

---

# Chamfering and Deburring Machine

---

LD 180/280 C smallest  
solution in the market

**LIEBHERR**

Liebherr-Verzahntechnik GmbH



# LD 180/280 C Chamfer Cut



LD 180/280 C provided for EATON - confidential use

**LIEBHERR**



## **LD 180/280 C Chamfer Cut**

### **LD 180/280 C Chamfer Cut**

Standalone machine for high chamfer quality, and for integration in existing manufacturing systems

Workpiece: Max. Ø 280 mm  
Module: 5 mm (opt. 6)



## Advantages of LD 180/280 C Chamfer Cut

- Smallest footprint in the market
- Suitable for integration in existing manufacturing plants
- Optimized workpiece clamping
- Fast Set-up
- Dry machining
- Hydraulic free machine
  
- Simple adjustment of corrections via CNC axes
- Simple corrections at varying flank modifications
- Chamfering possible on both sides

## Technical specifications LD 180/280 C Chamfer Cut

Specification	LD180 C	LD 280 C
min. workpiece diameter	Ø 15mm	Ø 15mm
max. workpiece diameter	Ø 180mm	Ø 280mm
max. workpiece weight	8 kg	15 kg
min. module	0,8mm	0,8mm
max. module	5 mm (6 Option)	5 mm (6 Option)
cycle time (gear-related)	< 12s	*reduced rotation speed
tool diameter min. / max.	Ø30mm / Ø130mm	Ø30mm / Ø130mm



# LD 180 / 280 C



LD 180/280 C provided for EATON - confidential use

# LD 180 / 280 C with plastic chain conveyor



# Advantages of LD 180/280 C – ChamferCut



- Smallest footprint in the market
- Suitable for integration in existing manufacturing plants
- Optimized workpiece clamping
- Fast Set-up
- Dry machining
- Hydraulic free machine
- Simple adjustment of corrections via CNC axes
- Simple corrections at varying flank modifications
- Chamfering possible on both sides



# LD 180 / 280 C – Highlights for operating

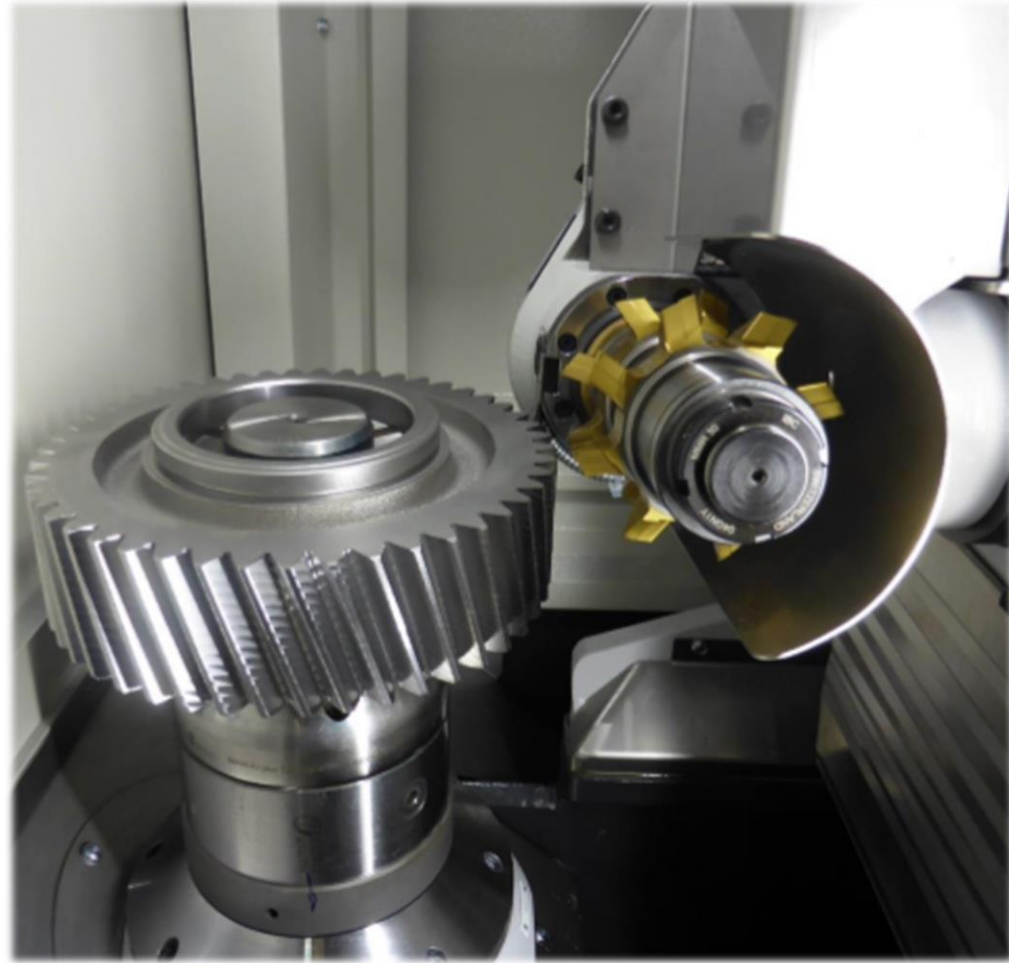


Ergonomic tool change

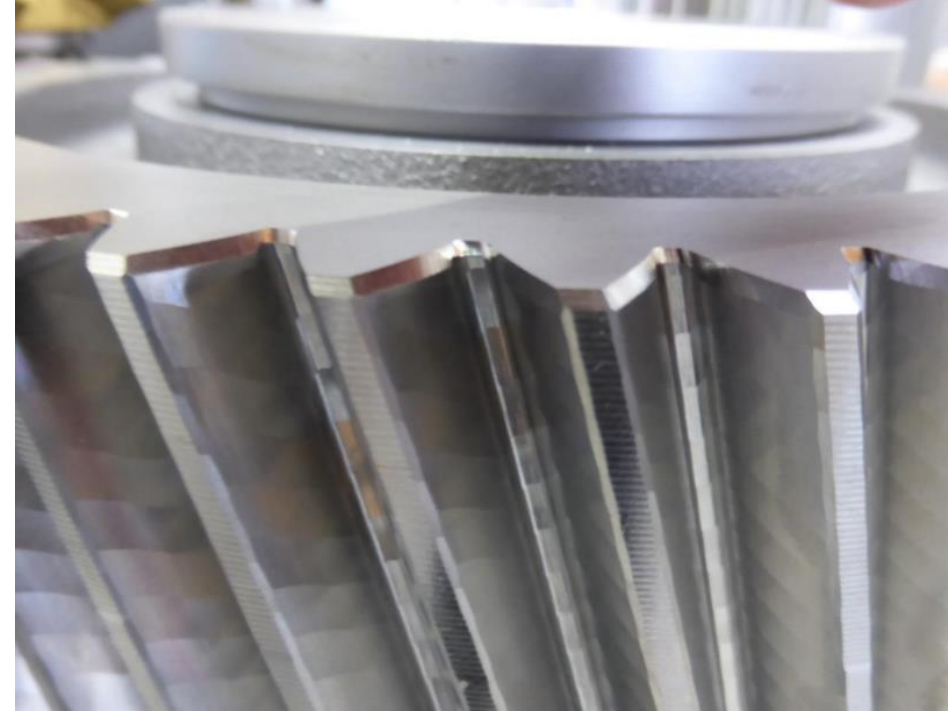
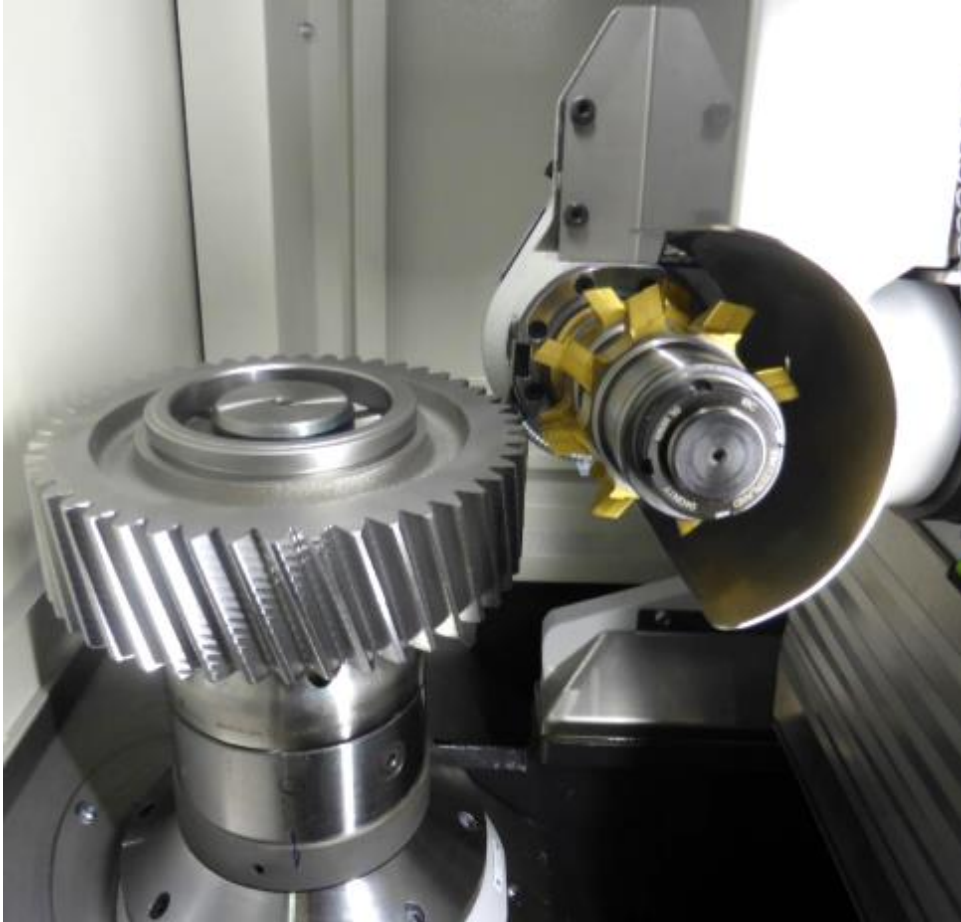
## **LD 180 / 280 is designed for ergonomic operation**

- The chamfer cut head can be swiveled to the 90° position (see besides picture)
- Therefore, the Chamfer cut tool can be easily set-up in an operator-friendly position
- Shortest distance from the operator door to the Chamfer Cut head (one arm length)
- Good access to the machine table, to exchange the clamping fixture

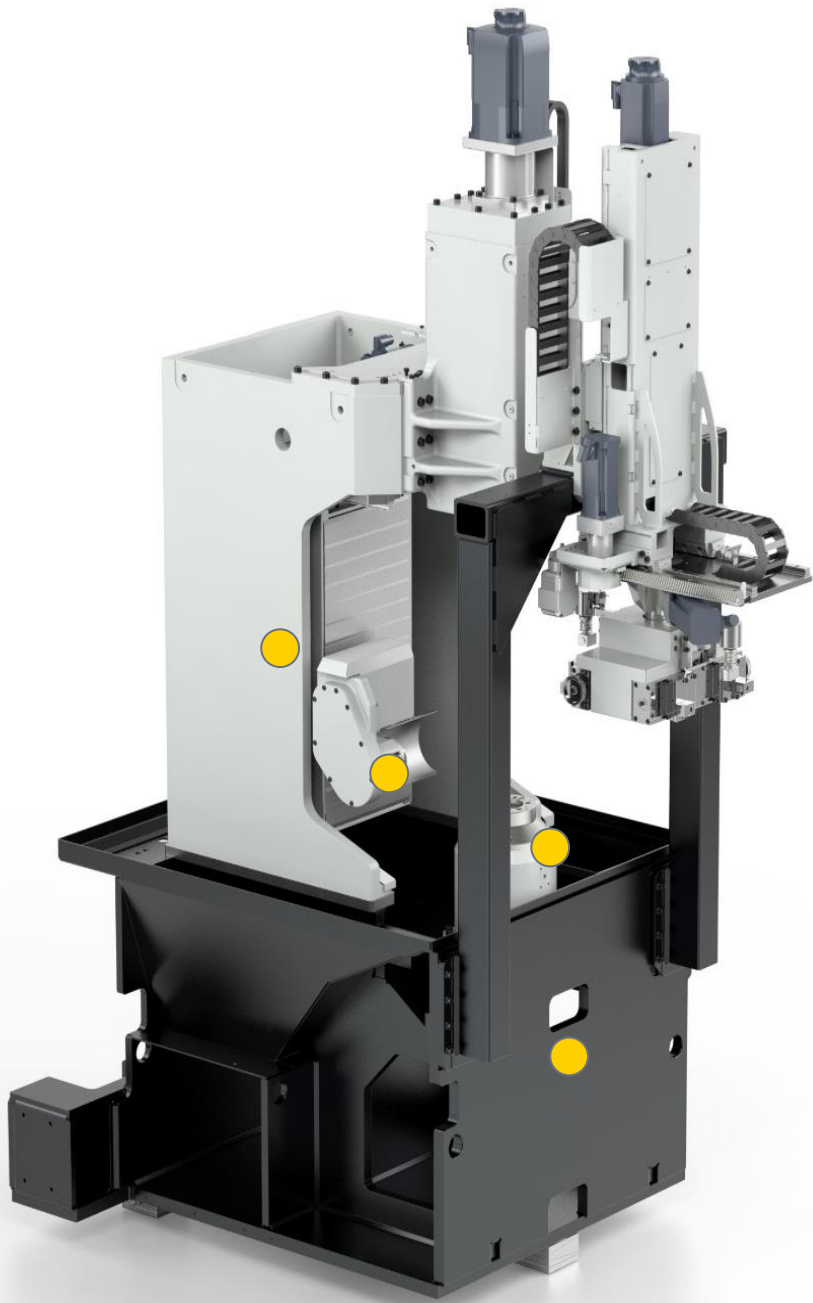
# Application Examples



# Application Examples



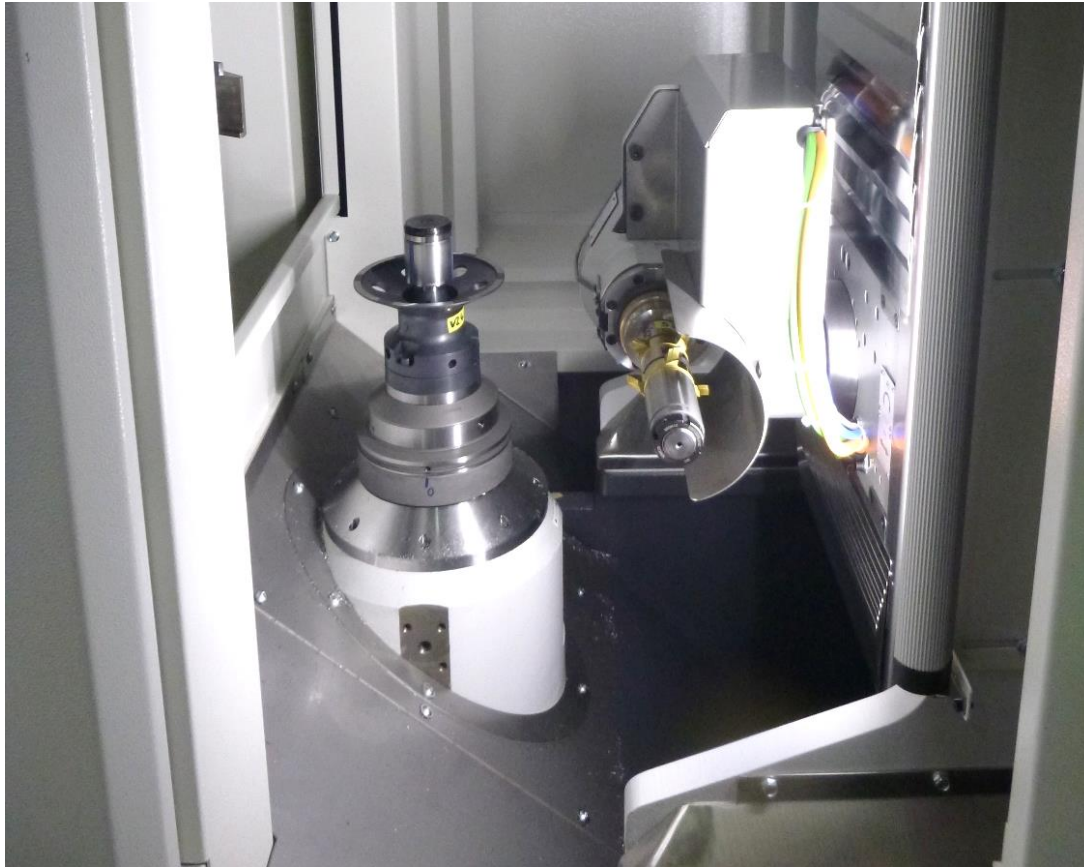
LD 180/280 C provided for EATON - confidential use



## LD 180/280 C Chamfer Cut Machine Design

- extremely precise chamfer geometry, no bulging's, ideal for honing
- root chamfering easily possible (standard)
- Good maintenance access
- setup via CNC-axes, easy changeover

# Advantages of LD 180/280 C – ChamferCut



Perfect chip removal concept

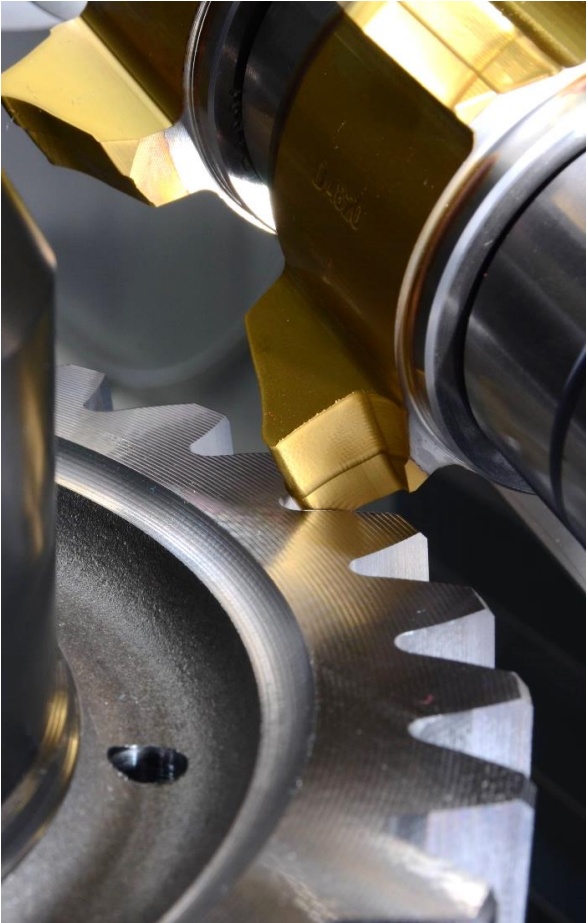


Available with chip conveyor

# Technology



# Chamfer Technologies on the LD 180/280 C



ChamferCut



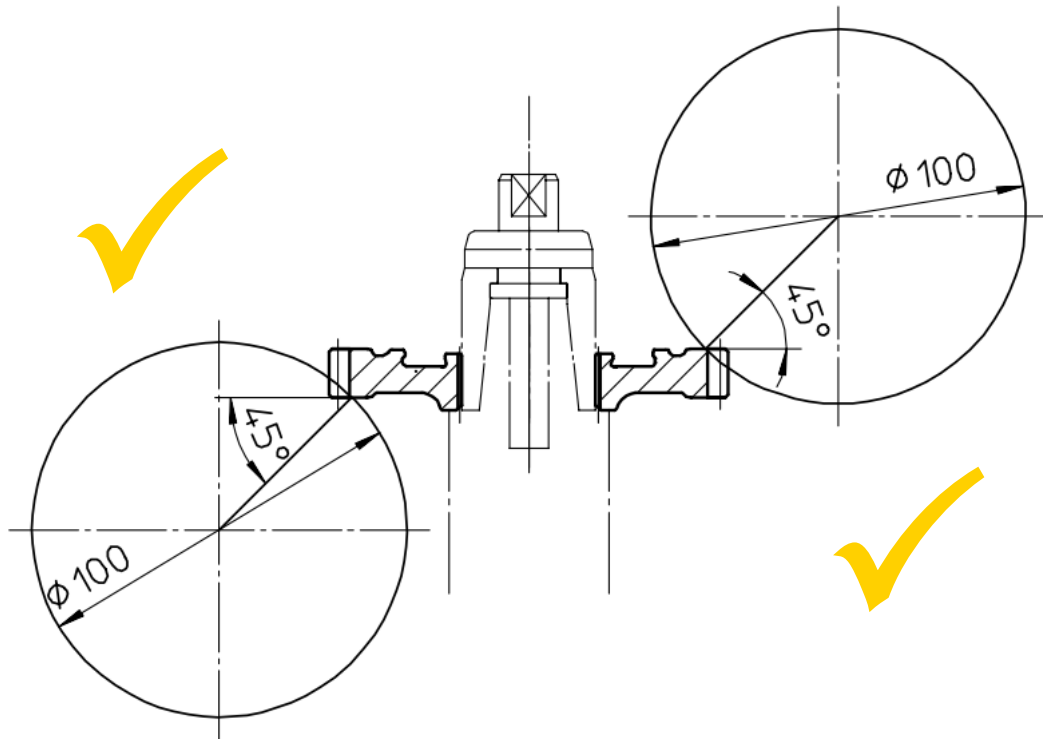
ChamferCut - CG



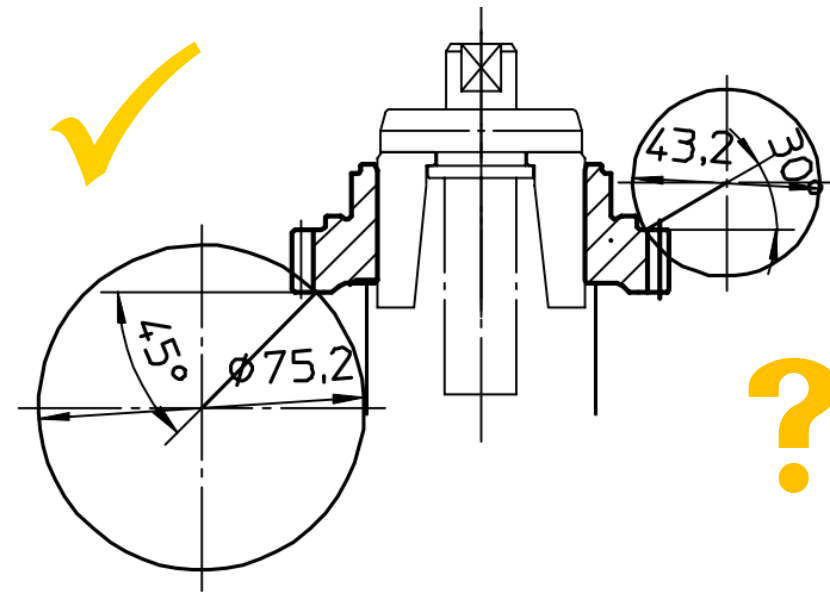
FlexChamfer

# ChamferCut: Impact of the part geometry

ideal geometry for ChamferCut



critical geometry due to interference



parts are critical, if there is a interference contour near the root diameter



---

**ChamferCut  
Chamfering despite  
Interference  
Contours**

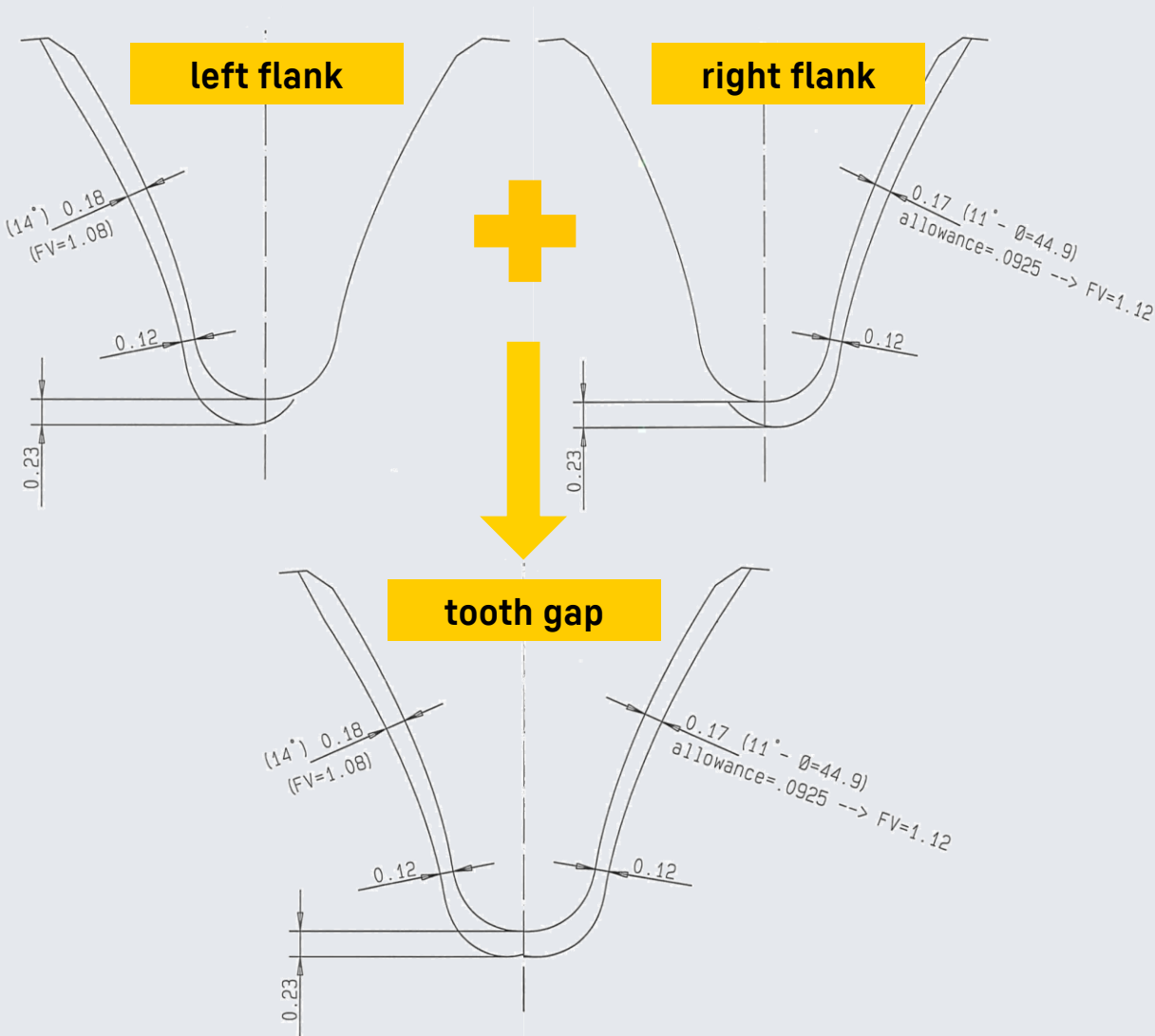
---

**LIEBHERR**

ChamferCut



# ChamferCut 2018 – A new approach

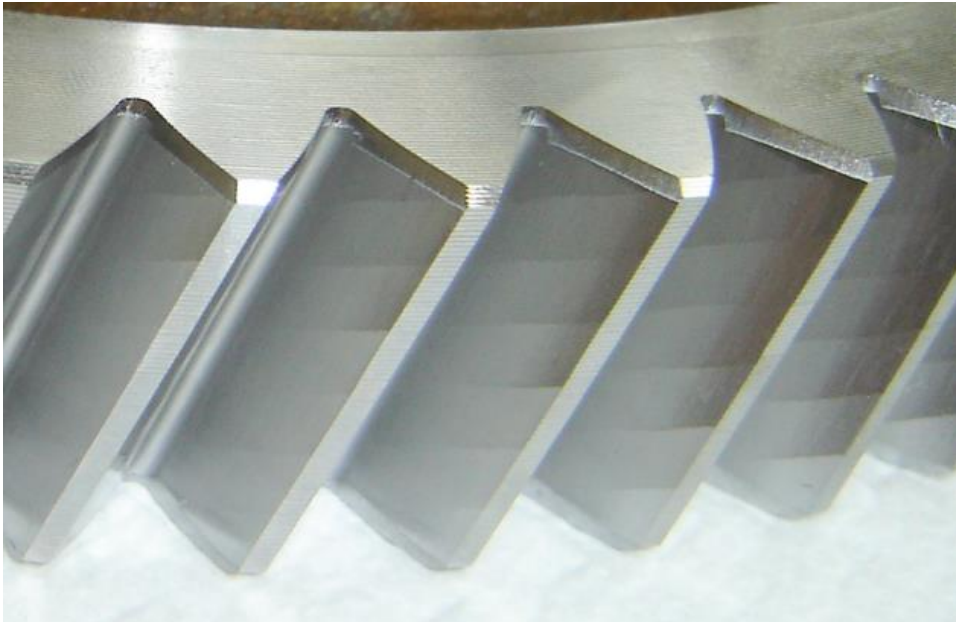


- separate chamfering of left and right flank
- creation of the chamfer angle by swivelling off the vertical
- almost the same centre distance as in hobbing
- chamfering despite interference possible
  - wider applicability of the process
  - more degrees of freedom for the chamfer design

# Chamfering Quality and Chips

## Chamfer formation

A homogeneous chamfer along the whole contour of the gap is created. The chamfering of the tooth root is also easily possible.



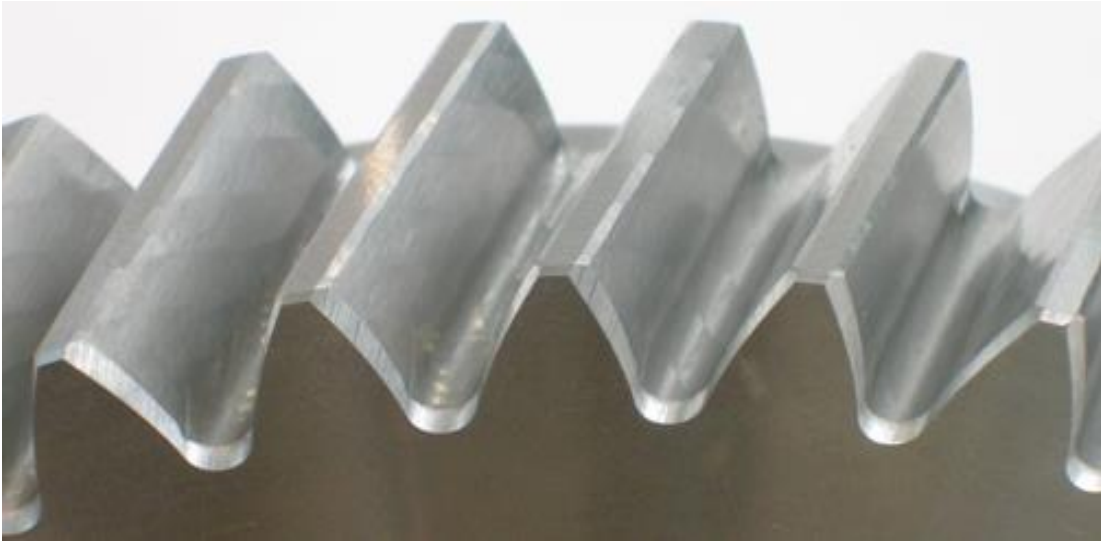
## Chip of the ChamferCut

The whole contour is created in a single cut. There are no generating flats.

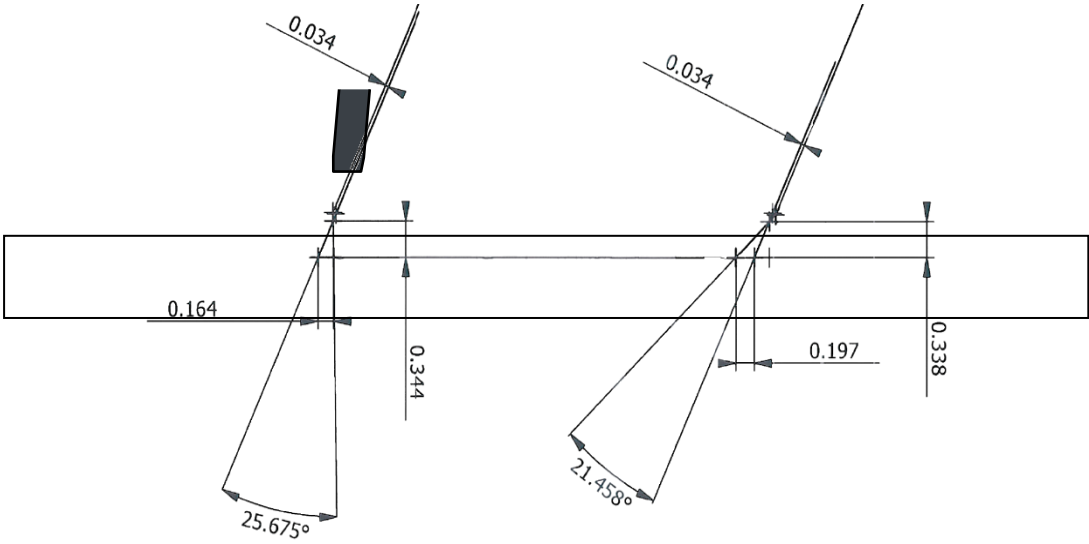


# Chamfer Formation

chamfer form



chamfer size

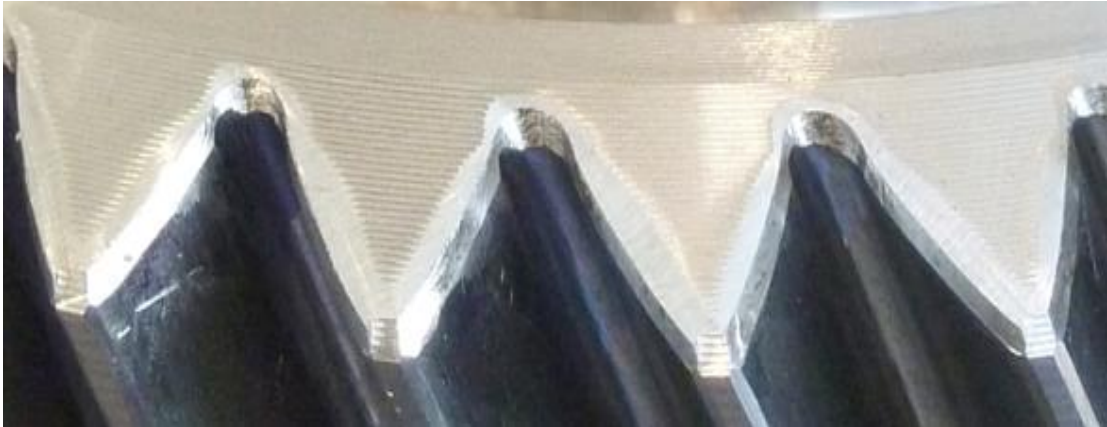


# Chamfering Quality (Process Comparison)

ChamferCut



press deburring





**Application example**

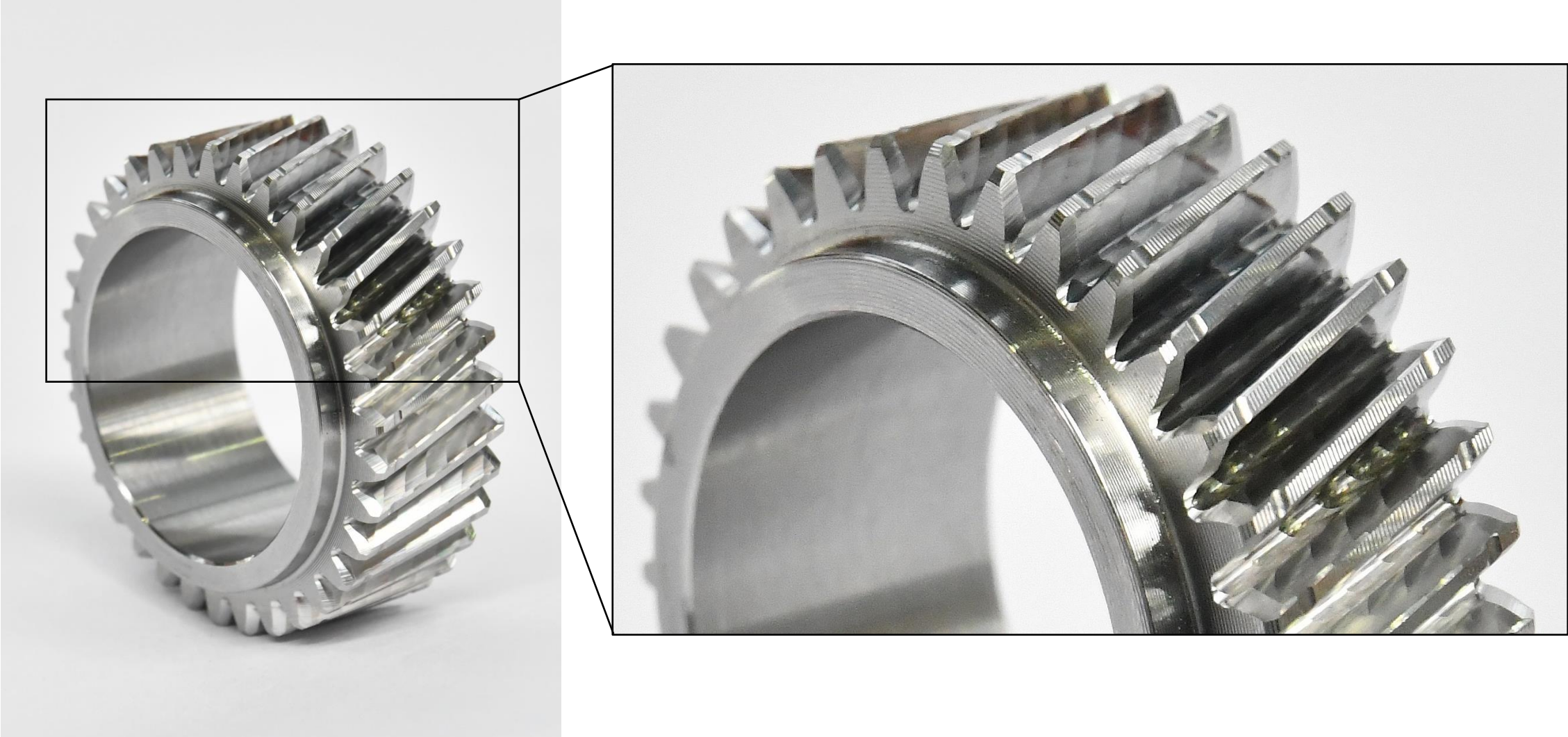


**ChamferCut – Tool set  
out of 3 tools**



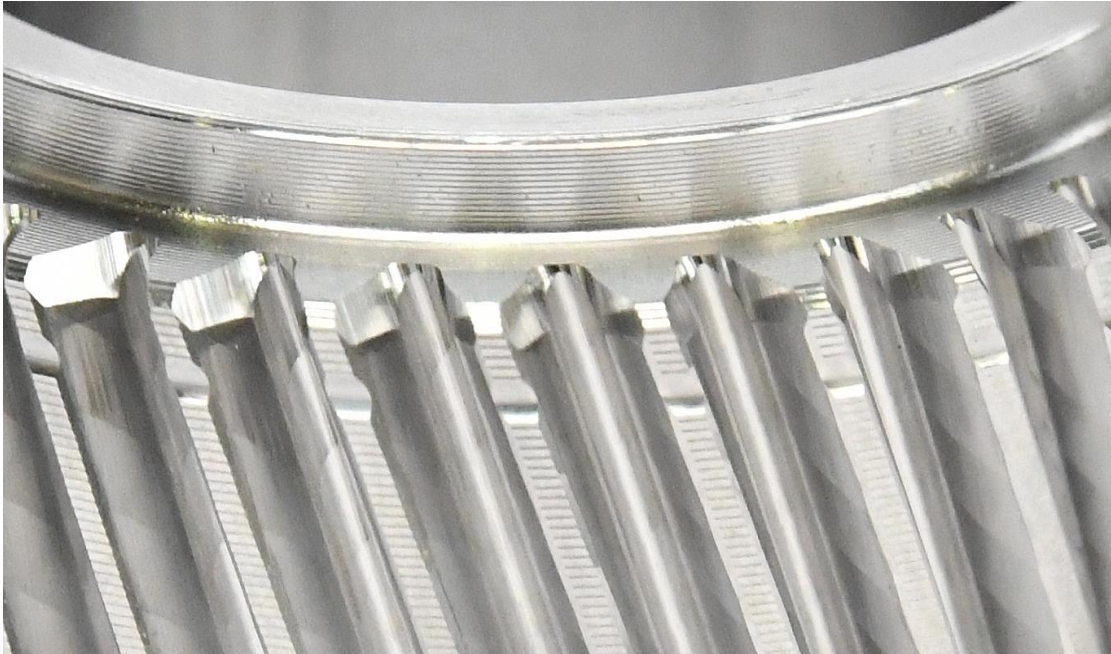


# Chamfer formation (form)

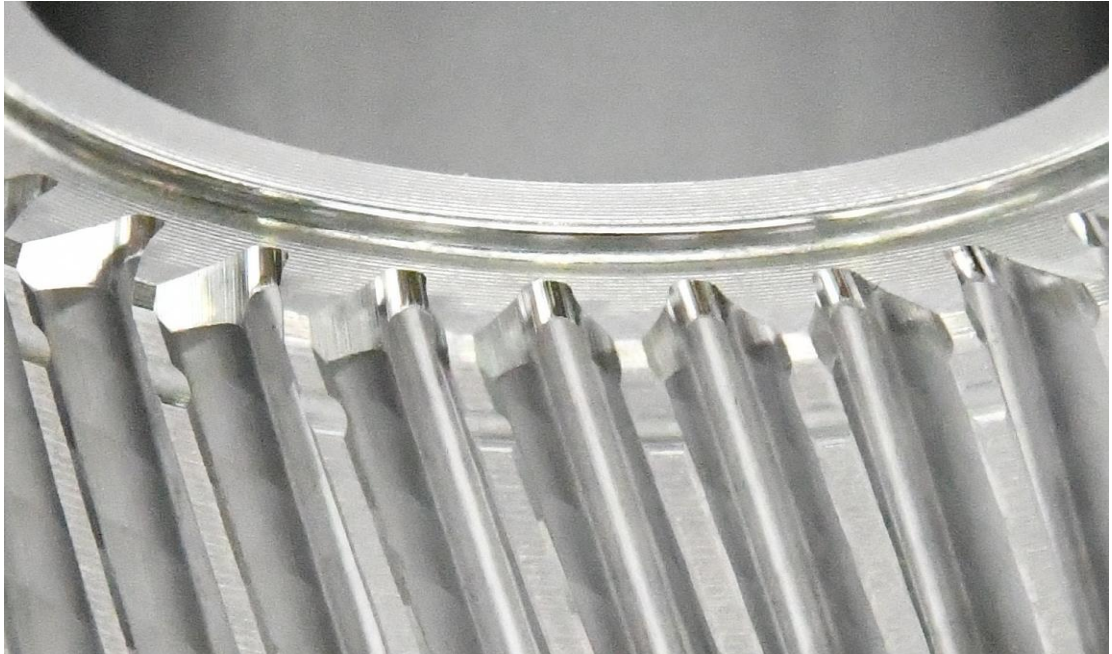


# Chamfer formation (form)

Top (high interference)

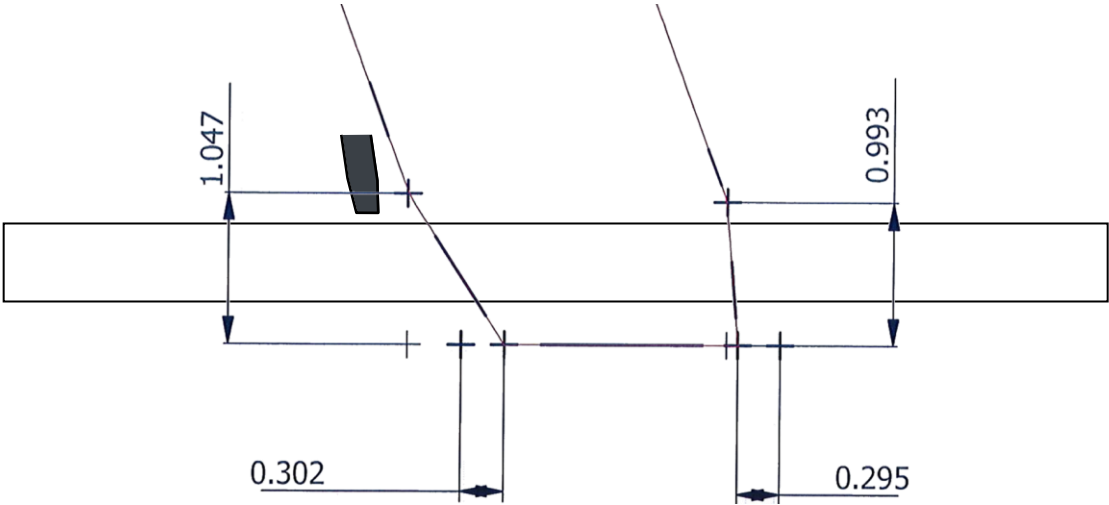


Bottom (low interference)

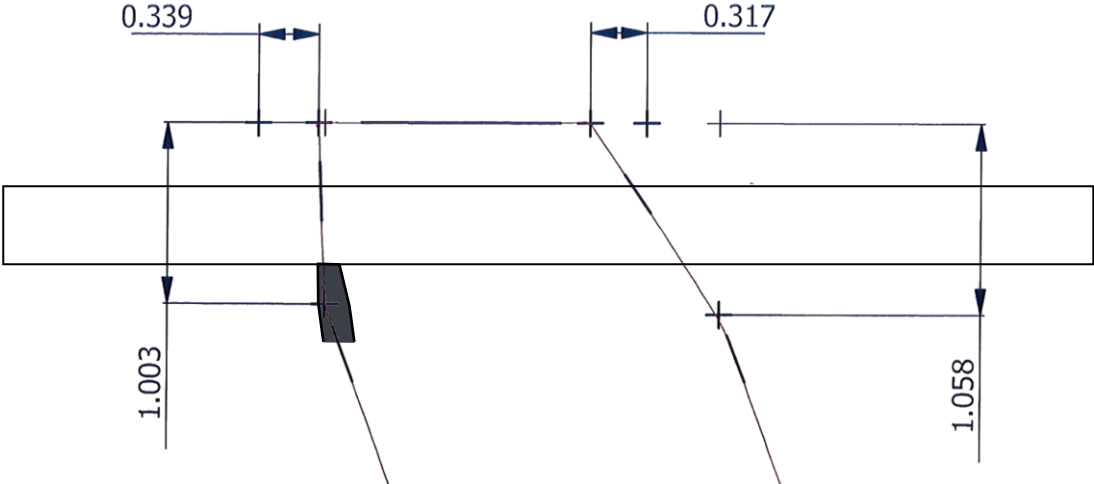


# Chamfer formation (size)

## Top (high interference)

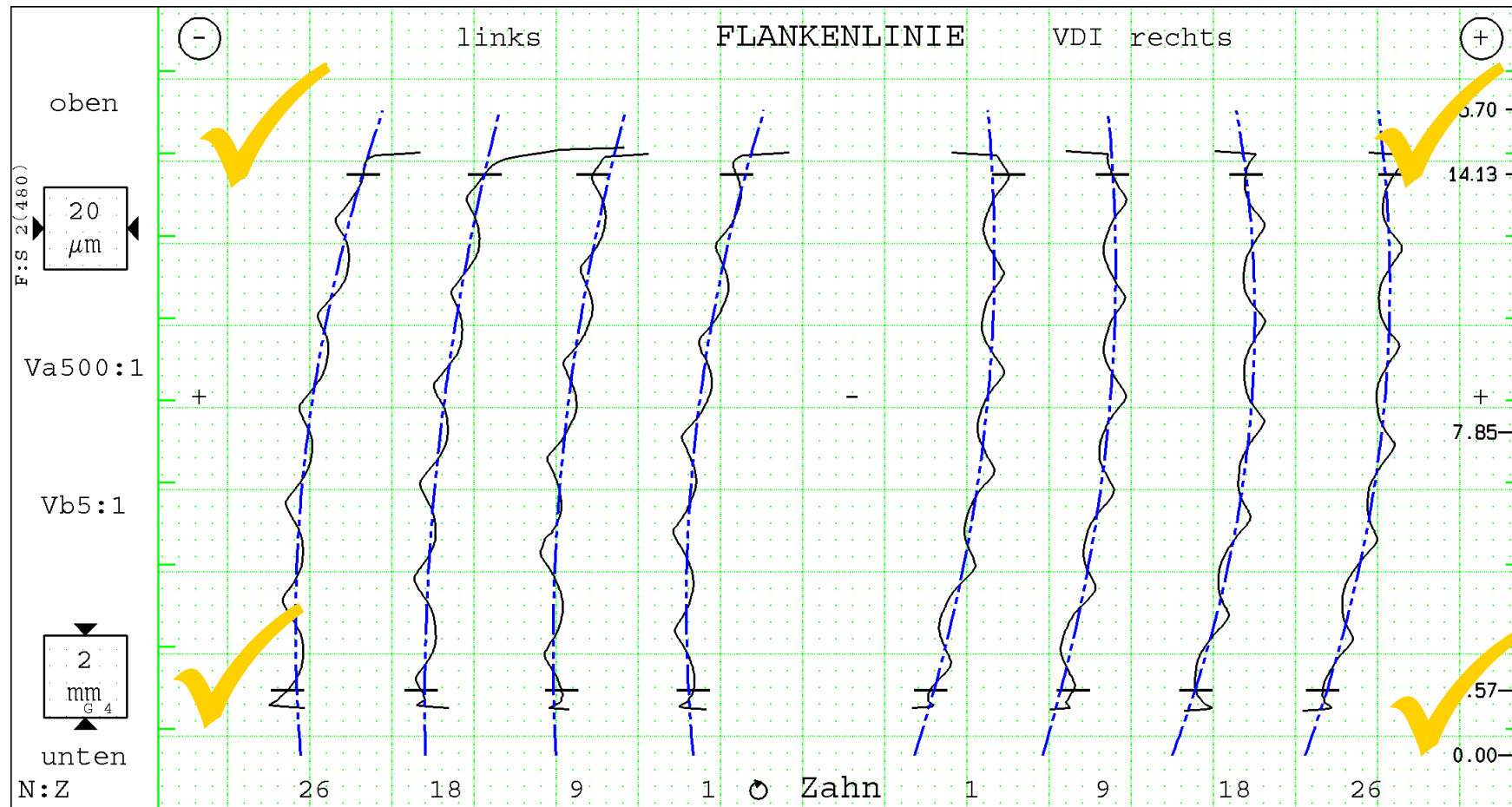


## Bottom (low interference)





# ChamferCut: Chamfering without deformations

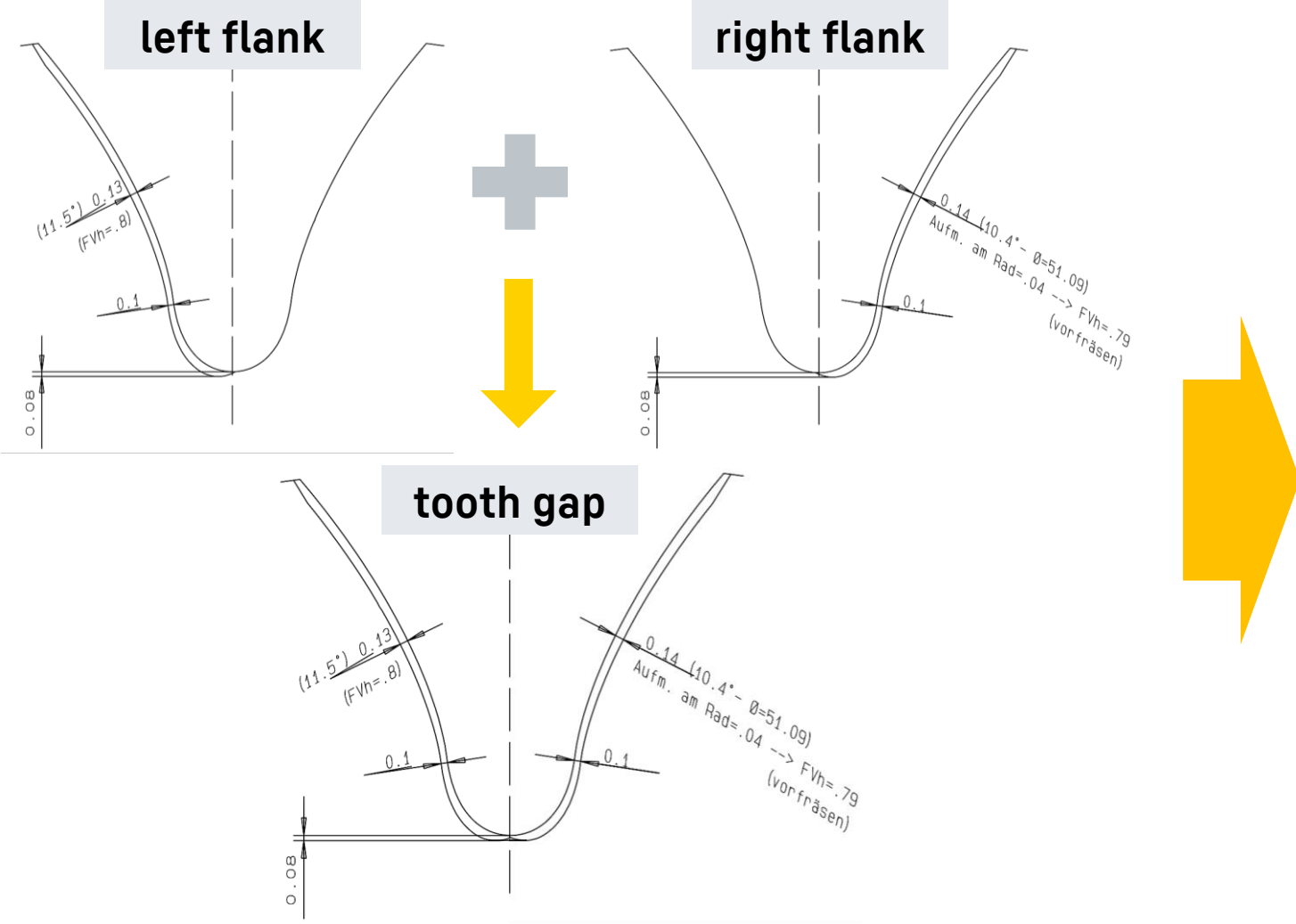


due to the cutting principle, there are no bulgings in the lead or deformations on the part

# Application example – Shaft



# ChamferCut CG – A new approach (2018)



# ChamferCut CG – Chamfering of Shafts





# ChamferCut CG – Application Examples

Speed Gear (Car)



Shaft (Truck)



Reference parts for all typical applications and high volume manufacturers

# ChamferCut CG – Chamfering despite interference contours



- new approach for chamfering with the ChamferCut principle despite interference contours
- one chamfering tool per each flank
- up to 4 tools on the arbor are possible
- wider applicability of the process
- just minimal longer chamfering times in the range of a few seconds
- very precise setup of the chamfers via CNC corrections

# What about volumes?

And what if my batch sizes do not allow part specific chamfering tools?



LIEBHERR

LIEBHERR

LD 280 C

5679

LIEBHERR

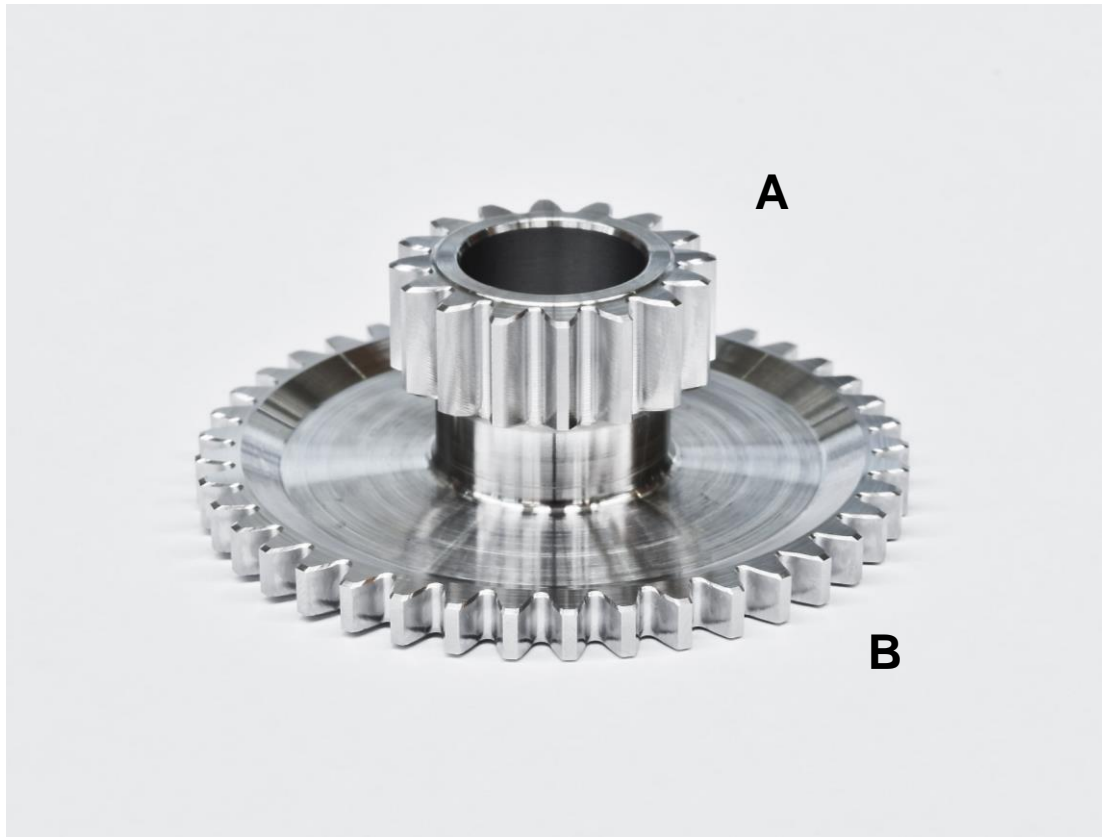
LD 280 C

LIEBHERR

# Application Example – Planetary Gear



## Planetary gear



## Workpiece

	A	B	
– Module	1.635	1.57	mm
– Number of teeth	16	41	
– Pressure angle	22°	22°	
– Helix angle	0°	0°	
– Tip diameter	30.1	66.7	mm
– Tooth width	11.5	5.0	mm
– Material	32CDV12		
– Tensile strength	1,270 N/mm <sup>2</sup>		
– Finish skiving			

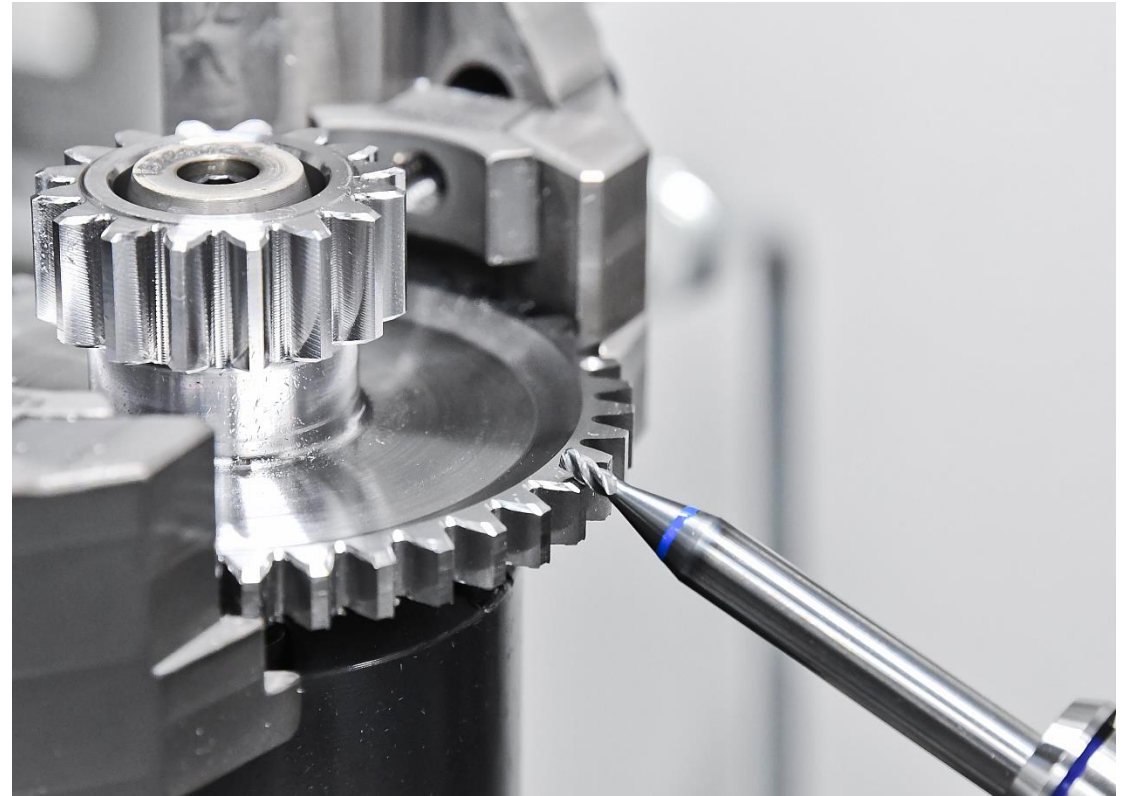
# FlexChamfer – Skiving and Chamfering time-parallel



gear A



gear B



**CNC-controlled and flexible chamfering of two gears in one clamping setup**

# FlexChamfer – Stepped Pinion (Aerospace)

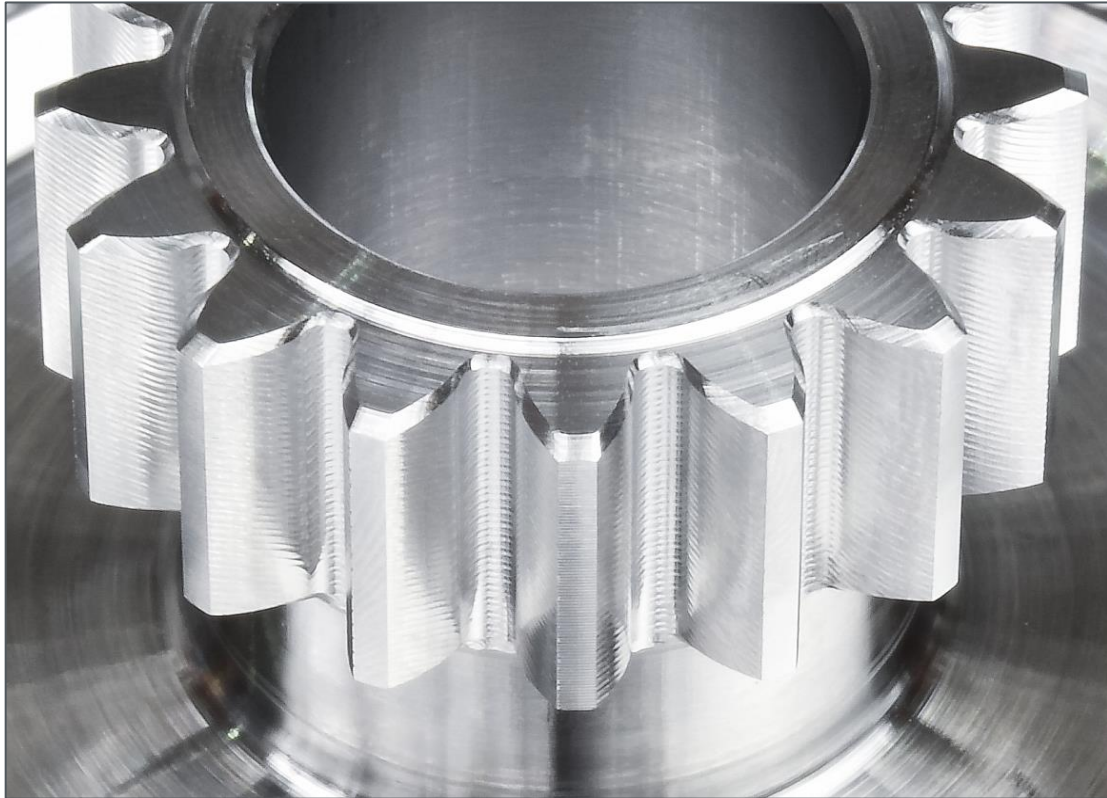


**FlexChamfer: precise chamfers with stock tools (also applicable on collision gears)**

# FlexChamfer – Chamfer Formation (Form)



gear A (top)



gear B (top)



**precise and flexible chamfering with standard tools**



# LH GearTec – Dedicated HMI for FlexChamfer (workpiece geometry)

eWON VPN router not present! 2  
3/8/2023 4:23 PM → 830-0351 VZ 13 Maintenance

Workpieces > W-Proberad-m2.7-Flexchamfern

Check Activate **Graphic** Information Printing Production

Header data *	Geometry	Expanded geometry	Determining dimensions finished part	Position dependency
Workpiece *	Radius im Fuß		Full rounding radius	
Automation	Interfering contour(s)		None	
Parameter set switchover	Case distinction for parameterization		Case A	
Cylindrical gear	Definition of the front sides to be deburred			
• Geometry	Tip diameter	$d_{a2}$ mm	130	
Profile modifications	Width of the gear body	$b_2$ mm	29.5	
Tooth trace modifications	Diameter up to the start of the chamfer – gearing top edge	mm	113.5	
Gear skiving	Diameter up to the start of the chamfer – gearing bottom edge	mm	114	
Cuts	Radius from the horizontal transverse face to the shaft – gearing top edge	mm	0	
Wear	Radius from the horizontal transverse face to the shaft – gearing bottom edge	mm	0	
Corrections	Radius of the chamfer – gearing top edge	mm	Optional	
Position detection additional machining	Radius of the chamfer – gearing bottom edge	mm	Optional	
FlexChamfer top OperatorSide	Starting angle of the chamfer, with respect to the horizontal transverse face – gearing top edge	°	15	
Cuts	Starting angle of the chamfer, with respect to the horizontal transverse face – gearing bottom edge	°	0	
Wear				
FlexChamfer bottom OperatorSide				
Cuts				

Cancel Save

# LH GearTec – Dedicated HMI for FlexChamfer (root fillet)

4/28/2023 11:56 AM → W-ABTRIEBSWELLE\_Test\_Flex\_WF-ET (<MLimAsWrngEnable>)

Workpieces > W-ABTRIEBSWELLE\_Test\_Flex\_WF-ET

Check Activation **Graphic** Information Printing Production

Header data

Geometry Expanded geometry Determining dimensions Finished part Position dependency

FlexChamfer

Radius im Fuß	Full rounding radius
Interfering contour(s)	None
Case distinction for parameterization	Case A - parallel front sides

Definition of the front sides to be deburred

Tip diameter	$d_{a2}$ mm	169
Width of the gear body	$b_2$ mm	83.5
Diameter up to the start of the chamfer - gearing top edge	mm	159.3
Diameter up to the start of the chamfer - gearing bottom edge	mm	159.3
Radius from the horizontal transverse face to the shaft - gearing top edge	mm	0
Radius from the horizontal transverse face to the shaft - gearing bottom edge	mm	0
Radius of the chamfer - gearing top edge	mm	Optional
Radius of the chamfer - gearing bottom edge	mm	Optional
Starting angle of the chamfer, with respect to the horizontal transverse face - gearing top edge	°	0
Starting angle of the chamfer, with respect to the horizontal transverse face - gearing bottom edge	°	0

# LH GearTec – Dedicated HMI for FlexChamfer (chamfer geometry)

3/8/2023 4:25 PM → 830-0351 VZ 13 Maintenance

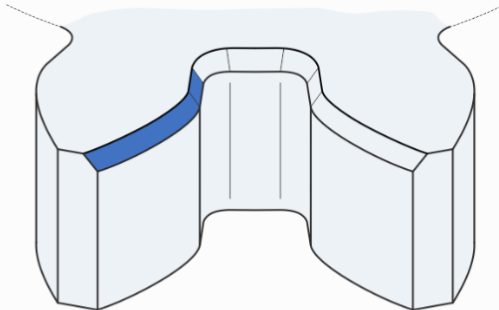
Workpieces > W-Proberad-m2.7-Flexchamfern

Check Activate **Graphic** Information Printing Production

Header data \* FlexChamfer top OperatorSide \* Chamfer geometry Process information Corrections

Workpiece Automation Parameter set switchover Cylindrical gear \* Geometry Profile modifications Tooth trace modifications Gear skiving Cuts Wear Corrections Position detection additional machining FlexChamfer top OperatorSide Cuts Wear FlexChamfer top OperatorSide \* Cuts

Create left chamfer	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Create right chamfer	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Root deburred	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Chamfer angle (at V-circle)	Left chamfer: 45°	Right chamfer: 45°
Chamfer width	mm: 0.5	mm: 0.5
Chamfer width in the root	mm: 0.2	
Representation of the generated chamfer		
Chamfer depth at the tip form circle (cylindrical section direction)	Left chamfer: mm: 0.43	Right chamfer: mm: 0.71
Chamfer depth at the V-circle (cylindrical section direction)	mm: 0.46	mm: 0.98
Chamfer depth at the root form diameter (cylindrical section direction)	mm: 0.26	mm: 0.91
Chamfer angle (at V-circle) (cylindrical section direction)	°: 41.75	°: 41.75
Chamfer width minimum	mm: 0.5	mm: 0.5
Chamfer width in the root	mm: -0.16	



Cancel Save

# LH GearTec – Dedicated HMI for FlexChamfer (tool data)

3/8/2023 4:24 PM → 830-0351 VZ 13 Maintenance M

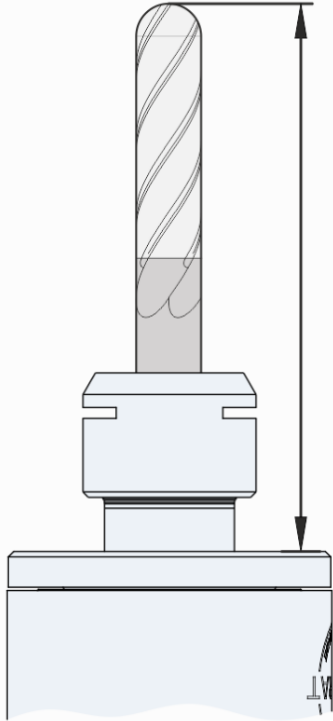
Workpieces > W-Proberad-m2.7-Flexchamfern > Schaftfraeser 202392 D3(1)

Graphic Information Printing Production

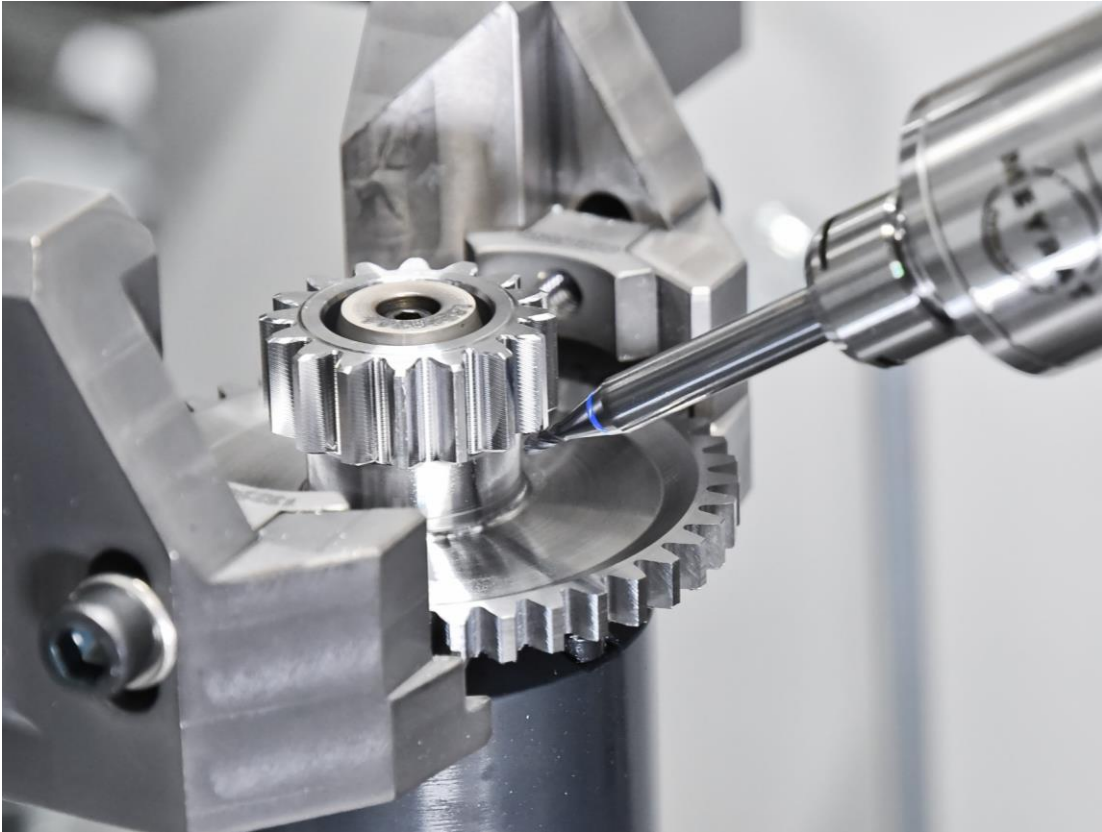
Header data

- Tool

Shank hob shape	Cylindrical
Extended length	mm 41.35
Cutting edge length	mm 8
Number of cutting edges	3
Direction of cut	Right
Hob diameter	mm 3
Tip radius	mm 0



# FlexChamfer - Summary



- Flexible solution especially for external gears with interference contours or internal gears
- Consistent chamfer width from tip to the root
- Time parallel chamfering for hobbing, shaping or skiving
- Generation of variable chamfer shapes with CNC technology
- Use of standard end mills (stock tools)



**Workpieces leave the machine burr-free with a defined chamfer. This is unique!**

# HMI & Software



LHStation & LHMobile

## New Liebherr Panel

- **Flexible mount** for cabinet integration or installation on an external bracket (depending on machine type)
- **8 freely configurable buttons or key-switches** for custom-extensions
- **Context-sensitive display** of PLC/NC keys and machine/program states
- Portable **handheld terminal** as a **standard** component

## LHStation



- New GUI surface **LHGearTec**
- **24" Touch Monitor**
- **2 USB Ports** for flexible data Import Export
- **Reduced tactile switches** (NC-Start/Stop, hand wheel) for fast access
- **Tactile numeric block** for fast input of tool und workpiece data
- **Cable-based transmission** for maximized safety

## LHMobile

LD 180/280 C provided for EATON - confidential use

**LIEBHERR**

LHStation & LHMobile

# New Liebherr Panel

## LHStation



## LHMobile

- Standardized **Operation Mode Switch** (EKS) with RFID chips for fast mode selection and user authentication



LHStation & LHMobile

# New Liebherr Panel



LC 280 DC

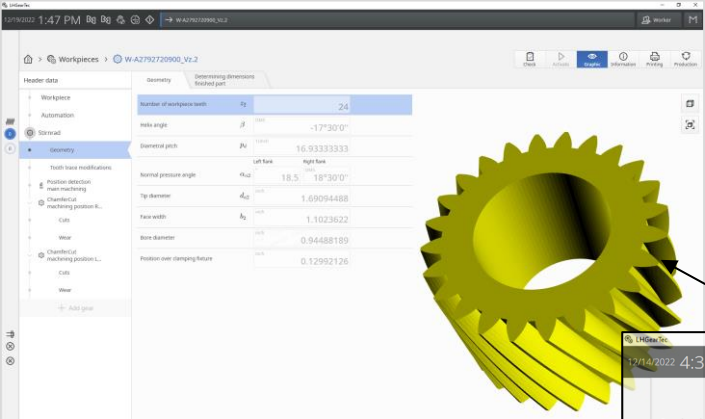


LGG 280

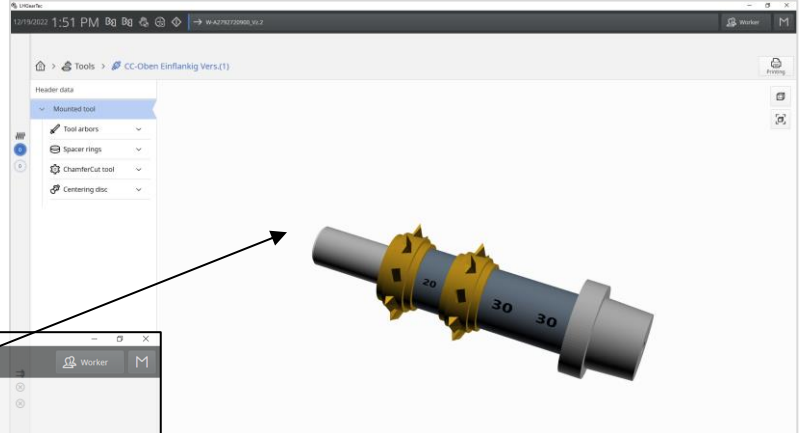
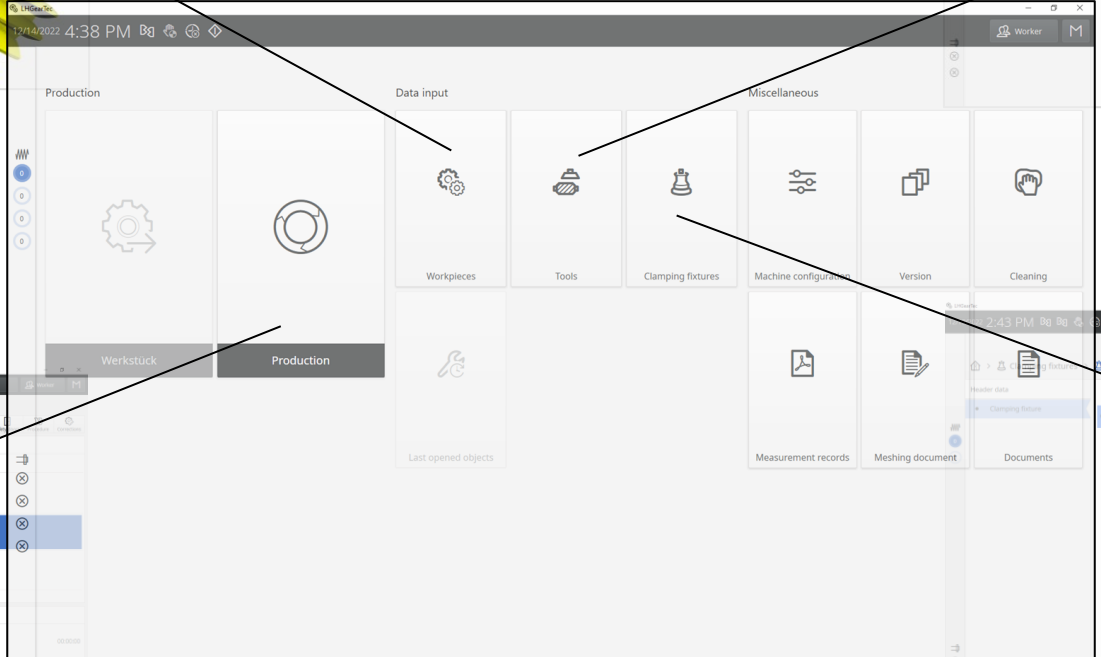


LD 180/280 C provided for EATON - confidential use

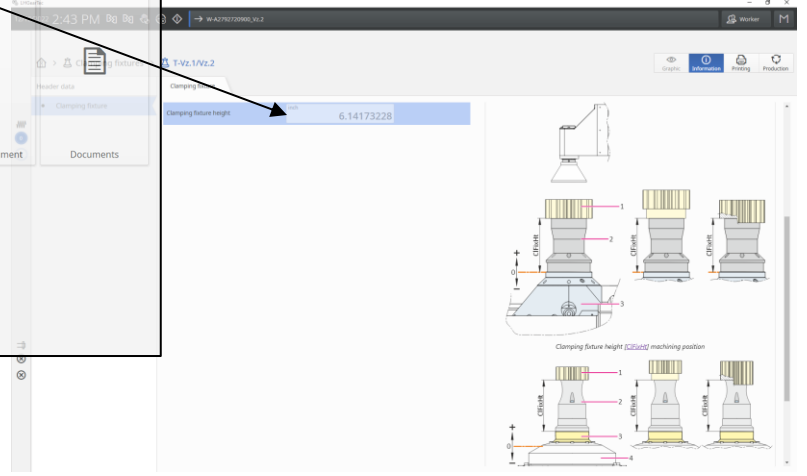
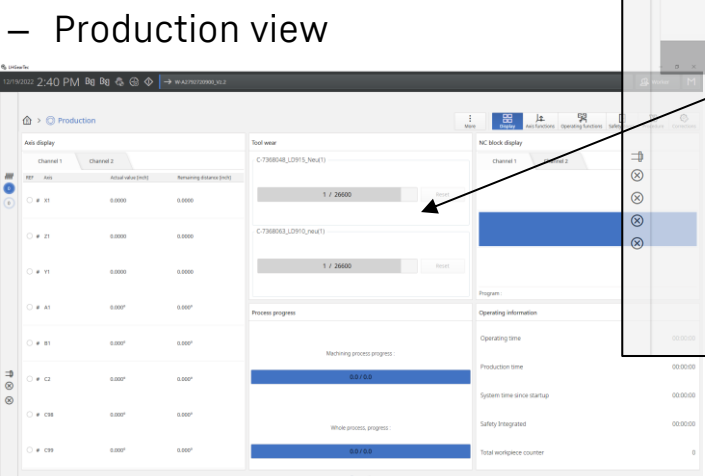
# LD 180 / 280 C with LHGearTec HMI



- Parametric workpiece data input
- Production view

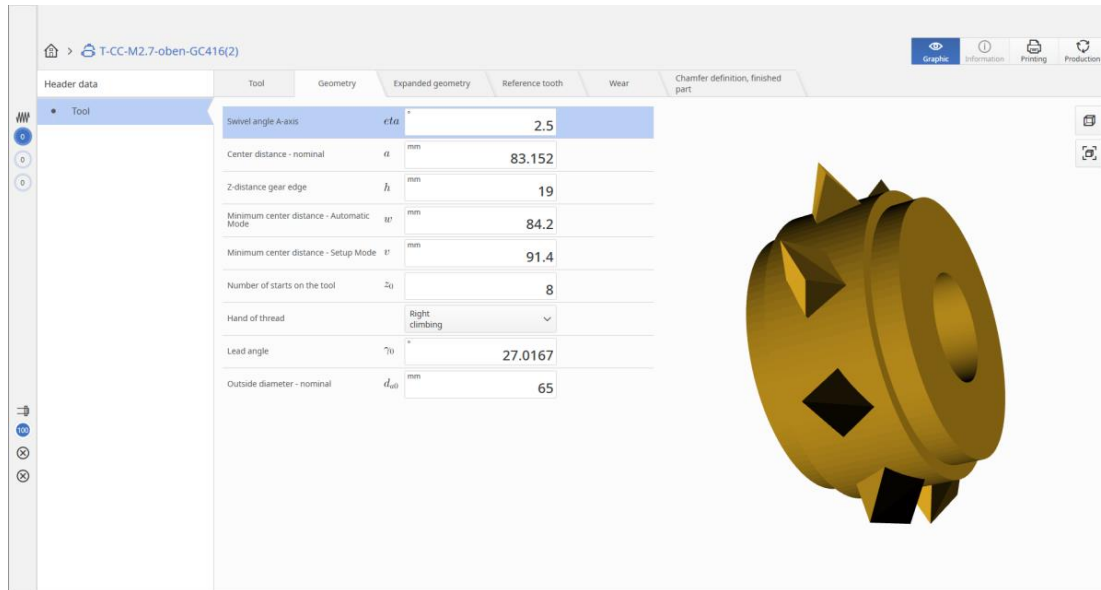


- Parametric tool definition
- Fixture definition



# User Interface (from Liebherr)

## HMI



The screenshot displays the Liebherr HMI software interface for tool setup. The interface is divided into several sections: a top navigation bar with icons for Graphic, Information, Printing, and Production; a left sidebar with a tree view; a central parameter table; and a 3D model of a gear with chamfered teeth on the right.

Parameter	Symbol	Unit	Value
Swivel angle A-axis	$\epsilon_{fa}$		2.5
Center distance - nominal	$a$	mm	83.152
Z-distance gear edge	$h$	mm	19
Minimum center distance - Automatic Mode	$a_{min}$	mm	84.2
Minimum center distance - Setup Mode	$a_{min}$	mm	91.4
Number of starts on the tool	$z_0$		8
Hand of thread		Right climbing	
Lead angle	$\gamma_0$		27.0167
Outside diameter - nominal	$d_{out}$	mm	65

For an easy machine setup, Liebherr provides a **special software** designed to apply FETTE ChamferCut tools.

The main features are:

- input data identical to FETTE setup chart
- automatic loading of the setup sheet (XML file)
- graphical support
- automatic chamfer correction based on measured width
- self-correcting setup data after resharpener

# Adjustment Possibilities - Basics

## Chamfer size

### X1-correction Chamfer [T]

Correction of chamfer size. With a positive correction value, chamfer gets smaller, with a negative bigger.

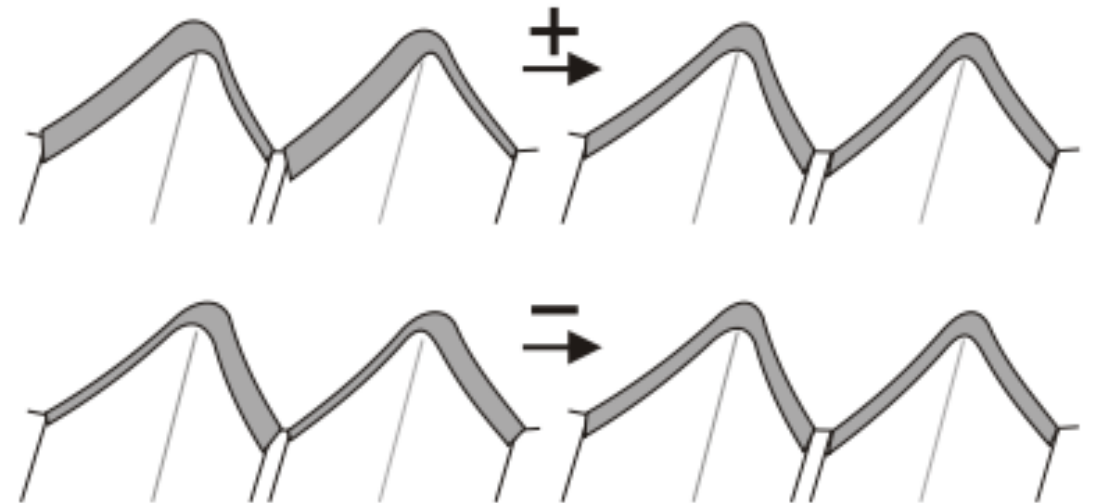


## Chamfer symmetry

### C2-Correction Chamfer [O]

Correction of chamfer symmetry (same width of left and right flank). With a positive correction value, chamfer width shifts to the right, with a negative value to the left side.

Corrections of the C2-axis are required after corrections on the A1-axis.



# Automatic Chamfer Correction

Production

Total

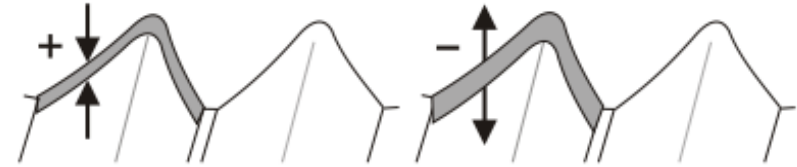
	Set point value	Current	Actual value, left	Actual value, right	Current	Set point value
Chamfer width	mm 0.83	mm (0) 0	mm (0.83) 0.83	mm (0.87) 0.87	mm 0	mm 0.87
Chamfer depth	mm	mm (0) 0	mm (0) 0	mm (0) 0	mm	mm

	Actual value
X-correction ChamferCut	mm (0) 0
Z-correction ChamferCut	mm (0.2) 0.2
C-correction ChamferCut	mm (-0.15) -0.15
Y-correction ChamferCut	mm (0) 0
A-correction ChamferCut	mm (0) 0

## Chamfer width

### Z1-correction Chamfer [T]

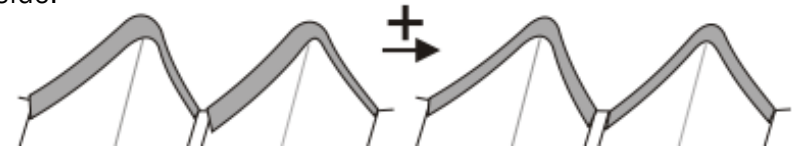
Correction of chamfer size. With a positive correction value, chamfer gets smaller, with a negative bigger.



## Chamfer symmetry

### C2-correction Chamfer [T]

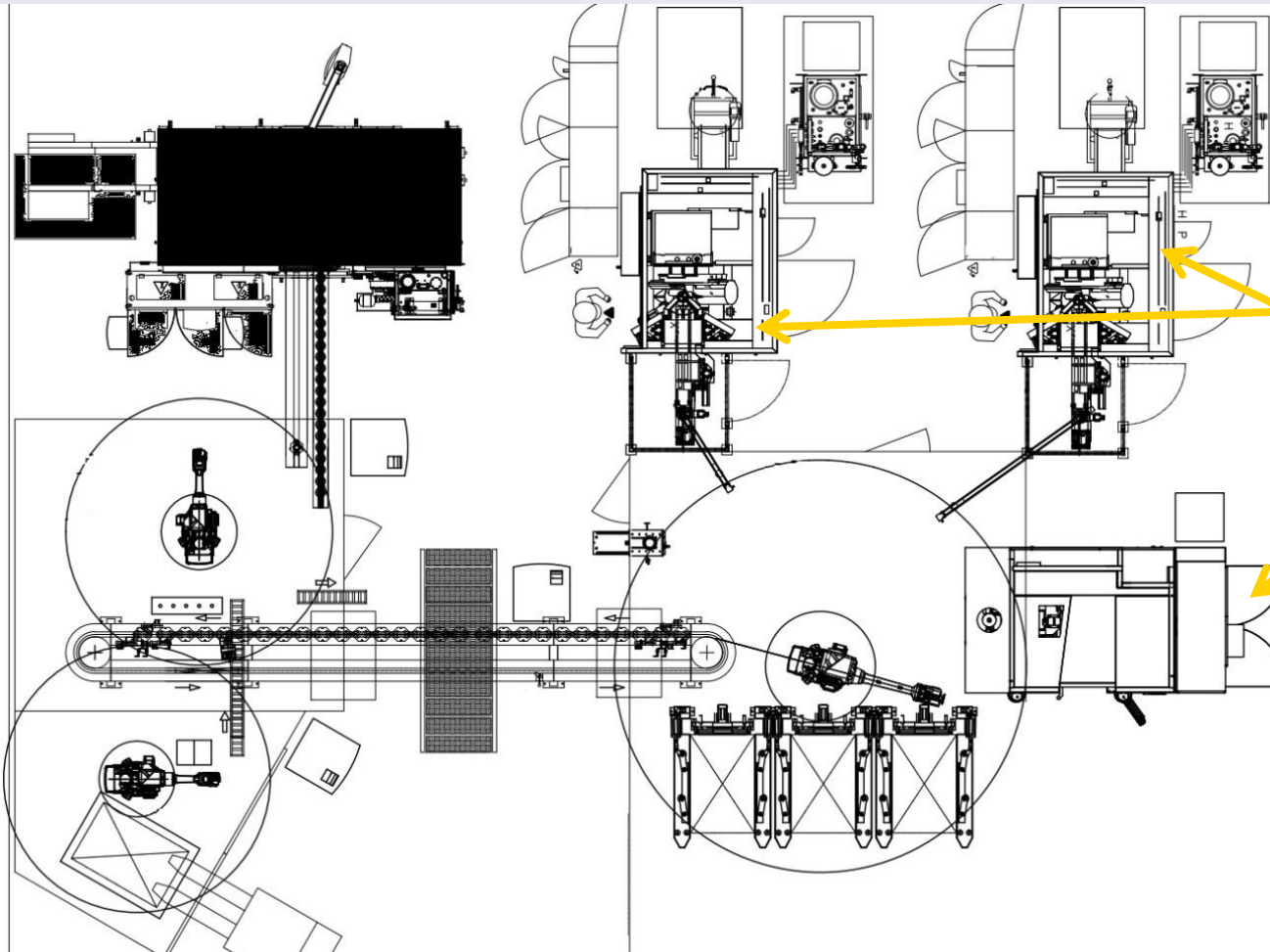
Correction of chamfer symmetry (same width of left and right flank). With a positive correction value, chamfer width shifts to the right, with a negative value to the left side.



chamfer corrections based on the measured chamfer width

## Layout of a Customer Solution

- already in use by an automotive manufacturer
- some more solutions are possible by automations from Liebherr



2 Hobbing  
MC's  
&  
1x LD 180 C

# Customer Solution: Integration in existing production environment



LD 180/280 C provided for EATON - confidential use

Integration of the ChamferCut solution in a cell layout

## Layout of a Customer Solution



LD 180/280 C provided for EATON - confidential use

**LIEBHERR**



Integration of the ChamferCut solution in a cell layout

## Layout of a Customer Solution





## Layout of a Customer Solution

# 08

# Automation

---

# Automation solutions for LD 180 / 280 C

**LD in combination with a conveyor**



**LD in combination with a robot solution (direct loading on machine table)**

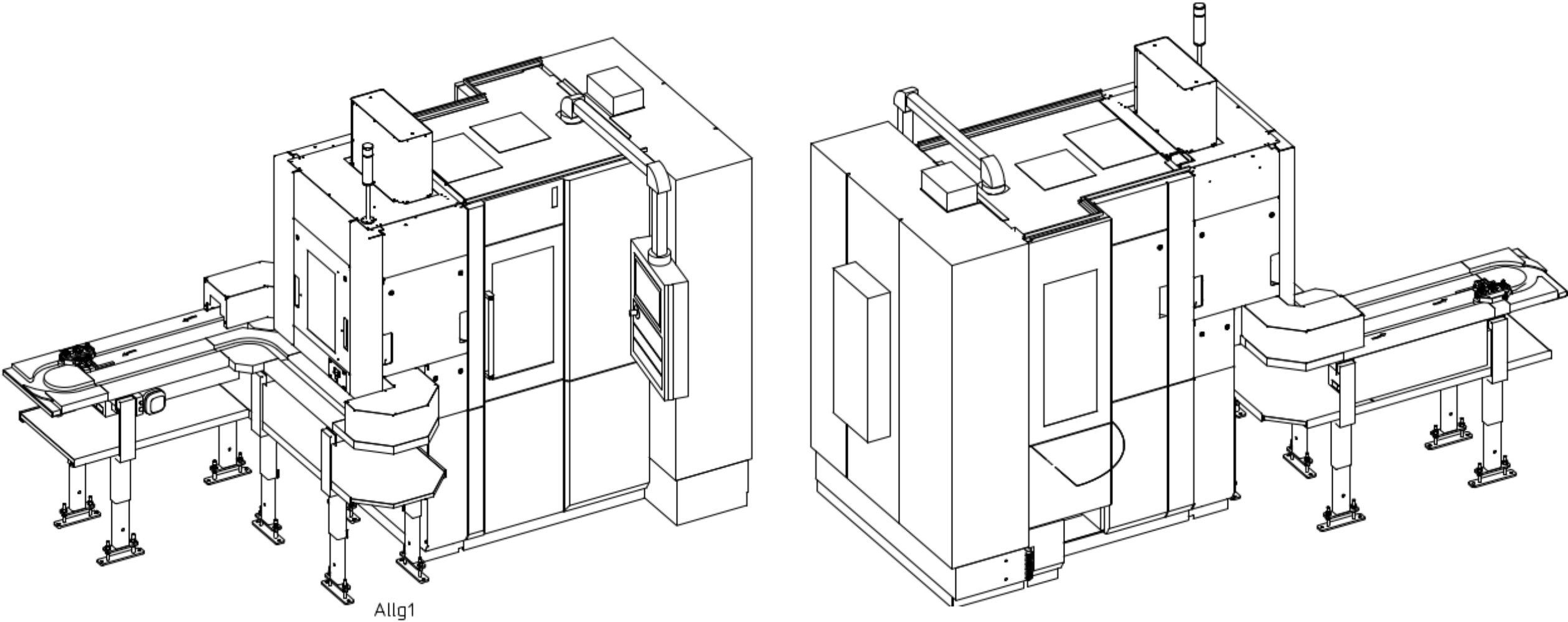


# Automation solutions for LD 180 / 280 C

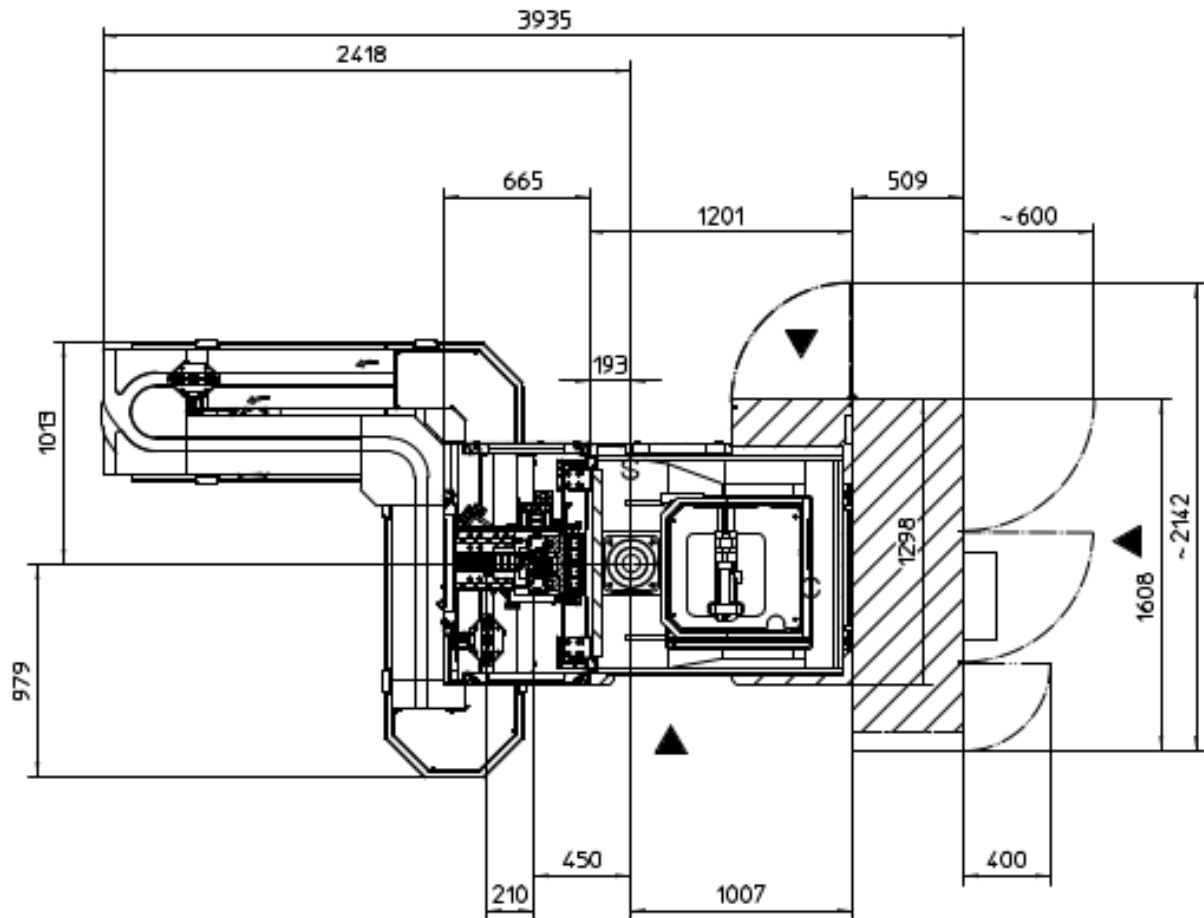


LD 180/280 C provided for EATON - confidential use

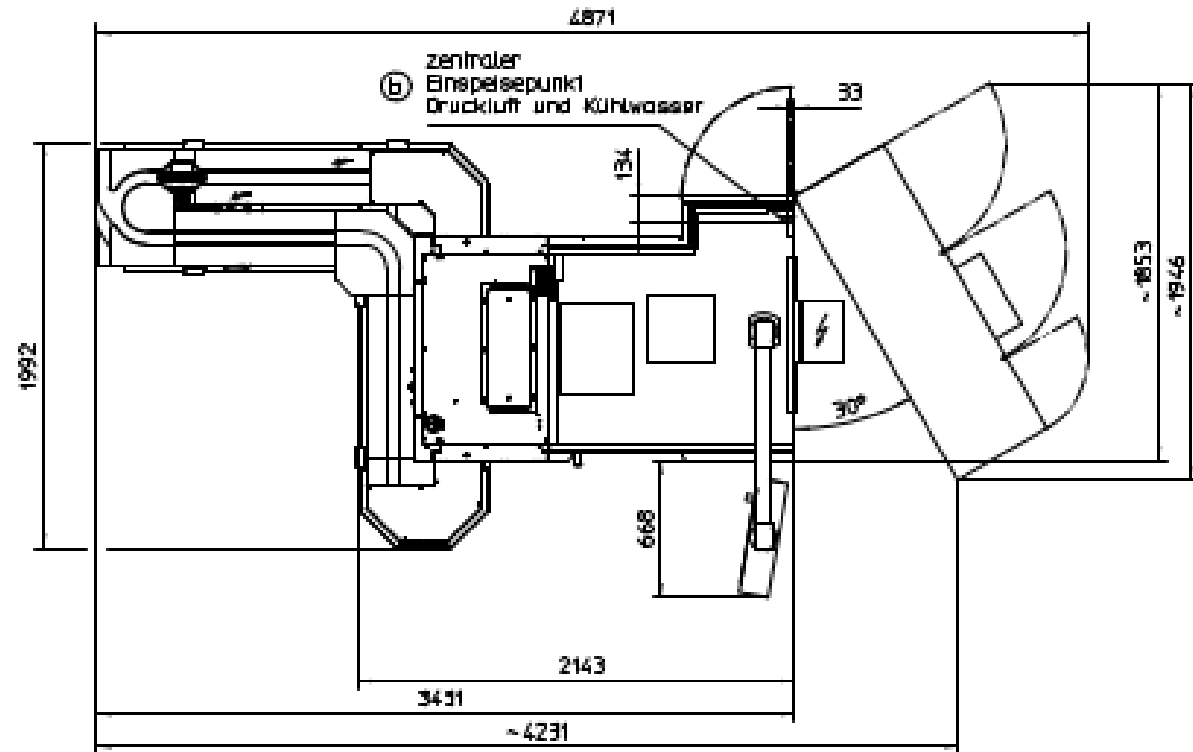
# LD 180/280 C with external conveyor solution



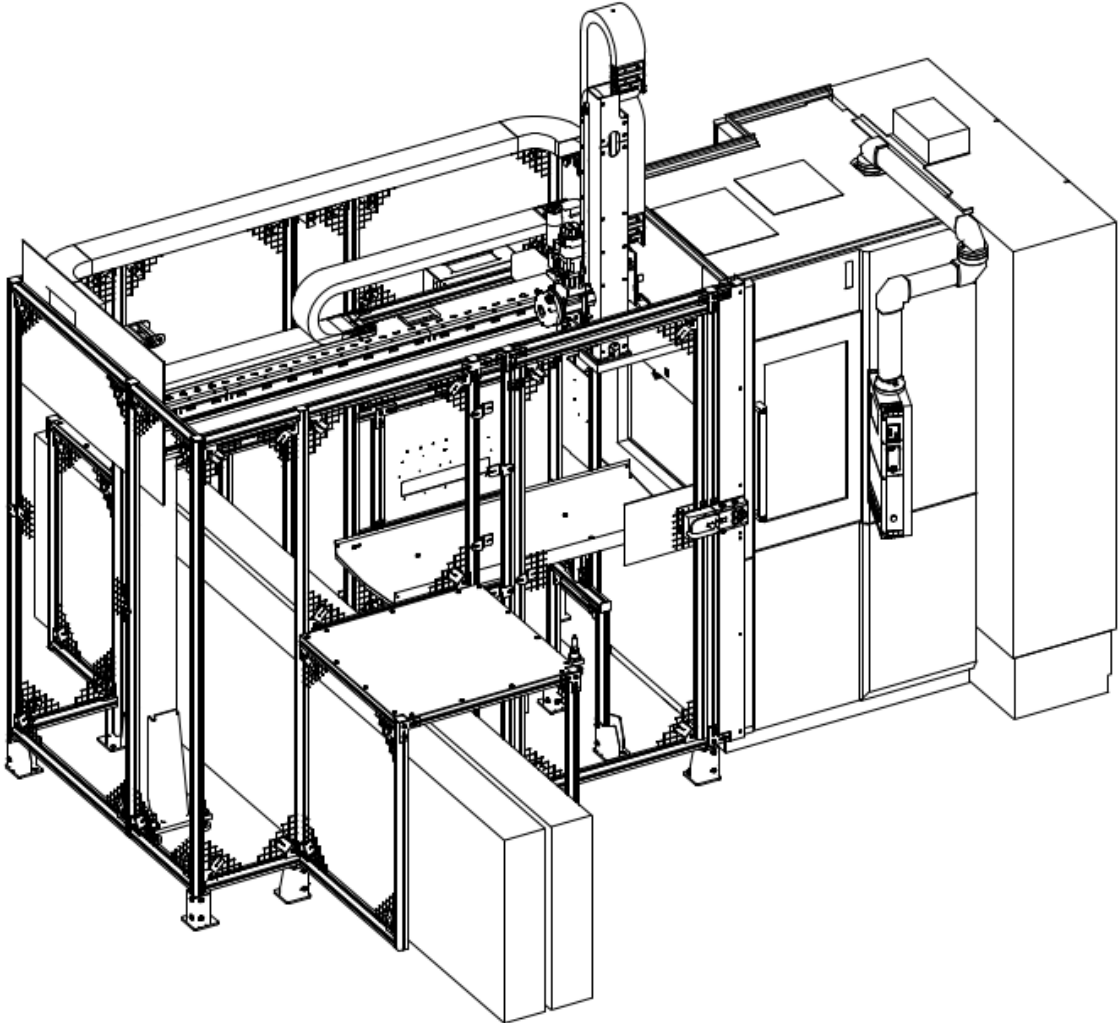
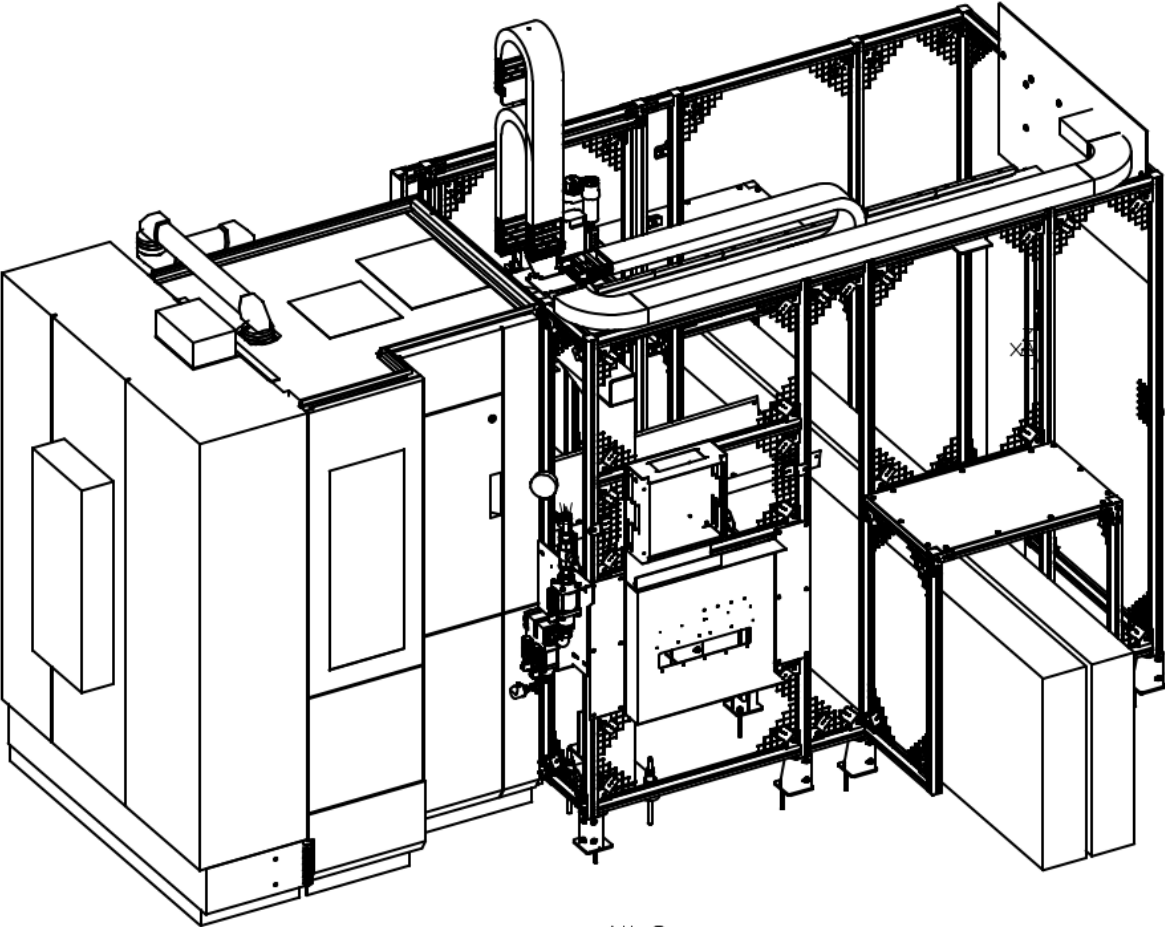
# LD 180/280 C with external conveyor solution



Druckluft  
compressed air  
DN 18  
4 - 6 bar  
500 - 800 l/min



# LD 180/280 C with pick & place unit





LD180 / 280 C

## LD 180 / 280 C



- higher performance (cycle time) & excellent chamfer-form (shape)
- high efficiency due to minimal tool costs per piece
- considerable small machine footprint
- fast, intelligent, flexible automation solution
- 10 years technology experience & successful customer application
- hook ready machine
- Liebherr product range:
  - Chamfer Cut on the tool-arbor (subsequent chamfering)
  - Chamfer Cut machine integrated (parallel chamfering)
  - Chamfer Cut „stand alone“ (retrofit-solution for actual production)

**Thank  
you.**

