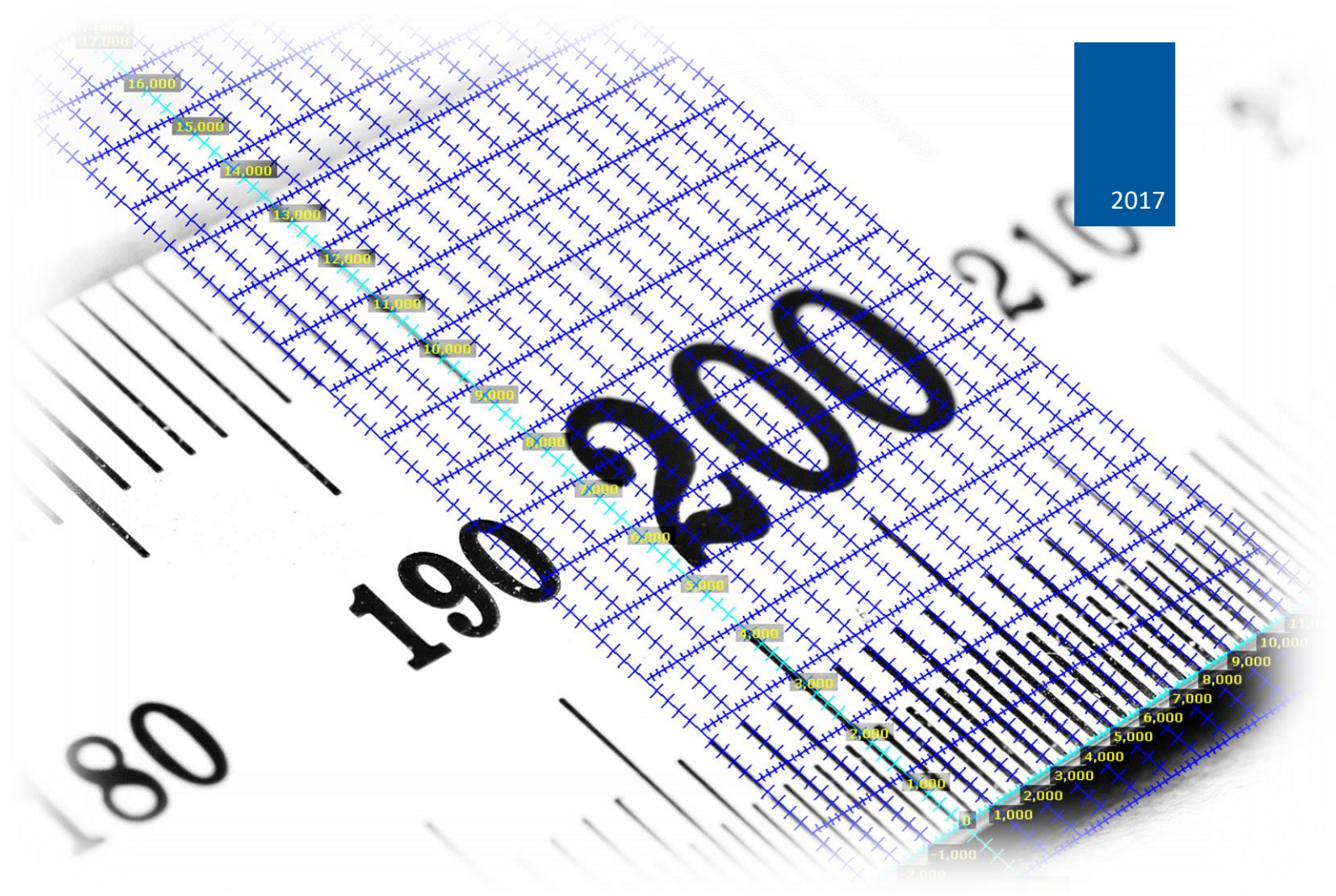


2017

MERCURY® RT

REAL-TIME TRACKING SYSTEM

GETTING STARTED STEP-BY-STEP WALK-THROUGH

ING. PETR GAJDOŠ

Universal Grip LLC - 72 Loring Ave. St. #2 - Salem, MA 01970 USA - 1.978.882.1480 - www.universalgripco.com

Content

1 Installation

Follow the Installation Guide.

2 Licensing

2.1 SW license

To get a software license bonded to a PC a license request has to be generated and sent to license.request@mercuryprogram.eu

Caution: License request must be created on the same PC where the application is to be used and will not work on any other computer.

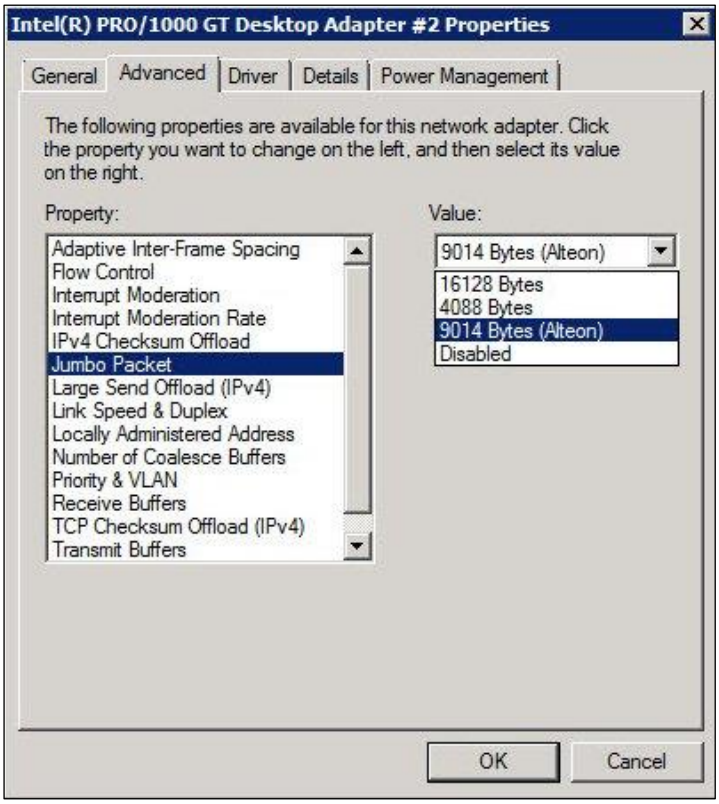
2.2 HW license

License can be bonded to a USB HASP key. This is aimed for use in industry where malfunction of PC must be quickly solved and therefor the license can be carried on this HW key.

3 Camera Connection

For well function of digital image correlation use **monochrome cameras** with **global shutter**. (Rolling shutter will lead to distorted images during faster movements; rolling shutter can be used only for snapshot based measurements).

3.1 Ethernet



When connecting Ethernet cameras make sure that the network adapter is capable of 1000Mbit/s data flow and allows to set large Jumbo Packets of 9k MTU. This is done in properties of the network adapter.

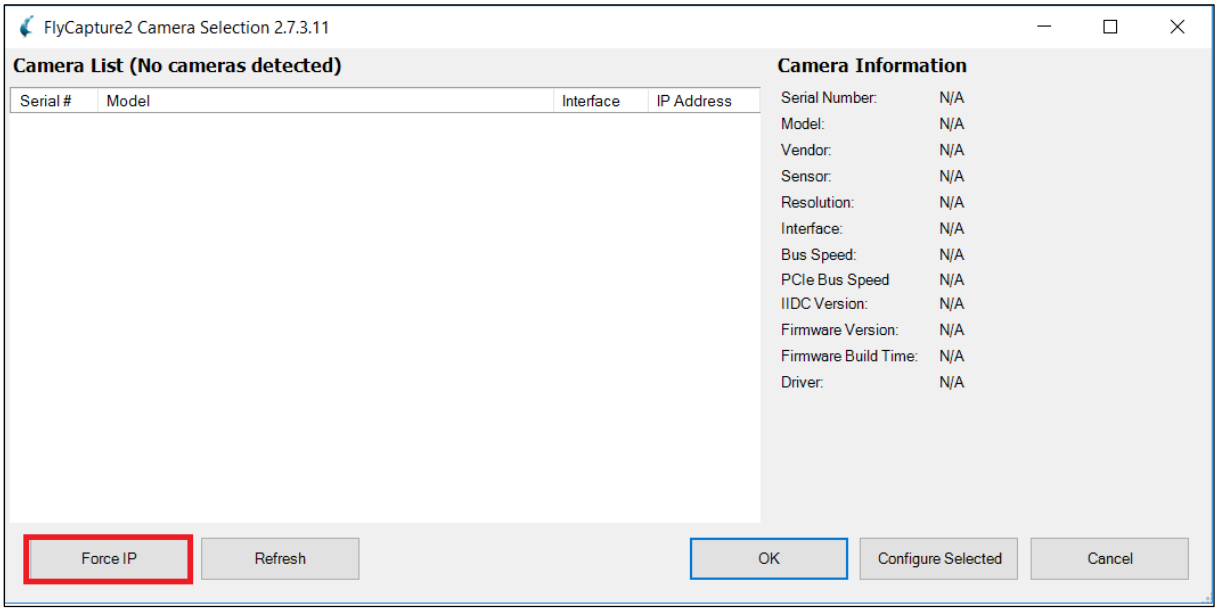
Not setting of this packet size may cause the camera not using the whole capability and runs on smaller FPS.

Also make sure that the used cable complies with CAT5e.

Ethernet cameras needs to be powered as Ethernet cable does not carry a voltage. However there are special network adaptors designed for Giga Ethernet Vision (Frame Grabbers) with function of PoE (Power over Ethernet). These adaptors can power the camera through the Ethernet cable. If PoE is not available an external supply must be provided using the GPIO connector on the back side of the camera.

3.1.1 PointGrey Cameras

All PointGray cameras usually have the same default IP address. So when using more than one at the time open PointGrey FlyCapture software, select one of the cameras, and press Force IP.



3.2 USB3

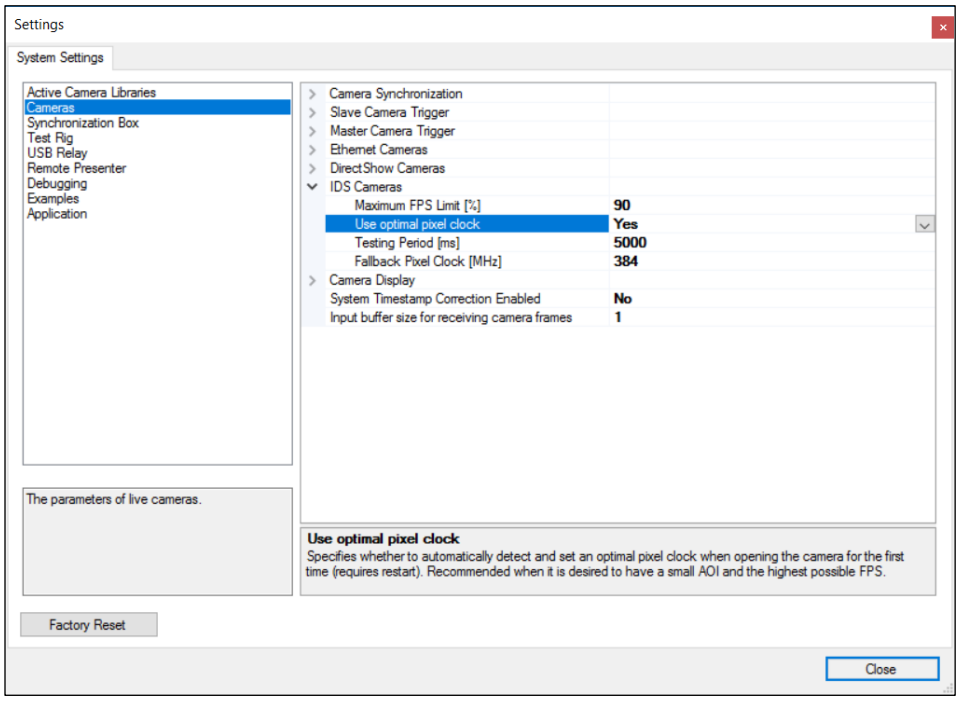
USB 3 camera is powered through the USB bus and such it does not need external power. Cameras on this kind of bus are generally faster than GigE cameras, but this speed brings some restrictions.

For stable function of USB 3 cameras make sure that:

- Camera is connected to dedicated PCIe card. If there is a need to use integrated USB adaptor on motherboard look for USB chipset by Renesas
- No other device (mouse, keyboard, printer) is plugged into the same bus as the camera (if the PCIe card is dual or quarto port 2 or 4 cameras can be connected)
- Use only USB 3 Vision complied cables of length ≤5m. If possible use rather shorter cables such 3 or 4m
- Use ≤95% of maximal FPS

3.2.1 IDS Cameras

IDS USB3 cameras allows to use one custom feature that comes really handy. It is called Optimal Pixel Clock. This tries out the capability of the adapter and searches for the maximal stable speed. This feature can be activated in Settings.

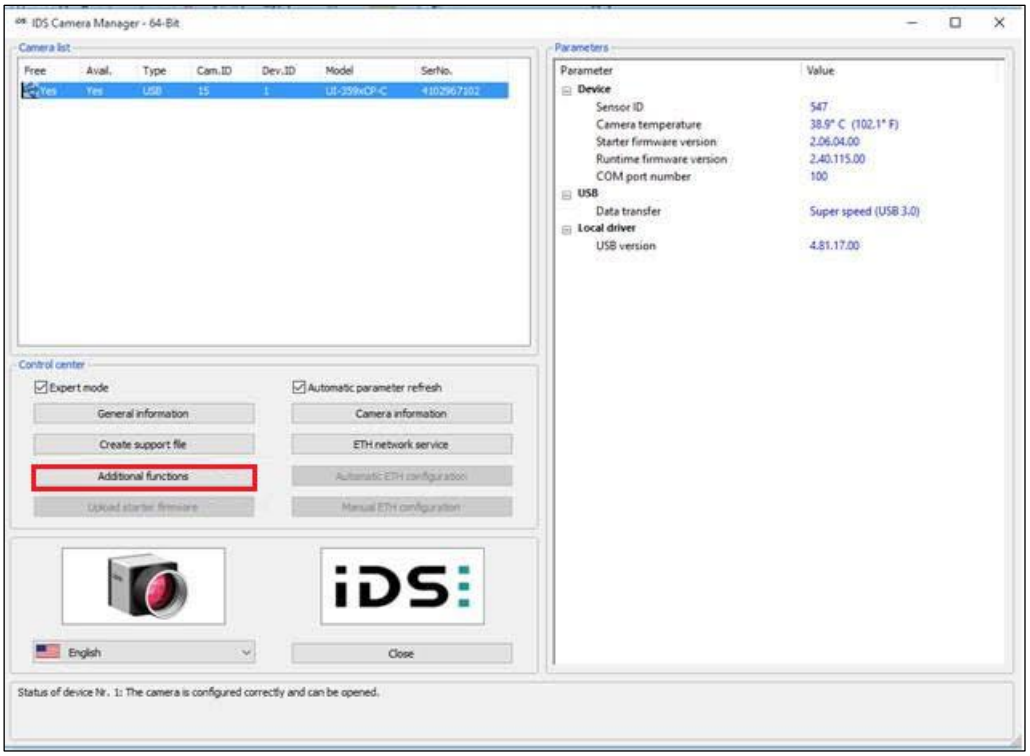


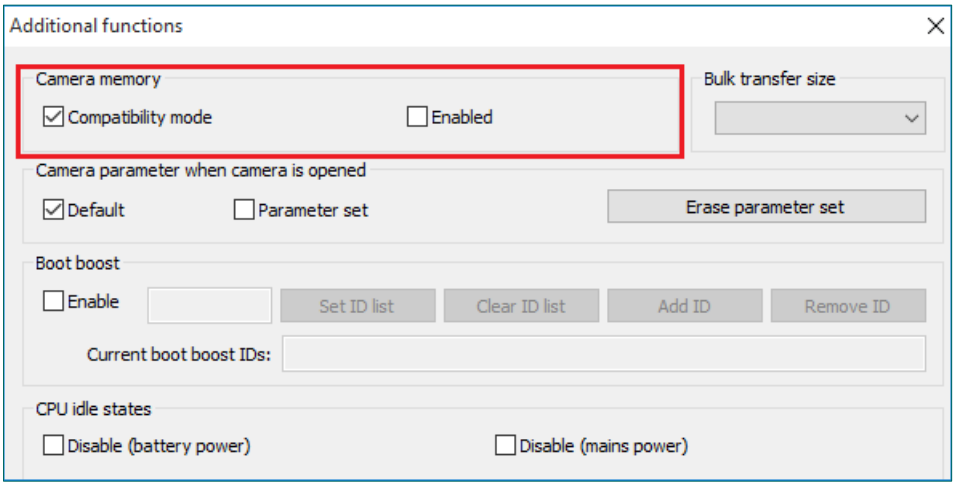
Caution: This feature can be used only when the internal memory of the camera is disabled. Otherwise might lead to MercuryRT crash. Here is the message from log.txt

```
FATAL: Unhandled exception on domain thread.
MercuryRT.Domain.Cameras.Devices.IDSCameraException:
IDSCamera: Optimal() failed! (NOT_SUPPORTED)
   by MercuryRT.Domain.Cameras.Devices.IDSCamera.InitPixelClock()
```

In such a case the internal camera memory can be disabled by running the IDS CAMERA MANAGED. Select the camera and press Advanced Functions. And uncheck the Camera Memory.

Second option is to set the parameter Use optimal clock to NO and set the Fallback Pixel Clock manually.


IDS Camera Manager - 64-Bit
Camera list
Free
Aval.
Type
Cam.ID
Dev.ID
Model
SerNo.
Yes
Yes
USB
15
1
UI-359xCP-C
4102967102
Parameters
Parameter
Value
Device
Sensor ID
547
Camera temperature
38.9° C (102.1° F)
Starter firmware version
2.06.04.00
Runtime firmware version
2.40.115.00
COM port number
100
USB
Data transfer
Super speed (USB 3.0)
Local driver
USB version
4.81.17.00
Control center
Expert mode
Automatic parameter refresh
General information
Camera information
Create support file
ETH network service
Additional functions
Automatic ETH configuration
Upload starter firmware
Manual ETH configuration
English
Close
Status of device Nr. 1: The camera is configured correctly and can be opened.

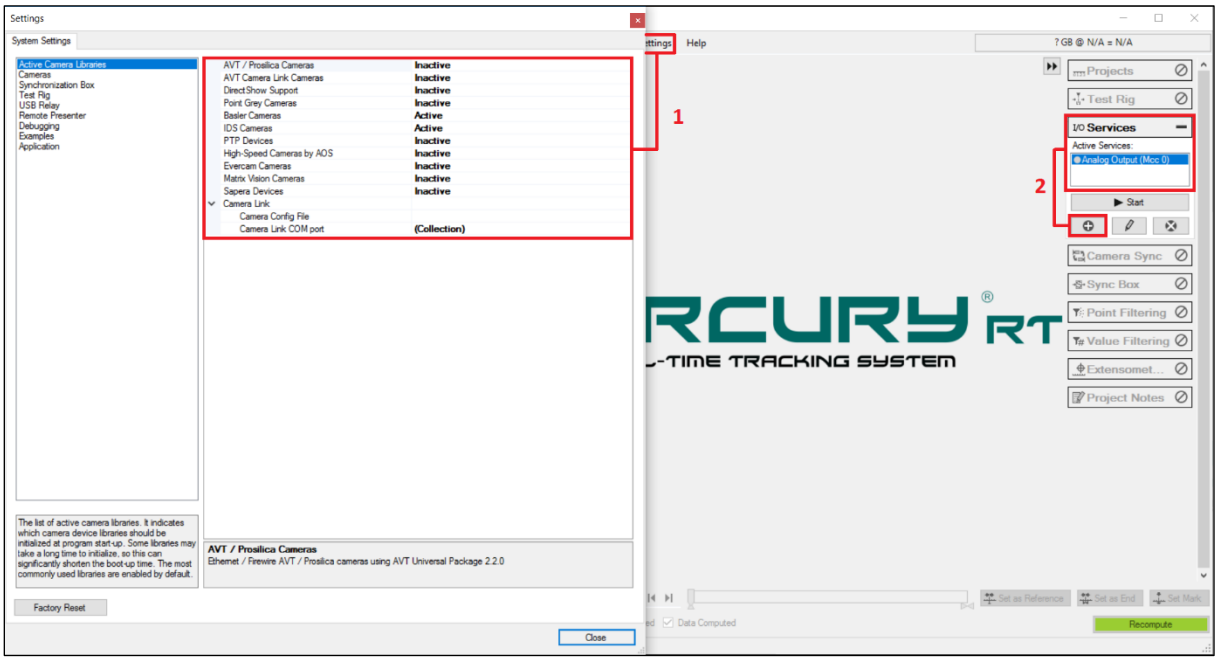

Additional functions
Camera memory
Compatibility mode
Enabled
Bulk transfer size
Camera parameter when camera is opened
Default
Parameter set
Erase parameter set
Boot boost
Enable
Set ID list
Clear ID list
Add ID
Remove ID
Current boot boost IDs:
CPU idle states
Disable (battery power)
Disable (mains power)

4 Running the MercuryRT for the first time (Mono-2D)

4.1 Initial setup

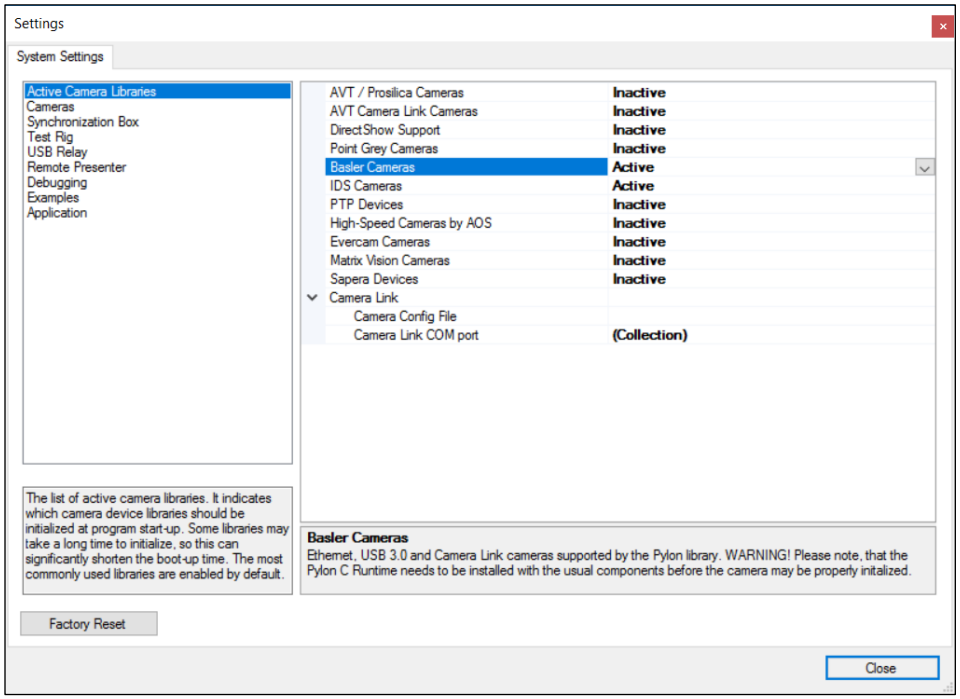
While launching the application for the first time you will be asked to select the active camera libraries that you will actively use. This can be later changed in settings.

Following Image shows the first two things that should be set. The firs is set the camera libraries and the second set the mean of getting the data out of MercuryRT.



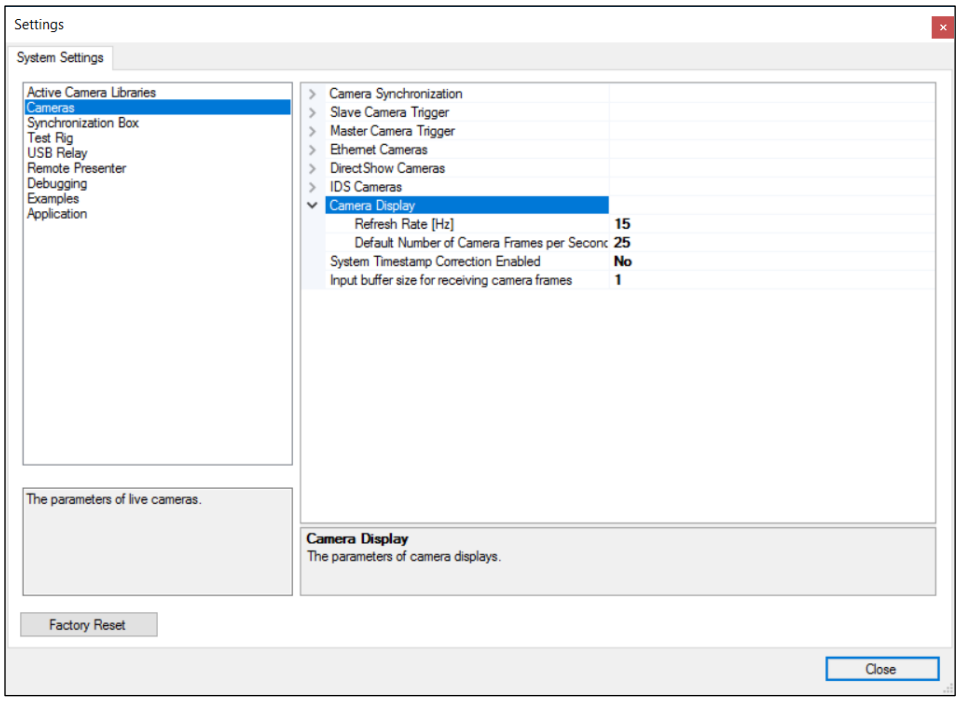
4.1.1 Camera Library Selection and Setup

Easily set to Active all camera libraries you know that are to be used with this system. But remember that the more the libraries are activated the more cameras are to be searched during the start of the program. So having all the libraries activated may lead to MercuryRT starting quit long.



Following setting is more like optional than needed.

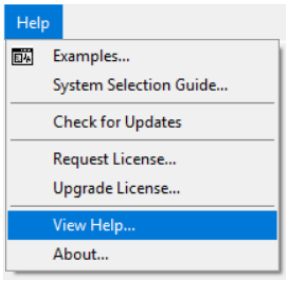
Refresh Rate – this sets the number of refreshes of the camera window. This can save some PC performance for correlation, as it does not refresh the camera window. Setting this parameter to 10 or 15 can help to calculate more images per second when using high fps (over 200 or such). But still fluent enough to see what is going on in the field of view.

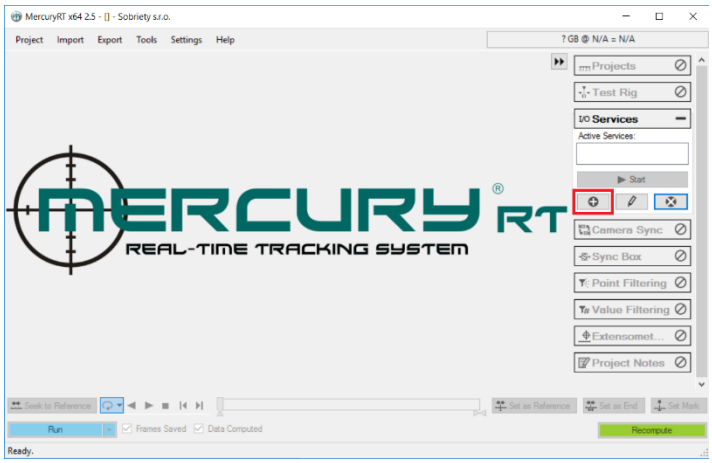


Default Number of Camera Frames Per Second – this is what you read. A number of frames per second the system tries to set (only tries because the camera can have lower maximum) with a new project.

4.1.2 Output Configuration

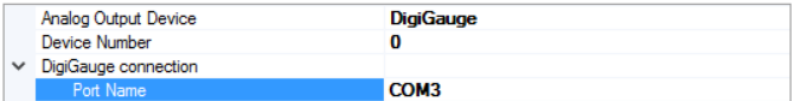
To set the Output follow the Reference Handbook chapter 8.1. The handbook can be found in Help/View Help…





To set which value is to be send o output see chapter 4.2.8.

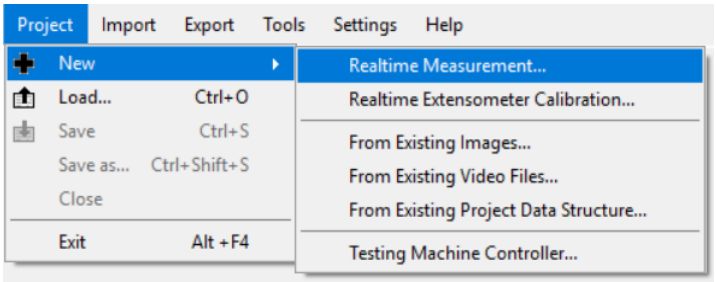
Caution: Enter Name in format of COM#, not only #



Caution: When using serial RS232 cable to connect PC and machine, use crossed cable.

4.2 Creating New Project and its Setting

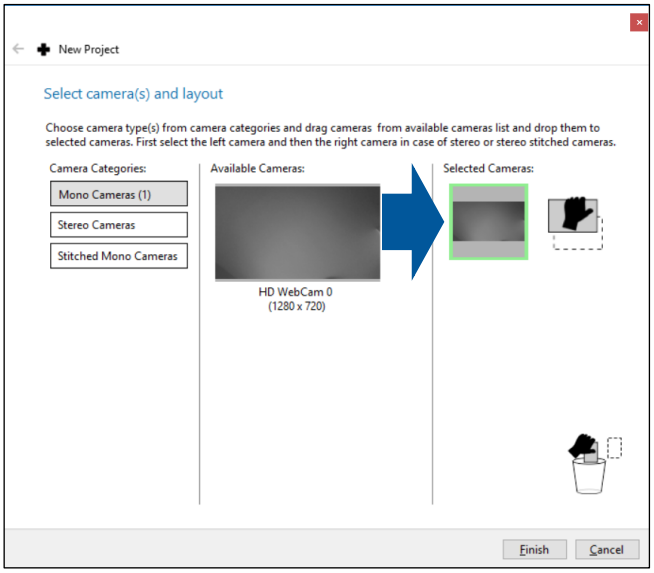
To create new project go to Project/New/Realtime Measurement… and select directory to save the project file.



Caution: Project consists of one file like *MyProject.mpr* and folder with calibration and image data that is called *Data_MyProject.* This means that when copying the project both file and folder needs to be copied.

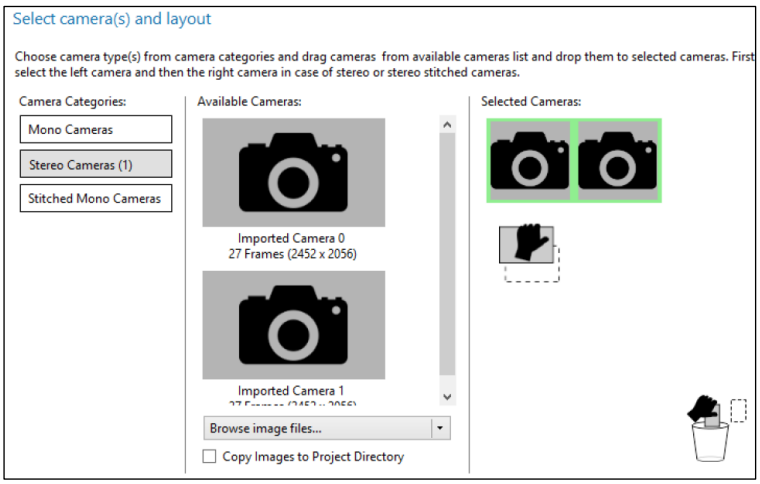
4.2.1 Camera Selection

When New Realtime Measurement pressed camera selection window with list of connected cameras will pop up. Here the camera configuration can be set. To select the camera use drag and draw to move the camera view to the right side of the selector



Mono Camera – used for 2D measurements. One or more cameras can be used.

Stereo Camera – To create a camera stereo pair drag two individual cameras and assign them as Left and Right Camera.



Note: Easiest way of recognition left and right is to cover or wave in front of the left camera to recognise it in the selector.

Cameras can be combined between each other. With three cameras three stereo pairs can be created. (**CAM1-CAM2**; CAM2-CAM3; **CAM1-CAM3**)

Stitched Mono Cameras – used for 2D measurements with extended field of view. Used for measurements where a measured point travels from CAM1 to CAM2 or for cases where there is a gap between both fields of view.

After selection press **Finish** to open the Camera Window.

Caution: Make sure that GAIN of the camera is set to 0.

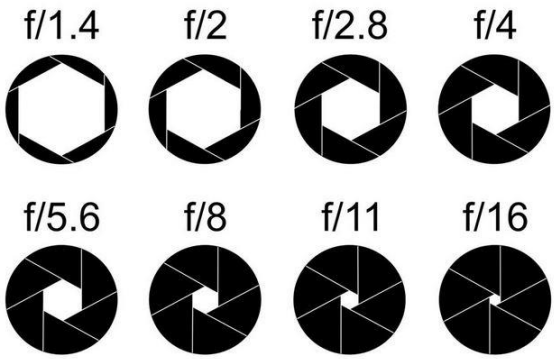
4.2.2 Setting the Scene

To set the scene and prepare the system for calibration following steps have to be performed:

- **Light setup** – turn on the light and point it towards the measured area. The brightness of the picture can be modified in two ways.

IRIS aperture on the lens

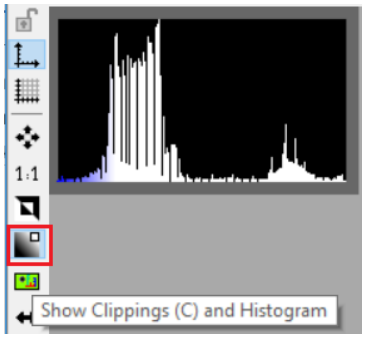
The aperture regulates the amount of light incident on the surface of the camera sensor. However more light brings possibility of short shutter time which is desired, small aperture number causes thin Depth of Field. In addition, the best optical performance of the lenses is generally in the middle of the range. **So recommended setting is between 4 and 11.**



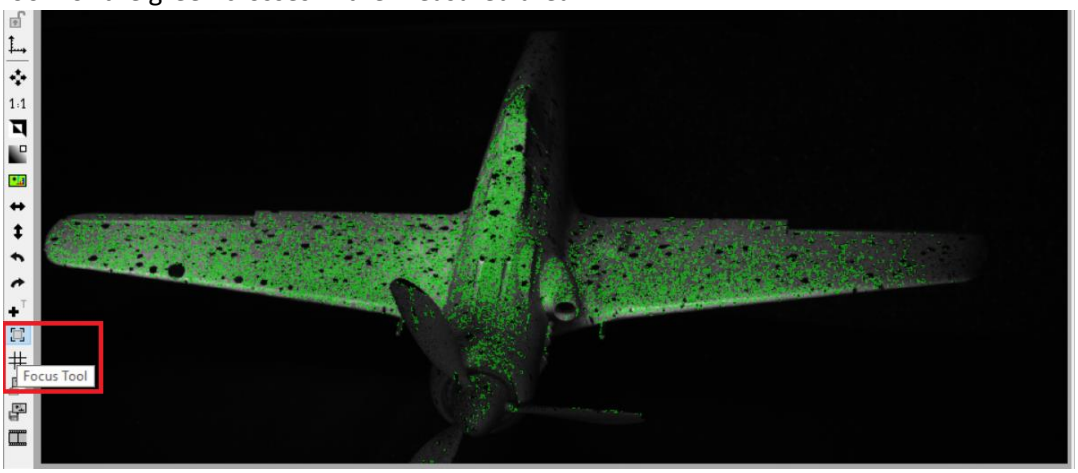
Shutter Time

Adjusting the exposure time should be the second step after setting the aperture. This value should be as low as possible to minimize the risk of motion blur that would lead to worse resolution of the system.

Set the shutter time in such a way that there is no blue or red pixels on your specimen when you have Show Clippings enabled. (Reference Handbook chap. 3.2)



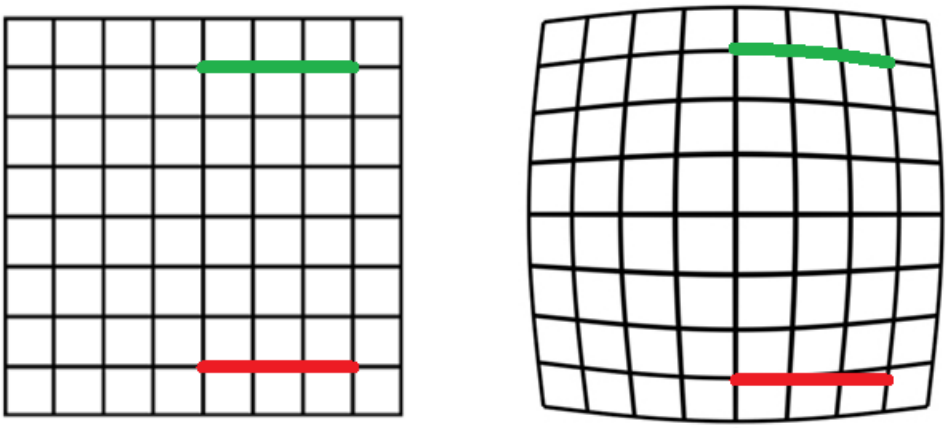
- **Focus the camera** – To focus the camera the easiest way is to use our Focus Tool that marks the highest contrast with the green cross. Simply turn the focus ring on the lens and look for the green crosses in the measured area.



4.2.3 Camera Calibration

Camera calibration also called **Distortion Compensation** is performed for two reasons.

The first reason is that it compensates the distortion of the lens it has for its spherical shape. Following image shows the reason of need of distortion correction.

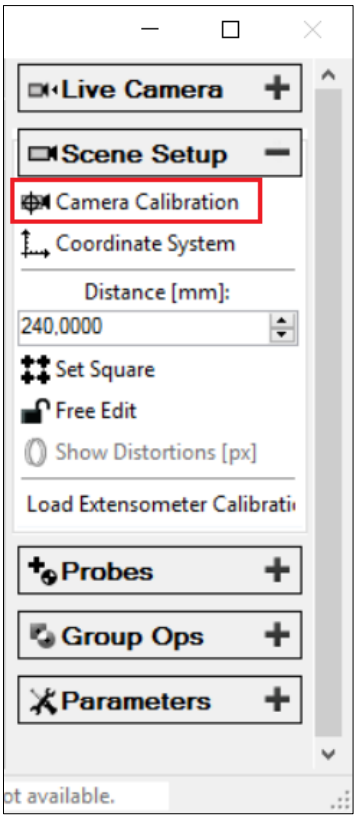


Object Barrel Distortion

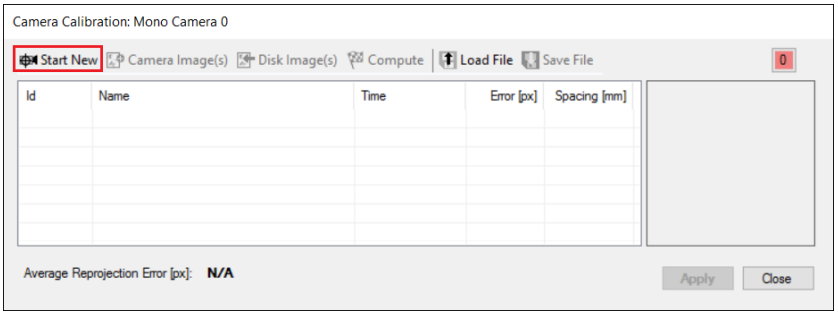
Let horizontal direction be X-axis and vertical direction Y-axis. And let the lines represent movement of a point from centre to the side of the grid. You can see that both trajectories are in X direction only. When correction applied, the system calculates the true position and keeps the movement as uniaxial. When correction is missing, even the point moved along X-axis only the system would evaluate the movement as X and Y displacement.

The second reason is that the system computes the mathematical model of the lens and enables to compensate the perspective so a plane offset can be applied. This is very useful feature for creating measurement templates for different sample widths.

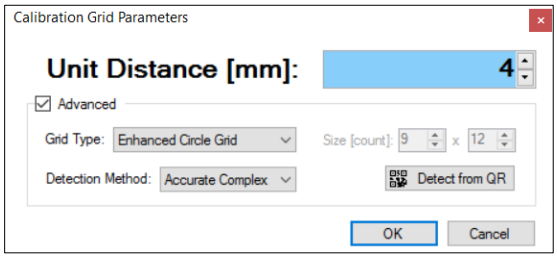
To perform the calibration press the **Camera Calibration** button in the Camera Window.



Camera Calibration dialog window will appear. Than select **Start New**.



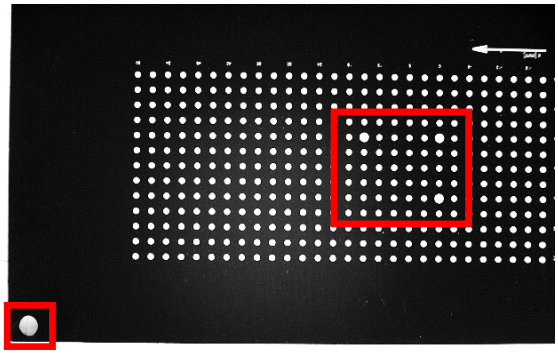
Now **Grid Type**, **Detection Method** and **Unit Distance** have to be set.



See next page

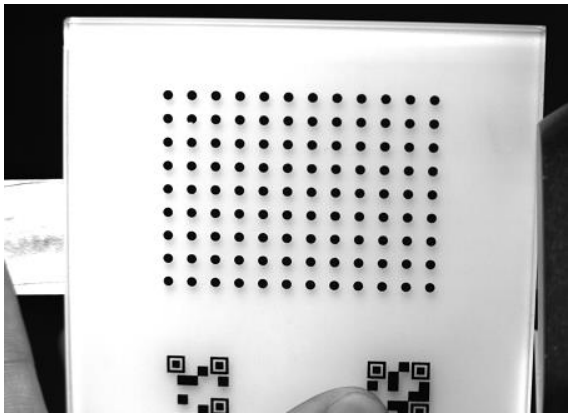
Grid Type – There are three supported grid types.

- **Enhanced circle grid** – mainly used grid type since v2.4. When using this grid a **Unit Distance** is labelled on the grid. **Three bigger dots must be visible for the camera together with one row of dots on each side.** Grid can cover the whole Field of View.

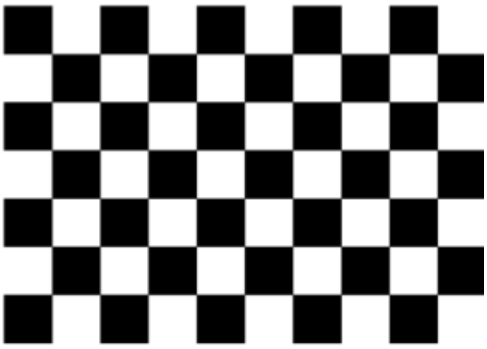


Caution: Holes in the corner of the grid are due to a production reasons and in some cases may lead to malfunction of the detection algorithm. In such a case, place the grid in a way that the hole is not visible on cover it.

- **Circle grid** – grid type used for versions 2.0 – 2.4 (still supported). The **Unit Distance** and **Size** (12x9) coded in the QR codes on the grid. To read them press **Detect from QR**. When using this grid type **all dots must be seen** in the camera. The grid should cover 1/3 to 2/3 of Field of View



- **Chessboard** – this grid type is supported but never has been delivered together with MercuryRT system. The Unit Distance is size of one black or white field and Size is the number of the intersections. Here 9x6. The whole grid must be visible.

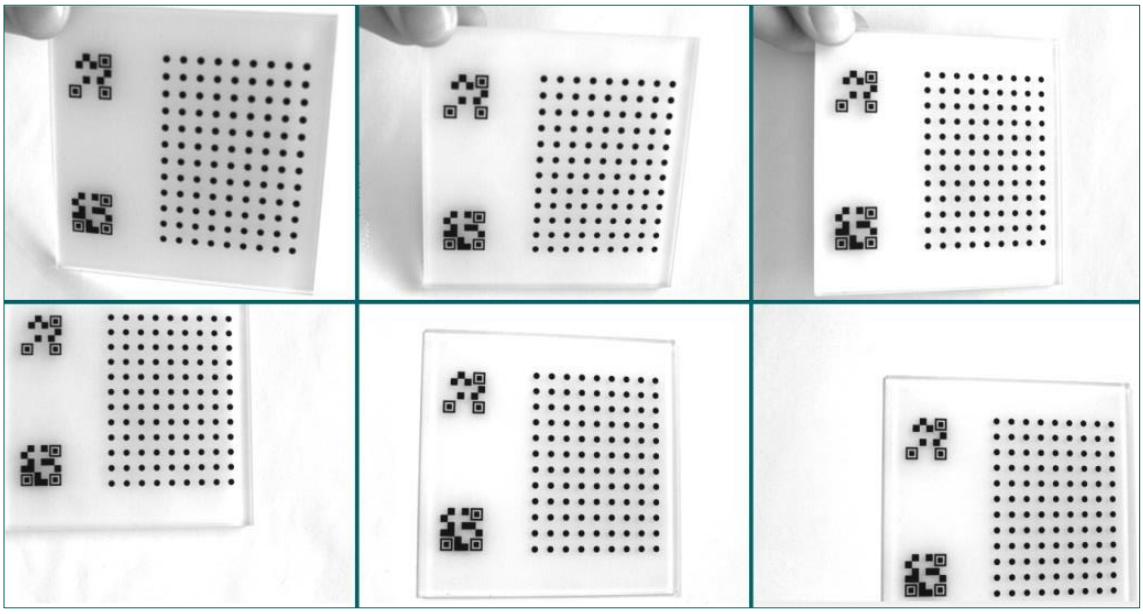


Detection Method – Method of the grid detection. Is comprised of the following

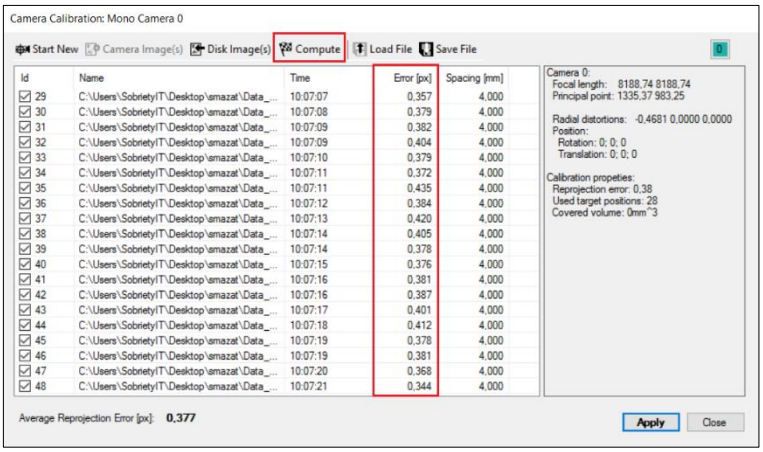
- **Fast** – the grid is detected faster for the price of a decreased accuracy.
- **Accurate** – the grid is detected slower with the benefit of an increased accuracy
- **Complex** – allows the algorithm to take more time and to choose different parameters in order to successful grid finding. This method cannot be used when using a chessboard grid.

Note: **Use the Accuracy Complex method. The fast method reduces the image in a first step to make the detection faster. The time difference is not significant for cameras with resolution <12Mpx.**

Now start capturing the grid images by pressing the **Camera Images** button. At the end, the images should cover the whole FoV and cover **also different angles.** If the detection fails, try to set the Shutter Time 1 or 2ms higher to high the contrast on the grid.



Caution: **Showing the grid under different angles and not only parallel to camera sensor is very important. Based on these images the system calculates the perspective and focal length of the lens and can perform the plane offset.**

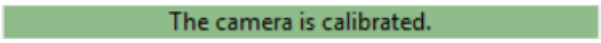


After capturing at least **15 images** press **Compute** button at the top of the window.

When computation done, an **Error** value for each image will appear. This is represents a re-projection error of the dot centre. This value can lay in interval between 0.05 and 0.6px. This does not mean that the system will have an error of 0.377px (value from image). This value is more or less senseless for the user. The only thing it is good for is to check if any significantly exceeds the other. This can be caused by motion blur of this single image.

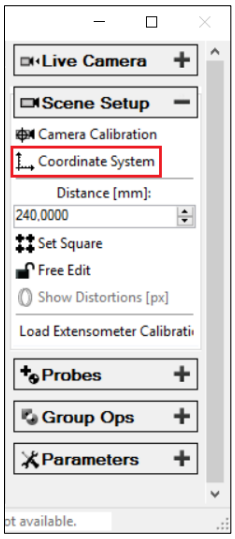
Caution: **Do not remove images with slightly higher error. These images can be those with more acute angle and carries more perspective information. Remove images with error higher 1px (for standard measurements). Better to have more even a worse images than just few "nice ones".**

When Apply button pressed a previously red bar in the Camera Window becomes green and the calibration is done.

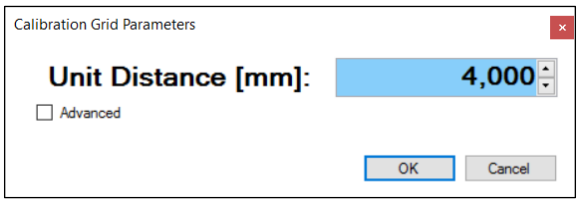


4.2.4 Setting the Coordinate System

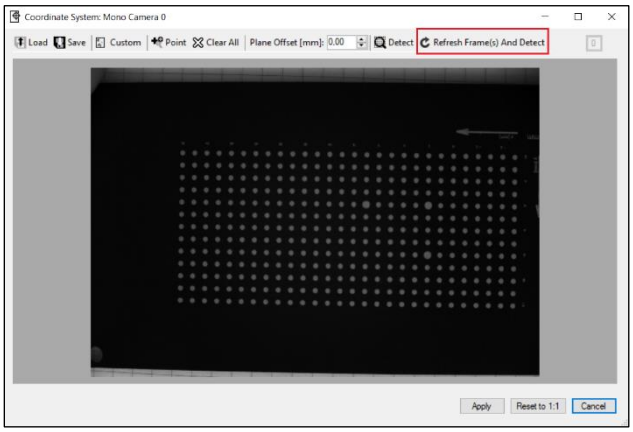
Coordinate system sets the ration between pixel and physical unit, millimetre, and defines the measurement plane, that does not have to be parallel to the camera sensor plane.



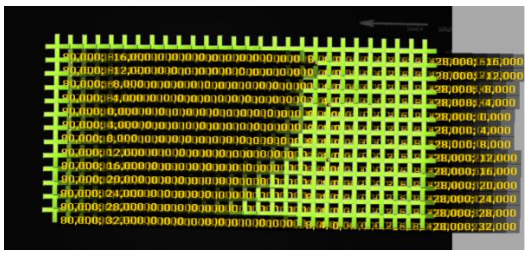
To start the Coordinate System setting press Coordinate System button to open proper dialog window. If calibration parameters were set during the Camera Calibration, parameters are filled in automatically. If not, or a different grid is used, these parameters must be filled in (see chap. 4.2.3).



To set the Coordinate System properly place the grid into the measured plane. This can be done by placing the grid into the grips of the test machine or pressing the grid towards the specimen clamped in the grids.

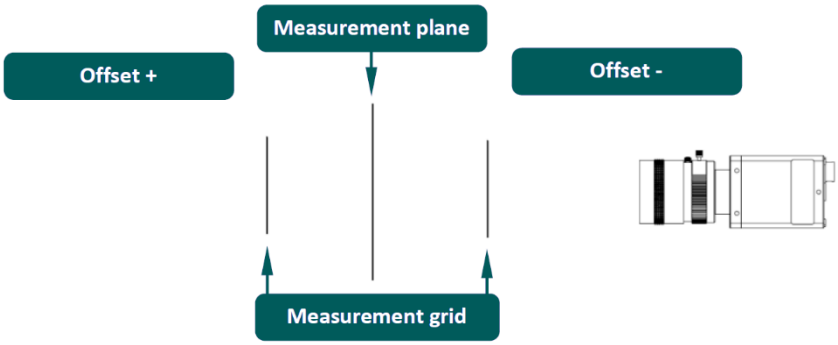


After placing the grid into the right position press **Refresh Frame And Detect.** When the detection is successful green crosses are placed over detected dots of the grid.



After detection the Coordinate System is set, however to the wrong plane. The system now “lays” on the grind and not on the specimen. To correct the working plane use the **Plane Offset** feature.

When Calibration done and perspective known, Mercury can move the measuring plane closer or farther from the camera.



If the grid is pressed towards the specimen, enter the grid thickness to get to the surface of the specimen:

- MercuryRT black aluminium grid thickness 3mm
- MercuryRT white glass grid thickness 4mm

Recommended procedure is to set the Coordinate System to the axis of the machine for the first project and that create measurement templates for different sample thicknesses by copying the first setting.

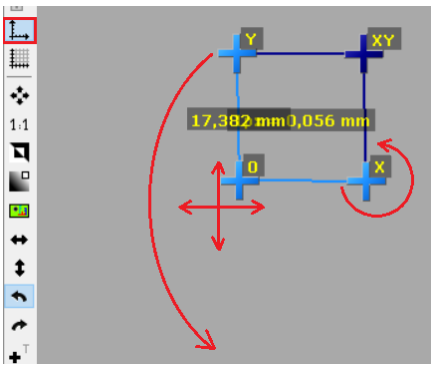
When setting the Coordinate System for different templates, the type of used grips has to be considered.

For wedge grips only half of the specimen thickness will be entered.

For vise it is beneficial to measure from the fixed side as the measurement plane will not change.

After Applying the Coordinate System it can be adjusted in the Camera Window. Move it by dragging by ZERO, rotate it by dragging point X and flip the Y direction by dragging the point Y.

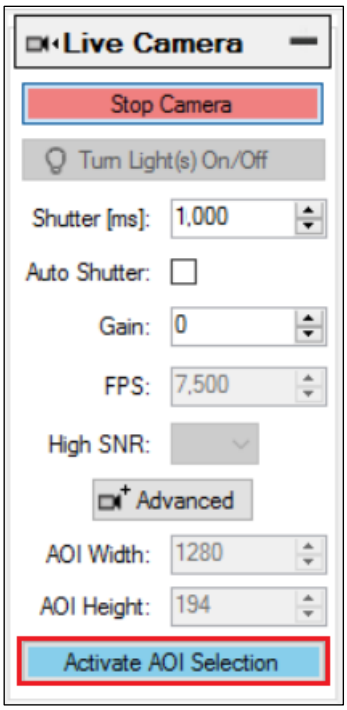
System can be hidden to prevent the unwanted change.



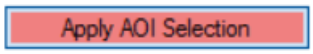
4.2.5 Applying Area of Interest

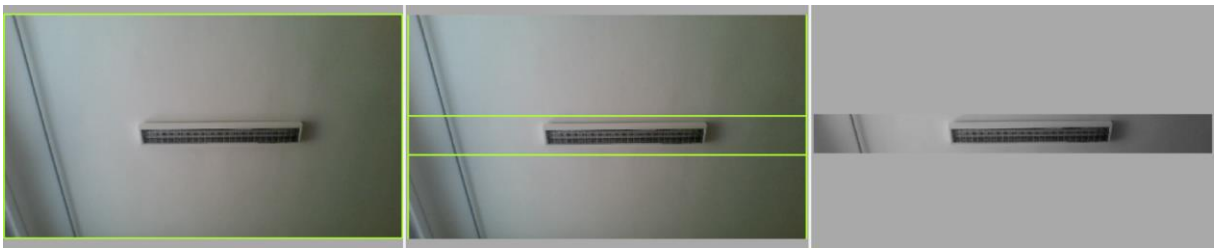
Area of Interest (AoI) is feature that lowers the read-out number of pixels of the camera sensor. This feature is used for two reasons.

- **Higher FPS** – the frame rate of the camera is usually limited by the bus. It is just impossible to push more data through. But when the AoI is applied each image can be made smaller and therefore it is possible to get more images per second through.
- **Drive space and performance saving** – even when high frame rate is not needed smaller image can save space on the drive and also saves some PC performance as the algorithm does not have to search bigger images.



To set the AoI press **Activate AOI Selection** button in Live Camera section of the Camera Window. When green lines appear, drag them to set optimal Area of Interest. When the width is not measured, it is not necessary to see the edge of the specimen and it is possible to obtain higher FPS. When the selection done, confirm it by pressing **Apply AOI Selection.** With the same procedure, the AOI can be reset.

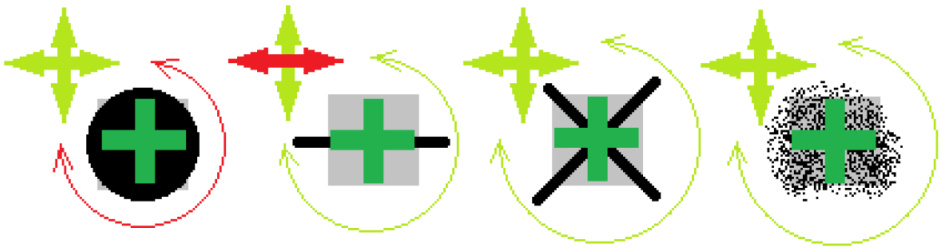




4.2.6 Specimen Preparation

High number of specimens can be measured without applying an additional pattern but marking is robust and sometimes unavoidable. Mainly for materials without distinctive texture such as polished metal or polymers. These materials has none or almost none pattern and therefor caries no information.

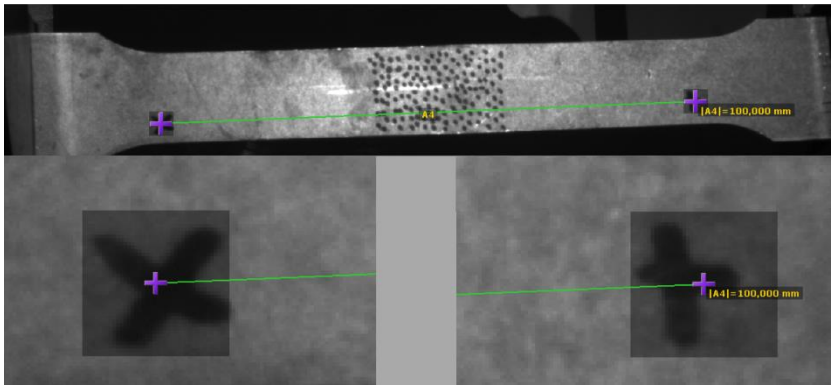
Most basic way to mark the specimen is to use a marking pen like Schneider MAXX 130. **No exact mark is needed just anything that will create contrast on the surface and will deform with the specimen.** However making a cross or speckle pattern is the best choice as it removes all Degrees of Freedom.



Following chart shows which DoF are constrained with different way of marking.

	DOT	LINE	CROSS	SPECKLE
Horizontal translation	YES	NO	YES	YES
Vertical translation	YES	YES	YES	YES
Rotation	NO	YES	YES	YES

The marks do not have to be made very precisely at the Gauge Length distance just close to it. MercuryRT allows the user to set the precise Gauge Length manually and the only needed thing is to have some contract in the dark are around the measured points (Correlation Template).



The most common way to apply the speckle patter is to use a spray paint. We recommend using **matt white** to apply a thin layer of base color and **dark red primer** for dots.

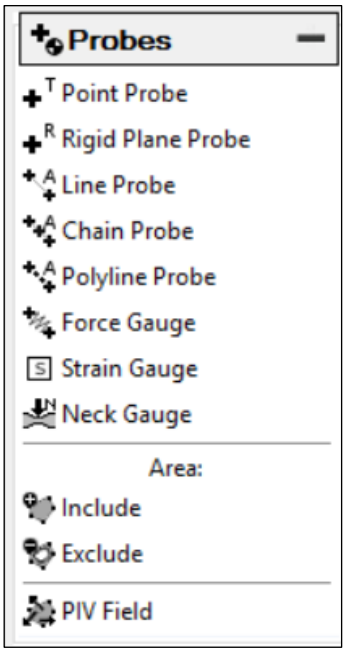
Note: **The layer of the base color should be as thin as possible. Just to prevent reflections. This is crucial at high deformations. Thick layer of paint may create a crust that will crack.**

To create fine dots (small sized specimen) use quick motion over area of interest or spray through some very fine metallic mesh.

To create larger dots (medium sized specimen) throttle the spray (pressing the throttle just a little until larger blobs start to come out.

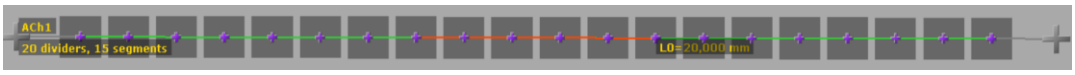
4.2.7 Setting the Measurement

With Calibration done and Coordinate System set it is time to setup the measurement by applying different kind of measuring probes. Right click on the inserted point opens its dialog window to select measured value. **See following chapters for Length and Width measurement.**

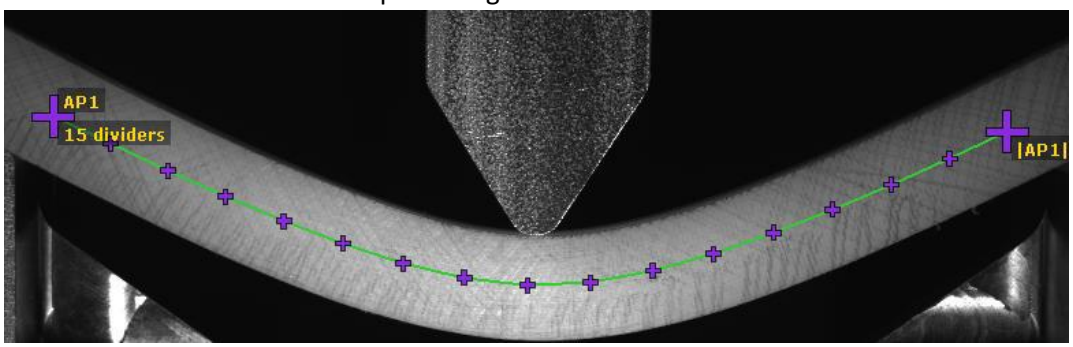


- **Point Probe** – tracks movement at the selected point. Measures displacement, velocity or acceleration. Euclidean or directional
- **Rigid Plane Probe** – sets the rigid points in the field of view such as stable parts of machine. This point is used in very small number of cases.
- **Line Probe** – basic extensometer. Measures change of distance between two points. Can measure total length as well as delta of this length. Measures in physical unit or in percent. Allows width measurement in one point that keeps its relative position along the line (e.g. 28% from start point). Length and orientation can by set manually.

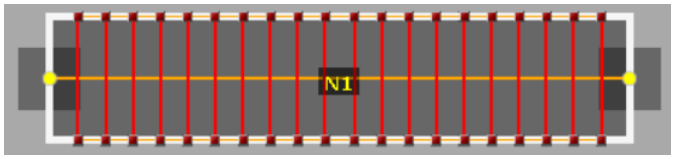
- **Chain Probe** – finds its place in measurement of longer prismatic samples with small measured length. Finds the highest elongation along the sample and allows to measure over the neck.



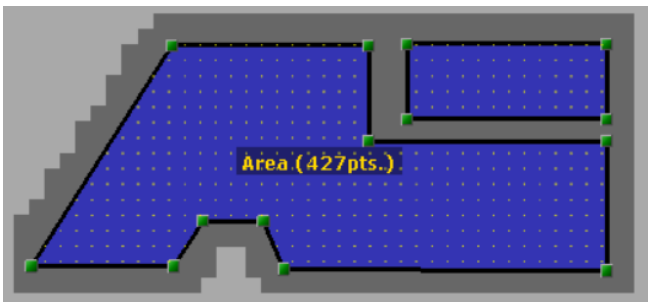
- **Polyline probe** – helpful during bending tests. Measures elongation as basic line but polyline is divided into subsections with inner points that are being tracked and so it can follow the curvature of the sample during the measurement



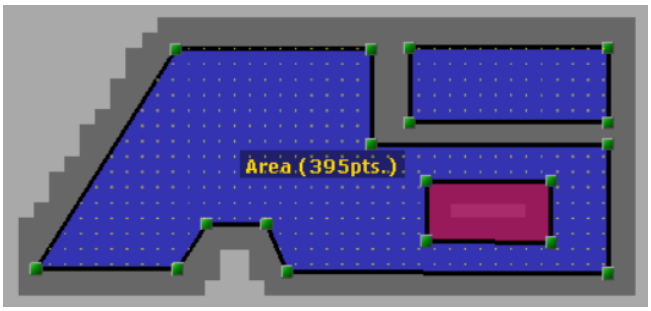
- **Force Gauge** – mainly for education purposes. Hooks law calculator. When stiffness entered returns force during elongation.
- **Strain Gauge** – simulates a foil strain gauge and allows strain measurement. Can visualize direction of major and minor strain and **is always aligned with the Coordinate System**.
- **Neck Gauge** – recommended probe for width measurements. Can be divided into subsections. Neck gauge automatically detects edge of the specimen and searches for the highest gradient of deformation (transverse contraction).



- **Area Include** – sets boundary points for FullField measurement and defines the area of interest. Area inside of these points is uniformly filled with the measurement points. Even the area is split into more isolated areas it is computed as one.



- **Area Exclude** – sets boundary point for area that should be excluded from the measure area.

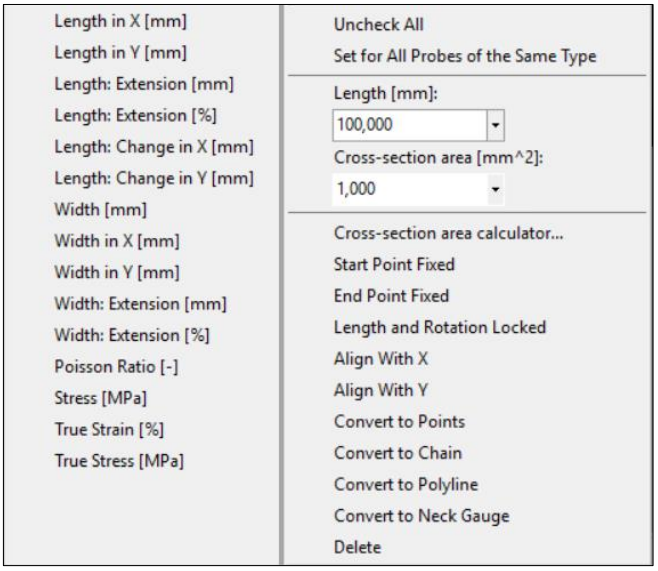


Note: **SHIFT + MouseLeftClick can delete Probes**

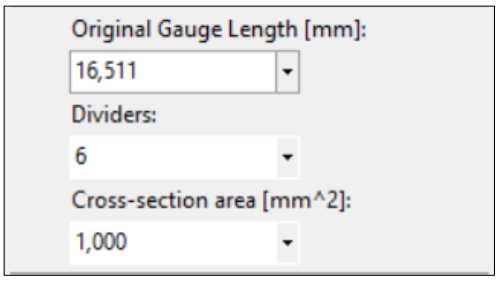
4.2.7.1 Length Measurement

To measure the length or longitudinal elongation the **Line** or **Chain Probe** is commonly used.

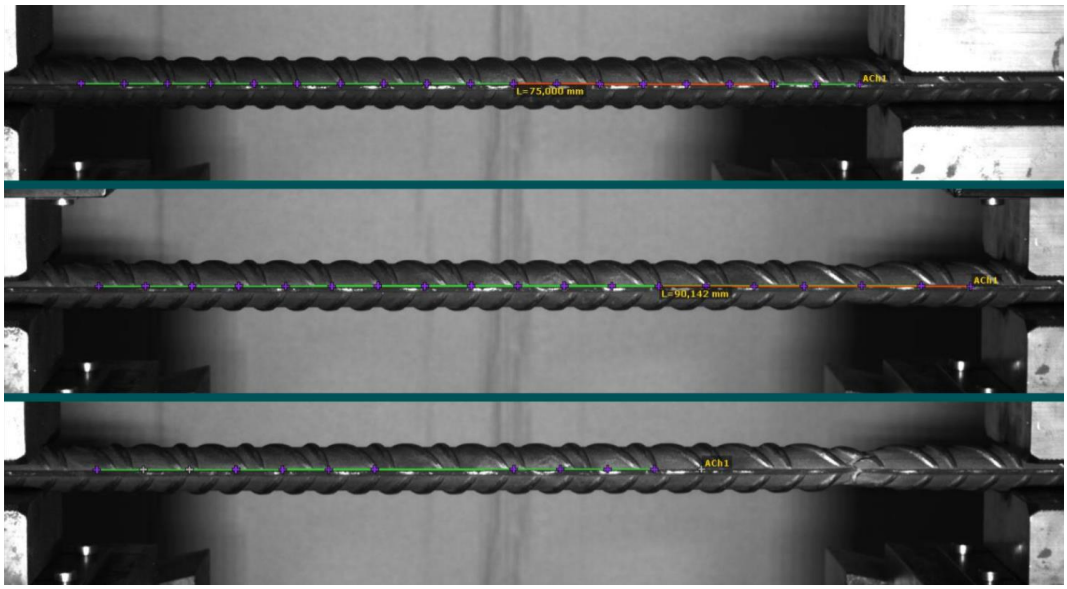
- **Line Probe** – applicable for most of the basic measurements. Just place the line on the specimen in measurement direction and in dialog opened by right click on the line select desired value. Than set the **Length** as initial Gauge Length.
  Stress can be calculated if a force signal is acquired.



- **Chain Probe** – origin of this probe is in concrete steel measurement. Typical use is for long specimens with small Gauge Length (e.g. 400mm sample size, 70mm gauge length) and standard says that the measurement must be performed over the crack otherwise the test is invalid.



Apply the probe over whole length of the specimen and then open the dialog. Divide the probe into higher number of sections in **Dividers** box and set **Original Gauge Length**. **Recommended number of dividers is 19** because when one point is lost it is more than 5% of points and reference image is refreshed (description later within Incremental Step).

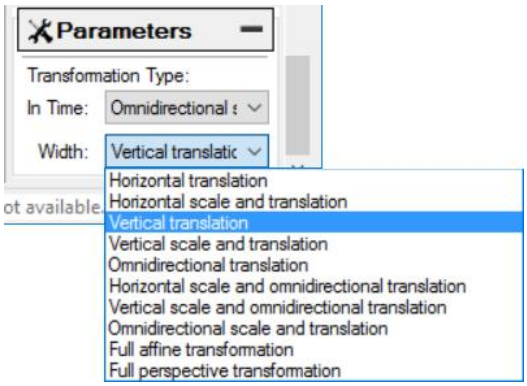


4.2.7.2 Width Measurement

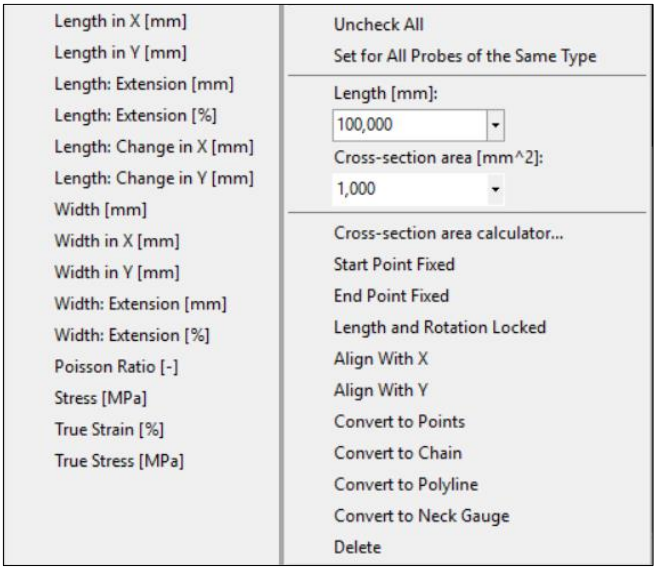
To measure the width or transversal contraction the **Line Probe** or **Neck Gauge** is used.

Caution: To measure the width successfully good contrast between the sample and background is essential. Put some uniform contrast plate behind the specimen.

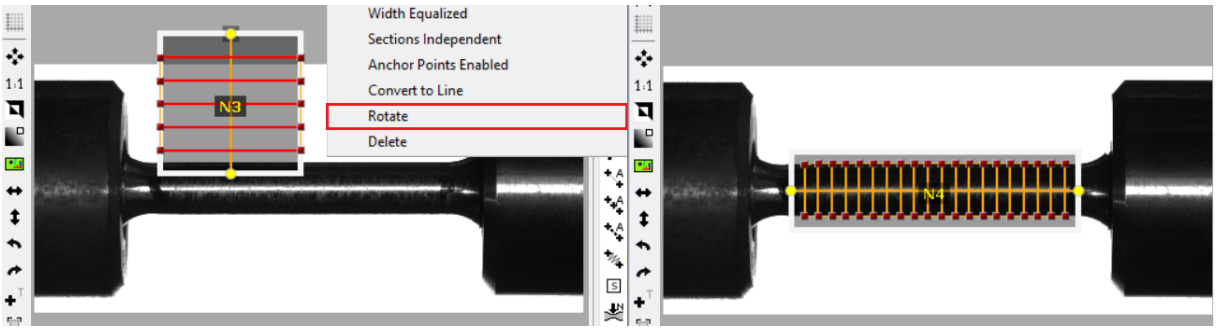
Caution: Width measurement is like using a line for marking. It is constrained in one direction only. Moreover, remember that the longer side of the sensor is always set as horizontal. That is why a proper Transformation Type needs to be set. Choose Vertical or Horizontal translation.



- **Line Probe** – measures width or width change in single point and can be set in line probe dialog as **Width** or **Width: Extension**

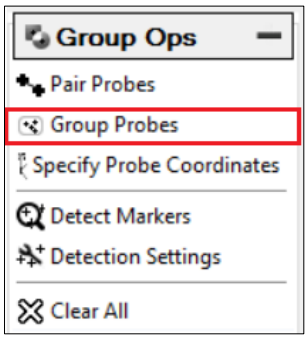


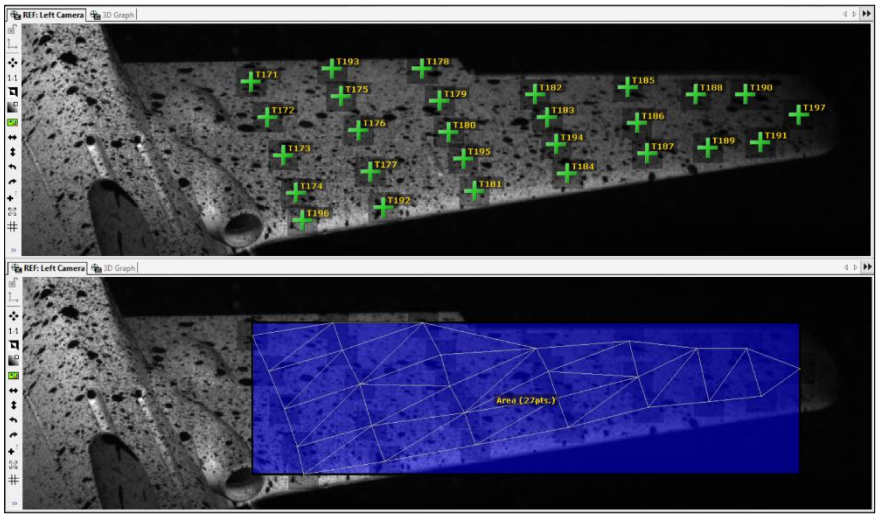
- **Neck Gauge** – enables user to measure the width or width change in multiple positions and automatically finds the biggest gradient of strain.
  Insert the Neck Gauge into a picture. If the orientation does not fit rotate it. Than adjust the size and position of the gauge.
  Note: Neck Gauge can measure length as well.
  Caution: The yellow points of the Neck Gauge are tracked as well, therefore some contrast must be present under these points.

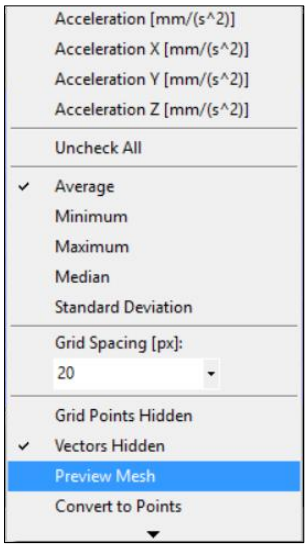


4.2.7.3 Area Measurement

Area measurement also very often called "DIC measurement" (all of MercuryRT measurements are based on DIC but a lot of people have linked DIC and colourful maps) mostly set with **Include** and **Exclude** commands. But the **Area can also set discretely by selecting individual points**. This feature finds its use with measurement of large surfaces where application of speckle pattern is difficult or not wanted. Example can be a wing of airplane. To do so insert the points and afterwards press **Group Probes**.



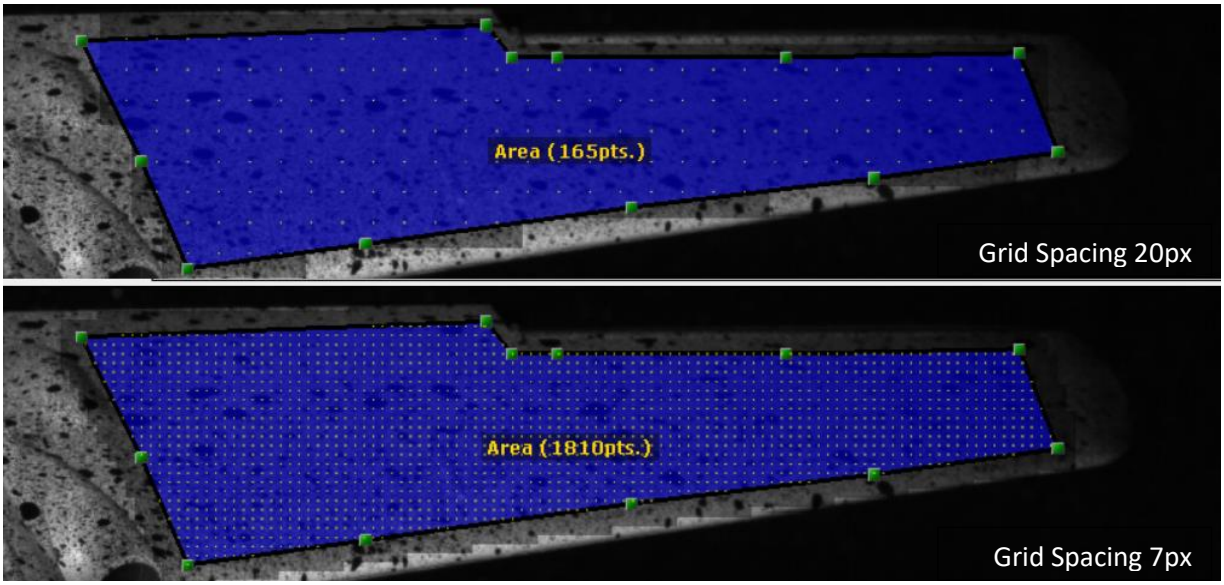




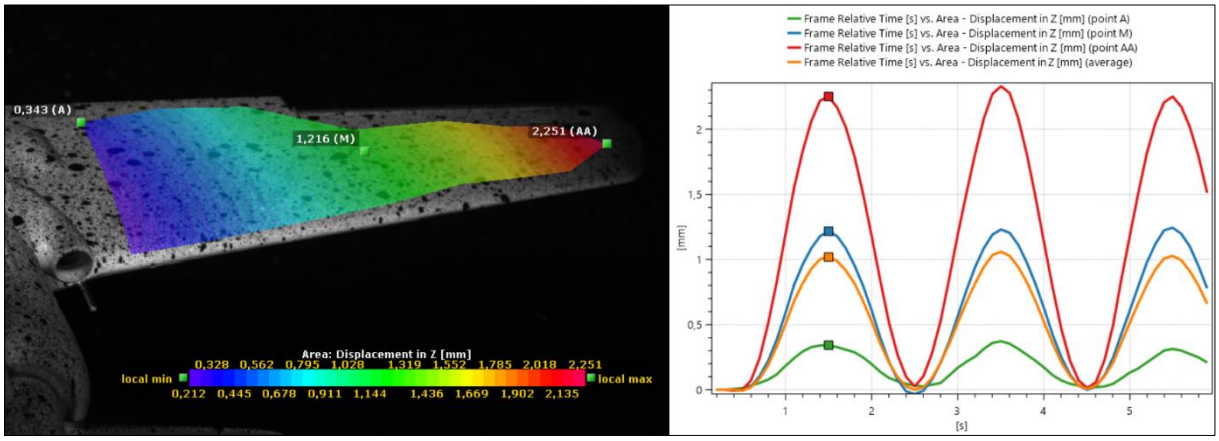
Area can measure **displacement, velocity, acceleration** and **strain**. All of these values can be measured as **Euclidean** or **directional**. **E1 computes major principal strain, E2 minor principal strain. In stereo mode E1-major; E2-intermadiate and E3-minor principal strain.**

Note: Due to big PC performance demand, it is recommended to measure FullField measurements as post-process.

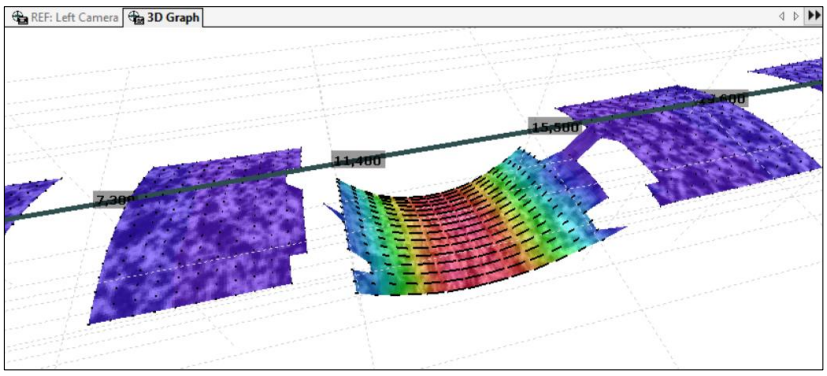
The density of the calculation points (like mesh with FEA) can be adjusted in Area Dialog as **Grid Spacing**, which is the distance between the points in pixels.



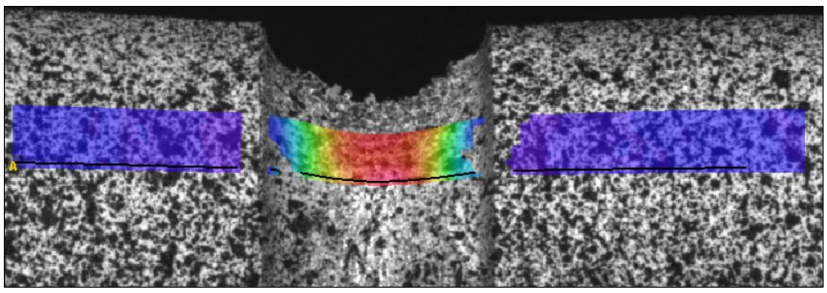
In default setting only average value from the whole area is plotted in the graph. However **local values can be plotted by clicking in the are in the Camera Window.** See following image. Orange curve represents average value, red is at the tip of the wing and green is the one on the left.



For Euclidean Displacement, E1, E2 and E3 vectors can be shown. To enable this feature open Area Dialog and uncheck the **Vectors Hidden.**

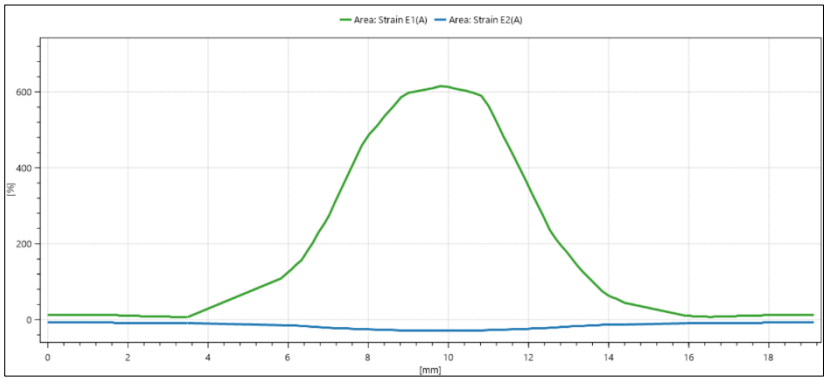


Holding the mouse wheel and dragging over computed area a **section line** is inserted. Major and minor principal strains can be read out along this line. With another wheel click removes the line.



Strain distribution along the line is plotted in **Area Cross** Section tab in Main Window.

Number of the lines is adjusted in *Settings/ Presentation/ PostProcessing/ Section Count*



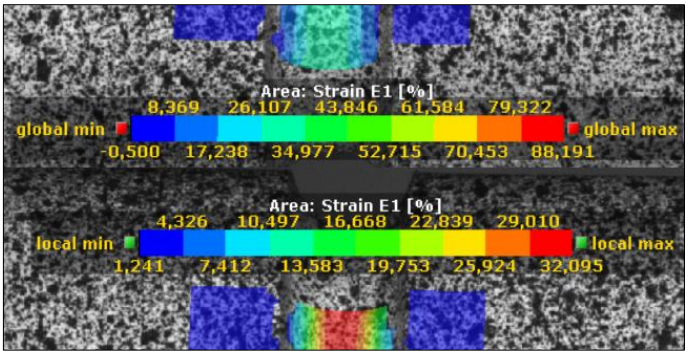
Color scale can be switched between Global, Local and Custom range. Scale is changed by clicking on the square next to max or min.

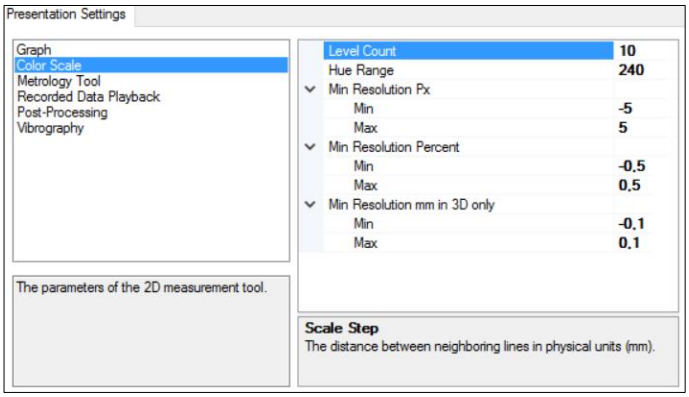
Global – uses the max and min value from the whole measurement.

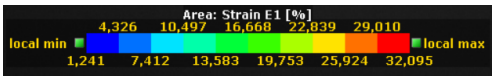
Local – uses the max and min value from the individual image. Range is changing with every image.

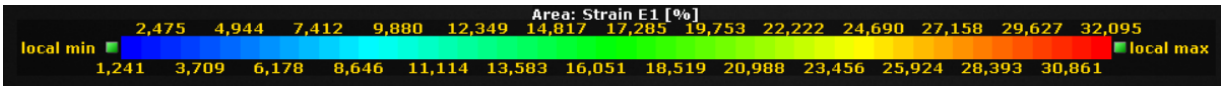
Custom – user defined range. Dragging the square next to max or min sets the range.

Number of color levels is set in Settings/ Presentation/ Color Scale/ Level Counts



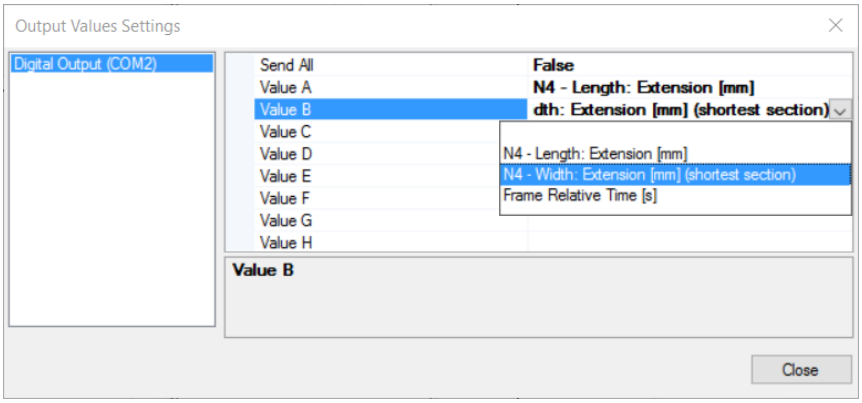


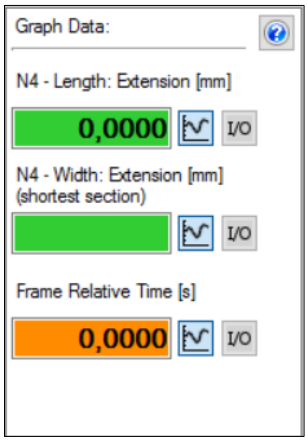




4.2.8 Setting the Output

If there is an active Output Serie (chap. 4.1.2) output values can be set. This is done in Main Window next to measured values in **Graph Data**. Press the **I/O** button next to value that is to be sent to output to open the dialog window.





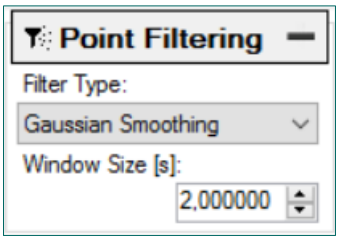
Value A, B, C… are channels of the output and in this dialog, measured value can be set to each channel.

4.2.9 Filtering the Data

Two kinds of filtering can be applied.

- Point Filtering – performs filtering of the image data. Graph data is already filtered.
- Value Filtering – perform filtering of the graph data. Creates new data series with applied filter

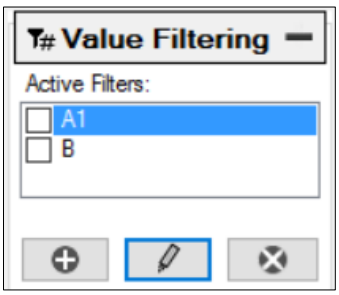
4.2.9.1 Point Filtering



Three type of point filters are available. **Averaging, Gaussian Smoothing** and **Batch Averaging**. First two are performed over defined time window. Batch Averaging is used with Run with Snap Mode and Run with Timer described in chapter 4.3.

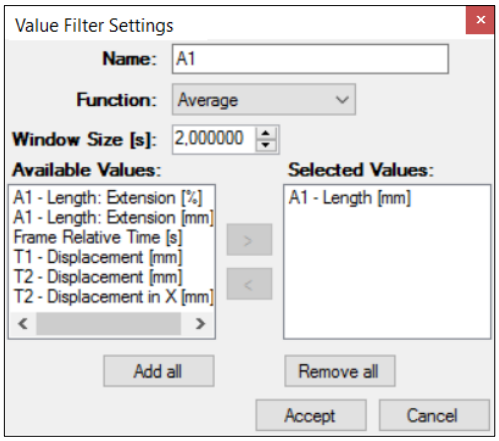
Caution: Use Batch Averaging only with Snap Mode and Timer otherwise the system will run but all data points would be charted as one in the graph.

4.2.9.2 Value Filtering



Different user defined value filters can be setup and also set as active or inactive.

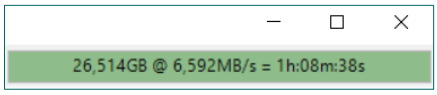
To create new filter press the button to open the **Value Filter Setting** dialog window.



Define the **Name** of the filter and set desired **Function** (averaging, minimum, maximum, median, standard deviation). Set the time **Window Size** and choose from Active Values.

4.3 Running the Measurement

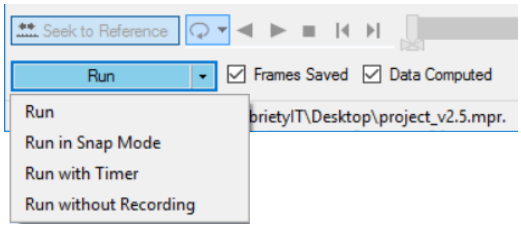
After all setup it is finally time for first Run of the measurement. Four different Run regimes are available together with two additional options.



Frames Saved – image data is saved for later post-process or video export.

Caution: When frames are saved frame rate has to be set carefully as the drive can run out of space. Available record time can be checked at right-top corner of the Main Window.

Data Computed – data are computed during recording. If unchecked image data is only recorded for post-processing.



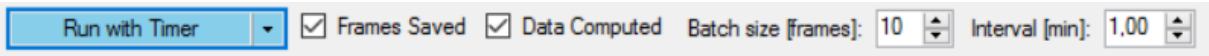
Run – default run regime. System runs on selected frame rate (if possible). Frame Saved and Data Computed option is available. After stopping keeps data in graph.

Run in Snap Mode – batch of images is captured only on manual trigger (pressing Snap Frame, using wireless presenter or remote control command). Frame Saved and Data Computed option is available. Bath size can be set (one trigger pulse – multiple images).

Used during measurements with manual control of loading – wagon measurement, bridge measurements.

Run with Timer – defined batch size is captured in defined time interval. Frame Saved and Data Computed option is available.

Used during long-term measurements – 24hour test of thermal behaviour of structure during climatic change.

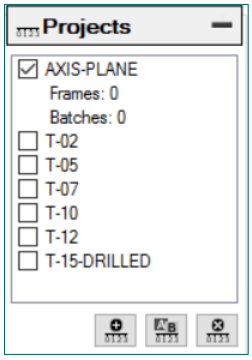


Run without Recording – processes the image data online. Does not record the image data. After stopping the measurement, all graph data is erased.

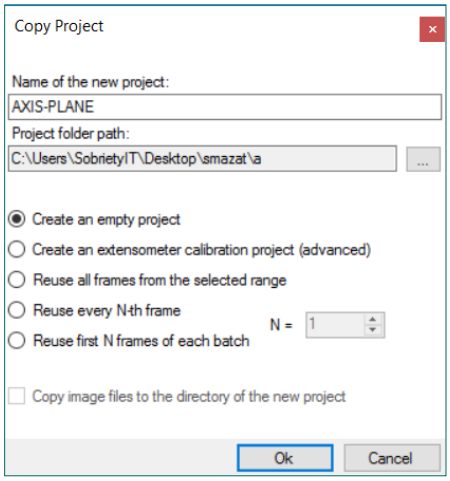
Note: Regime created for industrial use. No need of post-process. Erasing the graph data is performed with start of the measurement and can take up to few seconds when tens of thousands data points are captured. In Run without regime, MercuryRT responds the fastest.

4.4 Copying the Template

If new template for the similar type of test has to be created it can be done very easy with out need of repeating the calibration or coordinate system setting. For this operation a **Project Manager** panel in Main Window is used.



Activate the project which setting is to be copied and press button to open the **Copy Project** dialog window



Enter the name of the new project and select one of these options:

Create an empty measurement – copies all setting and probe layout but does not copy graph and image data.

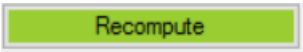
Reuse all frames from the selected range – when recorded image data is present it copies the setting, probe layout and image data from selected range to perform new analysis with the same image data.

Reuse every N-th Frame – when recorded image data is present it copies the setting, probe layout and every N-th image from selected range.

Reuse first N frames of each batch – copies the setting, probe layout and first N images from each batch.

4.5 Post-Process analysis

System MercuryRT allows user to perform as many analyses as required. Just unlock the measurement by clicking on the red lock in the camera window . Than rearrange the probes or change the correlation parameters and press **Recompute** button in Main Window.

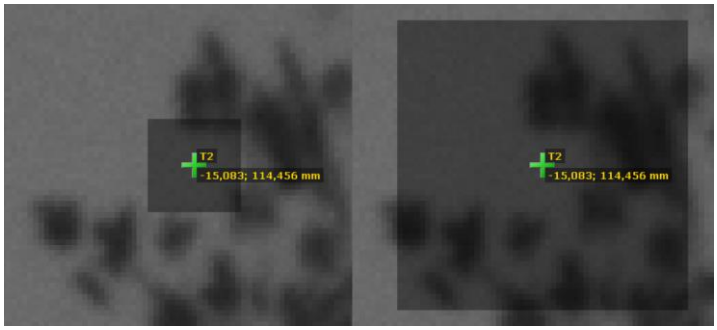


4.6 Tuning the correlation (Loosing the points)

Loss of the points is the biggest nightmare during the video measurements. A lot of tuning can be done in **Parameters Panel** in Camera Window.

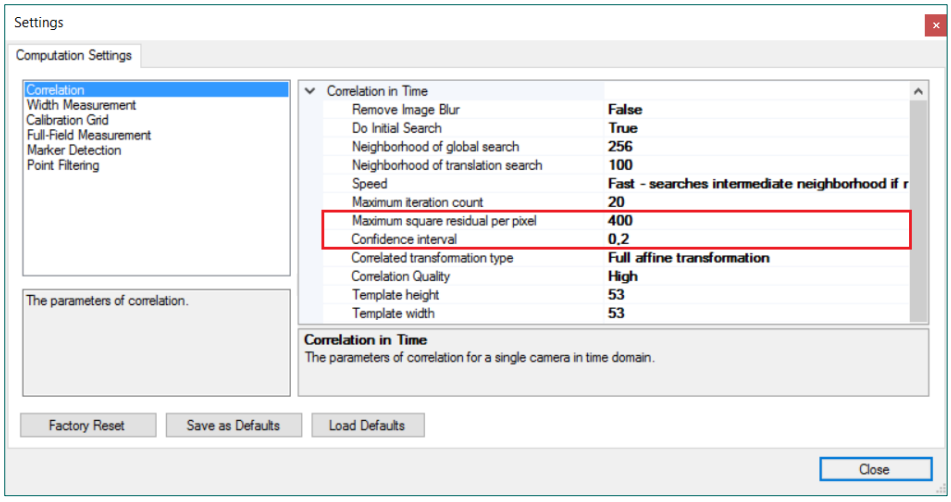
In general there are only few reasons for this to happen.

- **Too little Information in Correlation Template** – too little Template
  Hint: *enlarge the Template Size. Following picture shows the difference between 20x20px and 53x53px Template Size*



  Note: **Bigger Template Size carries more information but also need more time to be calculated and negatively affects the maximum possible calculated FPS.**

- **Too big deformation** – the measured surface is simply deformed to beyond the recognition of the system.
  Hint 1: *Try to high the frame rate. The system is capable of measuring very large deformation, but this deformation must not be a step change. Higher frame rate may help to capture the deformation fluently.*
  Hint 2: *Check if the **Incremental Step** is set to **-1**. In case of point loss this feature sets the previous image as a new reference. Otherwise the system keeps the first image as reference until the end.*
  Hint 3: *Set more fitting Transformation Type – sometimes the **Full Affine Transformation** is unnecessarily complex method of computation. For planar tests with longitudinal elongation and transverse contraction **Omnidirectional Scale and Translation** is more than enough. For longitudinal direction only even **Horizontal/Vertical Translation** only.*
  Hint 3: *Loosen the correlation limits in Settings/Computation. High the **Maximum square residual per pixel** to 800 (or higher if needed) and **Confidance interval** to 0.25 (0.4)*



- **Measured point gets of the Field of View** – some samples rotated during the test and the point can get into cover or out of sight.
  Hint*: Try to explain to the customer that this is no go* ☺

5 Using a Stitched Mono Cameras

Stitching is used when long Gauge Length is required or very high elongation expected. Using multiple lower resolution cameras instead of one high resolution is often cost-saving and higher frame rate achieving option.

Stitching can be set in two ways:

- **Overlapping FoV** – Fields of View are overlapping each other so the measured point can travel between them. Used for high elongating materials
- **Separated FoV** – Fields of View are separated and cameras only share the coordinate system. Used for long specimens with standard or lower elongation.

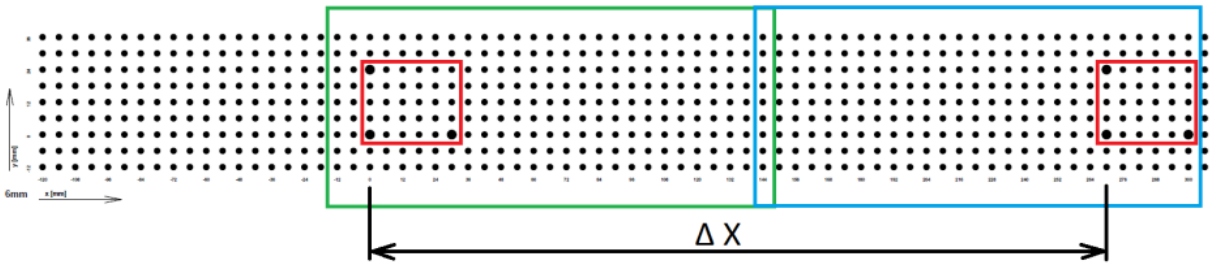
Create a new project following chapter 4.2.1 section **Stitched Mono Cameras**.

5.1 Calibration of the Stitched Cameras

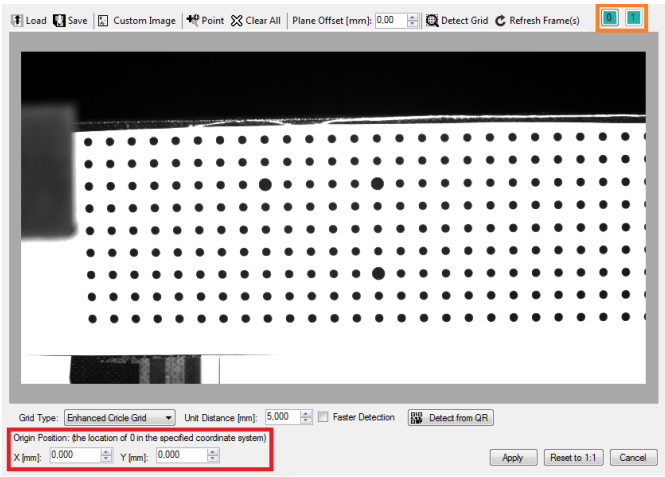
Stitched camera calibration is very similar to Mono camera calibration only with difference of presence of multiple cameras. Each camera is calibrated separately.

5.2 Setting of Stitched Coordinate System

A special calibration grid is used for stitched coordinate system. Grid of such kind contains more enhanced points (0;X;Y) in known relative distance, one coordinate system for each camera.



One coordinate system must be visible in each camera (only one). Switch between cameras in **Coordinate System** dialog window by selection 0, 1… in top-right corner. MercuryRT grids are labelled with numerical scale for easy reading of the coordinate systems distance. This **value must be entered in the bottom of the dialog window**. When ready press **Refresh Frames**.



Caution: For successful point transfer between the cameras an overlap of at least 200 pixels is required.

6 Using a Stereoscopic System (Stereo-3D)

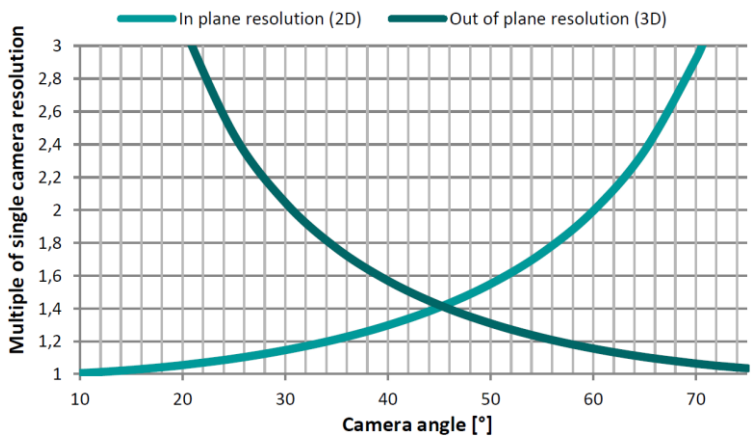
To create a new measurement follow chapter 4.2.1 section **Stereo Camera.**

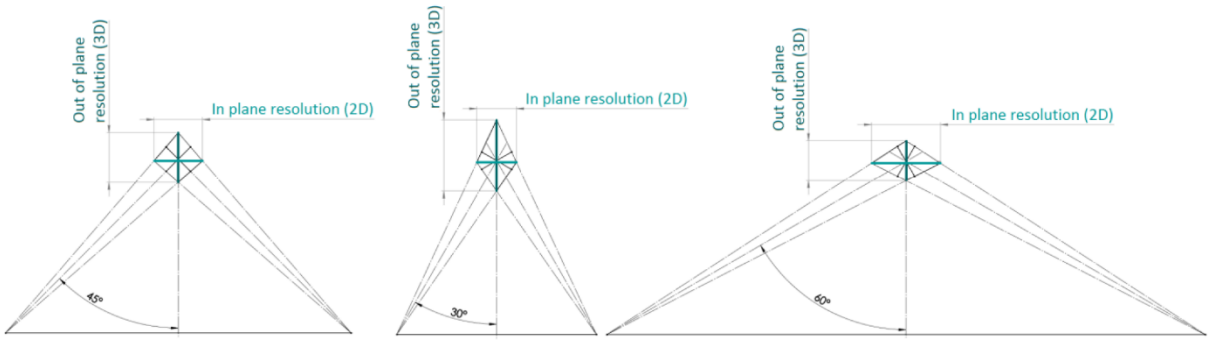
6.1 Setting the Cameras

The cameras should be mounted in a way that does not allow relative movement between them. When done so, the whole system can be moved as a rigid thing as long as the cameras does not change its relative position.

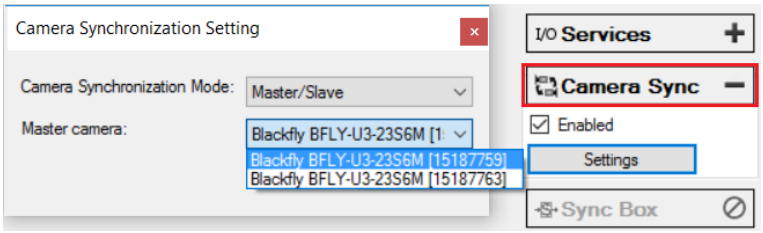
The out-of-plane resolution of a stereo measurement depends on the angle between the cameras. The following chart shows the dependency of resolution on the camera angle. The vertical axis shows a multiple of a single camera resolution for in or out-of-plane measurement with a certain camera angle.

Example: If the single camera resolution is 1 µm, for 30° angle the in-plane resolution is 1.14 times = 1.14 µm and the out-of-plane resolution is 2 times = 2 µm in comparison to single camera resolution.





Cameras of the Stereo System should be synchronized to capture the images at the very same moment. Enable sync in **Camera Sync** panel in Main Window. Two modes of sync can be set.



Master/Slave – one of the camera becomes Master that triggers the Slave camera. Set one of the cameras as master and if the system stops acquiring the images select the other one.

External Trigger – used when the cameras are connected to SyncBox or other trigger impulse-generating device.

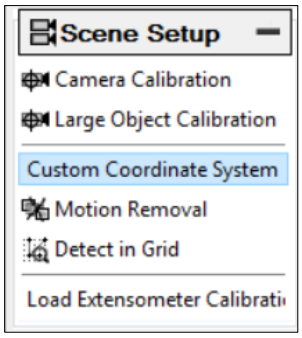
Caution: Use synchronization cable if possible. Run the stereo system without sync only in the most critical case; more critical with low FPS as the time gap between left and right camera is more significant.

6.2 Stereo Camera Calibration

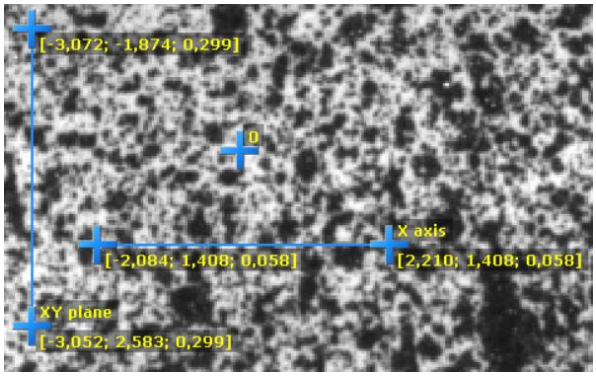
The Stereo Camera Calibration is performed in the very same way as Mono Camera Calibration with only one difference; **the grid has to visible in both of the cameras**. Unlike the camera calibration in mono mode, the calibration of a stereo camera pair is necessary before performing any measurements.

6.3 Setting a Coordinate System

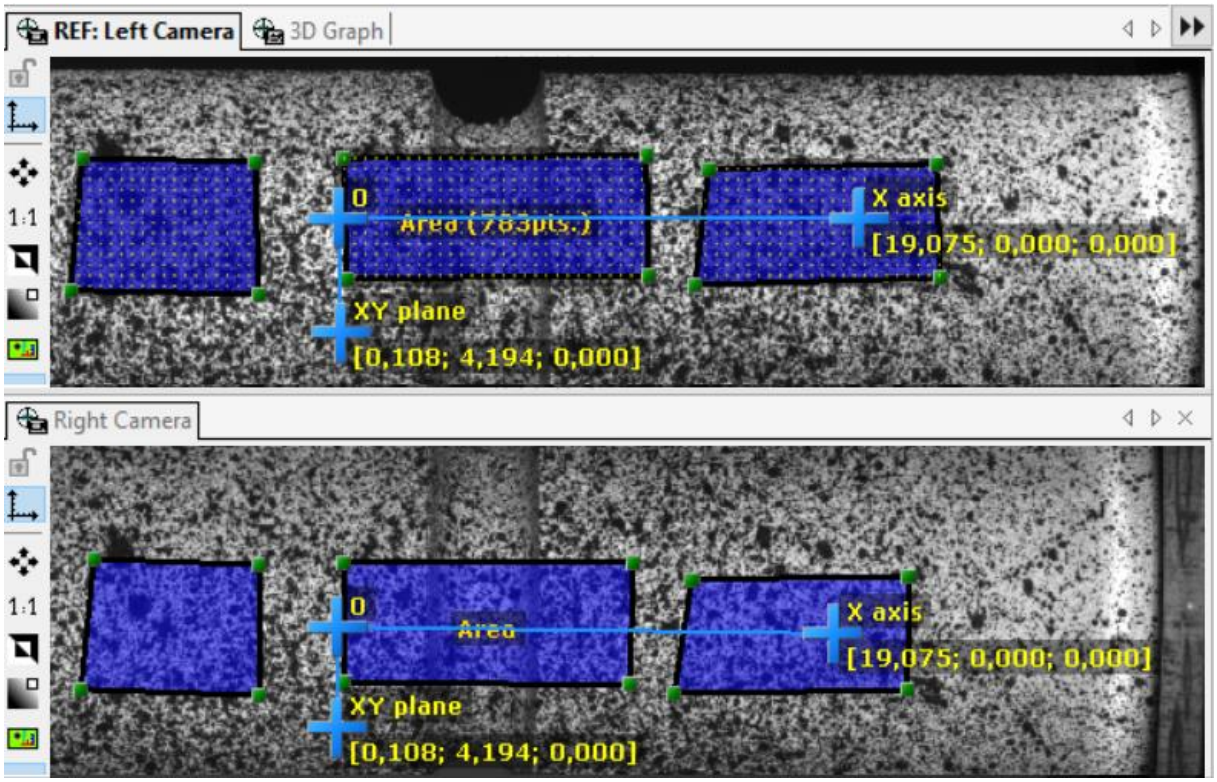
Setting of the Coordinate System is optional with 3D measurement. Due to need of computing the relative position between the cameras during the calibration the system sets default Coordinate System as – X-axis aligned with Left Camera horizontal and Y-axis aligned with Left Camera vertical. Origin of the Coordinate System is in the centre of the Left Camera.



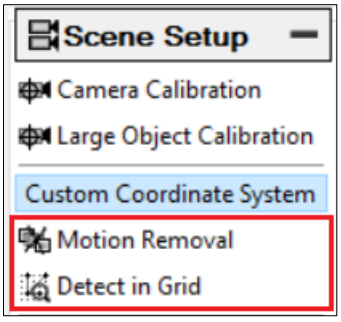
This default coordinate system can be user-defined by applying **Custom Coordinate System.** This feature adds a blue coordinate system that can be set by defining the X-axis and XY plane rotation.



The points of the coordinate system must be visible in both cameras and must be correlated. X-axis direction and XY plane rotation can be split into separated lines.



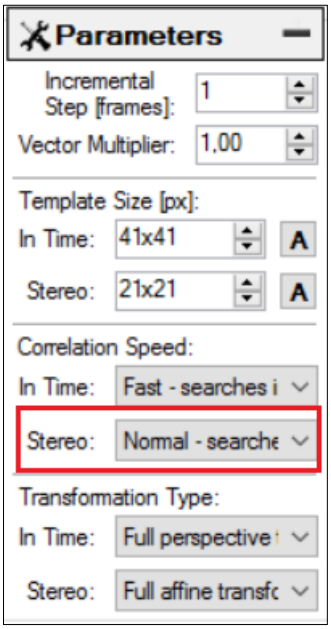
Custom system can be set as well by detecting the calibration grid in the image. To do so, press the **Detect in Grid** button. Then set the grid parameters and detection method and press Refresh Frames when the grid is in the right position.



When the Custom Coordinate System is set **Motion Removal** feature is enabled. This sets the origin of the Coordinate System as a point of reference (like floating Coordinate System).

6.4 Applying probes

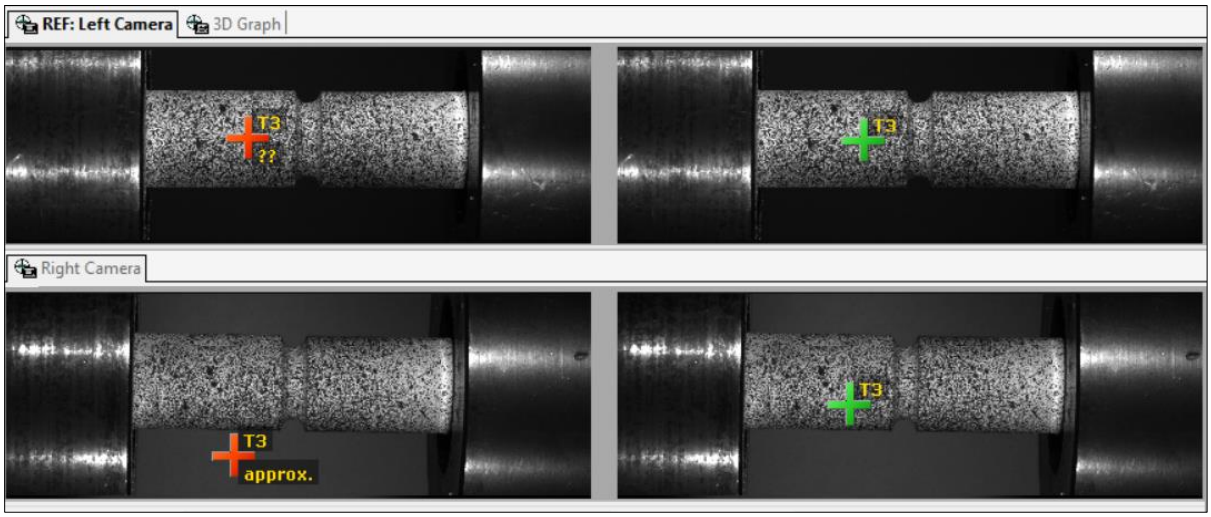
Application of the measurement probes in Stereo mode is more preparation demanding. The system needs to find the match between the left and right camera.



When the point is red, the match was not found; green means ready to go.

Points can be inserted only in Left camera in reference frame. If the point is not green immediately after inserting, try to move with it a little, however it is recommended to set the **Correlation Speed** for Stereo to **Normal**. When do so the system searches for the point in the whole image and not only the close region.

Note: If the pattern is not good, (blurred, repetitive…) it is better to zoom in and check the match by eye.



Caution: Specular and reflective surface is very difficult to measure. Point measurement can be performed but area measurement is very inclinable to fail. Use of speckle pattern is recommended.