FalCon Mov3D – Accuracy of 3D Motion Analysis FAQ

- ***How accurate can I measure by means of 3D motion analysis?***

The following details affect the achievable accuracy:

- **Tracking accuracy** in parts of a pixel.
- Efficiency of **camera calibration**: see residual error of all used images of the test panel.
- Quality of **camera position** evaluated by control points: see standard deviations of its parameters. Even if their absolute values give no hints to the accuracy in the 3D volume, one gets an impression about the certainty of the camera orientation. The graphical representation of the residual errors in the image overlay helps to find bad settings.
  Take care to use control points well spread in the field of view!
- The **stereo setup = base distance and angle** between the cameras defines the accuracy in triangulation. In most cases the accuracy in the direction of view is worse than in the plane which is coplanar to the camera sensor.
- The **synchronicity** of the cameras: dynamic processes can be analyzed only if all cameras run fully synchronously. This needs to be valid not only for common start after trigger, but also for recording sync.

How to check 3D accuracy:

- Ensure the **synchronicity** of the stereo cameras: use a high-speed clock or ask your camera supplier to check the used sync, triggering and network.
- **Remeasure** the set of **control points**, used for evaluation of the camera position, with the analysis tool: check the differences to the given control point coordinates. Their point-wise coordinates, their standard deviations and the mean error describe how the given set of points can be reproduced.

  Typical good results in a vehicle crash setting show residual errors of about **1-2 mm in a plane parallel to the stereo base** and about 3 mm in the axis of camera view. In case of a sled test with on-board cameras the accuracy is mostly **better than 1 mm**.
- In case of dynamic camera positions check the **dynamic 3D trajectories** of selected control points: Judge their deviations.
- Perform a comparison with **new points** (with known static 3D coordinates) which are not in the set of the control points: are their deviations in the same range as the control points?

- Check the **standard deviations of new points** which allow defining an expectable error.

  Example: If x and z show a standard deviation (= sigma) of 1 mm and y (= direction of view/depth) shows 5 mm, you can not expect to measure more precisely than these values. Statistically the expectation of a measurement value is 68.3 % within the range ±1×sigma and 99.7 % within ±3×sigma.

- Note: This helps you to see poor measurements and to get a feeling about the accuracy of the triangulation, but it does **not** give you a feedback of **absolute error**.
  Why? If you have asynchronous cameras the error will be just a misalignment – even at small standard deviation of the coordinates.

- Remeasure a **known scale** = distance between points with known 3D coordinates:

  Static check: Measure the distance between two circle centers on the calibration panel. This “easy” case should provide high accuracy.

  Dynamic check: Measure the distance of two targets on a moving test object (car). Does it remain constant even if the test object moves through the field of view?