

Feature: Masking

General

The described feature is available for all μShape™ versions.

Masks are a fundamental feature of all μShape™ program versions allowing you to select respectively deselect specific regions of the data map for measurement and analysis. The first section of this paper describes the various mask types of μShape™ and how they are applied. In the second section a brief description of the user interface is given.

1 Mask Types

μShape™ knows four types of masks. Each type works on certain data maps and offers different settings depending on the mask type. The following sections explain the different mask types. Because all masks are superimposed their definition order has to be considered when special analysis areas are desired.

The μShape™ feature “Reference Marks” is closely related to masking, it uses a similar user interface and can also be displayed within the live image, but it is not masking any data points. See [G1] for a detailed description.

1.1 Crop Mask



The **Crop mask** works directly on the image acquisition layer and reduces the overall image area. It is applied before the conventional measurement mask. Use it for example if the aperture does not cover the whole camera image. The way Cropping works is described in [G2]. Note that Cropping may not be offered for all interferometer types, it depends on the camera interface.

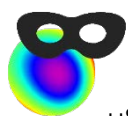
1.2 Measurement Masks



A measurement mask is applied during data acquisition and acts directly on the camera image. The data within image areas which have been masked out are not stored in the software. Such data points are marked as so-called no-values.

When the measurement mask is changed, a new measurement is required but not automatically started. μShape™ displays a warning message only. It is recommended to define a measurement mask which is a little bit smaller than the visible interference pattern to avoid problems at aperture edges.

1.3 Analysis Mask



While the crop and the measurement mask are applied to the camera image the analysis mask operates on the raw (phase) data map which is calculated from the detected fringe image and composes the basic data map stored in μShape files (*.ms). Analysis masks do not require a new measurement to become active, only a new data analysis is induced. Data points masked out by an analysis mask

are only temporarily deleted; a later change of the analysis mask can include these points again – as long as they are within the crop and measurement mask.

A specialty of the standard analysis mask is a feature called Automatic Pupil Finding (APF, see [G3]). With its help a mask (single mask object or combination of several mask objects) can be fitted in position and size to the data area where valid measurement data is detected.

1.4 Special Analysis Masks

The special analysis masks operate on the aberration map calculated from the raw data map where the analysis mask is already applied. Like the common analysis mask the special analysis masks do not require a new measurement when changing the mask.

Special analysis masks are used for additional analyses such as ISO or Zernike analysis and for special analysis functions offered as μShape™ add-on modules (e.g. MTF analysis or Multiple Statistics). By using additional special analysis masks it is possible to apply a certain analysis on a specific data area without influencing other analyses.

Caused in the fact that special analysis masks are applied to the area defined by the common analysis mask those can have a status related to the analysis mask. They can be **equal**, **linked** or **free**. Only free masks are independent of the common analysis mask [G3].

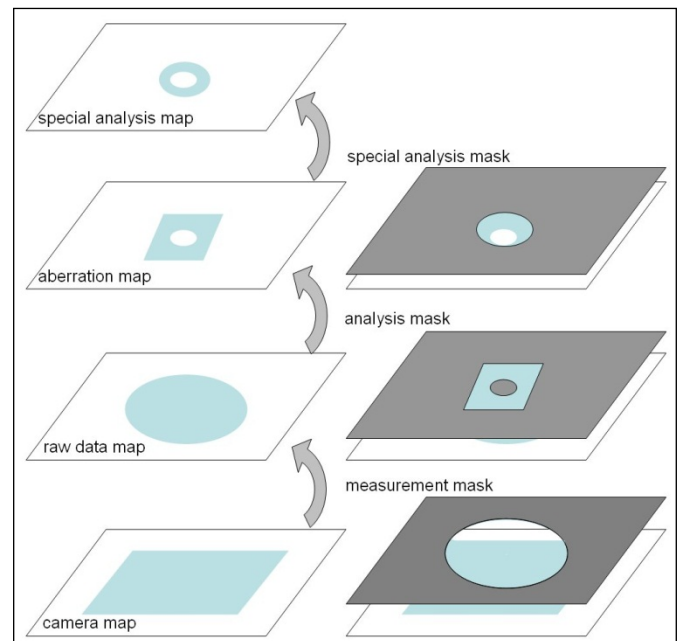


Fig. 1: Order of applied masks

1.5 Superimposing of the mask types

The individual mask types are superimposed. That means that data points masked out by a superior mask are not available anymore for following mask operations. Only areas where all masks are transparent are used for calculations and are displayed. While measurement and analysis masks influence all calculations, special analysis masks only affect the corresponding analysis.

The different mask types are applied in the following order:

1. Crop Mask
2. Measurement Mask
3. Analysis Mask
4. Special Analysis Mask

Fig. 1 demonstrates the remaining data area after the masks are applied. Crop mask (see [2]) is not shown, if available and set it is used first of all and defines the camera map.

2 User Interface

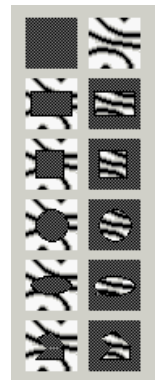
2.1 General Principle

A mask is defined as a combination of individual geometric figures. Those can be circles, ellipses, squares, rectangles or user-defined shapes (polygons). The individual objects are defined as solid objects, not as contours (outlines). There are transparent and opaque mask objects. Opaque objects exclude the data inside the outline. Transparent objects make data points inside their outlines available (visible). All points outside a mask object are not influenced by the particular mask object. For most mask types a mask can consist of several objects used in combination to delimit particular surfaces such as annuli etc.

Some special analyses (e.g. Zernike, ISO) are carried out normally on a single mask object only (here on circles). But more than one circle can be defined at the same time and is analyzed in automatic sequential allowing multiple area analyses. See [K1] for more details.

2.2 Mask Editors for Measurement and Analysis Mask

The masks are defined by using a mask editor. The layout of this mask editor differs slightly depending on the particular mask type. To open the mask editor press the corresponding button on the toolbar or select the appropriate entry from the menu. If the selected mask allows several objects, a mask object toolbar will be displayed in the editor. The picture to the right shows the toolbar as used for measurement and standard analysis masks. On the right side the transparent objects are listed, on the left the opaque ones.



Since the individual mask objects define only the visibility inside its outlines you have to define first the general background visibility to be opaque (top-left) or transparent (top-right) which is the default. By using these background buttons all mask objects are deleted. After the background is defined, create the individual objects successively. To select a figure press a button by mouse click. Then move the mouse to the desired position at the displayed map and press the mouse button a second time. The desired object is created and can be positioned exactly using the object handles. The final mask is defined by the transparent area of all mask objects.

2.3 Example

To define a circular measurement mask to exclude aperture edge effects first press the top left button to set all opaque. Then open the aperture by creating a transparent circle (4th button from top at the right column). Place the circle in a way that the aperture rim is slightly outside the circle edge.

It is also possible to save masks to a file and re-load them for future use. When loaded from file, the mask is set to the same position as it was saved (provided that the camera resolution is the same), and in most cases can be easily adapted. Saving masks is recommended especially for complex masks consisting of several objects.

2.4 Special Mask Editors

Most add-on Modules offer their own mask editor. These editors are described in papers and direct help pages dealing with the related add-on analysis. When the module *Multiple*

Aperture or *Prisms* is activated and the corresponding type in the analysis mask editor is selected other mask objects are offered. With them special wedge or prism masks can be defined.

3 How μShape™ stores masks internally

3.1 Mask objects

Each mask contains a background setting (opaque or transparent) and a list of individual mask elements. Each element is defined by its contour (e.g. circle or polygon) and whether its enclosed area is opaque (i.e. covering all data pixels inside its contour) or transparent (i.e. making all inside pixels visible). The final information which data pixel is visible and which is masked is generated by μShape™ starting from the background setting and layering each mask element over the previous one. Therefore, the order of defining the mask elements influences the final visibility of each pixel.

3.2 Size and position

μShape™ stores the mask parameters internally always in units of (data map resp. camera) pixels. For using absolute units like mm to define a mask the system has to be scaled first. That can be done automatically or manually [G5]. Lateral scaling changes the display in the user interface only, size and position of each mask element is converted to pixel units when leaving the mask dialog. Therefore the size (in pixels) of masks is not influenced by changing the scaling.

4 Trouble Shooting

If the final aperture does not fit to the specified mask(s) it can have several reasons:

No data available

- Calibration data are considered but not available.
- The entire aperture is masked by the measurement or analysis mask (all opaque)
- Special analysis masks are defined were no data available
- During phase shifting no modulation is detected (see [K2] for more details).

Mask is not applied

- Transparent objects defined on transparent background

Final aperture does not fit to mask geometry

- Edge trimming is activated, reducing the aperture after masking (see [G4] for more details).
- Reduction ratio < 1 is set in the Analysis Mask dialog
- Individual areas of the sample could not be measured caused by missing modulation (see [K2] for more details)
- When using the asphere alignment fit the final aperture may be reduced to the specified sample diameter (see [K3] for more details)

5 Reference Documents

- [G1] Feature: Reference Marks in Live Image ("mShape_ReferenceMarks.pdf")
- [G2] Feature: Cropping Camera Image ("mShape_Crop.pdf")
- [G3] Feature: Automatic Pupil Finding & Masks Coupling ("mShape_AutoMasks.pdf")
- [G4] Feature: Wave aberration setup dialog ("mShape_WaveAberr.pdf")
- [G5] Feature: Scaling of Graphical Result Windows ("mShape_Scaling.pdf")
- [K1] Knowledge Base: Analysis of Multiple Apertures ("KB_MultiAnalyses.pdf")
- [K2] Knowledge Base: Analysis Phase Shifting ("KB_PhaseShifting.pdf")
- [K3] Knowledge Base: Spherical Asphere Test ("KB_SphAsphTest.pdf")

The references can be found in our download area (www.trioptics-berlin.com/download).

If you need more information don't hesitate to contact us at software@trioptics-berlin.com.