

A-0, ALPHA-0

To start finding the modified DH-parameters of our robot we define a coordinate system to serve as a reference. Because we can choose where to place it we want to do it in a way that simplifies our task:

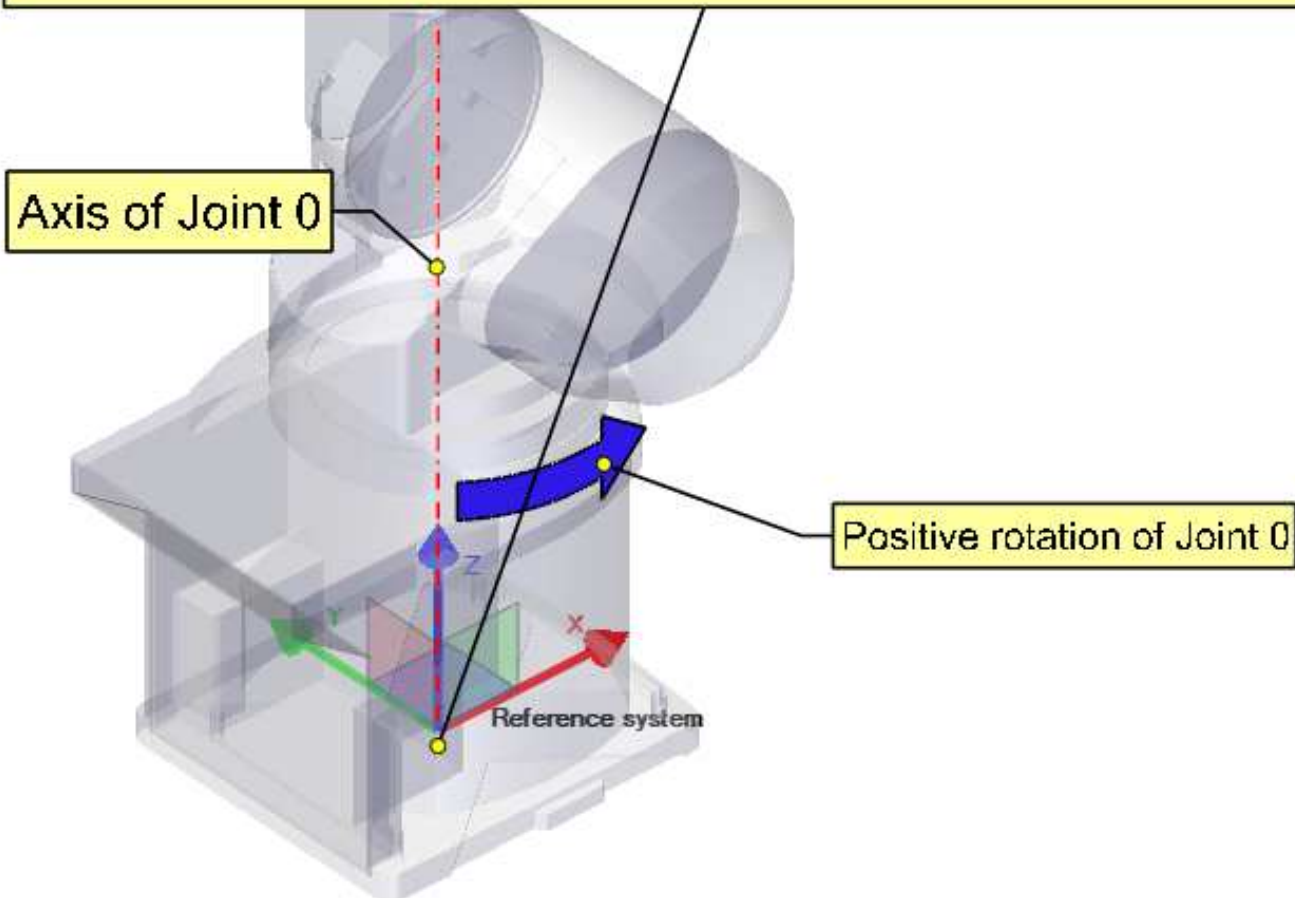
We choose our reference coordinate system at the intersection of the axis of joint-0 and the base plate. We point the X-axis towards the end effector and the Z-axis pointing up. Note that the rotation direction of joint-0 is right handed to our Z-axis.

Also note that by following this convention the Z-axis of our coordinate system coincides with the axis of joint-0 and points in the same direction and thus A_0 and ALPHA_0 are 0.

We set:

```
setp genserkins.ALPHA-0 = 0
```

```
setp genserkins.A-0 = 0
```

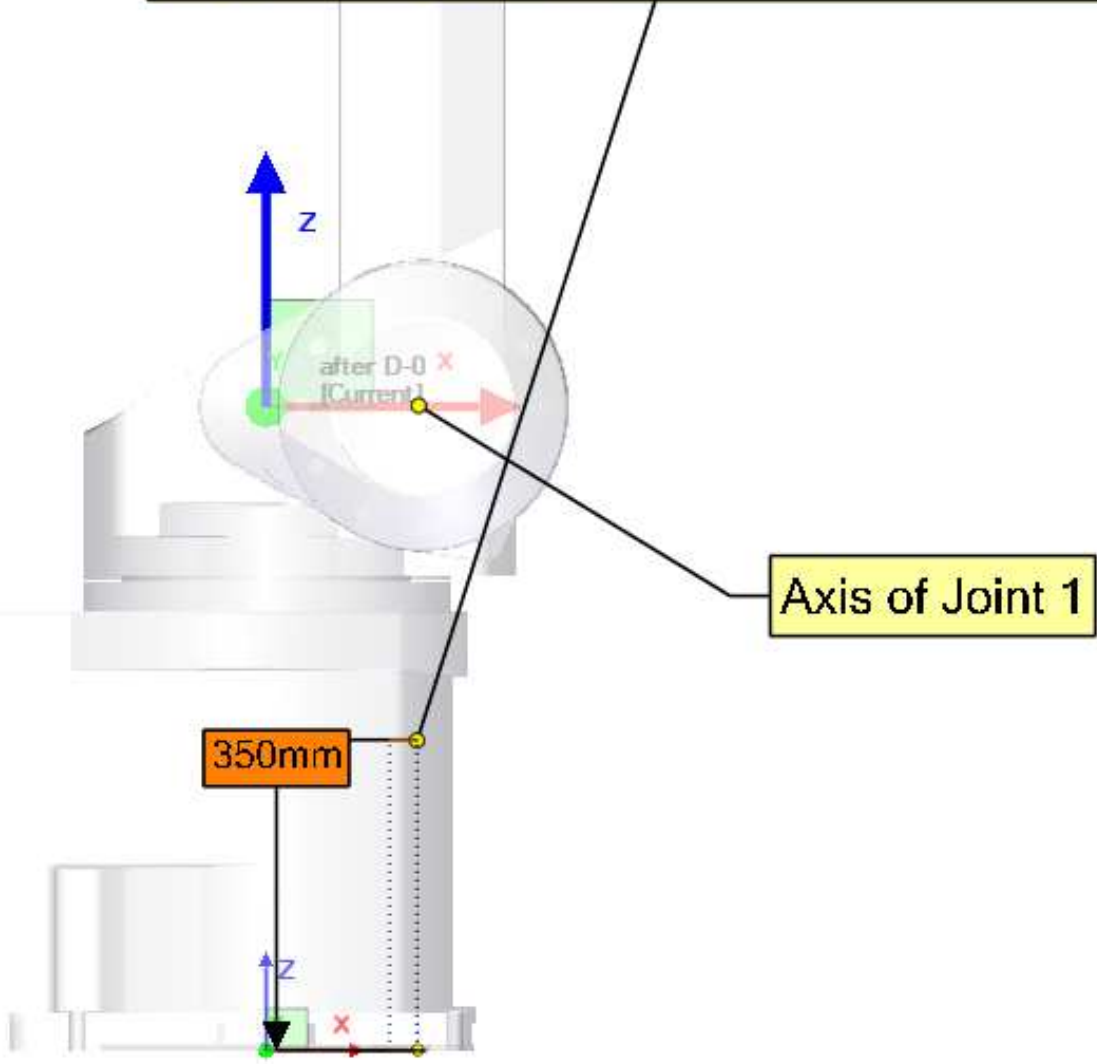




D-0

We move our coordinate system 350 mm along its Z-Axis until its X-Axis intersects the axis of joint 1.

```
setp genserkins.D-0 = 350
```



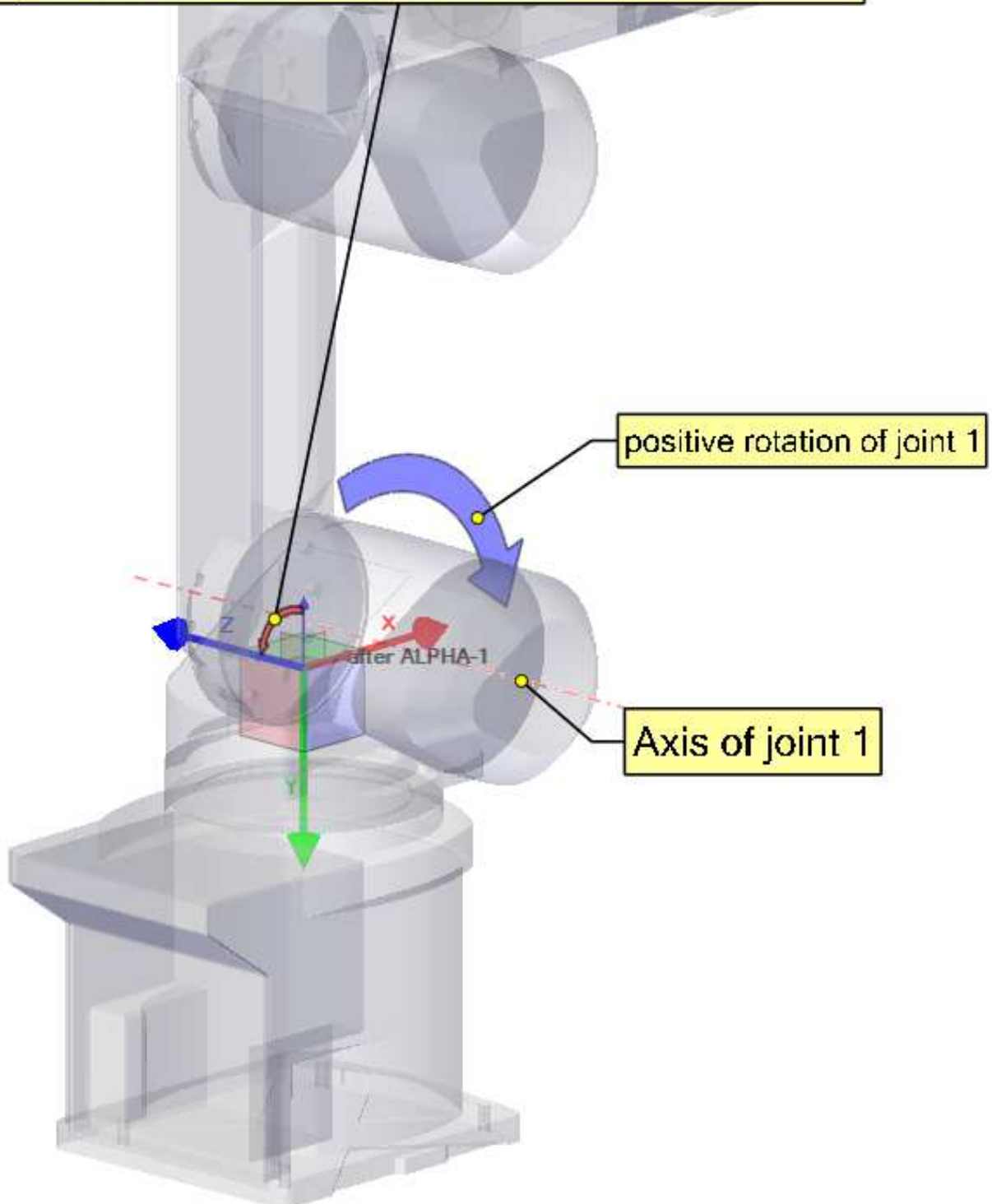
ALPHA-1

To make our Z-axis face the same direction as the axis of joint-1 we need to rotate our coordinate system 90° around its X-axis in the negative sense (use right hand rule with thumb along X).

A rotation around X corresponds to an alpha-value.

Note the alpha values have to be defined in radians. As 360° is equal to 2π our -90° is equal to $-\pi/2 = -1.570796327$

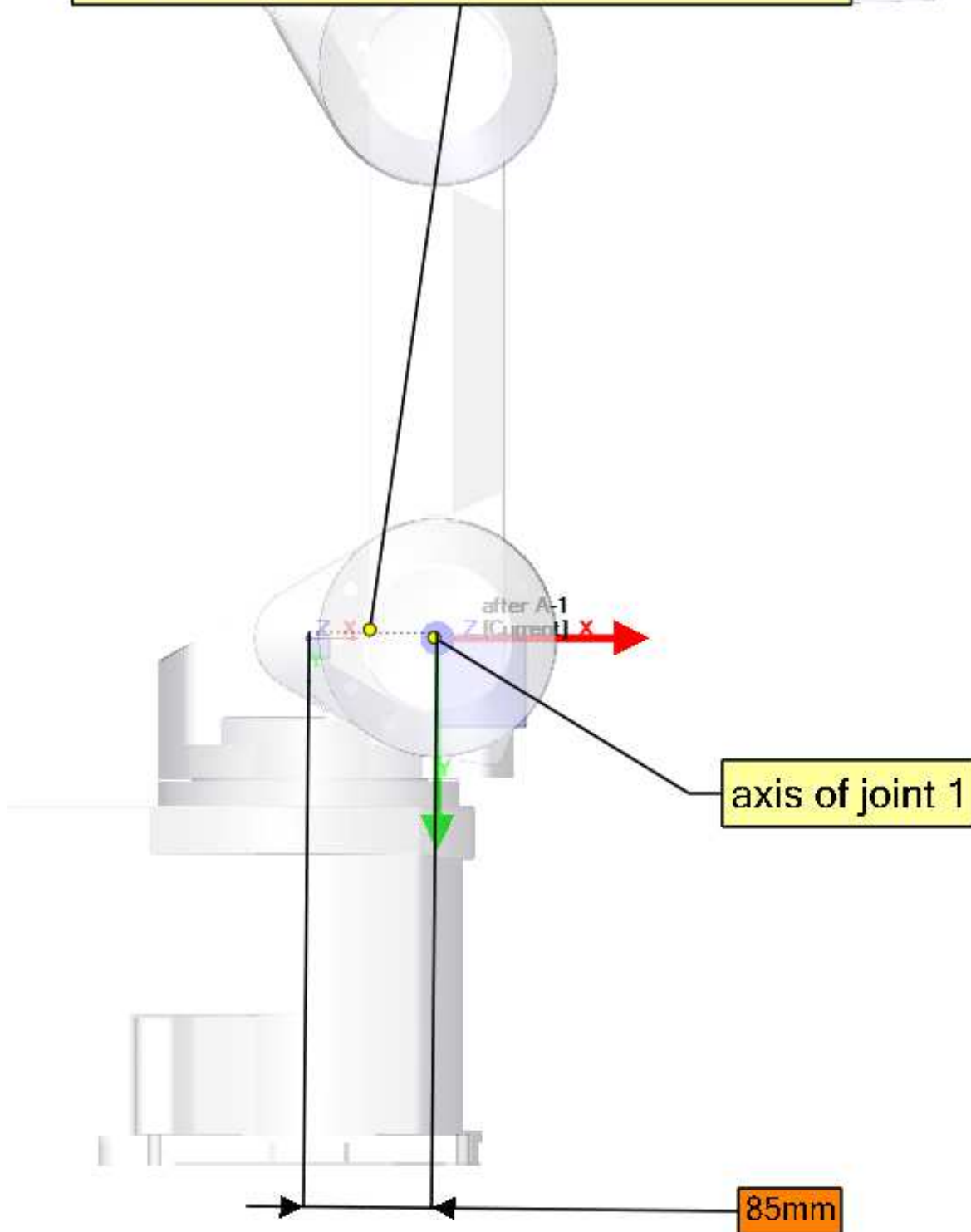
```
setp genserkins.ALPHA-1 = -1.570796327
```

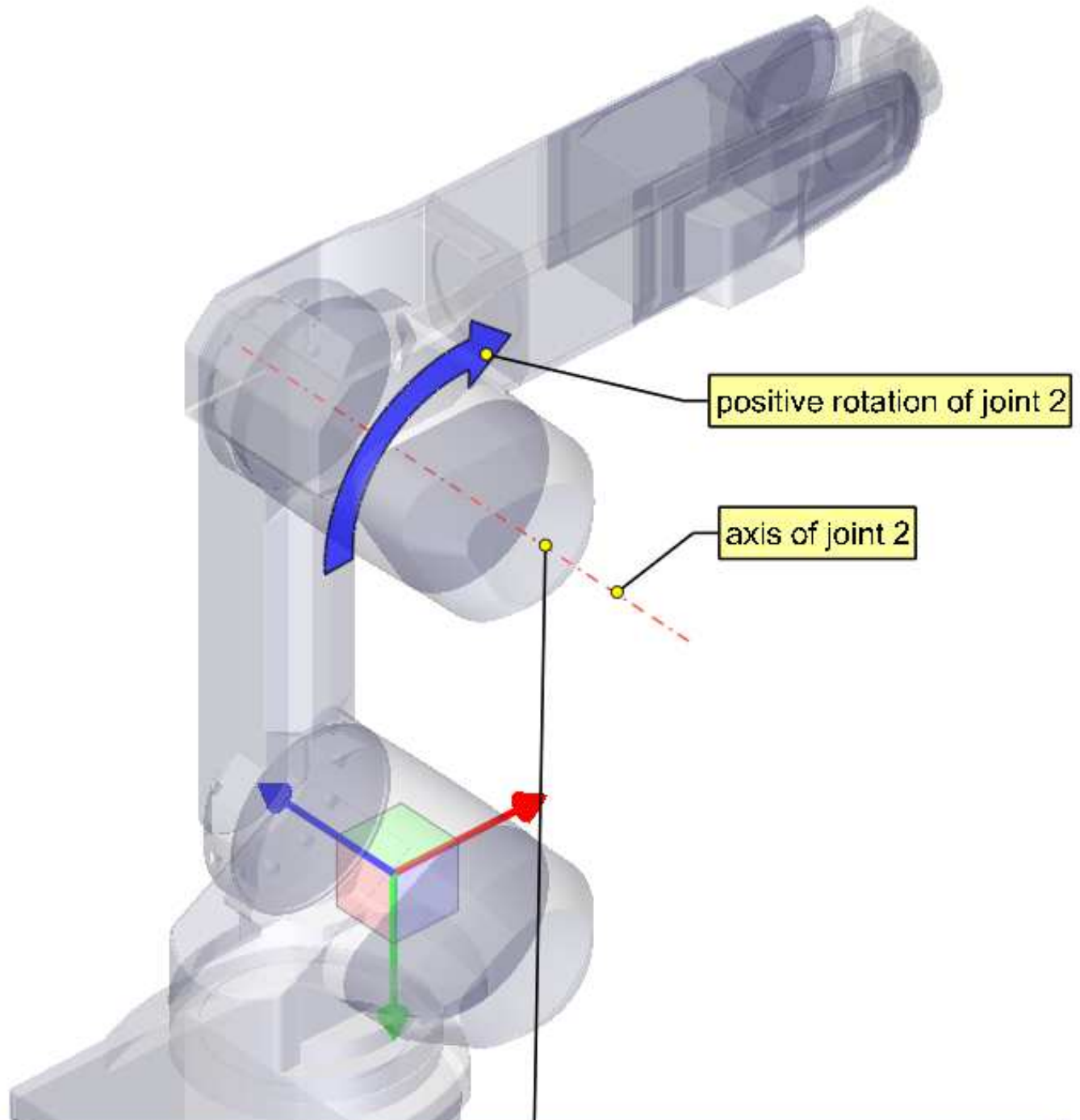


A-1

To make our Z-axis colinear with the axis of joint-1 we need to move our coordinate system 85mm along the X-axis.

```
setp gensekkins.A-1 = 85
```





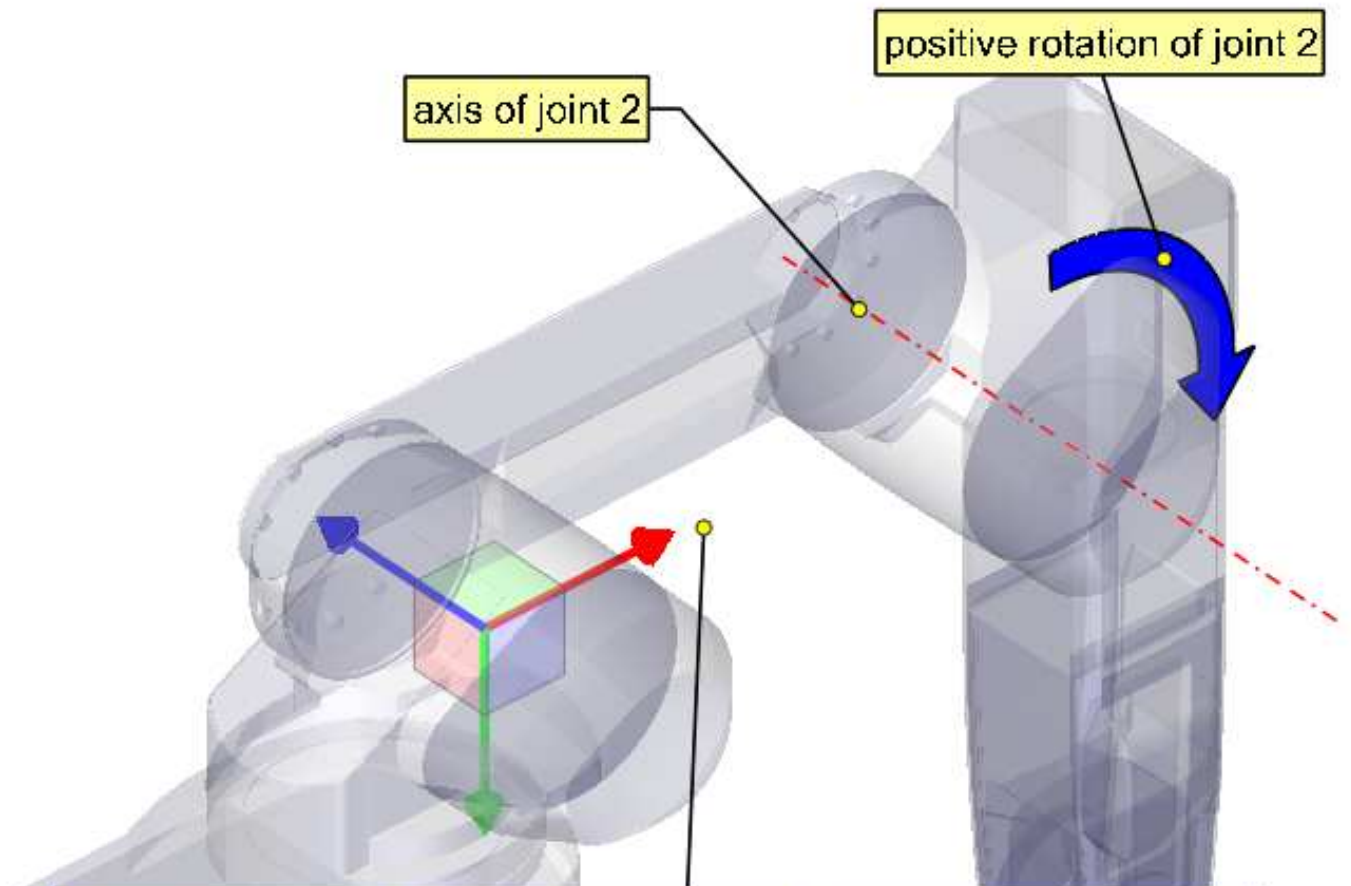
Note:

In order to make our X-axis intersect the axis of joint-2 we would need to rotate our coordinate system around its Z-axis. To do this we could, in theory, define θ_1 equal to -90° .

However gensek does not allow the definition of theta values. In gensek.c we see that the theta values for all joints are set to 0.

Now theta of course is the rotation of the joint itself and so is variable in an angular joint. Theta values are only used to define the home pose of a robot in the way of an offset.

So if we could define θ_1 equal to -90° we could define joint-1 to be oriented this way for 0° . Since we cannot define it we need to rotate joint-1 in a way so that our X-axis intersects with the axis of the next joint.



By rotating our joint-1 by 90° we made our X-axis intersect the axis of the next joint and we can continue defining our DH-Parameters.

D-1

Since the axis of joint 1 and the axis of joint 2 are parallel our X-axis already intersects the axis of joint 2 and thus parameter D-1 is 0.

`setp genserkins.D-1 = 0`

ALPHA-2

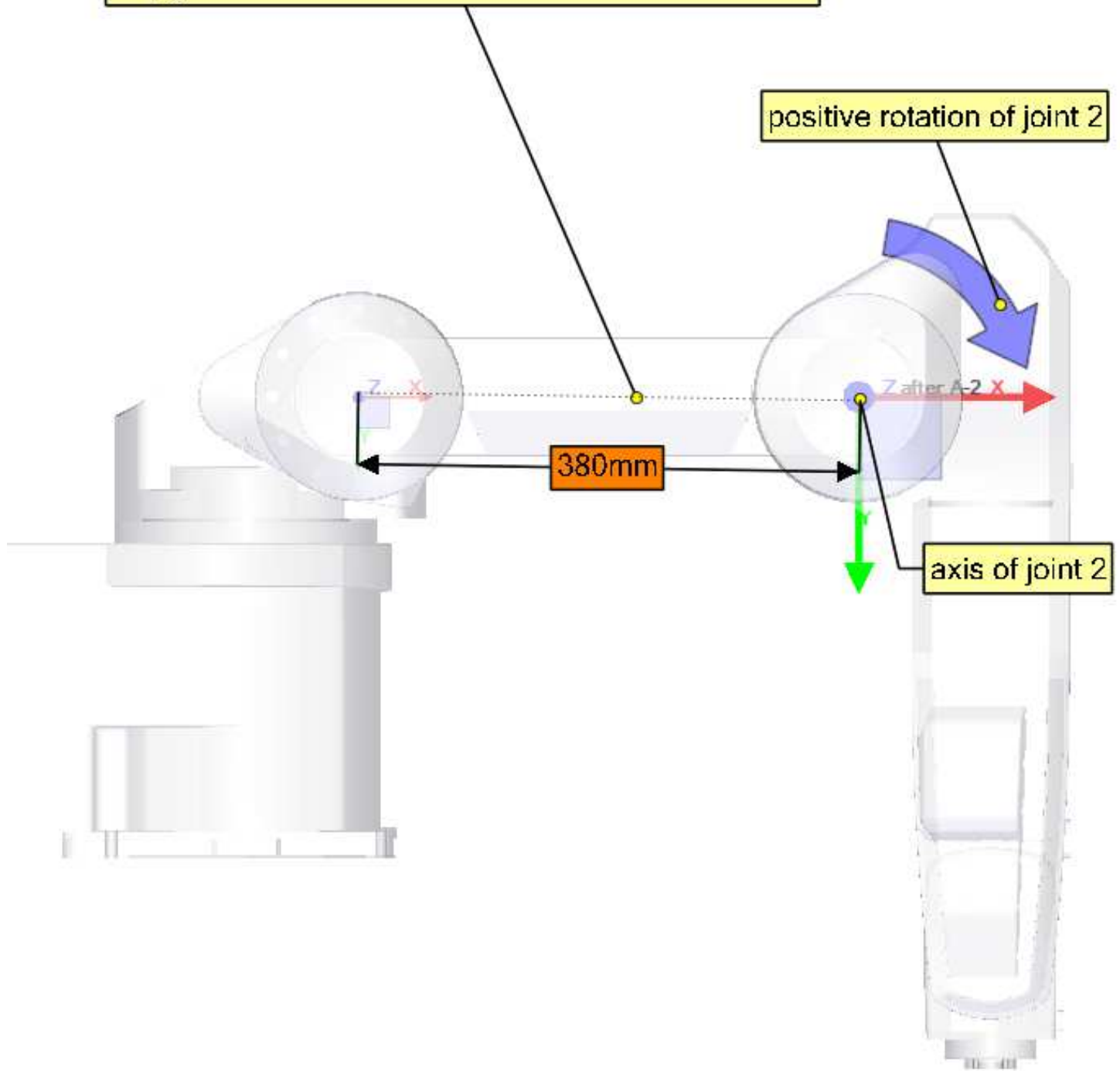
The axis of joint 1 is parallel to the axis of joint 2 and points in the same direction. Thus we do not need to rotate our Z-axis.

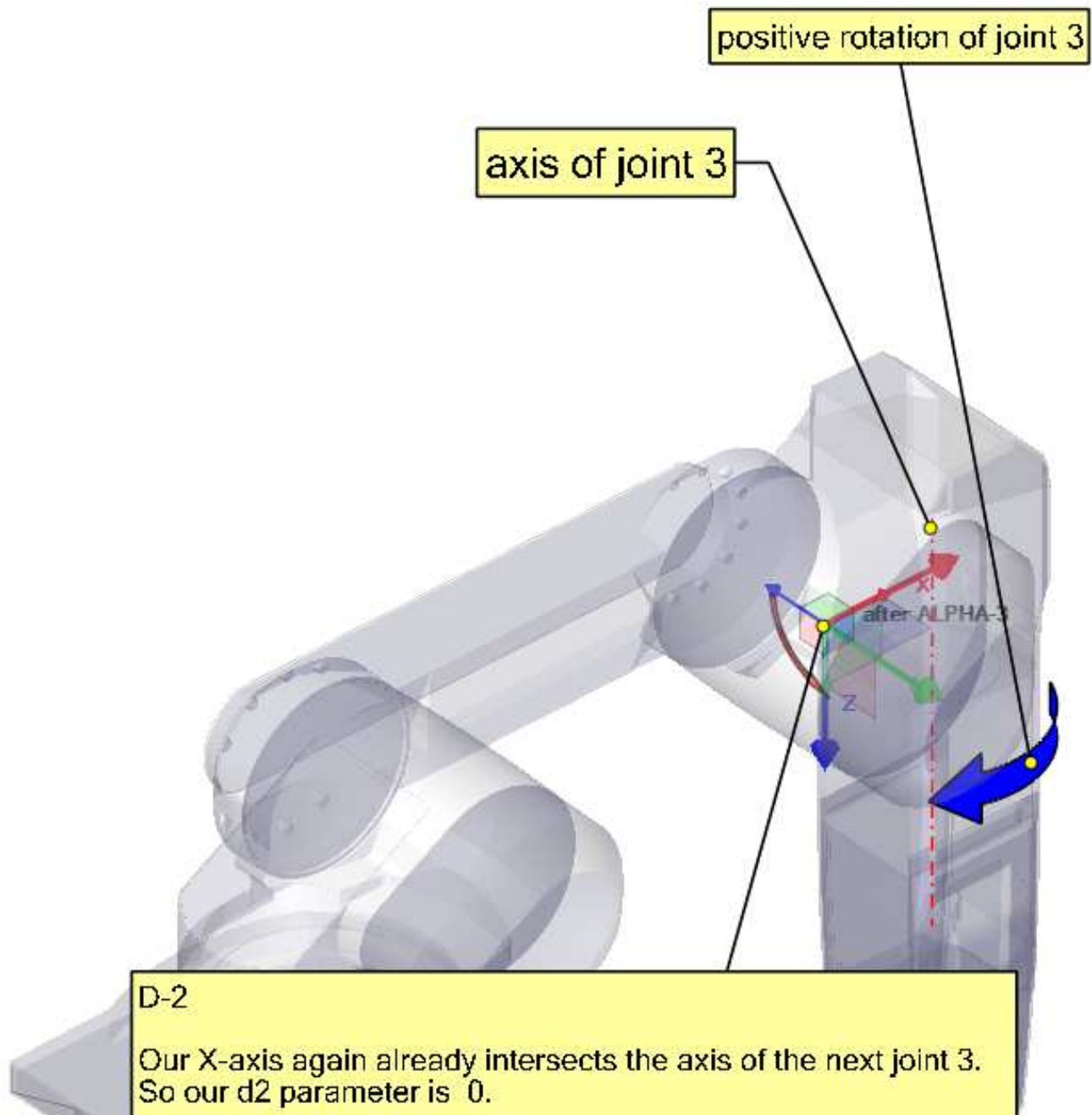
`setp genserkins.ALPHA-2 = 0`

A-2

We move our coordinate system 380mm along its X-axis to get its Z-axis colinear with the axis of joint-2.

setp genserkins.A-2 = 380





D-2

Our X-axis again already intersects the axis of the next joint 3.
So our d2 parameter is 0.

```
setp genserkins.D-2 = 0
```

ALPHA-3

To make our Z-axis face the same direction as the axis of joint-3
we need to rotate or coordinate system 90° around its X-axis in
the negative sense (use right hand rule with thumb along X).
A rotation around X corresponds to an alpha-value.
Note the alpha values have to be defined in radians. As 360°
is equal to $2 \cdot \text{Pi}$ our -90° is equal to $-\text{Pi}/2 = -1.570796327$

```
setp genserkins.ALPHA-3 = -1.570796327
```

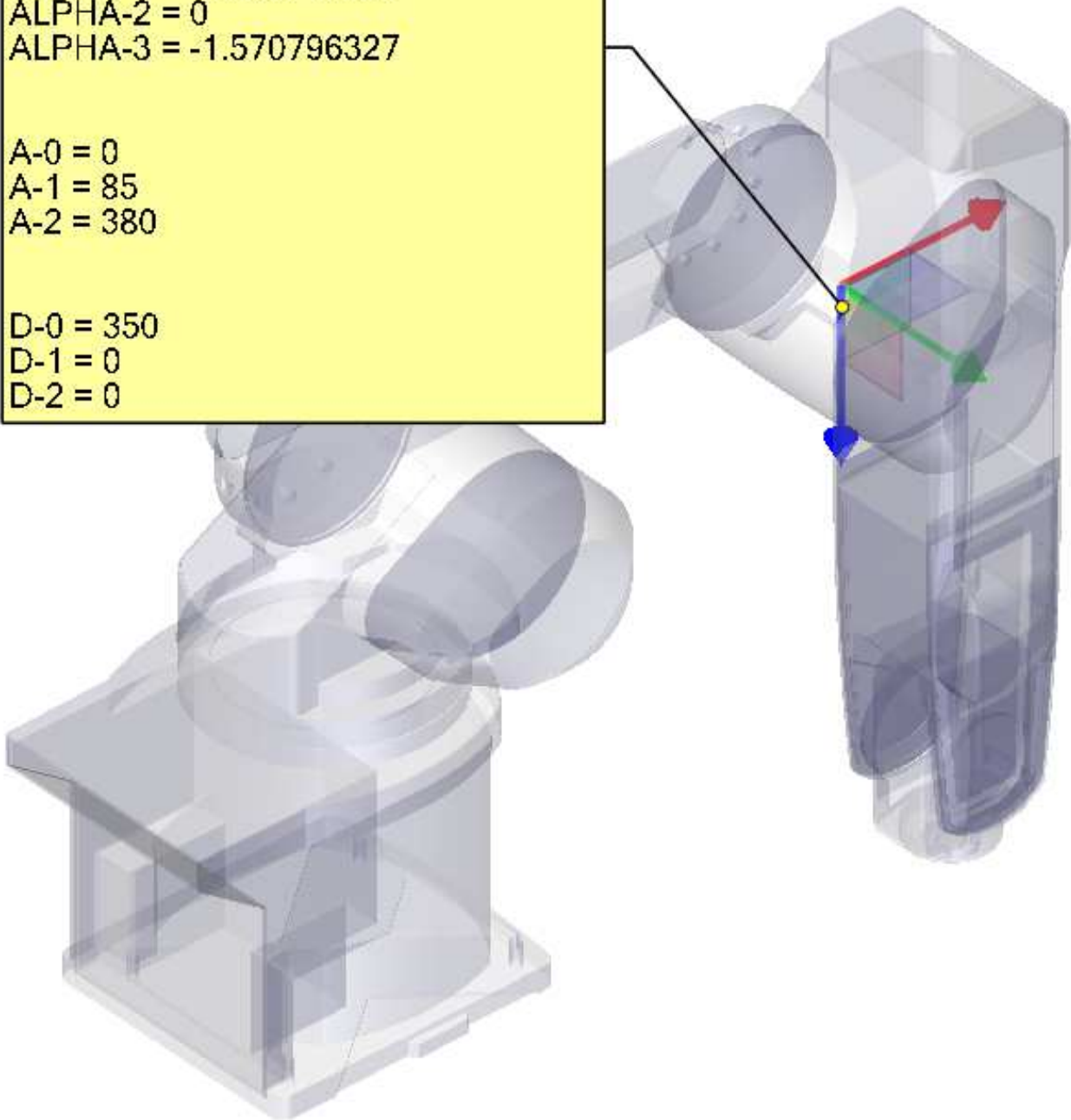
After rotating our coordinate system by ALPHA-3 our Z-axis points in the same direction as the axis of joint 3.

Our modified DH-Parameters so far:

ALPHA-0 = 0
ALPHA-1 = -1.570796327
ALPHA-2 = 0
ALPHA-3 = -1.570796327

A-0 = 0
A-1 = 85
A-2 = 380

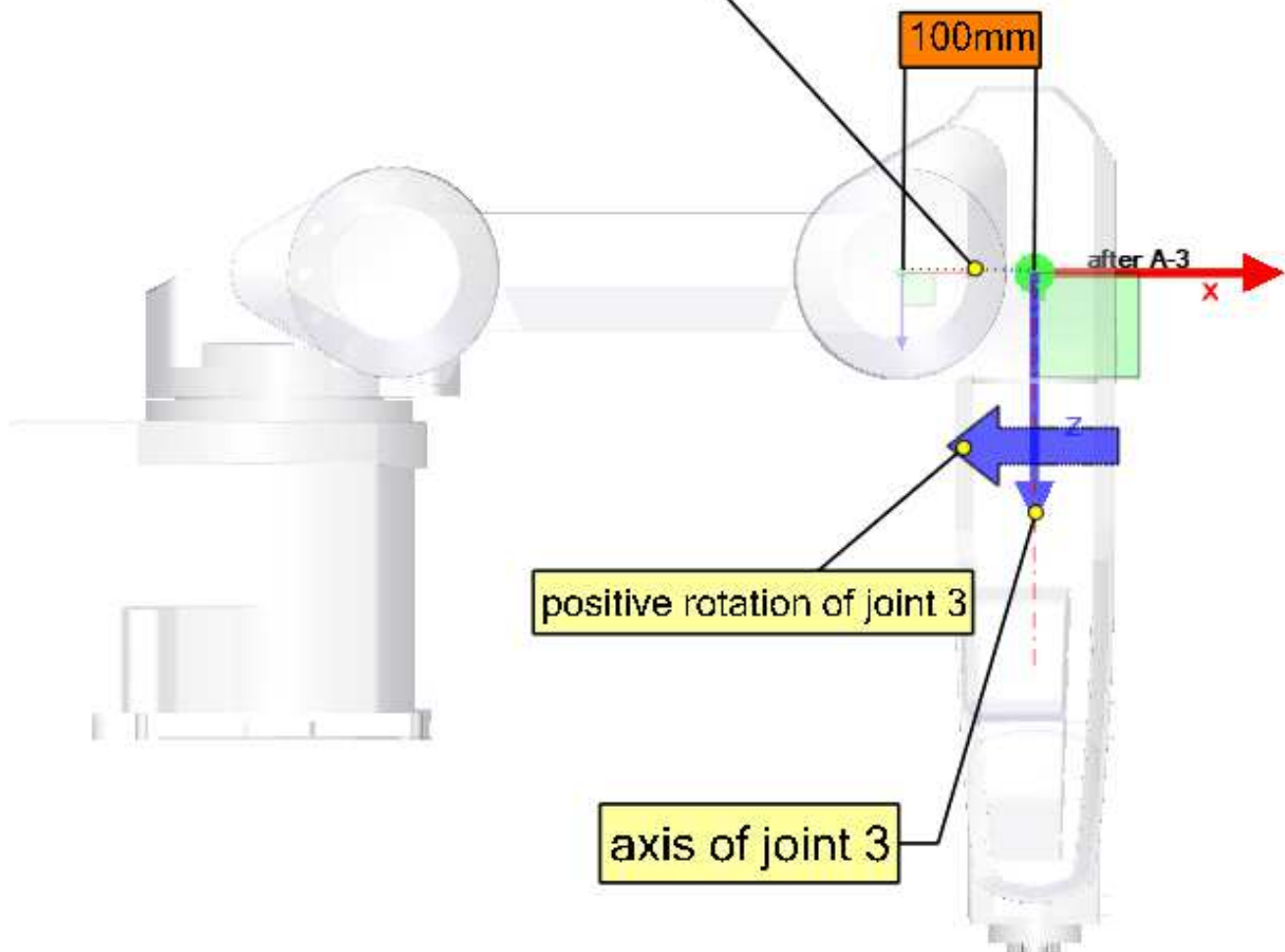
D-0 = 350
D-1 = 0
D-2 = 0



A-3

To make our Z-axis colinear with the axis of joint 3 we need to move our coordinate system 100mm along its X-axis.

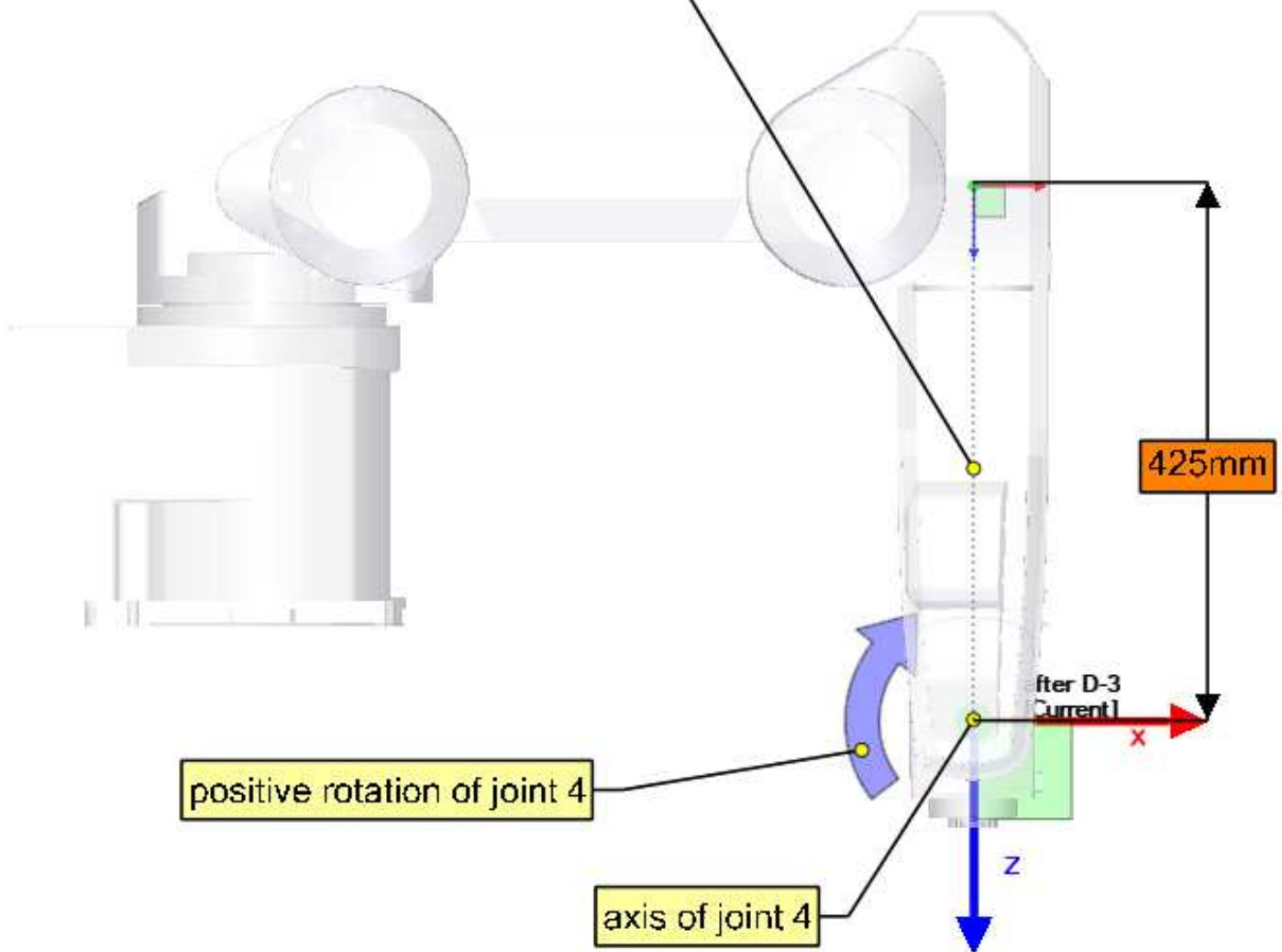
setp genserkins.A-3 = 100



D-3

We move our coordinate system 425 mm along its Z-Axis until its X-Axis intersects the axis of joint 4.

setp genserkins.D-3 = 425



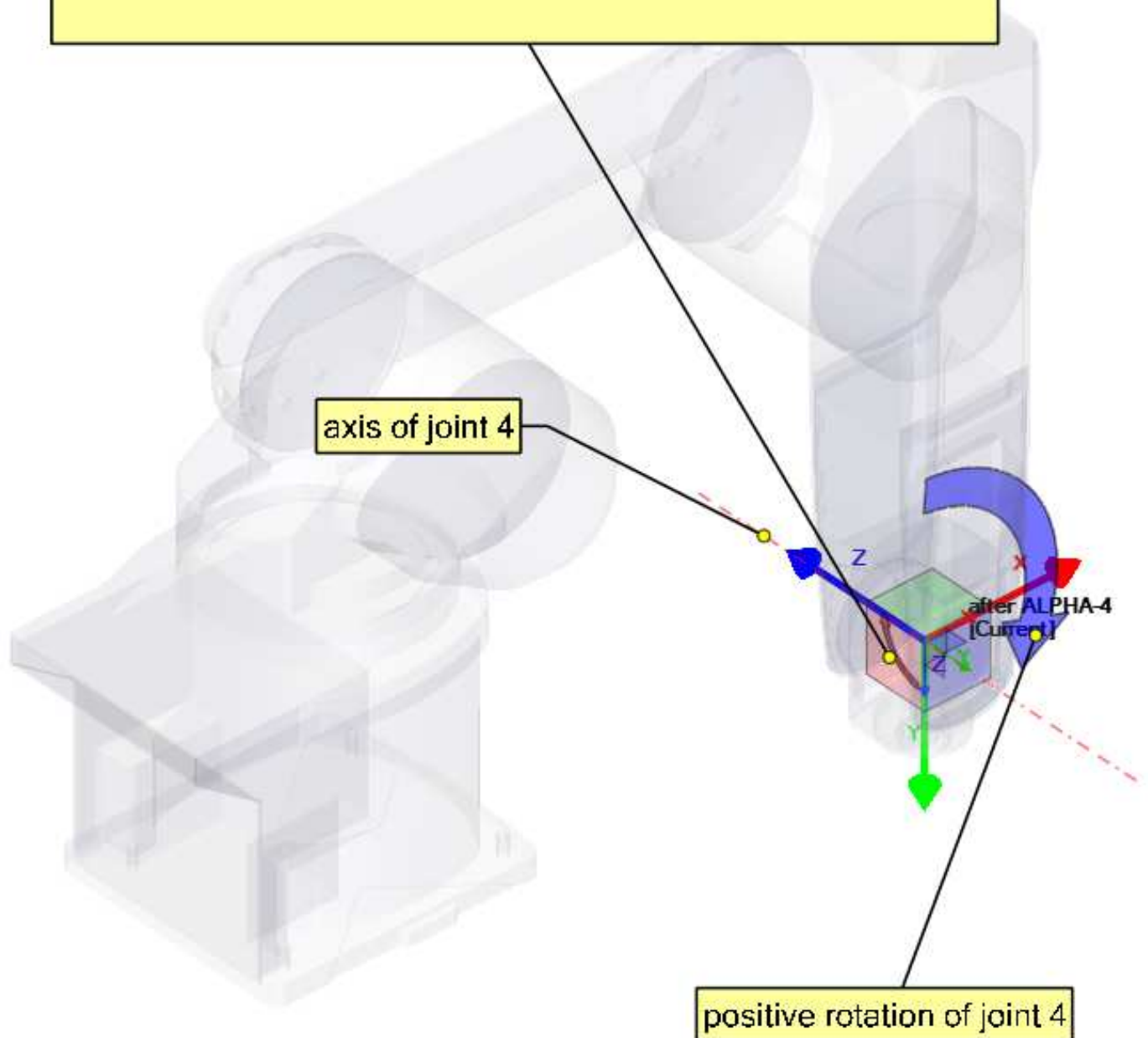
ALPHA-4

To make our Z-axis face the same direction as the axis of joint-4 we need to rotate our coordinate system 90° around its X-axis in the positive sense (use right hand rule with thumb along X).

A rotation around X corresponds to an alpha-value.

Note the alpha values have to be defined in radians. As 360° is equal to $2 \cdot \text{Pi}$ our 90° is equal to $\text{Pi}/2 = 1.570796327$

```
setp genserkins.ALPHA-4 = 1.570796327
```

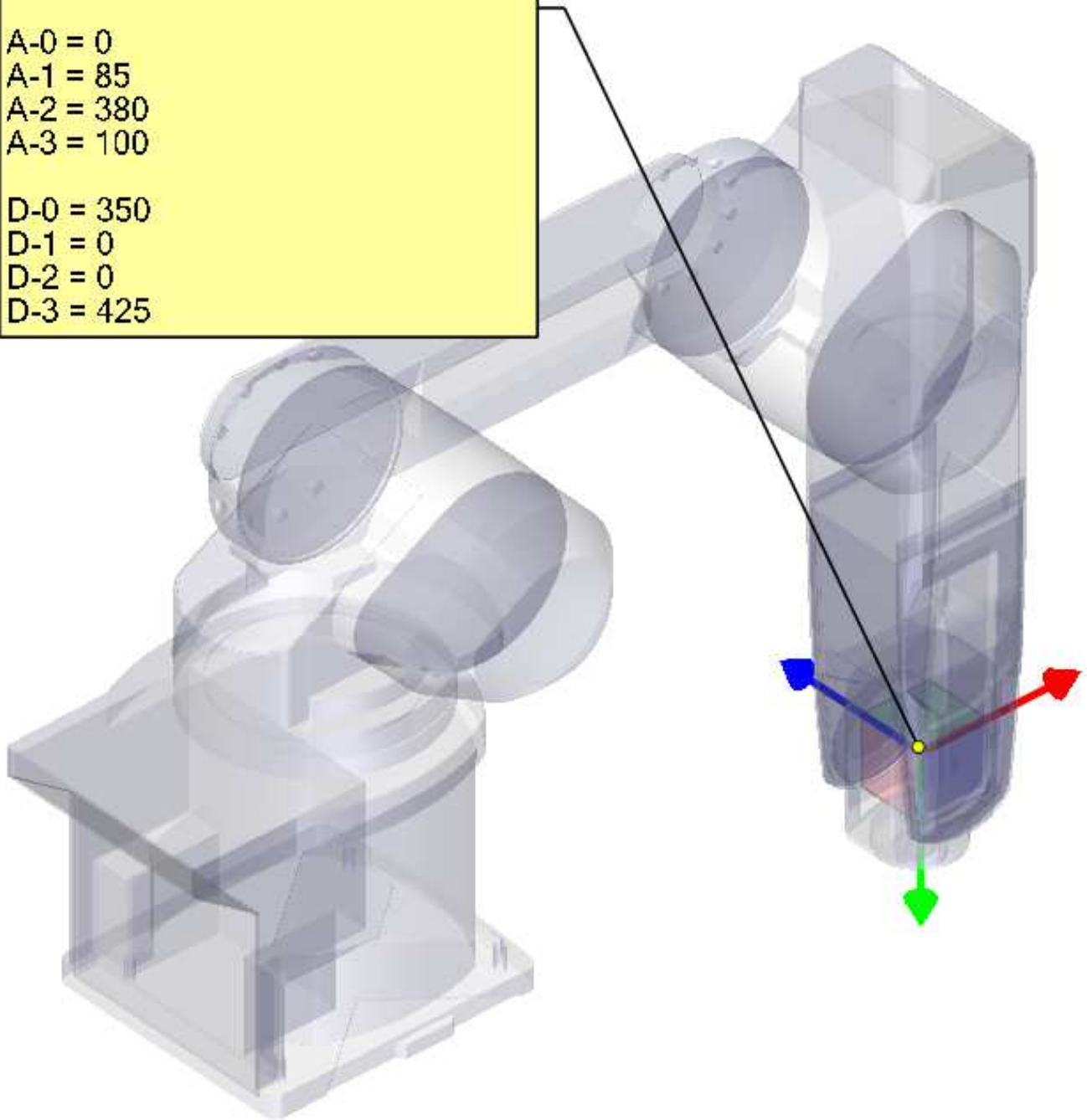


Our modified DH-Parameters so far:

ALPHA-0 = 0
ALPHA-1 = -1.570796327
ALPHA-2 = 0
ALPHA-3 = -1.570796327
ALPHA-4 = 1.570796327

A-0 = 0
A-1 = 85
A-2 = 380
A-3 = 100

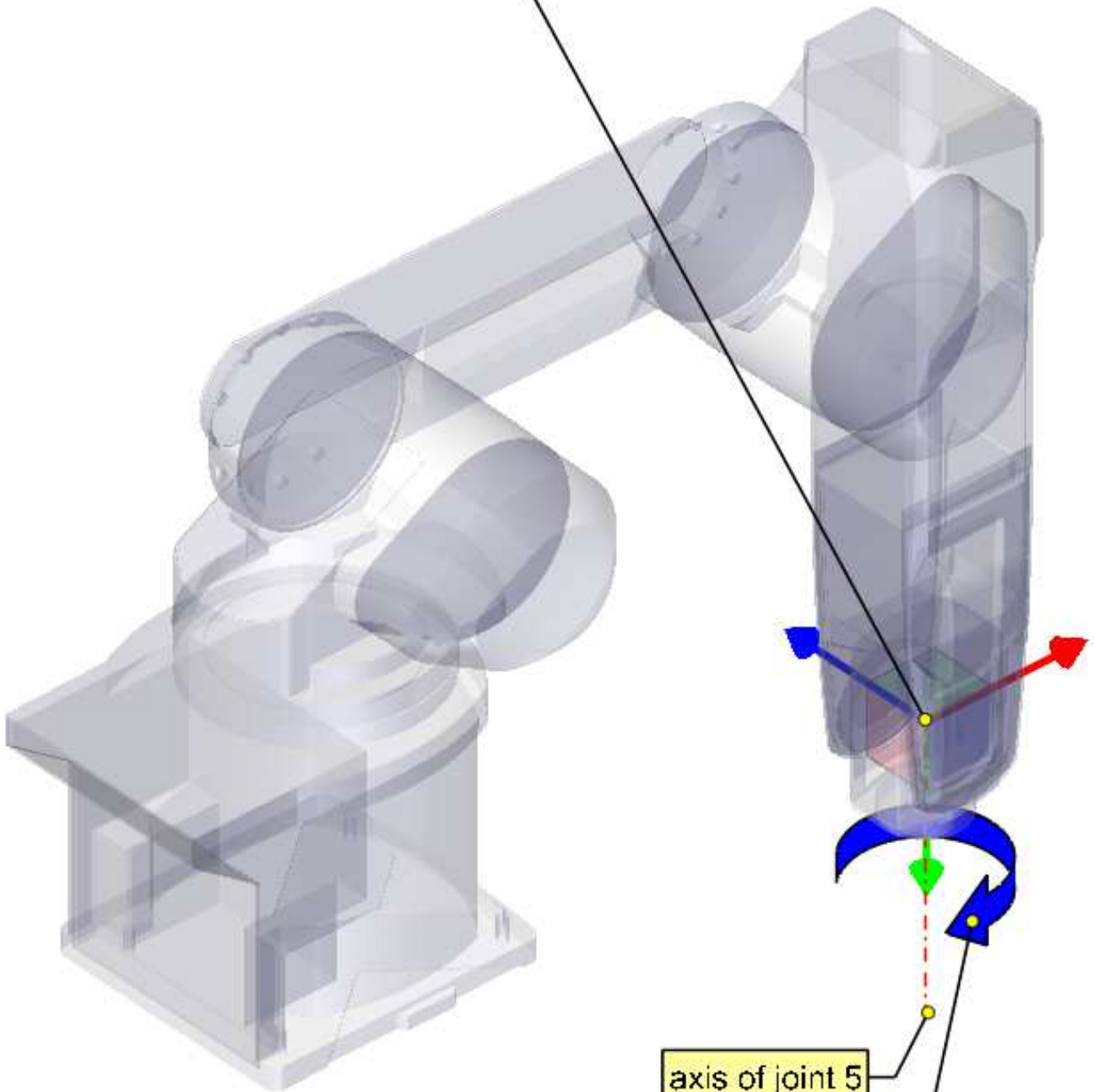
D-0 = 350
D-1 = 0
D-2 = 0
D-3 = 425



A-4

Since the origin of our coordinate system intersects the axis of the next joint 4 we can set A-4 to 0.

```
setp genserkins.A-4 = 0
```



axis of joint 5

positive rotation of joint 5

D-4

Since the origin of our coordinate system lies on the axis of the next joint our d4 parameter is also 0.

```
setp genserkins.D-4 = 0
```

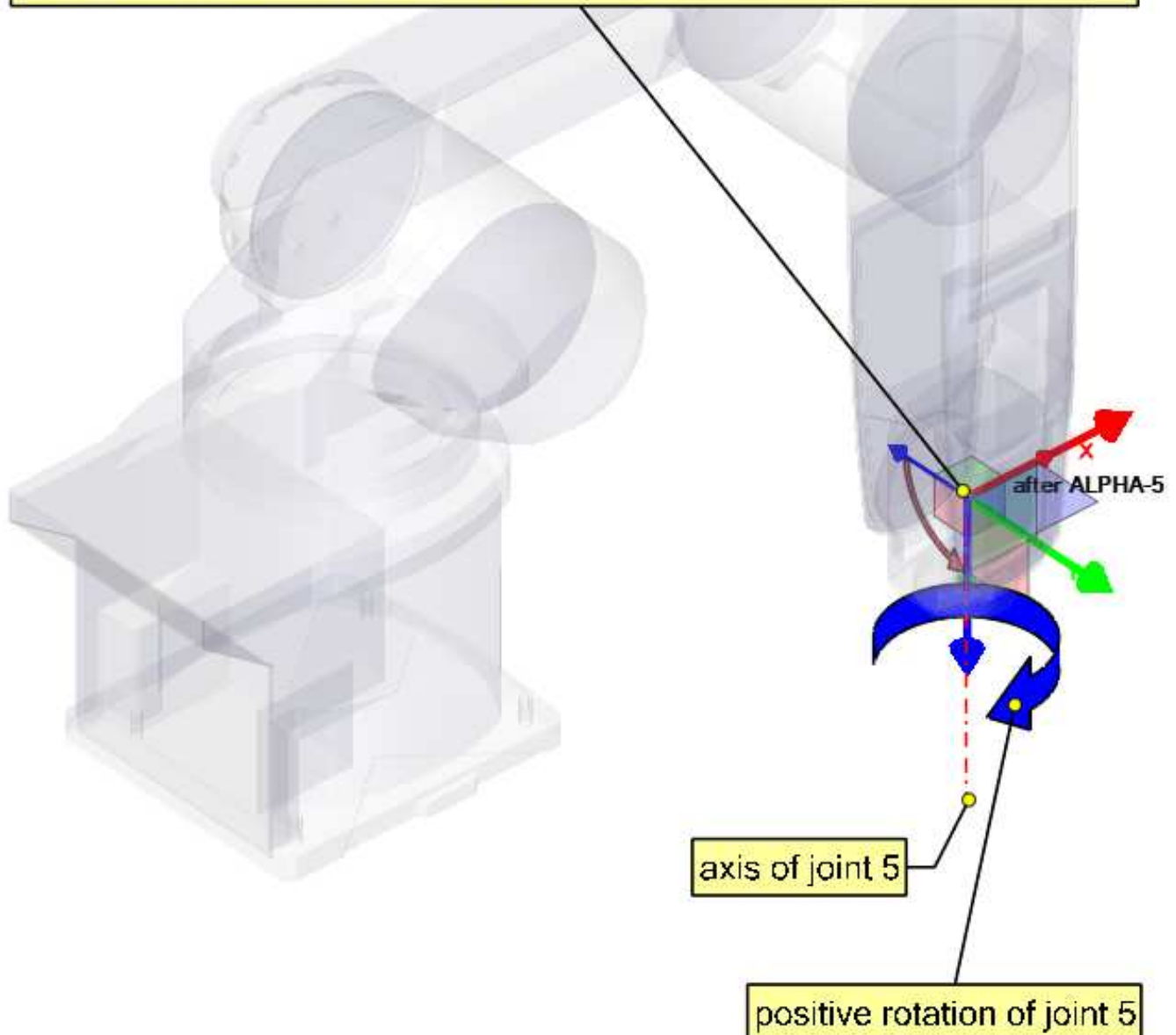
ALPHA-5

To make our Z-axis face the same direction as the axis of joint-5 we need to rotate our coordinate system 90° around its X-axis in the negative sense (use right hand rule with thumb along X).

A rotation around X corresponds to an alpha-value.

Note the alpha values have to be defined in radians. As 360° is equal to $2 \cdot \text{Pi}$ our -90° is equal to $-\text{Pi}/2 = -1.570796327$

```
setp genserkins.ALPHA-5 = -1.570796327
```

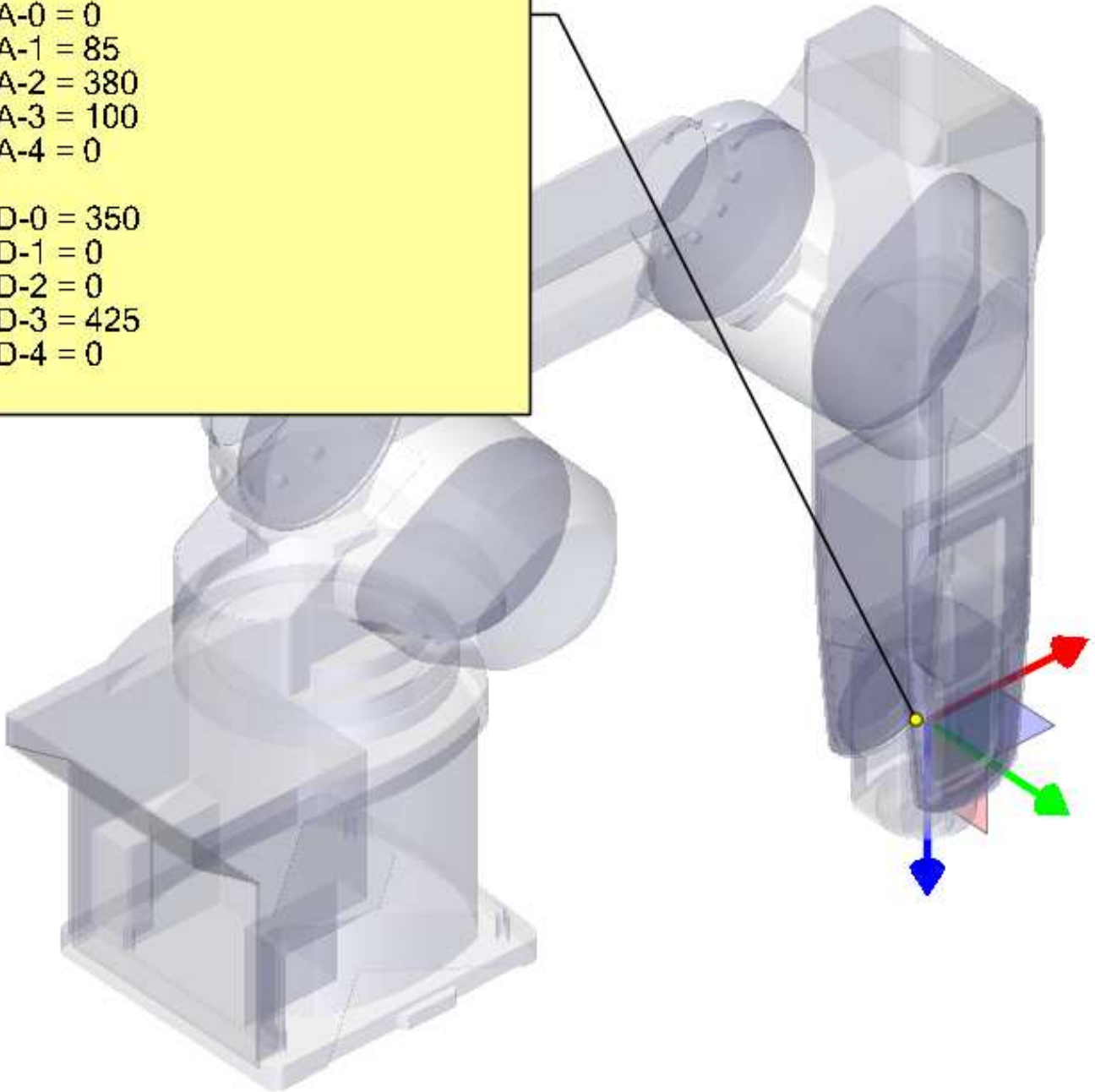


Our modified DH-Parameters so far:

ALPHA-0 = 0
ALPHA-1 = -1.570796327
ALPHA-2 = 0
ALPHA-3 = -1.570796327
ALPHA-4 = 1.570796327
ALPHA-5 = -1.570796327

A-0 = 0
A-1 = 85
A-2 = 380
A-3 = 100
A-4 = 0

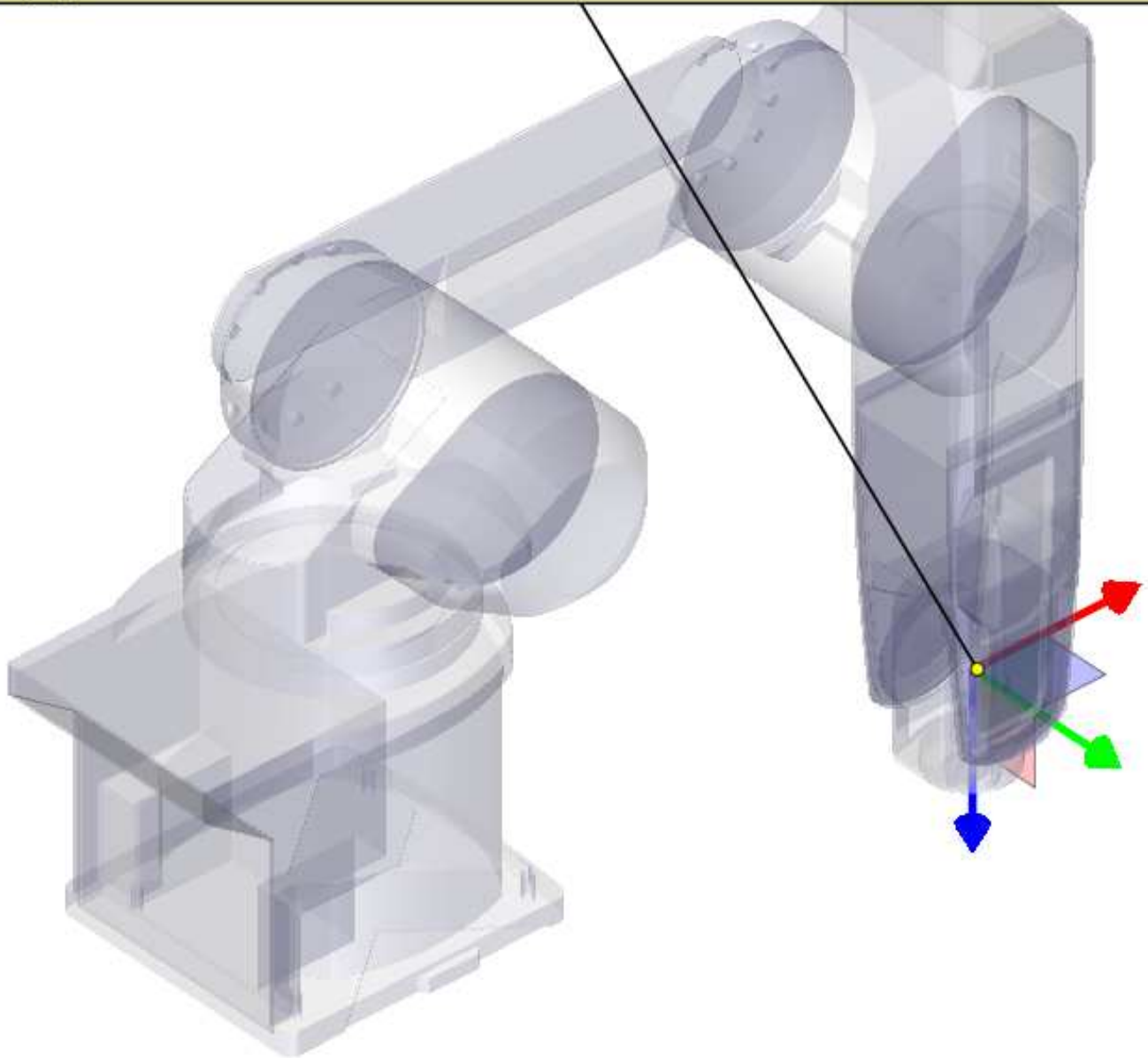
D-0 = 350
D-1 = 0
D-2 = 0
D-3 = 425
D-4 = 0



A-5

Since the origin of our coordinate system intersects the axis of the next joint-5 we can set A-5 to 0.

```
setp genserkins.A-5 = 0
```

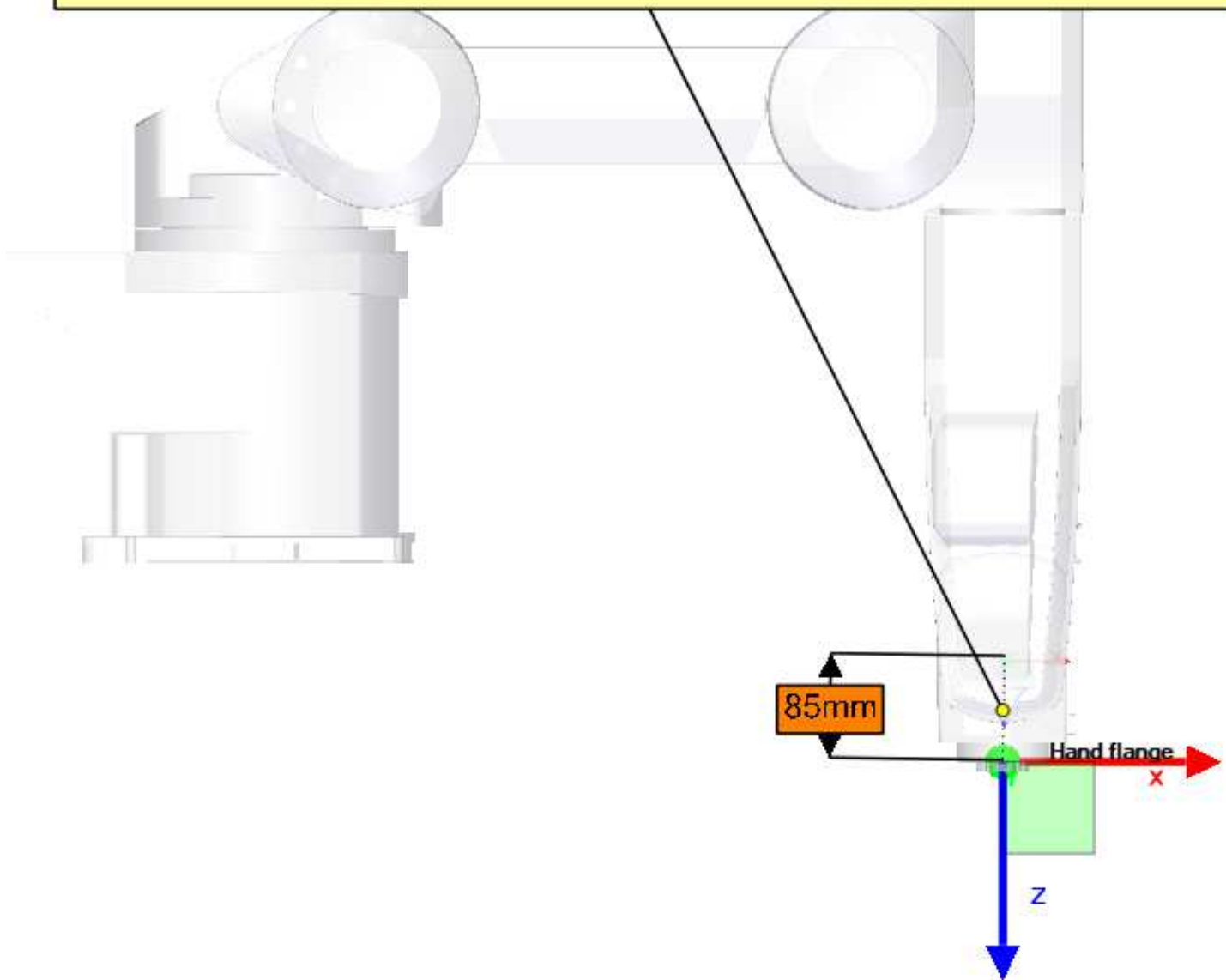


D-5

We move our coordinate system for 85mm along its Z-axis.

With this we have finished setting up our modified DH- parameters and leaves our coordinate system at the center of the hand flange.

setp genserkins.D-5 = 85

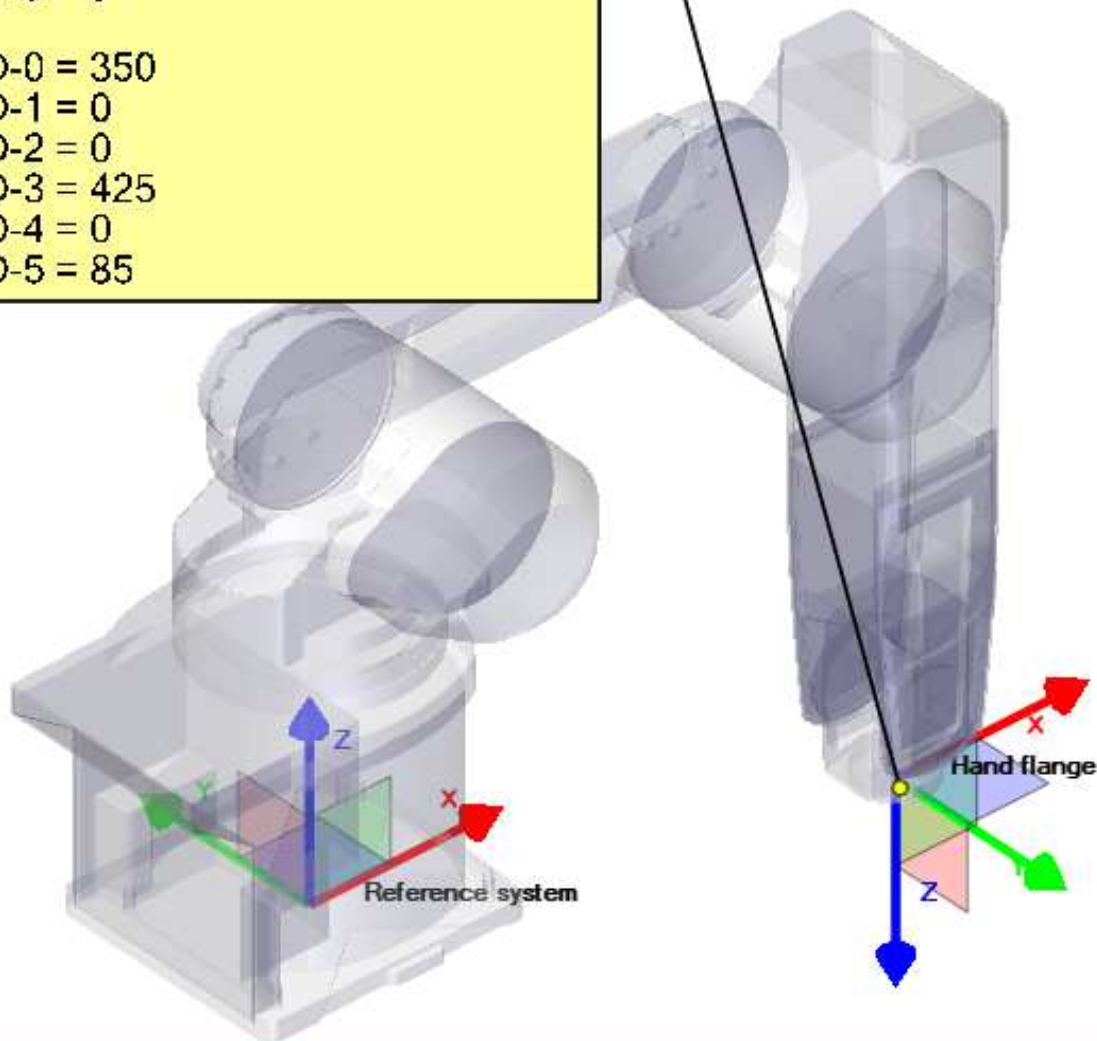


Our final modified DH-Parameters:

ALPHA-0 = 0
ALPHA-1 = -1.570796327
ALPHA-2 = 0
ALPHA-3 = -1.570796327
ALPHA-4 = 1.570796327
ALPHA-5 = -1.570796327

A-0 = 0
A-1 = 85
A-2 = 380
A-3 = 100
A-4 = 0
A-5 = 0

D-0 = 350
D-1 = 0
D-2 = 0
D-3 = 425
D-4 = 0
D-5 = 85



So now if we have done everything right gensekins will calculate the position and orientation of this hand flange in reference to the coordinate system we chose when we started out at the base of our robot.