Curve

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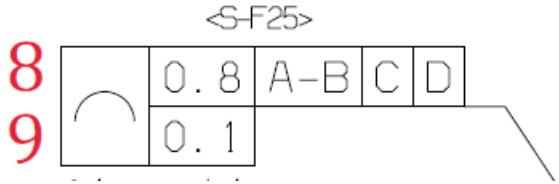
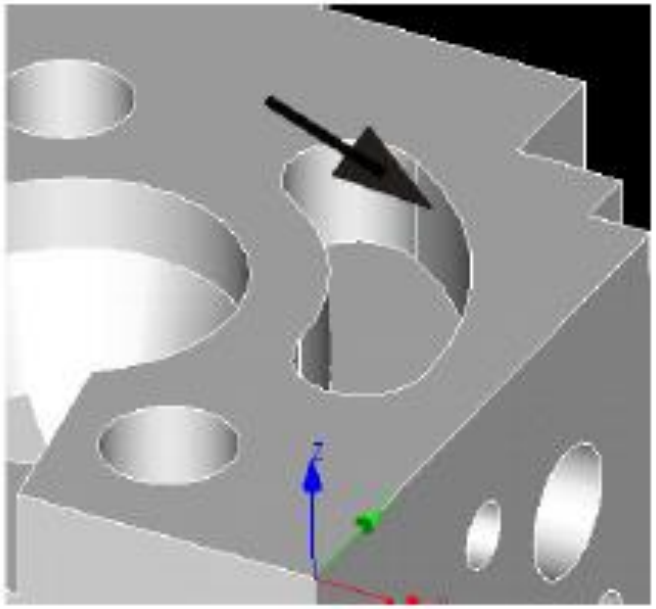
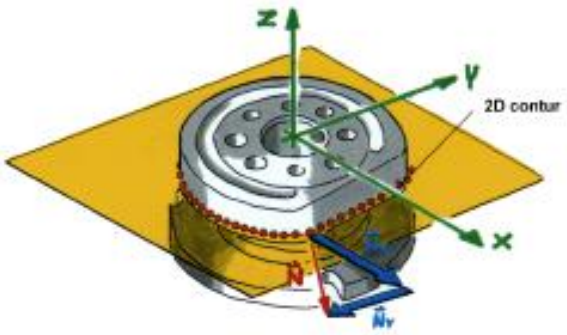
What is Curve?

Curve is an optional addition to Calypso used to measure non-standard geometries.
In GD&T terms, Profile Of A Line



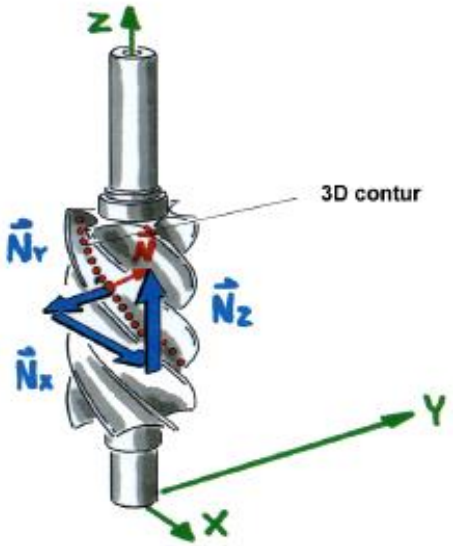


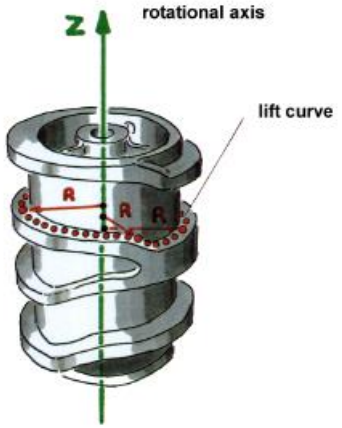
Types of Curves



Plane Curve (2D Curve)

3D Curve



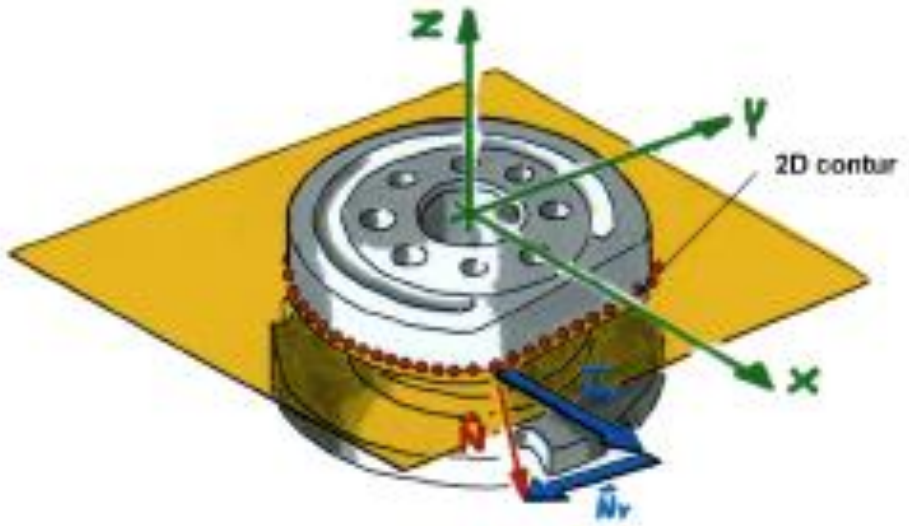


Lift Curve

Plane Curve (2D Curve)

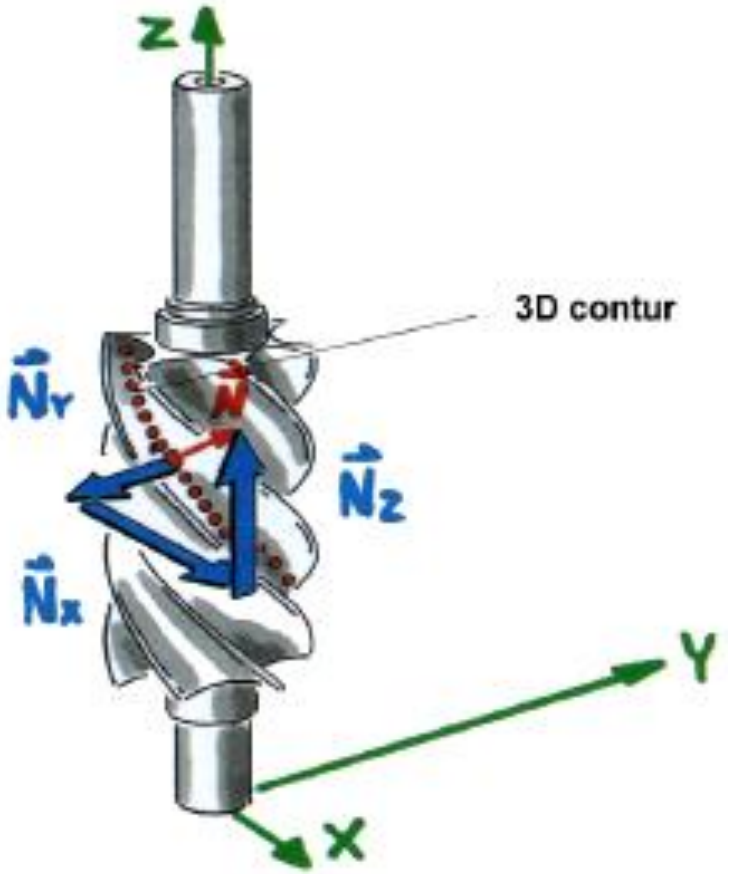
All curve points and all normal vectors lie in a single plane in this case.

Plane curves arise from sectioning a (conceptual) plane with a body. They exist on work pieces with two-dimensional curve properties, for example camshafts.



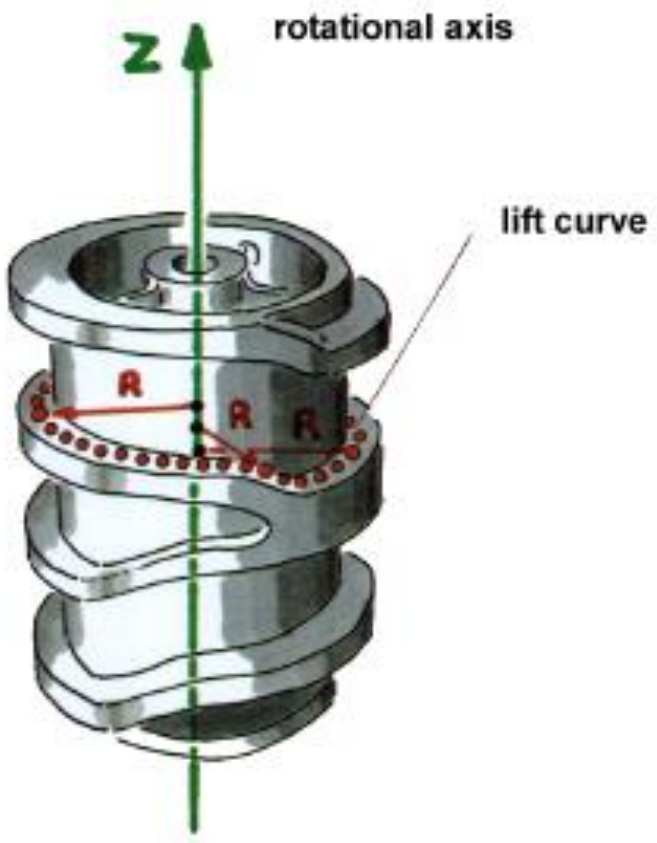
3D Curve

3D curves have three degrees of freedom: they are, in theory, not restricted in any direction. You can measure and test 3D curves in CALYPSO.



Lift Curve

Lift curves are special three-dimensional curves, which form part of a cylindrical surface. As the lift curve runs at a constant distance from the cylinder axis, they only have two variable values: the deviation of the curve in a certain direction (in the example the Z axis) and the angle of rotation on the cylinder surface.



Nominal Values, How do we get them?

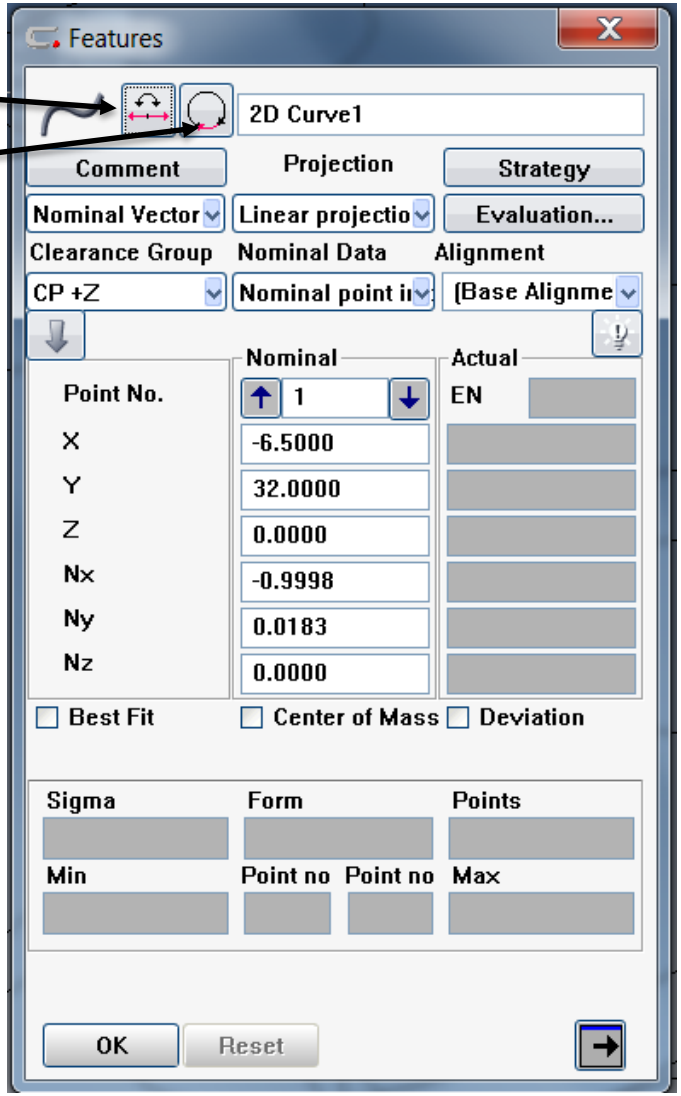
In order to define nominal data, you can:

- import an existing file.
  - The file can be one of the following formats: VDA (Cons, Curve, MDI, PSET, POINT, CIRCLE), ASCII, PAB or DXF. In the case of ASCII files, the values read are interpreted in the following order:
  - x-nominal, y-nominal, z-nominal, u-nominal, v-nominal, w-nominal, x, y, z, u, v, w.
- use the point generator to define the curve points: either to mathematically freely define the curve points or to import external files with different formats.
- digitalize a curve. You generate the nominal values of an unknown profile by probing.
- enter the nominal data from the keyboard, for instance from a technical drawing.
- extract the nominal data from the CAD model: from the menu CAD Modification or by mouse click.

Curve Feature Definitions

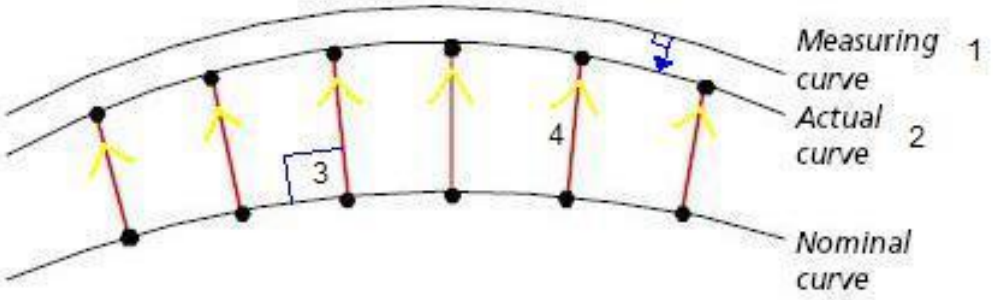
Inside/ Outside switch

Open/Closed



Curve Feature Definitions
How is the Curved Calculated?

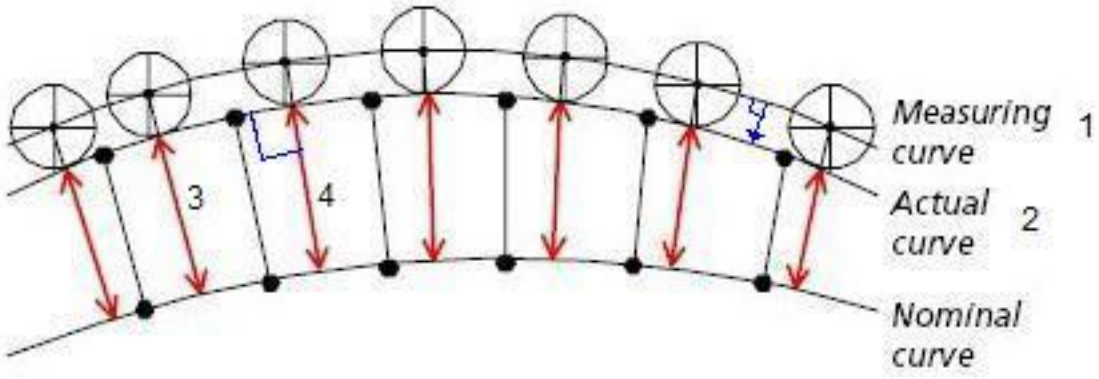
Deviation in nominal vector direction



1.) Curve is measured, and a curve is then created through ball center (“Measuring curve”).
2.) The ball center curve is compensated the stylus radius, and is done so perpendicular to the actual ball center curve. This creates the “Actual curve”.
3.) The nominal points are projected along the nominal vector until they pierce the actual curve.
4.) The deviation is then reported from the nominal point, along the nominal vector, to the actual
curve. (shown in red)

Curve Feature Definitions
How is the Curved Calculated?

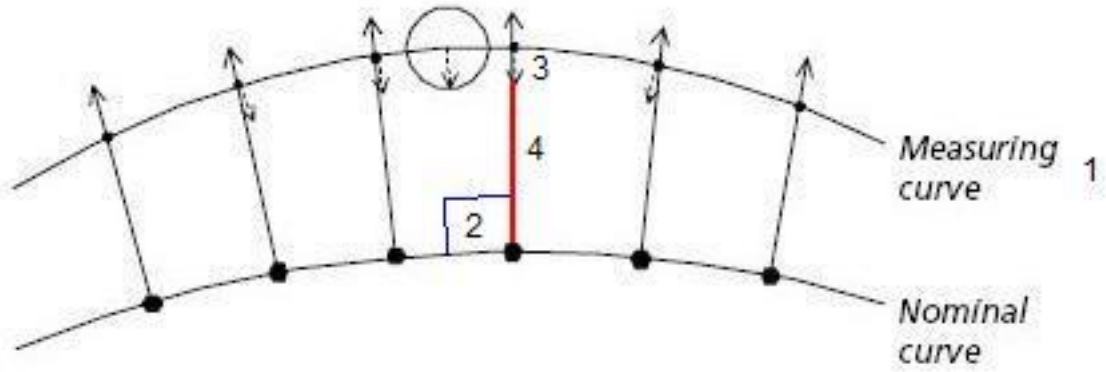
Actual -> Nominal deviation



1.) Curve is measured, and a curve is then created through ball center (“Measuring curve”).
2.) The ball center curve is compensated the stylus radius, and is done so perpendicular to the actual ball center curve. This creates the “Actual curve”.
3.) All measured actual points, are projected along their actual vectors until they pierce the nominal curve.
4.) The deviation is then reported from the actual curve and points, along the actual vector/s, to the nominal curve. (shown in red)

Curve Feature Definitions
How is the Curved Calculated?

Space Point Evaluation (2-D curves only)



1.) Curve is measured, and a curve is then created through ball center (“Measuring curve”).

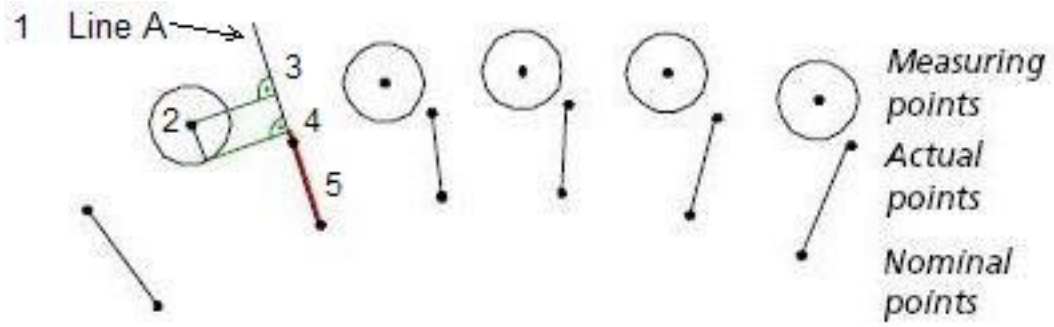
2.) The nominal points are projected along the nominal vector until they pierce the ball center curve.

3.) The actual points are then compensated along the nominal vector (not the actual)

4.) The deviation is then reported the same as a space point. (shown in red)

Curve Feature Definitions
How is the Curved Calculated?

Space Point Evaluation (without interpolation)



1.) The nominal points are projected along their nominal vectors.

2.) This creates a theoretical line (“Line A”), and Line A then looks for the closest actual point.

(closest point can be on either side of Line A)

3.) That closest point is projected perpendicular to the nominal.

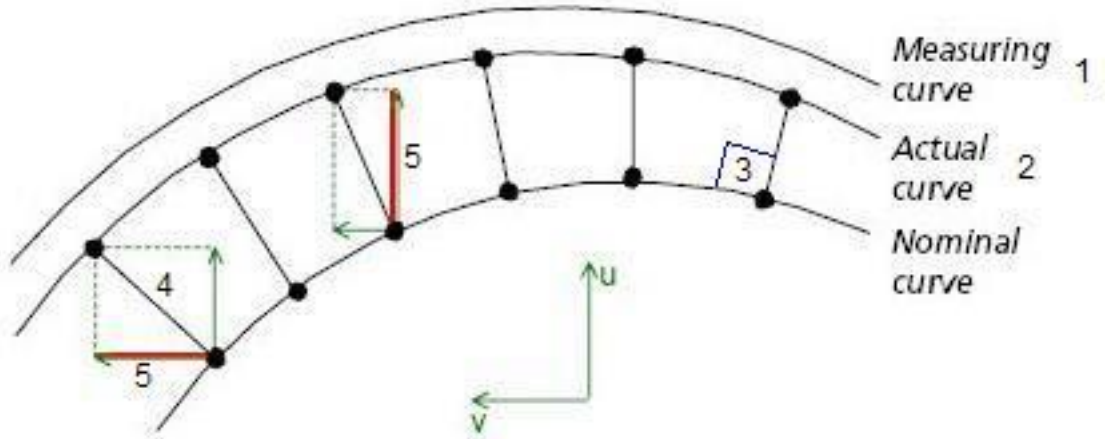
4.) The point is now ball compensated along nominal vector.

5.) The deviation is then reported from nominal points to these calculated points. (shown in red)

Note: High data density is recommended to reduce any projected errors!

Curve Feature Definitions
How is the Curved Calculated?

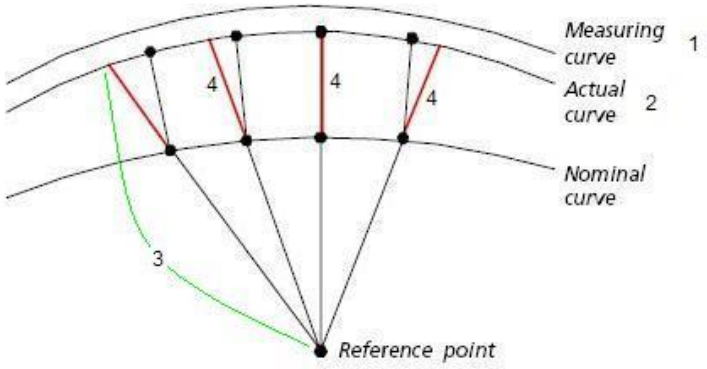
Deviation in grid coordinates (2-D curves only)



1.) Curve is measured, and a curve is then created through ball center (“Measuring curve”).
2.) The ball center curve is compensated the stylus radius, and is done so perpendicular to the actual ball center curve. This creates the “Actual curve”.
3.) The nominal points are projected along the nominal vector until they pierce the actual curve (like the “Deviation in nominal vector direction” method)
4.) After this theoretical deviation line is made, the other 2 legs of the triangle are made (in the U and V directions.
5.) The deviation is then reported as the longest leg of the triangle along U or V. (not the actual point to point distance)

Curve Feature Definitions
How is the Curved Calculated?

Radial deviation (2-D curves only)



1.) Curve is measured, and a curve is then created through ball center (“Measuring curve”).
2.) The ball center curve is compensated the stylus radius, and is done so perpendicular to the actual ball center curve. This creates the “Actual curve”.
3.) A theoretical line is then made from your “Reference point” to each nominal point, and then extended until it pierces the actual curve.
4.) The deviation is then reported from the nominal point, in the direction from the reference point, until it pierces the actual curve (shown in red)
Note: Typically this method is used on Cams, and a tappet radius may or may not be entered.

What does it all mean?

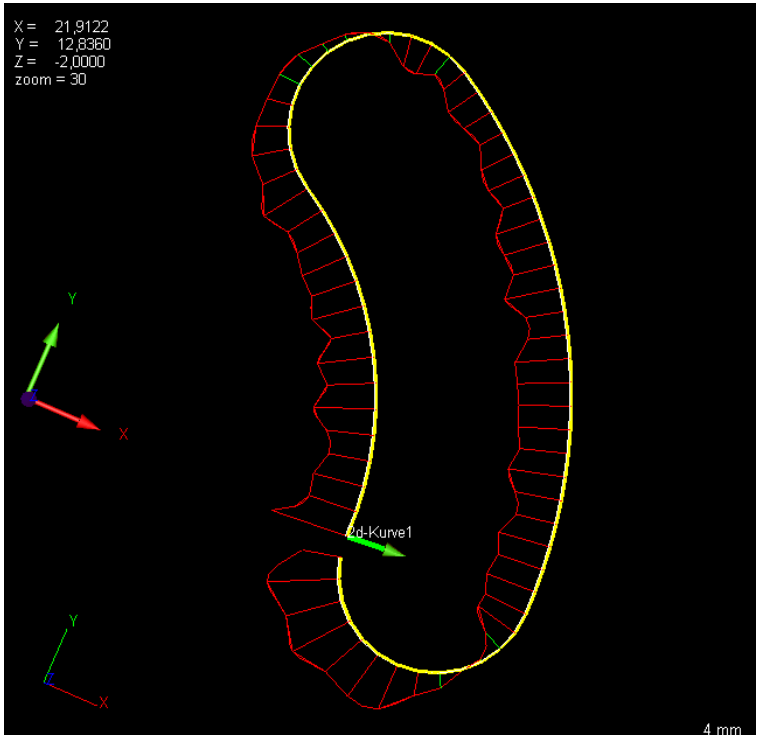
In the vast majority of cases

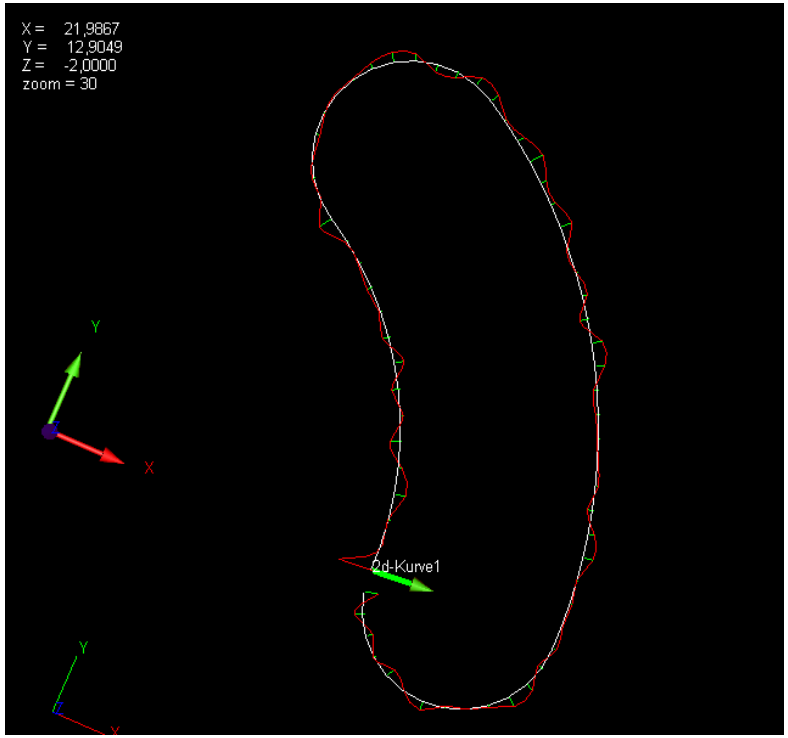
Nominal Vector Direction

is the recommended setting to calculate the actual values and their deviations from nominal

Best Fit

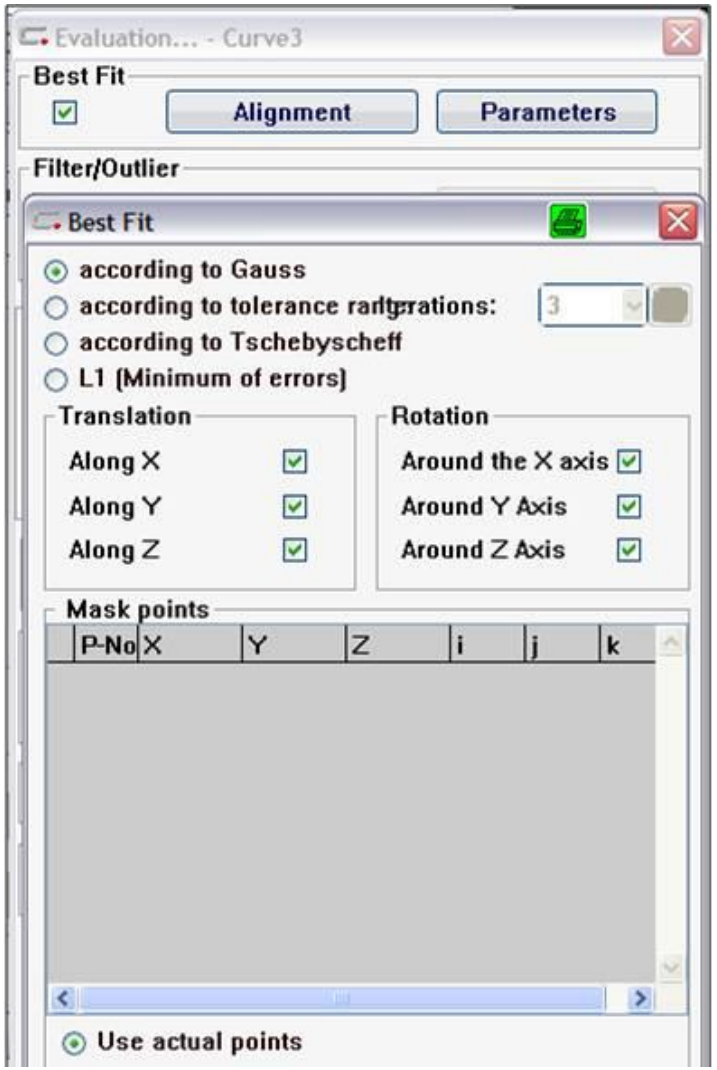
In metrology, fitting is understood as the mathematical separation of **form deviations** and **positional deviations**. This means you can use best fit to obtain a mathematical correction of positional deviation of the nominal curve.





With "Evaluation" the best fit of the curve can be defined.

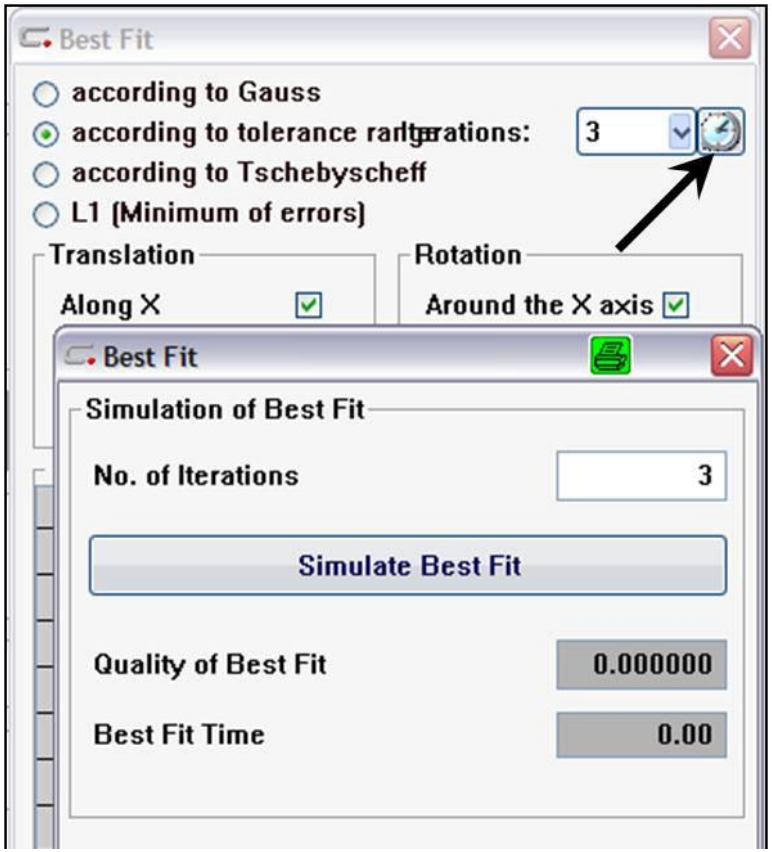
- Restrict Translation and Rotation
- Masking Points
- Search distance



Best fit methods

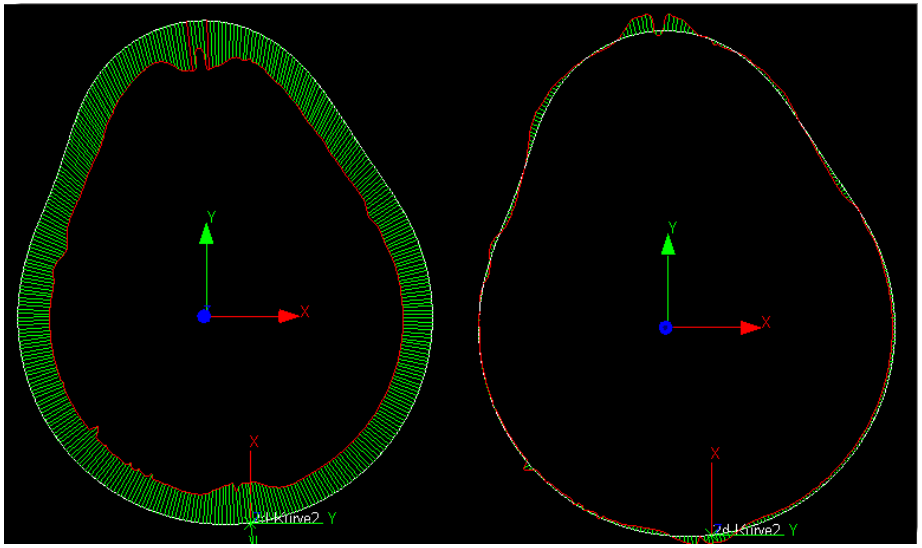
CALYPSO provides for the fitting several methods:

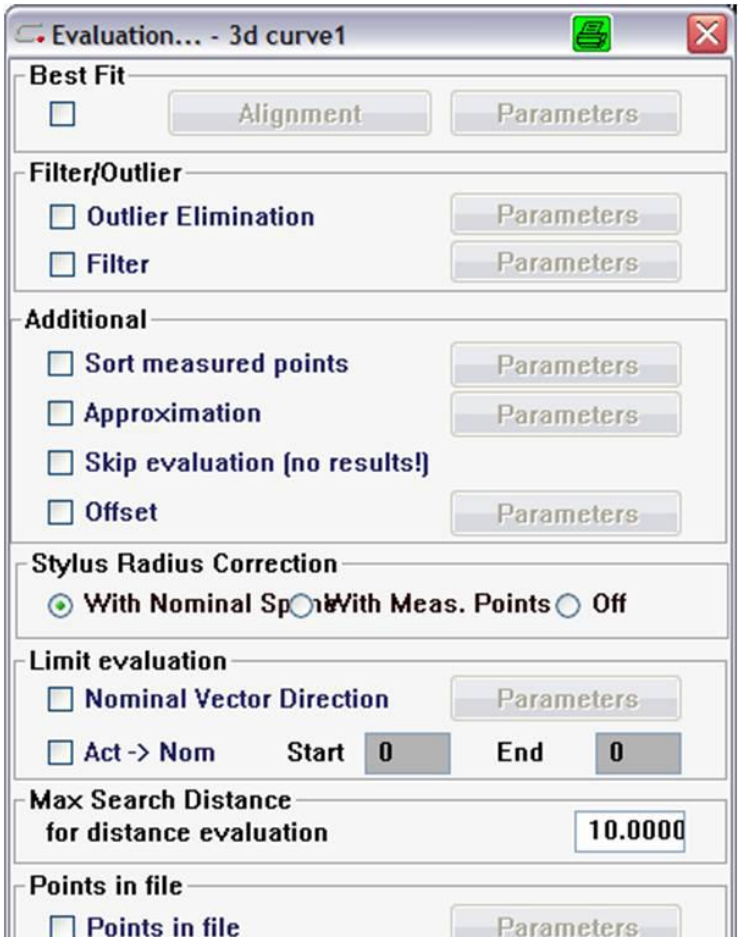
- According to Gauss (also called LSQ or L2)Standard calculation, minimizes the square deviations
- According to tolerance with iteration Tries all possible points to be included in the tolerance band. Further input possible: Number of iterations, Simulate best fit.
- According to Tschebyscheffcalculates the curve in center between minimum and maximum value
- L1minimizes the deviation, in contrast to Gauss (minimizes the square deviations)an even greater suppression of deviations



Curve Offset

The offset calculation allows constant positive/negative differences in the dimensions of a work piece or known constant errors in the nominal data to be taken into account.

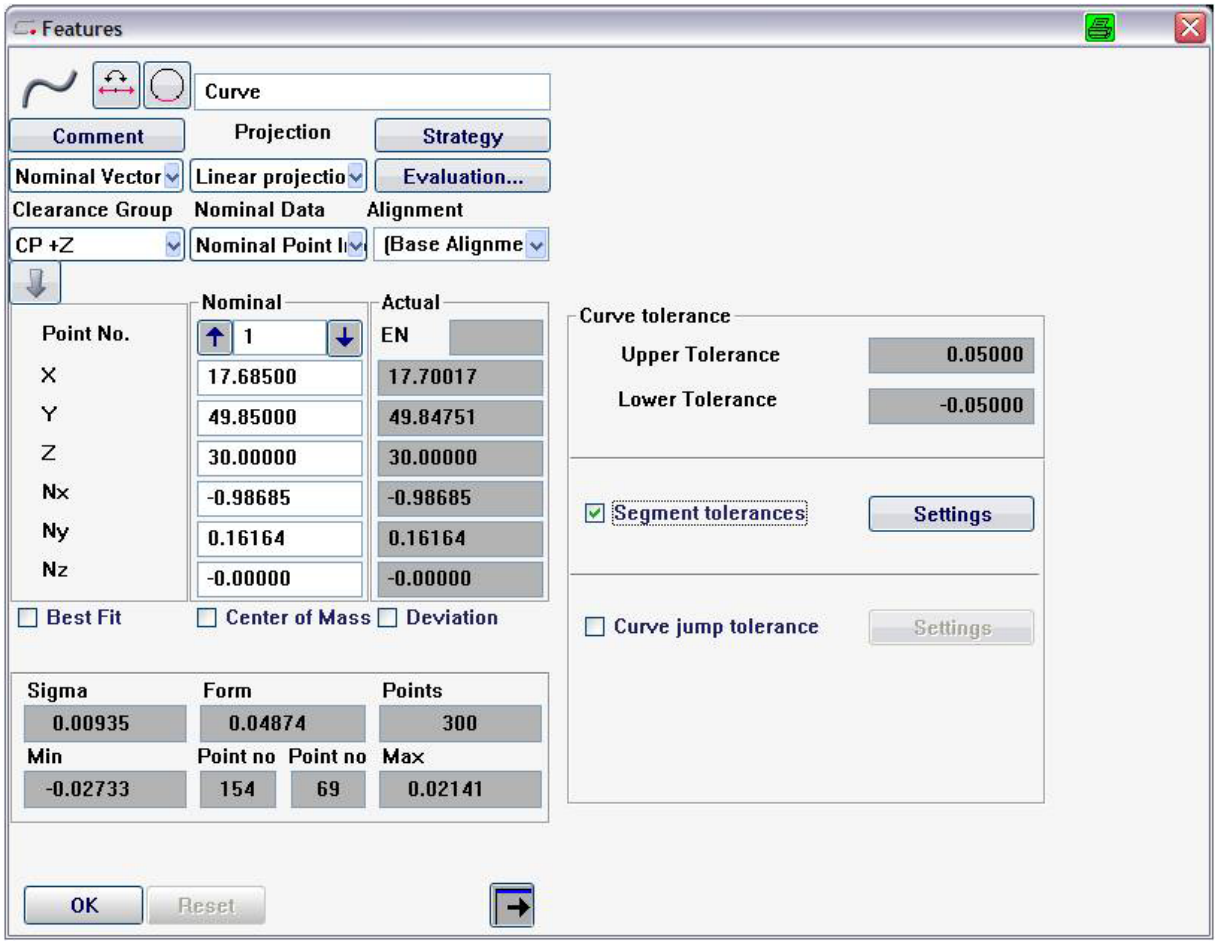




Actual Values and Evaluation

Tolerances can be defined for:

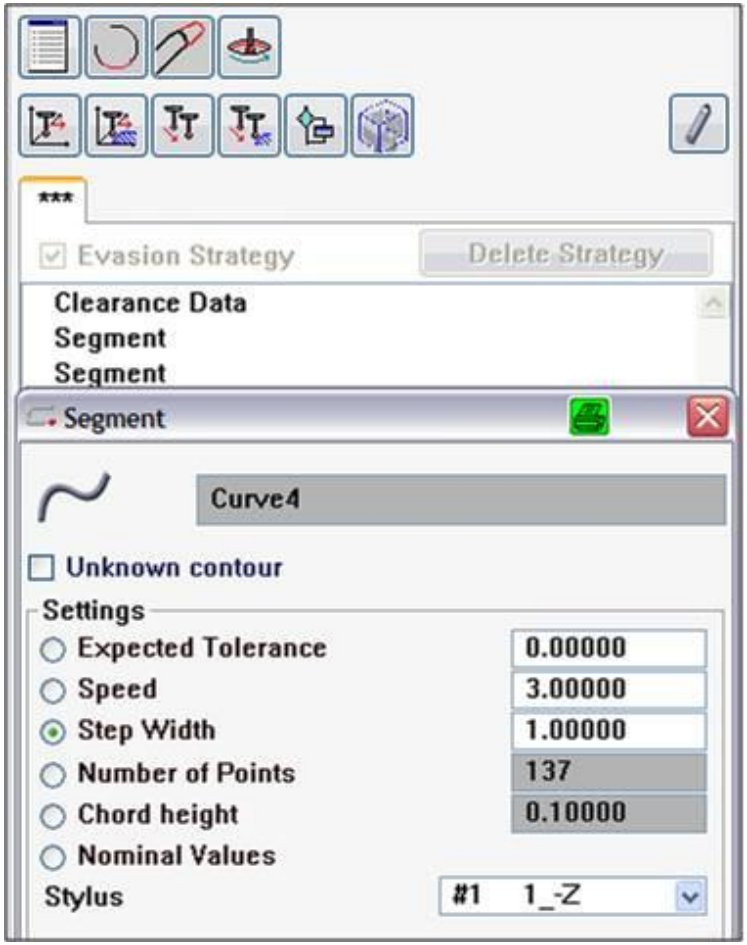
- the entire curve
- individual curve segments.



Curve Strategy

Here we set the Speed and Step Width or Number of Points

If our Curve is “broken” into segments we can define the run parameters here for each segment



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