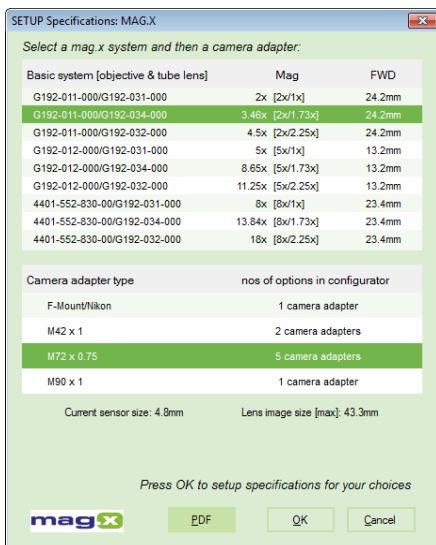
If you select another original mag.x system, then the adapter list is likely to change as the list depends on the tube lens.

NB if the mag.x maximum image size is less than the sensor size, then you will see a red warning note below the adapter list.



Click on the camera adapter that you want to use and press OK.

NB for some of the camera adapter types, there are more than one possible adapter. You can make your choice of the exact adapter in the [mag.x configurator](#), where you can select other key items that don't affect these optical parameters, but can be essential to your project.



The dialog will close and MachVis will apply your choices to the main form specifications. Provided that your sensor choice is not too large, you will see a mag.x solution in the spreadsheet - normally at the top of the list.

NB it is more than likely that you will see one or more Optem solutions at the same time!

NB if you want to see more details on the objective/tube lenses, then click on the PDF button at center bottom. This will load a single sheet pdf with a table of extra data:

mag.x system 125 optical configurations

Objective Plan Apochromat					Tube lens system											
					1x			1.73x				2.25x				
					f'tub = 250mm			f'tub = 432.5mm				f'tub = 563mm				
					2y' = 25mm			2y' = 43.3mm				2y' = 57mm				
Magn. / NA	WD	f'obj	δ	R0	M	2y	NA'	R'0	M	2y	NA'	R'0	M	2y	NA'	R'0
	mm	mm	μm	lp/mm		mm		lp/mm		mm		lp/mm		mm		lp/mm
2x / 0.08	24.8	125	± 42.7	293	2	12.5	0.04	147	3.5	12.5	0.023	85	4.5	12.5	0.018	65
5x / 0.2	13	50	± 6.8	733	5	5	0.04	147	8.7	5	0.023	85	11.25	5	0.018	65
8x / 0.32	23	31.3	± 2.7	1172	8	3.1	0.04	147	13.8	3.1	0.023	85	18	3.1	0.018	65

NA: Numerical aperture in the object space = $n \cdot \sin(\sigma)$
 WD: Working distance
 f'obj: Focal length of the objective
 f'tub: Focal length of the tube lens
 δobj: Depth of field at 546 nm $\delta_{obj} = \pm n \cdot \lambda / (2 \cdot NA^2)$
 R0, ima: Cut off frequency in image space at 546 nm
 R0, obj: Cut off frequency in object space at 546 nm $R_{cut, obj} = (2 \cdot NA) / \lambda$
 R0, ima: Cut off frequency in image space 546 nm
 2y': Image field size (maximum detector diagonal)
 2y: Object field size
 M: Magnification of the overall system $M = V_{obj} \cdot V_{tub}$

Order number	Description
G192-012-000	Objective lens LD-Plan Apo 5x/0.2
G192-011-000	Objective lens LD-Plan Apo 2x/0.08
4401-552-830-00	Objective lens LD-Plan Apo 8x/0.32
G192-031-000	Tube lens 1x
G192-034-000	Tube lens 1.73x
G192-032-000	Tube lens 2.25x

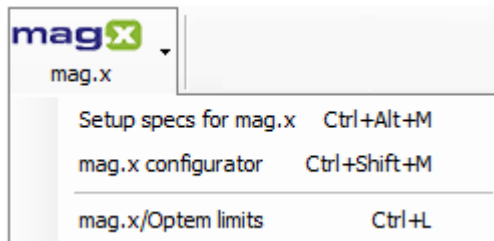
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mag.x configurator

mag.x & Optem systems » mag.x micro inspection system »

mag.x systems: configurator

This configurator allows a user to choose various **optional** accessories for a mag.x system, once a mag.x solution has been selected.



How to load mag.x configurator:

Press key combination: *Ctrl+Shift+M*

or

Click second item in the mag.x drop down menu in the main toolbar

or

Right click any mag.x solution in the results spreadsheet

This dialog is only available IF the current solution in the main form is a mag.x system!

Before version 4, MachVis had no configurator! For the conventional lenses [e.g. *Rogonar, Rodagon, Inspec, MeVis-C, Macro-CCD & flo.x*], MachVis chooses **all** accessories as part of the solution finding process - their mechanical 'lengths' being essential in locating the sensor relative to the lens. Therefore no configurator was needed, since there were no optional accessories up for choice!

However the micro inspection systems [mag.x and Optem] support a wide range of extras and options which do not effect the sensor location. These therefore require configurators to allow you to make those choices.

The [mag.x systems](#) have their own configurator - added when mag.x's were included in version 4.0 of MachVis. [Optem systems](#) also have a [dedicated configurator](#) which was added in version 5.0.

Background

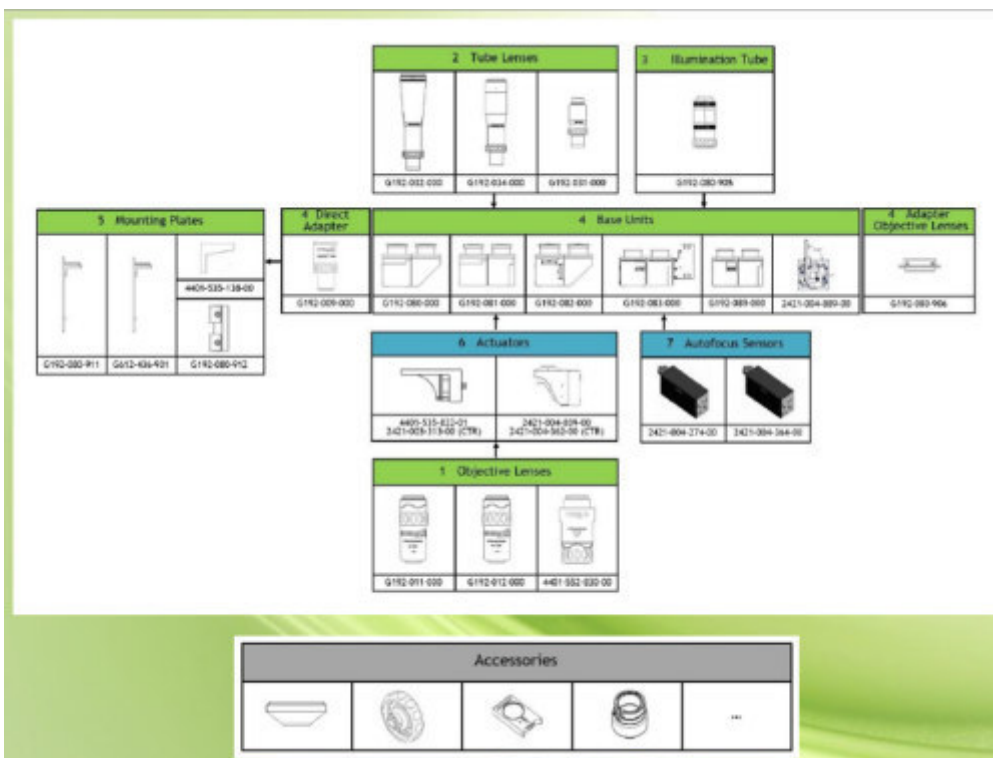
The four key mag.x elements, defining the optical path from object to camera sensor, are as follows:

- objective lens [fixed by MachVis]
- base unit [USER SELECTED from six options in the configurator]
- tube lens [fixed by MachVis]
- camera adapter [fixed by MachVis - in most cases!]

So first, of all, the user must select the base unit.

Moreover the mag.x range is highly modular and has a whole set of options available to support different analysis tools & behaviours.

Schematic overview of mag.x accessories as shown in the mag.x system 125 pdf.



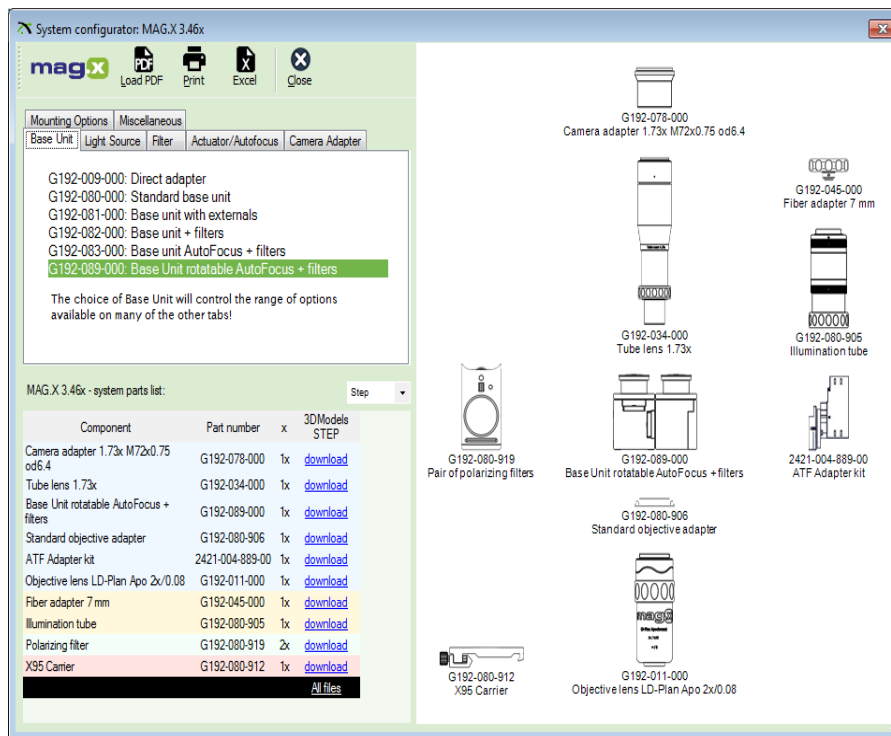
For the mag.x system, the user selectable components may be separated into seven groups:

1. Base units [this key choice will determine the 'availability' of the other items]
2. Light source/adapters for illumination
3. Polarization filter options
4. Actuator/autofocus options
5. Camera Adapter options - often, but not always, only one.
6. Mount items - X95 and/or mounting plates
7. Miscellaneous items - currently darkfield adapter

The mag.x configurator, a popup form, allows you to specify allowable items from these groupings. The configurator will change its 'offerings' when the base unit is changed, thus preventing illegitimate choices.

mag.x configurator form

To load the configurator, simply click on the **mag.x** drop down button in the toolbar, selecting the '*mag.x configurator*' option.



The form is composed of three main areas:

1. [toolbar](#) at very top - offering some useful but not crucial functions
2. [tabbed setup](#) region at top left - where your selections from the seven groups are made
3. [spreadsheet](#) at lower left - listing all the currently selected items. Note the use of colour to separate out items from different groups.
4. [schematic diagram](#) of current configuration at right.

The last two are display only, so need no further explanation, except to note that they update immediately to reflect your current choices.

1: Toolbar

This currently offers the following functions:

- Load the Excelitas PDF that overviews the mag.x systems
- Print out your current configuration - for mag.x systems this is a two page item.
- Export the parts list to Excel [the resultant small spreadsheet has some simple formatting]

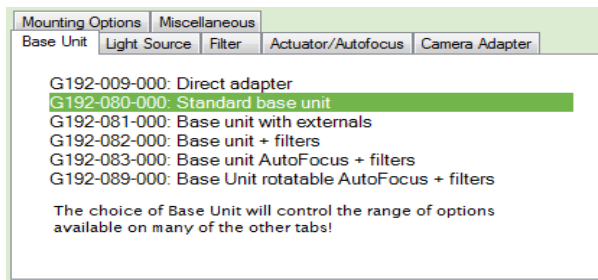
2: Tabbed setup region

Here you make your configuration choices using simple lists and checkboxes. This region has five tabs:

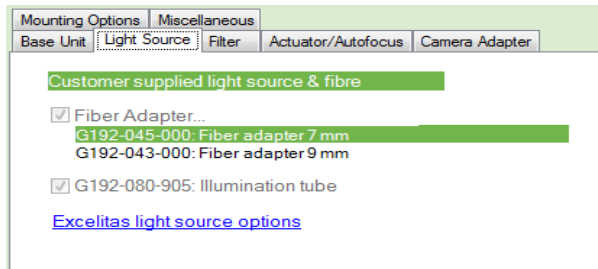
2.1: Base Units

There are six base units, appropriate for a wide number of needs.

Your choice here will determine what other accessories are offered. For example the Direct



Adapter does not support light source items, filters or most of the miscellaneous items, while all the Compact Units support illumination systems and some support filters and/or autofocus.

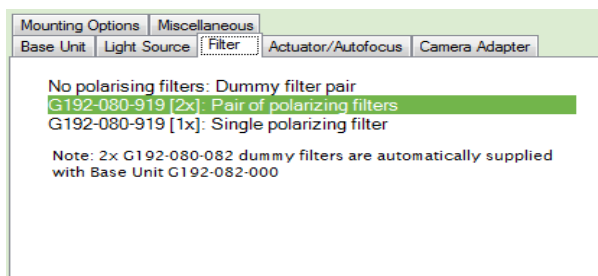


2.2: Light source subsystem

All base units, apart from the direct adapter, support a light source. For such, the illumination tube adapter is automatically included. You also have a choice between a 7mm & 9mm fibre adapter.

In the past, the Machine Vision group directly offered a range of light sources or 'Customer supplied' as alternatives. Now these can be obtained from our parent company Excelitas - which offers an outstanding range of [light sources](#).

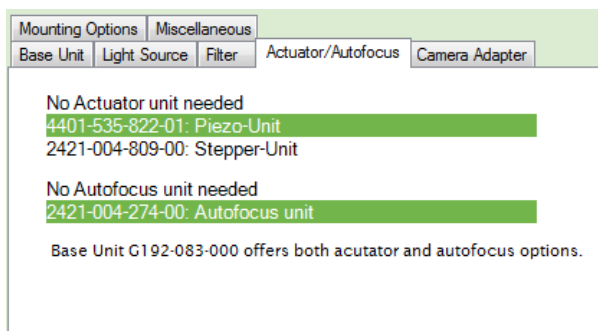
illumination & light source selection is a very significant choice, so please discuss this with us.



2.3: Filters

If you use the appropriate compact base units [those named '+ filters'], then you can have two polarising filters holders.

Alternatively you can use one or two 'dummy' filters to hold bandpass filters or indeed any filter that you wish to use - these will be of your own supply.

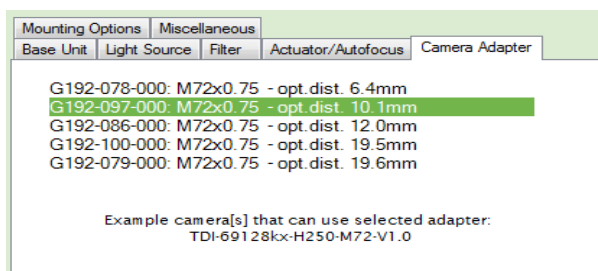


2.4: Actuators and Autofocus

All base units, apart from the direct adapter, can support an actuator [piezo or stepper].

Two base units [083 & 089] can also support autofocus [provided an actuator is chosen first].

MV will display the appropriate options and will also automatically include the necessary controller unit



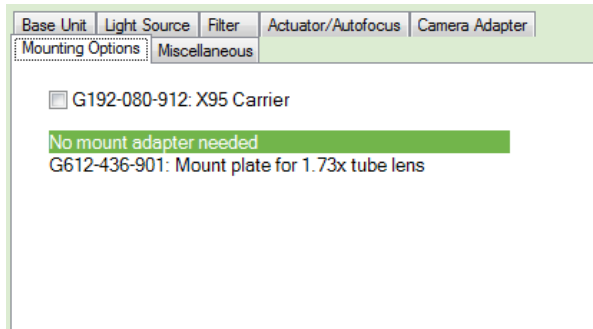
2.5: Camera adapter options

Each of the three mag.x camera tubes will support a set of **different** camera adapter types:

- 1x [G192-031-000] - CMount, M42, M58 & M90
- 1.73x [G192-034-000] - FMount, M42, M72 & M90
- 2.25x [G192-032-000] - FMount, M42, M58, M72, M90 & M95

one type will be chosen in the main program

However there may be several alternative mounts in each type in the set for different cameras. These will be listed here for you to make your own choice [here for the M72]. When selected, MV will also display below examples of the names of camera[s] for which specific adapter is suitable.

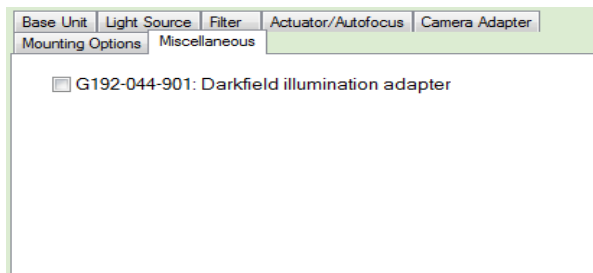


2.6: Mounting options

- X95 carrier enables the mag.x system to be mated with the high quality Excelitas [x95 mounting system](#)

There are also some extra mount adapters for

- Direct adapter base unit [G192-009]
- other base units when using the 1.73x or 2.25x tube lens



2.7: Miscellaneous

At present there is only one item grouped under miscellaneous - choices of base unit etc may determine availability in this tab.

- darkfield illumination is available with all base units

3: Component spreadsheet

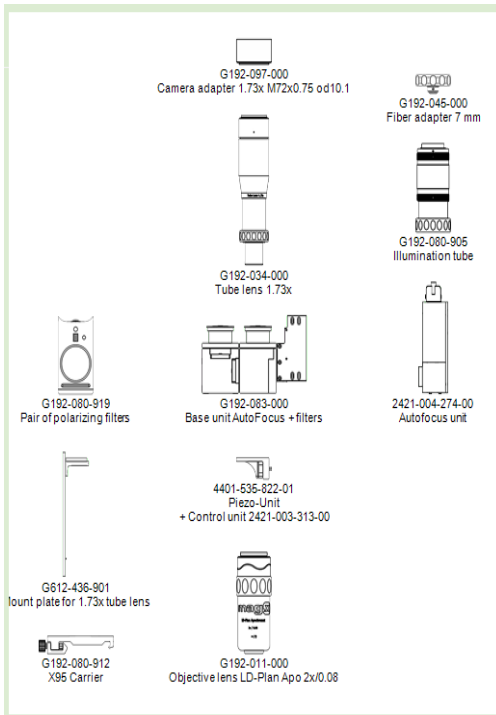
This is a simple list of all components in the current configuration. The main optical elements, including optional DIC module and camera adapter, are listed first, then items from lighting, filters and finally any miscellaneous items. Note the use of background colours to differentiate.

Component	Part number	x	3DModels STEP
Camera adapter 1.73x M72x0.75 od10.1	G192-097-000	1x	download
Tube lens 1.73x	G192-034-000	1x	download
Base unit AutoFocus + filters	G192-083-000	1x	download
Piezo-Unit	4401-535-822-01	1x	download
Control unit	2421-003-313-00	1x	download
Autofocus unit	2421-004-274-00	1x	download
Objective lens LD-Plan Apo 2x/0.08	G192-011-000	1x	download
Fiber adapter 7 mm	G192-045-000	1x	download
Illumination tube	G192-080-905	1x	download
Polarizing filter	G192-080-919	2x	download
All files			

The rightmost column contains links to enable you to download a zipped STEP or Parasolid [3DModel] of the part to the ..\3DModels folder - if available! The '**All Files**' link at the column bottom will allow you to download all these files at once. The file type is set by the simple drop-down list above the spreadsheet.

4: System schematic

This is a 'read only' schematic of the items that you have selected, in generally the correct spatial locations. For clarity any filters are shown to one side, rather than inside the appropriate base units.



Final Notes

Your mag.x configuration selections will be:

- saved to disk on program close
- saved with your specifications file
- included in the printout [as an extra page]
- included in the email RFQ.

When satisfied, click the OK button and you will return to the main form.

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Optem introduction

mag.x & Optem systems » Optem micro inspection system »

Optem systems: introduction

The Excelitas Optem Fusion range is an outstanding modular lens system, specifically designed for OEMs wishing to integrate high quality imaging into their machine vision systems. Depending upon choices made, the final system can have:

- fixed magnification and/or zoom [7:1 or 12.5:1]
- single or dual channel, e.g. two different fixed magnifications branches or one zoom/one fixed or...
- magnifications from 0.16x to 325x
- FOV from 4.5 to 100mm
- resolution from 16 to 1800 lp/mm
- working distance from 13 to 490mm
- covers Visible & [NIR/SWIR](#) wavebands

NB some of these limiting performance values will be obtained at the expense of others. Sadly you can't always have everything at once!



[example of a **simple** single channel Optem system]

Optem Fusion also offers:

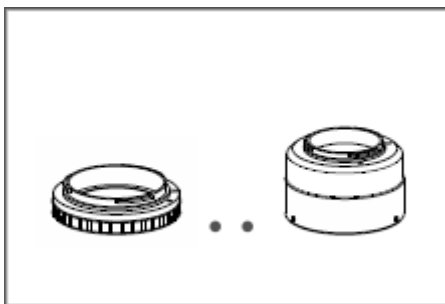
- Choice of camera mount - C, CS, F, EOS, 4/3 camera mount and most any format
- Optional Integrated LED or Halogen illumination [coaxial or ring-light]
- Optional Stepper motorized zoom and focus
- Optional integrated 90° Mirror Cubes and 50/50 Cubes to modify optical path to alter shape and fit

Optem Fusion system layout.

This high degree of flexibility is achieved by using a wide range of carefully optimised and interchangeable modules.



In more detail - an Optem system **always** contains one of each of the following five key modules. These are always arranged in the order shown in the table below, working from the camera down. Accessories can also be fitted between some of these modules.



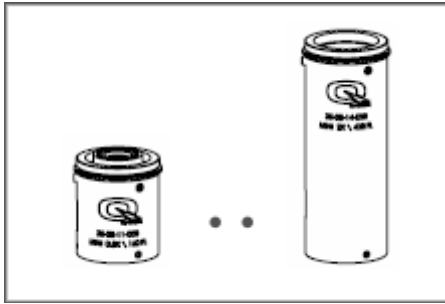
Camera Mounts

Optem provides a whole range of mounts e.g. C, CS, F, EOS, 4/3, Sony Alpha & Pentax K

Obviously, your camera will attach to this.

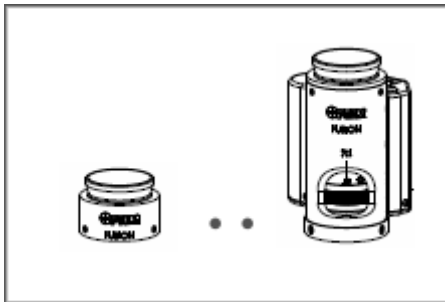
Camera tubes

Similar to the eyepiece in a conventional microscope - it is a key component determining optical performance [along with the lower lens].



Optem provides standard size units with magnification from 0.4x to 1x. Also a mini camera tube range with magnifications from 0.8x to 3x

optional accessories*

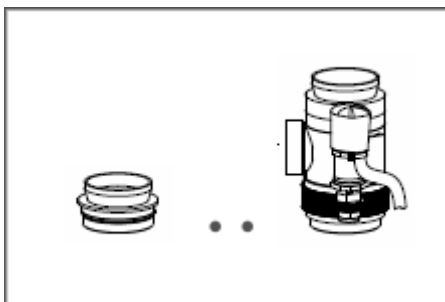


Zoom modules

This generic term includes an economical fixed magnification option. If versatility is required, there are 7:1 or 12.5:1 zoom units with optional manual detent or stepper drive adjustment.

Zooms adjust the system magnification equally above and below the nominal value [set by the lower lens and camera tube]

optional accessories*

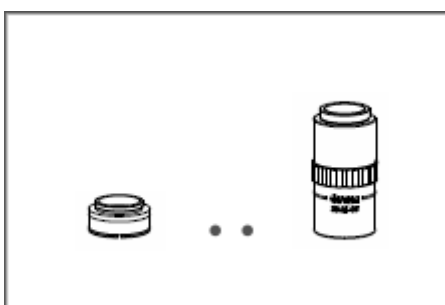


Lower function modules

Various interesting functions:

- basic - optional fluorescent holder
- 15mm focus unit - optional stepper drive
- coax illumination unit with optional 5mm focus unit - optional stepper drive

optional accessories*



Lower lens

Similar to the objective in a conventional microscope - it determines the working distance and sets the max FOV.

Standard lower lenses have magnifications between 0.4 and 4x.

Long working distance objectives offer magnifications from 2x to 50x

The **optional accessories*** provide even more flexibility. They range from simple inline clamps for mounting, filter holders and aperture sets to 45 degree mirror cubes - if it required to 'bend' the system.

Beam splitter - dual branch system. There is also a 50/50 beam splitter cube which will convert the system from a single channel to a dual channel if two different magnifications are required - one for initial location and the other for detailed inspection. NB in the dual channel case, both branches can be fixed mag or with a zoom, tho it is unusual to have zooms in both. The choice is yours. Indeed it has been known for the second branch to be fitted with an eyepiece for direct visual inspection!

Some accessories cannot be used in all locations, and others have preferred positions. The configurator contains the necessary information and will only offer you allowable options.

Illumination options

This system will work perfectly well in natural light, but there are lighting options available:

- Ring lights - halogen or LED
- Coaxial Illumination - halogen or LED

Halogen based system employ a fibre optic delivery system

Coaxial illumination will limit the maximum field of view quite considerably in some cases. Information on this can be shown in the [Optem setup dialog](#). Coaxial lighting will also limit the possible lower functions modules to one of three which have the necessary port.

Ringlights are normally fitted between the lower function module and the lower lens. However, if using the long working distance objective a fibre optic ringlight can be placed around the objective.

You can use both ring light and coaxial illumination if so desired.

Stepper control options

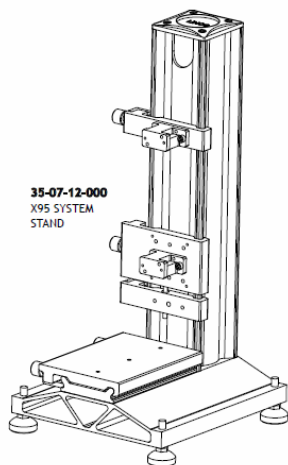
Stepper motors and their control systems are available for

- Zoom adjustment
- Focus adjustment

These require specific zoom and lower function modules. If you choose those specific parts then you must use a stepper system to control them - manual adjustment can damage the motors!

NB each stepper controller can control 1 or 2 stepper units. The program will offer the minimum number of control units necessary to minimise cost.

Mounting options

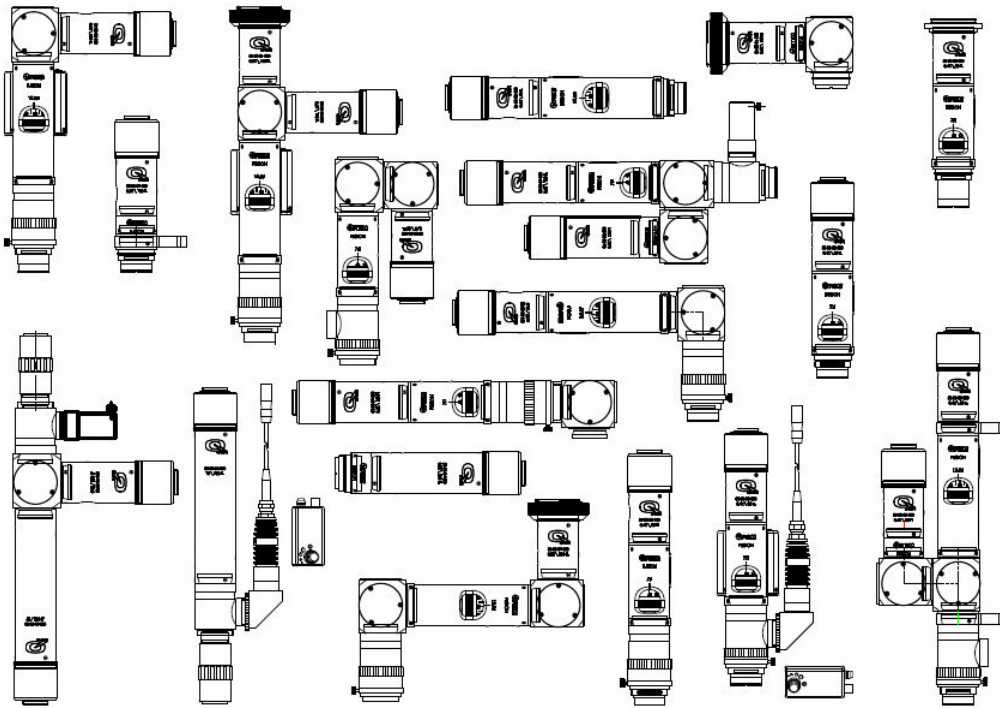


X95 stand

The complete Optem device can easily be mounted on your existing system or we can supply an appropriate stand using our [robust X95 rail system](#).

The X95 is designed especially for three-dimensional structures.

It has slotted holes for fastening to optical tables with M6 or 1/4" bore hole patterns. The sophisticated design, consisting of a precise rail and compatible carriers with spring-loaded clamping, ensures an extremely precise positioning of components in the structure.



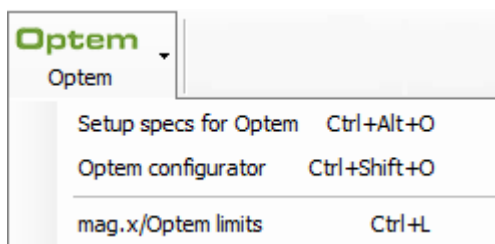
[some of many possible Optem Fusion configurations]

Optem & MachVis - setup and configurator dialogs

In v4.0, MachVis first included the [mag.x micro inspection system](#). Since the Optem Fusion [v5.0] is also a micro inspection system, we have followed a similar approach. An Optem system has a specific magnification that is independent of the FWD, but needs the object to be located fairly precisely at the design FWD.

We consider each combination of lower lens and camera tube to define one system, similar to the nine mag.x systems, since they have different optical properties. This does mean that there are a LOT of Optem systems [over two hundred at present]. However these will never all appear as solutions in the main MachVis spreadsheet.

Even so, there are two special utilities to help get the Optem you need. These tools are accessed via the dropdown 'Optem' button in the toolbar:



Setup specs for Optem: Optem systems can appear as solutions to a general task, but if you specifically want to use an Optem, then it will help you to use the [Optem setup](#) dialog.

You only need make a few simple choices and MachVis will setup the conditions that ensure that at least your chosen Optem solution will be visible as a solution.

Optem configurator: For a given MachVis solution the lower lens and camera adapter are fixed. However there is still a large number of options and accessories to be selected, camera mount, zoom modules, illumination & control, bends, single or dual channel systems and much more.

You can see what is available and make your choices in the [Optem configurator](#) dialog.

Multiple mag.x/Optem solutions. Although you will never see ALL the different Optem systems appearing as solutions in the main spreadsheet, you may find quite a few appearing at once with similar magnifications and free working distances. You might find that somewhat annoying. If so, you can control

and even limit the number of Optems/mag.x's appearing. Select the final option [or press Ctrl + L] and you will see the [mag.x/Optem limits dialog](#).

[click here to see [Excelitas Optem Fusion webpage](#) in your browser]

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Optem SWIR mode

mag.x & Optem systems » Optem micro inspection system »

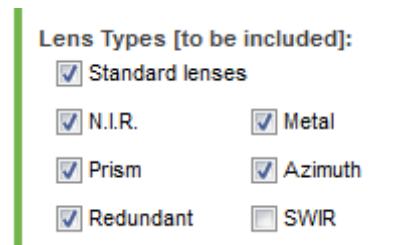
Optem systems: SWIR mode

The original Optem Fusion system was purely for the visible waveband. Now Optem Fusion [MV5.2] can also image in the **NIR/SWIR**.

A **subset** of the standard optical components [e.g. lower lenses, zoom modules & camera tubes] are available, as alternatives, designed specifically for the NIR/SWIR bands [700 to 1700nm with primary wavelength at 1177nm]

Non optical components such as adapters and some modules are, of course, completely cross compatible!

This capability is modelled in MachVis using the SWIR mode.



To enable the SWIR mode simply check the SWIR checkbox in the 'Lens Types' group in the results tab.

MachVis will now only display Optem systems that can be composed of SWIR optical modules.

This subset will be offered in the setup module and in the configurator, so you won't be able to choose items that are NOT suitable for the SWIR!

Note that only the fixed and the 7:1 modules are offered as SWIR. At present the 12.5:1 zoom is for the visible only.

To distinguish between visible and SWIR optical components - the visible elements have part numbers of the format 35-YY-YY-YYY. The SWIR equivalents have part code format 45-YY-YY-YYY. Non optical components retain their existing 35 specifier. MachVis will automatically display the appropriate part codes.

NB - the NIR checkbox above purely refers to one or two of the convention lenses which were designed for the 700-1100nm waveband. This has nothing to do with the Optem SWIR option!

waveband definitions:

for machine vision, the waveband names were historically based around detector technology:

VIS	Visible	400-700nm	Silicon with IR cut filter
NIR	Near Infra Red	700-1100nm	Silicon
SWIR	Short Wave Infra Red		InGaAs

These are still used. Clearly there is some overlap in the definitions!

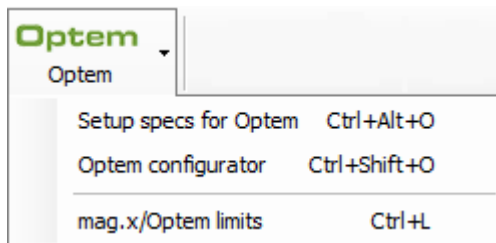
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setup - simple UI

mag.x & Optem systems » Optem micro inspection system » Optem key parameters [conditions] setup »

Optem setup conditions: simple UI

This dialog will setup the conditions that ensure that a chosen Optem Fusion solution will be visible in the main form [you may well see others too].



How to load Optem setup dialog:

Press key combination: *Ctrl+Alt+O*

or

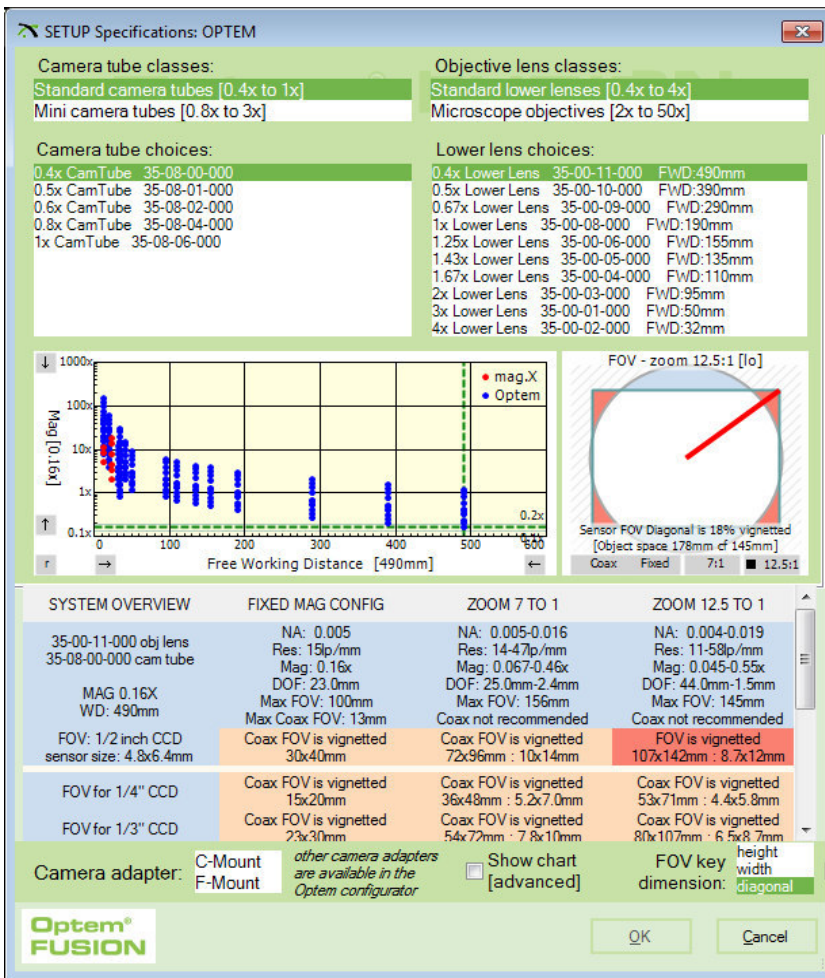
Click first item in the Optem drop down menu in the main toolbar

In the dialog you will need to three two essentials [[two key optical components](#) and an adapter]:

- camera tube [essentially an eyepiece]
- lower lens [objective]
- camera adapter type - F-mount or C-mount [other adapters can be selected in the [Optem configurator](#)]

[feedback will be provide to help you see the implications of your choice]

To load the setup dialog, simply click on the **Optem drop down button** in the toolbar, selecting the '*Setup specs for Optem*' option or press the CTRL+ ALT + O key combination.

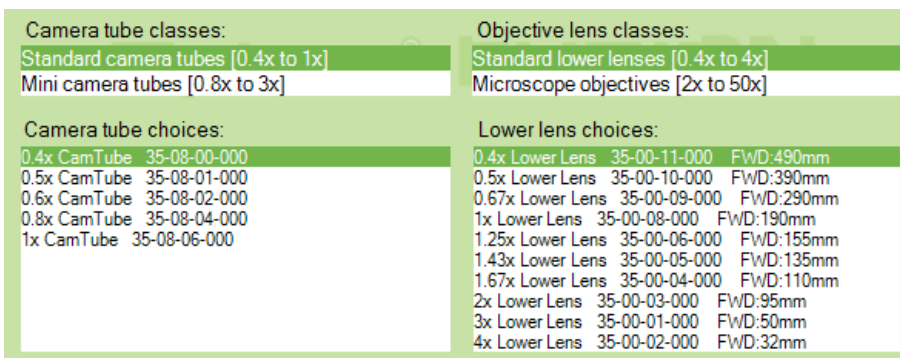


Initially you will see the simple version of the dialog UI. Besides making the choices, you will get feedback on your choice. To that end the simple UI has five key areas; from top to bottom:

- A: **List area** to select one combination of objective and camera tube
- B: Interactive **plot of Mag v FWD**
- C: **plot of Field of View [FOV]**
- D: Spreadsheet showing **performance of current selection**
- E: **Mount choice**, chart UI and key sensor dimension

A: List Area

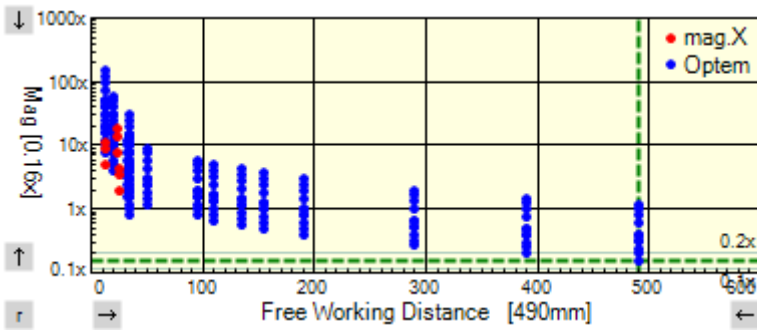
You can see/choose a specific combination of objective and camera tube:



- 1) Top two lists to select the general class of camera tube and objective that you want.
- 2) Bottom two lists of the camera tubes and objectives in those classes [these will be updated as you change your class selections above]

B: Interactive Plot of Mag v FWD

This plot shows the 'location' of all Optem [blue]/mag.x [red] systems in this key optical space:

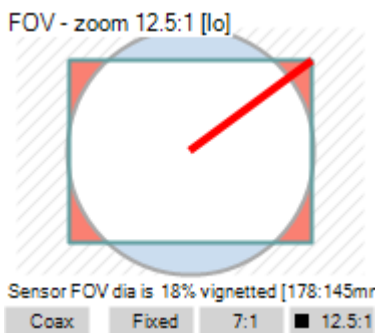


The current system is shown by the heavy dotted green cursor... in this case the system has a magnification of 0.16x and an FWD of 490mm.

If you click on another system in the plot, then that will become the current system whose data is displayed below. If that point represents two or more systems you will see a popup list from which you can make your selection. The selected items in the lists at top will also update to keep in step.

C: Field of View Plot

This diagram shows the maximum *field of view* [circular] allowed by this Optem v the field of view of the current sensor [rectangular]. Unilluminated areas are shown in red, indicating this is may be a problem. No light means no information; so the whole machine vision system may be blind in those outer regions!



sample two columns table 600pixels wide

The buttons along the bottom allow you to see
 - effect of using coaxial illumination module [smaller max FOV]
 - fixed or zoom modules [at lo end of the zoom mag range]

[detailed discussion of FOV/vignetting plot](#)

D: Current system spreadsheet

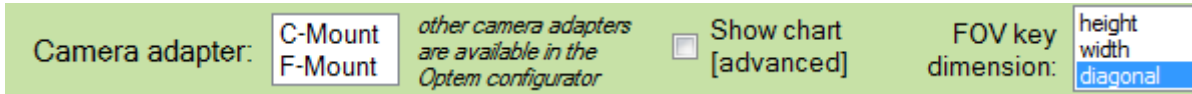
Beneath the plot is a four column spreadsheet. In it, you will see [optical performance data for the selected system.](#)

SYSTEM OVERVIEW	FIXED MAG CONFIG	ZOOM 7 TO 1	ZOOM 12.5 TO 1
35-00-11-000 obj lens 35-08-00-000 cam tube	NA: 0.005 Res: 15lp/mm Mag: 0.16x DOF: 23.0mm Max FOV: 100mm Max Coax FOV: 13mm	NA: 0.005-0.016 Res: 14-47lp/mm Mag: 0.067-0.46x DOF: 25.0mm-2.4mm Max FOV: 156mm Coax not recommended	NA: 0.004-0.019 Res: 11-58lp/mm Mag: 0.045-0.55x DOF: 44.0mm-1.5mm Max FOV: 145mm Coax not recommended
MAG 0.16X WD: 490mm	Coax FOV is vignetted 30x40mm	Coax FOV is vignetted 72x96mm : 10x14mm	FOV is vignetted 107x142mm : 8.7x12mm
FOV: 1/2 inch CCD sensor size: 4.8x6.4mm			

The data includes field of view information and is designed to help you make an informed system choice. The spreadsheet is updated when you change a selection in the lists.

E: Mount Choice, alternative UI option & sensor dimension

Almost at the bottom of the screen is a bar with controls offering three choices. Underneath the bar are the OK or Cancel buttons to close the form.



1) Camera adapter choice

Beneath the technical info spreadsheet, is a two element list where you may choose either C or F mount camera adapters. NB dont worry if you dont want to use either of these, in the [configurator](#) there is a much wider selection!

2) Advanced chart display

If you check the '*Show grid [advanced]*' box at lower right, then the [UI will change to the advanced version](#): that provides much more technical information to help make your choice.

3) Sensor dimension

Here you can choose which is the [key dimension](#). This will impact the FOV plot above, and will be applied to the main system specifications. It may also change the vignetting colouring in the spreadsheet above!

When you are happy with your choices, press the OK button, the dialog will close and MachVis will apply your choices to the main form specifications.

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setup - advanced UI

mag.x & Optem systems » Optem micro inspection system » Optem key parameters [conditions] setup »

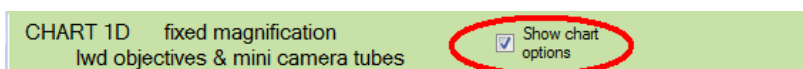
Optem setup conditions: advanced UI

[notes: [simple version of dialog](#), [FOV plot](#)]

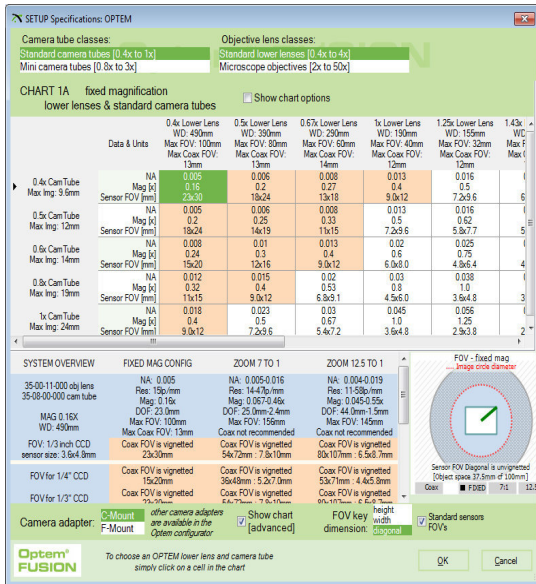
As discussed in the [Optem introduction](#), there are over 200 combinations of lower lens and camera tube, yielding different magnifications, working distances etc. These values were originally given in the Optem specifications pdf, in 12 main charts - for different sub groups of the lenses, camera tubes and zoom options.

This chart format has been replicated in the Optem Setup dialog - advanced version, and you can very easily switch charts to find the inspect the system type that the you want.

So to activate the advanced UI, simply check the 'Show chart [advanced]'' box at lower right.



Once activated, to select one specific combination, all you have to do is click on its cell in the chart!



Screen capture of the advanced version of the setup dialog UI.

The key change is the central area where the two lists of camera tubes & lower lenses have been replaced by a spreadsheet with camera tubes down the side and lower lenses as the horizontal items.

The spreadsheet shows optical data for each camera tube/lower lens combination to help you make an informed choice.

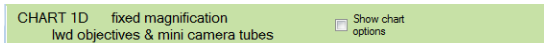
You can select what is shown in the row/column headers and in the spreadsheet cells - to concentrate on what is important to your project.

NB since the dialog is resizable so you can make it wider to display the whole chart, if you so wish.

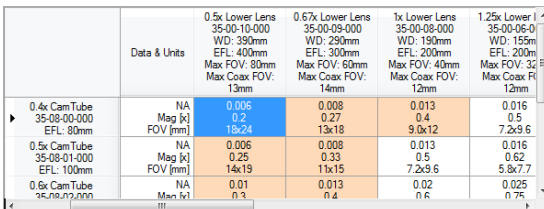
Working from top to bottom, there are five obvious subdivisions to the advanced UI:



1) Same lists as in simple UI to select the big classes for the camera tubes and the lower lens. Changing these will also change the displayed chart.



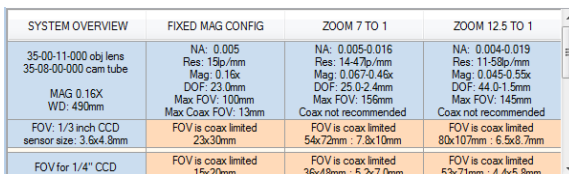
2) Chart title and one check box to show chart options [selecting zoom type, grid header info & grid cell info - see below]



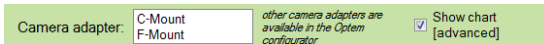
3) The chart showing data for different combinations of lower lens and camera tube.

Both headers and cells can be set to show the specific data that you want to see.

Colour coding and other options for data display



4) Spreadsheet with [opto-mechanical information on your current selection](#) - including data for fixed magnification and both zoom types. In particular it contains FOV data.



5) Camera adapter options. Only the C & F mounts are shown here for consistency with the rest of MachVis. However, in the [Optem configurator](#), you can choose other camera mounts!

Check box: display chart options



Check here to display grid options [choosing head and cell contents]



- list to choose from fixed mag, 7:1 zoom, 12.5:1 zoom. This will also change the chart
- row 1 of checkboxes to set chart header text
- row 2 of checkboxes to set chart cell info

	Data & Units	2x M Plan Apo 28-21-02-000 WD: 34mm EFL: 100mm	5x M Plan Apo 28-21-05-000 WD: 34mm EFL: 40mm	10x M Plan Apo 28-21-10-000 WD: 34mm EFL: 20mm	20x M 28-21- WD: 34mm EFL: 10mm
0.8x MiniCT 35-08-11-000 EFL: 160mm	NA Res [p/mm] Mag [x] DOF [mm]	0.018 : 0.057 54 : 170 0.22 : 2.8 1.8 : 0.18	0.045 : 0.14 135 : 420 0.56 : 6.9 0.28 : 0.029	0.09 : 0.3 270 : 900 1.1 : 14.0 0.07 : 0.006	0.18 540 2.2 0.018
1x MiniCT 35-08-12-000 EFL: 200mm	NA Res [p/mm] Mag [x] DOF [mm]	0.018 : 0.057 54 : 170 0.28 : 3.5 1.8 : 0.18	0.045 : 0.14 135 : 420 0.7 : 8.6 0.28 : 0.029	0.09 : 0.3 270 : 900 1.4 : 17.0 0.07 : 0.006	0.18 540 2.8 0.018
1.5x MiniCT 35-08-13-000 EFL: 300mm	NA Res [p/mm] Mag [x] DOF [mm]	0.018 : 0.057 54 : 170 0.84 : 10.0 1.8 : 0.18	0.045 : 0.14 135 : 420 2.1 : 26.0 0.28 : 0.029	0.09 : 0.3 270 : 900 4.2 : 52.0 0.07 : 0.006	0.18 540 8.4 0.018
2x MiniCT 35-08-14-000 EFL: 400mm	NA Res [p/mm] Mag [x] DOF [mm]	0.018 : 0.057 54 : 170 1.1 : 14.0 1.8 : 0.178	0.045 : 0.14 135 : 420 2.8 : 35.0 0.28 : 0.029	0.09 : 0.3 270 : 900 5.5 : 69.0 0.07 : 0.006	0.18 540 11.0 0.018

Here is the chart after some changes to the options.

In particular, a zoom has been chosen and each cell will now contain data for both ends of the zoom range.

The grid is not colour coded as sensor FOV is not chosen.

more consequences of various options:

- **Checked 'Max FOV' box:** Column header will show FOV allowed by Lower Lens [LL] data. Row header will show max image size allowed by Camera Tube [CT] data.
- **Checked 'Sensor FOV' box:** each grid cell will show rectangular FOV of the current sensor. Cells colour coded as below

Colour coding [when 'Sensor FOV' is checked]:

- blue - no vignetting of current sensor
- orange - vignetting IF coax illumination used
- red - chosen sensor will be vignettted [clipped] either by the Lower Lens

When you are happy with your choices, press the OK button, the dialog will close and MachVis will apply your choices to the main form specifications.

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selected system data

mag.x & Optem systems » Optem micro inspection system » Optem key parameters [conditions] setup »

Optem setup conditions: data for selected system

[notes: [simple version of dialog](#)]

The Optem setup dialog is designed to help you choose a combination of lower lens and camera tube that will give the performance that you require. The selection can be made using the [simple UI](#) or the [advanced UI](#) - the latter replicating the Optem system pdf.

Both UI's contain a sub section that shows the fullest amount of opto mechanical data on the current selection to help you make your choice. This is important, so we have devoted an entire page to the subject - including the topic of **sensor field of view**.

SYSTEM OVERVIEW	FIXED MAG CONFIG	ZOOM 7 TO 1	ZOOM 12.5 TO 1
35-00-05-000 obj lens 35-08-00-000 cam tube MAG 0.57X WD: 135mm	NA: 0.018 Res: 54lp/mm Mag: 0.57x DOF: 1.8mm Max FOV: 28mm Max Coax FOV: 13mm	NA: 0.017-0.055 Res: 51-166lp/mm Mag: 0.24-1.7x DOF: 2.0-0.19mm Max FOV: 44mm Max Coax FOV: 19mm	NA: 0.013-0.069 Res: 39-206lp/mm Mag: 0.16-2.0x DOF: 3.4-0.12mm Max FOV: 41mm Max Coax FOV: 19mm
FOV: 1/3 inch CCD sensor size: 3.6x4.8mm	FOV is unobstructed 6.3x8.4mm	FOV is coax limited 15x20mm : 2.1x2.8mm	FOV is coax limited 23x30mm : 1.8x2.4mm
FOV for 1/4" CCD	FOV is unobstructed 4.2x5.6mm	FOV is unobstructed 10x13mm : 1.4x1.9mm	FOV is coax limited 15x20mm : 1.2x1.6mm

This spreadsheet contains 4 columns

- row title
- data for the fixed magnification system
- data for the 7 to 1 zoom system
- data for the 12.5 to 1 zoom system

In the zoom columns we show the values for the lower magnification then the higher magnification

The first row contains various items that may be of use to you

- numerical aperture
- resolution in line pairs per millimetre
- magnification
- maximum field of view [object space] as allowed by the system mechanics
- maximum field of view if coaxial illumination is used [with warning if not appropriate.

The following rows [2-10] contain field of view data for different sensors:

SYSTEM OVERVIEW	FIXED MAG CONFIG	ZOOM 7 TO 1	ZOOM 12.5 TO 1
FOV: 1/3 inch CCD sensor size: 3.6x4.8mm	FOV is unobstructed 6.3x8.4mm	FOV is coax limited 15x20mm : 2.1x2.8mm	FOV is coax limited 23x30mm : 1.8x2.4mm
FOV for 1/4" CCD	FOV is unobstructed 4.2x5.6mm	FOV is unobstructed 10x13mm : 1.4x1.9mm	FOV is coax limited 15x20mm : 1.2x1.6mm
FOV for 1/3" CCD	FOV is unobstructed 6.3x8.4mm	FOV is coax limited 15x20mm : 2.1x2.8mm	FOV is coax limited 23x30mm : 1.8x2.4mm
FOV for 1/2" CCD	FOV is coax limited 8.4x11mm	FOV is coax limited 20x27mm : 2.8x3.8mm	FOV is Vignetted 30x40mm : 2.4x3.2mm
FOV for 2/3" CCD	FOV is coax limited 12.15x16.2mm	FOV is Vignetted 30x37mm : 2.3x2.9mm	FOV is Vignetted 41.55x55.4mm : 3.2x4.1mm

The first of these, row 2, shows field of view data for the sensor selected in the main program

Image [sensor] size:

1/2 inch CCD ▼

Standard sensor value

full height

full width

subsequent rows show the FOV for a sequence of standard sensors of increasing size, 1/4", 1/3", 1/2", 2/3", 1", 4/3", APS-C and 35mm. Each cell contains a comment related to vignetting [if any] and the size of the field of view in object space for that sensor [simply determined by the system magnification]

One important feature is that the cells are colour coded according to the vignetting status:

- blue - the sensor field of view [S-FOV] in completely unobstructed even if coaxial illumination is used
- orange - the field of view is vignitted [clipped] only if coaxial illumination is used
- red - the field of view is vignitted, even if no coaxial illumination is used.

S-FOV & vignetting

This requires some careful definition. The S-FOV is simply the sensor key dimension [height, width or diagonal] scaled by the system magnification, i.e projected into object space.

The program knows the maximum permissible FOV [aka FOV_M] for the system. It also knows the max FOV [aka FOV_{MC}] if coaxial illumination is used. FOV_{MC} is less than FOV_M - and is sometimes much smaller!

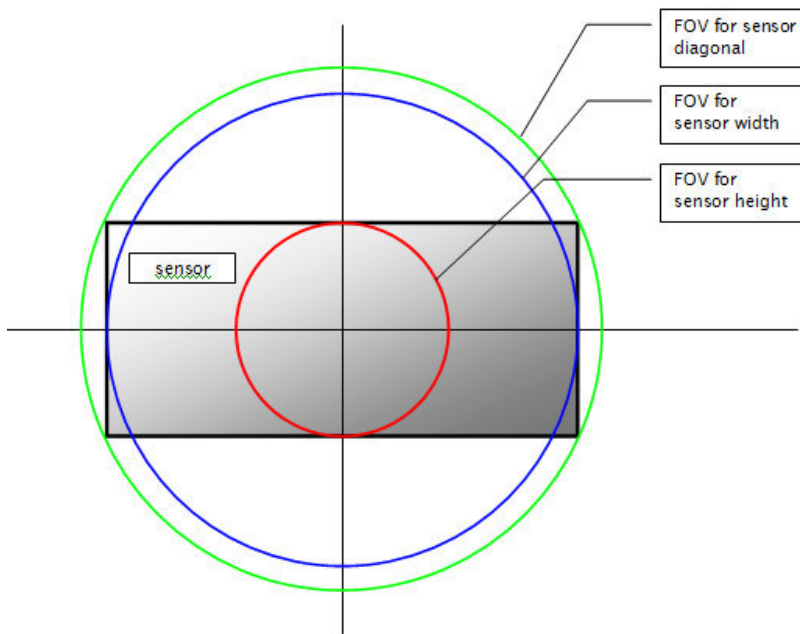
If the S-FOV is less than FOV_{MC} , then the sensor is unvignetted.

If the S-FOV is less than FOV_M , then the sensor is vignetted if coax illumination is used

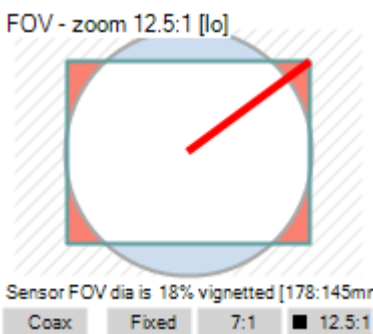
If the S-FOV is greater than FOV_{MC} , then the system is vignetted in any setup

Sensor key dimension

Here we show the three options for the key sensor dimension:



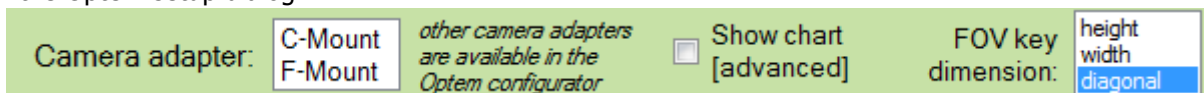
A similar graphic is shown in the Optem [setup dialog](#), but scaled for a specific case



Here, though, the circle represents the maximum FOV permitted by the current Optem while the rectangle is the sensor FOV. The single line represents the key dimension. Red colouring indicates vignetting of the sensor.

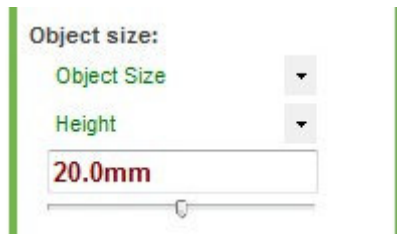
The type of key dimension that is currently used is either set:

1) in the Optem setup dialog:



[here choosing the diagonal option]

2) in the main program using the second drop down list:



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FOV/vignetting plot

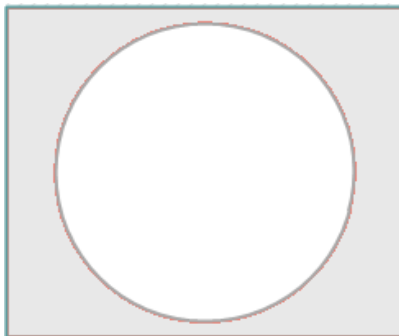
mag.x & Optem systems » Optem micro inspection system » Optem key parameters [conditions] setup »

Optem FOV/vignetting plot

[background notes on the vignetting\[FOV\], image size and sensor dimensions](#)

The Optem Field of View [FOV] or vignetting plot is composed of two basic shapes:

- a circle - representing the [field of view](#) [FOV] of the lens
- a rectangle - representing the [rectangular CCD sensor](#) in the camera



Because both are centred along the optical axis they can be superimposed about their mid points.

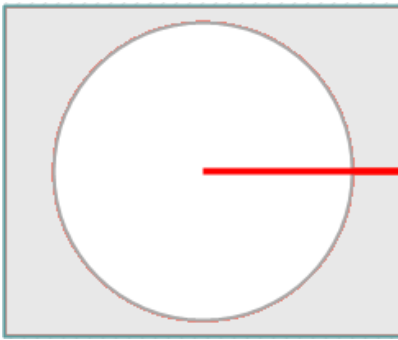
Now the FOV is 'drawn' on the object plane , but the sensor lies on the equivalent image surface.

So to compare these fairly we have projected the sensor onto object space - a simple matter of dividing sensor height/width by system magnification!

As shown above, the outer portion of the sensor will receive no light. This is often also called vignetting, hence the name of this plot. This sensor vignetting is not to be confused with the [vignetting inside the lens](#) itself which determines the field of view!

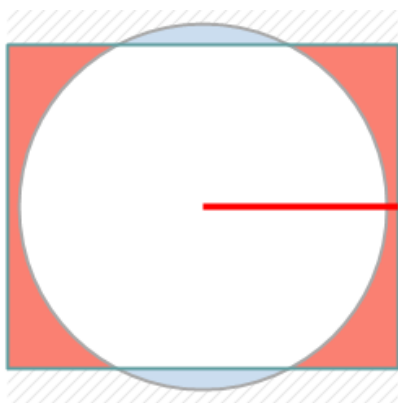
You will also see a thick line representing the 'key dimension' - the dimension that the image is 'fitted' to.

In this case the sensor width is the key dimension but you can easily choose the height [vertical] or the diagonal



Remember - using this dialog to choose an optem will always make magnification be a key parameter in the main program and NOT object size.

Vignetted pixels in the sensor provide no information to the image processor, and so may be considered as wasted! Sometimes a smaller sensor may be appropriate!



We have enhanced the diagram by colouring different portions of the plot to convey information:

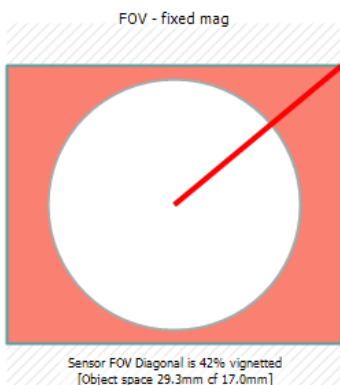
- white: this is 'good' - these parts of the FOV will be imaged onto pixels in the sensor
- pale blue: portions of the FOV that are not imaged by the sensor
- red: areas of the sensor that are vignetted
- hatched grey: object space outside of the FOV & sensor

The plots is further enhanced with text which gives:

- the percentage of vignetting
- the FOV key dimension and compares it with the FOV size

Possible scenarios in the FOV Plot

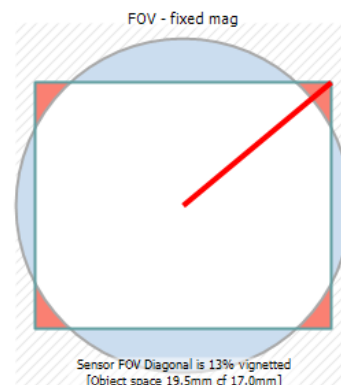
If there is sensor vignetting, we can see three cases which may or may not be of concern



sensor vignetted in height, width and diagonally

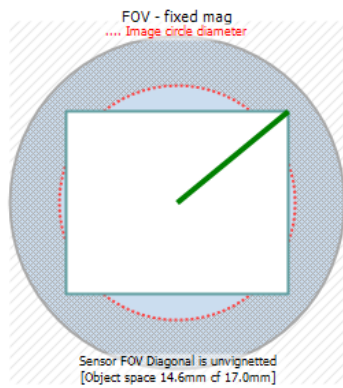


sensor vignetted for width and diagonal only



sensor vignetted on diagonal only, i.e. corners

If there is no vignetting, then you will probably see a dotted red circle - this is the [image circle](#) [again projected into object space]

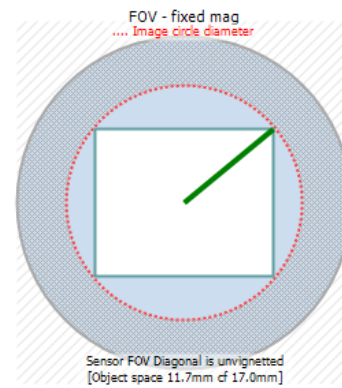


The red dotted circle shows the image size limit of the lens.

This means the maximum image size as **designed**.

Images can form outside this circle but there can be no guarantees on the image quality in that region!

E.g corners of the left hand case may show low resolution!



Finally there are also four option buttons at the bottom of the plot.



the left hand button is a toggle - it will alternate between coaxial FOV and the standard FOV

the three right hand buttons are linked. With these you can choose to show the FOV from the fixed mag option, or the 7:1 zoom or the 12.5:1 zoom. for the zoom options we show the FOV values at the low end of the range.

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vignetting & FOV notes

mag.x & Optem systems » Optem micro inspection system » Optem key parameters [conditions] setup » FOV/vignetting plot »

about vignetting, FOV and image size

This provides background to topics of vignetting/Field of View [FOV], image size & sensor size and how they are related - it provides the background theory to the [FOV plot](#)

One aim of the Optem setup dialog is to help you understand the trade offs that may occur between

- field of view [FOV] and lens vignetting
- image size limits
- sensor filling or clipping [also vignetting]

FOV & Lens Vignetting

Lenses are designed to form sharp images of objects up to a certain size, h . Image quality is best for an object point at the centre of the field of view, but can tail off toward toward the edge. One way round this is to deliberately cut off some of the 'worst' rays from falling on the sensor - this is known as vignetting.

One bad side effect of this 'soft' vignetting is that the light levels can drop significantly at the edge of the image.

A well designed machine vision lens will offer good quality imaging right up to h , and so will not need that 'soft' vignetting.

However, all lenses will have hard vignetting where the light from object points beyond h is completely cut off by deliberate use of apertures in the mechanical design of the lens. That is the Field of View [FOV]. For Optem systems, the FOV is set by the lower lens [objective] - the value is shown in the specifier guide and [as shown below] in the [Optem setup dialog](#)

0.4x Lower Lens 35-00-11-000 WD: 490mm FFI: 500mm Max FOV: 100mm	0.5x Lower Lens 35-00-10-000 WD: 390mm FFI: 400mm Max FOV: 80mm	0.67x Lower Lens 35-00-09-000 WD: 290mm FFI: 300mm Max FOV: 60mm	1x Lower Lens 35-00-08-000 WD: 190mm FFI: 200mm Max FOV: 40mm	1.25x Lower Lens 35-00-06-000 WD: 155mm FFI: 160mm Max FOV: 32mm
------------------------------------------------------------------------------	-----------------------------------------------------------------------------	------------------------------------------------------------------------------	---------------------------------------------------------------------------	------------------------------------------------------------------------------

Image size

Lenses are designed to form a specific size image h' for a maximum object size h - the optimisation aims to maintain good image performance within h' .

Now a lens can still form an image for object points large than h , but the performance tends to drop rapidly for image size greater than h' !

So you can inspect a larger image than h' , but do not expect high resolution. *Caveat emptor!*

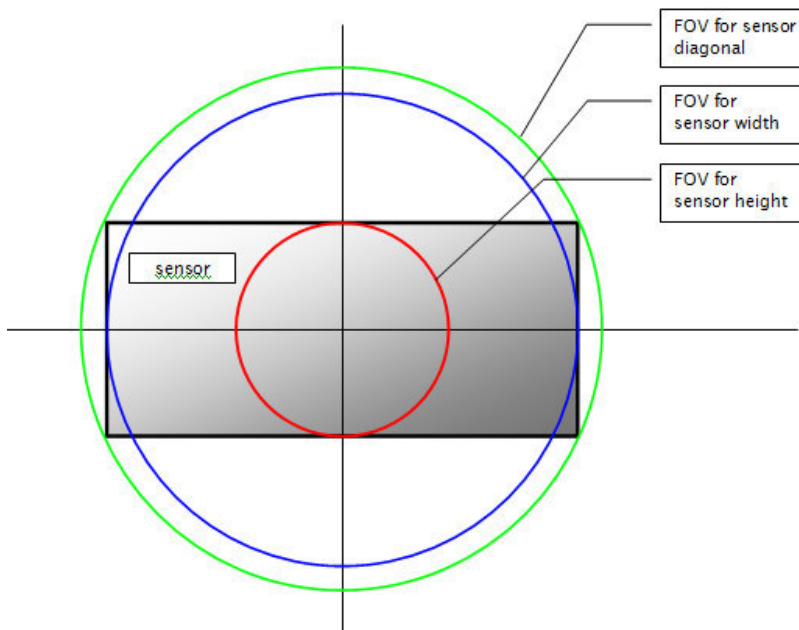
Sensor key dimensions

Sensors are always rectangular, so we show the three options for the key sensor dimension:

- height [this is always taken as the shortest side]
- width - longest side
- diagonal

Each dimension will have its own effective FOV [touching circle] which is simply given by the dimension / system magnification. So the height requires a much smaller system FOV

NB for line scan sensors we just treat the height as effectively zero



It may be that the lens limits are such that light does not fall on the outer portions of the sensor - this is also known as vignetting - which is slightly confusing!

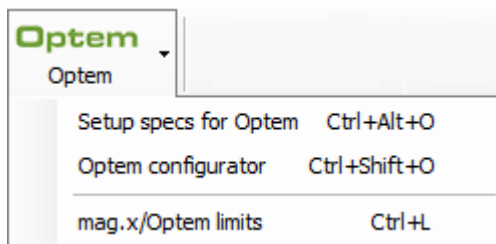
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Introduction

mag.x & Optem systems » Optem micro inspection system » Optem configurator »

Optem configurator: basics

*This configurator allows a user to choose various **optional** accessories, once a Optem main solution has been selected.*



Ways to load Optem configurator:

Press key combination: *Ctrl+Shift+O*

or

Click second item in the Optem drop down menu in the main toolbar

or

Right click any Optem solution in the results spreadsheet

This form is only available IF the current solution in the main form is an Optem system!

*Before version 4, MachVis had no configurator! For the conventional lenses [e.g. Rogonar, Rodagon, Inspec, MeVis-C, Macro-CCD & flo.x], MachVis chooses **all** accessories as part of the solution finding process - their mechanical 'lengths' being essential in locating the sensor relative to the lens. Therefore no configurator was needed, since there were no optional accessories up for choice!*

However the micro inspection systems [mag.x and Optem] support a wide range of extras and options which do not effect the sensor location. These therefore require a configurator to allow you to make those choices.

This page describes the [Optem system](#) configurator [added in v5] - which is considerably more complex than the [mag.x configurator](#)!

The form, as shown here, is split into two main parts set side by side, one for defining the configuration and the other for displaying that system.

1: Setup area

This is where you:

- 1.1: make [key decisions](#) that effect the overall layout and options available
- 1.2: select [individual parts](#) for the five essential modules
- 1.3: select [accessories](#) which live between the modules
- 1.4: choose [lighting & control](#) items
- 1.5: review [optical information](#) about the system

2: Tabbed 'results' area

In this area you can choose to see either:

- 2:1: [parts list](#) [colour coded by section]
- 2:2: [system schematic](#) [outline drawing]

on any change in the setup area, these will update automatically.

Finally the toolbar at the top offers some useful capabilities:

- Load the PDF that describes the optem systems
- Print out your current configuration - for Optems this is a three page item.
- Create and email requesting a quotation for this system
- Export the parts list to Excel [the resultant small spreadsheet has some simple formatting]
- Undo & Redo changes to the configuration

1.1: Key decisions

At the top of the Setup area are three selectable lists representing three key choices:

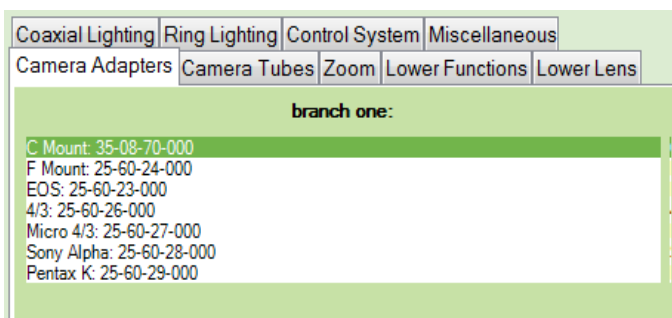
The choices you make here will have a major impact on the system layout and the range of parts that are offered to you in the rest of the setup area.

- 1) Single or [dual channel](#): one or two branches to the system - providing one or two outputs, i.e. two image sensors. If two, then a beam splitter has to be used and this can be located above or below the zoom module. By using different camera tubes each sensor can work with different magnification/field of view at the same time.
- 2) Type of lighting: none, coaxial or ring light. Typically this will depend upon the type of material being inspected
- 3) Type of analysis. Most customers just use standard analysis, but it is possible to support florescence or polarisation analysis if needed.

Whenever you make a change here the specific parts options discussed below will update immediately, to those which are compatible with these key choices.

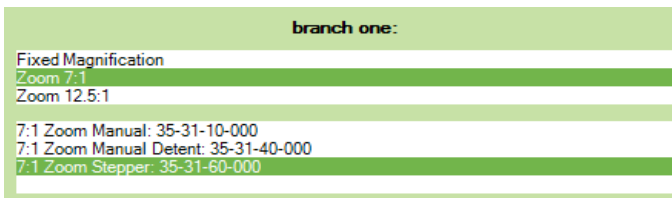
1.2: Module selection

Module selection is made in the tabbed area under the key decisions area.



Each MachVis system contains five key modules - camera adapter, camera tube, zoom/fixed mag, lower function and lower lens. The first five tabs allow you to choose the components for these modules. This screen capture shows the available camera adapters in a list, showing a description and part code. Simply click to select.

For the zoom module, you have two clickable lists instead of one:



The first [top] list allows you to choose between a fixed magnification system, or one of the two available zooms ranges. The second list shows the available options for that first choice.

For the lower lens and the camera tube the single list is not editable! This is because these parts are fixed by your system choice. You can see the other alternatives, BUT cannot alter them.

If using a dual branch system, then you will see two lists, side by side, one for each branch. Of course, this only applies for the modules that are 'above' the beam splitter, i.e. camera adapters, camera tubes and maybe zoom modules. The lower function module and lower lens are always in common.

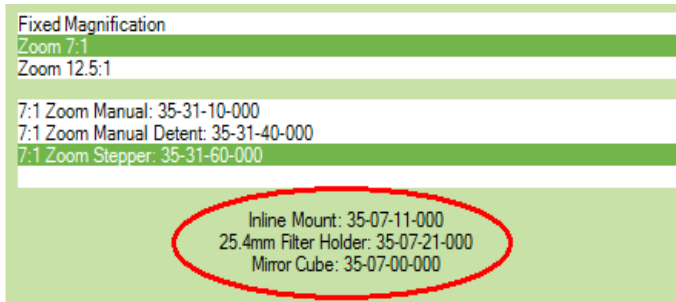
1.3: Accessories

There are a number of accessories that can be used to change functionality, alter physical layout or support the main optics. One or more of these can be inserted at **various points** between modules.

These points will be indicated in the five module related tabs, by the words '**Click to add accessories**'.

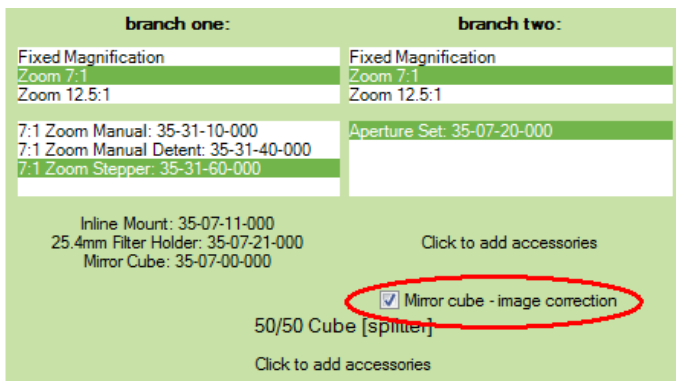


If you click on that text, then the [accessories dialog](#) will appear which will allow you to add, delete or alter the accessories at that point. Once choices have been made then the text change to will show those accessories. The parts list and system schematic will update accordingly.



To recall the accessories dialog, simply click on that text again.

NB One or two named accessories are made available by checkboxes at specific points.



For example, if you have chosen a dual system [with two branches as shown above], then it is very common that add a mirror cube in the second branch. This re-inverts the inverted image caused by passing thru the mirror branch of the beam splitter. It also has the nice benefit of keeping the system compact. Being so common, it is sensible to offer it via a checkbox, rather than via the more long winded way of the accessories dialog.

1.4: Lighting and control

Illumination and stepper control options are important, even critical, elements of the overall system, but are not directly part of the imaging assembly itself. Obviously there are cross links, but we handle them as separately as possible in their own dedicated tabs!

1.4.1: Illumination System [coaxial and/or ring light]

The overall decision as to type of lighting is made in the [key decisions](#) area at the top of the dialog, where you can choose none, coaxial illumination, ring lighting or both.

The choice of lighting type will also determine the possible parts in the lower function module - the configurator will only present those that are suitable.

If you need lighting, but want to supply your own, that is fine. Simply check the '**User to supply illumination subsystem**' checkbox. This choice will be reflected in the parts list, schematic, print-out and quotation request.

However, Excelitas does supply illumination systems that will cover the most general usage, so these notes assume that to be suitable for you.

Camera Adapters	Camera Tubes	Zoom	Lower Functions	Lower Lens
Coaxial Lighting	Ring Lighting	Control System	Miscellaneous	

Polariser 29-69-02-000

Fiber Optic Lamphouse 30-16-02-000
 10mm Fiber Optic Adapter 30-16-01-000
 60inch Flexible Fiber Optic 30-16-60-000

110v Halogen Illuminator 29-60-83-000
 220v Halogen Illuminator 29-60-84-000

User to supply Illumination subsystem. This will probably require a custom adapter or modification.

NB We list here the purely Qioptiq lighting elements - basic modules that work - these provide the most general usage. However, we are happy to supply mounting information for customers that want to have something more specific for their application. This is because lighting can be the hardest part of the optical system and every application is different.

Here we see the Coaxial Lighting tab, and below we show the equivalent Ring Light tab.

Camera Adapters	Camera Tubes	Zoom	Lower Functions	Lower Lens
Coaxial Lighting	Ring Lighting	Control System	Miscellaneous	

LED Illumination system
 Illumination via fiber optic [Halogen or LED]

LED Optic Ringlight Adapter 35-07-40-000
 LED Optic Ringlight 35-07-41-000

User to supply Illumination subsystem. This will probably require a custom adapter or modification.

NB We list here the purely Qioptiq lighting elements - basic modules that work - these provide the most general usage.

However, we are happy to supply mounting information for customers that want to have something more specific for their application. This is because lighting can be the hardest part of the optical system and every application is different.

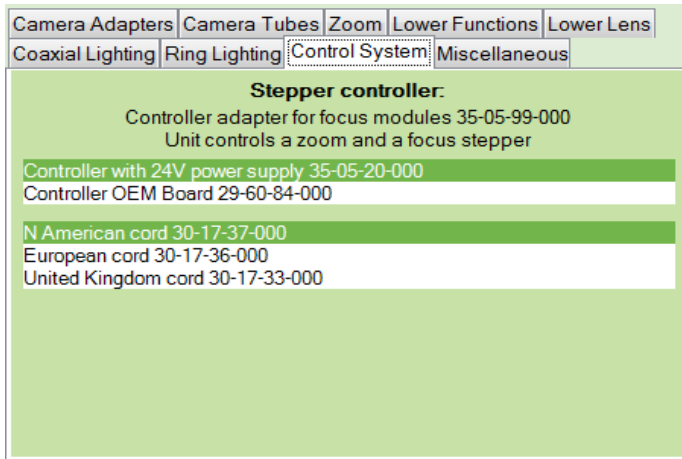
As can be seen above, in both there are still subsidiary choices to be made. For both coaxial and ringlighting there are halogen or LED sources. These are chosen in the list at the top of the tab. Any other choices will be shown beneath in selectable lists or via checkbox. Any essential components where there is no option are simple shown as text.

1.4.2: Control Systems

Main modules with stepper motors drives can be selected for:

- zoom control - in the zoom module[s]
- focus - in the lower function module

Though unusual you may therefore have up to three steppers to control. These stepper motors must be driven properly and not forced manually. Therefore if steppers are selected, the control units will be included automatically.



Having said that, there are options relating to the power supply, which can be included with the controller or supplied by the user. If the former, then there is also a choice of power cord.

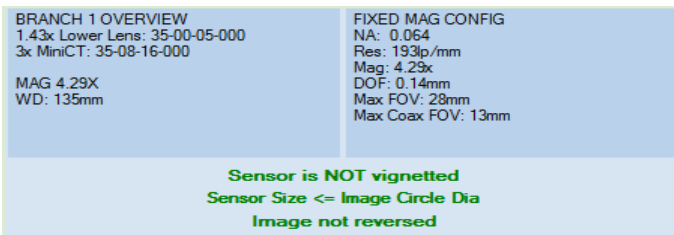
Each stepper controller can manage up to two 'axes' or steppers. The program will determine the smallest number of controllers needed - to minimise cost. In the unusual case that two controllers are required, the program assumes that both will be the same type.

In the screen capture above we can see that both modules with focus and zoom steppers have been selected, and the full controller with power supply chosen.

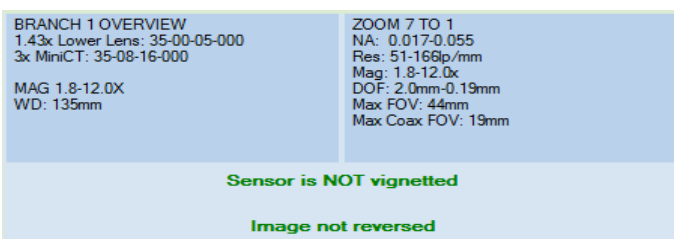
Finally, for focus stepper a controller adapter board is required and is therefore automatically included.

1.5: Optical information

Underneath the choices area, we supply feedback on the optical properties of the current selection:

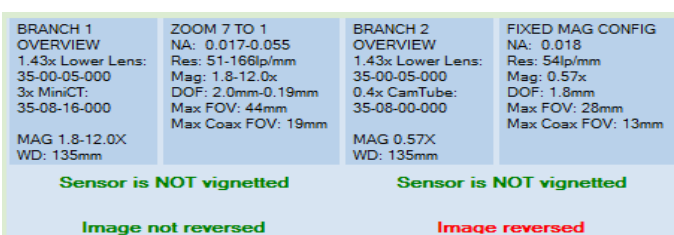


If a zoom module has been chosen, then the values in the second block are different and [mostly] doubled, giving the data at the two extremes of the zoom range.



Adding in a mirror cube will reverse the image. The program keeps track no matter how many such cubes are included and notes whether the image is inverted compared to the basic system with no cubes.

This is of especial significance in a dual channel system where the beam splitter adds an inversion to the secondary branch. Note how the information blocks have been doubled - one for each branch.



In such a case the system engineer needs to be aware of the difference and either be able to correct it in his software, or add a mirror cube to the second branch to re-invert the image. NB in a dual channel system, the user has a free choice of camera tube in the second branch.

2.1: Parts List


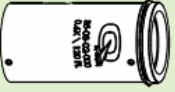


This is an ordered list of the items used in the current selection. These parts are arranged in sections covering the imaging system, and then any lighting or control systems. The imaging system is ordered from the camera adapter on top down to the lower lens.

Section	Module	Component	Part number	x	Weight	In system length	3DModels
Optics	Camera Adapter	F Mount	25-60-24-000	1x	23g	0mm	download
	Camera Tube	Camera Tube 0.6X / 120mm	35-08-02-000	1x	170g	76mm	download
	accessory	Inline Mount	35-07-11-000	1x	43g	13mm	download
	accessory	Mirror Cube	35-07-00-000	1x	190g	56mm	download
	accessory	Aperture Set	35-07-20-000	1x	34g	19mm	download
	Zoom Mod	7:1 Zoom Stepper	35-31-60-000	1x	380g	85mm	download
	Lower Func Mod	Coax Illumination 5mm Focus Stepper	35-04-30-000	1x	NA	56mm	download
	Lower Lens	0.4x / 500mm	35-00-11-000	1x	17g	12mm	download
Coax Light		Fiber Optic Lamphouse	30-16-02-000	1x	31g	51mm	download
		10mm Fiber Optic Adapter	30-16-01-000	1x	20g	NA	download
		60inch Flexible Fiber Optic	30-16-60-000	1x	326g	NA	download
		220v Halogen Illuminator	29-60-84-000	1x	4536g	NA	download
Ring Light		LED Optic Ringlight Adapter	35-07-40-000	1x	NA	NA	download
		LED Optic Ringlight	35-07-41-000	1x	NA	32mm	download
Control Unit		Controller Adapter for Focus Module	35-05-99-000	1x	NA	NA	download
		Stepper Controller 24v Power Supply	35-05-20-000	1x	NA	NA	
		N Amer Cord	30-17-37-000	1x	NA	NA	
Miscellaneous		X95 System Stand	35-07-12-000	1x	NA	NA	download
Total weight					5769g 12lb12oz		All Files

Note that the three rightmost columns shows

- 1) the weight of each component and also a combined weight for the system
- 2) the length contribution to the Optem system [this will be less than the actual component length]
- 3) links to enable you to download a zipped STEP [3DModel] of the part to the ..\3DModels folder. The **'All Files'** link at the column bottom will allow you to download all these parts at once.

You can choose to show component graphics in the spreadsheet, though this will expand the row heights:

Component	Graphic	Part number	x
F Mount		25-60-24-000	1x
Camera Tube 0.6X / 120mm		35-08-02-000	1x
Inline Mount		35-07-11-000	1x
Mirror Cube		35-07-00-000	1x

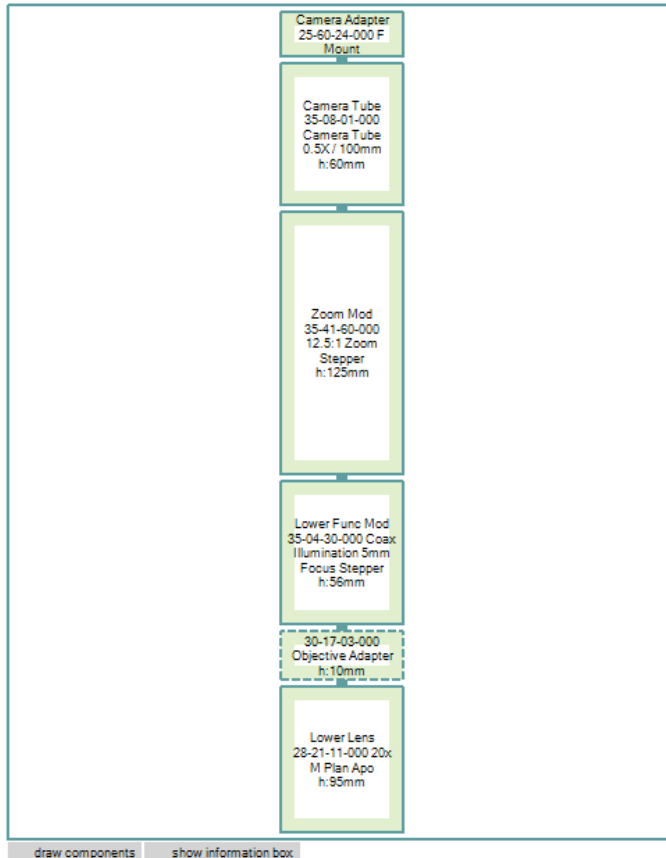
If a dual channel system is chosen, then the imaging components are shown in the section order:

- branch 1 [above the beam splitter]
- branch 2 [above the splitter]

- beam splitter
- main stem [below the splitter]

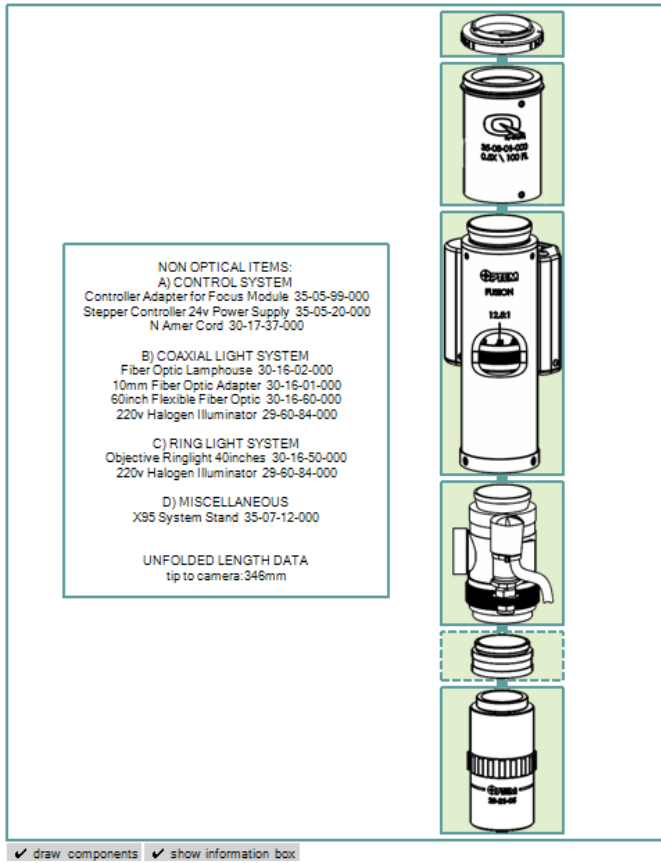
2:2 System Schematic

This is a schematic showing the system as made up of the chosen parts in the imaging system. The schematic starts at the page bottom with the lower lens [normally] and works up to the camera adapter at the top in sequential order.

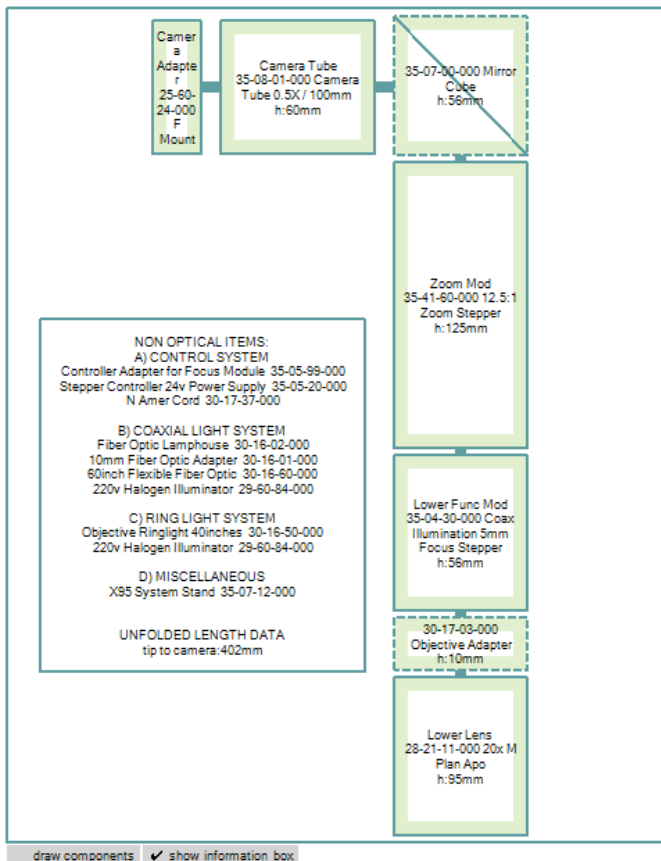


Each part is represented by a rectangle containing the part code and description. The length of each rectangle is in proportion to the length of the real item - unless it is very 'flat' in which case the rectangle height is bigger to accommodate the text.

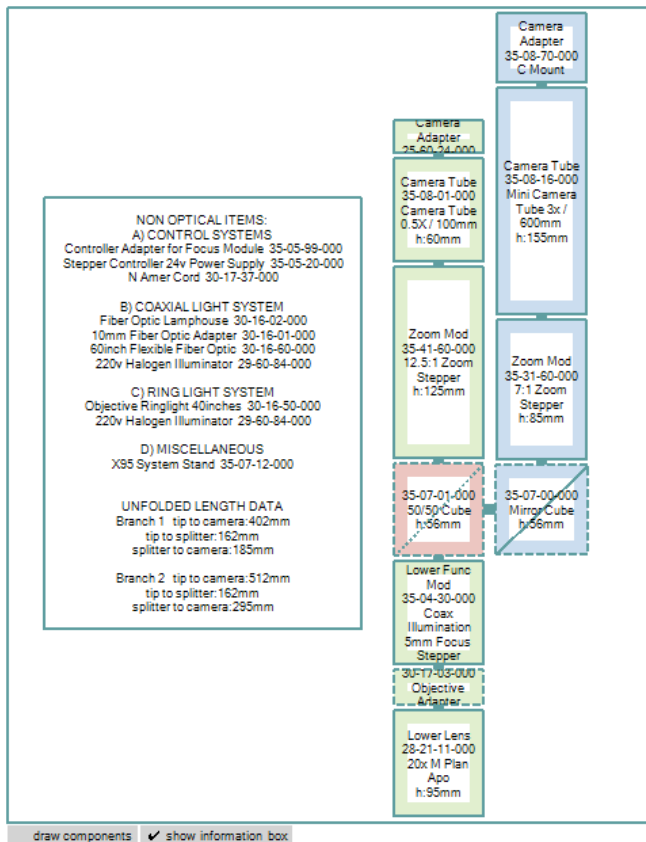
You can choose to show/hide the information box and you can also choose to show component graphics inside the boxes instead of the text.



If bends or beam splitters are included then the schematic shows the 'folds' appropriately. With mirror cubes, a diagonal is drawn inside the rectangle to indicate the proper mirror orientation.



Items from the five main modules have a solid outline. Accessories, including a beam splitter [if used] have dotted outlines. If a dual system is used, then the branches are coloured differently, as is the beam splitter.



Beside the rectangles, a text box is also drawn - this contains details of any illumination or control systems - part codes etc. It also contains the **unfolded** system length from the lower lens to the image sensor. If a dual channel system is chosen, then the unfolded lengths of both branches are given, along with unfolded distances to the entrance face of the splitter, and from the exit face of the splitter.

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configurator - accessories

mag.x & Optem systems » Optem micro inspection system » Optem configurator »

Optem configurator: accessories dialog

[This dialog is a popup from the Optem configurator]

Accessories can be added between these main modules:

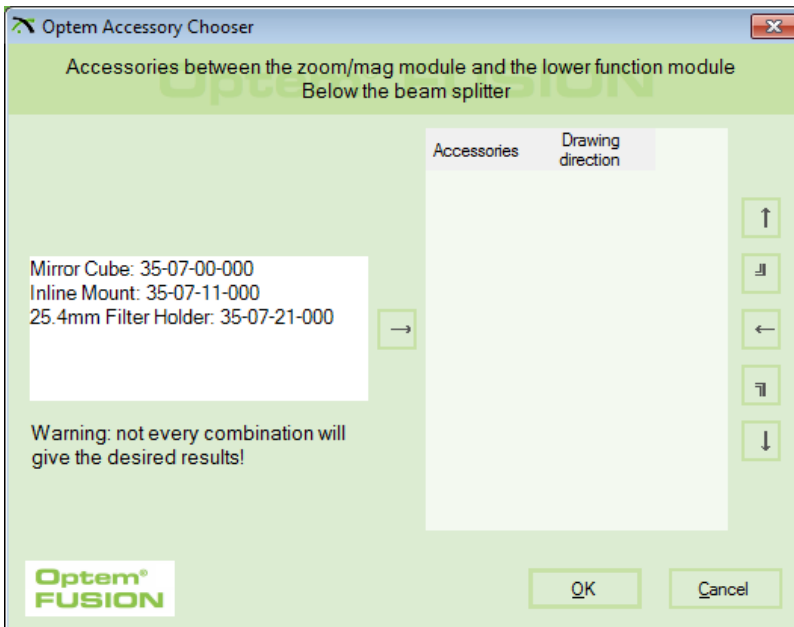
- camera tube & zoom/fixed mag module
- zoom/fixed mag module & lower function module
- lower function module & lower lens

If a beam splitter is used to make a dual channel system then accessories can be added above and below the splitter - in fact anywhere you see the words **'click to add accessories'**!

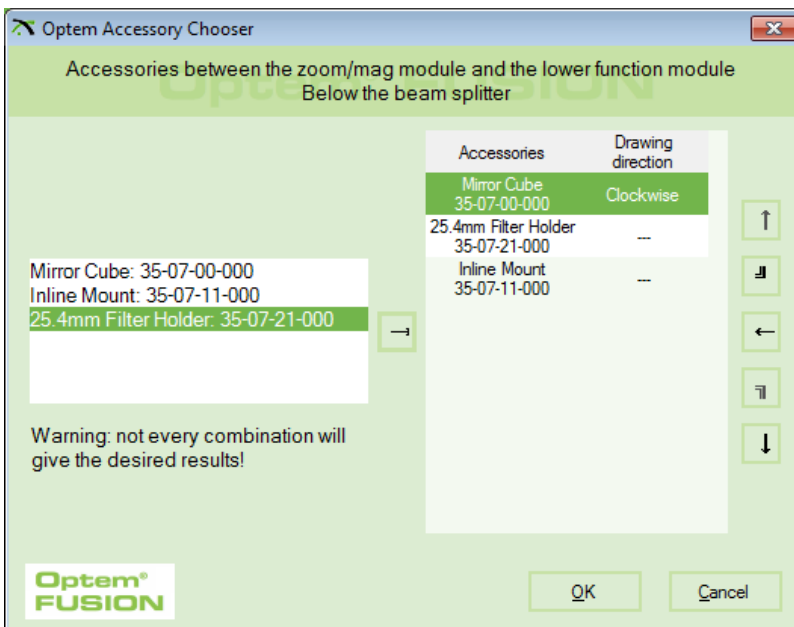
Accessories perform specific tasks which may be optical and/or mechanical in nature. For example, a mirror cube will bend the optics physically, but will also invert the image.

The Optem accessory dialog, shown here, enables the adding, sorting and deletion of accessories from your design.

First of all, the available accessories are listed on the left hand side of the dialog



Your selection is listed on the right hand side. As shown below, you can, in principle, have more than copy of the same item.



To 'add' an accessory, select it in the left hand list and then click the '→' button in the center. Repeat as desired.

NB as noted, adding in a mirror cube will reverse the image. The main configurator keeps track no matter how many such cubes are included and notes whether the image is inverted compared to the basic system with no cubes. This is especially significant for [dual channel systems](#) where it would be easy to get the two images showing opposite 'handedness' as shown here.

BRANCH 1 OVERVIEW 1.43x Lower Lens: 35-00-05-000 3x MiniCT: 35-08-16-000 MAG 1.8-12.0X WD: 135mm	ZOOM 7 TO 1 NA: 0.017-0.055 Res: 51-166lp/mm Mag: 1.8-12.0x DOF: 2.0mm-0.19mm Max FOV: 44mm Max Coax FOV: 19mm	BRANCH 2 OVERVIEW 1.43x Lower Lens: 35-00-05-000 0.6x CamTube: 35-08-02-000 MAG 0.86X WD: 135mm	FIXED MAG CONFIG NA: 0.029 Res: 86lp/mm Mag: 0.86x DOF: 0.69mm Max FOV: 28mm Max Coax FOV: 13mm
Sensor is NOT vignetted		Sensor is NOT vignetted	
Image not reversed		Image reversed	

On the far right hand side are 5 icons for 'adjusting' your current selection in the right hand side list. From the top:

- ↑ move item up the list
- ↺ set mirror cube to rotate anti-clockwise - this only effects the systems schematic layout.
- ← take item out of the list
- ↻ set mirror cube to rotate clockwise - this only effects the systems schematic layout
- ↓ move item down the list

When satisfied click OK and the chosen accessories will appear in the main configurator, including the system schematic and the parts list.

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configurator - dual channel

mag.x & Optem systems » Optem micro inspection system » Optem configurator »

Optem configurator: dual channel systems

The default Optem system is a simple system made up of five main modules, as itemised below. It has one objective and one camera tube, and can be fixed magnification or a zoom.

camera adapter
camera tube
zoom/fixed
lower function module
lower[objective] lens

However, for some applications, a dual field of view may be appropriate, a low magnification, wide field for acquisition and a high magnification, narrow field for detailed inspection. To provide this a beam splitter is used, in one of two configurations. This is the preferred configuration:

camera adapter *camera adapter*
camera tube *camera tube*
beam splitter
zoom/fixed
lower function module
lower[objective] lens

and here is the alternative configuration - however this can suffer more from vignetting:

camera adapter *camera adapter*
camera tube *camera tube*
zoom/fixed *zoom/fixed*
beam splitter

*lower function module
lower[objective] lens*

To choose a dual channel system is a major step and so is specified in the [key decisions area](#) of the configurator.

This will have an impact in four areas of the configurator UI:

- 1) doubled choices in main module tabs - two sets of lists etc in the appropriate
- 2) double display in the optical information area
- 3) parts list
- 4) schematic

In more detail:

Coaxial Lighting	Ring Lighting	Control System	Miscellaneous
Camera Adapters	Camera Tubes	Zoom	Lower Functions
branch one [fixed]: Camera Tube 0.4X 80mm: 35-08-00-000 Camera Tube 0.5X 100mm: 35-08-01-000 Camera Tube 0.6X 120mm: 35-08-02-000 Camera Tube 0.8X 160mm: 35-08-04-000 Camera Tube 1X 200mm: 35-08-06-000 Mini Camera Tube 0.8x 160mm: 35-08-11- Mini Camera Tube 1x 200mm: 35-08-12- Mini Camera Tube 1.5x 300mm: 35-08-13- Mini Camera Tube 2x 400mm: 35-08-14- Mini Camera Tube 2.5x 500mm: 35-08-15- Mini Camera Tube 3x 600mm: 35-08-16-		branch two: Camera Tube 0.4X 80mm: 35-08-00-000 Camera Tube 0.5X 100mm: 35-08-01-000 Camera Tube 0.6X 120mm: 35-08-02-000 Camera Tube 0.8X 160mm: 35-08-04-000 Camera Tube 1X 200mm: 35-08-06-000 Mini Camera Tube 0.8x 160mm: 35-08-11- Mini Camera Tube 1x 200mm: 35-08-12- Mini Camera Tube 1.5x 300mm: 35-08-13- Mini Camera Tube 2x 400mm: 35-08-14- Mini Camera Tube 2.5x 500mm: 35-08-15- Mini Camera Tube 3x 600mm: 35-08-16-	
<input checked="" type="checkbox"/> Camera Tube Clamp NB clamps for standard stereo type stands also available [76, 82, 83 or 84mm dia]		<input type="checkbox"/> Camera Tube Clamp NB clamps for standard stereo type stands also available [76, 82, 83 or 84mm dia]	
Click to add accessories		Click to add accessories	

1: doubled choices in main module tabs - two sets of lists etc in the appropriate main module tabs, arranged side by side, one for each branch.

Here we are displaying the camera adapter tab, and have chosen to have the beam splitter between that and the adapter.

Note that you can add accessories in the main stem under the splitter and also above the splitter in either/both branches

BRANCH 1 OVERVIEW 1.43x Lower Lens: 35-00-05-000 3x MiniCT: 35-08-16-000 MAG 1.8-12.0X WD: 135mm	ZOOM 7 TO 1 NA: 0.017-0.055 Res: 51-166lp/mm Mag: 1.8-12.0x DOF: 2.0mm-0.19mm Max FOV: 44mm Max Coax FOV: 19mm	BRANCH 2 OVERVIEW 1.43x Lower Lens: 35-00-05-000 0.6x CamTube: 35-08-02-000 MAG 0.86X WD: 135mm	FIXED MAG CONFIG NA: 0.029 Res: 86lp/mm Mag: 0.86x DOF: 0.69mm Max FOV: 28mm Max Coax FOV: 13mm
Sensor is NOT vignetted Image not reversed		Sensor is NOT vignetted Image reversed	

2: double display in the optical information area.

LHS boxes deal with branch 1. RHS boxes deal with branch 1.

3: parts list shows detailed breakdown for both branches

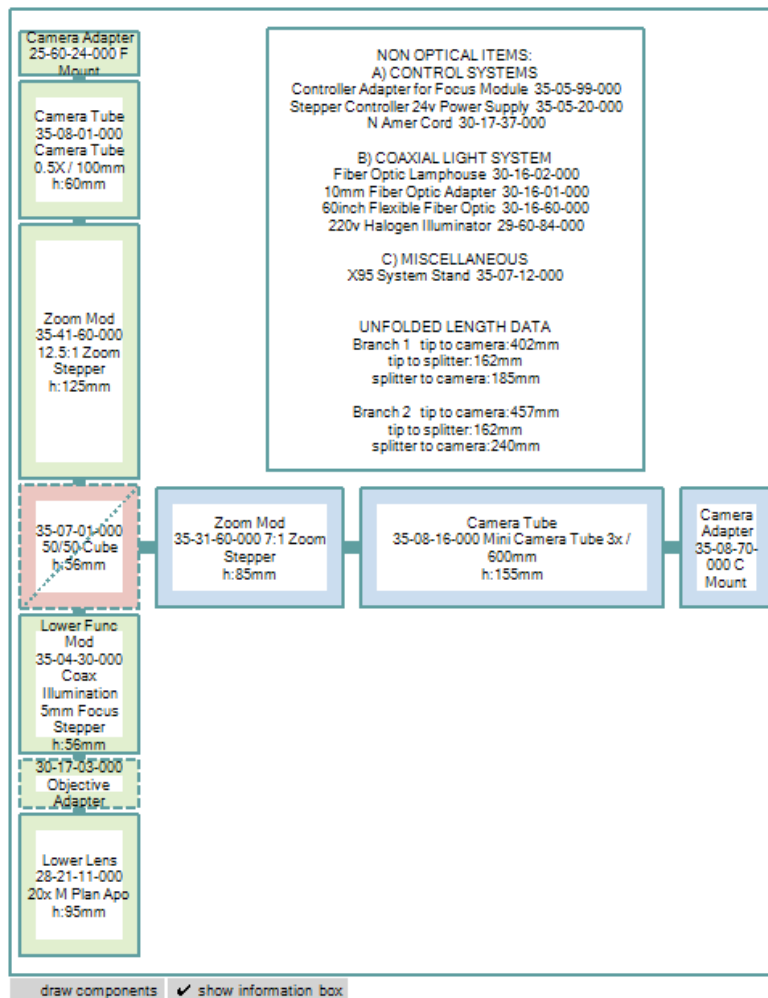
This structure is followed in the printout and in the email RFQ

Section	Module	Component	Part number	x	Weight
Branch 1	Camera Adapter	C Mount	35-08-70-000	1x	40g
	Camera Tube	Mini Camera Tube 3x / 600mm	35-08-16-000	1x	337g
Branch 2	Camera Adapter	C Mount	35-08-70-000	1x	40g
	Camera Tube	Camera Tube 0.6X / 120mm	35-08-02-000	1x	170g
Path splitter		50/50 Cube	35-07-01-000	1x	204g
Main stem	Zoom Mod	7:1 Zoom Manual	35-31-10-000	1x	252g
	accessory	25.4mm Filter Holder	35-07-21-000	1x	34g
	Lower Func Mod	Coax Illumination 5mm Focus Stepper	35-04-30-000	1x	255g
	Lower Lens	1.43x / 140mm	35-00-05-000	1x	17g
Coax Light		Fiber Optic Lamphouse	30-16-02-000	1x	31g
		10mm Fiber Optic Adapter	30-16-01-000	1x	20g
		60inch Flexible Fiber Optic	30-16-60-000	1x	326g
		220v Halogen Illuminator	29-60-84-000	1x	4536g
Control Unit		Controller Adapter for Focus Module	35-05-99-000	1x	NA
		Stepper Controller 24v Power Supply	35-05-20-000	1x	NA
		N Amer Cord	30-17-37-000	1x	NA
Total weight					6263g 13lb13oz

4: schematic shows layout for both branches.

The text box also gives unfolded length data for both branches, including sub lengths from objective to front of splitter and from rear of splitter to camera sensor

As we have said elsewhere, you can choose to show individual component graphics in the schematic instead of the text.



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mag.x & Optems - limiting solution numbers

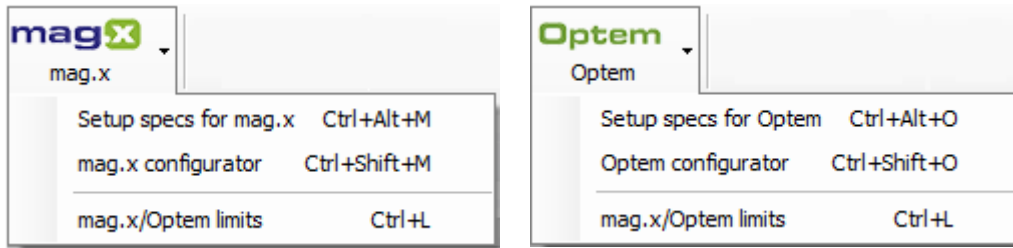
mag.x & Optem systems >>

Limiting the number of solutions

As you will see elsewhere it is quite possible to find several Optem and mag.x systems with similar magnifications and Free Working Distances [FWD's]. These are key properties for these micro inspection systems.

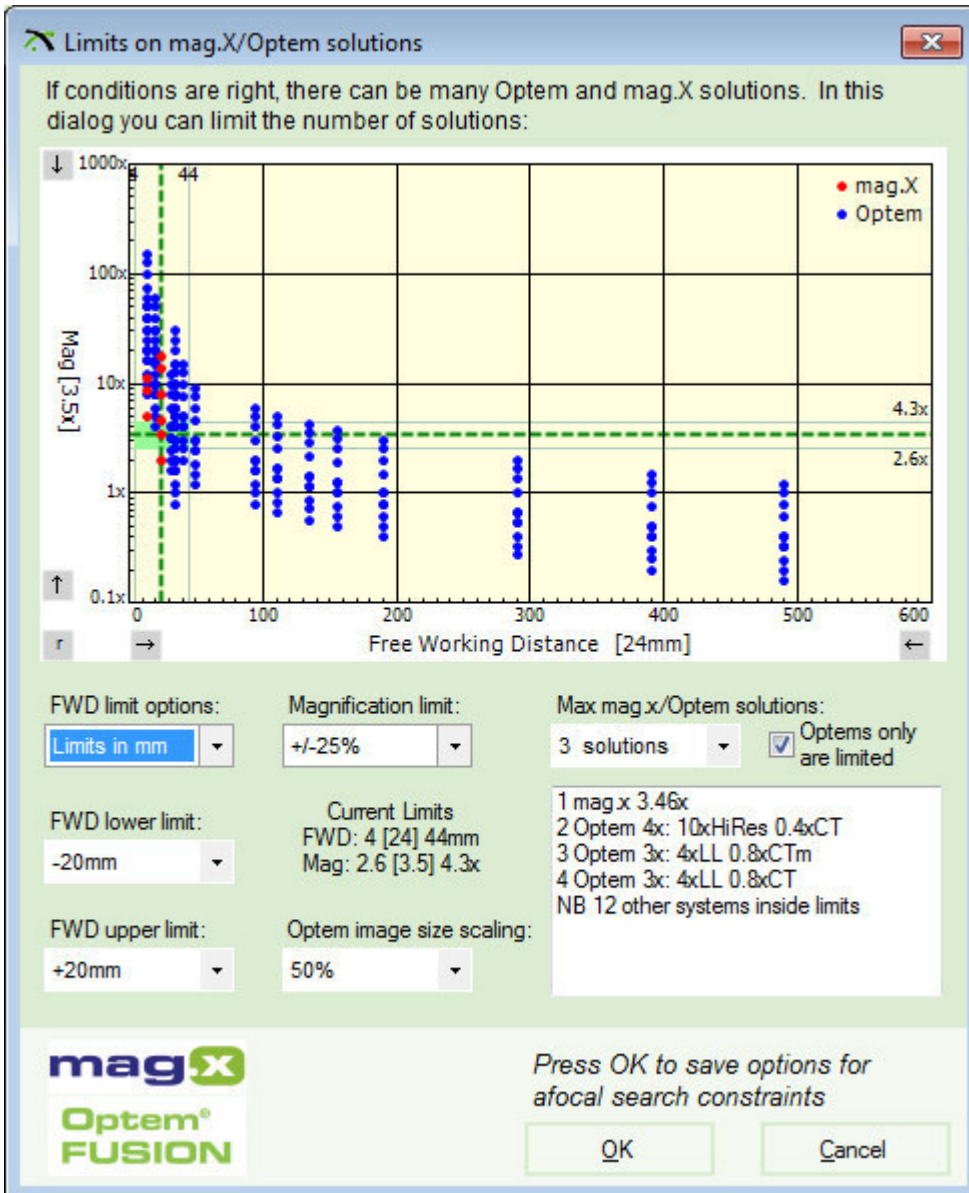
If they were not limited you might end up with 5, 10, 15 or more Optems in the final solution list in the main program. This can be rather distracting, so by default MachVis displays the top 3 Optems only, but you can easily change this.

You can also you can tighten constraints on either magnification and/or FWD.



Pull down either the mag.x or Optem menu and select the final menu item OR press **Ctrl + L** keys simultaneously.

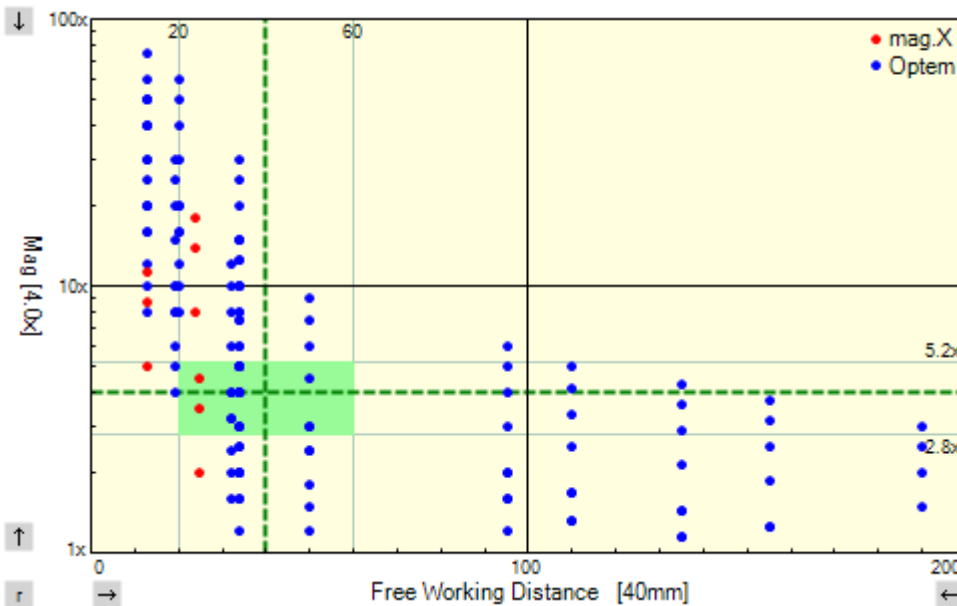
You will now see the magX/Optems limits dialog:



The key feature is the mag v FWD plot. Each blue or red dot represents one or more Optem or mag.x systems.

The green dotted crosshair represents the current requirements for magnification and FWD. Acceptable bands lie on either side, shown by faint green dotted lines. If a system falls within both bands [i.e. the green rectangle] then it will appear in the solutions list.

You can use the arrow buttons round the plot to 'enlarge' and specific area.



The 'r' button at bottom left of the plot will reset the scales to the defaults.

Underneath the plot are various lists where you can alter various choices. The plot details will update immediately along with the list of Optems/mag.x's satisfying the current limits.

FWD limit options:
 Limits in mm ▾
 FWD lower limit:
 -20mm ▾
 FWD upper limit:
 +20mm ▾

Alter the FWD limits [upper and lower limit separately]

in the top dropdown list you can choose to:

- use the values in the datafile
- set as a percentage of the nominal FWD
- set values in millimetres

the bottom 2 dropdown lists enable you to set the upper and lower limits separately

Magnification limit:
 +/-25% ▾

Alter the magnification limits as a percentage of the nominal value in this single dropdown list

Max mag.x/Optem solutions:
 3 solutions ▾ Optems only are limited

Alter maximum number of micro inspection systems

using a dropdown list. Use the checkbox to limit this to Optems only - since there will usually be more of them on offer

[new in MV5.2]

Optem image size scaling:
 50% ▾

When satisfied, simply click the 'OK' button.

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New features in version 5.3

General MachVis notes »

General: version history

v5.3.0

- UI makeover to mirror the machvis webapp, with the full Excelitas styling
- New mag.X camera adapters for the 1.0x camera tube [F-mount and M72]

v5.2.0

- New camera adapters: TFL [M35*0.75] and TFL II [M48*0.75] in main program
- New Lens: Inspec.x L Float 5.6/120
- New Lens: d.fine HR 2.4/128 3.33x - ultra high resolution lens with large 82mm image circle, resolving down to 3.5um
- Update: mag.x configurator refreshed plus new base unit [-089], new actuator/autofocus options, new mount options and complete new range of camera adapters]
- Update: Optem [FOV plot](#) shows image size when appropriate
- Update: Optem SWIR options - allows imaging in NIR/SWIR
- Update: Optem configurator
- Update: Optem camera tube image size limit on sensor size now modelled [compliments the lower lens FOV limit]
- Updated part numbers for improved Apo Rodagon D 2x and Inspec.x L 4/100
- Improved optical models for the internal MeVisC lens movements
- Obsolete: Focus adapters, but retained for backward compatibility
- Obsolete: Flo.x lens, but retained for backward compatibility

v5.1.0

- Optem: Fetura zoom module added as alternative to standard 12.5:1 zoom
- Optem: Tunable Lens Focus Module provides alternative focus mechanism to existing steppers
- Printout: Field of View diagrams added for mag.X, Optem and standard lenses
- New Options form: [dialog to allow user choice of locations for various files](#)
- New Standard lenses: [dialog to set specifications to get a specific standard lens](#) first in the results list

v5.0.6

- New: [Optem Fusion micro inspection system](#) - over two hundred different objective & camera tube combinations
 - Custom [Optem setup dialog](#) to set specifications to get a specific Optem system at top of the results list
 - Custom [Optem configurator](#) to choose key units, illumination & control sub systems and more
- New: [dialog to limiting the number](#) of mag.x/Optem solutions displayed
- New mag.x lens: 8x objective. NA 0.32 with diffraction limited performance over all field [106mm x 55mm (L x Ø)] and 24mm working distance.
- New mag.x lens: 1.73x camera tube. With the new objective we go from four to nine possible mag.x systems
- Additions to mag.x accessories, including 2 new compact base units supporting polarisation filters, optional DIC module, X95 Carrier and a mount for the Direct adapter base unit - now available in base unit. Modified lighting options. Finger Lakes camera adapter for the 2.25x tube lens.
- Obsolete mag.x accessories - large base units - removed from configurator
- Refreshed mag.x setup and configurator dialogs
- Full metal mounts for some standard lenses
- Azimuth marked mounts for some standard lenses - best azimuth for line scan systems
- New camera adapter: M90

v4.1

- New lenses: Rodagon M42's 40, 50 & 60mm focal length - robust lenses for line scan in high vibration environments
- New lens: Rodagon 35mm - new design
- New lens: MeVis-C Traffic 1.6/25 – *minimal* focus shift under different lighting conditions
- New Modular Focus unit – more stable than older version
- Updated datasheets

v4.0.1

- New: [mag.x micro inspection system](#)
- Custom [mag.x setup dialog](#) to set specifications to get a specific mag.X system at top of results list
- Custom [mag.x configurator](#) to choose base unit, illumination sub system, filters and more.
- New lens: inspec.x float with 0.3x to 3.0x mag range
- New lens: flo.x - variable focal length optic [[see webpage](#)]
- New camera adapter: S Mount [for the flo.x lens only]
- Updated data sheets
- Help file completely revised

v3.9.0

- New lenses: MeVis-CF 16, 35 and 50mm; Macro-CCD lenses
- New camera adapter: M95
- Focus tubes and camera adapters for M95
- Updated data sheets
- Some small enhancements

v3.8.0

- New lenses: NIR lenses and inspec.x L lenses for use with prism as well as Apo-Rodagon N 90 and Rodagon 150
- Highlighted solution in result table remains highlighted when specification values are changed
- Remark column for lenses implemented
- Obsolete lenses are marked
- Many small enhancements

v3.7.1

- New lenses: Apo-Rodagon HR 0.5x, inspec.x L 3.5/105 5x included
- New adapter for inspec.x L lenses included
- New order numbers included
- Many small enhancements

v3.6.1

- Added two new lenses: Rodagon F 40 and Rodagon F 60
- Standard sensor dimensions are now displayed in the sensor dimension boxes if a standard sensor is chosen
- protection against corrupt INI file causing a crash
- Online help extended with a hint on using full diameter as object size

v3.5.1

- Links to 3D CAD data on the Qioptiq website included
- New Summary feature for concise overview of suggested solution
- New lens overview PDF added
- New lens added: inspec.x L 4/105 3.5x
- Apo Rodagon D1x is no longer used in retro position
- New address of Linos office added
- Small changes to the printout
- New datasheet for inspec.x M 2.8/100
- Online help extended (description how to set up a [camera list](#) is added)

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System requirements

General MachVis notes »

General: PC requirements

Excelitas MachVis has the following system requirements:

- PC with at least 1GHz CPU frequency
- 256Mbyte of Ram
- Screen resolution of 1024x768
- Keyboard and mouse
- Operating System: Win 7, Win 8 or Win 10

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Accuracy statement

General MachVis notes »

General: results accuracy statement

To the best of our knowledge, the results calculated by MachVis are accurate, and have been repeatedly confirmed in real world usage, by Excelitas engineers and experienced users. However the software is provided free of charge and without any guarantee of correctness by Excelitas Technologies Corp..

In case you find any errors please contact Excelitas Technologies at the address given on the [contact page](#) for Machine Vision.

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Excelitas - contacts

Excelitas Technologies »

Excelitas webpages & contact info

Qioptiq Photonics is an [Excelitas Technologies](#) company and is a world leader in the design and manufacturer of photonic products and solutions.

1: Machine Vision at Excelitas Technologies

Main Excelitas webpages for machine vision:

- www.excelitas.com/application/industrial-manufacturing/machine-vision-and-inspection - machine vision market areas
- www.excelitas.com/product-category/inspection-and-machine-vision-lenses - machine vision lens overview
- www.excelitas.com/product/magx-125-widefield-microscope-system - mag.x systems webpage inc brochure pdf
- www.excelitas.com/product/optem-fusion-micro-imaging-system - Optem systems webpage inc brochure pdf
- www.qioptiq-shop.com/en/Precision-Optics/LINOS-Machine-Vision-Solutions - Q-shop: machine vision section

NB web pages will be opened in your default browser

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2: Excelitas - general

Main Excelitas webpages:

- www.excelitas.com - home page of main website
- www.excelitas.com/product-category/linos - world famous LINOS catalog [optics and opto-mechanics]
- www.qioptiq-shop.com - home page of Q-shop [our e-commerce site]
- www.winlens.de - home page of lens design software site

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