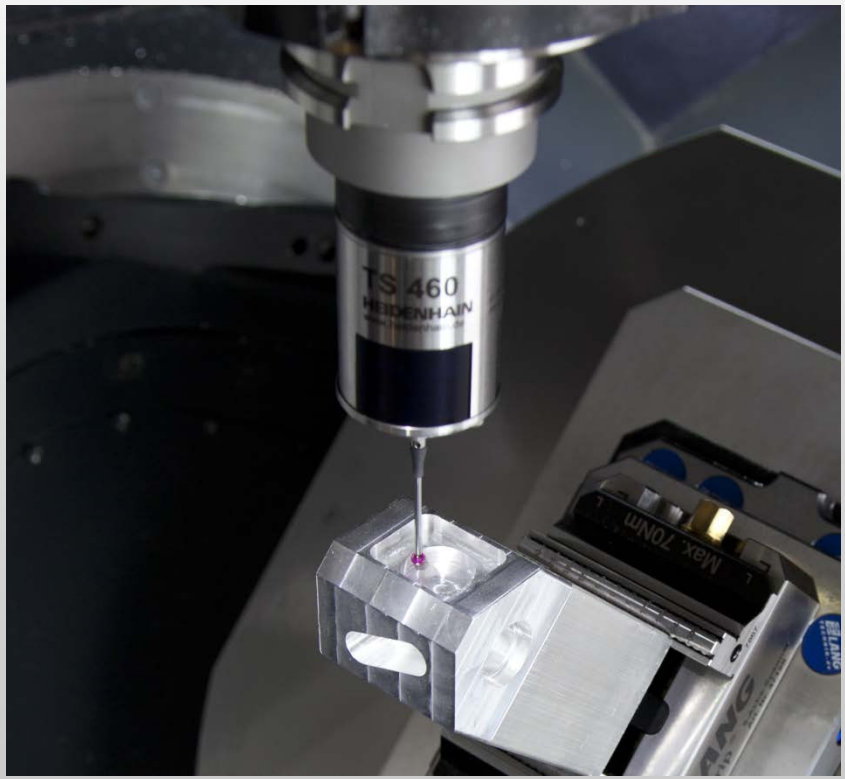
HEIDENHAIN

Aligning an Inclined Plane



Instructor: Michael Wiendl

Company: Dr. Johannes HEIDENHAIN GmbH
Position: Trainer for NC Programming

Align the Plane

Exercise

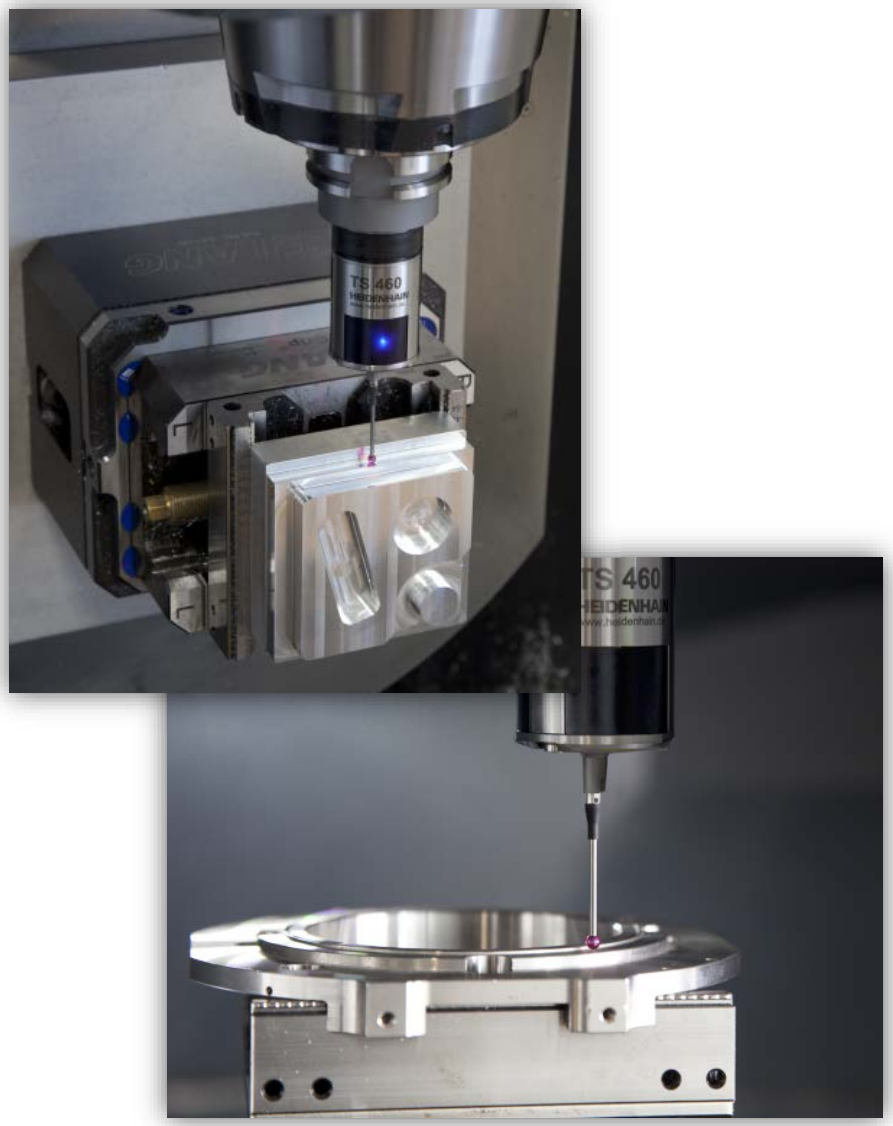
- Workpiece must be reworked
- Workpiece should also be aligned to a plane

Solution 1

- PROBING PL (manual operation)
- Machine with two rotary axes
- 3-D touch probe or mechanical touch probe

Solution 2

- Probing Cycle 431
- Machine with two rotary axes
- 3-D touch probe



HEIDENHAIN

Aligning a Plane

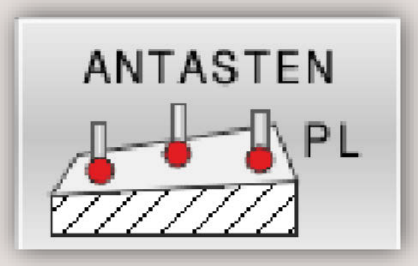
Manual Operation

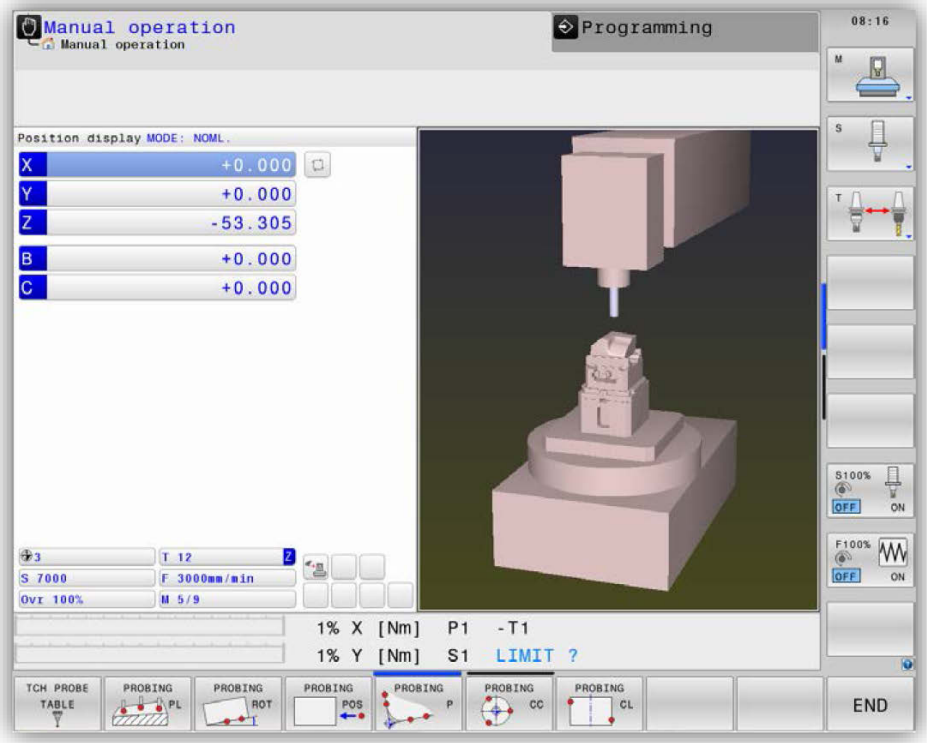
TNC 620/640

Align Plane with Probing Function

Used for:

- Inserting a touch probe
- Manual Operation
  - Probing functions
  - Probing PL (PL = plane)





Align Plane with Probing Function

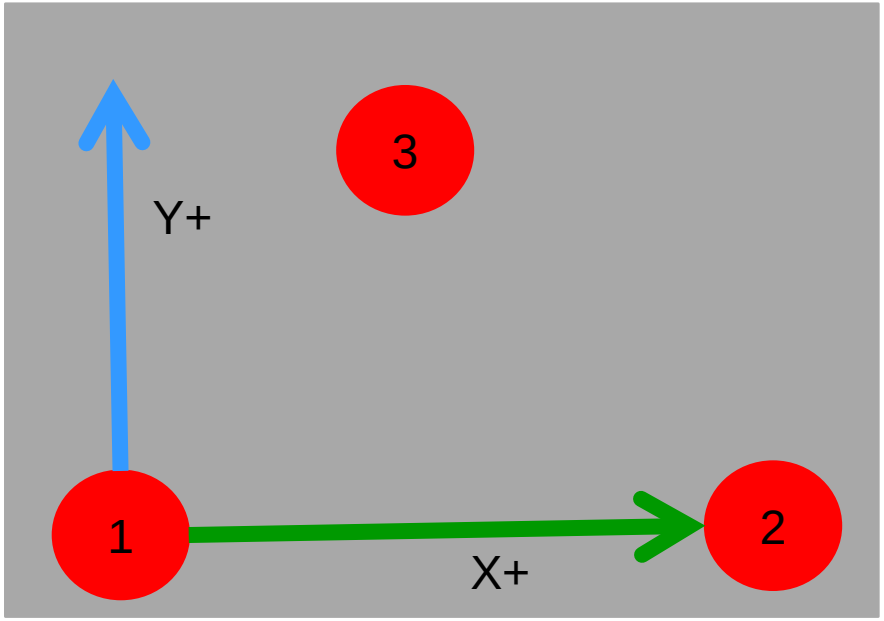
Arrangement of measured points

- Point 1 → Point 2
  Alignment in positive X axis

- Point 3
  Alignment in positive Y axis

Note:

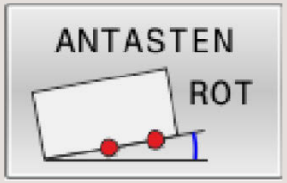
Point 3 must be above points 1 and 2, otherwise the alignment is not correct.



Align Plane with Probing Function

Align X+ axis:

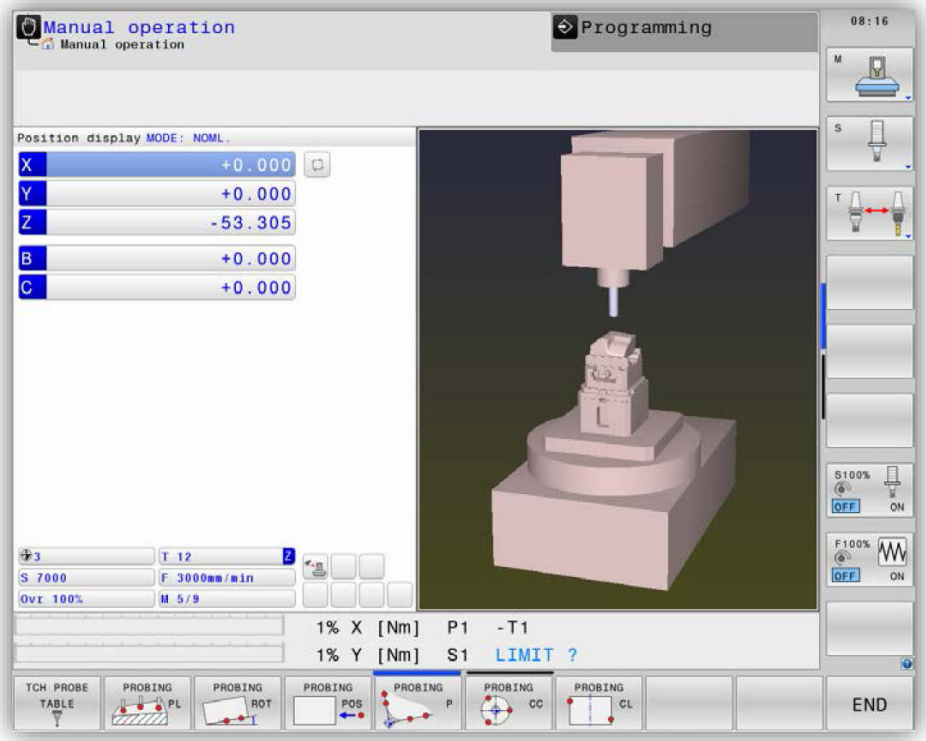
- Press the PROBING ROT soft key



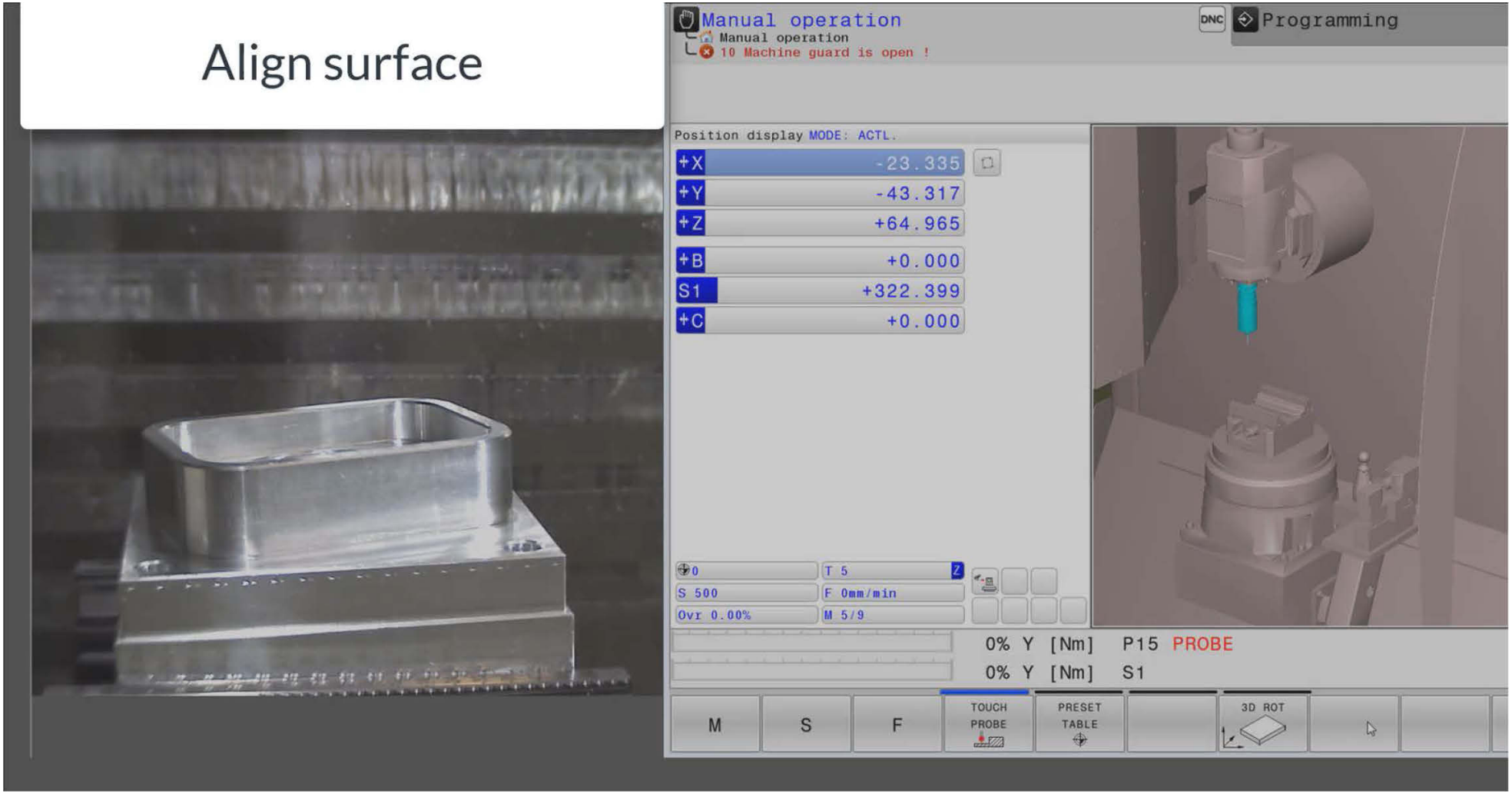
- Component edge with axis directions

  or

- Probe hole/stud combinations



Align Plane with Manual Probing Function



HEIDENHAIN

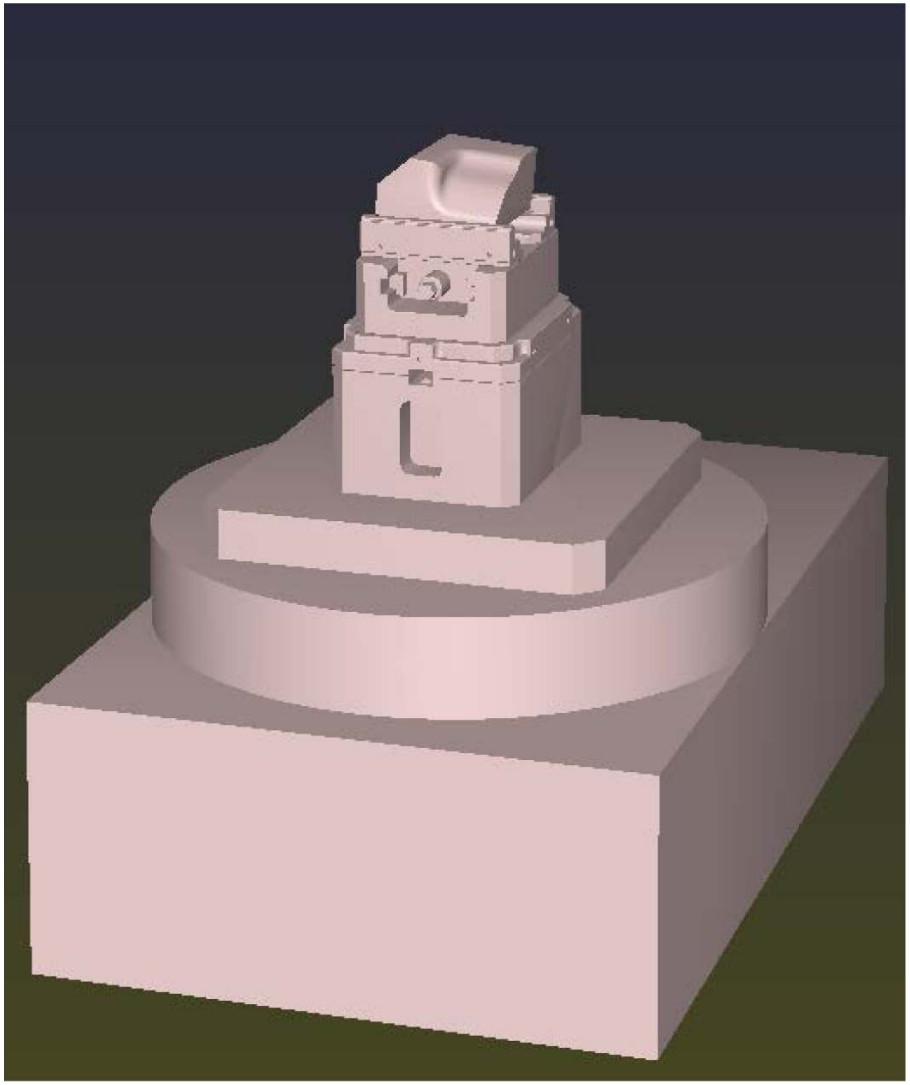
Machining with 3-D Basic Rotation

- With Three Axes
- Tilted machining with PLANE SPATIAL
- From 3+1 Inclined Machining up to 5 Axes Simultaneously

Workpiece – Application

Continued machining of workpiece

- Inclination:
  - SPA: –0.9861°
  - SPB: +5.1200°
  - SPC: +0.0000°



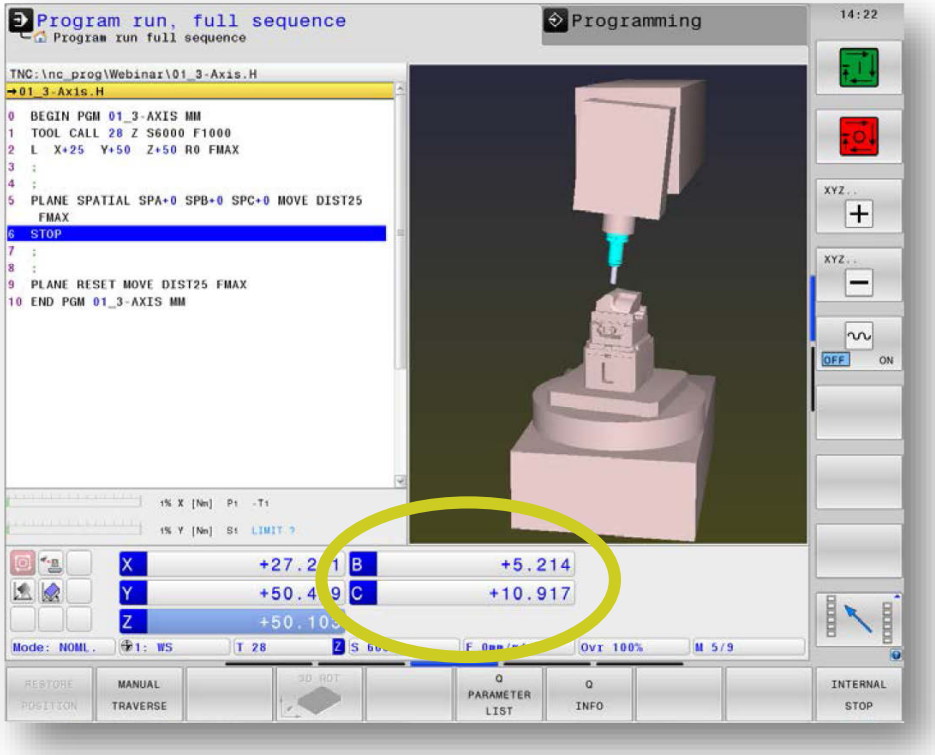
Programming:

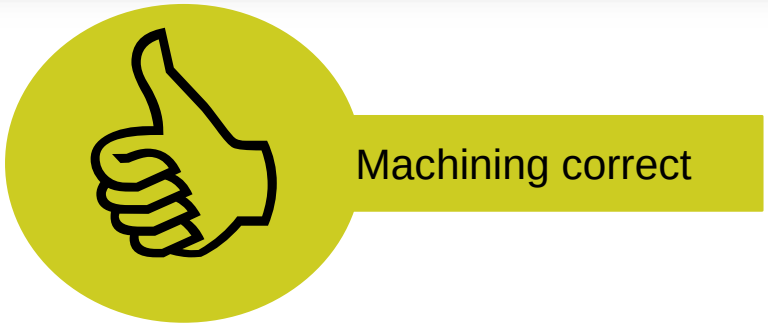
- With **PLANE SPATIAL SPA+0 SPB+0 SPC+0** you tilt the tool until it is perpendicular to the aligned surface

- Now you can program the machining as usual, with 3-axis operations

→ Please note that after every TOOL CALL, the tool has to be tilted again with PLANE SPATIAL.

→ You can reset the 3-D basic rotation with **M143.**



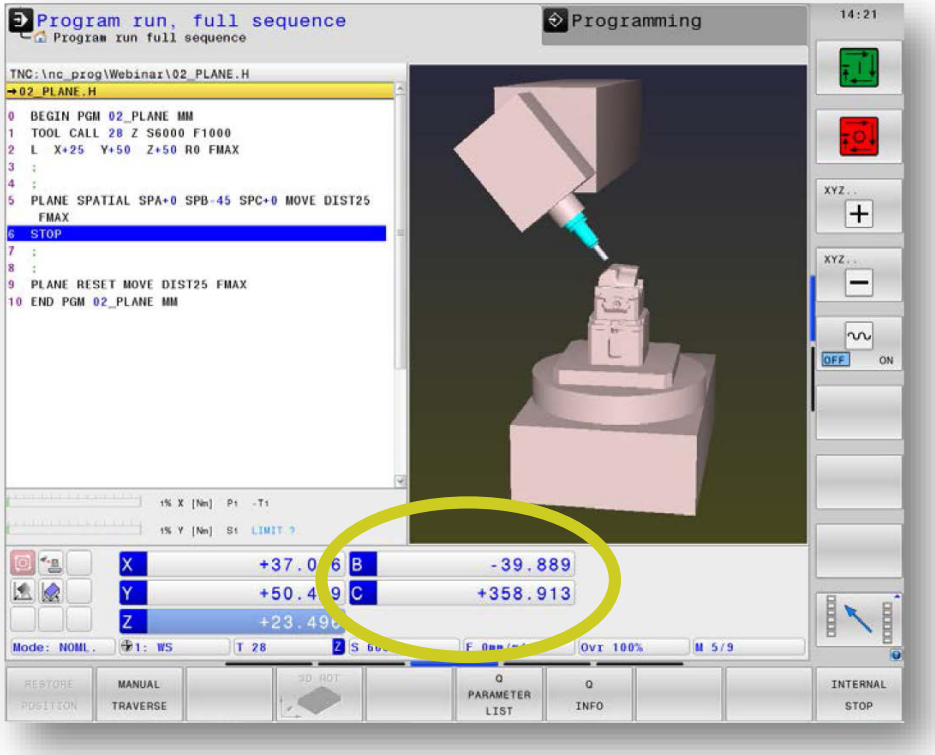


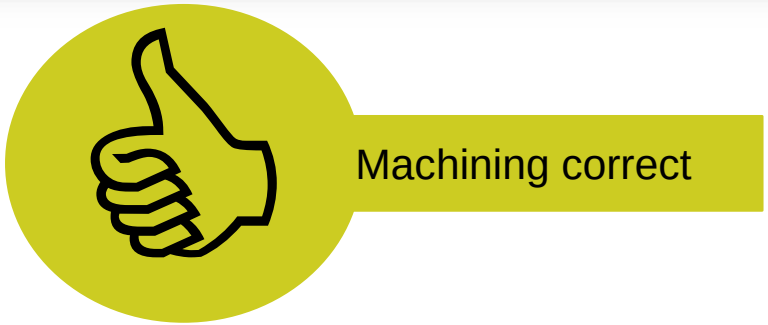
Programming:

- With **PLANE SPATIAL SPA+0 SPB+0 SPC+0** you tilt the tool until it is perpendicular to the aligned surface

- Now you can program the machining as usual, with 3+2-axis operations with all tilting functions (except PLANE AXIAL)

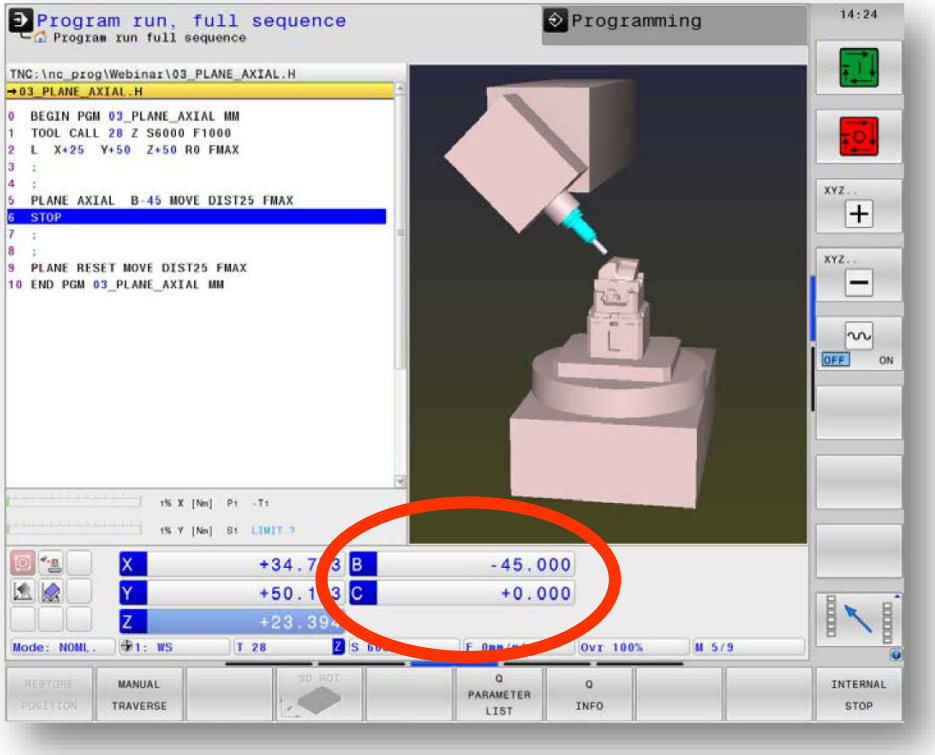
→ Please note that instead of PLANE RESET, **PLANE SPATIAL SPA+0 SPB+0 SPC+0** has to be programmed in order to return to the tilted alignment.





Programming:

- With **PLANE SPATIAL SPA+0 SPB+0 SPC+0** you tilt the tool until it is perpendicular to the aligned surface
- The definition with PLANE AXIAL ignores the 3-D basic rotation



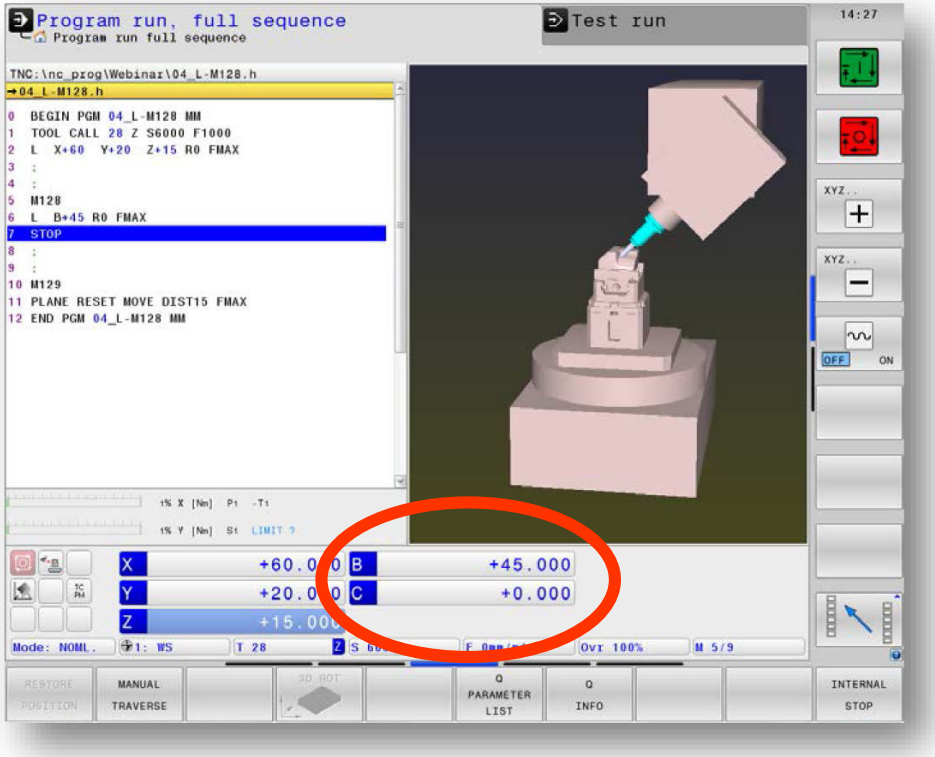
Machining incorrect

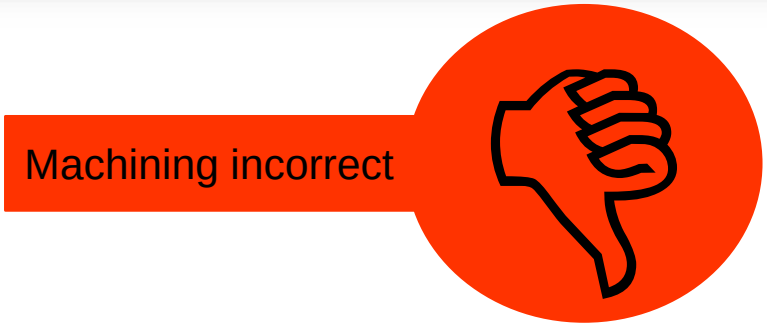
From 3+1 Inclined Machining up to 5 Axes Simultaneously

Programming:

- Activate **M128** (Tool Center Point Management)
- Position the tool to 45° in the B axis:
  L B+45 R0
- The combination of
  - 3-D basic rotation
  - M128
  - L

  generates an incorrect result.



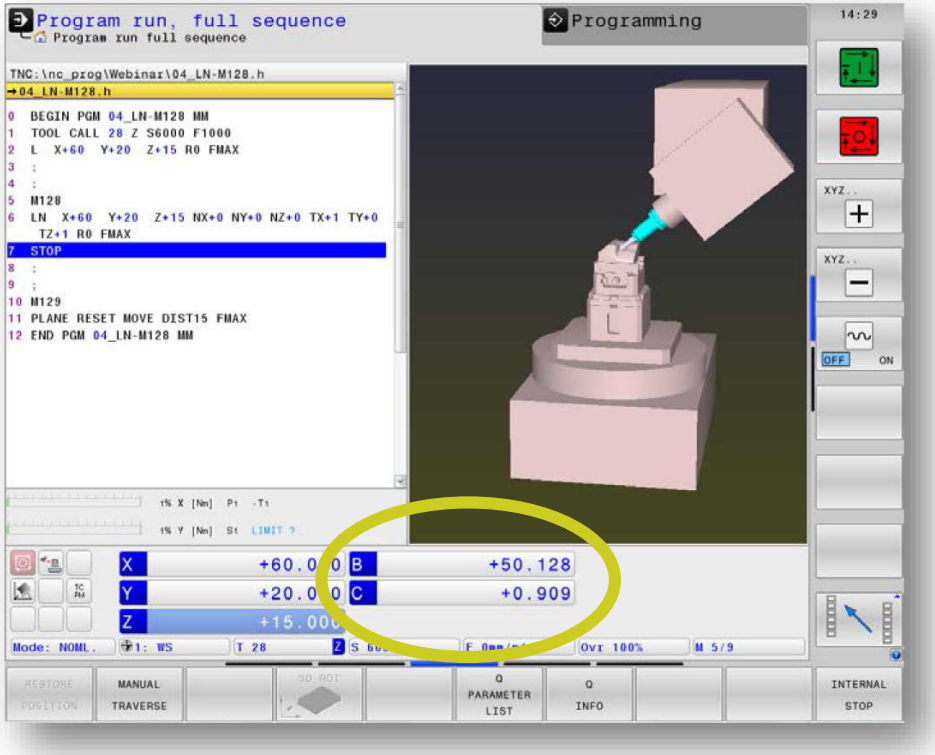


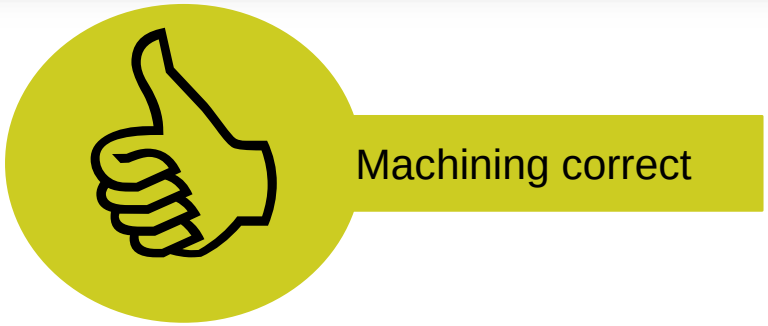
From 3+1 Inclined Machining up to 5 Axes Simultaneously

Programming:

- Activate **M128** (Tool Center Point Management)
- Position the tool to 45° in the B axis:
  LN TX+1 TY+0 TZ+1
- The combination of
  - 3-D basic rotation
  - M128
  - LN

  generates the correct result.



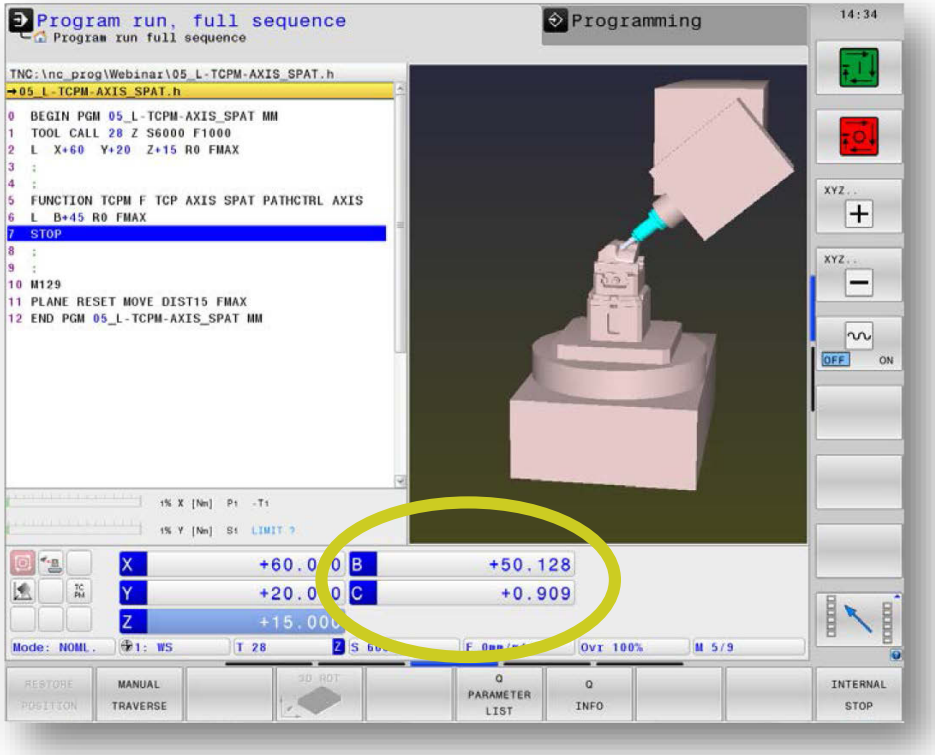


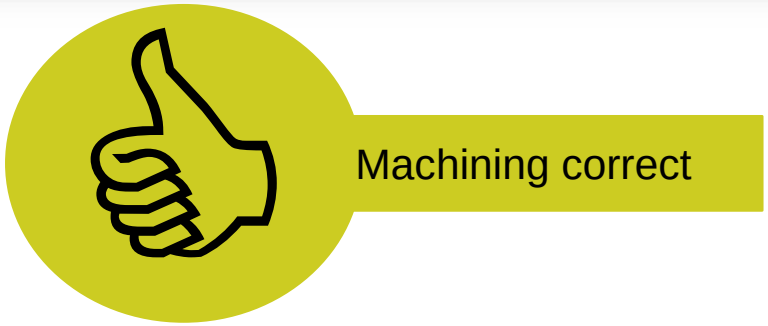
From 3+1 Inclined Machining up to 5 Axes Simultaneously

Programming:

- Activate **TCPM** (Tool Center Point Management) with **AXIS SPAT** (spatial angles)
- Position the tool to 45° in the B axis:
  L B+45 R0
- The combination of
  - 3-D basic rotation
  - TCPM … AXIS SPAT …
  - L

  generates the correct result.





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Aligning a Plane

Program Run

Single Block/Full Sequence

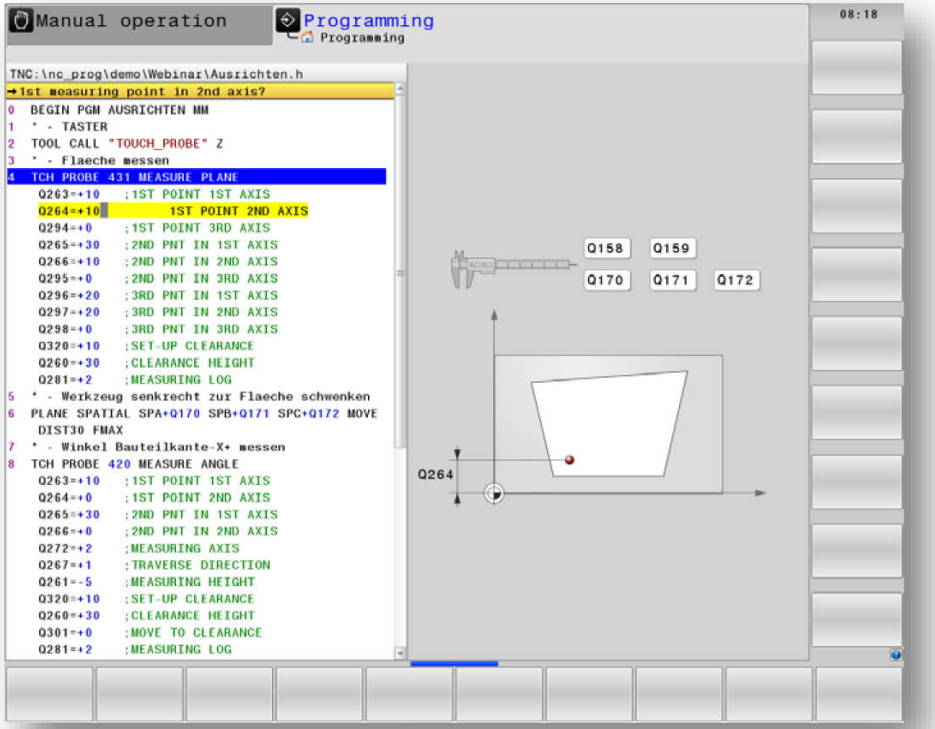
Measure Plane with Probing Cycle 431

Probing Cycle 431

- Three points are measured
  - X coordinate
  - Y coordinate
  - Z coordinate
- The spatial angles of the plane are calculated from the measured points and saved in Q parameters:
  - Q170 → spatial angle in A
  - Q171 → spatial angle in B
  - Q172 → spatial angle in C
  - Q158 → Projection angle of the A axis
  - Q1589 → Projection angle of the B axis

Note:

The sequence of the measured points influences the angles



Measure Plane with Probing Cycle 431

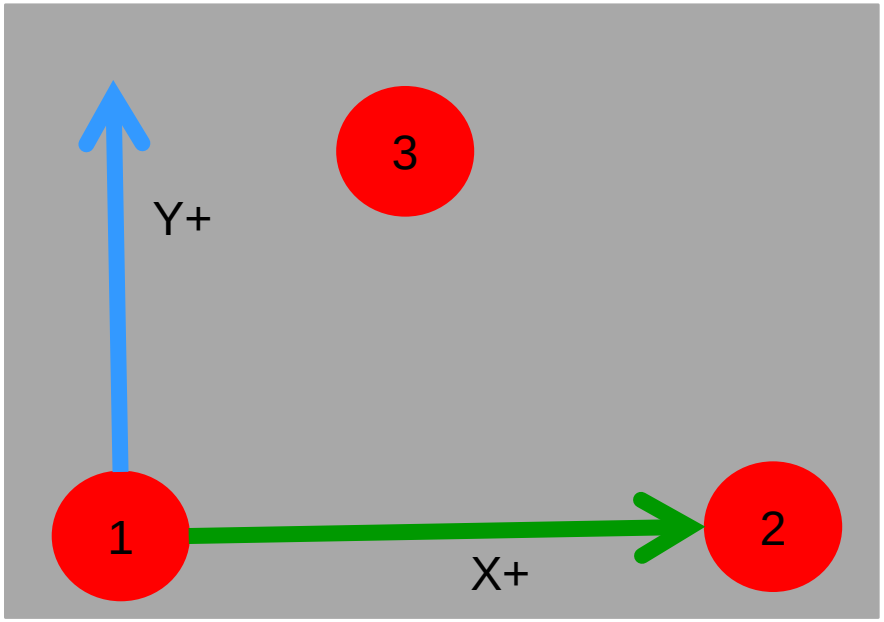
Arrangement of measured points

- Point 1 → Point 2
  Alignment in positive X axis

- Point 3
  Alignment in positive Y axis

Note:

Point 3 must be above points 1 and 2, otherwise the alignment is not correct.



Tilting the tool

- The tool is tilted with
  - PLANE SPATIAL
  - CYCLE 19
  - PLANE PROJECTED

PLANE SPATIAL **SPA+Q170 SPB+Q171 SPC+Q172** MOVE DIST0 FMAX
or
PLANE PROJECTED **PROPR+Q158 PROMIN+Q159** ROT0 MOVE DIST0 FMAX
or
Cycle 19 **A+Q170 B+Q171 C+Q172** &
L A+Q120 B+Q121 C+Q122 R0 FMAX

→ Tool is positioned vertically on the plane to be machined

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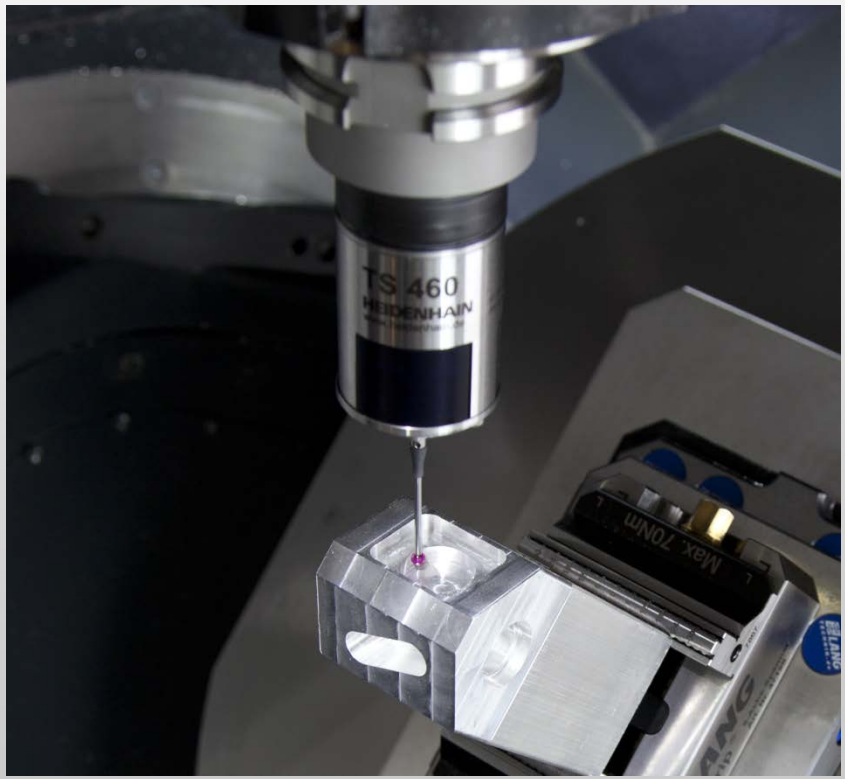
Alignment of X Axis Parallel to the Component Edge



Alignment of X Axis Parallel to the Component Edge

Exercise

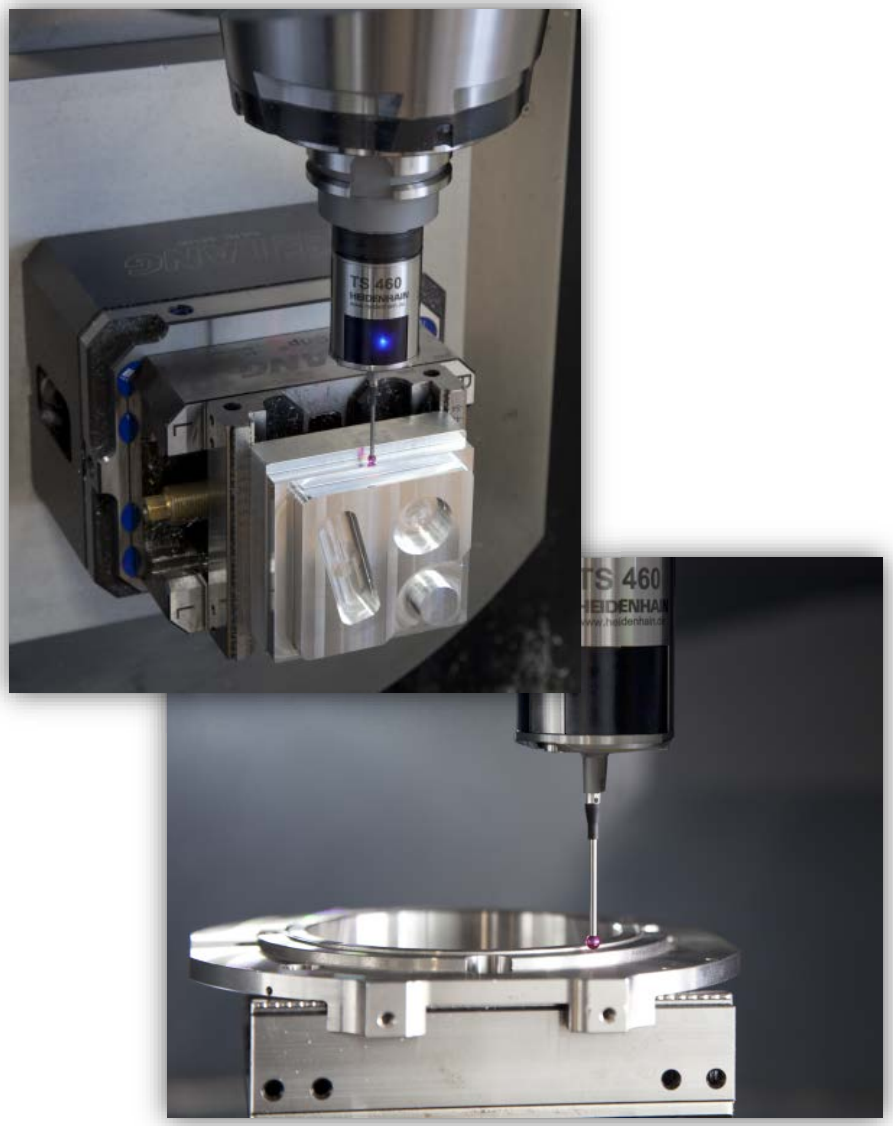
- After having aligned the plane, align the X axis parallel to the edge of the component

Why?

- Depending on the positioning of points 1 and 2, the positive X axis might not be parallel to the component edge

Solution

- Probing Cycle 420
- Machine with two rotary axes
- 3-D touch probe



Alignment of X Axis Parallel to the Component Edge

Probing Cycle 420

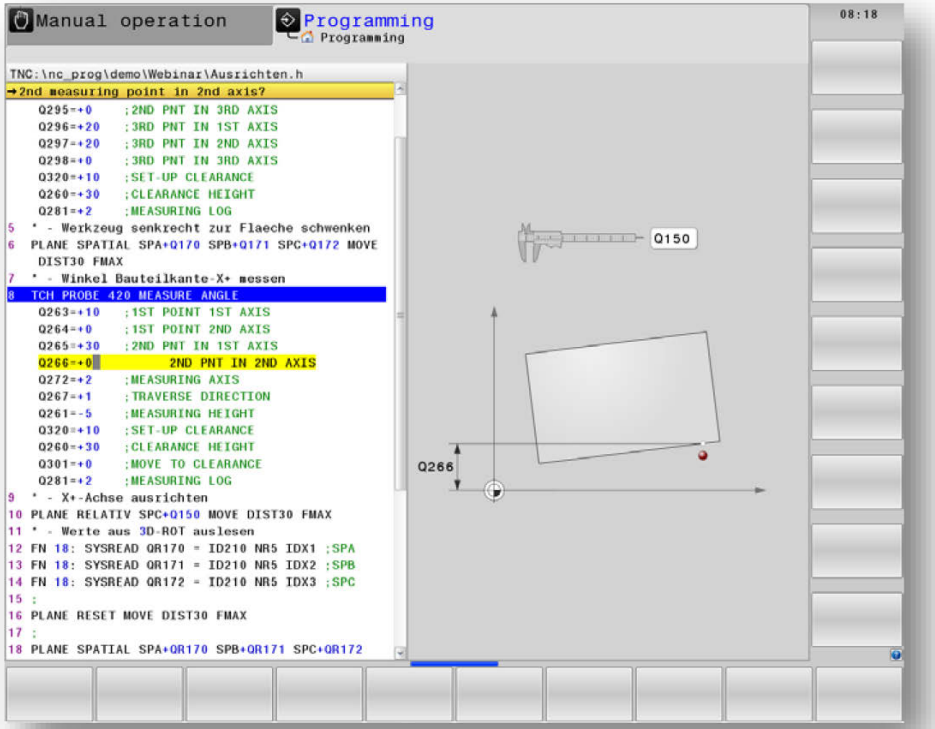
- The angle of the component edge is measured and saved in Parameter Q150
- The measured angle must be added to the existing tilting:

PLANE RELATIV **SPC+Q150** MOVE DIST0 FMAX

Remanently saving parameters

- With QR parameters (remanent parameters) the most important parameters are saved:
  - Q**R**170 = Q170
  - Q**R**171 = Q171
  - Q**R**172 = Q172
  - Q**R**150 = Q150

The component is aligned.



Read Values from 3-D ROT

Benefit

- The angles that are stored in 3-D ROT are the result from
  - PLANE SPATIAL
  - PLANE RELATIV
- Therefore, no combination must be programmed.

- Read the tilt values
  - FN18 QR170 ID210 NR5 IDX1 → SPA
  - FN18 QR171 ID210 NR5 IDX2 → SPB
  - FN18 QR172 ID210 NR5 IDX3 → SPC

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Align Tilted Plane

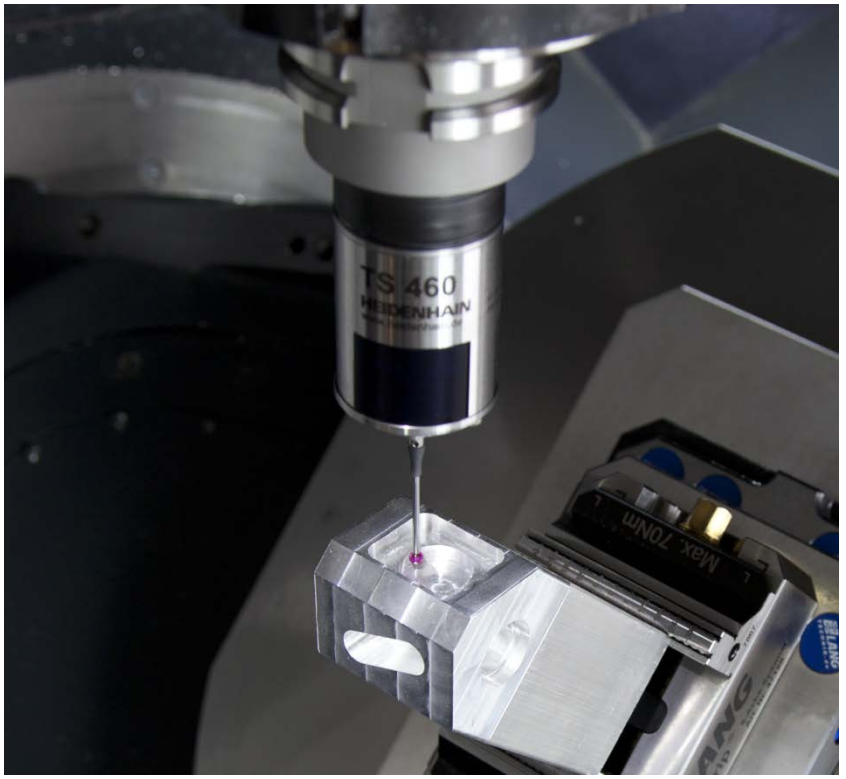
Align Tilted Plane

Exercise:

- A tilted plane should be accurately aligned

Programming:

- Tilt the tool to the surface with:
  PLANE SPATIAL SPA+45 SPB+0 SPC+0
- Measure the plane as usual (TCH PROBE 431 always measures the difference to the active tilting)
- Tilt the difference:
  - PLANE RELATIV SPC+Q172 STAY
  - PLANE RELATIV SPB+Q171 STAY
  - PLANE RELATIV SPA+Q170 MOVE
- Surface can be machined



Note:

The tilting sequence **SPC-SPB-SPA** must be adhered to.

Switch to the Programming Station

HEIDENHAIN

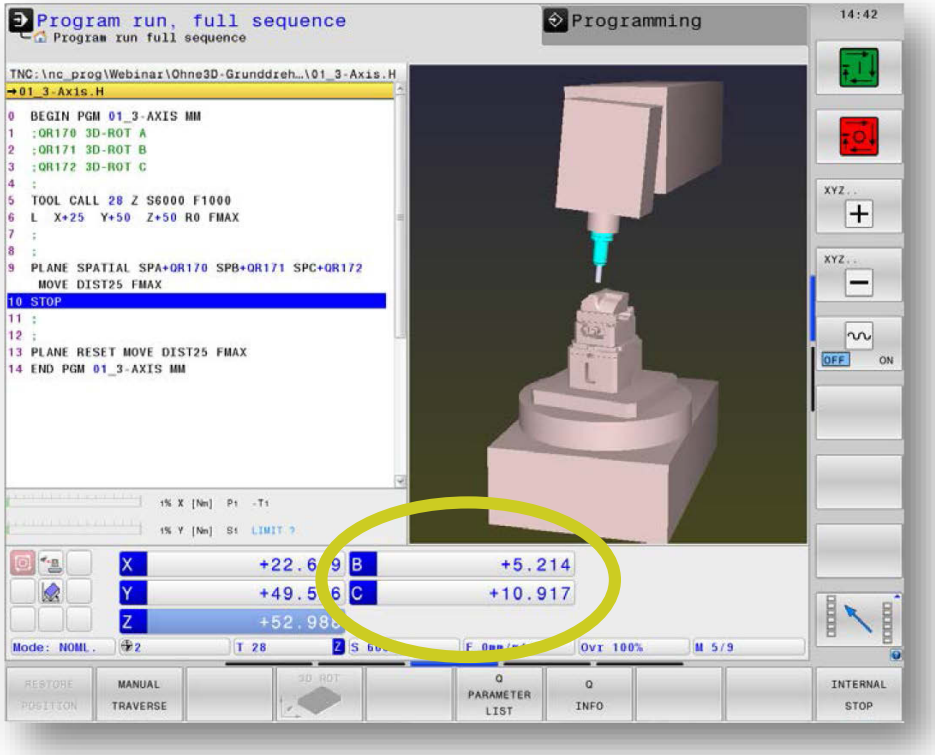
Machining without 3-D Basic Rotation

- With Three Axes
- Tilted Machining with PLANE RELATIV
- Tilted Machining with PLANE SPATIAL
- From 3+1 Inclined Machining up to 5 Axes Simultaneously

Programming:

- The angles of the surface are saved in the following parameters:
  - QR170 = 3D-ROT A
  - QR171 = 3D-ROT B
  - QR172 = 3D-ROT C
- With **SPA+QR170 SPB+QR171 SPC+QR172** you tilt the tool until it is perpendicular to the aligned surface
- Now you can program the machining as usual, with 3-axis operations

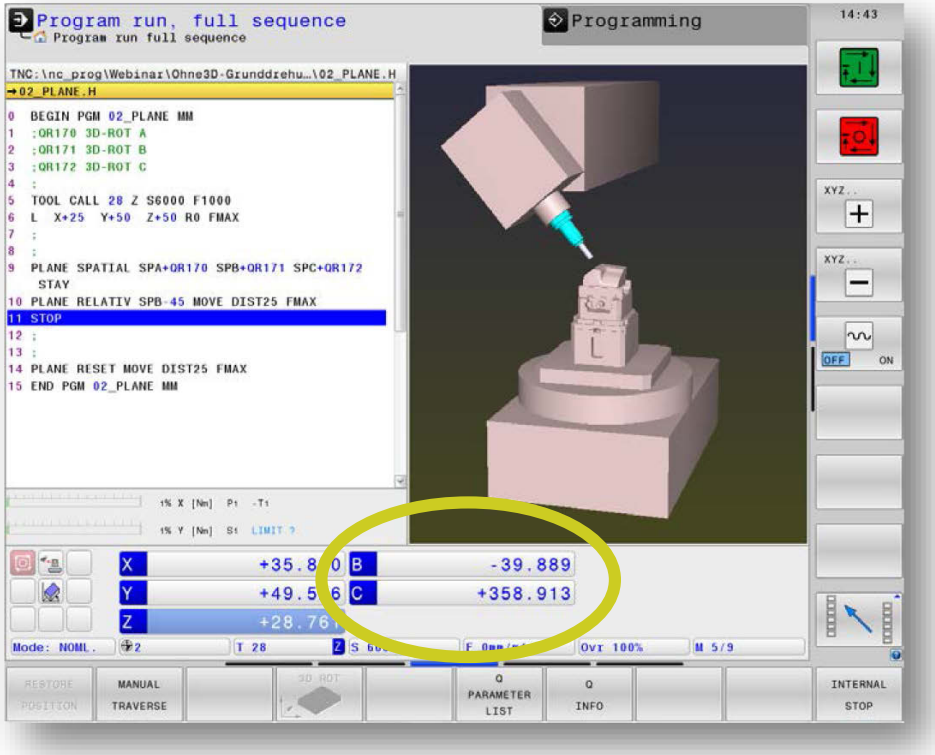
→ Please note that after every TOOL CALL, the tool has to be tilted again with PLANE SPATIAL.



Machining correct

Programming:

- With **PLANE SPATIAL SPA+QR170 SPB+QR171 SPC+QR172** you tilt the tool until it is perpendicular to the aligned surface
- Since PLANE SPATIAL was already used for the alignment, **PLANE RELATIV** must be used to program the subsequent tilting movements
- In order to tilt back to the aligned plane, program PLANE SPATIAL SPA+QR170 SPB+QR171 SPC+QR172



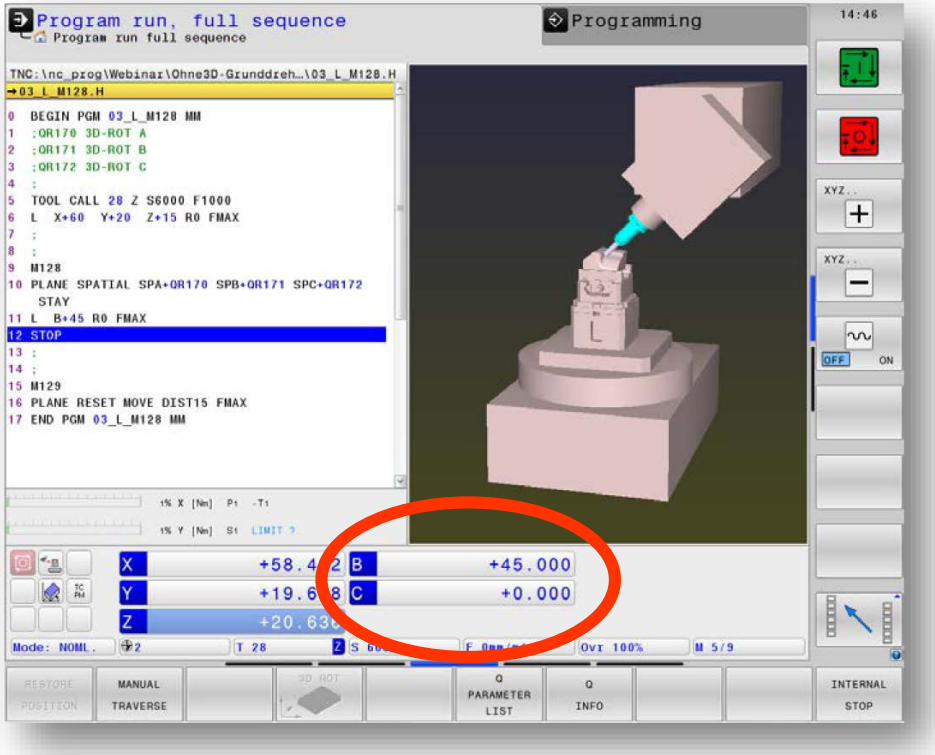
Machining correct

From 3+1 Inclined Machining up to 5 Axes Simultaneously

Programming:

- Activate **M128** (Tool Center Point Management)
- With **PLANE SPATIAL SPA+QR170 SPB+QR171 SPC+QR172** you tilt the tool until it is perpendicular to the aligned surface
- Position the tool to 45° in the B axis:
  L B+45 R0
- The combination of
  - M128
  - PLANE SPATIAL
  - L

  generates an incorrect result



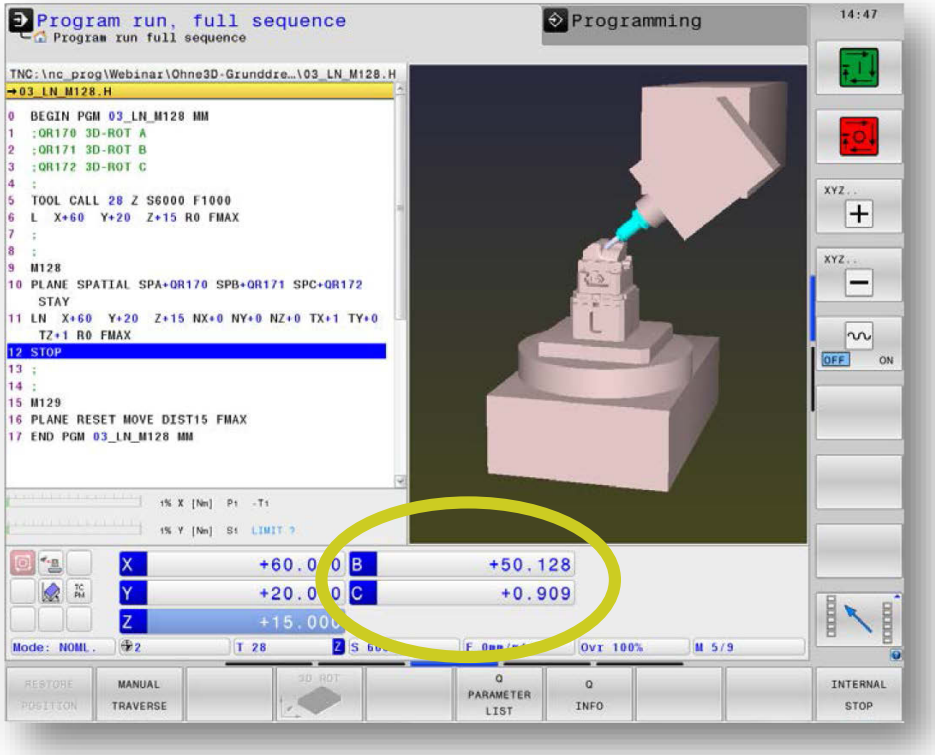
Machining incorrect

From 3+1 Inclined Machining up to 5 Axes Simultaneously

Programming:

- Activate **M128** (Tool Center Point Management)
- With **PLANE SPATIAL SPA+QR170 SPB+QR171 SPC+QR172** you tilt the tool until it is perpendicular to the aligned surface
- Position the tool to 45° in the B axis:
  LN TX+1 TY+0 TZ+1
- The combination of
  - M128
  - PLANE SPATIAL
  - LN

  generates the correct result



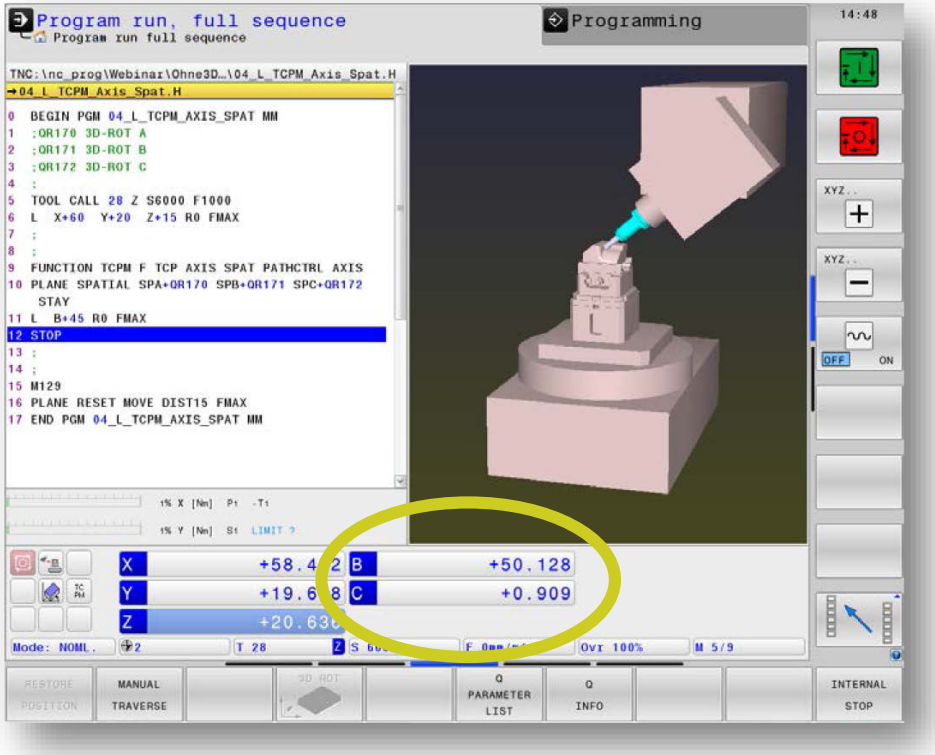
Machining correct

From 3+1 Inclined Machining up to 5 Axes Simultaneously

Programming:

- Activate **TCPM** (Tool Center Point Management) with **AXIS SPAT** (spatial angles)
- With **PLANE SPATIAL SPA+QR170 SPB+QR171 SPC+QR172** you tilt the tool until it is perpendicular to the aligned surface
- Position the tool to 45° in the B axis:
  L B+45 R0
- The combination of
  - TCPM … AXIS SPAT …
  - PLANE SPATIAL
  - L

  generates the correct result



Machining correct

Have fun aligning!

Please do not hesitate to contact us should you have any questions:

Tel.: +49 8669 31-3103

E-mail:
3103@heidenhain.de

HEIDENHAIN

Thank you very much for your attention!

Michael Wiendl