# Directions for the calibration of cameras with an AICON target panel

**AICON** 3D Systems GmbH
Celler Straße 32
D-38114 Braunschweig

Phone: +49 (0) 5 31 58 000 58
Fax: +49 (0) 5 31 58 000 60
Email: info@aicon.de
Internet: http://www.aicon.de

# Contents

# 1. Introduction

AICON target panels are used to determine camera parameters (interior orientation of a camera) and possibly to determine camera positions (exterior orientation of a camera). The FalCon-software CamFolder provides the calculation of the distortion index (ISO 8721 / SAE-J211/2, “5-ring-panel”).
The target panels are available in different types and sizes, either as a panel made of carbon fiber material (CFK) or as an aluminum panel, as a flat or a spatial model. All panels have in common that they are equipped with a large number of different round reference targets. These reference targets are most precisely calibrated, i.e. their 3D-coordinates are determined in advance and are therefore assumed as known. Each panel has a calibration protocol enclosed.
When looking at the reference targets, we have to distinguish between the coded and not-coded points. The coded points contain information about the point number and therefore support an automatic measurement and calculation. The remaining targets are selected depending on the application (e.g. five point targets (MXT) for crash-test measurement applications)
The photogrammetric method of the spatial resection, which allows a common determination of camera parameters and camera positions, is used to determine the camera parameters.

# 2. Realization of camera calibrations

## 2.1. General information

In order to determine the camera parameters, the cameras that have to be calibrated need to take pictures of the reference panels. You need to pay attention to the following information: The image of the panel needs to be as format filling as possible because this facilitates the determination of the distortion for the entire image format. This format filling does not necessarily have to be in one image, depending on the focal length and the environmental conditions more images might be necessary. But it is important that in the total of the images the format is well used.

In order to achieve a precise determination of the main point, it is useful to perform a rotation around the camera axis (swing). The best results are achievable, if you perform a 90-degree rotation as well as a 180-degree rotation.

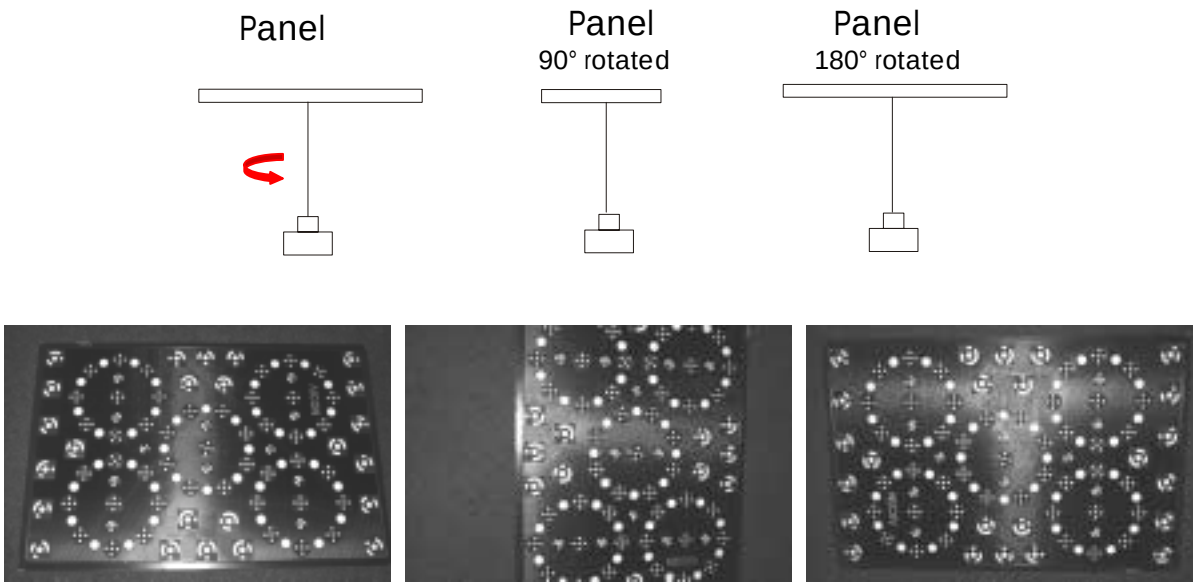
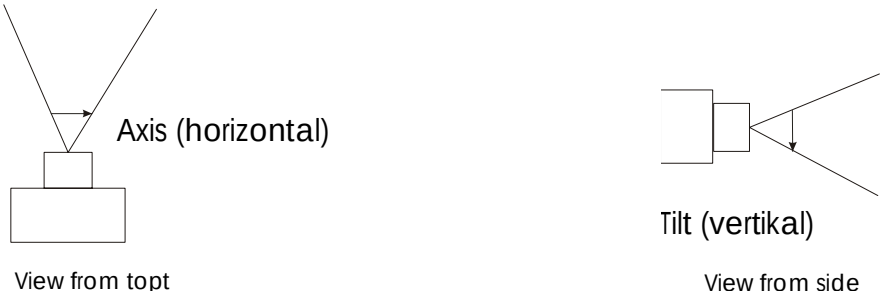



**Fig. 1:** Swing of the camera and the reference panel respectively

A tipping over of the panel relatively to the camera causes the taking of sloped images (images from different directions (axis) or with different inclinations (tilts), see Fig. 2 and Fig. 3). These sloped images improve the dimension of the calibration images and stabilize the determination of the focal length especially when using longer focal lengths. If you use two-dimensional reference panels, sloped images are presupposition for the determination of the focal length. In this case, a determination of the focal length is impossible when taking images perpendicular to the reference panel, because changing the focal length has the same effect as changing the camera distance, which results in the fact that the parameters are not determinable independent of each other.




Axis (horizontal) + tilt (vertical) = tipping over

**Fig. 2:** Tipping over of the camera

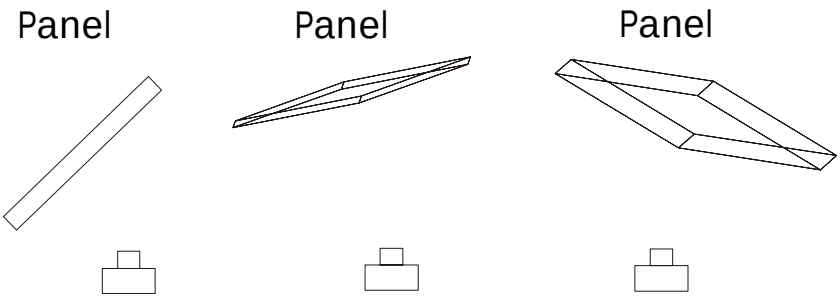



**Fig. 3:** Sloped images of the reference panel

## 2.2. Arrangement of examples

In the following three different arrangements are shown.

### 2.2.1 Calibration with 7 images

The following images are useful for a calibration performance:

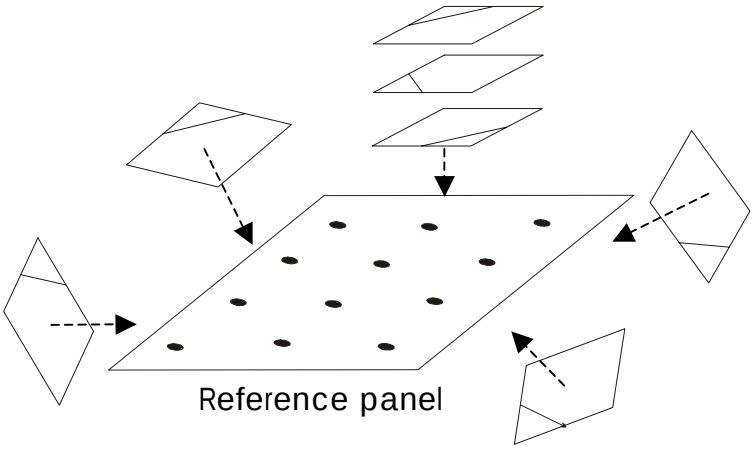
Images 1-3: Different swings between camera and reference panel

Images 4-7: Different tipping overs (tilt and axis) between the camera and the reference panel

**Important:**

- The image format is well used in the total of the images.
- The swung images can also be taken in the sloped images.

Figure 4 shows a diagram of the camera positions



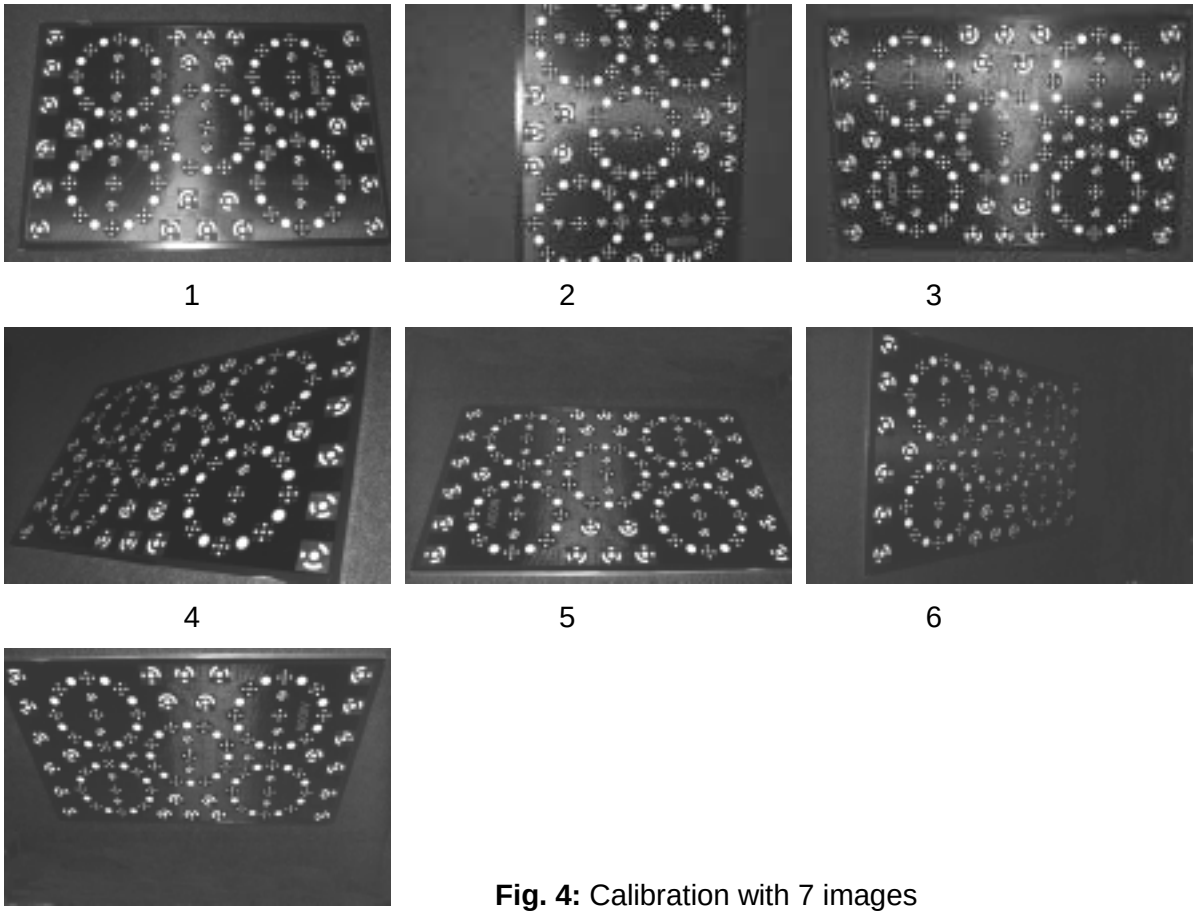



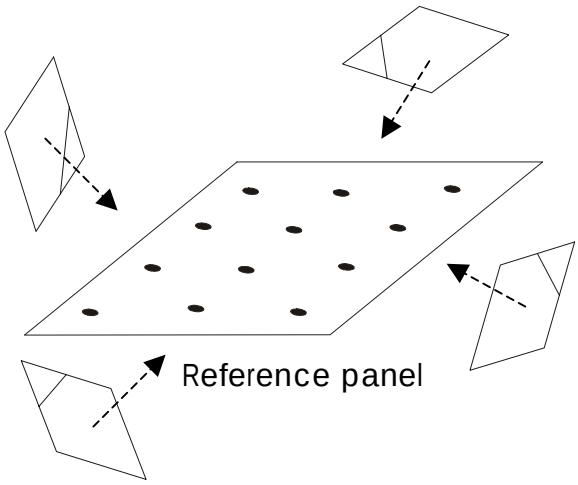

**Fig. 4:** Calibration with 7 images

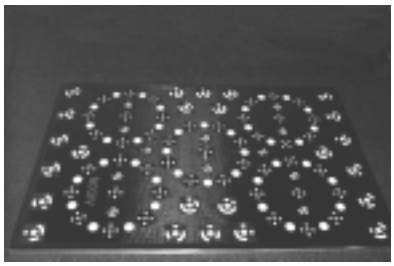
### 2.2.2 Calibration with 4 images

Images 1-4: Sloped images with a simultaneous swing

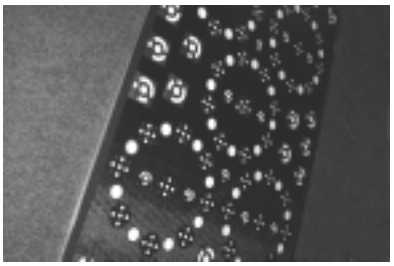
**Important:**

- The image format is well used in the total of the images.

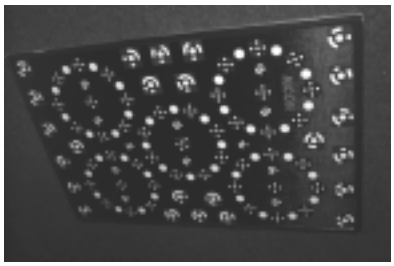


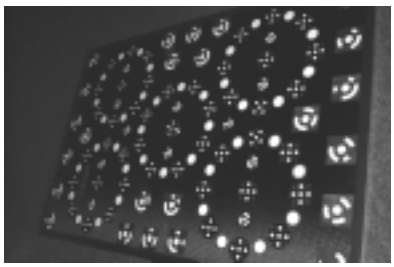
1



2



3



4

**Fig. 5:** Calibration with 4 images

### 2.2.3 Calibration with one image

Generally, it is possible to calibrate with only one image, but it is also important that the image format is well filled. An image perpendicular to the reference panel is necessary to guarantee an optimal utilization of the image format, so this arrangement is unfavorable for the utilization of a flat reference panel (also see 2.1).

# 3. Determination of the camera position

The reference panel can be used to determine the position of one or more cameras, even though in general the camera parameters are already known. In order to determine, you place the panel in front of the cameras (an image as format filling as possible is advantageous). An image is taken with each camera. The following calculation determines the camera positions relative to the coordinate system of the reference panel. If you use the determined positions to calculate 3D-points, these coordinates are in the local coordinate system of the reference panel and need to be transformed into the target coordinate system if necessary.