Tutorial 99.04.001 - evoloid gear calculation

created by: Florian Eigner | imk Health Intelligence GmbH | Amselgrund 30 | 09128 Chemnitz

contact: nextgear@imk-ic.com

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1 Load paths and settings

```
Warning: Function vecnorm has the same name as a MATLAB built-in. We suggest you rename the function to avoid a
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avoid a potential name conflict.
```
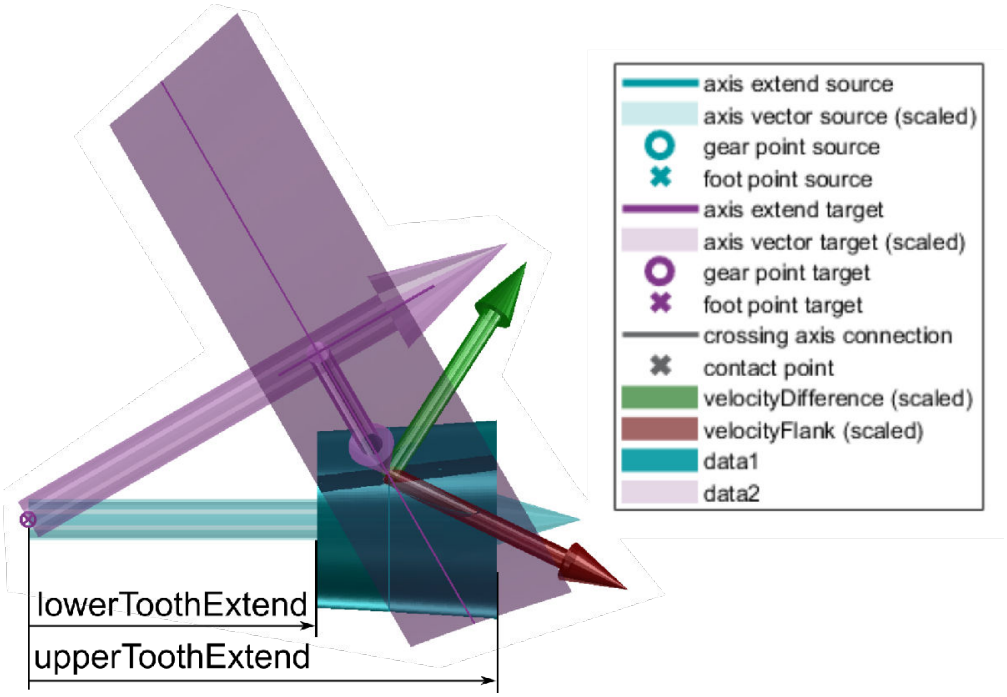

2 Kinematics at the gear pair

2.1 Design target - set up the intention of the gear pair

Create a *iU_gear* for both gears.

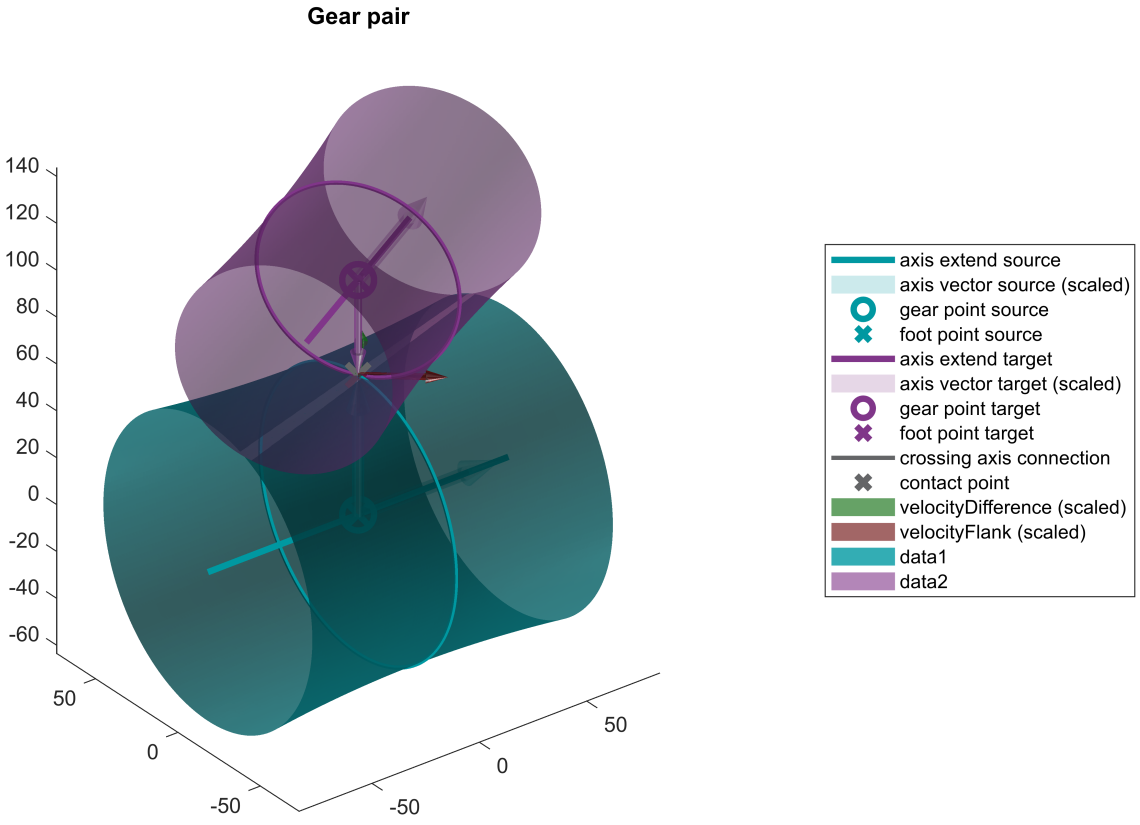


2.1.1 Radial settings

2.1.2 Axial settings

2.2 Merge the design target and the iU_gears to a gear pair

```
creating gearPair from iUgear <gear_1> and iUgear <gear_2> ...
... optimize radius ratio to match betaSource =  0.873 ...
... optimized radius ratio to -0.684 ...
...done.

conjugating basesurface of gear <gear_1_init> to basesurface of basegear: <gear_2> ....done.
```



3. Profile und rack

3.1 Profile

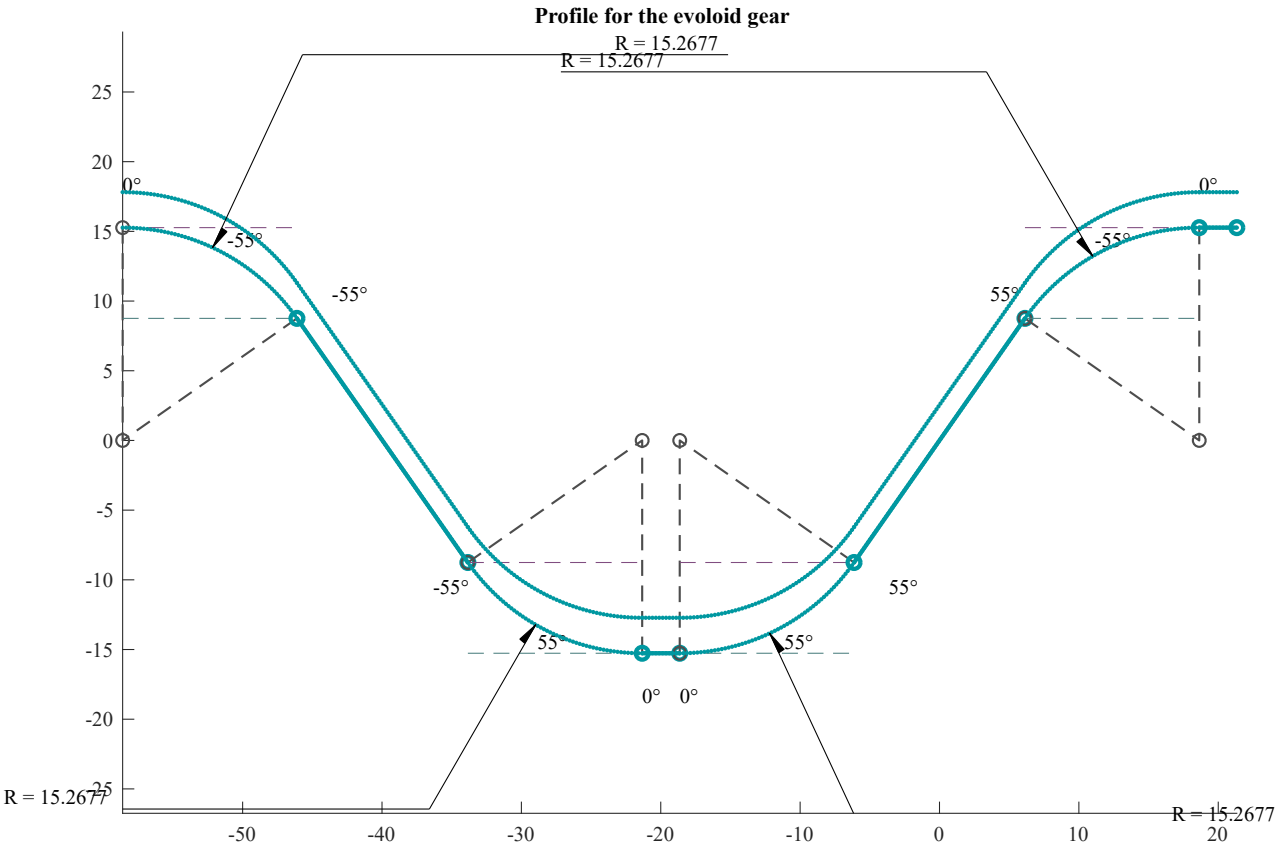
3.1.1 Set parameters for the profile

```
m_n = 25.4462
```

Define for both gears a profileOffset. To generate a backlash ***profileOffset_gear1*** should be smaller than ***profileOffset_gear2***.

3.1.2 Create the profile depending on the type

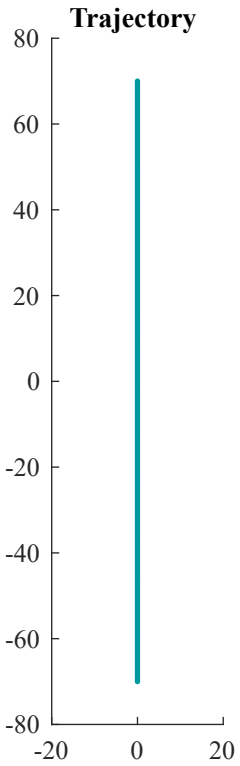
3.1.3 Plot the profile



3.2 Trajectory

3.2.1 Create the trajectory

3.2.2 Plot the trajectory

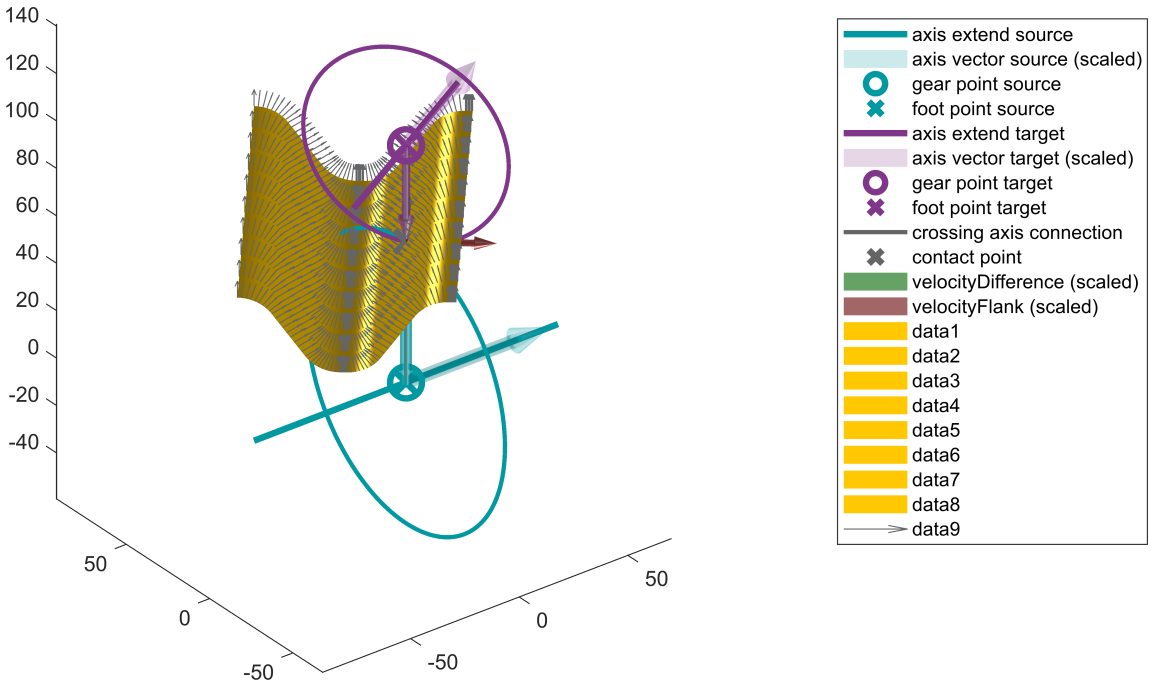


3.3 Create the rack

3.3.1 Merge the profile, trajectory and kinematics to an clc_geoRack

3.3.2 Plot the rack

rack in global position

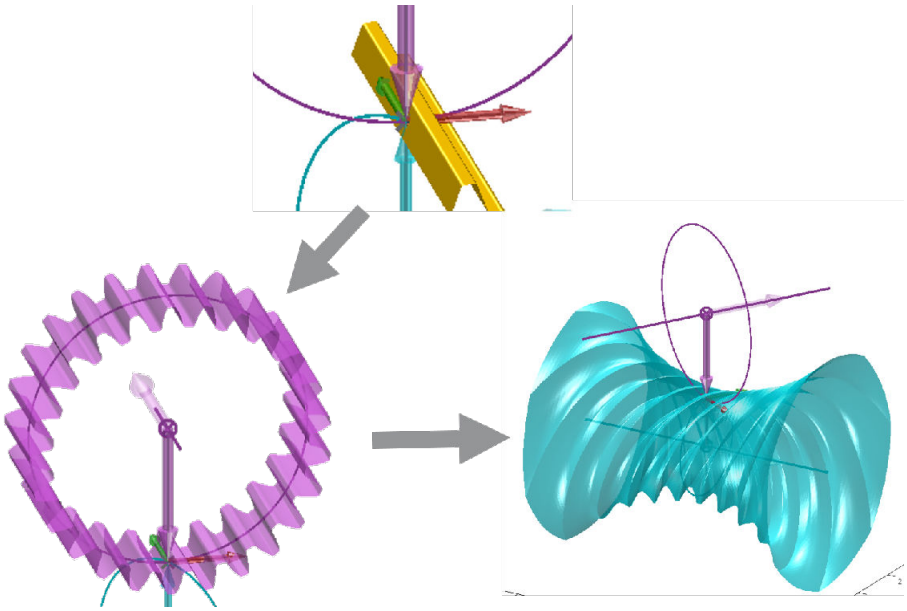


4 Conjugation process

4.1 Strategy for conjugation

We conjugate with the following strategy:

1. $rack_{gear1} \rightarrow gear_1$
2. $rack_{gear1,modified} \rightarrow gear_1 \rightarrow gear_2$



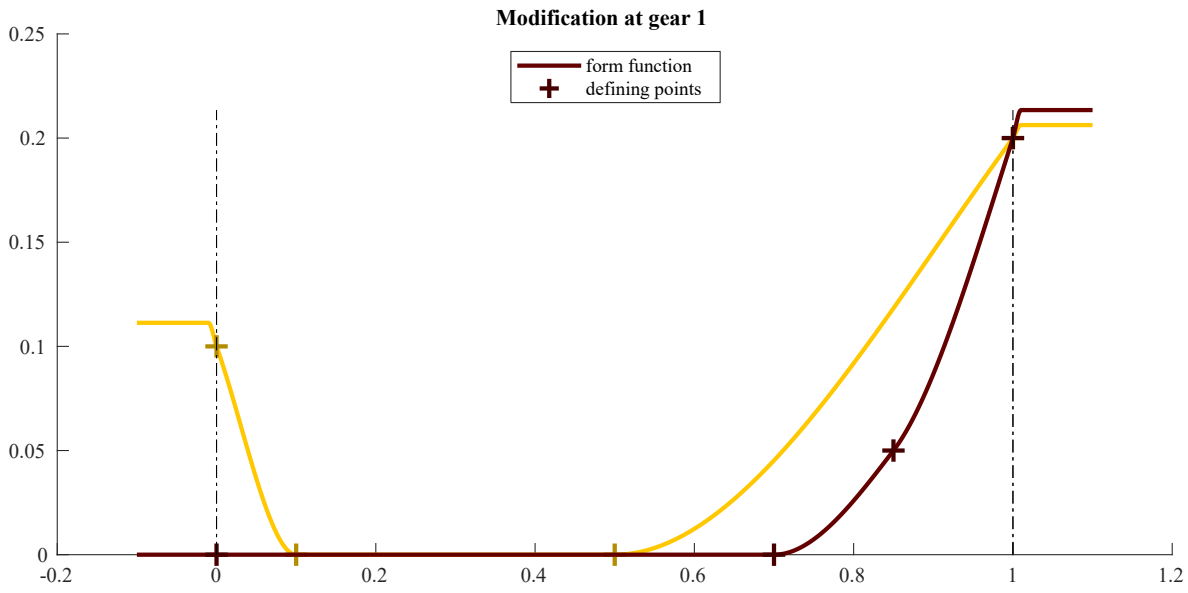
4.2 Gear 1

4.2.1 Define modification

Modification **along the teeth.**

Modification along the profile

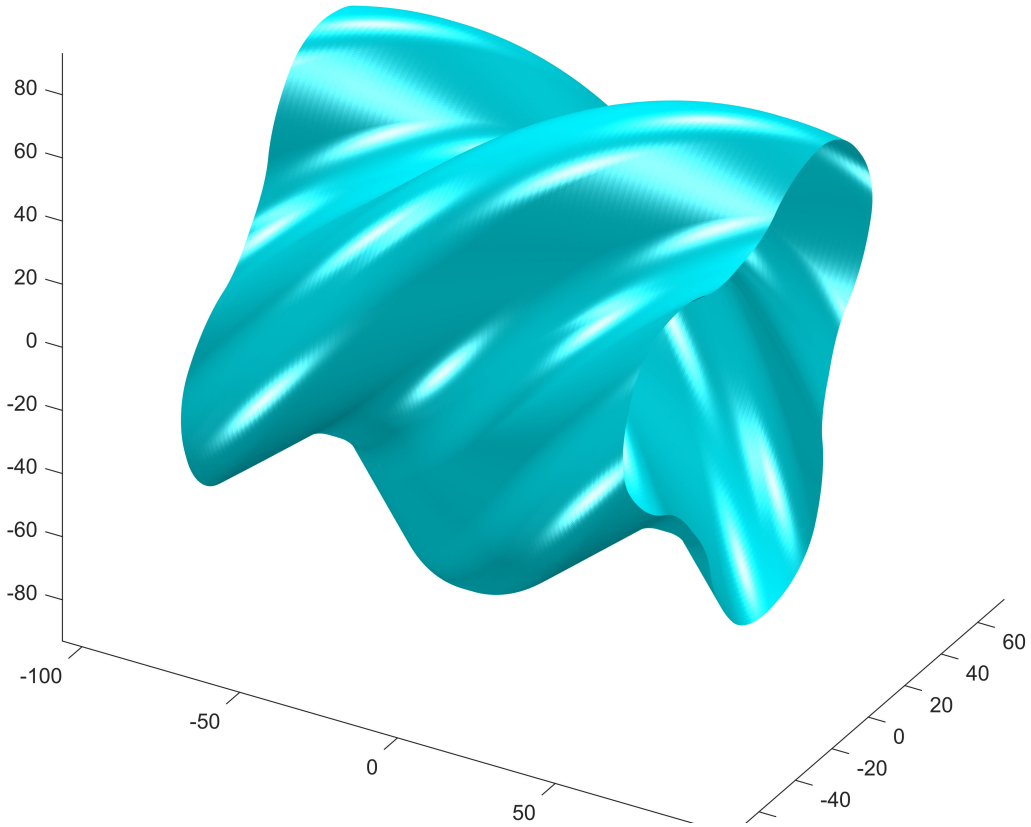
Plot the convexity parameters



4.2.2 Calculation

```
conjugating rack <geoRack28> to gear: <gear_1> .... .. done.
```

4.2.3 Plot



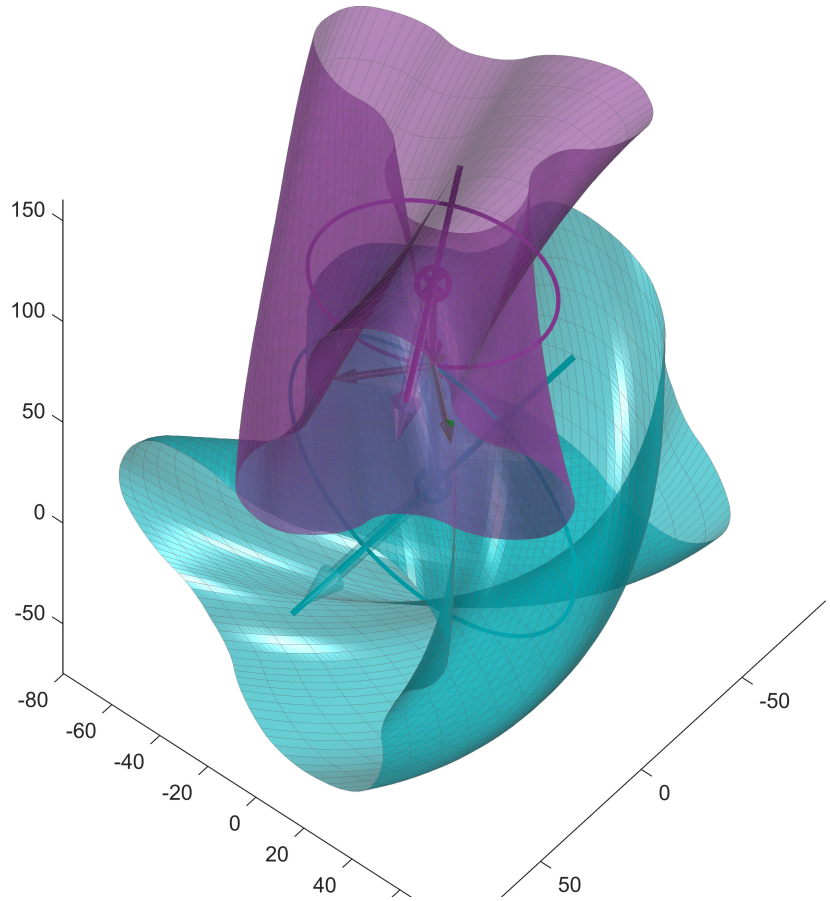
4.3 Gear 2

4.3.1 Calculation

Since we use the conjugation strategy $gear_1 \rightarrow gear_2$ we need to calculate a "tool" similar to gear 1 first. The tool is the conjugation from the modified rack to the kinematics of gear 1.

```
conjugating rack <geoRack680> to gear: <gear_1> .... .. done.
conjugating gear <pinion> to basegear: <gear_2> ....done.
```

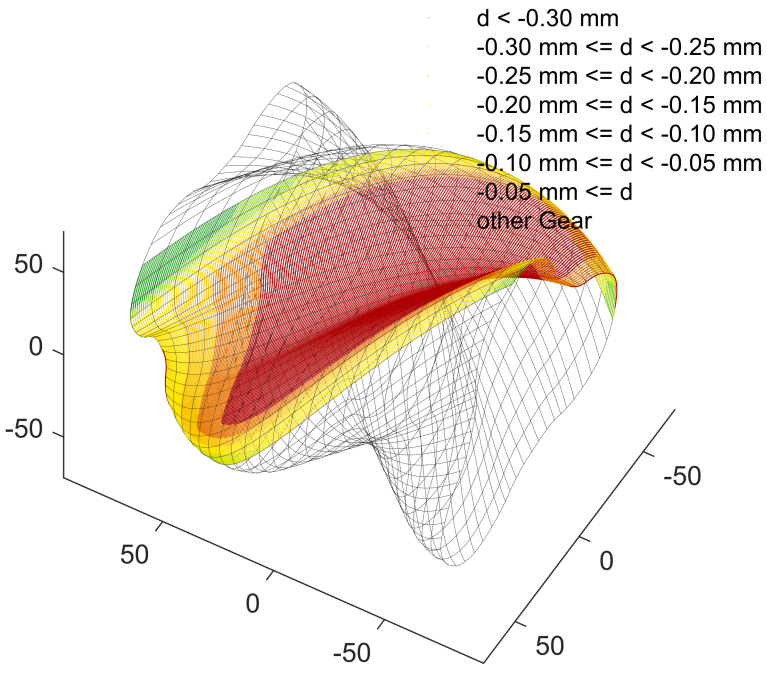
4.4 Plot the gears



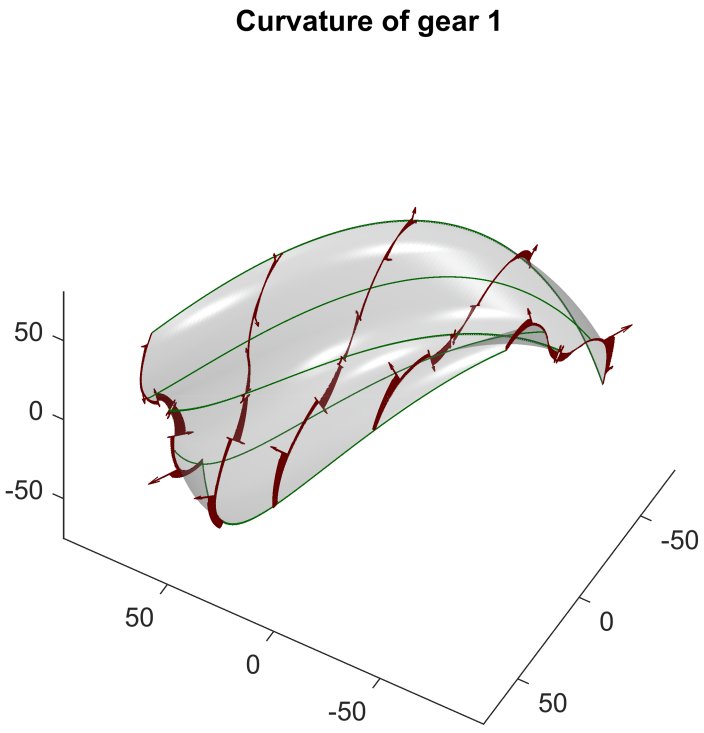
5 Post processing

5.1 geometry analysis

5.1.1 Check modification at gear 1

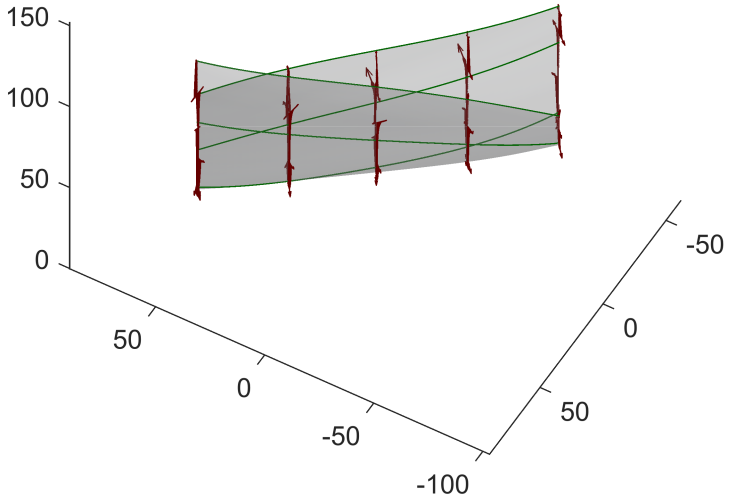


5.1.2 Check curvature at gear 1

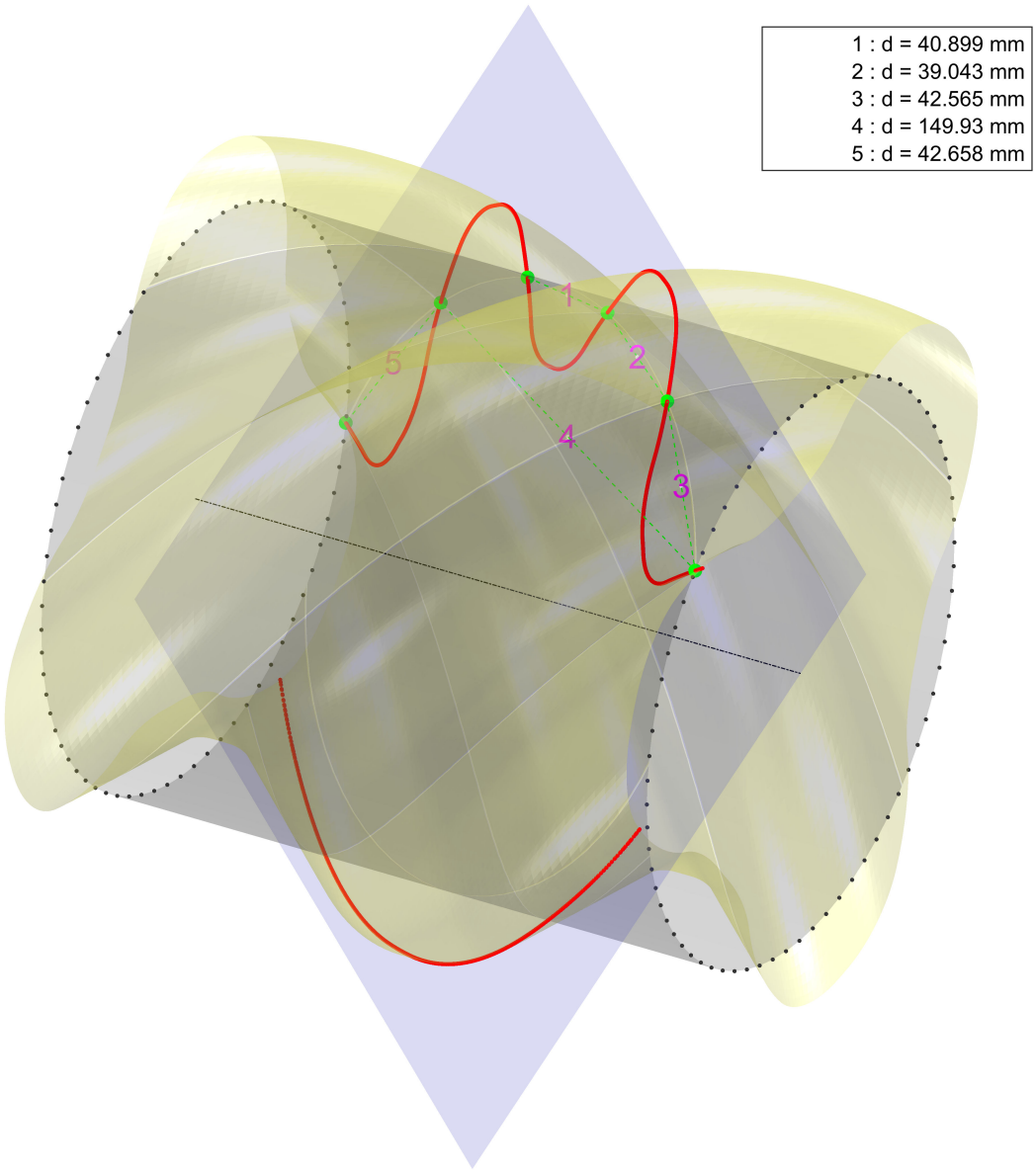


5.1.3 Check curvature at gear 2

Curvature of gear 2



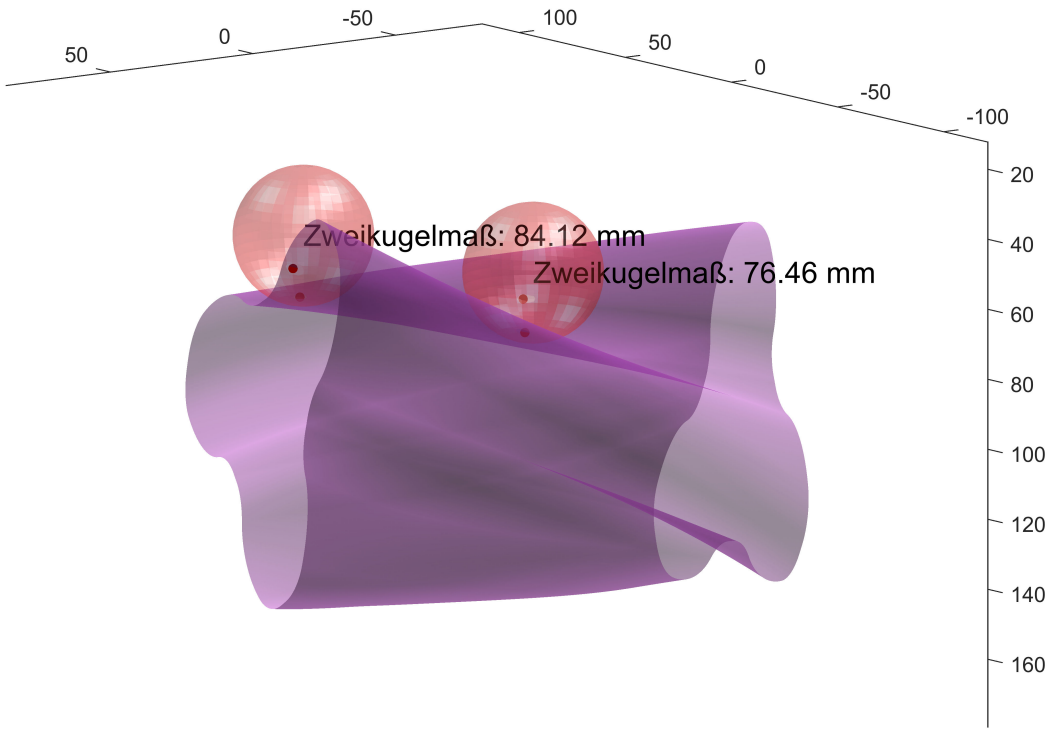
5.1.4 Create a section



5.1.5 Two-ball-dimension

Calculate the position of the ball.

Plot the result.



5.2 Contact analysis

5.2.1 Setup

Setup boundaries

Define friction

5.2.2 Run "one-tooth" analysis

```
Contact analysis: Create mbsObj.
Contact analysis: Calculate mbs steps.
finished MBS step #: 1
finished MBS step #: 2
finished MBS step #: 3
finished MBS step #: 4
finished MBS step #: 5
finished MBS step #: 6
finished MBS step #: 7
finished MBS step #: 8
finished MBS step #: 9
finished MBS step #: 10
finished MBS step #: 11
finished MBS step #: 12
finished MBS step #: 13
finished MBS step #: 14
finished MBS step #: 15
finished MBS step #: 16
finished MBS step #: 17
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 18
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 19
```

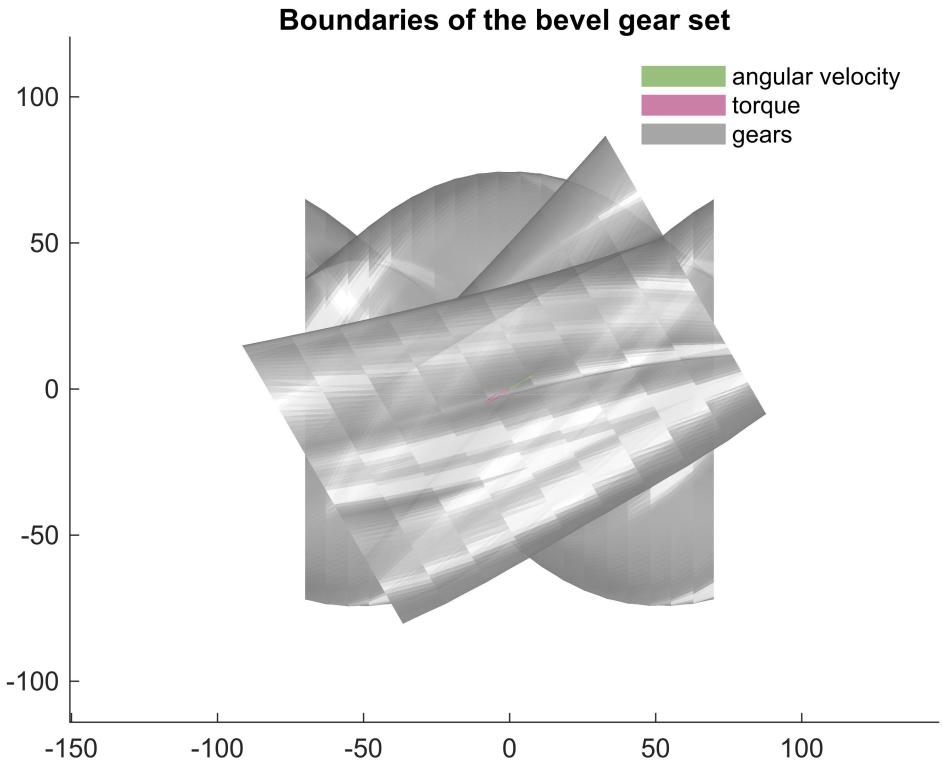
```
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 20
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 21
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 22
Reached end of first direction. Calculate steps of other direction...finished MBS step #: 23
finished MBS step #: 24
finished MBS step #: 25
finished MBS step #: 26
finished MBS step #: 27
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 28
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 29
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 30
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 31
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 32
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 33
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 34
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 35
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 36
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 37
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 38
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 39
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 40
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 41
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 42
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 43
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 44
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 45
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 46
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 47
48 steps calculated in both directions.Contact analysis: Calculate hertzian contact.
Warning: cpaHertzianContact: normals at contact point for some steps not parallel! No Hertzian contact
for these steps:
 mbsStep 43:  |<n1,n2>| = -0.985156.
 mbsStep 44:  |<n1,n2>| = -0.931685.
Contact analysis: finished.
```

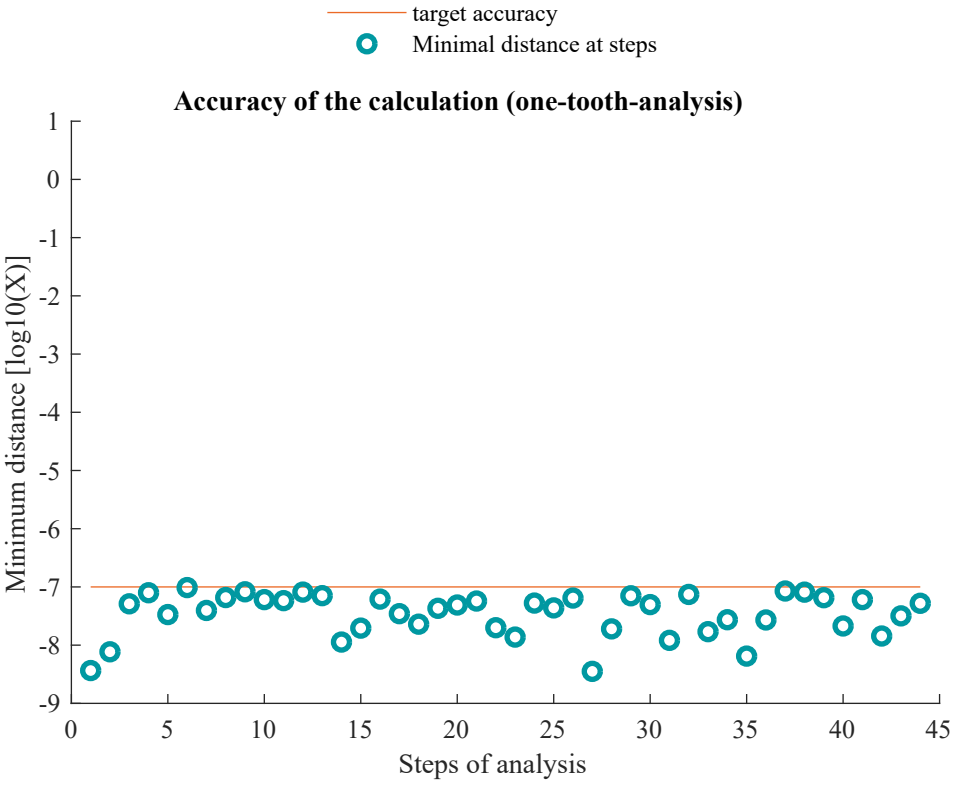
5.2.3 Merge to analysis with all teeth

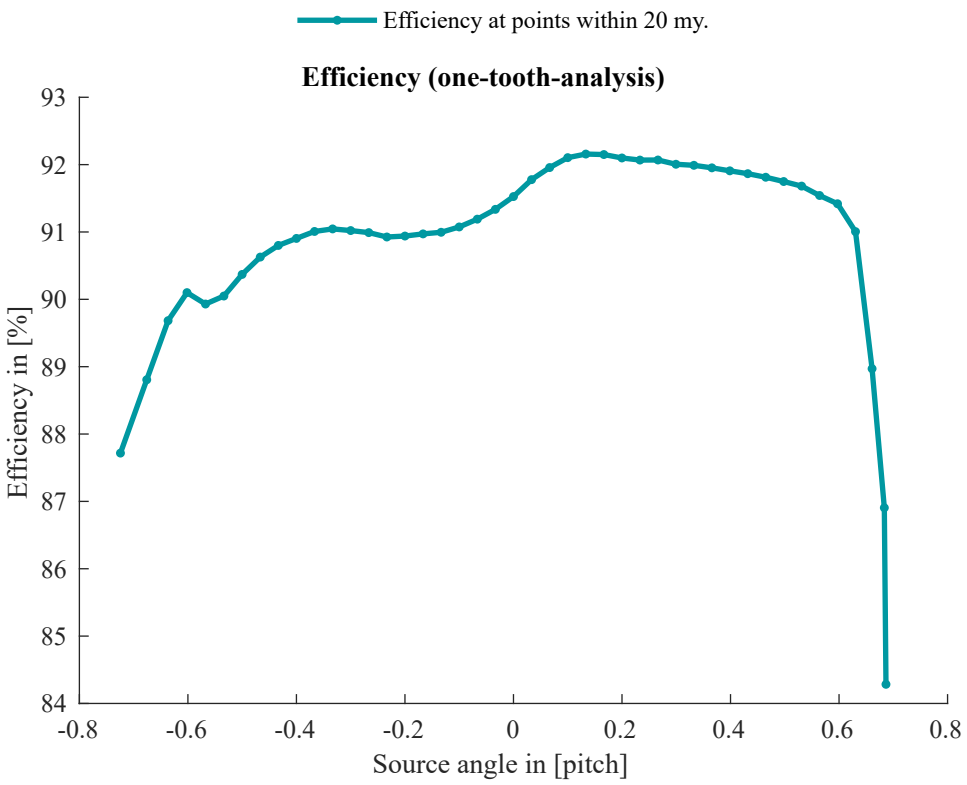
```
finished MBS step #: 1
finished MBS step #: 2
finished MBS step #: 3
finished MBS step #: 4
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 5
finished MBS step #: 6
finished MBS step #: 7
finished MBS step #: 8
```

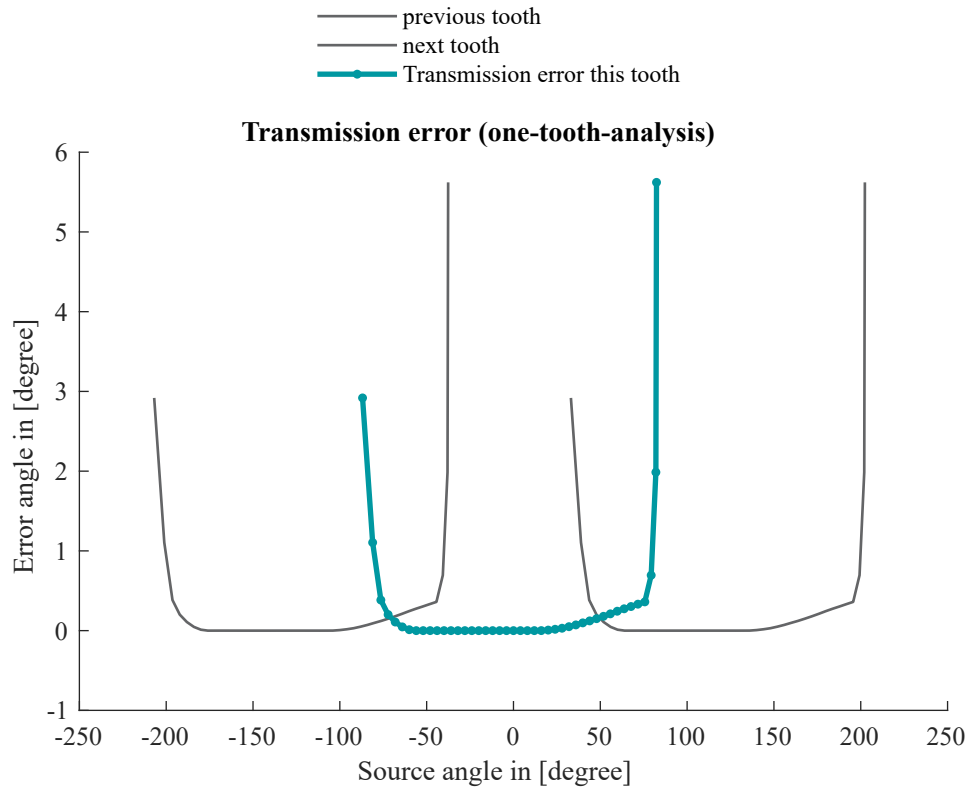
```
finished MBS step #: 9
finished MBS step #: 10
finished MBS step #: 11
finished MBS step #: 12
finished MBS step #: 13
finished MBS step #: 14
finished MBS step #: 15
finished MBS step #: 16
finished MBS step #: 17
finished MBS step #: 18
finished MBS step #: 19
finished MBS step #: 20
finished MBS step #: 21
finished MBS step #: 22
finished MBS step #: 23
finished MBS step #: 24
finished MBS step #: 25
finished MBS step #: 26
finished MBS step #: 27
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 28
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 29
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 30
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 31
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 32
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 33
Warning: There are less than 50 points for evaluating efficiency. The result might be inaccurate.
finished MBS step #: 34
finished MBS step #: 35
finished MBS step #: 36
finished MBS step #: 37
finished MBS step #: 38
finished MBS step #: 39
finished MBS step #: 40
finished MBS step #: 41
finished MBS step #: 42
```

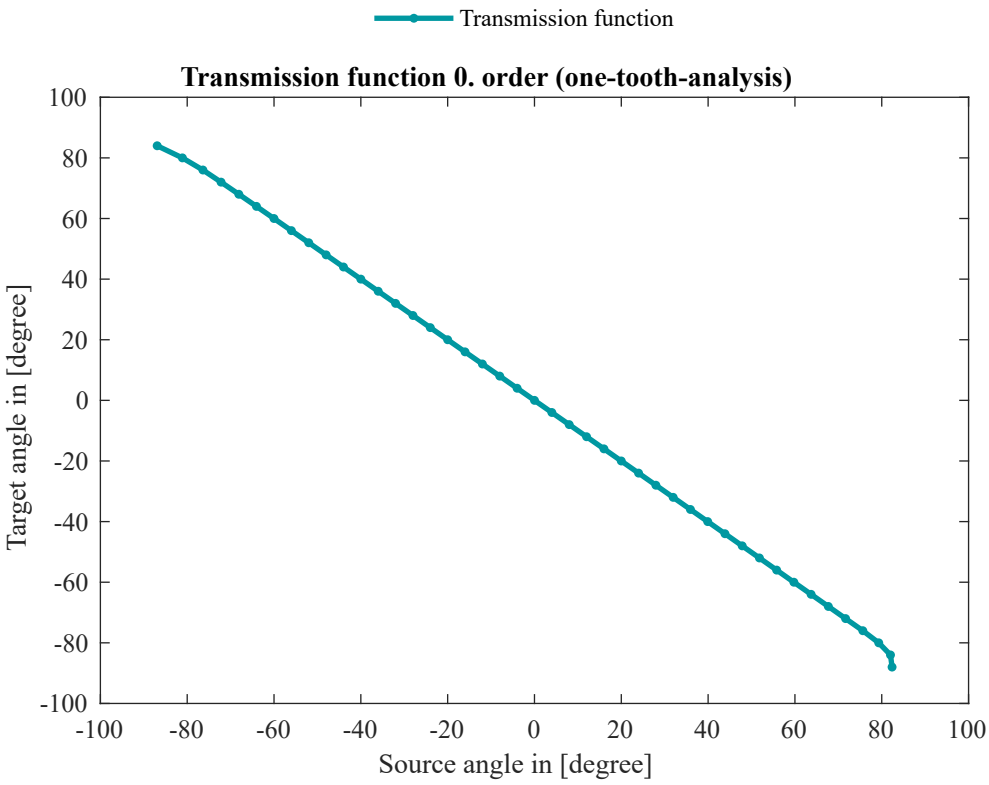
5.2.4 Results of contact analysis

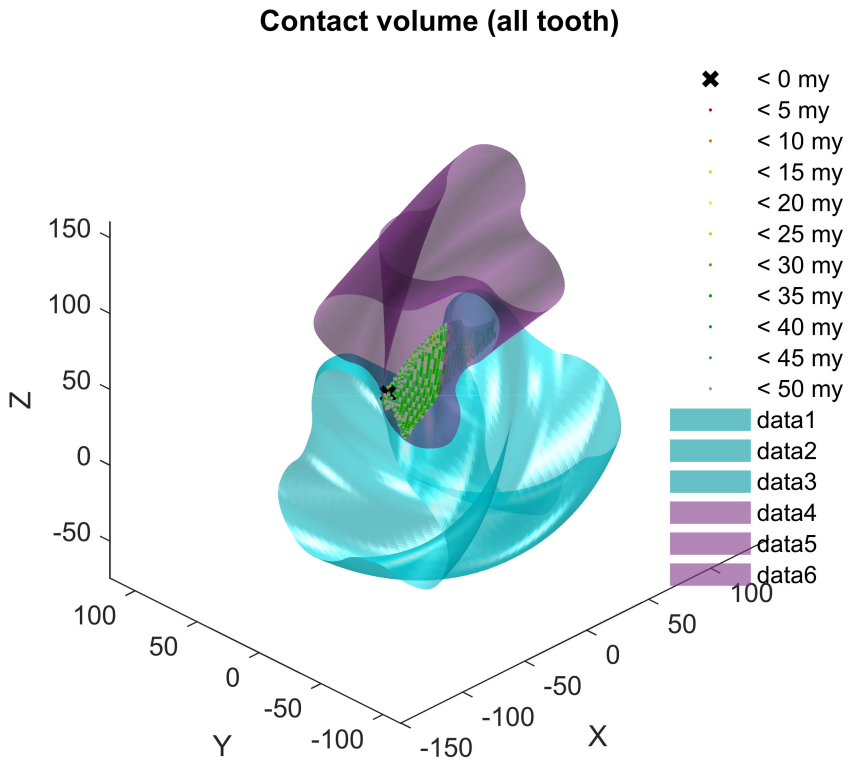

Boundaries of the bevel gear set
angular velocity
torque
gears
100
50
0
-50
-100
-150
-100
-50
0
50
100


target accuracy
Minimal distance at steps
Accuracy of the calculation (one-tooth-analysis)
Minimum distance [log10(X)]
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
0
5
10
15
20
25
30
35
40
45
Steps of analysis

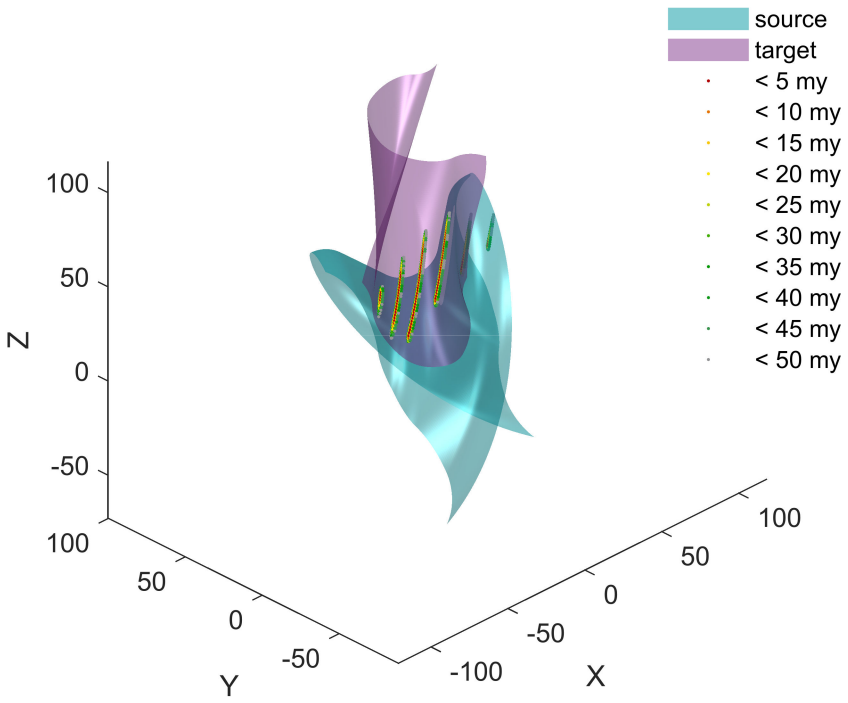

Efficiency at points within 20 my.
Efficiency (one-tooth-analysis)
Efficiency in [%]
93
92
91
90
89
88
87
86
85
84
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
Source angle in [pitch]


previous tooth
next tooth
Transmission error this tooth
Transmission error (one-tooth-analysis)
Error angle in [degree]
6
5
4
3
2
1
0
-1
-250
-200
-150
-100
-50
0
50
100
150
200
250
Source angle in [degree]

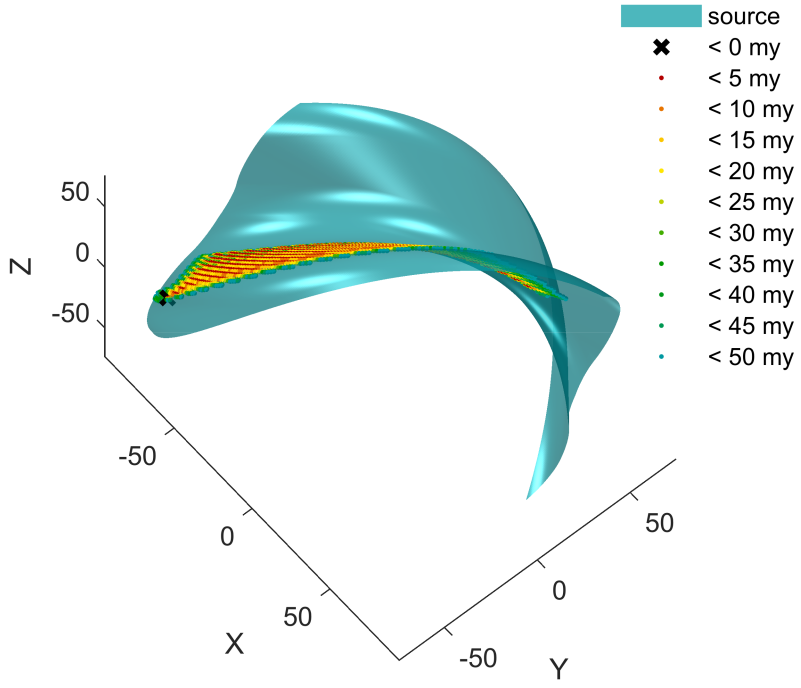

Transmission function
Transmission function 0. order (one-tooth-analysis)
Target angle in [degree]
Source angle in [degree]
100
80
60
40
20
0
-20
-40
-60
-80
-100
-100 -80 -60 -40 -20 0 20 40 60 80 100

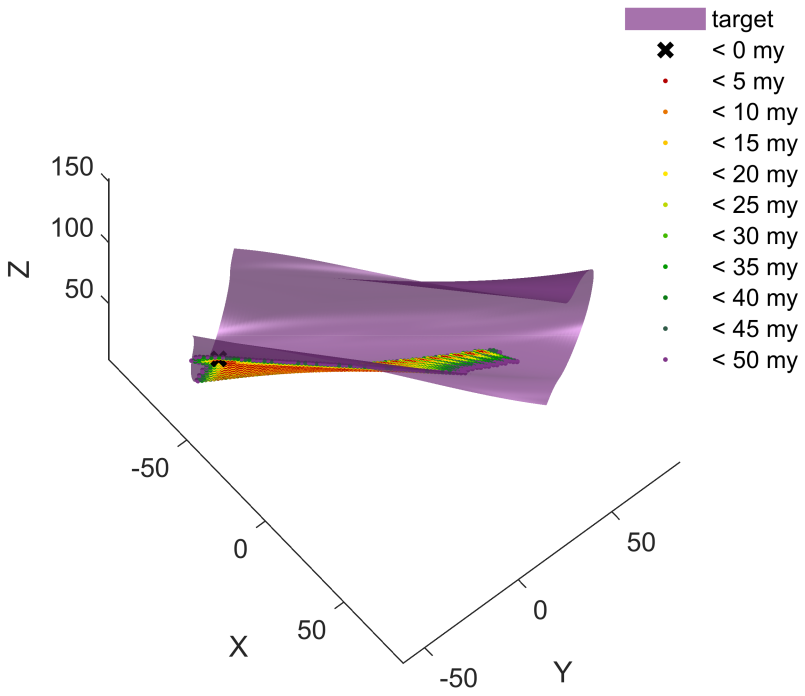

Contact volume (all tooth)
< 0 my
< 5 my
< 10 my
< 15 my
< 20 my
< 25 my
< 30 my
< 35 my
< 40 my
< 45 my
< 50 my
data1
data2
data3
data4
data5
data6
Z
150
100
50
0
-50
Y
100
50
0
-50
-100
X
-150
-100
-50
0
50
100

Contact volume (all tooth)



Ease-Off at gear 1




Ease-Off at gear 2
target
< 0 my
< 5 my
< 10 my
< 15 my
< 20 my
< 25 my
< 30 my
< 35 my
< 40 my
< 45 my
< 50 my
150
100
50
Z
-50
0
50
X
50
0
-50
Y

6 Export