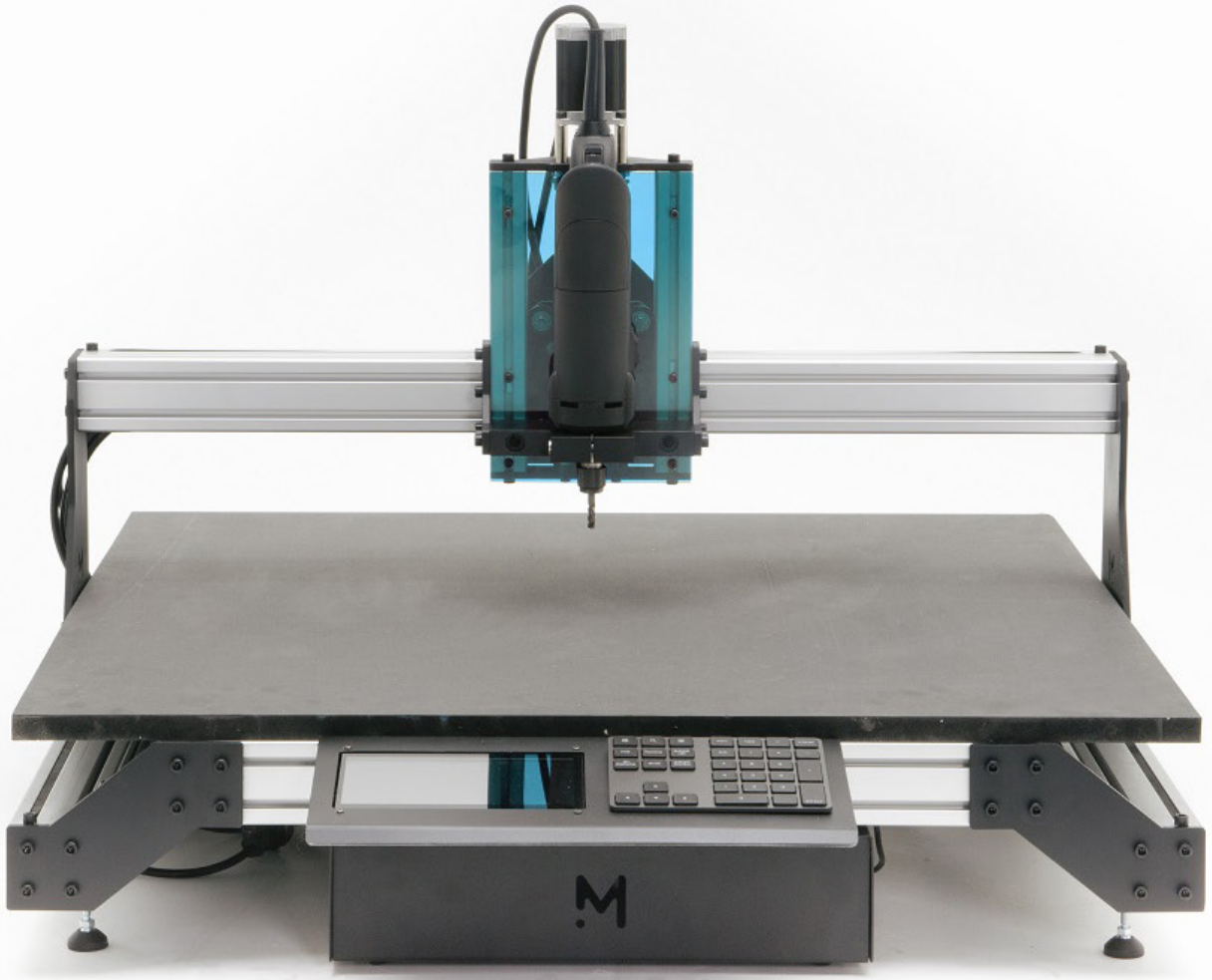
MEKANIKA

EVO

CALIBRATION METHODOLOGY



Calibration is the **comparison of measurement values** delivered by a machine under test **with those of a standard value of known accuracy**.

In our case, since Evo comes as a kit and can be assembled with minor misalignments, the point of calibrating the machine is to **make sure that it can achieve the accuracy it was designed for**.

It is not mandatory to calibrate Evo before working on it, the machine will already run smoothly, but you might notice small measurement errors (especially on larger workpieces). The goal of this documentation is to provide a guide to correct these errors easily.

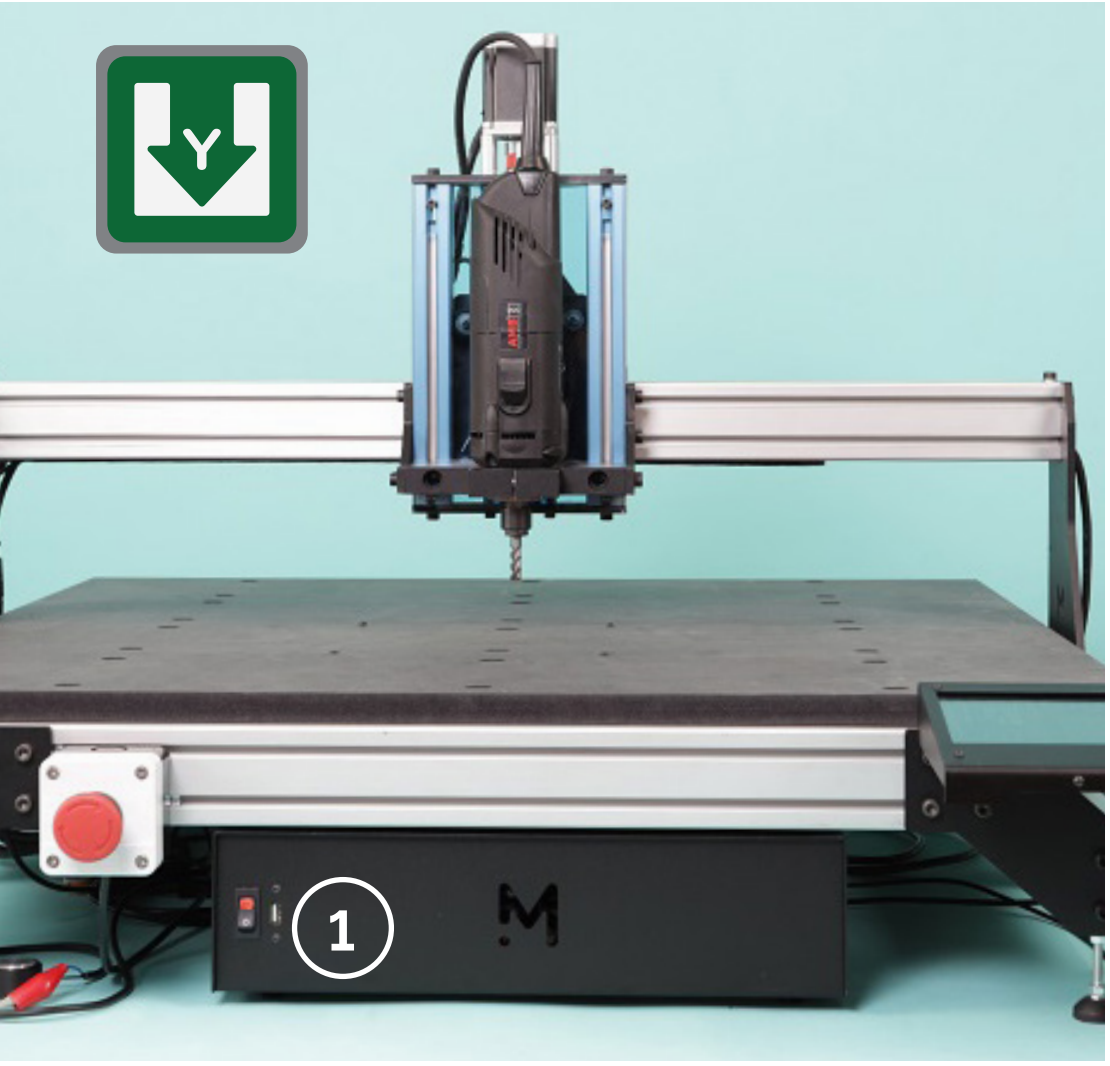
The documentation is divided into 3 sections, corresponding to **3 different tests** that have to be performed on the machine. Don't forget to **download the relevant G-codes** on our website before starting.

1. Measurements
2. Calibration
3. Spindle tramming

1. MEASUREMENTS

STEP #01 : SQUARING THE MACHINE

1. Switch on the control unit of the CNC router
2. Move manually the machine to the front
3. Press the "**Square Gantry**" button



STEP #02 : HOMING THE MACHINE

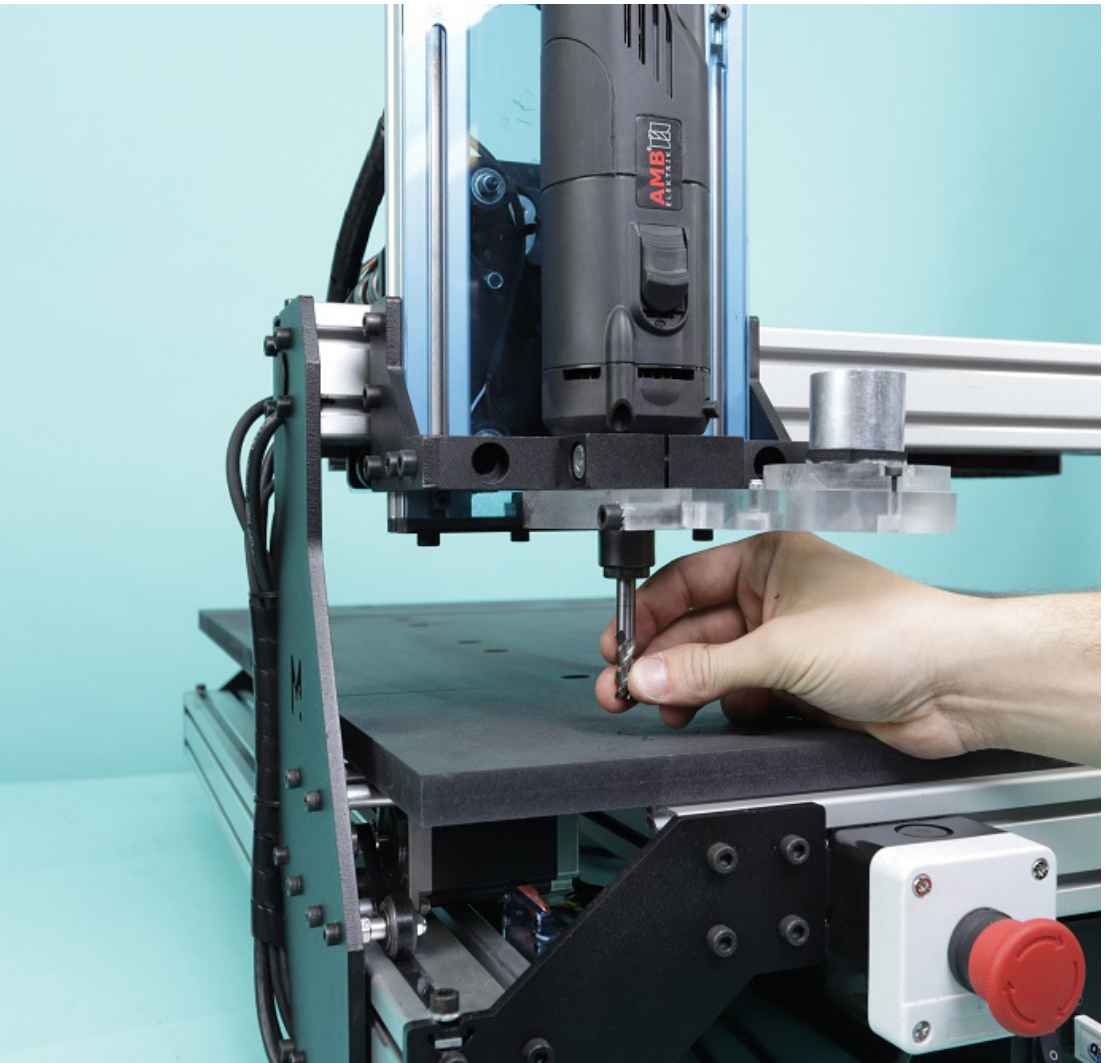
1. Press the **“Home”** button

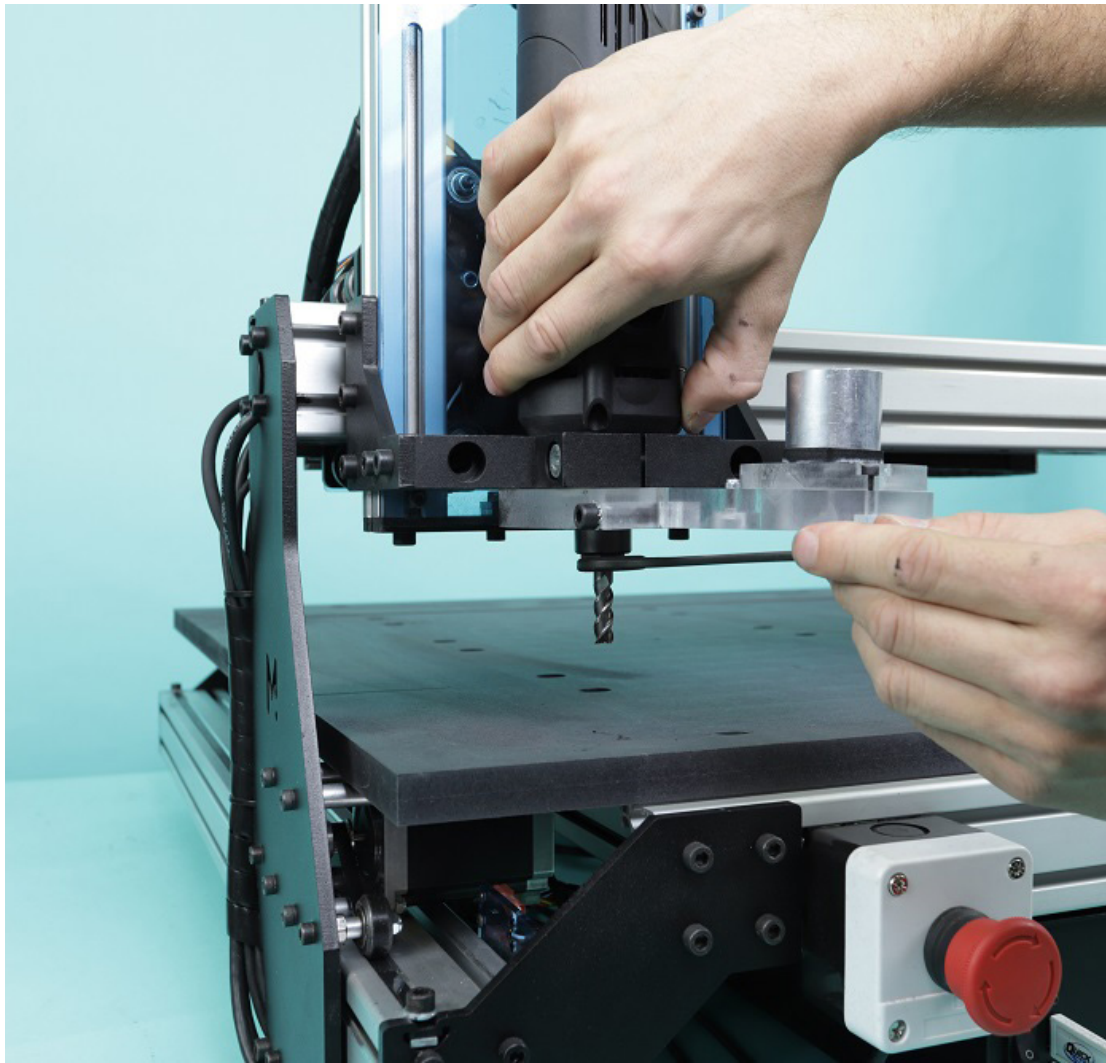
STEP #03 : DEFINING THE WORKING COORDINATES

1. Press the **“XY”** button to define the current position as the X0 Y0 working coordinates

STEP #04 : CHANGING THE ENDMILL

1. Install the **8mm endmill** (included in the EVO kit)

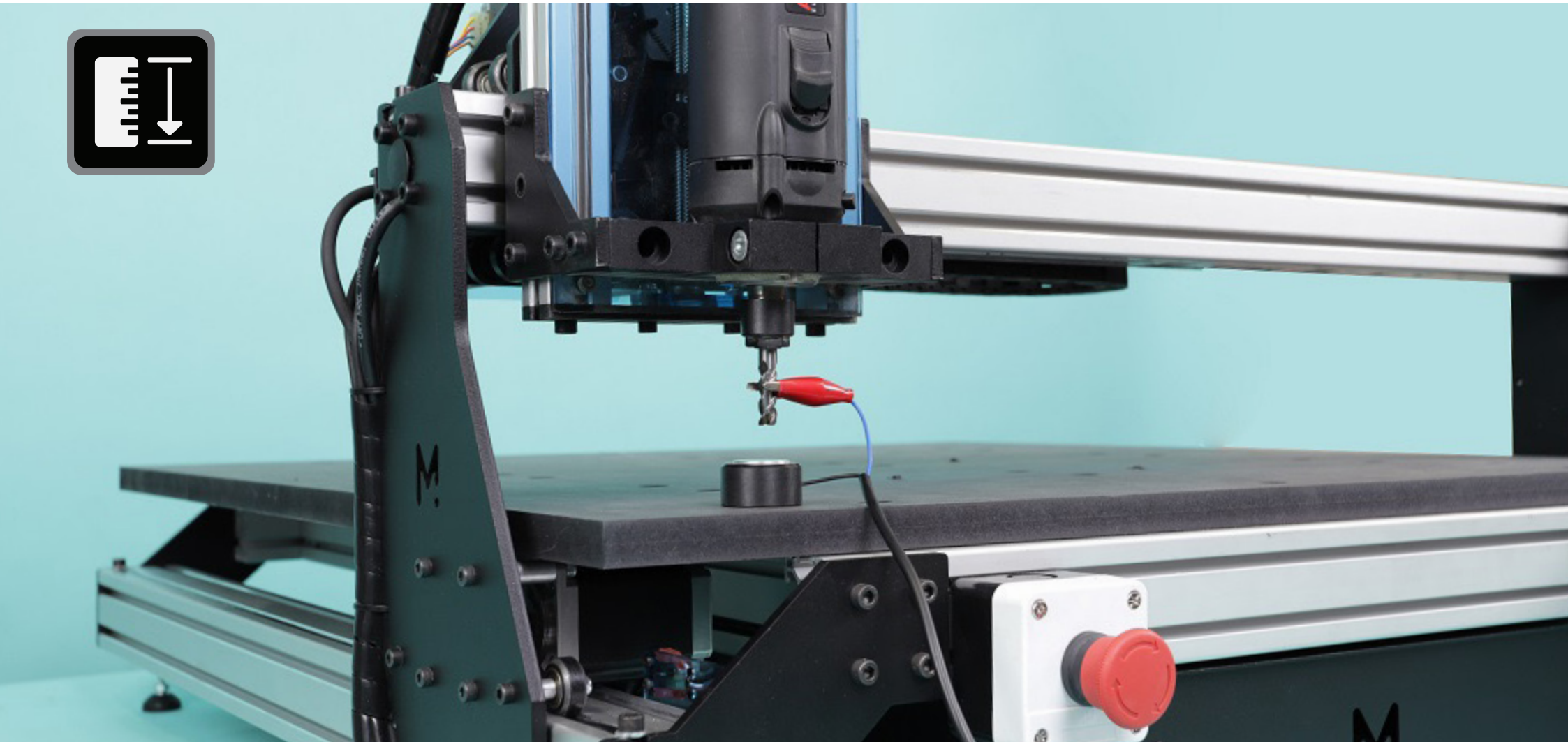




1. MEASUREMENTS

STEP #05 : MEASURING THE TOOL LENGTH

1. Place the crocodile clip on the endmill
2. Place the probing device underneath the endmill
3. Press on the **“Tool measure length”** button



STEP #06 : LOADING THE GCODE

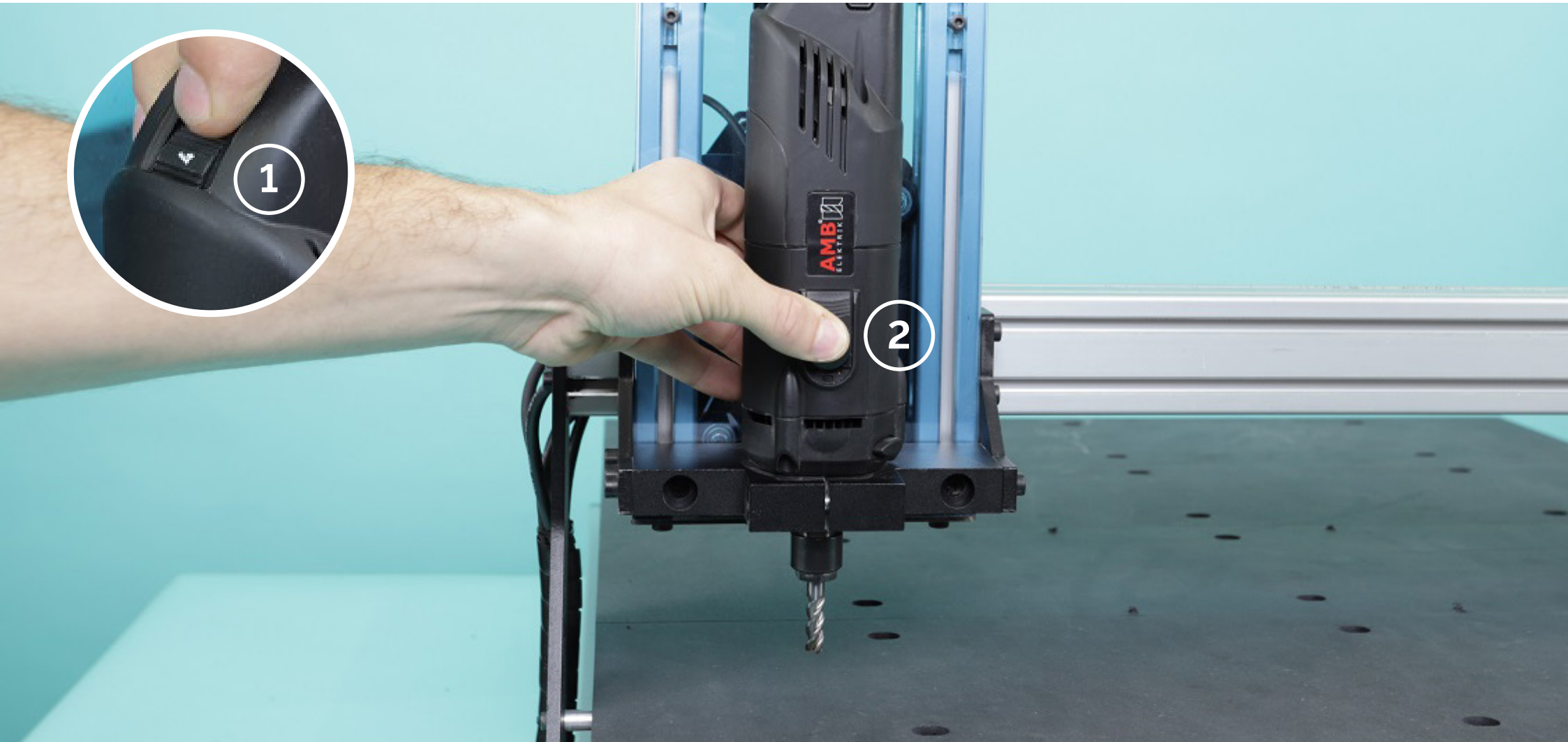
1. Download the Calibration G-codes on our support page
2. Load them on your control unit with a USB key or using the Shared folder of the Raspberry Pi
3. Press the **“Open Gcode”** button
4. Open the **“Squaring test”** file

STEP #07 : SWITCHING ON THE SPINDLE

1. Set the rotation speed on **“4”**
2. **Switch on the spindle**

WEAR SOME SECURITY GLASSES AND EAR PROTECTIONS

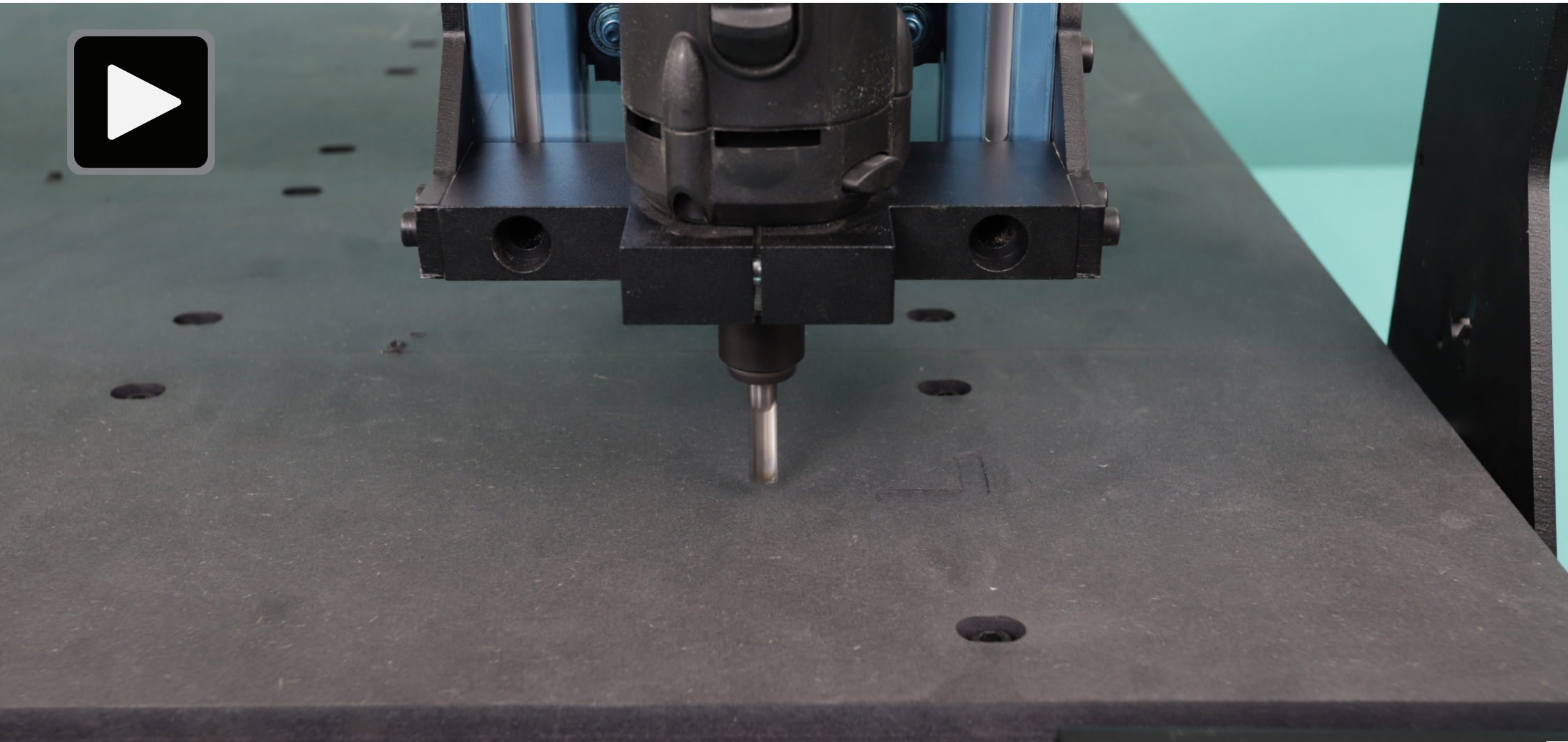
NO NEED TO INSTALL THE DUST SHOE FOR THIS OPERATION



STEP #08 : MILLING

1. Press the **“Play”** button

WEAR SOME SECURITY GLASSES AND EAR PROTECTIONS



STEP #09: PREPARING FOR THE NEXT STEP

1. Once the work is finished, press the **“Stop”** button
2. Switch off the spindle
3. Bring the machine to the back with the **“Y+ arrow”** button

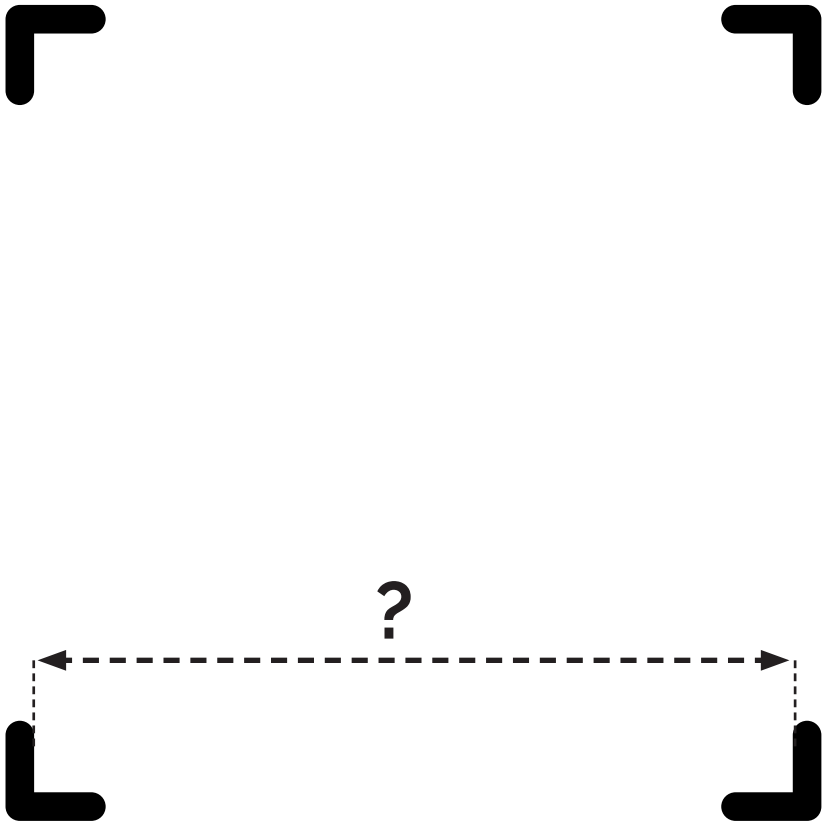
1. MEASUREMENTS

STEP #10 : MEASURING THE “X” LENGTH

1. Use a measuring tape or a ruler to measure the **“X” length**

TAKE YOUR TIME TO TAKE ACCURATE MEASUREMENTS, AS THEY WILL STRONGLY INFLUENCE THE CALIBRATION

PAY ATTENTION TO MEASURE THE INNER DIMENSION AS SHOWN ON THE DRAWING

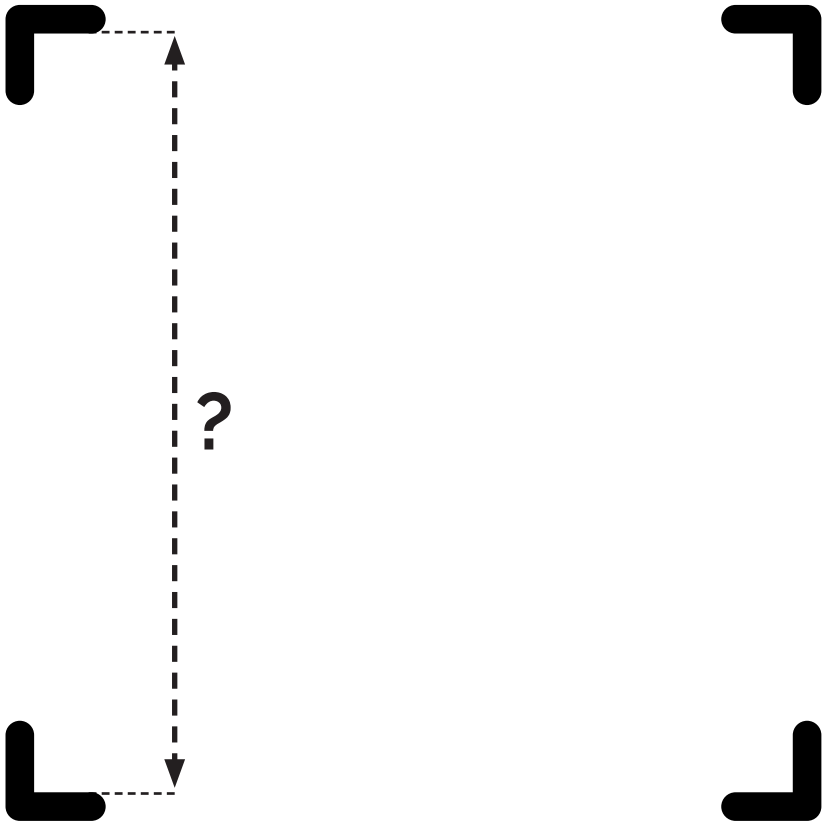


1. MEASUREMENTS

STEP #11 : MEASURING THE “Y” LENGTH

1. Use a measuring tape or a ruler to measure the **“Y” length**

PAY ATTENTION TO MEASURE THE INNER DIMENSION AS SHOWN ON THE DRAWING

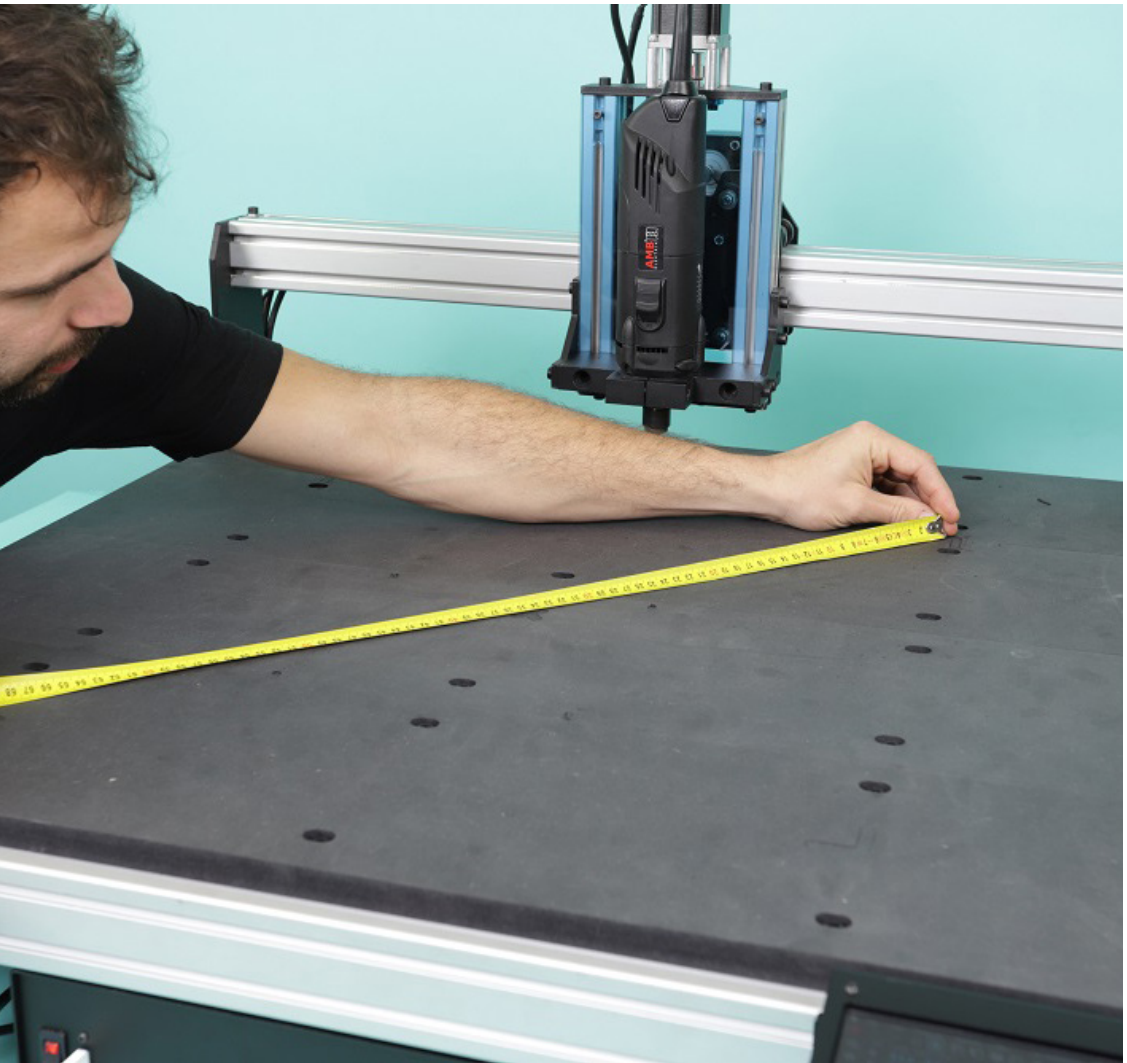


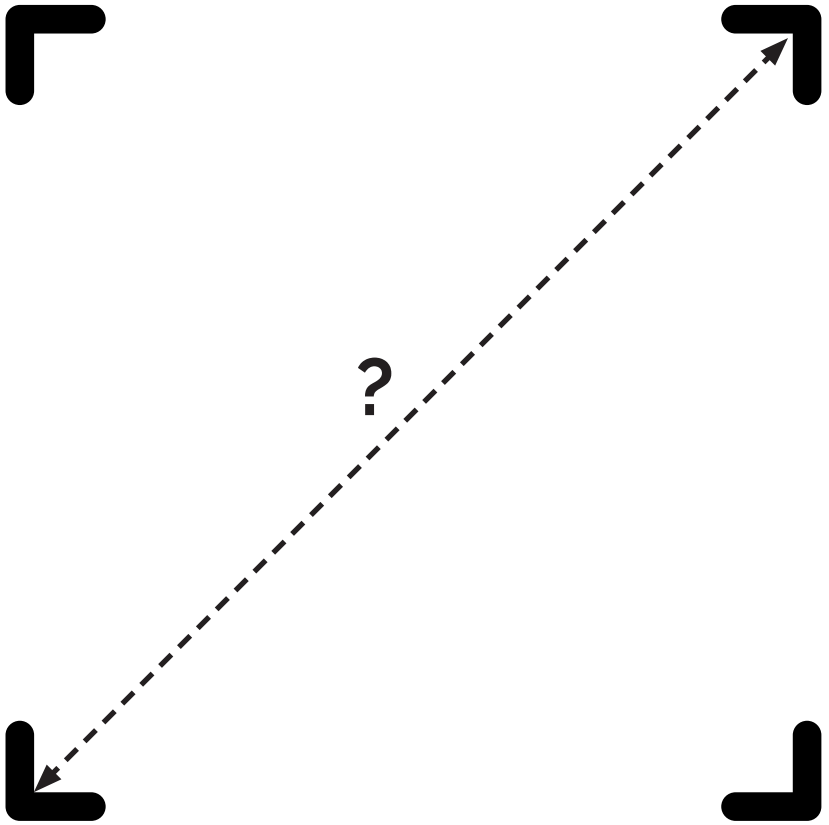
1. MEASUREMENTS

STEP #12 : MEASURING THE DIAGONAL 1

1. Use a measuring tape or a ruler to measure the **diagonal 1**

PAY ATTENTION TO MEASURE THE INNER DIMENSION AS SHOWN ON THE DRAWING

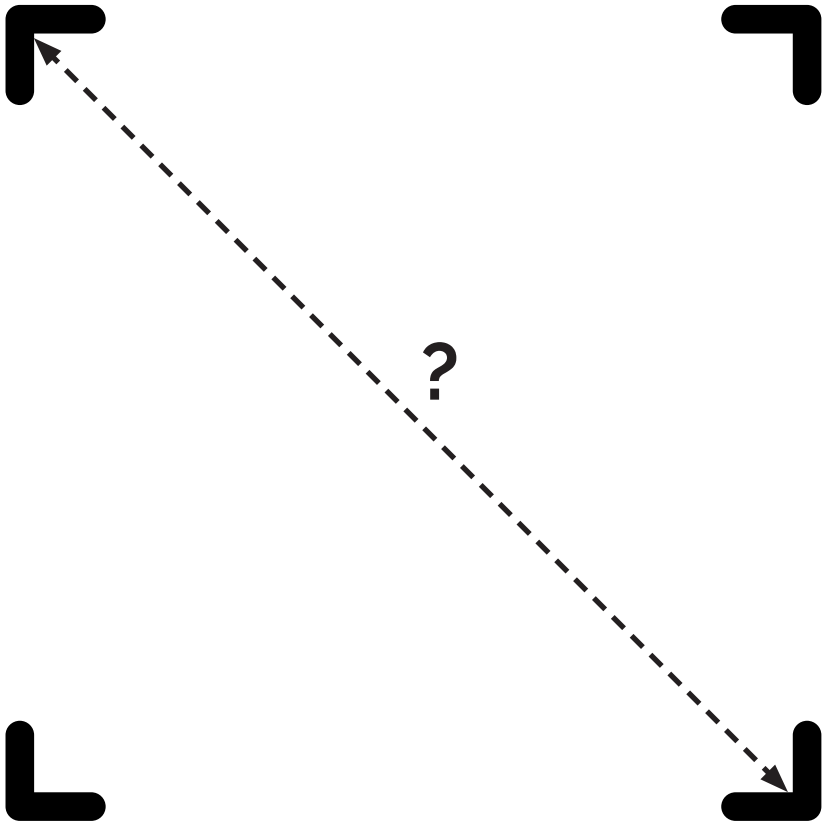




STEP #13 : MEASURING THE DIAGONAL 2

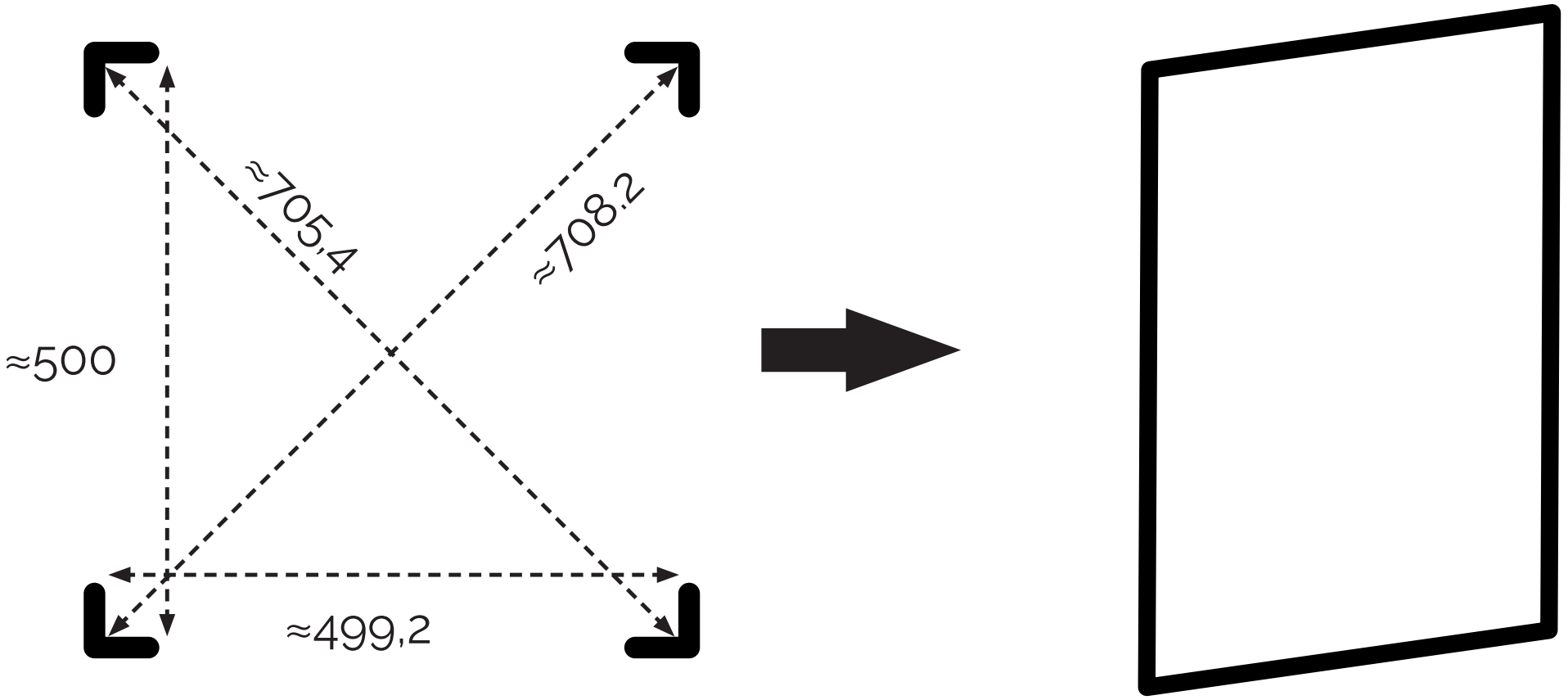
1. Use a measuring tape or a ruler to measure the **diagonal 2**

PAY ATTENTION TO MEASURE THE INNER DIMENSION AS SHOWN ON THE DRAWING



STEP #14 : DRAWING THE REAL GEOMETRY

1. Write down all the measured dimensions
2. Draw the real geometry of the machine and exaggerate the shape to emphasis the lengths and angles

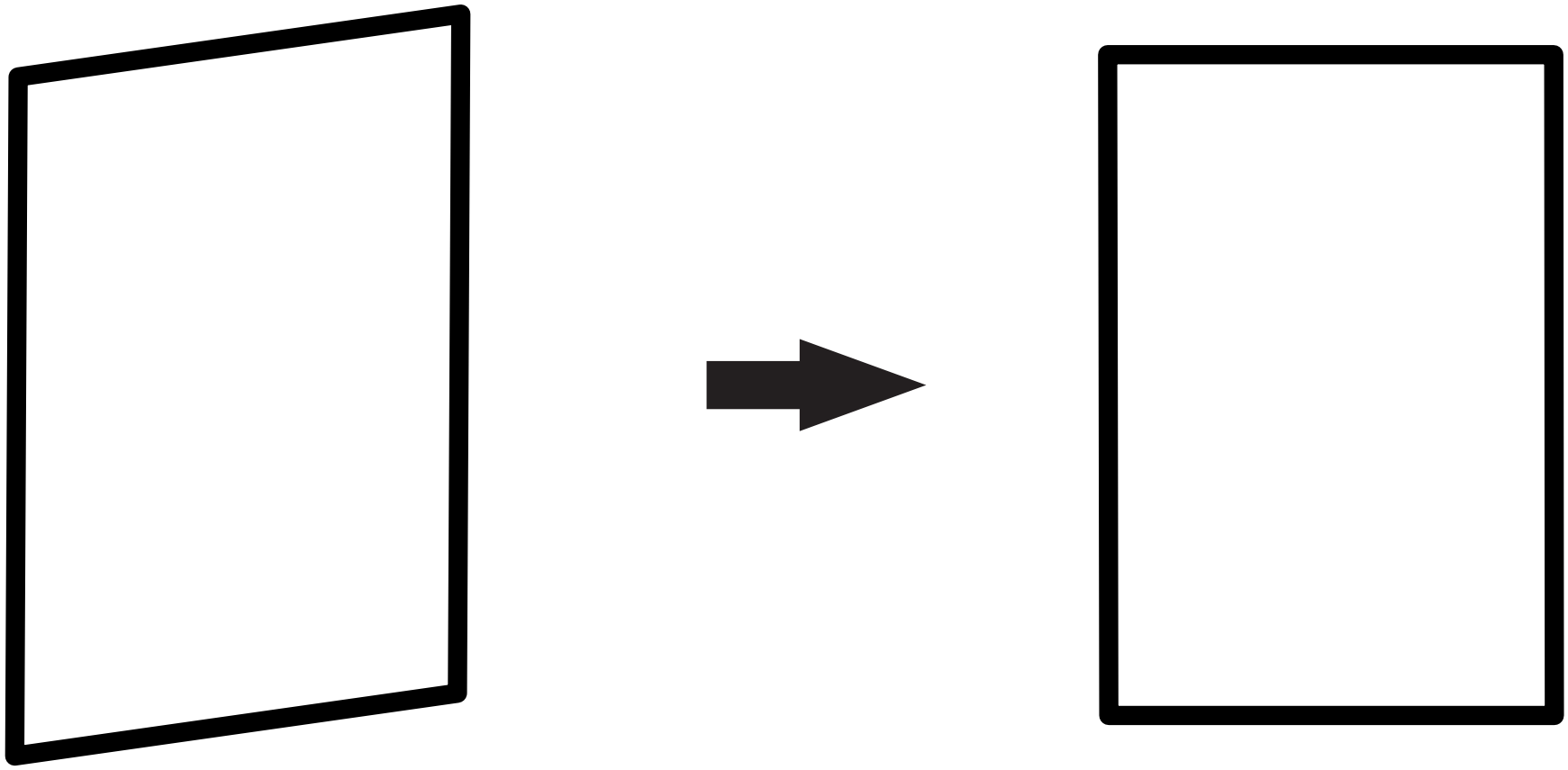


2. CALIBRATION

STEP #01 : FROM A PARALLELOGRAM TO A RECTANGLE

1. In this case, the first thing to do is to rectify the shape to obtain a rectangle

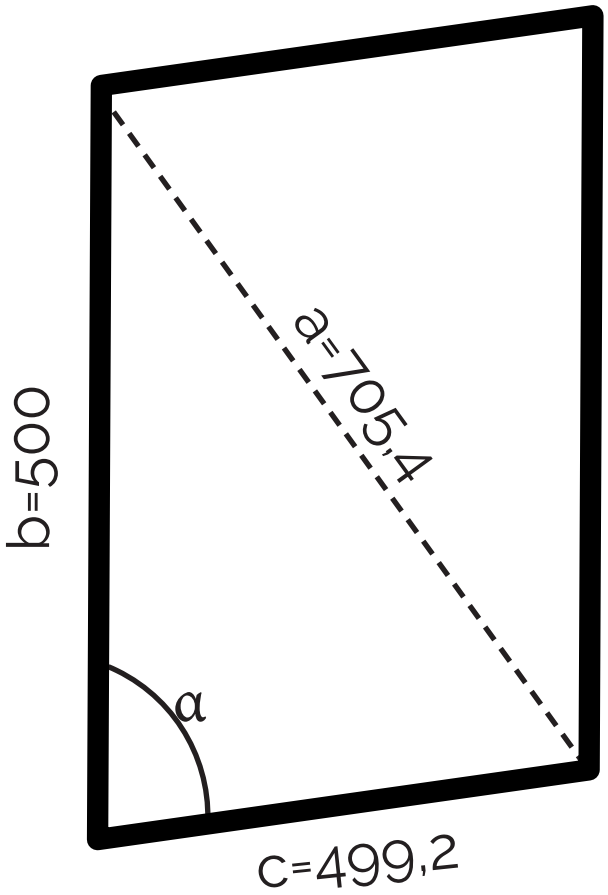
IF YOU MEASURED IDENTICAL DIAGONALS ON THE PREVIOUS STEP, GO STRAIGHT TO STEP#05



2. CALIBRATION

STEP #02 : MEASURING THE ANGLE

1. To be able to square this shape, we need to know its actual angles
2. Refer to the drawing and use [this online angle calculator]



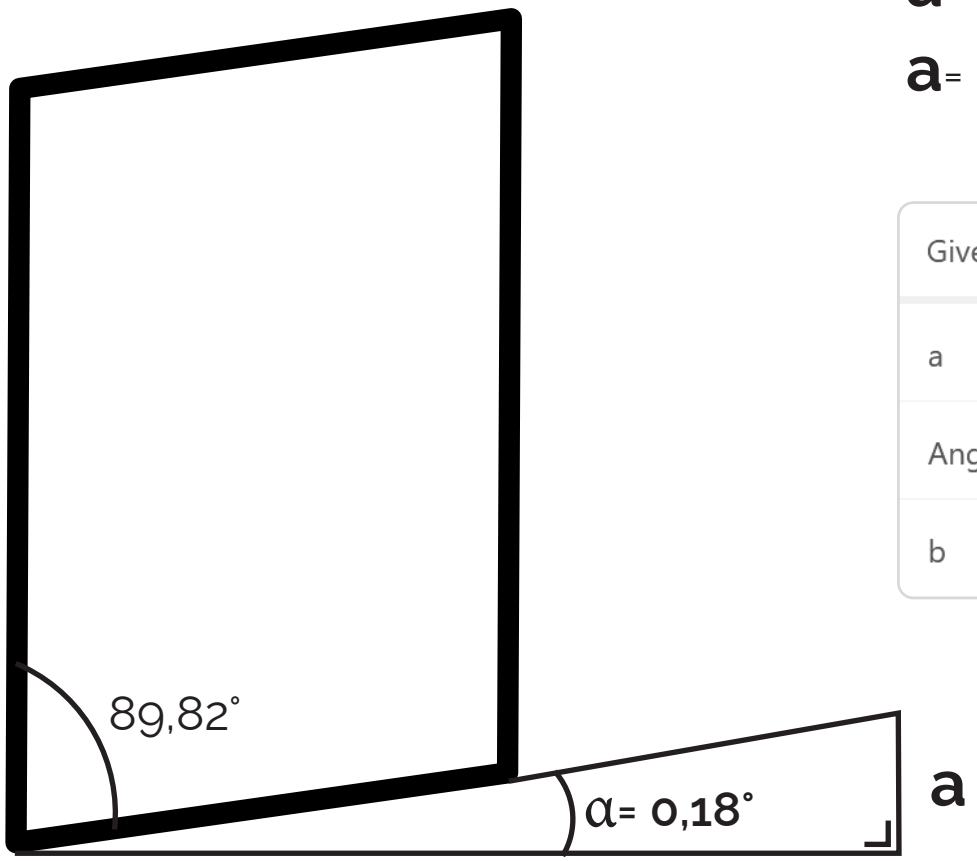
In our case:

$\alpha = 89{,}82^{\circ}$

Given	SSS (three sides)
Side a	705.4 mm
Side b	500 mm
Side c	499.2 mm
Angle α	89.82 deg

STEP #03 : MEASURING THE OFFSET DISTANCE

1. To rectify the angle, we need to know the offset distance
2. Refer to the drawing and use [this online calculator]



b = 699 (S,M)
= 1099 (L)

In our case:

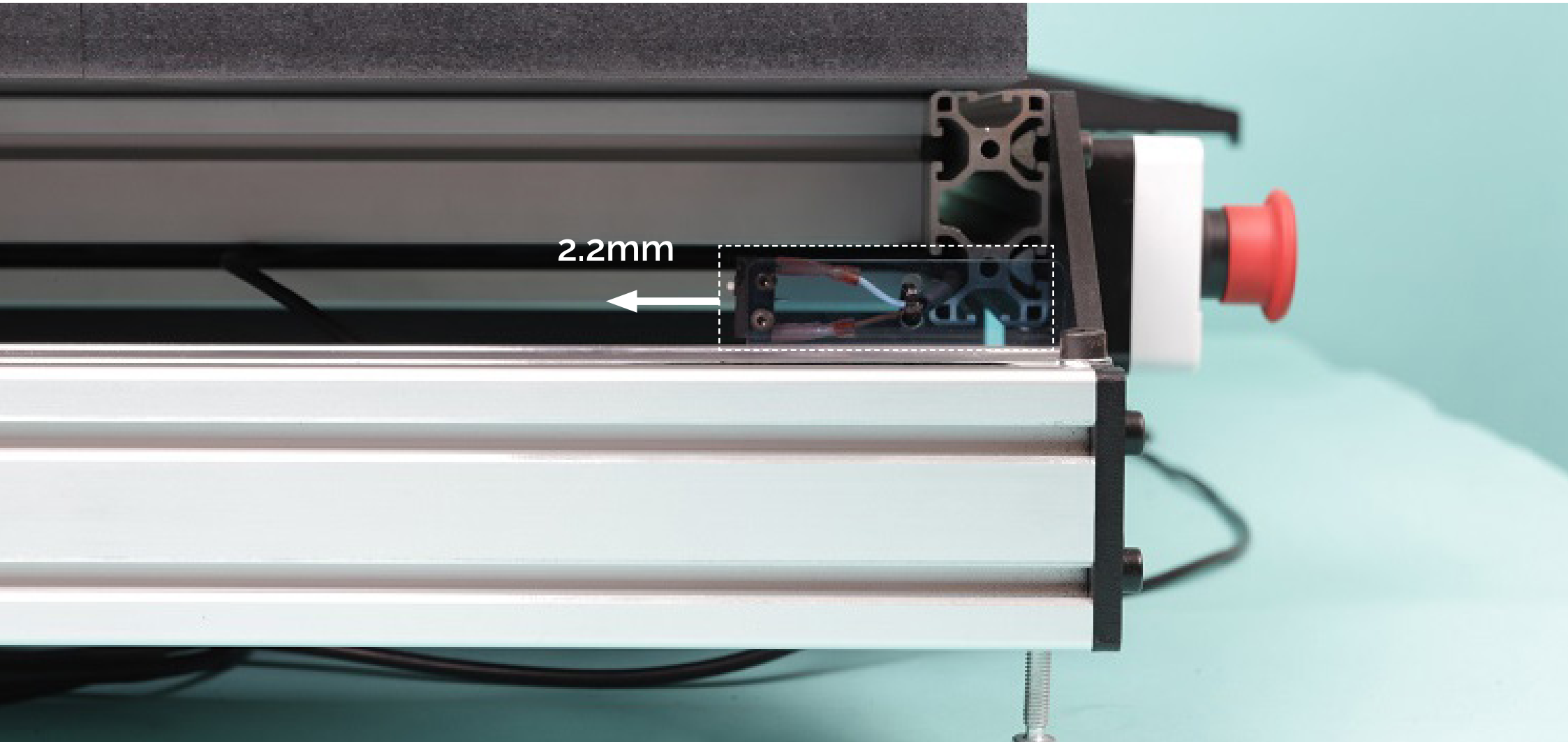
a= 2,2 mm (if EVO-S or -M)

a= 3,5 mm (if EVO-L)

Given	angle α and one side
a	2.196 mm
Angle α	0.18 deg
b	699 mm

STEP #04 : MOVING THE LIMIT SWITCH SUPPORT

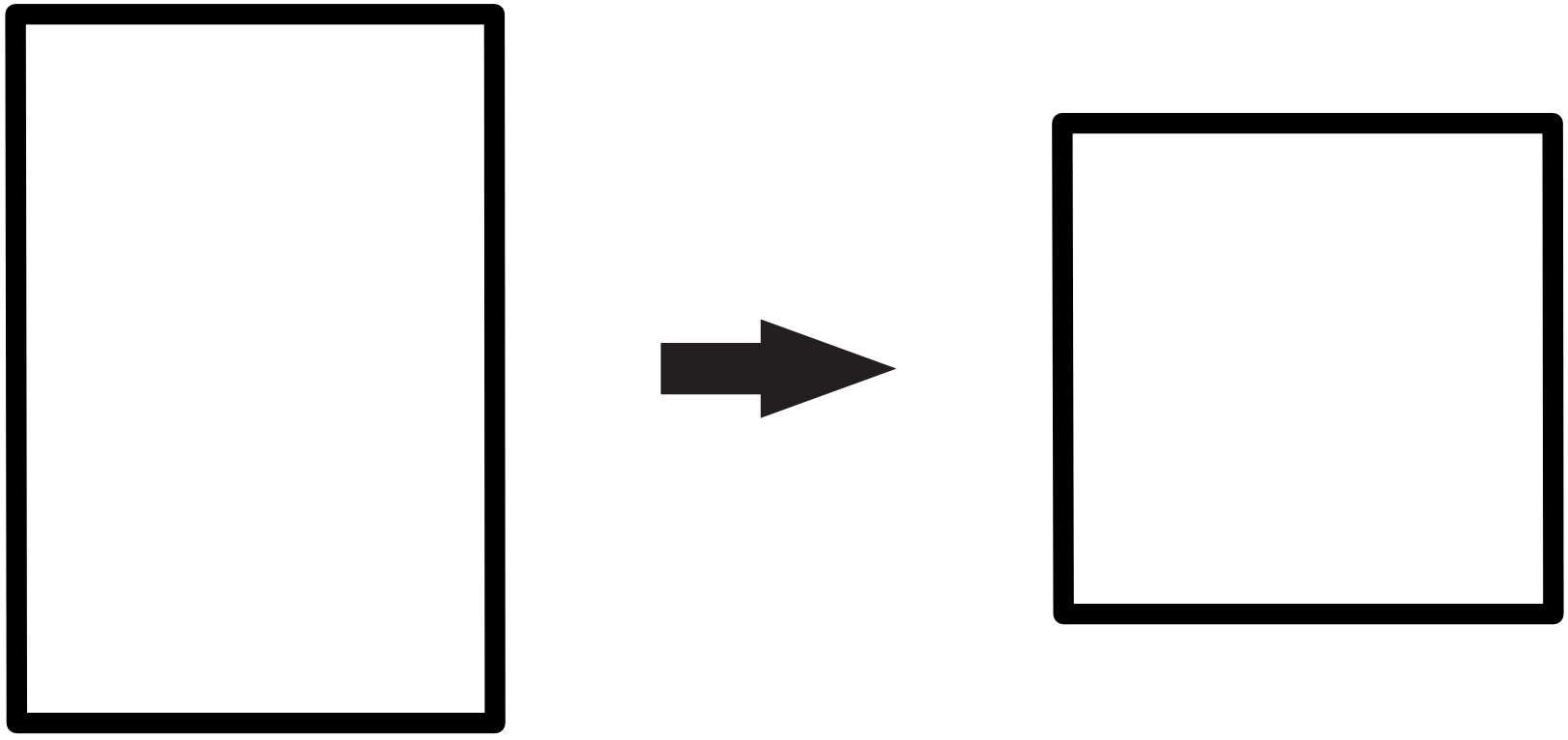
1. In this case, we need to move the Y1 limit switch support by 2,2mm
2. Take the 3mm hex key to unscrew the M4 screws and slide the acrylic plate easily



STEP #05 : FROM A RECTANGLE TO A SQUARE

1. The second thing to do is to rectify the shape to obtain a square

IF YOU MEASURED EXACTLY 500MM LENGTHS FOR X AND Y, GO STRAIGHT TO STEP#01 FROM CHAPTER 3

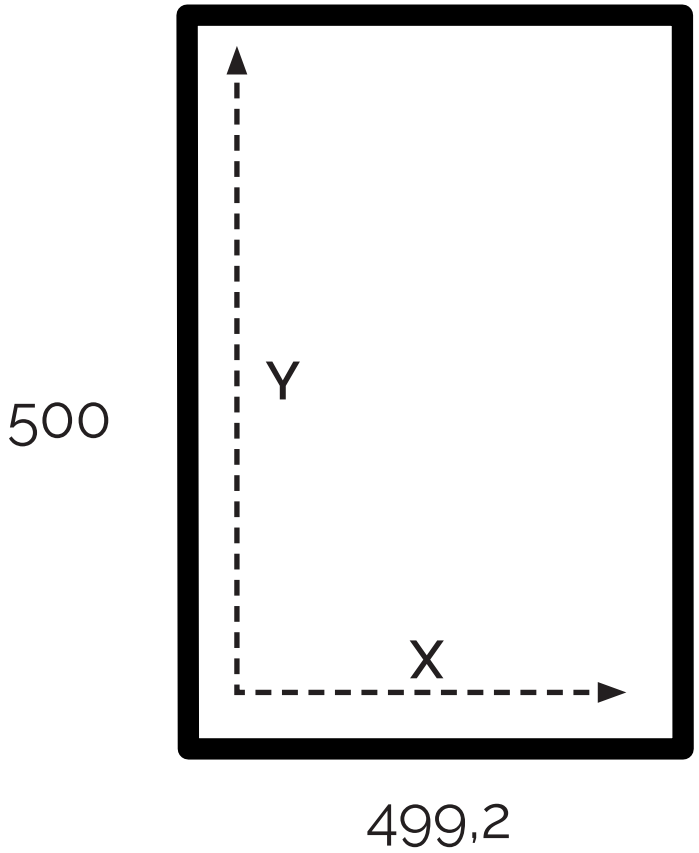


STEP #06 : CALCULATING A NEW STEPS/UNIT VALUE

During the assembly, you had to firmly tighten the belts to make sure that the they wouldn't slip while the machine is moving. Although that is very important for the machine to work properly, it can have a small negative effect on accuracy.

Indeed, **as you stretch the belt to tighten it, its real pitch becomes larger than the theoretical one**. That effect, combined with the fact that there might be a small tolerance error on the pitch of the pulley as well, can lead to a **positioning error.**

This issue can be very easily solved by changing a software setting: the **motors steps/unit** defined inside PlanetCNC. We can find how to change them with a simple formula, **using the X & Y measurements taken earlier.** In our case, only the X-axis needs to recalibrated, since the Y-axis measurement was exactly 500mm.



The **default motors steps/unit** value used on both the X & Y motors is: **160 steps/mm.**

To match to reality, we have to modify this value according to the following formula:

new_value = 160 * distance_reference / distance_measured

so in our case for the X-axis:

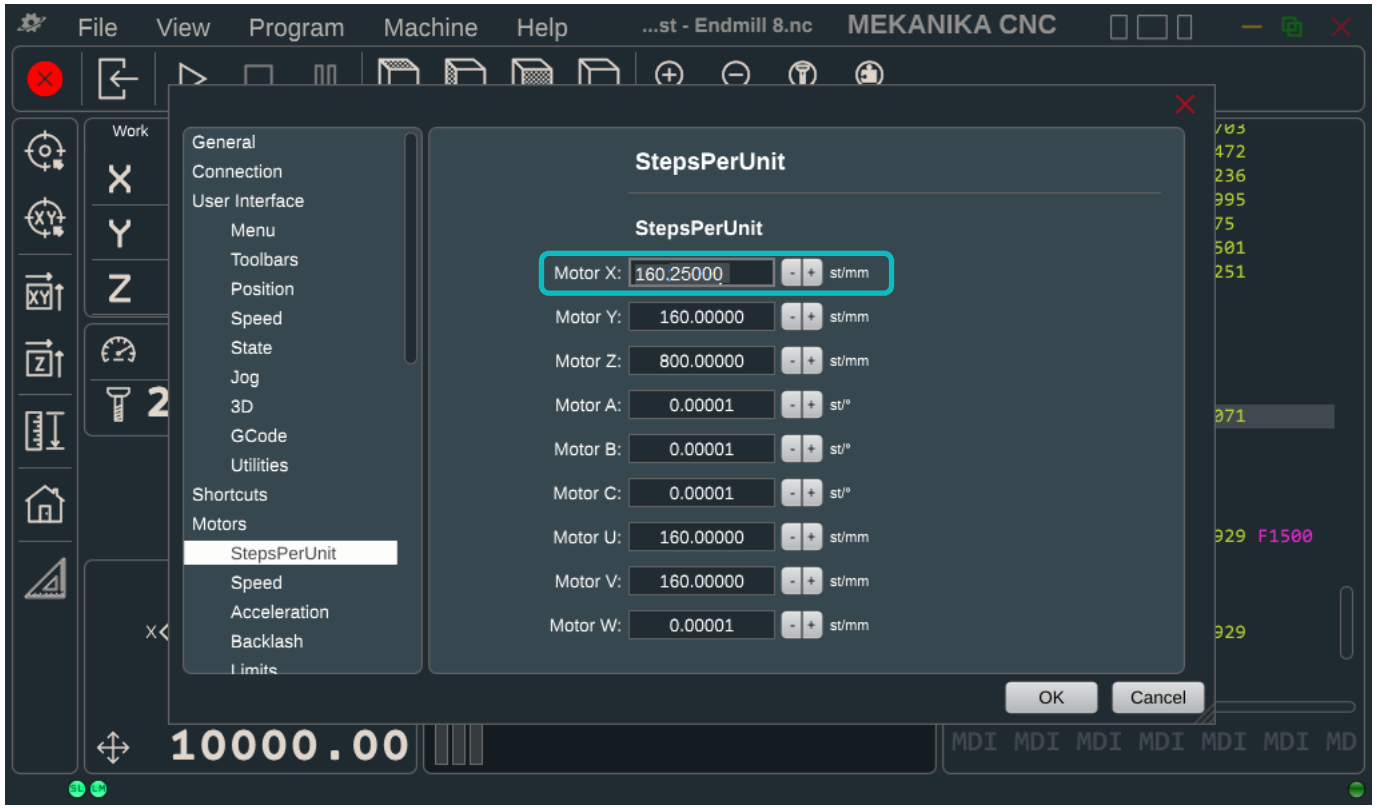
new_value_X = 160 * 500 / 499.2

new_value_X = 160.25

(do the same for the Y-axis if necessary)

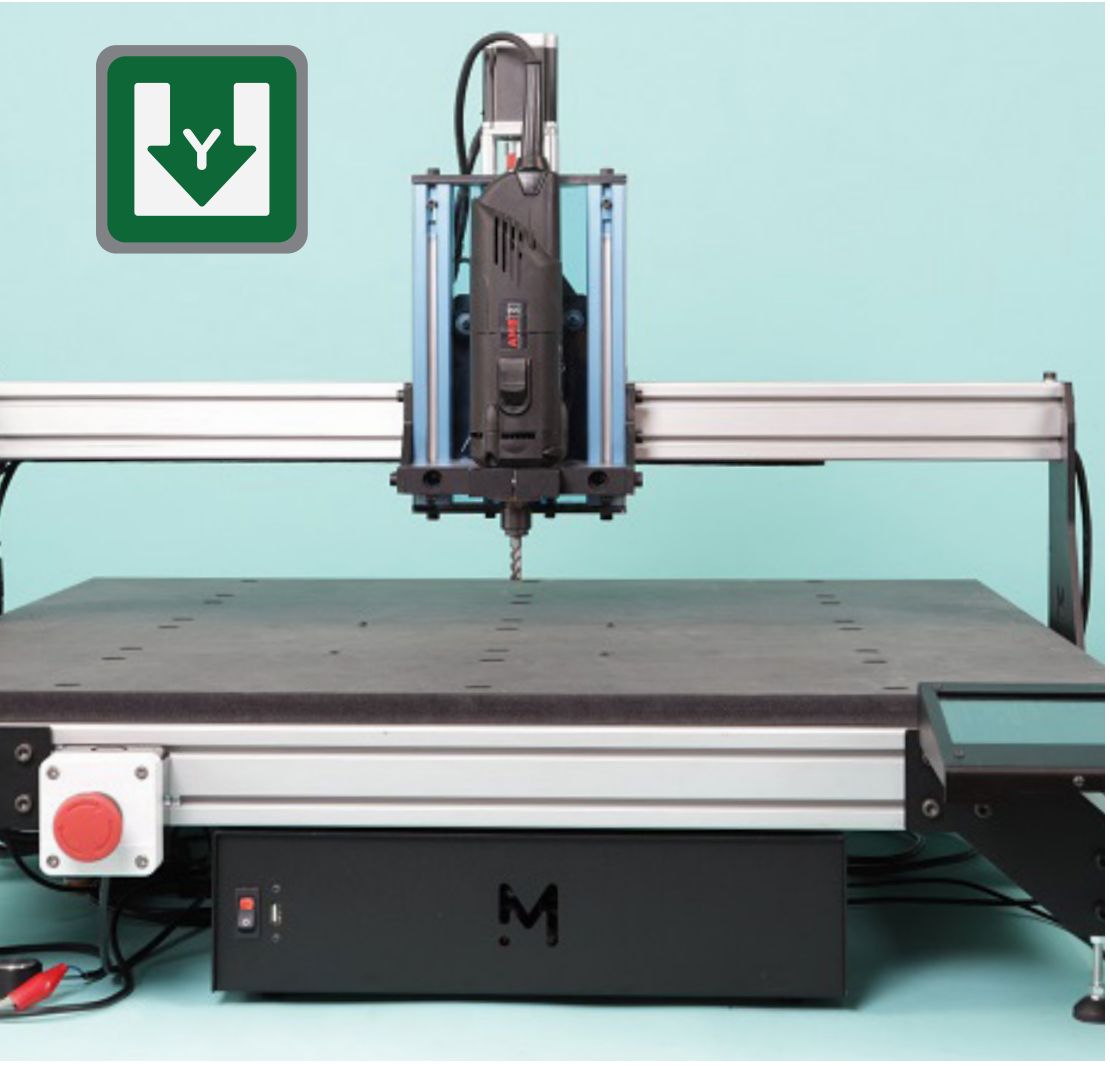
STEP #07 : MODIFICATION OF THE STEPS/UNIT VALUE

1. In PlanetCNC, navigate to **File -> Settings -> Motors -> StepsPerUnit**
2. Change the value of **Motor X** and **Motor Y** with the values that you found.



STEP #08 : VERIFICATIONS

1. Move the machine to the front
2. Press the "**Square Gantry**" button

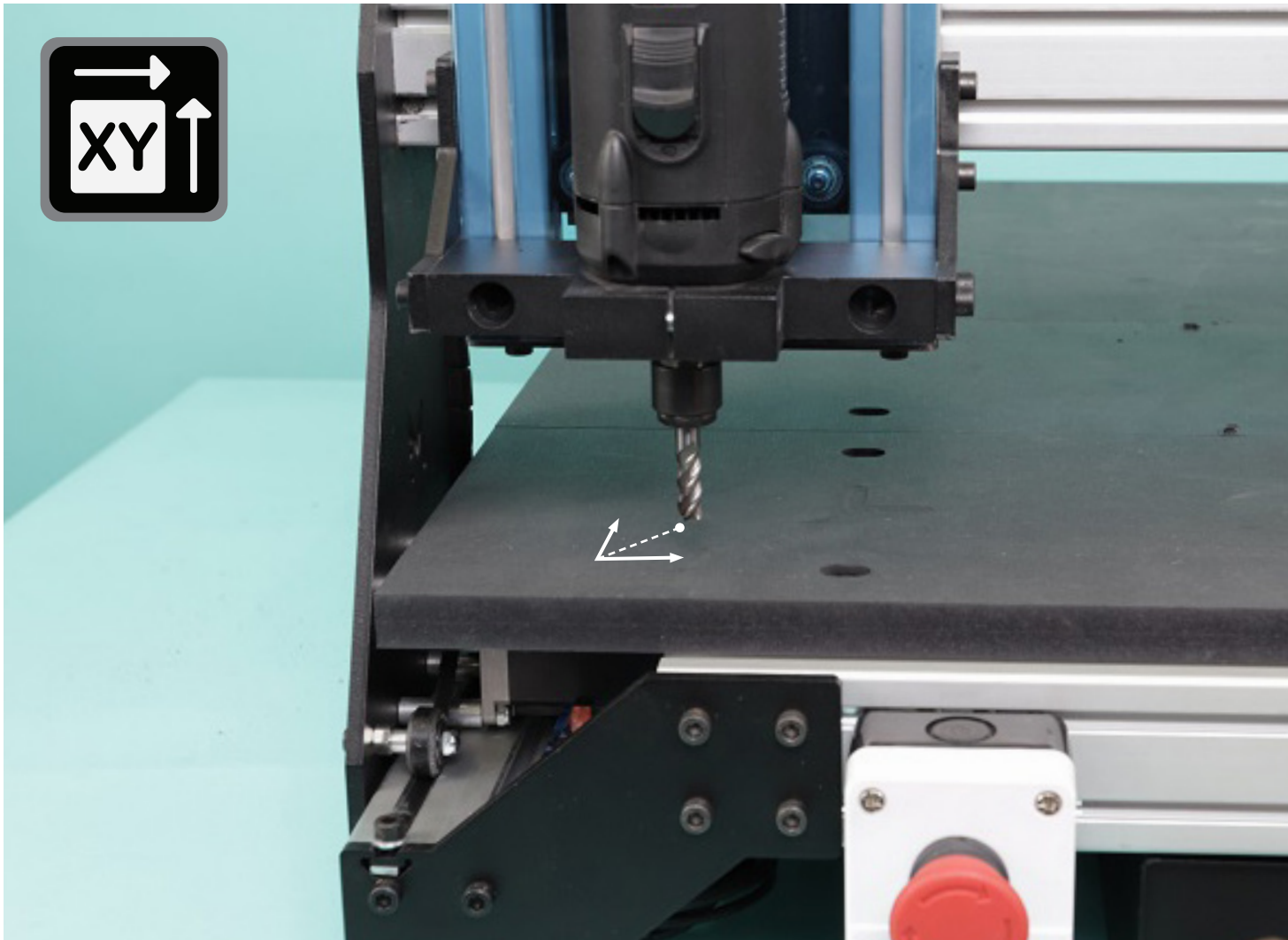


STEP #09 : OFFSET OF THE WORKING COORDINATES

1. Type "**G0 X20 Y20**" in the Planet CNC console and press **"Enter"**
2. Press the "**XY**"button

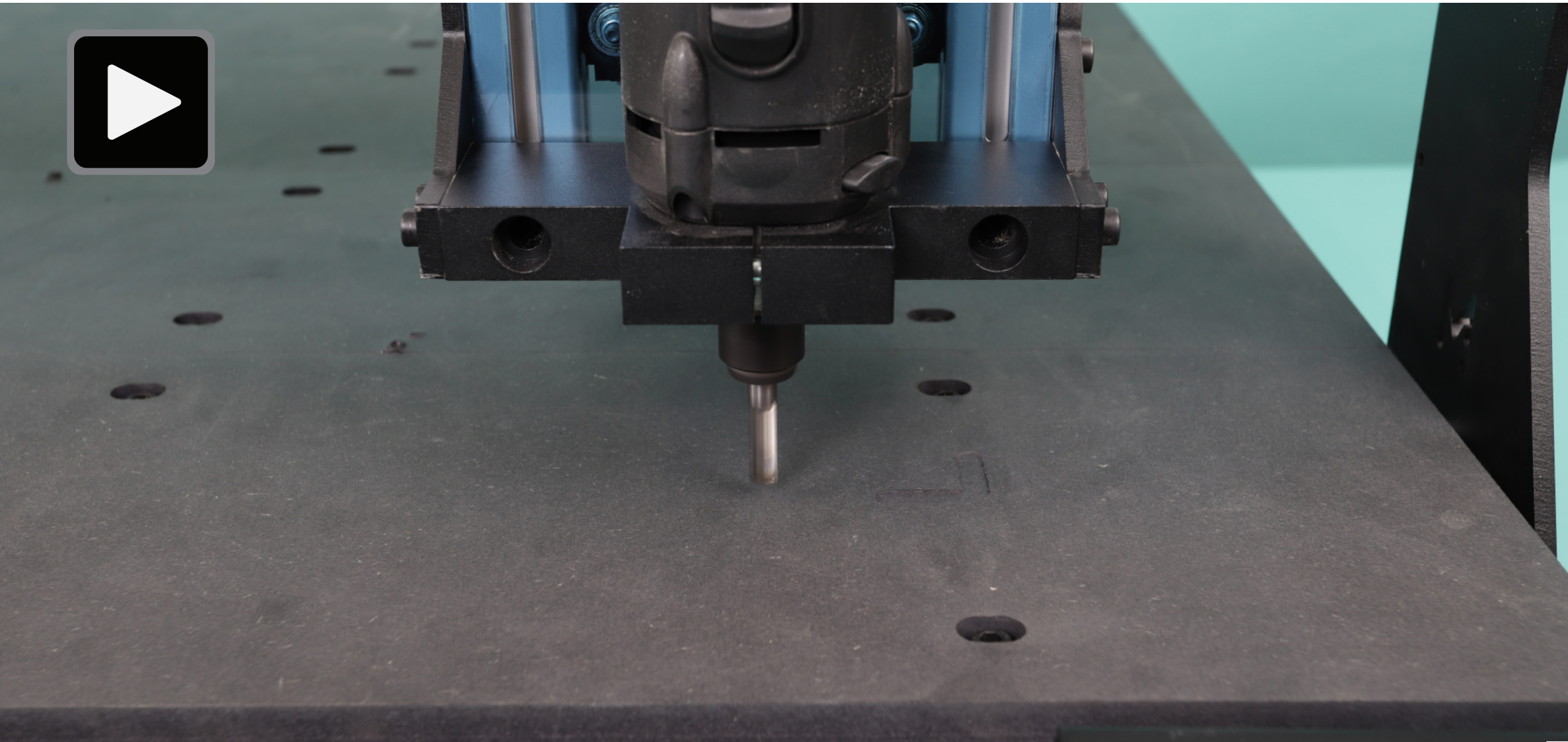
```
116: N111 X556.472 Y569.719
117: N112 X556.703 Y569.619
118: N113 X556.927 Y569.505
119: N114 X557.143 Y569.377
120: N115 X557.351 Y569.236
121: N116 X557.55 Y569.082
122: N117 X557.738 Y568.916
123: N118 X557.916 Y568.738
124: N119 X558.082 Y568.55
125: N120 X558.236 Y568.351
126: N121 X558.377 Y568.143
127: N122 X558.505 Y567.927
128: N123 X558.619 Y567.703
129: N124 X558.719 Y567.472
130: N125 X558.804 Y567.236
131: N126 X558.874 Y566.995
132: N127 X558.929 Y566.75
133: N128 X558.968 Y566.501
134: N129 X558.992 Y566.251
135: N130 X559 Y566
136: N131 Y556
137: N132 G0 Z15
138: N133 M9
139: N134 M5
140: N135 M0
141: %
```

G0 X20 Y20



STEP #10 : MILLING

1. **Switch on the spindle**
2. Press the **“Play”** button



2. CALIBRATION

STEP #11 :MEASUREMENTS VERIFICATIONS

1. Measure the lengths “**X**” and “**Y**”
2. Measure the **diagonals**
3. According to the measurements, go back to **STEP#01** or go to the next chapter “Tramming the spindle”
4. Repeat until you find the right values in the end




3.TRAMMING THE SPINDLE

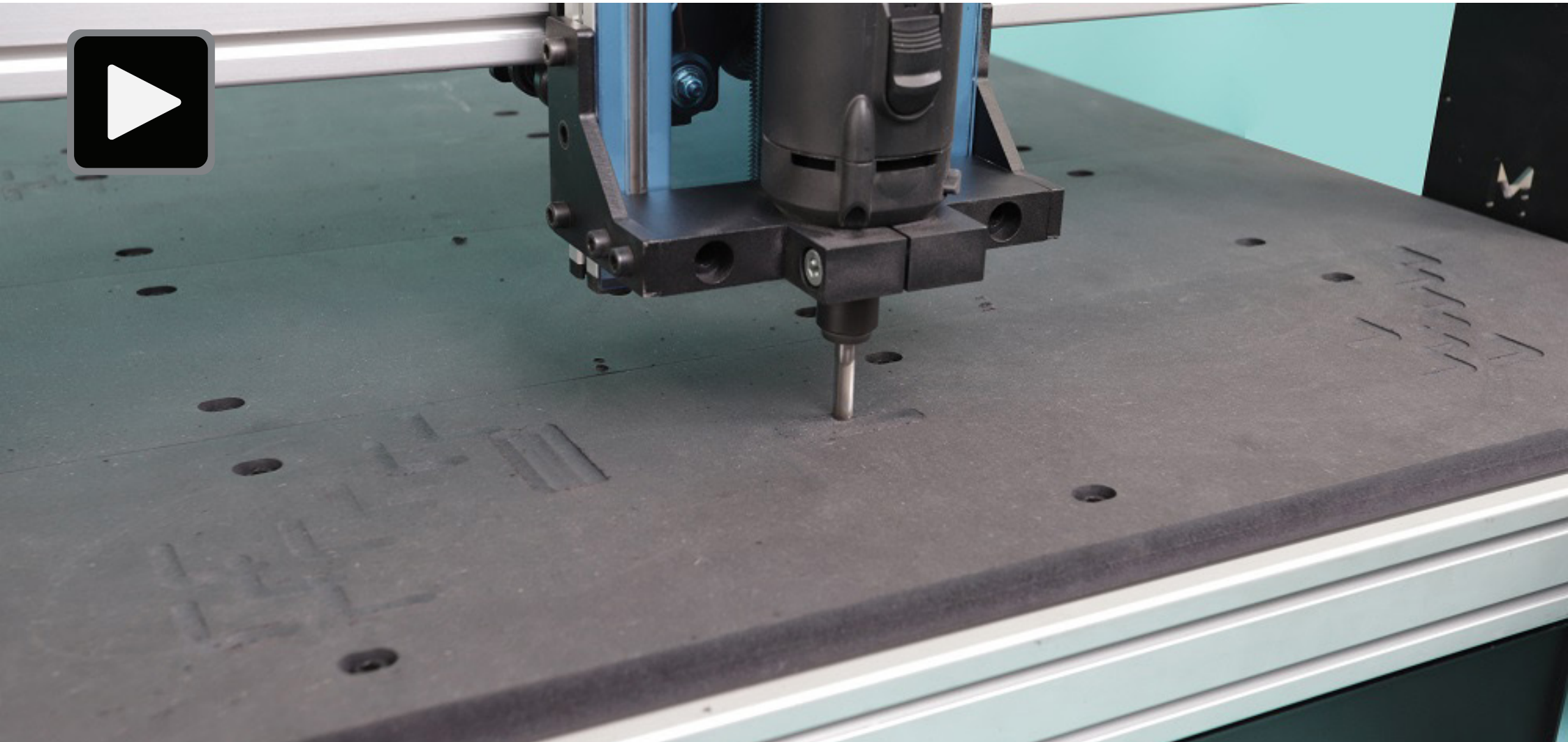
STEP #01 : LOADING THE G-CODE

1. Press the **“Open G-code”** button
2. Open the **“Spindle test”**

3.TRAMMING THE SPINDLE

STEP #02 : MILLING

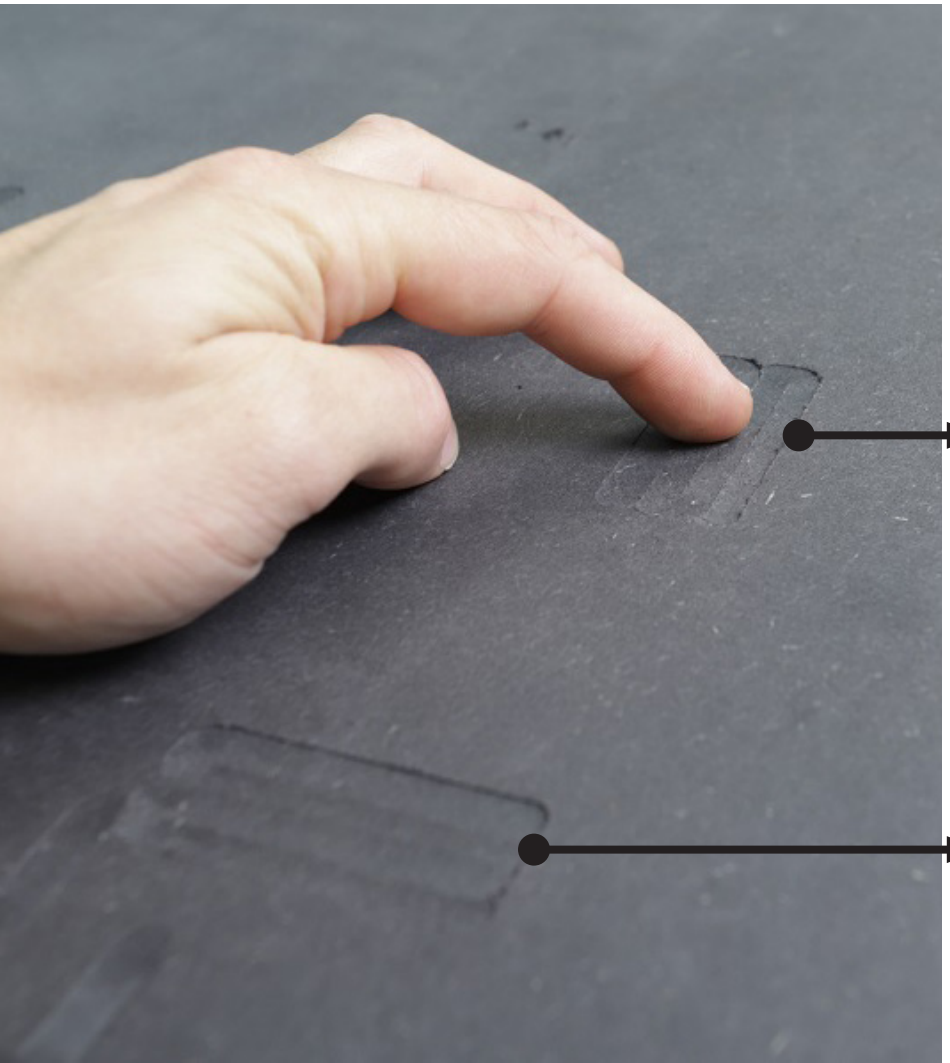
1. **Switch on the spindle**
2. Press the **“Play”** button

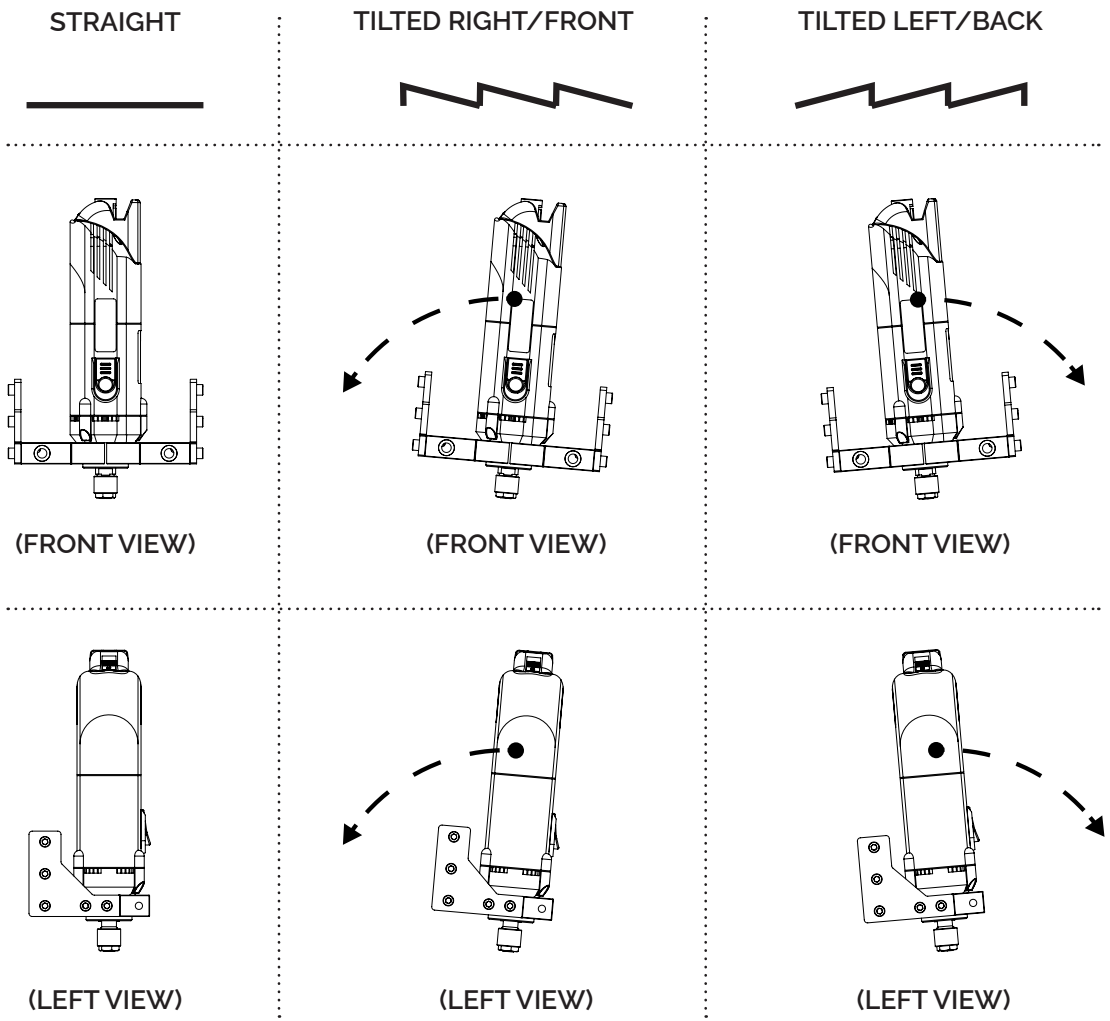


3.TRAMMING THE SPINDLE

STEP #03 : ANGLE VERIFICATION

1. With your finger tip, identify if the surface is flat or bumpy.
2. Refer to the table to identify in which direction you have to tram your spindle (we purposely exaggerated the tilt for more clarity)

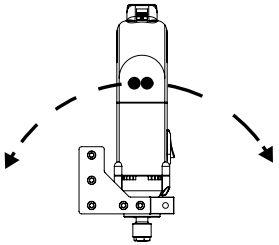




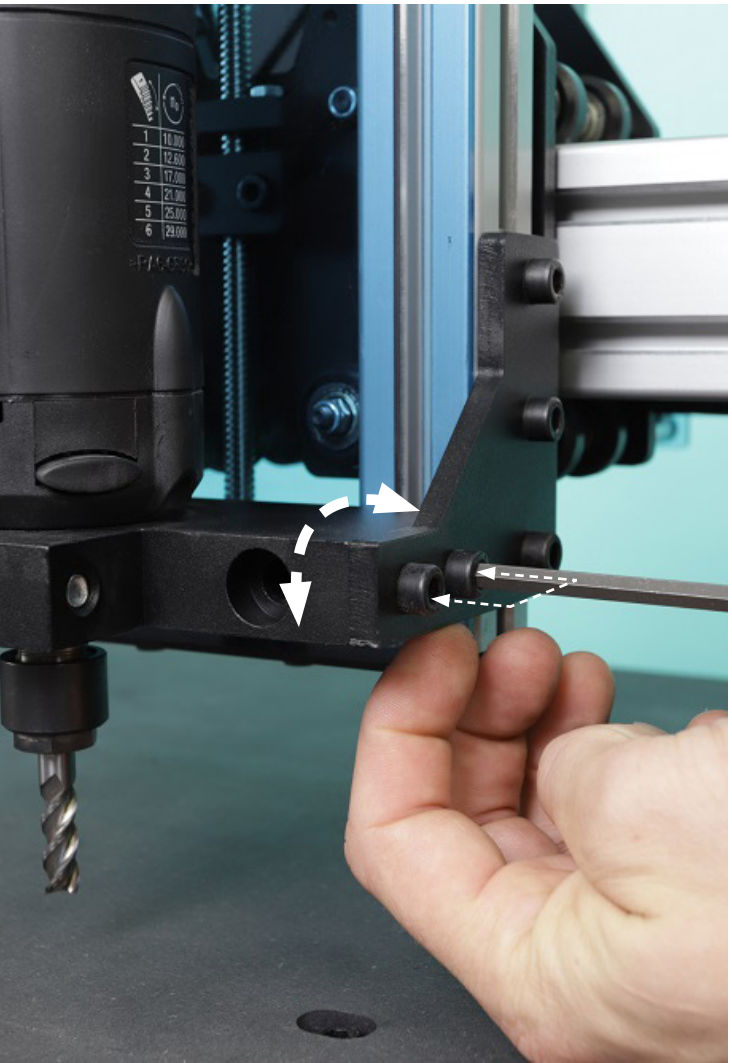
3.TRAMMING THE SPINDLE

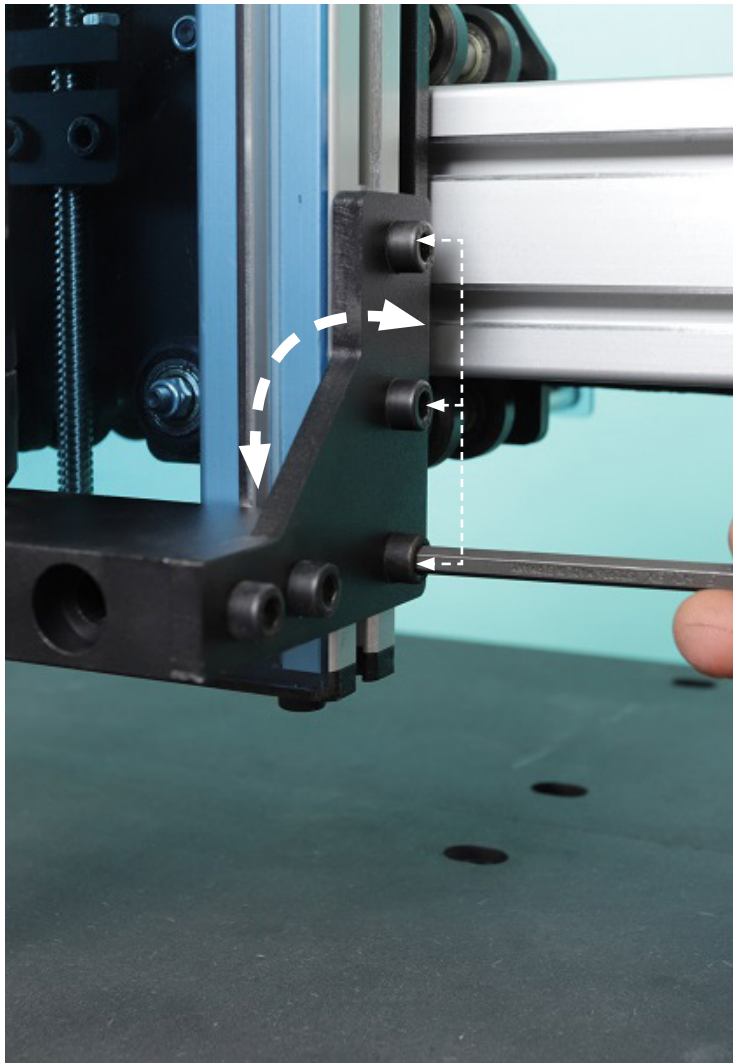
STEP #04 : TRAMMING THE SPINDLE ACCORDING TO THE X AXIS

There are three possibilities to tram the spindle according to the X axis, try them in the following order:



1. Play with the screws of the AMB support
2. Play with the screws of the specific part “spindle support”
3. Play with the screws of the aluminium profile of the gantry



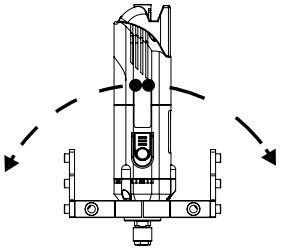


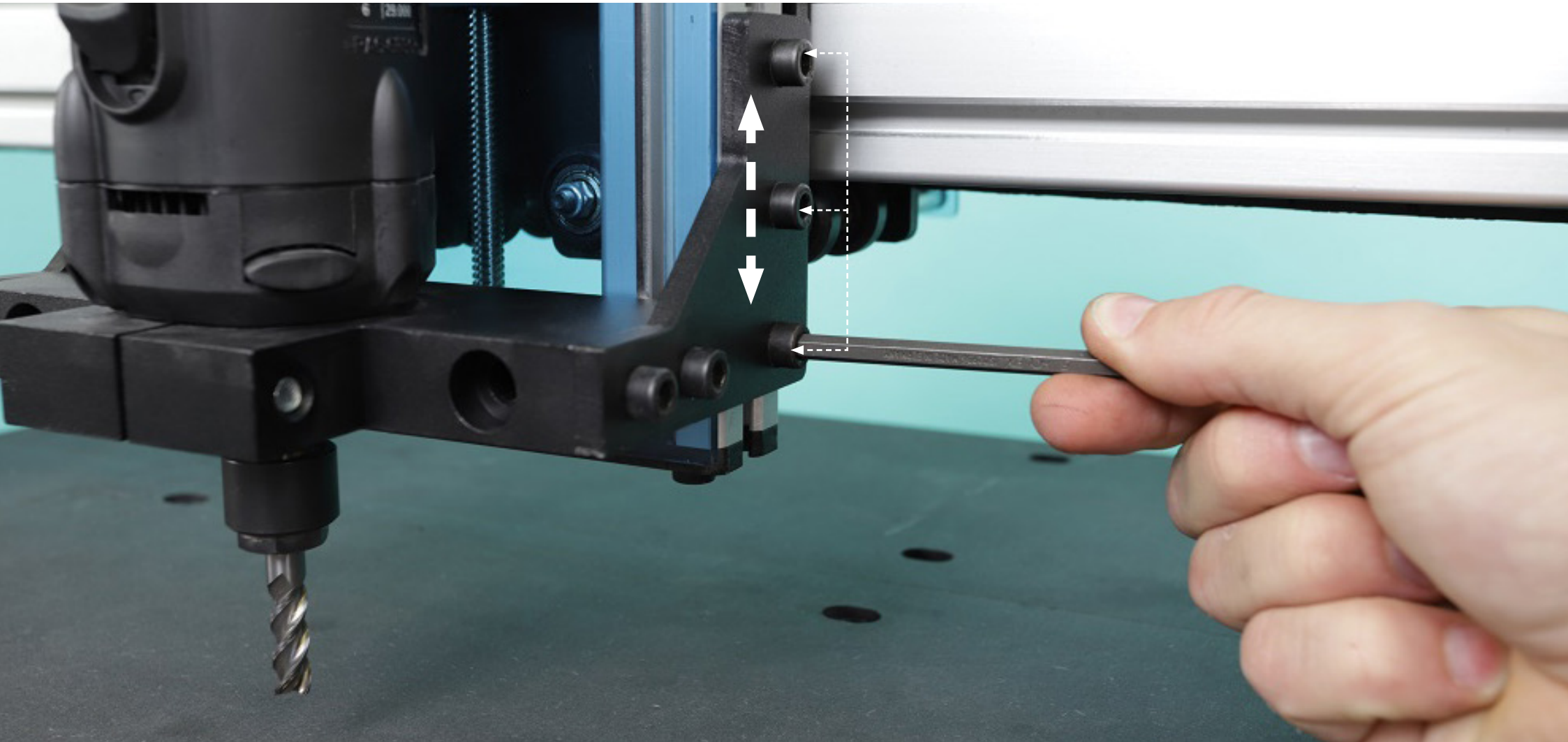
3.TRAMMING THE SPINDLE

STEP #05 : TRAMMING THE SPINDLE ACCORDING TO THE Y AXIS

There is one possibility to tram the spindle according to the Y axis :

1. Play with the screws of the specific part “spindle support”





3.TRAMMING THE SPINDLE

STEP #06 : OFFSET OF THE WORKING COORDINATES

1. Type “**G0 X20 Y20**” in the Planet CNC console and press “Enter”
2. Press the “**XY**”button

```
116: N111 X556.472 Y569.719
117: N112 X556.703 Y569.619
118: N113 X556.927 Y569.505
119: N114 X557.143 Y569.377
120: N115 X557.351 Y569.236
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131: N126 X558.874 Y566.995
132: N127 X558.929 Y566.75
133: N128 X558.968 Y566.501
134: N129 X558.992 Y566.251
135: N130 X559 Y566
136: N131 Y556
137: N132 G0 Z15
138: N133 M9
139: N134 M5
140: N135 M0
141: %
```
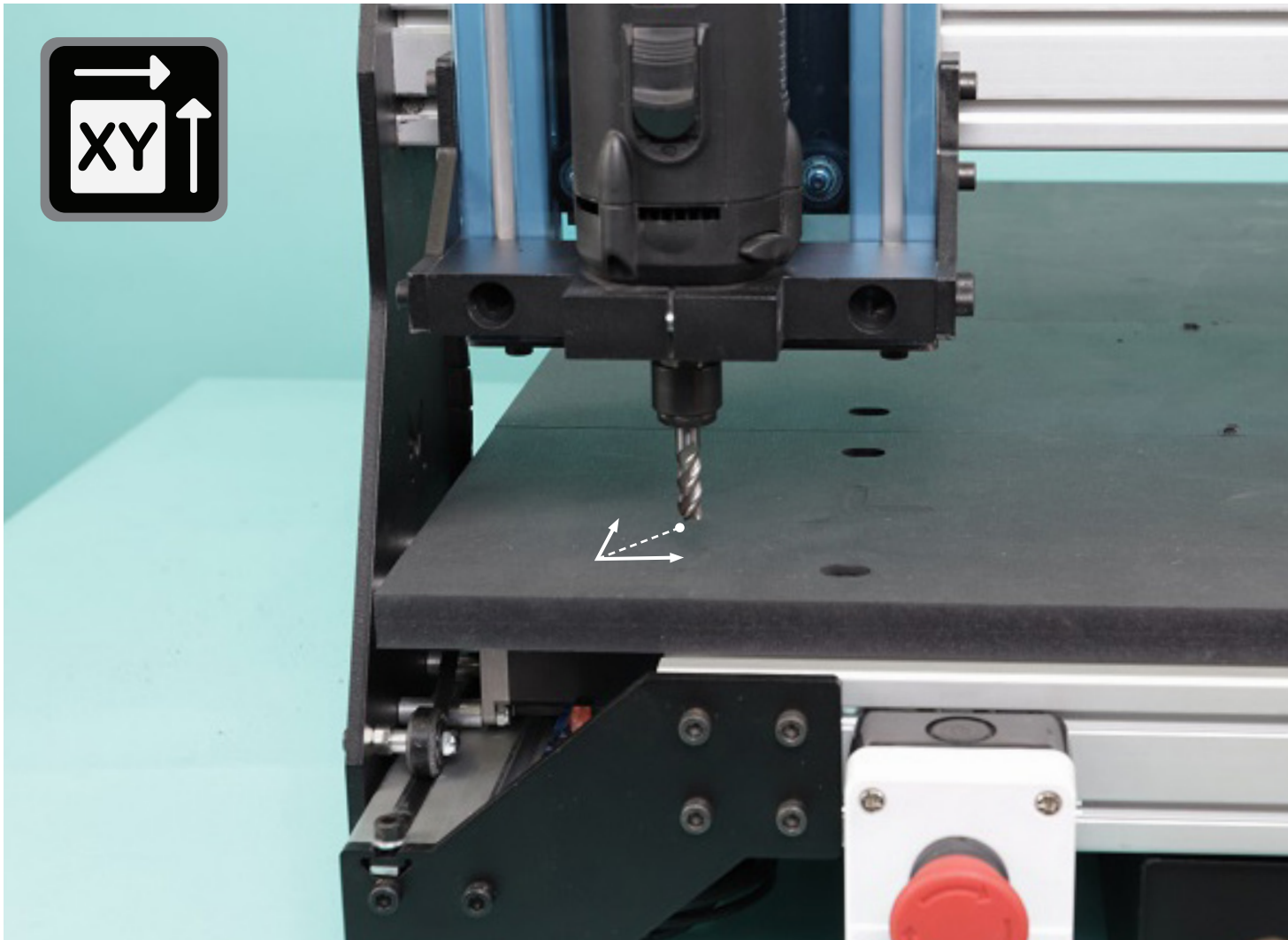
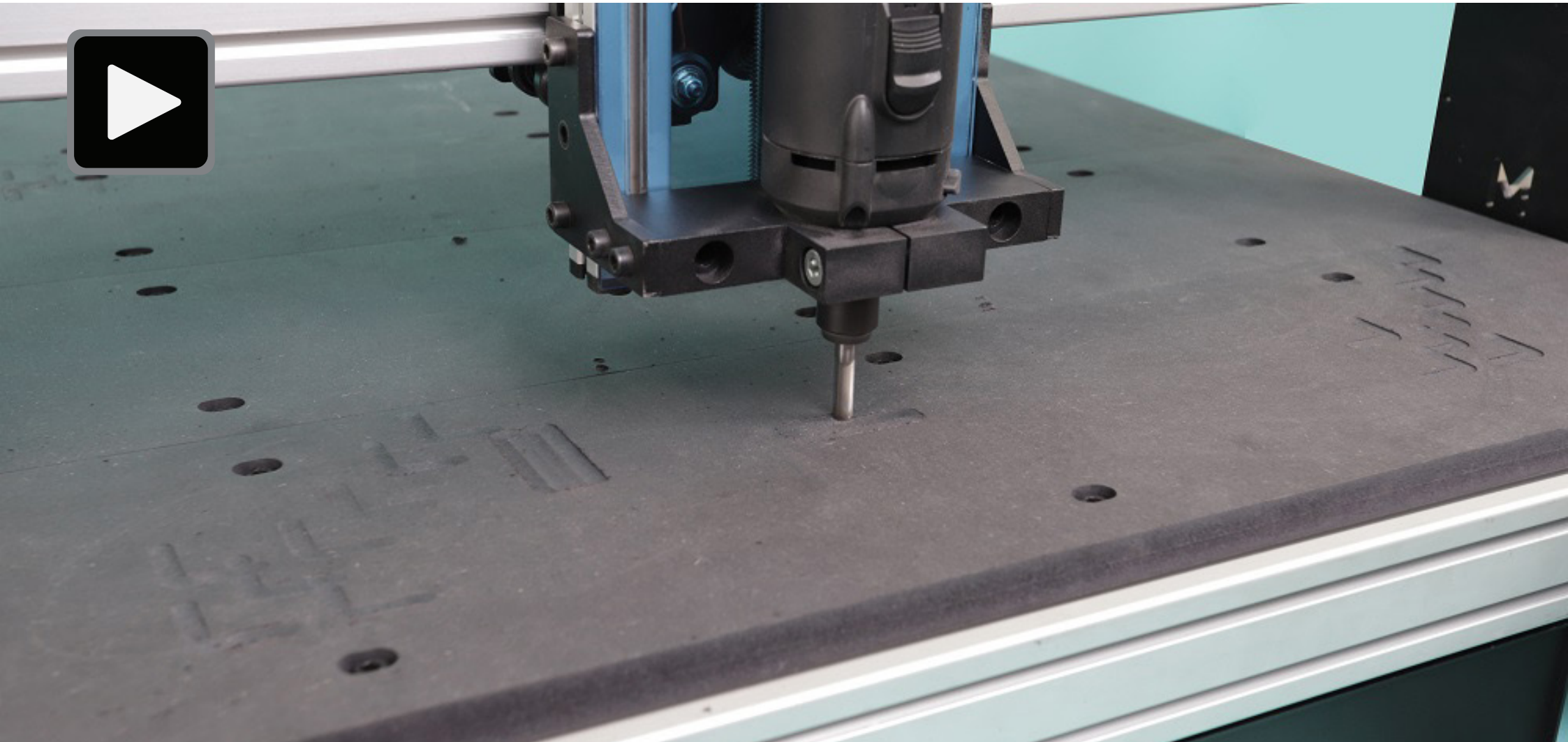

G0 X20 Y20



3.TRAMMING THE SPINDLE

STEP #07 : MILLING

1. **Switch on the spindle**
2. Press the **“Play”** button



3.TRAMMING THE SPINDLE

STEP #08 : ANGLE VERIFICATION

1. With your finger tip, identify if the surface is flat or bumpy.
2. According to the surface, go back to **STEP#01**