

SuperSurf

Optical scanner analysis

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We are dedicated to designing and producing the best value for money PEM fuel cell stacks in the market.



Background



A optical scanner was design and built aiming at cell plate thickness measurements for the quality production control of Nedstack cell plates under the project SuperSurf.

The concept was developed by DEMCON under specifications provided by Nedstack.

Nedstack has the task of evaluating the prototype and providing feedback about capabilities and potential aspects that might need to be improved.

This report describes all the testing procedures and results obtained in the evaluation the prototype. Based on the results, feedback on improvements are provided for the current target application as well as for more advanced testing.

Deliverable & Planning

For the current target application (SuperSurf project) the following activities were carried out:

1. Determination of standard deviations in measurements through:
 - *Reproducibility test* – 10 measurements of each sampling point were made to evaluate the accuracy and standard deviations.
 - *Clamping test* – Deviations in each single sampling point were determined by varying the clamping order.
 - *Rotation test* – Measurements are taken for the sampling points and then the cell plate is rotated 180° for measuring the sampling point in the cell plate in the equivalent sampling point.
2. Processing data display
3. Post-processing data

Also, suggestions for additional testing features (out of the scope of the project) are provided

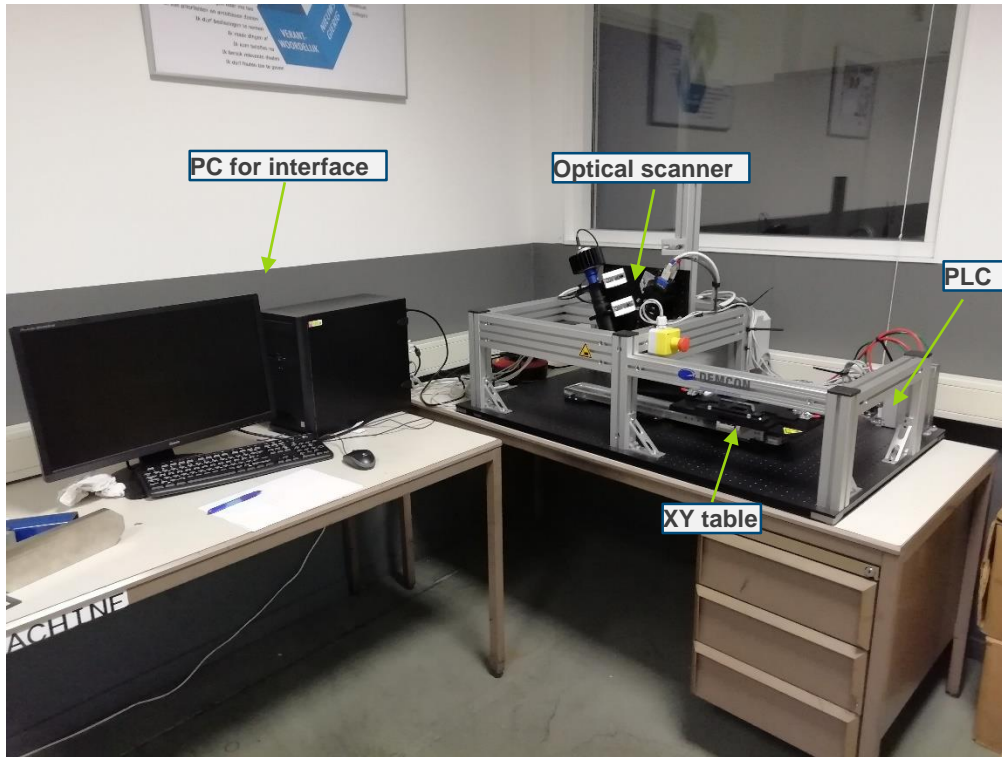
Deliverable: report

Deliverable types:

R – document, report DEM – demonstrator, pilot, prototype OTHER – software, technical diagrams .etc.

Overview of the optical scanner prototype

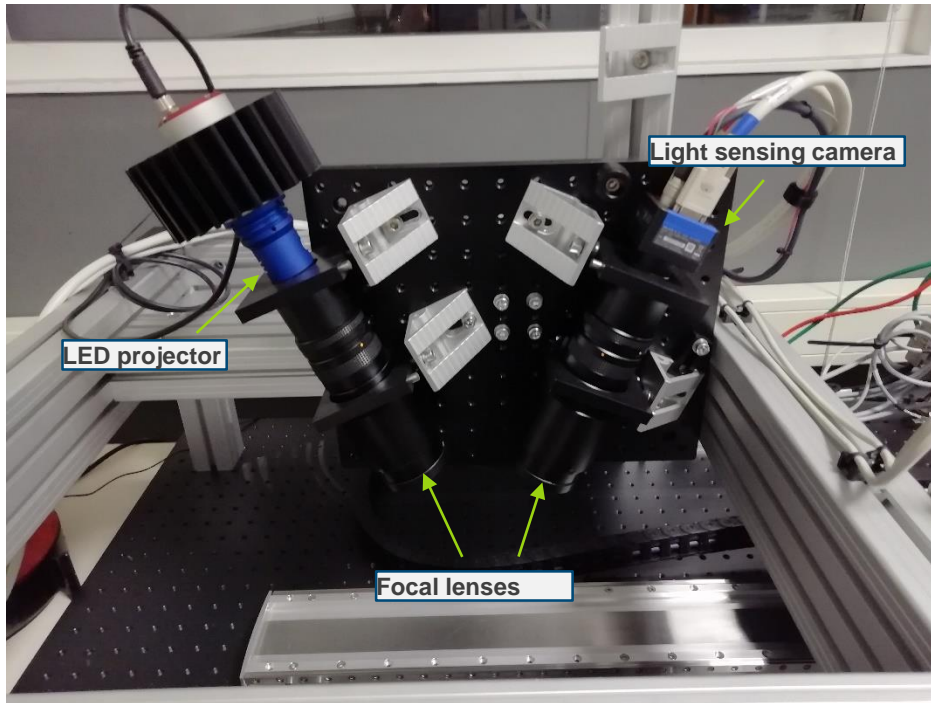
The Optical scanner prototype



The prototype is composed of:

- 1 PC used as the interface
- 1 Optical scanner
- 1 Cell plate holder
- 1 PLC

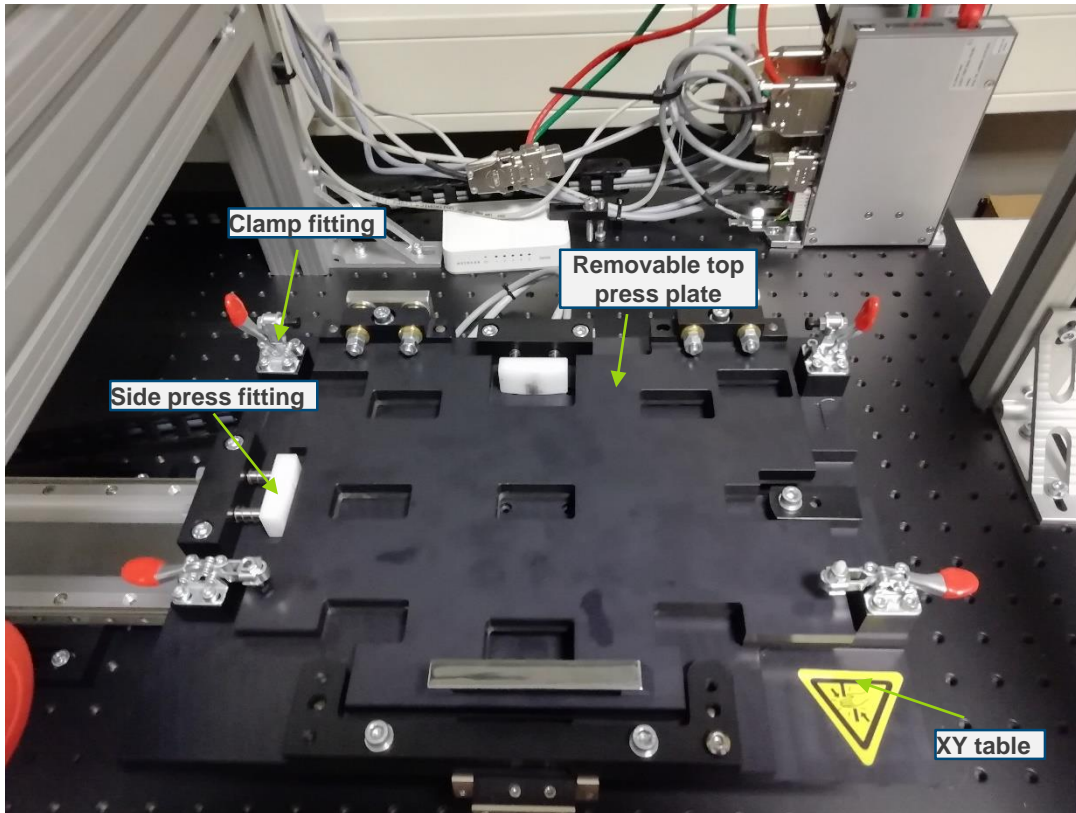
The Optical scanner



Optical scanner is a triangulation LED 3D scanner type composed of:

- 1 line-type LED projector
- 2 Focal lenses
- 1 light sensing camera

Cell plate holder



The cell plate holder is composed of:

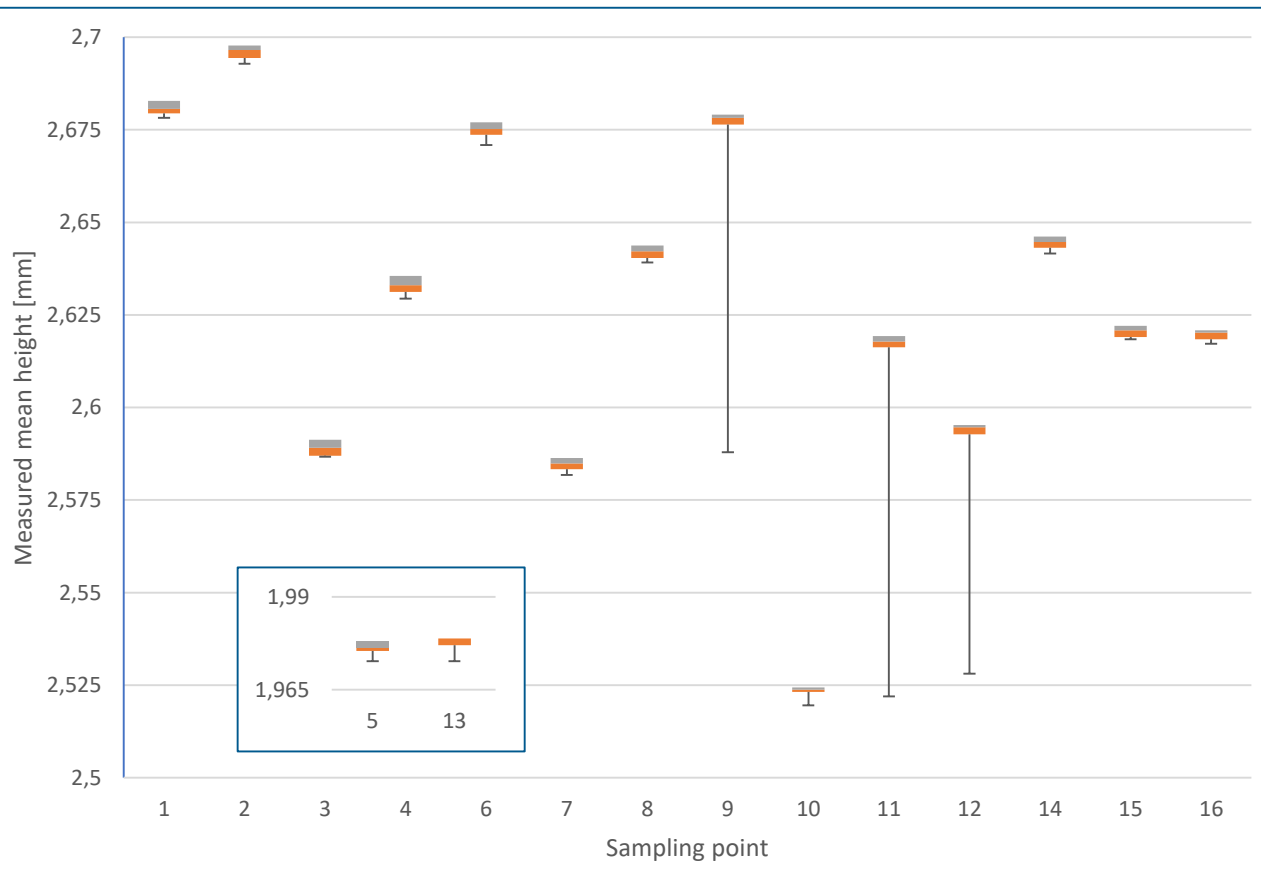
- 1 XY table
- 2 side press fittings for positioning the cell plate
- 1 removable top press plate for cell plate flattening
- 4 clamp fittings

The removable plate has 11 holes to enable the measurement of the 16 points in the cell plate

Prototype testing

Reproducibility test

10 measurements of each sampling point were taken to evaluate the reproducibility of the measurement as well as standard deviations (only median height values are analyzed).



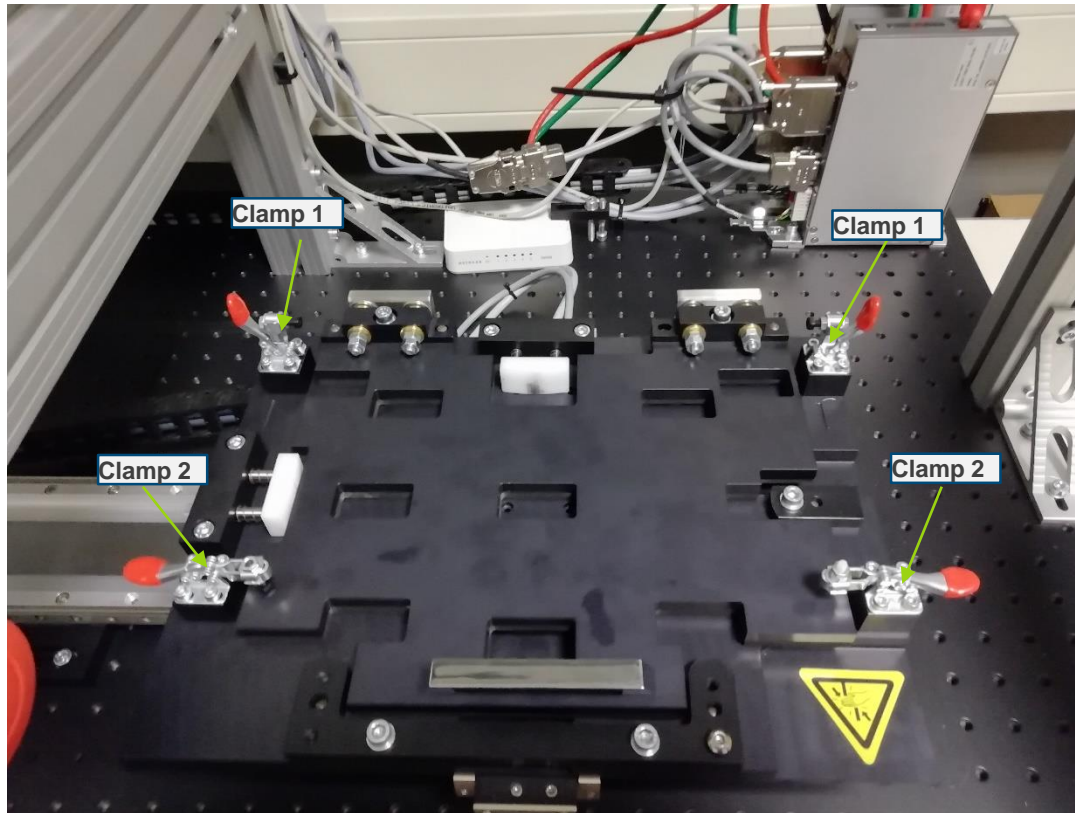
Remarks:

- Very high reproducibility is obtained.
- Average difference between maximum and minimum values in each sampling point is approx. **5 μm** , excluding points 9, 11 and 12.
- Major deviations are found in these points with values of 91, 97 and 67 μm respectively.
- These deviations might be caused by the XY table positioning accuracy

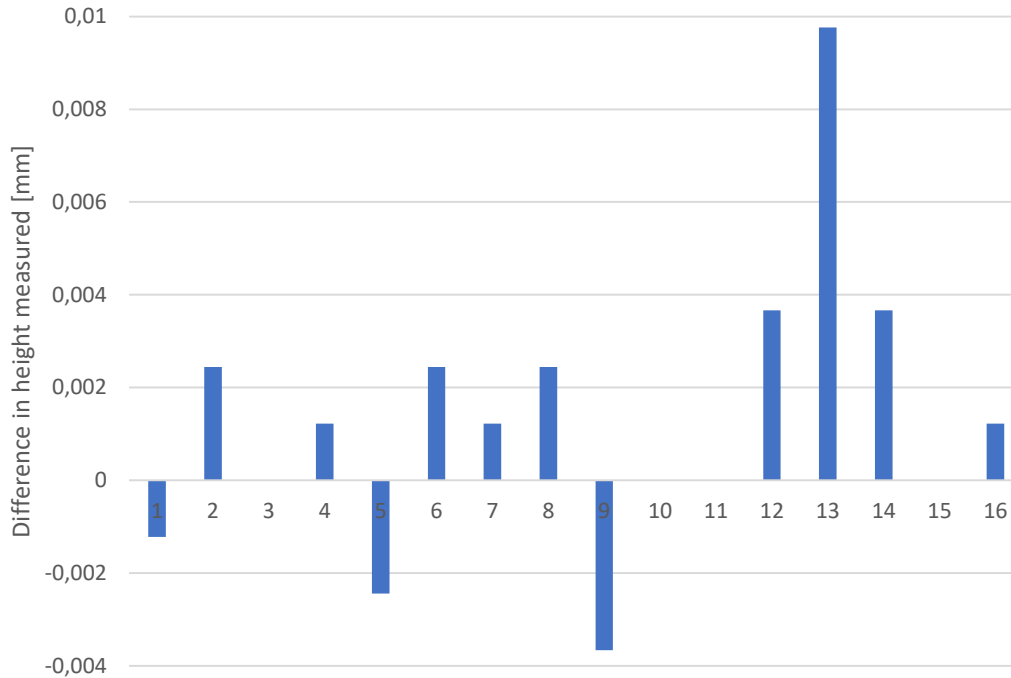
Clamping test

In this test, the clamping order was varied to determine the influence on the measurements.

- 1. The top press plate was first clamped by “Clamps 1” and then by “Clamps 2”. The height measurement in each sampling point was carried out.
- 2. The top press plate was first clamped by “Clamps 2” and then by “Clamps 1”. The height measurement in each sampling point were carried out.



Clamping test



Remarks:

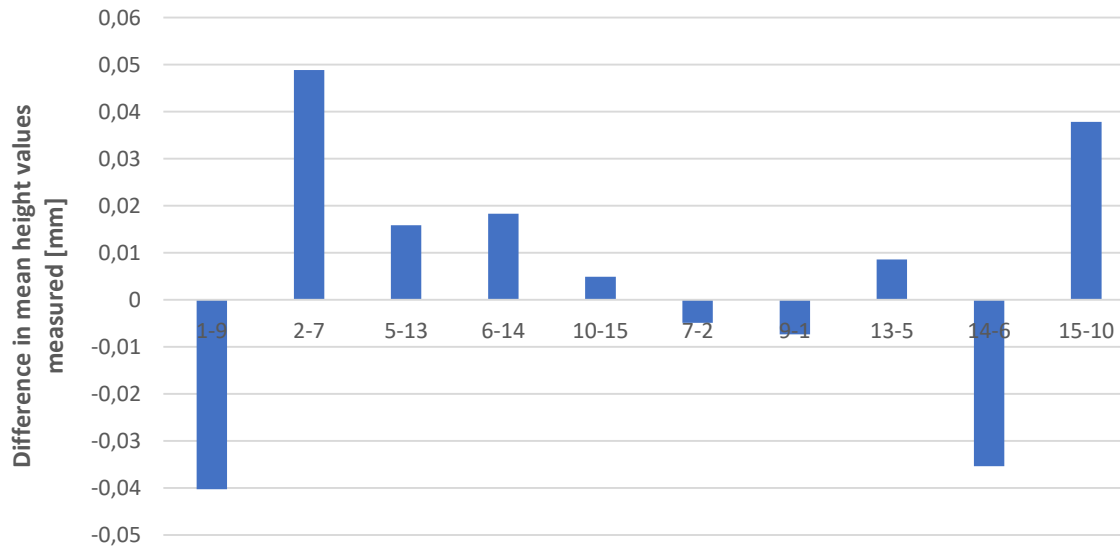
- Difference in height measured from one clamping order to other one is, in general, very small (below 4 μm)
- Max difference is 9.7 μm in the sampling point 13.

Rotation test

This test followed these steps:

1. Placing of cell in the holder.
2. Measurement of the height of the cell plate in the defined sampling points.
3. Rotation the cell plate in 180°.
4. Measurement of the height in the previous defined sampling points.

For this test, the height values measured in the sampling points 1, 2, 4, 5, 6, 7, 9, 10, 12, 13, 14 and 15 in step 2 are compared with 9, 7, 12, 13, 14, 2, 1, 15, 4, 5, 6 and 10 in step 4 respectively. Points 3, 8, 11 and 16 are excluded.



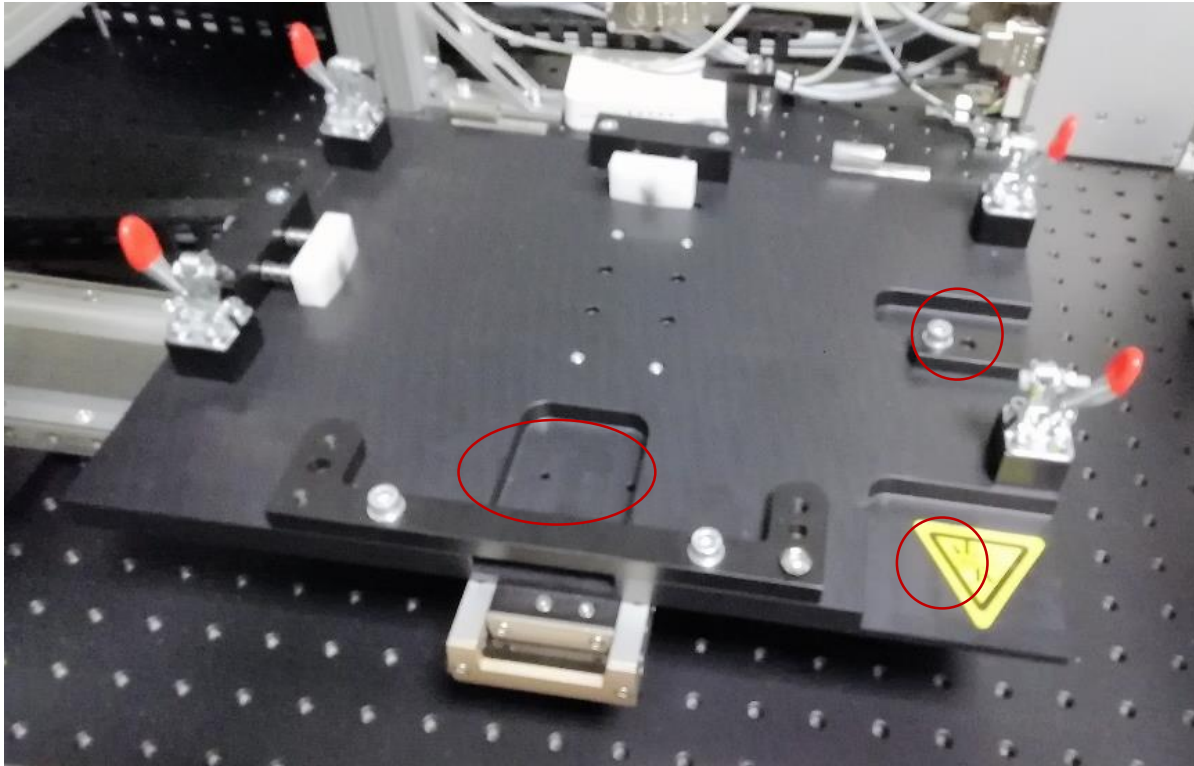
Remarks:

- The height measurement is highly dependent on the cell plate positioning.
- A maximum deviation of **50 μm** is obtained for point 2-7.

Hardware improvements

XY table

- The cell plate is not completely supported underneath



XY table

- The use of a less stiffer foam to assure pressure in all cell plate

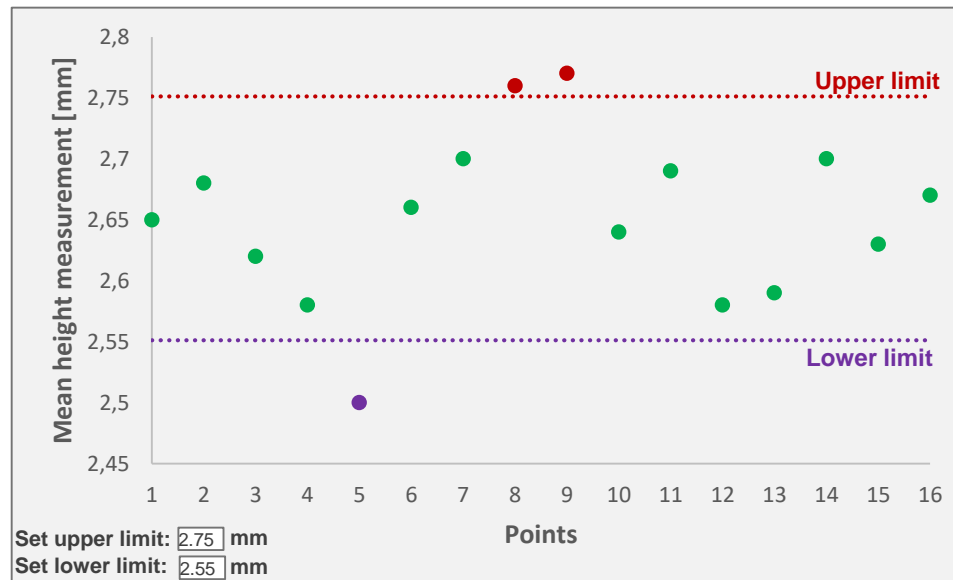


Data processing

Processing data display (GUI)

To be sure.

- The measuring data is displayed in a table, reporting the maximum, mean, median and minimum height measured for each point. Most of the available data is not of useful information for the target application. Therefore the focus should be in **displaying mainly the median height measurement**.
- For the quality control in the production site, the aim is to verify if the measured height is within the imposed limits as well as if the deviation in height between sampling points is within the imposed limits. Therefore, it would be also useful to **display the values in a graph** as shown below.



Post-processing data

- The measurement of the height of the cell plates aims at generating a conformity certificate of the production batch.
- Therefore, it would be more adequate if the results acquired for a specific cell plate are exported to an excel document that could be easily linked to a conformity certificate template, instead of exporting all day measurements to a single excel file.
- The excel file should contain:
 - Cell plate ID / batch
 - Cell plate type (FCS, FCT,... / anode, cathode)
 - Measurement date
 - Table with detailed height measurements (max, min, mean and median)

Conclusions for the current application (quality control of cell plates)

Conclusions

- Measurements tests showed that the deviations in measurements are below 50 μm and thus significant
- Nevertheless improvements in plate holding can lead to minor deviations below 10 μm
- Major deviations are observed in the rotation test, nevertheless these deviations might be related to the position of the cell plate rather than the accuracy of the measurement.
- Major improvements are required in the processing and post-processing data. A fast check of the cell plate quality is required and must be available during the measurements as well as an adequate exportation of the data for generating of a conformity certificate.

Additional testing features

Additional testing features

Additional test features can be included that would increase the number of applications, namely:

- **Cell Plate full scanning** – this feature would provide a satisfactory information on the thickness of the whole cell plate. Nevertheless, display data need to be improved:
 - With a color palette that would make the correspondence between color and height;
 - The XY table should be modified to a vacuum type holding system to assure flatness of the plate;
- **Line scanning** – it would provide information on the thickness variation along the sealing groves and flowfield region (water side). The data should be displayed in an XY line graph.
- To remark that the implementation of a vacuum holding XY table would also enable the measurement of the preform plates as well as eliminate the interference of the fittings in the scanning measurements.