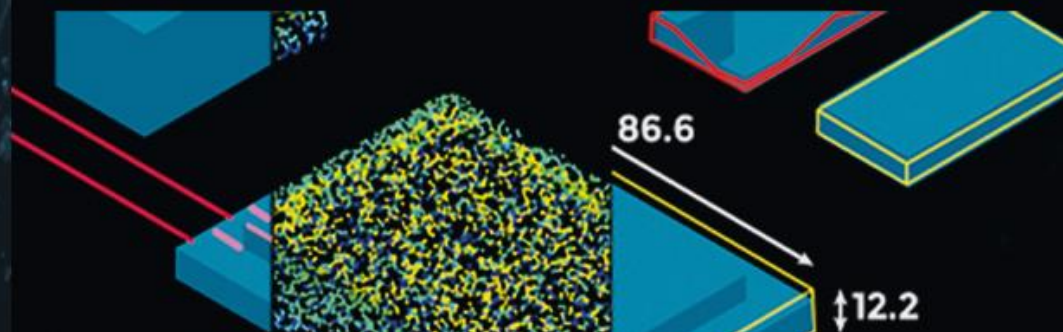


CLIMB HIGHER WITH 3D



# 3D Inspection

Defect Detection and Measurement

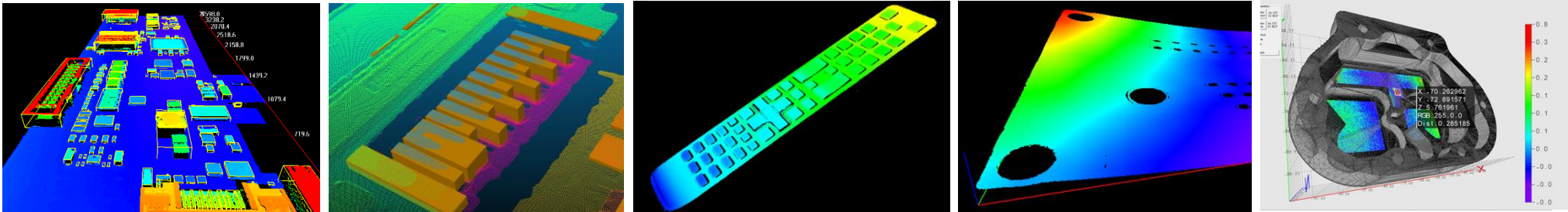


# Open eVision 3D Overview



# Easy3D, Easy3DLaserLine, Easy3DObject and Easy3DMatch are a set of libraries for solving inspection tasks using 3D acquisition & processing

- Laser line triangulation, 3D measurement, PCB warpage, connector inspection, 3D segmentation, 3D alignment, 3D inspection, ...

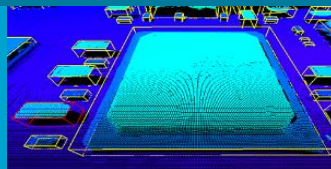


## Easy3DLaserLine, Easy3DObject and Easy3DMatch give access to Easy3D



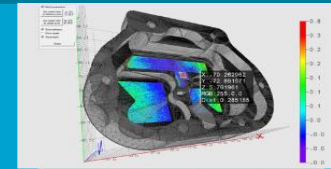
### Easy3DLaserLine

ELaserLineExtractor  
E3DObjectBasedCalibration  
E3DExplicitGeometricCalibration



### Easy3DObject

E3DObjectExtractor  
E3DObject



### Easy3DMatch

E3DAligner  
E3DMatcher  
EPointCloudMerger

## Easy3D

3D containers, conversion, filtering, statistics, 3D viewer, I/O operations, ...

### EDepthMap

EDepthMapToPointCloud  
EDepthMapToMesh  
EFilter  
E3DConverter  
E3DScaleCalibration

### EPointCloud

E3DPlaneFitter  
E3DPlaneFinder  
E3DDecimator  
E3DCropper  
E3DPointCloudStatistics  
E3DPrincipalAxisExtractor  
E3DViewer

### EZMap

EPointCloudToZMap  
EZMapToPointCloud  
EFilter

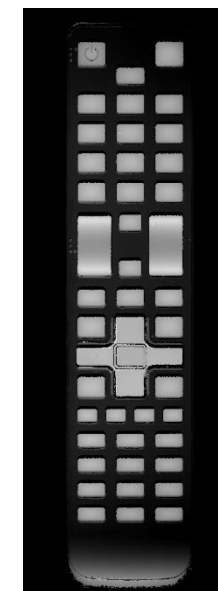
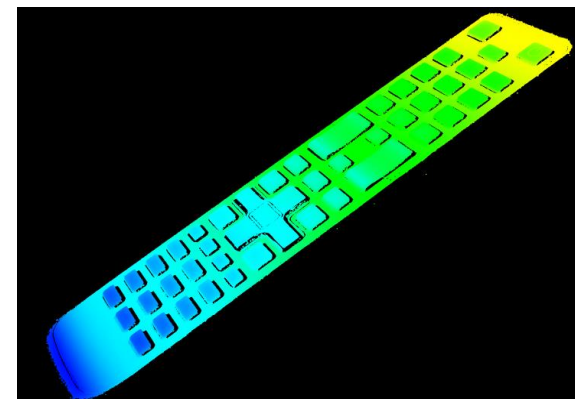
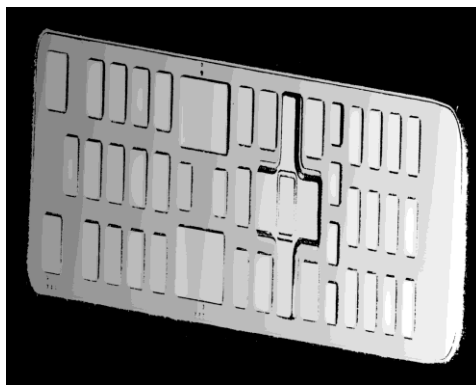
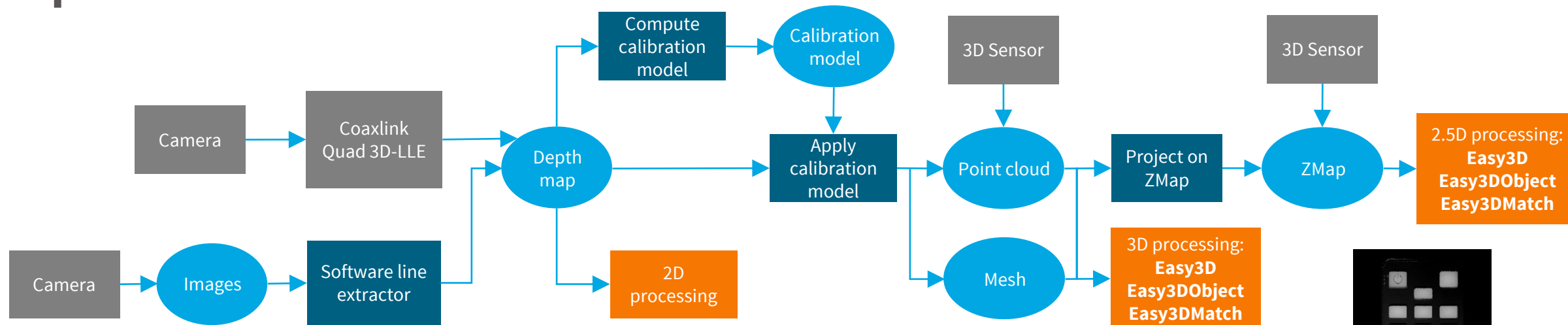
### EMesh

EMeshToZMap





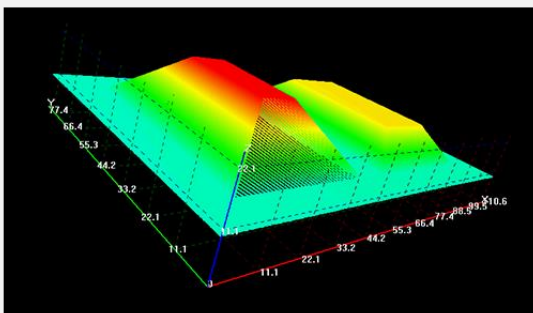
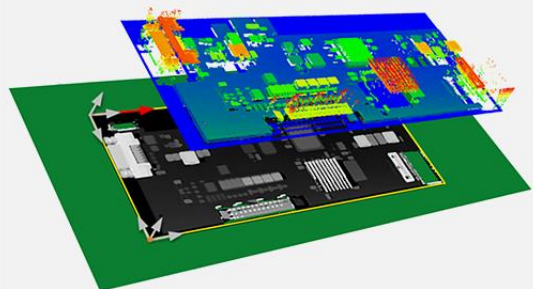
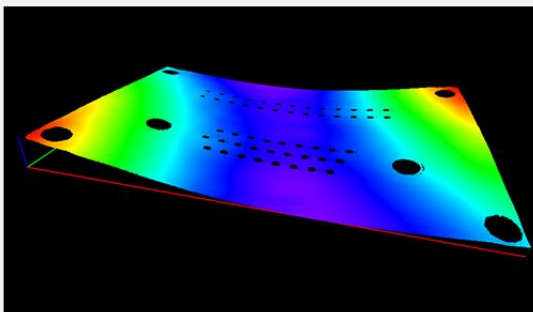
# Open eVision 3D workflow





**Easy3D**





# Easy3D

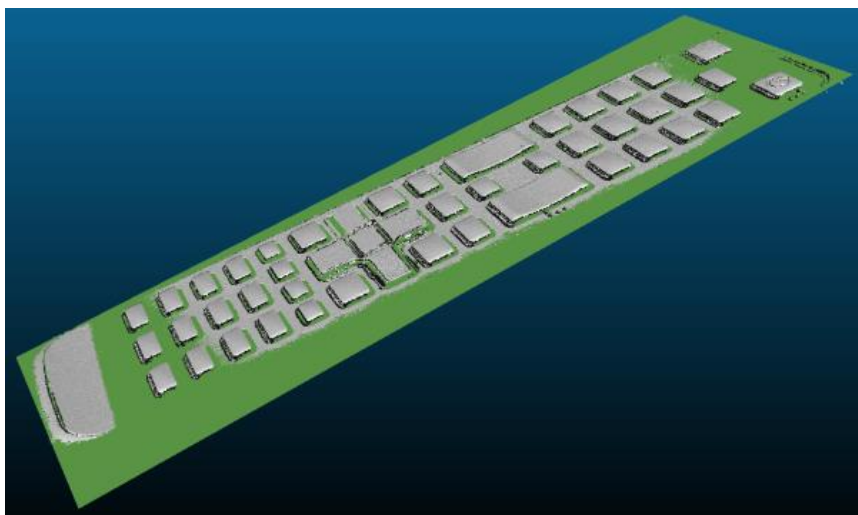
## 3D image processing library

- Point cloud processing and management
- Flexible ZMap generation
- 3D processing functions for cropping, decimating, fitting and aligning point clouds
- Compatible with many 3D sensors
- Interactive 3D display with the 3D Viewer

## A PointCloud is a list of calibrated 3D positions

### Supported operations:

- Creation, transformation, cropping, decimation, shape fitting, statistics, computation of planes...
- Loading and saving in standard formats (PCD, OBJ, XYZ, PLY...)



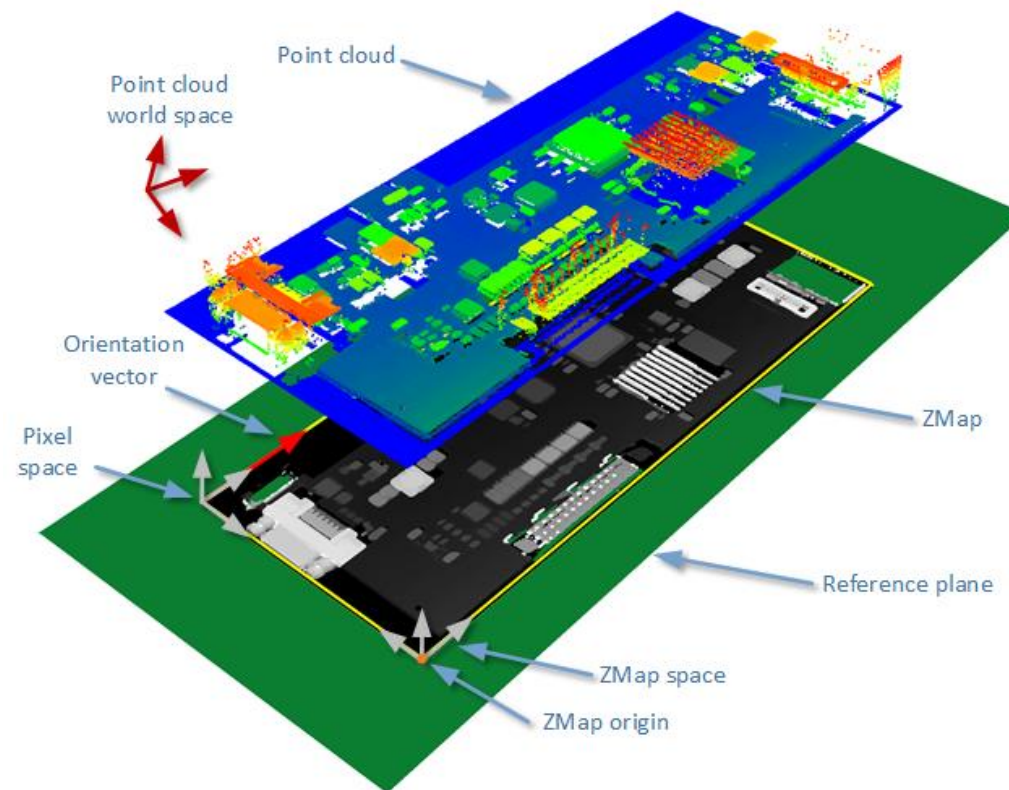
```
float distance_tolerance=0.1f;  
E3DPlaneFinder plane_finder(distance_tolerance);  
  
E3DPlane reference_plane;  
reference_plane=plane_finder.Find(point_cloud);
```

*Example: finding the largest plane in a point cloud using the E3DPlaneFinder class*

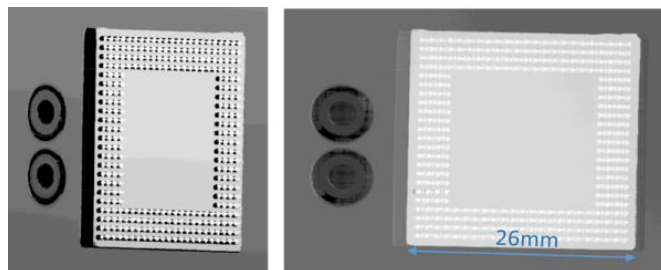


## ZMap

- A ZMap is the projection of a 3D Point Cloud on a reference plane, with the distances coded as the pixel values
- ZMaps are grey-scale images, compatible with all Open eVision 2D libraries
- ZMaps are distortion free, with affine transformation from/to world coordinate system



*ZMap is built by projecting a point cloud to a reference plane. Pixel values are the distance to that plane.*



*Compared to a Depth map, a ZMap is corrected and has a metric scale*

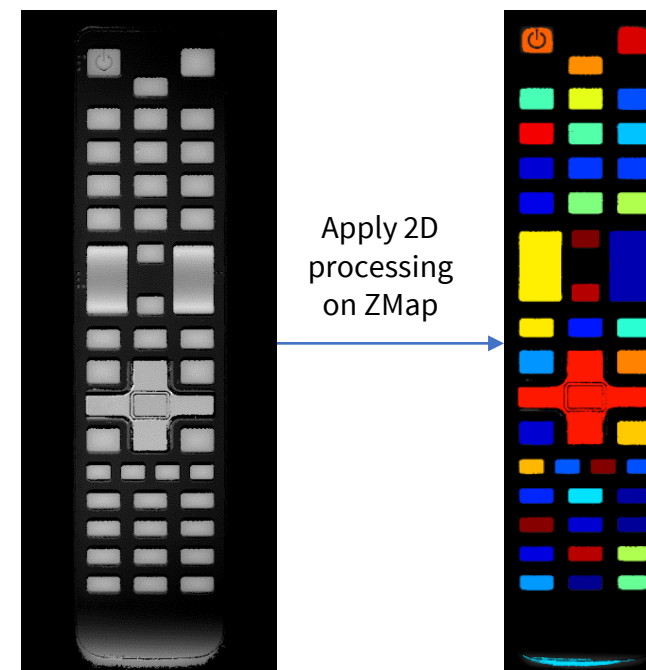
## Processing of ZMap

- All Open eVision 2D libraries can be used on ZMap images for pattern matching and measurements
  - EasyObject
  - EasyMatch
  - EasyGauge
  - EasyImage
  - EasyFind

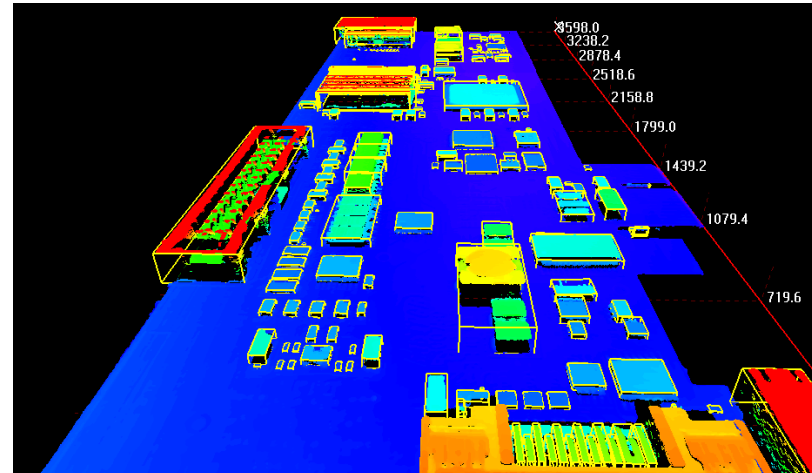
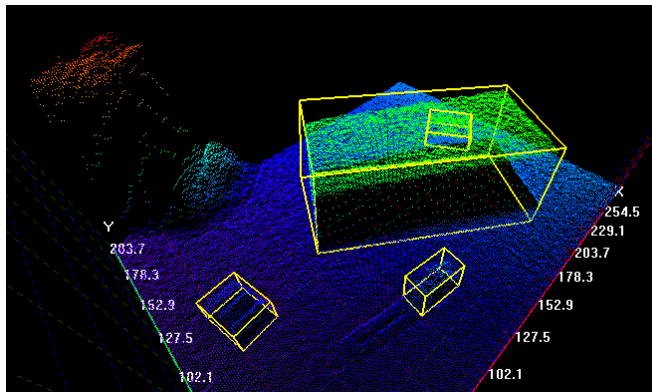
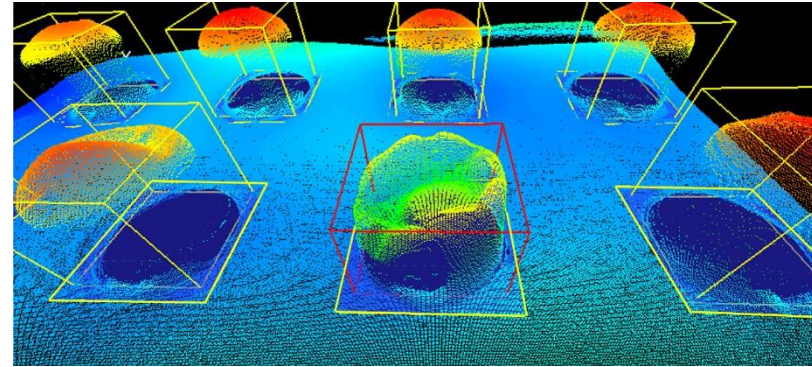
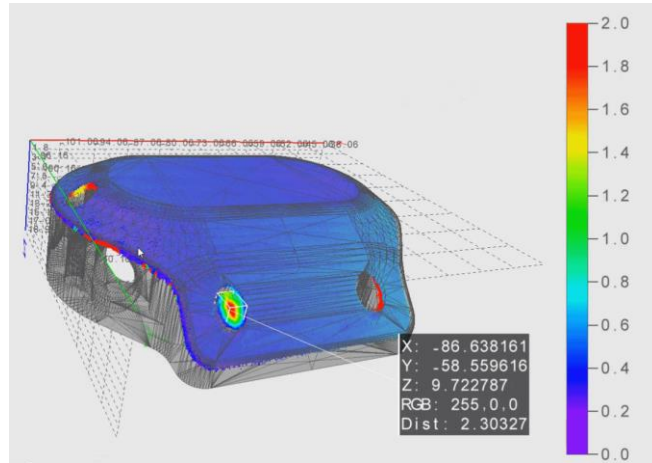


# Open eVision

Image Analysis Software Tools



## E3DViewer class is an interactive viewer for Point Clouds and ZMaps



## Compatibility with 3D sensors

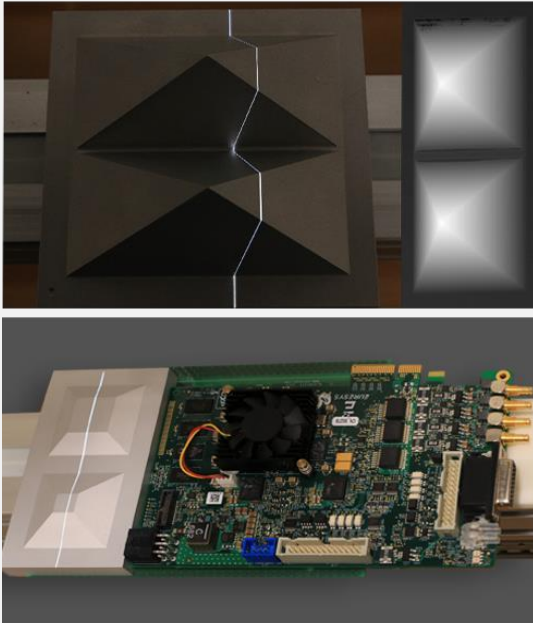
- It is possible to push 3D data from third-party 3D sensors to Easy3D containers
- Some of the supported sensor's brands:



# Easy3DLaserLine







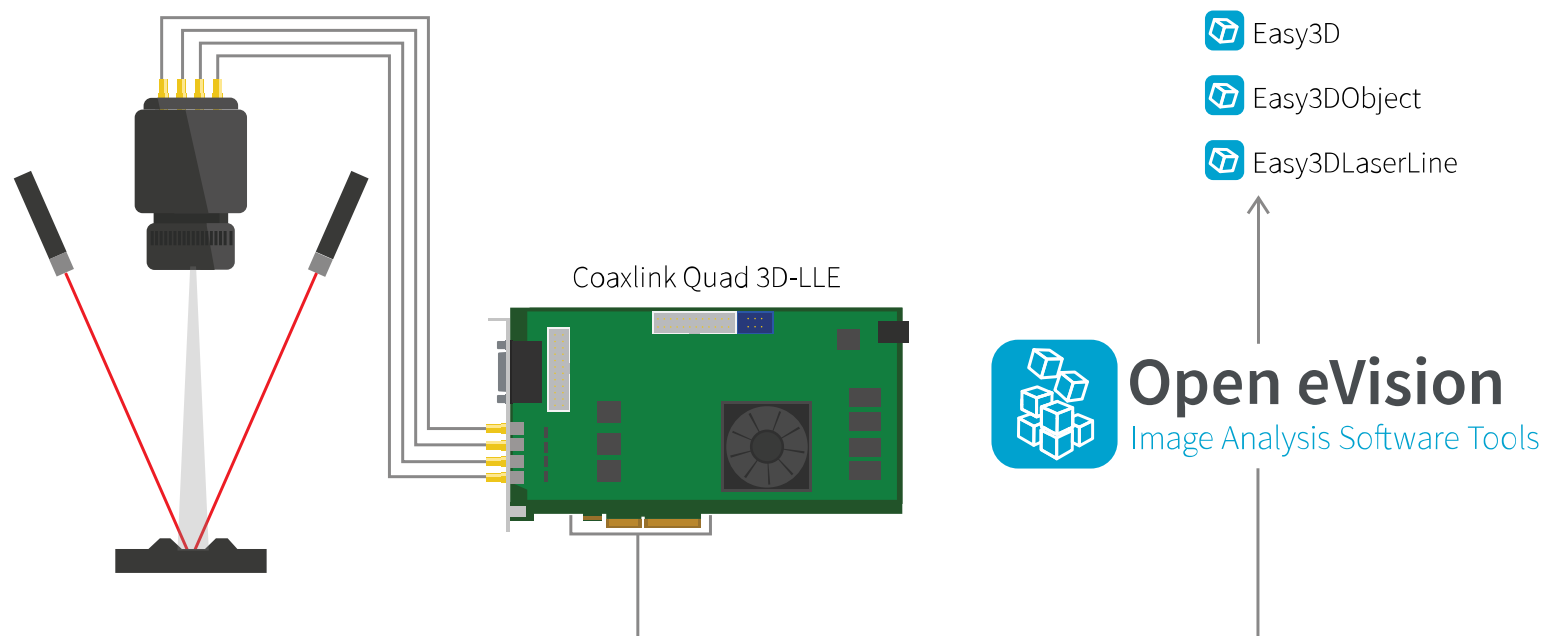
# Easy3DLaserLine

## 3D laser line extraction and calibration library

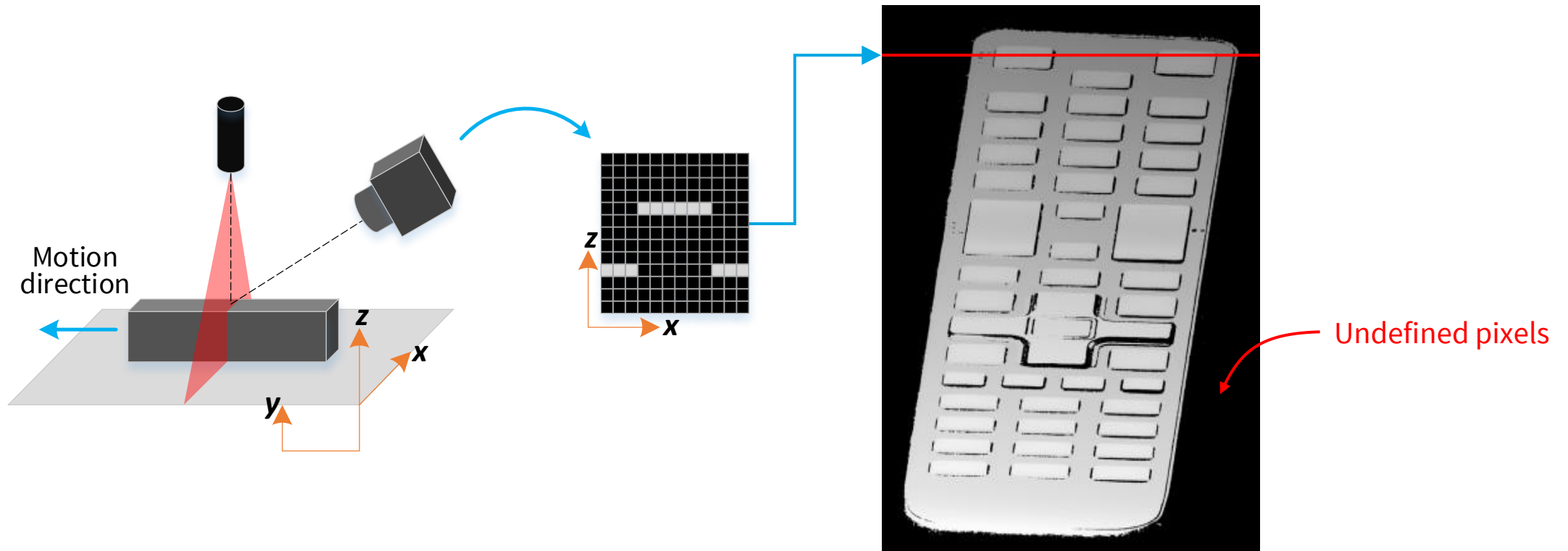
- Single and Dual Laser Line Extraction into a depth map
- Convenient and powerful 3D calibration for laser triangulation setups
- Compatible with the Coaxlink Quad 3D-LLE frame grabber

## Laser line triangulation is one of the main principles to acquire 3D data at high speed and high accuracy

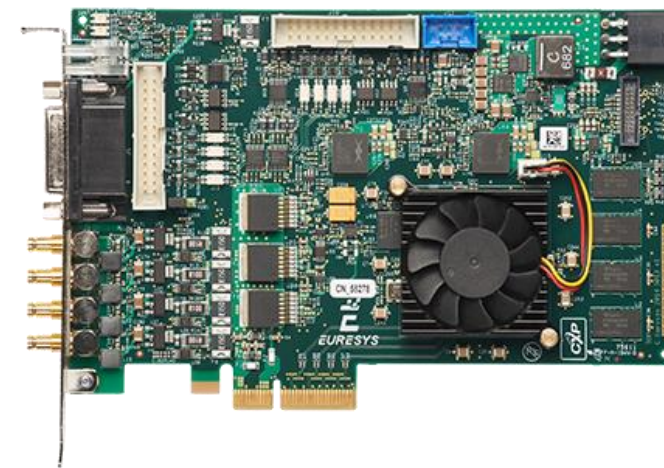
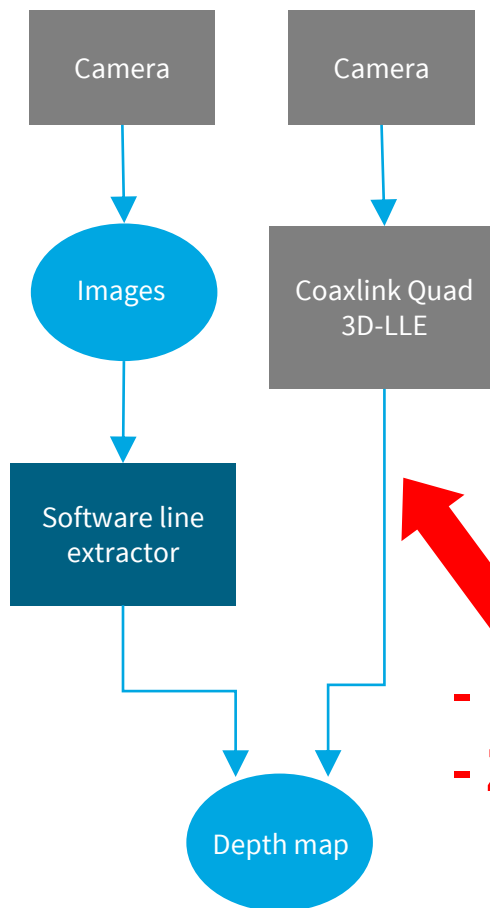
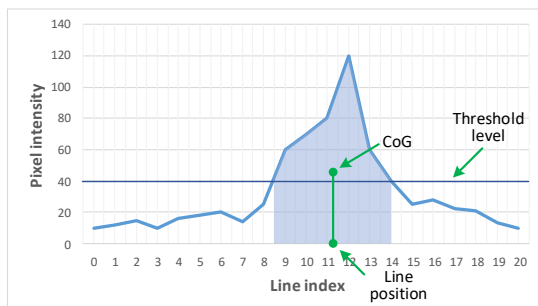
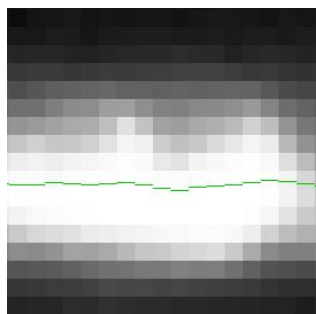
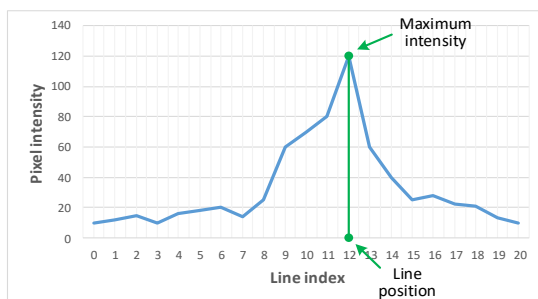
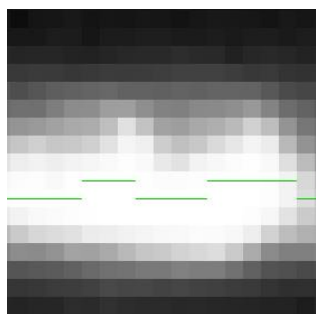
- Euresys provides a dedicated CoaXPress card Coaxlink Quad 3D-LLE and a processing library Easy3DLaserLine



**Extracted profile positions are converted to grey scale values and are stacked in an image, that's the depth map**



## Software or hardware extraction



**- Faster**  
**- Zero host CPU load**

**CXP-6**

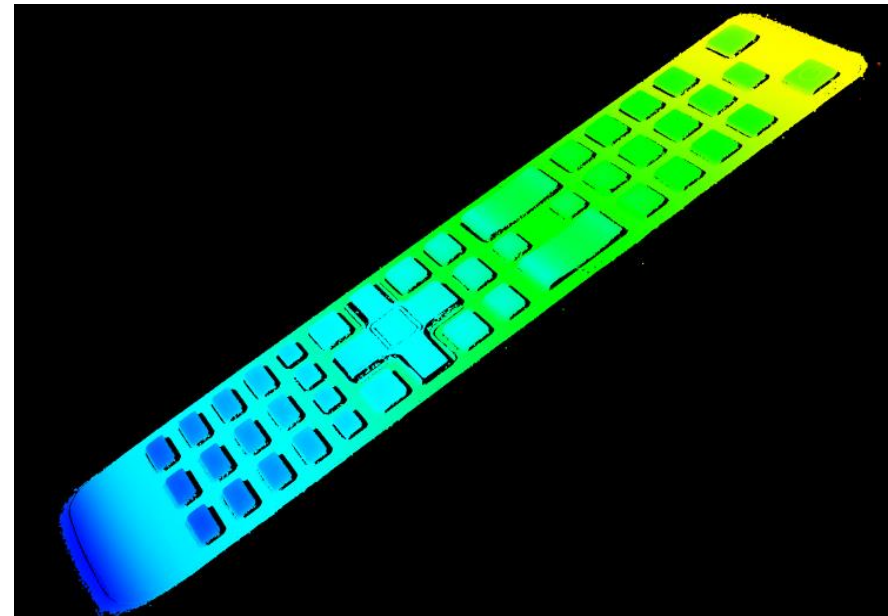
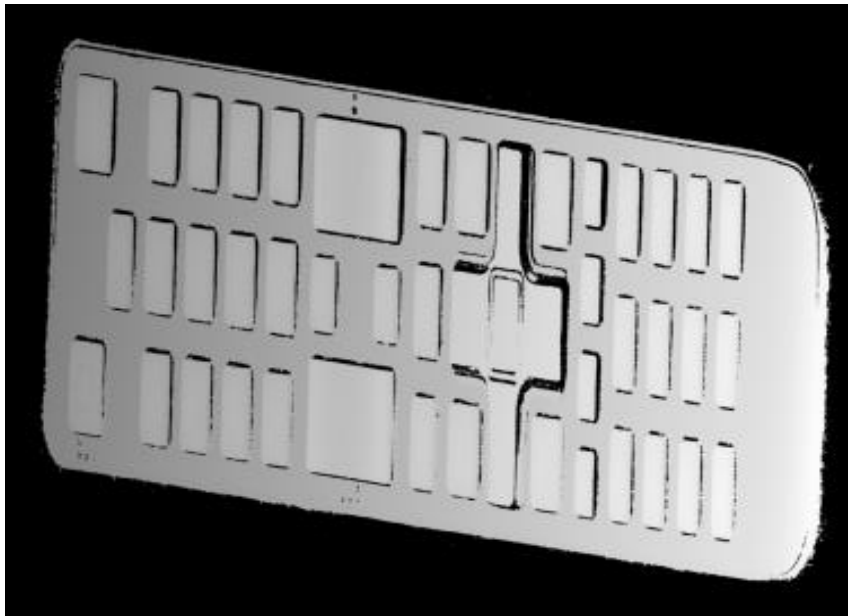
# Coaxlink Quad 3D-LLE

## Quad CXP-6 frame grabber with on-board laser line extraction for 3D profiling

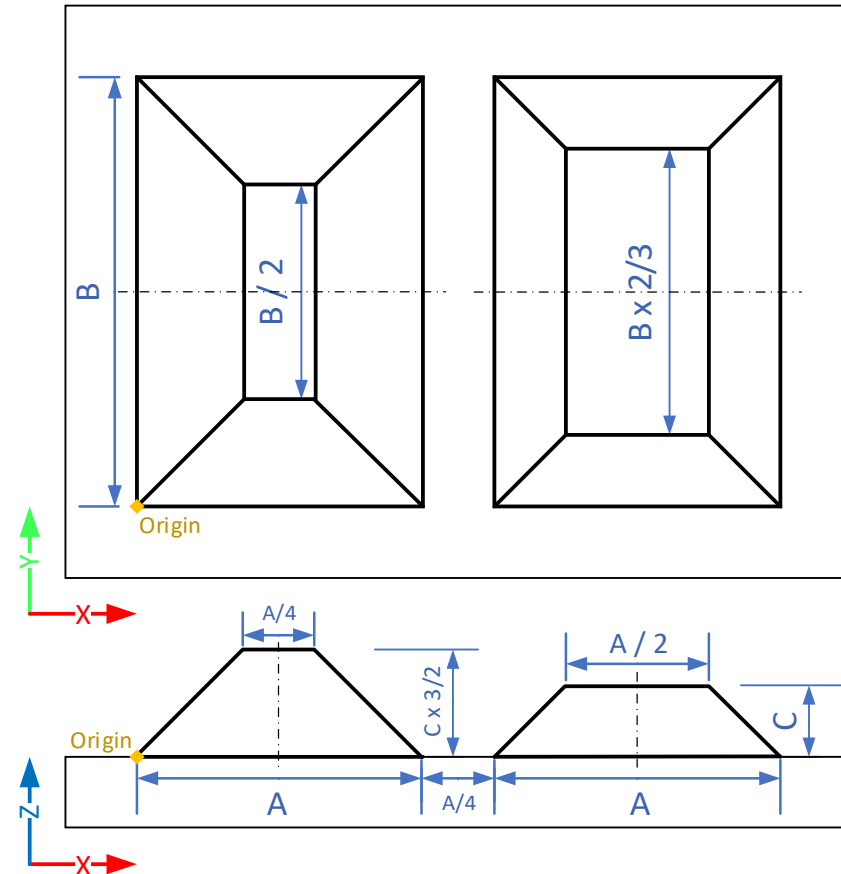
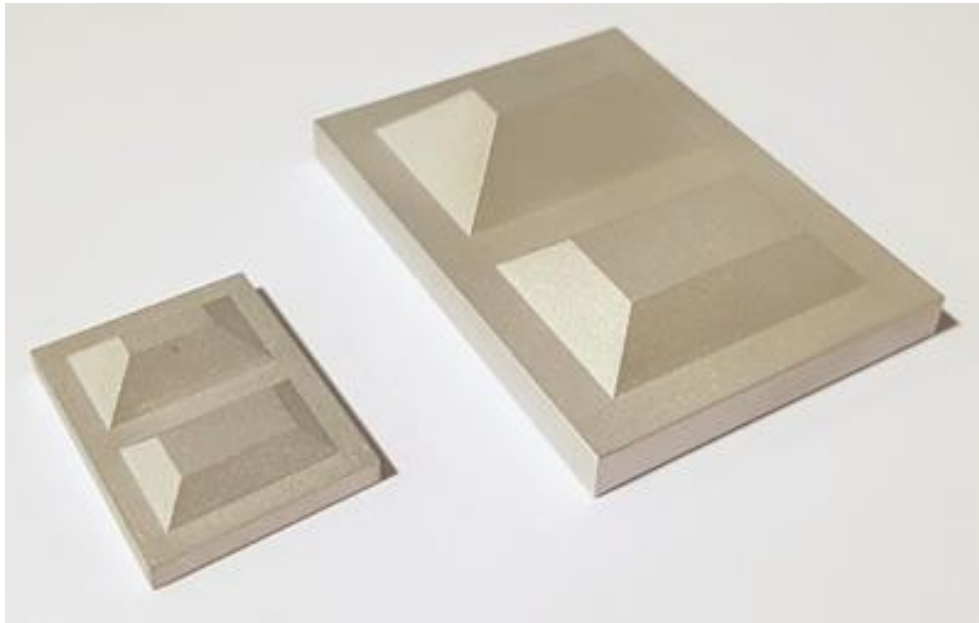
- Laser line extraction with zero host CPU usage
- Single and Dual Laser Line Extraction into a depth map
- Real-time generation of 16-bit 3D height maps
- Choice of algorithms: Maximum, Peak, Center of Gravity (COG)
- Precision: up to 1/256 pixel (with Peak and COG algorithms)
- Performance: - 19,000 profiles/s from 1024 x 128 images  
- 38,000 profiles/s from 1024 x 64 images



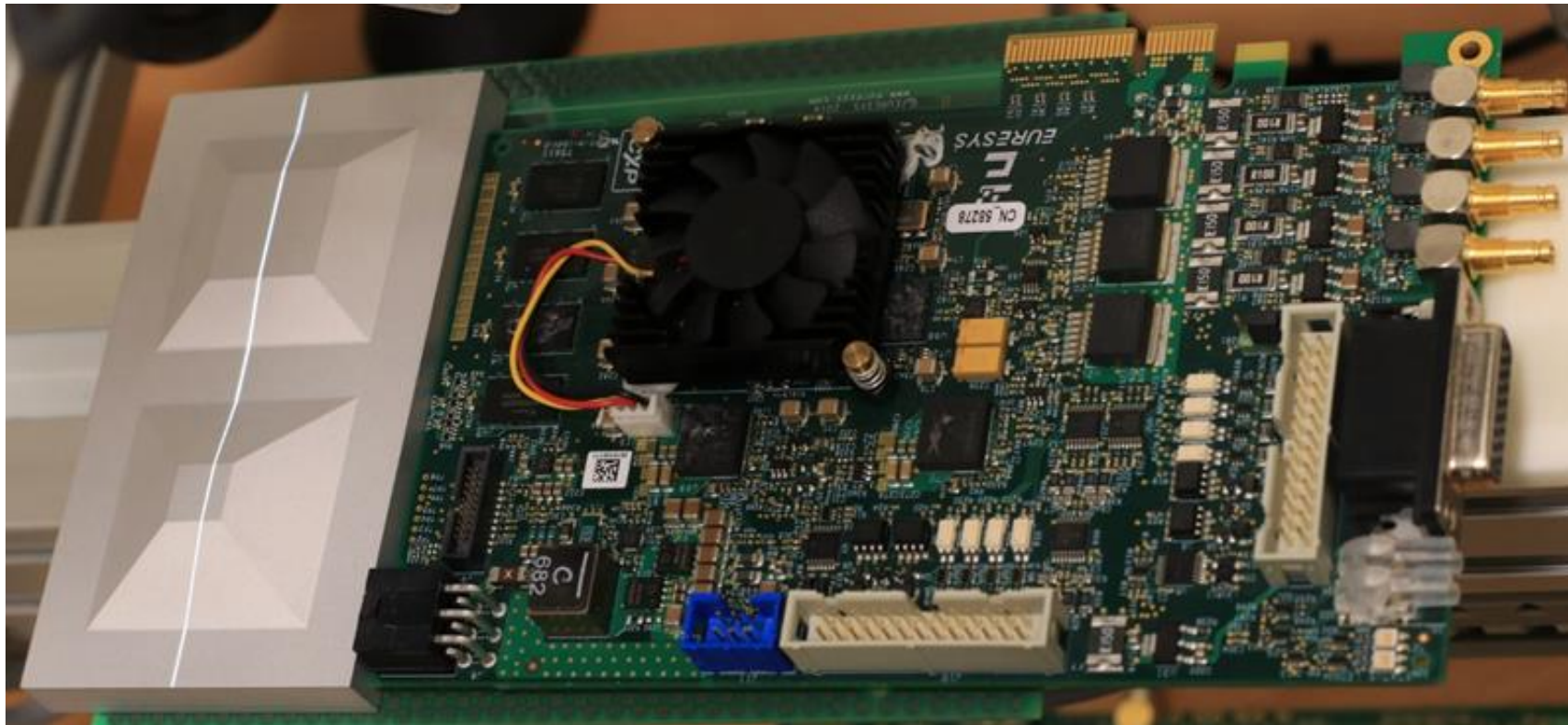
**A Calibration Model is required to transform the Depth Map into a rectified (without distortion) and metric 3D representation**



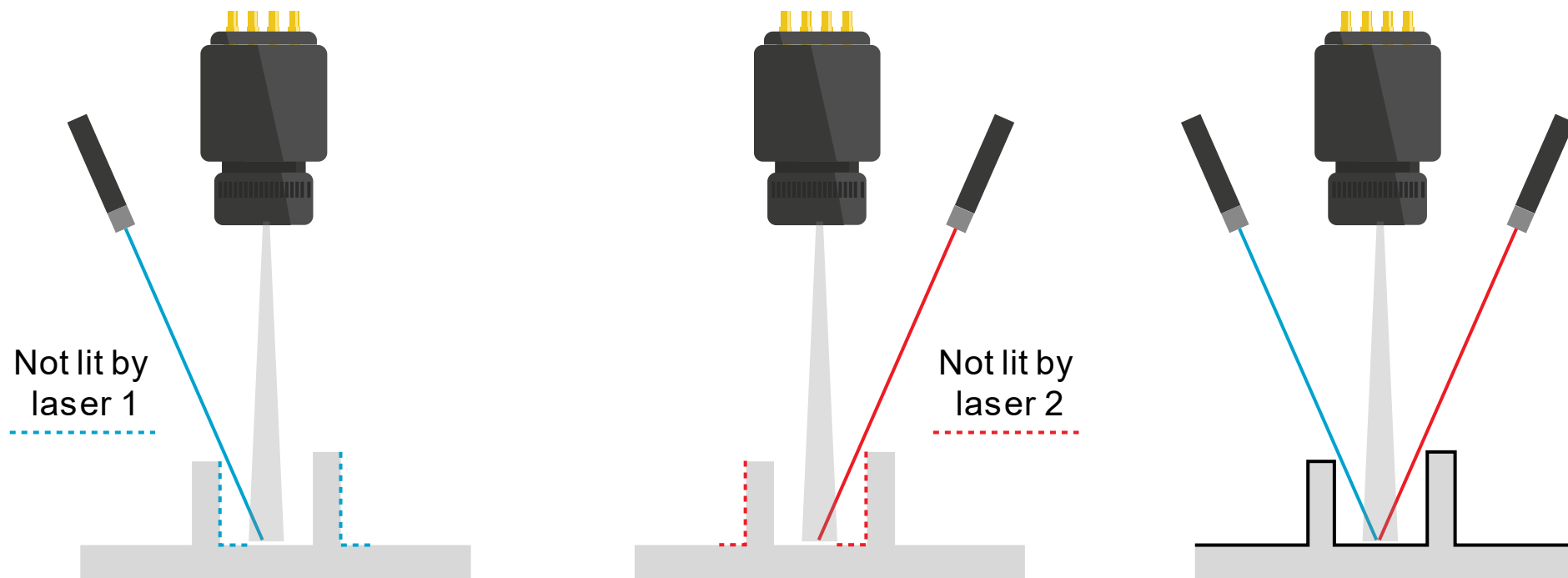
## Compute a calibration model from a single scan of the calibration object



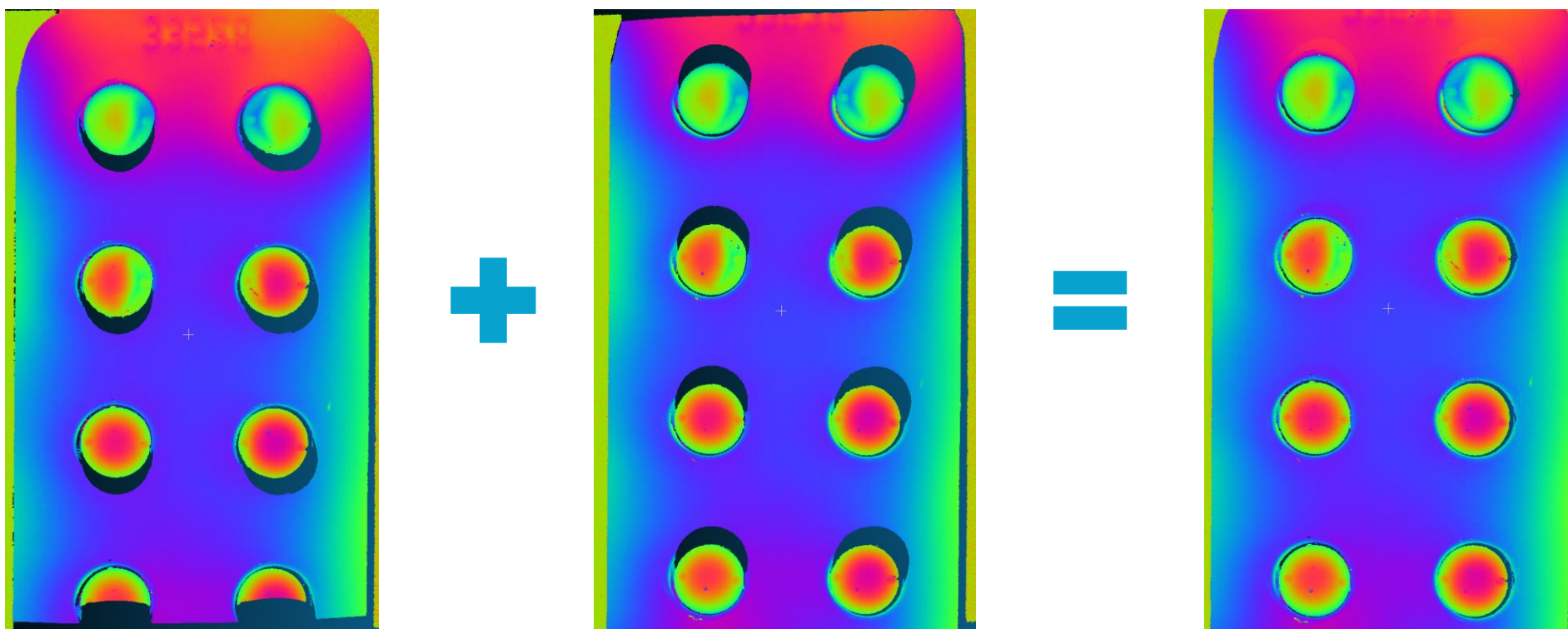
**The calibration object size must fit the working area of the project**



## Dual laser line extraction: reduction of occlusions



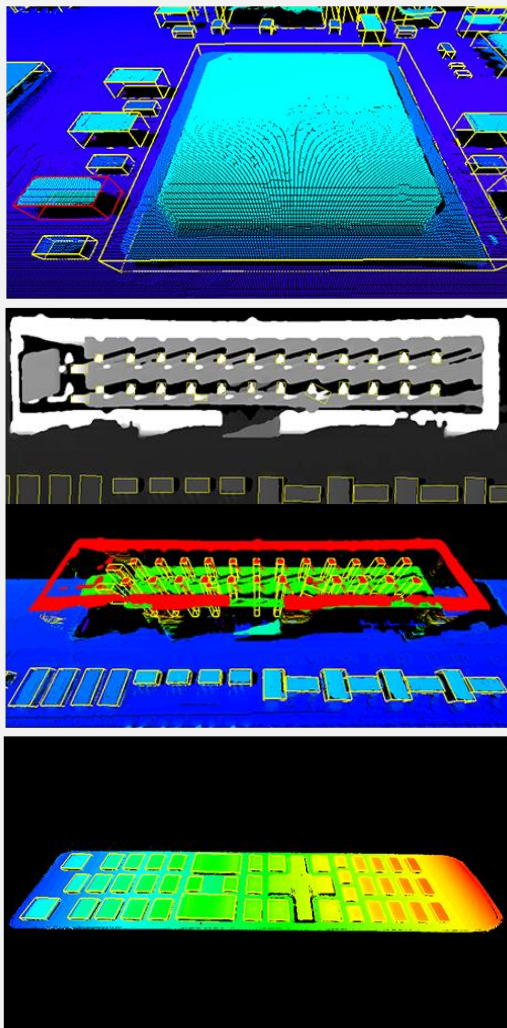
**The object-based calibration is compatible with dual laser lines and allows the merging of the two depth maps into a single point cloud**





# Easy3DObject





# Easy3DObject

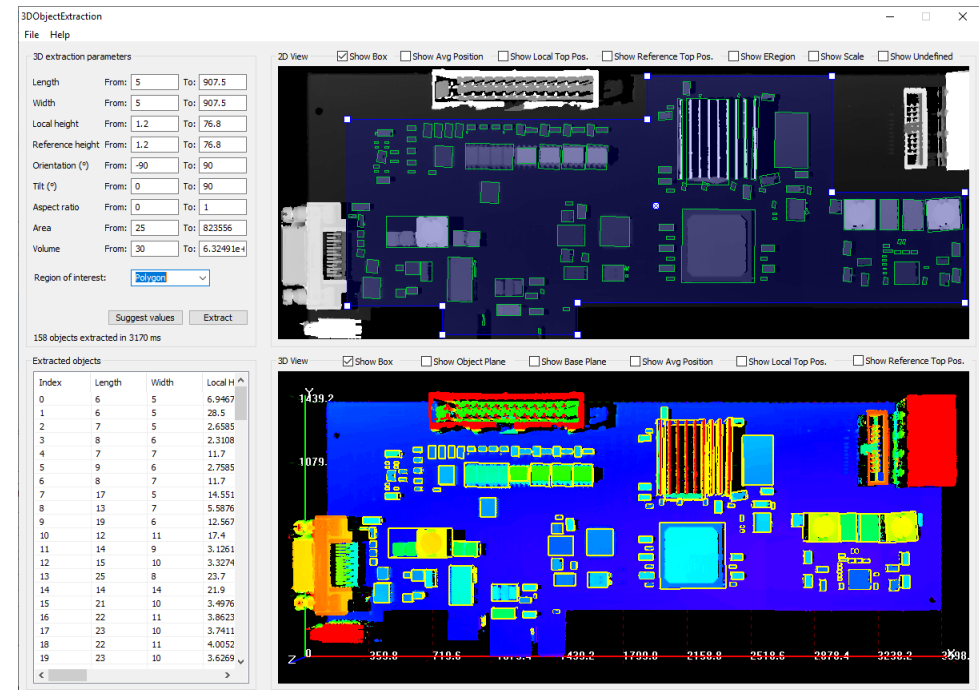
## 3D alignment and inspection library

- Align a scanned 3D object with another scan or with a reference mesh
- Compute the local distances between 3D scans and a golden sample or reference mesh
- Detect anomalies such as misplaced features, geometric distortions, gaps, bumps,...
- Compatible with all 3D sensors that produce point clouds, depth maps or height maps

# Easy3DObject is a high-level library to automatically detect objects and measure their 3D features

## Use cases:

- PCB inspection
- Connector inspection
- Pharmaceutical blister pack inspection
- Any inspection where the segmentation of objects from a ZMap is possible



## Workflow

- Load or build (from an image, a point cloud) an EZMap
- Set the geometric extraction criteria (size, orientation, shape...)
- Extract the 3D objects (with or without an ERegion)
- Get and process the extracted E3DObject list

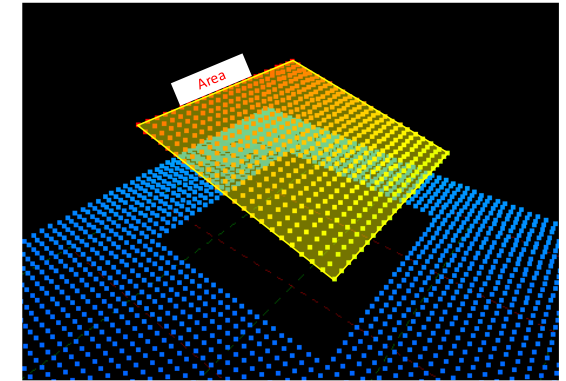
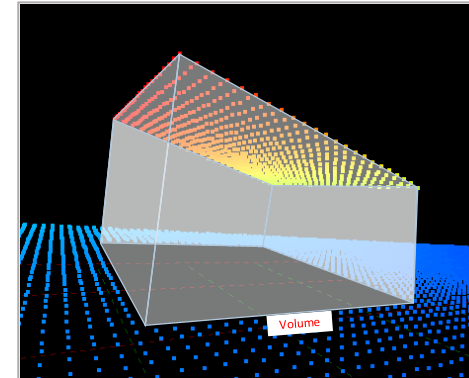
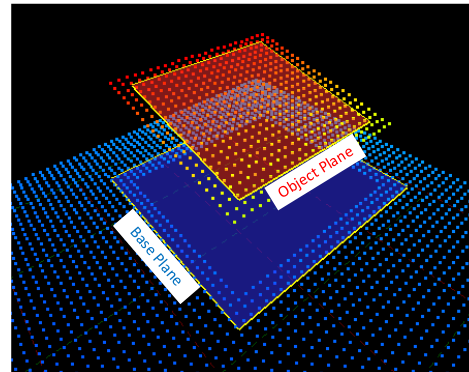
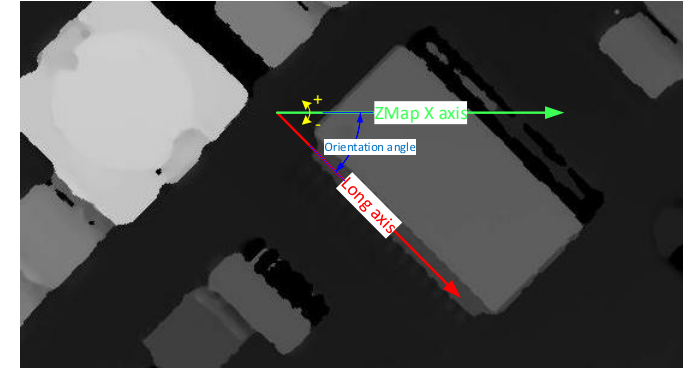
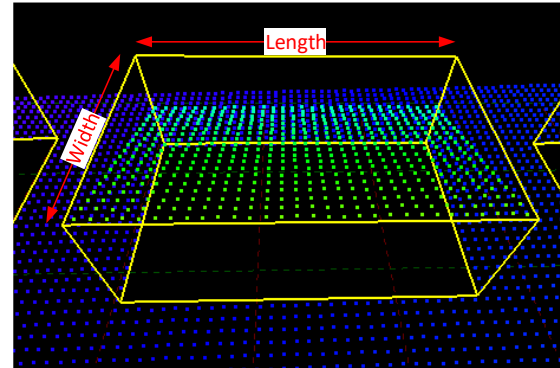
```
E3DObjectExtractor extractor;
extractor.SetLengthRange(EFloatRange(2, 64));

EZMap8 zmap;
extractor.Extract(zmap);

std::vector<E3DObject> objects;
objects = extractor.GetObjects();
```

## 3D object attributes

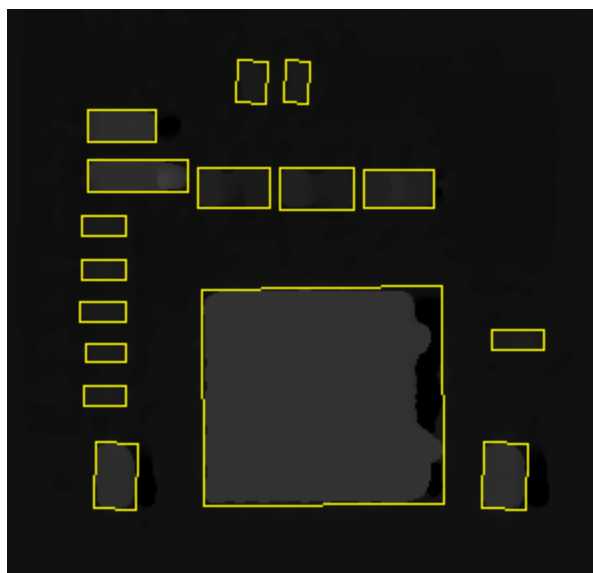
- Length and Width
- Orientation angle
- Object plane and base plane
- Local and reference tilt angles
- Top positions and heights
- Average position
- Bounding box
- Aspect ratio
- Area
- Volume



**All dimensions are expressed in real world unit, the unit of the ZMap.**



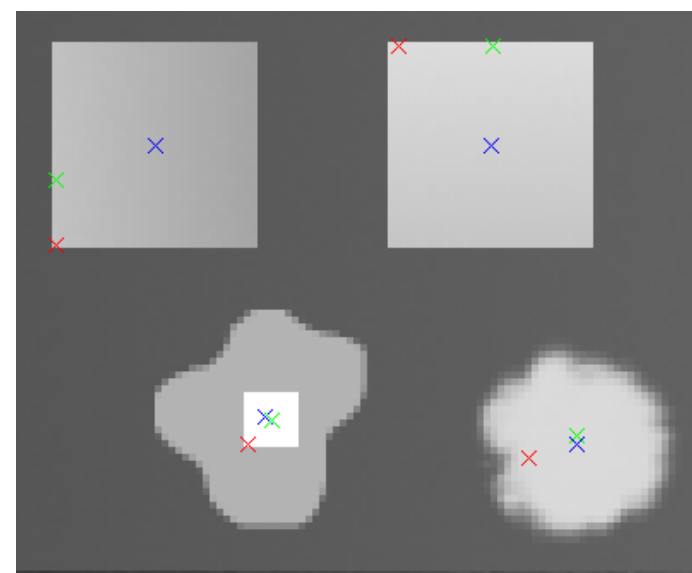
The result of the extraction is a list of E3DObject, with all the geometrical features - displayed in 2D



*ERectangleRegion*

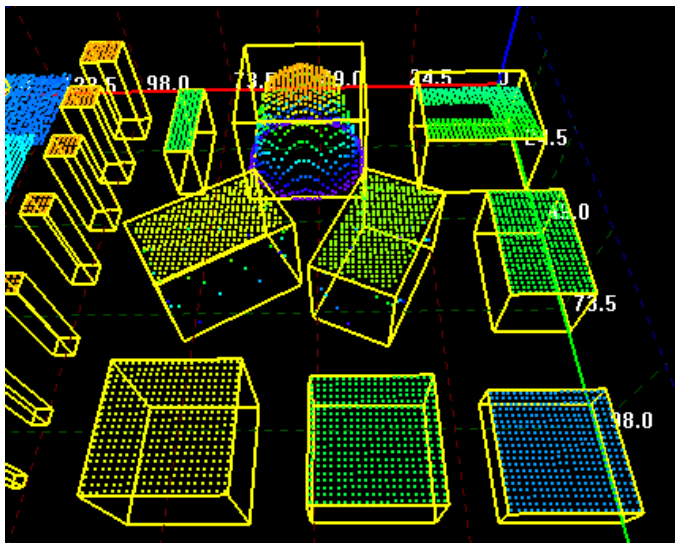


*ERegion*

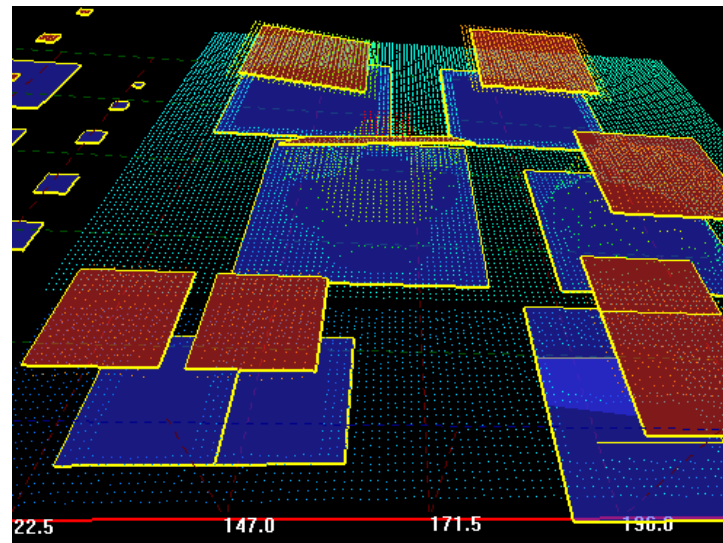


*Average, Local Top, Reference Top positions*

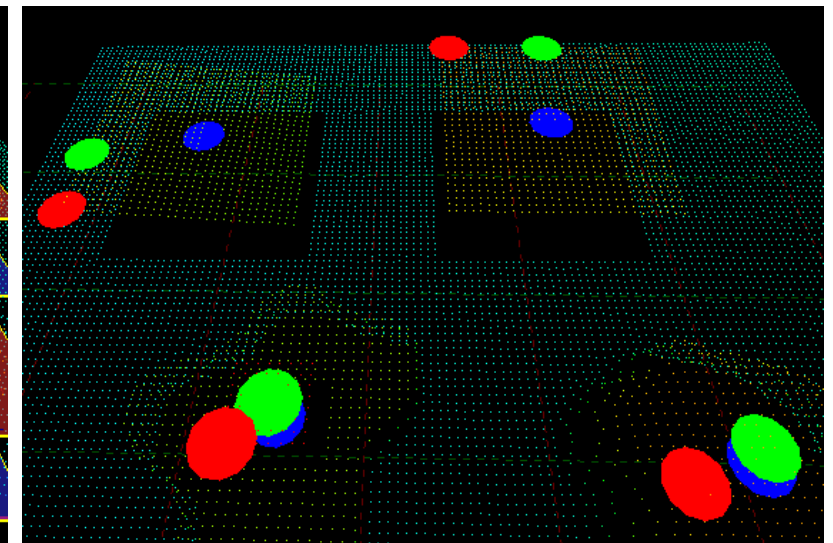
The result of the extraction is a list of E3DObject, with all the geometrical features - displayed in 3D



*3D Bounding Box*



*Object and Base Planes*



*Average, Local Top, Reference Top positions*

# A demo application is provided with source code to illustrate the usage of Easy3DObject

3DObjectExtraction

File Help

3D extraction parameters

Length From: 5 To: 907.5

Width From: 5 To: 907.5

Local height From: 1.2 To: 76.8

Reference height From: 1.2 To: 76.8

Orientation (°) From: -90 To: 90

Tilt (°) From: 0 To: 90

Aspect ratio From: 0 To: 1

Area From: 25 To: 823556

Volume From: 30 To: 6.32491e+4

Region of interest: Polygon

Suggest values Extract

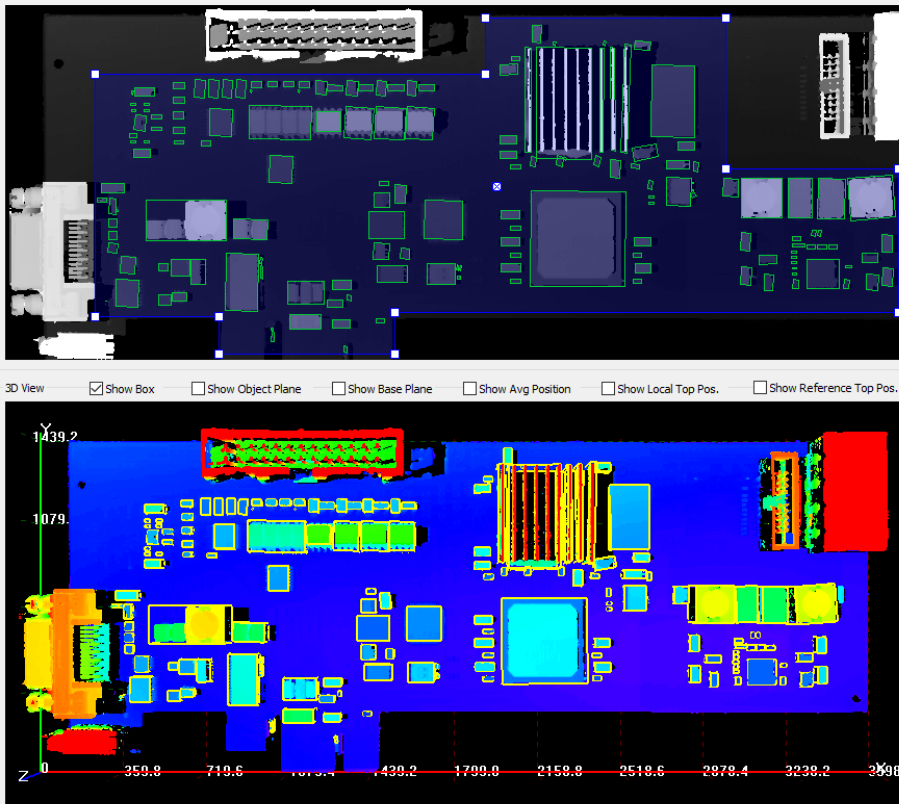
158 objects extracted in 3170 ms

Extracted objects

Index	Length	Width	Local H
0	6	5	6.9467
1	6	5	28.5
2	7	5	2.6585
3	8	6	2.3108
4	7	7	11.7
5	9	6	2.7585
6	8	7	11.7
7	17	5	14.551
8	13	7	5.5876
9	19	6	12.567
10	12	11	17.4
11	14	9	3.1261
12	15	10	3.3274
13	25	8	23.7
14	14	14	21.9
15	21	10	3.4976
16	22	11	3.8623
17	23	10	3.7411
18	22	11	4.0052
19	23	10	3.6269

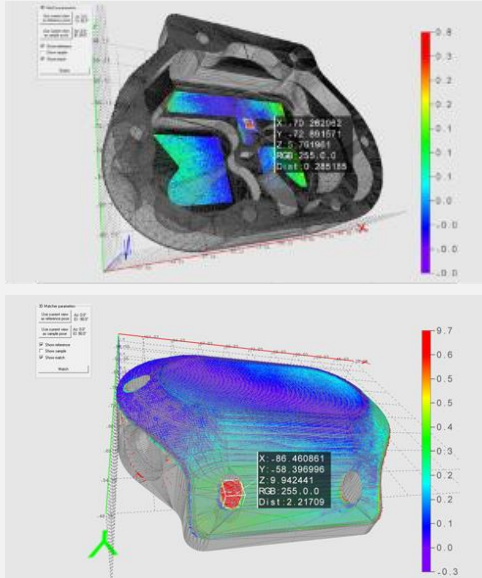
2D View ☒ Show Box ☐ Show Avg Position ☐ Show Local Top Pos. ☐ Show Reference Top Pos. ☐ Show ERegion ☐ Show Scale ☐ Show Undefined

3D View ☒ Show Box ☐ Show Object Plane ☐ Show Base Plane ☐ Show Avg Position ☐ Show Local Top Pos. ☐ Show Reference Top Pos.



# Easy3DMatch





# Easy3DMatch

## 3D alignment and inspection library

- Align a scanned 3D object with another scan or with a reference mesh
- Compute the local distances between 3D scans and a golden sample or reference mesh
- Detect anomalies such as misplaced features, geometric distortions, gaps, bumps,...
- Compatible with all 3D sensors that produce point clouds, depth maps or height maps

## Easy3DMatch

- Align a scanned 3D object with another scan or with a reference mesh

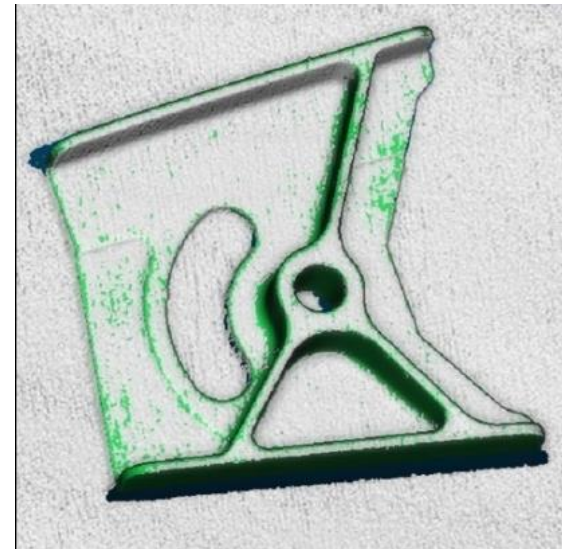
*Reference*



*Sample object*



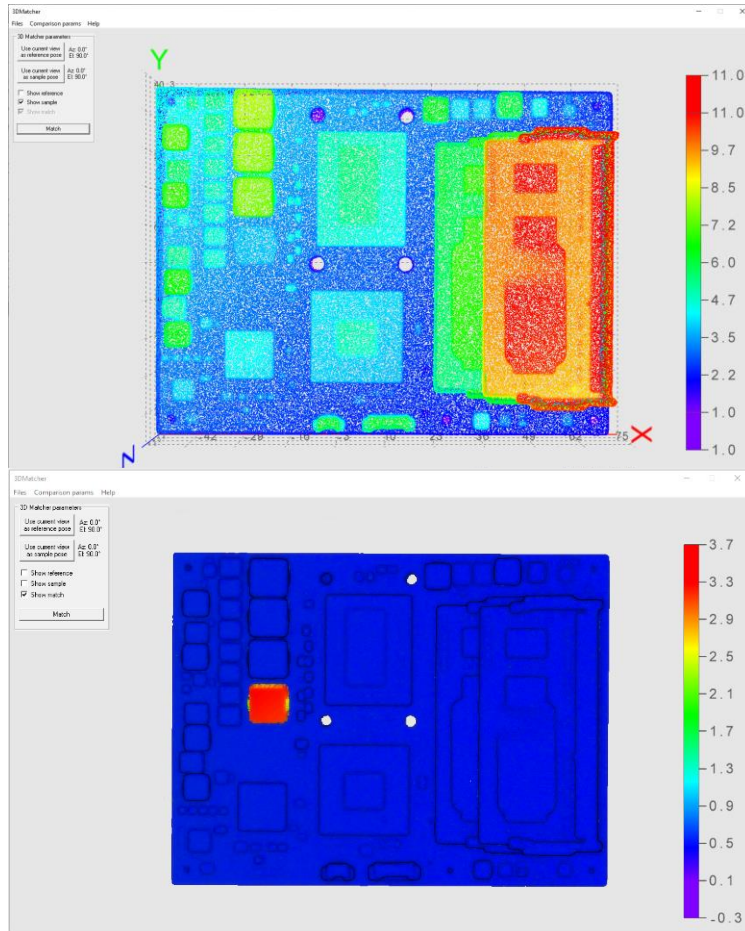
*Aligned*





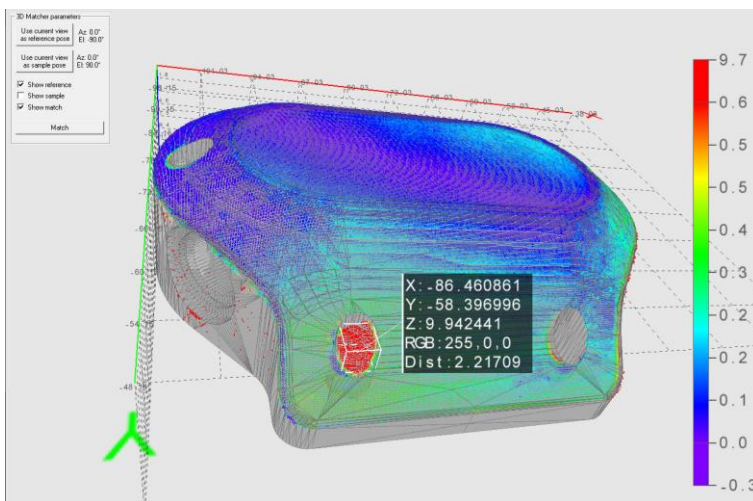
## Easy3DMatch

- Align a scanned 3D object with another scan or with a reference mesh
- Compute the local distances between 3D scans and a golden sample or reference mesh

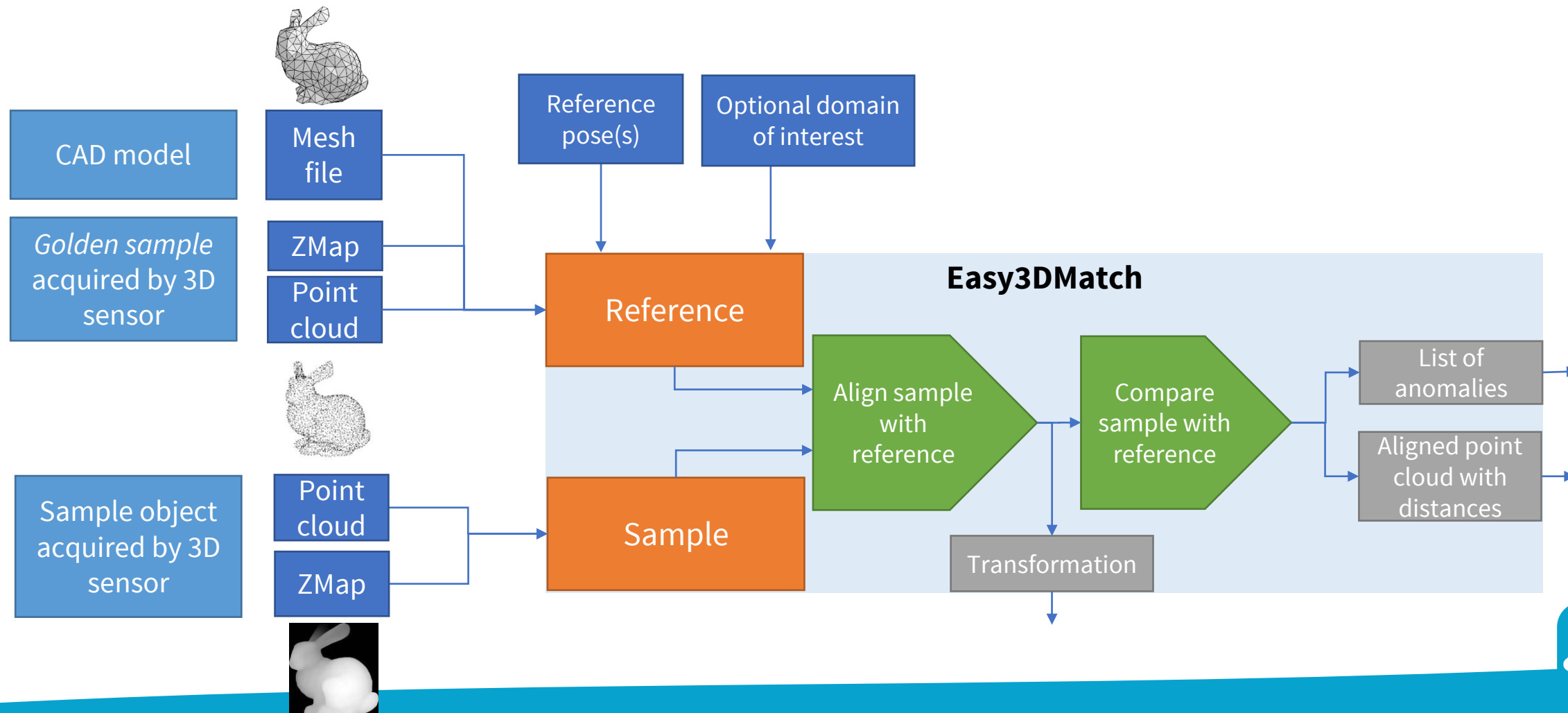


## Easy3DMatch

- Align a scanned 3D object with another scan or with a reference mesh
- Compute the local distances between 3D scans and a golden sample or reference mesh
- Detect anomalies such as misplaced features, geometric distortions, gaps, bumps,...



## Easy3DMatch workflow



CLIMB HIGHER WITH 3D



# 3D Inspection

Defect Detection and Measurement

